TEST CODE:

CS 436
Exam 2

Monday October 30, 2006

CLOSED BOOK
(one sheet of notes and a calculator allowed)

Name _____

Problem	**Points**	**Max Points**
0	_____	**5**
1	_____	**20**
2	_____	**15**
3	_____	**20**
4	_____	**20**
5	_____	**20**
TOTAL	_____	**100**

TEST CODE:

Question 0: AI History (5 Points). Answer **one** of the following:

Who coined the term Artificial Intelligence and also invented LISP?

John McCarthy

What was the name of the founding conference in AI in the summer of 1956?

The Dartmouth Workshop

Question 1: Ant Systems (20 Points)

- Describe the effect of increasing the *alpha* parameter relative to the *beta* parameter. **(7 points)**

The higher alpha is relative to beta the more the pheromone trails are used in decision making versus the inverse distance values.

Compare the approximate effect of increasing the number of ants from *X* to *2X* versus decreasing the pheromone decay rate from 0.5 to 0.25. **(7 points)**

Approximately the same effect. There are subtle differences… lower decay rates allow good paths to live longer without being reinforced, while having more ants will only allow good paths to live longer if they are chosen and reinforced a second time (statistically this should happen). And of course adding more ants will slow the algorithm down if run the same number of epochs.

- Does having 'elite ants' affect the completeness of the Ant-System search algorithm? **(6 points)**

No

Question 2: Agents (15 Points)

What is the relationship between a *rational agent* and its *performance measure + percept sequence* seen so far? **(5 points)**

From the book:

"The performance measure evaluates the behavior of the agent in an environment. A rational agent acts so as to maximize the expected value of the performance measure given the percent sequence it has seen so far"

- Explain the differences between *Simple Reflex Agents*, *Model Based Agents* and *Goal Based Agents*. ~~Use examples.~~ **(5 points)**

Simple Reflex Agents: Agents select actions based upon current percepts, ignoring all percept history.

Model Based Agents: Maintain an internal 'state' to track aspects of the world that are not necessarily observable in current percepts.

Goal Based Agents: Act to achieve an internal goal in addition to keeping a current state description.

- Circle the Attributes of the Agent Task Environments below **(5 points)**

Sodoku Solver:

Fully Observable vs Partially Observable **Deterministic** vs Stochastic

Static vs Dynamic **Discrete** vs Continuous **Single Agent** vs Multi Agent

Automatic Taxi Driver:

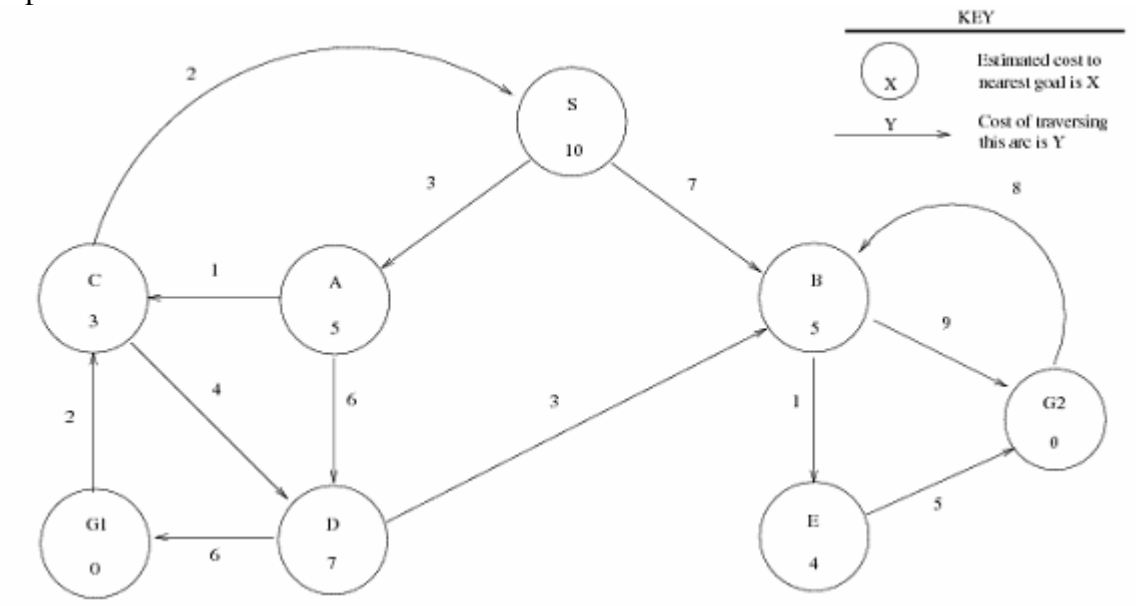
Fully Observable vs **Partially Observable** Deterministic vs **Stochastic**

Static vs **Dynamic** Discrete vs **Continuous** Single Agent vs **Multi Agent**

TEST CODE:

Question 3: Search (20 Points)

Consider the search space below, where *S* is the start node and *G1* and *G2* are goal nodes. Arcs are labeled with the cost of traversing them and the estimated cost to a goal is reported inside nodes.



For each of the following search strategies, indicate which goal state is reached (if any) and list, *in order*, all the states *visited*. When all else is equal, nodes are removed from *UNUSED list* in alphabetical order. **Avoid cycles**. *Use the next page as scratch paper.*

Breadth First ***(4 points)***

Goal state reached: __ G2 ___ States visited:__ ~~S A B C D E~~ **G2** G1 _____

Iterative Deepening ***(4 points)***

Goal state reached: ___G2___ States visited:____ S | S A C | S A C D B E **G2** _____

Hill Climbing (using the *h* function only) ***(4 points)***

Goal state reached: _ G2 _ States visited:_ (random) S A C Dead end -- S B E G2____

A* ***(4 points)***

Goal state reached: _____ States visited:_____

Simulated Annealing: Imagine that the Simulated Annealing algorithm is at state **A** and randomly chooses **D** as the candidate next state. Assuming a temperature T of 4 what is the probability of accepting **D**? ***(4 points)***

$e^{2/4} = .61$

Question 4: Constriant Satisfaction Problems (20 Points)

- Write down the constraints for this cryptarithmetic puzzle. **(7 points)**

```
    S E N D
+   M O R E
-------------
  M O N E Y
```

D + E = Y + 10*X1

X1 + N + R = E + 10*X2

X2 + E + O = N + 10*X3

X3 + S + M = O + 10*X4

X4 = M

ALLDIFF (S, E, N, D, M, O, R, E, Y)

- Explain how you would use the *minimum remaining values (MRV)* heuristic, the *degree* heuristic, and *least constraining value* heuristic to build a smarter variable selector for `Backtracking-Search(csp)`. **(6 points)**

Use degree heuristic to choose the first variable (region), otherwise choose variable with MRV heuristic. Next choose value to assign to variable via the LCV heuristic.

Break ties in MRV via Degree.

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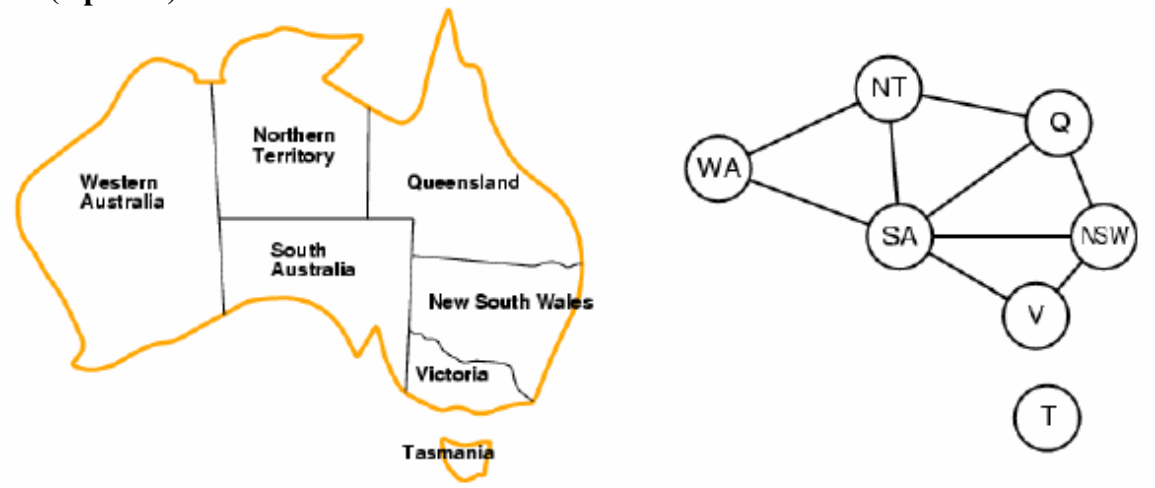
Question 4: Constriant Satisfaction Problems *(continued)*

