CS 511 (Fall 2001): Solutions and notes to homework #1

1. **Grading standard:**
   - Problem #1: (total 5pts)
     - Production rules: (3pts)
     - Search strategy: (2pts)
     --- Clearly write out Conflicting set and firing rule (1pt)
     - Bad rules or strategy receive 1pt penalty.
     - Bad presentation of rules receive 1pt 0.5~1pt penalty.
   - Problem #2: (total 12pts)
     - Production rules: (3pts)
     --- Include 3 parts (1pt/each): rules, working memory and control structure
     - Semantic network: (3pts)
     - Frame: (3pts)
     - Pros and cons: (3pts, 1pt/per representation)

2. **Popular problems in hw1:**
   - Correct understanding of problem:
     - If you think the interpretation of the questions are vague, try to figure out them before you start to work on it. Ask the instructor and the TA.
     - E.g. In homework1 problem2:
       - “The process” means “in order to finish homework, you should…” not “8-puzzles problem”.
       - It also requires you to present this process by 3 different approaches: Production system, semantic network, and frame. List their pros and cons respectively or compare these 3 approaches together.
   - Problem#1
     - A lot of student lost 1 pt because they didn’t give conflicting set and firing rule or they didn’t find a good rule.
     - The question doesn’t mention the goal state while a lot of student assumed there was one for this question. It’s not necessary to give one, but it is okay if you have it.
   - Problem#2
     - Misunderstand questions
     - Mixing frame with semantic network.
     - Mixing pros with cons for 3 different representations.

**Hint to answer of Hw#1 (Answer is not unique)**

Note: Some of the contents below are from some student’s homework

**Problem #1:**
- Not focus on algorithms but on rules, conflicting set and firing rule.
- Key to the rules: Move blank tile if you can
- Good and clear presentation to rules
- Good examples
  - Example1: To set the production rules to this problem:
    1. **Present this problem:**
Use a 3x3 matrix to present the status of 8-puzzles and 0 to present the blank tile. So the initial state will be:

```
 1 2 3
 4 0 5
 6 7 8
```

Let $P_{i,j}$ be the puzzle in the matrix with row $i$ and column $j$, $1 \leq i, j \leq 3$. If $P_{i,j}$ is the blank tile, let $P_{i,j}=0$, hence $P_{i,j} \in \{0,1,\ldots,8\}$.

2. **Rules:**
   If the blank tile can move to the left, right, up and down, then move.
   That is:
   Let $(i_0, j_0)$ be the current position of the blank tile, so $P_{i_0,j_0}=0$ then rules will be:
   
   **Rule 1:** $P_{i_0,j_0}$ move **left**:
   If $(j_0-1 \geq 1)$ then \{ $P_{i_0,j_0}:=P_{i_0,(j_0-1)}$; $P_{i_0,(j_0-1)}:=0$; \};
   
   **Rule 2:** $P_{i_0,j_0}$ move **right**:
   If $(j_0+1 \leq 3)$ then \{ $P_{i_0,j_0}:=P_{i_0,(j_0+1)}$; $P_{i_0,(j_0+1)}:=0$; \};
   
   **Rule 3:** $P_{i_0,j_0}$ move **up**:
   If $(i_0-1 \geq 1)$ then \{ $P_{i_0,j_0}:=P(i_0-1),j_0$; $P(i_0-1),j_0:=0$; \};
   
   **Rule 4:** $P_{i_0,j_0}$ move **down**:
   If $(i_0+1 \leq 3)$ then \{ $P_{i_0,j_0}:=P(i_0+1),j_0$; $P(i_0+1),j_0:=0$; \};

3. **Search strategy (this is not required, but many students have it):**
   Define an evaluation function $f(n)$, which means, in the nth iteration, the number of $P_{i,j}$ whose position is different from its final state.
   We use the following strategy to select the firing rule from all of available rules (conflict set):
   1) Choose rule, which can make $f$’s value decreased mostly, but this result should not reverse of last step.
   2) If all rules’ impact on $f$ is the same, choose randomly from rule1,2,3,4
   3) If no rule to use, back to next step and reselect another rule.

4. **3 iterations of an inference process from the initial state of 123405678.**
   Step 0
   
   ```
   1 2 3
   4 0 5
   6 7 8
   ```
   
   Step 1
   
   ```
   1 2 3
   0 4 5
   6 7 8
   ```
   
   Conflicting set: \{Rule1, Rule2, Rule3, Rule4\}
Firing rule: \{Rule1\}

\[
\begin{array}{ccc}
1 & 2 & 3 \\
6 & 4 & 5 \\
0 & 7 & 8 \\
\end{array}
\]

Conflicting set: \{Rule2, Rule3, Rule4\}

Firing rule: \{Rule4\}

\[
\begin{array}{ccc}
1 & 2 & 3 \\
6 & 4 & 5 \\
7 & 0 & 8 \\
\end{array}
\]

Conflicting set: \{Rule2, Rule3\}

Firing rule: \{Rule2\}

### Problem #2:
- Key to Production system: 3 parts
  - Rules: if (condition) then (action); or Condition → Action
  - Working memory: all possible current state that your production system could have
  - Conflicting set: all possible rules that you can select
  - Firing rule: the rule you select in some status
- Key to semantic system: a kind of diagram presentation to knowledge

\[\text{Node: objects} \rightarrow \text{Relationship between nodes}\]

- Key to frames: a kind of diagram presentation to knowledge
  - Use line point to another frame (object). In frame there are different slots, which describe the objects relationship with other objects and also its attribute.
- Key to pro and cons
  1) Production system
     ---Easy to inference and reasoning
     ---Efficiency increases when the size of rule sets increases
  2) Semantic network (Frame)
     ---Hierarchy and object-oriented
     ---Less restricted in representing knowledge.

- Good examples:
  1. **Production system:**
     - Rules:
       - If study notes then must have attended lectures
       - If finish homework then might have attended the lectures
       - If finish homework then might have finished reading assignment
       - If finish homework then might have studied notes
     - Working memory:
       - Initial state: attend lectures, finish reading assignment, study notes
Finish state: finish homework

- Control structure:
  In order to execute an action, you must have executed its pre-required action.

- Pros & cons:
  --- Similar to human natural thinking process
  --- Knowledge base is independent with rules, easy to add, delete, modify and maintain
  --- Strict inference and reasoning process
  --- Efficiency ↓ when rule sets ↑
  --- Less restricted in representing knowledge.

2. Semantic network:

   ![Semantic network diagram]

- Pros & cons:
  --- Straightforward and direct present knowledge
  --- Especially clearly to present hierarchical and object-oriented knowledge
  --- Efficiency to search, not the whole network but only along relationship
  --- Limitless in knowledge express

3. Framework (similar to semantic network)

   ![Framework diagram]

- Pros & cons:
  --- Straightforward and direct present knowledge
--- Especially clearly present hierarchical and object-oriented knowledge, close to the concept “Class”, save storage space
--- Efficiency search