CS 6375

ASSIGNMENT \_\_\_\_\_2\_\_\_\_\_\_\_

Names of students in your group:

Yiming Zhou

Number of free late days used: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_   
Note: You are allowed a **total** of 4 free late days for the **entire semester**. You can use at most 2 for each assignment. After that, there will be a penalty of 10% for each late day.

Please list clearly all the sources/references that you have used in this assignment.

**1. Representing Boolean Functions**

a)

Leaf

Leaf

Leaf

Leaf

Leaf

Leaf

Leaf

Leaf

Y

Y

N

N

Y

N

Y

N

Y

N

Y

N

Y

N

b)

Leaf

Leaf

Leaf

Leaf

Leaf

Y

Y

N

N

Y

N

Y

N

c)

Leaf

Leaf

Leaf

Leaf

Leaf

Leaf

Y

Y

N

N

Y

N

Y

N

Y

N

d)

Zero nodes are needed to represent this concept.

**2. Decision Tree**

Procedure and details are as follow:

Initial entropy is 1.0.

STEP 1:

X1 is chosen to be the root node.

STEP 2:

X3 is chosen to be the left child node of root node. And entropy of its subsets are all zero, so create leaf nodes under this node.

STEP 3:

X2 is chosen to be the left child node of root node.

STEP 4:

X3 is chosen to be the left child. Since all attributes are present in this track, stop branching and create leaf nodes.

STEP 5:

X3 is chosen to be the right child. Since all attributes are present in this track, stop branching and create leaf nodes.

{[1, 0, 1, 0]}

{[1, 0, 0, 1], [1, 1, 0, 1], [1, 0, 0, 1], [1, 0, 0, 1]}

{[0, 1, 1, 0]}

{[0, 1, 0, 1]}

{}

{[0, 0, 0, 0], [0, 0, 0, 0], [0, 0, 0, 0]}

Y

Y

N

N

Y

N

Y

N

Y

N

**3. Programming**

**a) Output for datasets using my pruning strategy:**

**i) Output for Iris Data Set**

\*\*\*\*\*\*\*\*\*\* Building Tree ...... \*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\* Decision Tree \*\*\*\*\*\*\*\*\*\*

(Id:0 Depth:0 Question:Is PetalW >= 1.0?)

--> True:

(Id:2 Depth:1 Question:Is PetalW >= 1.8?)

--> True:

(Id:6 Depth:2 Question:Is PetalL >= 4.9?)

--> True:

(Id:14 Depth:3 Label:Iris-virginica)

--> False:

(Id:13 Depth:3 Question:Is SepalW >= 3.2?)

--> True:

(Id:28 Depth:4 Label:Iris-versicolor)

--> False:

(Id:27 Depth:4 Label:Iris-virginica)

--> False:

(Id:5 Depth:2 Question:Is PetalL >= 5.0?)

--> True:

(Id:12 Depth:3 Question:Is PetalW >= 1.6?)

--> True:

(Id:26 Depth:4 Question:Is PetalL >= 5.8?)

--> True:

(Id:54 Depth:5 Label:Iris-virginica)

--> False:

(Id:53 Depth:5 Label:Iris-versicolor)

--> False:

(Id:25 Depth:4 Label:Iris-virginica)

--> False:

(Id:11 Depth:3 Question:Is PetalW >= 1.7?)

--> True:

(Id:24 Depth:4 Label:Iris-virginica)

--> False:

(Id:23 Depth:4 Label:Iris-versicolor)

--> False:

(Id:1 Depth:1 Label:Iris-setosa)

\*\*\*\*\*\*\*\*\*\* Leaf nodes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

id = 14 depth =3

id = 28 depth =4

id = 27 depth =4

id = 54 depth =5

id = 53 depth =5

id = 25 depth =4

id = 24 depth =4

id = 23 depth =4

id = 1 depth =1

\*\*\*\*\*\*\*\*\*\* Non-leaf nodes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

id = 0 depth =0

id = 2 depth =1

id = 6 depth =2

id = 13 depth =3

id = 5 depth =2

id = 12 depth =3

id = 26 depth =4

id = 11 depth =3

\*\*\*\*\*\*\*\*\*\*\*\*\* Tree before pruning \*\*\*\*\*\*\*

(Id:0 Depth:0 Question:Is PetalW >= 1.0?)

--> True:

(Id:2 Depth:1 Question:Is PetalW >= 1.8?)

--> True:

(Id:6 Depth:2 Question:Is PetalL >= 5.0?)

--> True:

(Id:14 Depth:3 Label:Iris-virginica)

--> False:

(Id:13 Depth:3 Question:Is SepalW >= 3.2?)

--> True:

(Id:28 Depth:4 Label:Iris-versicolor)

--> False:

(Id:27 Depth:4 Label:Iris-virginica)

--> False:

(Id:5 Depth:2 Question:Is PetalL >= 5.0?)

--> True:

(Id:12 Depth:3 Question:Is PetalW >= 1.6?)

--> True:

(Id:26 Depth:4 Label:Iris-versicolor)

--> False:

(Id:25 Depth:4 Label:Iris-virginica)

--> False:

(Id:11 Depth:3 Label:Iris-versicolor)

--> False:

(Id:1 Depth:1 Label:Iris-setosa)

Accuracy on test = 0.933

\*\*\*\*\*\*\*\*\*\*\*\*\* Start pruning \*\*\*\*\*\*\*

Initial accuracy:0.933

Test pruning id:26 -- accuracy:0.933

Prune 26 Success

Test pruning id:13 -- accuracy:0.933

Prune 13 Success

Test pruning id:12 -- accuracy:0.967

Prune 12 Success

Test pruning id:11 -- accuracy:0.967

Prune 11 Success

Test pruning id:6 -- accuracy:0.967

Prune 6 Success

Test pruning id:5 -- accuracy:0.933

Prune 5 Fail

Test pruning id:2 -- accuracy:0.6

Prune 2 Fail

Test pruning id:0 -- accuracy:0.267

Prune 0 Fail

\*\*\*\*\*\*\*\*\*\*\*\*\*Tree after pruning\*\*\*\*\*\*\*

(Id:0 Depth:0 Question:Is PetalW >= 1.0?)

--> True:

(Id:2 Depth:1 Question:Is PetalW >= 1.8?)

--> True:

(Id:6 Depth:2 Label:Iris-virginica)

--> False:

(Id:5 Depth:2 Question:Is PetalL >= 5.0?)

--> True:

(Id:12 Depth:3 Label:Iris-virginica)

--> False:

(Id:11 Depth:3 Label:Iris-versicolor)

--> False:

(Id:1 Depth:1 Label:Iris-setosa)

Accuracy on test = 0.967

ii) Output for UCI’s balance-scale Data Set

\*\*\*\*\*\*\*\*\*\* Building Tree ...... \*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\* Decision Tree \*\*\*\*\*\*\*\*\*\*

(Id:0 Depth:0 Question:Is Unnamed: 0 >= 300?)

--> True:

(Id:2 Depth:1 Question:Is Right-Distance >= 4?)

--> True:

(Id:6 Depth:2 Question:Is Right-Weight >= 3?)

--> True:

(Id:14 Depth:3 Question:Is Left-Distance >= 4?)

--> True:

(Id:30 Depth:4 Question:Is Unnamed: 0 >= 488?)

--> True:

(Id:62 Depth:5 Question:Is Right-Weight >= 5?)

--> True:

(Id:126 Depth:6 Question:Is Right-Distance >= 5?)

--> True:

(Id:254 Depth:7 Question:Is Unnamed: 0 >= 624?)

--> True:

(Id:510 Depth:8 Label:B)

--> False:

(Id:509 Depth:8 Label:R)

--> False:

(Id:253 Depth:7 Question:Is Unnamed: 0 >= 623?)

--> True:

(Id:508 Depth:8 Label:L)

--> False:

(Id:507 Depth:8 Label:B)

--> False:

(Id:125 Depth:6 Question:Is Right-Distance >= 5?)

--> True:

(Id:252 Depth:7 Question:Is Right-Weight >= 4?)

--> True:

(Id:506 Depth:8 Question:Is Unnamed: 0 >= 619?)

--> True:

(Id:1014 Depth:9 Label:L)

--> False:

(Id:1013 Depth:9 Label:B)

--> False:

(Id:505 Depth:8 Label:L)

--> False:

(Id:251 Depth:7 Label:L)

--> False:

(Id:61 Depth:5 Question:Is Right-Weight >= 4?)

--> True:

(Id:124 Depth:6 Question:Is Left-Weight >= 4?)

--> True:

(Id:250 Depth:7 Question:Is Unnamed: 0 >= 469?)

--> True:

(Id:502 Depth:8 Label:R)

--> False:

(Id:501 Depth:8 Label:B)

--> False:

(Id:249 Depth:7 Label:R)

--> False:

(Id:123 Depth:6 Question:Is Unnamed: 0 >= 363?)

--> True:

(Id:248 Depth:7 Question:Is Right-Distance >= 5?)

--> True:

(Id:498 Depth:8 Question:Is Left-Distance >= 5?)

--> True:

(Id:998 Depth:9 Label:B)

--> False:

(Id:997 Depth:9 Label:L)

--> False:

(Id:497 Depth:8 Label:L)

--> False:

(Id:247 Depth:7 Question:Is Right-Distance >= 5?)

--> True:

(Id:496 Depth:8 Label:R)

--> False:

(Id:495 Depth:8 Label:B)

--> False:

(Id:29 Depth:4 Question:Is Unnamed: 0 >= 563?)

--> True:

(Id:60 Depth:5 Question:Is Right-Weight >= 4?)

--> True:

(Id:122 Depth:6 Label:R)

--> False:

(Id:121 Depth:6 Question:Is Right-Distance >= 5?)

--> True:

(Id:244 Depth:7 Label:B)

--> False:

(Id:243 Depth:7 Label:L)

--> False:

(Id:59 Depth:5 Question:Is Left-Distance >= 3?)

--> True:

(Id:120 Depth:6 Question:Is Right-Weight >= 4?)

--> True:

(Id:242 Depth:7 Label:R)

--> False:

(Id:241 Depth:7 Question:Is Right-Distance >= 5?)

--> True:

(Id:484 Depth:8 Label:R)

--> False:

(Id:483 Depth:8 Question:Is Left-Weight >= 4?)

--> True:

(Id:968 Depth:9 Label:B)

--> False:

(Id:967 Depth:9 Label:R)

--> False:

(Id:119 Depth:6 Label:R)

--> False:

(Id:13 Depth:3 Question:Is Left-Distance >= 2?)

--> True:

(Id:28 Depth:4 Question:Is Left-Distance >= 3?)

--> True:

(Id:58 Depth:5 Question:Is Unnamed: 0 >= 328?)

--> True:

(Id:118 Depth:6 Label:L)

--> False:

(Id:117 Depth:6 Question:Is Unnamed: 0 >= 309?)

--> True:

(Id:236 Depth:7 Label:R)

--> False:

(Id:235 Depth:7 Label:L)

--> False:

(Id:57 Depth:5 Question:Is Right-Weight >= 2?)

--> True:

(Id:116 Depth:6 Question:Is Unnamed: 0 >= 534?)

--> True:

(Id:234 Depth:7 Label:B)

--> False:

(Id:233 Depth:7 Question:Is Unnamed: 0 >= 409?)

--> True:

(Id:468 Depth:8 Question:Is Right-Distance >= 5?)

--> True:

(Id:938 Depth:9 Label:R)

--> False:

(Id:937 Depth:9 Label:L)

--> False:

(Id:467 Depth:8 Label:B)

--> False:

(Id:115 Depth:6 Label:L)

--> False:

(Id:27 Depth:4 Question:Is Right-Weight >= 2?)

--> True:

(Id:56 Depth:5 Label:R)

--> False:

(Id:55 Depth:5 Question:Is Unnamed: 0 >= 379?)

--> True:

(Id:112 Depth:6 Question:Is Right-Distance >= 5?)

--> True:

(Id:226 Depth:7 Question:Is Left-Weight >= 5?)

--> True:

(Id:454 Depth:8 Label:B)

--> False:

(Id:453 Depth:8 Label:R)

--> False:

(Id:225 Depth:7 Label:L)

--> False:

(Id:111 Depth:6 Label:B)

--> False:

(Id:5 Depth:2 Question:Is Left-Distance >= 2?)

--> True:

(Id:12 Depth:3 Question:Is Right-Weight >= 4?)

--> True:

(Id:26 Depth:4 Question:Is Right-Distance >= 3?)

--> True:

(Id:54 Depth:5 Question:Is Left-Distance >= 4?)

--> True:

(Id:110 Depth:6 Question:Is Left-Weight >= 4?)

--> True:

(Id:222 Depth:7 Label:L)

--> False:

(Id:221 Depth:7 Question:Is Unnamed: 0 >= 372?)

--> True:

(Id:444 Depth:8 Label:B)

--> False:

(Id:443 Depth:8 Question:Is Unnamed: 0 >= 347?)

--> True:

(Id:888 Depth:9 Question:Is Right-Weight >= 5?)

--> True:

(Id:1778 Depth:10 Label:R)

--> False:

(Id:1777 Depth:10 Label:L)

--> False:

(Id:887 Depth:9 Label:B)

--> False:

(Id:109 Depth:6 Question:Is Unnamed: 0 >= 567?)

--> True:

(Id:220 Depth:7 Question:Is Right-Weight >= 5?)

--> True:

(Id:442 Depth:8 Label:B)

--> False:

(Id:441 Depth:8 Label:L)

--> False:

(Id:219 Depth:7 Question:Is Right-Weight >= 5?)

--> True:

(Id:440 Depth:8 Label:R)

--> False:

(Id:439 Depth:8 Question:Is Left-Distance >= 3?)

--> True:

(Id:880 Depth:9 Question:Is Left-Weight >= 4?)

--> True:

(Id:1762 Depth:10 Label:B)

--> False:

(Id:1761 Depth:10 Label:R)

--> False:

(Id:879 Depth:9 Label:R)

--> False:

(Id:53 Depth:5 Question:Is Left-Distance >= 3?)

--> True:

(Id:108 Depth:6 Question:Is Unnamed: 0 >= 340?)

--> True:

(Id:218 Depth:7 Label:L)

--> False:

(Id:217 Depth:7 Question:Is Unnamed: 0 >= 321?)

--> True:

(Id:436 Depth:8 Label:R)

--> False:

(Id:435 Depth:8 Label:L)

--> False:

(Id:107 Depth:6 Question:Is Right-Distance >= 2?)

--> True:

(Id:216 Depth:7 Question:Is Unnamed: 0 >= 421?)

--> True:

(Id:434 Depth:8 Question:Is Right-Weight >= 5?)

--> True:

(Id:870 Depth:9 Question:Is Left-Weight >= 5?)

--> True:

(Id:1742 Depth:10 Label:B)

--> False:

(Id:1741 Depth:10 Label:R)

--> False:

(Id:869 Depth:9 Label:L)

--> False:

(Id:433 Depth:8 Label:B)

--> False:

(Id:215 Depth:7 Label:L)

--> False:

(Id:25 Depth:4 Question:Is Unnamed: 0 >= 325?)

--> True:

(Id:52 Depth:5 Question:Is Left-Distance >= 3?)

--> True:

(Id:106 Depth:6 Label:L)

--> False:

(Id:105 Depth:6 Question:Is Right-Distance >= 3?)

--> True:

(Id:212 Depth:7 Question:Is Right-Weight >= 3?)

--> True:

(Id:426 Depth:8 Question:Is Left-Weight >= 5?)

--> True:

(Id:854 Depth:9 Label:L)

--> False:

(Id:853 Depth:9 Label:R)

--> False:

(Id:425 Depth:8 Label:L)

--> False:

(Id:211 Depth:7 Label:L)

--> False:

(Id:51 Depth:5 Question:Is Unnamed: 0 >= 312?)

--> True:

(Id:104 Depth:6 Label:B)

--> False:

(Id:103 Depth:6 Label:L)

--> False:

(Id:11 Depth:3 Question:Is Right-Weight >= 3?)

--> True:

(Id:24 Depth:4 Question:Is Right-Distance >= 2?)

--> True:

(Id:50 Depth:5 Label:R)

--> False:

(Id:49 Depth:5 Question:Is Right-Weight >= 5?)

--> True:

(Id:100 Depth:6 Question:Is Left-Weight >= 5?)

--> True:

(Id:202 Depth:7 Label:B)

--> False:

(Id:201 Depth:7 Label:R)

--> False:

(Id:99 Depth:6 Question:Is Right-Weight >= 4?)

--> True:

(Id:200 Depth:7 Question:Is Left-Weight >= 5?)

--> True:

(Id:402 Depth:8 Label:L)

--> False:

(Id:401 Depth:8 Label:B)

--> False:

(Id:199 Depth:7 Label:L)

--> False:

(Id:23 Depth:4 Question:Is Unnamed: 0 >= 507?)

--> True:

(Id:48 Depth:5 Label:R)

--> False:

(Id:47 Depth:5 Question:Is Right-Weight >= 2?)

--> True:

(Id:96 Depth:6 Question:Is Right-Distance >= 3?)

--> True:

(Id:194 Depth:7 Label:R)

--> False:

(Id:193 Depth:7 Question:Is Right-Distance >= 2?)

--> True:

(Id:388 Depth:8 Question:Is Left-Weight >= 5?)

--> True:

(Id:778 Depth:9 Label:L)

--> False:

(Id:777 Depth:9 Label:B)

--> False:

(Id:387 Depth:8 Label:L)

--> False:

(Id:95 Depth:6 Label:L)

--> False:

(Id:1 Depth:1 Question:Is Right-Distance >= 2?)

--> True:

(Id:4 Depth:2 Question:Is Right-Weight >= 2?)

--> True:

(Id:10 Depth:3 Question:Is Unnamed: 0 >= 181?)

--> True:

(Id:22 Depth:4 Question:Is Right-Distance >= 3?)

--> True:

(Id:46 Depth:5 Question:Is Right-Weight >= 3?)

--> True:

(Id:94 Depth:6 Question:Is Left-Distance >= 5?)

--> True:

(Id:190 Depth:7 Question:Is Unnamed: 0 >= 238?)

--> True:

(Id:382 Depth:8 Label:R)

--> False:

(Id:381 Depth:8 Label:L)

--> False:

(Id:189 Depth:7 Label:R)

--> False:

(Id:93 Depth:6 Question:Is Left-Distance >= 4?)

--> True:

(Id:188 Depth:7 Question:Is Right-Distance >= 5?)

--> True:

(Id:378 Depth:8 Question:Is Left-Distance >= 5?)

--> True:

(Id:758 Depth:9 Label:B)

--> False:

(Id:757 Depth:9 Label:R)

--> False:

(Id:377 Depth:8 Question:Is Right-Distance >= 4?)

--> True:

(Id:756 Depth:9 Question:Is Left-Distance >= 5?)

--> True:

(Id:1514 Depth:10 Label:L)

--> False:

(Id:1513 Depth:10 Label:B)

--> False:

(Id:755 Depth:9 Label:L)

--> False:

(Id:187 Depth:7 Question:Is Right-Distance >= 4?)

--> True:

(Id:376 Depth:8 Label:R)

--> False:

(Id:375 Depth:8 Question:Is Left-Distance >= 2?)

--> True:

(Id:752 Depth:9 Label:B)

--> False:

(Id:751 Depth:9 Label:R)

--> False:

(Id:45 Depth:5 Question:Is Right-Weight >= 4?)

--> True:

(Id:92 Depth:6 Question:Is Left-Distance >= 4?)

--> True:

(Id:186 Depth:7 Question:Is Unnamed: 0 >= 246?)

--> True:

(Id:374 Depth:8 Label:B)

--> False:

(Id:373 Depth:8 Question:Is Unnamed: 0 >= 221?)

--> True:

(Id:748 Depth:9 Question:Is Right-Weight >= 5?)

--> True:

(Id:1498 Depth:10 Label:R)

--> False:

(Id:1497 Depth:10 Label:L)

--> False:

(Id:747 Depth:9 Label:B)

--> False:

(Id:185 Depth:7 Label:R)

--> False:

(Id:91 Depth:6 Question:Is Left-Distance >= 2?)

--> True:

(Id:184 Depth:7 Question:Is Unnamed: 0 >= 286?)

--> True:

(Id:370 Depth:8 Label:B)

--> False:

(Id:369 Depth:8 Question:Is Unnamed: 0 >= 206?)

--> True:

(Id:740 Depth:9 Label:L)

--> False:

(Id:739 Depth:9 Question:Is Right-Weight >= 3?)

--> True:

(Id:1480 Depth:10 Label:B)

--> False:

(Id:1479 Depth:10 Label:L)

--> False:

(Id:183 Depth:7 Label:R)

--> False:

(Id:21 Depth:4 Question:Is Right-Distance >= 3?)

--> True:

(Id:44 Depth:5 Label:R)

--> False:

(Id:43 Depth:5 Question:Is Right-Weight >= 3?)

--> True:

(Id:88 Depth:6 Label:R)

--> False:

(Id:87 Depth:6 Question:Is Unnamed: 0 >= 81?)

--> True:

(Id:176 Depth:7 Question:Is Left-Distance >= 5?)

--> True:

(Id:354 Depth:8 Label:L)

--> False:

(Id:353 Depth:8 Question:Is Left-Distance >= 2?)

--> True:

(Id:708 Depth:9 Label:B)

--> False:

(Id:707 Depth:9 Label:R)

--> False:

(Id:175 Depth:7 Label:R)

--> False:

(Id:9 Depth:3 Question:Is Unnamed: 0 >= 176?)

--> True:

(Id:20 Depth:4 Question:Is Left-Distance >= 2?)

--> True:

(Id:42 Depth:5 Label:L)

--> False:

(Id:41 Depth:5 Question:Is Right-Distance >= 4?)

--> True:

(Id:84 Depth:6 Label:R)

--> False:

(Id:83 Depth:6 Question:Is Right-Distance >= 3?)

--> True:

(Id:168 Depth:7 Label:B)

--> False:

(Id:167 Depth:7 Label:L)

--> False:

(Id:19 Depth:4 Question:Is Left-Distance >= 4?)

--> True:

(Id:40 Depth:5 Question:Is Right-Distance >= 4?)

--> True:

(Id:82 Depth:6 Question:Is Unnamed: 0 >= 79?)

--> True:

(Id:166 Depth:7 Question:Is Right-Distance >= 5?)

--> True:

(Id:334 Depth:8 Question:Is Left-Distance >= 5?)

--> True:

(Id:670 Depth:9 Label:B)

--> False:

(Id:669 Depth:9 Label:R)

--> False:

(Id:333 Depth:8 Label:L)

--> False:

(Id:165 Depth:7 Label:B)

--> False:

(Id:81 Depth:6 Label:L)

--> False:

(Id:39 Depth:5 Question:Is Right-Distance >= 3?)

--> True:

(Id:80 Depth:6 Question:Is Unnamed: 0 >= 152?)

--> True:

(Id:162 Depth:7 Question:Is Right-Distance >= 4?)

--> True:

(Id:326 Depth:8 Question:Is Right-Distance >= 5?)

--> True:

(Id:654 Depth:9 Label:R)

--> False:

(Id:653 Depth:9 Label:B)

--> False:

(Id:325 Depth:8 Label:L)

--> False:

(Id:161 Depth:7 Question:Is Left-Distance >= 3?)

--> True:

(Id:324 Depth:8 Question:Is Right-Distance >= 4?)

--> True:

(Id:650 Depth:9 Label:R)

--> False:

(Id:649 Depth:9 Label:B)

--> False:

(Id:323 Depth:8 Label:R)

--> False:

(Id:79 Depth:6 Question:Is Unnamed: 0 >= 26?)

--> True:

(Id:160 Depth:7 Question:Is Left-Distance >= 2?)

--> True:

(Id:322 Depth:8 Question:Is Unnamed: 0 >= 51?)

--> True:

(Id:646 Depth:9 Label:L)

--> False:

(Id:645 Depth:9 Label:B)

--> False:

(Id:321 Depth:8 Label:B)

--> False:

(Id:159 Depth:7 Label:R)

--> False:

(Id:3 Depth:2 Question:Is Left-Distance >= 2?)

--> True:

(Id:8 Depth:3 Question:Is Unnamed: 0 >= 75?)

--> True:

(Id:18 Depth:4 Question:Is Right-Weight >= 4?)

--> True:

(Id:38 Depth:5 Question:Is Unnamed: 0 >= 190?)

--> True:

(Id:78 Depth:6 Label:L)

--> False:

(Id:77 Depth:6 Question:Is Right-Weight >= 5?)

--> True:

(Id:156 Depth:7 Question:Is Left-Distance >= 5?)

--> True:

(Id:314 Depth:8 Label:B)

--> False:

(Id:313 Depth:8 Label:R)

--> False:

(Id:155 Depth:7 Question:Is Left-Distance >= 5?)

--> True:

(Id:312 Depth:8 Label:L)

--> False:

(Id:311 Depth:8 Label:B)

--> False:

(Id:37 Depth:5 Label:L)

--> False:

(Id:17 Depth:4 Question:Is Right-Weight >= 3?)

--> True:

(Id:36 Depth:5 Question:Is Right-Weight >= 4?)

--> True:

(Id:74 Depth:6 Label:R)

--> False:

(Id:73 Depth:6 Question:Is Left-Distance >= 3?)

--> True:

(Id:148 Depth:7 Label:B)

--> False:

(Id:147 Depth:7 Label:R)

--> False:

(Id:35 Depth:5 Question:Is Right-Weight >= 2?)

--> True:

(Id:72 Depth:6 Question:Is Left-Distance >= 3?)

--> True:

(Id:146 Depth:7 Label:L)

--> False:

(Id:145 Depth:7 Label:B)

--> False:

(Id:71 Depth:6 Label:L)

--> False:

(Id:7 Depth:3 Question:Is Right-Weight >= 3?)

--> True:

(Id:16 Depth:4 Question:Is Left-Weight >= 3?)

--> True:

(Id:34 Depth:5 Question:Is Right-Weight >= 4?)

--> True:

(Id:70 Depth:6 Label:R)

--> False:

(Id:69 Depth:6 Label:B)

--> False:

(Id:33 Depth:5 Label:R)

--> False:

(Id:15 Depth:4 Question:Is Left-Weight >= 2?)

--> True:

(Id:32 Depth:5 Question:Is Right-Weight >= 2?)

--> True:

(Id:66 Depth:6 Question:Is Left-Weight >= 3?)

--> True:

(Id:134 Depth:7 Label:L)

--> False:

(Id:133 Depth:7 Label:B)

--> False:

(Id:65 Depth:6 Label:L)

--> False:

(Id:31 Depth:5 Question:Is Right-Weight >= 2?)

--> True:

(Id:64 Depth:6 Label:R)

--> False:

(Id:63 Depth:6 Label:B)

\*\*\*\*\*\*\*\*\*\* Leaf nodes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

id = 510 depth =8

id = 509 depth =8

id = 508 depth =8

id = 507 depth =8

id = 1014 depth =9

id = 1013 depth =9

id = 505 depth =8

id = 251 depth =7

id = 502 depth =8

id = 501 depth =8

id = 249 depth =7

id = 998 depth =9

id = 997 depth =9

id = 497 depth =8

id = 496 depth =8

id = 495 depth =8

id = 122 depth =6

id = 244 depth =7

id = 243 depth =7

id = 242 depth =7

id = 484 depth =8

id = 968 depth =9

id = 967 depth =9

id = 119 depth =6

id = 118 depth =6

id = 236 depth =7

id = 235 depth =7

id = 234 depth =7

id = 938 depth =9

id = 937 depth =9

id = 467 depth =8

id = 115 depth =6

id = 56 depth =5

id = 454 depth =8

id = 453 depth =8

id = 225 depth =7

id = 111 depth =6

id = 222 depth =7

id = 444 depth =8

id = 1778 depth =10

id = 1777 depth =10

id = 887 depth =9

id = 442 depth =8

id = 441 depth =8

id = 440 depth =8

id = 1762 depth =10

id = 1761 depth =10

id = 879 depth =9

id = 218 depth =7

id = 436 depth =8

id = 435 depth =8

id = 1742 depth =10

id = 1741 depth =10

id = 869 depth =9

id = 433 depth =8

id = 215 depth =7

id = 106 depth =6

id = 854 depth =9

id = 853 depth =9

id = 425 depth =8

id = 211 depth =7

id = 104 depth =6

id = 103 depth =6

id = 50 depth =5

id = 202 depth =7

id = 201 depth =7

id = 402 depth =8

id = 401 depth =8

id = 199 depth =7

id = 48 depth =5

id = 194 depth =7

id = 778 depth =9

id = 777 depth =9

id = 387 depth =8

id = 95 depth =6

id = 382 depth =8

id = 381 depth =8

id = 189 depth =7

id = 758 depth =9

id = 757 depth =9

id = 1514 depth =10

id = 1513 depth =10

id = 755 depth =9

id = 376 depth =8

id = 752 depth =9

id = 751 depth =9

id = 374 depth =8

id = 1498 depth =10

id = 1497 depth =10

id = 747 depth =9

id = 185 depth =7

id = 370 depth =8

id = 740 depth =9

id = 1480 depth =10

id = 1479 depth =10

id = 183 depth =7

id = 44 depth =5

id = 88 depth =6

id = 354 depth =8

id = 708 depth =9

id = 707 depth =9

id = 175 depth =7

id = 42 depth =5

id = 84 depth =6

id = 168 depth =7

id = 167 depth =7

id = 670 depth =9

id = 669 depth =9

id = 333 depth =8

id = 165 depth =7

id = 81 depth =6

id = 654 depth =9

id = 653 depth =9

id = 325 depth =8

id = 650 depth =9

id = 649 depth =9

id = 323 depth =8

id = 646 depth =9

id = 645 depth =9

id = 321 depth =8

id = 159 depth =7

id = 78 depth =6

id = 314 depth =8

id = 313 depth =8

id = 312 depth =8

id = 311 depth =8

id = 37 depth =5

id = 74 depth =6

id = 148 depth =7

id = 147 depth =7

id = 146 depth =7

id = 145 depth =7

id = 71 depth =6

id = 70 depth =6

id = 69 depth =6

id = 33 depth =5

id = 134 depth =7

id = 133 depth =7

id = 65 depth =6

id = 64 depth =6

id = 63 depth =6

\*\*\*\*\*\*\*\*\*\* Non-leaf nodes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

id = 0 depth =0

id = 2 depth =1

id = 6 depth =2

id = 14 depth =3

id = 30 depth =4

id = 62 depth =5

id = 126 depth =6

id = 254 depth =7

id = 253 depth =7

id = 125 depth =6

id = 252 depth =7

id = 506 depth =8

id = 61 depth =5

id = 124 depth =6

id = 250 depth =7

id = 123 depth =6

id = 248 depth =7

id = 498 depth =8

id = 247 depth =7

id = 29 depth =4

id = 60 depth =5

id = 121 depth =6

id = 59 depth =5

id = 120 depth =6

id = 241 depth =7

id = 483 depth =8

id = 13 depth =3

id = 28 depth =4

id = 58 depth =5

id = 117 depth =6

id = 57 depth =5

id = 116 depth =6

id = 233 depth =7

id = 468 depth =8

id = 27 depth =4

id = 55 depth =5

id = 112 depth =6

id = 226 depth =7

id = 5 depth =2

id = 12 depth =3

id = 26 depth =4

id = 54 depth =5

id = 110 depth =6

id = 221 depth =7

id = 443 depth =8

id = 888 depth =9

id = 109 depth =6

id = 220 depth =7

id = 219 depth =7

id = 439 depth =8

id = 880 depth =9

id = 53 depth =5

id = 108 depth =6

id = 217 depth =7

id = 107 depth =6

id = 216 depth =7

id = 434 depth =8

id = 870 depth =9

id = 25 depth =4

id = 52 depth =5

id = 105 depth =6

id = 212 depth =7

id = 426 depth =8

id = 51 depth =5

id = 11 depth =3

id = 24 depth =4

id = 49 depth =5

id = 100 depth =6

id = 99 depth =6

id = 200 depth =7

id = 23 depth =4

id = 47 depth =5

id = 96 depth =6

id = 193 depth =7

id = 388 depth =8

id = 1 depth =1

id = 4 depth =2

id = 10 depth =3

id = 22 depth =4

id = 46 depth =5

id = 94 depth =6

id = 190 depth =7

id = 93 depth =6

id = 188 depth =7

id = 378 depth =8

id = 377 depth =8

id = 756 depth =9

id = 187 depth =7

id = 375 depth =8

id = 45 depth =5

id = 92 depth =6

id = 186 depth =7

id = 373 depth =8

id = 748 depth =9

id = 91 depth =6

id = 184 depth =7

id = 369 depth =8

id = 739 depth =9

id = 21 depth =4

id = 43 depth =5

id = 87 depth =6

id = 176 depth =7

id = 353 depth =8

id = 9 depth =3

id = 20 depth =4

id = 41 depth =5

id = 83 depth =6

id = 19 depth =4

id = 40 depth =5

id = 82 depth =6

id = 166 depth =7

id = 334 depth =8

id = 39 depth =5

id = 80 depth =6

id = 162 depth =7

id = 326 depth =8

id = 161 depth =7

id = 324 depth =8

id = 79 depth =6

id = 160 depth =7

id = 322 depth =8

id = 3 depth =2

id = 8 depth =3

id = 18 depth =4

id = 38 depth =5

id = 77 depth =6

id = 156 depth =7

id = 155 depth =7

id = 17 depth =4

id = 36 depth =5

id = 73 depth =6

id = 35 depth =5

id = 72 depth =6

id = 7 depth =3

id = 16 depth =4

id = 34 depth =5

id = 15 depth =4

id = 32 depth =5

id = 66 depth =6

id = 31 depth =5

\*\*\*\*\*\*\*\*\*\*\*\*\* Tree before pruning \*\*\*\*\*\*\*

(Id:0 Depth:0 Question:Is Unnamed: 0 >= 302?)

--> True:

(Id:2 Depth:1 Question:Is Right-Weight >= 4?)

--> True:

(Id:6 Depth:2 Question:Is Right-Distance >= 3?)

--> True:

(Id:14 Depth:3 Question:Is Unnamed: 0 >= 593?)

--> True:

(Id:30 Depth:4 Question:Is Right-Distance >= 5?)

--> True:

(Id:62 Depth:5 Question:Is Unnamed: 0 >= 599?)

--> True:

(Id:126 Depth:6 Question:Is Right-Weight >= 5?)

--> True:

(Id:254 Depth:7 Question:Is Left-Distance >= 5?)

--> True:

(Id:510 Depth:8 Label:B)

--> False:

(Id:509 Depth:8 Label:R)

--> False:

(Id:253 Depth:7 Label:L)

--> False:

(Id:125 Depth:6 Label:B)

--> False:

(Id:61 Depth:5 Question:Is Left-Distance >= 5?)

--> True:

(Id:124 Depth:6 Label:L)

--> False:

(Id:123 Depth:6 Question:Is Right-Weight >= 5?)

--> True:

(Id:248 Depth:7 Label:B)

--> False:

(Id:247 Depth:7 Label:L)

--> False:

(Id:29 Depth:4 Question:Is Right-Distance >= 4?)

--> True:

(Id:60 Depth:5 Question:Is Left-Distance >= 5?)

--> True:

(Id:122 Depth:6 Question:Is Right-Distance >= 5?)

--> True:

(Id:246 Depth:7 Label:R)

--> False:

(Id:245 Depth:7 Question:Is Left-Weight >= 4?)

--> True:

(Id:492 Depth:8 Question:Is Right-Weight >= 5?)

--> True:

(Id:986 Depth:9 Label:B)

--> False:

(Id:985 Depth:9 Label:L)

--> False:

(Id:491 Depth:8 Label:R)

--> False:

(Id:121 Depth:6 Question:Is Left-Distance >= 4?)

--> True:

(Id:244 Depth:7 Question:Is Right-Distance >= 5?)

--> True:

(Id:490 Depth:8 Label:R)

--> False:

(Id:489 Depth:8 Question:Is Right-Weight >= 5?)

--> True:

(Id:980 Depth:9 Label:R)

--> False:

(Id:979 Depth:9 Question:Is Left-Weight >= 4?)

--> True:

(Id:1960 Depth:10 Label:B)

--> False:

(Id:1959 Depth:10 Label:R)

--> False:

(Id:243 Depth:7 Label:R)

--> False:

(Id:59 Depth:5 Question:Is Left-Distance >= 3?)

--> True:

(Id:120 Depth:6 Question:Is Unnamed: 0 >= 367?)

--> True:

(Id:242 Depth:7 Question:Is Right-Weight >= 5?)

--> True:

(Id:486 Depth:8 Question:Is Left-Distance >= 5?)

--> True:

(Id:974 Depth:9 Label:B)

--> False:

(Id:973 Depth:9 Question:Is Unnamed: 0 >= 472?)

--> True:

(Id:1948 Depth:10 Question:Is Left-Distance >= 4?)

--> True:

(Id:3898 Depth:11 Label:L)

--> False:

(Id:3897 Depth:11 Label:B)

--> False:

(Id:1947 Depth:10 Label:R)

--> False:

(Id:485 Depth:8 Question:Is Left-Distance >= 4?)

--> True:

(Id:972 Depth:9 Label:L)

--> False:

(Id:971 Depth:9 Question:Is Left-Weight >= 5?)

--> True:

(Id:1944 Depth:10 Label:L)

--> False:

(Id:1943 Depth:10 Label:B)

--> False:

(Id:241 Depth:7 Label:R)

--> False:

(Id:119 Depth:6 Label:R)

--> False:

(Id:13 Depth:3 Question:Is Left-Distance >= 2?)

--> True:

(Id:28 Depth:4 Question:Is Left-Distance >= 3?)

--> True:

(Id:58 Depth:5 Label:L)

--> False:

(Id:57 Depth:5 Question:Is Right-Distance >= 2?)

--> True:

(Id:116 Depth:6 Question:Is Unnamed: 0 >= 421?)

--> True:

(Id:234 Depth:7 Question:Is Right-Weight >= 5?)

--> True:

(Id:470 Depth:8 Label:R)

--> False:

(Id:469 Depth:8 Label:L)

--> False:

(Id:233 Depth:7 Label:B)

--> False:

(Id:115 Depth:6 Label:L)

--> False:

(Id:27 Depth:4 Question:Is Right-Distance >= 2?)

--> True:

(Id:56 Depth:5 Label:R)

--> False:

(Id:55 Depth:5 Question:Is Right-Weight >= 5?)

--> True:

(Id:112 Depth:6 Question:Is Left-Weight >= 5?)

--> True:

(Id:226 Depth:7 Label:B)

--> False:

(Id:225 Depth:7 Label:R)

--> False:

(Id:111 Depth:6 Label:B)

--> False:

(Id:5 Depth:2 Question:Is Left-Distance >= 2?)

--> True:

(Id:12 Depth:3 Question:Is Right-Distance >= 5?)

--> True:

(Id:26 Depth:4 Question:Is Left-Distance >= 4?)

--> True:

(Id:54 Depth:5 Question:Is Left-Weight >= 4?)

--> True:

(Id:110 Depth:6 Label:L)

--> False:

(Id:109 Depth:6 Question:Is Right-Weight >= 3?)

--> True:

(Id:220 Depth:7 Question:Is Left-Distance >= 5?)

--> True:

(Id:442 Depth:8 Label:B)

--> False:

(Id:441 Depth:8 Label:R)

--> False:

(Id:219 Depth:7 Label:L)

--> False:

(Id:53 Depth:5 Question:Is Right-Weight >= 2?)

--> True:

(Id:108 Depth:6 Question:Is Left-Weight >= 5?)

--> True:

(Id:218 Depth:7 Question:Is Right-Weight >= 3?)

--> True:

(Id:438 Depth:8 Question:Is Left-Distance >= 3?)

--> True:

(Id:878 Depth:9 Label:B)

--> False:

(Id:877 Depth:9 Label:R)

--> False:

(Id:437 Depth:8 Label:B)

--> False:

(Id:217 Depth:7 Question:Is Unnamed: 0 >= 434?)

--> True:

(Id:436 Depth:8 Question:Is Right-Weight >= 3?)

--> True:

(Id:874 Depth:9 Label:R)

--> False:

(Id:873 Depth:9 Label:L)

--> False:

(Id:435 Depth:8 Label:R)

--> False:

(Id:107 Depth:6 Label:L)

--> False:

(Id:25 Depth:4 Question:Is Right-Weight >= 3?)

--> True:

(Id:52 Depth:5 Question:Is Unnamed: 0 >= 360?)

--> True:

(Id:106 Depth:6 Question:Is Left-Distance >= 3?)

--> True:

(Id:214 Depth:7 Label:L)

--> False:

(Id:213 Depth:7 Question:Is Right-Distance >= 3?)

--> True:

(Id:428 Depth:8 Question:Is Left-Weight >= 5?)

--> True:

(Id:858 Depth:9 Question:Is Right-Distance >= 4?)

--> True:

(Id:1718 Depth:10 Label:R)

--> False:

(Id:1717 Depth:10 Label:L)

--> False:

(Id:857 Depth:9 Label:R)

--> False:

(Id:427 Depth:8 Label:L)

--> False:

(Id:105 Depth:6 Question:Is Right-Distance >= 3?)

--> True:

(Id:212 Depth:7 Question:Is Right-Distance >= 4?)

--> True:

(Id:426 Depth:8 Question:Is Left-Distance >= 4?)

--> True:

(Id:854 Depth:9 Label:B)

--> False:

(Id:853 Depth:9 Label:R)

--> False:

(Id:425 Depth:8 Label:B)

--> False:

(Id:211 Depth:7 Label:L)

--> False:

(Id:51 Depth:5 Question:Is Left-Distance >= 3?)

--> True:

(Id:104 Depth:6 Label:L)

--> False:

(Id:103 Depth:6 Question:Is Right-Distance >= 4?)

--> True:

(Id:208 Depth:7 Question:Is Right-Weight >= 2?)

--> True:

(Id:418 Depth:8 Label:B)

--> False:

(Id:417 Depth:8 Label:L)

--> False:

(Id:207 Depth:7 Label:L)

--> False:

(Id:11 Depth:3 Question:Is Right-Distance >= 3?)

--> True:

(Id:24 Depth:4 Question:Is Right-Weight >= 2?)

--> True:

(Id:50 Depth:5 Label:R)

--> False:

(Id:49 Depth:5 Question:Is Right-Distance >= 5?)

--> True:

(Id:100 Depth:6 Question:Is Left-Weight >= 5?)

--> True:

(Id:202 Depth:7 Label:B)

--> False:

(Id:201 Depth:7 Label:R)

--> False:

(Id:99 Depth:6 Label:L)

--> False:

(Id:23 Depth:4 Question:Is Right-Weight >= 3?)

--> True:

(Id:48 Depth:5 Question:Is Right-Distance >= 2?)

--> True:

(Id:98 Depth:6 Label:R)

--> False:

(Id:97 Depth:6 Label:L)

--> False:

(Id:47 Depth:5 Question:Is Right-Weight >= 2?)

--> True:

(Id:96 Depth:6 Question:Is Right-Distance >= 2?)

--> True:

(Id:194 Depth:7 Question:Is Left-Weight >= 5?)

--> True:

(Id:390 Depth:8 Label:L)

--> False:

(Id:389 Depth:8 Label:B)

--> False:

(Id:193 Depth:7 Label:L)

--> False:

(Id:95 Depth:6 Label:L)

--> False:

(Id:1 Depth:1 Question:Is Right-Weight >= 3?)

--> True:

(Id:4 Depth:2 Question:Is Right-Distance >= 2?)

--> True:

(Id:10 Depth:3 Question:Is Right-Distance >= 3?)

--> True:

(Id:22 Depth:4 Label:R)

--> False:

(Id:21 Depth:4 Question:Is Unnamed: 0 >= 186?)

--> True:

(Id:44 Depth:5 Question:Is Left-Distance >= 4?)

--> True:

(Id:90 Depth:6 Question:Is Right-Weight >= 5?)

--> True:

(Id:182 Depth:7 Question:Is Left-Distance >= 5?)

--> True:

(Id:366 Depth:8 Label:B)

--> False:

(Id:365 Depth:8 Label:R)

--> False:

(Id:181 Depth:7 Question:Is Right-Weight >= 4?)

--> True:

(Id:364 Depth:8 Question:Is Left-Distance >= 5?)

--> True:

(Id:730 Depth:9 Label:L)

--> False:

(Id:729 Depth:9 Label:B)

--> False:

(Id:363 Depth:8 Label:L)

--> False:

(Id:89 Depth:6 Question:Is Right-Weight >= 4?)

--> True:

(Id:180 Depth:7 Label:R)

--> False:

(Id:179 Depth:7 Question:Is Left-Distance >= 2?)

--> True:

(Id:360 Depth:8 Label:B)

--> False:

(Id:359 Depth:8 Label:R)

--> False:

(Id:43 Depth:5 Label:R)

--> False:

(Id:9 Depth:3 Question:Is Unnamed: 0 >= 85?)

--> True:

(Id:20 Depth:4 Question:Is Left-Distance >= 2?)

--> True:

(Id:42 Depth:5 Question:Is Unnamed: 0 >= 185?)

--> True:

(Id:86 Depth:6 Label:L)

--> False:

(Id:85 Depth:6 Question:Is Unnamed: 0 >= 120?)

--> True:

(Id:172 Depth:7 Label:B)

--> False:

(Id:171 Depth:7 Question:Is Right-Weight >= 5?)

--> True:

(Id:344 Depth:8 Label:R)

--> False:

(Id:343 Depth:8 Label:L)

--> False:

(Id:41 Depth:5 Label:R)

--> False:

(Id:19 Depth:4 Question:Is Left-Distance >= 3?)

--> True:

(Id:40 Depth:5 Question:Is Right-Weight >= 4?)

--> True:

(Id:82 Depth:6 Label:R)

--> False:

(Id:81 Depth:6 Label:B)

--> False:

(Id:39 Depth:5 Label:R)

--> False:

(Id:3 Depth:2 Question:Is Right-Distance >= 3?)

--> True:

(Id:8 Depth:3 Question:Is Unnamed: 0 >= 177?)

--> True:

(Id:18 Depth:4 Question:Is Right-Weight >= 2?)

--> True:

(Id:38 Depth:5 Question:Is Left-Distance >= 4?)

--> True:

(Id:78 Depth:6 Question:Is Right-Distance >= 5?)

--> True:

(Id:158 Depth:7 Label:R)

--> False:

(Id:157 Depth:7 Question:Is Right-Distance >= 4?)

--> True:

(Id:316 Depth:8 Question:Is Left-Distance >= 5?)

--> True:

(Id:634 Depth:9 Label:L)

--> False:

(Id:633 Depth:9 Label:B)

--> False:

(Id:315 Depth:8 Label:L)

--> False:

(Id:77 Depth:6 Question:Is Right-Distance >= 4?)

--> True:

(Id:156 Depth:7 Label:R)

--> False:

(Id:155 Depth:7 Question:Is Left-Distance >= 2?)

--> True:

(Id:312 Depth:8 Label:B)

--> False:

(Id:311 Depth:8 Label:R)

--> False:

(Id:37 Depth:5 Question:Is Left-Distance >= 2?)

--> True:

(Id:76 Depth:6 Label:L)

--> False:

(Id:75 Depth:6 Question:Is Right-Distance >= 4?)

--> True:

(Id:152 Depth:7 Label:R)

--> False:

(Id:151 Depth:7 Label:B)

--> False:

(Id:17 Depth:4 Question:Is Right-Weight >= 2?)

--> True:

(Id:36 Depth:5 Label:R)

--> False:

(Id:35 Depth:5 Question:Is Left-Distance >= 4?)

--> True:

(Id:72 Depth:6 Question:Is Right-Distance >= 5?)

--> True:

(Id:146 Depth:7 Question:Is Left-Distance >= 5?)

--> True:

(Id:294 Depth:8 Label:B)

--> False:

(Id:293 Depth:8 Label:R)

--> False:

(Id:145 Depth:7 Question:Is Right-Distance >= 4?)

--> True:

(Id:292 Depth:8 Question:Is Left-Distance >= 5?)

--> True:

(Id:586 Depth:9 Label:L)

--> False:

(Id:585 Depth:9 Label:B)

--> False:

(Id:291 Depth:8 Label:L)

--> False:

(Id:71 Depth:6 Question:Is Unnamed: 0 >= 152?)

--> True:

(Id:144 Depth:7 Question:Is Right-Distance >= 4?)

--> True:

(Id:290 Depth:8 Question:Is Right-Distance >= 5?)

--> True:

(Id:582 Depth:9 Label:R)

--> False:

(Id:581 Depth:9 Label:B)

--> False:

(Id:289 Depth:8 Label:L)

--> False:

(Id:143 Depth:7 Question:Is Left-Distance >= 3?)

--> True:

(Id:288 Depth:8 Question:Is Right-Distance >= 4?)

--> True:

(Id:578 Depth:9 Label:R)

--> False:

(Id:577 Depth:9 Label:B)

--> False:

(Id:287 Depth:8 Label:R)

--> False:

(Id:7 Depth:3 Question:Is Unnamed: 0 >= 50?)

--> True:

(Id:16 Depth:4 Question:Is Left-Distance >= 2?)

--> True:

(Id:34 Depth:5 Question:Is Right-Distance >= 2?)

--> True:

(Id:70 Depth:6 Question:Is Unnamed: 0 >= 181?)

--> True:

(Id:142 Depth:7 Label:L)

--> False:

(Id:141 Depth:7 Question:Is Right-Weight >= 2?)

--> True:

(Id:284 Depth:8 Question:Is Left-Distance >= 5?)

--> True:

(Id:570 Depth:9 Label:L)

--> False:

(Id:569 Depth:9 Label:B)

--> False:

(Id:283 Depth:8 Label:L)

--> False:

(Id:69 Depth:6 Label:L)

--> False:

(Id:33 Depth:5 Question:Is Left-Weight >= 3?)

--> True:

(Id:68 Depth:6 Question:Is Unnamed: 0 >= 256?)

--> True:

(Id:138 Depth:7 Label:R)

--> False:

(Id:137 Depth:7 Label:L)

--> False:

(Id:67 Depth:6 Label:B)

--> False:

(Id:15 Depth:4 Question:Is Right-Distance >= 2?)

--> True:

(Id:32 Depth:5 Label:R)

--> False:

(Id:31 Depth:5 Question:Is Unnamed: 0 >= 30?)

--> True:

(Id:64 Depth:6 Label:B)

--> False:

(Id:63 Depth:6 Question:Is Unnamed: 0 >= 5?)

--> True:

(Id:128 Depth:7 Question:Is Right-Weight >= 2?)

--> True:

(Id:258 Depth:8 Label:R)

--> False:

(Id:257 Depth:8 Label:L)

--> False:

(Id:127 Depth:7 Label:B)

Accuracy on test = 0.824

\*\*\*\*\*\*\*\*\*\*\*\*\* Start pruning \*\*\*\*\*\*\*

Initial accuracy:0.824

Test pruning id:888 -- accuracy:0.824

Prune 888 Success

Test pruning id:880 -- accuracy:0.824

Prune 880 Success

Test pruning id:870 -- accuracy:0.824

Prune 870 Success

Test pruning id:756 -- accuracy:0.824

Prune 756 Success

Test pruning id:748 -- accuracy:0.824

Prune 748 Success

Test pruning id:739 -- accuracy:0.824

Prune 739 Success

Test pruning id:506 -- accuracy:0.824

Prune 506 Success

Test pruning id:498 -- accuracy:0.824

Prune 498 Success

Test pruning id:483 -- accuracy:0.824

Prune 483 Success

Test pruning id:468 -- accuracy:0.824

Prune 468 Success

Test pruning id:443 -- accuracy:0.824

Prune 443 Success

Test pruning id:439 -- accuracy:0.824

Prune 439 Success

Test pruning id:434 -- accuracy:0.824

Prune 434 Success

Test pruning id:426 -- accuracy:0.824

Prune 426 Success

Test pruning id:388 -- accuracy:0.824

Prune 388 Success

Test pruning id:378 -- accuracy:0.824

Prune 378 Success

Test pruning id:377 -- accuracy:0.824

Prune 377 Success

Test pruning id:375 -- accuracy:0.824

Prune 375 Success

Test pruning id:373 -- accuracy:0.824

Prune 373 Success

Test pruning id:369 -- accuracy:0.824

Prune 369 Success

Test pruning id:353 -- accuracy:0.824

Prune 353 Success

Test pruning id:334 -- accuracy:0.824

Prune 334 Success

Test pruning id:326 -- accuracy:0.824

Prune 326 Success

Test pruning id:324 -- accuracy:0.824

Prune 324 Success

Test pruning id:322 -- accuracy:0.824

Prune 322 Success

Test pruning id:254 -- accuracy:0.824

Prune 254 Success

Test pruning id:253 -- accuracy:0.824

Prune 253 Success

Test pruning id:252 -- accuracy:0.824

Prune 252 Success

Test pruning id:250 -- accuracy:0.824

Prune 250 Success

Test pruning id:248 -- accuracy:0.824

Prune 248 Success

Test pruning id:247 -- accuracy:0.824

Prune 247 Success

Test pruning id:241 -- accuracy:0.824

Prune 241 Success

Test pruning id:233 -- accuracy:0.824

Prune 233 Success

Test pruning id:226 -- accuracy:0.824

Prune 226 Success

Test pruning id:221 -- accuracy:0.824

Prune 221 Success

Test pruning id:220 -- accuracy:0.824

Prune 220 Success

Test pruning id:219 -- accuracy:0.824

Prune 219 Success

Test pruning id:217 -- accuracy:0.824

Prune 217 Success

Test pruning id:216 -- accuracy:0.824

Prune 216 Success

Test pruning id:212 -- accuracy:0.824

Prune 212 Success

Test pruning id:200 -- accuracy:0.824

Prune 200 Success

Test pruning id:193 -- accuracy:0.824

Prune 193 Success

Test pruning id:190 -- accuracy:0.824

Prune 190 Success

Test pruning id:188 -- accuracy:0.824

Prune 188 Success

Test pruning id:187 -- accuracy:0.824

Prune 187 Success

Test pruning id:186 -- accuracy:0.824

Prune 186 Success

Test pruning id:184 -- accuracy:0.824

Prune 184 Success

Test pruning id:176 -- accuracy:0.824

Prune 176 Success

Test pruning id:166 -- accuracy:0.824

Prune 166 Success

Test pruning id:162 -- accuracy:0.824

Prune 162 Success

Test pruning id:161 -- accuracy:0.824

Prune 161 Success

Test pruning id:160 -- accuracy:0.824

Prune 160 Success

Test pruning id:156 -- accuracy:0.824

Prune 156 Success

Test pruning id:155 -- accuracy:0.824

Prune 155 Success

Test pruning id:126 -- accuracy:0.824

Prune 126 Success

Test pruning id:125 -- accuracy:0.824

Prune 125 Success

Test pruning id:124 -- accuracy:0.824

Prune 124 Success

Test pruning id:123 -- accuracy:0.832

Prune 123 Success

Test pruning id:121 -- accuracy:0.832

Prune 121 Success

Test pruning id:120 -- accuracy:0.84

Prune 120 Success

Test pruning id:117 -- accuracy:0.84

Prune 117 Success

Test pruning id:116 -- accuracy:0.84

Prune 116 Success

Test pruning id:112 -- accuracy:0.84

Prune 112 Success

Test pruning id:110 -- accuracy:0.84

Prune 110 Success

Test pruning id:109 -- accuracy:0.84

Prune 109 Success

Test pruning id:108 -- accuracy:0.84

Prune 108 Success

Test pruning id:107 -- accuracy:0.84

Prune 107 Success

Test pruning id:105 -- accuracy:0.848

Prune 105 Success

Test pruning id:100 -- accuracy:0.848

Prune 100 Success

Test pruning id:99 -- accuracy:0.848

Prune 99 Success

Test pruning id:96 -- accuracy:0.848

Prune 96 Success

Test pruning id:94 -- accuracy:0.848

Prune 94 Success

Test pruning id:93 -- accuracy:0.848

Prune 93 Success

Test pruning id:92 -- accuracy:0.848

Prune 92 Success

Test pruning id:91 -- accuracy:0.848

Prune 91 Success

Test pruning id:87 -- accuracy:0.848

Prune 87 Success

Test pruning id:83 -- accuracy:0.848

Prune 83 Success

Test pruning id:82 -- accuracy:0.848

Prune 82 Success

Test pruning id:80 -- accuracy:0.848

Prune 80 Success

Test pruning id:79 -- accuracy:0.848

Prune 79 Success

Test pruning id:77 -- accuracy:0.848

Prune 77 Success

Test pruning id:73 -- accuracy:0.848

Prune 73 Success

Test pruning id:72 -- accuracy:0.84

Prune 72 Fail

Test pruning id:66 -- accuracy:0.848

Prune 66 Success

Test pruning id:62 -- accuracy:0.848

Prune 62 Success

Test pruning id:61 -- accuracy:0.848

Prune 61 Success

Test pruning id:60 -- accuracy:0.848

Prune 60 Success

Test pruning id:59 -- accuracy:0.824

Prune 59 Fail

Test pruning id:58 -- accuracy:0.848

Prune 58 Success

Test pruning id:57 -- accuracy:0.848

Prune 57 Success

Test pruning id:55 -- accuracy:0.848

Prune 55 Success

Test pruning id:54 -- accuracy:0.848

Prune 54 Success

Test pruning id:53 -- accuracy:0.832

Prune 53 Fail

Test pruning id:52 -- accuracy:0.84

Prune 52 Fail

Test pruning id:51 -- accuracy:0.856

Prune 51 Success

Test pruning id:49 -- accuracy:0.856

Prune 49 Success

Test pruning id:47 -- accuracy:0.856

Prune 47 Success

Test pruning id:46 -- accuracy:0.856

Prune 46 Success

Test pruning id:45 -- accuracy:0.856

Prune 45 Success

Test pruning id:43 -- accuracy:0.856

Prune 43 Success

Test pruning id:41 -- accuracy:0.856

Prune 41 Success

Test pruning id:40 -- accuracy:0.856

Prune 40 Success

Test pruning id:39 -- accuracy:0.856

Prune 39 Success

Test pruning id:38 -- accuracy:0.848

Prune 38 Fail

Test pruning id:36 -- accuracy:0.856

Prune 36 Success

Test pruning id:35 -- accuracy:0.848

Prune 35 Fail

Test pruning id:34 -- accuracy:0.856

Prune 34 Success

Test pruning id:32 -- accuracy:0.856

Prune 32 Success

Test pruning id:31 -- accuracy:0.856

Prune 31 Success

Test pruning id:30 -- accuracy:0.856

Prune 30 Success

Test pruning id:29 -- accuracy:0.832

Prune 29 Fail

Test pruning id:28 -- accuracy:0.856

Prune 28 Success

Test pruning id:27 -- accuracy:0.856

Prune 27 Success

Test pruning id:26 -- accuracy:0.864

Prune 26 Success

Test pruning id:25 -- accuracy:0.856

Prune 25 Fail

Test pruning id:24 -- accuracy:0.864

Prune 24 Success

Test pruning id:23 -- accuracy:0.856

Prune 23 Fail

Test pruning id:22 -- accuracy:0.864

Prune 22 Success

Test pruning id:21 -- accuracy:0.856

Prune 21 Fail

Test pruning id:20 -- accuracy:0.864

Prune 20 Success

Test pruning id:19 -- accuracy:0.864

Prune 19 Success

Test pruning id:18 -- accuracy:0.856

Prune 18 Fail

Test pruning id:17 -- accuracy:0.856

Prune 17 Fail

Test pruning id:16 -- accuracy:0.872

Prune 16 Success

Test pruning id:15 -- accuracy:0.872

Prune 15 Success

Test pruning id:14 -- accuracy:0.832

Prune 14 Fail

Test pruning id:13 -- accuracy:0.88

Prune 13 Success

Test pruning id:12 -- accuracy:0.872

Prune 12 Fail

Test pruning id:11 -- accuracy:0.864

Prune 11 Fail

Test pruning id:10 -- accuracy:0.872

Prune 10 Fail

Test pruning id:9 -- accuracy:0.864

Prune 9 Fail

Test pruning id:8 -- accuracy:0.856

Prune 8 Fail

Test pruning id:7 -- accuracy:0.88

Prune 7 Success

Test pruning id:6 -- accuracy:0.776

Prune 6 Fail

Test pruning id:5 -- accuracy:0.848

Prune 5 Fail

Test pruning id:4 -- accuracy:0.856

Prune 4 Fail

Test pruning id:3 -- accuracy:0.784

Prune 3 Fail

Test pruning id:2 -- accuracy:0.768

Prune 2 Fail

Test pruning id:1 -- accuracy:0.76

Prune 1 Fail

Test pruning id:0 -- accuracy:0.392

Prune 0 Fail

\*\*\*\*\*\*\*\*\*\*\*\*\*Tree after pruning\*\*\*\*\*\*\*

(Id:0 Depth:0 Question:Is Unnamed: 0 >= 302?)

--> True:

(Id:2 Depth:1 Question:Is Right-Weight >= 4?)

--> True:

(Id:6 Depth:2 Question:Is Right-Distance >= 3?)

--> True:

(Id:14 Depth:3 Question:Is Unnamed: 0 >= 593?)

--> True:

(Id:30 Depth:4 Label:L)

--> False:

(Id:29 Depth:4 Question:Is Right-Distance >= 4?)

--> True:

(Id:60 Depth:5 Label:R)

--> False:

(Id:59 Depth:5 Question:Is Left-Distance >= 3?)

--> True:

(Id:120 Depth:6 Label:L)

--> False:

(Id:119 Depth:6 Label:R)

--> False:

(Id:13 Depth:3 Label:L)

--> False:

(Id:5 Depth:2 Question:Is Left-Distance >= 2?)

--> True:

(Id:12 Depth:3 Question:Is Right-Distance >= 5?)

--> True:

(Id:26 Depth:4 Label:L)

--> False:

(Id:25 Depth:4 Question:Is Right-Weight >= 3?)

--> True:

(Id:52 Depth:5 Question:Is Unnamed: 0 >= 360?)

--> True:

(Id:106 Depth:6 Question:Is Left-Distance >= 3?)

--> True:

(Id:214 Depth:7 Label:L)

--> False:

(Id:213 Depth:7 Question:Is Right-Distance >= 3?)

--> True:

(Id:428 Depth:8 Question:Is Left-Weight >= 5?)

--> True:

(Id:858 Depth:9 Question:Is Right-Distance >= 4?)

--> True:

(Id:1718 Depth:10 Label:R)

--> False:

(Id:1717 Depth:10 Label:L)

--> False:

(Id:857 Depth:9 Label:R)

--> False:

(Id:427 Depth:8 Label:L)

--> False:

(Id:105 Depth:6 Label:L)

--> False:

(Id:51 Depth:5 Label:L)

--> False:

(Id:11 Depth:3 Question:Is Right-Distance >= 3?)

--> True:

(Id:24 Depth:4 Label:R)

--> False:

(Id:23 Depth:4 Question:Is Right-Weight >= 3?)

--> True:

(Id:48 Depth:5 Question:Is Right-Distance >= 2?)

--> True:

(Id:98 Depth:6 Label:R)

--> False:

(Id:97 Depth:6 Label:L)

--> False:

(Id:47 Depth:5 Label:L)

--> False:

(Id:1 Depth:1 Question:Is Right-Weight >= 3?)

--> True:

(Id:4 Depth:2 Question:Is Right-Distance >= 2?)

--> True:

(Id:10 Depth:3 Question:Is Right-Distance >= 3?)

--> True:

(Id:22 Depth:4 Label:R)

--> False:

(Id:21 Depth:4 Question:Is Unnamed: 0 >= 186?)

--> True:

(Id:44 Depth:5 Question:Is Left-Distance >= 4?)

--> True:

(Id:90 Depth:6 Question:Is Right-Weight >= 5?)

--> True:

(Id:182 Depth:7 Question:Is Left-Distance >= 5?)

--> True:

(Id:366 Depth:8 Label:B)

--> False:

(Id:365 Depth:8 Label:R)

--> False:

(Id:181 Depth:7 Question:Is Right-Weight >= 4?)

--> True:

(Id:364 Depth:8 Question:Is Left-Distance >= 5?)

--> True:

(Id:730 Depth:9 Label:L)

--> False:

(Id:729 Depth:9 Label:B)

--> False:

(Id:363 Depth:8 Label:L)

--> False:

(Id:89 Depth:6 Question:Is Right-Weight >= 4?)

--> True:

(Id:180 Depth:7 Label:R)

--> False:

(Id:179 Depth:7 Question:Is Left-Distance >= 2?)

--> True:

(Id:360 Depth:8 Label:B)

--> False:

(Id:359 Depth:8 Label:R)

--> False:

(Id:43 Depth:5 Label:R)

--> False:

(Id:9 Depth:3 Question:Is Unnamed: 0 >= 85?)

--> True:

(Id:20 Depth:4 Label:L)

--> False:

(Id:19 Depth:4 Label:R)

--> False:

(Id:3 Depth:2 Question:Is Right-Distance >= 3?)

--> True:

(Id:8 Depth:3 Question:Is Unnamed: 0 >= 177?)

--> True:

(Id:18 Depth:4 Question:Is Right-Weight >= 2?)

--> True:

(Id:38 Depth:5 Question:Is Left-Distance >= 4?)

--> True:

(Id:78 Depth:6 Question:Is Right-Distance >= 5?)

--> True:

(Id:158 Depth:7 Label:R)

--> False:

(Id:157 Depth:7 Question:Is Right-Distance >= 4?)

--> True:

(Id:316 Depth:8 Question:Is Left-Distance >= 5?)

--> True:

(Id:634 Depth:9 Label:L)

--> False:

(Id:633 Depth:9 Label:B)

--> False:

(Id:315 Depth:8 Label:L)

--> False:

(Id:77 Depth:6 Label:R)

--> False:

(Id:37 Depth:5 Question:Is Left-Distance >= 2?)

--> True:

(Id:76 Depth:6 Label:L)

--> False:

(Id:75 Depth:6 Question:Is Right-Distance >= 4?)

--> True:

(Id:152 Depth:7 Label:R)

--> False:

(Id:151 Depth:7 Label:B)

--> False:

(Id:17 Depth:4 Question:Is Right-Weight >= 2?)

--> True:

(Id:36 Depth:5 Label:R)

--> False:

(Id:35 Depth:5 Question:Is Left-Distance >= 4?)

--> True:

(Id:72 Depth:6 Question:Is Right-Distance >= 5?)

--> True:

(Id:146 Depth:7 Question:Is Left-Distance >= 5?)

--> True:

(Id:294 Depth:8 Label:B)

--> False:

(Id:293 Depth:8 Label:R)

--> False:

(Id:145 Depth:7 Question:Is Right-Distance >= 4?)

--> True:

(Id:292 Depth:8 Question:Is Left-Distance >= 5?)

--> True:

(Id:586 Depth:9 Label:L)

--> False:

(Id:585 Depth:9 Label:B)

--> False:

(Id:291 Depth:8 Label:L)

--> False:

(Id:71 Depth:6 Question:Is Unnamed: 0 >= 152?)

--> True:

(Id:144 Depth:7 Question:Is Right-Distance >= 4?)

--> True:

(Id:290 Depth:8 Question:Is Right-Distance >= 5?)

--> True:

(Id:582 Depth:9 Label:R)

--> False:

(Id:581 Depth:9 Label:B)

--> False:

(Id:289 Depth:8 Label:L)

--> False:

(Id:143 Depth:7 Question:Is Left-Distance >= 3?)

--> True:

(Id:288 Depth:8 Question:Is Right-Distance >= 4?)

--> True:

(Id:578 Depth:9 Label:R)

--> False:

(Id:577 Depth:9 Label:B)

--> False:

(Id:287 Depth:8 Label:R)

--> False:

(Id:7 Depth:3 Label:L)

Accuracy on test = 0.88

**b) Summation of results and Details of Pruning Strategy**

**i) Summation of results**

In the output above, both driver.py and DecisionTree.py are implemented well with functions performing good. Here are the most import functions of this files:

1. Build Decision Tree
2. Traverse Decision Tree’s Leaf Nodes and Non-leaf Nodes and return them
3. Pruning Decision Tree using specific strategy
4. Computing accuracy

In both results, accuracy on test set increase after pruning procedure even tree sizes are considerably decreased.

**ii) Details of Pruning Strategy**

My pruning strategy is:

* 1. Sort all non-leaf nodes with respect to their id values from high to low
  2. Traverse the sorted nodes, and try cutting branch below each node. If test accuracy increases, cutting is successful, otherwise, it fails to cutting branch. Then start another try.

The main idea for pruning is that, ideally, we want to find a decision tree that performs best all data including those not in dataset. But it is impossible to do that, because we have limited data. One possible and seemingly likely method is looking for a decision tree that achieves highest accuracy on test set. But there are problems:

* 1. Even test data itself might have bias. With highest accuracy on test set doesn’t mean the model has such performance on generalization on other data. So it makes no sense to do so.
  2. Computational expense to looking for the global solution for subsets of nodes of pre-pruned decision tree is extremely high especially for large data set with many attributes and it grows exponentially.

Instead of looking for global optimization of test set, my strategy behaves similarly with greedy search. It prunes nodes of higher id values then lower, which means it cuts nodes deeper then shallower. Otherwise, the hypothesis boundary would shrink quickly at the mean time many possible hypotheses are missed. My strategy tries cutting small branches then large branches. And time for this strategy is linear.

**c) Assumptions**

1) Class of each instance is dependent on attributes we have in datasets.

2) The relationship between attributes of real number value and class is linear.