Cooperating Intelligent Systems – written exam October 2008

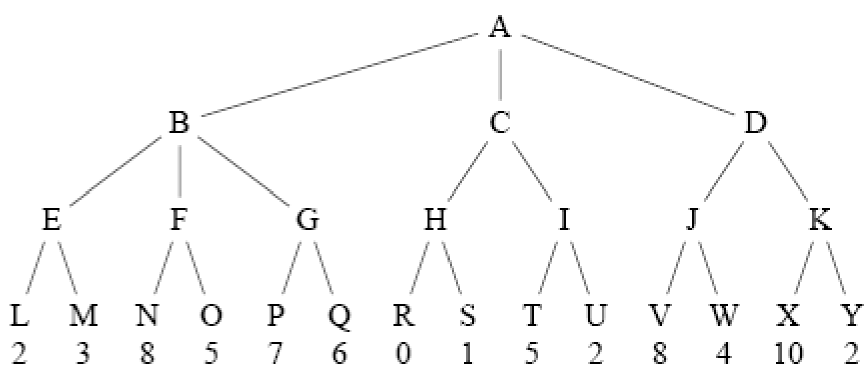
You must achieve at least 50% of the points on this written exam to continue to the oral exam.

The total number of points is 35.

No books, cell phones, calculators are permitted during the exam.

1. Game playing

Consider the (hypothetical) game tree below.



Assume that the first player (about to move) is the maximizing player.

(a) What is the optimum game path if the players follow the minimax rule? [1 point]

(b) Write down the $\alpha-\beta$ pruning rules (2 of them). [2 points]

(c) If the tree is expanded from left to right, which nodes will not be expanded? [2 points]

(d) If the tree is expanded from right to left, which nodes will not be expanded? [2 points]

2. Informed search

Companies like DHL, UPS, Federal Express, or the U.S. Postal Service are in the business of shipping parcels between many destinations. For each individual parcel, the problem is to find the best path from the sender's location to its destination. In the following sections, you need to apply different search algorithms to solve a simplified parcel routing problem. The graph with the cities (nodes) to be considered is shown below. The numbers on the edges indicate the driving distances in kilometers. A separate table contains the straight-line distances ("as the crow flies") between the cities for this graph (obtained from http://www.indo.com/), measured in kilometers.

For each of the algorithms, you need to draw the search tree. It might be advisable to draw the search tree first on a separate sheet of paper, and then copy the relevant parts to the exam sheet. Fill in the necessary values (evaluation function etc.)

Use the alphabetical order on the full names of the nodes (not their abbreviations) to determine the order in which successor nodes are examined. You can assume that your algorithms avoid cycles by not re-visiting previously inspected nodes.

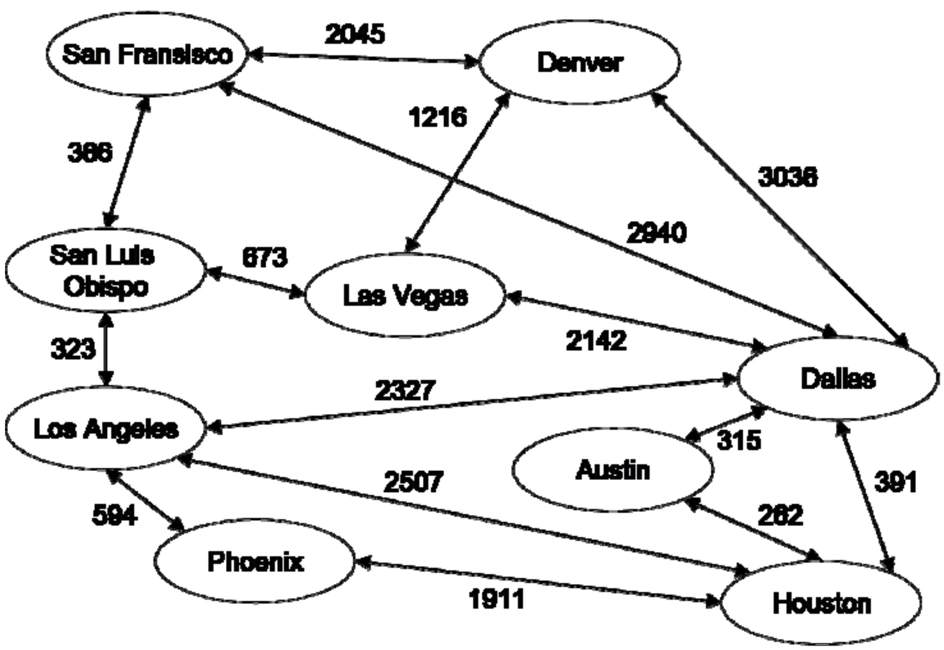


Figure 1: Some American cities and true driving distances.

Table 1: Straight line distances (kilometers) between the cities in the figure above.

km	*Austin*	*Dallas*	*Denver*	*Houston*	*Las Vegas*	*Los Angeles*	*Phoenix*	*San Francisco*	*San Luis Obispo*
Austin		291	1234	236	1751	1989	1400	2427	2210
Dallas	291		1062	360	1734	2014	1429	2402	2219
Denver	1234	1062		1407	991	1358	944	1549	1480
Houston	236	360	1407		1982	2225	1635	2658	2445
Las Vegas	175	1734	991	1982		372	413	676	503
Los Angeles	1989	2014	1358	2225	372		590	554	243
Phoenix	1400	1429	944	1635	413	590		1059	813
San Francisco	2427	2402	1549	2658	676	554	1059		327
San Luis Obispo	2210	2219	1480	2445	503	243	813	327	

(a) Show how Greedy-Best-First search solves the task. [2 points]

(b) Show how A* solves the task. [2 points]

(c) What is meant by an admissible heuristic? [1 point]

(d) Prove that A* is an optimal algorithm for tree search if the heuristic is admissible. [3 points]

3. Logic

(a) Translate each of the following sentences to English. [6 points]

$$\forall x Woman(x) \land ComputerScientist(x) \Rightarrow Likes(x, ThaiFood)$$

$$Woman(Ursula) \land ComputerScientist(Ursula)$$

$$Vegetarian(Ursula)$$

$$\forall x Vegetarian(x) \land EatsAt(s, ThaiGarden) \Rightarrow Eats(x, VegPadThai)$$

$$\forall x Person(x) \land Likes(x, ThaiFood) \land Visits(x, Williamstown) \Rightarrow EatsAt(s, ThaiGarden)$$

$$\forall x Woman(x) \Rightarrow Person(x)$$

(b) You are told that Ursula is in Williamstown visiting her friend Andrea. That is,

$$Visits(Ursula, Williamstown)$$

Use an inference method to prove that Ursula will be eating Vegetable Pad Thai. That is,

$$Eats(Ursula, VegPadThai)$$

Explain clearly what you do in each step. [5 points]

4. Bayesian network

We want to design a troubleshooting advisor for PC:s. Let CF be a Boolean random variable representing whether the Computer Fails (CF = true) or not.

Assume there are two possible causes of failure: Electricity-Failure and Malfunction-of-the-Computer, represented using the Boolean random variables EF and MC, respectively.

Let

$P(EF) = 0.1$,

$P(MC) = 0.2$,

$P(CF \mid \neg EF, \neg MC) = 0.0$,

$P(CF \mid \neg EF, MC) = 0.5$,

$P(CF \mid EF, \neg MC) = 1.0$, and

$P(CF \mid EF, MC) = 1.0$.

(a) Draw the Bayesian Network for this problem (marking the conditional probabilities) [3 points]

(b) Compute the joint probability for Computer-Fails, No-Electricity-Failure and Malfunction-of-the-Computer: $P(CF, \neg EF, MC)$ [3 points]

(c) Compute the conditional probability for Malfunction-of-the-Computer if we have an Electricity-Failure: $P(MC \mid EF)$ [3 points]

(d) Compute the conditional probability for Electricty-Failure if we observe that the Computer-Fails: $P(EF \mid CF)$ [3 points]