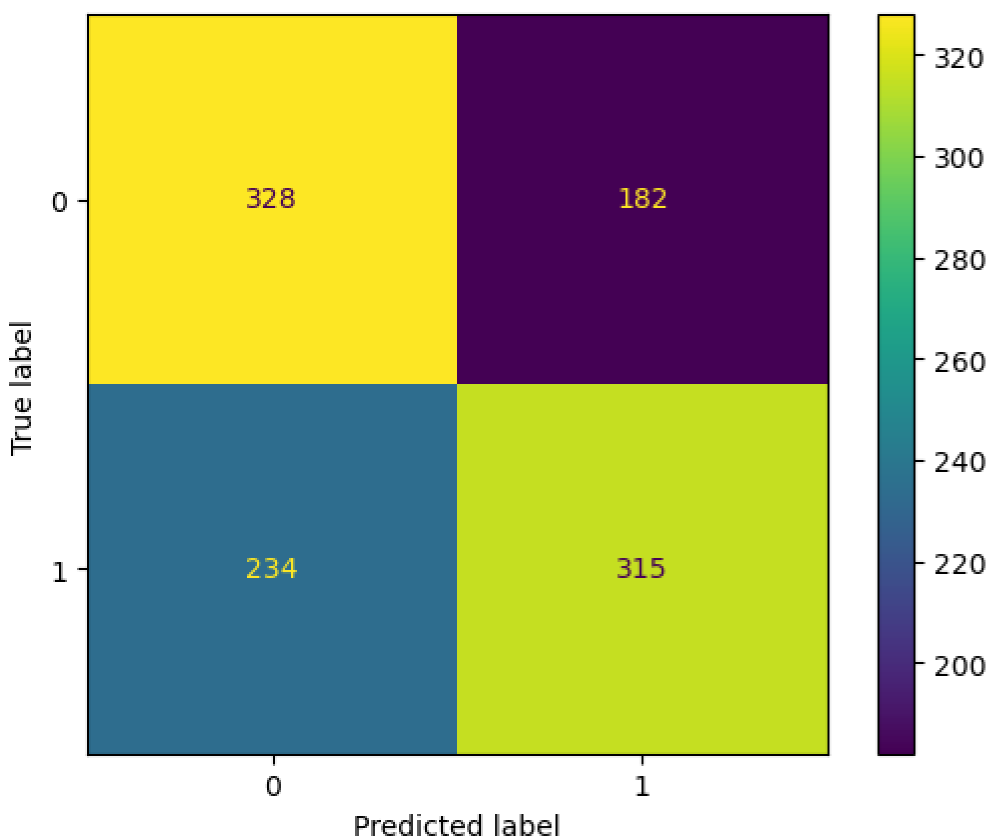
In [1]:
```
# Nowcasting for price change predictions!
# Probably should set random seed at some point...
import pandas as pd
import numpy as np
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_curve, roc_auc_score
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import confusion_matrix
from sklearn.metrics import ConfusionMatrixDisplay
import matplotlib.pyplot as plt
from sklearn import tree
from sklearn import preprocessing
# Scale the lagged trade volumes ~ this may improve our scores
# Another attempt can come from hyperparameter selection
```

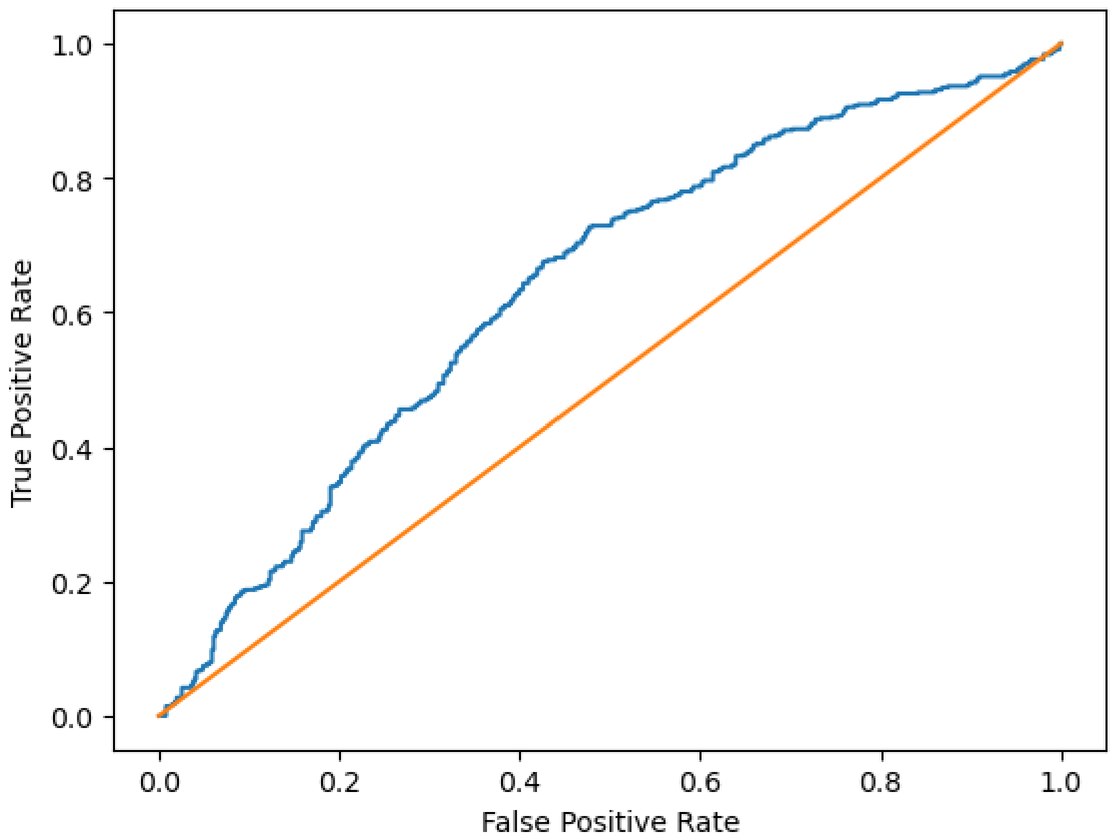
In [2]:
```
# Model List:
m_list = ['Logistic Regression', 'Decision Tree', 'Random Forest', 'Gradient B
acc_l = []
auc_l = []
# Read in data ~ trust me its cleaned we're good to start
# We want to scale only the trade volume...
# Distinctly recall that we are only supposed to scale on training data ~ make
df = pd.read_csv(r'C:\Users\huang\OneDrive\Documents\ECO481\Bone Prices\merged
# We must make the training and test split, keep in mind it is timeseries data
x_train = df[['Lagged Total Trade Volume', 'Lagged Price Change Indicator', 'L
             'Lagged Price Change Indicator Substitute 1', 'Lagged Total Trade
             'Lagged Total Trade volume Substitute 3', 'Lagged Price Change In
             'Lagged Price Change Indicator Substitute 4']].loc[1: 4238]
x_test = df[['Lagged Total Trade Volume', 'Lagged Price Change Indicator', 'La
             'Lagged Price Change Indicator Substitute 1', 'Lagged Total Trade
             'Lagged Total Trade volume Substitute 3', 'Lagged Price Change In
             'Lagged Price Change Indicator Substitute 4']].loc[4239: 5298]
y_train = df[['Price Change Indicator']].loc[1: 4238]
y_test = df[['Price Change Indicator']].loc[4239: 5298]
# scaler
scaler = preprocessing.StandardScaler().fit(x_train[['Lagged Total Trade Volum
                                                     'Lagged Total Trade volume
                                                     'Lagged Total Trade volume
# Apply scaler onto training and test  data for x
x_training_scaled = scaler.transform(x_train[['Lagged Total Trade Volume', 'La
                                                     'Lagged Total Trade volume
                                                     'Lagged Total Trade volume
x_testing_scaled = scaler.transform(x_test[['Lagged Total Trade Volume', 'Lagg
                                                     'Lagged Total Trade volume
                                                     'Lagged Total Trade volume
# Have the unscaled categorical variables be their own separate DF, we will co
# problem as they are of the same length:
# Notice that we have converted these into np.array
x_training_other = x_train[['Lagged Price Change Indicator', 'Lagged Price Cha
                           'Lagged Price Change Indicator Substitute 2', 'Lagg
                           'Lagged Price Change Indicator Substitute 4']].to_r
x_test_other = x_test[['Lagged Price Change Indicator', 'Lagged Price Change I
                           'Lagged Price Change Indicator Substitute 2', 'Lagg
                           'Lagged Price Change Indicator Substitute 4']].to_r
# Concat the two
x_train_scaled = np.concatenate((x_training_scaled, x_training_other), axis =
x_test_scaled = np.concatenate((x_testing_scaled, x_test_other), axis = 1)
```

In [3]:
```
# perhaps Logistic regressions might be good
# Logistic Model
logit = LogisticRegression()
logit.fit(x_train_scaled, y_train)
# confusion matrix:
cml = confusion_matrix(y_test, logit.predict(x_test_scaled))
displ = ConfusionMatrixDisplay(cml)
displ.plot()
plt.show()
# ROC curve + AUC score
score1 = logit.score(x_test_scaled, y_test)
print(score1)
predictions_log = logit.predict_proba(x_test_scaled)
# Retrieve fpr, and tpr ~ we can graph ROC and 45 degree line with this
fpr_l,tpr_l,threshold_l = roc_curve(y_test, predictions_log[:,1])
plt.plot(fpr_l, tpr_l, fpr_l, fpr_l)
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
# AUC
auc_log = roc_auc_score(y_test, predictions_log[:,1])
acc_l.append(score1)
auc_l.append(auc_log)
print('The AUC is equal to:', auc_log)
```

```
C:\Users\huang\anaconda3\lib\site-packages\sklearn\utils\validation.py:993: D
ataConversionWarning: A column-vector y was passed when a 1d array was expect
ed. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```



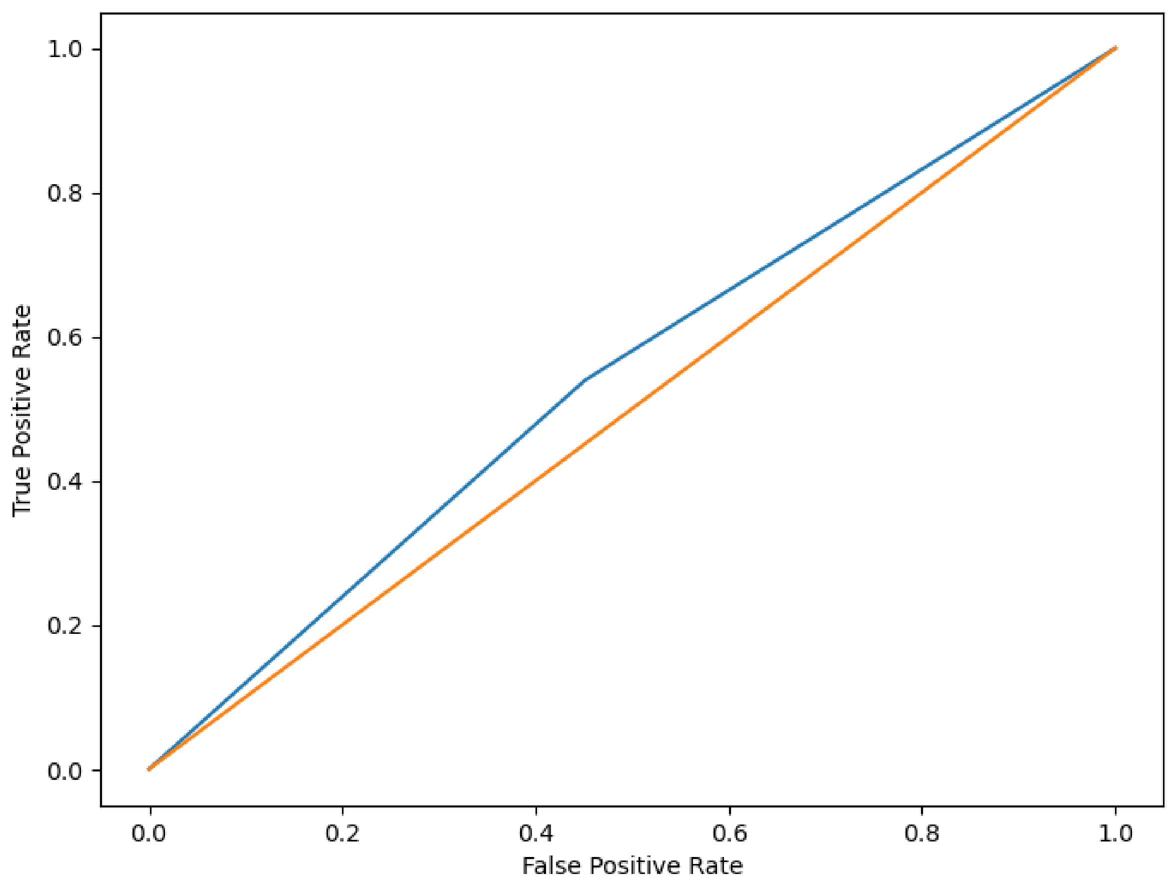
```
0.607176581680831
The AUC is equal to: 0.6391210400371441
```



In [4]:
```
# Lets start off simple with a good old fashioned decision tree:
# Consider scaling the trade volumes?
tree_class = DecisionTreeClassifier()
d_tree = DecisionTreeClassifier(max_depth = 5)
clf = tree_class.fit(x_train_scaled, y_train)
# Accuracy Score
tree_score = tree_class.score(x_test_scaled, y_test)
plt.figure(figsize=(8,6))
# Create a tree plot

# ROC + AUC
predictions_tree = tree_class.predict_proba(x_test_scaled)
fpr_t,tpr_t,threshold_t = roc_curve(y_test, predictions_tree[:,1])
plt.plot(fpr_t, tpr_t, fpr_t, fpr_t)
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
# AUC
auc_tree = roc_auc_score(y_test, predictions_tree[:,1])
acc_l.append(tree_score)
auc_l.append(auc_tree)
print('The AUC is equal to:', tree_score)
print('The accuracy score is equal to:', auc_tree)
# Predictions are almost as good as random ~ that is predicted outcomes for te
# will only correctly predict the outcome around half of the time.
```

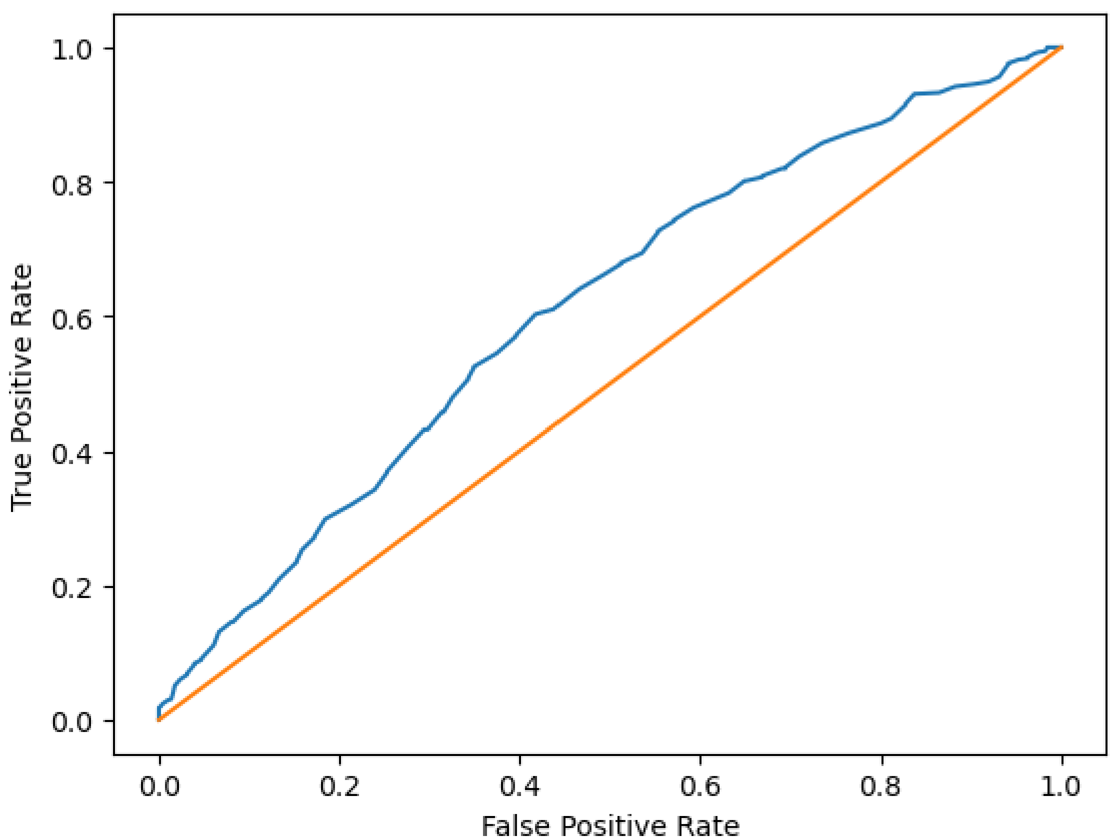
```
The AUC is equal to: 0.5439093484419264
The accuracy score is equal to: 0.544090860387871
```



In [5]:
```
# We now go on to run a random forest
forest = RandomForestClassifier()
forest.fit(x_train_scaled, y_train)
forest_score = forest.score(x_test_scaled, y_test)
print(forest_score)
# ROC + AUC
predictions_forest = forest.predict_proba(x_test_scaled)
fpr_f,tpr_f,threshold_f = roc_curve(y_test, predictions_forest[:,1])
plt.plot(fpr_f,tpr_f, fpr_f, fpr_f)
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
# AUC
auc_forest = roc_auc_score(y_test, predictions_forest[:,1])
acc_l.append(forest_score)
auc_l.append(auc_forest)
print('The AUC is equal to:', auc_forest)
```

```
C:\Users\huang\AppData\Local\Temp\ipykernel_25792\2532163389.py:3: DataConver
sionWarning: A column-vector y was passed when a 1d array was expected. Pleas
e change the shape of y to (n_samples,), for example using ravel().
  forest.fit(x_train_scaled, y_train)

0.5835694050991501
The AUC is equal to: 0.6115111253973355
```

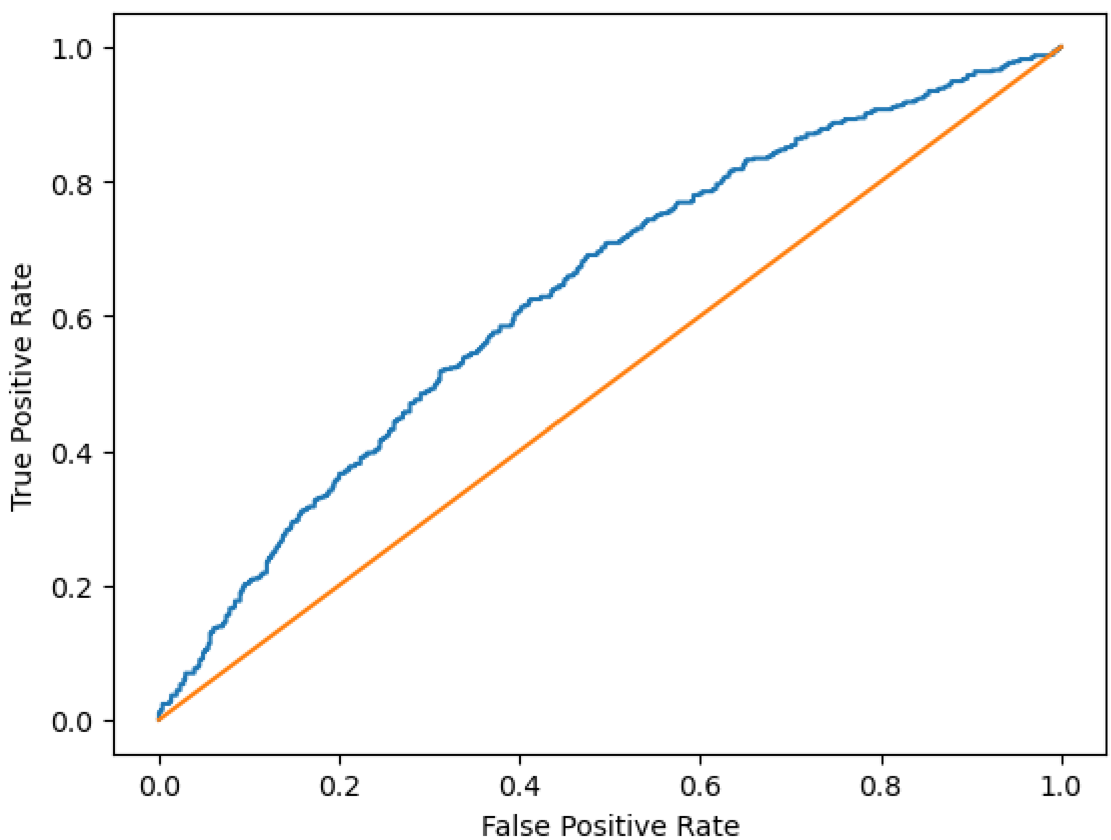


In [6]:
```
# Perhaps we could try gradient boosting decision trees?
from sklearn.ensemble import GradientBoostingClassifier
from xgboost import XGBClassifier

GBC = GradientBoostingClassifier(n_estimators = 100, learning_rate = 0.1,
                                 max_leaf_nodes = None, criterion = "squared_e
# Make the fit?
GBC.fit(x_train_scaled, y_train)
gbc_score = GBC.score(x_test_scaled, y_test)
print(gbc_score)
# ROC + AUC
predictions_boosted = GBC.predict_proba(x_test_scaled)
fpr_b,tpr_b,threshold_b = roc_curve(y_test, predictions_boosted[:,1])
plt.plot(fpr_b,tpr_b, fpr_b, fpr_b)
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
# AUC
auc_boosted = roc_auc_score(y_test, predictions_boosted[:,1])
acc_l.append(gbc_score)
auc_l.append(auc_boosted)
print('The AUC is equal to:', auc_boosted)
```

```
C:\Users\huang\anaconda3\lib\site-packages\sklearn\ensemble\_gb.py:494: DataC
onversionWarning: A column-vector y was passed when a 1d array was expected.
Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)

0.6015108593012276
The AUC is equal to: 0.6368298867816709
```

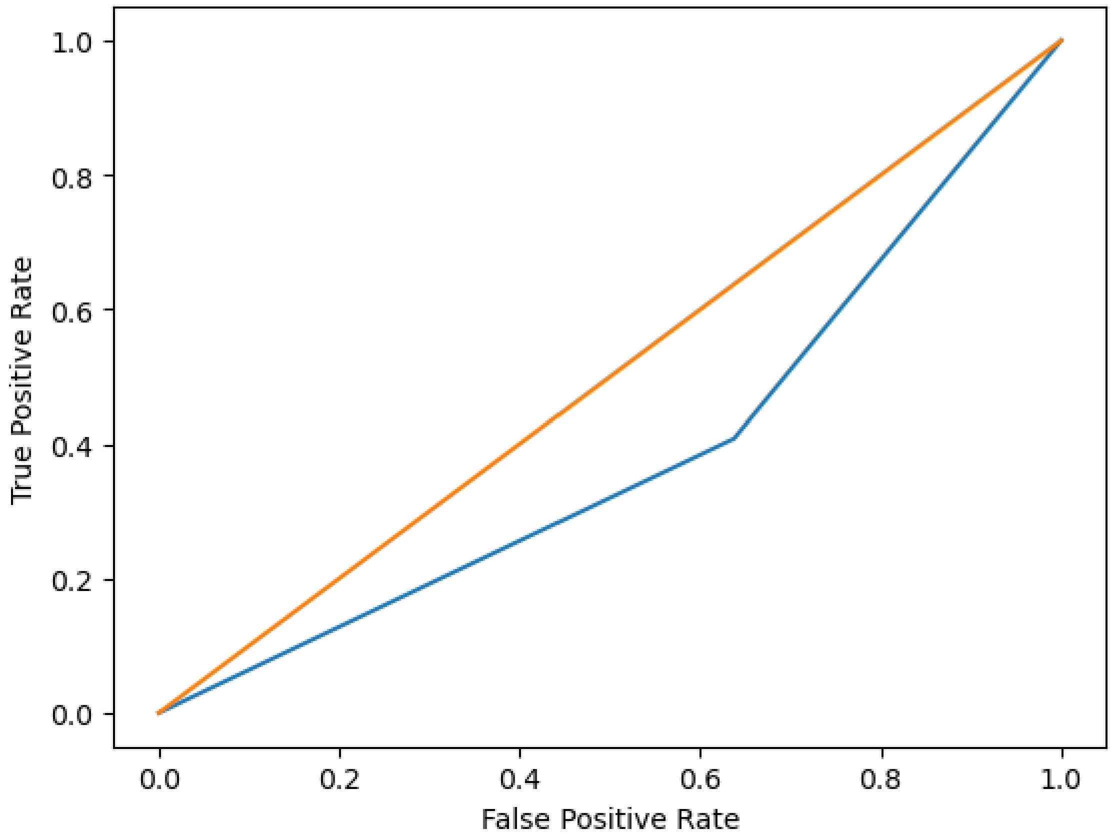


In [7]:
```
# Now do one for the persistence model ~ I think it would be around 0.5 AUC in
# that indicators tend not to be affected by random walk?
def model_persistence(x):
    return x
# walk-forward validation
predictions = list()
total_trues = 0
for x,y in zip(x_test['Lagged Price Change Indicator'], y_test['Price Change I
    yhat = model_persistence(x)
    predictions.append(yhat)
    if yhat == y:
        total_trues += 1
    else:
        pass
pers_score = total_trues/len(predictions)
# Accuracy Scores

# AUC
fpr_p,tpr_p,threshold_p = roc_curve(y_test, predictions)
plt.plot(fpr_p,tpr_p, fpr_p, fpr_p)
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
# AUC
auc_persistent = roc_auc_score(y_test, predictions)
acc_l.append(pers_score)
auc_l.append(auc_persistent)
print('The AUC is equal to:', auc_persistent)
# Yikes this thing is worse than random ~ does it translate to random walk bei
# This is interesting I suppose...

# Specifically for prices EMH may hold in the case of price indicators ~ we ca
# but perhaps we can predict the direction of the price change? Direction of p
# to not have random walk, unlike in prices...
```

```
The AUC is equal to: 0.385379834994107
```


True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0

In [8]:
```
# Create a KNN model, hyperparameter tuning ~ we want to find the optimal # of
from sklearn.model_selection import cross_val_score
k_list = []
cv_l = []
acc_l1 = []
auc_l1 = []
ind_knn = 1
knn_df1 = scaler.transform(df[['Lagged Total Trade Volume', 'Lagged Total Trad
                                                      'Lagged Total Trade volume
                              'Lagged Total Trade volume Substitute 3','Lagg
knn_df2 = df[['Lagged Price Change Indicator', 'Lagged Price Change Indicator
                           'Lagged Price Change Indicator Substitute 2', 'Lagg
                           'Lagged Price Change Indicator Substitute 4']].to_r
knn_df3 = np.concatenate((knn_df1, knn_df2), axis = 1)
knn_predicted = df[['Price Change Indicator']]
while ind_knn in range(11):
    # neighbor list
    k_list.append(ind_knn)
    KNN = KNeighborsClassifier(n_neighbors = ind_knn)
    KNN.fit(x_train_scaled, y_train)
    # accuracy score
    score = KNN.score(x_test_scaled, y_test)
    acc_l1.append(score)
    # cross validation
    cross_val_scores = cross_val_score(KNN, knn_df3, knn_predicted, cv = 5)
    cross_val_mean = cross_val_scores.mean()
    cv_l.append(cross_val_mean)
    # Confusion Matrices
    cm = confusion_matrix(y_test, KNN.predict(x_test_scaled))
    disp = ConfusionMatrixDisplay(cm, display_labels = None)
    disp.plot()
    # auc and predictions:
    plt.show()
    predictions_knn = KNN.predict_proba(x_test_scaled)
    fpr_k,tpr_k,threshold_k = roc_curve(y_test, predictions_knn[:,1])
    plt.plot(fpr_k,tpr_k, fpr_k, fpr_k)
    plt.xlabel('False Positive Rate')
    plt.ylabel('True Positive Rate')

    auc_knn = roc_auc_score(y_test, predictions_knn[:,1])
    auc_l1.append(auc_knn)
    print('The AUC is equal to:', auc_knn)
    ind_knn += 1
```

```
C:\Users\huang\anaconda3\lib\site-packages\sklearn\neighbors\_classification.
py:198: DataConversionWarning: A column-vector y was passed when a 1d array w
as expected. Please change the shape of y to (n_samples,), for example using
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  return self._fit(X, y)
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py:228: FutureWarning: Unlike other reduction functions (e.g. `skew`, `kurtos
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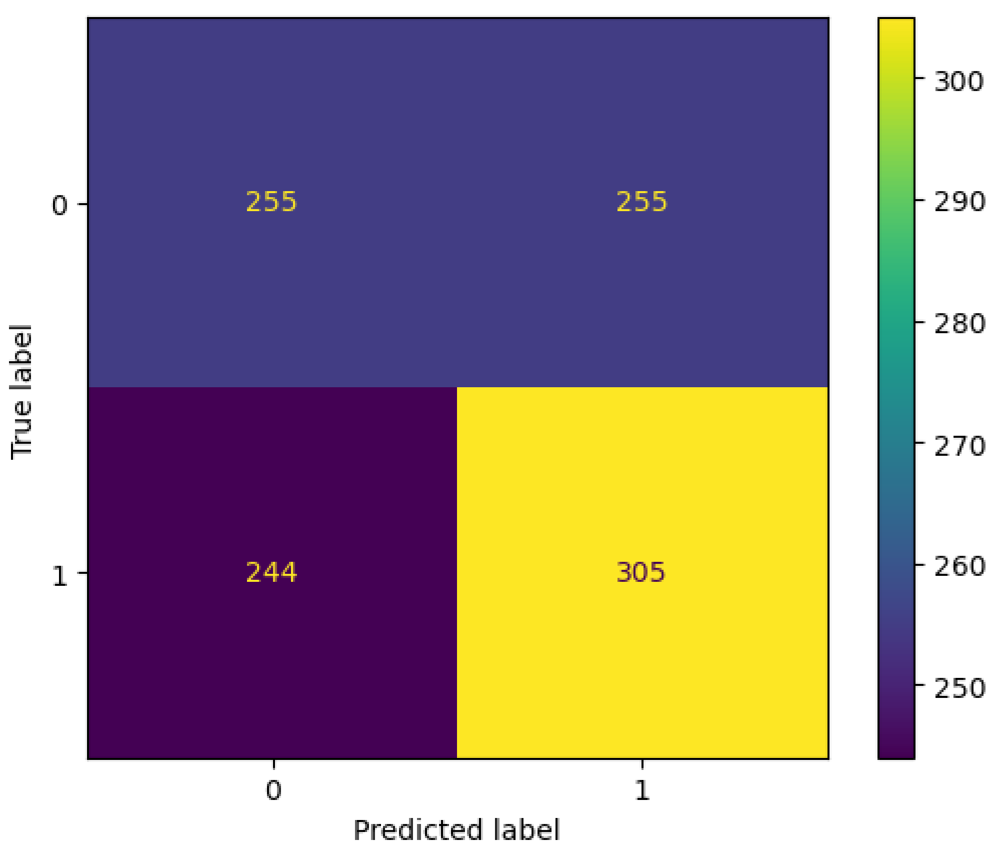

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The AUC is equal to: 0.5277777777777778
```

```
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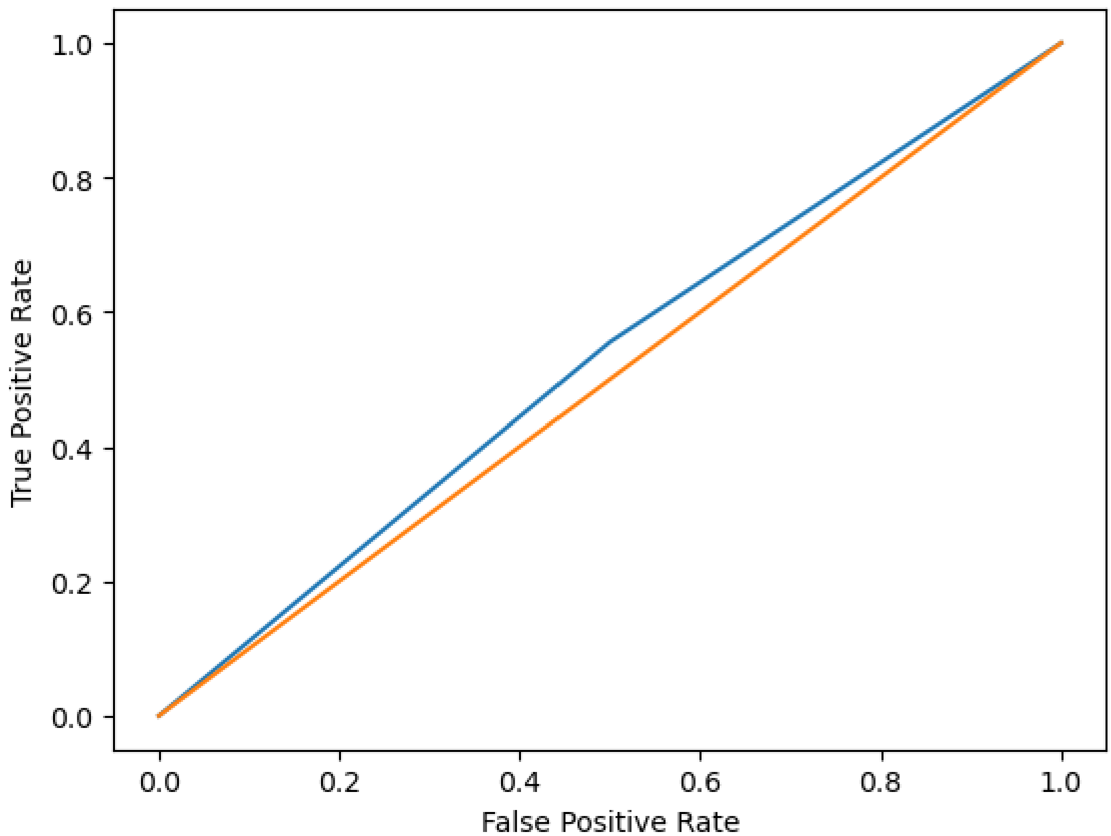

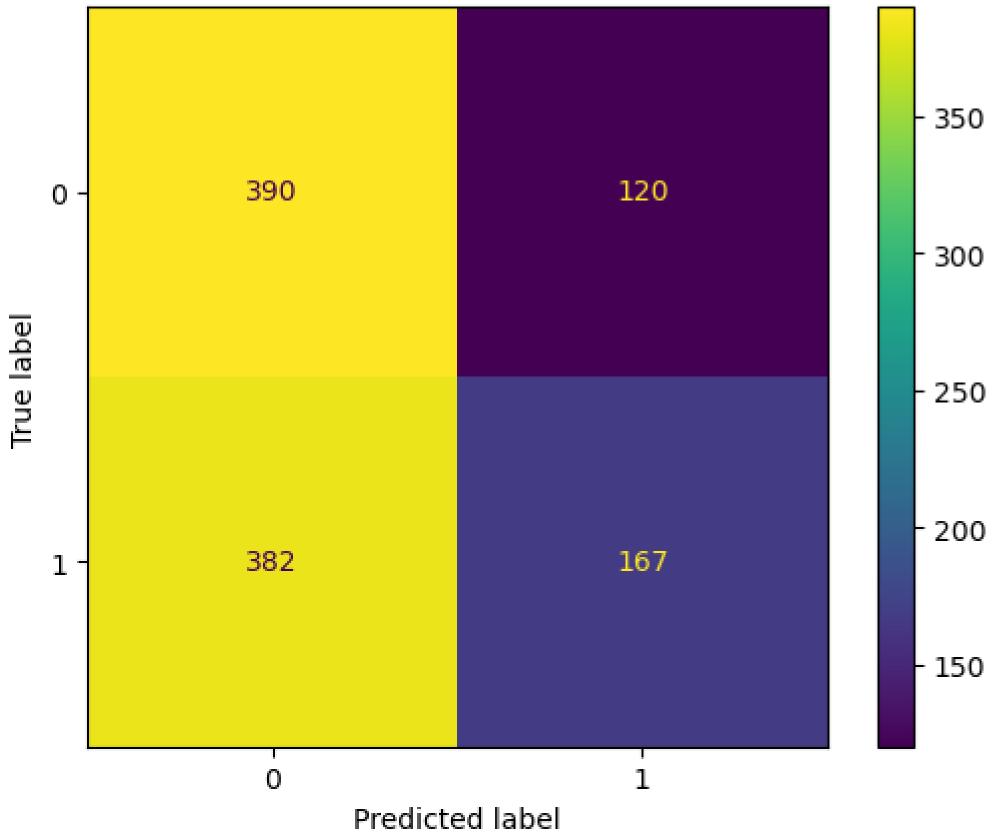


```
The AUC is equal to: 0.562934390513947
```

```
C:\Users\huang\anaconda3\lib\site-packages\sklearn\neighbors\_classification.
py:198: DataConversionWarning: A column-vector y was passed when a 1d array w
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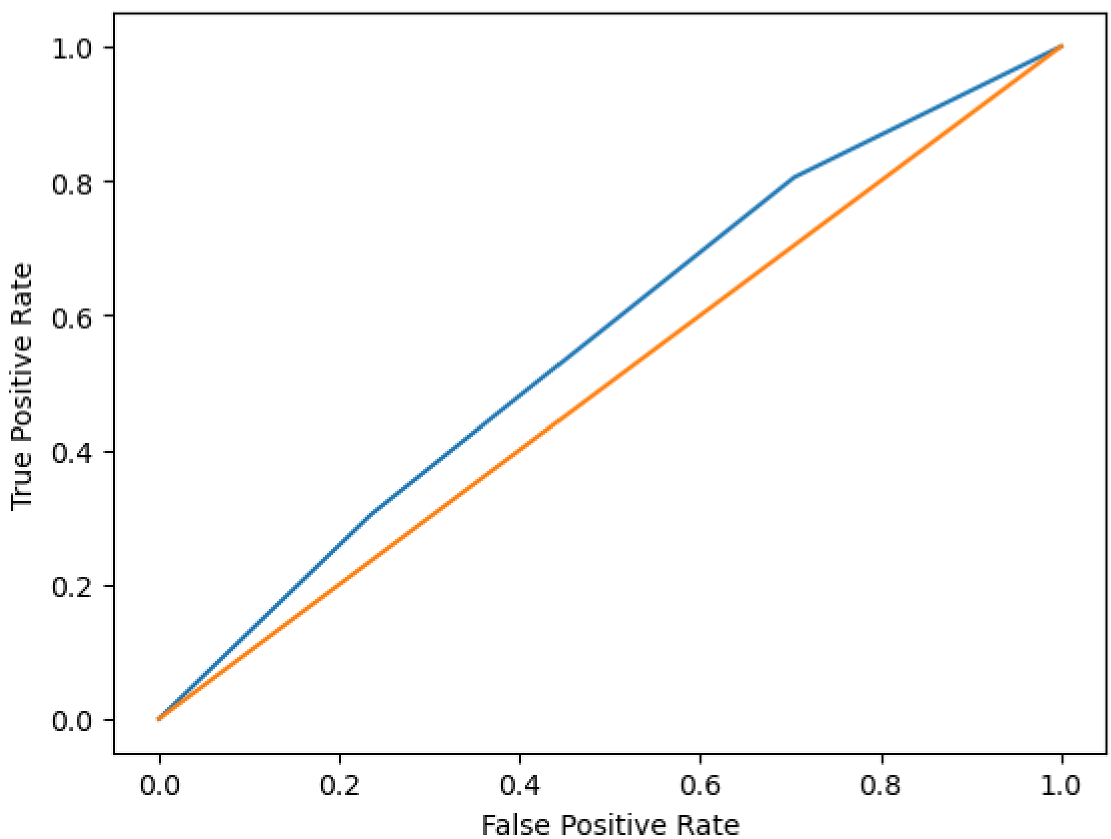

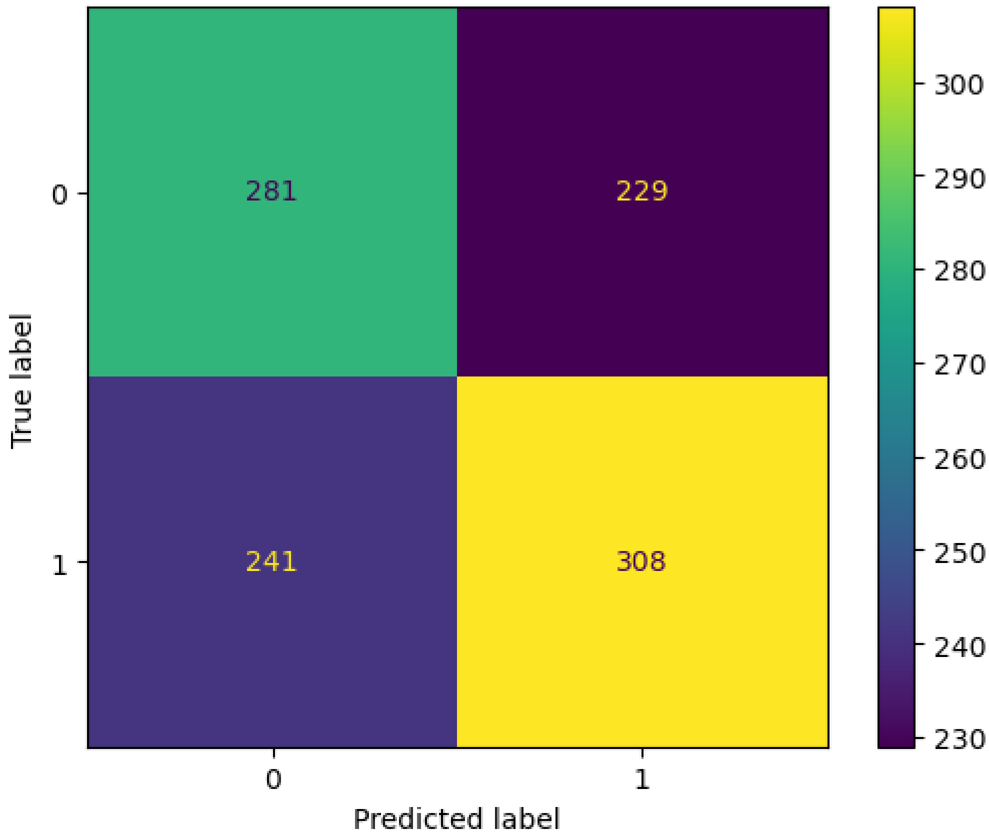


```
The AUC is equal to: 0.5676238437087039
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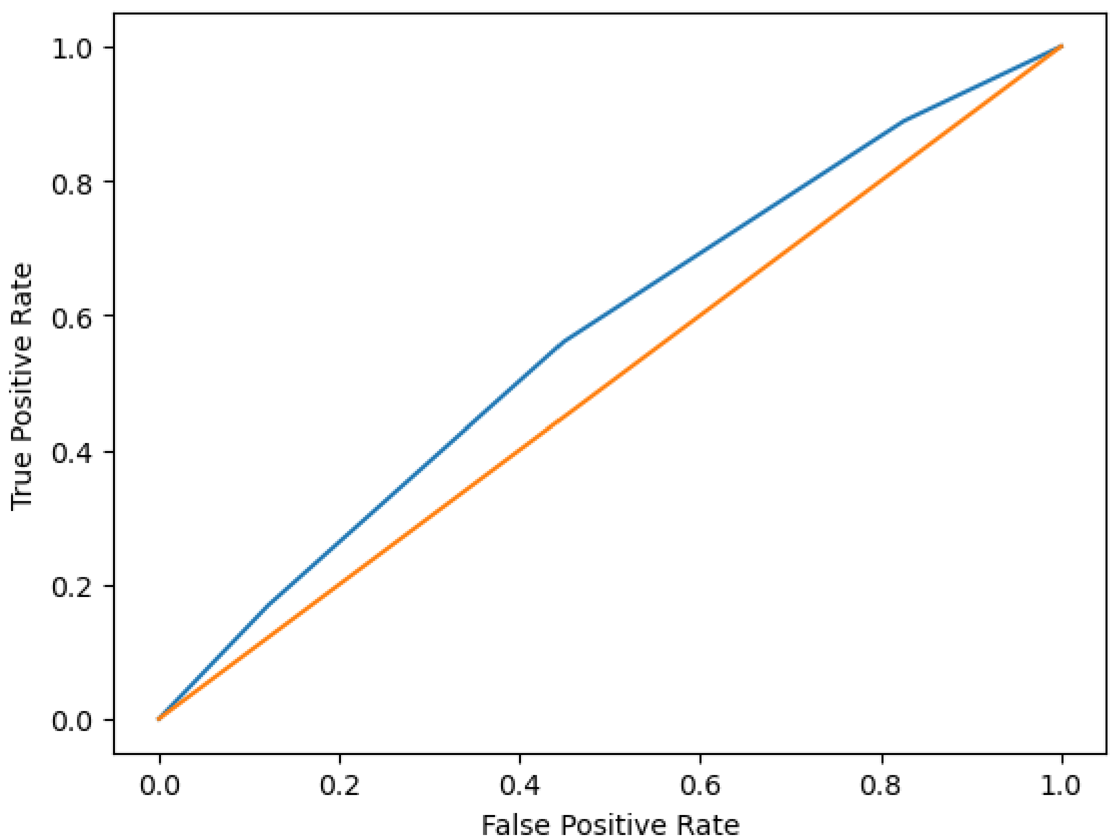

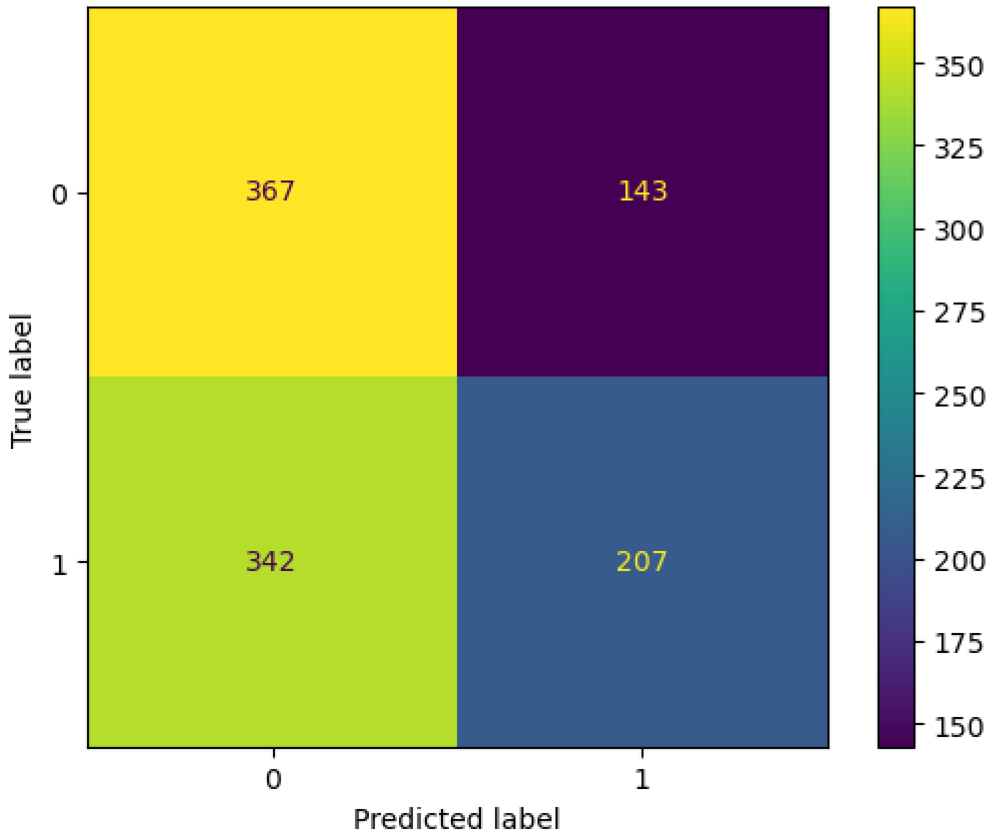


```
The AUC is equal to: 0.5735383406550234
```

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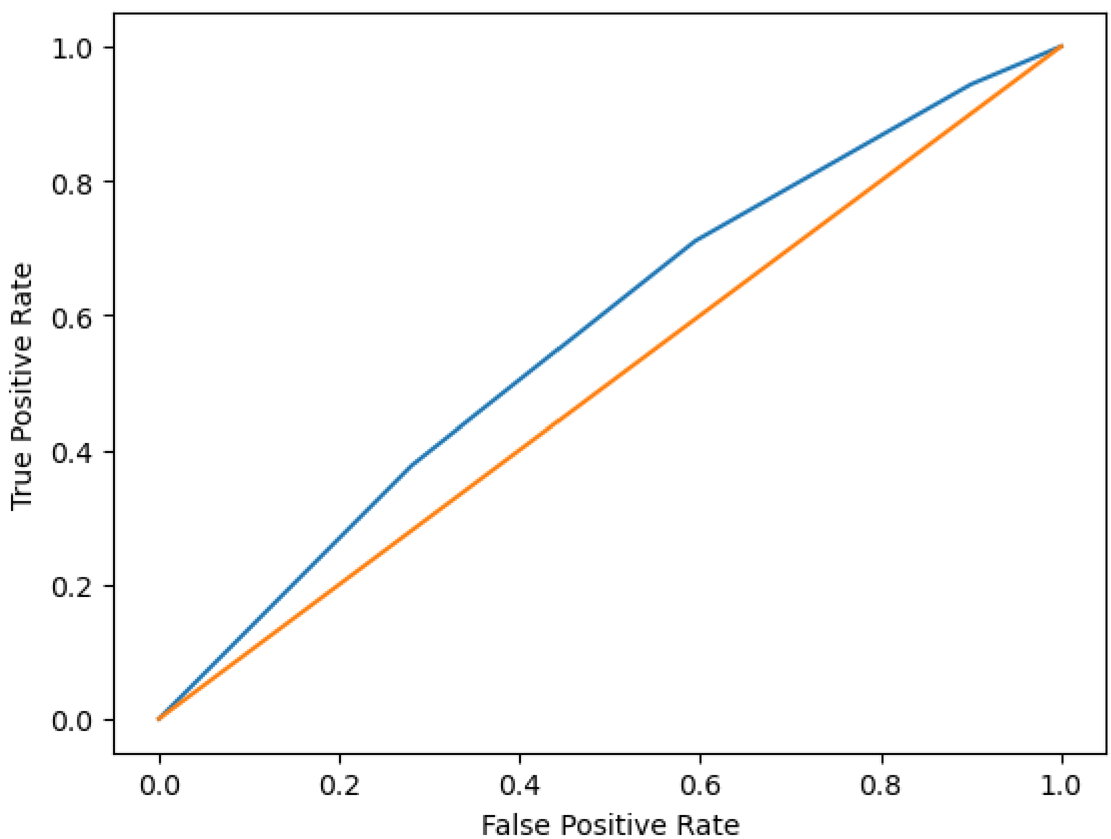

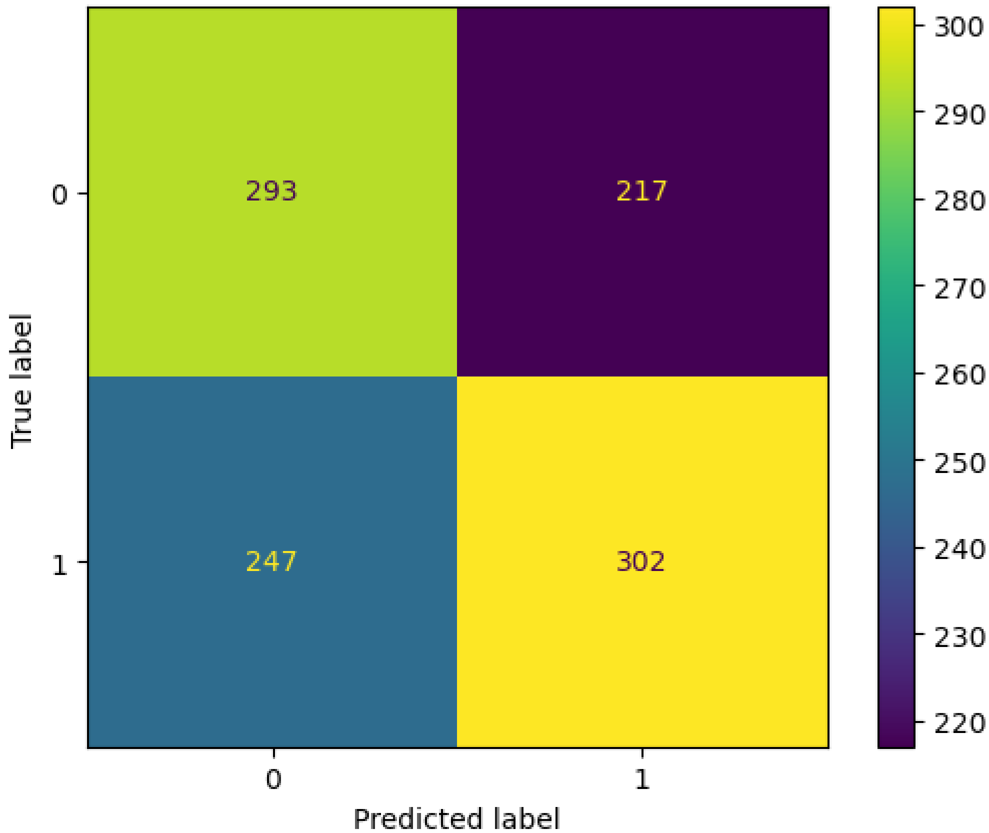


```
The AUC is equal to: 0.5772456159148541
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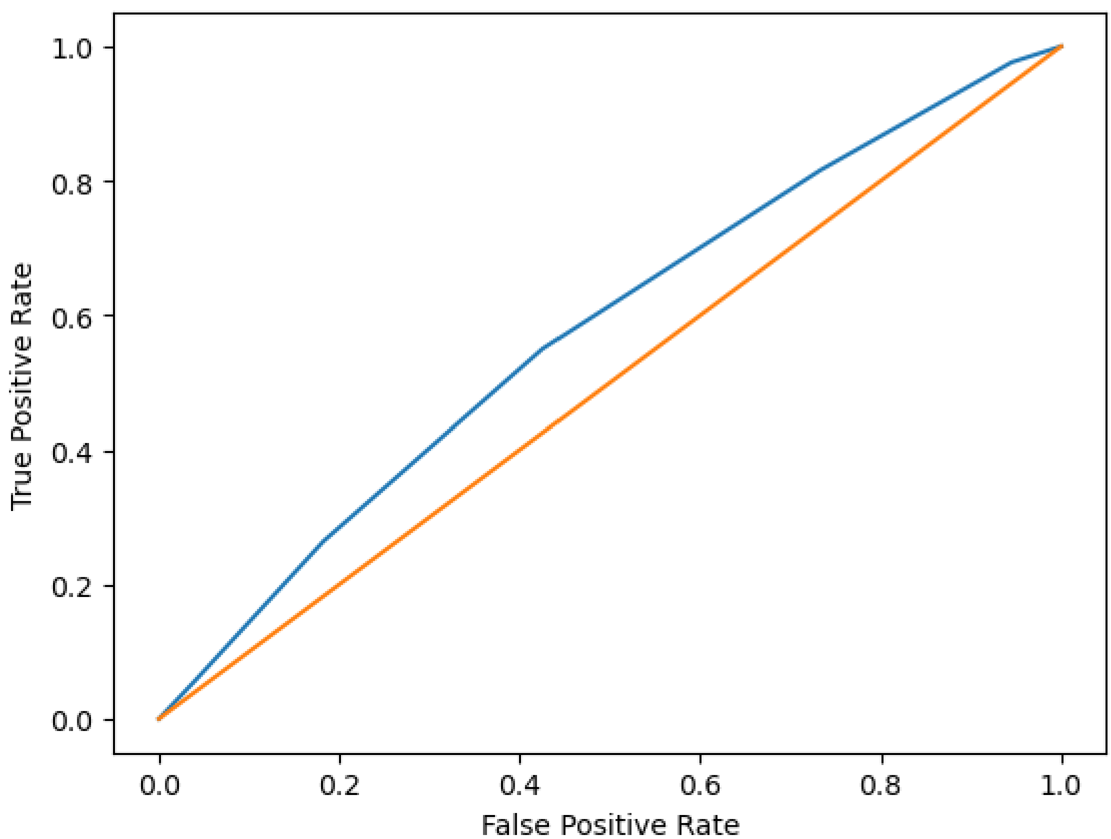

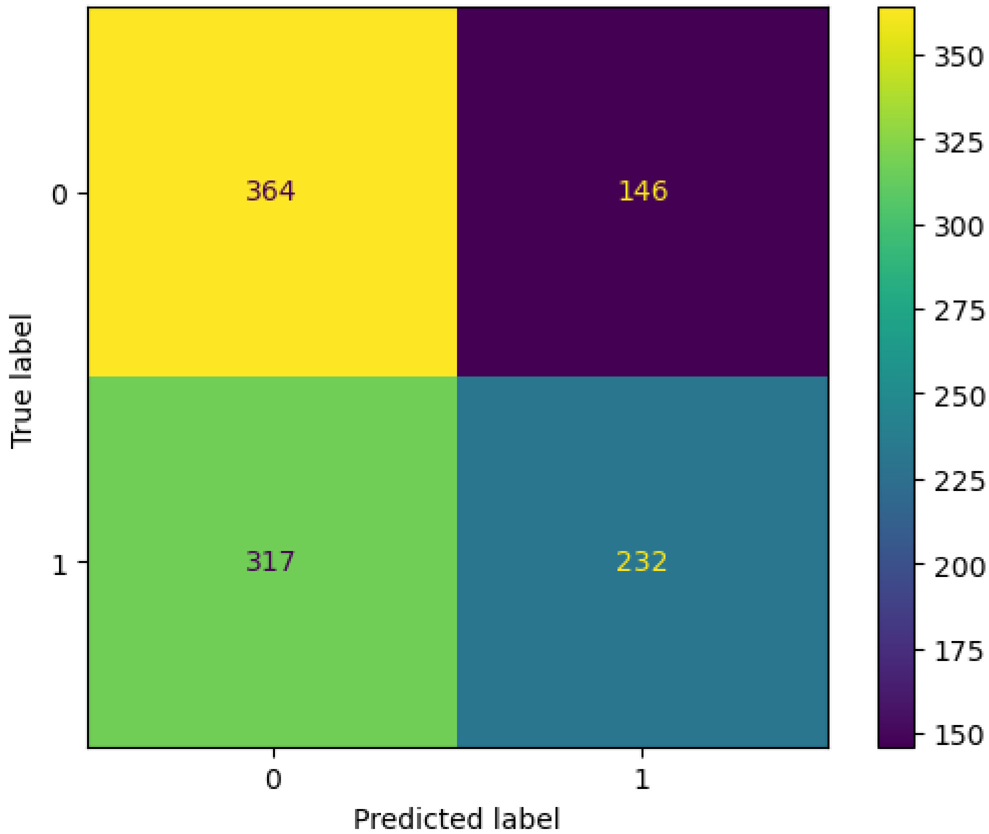


```
The AUC is equal to: 0.5851083967284547
```

```
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py:198: DataConversionWarning: A column-vector y was passed when a 1d array w
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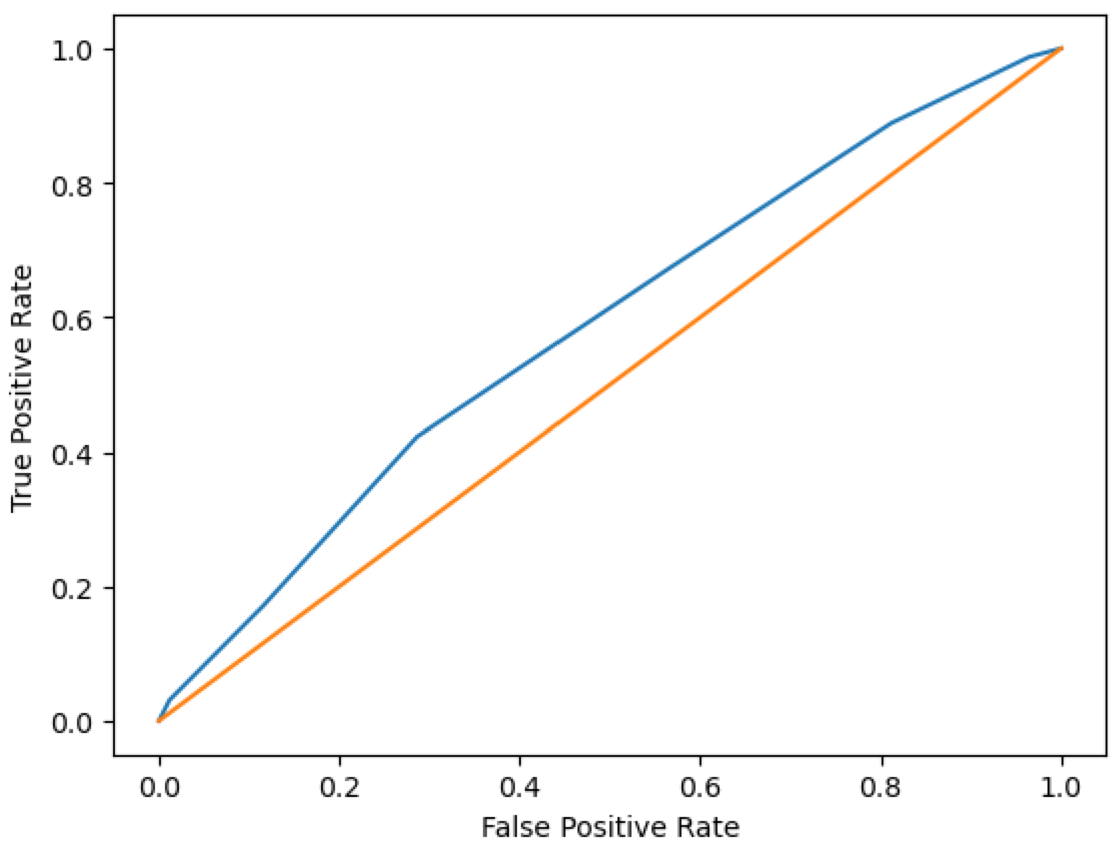

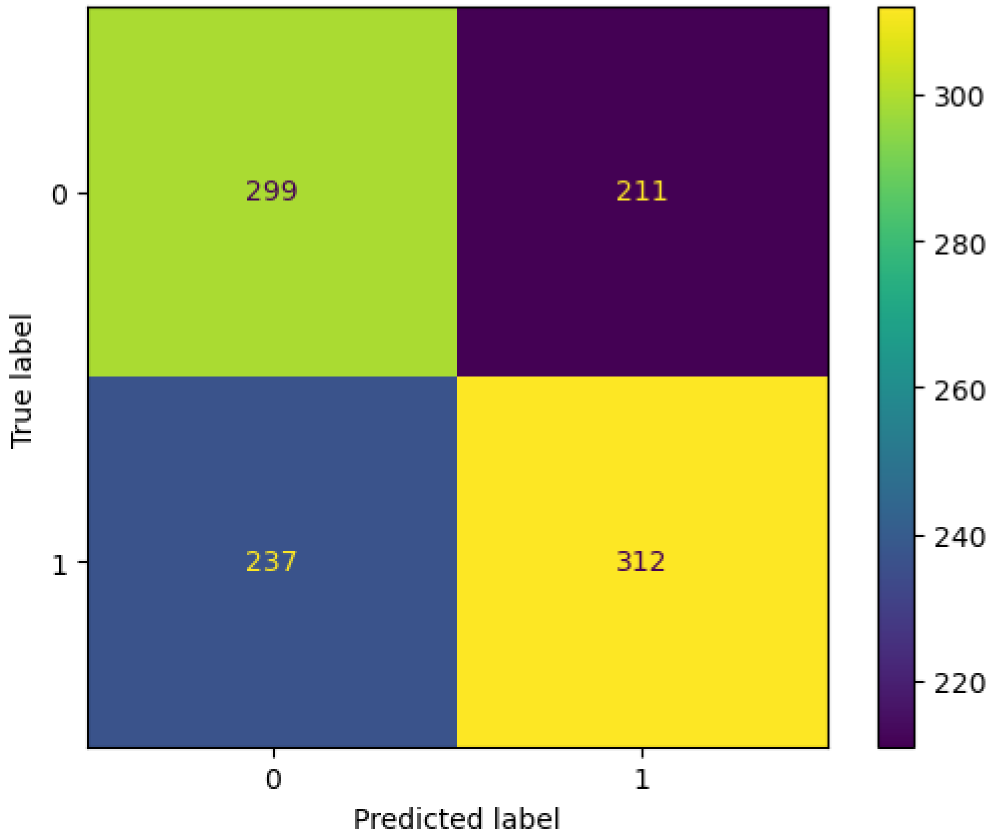


```
The AUC is equal to: 0.599580342155077
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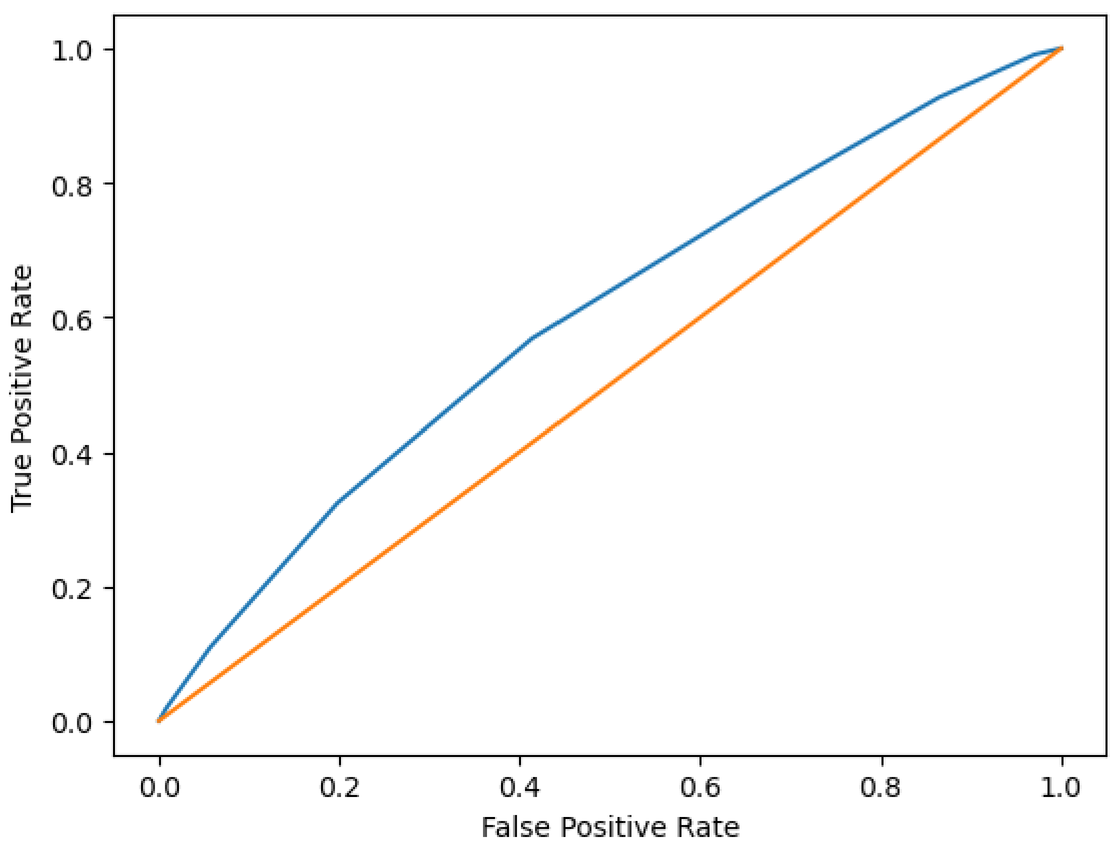

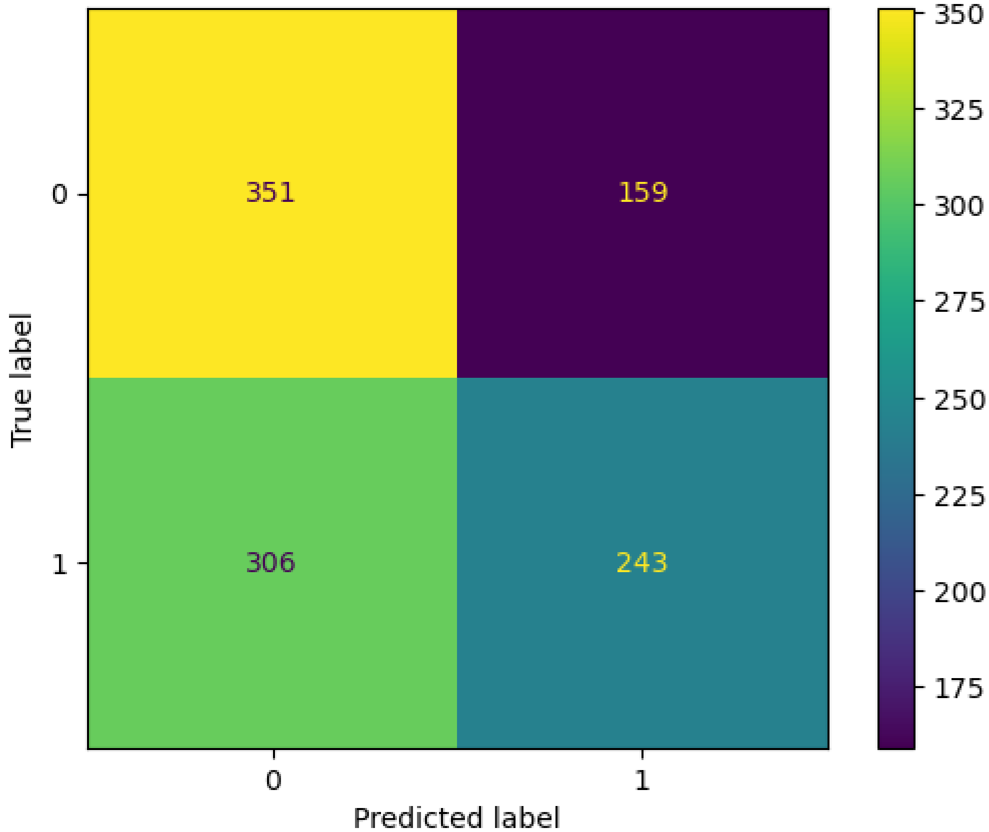


```
The AUC is equal to: 0.5959855709132469
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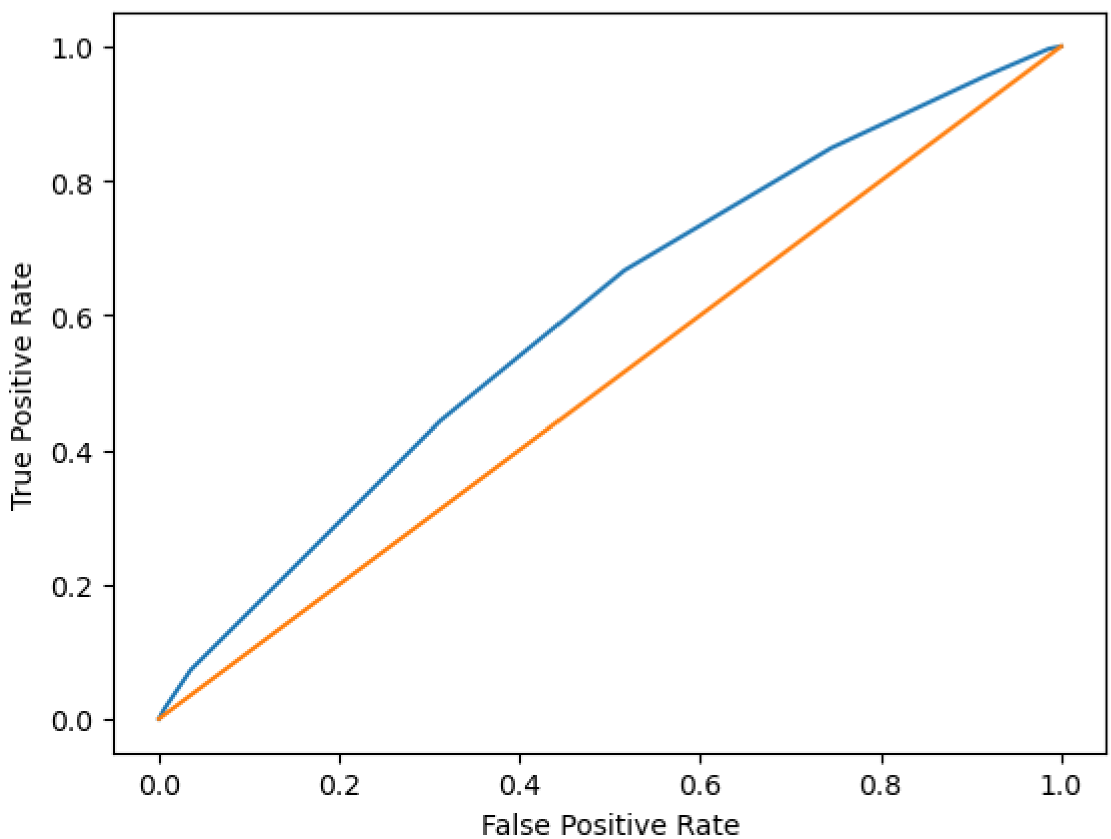

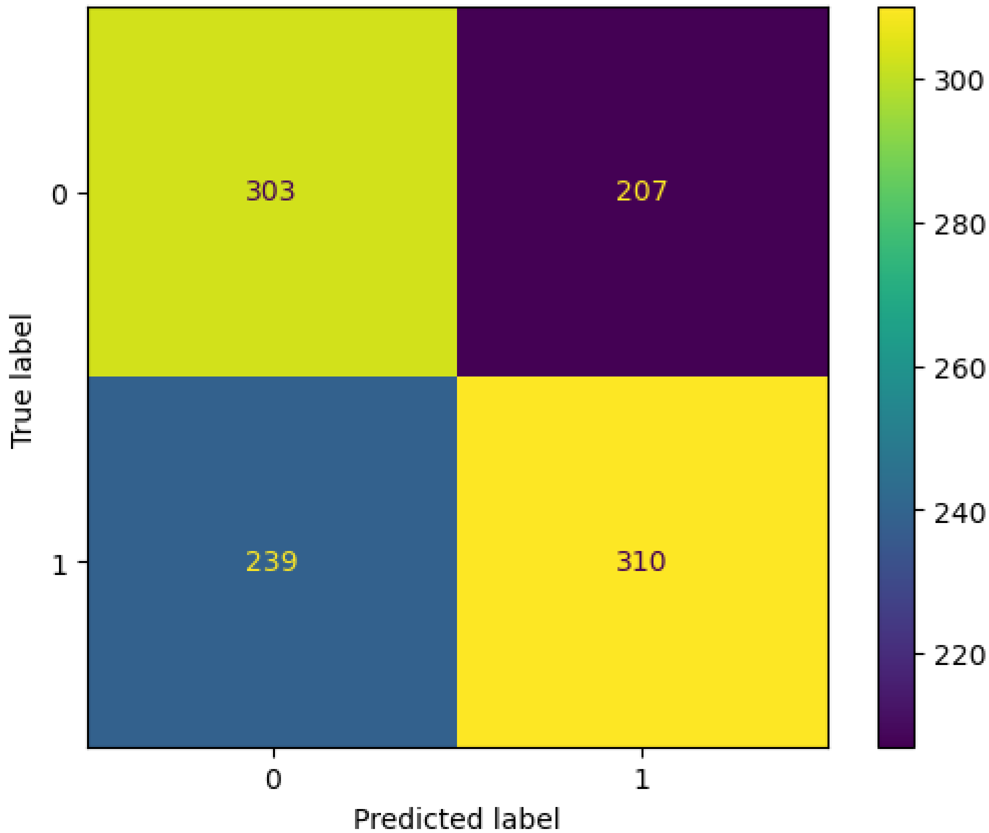


```
The AUC is equal to: 0.5971088253151897
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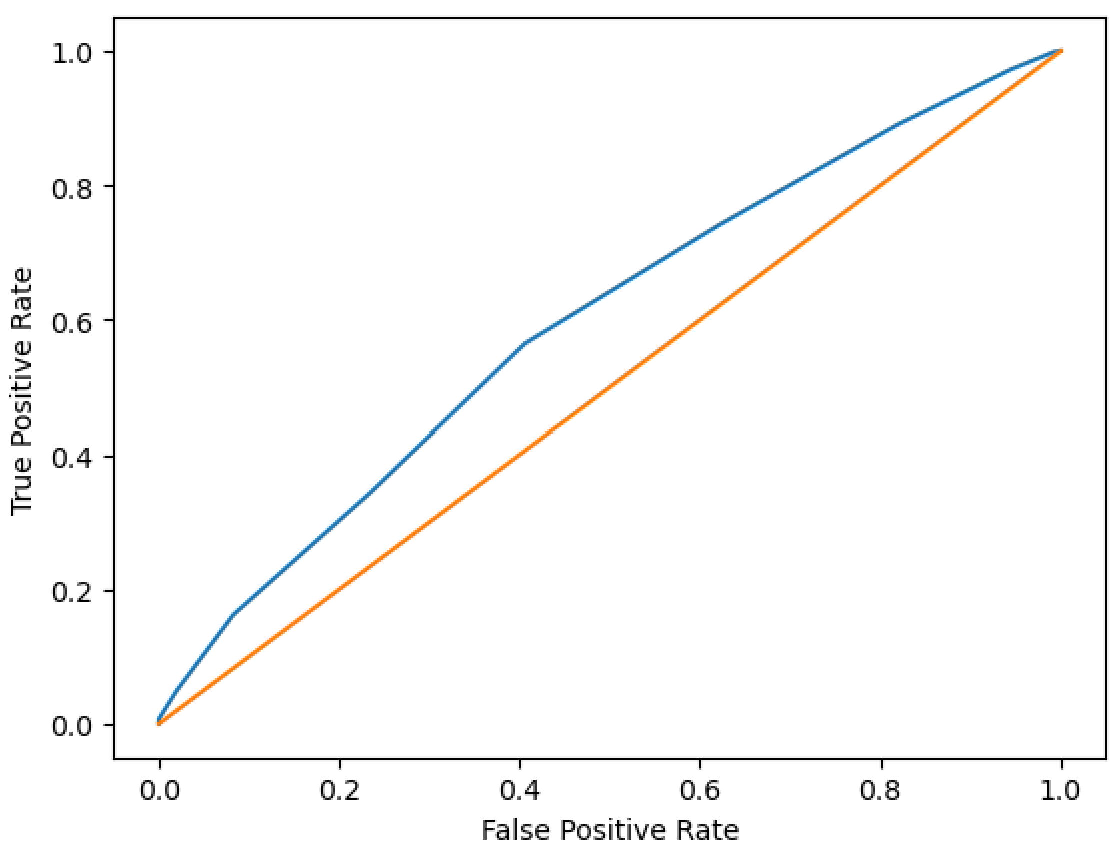
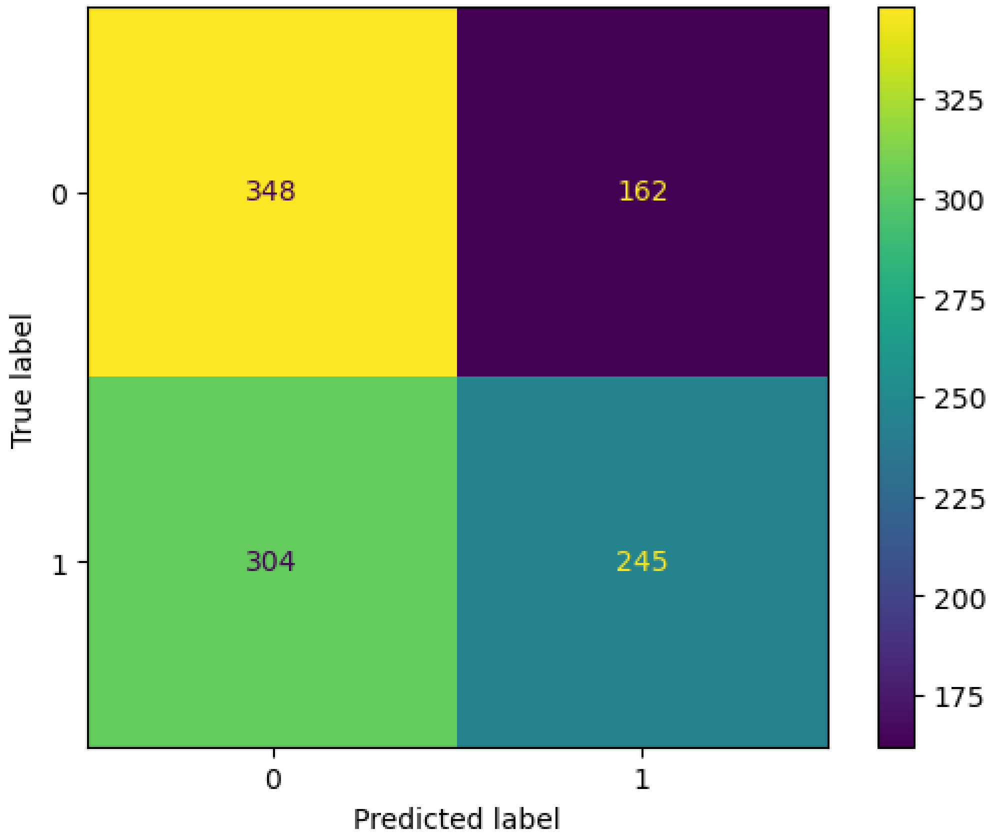
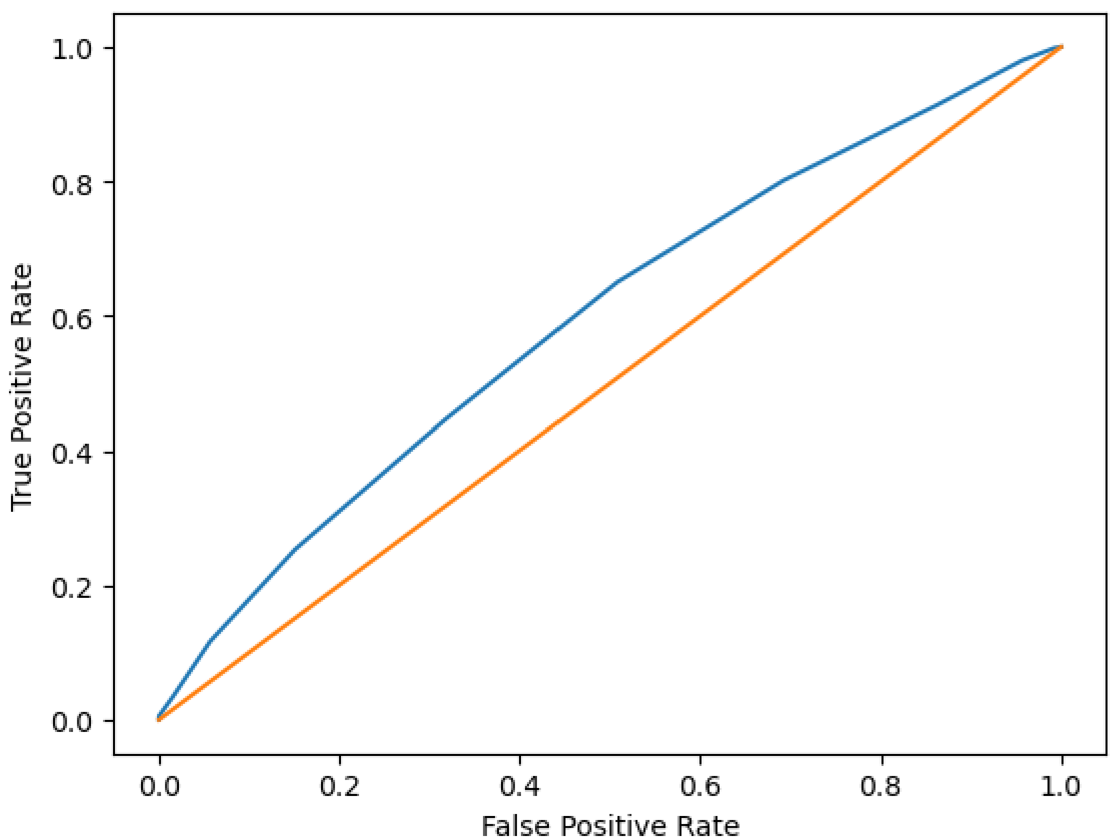
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```





The AUC is equal to: 0.5953569770348941



In [9]:
```
knn_outcomes = pd.DataFrame(list(zip(k_list, cv_l, acc_l1, auc_l1)), columns =

knn_outcomes
```

Out[9]:

	Number of Neighbors	CV Score	Accuracy Score	AUC
0	1	0.527931	0.528801	0.527778
1	2	0.531708	0.525968	0.562934
2	3	0.546620	0.556185	0.567624
3	4	0.536807	0.542021	0.573538
4	5	0.556057	0.561851	0.577246
5	6	0.554360	0.562795	0.585108
6	7	0.564363	0.576959	0.599580
7	8	0.564553	0.560907	0.595986
8	9	0.566249	0.578848	0.597109
9	10	0.560399	0.559962	0.595357

In [10]:
```
# get the maximum CV
ind_knn1 = 1
max_cv = knn_outcomes['CV Score'][ind_knn1]
while ind_knn1 in range(len(knn_outcomes['CV Score'])):
    if knn_outcomes['CV Score'][ind_knn1] > max_cv:
        max_cv = knn_outcomes['CV Score'][ind_knn1]
        max_ind = ind_knn1
    else:
        pass
    ind_knn1 += 1
acc_l.append(knn_outcomes['Accuracy Score'][max_ind])
auc_l.append(knn_outcomes['AUC'][max_ind])
```

In [11]:
```
# table for model results
model_outcomes_df = pd.DataFrame(list(zip(m_list, acc_l, auc_l)), columns = ['
model_outcomes_df
```

Out[11]:

	Model	Accuracy Score	AUC
0	Logistic Regression	0.607177	0.639121
1	Decision Tree	0.543909	0.544091
2	Random Forest	0.583569	0.611511
3	Gradient Boosted Tree	0.601511	0.636830
4	Persistent Model	0.386213	0.385380
5	KNN	0.578848	0.597109

In [ ]: