Assingment 4

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Task 1

Load the dataset

```
import pandas as pd
# Replace 'filename.csv' with the actual name of your CSV file.
df = pd.read_csv('winequality-red.csv')
# Display the first few rows of the DataFrame to verify the data.
df.head()
```

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	quality
0	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4	5
1	7.8	0.88	0.00	2.6	0.098	25.0	67.0	0.9968	3.20	0.68	9.8	5
2	7.8	0.76	0.04	2.3	0.092	15.0	54.0	0.9970	3.26	0.65	9.8	5
3	11.2	0.28	0.56	1.9	0.075	17.0	60.0	0.9980	3.16	0.58	9.8	6
4	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4	5

Task 2

Data Preporcessing including visualization

```
# Get summary statistics of numerical columns.
df.describe()
```

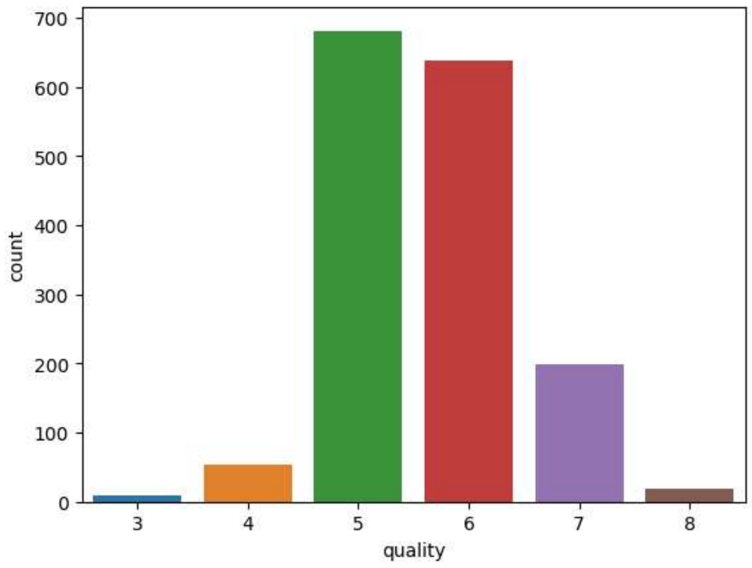
	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	al
count	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.0
mean	8.319637	0.527821	0.270976	2.538806	0.087467	15.874922	46.467792	0.996747	3.311113	0.658149	10.4
std	1.741096	0.179060	0.194801	1.409928	0.047065	10.460157	32.895324	0.001887	0.154386	0.169507	1.0
min	4.600000	0.120000	0.000000	0.900000	0.012000	1.000000	6.000000	0.990070	2.740000	0.330000	8.4
25%	7.100000	0.390000	0.090000	1.900000	0.070000	7.000000	22.000000	0.995600	3.210000	0.550000	9.5
50%	7.900000	0.520000	0.260000	2.200000	0.079000	14.000000	38.000000	0.996750	3.310000	0.620000	10.2
75%	9.200000	0.640000	0.420000	2.600000	0.090000	21.000000	62.000000	0.997835	3.400000	0.730000	11.1

```
# Check for missing values.
missing_values = df.isnull().sum()
print(missing_values)
# Impute missing values with the mean for numerical columns.
df.fillna(df.mean(), inplace=True)
```

```
fixed acidity           0
volatile acidity        0
citric acid             0
residual sugar          0
chlorides               0
free sulfur dioxide     0
total sulfur dioxide    0
density                 0
pH                      0
sulphates               0
alcohol                 0
quality                 0
dtype: int64
```

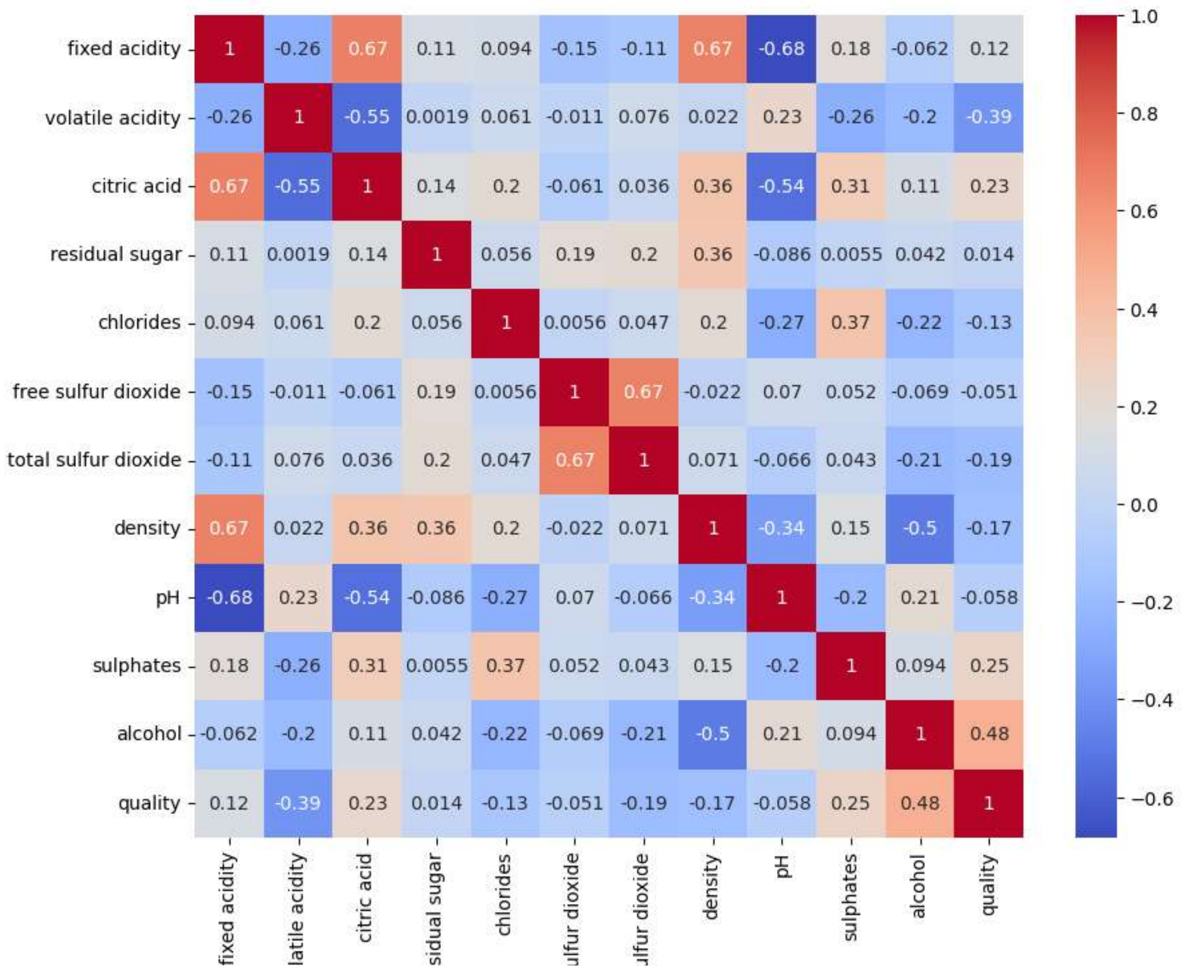
Countplot

```
import seaborn as sns
import matplotlib.pyplot as plt
# Example: Countplot for the 'quality' column.
sns.countplot(data=df, x='quality')
plt.show()
```



Correlation Matrix

```
import seaborn as sns
# Calculate the correlation matrix.
corr_matrix = df.corr()
# Create a heatmap of the correlation matrix.
plt.figure(figsize=(10, 8))
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm')
plt.show()
```



Task 4

Machine Learning Model Building

```
import numpy as np
import pandas as pd
import seaborn as sns
from sklearn.svm import SVR
import matplotlib.pyplot as plt
from sklearn.linear_model import Lasso
from sklearn.linear_model import Ridge
from sklearn.linear_model import ElasticNet
from sklearn.tree import DecisionTreeRegressor
from sklearn.metrics import mean_squared_error
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import LinearRegression
from sklearn.ensemble import RandomForestRegressor
from sklearn.ensemble import GradientBoostingRegressor
from sklearn.model_selection import train_test_split, GridSearchCV
```

```
# Split the data into train and test split and we use 20 percent data for testing
x_train,x_test,y_train,y_test= train_test_split(df.drop("quality", axis=1),
                                                df["quality"],
                                                test_size=0.2,
                                                random_state=42)
x_train.shape,x_test.shape,y_train.shape, y_test.shape
```

```
((1279, 11), (320, 11), (1279,), (320,))
```

```
# Data Preprocessing (--normalise the values of dataset)
std= StandardScaler()
x_train= std.fit_transform(x_train)
x_test=std.transform(x_test)
```

```
# Defining Models
models=[
        LinearRegression(),
        RandomForestRegressor(),
        DecisionTreeRegressor(),
        GradientBoostingRegressor(),
        SVR(),
        Lasso(),
        Ridge(),
        ElasticNet()
]
```

```
# Defining parameters
Linear_param={'n_jobs':[-1]}
Random_param={'n_estimators':[100,200],
              'max_depth':[6,8],
              'min_samples_split':[2,4],
              'criterion':['squared_error'],
                                       }
Decsion_param={'splitter':['best'],
               'max_depth':[8,10],
               'min_samples_split':[2],
               'criterion':['squared_error'],

              }
gradient_param={'n_estimators':[100,200],
                   'learning_rate':[0.1, 0.01,0.001],
                   'max_depth':[8,10],
                   'min_samples_leaf':[2,4,5],
                   'loss':['squared_error'],
                    }
SVR_param={'kernel':['rbf','poly'],
      'gamma':['scale', 'auto'],
    }
Lasso_param={'alpha':[1.0,1.1],
             'max_iter':[1000,1200],
             'selection':['cyclic', 'random']
}
Ridge_param={ 'alpha':[1.0,1.1],
             'max_iter':[1000,1200],
             'solver':['auto','svd','lsqr']

}
ElasticNet_param={'alpha':[1.0,1.1],
                 'max_iter':[1000,1400],
                 'selection':['cyclic', 'random']
}
parameters=[
            Linear_param,
            Random_param,
            Decsion_param,
            gradient_param,
            SVR_param,
            Lasso_param,
            Ridge_param,
            ElasticNet_param
            ]
```

Task 5

Evaluate the Model

Hyperparameter Tuning

```
# Train the models using GridSearchCV
result={}
for i in range(len(models)):
    temp = []
    regressor = GridSearchCV(models[i], parameters[i], cv=2, scoring="r2", n_jobs=-1).fit(x_train, y_train)    # fitting the object
    models[i] = models[i].__class__.__name__
    best_parameters = regressor.best_params_
    y_pred = regressor.predict(x_test)
    mse = mean_squared_error(y_test, y_pred)
    temp.append(mse)
    result[f"{models[i]}"] = temp
```

```
result
final_results= pd.DataFrame(result)
final_results=final_results.T
final_results.columns = ["MeanSquaredError"]
final_results
```

	MeanSquaredError
LinearRegression	0.390025
RandomForestRegressor	0.333888
DecisionTreeRegressor	0.541155
GradientBoostingRegressor	0.357565
SVR	0.351374
Lasso	0.657160
Ridge	0.390039
ElasticNet	0.657160

Task 5

Test with Random Observation

```
# Create a random observation (replace with actual feature values).
random_observation = [7.0, 0.6, 0.1, 2.0, 0.075, 20, 50, 0.9975, 3.4, 0.6, 10.0]
# Reshape the random observation to match the input format (1 sample).
random_observation = np.array(random_observation).reshape(1, -1)
# Use the best model from GridSearchCV to predict.
prediction_grid_search = regressor.predict(random_observation)
print(f"GridSearchCV Prediction: {prediction_grid_search[0]}")
```

```
GridSearchCV Prediction: 5.623924941360438
```