

BITS PILANI, DUBAI CAMPUS
Dubai International Academic City, Dubai
Second Semester 2012-13
Comprehensive Exam(Closed Book)

No. of Questions: 9

No. of Pages : 4

Course Number& Title : EA C461 – Artificial Intelligence Marks : 40 Weightage : 40%

Duration : 3 Hours Date: 3 - 6 - 2013 Time: 8.30 AM – 11.30AM Year : IV year

Note : Answer All Questions and write the algorithm wherever asked for.

1. a. Discuss the working of the Recursive Best First Search (RBFS) algorithm.
- b. Explain how the algorithm works with the example of moving from Arad to Budapest given the following map of Romania and the heuristic (SLD to Bucharest) (2 + 4M)

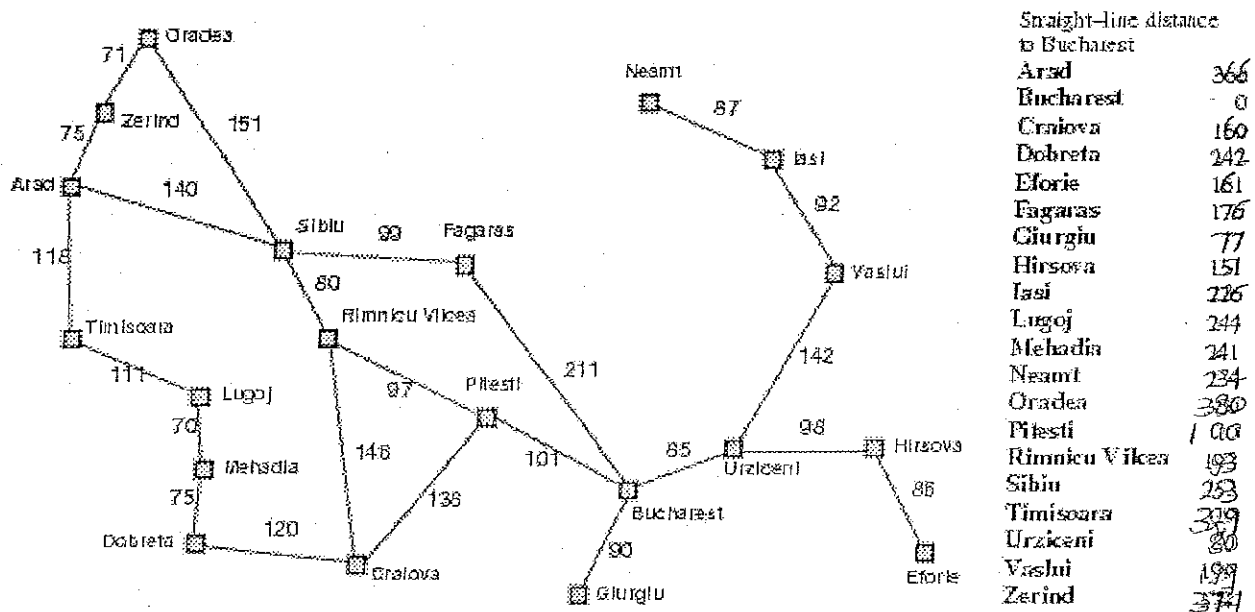


Figure 1

2. Represent the following sentences in First Order Logic and convert them to the conjunctive normal form. (2 + 2 + 1 + 1 M)
 - a. You can fool some of the people all of the time, and all of the people some of the time, but you can't fool all of the people all of the time.
 - b. An apple a day keeps the doctor away.

3. Explain the working of the Alpha – Beta pruning algorithm, and show how this algorithm works for the given search space. (2 + 2 M)

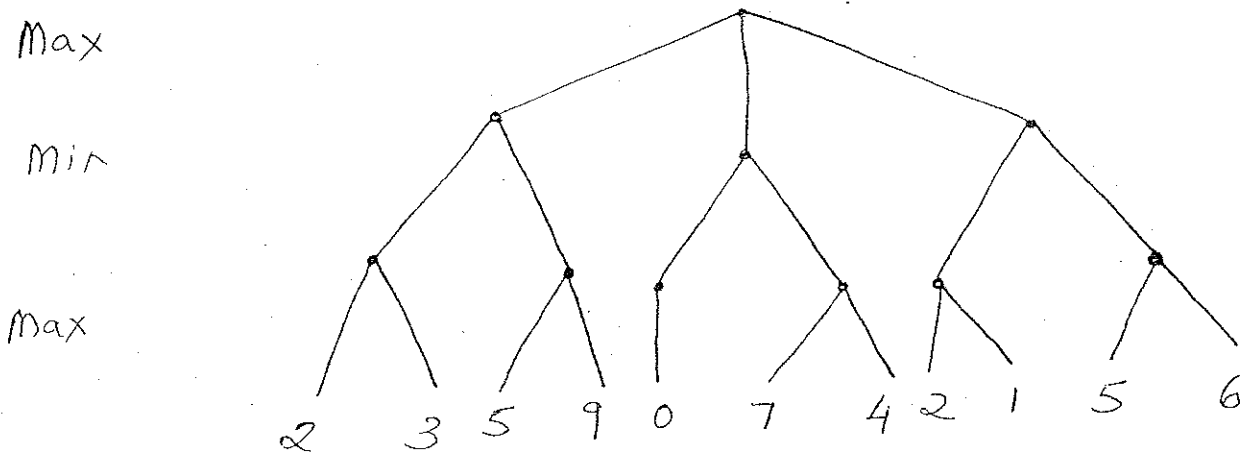
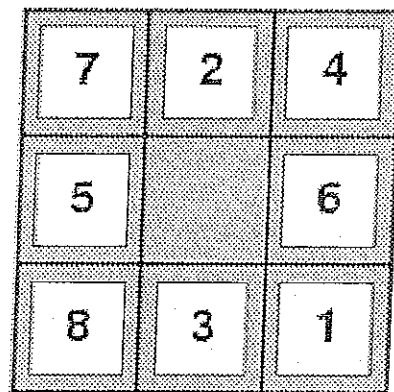
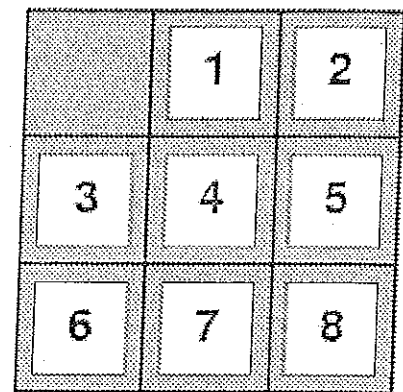


Figure 2

4. Given the start state and goal state of the given 8 tiles problem calculate the heuristic values h_1 and h_2 where h_1 is total number of misplaced tiles and h_2 is the Manhattan distance (i.e. the number of tiles from the desired location of each tile). (2 + 2M)



Start State



Goal State

Figure 3

5. Write LISP functions to perform the following operations, and show how you would invoke this function in LISP and give the output for some sample value which you consider.
- Find the factorial of a given number
 - To find the absolute value of a given number. (2 + 2M)

6. Given the following values, construct the Bayesian network and represent the corresponding values in the network. (3M)

$$\begin{aligned}P(\text{influenza}) &= 0.05 \\P(\text{smokes}) &= 0.2 \\P(\text{soreThroat}|\text{influenza}) &= 0.3 \\P(\text{soreThroat}|\neg\text{influenza}) &= 0.001 \\P(\text{fever}|\text{influenza}) &= 0.9 \\P(\text{fever}|\neg\text{influenza}) &= 0.05 \\P(\text{bronchitis}|\text{influenza} \wedge \text{smokes}) &= 0.99 \\P(\text{bronchitis}|\text{influenza} \wedge \neg\text{smokes}) &= 0.9 \\P(\text{bronchitis}|\neg\text{influenza} \wedge \text{smokes}) &= 0.7 \\P(\text{bronchitis}|\neg\text{influenza} \wedge \neg\text{smokes}) &= 0.0001 \\P(\text{coughing}|\text{bronchitis}) &= 0.8 \\P(\text{coughing}|\neg\text{bronchitis}) &= 0.07 \\P(\text{wheezing}|\text{bronchitis}) &= 0.6 \\P(\text{wheezing}|\neg\text{bronchitis}) &= 0.001\end{aligned}$$

7. A company has two plants to manufacture motorcycles. 70% motor cycles are manufactured at the first plant, while 30% are manufactured at the second plant. At the first plant, 80% motorcycles are rated of the standard quality while at the second plant, 90% are rated of standard quality. A motorcycle, randomly picked up, is found to be of standard quality. Find the probability that it has come out from the second plant. (3M)
8. a. What are the benefits of using Neural Networks (NN) commercially, explain with one example.
- b. The given Neural Network is designed to perform the logical EX-OR operation. Explain why a single layer NN cannot be used for this classification.
- c. The given NN is connected as a three layer (1 input, 1 hidden and 1 output layer) back propagation NN, give the weight corrections for this network for one epoch. Assume the inputs provided at x_1 and x_2 is 1 and the desired output of this NN is 0. (2 + 1 + 5M)

Please turn over for Figure

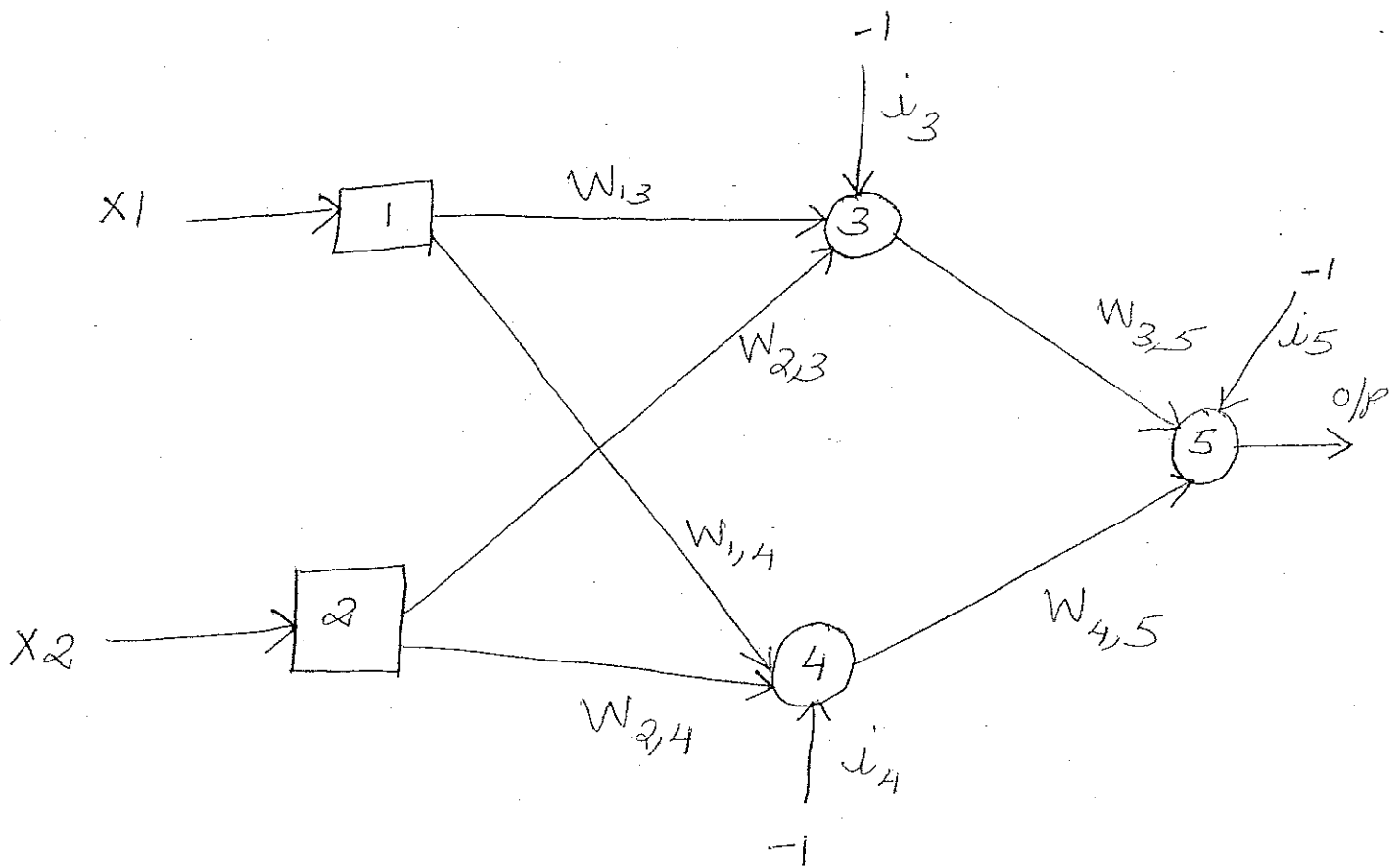


Figure 4

The values of the weights and the other inputs is specified as follows

$w_{1,3} = 0.5$, $w_{1,4} = 0.9$, $w_{2,3} = 0.4$, $w_{2,4} = 1.0$, $w_{3,5} = -1.2$, $w_{4,5} = 1.1$,

$i_3 = 0.8$, $i_4 = -0.1$, $i_5 = 0.3$.

9. Explain the following concepts as short notes

a. Function of hidden variables and the EM algorithm

b. Decision Trees as a learning method.

1 x 2 = 2M

***** ALL THE BEST *****

1. a - Algorithm
 b. Solution — see attached page

2. Predicate logic

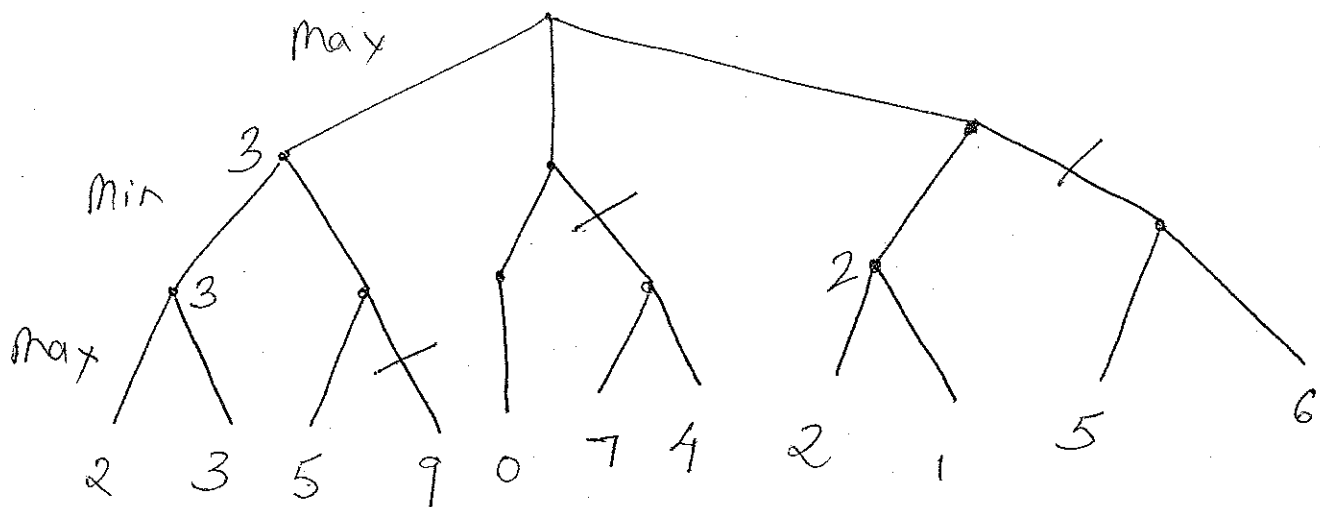
a) $\exists P(\forall T. \text{fooled}(P, T)) \wedge \forall P(\exists T \text{fooled}(P, T))$
 $\wedge \neg \forall P(\forall T \text{fooled}(P, T))$ — 2m

Convert to CNF — 2m.

b) Predicate logic

$\forall x : \text{person}(x) \wedge \text{eats}(x, \text{apple}) \rightarrow \text{away}(x, \text{data})$ — 1m

Convert to CNF — 1m.



4 - B. algorithm — 2m.

4. $h_1(s) = \textcircled{8} - 2m$ (2)

$$h_2(s) = 3 + 1 + 2 + 2 + 2 + 3 + 3 + 2$$

$$= \textcircled{18} - 2m$$

5. a. Factorial of a given number

(defun factorial (num)

(cond ((< num 0) 1)

(t (* (factorial (- num 1)) num))))

~~2m~~
1.5m

To call function (factorial 4) $\rightarrow 24$

b) To find the abs value of a number $\rightarrow 0.5m$

(defun abs (a)

(cond ((> a 0) a)

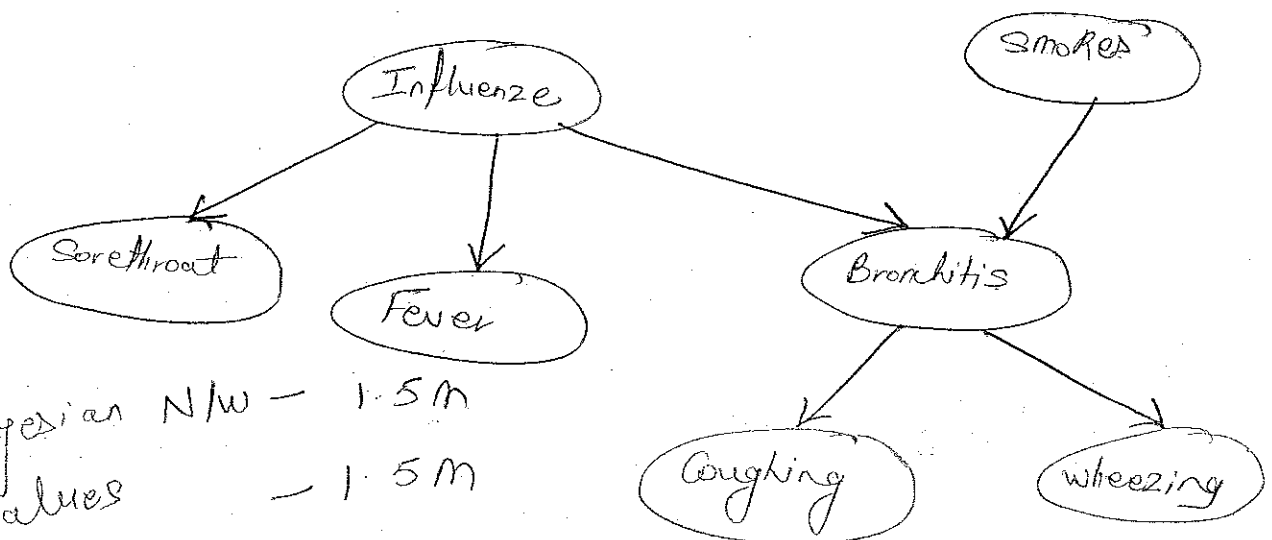
(t (-a)))))

1.5m

To invoke (abs 2) $\rightarrow 2$

(abs -3) $\rightarrow 3$ 0.5m

6.



7. A - Event that motorcycle is manufactured in plant 1 (3)

B - Event that motorcycle is manufactured in plant 2

E - Event that motorcycle is of standard quality

$$P(A) = \frac{70}{100} = \frac{7}{10}, \quad P(B) = \frac{30}{100} = \frac{3}{10}$$

$$P(E|A) = \frac{80}{100} = \frac{8}{10}, \quad P(E|B) = \frac{90}{100} = \frac{9}{10}$$

Using Bayes Theorem

$$P(B|E) = \frac{P(B) \cdot P(E|B)}{P(A) \cdot P(E|A) + P(B) \cdot P(E|B)}$$

$$= \frac{\frac{3}{10} \times \frac{9}{10}}{\frac{7}{10} \times \frac{8}{10} + \frac{3}{10} \times \frac{9}{10}}$$

$$= \frac{27}{56 + 27}$$

$$= \frac{27}{83}$$

8. a. Any one benefit of NN - 2m.

b. Single layer NN can be used to classify linearly separable patterns only explain - 1m.

c. See attached sheet for problem - 5m.

9. Short Notes $1 \times 2 = 2m$

function RECURSIVE-BEST-FIRST-SEARCH(*problem*) **returns** a solution, or failure
 RBFS(*problem*, MAKE-NODE(INITIAL-STATE[*problem*]), ∞)

function RBFS(*problem*, *node*, *f-limit*) **returns** a solution, or failure and a new *f*-cost limit

if GOAL-TEST[*problem*](*state*) **then return** *node*

successors \leftarrow EXPAND(*node*, *problem*)

if *successors* is empty **then return** failure, ∞

for each *s* **in** *successors* **do**

f[s] \leftarrow max(*g*(*s*) + *h*(*s*), *f*[*node*])

repeat

best \leftarrow the lowest *f*-value node in *successors*

 if *f*[*best*] > *f-limit* **then return** failure, *f*[*best*]

alternative \leftarrow the second-lowest *f*-value among *successors*

result, *f*[*best*] \leftarrow RBFS(*problem*, *best*, min(*f-limit*, *alternative*))

if *result* \neq failure **then return** *result*

Figure 4.5 The algorithm for recursive best-first search.

than continuing indefinitely down the current path, it keeps track of the *f*-value of the best alternative path available from any ancestor of the current node. If the current node exceeds this limit, the recursion unwinds back to the alternative path. As the recursion unwinds, RBFS replaces the *f*-value of each node along the path with the best *f*-value of its children. In this way, RBFS remembers the *f*-value of the best leaf in the forgotten subtree and can therefore decide whether it's worth reexpanding the subtree at some later time. Figure 4.6 shows how RBFS reaches Bucharest.

RBFS is somewhat more efficient than IDA*, but still suffers from excessive node re-generation. In the example in Figure 4.6, RBFS first follows the path via Rimnicu Vilcea, then "changes its mind" and tries Fagaras, and then changes its mind back again. These mind changes occur because every time the current best path is extended, there is a good chance that its *f*-value will increase—*h* is usually less optimistic for nodes closer to the goal. When this happens, particularly in large search spaces, the second-best path might become the best path, so the search has to backtrack to follow it. Each mind change corresponds to an iteration of IDA*, and could require many reexpansions of forgotten nodes to recreate the best path and extend it one more node.

Like A*, RBFS is an optimal algorithm if the heuristic function *h*(*n*) is admissible. Its space complexity is $O(bd)$, but its time complexity is rather difficult to characterize: it depends both on the accuracy of the heuristic function and on how often the best path changes as nodes are expanded. Both IDA* and RBFS are subject to the potentially exponential increase in complexity associated with searching on graphs (see Section 3.5), because they cannot check for repeated states other than those on the current path. Thus, they may explore the same state many times.

IDA* and RBFS suffer from using *too little* memory. Between iterations, IDA* retains only a single number: the current *f*-cost limit. RBFS retains more information in memory.

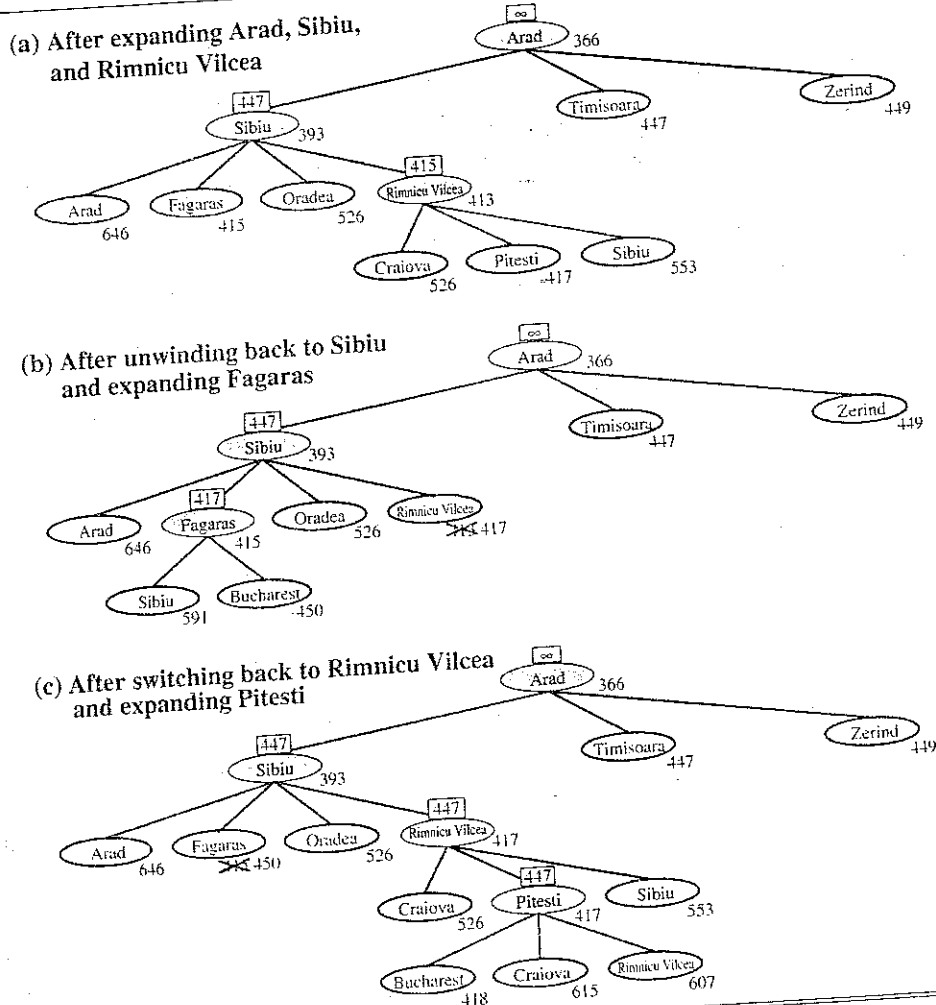


Figure 4.6 Stages in an RBFS search for the shortest route to Bucharest. The f -limit value for each recursive call is shown on top of each current node. (a) The path via Rimnicu Vilcea is followed until the current best leaf (Pitesti) has a value that is worse than the best alternative path (Fagaras). (b) The recursion unwinds and the best leaf value of the forgotten subtree (417) is backed up to Rimnicu Vilcea; then Fagaras is expanded, revealing a best leaf value of 450. (c) The recursion unwinds and the best leaf value of the forgotten subtree (450) is backed up to Fagaras; then Rimnicu Vilcea is expanded. This time, because the best alternative path (through Timisoara) costs at least 447, the expansion continues to Bucharest.

but it uses only $O(bd)$ memory: even if more memory were available, RBFS has no way to make use of it.

It seems sensible, therefore, to use all available memory. Two algorithms that do this are **MA*** (memory-bounded A*) and **SMA*** (simplified MA*). We will describe SMA*, which

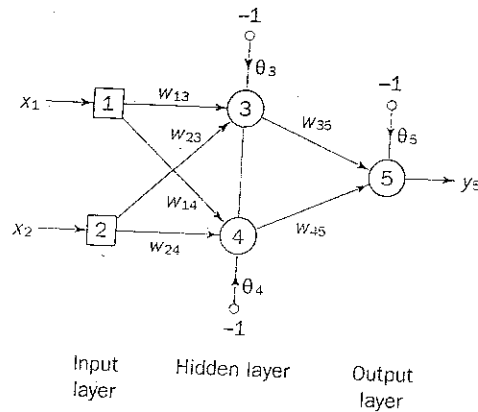


Figure 6.10 Three-layer network for solving the Exclusive-OR operation

The effect of the threshold applied to a neuron in the hidden or output layer is represented by its weight, θ , connected to a fixed input equal to -1 .

The initial weights and threshold levels are set randomly as follows:

$$w_{13} = 0.5, w_{14} = 0.9, w_{23} = 0.4, w_{24} = 1.0, w_{35} = -1.2, w_{45} = 1.1, \theta_3 = 0.8, \theta_4 = -0.1 \text{ and } \theta_5 = 0.3$$

Consider a training set where inputs x_1 and x_2 are equal to 1 and desired output y_{d5} is 0. The actual outputs of neurons 3 and 4 in the hidden layer are calculated as

$$y_3 = \text{sigmoid}(x_1 w_{13} + x_2 w_{23} - \theta_3) = 1/[1 + e^{-(1 \times 0.5 + 1 \times 0.4 - 1 \times 0.8)}] = 0.5250$$

$$y_4 = \text{sigmoid}(x_1 w_{14} + x_2 w_{24} - \theta_4) = 1/[1 + e^{-(1 \times 0.9 + 1 \times 1.0 + 1 \times 0.1)}] = 0.8808$$

Now the actual output of neuron 5 in the output layer is determined as

$$y_5 = \text{sigmoid}(y_3 w_{35} + y_4 w_{45} - \theta_5) = 1/[1 + e^{-(-0.5250 \times 1.2 + 0.8808 \times 1.1 - 1 \times 0.3)}] = 0.5097$$

Thus, the following error is obtained:

$$e = y_{d5} - y_5 = 0 - 0.5097 = -0.5097$$

The next step is weight training. To update the weights and threshold levels in our network, we propagate the error, e , from the output layer backwards to the input layer.

First, we calculate the error gradient for neuron 5 in the output layer:

$$\delta_5 = y_5(1 - y_5)e = 0.5097 \times (1 - 0.5097) \times (-0.5097) = -0.1274$$

Then we determine the weight corrections assuming that the learning rate parameter, α , is equal to 0.1:

$$\Delta w_{35} = \alpha \times y_3 \times \delta_5 = 0.1 \times 0.5250 \times (-0.1274) = -0.0067$$

$$\Delta w_{45} = \alpha \times y_4 \times \delta_5 = 0.1 \times 0.8808 \times (-0.1274) = -0.0112$$

$$\Delta \theta_5 = \alpha \times (-1) \times \delta_5 = 0.1 \times (-1) \times (-0.1274) = 0.0127$$

Next we calculate the error gradients for neurons 3 and 4 in the hidden layer:

$$\delta_3 = y_3(1 - y_3) \times \delta_5 \times w_{35} = 0.5250 \times (1 - 0.5250) \times (-0.1274) \times (-1.2) = 0.0381$$

$$\delta_4 = y_4(1 - y_4) \times \delta_5 \times w_{45} = 0.8808 \times (1 - 0.8808) \times (-0.1274) \times 1.1 = -0.0147$$

We then determine the weight corrections:

$$\Delta w_{13} = \alpha \times x_1 \times \delta_3 = 0.1 \times 1 \times 0.0381 = 0.0038$$

$$\Delta w_{23} = \alpha \times x_2 \times \delta_3 = 0.1 \times 1 \times 0.0381 = 0.0038$$

$$\Delta \theta_3 = \alpha \times (-1) \times \delta_3 = 0.1 \times (-1) \times 0.0381 = -0.0038$$

$$\Delta w_{14} = \alpha \times x_1 \times \delta_4 = 0.1 \times 1 \times (-0.0147) = -0.0015$$

$$\Delta w_{24} = \alpha \times x_2 \times \delta_4 = 0.1 \times 1 \times (-0.0147) = -0.0015$$

$$\Delta \theta_4 = \alpha \times (-1) \times \delta_4 = 0.1 \times (-1) \times (-0.0147) = 0.0015$$

At last, we update all weights and threshold levels in our network:

$$w_{13} = w_{13} + \Delta w_{13} = 0.5 + 0.0038 = 0.5038$$

$$w_{14} = w_{14} + \Delta w_{14} = 0.9 - 0.0015 = 0.8985$$

$$w_{23} = w_{23} + \Delta w_{23} = 0.4 + 0.0038 = 0.4038$$

$$w_{24} = w_{24} + \Delta w_{24} = 1.0 - 0.0015 = 0.9985$$

$$w_{35} = w_{35} + \Delta w_{35} = -1.2 - 0.0067 = -1.2067$$

$$w_{45} = w_{45} + \Delta w_{45} = 1.1 - 0.0112 = 1.0888$$

$$\theta_3 = \theta_3 + \Delta \theta_3 = 0.8 - 0.0038 = 0.7962$$

$$\theta_4 = \theta_4 + \Delta \theta_4 = -0.1 + 0.0015 = -0.0985$$

$$\theta_5 = \theta_5 + \Delta \theta_5 = 0.3 + 0.0127 = 0.3127$$

The training process is repeated until the sum of squared errors is less than 0.001.

Why do we need to sum the squared errors?

The sum of the squared errors is a useful indicator of the network's performance. The back-propagation training algorithm attempts to minimise this criterion. When the value of the sum of squared errors in an entire pass through all

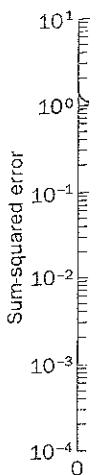


Figure 6.11 Learning curve

training sets, converged. In defined as less squared errors learning curve:

It took 224 Exclusive-OR outputs satisfied the criterion.

$$w_{13} = 4.7621$$

$$w_{45} = 9.7691$$

The network presenting all the results shown in Table

Table 6.4 Final

Inputs	
x_1	x_2
1	1
0	1
1	0
0	0

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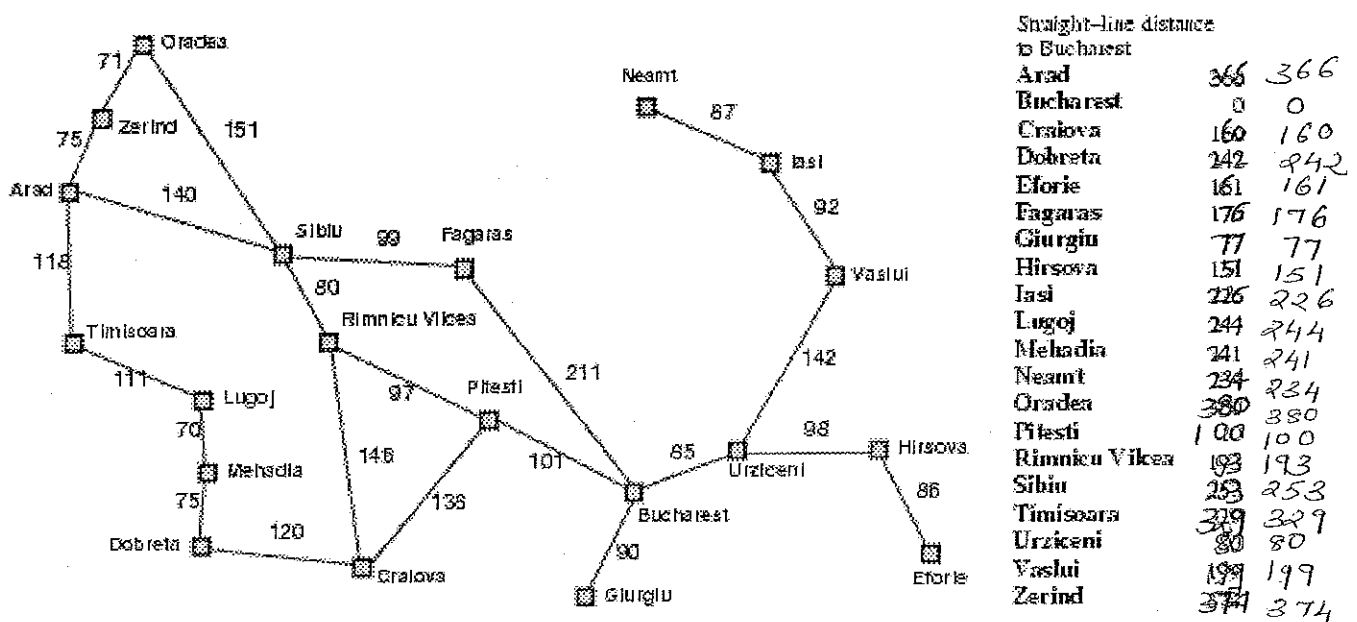


Figure 1

2. Represent the following sentences in First Order Logic and convert them to the conjunctive normal form. (2 + 2 + 1 + 1 M)
 - a. You can fool some of the people all of the time, and all of the people some of the time, but you can't fool all of the people all of the time.
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3. Explain the working of the Alpha – Beta pruning **algorithm**, and show how this algorithm works for the given search space. (2 + 2 M)

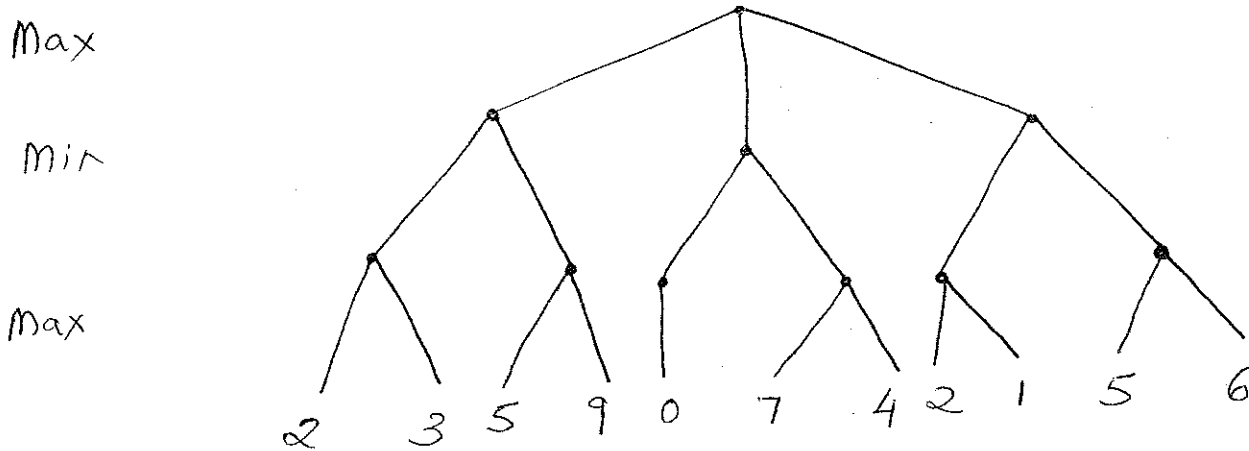


Figure 2

4. Given the start state and goal state of the given 8 tiles problem calculate the heuristic values h_1 and h_2 where h_1 is total number of misplaced tiles and h_2 is the Manhattan distance (i.e the number of tiles from the desired location of each tile) . (2 + 2M)

7	2	4
5		6
8	3	1

Start State

	1	2
3	4	5
6	7	8

Goal State

5. Write LISP functions to perform the following operations, and show how you would invoke this function in LISP and give the output for some sample value which you consider.
- Find the factorial of a given number
 - To find the absolute value of a given number. (2 + 2M)

6. Given the following values, construct the Bayesian network and represent the corresponding values in the network. (3M)

$$P(\text{influenza}) = 0.05$$

$$P(\text{smokes}) = 0.2$$

$$P(\text{soreThroat}|\text{influenza}) = 0.3$$

$$P(\text{soreThroat}|\neg\text{influenza}) = 0.001$$

$$P(\text{fever}|\text{influenza}) = 0.9$$

$$P(\text{fever}|\neg\text{influenza}) = 0.05$$

$$P(\text{bronchitis}|\text{influenza} \wedge \text{smokes}) = 0.99$$

$$P(\text{bronchitis}|\text{influenza} \wedge \neg\text{smokes}) = 0.9$$

$$P(\text{bronchitis}|\neg\text{influenza} \wedge \text{smokes}) = 0.7$$

$$P(\text{bronchitis}|\neg\text{influenza} \wedge \neg\text{smokes}) = 0.0001$$

$$P(\text{coughing}|\text{bronchitis}) = 0.8$$

$$P(\text{coughing}|\neg\text{bronchitis}) = 0.07$$

$$P(\text{wheezing}|\text{bronchitis}) = 0.6$$

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7. A company has two plants to manufacture motorcycles. 70% motor cycles are manufactured at the first plant, while 30% are manufactured at the second plant. At the first plant, 80% motorcycles are rated of the standard quality while at the second plant, 90% are rated of standard quality. A motorcycle, randomly picked up, is found to be of standard quality. Find the probability that it has come out from the second plant. (3M)
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Please turn over for Figure

