Nicholas Nhat Tran 1002027150

CSE 4309 Assignment 5

Task 1 (35 pts)

In your answers.pdf document, you need to provide parts of the output for some invocations of your program listed below. For each invocation, provide:

- The full output of the training stage.
- ONLY THE LAST LINE (the line printing the classification accuracy) of the output by the test stage.

Include this output for the following invocations of your program:

```
decision_tree.py pendigits_training pendigits_test optimized 50
decision_tree.py pendigits_training pendigits_test 1 50
decision_tree.py pendigits_training pendigits_test 3 50
```

optimized 50 (decision_tree.py pendigits_training pendigits_test)

tree= 1, node= 1, feature=16, thr= 25.00, gain=0.622315
tree= 1, node= 2, feature= 5, thr= 41.00, gain=0.587774
tree= 1, node= 3, feature=14, thr= 58.00, gain=0.693090
tree= 1, node= 4, feature=10, thr= 19.00, gain=0.694970
tree= 1, node= 5, feature=11, thr= 39.00, gain=0.621049
tree= 1, node= 6, feature= 1, thr= 36.00, gain=0.704917
tree= 1, node= 7, feature= 9, thr= 57.00, gain=0.799162
tree= 1, node= 8, feature=15, thr= 57.00, gain=0.484033
tree= 1, node= 9, feature= 6, thr= 65.00, gain=0.624701
tree= 1, node= 10, feature=15, thr= 39.00, gain=0.224463
tree= 1, node= 11, feature= 4, thr= 91.00, gain=0.685047
tree= 1, node= 12, feature=15, thr= 40.00, gain=0.252781
tree= 1, node= 13, feature=11, thr= 34.00, gain=0.595866
tree= 1, node= 14, feature=15, thr= 97.00, gain=0.723674
tree= 1, node= 15, feature= 8, thr= 27.00, gain=0.231693
tree= 1, node= 16, feature= 1, thr= 16.00, gain=0.024945
tree= 1, node= 17, feature=11, thr= 85.00, gain=0.993570

```
tree= 1, node= 18, feature=16, thr=  2.00, gain=0.203643
tree= 1, node= 19, feature=10, thr= 62.00, gain=0.527032
tree= 1, node= 20, feature=13, thr= 32.00, gain=0.721928
tree= 1, node= 21, feature= 9, thr= 35.00, gain=0.140854
tree= 1, node= 22, feature= 7, thr= 72.00, gain=0.523322
tree= 1, node= 23, feature= 8, thr= 77.00, gain=0.395504
tree= 1, node= 24, feature= 2, thr= 85.00, gain=0.549200
tree= 1, node= 25, feature=14, thr=  8.00, gain=0.118655
tree= 1, node= 26, feature=16, thr= 32.00, gain=0.225545
tree= 1, node= 27, feature=10, thr= 20.00, gain=0.423288
tree= 1, node= 28, feature=12, thr= 32.00, gain=0.166116
tree= 1, node= 29, feature=14, thr= 74.00, gain=0.380947
tree= 1, node= 30, feature= 3, thr= 56.00, gain=0.100654
tree= 1, node= 31, feature= 4, thr= 36.00, gain=0.970951
tree= 1, node= 32, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 33, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 34, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 35, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 36, feature=10, thr= 83.00, gain=0.111601
tree= 1, node= 37, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 38, feature=15, thr= 27.00, gain=0.761426
tree= 1, node= 39, feature= 1, thr= 39.00, gain=0.209277
tree= 1, node= 40, feature= 4, thr= 97.00, gain=0.352611
tree= 1, node= 41, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 42, feature=10, thr=  2.00, gain=0.074757
tree= 1, node= 43, feature= 7, thr= 69.00, gain=0.275736
tree= 1, node= 44, feature=16, thr= 11.00, gain=0.336642
tree= 1, node= 45, feature= 2, thr= 80.00, gain=0.343449
tree= 1, node= 46, feature= 3, thr= 90.00, gain=0.247191
tree= 1, node= 47, feature= 6, thr= 90.00, gain=0.778977
tree= 1, node= 48, feature= 9, thr= 77.00, gain=0.509516
tree= 1, node= 49, feature= 7, thr= 53.00, gain=0.711709
```

```
tree= 1, node= 50, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 51, feature= 2, thr= 64.00, gain=0.061946
tree= 1, node= 52, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 53, feature= 1, thr= 54.00, gain=0.134550
tree= 1, node= 54, feature= 7, thr= 42.00, gain=0.268574
tree= 1, node= 55, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 56, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 57, feature=13, thr= 27.00, gain=0.159034
tree= 1, node= 58, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 59, feature= 6, thr= 55.00, gain=0.006884
tree= 1, node= 60, feature= 7, thr= 98.00, gain=0.025464
tree= 1, node= 61, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 62, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 63, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 72, feature= 6, thr= 10.00, gain=0.016354
tree= 1, node= 73, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 76, feature= 8, thr= 73.00, gain=0.488771
tree= 1, node= 77, feature= 8, thr= 55.00, gain=0.841667
tree= 1, node= 78, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 79, feature= 2, thr= 93.00, gain=0.056830
tree= 1, node= 80, feature= 6, thr= 71.00, gain=0.238685
tree= 1, node= 81, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 84, feature= 9, thr= 13.00, gain=0.365288
tree= 1, node= 85, feature= 8, thr= 75.00, gain=0.049516
tree= 1, node= 86, feature=13, thr= 56.00, gain=0.299231
tree= 1, node= 87, feature= 9, thr= 65.00, gain=0.184531
tree= 1, node= 88, feature=15, thr= 98.00, gain=0.363316
tree= 1, node= 89, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 90, feature=16, thr= 15.00, gain=0.133354
tree= 1, node= 91, feature= 1, thr= 38.00, gain=0.687959
tree= 1, node= 92, feature=10, thr= 24.00, gain=0.226290
tree= 1, node= 93, feature= 6, thr= 86.00, gain=0.891051
```

```
tree= 1, node= 94, feature= 3, thr=100.00, gain=0.090544
tree= 1, node= 95, feature= 7, thr= 76.00, gain=0.981132
tree= 1, node= 96, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 97, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 98, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 99, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=102, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=103, feature= 9, thr=  4.00, gain=0.027338
tree= 1, node=106, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=107, feature=15, thr=  8.00, gain=0.045639
tree= 1, node=108, feature=15, thr= 68.00, gain=0.176082
tree= 1, node=109, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=114, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=115, feature= 2, thr= 45.00, gain=0.028970
tree= 1, node=118, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=119, feature= 7, thr= 50.00, gain=0.097300
tree= 1, node=120, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=121, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=144, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=145, feature=10, thr= 20.00, gain=0.010906
tree= 1, node=152, feature= 9, thr= 31.00, gain=0.447129
tree= 1, node=153, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=154, feature= 6, thr= 81.00, gain=0.286397
tree= 1, node=155, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=158, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=159, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=160, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=161, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=168, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=169, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=170, feature=13, thr= 37.00, gain=0.021912
tree= 1, node=171, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 1, node=172, feature= 7, thr= 59.00, gain=0.196212
tree= 1, node=173, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=174, feature=16, thr= 17.00, gain=0.161571
tree= 1, node=175, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=176, feature= 8, thr= 70.00, gain=0.188572
tree= 1, node=177, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=180, feature= 1, thr= 70.00, gain=0.032594
tree= 1, node=181, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=182, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=183, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=184, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=185, feature= 1, thr= 81.00, gain=0.130973
tree= 1, node=186, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=187, feature= 2, thr= 82.00, gain=0.669245
tree= 1, node=188, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=189, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=190, feature= 5, thr= 57.00, gain=0.309543
tree= 1, node=191, feature=12, thr= 40.00, gain=0.549553
tree= 1, node=206, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=207, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=214, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=215, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=216, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=217, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=230, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=231, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=238, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=239, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=290, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=291, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=304, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=305, feature= 2, thr= 88.00, gain=0.291706
```

```
tree= 1, node=308, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=309, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=340, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=341, feature=10, thr=  6.00, gain=0.007098
tree= 1, node=344, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=345, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=348, feature= 3, thr= 85.00, gain=0.116445
tree= 1, node=349, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=352, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=353, feature= 2, thr= 44.00, gain=0.045036
tree= 1, node=360, feature=12, thr= 69.00, gain=0.027070
tree= 1, node=361, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=370, feature=15, thr= 55.00, gain=0.118084
tree= 1, node=371, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=374, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=375, feature= 5, thr= 43.00, gain=0.129234
tree= 1, node=380, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=381, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=382, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=383, feature= 3, thr= 63.00, gain=0.101067
tree= 1, node=610, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=611, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=682, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=683, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=696, feature= 4, thr= 88.00, gain=0.072092
tree= 1, node=697, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=706, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=707, feature= 4, thr= 90.00, gain=0.031519
tree= 1, node=720, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=721, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=740, feature= 4, thr=100.00, gain=0.053232
tree= 1, node=741, feature=-1, thr= -1.00, gain=0.000000
```

tree= 1, node=750, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=751, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=766, feature= 2, thr= 72.00, gain=0.075491
tree= 1, node=767, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1392, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1393, feature= 2, thr= 90.00, gain=0.024167
tree= 1, node=1414, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1415, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1480, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1481, feature= 7, thr= 15.00, gain=0.023465
tree= 1, node=1532, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1533, feature= 3, thr= 42.00, gain=0.066047
tree= 1, node=2786, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2787, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2962, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2963, feature= 3, thr= 87.00, gain=0.008261
tree= 1, node=3066, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3067, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=5926, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=5927, feature=-1, thr= -1.00, gain=0.000000

Classification Accuracy

classification accuracy=0.8662

150 (decision_tree.py pendigits_training pendigits_test)

tree= 1, node= 1, feature= 7, thr= 25.00, gain=0.296121
tree= 1, node= 2, feature= 3, thr= 54.00, gain=0.136543
tree= 1, node= 3, feature= 8, thr= 47.00, gain=0.455852
tree= 1, node= 4, feature= 7, thr= 9.00, gain=0.149328
tree= 1, node= 5, feature= 8, thr= 50.00, gain=0.628895
tree= 1, node= 6, feature= 2, thr=100.00, gain=0.299041

```
tree= 1, node=  7, feature= 2, thr= 73.00, gain=0.390366
tree= 1, node=  8, feature=16, thr=  1.00, gain=0.681767
tree= 1, node=  9, feature= 2, thr=100.00, gain=0.457452
tree= 1, node= 10, feature= 1, thr= 81.00, gain=0.498690
tree= 1, node= 11, feature=15, thr= 27.00, gain=0.309530
tree= 1, node= 12, feature= 7, thr= 50.00, gain=0.089727
tree= 1, node= 13, feature= 8, thr= 14.00, gain=0.667469
tree= 1, node= 14, feature= 9, thr= 57.00, gain=0.251160
tree= 1, node= 15, feature= 6, thr= 70.00, gain=0.344940
tree= 1, node= 16, feature= 2, thr= 99.00, gain=0.081794
tree= 1, node= 17, feature= 8, thr=  2.00, gain=0.474768
tree= 1, node= 18, feature=13, thr= 60.00, gain=0.576705
tree= 1, node= 19, feature=10, thr= 16.00, gain=0.804839
tree= 1, node= 20, feature=14, thr= 51.00, gain=0.721994
tree= 1, node= 21, feature= 8, thr= 43.00, gain=0.098818
tree= 1, node= 22, feature= 4, thr= 89.00, gain=0.370720
tree= 1, node= 23, feature=11, thr= 55.00, gain=0.313400
tree= 1, node= 24, feature=14, thr= 30.00, gain=0.928704
tree= 1, node= 25, feature=14, thr= 53.00, gain=0.801967
tree= 1, node= 26, feature=15, thr=100.00, gain=0.642830
tree= 1, node= 27, feature=12, thr= 39.00, gain=0.800937
tree= 1, node= 28, feature= 9, thr= 19.00, gain=0.244374
tree= 1, node= 29, feature=16, thr= 11.00, gain=0.338617
tree= 1, node= 30, feature= 7, thr= 83.00, gain=0.108965
tree= 1, node= 31, feature=14, thr= 16.00, gain=0.473045
tree= 1, node= 32, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 33, feature= 3, thr=  7.00, gain=0.059563
tree= 1, node= 34, feature= 5, thr= 11.00, gain=0.530745
tree= 1, node= 35, feature= 9, thr= 32.00, gain=0.046794
tree= 1, node= 36, feature= 7, thr= 14.00, gain=0.127874
tree= 1, node= 37, feature= 1, thr= 32.00, gain=0.441125
tree= 1, node= 38, feature= 4, thr= 87.00, gain=0.080280
```

```
tree= 1, node= 39, feature= 9, thr= 52.00, gain=0.617944
tree= 1, node= 40, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 41, feature= 6, thr= 97.00, gain=0.072921
tree= 1, node= 42, feature= 3, thr= 62.00, gain=0.033602
tree= 1, node= 43, feature=16, thr= 10.00, gain=0.463402
tree= 1, node= 44, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 45, feature= 4, thr= 96.00, gain=0.019447
tree= 1, node= 46, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 47, feature=14, thr= 24.00, gain=0.315838
tree= 1, node= 48, feature=13, thr= 51.00, gain=0.106445
tree= 1, node= 49, feature= 7, thr= 41.00, gain=0.038226
tree= 1, node= 50, feature= 5, thr= 48.00, gain=0.289079
tree= 1, node= 51, feature= 8, thr= 27.00, gain=0.109528
tree= 1, node= 52, feature=13, thr= 94.00, gain=0.383264
tree= 1, node= 53, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 54, feature= 7, thr= 50.00, gain=0.428198
tree= 1, node= 55, feature= 4, thr= 64.00, gain=0.065225
tree= 1, node= 56, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 57, feature=14, thr= 25.00, gain=0.246889
tree= 1, node= 58, feature= 1, thr= 63.00, gain=0.376822
tree= 1, node= 59, feature= 9, thr= 97.00, gain=0.277361
tree= 1, node= 60, feature=14, thr= 18.00, gain=0.649157
tree= 1, node= 61, feature= 5, thr= 41.00, gain=0.385613
tree= 1, node= 62, feature= 7, thr= 48.00, gain=0.110092
tree= 1, node= 63, feature=14, thr= 24.00, gain=0.186255
tree= 1, node= 66, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 67, feature=12, thr= 30.00, gain=0.155163
tree= 1, node= 68, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 69, feature= 6, thr= 41.00, gain=0.045117
tree= 1, node= 70, feature=14, thr= 36.00, gain=0.358570
tree= 1, node= 71, feature= 6, thr= 75.00, gain=0.159015
tree= 1, node= 72, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 1, node= 73, feature= 9, thr= 14.00, gain=0.347345
tree= 1, node= 74, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 75, feature= 2, thr= 83.00, gain=0.113077
tree= 1, node= 76, feature= 8, thr=  5.00, gain=0.357691
tree= 1, node= 77, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 78, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 79, feature=12, thr= 39.00, gain=0.226638
tree= 1, node= 82, feature=10, thr= 43.00, gain=0.037094
tree= 1, node= 83, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 84, feature=13, thr= 94.00, gain=0.238444
tree= 1, node= 85, feature= 5, thr= 27.00, gain=0.010348
tree= 1, node= 86, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 87, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 90, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 91, feature=14, thr= 18.00, gain=0.279587
tree= 1, node= 94, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 95, feature= 7, thr=  3.00, gain=0.011873
tree= 1, node= 96, feature=10, thr=  1.00, gain=0.274631
tree= 1, node= 97, feature= 1, thr= 72.00, gain=0.086122
tree= 1, node= 98, feature= 2, thr= 79.00, gain=0.201181
tree= 1, node= 99, feature=14, thr= 84.00, gain=0.679127
tree= 1, node=100, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=101, feature= 1, thr= 11.00, gain=0.438469
tree= 1, node=102, feature=16, thr= 93.00, gain=0.554081
tree= 1, node=103, feature= 8, thr= 43.00, gain=0.095500
tree= 1, node=104, feature= 3, thr= 21.00, gain=0.214869
tree= 1, node=105, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=108, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=109, feature= 5, thr= 62.00, gain=0.592547
tree= 1, node=110, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=111, feature= 8, thr= 27.00, gain=0.049469
tree= 1, node=114, feature= 9, thr= 46.00, gain=0.125532
```

```
tree= 1, node=115, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=116, feature=12, thr= 38.00, gain=0.064322
tree= 1, node=117, feature=14, thr= 20.00, gain=0.047123
tree= 1, node=118, feature= 5, thr= 68.00, gain=0.405855
tree= 1, node=119, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=120, feature=13, thr= 46.00, gain=0.461320
tree= 1, node=121, feature= 1, thr= 75.00, gain=0.273609
tree= 1, node=122, feature=15, thr= 28.00, gain=0.146242
tree= 1, node=123, feature= 7, thr= 97.00, gain=0.078135
tree= 1, node=124, feature=13, thr= 49.00, gain=0.334026
tree= 1, node=125, feature=16, thr=  7.00, gain=0.089204
tree= 1, node=126, feature= 8, thr= 58.00, gain=0.247842
tree= 1, node=127, feature= 9, thr= 28.00, gain=0.177619
tree= 1, node=134, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=135, feature= 9, thr= 61.00, gain=0.067754
tree= 1, node=138, feature= 9, thr=  9.00, gain=0.526861
tree= 1, node=139, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=140, feature= 8, thr= 68.00, gain=0.341154
tree= 1, node=141, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=142, feature=14, thr= 48.00, gain=0.384002
tree= 1, node=143, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=146, feature=11, thr= 80.00, gain=0.238685
tree= 1, node=147, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=150, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=151, feature= 3, thr= 40.00, gain=0.169739
tree= 1, node=152, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=153, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=158, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=159, feature=10, thr= 21.00, gain=0.228514
tree= 1, node=164, feature= 7, thr= 16.00, gain=0.052025
tree= 1, node=165, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=168, feature=12, thr= 54.00, gain=0.239397
```

```
tree= 1, node=169, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=170, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=171, feature=10, thr= 32.00, gain=0.266765
tree= 1, node=182, feature=10, thr= 74.00, gain=0.352821
tree= 1, node=183, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=190, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=191, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=192, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=193, feature= 6, thr= 72.00, gain=0.086485
tree= 1, node=194, feature=16, thr=  3.00, gain=0.025358
tree= 1, node=195, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=196, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=197, feature=11, thr= 98.00, gain=0.919455
tree= 1, node=198, feature= 4, thr=100.00, gain=0.011046
tree= 1, node=199, feature=15, thr=100.00, gain=0.964399
tree= 1, node=202, feature=16, thr= 20.00, gain=0.335499
tree= 1, node=203, feature= 8, thr= 38.00, gain=0.109363
tree= 1, node=204, feature= 2, thr= 81.00, gain=0.016230
tree= 1, node=205, feature=15, thr= 71.00, gain=0.758287
tree= 1, node=206, feature= 6, thr= 37.00, gain=0.787127
tree= 1, node=207, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=208, feature= 5, thr= 49.00, gain=0.240614
tree= 1, node=209, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=218, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=219, feature= 5, thr= 95.00, gain=0.016655
tree= 1, node=222, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=223, feature= 8, thr= 31.00, gain=0.010652
tree= 1, node=228, feature= 5, thr= 82.00, gain=0.286031
tree= 1, node=229, feature= 6, thr=100.00, gain=0.057980
tree= 1, node=232, feature=12, thr= 12.00, gain=0.138030
tree= 1, node=233, feature= 5, thr= 43.00, gain=0.041796
tree= 1, node=234, feature=-1, thr= -1.00, gain=0.000000
```

tree= 1, node=235, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=236, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=237, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=240, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=241, feature= 1, thr= 48.00, gain=0.068678
tree= 1, node=242, feature=10, thr= 44.00, gain=0.091402
tree= 1, node=243, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=244, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=245, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=246, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=247, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=248, feature=11, thr= 55.00, gain=0.665132
tree= 1, node=249, feature=10, thr= 39.00, gain=0.678606
tree= 1, node=250, feature= 8, thr= 84.00, gain=0.264097
tree= 1, node=251, feature=14, thr= 1.00, gain=0.198712
tree= 1, node=252, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=253, feature= 8, thr= 99.00, gain=0.172948
tree= 1, node=254, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=255, feature= 6, thr= 80.00, gain=0.351633
tree= 1, node=270, feature=11, thr=100.00, gain=0.006187
tree= 1, node=271, feature= 7, thr= 8.00, gain=0.058891
tree= 1, node=276, feature= 6, thr= 21.00, gain=0.096411
tree= 1, node=277, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=280, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=281, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=284, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=285, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=292, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=293, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=302, feature=11, thr= 90.00, gain=0.786117
tree= 1, node=303, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=318, feature=-1, thr= -1.00, gain=0.000000

```
tree= 1, node=319, feature=11, thr=100.00, gain=0.017778
tree= 1, node=328, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=329, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=336, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=337, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=342, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=343, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=364, feature= 4, thr= 97.00, gain=0.023386
tree= 1, node=365, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=386, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=387, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=388, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=389, feature=14, thr=  2.00, gain=0.036393
tree= 1, node=394, feature= 5, thr= 35.00, gain=0.184243
tree= 1, node=395, feature= 3, thr= 39.00, gain=0.213558
tree= 1, node=396, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=397, feature=16, thr= 58.00, gain=0.725757
tree= 1, node=398, feature= 2, thr= 94.00, gain=0.101861
tree= 1, node=399, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=404, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=405, feature= 7, thr= 56.00, gain=0.008573
tree= 1, node=406, feature= 3, thr= 61.00, gain=0.174110
tree= 1, node=407, feature= 7, thr= 64.00, gain=0.076783
tree= 1, node=408, feature=14, thr=100.00, gain=0.018963
tree= 1, node=409, feature=14, thr= 64.00, gain=0.026410
tree= 1, node=410, feature=11, thr= 87.00, gain=0.841465
tree= 1, node=411, feature=16, thr= 98.00, gain=0.030921
tree= 1, node=412, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=413, feature= 4, thr= 89.00, gain=0.457221
tree= 1, node=416, feature=10, thr= 49.00, gain=0.068586
tree= 1, node=417, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=438, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 1, node=439, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=446, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=447, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=456, feature= 5, thr= 49.00, gain=0.145657
tree= 1, node=457, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=458, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=459, feature=15, thr= 74.00, gain=0.211189
tree= 1, node=464, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=465, feature= 7, thr= 98.00, gain=0.109869
tree= 1, node=466, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=467, feature= 9, thr= 63.00, gain=0.032507
tree= 1, node=482, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=483, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=484, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=485, feature=13, thr= 68.00, gain=0.014248
tree= 1, node=496, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=497, feature= 5, thr= 76.00, gain=0.291835
tree= 1, node=498, feature=13, thr= 84.00, gain=0.108023
tree= 1, node=499, feature= 4, thr= 90.00, gain=0.671517
tree= 1, node=500, feature= 5, thr= 53.00, gain=0.249568
tree= 1, node=501, feature= 2, thr= 97.00, gain=0.315314
tree= 1, node=502, feature= 4, thr= 93.00, gain=0.168592
tree= 1, node=503, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=506, feature=10, thr= 62.00, gain=0.189297
tree= 1, node=507, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=510, feature= 9, thr= 74.00, gain=0.394926
tree= 1, node=511, feature= 6, thr= 86.00, gain=0.085043
tree= 1, node=540, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=541, feature=14, thr= 39.00, gain=0.094743
tree= 1, node=542, feature= 1, thr= 94.00, gain=0.345137
tree= 1, node=543, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=552, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 1, node=553, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=604, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=605, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=638, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=639, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=728, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=729, feature=10, thr= 40.00, gain=0.159350
tree= 1, node=778, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=779, feature=15, thr=100.00, gain=0.076538
tree= 1, node=788, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=789, feature=16, thr= 76.00, gain=0.632130
tree= 1, node=790, feature=10, thr= 33.00, gain=0.077022
tree= 1, node=791, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=794, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=795, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=796, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=797, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=810, feature= 6, thr= 73.00, gain=0.074476
tree= 1, node=811, feature=10, thr=  7.00, gain=0.003976
tree= 1, node=812, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=813, feature=16, thr= 19.00, gain=0.991553
tree= 1, node=814, feature=11, thr= 78.00, gain=0.404858
tree= 1, node=815, feature=11, thr= 64.00, gain=0.594404
tree= 1, node=816, feature=12, thr=100.00, gain=0.129234
tree= 1, node=817, feature= 2, thr= 63.00, gain=0.020457
tree= 1, node=818, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=819, feature=15, thr= 29.00, gain=0.096006
tree= 1, node=820, feature=10, thr=  1.00, gain=0.048715
tree= 1, node=821, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=822, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=823, feature= 7, thr= 63.00, gain=0.030833
tree= 1, node=826, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 1, node=827, feature=14, thr= 58.00, gain=0.096125
tree= 1, node=832, feature= 1, thr=100.00, gain=0.069054
tree= 1, node=833, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=912, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=913, feature=13, thr= 36.00, gain=0.305958
tree= 1, node=918, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=919, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=930, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=931, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=934, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=935, feature=16, thr=  1.00, gain=0.000049
tree= 1, node=970, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=971, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=994, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=995, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=996, feature=11, thr=100.00, gain=0.397243
tree= 1, node=997, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=998, feature= 1, thr= 54.00, gain=0.150501
tree= 1, node=999, feature= 6, thr= 93.00, gain=0.540280
tree= 1, node=1000, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1001, feature=11, thr= 54.00, gain=0.808834
tree= 1, node=1002, feature=16, thr=  2.00, gain=0.249444
tree= 1, node=1003, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1004, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1005, feature= 3, thr= 35.00, gain=0.092200
tree= 1, node=1012, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1013, feature=15, thr=  3.00, gain=0.566575
tree= 1, node=1020, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1021, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1022, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1023, feature=16, thr= 17.00, gain=0.128635
tree= 1, node=1082, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 1, node=1083, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1084, feature=13, thr= 49.00, gain=0.129234
tree= 1, node=1085, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1458, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1459, feature=11, thr= 58.00, gain=0.093171
tree= 1, node=1558, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1559, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1578, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1579, feature=11, thr= 46.00, gain=0.753198
tree= 1, node=1580, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1581, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1620, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1621, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1622, feature= 2, thr= 79.00, gain=0.092734
tree= 1, node=1623, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1626, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1627, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1628, feature= 1, thr= 20.00, gain=0.052005
tree= 1, node=1629, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1630, feature= 7, thr= 76.00, gain=0.053252
tree= 1, node=1631, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1632, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1633, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1634, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1635, feature= 5, thr= 53.00, gain=0.387053
tree= 1, node=1638, feature= 1, thr= 56.00, gain=0.197799
tree= 1, node=1639, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1640, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1641, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1646, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1647, feature=15, thr= 98.00, gain=0.131016
tree= 1, node=1654, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 1, node=1655, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1664, feature=10, thr= 13.00, gain=0.018571
tree= 1, node=1665, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1826, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1827, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1870, feature=10, thr=100.00, gain=0.011696
tree= 1, node=1871, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1992, feature=11, thr=  1.00, gain=0.036862
tree= 1, node=1993, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1996, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1997, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1998, feature= 3, thr= 22.00, gain=0.106890
tree= 1, node=1999, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2002, feature= 4, thr= 93.00, gain=0.102945
tree= 1, node=2003, feature= 5, thr= 74.00, gain=0.041671
tree= 1, node=2004, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2005, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2010, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2011, feature=13, thr= 28.00, gain=0.037943
tree= 1, node=2026, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2027, feature= 7, thr= 79.00, gain=0.173090
tree= 1, node=2046, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2047, feature=16, thr= 79.00, gain=0.068125
tree= 1, node=2168, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2169, feature= 8, thr= 93.00, gain=0.131107
tree= 1, node=2918, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2919, feature= 6, thr= 96.00, gain=0.044061
tree= 1, node=3158, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3159, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3244, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3245, feature= 2, thr= 82.00, gain=0.009460
tree= 1, node=3256, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 1, node=3257, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3260, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3261, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3270, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3271, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3276, feature= 8, thr= 17.00, gain=0.005079
tree= 1, node=3277, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3294, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3295, feature= 9, thr= 38.00, gain=0.061086
tree= 1, node=3328, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3329, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3740, feature= 6, thr=100.00, gain=0.005184
tree= 1, node=3741, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3984, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3985, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3996, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3997, feature= 6, thr= 83.00, gain=0.039626
tree= 1, node=4004, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=4005, feature= 7, thr= 91.00, gain=0.036350
tree= 1, node=4006, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=4007, feature=10, thr= 77.00, gain=0.094084
tree= 1, node=4022, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=4023, feature=15, thr=  8.00, gain=0.029809
tree= 1, node=4054, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=4055, feature=10, thr= 64.00, gain=0.108600
tree= 1, node=4094, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=4095, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=4338, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=4339, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=5838, feature= 6, thr= 95.00, gain=0.027698
tree= 1, node=5839, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=6490, feature=-1, thr= -1.00, gain=0.000000
```

tree= 1, node=6491, feature= 3, thr= 82.00, gain=0.024593
tree= 1, node=6552, feature=16, thr= 73.00, gain=0.045447
tree= 1, node=6553, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=6590, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=6591, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=7480, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=7481, feature=11, thr= 46.00, gain=0.026506
tree= 1, node=7994, feature= 5, thr= 28.00, gain=0.522559
tree= 1, node=7995, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=8010, feature=15, thr= 39.00, gain=0.071391
tree= 1, node=8011, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=8014, feature= 3, thr= 81.00, gain=0.085299
tree= 1, node=8015, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=8046, feature= 3, thr= 82.00, gain=0.030636
tree= 1, node=8047, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=8110, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=8111, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=11676, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=11677, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=12982, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=12983, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=13104, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=13105, feature= 2, thr= 85.00, gain=0.044743
tree= 1, node=14962, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=14963, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=15988, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=15989, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=16020, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=16021, feature= 6, thr= 86.00, gain=0.037088
tree= 1, node=16028, feature= 2, thr=100.00, gain=0.041870
tree= 1, node=16029, feature=16, thr= 1.00, gain=0.119034
tree= 1, node=16092, feature=10, thr= 51.00, gain=0.279495

```
tree= 1, node=16093, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=26210, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=26211, feature=10, thr= 28.00, gain=0.140615
tree= 1, node=32042, feature=13, thr= 41.00, gain=0.025530
tree= 1, node=32043, feature= 9, thr= 67.00, gain=0.043505
tree= 1, node=32056, feature=12, thr= 37.00, gain=0.018940
tree= 1, node=32057, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=32058, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=32059, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=32184, feature= 8, thr= 75.00, gain=0.260452
tree= 1, node=32185, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=52422, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=52423, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=64084, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=64085, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=64086, feature= 2, thr= 74.00, gain=0.031052
tree= 1, node=64087, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=64112, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=64113, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=64368, feature= 6, thr= 81.00, gain=0.028939
tree= 1, node=64369, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=128172, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=128173, feature=13, thr=  5.00, gain=0.071927
tree= 1, node=128736, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=128737, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=256346, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=256347, feature= 9, thr= 52.00, gain=0.028359
tree= 1, node=512694, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=512695, feature=-1, thr= -1.00, gain=0.000000
```

Classification Accuracy

classification accuracy=0.8010

3 50 (decision_tree.py pendigits_training pendigits_test)

tree= 1, node= 1, feature= 5, thr= 44.00, gain=0.537612
tree= 1, node= 2, feature=14, thr= 53.00, gain=0.707126
tree= 1, node= 3, feature= 9, thr= 50.00, gain=0.421835
tree= 1, node= 4, feature= 7, thr= 23.00, gain=0.380262
tree= 1, node= 5, feature= 1, thr= 48.00, gain=0.215853
tree= 1, node= 6, feature=10, thr= 39.00, gain=0.272756
tree= 1, node= 7, feature=13, thr= 33.00, gain=0.147910
tree= 1, node= 8, feature=11, thr= 42.00, gain=0.166689
tree= 1, node= 9, feature=13, thr= 58.00, gain=0.236046
tree= 1, node= 10, feature= 8, thr= 24.00, gain=0.048597
tree= 1, node= 11, feature= 3, thr= 8.00, gain=0.070818
tree= 1, node= 12, feature=16, thr= 24.00, gain=0.881154
tree= 1, node= 13, feature= 5, thr= 73.00, gain=0.063808
tree= 1, node= 14, feature= 6, thr= 66.00, gain=0.554559
tree= 1, node= 15, feature= 6, thr= 70.00, gain=0.140565
tree= 1, node= 16, feature= 7, thr= 18.00, gain=0.133003
tree= 1, node= 17, feature= 1, thr= 52.00, gain=0.223793
tree= 1, node= 18, feature= 4, thr= 94.00, gain=0.432995
tree= 1, node= 19, feature= 1, thr= 69.00, gain=0.441346
tree= 1, node= 20, feature=11, thr= 49.00, gain=0.566907
tree= 1, node= 21, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 22, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 23, feature=10, thr= 1.00, gain=0.201140
tree= 1, node= 24, feature= 6, thr= 99.00, gain=0.077252
tree= 1, node= 25, feature=10, thr= 6.00, gain=0.179887
tree= 1, node= 26, feature= 2, thr= 79.00, gain=0.368251
tree= 1, node= 27, feature= 8, thr= 78.00, gain=0.508310
tree= 1, node= 28, feature=10, thr= 89.00, gain=0.243282
tree= 1, node= 29, feature=13, thr= 18.00, gain=0.123175
tree= 1, node= 30, feature=15, thr= 45.00, gain=0.340628

tree= 1, node= 31, feature=16, thr= 25.00, gain=0.346201
tree= 1, node= 32, feature=11, thr= 21.00, gain=0.556673
tree= 1, node= 33, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 34, feature= 5, thr= 29.00, gain=0.183243
tree= 1, node= 35, feature=10, thr= 18.00, gain=0.740393
tree= 1, node= 36, feature= 6, thr= 65.00, gain=0.696708
tree= 1, node= 37, feature=10, thr= 29.00, gain=0.923997
tree= 1, node= 38, feature= 3, thr= 55.00, gain=0.036111
tree= 1, node= 39, feature= 6, thr= 63.00, gain=0.511008
tree= 1, node= 40, feature= 6, thr= 23.00, gain=0.064900
tree= 1, node= 41, feature= 3, thr= 44.00, gain=0.048133
tree= 1, node= 46, feature=15, thr= 86.00, gain=0.452494
tree= 1, node= 47, feature=13, thr=100.00, gain=0.344186
tree= 1, node= 48, feature=14, thr= 15.00, gain=0.093440
tree= 1, node= 49, feature=11, thr= 40.00, gain=0.045983
tree= 1, node= 50, feature= 7, thr= 72.00, gain=0.215155
tree= 1, node= 51, feature= 6, thr= 52.00, gain=0.586044
tree= 1, node= 52, feature=14, thr= 88.00, gain=0.721310
tree= 1, node= 53, feature= 6, thr= 45.00, gain=0.248288
tree= 1, node= 54, feature= 8, thr= 52.00, gain=0.398894
tree= 1, node= 55, feature=12, thr= 49.00, gain=0.868453
tree= 1, node= 56, feature= 1, thr= 36.00, gain=0.195752
tree= 1, node= 57, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 58, feature= 8, thr= 54.00, gain=0.423837
tree= 1, node= 59, feature=10, thr= 45.00, gain=0.329256
tree= 1, node= 60, feature=14, thr= 34.00, gain=0.936640
tree= 1, node= 61, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 62, feature= 3, thr= 58.00, gain=0.225813
tree= 1, node= 63, feature= 4, thr= 91.00, gain=0.261161
tree= 1, node= 64, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 65, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 68, feature= 1, thr= 22.00, gain=0.159239

```
tree= 1, node= 69, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 70, feature= 9, thr= 46.00, gain=0.019181
tree= 1, node= 71, feature=13, thr= 54.00, gain=0.488050
tree= 1, node= 72, feature=13, thr= 34.00, gain=0.056333
tree= 1, node= 73, feature= 4, thr= 56.00, gain=0.236986
tree= 1, node= 74, feature=10, thr=  4.00, gain=0.225803
tree= 1, node= 75, feature=15, thr=  6.00, gain=0.363834
tree= 1, node= 76, feature=13, thr= 70.00, gain=0.077629
tree= 1, node= 77, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 78, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 79, feature=10, thr= 61.00, gain=0.033909
tree= 1, node= 80, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 81, feature=12, thr= 41.00, gain=0.162211
tree= 1, node= 82, feature=14, thr= 60.00, gain=0.020359
tree= 1, node= 83, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 92, feature= 6, thr= 68.00, gain=0.086025
tree= 1, node= 93, feature= 1, thr= 78.00, gain=0.028173
tree= 1, node= 94, feature=15, thr= 50.00, gain=0.150845
tree= 1, node= 95, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node= 96, feature=11, thr=  1.00, gain=0.045370
tree= 1, node= 97, feature= 5, thr= 66.00, gain=0.323099
tree= 1, node= 98, feature= 8, thr= 53.00, gain=0.018012
tree= 1, node= 99, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=100, feature= 6, thr= 56.00, gain=0.371025
tree= 1, node=101, feature=15, thr= 60.00, gain=0.366065
tree= 1, node=102, feature= 2, thr= 80.00, gain=0.023374
tree= 1, node=103, feature= 4, thr= 83.00, gain=0.293350
tree= 1, node=104, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=105, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=106, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=107, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=108, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 1, node=109, feature=16, thr= 32.00, gain=0.597000
tree= 1, node=110, feature= 9, thr= 30.00, gain=0.103327
tree= 1, node=111, feature= 1, thr= 20.00, gain=0.026001
tree= 1, node=112, feature= 2, thr= 81.00, gain=0.076538
tree= 1, node=113, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=116, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=117, feature= 9, thr= 74.00, gain=0.083788
tree= 1, node=118, feature= 3, thr= 69.00, gain=0.199922
tree= 1, node=119, feature=13, thr= 30.00, gain=0.094467
tree= 1, node=120, feature=12, thr= 21.00, gain=0.317703
tree= 1, node=121, feature= 1, thr= 32.00, gain=0.206890
tree= 1, node=124, feature=13, thr= 68.00, gain=0.088387
tree= 1, node=125, feature=16, thr=  1.00, gain=0.133193
tree= 1, node=126, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=127, feature=13, thr= 46.00, gain=0.053151
tree= 1, node=136, feature=10, thr= 50.00, gain=0.099208
tree= 1, node=137, feature= 1, thr= 45.00, gain=0.071047
tree= 1, node=140, feature= 4, thr= 87.00, gain=0.012934
tree= 1, node=141, feature= 1, thr= 85.00, gain=0.027025
tree= 1, node=142, feature= 3, thr= 73.00, gain=0.314963
tree= 1, node=143, feature= 3, thr= 60.00, gain=0.385585
tree= 1, node=144, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=145, feature= 6, thr= 60.00, gain=0.179909
tree= 1, node=146, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=147, feature= 6, thr=100.00, gain=0.199987
tree= 1, node=148, feature=12, thr= 23.00, gain=0.186518
tree= 1, node=149, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=150, feature= 5, thr= 37.00, gain=0.048617
tree= 1, node=151, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=152, feature= 1, thr= 20.00, gain=0.315302
tree= 1, node=153, feature= 4, thr=100.00, gain=0.075391
tree= 1, node=158, feature=-1, thr= -1.00, gain=0.000000
```

tree= 1, node=159, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=162, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=163, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=164, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=165, feature=16, thr= 89.00, gain=0.016721
tree= 1, node=184, feature=13, thr= 82.00, gain=0.326676
tree= 1, node=185, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=186, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=187, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=188, feature= 5, thr= 40.00, gain=0.029515
tree= 1, node=189, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=192, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=193, feature= 9, thr= 45.00, gain=0.075553
tree= 1, node=194, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=195, feature= 2, thr= 98.00, gain=0.237093
tree= 1, node=196, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=197, feature= 5, thr= 85.00, gain=0.093162
tree= 1, node=200, feature=12, thr= 42.00, gain=0.393723
tree= 1, node=201, feature= 6, thr= 72.00, gain=0.071982
tree= 1, node=202, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=203, feature=14, thr= 82.00, gain=0.990617
tree= 1, node=204, feature=10, thr= 26.00, gain=0.100440
tree= 1, node=205, feature=15, thr= 90.00, gain=0.969204
tree= 1, node=206, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=207, feature=12, thr= 5.00, gain=0.486028
tree= 1, node=218, feature= 7, thr= 62.00, gain=0.312764
tree= 1, node=219, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=220, feature= 1, thr= 59.00, gain=0.138007
tree= 1, node=221, feature= 6, thr= 93.00, gain=0.380656
tree= 1, node=222, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=223, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=224, feature=-1, thr= -1.00, gain=0.000000

tree= 1, node=225, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=234, feature= 5, thr= 70.00, gain=0.150035
tree= 1, node=235, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=236, feature=12, thr= 3.00, gain=0.260247
tree= 1, node=237, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=238, feature=14, thr= 13.00, gain=0.294617
tree= 1, node=239, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=240, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=241, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=242, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=243, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=248, feature= 1, thr= 1.00, gain=0.431793
tree= 1, node=249, feature= 2, thr= 75.00, gain=0.589993
tree= 1, node=250, feature= 5, thr= 60.00, gain=0.141603
tree= 1, node=251, feature= 6, thr= 88.00, gain=0.323344
tree= 1, node=254, feature=14, thr= 18.00, gain=0.232312
tree= 1, node=255, feature= 6, thr= 72.00, gain=0.045294
tree= 1, node=272, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=273, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=274, feature=14, thr= 18.00, gain=0.165427
tree= 1, node=275, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=280, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=281, feature=15, thr= 76.00, gain=0.173429
tree= 1, node=282, feature= 1, thr= 59.00, gain=0.019475
tree= 1, node=283, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=284, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=285, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=286, feature= 5, thr= 1.00, gain=0.156634
tree= 1, node=287, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=290, feature=10, thr= 22.00, gain=0.706274
tree= 1, node=291, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=294, feature=13, thr= 20.00, gain=0.253232

```
tree= 1, node=295, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=296, feature= 4, thr=100.00, gain=0.000699
tree= 1, node=297, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=300, feature=14, thr=  6.00, gain=0.190445
tree= 1, node=301, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=304, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=305, feature= 7, thr= 75.00, gain=0.080921
tree= 1, node=306, feature=10, thr= 74.00, gain=0.065875
tree= 1, node=307, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=330, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=331, feature= 5, thr= 35.00, gain=0.202578
tree= 1, node=368, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=369, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=376, feature= 2, thr= 93.00, gain=0.024471
tree= 1, node=377, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=386, feature=10, thr= 20.00, gain=0.024428
tree= 1, node=387, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=390, feature= 5, thr= 72.00, gain=0.034342
tree= 1, node=391, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=394, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=395, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=400, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=401, feature= 1, thr= 88.00, gain=0.137099
tree= 1, node=402, feature= 2, thr= 65.00, gain=0.021943
tree= 1, node=403, feature=12, thr= 46.00, gain=0.085493
tree= 1, node=406, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=407, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=408, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=409, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=410, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=411, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=414, feature= 8, thr= 49.00, gain=0.140811
```

tree= 1, node=415, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=436, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=437, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=440, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=441, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=442, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=443, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=468, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=469, feature=16, thr= 22.00, gain=0.563600
tree= 1, node=472, feature=10, thr= 18.00, gain=0.095034
tree= 1, node=473, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=476, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=477, feature= 2, thr= 93.00, gain=0.429021
tree= 1, node=496, feature= 5, thr= 68.00, gain=0.053293
tree= 1, node=497, feature= 1, thr= 40.00, gain=0.423162
tree= 1, node=498, feature=13, thr= 71.00, gain=0.029576
tree= 1, node=499, feature=11, thr= 92.00, gain=0.505523
tree= 1, node=500, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=501, feature=14, thr= 15.00, gain=0.216105
tree= 1, node=502, feature=13, thr= 35.00, gain=0.023060
tree= 1, node=503, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=508, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=509, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=510, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=511, feature= 9, thr= 76.00, gain=0.019676
tree= 1, node=548, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=549, feature= 9, thr= 58.00, gain=0.153807
tree= 1, node=562, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=563, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=564, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=565, feature=12, thr= 27.00, gain=0.138112
tree= 1, node=572, feature=-1, thr= -1.00, gain=0.000000

```
tree= 1, node=573, feature= 8, thr= 43.00, gain=0.104735
tree= 1, node=580, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=581, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=588, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=589, feature=11, thr= 78.00, gain=0.115378
tree= 1, node=592, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=593, feature= 6, thr= 81.00, gain=0.043151
tree= 1, node=600, feature= 4, thr=100.00, gain=0.158178
tree= 1, node=601, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=610, feature=16, thr=  2.00, gain=0.591722
tree= 1, node=611, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=612, feature= 7, thr= 46.00, gain=0.010164
tree= 1, node=613, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=662, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=663, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=752, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=753, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=772, feature=14, thr=  4.00, gain=0.006679
tree= 1, node=773, feature=11, thr= 21.00, gain=0.024692
tree= 1, node=780, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=781, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=802, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=803, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=804, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=805, feature=10, thr=  3.00, gain=0.014903
tree= 1, node=806, feature= 7, thr= 64.00, gain=0.022214
tree= 1, node=807, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=828, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=829, feature=14, thr= 38.00, gain=0.123912
tree= 1, node=938, feature=10, thr= 59.00, gain=0.200906
tree= 1, node=939, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=944, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 1, node=945, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=954, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=955, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=992, feature= 5, thr= 47.00, gain=0.055441
tree= 1, node=993, feature=10, thr= 64.00, gain=0.527603
tree= 1, node=994, feature= 5, thr= 60.00, gain=0.257839
tree= 1, node=995, feature= 4, thr= 98.00, gain=0.286181
tree= 1, node=996, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=997, feature= 9, thr= 81.00, gain=0.040437
tree= 1, node=998, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=999, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1002, feature= 2, thr= 74.00, gain=0.352861
tree= 1, node=1003, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1004, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1005, feature= 5, thr= 59.00, gain=0.146504
tree= 1, node=1022, feature=11, thr= 43.00, gain=0.059488
tree= 1, node=1023, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1098, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1099, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1130, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1131, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1146, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1147, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1178, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1179, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1186, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1187, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1200, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1201, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1220, feature=11, thr= 88.00, gain=0.016430
tree= 1, node=1221, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1224, feature= 9, thr= 68.00, gain=0.139233
```

```
tree= 1, node=1225, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1544, feature= 3, thr= 36.00, gain=0.019890
tree= 1, node=1545, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1546, feature= 3, thr= 74.00, gain=0.069360
tree= 1, node=1547, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1610, feature=11, thr= 50.00, gain=0.273154
tree= 1, node=1611, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1612, feature= 8, thr= 42.00, gain=0.028196
tree= 1, node=1613, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1658, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1659, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1876, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1877, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1984, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1985, feature=10, thr= 62.00, gain=0.469161
tree= 1, node=1986, feature=10, thr= 28.00, gain=0.254118
tree= 1, node=1987, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1988, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1989, feature=13, thr= 43.00, gain=0.068165
tree= 1, node=1990, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1991, feature= 5, thr= 70.00, gain=0.989588
tree= 1, node=1994, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=1995, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2004, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2005, feature=10, thr= 56.00, gain=0.718938
tree= 1, node=2010, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2011, feature= 4, thr= 93.00, gain=0.030926
tree= 1, node=2044, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2045, feature= 9, thr= 60.00, gain=0.082320
tree= 1, node=2440, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2441, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=2448, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 1, node=2449, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3088, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3089, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3092, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3093, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3220, feature= 2, thr= 89.00, gain=0.025172
tree= 1, node=3221, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3224, feature=14, thr= 38.00, gain=0.055160
tree= 1, node=3225, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3970, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3971, feature= 3, thr= 12.00, gain=0.092284
tree= 1, node=3972, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3973, feature=16, thr=  7.00, gain=0.170930
tree= 1, node=3978, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3979, feature= 3, thr= 50.00, gain=0.054115
tree= 1, node=3982, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=3983, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=4010, feature= 5, thr= 90.00, gain=0.057827
tree= 1, node=4011, feature=10, thr= 70.00, gain=0.189823
tree= 1, node=4022, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=4023, feature= 2, thr= 72.00, gain=0.110145
tree= 1, node=4090, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=4091, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=6440, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=6441, feature= 7, thr= 62.00, gain=0.135544
tree= 1, node=6448, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=6449, feature= 8, thr= 36.00, gain=0.073309
tree= 1, node=7942, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=7943, feature= 3, thr= 34.00, gain=0.017411
tree= 1, node=7946, feature= 7, thr= 75.00, gain=0.383273
tree= 1, node=7947, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=7958, feature= 6, thr= 94.00, gain=0.026138
```

```
tree= 1, node=7959, feature= 4, thr= 99.00, gain=0.315643
tree= 1, node=8020, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=8021, feature=13, thr= 58.00, gain=0.035484
tree= 1, node=8022, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=8023, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=8046, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=8047, feature= 8, thr= 83.00, gain=0.080136
tree= 1, node=12882, feature= 3, thr= 28.00, gain=0.249882
tree= 1, node=12883, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=12898, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=12899, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=15886, feature= 3, thr= 29.00, gain=0.005163
tree= 1, node=15887, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=15892, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=15893, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=15916, feature=16, thr= 18.00, gain=0.059589
tree= 1, node=15917, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=15918, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=15919, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=16042, feature=11, thr= 89.00, gain=0.045144
tree= 1, node=16043, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=16094, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=16095, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=25764, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=25765, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=31772, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=31773, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=31832, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=31833, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=32084, feature=-1, thr= -1.00, gain=0.000000
tree= 1, node=32085, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node= 1, feature= 4, thr= 93.00, gain=0.438164
```

```
tree= 2, node=  2, feature=10, thr= 46.00, gain=0.417517
tree= 2, node=  3, feature= 1, thr= 56.00, gain=0.466070
tree= 2, node=  4, feature= 1, thr= 60.00, gain=0.327045
tree= 2, node=  5, feature=16, thr=  7.00, gain=0.550355
tree= 2, node=  6, feature=13, thr= 48.00, gain=0.146719
tree= 2, node=  7, feature= 7, thr= 35.00, gain=0.455685
tree= 2, node=  8, feature=12, thr= 31.00, gain=0.434611
tree= 2, node=  9, feature= 1, thr= 89.00, gain=0.207335
tree= 2, node= 10, feature= 2, thr= 86.00, gain=0.654183
tree= 2, node= 11, feature=15, thr= 58.00, gain=0.288112
tree= 2, node= 12, feature=10, thr= 27.00, gain=0.473270
tree= 2, node= 13, feature= 1, thr=  1.00, gain=0.179453
tree= 2, node= 14, feature=10, thr= 33.00, gain=0.953468
tree= 2, node= 15, feature= 9, thr= 74.00, gain=0.456901
tree= 2, node= 16, feature=12, thr=  6.00, gain=0.395550
tree= 2, node= 17, feature= 4, thr= 68.00, gain=0.228836
tree= 2, node= 18, feature= 7, thr= 34.00, gain=0.348674
tree= 2, node= 19, feature= 7, thr= 48.00, gain=0.333402
tree= 2, node= 20, feature=16, thr=  2.00, gain=0.019243
tree= 2, node= 21, feature=14, thr= 19.00, gain=0.394268
tree= 2, node= 22, feature=12, thr= 82.00, gain=0.668692
tree= 2, node= 23, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node= 24, feature=11, thr= 67.00, gain=0.194597
tree= 2, node= 25, feature=11, thr= 61.00, gain=0.649239
tree= 2, node= 26, feature= 9, thr= 44.00, gain=0.372193
tree= 2, node= 27, feature=11, thr= 51.00, gain=0.916000
tree= 2, node= 28, feature= 7, thr= 15.00, gain=0.165828
tree= 2, node= 29, feature=12, thr= 39.00, gain=0.797616
tree= 2, node= 30, feature= 1, thr= 69.00, gain=0.259810
tree= 2, node= 31, feature=16, thr= 63.00, gain=0.692237
tree= 2, node= 32, feature= 7, thr= 54.00, gain=0.300957
tree= 2, node= 33, feature= 6, thr= 56.00, gain=0.679056
```

tree= 2, node= 34, feature=13, thr= 60.00, gain=0.461273
tree= 2, node= 35, feature=11, thr= 74.00, gain=0.653014
tree= 2, node= 36, feature=12, thr= 36.00, gain=0.543629
tree= 2, node= 37, feature=14, thr= 59.00, gain=0.555364
tree= 2, node= 38, feature= 3, thr= 34.00, gain=0.052370
tree= 2, node= 39, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node= 40, feature= 2, thr= 69.00, gain=0.157399
tree= 2, node= 41, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node= 42, feature= 3, thr= 23.00, gain=0.113010
tree= 2, node= 43, feature= 7, thr= 50.00, gain=0.105331
tree= 2, node= 44, feature=12, thr= 6.00, gain=0.203341
tree= 2, node= 45, feature=10, thr= 69.00, gain=0.012905
tree= 2, node= 48, feature= 7, thr= 51.00, gain=0.083726
tree= 2, node= 49, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node= 50, feature= 2, thr= 91.00, gain=0.405868
tree= 2, node= 51, feature=11, thr= 77.00, gain=0.121553
tree= 2, node= 52, feature=16, thr= 23.00, gain=0.815142
tree= 2, node= 53, feature= 5, thr= 36.00, gain=0.169075
tree= 2, node= 54, feature= 7, thr= 66.00, gain=0.052890
tree= 2, node= 55, feature=16, thr= 26.00, gain=0.361095
tree= 2, node= 56, feature= 2, thr= 84.00, gain=0.187843
tree= 2, node= 57, feature= 1, thr= 78.00, gain=0.481623
tree= 2, node= 58, feature=14, thr= 16.00, gain=0.281194
tree= 2, node= 59, feature= 1, thr= 78.00, gain=0.122914
tree= 2, node= 60, feature=16, thr= 38.00, gain=0.952266
tree= 2, node= 61, feature= 7, thr= 50.00, gain=0.134019
tree= 2, node= 62, feature= 5, thr= 77.00, gain=0.529588
tree= 2, node= 63, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node= 64, feature= 6, thr= 63.00, gain=0.481226
tree= 2, node= 65, feature= 2, thr= 72.00, gain=0.465913
tree= 2, node= 66, feature= 3, thr= 20.00, gain=0.247376
tree= 2, node= 67, feature=-1, thr= -1.00, gain=0.000000

```
tree= 2, node= 68, feature= 9, thr= 57.00, gain=0.906802
tree= 2, node= 69, feature= 7, thr= 26.00, gain=0.300461
tree= 2, node= 70, feature= 9, thr= 28.00, gain=0.357185
tree= 2, node= 71, feature= 8, thr= 15.00, gain=0.970427
tree= 2, node= 72, feature= 9, thr= 55.00, gain=0.069195
tree= 2, node= 73, feature=16, thr=  9.00, gain=0.955506
tree= 2, node= 74, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node= 75, feature= 4, thr= 78.00, gain=0.068116
tree= 2, node= 76, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node= 77, feature= 1, thr= 97.00, gain=0.036122
tree= 2, node= 80, feature=11, thr= 88.00, gain=0.071204
tree= 2, node= 81, feature=15, thr= 54.00, gain=0.071023
tree= 2, node= 84, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node= 85, feature= 8, thr= 70.00, gain=0.260145
tree= 2, node= 86, feature=15, thr= 52.00, gain=0.242047
tree= 2, node= 87, feature= 1, thr= 64.00, gain=0.089082
tree= 2, node= 88, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node= 89, feature=16, thr= 43.00, gain=0.243399
tree= 2, node= 90, feature=11, thr= 98.00, gain=0.241495
tree= 2, node= 91, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node= 96, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node= 97, feature=15, thr= 31.00, gain=0.040644
tree= 2, node=100, feature=10, thr= 57.00, gain=0.385268
tree= 2, node=101, feature=14, thr= 13.00, gain=0.455599
tree= 2, node=102, feature=10, thr= 61.00, gain=0.416381
tree= 2, node=103, feature=12, thr= 20.00, gain=0.185701
tree= 2, node=104, feature= 5, thr= 31.00, gain=0.170484
tree= 2, node=105, feature= 5, thr=100.00, gain=0.073803
tree= 2, node=106, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=107, feature=10, thr= 26.00, gain=0.621896
tree= 2, node=108, feature= 1, thr= 29.00, gain=0.047035
tree= 2, node=109, feature= 4, thr= 98.00, gain=0.125916
```

```
tree= 2, node=110, feature=16, thr=  1.00, gain=0.251729
tree= 2, node=111, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=112, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=113, feature= 4, thr= 98.00, gain=0.052078
tree= 2, node=114, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=115, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=116, feature= 1, thr= 70.00, gain=0.045860
tree= 2, node=117, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=118, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=119, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=120, feature=14, thr=  4.00, gain=0.126461
tree= 2, node=121, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=122, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=123, feature=14, thr= 34.00, gain=0.605187
tree= 2, node=124, feature=14, thr= 35.00, gain=0.087480
tree= 2, node=125, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=128, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=129, feature=11, thr= 25.00, gain=0.404863
tree= 2, node=130, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=131, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=132, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=133, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=136, feature=13, thr= 54.00, gain=0.010323
tree= 2, node=137, feature= 3, thr= 63.00, gain=0.160083
tree= 2, node=138, feature=14, thr= 91.00, gain=0.573869
tree= 2, node=139, feature=14, thr= 70.00, gain=0.381614
tree= 2, node=140, feature= 1, thr= 40.00, gain=0.142854
tree= 2, node=141, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=142, feature= 8, thr=  2.00, gain=0.060640
tree= 2, node=143, feature= 8, thr= 18.00, gain=0.023238
tree= 2, node=144, feature= 9, thr= 20.00, gain=0.094537
tree= 2, node=145, feature=16, thr= 74.00, gain=0.644214
```

```
tree= 2, node=146, feature=14, thr= 30.00, gain=0.039539
tree= 2, node=147, feature= 6, thr= 29.00, gain=0.557583
tree= 2, node=150, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=151, feature= 9, thr= 95.00, gain=0.238685
tree= 2, node=154, feature=12, thr= 41.00, gain=0.491237
tree= 2, node=155, feature=15, thr= 24.00, gain=0.076338
tree= 2, node=160, feature=10, thr= 72.00, gain=0.084428
tree= 2, node=161, feature=13, thr= 74.00, gain=0.276321
tree= 2, node=162, feature=10, thr= 72.00, gain=0.239972
tree= 2, node=163, feature= 9, thr= 80.00, gain=0.175306
tree= 2, node=170, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=171, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=172, feature= 4, thr= 81.00, gain=0.343645
tree= 2, node=173, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=174, feature= 6, thr= 72.00, gain=0.209202
tree= 2, node=175, feature=10, thr= 70.00, gain=0.336079
tree= 2, node=178, feature= 4, thr= 61.00, gain=0.322448
tree= 2, node=179, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=180, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=181, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=194, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=195, feature= 8, thr= 46.00, gain=0.118921
tree= 2, node=200, feature= 2, thr= 86.00, gain=0.114872
tree= 2, node=201, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=202, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=203, feature=15, thr= 16.00, gain=0.099208
tree= 2, node=204, feature= 6, thr= 90.00, gain=0.182931
tree= 2, node=205, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=206, feature=12, thr=  2.00, gain=0.028865
tree= 2, node=207, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=208, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=209, feature= 7, thr= 15.00, gain=0.043099
```

```
tree= 2, node=210, feature=15, thr=100.00, gain=0.000394
tree= 2, node=211, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=214, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=215, feature=16, thr= 30.00, gain=0.078787
tree= 2, node=216, feature=14, thr= 24.00, gain=0.264596
tree= 2, node=217, feature=12, thr= 38.00, gain=0.191433
tree= 2, node=218, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=219, feature= 5, thr= 68.00, gain=0.272971
tree= 2, node=220, feature= 2, thr= 99.00, gain=0.348194
tree= 2, node=221, feature=14, thr=  5.00, gain=0.131107
tree= 2, node=226, feature= 8, thr= 15.00, gain=0.114676
tree= 2, node=227, feature=13, thr= 93.00, gain=0.290934
tree= 2, node=232, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=233, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=240, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=241, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=246, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=247, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=248, feature=12, thr= 26.00, gain=0.133699
tree= 2, node=249, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=258, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=259, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=272, feature=16, thr=100.00, gain=0.001666
tree= 2, node=273, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=274, feature= 7, thr= 62.00, gain=0.026954
tree= 2, node=275, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=276, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=277, feature= 7, thr=  1.00, gain=0.012865
tree= 2, node=278, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=279, feature= 7, thr= 70.00, gain=0.123720
tree= 2, node=280, feature= 5, thr= 66.00, gain=0.076883
tree= 2, node=281, feature= 8, thr=  2.00, gain=0.096232
```

```
tree= 2, node=284, feature= 5, thr= 35.00, gain=0.355061
tree= 2, node=285, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=286, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=287, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=288, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=289, feature= 9, thr= 46.00, gain=0.023466
tree= 2, node=290, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=291, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=292, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=293, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=294, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=295, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=302, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=303, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=308, feature= 6, thr= 51.00, gain=0.074605
tree= 2, node=309, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=310, feature=16, thr=  1.00, gain=0.125446
tree= 2, node=311, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=320, feature=13, thr= 75.00, gain=0.200942
tree= 2, node=321, feature= 6, thr= 61.00, gain=0.031003
tree= 2, node=322, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=323, feature= 7, thr= 73.00, gain=0.857744
tree= 2, node=324, feature=10, thr= 57.00, gain=0.249449
tree= 2, node=325, feature= 8, thr= 72.00, gain=0.123950
tree= 2, node=326, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=327, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=344, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=345, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=348, feature=12, thr= 47.00, gain=0.031053
tree= 2, node=349, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=350, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=351, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 2, node=356, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=357, feature=10, thr= 57.00, gain=0.322506
tree= 2, node=390, feature= 2, thr= 74.00, gain=0.163524
tree= 2, node=391, feature= 8, thr= 54.00, gain=0.101511
tree= 2, node=400, feature= 3, thr= 43.00, gain=0.110875
tree= 2, node=401, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=406, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=407, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=408, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=409, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=412, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=413, feature= 3, thr= 90.00, gain=0.047777
tree= 2, node=418, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=419, feature= 2, thr= 72.00, gain=0.030393
tree= 2, node=420, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=421, feature=11, thr= 22.00, gain=0.032348
tree= 2, node=430, feature=16, thr=  1.00, gain=0.148575
tree= 2, node=431, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=432, feature= 8, thr= 46.00, gain=0.012128
tree= 2, node=433, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=434, feature= 9, thr= 35.00, gain=0.317827
tree= 2, node=435, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=438, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=439, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=440, feature= 9, thr= 67.00, gain=0.287205
tree= 2, node=441, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=442, feature= 3, thr= 22.00, gain=0.219792
tree= 2, node=443, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=452, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=453, feature=13, thr= 75.00, gain=0.094393
tree= 2, node=454, feature= 6, thr= 76.00, gain=0.043319
tree= 2, node=455, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 2, node=496, feature=11, thr= 88.00, gain=0.206742
tree= 2, node=497, feature= 9, thr=100.00, gain=0.009845
tree= 2, node=544, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=545, feature= 7, thr= 45.00, gain=0.005058
tree= 2, node=548, feature= 9, thr=100.00, gain=0.047003
tree= 2, node=549, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=554, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=555, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=558, feature= 5, thr= 56.00, gain=0.761862
tree= 2, node=559, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=560, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=561, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=562, feature=13, thr= 85.00, gain=0.911752
tree= 2, node=563, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=568, feature= 8, thr=  1.00, gain=0.000456
tree= 2, node=569, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=578, feature= 4, thr= 84.00, gain=0.039299
tree= 2, node=579, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=616, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=617, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=620, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=621, feature= 3, thr= 54.00, gain=0.008425
tree= 2, node=640, feature=13, thr= 40.00, gain=0.085405
tree= 2, node=641, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=642, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=643, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=646, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=647, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=648, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=649, feature=14, thr= 16.00, gain=0.264363
tree= 2, node=650, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=651, feature=10, thr= 78.00, gain=0.112505
```

```
tree= 2, node=696, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=697, feature= 3, thr=  1.00, gain=0.004448
tree= 2, node=714, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=715, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=780, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=781, feature= 8, thr= 37.00, gain=0.011701
tree= 2, node=782, feature=10, thr= 16.00, gain=0.252057
tree= 2, node=783, feature=13, thr= 43.00, gain=0.221957
tree= 2, node=800, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=801, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=826, feature=14, thr=  1.00, gain=0.001392
tree= 2, node=827, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=838, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=839, feature= 6, thr= 93.00, gain=0.024558
tree= 2, node=842, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=843, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=860, feature=15, thr= 40.00, gain=0.645254
tree= 2, node=861, feature= 8, thr= 71.00, gain=0.075248
tree= 2, node=864, feature= 1, thr= 14.00, gain=0.035621
tree= 2, node=865, feature=12, thr=  9.00, gain=0.081195
tree= 2, node=868, feature=10, thr=  6.00, gain=0.096773
tree= 2, node=869, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=880, feature= 4, thr= 99.00, gain=0.028936
tree= 2, node=881, feature=12, thr= 33.00, gain=0.692769
tree= 2, node=884, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=885, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=906, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=907, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=908, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=909, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=992, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=993, feature=10, thr= 51.00, gain=0.123251
```

```
tree= 2, node=994, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=995, feature=12, thr= 60.00, gain=0.036794
tree= 2, node=1090, feature= 3, thr=  1.00, gain=0.027526
tree= 2, node=1091, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1096, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1097, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1116, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1117, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1124, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1125, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1136, feature= 3, thr= 23.00, gain=0.081169
tree= 2, node=1137, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1156, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1157, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1242, feature= 3, thr= 53.00, gain=0.039274
tree= 2, node=1243, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1280, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1281, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1298, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1299, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1302, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1303, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1394, feature=15, thr= 82.00, gain=0.021056
tree= 2, node=1395, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1562, feature= 3, thr= 23.00, gain=0.075268
tree= 2, node=1563, feature= 2, thr= 85.00, gain=0.091147
tree= 2, node=1564, feature=13, thr= 47.00, gain=0.038156
tree= 2, node=1565, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1566, feature= 9, thr= 37.00, gain=0.062787
tree= 2, node=1567, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1652, feature= 7, thr= 22.00, gain=0.056220
tree= 2, node=1653, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 2, node=1678, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1679, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1720, feature= 6, thr= 97.00, gain=0.070052
tree= 2, node=1721, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1722, feature= 2, thr= 98.00, gain=0.087543
tree= 2, node=1723, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1728, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1729, feature= 1, thr= 26.00, gain=0.022922
tree= 2, node=1730, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1731, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1736, feature= 2, thr= 80.00, gain=0.118438
tree= 2, node=1737, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1760, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1761, feature= 7, thr= 50.00, gain=0.518632
tree= 2, node=1762, feature=13, thr= 49.00, gain=0.020061
tree= 2, node=1763, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1986, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1987, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1990, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=1991, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=2180, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=2181, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=2272, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=2273, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=2484, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=2485, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=2788, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=2789, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3124, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3125, feature= 1, thr= 50.00, gain=0.057323
tree= 2, node=3126, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3127, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 2, node=3128, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3129, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3132, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3133, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3304, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3305, feature= 2, thr= 85.00, gain=0.008123
tree= 2, node=3440, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3441, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3444, feature= 5, thr= 67.00, gain=0.052585
tree= 2, node=3445, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3458, feature=11, thr=  1.00, gain=0.118405
tree= 2, node=3459, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3472, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3473, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3522, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3523, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3524, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=3525, feature= 4, thr= 98.00, gain=0.098959
tree= 2, node=6250, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=6251, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=6610, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=6611, feature= 9, thr=100.00, gain=0.006791
tree= 2, node=6888, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=6889, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=6916, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=6917, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=7050, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=7051, feature= 9, thr= 71.00, gain=0.024660
tree= 2, node=13222, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=13223, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=14102, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=14103, feature=14, thr=  6.00, gain=0.027187
```

```
tree= 2, node=28206, feature=-1, thr= -1.00, gain=0.000000
tree= 2, node=28207, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 1, feature=11, thr= 57.00, gain=0.474440
tree= 3, node= 2, feature= 1, thr= 56.00, gain=0.344758
tree= 3, node= 3, feature= 9, thr= 68.00, gain=0.335043
tree= 3, node= 4, feature= 8, thr= 15.00, gain=0.517696
tree= 3, node= 5, feature=13, thr= 31.00, gain=0.170747
tree= 3, node= 6, feature= 9, thr= 46.00, gain=0.176647
tree= 3, node= 7, feature=15, thr= 18.00, gain=0.442874
tree= 3, node= 8, feature= 9, thr= 29.00, gain=0.048008
tree= 3, node= 9, feature= 5, thr= 41.00, gain=0.098091
tree= 3, node= 10, feature= 1, thr= 70.00, gain=0.225868
tree= 3, node= 11, feature= 1, thr=100.00, gain=0.412706
tree= 3, node= 12, feature=16, thr= 1.00, gain=0.656448
tree= 3, node= 13, feature=14, thr= 17.00, gain=0.793182
tree= 3, node= 14, feature= 5, thr= 57.00, gain=0.619364
tree= 3, node= 15, feature= 9, thr= 99.00, gain=0.157794
tree= 3, node= 16, feature=15, thr= 85.00, gain=0.537376
tree= 3, node= 17, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 18, feature=14, thr= 24.00, gain=0.954188
tree= 3, node= 19, feature= 6, thr=100.00, gain=0.152660
tree= 3, node= 20, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 21, feature= 6, thr= 71.00, gain=0.240705
tree= 3, node= 22, feature=11, thr= 1.00, gain=0.141418
tree= 3, node= 23, feature=11, thr= 20.00, gain=0.407431
tree= 3, node= 24, feature=15, thr= 24.00, gain=0.470719
tree= 3, node= 25, feature= 8, thr= 14.00, gain=0.510474
tree= 3, node= 26, feature= 3, thr= 90.00, gain=0.266358
tree= 3, node= 27, feature=12, thr= 35.00, gain=0.641203
tree= 3, node= 28, feature= 6, thr= 60.00, gain=0.908810
tree= 3, node= 29, feature=11, thr= 73.00, gain=0.129920
tree= 3, node= 30, feature=10, thr= 57.00, gain=0.653424
```

tree= 3, node= 31, feature=10, thr= 74.00, gain=0.428642
tree= 3, node= 32, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 33, feature= 1, thr= 24.00, gain=0.034099
tree= 3, node= 36, feature= 5, thr= 10.00, gain=0.129234
tree= 3, node= 37, feature= 4, thr= 87.00, gain=0.794688
tree= 3, node= 38, feature= 8, thr= 78.00, gain=0.149738
tree= 3, node= 39, feature= 2, thr= 83.00, gain=0.407357
tree= 3, node= 42, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 43, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 44, feature=14, thr= 36.00, gain=0.439309
tree= 3, node= 45, feature= 6, thr= 22.00, gain=0.184720
tree= 3, node= 46, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 47, feature= 4, thr= 85.00, gain=0.064418
tree= 3, node= 48, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 49, feature=11, thr= 85.00, gain=0.098062
tree= 3, node= 50, feature=15, thr= 77.00, gain=0.056525
tree= 3, node= 51, feature= 3, thr= 75.00, gain=0.052487
tree= 3, node= 52, feature=11, thr= 93.00, gain=0.087836
tree= 3, node= 53, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 54, feature= 3, thr= 30.00, gain=0.107245
tree= 3, node= 55, feature= 7, thr= 22.00, gain=0.194775
tree= 3, node= 56, feature=10, thr= 13.00, gain=0.370281
tree= 3, node= 57, feature= 4, thr= 87.00, gain=0.068276
tree= 3, node= 58, feature= 5, thr= 68.00, gain=0.716467
tree= 3, node= 59, feature=11, thr= 80.00, gain=0.022798
tree= 3, node= 60, feature=10, thr= 30.00, gain=0.562971
tree= 3, node= 61, feature=15, thr= 63.00, gain=0.070602
tree= 3, node= 62, feature= 4, thr= 56.00, gain=0.267955
tree= 3, node= 63, feature= 3, thr= 14.00, gain=0.272094
tree= 3, node= 66, feature= 3, thr= 40.00, gain=0.044627
tree= 3, node= 67, feature= 9, thr= 1.00, gain=0.028420
tree= 3, node= 72, feature=-1, thr= -1.00, gain=0.000000

```
tree= 3, node= 73, feature= 9, thr= 19.00, gain=0.554924
tree= 3, node= 74, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 75, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 76, feature= 6, thr= 50.00, gain=0.139281
tree= 3, node= 77, feature=10, thr= 73.00, gain=0.539519
tree= 3, node= 78, feature= 9, thr= 30.00, gain=0.180143
tree= 3, node= 79, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 88, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 89, feature= 3, thr= 23.00, gain=0.085717
tree= 3, node= 90, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 91, feature=13, thr= 53.00, gain=0.253842
tree= 3, node= 94, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 95, feature=12, thr= 15.00, gain=0.364511
tree= 3, node= 98, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node= 99, feature= 9, thr= 23.00, gain=0.286057
tree= 3, node=100, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=101, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=102, feature= 1, thr= 45.00, gain=0.427631
tree= 3, node=103, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=104, feature=10, thr= 62.00, gain=0.254253
tree= 3, node=105, feature=10, thr= 55.00, gain=0.554377
tree= 3, node=108, feature= 2, thr=100.00, gain=0.195643
tree= 3, node=109, feature= 3, thr= 49.00, gain=0.042539
tree= 3, node=110, feature=14, thr= 73.00, gain=0.754880
tree= 3, node=111, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=112, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=113, feature= 5, thr= 19.00, gain=0.044370
tree= 3, node=114, feature= 8, thr= 77.00, gain=0.159727
tree= 3, node=115, feature= 5, thr= 44.00, gain=0.112242
tree= 3, node=116, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=117, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=118, feature= 3, thr= 65.00, gain=0.208547
```

```
tree= 3, node=119, feature= 5, thr= 71.00, gain=0.051493
tree= 3, node=120, feature= 2, thr=100.00, gain=0.194316
tree= 3, node=121, feature= 6, thr= 76.00, gain=0.771709
tree= 3, node=122, feature=15, thr= 45.00, gain=0.026042
tree= 3, node=123, feature= 8, thr= 78.00, gain=0.521157
tree= 3, node=124, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=125, feature=13, thr= 40.00, gain=0.051312
tree= 3, node=126, feature= 1, thr= 62.00, gain=0.548487
tree= 3, node=127, feature= 5, thr= 47.00, gain=0.517635
tree= 3, node=132, feature= 1, thr=  1.00, gain=0.020617
tree= 3, node=133, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=134, feature= 3, thr= 46.00, gain=0.188184
tree= 3, node=135, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=146, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=147, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=152, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=153, feature=10, thr=  1.00, gain=0.289317
tree= 3, node=154, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=155, feature= 3, thr= 15.00, gain=0.192352
tree= 3, node=156, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=157, feature=13, thr= 40.00, gain=0.153817
tree= 3, node=178, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=179, feature= 3, thr= 42.00, gain=0.051962
tree= 3, node=182, feature= 2, thr= 83.00, gain=0.375084
tree= 3, node=183, feature=16, thr= 34.00, gain=0.413817
tree= 3, node=190, feature=10, thr= 15.00, gain=0.018501
tree= 3, node=191, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=198, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=199, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=204, feature= 2, thr= 89.00, gain=0.570579
tree= 3, node=205, feature=11, thr= 94.00, gain=0.037529
tree= 3, node=208, feature=14, thr=  6.00, gain=0.236619
```

```
tree= 3, node=209, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=210, feature=14, thr=  1.00, gain=0.108184
tree= 3, node=211, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=216, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=217, feature= 1, thr= 79.00, gain=0.052308
tree= 3, node=218, feature= 1, thr= 31.00, gain=0.595467
tree= 3, node=219, feature=13, thr= 81.00, gain=0.341907
tree= 3, node=220, feature=10, thr= 59.00, gain=0.557640
tree= 3, node=221, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=226, feature= 5, thr=  3.00, gain=0.016901
tree= 3, node=227, feature= 8, thr= 48.00, gain=0.188572
tree= 3, node=228, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=229, feature= 4, thr= 59.00, gain=0.057289
tree= 3, node=230, feature= 9, thr= 80.00, gain=0.142686
tree= 3, node=231, feature= 3, thr=  8.00, gain=0.142093
tree= 3, node=236, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=237, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=238, feature=11, thr= 89.00, gain=0.036795
tree= 3, node=239, feature= 6, thr=100.00, gain=0.179895
tree= 3, node=240, feature=16, thr= 66.00, gain=0.768929
tree= 3, node=241, feature= 7, thr= 13.00, gain=0.273406
tree= 3, node=242, feature= 4, thr= 59.00, gain=0.186121
tree= 3, node=243, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=244, feature= 8, thr= 81.00, gain=0.291761
tree= 3, node=245, feature=12, thr= 60.00, gain=0.528757
tree= 3, node=246, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=247, feature=10, thr= 82.00, gain=0.264413
tree= 3, node=250, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=251, feature=13, thr= 69.00, gain=0.033586
tree= 3, node=252, feature= 4, thr= 68.00, gain=0.618429
tree= 3, node=253, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=254, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 3, node=255, feature=12, thr=100.00, gain=0.635490
tree= 3, node=264, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=265, feature= 8, thr=  1.00, gain=0.001469
tree= 3, node=268, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=269, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=306, feature= 6, thr= 66.00, gain=0.118533
tree= 3, node=307, feature=11, thr= 30.00, gain=0.176425
tree= 3, node=310, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=311, feature= 3, thr= 52.00, gain=0.090034
tree= 3, node=314, feature= 5, thr= 65.00, gain=0.083213
tree= 3, node=315, feature=14, thr= 21.00, gain=0.297472
tree= 3, node=358, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=359, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=364, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=365, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=366, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=367, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=380, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=381, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=408, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=409, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=410, feature= 3, thr= 44.00, gain=0.045836
tree= 3, node=411, feature=16, thr=100.00, gain=0.043099
tree= 3, node=416, feature= 8, thr= 71.00, gain=0.452350
tree= 3, node=417, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=420, feature= 8, thr= 81.00, gain=0.382958
tree= 3, node=421, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=434, feature=15, thr= 38.00, gain=0.647376
tree= 3, node=435, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=436, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=437, feature= 4, thr= 98.00, gain=0.165168
tree= 3, node=438, feature=13, thr= 51.00, gain=0.128506
```

```
tree= 3, node=439, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=440, feature=15, thr= 20.00, gain=0.173196
tree= 3, node=441, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=452, feature= 2, thr=100.00, gain=0.253324
tree= 3, node=453, feature=12, thr= 62.00, gain=0.155083
tree= 3, node=454, feature= 5, thr= 48.00, gain=0.017073
tree= 3, node=455, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=458, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=459, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=460, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=461, feature= 4, thr= 88.00, gain=0.045007
tree= 3, node=462, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=463, feature= 6, thr= 89.00, gain=0.104419
tree= 3, node=476, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=477, feature=12, thr= 33.00, gain=0.274392
tree= 3, node=478, feature= 2, thr= 97.00, gain=0.106736
tree= 3, node=479, feature=12, thr= 28.00, gain=0.537532
tree= 3, node=480, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=481, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=482, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=483, feature= 6, thr= 39.00, gain=0.260399
tree= 3, node=484, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=485, feature= 5, thr=  1.00, gain=0.003685
tree= 3, node=488, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=489, feature= 4, thr= 94.00, gain=0.625923
tree= 3, node=490, feature= 9, thr= 77.00, gain=0.060785
tree= 3, node=491, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=494, feature=14, thr= 19.00, gain=0.024039
tree= 3, node=495, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=502, feature= 1, thr= 11.00, gain=0.101571
tree= 3, node=503, feature=10, thr= 66.00, gain=0.051039
tree= 3, node=504, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 3, node=505, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=510, feature=15, thr= 86.00, gain=0.041611
tree= 3, node=511, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=530, feature= 9, thr= 12.00, gain=0.018422
tree= 3, node=531, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=612, feature= 7, thr= 62.00, gain=0.511480
tree= 3, node=613, feature= 5, thr= 82.00, gain=0.058589
tree= 3, node=614, feature= 9, thr= 28.00, gain=0.183923
tree= 3, node=615, feature= 4, thr=100.00, gain=0.024813
tree= 3, node=622, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=623, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=628, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=629, feature=10, thr= 59.00, gain=0.231676
tree= 3, node=630, feature= 4, thr= 89.00, gain=0.361680
tree= 3, node=631, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=820, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=821, feature= 1, thr= 99.00, gain=0.134626
tree= 3, node=822, feature=16, thr=  8.00, gain=0.018423
tree= 3, node=823, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=832, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=833, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=840, feature= 1, thr= 78.00, gain=0.146205
tree= 3, node=841, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=868, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=869, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=874, feature=13, thr= 82.00, gain=0.479766
tree= 3, node=875, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=876, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=877, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=880, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=881, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=904, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 3, node=905, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=906, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=907, feature=13, thr= 41.00, gain=0.088971
tree= 3, node=908, feature= 4, thr= 79.00, gain=0.038335
tree= 3, node=909, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=922, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=923, feature= 9, thr= 93.00, gain=0.065280
tree= 3, node=926, feature= 1, thr= 42.00, gain=0.543564
tree= 3, node=927, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=954, feature=16, thr= 20.00, gain=0.035671
tree= 3, node=955, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=956, feature= 3, thr= 87.00, gain=0.083715
tree= 3, node=957, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=958, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=959, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=966, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=967, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=970, feature= 6, thr= 31.00, gain=0.084865
tree= 3, node=971, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=978, feature=11, thr= 78.00, gain=0.423967
tree= 3, node=979, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=980, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=981, feature= 3, thr= 29.00, gain=0.172907
tree= 3, node=988, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=989, feature= 9, thr= 79.00, gain=0.028808
tree= 3, node=1004, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1005, feature= 6, thr= 28.00, gain=0.190012
tree= 3, node=1006, feature= 7, thr= 96.00, gain=0.108023
tree= 3, node=1007, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1020, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1021, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1060, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 3, node=1061, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1224, feature= 7, thr= 50.00, gain=0.194200
tree= 3, node=1225, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1226, feature= 4, thr= 94.00, gain=0.249100
tree= 3, node=1227, feature= 1, thr= 12.00, gain=0.182365
tree= 3, node=1228, feature=10, thr= 57.00, gain=0.019591
tree= 3, node=1229, feature= 5, thr= 97.00, gain=0.357508
tree= 3, node=1230, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1231, feature= 9, thr= 46.00, gain=0.484293
tree= 3, node=1258, feature=11, thr= 35.00, gain=0.280109
tree= 3, node=1259, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1260, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1261, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1642, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1643, feature= 5, thr= 13.00, gain=0.059195
tree= 3, node=1644, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1645, feature=16, thr= 17.00, gain=0.014076
tree= 3, node=1680, feature=10, thr= 46.00, gain=0.175361
tree= 3, node=1681, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1748, feature= 5, thr= 11.00, gain=0.017983
tree= 3, node=1749, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1814, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1815, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1816, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1817, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1846, feature=14, thr=  6.00, gain=0.199331
tree= 3, node=1847, feature=10, thr= 51.00, gain=0.323248
tree= 3, node=1852, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1853, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1908, feature= 9, thr= 81.00, gain=0.106631
tree= 3, node=1909, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1912, feature= 5, thr= 99.00, gain=0.023824
```

```
tree= 3, node=1913, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1940, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1941, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1956, feature= 9, thr= 77.00, gain=0.023526
tree= 3, node=1957, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1962, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1963, feature= 2, thr= 87.00, gain=0.519703
tree= 3, node=1978, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=1979, feature= 5, thr= 63.00, gain=0.039238
tree= 3, node=2010, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=2011, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=2012, feature= 4, thr= 66.00, gain=0.023519
tree= 3, node=2013, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=2448, feature=12, thr= 22.00, gain=0.577829
tree= 3, node=2449, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=2452, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=2453, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=2454, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=2455, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=2456, feature=14, thr= 30.00, gain=0.068432
tree= 3, node=2457, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=2458, feature=12, thr=  3.00, gain=0.120668
tree= 3, node=2459, feature=12, thr=  2.00, gain=0.730475
tree= 3, node=2462, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=2463, feature=14, thr= 16.00, gain=0.519230
tree= 3, node=2516, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=2517, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3286, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3287, feature=14, thr= 14.00, gain=0.131744
tree= 3, node=3290, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3291, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3360, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 3, node=3361, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3496, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3497, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3692, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3693, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3694, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3695, feature=12, thr= 61.00, gain=0.170331
tree= 3, node=3816, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3817, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3824, feature= 1, thr= 39.00, gain=0.052181
tree= 3, node=3825, feature= 4, thr=100.00, gain=0.320760
tree= 3, node=3912, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3913, feature= 5, thr= 48.00, gain=0.242292
tree= 3, node=3926, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3927, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3958, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=3959, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=4024, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=4025, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=4896, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=4897, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=4912, feature=12, thr=  6.00, gain=0.006644
tree= 3, node=4913, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=4916, feature= 3, thr= 58.00, gain=0.250543
tree= 3, node=4917, feature= 1, thr= 38.00, gain=0.014899
tree= 3, node=4918, feature=13, thr= 33.00, gain=0.250183
tree= 3, node=4919, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=4926, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=4927, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=6574, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=6575, feature=16, thr= 89.00, gain=0.054467
tree= 3, node=7390, feature=-1, thr= -1.00, gain=0.000000
```

```
tree= 3, node=7391, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=7648, feature=11, thr=100.00, gain=0.015342
tree= 3, node=7649, feature= 5, thr= 75.00, gain=0.081847
tree= 3, node=7650, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=7651, feature=14, thr= 30.00, gain=0.140327
tree= 3, node=7826, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=7827, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=9824, feature=11, thr=  6.00, gain=0.008794
tree= 3, node=9825, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=9832, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=9833, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=9834, feature=13, thr= 23.00, gain=0.133016
tree= 3, node=9835, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=9836, feature=14, thr= 14.00, gain=0.097941
tree= 3, node=9837, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=13150, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=13151, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=15296, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=15297, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=15298, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=15299, feature=13, thr= 67.00, gain=0.246399
tree= 3, node=15302, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=15303, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=19648, feature=11, thr=  5.00, gain=0.029086
tree= 3, node=19649, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=19668, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=19669, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=19672, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=19673, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=30598, feature= 9, thr= 80.00, gain=0.062097
tree= 3, node=30599, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=39296, feature= 2, thr= 70.00, gain=0.024868
```

tree= 3, node=39297, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=61196, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=61197, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=78592, feature=-1, thr= -1.00, gain=0.000000
tree= 3, node=78593, feature=-1, thr= -1.00, gain=0.000000

Classification Accuracy

classification accuracy=0.8499

Task 1b (10 pts extra credit)

A maximum of 10 extra credit points will be given to the submission or submissions that identify the function arguments (hyperparameters) achieving the best test accuracy for any of the three test datasets. These function arguments, and the attained accuracy, should be reported in answers.pdf, under a clear "Task 1b" heading. These results should be achievable by calling the function you submit for Task 1. You should achieve the reported accuracy at least five out of 10 times when you run your code.

Step 1: Option Search (selecting 50 trees)

Optimized is only ran once because each "optimized" run will return identical trees on each attempt.

Median Classification Accuracy	Number of Attempts	Option	Pruning Threshold
0.8662	1	optimized	50
0.9209	15	10	50
0.9289	15	15	50
0.9391	15	25	50
0.9393	15	40	50
0.9430	15	50	50
0.9423	15	60	50

Step 2: Pruning Threshold Search (selecting pruning threshold of 2)

Median Classification Accuracy	Number of Attempts	Option	Pruning Threshold
0.9581	15	50	2
0.9561	15	50	5
0.9560	15	50	10
0.9500	15	50	25
0.9340	15	50	50
0.9352	15	50	75
0.9272	15	50	100

I found the function arguments that achieve the best accuracy for the pendigits_string datasets to be: 50 trees and a pruning threshold of 2. This had a median classification accuracy of 0.9581 over 15 attempts.

Task 2 (35 pts)

k=1

```
classification accuracy=0.9743
```

k=3

```
classification accuracy=0.9750
```

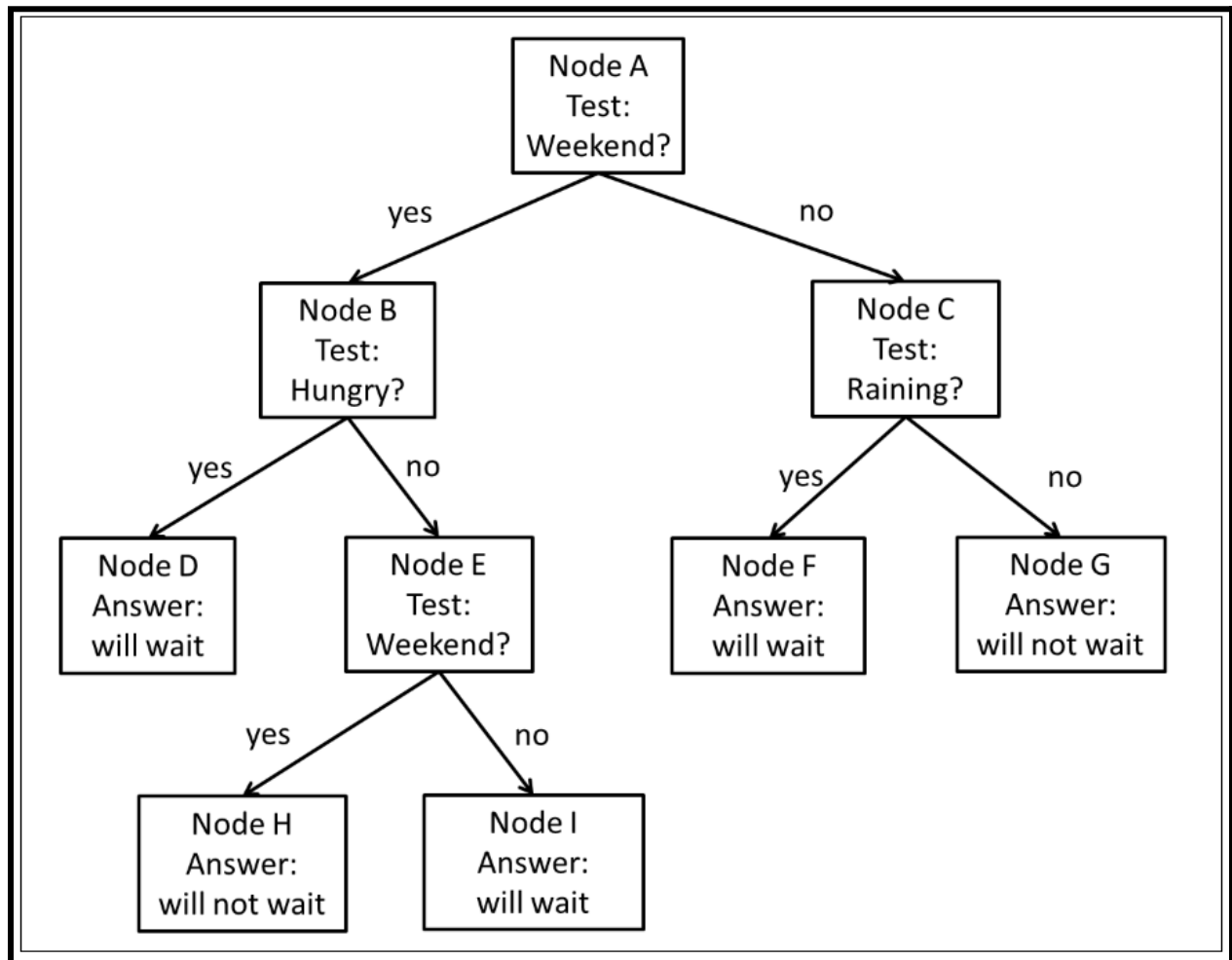k=5

```
classification accuracy=0.9763
```

Task 3 (10 pts)

Figure 1: A decision tree for estimating whether the patron will be willing to wait for a table at a restaurant.

Part a (2 points): Suppose that, on the entire set of training samples available for constructing the decision tree of Figure 1, 80 people decided to wait, and 20 people decided not to wait. What is the initial entropy at node A (before the test is applied)?

Part b (2 points): As mentioned in the previous part, at node A 80 people decided to wait, and 20 people decided not to wait.

- Out of the cases where people decided to wait, in 20 cases it was weekend and in 60 cases it was not weekend.
- Out of the cases where people decided not to wait, in 15 cases it was weekend and in 5 cases it was not weekend.

What is the information gain for the weekend test at node A? ⬆

Part c (2 points): In the decision tree of Figure 1, node E uses the exact same test (whether it is weekend or not) as node A. What is the information gain, at node E, of using the weekend test?

Part d (2 points): We have a test case of a hungry patron who came in on a rainy Tuesday. Which leaf node does this test case end up in? What does the decision tree output for that case?

Part e (2 points): We have a test case of a not hungry patron who came in on a sunny Saturday. Which leaf node does this test case end up in? What does the decision tree output for that case?

Part a (2 pts)

p(Wait) = 80/100 = 0.8
p(Don't Wait) = 20/100 = 0.2

$$H(S) = - \sum p_i log_2 (p_i)$$

H(A) = -[0.8*log2(0.8)+0.2*log2(0.2)]
H(A) = -[0.8*-0.321928095+0.2*-2.32192809]
H(A) = 0.721928094

Part b (2 pts)

Gain = H(Parent) – H(Children)

Child Node 1: Weekend

p(Wait) = 20/35
p(Don't Wait) = 15/35
H(Weekend) = –[(20/35*log2(20/35))+(15/35*log2(15/35))]
H(Weekend) = 0.985228136

Child Node 2: Not Weekend

p(Wait) = 60/65
p(Don't Wait) = 5/65
H(Not Weekend) = –[(60/65*log2(60/65))+(5/65*log2(5/65))]
H(Not Weekend) = 0.391243564

Weighted Average of Children

H(Children) = (35/100*H(Weekend)+65/100*H(Not Weekend)
H(Children) = (35/100*0.985228136+65/100*0.391243564)
H(Children) = 0.599138164

Info Gain

Information Gain = H(A) – H(Children) = 0.721928094 – 0.599138164
Information Gain = 0.12278993

Part c (2 pts)

Weighted Average of Children

H(Children) = 100/100*H(H)+0/100*H(I) = H(H)
H(Children) = H(H)
H(H) = H(E) because sample sets are identical

Info Gain

Information Gain = H(E) − H(H) = H(E) − H(E) = 0

Part d (2 pts)

The leaf node that the test case ends in is Node F. The decision tree outputs "will wait."

Part e (2 pts)

The leaf node that the test case ends in is Node H. The decision tree outputs "will not wait."

Task 4 (10 pts)

Class	A	B	C
X	1	2	1
X	2	1	2
X	3	2	2
X	1	3	3
X	1	2	2
Y	2	1	1
Y	3	1	1
Y	2	2	2
Y	3	3	1
Y	2	1	1

We want to build a decision tree that determines whether a certain pattern is of type X or type Y. The decision tree can only use tests that are based on attributes A, B, and C. Each attribute has 3 possible values: 1, 2, 3 (we do not apply any thresholding). We have the 10 training examples, shown on the table (each row corresponds to a training example).

What is the information gain of each attribute at the root? Which attribute achieves the highest information gain at the root?

Parent Entropy

$H(S) = -[(5/10*\log2(5/10))+(5/10*\log2(5/10))]$
$H(S) = 1$

Attribute A Info Gain

Information Gain $(S, A) = H(S) -$
$[(S_{A=1}/10)H(S_{A=1})+(S_{A=2}/10)H(S_{A=2})+(S_{A=3}/10)H(S_{A=3})]$
$H(S_{A=1}) = -[(3/3*\log2(3/3))+(0/3*\log2(0/3))] = 0$
$H(S_{A=2}) = -[(1/4*\log2(1/4))+(3/4*\log2(3/4))] = 0.811278124$
$H(S_{A=3}) = -[(1/3*\log2(1/3))+(2/3*\log2(2/3))] = 0.918295834$
$H(S, A) = 1-[(4/10*0.811278124)+(3/10*0.918295834)] = 0.4$

Attribute B Info Gain

Information Gain $(S, B) = H(S) -$
$[(S_{B=1}/10)H(S_{B=1})+(S_{B=2}/10)H(S_{B=2})+(S_{B=3}/10)H(S_{B=3})]$
$H(S_{B=1}) = -[(1/4*\log2(1/4))+(3/4*\log2(3/4))] = 0.811278124$
$H(S_{B=2}) = -[(3/4*\log2(3/4))+(1/4*\log2(1/4))] = 0.811278124$
$H(S_{B=3}) = -[(1/2*\log2(1/2))+(1/2*\log2(1/2))] = 1$
$H(S, B) = 1-[(4/10*0.811278124)+(4/10*0.811278124)+(2/10*1.0)] = 0.150977501$

Attribute C Info Gain

Information Gain $(S, C) = H(S) -$
$[(S_{C=1}/10)H(S_{C=1})+(S_{C=2}/10)H(S_{C=2})+(S_{C=3}/10)H(S_{C=3})]$
$H(S_{C=1}) = -[(1/5*\log2(1/5))+(4/5*\log2(4/5))] = 0.721928095$
$H(S_{C=2}) = -[(3/4*\log2(3/4))+(1/4*\log2(1/4))] = 0.811278124$
$H(S_{C=3}) = -[(1/1*\log2(1/2))+(0/1*\log2(1/2))] = 0$
$H(S, C) = 1-[(5/10*0.721928095)+(4/10*0.811278124)] = 0.314524703$

Most Info Gain at Root

Attribute A provides the highest information gain at the root with an information gain of 0.4.

Task 5 (5 pts)

Suppose that, at a node N of a decision tree, we have 1000 training examples. There are four possible class labels (A, B, C, D) for each of these training examples.

Part a: What is the highest possible and lowest possible entropy value at node N?

Part b: Suppose that, at node N, we choose an attribute K. What is the highest possible and lowest possible information gain for that attribute?

Part a

The lowest possible entry value at node N is 0.
$H(N) = -[(1*\log2(1))+(0*\log2(0))+(0*\log2(0))+(0*\log2(0))] = 0$

The highest possible entry value at node N is 2.0.
$H(N) = -[(1/4\log2(1/4))+(1/4\log2(1/4))+(1/4\log2(1/4))+(1/4\log2(1/4))] = 2$

Part b

The lowest possible information gain for attribute K is 0 when all 1000 training examples are one class.
        Since the parent is a pure leaf node, it produces children that have an entropy of 0 due to already having a selected label, rendering the information gain/question useless.
$H(Child) = 0$
$H(N, K) = H(N) - H(Child) = 0 - 0 = 0$

The highest possible information gain for attribute K is 2.0 when all 1000 training examples are split equally into 4 nodes.
        The perfect attribute K splits the data equally, creating four child leaf nodes. Since leaf nodes are pure, their entropy is effectively 0 across all the generated child nodes. The attribute K does not have to split the data perfectly, the important thing is that the resulting leaf nodes are part of the defined set of classes.

H(Children) = 0
H(N, K) = H(N) – H(Children) = 2 – 0 = 2

Task 6 (5 pts)

Yes, I can guarantee achieving better than 60% accuracy by inverting the classifier's prediction. Since the classifier only defines two outcomes—winning and losing—then inverting the classification will yield in either predicting a win or loss. With the error rate being wrong about a win 72% of the time (100% – 28% = 72%), we can apply the inversion logic to be right about a win 72% of the time.