UNIVERSITY OF MUMBAI

Teacher's Reference Manual

M. Sc (Information Technology)

(Choice Based Credit System with effect from the academic year 2019 – 2020)

PSIT1P2

Data Science Practical

Table of Contents

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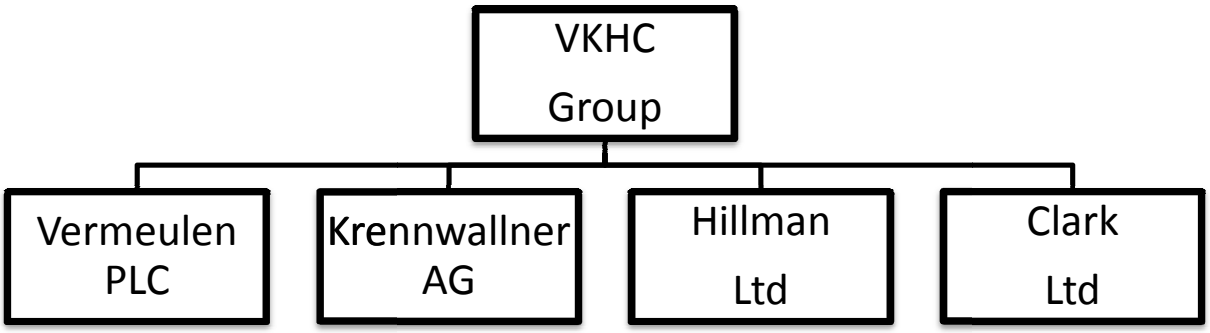
Prerequisites to Data Science Practical

Vermeulen-Krennwallner-Hillman-Clark Group (VKHCG) is a hypothetical medium-size international company. It consists of four subcompanies: Vermeulen PLC, Krennwallner AG, Hillman Ltd, and Clark Ltd.



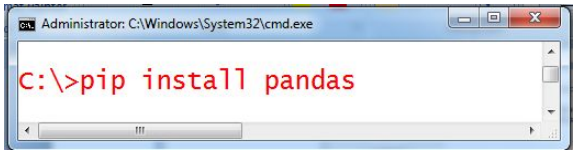
Vermeulen PLC is a data processing company that processes all the data within thegroup companies. The company handles allthe information technology aspects of the business.	**Krennwallner AG** is an advertising and media company that prepares advertising andmedia content for the customers of the group.	**The Hillman** company is a supply chain and logistics company.	**The Clark** company is a venture capitalist and accounting company .
The company supplies • Data science • Networks, servers, and communication systems • Internal and external web sites • Data analysis business activities • Decision science • Process automation • Management reporting	*The company supplies* • Advertising on billboards • Advertising and content management for online delivery • Event management for key customers	*The Company provisions* a worldwide supply chain solution to the businesses, including • Third-party warehousing • International shipping • Door-to-door logistics	*The Company processes* the following financial responsibilities of the group: • Financial insights • Venture capital management • Investments planning • Forex (foreign exchange) trading

Software requirements:

- R-Console 3.XXX or Above
- R Studio 1.XXX or above
- Python 2.7 for Cassandra and 3.XXX or above

- While installing Python check the option to Add Python to PATH Variable

- Open CMD in Administrative Mode

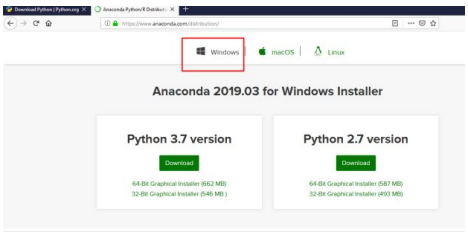


- Similarly install the following packages using pip

1.	matplotlib	**8.**	datetime	**15.**	sqlalchemy
2.	numpy	**9.**	json	**16.**	sql.connector
3.	opencv-python	**10.**	msgpack	**17.**	geopandas
4.	networkx	**11.**	scipy	**18.**	quandl
5.	sys	**12.**	geopy	**19.**	mlxtend
6.	uuid	**13.**	pysqlite3	**20.**	folium
7.	pyspark	**14.**	openpyxl		

Packages can also be installed using Anaconda

- Download Anaconda from https://www.anaconda.com and visit downloads tab.
- In the downloads page, scroll down until you see the download options for windows. **Click on the download button for python 3.7**. This will initiate a download for the **anaconda installer**.



- Follow through the instructions for installing as shown in the next few images. Choose any destination folder according to your liking and uncheck "**Add anaconda to my PATH environment variable**."

- Apache Cassandra https://downloads.datastax.com/#ddacs
- There is a dependency on the Visual C++ 2008 runtime (32bit), but Windows 7 and Windows 2008 Server R2 has it already installed. Download it from: http://www.microsoft.com/download/en/details.aspx?displaylang=en&id=29
- JDK 1.8
- Sypder

If Working on Windows OS, create a Directory C:/VKHCG.

R Packages

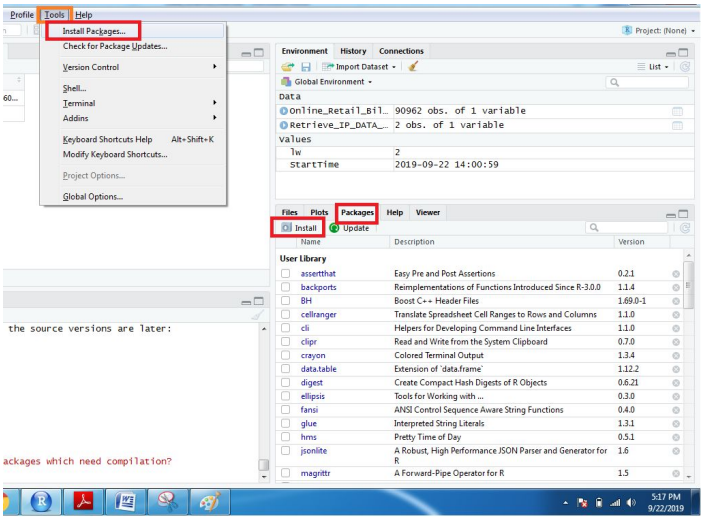
- R- Studio

  R – Studio:

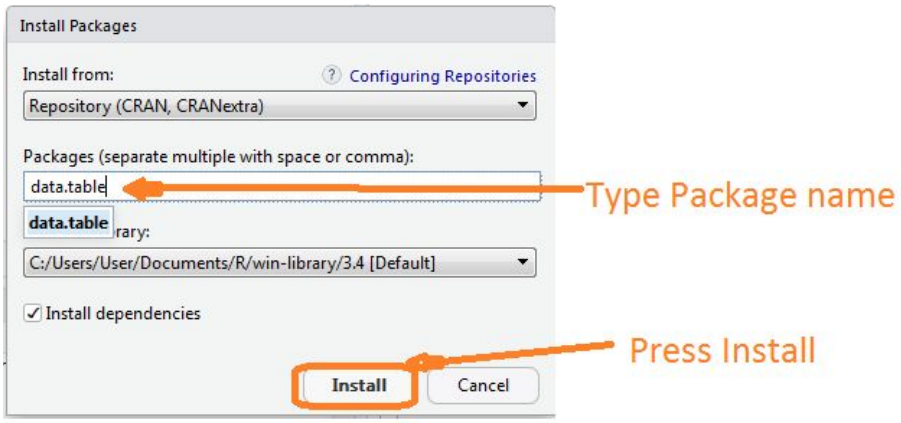
  Go to Tools → Install Packages

  OR

  Select Install tab from Package Tab



Then type the package name in package text field



  - Install following package
    - Data.Table Package
    - ReadR Package
    - JSONLite Package
    - Ggplot2 Package
    - Sparklyr Package
    - Tibble package

- R – Console

  Use the following command:

- install.packages ("data.table")
- install.packages("readr")
- install.packages ("jsonlite")
- install.packages("ggplot2")
- install.packages("sparklyr")
- install.packages("tibble")

Sample Data

The following data is for the examples in
Type of file: Comma-separated values (CSV)

1. IP Addresses Data Sets

Location:VKHCG\01-Vermeulen\00-RawData

Data file: IP_DATA_C_VKHCG.csv	No. of Record: 255
Data file: IP_DATA_ALL.csv	No. of Records: 1,247,502
Data file: IP_DATA_CORE.csv	No. of Records: 3,562

2. Customer Data Sets

Location: VKHCG\ 02-Krennwallner\00-RawData

Data file: DE_Billboard_Locations.csv	No. of Records: 8,873

3. Logistics Data Sets

Location: VKHCG\03-Hillman\00-RawData

Data file: GB_Postcode_Full.csv	No. of Records: 1,714,591
Data file: GB_Postcode_Warehouse.csv	No. of Records: 3,005
Data file: GB_Postcodes_Shops.csv	No. of Records: 1,048,575

4. Exchange Rate Data Set

Location: VKHCG\04-Clark\00-RawData

Data file: Euro_ExchangeRates.csv	No. of Records: 4,697

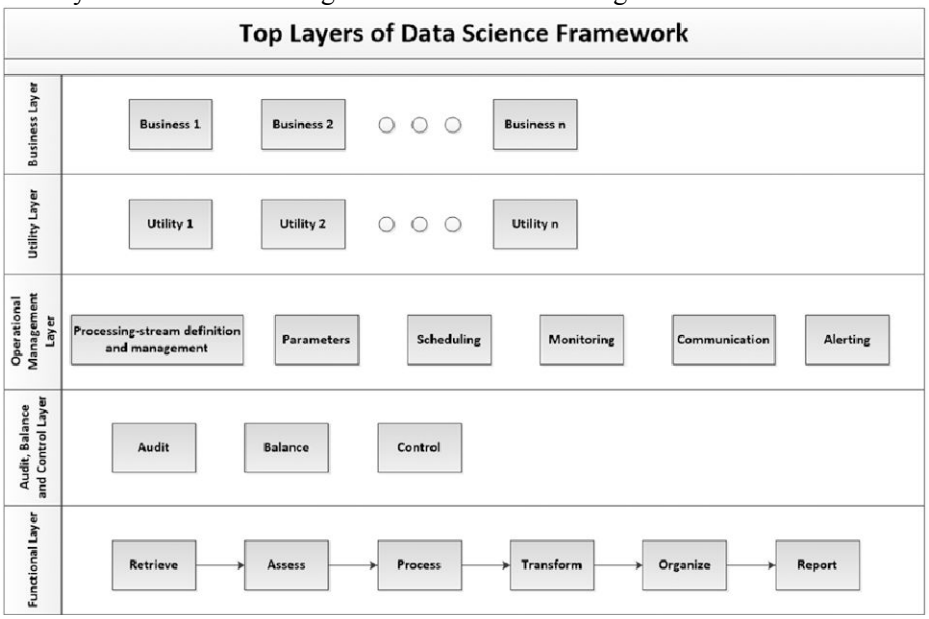
5. Profit-and-Loss Statement Data Set

Location: VKHCG\04-Clark\00-RawData

Data file: Profit_And_Loss.csv	No. of Records: 2,442

Data Science Framework

Data science is a series of discoveries. Build a basic framework that can be used for your data processing. This will enable to construct a data science solution and then easily transfer it to your data engineering environments.The layered framework is engineered with the following structures.



1. The Business Layer
2. The Utility Layer
3. The Operational Management Layer
4. The Audit, Balance, and Control Layer
5. The Functional Layer

5.1 *Data models*

5.2 *Processing algorithms*

Processing algorithm example is spread across six supersteps:

5.2.1 ***Retrieve*:** This super step contains all the processing chains for retrieving data from the raw data lake via a more structured format.

5.2.2 ***Assess*:** This superstep contains all the processing chains for quality assurance and additional data enhancements.

5.2.3 ***Process*:** This superstep contains all the processing chains for building the data vault.

5.2.4 ***Transform*:** This superstep contains all the processing chains for building the data warehouse.

5.2.5 ***Organize*:** This superstep contains all the processing chains for building the data marts.

5.2.6 ***Report*:** This superstep contains all the processing chains for building virtualization and reporting the actionable knowledge.

5.3 *Provisioning of infrastructure.*

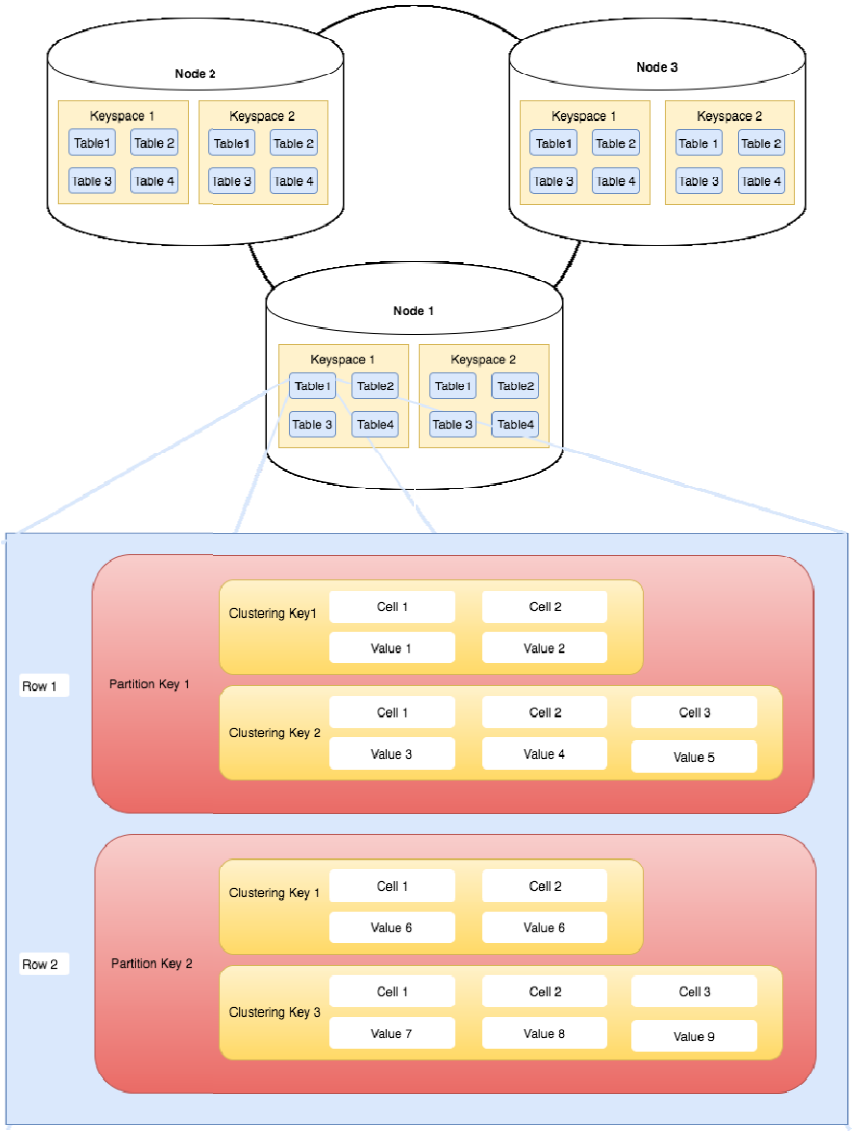
Practical 1:

Creating Data Model using Cassandra.

Cassandra Data Model

Cluster

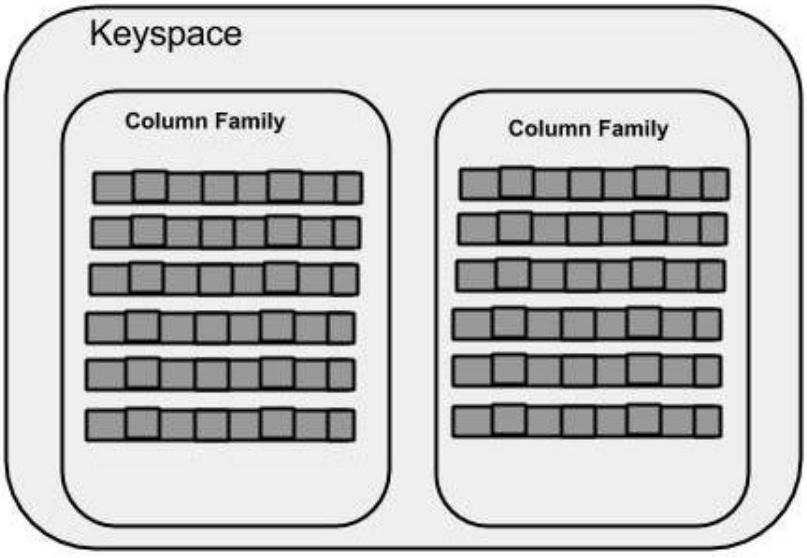
Cassandra database is distributed over several machines that operate together. The outermost container is known as the Cluster. For failure handling, every node contains a replica, and in case of a failure, the replica takes charge. Cassandra arranges the nodes in a cluster, in a ring format, and assigns data to them.



Keyspace

Keyspace is the outermost container for data in Cassandra. The basic attributes of a Keyspace in Cassandra are −

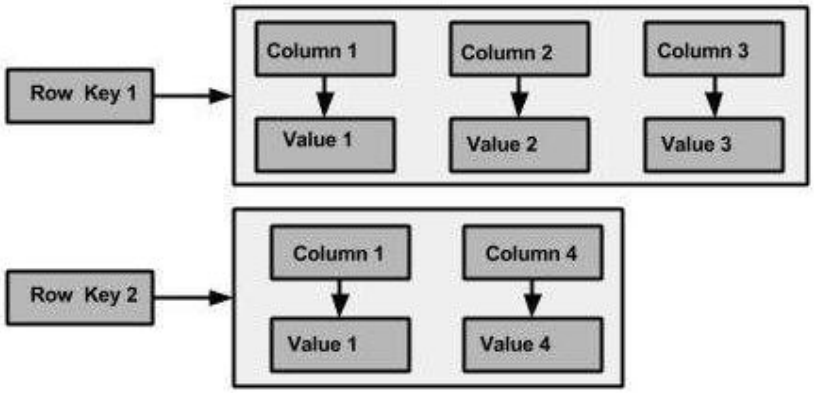
- **Replication factor** − It is the number of machines in the cluster that will receive copies of the same data.
- **Replica placement strategy** − It is nothing but the strategy to place replicas in the ring. We have strategies such as **simple strategy** (rack-aware strategy), **old network topology strategy** (rack-aware strategy), and **network topology strategy** (datacenter-shared strategy).
- **Column families** − Keyspace is a container for a list of one or more column families. A column family, in turn, is a container of a collection of rows. Each row contains ordered columns. Column families represent the structure of your data. Each keyspace has at least one and often many column families.



Column Family

A column family is a container for an ordered collection of rows. Each row, in turn, is an ordered collection of columns. The following table lists the points that differentiate a column family from a table of relational databases.

Relational Table	Cassandra column Family
A schema in a relational model is fixed. Once we define certain columns for a table, while inserting data, in every row all the columns must be filled at least with a null value.	In Cassandra, although the column families are defined, the columns are not. You can freely add any column to any column family at any time.
Relational tables define only columns and the user fills in the table with values.	In Cassandra, a table contains columns, or can be defined as a super column family.



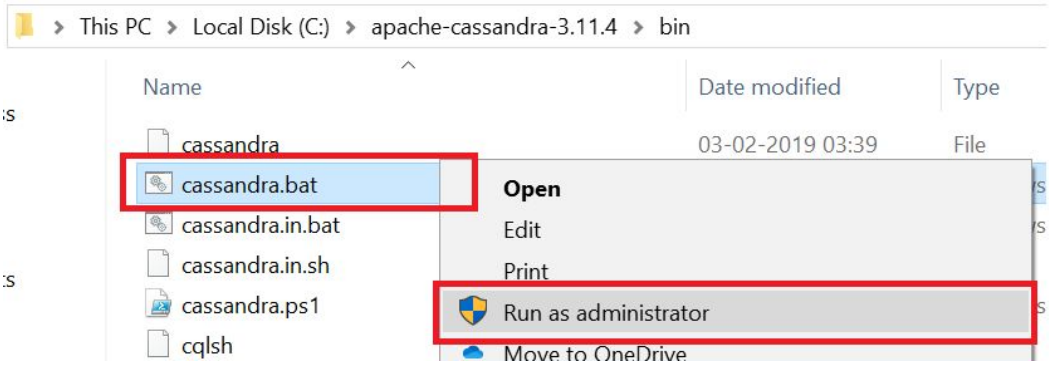
Data Models of Cassandra and RDBMS

RDBMS	Cassandra
RDBMS deals with structured data.	Cassandra deals with unstructured data.
It has a fixed schema.	Cassandra has a flexible schema.
In RDBMS, a table is an array of arrays. (ROW x COLUMN)	In Cassandra, a table is a list of "nested key-value pairs". (ROW x COLUMN

	key x COLUMN value)
Database is the outermost container that contains data corresponding to an application.	Keyspace is the outermost container that contains data corresponding to an application.
Tables are the entities of a database.	Tables or column families are the entity of a keyspace.
Row is an individual record in RDBMS.	Row is a unit of replication in Cassandra.
Column represents the attributes of a relation.	Column is a unit of storage in Cassandra.
RDBMS supports the concepts of foreign keys, joins.	Relationships are represented using collections.

Go to Cassandra directory

C:\apache-cassandra-3.11.4\bin



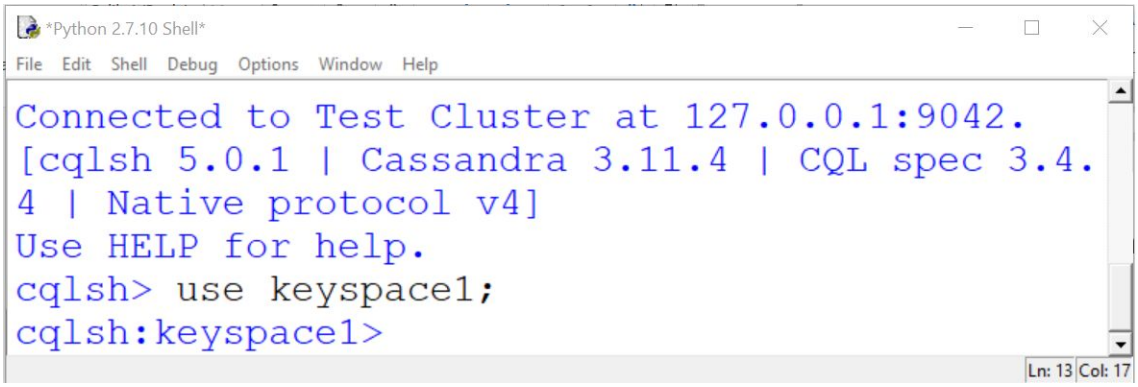
Run Cassandra.bat file

Open C:\apache-cassandra-3.11.4\bin\cqlsh.py with python 2.7 and run

Creating a Keyspace using Cqlsh

Create keyspace keyspace1 with replication = {'class':'SimpleStratergy', 'replication_factor': 3};

Use keyspace1;



Create table dept (dept_id int PRIMARY KEY, dept_name text, dept_loc text);

Create table emp (emp_id int PRIMARY KEY, emp_name text, dept_id int, email text, phone text);

Insert into dept (dept_id, dept_name, dept_loc) values (1001, 'Accounts', 'Mumbai');

Insert into dept (dept_id, dept_name, dept_loc) values (1002, 'Marketing', 'Delhi');

Insert into dept (dept_id, dept_name, dept_loc) values (1003, 'HR', 'Chennai');

Insert into emp (emp_id, emp_name, dept_id, email, phone) values (1001, 'ABCD', 1001, 'abcd@company.com', '1122334455');

Insert into emp (emp_id, emp_name, dept_id, email, phone) values (1002, 'DEFG', 1001, 'defg@company.com', '2233445566');

Insert into emp (emp_id, emp_name, dept_id, email, phone) values (1003, 'GHIJ', 1002, 'ghij@company.com', '3344556677');

Insert into emp (emp_id, emp_name, dept_id, email, phone) values (1004, 'JKLM', 1002, 'jklm@company.com', '4455667788');

Insert into emp (emp_id, emp_name, dept_id, email, phone) values (1005, 'MNOP', 1003, 'mnop@company.com', '5566778899');

Insert into emp (emp_id, emp_name, dept_id, email, phone) values (1006, 'MNOP', 1003, 'mnop@company.com', '5566778844');

```
cqlsh:keyspace1> select * from emp;

 emp_id | dept_id | email              | emp_name | phone
--------+---------+--------------------+----------+------------
   1006 |    1003 | mnop@company.com |     MNOP | 5566778844
   1004 |    1002 | jklm@company.com |     JKLM | 4455667788
   1005 |    1003 | mnop@company.com |     MNOP | 5566778899
   1001 |    1001 | abcd@company.com |     ABCD | 1122334455
   1003 |    1002 | ghij@company.com |     GHIJ | 3344556677
   1002 |    1001 | defg@company.com |     DEFG | 2233445566

(6 rows)
```

```
cqlsh:keyspace1> select * from dept;

 dept_id | dept_loc | dept_name
---------+----------+-----------
    1001 |   Mumbai |  Accounts
    1003 |  Chennai |         HR
    1002 |    Delhi | Marketing

(3 rows)
```

update dept set dept_name='Human Resource' where dept_id=1003;

```
cqlsh:keyspace1> select * from dept;

 dept_id | dept_loc | dept_name
---------+----------+----------------
    1001 |   Mumbai |       Accounts
    1003 |  Chennai | Human Resource
    1002 |    Delhi |      Marketing

(3 rows)
```

```
cqlsh:keyspace1> delete from emp where emp_id=1006;
cqlsh:keyspace1> select * from emp;

 emp_id | dept_id | email              | emp_name | phone
--------+---------+--------------------+----------+------------
   1004 |    1002 | jklm@company.com |     JKLM | 4455667788
   1005 |    1003 | mnop@company.com |     MNOP | 5566778899
   1001 |    1001 | abcd@company.com |     ABCD | 1122334455
   1003 |    1002 | ghij@company.com |     GHIJ | 3344556677
   1002 |    1001 | defg@company.com |     DEFG | 2233445566

(5 rows)
```

Practical 2:

The **Homogeneous Ontology for Recursive Uniform Schema (HORUS)** is used as an internal data format structure that enables the framework to reduce the permutations of transformations required by the framework. The use of HORUS methodology results in a hub-and-spoke data transformation approach. External data formats are converted to HORUS format, and then a HORUS format is transformed into any other external format. The basic concept is to take native raw data and then transform it first to a single format. That means that there is only one format for text files, one format for JSON or XML, one format for images and video. Therefore, to achieve any-to-any transformation coverage, the framework's only requirements are a data-format-to-HORUS and HURUS-to- data-format converter.

Sourc code is located in C:\VKHCG\05-DS\9999-Data **directory**

Write Python / R Program to convert from the following formats to HORUS format:

A. Text delimited CSVto HORUS format.

Code:

```
# Utility Start CSV to HORUS ==================================
# Standard Tools
#=============================================================
import pandas as pd
# Input Agreement ============================================
sInputFileName='C:/VKHCG/05-DS/9999-Data/Country_Code.csv'
InputData=pd.read_csv(sInputFileName,encoding="latin-1")
print('Input Data Values ===================================')
print(InputData)
print('=====================================================')
# Processing Rules ===========================================
ProcessData=InputData
# Remove columns ISO-2-Code and ISO-3-CODE
ProcessData.drop('ISO-2-CODE', axis=1,inplace=True)
ProcessData.drop('ISO-3-Code', axis=1,inplace=True)
# Rename Country and ISO-M49
ProcessData.rename(columns={'Country': 'CountryName'}, inplace=True)
ProcessData.rename(columns={'ISO-M49': 'CountryNumber'}, inplace=True)
# Set new Index
ProcessData.set_index('CountryNumber', inplace=True)
# Sort data by CurrencyNumber
ProcessData.sort_values('CountryName', axis=0, ascending=False, inplace=True)

print('Process Data Values ===================================')
print(ProcessData)
print('=====================================================')
# Output Agreement ===========================================
OutputData=ProcessData

sOutputFileName='C:/VKHCG/05-DS/9999-Data/HORUS-CSV-Country.csv'
OutputData.to_csv(sOutputFileName, index = False)

print('CSV to HORUS - Done')
# Utility done ===============================================
```

Output:

```
=============== RESTART: C:\VKHCG\05-DS\9999-Data\CSV2HORUS.py ===============
Input Data Values ===================================
                    Country ISO-2-CODE ISO-3-Code  ISO-M49
0                 Afghanistan        AF        AFG        4
1               Aland Islands        AX        ALA      248
2                     Albania        AL        ALB        8
3                     Algeria        DZ        DZA       12
4              American Samoa        AS        ASM       16
..                        ...       ...        ...      ...
242  Wallis and Futuna Islands        WF        WLF      876
243             Western Sahara        EH        ESH      732
244                      Yemen        YE        YEM      887
245                     Zambia        ZM        ZMB      894
246                   Zimbabwe        ZW        ZWE      716

[247 rows x 4 columns]
=====================================================
Process Data Values =================================
                              CountryName
CountryNumber
716                             Zimbabwe
894                               Zambia
887                                Yemen
732                       Western Sahara
876            Wallis and Futuna Islands
...                                  ...
16                        American Samoa
12                               Algeria
8                                Albania
248                        Aland Islands
4                            Afghanistan

[247 rows x 1 columns]
=====================================================
CSV to HORUS - Done
>>>
```

B. XML to HORUS Format

Code:

```
# Utility Start XML to HORUS ==================================
# Standard Tools
import pandas as pd
import xml.etree.ElementTree as ET
def df2xml(data):
    header = data.columns
    root = ET.Element('root')
    for row in range(data.shape[0]):
        entry = ET.SubElement(root,'entry')
        for index in range(data.shape[1]):
            schild=str(header[index])
            child = ET.SubElement(entry, schild)
            if str(data[schild][row]) != 'nan':
                child.text = str(data[schild][row])
            else:
                child.text = 'n/a'
            entry.append(child)
    result = ET.tostring(root)
    return result
def xml2df(xml_data):
    root = ET.XML(xml_data)
    all_records = []
    for i, child in enumerate(root):
        record = {}
        for subchild in child:
            record[subchild.tag] = subchild.text
        all_records.append(record)
    return pd.DataFrame(all_records)

sInputFileName='C:/VKHCG/05-DS/9999-Data/Country_Code.xml'

InputData = open(sInputFileName).read()
print('=====================================================')
print('Input Data Values ===================================')
print('=====================================================')
```

```
print(InputData)
print('=============================================================')
#=============================================================
# Processing Rules ===========================================
#=============================================================
ProcessDataXML=InputData
# XML to Data Frame
ProcessData=xml2df(ProcessDataXML)
# Remove columns ISO-2-Code and ISO-3-CODE
ProcessData.drop('ISO-2-CODE', axis=1,inplace=True)
ProcessData.drop('ISO-3-Code', axis=1,inplace=True)
# Rename Country and ISO-M49
ProcessData.rename(columns={'Country': 'CountryName'}, inplace=True)
ProcessData.rename(columns={'ISO-M49': 'CountryNumber'}, inplace=True)
# Set new Index
ProcessData.set_index('CountryNumber', inplace=True)
# Sort data by CurrencyNumber
ProcessData.sort_values('CountryName', axis=0, ascending=False, inplace=True)
print('=============================================================')
print('Process Data Values ================================')
print('=============================================================')
print(ProcessData)
print('=============================================================')
OutputData=ProcessData
sOutputFileName='C:/VKHCG/05-DS/9999-Data/HORUS-XML-Country.csv'
OutputData.to_csv(sOutputFileName, index = False)
print('=============================================================')
print('XML to HORUS - Done')
print('=============================================================')
# Utility done ===============================================
```

Output:

```
=============== RESTART: C:\VKHCG\05-DS\9999-Data\XML2HORUS.py ===============
=================================================
Input Data Values ==============================
=================================================
Squeezed text (385 lines).
=================================================
=================================================
Process Data Values ============================
=================================================
                            CountryName
CountryNumber
716                            Zimbabwe
894                              Zambia
887                               Yemen
732                      Western Sahara
876          Wallis and Futuna Islands
...                                ...
16                      American Samoa
12                             Algeria
8                              Albania
248                      Aland Islands
4                          Afghanistan

[247 rows x 1 columns]
=================================================
=================================================
XML to HORUS - Done
=================================================
>>>
```

C. JSON to HORUS Format

Code:

```
# Utility Start JSON to HORUS ==================================
# Standard Tools
#===============================================================
import pandas as pd
# Input Agreement ==============================================
sInputFileName='C:/VKHCG/05-DS/9999-Data/Country_Code.json'
InputData=pd.read_json(sInputFileName, orient='index', encoding="latin-1")
print('Input Data Values ===================================')
print(InputData)
print('=====================================================')
# Processing Rules =============================================
ProcessData=InputData
# Remove columns ISO-2-Code and ISO-3-CODE
ProcessData.drop('ISO-2-CODE', axis=1,inplace=True)
ProcessData.drop('ISO-3-Code', axis=1,inplace=True)
# Rename Country and ISO-M49
ProcessData.rename(columns={'Country': 'CountryName'}, inplace=True)
ProcessData.rename(columns={'ISO-M49': 'CountryNumber'}, inplace=True)
# Set new Index
ProcessData.set_index('CountryNumber', inplace=True)
# Sort data by CurrencyNumber
ProcessData.sort_values('CountryName', axis=0, ascending=False, inplace=True)
print('Process Data Values ===================================')
print(ProcessData)
print('=====================================================')
# Output Agreement =============================================
OutputData=ProcessData
sOutputFileName='c:/VKHCG/05-DS/9999-Data/HORUS-JSON-Country.csv'
OutputData.to_csv(sOutputFileName, index = False)
print('JSON to HORUS - Done')
# Utility done =================================================
```

Output:

```
>>>
============== RESTART: C:\VKHCG\05-DS\9999-Data\JSON2HORUS.py ==============
Input Data Values ===================================
                        Country ISO-2-CODE ISO-3-Code  ISO-M49
0                   Afghanistan         AF         AFG        4
1                 Aland Islands         AX         ALA      248
10                    Argentina         AR         ARG       32
100                     Hungary         HU         HUN      348
101                     Iceland         IS         ISL      352
..                          ...        ...         ...      ...
95                       Guyana         GY         GUY      328
96                        Haiti         HT         HTI      332
97    Heard and Mcdonald Islands         HM         HMD      334
98   Holy Seeÿ(Vatican City State)       VA         VAT      336
99                     Honduras         HN         HND      340

[247 rows x 4 columns]
=====================================================
Process Data Values ===================================
                            CountryName
CountryNumber
716                        Zimbabwe
894                          Zambia
887                           Yemen
732                  Western Sahara
876           Wallis and Futuna Islands
...                              ...
16                   American Samoa
12                          Algeria
8                           Albania
248                  Aland Islands
4                      Afghanistan

[247 rows x 1 columns]
=====================================================
JSON to HORUS - Done
>>>
```

D. MySql Database to HORUS Format

Code:

```
# Utility Start Database to HORUS ====================================
# Standard Tools
#=============================================================
import pandas as pd
import sqlite3 as sq
# Input Agreement ============================================
sInputFileName='C:/VKHCG/05-DS/9999-Data/utility.db'
sInputTable='Country_Code'
conn = sq.connect(sInputFileName)
sSQL='select * FROM ' + sInputTable + ';'
InputData=pd.read_sql_query(sSQL, conn)
print('Input Data Values ===================================')
print(InputData)
print('=============================================================')
# Processing Rules ===========================================
ProcessData=InputData
# Remove columns ISO-2-Code and ISO-3-CODE
ProcessData.drop('ISO-2-CODE', axis=1,inplace=True)
ProcessData.drop('ISO-3-Code', axis=1,inplace=True)
# Rename Country and ISO-M49
ProcessData.rename(columns={'Country': 'CountryName'}, inplace=True)
ProcessData.rename(columns={'ISO-M49': 'CountryNumber'}, inplace=True)
# Set new Index
ProcessData.set_index('CountryNumber', inplace=True)
# Sort data by CurrencyNumber
ProcessData.sort_values('CountryName', axis=0, ascending=False, inplace=True)
print('Process Data Values ===================================')
print(ProcessData)
print('=============================================================')
# Output Agreement ===========================================
OutputData=ProcessData
sOutputFileName='C:/VKHCG/05-DS/9999-Data/HORUS-CSV-Country.csv'
OutputData.to_csv(sOutputFileName, index = False)
print('Database to HORUS - Done')
# Utility done ===============================================
```

Output:

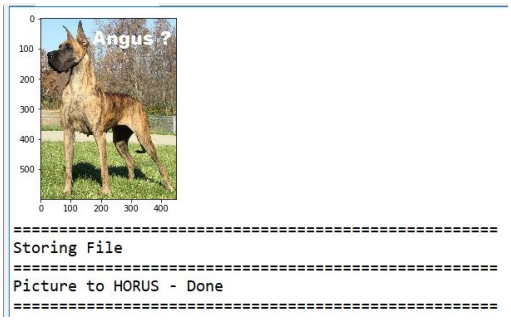
```
>>>
========== RESTART: C:\VKHCG\05-DS\9999-Data\DATABASE2HORUS.py ==========
Input Data Values ===================================
     index                    Country ISO-2-CODE ISO-3-Code  ISO-M49
0        0                Afghanistan         AF         AFG        4
1        1             Aland Islands         AX         ALA      248
2        2                    Albania         AL         ALB        8
3        3                    Algeria         DZ         DZA       12
4        4             American Samoa         AS         ASM       16
..     ...                        ...        ...         ...      ...
242    242  Wallis and Futuna Islands         WF         WLF      876
243    243             Western Sahara         EH         ESH      732
244    244                      Yemen         YE         YEM      887
245    245                     Zambia         ZM         ZMB      894
246    246                   Zimbabwe         ZW         ZWE      716

[247 rows x 5 columns]
=============================================================
Process Data Values ===================================
                index                    CountryName
CountryNumber
716               246                       Zimbabwe
894               245                         Zambia
887               244                          Yemen
732               243                 Western Sahara
876               242  Wallis and Futuna Islands
...               ...                            ...
16                  4                American Samoa
12                  3                       Algeria
8                   2                       Albania
248                 1                  Aland Islands
4                   0                    Afghanistan

[247 rows x 2 columns]
=============================================================
Database to HORUS - Done
>>>
```

E. Picture (JPEG) to HORUS Format **(Use SPYDER to run this program)**

Code:

```
# Utility Start Picture to HORUS ====================================
# Standard Tools
#====================================================================
from scipy.misc import imread
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
# Input Agreement ===================================================
sInputFileName='C:/VKHCG/05-DS/9999-Data/Angus.jpg'
InputData = imread(sInputFileName, flatten=False, mode='RGBA')

print('Input Data Values ==================================')
print('X: ',InputData.shape[0])
print('Y: ',InputData.shape[1])
print('RGBA: ', InputData.shape[2])
print('====================================================')
# Processing Rules ==================================================
ProcessRawData=InputData.flatten()
y=InputData.shape[2] + 2
x=int(ProcessRawData.shape[0]/y)
ProcessData=pd.DataFrame(np.reshape(ProcessRawData, (x, y)))
sColumns= ['XAxis','YAxis','Red', 'Green', 'Blue','Alpha']
ProcessData.columns=sColumns
ProcessData.index.names =['ID']
print('Rows: ',ProcessData.shape[0])
print('Columns :',ProcessData.shape[1])
print('====================================================')
print('Process Data Values ================================')
print('====================================================')
plt.imshow(InputData)
plt.show()
print('====================================================')
# Output Agreement ==================================================
OutputData=ProcessData
print('Storing File')
sOutputFileName='C:/VKHCG/05-DS/9999-Data/HORUS-Picture.csv'
OutputData.to_csv(sOutputFileName, index = False)
print('====================================================')
print('Picture to HORUS - Done')
print('====================================================')
```

Output:



F. Video to HORUS Format

Code:

Movie to Frames

```
# Utility Start Movie to HORUS (Part 1) ======================
# Standard Tools
#=================================================================
import os
import shutil
import cv2
#=================================================================
sInputFileName='C:/VKHCG/05-DS/9999-Data/dog.mp4'
sDataBaseDir='C:/VKHCG/05-DS/9999-Data/temp'
if os.path.exists(sDataBaseDir):
shutil.rmtree(sDataBaseDir)
if not os.path.exists(sDataBaseDir):
os.makedirs(sDataBaseDir)
print('=============================================================')
print('Start Movie to Frames')
print('=============================================================')
vidcap = cv2.VideoCapture(sInputFileName)
success,image = vidcap.read()
count = 0
while success:
success,image = vidcap.read()
sFrame=sDataBaseDir + str('/dog-frame-' + str(format(count, '04d'))+ '.jpg')
print('Extracted: ', sFrame)
cv2.imwrite(sFrame, image)
if os.path.getsize(sFrame) == 0:
count += -1
os.remove(sFrame)
print('Removed: ', sFrame)
if cv2.waitKey(10) == 27: # exit if Escape is hit
break
        count += 1
print('=============================================================')
print('Generated : ', count, ' Frames')
print('=============================================================')
print('Movie to Frames HORUS - Done')
print('=============================================================')
# Utility done ===============================================
```

```
>>>
========== RESTART: C:\VKHCG\05-DS\9999-Data\MOVIE2HORUSFrame.py ==========
=================================================
Start Movie to Frames
=================================================
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0000.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0001.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0002.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0003.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0004.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0005.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0006.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0007.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0008.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0009.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0010.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0099.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0100.jpg
Extracted:  C:/VKHCG/05-DS/9999-Data/temp/dog-frame-0101.jpg
=================================================
Generated :  101  Frames
=================================================
Movie to Frames HORUS - Done
=================================================
>>>
```

Now frames are created and need to load them into HORUS.

Frames to Horus **(Use SPYDER to run this program)**

```
# Utility Start Movie to HORUS (Part 2) ======================
# Standard Tools
#=============================================================
from scipy.misc import imread
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import os
# Input Agreement ============================================
sDataBaseDir='C:/VKHCG/05-DS/9999-Data/temp'
f=0
for file in os.listdir(sDataBaseDir):
if file.endswith(".jpg"):
f += 1
sInputFileName=os.path.join(sDataBaseDir, file)
print('Process : ', sInputFileName)
InputData = imread(sInputFileName, flatten=False, mode='RGBA')
print('Input Data Values ===================================')
print('X: ',InputData.shape[0])
print('Y: ',InputData.shape[1])
print('RGBA: ', InputData.shape[2])
        print('=====================================================')
# Processing Rules ===========================================
ProcessRawData=InputData.flatten()
y=InputData.shape[2] + 2
x=int(ProcessRawData.shape[0]/y)
ProcessFrameData=pd.DataFrame(np.reshape(ProcessRawData, (x, y)))
ProcessFrameData['Frame']=file
print('=====================================================')
print('Process Data Values ================================')
print('=====================================================')
plt.imshow(InputData)
plt.show()
if f == 1:
ProcessData=ProcessFrameData
else:
ProcessData=ProcessData.append(ProcessFrameData)
if f > 0:
sColumns= ['XAxis','YAxis','Red', 'Green', 'Blue','Alpha','FrameName']
ProcessData.columns=sColumns
print('=====================================================')
ProcessFrameData.index.names =['ID']
print('Rows: ',ProcessData.shape[0])
print('Columns :',ProcessData.shape[1])
print('=====================================================')
# Output Agreement ===========================================
OutputData=ProcessData
print('Storing File')
sOutputFileName='C:/VKHCG/05-DS/9999-Data/HORUS-Movie-Frame.csv'
OutputData.to_csv(sOutputFileName, index = False)
print('=====================================================')
print('Processed ; ', f,' frames')
```

```
print('=========================================================')
print('Movie to HORUS - Done')
print('=========================================================')
```

Output:

```
=========================================================
Rows:  15667200
Columns : 7
=========================================================
Storing File
=========================================================
Processed ;  102  frames
=========================================================
Movie to HORUS - Done
=========================================================
```

dog-frame-0000.jpeg

dog-frame-0001.jpeg

dog-frame-0100.jpeg

dog-frame-0101.jpeg

Check the files from C:\VKHCG\05-DS\9999-Data\temp

The movie clip is converted into 102 picture frames and then to HORUS format.

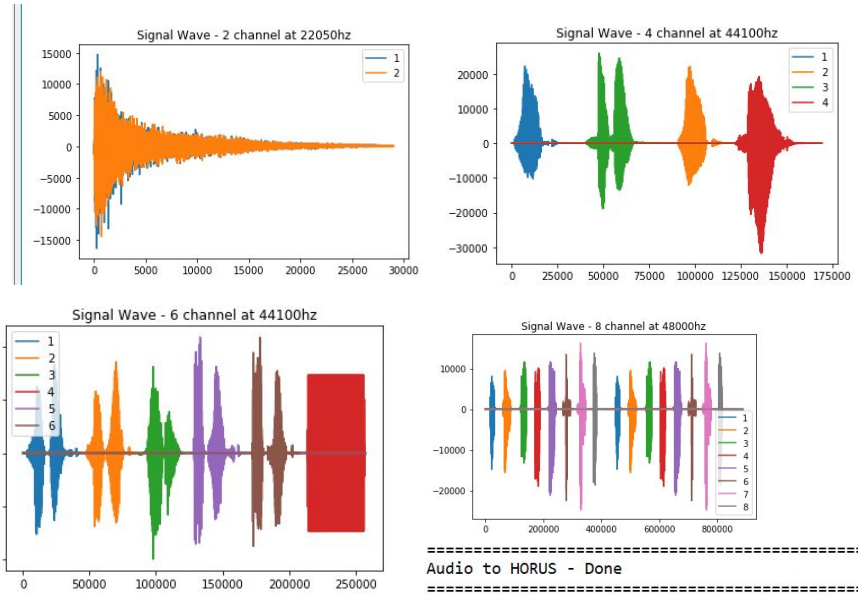
G. Audio to HORUS Format

Code:

```
# Utility Start Audio to HORUS ================================
# Standard Tools
#=============================================================
from scipy.io import wavfile
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
#=============================================================
def show_info(aname, a,r):
    print ('----------------')
    print ("Audio:", aname)
    print ('----------------')
    print ("Rate:", r)
    print ('----------------')
    print ("shape:", a.shape)
    print ("dtype:", a.dtype)
    print ("min, max:", a.min(), a.max())
    print ('----------------')
    plot_info(aname, a,r)
#=============================================================
def plot_info(aname, a,r):
    sTitle= 'Signal Wave - '+ aname + ' at ' + str(r) + 'hz'
    plt.title(sTitle)
    sLegend=[]
    for c in range(a.shape[1]):
        sLabel = 'Ch' + str(c+1)
        sLegend=sLegend+[str(c+1)]
        plt.plot(a[:,c], label=sLabel)
    plt.legend(sLegend)
    plt.show()
#=============================================================
sInputFileName='C:/VKHCG/05-DS/9999-Data/2ch-sound.wav'
print('=============================================================')
print('Processing : ', sInputFileName)
print('=============================================================')
InputRate, InputData = wavfile.read(sInputFileName)
show_info("2 channel", InputData,InputRate)
ProcessData=pd.DataFrame(InputData)
sColumns= ['Ch1','Ch2']
ProcessData.columns=sColumns
OutputData=ProcessData
sOutputFileName='C:/VKHCG/05-DS/9999-Data/HORUS-Audio-2ch.csv'
OutputData.to_csv(sOutputFileName, index = False)
#=============================================================
sInputFileName='C:/VKHCG/05-DS/9999-Data/4ch-sound.wav'
print('=============================================================')
print('Processing : ', sInputFileName)
print('=============================================================')
InputRate, InputData = wavfile.read(sInputFileName)
show_info("4 channel", InputData,InputRate)
ProcessData=pd.DataFrame(InputData)
```

```
sColumns= ['Ch1','Ch2','Ch3', 'Ch4']
ProcessData.columns=sColumns
OutputData=ProcessData
sOutputFileName='C:/VKHCG/05-DS/9999-Data/HORUS-Audio-4ch.csv'
OutputData.to_csv(sOutputFileName, index = False)
#================================================================
sInputFileName='C:/VKHCG/05-DS/9999-Data/6ch-sound.wav'
print('================================================================')
print('Processing : ', sInputFileName)
print('================================================================')
InputRate, InputData = wavfile.read(sInputFileName)
show_info("6 channel", InputData,InputRate)
ProcessData=pd.DataFrame(InputData)
sColumns= ['Ch1','Ch2','Ch3', 'Ch4', 'Ch5','Ch6']
ProcessData.columns=sColumns
OutputData=ProcessData
sOutputFileName='C:/VKHCG/05-DS/9999-Data/HORUS-Audio-6ch.csv'
OutputData.to_csv(sOutputFileName, index = False)
#================================================================
sInputFileName='C:/VKHCG/05-DS/9999-Data/8ch-sound.wav'
print('================================================================')
print('Processing : ', sInputFileName)
print('================================================================')
InputRate, InputData = wavfile.read(sInputFileName)
show_info("8 channel", InputData,InputRate)
ProcessData=pd.DataFrame(InputData)
sColumns= ['Ch1','Ch2','Ch3', 'Ch4', 'Ch5','Ch6','Ch7','Ch8']
ProcessData.columns=sColumns
OutputData=ProcessData
sOutputFileName='C:/VKHCG/05-DS/9999-Data/HORUS-Audio-8ch.csv'
OutputData.to_csv(sOutputFileName, index = False)
print('================================================================')
print('Audio to HORUS - Done')
```

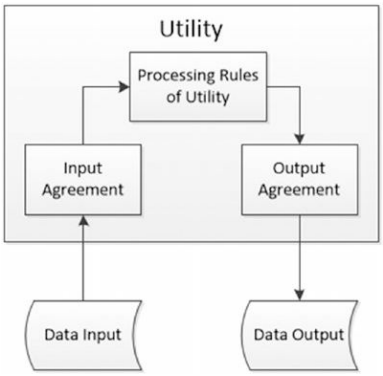
Output:



Practical 3: Utilities and Auditing

Basic Utility Design

1. Load data as per input agreement.
2. Apply processing rules of utility.
3. Save data as per output agreement.



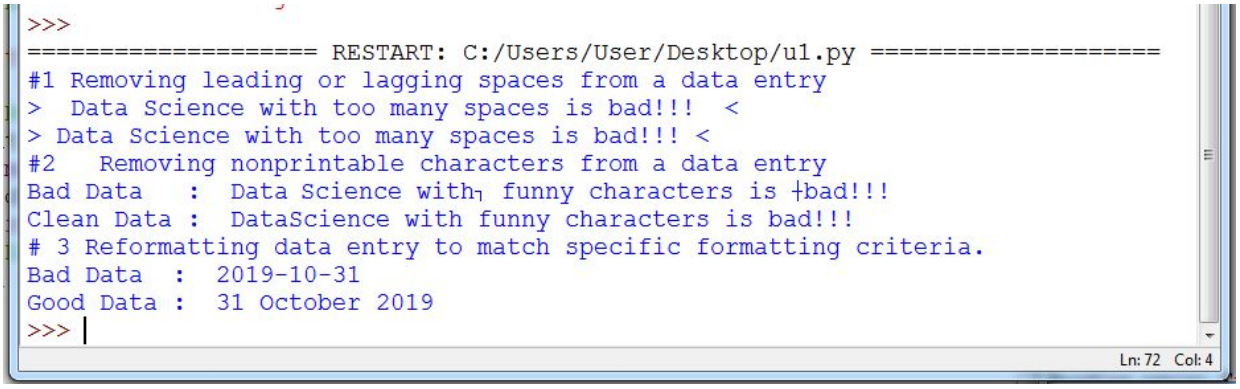
There are three types of utilities
- Data processing utilities
- Maintenance utilities
- Processing utilities

A. Fixers Utilities:

Fixers enable your solution to take your existing data and fix a specific quality issue.

```
#---------------------------- Program to Demonstrate Fixers utilities --------------------
import string
import datetime as dt
# 1 Removing leading or lagging spaces from a data entry
print('#1 Removing leading or lagging spaces from a data entry');
baddata = " Data Science with too many spaces is bad!!! "
print('>',baddata,'<')
cleandata=baddata.strip()
print('>',cleandata,'<')

# 2  Removing nonprintable characters from a data entry
print('#2   Removing nonprintable characters from a data entry')
printable = set(string.printable)
baddata = "Data\x00Science with\x02 funny characters is \x10bad!!!"
cleandata=''.join(filter(lambda x: x in string.printable,baddata))
print('Bad Data   : ',baddata);
print('Clean Data : ',cleandata)

# 3 Reformatting data entry to match specific formatting criteria.
#   Convert YYYY/MM/DD to DD Month YYYY
print('# 3 Reformatting data entry to match specific formatting criteria.')
baddate = dt.date(2019, 10, 31)
baddata=format(baddate,'%Y-%m-%d')
gooddate = dt.datetime.strptime(baddata,'%Y-%m-%d')
gooddata=format(gooddate,'%d %B %Y')
print('Bad Data  : ',baddata)
print('Good Data : ',gooddata)
```

Output:



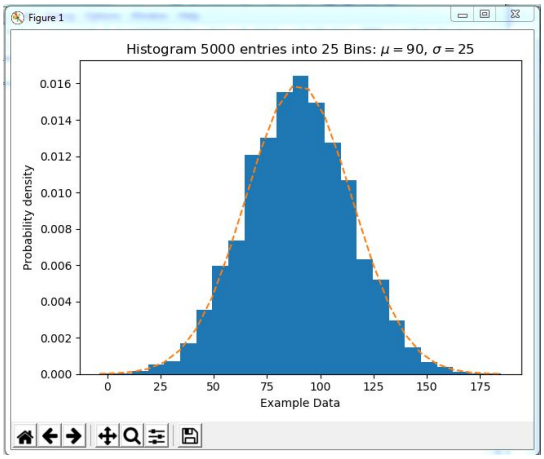
B. Data Binning or Bucketing

Binning is a data preprocessing technique used to reduce the effects of minor observation errors. Statistical data binning is a way to group a number of more or less continuous values into a smaller number of "bins."

Code :

```
import numpy as np
import matplotlib.mlab as mlab
import matplotlib.pyplot as plt
import scipy.stats as stats

np.random.seed(0)
# example data
mu = 90  # mean of distribution
sigma = 25  # standard deviation of distribution
x = mu + sigma * np.random.randn(5000)
num_bins = 25
fig, ax = plt.subplots()

# the histogram of the data
n, bins, patches = ax.hist(x, num_bins, density=1)

# add a 'best fit' line
y = stats.norm.pdf(bins, mu, sigma)
# mlab.normpdf(bins, mu, sigma)
ax.plot(bins, y, '--')
ax.set_xlabel('Example Data')
ax.set_ylabel('Probability density')
sTitle=r'Histogram ' + str(len(x)) + ' entries into ' + str(num_bins) + ' Bins: $\mu=' + str(mu) + '$, $\sigma=' +
str(sigma) + '$'
ax.set_title(sTitle)

fig.tight_layout()
sPathFig='C:/VKHCG/05-DS/4000-UL/0200-DU/DU-Histogram.png'
fig.savefig(sPathFig)
plt.show()
```

Output:



C. Averaging of Data

The use of averaging of features value enables the reduction of data volumes in a control fashion to improve effective data processing.

C:\VKHCG\05-DS\4000-UL\0200-DU\DU-Mean.py

Code:

```
import pandas as pd
##################################################################
InputFileName='IP_DATA_CORE.csv'
OutputFileName='Retrieve_Router_Location.csv'
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ')
print('##################################')
sFileName=Base + '/01-Vermeulen/00-RawData/' + InputFileName
print('Loading :',sFileName)
IP_DATA_ALL=pd.read_csv(sFileName,header=0,low_memory=False,
  usecols=['Country','Place Name','Latitude','Longitude'], encoding="latin-1")
IP_DATA_ALL.rename(columns={'Place Name': 'Place_Name'}, inplace=True)
AllData=IP_DATA_ALL[['Country', 'Place_Name','Latitude']]
print(AllData)
MeanData=AllData.groupby(['Country', 'Place_Name'])['Latitude'].mean()
print(MeanData)
##################################################################
```

Output:

```
>>>
========== RESTART: C:\VKHCG\05-DS\4000-UL\0200-DU\DU-Mean.py ==========
##################################
Working Base : C:/VKHCG  using
##################################
Loading : C:/VKHCG/01-Vermeulen/00-RawData/IP_DATA_CORE.csv
     Country Place_Name  Latitude
0         US   New York   40.7528
1         US   New York   40.7528
2         US   New York   40.7528
3         US   New York   40.7528
4         US   New York   40.7528
...      ...        ...       ...
3557      DE     Munich   48.0915
3558      DE     Munich   48.1833
3559      DE     Munich   48.1000
3560      DE     Munich   48.1480
3561      DE     Munich   48.1480

[3562 rows x 3 columns]
Country  Place_Name
DE       Munich        48.143223
GB       London        51.509406
US       New York      40.747044
Name: Latitude, dtype: float64
```

D. Outlier Detection

Outliers are data that is so different from the rest of the data in the data set that it may be caused by an error in the data source. There is a technique called outlier detection that, with good data science, will identify these outliers.

C:\VKHCG\05-DS\4000-UL\0200-DU\DU-Outliers.py

Code:

```
##################################################################
# -*- coding: utf-8 -*-
##################################################################
import pandas as pd
##################################################################
InputFileName='IP_DATA_CORE.csv'
OutputFileName='Retrieve_Router_Location.csv'
Base='C:/VKHCG'
print('################################')
print('Working Base :',Base)
print('################################')
##################################################################
sFileName=Base + '/01-Vermeulen/00-RawData/' + InputFileName
print('Loading :',sFileName)
IP_DATA_ALL=pd.read_csv(sFileName,header=0,low_memory=False,
  usecols=['Country','Place Name','Latitude','Longitude'], encoding="latin-1")
IP_DATA_ALL.rename(columns={'Place Name': 'Place_Name'}, inplace=True)
LondonData=IP_DATA_ALL.loc[IP_DATA_ALL['Place_Name']=='London']
AllData=LondonData[['Country', 'Place_Name','Latitude']]
print('All Data')
print(AllData)
MeanData=AllData.groupby(['Country', 'Place_Name'])['Latitude'].mean()
StdData=AllData.groupby(['Country', 'Place_Name'])['Latitude'].std()
print('Outliers')
UpperBound=float(MeanData+StdData)
print('Higher than ', UpperBound)
OutliersHigher=AllData[AllData.Latitude>UpperBound]
print(OutliersHigher)
LowerBound=float(MeanData-StdData)
print('Lower than ', LowerBound)
OutliersLower=AllData[AllData.Latitude<LowerBound]
print(OutliersLower)
print('Not Outliers')
OutliersNot=AllData[(AllData.Latitude>=LowerBound) & (AllData.Latitude<=UpperBound)]
print(OutliersNot)
##################################################################
```

Output:

```
========== RESTART: C:\VKHCG\05-DS\4000-UL\0200-DU\DU-Outliers.py ==========
################################
Working Base : C:/VKHCG
################################
Loading : C:/VKHCG/01-Vermeulen/00-RawData/IP_DATA_CORE.csv
All Data
     Country Place_Name  Latitude
1910      GB     London   51.5130
```

```
1911    GB    London   51.5508
1912    GB    London   51.5649
1913    GB    London   51.5895
1914    GB    London   51.5232
...     ...     ...      ...
3434    GB    London   51.5092
3435    GB    London   51.5092
3436    GB    London   51.5163
3437    GB    London   51.5085
3438    GB    London   51.5136

[1502 rows x 3 columns]
Outliers
Higher than  51.51263550786781
     Country Place_Name  Latitude
1910    GB    London   51.5130
1911    GB    London   51.5508
1912    GB    London   51.5649
1913    GB    London   51.5895
1914    GB    London   51.5232
1916    GB    London   51.5491
1919    GB    London   51.5161
1920    GB    London   51.5198
1921    GB    London   51.5198
1923    GB    London   51.5237
1924    GB    London   51.5237
1925    GB    London   51.5237
1926    GB    London   51.5237
1927    GB    London   51.5232
3436    GB    London   51.5163
3438    GB    London   51.5136
Lower than  51.50617687562166
     Country Place_Name  Latitude
1915    GB    London   51.4739
Not Outliers
     Country Place_Name  Latitude
1917    GB    London   51.5085
1918    GB    London   51.5085
1922    GB    London   51.5085
1928    GB    London   51.5085
1929    GB    London   51.5085
...     ...     ...      ...
3432    GB    London   51.5092
3433    GB    London   51.5092
3434    GB    London   51.5092
3435    GB    London   51.5092
3437    GB    London   51.5085
[1485 rows x 3 columns]
```

Audit

The audit, balance, and control layer is the area from which you can observe what is currently running within your data science environment. It records

- Process-execution statistics
- Balancing and controls
- Rejects and error-handling
- Codes management

An audit is a systematic and independent examination of the ecosystem.
The audit sublayer records the processes that are running at any specific point within the environment. This information is used by data scientists and engineers to understand and plan future improvements to the processing.

E. Logging

Write a Python / R program for basic logging in data science.

C:\VKHCG\77-Yoke\Yoke_Logging.py

Code:

```
import sys
import os
import logging
import uuid
import shutil
import time
################################################################
    Base='C:/VKHCG'
################################################################
sCompanies=['01-Vermeulen','02-Krennwallner','03-Hillman','04-Clark']
sLayers=['01-Retrieve','02-Assess','03-Process','04-Transform','05-Organise','06-Report']
sLevels=['debug','info','warning','error']

for sCompany in sCompanies:
    sFileDir=Base + '/' + sCompany
    if not os.path.exists(sFileDir):
        os.makedirs(sFileDir)
    for sLayer in sLayers:
        log = logging.getLogger()  # root logger
        for hdlr in log.handlers[:]:  # remove all old handlers
            log.removeHandler(hdlr)
        #-----------------------------------------------------------------------------
        sFileDir=Base + '/' + sCompany + '/' + sLayer + '/Logging'
        if os.path.exists(sFileDir):
            shutil.rmtree(sFileDir)
        time.sleep(2)
        if not os.path.exists(sFileDir):
            os.makedirs(sFileDir)
```

```
skey=str(uuid.uuid4())
sLogFile=Base + '/' + sCompany + '/' + sLayer + '/Logging/Logging_'+skey+'.log'
print('Set up:',sLogFile)
# set up logging to file - see previous section for more details
logging.basicConfig(level=logging.DEBUG,
                    format='%(asctime)s %(name)-12s %(levelname)-8s %(message)s',
                    datefmt='%m-%d %H:%M',
                    filename=sLogFile,
                    filemode='w')
# define a Handler which writes INFO messages or higher to the sys.stderr
console = logging.StreamHandler()
console.setLevel(logging.INFO)
# set a format which is simpler for console use
formatter = logging.Formatter('%(name)-12s: %(levelname)-8s %(message)s')
# tell the handler to use this format
console.setFormatter(formatter)
# add the handler to the root logger
logging.getLogger('').addHandler(console)
 # Now, we can log to the root logger, or any other logger. First the root...
logging.info('Practical Data Science is fun!.')

for sLevel in sLevels:
    sApp='Apllication-'+ sCompany + '-' + sLayer + '-' + sLevel
    logger = logging.getLogger(sApp)
    if sLevel == 'debug':
        logger.debug('Practical Data Science logged a debugging message.')
     if sLevel == 'info':
        logger.info('Practical Data Science logged information message.')
    if sLevel == 'warning':
        logger.warning('Practical Data Science logged a warning message.')
    if sLevel == 'error':
        logger.error('Practical Data Science logged an error message.')

#------------------------------------------------------------------------
```

Output:

```
>>>
================== RESTART: C:\VKHCG\77-Yoke\Yoke_Logging.py ==================
Set up: C:/VKHCG/01-Vermeulen/01-Retrieve/Logging/Logging_61705603-bb6e-47f0-b5a
9-23d42e267311.log
root        : INFO     Practical Data Science is fun!.
Apllication-01-Vermeulen-01-Retrieve-info: INFO     Practical Data Science logge
d information message.
Apllication-01-Vermeulen-01-Retrieve-warning: WARNING  Practical Data Science lo
gged a warning message.
Apllication-01-Vermeulen-01-Retrieve-error: ERROR    Practical Data Science logg
ed an error message.
Set up: C:/VKHCG/01-Vermeulen/02-Assess/Logging/Logging_a7fecb9b-4d40-474e-bc2d-
994958d85194.log
```

Practical 4

Retrieve Superstep

The Retrieve superstep is a practical method for importing completely into the processing ecosystem a data lake consisting of various external data sources. The Retrieve superstep is the first contact between your data science and the source systems. I will guide you through a methodology of how to handle this discovery of the data up to the point you have all the data you need to evaluate the system you are working with, by deploying your data science skills. The successful retrieval of the data is a major stepping-stone to ensuring that you are performing good data science. Data lineage delivers the audit trail of the data elements at the lowest granular level, to ensure full data governance.

Data tagged in respective analytical models define the profile of the data that requires loading and guides the data scientist to what additional processing is required.

A. Perform the following data processing using R.

Use R-Studio for the following:

```
>library(readr)
Warning message:package 'readr' was built under R version 3.4.4
```

Load a table named IP_DATA_ALL.csv.

```
>IP_DATA_ALL <- read_csv("C:/VKHCG/01-Vermeulen/00-RawData/IP_DATA_ALL.csv")
Parsed with column specification:
cols(
  ID = col_double(),
  Country = col_character(),
  `Place Name` = col_character(),
  `Post Code` = col_double(),
  Latitude = col_double(),
  Longitude = col_double(),
  `First IP Number` = col_double(),
  `Last IP Number` = col_double()
)

>View(IP_DATA_ALL)
>spec(IP_DATA_ALL)
cols(
  ID = col_double(),
  Country = col_character(),
  `Place Name` = col_character(),
  `Post Code` = col_double(),
  Latitude = col_double(),
  Longitude = col_double(),
  `First IP Number` = col_double(),
  `Last IP Number` = col_double()
)
```

This informs you that you have the following eight columns:

- ID of type integer
- Place name of type character
- Post code of type character
- Latitude of type numeric double
- Longitude of type numeric double

- First IP number of type integer
- Last IP number of type integer

```
>library(tibble)
>set_tidy_names(IP_DATA_ALL, syntactic = TRUE, quiet = FALSE)
New names:
Place Name -> Place.Name
Post Code -> Post.Code
First IP Number -> First.IP.Number
Last IP Number -> Last.IP.Number
```

This informs you that four of the field names are not valid and suggests new field names that are valid.You can fix any detected invalid column names by executing
IP_DATA_ALL_FIX=set_tidy_names(IP_DATA_ALL, syntactic = TRUE, quiet = TRUE)
By using command View(IP_DATA_ALL_FIX), you can check that you have fixed the columns. The new table IP_DATA_ALL_FIX.csv will fix the invalid column names with valid names.

```
>sapply(IP_DATA_ALL_FIX, typeof)
          ID      Country   Place.Name     Post.Code     Latitude
    "double"  "character"  "character"     "double"     "double"
   Longitude First.IP.Number  Last.IP.Number
    "double"     "double"     "double"
>library(data.table)
>hist_country=data.table(Country=unique(IP_DATA_ALL_FIX[is.na(IP_DATA_ALL_FIX ['Country']) == 0, ]$Country
))
>setorder(hist_country,'Country')
>hist_country_with_id=rowid_to_column(hist_country, var = "RowIDCountry")
>View(hist_country_fix)
>IP_DATA_COUNTRY_FREQ=data.table(with(IP_DATA_ALL_FIX, table(Country)))
>View(IP_DATA_COUNTRY_FREQ)
```

IP_DATA_COUNTRY_FREQ

Filter

	Country	N
2	GB	1502
3	US	1383
1	DE	677

- The two biggest subset volumes are from the US and GB.
- The US has just over four times the data as GB.

```
hist_latitude =data.table(Latitude=unique(IP_DATA_ALL_FIX [is.na(IP_DATA_ALL_with_ID ['Latitude']) == 0, ]$Lati
tude))
setkeyv(hist_latitude, 'Latitude')
setorder(hist_latitude)
hist_latitude_with_id=rowid_to_column(hist_latitude, var = "RowID")
View(hist_latitude_with_id)
IP_DATA_Latitude_FREQ=data.table(with(IP_DATA_ALL_FIX,table(Latitude)))
View(IP_DATA_Latitude_FREQ)
```

	Latitude	N
133	51.5092	1478
1	40.6888	130
107	48.15	114
9	40.7143	113

- The two biggest data volumes are from latitudes 51.5092 and 40.6888.
- The spread appears to be nearly equal between the top-two latitudes.

```
>sapply(IP_DATA_ALL_FIX[,'Latitude'], min, na.rm=TRUE)
Latitude  40.6888
```

What does this tell you?
Fact: The range of latitude for the Northern Hemisphere is from 0 to 90. So, if you do not have any latitudes farther south than 40.6888, you can improve your retrieve routine.

```
>sapply(IP_DATA_ALL_FIX[,'Country'], min, na.rm=TRUE)
Country    "DE"
```

Minimum business frequency is from DE – Denmark.

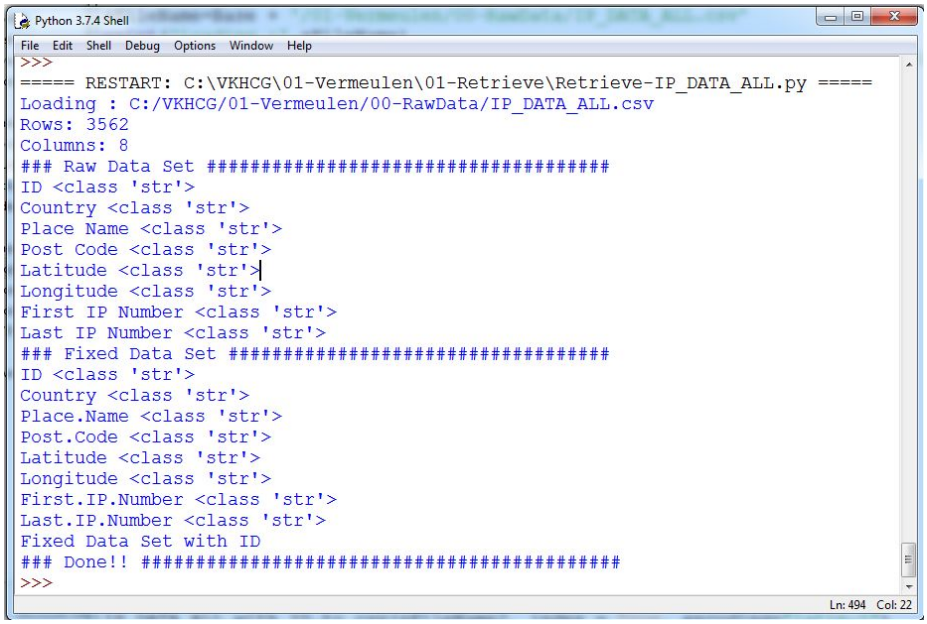
```
>sapply(IP_DATA_ALL_FIX[,'Latitude'], max, na.rm=TRUE)
Latitude
 51.5895
>sapply(IP_DATA_ALL_FIX[,'Country'], max, na.rm=TRUE)
Country
  "US"
```

The result is 51.5895. What does this tell you?
Fact: The range in latitude for the Northern Hemisphere is from 0 to 90. So, if you do not have any latitudes more northerly than 51.5895, you can improve your retrieve routine.

```
>sapply(IP_DATA_ALL_FIX [,'Latitude'], mean, na.rm=TRUE)
Latitude
46.69097
>sapply(IP_DATA_ALL_FIX [,'Latitude'], median, na.rm=TRUE)
Latitude
  48.15
>sapply(IP_DATA_ALL_FIX [,'Latitude'], range, na.rm=TRUE)
     Latitude
[1,]  40.6888
[2,]  51.5895

>sapply(IP_DATA_ALL_FIX [,'Latitude'], quantile, na.rm=TRUE)
     Latitude
0%    40.6888
25%   40.7588
50%   48.1500
75%   51.5092
100%  51.5895

>sapply(IP_DATA_ALL_FIX [,'Latitude'], sd, na.rm=TRUE)
Latitude
4.890387
>sapply(IP_DATA_ALL_FIX [,'Longitude'], sd, na.rm=TRUE)
Longitude
 38.01702
```

B. Program to retrieve different attributes of data.

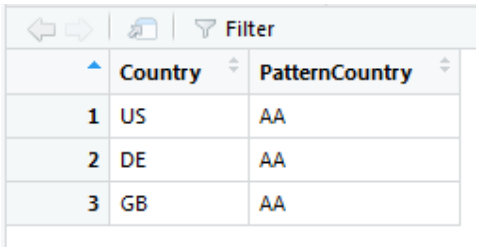
```
##### C:\ VKHCG\01-Vermeulen\01-Retrieve\Retrive_IP_DATA_ALL.py###
import sys
import os
import pandas as pd
################################################################
Base='C:/VKHCG'
################################################################
sFileName=Base + '/01-Vermeulen/00-RawData/IP_DATA_ALL.csv'
print('Loading :',sFileName)
IP_DATA_ALL=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
################################################################
sFileDir=Base + '/01-Vermeulen/01-Retrieve/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
print('Rows:', IP_DATA_ALL.shape[0])
print('Columns:', IP_DATA_ALL.shape[1])
print('### Raw Data Set #########################################')
for i in range(0,len(IP_DATA_ALL.columns)):
    print(IP_DATA_ALL.columns[i],type(IP_DATA_ALL.columns[i]))
print('### Fixed Data Set #######################################')
IP_DATA_ALL_FIX=IP_DATA_ALL
for i in range(0,len(IP_DATA_ALL.columns)):
    cNameOld=IP_DATA_ALL_FIX.columns[i] + '     '
    cNameNew=cNameOld.strip().replace(" ", ".")
    IP_DATA_ALL_FIX.columns.values[i] = cNameNew
    print(IP_DATA_ALL.columns[i],type(IP_DATA_ALL.columns[i]))
################################################################
#print(IP_DATA_ALL_FIX.head())
################################################################
print('Fixed Data Set with ID')
IP_DATA_ALL_with_ID=IP_DATA_ALL_FIX
IP_DATA_ALL_with_ID.index.names = ['RowID']
#print(IP_DATA_ALL_with_ID.head())
sFileName2=sFileDir + '/Retrieve_IP_DATA.csv'
IP_DATA_ALL_with_ID.to_csv(sFileName2, index = True, encoding="latin-1")
################################################################
print('### Done!! ############################################')
################################################################
```



C. Data Pattern

To determine a pattern of the data values, Replace all alphabet values with an uppercase case *A*, all numbers with an uppercase *N*, and replace any spaces with a lowercase letter *b* and all other unknown characters with a lowercase *u*. As a result, "Good Book 101" becomes "AAAAbAAAAbNNNu."This pattern creation is beneficial for designing any specific assess rules. This pattern view of data is a quick way to identify common patterns or determine standard layouts.

```
library(readr)
library(data.table)
FileName=paste0('c:/VKHCG/01-Vermeulen/00-RawData/IP_DATA_ALL.csv')
IP_DATA_ALL <- read_csv(FileName)
hist_country=data.table(Country=unique(IP_DATA_ALL$Country))
pattern_country=data.table(Country=hist_country$Country,
                           PatternCountry=hist_country$Country)
oldchar=c(letters,LETTERS)
newchar=replicate(length(oldchar),"A")
for (r in seq(nrow(pattern_country))){
  s=pattern_country[r,]$PatternCountry;
  for (c in seq(length(oldchar))){
    s=chartr(oldchar[c],newchar[c],s)
  };
  for (n in seq(0,9,1)){
    s=chartr(as.character(n),"N",s)
  };
  s=chartr(" ","b",s)
  s=chartr(".","u",s)
  pattern_country[r,]$PatternCountry=s;
};
View(pattern_country)
```

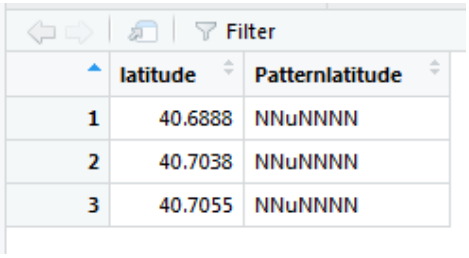


Filter

	Country	PatternCountry
1	US	AA
2	DE	AA
3	GB	AA

Example 2: This is a common use of patterns to separate common standards and structures. Pattern can be loaded in separate retrieve procedures. If the same two patterns, NNNNuNNuNN and uuNNuNNuNN, are found, you can send NNNNuNNuNN directly to be converted into a date, while uuNNuNNuNN goes through a quality-improvement process to then route back to the same queue as NNNNuNNuNN, once it complies.

```
library(readr)
library(data.table)
Base='C:/VKHCG'
FileName=paste0(Base,'/01-Vermeulen/00-RawData/IP_DATA_ALL.csv')
IP_DATA_ALL <- read_csv(FileName)
hist_latitude=data.table(Latitude=unique(IP_DATA_ALL$Latitude))
pattern_latitude=data.table(latitude=hist_latitude$Latitude,
                            Patternlatitude=as.character(hist_latitude$Latitude))
oldchar=c(letters,LETTERS)
newchar=replicate(length(oldchar),"A")
for (r in seq(nrow(pattern_latitude))){
  s=pattern_latitude[r,]$Patternlatitude;
  for (c in seq(length(oldchar))){
    s=chartr(oldchar[c],newchar[c],s)
  };
  for (n in seq(0,9,1)){
    s=chartr(as.character(n),"N",s)
  };
  s=chartr(" ","b",s)
  s=chartr("+","u",s)
  s=chartr("-","u",s)
  s=chartr(".","u",s)
  pattern_latitude[r,]$Patternlatitude=s;
};
setorder(pattern_latitude,latitude)
View(pattern_latitude[1:3])
```



Filter

	latitude	Patternlatitude
1	40.6888	NNuNNNN
2	40.7038	NNuNNNN
3	40.7055	NNuNNNN

D. Loading IP_DATA_ALL:

This data set contains all the IP address allocations in the world. It will help you to locateyour customers when interacting with them online.
Create a new Python script file and save it as Retrieve-IP_DATA_ALL.py in directory C:\VKHCG\01-Vermeulen\01-Retrieve.

```
##############Retrieve-IP_DATA_ALL.py#########################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
################################################################
Base='C:/VKHCG'
################################################################
sFileName=Base + '/01-Vermeulen/00-RawData/IP_DATA_ALL.csv'
print('Loading :',sFileName)
IP_DATA_ALL=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
################################################################
sFileDir=Base + '/01-Vermeulen/01-Retrieve/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
print('Rows:', IP_DATA_ALL.shape[0])
print('Columns:', IP_DATA_ALL.shape[1])
print('### Raw Data Set #####################################')
for i in range(0,len(IP_DATA_ALL.columns)):
    print(IP_DATA_ALL.columns[i],type(IP_DATA_ALL.columns[i]))
print('### Fixed Data Set #####################################')
IP_DATA_ALL_FIX=IP_DATA_ALL
for i in range(0,len(IP_DATA_ALL.columns)):
    cNameOld=IP_DATA_ALL_FIX.columns[i] + '     '
    cNameNew=cNameOld.strip().replace(" ", ".")
    IP_DATA_ALL_FIX.columns.values[i] = cNameNew
    print(IP_DATA_ALL.columns[i],type(IP_DATA_ALL.columns[i]))
################################################################
#print(IP_DATA_ALL_FIX.head())
################################################################
print('Fixed Data Set with ID')
IP_DATA_ALL_with_ID=IP_DATA_ALL_FIX
IP_DATA_ALL_with_ID.index.names = ['RowID']
#print(IP_DATA_ALL_with_ID.head())

sFileName2=sFileDir + '/Retrieve_IP_DATA.csv'
IP_DATA_ALL_with_ID.to_csv(sFileName2, index = True, encoding="latin-1")
################################################################
print('### Done!! ############################################')
################################################################
```

```
>>>
===== RESTART: C:\VKHCG\01-Vermeulen\01-Retrieve\Retrieve-IP_DATA_ALL.py =====
Loading : C:/VKHCG/01-Vermeulen/00-RawData/IP_DATA_ALL.csv
Rows: 3562
Columns: 8
### Raw Data Set ####################################
ID <class 'str'>
Country <class 'str'>
Place Name <class 'str'>
Post Code <class 'str'>
Latitude <class 'str'>
Longitude <class 'str'>
First IP Number <class 'str'>
Last IP Number <class 'str'>
### Fixed Data Set ##################################
ID <class 'str'>
Country <class 'str'>
Place.Name <class 'str'>
Post.Code <class 'str'>
Latitude <class 'str'>
Longitude <class 'str'>
First.IP.Number <class 'str'>
Last.IP.Number <class 'str'>
Fixed Data Set with ID
### Done!! ##########################################
>>>
```

Similarly execute the code for:

Loading IP_DATA_C_VKHCG

Loading IP_DATA_CORE

Loading COUNTRY-CODES

Loading DE_Billboard_Locations

Loading GB_Postcode_Full

Loading GB_Postcode_Warehouse

Loading GB_Postcode_Shops

Loading Euro_ExchangeRates

Load: Profit_And_Loss

Assistinga company with its processing.
The means are as follows:

- Identify the data sources required.
- Identify source data format (CSV, XML, JSON, or database).
- Data profile the data distribution (Skew, Histogram, Min, Max).
- Identify any loading characteristics (Columns Names, Data Types, Volumes).
- Determine the delivery format (CSV, XML, JSON, or database).

Vermeulen PLC

The company has two main jobs on which to focus your attention:
• Designing a routing diagram for company
• Planning a schedule of jobs to be performed for the router network

Start your Python editor and create a text file named Retrieve-IP_Routing.py in directory.
C:\VKHCG\01-Vermeulen\01-Retrieve.

```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
from math import radians, cos, sin, asin, sqrt
################################################################
def haversine(lon1, lat1, lon2, lat2,stype):
    """
    Calculate the great circle distance between two points
    on the earth (specified in decimal degrees)
    """
    # convert decimal degrees to radians
    lon1, lat1, lon2, lat2 = map(radians, [lon1, lat1, lon2, lat2])
    # haversine formula
    dlon = lon2 - lon1
    dlat = lat2 - lat1
    a = sin(dlat/2)**2 + cos(lat1) * cos(lat2) * sin(dlon/2)**2
    c = 2 * asin(sqrt(a))
    if stype == 'km':
        r = 6371 # Radius of earth in kilometers
    else:
        r = 3956 # Radius of earth in miles
    d=round(c * r,3)
    return d
################################################################
Base='C:/VKHCG'
################################################################
sFileName=Base + '/01-Vermeulen/00-RawData/IP_DATA_CORE.csv'
print('Loading :',sFileName)
IP_DATA_ALL=pd.read_csv(sFileName,header=0,low_memory=False,
  usecols=['Country','Place Name','Latitude','Longitude'], encoding="latin-1")
################################################################
sFileDir=Base + '/01-Vermeulen/01-Retrieve/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
################################################################
IP_DATA = IP_DATA_ALL.drop_duplicates(subset=None, keep='first', inplace=False)
IP_DATA.rename(columns={'Place Name': 'Place_Name'}, inplace=True)
IP_DATA1 = IP_DATA
IP_DATA1.insert(0, 'K', 1)
IP_DATA2 = IP_DATA1
################################################################
print(IP_DATA1.shape)
################################################################
```

```
IP_CROSS=pd.merge(right=IP_DATA1,left=IP_DATA2,on='K')
IP_CROSS.drop('K', axis=1, inplace=True)
IP_CROSS.rename(columns={'Longitude_x': 'Longitude_from', 'Longitude_y': 'Longitude_to'},
inplace=True)
IP_CROSS.rename(columns={'Latitude_x': 'Latitude_from', 'Latitude_y': 'Latitude_to'},
inplace=True)
IP_CROSS.rename(columns={'Place_Name_x': 'Place_Name_from', 'Place_Name_y':
'Place_Name_to'}, inplace=True)
IP_CROSS.rename(columns={'Country_x': 'Country_from', 'Country_y': 'Country_to'},
inplace=True)
#####################################################################
IP_CROSS['DistanceBetweenKilometers'] = IP_CROSS.apply(lambda row:
   haversine(
         row['Longitude_from'],
         row['Latitude_from'],
         row['Longitude_to'],
         row['Latitude_to'],
         'km')
         ,axis=1)
#####################################################################
IP_CROSS['DistanceBetweenMiles'] = IP_CROSS.apply(lambda row:
   haversine(
         row['Longitude_from'],
         row['Latitude_from'],
         row['Longitude_to'],
         row['Latitude_to'],
         'miles')
         ,axis=1)
print(IP_CROSS.shape)
sFileName2=sFileDir + '/Retrieve_IP_Routing.csv'
IP_CROSS.to_csv(sFileName2, index = False, encoding="latin-1")
#####################################################################
print('### Done!! ############################################')
#####################################################################
```

Output:

See the file named Retrieve_IP_Routing.csv in C:\VKHCG\01-Vermeulen\01-Retrieve\01-EDS\02-Python.

1	Country_from	Place_Name_from	Latitude_from	Longitude_from	Country_to	Place_Name_to	Latitude_to	Longitude_to	DistanceBetweenKilometers	DistanceBetweenMiles
2	US	New York	40.7528	-73.9725	US	New York	40.7528	-73.9725	0	0
3	US	New York	40.7528	-73.9725	US	New York	40.7214	-74.0052	4.448	2.762
4	US	New York	40.7528	-73.9725	US	New York	40.7662	-73.9862	1.885	1.17
5	US	New York	40.7528	-73.9725	US	New York	40.7449	-73.9782	1.001	0.622
6	US	New York	40.7528	-73.9725	US	New York	40.7605	-73.9933	1.95	1.211
7	US	New York	40.7528	-73.9725	US	New York	40.7588	-73.968	0.767	0.476
8	US	New York	40.7528	-73.9725	US	New York	40.7637	-73.9727	1.212	0.753
9	US	New York	40.7528	-73.9725	US	New York	40.7553	-73.9924	1.699	1.055
10	US	New York	40.7528	-73.9725	US	New York	40.7308	-73.9975	3.228	2.004
11	US	New York	40.7528	-73.9725	US	New York	40.7694	-73.9609	2.088	1.297

Total Records: 22501

So, the distance between a router in New York (40.7528, -73.9725) to anoher router in New York (40.7214, -74.0052) is 4.448 kilometers, or 2.762 miles.

Building a Diagram for the Scheduling of Jobs

Start your Python editor and create a text file named Retrieve-Router-Location.py in directory. C:\VKHCG\01-Vermeulen\01-Retrieve.

```
##################    Retrieve-Router-Location.py   ######################
# -*- coding: utf-8 -*-
#################################################################
import sys
import os
import pandas as pd
#################################################################
InputFileName='IP_DATA_CORE.csv'
OutputFileName='Retrieve_Router_Location.csv'
#################################################################
Base='C:/VKHCG'
#################################################################
sFileName=Base + '/01-Vermeulen/00-RawData/' + InputFileName
print('Loading :',sFileName)
IP_DATA_ALL=pd.read_csv(sFileName,header=0,low_memory=False,
  usecols=['Country','Place Name','Latitude','Longitude'], encoding="latin-1")
#################################################################
IP_DATA_ALL.rename(columns={'Place Name': 'Place_Name'}, inplace=True)
#################################################################
sFileDir=Base + '/01-Vermeulen/01-Retrieve/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)

ROUTERLOC = IP_DATA_ALL.drop_duplicates(subset=None, keep='first', inplace=False)

print('Rows :',ROUTERLOC.shape[0])
print('Columns :',ROUTERLOC.shape[1])

sFileName2=sFileDir + '/' + OutputFileName
ROUTERLOC.to_csv(sFileName2, index = False, encoding="latin-1")
#################################################################
print('### Done!! ############################################')
#################################################################
```

Output:

```
>>>
=== RESTART: C:\VKHCG\01-Vermeulen\01-Retrieve\Retrieve-Router-Location.py ===
Loading : C:/VKHCG/01-Vermeulen/00-RawData/IP_DATA_CORE.csv
Rows : 150
Columns : 4
### Done!! ############################################
```

See the file named Retrieve_Router_Location.csv in C:\VKHCG\01-Vermeulen\01-Retrieve\01-EDS\02-Python.

1	Country	Place_Name	Latitude	Longitude
2	US	New York	40.7528	-73.9725
3	US	New York	40.7214	-74.0052
4	US	New York	40.7662	-73.9862
5	US	New York	40.7449	-73.9782
6	US	New York	40.7605	-73.9933
7	US	New York	40.7588	-73.968
8	US	New York	40.7637	-73.9727
9	US	New York	40.7553	-73.9924
10	US	New York	40.7308	-73.9975

Krennwallner AG

The company has two main jobs in need of your attention:

- *Picking content for billboards*: I will guide you through the data science required to pick advertisements for each billboard in the company.
- *Understanding your online visitor data*: I will guide you through the evaluation of the web traffic to the billboard's online web servers.

Picking Content for Billboards

Start your Python editor and create a text file named Retrieve-DE-Billboard-Locations.py in directory.
C:\VKHCG\02-Krennwallner\01-Retrieve.

```
################## Retrieve-DE-Billboard-Locations.py    ###############
# -*- coding: utf-8 -*-
########################################################################
import sys
import os
import pandas as pd
########################################################################
InputFileName='DE_Billboard_Locations.csv'
OutputFileName='Retrieve_DE_Billboard_Locations.csv'
Company='02-Krennwallner'
########################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
########################################################################
Base='C:/VKHCG'
sFileName=Base + '/' + Company + '/00-RawData/' + InputFileName
print('Loading :',sFileName)
IP_DATA_ALL=pd.read_csv(sFileName,header=0,low_memory=False,
  usecols=['Country','PlaceName','Latitude','Longitude'])

IP_DATA_ALL.rename(columns={'PlaceName': 'Place_Name'}, inplace=True)
########################################################################
```

```
sFileDir=Base + '/' + Company + '/01-Retrieve/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)

ROUTERLOC = IP_DATA_ALL.drop_duplicates(subset=None, keep='first', inplace=False)

print('Rows :',ROUTERLOC.shape[0])
print('Columns :',ROUTERLOC.shape[1])

sFileName2=sFileDir + '/' + OutputFileName
ROUTERLOC.to_csv(sFileName2, index = False)

#################################################################
print('### Done!! ################################################')
#################################################################
```

```
>>>
 RESTART: C:\VKHCG\02-Krennwallner\01-Retrieve\Retrieve-DE-Billboard-Locations.py
################################
Working Base : C:/VKHCG  using  win32
################################
Loading : C:/VKHCG/02-Krennwallner/00-RawData/DE_Billboard_Locations.csv
Rows : 8873
Columns : 4
### Done!! ############################################
```

See the file named Retrieve_Router_Location.csv in C:\VKHCG\02-Krennwallner\01-Retrieve\01-EDS\02-Python.

1	Country	Place_Name	Latitude	Longitude
2	US	New York	40.7528	-73.9725
3	US	New York	40.7214	-74.0052
4	US	New York	40.7662	-73.9862
5	US	New York	40.7449	-73.9782
6	US	New York	40.7605	-73.9933
7	US	New York	40.7588	-73.968
8	US	New York	40.7637	-73.9727
9	US	New York	40.7553	-73.9924
10	US	New York	40.7308	-73.9975

Understanding Your Online Visitor Data

Let's retrieve the visitor data for the billboard we have in Germany.

Several times it was found that common and important information is buried somewhere in the company's various data sources. Investigating any direct suppliers or consumers' upstream or downstream data sources attached to the specific business process is necessary. That is part of your skills that you are applying to data science. Numerous insightful fragments of information was found in the data sources surrounding a customer's business processes.

Start your Python editor and create a file named Retrieve-Online-Visitor.py in directory C:\VKHCG\02-Krennwallner\01-Retrieve.

```
#################################################################
# -*- coding: utf-8 -*-
```

```
#####################################################################
import sys
import os
import pandas as pd
import gzip as gz
#####################################################################
InputFileName='IP_DATA_ALL.csv'
OutputFileName='Retrieve_Online_Visitor'
CompanyIn= '01-Vermeulen'
CompanyOut= '02-Krennwallner'
#####################################################################
Base='C:/VKHCG'
print('#################################')
print('Working Base :',Base, ' using ', sys.platform)
print('#################################')
#####################################################################
Base='C:/VKHCG'
sFileName=Base + '/' + CompanyIn + '/00-RawData/' + InputFileName
print('Loading :',sFileName)
IP_DATA_ALL=pd.read_csv(sFileName,header=0,low_memory=False,
  usecols=['Country','Place Name','Latitude','Longitude','First IP Number','Last IP Number'])

IP_DATA_ALL.rename(columns={'Place Name': 'Place_Name'}, inplace=True)
IP_DATA_ALL.rename(columns={'First IP Number': 'First_IP_Number'}, inplace=True)
IP_DATA_ALL.rename(columns={'Last IP Number': 'Last_IP_Number'}, inplace=True)
#####################################################################
sFileDir=Base + '/' + CompanyOut + '/01-Retrieve/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)

visitordata = IP_DATA_ALL.drop_duplicates(subset=None, keep='first', inplace=False)
visitordata10=visitordata.head(10)

print('Rows :',visitordata.shape[0])
print('Columns :',visitordata.shape[1])

print('Export CSV')
sFileName2=sFileDir + '/' + OutputFileName + '.csv'
visitordata.to_csv(sFileName2, index = False)
print('Store All:',sFileName2)

sFileName3=sFileDir + '/' + OutputFileName + '_10.csv'
visitordata10.to_csv(sFileName3, index = False)
print('Store 10:',sFileName3)

for z in ['gzip', 'bz2', 'xz']:
    if z == 'gzip':
        sFileName4=sFileName2 + '.gz'
```

```
    else:
        sFileName4=sFileName2 + '.' + z
    visitordata.to_csv(sFileName4, index = False, compression=z)
    print('Store :',sFileName4)
#####################################################################
print('Export JSON')
for sOrient in ['split','records','index', 'columns','values','table']:
    sFileName2=sFileDir + '/' + OutputFileName + '_' + sOrient + '.json'
    visitordata.to_json(sFileName2,orient=sOrient,force_ascii=True)
    print('Store All:',sFileName2)

    sFileName3=sFileDir + '/' + OutputFileName + '_10_' + sOrient + '.json'
    visitordata10.to_json(sFileName3,orient=sOrient,force_ascii=True)
    print('Store 10:',sFileName3)

    sFileName4=sFileName2 + '.gz'
    file_in = open(sFileName2, 'rb')
    file_out = gz.open(sFileName4, 'wb')
    file_out.writelines(file_in)
    file_in.close()
    file_out.close()
    print('Store GZIP All:',sFileName4)

    sFileName5=sFileDir + '/' + OutputFileName + '_' + sOrient + '_UnGZip.json'
    file_in = gz.open(sFileName4, 'rb')
    file_out = open(sFileName5, 'wb')
    file_out.writelines(file_in)
    file_in.close()
    file_out.close()
    print('Store UnGZIP All:',sFileName5)
#####################################################################
print('### Done!! ############################################')
#####################################################################
```

Output:

```
== RESTART: C:\VKHCG\02-Krennwallner\01-Retrieve\Retrieve-Online-Visitor.py ==
################################
Working Base : C:/VKHCG  using  win32
################################
Loading : C:/VKHCG/01-Vermeulen/00-RawData/IP_DATA_ALL.csv
Rows : 3562
Columns : 6
Export CSV
Store All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor.csv
Store 10: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_10.csv
Store : C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor.csv.gz
Store : C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor.csv.bz2
Store : C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor.csv.xz
Export JSON
Store All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_split.json
Store 10: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_10_split.json
Store GZIP All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_split.json.gz
Store UnGZIP All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_split_UnGZip.json
Store All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_records.json
Store 10: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_10_records.json
Store GZIP All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_records.json.gz
Store UnGZIP All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_records_UnGZip.json
Store All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_index.json
Store 10: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_10_index.json
Store GZIP All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_index.json.gz
Store UnGZIP All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_index_UnGZip.json
Store All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_columns.json
Store 10: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_10_columns.json
Store GZIP All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_columns.json.gz
Store UnGZIP All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_columns_UnGZip.json
Store All: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor_values.json
```

See the file named Retrieve_Online_Visitor.csv in

C:\VKHCG\02-Krennwallner\01-Retrieve\01-EDS\02-Python.

	A	B	C	D	E	F
1	Country	Place_Name	Latitude	Longitude	First_IP_Number	Last_IP_Number
2	US	New York	40.6888	-74.0203	400887248	400887263
3	US	New York	40.6888	-74.0203	400904512	400904543
4	US	New York	40.6888	-74.0203	401402080	401402095
5	US	New York	40.6888	-74.0203	402261072	402261087
6	US	New York	40.6888	-74.0203	402288032	402288047
7	US	New York	40.6888	-74.0203	641892352	641900543
8	US	New York	40.6888	-74.0203	644464896	644465151
9	US	New York	40.6888	-74.0203	758770912	758770927
10	US	New York	40.6888	-74.0203	1075972352	1075975167

You can also see the following JSON files of only ten records.

XML processing.

Start Python editor and create a file named Retrieve-Online-Visitor-XML.py indirectory C:\VKHCG\02-Krennwallner\01-Retrieve.

```
########################################################################
# -*- coding: utf-8 -*-
########################################################################
import sys
import os
import pandas as pd
import xml.etree.ElementTree as ET
########################################################################
def df2xml(data):
    header = data.columns
    root = ET.Element('root')
    for row in range(data.shape[0]):
        entry = ET.SubElement(root,'entry')
        for index in range(data.shape[1]):
            schild=str(header[index])
            child = ET.SubElement(entry, schild)
            if str(data[schild][row]) != 'nan':
                child.text = str(data[schild][row])
            else:
                child.text = 'n/a'
            entry.append(child)
    result = ET.tostring(root)
    return result
########################################################################
def xml2df(xml_data):
    root = ET.XML(xml_data)
    all_records = []
    for i, child in enumerate(root):
        record = {}
        for subchild in child:
```

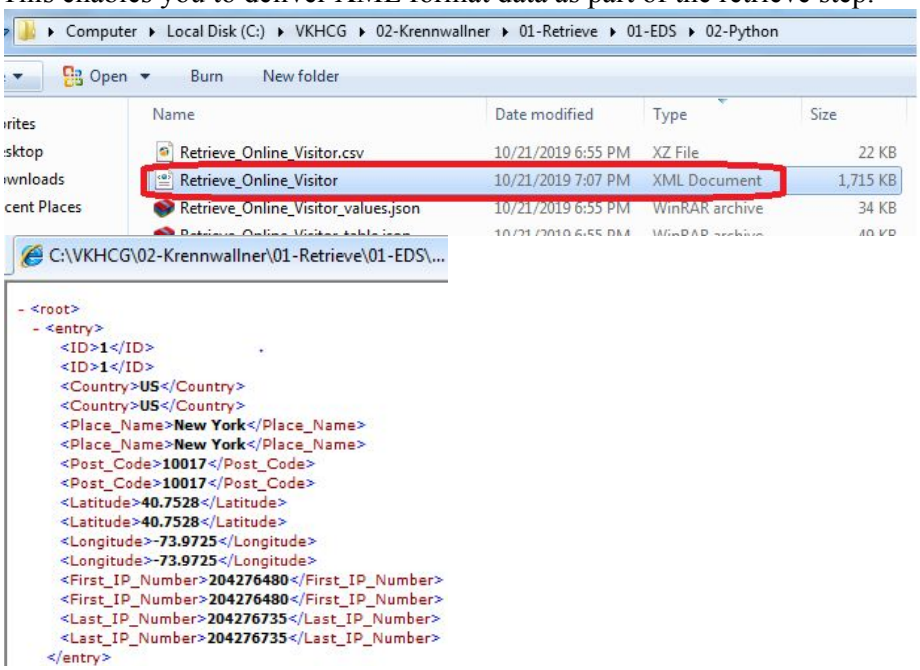
```
            record[subchild.tag] = subchild.text
        all_records.append(record)
    return pd.DataFrame(all_records)
#####################################################################
InputFileName='IP_DATA_ALL.csv'
OutputFileName='Retrieve_Online_Visitor.xml'
CompanyIn= '01-Vermeulen'
CompanyOut= '02-Krennwallner'
#####################################################################
if sys.platform == 'linux':
    Base=os.path.expanduser('~') + '/VKHCG'
else:
    Base='C:/VKHCG'
#####################################################################
print('#################################')
print('Working Base :',Base, ' using ', sys.platform)
print('#################################')
#####################################################################
sFileName=Base + '/' + CompanyIn + '/00-RawData/' + InputFileName
print('Loading :',sFileName)
IP_DATA_ALL=pd.read_csv(sFileName,header=0,low_memory=False)

IP_DATA_ALL.rename(columns={'Place Name': 'Place_Name'}, inplace=True)
IP_DATA_ALL.rename(columns={'First IP Number': 'First_IP_Number'}, inplace=True)
IP_DATA_ALL.rename(columns={'Last IP Number': 'Last_IP_Number'}, inplace=True)
IP_DATA_ALL.rename(columns={'Post Code': 'Post_Code'}, inplace=True)
#####################################################################
sFileDir=Base + '/' + CompanyOut + '/01-Retrieve/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)

visitordata = IP_DATA_ALL.head(10000)

print('Original Subset Data Frame')
print('Rows :',visitordata.shape[0])
print('Columns :',visitordata.shape[1])
print(visitordata)

print('Export XML')
sXML=df2xml(visitordata)

sFileName=sFileDir + '/' + OutputFileName
file_out = open(sFileName, 'wb')
file_out.write(sXML)
file_out.close()
print('Store XML:',sFileName)

xml_data = open(sFileName).read()
```

```
unxmlrawdata=xml2df(xml_data)
print('Raw XML Data Frame')
print('Rows :',unxmlrawdata.shape[0])
print('Columns :',unxmlrawdata.shape[1])
print(unxmlrawdata)
unxmldata = unxmlrawdata.drop_duplicates(subset=None, keep='first', inplace=False)
print('Deduplicated XML Data Frame')
print('Rows :',unxmldata.shape[0])
print('Columns :',unxmldata.shape[1])
print(unxmldata)
#########################################################################
#print('### Done!! ################################################')
#########################################################################
```

Output:

```
Working Base : C:/VKHCG  using  win32
##############################
Loading : C:/VKHCG/01-Vermeulen/00-RawData/IP_DATA_ALL.csv
Original Subset Data Frame
Rows : 3562
Columns : 8
      ID Country Place_Name  ... Longitude  First_IP_Number  Last_IP_Number
0      1    US   New York  ... -73.9725       204276480       204276735
1      2    US   New York  ... -73.9725       301984864       301985791
2      3    US   New York  ... -73.9725       404678736       404679039
3      4    US   New York  ... -73.9725       411592704       411592959
4      5    US   New York  ... -73.9725       416784384       416784639
...   ...   ...       ... ...      ...            ...             ...
3557  3558    DE    Munich  ...  11.5392     1591269504      1591269631
3558  3559    DE    Munich  ...  11.7500     1558374784      1558374911
3559  3560    DE    Munich  ...  11.4667     1480845312      1480845439
3560  3561    DE    Munich  ...  11.7434     1480596992      1480597503
3561  3562    DE    Munich  ...  11.7434     1558418432      1558418943

[3562 rows x 8 columns]
Export XML
Store XML: C:/VKHCG/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor.xml
Raw XML Data Frame
Rows : 3562
Columns : 8
      ID Country Place_Name  ... Longitude First_IP_Number Last_IP_Number
0      1    US   New York  ... -73.9725       204276480       204276735
1      2    US   New York  ... -73.9725       301984864       301985791
2      3    US   New York  ... -73.9725       404678736       404679039
3      4    US   New York  ... -73.9725       411592704       411592959
4      5    US   New York  ... -73.9725       416784384       416784639
...   ...   ...       ... ...      ...             ...             ...
3557  3558    DE    Munich  ...  11.5392      1591269504      1591269631
3558  3559    DE    Munich  ...    11.75      1558374784      1558374911
3559  3560    DE    Munich  ...  11.4667      1480845312      1480845439
3560  3561    DE    Munich  ...  11.7434      1480596992      1480597503
3561  3562    DE    Munich  ...  11.7434      1558418432      1558418943

[3562 rows x 8 columns]
Deduplicated XML Data Frame
Rows : 3562
Columns : 8
      ID Country Place_Name  ... Longitude First_IP_Number Last_IP_Number
0      1    US   New York  ... -73.9725       204276480       204276735
1      2    US   New York  ... -73.9725       301984864       301985791
2      3    US   New York  ... -73.9725       404678736       404679039
3      4    US   New York  ... -73.9725       411592704       411592959
4      5    US   New York  ... -73.9725       416784384       416784639
...   ...   ...       ... ...      ...             ...             ...
3557  3558    DE    Munich  ...  11.5392      1591269504      1591269631
3558  3559    DE    Munich  ...    11.75      1558374784      1558374911
3559  3560    DE    Munich  ...  11.4667      1480845312      1480845439
3560  3561    DE    Munich  ...  11.7434      1480596992      1480597503
3561  3562    DE    Munich  ...  11.7434      1558418432      1558418943

[3562 rows x 8 columns]
>>>
```

See a file named Retrieve_Online_Visitor.xml in
C:\VKHCG\02-Krennwallner\01-Retrieve\01-EDS\02-Python.
This enables you to deliver XML format data as part of the retrieve step.



Hillman Ltd

The company has four main jobs requiring your attention:

- *Planning the locations of the warehouses*: Hillman has countless UK warehouses, but owing to financial hardships, the business wants to shrink the quantity of warehouses by 20%.
- *Planning the shipping rules for best-fit international logistics*: At Hillman Global Logistics' expense, the company has shipped goods from its international warehouses to its UK shops. This model is no longer sustainable. The co-owned shops now want more feasibility regarding shipping options.
- *Adopting the best packing option for shipping in containers*: Hillman has introduced a new three-size-shipping-container solution. It needs a packing solution encompassing the warehouses, shops, and customers.
- *Creating a delivery route*: Hillman needs to preplan a delivery route for each of its warehouses to shops, to realize a 30% savings in shipping costs.

Planning Shipping Rules for Best-Fit International Logistics

(Befor this Program, first understand the business terms explained in the reference book)

EXW—Ex Works (Named Place of Delivery)

By this term, the seller makes the goods available at its premises or at another namedplace. This term places the maximum obligation on the buyer and minimum obligationson the seller.
Start yourPython editor and create a file named Retrieve-Incoterm-EXW.py in directory
C:\VKHCG\03-Hillman\01-Retrieve.

```
##################################################################
# -*- coding: utf-8 -*-
```

```
import os
import sys
import pandas as pd
IncoTerm='EXW'
InputFileName='Incoterm_2010.csv'
OutputFileName='Retrieve_Incoterm_' + IncoTerm + '_RuleSet.csv'
Company='03-Hillman'
#####################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
sFileDir=Base + '/' + Company + '/01-Retrieve/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
#####################################################################
### Import Incoterms
#####################################################################
sFileName=Base + '/' + Company + '/00-RawData/' + InputFileName
print('############')
print('Loading :',sFileName)
IncotermGrid=pd.read_csv(sFileName,header=0,low_memory=False)
IncotermRule=IncotermGrid[IncotermGrid.Shipping_Term == IncoTerm]
print('Rows :',IncotermRule.shape[0])
print('Columns :',IncotermRule.shape[1])
print('############')
print(IncotermRule)
sFileName=sFileDir + '/' + OutputFileName
IncotermRule.to_csv(sFileName, index = False)
print('### Done!! ############################################')
```

Output

See the file named Retrieve_Incoterm_EXW.csv in C:\VKHCG\03-Hillman\01-Retrieve\01-EDS\02-Python. Open this file,

```
>>>
===== RESTART: C:\VKHCG\03-Hillman\01-Retrieve\Retrieve-Incoterm-EXW.py =====
##################################
Working Base : C:/VKHCG  using  win32
##################################
############
Loading : C:/VKHCG/03-Hillman/00-RawData/Incoterm_2010.csv
Rows : 1
Columns : 9
############
  Shipping_Term  Seller Carrier Port_From  ... Port_To Terminal Named_Place  Buyer
0           EXW  Seller   Buyer     Buyer  ...   Buyer    Buyer       Buyer  Buyer

[1 rows x 9 columns]
### Done!! ############################################
```

FCA—Free Carrier (Named Place of Delivery)
Under this condition, the seller delivers the goods, cleared for export, at a named place.
If I were to buy *Practical Data Science* at an overseas duty-free shop and then pick it up at the duty-free desk before taking it home, and the shop has shipped it FCA— Free Carrier—to the duty-free desk, the moment I pay at the register, the ownership is transferred to me, but if anything happens to the book between the shop and the duty-free desk, the shop will have to pay. It is only once I pick it up at the desk that I will have to pay, if anything happens. So, the moment I take the book, the transaction becomes EXW, so I have to pay any necessary import duties on arrival in my home country. Let's see what the data science finds. Start your Python editor and create a text file named Retrieve-Incoterm-FCA.py in directory .\VKHCG\03-Hillman\01-Retrieve.

```
################################################################
# -*- coding: utf-8 -*-
################################################################
import os
import sys
import pandas as pd
################################################################
IncoTerm='FCA'
InputFileName='Incoterm_2010.csv'
OutputFileName='Retrieve_Incoterm_' + IncoTerm + '_RuleSet.csv'
Company='03-Hillman'
################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
################################################################
sFileDir=Base + '/' + Company + '/01-Retrieve/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
################################################################
### Import Incoterms
################################################################
sFileName=Base + '/' + Company + '/00-RawData/' + InputFileName
print('############')
print('Loading :',sFileName)
IncotermGrid=pd.read_csv(sFileName,header=0,low_memory=False)
IncotermRule=IncotermGrid[IncotermGrid.Shipping_Term == IncoTerm]
print('Rows :',IncotermRule.shape[0])
print('Columns :',IncotermRule.shape[1])
print('############')

print(IncotermRule)
################################################################
```

```
sFileName=sFileDir + '/' + OutputFileName
IncotermRule.to_csv(sFileName, index = False)

#################################################################
print('### Done!! ############################################')
#################################################################
```

Output:

```
>>>
===== RESTART: C:\VKHCG\03-Hillman\01-Retrieve\Retrieve-Incoterm-FCA.py =====
################################
Working Base : C:/VKHCG  using  win32
################################
############
Loading : C:/VKHCG/03-Hillman/00-RawData/Incoterm_2010.csv
Rows : 1
Columns : 9
############
  Shipping_Term  Seller Carrier Port_From  ... Port_To Terminal Named_Place  Buyer
1           FCA  Seller  Seller     Buyer  ...   Buyer    Buyer       Buyer  Buyer

[1 rows x 9 columns]
### Done!! ############################################
```

CPT—Carriage Paid To (Named Place of Destination)

The seller, under this term, pays for the carriage of the goods up to the named place of destination. However, the goods are considered to be delivered when they have been handed over to the first carrier, so that the risk transfers to the buyer upon handing the goods over to the carrier at the place of shipment in the country of export.

Start your Python editor and create a file named Retrieve-Incoterm-CPT.py in directory C:\VKHCG\03-Hillman\01-Retrieve.

CIP—Carriage and Insurance Paid To (Named Place of Destination)

This term is generally similar to the preceding CPT, with the exception that the seller is required to obtain insurance for the goods while in transit. Following is the data science version.

DAT—Delivered at Terminal (Named Terminal at Port or Place of Destination)

This Incoterm requires that the seller deliver the goods, unloaded, at the named terminal. The seller covers all the costs of transport (export fees, carriage, unloading from the main carrier at destination port, and destination port charges) and assumes all risks until arrival at the destination port or terminal.

DAP—Delivered at Place (Named Place of Destination)

According to Incoterm 2010's definition, DAP—Delivered at Place—means that, at the disposal of the buyer, the seller delivers when the goods are placed on the arriving means of transport, ready for unloading at the named place of destination. Under DAP terms, the risk passes from seller to buyer from the point of destination mentioned in the contract of delivery.

DDP—Delivered Duty Paid (Named Place of Destination)

By this term, the seller is responsible for delivering the goods to the named place in the country of the buyer and pays all costs in bringing the goods to the destination, including import duties and taxes. The seller is not responsible for unloading. This term places the maximum obligations on the seller and minimum obligations

on the buyer. No risk or responsibility is transferred to the buyer until delivery of the goods at the named place of destination.

Possible Shipping Routes

There are numerous potential shipping routes available to the company. The retrieve step can generate the potential set, by using a route combination generator. This will give you a set of routes, but it is highly unlikely that you will ship along all of them. It is simply a population of routes that can be used by the data science to find the optimum solution.

Start your Python editor and create a file named Retrieve-Warehouse-Incoterm-Chains.py in directory C:\VKHCG\03-Hillman\01-Retrieve.

Adopt New Shipping Containers

Adopting the best packing option for shipping in containers will require that I introduce a new concept. Shipping of containers is based on a concept reducing the packaging you use down to an optimum set of sizes having the following requirements:

- The product must fit within the box formed by the four sides of a cube.
- The product can be secured using packing foam, which will fill any void volume in the packaging.
- Packaging must fit in shipping containers with zero space gaps.
- Containers can only hold product that is shipped to a single warehouse, shop, or customer.

Start your Python editor and create a text file named Retrieve-Container-Plan.py in directory .
C:\VKHCG\03-Hillman\01-Retrieve.

***** Replace pd.DataFrame.from_items with pd.DataFrame.from_dict**

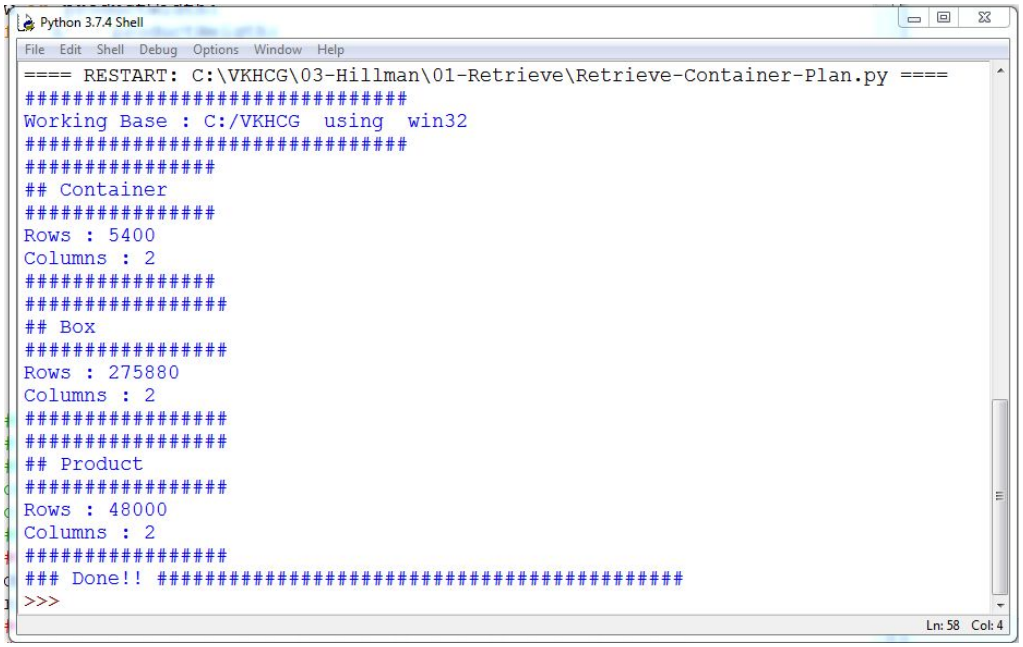
```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
################################################################
ContainerFileName='Retrieve_Container.csv'
BoxFileName='Retrieve_Box.csv'
ProductFileName='Retrieve_Product.csv'
Company='03-Hillman'
################################################################
Base='C:/VKHCG'
################################################################
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
################################################################
sFileDir=Base + '/' + Company + '/01-Retrieve/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
################################################################
### Create the Containers
################################################################
containerLength=range(1,21)
containerWidth=range(1,10)
containerHeigth=range(1,6)
```

```
containerStep=1
c=0
for l in containerLength:
    for w in containerWidth:
        for h in containerHeigth:
            containerVolume=(l/containerStep)*(w/containerStep)*(h/containerStep)
            c=c+1
            ContainerLine=[('ShipType', ['Container']),
                    ('UnitNumber', ('C'+format(c,"06d"))),
                    ('Length',(format(round(l,3),".4f"))),
                    ('Width',(format(round(w,3),".4f"))),
                    ('Height',(format(round(h,3),".4f"))),
                    ('ContainerVolume',(format(round(containerVolume,6),".6f")))]
            if c==1:
               ContainerFrame = pd.DataFrame.from_dict(ContainerLine)
            else:
                ContainerRow = pd.DataFrame.from_dict(ContainerLine)
                ContainerFrame = ContainerFrame.append(ContainerRow)
            ContainerFrame.index.name = 'IDNumber'

print('#################')
print('## Container')
print('#################')
print('Rows :',ContainerFrame.shape[0])
print('Columns :',ContainerFrame.shape[1])
print('#################')
#####################################################################
sFileContainerName=sFileDir + '/' + ContainerFileName
ContainerFrame.to_csv(sFileContainerName, index = False)
#####################################################################
## Create valid Boxes with packing foam
#####################################################################
boxLength=range(1,21)
boxWidth=range(1,21)
boxHeigth=range(1,21)
packThick=range(0,6)
boxStep=10
b=0
for l in boxLength:
    for w in boxWidth:
        for h in boxHeigth:
            for t in packThick:
                boxVolume=round((l/boxStep)*(w/boxStep)*(h/boxStep),6)
                productVolume=round(((l-t)/boxStep)*((w-t)/boxStep)*((h-t)/boxStep),6)
                if productVolume > 0:
                    b=b+1
                    BoxLine=[('ShipType', ['Box']),
                      ('UnitNumber', ('B'+format(b,"06d"))),
```

```
                ('Length',(format(round(l/10,6),".6f"))),
                ('Width',(format(round(w/10,6),".6f"))),
                ('Height',(format(round(h/10,6),".6f"))),
                ('Thickness',(format(round(t/5,6),".6f"))),
                ('BoxVolume',(format(round(boxVolume,9),".9f"))),
                ('ProductVolume',(format(round(productVolume,9),".9f")))]
            if b==1:
                BoxFrame = pd.DataFrame.from_dict(BoxLine)
            else:
                BoxRow = pd.DataFrame.from_dict(BoxLine)
                BoxFrame = BoxFrame.append(BoxRow)
            BoxFrame.index.name = 'IDNumber'
print('#################')
print('## Box')
print('#################')
print('Rows :',BoxFrame.shape[0])
print('Columns :',BoxFrame.shape[1])
print('#################')
#####################################################################
sFileBoxName=sFileDir + '/' + BoxFileName
BoxFrame.to_csv(sFileBoxName, index = False)
#####################################################################
## Create valid Product
#####################################################################
productLength=range(1,21)
productWidth=range(1,21)
productHeigth=range(1,21)
productStep=10
p=0
for l in productLength:
    for w in productWidth:
        for h in productHeigth:
            productVolume=round((l/productStep)*(w/productStep)*(h/productStep),6)
            if productVolume > 0:
                p=p+1
                ProductLine=[('ShipType', ['Product']),
                  ('UnitNumber', ('P'+format(p,"06d"))),
                  ('Length',(format(round(l/10,6),".6f"))),
                  ('Width',(format(round(w/10,6),".6f"))),
                  ('Height',(format(round(h/10,6),".6f"))),
                  ('ProductVolume',(format(round(productVolume,9),".9f")))]
                if p==1:
                  ProductFrame = pd.DataFrame.from_dict(ProductLine)
                else:
                  ProductRow = pd.DataFrame.from_dict(ProductLine)
                  ProductFrame = ProductFrame.append(ProductRow)
                BoxFrame.index.name = 'IDNumber'
print('#################')
```

```
print('## Product')
print('##################')
print('Rows :',ProductFrame.shape[0])
print('Columns :',ProductFrame.shape[1])
print('##################')
#####################################################################
sFileProductName=sFileDir + '/' + ProductFileName
ProductFrame.to_csv(sFileProductName, index = False)
#####################################################################
#####################################################################
print('### Done!! ##############################################')
#####################################################################
```

Output:



Your second simulation is the cardboard boxes for the packing of the products. The requirement is for boxes having a dimension of 100 centimeters × 100 centimeters × 100 centimeters to 2.1 meters × 2.1 meters × 2.1 meters. You can also use between zero and 600 centimeters of packing foam to secure any product in the box.

See the container data file Retrieve_Container.csv and Retrieve_Box.csv in C:\VKHCG\03-Hillman\01-Retrieve\01-EDS\02-Python.

Create a Delivery Route

The model enables you to generate a complex routing plan for the shipping routes of the company. Start your Python editor and create a text file named Retrieve-Route-Plan.py in directory . C:\VKHCG\03-Hillman\01-Retrieve.

```
#####################################################################
# -*- coding: utf-8 -*-
#####################################################################
```

```
import os
import sys
import pandas as pd
from geopy.distance import vincenty
#################################################################
InputFileName='GB_Postcode_Warehouse.csv'
OutputFileName='Retrieve_GB_Warehouse.csv'
Company='03-Hillman'
#################################################################
Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
#################################################################
sFileDir=Base + '/' + Company + '/01-Retrieve/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
#################################################################
sFileName=Base + '/' + Company + '/00-RawData/' + InputFileName
print('############')
print('Loading :',sFileName)
Warehouse=pd.read_csv(sFileName,header=0,low_memory=False)

WarehouseClean=Warehouse[Warehouse.latitude != 0]
WarehouseGood=WarehouseClean[WarehouseClean.longitude != 0]

WarehouseGood.drop_duplicates(subset='postcode', keep='first', inplace=True)

WarehouseGood.sort_values(by='postcode', ascending=1)
#################################################################
sFileName=sFileDir + '/' + OutputFileName
WarehouseGood.to_csv(sFileName, index = False)
#################################################################

WarehouseLoop = WarehouseGood.head(20)

for i in range(0,WarehouseLoop.shape[0]):
    print('Run :',i,' =======>>>>>>>>>>>',WarehouseLoop['postcode'][i])
    WarehouseHold = WarehouseGood.head(10000)
    WarehouseHold['Transaction']=WarehouseHold.apply(lambda row:
            'WH-to-WH'
            ,axis=1)
    OutputLoopName='Retrieve_Route_' + 'WH-' + WarehouseLoop['postcode'][i] + '_Route.csv'

    WarehouseHold['Seller']=WarehouseHold.apply(lambda row:
            'WH-' + WarehouseLoop['postcode'][i]
            ,axis=1)
```

```
    WarehouseHold['Seller_Latitude']=WarehouseHold.apply(lambda row:
            WarehouseHold['latitude'][i],axis=1)
    WarehouseHold['Seller_Longitude']=WarehouseHold.apply(lambda row:
            WarehouseLoop['longitude'][i],axis=1)

    WarehouseHold['Buyer']=WarehouseHold.apply(lambda row:
            'WH-' + row['postcode'],axis=1)

    WarehouseHold['Buyer_Latitude']=WarehouseHold.apply(lambda row:
            row['latitude'],axis=1)
    WarehouseHold['Buyer_Longitude']=WarehouseHold.apply(lambda row:
            row['longitude'],axis=1)

    WarehouseHold['Distance']=WarehouseHold.apply(lambda row: round(
       vincenty((WarehouseLoop['latitude'][i],WarehouseLoop['longitude'][i]),
            (row['latitude'],row['longitude'])).miles,6),axis=1)

    WarehouseHold.drop('id', axis=1, inplace=True)
    WarehouseHold.drop('postcode', axis=1, inplace=True)
    WarehouseHold.drop('latitude', axis=1, inplace=True)
    WarehouseHold.drop('longitude', axis=1, inplace=True)
    ######################################################################
    sFileLoopName=sFileDir + '/' + OutputLoopName
    WarehouseHold.to_csv(sFileLoopName, index = False)
######################################################################
print('### Done!! ############################################')
######################################################################
```

Output:

```
====== RESTART: C:\VKHCG\03-Hillman\01-Retrieve\Retrieve-Route-Plan.py ======
################################
Working Base : C:/VKHCG  using  win32
################################
###########
Loading : C:/VKHCG/03-Hillman/00-RawData/GB_Postcode_Warehouse.csv
Run : 0  =======>>>>>>>>>> AB10
Run : 1  =======>>>>>>>>>> AB11
Run : 2  =======>>>>>>>>>> AB12
Run : 3  =======>>>>>>>>>> AB13
Run : 4  =======>>>>>>>>>> AB14
Run : 5  =======>>>>>>>>>> AB15
Run : 6  =======>>>>>>>>>> AB16
Run : 7  =======>>>>>>>>>> AB21
Run : 8  =======>>>>>>>>>> AB22
Run : 9  =======>>>>>>>>>> AB23
Run : 10  =======>>>>>>>>>> AB24
Run : 11  =======>>>>>>>>>> AB25
Run : 12  =======>>>>>>>>>> AB30
```

```
Run : 13 =======>>>>>>>>>> AB31
Run : 14 =======>>>>>>>>>> AB32
Run : 15 =======>>>>>>>>>> AB33
Run : 16 =======>>>>>>>>>> AB34
Run : 17 =======>>>>>>>>>> AB35
Run : 18 =======>>>>>>>>>> AB36
Run : 19 =======>>>>>>>>>> AB37
### Done!! ############################################
>>>
```

See the collection of files similar in format to Retrieve_Route_WH-AB11_Route.csv in C:\VKHCG\03-Hillman\01-Retrieve\01-EDS\02-Python.

	Transaction	Seller	Seller_Latitude	Seller_Longitude	Buyer	Buyer_Latitude	Buyer_Longitude	Distance
2	WH-to-WH	WH-AB11	57.13875	-2.09089	WH-AB10	57.13514	-2.11731	1.024915
3	WH-to-WH	WH-AB11	57.13875	-2.09089	WH-AB11	57.13875	-2.09089	0
4	WH-to-WH	WH-AB11	57.13875	-2.09089	WH-AB12	57.101	-2.1106	2.715503
5	WH-to-WH	WH-AB11	57.13875	-2.09089	WH-AB13	57.10801	-2.23776	5.922893

Global Post Codes

Open RStudio and use R to process the following R script:
Retrieve-Postcode-Global.r.

```
library(readr)
All_Countries <- read_delim("C:/VKHCG/03-Hillman/00-RawData/All_Countries.txt",
                            "\t", col_names = FALSE,
                            col_types = cols(
                              X12 = col_skip(),
                              X6 = col_skip(),
                              X7 = col_skip(),
                              X8 = col_skip(),
                              X9 = col_skip()),
                            na = "null", trim_ws = TRUE)
write.csv(All_Countries,
          file = "C:/VKHCG/03-Hillman/01-Retrieve/01-EDS/01-R/Retrieve_All_Countries.csv")
```

Output:

The program will successfully uploaded a new file named Retrieve_All_Countries.csv, after removing column No. 6, 7, 8, 9 and 12 from All_Countries.txt

	A	B	C	D	E	F	G	H
1		X1	X2	X3	X4	X5	X10	X11
2	1	x1	x2	x3	x4	x5	x10	x11
3	2	AD	AD100	Canillo			42.5833	1.6667
4	3	AD	AD200	Encamp			42.5333	1.6333
5	4	AD	AD300	Ordino			42.6	1.55
6	5	AD	AD400	La Massana			42.5667	1.4833
7	6	AD	AD500	Andorra la Vella			42.5	1.5
8	7	AD	AD600	Sant Juli<c3> de Lòria			42.4667	1.5
9	8	AD	AD700	Escaldes-Engordany			42.5	1.5667
10	9	AR	3636	POZO CERCADO (EL CHORRO (F), DPTO. RIVADAVIA (S))	Salta	A	-23.4933	-61.9267
11	10	AR	4123	LAS SALADAS	Salta	A	-25.7833	-64.5

Clark Ltd

Clark is the financial powerhouse of the group. It must process all the money-related data sources.

Forex-The first financial duty of the company is to perform any foreign exchange trading.

Forex Base Data-Previously, you found a single data source (Euro_ExchangeRates.csv) for forex rates in Clark. Earlier in the chapter, I helped you to create the load, as part of your R processing.

The relevant file is Retrieve_Retrieve_Euro_ExchangeRates.csv in directory C:\ VKHCG\04-Clark\01-Retrieve\01-EDS\01-R. So, that data is ready.

Financials - Clark generates the financial statements for all the group's companies.

Financial Base Data - You found a single data source (Profit_And_Loss.csv) in Clark for financials and, as mentioned previously, a single data source (Euro_ExchangeRates.csv) for forex rates. The file relevant file is Retrieve_Profit_And_Loss.csv in directory C:\VKHCG\04-Clark\01-Retrieve\ 01-EDS\01-R.

Person Base Data

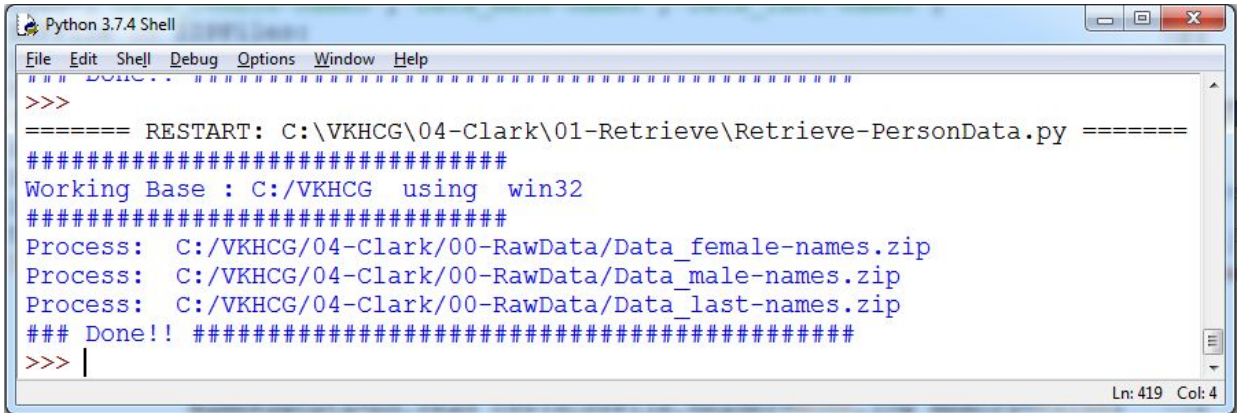
Start Python editor and create a file named Retrieve-PersonData.py in directory . C:\VKHCG\04-Clark\01-Retrieve.

```
##################################################################
# -*- coding: utf-8 -*-
##################################################################
import sys
import os
import shutil
import zipfile
import pandas as pd
##################################################################
Base='C:/VKHCG'
##################################################################
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
##################################################################
Company='04-Clark'
ZIPFiles=['Data_female-names','Data_male-names','Data_last-names']
for ZIPFile in ZIPFiles:
    InputZIPFile=Base+'/'+Company+'/00-RawData/' + ZIPFile + '.zip'
    OutputDir=Base+'/'+Company+'/01-Retrieve/01-EDS/02-Python/' + ZIPFile
    OutputFile=Base+'/'+Company+'/01-Retrieve/01-EDS/02-Python/Retrieve-'+ZIPFile+'.csv'
    zip_file = zipfile.ZipFile(InputZIPFile, 'r')
    zip_file.extractall(OutputDir)
    zip_file.close()
    t=0
    for dirname, dirnames, filenames in os.walk(OutputDir):
        for filename in filenames:
            sCSVFile = dirname + '/' + filename
            t=t+1
```

```
        if t==1:
            NameRawData=pd.read_csv(sCSVFile,header=None,low_memory=False)
            NameData=NameRawData
        else:
            NameRawData=pd.read_csv(sCSVFile,header=None,low_memory=False)
            NameData=NameData.append(NameRawData)
    NameData.rename(columns={0 : 'NameValues'},inplace=True)
    NameData.to_csv(OutputFile, index = False)
    shutil.rmtree(OutputDir)
    print('Process: ',InputZIPFile)
##################################################################
print('### Done!! ################################################')
##################################################################
```

This generates three files named

Retrieve-Data_female-names.csv
Retrieve-Data_male-names.csv
Retrieve-Data_last-names.csv

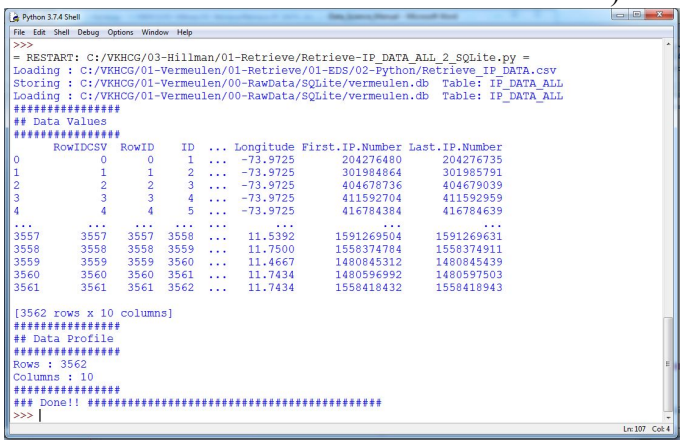


Connecting to other Data Sources

A. Program to connect to different data sources.

SQLite:

```
########################################## ######################
# -*- coding: utf-8 -*-
#########################################################################
import sqlite3 as sq
import pandas as pd
#########################################################################
Base='C:/VKHCG'
sDatabaseName=Base + '/01-Vermeulen/00-RawData/SQLite/vermeulen.db'
conn = sq.connect(sDatabaseName)
#########################################################################
sFileName='C:/VKHCG/01-Vermeulen/01-Retrieve/01-EDS/02-Python/Retrieve_IP_DATA.csv'
print('Loading :',sFileName)
IP_DATA_ALL_FIX=pd.read_csv(sFileName,header=0,low_memory=False)
IP_DATA_ALL_FIX.index.names = ['RowIDCSV']
sTable='IP_DATA_ALL'
print('Storing :',sDatabaseName,' Table:',sTable)
IP_DATA_ALL_FIX.to_sql(sTable, conn, if_exists="replace")
print('Loading :',sDatabaseName,' Table:',sTable)
TestData=pd.read_sql_query("select * from IP_DATA_ALL;", conn)
print('#################')
print('## Data Values')
print('#################')
print(TestData)
print('#################')
print('## Data Profile')
print('#################')
print('Rows :',TestData.shape[0])
print('Columns :',TestData.shape[1])
print('#################')
print('### Done!! ############################################')
```



MySQL:

Open MySql

Create a database “DataScience”

Create a python file and add the following code:

```
################# Connection With MySQL ######################
import mysql.connector

conn = mysql.connector.connect(host='localhost',
                               database='DataScience',
                               user='root',
                               password='root')
conn.connect
if(conn.is_connected):
   print('###### Connection With MySql Established Successfullly ##### ')
else:
   print('Not Connected -- Check Connection Properites')
```

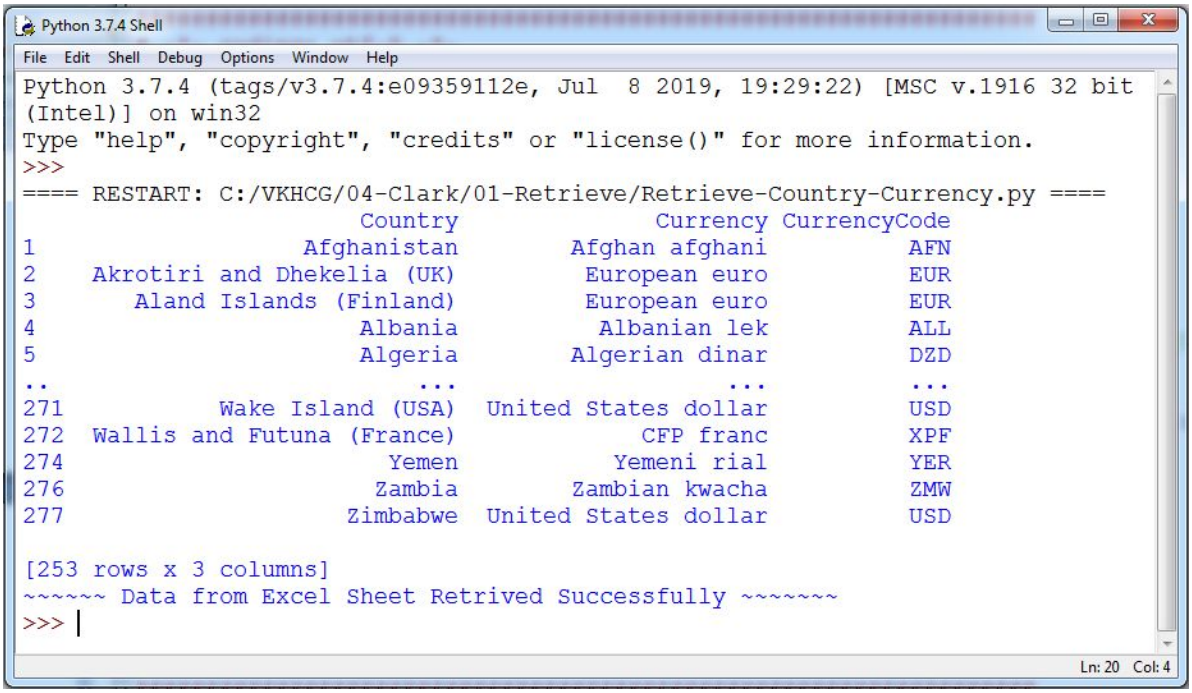
```
>>>
 RESTART: C:/Users/User/AppData/Local/Programs/Python/Python37-32/mysqlconnection.py
###### Connection With MySql Established Successfullly #####
>>>
```

Microsoft Excel

```
##################Retrieve-Country-Currency.py
#####################################################################
# -*- coding: utf-8 -*-
#####################################################################
import os
import pandas as pd
#####################################################################
Base='C:/VKHCG'
#####################################################################
sFileDir=Base + '/01-Vermeulen/01-Retrieve/01-EDS/02-Python'
#if not os.path.exists(sFileDir):
#os.makedirs(sFileDir)
#####################################################################
CurrencyRawData = pd.read_excel('C:/VKHCG/01-Vermeulen/00-RawData/Country_Currency.xlsx')
sColumns = ['Country or territory', 'Currency', 'ISO-4217']
CurrencyData = CurrencyRawData[sColumns]
CurrencyData.rename(columns={'Country or territory': 'Country', 'ISO-4217':
'CurrencyCode'}, inplace=True)
CurrencyData.dropna(subset=['Currency'],inplace=True)
CurrencyData['Country'] = CurrencyData['Country'].map(lambda x: x.strip())
CurrencyData['Currency'] = CurrencyData['Currency'].map(lambda x:
x.strip())
```

```
CurrencyData['CurrencyCode'] = CurrencyData['CurrencyCode'].map(lambda x:
x.strip())
print(CurrencyData)
print('~~~~~~ Data from Excel Sheet Retrived Successfully ~~~~~~~ ')
#####################################################################
sFileName=sFileDir + '/Retrieve-Country-Currency.csv'
CurrencyData.to_csv(sFileName, index = False)
#####################################################################
```

OUTPUT:



Practical 5:

Assessing Data

Assess Superstep

Data quality refers to the condition of a set of qualitative or quantitative variables. Dataquality is a multidimensional measurement of the acceptability of specific data sets. Inbusiness, data quality is measured to determine whether data can be used as a basis forreliable intelligence extraction for supporting organizational decisions. Data profiling involves observing in your data sources all the viewpoints that theinformation offers. The main goal is to determine if individual viewpoints are accurateand complete. The Assess superstep determines what additional processing to apply tothe entries that are noncompliant.

Errors

Typically, one of four things can be done with an error to the data.

1. Accept the Error
2. Reject the Error
3. Correct the Error
4. Create a Default Value

A. Perform error management on the given data using pandas package.

Python pandas package enables several automatic error-management features.

File Location: C:\VKHCG\01-Vermeulen\02-Assess

Missing Values in Pandas:

i. Drop the Columns Where All Elements Are Missing Values

	A	B	C	D	E	F	G	H
1	ID	FieldA	FieldB	FieldC	FieldD	FieldE	FieldF	FieldG
2	1	Good	Better	Best	1024		10241	1
3	2	Good		Best	512		5121	2
4	3	Good	Better		256		256	3
5	4	Good	Better	Best			211	4
6	5	Good	Better		64		6411	5
7	6	Good		Best	32		32	6
8	7		Better	Best	16		1611	7
9	8			Best	8		8111	8
10	9				4		41	9
11	10	A	B	C	2		21111	10
12								11
13	10	Good	Better	Best	1024		102411	12
14	10	Good		Best	512		512	13
15	10	Good	Better		256		1256	14
16	10	Good	Better	Best				15
17	10	Good	Better		64		164	16
18	10	Good		Best	32		322	17
19	10		Better	Best	16		163	18
20	10			Best	8		844	19
21	10				4		4555	20
22	10	A	B	C	2		111	21

Code :

```
##################### Assess-Good-Bad-01.py#########################
# -*- coding: utf-8 -*-
#####################################################################
import sys
import os
```

```
import pandas as pd
#################################################################
Base='C:/VKHCG'
#################################################################
print('#################################')
print('Working Base :',Base, ' using ', sys.platform)
print('#################################')
#################################################################
sInputFileName='Good-or-Bad.csv'
sOutputFileName='Good-or-Bad-01.csv'
Company='01-Vermeulen'
#################################################################
Base='C:/VKHCG'
#################################################################
sFileDir=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
#################################################################
### Import Warehouse
#################################################################
sFileName=Base + '/' + Company + '/00-RawData/' + sInputFileName
print('Loading :',sFileName)
RawData=pd.read_csv(sFileName,header=0)
print('#################################')
print('## Raw Data Values')
print('#################################')
print(RawData)
print('#################################')
print('## Data Profile')
print('#################################')
print('Rows :',RawData.shape[0])
print('Columns :',RawData.shape[1])
print('#################################')
#################################################################
sFileName=sFileDir + '/' + sInputFileName
RawData.to_csv(sFileName, index = False)
#################################################################
TestData=RawData.dropna(axis=1, how='all')
#################################################################
print('#################################')
print('## Test Data Values')
print('#################################')
```

```
print(TestData)
print('################################')
print('## Data Profile')
print('################################')
print('Rows :',TestData.shape[0])
print('Columns :',TestData.shape[1])
print('################################')
#####################################################################
sFileName=sFileDir + '/' + sOutputFileName
TestData.to_csv(sFileName, index = False)
#####################################################################
print('################################')
print('### Done!! ####################')
print('################################')
#####################################################################
```

Output:

```
>>>
======= RESTART: C:\VKHCG\01-Vermeulen\02-Assess\Assess-Good-Bad-01.py =======
################################
Working Base : C:/VKHCG  using  win32
################################
Loading : C:/VKHCG/01-Vermeulen/00-RawData/Good-or-Bad.csv
################################
## Raw Data Values
################################
     ID FieldA  FieldB FieldC  FieldD  FieldE    FieldF  FieldG
0   1.0   Good  Better   Best  1024.0     NaN   10241.0       1
1   2.0   Good     NaN   Best   512.0     NaN    5121.0       2
2   3.0   Good  Better    NaN   256.0     NaN     256.0       3
3   4.0   Good  Better   Best     NaN     NaN     211.0       4
4   5.0   Good  Better    NaN    64.0     NaN    6411.0       5
5   6.0   Good     NaN   Best    32.0     NaN      32.0       6
6   7.0    NaN  Better   Best    16.0     NaN    1611.0       7
7   8.0    NaN     NaN   Best     8.0     NaN    8111.0       8
8   9.0    NaN     NaN    NaN     4.0     NaN      41.0       9
9  10.0      A       B      C     2.0     NaN   21111.0      10
10  NaN    NaN     NaN    NaN     NaN     NaN       NaN      11
11 10.0   Good  Better   Best  1024.0     NaN  102411.0      12
12 10.0   Good     NaN   Best   512.0     NaN     512.0      13
13 10.0   Good  Better    NaN   256.0     NaN    1256.0      14
14 10.0   Good  Better   Best     NaN     NaN       NaN      15
15 10.0   Good  Better    NaN    64.0     NaN     164.0      16
16 10.0   Good     NaN   Best    32.0     NaN     322.0      17
17 10.0    NaN  Better   Best    16.0     NaN     163.0      18
18 10.0    NaN     NaN   Best     8.0     NaN     844.0      19
19 10.0    NaN     NaN    NaN     4.0     NaN    4555.0      20
20 10.0      A       B      C     2.0     NaN     111.0      21
```

```
################################
## Data Profile
################################
Rows : 21
Columns : 8
################################
################################
## Test Data Values
################################
    ID FieldA  FieldB FieldC  FieldD   FieldF  FieldG
0   1.0   Good  Better   Best  1024.0   10241.0      1
1   2.0   Good     NaN   Best   512.0    5121.0      2
2   3.0   Good  Better    NaN   256.0     256.0      3
3   4.0   Good  Better   Best     NaN     211.0      4
4   5.0   Good  Better    NaN    64.0    6411.0      5
5   6.0   Good     NaN   Best    32.0      32.0      6
6   7.0    NaN  Better   Best    16.0    1611.0      7
7   8.0    NaN     NaN   Best     8.0    8111.0      8
8   9.0    NaN     NaN    NaN     4.0      41.0      9
9  10.0      A       B      C     2.0   21111.0     10
10  NaN    NaN     NaN    NaN     NaN      NaN     11
11 10.0   Good  Better   Best  1024.0  102411.0     12
12 10.0   Good     NaN   Best   512.0     512.0     13
13 10.0   Good  Better    NaN   256.0    1256.0     14
14 10.0   Good  Better   Best     NaN      NaN     15
15 10.0   Good  Better    NaN    64.0     164.0     16
16 10.0   Good     NaN   Best    32.0     322.0     17
17 10.0    NaN  Better   Best    16.0     163.0     18
18 10.0    NaN     NaN   Best     8.0     844.0     19
19 10.0    NaN     NaN    NaN     4.0    4555.0     20
20 10.0      A       B      C     2.0     111.0     21
################################
## Data Profile
################################
Rows : 21
Columns : 7
################################
################################
### Done!! ####################
################################
>>>
```

All of column E has been deleted, owing to the fact that all values in that column were missing values/errors.

ii. Drop the Columns Where Any of the Elements Is Missing Values

```
################### Assess-Good-Bad-02.py#############################
# -*- coding: utf-8 -*-
#####################################################################
```

```
import sys
import os
import pandas as pd
#################################################################
Base='C:/VKHCG'
sInputFileName='Good-or-Bad.csv'
sOutputFileName='Good-or-Bad-02.csv'
Company='01-Vermeulen'
#################################################################
Base='C:/VKHCG'
#################################################################
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
#################################################################
sFileDir=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
#################################################################
### Import Warehouse
#################################################################
sFileName=Base + '/' + Company + '/00-RawData/' + sInputFileName
print('Loading :',sFileName)
RawData=pd.read_csv(sFileName,header=0)

print('################################')
print('## Raw Data Values')
print('################################')
print(RawData)
print('################################')
print('## Data Profile')
print('################################')
print('Rows :',RawData.shape[0])
print('Columns :',RawData.shape[1])
print('################################')
#################################################################
sFileName=sFileDir + '/' + sInputFileName
RawData.to_csv(sFileName, index = False)
#################################################################
TestData=RawData.dropna(axis=1, how='any')
#################################################################
print('################################')
```

```
print('## Test Data Values')
print('################################')
print(TestData)
print('################################')
print('## Data Profile')
print('################################')
print('Rows :',TestData.shape[0])
print('Columns :',TestData.shape[1])
print('################################')
#####################################################################
sFileName=sFileDir + '/' + sOutputFileName
TestData.to_csv(sFileName, index = False)
#####################################################################
print('################################')
print('### Done!! ####################')
print('################################')
#####################################################################
```

```
>>>
======= RESTART: C:\VKHCG\01-Vermeulen\02-Assess\Assess-Good-Bad-02.py =======
################################
Working Base : C:/VKHCG  using  win32
################################
Loading : C:/VKHCG/01-Vermeulen/00-RawData/Good-or-Bad.csv
################################
## Raw Data Values
################################
    ID FieldA  FieldB FieldC  FieldD  FieldE    FieldF  FieldG
0    1.0   Good  Better   Best  1024.0     NaN   10241.0       1
1    2.0   Good     NaN   Best   512.0     NaN    5121.0       2
2    3.0   Good  Better    NaN   256.0     NaN     256.0       3
3    4.0   Good  Better   Best     NaN     NaN     211.0       4
4    5.0   Good  Better    NaN    64.0     NaN    6411.0       5
5    6.0   Good     NaN   Best    32.0     NaN      32.0       6
6    7.0    NaN  Better   Best    16.0     NaN    1611.0       7
7    8.0    NaN     NaN   Best     8.0     NaN    8111.0       8
8    9.0    NaN     NaN    NaN     4.0     NaN      41.0       9
9   10.0      A       B      C     2.0     NaN   21111.0      10
10   NaN    NaN     NaN    NaN     NaN     NaN       NaN      11
11  10.0   Good  Better   Best  1024.0     NaN  102411.0      12
12  10.0   Good     NaN   Best   512.0     NaN     512.0      13
13  10.0   Good  Better    NaN   256.0     NaN    1256.0      14
14  10.0   Good  Better   Best     NaN     NaN       NaN      15
15  10.0   Good  Better    NaN    64.0     NaN     164.0      16
16  10.0   Good     NaN   Best    32.0     NaN     322.0      17
17  10.0    NaN  Better   Best    16.0     NaN     163.0      18
```

```
18  10.0    NaN    NaN   Best    8.0    NaN    844.0     19
19  10.0    NaN    NaN    NaN    4.0    NaN   4555.0     20
20  10.0      A      B      C    2.0    NaN    111.0     21
##################################
## Data Profile
##################################
Rows : 21
Columns : 8
##################################
##################################
## Test Data Values
##################################
   FieldG
0       1
1       2
2       3
3       4
4       5
5       6
6       7
7       8
8       9
9      10
10     11
11     12
12     13
13     14
14     15
15     16
16     17
17     18
18     19
19     20
20     21
##################################
## Data Profile
##################################
Rows : 21
Columns : 1
##################################
##################################
### Done!! ####################
##################################
>>>
```

iii. Keep Only the Rows That Contain a Maximum of Two Missing Values

```
#####################    Assess-Good-Bad-03.py  #################
# -*- coding: utf-8 -*-
#########################################################################
import sys
import os
import pandas as pd
#########################################################################
sInputFileName='Good-or-Bad.csv'
sOutputFileName='Good-or-Bad-03.csv'
Company='01-Vermeulen'
Base='C:/VKHCG'
#########################################################################
print('#################################')
print('Working Base :',Base, ' using Windows ~~~~')
print('#################################')
#########################################################################
sFileDir=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
#########################################################################
### Import Warehouse
#########################################################################
sFileName=Base + '/' + Company + '/00-RawData/' + sInputFileName
print('Loading :',sFileName)
RawData=pd.read_csv(sFileName,header=0)

print('#################################')
print('## Raw Data Values')
print('#################################')
print(RawData)
print('#################################')
print('## Data Profile')
print('#################################')
print('Rows :',RawData.shape[0])
print('Columns :',RawData.shape[1])
print('#################################')
#########################################################################
sFileName=sFileDir + '/' + sInputFileName
RawData.to_csv(sFileName, index = False)
#########################################################################
TestData=RawData.dropna(thresh=2)
```

```
print('#################################')
print('## Test Data Values')
print('#################################')
print(TestData)
print('#################################')
print('## Data Profile')
print('#################################')
print('Rows :',TestData.shape[0])
print('Columns :',TestData.shape[1])
print('#################################')
sFileName=sFileDir + '/' + sOutputFileName
TestData.to_csv(sFileName, index = False)
#####################################################################
print('#################################')
print('### Done!! ####################')
print('#################################')
#####################################################################
```

Before

	A	B	C	D	E	F	G	H
1	ID	FieldA	FieldB	FieldC	FieldD	FieldE	FieldF	FieldG
2	1	Good	Better	Best	1024		10241	1
3	2	Good		Best	512		5121	2
4	3	Good	Better		256		256	3
5	4	Good	Better	Best			211	4
6	5	Good	Better		64		6411	5
7	6	Good		Best	32		32	6
8	7		Better	Best	16		1611	7
9	8			Best	8		8111	8
10	9				4		41	9
11	10	A	B	C	2		21111	10
12								11
13	10	Good	Better	Best	1024		102411	12
14	10	Good		Best	512		512	13
15	10	Good	Better		256		1256	14
16	10	Good	Better	Best				15
17	10	Good	Better		64		164	16
18	10	Good		Best	32		322	17
19	10		Better	Best	16		163	18
20	10			Best	8		844	19
21	10				4		4555	20
22	10	A	B	C	2		111	21

After

	A	B	C	D	E	F	G	H
1	ID	FieldA	FieldB	FieldC	FieldD	FieldE	FieldF	FieldG
2	1	Good	Better	Best	1024		10241	1
3	2	Good		Best	512		5121	2
4	3	Good	Better		256		256	3
5	4	Good	Better	Best			211	4
6	5	Good	Better		64		6411	5
7	6	Good		Best	32		32	6
8	7		Better	Best	16		1611	7
9	8			Best	8		8111	8
10	9				4		41	9
11	10	A	B	C	2		21111	10
12	10	Good	Better	Best	1024		102411	12
13	10	Good		Best	512		512	13
14	10	Good	Better		256		1256	14
15	10	Good	Better	Best				15
16	10	Good	Better		64		164	16
17	10	Good		Best	32		322	17
18	10		Better	Best	16		163	18
19	10			Best	8		844	19
20	10				4		4555	20
21	10	A	B	C	2		111	21

Row with more than two missing values got deleted.

The next step along the route is to generate a full network routing solution for the company, to resolve the data issues in the retrieve data.

B. Write Python / R program to create the network routing diagram from the given data onrouters.

```
########## Assess-Network-Routing-Company.py ####################
import sys
import os
import pandas as pd
#################################################################
pd.options.mode.chained_assignment = None
#################################################################
Base='C:/VKHCG'
#################################################################
print('##################################')
print('Working Base :',Base, ' using Windows')
print('##################################')
#################################################################
sInputFileName1='01-Retrieve/01-EDS/01-R/Retrieve_Country_Code.csv'
sInputFileName2='01-Retrieve/01-EDS/02-Python/Retrieve_Router_Location.csv'
sInputFileName3='01-Retrieve/01-EDS/01-R/Retrieve_IP_DATA.csv'
#################################################################
sOutputFileName='Assess-Network-Routing-Company.csv'
Company='01-Vermeulen'
#################################################################
#################################################################
### Import Country Data
#################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName1
print('##################################')
print('Loading :',sFileName)
print('##################################')
CountryData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
print('Loaded Country:',CountryData.columns.values)
print('##################################')
#################################################################
## Assess Country Data
#################################################################
print('##################################')
print('Changed :',CountryData.columns.values)
CountryData.rename(columns={'Country': 'Country_Name'}, inplace=True)
CountryData.rename(columns={'ISO-2-CODE': 'Country_Code'}, inplace=True)
CountryData.drop('ISO-M49', axis=1, inplace=True)
CountryData.drop('ISO-3-Code', axis=1, inplace=True)
CountryData.drop('RowID', axis=1, inplace=True)
print('To :',CountryData.columns.values)
print('##################################')
```

```
#####################################################################
#####################################################################
### Import Company Data
#####################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName2
print('################################')
print('Loading :',sFileName)
print('################################')
CompanyData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
print('Loaded Company :',CompanyData.columns.values)
print('################################')
#####################################################################
## Assess Company Data
#####################################################################
print('################################')
print('Changed :',CompanyData.columns.values)
CompanyData.rename(columns={'Country': 'Country_Code'}, inplace=True)
print('To :',CompanyData.columns.values)
print('################################')
#####################################################################
#####################################################################
### Import Customer Data
#####################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName3
print('################################')
print('Loading :',sFileName)
print('################################')
CustomerRawData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
print('################################')
print('Loaded Customer :',CustomerRawData.columns.values)
print('################################')
#####################################################################
CustomerData=CustomerRawData.dropna(axis=0, how='any')
print('################################')
print('Remove Blank Country Code')
print('Reduce Rows from', CustomerRawData.shape[0],' to ', CustomerData.shape[0])
print('################################')
#####################################################################
print('################################')
print('Changed :',CustomerData.columns.values)
CustomerData.rename(columns={'Country': 'Country_Code'}, inplace=True)
print('To :',CustomerData.columns.values)
print('################################')
#####################################################################
print('################################')
print('Merge Company and Country Data')
print('################################')
CompanyNetworkData=pd.merge(
```

```
        CompanyData,
        CountryData,
        how='inner',
        on='Country_Code'
        )
#####################################################################
print('################################')
print('Change ',CompanyNetworkData.columns.values)
for i in CompanyNetworkData.columns.values:
   j='Company_'+i
   CompanyNetworkData.rename(columns={i: j}, inplace=True)
print('To ', CompanyNetworkData.columns.values)
print('################################')
#####################################################################
#####################################################################
sFileDir=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir):
   os.makedirs(sFileDir)
#####################################################################
sFileName=sFileDir + '/' + sOutputFileName
print('################################')
print('Storing :', sFileName)
print('################################')
CompanyNetworkData.to_csv(sFileName, index = False, encoding="latin-1")
#####################################################################
#####################################################################
print('################################')
print('### Done!! ####################')
print('################################')
#####################################################################
```

Output:

Go to C:\VKHCG\01-Vermeulen\02-Assess\01-EDS\02-Python folder and open Assess-Network-Routing-Company.csv

	A	B	C	D	E
1	ny_Countr	Company_Place_Name	Company_Latitude	Company_Longitude	Company_Country_Name
2	US	New York	40.7528	-73.9725	United States of America
3	US	New York	40.7214	-74.0052	United States of America
4	US	New York	40.7662	-73.9862	United States of America
5	US	New York	40.7449	-73.9782	United States of America
6	US	New York	40.7605	-73.9933	United States of America
7	US	New York	40.7588	-73.968	United States of America
8	US	New York	40.7637	-73.9727	United States of America
9	US	New York	40.7553	-73.9924	United States of America

Next, Access the the customers location using network router location.

```
####################Assess-Network-Routing-Customer.py ######################
import sys
import os
import pandas as pd
##########################################################################
pd.options.mode.chained_assignment = None
##########################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
##########################################################################
sInputFileName=Base+'/01-Vermeulen/02-Assess/01-EDS/02-Python/Assess-Network-Routing-
Customer.csv'
##########################################################################
sOutputFileName='Assess-Network-Routing-Customer.gml'
Company='01-Vermeulen'
##########################################################################
### Import Country Data
##########################################################################
sFileName=sInputFileName
print('##################################')
print('Loading :',sFileName)
print('##################################')
CustomerData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
print('Loaded Country:',CustomerData.columns.values)
print('##################################')
print(CustomerData.head())
print('##################################')
print('### Done!! ####################')
print('##################################')
##########################################################################
```

Output

Assess-Network-Routing-Customer.csv

	A	B	C	D	E
1	ıer_Countr	tomer_Place_Na	Customer_Latitude	Customer_Longitude	Customer_Country_Name
2	BW	Gaborone	-24.6464	25.9119	Botswana
3	BW	Francistown	-21.1667	27.5167	Botswana
4	BW	Maun	-19.9833	23.4167	Botswana
5	BW	Molepolole	-24.4167	25.5333	Botswana
6	NE	Niamey	13.5167	2.1167	Niger
7	MZ	Maputo	-25.9653	32.5892	Mozambique
8	MZ	Tete	-16.1564	33.5867	Mozambique
9	MZ	Quelimane	-17.8786	36.8883	Mozambique
10	MZ	Chimoio	-19.1164	33.4833	Mozambique
11	MZ	Matola	-25.9622	32.4589	Mozambique
12	MZ	Pemba	-12.9608	40.5078	Mozambique
13	MZ	Lichinga	-13.3128	35.2406	Mozambique
14	MZ	Maxixe	-23.8597	35.3472	Mozambique
15	MZ	Chibuto	-24.6867	33.5306	Mozambique
16	MZ	Ressano Garcia	-25.4428	31.9953	Mozambique
17	GH	Tema	5.6167	-0.0167	Ghana
18	GH	Kumasi	6.6833	-1.6167	Ghana
19	GH	Takoradi	4.8833	-1.75	Ghana
20	GH	Accra	5.55	-0.2167	Ghana

Assess-Network-Routing-Node.py

```
#####################################################################
import sys
import os
import pandas as pd
#####################################################################
pd.options.mode.chained_assignment = None
#####################################################################
Base='C:/VKHCG'
#####################################################################
print('#################################')
print('Working Base :',Base, ' using ', sys.platform)
print('#################################')
#####################################################################
sInputFileName='01-Retrieve/01-EDS/02-Python/Retrieve_IP_DATA.csv'
#####################################################################
sOutputFileName='Assess-Network-Routing-Node.csv'
Company='01-Vermeulen'
#####################################################################
### Import IP Data
#####################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName
print('#################################')
print('Loading :',sFileName)
print('#################################')
IPData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
print('Loaded IP :', IPData.columns.values)
print('#################################')
#####################################################################
print('#################################')
print('Changed :',IPData.columns.values)
IPData.drop('RowID', axis=1, inplace=True)
IPData.drop('ID', axis=1, inplace=True)
IPData.rename(columns={'Country': 'Country_Code'}, inplace=True)
IPData.rename(columns={'Place.Name': 'Place_Name'}, inplace=True)
IPData.rename(columns={'Post.Code': 'Post_Code'}, inplace=True)
IPData.rename(columns={'First.IP.Number': 'First_IP_Number'}, inplace=True)
IPData.rename(columns={'Last.IP.Number': 'Last_IP_Number'}, inplace=True)
print('To :',IPData.columns.values)
print('#################################')
#####################################################################
print('#################################')
print('Change ',IPData.columns.values)
for i in IPData.columns.values:
    j='Node_'+i
    IPData.rename(columns={i: j}, inplace=True)
print('To ', IPData.columns.values)
print('#################################')
```

```
#####################################################################
sFileDir=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir):
   os.makedirs(sFileDir)
#####################################################################
sFileName=sFileDir + '/' + sOutputFileName
print('#################################')
print('Storing :', sFileName)
print('#################################')
IPData.to_csv(sFileName, index = False, encoding="latin-1")
#####################################################################
print('#################################')
print('### Done!! ####################')
print('#################################')
#####################################################################
```

Output:

C:/VKHCG/01-Vermeulen/02-Assess/01-EDS/02-Python/Assess-Network-Routing-Node.csv

	A	B	C	D	E	F	G
1	Node_Country_Code	Node_Place_Name	Node_Post_Code	Node_Latitude	Node_Longitude	ode_First_IP_Numb	Node_Last_IP_Number
2	BW	Gaborone		-24.6464	25.9119	692781056	692781567
3	BW	Gaborone		-24.6464	25.9119	692781824	692783103
4	BW	Gaborone		-24.6464	25.9119	692909056	692909311
5	BW	Gaborone		-24.6464	25.9119	692909568	692910079
6	BW	Gaborone		-24.6464	25.9119	693051392	693052415
7	BW	Gaborone		-24.6464	25.9119	693078272	693078527
8	BW	Gaborone		-24.6464	25.9119	693608448	693616639
9	BW	Gaborone		-24.6464	25.9119	696929792	696930047
10	BW	Gaborone		-24.6464	25.9119	700438784	700439039
11	BW	Gaborone		-24.6464	25.9119	702075904	702076927
12	BW	Gaborone		-24.6464	25.9119	702498816	702499839
13	BW	Gaborone		-24.6464	25.9119	702516224	702517247
14	BW	Gaborone		-24.6464	25.9119	774162663	774162667
15	BW	Gaborone		-24.6464	25.9119	1401887232	1401887743
16	BW	Gaborone		-24.6464	25.9119	1754209024	1754209279
17	NE	Niamey		13.5167	2.1167	696918528	696919039
18	NE	Niamey		13.5167	2.1167	696922112	696924159
19	NE	Niamey		13.5167	2.1167	701203456	701203711
20	NE	Niamey		13.5167	2.1167	758886912	758887167
21	NE	Niamey		13.5167	2.1167	1347294153	1347294160
22	NE	Niamey		13.5167	2.1167	1755108096	1755108351
23	NE	Niamey		13.5167	2.1167	1755828480	1755828735
24	MZ	Maputo		-25.9653	32.5892	692883456	692883967
25	MZ	Maputo		-25.9653	32.5892	692944896	692946943

Directed Acyclic Graph (DAG)

A directed acyclic graph is a specific graph that only has one path through the graph.

C. Write a Python / R program to build directed acyclic graph.

Open your python editor and create a file named Assess-DAG-Location.py in directory C:\VKHCG\01-Vermeulen\02-Assess

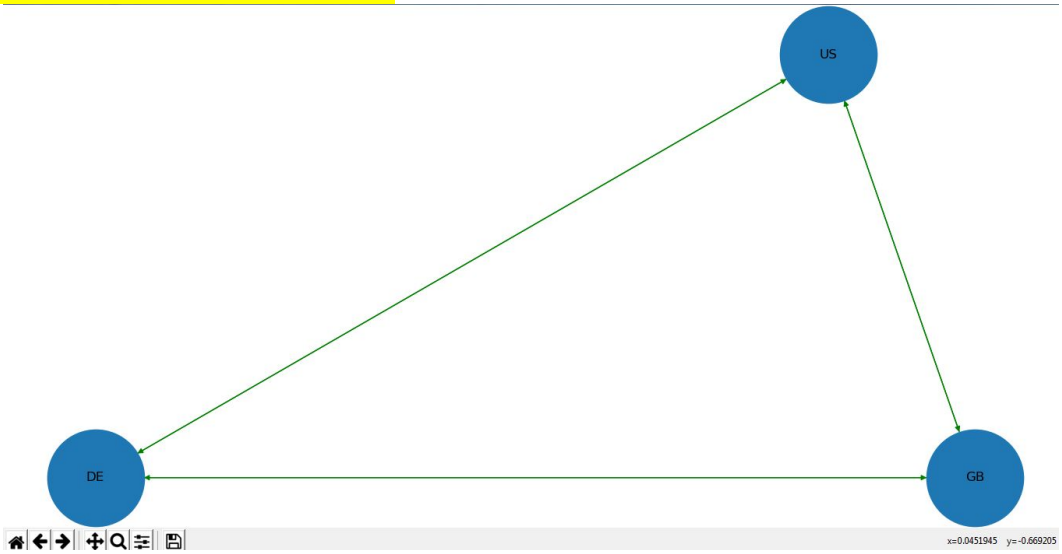
```
################################################################
import networkx as nx
import matplotlib.pyplot as plt
import sys
import os
import pandas as pd
################################################################
Base='C:/VKHCG'
################################################################
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
################################################################
sInputFileName='01-Retrieve/01-EDS/02-Python/Retrieve_Router_Location.csv'
sOutputFileName1='Assess-DAG-Company-Country.png'
sOutputFileName2='Assess-DAG-Company-Country-Place.png'
Company='01-Vermeulen'
################################################################
### Import Company Data
################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName
print('################################')
print('Loading :',sFileName)
print('################################')
CompanyData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
print('Loaded Company :',CompanyData.columns.values)
print('################################')
################################################################
print(CompanyData)
print('################################')
print('Rows : ',CompanyData.shape[0])
print('################################')
################################################################
G1=nx.DiGraph()
G2=nx.DiGraph()
################################################################
for i in range(CompanyData.shape[0]):
    G1.add_node(CompanyData['Country'][i])
    sPlaceName= CompanyData['Place_Name'][i] + '-' + CompanyData['Country'][i]
    G2.add_node(sPlaceName)
```

```
print('#################################')
for n1 in G1.nodes():
    for n2 in G1.nodes():
        if n1 != n2:
            print('Link :',n1,' to ', n2)
            G1.add_edge(n1,n2)
print('#################################')

print('#################################')
print("Nodes of graph: ")
print(G1.nodes())
print("Edges of graph: ")
print(G1.edges())
print('#################################')
######################################################################
sFileDir=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
######################################################################
sFileName=sFileDir + '/' + sOutputFileName1
print('#################################')
print('Storing :', sFileName)
print('#################################')
nx.draw(G1,pos=nx.spectral_layout(G1),
        nodecolor='r',edge_color='g',
        with_labels=True,node_size=8000,
        font_size=12)
plt.savefig(sFileName) # save as png
plt.show() # display
######################################################################
print('#################################')
for n1 in G2.nodes():
    for n2 in G2.nodes():
        if n1 != n2:
            print('Link :',n1,' to ', n2)
            G2.add_edge(n1,n2)
print('#################################')

print('#################################')
print("Nodes of graph: ")
print(G2.nodes())
print("Edges of graph: ")
print(G2.edges())
print('#################################')
######################################################################
sFileDir=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir):
```

```
    os.makedirs(sFileDir)
#####################################################################
sFileName=sFileDir + '/' + sOutputFileName2
print('################################')
print('Storing :', sFileName)
print('################################')
nx.draw(G2,pos=nx.spectral_layout(G2),
        nodecolor='r',edge_color='b',
        with_labels=True,node_size=8000,
        font_size=12)
plt.savefig(sFileName) # save as png
plt.show() # display
#####################################################################
```

Output:

```
################################
Rows :  150
################################
################################
Link : US  to  DE
Link : US  to  GB
Link : DE  to  US
Link : DE  to  GB
Link : GB  to  US
Link : GB  to  DE
################################
################################
Nodes of graph:
['US', 'DE', 'GB']
Edges of graph:
[('US', 'DE'), ('US', 'GB'), ('DE', 'US'), ('DE', 'GB'), ('GB', 'US'), ('GB', 'DE')]
################################
```



Customer Location DAG

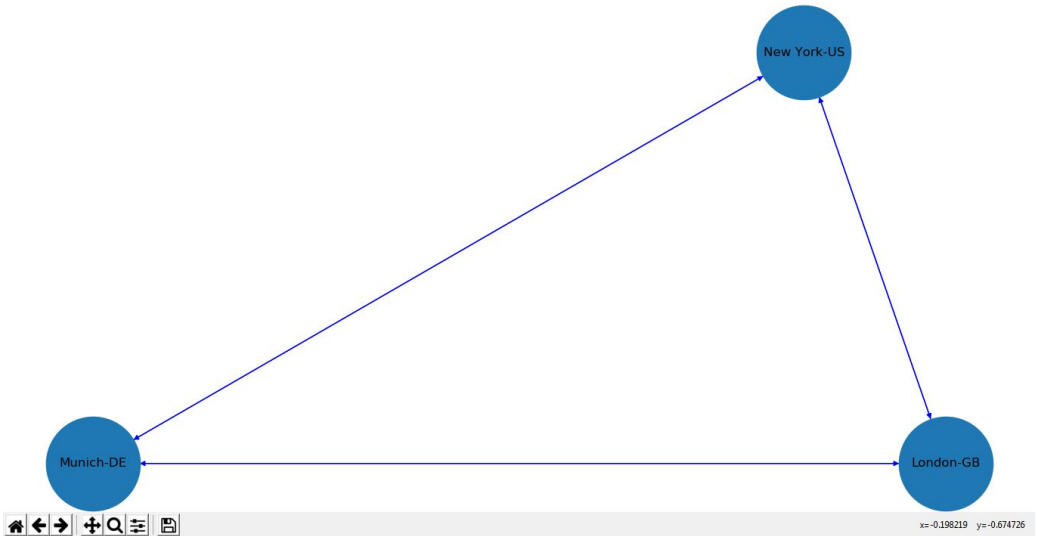
```
################### Assess-DAG-Location.py###################
import networkx as nx
import matplotlib.pyplot as plt
import sys
import os
import pandas as pd
#####################################################################
Base='C:/VKHCG'
#####################################################################
print('#################################')
print('Working Base :',Base, ' using ', sys.platform)
print('#################################')
#####################################################################
sInputFileName='01-Retrieve/01-EDS/02-Python/Retrieve_Router_Location.csv'
sOutputFileName1='Assess-DAG-Company-Country.png'
sOutputFileName2='Assess-DAG-Company-Country-Place.png'
Company='01-Vermeulen'
#####################################################################
### Import Company Data
#####################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName
print('#################################')
print('Loading :',sFileName)
print('#################################')
CompanyData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
print('Loaded Company :',CompanyData.columns.values)
print('#################################')
#####################################################################
print(CompanyData)
print('#################################')
print('Rows : ',CompanyData.shape[0])
print('#################################')
#####################################################################
G1=nx.DiGraph()
G2=nx.DiGraph()
#####################################################################
for i in range(CompanyData.shape[0]):
    G1.add_node(CompanyData['Country'][i])
    sPlaceName= CompanyData['Place_Name'][i] + '-' + CompanyData['Country'][i]
    G2.add_node(sPlaceName)

print('#################################')
for n1 in G1.nodes():
    for n2 in G1.nodes():
        if n1 != n2:
            print('Link :',n1,' to ', n2)
            G1.add_edge(n1,n2)
```

```
print('################################')

print('################################')
print("Nodes of graph: ")
print(G1.nodes())
print("Edges of graph: ")
print(G1.edges())
print('################################')
#####################################################################
sFileDir=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
#####################################################################
sFileName=sFileDir + '/' + sOutputFileName1
print('################################')
print('Storing :', sFileName)
print('################################')
nx.draw(G1,pos=nx.spectral_layout(G1),
        nodecolor='r',edge_color='g',
        with_labels=True,node_size=8000,
        font_size=12)
plt.savefig(sFileName) # save as png
plt.show() # display
#####################################################################
print('################################')
for n1 in G2.nodes():
    for n2 in G2.nodes():
        if n1 != n2:
            print('Link :',n1,' to ', n2)
            G2.add_edge(n1,n2)
print('################################')

print('################################')
print("Nodes of graph: ")
print(G2.nodes())
print("Edges of graph: ")
print(G2.edges())
print('################################')
#####################################################################
sFileDir=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
#####################################################################
sFileName=sFileDir + '/' + sOutputFileName2
print('################################')
print('Storing :', sFileName)
print('################################')
nx.draw(G2,pos=nx.spectral_layout(G2),
```

```
        nodecolor='r',edge_color='b',
        with_labels=True,node_size=8000,
        font_size=12)
plt.savefig(sFileName) # save as png
plt.show() # display
#####################################################################
```

Output:

```
#################################
Link : New York-US  to  Munich-DE
Link : New York-US  to  London-GB
Link : Munich-DE  to  New York-US
Link : Munich-DE  to  London-GB
Link : London-GB  to  New York-US
Link : London-GB  to  Munich-DE
#################################
#################################
Nodes of graph:
['New York-US', 'Munich-DE', 'London-GB']
Edges of graph:
[('New York-US', 'Munich-DE'), ('New York-US', 'London-GB'), ('Munich-DE', 'New York-US'),
('Munich-DE', 'London-GB'), ('London-GB', 'New York-US'), ('London-GB', 'Munich-DE')]
```



Open your Python editor and create a file named Assess-DAG-GPS.py in directory C:\VKHCG\01-Vermeulen\02-Assess.

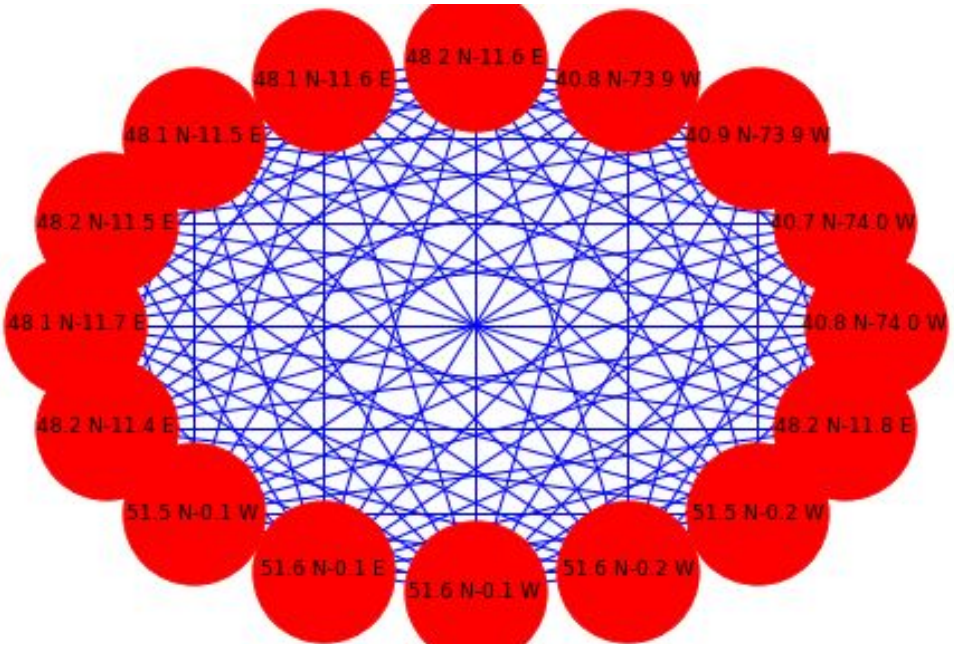
```
import networkx as nx
import matplotlib.pyplot as plt
import sys
import os
import pandas as pd
```

```
Base='C:/VKHCG'
print('#################################')
print('Working Base :',Base, ' using ', sys.platform)
print('#################################')
sInputFileName='01-Retrieve/01-EDS/02-Python/Retrieve_Router_Location.csv'
sOutputFileName='Assess-DAG-Company-GPS.png'
Company='01-Vermeulen'
### Import Company Data
sFileName=Base + '/' + Company + '/' + sInputFileName
print('#################################')
print('Loading :',sFileName)
print('#################################')
CompanyData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
print('Loaded Company :',CompanyData.columns.values)
print('#################################')
print(CompanyData)
print('#################################')
print('Rows : ',CompanyData.shape[0])
print('#################################')
G=nx.Graph()
for i in range(CompanyData.shape[0]):
    nLatitude=round(CompanyData['Latitude'][i],2)
    nLongitude=round(CompanyData['Longitude'][i],2)

    if nLatitude < 0:
        sLatitude = str(nLatitude*-1) + ' S'
    else:
        sLatitude = str(nLatitude) + ' N'

    if nLongitude < 0:
        sLongitude = str(nLongitude*-1) + ' W'
    else:
        sLongitude = str(nLongitude) + ' E'

    sGPS= sLatitude + '-' + sLongitude
    G.add_node(sGPS)

print('#################################')
for n1 in G.nodes():
    for n2 in G.nodes():
        if n1 != n2:
            print('Link :',n1,' to ', n2)
            G.add_edge(n1,n2)
print('#################################')

print('#################################')
print("Nodes of graph: ")
print(G.number_of_nodes())
```

```
print("Edges of graph: ")
print(G.number_of_edges())
print('#################################')
```

Output:

```
=== RESTART: C:\VKHCG\01-Vermeulen\02-Assess\Assess-DAG-GPS-unsmoothed.py ===
#################################
Working Base : C:/VKHCG  using  win32
#################################
Loading : C:/VKHCG/01-Vermeulen/01-Retrieve/01-EDS/02-Python/Retrieve_Router_Location.csv
#################################
Loaded Company : ['Country' 'Place_Name' 'Latitude' 'Longitude']
#################################
   Country Place_Name  Latitude  Longitude
0       US   New York   40.7528   -73.9725
1       US   New York   40.7214   -74.0052
-
-
-
Link : 48.15 N-11.74 E  to  48.15 N-11.46 E
Link : 48.15 N-11.74 E  to  48.09 N-11.54 E
Link : 48.15 N-11.74 E  to  48.18 N-11.75 E
Link : 48.15 N-11.74 E  to  48.1 N-11.47 E
#################################
Nodes of graph:
117
Edges of graph:
6786
#################################
>>>
```



D. Write a Python / R program to pick the content for Bill Boards from the given data.

Picking Content for Billboards

The basic process required is to combine two sets of data and then calculate the number of visitors per day from the range of IP addresses that access the billboards in Germany.

Bill Board Location: Rows - 8873

Access Visitors: Rows - 75999

Access Location Record: Rows – 1,81,235

Open Python editor and create a file named **Assess-DE-Billboard.py** in directory C:\VKHCG\02-Krennwallner\02-Assess

```
################## Assess-DE-Billboard.py#######################
import sys
import os
import sqlite3 as sq
import pandas as pd
#################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
#################################################################
sInputFileName1='01-Retrieve/01-EDS/02-Python/Retrieve_DE_Billboard_Locations.csv'
sInputFileName2='01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor.csv'
sOutputFileName='Assess-DE-Billboard-Visitor.csv'
Company='02-Krennwallner'
#################################################################
sDataBaseDir=Base + '/' + Company + '/02-Assess/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
#################################################################
sDatabaseName=sDataBaseDir + '/krennwallner.db'
conn = sq.connect(sDatabaseName)
#################################################################
### Import Billboard Data
#################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName1
print('##################################')
print('Loading :',sFileName)
print('##################################')
BillboardRawData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
BillboardRawData.drop_duplicates(subset=None, keep='first', inplace=True)
BillboardData=BillboardRawData
print('Loaded Company :',BillboardData.columns.values)
print('##################################')
#################################################################
print('################')
sTable='Assess_BillboardData'
print('Storing :',sDatabaseName,' Table:',sTable)
```

```
BillboardData.to_sql(sTable, conn, if_exists="replace")
print('################')
#######################################################################
print(BillboardData.head())
print('################################')
print('Rows : ',BillboardData.shape[0])
print('################################')
#######################################################################
### Import Billboard Data
#######################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName2
print('################################')
print('Loading :',sFileName)
print('################################')
VisitorRawData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
VisitorRawData.drop_duplicates(subset=None, keep='first', inplace=True)
VisitorData=VisitorRawData[VisitorRawData.Country=='DE']
print('Loaded Company :',VisitorData.columns.values)
print('################################')
#######################################################################
print('################')
sTable='Assess_VisitorData'
print('Storing :',sDatabaseName,' Table:',sTable)
VisitorData.to_sql(sTable, conn, if_exists="replace")
print('################')
#######################################################################
print(VisitorData.head())
print('################################')
print('Rows : ',VisitorData.shape[0])
print('################################')
#######################################################################
print('################')
sTable='Assess_BillboardVisitorData'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL="select distinct"
sSQL=sSQL+ " A.Country AS BillboardCountry,"
sSQL=sSQL+ " A.Place_Name AS BillboardPlaceName,"
sSQL=sSQL+ " A.Latitude AS BillboardLatitude, "
sSQL=sSQL+ " A.Longitude AS BillboardLongitude,"
sSQL=sSQL+ " B.Country AS VisitorCountry,"
sSQL=sSQL+ " B.Place_Name AS VisitorPlaceName,"
sSQL=sSQL+ " B.Latitude AS VisitorLatitude, "
sSQL=sSQL+ " B.Longitude AS VisitorLongitude,"
sSQL=sSQL+ " (B.Last_IP_Number - B.First_IP_Number) * 365.25 * 24 * 12 AS VisitorYearRate"
sSQL=sSQL+ " from"
sSQL=sSQL+ " Assess_BillboardData as A"
sSQL=sSQL+ " JOIN "
sSQL=sSQL+ " Assess_VisitorData as B"
```

```
sSQL=sSQL+ " ON "
sSQL=sSQL+ " A.Country = B.Country"
sSQL=sSQL+ " AND "
sSQL=sSQL+ " A.Place_Name = B.Place_Name;"
BillboardVistorsData=pd.read_sql_query(sSQL, conn)
print('#################')
#########################################################################
print('#################')
sTable='Assess_BillboardVistorsData'
print('Storing :',sDatabaseName,' Table:',sTable)
BillboardVistorsData.to_sql(sTable, conn, if_exists="replace")
print('#################')
#########################################################################
print(BillboardVistorsData.head())
print('#################################')
print('Rows : ',BillboardVistorsData.shape[0])
print('#################################')
#########################################################################
sFileDir=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir):
   os.makedirs(sFileDir)
#########################################################################
print('#################################')
print('Storing :', sFileName)
print('#################################')
sFileName=sFileDir + '/' + sOutputFileName
BillboardVistorsData.to_csv(sFileName, index = False)
print('#################################')
#########################################################################
print('### Done!! ############################################')
#########################################################################
```

Output:

C:\VKHCG\02-Krennwallner\01-Retrieve\01-EDS\02-Python\Retrieve_Online_Visitor.csv containing, 10,48,576**(Ten lack Forty Eight Thousand Five Hundred and Seventy Six)**rows.

	A	B	C	D	E	F
1	Country	Place_Name	Latitude	Longitude	First_IP_Number	Last_IP_Number
2	BW	Gaborone	-24.6464	25.9119	692781056	692781567
3	BW	Gaborone	-24.6464	25.9119	692781824	692783103
4	BW	Gaborone	-24.6464	25.9119	692909056	692909311
1048556	NL	Amsterdam	52.3556	4.9136	385939968	385940479
1048557	NL	Amsterdam	52.3556	4.9136	385942528	385943551
1048558	NL	Amsterdam	52.3556	4.9136	385957888	385961983
1048559	NL	Amsterdam	52.3556	4.9136	386003200	386003967
1048560	NL	Amsterdam	52.3556	4.9136	386012160	386012671
1048561	NL	Amsterdam	52.3556	4.9136	386013184	386013695
1048562	NL	Amsterdam	52.3556	4.9136	386015232	386015487
1048563	NL	Amsterdam	52.3556	4.9136	386020352	386021375
1048564	NL	Amsterdam	52.3556	4.9136	386035712	386039807
1048565	NL	Amsterdam	52.3556	4.9136	386060288	386068479
1048566	NL	Amsterdam	52.3556	4.9136	386073344	386073599
1048567	NL	Amsterdam	52.3556	4.9136	386074112	386074623
1048568	NL	Amsterdam	52.3556	4.9136	386076416	386076671
1048569	NL	Amsterdam	52.3556	4.9136	386088960	386089983
1048570	NL	Amsterdam	52.3556	4.9136	386095616	386096127
1048571	NL	Amsterdam	52.3556	4.9136	386109440	386113535
1048572	NL	Amsterdam	52.3556	4.9136	386191360	386195455
1048573	NL	Amsterdam	52.3556	4.9136	386201600	386203135
1048574	NL	Amsterdam	52.3556	4.9136	386215936	386220031
1048575	NL	Amsterdam	52.3556	4.9136	386228224	386232319
1048576	NL	Amsterdam	52.3556	4.9136	386244608	386244863

Retrieve_Online_Visitor

SQLite Visitor's Database

C:/VKHCG/02-Krennwallner/02-Assess/SQLite/krennwallner.db Table:

	BillboardCountry	BillboardPlaceName	...	VisitorLongitude	VisitorYearRate
0	DE	Lake	...	8.5667	26823960.0
1	DE	Horb	...	8.6833	26823960.0
2	DE	Horb	...	8.6833	53753112.0
3	DE	Horb	...	8.6833	107611416.0
4	DE	Horb	...	8.6833	13359384.0

	A	B	C	D	E	F	G	H	I
1	BillboardCountry	BillboardPlaceName	BoardLatit	oardLongi	sitorCount	VisitorPlaceName	sitorLatitu	itorLongitu	VisitorYearRate
2	DE	Lake	51.7833	8.5667	DE	Lake	51.7833	8.5667	26823960
3	DE	Horb	48.4333	8.6833	DE	Horb	48.4333	8.6833	26823960
4	DE	Horb	48.4333	8.6833	DE	Horb	48.4333	8.6833	53753112
5	DE	Horb	48.4333	8.6833	DE	Horb	48.4333	8.6833	107611416
6	DE	Horb	48.4333	8.6833	DE	Horb	48.4333	8.6833	13359384
7	DE	Horb	48.4333	8.6833	DE	Horb	48.4889	8.6734	26823960
8	DE	Horb	48.4333	8.6833	DE	Horb	48.4889	8.6734	53753112
9	DE	Hardenberg	51.1	7.7333	DE	Hardenberg	51.1	7.7333	26823960
181221	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1167	8.6833	1157112
181222	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1167	8.6833	24299352
181223	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1167	8.6833	807769368
181224	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1172	8.7281	53753112
181225	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1172	8.7281	26823960
181226	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1172	8.7281	107611416
181227	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1172	8.7281	1577880
181228	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1184	8.6095	15042456
181229	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1184	8.6095	10834776
181230	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1319	8.6838	736344
181231	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1319	8.6838	0
181232	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1327	8.7668	736344
181233	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1492	8.7097	1723360536
181234	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1492	8.7097	430761240
181235	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1528	8.745	26823960
181236	DE	Frankfurt	50.1327	8.7668	DE	Frankfurt	50.1878	8.6632	1577880

Assess-DE-Billboard-Visitor

E. Write a Python / R program to generate GML file from the given csv file.

Understanding Your Online Visitor Data

Online visitors have to be mapped to their closest billboard, to ensure we understand where and what they can access.