- Use the AC3 Algorithm to show that arc consistency is able to detect the inconsistency of the partial map-coloring assignment {WA = red, V=blue}. **(7 points)**




```
function AC-3( csp) returns the CSP, possibly with reduced domains
   inputs: csp, a binary CSP with variables {X1, X2, ..., Xn}
   local variables: queue, a queue of arcs, initially all the arcs in csp
   while queue is not empty do
      (Xi, Xj) ← REMOVE-FIRST(queue)
      if RM-INCONSISTENT-VALUES(Xi, Xj) then
         for each Xk in NEIGHBORS[Xi] do
            add (Xk, Xi) to queue

function RM-INCONSISTENT-VALUES( Xi, Xj) returns true iff remove a value
   removed ← false
   for each x in DOMAIN[Xi] do
      if no value y in DOMAIN[Xj] allows (x,y) to satisfy constraint(Xi, Xj)
         then delete x from DOMAIN[Xi]; removed ← true
   return removed
```

Starting queue on right – result of AC3 on left

		WA={R}, NT={RGB}, SA={RGB}, Q={RGB}, NSW={RGB}, V={B}
V-NSW	➔	WA={R}, NT={RGB}, SA={RGB}, Q={RGB}, NSW={RG}, V={B}
V-SA	➔	WA={R}, NT={RGB}, SA={RG}, Q={RGB}, NSW={RG}, V={B}
WA-SA	➔	WA={R}, NT={RGB}, SA={G}, Q={RGB}, NSW={RG}, V={B}
NT-SA	➔	WA={R}, NT={RB}, SA={G}, Q={RGB}, NSW={RG}, V={B}
WA-NT	➔	WA={R}, NT={B}, SA={G}, Q={RGB}, NSW={RG}, V={B}
SA-NSW	➔	WA={R}, NT={B}, SA={G}, Q={RGB}, NSW={R}, V={B}
SA-Q	➔	WA={R}, NT={B}, SA={G}, Q={RB}, NSW={R}, V={B}
NT-Q	➔	WA={R}, NT={B}, SA={G}, Q={R}, NSW={R}, V={B}
NSW-Q		CONFLICT!!

Work through pseudo-code, you will find a conflict when NSW-Q is evaluated.

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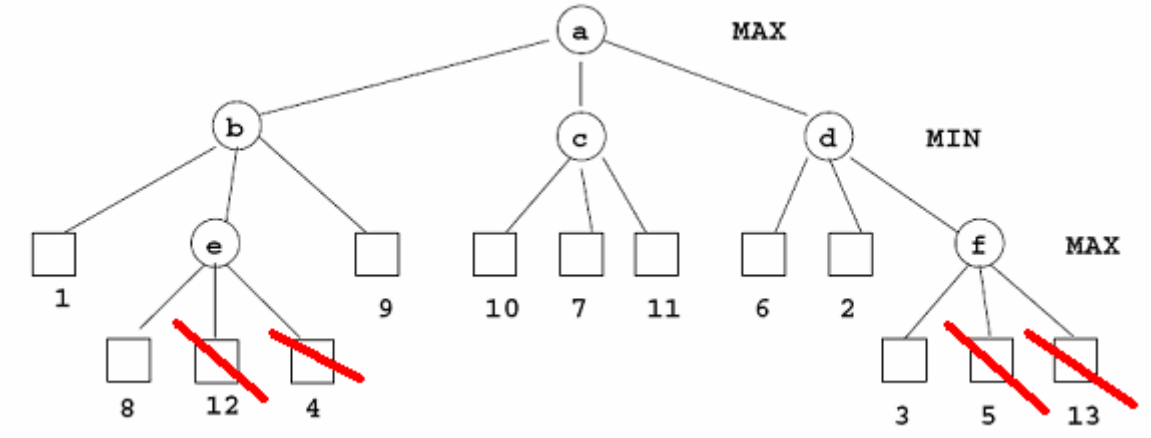
Question 5: Adversarial Search (20 Points)

- Circle the nodes unexpanded by Alpha-Beta Pruning. **(15 points)**



For this problem, at least one leaf node is expanded for every 'direction' or 'choice' from a non-leaf node. See pseudo code. Is this true in general???

- What is the worst-case ordering of successor nodes for Alpha-Beta Pruning?
(5 points)

When the successor function always produces moves that are better than the last one, ….. producing moves in 'worst to best' order.

Optimal order is 'best to worst'. Note that 'best' and 'worst' value depends on if the nodes are being maximized or minimized.