# Random Forest

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## 1 Random Forest

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### 1.0.1 Import all the packages

```
In [1]: import pandas as pd
        import logging
        from sklearn.model_selection import train_test_split, cross_val_score
        from sklearn.ensemble import RandomForestClassifier
        from sklearn.metrics import confusion_matrix, roc_curve
        import scikitplot as skplt
        import glob
        import numpy as np
        import matplotlib.pyplot as plt
        import seaborn as sns
        from imblearn.combine import SMOTETomek
        from collections import Counter
        import random
```

### 1.0.2 Define data reader function, to return the orederd_product_key and campaign_key columns from our data

```
In [2]: def data_reader(file):
            data_read = pd.read_csv(file)
            data = data_read.drop(["Ordered_Product_Key", "Campaign_Key"], 1)
            return data
```

### 1.0.3 Checks for NaNs and if any fraud actually exists in the file

```
In [3]: def file_checker(dataframe):
            num_nan = np.sum(dataframe.isnull().sum())
            num_fraud = dataframe['fraud_status'].sum()
            return num_nan, num_fraud
```

### 1.0.4 Uses SMOTE and Tomek Links to under and over sample to combat the class imbalance

```
In [4]: def get_smote(feature, label):
            print("Raw Data: " + str(sorted(Counter(label).items())))
            smt = SMOTETomek(random_state=42)
            feature_resampled, label_resampled = smt.fit_sample(feature, label)
            print("Resampled: " + str(sorted(Counter(label_resampled).items())))
            return feature_resampled, label_resampled
```

### 1.0.5 Plot socres for different trees and save the plot in the local file

```
In [5]: def plotter(scores, array1, array2, tree_list, directory, file_write):
            plt.plot(tree_list, scores)
            plt.plot(tree_list, array1 + array2, 'b--')
            plt.plot(tree_list, array1 - array2, 'b--')
            plt.ylabel('CV score')
            plt.xlabel('# of trees')
            plt.savefig(directory + 'accuracy_plots/dataset' + str(file_write).strip(file_dir)
```

### 1.0.6 Calculate the model recall, precision, f1 and auc value

```
In [6]: def data_scorer(model, features, labels, folds):
            recall = np.mean(cross_val_score(model, X = features, y = labels, cv = folds, scor
            precision = np.mean(cross_val_score(model, X = features, y = labels, cv = folds, s
            accuracy = np.mean(cross_val_score(model, X = features, y = labels, cv = folds, sc
            f1 = np.mean(cross_val_score(model, X = features, y = labels, cv = folds, scoring =
            auc = np.mean(cross_val_score(model, X = features, y = labels, cv = folds, scoring
            return accuracy, recall, precision, f1, auc
```

### 1.0.7 Define test model with features and labels

```
In [7]: def test_model(no_trees, features, labels):
            random_forest = RandomForestClassifier(no_trees)
            model_metric = cross_val_score(random_forest, features, labels)
            return model_metric
```

### 1.0.8 Set a seed for reproducability

```
In [8]: random.seed(123)
```

### 1.0.9 Setup File Structure and create a data list

```
In [17]: file_dir = "/Users/sunmengnan/Documents/Github2/thgfd/data/stratified/"
         files = glob.glob(file_dir + "dataset*.csv")
         data_list = []
```

### 1.0.10 For each file in the file list, the main process would be: read in data, then check for any fraud, for each site, split out into test and train data set, and seperate labels and features, train classifier, define variable importances, remove the umimportant variables, retrain model, check there are enough minority cases to run 10 fold cross-validation and return matrix, finally calculate prediction probabilities

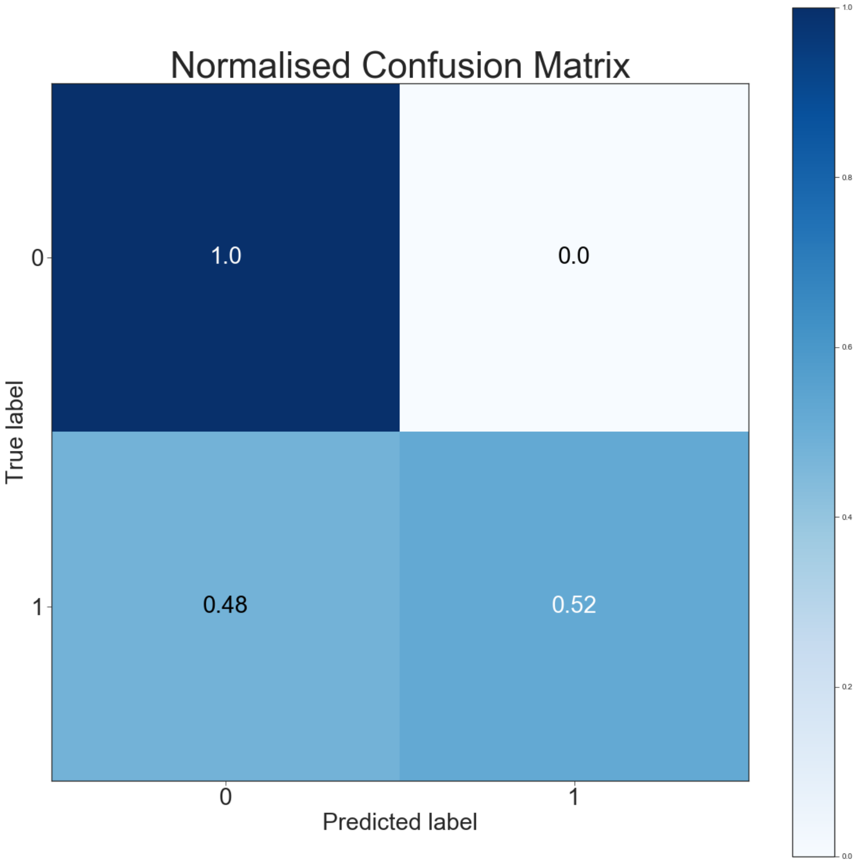
```
In [24]: import warnings
         warnings.filterwarnings('ignore')
         for file in files:
             filename = file.strip(file_dir)
             site = data_reader(file)
             file_checks = file_checker(site)
             if file_checks[1] > 0:
                 train, test = train_test_split(site, test_size = 0.5, random_state = 42)
                 train_x = train.loc[:, train.columns != "fraud_status"]
                 train_y = train['fraud_status']
                 test_x = test.loc[:, test.columns != "fraud_status"]
                 test_y = test['fraud_status']
                 classifier = RandomForestClassifier(80)
                 classifier.fit(train_x, train_y)
                 importances = pd.Series(classifier.feature_importances_, name = "Importances"
                 var_importance = pd.concat([pd.Series(test_x.columns, name = "Names"), importa
                 var_importance = var_importance.sort_values(by = "Importances", ascending = Fa
                 var_importance = var_importance.drop("index", 1)
                 sns.set_style('ticks')
                 fig, ax = plt.subplots()
                 fig.set_size_inches(w = 20, h = 20)
                 sns.barplot(y = "Names", x = "Importances", data = var_importance, ax = ax)
                 sns.despine()
                 fig.savefig("/Users/sunmengnan/Desktop/FD/plot/" +
                             filename+ "variable_importance_no_smote.png")

                 unimportant = var_importance.drop(var_importance[var_importance.Importances <
                 unimportant = unimportant["Names"]
                 unimportant.to_csv("/Users/sunmengnan/Desktop/FD/result/"+
                                    filename + "important_variables.csv",index = True)

                 train_x = pd.DataFrame(train_x)
                 train_x.columns = train.loc[:, train.columns != "fraud_status"].columns
                 train_x = train_x[unimportant]
                 train_x = train_x.as_matrix()
                 test_x = test[unimportant].values
                 test_y = test['fraud_status'].values

                 clf = RandomForestClassifier(80, n_jobs = -1, random_state=42)
                 clf.fit(train_x, train_y)
                 clf.predict(test_x)
```

```
        if sum(test_y) < 10:
            cv = sum(test_y)
        else:
            cv = 10

        accuracy, recall, precision, f_score, auc = data_scorer(clf, test_x, test_y, 
        results = [filename, accuracy, recall, precision, f_score, auc]

        y_prob = clf.predict_proba(test_x)
        y_pred = clf.predict(test_x)

        fig, ax = plt.subplots()
        fig.set_size_inches(w = 20, h = 20)
        skplt.metrics.plot_roc_curve(test_y, y_prob, title = "Random Forest ROC Site 
                                     ax = ax, title_fontsize=46, text_fontsize = 30)
        fig.savefig("/Users/sunmengnan/Desktop/FD/plot/" + filename + "rf_roc_no_smot

        fig, ax = plt.subplots()
        fig.set_size_inches(w = 20, h = 20)
        skplt.metrics.plot_confusion_matrix(test_y, y_pred, normalize = True, ax = ax
                                            text_fontsize=30, title_fontsize=46,
                                            title="Normalised Confusion Matrix")

        fig.savefig("/Users/sunmengnan/Desktop/FD/plot/"+ filename + "rf_confusion_no
        data_list.append(results)
    else:
        pass
```

### 1.0.11 From the file and plots that generate, we can view the confusion matrix, taking site 11 for example,

In [29]:
```
from IPython.display import Image
Image(filename="/Users/sunmengnan/Desktop/FD/plot/_11.csvrf_confusion_no_smote.png",wi
```

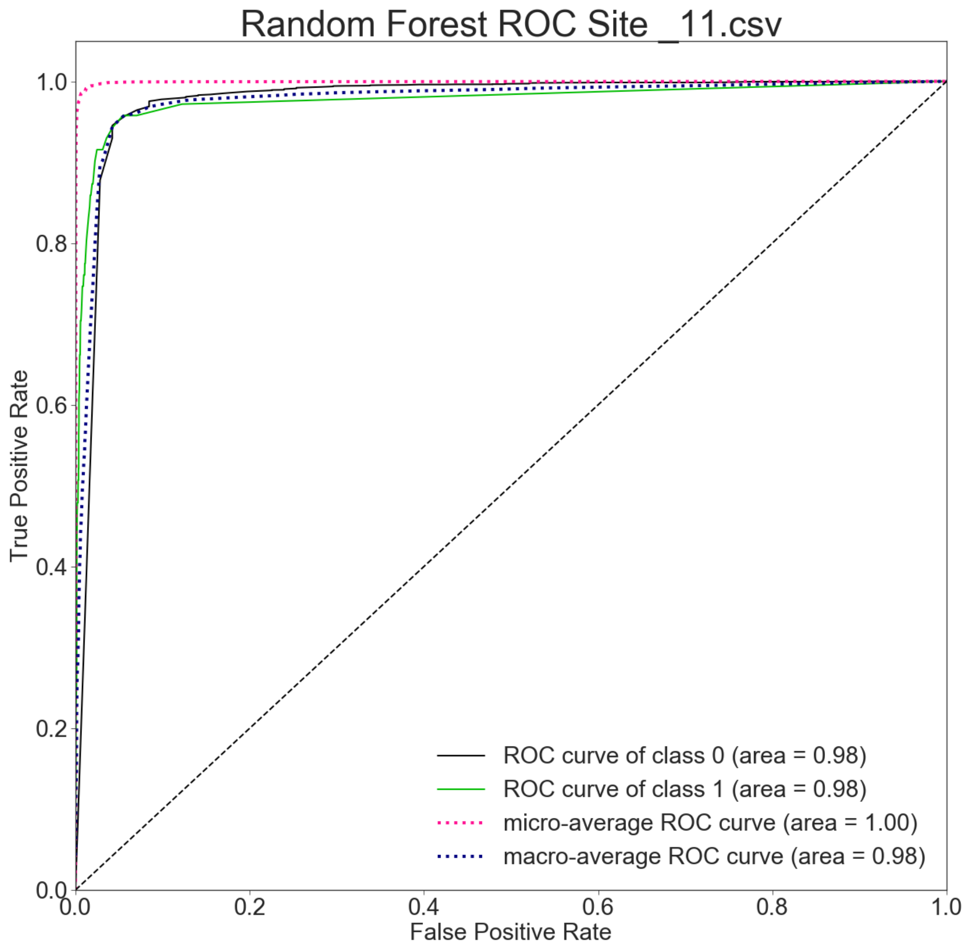
Out[29]:



### 1.0.12 Also, we can visualize the random forest ROC curve

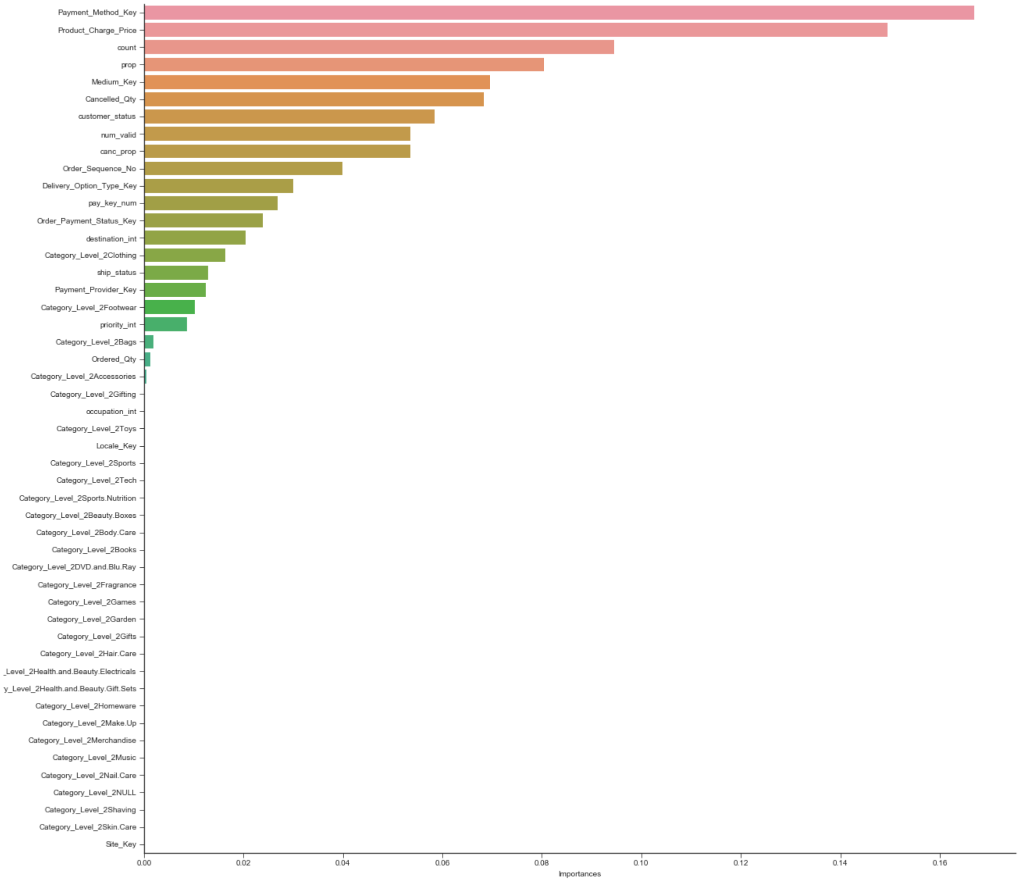
```
In [30]: Image(filename="/Users/sunmengnan/Desktop/FD/plot/_11.csvrf_roc_no_smote.png",width=60
```

```
   Out[30]:
```



### 1.0.13 Finally, we can find the most important features as followed

```
In [34]: Image(filename="/Users/sunmengnan/Desktop/FD/plot/_11.csvvariable_importance_no_smote

   Out[34]:
```



### 1.0.14 Output our result as a csv file into the local file

```
In [35]: results_df = pd.DataFrame(data_list, columns = ["File","Accuracy", " recall", "precis
         results_df.to_csv("/Users/sunmengnan/Desktop/FD/result/random_forest_results.csv",
                           index = False)
```