Data Analysis - Pandas

June 28, 2024

Abstract

This paper explores data analysis using the Pandas library in Python. We discuss various techniques and functions provided by Pandas to manipulate, analyze, and visualize data effectively.

Credits - zero-to-mastery-ml - https://github.com/mrdbourke/zero-to-mastery-ml/tree/master/data

https://www.udemy.com/course/complete-machine-learning-and-data-science-zero-to-mastery

[334]:
```
from IPython.display import display, Image

display(Image(filename="./Resources/Images/Pandas Image.png"))
```

This statement imports the Pandas library and allows you to use it in your script with the alias pd, which is a common convention in the Python community. https://pandas.pydata.org/

[291]:
```
import pandas as pd
```

pd.Series is a data structure in the Pandas library, which is a powerful data manipulation and analysis library for Python. A Series is a one-dimensional array-like object that can hold data of any type (integer, float, string, Python objects, etc.). It is similar to a column in a spreadsheet or a SQL table. Each element in a Series has an associated label, known as the index.

[292]:
```python
# Series = 1 - dimensional

series = pd.Series(["BMW","Toyota","Honda"])
colours = pd.Series(["White","Yellow","Blue"])
series,colours
```

[292]:
```
(0       BMW
 1    Toyota
 2     Honda
 dtype: object,
 0     White
 1    Yellow
 2      Blue
 dtype: object)
```

A DataFrame is another core data structure in the Pandas library. It is a two-dimensional, size-mutable, and potentially heterogeneous tabular data structure with labeled axes (rows and columns). Think of it as a table or a spreadsheet in Python, where each column can hold different types of data.

[293]:
```python
# Dataframe = 2 - dimensional

car_data = pd.DataFrame({"Car make": series,"Colours": colours})
car_data
```

[293]:

	Car make	Colours
0	BMW	White
1	Toyota	Yellow
2	Honda	Blue

[294]:
```python
# Importing the data

car_sales =pd.read_csv("./Resources/car-sales.csv")
car_sales
```

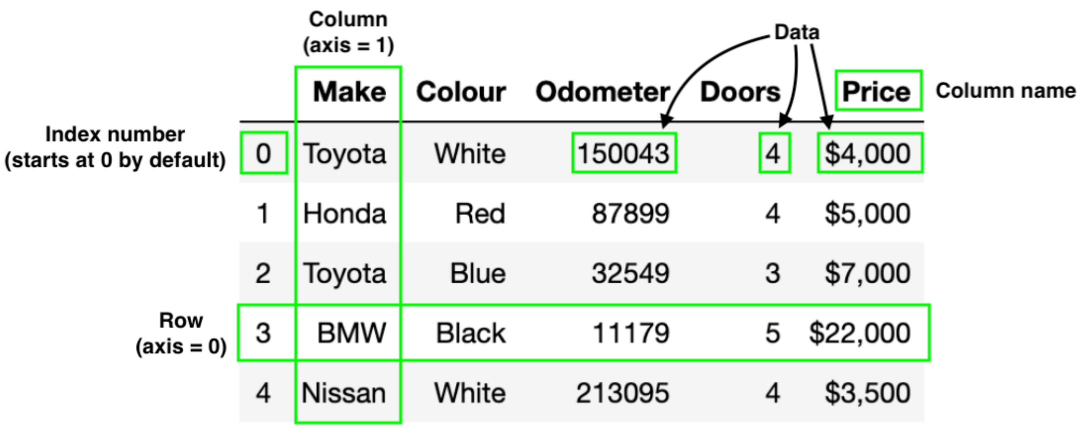
[294]:

	Make	Colour	Odometer (KM)	Doors	Price
0	Toyota	White	150043	4	$4,000.00
1	Honda	Red	87899	4	$5,000.00
2	Toyota	Blue	32549	3	$7,000.00
3	BMW	Black	11179	5	$22,000.00
4	Nissan	White	213095	4	$3,500.00
5	Toyota	Green	99213	4	$4,500.00
6	Honda	Blue	45698	4	$7,500.00
7	Honda	Blue	54738	4	$7,000.00
8	Toyota	White	60000	4	$6,250.00
9	Nissan	White	31600	4	$9,700.00

Anatomy of a Pandas DataFrame - Credits https://www.ibmmainframer.com/python-tutorial/pandas__viewing__data/

[295]:
```python
from IPython.display import display, Image

display(Image(filename="./Resources/Images/pandas-dataframe-anatomy.png"))
```



[296]:
```python
# Exporting the DataFrame to see how does it work
## Note index=False removes additional indexing column

car_sales.to_csv("Resources/exported-car-sales.csv", index=False)
exported_car_sales = pd.read_csv("Resources/exported-car-sales.csv")
exported_car_sales
```

[296]:
```
     Make Colour  Odometer (KM)  Doors       Price
0  Toyota  White         150043      4   $4,000.00
1   Honda    Red          87899      4   $5,000.00
2  Toyota   Blue          32549      3   $7,000.00
3     BMW  Black          11179      5  $22,000.00
4  Nissan  White         213095      4   $3,500.00
5  Toyota  Green          99213      4   $4,500.00
6   Honda   Blue          45698      4   $7,500.00
7   Honda   Blue          54738      4   $7,000.00
8  Toyota  White          60000      4   $6,250.00
9  Nissan  White          31600      4   $9,700.00
```

0.0.1 Describing the data using Attributes and functions.

[297]:
```
#information about the dataset
car_sales.dtypes
```

[297]:
```
Make             object
Colour           object
Odometer (KM)     int64
Doors             int64
Price            object
dtype: object
```

[298]:
```
# How to return list of column names
car_sales_columns = car_sales.columns
car_sales_columns
```

[298]:
```
Index(['Make', 'Colour', 'Odometer (KM)', 'Doors', 'Price'], dtype='object')
```

[299]:
```
# Index data
car_sales.index
```

[299]:
```
RangeIndex(start=0, stop=10, step=1)
```

[300]:
```
# Describing the data set, Statistically. Works only on Numeric Columns.
car_sales.describe()
#if we notice only the int64 dtypes gets populated.
```

[300]:

	Odometer (KM)	Doors
count	10.000000	10.000000
mean	78601.400000	4.000000
std	61983.471735	0.471405
min	11179.000000	3.000000
25%	35836.250000	4.000000
50%	57369.000000	4.000000
75%	96384.500000	4.000000
max	213095.000000	5.000000

[301]:
```
#This method provides useful information about the DataFrame, such as the
 ↪number of non-null entries,
#data type of each column, memory usage, and more.
car_sales.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10 entries, 0 to 9
Data columns (total 5 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   Make           10 non-null     object
 1   Colour         10 non-null     object
```

```
 2   Odometer (KM)  10 non-null     int64
 3   Doors          10 non-null     int64
 4   Price          10 non-null     object
dtypes: int64(2), object(3)
memory usage: 528.0+ bytes
```

[302]:
```
# Lets find the mean for numeric values.
car_sales.mean(numeric_only=True)
```

[302]:
```
Odometer (KM)    78601.4
Doors                4.0
dtype: float64
```

[303]:
```
# Lets find the sum
car_sales.sum(numeric_only=True)
```

[303]:
```
Odometer (KM)    786014
Doors                40
dtype: int64
```

[304]:
```
#Number of rows
len(car_sales)
```

[304]:
```
10
```

0.0.2 Viewing and selecting data

[305]:
```
#Look first few rows - By default head() returns five if not specified else␣
↪goes by head(7)
car_sales.head()
```

[305]:

	Make	Colour	Odometer (KM)	Doors	Price
0	Toyota	White	150043	4	$4,000.00
1	Honda	Red	87899	4	$5,000.00
2	Toyota	Blue	32549	3	$7,000.00
3	BMW	Black	11179	5	$22,000.00
4	Nissan	White	213095	4	$3,500.00

[306]:
```
#Look bottom few rows - By default tail() returns five if not specified else␣
↪goes by tail(7)
car_sales.tail(2)
```

[306]:

	Make	Colour	Odometer (KM)	Doors	Price
8	Toyota	White	60000	4	$6,250.00
9	Nissan	White	31600	4	$9,700.00

[307]:
```
# .loc and .iloc
animals = pd.Series(["Panda","Snake","cat","Dog"],index=[0,3,9,3])
```

```
animals
```

[307]:
```
0    Panda
3    Snake
9      cat
3      Dog
dtype: object
```

loc method is used for label-based indexing. It allows you to access a group of rows and columns by labels or a boolean array.

iloc method is used for integer-location based indexing. It allows you to access a group of rows and columns by integer positions (similar to indexing in NumPy).

[308]:
```
animals.loc[3],animals.iloc[3]
```

[308]:
```
(3    Snake
 3      Dog
 dtype: object,
 'Dog')
```

[309]:
```
# upto position 3 that is 0 ,1 and 2 Index.
animals.iloc[:3]
```

[309]:
```
0    Panda
3    Snake
9      cat
dtype: object
```

[310]:
```
# various ways to read a particular column
car_sales.Make
```

[310]:
```
0    Toyota
1     Honda
2    Toyota
3       BMW
4    Nissan
5    Toyota
6     Honda
7     Honda
8    Toyota
9    Nissan
Name: Make, dtype: object
```

[311]:
```
# various ways to read a particular column
car_sales["Make"]
```

[311]:
```
0    Toyota
1     Honda
2    Toyota
3       BMW
4    Nissan
5    Toyota
6     Honda
7     Honda
8    Toyota
9    Nissan
Name: Make, dtype: object
```

[312]:
```
# Applying filters
car_sales[car_sales["Make"]=="Toyota"]
```

[312]:

	Make	Colour	Odometer (KM)	Doors	Price
0	Toyota	White	150043	4	$4,000.00
2	Toyota	Blue	32549	3	$7,000.00
5	Toyota	Green	99213	4	$4,500.00
8	Toyota	White	60000	4	$6,250.00

[313]:
```
# Crosstab  It is used to summarize the relationship between two  variables.
# The function returns a DataFrame that contains the frequency of each␣
↪combination of the factors.
pd.crosstab(car_sales["Make"],car_sales["Doors"])
```

[313]:

Doors	3	4	5
Make			
BMW	0	0	1
Honda	0	3	0
Nissan	0	2	0
Toyota	1	3	0

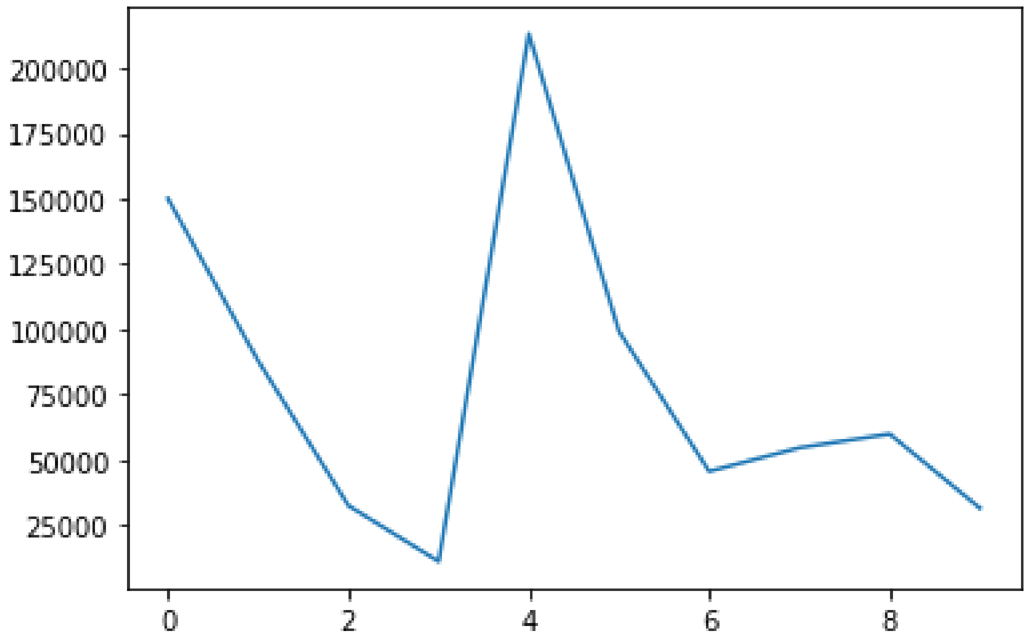
[314]:
```
#Group By function
car_sales.groupby(["Make"]).mean()
```

[314]:

	Odometer (KM)	Doors
Make		
BMW	11179.000000	5.00
Honda	62778.333333	4.00
Nissan	122347.500000	4.00
Toyota	85451.250000	3.75

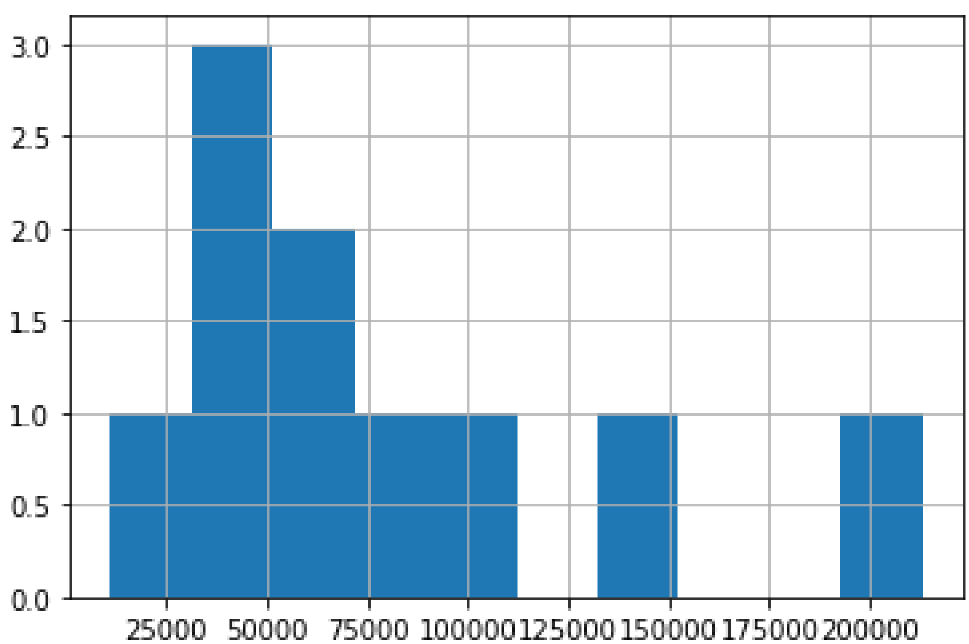
[315]:
```
# just few charts from Matplotlib
car_sales["Odometer (KM)"].plot()
```

[315]: <AxesSubplot:>



[316]:
```
# just few charts from Matplotlib
car_sales["Odometer (KM)"].hist()
```

[316]: <AxesSubplot:>



[317]:
```
# Converting one of Obj dtype to int
#Removing Symbols, comma


# Clean 'Price' column and convert to integer
car_sales['Price'] = car_sales['Price'].str.replace('\$', '').str.replace(',',␣
 ↪'',regex=True).astype(float).astype(int)

car_sales
```

```
/local/pkg/python/root-python-3.7/lib/python3.7/site-
packages/ipykernel_launcher.py:6: FutureWarning: The default value of regex will
change from True to False in a future version.
```

[317]:

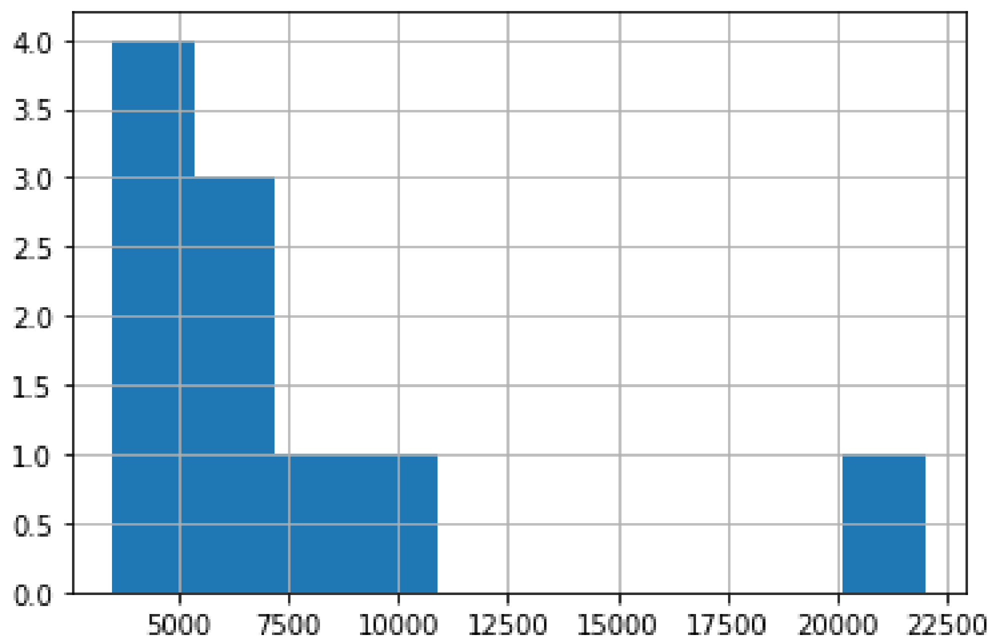
	Make	Colour	Odometer (KM)	Doors	Price
0	Toyota	White	150043	4	4000
1	Honda	Red	87899	4	5000
2	Toyota	Blue	32549	3	7000
3	BMW	Black	11179	5	22000
4	Nissan	White	213095	4	3500
5	Toyota	Green	99213	4	4500
6	Honda	Blue	45698	4	7500
7	Honda	Blue	54738	4	7000
8	Toyota	White	60000	4	6250
9	Nissan	White	31600	4	9700

[318]:
```
car_sales.dtypes
```

[318]:
```
Make              object
Colour            object
Odometer (KM)      int64
Doors              int64
Price              int64
dtype: object
```

[319]:
```
# just few charts from Matplotlib
car_sales["Price"].hist()
```

[319]:
```
<AxesSubplot:>
```



0.0.3 Manipulating Data

[320]:
```
#Exploring one of the column using upper case function
car_sales["Make"]=car_sales["Make"].str.upper()
car_sales
```

[320]:
```
     Make Colour  Odometer (KM)  Doors  Price
0  TOYOTA  White         150043      4   4000
1   HONDA    Red          87899      4   5000
2  TOYOTA   Blue          32549      3   7000
3     BMW  Black          11179      5  22000
4  NISSAN  White         213095      4   3500
5  TOYOTA  Green          99213      4   4500
6   HONDA   Blue          45698      4   7500
7   HONDA   Blue          54738      4   7000
8  TOYOTA  White          60000      4   6250
9  NISSAN  White          31600      4   9700
```

[321]:
```
#Importing another csv files where we can find some missing values and play␣
 ↪around with it
car_sales_missing = pd.read_csv("Resources/car-sales-missing-data.csv")
car_sales_missing
```

[321]:
```
     Make Colour  Odometer  Doors    Price
0  Toyota  White  150043.0    4.0   $4,000
```

```
1   Honda    Red   87899.0   4.0   $5,000
2  Toyota   Blue       NaN   3.0   $7,000
3     BMW  Black   11179.0   5.0  $22,000
4  Nissan  White  213095.0   4.0   $3,500
5  Toyota  Green       NaN   4.0   $4,500
6   Honda    NaN       NaN   4.0   $7,500
7   Honda   Blue       NaN   4.0      NaN
8  Toyota  White   60000.0   NaN      NaN
9     NaN  White   31600.0   4.0   $9,700
```

[322]:

```python
#filling missing values using mean function.
car_sales_missing["Odometer"]=car_sales_missing["Odometer"].
 ↪fillna(car_sales_missing["Odometer"].mean())
car_sales_missing["Odometer"]=car_sales_missing["Odometer"].astype(int)
car_sales_missing
```

[322]:

	Make	Colour	Odometer	Doors	Price
0	Toyota	White	150043	4.0	$4,000
1	Honda	Red	87899	4.0	$5,000
2	Toyota	Blue	92302	3.0	$7,000
3	BMW	Black	11179	5.0	$22,000
4	Nissan	White	213095	4.0	$3,500
5	Toyota	Green	92302	4.0	$4,500
6	Honda	NaN	92302	4.0	$7,500
7	Honda	Blue	92302	4.0	NaN
8	Toyota	White	60000	NaN	NaN
9	NaN	White	31600	4.0	$9,700

[323]:

```python
# we can drop the missing values using the function.
car_sales_missing_dropped=car_sales_missing.dropna()
car_sales_missing_dropped
```

[323]:

	Make	Colour	Odometer	Doors	Price
0	Toyota	White	150043	4.0	$4,000
1	Honda	Red	87899	4.0	$5,000
2	Toyota	Blue	92302	3.0	$7,000
3	BMW	Black	11179	5.0	$22,000
4	Nissan	White	213095	4.0	$3,500
5	Toyota	Green	92302	4.0	$4,500

[324]:

```python
#Lets create few more series and add them to the dataframe.

seats_column = pd.Series([5,5,5,5,6])

#New column called seats
car_sales["Seats"]=seats_column
car_sales
```

[324]:

	Make	Colour	Odometer (KM)	Doors	Price	Seats
0	TOYOTA	White	150043	4	4000	5.0
1	HONDA	Red	87899	4	5000	5.0
2	TOYOTA	Blue	32549	3	7000	5.0
3	BMW	Black	11179	5	22000	5.0
4	NISSAN	White	213095	4	3500	6.0
5	TOYOTA	Green	99213	4	4500	NaN
6	HONDA	Blue	45698	4	7500	NaN
7	HONDA	Blue	54738	4	7000	NaN
8	TOYOTA	White	60000	4	6250	NaN
9	NISSAN	White	31600	4	9700	NaN

[244]:

```
car_sales["Seats"]=car_sales["Seats"].fillna(car_sales["Seats"].min())
car_sales
```

[244]:

	Make	Colour	Odometer (KM)	Doors	Price	Seats
0	TOYOTA	White	150043	4	$4,000.00	5.0
1	HONDA	Red	87899	4	$5,000.00	5.0
2	TOYOTA	Blue	32549	3	$7,000.00	5.0
3	BMW	Black	11179	5	$22,000.00	5.0
4	NISSAN	White	213095	4	$3,500.00	6.0
5	TOYOTA	Green	99213	4	$4,500.00	5.0
6	HONDA	Blue	45698	4	$7,500.00	5.0
7	HONDA	Blue	54738	4	$7,000.00	5.0
8	TOYOTA	White	60000	4	$6,250.00	5.0
9	NISSAN	White	31600	4	$9,700.00	5.0

[325]:

```
# Adding column - fuel economy with few arithmetic operations to gain some␣
↪experience.
fuel_economy =[7.5,9.2,5.0,9.6,8.7,8.3,8.1,9.1,9.6,8.7]
car_sales["Fuel per 100KM"]=fuel_economy
car_sales
```

[325]:

	Make	Colour	Odometer (KM)	Doors	Price	Seats	Fuel per 100KM
0	TOYOTA	White	150043	4	4000	5.0	7.5
1	HONDA	Red	87899	4	5000	5.0	9.2
2	TOYOTA	Blue	32549	3	7000	5.0	5.0
3	BMW	Black	11179	5	22000	5.0	9.6
4	NISSAN	White	213095	4	3500	6.0	8.7
5	TOYOTA	Green	99213	4	4500	NaN	8.3
6	HONDA	Blue	45698	4	7500	NaN	8.1
7	HONDA	Blue	54738	4	7000	NaN	9.1
8	TOYOTA	White	60000	4	6250	NaN	9.6
9	NISSAN	White	31600	4	9700	NaN	8.7

[326]:

```
car_sales["Total Fuel Used"]=car_sales["Odometer (KM)"]/100*car_sales["Fuel per␣
↪100KM"].astype(int)
```

```
car_sales
```

[326]:

```
     Make Colour  Odometer (KM)  Doors  Price  Seats  Fuel per 100KM  \
0  TOYOTA  White         150043      4   4000    5.0             7.5
1   HONDA    Red          87899      4   5000    5.0             9.2
2  TOYOTA   Blue          32549      3   7000    5.0             5.0
3     BMW  Black          11179      5  22000    5.0             9.6
4  NISSAN  White         213095      4   3500    6.0             8.7
5  TOYOTA  Green          99213      4   4500    NaN             8.3
6   HONDA   Blue          45698      4   7500    NaN             8.1
7   HONDA   Blue          54738      4   7000    NaN             9.1
8  TOYOTA  White          60000      4   6250    NaN             9.6
9  NISSAN  White          31600      4   9700    NaN             8.7

   Total Fuel Used
0         10503.01
1          7910.91
2          1627.45
3          1006.11
4         17047.60
5          7937.04
6          3655.84
7          4926.42
8          5400.00
9          2528.00
```

[327]:

```
car_sales["Number of Wheels"]=4
car_sales["Number of Wheel"]=4
car_sales["Safety Test Passed"]=True
car_sales
```

[327]:

```
     Make Colour  Odometer (KM)  Doors  Price  Seats  Fuel per 100KM  \
0  TOYOTA  White         150043      4   4000    5.0             7.5
1   HONDA    Red          87899      4   5000    5.0             9.2
2  TOYOTA   Blue          32549      3   7000    5.0             5.0
3     BMW  Black          11179      5  22000    5.0             9.6
4  NISSAN  White         213095      4   3500    6.0             8.7
5  TOYOTA  Green          99213      4   4500    NaN             8.3
6   HONDA   Blue          45698      4   7500    NaN             8.1
7   HONDA   Blue          54738      4   7000    NaN             9.1
8  TOYOTA  White          60000      4   6250    NaN             9.6
9  NISSAN  White          31600      4   9700    NaN             8.7

   Total Fuel Used  Number of Wheels  Number of Wheel  Safety Test Passed
0         10503.01                 4                4                True
1          7910.91                 4                4                True
2          1627.45                 4                4                True
```

```
3         1006.11                 4                 4                 True
4        17047.60                 4                 4                 True
5         7937.04                 4                 4                 True
6         3655.84                 4                 4                 True
7         4926.42                 4                 4                 True
8         5400.00                 4                 4                 True
9         2528.00                 4                 4                 True
```

[328]:
```python
# How to remove one of the column
car_sales.drop("Number of Wheel",axis=1,inplace=True)
car_sales
```

[328]:
```
     Make Colour  Odometer (KM)  Doors  Price  Seats  Fuel per 100KM  \
0  TOYOTA  White         150043      4   4000    5.0             7.5
1   HONDA    Red          87899      4   5000    5.0             9.2
2  TOYOTA   Blue          32549      3   7000    5.0             5.0
3     BMW  Black          11179      5  22000    5.0             9.6
4  NISSAN  White         213095      4   3500    6.0             8.7
5  TOYOTA  Green          99213      4   4500    NaN             8.3
6   HONDA   Blue          45698      4   7500    NaN             8.1
7   HONDA   Blue          54738      4   7000    NaN             9.1
8  TOYOTA  White          60000      4   6250    NaN             9.6
9  NISSAN  White          31600      4   9700    NaN             8.7

   Total Fuel Used  Number of Wheels  Safety Test Passed
0         10503.01                 4                True
1          7910.91                 4                True
2          1627.45                 4                True
3          1006.11                 4                True
4         17047.60                 4                True
5          7937.04                 4                True
6          3655.84                 4                True
7          4926.42                 4                True
8          5400.00                 4                True
9          2528.00                 4                True
```

[331]:
```python
#How to shuffle the rows in the dataframe and return. Fraction 0.5 is 50 percent
car_sales=car_sales.sample(frac=1)
car_sales
```

[331]:
```
     Make Colour  Odometer (KM)  Doors  Price  Seats  Fuel per 100KM  \
5  TOYOTA  Green          99213      4   4500    NaN             8.3
0  TOYOTA  White         150043      4   4000    5.0             7.5
3     BMW  Black          11179      5  22000    5.0             9.6
4  NISSAN  White         213095      4   3500    6.0             8.7
7   HONDA   Blue          54738      4   7000    NaN             9.1
1   HONDA    Red          87899      4   5000    5.0             9.2
```

```
9  NISSAN  White       31600      4   9700    NaN              8.7
6   HONDA   Blue       45698      4   7500    NaN              8.1
8  TOYOTA  White       60000      4   6250    NaN              9.6
2  TOYOTA   Blue       32549      3   7000    5.0              5.0

   Total Fuel Used  Number of Wheels  Safety Test Passed
5          7937.04                 4                True
0         10503.01                 4                True
3          1006.11                 4                True
4         17047.60                 4                True
7          4926.42                 4                True
1          7910.91                 4                True
9          2528.00                 4                True
6          3655.84                 4                True
8          5400.00                 4                True
2          1627.45                 4                True
```

[332]:
```
#How to reset the shuffled dataset to back in order
car_sales.reset_index(drop=True, inplace=True)
car_sales
```

[332]:
```
     Make Colour  Odometer (KM)  Doors  Price  Seats  Fuel per 100KM  \
0  TOYOTA  Green          99213      4   4500    NaN              8.3
1  TOYOTA  White         150043      4   4000    5.0              7.5
2     BMW  Black          11179      5  22000    5.0              9.6
3  NISSAN  White         213095      4   3500    6.0              8.7
4   HONDA   Blue          54738      4   7000    NaN              9.1
5   HONDA    Red          87899      4   5000    5.0              9.2
6  NISSAN  White          31600      4   9700    NaN              8.7
7   HONDA   Blue          45698      4   7500    NaN              8.1
8  TOYOTA  White          60000      4   6250    NaN              9.6
9  TOYOTA   Blue          32549      3   7000    5.0              5.0

   Total Fuel Used  Number of Wheels  Safety Test Passed
0          7937.04                 4                True
1         10503.01                 4                True
2          1006.11                 4                True
3         17047.60                 4                True
4          4926.42                 4                True
5          7910.91                 4                True
6          2528.00                 4                True
7          3655.84                 4                True
8          5400.00                 4                True
9          1627.45                 4                True
```

A lambda function in Python is a small anonymous function defined using the lambda keyword. It allows you to create a function without a proper name (anonymous) and

is typically used for short, simple operations where defining a full function using def would be overkill.

[333]:
```
#Applying Lambda function
car_sales["Odometer (KM)"]=car_sales["Odometer (KM)"].apply(lambda x: x/1.6)
car_sales
```

[333]:

	Make	Colour	Odometer (KM)	Doors	Price	Seats	Fuel per 100KM	\
0	TOYOTA	Green	62008.125	4	4500	NaN	8.3	
1	TOYOTA	White	93776.875	4	4000	5.0	7.5	
2	BMW	Black	6986.875	5	22000	5.0	9.6	
3	NISSAN	White	133184.375	4	3500	6.0	8.7	
4	HONDA	Blue	34211.250	4	7000	NaN	9.1	
5	HONDA	Red	54936.875	4	5000	5.0	9.2	
6	NISSAN	White	19750.000	4	9700	NaN	8.7	
7	HONDA	Blue	28561.250	4	7500	NaN	8.1	
8	TOYOTA	White	37500.000	4	6250	NaN	9.6	
9	TOYOTA	Blue	20343.125	3	7000	5.0	5.0	

	Total Fuel Used	Number of Wheels	Safety Test Passed
0	7937.04	4	True
1	10503.01	4	True
2	1006.11	4	True
3	17047.60	4	True
4	4926.42	4	True
5	7910.91	4	True
6	2528.00	4	True
7	3655.84	4	True
8	5400.00	4	True
9	1627.45	4	True

[ ]: