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Report ID3

Advantages and Disadvantages of your own program vs Weka

The advantages of using your own program are very clear:

• As the author you are able to understand every single detail of the implementation, which may give you insights into why some results are occurring.

• If a mistake is found in the way the program works, with direct access to the code a fix can be implemented immediately, contrary to a proprietary tool, where you have to submit a bug report to the developer and wait until he fixes the code.

• There are no licensing issues when using your own code in commercial applications.

• Access to the entire code base, allows you to custom set the implementation for the specific requirements of the environment the tool is going to be used.

• A code based tool is easier to integrate in a server environment, compared with a gui based tool.

On the other hand the disadvantages are the following

• An implementation like the one we just made might have bugs that haven't been found, due to limited testing.

- Commercial tools often have a lot of optimizations in order to provide the best performance possible, something that our naive implementation can't compete with.

- Weka has a lot more options for manipulating and using the data, from changing the algorithm used, to having a lot of tools for dealing with data.

- You can be reassured of the fact that the tool works properly.

- A lot more insight into the resulting tree, and the way it is structured.

- Integrated testing suite, in weka.

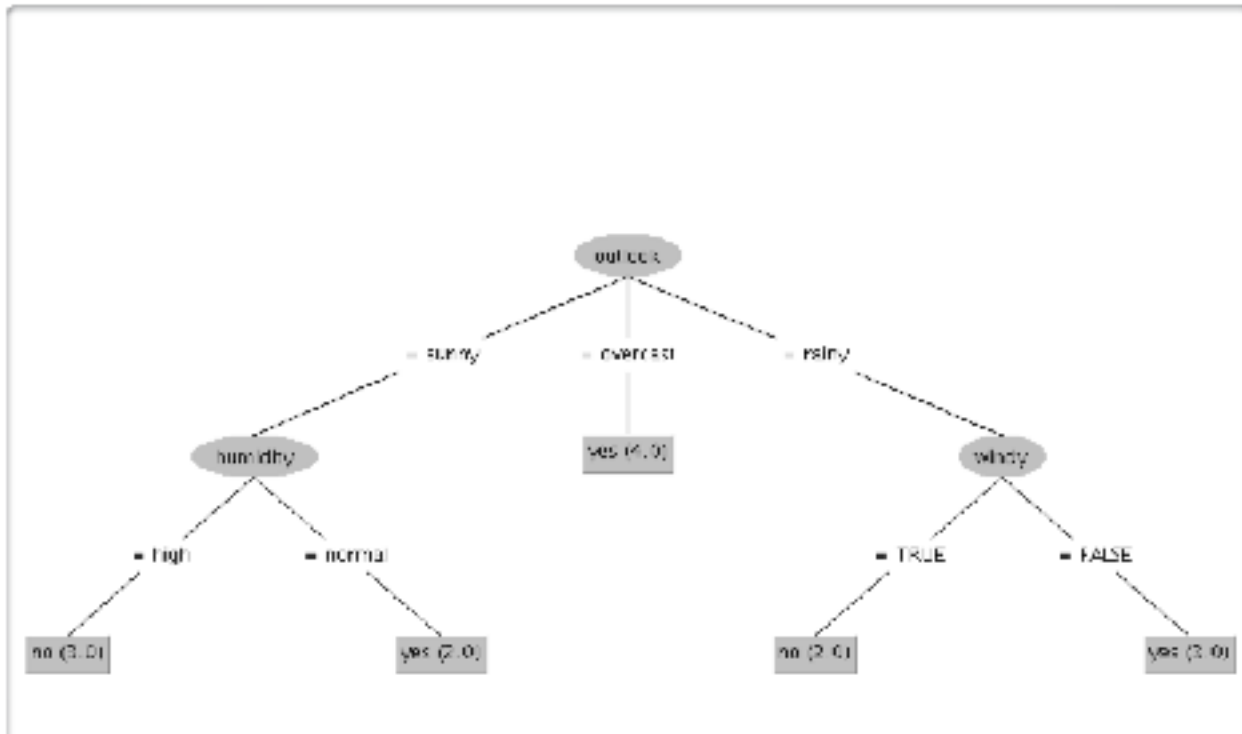- Package manager in weka, that allows you to expand its functionality.

Criteria Followed for Datasets

The dataset of cars was chosen due to the following characteristics:

- It was a data-set for a classification problem, something that decision trees excel at.

- The data was purely categorical, something that was crucial for the formation of our own decision tree, because our parser and implementation can only handle discrete values.

- The number of attributes was small, compared to the number of labeled input vectors.

- The input vectors, where relatively easy to clean regarding their discrepancies with their descriptions.

Graphics

Case 1

As we can see in this first example, both decision trees are exactly the same, and provide the same answers.

Case 2

In a more complex example such as the car classification, it is obvious that the Weka implementation is superior since the resulting tree is much shorter than the output of our program. This is because the use of better algorithms in this case J48 in the case of Weka, wich is an improvement and extension over the common ID3, we are using.

See the end of the document for the full trees

Where would you use decision trees?

I would mainly use them in the following scenarios, in the cases where a classification needs to be made, and the most influential factors in the final decision are well understood, and the decision tree is used only to optimize on top of those key metrics.

Full Tree Weka - J48 pruned tree

```
safety = low: unacc (576.0)
safety = med
|   persons = 2: unacc (192.0)
|   persons = 4
|   |   buying = vhigh
|   |   |   maint = vhigh: unacc (12.0)
|   |   |   maint = high: unacc (12.0)
|   |   |   maint = med
|   |   |   |   lug_boot = small: unacc (4.0)
|   |   |   |   lug_boot = med: unacc (4.0/2.0)
|   |   |   |   lug_boot = big: acc (4.0)
|   |   |   maint = low
|   |   |   |   lug_boot = small: unacc (4.0)
```

```
|   |   |   |   |       lug_boot = med: unacc (4.0/2.0)
|   |   |   |   |       lug_boot = big: acc (4.0)
|   |   buying = high
|   |   |       lug_boot = small: unacc (16.0)
|   |   |       lug_boot = med
|   |   |   |       doors = 2: unacc (4.0)
|   |   |   |       doors = 3: unacc (4.0)
|   |   |   |       doors = 4: acc (4.0/1.0)
|   |   |   |       doors = 5more: acc (4.0/1.0)
|   |   |       lug_boot = big
|   |   |   |       maint = vhigh: unacc (4.0)
|   |   |   |       maint = high: acc (4.0)
|   |   |   |       maint = med: acc (4.0)
|   |   |   |       maint = low: acc (4.0)
|   |   buying = med
|   |   |       maint = vhigh
|   |   |   |       lug_boot = small: unacc (4.0)
|   |   |   |       lug_boot = med: unacc (4.0/2.0)
|   |   |   |       lug_boot = big: acc (4.0)
|   |   |       maint = high
|   |   |   |       lug_boot = small: unacc (4.0)
|   |   |   |       lug_boot = med: unacc (4.0/2.0)
|   |   |   |       lug_boot = big: acc (4.0)
|   |   |       maint = med: acc (12.0)
|   |   |       maint = low
|   |   |   |       lug_boot = small: acc (4.0)
|   |   |   |       lug_boot = med: acc (4.0/2.0)
|   |   |   |       lug_boot = big: good (4.0)
|   |   buying = low
|   |   |       maint = vhigh
|   |   |   |       lug_boot = small: unacc (4.0)
|   |   |   |       lug_boot = med: unacc (4.0/2.0)
|   |   |   |       lug_boot = big: acc (4.0)
|   |   |       maint = high: acc (12.0)
|   |   |       maint = med
|   |   |   |       lug_boot = small: acc (4.0)
|   |   |   |       lug_boot = med: acc (4.0/2.0)
|   |   |   |       lug_boot = big: good (4.0)
|   |   |       maint = low
|   |   |   |       lug_boot = small: acc (4.0)
|   |   |   |       lug_boot = med: acc (4.0/2.0)
|   |   |   |       lug_boot = big: good (4.0)
|   persons = more
|   |   lug_boot = small
|   |   |       buying = vhigh: unacc (16.0)
|   |   |       buying = high: unacc (16.0)
```

```
|   |   |       buying = med
|   |   |   |       maint = vhigh: unacc (4.0)
|   |   |   |       maint = high: unacc (4.0)
|   |   |   |       maint = med: acc (4.0/1.0)
|   |   |   |       maint = low: acc (4.0/1.0)
|   |   |       buying = low
|   |   |   |       maint = vhigh: unacc (4.0)
|   |   |   |       maint = high: acc (4.0/1.0)
|   |   |   |       maint = med: acc (4.0/1.0)
|   |   |   |       maint = low: acc (4.0/1.0)
|   |   lug_boot = med
|   |   |       buying = vhigh
|   |   |   |       maint = vhigh: unacc (4.0)
|   |   |   |       maint = high: unacc (4.0)
|   |   |   |       maint = med: acc (4.0/1.0)
|   |   |   |       maint = low: acc (4.0/1.0)
|   |   |       buying = high
|   |   |   |       maint = vhigh: unacc (4.0)
|   |   |   |       maint = high: acc (4.0/1.0)
|   |   |   |       maint = med: acc (4.0/1.0)
|   |   |   |       maint = low: acc (4.0/1.0)
|   |   |       buying = med: acc (16.0/5.0)
|   |   |       buying = low
|   |   |   |       maint = vhigh: acc (4.0/1.0)
|   |   |   |       maint = high: acc (4.0)
|   |   |   |       maint = med: good (4.0/1.0)
|   |   |   |       maint = low: good (4.0/1.0)
|   |   lug_boot = big
|   |   |       buying = vhigh
|   |   |   |       maint = vhigh: unacc (4.0)
|   |   |   |       maint = high: unacc (4.0)
|   |   |   |       maint = med: acc (4.0)
|   |   |   |       maint = low: acc (4.0)
|   |   |       buying = high
|   |   |   |       maint = vhigh: unacc (4.0)
|   |   |   |       maint = high: acc (4.0)
|   |   |   |       maint = med: acc (4.0)
|   |   |   |       maint = low: acc (4.0)
|   |   |       buying = med
|   |   |   |       maint = vhigh: acc (4.0)
|   |   |   |       maint = high: acc (4.0)
|   |   |   |       maint = med: acc (4.0)
|   |   |   |       maint = low: good (4.0)
|   |   |       buying = low
|   |   |   |       maint = vhigh: acc (4.0)
|   |   |   |       maint = high: acc (4.0)
```

```
|   |   |   |     maint = med: good (4.0)
|   |   |   |     maint = low: good (4.0)
safety = high
|     persons = 2: unacc (192.0)
|     persons = 4
|   |     buying = vhigh
|   |   |     maint = vhigh: unacc (12.0)
|   |   |     maint = high: unacc (12.0)
|   |   |     maint = med: acc (12.0)
|   |   |     maint = low: acc (12.0)
|   |     buying = high
|   |   |     maint = vhigh: unacc (12.0)
|   |   |     maint = high: acc (12.0)
|   |   |     maint = med: acc (12.0)
|   |   |     maint = low: acc (12.0)
|   |     buying = med
|   |   |     maint = vhigh: acc (12.0)
|   |   |     maint = high: acc (12.0)
|   |   |     maint = med
|   |   |   |     lug_boot = small: acc (4.0)
|   |   |   |     lug_boot = med: acc (4.0/2.0)
|   |   |   |     lug_boot = big: vgood (4.0)
|   |   |     maint = low
|   |   |   |     lug_boot = small: good (4.0)
|   |   |   |     lug_boot = med: vgood (4.0/2.0)
|   |   |   |     lug_boot = big: vgood (4.0)
|   |     buying = low
|   |   |     maint = vhigh: acc (12.0)
|   |   |     maint = high
|   |   |   |     lug_boot = small: acc (4.0)
|   |   |   |     lug_boot = med: acc (4.0/2.0)
|   |   |   |     lug_boot = big: vgood (4.0)
|   |   |     maint = med
|   |   |   |     lug_boot = small: good (4.0)
|   |   |   |     lug_boot = med: vgood (4.0/2.0)
|   |   |   |     lug_boot = big: vgood (4.0)
|   |   |     maint = low
|   |   |   |     lug_boot = small: good (4.0)
|   |   |   |     lug_boot = med: vgood (4.0/2.0)
|   |   |   |     lug_boot = big: vgood (4.0)
|     persons = more
|   |     buying = vhigh
|   |   |     maint = vhigh: unacc (12.0)
|   |   |     maint = high: unacc (12.0)
|   |   |     maint = med: acc (12.0/1.0)
|   |   |     maint = low: acc (12.0/1.0)
```

```
|   |    buying = high
|   |   |    maint = vhigh: unacc (12.0)
|   |   |    maint = high: acc (12.0/1.0)
|   |   |    maint = med: acc (12.0/1.0)
|   |   |    maint = low: acc (12.0/1.0)
|   |    buying = med
|   |   |    maint = vhigh: acc (12.0/1.0)
|   |   |    maint = high: acc (12.0/1.0)
|   |   |    maint = med
|   |   |   |    lug_boot = small: acc (4.0/1.0)
|   |   |   |    lug_boot = med: vgood (4.0/1.0)
|   |   |   |    lug_boot = big: vgood (4.0)
|   |   |    maint = low
|   |   |   |    lug_boot = small: good (4.0/1.0)
|   |   |   |    lug_boot = med: vgood (4.0/1.0)
|   |   |   |    lug_boot = big: vgood (4.0)
|   |    buying = low
|   |   |    maint = vhigh: acc (12.0/1.0)
|   |   |    maint = high
|   |   |   |    lug_boot = small: acc (4.0/1.0)
|   |   |   |    lug_boot = med: vgood (4.0/1.0)
|   |   |   |    lug_boot = big: vgood (4.0)
|   |   |    maint = med
|   |   |   |    lug_boot = small: good (4.0/1.0)
|   |   |   |    lug_boot = med: vgood (4.0/1.0)
|   |   |   |    lug_boot = big: vgood (4.0)
|   |   |    maint = low
|   |   |   |    lug_boot = small: good (4.0/1.0)
|   |   |   |    lug_boot = med: vgood (4.0/1.0)
|   |   |   |    lug_boot = big: vgood (4.0)
```

Own Implementation of ID3

```
safety: low
  ANSWER: unacc
safety: med
  persons: 2
    ANSWER: unacc
  persons: 4
    buying: vhigh
      maint: vhigh
        ANSWER: unacc
      maint: high
        ANSWER: unacc
      maint: med
```

```
                    lug_boot: small
                      ANSWER: unacc
                    lug_boot: med
                      doors: 2
                        ANSWER: unacc
                      doors: 3
                        ANSWER: unacc
                      doors: 4
                        ANSWER: acc
                      doors: 5more
                        ANSWER: acc
                    lug_boot: big
                      ANSWER: acc
                  maint: low
                    lug_boot: small
                      ANSWER: unacc
                    lug_boot: med
                      doors: 2
                        ANSWER: unacc
                      doors: 3
                        ANSWER: unacc
                      doors: 4
                        ANSWER: acc
                      doors: 5more
                        ANSWER: acc
                    lug_boot: big
                      ANSWER: acc
                buying: high
                  lug_boot: small
                    ANSWER: unacc
                  lug_boot: med
                    doors: 2
                      ANSWER: unacc
                    doors: 3
                      ANSWER: unacc
                    doors: 4
                      maint: vhigh
                        ANSWER: unacc
                      maint: high
                        ANSWER: acc
                      maint: med
                        ANSWER: acc
                      maint: low
                        ANSWER: acc
                    doors: 5more
                      maint: vhigh
```

```
                ANSWER: unacc
           maint: high
             ANSWER: acc
           maint: med
             ANSWER: acc
           maint: low
             ANSWER: acc
       lug_boot: big
         maint: vhigh
           ANSWER: unacc
         maint: high
           ANSWER: acc
         maint: med
           ANSWER: acc
         maint: low
           ANSWER: acc
   buying: med
     maint: vhigh
       lug_boot: small
         ANSWER: unacc
       lug_boot: med
         doors: 2
           ANSWER: unacc
         doors: 3
           ANSWER: unacc
         doors: 4
           ANSWER: acc
         doors: 5more
           ANSWER: acc
       lug_boot: big
         ANSWER: acc
     maint: high
       lug_boot: small
         ANSWER: unacc
       lug_boot: med
         doors: 2
           ANSWER: unacc
         doors: 3
           ANSWER: unacc
         doors: 4
           ANSWER: acc
         doors: 5more
           ANSWER: acc
       lug_boot: big
         ANSWER: acc
     maint: med
```

```
            ANSWER: acc
      maint: low
        lug_boot: small
          ANSWER: acc
        lug_boot: med
          doors: 2
            ANSWER: acc
          doors: 3
            ANSWER: acc
          doors: 4
            ANSWER: good
          doors: 5more
            ANSWER: good
        lug_boot: big
          ANSWER: good
  buying: low
      maint: vhigh
        lug_boot: small
          ANSWER: unacc
        lug_boot: med
          doors: 2
            ANSWER: unacc
          doors: 3
            ANSWER: unacc
          doors: 4
            ANSWER: acc
          doors: 5more
            ANSWER: acc
        lug_boot: big
          ANSWER: acc
      maint: high
        ANSWER: acc
      maint: med
        lug_boot: small
          ANSWER: acc
        lug_boot: med
          doors: 2
            ANSWER: acc
          doors: 3
            ANSWER: acc
          doors: 4
            ANSWER: good
          doors: 5more
            ANSWER: good
        lug_boot: big
          ANSWER: good
```

```
            maint: low
              lug_boot: small
                ANSWER: acc
              lug_boot: med
                doors: 2
                  ANSWER: acc
                doors: 3
                  ANSWER: acc
                doors: 4
                  ANSWER: good
                doors: 5more
                  ANSWER: good
              lug_boot: big
                ANSWER: good
        persons: more
          buying: vhigh
            maint: vhigh
              ANSWER: unacc
            maint: high
              ANSWER: unacc
            maint: med
              lug_boot: small
                ANSWER: unacc
              lug_boot: med
                doors: 2
                  ANSWER: unacc
                doors: 3
                  ANSWER: acc
                doors: 4
                  ANSWER: acc
                doors: 5more
                  ANSWER: acc
              lug_boot: big
                ANSWER: acc
            maint: low
              lug_boot: small
                ANSWER: unacc
              lug_boot: med
                doors: 2
                  ANSWER: unacc
                doors: 3
                  ANSWER: acc
                doors: 4
                  ANSWER: acc
                doors: 5more
                  ANSWER: acc
```

```
                lug_boot: big
                  ANSWER: acc
        buying: high
          lug_boot: small
            ANSWER: unacc
          lug_boot: med
            doors: 2
              ANSWER: unacc
            doors: 3
              maint: vhigh
                ANSWER: unacc
              maint: high
                ANSWER: acc
              maint: med
                ANSWER: acc
              maint: low
                ANSWER: acc
            doors: 4
              maint: vhigh
                ANSWER: unacc
              maint: high
                ANSWER: acc
              maint: med
                ANSWER: acc
              maint: low
                ANSWER: acc
            doors: 5more
              maint: vhigh
                ANSWER: unacc
              maint: high
                ANSWER: acc
              maint: med
                ANSWER: acc
              maint: low
                ANSWER: acc
          lug_boot: big
            maint: vhigh
              ANSWER: unacc
            maint: high
              ANSWER: acc
            maint: med
              ANSWER: acc
            maint: low
              ANSWER: acc
        buying: med
          maint: vhigh
```

```
                    lug_boot: small
                      ANSWER: unacc
                    lug_boot: med
                      doors: 2
                        ANSWER: unacc
                      doors: 3
                        ANSWER: acc
                      doors: 4
                        ANSWER: acc
                      doors: 5more
                        ANSWER: acc
                    lug_boot: big
                      ANSWER: acc
                  maint: high
                    lug_boot: small
                      ANSWER: unacc
                    lug_boot: med
                      doors: 2
                        ANSWER: unacc
                      doors: 3
                        ANSWER: acc
                      doors: 4
                        ANSWER: acc
                      doors: 5more
                        ANSWER: acc
                    lug_boot: big
                      ANSWER: acc
                  maint: med
                    doors: 2
                      lug_boot: small
                        ANSWER: unacc
                      lug_boot: med
                        ANSWER: acc
                      lug_boot: big
                        ANSWER: acc
                    doors: 3
                      ANSWER: acc
                    doors: 4
                      ANSWER: acc
                    doors: 5more
                      ANSWER: acc
                  maint: low
                    lug_boot: small
                      doors: 2
                        ANSWER: unacc
                      doors: 3
```

```
                        ANSWER: acc
              doors: 4
                ANSWER: acc
              doors: 5more
                ANSWER: acc
          lug_boot: med
            doors: 2
              ANSWER: acc
            doors: 3
              ANSWER: good
            doors: 4
              ANSWER: good
            doors: 5more
              ANSWER: good
          lug_boot: big
            ANSWER: good
  buying: low
    maint: vhigh
      lug_boot: small
        ANSWER: unacc
      lug_boot: med
        doors: 2
          ANSWER: unacc
        doors: 3
          ANSWER: acc
        doors: 4
          ANSWER: acc
        doors: 5more
          ANSWER: acc
      lug_boot: big
        ANSWER: acc
    maint: high
      doors: 2
        lug_boot: small
          ANSWER: unacc
        lug_boot: med
          ANSWER: acc
        lug_boot: big
          ANSWER: acc
      doors: 3
        ANSWER: acc
      doors: 4
        ANSWER: acc
      doors: 5more
        ANSWER: acc
    maint: med
```

```
                    lug_boot: small
                      doors: 2
                        ANSWER: unacc
                      doors: 3
                        ANSWER: acc
                      doors: 4
                        ANSWER: acc
                      doors: 5more
                        ANSWER: acc
                    lug_boot: med
                      doors: 2
                        ANSWER: acc
                      doors: 3
                        ANSWER: good
                      doors: 4
                        ANSWER: good
                      doors: 5more
                        ANSWER: good
                    lug_boot: big
                      ANSWER: good
                  maint: low
                    lug_boot: small
                      doors: 2
                        ANSWER: unacc
                      doors: 3
                        ANSWER: acc
                      doors: 4
                        ANSWER: acc
                      doors: 5more
                        ANSWER: acc
                    lug_boot: med
                      doors: 2
                        ANSWER: acc
                      doors: 3
                        ANSWER: good
                      doors: 4
                        ANSWER: good
                      doors: 5more
                        ANSWER: good
                    lug_boot: big
                      ANSWER: good
            safety: high
              persons: 2
                ANSWER: unacc
              persons: 4
                buying: vhigh
```

```
            maint: vhigh
              ANSWER: unacc
            maint: high
              ANSWER: unacc
            maint: med
              ANSWER: acc
            maint: low
              ANSWER: acc
        buying: high
          maint: vhigh
              ANSWER: unacc
          maint: high
              ANSWER: acc
          maint: med
              ANSWER: acc
          maint: low
              ANSWER: acc
        buying: med
          maint: vhigh
              ANSWER: acc
          maint: high
              ANSWER: acc
          maint: med
            lug_boot: small
              ANSWER: acc
            lug_boot: med
              doors: 2
                ANSWER: acc
              doors: 3
                ANSWER: acc
              doors: 4
                ANSWER: vgood
              doors: 5more
                ANSWER: vgood
            lug_boot: big
              ANSWER: vgood
          maint: low
            lug_boot: small
              ANSWER: good
            lug_boot: med
              doors: 2
                ANSWER: good
              doors: 3
                ANSWER: good
              doors: 4
                ANSWER: vgood
```

```
                        doors: 5more
                          ANSWER: vgood
                  lug_boot: big
                    ANSWER: vgood
            buying: low
              maint: vhigh
                ANSWER: acc
              maint: high
                lug_boot: small
                  ANSWER: acc
                lug_boot: med
                  doors: 2
                    ANSWER: acc
                  doors: 3
                    ANSWER: acc
                  doors: 4
                    ANSWER: vgood
                  doors: 5more
                    ANSWER: vgood
                lug_boot: big
                  ANSWER: vgood
              maint: med
                lug_boot: small
                  ANSWER: good
                lug_boot: med
                  doors: 2
                    ANSWER: good
                  doors: 3
                    ANSWER: good
                  doors: 4
                    ANSWER: vgood
                  doors: 5more
                    ANSWER: vgood
                lug_boot: big
                  ANSWER: vgood
              maint: low
                lug_boot: small
                  ANSWER: good
                lug_boot: med
                  doors: 2
                    ANSWER: good
                  doors: 3
                    ANSWER: good
                  doors: 4
                    ANSWER: vgood
                  doors: 5more
```

```
                    ANSWER: vgood
            lug_boot: big
              ANSWER: vgood
        persons: more
          buying: vhigh
            maint: vhigh
              ANSWER: unacc
            maint: high
              ANSWER: unacc
            maint: med
              doors: 2
                lug_boot: small
                  ANSWER: unacc
                lug_boot: med
                  ANSWER: acc
                lug_boot: big
                  ANSWER: acc
              doors: 3
                ANSWER: acc
              doors: 4
                ANSWER: acc
              doors: 5more
                ANSWER: acc
            maint: low
              doors: 2
                lug_boot: small
                  ANSWER: unacc
                lug_boot: med
                  ANSWER: acc
                lug_boot: big
                  ANSWER: acc
              doors: 3
                ANSWER: acc
              doors: 4
                ANSWER: acc
              doors: 5more
                ANSWER: acc
          buying: high
            maint: vhigh
              ANSWER: unacc
            maint: high
              doors: 2
                lug_boot: small
                  ANSWER: unacc
                lug_boot: med
                  ANSWER: acc
```

```
                    lug_boot: big
                      ANSWER: acc
                doors: 3
                  ANSWER: acc
                doors: 4
                  ANSWER: acc
                doors: 5more
                  ANSWER: acc
            maint: med
                doors: 2
                    lug_boot: small
                      ANSWER: unacc
                    lug_boot: med
                      ANSWER: acc
                    lug_boot: big
                      ANSWER: acc
                doors: 3
                  ANSWER: acc
                doors: 4
                  ANSWER: acc
                doors: 5more
                  ANSWER: acc
            maint: low
                doors: 2
                    lug_boot: small
                      ANSWER: unacc
                    lug_boot: med
                      ANSWER: acc
                    lug_boot: big
                      ANSWER: acc
                doors: 3
                  ANSWER: acc
                doors: 4
                  ANSWER: acc
                doors: 5more
                  ANSWER: acc
        buying: med
            maint: vhigh
                doors: 2
                    lug_boot: small
                      ANSWER: unacc
                    lug_boot: med
                      ANSWER: acc
                    lug_boot: big
                      ANSWER: acc
                doors: 3
```

```
          ANSWER: acc
      doors: 4
        ANSWER: acc
      doors: 5more
        ANSWER: acc
    maint: high
      doors: 2
        lug_boot: small
          ANSWER: unacc
        lug_boot: med
          ANSWER: acc
        lug_boot: big
          ANSWER: acc
      doors: 3
        ANSWER: acc
      doors: 4
        ANSWER: acc
      doors: 5more
        ANSWER: acc
    maint: med
      lug_boot: small
        doors: 2
          ANSWER: unacc
        doors: 3
          ANSWER: acc
        doors: 4
          ANSWER: acc
        doors: 5more
          ANSWER: acc
      lug_boot: med
        doors: 2
          ANSWER: acc
        doors: 3
          ANSWER: vgood
        doors: 4
          ANSWER: vgood
        doors: 5more
          ANSWER: vgood
      lug_boot: big
        ANSWER: vgood
    maint: low
      lug_boot: small
        doors: 2
          ANSWER: unacc
        doors: 3
          ANSWER: good
```

```
                  doors: 4
                    ANSWER: good
                  doors: 5more
                    ANSWER: good
              lug_boot: med
                  doors: 2
                    ANSWER: good
                  doors: 3
                    ANSWER: vgood
                  doors: 4
                    ANSWER: vgood
                  doors: 5more
                    ANSWER: vgood
              lug_boot: big
                ANSWER: vgood
      buying: low
        maint: vhigh
            doors: 2
              lug_boot: small
                    ANSWER: unacc
              lug_boot: med
                    ANSWER: acc
              lug_boot: big
                    ANSWER: acc
            doors: 3
              ANSWER: acc
            doors: 4
              ANSWER: acc
            doors: 5more
              ANSWER: acc
        maint: high
          lug_boot: small
            doors: 2
                ANSWER: unacc
            doors: 3
              ANSWER: acc
            doors: 4
                ANSWER: acc
            doors: 5more
              ANSWER: acc
          lug_boot: med
            doors: 2
                ANSWER: acc
            doors: 3
                ANSWER: vgood
            doors: 4
```

```
              ANSWER: vgood
          doors: 5more
              ANSWER: vgood
        lug_boot: big
          ANSWER: vgood
    maint: med
      lug_boot: small
        doors: 2
          ANSWER: unacc
        doors: 3
          ANSWER: good
        doors: 4
          ANSWER: good
        doors: 5more
          ANSWER: good
      lug_boot: med
        doors: 2
          ANSWER: good
        doors: 3
          ANSWER: vgood
        doors: 4
          ANSWER: vgood
        doors: 5more
          ANSWER: vgood
      lug_boot: big
        ANSWER: vgood
    maint: low
      lug_boot: small
        doors: 2
          ANSWER: unacc
        doors: 3
          ANSWER: good
        doors: 4
          ANSWER: good
        doors: 5more
          ANSWER: good
      lug_boot: med
        doors: 2
          ANSWER: good
        doors: 3
          ANSWER: vgood
        doors: 4
          ANSWER: vgood
        doors: 5more
          ANSWER: vgood
      lug_boot: big
```

ANSWER: vgood