project4a_ml_evaluation

April 1, 2023

[ ]:
```
pip install -r requirements.txt
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: joblib==1.2.0 in
/Users/liamgersten/Library/Python/3.9/lib/python/site-packages (from -r
requirements.txt (line 1)) (1.2.0)
Requirement already satisfied: numpy==1.24.2 in
/Users/liamgersten/Library/Python/3.9/lib/python/site-packages (from -r
requirements.txt (line 2)) (1.24.2)
Requirement already satisfied: pandas==1.5.3 in
/Users/liamgersten/Library/Python/3.9/lib/python/site-packages (from -r
requirements.txt (line 3)) (1.5.3)
Requirement already satisfied: pydantic==1.10.6 in
/Users/liamgersten/Library/Python/3.9/lib/python/site-packages (from -r
requirements.txt (line 4)) (1.10.6)
Requirement already satisfied: python-dateutil==2.8.2 in
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-packages
(from -r requirements.txt (line 5)) (2.8.2)
Requirement already satisfied: pytz==2022.7.1 in
/Users/liamgersten/Library/Python/3.9/lib/python/site-packages (from -r
requirements.txt (line 6)) (2022.7.1)
Requirement already satisfied: scikit-learn==1.2.1 in
/Users/liamgersten/Library/Python/3.9/lib/python/site-packages (from -r
requirements.txt (line 7)) (1.2.1)
Requirement already satisfied: scipy==1.10.1 in
/Users/liamgersten/Library/Python/3.9/lib/python/site-packages (from -r
requirements.txt (line 8)) (1.10.1)
Requirement already satisfied: six==1.16.0 in
/Users/liamgersten/Library/Python/3.9/lib/python/site-packages (from -r
requirements.txt (line 9)) (1.16.0)
Requirement already satisfied: threadpoolctl==3.1.0 in
/Users/liamgersten/Library/Python/3.9/lib/python/site-packages (from -r
requirements.txt (line 10)) (3.1.0)
Requirement already satisfied: typing_extensions==4.5.0 in
/Users/liamgersten/Library/Python/3.9/lib/python/site-packages (from -r
requirements.txt (line 11)) (4.5.0)
Note: you may need to restart the kernel to use updated packages.
```

[ ]:

```
"""
Python imports
"""

import predict
import csv
import numpy as np
import matplotlib.pyplot as plt
```

[ ]:

```
"""
Global variables
"""

TEST_FILE_NAME = "student_data.csv"
DataSet = list[dict]
Matrix = list[list[int]]
FIGSIZE = (10, 5)
NBINS = 10
COLORS = ["red", "blue", "green", "orange", "purple", "grey", "yellow",␣
 ↪"maroon"]
```

