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ROLL NUMBER: 546

COURSE: MSc CS

SUBJECT: FUNDAMENTALS OF DATA SCIENCE

PRACTICAL: 1-8

PRACTICAL 1

Data Collection: Data collection is defined as the procedure of collecting, measuring and analyzing accurate insights for research using standard validated techniques. A researcher can evaluate their hypothesis on the basis of collected data. In most cases, data collection is the primary and most important step for research, irrespective of the field of research. The approach of data collection is different for different fields of study, depending on the required information. The most critical objective of data collection is ensuring that information-rich and reliable data is collected for statistical analysis so that data-driven decisions can be made for research.

Data Collection and Datasets

From .csv Files From Excel Files From SQL Files

```
my_dict={'Name':["a","b","c","d","e","f","g"],
        'age':[20,27,35,45,55,43,35],
        'designation':["VP","CEO","CFO","VP","VP","CEO","MD"]}
```

```
import pandas as pd
import numpy as np
df=pd.DataFrame(my_dict)
df
```

```
  Name  age designation
0    a   20          VP
1    b   27         CEO
2    c   35         CFO
3    d   45          VP
4    e   55          VP
5    f   43         CEO
6    g   35          MD
```

```
df.to_csv('Csv example')
df
```

```
  Name  age designation
0    a   20          VP
1    b   27         CEO
2    c   35         CFO
3    d   45          VP
4    e   55          VP
5    f   43         CEO
6    g   35          MD
```

```
df_csv=pd.read_csv('Csv example')
df_csv
```

```
   Unnamed: 0 Name  age designation
0           0    a   20          VP
1           1    b   27         CEO
2           2    c   35         CFO
3           3    d   45          VP
```

```
4           4    e   55          VP
5           5    f   43         CEO
6           6    g   35          MD
```

```
df.to_csv('CSV Ex',index=False)
df_csv=pd.read_csv('CSV Ex')
df_csv
```

```
  Name  age designation
0    a   20          VP
1    b   27         CEO
2    c   35         CFO
3    d   45          VP
4    e   55          VP
5    f   43         CEO
6    g   35          MD
```

```
import pandas as pd
Location = "/content/drive/MyDrive/Colab Notebooks/student-mat.csv"
df = pd.read_csv(Location, header=None)
df.head()
```

```
       0    1    2        3        4        5     6     7        8
9   \
0  school  sex  age  address  famsize  Pstatus  Medu  Fedu     Mjob      F
job
1      GP    F   18        U      GT3        A     4     4  at_home   teac
her
2      GP    F   17        U      GT3        T     1     1  at_home     ot
her
3      GP    F   15        U      LE3        T     1     1  at_home     ot
her
4      GP    F   15        U      GT3        T     4     2   health  servi
ces

   ...      23        24     25    26    27      28        29  30  31  32
0  ...  famrel  freetime  goout  Dalc  Walc  health  absences  G1  G2  G3
1  ...       4         3      4     1     1       3         6   5   6   6
2  ...       5         3      3     1     1       3         4   5   5   6
3  ...       4         3      2     2     3       3        10   7   8  10
4  ...       3         2      2     1     1       5         2  15  14  15

[5 rows x 33 columns]
```

```
import pandas as pd
Location = "/content/drive/MyDrive/Colab Notebooks/student-mat.csv"
df = pd.read_csv(Location)
df.head()
```

```
  school sex  age address famsize Pstatus  Medu  Fedu     Mjob      Fjob
...  \
0     GP   F   18       U     GT3       A     4     4  at_home   teacher
...
1     GP   F   17       U     GT3       T     1     1  at_home     other
...
```

```
2     GP    F    15        U      LE3        T     1     1  at_home     other
...
3     GP    F    15        U      GT3        T     4     2   health  services
...
4     GP    F    16        U      GT3        T     3     3    other     other
...

  famrel freetime  goout  Dalc  Walc health absences  G1  G2  G3
0      4        3      4     1     1      3        6   5   6   6
1      5        3      3     1     1      3        4   5   5   6
2      4        3      2     2     3      3       10   7   8  10
3      3        2      2     1     1      5        2  15  14  15
4      4        3      2     1     2      5        4   6  10  10

[5 rows x 33 columns]
```

```
import pandas as pd
Location = "/content/drive/MyDrive/Colab Notebooks/student-mat.csv"
# To add headers as we load the data...
df = pd.read_csv(Location, names=['RollNo','Names','Grades'])
# To add headers to a dataframe
df.columns = ['RollNo','Names','Grades']
df.head()
```

```
RollNo  \
school sex age address famsize Pstatus Medu Fedu Mjob    Fjob     reason g
uardian traveltime studytime failures schoolsup famsup paid activities nur
sery higher internet romantic famrel freetime goout Dalc Walc health absen
ces     G1
GP     F    18   U       GT3      A        4     4     at_home teacher   course m
other   2          2         0        yes        no     no   no          yes
yes    no       no        4      3        4     1    1    3      6
5
           17   U       GT3      T        1     1     at_home other     course f
ather   1          2         0        no         yes    no   no          no
yes    yes      no        5      3        3     1    1    3      4
5
           15   U       LE3      T        1     1     at_home other     other  m
other   1          2         3        yes        no     yes  no          yes
yes    yes      no        4      3        2     2    3    3      10
7
                       GT3      T        4     2     health  services home   m
other   1          3         0        no         yes    yes  yes         yes
yes    yes      yes       3      2        2     1    1    5      2
15


Names  \
school sex age address famsize Pstatus Medu Fedu Mjob    Fjob     reason g
uardian traveltime studytime failures schoolsup famsup paid activities nur
sery higher internet romantic famrel freetime goout Dalc Walc health absen
ces    G2
GP     F    18   U       GT3      A        4     4     at_home teacher   course m
```

```
other   2          2         0        yes       no      no   no          yes
yes    no       no       4      3        4     1    1    3      6
6
           17  U       GT3     T       1    1    at_home other    course f
ather   1          2         0        no        yes     no   no          no
yes    yes      no       5      3        3     1    1    3      4
5
           15  U       LE3     T       1    1    at_home other    other  m
other   1          2         3        yes       no      yes  no          yes
yes    yes      no       4      3        2     2    3    3      10
8
                       GT3     T       4    2    health  services home   m
other   1          3         0        no        yes     yes  yes         yes
yes    yes      yes      3      2        2     1    1    5      2
14


Grades
school sex age address famsize Pstatus Medu Fedu Mjob    Fjob     reason g
uardian traveltime studytime failures schoolsup famsup paid activities nur
sery higher internet romantic famrel freetime goout Dalc Walc health absen
ces     G3
GP     F    18  U       GT3     A       4    4    at_home teacher  course m
other   2          2         0        yes       no      no   no          yes
yes    no       no       4      3        4     1    1    3      6
6
           17  U       GT3     T       1    1    at_home other    course f
ather   1          2         0        no        yes     no   no          no
yes    yes      no       5      3        3     1    1    3      4
6
           15  U       LE3     T       1    1    at_home other    other  m
other   1          2         3        yes       no      yes  no          yes
yes    yes      no       4      3        2     2    3    3      10
10
                       GT3     T       4    2    health  services home   m
other   1          3         0        no        yes     yes  yes         yes
yes    yes      yes      3      2        2     1    1    5      2
15
```

```
import pandas as pd
names = ['Bob','Jessica','Mary','John','Mel']
grades = [76,95,77,78,99]
bsdegrees = [1,1,0,0,1]
msdegrees = [2,1,0,0,0]
phddegrees = [0,1,0,0,0]
Degrees = zip(names,grades,bsdegrees,msdegrees,phddegrees)
columns = ['Names','Grades','BS','MS','PhD']
df = pd.DataFrame(data = Degrees, columns=columns)
df
```

```
     Names  Grades  BS  MS  PhD
0      Bob      76   1   2    0
1  Jessica      95   1   1    1
2     Mary      77   0   0    0
```

```
3     John      78   0   0    0
4      Mel      99   1   0    0
```

```
import pandas as pd
Location = "/content/drive/MyDrive/Colab Notebooks/gradedata.xlsx"
df = pd.read_excel(Location)

#Changing column Names
df.columns = ['first','last','sex','age','exer','hrs','grd','addr']
df.head()
```

```
     first      last     sex  age  exer  hrs   grd  \
0   Marcia      Pugh  female   17     3   10  82.4
1   Kadeem  Morrison    male   18     4    4  78.2
2     Nash    Powell    male   18     5    9  79.3
3  Noelani    Wagner  female   14     2    7  83.2
4  Noelani    Cherry  female   18     4   15  87.4

                                         addr
0        7379 Highland Rd. , Dublin, GA 31021
1          8 Bayport St. , Honolulu, HI 96815
2           Encino, CA 91316, 3 Lilac Street
3  Riverview, FL 33569, 9998 North Smith Dr.
4   97 SE. Ocean Street , Bethlehem, PA 18015
```

```
pip install xlsxwriter
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Collecting xlsxwriter
  Downloading XlsxWriter-3.0.3-py3-none-any.whl (149 kB)
```

```
import pandas as pd
names = ['Bob','Jessica','Mary','John','Mel']
grades = [76,95,77,78,99]
GradeList = zip(names,grades)
df = pd.DataFrame(data = GradeList,columns=['Names','Grades'])

writer = pd.ExcelWriter('dataframe.xlsx', engine='xlsxwriter')
df.to_excel(writer, sheet_name='Sheet1')
writer.save()
```

```
import sqlite3
con = sqlite3.connect("/content/drive/MyDrive/Colab Notebooks/portal_mammals.sqlite")
cur = con.cursor()
for row in cur.execute('SELECT * FROM species;'):
    print(row)
con.close()
```

```
('AB', 'Amphispiza', 'bilineata', 'Bird')
('AH', 'Ammospermophilus', 'harrisi', 'Rodent')
('AS', 'Ammodramus', 'savannarum', 'Bird')
('BA', 'Baiomys', 'taylori', 'Rodent')
('CB', 'Campylorhynchus', 'brunneicapillus', 'Bird')
```

```
('CM', 'Calamospiza', 'melanocorys', 'Bird')
('CQ', 'Callipepla', 'squamata', 'Bird')
('CS', 'Crotalus', 'scutalatus', 'Reptile')
('CT', 'Cnemidophorus', 'tigris', 'Reptile')
('CU', 'Cnemidophorus', 'uniparens', 'Reptile')
('CV', 'Crotalus', 'viridis', 'Reptile')
('DM', 'Dipodomys', 'merriami', 'Rodent')
('DO', 'Dipodomys', 'ordii', 'Rodent')
('DS', 'Dipodomys', 'spectabilis', 'Rodent')
('DX', 'Dipodomys', 'sp.', 'Rodent')
('EO', 'Eumeces', 'obsoletus', 'Reptile')
('GS', 'Gambelia', 'silus', 'Reptile')
('NL', 'Neotoma', 'albigula', 'Rodent')
('NX', 'Neotoma', 'sp.', 'Rodent')
('OL', 'Onychomys', 'leucogaster', 'Rodent')
('OT', 'Onychomys', 'torridus', 'Rodent')
('OX', 'Onychomys', 'sp.', 'Rodent')
('PB', 'Chaetodipus', 'baileyi', 'Rodent')
('PC', 'Pipilo', 'chlorurus', 'Bird')
('PE', 'Peromyscus', 'eremicus', 'Rodent')
('PF', 'Perognathus', 'flavus', 'Rodent')
('PG', 'Pooecetes', 'gramineus', 'Bird')
('PH', 'Perognathus', 'hispidus', 'Rodent')
('PI', 'Chaetodipus', 'intermedius', 'Rodent')
('PL', 'Peromyscus', 'leucopus', 'Rodent')
('PM', 'Peromyscus', 'maniculatus', 'Rodent')
('PP', 'Chaetodipus', 'penicillatus', 'Rodent')
('PU', 'Pipilo', 'fuscus', 'Bird')
('PX', 'Chaetodipus', 'sp.', 'Rodent')
('RF', 'Reithrodontomys', 'fulvescens', 'Rodent')
('RM', 'Reithrodontomys', 'megalotis', 'Rodent')
('RO', 'Reithrodontomys', 'montanus', 'Rodent')
('RX', 'Reithrodontomys', 'sp.', 'Rodent')
('SA', 'Sylvilagus', 'audubonii', 'Rabbit')
('SB', 'Spizella', 'breweri', 'Bird')
('SC', 'Sceloporus', 'clarki', 'Reptile')
('SF', 'Sigmodon', 'fulviventer', 'Rodent')
('SH', 'Sigmodon', 'hispidus', 'Rodent')
('SO', 'Sigmodon', 'ochrognathus', 'Rodent')
('SS', 'Spermophilus', 'spilosoma', 'Rodent')
('ST', 'Spermophilus', 'tereticaudus', 'Rodent')
('SU', 'Sceloporus', 'undulatus', 'Reptile')
('SX', 'Sigmodon', 'sp.', 'Rodent')
('UL', 'Lizard', 'sp.', 'Reptile')
('UP', 'Pipilo', 'sp.', 'Bird')
('UR', 'Rodent', 'sp.', 'Rodent')
('US', 'Sparrow', 'sp.', 'Bird')
('ZL', 'Zonotrichia', 'leucophrys', 'Bird')
('ZM', 'Zenaida', 'macroura', 'Bird')
```

```python
import sqlite3

# Create a SQL connection to our SQLite database
con = sqlite3.connect("/content/drive/MyDrive/Colab Notebooks/portal_mamma
ls.sqlite")

cur = con.cursor()

# Return all results of query
cur.execute('SELECT plot_id FROM plots WHERE plot_type="Control"')
print(cur.fetchall())

# Return first result of query
cur.execute('SELECT species FROM species WHERE taxa="Bird"')
print(cur.fetchone())

# Be sure to close the connection
con.close()
```

```
[(2,), (4,), (8,), (11,), (12,), (14,), (17,), (22,)]
('bilineata',)
```

```
import pandas as pd
import sqlite3

# Read sqlite query results into a pandas DataFrame
con = sqlite3.connect("/content/drive/MyDrive/Colab Notebooks/portal_mamma
ls.sqlite")
df = pd.read_sql_query("SELECT * from surveys", con)

# Verify that result of SQL query is stored in the dataframe
print(df.head())

con.close()
```

```
   record_id  month  day  year  plot_id species_id sex  hindfoot_length  \
0          1      7   16  1977        2         NL   M             32.0
1          2      7   16  1977        3         NL   M             33.0
2          3      7   16  1977        2         DM   F             37.0
3          4      7   16  1977        7         DM   M             36.0
4          5      7   16  1977        3         DM   M             35.0

   weight
0     NaN
1     NaN
2     NaN
3     NaN
4     NaN
```

```
from pandas import DataFrame
Cars={'Brand':['Honda Civic','Toyota Corolla','Ford Focus','Audi A4'],
      'Price':[22000,25000,27000,35000]
      }
df=DataFrame(Cars,columns=['Brand','Price'])
print(df)
```

```
            Brand  Price
0     Honda Civic  22000
1  Toyota Corolla  25000
```

```
2      Ford Focus  27000
3         Audi A4  35000
```

```
import sqlite3
conn=sqlite3.connect('TestDB1.db')
c=conn.cursor()

c.execute('CREATE TABLE CARS2(Brand text, Price number)')
conn.commit()

df.to_sql('CARS2',conn,if_exists='replace',index=False)
df
```

```
            Brand  Price
0     Honda Civic  22000
1  Toyota Corolla  25000
2      Ford Focus  27000
3         Audi A4  35000
```

```
c.execute('''
SELECT Brand,max(Price) from CARS2
''')
```

```
<sqlite3.Cursor at 0x7f39bd9e1ce0>
```

```
df=DataFrame(c.fetchall(),columns=['Brand','Price'])
df
```

```
     Brand  Price
0  Audi A4  35000
```

Example1

```
import pandas as pd
import os
import sqlite3 as lite
from sqlalchemy import create_engine

studentId=["rj101","rj150","rj134","rj70"]
SName=["Saurabh","Giftson","Vikas","Radha"]
LName=["Chavan","Paul","Bisoi","Rai"]
Department=["Bms","Bcom","BscCS","BScIT"]
Email=["100rabh@gmail.com","gift01@gmail.com","vik21@gmail.com","rad01@gmail.com"]

studata = zip(studentId,SName,LName,Department,Email)

df = pd.DataFrame(data =studata, columns=['StudentId','SName','LName','Department','Email'])
df
```

```
  StudentId    SName   LName Department              Email
0     rj101  Saurabh  Chavan        Bms  100rabh@gmail.com
1     rj150  Giftson    Paul       Bcom   gift01@gmail.com
2     rj134    Vikas   Bisoi      BscCS    vik21@gmail.com
3      rj70    Radha     Rai      BScIT    rad01@gmail.com
```

```
df1=df.to_csv('studentdata.csv',index=False,header=True)
df1
```

```
df2=df.to_excel('studentdata2.xlsx',index=False,header=True)

df2
```

```
db_filename = r'studentdata.db'
con = lite.connect(db_filename)
df.to_sql('student',
con,
schema=None,
if_exists='replace',
index=True,
index_label=None,
chunksize=None,
dtype=None)
con.close()
```

```
db_file = r'studentdata.db'
engine = create_engine(r"sqlite:///{}" .format(db_file))
sql = 'SELECT * from student '


studf = pd.read_sql(sql, engine)
studf
```

```
   index StudentId    SName   LName Department              Email
0      0     rj101  Saurabh  Chavan        Bms  100rabh@gmail.com
1      1     rj150  Giftson    Paul       Bcom   gift01@gmail.com
2      2     rj134    Vikas   Bisoi      BscCS    vik21@gmail.com
3      3      rj70    Radha     Rai      BScIT    rad01@gmail.com
```

```
import numpy as np
import pandas as pd
```

```
state=pd.read_csv("/content/drive/MyDrive/Colab Notebooks/US_violent_crime
.csv")
state.head()
```

```
        State  Murder  Assault  UrbanPop  Rape
0     Alabama    13.2      236        58  21.2
1      Alaska    10.0      263        48  44.5
2     Arizona     8.1      294        80  31.0
3    Arkansas     8.8      190        50  19.5
4  California     9.0      276        91  40.6
```

```
def some_func(x):
  return x*2
state.apply(some_func) #update each entry of dataframe without any loop
state.apply(lambda n: n*2) #lambda also works the same
```

```
                           State  Murder  Assault  UrbanPop  Rape
0                 AlabamaAlabama    26.4      472       116  42.4
1                   AlaskaAlaska    20.0      526        96  89.0
2                 ArizonaArizona    16.2      588       160  62.0
```

```
3               ArkansasArkansas    17.6      380       100  39.0
4           CaliforniaCalifornia    18.0      552       182  81.2
5               ColoradoColorado    15.8      408       156  77.4
6         ConnecticutConnecticut     6.6      220       154  22.2
7               DelawareDelaware    11.8      476       144  31.6
8                 FloridaFlorida    30.8      670       160  63.8
9                 GeorgiaGeorgia    34.8      422       120  51.6
10                  HawaiiHawaii    10.6       92       166  40.4
11                    IdahoIdaho     5.2      240       108  28.4
12              IllinoisIllinois    20.8      498       166  48.0
13                IndianaIndiana    14.4      226       130  42.0
14                      IowaIowa     4.4      112       114  22.6
15                  KansasKansas    12.0      230       132  36.0
16              KentuckyKentucky    19.4      218       104  32.6
17            LouisianaLouisiana    30.8      498       132  44.4
18                    MaineMaine     4.2      166       102  15.6
19              MarylandMaryland    22.6      600       134  55.6
20    MassachusettsMassachusetts     8.8      298       170  32.6
21              MichiganMichigan    24.2      510       148  70.2
22            MinnesotaMinnesota     5.4      144       132  29.8
23        MississippiMississippi    32.2      518        88  34.2
24              MissouriMissouri    18.0      356       140  56.4
25                MontanaMontana    12.0      218       106  32.8
26              NebraskaNebraska     8.6      204       124  33.0
27                  NevadaNevada    24.4      504       162  92.0
28    New HampshireNew Hampshire     4.2      114       112  19.0
29          New JerseyNew Jersey    14.8      318       178  37.6
30          New MexicoNew Mexico    22.8      570       140  64.2
31              New YorkNew York    22.2      508       172  52.2
32  North CarolinaNorth Carolina    26.0      674        90  32.2
33      North DakotaNorth Dakota     1.6       90        88  14.6
34                      OhioOhio    14.6      240       150  42.8
35              OklahomaOklahoma    13.2      302       136  40.0
36                  OregonOregon     9.8      318       134  58.6
37      PennsylvaniaPennsylvania    12.6      212       144  29.8
38      Rhode IslandRhode Island     6.8      348       174  16.6
39  South CarolinaSouth Carolina    28.8      558        96  45.0
40      South DakotaSouth Dakota     7.6      172        90  25.6
41            TennesseeTennessee    26.4      376       118  53.8
42                    TexasTexas    25.4      402       160  51.0
43                      UtahUtah     6.4      240       160  45.8
44                VermontVermont     4.4       96        64  22.4
45              VirginiaVirginia    17.0      312       126  41.4
46          WashingtonWashington     8.0      290       146  52.4
47    West VirginiaWest Virginia    11.4      162        78  18.6
48            WisconsinWisconsin     5.2      106       132  21.6
49                WyomingWyoming    13.6      322       120  31.2
```

```
state.transform(func = lambda x : x * 10)
```

```
                                                State  Murder  Assault  \
0   AlabamaAlabamaAlabamaAlabamaAlabamaAlabamaAlab...   132.0     2360
1   AlaskaAlaskaAlaskaAlaskaAlaskaAlaskaAlaskaAlas...   100.0     2630
2   ArizonaArizonaArizonaArizonaArizonaArizonaAriz...    81.0     2940
```

```
3   ArkansasArkansasArkansasArkansasArkansasArkans...    88.0     1900
4   CaliforniaCaliforniaCaliforniaCaliforniaCalifo...    90.0     2760
5   ColoradoColoradoColoradoColoradoColoradoColora...    79.0     2040
6   ConnecticutConnecticutConnecticutConnecticutCo...    33.0     1100
7   DelawareDelawareDelawareDelawareDelawareDelawa...    59.0     2380
8   FloridaFloridaFloridaFloridaFloridaFloridaFlor...   154.0     3350
9   GeorgiaGeorgiaGeorgiaGeorgiaGeorgiaGeorgiaGeor...   174.0     2110
10  HawaiiHawaiiHawaiiHawaiiHawaiiHawaiiHawaiiHawa...    53.0      460
11  IdahoIdahoIdahoIdahoIdahoIdahoIdahoIdahoIdahoI...    26.0     1200
12  IllinoisIllinoisIllinoisIllinoisIllinoisIllino...   104.0     2490
13  IndianaIndianaIndianaIndianaIndianaIndianaIndi...    72.0     1130
14           IowaIowaIowaIowaIowaIowaIowaIowaIowaIowa    22.0      560
15  KansasKansasKansasKansasKansasKansasKansasKans...    60.0     1150
16  KentuckyKentuckyKentuckyKentuckyKentuckyKentuc...    97.0     1090
17  LouisianaLouisianaLouisianaLouisianaLouisianaL...   154.0     2490
18  MaineMaineMaineMaineMaineMaineMaineMaineMaineM...    21.0      830
19  MarylandMarylandMarylandMarylandMarylandMaryla...   113.0     3000
20  MassachusettsMassachusettsMassachusettsMassach...    44.0     1490
21  MichiganMichiganMichiganMichiganMichiganMichig...   121.0     2550
22  MinnesotaMinnesotaMinnesotaMinnesotaMinnesotaM...    27.0      720
23  MississippiMississippiMississippiMississippiMi...   161.0     2590
24  MissouriMissouriMissouriMissouriMissouriMissou...    90.0     1780
25  MontanaMontanaMontanaMontanaMontanaMontanaMont...    60.0     1090
26  NebraskaNebraskaNebraskaNebraskaNebraskaNebras...    43.0     1020
27  NevadaNevadaNevadaNevadaNevadaNevadaNevadaNeva...   122.0     2520
28  New HampshireNew HampshireNew HampshireNew Ham...    21.0      570
29  New JerseyNew JerseyNew JerseyNew JerseyNew Je...    74.0     1590
30  New MexicoNew MexicoNew MexicoNew MexicoNew Me...   114.0     2850
31  New YorkNew YorkNew YorkNew YorkNew YorkNew Yo...   111.0     2540
32  North CarolinaNorth CarolinaNorth CarolinaNort...   130.0     3370
33  North DakotaNorth DakotaNorth DakotaNorth Dako...     8.0      450
34           OhioOhioOhioOhioOhioOhioOhioOhioOhioOhio    73.0     1200
35  OklahomaOklahomaOklahomaOklahomaOklahomaOklaho...    66.0     1510
36  OregonOregonOregonOregonOregonOregonOregonOreg...    49.0     1590
37  PennsylvaniaPennsylvaniaPennsylvaniaPennsylvan...    63.0     1060
38  Rhode IslandRhode IslandRhode IslandRhode Isla...    34.0     1740
39  South CarolinaSouth CarolinaSouth CarolinaSout...   144.0     2790
40  South DakotaSouth DakotaSouth DakotaSouth Dako...    38.0      860
41  TennesseeTennesseeTennesseeTennesseeTennesseeT...   132.0     1880
42  TexasTexasTexasTexasTexasTexasTexasTexasTexasT...   127.0     2010
43           UtahUtahUtahUtahUtahUtahUtahUtahUtahUtah    32.0     1200
44  VermontVermontVermontVermontVermontVermontVerm...    22.0      480
45  VirginiaVirginiaVirginiaVirginiaVirginiaVirgin...    85.0     1560
46  WashingtonWashingtonWashingtonWashingtonWashin...    40.0     1450
47  West VirginiaWest VirginiaWest VirginiaWest Vi...    57.0      810
48  WisconsinWisconsinWisconsinWisconsinWisconsinW...    26.0      530
49  WyomingWyomingWyomingWyomingWyomingWyomingWyom...    68.0     1610

    UrbanPop   Rape
0        580  212.0
1        480  445.0
2        800  310.0
3        500  195.0
4        910  406.0
```

```
5        780  387.0
6        770  111.0
7        720  158.0
8        800  319.0
9        600  258.0
10       830  202.0
11       540  142.0
12       830  240.0
13       650  210.0
14       570  113.0
15       660  180.0
16       520  163.0
17       660  222.0
18       510   78.0
19       670  278.0
20       850  163.0
21       740  351.0
22       660  149.0
23       440  171.0
24       700  282.0
25       530  164.0
26       620  165.0
27       810  460.0
28       560   95.0
29       890  188.0
30       700  321.0
31       860  261.0
32       450  161.0
33       440   73.0
34       750  214.0
35       680  200.0
36       670  293.0
37       720  149.0
38       870   83.0
39       480  225.0
40       450  128.0
41       590  269.0
42       800  255.0
43       800  229.0
44       320  112.0
45       630  207.0
46       730  262.0
47       390   93.0
48       660  108.0
49       600  156.0
```

```
#usinggroupby
mean_purchase =state.groupby('State')["Murder"].mean().rename("User_mean")
.reset_index()
print(mean_purchase)
```

```
             State  User_mean
0          Alabama       13.2
1           Alaska       10.0
```

```
2          Arizona       8.1
3         Arkansas       8.8
4       California       9.0
5         Colorado       7.9
6      Connecticut       3.3
7         Delaware       5.9
8          Florida      15.4
9          Georgia      17.4
10          Hawaii       5.3
11           Idaho       2.6
12        Illinois      10.4
13         Indiana       7.2
14            Iowa       2.2
15          Kansas       6.0
16        Kentucky       9.7
17       Louisiana      15.4
18           Maine       2.1
19        Maryland      11.3
20   Massachusetts       4.4
21        Michigan      12.1
22       Minnesota       2.7
23     Mississippi      16.1
24        Missouri       9.0
25         Montana       6.0
26        Nebraska       4.3
27          Nevada      12.2
28   New Hampshire       2.1
29      New Jersey       7.4
30      New Mexico      11.4
31        New York      11.1
32  North Carolina      13.0
33    North Dakota       0.8
34            Ohio       7.3
35        Oklahoma       6.6
36          Oregon       4.9
37    Pennsylvania       6.3
38    Rhode Island       3.4
39  South Carolina      14.4
40    South Dakota       3.8
41       Tennessee      13.2
42           Texas      12.7
43            Utah       3.2
44         Vermont       2.2
45        Virginia       8.5
46      Washington       4.0
47   West Virginia       5.7
48       Wisconsin       2.6
49         Wyoming       6.8
```

```
mer=state.merge(mean_purchase)
mer
```

```
             State  Murder  Assault  UrbanPop  Rape  User_mean
0          Alabama    13.2      236        58  21.2       13.2
```

```
1           Alaska    10.0      263        48  44.5       10.0
2          Arizona     8.1      294        80  31.0        8.1
3         Arkansas     8.8      190        50  19.5        8.8
4       California     9.0      276        91  40.6        9.0
5         Colorado     7.9      204        78  38.7        7.9
6      Connecticut     3.3      110        77  11.1        3.3
7         Delaware     5.9      238        72  15.8        5.9
8          Florida    15.4      335        80  31.9       15.4
9          Georgia    17.4      211        60  25.8       17.4
10          Hawaii     5.3       46        83  20.2        5.3
11           Idaho     2.6      120        54  14.2        2.6
12        Illinois    10.4      249        83  24.0       10.4
13         Indiana     7.2      113        65  21.0        7.2
14            Iowa     2.2       56        57  11.3        2.2
15          Kansas     6.0      115        66  18.0        6.0
16        Kentucky     9.7      109        52  16.3        9.7
17       Louisiana    15.4      249        66  22.2       15.4
18           Maine     2.1       83        51   7.8        2.1
19        Maryland    11.3      300        67  27.8       11.3
20   Massachusetts     4.4      149        85  16.3        4.4
21        Michigan    12.1      255        74  35.1       12.1
22       Minnesota     2.7       72        66  14.9        2.7
23     Mississippi    16.1      259        44  17.1       16.1
24        Missouri     9.0      178        70  28.2        9.0
25         Montana     6.0      109        53  16.4        6.0
26        Nebraska     4.3      102        62  16.5        4.3
27          Nevada    12.2      252        81  46.0       12.2
28   New Hampshire     2.1       57        56   9.5        2.1
29      New Jersey     7.4      159        89  18.8        7.4
30      New Mexico    11.4      285        70  32.1       11.4
31        New York    11.1      254        86  26.1       11.1
32  North Carolina    13.0      337        45  16.1       13.0
33    North Dakota     0.8       45        44   7.3        0.8
34            Ohio     7.3      120        75  21.4        7.3
35        Oklahoma     6.6      151        68  20.0        6.6
36          Oregon     4.9      159        67  29.3        4.9
37    Pennsylvania     6.3      106        72  14.9        6.3
38    Rhode Island     3.4      174        87   8.3        3.4
39  South Carolina    14.4      279        48  22.5       14.4
40    South Dakota     3.8       86        45  12.8        3.8
41       Tennessee    13.2      188        59  26.9       13.2
42           Texas    12.7      201        80  25.5       12.7
43            Utah     3.2      120        80  22.9        3.2
44         Vermont     2.2       48        32  11.2        2.2
45        Virginia     8.5      156        63  20.7        8.5
46      Washington     4.0      145        73  26.2        4.0
47   West Virginia     5.7       81        39   9.3        5.7
48       Wisconsin     2.6       53        66  10.8        2.6
49         Wyoming     6.8      161        60  15.6        6.8
```

```
#checking for missing values
print(state.isnull().sum())
```

```
State       0
Murder      0
Assault     0
UrbanPop    0
Rape        0
dtype: int64
```

EXAMPLE2

```
import pandas as pd
import numpy as np
cols=['col0', 'col1', 'col2', 'col3', 'col4']
rows=['row0', 'row1', 'row2', 'row3', 'row4']
data=np.random.randint(0, 100, size=(5,5))
df=pd.DataFrame(data, columns=cols, index=rows)
df.head()
```

```
      col0  col1  col2  col3  col4
row0    23    19    47    30    65
row1    85     4    34    64    33
row2    98    14     4    40    11
row3    34    12    42    22    28
row4    46    52    57    64     9
```

```
df.iloc[4,2]
```

```
57
```

```
df.iloc[3, 3]=0
df.iloc[1, 2]=np.nan
df.iloc[4, 0]=np.nan
df['col5']=0
df['col6']=np.nan
df.head()
```

```
      col0  col1  col2  col3  col4  col5  col6
row0  23.0    19  47.0    30    65     0   NaN
row1  85.0     4   NaN    64    33     0   NaN
row2  98.0    14   4.0    40    11     0   NaN
row3  34.0    12  42.0     0    28     0   NaN
row4   NaN    52  57.0    64     9     0   NaN
```

```
df.loc[:,df.all()]
```

```
      col0  col1  col2  col4  col6
row0  23.0    19  47.0    65   NaN
row1  85.0     4   NaN    33   NaN
row2  98.0    14   4.0    11   NaN
row3  34.0    12  42.0    28   NaN
row4   NaN    52  57.0     9   NaN
```

```
df.loc[:,df.any()]
```

```
      col0  col1  col2  col3  col4
row0  23.0    19  47.0    30    65
row1  85.0     4   NaN    64    33
row2  98.0    14   4.0    40    11
```

```
row3  34.0    12  42.0     0    28
row4   NaN    52  57.0    64     9
```

```
df.loc[:,df.isnull().any()]
```

```
      col0  col2  col6
row0  23.0  47.0   NaN
row1  85.0   NaN   NaN
row2  98.0   4.0   NaN
row3  34.0  42.0   NaN
row4   NaN  57.0   NaN
```

```
df.loc[:,df.notnull().all()]
```

```
      col1  col3  col4  col5
row0    19    30    65     0
row1     4    64    33     0
row2    14    40    11     0
row3    12     0    28     0
row4    52    64     9     0
```

```
df.dropna(how="all",axis=0)
```

```
      col0  col1  col2  col3  col4  col5  col6
row0  23.0    19  47.0    30    65     0   NaN
row1  85.0     4   NaN    64    33     0   NaN
row2  98.0    14   4.0    40    11     0   NaN
row3  34.0    12  42.0     0    28     0   NaN
row4   NaN    52  57.0    64     9     0   NaN
```

```
df.fillna(df.sum())
```

```
       col0  col1   col2  col3  col4  col5  col6
row0   23.0    19   47.0    30    65     0   0.0
row1   85.0     4  150.0    64    33     0   0.0
row2   98.0    14    4.0    40    11     0   0.0
row3   34.0    12   42.0     0    28     0   0.0
row4  240.0    52   57.0    64     9     0   0.0
```

```
#Demonstrate transfomr function using pandas in python
import pandas as pd
import numpy as np
import random
data = pd.DataFrame({
    'C' : [random.choice(('a','b','c')) for i in range(1000000)],
    'A' : [random.randint(1,10) for i in range(1000000)],
    'B' : [random.randint(1,10) for i in range(1000000)]

})
data
```

```
        C   A   B
0       c   4   4
1       a   7  10
2       b   2   4
3       a  10   7
```

```
4       a   8   2
...     ..  ..  ..
999995  a   1   9
999996  a   7   9
999997  a   3   4
999998  c   5   9
999999  a   9   9

[1000000 rows x 3 columns]
```

```
v=data.groupby('C')["A"].mean
v
```

```
<bound method GroupBy.mean of <pandas.core.groupby.generic.SeriesGroupBy o
bject at 0x7f39ba052b90>>
```

```
mean=data.groupby('C')["A"].mean().rename("D").reset_index()
mean
```

```
   C         D
0  a  5.499408
1  b  5.495739
2  c  5.498086
```

```
df_1=data.merge(mean)
df_1
```

```
        C   A   B         D
0       c   4   4  5.498086
1       c   3   4  5.498086
2       c   5  10  5.498086
3       c   3   3  5.498086
4       c   9   6  5.498086
...    ..  ..  ..       ...
999995  b   2   3  5.495739
999996  b   3   8  5.495739
999997  b  10  10  5.495739
999998  b  10   6  5.495739
999999  b  10   5  5.495739

[1000000 rows x 4 columns]
```

PRACTICAL 2-3

Data visualization allows us to quickly interpret the data and adjust different variables to see their effect

•Technology is increasingly making it easier for us to do so

Why visualize data?

o Observe the patterns

o Identify extreme values that could be anomalies

o Easy interpretation Popular plotting libraries in Python Python offers multiple graphing libraries that offers diverse features

• 1) matplotlib --> to create 2D graphs and plots •

2) pandas visualization --> easy to use interface, built on Matplotlib •

3) seaborn --> provides a high level interface for drawing attractive and informative statistical graphics •

4) ggplot --> based on R’s ggplot2, uses Grammar of Graphics •

5) plotly --> can create interactive plots

Scatter Plot What is a scatter plot? A scatter plot is a set of points that represents the values obtained for two different variables plotted on a horizontal and vertical axes

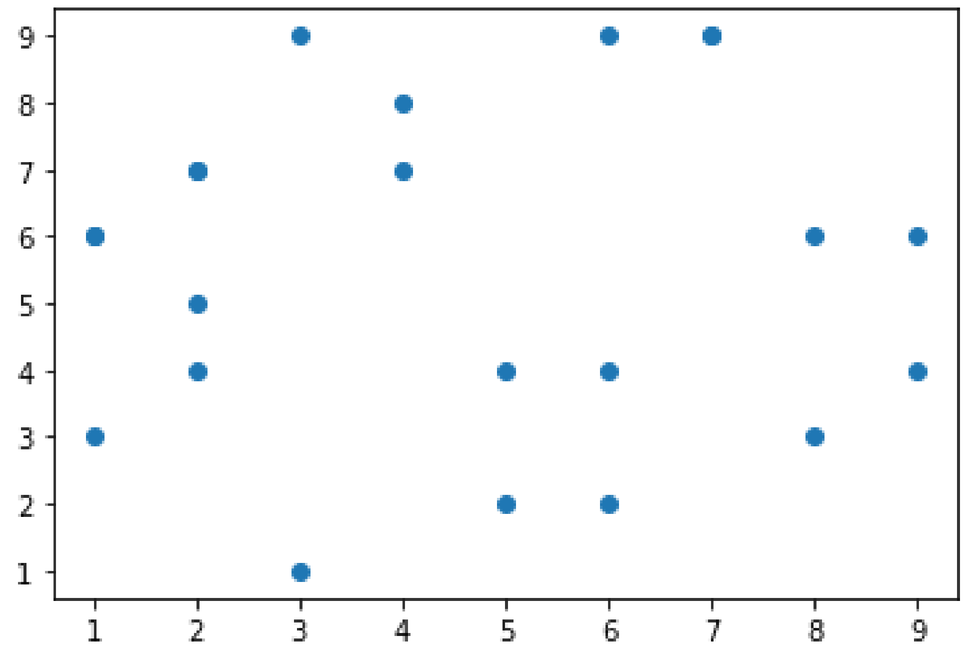
When to use scatter plots?

Scatter plots are used to convey the relationship between two numerical variables

Scatter plots are sometimes called correlation plots because they show how two variables are correlated

```
import matplotlib.pyplot as plt
# create a figure and axis
fig, ax = plt.subplots()


x = [2, 4, 6, 6, 9, 2, 7, 2, 6, 1, 8, 4, 5, 9, 1, 2, 3, 7, 5, 8, 1, 3]
y = [7, 8, 2, 4, 6, 4, 9, 5, 9, 3, 6, 7, 2, 4, 6, 7, 1, 9, 4, 3, 6, 9]

ax.scatter(x, y)
```

```
<matplotlib.collections.PathCollection at 0x7fb57e1d3e10>
```

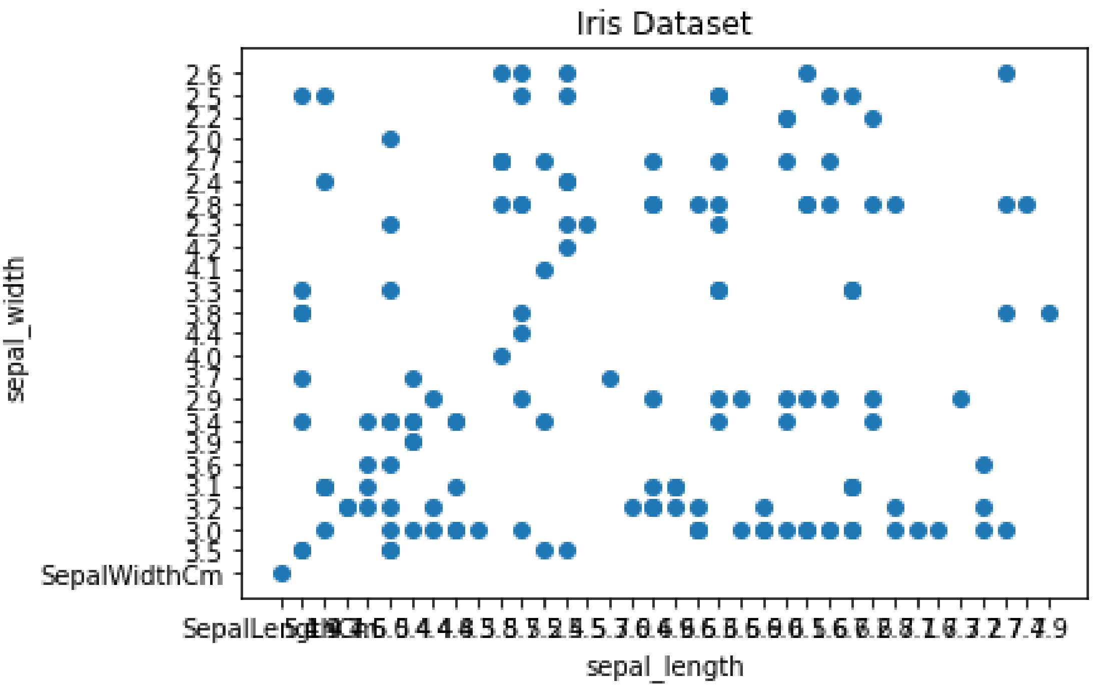


```
import pandas as pd
iris = pd.read_csv('/content/drive/MyDrive/Colab Notebooks/Iris.csv', name
s=['sepal_length', 'sepal_width', 'petal_length', 'petal_width', 'class'])
print(iris.head())
```

```
     sepal_length   sepal_width   petal_length   petal_width          class
Id  SepalLengthCm  SepalWidthCm  PetalLengthCm  PetalWidthCm        Species
1             5.1           3.5            1.4           0.2    Iris-setosa
2             4.9           3.0            1.4           0.2    Iris-setosa
3             4.7           3.2            1.3           0.2    Iris-setosa
4             4.6           3.1            1.5           0.2    Iris-setosa
```

```
import matplotlib.pyplot as plt
# create a figure and axis
fig, ax = plt.subplots()

# scatter the sepal_length against the sepal_width
ax.scatter(iris['sepal_length'], iris['sepal_width'])
# set a title and labels
ax.set_title('Iris Dataset')
ax.set_xlabel('sepal_length')
ax.set_ylabel('sepal_width')
```

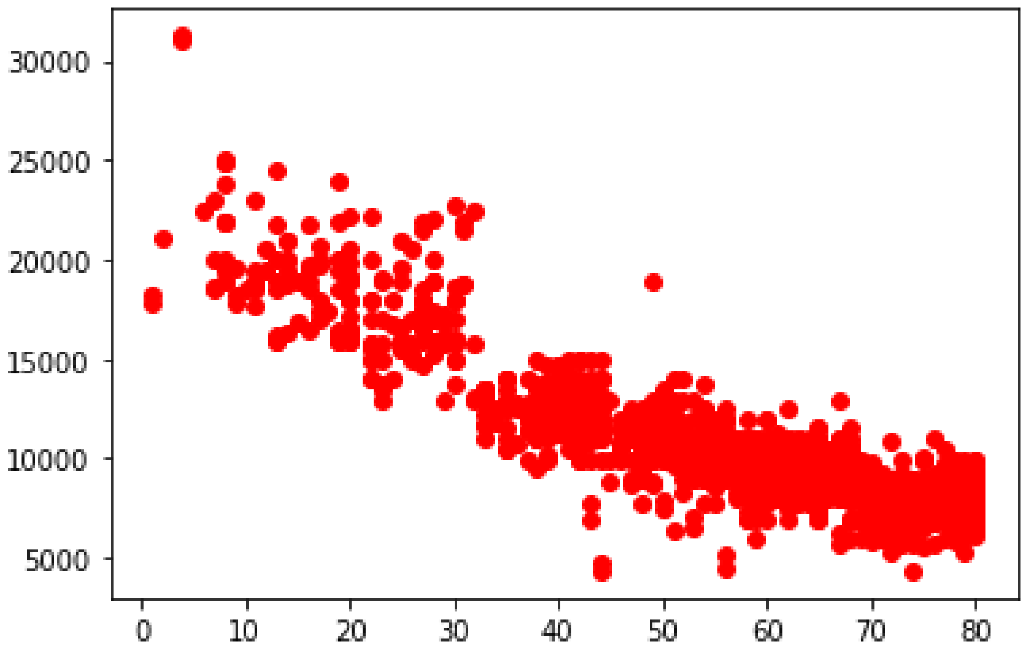
```
Text(0, 0.5, 'sepal_width')
```



```
import pandas as pd
cars_data=pd.read_csv('/content/drive/MyDrive/Colab Notebooks/Toyota.csv',
index_col=0)
cars_data.head()
```

```
   Price   Age     KM FuelType  HP  MetColor  Automatic    CC  Doors  Weig
ht
0  13500  23.0  46986   Diesel  90       1.0          0  2000  three    11
65
1  13750  23.0  72937   Diesel  90       1.0          0  2000      3    11
65
2  13950  24.0  41711   Diesel  90       NaN          0  2000      3    11
65
3  14950  26.0  48000   Diesel  90       0.0          0  2000      3    11
65
4  13750  30.0  38500   Diesel  90       0.0          0  2000      3    11
70
```

```
import matplotlib.pyplot as plt
plt.scatter(cars_data['Age'],cars_data['Price'], c='red')
plt.show()
```

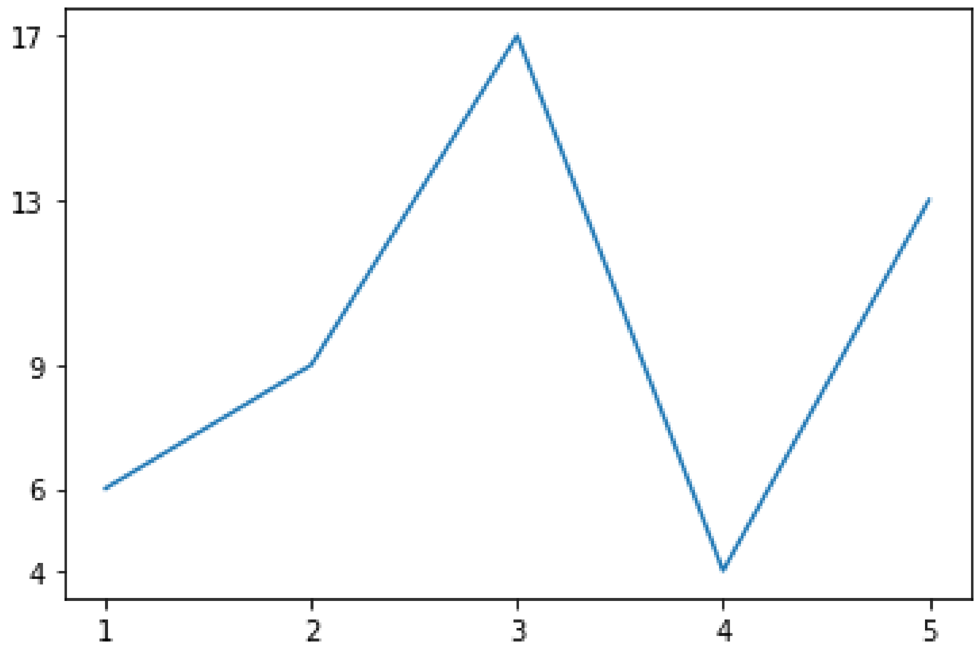


Line Chart

In Matplotlib we can create a line chart by calling the plot method. We can also plot multiple columns in one graph, by looping through the columns we want and plotting each column on the same axis.

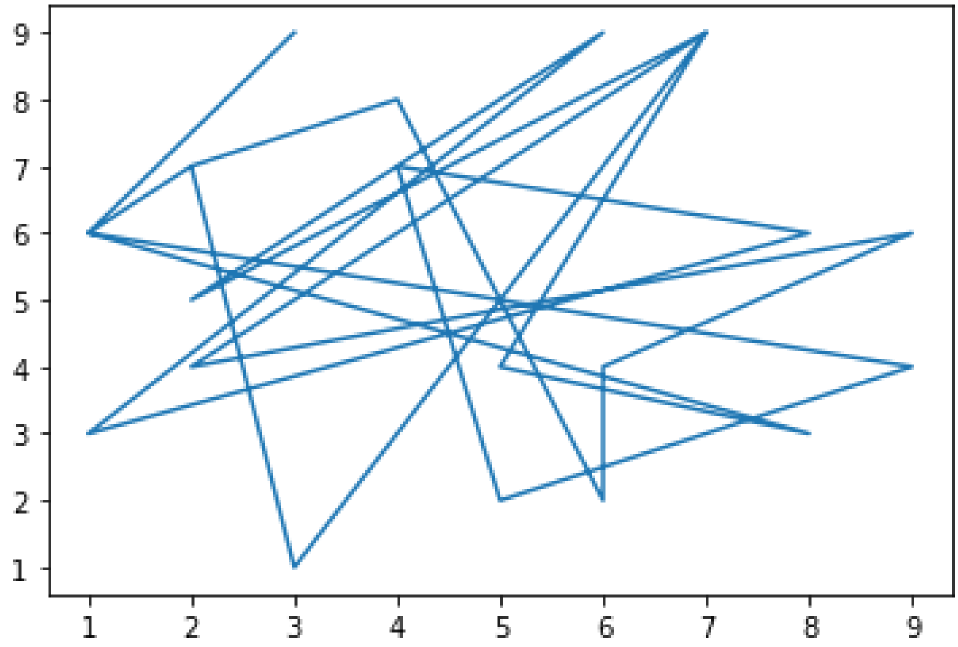
```
import pandas as pd
import numpy as np
from matplotlib import pyplot as plt
x=range(1,6)
y=np.random.randint(1,20,5)
plt.plot(x,y)

plt.xticks(x)
plt.yticks(y)
```

```
([<matplotlib.axis.YTick at 0x7fb576e52f90>,
  <matplotlib.axis.YTick at 0x7fb576e52850>,
  <matplotlib.axis.YTick at 0x7fb576e99ad0>,
  <matplotlib.axis.YTick at 0x7fb576e78b10>,
  <matplotlib.axis.YTick at 0x7fb576e78d90>],
 <a list of 5 Text major ticklabel objects>)
```



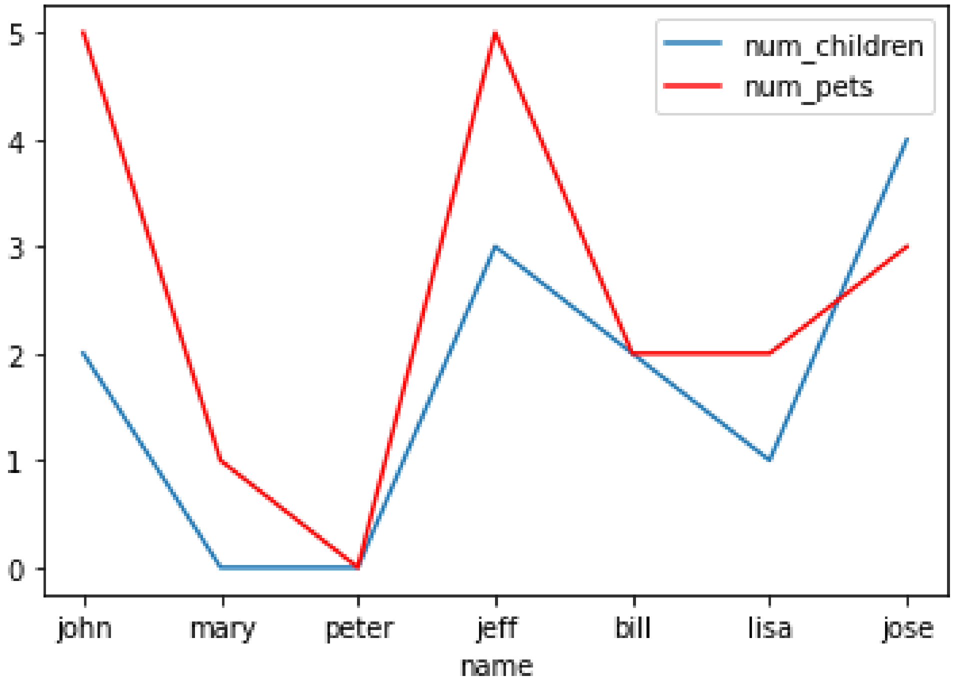
```
import matplotlib.pyplot as plt
# create a figure and axis
fig, ax = plt.subplots()

x = [2, 4, 6, 6, 9, 2, 7, 2, 6, 1, 8, 4, 5, 9, 1, 2, 3, 7, 5, 8, 1, 3]
y = [7, 8, 2, 4, 6, 4, 9, 5, 9, 3, 6, 7, 2, 4, 6, 7, 1, 9, 4, 3, 6, 9]
ax.plot(x,y)
```

```
[<matplotlib.lines.Line2D at 0x7fb5755ca110>]
```



```
import pandas as pd
df = pd.DataFrame({
    'name':['john','mary','peter','jeff','bill','lisa','jose'],
    'age':[23,78,22,19,45,33,20],
    'gender':['M','F','M','M','M','F','M'],
    'state':['california','dc','california','dc','california','texas','tex
as'],
    'num_children':[2,0,0,3,2,1,4],
    'num_pets':[5,1,0,5,2,2,3]
})
# From pandas to plot multiple plots on same figure
# gca stands for 'get current axis'
ax = plt.gca()

df.plot(kind='line',x='name',y='num_children',ax=ax)
df.plot(kind='line',x='name',y='num_pets', color='red',ax=ax)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fb5755f8f90>
```



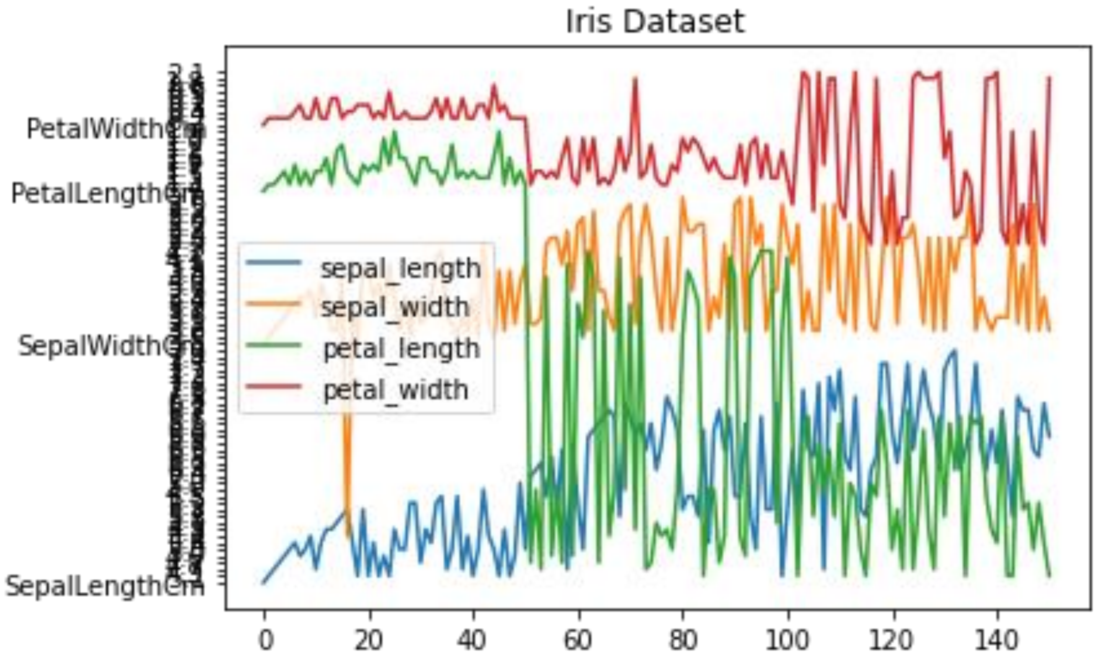
```
import pandas as pd
iris = pd.read_csv('/content/drive/MyDrive/Colab Notebooks/Iris.csv', name
s=['sepal_length', 'sepal_width', 'petal_length', 'petal_width', 'class'])
print(iris.head())
```

```
     sepal_length   sepal_width   petal_length   petal_width         class
Id  SepalLengthCm  SepalWidthCm  PetalLengthCm  PetalWidthCm       Species
1             5.1           3.5            1.4           0.2   Iris-setosa
2             4.9           3.0            1.4           0.2   Iris-setosa
3             4.7           3.2            1.3           0.2   Iris-setosa
4             4.6           3.1            1.5           0.2   Iris-setosa
```

```
# get columns to plot
columns = iris.columns.drop(['class'])
# create x data
x_data = range(0, iris.shape[0])
# create figure and axis
fig, ax = plt.subplots()
```

```
# plot each column
for column in columns:
    ax.plot(x_data, iris[column], label=column)
# set title and legend
ax.set_title('Iris Dataset')
ax.legend()
```

```
<matplotlib.legend.Legend at 0x7fb575538590>
```

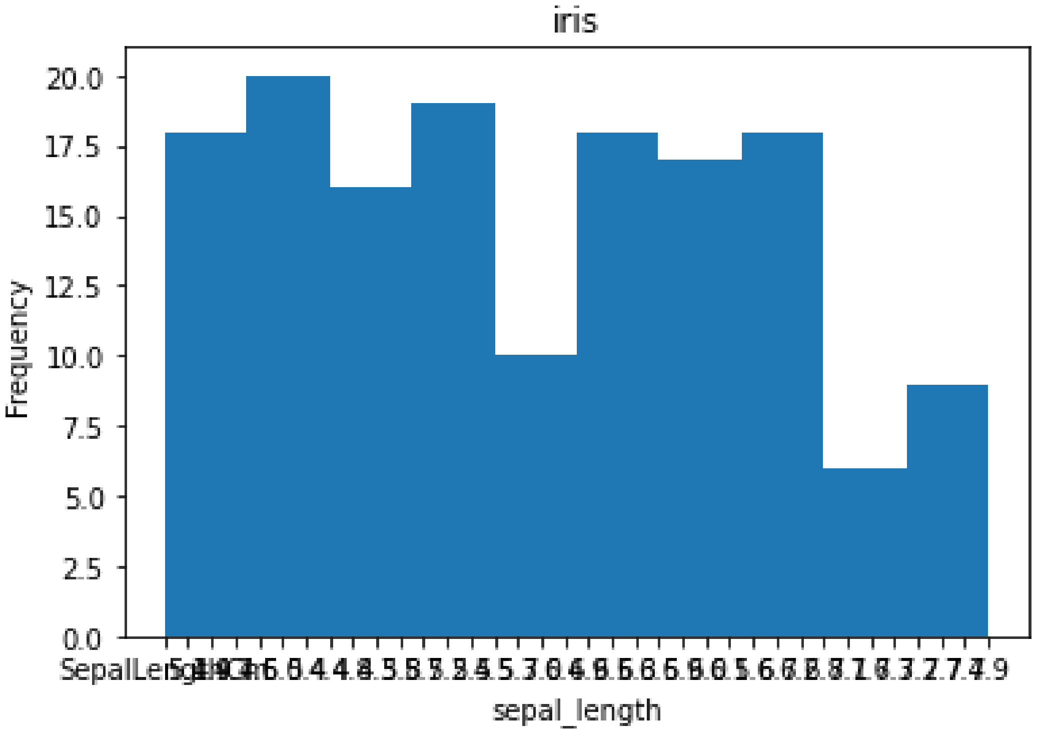


Histogram

In Matplotlib we can create a Histogram using the hist method. If we pass it categorical data like the points column from the wine-review dataset it will automatically calculate how often each class occurs.

```
# create figure and axis
fig, ax = plt.subplots()
# plot histogram
ax.hist(iris['sepal_length'])
# set title and labels
ax.set_title('iris')
ax.set_xlabel('sepal_length')
ax.set_ylabel('Frequency')
```

```
Text(0, 0.5, 'Frequency')
```



Bar Chart

A bar chart can be created using the bar method. The bar-chart isn't automatically calculating the frequency of a category so we are going to use pandas value_counts function to do this. The bar-chart is useful for categorical data that doesn't have a lot of different categories (less than 30) because else it can get quite messy.

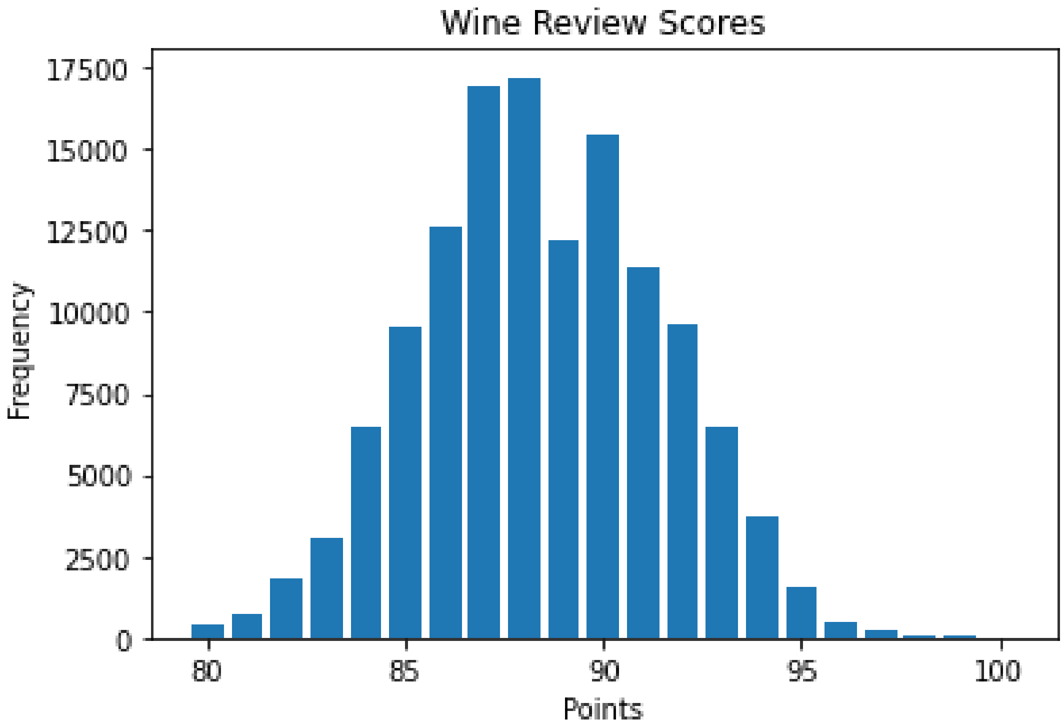
```
wine_reviews = pd.read_csv('/content/drive/MyDrive/Colab Notebooks/winemag
-data-130k-v2.csv', index_col=0)
wine_reviews.head()
```

```
    country                                        description  \
0     Italy  Aromas include tropical fruit, broom, brimston...
1  Portugal  This is ripe and fruity, a wine that is smooth...
2        US  Tart and snappy, the flavors of lime flesh and...
3        US  Pineapple rind, lemon pith and orange blossom ...
4        US  Much like the regular bottling from 2012, this...

                         designation  points  price           province  \
0                       Vulkà Bianco      87    NaN  Sicily & Sardinia
1                           Avidagos      87   15.0              Douro
2                                NaN      87   14.0             Oregon
3              Reserve Late Harvest       87   13.0           Michigan
4 Vintner's Reserve Wild Child Block      87   65.0             Oregon

             region_1           region_2         taster_name  \
0                Etna                NaN       Kerin O’Keefe
1                 NaN                NaN          Roger Voss
2   Willamette Valley  Willamette Valley        Paul Gregutt
3 Lake Michigan Shore                NaN  Alexander Peartree
```

```
4    Willamette Valley  Willamette Valley        Paul Gregutt

  taster_twitter_handle                                              title
\
0          @kerinokeefe                  Nicosia 2013 Vulkà Bianco  (Etna)
1            @vossroger      Quinta dos Avidagos 2011 Avidagos Red (Douro)
2           @paulgwine       Rainstorm 2013 Pinot Gris (Willamette Valley)
3                   NaN  St. Julian 2013 Reserve Late Harvest Riesling ...
4           @paulgwine   Sweet Cheeks 2012 Vintner's Reserve Wild Child...

          variety               winery
0     White Blend              Nicosia
1  Portuguese Red  Quinta dos Avidagos
2      Pinot Gris            Rainstorm
3        Riesling           St. Julian
4      Pinot Noir         Sweet Cheeks
```

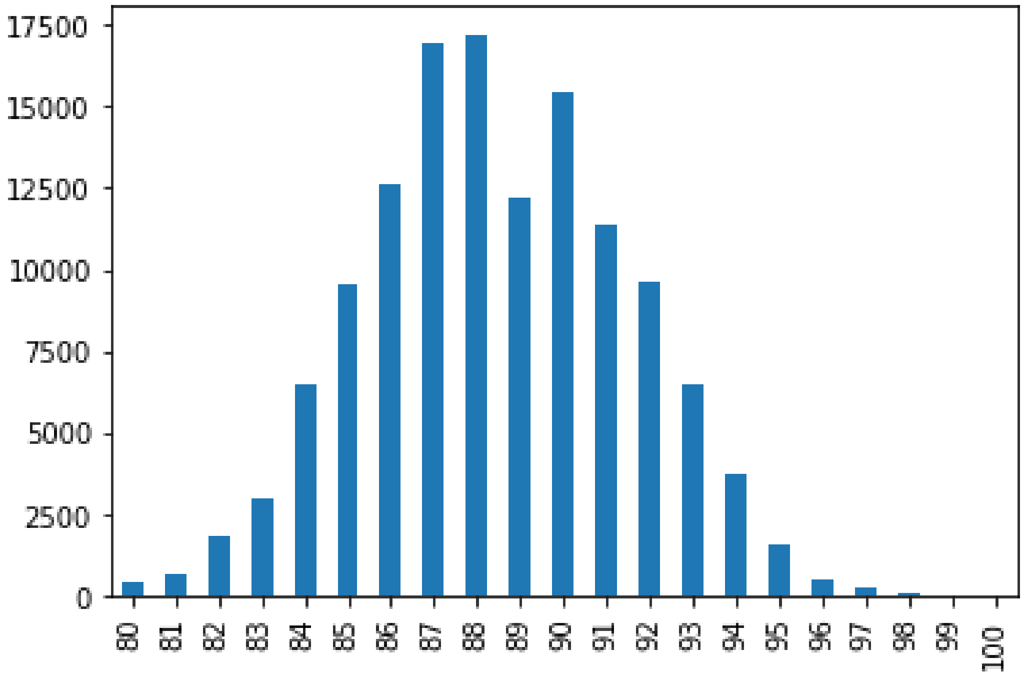
```
#Bar Chart
# create a figure and axis
fig, ax = plt.subplots()
# count the occurrence of each class
data = wine_reviews['points'].value_counts()
# get x and y data
points = data.index
frequency = data.values
# create bar chart
ax.bar(points, frequency)
# set title and labels
ax.set_title('Wine Review Scores')
ax.set_xlabel('Points')
ax.set_ylabel('Frequency')
```

```
Text(0, 0.5, 'Frequency')
```



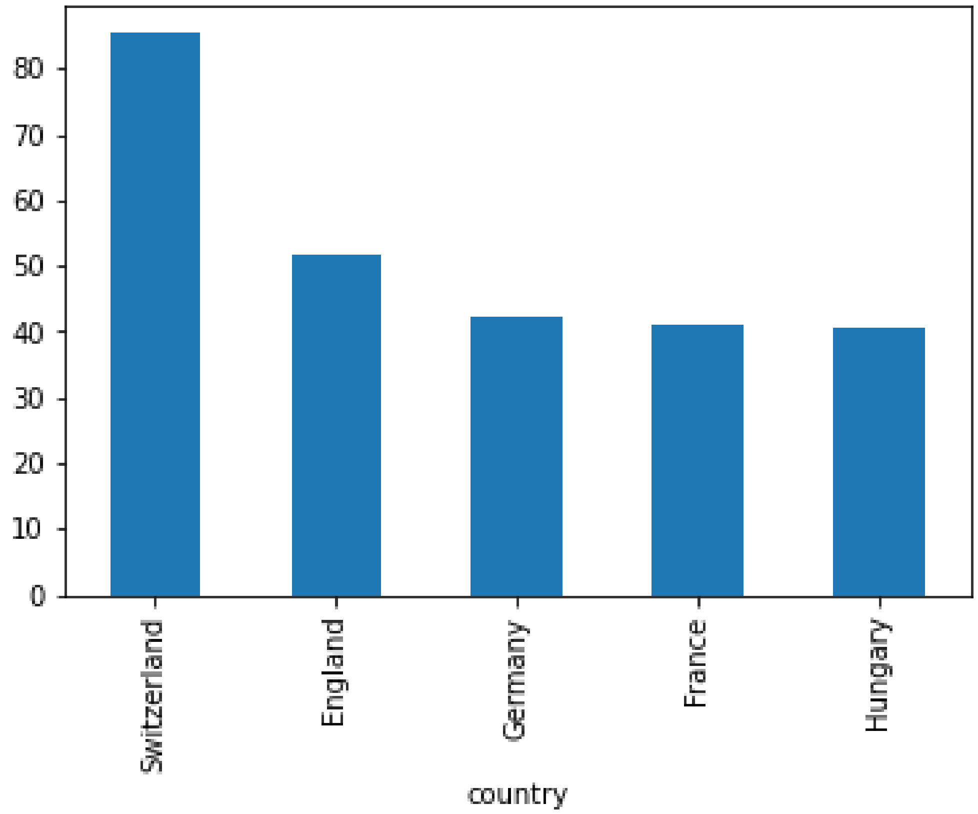
```
wine_reviews['points'].value_counts().sort_index().plot.bar()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f629781eb10>
```



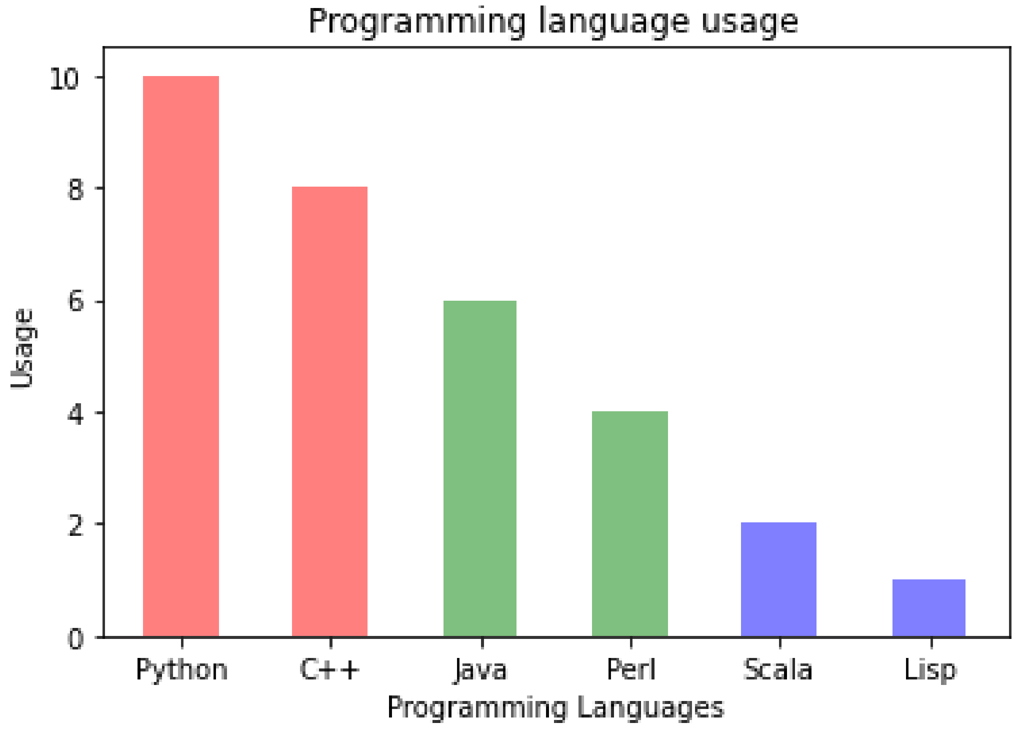
```
wine_reviews.groupby("country").price.mean().sort_values(ascending=False)[
:5].plot.bar()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f629781e290>
```



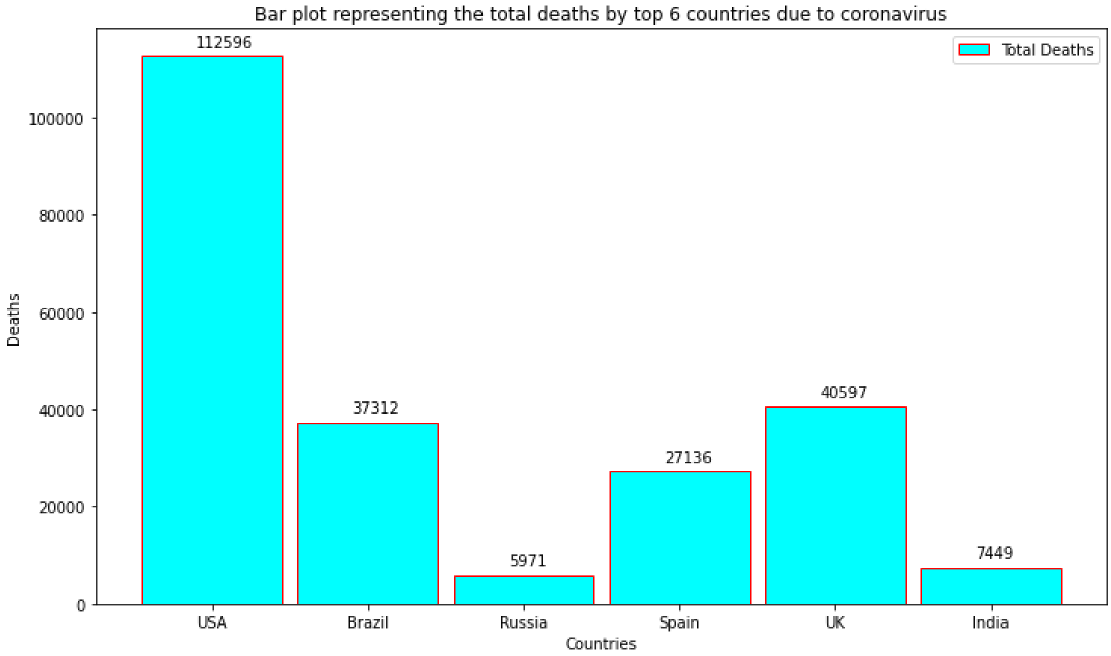
```
import numpy as np
import matplotlib.pyplot as plt
objects = ('Python', 'C++', 'Java', 'Perl', 'Scala', 'Lisp')
y_pos = np.arange(len(objects))
performance = [10,8,6,4,2,1]
# Bar Chart
# X Axis positions as first parameter list, it can be floating point numbe
rs also
# Y Values as 2nd parameter list
# Alpha is transparency,
# Align can be center or edge
# Color can be single value or a list of color codes, one for each bar.
plt.bar(y_pos, performance, width=0.5, align='center', alpha=0.5, color=['
r', 'r', 'g', 'g', 'b', 'b'])
# To define labels for x axis values.
plt.xticks(y_pos, objects)
plt.ylabel('Usage')
plt.xlabel('Programming Languages')
plt.title('Programming language usage')
```

```
Text(0.5, 1.0, 'Programming language usage')
```



```
# Importing the matplotlib library
import matplotlib.pyplot as plt

# Declaring the figure or the plot (y, x) or (width, height)
plt.figure(figsize = (12,7))

# Categorical data: Country names
countries = ['USA', 'Brazil', 'Russia', 'Spain', 'UK', 'India']

# Integer value interms of death counts
totalDeaths = [112596, 37312, 5971, 27136, 40597, 7449]

# Passing the parameters to the bar function, this is the main function wh
ich creates the bar plot
plt.bar(countries, totalDeaths, width= 0.9, align='center',color='cyan', e
dgecolor = 'red')

# This is the location for the annotated text
i = 1.0
j = 2000

# Annotating the bar plot with the values (total death count)
for i in range(len(countries)):
    plt.annotate(totalDeaths[i], (-0.1 + i, totalDeaths[i] + j))

# Creating the legend of the bars in the plot
plt.legend(labels = ['Total Deaths'])

# Giving the tilte for the plot
plt.title("Bar plot representing the total deaths by top 6 countries due t
o coronavirus")
```

```
# Namimg the x and y axis
plt.xlabel('Countries')
plt.ylabel('Deaths')

# Saving the plot as a 'png'
plt.savefig('1BarPlot.png')

# Displaying the bar plot
plt.show()
```

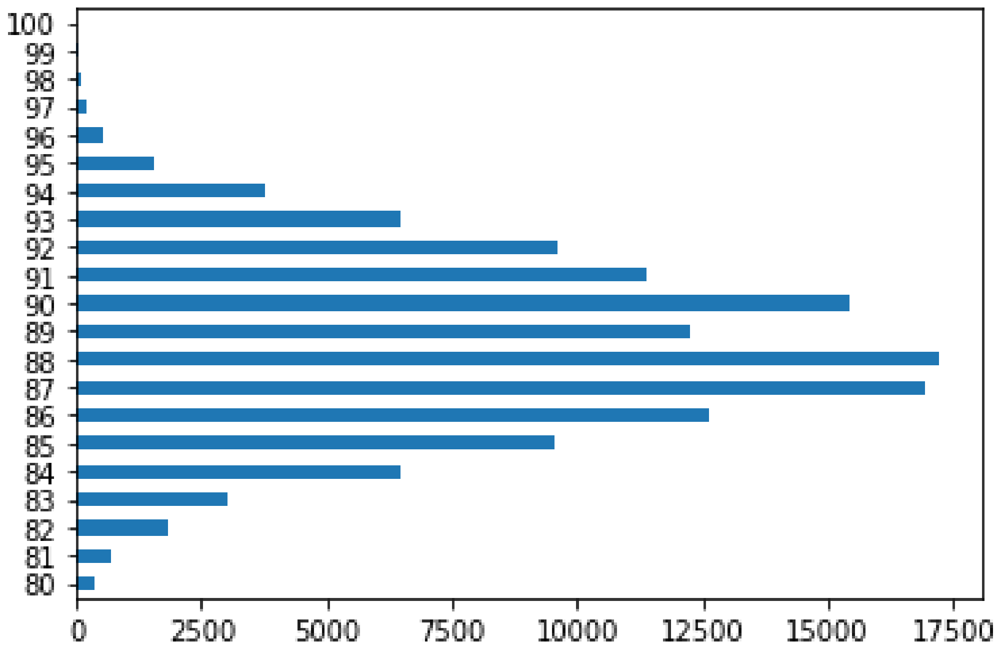


Horizontal bar plot

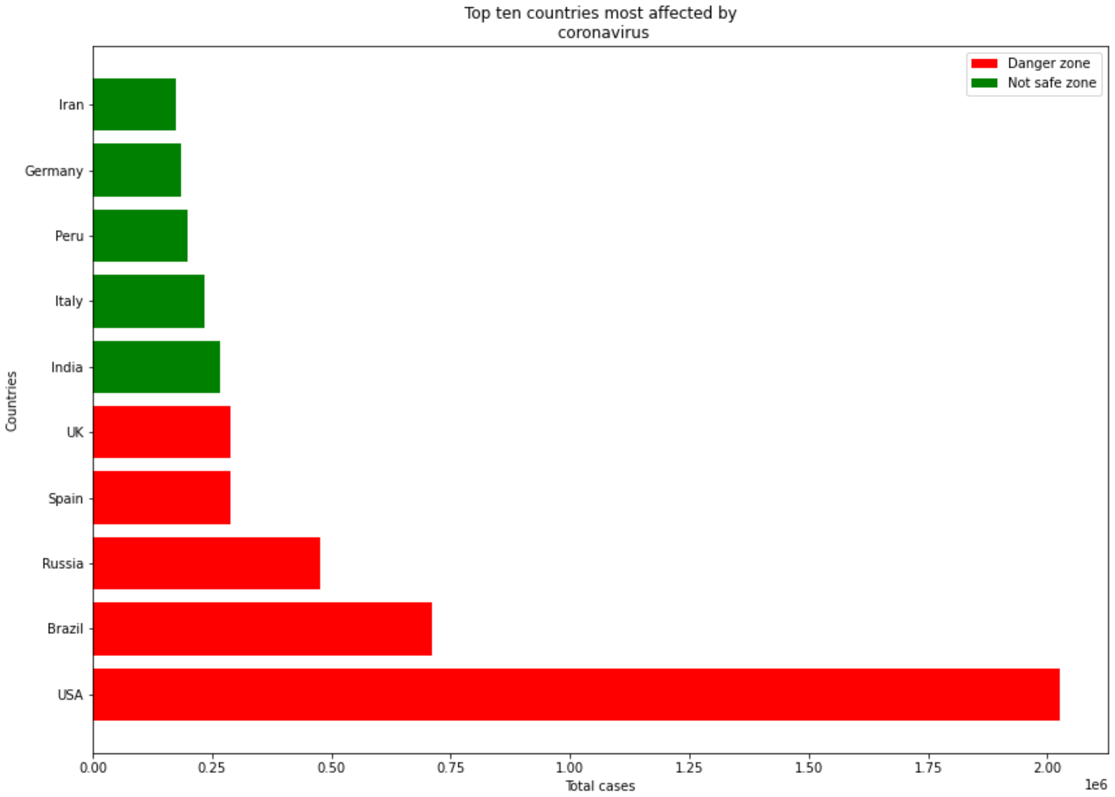
It's also really simple to make a horizontal bar-chart using the plot.barh() method. By adding one extra character 'h', we can align the bars horizontally. Also, we can represent the bars in two or more different colors, this will increase the readability of the plots.

```
wine_reviews['points'].value_counts().sort_index().plot.barh()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f62975f6d50>
```



```
# Importing the matplotlib library
import matplotlib.pyplot as plt

# Declaring the figure or the plot (y, x) or (width, height)
plt.figure(figsize=[14, 10])

# Passing the parameters to the bar function, this is the main function which creates the bar plot
# For creating the horizontal make sure that you append 'h' to the bar function name
plt.barh(['USA', 'Brazil', 'Russia', 'Spain', 'UK'], [2026493, 710887, 476658, 288797, 287399], label = "Danger zone", color = 'r')
plt.barh(['India', 'Italy', 'Peru', 'Germany', 'Iran'], [265928, 235278, 199696, 186205, 173832], label = "Not safe zone", color = 'g')

# Creating the legend of the bars in the plot
plt.legend()

# Namimg the x and y axis
plt.xlabel('Total cases')
plt.ylabel('Countries')

# Giving the tilte for the plot
plt.title('Top ten countries most affected by\n coronavirus')

# Saving the plot as a 'png'
plt.savefig('2BarPlot.png')

# Displaying the bar plot
plt.show()
```

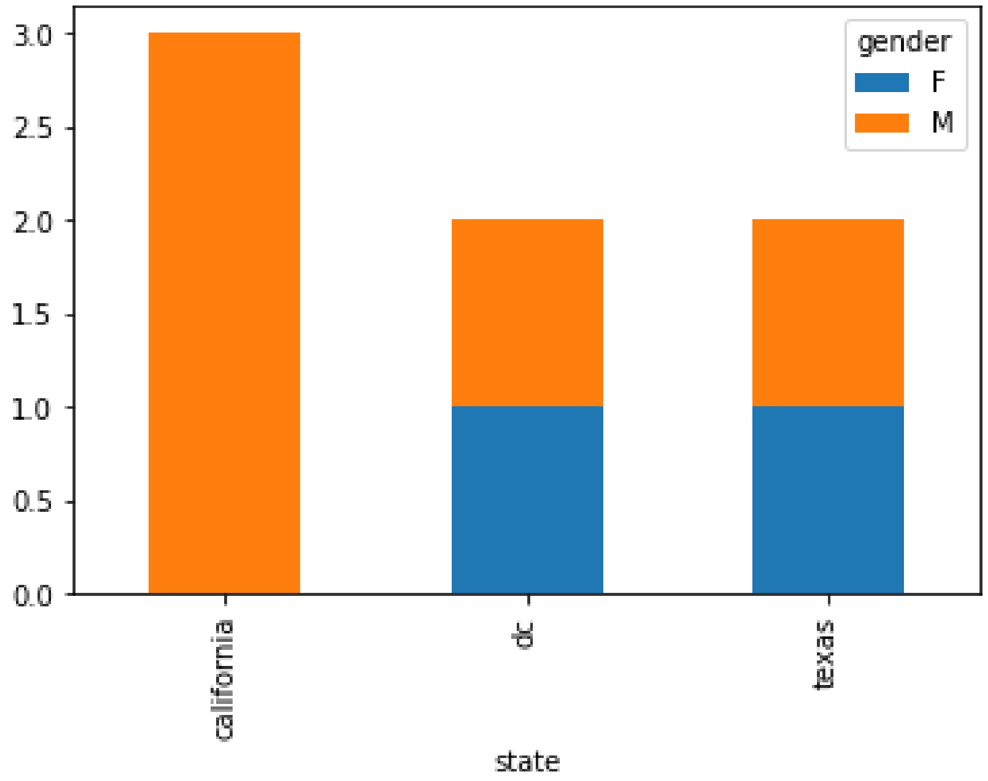


Stacking two bar plots on top of each other

At times you might want to stack two or more bar plots on top of each other. With the help of this, you can differentiate two separate quantities visually. To do this just follow.

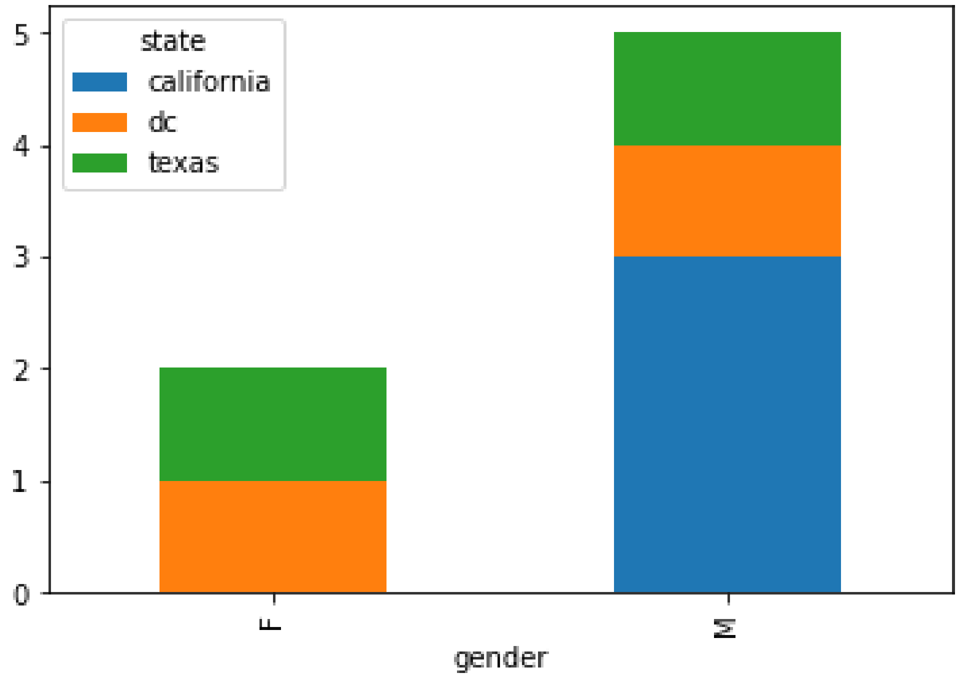
```
import pandas as pd
df = pd.DataFrame({
    'name':['john','mary','peter','jeff','bill','lisa','jose'],
    'age':[23,78,22,19,45,33,20],
    'gender':['M','F','M','M','M','F','M'],
    'state':['california','dc','california','dc','california','texas','tex
as'],
    'num_children':[2,0,0,3,2,1,4],
    'num_pets':[5,1,0,5,2,2,3]
})
# From pandas to plot multiple plots on same figure

df.groupby(['state','gender']).size().unstack().plot(kind='bar', stacked=T
rue)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f62974a7a50>
```



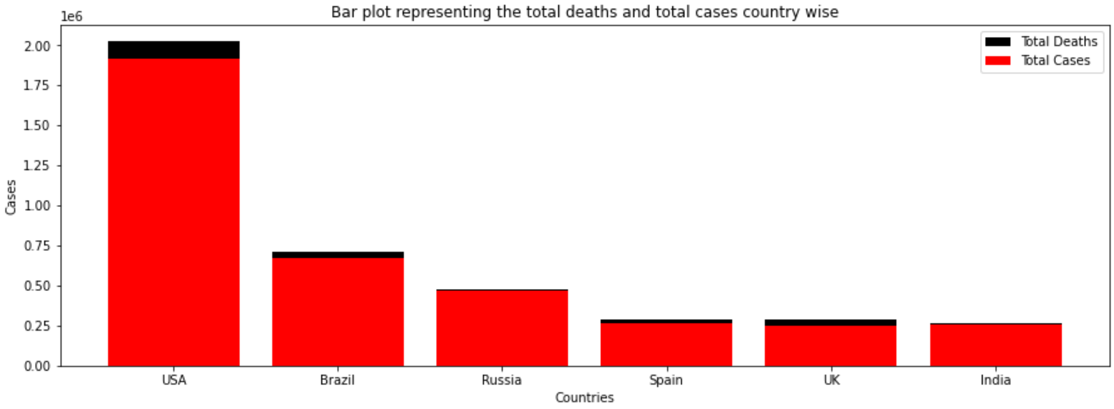
```
df.groupby(['gender','state']).size().unstack().plot(kind='bar',stacked=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f629748ed10>
```



```
# Importing the matplotlib library
import matplotlib.pyplot as plt

# Declaring the figure or the plot (y, x) or (width, height)
```

```
plt.figure(figsize=[15, 5])

# Categorical data: Country names
countries = ['USA', 'Brazil', 'Russia', 'Spain', 'UK', 'India']

# Integer value interms of total cases
totalCases = (2026493, 710887, 476658, 288797, 287399, 265928)

# Integer value interms of death counts
totalDeaths = (113055, 37312, 5971, 27136, 40597, 7473)

# Plotting both the total death and the total cases in a single plot. Form
ula total cases - total deaths
for i in range(len(countries)):
    plt.bar(countries[i], totalDeaths[i], bottom = totalCases[i] -  totalD
eaths[i], color='black')
    plt.bar(countries[i], totalCases[i] - totalDeaths[i], color='red')

# Creating the legend of the bars in the plot
plt.legend(labels = ['Total Deaths','Total Cases'])

# Giving the tilte for the plot
plt.title("Bar plot representing the total deaths and total cases country
wise")

# Namimg the x and y axis
plt.xlabel('Countries')
plt.ylabel('Cases')

# Saving the plot as a 'png'
plt.savefig('3BarPlot.png')

# Displaying the bar plot
plt.show()
```

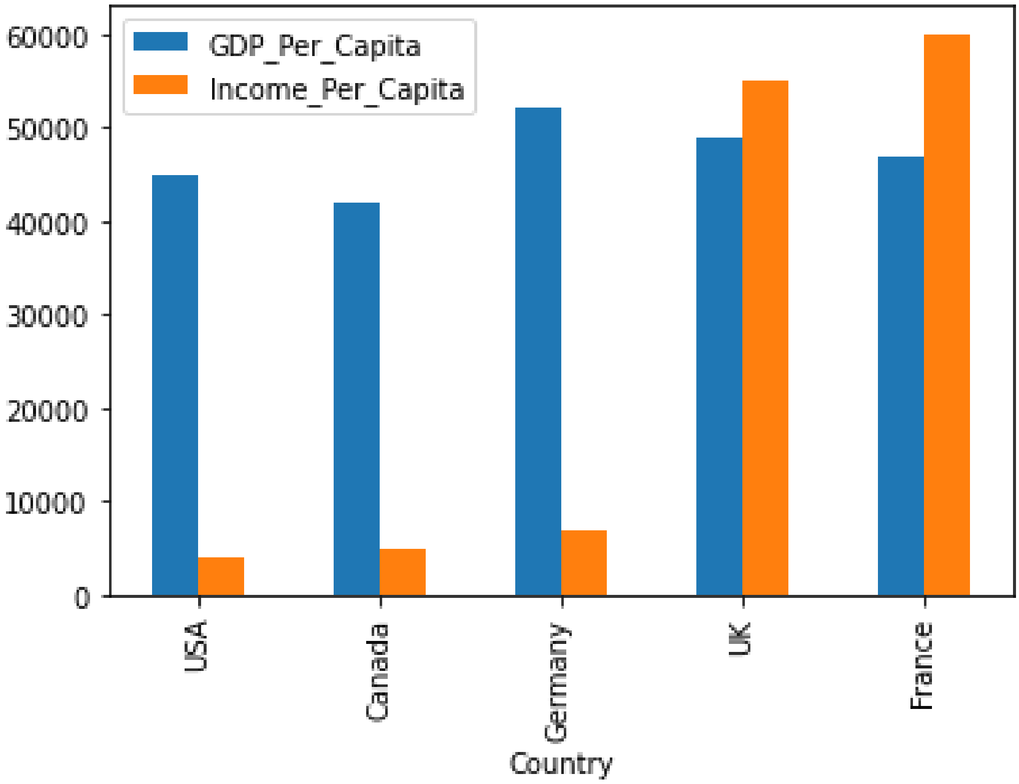


Plotting two or bar plot next to another (Grouping)

Often many-a-times you might want to group two or more plots just to represent two or more different quantities or whatever. Also in the below code, you can learn to override the name of the x-axis with the name of your choice.

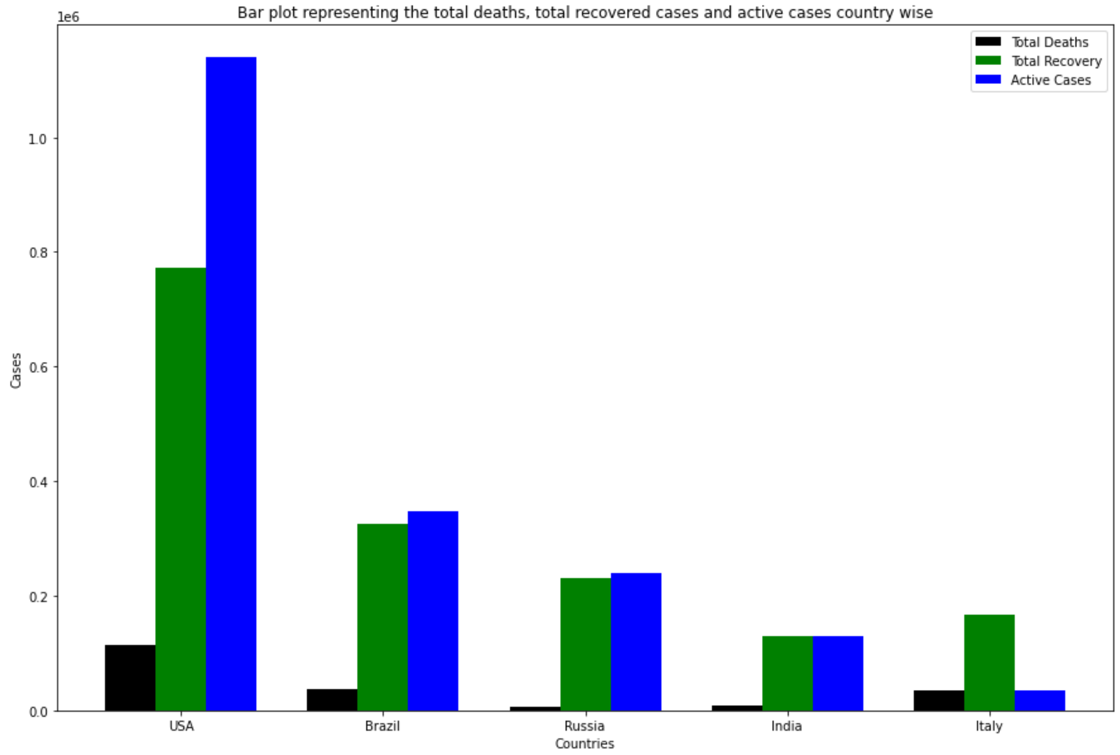
```
import pandas as pd
from matplotlib import pyplot as plt

Data = {'Country': ['USA','Canada','Germany','UK','France'],
        'GDP_Per_Capita': [45000,42000,52000,49000,47000],
        'Income_Per_Capita': [4000,5000,7000,55000,60000]
       }


df = pd.DataFrame(Data)
# Multiple metrics in same chart
df.plot(x ='Country', y=['GDP_Per_Capita', 'Income_Per_Capita'], kind = 'b
ar')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f62973d7550>
```



```
# Importing the matplotlib library
import numpy as np
import matplotlib.pyplot as plt

# Declaring the figure or the plot (y, x) or (width, height)
plt.figure(figsize=[15, 10])

# Data to be plotted
```

```python
totalDeath = [113055, 37312, 5971, 7473, 33964]
totalRecovery = [773480, 325602, 230688, 129095, 166584]
activeCases = [1139958, 347973, 239999, 129360, 34730]
country = ['USA', 'Brazil', 'Russia', 'India', 'Italy']

# Using numpy to group 3 different data with bars
X = np.arange(len(totalDeath))

# Passing the parameters to the bar function, this is the main function which creates the bar plot
# Using X now to align the bars side by side
plt.bar(X, totalDeath, color = 'black', width = 0.25)
plt.bar(X + 0.25, totalRecovery, color = 'g', width = 0.25)
plt.bar(X + 0.5, activeCases, color = 'b', width = 0.25)

# Creating the legend of the bars in the plot
plt.legend(['Total Deaths', 'Total Recovery', 'Active Cases'])

# Overiding the x axis with the country names
plt.xticks([i + 0.25 for i in range(5)], country)

# Giving the tilte for the plot
plt.title("Bar plot representing the total deaths, total recovered cases and active cases country wise")

# Namimg the x and y axis
plt.xlabel('Countries')
plt.ylabel('Cases')

# Saving the plot as a 'png'
plt.savefig('4BarPlot.png')

# Displaying the bar plot
plt.show()
```

