Submission1

by Ye Yao

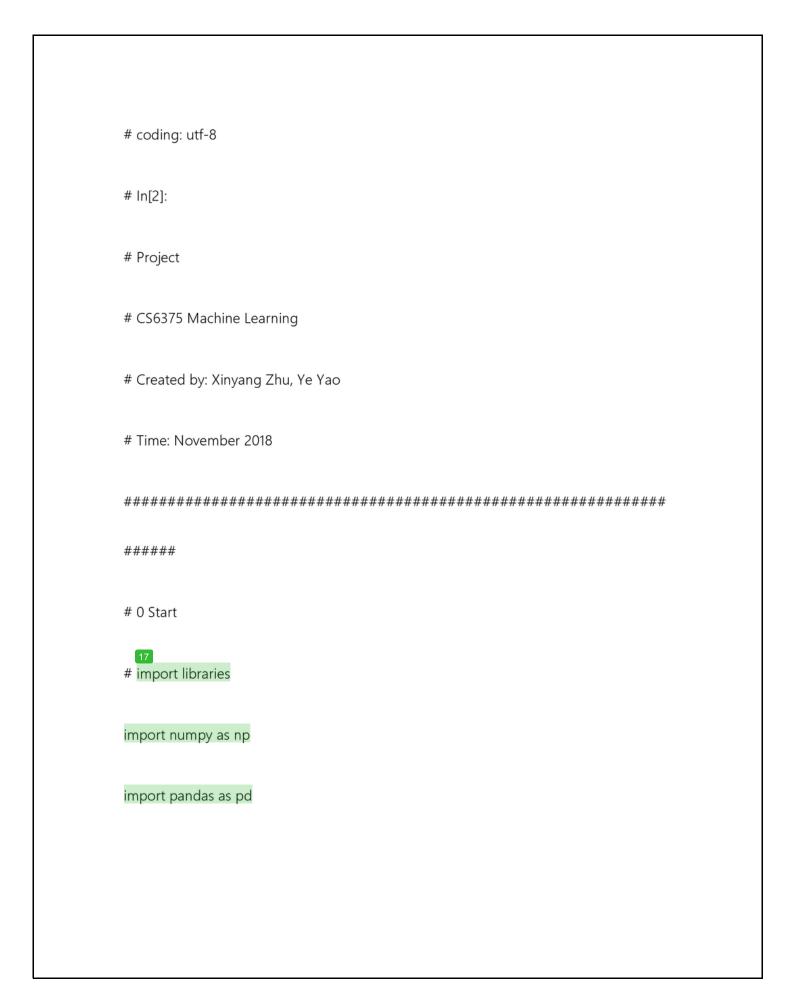
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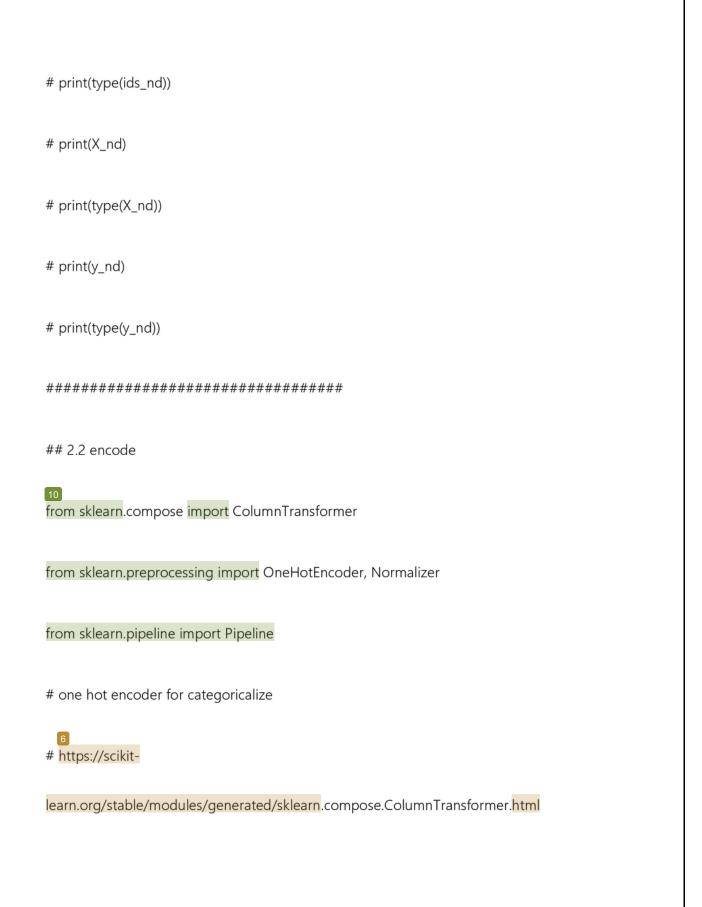


```
######
#1Load Data
# directory path
dir_path = "./dataset/"
# set the urls of dataset
train_values_url = dir_path + "Warm_Up_Machine_Learning_with_a_Heart_-
_Train_Values.csv"
train_labels_url = dir_path + "Warm_Up_Machine_Learning_with_a_Heart_-
_Train_Labels.csv"
# load dataset
values_df = pd.read_csv(train_values_url)
labels_df = pd.read_csv(train_labels_url)
```

# In[5]:	
#######################################	
#####	
# 1.2 Data Exploration	
import seaborn as sns	
values_df.head()	
# In[16]:	
values_df.dtypes	
# In[11]:	
labels_df.head()	
# In[17]:	
labels_df.dtypes	
# In[6]:	

```
labels_df.heart_disease_present.value_counts().plot.bar(title='Number with Heart
Disease')
# In[40]:
features_to_show = [ 'age',
              'sex',
             'max_heart_rate_achieved',
             'resting_blood_pressure',
             ]
sns.set(style="darkgrid")
sns.pairplot(values_df.join(labels_df['heart_disease_present']),
        hue='heart_disease_present',
        vars=values_df[features_to_show])
# In[16]:
```

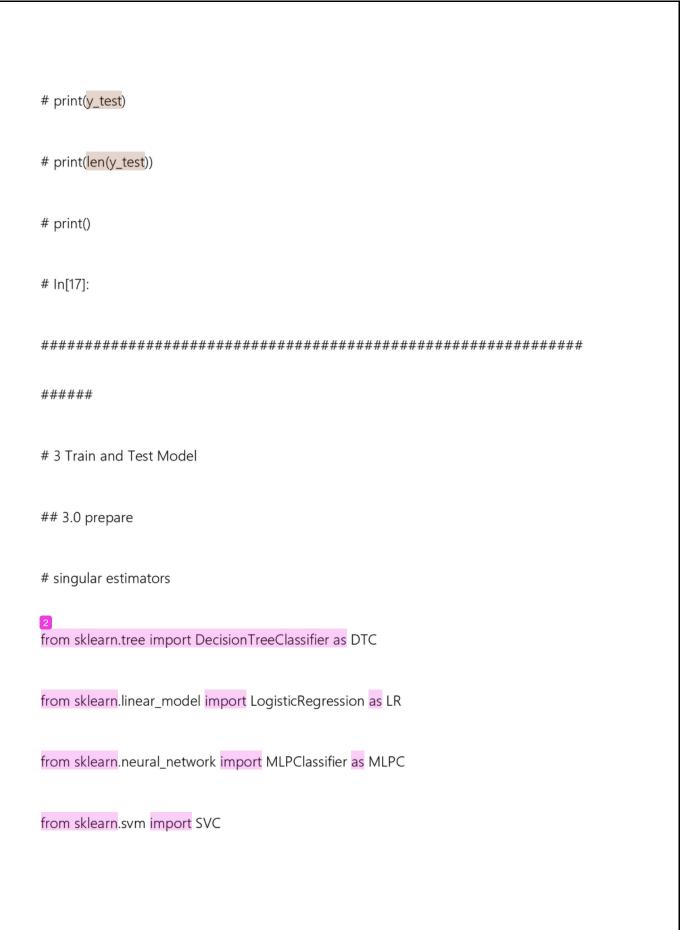
```
######
# 2 Pre-Process
## 2.1
# convert to ndarray
values_nd = values_df.values
labels_nd = labels_df.values
# separate
ids_nd = values_nd[:, 0]
X_nd = values_nd[:, 1:]
\# ids_nd, X_nd = np.split(values_nd, [1], axis=1)
y_nd = labels_nd[:, -1]
# print(ids_nd)
```



```
# https://scikit-
learn.org/stable/modules/generated/sklearn.preprocessing.OneHotEncoder.html#sklear
n.preprocessing.OneHotEncoder
# https://stackoverflow.com/questions/43588679/issue-with-onehotencoder-for-
categorical-features
ct = ColumnTransformer(
  [('enc', OneHotEncoder(), [1])],
  remainder='passthrough'
)
# normalizer
# https://scikit-
learn.org/stable/modules/generated/sklearn.preprocessing.Normalizer.html#sklearn.pre
processing. Normalizer
norm = Normalizer()
```

```
# build the preprocessing pipeline
# https://scikit-learn.org/stable/modules/generated/sklearn.pipeline.Pipeline.html
prep = Pipeline(
  [('ct', ct),
  ('norm', norm)]
)
# fit the preprocessing pipeline
prep.fit(X_nd)
# transform on X_nd
enc_X_nd = prep.transform(X_nd)
# print("X_enc_nd:\n", X_enc_nd)
## 2.3 train-test split
```

```
from sklearn.model_selection import train_test_split
# split into train and test data
X_train, X_test, y_train, y_test = train_test_split(enc_X_nd, y_nd, test_size=0.15)
# print(X_train)
# print(len(X_train))
# print(len(X_train[0]))
# print()
# print(X_test)
# print(len(X_test))
# print()
# print(y_train)
# print(len(y_train))
# print()
```



```
from sklearn.naive_bayes import GaussianNB as NB
from sklearn.neighbors import KNeighborsClassifier as KNNC
# ensembling estimators
from sklearn.ensemble import BaggingClassifier as BaggingC
from sklearn.ensemble import RandomForestClassifier as RFC
from sklearn.ensemble import AdaBoostClassifier as AdaBoostC
from sklearn.ensemble import GradientBoostingClassifier as GBC
from xgboost import XGBClassifier as XGB
# command to install xgboost:
# conda install -c conda-forge xgboost
# metrics
from sklearn.metrics import log_loss
# grid search cross validation
```

```
from sklearn.model_selection import GridSearchCV
# ignore ConverenceWarning
import warnings
from sklearn.exceptions import ConvergenceWarning
warnings.filterwarnings("ignore", category=ConvergenceWarning)
## 3.1 train and test models using GridSearchCV
models = {
  'DT': DTC(),
  'LR': LR(),
  'MLP': MLPC(),
  'SVC': SVC(),
  'NB': NB(),
```

```
'KNN': KNNC(),
  'Bagging': BaggingC(),
  'RF': RFC(),
  'AdaBoost': AdaBoostC(),
  'GB': GBC(),
  'XGB': XGB(),
}
param_dict = {
  # 0.67 {'max_depth': 1, 'max_leaf_nodes': None, 'min_samples_leaf': 1,
'min_samples_split': 2}
  'DT': {
     'max_depth': [1,2,3,None],
     'max_leaf_nodes': [4,6,8,10,None],
```

```
'min_samples_leaf': [1,2,3],
      'min_samples_split': [2,4,6]
  },
  # LR 0.64 {'C': 5.0, 'class_weight': None, 'fit_intercept': False, 'penalty': 'l2', 'solver':
'sag'}
  'LR': {
     "solver": ['lbfgs', 'liblinear', 'sag', 'saga'],
     "penalty": ['l2'],
     "C": [1.0, 1.5, 2.0, 5.0, 10],
     "fit_intercept": [True, False],
     "class_weight": [None, 'balanced']
  },
```

```
# MLP 0.63 {'activation': 'tanh', 'early_stopping': False, 'hidden_layer_sizes': (100, 100,
50), 'learning_rate': 'invscaling', 'max_iter': 1000}
  'MLP': {
     "max_iter": [500, 1000, 2000],
        "hidden_layer_sizes": [(100,100,50)],
     "hidden_layer_sizes": [
        (40,20,10),
        (20,10,5),
        (10,5,5)
     ],
     "activation": ['tanh', 'relu'],
     "learning_rate": ['constant', 'invscaling', 'adaptive'],
     "early_stopping": [True, False],
```

```
},
   # SVC 0.64 ('coef0': 0.5, 'gamma': 'scale', 'kernel': 'poly', 'probability': True, 'shrinking':
False}
   'SVC': {
     "probability": [True],
        "C": [5000, 10000, 20000, 30000],
     "kernel": ["poly", "rbf", "sigmoid"],
     "coef0": [0.0, 0.1, 0.2, 0.3, 0.5],
     "shrinking": [True, False],
     "gamma": ['scale', 'auto']
   },
   # NB 1.30 {}
   'NB': {
```

```
# Nothing can be tuned
},
# KNN 0.71 {'algorithm': 'auto', 'n_neighbors': 7, 'p': 2, 'weights': 'uniform'}
'KNN': {
  "n_neighbors": [1, 2, 3, 5, 7],
  "weights": ['uniform', 'distance'],
  "algorithm": ['auto', 'ball_tree', 'kd_tree', 'brute'],
  "p": [1, 2, 3]
},
# Bagging 0.56 {'max_features': 0.8, 'max_samples': 0.3, 'n_estimators': 100}
'Bagging': {
    "n_estimators": [10, 20, 50, 100, 200],
    "max_samples": [0.01, 0.1, 0.3, 0.5],
```

```
"max_features": [0.5, 0.8, 1.0]
  },
  # RF 0.58 {'criterion': 'gini', 'max_depth': 5, 'max_features': 'auto', 'n_estimators': 50}
  'RF': {
     "n_estimators": [10, 20, 50, 100],
     "criterion": ["gini", "entropy"],
     "max_depth": [None, 5, 10, 20],
     "max_features": [None, "auto", "log2"]
  },
  # GB 0.38 {'learning_rate': 0.05, 'max_depth': 5, 'max_features': 'log2', 'n_estimators':
50}
  'GB': {
      "learning_rate": [0.005, 0.01, 0.05, 0.1],
```

```
"n_estimators": [5, 10, 50, 100],
      "max_depth": [5, 10, 20],
      "max_features": [None, "auto", "log2"]
  },
  # AdaBoost 0.63 {'algorithm': 'SAMME.R', 'learning_rate': 1, 'n_estimators': 5}
  'AdaBoost': {
     "n_estimators": [5, 10, 20, 50, 100, 200],
     "learning_rate": [0.01, 0.1, 1],
     "algorithm": ["SAMME", "SAMME.R"],
  },
  # XGB 0.55 {'booster': 'gbtree', 'learning_rate': 0.1, 'min_child_weight': 10,
'n_estimators': 100}
  'XGB': {
```

```
"learning_rate": [0.01, 0.1, 1],
     "n_estimators": [10, 100, 200, 500],
     "min_child_weight": [5, 10, 20],
     "booster": ['gbtree', 'gblinear', 'dart']
}
####################
# DEBUG
# fast
# selected_model_names = ['DT','SVC']
# mid
# selected_model_names = ['DT','SVC','NB','KNN',
                 'Bagging','RF','AdaBoost','GB','XGB']
```

```
# all
selected_model_names = ['DT','MLP','SVC','NB','KNN',
               'Bagging','RF','AdaBoost','GB','XGB']
###################
# function: grid search cross validation
# argument: model name, e.g. 'DT'
# return: trained GridSearchCV model
def _gscv(model, params, X_train, y_train):
  gscv = GridSearchCV(model, params, iid=True, cv=3, scoring="neg_log_loss")
  gscv.fit(X_train, list(y_train))
  return gscv
# function: test gscv model on the test data
# argument: trained gscv model
```

```
# return: an array of predicted probabilities of a classification of 1
def _test(gscv, X_test, y_test):
  # test on test data
  y_pred = gscv.predict_proba(X_test)
   print("y_pred:\n", y_pred)
  # get metrics (log loss)
  print(model_name,"%.2f" % log_loss(list(y_test), y_pred), gscv.best_params_)
  # We only need the second column
  y_pred = y_pred[:,-1]
  return y_pred
# function: show the testing result
# arguments: y_pred, y_label
def _show_test_result(y_pred, y_label):
```

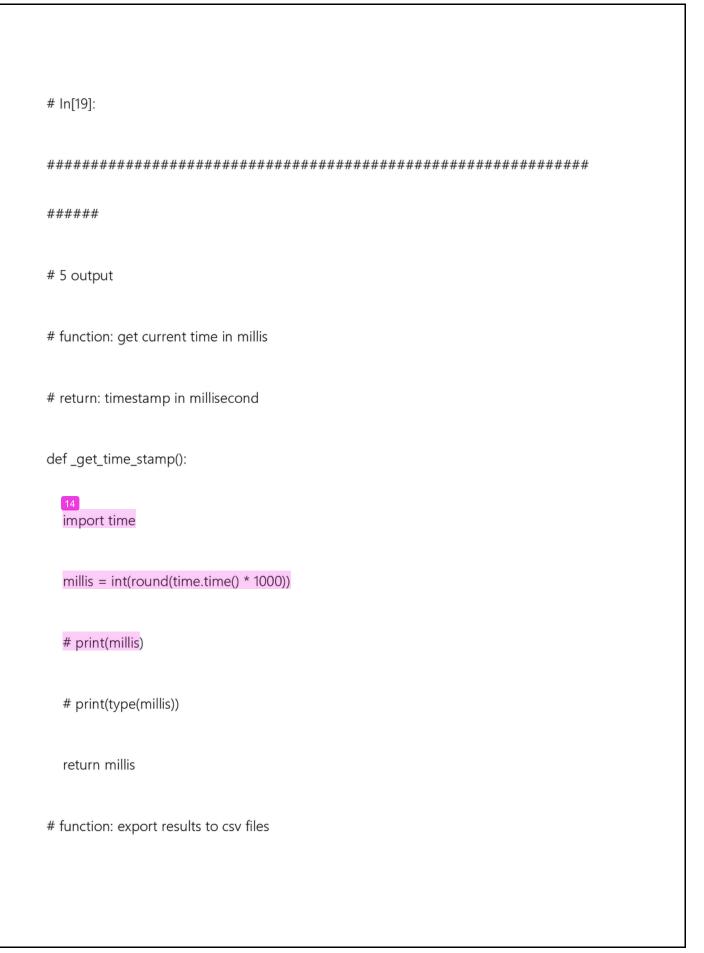
```
df = pd.DataFrame()
  df['y\_predict'] = y\_pred
  df['y_label'] = y_label
  display(df)
# function: draw ROC
# arguments: y_pred, y_label
def _draw_roc(y_pred, y_label):
  import matplotlib.pyplot as plt
  from sklearn.metrics import roc_curve, auc
  y_label = y_label.astype(int)
  # Compute ROC curve and ROC area for each class
  fpr, tpr, _ = roc_curve(y_label, y_pred)
  roc_auc = auc(fpr, tpr)
```

```
# Draw ROC curve
  plt.figure()
  plt.plot(fpr, tpr, color='darkblue',
        lw=1.5, label='ROC curve (area = %0.2f)' % roc_auc)
  plt.plot([0, 1], [0, 1], color='grey', lw=1, linestyle='--')
  plt.xlim([0.0, 1.0])
  plt.ylim([0.0, 1.05])
  plt.xlabel('False Positive Rate')
  plt.ylabel('True Positive Rate')
  plt.legend(loc="lower right")
  plt.show()
# train and test on models
gscvs = \{\}
```

```
preds = {}
for i, model_name in enumerate(selected_model_names):
  print("#", i, model_name)
  # train model
  gscv = _gscv(models[model_name], param_dict[model_name], X_train, y_train)
  gscvs[model_name] = gscv
  # test model
  y_pred = _test(gscv, X_test, y_test)
  preds[model_name] = y_pred
  # show test results
    _show_test_result(y_pred, y_test)
  # draw ROC
  _draw_roc(y_pred, y_test)
```

```
print()
# In[18]:
######
# 4 Predict on evaluation test data
## 4.1 load evaluation test dataset
test_values_url = dir_path + "Warm_Up_Machine_Learning_with_a_Heart_-
_Test_Values.csv"
test_df = pd.read_csv(test_values_url)
## 4.2 pre-process
testset_ndarr = test_df.values
test_ids, test_values = np.split(testset_ndarr, [1], axis=1)
# print(test_values)
```

```
# encode test data
enc_test_values = prep.transform(test_values)
# print(enc_test_values)
# 4.3 predict
preds = {}
for model_name in gscvs:
  gscv = gscvs[model_name]
  preds[model_name] = gscv.predict_proba(enc_test_values)
# print out predictions
# for m_n in preds:
    print(m_n)
    print(preds[m])
    print()
```



```
# argument: model name, header, patient ids, prediction probabilities
def _output(model_name, header, test_ids_list, pred):
  # export to DataFrame
  col_id_name = header[0]
  col_label_name = header[1]
  res_dict = {col_id_name: test_ids_list, col_label_name: pred[:,1]}
  res_df = pd.DataFrame.from_dict(res_dict)
  # write to csv file
  time_stamp = str(int(_get_time_stamp() / 1000))
  output_path = "./" + time_stamp + "-" + model_name + ".csv"
  res_df.to_csv(output_path, index=False)
# output predictions
header = labels_df.columns
```

```
test_ids_list = list(test_ids.flatten())
for model_name in preds:
  time_stamp = _get_time_stamp()
  _output(model_name, header, test_ids_list, preds[model_name])
```

Submission1

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