```
from google.colab import drive
drive.mount('/content/drive')
```

```
     Mounted at /content/drive
```

Import Libraries

```
# importting the necessary python libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sb
import zipfile
import plotly.express as px
from sklearn.linear_model import LinearRegression
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn.svm import SVC
from sklearn.model_selection import train_test_split
from  sklearn.preprocessing import StandardScaler
from sklearn.pipeline import Pipeline
import numpy
from sklearn.metrics import r2_score , mean_absolute_error,mean_absolute_percentage_error,mean_squared_error
from sklearn.neighbors import KNeighborsRegressor
from sklearn.model_selection import GridSearchCV
%matplotlib inline
```

```
Path = "/content/drive/MyDrive/garments_worker_productivity 2 (2).csv"
```

```
df = pd.read_csv(Path, index_col= False)
```

```
df.head(5)
```

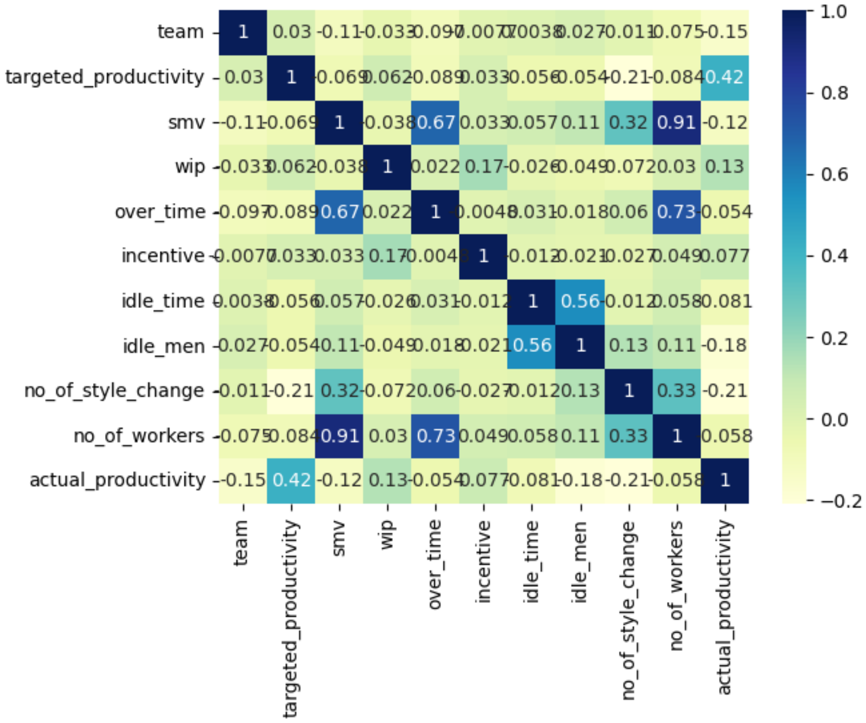
	date	quarter	department	day	team	targeted_productivity	smv	wip	over_time	incentive	idle_time	idle_men	no_o
0	1/1/2015	Quarter1	sweing	Thursday	8	0.80	26.16	1108.0	7080	98	0.0	0	
1	1/1/2015	Quarter1	finishing	Thursday	1	0.75	3.94	NaN	960	0	0.0	0	
2	1/1/2015	Quarter1	sweing	Thursday	11	0.80	11.41	968.0	3660	50	0.0	0	
3	1/1/2015	Quarter1	sweing	Thursday	12	0.80	11.41	968.0	3660	50	0.0	0	
4	1/1/2015	Quarter1	sweing	Thursday	6	0.80	25.90	1170.0	1920	50	0.0	0	

```
# checking the rows and columns of thte dataset
df.shape
```

```
     (1197, 15)
```

```
corrplot = sb.heatmap(df.corr(), cmap="YlGnBu", annot=True)
plt.show()
```

```
<ipython-input-7-3e5099b80ef3>:1: FutureWarning: The default value of numeric_only in DataFrame.corr is deprecated. In a future vers
  corrplot = sb.heatmap(df.corr(), cmap="YlGnBu", annot=True)
```



DATA PREPROCESSING

```
# info about the data, this can also show us whether there are nan values and how many they are
# df.info()
```

```
df.isnull().sum()
```

```
date                      0
quarter                   0
department                0
day                       0
team                      0
targeted_productivity     0
smv                       0
wip                     506
over_time                 0
incentive                 0
idle_time                 0
idle_men                  0
no_of_style_change        0
no_of_workers             0
actual_productivity       0
dtype: int64
```

```
# This code gives us the column in the datset
df.columns
```

```
Index(['date', 'quarter', 'department', 'day', 'team', 'targeted_productivity',
       'smv', 'wip', 'over_time', 'incentive', 'idle_time', 'idle_men',
       'no_of_style_change', 'no_of_workers', 'actual_productivity'],
      dtype='object')
```

```
#Changing the date to real date_time object
df.date = pd.to_datetime(df.date)
```

```
# Renaming some columns to a readable column
df = df.rename(columns = { "wip" :"work_in_progress",
        "smv":  "standard_minute_value" })
```

```
# handled the missing data by filling the missing  values with median
df.work_in_progress = df.work_in_progress.fillna(df.work_in_progress.median())
```

We are still in Data Precessing , so we will be checking some columns to see if there are issues and we will rectify them

```
df.department.unique()    # we see an issue with this and we are rectifying below

     array(['sweing', 'finishing ', 'finishing'], dtype=object)
```

```
df.department = df.department.replace(to_replace = "finishing " , value = "finishing")
df.department = df.department.replace(to_replace = "sweing" , value = "sewing")  # There was a aspelling error so we fixed it
```

```
# df.isnull().sum()
```

```
df.department.unique()   # confirmed if the code fixed the problem ----- This is optional

     array(['sewing', 'finishing'], dtype=object)
```

```
# This gives us te statistical summary of our dataset
# df.describe().transpose()
```

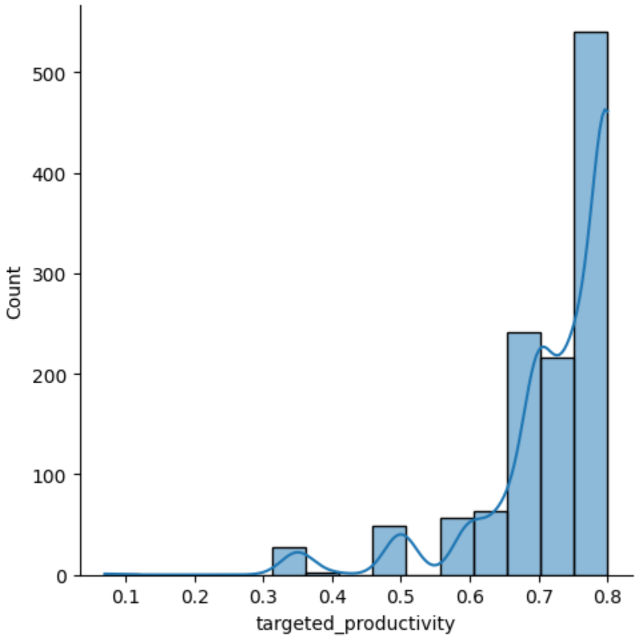
```
# Changing the weekdays as 1 and weekends as 0

df.day = df.day.replace({"Wednesday" : 1,"Tuesday": 1,"Thursday": 1,"Monday": 1
                         , "Sunday" : 0, "Saturday" : 0})
```

```
df.day.unique()    # This  is optional

     array([1, 0])
```

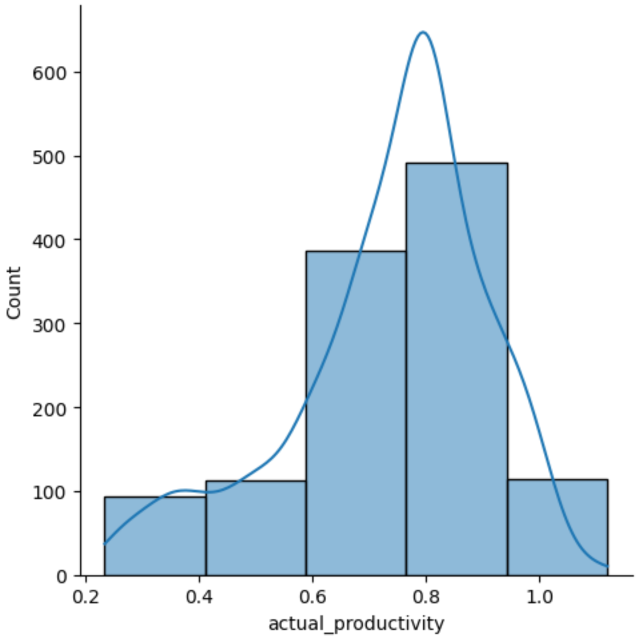
```
df.dtypes   # Here we see the type of each columns and we see that the columns are the right way
#            # but we still fo further to change some

     date                     datetime64[ns]
     quarter                          object
     department                       object
     day                               int64
     team                              int64
     targeted_productivity           float64
     standard_minute_value           float64
     work_in_progress                float64
     over_time                         int64
     incentive                         int64
     idle_time                       float64
     idle_men                          int64
     no_of_style_change                int64
     no_of_workers                   float64
     actual_productivity             float64
     dtype: object
```

EDA

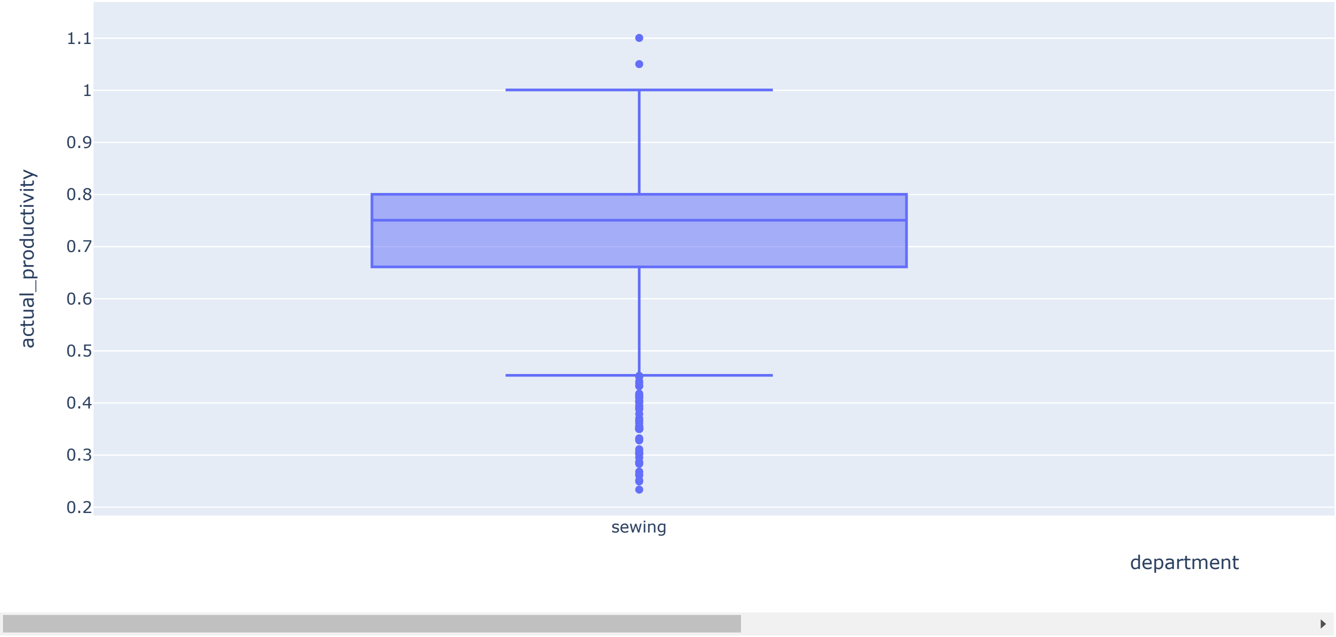
```
sb.displot(data = df, x= "targeted_productivity" , bins = 15 , kde = True);   # semi colon is to not show the necessary information
```



```
sb.displot(data = df , x = "actual_productivity", bins = 5, kde = True);
```



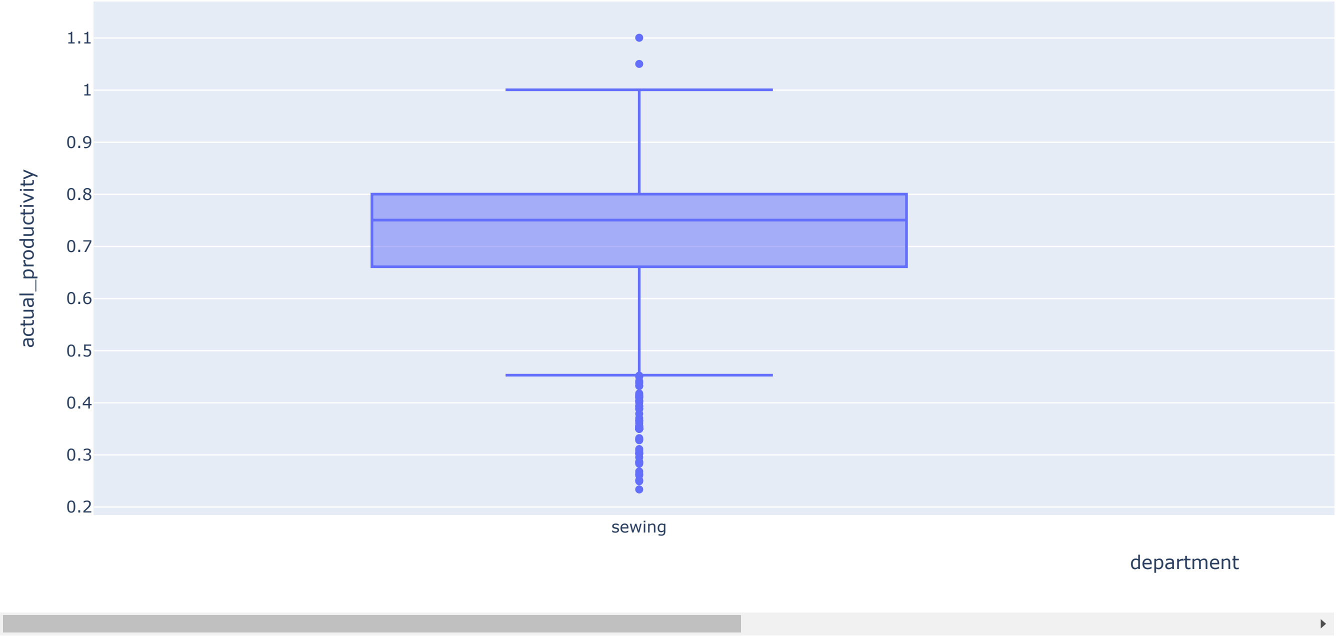
```
fig = px.box(df, y = "actual_productivity" , x = "department")
fig.show()
# So we see the the precise value of the outlier in the actual_productivity column
```



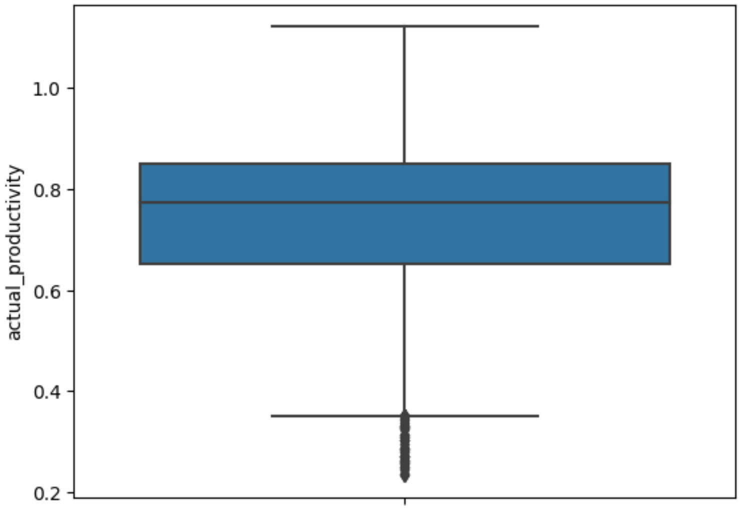
```
# # Removing the outlier
# df = df[df["actual_productivity"] > 0.49]
```

We did not remove the whole outlier due to the less number of our dataset -- we had originally 1197 total dataset and if we remove the total outlier , it will affect our machine learning model when training

```
fig = px.box(df, y = "actual_productivity" , x = "department")
fig.show()
```



```
sb.boxplot(y = "actual_productivity" , data = df);
```



```
# df.columns
```

```
# Define a mapping from departments to numeric values
department_mapping = {
    'sewing': 1,
    'finishing': 2,
}

df['department'] = df['department'].map(department_mapping)
```

```
Quarter = pd.get_dummies(df["quarter"] )
df = pd.concat([df , Quarter], axis =1)
```

```
df["quarter"].unique()
```

```
array(['Quarter1', 'Quarter2', 'Quarter3', 'Quarter4', 'Quarter5'],
      dtype=object)
```

```
Quarter
```

	Quarter1	Quarter2	Quarter3	Quarter4	Quarter5
0	1	0	0	0	0
1	1	0	0	0	0
2	1	0	0	0	0
3	1	0	0	0	0
4	1	0	0	0	0
...	...	...	...	...	...
1192	0	1	0	0	0
1193	0	1	0	0	0
1194	0	1	0	0	0
1195	0	1	0	0	0
1196	0	1	0	0	0

1197 rows × 5 columns

```
df.shape
```

```
(1197, 20)
```

```
df.head(4)
```

	date	quarter	department	day	team	targeted_productivity	standard_minute_value	work_in_progress	over_time	incentive	idle_
0	2015-01-01	Quarter1	1	1	8	0.80	26.16	1108.0	7080	98	
1	2015-01-01	Quarter1	2	1	1	0.75	3.94	1039.0	960	0	
2	2015-01-01	Quarter1	1	1	11	0.80	11.41	968.0	3660	50	
3	2015-01-01	Quarter1	1	1	12	0.80	11.41	968.0	3660	50	

```
df = df.drop(["quarter" , "date"] ,axis =1)
```

```
df
```

	department	day	team	targeted_productivity	standard_minute_value	work_in_progress	over_time	incentive	idle_time	idle_m
0	1	1	8	0.80	26.16	1108.0	7080	98	0.0	
1	2	1	1	0.75	3.94	1039.0	960	0	0.0	
2	1	1	11	0.80	11.41	968.0	3660	50	0.0	
3	1	1	12	0.80	11.41	968.0	3660	50	0.0	
4	1	1	6	0.80	25.90	1170.0	1920	50	0.0	
...	...	...	...	...	...	...	...	...	...	
1192	2	1	10	0.75	2.90	1039.0	960	0	0.0	
1193	2	1	8	0.70	3.90	1039.0	960	0	0.0	
1194	2	1	7	0.65	3.90	1039.0	960	0	0.0	
1195	2	1	9	0.75	2.90	1039.0	1800	0	0.0	
1196	2	1	6	0.70	2.90	1039.0	720	0	0.0	

1197 rows × 18 columns

```
df.dtypes
```

```
department                 int64
day                        int64
team                       int64
targeted_productivity    float64
standard_minute_value    float64
work_in_progress         float64
over_time                  int64
incentive                  int64
idle_time                float64
idle_men                   int64
no_of_style_change         int64
no_of_workers            float64
actual_productivity      float64
Quarter1                   uint8
Quarter2                   uint8
Quarter3                   uint8
Quarter4                   uint8
Quarter5                   uint8
dtype: object
```

```
df.isnull().sum()
```

```
department               0
day                      0
team                     0
targeted_productivity    0
standard_minute_value    0
work_in_progress         0
over_time                0
incentive                0
idle_time                0
idle_men                 0
no_of_style_change       0
no_of_workers            0
actual_productivity      0
Quarter1                 0
```

```
     Quarter2                0
     Quarter3                0
     Quarter4                0
     Quarter5                0
     dtype: int64
```

```
X = df.drop(["actual_productivity"] , axis =1)
Y = df["actual_productivity"]
```

```
df.columns
```

```
     Index(['department', 'day', 'team', 'targeted_productivity',
            'standard_minute_value', 'work_in_progress', 'over_time', 'incentive',
            'idle_time', 'idle_men', 'no_of_style_change', 'no_of_workers',
            'actual_productivity', 'Quarter1', 'Quarter2', 'Quarter3', 'Quarter4',
            'Quarter5'],
           dtype='object')
```

```
# from sklearn.decomposition import PCA

# pca = PCA(0.98)   # retain 98% of useful features
# X_pca = pca.fit_transform(X)
# X_pca.shape
```

```
df.columns
```

```
     Index(['department', 'day', 'team', 'targeted_productivity',
            'standard_minute_value', 'work_in_progress', 'over_time', 'incentive',
            'idle_time', 'idle_men', 'no_of_style_change', 'no_of_workers',
            'actual_productivity', 'Quarter1', 'Quarter2', 'Quarter3', 'Quarter4',
            'Quarter5'],
           dtype='object')
```

Double-click (or enter) to edit

```
X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.20)
```

```
X_train
```

	department	day	team	targeted_productivity	standard_minute_value	work_in_pr
48	1	0	4	0.80	28.08	
19	2	0	4	0.80	4.15	
316	1	0	1	0.80	49.10	
991	1	0	9	0.75	18.79	
39	2	0	7	0.80	3.94	
...	...	...	...	...	...	
993	1	0	10	0.70	21.82	
1156	1	1	4	0.75	26.82	
1015	1	1	6	0.75	18.79	
414	1	0	8	0.35	15.09	
1194	2	1	7	0.65	3.90	

957 rows × 17 columns

```
Y_train
```

```
     48      0.800598
     19      0.988025
     316     0.403242
     991     0.750396
     39      0.625313
               ...
     993     0.700237
     1156    0.850084
     1015    0.750797
     414     0.349990
     1194    0.625625
     Name: actual_productivity, Length: 957, dtype: float64
```

Linear Regressor

```
lrmodel = LinearRegression()
lrmodel.fit(X_train, Y_train)
Y_pred = lrmodel.predict(X_test)
mae = mean_absolute_error(Y_pred, Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.11351837941416111
mse = 0.025192845640267136
```

```
X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.25)
lrmodel = LinearRegression()
lrmodel.fit(X_train, Y_train)
Y_pred = lrmodel.predict(X_test)
mae = mean_absolute_error(Y_pred, Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.10343933358324321
mse = 0.020738936840156444
```

```
X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.30)
lrmodel = LinearRegression()
lrmodel.fit(X_train, Y_train)
Y_pred = lrmodel.predict(X_test)
mae = mean_absolute_error(Y_pred, Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.10189225264636702
mse = 0.019985015155800992
```

```
X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.35)
lrmodel = LinearRegression()
lrmodel.fit(X_train, Y_train)
Y_pred = lrmodel.predict(X_test)
mae = mean_absolute_error(Y_pred, Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.10883258914502238
mse = 0.021447670465546412
```

Decision Tree Regressor

```
d_reg = DecisionTreeRegressor()
d_reg.fit(X_train,Y_train)
Y_pred = d_reg.predict(X_test)
Y_pred
mae = mean_absolute_error(Y_pred , Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.09305682181384249
mse = 0.02342941303989847
```

```
X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.25)
d_reg = DecisionTreeRegressor()
d_reg.fit(X_train,Y_train)
Y_pred = d_reg.predict(X_test)
Y_pred
mae = mean_absolute_error(Y_pred , Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.08213200909861113
mse = 0.020573664390537785
```

```
X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.30)
d_reg = DecisionTreeRegressor()
d_reg.fit(X_train,Y_train)
Y_pred = d_reg.predict(X_test)
Y_pred
mae = mean_absolute_error(Y_pred , Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.09409316947268519
mse = 0.025991788411543135
```

```
X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.35)
d_reg = DecisionTreeRegressor()
d_reg.fit(X_train,Y_train)
Y_pred = d_reg.predict(X_test)
Y_pred
mae = mean_absolute_error(Y_pred , Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.09881940373906126
mse = 0.028922952148366397
```

Random Forest Regressor

```
rfr = RandomForestRegressor()
rfr.fit(X_train,Y_train)
Y_pred = rfr.predict(X_test)
Y_pred
mae = mean_absolute_error(Y_pred , Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.0776579676340496
mse = 0.01570121770338763
```

```
X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.25)
rfr = RandomForestRegressor()
rfr.fit(X_train,Y_train)
Y_pred = rfr.predict(X_test)
Y_pred
mae = mean_absolute_error(Y_pred , Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.07842874889803038
mse = 0.015371831078088623
```

```
X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.30)
rfr = RandomForestRegressor()
rfr.fit(X_train,Y_train)
Y_pred = rfr.predict(X_test)
Y_pred
mae = mean_absolute_error(Y_pred , Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.07269489695811261
mse = 0.014896423140963603
```

```
X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.35)
rfr = RandomForestRegressor()
rfr.fit(X_train,Y_train)
Y_pred = rfr.predict(X_test)
Y_pred
mae = mean_absolute_error(Y_pred , Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
     Mae = 0.07462120909869058
     mse = 0.015596585712152665
```

Random Forest Regressor with Grid search

```
####rfr_g = RandomForestRegressor()
##parameter = {"max_depth":[1, 15],'min_samples_split':[2,15]}
clf = GridSearchCV(rfr_g,parameter)
clf.fit(X_train,Y_train)
print(clf.best_params_)
grid_predictions = clf.predict(X_test)
mae = mean_absolute_error(grid_predictions , Y_test)
print(f"Mae = {mae}")
mape = mean_absolute_percentage_error(grid_predictions, Y_test)
print(f"Mape = {mape}")
```

```
     ---------------------------------------------------------------------------
     NameError                                 Traceback (most recent call last)
     <ipython-input-58-88e3049a56e9> in <cell line: 3>()
           1 ##rfr_g = RandomForestRegressor()
           2 parameter = {"max_depth":[1, 15],'min_samples_split':[2,15]}
     ----> 3 clf = GridSearchCV(rfr_g,parameter)
           4 clf.fit(X_train,Y_train)
           5 print(clf.best_params_)

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

SEARCH STACK OVERFLOW

```
##X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.25)
##rfr_g = RandomForestRegressor()
parameter = {"max_depth":[1, 15],'min_samples_split':[2,15]}
clf = GridSearchCV(rfr_g,parameter)
clf.fit(X_train,Y_train)
print(clf.best_params_)
grid_predictions = clf.predict(X_test)
mae = mean_absolute_error(grid_predictions , Y_test)
print(f"Mae = {mae}")
mape = mean_absolute_percentage_error(grid_predictions, Y_test)
print(f"Mape = {mape}")
```

```
##X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.30)
##rfr_g = RandomForestRegressor()
parameter = {"max_depth":[1, 15],'min_samples_split':[2,15]}
clf = GridSearchCV(rfr_g,parameter)
clf.fit(X_train,Y_train)
print(clf.best_params_)
grid_predictions = clf.predict(X_test)
mae = mean_absolute_error(grid_predictions , Y_test)
print(f"Mae = {mae}")
mape = mean_absolute_percentage_error(grid_predictions, Y_test)
print(f"Mape = {mape}")
```

```
##X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.35)
##rfr_g = RandomForestRegressor()
parameter = {"max_depth":[1, 15],'min_samples_split':[2,15]}
clf = GridSearchCV(rfr_g,parameter)
clf.fit(X_train,Y_train)
print(clf.best_params_)
grid_predictions = clf.predict(X_test)
mae = mean_absolute_error(grid_predictions , Y_test)
print(f"Mae = {mae}")
mape = mean_absolute_percentage_error(grid_predictions, Y_test)
print(f"Mape = {mape}")
```

Support vector Regressor

```
from sklearn.svm import SVR
s_reg = SVR()
s_reg.fit(X_train,Y_train)
Y_pred = s_reg.predict(X_test)
Y_pred
mae = mean_absolute_error(Y_pred , Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.13424446904220322
mse = 0.031222923038842755
```

```
X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.25)
s_reg = SVR()
s_reg.fit(X_train,Y_train)
Y_pred = s_reg.predict(X_test)
Y_pred
mae = mean_absolute_error(Y_pred , Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.1254614750583554
mse = 0.026525675072420374
```

```
X_train , X_test , Y_train , Y_test = train_test_split(X , Y, test_size = 0.30)
s_reg = SVR()
s_reg.fit(X_train,Y_train)
Y_pred = s_reg.predict(X_test)
Y_pred
mae = mean_absolute_error(Y_pred , Y_test)
print(f"Mae = {mae}")
mse = mean_squared_error(Y_pred, Y_test)
print(f"mse = {mse}")
```

```
Mae = 0.12907064340648083
mse = 0.027738919157042515
```