Open your Python editor and create a file called Assess-Billboard_2_Visitor.py in directory C:\VKHCG\ 02-Krennwallner\02-Assess.

```
##################################################################
# -*- coding: utf-8 -*-
##################################################################
import networkx as nx
```

```
import sys
import os
import sqlite3 as sq
import pandas as pd
from geopy.distance import vincenty
#####################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
#####################################################################
Company='02-Krennwallner'
sTable='Assess_BillboardVisitorData'
sOutputFileName='Assess-DE-Billboard-Visitor.gml'
#####################################################################
sDataBaseDir=Base + '/' + Company + '/02-Assess/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
#####################################################################
sDatabaseName=sDataBaseDir + '/krennwallner.db'
conn = sq.connect(sDatabaseName)
#####################################################################
print('#################')
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL="select "
sSQL=sSQL+ " A.BillboardCountry,"
sSQL=sSQL+ " A.BillboardPlaceName,"
sSQL=sSQL+ " ROUND(A.BillboardLatitude,3) AS BillboardLatitude, "
sSQL=sSQL+ " ROUND(A.BillboardLongitude,3) AS BillboardLongitude,"

sSQL=sSQL+ " (CASE WHEN A.BillboardLatitude < 0 THEN "
sSQL=sSQL+ "  'S' || ROUND(ABS(A.BillboardLatitude),3)"
sSQL=sSQL+ " ELSE "
sSQL=sSQL+ "  'N' || ROUND(ABS(A.BillboardLatitude),3)"
sSQL=sSQL+ " END ) AS sBillboardLatitude,"

sSQL=sSQL+ " (CASE WHEN A.BillboardLongitude < 0 THEN "
sSQL=sSQL+ "  'W' || ROUND(ABS(A.BillboardLongitude),3)"
sSQL=sSQL+ " ELSE "
sSQL=sSQL+ "  'E' || ROUND(ABS(A.BillboardLongitude),3)"
sSQL=sSQL+ " END ) AS sBillboardLongitude,"

sSQL=sSQL+ " A.VisitorCountry,"
sSQL=sSQL+ " A.VisitorPlaceName,"
sSQL=sSQL+ " ROUND(A.VisitorLatitude,3) AS VisitorLatitude, "
sSQL=sSQL+ " ROUND(A.VisitorLongitude,3) AS VisitorLongitude,"

sSQL=sSQL+ " (CASE WHEN A.VisitorLatitude < 0 THEN "
```

```
sSQL=sSQL+ "  'S' || ROUND(ABS(A.VisitorLatitude),3)"
sSQL=sSQL+ " ELSE "
sSQL=sSQL+ "  'N' ||ROUND(ABS(A.VisitorLatitude),3)"
sSQL=sSQL+ " END ) AS sVisitorLatitude,"

sSQL=sSQL+ " (CASE WHEN A.VisitorLongitude < 0 THEN "
sSQL=sSQL+ "  'W' || ROUND(ABS(A.VisitorLongitude),3)"
sSQL=sSQL+ " ELSE "
sSQL=sSQL+ "  'E' || ROUND(ABS(A.VisitorLongitude),3)"
sSQL=sSQL+ " END ) AS sVisitorLongitude,"

sSQL=sSQL+ " A.VisitorYearRate"
sSQL=sSQL+ " from"
sSQL=sSQL+ " Assess_BillboardVistorsData AS A;"
BillboardVistorsData=pd.read_sql_query(sSQL, conn)
print('################')
#####################################################################
BillboardVistorsData['Distance']=BillboardVistorsData.apply(lambda row:
   round(
   vincenty((row['BillboardLatitude'],row['BillboardLongitude']),
            (row['VisitorLatitude'],row['VisitorLongitude'])).miles
         ,4)
     ,axis=1)
#####################################################################
G=nx.Graph()
#####################################################################

for i in range(BillboardVistorsData.shape[0]):
   sNode0='MediaHub-' + BillboardVistorsData['BillboardCountry'][i]

   sNode1='B-'+ BillboardVistorsData['sBillboardLatitude'][i] + '-'
   sNode1=sNode1 + BillboardVistorsData['sBillboardLongitude'][i]
   G.add_node(sNode1,
            Nodetype='Billboard',
            Country=BillboardVistorsData['BillboardCountry'][i],
            PlaceName=BillboardVistorsData['BillboardPlaceName'][i],
            Latitude=round(BillboardVistorsData['BillboardLatitude'][i],3),
            Longitude=round(BillboardVistorsData['BillboardLongitude'][i],3))

   sNode2='M-'+ BillboardVistorsData['sVisitorLatitude'][i] + '-'
   sNode2=sNode2 + BillboardVistorsData['sVisitorLongitude'][i]
   G.add_node(sNode2,
            Nodetype='Mobile',
            Country=BillboardVistorsData['VisitorCountry'][i],
            PlaceName=BillboardVistorsData['VisitorPlaceName'][i],
            Latitude=round(BillboardVistorsData['VisitorLatitude'][i],3),
            Longitude=round(BillboardVistorsData['VisitorLongitude'][i],3))
```

```
    print('Link Media Hub :',sNode0,' to Billboard : ', sNode1)
    G.add_edge(sNode0,sNode1)

    print('Link Post Code :',sNode1,' to GPS : ', sNode2)
    G.add_edge(sNode1,sNode2,distance=round(BillboardVistorsData['Distance'][i]))

#################################################################
print('################################')
print("Nodes of graph: ",nx.number_of_nodes(G))
print("Edges of graph: ",nx.number_of_edges(G))
print('################################')
#################################################################
sFileDir=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
#################################################################
sFileName=sFileDir + '/' + sOutputFileName
print('################################')
print('Storing :', sFileName)
print('################################')
nx.write_gml(G,sFileName)
sFileName=sFileName +'.gz'
nx.write_gml(G,sFileName)
#################################################################
#################################################################
print('### Done!! ############################################')
#################################################################
```

Output:
This will produce a set of demonstrated values onscreen, plus a graph data file named Assess-DE-Billboard-Visitor.gml.

(It takes a long time to complete the process, after completion the gml file can be viewed in text editor)

Hence, we have applied formulae to extract features, such as the distance between the billboard and the visitor.

Planning an Event for Top-Ten Customers

Open Python editor and create a file named Assess-Visitors.py in directory C:\VKHCG\02-Krennwallner\02-Assess

```
#################################################################
import sys
import os
import sqlite3 as sq
import pandas as pd
from pandas.io import sql
#################################################################
Base='C:/VKHCG'
```

```
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
#####################################################################
Company='02-Krennwallner'
sInputFileName='01-Retrieve/01-EDS/02-Python/Retrieve_Online_Visitor.csv'
#####################################################################
sDataBaseDir=Base + '/' + Company + '/02-Assess/SQLite'
if not os.path.exists(sDataBaseDir):
   os.makedirs(sDataBaseDir)
#####################################################################
sDatabaseName=sDataBaseDir + '/krennwallner.db'
conn = sq.connect(sDatabaseName)
#####################################################################
### Import Country Data
#####################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName
print('################################')
print('Loading :',sFileName)
print('################################')
VisitorRawData=pd.read_csv(sFileName,
                           header=0,
                           low_memory=False,
                           encoding="latin-1",
                           skip_blank_lines=True)
VisitorRawData.drop_duplicates(subset=None, keep='first', inplace=True)
VisitorData=VisitorRawData
print('Loaded Company :',VisitorData.columns.values)
print('################################')
#####################################################################
print('################')
sTable='Assess_Visitor'
print('Storing :',sDatabaseName,' Table:',sTable)
VisitorData.to_sql(sTable, conn, if_exists="replace")
print('################')
#####################################################################
print(VisitorData.head())
print('################################')
print('Rows : ',VisitorData.shape[0])
print('################################')
#####################################################################
print('################')
sView='Assess_Visitor_UseIt'
print('Creating :',sDatabaseName,' View:',sView)
sSQL="DROP VIEW IF EXISTS " + sView + ";"
sql.execute(sSQL,conn)

sSQL="CREATE VIEW " + sView + " AS"
```

```
sSQL=sSQL+ " SELECT"
sSQL=sSQL+ " A.Country,"
sSQL=sSQL+ " A.Place_Name,"
sSQL=sSQL+ " A.Latitude,"
sSQL=sSQL+ " A.Longitude,"
sSQL=sSQL+ " (A.Last_IP_Number - A.First_IP_Number) AS UsesIt"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " Assess_Visitor as A"
sSQL=sSQL+ " WHERE"
sSQL=sSQL+ " Country is not null"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " Place_Name is not null;"
sql.execute(sSQL,conn)
######################################################################
print('#################')
sView='Assess_Total_Visitors_Location'
print('Creating :',sDatabaseName,' View:',sView)
sSQL="DROP VIEW IF EXISTS " + sView + ";"
sql.execute(sSQL,conn)

sSQL="CREATE VIEW " + sView + " AS"
sSQL=sSQL+ " SELECT"
sSQL=sSQL+ " Country,"
sSQL=sSQL+ " Place_Name,"
sSQL=sSQL+ " SUM(UsesIt) AS TotalUsesIt"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " Assess_Visitor_UseIt"
sSQL=sSQL+ " GROUP BY"
sSQL=sSQL+ " Country,"
sSQL=sSQL+ " Place_Name"
sSQL=sSQL+ " ORDER BY"
sSQL=sSQL+ " TotalUsesIt DESC"
sSQL=sSQL+ " LIMIT 10;"
sql.execute(sSQL,conn)
######################################################################
print('#################')
sView='Assess_Total_Visitors_GPS'
print('Creating :',sDatabaseName,' View:',sView)
sSQL="DROP VIEW IF EXISTS " + sView + ";"
sql.execute(sSQL,conn)

sSQL="CREATE VIEW " + sView + " AS"
sSQL=sSQL+ " SELECT"
sSQL=sSQL+ " Latitude,"
sSQL=sSQL+ " Longitude,"
sSQL=sSQL+ " SUM(UsesIt) AS TotalUsesIt"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " Assess_Visitor_UseIt"
```

```
sSQL=sSQL+ " GROUP BY"
sSQL=sSQL+ " Latitude,"
sSQL=sSQL+ " Longitude"
sSQL=sSQL+ " ORDER BY"
sSQL=sSQL+ " TotalUsesIt DESC"
sSQL=sSQL+ " LIMIT 10;"
sql.execute(sSQL,conn)
#####################################################################
sTables=['Assess_Total_Visitors_Location', 'Assess_Total_Visitors_GPS']
for sTable in sTables:
   print('#################')
   print('Loading :',sDatabaseName,' Table:',sTable)
   sSQL=" SELECT "
   sSQL=sSQL+ " *"
   sSQL=sSQL+ " FROM"
   sSQL=sSQL+ " " + sTable + ";"
   TopData=pd.read_sql_query(sSQL, conn)
   print('#################')
   print(TopData)
   print('#################')
   print('#################################')
   print('Rows : ',TopData.shape[0])
   print('#################################')
#####################################################################
print('### Done!! ############################################')
#####################################################################
```

Output:

```
Python 3.7.4 Shell
File  Edit  Shell  Debug  Options  Window  Help
#################
Loading : C:/VKHCG/02-Krennwallner/02-Assess/SQLite/krennwallner.db  Table: Assess_Total_Visitors_Location
#################
  Country     Place_Name  TotalUsesIt
0      CN        Beijing     53139475
1      US      Palo Alto     33682341
2      US  Fort Huachuca     33472427
3      JP          Tokyo     31404799
4      US      Cambridge     25598851
5      US      San Diego     17751367
6      CN      Guangzhou     17563744
7      US         Newark     17270604
8      US        Raleigh     17167484
9      US         Durham     16914033
#################
################################
Rows :  10
################################
#################
Loading : C:/VKHCG/02-Krennwallner/02-Assess/SQLite/krennwallner.db  Table: Assess_Total_Visitors_GPS
#################
   Latitude  Longitude  TotalUsesIt
0   39.9289   116.3883     53139732
1   37.3762  -122.1826     33551404
2   31.5273  -110.3607     33472427
3   35.6427   139.7677     31439772
4   23.1167   113.2500     17577053
5   42.3646   -71.1028     16890698
6   40.7355   -74.1741     16813373
7   42.3223   -83.1763     16777212
8   35.7977   -78.6253     16761084
9   32.8072  -117.1649     16747680
#################
```

F. Write a Python / R program to plan the locations of the warehouses from the given data.

Planning the Locations of the Warehouses

Planning the location of the warehouses requires the assessment of the GPS locations of these warehouses against the requirements for Hillman's logistics needs.

Open your editor and create a file named Assess-Warehouse-Address.py in directory C:\VKHCG\03-Hillman\02-Assess.

```
################### Assess-Warehouse-Address.py  ###################
# -*- coding: utf-8 -*-
#################################################################
import os
import pandas as pd
from geopy.geocoders import Nominatim
geolocator = Nominatim()
#################################################################
InputDir='01-Retrieve/01-EDS/01-R'
InputFileName='Retrieve_GB_Postcode_Warehouse.csv'
EDSDir='02-Assess/01-EDS'
OutputDir=EDSDir + '/02-Python'
OutputFileName='Assess_GB_Warehouse_Address.csv'
Company='03-Hillman'
#################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using Windows')
print('##################################')
#################################################################
sFileDir=Base + '/' + Company + '/' + EDSDir
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
#################################################################
sFileDir=Base + '/' + Company + '/' + OutputDir
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
#################################################################
sFileName=Base + '/' + Company + '/' + InputDir + '/' + InputFileName
print('###########')
print('Loading :',sFileName)
Warehouse=pd.read_csv(sFileName,header=0,low_memory=False)
Warehouse.sort_values(by='postcode', ascending=1)
#################################################################
## Limited to 10 due to service limit on Address Service.
#################################################################
WarehouseGoodHead=Warehouse[Warehouse.latitude != 0].head(5)
WarehouseGoodTail=Warehouse[Warehouse.latitude != 0].tail(5)
#################################################################
WarehouseGoodHead['Warehouse_Point']=WarehouseGoodHead.apply(lambda row:
        (str(row['latitude'])+','+str(row['longitude']))
        ,axis=1)
WarehouseGoodHead['Warehouse_Address']=WarehouseGoodHead.apply(lambda row:
        geolocator.reverse(row['Warehouse_Point']).address
```

```
        ,axis=1)
WarehouseGoodHead.drop('Warehouse_Point', axis=1, inplace=True)
WarehouseGoodHead.drop('id', axis=1, inplace=True)
WarehouseGoodHead.drop('postcode', axis=1, inplace=True)
#####################################################################
WarehouseGoodTail['Warehouse_Point']=WarehouseGoodTail.apply(lambda row:
        (str(row['latitude'])+','+str(row['longitude']))
        ,axis=1)
WarehouseGoodTail['Warehouse_Address']=WarehouseGoodTail.apply(lambda row:
        geolocator.reverse(row['Warehouse_Point']).address
        ,axis=1)
WarehouseGoodTail.drop('Warehouse_Point', axis=1, inplace=True)
WarehouseGoodTail.drop('id', axis=1, inplace=True)
WarehouseGoodTail.drop('postcode', axis=1, inplace=True)
#####################################################################
WarehouseGood=WarehouseGoodHead.append(WarehouseGoodTail, ignore_index=True)
print(WarehouseGood)
#####################################################################
sFileName=sFileDir + '/' + OutputFileName
WarehouseGood.to_csv(sFileName, index = False)
#####################################################################
print('### Done!! ############################################')
#####################################################################
```

Output:

```
################################
Working Base : C:/VKHCG  using Windows
################################
###########
Loading : C:/VKHCG/03-Hillman/01-Retrieve/01-EDS/01-R/Retrieve_GB_Postcode_Warehouse.csv
    latitude  longitude                                  Warehouse_Address
0  57.135140  -2.117310  35, Broomhill Road, Broomhill, Aberdeen, Aberd...
1  57.138750  -2.090890  South Esplanade West, Torry, Aberdeen, Aberdee...
2  57.101000  -2.110600  A92, Cove and Altens, Aberdeen, Aberdeen City,...
3  57.108010  -2.237760  Colthill Circle, Milltimber, Countesswells, Ab...
4  57.100760  -2.270730  Johnston Gardens East, Peterculter, South Last...
5  53.837717  -1.780013  HM Revenue and Customs, Riverside Estate, Temp...
6  53.794470  -1.766539  Listerhills Road Norcroft Street, Listerhills ...
7  51.518556  -0.714794  Sorting Office, Stafferton Way, Fishery, Maide...
8  54.890923  -2.943847  Royal Mail (Delivery Office), Junction Street,...
9  57.481338  -4.223951  Inverness Sorting & Delivery Office, Strothers...
### Done!! ############################################
>>>
```

G. Write a Python / R program using data science via clustering to determine new warehouses using the given data.

Global New Warehouse: Hillman wants to add extra global warehouses, and you are required to assess wherethey should be located. We only have to collect the possible locations for warehouses.

The following example will show you how to modify the data columns you read in that are totally ambiguous. Open Python editor and create a file named Assess-Warehouse-Global.py in directory C:\VKHCG\03-Hillman\02-Assess

```
#################          Assess-Warehouse-Global.py##############
# -*- coding: utf-8 -*-
######################################################################
import sys
import os
import pandas as pd
######################################################################
Base='C:/VKHCG'
######################################################################
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
######################################################################
Company='03-Hillman'
InputDir='01-Retrieve/01-EDS/01-R'
InputFileName='Retrieve_All_Countries.csv'
EDSDir='02-Assess/01-EDS'
OutputDir=EDSDir + '/02-Python'
OutputFileName='Assess_All_Warehouse.csv'
######################################################################
sFileDir=Base + '/' + Company + '/' + EDSDir
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
######################################################################
sFileDir=Base + '/' + Company + '/' + OutputDir
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
######################################################################
sFileName=Base + '/' + Company + '/' + InputDir + '/' + InputFileName
print('############')
print('Loading :',sFileName)
Warehouse=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
######################################################################
sColumns={'X1' : 'Country',
          'X2' : 'PostCode',
          'X3' : 'PlaceName',
          'X4' : 'AreaName',
          'X5' : 'AreaCode',
          'X10' : 'Latitude',
```

```
        'X11' : 'Longitude'}
Warehouse.rename(columns=sColumns,inplace=True)
WarehouseGood=Warehouse
#########################################################################
sFileName=sFileDir + '/' + OutputFileName
WarehouseGood.to_csv(sFileName, index = False)
#########################################################################
print('### Done!! ################################################')
#########################################################################
```

This will produce a set of demonstrated values onscreen, plus a graph data file named Assess_All_Warehouse.csv.

Output:

```
>>>
===== RESTART: C:\VKHCG\03-Hillman\02-Assess\Assess-Warehouse-Global.py =====
################################
Working Base : C:/VKHCG  using  win32
################################
###########
Loading : C:/VKHCG/03-Hillman/01-Retrieve/01-EDS/01-R/Retrieve_All_Countries.csv
### Done!! ############################################
>>>
                                                                    Ln: 33  Col: 4
```

Open Assess0_All_Warehose.csv from C:\VKHCG\03-Hillman\02-Assess\01-EDS\02-Python

	A	B	C	D	E	F	G	H
1	Unnamed: 0	Country	PostCode	PlaceName	AreaName	AreaCode	Latitude	Longitude
2	1	AD	AD100	Canillo			42.5833	1.6667
3	2	AD	AD200	Encamp			42.5333	1.6333
4	3	AD	AD300	Ordino			42.6	1.55
5	4	AD	AD400	La Massana			42.5667	1.4833
6	5	AD	AD500	Andorra la Vella			42.5	1.5
31621	31620	AT	4925	Gumpling	OberÃ¶sterreich	4	48.1555	13.4802
31622	31621	AT	4925	Windischhub	OberÃ¶sterreich	4	48.1555	13.4802
31623	31622	AT	4926	Obereselbach	OberÃ¶sterreich	4	48.1917	13.5784
31624	31623	AT	4926	Jetzing	OberÃ¶sterreich	4	48.1555	13.4802
31625	31624	AT	4926	Pilgersham	OberÃ¶sterreich	4	48.1772	13.5855
31626	31625	AT	4926	Grausgrub	OberÃ¶sterreich	4	48.1555	13.4802
31627	31626	AT	4926	Marienkirchen am Ha	OberÃ¶sterreich	4	48.1828	13.577
31628	31627	AT	4926	Stocket	OberÃ¶sterreich	4	48.1555	13.4802
31629	31628	AT	4926	Baching	OberÃ¶sterreich	4	48.1555	13.4802
31630	31629	AT	4926	Kern	OberÃ¶sterreich	4	48.1555	13.4802
31631	31630	AT	4926	Manaberg	OberÃ¶sterreich	4	48.1555	13.4802
31632	31631	AT	4926	Untereselbach	OberÃ¶sterreich	4	48.1555	13.4802
31633	31632	AT	4926	Hatting	OberÃ¶sterreich	4	48.1555	13.4802
31634	31633	AT	4926	Unering	OberÃ¶sterreich	4	48.1555	13.4802
31635	31634	AT	4926	Kleinbach	OberÃ¶sterreich	4	48.1555	13.4802
31636	31635	AT	4926	Lehen	OberÃ¶sterreich	4	48.1555	13.4802
31637	31636	AT	4926	Hof	OberÃ¶sterreich	4	48.1555	13.4802
31638	31637	AT	4931	GroÃŸweiffendorf	OberÃ¶sterreich	4	48.15	13.3333
31639	31638	AT	4931	Neulendt	OberÃ¶sterreich	4	48.1697	13.3531

Assess_All_Warehouse

H. Using the given data, write a Python / R program to plan the shipping routes for best-fit international logistics.

Hillman requires an international logistics solution to support all the required shippingroutes.

Open Python editor and create a file named Assess-Best-Fit-Logistics.py in directory C:\VKHCG\03-Hillman\02-Assess

```
##################################################################
# -*- coding: utf-8 -*-
##################################################################
import sys
import os
import pandas as pd
import networkx as nx
from geopy.distance import vincenty
import sqlite3 as sq
from pandas.io import sql
##################################################################
if sys.platform == 'linux':
    Base=os.path.expanduser('~') + '/VKHCG'
else:
    Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
##################################################################
Company='03-Hillman'
InputDir='01-Retrieve/01-EDS/01-R'
InputFileName='Retrieve_All_Countries.csv'
EDSDir='02-Assess/01-EDS'
OutputDir=EDSDir + '/02-Python'
OutputFileName='Assess_Best_Logistics.gml'
##################################################################
sFileDir=Base + '/' + Company + '/' + EDSDir
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
##################################################################
sFileDir=Base + '/' + Company + '/' + OutputDir
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
##################################################################
sDataBaseDir=Base + '/' + Company + '/02-Assess/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
##################################################################
sDatabaseName=sDataBaseDir + '/Hillman.db'
conn = sq.connect(sDatabaseName)
##################################################################
```

```
sFileName=Base + '/' + Company + '/' + InputDir + '/' + InputFileName
print('###########')
print('Loading :',sFileName)
Warehouse=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
#####################################################################
sColumns={'X1' : 'Country',
        'X2' : 'PostCode',
        'X3' : 'PlaceName',
        'X4' : 'AreaName',
        'X5' : 'AreaCode',
        'X10' : 'Latitude',
        'X11' : 'Longitude'}
Warehouse.rename(columns=sColumns,inplace=True)
WarehouseGood=Warehouse
#print(WarehouseGood.head())
#####################################################################
RoutePointsCountry=pd.DataFrame(WarehouseGood.groupby(['Country'])[['Latitude','Longitude'
]].mean())
#print(RoutePointsCountry.head())
print('################')
sTable='Assess_RoutePointsCountry'
print('Storing :',sDatabaseName,' Table:',sTable)
RoutePointsCountry.to_sql(sTable, conn, if_exists="replace")
print('################')
#####################################################################
RoutePointsPostCode=pd.DataFrame(WarehouseGood.groupby(['Country',
'PostCode'])[['Latitude','Longitude']].mean())
#print(RoutePointsPostCode.head())
print('################')
sTable='Assess_RoutePointsPostCode'
print('Storing :',sDatabaseName,' Table:',sTable)
RoutePointsPostCode.to_sql(sTable, conn, if_exists="replace")
print('################')
#####################################################################
RoutePointsPlaceName=pd.DataFrame(WarehouseGood.groupby(['Country',
'PostCode','PlaceName'])[['Latitude','Longitude']].mean())
#print(RoutePointsPlaceName.head())
print('################')
sTable='Assess_RoutePointsPlaceName'
print('Storing :',sDatabaseName,' Table:',sTable)
RoutePointsPlaceName.to_sql(sTable, conn, if_exists="replace")
print('################')
#####################################################################
### Fit Country to Country
#####################################################################
print('################')
sView='Assess_RouteCountries'
print('Creating :',sDatabaseName,' View:',sView)
```

```
sSQL="DROP VIEW IF EXISTS " + sView + ";"
sql.execute(sSQL,conn)

sSQL="CREATE VIEW " + sView + " AS"
sSQL=sSQL+ " SELECT DISTINCT"
sSQL=sSQL+ "   S.Country AS SourceCountry,"
sSQL=sSQL+ "   S.Latitude AS SourceLatitude,"
sSQL=sSQL+ "   S.Longitude AS SourceLongitude,"
sSQL=sSQL+ "   T.Country AS TargetCountry,"
sSQL=sSQL+ "   T.Latitude AS TargetLatitude,"
sSQL=sSQL+ "   T.Longitude AS TargetLongitude"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ "   Assess_RoutePointsCountry AS S"
sSQL=sSQL+ "   ,"
sSQL=sSQL+ "   Assess_RoutePointsCountry AS T"
sSQL=sSQL+ " WHERE S.Country <> T.Country"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " S.Country in ('GB','DE','BE','AU','US','IN')"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " T.Country in ('GB','DE','BE','AU','US','IN');"
sql.execute(sSQL,conn)

print('#################')
print('Loading :',sDatabaseName,' Table:',sView)
sSQL=" SELECT "
sSQL=sSQL+ " *"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " " + sView + ";"
RouteCountries=pd.read_sql_query(sSQL, conn)

RouteCountries['Distance']=RouteCountries.apply(lambda row:
   round(
   vincenty((row['SourceLatitude'],row['SourceLongitude']),
            (row['TargetLatitude'],row['TargetLongitude'])).miles,4),axis=1)

print(RouteCountries.head(5))
#####################################################################
### Fit Country to Post Code
#####################################################################
print('#################')
sView='Assess_RoutePostCode'
print('Creating :',sDatabaseName,' View:',sView)
sSQL="DROP VIEW IF EXISTS " + sView + ";"
sql.execute(sSQL,conn)

sSQL="CREATE VIEW " + sView + " AS"
sSQL=sSQL+ " SELECT DISTINCT"
sSQL=sSQL+ "   S.Country AS SourceCountry,"
```

```
sSQL=sSQL+ "   S.Latitude AS SourceLatitude,"
sSQL=sSQL+ "   S.Longitude AS SourceLongitude,"
sSQL=sSQL+ "   T.Country AS TargetCountry,"
sSQL=sSQL+ "   T.PostCode AS TargetPostCode,"
sSQL=sSQL+ "   T.Latitude AS TargetLatitude,"
sSQL=sSQL+ "   T.Longitude AS TargetLongitude"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ "   Assess_RoutePointsCountry AS S"
sSQL=sSQL+ "   ,"
sSQL=sSQL+ "   Assess_RoutePointsPostCode AS T"
sSQL=sSQL+ " WHERE S.Country = T.Country"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " S.Country in ('GB','DE','BE','AU','US','IN')"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " T.Country in ('GB','DE','BE','AU','US','IN');"
sql.execute(sSQL,conn)

print('################')
print('Loading :',sDatabaseName,' Table:',sView)
sSQL=" SELECT "
sSQL=sSQL+ " *"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " " + sView + ";"
RoutePostCode=pd.read_sql_query(sSQL, conn)

RoutePostCode['Distance']=RoutePostCode.apply(lambda row:
   round(
   vincenty((row['SourceLatitude'],row['SourceLongitude']),
            (row['TargetLatitude'],row['TargetLongitude'])).miles
         ,4)
     ,axis=1)

print(RoutePostCode.head(5))
#####################################################################
### Fit Post Code to Place Name
#####################################################################
print('################')
sView='Assess_RoutePlaceName'
print('Creating :',sDatabaseName,' View:',sView)
sSQL="DROP VIEW IF EXISTS " + sView + ";"
sql.execute(sSQL,conn)

sSQL="CREATE VIEW " + sView + " AS"
sSQL=sSQL+ " SELECT DISTINCT"
sSQL=sSQL+ "   S.Country AS SourceCountry,"
sSQL=sSQL+ "   S.PostCode AS SourcePostCode,"
sSQL=sSQL+ "   S.Latitude AS SourceLatitude,"
sSQL=sSQL+ "   S.Longitude AS SourceLongitude,"
```

```
sSQL=sSQL+ "   T.Country AS TargetCountry,"
sSQL=sSQL+ "   T.PostCode AS TargetPostCode,"
sSQL=sSQL+ "   T.PlaceName AS TargetPlaceName,"
sSQL=sSQL+ "   T.Latitude AS TargetLatitude,"
sSQL=sSQL+ "   T.Longitude AS TargetLongitude"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ "   Assess_RoutePointsPostCode AS S"
sSQL=sSQL+ "   ,"
sSQL=sSQL+ "   Assess_RoutePointsPLaceName AS T"
sSQL=sSQL+ " WHERE"
sSQL=sSQL+ " S.Country = T.Country"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " S.PostCode = T.PostCode"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " S.Country in ('GB','DE','BE','AU','US','IN')"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " T.Country in ('GB','DE','BE','AU','US','IN');"
sql.execute(sSQL,conn)

print('################')
print('Loading :',sDatabaseName,' Table:',sView)
sSQL=" SELECT "
sSQL=sSQL+ " *"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " " + sView + ";"
RoutePlaceName=pd.read_sql_query(sSQL, conn)

RoutePlaceName['Distance']=RoutePlaceName.apply(lambda row:
   round(
   vincenty((row['SourceLatitude'],row['SourceLongitude']),
             (row['TargetLatitude'],row['TargetLongitude'])).miles
         ,4)
     ,axis=1)

print(RoutePlaceName.head(5))
#####################################################################
G=nx.Graph()
#####################################################################
print('Countries:',RouteCountries.shape)
for i in range(RouteCountries.shape[0]):
   sNode0='C-' + RouteCountries['SourceCountry'][i]
   G.add_node(sNode0,
           Nodetype='Country',
           Country=RouteCountries['SourceCountry'][i],
           Latitude=round(RouteCountries['SourceLatitude'][i],4),
           Longitude=round(RouteCountries['SourceLongitude'][i],4))

   sNode1='C-' + RouteCountries['TargetCountry'][i]
```

```
    G.add_node(sNode1,
            Nodetype='Country',
            Country=RouteCountries['TargetCountry'][i],
            Latitude=round(RouteCountries['TargetLatitude'][i],4),
            Longitude=round(RouteCountries['TargetLongitude'][i],4))
    G.add_edge(sNode0,sNode1,distance=round(RouteCountries['Distance'][i],3))
    #print(sNode0,sNode1)
##########################################################################
print('Post Code:',RoutePostCode.shape)
for i in range(RoutePostCode.shape[0]):
    sNode0='C-' + RoutePostCode['SourceCountry'][i]
    G.add_node(sNode0,
            Nodetype='Country',
            Country=RoutePostCode['SourceCountry'][i],
            Latitude=round(RoutePostCode['SourceLatitude'][i],4),
            Longitude=round(RoutePostCode['SourceLongitude'][i],4))

    sNode1='P-' + RoutePostCode['TargetPostCode'][i]  + '-' + RoutePostCode['TargetCountry'][i]
    G.add_node(sNode1,
            Nodetype='PostCode',
            Country=RoutePostCode['TargetCountry'][i],
            PostCode=RoutePostCode['TargetPostCode'][i],
            Latitude=round(RoutePostCode['TargetLatitude'][i],4),
            Longitude=round(RoutePostCode['TargetLongitude'][i],4))
    G.add_edge(sNode0,sNode1,distance=round(RoutePostCode['Distance'][i],3))
    #print(sNode0,sNode1)
##########################################################################
print('Place Name:',RoutePlaceName.shape)
for i in range(RoutePlaceName.shape[0]):
    sNode0='P-' + RoutePlaceName['TargetPostCode'][i]  + '-'
    sNode0=sNode0 + RoutePlaceName['TargetCountry'][i]
    G.add_node(sNode0,
            Nodetype='PostCode',
            Country=RoutePlaceName['SourceCountry'][i],
            PostCode=RoutePlaceName['TargetPostCode'][i],
            Latitude=round(RoutePlaceName['SourceLatitude'][i],4),
            Longitude=round(RoutePlaceName['SourceLongitude'][i],4))

    sNode1='L-' + RoutePlaceName['TargetPlaceName'][i]  + '-'
    sNode1=sNode1 + RoutePlaceName['TargetPostCode'][i]  + '-'
    sNode1=sNode1 + RoutePlaceName['TargetCountry'][i]
    G.add_node(sNode1,
            Nodetype='PlaceName',
            Country=RoutePlaceName['TargetCountry'][i],
            PostCode=RoutePlaceName['TargetPostCode'][i],
            PlaceName=RoutePlaceName['TargetPlaceName'][i],
            Latitude=round(RoutePlaceName['TargetLatitude'][i],4),
            Longitude=round(RoutePlaceName['TargetLongitude'][i],4))
```

```
    G.add_edge(sNode0,sNode1,distance=round(RoutePlaceName['Distance'][i],3))
    #print(sNode0,sNode1)
##################################################################
sFileName=sFileDir + '/' + OutputFileName
print('################################')
print('Storing :', sFileName)
print('################################')
nx.write_gml(G,sFileName)
sFileName=sFileName +'.gz'
nx.write_gml(G,sFileName)
##################################################################
print('################################')
print('Path:', nx.shortest_path(G,source='P-SW1-GB',target='P-01001-US',weight='distance'))
print('Path length:', nx.shortest_path_length(G,source='P-SW1-GB',target='P-01001-
US',weight='distance'))
print('Path length (1):', nx.shortest_path_length(G,source='P-SW1-GB',target='C-
GB',weight='distance'))
print('Path length (2):', nx.shortest_path_length(G,source='C-GB',target='C-
US',weight='distance'))
print('Path length (3):', nx.shortest_path_length(G,source='C-US',target='P-01001-
US',weight='distance'))
print('################################')
print('Routes from P-SW1-GB < 2: ', nx.single_source_shortest_path(G,source='P-SW1-GB'
,cutoff=1))
print('Routes from P-01001-US < 2: ', nx.single_source_shortest_path(G,source='P-01001-US'
,cutoff=1))
print('################################')
##################################################################
print('################')
print('Vacuum Database')
sSQL="VACUUM;"
sql.execute(sSQL,conn)
print('################')
##################################################################
print('### Done!! ############################################')
##################################################################
```

Output:

You can now query features out of a graph, such as shortage pathsbetween locations and paths from a given location, using Assess_Best_Logistics.gml with appropirate application.

I. Write a Python / R program to decide the best packing option to ship in container from the given data.

Hillman wants to introduce new shipping containers into its logistics strategy. This program will through a process of assessing the possible container sizes.This example introduces features with ranges or tolerances.

Open Python editor and create a file named Assess-Shipping-Containers.py in directory C:\VKHCG\03-Hillman\02-Assess

```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
import sqlite3 as sq
from pandas.io import sql
################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
################################################################
Company='03-Hillman'
InputDir='01-Retrieve/01-EDS/02-Python'
InputFileName1='Retrieve_Product.csv'
InputFileName2='Retrieve_Box.csv'
InputFileName3='Retrieve_Container.csv'
EDSDir='02-Assess/01-EDS'
OutputDir=EDSDir + '/02-Python'
OutputFileName='Assess_Shipping_Containers.csv'
################################################################
sFileDir=Base + '/' + Company + '/' + EDSDir
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
################################################################
sFileDir=Base + '/' + Company + '/' + OutputDir
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
################################################################
sDataBaseDir=Base + '/' + Company + '/02-Assess/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
################################################################
sDatabaseName=sDataBaseDir + '/hillman.db'
conn = sq.connect(sDatabaseName)
################################################################
```

```
#####################################################################
### Import Product Data
#####################################################################
sFileName=Base + '/' + Company + '/' + InputDir + '/' + InputFileName1
print('###########')
print('Loading :',sFileName)
ProductRawData=pd.read_csv(sFileName,
                header=0,
                low_memory=False,
                encoding="latin-1"
                )
ProductRawData.drop_duplicates(subset=None, keep='first', inplace=True)
ProductRawData.index.name = 'IDNumber'
ProductData=ProductRawData[ProductRawData.Length <= 0.5].head(10)
print('Loaded Product :',ProductData.columns.values)
print('################################')
#####################################################################
print('################')
sTable='Assess_Product'
print('Storing :',sDatabaseName,' Table:',sTable)
ProductData.to_sql(sTable, conn, if_exists="replace")
print('################')
#####################################################################
print(ProductData.head())
print('################################')
print('Rows : ',ProductData.shape[0])
print('################################')
#####################################################################
#####################################################################
### Import Box Data
#####################################################################
sFileName=Base + '/' + Company + '/' + InputDir + '/' + InputFileName2
print('###########')
print('Loading :',sFileName)
BoxRawData=pd.read_csv(sFileName,
                header=0,
                low_memory=False,
                encoding="latin-1"
                )
BoxRawData.drop_duplicates(subset=None, keep='first', inplace=True)
BoxRawData.index.name = 'IDNumber'
BoxData=BoxRawData[BoxRawData.Length <= 1].head(1000)
print('Loaded Product :',BoxData.columns.values)
print('################################')
#####################################################################
print('################')
sTable='Assess_Box'
print('Storing :',sDatabaseName,' Table:',sTable)
```

```
BoxData.to_sql(sTable, conn, if_exists="replace")
print('################')
#####################################################################
print(BoxData.head())
print('################################')
print('Rows : ',BoxData.shape[0])
print('################################')
#####################################################################
#####################################################################
### Import Container Data
#####################################################################
sFileName=Base + '/' + Company + '/' + InputDir + '/' + InputFileName3
print('###########')
print('Loading :',sFileName)
ContainerRawData=pd.read_csv(sFileName,
                header=0,
                low_memory=False,
                encoding="latin-1"
                )
ContainerRawData.drop_duplicates(subset=None, keep='first', inplace=True)
ContainerRawData.index.name = 'IDNumber'
ContainerData=ContainerRawData[ContainerRawData.Length <= 2].head(10)
print('Loaded Product :',ContainerData.columns.values)
print('################################')
#####################################################################
print('################')
sTable='Assess_Container'
print('Storing :',sDatabaseName,' Table:',sTable)
BoxData.to_sql(sTable, conn, if_exists="replace")
print('################')
#####################################################################
print(ContainerData.head())
print('################################')
print('Rows : ',ContainerData.shape[0])
print('################################')
#####################################################################
#####################################################################
### Fit Product in Box
#####################################################################
print('################')
sView='Assess_Product_in_Box'
print('Creating :',sDatabaseName,' View:',sView)
sSQL="DROP VIEW IF EXISTS " + sView + ";"
sql.execute(sSQL,conn)

sSQL="CREATE VIEW " + sView + " AS"
sSQL=sSQL+ " SELECT"
sSQL=sSQL+ " P.UnitNumber AS ProductNumber,"
```

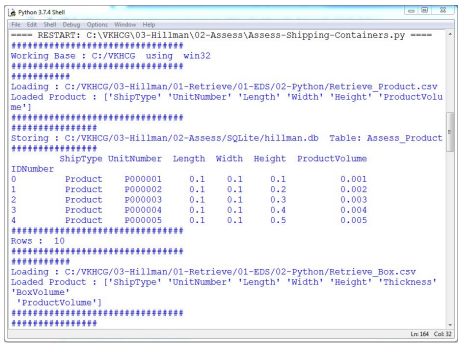
```
sSQL=sSQL+ " B.UnitNumber AS BoxNumber,"
sSQL=sSQL+ " (B.Thickness * 1000) AS PackSafeCode,"
sSQL=sSQL+ " (B.BoxVolume - P.ProductVolume) AS PackFoamVolume,"
sSQL=sSQL+ " ((B.Length*10) * (B.Width*10) * (B.Height*10)) * 167 AS
Air_Dimensional_Weight,"
sSQL=sSQL+ " ((B.Length*10) * (B.Width*10) * (B.Height*10)) * 333 AS
Road_Dimensional_Weight,"
sSQL=sSQL+ " ((B.Length*10) * (B.Width*10) * (B.Height*10)) * 1000 AS
Sea_Dimensional_Weight,"
sSQL=sSQL+ " P.Length AS Product_Length,"
sSQL=sSQL+ " P.Width AS Product_Width,"
sSQL=sSQL+ " P.Height AS Product_Height,"
sSQL=sSQL+ " P.ProductVolume AS Product_cm_Volume,"
sSQL=sSQL+ " ((P.Length*10) * (P.Width*10) * (P.Height*10)) AS Product_ccm_Volume,"
sSQL=sSQL+ " (B.Thickness * 0.95) AS Minimum_Pack_Foam,"
sSQL=sSQL+ " (B.Thickness * 1.05) AS Maximum_Pack_Foam,"
sSQL=sSQL+ " B.Length - (B.Thickness * 1.10) AS Minimum_Product_Box_Length,"
sSQL=sSQL+ " B.Length - (B.Thickness * 0.95) AS Maximum_Product_Box_Length,"
sSQL=sSQL+ " B.Width - (B.Thickness * 1.10) AS Minimum_Product_Box_Width,"
sSQL=sSQL+ " B.Width - (B.Thickness * 0.95) AS Maximum_Product_Box_Width,"
sSQL=sSQL+ " B.Height - (B.Thickness * 1.10) AS Minimum_Product_Box_Height,"
sSQL=sSQL+ " B.Height - (B.Thickness * 0.95) AS Maximum_Product_Box_Height,"
sSQL=sSQL+ " B.Length AS Box_Length,"
sSQL=sSQL+ " B.Width AS Box_Width,"
sSQL=sSQL+ " B.Height AS Box_Height,"
sSQL=sSQL+ " B.BoxVolume AS Box_cm_Volume,"
sSQL=sSQL+ " ((B.Length*10) * (B.Width*10) * (B.Height*10)) AS Box_ccm_Volume,"
sSQL=sSQL+ " (2 * B.Length * B.Width) + (2 * B.Length * B.Height) + (2 * B.Width *
B.Height) AS Box_sqm_Area,"
sSQL=sSQL+ " ((B.Length*10) * (B.Width*10) * (B.Height*10)) *  3.5 AS
Box_A_Max_Kg_Weight,"
sSQL=sSQL+ " ((B.Length*10) * (B.Width*10) * (B.Height*10)) *  7.7 AS
Box_B_Max_Kg_Weight,"
sSQL=sSQL+ " ((B.Length*10) * (B.Width*10) * (B.Height*10)) * 10.0 AS
Box_C_Max_Kg_Weight"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " Assess_Product as P"
sSQL=sSQL+ " ,"
sSQL=sSQL+ " Assess_Box as B"
sSQL=sSQL+ " WHERE"
sSQL=sSQL+ " P.Length >= (B.Length - (B.Thickness * 1.10))"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " P.Width >= (B.Width - (B.Thickness * 1.10))"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " P.Height >= (B.Height - (B.Thickness * 1.10))"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " P.Length <= (B.Length - (B.Thickness * 0.95))"
sSQL=sSQL+ " AND"
```

```
sSQL=sSQL+ " P.Width <= (B.Width - (B.Thickness * 0.95))"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " P.Height <= (B.Height - (B.Thickness * 0.95))"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " (B.Height - B.Thickness) >= 0"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " (B.Width - B.Thickness) >= 0"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " (B.Height - B.Thickness) >= 0"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " B.BoxVolume >= P.ProductVolume;"
sql.execute(sSQL,conn)
#####################################################################
### Fit Box in Pallet
#####################################################################
t=0
for l in range(2,8):
    for w in range(2,8):
        for h in range(4):
            t += 1
            PalletLine=[('IDNumber',[t]),
                        ('ShipType', ['Pallet']),
                        ('UnitNumber', ('L-'+format(t,"06d"))),
                        ('Box_per_Length',(format(2**l,"4d"))),
                        ('Box_per_Width',(format(2**w,"4d"))),
                        ('Box_per_Height',(format(2**h,"4d")))]
            if t==1:
               PalletFrame = pd.DataFrame.from_items(PalletLine)
            else:
                PalletRow = pd.DataFrame.from_items(PalletLine)
                PalletFrame = PalletFrame.append(PalletRow)
PalletFrame.set_index(['IDNumber'],inplace=True)
#####################################################################
PalletFrame.head()
print('################################')
print('Rows : ',PalletFrame.shape[0])
print('################################')
#####################################################################
### Fit Box on Pallet
#####################################################################
print('################')
sView='Assess_Box_on_Pallet'
print('Creating :',sDatabaseName,' View:',sView)
sSQL="DROP VIEW IF EXISTS " + sView + ";"
sql.execute(sSQL,conn)

sSQL="CREATE VIEW " + sView + " AS"
sSQL=sSQL+ " SELECT DISTINCT"
```

```
sSQL=sSQL+ " P.UnitNumber AS PalletNumber,"
sSQL=sSQL+ " B.UnitNumber AS BoxNumber,"
sSQL=sSQL+ " round(B.Length*P.Box_per_Length,3) AS Pallet_Length,"
sSQL=sSQL+ " round(B.Width*P.Box_per_Width,3) AS Pallet_Width,"
sSQL=sSQL+ " round(B.Height*P.Box_per_Height,3) AS Pallet_Height,"
sSQL=sSQL+ " P.Box_per_Length * P.Box_per_Width * P.Box_per_Height AS Pallet_Boxes"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " Assess_Box as B"
sSQL=sSQL+ " ,"
sSQL=sSQL+ " Assess_Pallet as P"
sSQL=sSQL+ " WHERE"
sSQL=sSQL+ " round(B.Length*P.Box_per_Length,3) <= 20"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " round(B.Width*P.Box_per_Width,3) <= 9"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " round(B.Height*P.Box_per_Height,3) <= 5;"
sql.execute(sSQL,conn)
#####################################################################
sTables=['Assess_Product_in_Box','Assess_Box_on_Pallet']
for sTable in sTables:
   print('################')
   print('Loading :',sDatabaseName,' Table:',sTable)
   sSQL=" SELECT "
   sSQL=sSQL+ " *"
   sSQL=sSQL+ " FROM"
   sSQL=sSQL+ " " + sTable + ";"
   SnapShotData=pd.read_sql_query(sSQL, conn)
   print('################')
   sTableOut=sTable + '_SnapShot'
   print('Storing :',sDatabaseName,' Table:',sTable)
   SnapShotData.to_sql(sTableOut, conn, if_exists="replace")
   print('################')
#####################################################################
### Fit Pallet in Container
#####################################################################
sTables=['Length','Width','Height']
for sTable in sTables:

   sView='Assess_Pallet_in_Container_' + sTable
   print('Creating :',sDatabaseName,' View:',sView)
   sSQL="DROP VIEW IF EXISTS " + sView + ";"
   sql.execute(sSQL,conn)

   sSQL="CREATE VIEW " + sView + " AS"
   sSQL=sSQL+ " SELECT DISTINCT"
   sSQL=sSQL+ " C.UnitNumber AS ContainerNumber,"
   sSQL=sSQL+ " P.PalletNumber,"
   sSQL=sSQL+ " P.BoxNumber,"
```

```
    sSQL=sSQL+ " round(C." + sTable + "/P.Pallet_" + sTable + ",0)"
    sSQL=sSQL+ " AS Pallet_per_" + sTable + ","
    sSQL=sSQL+ " round(C." + sTable + "/P.Pallet_" + sTable + ",0)"
    sSQL=sSQL+ " * P.Pallet_Boxes AS Pallet_" + sTable + "_Boxes,"
    sSQL=sSQL+ " P.Pallet_Boxes"
    sSQL=sSQL+ " FROM"
    sSQL=sSQL+ " Assess_Container as C"
    sSQL=sSQL+ " ,"
    sSQL=sSQL+ " Assess_Box_on_Pallet_SnapShot as P"
    sSQL=sSQL+ " WHERE"
    sSQL=sSQL+ " round(C.Length/P.Pallet_Length,0) > 0"
    sSQL=sSQL+ " AND"
    sSQL=sSQL+ " round(C.Width/P.Pallet_Width,0) > 0"
    sSQL=sSQL+ " AND"
    sSQL=sSQL+ " round(C.Height/P.Pallet_Height,0) > 0;"
    sql.execute(sSQL,conn)

    print('################')
    print('Loading :',sDatabaseName,' Table:',sView)
    sSQL=" SELECT "
    sSQL=sSQL+ " *"
    sSQL=sSQL+ " FROM"
    sSQL=sSQL+ " " + sView + ";"
    SnapShotData=pd.read_sql_query(sSQL, conn)
    print('################')
    sTableOut= sView + '_SnapShot'
    print('Storing :',sDatabaseName,' Table:',sTableOut)
    SnapShotData.to_sql(sTableOut, conn, if_exists="replace")
    print('################')
#####################################################################
print('################')
sView='Assess_Pallet_in_Container'
print('Creating :',sDatabaseName,' View:',sView)
sSQL="DROP VIEW IF EXISTS " + sView + ";"
sql.execute(sSQL,conn)

sSQL="CREATE VIEW " + sView + " AS"
sSQL=sSQL+ " SELECT"
sSQL=sSQL+ " CL.ContainerNumber,"
sSQL=sSQL+ " CL.PalletNumber,"
sSQL=sSQL+ " CL.BoxNumber,"
sSQL=sSQL+ " CL.Pallet_Boxes AS Boxes_per_Pallet,"
sSQL=sSQL+ " CL.Pallet_per_Length,"
sSQL=sSQL+ " CW.Pallet_per_Width,"
sSQL=sSQL+ " CH.Pallet_per_Height,"
sSQL=sSQL+ " CL.Pallet_Length_Boxes * CW.Pallet_Width_Boxes * CH.Pallet_Height_Boxes
AS Container_Boxes"
sSQL=sSQL+ " FROM"
```

```
sSQL=sSQL+ " Assess_Pallet_in_Container_Length_SnapShot as CL"
sSQL=sSQL+ " JOIN"
sSQL=sSQL+ " Assess_Pallet_in_Container_Width_SnapShot as CW"
sSQL=sSQL+ " ON"
sSQL=sSQL+ " CL.ContainerNumber = CW.ContainerNumber"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " CL.PalletNumber = CW.PalletNumber"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " CL.BoxNumber = CW.BoxNumber"
sSQL=sSQL+ " JOIN"
sSQL=sSQL+ " Assess_Pallet_in_Container_Height_SnapShot as CH"
sSQL=sSQL+ " ON"
sSQL=sSQL+ " CL.ContainerNumber = CH.ContainerNumber"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " CL.PalletNumber = CH.PalletNumber"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " CL.BoxNumber = CH.BoxNumber;"
sql.execute(sSQL,conn)
#########################################################################
sTables=['Assess_Product_in_Box','Assess_Pallet_in_Container']
for sTable in sTables:
    print('#################')
    print('Loading :',sDatabaseName,' Table:',sTable)
    sSQL=" SELECT "
    sSQL=sSQL+ " *"
    sSQL=sSQL+ " FROM"
    sSQL=sSQL+ " " + sTable + ";"
    PackData=pd.read_sql_query(sSQL, conn)
    print('#################')
    print(PackData)
    print('#################')
    print('###################################')
    print('Rows : ',PackData.shape[0])
    print('###################################')
    sFileName=sFileDir + '/' + sTable + '.csv'
    print(sFileName)
    PackData.to_csv(sFileName, index = False)
print('### Done!! ############################################')
#########################################################################
```



J. Write a Python program to create a delivery route using the given data.

Creating a Delivery Route

Hillman requires the complete grid plan of the delivery routes for the company, to ensure the suppliers, warehouses, shops, and customers can be reached by its new strategy. This new plan will enable the optimum routes between suppliers, warehouses, shops, and customers.

Open Python editor and create a file named Assess-Shipping-Routes.py in directory C:\VKHCG\03-Hillman\02-Assess.

```
##################################################################
# -*- coding: utf-8 -*-
##################################################################
import sys
import os
import pandas as pd
import sqlite3 as sq
from pandas.io import sql
import networkx as nx
from geopy.distance import vincenty
##################################################################
nMax=3
nMaxPath=10
nSet=False
nVSet=False
##################################################################
Base='C:/VKHCG'
##################################################################
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
##################################################################
Company='03-Hillman'
InputDir1='01-Retrieve/01-EDS/01-R'
InputDir2='01-Retrieve/01-EDS/02-Python'
InputFileName1='Retrieve_GB_Postcode_Warehouse.csv'
InputFileName2='Retrieve_GB_Postcodes_Shops.csv'
EDSDir='02-Assess/01-EDS'
OutputDir=EDSDir + '/02-Python'
OutputFileName1='Assess_Shipping_Routes.gml'
OutputFileName2='Assess_Shipping_Routes.txt'
##################################################################
sFileDir=Base + '/' + Company + '/' + EDSDir
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
##################################################################
sFileDir=Base + '/' + Company + '/' + OutputDir
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
##################################################################
sDataBaseDir=Base + '/' + Company + '/02-Assess/SQLite'
if not os.path.exists(sDataBaseDir):
```

```
    os.makedirs(sDataBaseDir)
#####################################################################
sDatabaseName=sDataBaseDir + '/hillman.db'
conn = sq.connect(sDatabaseName)
#####################################################################
#####################################################################
### Import Warehouse Data
#####################################################################
sFileName=Base + '/' + Company + '/' + InputDir1 + '/' + InputFileName1
print('###########')
print('Loading :',sFileName)
WarehouseRawData=pd.read_csv(sFileName,
                header=0,
                low_memory=False,
                encoding="latin-1"
                )
WarehouseRawData.drop_duplicates(subset=None, keep='first', inplace=True)
WarehouseRawData.index.name = 'IDNumber'
WarehouseData=WarehouseRawData.head(nMax)
WarehouseData=WarehouseData.append(WarehouseRawData.tail(nMax))
WarehouseData=WarehouseData.append(WarehouseRawData[WarehouseRawData.postcode=='KA13'])
if nSet==True:

WarehouseData=WarehouseData.append(WarehouseRawData[WarehouseRawData.postcode=='SW1W'])
WarehouseData.drop_duplicates(subset=None, keep='first', inplace=True)
print('Loaded Warehouses :',WarehouseData.columns.values)
print('#################################')
#####################################################################
print('################')
sTable='Assess_Warehouse_UK'
print('Storing :',sDatabaseName,' Table:',sTable)
WarehouseData.to_sql(sTable, conn, if_exists="replace")
print('################')
#####################################################################
print(WarehouseData.head())
print('#################################')
print('Rows : ',WarehouseData.shape[0])
print('#################################')
#####################################################################
### Import Shop Data
#####################################################################
sFileName=Base + '/' + Company + '/' + InputDir1 + '/' + InputFileName2
print('###########')
print('Loading :',sFileName)
ShopRawData=pd.read_csv(sFileName,
                header=0,
                low_memory=False,
                encoding="latin-1"
                )
ShopRawData.drop_duplicates(subset=None, keep='first', inplace=True)
ShopRawData.index.name = 'IDNumber'
ShopData=ShopRawData
print('Loaded Shops :',ShopData.columns.values)
```

```
print('################################')
#####################################################################
print('################')
sTable='Assess_Shop_UK'
print('Storing :',sDatabaseName,' Table:',sTable)
ShopData.to_sql(sTable, conn, if_exists="replace")
print('################')
#####################################################################
print(ShopData.head())
print('################################')
print('Rows : ',ShopData.shape[0])
print('################################')
#####################################################################
### Connect HQ
#####################################################################
print('################')
sView='Assess_HQ'
print('Creating :',sDatabaseName,' View:',sView)
sSQL="DROP VIEW IF EXISTS " + sView + ";"
sql.execute(sSQL,conn)

sSQL="CREATE VIEW " + sView + " AS"
sSQL=sSQL+ " SELECT"
sSQL=sSQL+ " W.postcode AS HQ_PostCode,"
sSQL=sSQL+ " 'HQ-' || W.postcode AS HQ_Name,"
sSQL=sSQL+ " round(W.latitude,6) AS HQ_Latitude,"
sSQL=sSQL+ " round(W.longitude,6) AS HQ_Longitude"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " Assess_Warehouse_UK as W"
sSQL=sSQL+ " WHERE"
sSQL=sSQL+ " TRIM(W.postcode) in ('KA13','SW1W');"
sql.execute(sSQL,conn)
#####################################################################
### Connect Warehouses
#####################################################################
print('################')
sView='Assess_Warehouse'
print('Creating :',sDatabaseName,' View:',sView)
sSQL="DROP VIEW IF EXISTS " + sView + ";"
sql.execute(sSQL,conn)

sSQL="CREATE VIEW " + sView + " AS"
sSQL=sSQL+ " SELECT"
sSQL=sSQL+ " W.postcode AS Warehouse_PostCode,"
sSQL=sSQL+ " 'WH-' || W.postcode AS Warehouse_Name,"
sSQL=sSQL+ " round(W.latitude,6) AS Warehouse_Latitude,"
sSQL=sSQL+ " round(W.longitude,6) AS Warehouse_Longitude"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " Assess_Warehouse_UK as W;"
sql.execute(sSQL,conn)
#####################################################################
### Connect Warehouse to Shops by PostCode
-#####################################################################
```

```
print('################')
sView='Assess_Shop'
print('Creating :',sDatabaseName,' View:',sView)
sSQL="DROP VIEW IF EXISTS " + sView + ";"
sql.execute(sSQL,conn)

sSQL="CREATE VIEW " + sView + " AS"
sSQL=sSQL+ " SELECT"
sSQL=sSQL+ " TRIM(S.postcode) AS Shop_PostCode,"
sSQL=sSQL+ " 'SP-' || TRIM(S.FirstCode) || '-' || TRIM(S.SecondCode) AS Shop_Name,"
sSQL=sSQL+ " TRIM(S.FirstCode) AS Warehouse_PostCode,"
sSQL=sSQL+ " round(S.latitude,6) AS Shop_Latitude,"
sSQL=sSQL+ " round(S.longitude,6) AS Shop_Longitude"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " Assess_Warehouse_UK as W"
sSQL=sSQL+ " JOIN"
sSQL=sSQL+ " Assess_Shop_UK as S"
sSQL=sSQL+ " ON"
sSQL=sSQL+ " TRIM(W.postcode) = TRIM(S.FirstCode);"
sql.execute(sSQL,conn)
######################################################################
######################################################################
G=nx.Graph()
######################################################################
print('################')
sTable = 'Assess_HQ'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL=" SELECT DISTINCT"
sSQL=sSQL+ " *"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " " + sTable + ";"
RouteData=pd.read_sql_query(sSQL, conn)
print('################')
######################################################################
print(RouteData.head())
print('################################')
print('HQ Rows : ',RouteData.shape[0])
print('################################')
######################################################################
for i in range(RouteData.shape[0]):
    sNode0=RouteData['HQ_Name'][i]
    G.add_node(sNode0,
               Nodetype='HQ',
               PostCode=RouteData['HQ_PostCode'][i],
               Latitude=round(RouteData['HQ_Latitude'][i],6),
               Longitude=round(RouteData['HQ_Longitude'][i],6))
######################################################################
print('################')
sTable = 'Assess_Warehouse'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL=" SELECT DISTINCT"
sSQL=sSQL+ " *"
sSQL=sSQL+ " FROM"
```

```
sSQL=sSQL+ " " + sTable + ";"
RouteData=pd.read_sql_query(sSQL, conn)
print('################')
#####################################################################
print(RouteData.head())
print('################################')
print('Warehouse Rows : ',RouteData.shape[0])
print('################################')
for i in range(RouteData.shape[0]):
   sNode0=RouteData['Warehouse_Name'][i]
   G.add_node(sNode0,
            Nodetype='Warehouse',
            PostCode=RouteData['Warehouse_PostCode'][i],
            Latitude=round(RouteData['Warehouse_Latitude'][i],6),
            Longitude=round(RouteData['Warehouse_Longitude'][i],6))
print('################')
sTable = 'Assess_Shop'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL=" SELECT DISTINCT"
sSQL=sSQL+ " *"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " " + sTable + ";"
RouteData=pd.read_sql_query(sSQL, conn)
print('################')
print(RouteData.head())
print('################################')
print('Shop Rows : ',RouteData.shape[0])
print('################################')
for i in range(RouteData.shape[0]):
   sNode0=RouteData['Shop_Name'][i]
   G.add_node(sNode0,
            Nodetype='Shop',
            PostCode=RouteData['Shop_PostCode'][i],
            WarehousePostCode=RouteData['Warehouse_PostCode'][i],
            Latitude=round(RouteData['Shop_Latitude'][i],6),
            Longitude=round(RouteData['Shop_Longitude'][i],6))
#####################################################################
## Create Edges
#####################################################################
print('################################')
print('Loading Edges')
print('################################')

for sNode0 in nx.nodes_iter(G):
   for sNode1 in nx.nodes_iter(G):
      if G.node[sNode0]['Nodetype']=='HQ' and \
         G.node[sNode1]['Nodetype']=='HQ' and \
         sNode0 != sNode1:
            distancemeters=round(\
                        vincenty(\
                              (\
                               G.node[sNode0]['Latitude'],\
                               G.node[sNode0]['Longitude']\
```

```
                                    ),\
                                    (\
                                     G.node[sNode1]['Latitude']\
                                     ,\
                                     G.node[sNode1]['Longitude']\
                                     )\
                                     ).meters\
                            ,0)
                distancemiles=round(\
                                vincenty(\
                                        (\
                                     G.node[sNode0]['Latitude'],\
                                     G.node[sNode0]['Longitude']\
                                     ),\
                                     (\
                                     G.node[sNode1]['Latitude']\
                                     ,\
                                     G.node[sNode1]['Longitude']\
                                     )\
                                     ).miles\
                            ,3)

                if distancemiles >= 0.05:
                   cost = round(150+(distancemiles * 2.5),6)
                   vehicle='V001'
                else:
                   cost = round(2+(distancemiles * 0.10),6)
                   vehicle='ForkLift'

                G.add_edge(sNode0,sNode1,DistanceMeters=distancemeters, \
                        DistanceMiles=distancemiles, \
                        Cost=cost,Vehicle=vehicle)
                if nVSet==True:
                   print('Edge-H-H:',sNode0,' to ', sNode1, \
                     ' Distance:',distancemeters,'meters',\
                     distancemiles,'miles','Cost', cost,'Vehicle',vehicle)

            if G.node[sNode0]['Nodetype']=='HQ' and \
               G.node[sNode1]['Nodetype']=='Warehouse' and \
               sNode0 != sNode1:
                  distancemeters=round(\
                                vincenty(\
                                        (\
                                     G.node[sNode0]['Latitude'],\
                                     G.node[sNode0]['Longitude']\
                                     ),\
                                     (\
                                     G.node[sNode1]['Latitude']\
                                     ,\
                                     G.node[sNode1]['Longitude']\
                                     )\
                                     ).meters\
                            ,0)
```

```
            distancemiles=round(\
                        vincenty(\
                              (\
                               G.node[sNode0]['Latitude'],\
                               G.node[sNode0]['Longitude']\
                               ),\
                               (\
                                G.node[sNode1]['Latitude']\
                                ,\
                                G.node[sNode1]['Longitude']\
                                )\
                                ).miles\
                        ,3)
            if distancemiles >= 10:
               cost = round(50+(distancemiles * 2),6)
               vehicle='V002'
            else:
               cost = round(5+(distancemiles * 1.5),6)
               vehicle='V003'
            if distancemiles <= 50:
               G.add_edge(sNode0,sNode1,DistanceMeters=distancemeters, \
                        DistanceMiles=distancemiles, \
                        Cost=cost,Vehicle=vehicle)
               if nVSet==True:
                  print('Edge-H-W:',sNode0,' to ', sNode1, \
                    ' Distance:',distancemeters,'meters',\
                    distancemiles,'miles','Cost', cost,'Vehicle',vehicle)

      if nSet==True and \
         G.node[sNode0]['Nodetype']=='Warehouse' and \
         G.node[sNode1]['Nodetype']=='Warehouse' and \
         sNode0 != sNode1:
            distancemeters=round(\
                        vincenty(\
                              (\
                               G.node[sNode0]['Latitude'],\
                               G.node[sNode0]['Longitude']\
                               ),\
                               (\
                                G.node[sNode1]['Latitude']\
                                ,\
                                G.node[sNode1]['Longitude']\
                                )\
                                ).meters\
                        ,0)
            distancemiles=round(\
                        vincenty(\
                              (\
                               G.node[sNode0]['Latitude'],\
                               G.node[sNode0]['Longitude']\
                               ),\
                               (\
                                G.node[sNode1]['Latitude']\
```

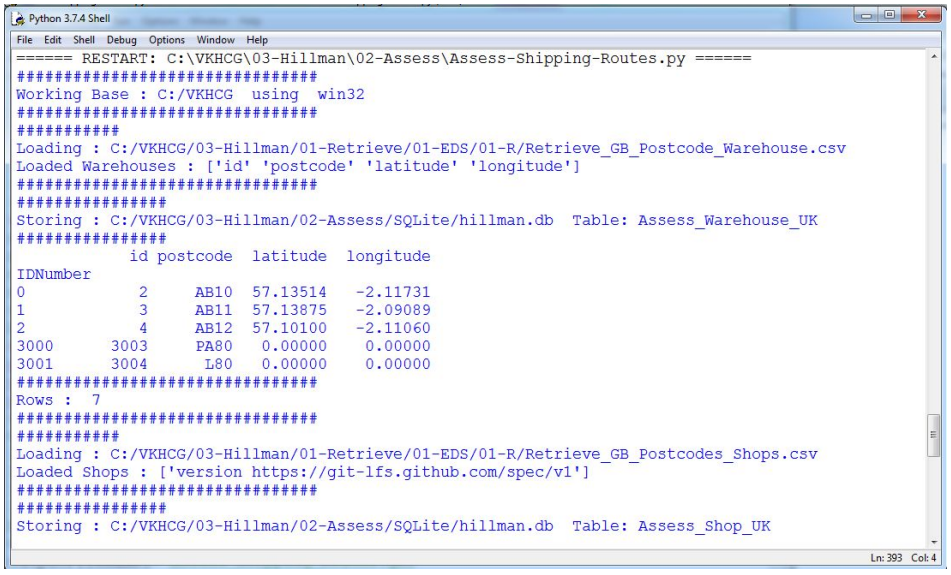
```
                                ,\
                                G.node[sNode1]['Longitude']\
                                )\
                                ).miles\
                        ,3)
            if distancemiles >= 10:
               cost = round(50+(distancemiles * 1.10),6)
               vehicle='V004'
            else:
               cost = round(5+(distancemiles * 1.05),6)
               vehicle='V005'

            if distancemiles <= 20:
               G.add_edge(sNode0,sNode1,DistanceMeters=distancemeters, \
                       DistanceMiles=distancemiles, \
                       Cost=cost,Vehicle=vehicle)
               if nVSet==True:
                  print('Edge-W-W:',sNode0,' to ', sNode1, \
                    ' Distance:',distancemeters,'meters',\
                    distancemiles,'miles','Cost', cost,'Vehicle',vehicle)

      if G.node[sNode0]['Nodetype']=='Warehouse' and \
         G.node[sNode1]['Nodetype']=='Shop' and \
         G.node[sNode0]['PostCode']==G.node[sNode1]['WarehousePostCode'] and \
         sNode0 != sNode1:

            distancemeters=round(\
                        vincenty(\
                              (\
                               G.node[sNode0]['Latitude'],\
                               G.node[sNode0]['Longitude']\
                               ),\
                               (\
                                G.node[sNode1]['Latitude']\
                                ,\
                                G.node[sNode1]['Longitude']\
                                )\
                                ).meters\
                        ,0)
            distancemiles=round(\
                        vincenty(\
                              (\
                               G.node[sNode0]['Latitude'],\
                               G.node[sNode0]['Longitude']\
                               ),\
                               (\
                                G.node[sNode1]['Latitude']\
                                ,\
                                G.node[sNode1]['Longitude']\
                                )\
                                ).miles\
                        ,3)
            if distancemiles >= 10:
```

```
            cost = round(50+(distancemiles * 1.50),6)
            vehicle='V006'
        else:
            cost = round(5+(distancemiles * 0.75),6)
            vehicle='V007'
        if distancemiles <= 10:
            G.add_edge(sNode0,sNode1,DistanceMeters=distancemeters, \
                    DistanceMiles=distancemiles, \
                    Cost=cost,Vehicle=vehicle)
            if nVSet==True:
                print('Edge-W-S:',sNode0,' to ', sNode1, \
                  ' Distance:',distancemeters,'meters',\
                  distancemiles,'miles','Cost', cost,'Vehicle',vehicle)

    if nSet==True and \
        G.node[sNode0]['Nodetype']=='Shop' and \
        G.node[sNode1]['Nodetype']=='Shop' and \
        G.node[sNode0]['WarehousePostCode']==G.node[sNode1]['WarehousePostCode'] and \
        sNode0 != sNode1:

            distancemeters=round(\
                        vincenty(\
                                (\
                                 G.node[sNode0]['Latitude'],\
                                 G.node[sNode0]['Longitude']\
                                 ),\
                                 (\
                                  G.node[sNode1]['Latitude']\
                                  ,\
                                  G.node[sNode1]['Longitude']\
                                  )\
                                  ).meters\
                        ,0)
            distancemiles=round(\
                        vincenty(\
                                (\
                                 G.node[sNode0]['Latitude'],\
                                 G.node[sNode0]['Longitude']\
                                 ),\
                                 (\
                                  G.node[sNode1]['Latitude']\
                                  ,\
                                  G.node[sNode1]['Longitude']\
                                  )\
                                  ).miles\
                        ,3)

            if distancemiles >= 0.05:
                cost = round(5+(distancemiles * 0.5),6)
                vehicle='V008'
            else:
                cost = round(1+(distancemiles * 0.1),6)
                vehicle='V009'
```

```
            if distancemiles <= 0.075:
               G.add_edge(sNode0,sNode1,DistanceMeters=distancemeters, \
                        DistanceMiles=distancemiles, \
                        Cost=cost,Vehicle=vehicle)
               if nVSet==True:
                  print('Edge-S-S:',sNode0,' to ', sNode1, \
                    ' Distance:',distancemeters,'meters',\
                    distancemiles,'miles','Cost', cost,'Vehicle',vehicle)

         if nSet==True and \
            G.node[sNode0]['Nodetype']=='Shop' and \
            G.node[sNode1]['Nodetype']=='Shop' and \
            G.node[sNode0]['WarehousePostCode']!=G.node[sNode1]['WarehousePostCode'] and \
            sNode0 != sNode1:

               distancemeters=round(\
                           vincenty(\
                                 (\
                                  G.node[sNode0]['Latitude'],\
                                  G.node[sNode0]['Longitude']\
                                  ),\
                                  (\
                                   G.node[sNode1]['Latitude']\
                                   ,\
                                   G.node[sNode1]['Longitude']\
                                   )\
                                   ).meters\
                           ,0)
               distancemiles=round(\
                           vincenty(\
                                 (\
                                  G.node[sNode0]['Latitude'],\
                                  G.node[sNode0]['Longitude']\
                                  ),\
                                  (\
                                   G.node[sNode1]['Latitude']\
                                   ,\
                                   G.node[sNode1]['Longitude']\
                                   )\
                                   ).miles\
                           ,3)

               cost = round(1+(distancemiles * 0.1),6)
               vehicle='V010'

               if distancemiles <= 0.025:
                  G.add_edge(sNode0,sNode1,DistanceMeters=distancemeters, \
                           DistanceMiles=distancemiles, \
                           Cost=cost,Vehicle=vehicle)
                  if nVSet==True:
                     print('Edge-S-S:',sNode0,' to ', sNode1, \
                       ' Distance:',distancemeters,'meters',\
```

```
                    distancemiles,'miles','Cost', cost,'Vehicle',vehicle)
sFileName=sFileDir + '/' + OutputFileName1
print('################################')
print('Storing :', sFileName)
print('################################')
nx.write_gml(G,sFileName)
sFileName=sFileName +'.gz'
nx.write_gml(G,sFileName)
print('Nodes:',nx.number_of_nodes(G))
print('Edges:',nx.number_of_edges(G))
sFileName=sFileDir + '/' + OutputFileName2
print('################################')
print('Storing :', sFileName)
print('################################')
## Create Paths
print('################################')
print('Loading Paths')
print('################################')
f = open(sFileName,'w')
l=0
sline = 'ID|Cost|StartAt|EndAt|Path|Measure'
if nVSet==True: print ('0', sline)
f.write(sline+ '\n')
for sNode0 in nx.nodes_iter(G):
    for sNode1 in nx.nodes_iter(G):
        if sNode0 != sNode1 and \
            nx.has_path(G, sNode0, sNode1)==True and \
            nx.shortest_path_length(G, \
              source=sNode0, \
              target=sNode1, \
              weight='DistanceMiles') < nMaxPath:
                l+=1
                sID='{:.0f}'.format(l)
                spath = ','.join(nx.shortest_path(G, \
                  source=sNode0, \
                  target=sNode1, \
                  weight='DistanceMiles'))
                slength= '{:.6f}'.format(\
                  nx.shortest_path_length(G, \
                  source=sNode0, \
                  target=sNode1, \
                  weight='DistanceMiles'))
                sline = sID + '|"DistanceMiles"|"' + sNode0 + '"|"' \
                + sNode1 + '"|"' + spath + '"|' + slength
                if nVSet==True: print (sline)
                f.write(sline + '\n')
                l+=1
                sID='{:.0f}'.format(l)
                spath = ','.join(nx.shortest_path(G, \
                  source=sNode0, \
                  target=sNode1, \
                  weight='DistanceMeters'))
                slength= '{:.6f}'.format(\
```

```
                nx.shortest_path_length(G, \
                source=sNode0, \
                target=sNode1, \
                weight='DistanceMeters'))
            sline = sID + '|"DistanceMeters"|"' + sNode0 + '"|"' \
            + sNode1 + '"|"' + spath + '"|' + slength
            if nVSet==True: print (sline)
            f.write(sline + '\n')
            l+=1
            sID='{:.0f}'.format(l)
            spath = ','.join(nx.shortest_path(G, \
              source=sNode0, \
              target=sNode1, \
              weight='Cost'))
            slength= '{:.6f}'.format(\
              nx.shortest_path_length(G, \
              source=sNode0, \
              target=sNode1, \
              weight='Cost'))
            sline = sID + '|"Cost"|"' + sNode0 + '"|"' \
            + sNode1 + '"|"' + spath + '"|' + slength
            if nVSet==True: print (sline)
            f.write(sline + '\n')
f.close()
print('Nodes:',nx.number_of_nodes(G))
print('Edges:',nx.number_of_edges(G))
print('Paths:',sID)
print('#################')
print('Vacuum Database')
sSQL="VACUUM;"
sql.execute(sSQL,conn)
print('#################')
print('### Done!! ############################################'
```



Clark Ltd

Clark Ltd is the accountancy company that handles everything related to the VKHCG's finances and personnel. Let's investigate Clark with new knowledge.

K. Write a Python program to create Simple forex trading planner from the given data.

Simple Forex Trading Planner

Clark requires the assessment of the group's forex data, for processing and data qualityissues. I will guide you through an example of a forex solution.

Open your Python editor and create a file named Assess-Forex.py in directory C:\VKHCG\04-Clark\02-Assess.

```
################################################################
import sys
import os
import sqlite3 as sq
import pandas as pd
################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
################################################################
Company='04-Clark'
sInputFileName1='01-Vermeulen/01-Retrieve/01-EDS/02-Python/Retrieve-Country-Currency.csv'
sInputFileName2='04-Clark/01-Retrieve/01-EDS/01-R/Retrieve_Euro_EchangeRates.csv'
################################################################
sDataBaseDir=Base + '/' + Company + '/02-Assess/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
################################################################
sDatabaseName=sDataBaseDir + '/clark.db'
conn = sq.connect(sDatabaseName)
################################################################
### Import Country Data
################################################################
sFileName1=Base + '/' + sInputFileName1
print('##################################')
print('Loading :',sFileName1)
print('##################################')
CountryRawData=pd.read_csv(sFileName1,header=0,low_memory=False, encoding="latin-1")
CountryRawData.drop_duplicates(subset=None, keep='first', inplace=True)
CountryData=CountryRawData
print('Loaded Company :',CountryData.columns.values)
print('##################################')
################################################################
print('#################')
sTable='Assess_Country'
print('Storing :',sDatabaseName,' Table:',sTable)
CountryData.to_sql(sTable, conn, if_exists="replace")
```

```
print('################')
#####################################################################
print(CountryData.head())
print('################################')
print('Rows : ',CountryData.shape[0])
print('################################')
#####################################################################
### Import Forex Data
#####################################################################
sFileName2=Base + '/' + sInputFileName2
print('################################')
print('Loading :',sFileName2)
print('################################')
ForexRawData=pd.read_csv(sFileName2,header=0,low_memory=False, encoding="latin-1")
ForexRawData.drop_duplicates(subset=None, keep='first', inplace=True)
ForexData=ForexRawData.head(5)
print('Loaded Company :',ForexData.columns.values)
print('################################')
#####################################################################
print('################')
sTable='Assess_Forex'
print('Storing :',sDatabaseName,' Table:',sTable)
ForexData.to_sql(sTable, conn, if_exists="replace")
print('################')
#####################################################################
print(ForexData.head())
print('################################')
print('Rows : ',ForexData.shape[0])
print('################################')
#####################################################################
print('################')
sTable='Assess_Forex'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL="select distinct"
sSQL=sSQL+ " A.CodeIn"
sSQL=sSQL+ " from"
sSQL=sSQL+ " Assess_Forex as A;"
CodeData=pd.read_sql_query(sSQL, conn)
print('################')
#####################################################################

for c in range(CodeData.shape[0]):
    print('################')
    sTable='Assess_Forex & 2x Country > ' + CodeData['CodeIn'][c]
    print('Loading :',sDatabaseName,' Table:',sTable)
    sSQL="select distinct"
    sSQL=sSQL+ " A.Date,"
    sSQL=sSQL+ " A.CodeIn,"
    sSQL=sSQL+ " B.Country as CountryIn,"
    sSQL=sSQL+ " B.Currency as CurrencyNameIn,"
    sSQL=sSQL+ " A.CodeOut,"
    sSQL=sSQL+ " C.Country as CountryOut,"
    sSQL=sSQL+ " C.Currency as CurrencyNameOut,"
```

```
    sSQL=sSQL+ " A.Rate"
    sSQL=sSQL+ " from"
    sSQL=sSQL+ " Assess_Forex as A"
    sSQL=sSQL+ " JOIN"
    sSQL=sSQL+ " Assess_Country as B"
    sSQL=sSQL+ " ON A.CodeIn = B.CurrencyCode"
    sSQL=sSQL+ " JOIN"
    sSQL=sSQL+ " Assess_Country as C"
    sSQL=sSQL+ " ON A.CodeOut = C.CurrencyCode"
    sSQL=sSQL+ " WHERE"
    sSQL=sSQL+ " A.CodeIn ='" + CodeData['CodeIn'][c] + "';"
    ForexData=pd.read_sql_query(sSQL, conn).head(1000)
    print('################')
    print(ForexData)
    print('################')
    sTable='Assess_Forex_' + CodeData['CodeIn'][c]
    print('Storing :',sDatabaseName,' Table:',sTable)
    ForexData.to_sql(sTable, conn, if_exists="replace")
    print('################')
    print('################################')
    print('Rows : ',ForexData.shape[0])
    print('################################')
#################################################################
print('### Done!! ############################################')
#################################################################
```

Output:

This will produce a set of demonstrated values onscreen by removing duplicate records and other related data processing.

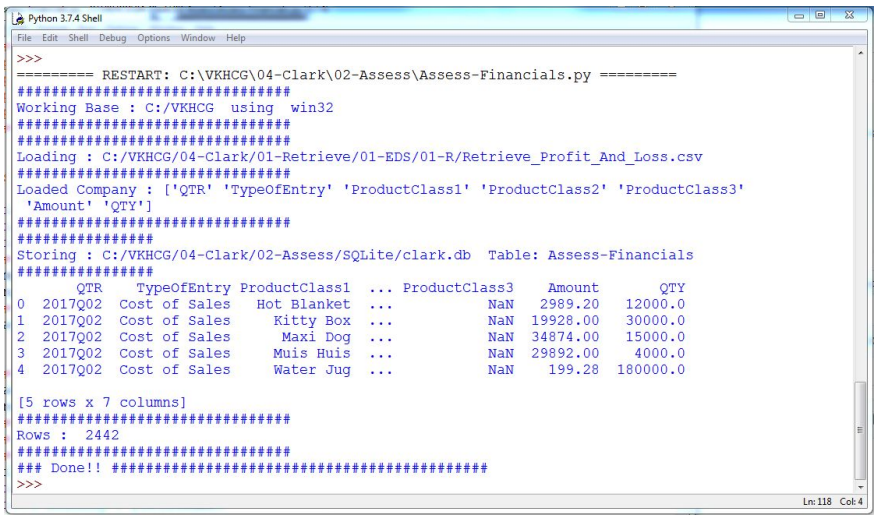
L. Write a Python program to process the balance sheet to ensure that only good data is processing.

Financials

Clark requires you to process the balance sheet for the VKHCG group companies. Go through a sample balance sheet data assessment, to ensure that only the good data is processed.
Open Python editor and create a file named Assess-Financials.py in directory C:\VKHCG\04-Clark\02-Assess.

```
#################################################################
import sys
import os
import sqlite3 as sq
import pandas as pd
#################################################################
if sys.platform == 'linux':
    Base=os.path.expanduser('~') + '/VKHCG'
else:
    Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
#################################################################
```

```
Company='04-Clark'
sInputFileName='01-Retrieve/01-EDS/01-R/Retrieve_Profit_And_Loss.csv'
##################################################################
sDataBaseDir=Base + '/' + Company + '/02-Assess/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
##################################################################
sDatabaseName=sDataBaseDir + '/clark.db'
conn = sq.connect(sDatabaseName)
##################################################################
### Import Financial Data
##################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName
print('################################')
print('Loading :',sFileName)
print('################################')
FinancialRawData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
FinancialData=FinancialRawData
print('Loaded Company :',FinancialData.columns.values)
print('################################')
##################################################################
print('################')
sTable='Assess-Financials'
print('Storing :',sDatabaseName,' Table:',sTable)
FinancialData.to_sql(sTable, conn, if_exists="replace")
print('################')
##################################################################
print(FinancialData.head())
print('################################')
print('Rows : ',FinancialData.shape[0])
print('################################')
##################################################################
##################################################################
print('### Done!! ############################################')
##################################################################
```



Write a Python program to store all master records for the financial calendar

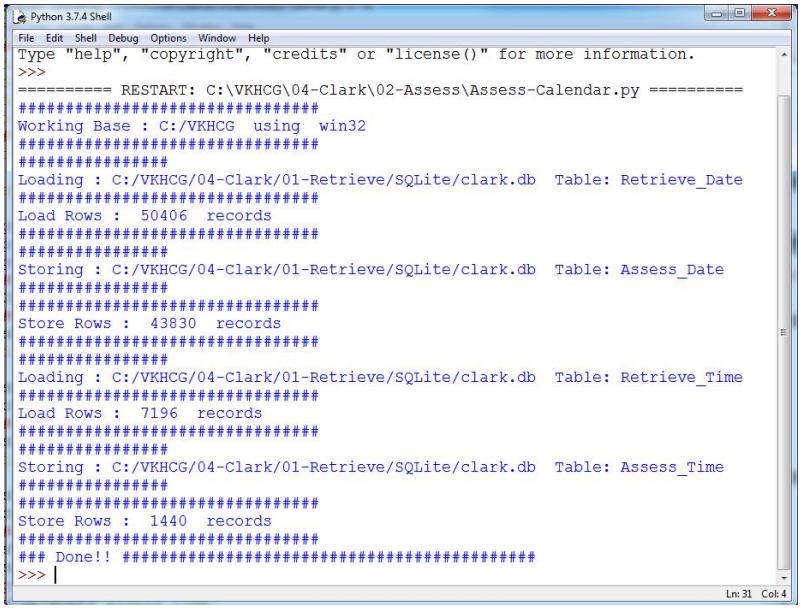
Financial Calendar

Clark stores all the master records for the financial calendar. So we import thecalendar from the retrieve step's data storage.

Open Python editor and create a file named Assess-Calendar.py in directory C:\VKHCG\04-Clark\02-Assess.

```
################################################################
import sys
import os
import sqlite3 as sq
import pandas as pd
################################################################
if sys.platform == 'linux':
    Base=os.path.expanduser('~') + '/VKHCG'
else:
    Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
################################################################
Company='04-Clark'
################################################################
sDataBaseDirIn=Base + '/' + Company + '/01-Retrieve/SQLite'
if not os.path.exists(sDataBaseDirIn):
    os.makedirs(sDataBaseDirIn)
sDatabaseNameIn=sDataBaseDirIn + '/clark.db'
connIn = sq.connect(sDatabaseNameIn)
################################################################
sDataBaseDirOut=Base + '/' + Company + '/01-Retrieve/SQLite'
if not os.path.exists(sDataBaseDirOut):
    os.makedirs(sDataBaseDirOut)
sDatabaseNameOut=sDataBaseDirOut + '/clark.db'
connOut = sq.connect(sDatabaseNameOut)
################################################################
sTableIn='Retrieve_Date'
sSQL='select * FROM ' + sTableIn + ';'
print('################')
sTableOut='Assess_Time'
print('Loading :',sDatabaseNameIn,' Table:',sTableIn)
dateRawData=pd.read_sql_query(sSQL, connIn)
dateData=dateRawData
################################################################
print('################################')
print('Load Rows : ',dateRawData.shape[0], ' records')
print('################################')
dateData.drop_duplicates(subset='FinDate', keep='first', inplace=True)
################################################################
print('################')
sTableOut='Assess_Date'
print('Storing :',sDatabaseNameOut,' Table:',sTableOut)
```

```
dateData.to_sql(sTableOut, connOut, if_exists="replace")
print('################')
#####################################################################
print('################################')
print('Store Rows : ',dateData.shape[0], ' records')
print('################################')
#####################################################################
#####################################################################
sTableIn='Retrieve_Time'
sSQL='select * FROM ' + sTableIn + ';'
print('################')
sTableOut='Assess_Time'
print('Loading :',sDatabaseNameIn,' Table:',sTableIn)
timeRawData=pd.read_sql_query(sSQL, connIn)
timeData=timeRawData
#####################################################################
print('################################')
print('Load Rows : ',timeData.shape[0], ' records')
print('################################')
timeData.drop_duplicates(subset=None, keep='first', inplace=True)
#####################################################################
print('################')
sTableOut='Assess_Time'
print('Storing :',sDatabaseNameOut,' Table:',sTableOut)
timeData.to_sql(sTableOut, connOut, if_exists="replace")
print('################')
#####################################################################
print('################################')
print('Store Rows : ',timeData.shape[0], ' records')
print('################################')
#####################################################################
print('### Done!! ############################################')
#####################################################################
```



M. Write a Python program to generate payroll from the given data.

People

Clark Ltd generates the payroll, so it holds all the staff records. Clark also handles all payments to suppliers and receives payments from customers' details on all companies.

Open Python editor and create a file named Assess-People.py in directory

C:\VKHCG\04-Clark\02-Assess.

```
##################################################################
import sys
import os
import sqlite3 as sq
import pandas as pd
##################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
##################################################################
Company='04-Clark'
sInputFileName1='01-Retrieve/01-EDS/02-Python/Retrieve-Data_female-names.csv'
sInputFileName2='01-Retrieve/01-EDS/02-Python/Retrieve-Data_male-names.csv'
sInputFileName3='01-Retrieve/01-EDS/02-Python/Retrieve-Data_last-names.csv'
sOutputFileName1='Assess-Staff.csv'
sOutputFileName2='Assess-Customers.csv'
##################################################################
sDataBaseDir=Base + '/' + Company + '/02-Assess/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
##################################################################
sDatabaseName=sDataBaseDir + '/clark.db'
conn = sq.connect(sDatabaseName)
##################################################################
### Import Female Data
##################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName1
print('##################################')
print('Loading :',sFileName)
print('##################################')
print(sFileName)
FemaleRawData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
FemaleRawData.rename(columns={'NameValues' : 'FirstName'},inplace=True)
FemaleRawData.drop_duplicates(subset=None, keep='first', inplace=True)
FemaleData=FemaleRawData.sample(100)
print('##################################')
##################################################################
print('################')
sTable='Assess_FemaleName'
print('Storing :',sDatabaseName,' Table:',sTable)
```

```
FemaleData.to_sql(sTable, conn, if_exists="replace")
print('################')
print('################################')
print('Rows : ',FemaleData.shape[0], ' records')
print('################################')
#####################################################################
### Import Male Data
sFileName=Base + '/' + Company + '/' + sInputFileName2
print('################################')
print('Loading :',sFileName)
print('################################')
MaleRawData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
MaleRawData.rename(columns={'NameValues' : 'FirstName'},inplace=True)
MaleRawData.drop_duplicates(subset=None, keep='first', inplace=True)
MaleData=MaleRawData.sample(100)
print('################################')
sTable='Assess_MaleName'
print('Storing :',sDatabaseName,' Table:',sTable)
MaleData.to_sql(sTable, conn, if_exists="replace")
print('################')
#####################################################################
print('################################')
print('Rows : ',MaleData.shape[0], ' records')
print('################################')
#####################################################################
### Import Surname Data
sFileName=Base + '/' + Company + '/' + sInputFileName3
print('################################')
print('Loading :',sFileName)
print('################################')
SurnameRawData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
SurnameRawData.rename(columns={'NameValues' : 'LastName'},inplace=True)
SurnameRawData.drop_duplicates(subset=None, keep='first', inplace=True)
SurnameData=SurnameRawData.sample(200)
print('################')
sTable='Assess_Surname'
print('Storing :',sDatabaseName,' Table:',sTable)
SurnameData.to_sql(sTable, conn, if_exists="replace")
print('################')
print('################################')
print('Rows : ',SurnameData.shape[0], ' records')
print('################################')
print('################')
sTable='Assess_FemaleName & Assess_MaleName'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL="select distinct"
sSQL=sSQL+ " A.FirstName,"
sSQL=sSQL+ " 'Female' as Gender"
```

```
sSQL=sSQL+ " from"
sSQL=sSQL+ " Assess_FemaleName as A"
sSQL=sSQL+ " UNION"
sSQL=sSQL+ " select distinct"
sSQL=sSQL+ " A.FirstName,"
sSQL=sSQL+ " 'Male' as Gender"
sSQL=sSQL+ " from"
sSQL=sSQL+ " Assess_MaleName as A;"
FirstNameData=pd.read_sql_query(sSQL, conn)
print('#################')
#####################################################################
#print('#################')
sTable='Assess_FirstName'
print('Storing :',sDatabaseName,' Table:',sTable)
FirstNameData.to_sql(sTable, conn, if_exists="replace")
print('#################')
#####################################################################
#####################################################################
print('#################')
sTable='Assess_FirstName x2 & Assess_Surname'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL="select distinct"
sSQL=sSQL+ " A.FirstName,"
sSQL=sSQL+ " B.FirstName AS SecondName,"
sSQL=sSQL+ " C.LastName,"
sSQL=sSQL+ " A.Gender"
sSQL=sSQL+ " from"
sSQL=sSQL+ " Assess_FirstName as A"
sSQL=sSQL+ " ,"
sSQL=sSQL+ " Assess_FirstName as B"
sSQL=sSQL+ " ,"
sSQL=sSQL+ " Assess_Surname as C"
sSQL=sSQL+ " WHERE"
sSQL=sSQL+ " A.Gender = B.Gender"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " A.FirstName <> B.FirstName;"
PeopleRawData=pd.read_sql_query(sSQL, conn)
People1Data=PeopleRawData.sample(10000)

sTable='Assess_FirstName & Assess_Surname'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL="select distinct"
sSQL=sSQL+ " A.FirstName,"
sSQL=sSQL+ " '' AS SecondName,"
sSQL=sSQL+ " B.LastName,"
sSQL=sSQL+ " A.Gender"
sSQL=sSQL+ " from"
sSQL=sSQL+ " Assess_FirstName as A"
```

```
sSQL=sSQL+ " ,"
sSQL=sSQL+ " Assess_Surname as B;"
PeopleRawData=pd.read_sql_query(sSQL, conn)
People2Data=PeopleRawData.sample(10000)
PeopleData=People1Data.append(People2Data)
print(PeopleData)
print('#################')
#########################################################################
#print('#################')
sTable='Assess_People'
print('Storing :',sDatabaseName,' Table:',sTable)
PeopleData.to_sql(sTable, conn, if_exists="replace")
print('#################')
#########################################################################
sFileDir=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir):
    os.makedirs(sFileDir)
#########################################################################
sOutputFileName = sTable+'.csv'
sFileName=sFileDir + '/' + sOutputFileName
print('#################################')
print('Storing :', sFileName)
print('#################################')
PeopleData.to_csv(sFileName, index = False)
print('#################################')
#########################################################################
print('### Done!! ################################################')
#########################################################################
```

OUTPUT:

```
Python 3.7.4 Shell
File  Edit  Shell  Debug  Options  Window  Help
========== RESTART: C:\VKHCG\04-Clark\02-Assess\Assess-People.py ==========
Loading : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve-Data_female-names.csv
C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve-Data_female-names.csv
Storing : C:/VKHCG/04-Clark/02-Assess/SQLite/clark.db  Table: Assess_FemaleName
Rows :  100  records
Loading : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve-Data_male-names.csv
Storing : C:/VKHCG/04-Clark/02-Assess/SQLite/clark.db  Table: Assess_MaleName
Rows :  100  records
Loading : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve-Data_last-names.csv
Storing : C:/VKHCG/04-Clark/02-Assess/SQLite/clark.db  Table: Assess_Surname
Rows :  200  records
Loading : C:/VKHCG/04-Clark/02-Assess/SQLite/clark.db  Table: Assess_FemaleName & Assess_MaleName
Storing : C:/VKHCG/04-Clark/02-Assess/SQLite/clark.db  Table: Assess_FirstName
Loading : C:/VKHCG/04-Clark/02-Assess/SQLite/clark.db  Table: Assess_FirstName x2 & Assess_Surname
Loading : C:/VKHCG/04-Clark/02-Assess/SQLite/clark.db  Table: Assess_FirstName & Assess_Surname
        FirstName SecondName  LastName  Gender
2471856    Miguel      Efren    Ortega    Male
3466902    Tommye    Coretta   Roberts  Female
3336496      Stan     Xavier     Costa    Male
1151796   Faviola       Gene     Heard  Female
893614     Dorene     Joelle   Mccloud  Female
...           ...        ...       ...     ...
31958    Santiago              Crook    Male
32635     Shaunte            Ferreira  Female
2436       Bernie              Dubose    Male
39951     Zoraida              Cherry  Female
7702       Dannie               Foret    Male

[20000 rows x 4 columns]
Storing : C:/VKHCG/04-Clark/02-Assess/SQLite/clark.db  Table: Assess_People
Storing : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_People.csv
################################
```

Practical 6:

Processing Data

A. Build the time hub, links, and satellites.

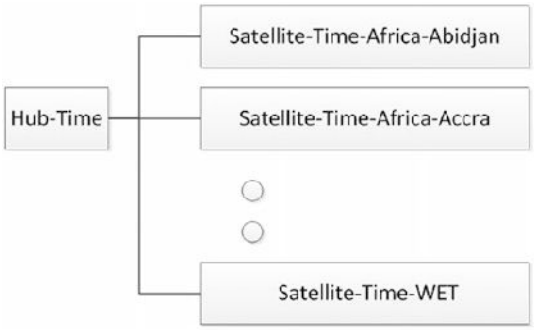
Open your Python editor and create a file named Process_Time.py. Save it into directory C:\VKHCG\01-Vermeulen\03-Process.

```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
from datetime import datetime
from datetime import timedelta
from pytz import timezone, all_timezones
import pandas as pd
import sqlite3 as sq
from pandas.io import sql
import uuid

pd.options.mode.chained_assignment = None
################################################################
if sys.platform == 'linux':
    Base=os.path.expanduser('~') + '/VKHCG'
else:
    Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
################################################################
Company='01-Vermeulen'
InputDir='00-RawData'
InputFileName='VehicleData.csv'
################################################################
sDataBaseDir=Base + '/' + Company + '/03-Process/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
################################################################
sDatabaseName=sDataBaseDir + '/Hillman.db'
conn1 = sq.connect(sDatabaseName)
################################################################
sDataVaultDir=Base + '/88-DV'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
################################################################
sDatabaseName=sDataVaultDir + '/datavault.db'
conn2 = sq.connect(sDatabaseName)
################################################################
base = datetime(2018,1,1,0,0,0)
```

```
numUnits=10*365*24
#######################################################################
date_list = [base - timedelta(hours=x) for x in range(0, numUnits)]
t=0
for i in date_list:
    now_utc=i.replace(tzinfo=timezone('UTC'))
    sDateTime=now_utc.strftime("%Y-%m-%d %H:%M:%S")
    print(sDateTime)
    sDateTimeKey=sDateTime.replace(' ','-').replace(':','-')
    t+=1
    IDNumber=str(uuid.uuid4())
    TimeLine=[('ZoneBaseKey', ['UTC']),
            ('IDNumber', [IDNumber]),
            ('nDateTimeValue', [now_utc]),
            ('DateTimeValue', [sDateTime]),
            ('DateTimeKey', [sDateTimeKey])]
    if t==1:
       TimeFrame = pd.DataFrame.from_items(TimeLine)
    else:
        TimeRow = pd.DataFrame.from_items(TimeLine)
        TimeFrame = TimeFrame.append(TimeRow)
#######################################################################
TimeHub=TimeFrame[['IDNumber','ZoneBaseKey','DateTimeKey','DateTimeValue']]
TimeHubIndex=TimeHub.set_index(['IDNumber'],inplace=False)
#######################################################################
TimeFrame.set_index(['IDNumber'],inplace=True)
#######################################################################
sTable = 'Process-Time'
print('Storing :',sDatabaseName,' Table:',sTable)
TimeHubIndex.to_sql(sTable, conn1, if_exists="replace")
#######################################################################
sTable = 'Hub-Time'
print('Storing :',sDatabaseName,' Table:',sTable)
TimeHubIndex.to_sql(sTable, conn2, if_exists="replace")
#######################################################################
active_timezones=all_timezones
z=0
for zone in active_timezones:
    t=0
    for j in range(TimeFrame.shape[0]):
        now_date=TimeFrame['nDateTimeValue'][j]
        DateTimeKey=TimeFrame['DateTimeKey'][j]
        now_utc=now_date.replace(tzinfo=timezone('UTC'))
        sDateTime=now_utc.strftime("%Y-%m-%d %H:%M:%S")
        now_zone = now_utc.astimezone(timezone(zone))
        sZoneDateTime=now_zone.strftime("%Y-%m-%d %H:%M:%S")
        print(sZoneDateTime)
        t+=1
```

```
        z+=1
        IDZoneNumber=str(uuid.uuid4())
        TimeZoneLine=[('ZoneBaseKey', ['UTC']),
                      ('IDZoneNumber', [IDZoneNumber]),
                      ('DateTimeKey', [DateTimeKey]),
                      ('UTCDateTimeValue', [sDateTime]),
                      ('Zone', [zone]),
                      ('DateTimeValue', [sZoneDateTime])]
        if t==1:
           TimeZoneFrame = pd.DataFrame.from_items(TimeZoneLine)
        else:
           TimeZoneRow = pd.DataFrame.from_items(TimeZoneLine)
           TimeZoneFrame = TimeZoneFrame.append(TimeZoneRow)

    TimeZoneFrameIndex=TimeZoneFrame.set_index(['IDZoneNumber'],inplace=False)
    sZone=zone.replace('/','-').replace(' ','')
    ################################################################
    sTable = 'Process-Time-'+sZone
    print('Storing :',sDatabaseName,' Table:',sTable)
    TimeZoneFrameIndex.to_sql(sTable, conn1, if_exists="replace")
#####################################################################
    ################################################################
    sTable = 'Satellite-Time-'+sZone
    print('Storing :',sDatabaseName,' Table:',sTable)
    TimeZoneFrameIndex.to_sql(sTable, conn2, if_exists="replace")
#####################################################################
print('#################')
print('Vacuum Databases')
sSQL="VACUUM;"
sql.execute(sSQL,conn1)
sql.execute(sSQL,conn2)
print('#################')
#####################################################################
print('### Done!! ############################################')
#####################################################################
```

You have built your first hub and satellites for time in the data vault.
The data vault has been built in directory ..\ VKHCG\88-DV\datavault.db. You can access it with your SQLite tools



Golden Nominal

A golden nominal record is a single person's record, with distinctive references for use by all systems. This gives the system a single view of the person. I use first name, other names, last name, and birth date as my golden nominal. The data we have in the assess directory requires a birth date to become a golden nominal. The proram will generate a golden nominal using our sample data set.
Open your Python editor and create a file called Process-People.py in the ..
C:\VKHCG\04-Clark\03-Process directory.

```
################################################################
import sys
import os
import sqlite3 as sq
import pandas as pd
from pandas.io import sql
from datetime import datetime, timedelta
from pytz import timezone, all_timezones
from random import randint
import uuid
################################################################
if sys.platform == 'linux':
    Base=os.path.expanduser('~') + '/VKHCG'
else:
    Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
################################################################
Company='04-Clark'
sInputFileName='02-Assess/01-EDS/02-Python/Assess_People.csv'
################################################################
sDataBaseDir=Base + '/' + Company + '/03-Process/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
################################################################
sDatabaseName=sDataBaseDir + '/clark.db'
conn1 = sq.connect(sDatabaseName)
################################################################
sDataVaultDir=Base + '/88-DV'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
################################################################
sDatabaseName=sDataVaultDir + '/datavault.db'
conn2 = sq.connect(sDatabaseName)
################################################################
### Import Female Data
################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName
print('################################')
print('Loading :',sFileName)
print('################################')
print(sFileName)
RawData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
```

```
RawData.drop_duplicates(subset=None, keep='first', inplace=True)

start_date = datetime(1900,1,1,0,0,0)
start_date_utc=start_date.replace(tzinfo=timezone('UTC'))

HoursBirth=100*365*24
RawData['BirthDateUTC']=RawData.apply(lambda row:
        (start_date_utc + timedelta(hours=randint(0, HoursBirth)))
        ,axis=1)
zonemax=len(all_timezones)-1
RawData['TimeZone']=RawData.apply(lambda row:
        (all_timezones[randint(0, zonemax)])
        ,axis=1)
RawData['BirthDateISO']=RawData.apply(lambda row:
        row["BirthDateUTC"].astimezone(timezone(row['TimeZone']))
        ,axis=1)
RawData['BirthDateKey']=RawData.apply(lambda row:
        row["BirthDateUTC"].strftime("%Y-%m-%d %H:%M:%S")
        ,axis=1)
RawData['BirthDate']=RawData.apply(lambda row:
        row["BirthDateISO"].strftime("%Y-%m-%d %H:%M:%S")
        ,axis=1)
RawData['PersonID']=RawData.apply(lambda row:
        str(uuid.uuid4())
        ,axis=1)

#################################################################

Data=RawData.copy()
Data.drop('BirthDateUTC', axis=1,inplace=True)
Data.drop('BirthDateISO', axis=1,inplace=True)
indexed_data = Data.set_index(['PersonID'])

print('################################')
#################################################################
print('#################')
sTable='Process_Person'
print('Storing :',sDatabaseName,' Table:',sTable)
indexed_data.to_sql(sTable, conn1, if_exists="replace")
print('#################')
#################################################################
PersonHubRaw=Data[['PersonID','FirstName','SecondName','LastName','BirthDateKey']]
PersonHubRaw['PersonHubID']=RawData.apply(lambda row:
        str(uuid.uuid4())
        ,axis=1)
PersonHub=PersonHubRaw.drop_duplicates(subset=None, \
                                       keep='first',\
                                       inplace=False)
indexed_PersonHub = PersonHub.set_index(['PersonHubID'])
sTable = 'Hub-Person'
print('Storing :',sDatabaseName,' Table:',sTable)
indexed_PersonHub.to_sql(sTable, conn2, if_exists="replace")
#################################################################
```

```
PersonSatelliteGenderRaw=Data[['PersonID','FirstName','SecondName','LastName'\
                    ,'BirthDateKey','Gender']]
PersonSatelliteGenderRaw['PersonSatelliteID']=RawData.apply(lambda row:
            str(uuid.uuid4())
            ,axis=1)
PersonSatelliteGender=PersonSatelliteGenderRaw.drop_duplicates(subset=None, \
                                            keep='first', \
                                            inplace=False)
indexed_PersonSatelliteGender = PersonSatelliteGender.set_index(['PersonSatelliteID'])
sTable = 'Satellite-Person-Gender'
print('Storing :',sDatabaseName,' Table:',sTable)
indexed_PersonSatelliteGender.to_sql(sTable, conn2, if_exists="replace")
################################################################
PersonSatelliteBirthdayRaw=Data[['PersonID','FirstName','SecondName','LastName',\
                     'BirthDateKey','TimeZone','BirthDate']]
PersonSatelliteBirthdayRaw['PersonSatelliteID']=RawData.apply(lambda row:
            str(uuid.uuid4())
            ,axis=1)
PersonSatelliteBirthday=PersonSatelliteBirthdayRaw.drop_duplicates(subset=None, \
                                            keep='first',\
                                            inplace=False)
indexed_PersonSatelliteBirthday = PersonSatelliteBirthday.set_index(['PersonSatelliteID'])
sTable = 'Satellite-Person-Names'
print('Storing :',sDatabaseName,' Table:',sTable)
indexed_PersonSatelliteBirthday.to_sql(sTable, conn2, if_exists="replace")
################################################################
sFileDir=Base + '/' + Company + '/03-Process/01-EDS/02-Python'
if not os.path.exists(sFileDir):
   os.makedirs(sFileDir)
################################################################
sOutputFileName = sTable + '.csv'
sFileName=sFileDir + '/' + sOutputFileName
print('################################')
print('Storing :', sFileName)
print('################################')
RawData.to_csv(sFileName, index = False)
print('################################')
################################################################
print('################')
print('Vacuum Databases')
sSQL="VACUUM;"
sql.execute(sSQL,conn1)
sql.execute(sSQL,conn2)
print('################')
################################################################
print('### Done!! ############################################')
################################################################
```

Output :

It will apply golden nominal rules by assuming nobody born before January 1, 1900, droping to two ISO complex date time structures, as the code does not translate into SQLite's data types and saves your new golden nominal to a CSV file.

Load the person into the data vault

```
========== RESTART: C:\VKHCG\04-Clark\03-Process\Process-People.py ==========
################################
Working Base : C:/VKHCG  using  win32
################################
################################
Loading : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_People.csv
################################
C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_People.csv
################################
################
Storing : C:/VKHCG/88-DV/datavault.db  Table: Process_Person
################
Storing : C:/VKHCG/88-DV/datavault.db  Table: Satellite-Person-Gender
Storing : C:/VKHCG/88-DV/datavault.db  Table: Satellite-Person-Names
################################
Storing : C:/VKHCG/04-Clark/03-Process/01-EDS/02-Python/Satellite-Person-Names.csv
################################
################################
################
Vacuum Databases
################
### Done!! ############################################
```

Vehicles

The international classification of vehicles is a complex process. There are standards, but these are not universally applied or similar between groups or countries.

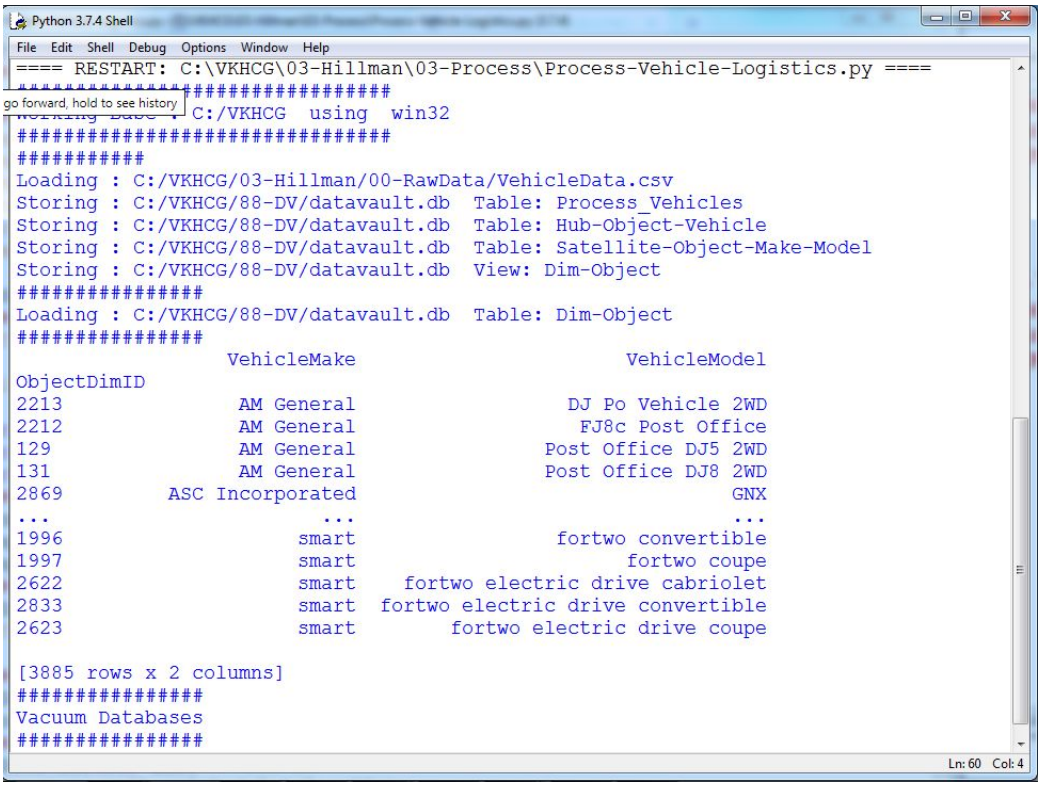
Let's load the vehicle data for Hillman Ltd into the data vault, as we will need it later. Create a new file named Process-Vehicle-Logistics.py in the Python editor in directory ..\VKHCG\03-Hillman\03-Process.

```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
import sqlite3 as sq
from pandas.io import sql
import uuid

pd.options.mode.chained_assignment = None
################################################################
if sys.platform == 'linux':
    Base=os.path.expanduser('~') + '/VKHCG'
else:
    Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
```

```
print('################################')
#######################################################################
Company='03-Hillman'
InputDir='00-RawData'
InputFileName='VehicleData.csv'
#######################################################################
sDataBaseDir=Base + '/' + Company + '/03-Process/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
#######################################################################
sDatabaseName=sDataBaseDir + '/Hillman.db'
conn1 = sq.connect(sDatabaseName)
#######################################################################
sDataVaultDir=Base + '/88-DV'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
#######################################################################
sDatabaseName=sDataVaultDir + '/datavault.db'
conn2 = sq.connect(sDatabaseName)
#######################################################################
sFileName=Base + '/' + Company + '/' + InputDir + '/' + InputFileName
print('############')
print('Loading :',sFileName)
VehicleRaw=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
#######################################################################
sTable='Process_Vehicles'
print('Storing :',sDatabaseName,' Table:',sTable)
VehicleRaw.to_sql(sTable, conn1, if_exists="replace")
#######################################################################
VehicleRawKey=VehicleRaw[['Make','Model']].copy()
VehicleKey=VehicleRawKey.drop_duplicates()
#######################################################################
VehicleKey['ObjectKey']=VehicleKey.apply(lambda row:
    str('('+ str(row['Make']).strip().replace(' ', '-').replace('/', '-').lower() +
     ')-(' + (str(row['Model']).strip().replace(' ', '-').replace(' ', '-').lower())
     +')')
       ,axis=1)
#######################################################################
VehicleKey['ObjectType']=VehicleKey.apply(lambda row:
    'vehicle'
       ,axis=1)
#######################################################################
VehicleKey['ObjectUUID']=VehicleKey.apply(lambda row:
    str(uuid.uuid4())
       ,axis=1)
#######################################################################
### Vehicle Hub
#######################################################################
```

```
#
VehicleHub=VehicleKey[['ObjectType','ObjectKey','ObjectUUID']].copy()
VehicleHub.index.name='ObjectHubID'
sTable = 'Hub-Object-Vehicle'
print('Storing :',sDatabaseName,' Table:',sTable)
VehicleHub.to_sql(sTable, conn2, if_exists="replace")
#####################################################################
### Vehicle Satellite
#####################################################################
#
VehicleSatellite=VehicleKey[['ObjectType','ObjectKey','ObjectUUID','Make','Model']].copy()
VehicleSatellite.index.name='ObjectSatelliteID'
sTable = 'Satellite-Object-Make-Model'
print('Storing :',sDatabaseName,' Table:',sTable)
VehicleSatellite.to_sql(sTable, conn2, if_exists="replace")


#####################################################################
### Vehicle Dimension
#####################################################################
sView='Dim-Object'
print('Storing :',sDatabaseName,' View:',sView)
sSQL="CREATE VIEW IF NOT EXISTS [" + sView + "] AS"
sSQL=sSQL+ " SELECT DISTINCT"
sSQL=sSQL+ "   H.ObjectType,"
sSQL=sSQL+ "   H.ObjectKey AS VehicleKey,"
sSQL=sSQL+ "   TRIM(S.Make) AS VehicleMake,"
sSQL=sSQL+ "   TRIM(S.Model) AS VehicleModel"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ "   [Hub-Object-Vehicle] AS H"
sSQL=sSQL+ " JOIN"
sSQL=sSQL+ "   [Satellite-Object-Make-Model] AS S"
sSQL=sSQL+ " ON"
sSQL=sSQL+ "     H.ObjectType=S.ObjectType"
sSQL=sSQL+ " AND"
sSQL=sSQL+ " H.ObjectUUID=S.ObjectUUID;"
sql.execute(sSQL,conn2)

print('################')
print('Loading :',sDatabaseName,' Table:',sView)
sSQL=" SELECT DISTINCT"
sSQL=sSQL+ " VehicleMake,"
sSQL=sSQL+ " VehicleModel"
sSQL=sSQL+ " FROM"
sSQL=sSQL+ " [" + sView + "]"
sSQL=sSQL+ " ORDER BY"
sSQL=sSQL+ " VehicleMake"
sSQL=sSQL+ " AND"
```

```
sSQL=sSQL+ " VehicleMake;"
DimObjectData=pd.read_sql_query(sSQL, conn2)

DimObjectData.index.name='ObjectDimID'
DimObjectData.sort_values(['VehicleMake','VehicleModel'],inplace=True, ascending=True)
print('#################')
print(DimObjectData)
#########################################################################
print('#################')
print('Vacuum Databases')
sSQL="VACUUM;"
sql.execute(sSQL,conn1)
sql.execute(sSQL,conn2)
print('#################')
#########################################################################
conn1.close()
conn2.close()
#########################################################################
#print('### Done!! ############################################')
#########################################################################
```

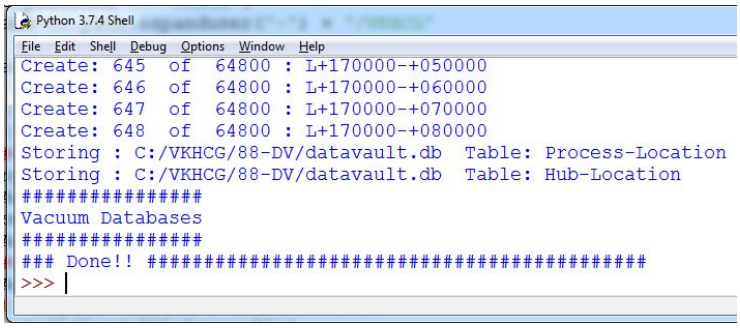


Human-Environment Interaction

The interaction of humans with their environment is a major relationship that guides people's behavior and the characteristics of the location. Activities such as mining and other industries, roads, and landscaping at a location create both positive and negative effects on the environment, but also on humans. A location earmarked as a green belt, to assist in reducing the carbon footprint, or a new interstate change its current and future characteristics. The location is a main data source for the data science, and, normally, we find unknown or unexpected effects on the data insights. In the Python editor, open a new file named Process_Location.py in directory ..\VKHCG\01-Vermeulen\03-Process.

```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
import sqlite3 as sq
from pandas.io import sql
import uuid
################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
################################################################
Company='01-Vermeulen'
InputAssessGraphName='Assess_All_Animals.gml'
EDSAssessDir='02-Assess/01-EDS'
InputAssessDir=EDSAssessDir + '/02-Python'
################################################################
sFileAssessDir=Base + '/' + Company + '/' + InputAssessDir
if not os.path.exists(sFileAssessDir):
    os.makedirs(sFileAssessDir)
################################################################
sDataBaseDir=Base + '/' + Company + '/03-Process/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
################################################################
sDatabaseName=sDataBaseDir + '/Vermeulen.db'
conn1 = sq.connect(sDatabaseName)
################################################################
sDataVaultDir=Base + '/88-DV'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
################################################################
sDatabaseName=sDataVaultDir + '/datavault.db'
conn2 = sq.connect(sDatabaseName)
t=0
tMax=360*180
################################################################
```

```
for Longitude in range(-180,180,10):
    for Latitude in range(-90,90,10):
        t+=1
        IDNumber=str(uuid.uuid4())
        LocationName='L'+format(round(Longitude,3)*1000, '+07d') +\
                        '-'+format(round(Latitude,3)*1000, '+07d')
        print('Create:',t,' of ',tMax,':',LocationName)
        LocationLine=[('ObjectBaseKey', ['GPS']),
                      ('IDNumber', [IDNumber]),
                      ('LocationNumber', [str(t)]),
                      ('LocationName', [LocationName]),
                      ('Longitude', [Longitude]),
                      ('Latitude', [Latitude])]
        if t==1:
            LocationFrame = pd.DataFrame.from_items(LocationLine)
        else:
            LocationRow = pd.DataFrame.from_items(LocationLine)
            LocationFrame = LocationFrame.append(LocationRow)
#####################################################################
LocationHubIndex=LocationFrame.set_index(['IDNumber'],inplace=False)
#####################################################################
sTable = 'Process-Location'
print('Storing :',sDatabaseName,' Table:',sTable)
LocationHubIndex.to_sql(sTable, conn1, if_exists="replace")
#####################################################################
sTable = 'Hub-Location'
print('Storing :',sDatabaseName,' Table:',sTable)
LocationHubIndex.to_sql(sTable, conn2, if_exists="replace")
#####################################################################
print('#################')
print('Vacuum Databases')
sSQL="VACUUM;"
sql.execute(sSQL,conn1)
sql.execute(sSQL,conn2)
print('#################')
#####################################################################
print('### Done!! ############################################')
#####################################################################
```



Forecasting

Forecasting is the ability to project a possible future, by looking at historical data. The datavault enables these types of investigations, owing to the complete history it collects as itprocesses the source's systems data. A data scientist supply answers to such questions as the following:

- What should we buy?
- What should we sell?
- Where will our next business come from?

People want to know what you calculate to determine what is about to happen.
Open a new file in your Python editor and save it as Process-Shares-Data.py in directory C: \VKHCG\04-Clark\03-Process. I will guide you through this process. You will require a library called quandl

type pip install quandl in cmd

```
################################################################
import sys
import os
import sqlite3 as sq
import quandl
import pandas as pd
################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
################################################################
Company='04-Clark'
sInputFileName='00-RawData/VKHCG_Shares.csv'
sOutputFileName='Shares.csv'
################################################################
sDataBaseDir=Base + '/' + Company + '/03-Process/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
################################################################
sFileDir1=Base + '/' + Company + '/01-Retrieve/01-EDS/02-Python'
if not os.path.exists(sFileDir1):
    os.makedirs(sFileDir1)
################################################################
sFileDir2=Base + '/' + Company + '/02-Assess/01-EDS/02-Python'
if not os.path.exists(sFileDir2):
    os.makedirs(sFileDir2)
################################################################
sFileDir3=Base + '/' + Company + '/03-Process/01-EDS/02-Python'
if not os.path.exists(sFileDir3):
    os.makedirs(sFileDir3)
################################################################
sDatabaseName=sDataBaseDir + '/clark.db'
conn = sq.connect(sDatabaseName)
################################################################
### Import Share Names Data
```

```
#################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName
print('################################')
print('Loading :',sFileName)
print('################################')
RawData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
RawData.drop_duplicates(subset=None, keep='first', inplace=True)
print('Rows   :',RawData.shape[0])
print('Columns:',RawData.shape[1])
print('################')
#################################################################
sFileName=sFileDir1 + '/Retrieve_' + sOutputFileName
print('################################')
print('Storing :', sFileName)
print('################################')
RawData.to_csv(sFileName, index = False)
print('################################')
#################################################################
sFileName=sFileDir2 + '/Assess_' + sOutputFileName
print('################################')
print('Storing :', sFileName)
print('################################')
RawData.to_csv(sFileName, index = False)
print('################################')
#################################################################
sFileName=sFileDir3 + '/Process_' + sOutputFileName
print('################################')
print('Storing :', sFileName)
print('################################')
RawData.to_csv(sFileName, index = False)
print('################################')
#################################################################
### Import Shares Data Details
nShares=RawData.shape[0]
#nShares=6
for sShare in range(nShares):
    sShareName=str(RawData['Shares'][sShare])
    ShareData = quandl.get(sShareName)
    UnitsOwn=RawData['Units'][sShare]
    ShareData['UnitsOwn']=ShareData.apply(lambda row:(UnitsOwn),axis=1)
    ShareData['ShareCode']=ShareData.apply(lambda row:(sShareName),axis=1)
    print('################')
    print('Share  :',sShareName)
    print('Rows   :',ShareData.shape[0])
    print('Columns:',ShareData.shape[1])
    print('################')
    #################################################################
    print('################')
```

```
    sTable=str(RawData['sTable'][sShare])
    print('Storing :',sDatabaseName,' Table:',sTable)
    ShareData.to_sql(sTable, conn, if_exists="replace")
    print('################')
    ###################################################################
    sOutputFileName = sTable.replace("/","-") + '.csv'
    sFileName=sFileDir1 + '/Retrieve_' + sOutputFileName
    print('################################')
    print('Storing :', sFileName)
    print('################################')
    ShareData.to_csv(sFileName, index = False)
    print('################################')
    ###################################################################
    sOutputFileName = sTable.replace("/","-") + '.csv'
    sFileName=sFileDir2 + '/Assess_' + sOutputFileName
    print('################################')
    print('Storing :', sFileName)
    print('################################')
    ShareData.to_csv(sFileName, index = False)
    print('################################')
    ###################################################################
    sOutputFileName = sTable.replace("/","-") + '.csv'
    sFileName=sFileDir3 + '/Process_' + sOutputFileName
    print('################################')
    print('Storing :', sFileName)
    print('################################')
    ShareData.to_csv(sFileName, index = False)
    print('################################')
print('### Done!! ############################################')
#####################################################################
```

Output:

```
======== RESTART: C:\VKHCG\04-Clark\03-Process\Process-Shares-Data.py ========
Working Base : C:/VKHCG  using  win32
Loading : C:/VKHCG/04-Clark/00-RawData/VKHCG_Shares.csv
Rows   : 10
Columns: 3
Storing : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve_Shares.csv
Storing : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_Shares.csv
Storing : C:/VKHCG/04-Clark/03-Process/01-EDS/02-Python/Process_Shares.csv
Share  : WIKI/GOOGL
Rows   : 3424
Columns: 14
Storing : C:/VKHCG/04-Clark/03-Process/SQLite/clark.db  Table: WIKI_Google
Storing : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve_WIKI_Google.csv
Storing : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_WIKI_Google.csv
Storing : C:/VKHCG/04-Clark/03-Process/01-EDS/02-Python/Process_WIKI_Google.csv
Share  : WIKI/MSFT
Rows   : 8076
Columns: 14
Storing : C:/VKHCG/04-Clark/03-Process/SQLite/clark.db  Table: WIKI_Microsoft
Storing : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve_WIKI_Microsoft.csv
Storing : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_WIKI_Microsoft.csv
```

```
Storing : C:/VKHCG/04-Clark/03-Process/01-EDS/02-Python/Process_WIKI_Microsoft.csv
Share  : WIKI/UPS
Rows   : 4622
Columns: 14
Storing : C:/VKHCG/04-Clark/03-Process/SQLite/clark.db  Table: WIKI_UPS
Storing : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve_WIKI_UPS.csv
Storing : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_WIKI_UPS.csv
Storing : C:/VKHCG/04-Clark/03-Process/01-EDS/02-Python/Process_WIKI_UPS.csv
Share  : WIKI/AMZN
Rows   : 5248
Columns: 14
Storing : C:/VKHCG/04-Clark/03-Process/SQLite/clark.db  Table: WIKI_Amazon
Storing : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve_WIKI_Amazon.csv
Storing : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_WIKI_Amazon.csv
Storing : C:/VKHCG/04-Clark/03-Process/01-EDS/02-Python/Process_WIKI_Amazon.csv
Share  : LOCALBTC/USD
Rows   : 1863
Columns: 6
Storing : C:/VKHCG/04-Clark/03-Process/SQLite/clark.db  Table: LOCALBTC_USD
Storing : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve_LOCALBTC_USD.csv
Storing : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_LOCALBTC_USD.csv
Storing : C:/VKHCG/04-Clark/03-Process/01-EDS/02-Python/Process_LOCALBTC_USD.csv
Share  : PERTH/AUD_USD_M
Rows   : 340
Columns: 8
Storing : C:/VKHCG/04-Clark/03-Process/SQLite/clark.db  Table: PERTH_AUD_USD_M
Storing : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve_PERTH_AUD_USD_M.csv
Storing : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_PERTH_AUD_USD_M.csv
Storing : C:/VKHCG/04-Clark/03-Process/01-EDS/02-Python/Process_PERTH_AUD_USD_M.csv
Share  : PERTH/AUD_USD_D
Rows   : 7989
Columns: 8
Storing : C:/VKHCG/04-Clark/03-Process/SQLite/clark.db  Table: PERTH_AUD_USD_D
Storing : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve_PERTH_AUD_USD_D.csv
Storing : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_PERTH_AUD_USD_D.csv
Storing : C:/VKHCG/04-Clark/03-Process/01-EDS/02-Python/Process_PERTH_AUD_USD_D.csv
Share  : FRED/GDP
Rows   : 290
Columns: 3
Storing : C:/VKHCG/04-Clark/03-Process/SQLite/clark.db  Table: FRED/GDP
Storing : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve_FRED-GDP.csv
Storing : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_FRED-GDP.csv
Storing : C:/VKHCG/04-Clark/03-Process/01-EDS/02-Python/Process_FRED-GDP.csv
Share  : FED/RXI_US_N_A_UK
Rows   : 49
Columns: 3
Storing : C:/VKHCG/04-Clark/03-Process/SQLite/clark.db  Table: FED_RXI_US_N_A_UK
Storing : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve_FED_RXI_US_N_A_UK.csv
Storing : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_FED_RXI_US_N_A_UK.csv
Storing : C:/VKHCG/04-Clark/03-Process/01-EDS/02-Python/Process_FED_RXI_US_N_A_UK.csv
Share  : FED/RXI_N_A_CA
Rows   : 49
Columns: 3
Storing : C:/VKHCG/04-Clark/03-Process/SQLite/clark.db  Table: FED_RXI_N_A_CA
Storing : C:/VKHCG/04-Clark/01-Retrieve/01-EDS/02-Python/Retrieve_FED_RXI_N_A_CA.csv
Storing : C:/VKHCG/04-Clark/02-Assess/01-EDS/02-Python/Assess_FED_RXI_N_A_CA.csv
Storing : C:/VKHCG/04-Clark/03-Process/01-EDS/02-Python/Process_FED_RXI_N_A_CA.csv
### Done!! ############################################
```

Practical 7:

Transforming Data

Transform Superstep

The Transform superstep allows you, as a data scientist, to take data from the data vault and formulate answers to questions raised by your investigations. The transformation step is the data science process that converts results into insights. It takes standard data science techniques and methods to attain insight and knowledge about the data that then can be transformed into actionable decisions, which, through storytelling, you can explain to non-data scientists what you have discovered in the data lake.

To illustrate the consolidation process, the example show a person being borne. Open a new file in the Python editor and save it as Transform-Gunnarsson_is_Born.py in directory C: \VKHCG\01-Vermeulen\04-Transform.

```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
from datetime import datetime
from pytz import timezone
import pandas as pd
import sqlite3 as sq
import uuid

pd.options.mode.chained_assignment = None
################################################################
Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
################################################################
Company='01-Vermeulen'
InputDir='00-RawData'
InputFileName='VehicleData.csv'
################################################################
sDataBaseDir=Base + '/' + Company + '/04-Transform/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
################################################################
sDatabaseName=sDataBaseDir + '/Vermeulen.db'
conn1 = sq.connect(sDatabaseName)
################################################################
sDataVaultDir=Base + '/88-DV'
if not os.path.exists(sDataVaultDir):
    os.makedirs(sDataVaultDir)
################################################################
sDatabaseName=sDataVaultDir + '/datavault.db'
conn2 = sq.connect(sDatabaseName)
################################################################
```

```
sDataWarehouseDir=Base + '/99-DW'
if not os.path.exists(sDataWarehouseDir):
   os.makedirs(sDataWarehouseDir)
##################################################################
sDatabaseName=sDataWarehouseDir + '/datawarehouse.db'
conn3 = sq.connect(sDatabaseName)
##################################################################
print('\n#################################')
print('Time Category')
print('UTC Time')
BirthDateUTC = datetime(1960,12,20,10,15,0)
BirthDateZoneUTC=BirthDateUTC.replace(tzinfo=timezone('UTC'))
BirthDateZoneStr=BirthDateZoneUTC.strftime("%Y-%m-%d %H:%M:%S")
BirthDateZoneUTCStr=BirthDateZoneUTC.strftime("%Y-%m-%d %H:%M:%S (%Z) (%z)")
print(BirthDateZoneUTCStr)
print('#################################')
print('Birth Date in Reykjavik :')
BirthZone = 'Atlantic/Reykjavik'
BirthDate = BirthDateZoneUTC.astimezone(timezone(BirthZone))
BirthDateStr=BirthDate.strftime("%Y-%m-%d %H:%M:%S (%Z) (%z)")
BirthDateLocal=BirthDate.strftime("%Y-%m-%d %H:%M:%S")
print(BirthDateStr)
print('#################################')
##################################################################
IDZoneNumber=str(uuid.uuid4())
sDateTimeKey=BirthDateZoneStr.replace(' ','-').replace(':','-')
TimeLine=[('ZoneBaseKey', ['UTC']),
          ('IDNumber', [IDZoneNumber]),
          ('DateTimeKey', [sDateTimeKey]),
          ('UTCDateTimeValue', [BirthDateZoneUTC]),
          ('Zone', [BirthZone]),
          ('DateTimeValue', [BirthDateStr])]
TimeFrame = pd.DataFrame.from_items(TimeLine)
##################################################################
TimeHub=TimeFrame[['IDNumber','ZoneBaseKey','DateTimeKey','DateTimeValue']]
TimeHubIndex=TimeHub.set_index(['IDNumber'],inplace=False)
##################################################################
sTable = 'Hub-Time-Gunnarsson'
print('\n#################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n#################################')
TimeHubIndex.to_sql(sTable, conn2, if_exists="replace")
sTable = 'Dim-Time-Gunnarsson'
TimeHubIndex.to_sql(sTable, conn3, if_exists="replace")
##################################################################
TimeSatellite=TimeFrame[['IDNumber','DateTimeKey','Zone','DateTimeValue']]
TimeSatelliteIndex=TimeSatellite.set_index(['IDNumber'],inplace=False)
##################################################################
BirthZoneFix=BirthZone.replace(' ','-').replace('/','-')
sTable = 'Satellite-Time-' + BirthZoneFix + '-Gunnarsson'
print('\n#################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n#################################')
```

```
TimeSatelliteIndex.to_sql(sTable, conn2, if_exists="replace")
sTable = 'Dim-Time-' + BirthZoneFix + '-Gunnarsson'
TimeSatelliteIndex.to_sql(sTable, conn3, if_exists="replace")
#####################################################################
print('\n###################################')
print('Person Category')
FirstName = 'Guðmundur'
LastName = 'Gunnarsson'
print('Name:',FirstName,LastName)
print('Birth Date:',BirthDateLocal)
print('Birth Zone:',BirthZone)
print('UTC Birth Date:',BirthDateZoneStr)
print('###################################')
#####################################################################
IDPersonNumber=str(uuid.uuid4())
PersonLine=[('IDNumber', [IDPersonNumber]),
            ('FirstName', [FirstName]),
            ('LastName', [LastName]),
            ('Zone', ['UTC']),
            ('DateTimeValue', [BirthDateZoneStr])]
PersonFrame = pd.DataFrame.from_items(PersonLine)
#####################################################################
TimeHub=PersonFrame
TimeHubIndex=TimeHub.set_index(['IDNumber'],inplace=False)
#####################################################################
sTable = 'Hub-Person-Gunnarsson'
print('\n###################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n###################################')
TimeHubIndex.to_sql(sTable, conn2, if_exists="replace")
sTable = 'Dim-Person-Gunnarsson'
TimeHubIndex.to_sql(sTable, conn3, if_exists="replace")
#####################################################################
```

Output : Guðmundur Gunnarsson was born on December 20, 1960, at 9:15 in Landspítali,Hringbraut 101, 101 Reykjavík, Iceland.

```
>>>
 RESTART: C:\VKHCG\01-Vermeulen\04-Transform\Transform-Gunnarsson_is_Born.py
Working Base : C:/VKHCG  using  win32
Time Category
UTC Time
1960-12-20 10:15:00 (UTC) (+0000)
###################################
Birth Date in Reykjavik :
1960-12-20 09:15:00 (-01) (-0100)
###################################
###################################
Storing : C:/VKHCG/99-DW/datawarehouse.db
 Table: Hub-Time-Gunnarsson
###################################
###################################
Storing : C:/VKHCG/99-DW/datawarehouse.db
 Table: Satellite-Time-Atlantic-Reykjavik-Gunnarsson
###################################
Person Category
Name: Guðmundur Gunnarsson
Birth Date: 1960-12-20 09:15:00
Birth Zone: Atlantic/Reykjavik
UTC Birth Date: 1960-12-20 10:15:00
###################################
Storing : C:/VKHCG/99-DW/datawarehouse.db
 Table: Hub-Person-Gunnarsson
###################################
```

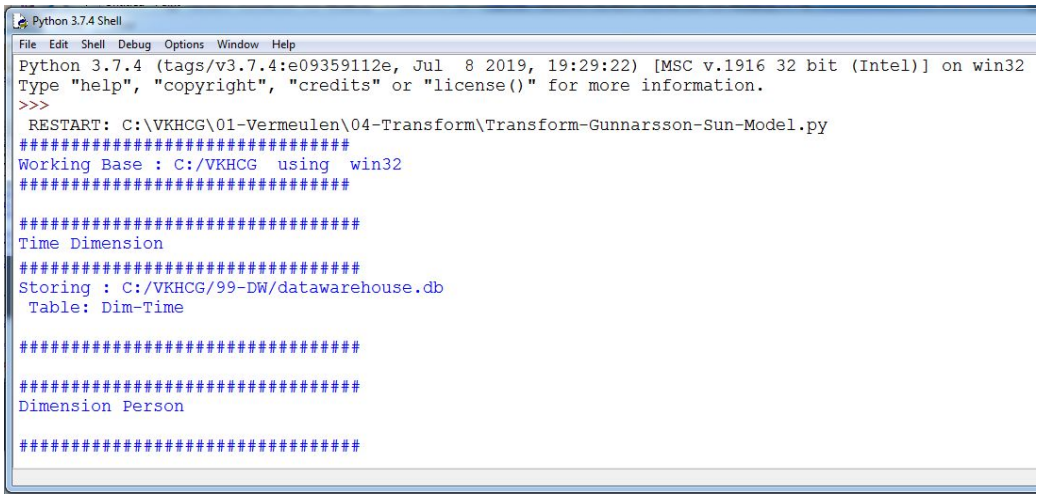
You must build three items: **dimension Person**, **dimension Time**, and **factPersonBornAtTime**. Open your Python editor and create a file named Transform-Gunnarsson-Sun-Model.py in directory C:\VKHCG\01-Vermeulen\04-Transform.

```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
from datetime import datetime
from pytz import timezone
import pandas as pd
import sqlite3 as sq
import uuid
pd.options.mode.chained_assignment = None
################################################################
if sys.platform == 'linux':
    Base=os.path.expanduser('~') + '/VKHCG'
else:
    Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
################################################################
Company='01-Vermeulen'
################################################################
sDataBaseDir=Base + '/' + Company + '/04-Transform/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
################################################################
sDatabaseName=sDataBaseDir + '/Vermeulen.db'
conn1 = sq.connect(sDatabaseName)
################################################################
sDataWarehousetDir=Base + '/99-DW'
if not os.path.exists(sDataWarehousetDir):
    os.makedirs(sDataWarehousetDir)
################################################################
sDatabaseName=sDataWarehousetDir + '/datawarehouse.db'
conn2 = sq.connect(sDatabaseName)
################################################################
print('\n#################################')
print('Time Dimension')
BirthZone = 'Atlantic/Reykjavik'
BirthDateUTC = datetime(1960,12,20,10,15,0)
BirthDateZoneUTC=BirthDateUTC.replace(tzinfo=timezone('UTC'))
BirthDateZoneStr=BirthDateZoneUTC.strftime("%Y-%m-%d %H:%M:%S")
BirthDateZoneUTCStr=BirthDateZoneUTC.strftime("%Y-%m-%d %H:%M:%S (%Z) (%z)")
BirthDate = BirthDateZoneUTC.astimezone(timezone(BirthZone))
```

```
BirthDateStr=BirthDate.strftime("%Y-%m-%d %H:%M:%S (%Z) (%z)")
BirthDateLocal=BirthDate.strftime("%Y-%m-%d %H:%M:%S")
#####################################################################
IDTimeNumber=str(uuid.uuid4())
TimeLine=[('TimeID', [IDTimeNumber]),
        ('UTCDate', [BirthDateZoneStr]),
        ('LocalTime', [BirthDateLocal]),
        ('TimeZone', [BirthZone])]
TimeFrame = pd.DataFrame.from_items(TimeLine)
#####################################################################
DimTime=TimeFrame
DimTimeIndex=DimTime.set_index(['TimeID'],inplace=False)
#####################################################################
sTable = 'Dim-Time'
print('\n#################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n#################################')
DimTimeIndex.to_sql(sTable, conn1, if_exists="replace")
DimTimeIndex.to_sql(sTable, conn2, if_exists="replace")
#####################################################################
print('\n#################################')
print('Dimension Person')
print('\n#################################')
FirstName = 'Guðmundur'
LastName = 'Gunnarsson'
#####################################################################
IDPersonNumber=str(uuid.uuid4())
PersonLine=[('PersonID', [IDPersonNumber]),
            ('FirstName', [FirstName]),
            ('LastName', [LastName]),
            ('Zone', ['UTC']),
            ('DateTimeValue', [BirthDateZoneStr])]
PersonFrame = pd.DataFrame.from_items(PersonLine)
#####################################################################
DimPerson=PersonFrame
DimPersonIndex=DimPerson.set_index(['PersonID'],inplace=False)
#####################################################################
sTable = 'Dim-Person'
print('\n#################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n#################################')
DimPersonIndex.to_sql(sTable, conn1, if_exists="replace")
DimPersonIndex.to_sql(sTable, conn2, if_exists="replace")
#####################################################################
print('\n#################################')
print('Fact - Person - time')
print('\n#################################')
IDFactNumber=str(uuid.uuid4())
```

```
PersonTimeLine=[('IDNumber', [IDFactNumber]),
                ('IDPersonNumber', [IDPersonNumber]),
                ('IDTimeNumber', [IDTimeNumber])]
PersonTimeFrame = pd.DataFrame.from_items(PersonTimeLine)
#####################################################################
FctPersonTime=PersonTimeFrame
FctPersonTimeIndex=FctPersonTime.set_index(['IDNumber'],inplace=False)
#####################################################################
sTable = 'Fact-Person-Time'
print('\n#################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n#################################')
FctPersonTimeIndex.to_sql(sTable, conn1, if_exists="replace")
FctPersonTimeIndex.to_sql(sTable, conn2, if_exists="replace")
#####################################################################
```

Output:



Building a Data Warehouse

Open the Transform-Sun-Models.py file from directory C:\VKHCG\01-Vermeulen\04-Transform.

```
#####################################################################
# -*- coding: utf-8 -*-
#####################################################################
import sys
import os
from datetime import datetime
from pytz import timezone
import pandas as pd
import sqlite3 as sq
import uuid
pd.options.mode.chained_assignment = None
#####################################################################
if sys.platform == 'linux':
    Base=os.path.expanduser('~') + '/VKHCG'
```

```
else:
    Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
#################################################################
Company='01-Vermeulen'
#################################################################
sDataBaseDir=Base + '/' + Company + '/04-Transform/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
#################################################################
sDatabaseName=sDataBaseDir + '/Vermeulen.db'
conn1 = sq.connect(sDatabaseName)
#################################################################
sDataVaultDir=Base + '/88-DV'
if not os.path.exists(sDataVaultDir):
    os.makedirs(sDataVaultDir)
#################################################################
sDatabaseName=sDataVaultDir + '/datavault.db'
conn2 = sq.connect(sDatabaseName)
#################################################################
sDataWarehouseDir=Base + '/99-DW'
if not os.path.exists(sDataWarehouseDir):
    os.makedirs(sDataWarehouseDir)
#################################################################
sDatabaseName=sDataWarehouseDir + '/datawarehouse.db'
conn3 = sq.connect(sDatabaseName)
#################################################################
sSQL=" SELECT DateTimeValue FROM [Hub-Time];"
DateDataRaw=pd.read_sql_query(sSQL, conn2)
DateData=DateDataRaw.head(1000)
print(DateData)
#################################################################
print('\n#################################')
print('Time Dimension')
print('\n#################################')
t=0
mt=DateData.shape[0]
for i in range(mt):
    BirthZone = ('Atlantic/Reykjavik','Europe/London','UCT')
    for j in range(len(BirthZone)):
        t+=1
        print(t,mt*3)
        BirthDateUTC = datetime.strptime(DateData['DateTimeValue'][i],"%Y-%m-%d %H:%M:%S")
        BirthDateZoneUTC=BirthDateUTC.replace(tzinfo=timezone('UTC'))
        BirthDateZoneStr=BirthDateZoneUTC.strftime("%Y-%m-%d %H:%M:%S")
        BirthDateZoneUTCStr=BirthDateZoneUTC.strftime("%Y-%m-%d %H:%M:%S (%Z) (%z)")
```

```
        BirthDate = BirthDateZoneUTC.astimezone(timezone(BirthZone[j]))
        BirthDateStr=BirthDate.strftime("%Y-%m-%d %H:%M:%S (%Z) (%z)")
        BirthDateLocal=BirthDate.strftime("%Y-%m-%d %H:%M:%S")
        ######################################################################
        IDTimeNumber=str(uuid.uuid4())
        TimeLine=[('TimeID', [str(IDTimeNumber)]),
                ('UTCDate', [str(BirthDateZoneStr)]),
                ('LocalTime', [str(BirthDateLocal)]),
                ('TimeZone', [str(BirthZone)])]
        if t==1:
            TimeFrame = pd.DataFrame.from_items(TimeLine)
        else:
            TimeRow = pd.DataFrame.from_items(TimeLine)
            TimeFrame=TimeFrame.append(TimeRow)
######################################################################
DimTime=TimeFrame
DimTimeIndex=DimTime.set_index(['TimeID'],inplace=False)
######################################################################
sTable = 'Dim-Time'
print('\n#################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n#################################')
DimTimeIndex.to_sql(sTable, conn1, if_exists="replace")
DimTimeIndex.to_sql(sTable, conn3, if_exists="replace")
######################################################################
sSQL=" SELECT " + \
     " FirstName," + \
     " SecondName," + \
     " LastName," + \
     " BirthDateKey " + \
     " FROM [Hub-Person];"
PersonDataRaw=pd.read_sql_query(sSQL, conn2)
PersonData=PersonDataRaw.head(1000)
######################################################################
print('\n#################################')
print('Dimension Person')
print('\n#################################')
t=0
mt=DateData.shape[0]
for i in range(mt):
    t+=1
    print(t,mt)
    FirstName = str(PersonData["FirstName"])
    SecondName = str(PersonData["SecondName"])
    if len(SecondName) > 0:
        SecondName=""
    LastName = str(PersonData["LastName"])
    BirthDateKey = str(PersonData["BirthDateKey"])
```

```
    ###################################################################
    IDPersonNumber=str(uuid.uuid4())
    PersonLine=[('PersonID', [str(IDPersonNumber)]),
                ('FirstName', [FirstName]),
                ('SecondName', [SecondName]),
                ('LastName', [LastName]),
                ('Zone', [str('UTC')]),
                ('BirthDate', [BirthDateKey])]
    if t==1:
       PersonFrame = pd.DataFrame.from_items(PersonLine)
    else:
       PersonRow = pd.DataFrame.from_items(PersonLine)
       PersonFrame = PersonFrame.append(PersonRow)
#####################################################################
DimPerson=PersonFrame
print(DimPerson)
DimPersonIndex=DimPerson.set_index(['PersonID'],inplace=False)
#####################################################################
sTable = 'Dim-Person'
print('\n#################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n#################################')
DimPersonIndex.to_sql(sTable, conn1, if_exists="replace")
DimPersonIndex.to_sql(sTable, conn3, if_exists="replace")
#####################################################################
```

Output:

You have successfully performed data vault to data warehouse transformation.

Simple Linear Regression

Linear regression is used if there is a relationship or significant association between the variables. This can be checked by scatterplots. If no linear association appears between the variables, fitting a linear regression model to the data will not provide a useful model.
A linear regression line has equations in the following form:
Y = a + bX,
Where, X = explanatory variable and
Y = dependent variable
b = slope of the line
a = intercept (the value of y when x = 0)

```
#####################################################################
# -*- coding: utf-8 -*-
#####################################################################
import sys
import os
import pandas as pd
import sqlite3 as sq
```

```
import matplotlib.pyplot as plt
import numpy as np

from sklearn import datasets, linear_model
from sklearn.metrics import mean_squared_error, r2_score
#####################################################################
Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
#####################################################################
#####################################################################
Company='01-Vermeulen'
#####################################################################
sDataBaseDir=Base + '/' + Company + '/04-Transform/SQLite'
if not os.path.exists(sDataBaseDir):
    os.makedirs(sDataBaseDir)
#####################################################################
sDatabaseName=sDataBaseDir + '/Vermeulen.db'
conn1 = sq.connect(sDatabaseName)
#####################################################################
sDataVaultDir=Base + '/88-DV'
if not os.path.exists(sDataVaultDir):
    os.makedirs(sDataVaultDir)
#####################################################################
sDatabaseName=sDataVaultDir + '/datavault.db'
conn2 = sq.connect(sDatabaseName)
#####################################################################
sDataWarehouseDir=Base + '/99-DW'
if not os.path.exists(sDataWarehouseDir):
    os.makedirs(sDataWarehouseDir)
#####################################################################
sDatabaseName=sDataWarehouseDir + '/datawarehouse.db'
conn3 = sq.connect(sDatabaseName)
#####################################################################
t=0
tMax=((300-100)/10)*((300-30)/5)
for heightSelect in range(100,300,10):
    for weightSelect in range(30,300,5):
        height = round(heightSelect/100,3)
        weight = int(weightSelect)
        bmi = weight/(height*height)
```

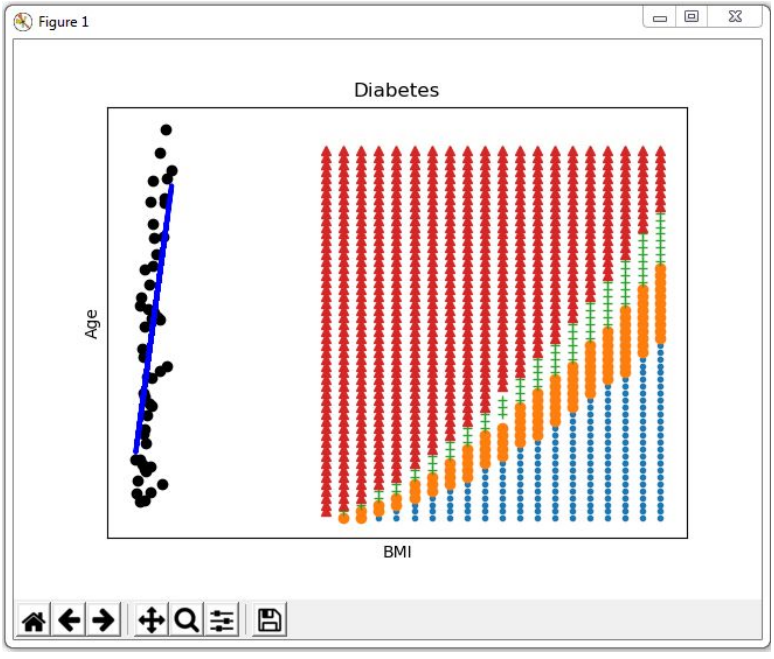
```
        if bmi <= 18.5:
            BMI_Result=1
        elif bmi > 18.5 and bmi < 25:
            BMI_Result=2
        elif bmi > 25 and bmi < 30:
            BMI_Result=3
        elif bmi > 30:
            BMI_Result=4
        else:
            BMI_Result=0
        PersonLine=[('PersonID', [str(t)]),
                    ('Height', [height]),
                    ('Weight', [weight]),
                    ('bmi', [bmi]),
                    ('Indicator', [BMI_Result])]
        t+=1
        print('Row:',t,'of',tMax)
        if t==1:
            PersonFrame = pd.DataFrame.from_items(PersonLine)
        else:
            PersonRow = pd.DataFrame.from_items(PersonLine)
            PersonFrame = PersonFrame.append(PersonRow)
#####################################################################
DimPerson=PersonFrame
DimPersonIndex=DimPerson.set_index(['PersonID'],inplace=False)
#####################################################################
sTable = 'Transform-BMI'
print('\n###################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n###################################')
DimPersonIndex.to_sql(sTable, conn1, if_exists="replace")
#####################################################################
#####################################################################
sTable = 'Person-Satellite-BMI'
print('\n###################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n###################################')
DimPersonIndex.to_sql(sTable, conn2, if_exists="replace")
#####################################################################
#####################################################################
sTable = 'Dim-BMI'
print('\n###################################')
```

```
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n#################################')
DimPersonIndex.to_sql(sTable, conn3, if_exists="replace")
#####################################################################
fig = plt.figure()
PlotPerson=DimPerson[DimPerson['Indicator']==1]
x=PlotPerson['Height']
y=PlotPerson['Weight']
plt.plot(x, y, ".")
PlotPerson=DimPerson[DimPerson['Indicator']==2]
x=PlotPerson['Height']
y=PlotPerson['Weight']
plt.plot(x, y, "o")
PlotPerson=DimPerson[DimPerson['Indicator']==3]
x=PlotPerson['Height']
y=PlotPerson['Weight']
plt.plot(x, y, "+")
PlotPerson=DimPerson[DimPerson['Indicator']==4]
x=PlotPerson['Height']
y=PlotPerson['Weight']
plt.plot(x, y, "^")
plt.axis('tight')
plt.title("BMI Curve")
plt.xlabel("Height(meters)")
plt.ylabel("Weight(kg)")
plt.plot()


# Load the diabetes dataset
diabetes = datasets.load_diabetes()

# Use only one feature
diabetes_X = diabetes.data[:, np.newaxis, 2]
diabetes_X_train = diabetes_X[:-30]
diabetes_X_test = diabetes_X[-50:]
diabetes_y_train = diabetes.target[:-30]
diabetes_y_test = diabetes.target[-50:]
regr = linear_model.LinearRegression()
regr.fit(diabetes_X_train, diabetes_y_train)
diabetes_y_pred = regr.predict(diabetes_X_test)
print('Coefficients: \n', regr.coef_)
print("Mean squared error: %.2f"
```

```
    % mean_squared_error(diabetes_y_test, diabetes_y_pred))
print('Variance score: %.2f' % r2_score(diabetes_y_test, diabetes_y_pred))
plt.scatter(diabetes_X_test, diabetes_y_test, color='black')
plt.plot(diabetes_X_test, diabetes_y_pred, color='blue', linewidth=3)
plt.xticks(())
plt.yticks(())
plt.axis('tight')
plt.title("Diabetes")
plt.xlabel("BMI")
plt.ylabel("Age")
plt.show()
```

Output:

```
Row: 1077 of 1080.0
Row: 1078 of 1080.0
Row: 1079 of 1080.0
Row: 1080 of 1080.0

################################
Storing : C:/VKHCG/99-DW/datawarehouse.db
 Table: Transform-BMI

################################

################################
Storing : C:/VKHCG/99-DW/datawarehouse.db
 Table: Person-Satellite-BMI

################################

################################
Storing : C:/VKHCG/99-DW/datawarehouse.db
 Table: Dim-BMI

################################
>>>
```



Practical 8:

Organizing Data

Organize Superstep

The Organize superstep takes the complete data warehouse you built at the end of the Transform superstep and subsections it into business-specific data marts. A data mart is the access layer of the data warehouse environment built to expose data to the users. The data mart is a subset of the data warehouse and is generally oriented to a specific business group.

Horizontal Style

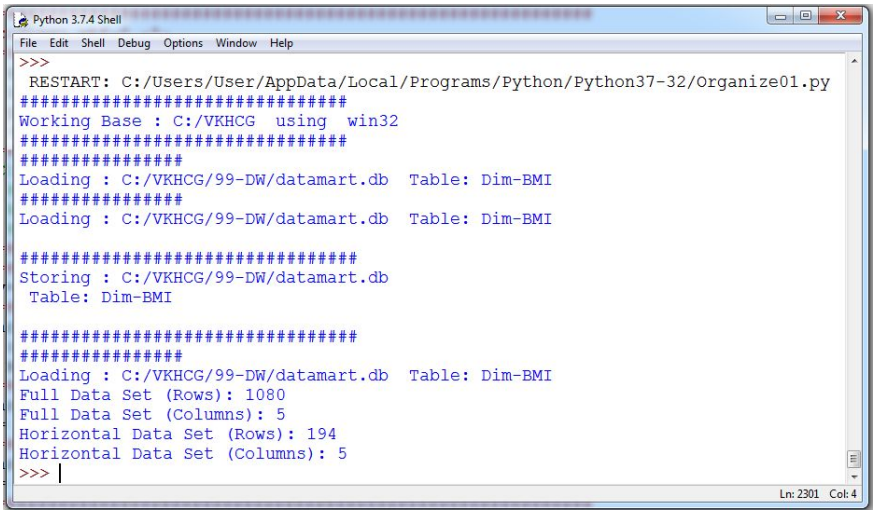
Performing horizontal-style slicing or subsetting of the data warehouse is achieved by applying a filter technique that forces the data warehouse to show only the data for a specific preselected set of filtered outcomes against the data population. The horizontal-style slicing selects the subset of rows from the population while preserving the columns. That is, the data science tool can see the complete record for the records in the subset of records.

C:\VKHCG\01-Vermeulen\05-Organise\ Organize-Horizontal.py

```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
import sqlite3 as sq
################################################################
Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
################################################################
################################################################
Company='01-Vermeulen'
################################################################
sDataWarehouseDir=Base + '/99-DW'
if not os.path.exists(sDataWarehouseDir):
    os.makedirs(sDataWarehouseDir)
################################################################
sDatabaseName=sDataWarehouseDir + '/datawarehouse.db'
conn1 = sq.connect(sDatabaseName)
################################################################
sDatabaseName=sDataWarehouseDir + '/datamart.db'
conn2 = sq.connect(sDatabaseName)
################################################################
print('################')
sTable = 'Dim-BMI'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL="SELECT * FROM [Dim-BMI];"
PersonFrame0=pd.read_sql_query(sSQL, conn1)
print('################')
sTable = 'Dim-BMI'
print('Loading :',sDatabaseName,' Table:',sTable)
```

```
sSQL="SELECT PersonID,\
    Height,\
    Weight,\
    bmi,\
    Indicator\
    FROM [Dim-BMI]\
    WHERE \
    Height > 1.5 \
    and Indicator = 1\
    ORDER BY \
        Height,\
        Weight;"
PersonFrame1=pd.read_sql_query(sSQL, conn1)
#####################################################################
DimPerson=PersonFrame1
DimPersonIndex=DimPerson.set_index(['PersonID'],inplace=False)
#####################################################################
sTable = 'Dim-BMI'
print('\n#################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n#################################')
#DimPersonIndex.to_sql(sTable, conn2, if_exists="replace")
#####################################################################
print('################')
sTable = 'Dim-BMI'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL="SELECT * FROM [Dim-BMI];"
PersonFrame2=pd.read_sql_query(sSQL, conn2)
print('Full Data Set (Rows):', PersonFrame0.shape[0])
print('Full Data Set (Columns):', PersonFrame0.shape[1])
print('Horizontal Data Set (Rows):', PersonFrame2.shape[0])
print('Horizontal Data Set (Columns):', PersonFrame2.shape[1])
```

Output:



The horizontal-style slicing selects the 194 subset of rows from the 1080 rows while preserving the columns.

Vertical Style

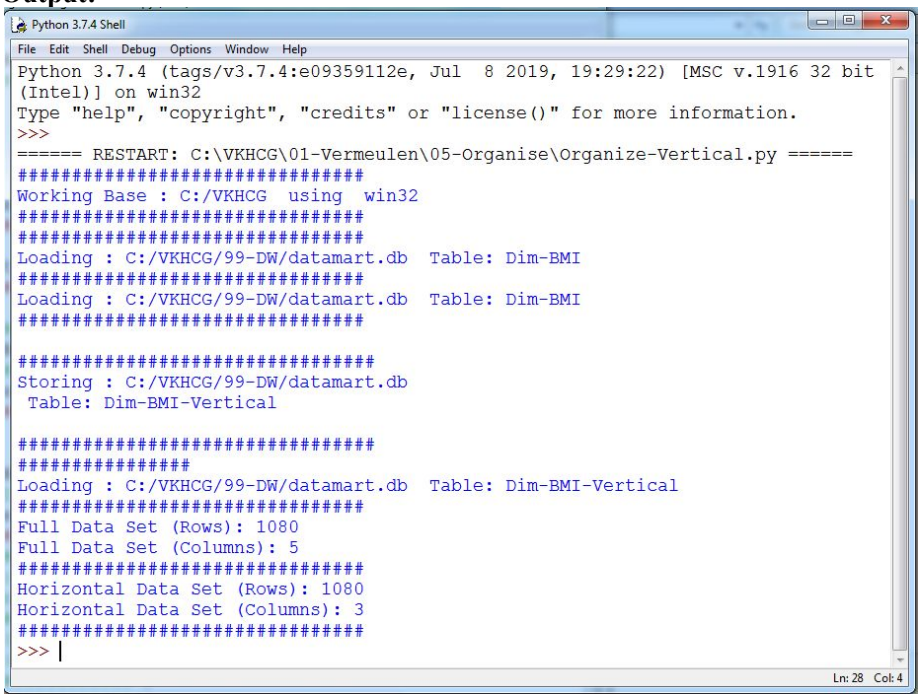
Performing vertical-style slicing or subsetting of the data warehouse is achieved by applying a filter technique that forces the data warehouse to show only the data for specific preselected filtered outcomes against the data population. The vertical-style slicing selects the subset of columns from the population, while preserving the rows. That is, the data science tool can see only the preselected columns from a record for all the records in the population.

C:\VKHCG\01-Vermeulen\05-Organise\ Organize-Vertical.py

```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
import sqlite3 as sq
################################################################
Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
################################################################
################################################################
Company='01-Vermeulen'
################################################################
sDataWarehouseDir=Base + '/99-DW'
if not os.path.exists(sDataWarehouseDir):
    os.makedirs(sDataWarehouseDir)
################################################################
sDatabaseName=sDataWarehouseDir + '/datawarehouse.db'
conn1 = sq.connect(sDatabaseName)
################################################################
sDatabaseName=sDataWarehouseDir + '/datamart.db'
conn2 = sq.connect(sDatabaseName)
################################################################
print('################################')
sTable = 'Dim-BMI'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL="SELECT * FROM [Dim-BMI];"
PersonFrame0=pd.read_sql_query(sSQL, conn1)
################################################################
print('################################')
sTable = 'Dim-BMI'
print('Loading :',sDatabaseName,' Table:',sTable)
print('################################')
sSQL="SELECT \
      Height,\
      Weight,\
      Indicator\
  FROM [Dim-BMI];"
PersonFrame1=pd.read_sql_query(sSQL, conn1)
################################################################
DimPerson=PersonFrame1
DimPersonIndex=DimPerson.set_index(['Indicator'],inplace=False)
```

```
#################################################################
sTable = 'Dim-BMI-Vertical'
print('\n#################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n#################################')
DimPersonIndex.to_sql(sTable, conn2, if_exists="replace")
#################################################################
print('################')
sTable = 'Dim-BMI-Vertical'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL="SELECT * FROM [Dim-BMI-Vertical];"
PersonFrame2=pd.read_sql_query(sSQL, conn2)
#################################################################
print('#################################')
print('Full Data Set (Rows):', PersonFrame0.shape[0])
print('Full Data Set (Columns):', PersonFrame0.shape[1])
print('#################################')
print('Horizontal Data Set (Rows):', PersonFrame2.shape[0])
print('Horizontal Data Set (Columns):', PersonFrame2.shape[1])
print('#################################')
#################################################################
```

Output:



The vertical-style slicing selects 3 of 5 from the population, while preserving the rows [1080].

Island Style

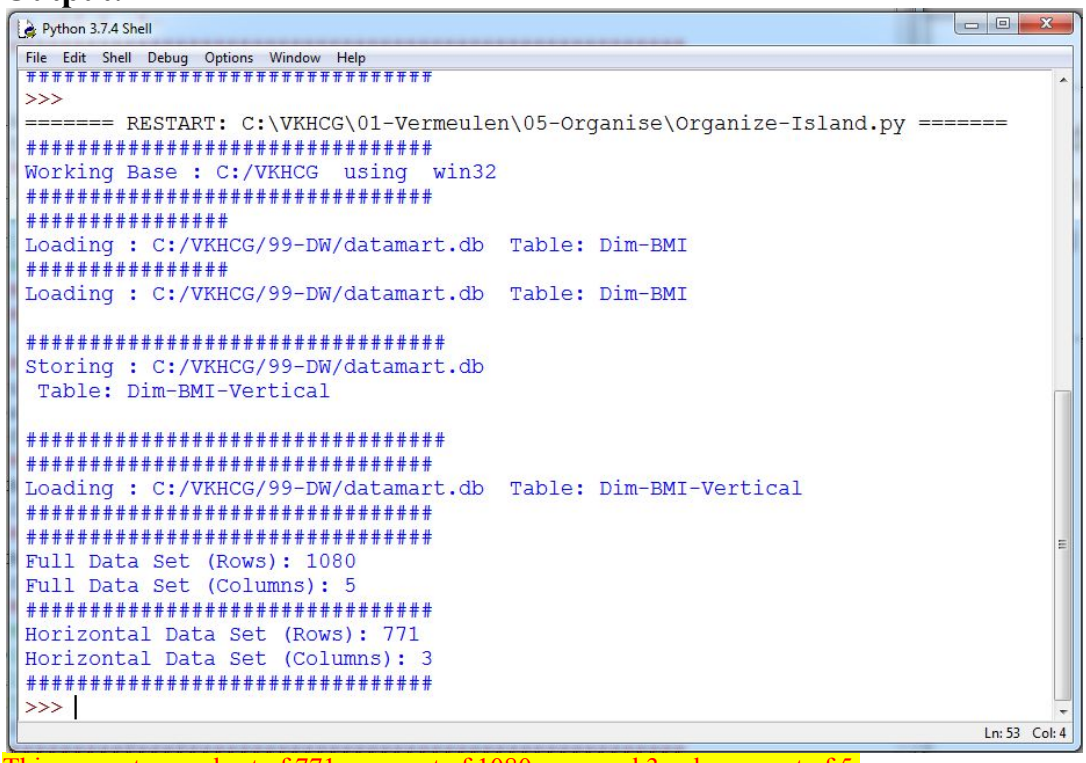
Performing island-style slicing or subsetting of the data warehouse is achieved by applying a combination of horizontal- and vertical-style slicing. This generates a subset of specific rows and specific columns reduced at the same time.

C:\VKHCG\01-Vermeulen\05-Organise\ Organize-Island.py

```
#####################################################################
# -*- coding: utf-8 -*-
#####################################################################
import sys
import os
import pandas as pd
import sqlite3 as sq
#####################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
#####################################################################
#####################################################################
Company='01-Vermeulen'
#####################################################################
sDataWarehouseDir=Base + '/99-DW'
if not os.path.exists(sDataWarehouseDir):
    os.makedirs(sDataWarehouseDir)
#####################################################################
sDatabaseName=sDataWarehouseDir + '/datawarehouse.db'
conn1 = sq.connect(sDatabaseName)
#####################################################################
sDatabaseName=sDataWarehouseDir + '/datamart.db'
conn2 = sq.connect(sDatabaseName)
#####################################################################
print('################')
sTable = 'Dim-BMI'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL="SELECT * FROM [Dim-BMI];"
PersonFrame0=pd.read_sql_query(sSQL, conn1)
#####################################################################
print('################')
sTable = 'Dim-BMI'
print('Loading :',sDatabaseName,' Table:',sTable)

sSQL="SELECT \
      Height,\
      Weight,\
      Indicator\
  FROM [Dim-BMI]\
  WHERE Indicator > 2\
  ORDER BY  \
      Height,\
      Weight;"
PersonFrame1=pd.read_sql_query(sSQL, conn1)
#####################################################################
DimPerson=PersonFrame1
DimPersonIndex=DimPerson.set_index(['Indicator'],inplace=False)
#####################################################################
sTable = 'Dim-BMI-Vertical'
print('\n#################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
```

```
print('\n#################################')
DimPersonIndex.to_sql(sTable, conn2, if_exists="replace")
#################################################################
print('#################################')
sTable = 'Dim-BMI-Vertical'
print('Loading :',sDatabaseName,' Table:',sTable)
print('#################################')
sSQL="SELECT * FROM [Dim-BMI-Vertical];"
PersonFrame2=pd.read_sql_query(sSQL, conn2)
#################################################################
print('#################################')
print('Full Data Set (Rows):', PersonFrame0.shape[0])
print('Full Data Set (Columns):', PersonFrame0.shape[1])
print('#################################')
print('Horizontal Data Set (Rows):', PersonFrame2.shape[0])
print('Horizontal Data Set (Columns):', PersonFrame2.shape[1])
print('#################################')
#################################################################
```

Output:



This generates a subset of 771 rows out of 1080 rows and 3 columns out of 5.

Secure Vault Style

The secure vault is a version of one of the horizontal, vertical, or island slicing techniques, but the outcome is also attached to the person who performs the query. This is common in multi-security environments, where different users are allowed to see different data sets.

This process works well, if you use a role-based access control (RBAC) approach to restricting system access to authorized users. The security is applied against the "role," and a person can then, by the security system, simply be added or removed from the role, to enable or disable access.

C:\VKHCG\01-Vermeulen\05-Organise\ Organize-Secure-Vault.py

```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
import sqlite3 as sq
################################################################
Base='C:/VKHCG'
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
################################################################
################################################################
Company='01-Vermeulen'
################################################################
sDataWarehouseDir=Base + '/99-DW'
if not os.path.exists(sDataWarehouseDir):
    os.makedirs(sDataWarehouseDir)
################################################################
sDatabaseName=sDataWarehouseDir + '/datawarehouse.db'
conn1 = sq.connect(sDatabaseName)
################################################################
sDatabaseName=sDataWarehouseDir + '/datamart.db'
conn2 = sq.connect(sDatabaseName)
################################################################
print('################')
sTable = 'Dim-BMI'
print('Loading :',sDatabaseName,' Table:',sTable)
sSQL="SELECT * FROM [Dim-BMI];"
PersonFrame0=pd.read_sql_query(sSQL, conn1)
################################################################
print('################')
sTable = 'Dim-BMI'
print('Loading :',sDatabaseName,' Table:',sTable)

sSQL="SELECT \
      Height,\
      Weight,\
      Indicator,\
      CASE Indicator\
      WHEN 1 THEN 'Pip'\
      WHEN 2 THEN 'Norman'\
      WHEN 3 THEN 'Grant'\
      ELSE 'Sam'\
      END AS Name\
  FROM [Dim-BMI]\
  WHERE Indicator > 2\
  ORDER BY  \
      Height,\
      Weight;"
PersonFrame1=pd.read_sql_query(sSQL, conn1)
```

```
#################################################################
DimPerson=PersonFrame1
DimPersonIndex=DimPerson.set_index(['Indicator'],inplace=False)
#################################################################
sTable = 'Dim-BMI-Secure'
print('\n#################################')
print('Storing :',sDatabaseName,'\n Table:',sTable)
print('\n#################################')
DimPersonIndex.to_sql(sTable, conn2, if_exists="replace")
#################################################################
print('#################################')
sTable = 'Dim-BMI-Secure'
print('Loading :',sDatabaseName,' Table:',sTable)
print('#################################')
sSQL="SELECT * FROM [Dim-BMI-Secure] WHERE Name = 'Sam';"
PersonFrame2=pd.read_sql_query(sSQL, conn2)
#################################################################
print('#################################')
print('Full Data Set (Rows):', PersonFrame0.shape[0])
print('Full Data Set (Columns):', PersonFrame0.shape[1])
print('#################################')
print('Horizontal Data Set (Rows):', PersonFrame2.shape[0])
print('Horizontal Data Set (Columns):', PersonFrame2.shape[1])
print('Only Sam Data')
print(PersonFrame2.head())
print('#################################')
#################################################################
```

Output:

```
Python 3.7.4 Shell
File  Edit  Shell  Debug  Options  Window  Help
>>>
==== RESTART: C:\VKHCG\01-Vermeulen\05-Organise\Organize-Secure-Vault.py ====
################################
Working Base : C:/VKHCG  using  win32
################################
################
Loading : C:/VKHCG/99-DW/datamart.db  Table: Dim-BMI
################
Loading : C:/VKHCG/99-DW/datamart.db  Table: Dim-BMI

################################
Storing : C:/VKHCG/99-DW/datamart.db
 Table: Dim-BMI-Secure

################################
################################
Loading : C:/VKHCG/99-DW/datamart.db  Table: Dim-BMI-Secure
################################
################################
Full Data Set (Rows): 1080
Full Data Set (Columns): 5
################################
Horizontal Data Set (Rows): 692
Horizontal Data Set (Columns): 4
Only Sam Data
   Indicator  Height  Weight Name
0          4     1.0      35  Sam
1          4     1.0      40  Sam
2          4     1.0      45  Sam
3          4     1.0      50  Sam
4          4     1.0      55  Sam
################################
```

Association Rule Mining

Association rule learning is a rule-based machine-learning method for discoveringinteresting relations between variables in large databases, similar to the data you willfind in a data lake. The technique enables you to investigate the interaction between datawithin the same population. Lift is simply estimatedby the ratio of the joint probability of two items x and y, divided by the product of theirindividual probabilities:

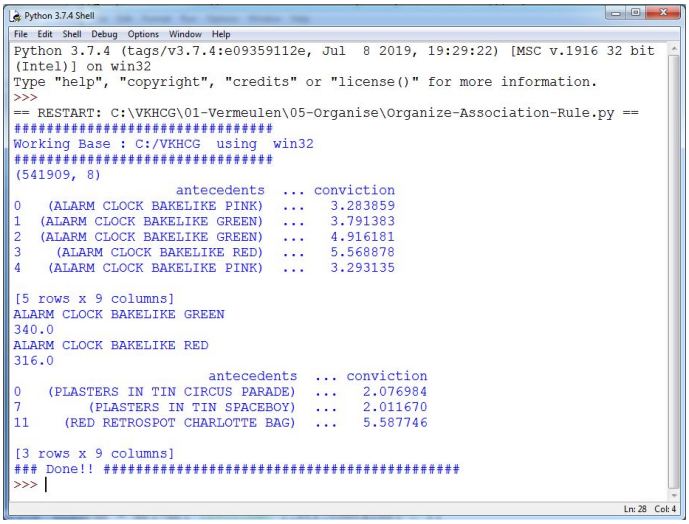
$$Lift = \frac{P(x,y)}{P(x)P(y)}$$

C:\VKHCG\01-Vermeulen\05-Organise\ Organize-Association-Rule.py

```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
from mlxtend.frequent_patterns import apriori
from mlxtend.frequent_patterns import association_rules
################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
################################################################
Company='01-Vermeulen'
InputFileName='Online-Retail-Billboard.xlsx'
EDSAssessDir='02-Assess/01-EDS'
InputAssessDir=EDSAssessDir + '/02-Python'
################################################################
sFileAssessDir=Base + '/' + Company + '/' + InputAssessDir
if not os.path.exists(sFileAssessDir):
    os.makedirs(sFileAssessDir)
################################################################
sFileName=Base+'/'+ Company + '/00-RawData/' + InputFileName
################################################################
df = pd.read_excel(sFileName)
print(df.shape)
################################################################
df['Description'] = df['Description'].str.strip()
df.dropna(axis=0, subset=['InvoiceNo'], inplace=True)
df['InvoiceNo'] = df['InvoiceNo'].astype('str')
df = df[~df['InvoiceNo'].str.contains('C')]

basket = (df[df['Country'] =="France"]
          .groupby(['InvoiceNo', 'Description'])['Quantity']
          .sum().unstack().reset_index().fillna(0)
          .set_index('InvoiceNo'))
################################################################
def encode_units(x):
    if x <= 0:
        return 0
```

```
    if x >= 1:
        return 1
#####################################################################
basket_sets = basket.applymap(encode_units)
basket_sets.drop('POSTAGE', inplace=True, axis=1)
frequent_itemsets = apriori(basket_sets, min_support=0.07, use_colnames=True)
rules = association_rules(frequent_itemsets, metric="lift", min_threshold=1)
print(rules.head())
rules[ (rules['lift'] >= 6) &
       (rules['confidence'] >= 0.8) ]
#####################################################################
sProduct1='ALARM CLOCK BAKELIKE GREEN'
print(sProduct1)
print(basket[sProduct1].sum())
sProduct2='ALARM CLOCK BAKELIKE RED'
print(sProduct2)
print(basket[sProduct2].sum())
#####################################################################
basket2 = (df[df['Country'] =="Germany"]
          .groupby(['InvoiceNo', 'Description'])['Quantity']
          .sum().unstack().reset_index().fillna(0)
          .set_index('InvoiceNo'))

basket_sets2 = basket2.applymap(encode_units)
basket_sets2.drop('POSTAGE', inplace=True, axis=1)
frequent_itemsets2 = apriori(basket_sets2, min_support=0.05, use_colnames=True)
rules2 = association_rules(frequent_itemsets2, metric="lift", min_threshold=1)

print(rules2[ (rules2['lift'] >= 4) &
       (rules2['confidence'] >= 0.5)])
#####################################################################
print('### Done!! ################################################')
#####################################################################
```

Output:



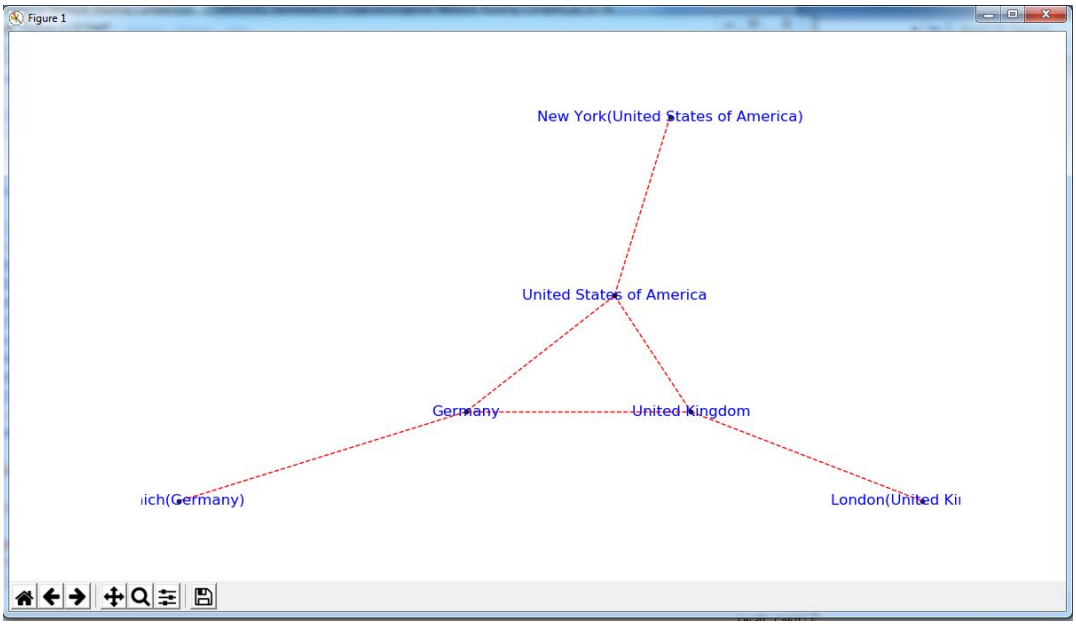
Create a Network Routing Diagram

I will guide you through a possible solution for the requirement, by constructing an island-style Organize superstep that uses a graph data model to reduce the records and the columns on the data set.

C:\VKHCG\01-Vermeulen\05-Organise\ Organise-Network-Routing-Company.py

```
################################################################
import sys
import os
import pandas as pd
import networkx as nx
import matplotlib.pyplot as plt
################################################################
pd.options.mode.chained_assignment = None
################################################################
Base='C:/VKHCG'
################################################################
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
################################################################
sInputFileName='02-Assess/01-EDS/02-Python/Assess-Network-Routing-Company.csv'
################################################################
sOutputFileName1='05-Organise/01-EDS/02-Python/Organise-Network-Routing-Company.gml'
sOutputFileName2='05-Organise/01-EDS/02-Python/Organise-Network-Routing-Company.png'
Company='01-Vermeulen'
################################################################
################################################################
### Import Country Data
################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName
print('##################################')
print('Loading :',sFileName)
print('##################################')
CompanyData=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
print('##################################')
################################################################
print(CompanyData.head())
print(CompanyData.shape)
################################################################
G=nx.Graph()
for i in range(CompanyData.shape[0]):
    for j in range(CompanyData.shape[0]):
        Node0=CompanyData['Company_Country_Name'][i]
        Node1=CompanyData['Company_Country_Name'][j]
        if Node0 != Node1:
            G.add_edge(Node0,Node1)

for i in range(CompanyData.shape[0]):
    Node0=CompanyData['Company_Country_Name'][i]
    Node1=CompanyData['Company_Place_Name'][i] + '('+ CompanyData['Company_Country_Name'][i] + ')'
    if Node0 != Node1:
        G.add_edge(Node0,Node1)
```

```
print('Nodes:', G.number_of_nodes())
print('Edges:', G.number_of_edges())
#####################################################################
sFileName=Base + '/' + Company + '/' + sOutputFileName1
print('#################################')
print('Storing :',sFileName)
print('#################################')
nx.write_gml(G, sFileName)
#####################################################################
sFileName=Base + '/' + Company + '/' + sOutputFileName2
print('#################################')
print('Storing Graph Image:',sFileName)
print('#################################')
plt.figure(figsize=(15, 15))
pos=nx.spectral_layout(G,dim=2)
nx.draw_networkx_nodes(G,pos, node_color='k', node_size=10, alpha=0.8)
nx.draw_networkx_edges(G, pos,edge_color='r', arrows=False, style='dashed')
nx.draw_networkx_labels(G,pos,font_size=12,font_family='sans-serif',font_color='b')
plt.axis('off')
plt.savefig(sFileName,dpi=600)
plt.show()
#####################################################################
print('#################################')
print('### Done!! ######################')
print('#################################')
#####################################################################
```



Picking Content for Billboards

To enable the marketing salespeople to sell billboard content, they will require a diagram to show what billboards connect to which office content publisher. Each of Krennwallner's billboards has a proximity sensor

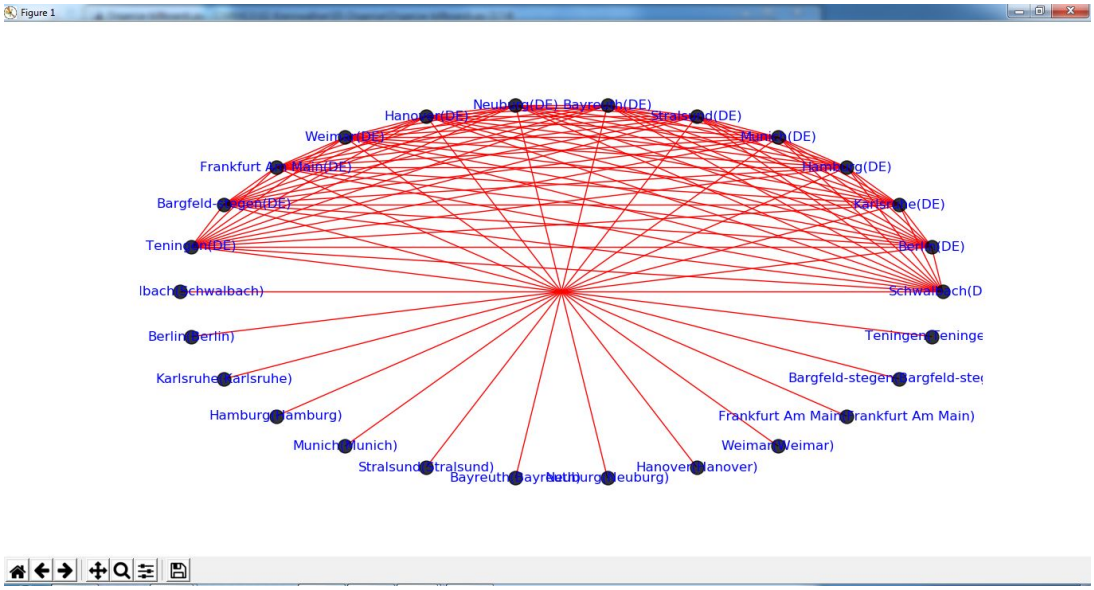
that enables the content managers to record when a registered visitor points his/her smartphone at the billboard content or touches the near-field pad with a mobile phone.
Program will assist you in building an organized graph of the billboards' locations data to help you to gain insights into the billboard locations and content picking process.

C:\VKHCG\02-Krennwallner\05-Organise\ Organise-billboards.py

```
################################################################
import sys
import os
import pandas as pd
import networkx as nx
import matplotlib.pyplot as plt
import numpy as np
################################################################
pd.options.mode.chained_assignment = None
################################################################
Base='C:/VKHCG'
################################################################
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
################################################################
sInputFileName='02-Assess/01-EDS/02-Python/Assess-DE-Billboard-Visitor.csv'
################################################################
sOutputFileName1='05-Organise/01-EDS/02-Python/Organise-Billboards.gml'
sOutputFileName2='05-Organise/01-EDS/02-Python/Organise-Billboards.png'
Company='02-Krennwallner'
################################################################
################################################################
### Import Company Data
################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName
print('##################################')
print('Loading :',sFileName)
print('##################################')
BillboardDataRaw=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
print('##################################')
################################################################
print(BillboardDataRaw.head())
print(BillboardDataRaw.shape)
BillboardData=BillboardDataRaw
sSample=list(np.random.choice(BillboardData.shape[0],20))
################################################################
G=nx.Graph()
for i in sSample:
    for j in sSample:
        Node0=BillboardData['BillboardPlaceName'][i] + '('+ BillboardData['BillboardCountry'][i] + ')'
        Node1=BillboardData['BillboardPlaceName'][j] + '('+ BillboardData['BillboardCountry'][i] + ')'
        if Node0 != Node1:
            G.add_edge(Node0,Node1)

for i in sSample:
    Node0=BillboardData['BillboardPlaceName'][i] + '('+ BillboardData['VisitorPlaceName'][i] + ')'
```

```
    Node1=BillboardData['BillboardPlaceName'][i] + '('+ BillboardData['VisitorCountry'][i] + ')'
    if Node0 != Node1:
        G.add_edge(Node0,Node1)

print('Nodes:', G.number_of_nodes())
print('Edges:', G.number_of_edges())
#####################################################################
sFileName=Base + '/02-Krennwallner/' + sOutputFileName1
print('##################################')
print('Storing :',sFileName)
print('##################################')
nx.write_gml(G, sFileName)
#####################################################################
sFileName=Base + '/02-Krennwallner/' + sOutputFileName2
print('##################################')
print('Storing Graph Image:',sFileName)
print('##################################')
plt.figure(figsize=(15, 15))
pos=nx.circular_layout(G,dim=2)
nx.draw_networkx_nodes(G,pos, node_color='k', node_size=150, alpha=0.8)
nx.draw_networkx_edges(G, pos,edge_color='r', arrows=False, style='solid')
nx.draw_networkx_labels(G,pos,font_size=12,font_family='sans-serif',font_color='b')
plt.axis('off')
plt.savefig(sFileName,dpi=600)
plt.show()
#####################################################################
print('##################################')
print('### Done!! ####################')
print('##################################')
#####################################################################
```

Output :



Create a Delivery Route

Hillman requires a new delivery route plan from HQ-KA13's delivery region. Themanaging director has to know the following:

- What his most expensive route is, if the cost is £1.50 per mile and twotrips are planned per day
- What the average travel distance in miles is for the region per 30-daymonth

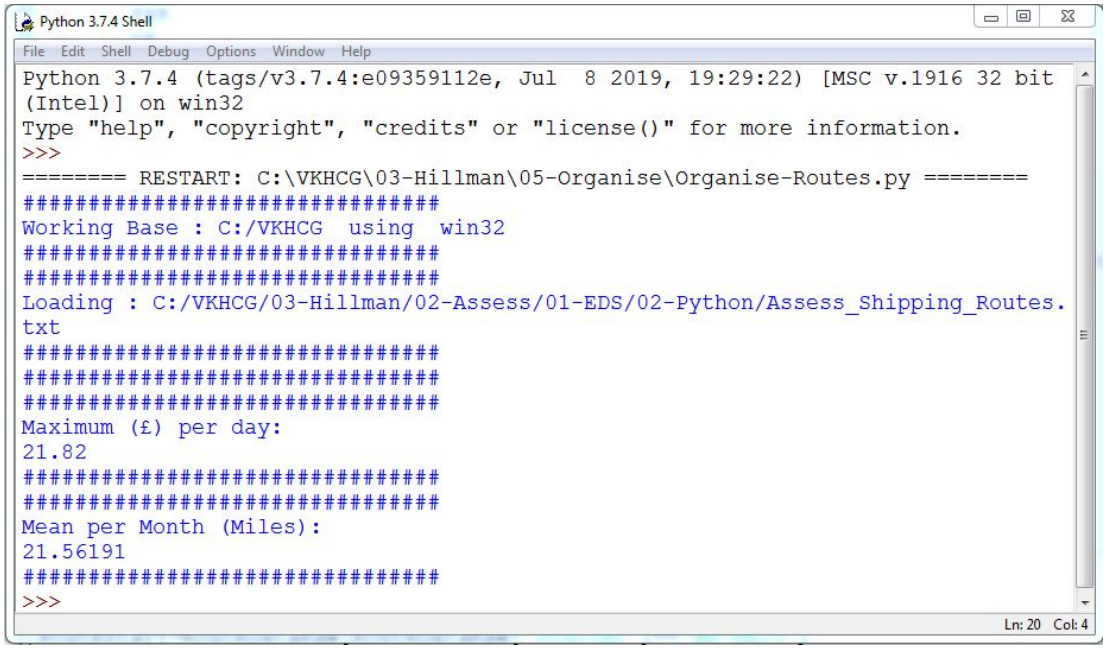
With your newfound knowledge in building the technology stack for turning datalakes into business assets, can you convert the graph stored in the Assess step called "Assess_Best_Logistics" into the shortest path between the two points?

C:\VKHCG\03-Hillman\05-Organise\Organise-Routes.py

```
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
################################################################
Base='C:/VKHCG'
################################################################
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
################################################################
sInputFileName='02-Assess/01-EDS/02-Python/Assess_Shipping_Routes.txt'
################################################################
sOutputFileName='05-Organise/01-EDS/02-Python/Organise-Routes.csv'
Company='03-Hillman'
################################################################
################################################################
### Import Routes Data
################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName
print('################################')
print('Loading :',sFileName)
print('################################')
RouteDataRaw=pd.read_csv(sFileName,header=0,low_memory=False, sep='|', encoding="latin-1")
print('################################')
################################################################
RouteStart=RouteDataRaw[RouteDataRaw['StartAt']=='WH-KA13']
################################################################
RouteDistance=RouteStart[RouteStart['Cost']=='DistanceMiles']
RouteDistance=RouteDistance.sort_values(by=['Measure'], ascending=False)
################################################################
RouteMax=RouteStart["Measure"].max()
```

```
RouteMaxCost=round((((RouteMax/1000)*1.5*2)),2)
print('################################')
print('Maximum (£) per day:')
print(RouteMaxCost)
print('################################')
#########################################################################
RouteMean=RouteStart["Measure"].mean()
RouteMeanMonth=round((((RouteMean/1000)*2*30)),6)
print('################################')
print('Mean per Month (Miles):')
print(RouteMeanMonth)
print('################################')
```

Output:



Clark Ltd

Our financial services company has been tasked to investigate the options to convert1 million pounds sterling into extra income. Mr. Clark Junior suggests using the simplevariance in the daily rate between the British pound sterling and the US dollar, togenerate extra income from trading. Your chief financial officer wants to know if this isfeasible?

Simple Forex Trading Planner

Your challenge is to take 1 million US dollars or just over six hunderd thou sand pounds sterling and, by simply converting it between pounds sterling and US dollars, achieve a profit. Are you up to this challenge? The Program will help you how to model this problem and achieve a positive outcome. The forex data has been collected on a daily basis by Clark's accounting department, from previous overseas transactions.

C:\VKHCG\04-Clark\05-Organise\Organise-Forex.py

```
# -*- coding: utf-8 -*-
#####################################################################
import sys
import os
import pandas as pd
import sqlite3 as sq
import re
#####################################################################
Base='C:/VKHCG'
#####################################################################
print('#################################')
print('Working Base :',Base, ' using ', sys.platform)
print('#################################')
#####################################################################
sInputFileName='03-Process/01-EDS/02-Python/Process_ExchangeRates.csv'
#####################################################################
sOutputFileName='05-Organise/01-EDS/02-Python/Organise-Forex.csv'
Company='04-Clark'
#####################################################################
sDatabaseName=Base + '/' + Company + '/05-Organise/SQLite/clark.db'
conn = sq.connect(sDatabaseName)
#conn = sq.connect(':memory:')
#####################################################################
#####################################################################
### Import Forex Data
#####################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName
print('#################################')
print('Loading :',sFileName)
print('#################################')
ForexDataRaw=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
print('#################################')
#####################################################################
ForexDataRaw.index.names = ['RowID']
sTable='Forex_All'
print('Storing :',sDatabaseName,' Table:',sTable)
ForexDataRaw.to_sql(sTable, conn, if_exists="replace")
#####################################################################
sSQL="SELECT 1 as Bag\
      , CAST(min(Date) AS VARCHAR(10)) as Date \
      ,CAST(1000000.0000000 as NUMERIC(12,4)) as Money \
      ,'USD' as Currency \
      FROM Forex_All \
      ;"
sSQL=re.sub("\s\s+", " ", sSQL)
nMoney=pd.read_sql_query(sSQL, conn)

#####################################################################
```

```
nMoney.index.names = ['RowID']
sTable='MoneyData'
print('Storing :',sDatabaseName,' Table:',sTable)
nMoney.to_sql(sTable, conn, if_exists="replace")
######################################################################
sTable='TransactionData'
print('Storing :',sDatabaseName,' Table:',sTable)
nMoney.to_sql(sTable, conn, if_exists="replace")
######################################################################
ForexDay=pd.read_sql_query("SELECT Date FROM Forex_All GROUP BY Date;", conn)
######################################################################
t=0
for i in range(ForexDay.shape[0]):
    sDay1=ForexDay['Date'][i]
    sDay=str(sDay1)
    sSQL='\
    SELECT M.Bag as Bag, \
           F.Date as Date, \
           round(M.Money * F.Rate,6) AS Money, \
           F.CodeIn AS PCurrency, \
           F.CodeOut AS Currency \
    FROM MoneyData AS M \
    JOIN \
    ( \
       SELECT \
       CodeIn, CodeOut, Date, Rate \
       FROM \
       Forex_All \
       WHERE\
       CodeIn = "USD" AND CodeOut = "GBP" \
       UNION \
       SELECT \
       CodeOut AS CodeIn, CodeIn AS CodeOut,  Date, (1/Rate) AS Rate \
       FROM \
       Forex_All \
       WHERE\
       CodeIn = "USD" AND CodeOut = "GBP" \
    ) AS F \
    ON \
    M.Currency=F.CodeIn \
    AND \
    F.Date ="' +sDay + '";'
    sSQL=re.sub("\s\s+", " ", sSQL)

    ForexDayRate=pd.read_sql_query(sSQL, conn)
    for j in range(ForexDayRate.shape[0]):
       sBag=str(ForexDayRate['Bag'][j])
       nMoney=str(round(ForexDayRate['Money'][j],2))
```

```
    sCodeIn=ForexDayRate['PCurrency'][j]
    sCodeOut=ForexDayRate['Currency'][j]

  sSQL='UPDATE MoneyData SET Date= "' + sDay + '", '
  sSQL= sSQL + ' Money = ' + nMoney + ', Currency="' + sCodeOut + '"'
  sSQL= sSQL + ' WHERE Bag=' + sBag + ' AND Currency="' + sCodeIn + '";'

  sSQL=re.sub("\s\s+", " ", sSQL)
  cur = conn.cursor()
  cur.execute(sSQL)
  conn.commit()
  t+=1
  print('Trade :', t, sDay, sCodeOut, nMoney)

  sSQL=' \
  INSERT INTO TransactionData ( \
                    RowID, \
                    Bag, \
                    Date, \
                    Money, \
                    Currency \
                ) \
  SELECT ' + str(t) + ' AS RowID, \
    Bag, \
    Date, \
    Money, \
    Currency \
  FROM MoneyData \
  ;'

  sSQL=re.sub("\s\s+", " ", sSQL)

  cur = conn.cursor()
  cur.execute(sSQL)
  conn.commit()
######################################################################
sSQL="SELECT RowID, Bag, Date, Money, Currency FROM TransactionData ORDER BY
RowID;"
sSQL=re.sub("\s\s+", " ", sSQL)
TransactionData=pd.read_sql_query(sSQL, conn)

OutputFile=Base + '/' + Company + '/' + sOutputFileName
TransactionData.to_csv(OutputFile, index = False)
######################################################################
```

Output:

Save the Assess-Forex.py file, then compile and execute with your Python compiler.
This will produce a set of demonstrated values onscreen.

Practical 9:

Generating Data

Report Superstep

The Report superstep is the step in the ecosystem that enhances the data science findings with the art of storytelling and data visualization. You can perform the best data science, but if you cannot execute a respectable and trustworthy Report step by turning your data science into actionable business insights, you have achieved no advantage for your business.

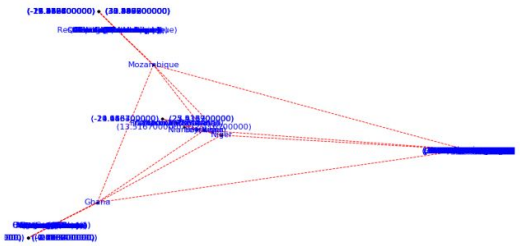
Vermeulen PLC

Vermeulen requires a map of all their customers' data links. Can you provide a report to deliver this? I will guide you through an example that delivers this requirement.

C:\VKHCG\01-Vermeulen\06-Report\Raport-Network-Routing-Customer.py

```
################################################################
import sys
import os
import pandas as pd
import networkx as nx
import matplotlib.pyplot as plt
################################################################
pd.options.mode.chained_assignment = None
################################################################
if sys.platform == 'linux':
    Base=os.path.expanduser('~') + 'VKHCG'
else:
    Base='C:/VKHCG'
################################################################
print('################################')
print('Working Base :',Base, ' using ', sys.platform)
print('################################')
################################################################
sInputFileName='02-Assess/01-EDS/02-Python/Assess-Network-Routing-Customer.csv'
################################################################
sOutputFileName1='06-Report/01-EDS/02-Python/Report-Network-Routing-Customer.gml'
sOutputFileName2='06-Report/01-EDS/02-Python/Report-Network-Routing-Customer.png'
Company='01-Vermeulen'
################################################################
################################################################
### Import Country Data
################################################################
sFileName=Base + '/' + Company + '/' + sInputFileName
print('################################')
print('Loading :',sFileName)
print('################################')
CustomerDataRaw=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
CustomerData=CustomerDataRaw.head(100)
print('Loaded Country:',CustomerData.columns.values)
print('################################')
################################################################
print(CustomerData.head())
```

```
print(CustomerData.shape)
#####################################################################
G=nx.Graph()
for i in range(CustomerData.shape[0]):
    for j in range(CustomerData.shape[0]):
        Node0=CustomerData['Customer_Country_Name'][i]
        Node1=CustomerData['Customer_Country_Name'][j]
        if Node0 != Node1:
            G.add_edge(Node0,Node1)

for i in range(CustomerData.shape[0]):
    Node0=CustomerData['Customer_Country_Name'][i]
    Node1=CustomerData['Customer_Place_Name'][i] + '('+ CustomerData['Customer_Country_Name'][i] + ')'
    Node2='('+ "{:.9f}".format(CustomerData['Customer_Latitude'][i]) + ')\
    ('+ "{:.9f}".format(CustomerData['Customer_Longitude'][i]) + ')'
    if Node0 != Node1:
        G.add_edge(Node0,Node1)
    if Node1 != Node2:
        G.add_edge(Node1,Node2)

print('Nodes:', G.number_of_nodes())
print('Edges:', G.number_of_edges())
#####################################################################
sFileName=Base + '/' + Company + '/' + sOutputFileName1
print('#################################')
print('Storing :',sFileName)
print('#################################')
nx.write_gml(G, sFileName)
#####################################################################
sFileName=Base + '/' + Company + '/' + sOutputFileName2
print('#################################')
print('Storing Graph Image:',sFileName)
print('#################################')

plt.figure(figsize=(25, 25))
pos=nx.spectral_layout(G,dim=2)
nx.draw_networkx_nodes(G,pos, node_color='k', node_size=10, alpha=0.8)
nx.draw_networkx_edges(G, pos,edge_color='r', arrows=False, style='dashed')
nx.draw_networkx_labels(G,pos,font_size=12,font_family='sans-serif',font_color='b')
plt.axis('off')
plt.savefig(sFileName,dpi=600)
plt.show()
print('#################################')
print('### Done!! ######################')
print('#################################')
```



Krennwallner AG

The Krennwallner marketing department wants to deploy the locations of the billboards onto the company web server. Can you prepare three versions of the locations' web pages?

- Locations clustered into bubbles when you zoom out
- Locations as pins
- Locations as heat map

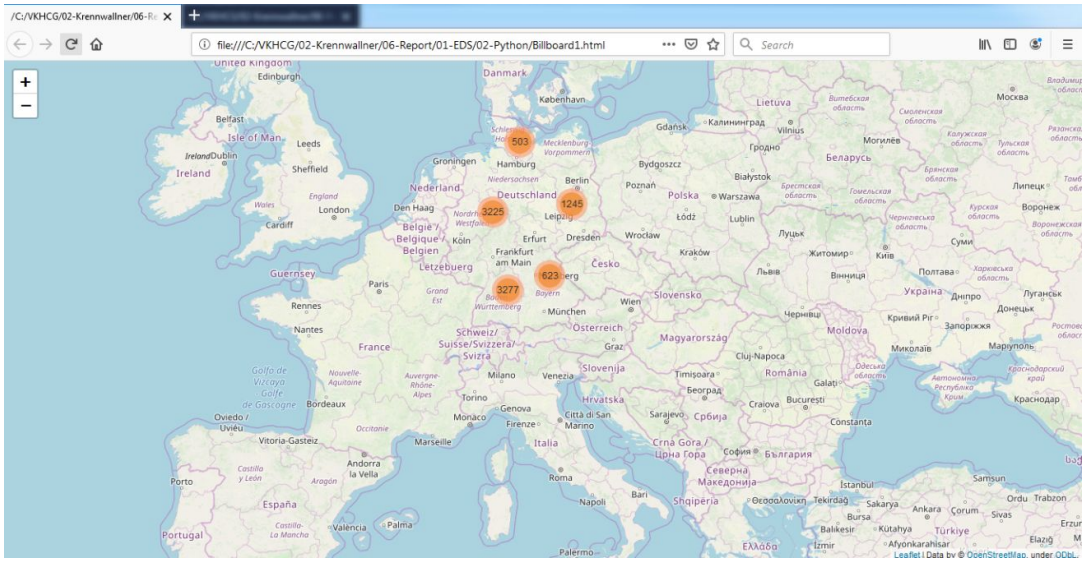
Picking Content for Billboards

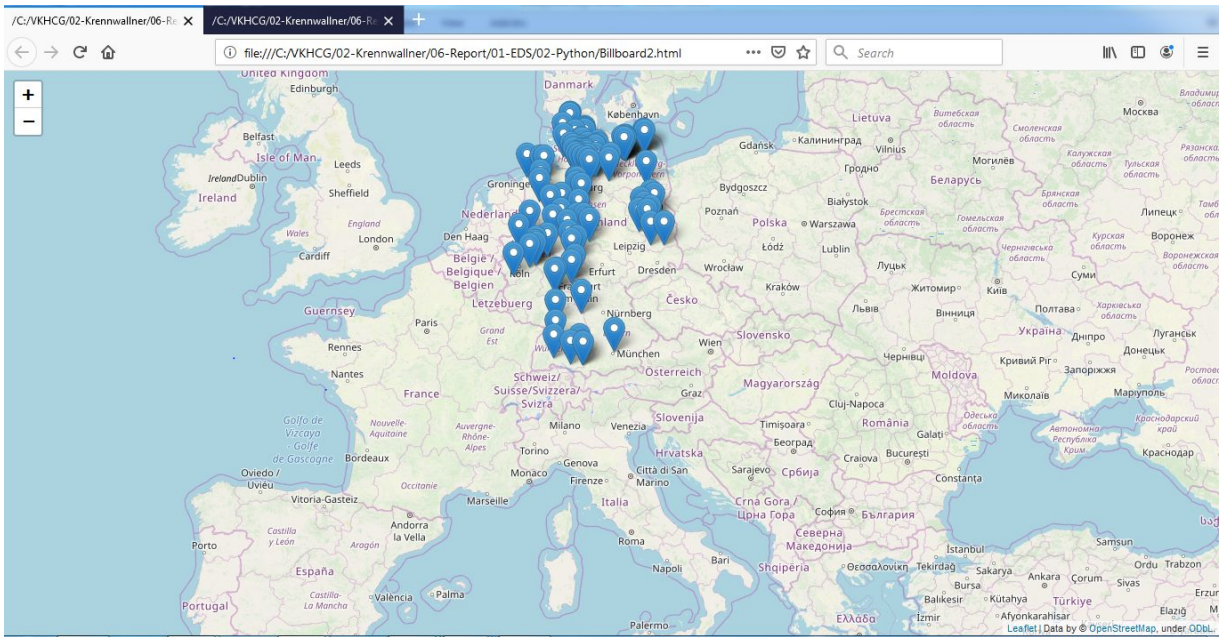
C:\VKHCG\02-Krennwallner\06-Report\Report_Billboard.py

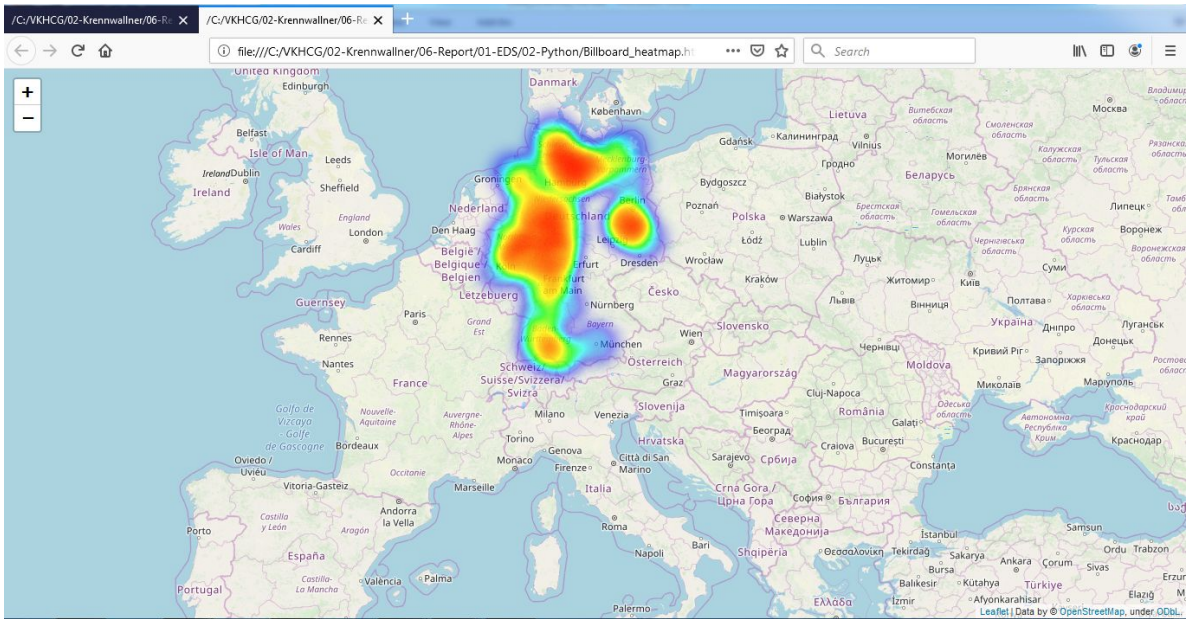
```
################################################################
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
from folium.plugins import FastMarkerCluster, HeatMap
from folium import Marker, Map
import webbrowser
################################################################
Base='C:/VKHCG'
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
################################################################
sFileName=Base+'/02-Krennwallner/01-Retrieve/01-EDS/02-Python/Retrieve_DE_Billboard_Locations.csv'
df = pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
df.fillna(value=0, inplace=True)
print(df.shape)
################################################################
t=0
for i in range(df.shape[0]):
    try:
        sLongitude=df["Longitude"][i]
        sLongitude=float(sLongitude)
    except Exception:
        sLongitude=float(0.0)
  try:
        sLatitude=df["Latitude"][i]
        sLatitude=float(sLatitude)
    except Exception:
        sLatitude=float(0.0)
try:
        sDescription=df["Place_Name"][i] + ' (' + df["Country"][i]+')'
    except Exception:
        sDescription='VKHCG'
    if sLongitude != 0.0 and sLatitude != 0.0:
        DataClusterList=list([sLatitude, sLongitude])
        DataPointList=list([sLatitude, sLongitude, sDescription])
        t+=1
        if t==1:
```

```
            DataCluster=[DataClusterList]
            DataPoint=[DataPointList]
        else:
            DataCluster.append(DataClusterList)
            DataPoint.append(DataPointList)
data=DataCluster
pins=pd.DataFrame(DataPoint)
pins.columns = [ 'Latitude','Longitude','Description']
#####################################################################
stops_map1 = Map(location=[48.1459806, 11.4985484], zoom_start=5)
marker_cluster = FastMarkerCluster(data).add_to(stops_map1)
sFileNameHtml=Base+'/02-Krennwallner/06-Report/01-EDS/02-Python/Billboard1.html'
stops_map1.save(sFileNameHtml)
webbrowser.open('file://' + os.path.realpath(sFileNameHtml))
#####################################################################
stops_map2 = Map(location=[48.1459806, 11.4985484], zoom_start=5)
for name, row in pins.iloc[:100].iterrows():
    Marker([row["Latitude"],row["Longitude"]], popup=row["Description"]).add_to(stops_map2)
sFileNameHtml=Base+'/02-Krennwallner/06-Report/01-EDS/02-Python/Billboard2.html'
stops_map2.save(sFileNameHtml)
webbrowser.open('file://' + os.path.realpath(sFileNameHtml))
#####################################################################
stops_heatmap = Map(location=[48.1459806, 11.4985484], zoom_start=5)
stops_heatmap.add_child(HeatMap([[row["Latitude"], row["Longitude"]] for name, row in
pins.iloc[:100].iterrows()]))
sFileNameHtml=Base+'/02-Krennwallner/06-Report/01-EDS/02-Python/Billboard_heatmap.html'
stops_heatmap.save(sFileNameHtml)
webbrowser.open('file://' + os.path.realpath(sFileNameHtml))
#####################################################################
print('### Done!! ################################################')
#####################################################################
```

Output:







Hillman Ltd

Dr. Hillman Sr. has just installed a camera system that enables the company to capture video and, therefore, indirectly, images of all containers that enter or leave the warehouse. Can you convert the number on the side of the containers into digits?

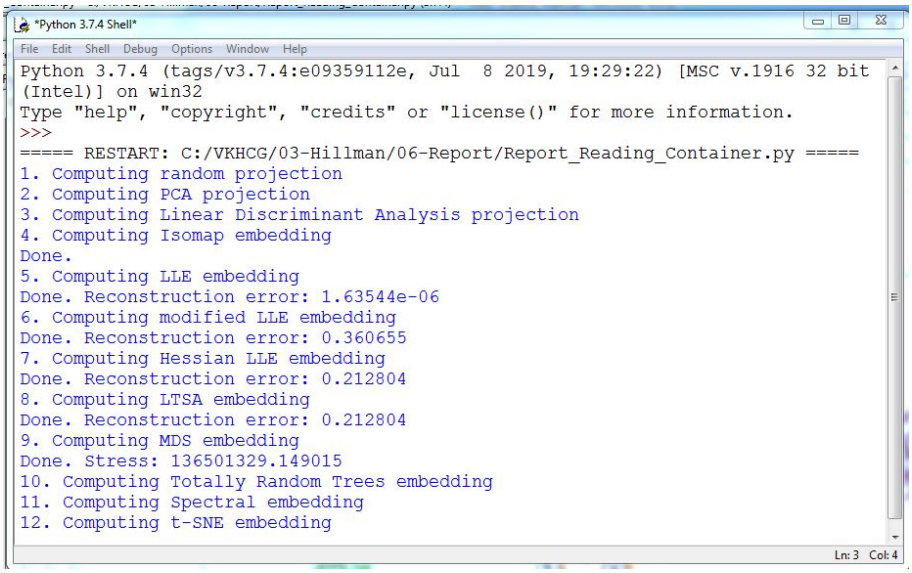
Reading the Containers

C:\VKHCG\03-Hillman\06-Report\ Report_Reading_Container.py

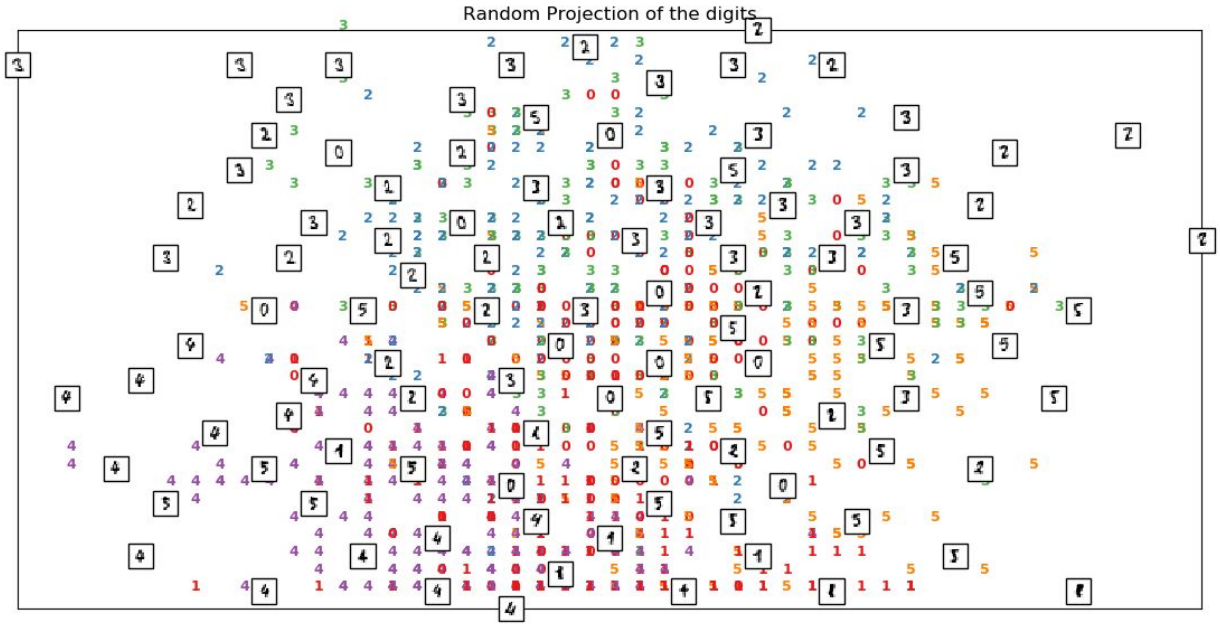
```
from time import time
import numpy as np
import matplotlib.pyplot as plt
from matplotlib import offsetbox
from sklearn import (manifold, datasets, decomposition, ensemble, discriminant_analysis, random_projection)
digits = datasets.load_digits(n_class=6)
X = digits.data
y = digits.target
n_samples, n_features = X.shape
n_neighbors = 30
def plot_embedding(X, title=None):
    x_min, x_max = np.min(X, 0), np.max(X, 0)
    X = (X - x_min) / (x_max - x_min)
    plt.figure(figsize=(10, 10))
    ax = plt.subplot(111)
    for i in range(X.shape[0]):
            plt.text(X[i, 0], X[i, 1], str(digits.target[i]),
                color=plt.cm.Set1(y[i] / 10.),
                fontdict={'weight': 'bold', 'size': 9})
    if hasattr(offsetbox, 'AnnotationBbox'):
        # only print thumbnails with matplotlib > 1.0
        shown_images = np.array([[1., 1.]]) # just something big
        for i in range(digits.data.shape[0]):
            dist = np.sum((X[i] - shown_images) ** 2, 1)
            if np.min(dist) < 4e-3:
                # don't show points that are too close
                continue
            shown_images = np.r_[shown_images, [X[i]]]
            imagebox = offsetbox.AnnotationBbox(offsetbox.OffsetImage(digits.images[i],
cmap=plt.cm.gray_r),X[i])
            ax.add_artist(imagebox)
        plt.xticks([]), plt.yticks([])
        if title is not None:
            plt.title(title)
n_img_per_row = 20
img = np.zeros((10 * n_img_per_row, 10 * n_img_per_row))
for i in range(n_img_per_row):
    ix = 10 * i + 1
    for j in range(n_img_per_row):
            iy = 10 * j + 1
            img[ix:ix + 8, iy:iy + 8] = X[i * n_img_per_row + j].reshape((8, 8))
plt.figure(figsize=(10, 10))
plt.imshow(img, cmap=plt.cm.binary)
plt.xticks([])
plt.yticks([])
plt.title('A selection from the 64-dimensional digits dataset')
print("Computing random projection")
rp = random_projection.SparseRandomProjection(n_components=2, random_state=42)
X_projected = rp.fit_transform(X)
plot_embedding(X_projected, "Random Projection of the digits")
print("Computing PCA projection")
t0 = time()
X_pca = decomposition.TruncatedSVD(n_components=2).fit_transform(X)
```

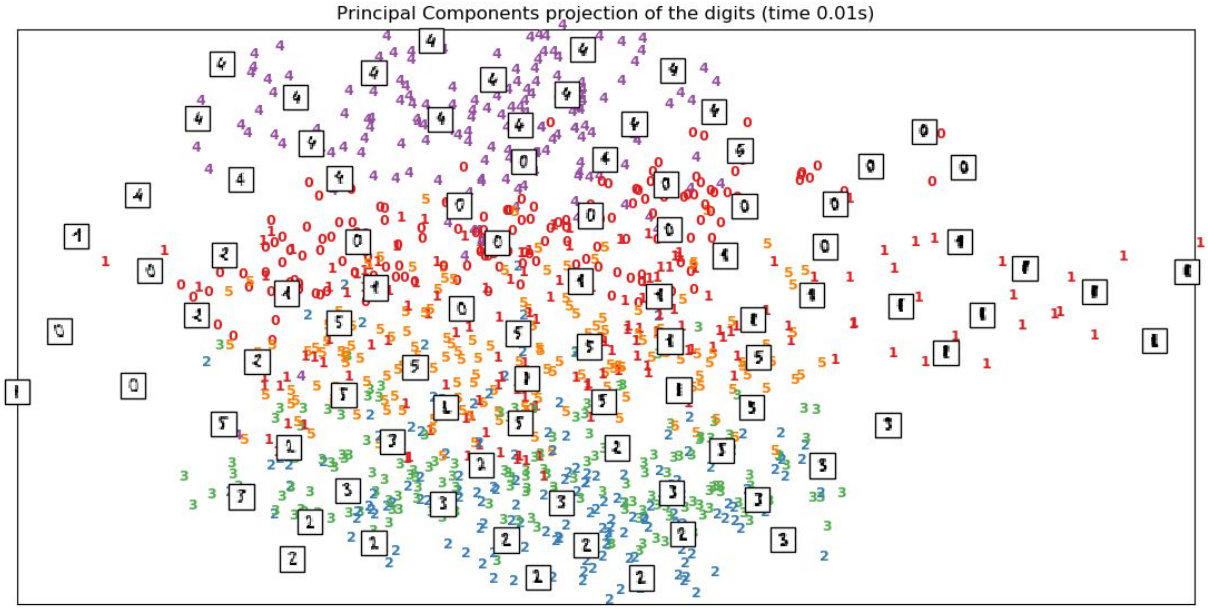
```
plot_embedding(X_pca,"Principal Components projection of the digits (time %.2fs)" %(time() - t0))
print("Computing Linear Discriminant Analysis projection")
X2 = X.copy()
X2.flat[::X.shape[1] + 1] += 0.01 # Make X invertible
t0 = time()
X_lda = discriminant_analysis.LinearDiscriminantAnalysis(n_components=2).fit_transform(X2, y)
plot_embedding(X_lda,"Linear Discriminant projection of the digits (time %.2fs)" %(time() - t0))
print("Computing Isomap embedding")
t0 = time()
X_iso = manifold.Isomap(n_neighbors, n_components=2).fit_transform(X)
print("Done.")
plot_embedding(X_iso,"Isomap projection of the digits (time %.2fs)" %(time() - t0))
print("Computing LLE embedding")
clf = manifold.LocallyLinearEmbedding(n_neighbors, n_components=2,method='standard')
t0 = time()
X_lle = clf.fit_transform(X)
print("Done. Reconstruction error: %g" % clf.reconstruction_error_)
plot_embedding(X_lle,"Locally Linear Embedding of the digits (time %.2fs)" %(time() - t0))
print("Computing modified LLE embedding")
clf = manifold.LocallyLinearEmbedding(n_neighbors, n_components=2,
method='modified')
t0 = time()
X_mlle = clf.fit_transform(X)
print("Done. Reconstruction error: %g" % clf.reconstruction_error_)
plot_embedding(X_mlle,"Modified Locally Linear Embedding of the digits (time %.2fs)" %(time() - t0))
print("Computing Hessian LLE embedding")
clf = manifold.LocallyLinearEmbedding(n_neighbors, n_components=2,method='hessian')
t0 = time()
X_hlle = clf.fit_transform(X)
print("Done. Reconstruction error: %g" % clf.reconstruction_error_)
plot_embedding(X_hlle,"Hessian Locally Linear Embedding of the digits (time %.2fs)" %(time() - t0))
print("Computing LTSA embedding")
clf = manifold.LocallyLinearEmbedding(n_neighbors, n_components=2,method='ltsa')
t0 = time()
X_ltsa = clf.fit_transform(X)
print("Done. Reconstruction error: %g" % clf.reconstruction_error_)
plot_embedding(X_ltsa,"Local Tangent Space Alignment of the digits (time %.2fs)" %(time() - t0))
print("Computing MDS embedding")
clf = manifold.MDS(n_components=2, n_init=1, max_iter=100)
t0 = time()
X_mds = clf.fit_transform(X)
print("Done. Stress: %f" % clf.stress_)
plot_embedding(X_mds,"MDS embedding of the digits (time %.2fs)" %(time() - t0))
print("Computing Totally Random Trees embedding")
hasher = ensemble.RandomTreesEmbedding(n_estimators=200, random_state=0,
max_depth=5)
t0 = time()
X_transformed = hasher.fit_transform(X)
pca = decomposition.TruncatedSVD(n_components=2)
X_reduced = pca.fit_transform(X_transformed)
plot_embedding(X_reduced,"Random forest embedding of the digits (time %.2fs)" %(time() - t0))
print("Computing Spectral embedding")
embedder = manifold.SpectralEmbedding(n_components=2, random_state=0,
```

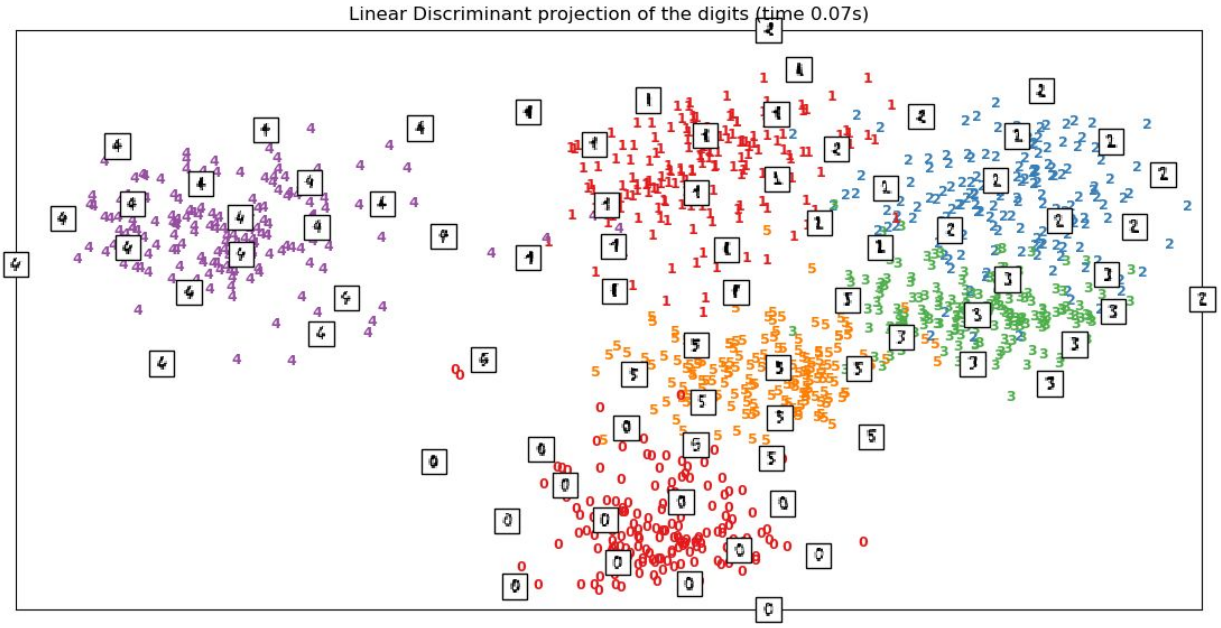
```
eigen_solver="arpack")
t0 = time()
X_se = embedder.fit_transform(X)
plot_embedding(X_se,"Spectral embedding of the digits (time %.2fs)" %(time() - t0))
print("Computing t-SNE embedding")
tsne = manifold.TSNE(n_components=2, init='pca', random_state=0)
t0 = time()
X_tsne = tsne.fit_transform(X)
plot_embedding(X_tsne,"t-SNE embedding of the digits (time %.2fs)" %(time() - t0))
plt.show()
```

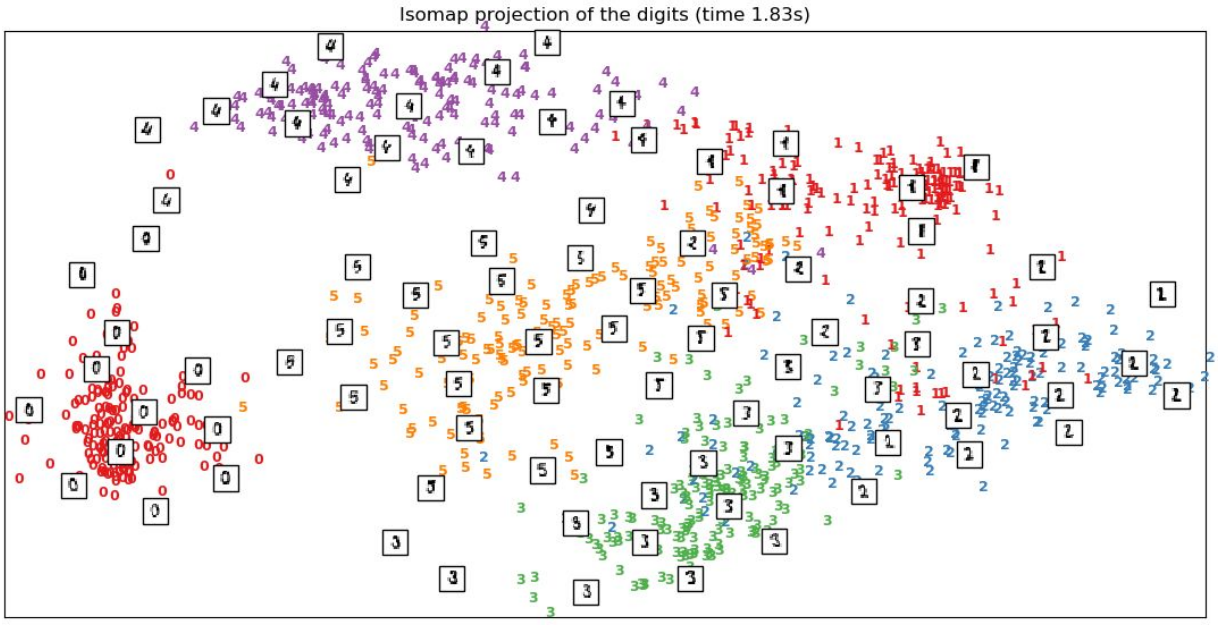


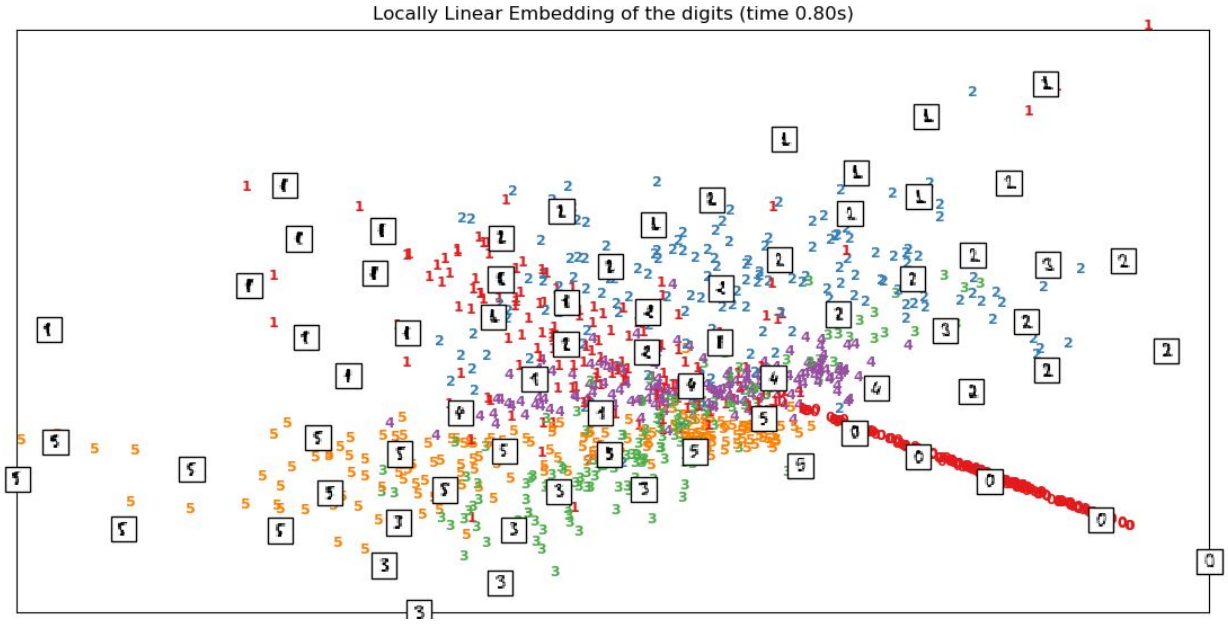
A selection from the 64-dimensional digits dataset

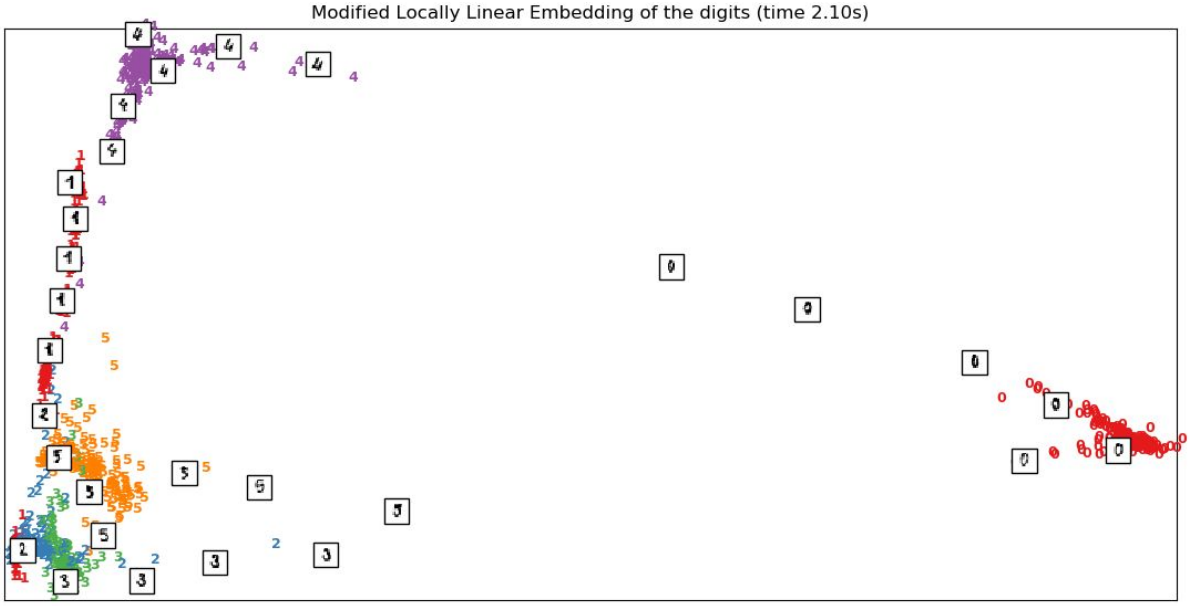

Random Projection of the digits

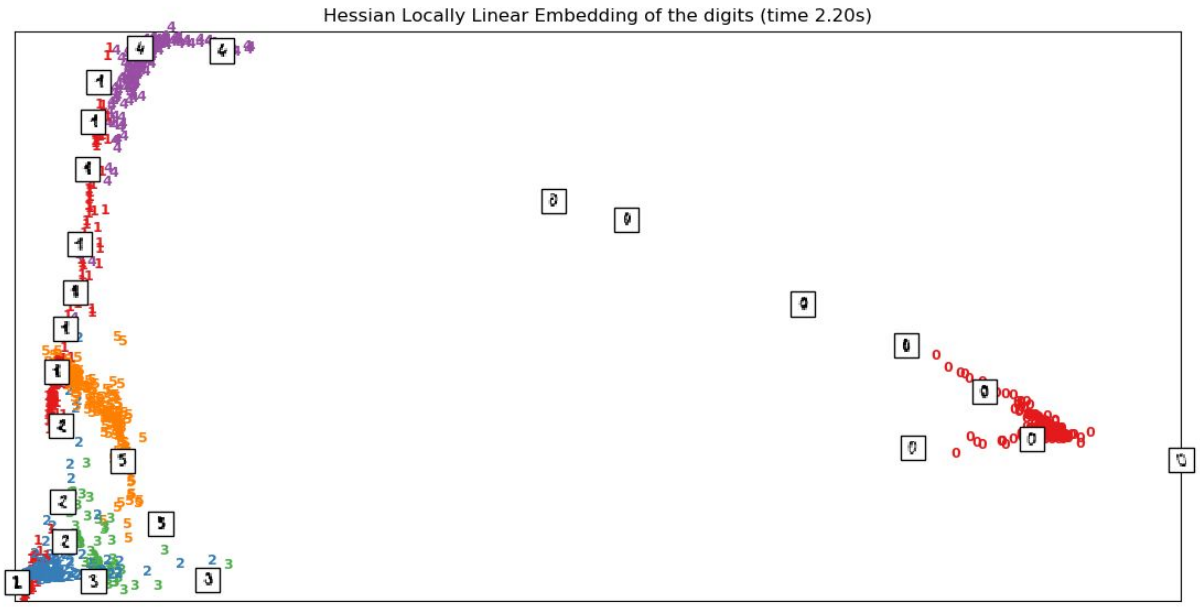

Principal Components projection of the digits (time 0.01s)

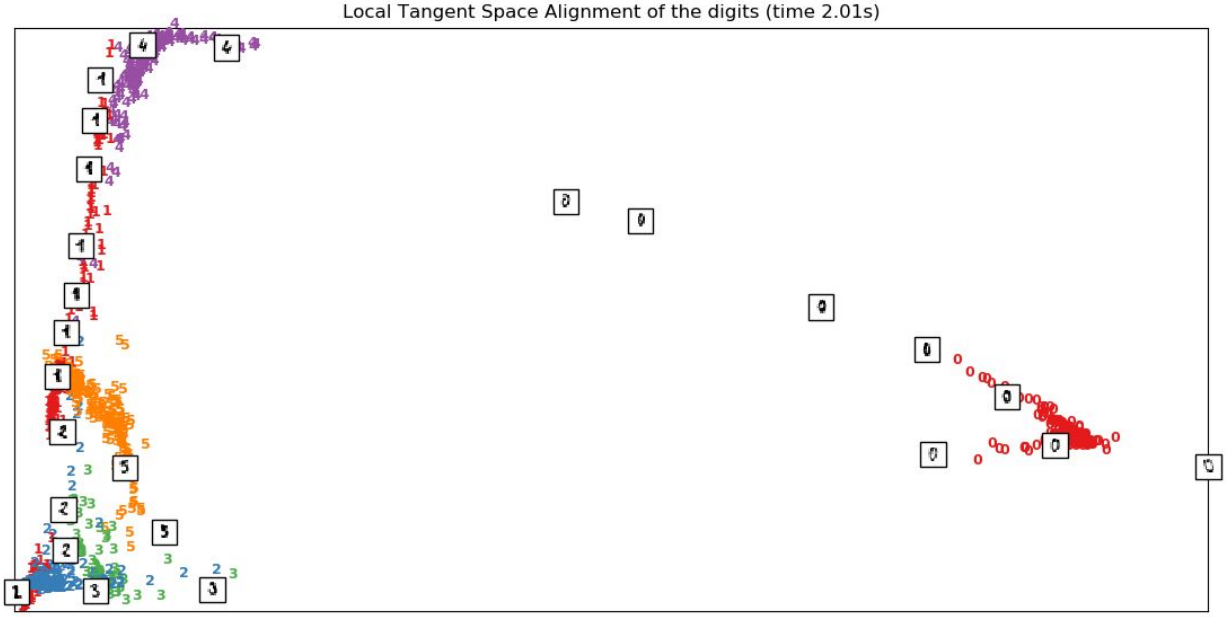

Linear Discriminant projection of the digits (time 0.07s)

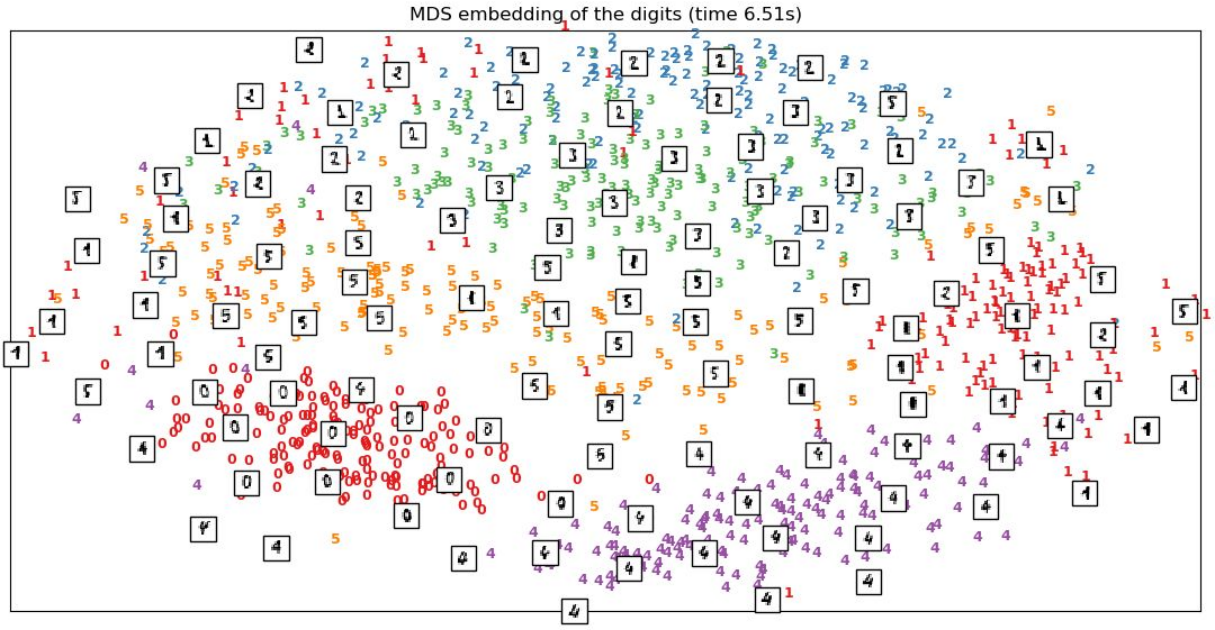

Isomap projection of the digits (time 1.83s)

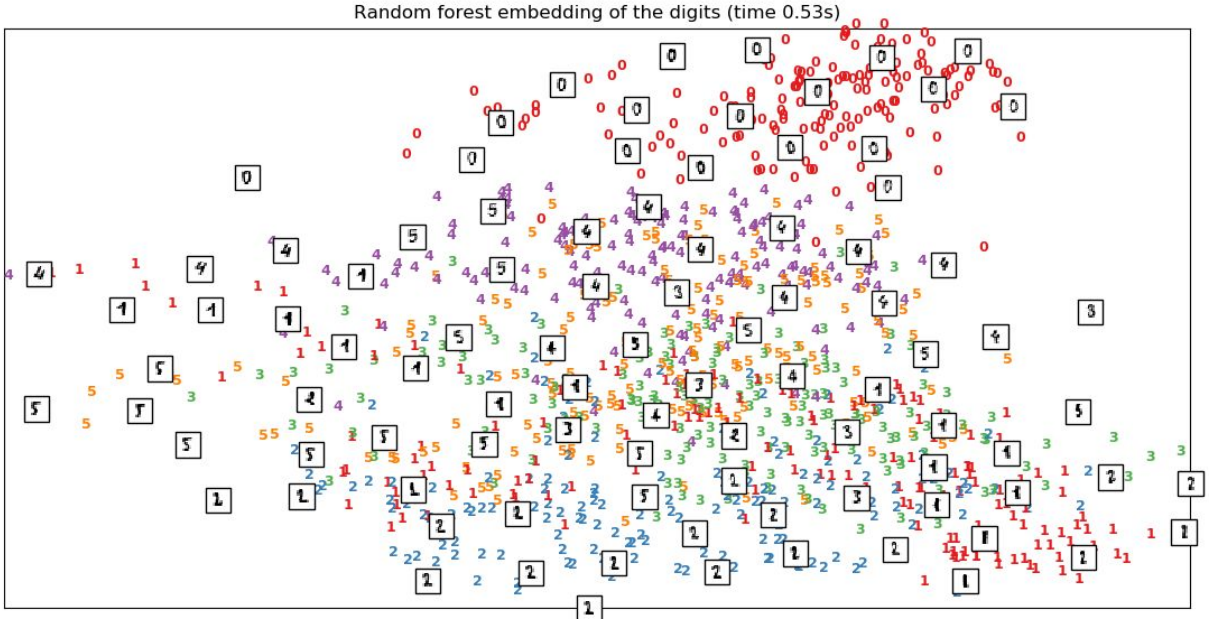

Locally Linear Embedding of the digits (time 0.80s)

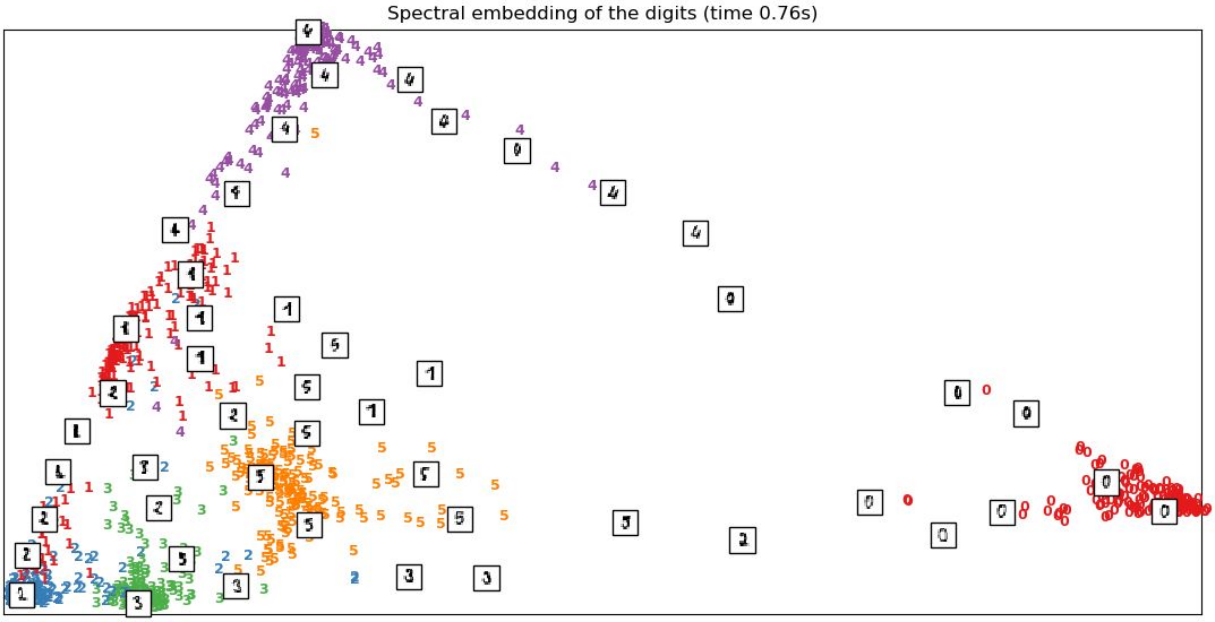

Modified Locally Linear Embedding of the digits (time 2.10s)

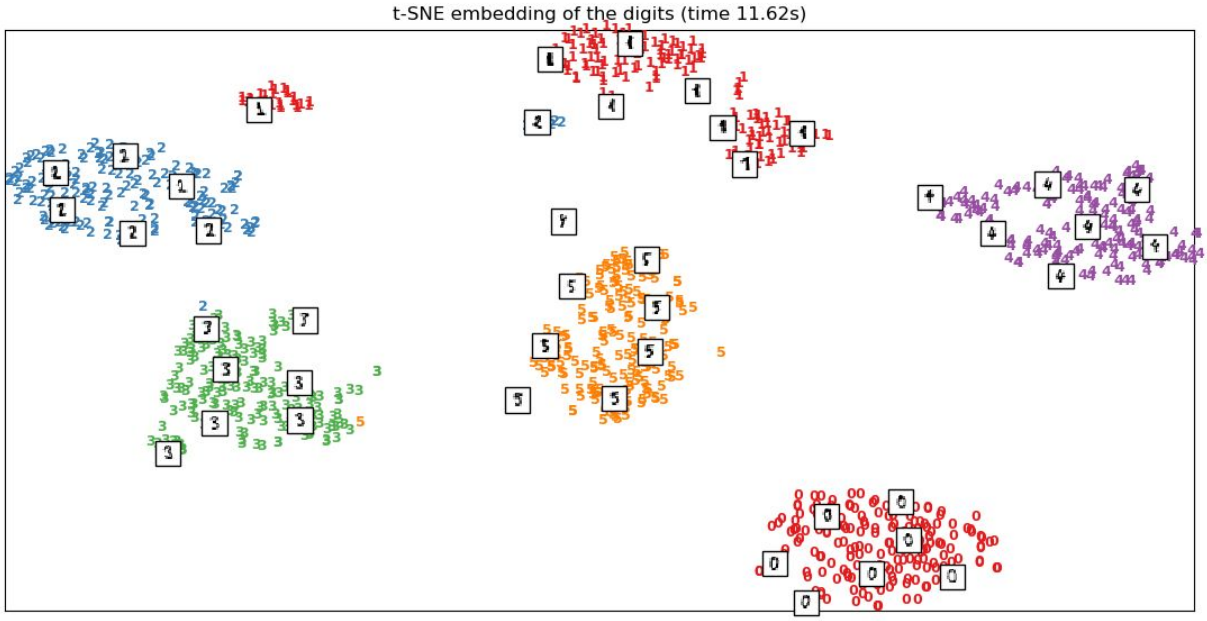

Hessian Locally Linear Embedding of the digits (time 2.20s)


Local Tangent Space Alignment of the digits (time 2.01s)


MDS embedding of the digits (time 6.51s)


Random forest embedding of the digits (time 0.53s)





You have successfully completed the container experiment. Which display format do you think is the best? The right answer is your choice, as it has to be the one that matches your own insight into the data, and there is not really a wrong answer.

Clark Ltd

The financial company in VKHCG is the Clark accounting firm that VKHCG owns with a 60% stake. The accountants are the financial advisers to the group and handle everything to do with the complex work of international accounting.

Financials

The VKHCG companies did well last year, and the teams at Clark must prepare a balance sheet for each company in the group. The companies require a balance sheet for each company, to be produced using the template (Balance-Sheet-Template.xlsx) that can be found in the example directory (..\VKHCG\04-Clark\00-RawData).

The Program will guide you through a process that will enable you to merge the data science with preformatted Microsoft Excel template, to produce a balance sheet for each of the VKHCG companies.
C:\VKHCG\04-Clark\06-Report\Report-Balance-Sheet.py

```
# -*- coding: utf-8 -*-
################################################################
import sys
import os
import pandas as pd
import sqlite3 as sq
import re
from openpyxl import load_workbook
################################################################
Base='C:/VKHCG'
################################################################
print('##################################')
print('Working Base :',Base, ' using ', sys.platform)
print('##################################')
################################################################
sInputTemplateName='00-RawData/Balance-Sheet-Template.xlsx'
################################################################
sOutputFileName='06-Report/01-EDS/02-Python/Report-Balance-Sheet'
Company='04-Clark'
################################################################
sDatabaseName=Base + '/' + Company + '/06-Report/SQLite/clark.db'
conn = sq.connect(sDatabaseName)
#conn = sq.connect(':memory:')
################################################################
### Import Balance Sheet Data
################################################################
for y in range(1,13):
    sInputFileName='00-RawData/BalanceSheets' + str(y).zfill(2) + '.csv'
    sFileName=Base + '/' + Company + '/' + sInputFileName
    print('##################################')
    print('Loading :',sFileName)
    print('##################################')
    ForexDataRaw=pd.read_csv(sFileName,header=0,low_memory=False, encoding="latin-1")
    print('##################################')
    ################################################################
    ForexDataRaw.index.names = ['RowID']
    sTable='BalanceSheets'
```

```
    print('Storing :',sDatabaseName,' Table:',sTable)
    if y == 1:
       print('Load Data')
       ForexDataRaw.to_sql(sTable, conn, if_exists="replace")
    else:
       print('Append Data')
       ForexDataRaw.to_sql(sTable, conn, if_exists="append")
###################################################################
sSQL="SELECT \
          Year, \
          Quarter, \
          Country, \
          Company, \
          CAST(Year AS INT) || 'Q' || CAST(Quarter AS INT) AS sDate, \
          Company || ' (' || Country || ')' AS sCompanyName , \
          CAST(Year AS INT) || 'Q' || CAST(Quarter AS INT) || '-' ||\
          Company || '-' || Country AS sCompanyFile \
       FROM BalanceSheets \
       GROUP BY \
          Year, \
          Quarter, \
          Country, \
          Company \
       HAVING Year is not null \
      ;"
sSQL=re.sub("\s\s+", " ", sSQL)
sDatesRaw=pd.read_sql_query(sSQL, conn)
print(sDatesRaw.shape)
sDates=sDatesRaw.head(5)
###################################################################
## Loop Dates
###################################################################
for i in range(sDates.shape[0]):
   sFileName=Base + '/' + Company + '/' + sInputTemplateName
   wb = load_workbook(sFileName)
   ws=wb.get_sheet_by_name("Balance-Sheet")
   sYear=sDates['sDate'][i]
   sCompany=sDates['sCompanyName'][i]
   sCompanyFile=sDates['sCompanyFile'][i]
   sCompanyFile=re.sub("\s+", "", sCompanyFile)

   ws['D3'] = sYear
   ws['D5'] = sCompany

   sFields = pd.DataFrame(
         [
        ['Cash','D16', 1],
        ['Accounts_Receivable','D17', 1],
        ['Doubtful_Accounts','D18', 1],
        ['Inventory','D19', 1],
        ['Temporary_Investment','D20', 1],
        ['Prepaid_Expenses','D21', 1],
        ['Long_Term_Investments','D24', 1],
```

```
        ['Land','D25', 1],
        ['Buildings','D26', 1],
        ['Depreciation_Buildings','D27', -1],
        ['Plant_Equipment','D28', 1],
        ['Depreciation_Plant_Equipment','D29', -1],
        ['Furniture_Fixtures','D30', 1],
        ['Depreciation_Furniture_Fixtures','D31', -1],
        ['Accounts_Payable','H16', 1],
        ['Short_Term_Notes','H17', 1],
        ['Current_Long_Term_Notes','H18', 1],
        ['Interest_Payable','H19', 1],
        ['Taxes_Payable','H20', 1],
        ['Accrued_Payroll','H21', 1],
        ['Mortgage','H24', 1],
        ['Other_Long_Term_Liabilities','H25', 1],
        ['Capital_Stock','H30', 1]
        ]
         )

nYear=str(int(sDates['Year'][i]))
nQuarter=str(int(sDates['Quarter'][i]))
sCountry=str(sDates['Country'][i])
sCompany=str(sDates['Company'][i])

sFileName=Base + '/' + Company + '/' + sOutputFileName + \
'-' + sCompanyFile + '.xlsx'

print(sFileName)

for j in range(sFields.shape[0]):

    sSumField=sFields[0][j]
    sCellField=sFields[1][j]
    nSumSign=sFields[2][j]

    sSQL="SELECT  \
          Year, \
          Quarter, \
          Country, \
          Company, \
          SUM(" + sSumField + ") AS nSumTotal \
        FROM BalanceSheets \
        GROUP BY \
          Year, \
          Quarter, \
          Country, \
          Company \
        HAVING \
           Year=" + nYear + " \
        AND \
           Quarter=" + nQuarter + " \
        AND \
           Country='" + sCountry + "' \
```

```
            AND \
                Company='" + sCompany + "' \
            ;"
        sSQL=re.sub("\s\s+", " ", sSQL)
        sSumRaw=pd.read_sql_query(sSQL, conn)
        ws[sCellField] = sSumRaw["nSumTotal"][0] * nSumSign
        print('Set cell',sCellField,' to ', sSumField,'Total')
    wb.save(sFileName)
```

Output:

You now have all the reports you need.

Check the Following files for generated reports in C:/VKHCG/04-Clark/06-Report/01-EDS/02-Python/

1. Report-Balance-Sheet-2000Q1-Clark-Afghanistan.xlsx
2. Report-Balance-Sheet-2000Q1-Hillman-Afghanistan.xlsx
3. Report-Balance-Sheet-2000Q1-Krennwallner-Afghanistan.xlsx
4. Report-Balance-Sheet-2000Q1-Vermeulen-Afghanistan.xlsx
5. Report-Balance-Sheet-2000Q1-Clark-AlandIslands.xlsx

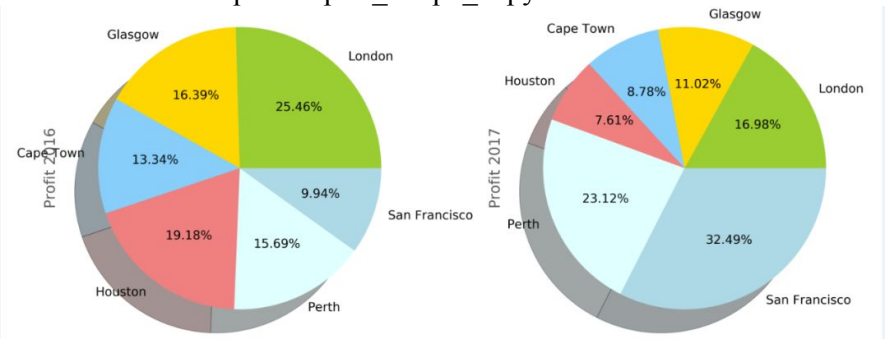
Graphics

This section will now guide you through a number of visualizations that particularly useful in presenting data to my customers.

Pie Graph

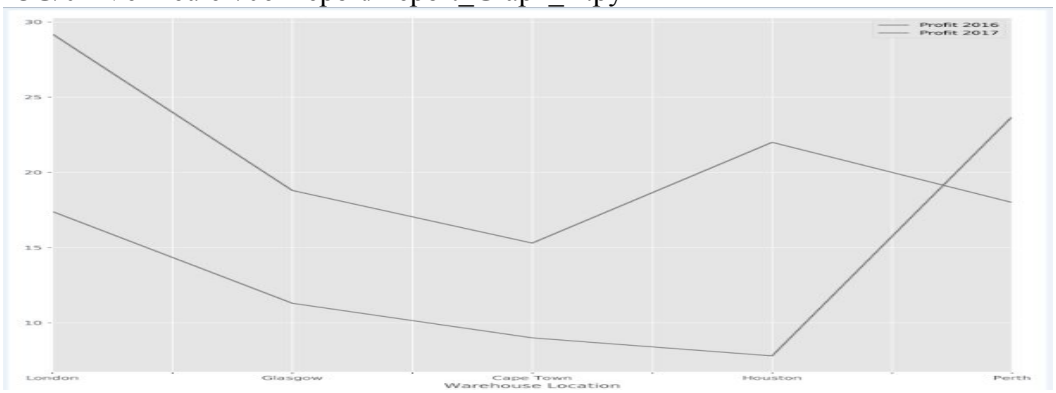
Double Pie

C:\VKHCG\01-Vermeulen\06-Report\Report_Graph_A.py



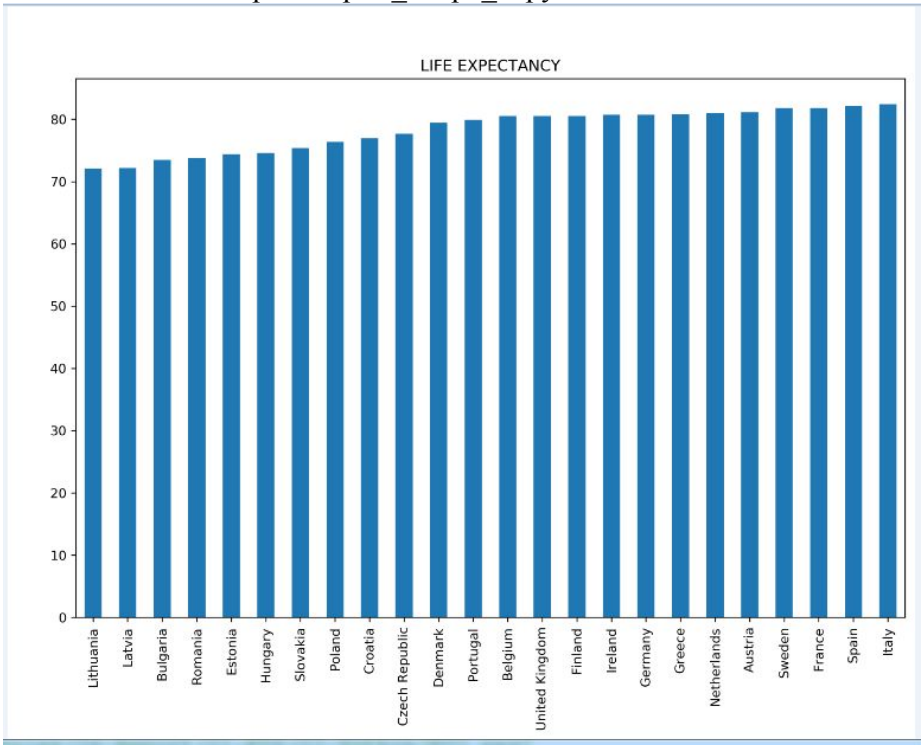
Line Graph

C:/VKHCG/01-Vermeulen/06-Report/Report_Graph_A.py



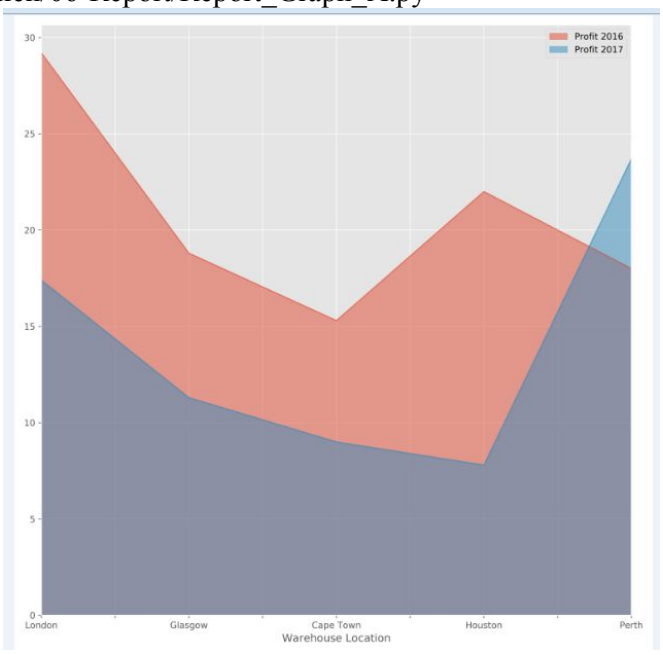
Bar Graph / Horizontal Bar Graph

C:/VKHCG/01-Vermeulen/06-Report/Report_Graph_A.py

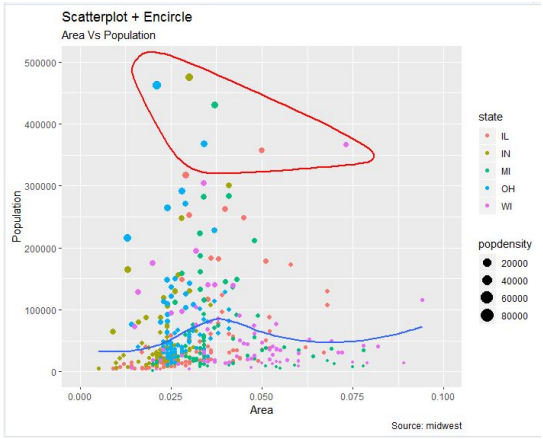


Area Graph

C:/VKHCG/01-Vermeulen/06-Report/Report_Graph_A.py

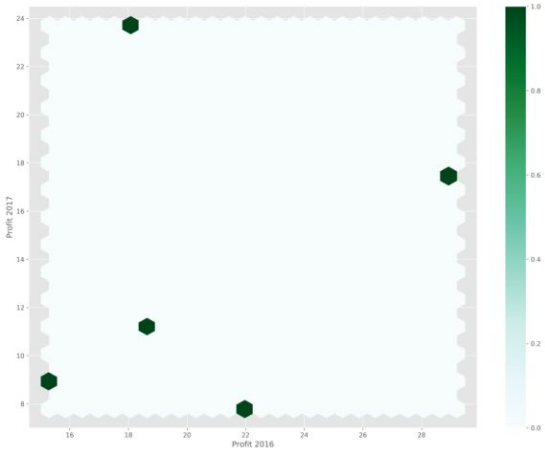


Scatter Graph : VKHCG/03-Hillman/06-Report/Report-Scatterplot-With-Encircling.r



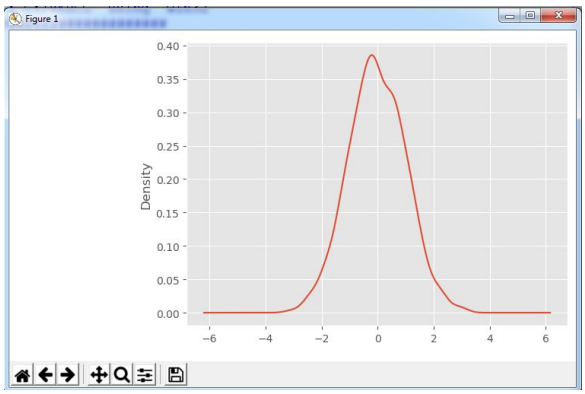
Hexbin:

Program : C:\VKHCG\01-Vermeulen\06-Report\Report_Graph_A.py



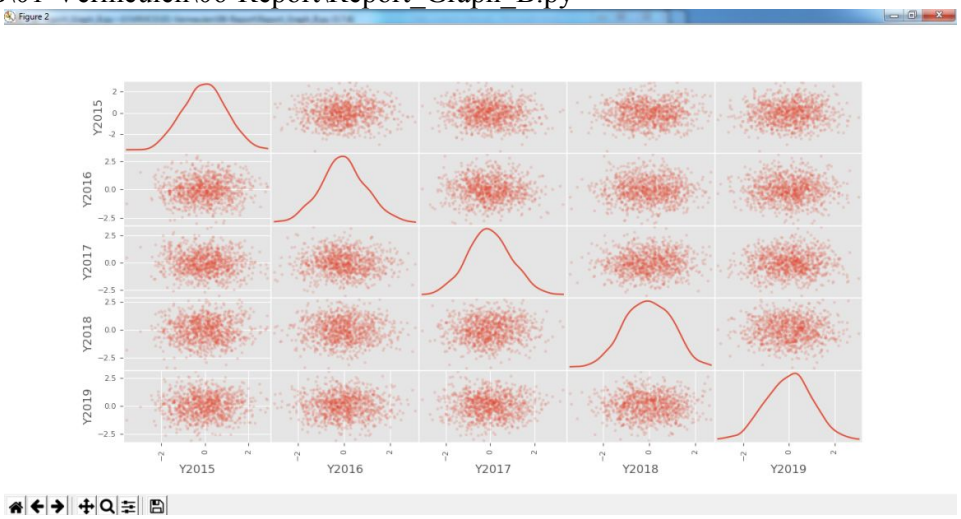
Kernel Density Estimation (KDE) Graph

C:\VKHCG\01-Vermeulen\06-Report\Report_Graph_B.py



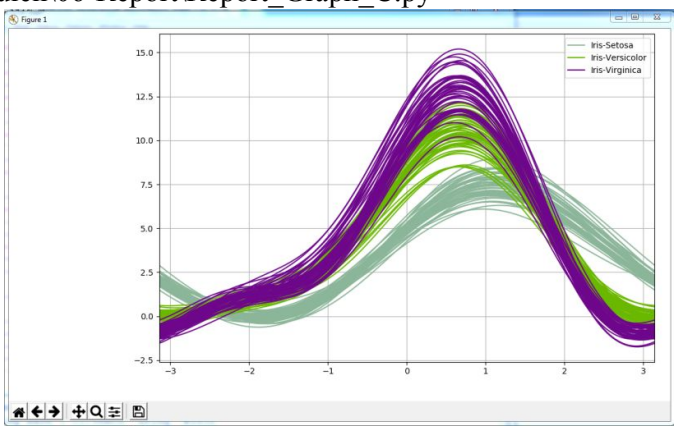
Scatter Matrix Graph

C:\VKHCG\01-Vermeulen\06-Report\Report_Graph_B.py



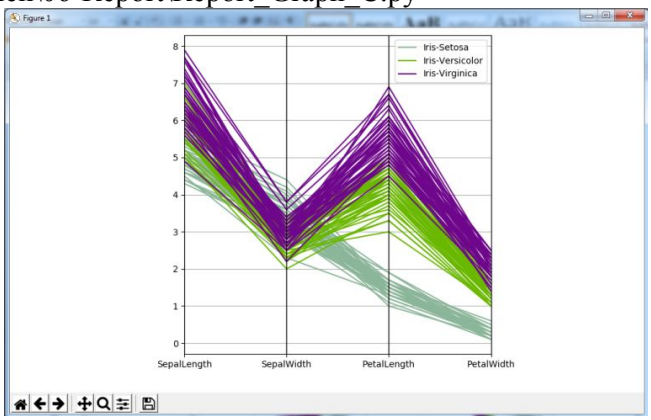
Andrews' Curves

C:\VKHCG\01-Vermeulen\06-Report\Report_Graph_C.py



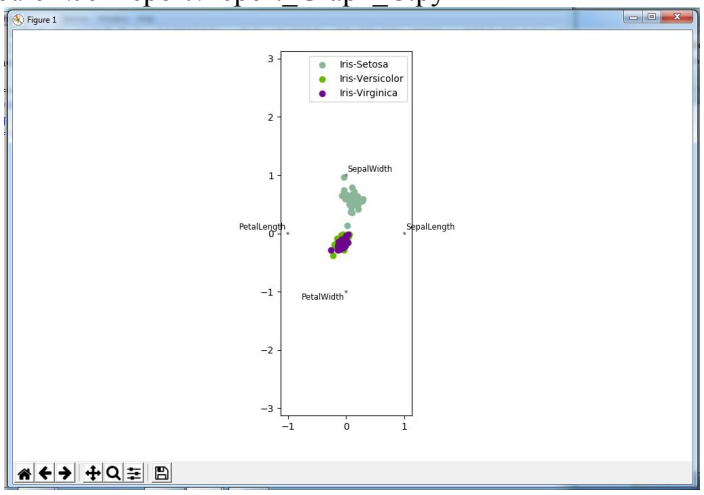
Parallel Coordinates

C:\VKHCG\01-Vermeulen\06-Report\Report_Graph_C.py



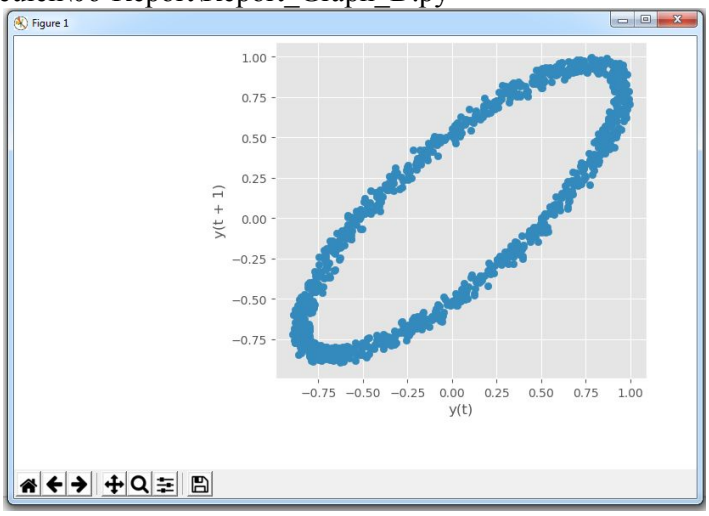
RADVIZ Method

C:\VKHCG\01-Vermeulen\06-Report\Report_Graph_C.py



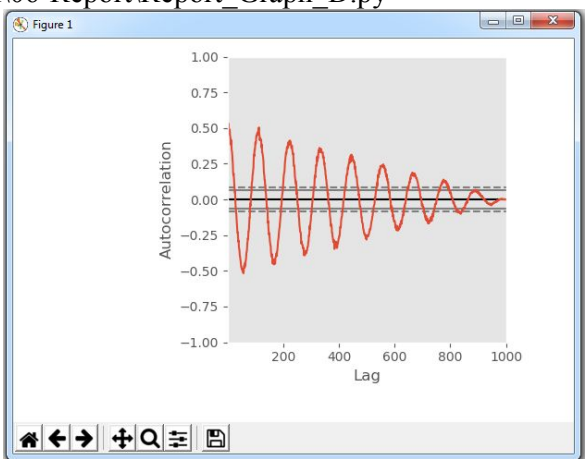
Lag Plot

C:\VKHCG\01-Vermeulen\06-Report\Report_Graph_D.py



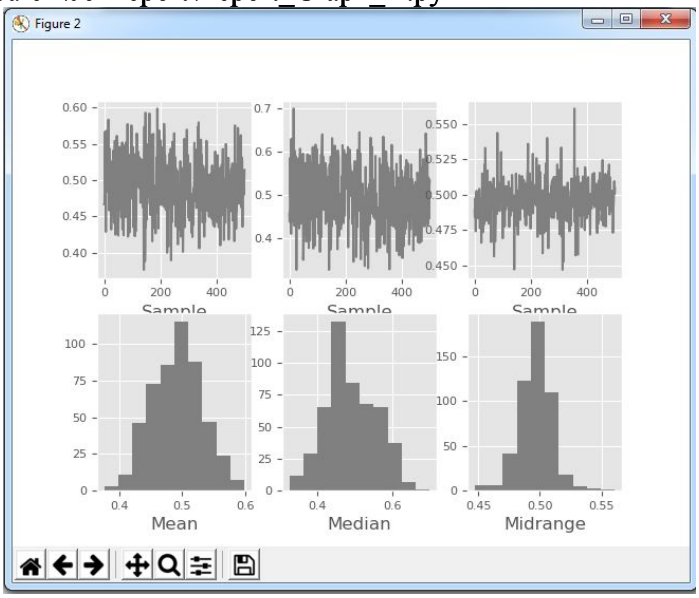
Autocorrelation Plot

C:\VKHCG\01-Vermeulen\06-Report\Report_Graph_D.py



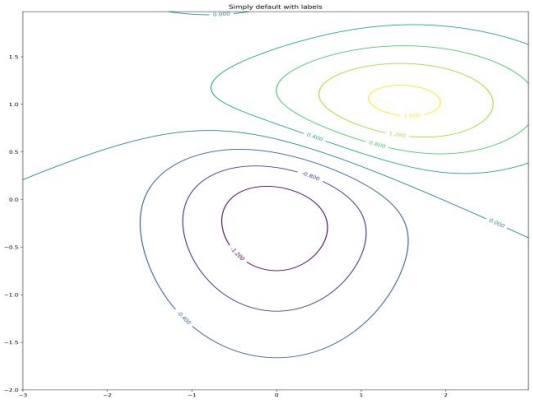
Bootstrap Plot

C:\VKHCG\01-Vermeulen\06-Report\Report_Graph_D.py



Contour Graphs

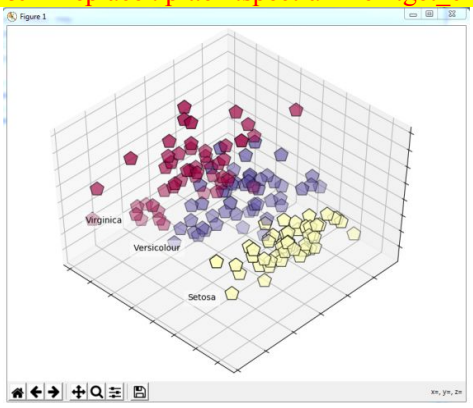
C:\VKHCG\01-Vermeulen\06-Report\Report_Graph_G.py



3D Graphs

C:\VKHCG\01-Vermeulen\06-Report\Report_PCA_IRIS.py

(add →import matplotlib.cm as cm& Replace : plt.cm.spectral →cm.get_cmap("Spectral") at Line 44)



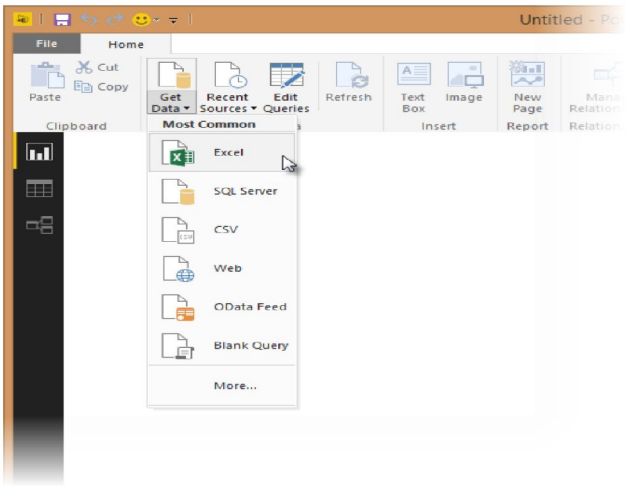
Practical 10:

Data Visualization with Power BI

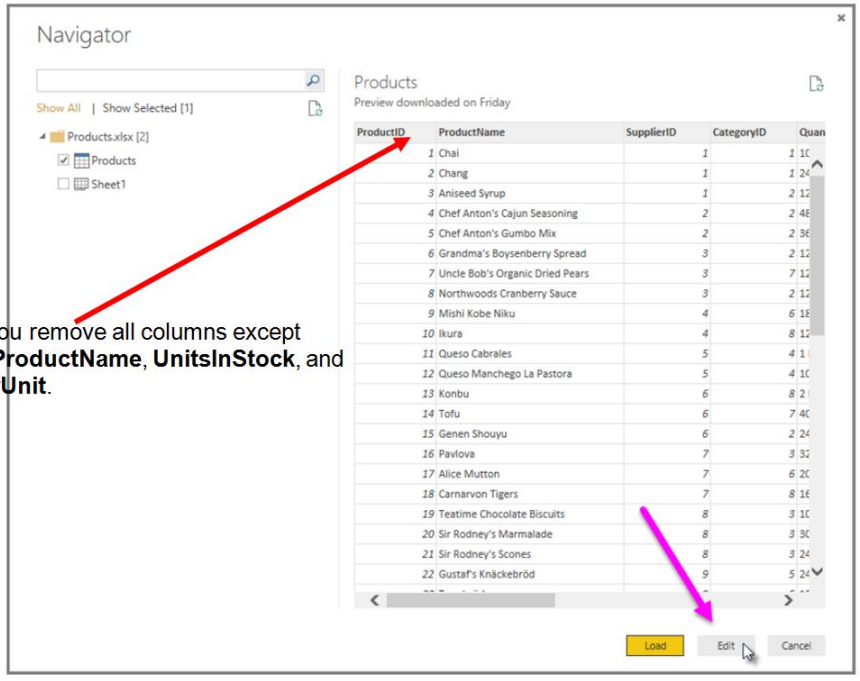
Case Study : Sales Data

Step 1: Connect to an Excel workbook

1. Launch Power BI Desktop.
2. From the Home ribbon, select **Get Data**. Excel is one of the **Most Common** data connections, so you can select it directly from the **Get Data** menu.



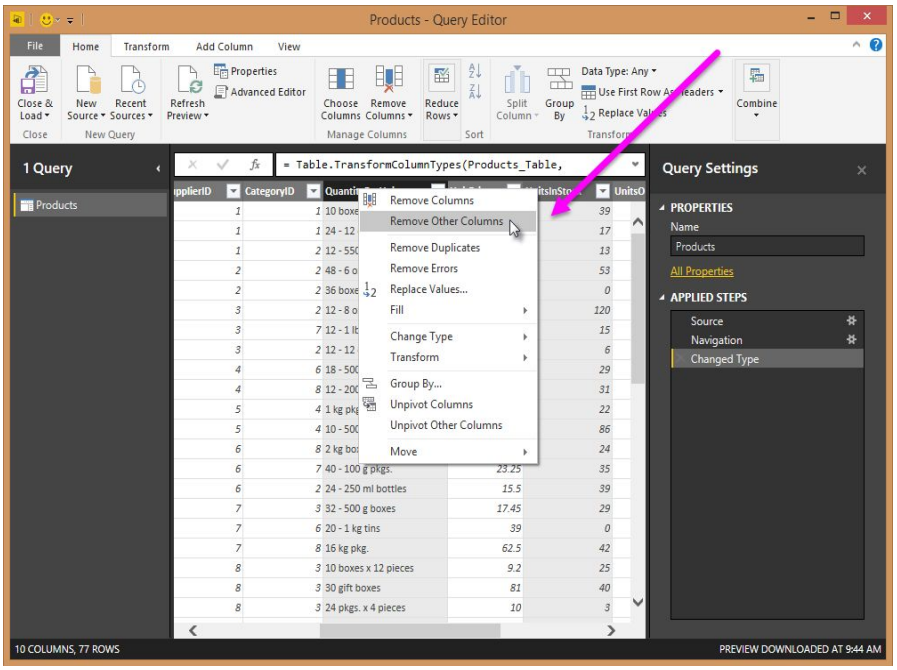
3. If you select the Get Data button directly, you can also select **File > Excel** and select **Connect**.
4. In the **Open File** dialog box, select the **Products.xlsx** file.

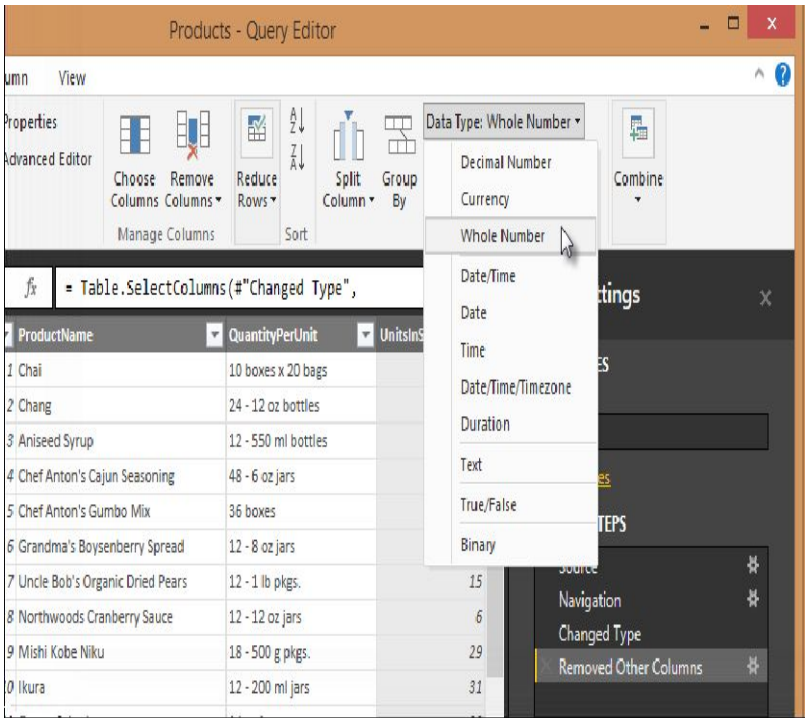


In this step you remove all columns except **ProductID**, **ProductName**, **UnitsInStock**, and **QuantityPerUnit**.

You can also open the Query Editor by selecting Edit Queries from the Home ribbon in Power BI Desktop. The following steps are performed in Query Editor.

1. In Query Editor, select the ProductID, ProductName, QuantityPerUnit, and UnitsInStock columns
   (use Ctrl+Click to select more than one column, or Shift+Click to select columns that are beside each other)
2. Select Remove Columns→Remove Other Columns from the ribbon, or right-click on a column header and click Remove Other Columns.





Step 3: Change the data type of the UnitsInStock column
For the Excel workbook, products in stock will always be a whole number, so in this step you confirm the UnitsInStock column's datatype is Whole Number.

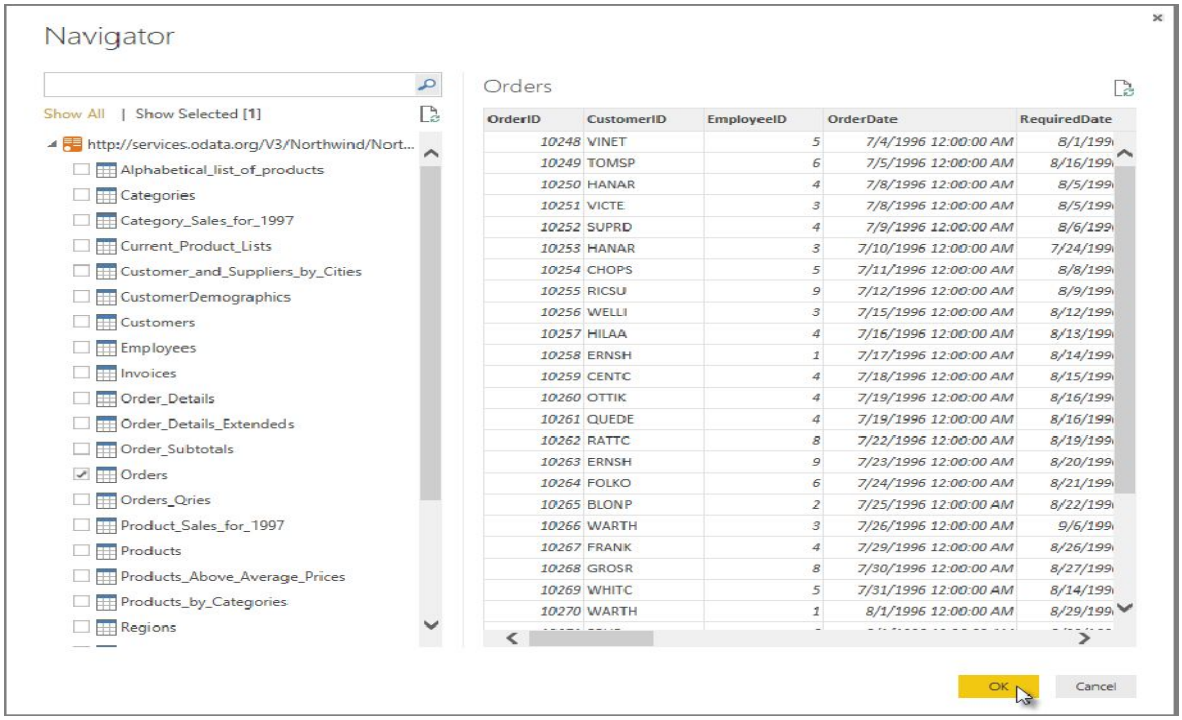
1. Select the UnitsInStock column.
2. 2. Select the Data Type drop-down button in the Home ribbon.
3. If not already a Whole Number, select Whole Number for data type from the drop down *(the Data Type: button also displays the data type for the current selection).*

Task 2: Import order data from an OData feed

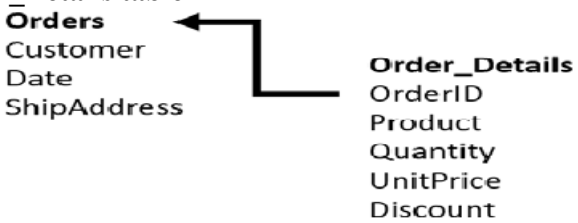
You import data into Power BI Desktop from the sample Northwind OData feed at the following URL, which you can copy (and then paste) in the steps below:
http://services.odata.org/V3/Northwind/Northwind.svc/

Step 1: Connect to an OData feed

1. From the **Home** ribbon tab in Query Editor, select **Get Data.**
2. Browse to the **OData Feed** data source.
3. In the **OData Feed** dialog box, paste the **URL** for the Northwind OData feed.
4. Select **OK**.

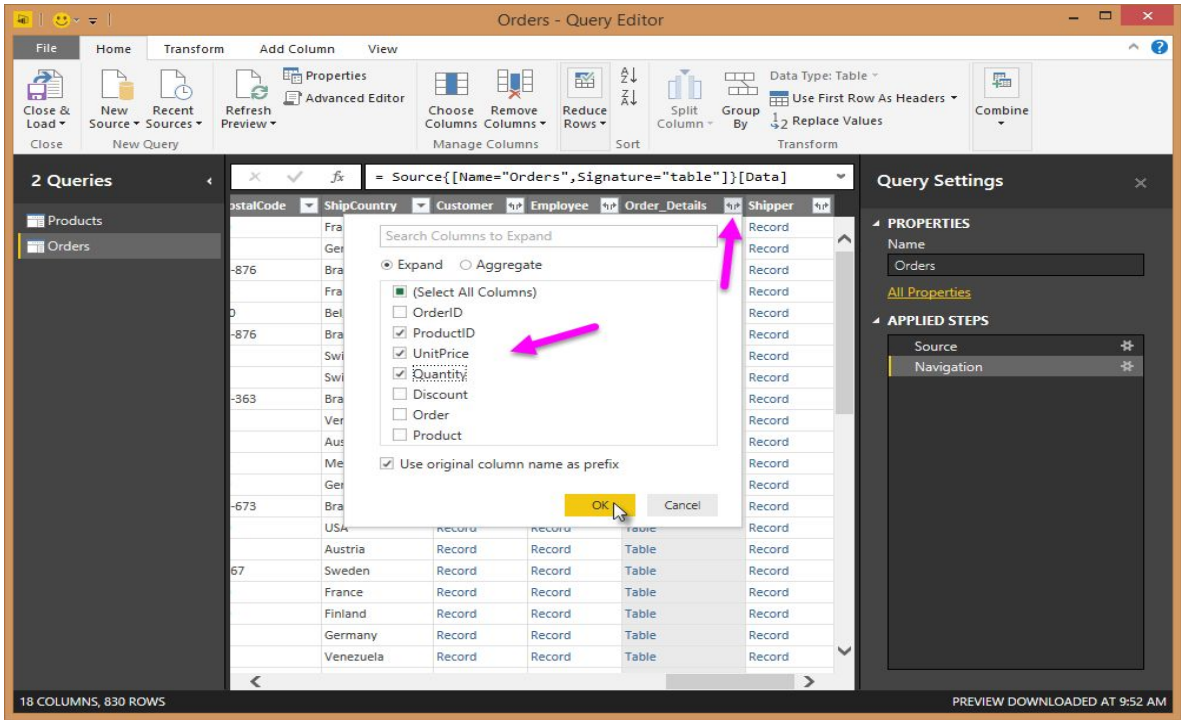


Step 2: Expand the Order_Details table



Expand the **Order_Details** table that is related to the **Orders** table, to combine the **ProductID**, **UnitPrice**, and **Quantity** columns from **Order_Details** into the **Orders** table.
The **Expand** operation combines columns from a related table into a subject table. When the query runs, rows from the related table (**Order_Details**) are combined into rows from the subject table (**Orders**).

After you expand the **Order_Details** table, three new columns and additional rows are added to the **Orders** table, one for each row in the nested or related table.
1. In the **Query View**, scroll to the **Order_Details** column.
2. In the **Order_Details** column, select the expand icon ().
3. In the **Expand** drop-down: a. Select **(Select All Columns)** to clear all columns.
   Select **ProductID**, **UnitPrice**, and **Quantity**.
   click **OK**.



Step 3: Remove other columns to only display columns of interest
In this step you remove all columns except **OrderDate, ShipCity**, **ShipCountry**, **Order_Details.ProductID**, **Order_Details.UnitPrice**, and **Order_Details.Quantity** columns. In the previous task, you used **Remove Other Columns**. For this task, you remove selected columns.
In the **Query View**, select all columns by completing a.

a. Click the first column (**OrderID**).
b. Shift+Click the last column (**Shipper**).
c. Now that all columns are selected, use Ctrl+Click to unselect the following columns: OrderDate, ShipCity, ShipCountry, Order_Details.ProductID, Order_Details.UnitPrice, and Order_Details.Quantity.

Now that only the columns we want to remove are selected, right-click on any selected column header and click Remove Columns.

Step 4: Calculate the line total for each Order_Details row

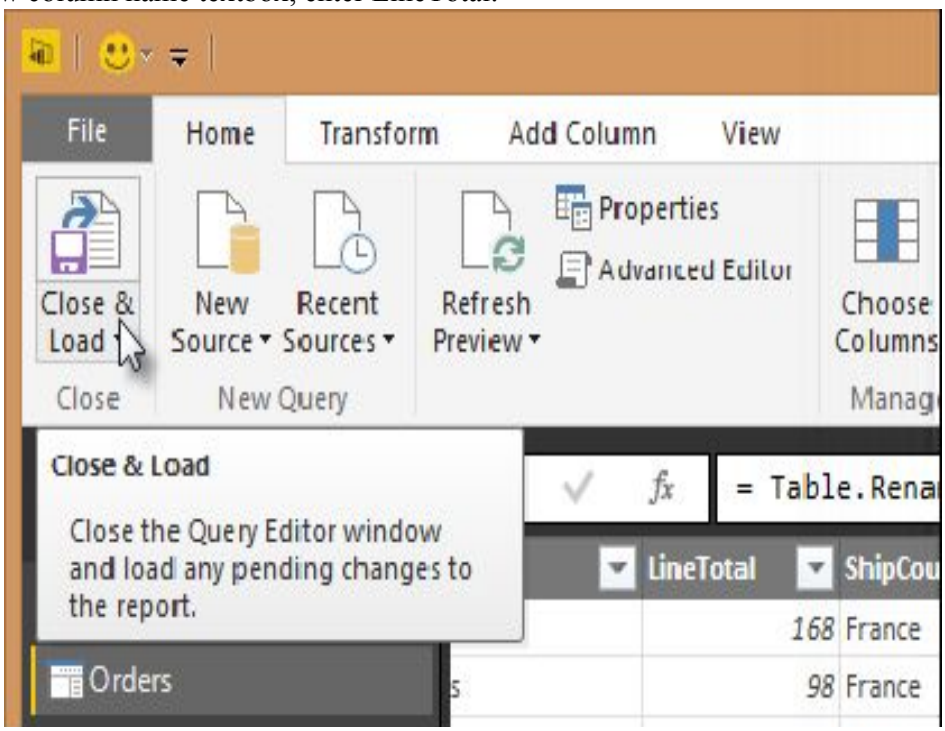
Power BI Desktop lets you to create calculations based on the columns you are importing, so you can enrich the data that you connect to. In this step, you create a **Custom Column** to calculate the line total for each **Order_Details** row.

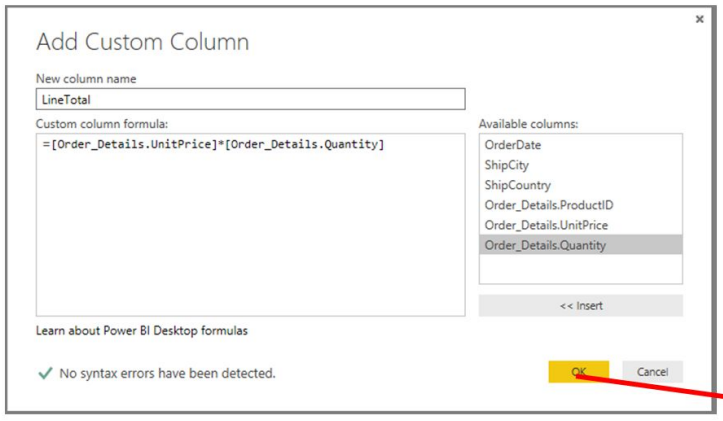
Calculate the line total for each **Order_Details** row:

1. In the **Add Column** ribbon tab, click **Add Custom Column**.

2. In the Add Custom Column dialog box, in the Custom Column Formula textbox, enter **[Order_Details.UnitPrice] * [Order_Details.Quantity].**

3. In the New column name textbox, enter LineTotal.



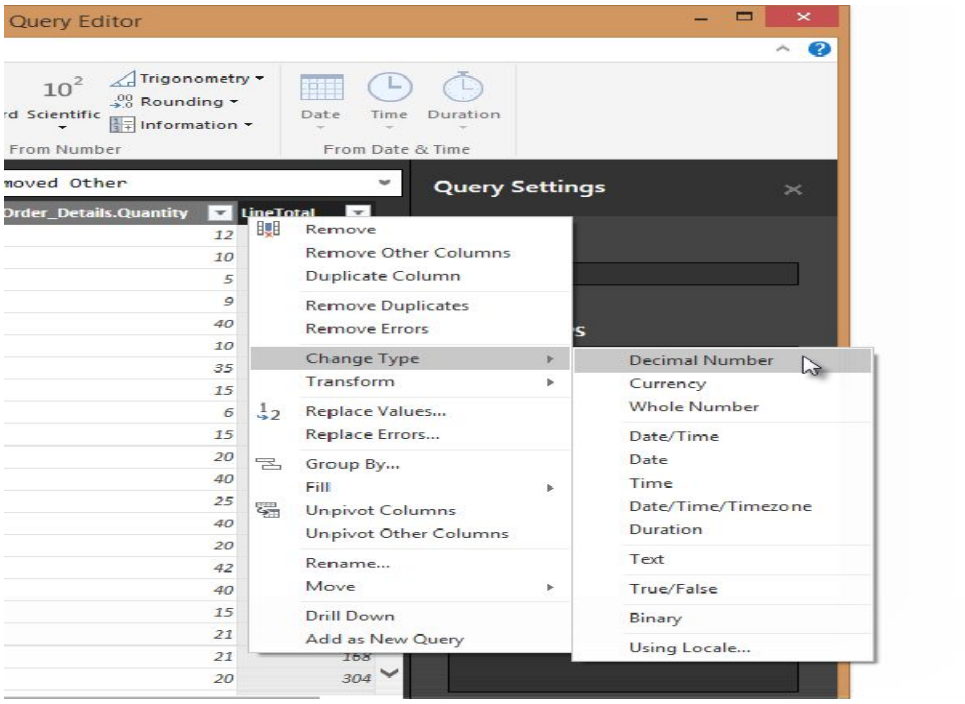


Click **OK**.

Step 5: Set the datatype of the LineTotal field

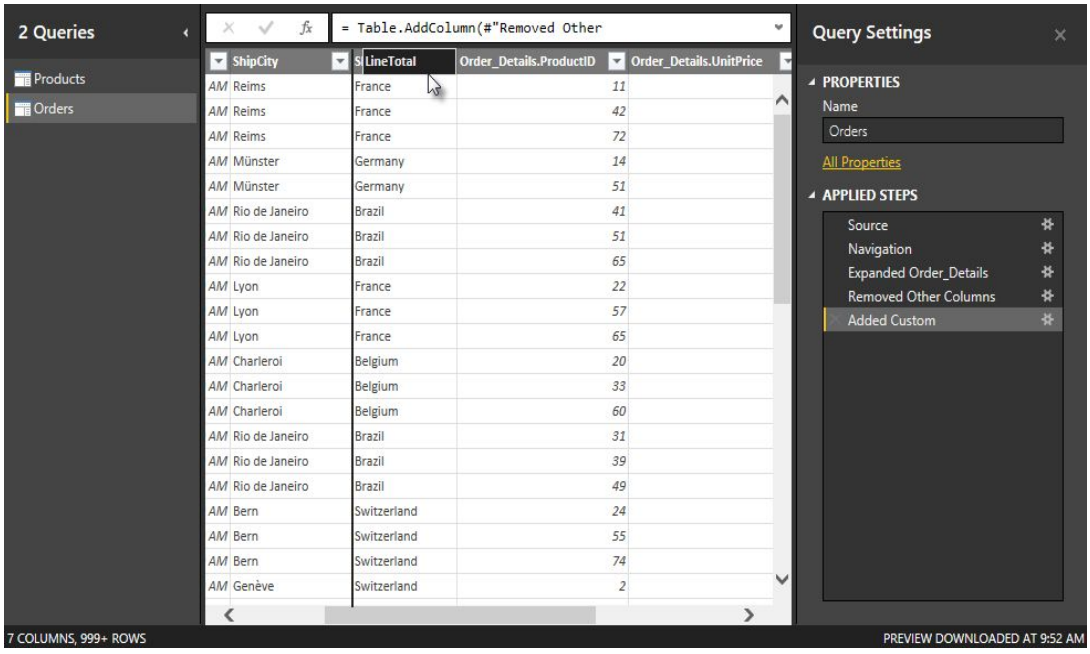
1. Right click the **LineTotal** column.

2. Select **Change Type** and choose **Decimal Number.**

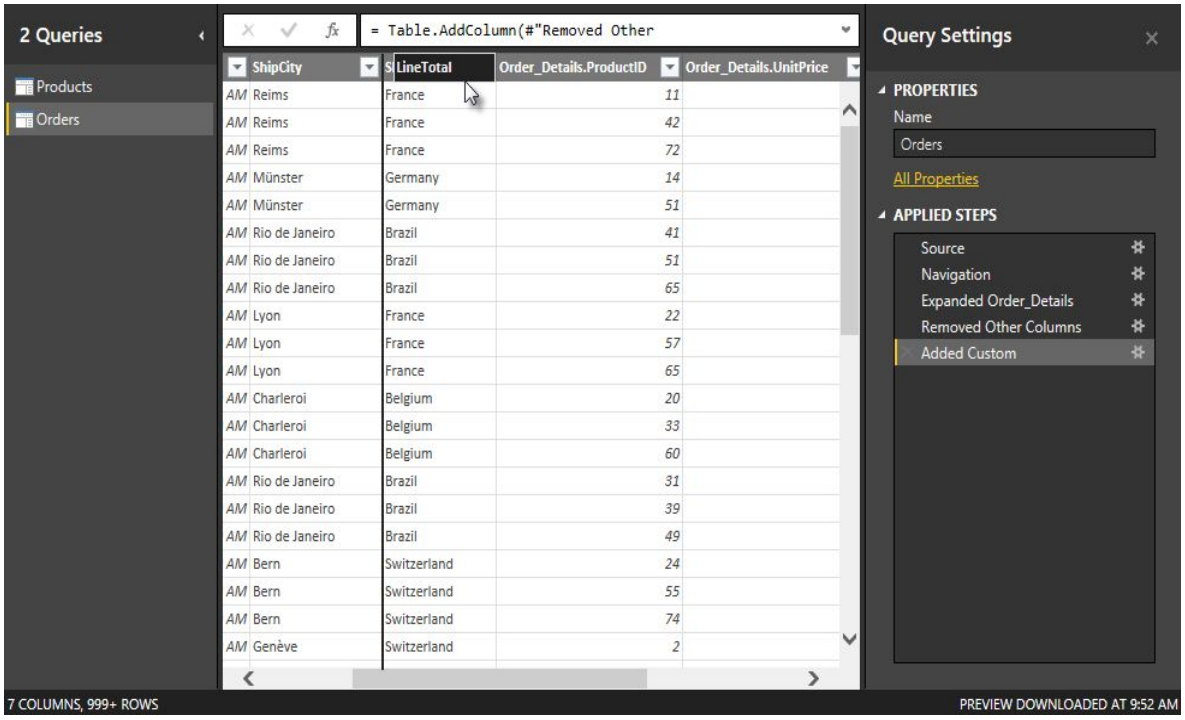


Step 6: Rename and reorder columns in the query

1. In **Query Editor**, drag the **LineTotal** column to the left, after **ShipCountry**.
2. Remove



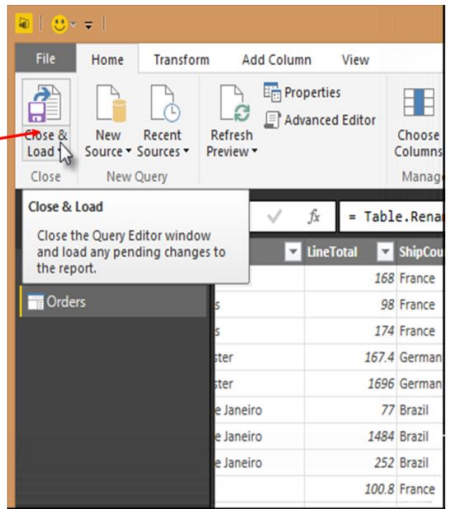
2. Remove the *Order_Details.* prefix from the **Order_Details.ProductID**, **Order_Details.UnitPrice** and **Order_Details.Quantity** columns, by double-clicking on each column header, and then deleting that text from the column name.



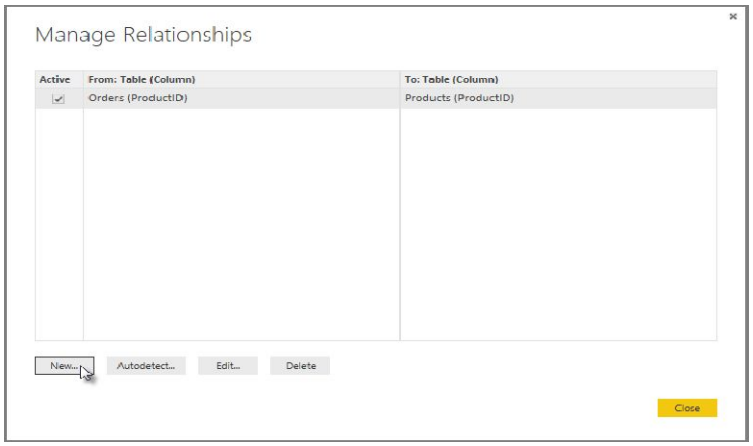
Task 3: Combine the Products and Total Sales queries

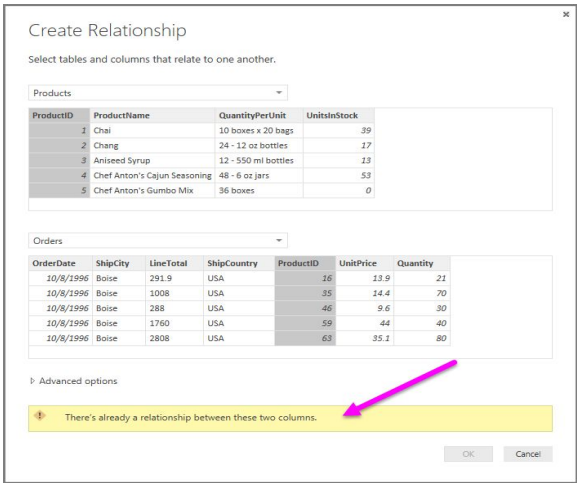
Step 1: Confirm the relationship between Products and Total Sales

1. First, we need to load the model that we created in Query Editor into Power BI Desktop. From the **Home** ribbon of Query Editor, select **Close & Load**.

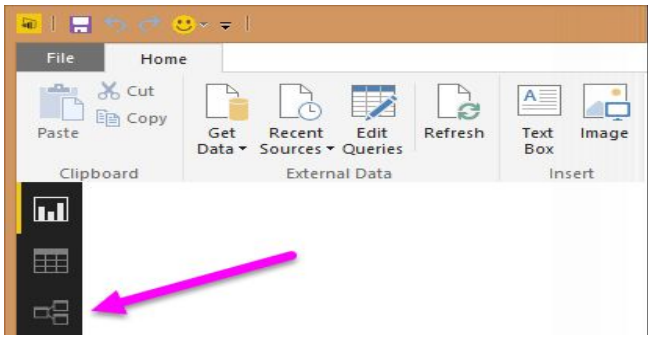


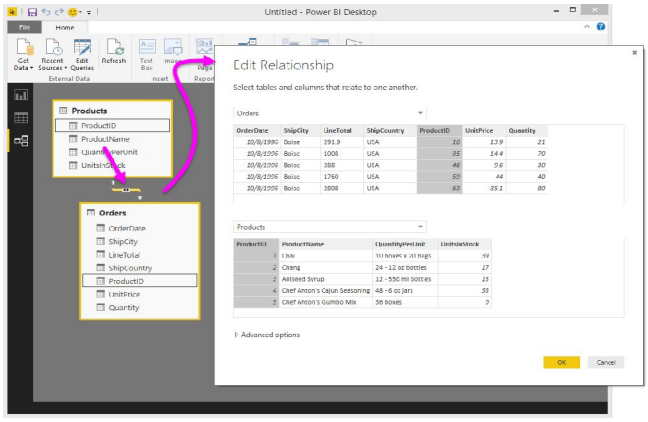
2. Power BI Desktop loads the data from the two queries
3. Once the data is loaded, select the Manage Relationships button Home ribbon
4. Select the New… button
5. When we attempt to create the relationship, we see that one already exists! As shown in the Create Relationship dialog (by the shaded columns), the ProductsID fields in each query already have an established relationship.





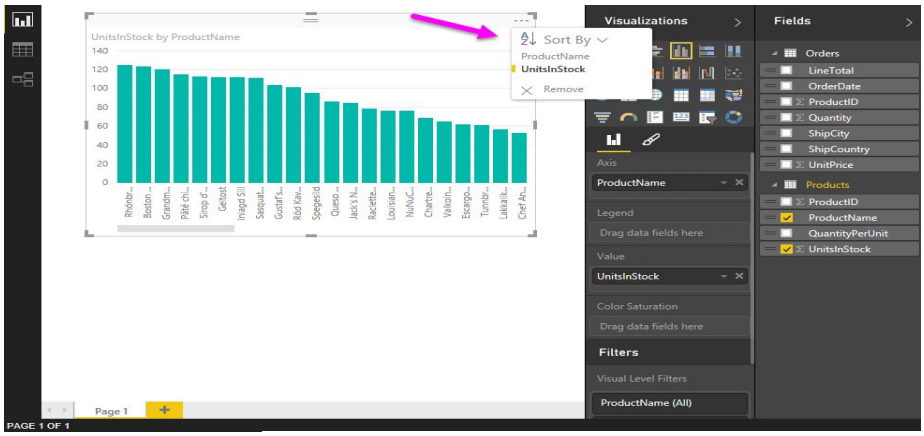
6. **Select Cancel, and then select Relationship view in Power BI Desktop.**

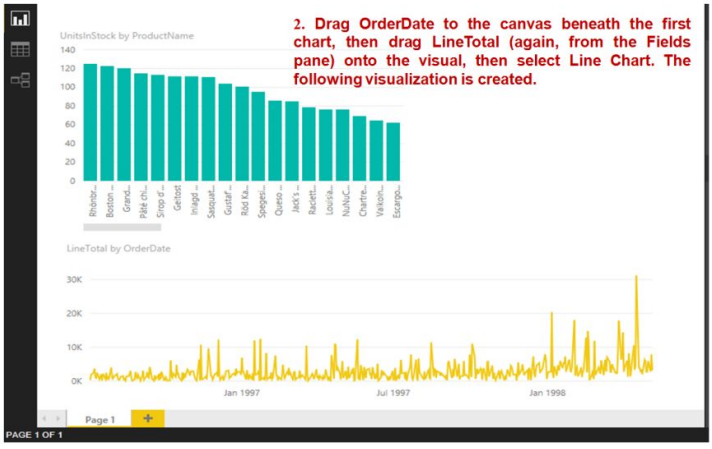




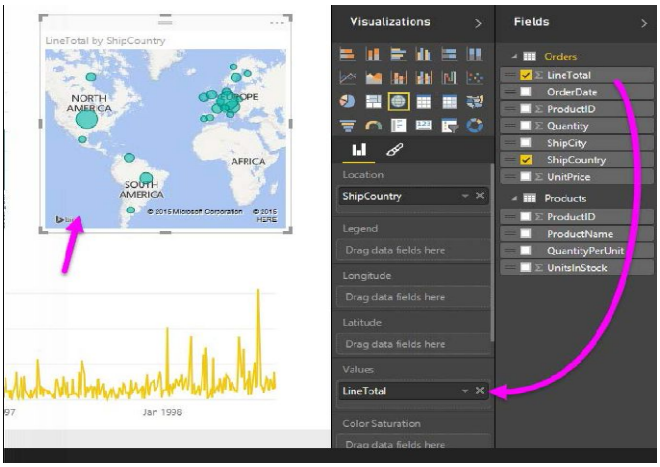
Task 4: Build visuals using your data

Step 1: Create charts showing Units in Stock by Product and Total Sales by Year

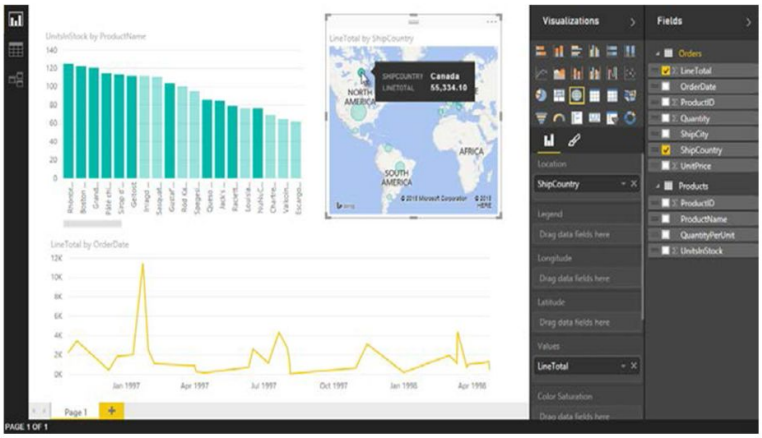




3. **Next, drag ShipCountry to a space on the canvas in the top right. Because you selected a geographic field, a map was created automatically. Now drag LineTotal to the Values field; the circles on the map for each country are now relative in size to the LineTotal for orders shipped to that country.**



Step 2: Interact with your report visuals to analyze further



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Dear Teacher,
Please send your valuable feedback and contribution to make this manual more effective.

Feel Free to connect us on …….

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Also join the M. Sc. IT Semester 1 - **Data Science Teacher's Group** on WhatsApp:

https://chat.whatsapp.com/BgllrrcbT3Q4SthOwqW0Uq
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