[ ]:

```
"""
Helper functions
"""

def get_test_data(filename: str) -> DataSet:
    """
    Returns test data from filename as a DataSet
    :param filename: name of csv file to read
    :return imported data
    """
    file = open(filename, 'r')
    reader = csv.DictReader(file)
    data = [row for row in reader]
    return data


def bar_chart(data: DataSet, feature_name: str, color: str) -> None:
    """
    Plots a bar chart of a feature in a data set
    :param data: DataSet containing the feature
    :param feature_name: Name of the feature to plot
    :param color: color for the bar chart
    :return None
    """
    bins = {}
    for row in data:
        if row[feature_name] not in bins:
            bins[row[feature_name]] = 0
        bins[row[feature_name]] += 1
    classes, values = list(bins.keys()), list(bins.values())
    fig, ax = plt.subplots()
    ax.barh(classes, values, color=color)
    for s in ['top', 'bottom', 'left', 'right']:
        ax.spines[s].set_visible(False)
    ax.xaxis.set_tick_params(pad = 5)
    ax.yaxis.set_tick_params(pad = 10)
    ax.invert_yaxis()
    for i in ax.patches:
        plt.text(
            i.get_width()+0.2, i.get_y()+0.5,
            str(round((i.get_width()), 2)),
            fontsize = 10,
            fontweight ='bold',
            color ='grey')
    ax.set_title(f"Test dataset distribution of {feature_name}", loc="left")
    plt.ylabel(feature_name)
    plt.xlabel("Count")
    plt.show()


def histogram(data: DataSet, feature_name: str, color: str) -> None:
    """
    Plots a histogram of a feature in a data set
    :param data: DataSet containing the feature
    :param feature_name: Name of the feature to plot
    :param color: color for the histogram
    :return None
    """
    if str(float(data[0][feature_name])) == data[0][feature_name]:
        values = [float(row[feature_name]) for row in data]
    else:
        values = [int(row[feature_name]) for row in data]
    fig, ax = plt.subplots()
    ax.hist(values, bins=NBINS, color=color)
    ax.set_title(f"Test dataset distribution of {feature_name}", loc="left")
    plt.xlabel(feature_name)
    plt.ylabel("Count")
    plt.show()



def plot_distribution(data: DataSet, feature_name: str, color: str) -> None:
    """
```

```python
    Plots the distribution of a feature in a data set
    :param data: DataSet containing the feature
    :param feature_name: Name of the feature to plot
    :param color: color for the plot
    :return None
    """
    is_categorical = True
    try:
        numeric = int(data[0][feature_name])
        if str(numeric) == data[0][feature_name]:
            is_categorical = False
    except:
        try:
            numeric = float(data[0][feature_name])
            if str(numeric) == data[0][feature_name]:
                is_categorical = False
        except:
            pass
    if is_categorical:
        bar_chart(data, feature_name, color)
    else:
        histogram(data, feature_name, color)


def plot_feature_distributions(data: DataSet) -> None:
    """
    Plots all feature distributions
    :param data: data to plot distributions of
    :return None
    """
    valid_features = set(data[0].keys())
    valid_features.remove("Student ID")
    valid_features = list(valid_features)
    for i in range(len(valid_features)):
        feature_name = valid_features[i]
        color = COLORS[i]
        plot_distribution(data, feature_name, color)


def get_predictions(data: DataSet) -> None:
    """
    Runs predict on dataset and adds it as a column to the data
    :param data: DataSet to predict with
    :return None (side effects only)
    """
    for row in data:
        result = predict.predict(row)
        row["Prediction"] = str(result["good_employee"])


def confusion_matrix(data: DataSet) -> Matrix:
    """
    Gets the confusion matrix for the data set after prediction
    :param data: data containing predictions
    :return: confusion matrix as a 2d list
    """
    matrix = [[0, 0], [0, 0]]
    for row in data:
        row_index = 0 if row["Good Candidate"] == "0" else 1
        col_index = 0 if row["Prediction"] == "0" else 1
        matrix[row_index][col_index] += 1
    return matrix


def display_from_predictions(data: DataSet, matrix: Matrix) -> None:
    """
    Displays the prediction distribution and confusion matrix
    :param data: data containing predictions
    :param matrix: confusion matrix
    :return: None
    """
    bar_chart(data, "Prediction", "grey")
    fig, ax = plt.subplots(figsize=(5, 5))
    ax.matshow(matrix, cmap=plt.cm.Blues, alpha=0.3)
    for i in range(len(matrix)):
        for j in range(len(matrix[0])):
            ax.text(
                x=i,
                y=j,
                s=matrix[i][j],
                va='center',
                ha='center',
                size='xx-large')

    plt.xlabel('Predictions', fontsize=18)
    plt.ylabel('Actuals', fontsize=18)
    plt.title('Confusion Matrix', fontsize=18)
    plt.show()


def report_from_predictions(matrix: Matrix) -> None:
    """
    Reports statistics from predictions and matrix
    :param data: data containing predictions
    :param matrix: confusion matrix
    :return: None
    """
    n = matrix[0][0] + matrix[0][1] + matrix[1][0] + matrix[1][1]
    print(f"Correctly predicted: {matrix[0][0] + matrix[1][1]}")
    print(f"Incorrectly predicted: {matrix[0][1] + matrix[1][0]}")
    print(f"Accuracy: {(matrix[0][0] + matrix[1][1])/n}")
    print(f"False positives: {matrix[0][1]}")
    print(f"False negtives: {matrix[1][0]}")
```

