predictions_v1

December 6, 2023

[ ]:
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### Libraries

# Misc.
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from matplotlib import colormaps as cm
import seaborn as sns
import datetime as dt
import os

# Preprocessing
from sklearn.preprocessing import OneHotEncoder, MinMaxScaler, StandardScaler
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.utils import class_weight

# Dimension Reduction
from sklearn.decomposition import PCA
from sklearn.manifold import Isomap, SpectralEmbedding, TSNE

# Models
from sklearn.neighbors import KNeighborsClassifier, NearestNeighbors
from sklearn.linear_model import LinearRegression, LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import AdaBoostClassifier, RandomForestClassifier
import xgboost as xgb

# Evaluation
from sklearn.metrics import f1_score, accuracy_score, balanced_accuracy_score
```

```
Intel MKL WARNING: Support of Intel(R) Streaming SIMD Extensions 4.2 (Intel(R)
SSE4.2) enabled only processors has been deprecated. Intel oneAPI Math Kernel
Library 2025.0 will require Intel(R) Advanced Vector Extensions (Intel(R) AVX)
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```

[ ]:
```
### Read data

data_path = f'{os.path.dirname(os.getcwd())}/data'
train_df = pd.read_csv(f'{data_path}/train.csv')
test_df = pd.read_csv(f'{data_path}/test.csv')

### Clean Information

def clean(df: pd.DataFrame):
    # Drop NaNs from beds and bathrooms_text columns
    df.dropna(subset = ['beds', 'bathrooms_text'], inplace = True)

    # Group hotel and shared rooms into 'other' category
    rooms_regrouped = df['room_type'].where((df['room_type'] == 'Entire home/
 ↪apt') | (df['room_type'] == 'Private room'), 'Other')
    df['rooms_regrouped'] = rooms_regrouped
    df['entire_bin'] = np.where(df['rooms_regrouped'] == 'Entire home/apt', 1,␣
 ↪0)
    df['private_bin'] = np.where(df['rooms_regrouped'] == 'Private room', 1, 0)
    df['other_room_bin'] = np.where(df['rooms_regrouped'] == 'Other', 1, 0)

    # Extract 'shared' keyword from bathrooms_text column
    def shared_bathrooms(row):
        if type(row['bathrooms_text']) is not str or 'shared' not in␣
 ↪row['bathrooms_text']:
            return 0
        return 1
    df['bathrooms_shared'] = df.apply(shared_bathrooms, axis = 1)

    # Extract number of baths from bathrooms_text column
    def extract_num(row):
        char_arr = np.array(row['bathrooms_text'].split())
        res = char_arr[np.char.isnumeric(char_arr)].astype(float)
        return res[0] if res.size != 0 else 1 # HOW TO IMPUTE TEXT-ONLY SAMPLES
    df['bathrooms_num'] = df.apply(extract_num, axis = 1)

    # Extract number of amenities from amenities column
    def extract_amenities(row):
        return set(row['amenities'][2:-2].split('''", "'''))
    df['amenities_ref'] = df.apply(extract_amenities, axis = 1)
    def count_amenities(row):
        return len(row['amenities_ref'])
    df['amenities_count'] = df.apply(count_amenities, axis = 1)

clean(train_df)
clean(test_df)
```

```
[ ]: ### Pull out relevant features identified in EDA

features = ['host_listings_count',␣
 ↪'calculated_host_listings_count_private_rooms', 'entire_bin', 'private_bin',␣
 ↪'other_room_bin', 'accommodates', 'bathrooms_shared', 'bathrooms_num',
            'beds', 'amenities_count', 'latitude', 'longitude',␣
 ↪'number_of_reviews', 'number_of_reviews_ltm', 'number_of_reviews_l30d',␣
 ↪'availability_30', 'availability_365',
            'neighbourhood_cleansed', 'property_type', 'host_id', 'price']
target = 'price'

### Split training data
X_train, X_test, y_train, y_test = train_test_split(train_df[features],␣
 ↪train_df[target], test_size = 0.2)

impute_features = ['host_listings_count',␣
 ↪'calculated_host_listings_count_private_rooms', 'entire_bin', 'private_bin',␣
 ↪'other_room_bin', 'accommodates', 'bathrooms_shared',
                   'bathrooms_num', 'beds', 'amenities_count', 'latitude',␣
 ↪'longitude', 'number_of_reviews', 'number_of_reviews_ltm',␣
 ↪'number_of_reviews_l30d', 'availability_30',
                   'availability_365']
regional_metrics_knn_df = X_train[impute_features]
regional_metrics_knn_df = MinMaxScaler().fit_transform(X =␣
 ↪regional_metrics_knn_df)
nearest_neighbors = NearestNeighbors(n_neighbors = 16).fit(X =␣
 ↪regional_metrics_knn_df)

def impute_nans(row, feature, metric):
    if np.isnan(row[feature]):
        neighbors = nearest_neighbors.kneighbors(row[impute_features].values.
 ↪reshape(1, -1), return_distance = False)
        if metric == 'mean':
            return X_train[feature].iloc[list(neighbors[0])].mean()
        if metric == 'median':
            return X_train[feature].iloc[list(neighbors[0])].median()
    else:
        return row[feature]

threshold = 20

mean_neighborhood_price = X_train[['neighbourhood_cleansed', 'price']].
 ↪groupby(by = 'neighbourhood_cleansed').mean().to_dict()['price']
median_neighborhood_price = X_train[['neighbourhood_cleansed', 'price']].
 ↪groupby(by = 'neighbourhood_cleansed').median().to_dict()['price']
neighborhood_counts = X_train['neighbourhood_cleansed'].value_counts()
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for neighborhood in neighborhood_counts.index:
    if neighborhood_counts[neighborhood] < threshold:
        mean_neighborhood_price.pop(neighborhood, None)
        median_neighborhood_price.pop(neighborhood, None)
X_train['mean_neighborhood_price'] = X_train['neighbourhood_cleansed'].
 ↪map(mean_neighborhood_price)
X_train['median_neighborhood_price'] = X_train['neighbourhood_cleansed'].
 ↪map(median_neighborhood_price)
X_train['mean_neighborhood_price'] = X_train.apply(impute_nans, args =␣
 ↪('mean_neighborhood_price', 'mean'), axis = 1)
X_train['median_neighborhood_price'] = X_train.apply(impute_nans, args =␣
 ↪('median_neighborhood_price', 'median'), axis = 1)

threshold = 20

mean_property_type_price = X_train[['property_type', 'price']].groupby(by =␣
 ↪'property_type').mean().to_dict()['price']
median_property_type_price = X_train[['property_type', 'price']].groupby(by =␣
 ↪'property_type').median().to_dict()['price']
property_counts = X_train['property_type'].value_counts()
for property in property_counts.index:
    if property_counts[property] < threshold:
        mean_property_type_price.pop(property, None)
        median_property_type_price.pop(property, None)
X_train['mean_property_type_price'] = X_train['property_type'].
 ↪map(mean_property_type_price)
X_train['median_property_type_price'] = X_train['property_type'].
 ↪map(median_property_type_price)
X_train['mean_property_type_price'] = X_train.apply(impute_nans, args =␣
 ↪('mean_property_type_price', 'mean'), axis = 1)
X_train['median_property_type_price'] = X_train.apply(impute_nans, args =␣
 ↪('median_property_type_price', 'median'), axis = 1)

threshold = 10

#mean_host_id_price = X_train[['host_id', 'price']].groupby(by = 'host_id').
 ↪mean().to_dict()['price']
#median_host_id_price = X_train[['host_id', 'price']].groupby(by = 'host_id').
 ↪median().to_dict()['price']
#host_counts = X_train['host_id'].value_counts()
#for host_id in host_counts.index:
#    if host_counts[host_id] < threshold:
#        mean_host_id_price.pop(host_id, None)
#        median_host_id_price.pop(host_id, None)
#X_train['mean_host_id_price'] = X_train['host_id'].map(mean_host_id_price)
#X_train['median_host_id_price'] = X_train['host_id'].map(median_host_id_price)
```

```
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  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

[ ]:
```
### Extraction of mean/median prices by categorical features

nearest_neighbors = NearestNeighbors(n_neighbors = 16).fit(X =␣
 ↪regional_metrics_knn_df)

X_test['mean_neighborhood_price'] = X_test['neighbourhood_cleansed'].
 ↪map(mean_neighborhood_price)
X_test['mean_neighborhood_price'] = X_test.apply(impute_nans, args =␣
 ↪('mean_neighborhood_price', 'mean'), axis = 1)

X_test['median_neighborhood_price'] = X_test['neighbourhood_cleansed'].
 ↪map(median_neighborhood_price)
X_test['median_neighborhood_price'] = X_test.apply(impute_nans, args =␣
 ↪('median_neighborhood_price', 'median'), axis = 1)
```

```
X_test['mean_property_type_price'] = X_test['property_type'].
 ↪map(mean_property_type_price)
X_test['mean_property_type_price'] = X_test.apply(impute_nans, args =␣
 ↪('mean_property_type_price', 'mean'), axis = 1)

X_test['median_property_type_price'] = X_test['property_type'].
 ↪map(median_property_type_price)
X_test['median_property_type_price'] = X_test.apply(impute_nans, args =␣
 ↪('median_property_type_price', 'median'), axis = 1)

#X_test['mean_host_id_price'] = X_test['host_id'].map(mean_host_id_price)
#X_test['mean_host_id_price'] = X_test.apply(impute_nans, args =␣
 ↪('mean_host_id_price', 'mean'), axis = 1)

#X_test['median_host_id_price'] = X_test['host_id'].map(median_host_id_price)
#X_test['median_host_id_price'] = X_test.apply(impute_nans, args =␣
 ↪('median_host_id_price', 'mean'), axis = 1)

X_train = X_train.drop(['neighbourhood_cleansed', 'property_type', 'host_id',␣
 ↪'price'], axis = 1)
X_test = X_test.drop(['neighbourhood_cleansed', 'property_type', 'host_id',␣
 ↪'price'], axis = 1)

ss = StandardScaler().fit(X = X_train)
X_train = pd.DataFrame(ss.transform(X = X_train), index = X_train.index,␣
 ↪columns = X_train.columns)
X_test = pd.DataFrame(ss.transform(X = X_test), index = X_test.index, columns =␣
 ↪X_test.columns)
```

```
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pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

0.0.1 Fit clustering methods identified in EDA to training set

embedding_features = ['accommodates', 'bathrooms_num', 'beds', 'latitude', 'longitude'] embedding_df = X_train[embedding_features] #mms = MinMaxScaler().fit(X = embedding_df) ss = StandardScaler().fit(X = embedding_df) #embedding_df = mms.transform(embedding_df) embedding_df = ss.transform(embedding_df)

1 Spectral Embedding with KNN

spectral_knn_embedding = SpectralEmbedding(n_components = 2, affinity = 'nearest_neighbors', n_neighbors = 15).fit(X = embedding_df)

2 Isomap

isomap_embedding = Isomap(n_neighbors = 15, n_components = 2).fit(X = embedding_df)

3 PCA

pca_embedding = PCA(n_components = 2).fit(X = embedding_df)

4 TSNE

tsne_embedding = TSNE(n_components = 2, perplexity = 50, n_iter = 1000).fit(X = embedding_df)

5 PCA

embedding_features = ['accommodates', 'bathrooms_num', 'beds', 'latitude', 'longitude'] embedding_df = X_train[embedding_features] #mms = MinMaxScaler().fit(X = embedding_df) ss = StandardScaler().fit(X = embedding_df) #embedding_df = mms.transform(embedding_df) embedding_df = ss.transform(embedding_df) pca_embedding = PCA(n_components = 2).fit(X = embedding_df) X_train['pca_embedding_x'], X_train['pca_embedding_y'] = pca_embedding.transform(X = embedding_df)[:,0], pca_embedding.transform(X = embedding_df)[:,1] X_test['pca_embedding_x'], X_test['pca_embedding_y'] = pca_embedding.transform(X = embedding_df_test)[:,0], pca_embedding.transform(X = embedding_df_test)[:,1]

X_train['spectral_knn_embedding_x'], X_train['spectral_knn_embedding_y'] = spectral_knn_embedding.embedding_[:,0], spectral_knn_embedding.embedding_[:,1] X_train['isomap_embedding_x'], X_train['isomap_embedding_y'] = isomap_embedding.embedding_[:,0], isomap_embedding.embedding_[:,1] X_train['pca_embedding_x'], X_train['pca_embedding_y'] = pca_embedding.transform(X = embedding_df)[:,0], pca_embedding.transform(X = embedding_df)[:,1] X_train['tsne_embedding_x'], X_train['tsne_embedding_y'] = tsne_embedding.embedding_[:,0], tsne_embedding.embedding_[:,1]

#mms = MinMaxScaler().fit(X = X_train) ss = StandardScaler().fit(X = X_train) X_train = pd.DataFrame(ss.transform(X = X_train), index = X_train.index, columns = X_train.columns)

5.0.1 Fit clustering methods identified in EDA to testing set

embedding_df_test = X_test[embedding_features]

6 Spectral Embedding with KNN

spectral_knn_embedding_test = SpectralEmbedding(n_components = 2, affinity = 'nearest_neighbors', n_neighbors = 15).fit(X = embedding_df_test)

7 Isomap

isomap_embedding_test = Isomap(n_neighbors = 15, n_components = 2).fit(X = embedding_df_test)

8 PCA

9 TSNE

tsne_embedding_test = TSNE(n_components = 2, perplexity = 50, n_iter = 1000).fit(X = embedding_df_test)

X_test['spectral_knn_embedding_x'], X_test['spectral_knn_embedding_y'] = spectral_knn_embedding_test.embedding_[:,0], spectral_knn_embedding_test.embedding_[:,1] X_test['isomap_embedding_x'], X_test['isomap_embedding_y'] = isomap_embedding_test.embedding_[:,0], isomap_embedding_test.embedding_[:,1] X_test['pca_embedding_x'], X_test['pca_embedding_y'] = pca_embedding.transform(X = embedding_df_test)[:,0], pca_embedding.transform(X = embedding_df_test)[:,1] X_test['tsne_embedding_x'], X_test['tsne_embedding_y'] = tsne_embedding_test.embedding_[:,0], tsne_embedding_test.embedding_[:,1]

X_test = pd.DataFrame(ss.transform(X = X_test), index = X_test.index, columns = X_test.columns)

Some random models for my own understanding (and entertainment)

[ ]:
```
linear_clf = LinearRegression().fit(X = X_train, y = y_train)
y_pred_linear = linear_clf.predict(X = X_test)
linear_acc = balanced_accuracy_score(y_true = y_test, y_pred = np.
↪round(y_pred_linear))
```

```
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pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/sklearn/metrics/_classification.py:2184: UserWarning: y_pred contains
classes not in y_true
  warnings.warn("y_pred contains classes not in y_true")
```

[ ]:
```
print(f'Linear Regression Accuracy: {linear_acc}')
```

```
Linear Regression Accuracy: 0.3485325834931585
```

[ ]:
```
logistic_clf = LogisticRegression().fit(X = X_train, y = y_train)
y_pred_logistic = logistic_clf.predict(X = X_test)
logistic_acc = balanced_accuracy_score(y_true = y_test, y_pred =␣
 ↪y_pred_logistic)
```

```
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/sklearn/utils/validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype,
pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
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  if is_sparse(pd_dtype):
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and will be removed in a future version. Check `isinstance(dtype,
pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/sklearn/linear_model/_logistic.py:458: ConvergenceWarning: lbfgs failed
to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/sklearn/utils/validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype,
```

```
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  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
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/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/sklearn/utils/validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype,
pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

[ ]:
```
print(f'Logistic Regression Accuracy: {logistic_acc}')
```

```
Logistic Regression Accuracy: 0.4385208727555882
```

[ ]:
```
tree_clf = DecisionTreeClassifier(min_samples_split = 1501).fit(X = X_train, y␣
↪= y_train)
y_pred_tree = tree_clf.predict(X = X_test)
tree_acc = balanced_accuracy_score(y_true = y_test, y_pred = y_pred_tree)
```

```
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/sklearn/utils/validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype,
pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
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/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
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```

```
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/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
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pd.SparseDtype)` instead.
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pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

[ ]:
```
print(f'Decision Tree Accuracy: {tree_acc}')
```

```
Decision Tree Accuracy: 0.3880396975379478
```

[ ]:
```
adaboost_estimator = DecisionTreeClassifier(max_depth = 1)
adaboost_clf = AdaBoostClassifier(estimator = adaboost_estimator, n_estimators␣
 ↪= 1000).fit(X = X_train, y = y_train)
y_pred_adaboost = adaboost_clf.predict(X = X_test)
adaboost_acc = balanced_accuracy_score(y_true = y_test, y_pred =␣
 ↪y_pred_adaboost)
```

```
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/sklearn/utils/validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype,
pd.SparseDtype)` instead.
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/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/sklearn/utils/validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype,
pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
```

```
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/sklearn/utils/validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype,
pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
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/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
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/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
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  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
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/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
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/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
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```

```
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/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
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  if is_sparse(pd_dtype):
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/sklearn/utils/validation.py:614: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype,
pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

[ ]:
```
print(f'AdaBoost Accuracy: {adaboost_acc}')
```

```
AdaBoost Accuracy: 0.308233335788292
```

[ ]:
```
xgb_params = {
    'n_estimators': [500, 750, 1000],
    'max_depth': [2, 3, 5, 7, 8],
}
#xgb_cv = GridSearchCV(xgb.XGBClassifier(), param_grid = xgb_params, scoring =␣
 ↪'accuracy', n_jobs = 3).fit(X = X_train, y = y_train)
#xgb_clf = xgb_cv.best_estimator_
```

[ ]:
```
classes_weights = class_weight.compute_sample_weight(class_weight = 'balanced',␣
 ↪y = y_train)
xgb_clf = xgb.XGBClassifier(n_estimators = 500, max_depth = 8, learning_rate =␣
 ↪0.1, reg_lambda = 0.7).fit(X = X_train, y = y_train, sample_weight =␣
 ↪classes_weights)
y_pred_xgb = xgb_clf.predict(X = X_test)
```

```
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/xgboost/data.py:299: FutureWarning: is_sparse is deprecated and will be
removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(dtype):
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/xgboost/data.py:301: FutureWarning: is_categorical_dtype is deprecated
and will be removed in a future version. Use isinstance(dtype, CategoricalDtype)
instead
  elif is_categorical_dtype(dtype) and enable_categorical:
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/xgboost/data.py:332: FutureWarning: is_categorical_dtype is deprecated
and will be removed in a future version. Use isinstance(dtype, CategoricalDtype)
instead
  if is_categorical_dtype(dtype)
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/xgboost/data.py:323: FutureWarning: is_categorical_dtype is deprecated
```

```
and will be removed in a future version. Use isinstance(dtype, CategoricalDtype)
instead
  return is_int or is_bool or is_float or is_categorical_dtype(dtype)
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/xgboost/data.py:427: FutureWarning: is_sparse is deprecated and will be
removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(data):
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/xgboost/data.py:299: FutureWarning: is_sparse is deprecated and will be
removed in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(dtype):
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/xgboost/data.py:301: FutureWarning: is_categorical_dtype is deprecated
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  elif is_categorical_dtype(dtype) and enable_categorical:
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
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and will be removed in a future version. Use isinstance(dtype, CategoricalDtype)
instead
  if is_categorical_dtype(dtype)
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/xgboost/data.py:323: FutureWarning: is_categorical_dtype is deprecated
and will be removed in a future version. Use isinstance(dtype, CategoricalDtype)
instead
  return is_int or is_bool or is_float or is_categorical_dtype(dtype)
```

[ ]:
```
xgb_acc = balanced_accuracy_score(y_true = y_test, y_pred = y_pred_xgb)
print(f'XGBoost Accuracy: {xgb_acc}')
```

```
XGBoost Accuracy: 0.5138963212625955

/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/sklearn/utils/validation.py:605: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype,
pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
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pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

[ ]:
```
rf_params = {
    'n_estimators': [15, 25, 75, 125, 500, 750, 1000],
    'max_depth': [2, 3, 5, 7, 8],
}
#rf_cv = GridSearchCV(RandomForestClassifier(), param_grid = rf_params, scoring␣
 ↪= 'accuracy').fit(X = X_train, y = y_train)
```

[ ]:
```
estimator_nums = [25, 125, 500, 1000, 2000]
rf_accs = []
for n in [25, 125, 500, 1000, 2000]:
    rf_clf = RandomForestClassifier(n_estimators = 500).fit(X = X_train, y =␣
 ↪y_train)
    y_pred_rf = rf_clf.predict(X = X_test)
    rf_acc = balanced_accuracy_score(y_true = y_test, y_pred = y_pred_rf)
    rf_accs.append(rf_acc)
plt.plot(estimator_nums, rf_accs)
plt.xscale('log')
plt.xlabel('Number of Estimators')
plt.ylabel('Balanced Accuracy Score')
plt.title('Random Forest Balanced Accuracy vs. Number of Trees')
```

```
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/sklearn/utils/validation.py:767: FutureWarning: is_sparse is deprecated
and will be removed in a future version. Check `isinstance(dtype,
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```

```
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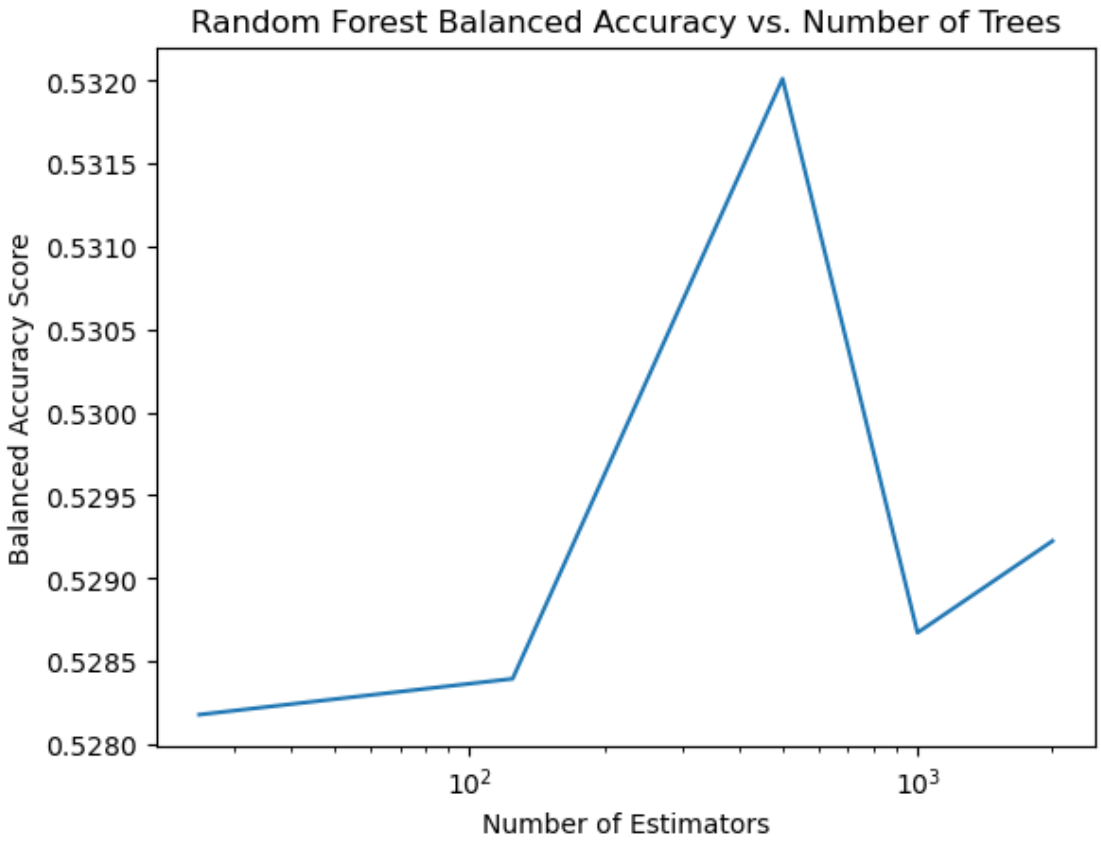
[ ]: Text(0.5, 1.0, 'Random Forest Balanced Accuracy vs. Number of Trees')



[ ]:
```
max_depth = [3, 5, 10, 25, 50, 100]
rf_accs = []
for d in max_depth:
    rf_clf = RandomForestClassifier(n_estimators = 500, max_depth = d).fit(X =␣
 ↪X_train, y = y_train)
    y_pred_rf = rf_clf.predict(X = X_test)
    rf_acc = balanced_accuracy_score(y_true = y_test, y_pred = y_pred_rf)
    rf_accs.append(rf_acc)
plt.plot(max_depth, rf_accs)
plt.xlabel('Maximum Depth')
plt.ylabel('Balanced Accuracy Score')
plt.title('Random Forest Balanced Accuracy vs. Maximum Depth')
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```
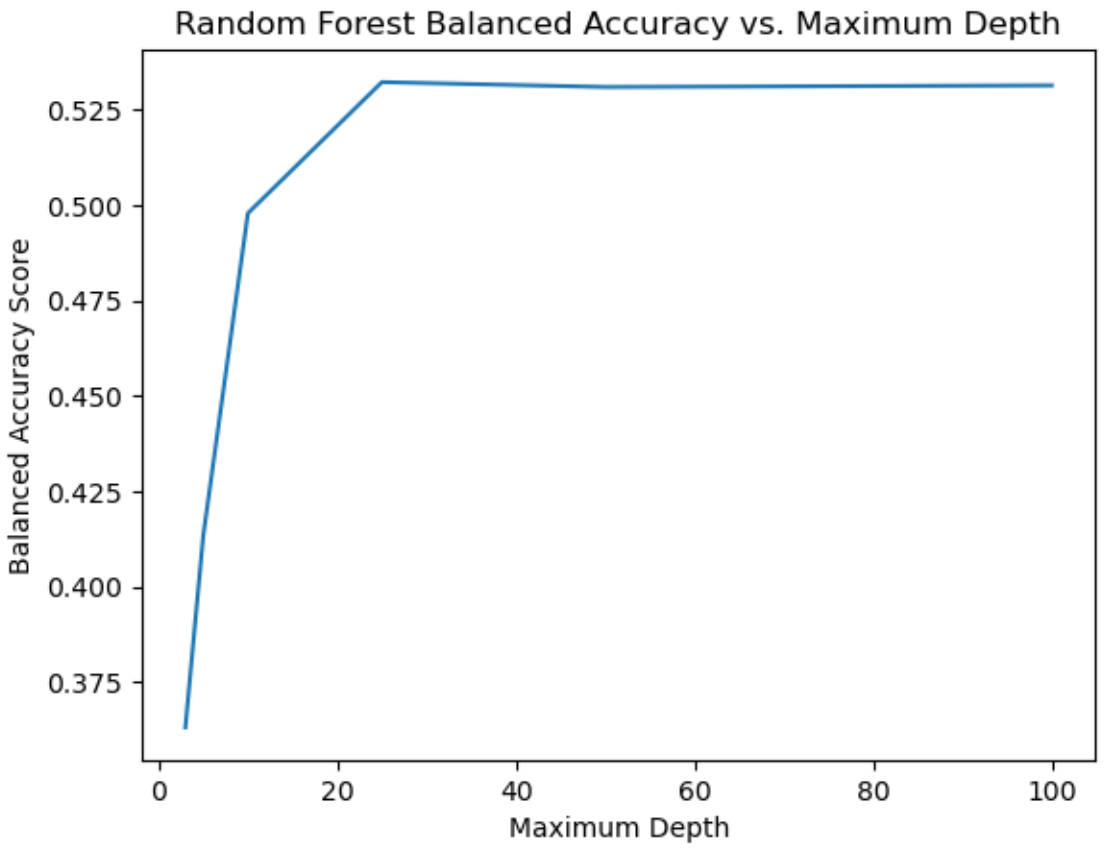

[ ]: Text(0.5, 1.0, 'Random Forest Balanced Accuracy vs. Maximum Depth')



[ ]:
```
classes_weights = class_weight.compute_sample_weight(class_weight = 'balanced',␣
 ↪y = y_train)

estimator_nums = [25, 125, 500, 1000]
xgb_accs = []
for n in estimator_nums:
    xgb_clf = xgb.XGBClassifier(n_estimators = n, max_depth = 8, learning_rate␣
 ↪= 0.1, reg_lambda = 0.7).fit(X = X_train, y = y_train, sample_weight =␣
 ↪classes_weights)
    y_pred_xgb = xgb_clf.predict(X = X_test)
    xgb_acc = balanced_accuracy_score(y_true = y_test, y_pred = y_pred_xgb)
    xgb_accs.append(xgb_acc)
plt.plot(estimator_nums, xgb_accs)
plt.xscale('log')
plt.xlabel('Number of Estimators')
plt.ylabel('Balanced Accuracy Score')
plt.title('XGBoost Balanced Accuracy vs. Number of Trees')
```

```
/opt/anaconda3/envs/cs671_final_project/lib/python3.9/site-
packages/xgboost/data.py:299: FutureWarning: is_sparse is deprecated and will be
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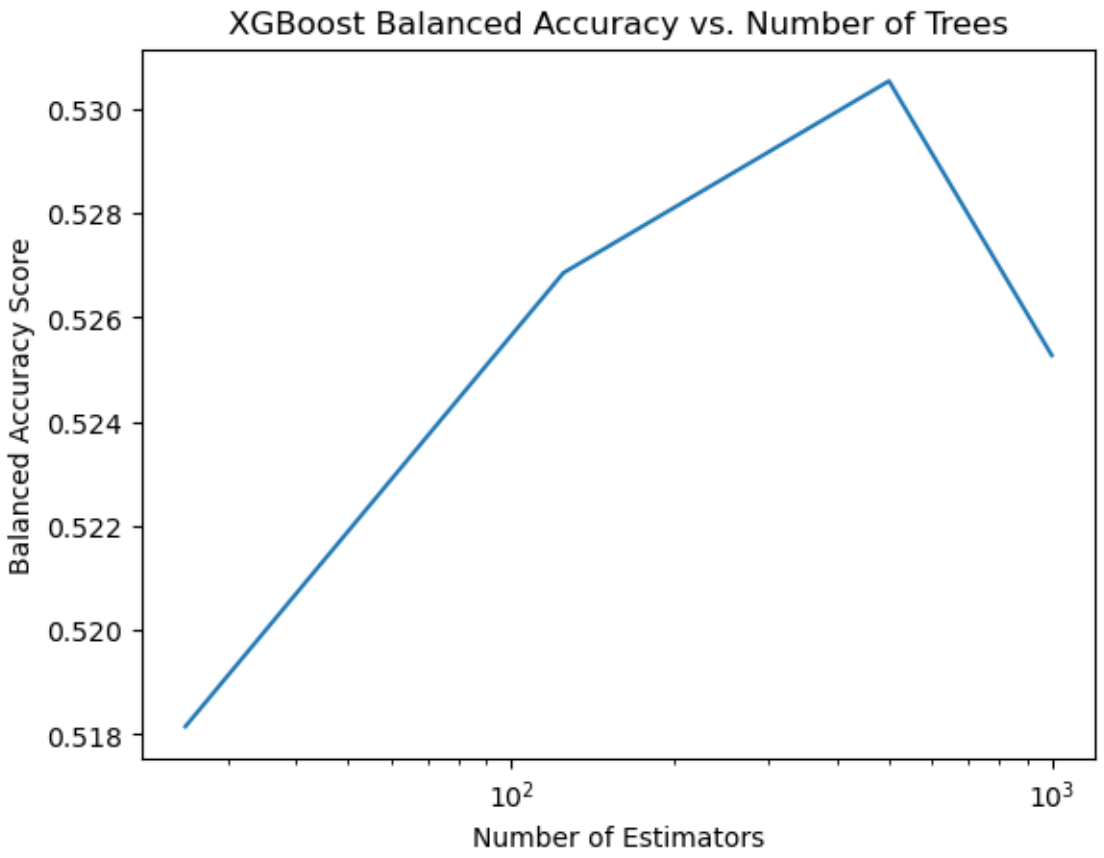
[ ]: Text(0.5, 1.0, 'XGBoost Balanced Accuracy vs. Number of Trees')



[ ]:
```
max_depth = [2, 4, 6, 8]
xgb_accs = []
for d in max_depth:
    xgb_clf = xgb.XGBClassifier(n_estimators = 500, max_depth = d,␣
 ↪learning_rate = 0.1, reg_lambda = 0.7).fit(X = X_train, y = y_train,␣
 ↪sample_weight = classes_weights)
    y_pred_xgb = xgb_clf.predict(X = X_test)
    xgb_acc = balanced_accuracy_score(y_true = y_test, y_pred = y_pred_xgb)
    xgb_accs.append(xgb_acc)
plt.plot(max_depth, xgb_accs)
plt.xlabel('Maximum Depth')
plt.ylabel('Balanced Accuracy Score')
plt.title('XGBoost Balanced Accuracy vs. Maximum Depth')
```

```
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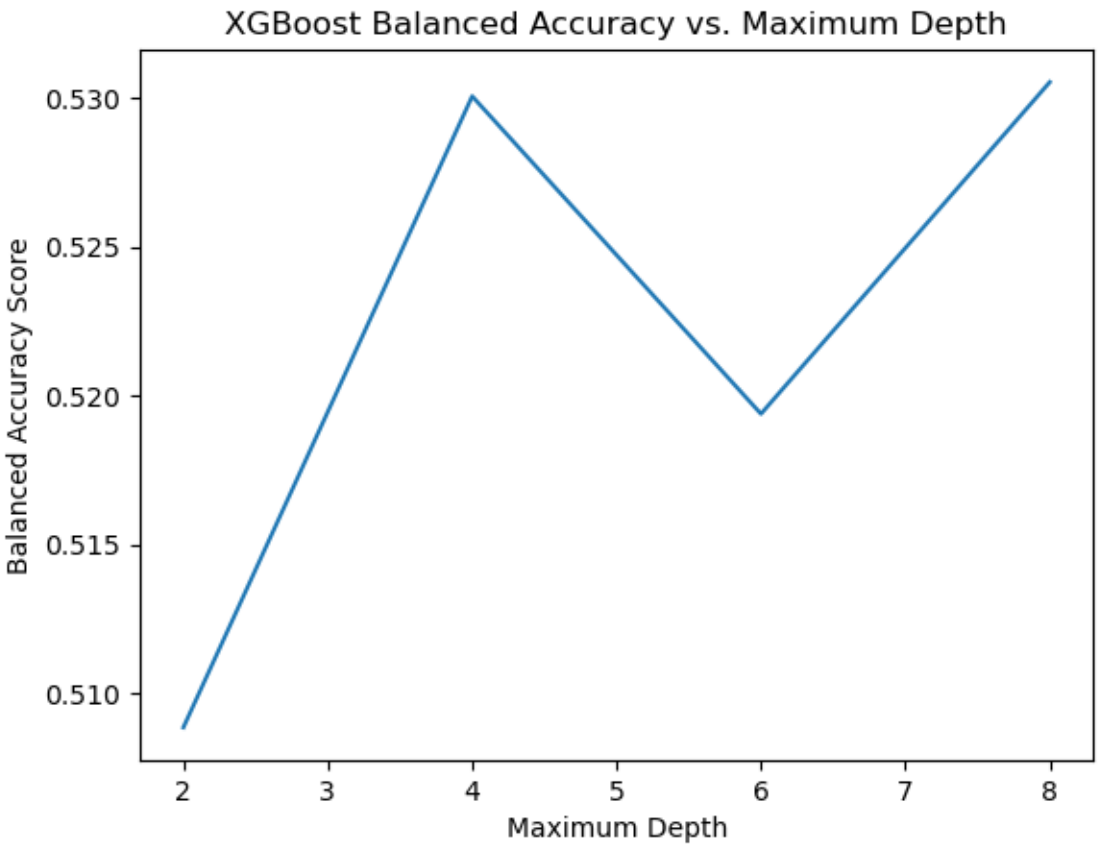
```
[ ]: Text(0.5, 1.0, 'XGBoost Balanced Accuracy vs. Maximum Depth')
```


XGBoost Balanced Accuracy vs. Maximum Depth
Balanced Accuracy Score
0.530
0.525
0.520
0.515
0.510
2
3
4
5
6
7
8
Maximum Depth

[ ]: