CPSC625-600 Midterm Exam (10/10/2007, Wed)[1]

Last name: _______________, First name: _______________

Time: **12:40pm–1:30pm (50 minutes +** α**)**, Total Points: **100**

Subject	Score
AI General	/5
Search	/35
Game Playing	/30
Propositional Logic	/30
Total	/100

- Be as **succinct** (i.e., brief) as possible.
- Read the questions carefully to see what kind of answer is expected (*explain blah* **in terms of ...** *blah*).
- Solve all problems.
- Total of X pages, including this cover and the Appendix at the end. **Before starting, count the pages and see if you have all X.**
- This is a closed book, closed note exam.

[1] Instructor: Yoonsuck Choe.

1 AI, in General

Question 1 (5 pts): What do you think is the main obstacle in achieving true AI? [This is an open question. Any reasonable answer will be fine. Don't write more than one paragraph.]

2 Search

Question 2 (5 pts): (1) What is the main drawback of hill-climbing or gradient-based approaches, and (2) how does simulated annealing overcome that?

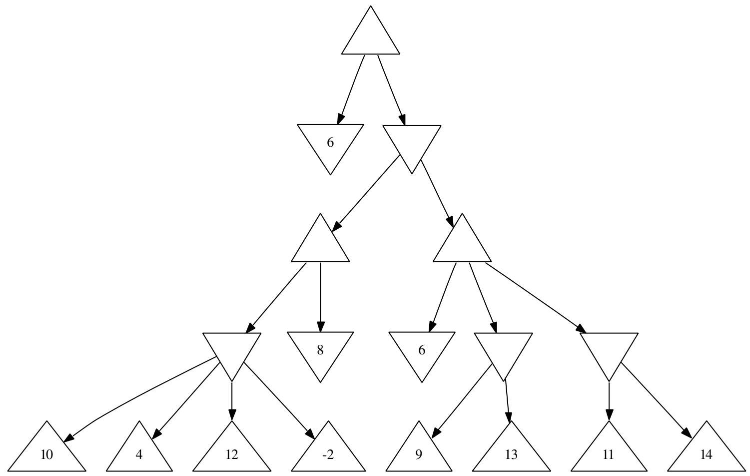
Question 3 (10 pts): Explain why A^* has exponential space complexity, and how IDA^* overcomes it.

Question 4 (10 pts): Heuristic functions need to meet a certain condition in order to make A* optimal. (1) What is this condition? and (2) briefly explain why that condition leads to optimality.

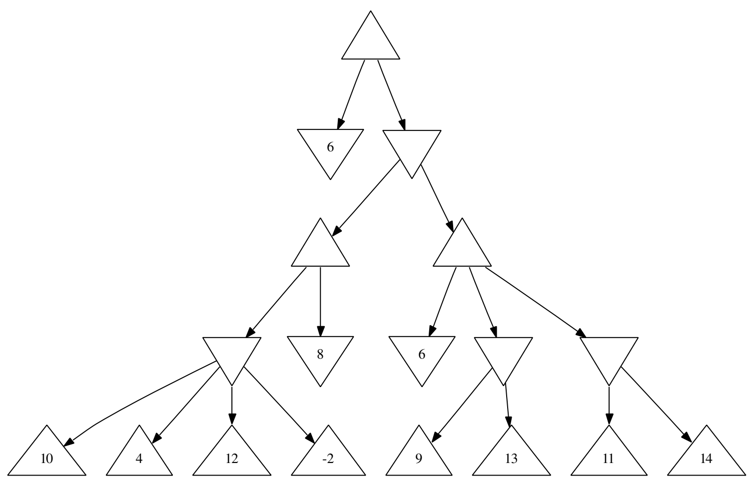
Question 5 (10 pts): In Simulated Annealing, there are two different ways to accept (rather than reject) a randomly picked operator (movement direction). (1) What are these two cases (explain in relation to the change in energy ΔE: when $\Delta E \leq 0$ vs. $\Delta E > 0$), and (2) explain how the temperature T affects the decision when ΔE is fixed (accept or reject). (**Note:** The goal of simulated annealing is to *minimize* the energy.)

3 Game Playing

Question 6 (10 pts): (1) Assign utility values in the following game tree using MIN-MAX search, and (2) draw the solution path.



Question 7 (10 pts): (1) Show the α and β cuts in the following game tree, and (2) draw the solution path.



Question 8 (10 pts): Explain why MIN-MAX gives suboptimal solutions if the players do not play optimally.

4 Propositional Logic

Use the laws of propositional logic at the end of the test as necessary (see the last page).

Question 9 (10 pts): Explain why the following equality is useful for resolution-based theorem proving:

$$C_1 \wedge C_2 \wedge ... \wedge C_n = C_1 \wedge C_2 \wedge ... \wedge C_n \wedge H$$

where H is a result of resolving a pair of clauses C_i and C_j.

Question 10 (10 pts): Given a knolwedge base and an inference engine (that uses a resolution theorem prover), how would you check if your knowledge base contains any error?

Question 11 (10 pts): Using **resolution**, show that:
$(P \wedge \neg S) \vee R$ is a logical consequence of

1. $Q \rightarrow P$
2. $Q \vee S \vee P$
3. $S \rightarrow R$

First, convert the problem into a form suitable for resolution. Then, show every step of the derivation.

Appendix: Laws of Propositional Logic

Note: There is no exam question on this page.

Use the laws of propositional logic below as necessary. You may detach the last page from the test.

- $P \vee Q = Q \vee P$,
  $P \wedge Q = Q \wedge P$ (commutative)
- $(P \vee Q) \vee H = P \vee (Q \vee H)$,
  $(P \wedge Q) \wedge H = P \wedge (Q \wedge H)$,(associative)
- $P \vee (Q \wedge H) = (P \vee Q) \wedge (P \vee H)$,
  $P \wedge (Q \vee H) = (P \wedge Q) \vee (P \wedge H)$ (distributive)
- $P \vee \textbf{False} = P, P \wedge \textbf{False} = \textbf{False}$
- $P \vee \textbf{True} = \textbf{True}$
  $P \wedge \textbf{True} = P$
- $P \vee \neg P = \textbf{True}$
  $P \wedge \neg P = \textbf{False}$
- $\neg(P \vee Q) = \neg P \wedge \neg Q$,
  $\neg(P \wedge Q) = \neg P \vee \neg Q$ (DeMorgan's law)
- $P \rightarrow Q = \neg Q \rightarrow \neg P$ (contrapositive)
- $P \rightarrow Q = \neg P \vee Q$

These are the common inference rules:

- Modus Ponens:

$$\frac{F \rightarrow G, F}{G}$$

- Unit Resolution:

$$\frac{F \vee G, \neg G}{F}$$

- Resolution:

$$\frac{F \vee G, \neg G \vee H}{F \vee H} \quad or\ equivalently \quad \frac{\neg F \rightarrow G, G \rightarrow H}{\neg F \rightarrow H}$$