In [ ]:

```
import numpy as np
import pandas as pd
from sklearn.pipeline import make_pipeline
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from statsmodels.stats.outliers_influence import variance_inflation_factor
from sklearn import preprocessing
from patsy import dmatrices
from sklearn.linear_model import LogisticRegression
from sklearn import tree
from sklearn.metrics import accuracy_score, recall_score, precision_score, f1_score
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import AdaBoostClassifier
from sklearn.neural_network import MLPClassifier
from sklearn.datasets import make_classification
from identification import vif_detection
import time
import matplotlib.pyplot as plt
import csv
```

In [ ]:

```
### Load in Data ###
data = pd.read_csv("data_cleaning/final_data.csv")


vars = ["REGION_YEAR","AGELAST","SEX","RACETHX","MARRY_YEARX","EDUCYR",
"BORNUSA","FOODST_YEAR","TTLP_YEARX","FAMINC_YEAR","POVCAT_YEAR","POVLEV_YEAR","WAGEP_Y
"DIVDP_YEARX","SALEP_YEARX","PENSP_YEARX","PUBP_YEARX","ADHDADDX","ACTDTY",
'UNINSURED_ONLY', 'PRIVATE_ONLY', 'MEDICAID_ONLY', 'MEDICARE_ANY', 'MEDICARE_ADV', 'MED
"RTHLTH","MNHLTH","EMPST","non_opioid_prescriptions","NUM_CONDITIONS","INJURY"]

data = data.dropna()

### Run identification ###
y = pd.DataFrame(data, columns=['opioid_prescribed_at_all'])
exog = pd.DataFrame(data, columns=vars)
exog_vars = vif_detection(data,exog, y)

### Data Normalization and Splitting ###
X=pd.DataFrame(exog_vars).to_numpy()
y=pd.DataFrame(y).to_numpy().reshape(len(y),)
scaler = StandardScaler()
X = scaler.fit_transform(X)
X_scaled = scaler.transform(X)
X_train, X_test_valid, y_train, y_test_valid = train_test_split(X_scaled, y, random_sta
X_valid, X_test, y_valid, y_test = train_test_split(X_test_valid, y_test_valid, random_
```

In [ ]:

```
baseline_majority_accuracy_valid = sum(y_valid) / len(y_valid)
print(f'baseline accuracy for valid {baseline_majority_accuracy_valid}')
baseline_majority_accuracy_test = sum(y_test) / len(y_test)
print(f'baseline accuracy for test {baseline_majority_accuracy_test}')
```

```
baseline accuracy for valid 0.1841505996660088
baseline accuracy for test 0.17789921068609593
```

In [ ]:

```
### Model 1-Logistic Regression ###
```

```
start_time = time.time()
log_reg= LogisticRegression(max_iter = 1000).fit(X_train, y_train)  # apply scaling on
y_predict = log_reg.predict(X_valid)
log_reg_time = time.time() - start_time
log_reg_accuracy = accuracy_score(y_valid, y_predict)
log_reg_precision = precision_score(y_valid, y_predict)
log_reg_recall = recall_score(y_valid, y_predict)
log_reg_f1 = f1_score(y_valid, y_predict)
print(f"logistic model accuracy on valid: {log_reg_accuracy*100:.1f}%")
print(f"logistic model precision on valid: {log_reg_precision*100:.1f}%")
print(f"logistic model recall on valid: {log_reg_recall*100:.1f}%")
print(f"logistic model f1 on valid: {log_reg_f1*100:.1f}%")
print(f'logistic model time in seconds to predict valid: {log_reg_time:.1f} seconds')
```

```
logistic model accuracy on valid: 82.2%
logistic model precision on valid: 59.2%
logistic model recall on valid: 10.3%
logistic model f1 on valid: 17.6%
logistic model time in seconds to predict valid: 2.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: Conver
genceWarning: 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(
```

In [ ]:

```
### Model 2-Decision Tree ###
start_time = time.time()
decision_tree = tree.DecisionTreeClassifier()
decision_tree = decision_tree.fit(X_train, y_train)
y_predict = decision_tree.predict(X_valid)
decision_tree_time = time.time() - start_time
decision_tree_accuracy = accuracy_score(y_valid, y_predict)
decision_tree_precision = precision_score(y_valid, y_predict)
decision_tree_recall = recall_score(y_valid, y_predict)
decision_tree_f1 = f1_score(y_valid, y_predict)

print(f"decision tree model accuracy on valid: {decision_tree_accuracy*100:.1f}%")
print(f"decision tree model precision on valid: {decision_tree_precision*100:.1f}%")
print(f"decision tree model recall on valid: {decision_tree_recall*100:.1f}%")
print(f"decision tree model f1 on valid: {decision_tree_f1*100:.1f}%")
print(f'decision tree model time in seconds to predict valid: {decision_tree_time:.1f}
```

```
decision tree model accuracy on valid: 73.2%
decision tree model precision on valid: 29.5%
decision tree model recall on valid: 32.7%
decision tree model f1 on valid: 31.1%
decision tree model time in seconds to predict valid: 0.4 seconds
```

In [ ]:

```
### Model 3-Random Forest ###
random_forest_times = []
random_forest_accuracy_scores = []
random_forest_precision_scores = []
random_forest_recall_scores = []
random_forest_f1_scores = []
```

```python
for estimator in [10,50,100,250,500]:
    start_time = time.time()
    forest_model = RandomForestClassifier(random_state = 0, n_jobs = 1, n_estimators =
    forest_model = forest_model.fit(X_train, y_train)
    y_predict = forest_model.predict(X_valid)

    forest_model_time = time.time() - start_time
    forest_model_accuracy = accuracy_score(y_valid, y_predict)
    forest_model_precision = precision_score(y_valid, y_predict)
    forest_model_recall = recall_score(y_valid, y_predict)
    forest_model_f1 = f1_score(y_valid, y_predict)

    random_forest_times.append(forest_model_time)
    random_forest_accuracy_scores.append(forest_model_accuracy)
    random_forest_precision_scores.append(forest_model_precision)
    random_forest_recall_scores.append(forest_model_recall)
    random_forest_f1_scores.append(forest_model_f1)

    print(f'\nrandom forest with {estimator} estimators')
    print(f"\taccuracy on valid: {forest_model_accuracy*100:.1f}%")
    print(f"\tprecision on valid: {forest_model_precision*100:.1f}%")
    print(f"\trecall on valid: {forest_model_recall*100:.1f}%")
    print(f"\tf1 on valid: {forest_model_f1*100:.1f}%")
    print(f'\tseconds to predict valid: {forest_model_time:.1f} seconds')
```

```
random forest with 10 estimators
        accuracy on valid: 83.0%
        precision on valid: 65.1%
        recall on valid: 16.9%
        f1 on valid: 26.8%
        seconds to predict valid: 0.5 seconds

random forest with 50 estimators
        accuracy on valid: 83.4%
        precision on valid: 71.6%
        recall on valid: 16.0%
        f1 on valid: 26.1%
        seconds to predict valid: 2.5 seconds

random forest with 100 estimators
        accuracy on valid: 83.3%
        precision on valid: 70.6%
        recall on valid: 15.8%
        f1 on valid: 25.9%
        seconds to predict valid: 5.1 seconds

random forest with 250 estimators
        accuracy on valid: 83.3%
        precision on valid: 72.9%
        recall on valid: 15.1%
        f1 on valid: 25.0%
        seconds to predict valid: 12.9 seconds

random forest with 500 estimators
        accuracy on valid: 83.5%
        precision on valid: 75.7%
        recall on valid: 15.4%
        f1 on valid: 25.6%
        seconds to predict valid: 28.3 seconds
```

In [ ]:

```
### Model 4-Neural Net ###
nn_times = []
nn_accuracy_scores = []
nn_precision_scores = []
nn_recall_scores = []
nn_f1_scores = []
for layers in [(100,50,25), (10, 5, 2), (25, 25, 25), (10, 9, 8), (10, 5), (100, 25)]:
    for active_func in ['relu', 'tanh', 'logistic']:
        for alpha_val in [0.0001, 0.001, .01]:
            for max_iterations in [100, 200, 500]:
                for type_of_solver in ['sgd', 'adam']:
                    start_time = time.time()
                    if type_of_solver == 'sgd':
                        clf = MLPClassifier(hidden_layer_sizes = layers,
                                            activation = active_func,
                                            alpha = alpha_val,
                                            solver = type_of_solver,
                                            learning_rate = 'adaptive',
                                            max_iter = max_iterations,
                                            shuffle = True,
                                            random_state=1).fit(X_train, y_train)
                    if type_of_solver == 'adam':
                        clf = MLPClassifier(hidden_layer_sizes = layers,
                                            activation = active_func,
                                            alpha = alpha_val,
                                            solver = type_of_solver,
                                            max_iter = max_iterations,
                                            shuffle = True,
                                            random_state=1).fit(X_train, y_train)
                    y_predict = clf.predict(X_valid)

                    nn_time = time.time() - start_time
                    nn_accuracy = accuracy_score(y_valid, y_predict)
                    nn_precision = precision_score(y_valid, y_predict)
                    nn_recall = recall_score(y_valid, y_predict)
                    nn_f1 = f1_score(y_valid, y_predict)

                    nn_times.append(nn_time)
                    nn_accuracy_scores.append(nn_accuracy)
                    nn_precision_scores.append(nn_precision)
                    nn_recall_scores.append(nn_recall)
                    nn_f1_scores.append(nn_f1)

                    print(f"\nneural net with {layers} layers, {active_func} activation
                    print(f"\taccuracy on valid: {nn_accuracy*100:.1f}%")
                    print(f"\tprecision on valid: {nn_precision*100:.1f}%")
                    print(f"\trecall on valid: {nn_recall*100:.1f}%")
                    print(f"\tf1 on valid: {nn_f1*100:.1f}%")
                    print(f'\tseconds to predict valid: {nn_time:.1f} seconds')
```

```
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, relu activation, 0.0001 alpha, 100 max iternation
s, and sgd type of solver
        accuracy on valid: 81.9%
        precision on valid: 57.3%
        recall on valid: 7.4%
```

```
        f1 on valid: 13.1%
        seconds to predict valid: 28.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, relu activation, 0.0001 alpha, 100 max iternation
s, and adam type of solver
        accuracy on valid: 81.0%
        precision on valid: 44.7%
        recall on valid: 12.6%
        f1 on valid: 19.7%
        seconds to predict valid: 30.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, relu activation, 0.0001 alpha, 200 max iternation
s, and sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 58.0%
        recall on valid: 10.1%
        f1 on valid: 17.3%
        seconds to predict valid: 54.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, relu activation, 0.0001 alpha, 200 max iternation
s, and adam type of solver
        accuracy on valid: 80.2%
        precision on valid: 40.1%
        recall on valid: 14.9%
        f1 on valid: 21.8%
        seconds to predict valid: 67.6 seconds

neural net with (100, 50, 25) layers, relu activation, 0.0001 alpha, 500 max iternation
s, and sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 58.3%
        recall on valid: 10.1%
        f1 on valid: 17.3%
        seconds to predict valid: 64.5 seconds

neural net with (100, 50, 25) layers, relu activation, 0.0001 alpha, 500 max iternation
s, and adam type of solver
        accuracy on valid: 79.4%
        precision on valid: 37.5%
        recall on valid: 17.7%
        f1 on valid: 24.1%
        seconds to predict valid: 150.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, relu activation, 0.001 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 59.1%
```

```
        recall on valid: 7.7%
        f1 on valid: 13.7%
        seconds to predict valid: 28.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, relu activation, 0.001 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 81.1%
        precision on valid: 45.5%
        recall on valid: 13.4%
        f1 on valid: 20.8%
        seconds to predict valid: 33.7 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, relu activation, 0.001 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.9%
        recall on valid: 9.8%
        f1 on valid: 16.7%
        seconds to predict valid: 55.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, relu activation, 0.001 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 80.2%
        precision on valid: 40.2%
        recall on valid: 15.6%
        f1 on valid: 22.5%
        seconds to predict valid: 67.9 seconds

neural net with (100, 50, 25) layers, relu activation, 0.001 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.9%
        recall on valid: 9.8%
        f1 on valid: 16.7%
        seconds to predict valid: 59.1 seconds

neural net with (100, 50, 25) layers, relu activation, 0.001 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 79.9%
        precision on valid: 39.6%
        recall on valid: 17.8%
        f1 on valid: 24.6%
        seconds to predict valid: 90.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, relu activation, 0.01 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
```

```
        precision on valid: 58.2%
        recall on valid: 7.6%
        f1 on valid: 13.4%
        seconds to predict valid: 28.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, relu activation, 0.01 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 81.4%
        precision on valid: 48.2%
        recall on valid: 12.1%
        f1 on valid: 19.4%
        seconds to predict valid: 38.6 seconds

neural net with (100, 50, 25) layers, relu activation, 0.01 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.9%
        recall on valid: 10.1%
        f1 on valid: 17.2%
        seconds to predict valid: 55.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, relu activation, 0.01 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 80.6%
        precision on valid: 41.7%
        recall on valid: 13.7%
        f1 on valid: 20.6%
        seconds to predict valid: 97.6 seconds

neural net with (100, 50, 25) layers, relu activation, 0.01 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.9%
        recall on valid: 10.1%
        f1 on valid: 17.2%
        seconds to predict valid: 54.9 seconds

neural net with (100, 50, 25) layers, relu activation, 0.01 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 80.1%
        precision on valid: 39.4%
        recall on valid: 14.8%
        f1 on valid: 21.5%
        seconds to predict valid: 179.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, tanh activation, 0.0001 alpha, 100 max iternation
s, and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.8%
        recall on valid: 7.9%
```

```
        f1 on valid: 13.9%
        seconds to predict valid: 35.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, tanh activation, 0.0001 alpha, 100 max iternation
s, and adam type of solver
        accuracy on valid: 81.3%
        precision on valid: 47.7%
        recall on valid: 13.5%
        f1 on valid: 21.1%
        seconds to predict valid: 39.8 seconds

neural net with (100, 50, 25) layers, tanh activation, 0.0001 alpha, 200 max iternation
s, and sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.0%
        recall on valid: 10.4%
        f1 on valid: 17.6%
        seconds to predict valid: 68.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, tanh activation, 0.0001 alpha, 200 max iternation
s, and adam type of solver
        accuracy on valid: 79.8%
        precision on valid: 38.0%
        recall on valid: 15.7%
        f1 on valid: 22.3%
        seconds to predict valid: 81.9 seconds

neural net with (100, 50, 25) layers, tanh activation, 0.0001 alpha, 500 max iternation
s, and sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.0%
        recall on valid: 10.4%
        f1 on valid: 17.6%
        seconds to predict valid: 69.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (500) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, tanh activation, 0.0001 alpha, 500 max iternation
s, and adam type of solver
        accuracy on valid: 77.9%
        precision on valid: 35.0%
        recall on valid: 23.6%
        f1 on valid: 28.2%
        seconds to predict valid: 203.8 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, tanh activation, 0.001 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.8%
```

```
        recall on valid: 7.9%
        f1 on valid: 13.9%
        seconds to predict valid: 34.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, tanh activation, 0.001 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 81.4%
        precision on valid: 48.1%
        recall on valid: 13.3%
        f1 on valid: 20.8%
        seconds to predict valid: 40.3 seconds

neural net with (100, 50, 25) layers, tanh activation, 0.001 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.3%
        recall on valid: 10.4%
        f1 on valid: 17.6%
        seconds to predict valid: 69.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, tanh activation, 0.001 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 80.5%
        precision on valid: 42.4%
        recall on valid: 15.7%
        f1 on valid: 23.0%
        seconds to predict valid: 91.2 seconds

neural net with (100, 50, 25) layers, tanh activation, 0.001 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.3%
        recall on valid: 10.4%
        f1 on valid: 17.6%
        seconds to predict valid: 78.0 seconds

neural net with (100, 50, 25) layers, tanh activation, 0.001 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 78.4%
        precision on valid: 36.6%
        recall on valid: 23.7%
        f1 on valid: 28.8%
        seconds to predict valid: 198.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, tanh activation, 0.01 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.1%
        recall on valid: 8.0%
```

```
        f1 on valid: 14.1%
        seconds to predict valid: 44.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, tanh activation, 0.01 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 81.8%
        precision on valid: 52.1%
        recall on valid: 13.0%
        f1 on valid: 20.8%
        seconds to predict valid: 48.0 seconds

neural net with (100, 50, 25) layers, tanh activation, 0.01 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.3%
        recall on valid: 10.3%
        f1 on valid: 17.5%
        seconds to predict valid: 78.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, tanh activation, 0.01 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 81.0%
        precision on valid: 44.9%
        recall on valid: 14.1%
        f1 on valid: 21.5%
        seconds to predict valid: 86.5 seconds

neural net with (100, 50, 25) layers, tanh activation, 0.01 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.3%
        recall on valid: 10.3%
        f1 on valid: 17.5%
        seconds to predict valid: 75.5 seconds

neural net with (100, 50, 25) layers, tanh activation, 0.01 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 78.6%
        precision on valid: 35.3%
        recall on valid: 19.5%
        f1 on valid: 25.1%
        seconds to predict valid: 159.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 50, 25) layers, logistic activation, 0.0001 alpha, 100 max iternat
ions, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 18.7 seconds
```

```
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, logistic activation, 0.0001 alpha, 100 max iternat
ions, and adam type of solver
        accuracy on valid: 82.3%
        precision on valid: 62.4%
        recall on valid: 9.3%
        f1 on valid: 16.2%
        seconds to predict valid: 28.6 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 50, 25) layers, logistic activation, 0.0001 alpha, 200 max iternat
ions, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 18.4 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, logistic activation, 0.0001 alpha, 200 max iternat
ions, and adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.7%
        recall on valid: 8.7%
        f1 on valid: 15.1%
        seconds to predict valid: 915.7 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 50, 25) layers, logistic activation, 0.0001 alpha, 500 max iternat
ions, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 20.6 seconds


neural net with (100, 50, 25) layers, logistic activation, 0.0001 alpha, 500 max iternat
ions, and adam type of solver
        accuracy on valid: 81.9%
        precision on valid: 55.0%
        recall on valid: 9.5%
        f1 on valid: 16.2%
        seconds to predict valid: 208.8 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 50, 25) layers, logistic activation, 0.001 alpha, 100 max iternati
ons, and sgd type of solver
        accuracy on valid: 81.6%
```

```
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 63.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 50, 25) layers, logistic activation, 0.001 alpha, 100 max iternati
ons, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 60.2%
        recall on valid: 8.2%
        f1 on valid: 14.5%
        seconds to predict valid: 100.8 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 50, 25) layers, logistic activation, 0.001 alpha, 200 max iternati
ons, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 78.5 seconds

neural net with (100, 50, 25) layers, logistic activation, 0.001 alpha, 200 max iternati
ons, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.4%
        recall on valid: 11.5%
        f1 on valid: 19.1%
        seconds to predict valid: 55.8 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 50, 25) layers, logistic activation, 0.001 alpha, 500 max iternati
ons, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 20.4 seconds

neural net with (100, 50, 25) layers, logistic activation, 0.001 alpha, 500 max iternati
ons, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.4%
        recall on valid: 11.5%
        f1 on valid: 19.1%
        seconds to predict valid: 118.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 50, 25) layers, logistic activation, 0.01 alpha, 100 max iternatio
ns, and sgd type of solver
```

```
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 19.1 seconds

neural net with (100, 50, 25) layers, logistic activation, 0.01 alpha, 100 max iternatio
ns, and adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 58.8%
        recall on valid: 11.0%
        f1 on valid: 18.6%
        seconds to predict valid: 15.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 50, 25) layers, logistic activation, 0.01 alpha, 200 max iternatio
ns, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 20.4 seconds

neural net with (100, 50, 25) layers, logistic activation, 0.01 alpha, 200 max iternatio
ns, and adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 58.8%
        recall on valid: 11.0%
        f1 on valid: 18.6%
        seconds to predict valid: 14.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 50, 25) layers, logistic activation, 0.01 alpha, 500 max iternatio
ns, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 18.5 seconds

neural net with (100, 50, 25) layers, logistic activation, 0.01 alpha, 500 max iternatio
ns, and adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 58.8%
        recall on valid: 11.0%
        f1 on valid: 18.6%
        seconds to predict valid: 13.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5, 2) layers, relu activation, 0.0001 alpha, 100 max iternations, a
nd sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 51.8%
```

```
        recall on valid: 4.7%
        f1 on valid: 8.6%
        seconds to predict valid: 10.0 seconds

neural net with (10, 5, 2) layers, relu activation, 0.0001 alpha, 100 max iternations, a
nd adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 62.2%
        recall on valid: 8.0%
        f1 on valid: 14.2%
        seconds to predict valid: 7.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5, 2) layers, relu activation, 0.0001 alpha, 200 max iternations, a
nd sgd type of solver
        accuracy on valid: 82.2%
        precision on valid: 60.0%
        recall on valid: 9.4%
        f1 on valid: 16.3%
        seconds to predict valid: 50.4 seconds

neural net with (10, 5, 2) layers, relu activation, 0.0001 alpha, 200 max iternations, a
nd adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 62.2%
        recall on valid: 8.0%
        f1 on valid: 14.2%
        seconds to predict valid: 26.2 seconds

neural net with (10, 5, 2) layers, relu activation, 0.0001 alpha, 500 max iternations, a
nd sgd type of solver
        accuracy on valid: 82.2%
        precision on valid: 60.6%
        recall on valid: 9.0%
        f1 on valid: 15.6%
        seconds to predict valid: 90.6 seconds

neural net with (10, 5, 2) layers, relu activation, 0.0001 alpha, 500 max iternations, a
nd adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 62.2%
        recall on valid: 8.0%
        f1 on valid: 14.2%
        seconds to predict valid: 26.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5, 2) layers, relu activation, 0.001 alpha, 100 max iternations, an
d sgd type of solver
        accuracy on valid: 81.7%
        precision on valid: 53.4%
        recall on valid: 4.5%
        f1 on valid: 8.4%
        seconds to predict valid: 33.8 seconds

neural net with (10, 5, 2) layers, relu activation, 0.001 alpha, 100 max iternations, an
```

```
d adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 59.6%
        recall on valid: 9.2%
        f1 on valid: 16.0%
        seconds to predict valid: 37.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5, 2) layers, relu activation, 0.001 alpha, 200 max iternations, an
d sgd type of solver
        accuracy on valid: 82.2%
        precision on valid: 60.2%
        recall on valid: 9.2%
        f1 on valid: 16.0%
        seconds to predict valid: 68.8 seconds

neural net with (10, 5, 2) layers, relu activation, 0.001 alpha, 200 max iternations, an
d adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 59.6%
        recall on valid: 9.2%
        f1 on valid: 16.0%
        seconds to predict valid: 37.5 seconds

neural net with (10, 5, 2) layers, relu activation, 0.001 alpha, 500 max iternations, an
d sgd type of solver
        accuracy on valid: 82.2%
        precision on valid: 60.7%
        recall on valid: 8.9%
        f1 on valid: 15.5%
        seconds to predict valid: 89.8 seconds

neural net with (10, 5, 2) layers, relu activation, 0.001 alpha, 500 max iternations, an
d adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 59.6%
        recall on valid: 9.2%
        f1 on valid: 16.0%
        seconds to predict valid: 37.8 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5, 2) layers, relu activation, 0.01 alpha, 100 max iternations, and
sgd type of solver
        accuracy on valid: 81.7%
        precision on valid: 52.3%
        recall on valid: 4.6%
        f1 on valid: 8.5%
        seconds to predict valid: 37.7 seconds

neural net with (10, 5, 2) layers, relu activation, 0.01 alpha, 100 max iternations, and
adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 60.6%
        recall on valid: 8.0%
```

```
        f1 on valid: 14.1%
        seconds to predict valid: 28.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5, 2) layers, relu activation, 0.01 alpha, 200 max iternations, and
sgd type of solver
        accuracy on valid: 82.2%
        precision on valid: 60.0%
        recall on valid: 9.4%
        f1 on valid: 16.3%
        seconds to predict valid: 73.7 seconds

neural net with (10, 5, 2) layers, relu activation, 0.01 alpha, 200 max iternations, and
adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 60.6%
        recall on valid: 8.0%
        f1 on valid: 14.1%
        seconds to predict valid: 28.2 seconds

neural net with (10, 5, 2) layers, relu activation, 0.01 alpha, 500 max iternations, and
sgd type of solver
        accuracy on valid: 82.2%
        precision on valid: 60.6%
        recall on valid: 9.0%
        f1 on valid: 15.6%
        seconds to predict valid: 89.7 seconds

neural net with (10, 5, 2) layers, relu activation, 0.01 alpha, 500 max iternations, and
adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 60.6%
        recall on valid: 8.0%
        f1 on valid: 14.1%
        seconds to predict valid: 25.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5, 2) layers, tanh activation, 0.0001 alpha, 100 max iternations, a
nd sgd type of solver
        accuracy on valid: 81.7%
        precision on valid: 63.2%
        recall on valid: 2.0%
        f1 on valid: 3.8%
        seconds to predict valid: 36.3 seconds

neural net with (10, 5, 2) layers, tanh activation, 0.0001 alpha, 100 max iternations, a
nd adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 61.5%
        recall on valid: 8.8%
        f1 on valid: 15.4%
        seconds to predict valid: 27.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
```

```
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5, 2) layers, tanh activation, 0.0001 alpha, 200 max iternations, a
nd sgd type of solver
        accuracy on valid: 81.8%
        precision on valid: 53.2%
        recall on valid: 8.9%
        f1 on valid: 15.3%
        seconds to predict valid: 73.7 seconds

neural net with (10, 5, 2) layers, tanh activation, 0.0001 alpha, 200 max iternations, a
nd adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 61.5%
        recall on valid: 8.8%
        f1 on valid: 15.4%
        seconds to predict valid: 28.2 seconds

neural net with (10, 5, 2) layers, tanh activation, 0.0001 alpha, 500 max iternations, a
nd sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.7%
        recall on valid: 9.1%
        f1 on valid: 15.6%
        seconds to predict valid: 103.4 seconds

neural net with (10, 5, 2) layers, tanh activation, 0.0001 alpha, 500 max iternations, a
nd adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 61.5%
        recall on valid: 8.8%
        f1 on valid: 15.4%
        seconds to predict valid: 27.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5, 2) layers, tanh activation, 0.001 alpha, 100 max iternations, an
d sgd type of solver
        accuracy on valid: 81.7%
        precision on valid: 63.2%
        recall on valid: 2.0%
        f1 on valid: 3.8%
        seconds to predict valid: 36.2 seconds

neural net with (10, 5, 2) layers, tanh activation, 0.001 alpha, 100 max iternations, an
d adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 61.0%
        recall on valid: 8.9%
        f1 on valid: 15.5%
        seconds to predict valid: 27.7 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5, 2) layers, tanh activation, 0.001 alpha, 200 max iternations, an
d sgd type of solver
        accuracy on valid: 81.8%
```

```
        precision on valid: 53.5%
        recall on valid: 8.9%
        f1 on valid: 15.3%
        seconds to predict valid: 72.9 seconds

neural net with (10, 5, 2) layers, tanh activation, 0.001 alpha, 200 max iternations, an
d adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 61.0%
        recall on valid: 8.9%
        f1 on valid: 15.5%
        seconds to predict valid: 27.0 seconds

neural net with (10, 5, 2) layers, tanh activation, 0.001 alpha, 500 max iternations, an
d sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.7%
        recall on valid: 9.1%
        f1 on valid: 15.6%
        seconds to predict valid: 88.8 seconds

neural net with (10, 5, 2) layers, tanh activation, 0.001 alpha, 500 max iternations, an
d adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 61.0%
        recall on valid: 8.9%
        f1 on valid: 15.5%
        seconds to predict valid: 8.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5, 2) layers, tanh activation, 0.01 alpha, 100 max iternations, and
sgd type of solver
        accuracy on valid: 81.7%
        precision on valid: 62.2%
        recall on valid: 1.9%
        f1 on valid: 3.7%
        seconds to predict valid: 10.6 seconds

neural net with (10, 5, 2) layers, tanh activation, 0.01 alpha, 100 max iternations, and
adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 60.7%
        recall on valid: 8.7%
        f1 on valid: 15.2%
        seconds to predict valid: 8.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5, 2) layers, tanh activation, 0.01 alpha, 200 max iternations, and
sgd type of solver
        accuracy on valid: 81.9%
        precision on valid: 54.4%
        recall on valid: 9.2%
        f1 on valid: 15.7%
        seconds to predict valid: 21.1 seconds
```

```
neural net with (10, 5, 2) layers, tanh activation, 0.01 alpha, 200 max iternations, and
adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 60.7%
        recall on valid: 8.7%
        f1 on valid: 15.2%
        seconds to predict valid: 15.1 seconds

neural net with (10, 5, 2) layers, tanh activation, 0.01 alpha, 500 max iternations, and
sgd type of solver
        accuracy on valid: 81.9%
        precision on valid: 55.9%
        recall on valid: 9.0%
        f1 on valid: 15.5%
        seconds to predict valid: 98.5 seconds

neural net with (10, 5, 2) layers, tanh activation, 0.01 alpha, 500 max iternations, and
adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 60.7%
        recall on valid: 8.7%
        f1 on valid: 15.2%
        seconds to predict valid: 27.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.0001 alpha, 100 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 23.8 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.0001 alpha, 100 max iternation
s, and adam type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 24.8 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.0001 alpha, 200 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 23.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
```

```
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.0001 alpha, 200 max iternation
s, and adam type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 24.4 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.0001 alpha, 500 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 23.4 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.0001 alpha, 500 max iternation
s, and adam type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 25.2 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.001 alpha, 100 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 24.3 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.001 alpha, 100 max iternation
s, and adam type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 24.1 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.001 alpha, 200 max iternation
```

```
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 23.0 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.001 alpha, 200 max iternation
s, and adam type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 25.1 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.001 alpha, 500 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 24.4 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.001 alpha, 500 max iternation
s, and adam type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 24.9 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.01 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 24.0 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.01 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
```

```
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 25.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.01 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 23.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.01 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 24.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.01 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 23.7 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5, 2) layers, logistic activation, 0.01 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 25.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, relu activation, 0.0001 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 81.8%
        precision on valid: 53.0%
        recall on valid: 10.9%
        f1 on valid: 18.1%
        seconds to predict valid: 59.0 seconds
```

```
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, relu activation, 0.0001 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 81.8%
        precision on valid: 52.5%
        recall on valid: 11.5%
        f1 on valid: 18.8%
        seconds to predict valid: 74.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, relu activation, 0.0001 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.9%
        recall on valid: 8.7%
        f1 on valid: 15.2%
        seconds to predict valid: 114.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, relu activation, 0.0001 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 81.7%
        precision on valid: 50.8%
        recall on valid: 12.7%
        f1 on valid: 20.3%
        seconds to predict valid: 170.1 seconds

neural net with (25, 25, 25) layers, relu activation, 0.0001 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.4%
        recall on valid: 9.6%
        f1 on valid: 16.4%
        seconds to predict valid: 152.0 seconds

neural net with (25, 25, 25) layers, relu activation, 0.0001 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 81.8%
        precision on valid: 52.7%
        recall on valid: 9.8%
        f1 on valid: 16.5%
        seconds to predict valid: 220.8 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, relu activation, 0.001 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 81.7%
        precision on valid: 51.8%
        recall on valid: 11.0%
```

```
        f1 on valid: 18.1%
        seconds to predict valid: 58.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, relu activation, 0.001 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 81.9%
        precision on valid: 54.7%
        recall on valid: 10.1%
        f1 on valid: 17.1%
        seconds to predict valid: 75.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, relu activation, 0.001 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.3%
        recall on valid: 9.4%
        f1 on valid: 16.1%
        seconds to predict valid: 118.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, relu activation, 0.001 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 81.6%
        precision on valid: 50.7%
        recall on valid: 12.6%
        f1 on valid: 20.2%
        seconds to predict valid: 167.2 seconds

neural net with (25, 25, 25) layers, relu activation, 0.001 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.2%
        recall on valid: 9.5%
        f1 on valid: 16.3%
        seconds to predict valid: 114.3 seconds

neural net with (25, 25, 25) layers, relu activation, 0.001 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 81.6%
        precision on valid: 50.2%
        recall on valid: 13.5%
        f1 on valid: 21.3%
        seconds to predict valid: 144.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, relu activation, 0.01 alpha, 100 max iternations, a
nd sgd type of solver
        accuracy on valid: 81.7%
        precision on valid: 52.0%
```

```
        recall on valid: 10.7%
        f1 on valid: 17.8%
        seconds to predict valid: 17.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, relu activation, 0.01 alpha, 100 max iternations, a
nd adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 55.4%
        recall on valid: 13.0%
        f1 on valid: 21.1%
        seconds to predict valid: 26.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, relu activation, 0.01 alpha, 200 max iternations, a
nd sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.8%
        recall on valid: 8.8%
        f1 on valid: 15.3%
        seconds to predict valid: 35.8 seconds

neural net with (25, 25, 25) layers, relu activation, 0.01 alpha, 200 max iternations, a
nd adam type of solver
        accuracy on valid: 81.9%
        precision on valid: 54.7%
        recall on valid: 10.6%
        f1 on valid: 17.8%
        seconds to predict valid: 81.3 seconds

neural net with (25, 25, 25) layers, relu activation, 0.01 alpha, 500 max iternations, a
nd sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.7%
        recall on valid: 9.5%
        f1 on valid: 16.2%
        seconds to predict valid: 85.3 seconds

neural net with (25, 25, 25) layers, relu activation, 0.01 alpha, 500 max iternations, a
nd adam type of solver
        accuracy on valid: 81.9%
        precision on valid: 54.7%
        recall on valid: 10.6%
        f1 on valid: 17.8%
        seconds to predict valid: 94.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, tanh activation, 0.0001 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 81.9%
        precision on valid: 54.8%
        recall on valid: 8.5%
```

```
        f1 on valid: 14.7%
        seconds to predict valid: 1332.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, tanh activation, 0.0001 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.4%
        recall on valid: 10.6%
        f1 on valid: 17.7%
        seconds to predict valid: 30.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, tanh activation, 0.0001 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.1%
        recall on valid: 10.0%
        f1 on valid: 17.0%
        seconds to predict valid: 41.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, tanh activation, 0.0001 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 81.9%
        precision on valid: 53.4%
        recall on valid: 11.8%
        f1 on valid: 19.3%
        seconds to predict valid: 45.6 seconds

neural net with (25, 25, 25) layers, tanh activation, 0.0001 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.3%
        recall on valid: 10.0%
        f1 on valid: 17.0%
        seconds to predict valid: 47.6 seconds

neural net with (25, 25, 25) layers, tanh activation, 0.0001 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 81.3%
        precision on valid: 46.9%
        recall on valid: 12.3%
        f1 on valid: 19.5%
        seconds to predict valid: 115.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, tanh activation, 0.001 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 81.9%
        precision on valid: 54.8%
```

```
        recall on valid: 8.5%
        f1 on valid: 14.7%
        seconds to predict valid: 20.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, tanh activation, 0.001 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 81.9%
        precision on valid: 54.0%
        recall on valid: 10.6%
        f1 on valid: 17.8%
        seconds to predict valid: 21.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, tanh activation, 0.001 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.1%
        recall on valid: 10.0%
        f1 on valid: 17.0%
        seconds to predict valid: 39.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, tanh activation, 0.001 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 81.8%
        precision on valid: 52.6%
        recall on valid: 10.1%
        f1 on valid: 17.0%
        seconds to predict valid: 44.4 seconds

neural net with (25, 25, 25) layers, tanh activation, 0.001 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.3%
        recall on valid: 10.0%
        f1 on valid: 17.0%
        seconds to predict valid: 45.4 seconds

neural net with (25, 25, 25) layers, tanh activation, 0.001 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 81.6%
        precision on valid: 50.0%
        recall on valid: 14.1%
        f1 on valid: 22.0%
        seconds to predict valid: 82.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, tanh activation, 0.01 alpha, 100 max iternations, a
nd sgd type of solver
        accuracy on valid: 81.9%
```

```
        precision on valid: 55.1%
        recall on valid: 8.5%
        f1 on valid: 14.7%
        seconds to predict valid: 19.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, tanh activation, 0.01 alpha, 100 max iternations, a
nd adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.5%
        recall on valid: 10.5%
        f1 on valid: 17.6%
        seconds to predict valid: 25.8 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, tanh activation, 0.01 alpha, 200 max iternations, a
nd sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.3%
        recall on valid: 10.0%
        f1 on valid: 17.0%
        seconds to predict valid: 46.5 seconds

neural net with (25, 25, 25) layers, tanh activation, 0.01 alpha, 200 max iternations, a
nd adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.2%
        recall on valid: 10.5%
        f1 on valid: 17.7%
        seconds to predict valid: 31.8 seconds

neural net with (25, 25, 25) layers, tanh activation, 0.01 alpha, 500 max iternations, a
nd sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.6%
        recall on valid: 10.0%
        f1 on valid: 17.0%
        seconds to predict valid: 52.1 seconds

neural net with (25, 25, 25) layers, tanh activation, 0.01 alpha, 500 max iternations, a
nd adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.2%
        recall on valid: 10.5%
        f1 on valid: 17.7%
        seconds to predict valid: 28.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (25, 25, 25) layers, logistic activation, 0.0001 alpha, 100 max iternati
ons, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
```

```
        f1 on valid: 0.0%
        seconds to predict valid: 13.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, logistic activation, 0.0001 alpha, 100 max iternati
ons, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 58.0%
        recall on valid: 10.1%
        f1 on valid: 17.3%
        seconds to predict valid: 23.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (25, 25, 25) layers, logistic activation, 0.0001 alpha, 200 max iternati
ons, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 14.2 seconds

neural net with (25, 25, 25) layers, logistic activation, 0.0001 alpha, 200 max iternati
ons, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 61.0%
        recall on valid: 7.7%
        f1 on valid: 13.8%
        seconds to predict valid: 28.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (25, 25, 25) layers, logistic activation, 0.0001 alpha, 500 max iternati
ons, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 15.3 seconds

neural net with (25, 25, 25) layers, logistic activation, 0.0001 alpha, 500 max iternati
ons, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 61.0%
        recall on valid: 7.7%
        f1 on valid: 13.8%
        seconds to predict valid: 29.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (25, 25, 25) layers, logistic activation, 0.001 alpha, 100 max iternatio
ns, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
```

```
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 14.7 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, logistic activation, 0.001 alpha, 100 max iternatio
ns, and adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.8%
        recall on valid: 10.0%
        f1 on valid: 17.0%
        seconds to predict valid: 23.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (25, 25, 25) layers, logistic activation, 0.001 alpha, 200 max iternatio
ns, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 14.7 seconds

neural net with (25, 25, 25) layers, logistic activation, 0.001 alpha, 200 max iternatio
ns, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 61.4%
        recall on valid: 7.7%
        f1 on valid: 13.8%
        seconds to predict valid: 29.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (25, 25, 25) layers, logistic activation, 0.001 alpha, 500 max iternatio
ns, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 14.6 seconds

neural net with (25, 25, 25) layers, logistic activation, 0.001 alpha, 500 max iternatio
ns, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 61.4%
        recall on valid: 7.7%
        f1 on valid: 13.8%
        seconds to predict valid: 28.7 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (25, 25, 25) layers, logistic activation, 0.01 alpha, 100 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
```

```
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 15.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (25, 25, 25) layers, logistic activation, 0.01 alpha, 100 max iternation
s, and adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.1%
        recall on valid: 10.6%
        f1 on valid: 17.9%
        seconds to predict valid: 23.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (25, 25, 25) layers, logistic activation, 0.01 alpha, 200 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 14.3 seconds

neural net with (25, 25, 25) layers, logistic activation, 0.01 alpha, 200 max iternation
s, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 59.4%
        recall on valid: 8.8%
        f1 on valid: 15.4%
        seconds to predict valid: 26.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (25, 25, 25) layers, logistic activation, 0.01 alpha, 500 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 15.1 seconds

neural net with (25, 25, 25) layers, logistic activation, 0.01 alpha, 500 max iternation
s, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 59.4%
        recall on valid: 8.8%
        f1 on valid: 15.4%
        seconds to predict valid: 26.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, relu activation, 0.0001 alpha, 100 max iternations, a
nd sgd type of solver
```

```
        accuracy on valid: 82.0%
        precision on valid: 56.5%
        recall on valid: 10.0%
        f1 on valid: 17.0%
        seconds to predict valid: 12.2 seconds

neural net with (10, 9, 8) layers, relu activation, 0.0001 alpha, 100 max iternations, a
nd adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 58.0%
        recall on valid: 10.1%
        f1 on valid: 17.3%
        seconds to predict valid: 13.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, relu activation, 0.0001 alpha, 200 max iternations, a
nd sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.8%
        recall on valid: 10.3%
        f1 on valid: 17.4%
        seconds to predict valid: 23.8 seconds

neural net with (10, 9, 8) layers, relu activation, 0.0001 alpha, 200 max iternations, a
nd adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 58.0%
        recall on valid: 10.1%
        f1 on valid: 17.3%
        seconds to predict valid: 13.2 seconds

neural net with (10, 9, 8) layers, relu activation, 0.0001 alpha, 500 max iternations, a
nd sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.8%
        recall on valid: 10.3%
        f1 on valid: 17.4%
        seconds to predict valid: 25.8 seconds

neural net with (10, 9, 8) layers, relu activation, 0.0001 alpha, 500 max iternations, a
nd adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 58.0%
        recall on valid: 10.1%
        f1 on valid: 17.3%
        seconds to predict valid: 13.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, relu activation, 0.001 alpha, 100 max iternations, an
d sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.0%
        recall on valid: 10.1%
        f1 on valid: 17.1%
        seconds to predict valid: 11.8 seconds
```

```
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, relu activation, 0.001 alpha, 100 max iternations, an
d adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 58.2%
        recall on valid: 10.0%
        f1 on valid: 17.0%
        seconds to predict valid: 13.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, relu activation, 0.001 alpha, 200 max iternations, an
d sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.9%
        recall on valid: 10.2%
        f1 on valid: 17.3%
        seconds to predict valid: 23.4 seconds

neural net with (10, 9, 8) layers, relu activation, 0.001 alpha, 200 max iternations, an
d adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.2%
        recall on valid: 11.2%
        f1 on valid: 18.7%
        seconds to predict valid: 21.5 seconds

neural net with (10, 9, 8) layers, relu activation, 0.001 alpha, 500 max iternations, an
d sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.9%
        recall on valid: 10.2%
        f1 on valid: 17.3%
        seconds to predict valid: 24.8 seconds

neural net with (10, 9, 8) layers, relu activation, 0.001 alpha, 500 max iternations, an
d adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.2%
        recall on valid: 11.2%
        f1 on valid: 18.7%
        seconds to predict valid: 20.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, relu activation, 0.01 alpha, 100 max iternations, and
sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.2%
        recall on valid: 10.1%
        f1 on valid: 17.2%
        seconds to predict valid: 11.3 seconds

neural net with (10, 9, 8) layers, relu activation, 0.01 alpha, 100 max iternations, and
```

```
adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 60.2%
        recall on valid: 9.5%
        f1 on valid: 16.4%
        seconds to predict valid: 13.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, relu activation, 0.01 alpha, 200 max iternations, and
sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.4%
        recall on valid: 10.6%
        f1 on valid: 17.8%
        seconds to predict valid: 24.2 seconds

neural net with (10, 9, 8) layers, relu activation, 0.01 alpha, 200 max iternations, and
adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 60.2%
        recall on valid: 9.5%
        f1 on valid: 16.4%
        seconds to predict valid: 13.4 seconds

neural net with (10, 9, 8) layers, relu activation, 0.01 alpha, 500 max iternations, and
sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.6%
        recall on valid: 10.6%
        f1 on valid: 17.8%
        seconds to predict valid: 25.8 seconds

neural net with (10, 9, 8) layers, relu activation, 0.01 alpha, 500 max iternations, and
adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 60.2%
        recall on valid: 9.5%
        f1 on valid: 16.4%
        seconds to predict valid: 13.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, tanh activation, 0.0001 alpha, 100 max iternations, a
nd sgd type of solver
        accuracy on valid: 81.9%
        precision on valid: 57.2%
        recall on valid: 7.8%
        f1 on valid: 13.8%
        seconds to predict valid: 13.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, tanh activation, 0.0001 alpha, 100 max iternations, a
nd adam type of solver
        accuracy on valid: 82.0%
```

```
        precision on valid: 58.4%
        recall on valid: 7.2%
        f1 on valid: 12.8%
        seconds to predict valid: 16.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, tanh activation, 0.0001 alpha, 200 max iternations, a
nd sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.4%
        recall on valid: 8.6%
        f1 on valid: 15.0%
        seconds to predict valid: 27.8 seconds

neural net with (10, 9, 8) layers, tanh activation, 0.0001 alpha, 200 max iternations, a
nd adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.0%
        recall on valid: 7.5%
        f1 on valid: 13.3%
        seconds to predict valid: 14.1 seconds

neural net with (10, 9, 8) layers, tanh activation, 0.0001 alpha, 500 max iternations, a
nd sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.4%
        recall on valid: 8.6%
        f1 on valid: 15.0%
        seconds to predict valid: 26.2 seconds

neural net with (10, 9, 8) layers, tanh activation, 0.0001 alpha, 500 max iternations, a
nd adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.0%
        recall on valid: 7.5%
        f1 on valid: 13.3%
        seconds to predict valid: 14.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, tanh activation, 0.001 alpha, 100 max iternations, an
d sgd type of solver
        accuracy on valid: 81.9%
        precision on valid: 57.2%
        recall on valid: 7.8%
        f1 on valid: 13.8%
        seconds to predict valid: 13.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, tanh activation, 0.001 alpha, 100 max iternations, an
d adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.9%
        recall on valid: 7.1%
```

```
        f1 on valid: 12.7%
        seconds to predict valid: 14.7 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, tanh activation, 0.001 alpha, 200 max iternations, an
d sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.4%
        recall on valid: 8.6%
        f1 on valid: 15.0%
        seconds to predict valid: 26.2 seconds

neural net with (10, 9, 8) layers, tanh activation, 0.001 alpha, 200 max iternations, an
d adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.6%
        recall on valid: 7.6%
        f1 on valid: 13.4%
        seconds to predict valid: 14.9 seconds

neural net with (10, 9, 8) layers, tanh activation, 0.001 alpha, 500 max iternations, an
d sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.4%
        recall on valid: 8.6%
        f1 on valid: 15.0%
        seconds to predict valid: 28.8 seconds

neural net with (10, 9, 8) layers, tanh activation, 0.001 alpha, 500 max iternations, an
d adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.6%
        recall on valid: 7.6%
        f1 on valid: 13.4%
        seconds to predict valid: 14.8 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, tanh activation, 0.01 alpha, 100 max iternations, and
sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.8%
        recall on valid: 8.2%
        f1 on valid: 14.4%
        seconds to predict valid: 13.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, tanh activation, 0.01 alpha, 100 max iternations, and
adam type of solver
        accuracy on valid: 81.9%
        precision on valid: 57.8%
        recall on valid: 7.0%
        f1 on valid: 12.5%
        seconds to predict valid: 14.5 seconds
```

```
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, tanh activation, 0.01 alpha, 200 max iternations, and
sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.1%
        recall on valid: 8.6%
        f1 on valid: 14.9%
        seconds to predict valid: 26.1 seconds

neural net with (10, 9, 8) layers, tanh activation, 0.01 alpha, 200 max iternations, and
adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.4%
        recall on valid: 7.2%
        f1 on valid: 12.8%
        seconds to predict valid: 13.1 seconds

neural net with (10, 9, 8) layers, tanh activation, 0.01 alpha, 500 max iternations, and
sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.1%
        recall on valid: 8.6%
        f1 on valid: 14.9%
        seconds to predict valid: 24.5 seconds

neural net with (10, 9, 8) layers, tanh activation, 0.01 alpha, 500 max iternations, and
adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.4%
        recall on valid: 7.2%
        f1 on valid: 12.8%
        seconds to predict valid: 12.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 9, 8) layers, logistic activation, 0.0001 alpha, 100 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 7.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, logistic activation, 0.0001 alpha, 100 max iternation
s, and adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 59.9%
        recall on valid: 10.0%
        f1 on valid: 17.1%
        seconds to predict valid: 11.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
```

```
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 9, 8) layers, logistic activation, 0.0001 alpha, 200 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 7.1 seconds

neural net with (10, 9, 8) layers, logistic activation, 0.0001 alpha, 200 max iternation
s, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 60.9%
        recall on valid: 8.5%
        f1 on valid: 14.9%
        seconds to predict valid: 14.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 9, 8) layers, logistic activation, 0.0001 alpha, 500 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 7.0 seconds

neural net with (10, 9, 8) layers, logistic activation, 0.0001 alpha, 500 max iternation
s, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 60.9%
        recall on valid: 8.5%
        f1 on valid: 14.9%
        seconds to predict valid: 14.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 9, 8) layers, logistic activation, 0.001 alpha, 100 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 7.1 seconds

neural net with (10, 9, 8) layers, logistic activation, 0.001 alpha, 100 max iternation
s, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 61.3%
        recall on valid: 7.8%
        f1 on valid: 13.9%
        seconds to predict valid: 9.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

```
neural net with (10, 9, 8) layers, logistic activation, 0.001 alpha, 200 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 6.9 seconds

neural net with (10, 9, 8) layers, logistic activation, 0.001 alpha, 200 max iternation
s, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 61.3%
        recall on valid: 7.8%
        f1 on valid: 13.9%
        seconds to predict valid: 8.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 9, 8) layers, logistic activation, 0.001 alpha, 500 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 6.9 seconds

neural net with (10, 9, 8) layers, logistic activation, 0.001 alpha, 500 max iternation
s, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 61.3%
        recall on valid: 7.8%
        f1 on valid: 13.9%
        seconds to predict valid: 8.8 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 9, 8) layers, logistic activation, 0.01 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 6.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 9, 8) layers, logistic activation, 0.01 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.9%
        recall on valid: 9.1%
        f1 on valid: 15.7%
        seconds to predict valid: 11.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
```

```
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 9, 8) layers, logistic activation, 0.01 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 6.9 seconds

neural net with (10, 9, 8) layers, logistic activation, 0.01 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 60.6%
        recall on valid: 8.5%
        f1 on valid: 14.9%
        seconds to predict valid: 11.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 9, 8) layers, logistic activation, 0.01 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 7.0 seconds

neural net with (10, 9, 8) layers, logistic activation, 0.01 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 60.6%
        recall on valid: 8.5%
        f1 on valid: 14.9%
        seconds to predict valid: 11.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5) layers, relu activation, 0.0001 alpha, 100 max iternations, and
sgd type of solver
        accuracy on valid: 81.8%
        precision on valid: 62.5%
        recall on valid: 2.9%
        f1 on valid: 5.5%
        seconds to predict valid: 8.6 seconds

neural net with (10, 5) layers, relu activation, 0.0001 alpha, 100 max iternations, and
adam type of solver
        accuracy on valid: 81.9%
        precision on valid: 59.8%
        recall on valid: 5.3%
        f1 on valid: 9.7%
        seconds to predict valid: 8.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
```

```
neural net with (10, 5) layers, relu activation, 0.0001 alpha, 200 max iternations, and
sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.7%
        recall on valid: 10.1%
        f1 on valid: 17.2%
        seconds to predict valid: 19.2 seconds

neural net with (10, 5) layers, relu activation, 0.0001 alpha, 200 max iternations, and
adam type of solver
        accuracy on valid: 81.9%
        precision on valid: 59.8%
        recall on valid: 5.3%
        f1 on valid: 9.7%
        seconds to predict valid: 8.9 seconds

neural net with (10, 5) layers, relu activation, 0.0001 alpha, 500 max iternations, and
sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.7%
        recall on valid: 10.1%
        f1 on valid: 17.2%
        seconds to predict valid: 20.3 seconds

neural net with (10, 5) layers, relu activation, 0.0001 alpha, 500 max iternations, and
adam type of solver
        accuracy on valid: 81.9%
        precision on valid: 59.8%
        recall on valid: 5.3%
        f1 on valid: 9.7%
        seconds to predict valid: 8.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5) layers, relu activation, 0.001 alpha, 100 max iternations, and s
gd type of solver
        accuracy on valid: 81.8%
        precision on valid: 62.5%
        recall on valid: 2.9%
        f1 on valid: 5.5%
        seconds to predict valid: 8.5 seconds

neural net with (10, 5) layers, relu activation, 0.001 alpha, 100 max iternations, and a
dam type of solver
        accuracy on valid: 81.9%
        precision on valid: 60.4%
        recall on valid: 5.3%
        f1 on valid: 9.7%
        seconds to predict valid: 7.7 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5) layers, relu activation, 0.001 alpha, 200 max iternations, and s
gd type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.2%
        recall on valid: 10.1%
```

```
        f1 on valid: 17.2%
        seconds to predict valid: 18.2 seconds

neural net with (10, 5) layers, relu activation, 0.001 alpha, 200 max iternations, and a
dam type of solver
        accuracy on valid: 81.9%
        precision on valid: 60.4%
        recall on valid: 5.3%
        f1 on valid: 9.7%
        seconds to predict valid: 9.0 seconds

neural net with (10, 5) layers, relu activation, 0.001 alpha, 500 max iternations, and s
gd type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.2%
        recall on valid: 10.1%
        f1 on valid: 17.2%
        seconds to predict valid: 18.1 seconds

neural net with (10, 5) layers, relu activation, 0.001 alpha, 500 max iternations, and a
dam type of solver
        accuracy on valid: 81.9%
        precision on valid: 60.4%
        recall on valid: 5.3%
        f1 on valid: 9.7%
        seconds to predict valid: 8.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5) layers, relu activation, 0.01 alpha, 100 max iternations, and sg
d type of solver
        accuracy on valid: 81.8%
        precision on valid: 62.5%
        recall on valid: 2.9%
        f1 on valid: 5.5%
        seconds to predict valid: 8.6 seconds

neural net with (10, 5) layers, relu activation, 0.01 alpha, 100 max iternations, and ad
am type of solver
        accuracy on valid: 81.9%
        precision on valid: 54.9%
        recall on valid: 9.3%
        f1 on valid: 15.9%
        seconds to predict valid: 7.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5) layers, relu activation, 0.01 alpha, 200 max iternations, and sg
d type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.7%
        recall on valid: 10.1%
        f1 on valid: 17.2%
        seconds to predict valid: 17.7 seconds

neural net with (10, 5) layers, relu activation, 0.01 alpha, 200 max iternations, and ad
am type of solver
```

```
        accuracy on valid: 81.9%
        precision on valid: 54.9%
        recall on valid: 9.3%
        f1 on valid: 15.9%
        seconds to predict valid: 6.6 seconds

neural net with (10, 5) layers, relu activation, 0.01 alpha, 500 max iternations, and sg
d type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.7%
        recall on valid: 10.1%
        f1 on valid: 17.2%
        seconds to predict valid: 19.2 seconds

neural net with (10, 5) layers, relu activation, 0.01 alpha, 500 max iternations, and ad
am type of solver
        accuracy on valid: 81.9%
        precision on valid: 54.9%
        recall on valid: 9.3%
        f1 on valid: 15.9%
        seconds to predict valid: 6.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5) layers, tanh activation, 0.0001 alpha, 100 max iternations, and
sgd type of solver
        accuracy on valid: 81.8%
        precision on valid: 57.1%
        recall on valid: 3.6%
        f1 on valid: 6.8%
        seconds to predict valid: 9.4 seconds

neural net with (10, 5) layers, tanh activation, 0.0001 alpha, 100 max iternations, and
adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.5%
        recall on valid: 8.8%
        f1 on valid: 15.3%
        seconds to predict valid: 10.7 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5) layers, tanh activation, 0.0001 alpha, 200 max iternations, and
sgd type of solver
        accuracy on valid: 81.9%
        precision on valid: 56.6%
        recall on valid: 8.1%
        f1 on valid: 14.1%
        seconds to predict valid: 20.4 seconds

neural net with (10, 5) layers, tanh activation, 0.0001 alpha, 200 max iternations, and
adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.5%
        recall on valid: 8.8%
        f1 on valid: 15.3%
        seconds to predict valid: 10.3 seconds
```

```
neural net with (10, 5) layers, tanh activation, 0.0001 alpha, 500 max iternations, and
sgd type of solver
        accuracy on valid: 81.9%
        precision on valid: 57.0%
        recall on valid: 8.1%
        f1 on valid: 14.2%
        seconds to predict valid: 20.5 seconds

neural net with (10, 5) layers, tanh activation, 0.0001 alpha, 500 max iternations, and
adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.5%
        recall on valid: 8.8%
        f1 on valid: 15.3%
        seconds to predict valid: 10.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5) layers, tanh activation, 0.001 alpha, 100 max iternations, and s
gd type of solver
        accuracy on valid: 81.8%
        precision on valid: 57.1%
        recall on valid: 3.6%
        f1 on valid: 6.8%
        seconds to predict valid: 9.6 seconds

neural net with (10, 5) layers, tanh activation, 0.001 alpha, 100 max iternations, and a
dam type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.9%
        recall on valid: 9.1%
        f1 on valid: 15.7%
        seconds to predict valid: 11.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5) layers, tanh activation, 0.001 alpha, 200 max iternations, and s
gd type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.2%
        recall on valid: 8.2%
        f1 on valid: 14.3%
        seconds to predict valid: 20.5 seconds

neural net with (10, 5) layers, tanh activation, 0.001 alpha, 200 max iternations, and a
dam type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.9%
        recall on valid: 9.1%
        f1 on valid: 15.7%
        seconds to predict valid: 11.2 seconds

neural net with (10, 5) layers, tanh activation, 0.001 alpha, 500 max iternations, and s
gd type of solver
        accuracy on valid: 81.9%
        precision on valid: 57.0%
```

```
        recall on valid: 8.1%
        f1 on valid: 14.2%
        seconds to predict valid: 22.5 seconds

neural net with (10, 5) layers, tanh activation, 0.001 alpha, 500 max iternations, and a
dam type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.9%
        recall on valid: 9.1%
        f1 on valid: 15.7%
        seconds to predict valid: 10.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5) layers, tanh activation, 0.01 alpha, 100 max iternations, and sg
d type of solver
        accuracy on valid: 81.8%
        precision on valid: 58.4%
        recall on valid: 3.7%
        f1 on valid: 7.0%
        seconds to predict valid: 9.3 seconds

neural net with (10, 5) layers, tanh activation, 0.01 alpha, 100 max iternations, and ad
am type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.6%
        recall on valid: 9.1%
        f1 on valid: 15.7%
        seconds to predict valid: 10.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (10, 5) layers, tanh activation, 0.01 alpha, 200 max iternations, and sg
d type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.2%
        recall on valid: 8.2%
        f1 on valid: 14.3%
        seconds to predict valid: 20.1 seconds

neural net with (10, 5) layers, tanh activation, 0.01 alpha, 200 max iternations, and ad
am type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.6%
        recall on valid: 9.1%
        f1 on valid: 15.7%
        seconds to predict valid: 10.7 seconds

neural net with (10, 5) layers, tanh activation, 0.01 alpha, 500 max iternations, and sg
d type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.2%
        recall on valid: 8.2%
        f1 on valid: 14.3%
        seconds to predict valid: 22.2 seconds

neural net with (10, 5) layers, tanh activation, 0.01 alpha, 500 max iternations, and ad
```

```
am type of solver
        accuracy on valid: 82.0%
        precision on valid: 57.6%
        recall on valid: 9.1%
        f1 on valid: 15.7%
        seconds to predict valid: 10.9 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5) layers, logistic activation, 0.0001 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 6.6 seconds

neural net with (10, 5) layers, logistic activation, 0.0001 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 59.7%
        recall on valid: 9.6%
        f1 on valid: 16.6%
        seconds to predict valid: 9.6 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5) layers, logistic activation, 0.0001 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 6.3 seconds

neural net with (10, 5) layers, logistic activation, 0.0001 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 59.7%
        recall on valid: 9.6%
        f1 on valid: 16.6%
        seconds to predict valid: 10.1 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5) layers, logistic activation, 0.0001 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 6.5 seconds

neural net with (10, 5) layers, logistic activation, 0.0001 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 82.2%
```

```
        precision on valid: 59.7%
        recall on valid: 9.6%
        f1 on valid: 16.6%
        seconds to predict valid: 10.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5) layers, logistic activation, 0.001 alpha, 100 max iternations, a
nd sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 6.1 seconds

neural net with (10, 5) layers, logistic activation, 0.001 alpha, 100 max iternations, a
nd adam type of solver
        accuracy on valid: 82.3%
        precision on valid: 61.5%
        recall on valid: 9.7%
        f1 on valid: 16.8%
        seconds to predict valid: 9.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5) layers, logistic activation, 0.001 alpha, 200 max iternations, a
nd sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 6.1 seconds

neural net with (10, 5) layers, logistic activation, 0.001 alpha, 200 max iternations, a
nd adam type of solver
        accuracy on valid: 82.3%
        precision on valid: 61.5%
        recall on valid: 9.7%
        f1 on valid: 16.8%
        seconds to predict valid: 9.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5) layers, logistic activation, 0.001 alpha, 500 max iternations, a
nd sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 5.9 seconds

neural net with (10, 5) layers, logistic activation, 0.001 alpha, 500 max iternations, a
nd adam type of solver
        accuracy on valid: 82.3%
        precision on valid: 61.5%
        recall on valid: 9.7%
```

```
        f1 on valid: 16.8%
        seconds to predict valid: 9.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5) layers, logistic activation, 0.01 alpha, 100 max iternations, an
d sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 6.0 seconds

neural net with (10, 5) layers, logistic activation, 0.01 alpha, 100 max iternations, an
d adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 59.7%
        recall on valid: 9.4%
        f1 on valid: 16.2%
        seconds to predict valid: 9.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5) layers, logistic activation, 0.01 alpha, 200 max iternations, an
d sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 5.3 seconds

neural net with (10, 5) layers, logistic activation, 0.01 alpha, 200 max iternations, an
d adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 59.7%
        recall on valid: 9.4%
        f1 on valid: 16.2%
        seconds to predict valid: 8.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (10, 5) layers, logistic activation, 0.01 alpha, 500 max iternations, an
d sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 5.4 seconds

neural net with (10, 5) layers, logistic activation, 0.01 alpha, 500 max iternations, an
d adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 59.7%
        recall on valid: 9.4%
        f1 on valid: 16.2%
        seconds to predict valid: 8.7 seconds
```

```
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, relu activation, 0.0001 alpha, 100 max iternations, an
d sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 60.4%
        recall on valid: 7.7%
        f1 on valid: 13.6%
        seconds to predict valid: 21.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, relu activation, 0.0001 alpha, 100 max iternations, an
d adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.6%
        recall on valid: 10.2%
        f1 on valid: 17.3%
        seconds to predict valid: 24.2 seconds

neural net with (100, 25) layers, relu activation, 0.0001 alpha, 200 max iternations, an
d sgd type of solver
        accuracy on valid: 82.2%
        precision on valid: 59.2%
        recall on valid: 10.3%
        f1 on valid: 17.6%
        seconds to predict valid: 38.8 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, relu activation, 0.0001 alpha, 200 max iternations, an
d adam type of solver
        accuracy on valid: 80.8%
        precision on valid: 43.9%
        recall on valid: 15.3%
        f1 on valid: 22.6%
        seconds to predict valid: 65.0 seconds

neural net with (100, 25) layers, relu activation, 0.0001 alpha, 500 max iternations, an
d sgd type of solver
        accuracy on valid: 82.2%
        precision on valid: 59.2%
        recall on valid: 10.3%
        f1 on valid: 17.6%
        seconds to predict valid: 51.1 seconds

neural net with (100, 25) layers, relu activation, 0.0001 alpha, 500 max iternations, an
d adam type of solver
        accuracy on valid: 80.6%
        precision on valid: 41.0%
        recall on valid: 12.0%
        f1 on valid: 18.6%
        seconds to predict valid: 108.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
```

```
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, relu activation, 0.001 alpha, 100 max iternations, and
sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 59.9%
        recall on valid: 7.5%
        f1 on valid: 13.3%
        seconds to predict valid: 27.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, relu activation, 0.001 alpha, 100 max iternations, and
adam type of solver
        accuracy on valid: 81.8%
        precision on valid: 52.8%
        recall on valid: 11.0%
        f1 on valid: 18.3%
        seconds to predict valid: 29.6 seconds

neural net with (100, 25) layers, relu activation, 0.001 alpha, 200 max iternations, and
sgd type of solver
        accuracy on valid: 82.2%
        precision on valid: 59.3%
        recall on valid: 10.5%
        f1 on valid: 17.8%
        seconds to predict valid: 50.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, relu activation, 0.001 alpha, 200 max iternations, and
adam type of solver
        accuracy on valid: 81.2%
        precision on valid: 46.5%
        recall on valid: 13.8%
        f1 on valid: 21.3%
        seconds to predict valid: 63.2 seconds

neural net with (100, 25) layers, relu activation, 0.001 alpha, 500 max iternations, and
sgd type of solver
        accuracy on valid: 82.2%
        precision on valid: 59.3%
        recall on valid: 10.5%
        f1 on valid: 17.8%
        seconds to predict valid: 49.9 seconds

neural net with (100, 25) layers, relu activation, 0.001 alpha, 500 max iternations, and
adam type of solver
        accuracy on valid: 80.7%
        precision on valid: 41.1%
        recall on valid: 10.8%
        f1 on valid: 17.1%
        seconds to predict valid: 132.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
```

```
neural net with (100, 25) layers, relu activation, 0.01 alpha, 100 max iternations, and
sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 59.6%
        recall on valid: 7.4%
        f1 on valid: 13.2%
        seconds to predict valid: 21.7 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, relu activation, 0.01 alpha, 100 max iternations, and
adam type of solver
        accuracy on valid: 82.4%
        precision on valid: 62.0%
        recall on valid: 10.9%
        f1 on valid: 18.5%
        seconds to predict valid: 28.0 seconds

neural net with (100, 25) layers, relu activation, 0.01 alpha, 200 max iternations, and
sgd type of solver
        accuracy on valid: 82.3%
        precision on valid: 60.4%
        recall on valid: 10.8%
        f1 on valid: 18.3%
        seconds to predict valid: 45.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, relu activation, 0.01 alpha, 200 max iternations, and
adam type of solver
        accuracy on valid: 81.7%
        precision on valid: 51.5%
        recall on valid: 14.3%
        f1 on valid: 22.3%
        seconds to predict valid: 78.1 seconds

neural net with (100, 25) layers, relu activation, 0.01 alpha, 500 max iternations, and
sgd type of solver
        accuracy on valid: 82.3%
        precision on valid: 60.4%
        recall on valid: 10.8%
        f1 on valid: 18.3%
        seconds to predict valid: 41.9 seconds

neural net with (100, 25) layers, relu activation, 0.01 alpha, 500 max iternations, and
adam type of solver
        accuracy on valid: 81.7%
        precision on valid: 51.2%
        recall on valid: 12.4%
        f1 on valid: 19.9%
        seconds to predict valid: 98.5 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, tanh activation, 0.0001 alpha, 100 max iternations, an
d sgd type of solver
```

```
        accuracy on valid: 82.0%
        precision on valid: 59.2%
        recall on valid: 7.7%
        f1 on valid: 13.6%
        seconds to predict valid: 30.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, tanh activation, 0.0001 alpha, 100 max iternations, an
d adam type of solver
        accuracy on valid: 81.8%
        precision on valid: 53.2%
        recall on valid: 10.4%
        f1 on valid: 17.4%
        seconds to predict valid: 33.2 seconds

neural net with (100, 25) layers, tanh activation, 0.0001 alpha, 200 max iternations, an
d sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.8%
        recall on valid: 10.4%
        f1 on valid: 17.6%
        seconds to predict valid: 53.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, tanh activation, 0.0001 alpha, 200 max iternations, an
d adam type of solver
        accuracy on valid: 80.4%
        precision on valid: 42.2%
        recall on valid: 16.9%
        f1 on valid: 24.1%
        seconds to predict valid: 68.6 seconds

neural net with (100, 25) layers, tanh activation, 0.0001 alpha, 500 max iternations, an
d sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.8%
        recall on valid: 10.4%
        f1 on valid: 17.6%
        seconds to predict valid: 56.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (500) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, tanh activation, 0.0001 alpha, 500 max iternations, an
d adam type of solver
        accuracy on valid: 79.3%
        precision on valid: 38.2%
        recall on valid: 20.0%
        f1 on valid: 26.2%
        seconds to predict valid: 168.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, tanh activation, 0.001 alpha, 100 max iternations, and
```

```
sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 59.2%
        recall on valid: 7.7%
        f1 on valid: 13.6%
        seconds to predict valid: 31.2 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, tanh activation, 0.001 alpha, 100 max iternations, and
adam type of solver
        accuracy on valid: 81.8%
        precision on valid: 53.5%
        recall on valid: 10.1%
        f1 on valid: 16.9%
        seconds to predict valid: 32.1 seconds


neural net with (100, 25) layers, tanh activation, 0.001 alpha, 200 max iternations, and
sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.7%
        recall on valid: 10.5%
        f1 on valid: 17.7%
        seconds to predict valid: 51.4 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, tanh activation, 0.001 alpha, 200 max iternations, and
adam type of solver
        accuracy on valid: 80.5%
        precision on valid: 42.8%
        recall on valid: 17.1%
        f1 on valid: 24.4%
        seconds to predict valid: 59.1 seconds


neural net with (100, 25) layers, tanh activation, 0.001 alpha, 500 max iternations, and
sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.7%
        recall on valid: 10.5%
        f1 on valid: 17.7%
        seconds to predict valid: 49.0 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (500) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, tanh activation, 0.001 alpha, 500 max iternations, and
adam type of solver
        accuracy on valid: 79.2%
        precision on valid: 37.3%
        recall on valid: 18.8%
        f1 on valid: 25.0%
        seconds to predict valid: 148.0 seconds

c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
```

```
neural net with (100, 25) layers, tanh activation, 0.01 alpha, 100 max iternations, and
sgd type of solver
        accuracy on valid: 82.0%
        precision on valid: 58.9%
        recall on valid: 7.7%
        f1 on valid: 13.6%
        seconds to predict valid: 26.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, tanh activation, 0.01 alpha, 100 max iternations, and
adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 56.6%
        recall on valid: 9.6%
        f1 on valid: 16.4%
        seconds to predict valid: 28.7 seconds

neural net with (100, 25) layers, tanh activation, 0.01 alpha, 200 max iternations, and
sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.5%
        recall on valid: 10.4%
        f1 on valid: 17.6%
        seconds to predict valid: 49.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, tanh activation, 0.01 alpha, 200 max iternations, and
adam type of solver
        accuracy on valid: 81.0%
        precision on valid: 45.5%
        recall on valid: 15.9%
        f1 on valid: 23.6%
        seconds to predict valid: 58.0 seconds

neural net with (100, 25) layers, tanh activation, 0.01 alpha, 500 max iternations, and
sgd type of solver
        accuracy on valid: 82.1%
        precision on valid: 57.5%
        recall on valid: 10.4%
        f1 on valid: 17.6%
        seconds to predict valid: 49.2 seconds

neural net with (100, 25) layers, tanh activation, 0.01 alpha, 500 max iternations, and
adam type of solver
        accuracy on valid: 80.8%
        precision on valid: 44.2%
        recall on valid: 15.3%
        f1 on valid: 22.8%
        seconds to predict valid: 110.9 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
```

```
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 25) layers, logistic activation, 0.0001 alpha, 100 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 19.3 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, logistic activation, 0.0001 alpha, 100 max iternation
s, and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 59.4%
        recall on valid: 8.8%
        f1 on valid: 15.4%
        seconds to predict valid: 20.7 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 25) layers, logistic activation, 0.0001 alpha, 200 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 25.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, logistic activation, 0.0001 alpha, 200 max iternation
s, and adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.7%
        recall on valid: 11.2%
        f1 on valid: 18.7%
        seconds to predict valid: 41.4 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 25) layers, logistic activation, 0.0001 alpha, 500 max iternation
s, and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 25.5 seconds

neural net with (100, 25) layers, logistic activation, 0.0001 alpha, 500 max iternation
s, and adam type of solver
        accuracy on valid: 82.0%
        precision on valid: 55.7%
        recall on valid: 10.1%
```

```
        f1 on valid: 17.0%
        seconds to predict valid: 53.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 25) layers, logistic activation, 0.001 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 19.6 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
neural net with (100, 25) layers, logistic activation, 0.001 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 82.1%
        precision on valid: 59.2%
        recall on valid: 8.7%
        f1 on valid: 15.2%
        seconds to predict valid: 20.7 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 25) layers, logistic activation, 0.001 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 25.0 seconds

neural net with (100, 25) layers, logistic activation, 0.001 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 82.3%
        precision on valid: 60.8%
        recall on valid: 10.5%
        f1 on valid: 17.9%
        seconds to predict valid: 26.1 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 25) layers, logistic activation, 0.001 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 25.4 seconds
```

```
neural net with (100, 25) layers, logistic activation, 0.001 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 82.3%
        precision on valid: 60.8%
        recall on valid: 10.5%
        f1 on valid: 17.9%
        seconds to predict valid: 26.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\neural_network\_multilayer_perceptro
n.py:614: ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and
the optimization hasn't converged yet.
  warnings.warn(
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 25) layers, logistic activation, 0.01 alpha, 100 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 19.1 seconds

neural net with (100, 25) layers, logistic activation, 0.01 alpha, 100 max iternations,
and adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 62.1%
        recall on valid: 8.7%
        f1 on valid: 15.2%
        seconds to predict valid: 17.2 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 25) layers, logistic activation, 0.01 alpha, 200 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
        seconds to predict valid: 25.1 seconds

neural net with (100, 25) layers, logistic activation, 0.01 alpha, 200 max iternations,
and adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 62.1%
        recall on valid: 8.7%
        f1 on valid: 15.2%
        seconds to predict valid: 17.0 seconds
c:\Users\matth\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: Unde
finedMetricWarning: Precision is ill-defined and being set to 0.0 due to no predicted sa
mples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
neural net with (100, 25) layers, logistic activation, 0.01 alpha, 500 max iternations,
and sgd type of solver
        accuracy on valid: 81.6%
        precision on valid: 0.0%
        recall on valid: 0.0%
        f1 on valid: 0.0%
```

```
        seconds to predict valid: 25.2 seconds

neural net with (100, 25) layers, logistic activation, 0.01 alpha, 500 max iternations,
and adam type of solver
        accuracy on valid: 82.2%
        precision on valid: 62.1%
        recall on valid: 8.7%
        f1 on valid: 15.2%
        seconds to predict valid: 17.6 seconds
```

In [ ]:

```
### Model 5-Ada Boost ###
ada_boost_times = []
ada_boost_accuracy_scores = []
ada_boost_precision_scores = []
ada_boost_recall_scores = []
ada_boost_f1_scores = []
for learning_rate in [0.01, .05, 0.1, 0.2]:
    for n in [100, 200, 500, 1000]:
        ada_boost = AdaBoostClassifier(n_estimators=n, learning_rate=learning_rate, alg
        y_predict = ada_boost.predict(X_valid)

        ada_boost_time = time.time() - start_time
        ada_boost_accuracy = accuracy_score(y_valid, y_predict)
        ada_boost_precision = precision_score(y_valid, y_predict)
        ada_boost_recall = recall_score(y_valid, y_predict)
        ada_boost_f1 = f1_score(y_valid, y_predict)

        ada_boost_times.append(ada_boost_time)
        ada_boost_accuracy_scores.append(ada_boost_accuracy)
        ada_boost_precision_scores.append(ada_boost_precision)
        ada_boost_recall_scores.append(ada_boost_recall)
        ada_boost_f1_scores.append(ada_boost_f1)

        print(f"\nAda accuracy with learning rate of {learning_rate} and number estimat
        print(f"\taccuracy on valid: {ada_boost_accuracy*100:.1f}%")
        print(f"\tprecision on valid: {ada_boost_precision*100:.1f}%")
        print(f"\trecall on valid: {ada_boost_recall*100:.1f}%")
        print(f"\tf1 on valid: {ada_boost_f1*100:.1f}%")
        print(f'\tseconds to predict valid: {ada_boost_time:.1f} seconds')
```

```
Ada accuracy with learning rate of 0.01 and number estimators 100:
        accuracy on valid: 82.8%
        precision on valid: 100.0%
        recall on valid: 6.8%
        f1 on valid: 12.7%
        seconds to predict valid: 1344.7 seconds

Ada accuracy with learning rate of 0.01 and number estimators 200:
        accuracy on valid: 82.8%
        precision on valid: 100.0%
        recall on valid: 6.8%
        f1 on valid: 12.7%
        seconds to predict valid: 1353.3 seconds

Ada accuracy with learning rate of 0.01 and number estimators 500:
        accuracy on valid: 82.8%
        precision on valid: 100.0%
        recall on valid: 6.8%
        f1 on valid: 12.7%
```

```
        seconds to predict valid: 1373.9 seconds

Ada accuracy with learning rate of 0.01 and number estimators 1000:
        accuracy on valid: 83.1%
        precision on valid: 83.1%
        recall on valid: 10.1%
        f1 on valid: 18.1%
        seconds to predict valid: 1422.0 seconds

Ada accuracy with learning rate of 0.05 and number estimators 100:
        accuracy on valid: 82.8%
        precision on valid: 100.0%
        recall on valid: 6.8%
        f1 on valid: 12.7%
        seconds to predict valid: 1426.2 seconds

Ada accuracy with learning rate of 0.05 and number estimators 200:
        accuracy on valid: 83.0%
        precision on valid: 81.6%
        recall on valid: 10.2%
        f1 on valid: 18.2%
        seconds to predict valid: 1434.3 seconds

Ada accuracy with learning rate of 0.05 and number estimators 500:
        accuracy on valid: 83.2%
        precision on valid: 72.6%
        recall on valid: 14.0%
        f1 on valid: 23.5%
        seconds to predict valid: 1454.5 seconds

Ada accuracy with learning rate of 0.05 and number estimators 1000:
        accuracy on valid: 83.4%
        precision on valid: 71.7%
        recall on valid: 15.9%
        f1 on valid: 26.0%
        seconds to predict valid: 1492.0 seconds

Ada accuracy with learning rate of 0.1 and number estimators 100:
        accuracy on valid: 83.1%
        precision on valid: 81.3%
        recall on valid: 10.4%
        f1 on valid: 18.4%
        seconds to predict valid: 1495.9 seconds

Ada accuracy with learning rate of 0.1 and number estimators 200:
        accuracy on valid: 83.3%
        precision on valid: 74.8%
        recall on valid: 13.7%
        f1 on valid: 23.1%
        seconds to predict valid: 1503.7 seconds

Ada accuracy with learning rate of 0.1 and number estimators 500:
        accuracy on valid: 83.4%
        precision on valid: 72.1%
        recall on valid: 16.0%
        f1 on valid: 26.2%
        seconds to predict valid: 1523.4 seconds

Ada accuracy with learning rate of 0.1 and number estimators 1000:
        accuracy on valid: 83.4%
```

```
        precision on valid: 70.1%
        recall on valid: 17.0%
        f1 on valid: 27.3%
        seconds to predict valid: 1561.9 seconds

Ada accuracy with learning rate of 0.2 and number estimators 100:
        accuracy on valid: 83.3%
        precision on valid: 74.3%
        recall on valid: 13.8%
        f1 on valid: 23.3%
        seconds to predict valid: 1565.7 seconds

Ada accuracy with learning rate of 0.2 and number estimators 200:
        accuracy on valid: 83.3%
        precision on valid: 71.2%
        recall on valid: 15.7%
        f1 on valid: 25.7%
        seconds to predict valid: 1573.7 seconds

Ada accuracy with learning rate of 0.2 and number estimators 500:
        accuracy on valid: 83.4%
        precision on valid: 70.0%
        recall on valid: 16.9%
        f1 on valid: 27.2%
        seconds to predict valid: 1594.9 seconds

Ada accuracy with learning rate of 0.2 and number estimators 1000:
        accuracy on valid: 83.3%
        precision on valid: 68.7%
        recall on valid: 17.4%
        f1 on valid: 27.8%
        seconds to predict valid: 1637.7 seconds
```

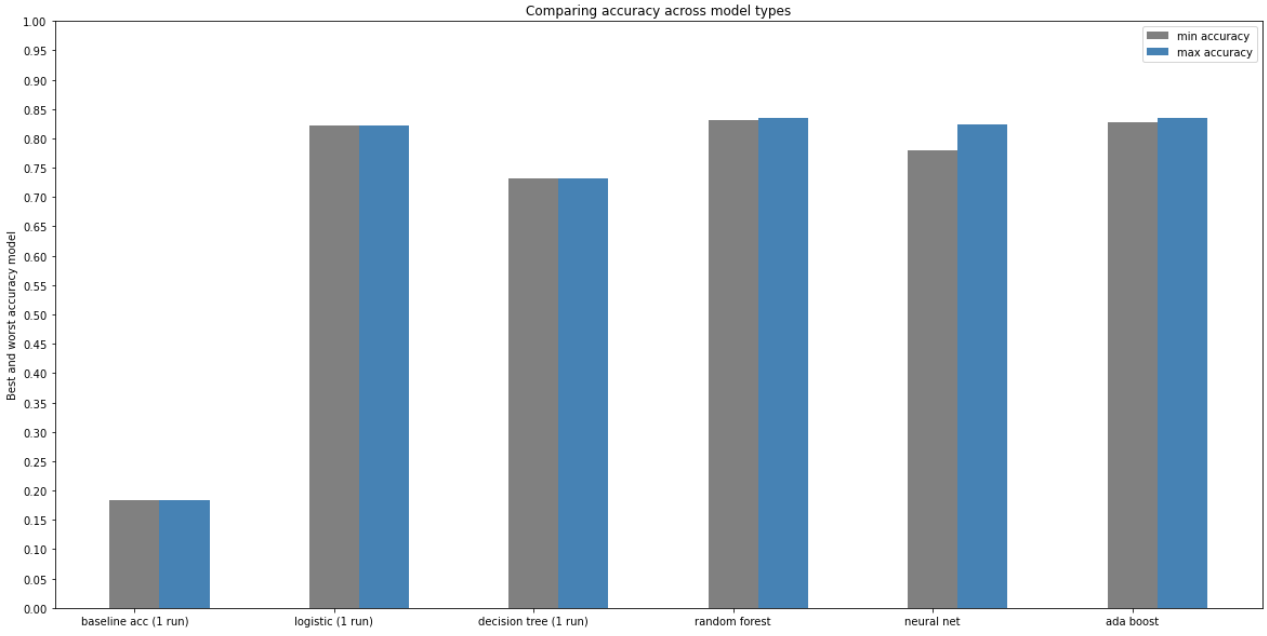
In [ ]:

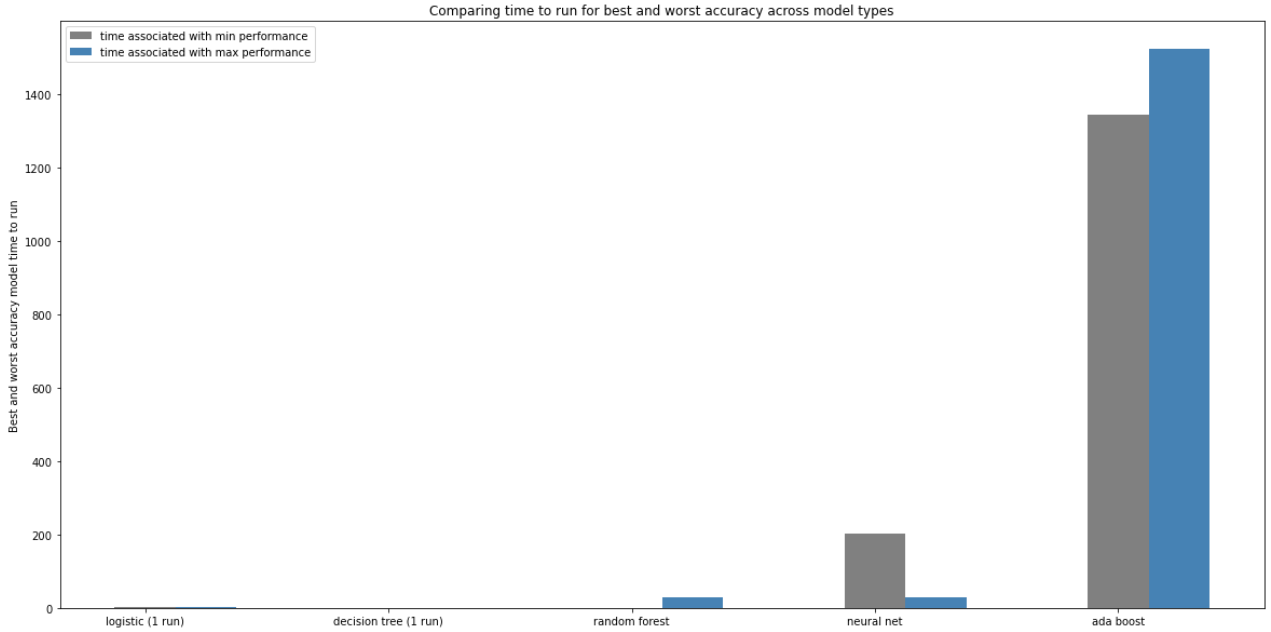
```
# Write nn lists to csv so we don't have to run this again
with open('valid_nn_info.csv', 'w') as f:
    write = csv.writer(f)
    write.writerow(nn_times)
    write.writerow(nn_accuracy_scores)
    write.writerow(nn_precision_scores)
    write.writerow(nn_recall_scores)
    write.writerow(nn_f1_scores)

with open('valid_ada_boost_info.csv', 'w') as f:
    write = csv.writer(f)
    write.writerow(ada_boost_times)
    write.writerow(ada_boost_accuracy_scores)
    write.writerow(ada_boost_precision_scores)
    write.writerow(ada_boost_recall_scores)
    write.writerow(ada_boost_f1_scores)
```

In [ ]:

```
# Let's graph the range of models associated with accuracy
barwidth = 0.25
n = 6
x = np.arange(n)
minimums_accuracy = [baseline_majority_accuracy_valid, log_reg_accuracy, decision_tree_
maximums_accuracy = [baseline_majority_accuracy_valid, log_reg_accuracy, decision_tree_
time_associated_with_min_accuracy = [log_reg_time, decision_tree_time,
                                     random_forest_times[random_forest_accuracy_scores.in
```

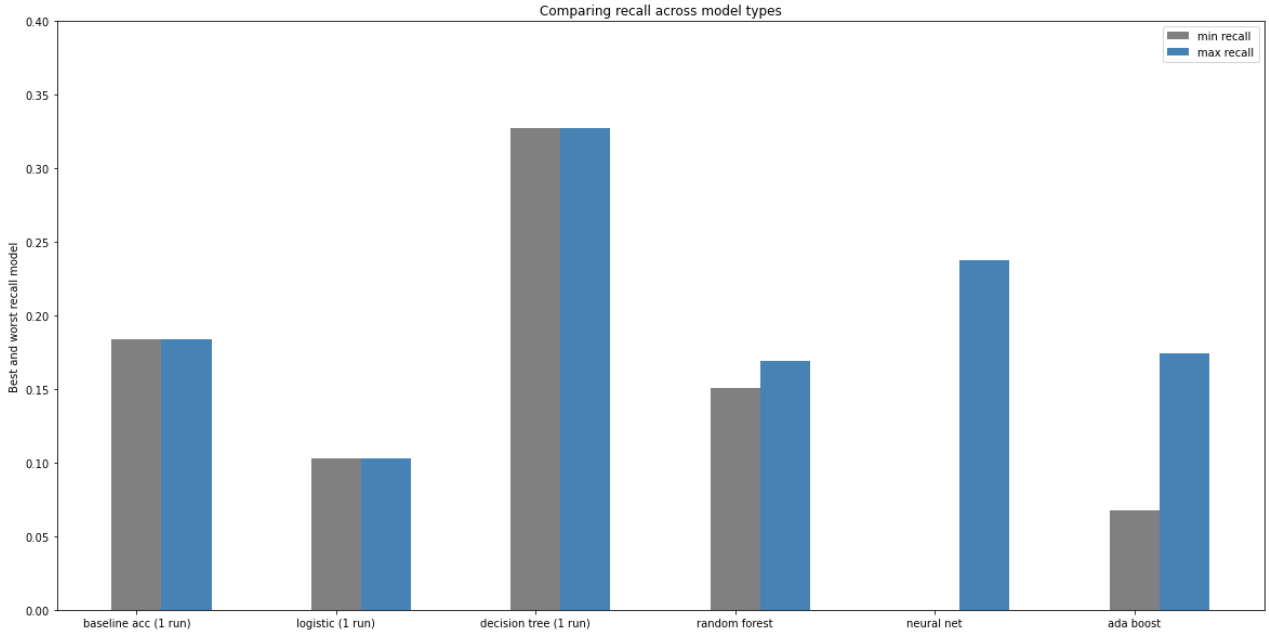
```
                                    nn_times[nn_accuracy_scores.index(min(nn_accuracy_sc
                                    ada_boost_times[ada_boost_accuracy_scores.index(min(
time_associated_with_max_accuracy = [log_reg_time, decision_tree_time,
                                    random_forest_times[random_forest_accuracy_scores.in
                                    nn_times[nn_accuracy_scores.index(max(nn_accuracy_sc
                                    ada_boost_times[ada_boost_accuracy_scores.index(max(
fig = plt.subplots(figsize=(20,10))
br1 = x
br2 = [x + barwidth for x in br1]
plt.bar(br1, minimums_accuracy, width=barwidth, color='grey', label='min accuracy')
plt.bar(br2, maximums_accuracy, width=barwidth, color='steelblue', label='max accuracy'
plt.ylabel('Best and worst accuracy model')
plt.title('Comparing accuracy across model types')
plt.yticks(np.arange(0, 1.01, 0.05))
plt.xticks(x, ('baseline acc (1 run)', 'logistic (1 run)', 'decision tree (1 run)', 'ra
plt.legend()
plt.show()

n = 5
x = np.arange(n)
fig = plt.subplots(figsize=(20,10))
br1 = x
br2 = [x + barwidth for x in br1]
plt.bar(br1, time_associated_with_min_accuracy, width=barwidth, color='grey', label='ti
plt.bar(br2, time_associated_with_max_accuracy, width=barwidth, color='steelblue', labe
plt.ylabel('Best and worst accuracy model time to run')
plt.title('Comparing time to run for best and worst accuracy across model types')
plt.xticks(x, ('logistic (1 run)', 'decision tree (1 run)', 'random forest', 'neural ne
plt.legend()
plt.show()
```

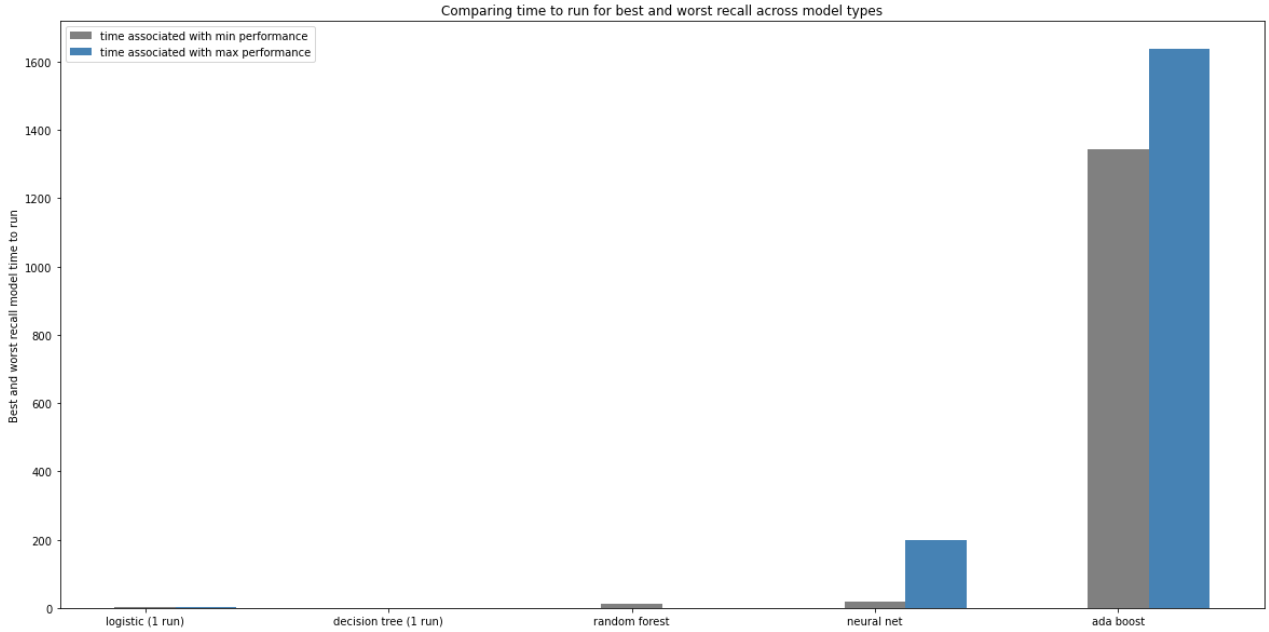




In [ ]:

```
# Let's graph the range of models associated with recall
barwidth = 0.25
n = 6
x = np.arange(n)
minimums_recall = [baseline_majority_accuracy_valid, log_reg_recall, decision_tree_reca
maximums_recall = [baseline_majority_accuracy_valid, log_reg_recall, decision_tree_reca
time_associated_with_min_recall = [log_reg_time, decision_tree_time,
                                   random_forest_times[random_forest_recall_scores.inde
                                   nn_times[nn_recall_scores.index(min(nn_recall_scores
                                   ada_boost_times[ada_boost_recall_scores.index(min(ad
time_associated_with_max_recall = [log_reg_time, decision_tree_time,
                                   random_forest_times[random_forest_recall_scores.inde
                                   nn_times[nn_recall_scores.index(max(nn_recall_scores
                                   ada_boost_times[ada_boost_recall_scores.index(max(ad
fig = plt.subplots(figsize=(20,10))
br1 = x
br2 = [x + barwidth for x in br1]
plt.bar(br1, minimums_recall, width=barwidth, color='grey', label='min recall')
plt.bar(br2, maximums_recall, width=barwidth, color='steelblue', label='max recall')
plt.ylabel('Best and worst recall model')
plt.title('Comparing recall across model types')
plt.yticks(np.arange(0, 0.41, 0.05))
plt.xticks(x, ('baseline acc (1 run)', 'logistic (1 run)', 'decision tree (1 run)', 'ra
plt.legend()
plt.show()

n = 5
x = np.arange(n)
fig = plt.subplots(figsize=(20,10))
br1 = x
br2 = [x + barwidth for x in br1]
plt.bar(br1, time_associated_with_min_recall, width=barwidth, color='grey', label='time
plt.bar(br2, time_associated_with_max_recall, width=barwidth, color='steelblue', label=
plt.ylabel('Best and worst recall model time to run')
plt.title('Comparing time to run for best and worst recall across model types')
plt.xticks(x, ('logistic (1 run)', 'decision tree (1 run)', 'random forest', 'neural ne
plt.legend()
plt.show()
```

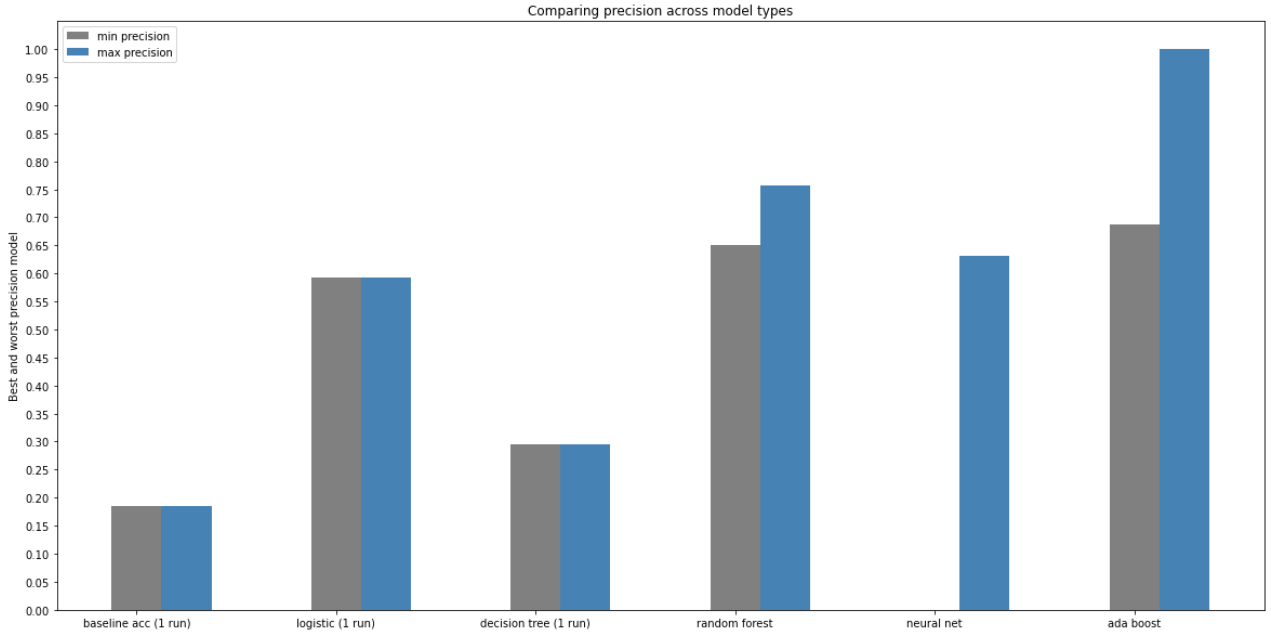


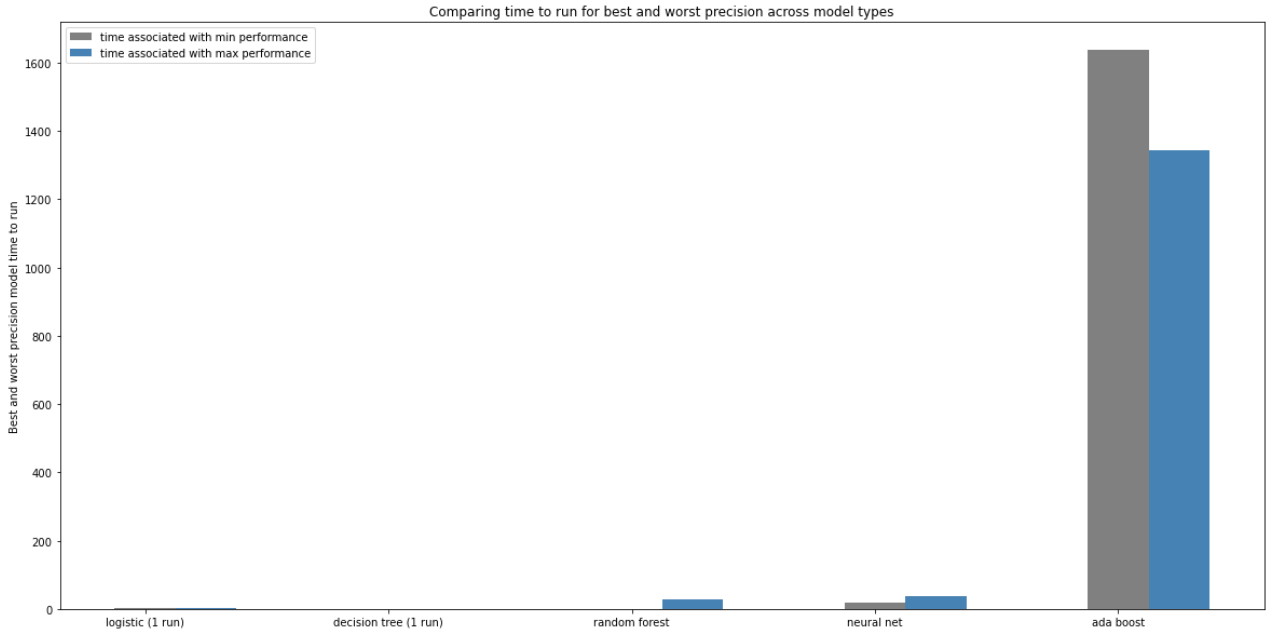


In [ ]:

```
# Let's graph the range of models associated with precision
barwidth = 0.25
n = 6
x = np.arange(n)
minimums_precision = [baseline_majority_accuracy_valid, log_reg_precision, decision_tre
maximums_precision = [baseline_majority_accuracy_valid, log_reg_precision, decision_tre
time_associated_with_min_precision = [log_reg_time, decision_tree_time,
                                      random_forest_times[random_forest_precision_scores.i
                                      nn_times[nn_precision_scores.index(min(nn_precision_
                                      ada_boost_times[ada_boost_precision_scores.index(min
time_associated_with_max_precision = [log_reg_time, decision_tree_time,
                                      random_forest_times[random_forest_precision_scores.i
                                      nn_times[nn_precision_scores.index(max(nn_precision_
                                      ada_boost_times[ada_boost_precision_scores.index(max
fig = plt.subplots(figsize=(20,10))
br1 = x
br2 = [x + barwidth for x in br1]
plt.bar(br1, minimums_precision, width=barwidth, color='grey', label='min precision')
plt.bar(br2, maximums_precision, width=barwidth, color='steelblue', label='max precisio
```

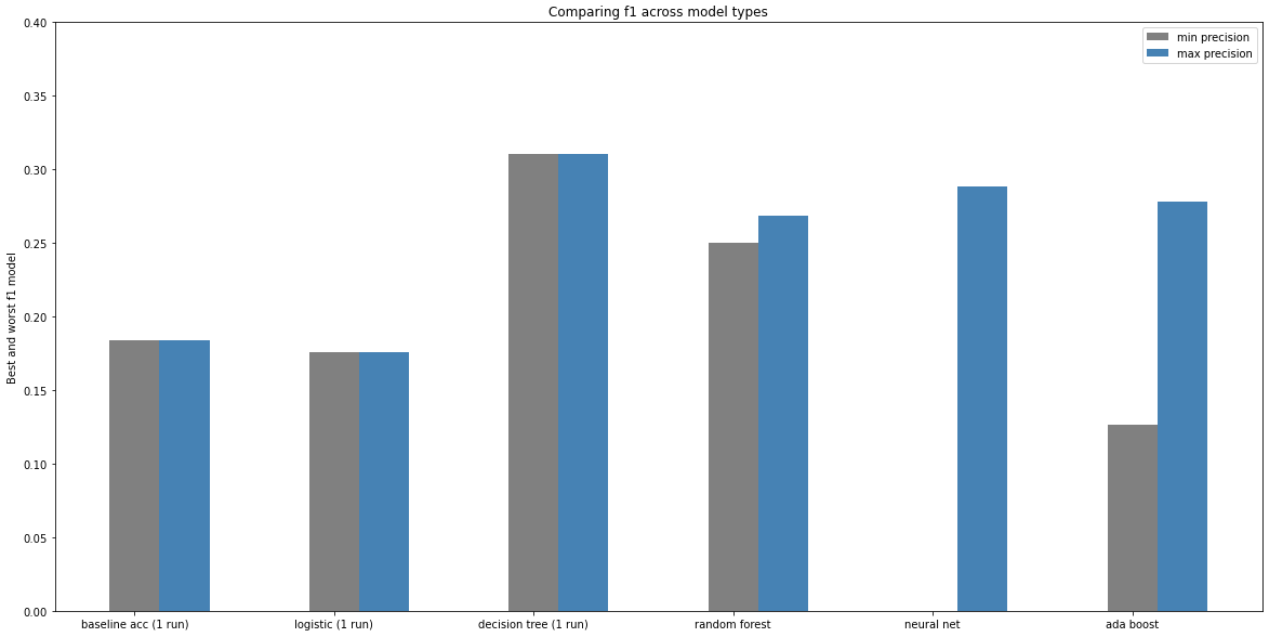
```
plt.ylabel('Best and worst precision model')
plt.title('Comparing precision across model types')
plt.yticks(np.arange(0, 1.01, 0.05))
plt.xticks(x, ('baseline acc (1 run)', 'logistic (1 run)', 'decision tree (1 run)', 'ra
plt.legend()
plt.show()

n = 5
x = np.arange(n)
fig = plt.subplots(figsize=(20,10))
br1 = x
br2 = [x + barwidth for x in br1]
plt.bar(br1, time_associated_with_min_precision, width=barwidth, color='grey', label='t
plt.bar(br2, time_associated_with_max_precision, width=barwidth, color='steelblue', lab
plt.ylabel('Best and worst precision model time to run')
plt.title('Comparing time to run for best and worst precision across model types')
plt.xticks(x, ('logistic (1 run)', 'decision tree (1 run)', 'random forest', 'neural ne
plt.legend()
plt.show()
```

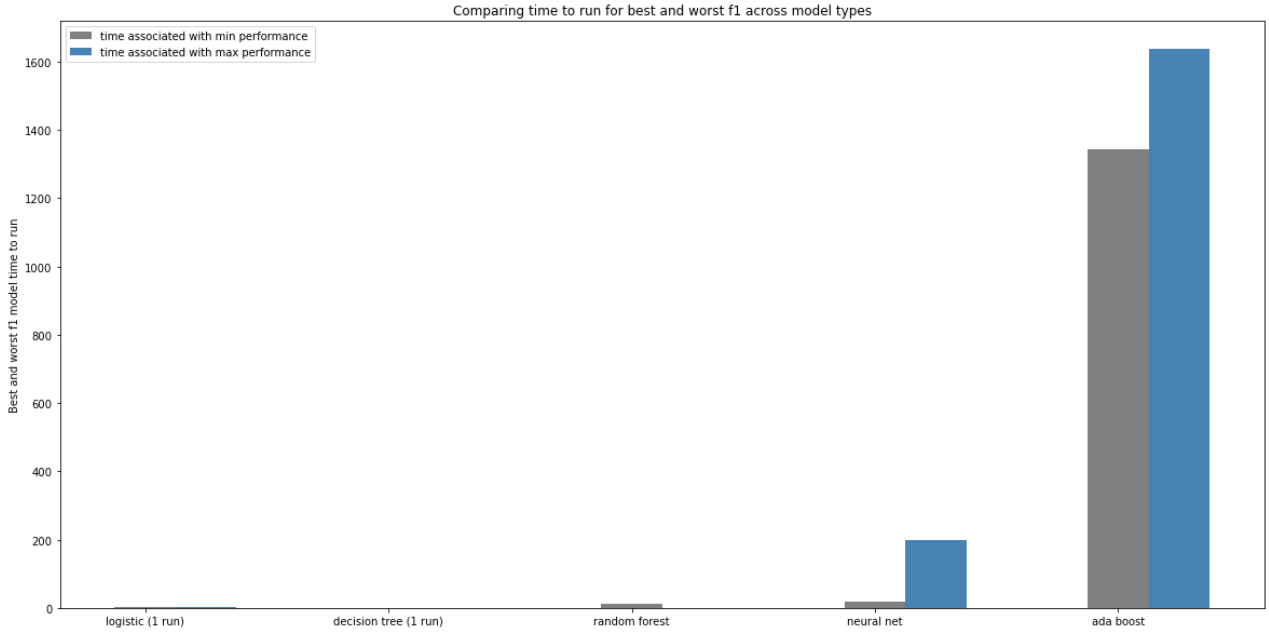




In [ ]:

```
# Let's graph the range of models associated with f1
barwidth = 0.25
n = 6
x = np.arange(n)
minimums_f1 = [baseline_majority_accuracy_valid, log_reg_f1, decision_tree_f1, min(rand
maximums_f1 = [baseline_majority_accuracy_valid, log_reg_f1, decision_tree_f1, max(rand
time_associated_with_min_f1 = [log_reg_time, decision_tree_time,
                               random_forest_times[random_forest_f1_scores.index(mi
                               nn_times[nn_f1_scores.index(min(nn_f1_scores))],
                               ada_boost_times[ada_boost_f1_scores.index(min(ada_bo
time_associated_with_max_f1 = [log_reg_time, decision_tree_time,
                               random_forest_times[random_forest_f1_scores.index(ma
                               nn_times[nn_f1_scores.index(max(nn_f1_scores))],
                               ada_boost_times[ada_boost_f1_scores.index(max(ada_bo
fig = plt.subplots(figsize=(20,10))
br1 = x
br2 = [x + barwidth for x in br1]
plt.bar(br1, minimums_f1, width=barwidth, color='grey', label='min precision')
plt.bar(br2, maximums_f1, width=barwidth, color='steelblue', label='max precision')
plt.ylabel('Best and worst f1 model')
plt.title('Comparing f1 across model types')
plt.yticks(np.arange(0, 0.41, 0.05))
plt.xticks(x, ('baseline acc (1 run)', 'logistic (1 run)', 'decision tree (1 run)', 'ra
plt.legend()
plt.show()

n = 5
x = np.arange(n)
fig = plt.subplots(figsize=(20,10))
br1 = x
br2 = [x + barwidth for x in br1]
plt.bar(br1, time_associated_with_min_f1, width=barwidth, color='grey', label='time ass
plt.bar(br2, time_associated_with_max_f1, width=barwidth, color='steelblue', label='tim
plt.ylabel('Best and worst f1 model time to run')
plt.title('Comparing time to run for best and worst f1 across model types')
plt.xticks(x, ('logistic (1 run)', 'decision tree (1 run)', 'random forest', 'neural ne
plt.legend()
plt.show()
```





In [ ]:

```
# Pick best one and run for y_test for each
```