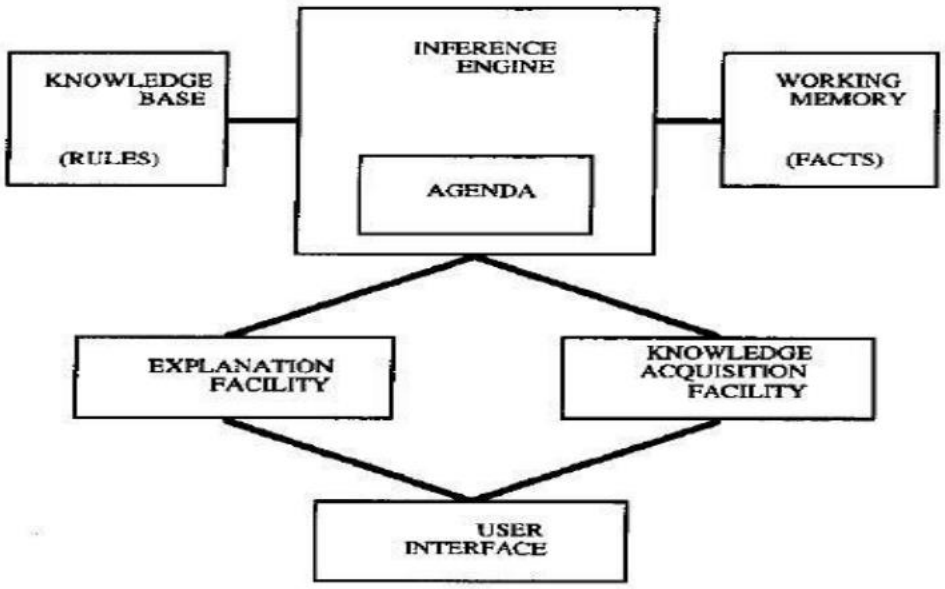
Section 2

CLIPS Language

- CLIPS is a tool for building expert systems.
- C Language Implementation Production System.
- Production system: computer system that relies on facts and rules to guide its decision making.
- Originally developed by the Software Technology Branch (STB) at **NASA** Johnson Space Center First release in 1986.
- CLIPS is case-sensitive.
- Each CLIPS command must have a matching number of left and right parentheses.

Elements of an Expert System (main components of ES from CLIPS:



- **Knowledge acquisition facility: automatic** way for the user to enter knowledge in the system bypassing the explicit coding by knowledge engineer.
- **Working memory:** global database of facts used by rules.
- **Inference engine:** makes inferences deciding which rules are satisfied and prioritizing.
  - ➢ **Agenda:** a prioritized list of rules created by the inference engine, whose patterns are satisfied by facts or objects in working memory.
- **Exploration facility:** explains reasoning of expert system to user.
- **User interface:** mechanism by which user and system communicate

Basic element of an Expert System in clips:

- Fact-list: Global memory for data
- Knowledge-base: Contain all the rules.
- Inference Engine: Control overall execution

Some command in CLIPS:

