Data Preparation and Exploration

1.Load and Explore a Dataset:

Load a dataset (e.g., Iris, Wine, Breast Cancer) and display the first few rows.

In [81]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

In [109…
```
df= pd.read_csv("iris.data.csv")
df
```

Out[109]:

	5.1	3.5	1.4	0.2	Iris-setosa
0	4.9	3.0	1.4	0.2	Iris-setosa
1	4.7	3.2	1.3	0.2	Iris-setosa
2	4.6	3.1	1.5	0.2	Iris-setosa
3	5.0	3.6	1.4	0.2	Iris-setosa
4	5.4	3.9	1.7	0.4	Iris-setosa
...	...	...	...	...	...
144	6.7	3.0	5.2	2.3	Iris-virginica
145	6.3	2.5	5.0	1.9	Iris-virginica
146	6.5	3.0	5.2	2.0	Iris-virginica
147	6.2	3.4	5.4	2.3	Iris-virginica
148	5.9	3.0	5.1	1.8	Iris-virginica

149 rows × 5 columns

2.Inspect the Data:

Display the data types of each column and summary statistics.

In [110…
```
df.columns
```

Out[110]:
```
Index(['5.1', '3.5', '1.4', '0.2', 'Iris-setosa'], dtype='object')
```

In [111…
```
df.describe()
```

Out[111]:

	5.1	3.5	1.4	0.2
count	149.000000	149.000000	149.000000	149.000000
mean	5.848322	3.051007	3.774497	1.205369
std	0.828594	0.433499	1.759651	0.761292
min	4.300000	2.000000	1.000000	0.100000
25%	5.100000	2.800000	1.600000	0.300000
50%	5.800000	3.000000	4.400000	1.300000
75%	6.400000	3.300000	5.100000	1.800000
max	7.900000	4.400000	6.900000	2.500000

In [112...

```
df.columns #find columns names
```

Out[112]:

```
Index(['5.1', '3.5', '1.4', '0.2', 'Iris-setosa'], dtype='object')
```

In [128...

```
df.shape
```

Out[128]:

```
(149, 5)
```

In [113...

```
x = df.iloc[:, :-1]  # Selects all rows and all columns except the last one
y = df.iloc[:, -1]     # Selects all rows and the last column
```

In [114...

```
x
```

Out[114]:

	5.1	3.5	1.4	0.2
0	4.9	3.0	1.4	0.2
1	4.7	3.2	1.3	0.2
2	4.6	3.1	1.5	0.2
3	5.0	3.6	1.4	0.2
4	5.4	3.9	1.7	0.4
...	...	...	...	...
144	6.7	3.0	5.2	2.3
145	6.3	2.5	5.0	1.9
146	6.5	3.0	5.2	2.0
147	6.2	3.4	5.4	2.3
148	5.9	3.0	5.1	1.8

149 rows × 4 columns

In [115...

```
print(y)
```

```
0         Iris-setosa
1         Iris-setosa
2         Iris-setosa
3         Iris-setosa
4         Iris-setosa
             ...
144    Iris-virginica
145    Iris-virginica
146    Iris-virginica
147    Iris-virginica
148    Iris-virginica
Name: Iris-setosa, Length: 149, dtype: object
```

In [116…

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 149 entries, 0 to 148
Data columns (total 5 columns):
 #   Column       Non-Null Count  Dtype  
---  ------       --------------  -----  
 0   5.1          149 non-null    float64
 1   3.5          149 non-null    float64
 2   1.4          149 non-null    float64
 3   0.2          149 non-null    float64
 4   Iris-setosa  149 non-null    object 
dtypes: float64(4), object(1)
memory usage: 5.9+ KB
```

know the target varaible

In [120…

```
print(df['Iris-setosa'].unique())
```

```
['Iris-setosa' 'Iris-versicolor' 'Iris-virginica']
```

In [121…

```
df.dtypes
```

Out[121]:

```
5.1            float64
3.5            float64
1.4            float64
0.2            float64
Iris-setosa     object
dtype: object
```

3.Check for Missing Values:

Identify and handle missing values in the dataset.

In [122…

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

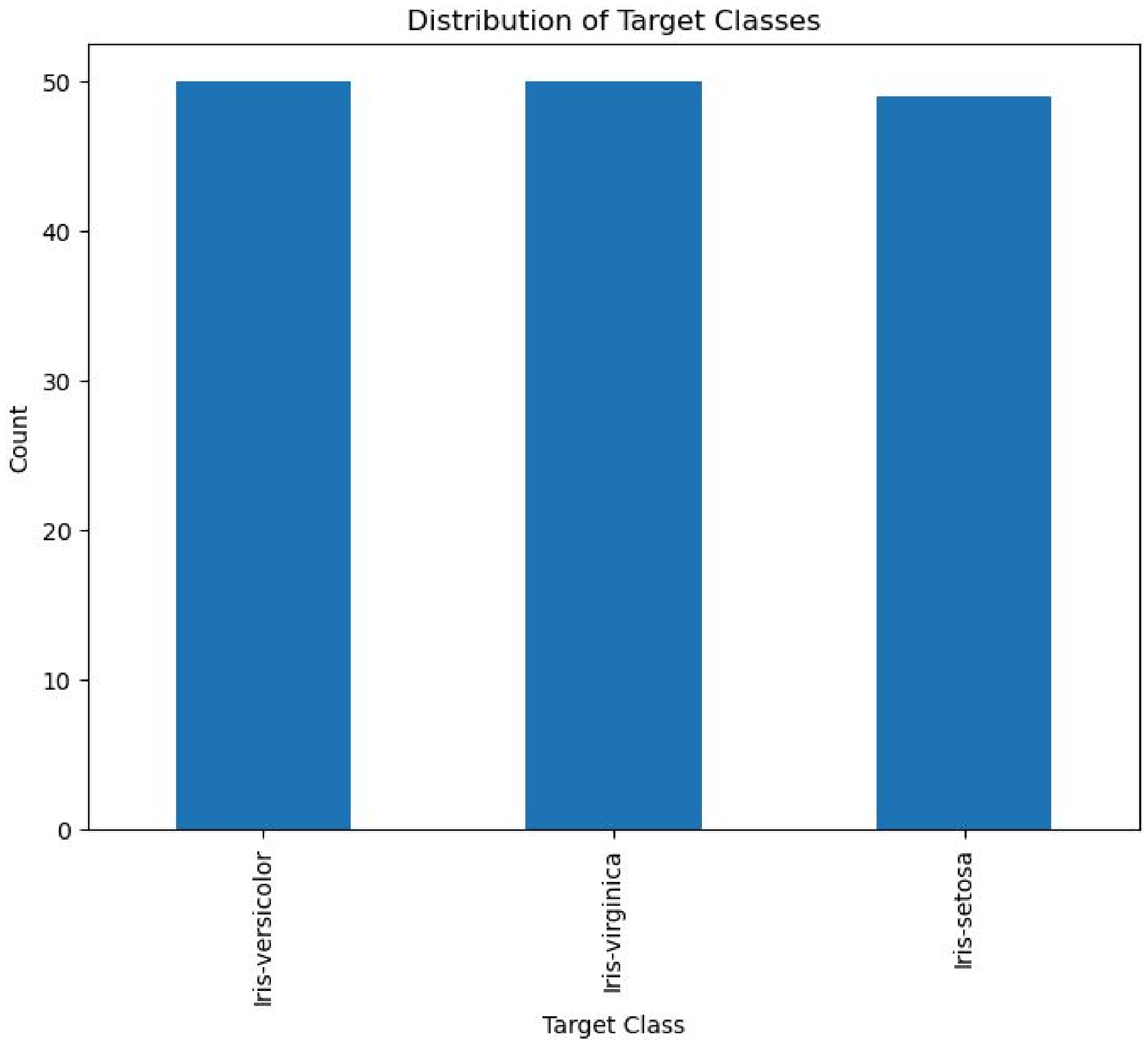
Out[122]:

```
5.1            0
3.5            0
1.4            0
0.2            0
Iris-setosa    0
dtype: int64
```

4. Data Visualization:

Visualize the distribution of classes in the target variable

In [124...
```
plt.figure(figsize=(8, 6))
df['Iris-setosa'].value_counts().plot(kind='bar')
plt.title('Distribution of Target Classes')
plt.xlabel('Target Class')
plt.ylabel('Count')
plt.show()
```



5. Feature Scaling:

Scale the features using StandardScaler or MinMaxScaler.

In [125...
```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
```

In [126...
```
scaler = StandardScaler()
X_scaled = scaler.fit_transform(x)
```

6. Train a Logistic Regression Model:

Train and evaluate a logistic regression model.

In [129...
```
x_train, x_test, y_train, y_test= train_test_split(X_scaled, y, test_size=0.2, ranc
```

In [130...
```
from sklearn.linear_model import LogisticRegression
```

In [131...
```
lr= LogisticRegression()
lr.fit(x_train, y_train)
y_pred= lr.predict(x_test)
```

In [133...
```
from sklearn.metrics import accuracy_score
```

In [134...
```
print(f'Logistic Regression Accuracy: {accuracy_score(y_test, y_pred)}')
```

```
Logistic Regression Accuracy: 0.9
```

7. Train a K-Nearest Neighbors (KNN) Model:

Train and evaluate a KNN model.

In [135...
```
from sklearn.neighbors import KNeighborsClassifier
```

In [137...
```
knn = KNeighborsClassifier()
knn.fit(x_train, y_train)
y_pred_knn = knn.predict(x_test)
print(f'KNN Accuracy: {accuracy_score(y_test, y_pred_knn)}')
```

```
KNN Accuracy: 0.9333333333333333
```

```
C:\Users\shaw3\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:22
8: FutureWarning: Unlike other reduction functions (e.g. `skew`, `kurtosis`), the
default behavior of `mode` typically preserves the axis it acts along. In SciPy 1.
11.0, this behavior will change: the default value of `keepdims` will become Fals
e, the `axis` over which the statistic is taken will be eliminated, and the value
None will no longer be accepted. Set `keepdims` to True or False to avoid this war
ning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

8. Train a Decision Tree Model:

Train and evaluate a decision tree model.

In [138...
```
from sklearn.tree import DecisionTreeClassifier
```

In [139...
```
dt = DecisionTreeClassifier()
dt.fit(x_train, y_train)
y_pred_dt = dt.predict(x_test)
print(f'Decision Tree Accuracy: {accuracy_score(y_test, y_pred_dt)}')
```

```
Decision Tree Accuracy: 0.9
```

9. Train a Random Forest Model:

Train and evaluate a random forest model.

In [140...
```
from sklearn.ensemble import RandomForestClassifier
```

In [141...
```
rf = RandomForestClassifier()
rf.fit(x_train, y_train)
y_pred_rf = rf.predict(x_test)
print(f'Random Forest Accuracy: {accuracy_score(y_test, y_pred_rf)}')
```

```
Random Forest Accuracy: 0.9
```

10.Train a Support Vector Machine (SVM) Model:

Train and evaluate an SVM model.

In [142...
```
from sklearn.svm import SVC
```

In [143...
```
svm = SVC()
svm.fit(x_train, y_train)
y_pred_svm = svm.predict(x_test)
print(f'SVM Accuracy: {accuracy_score(y_test, y_pred_svm)}')
```

```
SVM Accuracy: 0.9333333333333333
```

11. Train a Naive Bayes Model:

Train and evaluate a naive bayes model.

In [144...
```
from sklearn.naive_bayes import GaussianNB
```

In [145...
```
nb = GaussianNB()
nb.fit(x_train, y_train)
y_pred_nb = nb.predict(x_test)
print(f'Naive Bayes Accuracy: {accuracy_score(y_test, y_pred_nb)}')
```

```
Naive Bayes Accuracy: 0.8666666666666667
```

12. Train a Gradient Boosting Model:

Train and evaluate a gradient boosting model.

In [146...
```
from sklearn.ensemble import GradientBoostingClassifier
```

In [147...
```
gb = GradientBoostingClassifier()
gb.fit(x_train, y_train)
y_pred_gb = gb.predict(x_test)
print(f'Gradient Boosting Accuracy: {accuracy_score(y_test, y_pred_gb)}')
```

```
Gradient Boosting Accuracy: 0.9
```

13.Train a LightGBM Model:

Train and evaluate a LightGBM model

In [151...

```
pip install lightgbm
```

```
Collecting lightgbm
  Downloading lightgbm-4.5.0-py3-none-win_amd64.whl (1.4 MB)
     ---------------------------------------- 1.4/1.4 MB 6.5 MB/s eta 0:00:00
Requirement already satisfied: numpy>=1.17.0 in c:\users\shaw3\anaconda3\lib\site-packages (from lightgbm) (1.24.4)
Requirement already satisfied: scipy in c:\users\shaw3\anaconda3\lib\site-packages (from lightgbm) (1.9.1)
Installing collected packages: lightgbm
Successfully installed lightgbm-4.5.0
Note: you may need to restart the kernel to use updated packages.
```

In [153...

```
import lightgbm as lgb
```

In [154...

```
lgb_model = lgb.LGBMClassifier()
lgb_model.fit(x_train, y_train)
y_pred_lgb = lgb_model.predict(x_test)
print(f'LightGBM Accuracy: {accuracy_score(y_test, y_pred_lgb)}')
```

```
[LightGBM] [Info] Auto-choosing row-wise multi-threading, the overhead of testing
was 0.000090 seconds.
You can set `force_row_wise=true` to remove the overhead.
And if memory is not enough, you can set `force_col_wise=true`.
[LightGBM] [Info] Total Bins 89
[LightGBM] [Info] Number of data points in the train set: 119, number of used feat
ures: 4
[LightGBM] [Info] Start training from score -1.115562
[LightGBM] [Info] Start training from score -1.065551
[LightGBM] [Info] Start training from score -1.115562
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```

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[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
LightGBM Accuracy: 0.9
```

Model Tuning and Optimization:

Hyperparameter Tuning for Logistic Regression:

Perform hyperparameter tuning for logistic regression using GridSearchCV.

In [156...

```
from sklearn.model_selection import GridSearchCV
```

In [ ]:

```
# C: This is the inverse of regularization strength.
    #Smaller values specify stronger regularization. The grid specifies three possi
```

In [ ]:

```
#penalty: This specifies the type of regularization to use. 'l1' corresponds to Las
    #and 'l2' corresponds to Ridge (L2) regularization
```

In [157...

```
lr_params = {'C': [0.1, 1, 10], 'penalty': ['l1', 'l2']}
lr_grid = GridSearchCV(LogisticRegression(), lr_params, cv=5)
lr_grid.fit(x_train, y_train)
print(f'Best Logistic Regression Params: {lr_grid.best_params_}')
print(f'Logistic Regression Grid Search CV Score: {lr_grid.best_score_}')
```

```
Best Logistic Regression Params: {'C': 10, 'penalty': 'l2'}
Logistic Regression Grid Search CV Score: 0.9829710144927537
```

```
C:\Users\shaw3\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:
372: FitFailedWarning:
15 fits failed out of a total of 30.
The score on these train-test partitions for these parameters will be set to nan.
If these failures are not expected, you can try to debug them by setting error_sco
re='raise'.

Below are more details about the failures:
--------------------------------------------------------------------------------
15 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\shaw3\anaconda3\lib\site-packages\sklearn\model_selection\_valida
tion.py", line 680, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\shaw3\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.
py", line 1461, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "C:\Users\shaw3\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.
py", line 447, in _check_solver
    raise ValueError(
ValueError: Solver lbfgs supports only 'l2' or 'none' penalties, got l1 penalty.

  warnings.warn(some_fits_failed_message, FitFailedWarning)
C:\Users\shaw3\anaconda3\lib\site-packages\sklearn\model_selection\_search.py:969:
UserWarning: One or more of the test scores are non-finite: [        nan 0.90833333
nan 0.96666667        nan 0.98297101]
  warnings.warn(
```

Hyperparameter Tuning for KNN:

Perform hyperparameter tuning for KNN using GridSearchCV.

In [158...

```
knn_params = {'n_neighbors': [3, 5, 7], 'weights': ['uniform', 'distance']}
knn_grid = GridSearchCV(KNeighborsClassifier(), knn_params, cv=5)
knn_grid.fit(x_train, y_train)
print(f'Best KNN Params: {knn_grid.best_params_}')
print(f'KNN Grid Search CV Score: {knn_grid.best_score_}')
```

```
Best KNN Params: {'n_neighbors': 5, 'weights': 'uniform'}
KNN Grid Search CV Score: 0.9663043478260869
```

```
C:\Users\shaw3\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:22
8: FutureWarning: Unlike other reduction functions (e.g. `skew`, `kurtosis`), the
default behavior of `mode` typically preserves the axis it acts along. In SciPy 1.
11.0, this behavior will change: the default value of `keepdims` will become Fals
e, the `axis` over which the statistic is taken will be eliminated, and the value
None will no longer be accepted. Set `keepdims` to True or False to avoid this war
ning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
C:\Users\shaw3\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:22
8: FutureWarning: Unlike other reduction functions (e.g. `skew`, `kurtosis`), the
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```

```
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e, the `axis` over which the statistic is taken will be eliminated, and the value
None will no longer be accepted. Set `keepdims` to True or False to avoid this war
ning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

Hyperparameter Tuning for Decision Tree:

Perform hyperparameter tuning for decision tree using GridSearchCV

In [160…

```
dt_params = {'max_depth': [2, 4, 6], 'min_samples_split': [2, 4, 6]}
dt_grid = GridSearchCV(DecisionTreeClassifier(), dt_params, cv=5)
dt_grid.fit(x_train, y_train)
print(f'Best Decision Tree Params: {dt_grid.best_params_}')
print(f'Decision Tree Grid Search CV Score: {dt_grid.best_score_}')
```

```
Best Decision Tree Params: {'max_depth': 6, 'min_samples_split': 2}
Decision Tree Grid Search CV Score: 0.9916666666666668
```

Hyperparameter Tuning for Random Forest:

Perform hyperparameter tuning for random forest using GridSearchCV.

In [161…

```
rf_params = {'n_estimators': [50, 100, 150], 'max_depth': [2, 4, 6]}
rf_grid = GridSearchCV(RandomForestClassifier(), rf_params, cv=5)
rf_grid.fit(x_train, y_train)
print(f'Best Random Forest Params: {rf_grid.best_params_}')
print(f'Random Forest Grid Search CV Score: {rf_grid.best_score_}')
```

```
Best Random Forest Params: {'max_depth': 4, 'n_estimators': 50}
Random Forest Grid Search CV Score: 0.9916666666666668
```

Hyperparameter Tuning for SVM:

Perform hyperparameter tuning for SVM using GridSearchCV.

In [162…

```
svm_params = {'C': [0.1, 1, 10], 'gamma': ['scale', 'auto']}
svm_grid = GridSearchCV(SVC(), svm_params, cv=5)
svm_grid.fit(x_train, y_train)
print(f'Best SVM Params: {svm_grid.best_params_}')
print(f'SVM Grid Search CV Score: {svm_grid.best_score_}')
```

```
Best SVM Params: {'C': 1, 'gamma': 'scale'}
SVM Grid Search CV Score: 0.975
```

Hyperparameter Tuning for Gradient Boosting

In [163…

```
gb_params = {'n_estimators': [100, 200, 300], 'learning_rate': [0.1, 0.01, 0.001]}
gb_grid = GridSearchCV(GradientBoostingClassifier(), gb_params, cv=5)
gb_grid.fit(X_scaled, y)
print(f'Best Gradient Boosting Params: {gb_grid.best_params_}')
print(f'Best Gradient Boosting Accuracy: {gb_grid.best_score_:.2f}')
```

```
Best Gradient Boosting Params: {'learning_rate': 0.001, 'n_estimators': 100}
Best Gradient Boosting Accuracy: 0.97
```

In [ ]: