CPSC625-600 Midterm Exam (10/14/2010, Thu)[1]

Last name: _______________, First name: _______________

Time: **2:20pm–3:35pm (75 minutes + α)**, Total Points: **100**

Subject	Score
AI General	/10
Search	/30
Game Playing	/30
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 9 pages, including this cover and the Appendix at the end. **Before starting, count the pages and see if you have all 9.**
- This is a closed book, closed note exam.

[1] Instructor: Yoonsuck Choe.

1 AI, in General

Question 1 (10 pts): Do you think human-level AI is possible in the next 50 years? Explain why or why not. [This is an open question. Any reasonable answer will be fine. **Don't write more than one paragraph**. I expect a scientific answer. Unscientific answers will be given 0.]

2 Search

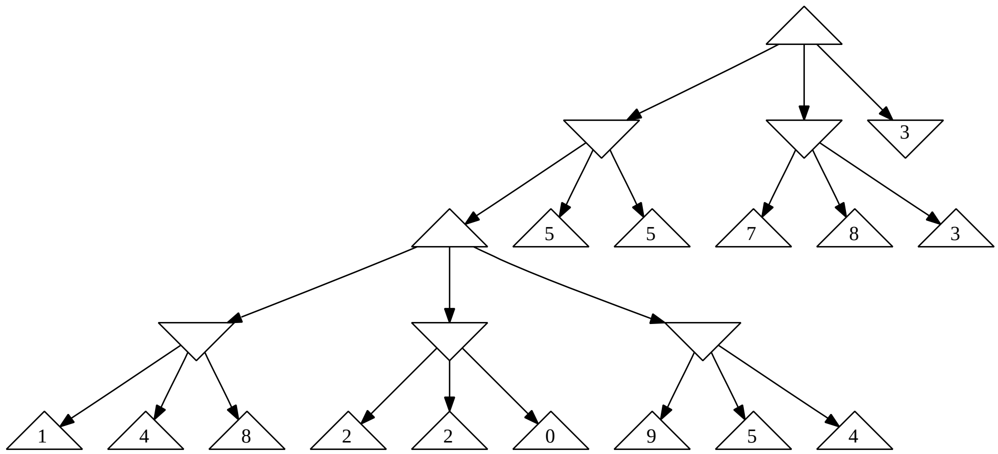
Question 2 (10 pts): Explain why A^* is generally faster than breadth-first search, considering that both have the same time and space complexity.

Question 3 (10 pts): (1) Explain why IDA*'s space complexity is linear with respect to the maximum depth of the exploration. (2) Explain how IDA*'s space complexity can be measured (it does not keep an explicit node list).

Question 4 (10 pts): In simulated annealing (SA) there are two quantities that are important in determining whether a certain random move will be accepted or rejected when the move results in an increase in energy (note: in SA, the objective is to reduce the energy). (1) What are these and (2) under what conditions are the moves accepted?

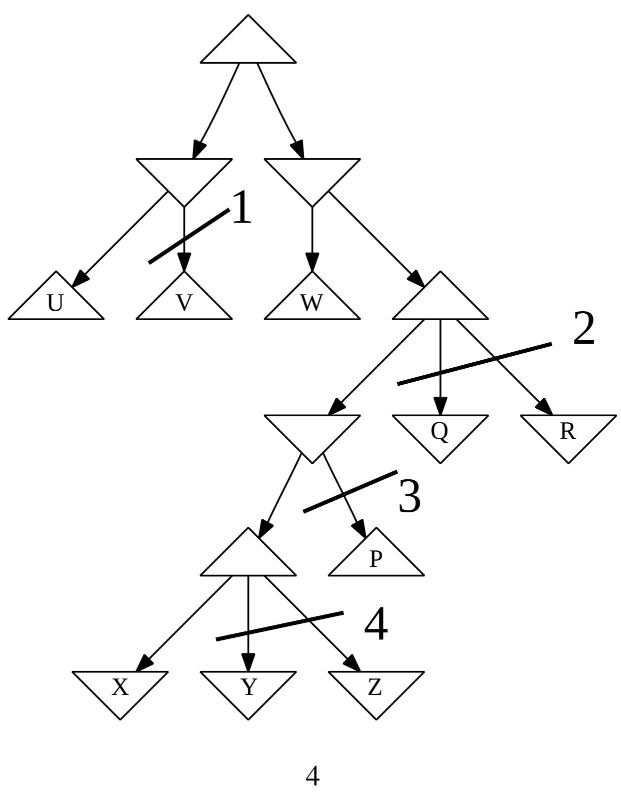
3 Game Playing

Question 5 (10 pts): (1) Fill out the utility value in the following Min-Max tree, and (2) show the solution path.



Question 6 (10 pts): Can the following cuts occur? For each of the indicated locations, (1) answer yes (cut can happen) or no (cut cannot happen), and (2) if yes, give an example (e.g., *when* $U = 10, V = 5$ *and ...*)

- Cut 1: YES / NO
- Cut 2: YES / NO
- Cut 3: YES / NO
- Cut 4: YES / NO



Question 7 (5 pts): Explain why node ordering is important for efficient alpha-beta pruning.

Question 8 (5 pts): For games with an element of chance, why does the actual magnitude of the utility values matter and not just the rank (ordering)?

4 Logic

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

Question 9 (5 pts): (1) Explain how a resolution theorem prover can be used to extract answers to questions like "Who is the father of X?".

Question 10 (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 11 (10 pts): Convert the following into prenex normal form, disjunctive normal form, and then skolemize: $\neg \exists x(\neg P(x) \rightarrow \neg(\exists y(Q(x, y) \vee R(y))))$.

Question 12 (5 pts): Given the premises below, show that $A \rightarrow E$ is a logical consequence. Use resolution.

1. $\neg B \wedge \neg A$
2. $D \vee \neg C \vee B$
3. C
4. $\neg D \vee E$

No exam questions on this page.

Appendix: Laws of Logic

Note: There is no exam question on this page.

Use the laws of 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)
- $P \vee \mathbf{False} = P, P \wedge \mathbf{False} = \mathbf{False}$
- $P \vee \mathbf{True} = \mathbf{True}$
  $P \wedge \mathbf{True} = P$
- $P \vee \neg P = \mathbf{True}$
  $P \wedge \neg P = \mathbf{False}$
- $\neg(P \vee Q) = \neg P \wedge \neg Q$,
  $\neg(P \wedge Q) = \neg P \vee \neg Q$ (DeMorgan's law)
- $P \to Q = \neg Q \to \neg P$ (contrapositive)
- $P \to Q = \neg P \vee Q$
- $(Qx, F(x)) \vee G = Qx, (F(x) \vee G)$
  $(Qx, F(x)) \wedge G = Qx, (F(x) \wedge G)$
- $\neg(\forall x, F(x)) = \exists x, (\neg F(x))$
  $\neg(\exists x, F(x)) = \forall x, (\neg F(x))$
- $(\forall x, F(x)) \wedge (\forall x, G(x)) = \forall x, (F(x) \wedge G(x))$
  $(\exists x, F(x)) \vee (\exists x, G(x)) = \exists x, (F(x) \vee G(x))$
- $(Q_1 x, F(x)) \vee (Q_2 x, H(x)) = Q_1 x, Q_2 z, (F(x) \vee H(z))$
  $(Q_1 x, F(x)) \wedge (Q_2 x, H(x)) = Q_1 x, Q_2 z, (F(x) \wedge H(z))$

These are the common inference rules:

- Modus Ponens:

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

- Unit Resolution:

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

- Resolution:

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