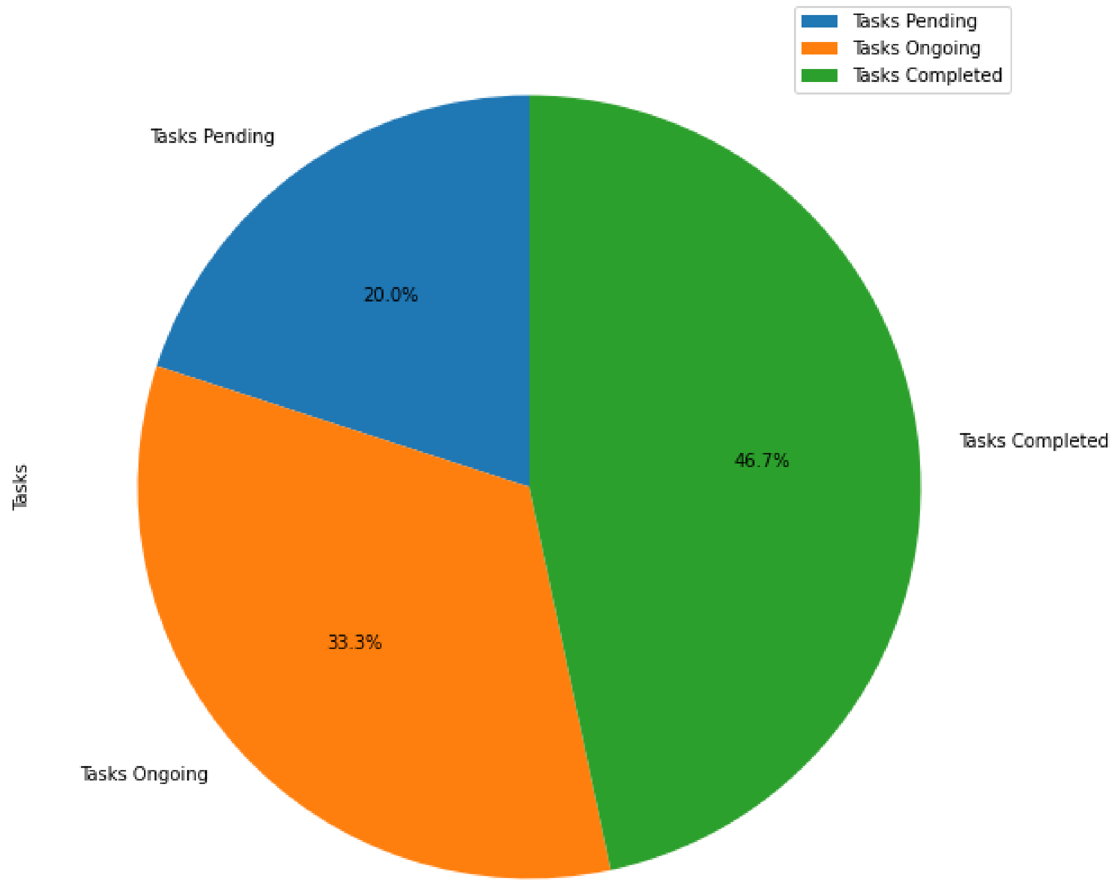


Pie chart

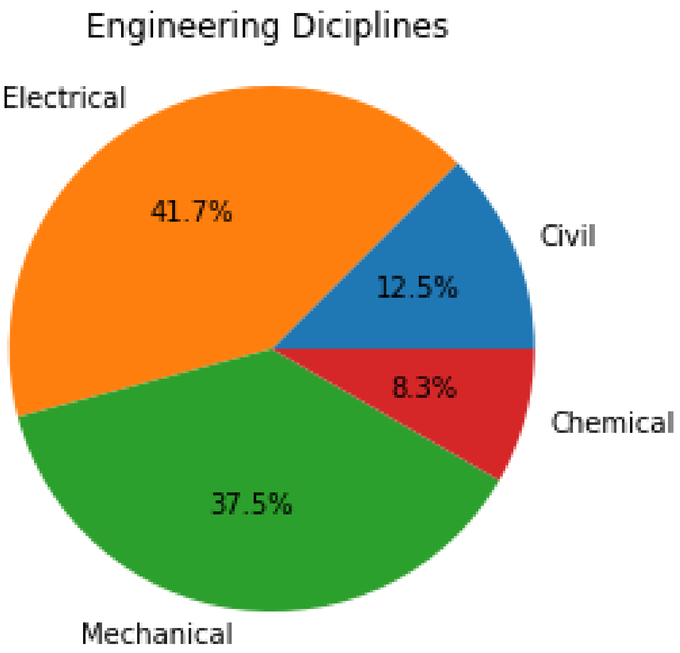
A pie chart is a type of data visualization that is used to illustrate numerical proportions in data.

```
# Data Frame plotting
from pandas import DataFrame
import matplotlib.pyplot as plt

Data = {'Tasks': [300,500,700],
        'Task Type' : ['Tasks Pending','Tasks Ongoing','Tasks Completed']
        }

df = DataFrame(Data)
df.set_index('Task Type', inplace=True)

# autopct has extra % at the end as escape, as % is interpreted as formatting string begin by default.
# Only pie chart needs labels to be data frame index
df.plot.pie(y='Tasks', figsize=(10,10),autopct='%1.1f%%', startangle=90)
```

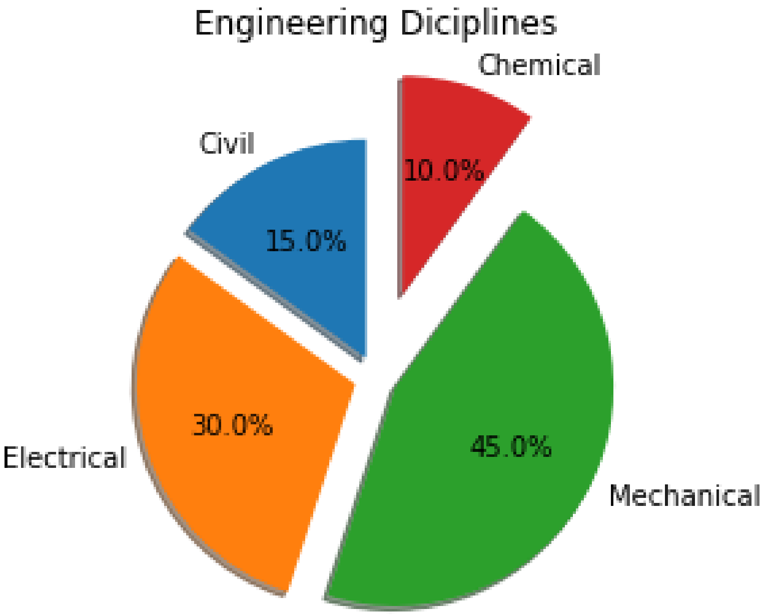
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6297541150>
```



```python
import numpy as np
import matplotlib.pyplot as plt
# if using a Jupyter notebook, include:
%matplotlib inline


# Pie chart, where the slices will be ordered and plotted counter-clockwise:
labels = ['Civil', 'Electrical', 'Mechanical', 'Chemical']
sizes = [15, 50, 45, 10]

fig, ax = plt.subplots()
ax.pie(sizes, labels=labels, autopct='%1.1f%%')
ax.axis('equal')  # Equal aspect ratio ensures the pie chart is circular.
ax.set_title('Engineering Diciplines')

plt.show()
```

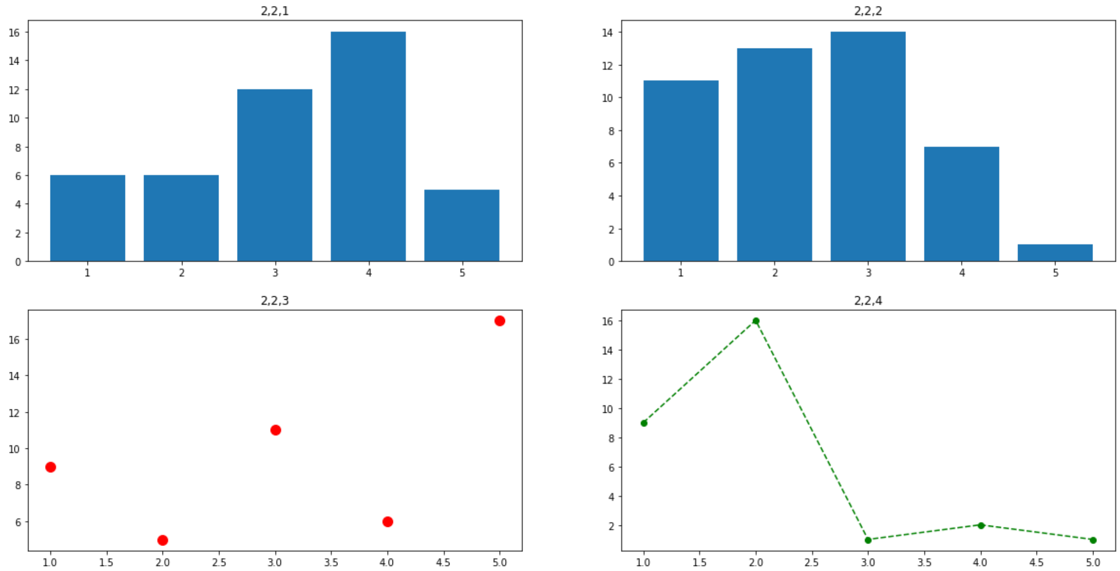


```
import numpy as np
import matplotlib.pyplot as plt
# if using a Jupyter notebook, include:
%matplotlib inline


# Pie chart, where the slices will be ordered and plotted counter-clockwis
e
labels = ['Civil', 'Electrical', 'Mechanical', 'Chemical']
sizes = [15, 30, 45, 10]

# Explode out the 'Chemical' pie piece by offsetting it a greater amount
explode = (0.1, 0.1, 0.1, 0.4)

fig, ax = plt.subplots()
ax.pie(sizes,
       explode=explode,
       labels=labels,
       autopct='%1.1f%%',
       shadow=True,
       startangle=90)
ax.axis('equal')  # Equal aspect ratio ensures the pie chart is circular.
ax.set_title('Engineering Diciplines')

plt.show()
```



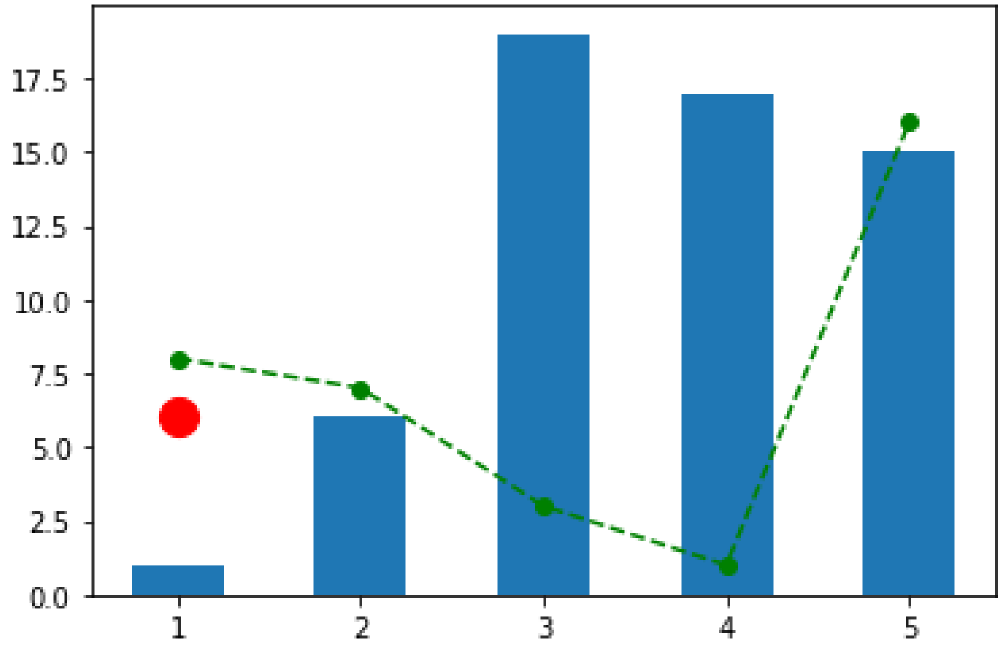
```
plt.figure(figsize=(20,10))
plt.subplot(2,2,1)
plt.bar(range(1,6), np.random.randint(1,20,5))
plt.title("2,2,1")
plt.subplot(2,2,2)
plt.bar(range(1,6), np.random.randint(1,20,5))
plt.title("2,2,2")
plt.subplot(2,2,3)
# s is the size of dot
plt.scatter(range(1,6), np.random.randint(1,20,5), s=100, color="r")
plt.title("2,2,3")
plt.subplot(2,2,4)
plt.plot(range(1,6), np.random.randint(1,20,5), marker='o', color='g', lin
estyle='--')
plt.title("2,2,4")
```

```
Text(0.5, 1.0, '2,2,4')
```



```
plt.bar(range(1,6), np.random.randint(1,20,5), width=0.5)
plt.scatter(range(1,6), np.random.randint(1,20,5), s=200, color="r")
plt.plot(range(1,6), np.random.randint(1,20,5), marker='o', color='g', lin
estyle='--')
```

```
[<matplotlib.lines.Line2D at 0x7f6296fa1310>]
```



Seaborn

• Seaborn is a Python data visualization library based on matplotlib • It provides a high level interface for drawing attractive and informative statistical graphics

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import os

os.chdir('/content/drive/MyDrive/Colab Notebooks')
cars_data=pd.read_csv('Toyota.csv',index_col=0,na_values=["??","????"])
cars_data.size
```

```
14360
```

```
cars_data.dropna(axis=0,inplace=True)
cars_data.size
```

```
10960
```

```
cars_data=pd.read_csv('Toyota.csv')
cars_data.head()
```

```
   Unnamed: 0  Price   Age     KM FuelType  HP  MetColor  Automatic    CC  
\
0           0  13500  23.0  46986   Diesel  90       1.0          0  2000
1           1  13750  23.0  72937   Diesel  90       1.0          0  2000
2           2  13950  24.0  41711   Diesel  90       NaN          0  2000
3           3  14950  26.0  48000   Diesel  90       0.0          0  2000
4           4  13750  30.0  38500   Diesel  90       0.0          0  2000

   Doors  Weight
0  three    1165
1      3    1165
2      3    1165
3      3    1165
4      3    1170
```

```
cars_data=pd.read_csv('Toyota.csv',index_col=0)
cars_data.head()
```

```
   Price   Age     KM FuelType  HP  MetColor  Automatic    CC  Doors  Weig
ht
0  13500  23.0  46986   Diesel  90       1.0          0  2000  three    11
65
1  13750  23.0  72937   Diesel  90       1.0          0  2000      3    11
65
2  13950  24.0  41711   Diesel  90       NaN          0  2000      3    11
65
3  14950  26.0  48000   Diesel  90       0.0          0  2000      3    11
65
4  13750  30.0  38500   Diesel  90       0.0          0  2000      3    11
70
```

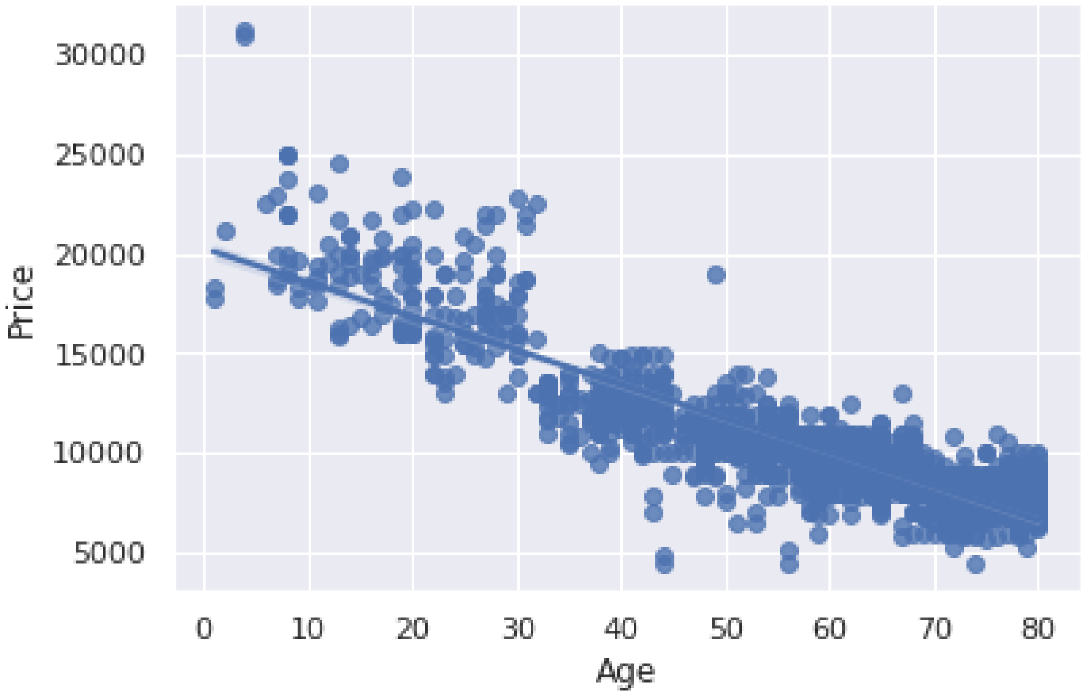
Scatter plot

Scatter plot of Price vs Age with default arguments

```
sns.set(style="darkgrid")
sns.regplot(x=cars_data['Age'],y=cars_data['Price'])
```

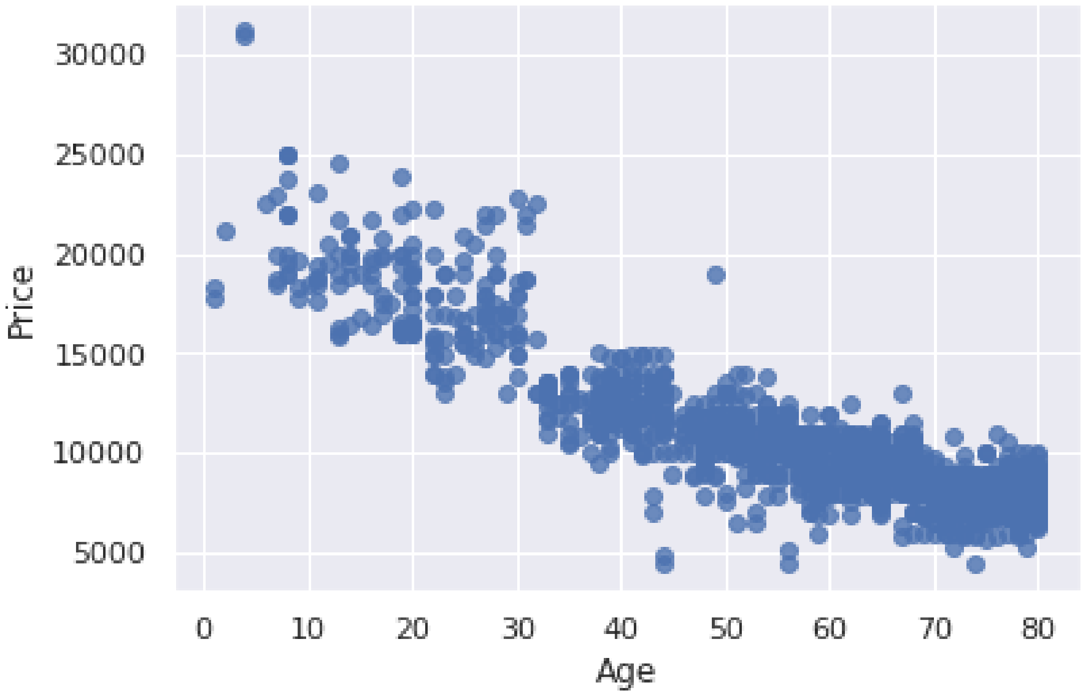
```
#It estimates and plots a regression model relating the x and y variables
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f628ae52cd0>
```



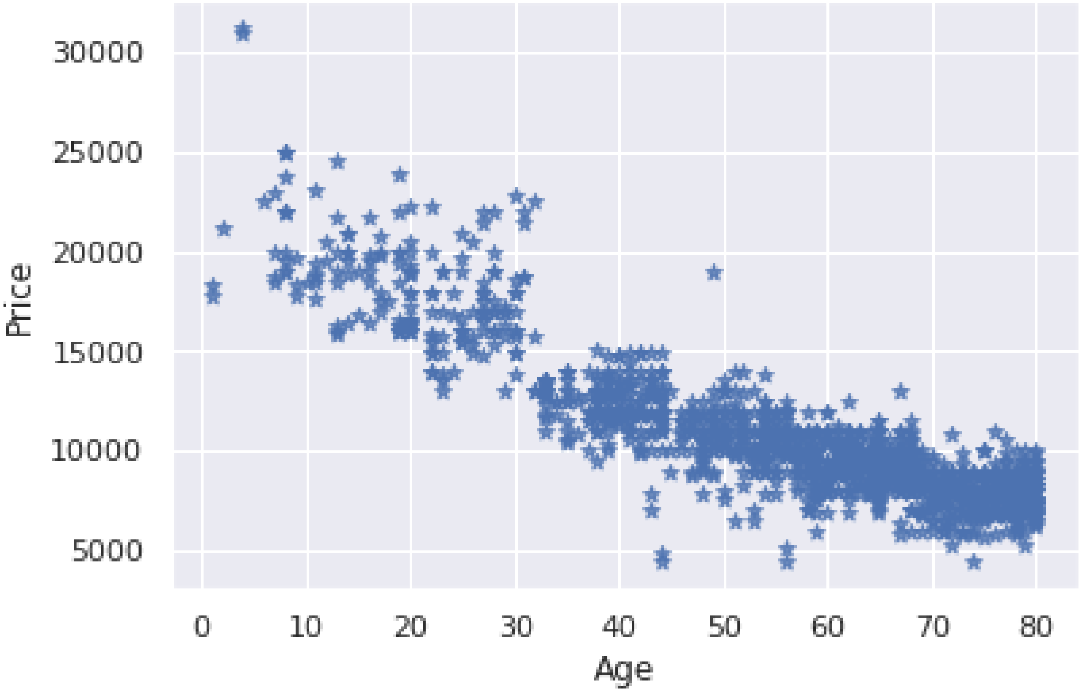
```
#Scatter plot of Price vs Age without the regression fit line
sns.regplot(x=cars_data['Age'],y=cars_data['Price'],fit_reg=False)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f628ad38190>
```



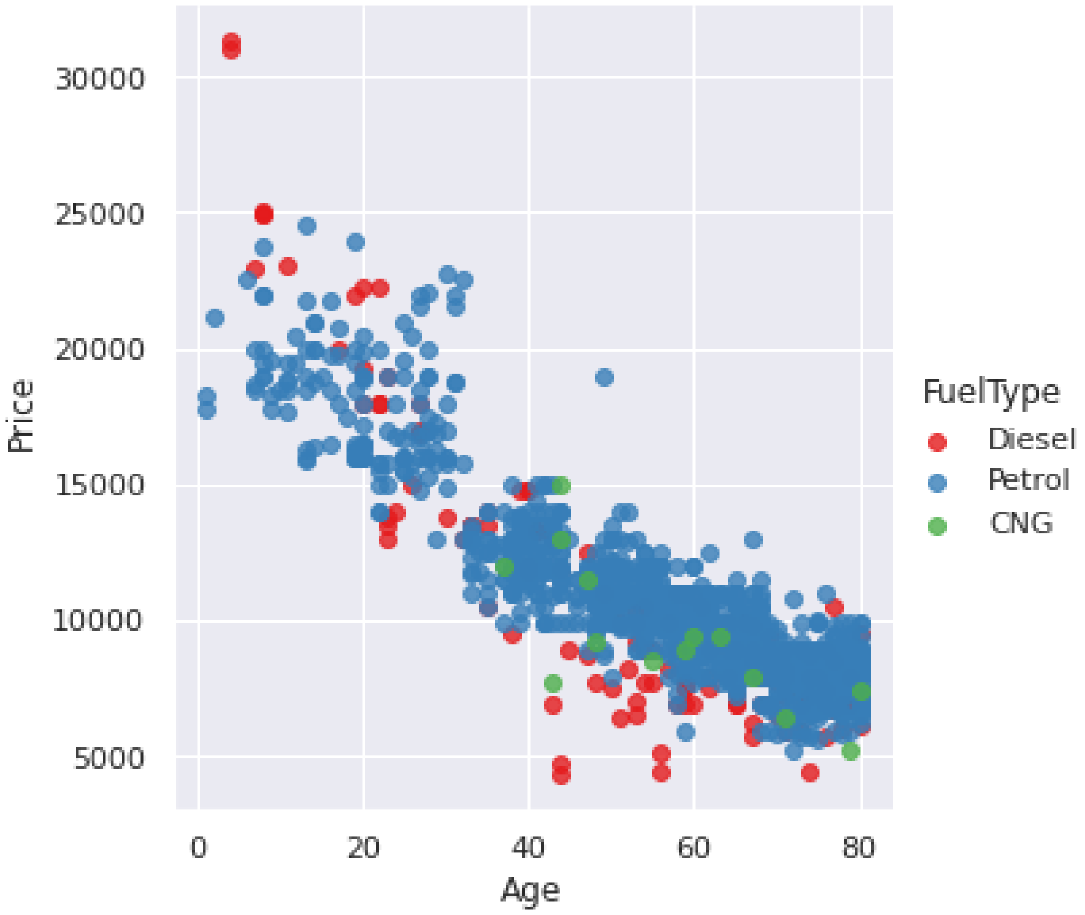
```
#Scatter plot of Price vs Age by customizing the appearance of markers
sns.regplot(x=cars_data['Age'], y=cars_data['Price'], marker="*", fit_reg=False)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f628ad22310>
```



```
# Scatter plot of Price vs Age by FuelType

#Using hue parameter, including another variable to show the fuel types categories with different colors

sns.lmplot(x='Age', y='Price', data=cars_data, fit_reg=False, hue='FuelType', legend=True, palette="Set1")
```

```
<seaborn.axisgrid.FacetGrid at 0x7f628ac8d210>
```

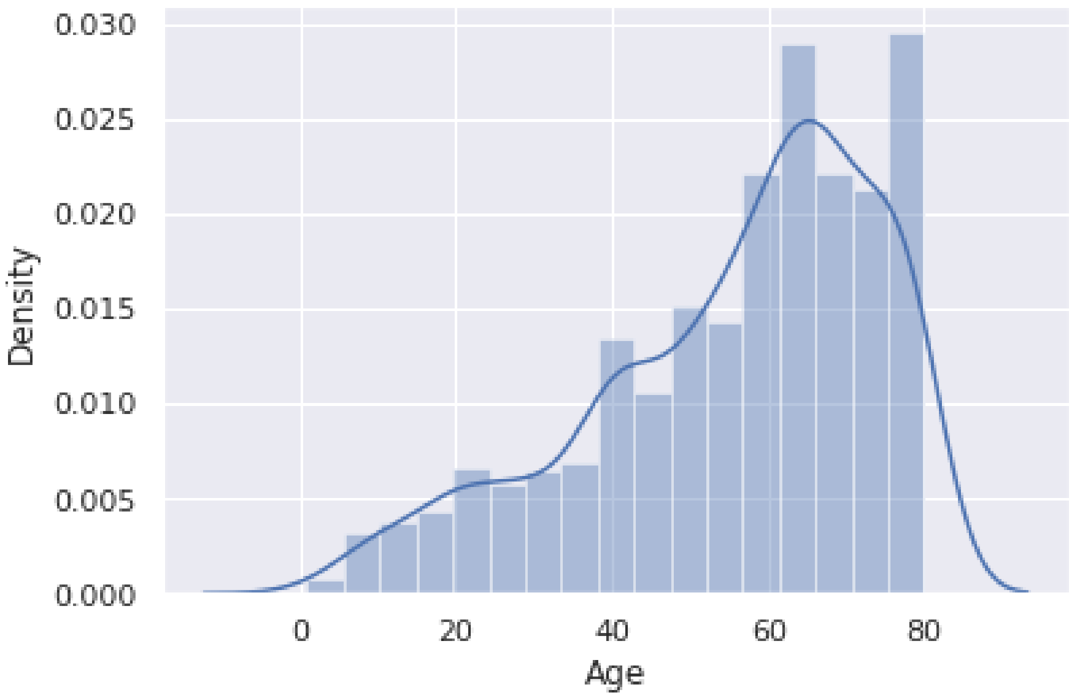


Histogram

Histogram with default kernel density estimate

```
sns.distplot(cars_data['Age'])
```

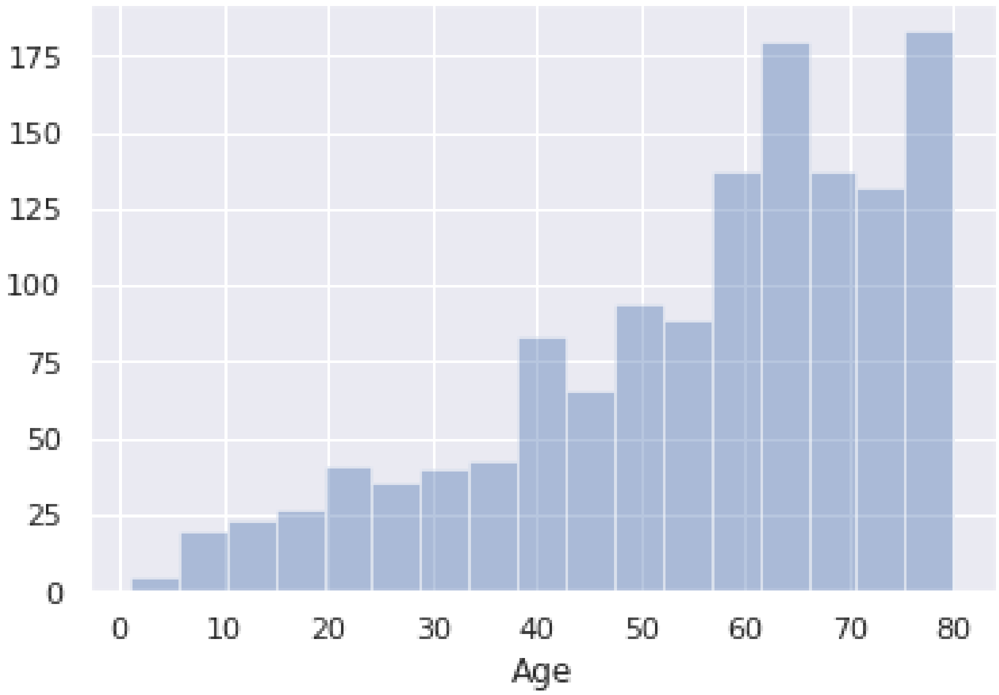
```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: Futu
reWarning: `distplot` is a deprecated function and will be removed in a fu
ture version. Please adapt your code to use either `displot` (a figure-lev
el function with similar flexibility) or `histplot` (an axes-level functio
n for histograms).
  warnings.warn(msg, FutureWarning)

<matplotlib.axes._subplots.AxesSubplot at 0x7f62883e5a10>
```



```
#Histogram without kernel density estimate
sns.distplot(cars_data['Age'],kde=False)
```

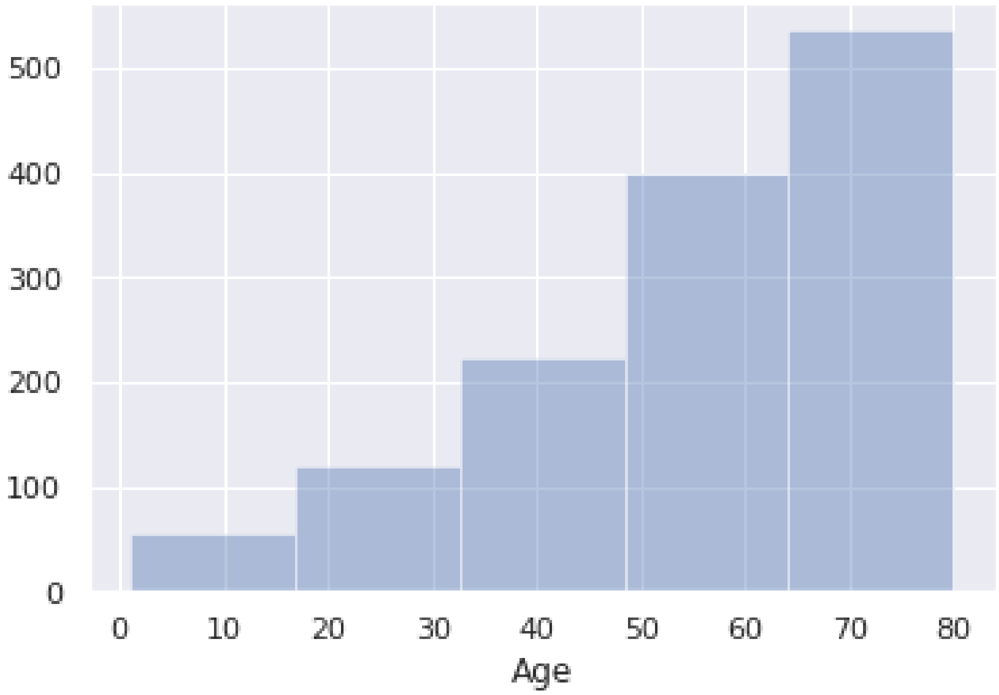
```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: Futu
reWarning: `distplot` is a deprecated function and will be removed in a fu
ture version. Please adapt your code to use either `displot` (a figure-lev
el function with similar flexibility) or `histplot` (an axes-level functio
n for histograms).
  warnings.warn(msg, FutureWarning)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f62882ffd10>
```



```
#Histogram with fixed no. of bins
sns.distplot(cars_data['Age'],kde=False, bins=5)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f62882a6c50>
```

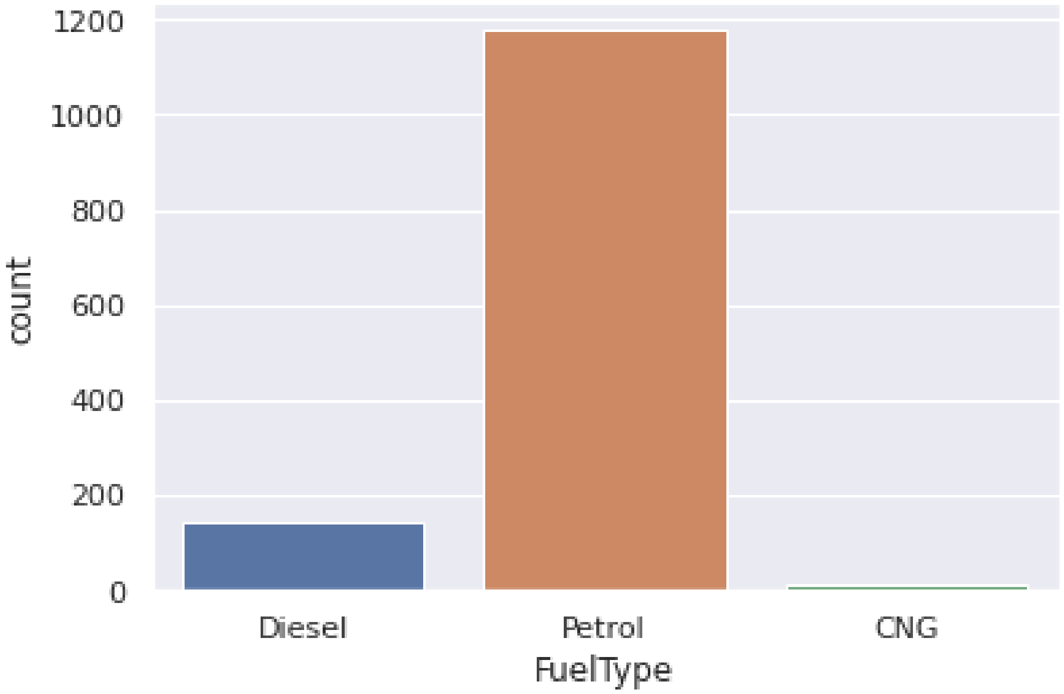


Bar plot

Frequency distribution of fuel type of the cars

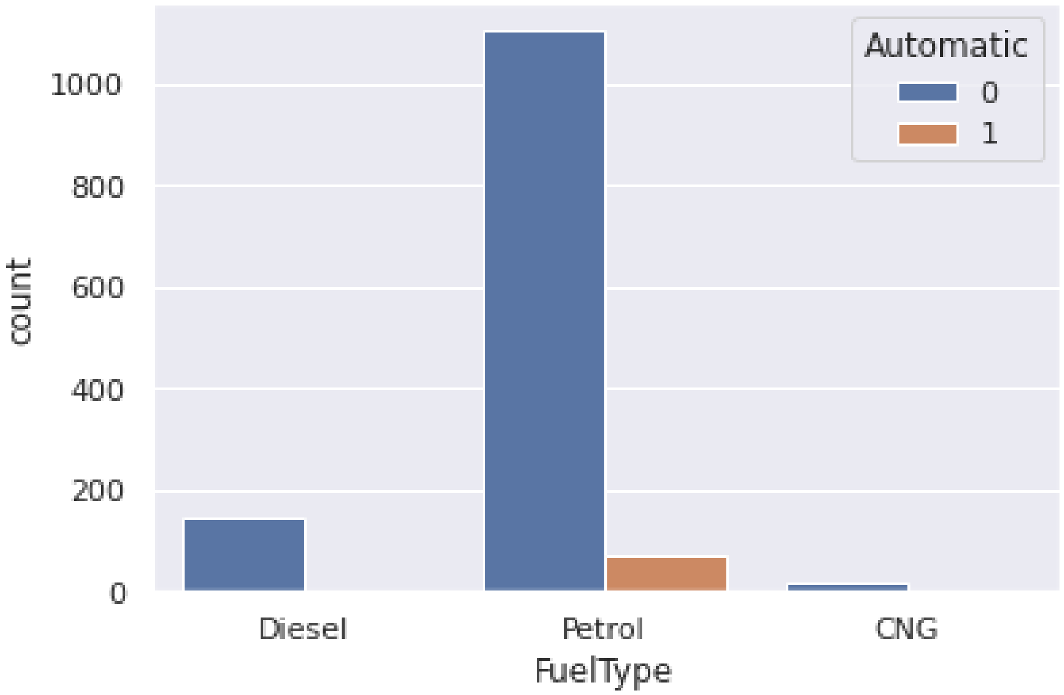
```
sns.countplot(x="FuelType", data=cars_data)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6288222150>
```



```
###Grouped bar plot
#Grouped bar plot of FuelType and Automatic

sns.countplot(x="FuelType", data=cars_data, hue="Automatic")
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f62881968d0>
```



```
pd.crosstab(index=cars_data['Automatic'], columns=cars_data['FuelType'],dr
opna=True)
```

```
FuelType   CNG  Diesel  Petrol
Automatic
0           15     144    1104
1            0       0      73
```

Box and whiskers plot

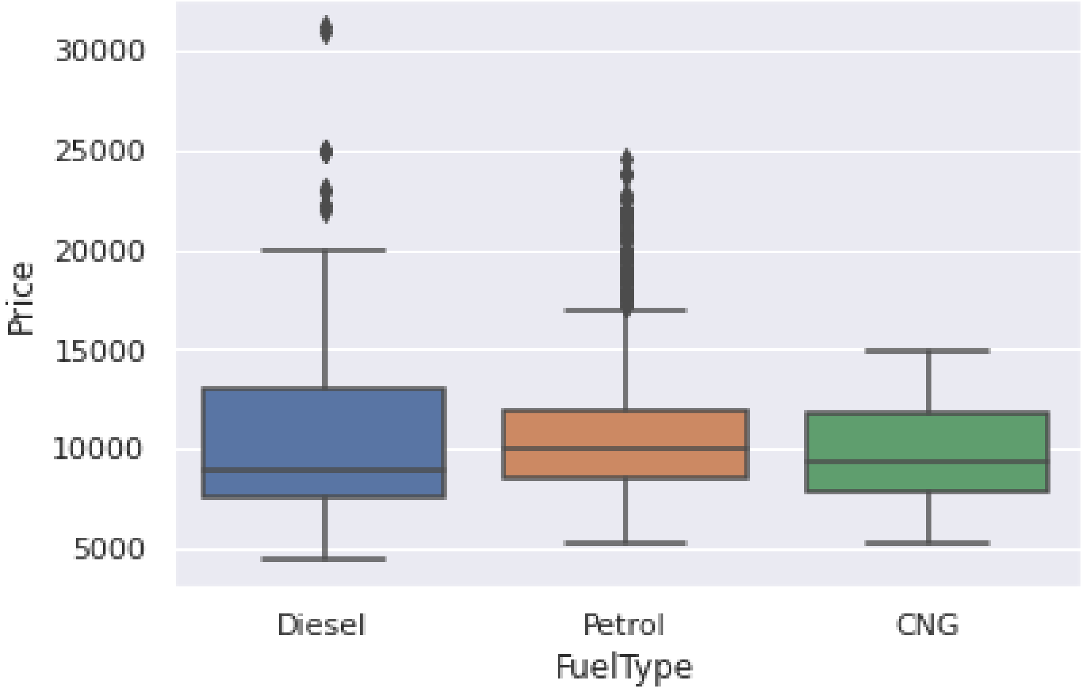
- Box and whiskers plot for numerical vs categorical variable

A Box Plot is also known as Whisker plot is created to display the summary of the set of data values having properties like minimum, first quartile, median, third quartile and maximum. In the box plot, a box is created from the first quartile to the third quartile, a vertical line is also there which goes through the box at the median. Here x-axis denotes the data to be plotted while the y-axis shows the frequency distribution.

- Price of the cars for various fuel types

```
sns.boxplot(x=cars_data['FuelType'],y=cars_data["Price"])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6288105bd0>
```

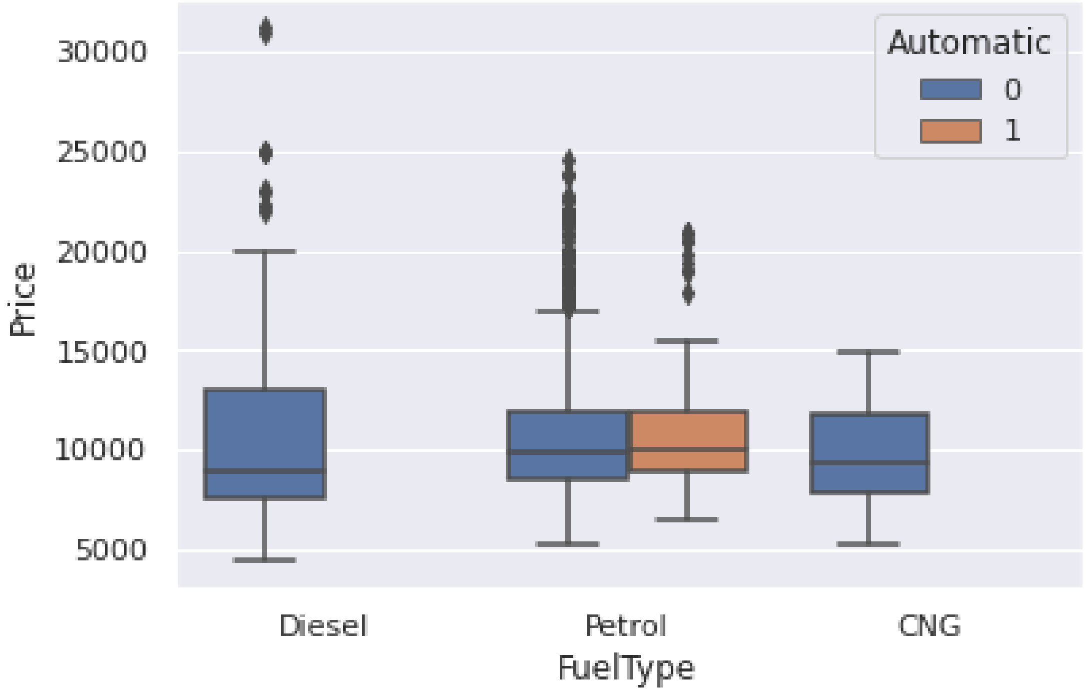


Grouped box and whiskers plot

- Grouped box and whiskers plot of Price vs FuelType and Automatic

```
sns.boxplot(x="FuelType", y=cars_data["Price"],hue="Automatic",data=cars_d
ata)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f62880a7690>
```



Box

whiskers plot and Histogram

 Let’s plot box whiskers plot and histogram on the same window

 Split the plotting window into 2 parts

```
f,(ax_box,ax_hist)=plt.subplots(2,gridspec_kw={"height_ratios": (.15, .85)
})
```

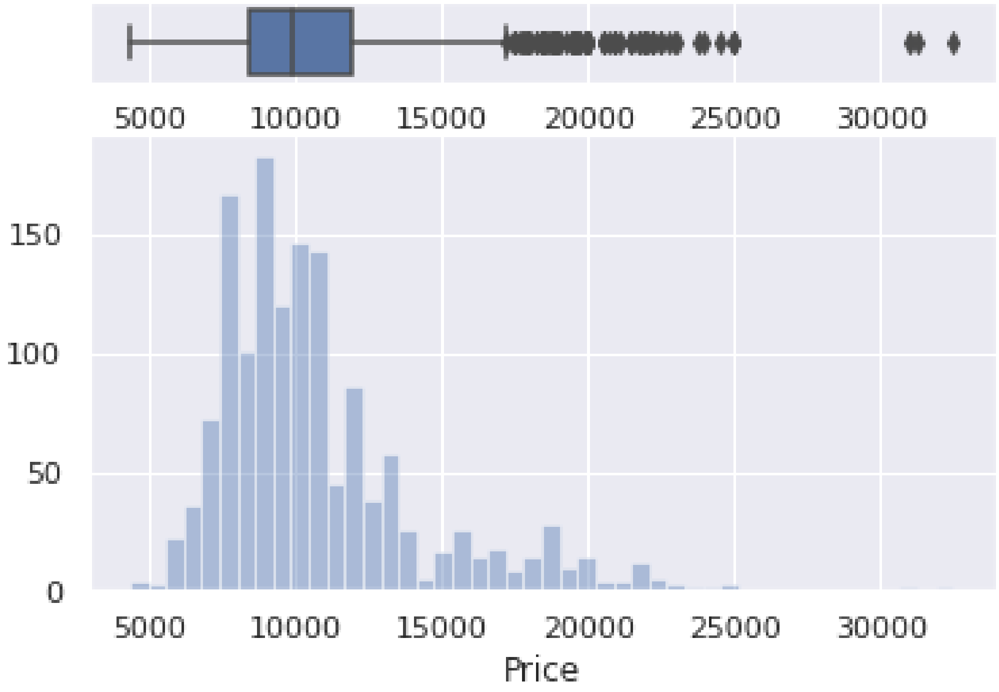
```
---------------------------------------------------------------------------
-
NameError                                 Traceback (most recent call last
)
<ipython-input-1-515edc54e648> in <module>
----> 1 f,(ax_box,ax_hist)=plt.subplots(2,gridspec_kw={"height_ratios": (.
15, .85)})

NameError: name 'plt' is not defined
```

Now, add create two plots

```
f,(ax_box,ax_hist)=plt.subplots(2,gridspec_kw={"height_ratios": (.15, .85)
})
sns.boxplot(cars_data['Price'],ax=ax_box)
sns.distplot(cars_data['Price'],ax=ax_hist,kde=False)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWa
rning: Pass the following variable as a keyword arg: x. From version 0.12,
the only valid positional argument will be `data`, and passing other argum
ents without an explicit keyword will result in an error or misinterpretat
ion.
  FutureWarning
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: Futu
reWarning: `distplot` is a deprecated function and will be removed in a fu
ture version. Please adapt your code to use either `displot` (a figure-lev
el function with similar flexibility) or `histplot` (an axes-level functio
n for histograms).
  warnings.warn(msg, FutureWarning)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6287f71050>
```



Pairwise plots

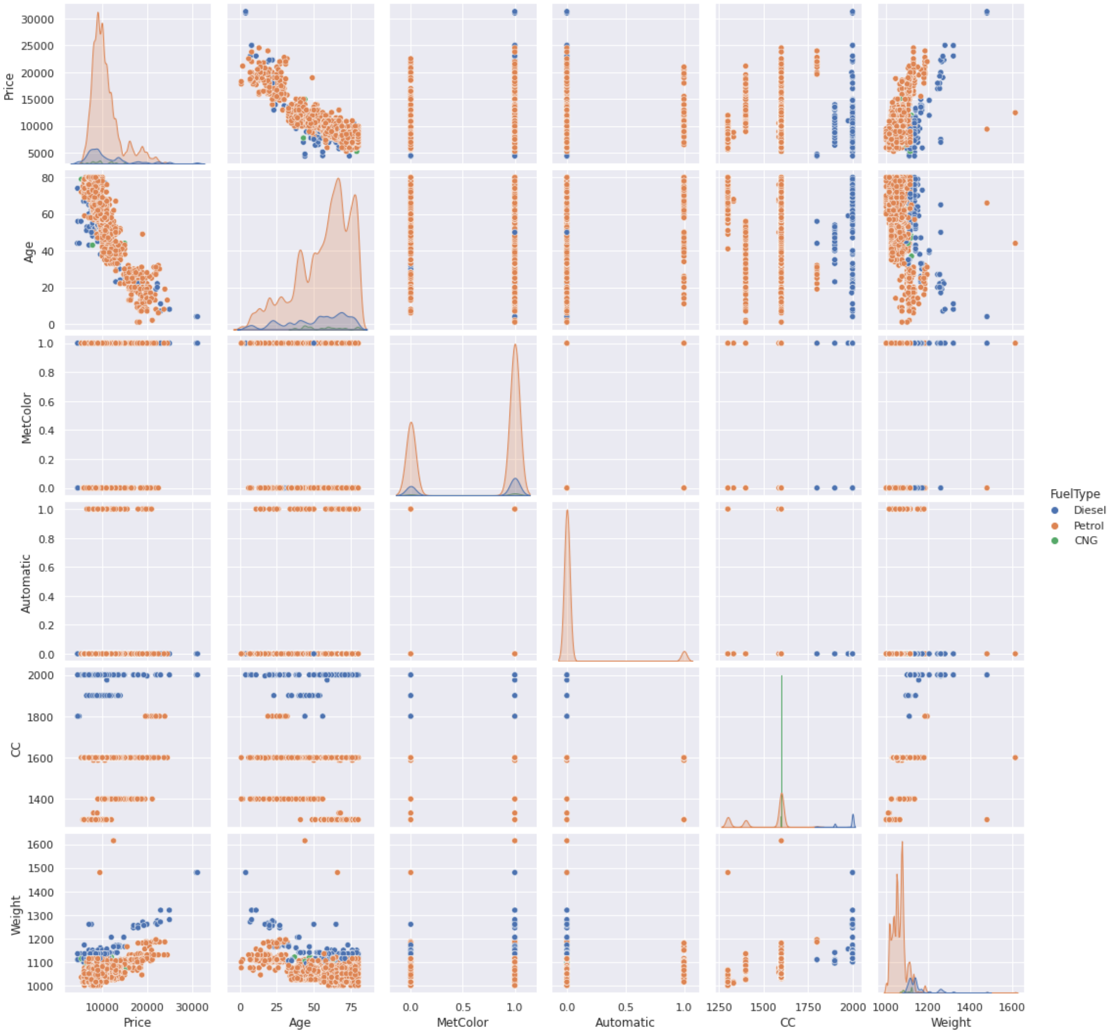
 It is used to plot pairwise relationships in a dataset

 Creates scatterplots for joint relationships and histograms for univariate distributions

```
sns.pairplot(cars_data,kind="scatter",hue="FuelType",diag_kws={'bw': 0.1})
plt.show()
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:1699: Futu
reWarning: The `bw` parameter is deprecated in favor of `bw_method` and `b
w_adjust`. Using 0.1 for `bw_method`, but please see the docs for the new
parameters and update your code.
  warnings.warn(msg, FutureWarning)
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:1699: Futu
reWarning: The `bw` parameter is deprecated in favor of `bw_method` and `b
w_adjust`. Using 0.1 for `bw_method`, but please see the docs for the new
```

```
parameters and update your code.
  warnings.warn(msg, FutureWarning)
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:1699: Futu
reWarning: The `bw` parameter is deprecated in favor of `bw_method` and `b
w_adjust`. Using 0.1 for `bw_method`, but please see the docs for the new
parameters and update your code.
  warnings.warn(msg, FutureWarning)
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:1699: Futu
reWarning: The `bw` parameter is deprecated in favor of `bw_method` and `b
w_adjust`. Using 0.1 for `bw_method`, but please see the docs for the new
parameters and update your code.
  warnings.warn(msg, FutureWarning)
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:1699: Futu
reWarning: The `bw` parameter is deprecated in favor of `bw_method` and `b
w_adjust`. Using 0.1 for `bw_method`, but please see the docs for the new
parameters and update your code.
  warnings.warn(msg, FutureWarning)
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:1699: Futu
reWarning: The `bw` parameter is deprecated in favor of `bw_method` and `b
w_adjust`. Using 0.1 for `bw_method`, but please see the docs for the new
parameters and update your code.
  warnings.warn(msg, FutureWarning)
```



Heatmap

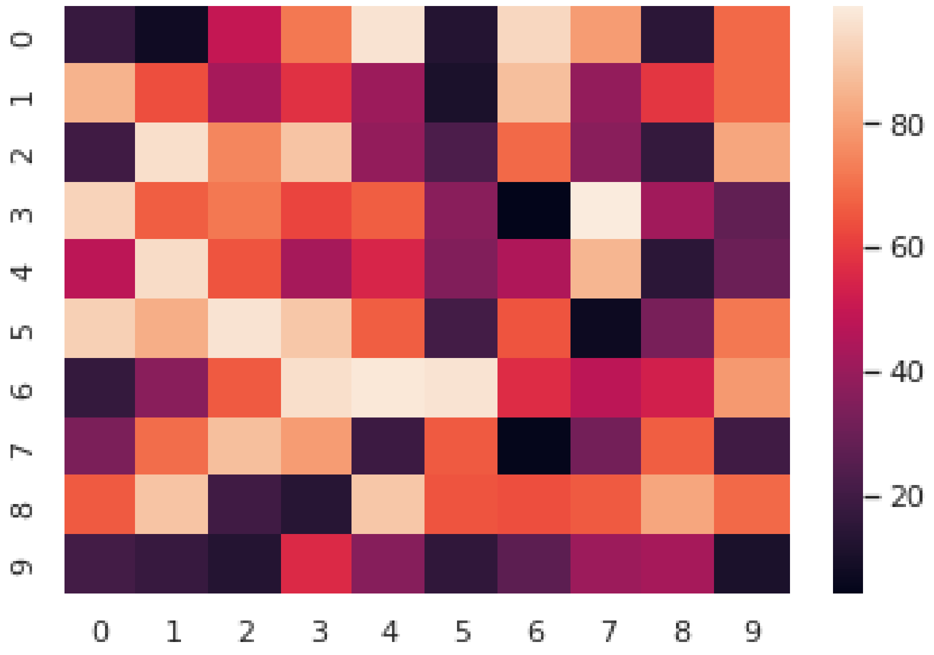
Heatmap is defined as a graphical representation of data using colors to visualize the value of the matrix. I

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import os
```

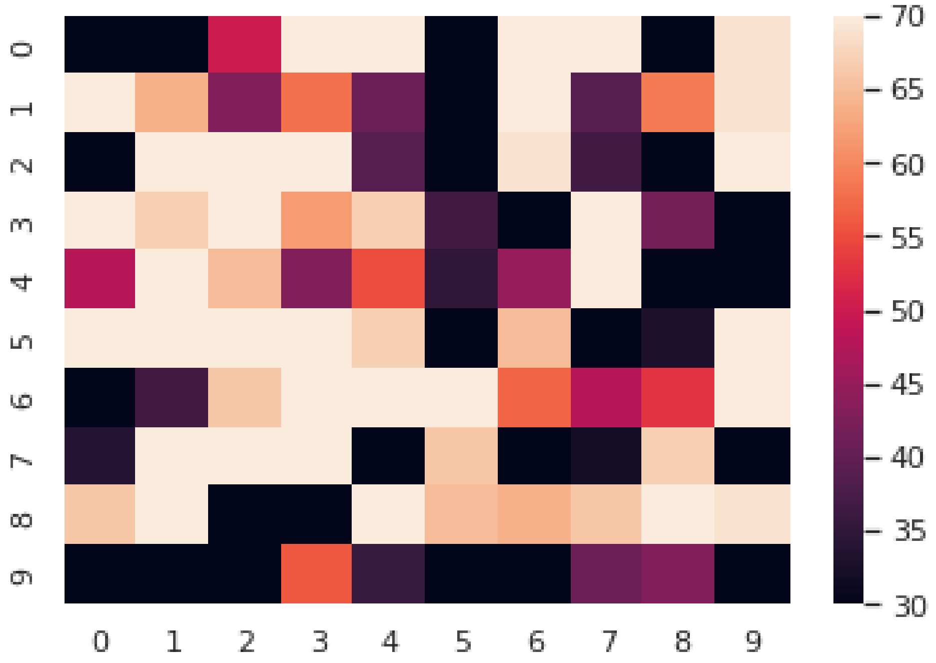
```
data=np.random.randint(1,100,size=(10,10))
print("The data to be plotted: \n")
print(data)
```

```
The data to be plotted:

[[18  8 50 72 97 13 94 80 15 69]
 [85 64 43 58 41 11 88 39 59 69]
 [20 96 75 89 39 23 69 37 17 82]
 [93 67 72 62 67 37  4 99 42 28]
 [48 95 65 43 55 35 45 86 15 30]
 [92 84 97 90 67 21 65  7 33 72]
 [17 37 66 96 98 97 57 48 53 79]
 [34 70 88 80 19 66  5 32 67 20]
 [66 89 20 14 90 65 64 66 82 69]
 [21 18 13 56 36 16 27 41 43 11]]
```

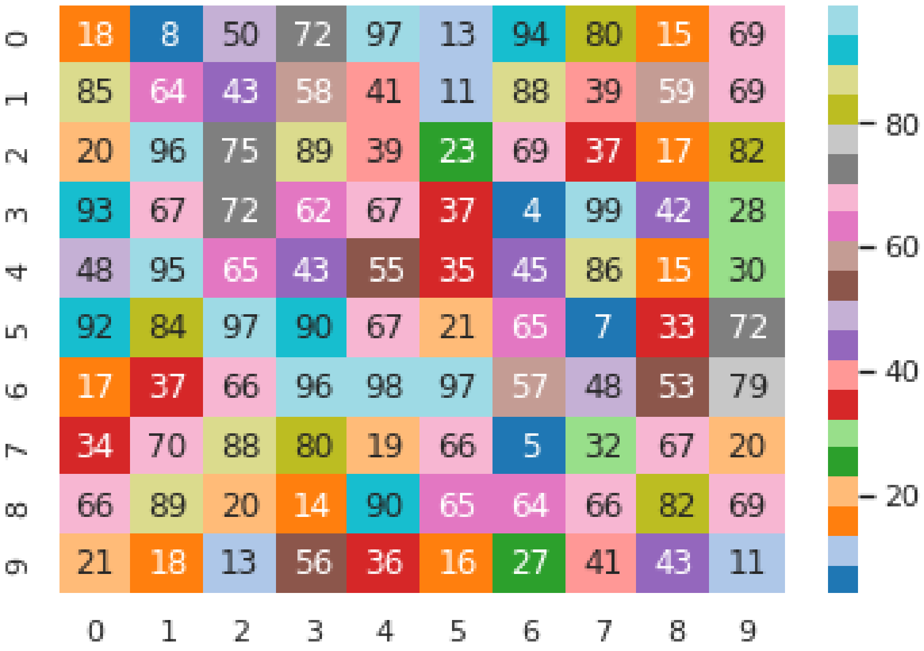
```
#Plotting Heatmap
hm=sns.heatmap(data=data)
plt.show()
```



```
hm = sns.heatmap(data=data,
                vmin='30',
                vmax='70')
plt.show()
```



```
# setting the parameter values
cmap = "tab20"
center = 0

# setting the parameter values
annot = True

# plotting the heatmap
hm = sns.heatmap(data=data, cmap=cmap, annot=annot)



# displaying the plotted heatmap
plt.show()
```



	0	1	2	3	4	5	6	7	8	9
0	18	8	50	72	97	13	94	80	15	69
1	85	64	43	58	41	11	88	39	59	69
2	20	96	75	89	39	23	69	37	17	82
3	93	67	72	62	67	37	4	99	42	28
4	48	95	65	43	55	35	45	86	15	30
5	92	84	97	90	67	21	65	7	33	72
6	17	37	66	96	98	97	57	48	53	79
7	34	70	88	80	19	66	5	32	67	20
8	66	89	20	14	90	65	64	66	82	69
9	21	18	13	56	36	16	27	41	43	11

PRACTICAL 4

Probability

Definition : Probability is a measure of the likelihood of an event to occur. Many events cannot be predicted with total certainty. We can predict only the chance of an event to occur i.e. how likely they are to happen, using it. Probability can range in from 0 to 1, where 0 means the event to be an impossible one and 1 indicates a certain event.The probability of all the events in a sample space adds up to 1.

Formula for Probability

The probability formula is defined as the possibility of an event to happen is equal to the ratio of the number of favourable outcomes and the total number of outcomes.

Probability of event to happen P(E) = Number of favourable outcomes/Total Number of outcomes

Eg 1

```
# probability of getting 3 when a die is rolled
ns = 6 #n(S) = {1,2,3,4,5,6}
na = 1 #n(A) = {3}
pa = na/ns # P(A)
print("probability of getting 3 is:",pa)
```

```
probability of getting 3 is: 0.16666666666666666
```

```
# probability of atleast getting one head when a coin is tossed thrice
ns = 8 #n(S) = {HHH, HHT, HTH, THH, TTH, THT, HTT, TTT}
na = 7 #n(A) = {HHH, HHT, HTH, THH, TTH, THT, HTT}
pa = na/ns # P(A)
print("probability of getting atleast one head is:",pa)
```

```
probability of getting atleast one head is: 0.875
```

```
# A glass jar contains 5 red, 3 blue and 2 green jelly beans. If a jelly b
ean is chosen at random from the jar,
#  mwhat is the probability that it is not blue?
ns = 10 #n(S) = {5red,3blue,2green}
na = 7 #n(A) = {5red, 2green}
pa = na/ns # P(A)
print("probability of getting not blue jellybean is:",pa)
```

```
probability of getting not blue jellybean is: 0.7
```

Independent and Dependent Events

If the occurrence of any event is completely unaffected by the occurrence of any other event, such events are known as an independent event in probability and the events which are affected by other events are known as dependent events.

eg.1

```
# If the probability that person A will be alive in 20 years
#is 0.7 and the probability that person B will be alive in
# 20 years is 0.5, what is the probability that they will
#both be alive in 20 years?

#These are independent events, so
P = 0.7*0.5
print("probability that they will be alive after 20 years is:",P)
```

```
probability that they will be alive after 20 years is: 0.35
```

```
def event_probability(n,s):
  return n/s
```

```
#A fair die is tossed twice. Find the probability of getting a 4 or 5 on t
he first toss and a 1,2, or 3 in the second toss.
pa = event_probability(2,6) # probability of getting a 4 or 5 on the first
toss
pb = event_probability(3,6) # probability of getting 1,2,3 in second toss
P = pa*pb
print("probability of getting a 4 or 5 on the first toss and a 1,2, or 3 i
n the second toss is:",P)
```

```
probability of getting a 4 or 5 on the first toss and a 1,2, or 3 in the s
econd toss is: 0.16666666666666666
```

```
# A bag contains 5 white marbles, 3 black marbles and 2 green marbles. In
each draw, a marble is drawn from the bag
# and not replaced. In three draws, find the probability of obtaining whit
e, black and green in that order.
pw = event_probability(5,10)
pb = event_probability(3,9)
pg = event_probability(2,8)
print("the probability of obtaining white, black and green in that order i
s ",(pw*pb*pg))
```

```
the probability of obtaining white, black and green in that order is  0.04
1666666666666664
```

```
# Sample Space
cards = 52

# Calculate the probability of drawing a heart or a club
hearts = 13
clubs = 13
heart_or_club = event_probability(hearts, cards) + event_probability(clubs
, cards)
print(heart_or_club )

0.5

# Calculate the probability of drawing an ace, king, or a queen
aces = 4
kings = 4
queens = 4
ace_king_or_queen = event_probability(aces, cards) + event_probability(kin
gs, cards) + event_probability(queens, cards)

print(heart_or_club)
print(ace_king_or_queen)

0.5
0.23076923076923078

# Calculate the probability of drawing a heart or an ace
hearts = 13
aces = 4
ace_of_hearts = 1
heart_or_ace = event_probability(hearts, cards) + event_probability(aces,
cards) - event_probability(ace_of_hearts, cards)
print(round(heart_or_ace, 1))

0.3

red_cards = 26
face_cards = 12
red_face_cards = 6
red_or_face_cards = event_probability(red_cards, cards) + event_probabilit
y(face_cards, cards) - event_probability(red_face_cards, cards)

print(round(heart_or_ace, 1))
print(round(red_or_face_cards, 1))

0.3
0.6
```

Complementary Events

For any event E1 there exists another event E1‘ which represents the remaining elements of the sample space S.

E1 = S – E1‘

If a dice is rolled then the sample space S is given as S = {1 , 2 , 3 , 4 , 5 , 6 }. If event E1 represents all the outcomes which is greater than 4, then E1 = {5, 6} and E1‘ = {1, 2, 3, 4}.

Thus E1‘ is the complement of the event E1.

Similarly, the complement of E1, E2, E3……….En will be represented as E1‘, E2‘, E3‘……….En‘

eg.1

```
#probabiltiy of not getting 5 when a fair die is rolled
ns = 6 #n(S) = {1,2,3,4,5,6}
na = 1 #n(A) = {5}
pa = na/ns # P(A)
print("probabilty of not getting 5 is:",1-pa)
```

```
probabilty of not getting 5 is: 0.8333333333333334
```

Conditional Probability

The formula for conditional probability is

`P(A|B) = P(A OR B) / P(B).`

The parts: P(A|B) = probability of A occurring, given B occurs P(A âˆ © B) = probability of both A and B occurring P(B) = probability of B occurring

Calculate the probability a student gets an A (80%+) in math, given they miss 10 or more classes.

```
import pandas as pd
import numpy as np
df = pd.read_csv('/content/drive/MyDrive/Colab Notebooks/student-mat.csv')
df.head(3)
```

```
  school sex  age address famsize Pstatus  Medu  Fedu     Mjob     Fjob  .
..  \
0     GP   F   18       U     GT3       A     4     4  at_home  teacher  .
..
1     GP   F   17       U     GT3       T     1     1  at_home    other  .
..
2     GP   F   15       U     LE3       T     1     1  at_home    other  .
..

  famrel freetime  goout  Dalc  Walc health absences G1 G2  G3
0      4        3      4     1     1      3        6  5  6   6
1      5        3      3     1     1      3        4  5  5   6
2      4        3      2     2     3      3       10  7  8  10

[3 rows x 33 columns]
```

```
len(df)
```

```
395
```

```
df['grade_A'] = np.where(df['G3']*5 >= 80, 1, 0)
```

```
df['high_absenses'] = np.where(df['absences'] >= 10, 1, 0)
```

```
df['count'] = 1
```

```
df = df[['grade_A','high_absenses','count']]
df.head()
```

```
   grade_A  high_absenses  count
0        0              0      1
1        0              0      1
2        0              1      1
3        0              0      1
4        0              0      1
```

```
final= pd.pivot_table(
    df,
    values='count',
    index=['grade_A'],
    columns=['high_absenses'],
    aggfunc=np.size,
    fill_value=0
)
```

```
print(final)
```

```
high_absenses    0   1
grade_A
0              277  78
1               35   5
```

We now have all the data we need to do our calculation. Lets start by calculating each individual part in the formula.

In our case: P(A) is the probability of a grade of 80% or greater. P(B) is the probability of missing 10 or more classes. P(A|B) is the probability of a 80%+ grade, given missing 10 or more classes.

Calculations of parts: P(A) = (35 + 5) / (35 + 5 + 277 + 78) = 0.10126582278481013 P(B) = (78 + 5) / (35 + 5 + 277 + 78) = 0.21012658227848102 P(A OR B) = 5 / (35 + 5 + 277 + 78) = 0.012658227848101266

And per the formula, P(A|B) = P(A Or B) / P(B), put it together.

P(A|B) = 0.012658227848101266/ 0.21012658227848102= 0.06

There we have it. The probability of getting at least an 80% final grade, given missing 10 or more classes is 6%. Conclusion

While the learning from our specific example is clear - go to class if you want good grades

PRACTICAL 5

```
# for inline plots in jupyter
%matplotlib inline
# import matplotlib
import matplotlib.pyplot as plt
# for latex equations
from IPython.display import Math, Latex
# for displaying images
from IPython.core.display import Image
import numpy as np
```

```
# import seaborn
import seaborn as sns
# settings for seaborn plotting style
sns.set(color_codes=True)
# settings for seaborn plot sizes
sns.set(rc={'figure.figsize':(5,5)})
```

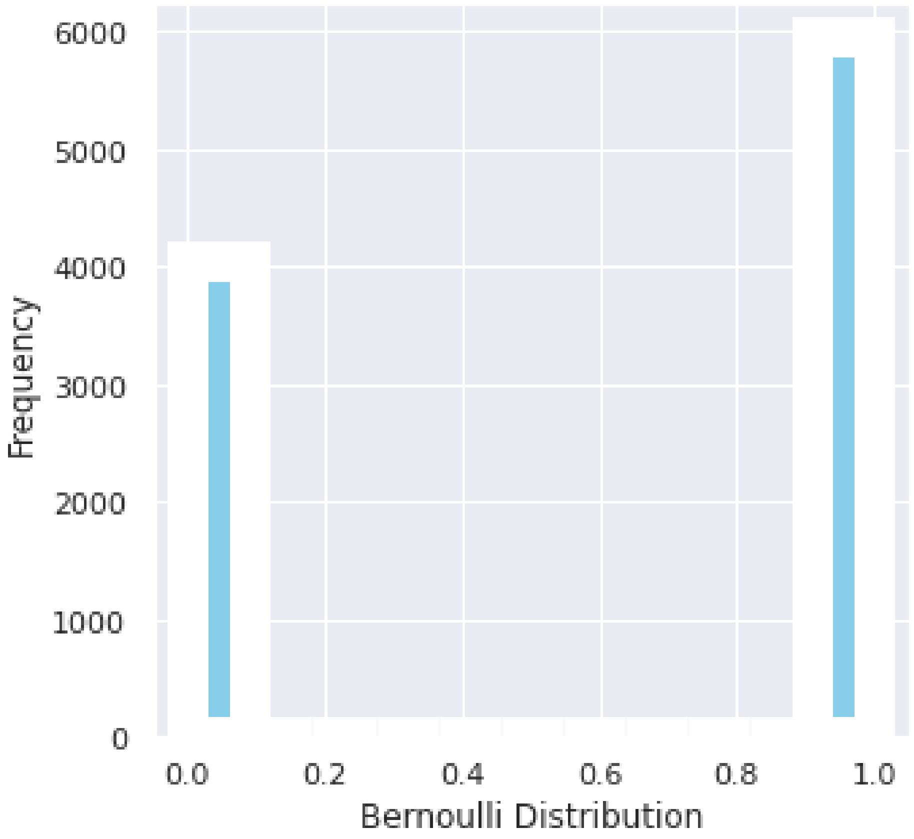
Bernoulli Distribution

```
from scipy.stats import bernoulli
data_bern = bernoulli.rvs(size=10000,p=0.6)
```

```
ax= sns.distplot(data_bern,
                 kde=False,
                 color="skyblue",
                 hist_kws={"linewidth": 15,'alpha':1})
ax.set(xlabel='Bernoulli Distribution', ylabel='Frequency')
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: Futu
reWarning: `distplot` is a deprecated function and will be removed in a fu
ture version. Please adapt your code to use either `displot` (a figure-lev
el function with similar flexibility) or `histplot` (an axes-level functio
n for histograms).
  warnings.warn(msg, FutureWarning)
```

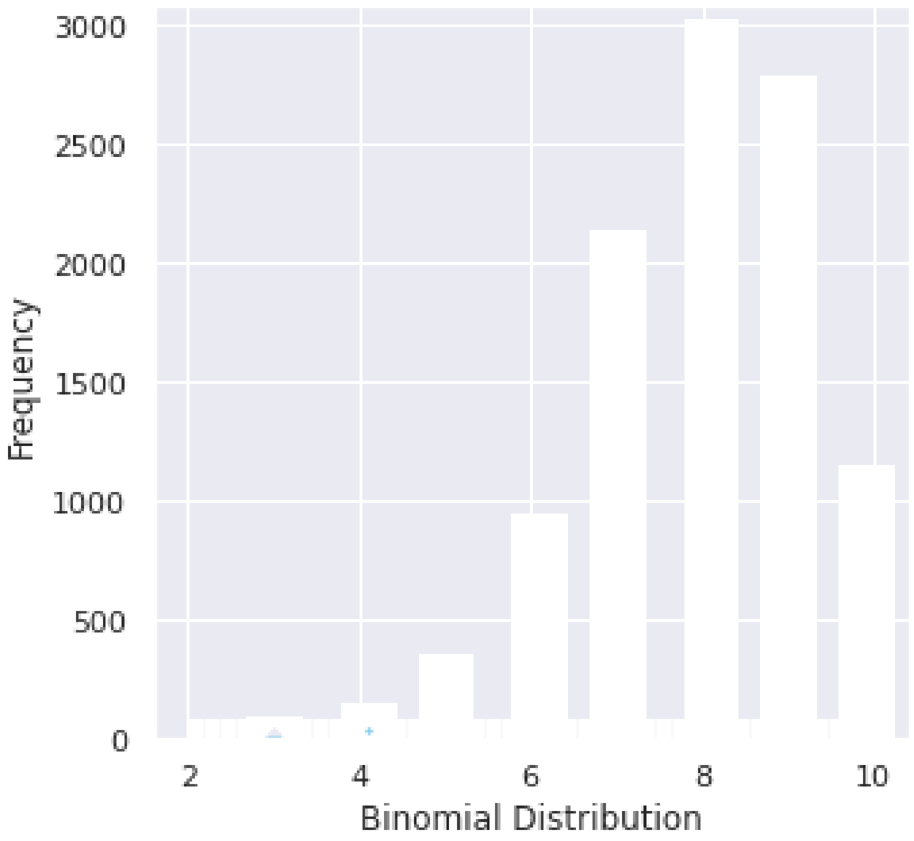
```
[Text(0, 0.5, 'Frequency'), Text(0.5, 0, 'Bernoulli Distribution')]
```



BINOMINAL DISTRIBUTION

