School of Computer Science & Software Engineering

Sample Questions 2006

AAI 7210 (CITS7210)

This paper contains: 6 pages (including the title page)
Time allowed: 2 hours 10 minutes

Rubric from actual paper:
The paper contains 5 questions, each of which is worth 15 marks.
Candidates should attempt FOUR (4) questions.
Marks for the paper total 60.

PLEASE NOTE

Examination candidates may only bring authorised materials into the examination room. If a supervisor finds, during the examination, that you have unauthorised material, in whatever form, in the vicinity of your desk or on your person, whether in the examination room or the toilets or en route to/from the toilets, the matter will be reported to the head of school and disciplinary action will normally be taken against you. This action may result in your being deprived of any credit for this examination or even, in some cases, for the whole unit. This will apply regardless of whether the material has been used at the time it is found.

Therefore, any candidate who has brought any unauthorised material whatsoever into the examination room should declare it to the supervisor immediately. Candidates who are uncertain whether any material is authorised should ask the supervisor for clarification.
Instructions

The rubric for the actual exam paper is as shown on the previous page.

The paper will contain 5 questions, each of which is worth 15 marks. You will be required to answer four questions, for a total of 60 marks. If more than four questions have been attempted, only the first four will be marked. If you change your mind after starting a question you should put a cross through the whole question and write “Not Attempted”.

The first question is an essay question, and is provided overleaf. You can prepare for it in advance. Note that you do not need to give specifics of algs or regurgitate specific results — it is your understanding and conclusions that are of interest. In addition to your own seminar research and lab work you can if you wish mention historical material as covered in Topic 1, you can make use of information that you learned from other seminars that you attended, and can refer to other material covered on the course if you wish.

The remaining 4 questions are on the material covered in topics 2 to 10 of the notes (and correspondingly in the textbook) and in the labs. These are the usual sort of questions that you will be familiar with: asking you what is meant by some terminology, what an algorithm is for, testing your understanding of an alg and how it works, solving a small problem with an algorithm, providing a Java implementation, discussing advantages, problems or limitations of algs, justifying or explaining an alg or an equation used by one, the theory of why it is good, etc. It is more about understanding than remembering — you will not be asked to recall lots of isolated “facts”.

Two sample questions are provided overleaf. These are provided to give you an idea of the size of a question — obviously the real exam will cover material not included in these.

Note also that the appropriate chapters of the text contain a wealth of problems that you can use to test your understanding of the material if you wish.
1. Some argue that scientific advancement comes primarily from a series of many incremental steps, while others believe that advances come primarily from fewer significant landmark discoveries. During this unit you will have seen examples of each of these, both in the lecture material and associated labs, and in studying your own research topic.

Discuss these two views of technological development as applied to AI in the context of what you have learned while undertaking this unit. Your answer should include a discussion of your research seminar topic, in which you were given the opportunity to investigate a single development in AI in some depth. It should also include a discussion of your practical project work, in which you were given the opportunity to investigate successively more sophisticated techniques for a game playing agent. *A good answer will convey what you have learned from your own explorations in this unit.* You may also refer, as appropriate, to lecture material and other research presentations from the course.
2.

(a) Briefly compare breadth-first and depth-first search. Your answer should consider the four main criteria on which search algorithms are usually compared. You may assume unit step cost, finite branching factor $b$, maximum branch length $m$, and optimal solution depth $d$.

You may answer in point form. For each point, you should state how the search performs under that criterion. You should briefly justify any statements or mathematical expressions.

**Breadth-first**

- **Completeness:** yes — since the children of a visited node are added to the end of a finite queue, all nodes will eventually be visited

(b) Would you be more likely to select an iterative deepening search for a search space with a low branching factor or for one with a high branching factor. Why?

(c) What do we mean by a heuristic? How is a heuristic used in the $A^*$ algorithm? State the evaluation function $f(n)$ used to evaluate a node $n$ in an $A^*$ search.

(d) What do we mean by an admissible heuristic. Does the cost metric for the $A^*$ algorithm necessarily increase monotonically along paths towards the goal given an admissible heuristic? Briefly justify your answer.

(e) How is it possible to automatically generate heuristics for a problem? Give a simple example.

(f) Briefly describe how simplified memory bounded $A^*$ ($SMA^*$) works. What problem can $SMA^*$ run into particularly with well balanced search trees?
3.

(a) Describe two aspects that distinguish planning from basic search.

(b) The following diagram shows the components of a ball-point pen: the Cap (C), the Head (H), the Body (B), the Tube (T), the Ink (I) and the stopper (S).

```
<table>
<thead>
<tr>
<th>Cap</th>
<th>Head</th>
<th>Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube</td>
<td>Ink</td>
<td>Stopper</td>
</tr>
</tbody>
</table>
```

The start state, in which all parts are unassembled, can be described in the STRIPS language by the conjunction of literals

$$
\neg \text{ass}(C, B), \neg \text{ass}(H, B), \neg \text{ass}(H, T), \neg \text{ass}(T, I), \neg \text{ass}(B, S)
$$

where, for example, $$\neg \text{ass}(C, B)$$ means that the Cap and Body are not assembled. In the goal state, each of these pairs of objects is assembled.

The pen can be assembled using the following operations:

1. The cap can be connected to the body.
2. The head can be connected to the body, providing the cap and body are not assembled.
3. The tube can be connected to the head, providing the head and body are not assembled.
4. The ink can be put in the tube, providing the head and tube are assembled, but the head and body are not assembled.
5. The stopper can be connected to the tube.
(i) Using the STRIPS language specify each of the above five actions.

(ii) Draw a least-commitment partial order plan for assembling the pen. Use solid lines to represent causal links, and dashed lines to represent ordering constraints.

(iii) How many linearisations of this partial-order plan are there?

(iv) Assume the technology is improved and the fourth operation is modified to:

4. The ink can be put in the tube, providing the head and tube are assembled, and either the head and body are not assembled, or (if they are) the stopper and tube are not assembled.

Can this operation be expressed in the basic STRIPS language? If so, how? If not, why not?

(c) Assume that our assembly agent may be required to assemble either of two types of pen kit. The first consists of the cap, head, body, tube and ink as shown above (the stopper can be omitted). The second consists of a cap, a body, and a preassembled insert consisting of a head, tube and ink (no stopper is required).

The agent does not know which type of pen it will be required to assemble until the parts arrive. It must then make an observation and proceed with the appropriate assembly.

Draw a partial order conditional plan for this problem.