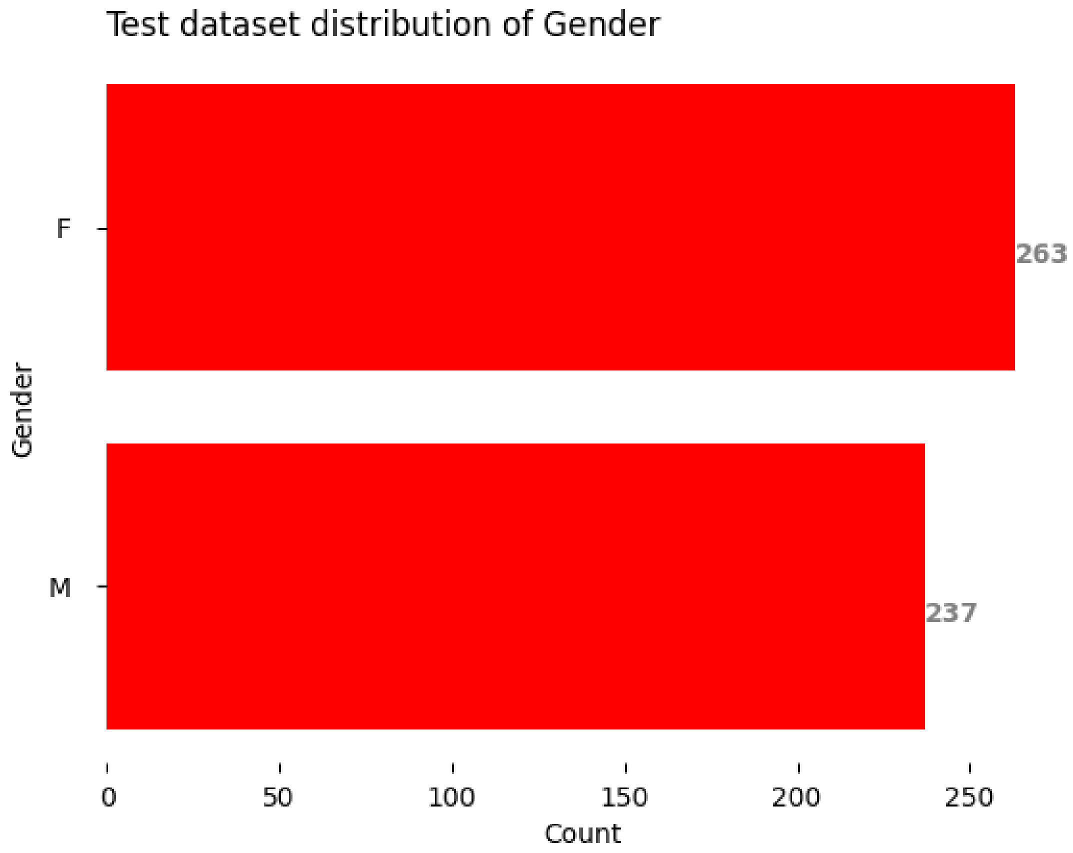
[ ]:

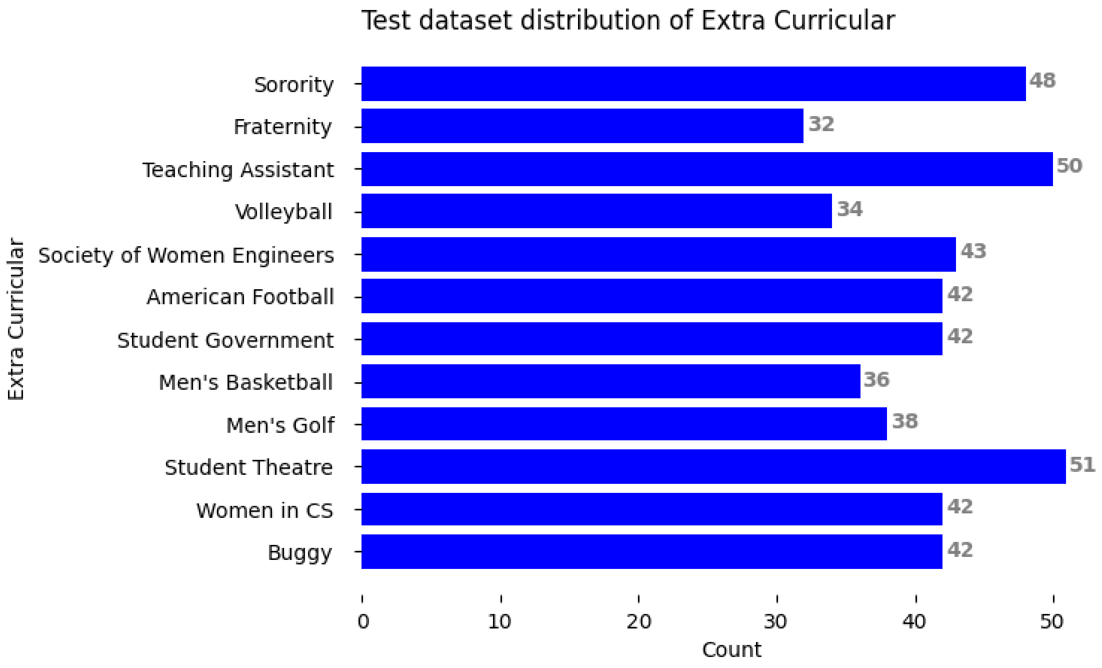
```
"""
Import data
"""

test_data: DataSet = get_test_data(TEST_FILE_NAME)
```

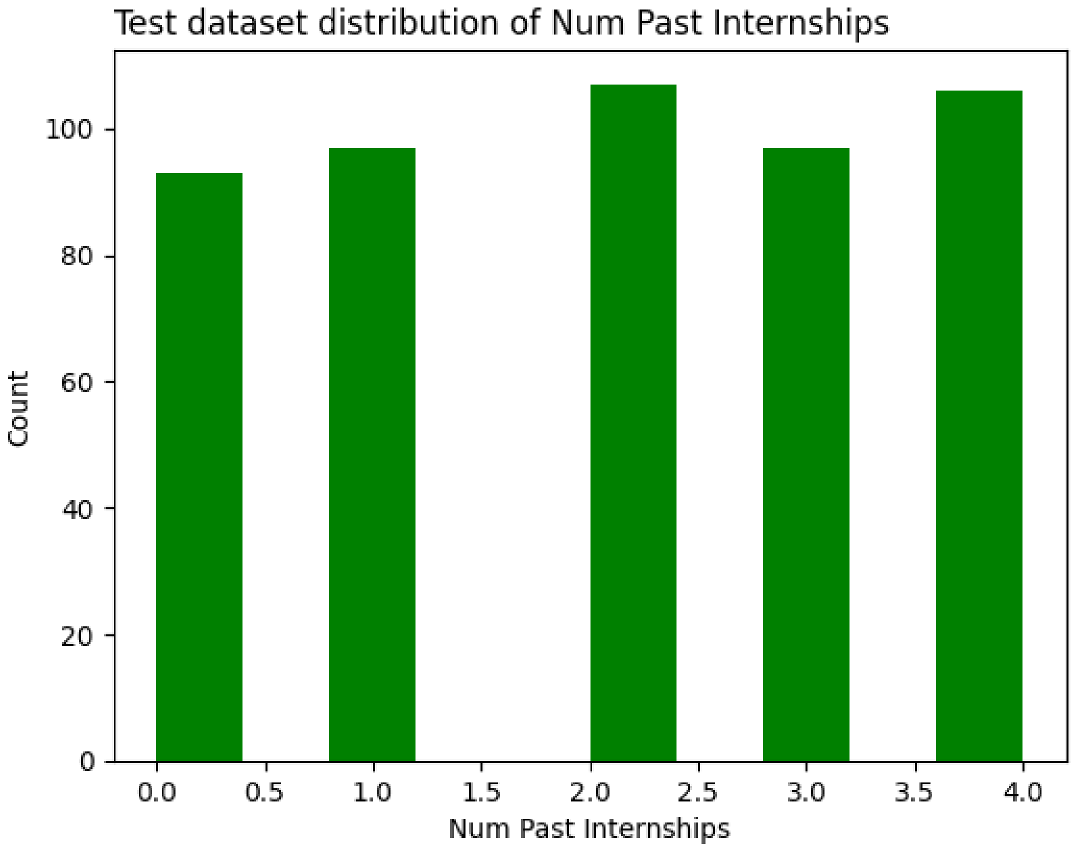
[ ]:

```
plot_feature_distributions(test_data)
```

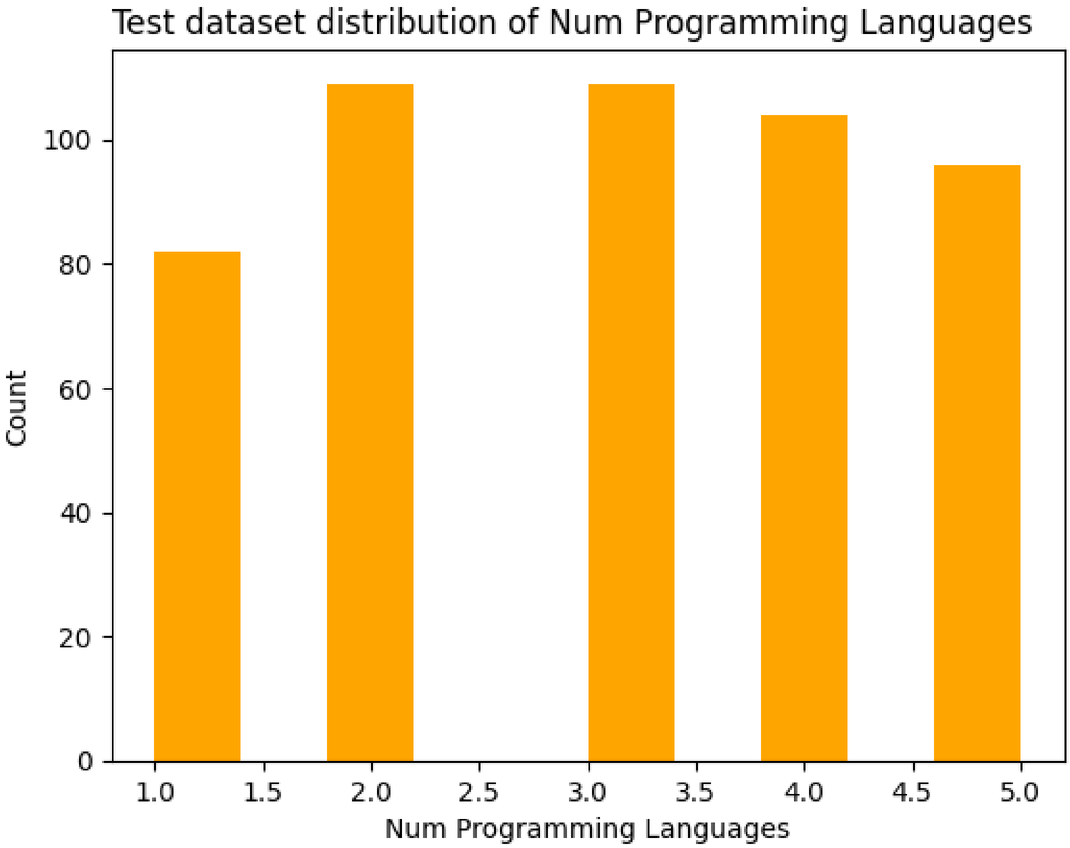


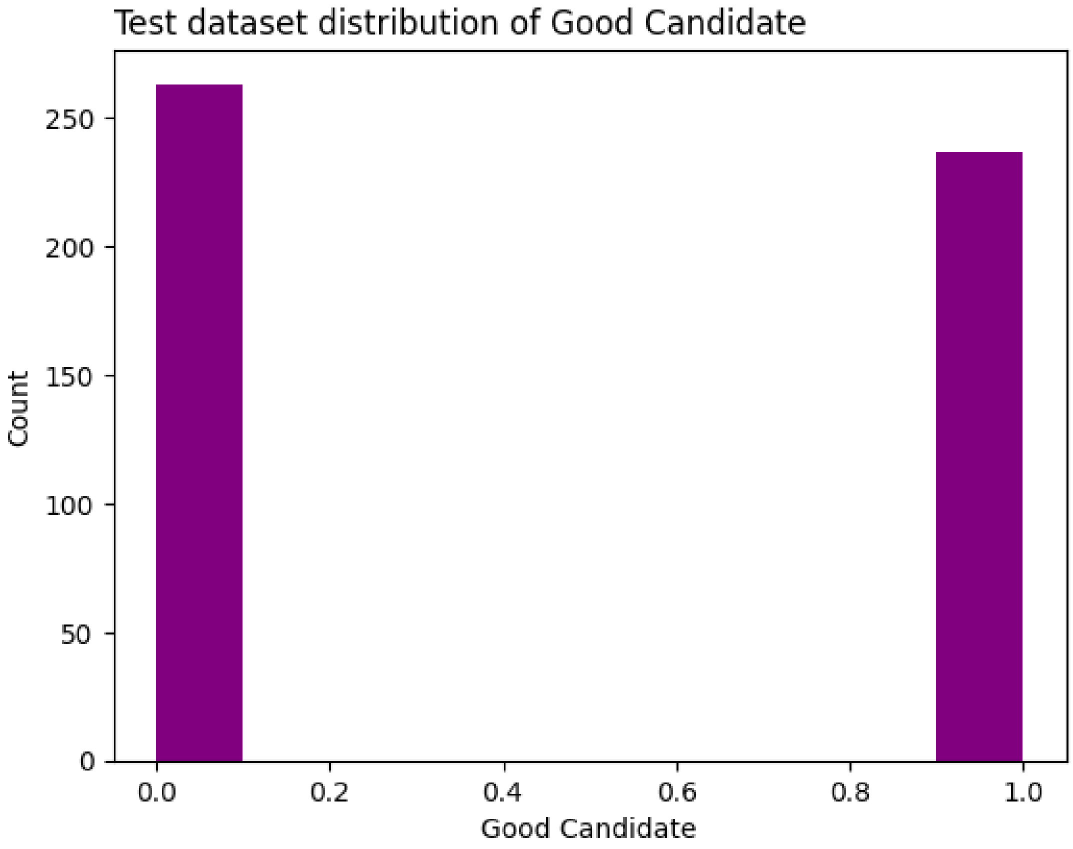


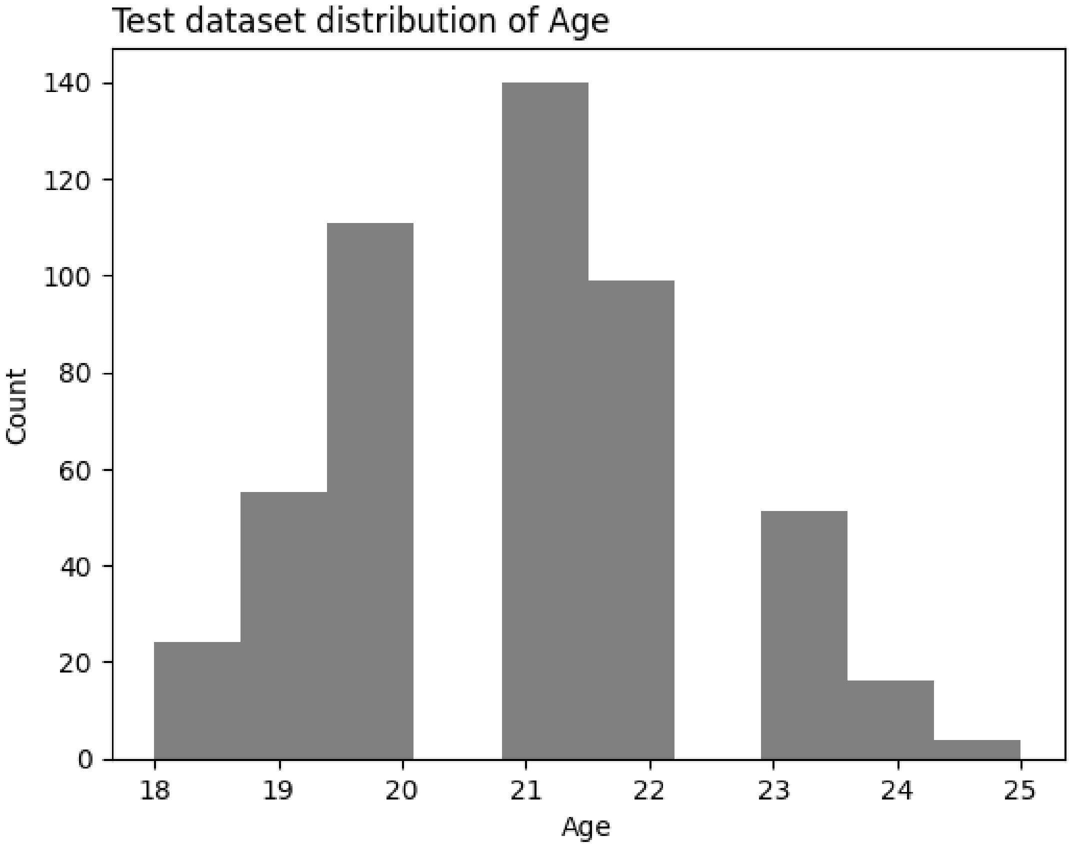
Test dataset distribution of Extra Curricular

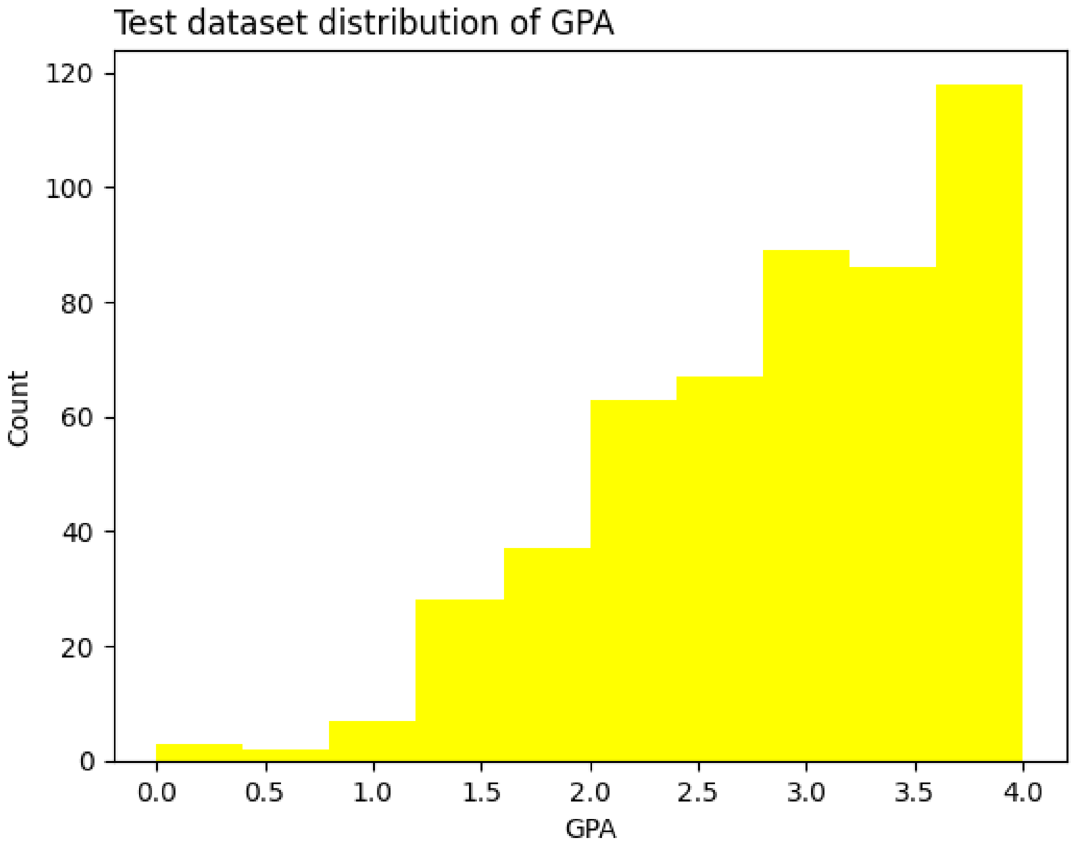


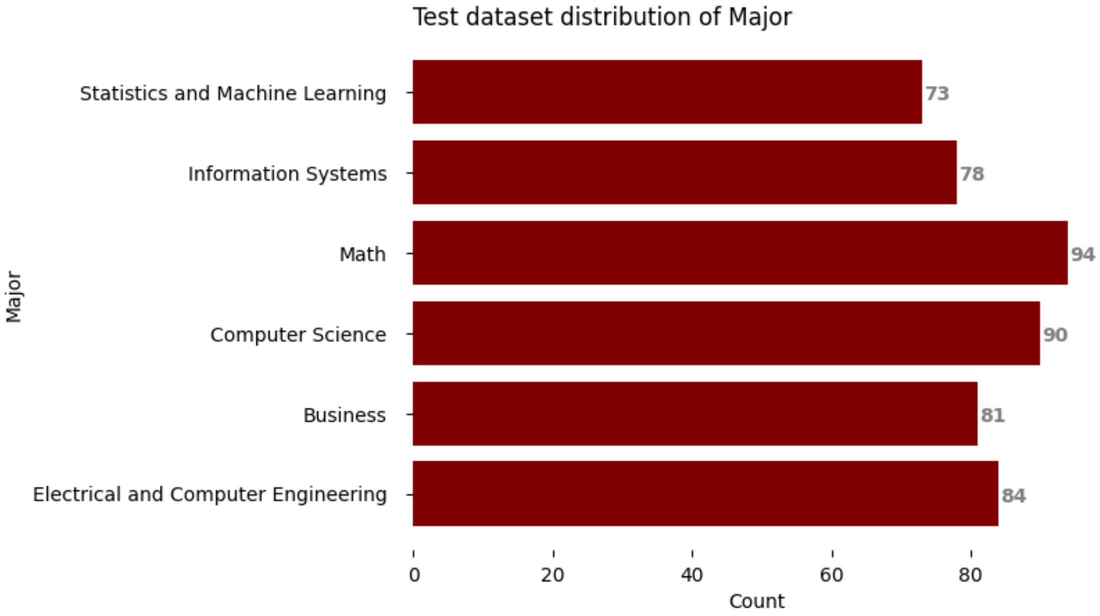
Test dataset distribution of Num Past Internships


Test dataset distribution of Num Programming Languages
Count
0
20
40
60
80
100
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Num Programming Languages


Test dataset distribution of Good Candidate
Count
0
50
100
150
200
250
0.0
0.2
0.4
0.6
0.8
1.0
Good Candidate


Test dataset distribution of Age
Count
0
20
40
60
80
100
120
140
18
19
20
21
22
23
24
25
Age

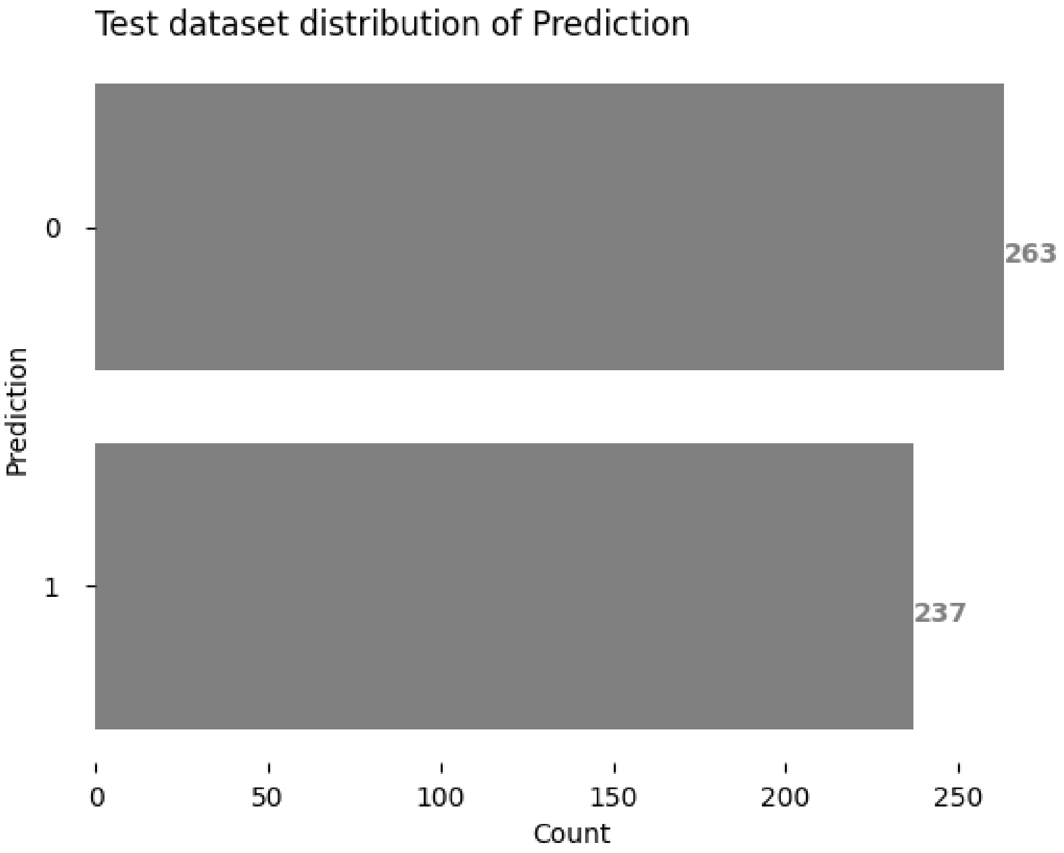

Test dataset distribution of GPA
Count
0
20
40
60
80
100
120
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
GPA

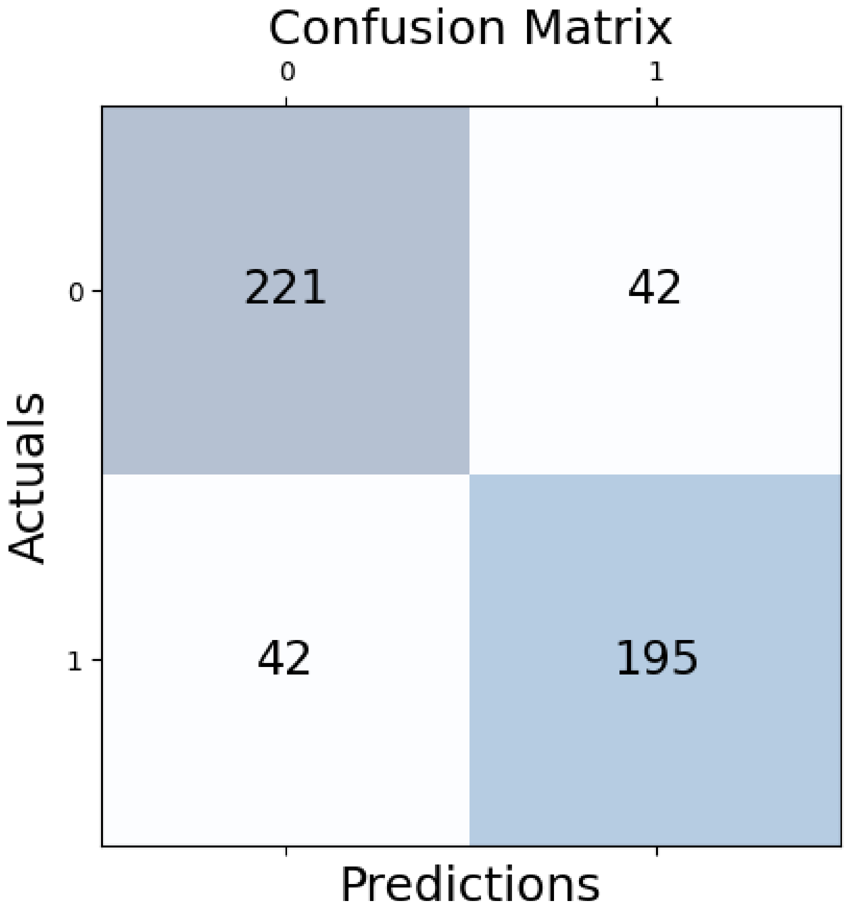

Test dataset distribution of Major
Major
Statistics and Machine Learning
Information Systems
Math
Computer Science
Business
Electrical and Computer Engineering
73
78
94
90
81
84
0
20
40
60
80
Count

```
[ ]: get_predictions(test_data)
```

```
[ ]: matrix: Matrix = confusion_matrix(test_data)
```

```
[ ]: display_from_predictions(test_data, matrix)
```





[ ]:

```
report_from_predictions(matrix)
```

```
Correctly predicted: 416
Incorrectly predicted: 84
Accuracy: 0.832
False positives: 42
False negtives: 42
```