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 [2]:

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%%bash
head phone_activity.csv
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-1.0,-0.793,-0.184,0.177,0.213,-0.346,-0.694,-0.29,-0.667,-0.514,-0.842,-1.0,-1.0,-1.0,-1
.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-
1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,
-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
.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
.675,-0.995,-0.996,-0.996,-0.995,-0.994,-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 [1]:

```
! btc phone_activity.csv -measureonly
```

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

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Licensed to:                 Alexander Makhratchev  (Evaluation)
Expiration Date:             2021-04-30   56 days left
Number of Threads:           1
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 -measureonly

Start Time:                 03/05/2021, 19:36


Data:
    Input:                      phone_activity.csv
    Target Column:              activity
    Number of instances:        10299
    Number of attributes:       561
    Number of classes:          6
    Class Balance:              0: 18.51%, 1: 17.25%, 2: 18.88%, 3: 16.72%, 4: 13.65%, 5:
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% ]
    Optimal Machine Learner:          10,  11,  12,  12,  13,  13


Estimated Memory Equivalent Capacity for...
    Decision Tree:                   6463 parameters
    Neural Networks:                   85 parameters
    Random Forest:                    95 parameters

Risk that model needs to overfit for 100% accuracy using...
    Decision Tree:                75.49%
    Neural Networks:             100.00%
    Random Forest:                 2.25%

Expected Generalization using...
    Decision Tree:                  4.10 bits/bit
    Neural Network:                60.08 bits/bit
    Random Forest:                108.41 bits/bit


Recommendations:






Time to Build Estimates:
    Decision Tree:             less than a minute
    Neural Network:              44 minutes

Messages:
Warning: Remapped class labels to be contiguous. Use -cm if DET/ROC-based accuracy measur
ements are wrong.
```

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 [1]:

