KBAI CS 4635 A, 4635 001, 7637 A, 7637 001
Final Examination
Assigned: Sunday, November 24, 2019
Due: 8 am, Monday, December 3, 2019

General Instructions

i. Please answer all questions.
ii. Please start your answer to each question on a new page.
iii. Please write your name on each page.
iv. The examination is open book, open notes, but the answers must be your own. Please cite any source you use.
v. Yes, we know that the examination is a little long: open-notes take-home examinations typically are so.

Part A: Short answer question (~10min, 10pts)

Given that a particular type of knowledge or problem can be encoded in many different ways, what is the importance of the selection of a particular representation?

Part B: Multi-part question (~45min, 30pts)

We learned about many different techniques that might be employed by knowledge-based intelligent agents. These techniques are not best understood in isolation, but in relationship to each other. Sometimes this means that one technique can be understood from the perspective of another – e.g. many techniques can be viewed, at least in part, as a kind of search. In other cases, this may mean understanding how complementary techniques can work together to build a more powerful overall system. For each pair of techniques below, explain a potential relationship (via perspective shift or complementation):

- Generate & Test and Diagnosis
- Planning and Search
- Analogical Reasoning and Case-Based Reasoning
- Semantic Networks and Frames
- Metareasoning and Configuration
- Metareasoning and Learning by Correcting Mistakes

Part C: Project-like question (~100min, 60pts)

For questions on this part, please be clear, precise and specific. Long answers in English will not count nearly as much as clear and precise answers in the language of KBAI: architectures, knowledge representations and data structures, methods and algorithms. Use examples to illustrate your answers. Portions of this question are drawn from (http://www.zhasea.com/logic/snape.html).

In the middle of the climactic episode of J. K. Rowling's children's novel *Harry Potter and the Sorcerer's Stone*, Harry Potter and Hermione Granger find themselves in a room whose two exits are blocked by raging flames.

On a table in the room stand seven bottles, along with a piece of paper inscribed with the following verses:

Danger lies before you, while safety lies behind,
Two of us will help you, whichever you would find,
One among us seven will let you move ahead,
Another will transport the drinker back instead,
Two among our number hold only nettle wine,
Three of us are killers, waiting hidden in line.
Choose, unless you wish to stay here forevermore,
To help you in your choice, we give you these clues four:

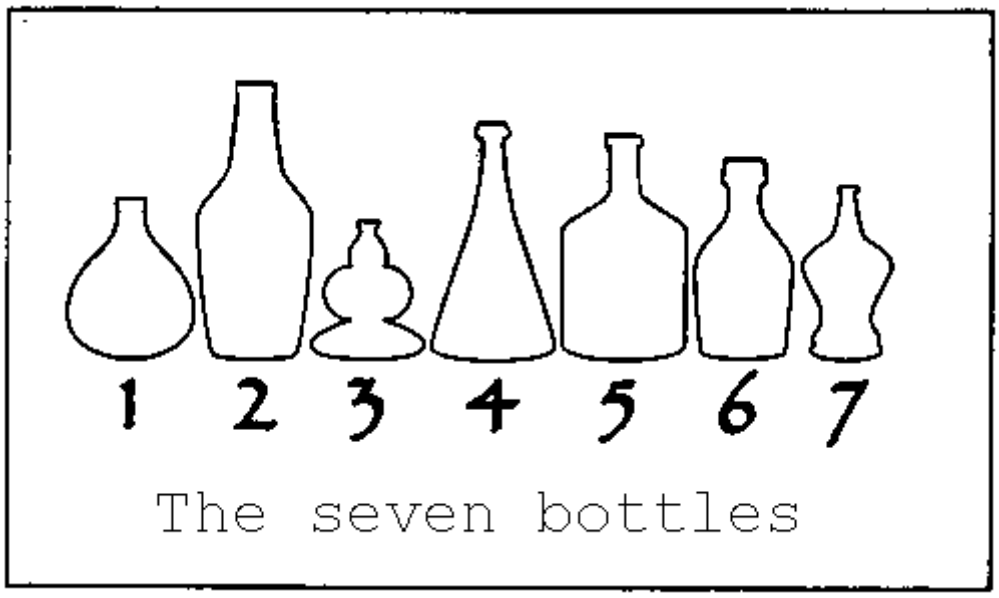
First, however slyly the poison tries to hide
You will always find some on nettle wine's left side;
Second, different are those who stand at either end,
But if you would move onward, neither is your friend;
Third, as you see clearly, all are different size,
Neither dwarf nor giant holds death in their insides;
Fourth, the second left and second on the right
Are twins once you taste them, though different at first sight.

(Rowling 1998, p. 285)

Hermione, who is an exceptionally avid student, realizes that she can use reasoning to determine the bottles that they need to escape from the room. As she says, "This isn't magic - it's logic - a puzzle. A lot of the greatest wizards haven't got an ounce of logic; they'd be stuck in here forever." Hermione thinks hard, and in a few minutes she is able to identify the bottles that allow escape. She goes back to sound the alarm, and Harry goes forward to confront the evil-doer.

Imagine that we want to build a robotic Hermione that is capable of solving this problem. It may be the case that some perception will be needed to solve the problem. If so, assume the visual configuration depicted on the top of the next page.

Question C1 (10pts)
Identify a knowledge-based technique (or a cooperating set of techniques) that could be used to solve the problem, including the central representation(s) and algorithm(s) used. You may assume some supporting techniques (e.g. to transform the input problem representation, to perceive the environment and augment the internal representation, etc). Identify these supporting techniques, but you need not describe their functioning in detail.



Question C2 (15pts)
Show how the problem is represented using your chosen representation.

Question C3 (15pts)
Show in detail how your selected technique would solve the problem. Be sure to describe the knowledge relied upon by the technique.

Question C4 (10pts)
Identify an alternative knowledge-based technique (or cooperating set of techniques) and accompanying representation that could be used to solve the problem. Sketch the means by which this technique would solve the problem (representation, knowledge and algorithms), though you need not go into as much specific detail as in parts C2&3.

Question C5 (10pts)
Consider that you build a robotic Hermione that implements both of your selected techniques (from parts C1&4). How could a metareasoning layer decide upon which of the two techniques to use, perhaps depending on additional characteristics of the context not described here? (You are free to invent these details, or speculate about them. Hint: think about the advantages and disadvantages of your two techniques). Might the metareasoning layer ever interrupt one technique and switch to the other? If so, when and why? If not, why not?