## CS4244 Knowledge-based Systems – 2015/2016 Semester 2
## Programming Assignment (due on Sunday, 28 February 2016, 11.59pm).

Question 5 of the study suggestion on pp.97-99 of the Textbook is attached for your reference. A sample program **diagnosis.clp** has been adapted from the CLIPS code given in question 5 and uploaded to IVLE. Program **diagnosis.clp** does not behave like what an expert system is supposed to be. First it requires the user to first tell the system all the symptoms present (i.e. to tell the symptoms beforehand). It will then ask: "Where is the pain?" and give a conclusion based on the site of pain and the symptoms present. Secondly, **diagnosis.clp** only runs for one session. To run it again, the user has to reset and repeat as before. Finally, if **diagnosis.clp** cannot find the diagnosis, it simply returns to the question "Where is the pain?"

For this assignment, modify **diagnosis.clp** and name it **XXXX.clp** (where XXXX is your name) to address the above problems. Thus instead of requiring the user to tell the symptoms, your program will now ask for the symptoms present according to the site of pain. Note that if the symptom is associated with an organ, it will name that organ. Refer to the study suggestion for hints in modifying the program. A 'question' template as suggested in the hints has already been added in **diagnosis.clp**. Your program should also allow multiple sessions until you stop the program. Moreover, if the program cannot diagnose the disease, it will respond by saying: "Sorry, I am not able to diagnose your disease!". Sample sessions with **diagnosis.clp** and a model program are shown below.

---

```
CLIPS> (clear)
CLIPS> (load "diagnosis.CLP")
TRUE
CLIPS> (reset)
CLIPS> (assert (sign (symptom fever))
               (sign (symptom diarrhea)))
<Fact-3>
CLIPS> (run)
Where is the pain? (1.Lower; 2.Upper; 3.Upper-Right; Others: stop) 1
My diagnosis: inflammation of small-intestine.
CLIPS> (reset)
CLIPS> (assert (sign (symptom diarrhea))
               (sign (symptom nausea)))
<Fact-3>
CLIPS> (run)
Where is the pain? (1.Lower; 2.Upper; 3.Upper-Right; Others: stop) 1
My diagnosis: ulceration of large-intestine.
CLIPS> (reset)
CLIPS> (assert (sign (symptom poor-appetite))
               (sign (symptom weight-loss)))
<Fact-3>
CLIPS> (run)
Where is the pain? (1.Lower; 2.Upper; 3.Upper-Right; Others: stop) 2
My diagnosis: tumor of stomach.
CLIPS> (reset)
CLIPS> (assert (sign (symptom weight-loss)))
<Fact-2>
CLIPS> (run)
Where is the pain? (1.Lower; 2.Upper; 3.Upper-Right; Others: stop) 2
```

```
Where is the pain? (1.Lower; 2.Upper; 3.Upper-Right; Others: stop) 5
CLIPS>
CLIPS> (clear)
CLIPS> (load "model.CLP")
TRUE
CLIPS> (reset)
CLIPS> (run)
Where is the pain? (1.Lower; 2.Upper; 3.Upper-Right; Others: stop) 1
Do you have diarrhea? (Y/y or N/n) Y
Do you have fever? (Y/y or N/n) Y

My diagnosis: inflammation of small-intestine.

Do you want to run this program again? (Y/y or N/n) Y
**************************************

Where is the pain? (1.Lower; 2.Upper; 3.Upper-Right; Others: stop) 1
Do you have diarrhea? (Y/y or N/n) y
Do you have fever? (Y/y or N/n) n
Do you have nausea? (Y/y or N/n) y

My diagnosis: ulceration of large-intestine.

Do you want to run this program again? (Y/y or N/n) y
**************************************

Where is the pain? (1.Lower; 2.Upper; 3.Upper-Right; Others: stop) 2
Do you have weight-loss? (Y/y or N/n) y
Do you have poor-appetite? (Y/y or N/n) y

My diagnosis: tumor of stomach.

Do you want to run this program again? (Y/y or N/n) y
**************************************

Where is the pain? (1.Lower; 2.Upper; 3.Upper-Right; Others: stop) 2
Do you have weight-loss? (Y/y or N/n) y
Do you have poor-appetite? (Y/y or N/n) n

Sorry, I am not able to diagnose your disease!

Do you want to run this program again? (Y/y or N/n) n
CLIPS>
```

---

Submit your program **XXXX.clp** to IVLE → Workbin → "Student Submission" folder by the due date Sunday, 28 February 2016, 11.59 pm. *Do not type in your program from the sample program in the book. You should use* **diagnosis.clp** *that can be downloaded from IVLE* in the **Assignments** folder. Use CLIPS version 6.23 which is also available the Assignments folder to ensure consistency of your output with the tester program. When running your program, use the default strategy (i.e. Depth strategy). Your program only needs to handle diagnoses given in the **diagnosis.clp** and you should not add in other diagnosis rules which may interfere with the diagnosis of **diagnosis.clp**.

continued

These arguments can easily be drawn using Venn diagrams. You can model them in CLIPS with three corresponding rules.

Here is the only template you will need. It says that a statement consists of a quantifier (all, some, or no), and two sets.

```
(deftemplate statement
  (field quantifier (type SYMBOL))
  (field set1 (type SYMBOL))
  (field set2 (type SYMBOL))
)
```

Thus, 'All As are Bs' would be represented by the statement

```
(statement (quantifier all) (set1 As) (set2 Bs))
```

Here are some facts to test the program on.

```
(deffacts the-facts
  (statement (quantifier all) (set1 puppies) (set2 dogs))
  (statement (quantifier all) (set1 dogs) (set2 mammals))
  (statement (quantifier all) (set1 mammals) (set2 animals))
  (statement (quantifier no) (set1 sea-creatures) (set2 dogs))
  (statement (quantifier some) (set1 sea-creatures)
             (set2 mammals))
)
```

5. Examine the CLIPS program for diagnosing causes of abdominal pain (Figure 5.8). (Hypochondriacs should be aware that these rules are merely copied from a textbook, and do not have the weight of a true diagnosis.)

```
;; TEMPLATES

;; A 'sign' is a symptom associated with a site in an organ or
;; appendage, e.g., a pain in the upper right abdomen.
(deftemplate sign
  (field symptom (type SYMBOL))
  (field organ (type SYMBOL) (default NIL))
  (field site (type SYMBOL) (default NIL))
)

;; A 'diagnosis' identifies a disorder with some organ.
;; The organ may not be specified or may be assumed.
(deftemplate diagnosis
  (field disorder (type SYMBOL))
  (field organ (type SYMBOL) (default NIL))
)
```

continued

```
;; FACTS
;; Some sample symptoms
(deffacts the-facts
 (sign (symptom pain) (organ abdomen) (site lower))
 (sign (symptom poor-appetite))
 (sign (symptom weight-loss))
)

;; RULES
;; If recurrent pain in upper abdomen & poor appetite & weight
;; loss then stomach tumor.
(defrule stomach-tumor
 (sign (symptom pain) (organ abdomen) (site upper))
 (sign (symptom poor-appetite))
 (sign (symptom weight-loss))
 =>
 (assert (diagnosis (disorder tumor) (organ stomach)))
)

;; If recurrent pain in lower abdomen & diarrhea & nausea & no
;; fever then inflammation of large intestine.
(defrule inflammation1
 (sign (symptom pain) (organ abdomen) (site lower))
 (sign (symptom diarrhea))
 (sign (symptom nausea))
 (not (sign fever))
 =>
 (assert (diagnosis (disorder inflammation)
                    (organ large-intestine)))
)

;; If recurrent pain in lower abdomen & recurrent diarrhea & fever
;; then inflammation of large intestine.
(defrule inflammation2
 (sign (symptom pain) (organ abdomen) (site lower))
 (sign (symptom diarrhea))
 (sign (symptom fever))
 =>
 (assert (diagnosis (disorder inflammation)
                    (organ large-intestine)))
)

;; If recurrent pain in upper right abdomen & no fever
;; then gallstones.

(defrule gallstones
 (sign (symptom pain) (organ abdomen) (site upper-right))
```

continued

```
 =>
 (assert (diagnosis (disorder gallstones)
                    (organ gallbladder)))
)
;; If recurrent pain in upper right abdomen & vomiting & fever
;; then gallbladder inflamation.
(defrule gallbladder
 (sign (symptom pain) (organ abdomen) (site upper-right))
 (sign (symptom vomiting))
 (sign (symptom fever))
 =>
 (assert (diagnosis (disorder inflammation)
                    (organ gallbladder)))
)
```

Figure 5.8 A CLIPS rule set for diagnosing abdominal disorders

This program has one obvious limitation. All the symptoms must be present in the initial state of the working memory for a diagnosis to ensue. Yet patients will typically mention only the most distressing symptoms first, such as pain, and may not mention other symptoms, such as swollen ankles, right away.

Modify the program so that it asks about missing symptoms. The easiest way to do this is to add rules that have as their sole condition a pain symptom, such as

```
(sign (symptom pain) (organ abdomen) (site lower))
```

and whose actions put questions to be asked into working memory. You will then need a rule to ask those questions and place the right sign vectors in working memory, depending upon the answer received. Here is a template for the 'question' datatype.

```
;; A 'question' asks about a symptom in some organ and has an
;; answer.
(deftemplate question
 (field symptom (type SYMBOL))
 (field organ (type SYMBOL) (default NIL))
 (field answer (type SYMBOL) (default NIL))
)
```

Thus both patterns in production rules and the working memory elements they match against must conform to this template.

6. What do you see as being the limitations of the 'salience' approach to the Penguin Problem in Box 5.5?