```
! python3 tryall.py phone_activity.csv btc
```

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

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Number of Threads:        1
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:                 03/04/2021, 22:03


Messages:
Clean only output: clean.csv, clean.state

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.

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rved.
```

```
Licensed to:              Alexander Makhratchev  (Evaluation)
Expiration Date:          2021-04-30   57 days left
Number of Threads:        1
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 -rank -o DTrank.py -riskoverfit --yes

Start Time:                 03/04/2021, 22:03

Attribute Ranking:
    Important columns:          53, 366, 310, 388, 422
    Overfit risk:                   0.0%
    Ignoring columns:           0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16,
17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39
, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 54, 55, 56, 57, 58, 59, 60, 61, 62,
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542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559,
560
    Test Accuracy Progression:     53 :   69.49%
                                   366 :   87.71%  change  +18.22%
                                   310 :   90.77%  change   +3.07%
                                   388 :   88.64%  change   -2.14%
                                   422 :   89.12%  change   +0.49%




Data:
    Input:                      train.csv (headerless csv)
    Target Column:              target
    Number of instances:        5149
    Number of attributes:       5
    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% ]
    Optimal Machine Learner:           8,   9,  10,  10,  11,  11


Estimated Memory Equivalent Capacity for...
    Decision Tree:                  1182 parameters
    Neural Networks:                   1 parameters
    Random Forest:                   385 parameters

Risk that model needs to overfit for 100% accuracy using...
    Decision Tree:                30.94%
    Neural Networks:               0.23%
    Random Forest:                17.91%

Expected Generalization using...
    Decision Tree:                 10.02 bits/bit
    Neural Network:              2106.00 bits/bit
    Random Forest:                 13.37 bits/bit


Recommendations:


    Note: Machine learner type DT given by user.


Time to Build Estimates:
    Decision Tree:             a few seconds


System Meter:                          DTrank.py
    Classifier Type:                   Decision Tree
    System Type:                       6-way classifier
    Training/Validation Split:         Unable to split dataset. The predictor was trained
and evaluated on the same data.
    Accuracy:
        Best-guess accuracy:               18.88%


        Overall Model Accuracy:            86.50% (4454/5149 correct)
        Improvement over best guess:       67.62% of possible  81.12%

    Model Capacity (MEC):                    1182 bits
    Generalization Ratio:                    9.69 bits/bit
    Model Efficiency:                        0.05 /parameter
    Generalization Index:                    3.13
    Percent of Data Memorized:             31.99%

    Full Confusion Matrix (count):
                   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 |    17    35     0    40    24   856

    Accuracy by Class:
              class |    TP    FP    TN    FN     TPR      TNR      PPV      NPV
F1       TS
                   0 |   764    97  3690   598   56.09%   86.05%   88.73%   86.05%   68.
74%   52.36%
                   1 |   533   239  3921   456   53.89%   89.58%   69.04%   89.58%   60.
53%   43.40%
                   2 |   600   103  3854   592   50.34%   86.68%   85.35%   86.68%   63.
32%   46.33%
                   3 |   821    67  3633   628   56.66%   85.26%   92.45%   85.26%   70.
26%   54.16%
                   4 |   880    73  3574   622   58.59%   85.18%   92.34%   85.18%   71.
69%   55.87%
                   5 |   856   116  3598   579   59.65%   86.14%   88.07%   86.14%   71.
13%   55.19%
```

```
End Time:
Runtime Duration:


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.

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Expiration Date:            2021-04-30   57 days left
Number of Threads:          1
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 NN -rank -o NNrank.py -riskoverfit --yes

Start Time:                   03/04/2021, 22:07

Attribute Ranking:
    Important columns:          53, 366, 310, 388, 422
    Overfit risk:                   0.0%
    Ignoring columns:           0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16,
17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39
, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 54, 55, 56, 57, 58, 59, 60, 61, 62,
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542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559,
560
    Test Accuracy Progression:      53 :   69.49%
                                   366 :   87.71%  change  +18.22%
                                   310 :   90.77%  change   +3.07%
                                   388 :   88.64%  change   -2.14%
                                   422 :   89.12%  change   +0.49%
```

```
Data:
    Input:                      train.csv (headerless csv)
    Target Column:              target
    Number of instances:        5149
    Number of attributes:       5
    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% ]
    Optimal Machine Learner:           8,   9,  10,  10,  11,  11


Estimated Memory Equivalent Capacity for...
    Decision Tree:                  1182 parameters
    Neural Networks:                   1 parameters
    Random Forest:                   385 parameters

Risk that model needs to overfit for 100% accuracy using...
    Decision Tree:                30.94%
    Neural Networks:               0.23%
    Random Forest:                17.91%

Expected Generalization using...
    Decision Tree:                 10.02 bits/bit
    Neural Network:              2106.00 bits/bit
    Random Forest:                 13.37 bits/bit


Recommendations:


    Note: Machine learner type NN given by user.


Time to Build Estimates:

    Neural Network:              15 minutes


System Meter:                         NNrank.py
    Classifier Type:                  Neural Network
    System Type:                      6-way classifier
    Training/Validation Split:        Unable to split dataset. The predictor was trained 
and evaluated on the same data.
    Accuracy:
        Best-guess accuracy:              18.88%


        Overall Model Accuracy:           85.29% (4392/5149 correct)
        Improvement over best guess:      66.41% of possible  81.12%

    Model Capacity (MEC):                      1 bit
    Generalization Ratio:               11313.47 bits/bit
    Model Efficiency:                      66.41 /parameter
    Generalization Index:                3651.00
    Percent of Data Memorized:              0.03%

    Full Confusion Matrix (count):
                   0 |   749    65    47     0     0     0
                   1 |    89   656    27     0     0     0
                   2 |    72    45   586     0     0     0
                   3 |     0     0     0   702    98    88
                   4 |     0     0     0   134   807    12
                   5 |     0     0     0    53    27   892

    Accuracy by Class:
              class |    TP    FP    TN    FN      TPR       TNR       PPV       NPV
```

```
F1       TS
                   0 |   749   112  3643   645   53.73%   84.96%   86.99%   84.96%   66.
43%   49.73%
                   1 |   656   116  3736   641   50.58%   85.36%   84.97%   85.36%   63.
41%   46.43%
                   2 |   586   117  3806   640   47.80%   85.61%   83.36%   85.61%   60.
76%   43.63%
                   3 |   702   186  3690   571   55.15%   86.60%   79.05%   86.60%   64.
97%   48.12%
                   4 |   807   146  3585   611   56.91%   85.44%   84.68%   85.44%   68.
07%   51.60%
                   5 |   892    80  3500   677   56.85%   83.79%   91.77%   83.79%   70.
21%   54.09%

End Time:
Runtime Duration:


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.

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Licensed to:                 Alexander Makhratchev  (Evaluation)
Expiration Date:             2021-04-30   56 days left
Number of Threads:           1
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 -rank -o RFrank.py -riskoverfit --yes

Start Time:                 03/05/2021, 00:57

Attribute Ranking:
    Important columns:           53, 366, 310, 388, 422
    Overfit risk:                    0.0%
    Ignoring columns:            0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16,
17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 3
, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 54, 55, 56, 57, 58, 59, 60, 61, 62,
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542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559,
560
    Test Accuracy Progression:     53 :   69.49%
                                   366 :   87.71%  change  +18.22%
                                   310 :   90.77%  change   +3.07%
                                   388 :   88.64%  change   -2.14%
                                   422 :   89.12%  change   +0.49%




Data:
    Input:                      train.csv (headerless csv)
    Target Column:              target
    Number of instances:        5149
    Number of attributes:       5
    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% ]
    Optimal Machine Learner:           8,   9,  10,  10,  11,  11


Estimated Memory Equivalent Capacity for...
    Decision Tree:                  1182 parameters
    Neural Networks:                   1 parameters
    Random Forest:                   385 parameters

Risk that model needs to overfit for 100% accuracy using...
    Decision Tree:                30.94%
    Neural Networks:               0.23%
    Random Forest:                17.91%

Expected Generalization using...
    Decision Tree:                 10.02 bits/bit
    Neural Network:              2106.00 bits/bit
    Random Forest:                 13.37 bits/bit


Recommendations:


    Note: Machine learner type RF given by user.


System Meter:                          RFrank.py
    Classifier Type:                   Random Forest
    System Type:                       6-way classifier
    Training/Validation Split:         Unable to split dataset. The predictor was trained
and evaluated on the same data.
    Accuracy:
        Best-guess accuracy:               18.88%


        Overall Model Accuracy:            98.65% (5080/5149 correct)
        Improvement over best guess:       79.77% of possible  81.12%

    Model Capacity (MEC):                      13 bits
    Generalization Ratio:                 1006.57 bits/bit
    Model Efficiency:                        6.13 /parameter
    Generalization Index:                  324.83
    Percent of Data Memorized:               0.31%

    Full Confusion Matrix (count):
```

```
                  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   848    35     5
                  4 |     0     0     0     7   946     0
                  5 |     0     0     0    16     6   950

    Accuracy by Class:
               class |    TP    FP    TN    FN     TPR      TNR      PPV      NPV       
F1       TS
                   0 |   861     0  4219    69   92.58%   98.39%  100.00%   98.39%   96.
15%   92.58%
                   1 |   772     0  4308    69   91.80%   98.42%  100.00%   98.42%   95.
72%   91.80%
                   2 |   703     0  4377    69   91.06%   98.45%  100.00%   98.45%   95.
32%   91.06%
                   3 |   848    40  4232    29   96.69%   99.32%   95.50%   99.32%   96.
09%   92.48%
                   4 |   946     7  4134    62   93.85%   98.52%   99.27%   98.52%   96.
48%   93.20%
                   5 |   950    22  4130    47   95.29%   98.87%   97.74%   98.87%   96.
50%   93.23%

End Time:
Runtime Duration:


Testing on heldout data...
Using  RF -rank achieved 85.17% 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.

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rved.
Licensed to:                 Alexander Makhratchev  (Evaluation)
Expiration Date:             2021-04-30   56 days left
Number of Threads:           1
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:                 03/05/2021, 01:04


Data:
    Input:                      train.csv (headerless csv)
    Target Column:              target
    Number of instances:        5149
    Number of attributes:       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% ]
    Optimal Machine Learner:            9,  10,  11,  11,  12,  12


Estimated Memory Equivalent Capacity for...
    Decision Tree:                    3187 parameters
    Neural Networks:                  73 parameters
    Random Forest:                    63 parameters

Risk that model needs to overfit for 100% accuracy using...
    Decision Tree:                74.46%
    Neural Networks:               4.30%
    Random Forest:                 3.04%

Expected Generalization using...
    Decision Tree:                  4.16 bits/bit
    Neural Network:                35.16 bits/bit
    Random Forest:                 81.73 bits/bit


Recommendations:


    Note: Machine learner type RF given by user.


System Meter:                          RF.py
    Classifier Type:                   Random Forest
    System Type:                       6-way classifier
    Training/Validation Split:         Unable to split dataset. The predictor was trained
and evaluated on the same data.
    Accuracy:
        Best-guess accuracy:               18.88%


        Overall Model Accuracy:           100.00% (5149/5149 correct)
        Improvement over best guess:       81.12% of possible  81.12%

    Model Capacity (MEC):                       5 bits
    Generalization Ratio:                 2652.69 bits/bit
    Model Efficiency:                       16.22 /parameter
    Generalization Index:                  856.06
    Percent of Data Memorized:               0.12%

    Full Confusion Matrix (count):
                   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

    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%
                   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 |   972     0  4177     0  100.00%  100.00%  100.00%  100.00%  100.
00%  100.00%

End Time:
Runtime Duration:


Testing on heldout data...
Using  RF achieved 98.45% 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.
```

```
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rved.
Licensed to:              Alexander Makhratchev  (Evaluation)
Expiration Date:          2021-04-30   56 days left
Number of Threads:        1
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 NN -o NN.py -riskoverfit --yes

Start Time:                 03/05/2021, 01:09


Data:
    Input:                      train.csv (headerless csv)
    Target Column:              target
    Number of instances:        5149
    Number of attributes:       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% ]
    Optimal Machine Learner:           9,  10,  11,  11,  12,  12


Estimated Memory Equivalent Capacity for...
    Decision Tree:                  3187 parameters
    Neural Networks:                  73 parameters
    Random Forest:                    63 parameters

Risk that model needs to overfit for 100% accuracy using...
    Decision Tree:                74.46%
    Neural Networks:               4.30%
    Random Forest:                 3.04%

Expected Generalization using...
    Decision Tree:                  4.16 bits/bit
    Neural Network:                35.16 bits/bit
    Random Forest:                 81.73 bits/bit


Recommendations:


    Note: Machine learner type NN given by user.


Time to Build Estimates:

    Neural Network:              19 minutes


System Meter:                         NN.py
    Classifier Type:                   Neural Network
    System Type:                       6-way classifier
    Training/Validation Split:         Unable to split dataset. The predictor was trained
and evaluated on the same data.
    Accuracy:
        Best-guess accuracy:               18.88%
        Overall Model Accuracy:            99.96% (5147/5149 correct)
        Improvement over best guess:       81.08% of possible  81.12%

    Model Capacity (MEC):                       1 bit
    Generalization Ratio:                13258.30 bits/bit
    Model Efficiency:                       81.08 /parameter
    Generalization Index:                 4278.62
    Percent of Data Memorized:               0.02%

    Full Confusion Matrix (count):
                   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 |     0     0     0     0     0   972

    Accuracy by Class:
               class |    TP    FP    TN    FN     TPR      TNR      PPV      NPV
F1       TS
                   0 |   861     0  4286     2   99.77%   99.95%  100.00%   99.95%   99.
88%   99.77%
                   1 |   772     0  4375     2   99.74%   99.95%  100.00%   99.95%   99.
87%   99.74%
                   2 |   703     0  4444     2   99.72%   99.96%  100.00%   99.96%   99.
86%   99.72%
                   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  4175     2   99.79%   99.95%  100.00%   99.95%   99.
90%   99.79%

End Time:
Runtime Duration:


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.

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Licensed to:              Alexander Makhratchev  (Evaluation)
Expiration Date:          2021-04-30   56 days left
Number of Threads:        1
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:                 03/05/2021, 01:24


Data:
    Input:                        train.csv (headerless csv)
    Target Column:                target
    Number of instances:          5149
    Number of attributes:         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% ]
    Optimal Machine Learner:           9,  10,  11,  11,  12,  12


Estimated Memory Equivalent Capacity for...
    Decision Tree:                  3187 parameters
    Neural Networks:                  73 parameters
    Random Forest:                    63 parameters

Risk that model needs to overfit for 100% accuracy using...
    Decision Tree:                74.46%
    Neural Networks:               4.30%
    Random Forest:                 3.04%

Expected Generalization using...
    Decision Tree:                  4.16 bits/bit
    Neural Network:                35.16 bits/bit
    Random Forest:                 81.73 bits/bit


Recommendations:


    Note: Machine learner type DT given by user.


Time to Build Estimates:
    Decision Tree:             a few seconds


System Meter:                          DT.py
    Classifier Type:                   Decision Tree
    System Type:                       6-way classifier
    Training/Validation Split:         Unable to split dataset. The predictor was trained
and evaluated on the same data.
    Accuracy:
        Best-guess accuracy:               18.88%


        Overall Model Accuracy:            99.98% (5148/5149 correct)
        Improvement over best guess:       81.10% of possible  81.12%

    Model Capacity (MEC):                    3187 bits
    Generalization Ratio:                    4.15 bits/bit
    Model Efficiency:                        0.02 /parameter
    Generalization Index:                    1.34
    Percent of Data Memorized:              74.72%

    Full Confusion Matrix (count):
                   0 |   861     0     0     0     0     0
                   1 |     1   771     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

    Accuracy by Class:
               class |    TP    FP    TN    FN     TPR      TNR      PPV      NPV
F1       TS
                   0 |   861     0  4287     1   99.88%   99.98%  100.00%   99.98%   99.
94%   99.88%
                   1 |   771     1  4377     0  100.00%  100.00%   99.87%  100.00%   99.
94%   99.87%
                   2 |   703     0  4445     1   99.86%   99.98%  100.00%   99.98%   99.
93%   99.86%
                   3 |   888     0  4260     1   99.89%   99.98%  100.00%   99.98%   99.
94%   99.89%
```

```
                    4 |    953      0   4195      1    99.90%    99.98%  100.00%    99.98%    99.
95%   99.90%
                    5 |    972      0   4176      1    99.90%    99.98%  100.00%    99.98%    99.
95%   99.90%

End Time:
Runtime Duration:


Testing on heldout data...
Using  DT achieved 37.36% test accuracy
##################################################
Done Running!
Summary:
{'DT -rank': 62.17, 'NN -rank': 83.67, 'RF -rank': 85.17, 'RF': 98.45, 'NN': 97.88, 'DT':
37.36}
Best Test Accuracy: 98.45
Using: RF
Total Time Elapsed: 12252 seconds
Traceback (most recent call last):
  File "tryall.py", line 176, in <module>
    run(sys.argv[1:])
  File "tryall.py", line 162, in run
    fileList = glob.glob(client + 'clean*')
NameError: name 'client' is not defined
```

Accuracy 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%

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 (BarcelonaTech). Vilanova i la Geltrú (08800), Spain activityrecognition '@' smartlab.ws

```
In [ ]:
```