Artificial Intelligence – Lab Assignment 3

UNIZG FER, academic year 2014/15

Handed out: May 4 Due: May 17 at 23:59

The topic of this lab assignment are rule based systems. The task is to implement an expert system shell that enables inference using backward chaining of production rules. You can implement this task in a programming language of your choice.

Expert system shell

The expert system shell implements an inference engine that uses a knoweldge base (consisting of facts and rules) to derive new knowledge. The antecedent and consequent of each production rule consist of an arbitrary number of attribute-value pairs, conjoined with conjunctions. On the left hand side of a rule there can be more than one value for a given attribute; in that case a disjunction between such values is assumed. E.g.,

```
IF atr1 = v11 & atr2 = v21|v22 THEN atr3 = v3 & atr4 = v4
```

You need to represent the production rules in memory using a suitable data structure. You must also implement the generation of this structure from text representation (parsing). You should implement a conflict resolution strategy based on rule order and rule priorities. Each rule should have a numerical priority (salience) value assigned to it, which should be used for resolving conflicts. The rule with a greater priority value will have precedence over rules with a lower priority value. Additionally, if two rules have the same priority value, then precedence is given to the first listed rule.
At the very start, the user must specify the attribute whose value is to be derived. Queries about values of attributes that cannot be derived using the knowledge base alone are to be answered by the user during program execution. After starting, the program should print out the knowledge base (the rules and the facts). After each step, the program should print out the state of memory, the set of conflicting rules, and the identifiers of rules that fired.

Example

To check that the shell works correctly, use an expert system for determining the model of a car, described next. The system variables are as follows:

```
SuperClass    =  Road, SUV
Class         =  Road_small, Road_large,
                 Road_mid, SUV_small, SUV_large
Size          =  small, mid, large
OffRoad       =  yes, no
Sport         =  yes, no
Comfortable   =  high, mid, low
```

```
Power         =  high, mid, low
Tradition     =  long, mid, short
All4Drive     =  yes, no
Longevity     =  yes, no
Parts         =  yes, no
Warranty      =  long, short
Price         =  low, mid, high
Country       =  Japan, Korea, Romania,
                 Germany, Italy, France
Reliable      =  yes, no
Manufacturer  =  Toyota, Volkswagen, Peugeot, Citroen,
                 Mercedes, BMW, Opel, Alfa, Dacia,
                 Kia, Mazda, Nissan, Fiat
Model         =  Aygo, RAV4, LandCruiser, Up, 107,
                 308, C1, C2, C_Class, BMW_1,
                 BMW_3, Corsa, Astra, Insignia,
                 A_Class, Giulietta, Logan, Sandero,
                 Proceed, Rio, Mazda_3, Mazda_6, BMW_5,
                 BMW_X5, BMW_1, Mito, Bravo, Punto,
                 C5, Avensis, Corolla, Yaris,
                 Golf, Passat, Juke
```

The functionality of the expert system is based on the following 55 rules (these rules should be encoded in structures that you use to represent the rules, or read into the program from a text file, if you decide to implement a parser):

```
1   IF    OffRoad = yes
    THEN  SuperClass = SUV
2   IF    OffRoad = no
    THEN  SuperClass = Road
3   IF    SuperClass = Road & Size = large
    THEN  Class = Road_large
4   IF    SuperClass = Road & Size = small
    THEN  Class = Road_small
5   IF    SuperClass = Road & Size = mid
    THEN  Class = Road_mid
6   IF    SuperClass = SUV & Size = small
    THEN  Class = SUV_small
7   IF    SuperClass = SUV & All4Drive = da & Size = large
    THEN   Class = SUV_large
8   IF    Country = Japan & Reliable = da &
          Longevity = da & Price = mid
    THEN  Manufacturer = Toyota
9   IF    Country = Japan & Reliable = da & Price = high
    THEN  Manufacturer = Mazyes
10  IF    Country = Japan & Tradition = short & Parts = no
    THEN  Manufacturer = Nissan
11  IF    Country = Germany & Tradition = long &
          Parts = yes & Price = mid
    THEN  Manufacturer = Volkswagen
12  IF    Country = Germany & Tradition = mid & Comfortable = high
    THEN  Manufacturer = Opel
13  IF    Country = Germany & Tradition = long & Sport = da &
          Power = high & Price = high
    THEN  Manufacturer = BMW
```

```
14  IF    Country = Germany & Tradition = long &
          Comfortable = high & Parts = yes & Price = high
15  THEN  Manufacturer = Mercedes
16  IF    Country = France & Comfortable = high & Longevity = no
    THEN  Manufacturer = Citroen
17  IF    Country = France & Comfortable = high & Power = mid & Tradition = mid
    THEN  Manufacturer = Peugeot
19  IF    Country = Italy & Price = mid & Sport = yes
    THEN  Manufacturer = Alfa
20  IF    Country = Italy & Price = low & Parts = yes
    THEN  Manufacturer = Fiat
21  IF    Country = Italy & Price = low & Parts = yes
    THEN  Manufacturer = Fiat
22  IF    Country = Korea & Warranty = long
    THEN  Manufacturer = Kia
23  IF    Country = Romania & Longevity = ne & Price = low & Warranty = short
    THEN  Manufacturer = Dacia
24  IF    Manufacturer = Toyota & Class = Road_small
    THEN  Model = Aygo
25  IF    Manufacturer = Toyota & Class = Road_mid
    THEN  Model = Corolla
26  IF    Manufacturer = Toyota & Class = Road_large
    THEN  Model = Avensis
27  IF    Manufacturer = Toyota & Class = SUV_small
    THEN  Model = RAV4
28  IF    Manufacturer = Toyota & Class = SUV_large
    THEN  Model = LandCruiser
29  IF    Manufacturer = Mazda & Class = Road_mid
    THEN  Model = Mazda_3
30  IF    Manufacturer = Mazda & Class = Road_large
    THEN  Model = Mazda_6
31  IF    Manufacturer = Nissan & Class = SUV_small & All4Drive = yes
    THEN  Model = Juke
32  IF    Manufacturer = VolksWagen & Class = Road_mid
    THEN  Model = Golf
33  IF    Manufacturer = VolksWagen & Class = Road_small
    THEN  Model = Up
34  IF    Manufacturer = VolksWagen & Class = Road_large
    THEN  Model = Passat
35  IF    Manufacturer = Opel & Class = Road_mid
    THEN  Model = Astra
36  IF    Manufacturer = Opel & Class = Road_small
    THEN  Model = Corsa
37  IF    Manufacturer = Opel & Class = Road_large
    THEN  Model = Insignia
38  IF    Manufacturer = Mercedes & Class = Road_small
    THEN  Model = A_Class
39  IF    Manufacturer = Mercedes & Class = Road_mid
    THEN  Model = C_Class
40  IF    Manufacturer = BMW & Class = Road_small
    THEN  Model = BMW_1
41  IF    Manufacturer = BMW & Class = Road_large
    THEN  Model = BMW_5
42  IF    Manufacturer = Mercedes & Class = SUV_large
    THEN  Model = BMW_X5
```

```
43  IF    Manufacturer = Fiat & Class = Road_mid
    THEN  Model = Bravo
44  IF    Manufacturer = Fiat & Class = Road_small
    THEN  Model = Punto
45  IF    Manufacturer = Alfa & Class = Road_mid
    THEN  Model = Giulietta
46  IF    Manufacturer = Fiat & Class = Road_small
    THEN  Model = Mito
47  IF    Manufacturer = Citroen & Class = Road_small & Sport = yes
    THEN  Model = C2
48  IF    Manufacturer = Citroen & Class = Road_small & Sport = no
    THEN  Model = C1
49  IF    Manufacturer = Citroen & Class = Road_large
    THEN  Model = C5
50  IF    Manufacturer = Dacia & Class = Road_mid
    THEN  Model = Logan
51  IF    Manufacturer = Dacia & Class = SUV_small
    THEN  Model = Sandero
52  IF    Manufacturer = Peugeout & Class = Road_mid
    THEN  Model = 308
53  IF    Manufacturer = Peugeout & Class = Road_small
    THEN  Model = 107
54  IF    Manufacturer = Kia & Class = Road_mid & Sport = yes
    THEN  Model = Proceed
55  IF    Manufacturer = Kia & Class = Road_mid & Sport = no
    THEN  Model = Rio
```