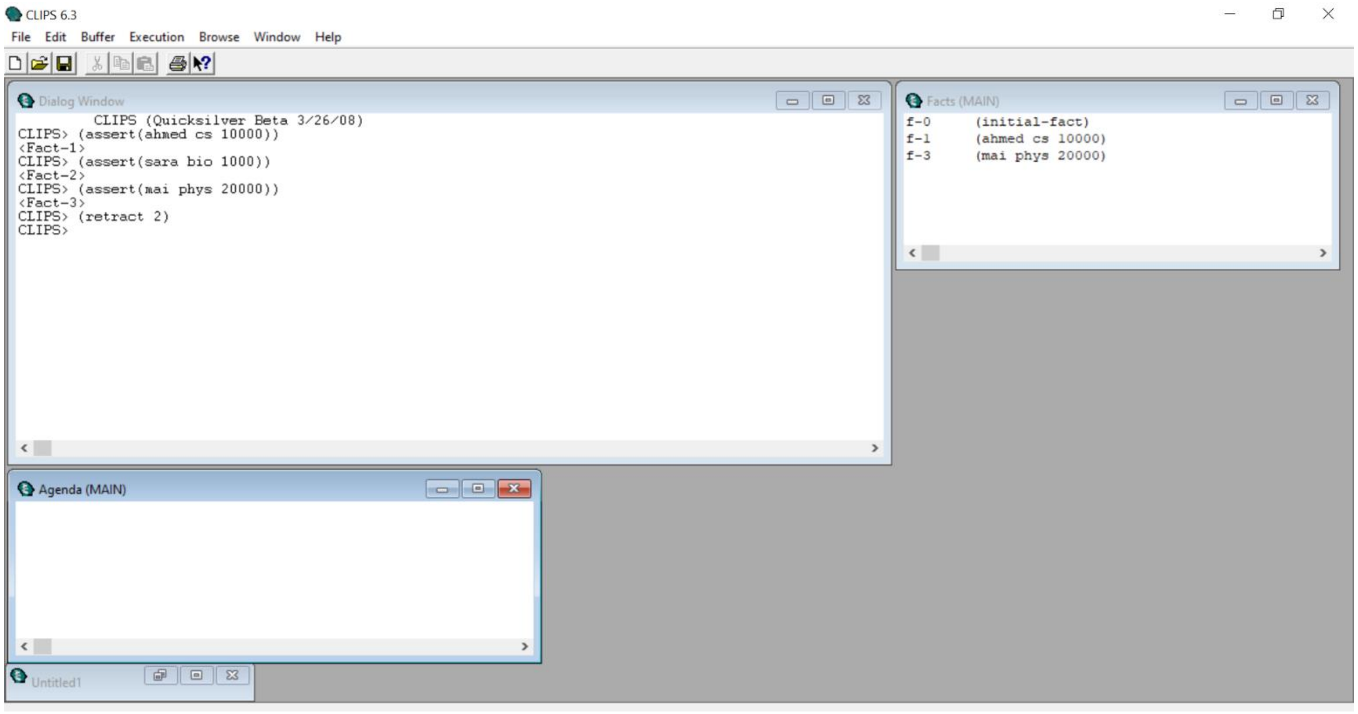
- CLIPS> Commands can be entered directly to CLIPS; this mode is called the top level.
- (exit) → to exit CLIPS program.
- (reset) → is the key method for starting or restarting.
- (run) → to let the program run and applies rules
- (clear) → clears the CLIPS environment and adds the *initialfact-deffacts* to the CLIPS environment.
- (retract <fact-index>+) → to remove fact.

Arithmetic operators:

- Examples:
  - 3 + 4 → (+ 3 4)
  - (3*4) + (5*6) → (+ (* 3 4) (* 5 6))
  - (x > 50 & y < 30)→ (and (> x 50) (< y 30)

Facts

- Fact Assertion
  - (assert<fact>)

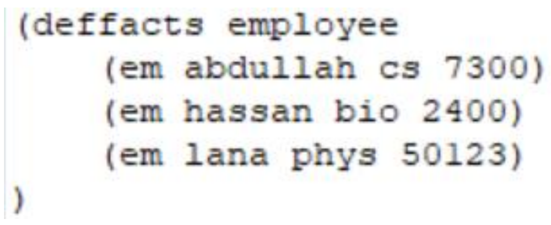


```
         CLIPS (Quicksilver Beta 3/26/08)
CLIPS> (assert(ahmed cs 10000))
<Fact-1>
CLIPS> (assert(sara bio 1000))
<Fact-2>
CLIPS> (assert(mai phys 20000))
<Fact-3>
CLIPS> (retract 2)
CLIPS>
```

```
f-0     (initial-fact)
f-1     (ahmed cs 10000)
f-3     (mai phys 20000)
```

deffacts

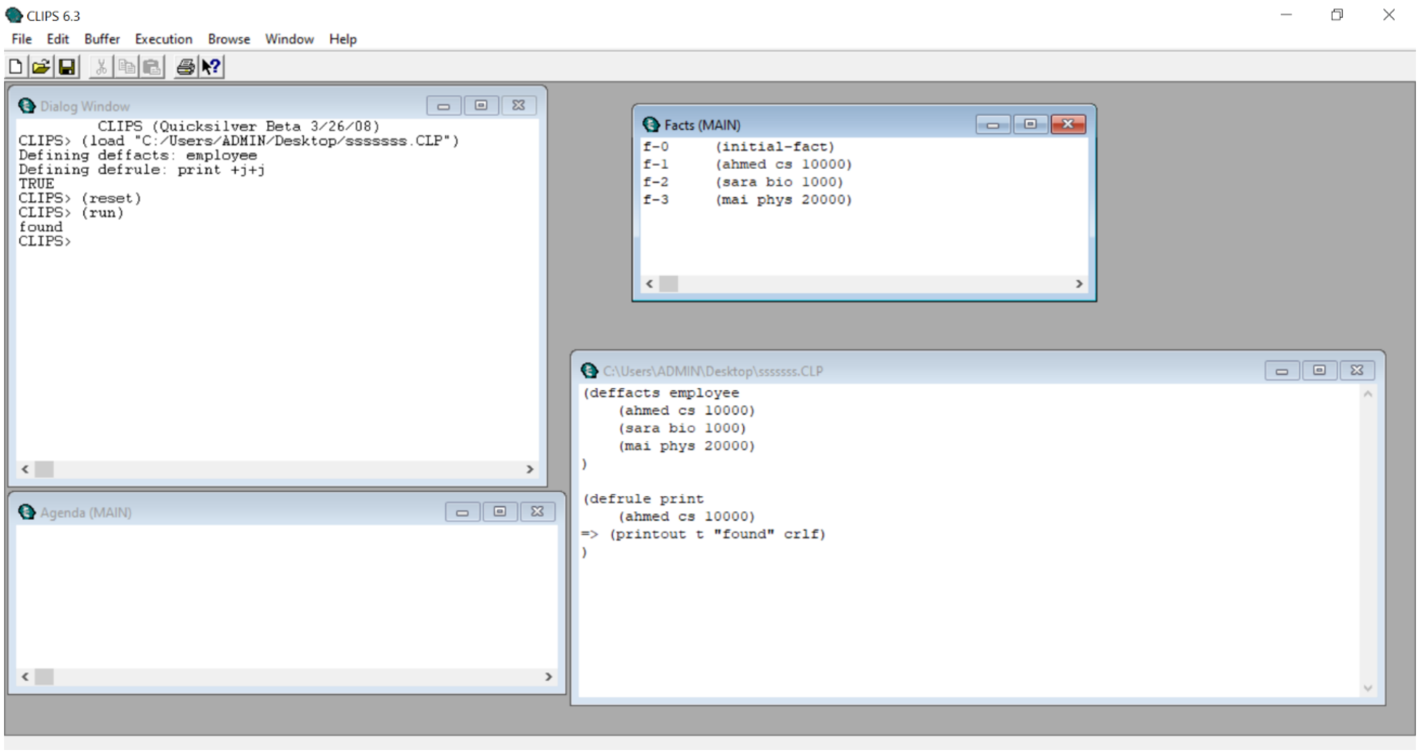
- The general format of a deffacts is: (deffacts<deffacts-name>[”optional comment”]<facts> *)



```
(deffacts employee
     (em abdullah cs 7300)
     (em hassan bio 2400)
     (em lana phys 50123)
)
```

defrule

- (defrule <rule-name>[“comment”]
  <pattern>*; Left-Hand Side (LHS) of the rule
  =>
  <actions>*; Right-Hand Side (RHS) of the rule



CLIPS 6.3
File Edit Buffer Execution Browse Window Help
Dialog Window
Facts (MAIN)
C:\Users\ADMIN\Desktop\sssssss.CLP
Agenda (MAIN)

```
         CLIPS (Quicksilver Beta 3/26/08)
CLIPS> (load "C:/Users/ADMIN/Desktop/sssssss.CLP")
Defining deffacts: employee
Defining defrule: print +j+j
TRUE
CLIPS> (reset)
CLIPS> (run)
found
CLIPS>
```

```
f-0     (initial-fact)
f-1     (ahmed cs 10000)
f-2     (sara bio 1000)
f-3     (mai phys 20000)
```

```
(deffacts employee
    (ahmed cs 10000)
    (sara bio 1000)
    (mai phys 20000)
)

(defrule print
    (ahmed cs 10000)
=> (printout t "found" crlf)
)
```

)

Examples:

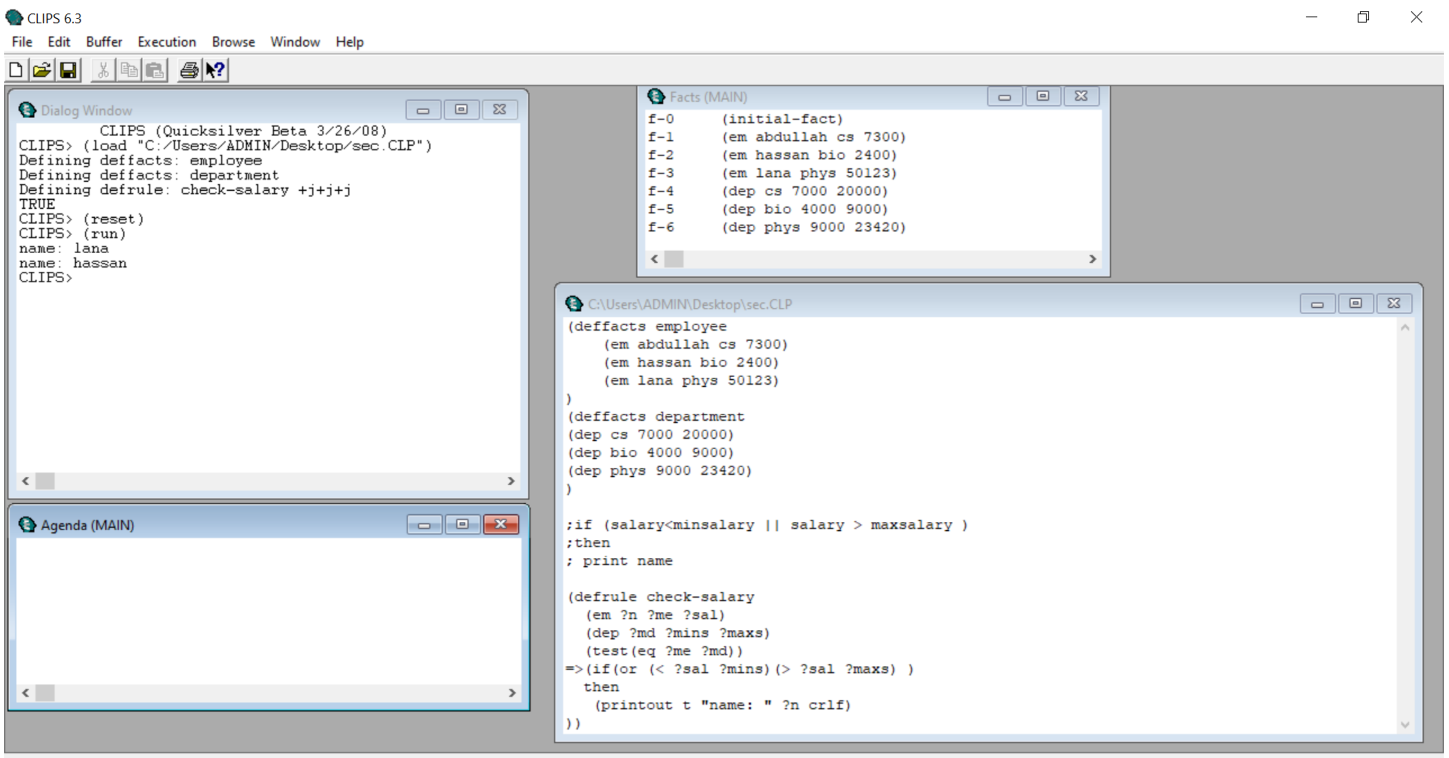
Represents the below facts in Knowledge base and find out how miss the rage of the salary accourding to employee major.

Major	Minimum salary	Maximum Salary
Computer Science	7000	20000
Biology	4000	9000
Physics	9000	23420

Name	Major	Salary
Abdullah	Computer Science	7300
Hassan	Biology	2400
Lana	Physics	50123

Who has more or less than regular salary the output should be look like this

<u>Answer:</u>


CLIPS 6.3
File Edit Buffer Execution Browse Window Help
Dialog Window
Facts (MAIN)
C:\Users\ADMIN\Desktop\sec.CLP
Agenda (MAIN)

```
         CLIPS (Quicksilver Beta 3/26/08)
CLIPS> (load "C:/Users/ADMIN/Desktop/sec.CLP")
Defining deffacts: employee
Defining deffacts: department
Defining defrule: check-salary +j+j+j
TRUE
CLIPS> (reset)
CLIPS> (run)
name: lana
name: hassan
CLIPS>
```

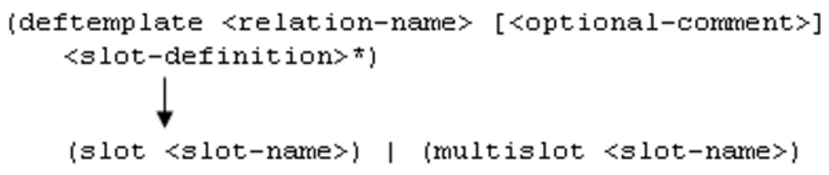
```
f-0     (initial-fact)
f-1     (em abdullah cs 7300)
f-2     (em hassan bio 2400)
f-3     (em lana phys 50123)
f-4     (dep cs 7000 20000)
f-5     (dep bio 4000 9000)
f-6     (dep phys 9000 23420)
```

```
(deffacts employee
    (em abdullah cs 7300)
    (em hassan bio 2400)
    (em lana phys 50123)
)
(deffacts department
(dep cs 7000 20000)
(dep bio 4000 9000)
(dep phys 9000 23420)
)

;if (salary<minsalary || salary > maxsalary )
;then
; print name

(defrule check-salary
  (em ?n ?me ?sal)
  (dep ?md ?mins ?maxs)
  (test(eq ?me ?md))
=>(if(or (< ?sal ?mins)(> ?sal ?maxs) )
  then
   (printout t "name: " ?n crlf)
))
```

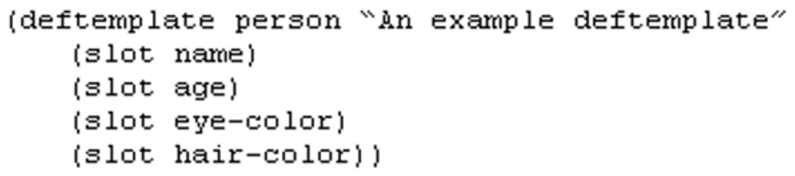
Section 3

Deftemplate

- is used to describe groups of facts sharing the same relation's name and contain common information.
- General format

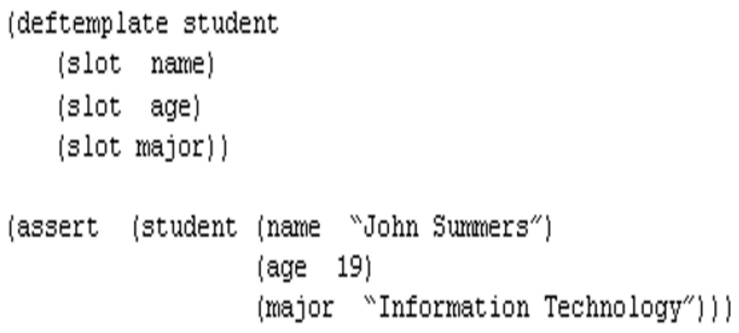


```
(deftemplate <relation-name> [<optional-comment>]
   <slot-definition>*)
        ↓
   (slot <slot-name>) | (multislot <slot-name>)
```



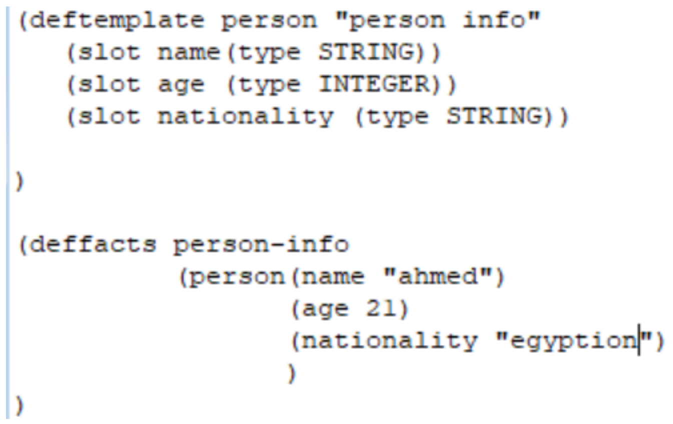
```
(deftemplate person "An example deftemplate"
   (slot name)
   (slot age)
   (slot eye-color)
   (slot hair-color))
```

- **CLIPS store all template facts known to it <u>in a fact list.</u>**
- **To add a fact to the list, we use the *assert* command.**



```
(deftemplate student
   (slot  name)
   (slot  age)
   (slot major))

(assert  (student (name  "John Summers")
                  (age  19)
                  (major  "Information Technology")))
```

- **To add a fact to the list, we use deffacts.**



```
(deftemplate person "person info"
   (slot name(type STRING))
   (slot age (type INTEGER))
   (slot nationality (type STRING))

)

(deffacts person-info
          (person(name "ahmed")
                 (age 21)
                 (nationality "egyption")
                 )
)
```

Fields

- Basic data type
- There are eight types of fields, also called the CLIPS primitive data types:
    - FLOAT
    - INTEGER
    - STRING
    - Symbols
    - External address
    - Fact address
    - Instance name
    - Instance address
- CLIPS is case-sensitive.

Variables

- Single field slot
    - ?var
    - **?**name (e.g. “amr”)
- Multi field slot
    - $?var
    - **$?**name (e.g., “amr ahmed”)

bind

- Associate symbols
- (bind ?percent (random 1 100))

Example:
CLIPS 2

Section 5

Deffunction

- **syntax**

  (deffunction <name> [<comment>]
  (<regular-parameter>* [<wildcard-parameter>])
  <action>*>)

  - **< regular-parameter > → <single-field-variable>**
  - **< wildcard-parameter> → <single-field-variable>**

Decision Tree

A tree is a hierarchical data structure consisting of:

- Nodes – store information
- Branches – connect the nodes
- The top node is the root, occupying the highest hierarchy.
- The leaves are at the bottom, occupying the lowest hierarchy.
- Every node, except the root, has exactly one parent.
- Every node may give rise to zero or more child nodes.
- A binary tree restricts the number of children per node to a maximum of two.

Examples:

R1: if animal isn't very big and doesn't have squeak

Then animal is squirrel

R2: if animal isn't very big and have squeak

Then animal is mouse

R3: if animal is very big and have long neck

Then animal is giraffe

R4: if animal is very big, doesn't have long neck and have a trunk

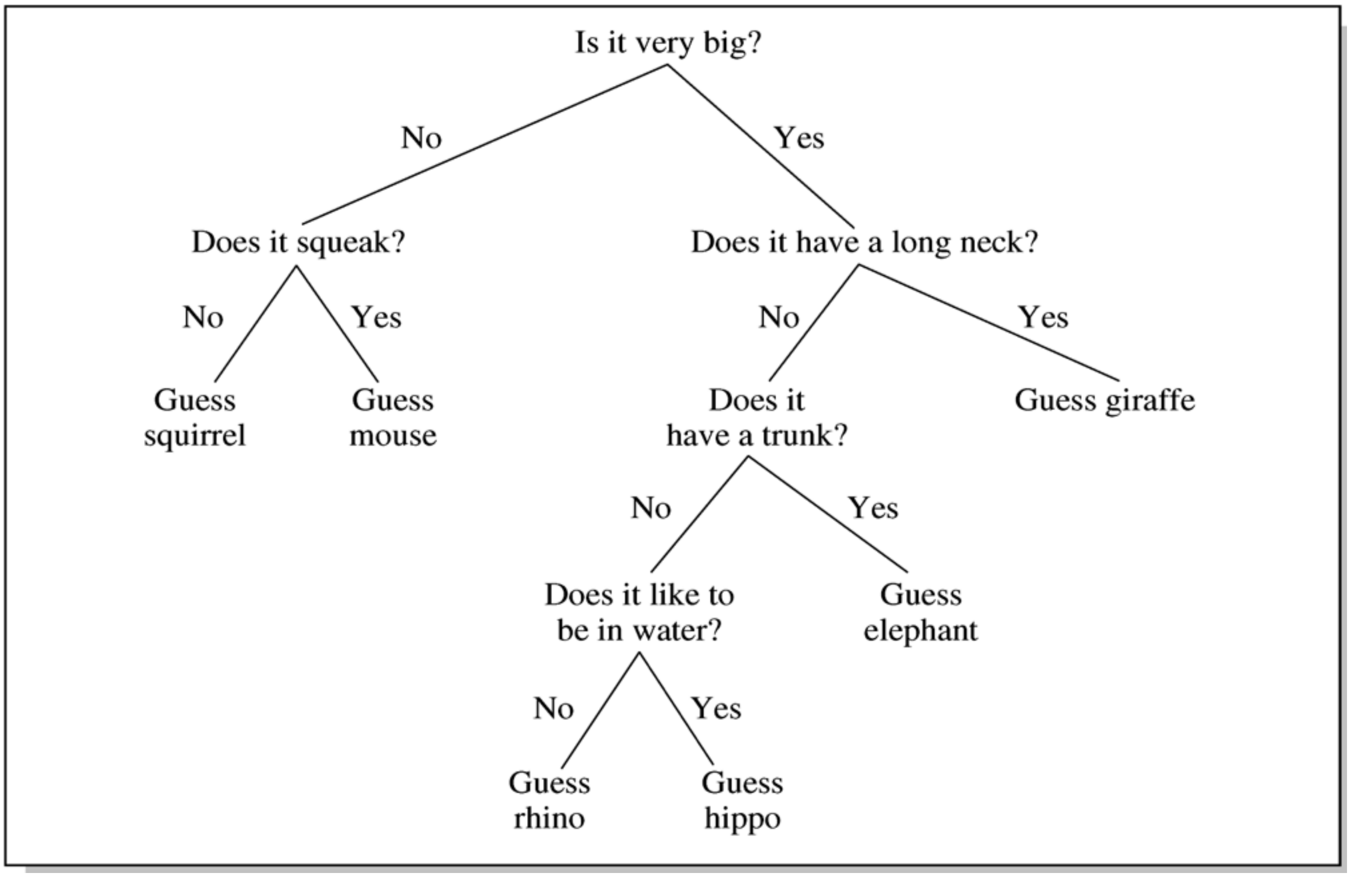
Then animal is elephant

R5: if animal is very big, doesn't have long neck, doesn't have a trunk and it like to be in water

Then animal is hippo

R6: if animal is very big, doesn't have long neck, doesn't have a trunk and doesn't it like to be in water

Then animal is rhino


Is it very big?
No
Yes
Does it squeak?
Does it have a long neck?
No
Yes
Guess squirrel
Guess mouse
No
Yes
Does it have a trunk?
Guess giraffe
No
Yes
Does it like to be in water?
Guess elephant
No
Yes
Guess rhino
Guess hippo

Examples:

R1: if the car starter is turning and you have petrol

Then call provider

R2: if the car starter is turning and no petrol in car

Then buy petrol

R3: if the car starter is not turning and lights are working and sole is clicked and terminals is clean

Then replace starter

R4: if the car starter is not turning and lights are working and sole is clicked and terminals isn't clean

Then clean terminals

R5: if the car starter is not turning and lights aren't working

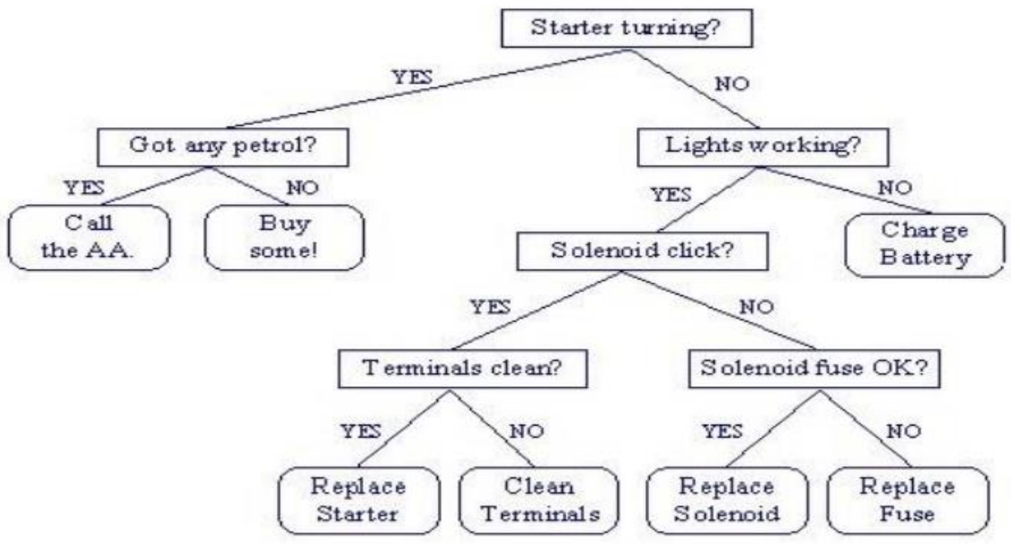
Then change battery

R6: if the car starter is not turning and lights are working and sole isn't clicked and fuse isn't working

Then replace fuse

R7: if the car starter is not turning and lights are working and sole isn't clicked and fuse is working

Then replace solenoid


Starter turning?
YES
NO
Got any petrol?
YES
NO
Call the AA.
Buy some!
Lights working?
YES
NO
Charge Battery
Solenoid click?
YES
NO
Terminals clean?
YES
NO
Replace Starter
Clean Terminals
Solenoid fuse OK?
YES
NO
Replace Solenoid
Replace Fuse