Assignment 4

Part 1

1. You are provided with the following URL: http://eecs.qmul.ac.uk/~emmanouilb/income_table.html (http://eecs.qmul.ac.uk/~emmanouilb/income_table.html). This webpage includes a table on individuals' income and shopping habits - the same that was used in the Week 3 lab.

1.1 Inspect the HTML code of the above URL, and provide a short report on the various tags present in the code. What is the function of each unique tag present in the HTML code?

The **'html'** tag represents the root of an HTML document.
The **'head'** element is a container for metadata (data about data) and is placed between the **'html'** tag and the **'body'** tag.
The **'body'** tag defines the document's body. The **'body'** element contains all the contents of an HTML document, such as headings, paragraphs, images, hyperlinks, tables, lists, etc.
The **'h1'** to **'h6'** tags are used to define HTML headings. **'h1'** defines the most important heading.
The **'p'** tag defines a paragraph.
The **'table'** tag defines an HTML table. An HTML table consists of one **'table'** element and one or more **'tr'**, **'th'**, and **'td'** elements.
The **'thead'** tag is used to group header content in an HTML table. The **'thead'** element is used in conjunction with the **'tbody'** and **'tfoot'** elements to specify each part of a table (header, body, footer).
The **'tr'** tag defines a row in an HTML table.
The **'td'** tag defines a standard data cell in an HTML table.

1.2 Using Beautiful Soup, scrape the table and convert it into a pandas dataframe. Perform data cleaning when necessary to remove extra characters (no need to handle missing values). In the report include the code that was used to scrape and convert the table and provide evidence that the table has been successfully scraped and converted (e.g. by displaying the contents of the dataframe).

In [209]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

In [208]:
```
from urllib.request import urlopen
from bs4 import BeautifulSoup
```

In [3]:
```
url = "http://eecs.qmul.ac.uk/~emmanouilb/income_table.html"
html = urlopen(url)
```

In [4]:
```
soup = BeautifulSoup(html, 'lxml')
print(type(soup))
```

```
<class 'bs4.BeautifulSoup'>
```

In [5]:
```
soup.find_all('td')
```

Out[5]:
```
[<td>India</td>,
 <td align="right">49</td>,
 <td align="right">86400</td>,
 <td>No</td>,
 <td>Brazil</td>,
 <td align="right">32</td>,
 <td align="right">57600</td>,
 <td>Yes</td>,
 <td>USA</td>,
 <td align="right">35</td>,
 <td align="right">64800</td>,
 <td>No</td>,
 <td>Brazil</td>,
 <td align="right">43</td>,
 <td align="right">73200</td>,
 <td>No</td>,
 <td>USA</td>,
 <td align="right">45</td>,
 <td align="right"></td>,
 <td>Yes</td>,
 <td>India</td>,
 <td align="right">40</td>,
 <td align="right">69600</td>,
 <td>Yes</td>,
 <td>Brazil</td>,
 <td align="right"></td>,
 <td align="right">62400</td>,
 <td>No</td>,
 <td>India</td>,
 <td align="right">53</td>,
 <td align="right">94800</td>,
 <td>Yes</td>,
 <td>USA</td>,
 <td align="right">55</td>,
 <td align="right">99600</td>,
 <td>No</td>,
 <td>India</td>,
 <td align="right">42</td>,
 <td align="right">80400</td>,
 <td>Yes</td>]
```

In [6]:
```
soup.find_all('tr')
```

Out[6]:
```
[<tr><th title="Field #1">Region</th>
 <th title="Field #2">Age</th>
 <th title="Field #3">Income</th>
 <th title="Field #4">Online Shopper</th>
 </tr>,
 <tr>
 <td>India</td>
 <td align="right">49</td>
 <td align="right">86400</td>
 <td>No</td>
 </tr>,
 <tr>
 <td>Brazil</td>
 <td align="right">32</td>
 <td align="right">57600</td>
 <td>Yes</td>
 </tr>,
 <tr>
 <td>USA</td>
 <td align="right">35</td>
 <td align="right">64800</td>
 <td>No</td>
 </tr>,
 <tr>
 <td>Brazil</td>
 <td align="right">43</td>
 <td align="right">73200</td>
 <td>No</td>
 </tr>,
 <tr>
 <td>USA</td>
 <td align="right">45</td>
 <td align="right"></td>
 <td>Yes</td>
 </tr>,
 <tr>
 <td>India</td>
 <td align="right">40</td>
 <td align="right">69600</td>
 <td>Yes</td>
 </tr>,
 <tr>
 <td>Brazil</td>
 <td align="right"></td>
 <td align="right">62400</td>
 <td>No</td>
 </tr>,
 <tr>
 <td>India</td>
 <td align="right">53</td>
 <td align="right">94800</td>
 <td>Yes</td>
 </tr>,
 <tr>
 <td>USA</td>
```

```
<td align="right">55</td>
<td align="right">99600</td>
<td>No</td>
</tr>,
<tr>
<td>India</td>
<td align="right">42</td>
<td align="right">80400</td>
<td>Yes</td>
</tr>]
```

In [7]:
```
# Create an empty list where the table header will be stored
header_list = []

# Find the 'th' html tags which denote table header
col_labels = soup.find_all('th')
col_str = str(col_labels)
cleantext_header = BeautifulSoup(col_str, "lxml").get_text()  # extract the text
header_list.append(cleantext_header) # Add the clean table header to the list

print(header_list)
```

```
['[Region, Age, Income, Online Shopper]']
```

In [15]:
```
rows = soup.find_all('tr')  # the 'tr' tag in html denotes a table row

# Create an empty list where the table will be stored
table_list = []

# For every row in the table, find each cell element and add it to the list
for row in rows:
    row_td = row.find_all('td')
    row_cells = str(row_td)
    row_cleantext = BeautifulSoup(row_cells, "lxml").get_text()  # extract the te
    table_list.append(row_cleantext)  # Add the clean table row to the list

print(table_list)
```

```
['[]', '[India, 49, 86400, No]', '[Brazil, 32, 57600, Yes]', '[USA, 35, 64800,
No]', '[Brazil, 43, 73200, No]', '[USA, 45, , Yes]', '[India, 40, 69600, Yes]',
'[Brazil, , 62400, No]', '[India, 53, 94800, Yes]', '[USA, 55, 99600, No]', '[I
ndia, 42, 80400, Yes]']
```

In [16]:
```
df_header = pd.DataFrame(header_list)
df_header.head()

df_header2 = df_header[0].str.split(',', expand=True)
df_header2.head()
```

Out[16]:

	0	1	2	3
0	[Region	Age	Income	Online Shopper]

In [19]:
```
df_table = pd.DataFrame(table_list)
df_table2 = df_table[0].str.split(',', expand=True)

df_table2
```

Out[19]:

	0	1	2	3
0	[]	None	None	None
1	[India	49	86400	No]
2	[Brazil	32	57600	Yes]
3	[USA	35	64800	No]
4	[Brazil	43	73200	No]
5	[USA	45		Yes]
6	[India	40	69600	Yes]
7	[Brazil		62400	No]
8	[India	53	94800	Yes]
9	[USA	55	99600	No]
10	[India	42	80400	Yes]

In [20]:
```
# Remove uneccesary characters
df_table2[0] = df_table2[0].str.strip('[')
df_table2[3] = df_table2[3].str.strip(']')


# Remove all rows with any missing values
df_table3 = df_table2.dropna(axis=0, how='any')

df_table3
```

Out[20]:

	0	1	2	3
1	India	49	86400	No
2	Brazil	32	57600	Yes
3	USA	35	64800	No
4	Brazil	43	73200	No
5	USA	45		Yes
6	India	40	69600	Yes
7	Brazil		62400	No
8	India	53	94800	Yes
9	USA	55	99600	No
10	India	42	80400	Yes

In [21]:
```
# We remove uneccessary characters from the header
df_header2[0] = df_header2[0].str.strip('[')
df_header2[3] = df_header2[3].str.strip(']')

df_header2
```

Out[21]:

	0	1	2	3
0	Region	Age	Income	Online Shopper

In [22]:
```
# We concatenate the two dataframes
frames = [df_header2, df_table3]
df = pd.concat(frames)

df
```

Out[22]:

	0	1	2	3
0	Region	Age	Income	Online Shopper
1	India	49	86400	No
2	Brazil	32	57600	Yes
3	USA	35	64800	No
4	Brazil	43	73200	No
5	USA	45		Yes
6	India	40	69600	Yes
7	Brazil		62400	No
8	India	53	94800	Yes
9	USA	55	99600	No
10	India	42	80400	Yes

In [23]:
```
df2 = df.rename(columns=df.iloc[0]) # We assign the first row to be the dataframe

df2
```

Out[23]:

	Region	Age	Income	Online Shopper
0	Region	Age	Income	Online Shopper
1	India	49	86400	No
2	Brazil	32	57600	Yes
3	USA	35	64800	No
4	Brazil	43	73200	No
5	USA	45		Yes
6	India	40	69600	Yes
7	Brazil		62400	No
8	India	53	94800	Yes
9	USA	55	99600	No
10	India	42	80400	Yes

In [24]:
```
df3 = df2.drop(df2.index[0]) # We drop the replicated header from the first row c

df3
```

Out[24]:

	Region	Age	Income	Online Shopper
1	India	49	86400	No
2	Brazil	32	57600	Yes
3	USA	35	64800	No
4	Brazil	43	73200	No
5	USA	45		Yes
6	India	40	69600	Yes
7	Brazil		62400	No
8	India	53	94800	Yes
9	USA	55	99600	No
10	India	42	80400	Yes

2. The list of the various MSc programmes offered by the School of EECS is provided at the following URL: http://eecs.qmul.ac.uk/postgraduate/programmes/ (http://eecs.qmul.ac.uk/postgraduate/programmes/). Perform web scraping on the table present in the above URL and convert it into a pandas dataframe that would include one row for each programme of study as shown in the webpage. The dataframe should include the following 5 columns: name of postgraduate degree programme (e.g. Advanced Electronic and Electrical Engineering), programme code for part-time study (e.g. H60C), programme code for full-time study (e.g. H60A), URL for part-time study programme details, URL for full-time study programme details. Perform data cleaning to remove unecessary characters when needed. In

the report include the code that was used to scrape, convert and clean the table and provide evidence that the table has been successfully scraped (e.g. by displaying the contents of the dataframe).

In [280]:
```
url_programmes = "http://eecs.qmul.ac.uk/postgraduate/programmes/"
html_programmes = urlopen(url_programmes)
soup_programmes = BeautifulSoup(html_programmes, 'lxml')
```

In [290]:
```
body = soup_programmes.find( "tbody" )
```

In [292]:
```
rows = body.find_all( "tr" )
```

In [276]:
```
#rows = soup_programmes.find_all("tr" , class_ = ["odd","even"])
#rows

# this does not work for some reason as the class object is broken
```

Out[276]:
```
[]
```

In [293]:
```
rows
```

Out[293]:
```
[<tr>
 <td><span>Advanced Electronic and Electrical Engineering</span></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/"
title="Use alt + click to follow the link">H60C</a></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/"
title="Use alt + click to follow the link">H60A</a></td>
 </tr>,
 <tr>
 <td>Artificial Intelligence</td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/artificial-intelligence-msc/" title="Use alt + click
to follow the link">I4U2</a> </td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/artificial-intelligence-msc/" title="Use alt + click
to follow the link">I4U1</a> </td>
 </tr>,
 <tr>
 <td><span>Big Data Science</span></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/big-data-science-msc/">H6J6</a></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/big-data-science-msc/">H6J7</a></td>
 </tr>,
 <tr>
 <td>Computer Games</td>
 <td style="text-align: center;"> </td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/computer-games-msc/">I4U4</a></td>
 </tr>,
 <tr>
 <td><span>Computer Science</span></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/computer-science-msc/">G4U2</a></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/computer-science-msc/">G4U1</a></td>
 </tr>,
 <tr>
 <td><span>Computer Science by Research</span></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/computer-science-by-research-msc/">G4Q2</a></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/computer-science-by-research-msc/">G4Q1</a></td>
 </tr>,
 <tr>
 <td><span>Computing and Information Systems</span></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/computing-and-information-systems-msc/">G5U6</a></td
>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/computing-and-information-systems-msc/">G5U5</a></td
>
 </tr>,
 <tr>
```

```
 <td><span>Data Science and Artificial Intelligence by Conversion</span></td>
 <td style="text-align: center;"> </td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/data-science-and-artificial-intelligence-msc/">I4U5
</a> </td>
 </tr>,
 <tr>
 <td><span>Electronic Engineering by Research</span></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/electronic-engineering-by-research-msc/">H6T6</a></t
d>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/electronic-engineering-by-research-msc/">H6T5</a></t
d>
 </tr>,
 <tr>
 <td><span>Internet of Things (Data)<br/></span></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/internet-of-things-data-msc/">I1T2</a></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/internet-of-things-data-msc/">I1T0</a></td>
 </tr>,
 <tr>
 <td><span>Machine Learning for Visual Data Analytics</span></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/machine-learning-for-visual-data-analytics-msc/">H6J
Z</a></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/machine-learning-for-visual-data-analytics-msc/">H6J
E</a></td>
 </tr>,
 <tr>
 <td><span>Media and Arts Technology by Research</span></td>
 <td style="text-align: center;"> </td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/media-and-arts-technology-by-research-msc/">G4Q3</a>
</td>
 </tr>,
 <tr>
 <td><span>Sound and Music Computing</span> </td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/sound-and-music-computing-msc/">H6T4</a></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/sound-and-music-computing-msc/">H6T8</a></td>
 </tr>,
 <tr>
 <td><span>Telecommunication and Wireless Systems</span></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/telecommunication-and-wireless-systems-msc/">H6JD</a
></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
aught/coursefinder/courses/telecommunication-and-wireless-systems-msc/">H6JA</a
></td>
 </tr>,
 <tr>
 <td><span>Digital and Technology Solutions (Apprenticeship)<br/></span></td>
 <td style="text-align: center;"><a href="https://www.qmul.ac.uk/postgraduate/t
```

```
aught/coursefinder/courses/digital-and-technology-solutions-specialist-msc/">I4
DA</a></td>
 <td style="text-align: center;"> </td>
 </tr>]
```

In [313]:
```
table_list = []

links = []

linkText = ''

for row in rows:

    row_td = row.find_all('td')

    text = row_td[0].get_text() +' , '+row_td[1].get_text()+' , '+row_td[2].get_t


    if row_td[1].find('a') != None :

        text  = text  + str(row_td[1].find('a').get('href')) +' , '

    elif row_td[1].find('a') == None :

        text  = text  + "  ,  "

    if row_td[2].find('a') != None :

        text  = text  + str(row_td[2].find('a').get('href')) +'  '

    elif row_td[2].find('a') == None :

        text  = text  + "  "

    #print(str(text))

    table_list.append(text)

    print(table_list)
```

```
['Advanced Electronic and Electrical Engineering , H60C , H60A , https://www.qm
ul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-elect
rical-engineering-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinde
r/courses/advanced-electronic-and-electrical-engineering-msc/) , https://www.qm
ul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-elect
rical-engineering-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinde
r/courses/advanced-electronic-and-electrical-engineering-msc/)  ']
['Advanced Electronic and Electrical Engineering , H60C , H60A , https://www.qm
ul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-elect
rical-engineering-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinde
r/courses/advanced-electronic-and-electrical-engineering-msc/) , https://www.qm
ul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-elect
rical-engineering-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinde
r/courses/advanced-electronic-and-electrical-engineering-msc/)  ', 'Artificial
 Intelligence , I4U2\xa0 , I4U1\xa0 , https://www.qmul.ac.uk/postgraduate/taugh
t/coursefinder/courses/artificial-intelligence-msc/ (https://www.qmul.ac.uk/pos
tgraduate/taught/coursefinder/courses/artificial-intelligence-msc/) , https://w
ww.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-
msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificia
l-intelligence-msc/)  ']
['Advanced Electronic and Electrical Engineering , H60C , H60A , https://www.qm
```

ul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/) ', 'Artificial Intelligence , I4U2\xa0 , I4U1\xa0 , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-msc/) ', 'Big Data Science , H6J6 , H6J7 , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/big-data-science-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/big-data-science-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/big-data-science-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/big-data-science-msc/) ']
['Advanced Electronic and Electrical Engineering , H60C , H60A , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/) ', 'Artificial Intelligence , I4U2\xa0 , I4U1\xa0 , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-msc/) ', 'Big Data Science , H6J6 , H6J7 , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/big-data-science-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/big-data-science-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/big-data-science-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/big-data-science-msc/) ', 'Computer Games , \xa0 , I4U4 , , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computer-games-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computer-games-msc/) ']
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(https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/machine-learning-for-visual-data-analytics-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/machine-learning-for-visual-data-analytics-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/machine-learning-for-visual-data-analytics-msc/) ', 'Media and Arts Technology by Research , \xa0 , G4Q3 , , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/media-and-arts-technology-by-research-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/media-and-arts-technology-by-research-msc/) ', 'Sound and Music Computing\xa0 , H6T4 , H6T8 , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/sound-and-music-computing-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/sound-and-music-computing-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/sound-and-music-computing-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/sound-and-music-computing-msc/) ', 'Telecommunication and Wireless Systems , H6JD , H6JA , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/telecommunication-and-wireless-systems-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/telecommunication-and-wireless-systems-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/telecommunication-and-wireless-systems-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/telecommunication-and-wireless-systems-msc/) ']
['Advanced Electronic and Electrical Engineering , H60C , H60A , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/advanced-electronic-and-electrical-engineering-msc/) ', 'Artificial Intelligence , I4U2\xa0 , I4U1\xa0 , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/artificial-intelligence-msc/) ', 'Big Data Science , H6J6 , H6J7 , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/big-data-science-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/big-data-science-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/big-data-science-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/big-data-science-msc/) ', 'Computer Games , \xa0 , I4U4 , , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computer-games-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computer-games-msc/) ', 'Computer Science , G4U2 , G4U1 , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computer-science-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computer-science-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computer-science-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computer-science-msc/) ', 'Computer Science by Research , G4Q2 , G4Q1 , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computer-science-by-research-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computer-science-by-research-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computer-science-by-research-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computer-science-by-research-msc/) ', 'Computing and Information Systems , G5U6 , G5U5 , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computing-and-information-systems-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computing-and-information-systems-msc/) , https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computing-and-information-systems-msc/ (https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/computing-and-information-systems-msc/) ', 'Data Science and Artificial Intelligen

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In [314]:
```
df_table = pd.DataFrame(table_list)
df_table2 = df_table[0].str.split(',', expand=True)

df_table2
```

Out[314]:

	0	1	2	3	
0	Advanced Electronic and Electrical Engineering	H60C	H60A	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.ac.u
1	Artificial Intelligence	I4U2	I4U1	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.ac.u
2	Big Data Science	H6J6	H6J7	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.ac.u
3	Computer Games		I4U4		https://www.qmul.ac
4	Computer Science	G4U2	G4U1	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.ac.u
5	Computer Science by Research	G4Q2	G4Q1	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.ac.u
6	Computing and Information Systems	G5U6	G5U5	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.ac.u
7	Data Science and Artificial Intelligence by Co...		I4U5		https://www.qmul.ac
8	Electronic Engineering by Research	H6T6	H6T5	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.ac.u
9	Internet of Things (Data)	I1T2	I1T0	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.ac.u
10	Machine Learning for Visual Data Analytics	H6JZ	H6JE	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.ac.u
11	Media and Arts Technology by Research		G4Q3		https://www.qmul.ac
12	Sound and Music Computing	H6T4	H6T8	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.ac.u
13	Telecommunication and Wireless Systems	H6JD	H6JA	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.ac.u
14	Digital and Technology Solutions (Apprenticesh...	I4DA		https://www.qmul.ac.uk/postgraduate/taught/co...	

In [315]:
```
header = ["Postgraduate Degree Programme" , "PT Code" , "FT Code" , "PT Code URL
```

In [316]:
```
df_table2.columns = header
```

In [317]:
```
df_table2
```

Out[317]:

	Postgraduate Degree Programme	PT Code	FT Code	PT Code URL Link	
0	Advanced Electronic and Electrical Engineering	H60C	H60A	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.
1	Artificial Intelligence	I4U2	I4U1	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.
2	Big Data Science	H6J6	H6J7	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.
3	Computer Games		I4U4		https://www.qmu
4	Computer Science	G4U2	G4U1	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.
5	Computer Science by Research	G4Q2	G4Q1	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.
6	Computing and Information	G5U6	G5U5	https://www.qmul.ac.uk/postgraduate/taught/co...	https://www.qmul.

3. Consider the graph in the figure below as displaying the links for a group of 5 webpages.

3.1 Which of the 5 nodes would you consider hubs and which would you consider authorities? Explain why.

• Authority Nodes: {1 , 2} because these nodes have many in-links.
• Hub Nodes: {3 , 4 , 5} because these nodes have many out-links to authorities.

3.2 Assume that this graph is to be used as input to the PageRank algorithm. Calculate the transition probabilities p_{ij} for all 5 nodes in the below graph (where i and j take values between 1 to 5). Add transitions with a uniform probability distribution in the case of dead-end nodes (do not consider cases of dead-end components).

In [318]:
```
import pandas as pd
import numpy as np
column_names = ['1', '2', '3', '4', '5']
row_names    = ['1', '2', '3', '4', '5']
```

In [325]:
```
matrix = np.reshape(('1/5', '1/5', '1/5', '1/5', '1/5',
                     '1/5', '1/5', '1/5', '1/5', '1/5',
                     '1/2', '1/2',  '0',  '0',  '0',
                     '1/2', '1/2',  '0',  '0',  '0',
                     '1/2', '1/2',  '0',  '0',  '0'
                    ), (5, 5))
```

In [326]:
```
df = pd.DataFrame(matrix, columns=column_names, index=row_names)
print("Transition Probabilities Matrix")
df
```

```
Transition Probabilities Matrix
```

Out[326]:

	1	2	3	4	5
1	1/5	1/5	1/5	1/5	1/5
2	1/5	1/5	1/5	1/5	1/5
3	1/2	1/2	0	0	0
4	1/2	1/2	0	0	0
5	1/2	1/2	0	0	0

3.3 Derive the PageRank $\pi(i)$ for all nodes, where $i = \{1, \ldots, 5\}$ corresponds to the node index. Assume that the teleportation probability is set to α.

I set the value to: α = 0.5

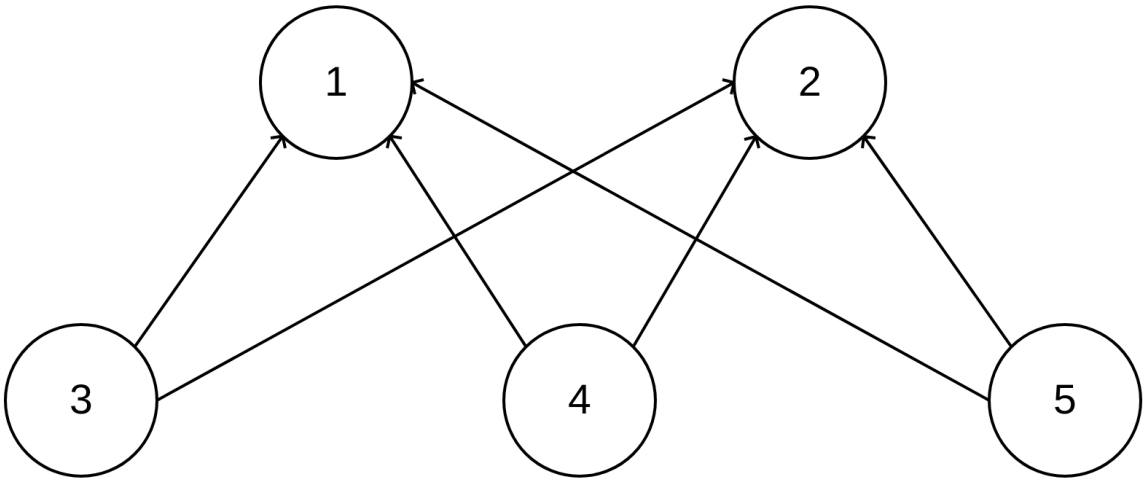
$\pi(1) = \alpha/5 + (1-\alpha).(\pi(1)/5 + \pi(2)/5 + \pi(3)/2 + \pi(4)/2 + \pi(5)/2)$
$\pi(1) = 0.5/5 + (1-0.5).(1/5 + 2/5 + 3/2 + 4/2 + 5/2)$
$\pi(1) = 3.4$

$\pi(2) = \alpha/5 + (1-\alpha).(\pi(1)/5 + \pi(2)/5 + \pi(3)/2 + \pi(4)/2 + \pi(5)/2)$
$\pi(2) = 0.5/5 + (1-0.5).(1/5 + 2/5 + 3/2 + 4/2 + 5/2)$
$\pi(2) = 3.4$

$\pi(3) = \alpha/5 + (1-\alpha).(\pi(1)/5 + \pi(2)/5)$
$\pi(3) = 0.5/5 + (1-0.5).(1/5 + 2/5)$
$\pi(3) = 0.4$

$\pi(4) = \alpha/5 + (1-\alpha).(\pi(1)/5 + \pi(2)/5)$
$\pi(4) = 0.5/5 + (1-0.5).(1/5 + 2/5)$
$\pi(4) = 0.4$

$\pi(5) = \alpha/5 + (1-\alpha).(\pi(1)/5 + \pi(2)/5)$
$\pi(5) = 0.5/5 + (1-0.5).(1/5 + 2/5)$
$\pi(5) = 0.4$



Part 2

1. Consider the following sentences related to data mining theory, and assume that each of the below sentences corresponds to a document d:

```
* Data refers to characteristics that are collected through observation.
* A dataset can be viewed as a collection of objects.
* Data objects are described by a number of attributes.
* An attribute is a characteristic or feature of an object.
```

1.1 Construct and display the document-term matrix for the above documents. Remove all stop words (here consider as stop words: articles, prepositions, conjunctions, pronouns, and common verbs) and punctuation marks; convert any plural nouns/adjectives to their singular form; and convert verbs to the present tense and first person singular form, before you construct the matrix.

27.1

	Data	refers	characteristics	collected	observation	dataset	viewed	collection	objects
Document 1	1	1	1	1	1	0	0	0	0
Document 2	0	0	0	0	0	1	1	1	1
Document 3	1	0	0	0	0	0	0	0	1
Document 4	0	0	0	0	0	0	0	0	0

1.2 Using the above constructed document-term matrix, calculate the inverse document frequency $idf(w)$ for all words w you have identified from question 1(a).

IDF(t) = log_e(Total number of documents / Number of documents with term t in it).

Total number of documents = 4

IDF(Data) = log(4 / 2) = 0.30

IDF(refers) = log(4 / 1) = 0.60

IDF(characteristics) = log(4 / 1) = 0.60

IDF(collected) = log(4 / 1) = 0.60

IDF(observation) = log(4 / 1) = 0.60

IDF(dataset) = log(4 / 1) = 0.60

IDF(viewed) = log(4 / 1) = 0.60

IDF(collection) = log(4 / 1) = 0.60

28.1

IDF(objects) = log(4 / 2) = 0.30

IDF(described) = log(4 / 1) = 0.60

IDF(number) = log(4 / 1) = 0.60

IDF(attributes) = log(4 / 1) = 0.60

IDF(attribute) = log(4 / 1) = 0.60

IDF(characteristic) = log(4 / 1) = 0.60

IDF(feature) = log(4 / 1) = 0.60

IDF(object) = log(4 / 1) = 0.60

2. Consider a timeseries y were we have obtained values of the timeseries for the following times t, as shown in the below table. Using linear interpolation, calculate the values v of the

timeseries for times $t = 3$ and $t = 5$.

t	1	4	6
y	2	8	5

for t=3 , y = 2 + (3-1 / 4-1) . (8-2) = 6

for t=5 , y = 8 + (5-4 / 6-4) . (5-8) = 6.5

3. Consider the following timeseries $y = \{0.1, 0.15, 0.2, 0.2, 0.3, 0.4, 0.25, 0.6, 0.5\}$. Perform binning on the timeseries using $k = 3$ values per bin, and show the resulting timeseries after binning.

$yNewTimeseries = \{0.15, 0.3, 0.45\}$

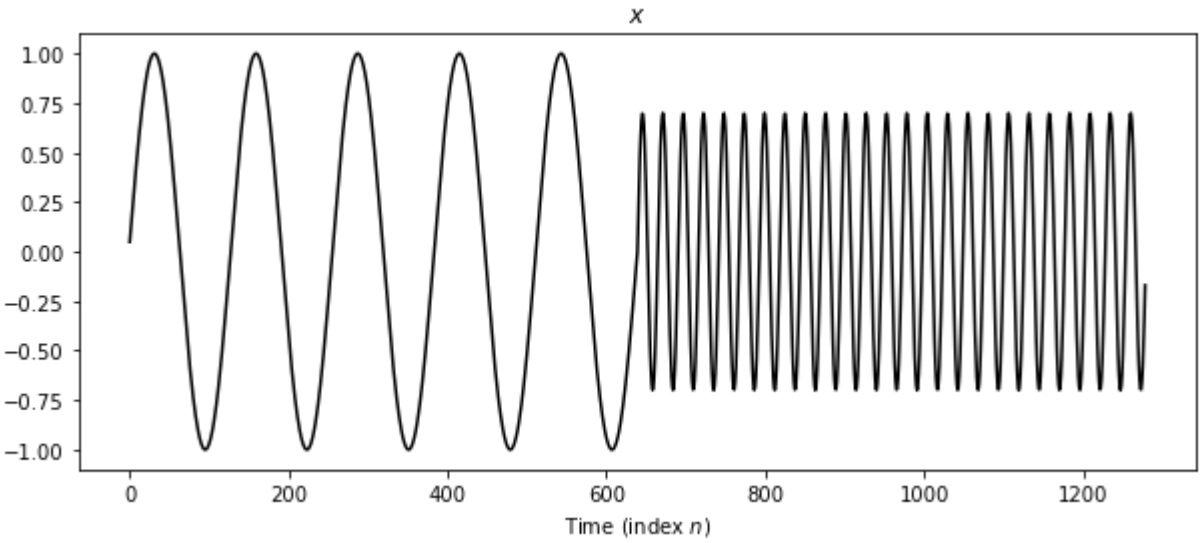
29.1

4. Load CSV file "timeseries.csv", which contains a univariate timeseries. Once loaded, convert the timeseries into a numpy array and use the numpy flatten() function to ensure that the loaded timeseries is one-dimensional. Compute the Discrete Fourier Transform (DFT) of the timeseries, and display plots for both the original timeseries and the magnitude of its DFT. How many predominant frequency components does the timeseries have?

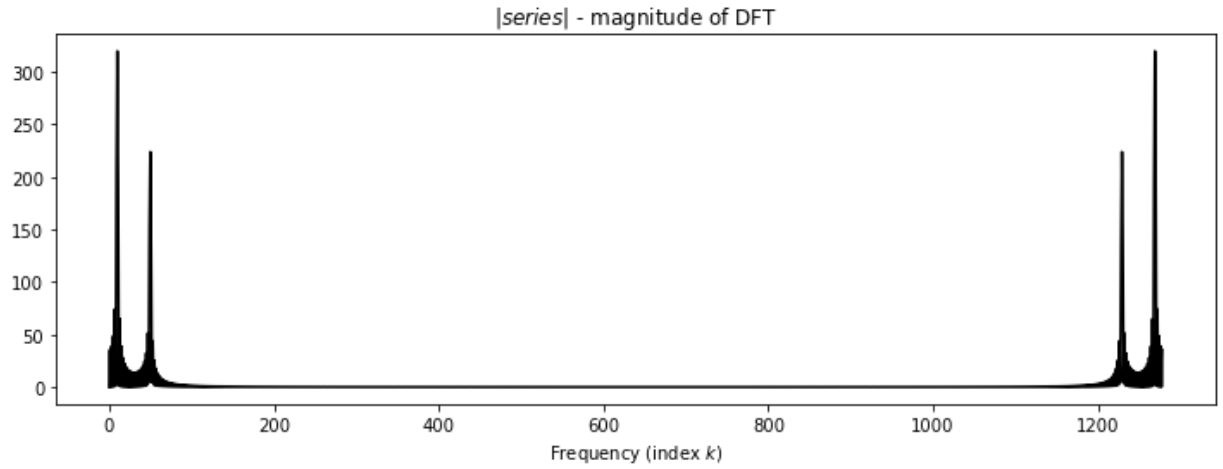
In [397]:
```
import pandas as pd
import numpy as np
import re
from pandas import read_csv
import matplotlib.pyplot as plt

#series = read_csv('timeseries.csv', header=0, index_col=0)

tempSeries = read_csv('./timeseries.csv')

a_df = tempSeries.values

seriesArray = a_df.flatten()

print(type(seriesArray))

#timeseries = pd.DataFrame(data = seriesArray)

#timeseries

#timeseries.plot(figsize=(15,4))

plt.figure(figsize=(10, 4))
plt.title('$x$')
plt.plot(seriesArray, 'k')
plt.xlabel('Time (index $n$)')
```

```
<class 'numpy.ndarray'>
```

Out[397]:
```
Text(0.5, 0, 'Time (index $n$)')
```



In [398]:
```
# numpy implementation of FFT
Xfft = np.fft.fft(seriesArray)

# Plot
plt.figure(figsize=(10, 4))
plt.title('$|series|$ - magnitude of DFT')
plt.plot(np.abs(Xfft), 'k')
plt.xlabel('Frequency (index $k$)')
plt.tight_layout()
```



There are two dominant frequncies 31.1

5. Using the daily births dataset from this lab tutorial, smooth the timeseries using trailing moving average smoothing and a window size that corresponds to one week; then replace any NaN values with zeros. Perform timeseries forecasting using the smoothed dataset in order to predict daily births for the first 5 days of 1960, using the models below. Show your forecasting results.

* AR model with $p=2$
* ARMA model with $p=2$ and $q=2$

In [352]:
```
from pandas import read_csv
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
import re


df = pd.read_csv('./births.csv', header=0, index_col=0)
```

In [353]:
```
print(df.head())
```

```
            Births
Date
1959-01-01      35
1959-01-02      32
1959-01-03      30
1959-01-04      31
1959-01-05      44
```

In [358]:
```
# Perform trailing moving average smoothing
rolling = df.rolling(window=7) # using a window of 3 samples: t, t-1, t-2
rolling_mean = rolling.mean()
rolling_mean = rolling_mean.fillna(0)
print(rolling_mean.head(10))
```

```
               Births
Date
1959-01-01   0.000000
1959-01-02   0.000000
1959-01-03   0.000000
1959-01-04   0.000000
1959-01-05   0.000000
1959-01-06   0.000000
1959-01-07  35.142857
1959-01-08  36.285714
1959-01-09  37.142857
1959-01-10  36.714286
```

In [362]:
```
print(type(rolling_mean))
```

```
<class 'pandas.core.frame.DataFrame'>
```

In [360]:
```
# Initialise
from statsmodels.tsa.arima.model import ARIMA
from random import random
```

In [363]:
```
#* AR model with $p=2$

# Fit AR model
model = ARIMA(rolling_mean, order=(2, 0, 0)) # p=2
model_fit = model.fit()

# Make prediction
yhat = model_fit.predict(len(rolling_mean), len(rolling_mean)+4) # arguments denc
print(yhat)
```

33.1

```
C:\Users\Moad\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:52
4: ValueWarning: No frequency information was provided, so inferred frequency D
will be used.
  warnings.warn('No frequency information was'
C:\Users\Moad\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:52
4: ValueWarning: No frequency information was provided, so inferred frequency D
will be used.
  warnings.warn('No frequency information was'
C:\Users\Moad\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:52
4: ValueWarning: No frequency information was provided, so inferred frequency D
will be used.
  warnings.warn('No frequency information was'

1960-01-01    45.672857
1960-01-02    45.492144
1960-01-03    45.304554
1960-01-04    45.120825
1960-01-05    44.941726
Freq: D, Name: predicted_mean, dtype: float64
```

In [364]:
```
#* ARMA model with $p=2$ and $q=2$

# Fit ARMA model
model = ARIMA(rolling_mean, order=(2, 0, 2)) # p=2, q=2
model_fit = model.fit()

# Make prediction
yhat = model_fit.predict(len(rolling_mean), len(rolling_mean)+4) # arguments denc
print(yhat)
```

```
C:\Users\Moad\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:52
4: ValueWarning: No frequency information was provided, so inferred frequency D
will be used.
  warnings.warn('No frequency information was'
C:\Users\Moad\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:52
4: ValueWarning: No frequency information was provided, so inferred frequency D
will be used.
  warnings.warn('No frequency information was'
C:\Users\Moad\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:52
4: ValueWarning: No frequency information was provided, so inferred frequency D
will be used.
  warnings.warn('No frequency information was'

1960-01-01    45.810272
1960-01-02    45.818766
1960-01-03    45.728027
1960-01-04    45.563874
1960-01-05    45.347092
Freq: D, Name: predicted_mean, dtype: float64
```

In [371]:
```

# Fit Autoregressive model
model = AutoReg(rolling_mean, lags=2, old_names=False) # "lags" indicates the moc
model_fit = model.fit()

# Make prediction
yhat = model_fit.predict(len(rolling_mean), len(rolling_mean)+4) # arguments denc
print(yhat)
```

```
1960-01-01    45.380177
1960-01-02    44.960852
1960-01-03    44.590676
1960-01-04    44.271699
1960-01-05    43.997395
Freq: D, dtype: float64

C:\Users\Moad\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:52
4: ValueWarning: No frequency information was provided, so inferred frequency D
will be used.
  warnings.warn('No frequency information was'
```

6. Using a similar process used in section 1 of this lab notebook, perform document clustering using k-means on the following wikipedia articles: supervised learning, unsupervised learning, semi-supervised learning, association rule learning, anomaly detection, cluster analysis, dimensionality reduction, regression analysis, statistical classification, data mining, data warehouse, online analytical processing. As with section 1,

use the elbow metric to find an appropriate number of clusters. Discuss and display the document clustering results.

In [372]:
```
import pandas as pd
import wikipedia
```

In [373]:
```
articles=['supervised learning', 'unsupervised learning', 'semi-supervised learni
wiki_lst=[]
title=[]
```

In [374]:
```
# Load wikipedia articles
for article in articles:
    print("loading content: ",article)
    wiki_lst.append(wikipedia.page(article, auto_suggest=False).content)
    title.append(article)
```

```
loading content:  supervised learning
loading content:  unsupervised learning
loading content:  semi-supervised learning
loading content:  association rule learning
loading content:  anomaly detection
loading content:  cluster analysis
loading content:  dimensionality reduction
loading content:  regression analysis
loading content:  statistical classification
loading content:  data mining
loading content:  data warehouse
loading content:  online analytical processing
```

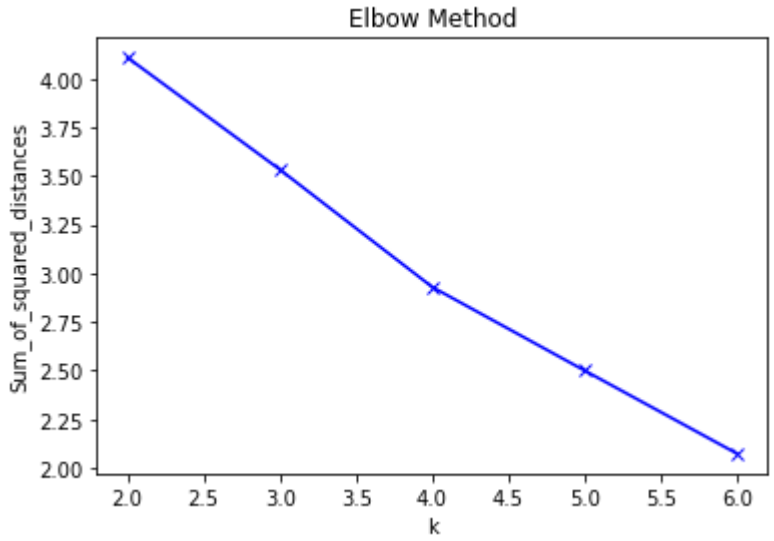
In [375]:
```
from sklearn.feature_extraction.text import TfidfVectorizer
```

In [377]:
```
vectorizer = TfidfVectorizer(stop_words={'english'})
X = vectorizer.fit_transform(wiki_lst) # Create tf-idf feature of the wikipedia c

print(X.shape) # Print dimensions of tf-idf feature
```

```
(12, 4219)
```

In [378]:
```
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans
```

In [379]:
```
Sum_of_squared_distances = []
K = range(2,7)

for k in K:
    km = KMeans(n_clusters=k, max_iter=200, n_init=10)
    km = km.fit(X)
    Sum_of_squared_distances.append(km.inertia_)

plt.plot(K, Sum_of_squared_distances, 'bx-')
plt.xlabel('k')
plt.ylabel('Sum_of_squared_distances')
plt.title('Elbow Method')
plt.show()
```



In [380]:
```
# Fit k-means model with k=4
true_k = 4
model = KMeans(n_clusters=true_k, init='k-means++', max_iter=200, n_init=10)
model.fit(X)

# Print list of documents and associated clusters
labels=model.labels_
wiki_cl=pd.DataFrame(list(zip(title,labels)),columns=['title','cluster'])
print(wiki_cl.sort_values(by=['cluster']))
```

37.1

```
                          title  cluster
0            supervised learning        0
2      semi-supervised learning        0
7           regression analysis        0
9                   data mining        1
10              data warehouse        1
11  online analytical processing        1
4             anomaly detection        2
1         unsupervised learning        3
3     association rule learning        3
5              cluster analysis        3
6      dimensionality reduction        3
8    statistical classification        3
```

From the results we can see that most of it makes sense but am not sure why 'anomaly detection' doesnt belong to cluster (2) I think it should belong to cluster (3) and I dont think 'dimensionality reduction' and 'statistical classification' belong to cluster (3) and I think 'association rule learning' should belong to cluster (1)

37.2

In [399]:
```
#print(wiki_lst[3])
```

Index of comments