```
from scipy.stats import binom
data_binom = binom.rvs(n=10,p=0.8,size=10000)

ax = sns.distplot(data_binom,
                  kde=False,
                  color='skyblue',
                  hist_kws={"linewidth": 15,'alpha':1})
ax.set(xlabel='Binomial Distribution', ylabel='Frequency')
```

```
[Text(0, 0.5, 'Frequency'), Text(0.5, 0, 'Binomial Distribution')]
```



Poisson Distribution

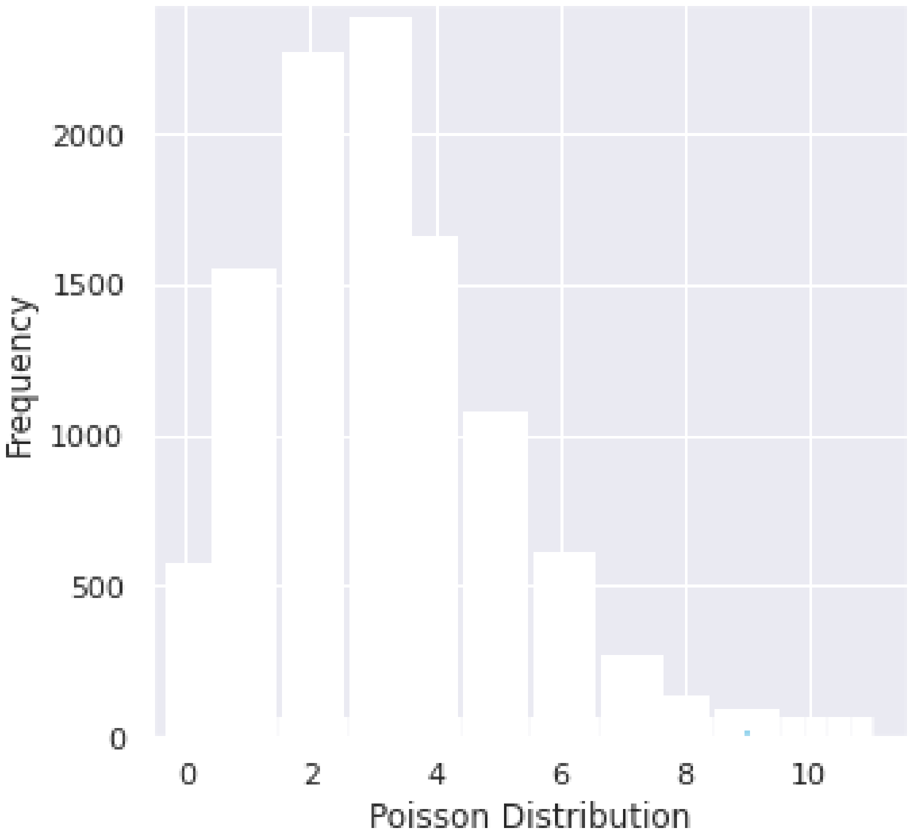
Poisson random variable is typically used to model the number of times an event happened in a time interval

```
from scipy.stats import poisson
data_poisson = poisson.rvs(mu=3, size=10000)
```

You can generate a poisson distributed discrete random variable using scipy.stats module's poisson.rvs() method which takes μ as a shape parameter and is nothing but the λ in the equation. To shift distribution use the loc parameter. size decides the number of random variates in the distribution. If you want to maintain reproducibility, include a random_state argument assigned to a number.

```
ax = sns.distplot(data_poisson,
                  bins=30,
                  kde=False,
                  color='skyblue',
                  hist_kws={"linewidth": 15,'alpha':1})
ax.set(xlabel='Poisson Distribution', ylabel='Frequency')
```

```
[Text(0, 0.5, 'Frequency'), Text(0.5, 0, 'Poisson Distribution')]
```


Frequency
2000
1500
1000
500
0
0
2
4
6
8
10
Poisson Distribution

PRACTICAL 6

CONTINOUS DISTRIBUTION

```
# for inline plots in jupyter
%matplotlib inline
# import matplotlib
import matplotlib.pyplot as plt
# for latex equations
from IPython.display import Math, Latex
# for displaying images
from IPython.core.display import Image
import numpy as np
```

```
# import seaborn
import seaborn as sns
# settings for seaborn plotting style
sns.set(color_codes=True)
# settings for seaborn plot sizes
sns.set(rc={'figure.figsize':(5,5)})
```

UNIFORM DISTRIBUTION

You can visualize uniform distribution in python with the help of a random number generator acting over an interval of numbers (a,b). You need to import the uniform function from scipy.stats module.

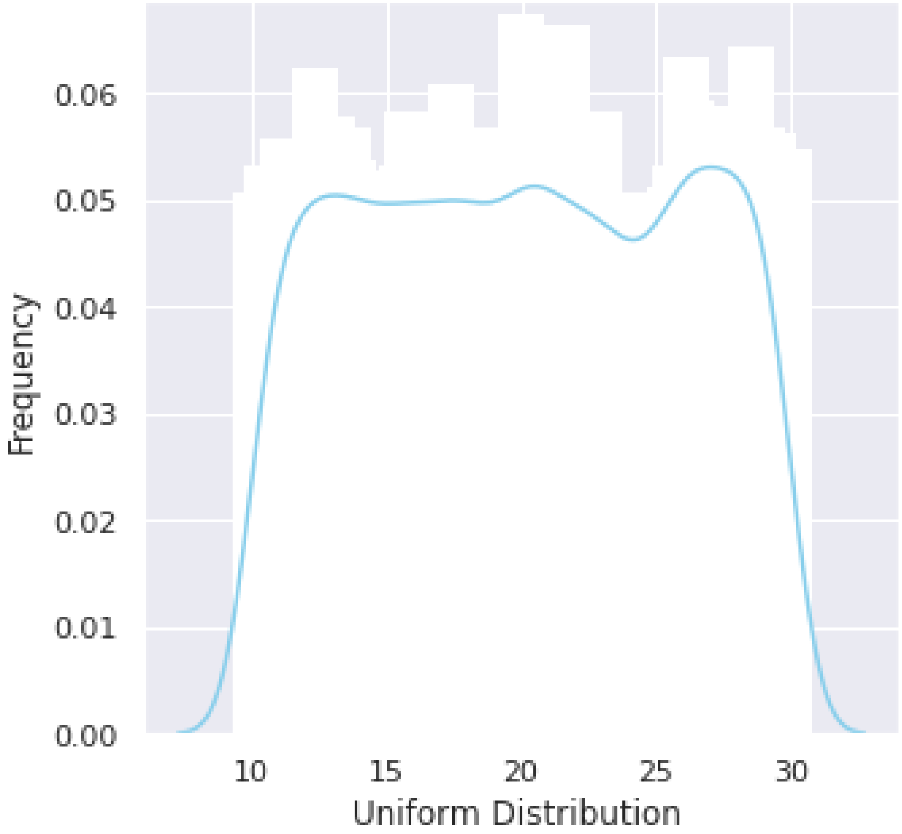
```
# import uniform distribution
from scipy.stats import uniform
```

```
# random numbers from uniform distribution
n = 10000
start = 10
width = 20
data_uniform = uniform.rvs(size=n, loc = start, scale=width)
```

```
ax = sns.distplot(data_uniform,
                  bins=100,
                  kde=True,
                  color='skyblue',
                  hist_kws={"linewidth": 15,'alpha':1})
ax.set(xlabel='Uniform Distribution ', ylabel='Frequency')
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: Futu
reWarning: `distplot` is a deprecated function and will be removed in a fu
ture version. Please adapt your code to use either `displot` (a figure-lev
el function with similar flexibility) or `histplot` (an axes-level functio
n for histograms).
  warnings.warn(msg, FutureWarning)
```

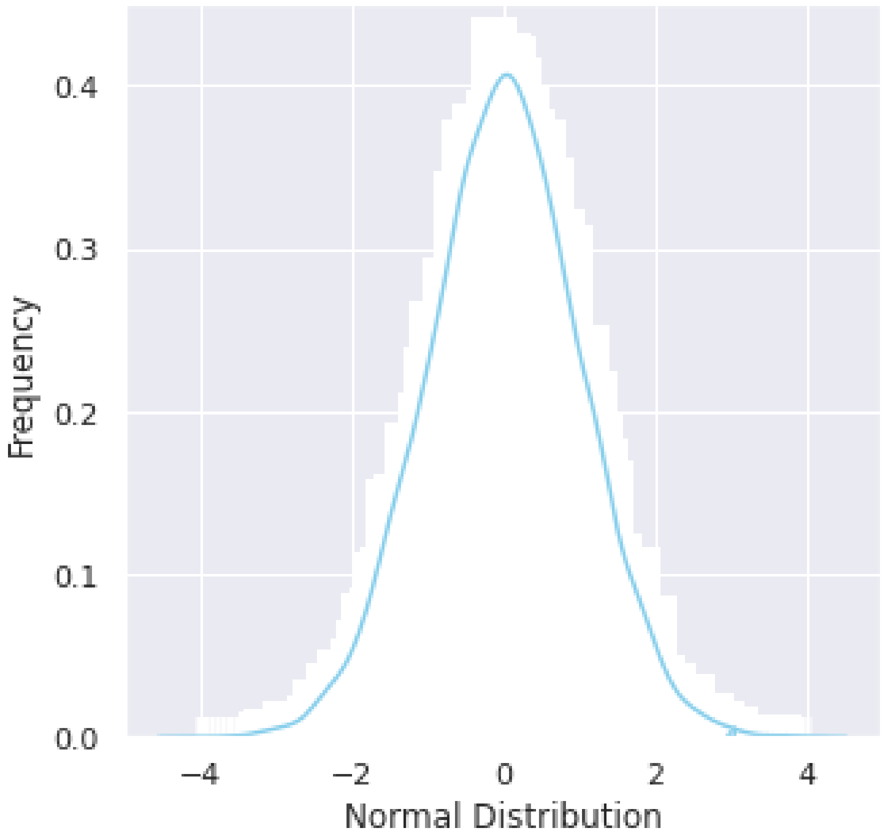
```
[Text(0, 0.5, 'Frequency'), Text(0.5, 0, 'Uniform Distribution ')]
```



NORMAL DISTRIBUTION

```
from scipy.stats import norm
# generate random numbers from N(0,1)
data_normal = norm.rvs(size=10000,loc=0,scale=1)

ax = sns.distplot(data_normal,
                  bins=100,
                  kde=True,
                  color='skyblue',
                  hist_kws={"linewidth": 15,'alpha':1})
ax.set(xlabel='Normal Distribution', ylabel='Frequency')
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: Futu
reWarning: `distplot` is a deprecated function and will be removed in a fu
ture version. Please adapt your code to use either `displot` (a figure-lev
el function with similar flexibility) or `histplot` (an axes-level functio
n for histograms).
  warnings.warn(msg, FutureWarning)

[Text(0, 0.5, 'Frequency'), Text(0.5, 0, 'Normal Distribution')]
```



Exponential Distribution

The exponential distribution describes the time between events in a Poisson point process, i.e., a process in which events occur continuously and independently at a constant average rate. It has a parameter λ

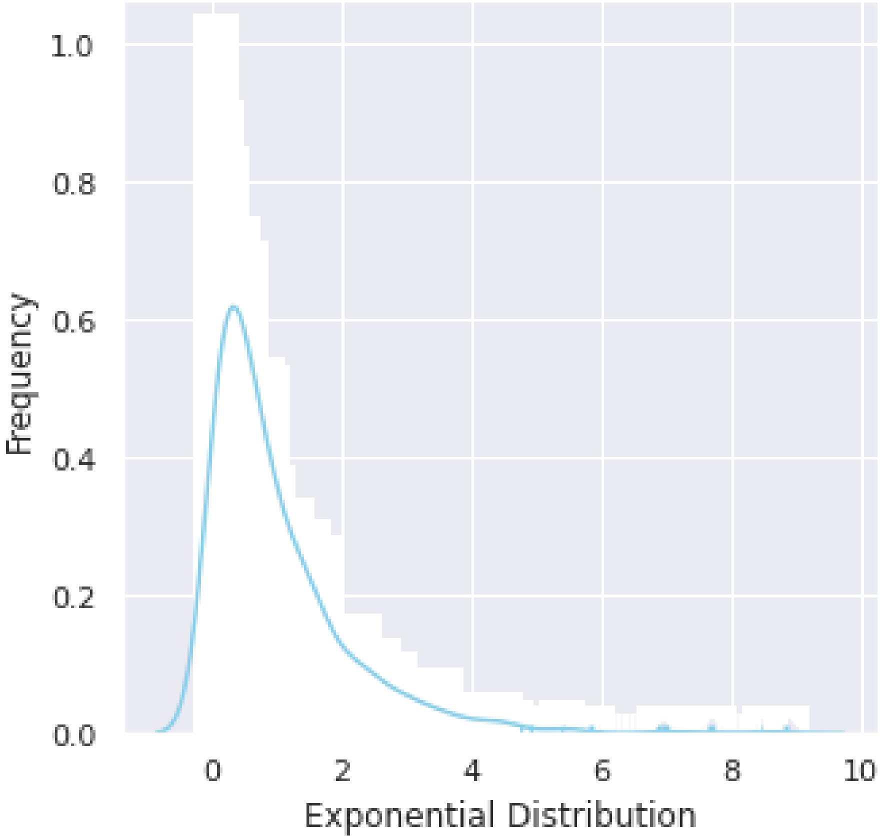
called rate parameter, and its equation is described as :

A decreasing exponential distribution looks like :

```
from scipy.stats import expon
data_expon = expon.rvs(scale=1,loc=0,size=1000)

ax = sns.distplot(data_expon,
                  kde=True,
                  bins=100,
                  color='skyblue',
                  hist_kws={"linewidth": 15,'alpha':1})
ax.set(xlabel='Exponential Distribution', ylabel='Frequency')
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: Futu
reWarning: `distplot` is a deprecated function and will be removed in a fu
ture version. Please adapt your code to use either `displot` (a figure-lev
el function with similar flexibility) or `histplot` (an axes-level functio
n for histograms).
  warnings.warn(msg, FutureWarning)
```

```
[Text(0, 0.5, 'Frequency'), Text(0.5, 0, 'Exponential Distribution')]
```



Chi Square Distribution

Chi Square distribution is used as a basis to verify the hypothesis.

It has two parameters:

df - (degree of freedom).

size - The shape of the returned array.

Draw out a sample for chi squared distribution with degree of freedom 2 with size 2x3:

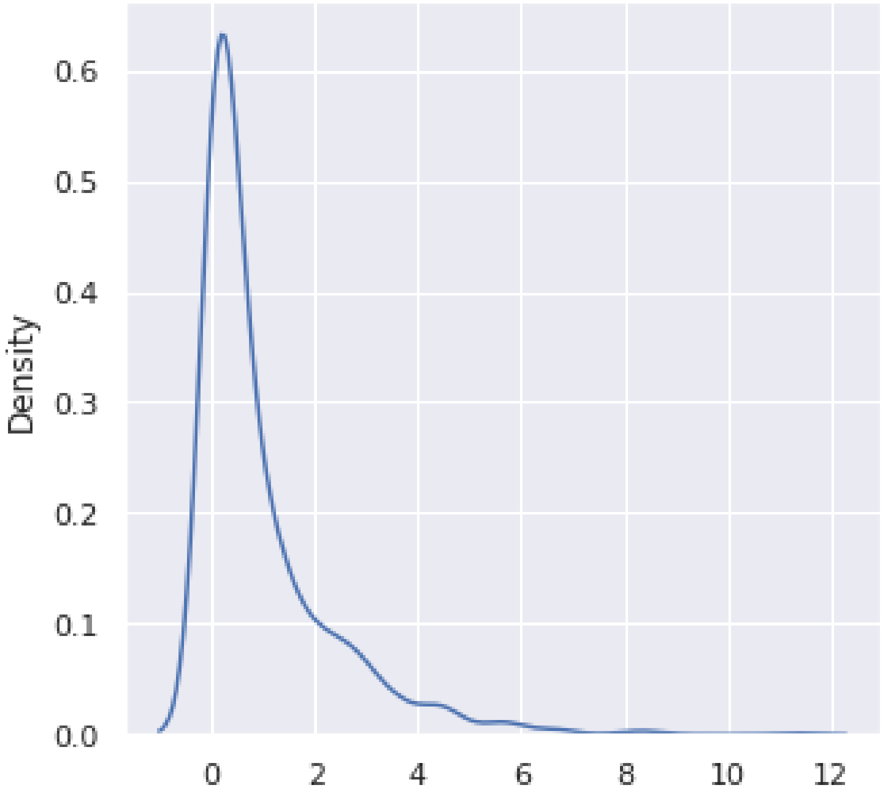
```
from numpy import random

x = random.chisquare(df=2, size=(2, 3))

print(x)
```

```
[[0.04103389 1.57798989 1.85507302]
 [5.82944896 1.46579974 0.8402198 ]]
```

```
from numpy import random
import matplotlib.pyplot as plt
import seaborn as sns

sns.distplot(random.chisquare(df=1, size=1000), hist=False)
```

```
plt.show()
```

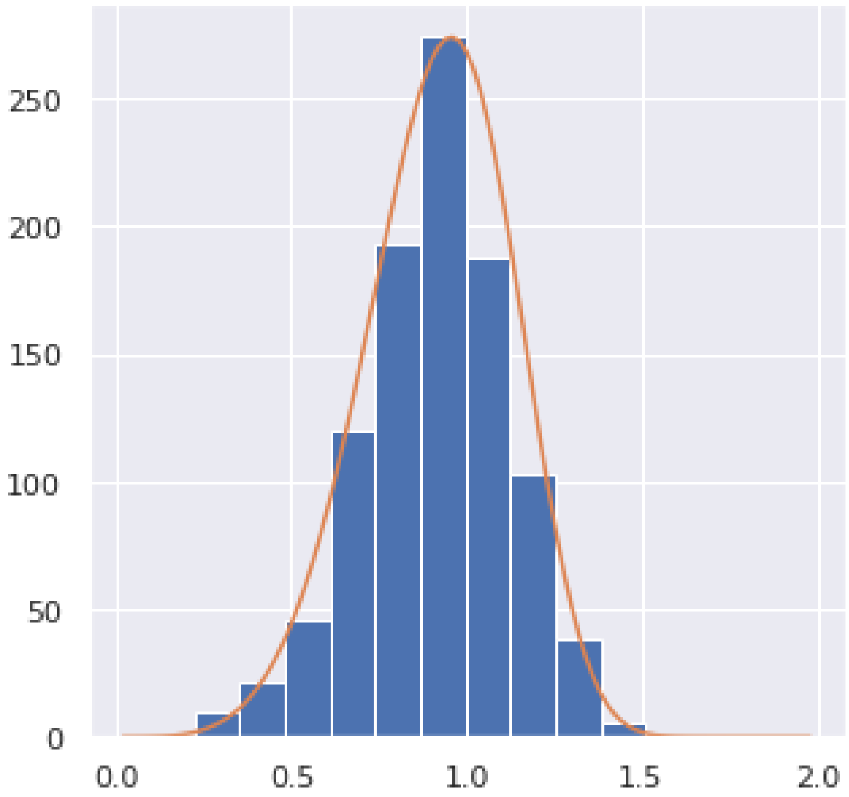
```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: Futu
reWarning: `distplot` is a deprecated function and will be removed in a fu
ture version. Please adapt your code to use either `displot` (a figure-lev
el function with similar flexibility) or `kdeplot` (an axes-level function
for kernel density plots).
  warnings.warn(msg, FutureWarning)
```



Weibull Distribution

```
a = 5. # shape

s = np.random.weibull(a, 1000)

#Display the histogram of the samples, along with the probability density
function:
import matplotlib.pyplot as plt

x = np.arange(1,100.)/50.

def weib(x,n,a):

    return (a / n) * (x / n)**(a - 1) * np.exp(-(x / n)**a)

count, bins, ignored = plt.hist(np.random.weibull(5.,1000))

x = np.arange(1,100.)/50.
```

```
scale = count.max()/weib(x, 1., 5.).max()

plt.plot(x, weib(x, 1., 5.)*scale)

plt.show()
```



PRACTICAL 7

```
import pandas as pd

df=pd.read_csv('/content/drive/MyDrive/Colab Notebooks/stats.csv')

df
```

```
        Name  Salary Country
0        Dan   40000     USA
1  Elizabeth   32000  Brazil
2        Jon   45000   Italy
3      Maria   54000     USA
4       Mark   72000     USA
5       Bill   62000  Brazil
6       Jess   92000   Italy
7      Julia   55000     USA
8       Jeff   35000   Italy
9        Ben   48000  Brazil
```

Measure of Central Tendancy

```
# Mean Salary
mean1=df['Salary'].mean()
mean1
```

```
53500.0
```

```
#Sum of Salaries
sum1=df['Salary'].sum()
sum1
```

```
535000
```

```
#Maximum Salary
max1=df['Salary'].max()
max1
```

```
92000
```

```
#Minimum Salary
min1=df['Salary'].min()
min1
```

```
32000
```

```
#Total count

count1=df['Salary'].count()
count1
```

```
10
```

```
#Median
median=df['Salary'].median()
median
```

```
51000.0
```

```
#Mode
mode1=df['Salary'].mode()
mode1
```

```
0    32000
1    35000
2    40000
3    45000
4    48000
5    54000
6    55000
7    62000
8    72000
9    92000
dtype: int64
```

```
countrywise_sum=df.groupby(['Country'])['Salary'].sum()
countrywise_sum
```

```
Country
Brazil    142000
Italy     172000
USA       221000
Name: Salary, dtype: int64
```

```
countrywise_count=df.groupby(['Country']).count()
countrywise_count
```

```
         Name  Salary
Country
Brazil      3       3
Italy       3       3
USA         4       4
```

Measure of variability

```
#variance of salaries
var1=df['Salary'].var()
var1
```

```
332055555.5555556
```

```
#standard deviation
std1=df['Salary'].std()
std1
```

```
18222.391598128816
```

Measure of Symmetry

```
skew1=df.skew(axis=0, skipna=True)
skew1
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:1: FutureWarn
ing: Dropping of nuisance columns in DataFrame reductions (with 'numeric_o
nly=None') is deprecated; in a future version this will raise TypeError.
Select only valid columns before calling the reduction.
  """Entry point for launching an IPython kernel.
```

```
Salary    1.021551
dtype: float64
```

```
#The skewness is positive so x will have right side tail.
df.describe()
```

```
             Salary
count     10.000000
mean   53500.000000
std    18222.391598
min    32000.000000
25%    41250.000000
50%    51000.000000
75%    60250.000000
max    92000.000000
```

PRACTICAL 8

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import scipy.stats as stats
from scipy.stats import ttest_1samp
from statsmodels.stats.power import tt_ind_solve_power
```

T test A t test is inferntial statistics which is used to determine if there is a significant difference betweenthe means of two groups which may be related in certain features

T-test has 2 types: 1) One sampled t test 2) Two sampled t test

t= (sample mean - population mean) / standard error

```
ages=[10,20,35,50,28,40,55,18,16,55,30,25,43,18,30,28,14,24,16,17,32,35,26
,27,65,18,43,23,21,20,19,70]
```

```
ages_mean=np.mean(ages)
print(ages_mean)
```

```
30.34375
```

```
#Lets take sample
sample_size=10
age_sample=np.random.choice(ages,sample_size)
age_sample
```

```
array([28, 16, 16, 43, 35, 27, 24, 10, 18, 16])
```

```
from scipy.stats import ttest_1samp
```

```
ttest,p_value=ttest_1samp(age_sample,30)
```

```
print(p_value)
```

```
0.0663276542607543
```

```
if p_value < 0.05:
    print("We are rejecting null hypothesis")
else:
    print("We are accepting null hypothesis")
```

```
We are accepting null hypothesis
```