# **Best Model Selector for Phone Activity Classification**

In the following notebook, we are going to be using a dataset from the UCI Machine Learning Repository. The dataset has 561 attributes, which are all gyroscope measurements, and they are all standardized. Our goal is to classify the activity level on a scale from 1 to 6. More information about the dataset:

https://www.apispreadsheets.com/datasets/122

Here is some sample data from the dataset:

#### In [1]:

%%bash
head phone\_activity.csv

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84, -0.817, -1.0, -0.0441, -0.122, -0.45, -0.99, -0.992, -0.994, -0.994, -0.99, -0.99, -1.0, -0.991, -1.
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0.28, -0.0195, -0.113, -0.995, -0.967, -0.979, -0.997, -0.964, -0.977, -0.939, -0.558, -0.818, 0.844,
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5,0.103,-0.402,0.909,-0.97,-0.982,-1.0,-0.992,-0.993,-1.0,-1.0,-0.927,0.00223,0.0275,-0.0
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191, 0.0869, 0.258, -0.273, 0.435, -0.315, 0.44, -0.269, 0.179, -0.089, -0.156, -0.19, 0.599, 0.968, -0.100, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089, -0.089,
 .149,0.0945,-0.998,-0.988,-0.979,-0.998,-0.989,-0.979,0.894,-0.167,0.0917,0.987,-0.122,0.
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293,-0.167,0.0899,-0.0663,0.0671,-0.237,0.239,-0.241,0.241,-0.408,-0.185,0.965,0.0734,0.0
191,0.0168,-0.996,-0.988,-0.992,-0.997,-0.987,-0.991,-0.997,-0.992,-0.99,0.994,0.993,0.98
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   .226,0.0695,0.0643,-0.0764,0.138,-0.0368,0.231,-0.115,0.319,-0.488,-0.0959,-0.136,0.611,0
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503, 0.606, -0.423, 0.374, -0.362, 0.367, -0.128, 0.138, -0.147, 0.153, 0.726, 0.939, 0.879, 0.0822, -0
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4,0.0785,-0.00397,0.171,0.18,0.293,0.155,0.244,0.612,0.108,0.255,0.265,-0.0286,-0.083,0.0
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26,0.222,0.059,0.177,0.483,0.279,-0.0188,0.201,0.171,-0.301,-0.0606,0.0644,-0.0248,-0.066
4,0.0779,-0.991,-0.993,-0.987,-0.991,-0.994,-0.988,-0.879,-0.953,-0.749,0.842,0.908,0.822
 , -0.988, -1.0, -1.0, -1.0, -0.99, -0.995, -0.989, -0.323, -0.314, -0.591, -0.0909, -0.0383, 0.41, -0.20, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.0909, -0.
84, -0.171, 0.0402, 0.229, -0.0273, 0.181, -0.283, 0.342, -0.0592, -0.187, 0.234, -0.442, -0.101, -0.0
477,-0.0677,-0.992,-0.996,-0.994,-0.993,-0.997,-0.994,-0.99,-0.997,-0.996,0.992,0.994,0.9
96,-0.996,-1.0,-1.0,-1.0,-0.993,-0.997,-0.993,-0.635,-0.765,-0.688,0.0866,-0.11,0.243,0.4
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-1.0, -1.0, -1.0, -0.983, -0.977, -0.979, -0.978, -0.984, -0.983, -1.0, -0.989, -0.907, -1.0, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838, 0.0838
  .0375,-0.295,-0.992,-0.993,-0.991,-0.995,-0.996,-0.992,-1.0,-0.992,-1.0,-1.0,0.272,-0.75,
-0.929, -0.992, -0.992, -0.991, -0.992, -0.995, -0.992, -1.0, -0.991, -0.85, -1.0, 0.0734, -0.371, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -0.000, -
  .675, -0.995, -0.996, -0.995, -0.995, -0.995, -1.0, -0.995, -0.956, -1.0, 0.314, -0.269, -0.57
3,0.013,0.0809,-0.234,0.118,-0.848,0.189,-0.0374,5
```

# Measurements

In [2]:

! btc phone activity.csv -measureonly

WARNING: Could not detect a GPU. Neural Network generation will be slow.

Brainome Table Compiler 0.991

Copyright (c) 2019-2021 Brainome, Inc. All Rights Reserved.

Licensed to: Alexander Makhratchev (Evaluation)

Expiration Date: 2021-04-30 44 days left

Maximum File Size: 30 GB unlimited Maximum Instances: Maximum Attributes: unlimited Maximum Classes: unlimited

Connected to: daimensions.brainome.ai (local execution)

Command:

btc phone activity.csv -measureonly

Start Time: 03/17/2021, 05:15 UTC

Pre-training Measurements

Data:

Input: phone activity.csv

Target Column: activity Number of instances: 10299

Number of attributes: 561 out of 561

Number of classes: 6

Class Balance:

5: 18.51% 4: 17.25% 6: 18.88%

1: 16.72% 3: 13.65%

2: 14.99%

Learnability:

Best guess accuracy: 18.88%

Data Sufficiency: Maybe enough data to generalize. [yellow] Capacity Progression: at [ 5%, 10%, 20%, 40%, 80%, 100% ] Ideal Machine Learner: 10, 11, 12, 12, 13, 13

Expected Generalization:

Decision Tree: 4.10 bits/bit
Neural Network: 61.08 bits/bit
Random Forest: 96.25 bits/bit

Expected Accuracy: Training Validation
Decision Tree: 100.00% 37.25%
Neural Network: 99.65% 98.02%
Random Forest: 100.00% 97.92%

Recommendations:

Time to Build Estimates:

Decision Tree: less than a minute Neural Network:

31 minutes

End Time: 03/17/2021, 05:19 UTC

Runtime Duration: 3m 51s

For this dataset, we will use a brute force approach for model selection. The tryall.py script allows us to try all 6 possible model configurations on a single dataset in a single line of code. The 3 models are decision tree, neural networks, and random forests, and we can also run each model with the -rank command.

In [3]:

! python3 tryall.py phone activity.csv btc

Error while deleting file : clean005828786797.csv

Error while deleting file : clean.state

Cleaning...

./btc 'phone activity.csv' -cleanonly --yes

WARNING: Could not detect a GPU. Neural Network generation will be slow.

Brainome Table Compiler 0.991

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Licensed to: Alexander Makhratchev (Evaluation)

Expiration Date: 2021-04-30 44 days left

Maximum File Size: 30 GB
Maximum Instances: unlimited
Maximum Attributes: unlimited
Maximum Classes: unlimited

Connected to: daimensions.brainome.ai (local execution)

Command:

btc phone activity.csv -cleanonly --yes

Start Time: 03/17/2021, 05:19 UTC

Messages:

Clean only output: clean.csv, clean.state

End Time: 03/17/2021, 05:19 UTC

Runtime Duration: 24s

Done Cleaning!
Splitting Data...
Done Splitting Data!

Running: DT -rank

./btc 'train.csv' -headerless -f DT -rank -o DTrank.py -riskoverfit --yes WARNING: Could not detect a GPU. Neural Network generation will be slow.

Brainome Table Compiler 0.991

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Licensed to:

Alexander Makhratchev (Evaluation)
Expiration Date:

Maximum File Size:

Maximum Instances:

Maximum Attributes:

Maximum Classes:

unlimited

unlimited

unlimited Maximum Classes:

Connected to: daimensions.brainome.ai (local execution)

Command:

btc train.csv -headerless -f DT -rank -o DTrank.py -riskoverfit --yes

03/17/2021, 05:19 UTC Start Time:

Cleaning...

Attribute Ranking:

53, 366, 310, 388, 422, Columns selected: Risk of coincidental column correlation: 0.0%

Test Accuracy Progression:

53 : 56.07%

366 : 61.27% change +5.20% 310 : 66.07% change +4.80% 388 : 66.28% change +0.21% 422 : 66.32% change +0.04%

Pre-training Measurements

Data:

train.csv (headerless csv) Input:

Target Column: target Number of instances: 5149

Number of attributes: 5

Number of classes: 6

5 out of 561

Number of classes: 6

Class Balance:

0: 16.72% 1: 14.99% 2: 13.65% 3: 17.25% 4: 18.51% 5: 18.88%

Learnability:

Best guess accuracy: 18.88%
Data Sufficiency: Maybe enough data to generalize. [yellow]

Capacity Progression: at [ 5%, 10%, 20%, 40%, 80%, 100% ] Ideal Machine Learner: 8, 9, 10, 10, 11, 11

Expected Generalization:

Decision Tree: 10.02 bits/bit Neural Network: 353.00 bits/bit Random Forest: 13.55 bits/bit

Expected Accuracy:
 Decision Tree:
 Neural Network:
 Random Forest: Training Validation 89.26% 66.30% 82.32% 82.10% Random Forest: 99.22% 84.47%

Recommendations:

Note: Model type DT given by user.

Time to Build Estimates:

Decision Tree: a few seconds Predictor: DTrank.py

Classifier Type: Decision Tree System Type: 6-way classifier

Training / Validation Split: Unable to split dataset. The predictor was trained an

d evaluated on the same data.

Accuracy:

Best-quess accuracy: 18.88%

Combined Model Accuracy: 86.50% (4454/5149 correct)

Model Capacity (MEC): 1182 bits

Generalization Ratio: 9.69 bits/bit Generalization Index: 3.13

Percent of Data Memorized: 31.99% Resilience to Noise: -0.58 dB

Combined Confusion Matrix:

Actual		Predict	ced				
0		764	84	11	0	0	2
1		222	533	12	0	0	5
2		68	35	600	0	0	0
3		0	0	0	821	43	24
4		0	0	0	67	880	6
5	- 1	17	35	Ω	4 0	24	856

Combined Accuracy by Class:

		class	TP	FP	TN	FN	TPR	TNR	PPV	NPV	
F1	TS	0	1 764	307	3981	97	88.73%	97.62%	71.34%	97.62%	79.
09%	65.41%	Ü	, , , ,	307	3301	3,	00.700	37.020	71.010	37.020	, , ,
		1	533	154	4223	239	69.04%	94.64%	77.58%	94.64%	73.
06%	57.56%	2	1 600	23	4423	103	85.35%	97.72%	96.31%	97.72%	90.
50%	82.64%	۷	1 000	23	4423	105	03.338	51.120	70.510	51.120	J0.
		3	821	107	4154	67	92.45%	98.41%	88.47%	98.41%	90.
42%	82.51%	4	I 880	67	4129	73	92.34%	98.26%	92.93%	98.26%	92.
63%	86.27%	4	1 000	67	4129	13	92.346	90.206	92.936	90.200	92.
		5	856	37	4140	116	88.07%	97.27%	95.86%	97.27%	91.
80%	84.84%										

End Time: 03/17/2021, 05:23 UTC

Runtime Duration: 3m 26s

Testing on heldout data using DT -rank achieved 62.17% test accuracy

Running: NN -rank

./btc 'train.csv' -headerless -f NN -rank -o NNrank.py -riskoverfit --yes WARNING: Could not detect a GPU. Neural Network generation will be slow.

#### Brainome Table Compiler 0.991

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Alexander Makhratchev (Evaluation) Licensed to:

Expiration Date: 2021-04-30 44 days left

Maximum File Size: 30 GB Maximum Instances: unlimited Maximum Attributes: unlimited Maximum Classes: unlimited

daimensions.brainome.ai (local execution) Connected to:

#### Command:

btc train.csv -headerless -f NN -rank -o NNrank.py -riskoverfit --yes

Start Time:

Attribute Ranking:

Columns selected: 53, 366, 310, 388, 422, Risk of coincidental column correlation: 0.0%

Test Accuracy Progression:

53 : 56.07%

366 : 61.27% change +5.20% 310: 66.07% change +4.80% 388: 66.28% change +0.21% 422 : 66.32% change +0.04%

# Pre-training Measurements

Data:

train.csv (headerless csv) Input:

Target Column: Target Column:
Number of instances:
Number of attributes: target 5149

5 out of 561 6

Number of classes:

Class Balance:

0: 16.72% 1: 14.99% 2: 13.65% 3: 17.25% 4: 18.51% 5: 18.88%

Learnability:

Best guess accuracy: Data Sufficiency: 18.88%

Maybe enough data to generalize. [yellow]

Capacity Progression: at [ 5%, 10%, 20%, 40%, 80%, 100% ] Ideal Machine Learner: 8, 9, 10, 10, 11, 11

Expected Generalization:

ected Generalization Decision Tree:

' Metwork: 10.02 bits/bit 353.00 bits/bit Random Forest: 13.55 bits/bit

Expected Accuracy: Training
Decision Tree: 89.26% Validation 89.26% 66.30% Neural Network: 89.26% 82.32% 82.10% Random Forest: 99.22% 84.47%

Recommendations:

Note: Model type NN given by user.

Time to Build Estimates:

Neural Network: 21 minutes

Predictor: NNrank.py Classifier Type: Neural Network 6-way classifier System Type:

Training / Validation Split: Unable to split dataset. The predictor was trained an

d evaluated on the same data.

Accuracy:

18.88% Best-guess accuracy:

Combined Model Accuracy: 85.29% (4392/5149 correct)

Model Capacity (MEC): 132 bits Model Capacity Utilized: 132 bits Generalization Ratio: 85.70 bits/bit

Generalization Index: 27.66 Percent of Data Memorized: 3.62%
Resilience to Noise: -1.52 dB

Combined Confusion Matrix:

Actual | Predicted 

 749
 65
 47
 0
 0
 0

 89
 656
 27
 0
 0
 0

 72
 45
 586
 0
 0
 0

 0
 0
 0
 702
 98
 88

 0
 0
 0
 134
 807
 12

 0
 0
 53
 27
 892

 0 0 | 749 65 0 47 1 | 2 | 3 | 4 | 5 I

Combined Accuracy by Class:

		class	TP	FP	TN	FN	TPR	TNR	PPV	NPV	
F1	TS	0	1 749	161	4127	112	86.99%	97.36%	82.31%	97.36%	84.
58%	73.29%										
31%	74.38%	1	656	110	4267	116	84.97%	97.35%	85.64%	97.35%	85.
		2	586	74	4372	117	83.36%	97.39%	88.79%	97.39%	85.
99%	75.42%	3	1 702	187	4074	186	79.05%	95.63%	78.97%	95.63%	79.
01%	65.30%										
62%	74.86%	4	807	125	4071	146	84.68%	96.54%	86.59%	96.54%	85.
020	, 1.000	5	892	100	4077	80	91.77%	98.08%	89.92%	98.08%	90.
84%	83.21%										

03/17/2021, 05:30 UTC

Runtime Duration: 7m 37s

Testing on heldout data using NN -rank achieved 83.67% test accuracy

Running: RF -rank

./btc 'train.csv' -headerless -f RF -rank -o RFrank.py -riskoverfit --yes WARNING: Could not detect a GPU. Neural Network generation will be slow.

### Brainome Table Compiler 0.991

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Expiration Date:

Alexander Makhratchev (Evaluation)

2021-04-30

Maximum File Size: 30 GB Maximum Instances: unlimited unlimited Maximum Attributes: Maximum Classes: unlimited

Connected to: daimensions.brainome.ai (local execution)

btc train.csv -headerless -f RF -rank -o RFrank.py -riskoverfit --yes

Start Time: 03/17/2021, 05:31 UTC

# Attribute Ranking:

Columns selected: 53, 366, 310, 388, 422, Risk of coincidental column correlation: 0.0%

Test Accuracy Progression:

53: 56.07%

366 : 61.27% change +5.20% 310 : 66.07% change +4.80% 388 : 66.28% change +0.21% 422 : 66.32% change +0.04%

#### Pre-training Measurements

Data:

train.csv (headerless csv)
target Input:

Target Column: Number of attributes: 5 out of 561
Number of classes: 6

Class Balance:

0: 16.72% 1: 14.99% 2: 13.65% 3: 17.25% 4: 18.51% 5: 18.88%

Learnability:

Best guess accuracy: 18.88%

Data Sufficiency: Maybe enough data to generalize. [yellow]

at [ 5%, 10%, 20%, 40%, 80%, 100% ] Capacity Progression: acity Progression:
Ideal Machine Learner: 8, 9, 10, 10, 11, 11

Expected Generalization:
Decision Tree: 10.02 bits/bit 353.00 bits/bit Neural Network: Random Forest: 13.55 bits/bit

Expected Accuracy:
 Decision Tree:
 Neural Network: Training Validation 66.30% 89.26% 82.32% 82.10% Random Forest: 99.22% 84.47%

Recommendations:

Note: Model type RF given by user.

Predictor: RFrank.py Classifier Type: Random Forest System Type: 6-way classifier

Training / Validation Split: Unable to split dataset. The predictor was trained an

d evaluated on the same data.

Accuracy:

Best-guess accuracy: 18.88%

Combined Model Accuracy: 98.64% (5079/5149 correct)

Model Capacity (MEC): 13 bits

Generalization Ratio: 1006.39 bits/bit Generalization Index: 324.77 Generalization Index.

Percent of Data Memorized: 0.31%
-2.59 dB

Combined Confusion Matrix:

Actual		Predict	ted				
0		861	0	0	0	0	0
1	-	0	772	0	0	0	0
2		0	0	703	0	0	0
3	-	0	0	0	850	34	4
4	-	0	0	0	9	944	0
5	1	0	0	0	17	6	949

Combined	Accuracy	by	Class:
----------	----------	----	--------

		class		TP	FP	TN	FN	TPR	TNR	PPV	NPV	
F1	TS											
		0		861	0	4288	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%											
		1		772	0	4377	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%											
		2		703	0	4446	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%			0.50	0.6	4005	0.0	05 500	00 110	0.5.000	00 110	0.6
0.70	00.000	3	1	850	26	4235	38	95.72%	99.11%	97.03%	99.11%	96.
37%	93.00%	4		0.4.4	4.0	4156	0	00 060	00 700	05 000	00 700	0.7
47%	95.07%	4	1	944	40	4156	9	99.06%	99.78%	95.93%	99.78%	97.
4/6	93.076	5		949	4	4173	23	97.63%	99.45%	99.58%	99.45%	98.
60%	97.23%	J	I	243	4	41/3	23	21.036	<i>99</i> .436	99.30%	<i>99</i> .436	20.
000	21.200											

# Attribute Ranking:

1: 42.45% 4: 22.34% 0: 18.81% 2: 12.90% 3: 3.49%

End Time: 03/17/2021, 05:35 UTC

Runtime Duration: 4m 8s

Testing on heldout data using  $\,$  RF -rank achieved 85.22% test accuracy

Running: RF

./btc 'train.csv' -headerless -f RF -o RF.py -riskoverfit --yes

WARNING: Could not detect a GPU. Neural Network generation will be slow.

## Brainome Table Compiler 0.991

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Expiration Date: 2021-04-30 44 days left

Maximum File Size: 30 GB
Maximum Instances: unlimited
Maximum Attributes: unlimited
Maximum Classes: unlimited

Connected to: daimensions.brainome.ai (local execution)

#### Command:

btc train.csv -headerless -f RF -o RF.py -riskoverfit --yes

Start Time: 03/17/2021, 05:35 UTC

## Pre-training Measurements

Data:

Input: train.csv (headerless csv)

Target Column: target Number of instances: 5149

Number of attributes: 561 out of 561

Number of classes: 6

Class Balance:

0: 16.72% 1: 14.99% 2: 13.65% 3: 17.25% 4: 18.51% 5: 18.88%

Learnability:

Best guess accuracy: 18.88% Data Sufficiency: Maybe Maybe enough data to generalize. [yellow]

Capacity Progression: at [ 5%, 10%, 20%, 40%, 80%, 100% ] Ideal Machine Learner: 9, 10, 11, 11, 12, 12

Expected Generalization:

Decision Tree: 4.16 bits/bit 4.16 bits/bit 41.93 bits/bit Random Forest: 63.57 bits/bit

Expected Accuracy:
Decision Tree:
Neural Network: Training Validation 100.00% 38.10% 99.42% 97.05% Random Forest: 100.00% 96.86%

Recommendations:

Note: Model type RF given by user.

Predictor: RF.py

Classifier Type: Random Forest System Type: 6-way classifier

Training / Validation Split: Unable to split dataset. The predictor was trained an

d evaluated on the same data.

Accuracy:

Best-guess accuracy: 18.88%

Combined Model Accuracy: 100.00% (5149/5149 correct)

Model Capacity (MEC): 5 bits

Generalization Ratio: 2652.69 bits/bit Generalization Index: 856.06

0.12% -3.01 dB Percent of Data Memorized: Resilience to Noise:

Combined Confusion Matrix:

	 	-				
Actual	Predict	ced				
0	861	0	0	0	0	0
1	0	772	0	0	0	0
2	0	0	703	0	0	0
3	0	0	0	888	0	0
4	0	0	0	0	953	0
5	0	0	0	0	0	972

	Combined	Accuracy by class		FP	TN	FN	TPR	TNR	PPV	NPV	
F1	TS										
		0	861	0	4288	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%										
0.00	100 000	1	772	0	4377	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%	2 1	703	0	4446	0	100.00%	100.00%	100.00%	100.00%	100.
0.0%	100.00%	۷	703	U	4446	U	100.00%	100.00%	100.00%	100.00%	100.
008	100.000	3	888	0	4261	0	100.00%	100.00%	100.00%	100.00%	100.

00%	100.00%										
		4	953	0	4196	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%										
		5 I	972	0	4177	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%	·									

# Attribute Ranking:

348 :       18.90%         503 :       9.82%         296 :       7.39%         504 :       5.94%         330 :       5.57%         502 :       4.94%         52 :       4.94%         16 :       3.27%         40 :       2.97%         129 :       2.36%         65 :       2.35%         50 :       2.14%         352 :       1.78%         7 :       1.34%         474 :       1.33%         450 :       1.21%         69 :       1.17%         537 :       1.06%         316 :       1.01%         166 :       0.90%         445 :       0.62%         94 :       0.62%         38 :       0.62%         49 :       0.58%         409 :       0.56%         371 :       0.54%         423 :       0.52%         245 :       0.48%         418 :       0.42%         138 :       0.41%         104 :       0.37%         75 :       0.37%         76 :       0.22%         310 :			
503 :       9.82%         296 :       7.39%         504 :       5.94%         330 :       5.57%         502 :       4.94%         52 :       4.94%         16 :       3.27%         40 :       2.97%         129 :       2.36%         65 :       2.35%         50 :       2.14%         352 :       1.78%         7 :       1.34%         474 :       1.33%         450 :       1.21%         69 :       1.17%         537 :       1.06%         316 :       1.01%         166 :       0.90%         445 :       0.65%         302 :       0.62%         38 :       0.62%         38 :       0.62%         39 :       0.58%         409 :       0.58%         409 :       0.58%         409 :       0.58%         409 :       0.42%         245 :       0.48%         464 :       0.48%         418 :       0.42%         218 :       0.37%         75 :       0.37%         174 :			
296:       7.39%         504:       5.94%         330:       5.57%         502:       4.94%         16:       3.27%         40:       2.97%         129:       2.36%         65:       2.35%         50:       2.14%         352:       1.78%         7:       1.34%         474:       1.33%         450:       1.21%         69:       1.17%         537:       1.06%         316:       1.01%         166:       0.90%         445:       0.62%         38:       0.62%         49:       0.58%         409:       0.58%         409:       0.56%         371:       0.54%         423:       0.52%         245:       0.48%         464:       0.48%         418:       0.42%         200:       0.42%         213:       0.37%         75:       0.37%         75:       0.37%         74:       0.29%         310:       0.28%         63:       0.26% <tr< td=""><td></td><td>:</td><td>18.90%</td></tr<>		:	18.90%
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55 541255124	326315450974	8 4 8 9 2 6 6 0 6 5 9 7		0.00% 0.00% 0.00% 0.00% 0.00% 0.00% 0.00% 0.00% 0.00% 0.00%
55 541255124	32631545097	8 4 8 9 2 6 6 0 6 5 9 7 4		0.00% 0.00% 0.00% 0.00% 0.00% 0.00% 0.00% 0.00% 0.00% 0.00% 0.00%
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03/17/2021, 05:37 UTC End Time:

Runtime Duration: 2m 30s

Testing on heldout data using RF achieved 98.54% test accuracy

Running: NN

./btc 'train.csv' -headerless -f NN -o NN.py -riskoverfit --yes

WARNING: Could not detect a GPU. Neural Network generation will be slow.

Expiration Date:

Maximum File Size:

Maximum Attributes:

Maximum Classes:

Connected to:

Dialnome, Inc. All Rights Reserved.

Alexander Makhratchev (Evaluation)

2021-04-30 44 days left

unlimited

unlimited

unlimited

unlimited

daimensions.brainome.ai (local execution)

Command:

btc train.csv -headerless -f NN -o NN.py -riskoverfit --yes

Start Time: 03/17/2021, 05:37 UTC

Pre-training Measurements

Data:

train.csv (headerless csv) Input:

Target Column: target Target Column:
Number of instances:
Number of attributes: 5149

561 out of 561

Number of classes: 6

Class Balance:

0: 16.72% 1: 14.99% 2: 13.65% 3: 17.25% 4: 18.51% 5: 18.88%

Learnability:

Best guess accuracy: 18.88%
Data Sufficiency: Maybe enough data to generalize. [yellow]

Capacity Progression: at [ 5%, 10%, 20%, 40%, 80%, 100% ] Ideal Machine Learner: 9, 10, 11, 11, 12, 12

Expected Generalization:

Decision Tree: 4.16 bits/bit Neural Network: 41.93 bits/bit Random Forest: 63.57 bits/bit

Expected Accuracy:
Decision Tree:
Neural Network:
Random Forest: Training Validation 100.00% 99.42% 38.10% 97.05% Random Forest: 100.00% 96.86%

Recommendations:

Note: Model type NN given by user.

Time to Build Estimates:

Neural Network: 35 minutes Predictor: NN.py

Classifier Type: Neural Network
System Type: 6-way classifier

Training / Validation Split: Unable to split dataset. The predictor was trained an

d evaluated on the same data.

Accuracy:

Best-guess accuracy: 18.88%

Combined Model Accuracy: 99.96% (5147/5149 correct)

Model Capacity (MEC): 3414 bits
Model Capacity Utilized: 3414 bits
Generalization Ratio: 3.86 bits/bit
Generalization Index: 1.25

Percent of Data Memorized: 80.20%
Resilience to Noise: -0.18 dB

# Combined Confusion Matrix:

Actual		Predict	ted				
0		861	0	0	0	0	0
1		0	772	0	0	0	0
2		0	0	703	0	0	0
3		0	0	0	887	1	0
4		0	0	0	1	952	0
5	1	0	0	0	0	0	972

Combined Accuracy by Class:

	OOMBITTOG 11	ccaracy by	orabb.								
		class	TP	FP	TN	FN	TPR	TNR	PPV	NPV	
F1	TS										
		0	861	0	4288	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%										
		1	772	0	4377	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%										
		2	703	0	4446	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%										
		3	887	1	4260	1	99.89%	99.98%	99.89%	99.98%	99.
89%	99.78%										
		4	952	1	4195	1	99.90%	99.98%	99.90%	99.98%	99.
90%	99.79%										
		5	972	0	4177	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%										

End Time: 03/17/2021, 05:51 UTC

Runtime Duration: 13m 59s

Testing on heldout data using NN achieved 97.88% test accuracy

Running: DT

./btc 'train.csv' -headerless -f DT -o DT.py -riskoverfit --yes

WARNING: Could not detect a GPU. Neural Network generation will be slow.

### Brainome Table Compiler 0.991

Copyright (c) 2019-2021 Brainome, Inc. All Rights Reserved.

Licensed to: Alexander Makhratchev (Evaluation)

Expiration Date: 2021-04-30 44 days left

Maximum File Size: 30 GB
Maximum Instances: unlimited
Maximum Attributes: unlimited
Maximum Classes: unlimited

Connected to: daimensions.brainome.ai (local execution)

#### Command:

btc train.csv -headerless -f DT -o DT.py -riskoverfit --yes

Start Time: 03/17/2021, 05:52 UTC

Pre-training Measurements

Data:

train.csv (headerless csv)
target Input:

Target Column: Number of instances: 5149

Number of attributes: 561 out of 561

Number of classes: 6

Class Balance:

0: 16.72% 1: 14.99% 2: 13.65% 3: 17.25% 4: 18.51% 5: 18.88%

Learnability:

18.88% Best guess accuracy:

Data Sufficiency: Maybe enough data to generalize. [yellow]

Capacity Progression: at [ 5%, 10%, 20%, 40%, 80%, 100% ] acity Progression:
Ideal Machine Learner: 9, 10, 11, 11, 12, 12

Expected Generalization: 4.16 bits/bit Neural Network: 41.93 bits/bit Random Forest: 63.57 bits/bit

Expected Accuracy:
 Decision Tree:
 Neural Network: Training 100.00% Validation 38.10% 99.42% 97.05% Random Forest: 100.00% 96.86%

Recommendations:

Note: Model type DT given by user.

Time to Build Estimates:

Decision Tree: a few seconds

Predictor: DT.py

Classifier Type: Decision Tree System Type: 6-way classifier

Training / Validation Split: Unable to split dataset. The predictor was trained an

d evaluated on the same data.

Accuracy:

Best-guess accuracy: 18.88%

Combined Model Accuracy: 99.98% (5148/5149 correct)

Model Capacity (MEC): 3187 bits

4.15 bits/bit

Generalization Ratio:
Generalization Index: 1.34 Percent of Data Memorized: 74.72% Resilience to Noise: -0.21 dB

Combined Confusion Matrix:

Actual | Predicted 0 0 | 861 0 0 0 1 771 0 0 1 | 1 0 0 0 703 0 0 2 |

3		0	0	0	888	0	0
4		0	0	0	0	953	0
5	1	0	0	0	0	0	972

	Combined A	Accuracy by	Class	3:							
		class	TP	FP	TN	FN	TPR	TNR	PPV	NPV	
F1	TS										
		0	861	1	4287	0	100.00%	100.00%	99.88%	100.00%	99.
94%	99.88%										
0.40	00 070	1	771	0	4377	1	99.87%	99.98%	100.00%	99.98%	99.
94%	99.87%	2	703	0	4446	0	100.00%	100.00%	100.00%	100.00%	1.00
00%	100.00%	۷	703	U	4446	U	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%	3	888	0	4261	0	100.00%	100.00%	100.00%	100.00%	100.
0.0%	100.00%	<b>3</b>	000	O	1201	O	100.000	100.000	100.000	100.000	100.
000	100,000	4	953	0	4196	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%										
		5	972	0	4177	0	100.00%	100.00%	100.00%	100.00%	100.
00%	100.00%										

End Time: 03/17/2021, 05:53 UTC

Runtime Duration: 1m 43s

Testing on heldout data using DT achieved 37.36% test accuracy

Done Running!

Summary:

{'DT -rank': 62.17, 'NN -rank': 83.67, 'RF -rank': 85.22, 'RF': 98.54, 'NN': 97.88, 'DT':

37.36}

Best Test Accuracy: 98.54

Using: RF

Total Time Elapsed: 2068 seconds

Error while deleting file : clean051920316141.csv

Error while deleting file : clean.state

# **Accuracy on Validation for Each Model:**

**Best Guess: 22.82%** 

DT -rank: 62.17%

NN -rank: 83.67%

RF -rank: 85.17%

DT: 37.36%

NN: 97.88%

RF: 98.45%

The random forest model worked the best with 98.45% accuracy, with the neural network followed closely behind. However the tryall script does take a while to run, especially on larger datasets.

# Citation:

UCI Machine Learning Repository Davide Anguita, Alessandro Ghio, Luca Oneto, Xavier Parra and Jorge L. Reyes-Ortiz. A Public Domain Dataset for Human Activity Recognition Using Smartphones. 21th European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning, ESANN 2013. Bruges, Belgium 24-26 April 2013. Jorge L. Reyes-Ortiz(1,2), Davide Anguita(1), Alessandro Ghio(1), Luca Oneto(1) and Xavier Parra(2) 1 - Smartlab - Non-Linear Complex Systems Laboratory DITEN - Università degli Studi di Genova, Genoa (I-16145), Italy. 2 - CETpD - Technical Research Centre for Dependency Care and Autonomous Living Universitat Politècnica de Catalunya (Barcelona Tech), Vilanova i la Geltrú (08800), Spain

	activityrecognition '@' smartlab.ws
I	in []: