In [ ]:

```
import numpy as np
import pandas as pd
from sklearn import tree
from sklearn import preprocessing
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
import matplotlib.pyplot as plt
```

In [ ]:

```
seattle = pd.read_csv('train.csv')
seattle.head()
```

Out[ ]:

	idx	date	precipitation	temp_max	temp_min	wind	weather
0	0	12/23/2015	6.1	5.0	2.8	7.6	0
1	1	2/1/2014	2.0	7.8	2.8	0.8	0
2	2	7/21/2014	0.0	23.9	13.3	2.2	1
3	3	3/11/2013	1.3	10.6	6.1	1.1	0
4	4	9/21/2013	0.0	21.1	13.3	2.5	1

In [ ]:

```
seattle.nunique()
```

Out[ ]:

```
idx              1022
date             1022
precipitation      97
temp_max           66
temp_min           53
wind               76
weather             5
dtype: int64
```

In [ ]:

```
df = seattle[(seattle['weather']==1) | (seattle['weather']==0)]
df.shape
```

Out[ ]:

```
(896, 7)
```

In [ ]:

```
def bootstrap_dataset(dataset, sample_size, number_of_samples):
    bootstrapped_datasets = []

    for sample_index in range(0, number_of_samples):
        sampled_dataset = np.random.choice(dataset, size=sample_size)
        bootstrapped_datasets.append(sampled_dataset)
        print(sampled_dataset)

    return bootstrapped_datasets
```

In [ ]:

```
def encode_features(array):
    encoder = preprocessing.LabelEncoder().fit(array)
    return encoder.transform(array)
```

In [ ]:

```
def build_decision_tree(features, targets):
    train_features, test_features, train_targets, test_targets = train_test_split(featur

    decision_tree = tree.DecisionTreeClassifier(random_state=456)
    decision_tree.fit(train_features, train_targets)

    print("Test Set Mean Squared Error = " + str(np.round(1 - decision_tree.score(test_f
```

In [ ]:
```python
def build_random_forest(features,targets):
    random_forest = RandomForestClassifier(random_state=4567, bootstrap=True, oob_score=
    random_forest.fit(features, targets)
    # Out-Of-Bag Error
    oob_error = np.round(random_forest.oob_score_,2)
    print("Random Forest with " + str(len(random_forest.estimators_)) + " trees has OOB
```

In [ ]:
```python
def oob_error_viz(features, targets, number_trees):
    # range is exclusive, it stops at N+1
    # starts with 5 trees, otherwise its too few for the algorithm to run
    min_number_trees = 5
    max_depth_array = range(min_number_trees, number_trees+1)
    oob_error_array = []
    for tree_i in max_depth_array:
        # show progress on computation
        if tree_i % 25 == 0:
            print("Building Random Forest with " + str(tree_i) + " trees")
        random_forest = RandomForestClassifier (random_state=4567, bootstrap=True, oob_s
        random_forest.fit(features, targets)
        # Out-Of-Bag Error
        oob_error_array.append(np.round(random_forest.oob_score_, 2))

    # outputs the Lowest OOB error and the OOB error for the biggest random forest built
    lowest_oob_error = min(oob_error_array)
    best_forest_size = oob_error_array.index(lowest_oob_error) + min_number_trees
    print("\nrandom Forest with " + str(best_forest_size) + " trees, has lowest OOB Erro
    print("Random Forest with " + str(number_trees) + " trees, has lowest OOB Error = "
    fig, ax = plt.subplots(figsize=(17, 12))
    # removing all borders except bottom ax. spines['top'].set_visible(False) ax.spines
    # setting y-axis limit to range to be from 0 to 1.
    plt.ylim([0, 1])
    ax.plot(max_depth_array, oob_error_array, color='#435373', linewidth=3)
    # setting plot title and naming axes
    plt.title("Out-Of-Bag Error as a function of number of trees\n in Random Forest", fo
    ax.set_xlabel("Number of trees in Random Forest", fontsize=18, labelpad=15)
    ax.set_ylabel("OOB Error", fontsize=18, labelpad=15)
    plt.show()
```

In [ ]:
```python
bootstrap_dataset(df['date'], sample_size=5, number_of_samples=6)
```

```
['4/30/2012' '6/2/2015' '7/25/2012' '9/22/2015' '8/25/2015']
['2/27/2015' '5/22/2014' '12/9/2012' '12/22/2014' '6/18/2012']
['3/22/2015' '1/22/2014' '10/3/2015' '1/12/2014' '4/13/2013']
['1/23/2015' '2/21/2015' '10/29/2012' '11/30/2012' '7/29/2014']
['10/26/2012' '8/15/2013' '2/17/2014' '2/1/2014' '2/16/2013']
['2/25/2015' '8/27/2013' '8/26/2013' '5/10/2013' '1/29/2015']
```

Out[ ]:
```
[array(['4/30/2012', '6/2/2015', '7/25/2012', '9/22/2015', '8/25/2015'],
       dtype=object),
 array(['2/27/2015', '5/22/2014', '12/9/2012', '12/22/2014', '6/18/2012'],
       dtype=object),
 array(['3/22/2015', '1/22/2014', '10/3/2015', '1/12/2014', '4/13/2013'],
       dtype=object),
 array(['1/23/2015', '2/21/2015', '10/29/2012', '11/30/2012', '7/29/2014'],
       dtype=object),
 array(['10/26/2012', '8/15/2013', '2/17/2014', '2/1/2014', '2/16/2013'],
       dtype=object),
 array(['2/25/2015', '8/27/2013', '8/26/2013', '5/10/2013', '1/29/2015'],
       dtype=object)]
```

In [ ]:
```python
features = df[["date", "precipitation", "temp_max", "temp_min", "wind"]].values
targets = df['weather'].values

# encoding features
```

```
features[:, 0] = encode_features(features[:, 0])
targets = encode_features(targets)
build_decision_tree(features, targets)
```

```
Test Set Mean Squared Error = 0.04
```

In [ ]:
```
build_random_forest(features, targets)
```

```
Random Forest with 100 trees has OOB Error: 0.96
```

In [ ]:
```
oob_error_viz(features, targets, number_trees=150)
```

```
/Users/ndminh/opt/anaconda3/lib/python3.9/site-packages/sklearn/ensemble/_forest.py:560:
UserWarning: Some inputs do not have OOB scores. This probably means too few trees were
used to compute any reliable OOB estimates.
  warn(
/Users/ndminh/opt/anaconda3/lib/python3.9/site-packages/sklearn/ensemble/_forest.py:560:
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/Users/ndminh/opt/anaconda3/lib/python3.9/site-packages/sklearn/ensemble/_forest.py:560:
UserWarning: Some inputs do not have OOB scores. This probably means too few trees were
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UserWarning: Some inputs do not have OOB scores. This probably means too few trees were
used to compute any reliable OOB estimates.
  warn(
/Users/ndminh/opt/anaconda3/lib/python3.9/site-packages/sklearn/ensemble/_forest.py:560:
UserWarning: Some inputs do not have OOB scores. This probably means too few trees were
used to compute any reliable OOB estimates.
  warn(
Building Random Forest with 25 trees
Building Random Forest with 50 trees
Building Random Forest with 75 trees
Building Random Forest with 100 trees
Building Random Forest with 125 trees
Building Random Forest with 150 trees

random Forest with 5 trees, has lowest OOB Error= 0.89
Random Forest with 150 trees, has lowest 00B Error = 0.96
```

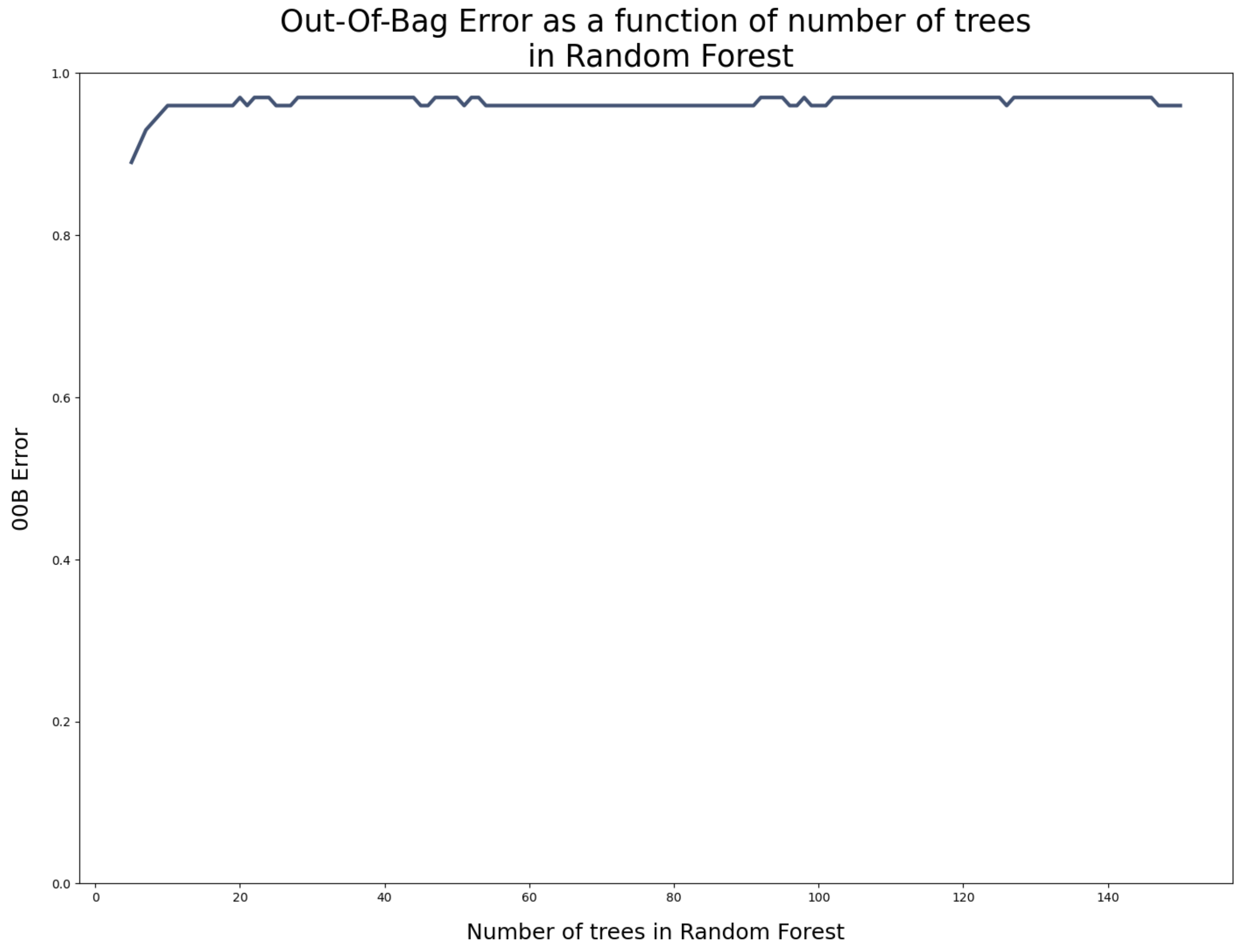
Out-Of-Bag Error as a function of number of trees
in Random Forest
OOB Error
Number of trees in Random Forest
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
120
140