# We'll be starting shortly!

To help us run the workshop smoothly, please kindly:

- Switch off screen sharing and mute your microphone
- Submit all questions using the Q&A function
- If you have an urgent request, please use the "Raise Hand" function

Thank you!

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# Data Science 101

Session 1

# Session Overview

- Introduction to Data Analytics
  - Data Analytics Process
- Pandas
  - DataFrame
  - Data Formats
  - Data Manipulation
  - Data Cleaning
- Plotly
  - Data Visualisation

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# Introduction - What is Data Analytics?


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# What Is Data Analytics?

- The process of extracting, processing and analysing data
- Deriving insights (useful information) from data
- Using the insights from data to support decision making
- Drawing a valid conclusion

# Who Uses Data Analytics?

- Commercial industries
  - Enable organizations to make more-informed business decisions
- Scientists and researchers
  - Verify or disprove scientific models, theories and hypotheses.

# Applications Of Data Analytics

- Retail Industry
  - Businesses can collect data about customer habits using data analytics to better understand their customers
  - This also helps them to predict trends and come up with new products to increase profit
- Pharmaceutical Industry
  - It is expensive to set up clinical trials
  - By using data analytics and artificial intelligence, we can improve the speed and efficiency of clinical trials

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# Statistics For Data Analytics

- Statistics is the science of learning from data
  - Data are numerical facts
- Includes methods of collecting, organizing and analyzing data
  - Such that meaningful conclusions can be drawn
- Basic statistics required as a skill set to do conduct analysis

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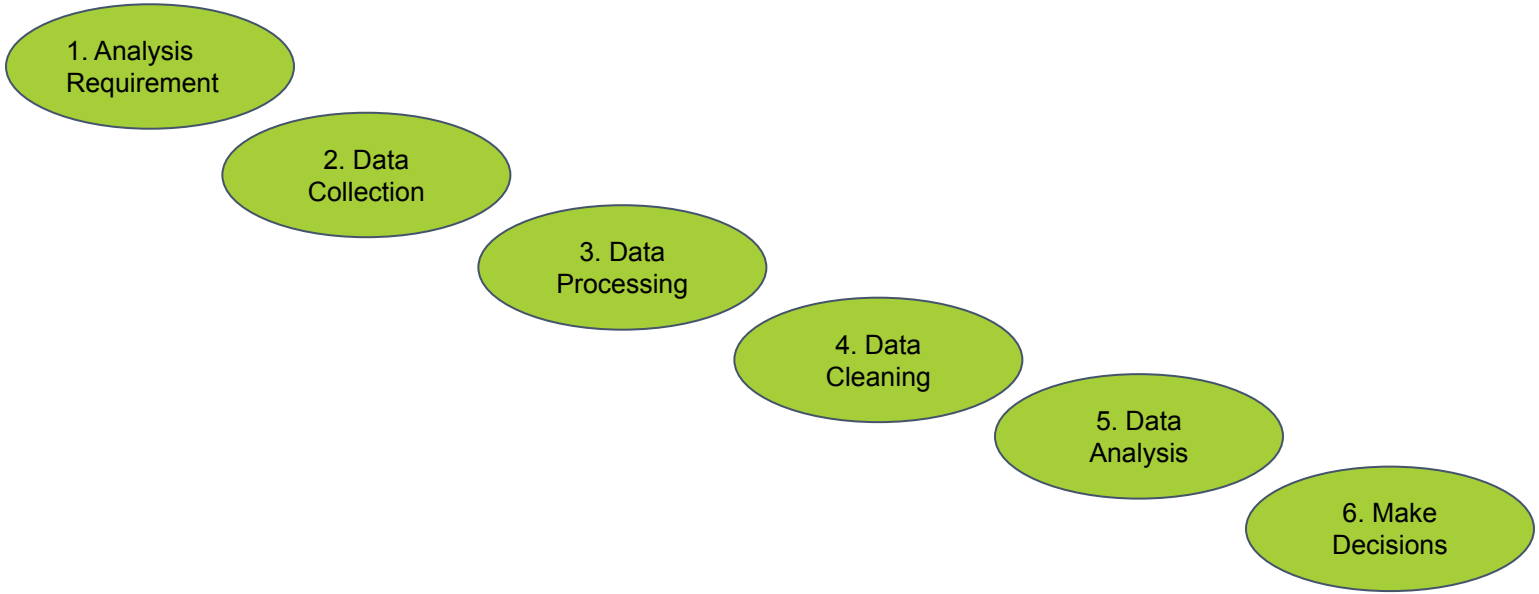
# Data Analytics Process

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# Data Analytics Process Explained

- Define the analysis requirements
  - What is the business problem you want to solve?
- Data collection
  - The act of collecting and gathering the data
- Data processing
  - Putting together the collected data in a structured manner

# Data Analytics Process Explained

- Data cleaning
  - Collected data is typically imperfect
  - We need to clean the data before analysis
- Data Analysis
  - Two key methods
    - Quantitative/Statistical Method
    - Graphical/Visualisation
- Make decisions
  - based on the conclusion from the data analysis

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# What We Will Cover In This Session

- Data processing
  - We will introduce to you a few common data format and Pandas has tools to read these format
- Data cleaning
  - Pandas has a few good tools for cleaning data
- Data Analysis
  - Focus on Graphical Methods for Visualisation

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# Google Colab

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# What Is Google Colab

- Google Colab is a free cloud service based on Jupyter Notebooks and it supports free GPU (Graphics Processing Unit)!
- Allows you to share your code with others
  - Others can view how you wrote your code and provide feedbacks
  - Similar to Google Doc and Google Drive
- We will be using Google Colab for most of our code in this workshop

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# Google Colab

- Often, we encounter errors on Python where it is unaware of which module you want

```
>>> import numpy as np
Traceback (most recent call last):
  File "<pyshell#0>", line 1, in <module>
    import numpy as np
ModuleNotFoundError: No module named 'numpy'
>>>
```

- Google colab helps you with these problems
  - Contains almost all the modules needed for data analysis

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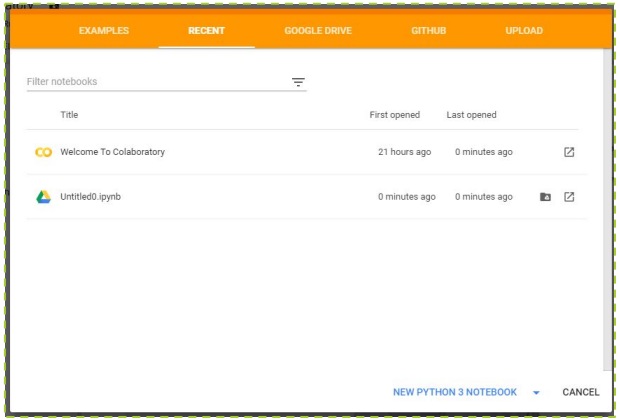
# Setting Up Google Colab

- Ensure you have signed in to your google account
- Start by opening a browser
  - https://colab.research.google.com
- Click on new Python 3 notebook

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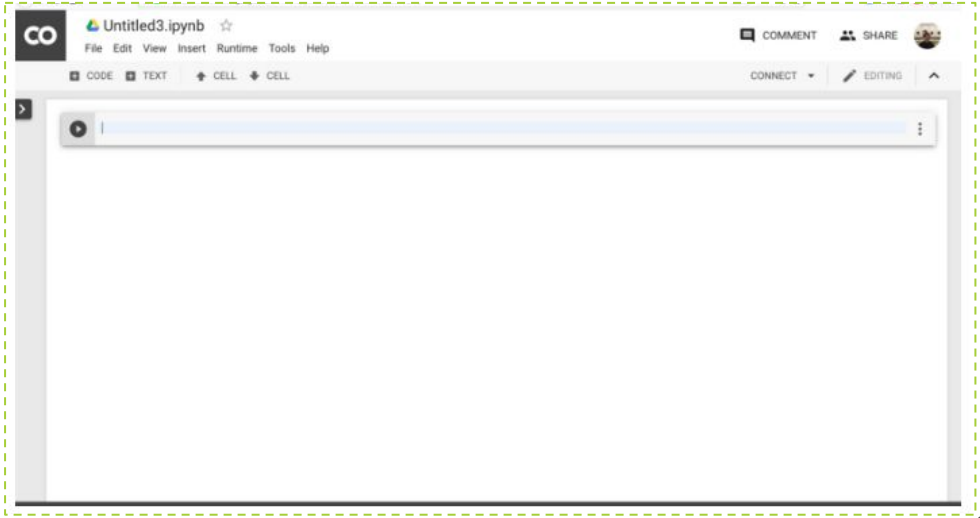
# Google Colab Layout

- By default, the surface of Google Colab looks similar to IDLE

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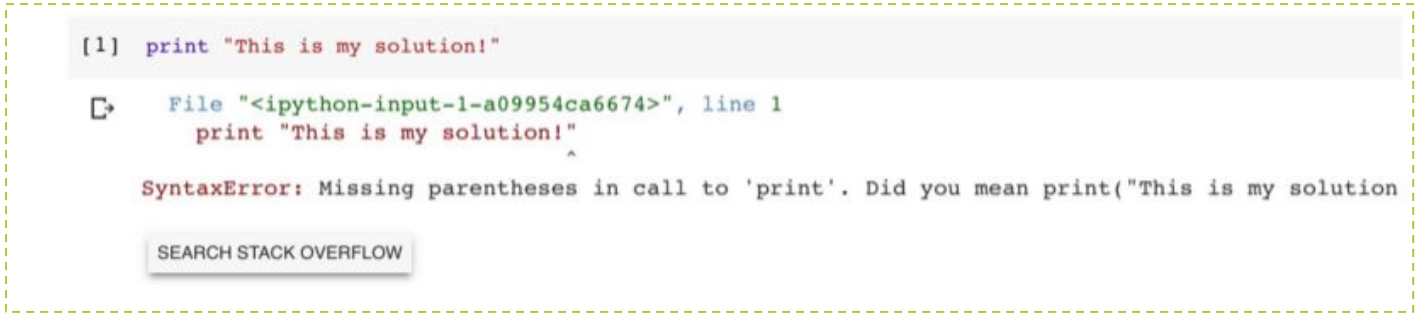
# How Google Colab Works

- Runs cell by cell
- Shares your answer and provides a very useful function to find possible answers

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# Sharing Codes

- Google Colab allows you to share your code with others
  - Similar to Google Docs
  - Permissions can also be selected
    - It is best to only allow others to view your code. Why?

# Google Colab (Demo/Practice - 1)

- If you have not already done so, create your first platform on google Colab
  - https://colab.research.google.com

# Checkpoint 1

- Every student must be able to:
  - Sign in to google account and opened a new Python Notebook on Google Colab

- For students who are waiting, try the following:
  - Familiarise yourself with the surface you would be working with

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# Introduction to Pandas

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# What Is Pandas?

- A software library written for the Python programming language for data analysis
  - Pandas stands for Python Data Analysis Library
- Offers data structures and operations for manipulating numerical tables

# Why Pandas?

- Pandas present data in a way that is suitable for data analysis
  - Series and DataFrame data structures
- Package contains multiple methods for convenient data filtering
- Pandas can read data from a variety of formats such as CSV, TSV, MS Excel, etc

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# Pandas Installation

- Install the necessary library and import pandas into python
  - Since we are using Google Colab, Pandas library already exist

```
1   import pandas as pd
```

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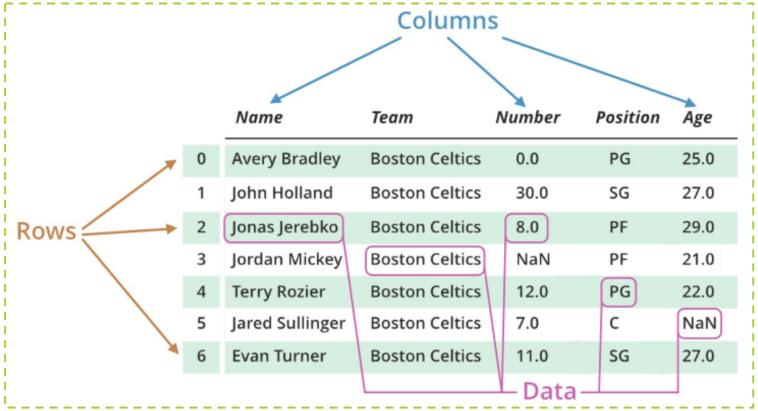
# DataFrame

- A two-dimensional, tabular data structure with labeled axes (rows and columns)
  - the primary pandas data structure
- You can think of a Dataframe as a spreadsheet in Python




| | Name | Team | Number | Position | Age |
|---|---|---|---|---|---|
| 0 | Avery Bradley | Boston Celtics | 0.0 | PG | 25.0 |
| 1 | John Holland | Boston Celtics | 30.0 | SG | 27.0 |
| 2 | Jonas Jerebko | Boston Celtics | 8.0 | PF | 29.0 |
| 3 | Jordan Mickey | Boston Celtics | NaN | PF | 21.0 |
| 4 | Terry Rozier | Boston Celtics | 12.0 | PG | 22.0 |
| 5 | Jared Sullinger | Boston Celtics | 7.0 | C | NaN |
| 6 | Evan Turner | Boston Celtics | 11.0 | SG | 27.0 |

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# Creating DataFrames

- Multiple ways to create DataFrames using python
  - Manually
    - List of lists
    - List of Dictionaries
  - Updating an existing dataset
- All outputs would be presented neatly and beautifully in a table format

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# List of Lists

- Creating multiple lists and storing them in a list
- Each column represents different categories

```
1   import pandas as pd
2   data = [
3       ['Alex', 20, 1050],
4       ['Bob', 52, 1400],
5       ['Cat', 23, 1690]
6   ]
7
8   df = pd.DataFrame(data, columns=['name', 'age', 'salary'])
9
10  print(df)
```

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# List of Dictionaries

- Creating multiple dictionaries and storing them in a list
- What's the difference in terms of the output?

```python
import pandas as pd

data = [
    {'name': 'Alex', 'age': 20, 'salary': 1050},
    {'name': 'Bob', 'age': 52, 'salary': 1400},
    {'name': 'Cat', 'age': 23, 'salary': 1690}
]

df = pd.DataFrame(data, columns=['name', 'age', 'salary'])

print(df)
```

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# Series

- A series is a row or column of a DataFrame
- In another word, a DataFrame is made up of multiple Series stuck together vertically and horizontally

# Creating DataFrames (Demo/Practice - 2)

- Try creating a DataFrame of your own (Name, weight, height)
  - List of Lists
  - List of Dictionaries

# Checkpoint 2

- Every student must be able to:
  - Understand what a DataFrame is and how to create one
  - Understand what a Series is
- For students who are waiting, try the following:
  - Read up if there are any other methods to create a DataFrame in Python
    - Which do you find easier?

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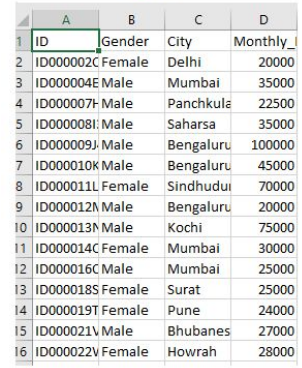
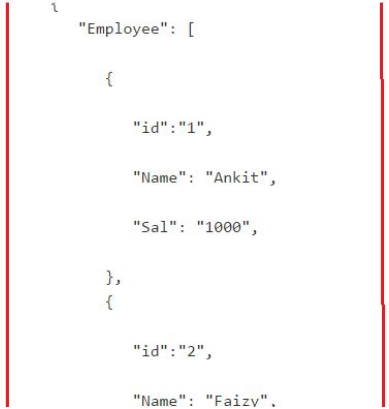
# Structured Datasets

**CSV**



| | A | B | C | D |
|---|---|---|---|---|
| 1 | ID | Gender | City | Monthly_I |
| 2 | ID000002C | Female | Delhi | 20000 |
| 3 | ID000004E | Male | Mumbai | 35000 |
| 4 | ID000007H | Male | Panchkula | 22500 |
| 5 | ID000008I | Male | Saharsa | 35000 |
| 6 | ID000009J | Male | Bengaluru | 100000 |
| 7 | ID000010K | Male | Bengaluru | 45000 |
| 8 | ID000011L | Female | Sindhudu | 70000 |
| 9 | ID000012M | Male | Bengaluru | 20000 |
| 10 | ID000013N | Male | Kochi | 75000 |
| 11 | ID000014O | Female | Mumbai | 30000 |
| 12 | ID000016Q | Male | Mumbai | 25000 |
| 13 | ID000018S | Female | Surat | 25000 |
| 14 | ID000019T | Female | Pune | 24000 |
| 15 | ID000021V | Male | Bhubanes | 27000 |
| 16 | ID000022W | Female | Howrah | 28000 |

**JSON**



```
{
  "Employee": [
    {
      "id":"1",
      "Name": "Ankit",
      "Sal": "1000",
    },
    {
      "id":"2",
      "Name": "Faizy",
```

```
<?xml version="1.0"?>
<contact-info>
<name>Ankit</name>
<company>Anlytics Vidhya</company>
<phone>+9187654321</phone>
</contact-info>
```

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# What are Data Formats?

- A format in which data is stored
- The information is coded in such a way that a program or application can recognize, read and use the data

# Data Formats

- Common types of data formats
  - CSV
  - JSON
  - Excel
  - XML
- We will be learning how to work with CSV format in pandas
  - Other formats can be found in the Appendix

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# Data Formats - Common Uses

| Data Format | Common Uses |
| --- | --- |
| CSV | Simple file format used to store tabular data, such as a spreadsheet or database |
| JSON | Primarily used to transmit data between a server and web applications |
| XML | XML is used to store or transport data in HTML applications. HTML is used to format and display the same data. XML separates the data from HTML |
| Excel (.xls) | Spreadsheet file created by Microsoft Excel |

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# CSV File Format

- The most common format is a Comma Separated Value (CSV) format
  - Most people know how it works and
  - Easily viewable in various products
    - Including Microsoft Excel and Python
- A CSV file is a human readable text file where each line has a number of fields, separated by commas or some other delimiter

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# CSV files on Google Colab

- In order to read files on Google Colab, we have to import them first (Recommend using Google Chrome!)

```
1  #importing csv files onto google colab
2  from google.colab import files
3  uploaded = files.upload()
```

- Successfully uploaded files would look like this

```
[1]  #importing csv files onto google colab
     from google.colab import files
     uploaded = files.upload()
```


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# Using Pandas to Read CSV

- We can read from CSV using **read_csv()** function
  - First import the file onto Google Colab
  - Return the file into Dataframe format

```
1   import pandas as pd
2
3   pd.read_csv('unit05-data.csv')
```

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# Extracting data in DataFrame

- We can extract columns and rows from a Data Frame
  - Exact syntax will be covered later
- For example, I want to find out the total number of cases of TB per 100k people in Singapore from 2000 to 2016
  - Simply extract the row where the country is Singapore and add them up using **.sum()**

```
1  import pandas as pd
2  df =pd.read_csv('unit05-data.csv')
3
4  sg = df[ (df['country'] == 'Singapore')]
5  sg['Estimated incidence (all forms) per 100 000 population'].sum()
```

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# Reading CSV in DataFrame (Demo/Practice - 3)

- unit05-data.csv is a csv file which contains data regarding the cases of Tuberculosis in multiple countries
- Using the file unit05-data.csv
  - How many cases of Tuberculosis were there in 2008 in total?
  - Find out how many cases of Tuberculosis per 100k people there were in Zimbabwe from 2000 to 2016

# Checkpoint 3

- Every student must be able to:
  - Open csv files into Dataframe
  - Extract specific data from dataframe
- For students who are waiting, try the following:
  - Access the csv file and add up the total number of Tuberculosis for each country
  - Read up on other ways to open csv files
    - Hint: Search up csv.writer()

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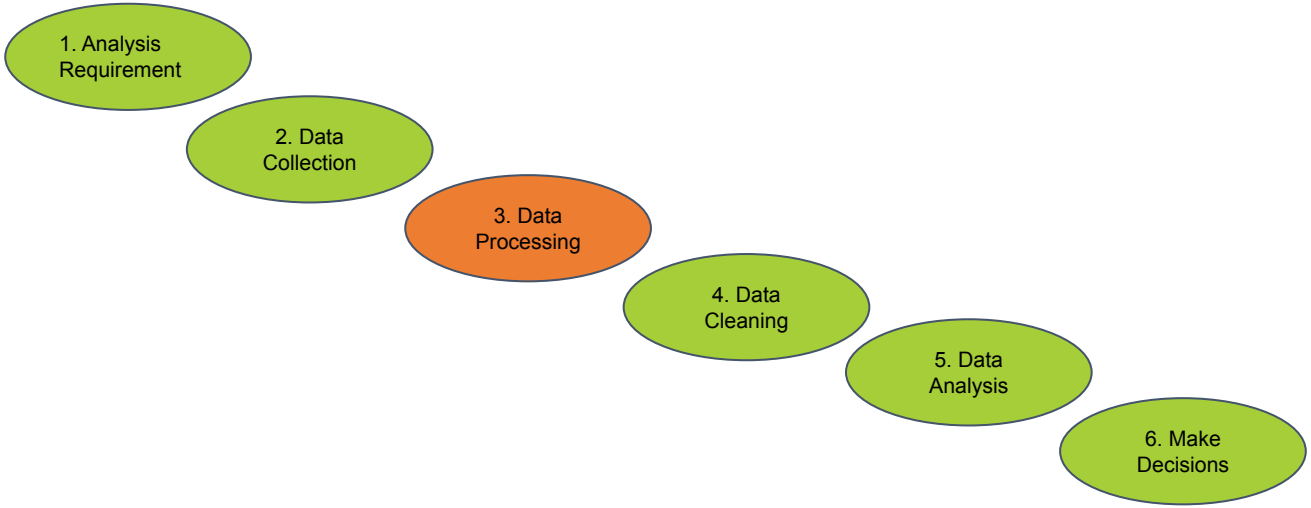
# Data Processing

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# Manipulating Data for Quantitative Analysis

- Common Data Manipulation Methods
  - Extract column, Extract row
  - Grouping and Aggregation - By single column, by multiple columns
  - Filtering (selecting rows based on 1 or more criteria)
  - Joining related data from different tables
  - Pivoting
- Application of Statistical Methods will be covered in Session 3

# Extracting A Row From DataFrame

- To extract a row, we use **loc()** function with the desired index we want

```
data = [
    {'name': 'Cat', 'age': 23, 'salary': 1690},
    {'name': 'Alex', 'age': 20, 'salary': 1050},
    {'name': 'Bob', 'age': 52, 'salary': 1400}

]

df = pd.DataFrame(data, columns=['name', 'age', 'salary'])
print(df.loc[0])
```

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# Extracting A Column From DataFrame

- On the other hand, to extract a column, we simply type in the title of the column we want

```
data = [
    {'name': 'Cat', 'age': 23, 'salary': 1690},
    {'name': 'Alex', 'age': 20, 'salary': 1050},
    {'name': 'Bob', 'age': 52, 'salary': 1400}

]

df = pd.DataFrame(data, columns=['name', 'age', 'salary'])
print(df['name'])
```

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# Extracting A Row And Column (Demo/Practice - 4)

- Based on the DataFrame you have created earlier
  - Extract a row
  - Extract a column

# Checkpoint 4

- Every student must be able to:
  - Extract a particular row or column from DataFrame

- For students who are waiting, try the following:
  - What are other functions or methods you have discovered that can extract rows and columns?

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# Grouping and Aggregation in Pandas

- Pandas comes with a whole host of sql-like aggregation functions you can apply when grouping on one or more column

# Sample Dataset

- Let's start by creating a sample dataset

```
1  import pandas as pd
2  student = ["Anna","Bob","Cass","Darius","Eugene","Felica","Gordon"]
3  classroom = ["A","A","B","A","B","B","B"]
4  age = [15,15,16,17,15,18,15]
5  score =  [80,82,95,70,67,98,85]
6  data = {"Student": student, "Class":classroom, "Age": age,"Score": score}
7  df = pd.DataFrame(data)
8  df
```

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# Grouping and Aggregation Example

- First we'll group by Class with Pandas' **groupby** function
- After grouping we can pass **aggregation** functions to the grouped object as a dictionary within the agg function
  - This dict takes the column that you're aggregating as a key, and either a single aggregation function or a list of aggregation functions as its value.
  - To apply aggregations to multiple columns, just add additional key:value pairs to the dictionary.

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# Grouping and Aggregation Code

- Sample code:

```
1  import pandas as pd
2  student = ["Anna","Bob","Cass","Darius","Eugene","Felica","Gordon"]
3  classroom = ["A","A","B","A","B","B","B"]
4  age = [15,15,16,17,15,18,15]
5  score =  [80,82,95,70,67,98,85]
6  data = {"Student": student, "Class":classroom, "Age": age,"Score": score}
7  df = pd.DataFrame(data)
8  class_score = df.groupby('Class').agg({'Score': ['mean', 'min', 'max']})
9  class_score
```

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# Grouping by Multiple Columns

- It’s simple to extend this to work with multiple grouping variables.
- Say we want to summarise student score by class AND age.
  - We can do this by passing a list of column names to class_score instead of a single string value

# Grouping by Multiple Columns: Code

- Sample Code:

```
1  import pandas as pd
2  student = ["Anna","Bob","Cass","Darius","Eugene","Felica","Gordon"]
3  classroom = ["A","A","B","A","B","B","B"]
4  age = [15,15,16,17,15,18,15]
5  score =  [80,82,95,70,67,98,85]
6  data = {"Student": student, "Class":classroom, "Age": age,"Score": score}
7  df = pd.DataFrame(data)
8  class_score = df.groupby(['Class','Age']).agg({'Score': ['mean', 'min', 'max']})
9  class_score
```

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# Grouping & Aggregation (Demo/Practice - 5)

- Create your own sample dataset
  - Similar to the earlier example

- Apply grouping and aggregation to your dataset

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# Checkpoint 5

- Every student must be able to:
  - Create a sample dataset
  - Group and aggregate the data
- For those who are waiting, try the following:
  - Try performing grouping and aggregation on one of the bigger datasets given (e.g. Unit05-Demo53.xls)
    - Summarise the ages by gender and country

# Filtering

- One of the biggest advantages of having the data as a Pandas Dataframe is that Pandas allows us to slice and dice the data in multiple ways
- Often, we may want to subset a pandas dataframe based on one or more values of a specific column
    - Essentially, we would like to select rows based on one value or multiple values present in a column

# Filtering Scenario

- Let’s go back to the tuberculosis example
  - Huge dataframe with 3651 rows and 7 columns

# Select Rows Based on Value of Column

- One way to filter by rows in Pandas is to use boolean expression
- We first create a boolean variable by taking the column of interest and checking if its value equals to the specific value that we want to select/keep

# Select Rows: Code

- For example, let us filter the dataframe or subset the dataframe based on year's value 2002
  - This conditional results in a boolean variable that has True when the value of year equals 2002, False otherwise
  - We can then use this boolean variable to filter the dataframe.

```
1  import pandas as pd
2  df = pd.read_csv('unit05-data.csv')
3
4  year_2002 = df[ (df['year'] == 2002)]
5  year_2002
```

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# Selection Results

- After subsetting we can see that new dataframe is much smaller in size

| | country | iso2 | iso3 | Region Code | year | Total Population | Estimated incidence (all forms) per 100 000 population |
|---|---|---|---|---|---|---|---|
| **2** | Afghanistan | AF | AFG | EMR | 2002 | 21979923 | 189.0 |
| **19** | Albania | AL | ALB | EUR | 2002 | 3119029 | 22.0 |
| **36** | Algeria | DZ | DZA | AFR | 2002 | 31995046 | 74.0 |
| **53** | American Samoa | AS | ASM | WPR | 2002 | 58731 | 3.9 |
| **70** | Andorra | AD | AND | EUR | 2002 | 70049 | 8.2 |
| **...** | ... | ... | ... | ... | ... | ... | ... |
| **3568** | Wallis and Futuna Islands | WF | WLF | WPR | 2002 | 14622 | 149.0 |
| **3585** | West Bank and Gaza Strip | PS | PSE | EMR | 2002 | 3379049 | 1.9 |
| **3602** | Yemen | YE | YEM | EMR | 2002 | 18919179 | 102.0 |
| **3619** | Zambia | ZM | ZMB | AFR | 2002 | 11120409 | 695.0 |
| **3636** | Zimbabwe | ZW | ZWE | AFR | 2002 | 12500525 | 617.0 |

213 rows × 7 columns

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# Select Rows Whose Column Value Does Not Equal a Specific Value

- Sometimes, you may want to keep rows of a data frame based on values of a column that does not equal something
- Let us filter our TB dataframe whose year column is not equal to 2002
    - Basically we want to have all the years' data except for the year 2002.

# Select Not Equal Rows: Code

- Instead of the equivalence operator (==), we can now use the non-equivalence operator (!=)

```
1   import pandas as pd
2   df = pd.read_csv('unit05-data.csv')
3
4   year_not_2002 = df[ (df['year'] != 2002)]
5   year_not_2002
```

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# Select Rows Whose Column Value is Not NA/NAN

- Often we may want to filter a Pandas dataframe such that we keep the rows if values of certain column is not NA/NAN.
- We can use Pandas **notnull()** method to filter based on NA/NAN values of a column.

```
1   import pandas as pd
2   df = pd.read_csv('unit05-data.csv')
3   df_not_null = df[df.year.notnull()]
4   df_not_null
```

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# Pandas isin()

- Pandas DataFrame.**isin()** function allows us to select rows using a list or any iterable
- If we use isin() with a single column, it will simply result in a boolean variable with True if the value matches and False if it does not

# Select Rows Based on a List

- Sometimes, we want to select rows using multiple values present in an iterable or a list
  - For example, let us say we want select rows for years [2002, 2008]

```
1  import pandas as pd
2  df = pd.read_csv('unit05-data.csv')
3
4  years = [2002,2008]
5  selection = df[df.year.isin(years)]
6
7  selection
```

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# Negation Symbol (~)

- We can also select rows based on values of a column that are not in a list or any iterable
- We will create a boolean variable just like before, but now we will negate the boolean variable by placing ~ in the front

# Select Rows Based on Values Not in List

- For example, to get rows where the year is not 2002 nor 2008, we can use the following code:

```
1  import pandas as pd
2  df = pd.read_csv('unit05-data.csv')
3
4  years = [2002,2008]
5  selection = df[~df.year.isin(years)]
6
7  selection
```

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# Select Rows Using Multiple Conditions

- We can combine multiple conditions using **&** operator
  - For example, we can combine the above two conditions to get Singapore's data from years 2002 and 2008

```
1  import pandas as pd
2  df = pd.read_csv('unit05-data.csv')
3
4  years = [2002,2008]
5  country = ["Singapore"]
6  selection = df[df.year.isin(years) & df.country.isin(country)]
7
8  selection
```

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# Filtering (Demo/Practice - 6)

- Using unit05-data.csv, try the following
  - Select Singapore's data from years 2002 and 2008
  - Select data between 2004 and 2008 that are not from Singapore

# Checkpoint 6

- Every student must be able to:
  - Filter and select rows of a DataFrame
- For those who are waiting, try the following:
  - Try filtering through the DataFrame for other countries' information, as well as information from other years

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# Joining Data From Multiple Data Frames

- In many scenarios, our data are often disjointed
  - Meaning they come in multiple files
- In order to process the data, we will first need to join the dataframes

# Creating More Datasets

```
1   import pandas as pd
2   student1 = ["Anna","Bob","Cass","Darius","Eugene","Felica","Gordon"]
3   classroom1 = ["A","A","B","A","B","B","B"]
4   age1 = [15,15,16,17,15,18,15]
5   score1 =  [80,82,95,70,67,98,85]
6   data1 = {"Student": student1, "Class":classroom1, "Age": age1,"Score": score1}
7   df1 = pd.DataFrame(data1)
8
9   student2 = ["Charlie","James","Ethan"]
10  classroom2 = ["C","C","C"]
11  age2 = [16,17,18]
12  score2 = [95,77,80]
13  data2 = {"Student": student2, "Class":classroom2, "Age": age2,"Score": score2}
14  df2 = pd.DataFrame(data2)
```

{<oding:lab}

# Concatenate By Row and Column

- We can concatenate two dataframes by using **pd.concat()**
  - What happens if we leave out ignore_index = True?

```
16  df_row = pd.concat([df1, df2], ignore_index=True)
17  df_row
```

- To concatenate DataFrames along column, you can specify the axis parameter as 1
  - But this will not make much sense in our example here
  - Will be useful if we wish to add in more fields for each student
    - E.g. Parents' name

{<oding:lab}

# Merge DataFrames

- Two DataFrames might hold different kinds of information about the same entity and linked by some common feature/column
- To join these DataFrames, pandas provides multiple functions like **concat()**, **merge()** , **join()**, etc
- We will cover merge()

# Merge DataFrames on Specific Keys

- Say we want to add in the students' id numbers
  - We have a separate data frame holding the id numbers
  - We can use **pd.merge()** to merge the data frames

```
18  student3 = ["Anna","Bob","Cass","Darius","Eugene","Felica","Gordon","Charlie","James","Ethan"]
19  id3 = [1,2,3,4,5,6,7,8,9,10]
20  data3 = {"Student":student3, "id":id3}
21  df3 = pd.DataFrame(data3,columns = ['Student', 'id'])
22
23  df_merge_col = pd.merge(df_row, df3, on="Student")
24  df_merge_col
```

{<oding:lab}

# Merge Dataframes (Demo/Practice - 7)

- Create 2 more datasets to supplement the dataset you created earlier
  - Create dataframes and try to merge your datasets
  - What happens when the order of the names are different?
  - How about when there is a different name?

# Checkpoint 7

- Every student must be able to:
  - Concatenate and Merge data frames
- For those who are waiting, try the following:
  - Read up on pd.concat
    - What other arguments can it accept?

# Pivot Tables

- A pivot table is a table of statistics that summarizes the data of a more extensive table
- A pivot table calculates a statistic on a breakdown of values
  - For the first column, it displays values as rows and for the second column as columns

# Pivoting in Pandas

- Pandas has a **pivot_table** function that applies a pivot on a DataFrame.
- It also supports aggfunc that defines the statistic to calculate when pivoting
  - aggfunc is np.mean by default, which calculates the average

# Pivoting in Pandas: Example

- Going back to our earlier dataset we used for merging, suppose we would like to have a breakdown of average scores with class in rows (specify index) and age in columns (specify columns)

```
27   df_merge_col.pivot_table(index="Class", columns="Age", values="Score")
```

# Pivoting in Pandas: Result

- The pivot table should look something like this

| Age | 15 | 16 | 17 | 18 |
|---|---|---|---|---|
| Class | | | | |
| A | 81.0 | NaN | 70.0 | NaN |
| B | 76.0 | 95.0 | NaN | 98.0 |
| C | NaN | 95.0 | 77.0 | 80.0 |

{<oding:lab}

# Set Missing Values To 0

- pivot_table has a **fill_value** argument to replace missing values with
  - None by default

```
27   df_merge_col.pivot_table(index="Class", columns="Age", values="Score", fill_value = 0)
```

{<oding:lab}

# Pandas Pivot Table (Demo/Practice - 8)

- Create a Pivot Table
  - Calculate the maximum and minimum score by class ages
  - Set missing values to 0

# Checkpoint 8

- Every student must be able to:
  - Create a Pivot Table
- For those who are waiting, try the following:
  - Read up on Pivot Tables
    - What is the difference between pd.pivot() and pd.pivot_table()

# Outputting The Data

- Now that we have our pivot table, let's output it into a .csv file

```
1   df_merge_col.to_csv (r'df_merge_col.csv', index = False, header=True)
```

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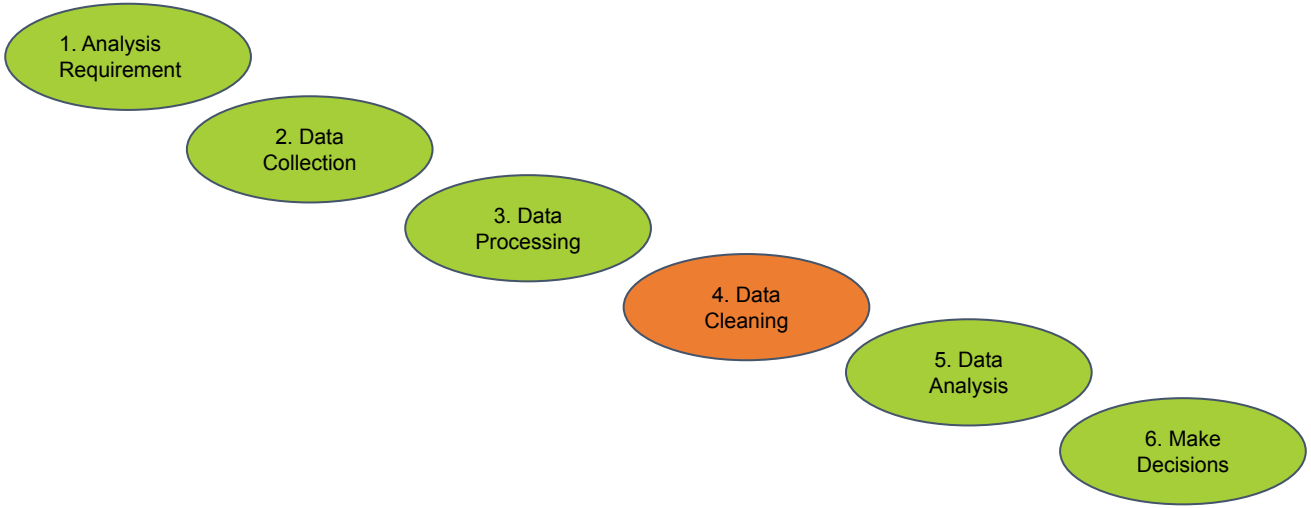
# Data Cleaning

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# Unstructured Data

- Our dataset usually contains different types of data in different formats
  - But a machine can only understand mathematical data.
- Our data may contain colors, date, gender, city etc. which are not in numerical format.
  - So they required to be converted in some numerical formats.

# What is Data Preprocessing?

- Sometimes data values are in different ranges which can cause some problems in learning.
  - So they need to be converted into some fixed ranges.
- Data preprocessing is simply converting these types of data into some valid numerical form in order for us to successfully perform data analysis
- Data preprocessing plays a very important role in Data Analytics

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# Data Preprocessing in Pandas

- Using Pandas, we can accomplish five typical steps in the processing and analysis of data, regardless of the origin of data
  - Load
  - Prepare
  - Manipulate
  - Model
  - Analyze

# Missing Data

- There are some specific rows in our dataset which doesn't contain any information for some specific columns.
- Handling missing values is very common in Data Analytics as our programs often do not work if there are missing rows or columns in a data frame

# Handling Missing Data

- Missing data can be handled commonly in two ways
  - Removing data
  - Imputation

# Removing Data

- In many cases, the solution is just removing the specific row. If we use pandas, then it is very simple. We just need to use one pandas methods called **dropna()**
- Suppose we have a panda dataframe df, which contains some missing values.

# Removing Data Example

- Let’s look at “MissingData.xls”
  - The file contains the information of a group of people who visited a restaurant on a particular date
  - A few ages are omitted, say, because some customers did not want to reveal their age
  - These customers did not get the discount
- The restaurant had a promotion on 21 May 2015, where customers 25 and above get to dine in for free
  - Find out the total number of people who enjoyed this perk

{<oding:lab}

# New Table With Missing Data

- Our table now looks something like this

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | **0** | **First Name** | **Last Name** | **Gender** | **Country** | **Age** | **Date** | **Id** |
| 2 | 1 | Dulce | Abril | Female | United States | 32 | 15/10/2017 | 1562 |
| 3 | 2 | Mara | Hashimoto | Female | Great Britain | 25 | 16/08/2016 | 1582 |
| 4 | 3 | Philip | Gent | Male | France | | 21/05/2015 | 2587 |
| 5 | 4 | Kathleen | Hanner | Female | United States | | 15/10/2017 | 3549 |
| 6 | 5 | Nereida | Magwood | Female | United States | | 16/08/2016 | 2468 |
| 7 | 6 | Gaston | Brumm | Male | United States | 24 | 21/05/2015 | 2554 |
| 8 | 7 | Etta | Hurn | Female | Great Britain | 56 | 15/10/2017 | 3598 |
| 9 | 8 | Earlean | Melgar | Female | United States | 27 | 16/08/2016 | 2456 |
| 10 | 9 | Vincenza | Weiland | Female | United States | 40 | 21/05/2015 | 6548 |
| 11 | 10 | Fallon | Winward | Female | Great Britain | 28 | 16/08/2016 | 5486 |

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# Remove Row with Missing Data

- We can use the **dropna()** function
  - dropna() takes in 1 optional argument, axis, which determines whether we remove a row or column. By default, it is 0 for row

```
1   import pandas as pd
2   df = pd.read_excel("MissingData.xls",typ = "series")
3   df = df.dropna()
4   df
```

{<oding:lab}

# Remove Column with Missing Data

- If we want to remove the column instead, we can set the argument axis = 1 inside the dropna() method
  - But in this example, it makes more sense to remove the row rather than the column

```
1  import pandas as pd
2  df = pd.read_excel("MissingData.xls",typ = "series")
3  df = df.dropna(axis=1)
4  df
```

{<oding:lab}

# Missing Data (Demo/Practice - 9)

- Using “MissingData.xls”, try the following:
  - Remove rows with missing data
  - Remove columns with missing data

# Checkpoint 9

- Every student must be able to:
  - Remove rows with missing data
  - Remove columns with missing data
- For those who are waiting, try the following:
  - How would removing rows/column with missing data affect our overall dataset?

{<oding:lab}

# Removing Data?

- Removing data, while convenient, is usually not the best solution.
- Sometimes deleting a row can delete some important information of other columns
- So there is another method called ‘Imputation’

# Imputation

- In imputation, instead of deleting a row, we fill the missing values by some other values
- The imputed values might be median, mean, 0 etc.
- The imputed values might not be exactly the same but it is very accurate to the right value

# Imputation Scenario

- We earlier established that customers who did not reveal their age were not eligible for the discount
  - Hence we do not need to count them in
  - But we might not want to remove the row entirely, as removing them will affect things like the overall percentage of customers who were given discounts

# Imputation in Pandas

- Since we know that only customers who are 25 and above will get a free meal, we can set the unknown to 0 so they will not be counted

```
1   import pandas as pd
2   df = pd.read_excel("MissingData.xls")
3   df["Age"] = df["Age"].fillna(0)
4   df
```

{<oding:lab}

# Imputation (Demo/Practice - 10)

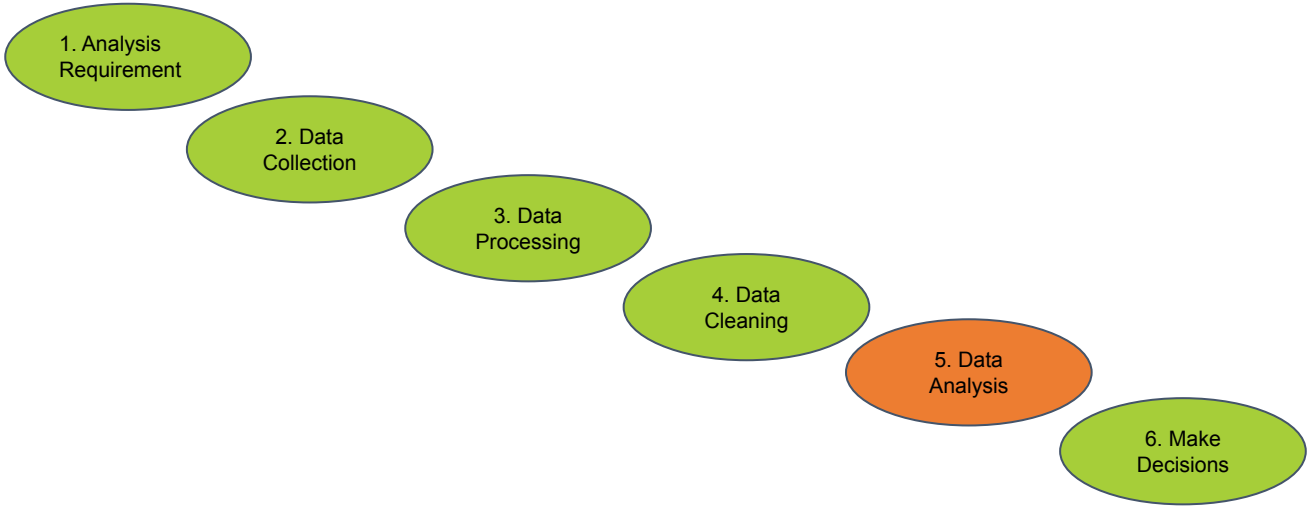
- Using “MissingData.xls”, try the following:
  - Impute data into missing rows

# Checkpoint 10

- Every student must be able to:
  - Impute missing data into a DataFrame
- For those who are waiting, try the following:
  - What are some other differences between removal and imputation?

{<oding:lab}

# Data Analysis

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# Data Analysis

- Two methods of Data Analysis
- Quantitative
  - This includes applying statistical methods to analyze data
- Graphical
  - This is all about visualising the data
- We will focus on graphical analysis in this session

# Data Visualisation

- Data visualization is the graphical representation of information and data.
  - Visual elements like charts, graphs, and maps are used
- Provides an accessible way to see and understand trends and patterns in data
- Analyze massive amounts of information and make data-driven decisions

{<oding:lab}

# Data Visualisation In Python

- Many well-known libraries which provide data visualisation tools on the internet
  - Matplotlib
- Our main focus is going to be on Plotly

{<oding:lab}

# What Is Plotly?

- A Python graphing library which enables users to create interactive graphs
- Allows user to share their data plotted with others

# Why Plotly?

- Equipped with a robust API
  - Users can create extremely fun and interactive plots
- Unlike other Python graphing libraries, Plotly has both online and offline mode
  - Online mode is a straightforward method for users to view their plots immediately
  - Offline mode sends the user a html link to be saved in a local file and viewed subsequently

{<oding:lab}

# Installing Plotly On Google Colab

- Install plotly

```
1   !pip install plotly
```

- Import necessary functions and and set your credentials
  - Note that setting credentials is only required for online mode

```
1   import plotly.express as px
```

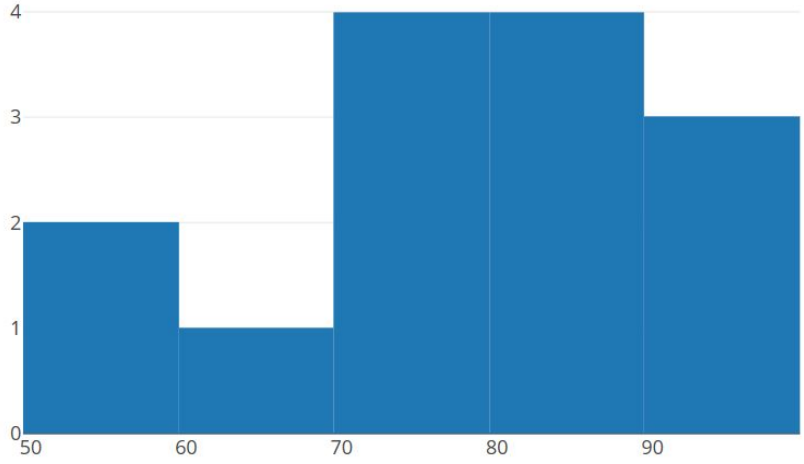
{<oding:lab}

# Plotting Histogram (Demo/Practice - 11)

- Let's create a random list of scores and plot the graph on plotly by using **px.histogram()**

```
1  import pandas as pd
2  import plotly.express as px
3
4  x = [84, 65, 78, 75, 89, 59, 90, 88, 83, 72, 91, 90, 73, 54]
5  df = pd.DataFrame(x, columns =["x"])
6  #df
7  data = px.histogram(df,x="x")
8  data
```

{<oding:lab}

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# Checkpoint 11

- Every student must be able to:
  - Plot a Histogram

- For students who are waiting, try the following:
  - Explore Plotly
  - Try to plot another histogram with your own data
  - Beautify your graph!

{<oding:lab}

# Plotting Boxplot (Demo/Practice - 12)

- Boxplot can be plotted when we use **px.box()**

```
1  import plotly.express as px
2  import pandas as pd
3  import numpy as np
4
5  y1 = [84, 65, 78, 75, 89, 59, 90, 88, 83, 72, 91, 90, 73, 54]
6  df = pd.DataFrame(y1,columns=['y1'])
7
8  boxplot = px.box(df,y='y1')
9  boxplot
```

- Try changing the y to x
- What if there are 2 sets of data? How do i plot 2 boxplots?

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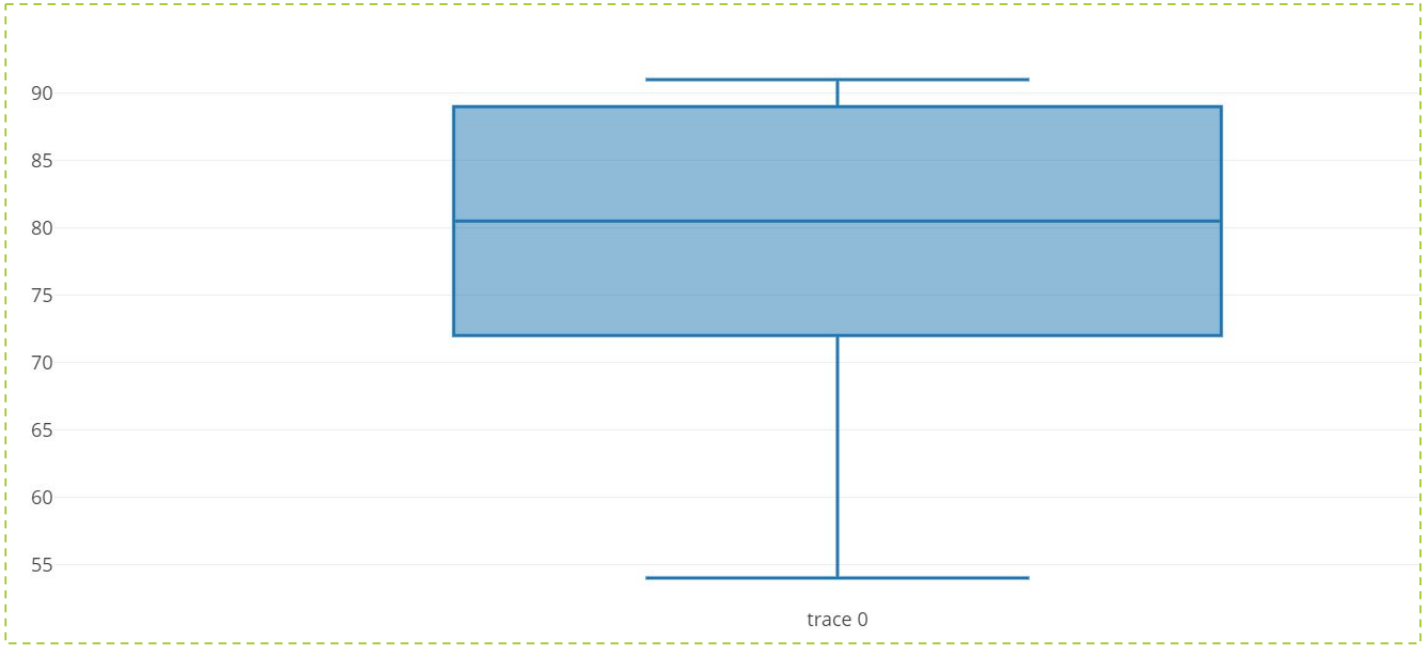


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# Checkpoint 12

- Every student must be able to:
  - Plot a Boxplot

- For students who are waiting, try the following:
  - Explore Plotly
  - Try to plot another boxplot with your own data
  - Beautify your graph!

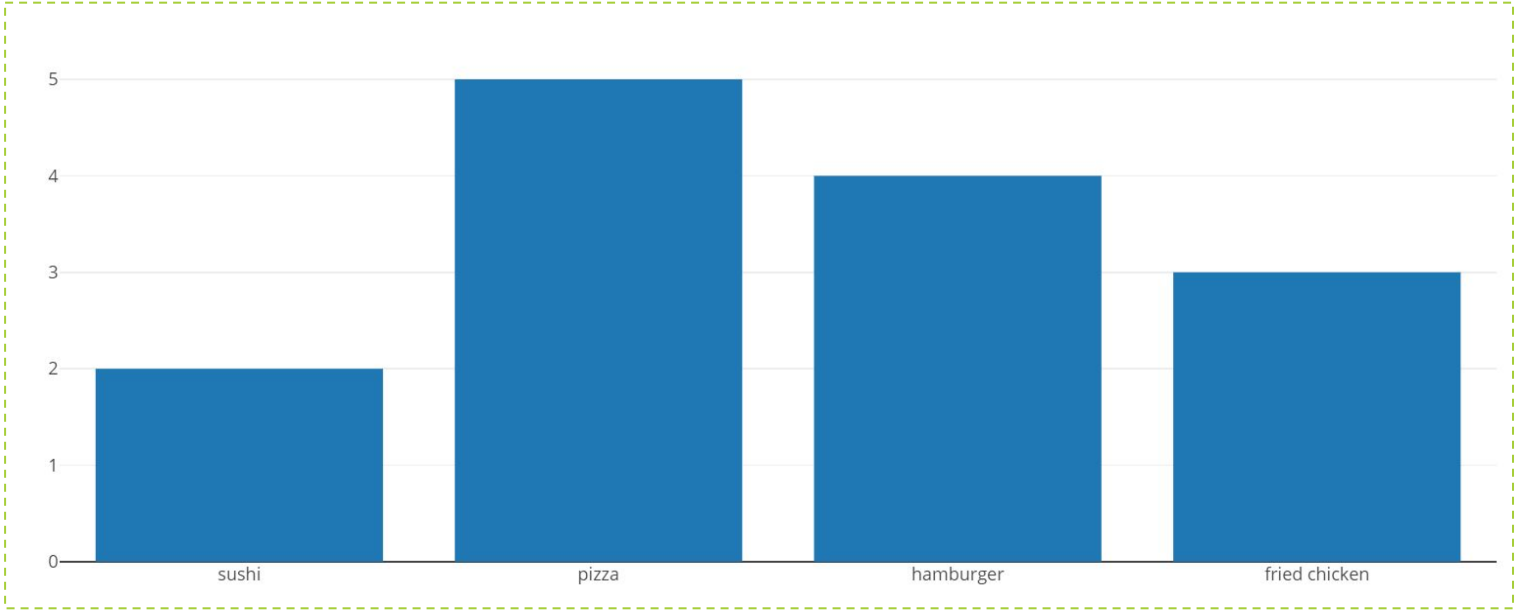
{<oding:lab}

# Plotting Bar Graph (Demo/Practice - 13)

- Bar Graph can be plotted with **px.bar()**

```
1  import plotly.express as px
2  import pandas as pd
3
4  foodItemList=['sushi', 'pizza', 'hamburger', 'fried chicken']
5  numberList=[2, 5, 4, 3]
6  df = pd.DataFrame({"Food Item":foodItemList, "Number of students":numberList})
7  data = px.bar(df,x="Food Item",y="Number of students")
8  data
```

{<oding:lab}

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# Checkpoint 13

- Every student must be able to:
  - Plot a Bar Graph

- For students who are waiting, try the following:
  - Explore Plotly
  - Try to plot another bar graph with your own data
  - Beautify your graph!

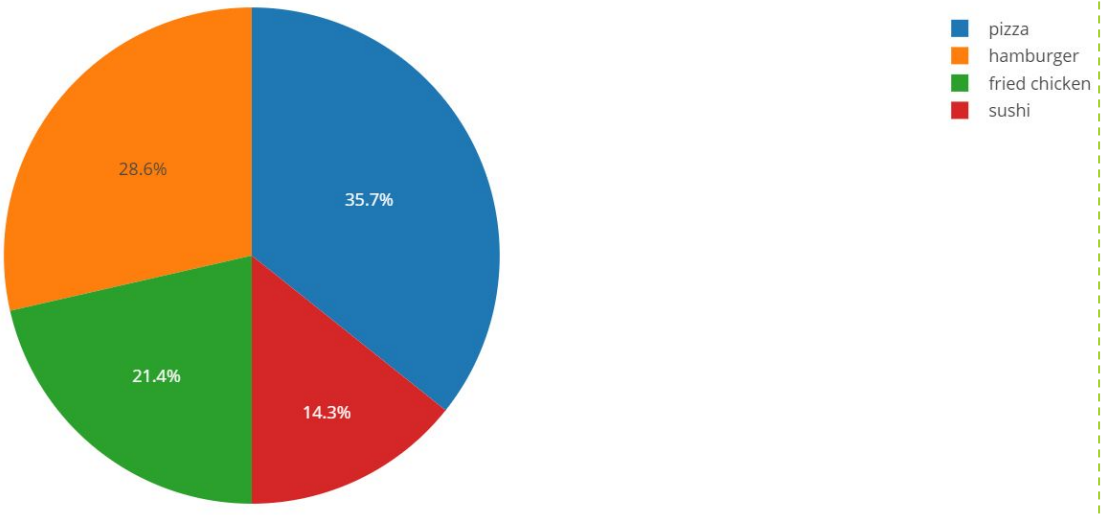
{<oding:lab}

# Plotting Pie Chart (Demo/Practice - 14)

- Pie Charts are plotted with **px.pie()** on plotly
- With the correct values typed in, the Pie Chart returns you the percentage taken up by each category

```
1  import plotly.express as px
2  import pandas as pd
3
4  foodItemList=['sushi', 'pizza', 'hamburger', 'fried chicken']
5  numberList=[2, 5, 4, 3]
6  df = pd.DataFrame({"Food Item":foodItemList, "Number of students":numberList})
7  #df
8
9  chart = px.pie(df,values="Number of students",names="Food Item")
10 chart
```

{<oding:lab}

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# Checkpoint 14

- Every student must be able to:
  - Plot a Pie Chart

- For students who are waiting, try the following:
  - Explore Plotly
  - Try to plot another pie chart with your own data
  - Beautify your graph!

{<oding:lab}

# Summary

- Introduction to Pandas
  - Pandas DataFrame & Series
  - Extracting Row and Column from DataFrame
- Data Formats
  - Reading JSON, CSV, Excel and XML Data in Pandas

# Summary

- More Pandas Functions
  - Data preprocessing
  - Grouping and aggregation
  - Filtering
  - Joining data from multiple data frames
  - Pivoting
  - Outputting the data

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# Summary

- Data Visualisation and Graphing
  - Visualisation and Graphing with Plotly
  - Histogram, Boxplot, Bar Graph, Pie Chart

# Your Feedback Matters!

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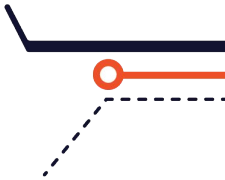
# Appendix



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# CSV Module in Python

- Python has a vast library of modules that are included with its distribution
  - csv module gives the Python programmer the ability to parse CSV files
  - The csv module will be able to read the vast majority of CSV files
  - Can also write CSV files using the csv module
- Documentation at: https://docs.python.org/3/library/csv.html

{<oding:lab}

# JSON Format

- JSON (JavaScript Object Notation) is a lightweight data-interchange format
  - Easy for humans to read and write
  - Easy for machines to parse and generate

# JSON Library In Python

- The json library can parse JSON from strings or files
- The library parses JSON strings into a Python dictionary or list
  - Can also convert Python dictionaries or lists into JSON strings
- But since we already have Pandas, we can use the Pandas JSON reader instead

# Reading JSON in Pandas

- pd.read_json() converts JSON strings to pandas object
- The following code snippet shows us how we can store a JSON string in a Dataframe:

```
1  import pandas as pd
2
3  json_str='{"country":"Netherlands","timezone":"Europe\/Amsterdam","ip":"46.19.37.108",
4      "continent_code":"EU","longitude":5.75,"latitude":52.5,"country_code":"NL"}'
5
6  data = pd.read_json(json_str, typ='series')
7  print("Series\n", data)
```

{<oding:lab}

# Importing JSON files

- We can also import a json file and print the content out into a Dataframe

```
1   import pandas as pd
2   df = pd.read_json ('example_1.json',typ='series')
3
4   df
```

{<oding:lab}

# JSON in Pandas (Demo/Practice - A1)

- Create a JSON string which stores your personal information
  - Eg, First and last name, age, nationality
- Print the json string out into a Dataframe
  - Extract the first column of data from the Dataframe
    - It should be your first name

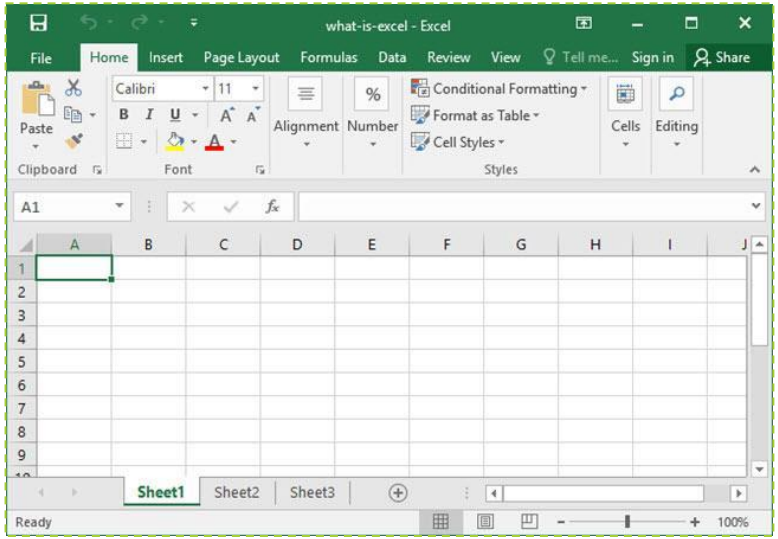
{<oding:lab}

# Checkpoint A1

- Every student must be able to:
  - Convert a JSON string into a dataframe
  -
- For students who are waiting, try the following:
  - Create a dictionary and convert it to json format

# What is Excel?

- Spreadsheet developed by Microsoft
  - One of the most used software programs in the world




{<oding:lab}

# Excel in Pandas

- Similar to all other data formats, we simply make use of built in method to access data from excel file
- Access the unit05_data.xls file

```
1   import pandas as pd
2   df = pd.read_excel ('unit05_data.xls',typ='series')
3
4   df
```

{<oding:lab}

# Extracting data from xls file on Dataframe

- Regardless of whichever data format the file was originally in, once the data is stored in a Dataframe, the extraction process is the same
- Accessing the xls file, to extract the females born in the United States

```
1   import pandas as pd
2   df = pd.read_excel ('unit05_data.xls',typ='series')
3
4   gender_and_country = df[ (df['Gender'] == 'Female') & (df['Country'] == 'United States') ]
5   gender_and_country
```

{<oding:lab}

# XLS file in Pandas (Demo/Practice - A2)

- Open up the XLS file ‘Unit05-Demo53’
- The file contains the information of a group of people who visited a restaurant on a particular date
- The restaurant had a promotion on 21 May 2015, where customers 25 and above get to dine in for free
    - Find out the total number of people who enjoyed this perk

# Checkpoint A2

- Every student must be able to:
  - Extract data from xls file
  - Understand the use of bitwise operators
- For students who are waiting, try the following:
  - Pandas contains many useful methods which helps to compute statistics like df.mean(), df.median() and df.std()
  - Play around with these methods with all the previous statistical practices we have done earlier

{<oding:lab}

# What Is XML?

- XML (eXtensible Markup Language) is another flexible format
  - Used to define and transfer data between computers
- Look at “Unit 05 - XML Sample Data.xml”
- XML files have a specific format

# Reading XML Files Using Python

- Using xml.etree.ElementTree
  - ET in short
- XML is a hierarchical data format
  - The most natural way to represent it is with a tree
- ET has two classes for this purpose
  - ElementTree represents the whole XML document as a tree
  - Element represents a single node in this tree

{<oding:lab}

# How XML Files Are Read

- Interactions with the whole document (reading and writing to/from
- files) are usually done on the ElementTree level
- Interactions with a single XML element and its sub-elements are done on the Element level

# Importing XML File Into Python

- Using ‘Unit 05 - XML Sample Data.xml”
- We can import this data by reading from a file

```
1   import xml.etree.ElementTree as ET
2   tree = ET.parse('Unit 05 - XML Sample Data.xml')
3   root = tree.getroot()
```

{<oding:lab}

# Reading XML Files Using Python

- The root object has children nodes over which we can iterate:

```
1   import xml.etree.ElementTree as ET
2   tree = ET.parse('Unit 05 - XML Sample Data.xml')
3   root = tree.getroot()
4   for child in root:
5     print(child.tag, child.attrib)
```

{<oding:lab}

# Nested Children

- Children are nested, and we can access specific child nodes by index
  - E.g. root[0][1].text

```
country {'name' : 'Liechtenstein'}
country {'name' : 'Singapore'}
country {'name' : 'Panama'}
'2008'
```

{<oding:lab}

# XML in Python (Demo/Practice - A3)

- Try reading ‘Unit 05 - XML Sample Data.xml’
  - Print the child tags and attributes

# Checkpoint A3

- Every Student must be able to:
  - Extract XML data from Python
- For students who are waiting, try the following:
  - Not all elements of the XML input will end up as elements of the parsed tree
    - Currently, this module skips over any XML comments, processing instructions, and document type declarations in the input.
    - Read it up yourself!

{<oding:lab}

# XML in Pandas

- It is fairly easy to import CSV, JSON and Excel files in Pandas dataframe by simply making use of the built in methods
- However there is no built in method to import XML to Pandas
  - We have to make use of standard XML package and do some extra work to convert the data to Pandas Dataframes

# Parsing XML file

- Recall how we parsed an XML file by using parse method
- Subsequently, we obtain the data from each element and store it in a series

```
import pandas as pd
import xml.etree.ElementTree as ET
tree = ET.parse('Unit 05 - XML Sample Data.xml')

for node in tree.getroot():
    name = node.attrib.get('name')
    rank = node.find('rank').text
    year = node.find('year').text
    gdppc = node.find('gdppc').text
```

{<oding:lab}

# Defining Dataframe

- To create a dataframe, we first define the column names for each column
- Then we append our series into our Dataframe

```
dfcols = ["country", "rank", "year", "gdppc"]
df_xml = pd.DataFrame(columns=dfcols)
df_xml = df_xml.append( pd.Series([name, rank, year, gdppc],index=dfcols) , ignore_index =True)

print(df_xml)
```

{<oding:lab}

# XML DataFrame (Demo/Practice - A4)

- Access the xml file - breakfast_menu.xml
- The file displays the name of the food, price, description and the calories
- Parse the xml file and extract the data and store the data in a Dataframe

| | food | price | description | calories |
|---|---|---|---|---|
| 0 | Belgian Waffles | $5.95 | Two of our famous Belgian Waffles with plenty ... | 650 |
| 1 | Strawberry Belgian Waffles | $7.95 | Light Belgian waffles covered with strawberrie... | 900 |
| 2 | Berry-Berry Belgian Waffles | $8.95 | Light Belgian waffles covered with an assortme... | 900 |
| 3 | French Toast | $4.50 | Thick slices made from our homemade sourdough ... | 600 |
| 4 | Homestyle Breakfast | $6.95 | Two eggs, bacon or sausage, toast, and our eve... | 950 |

{<oding:lab}

# Checkpoint A4

- Every student must be able to:
  - Parse an XML file and extract data from each row
  - Append data into a dataframe
- For those who are waiting, try the following:
  - Read up on the functions available to import csv, json and excel files into Pandas Dataframe

{<oding:lab}