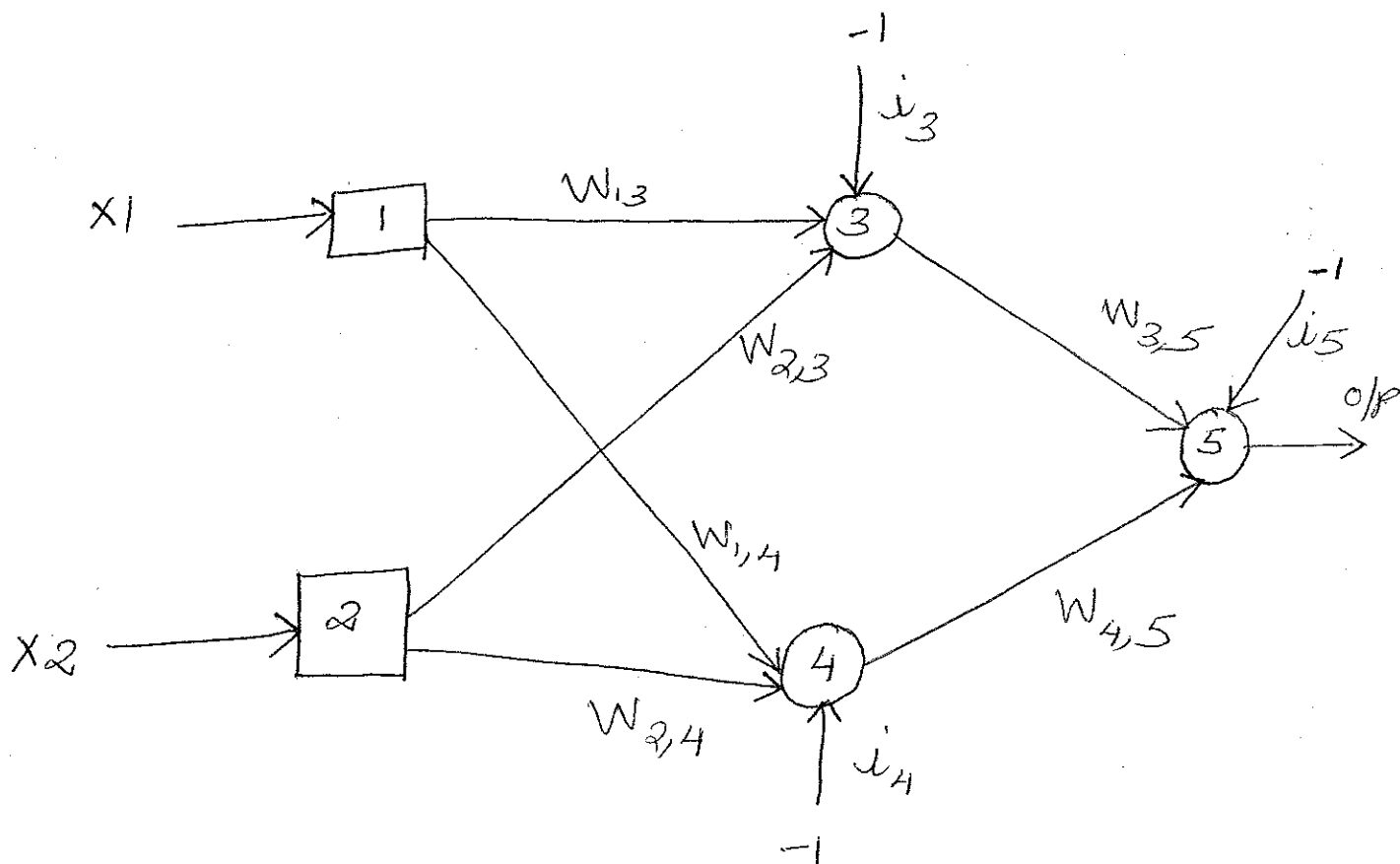


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$i_3 = 0.8$, $i_4 = -0.1$, $i_5 = 0.3$.

9. Explain the following concepts as short notes

- Function of hidden variables and the EM algorithm
- Decision Trees as a learning method.

1 x 2 = 2M

***** ALL THE BEST *****

Give the op of the following LISP programs

1) `(setq a '(John Peter))`

`(car a)` \rightarrow John

`(cadr a)` \rightarrow Peter

2) `(setq a (cons 'b (cons 'c nil)))`
`(caddr a)`

3) `(setq v (list a 34 25))`
`(caddr v)`

4) `(append '(1 2) '(2 3))`
`(1 2 2 3)`

5) `(setq bar '(a b c))`
`(caddr bar)`

`(setq foo (cadr bar))`
`(b c)`

E - Event that the rugby team member tests positive

F - Event that the rugby team member uses steroid.

$$P(E|F) = 0.95 \quad P(F) = 0.1$$

$$P(E|F') = 0.15 \quad P(F') = 0.9$$

$$P(F|E) = \frac{P(E|F) \cdot P(F)}{P(E|F) \cdot P(F) + P(E|F') \cdot P(F')}$$

$$= \frac{0.95 \times 0.1}{0.95 \times 0.1 + 0.15 \times 0.9}$$

$$= \underline{\underline{0.4130}}$$

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Test – 2(Open Book)

No. of Questions: 6

No. of Pages : 3

Course Number& Title : EA C461 – Artificial Intelligence Marks : 20 Weightage : 20%

Duration : 50 minutes Date: 1- 5- 2013 Time: 7.30 AM – 8.20AM Year : IV year

Note : Answer All Questions

1. In your local nuclear power station, there is an alarm that senses when a temperature gauge exceeds a given threshold. The gauge measures the temperature of the core. Consider the Boolean variables A (alarm sounds), FA (alarm is faulty), FG (gauge is faulty) and the multivalued nodes G (gauge reading) and T (actual core temperature).

i) Draw a Bayesian network for this domain, given that the gauge is more likely to fail when the core temperature gets too high.

ii) Is your network a polytree ?

iii) Suppose there are just two possible actual and measured temperatures, normal and high, the probability that the gauge gives the correct temperature is x when it is working, but y when it is faulty. Give the conditional probability table associated with G. (2 + 1 + 3M)

2. A manufacturer claims that its drug test will detect steroids (i.e. show positive for an athlete who uses steroid) 95% of the time(true positive)What the company does not tell you is that 15% of all steroid free individuals also test positive (false positive). 10 % of the rugby team members use steroids. Your friend in the rugby team has tested positive. What is the probability that he uses steroid ? 3M

3. Give the output of the following LISP statements. Assume these statements are executed sequentially.

i) (setq a '(John Peter))

(car a)

(cdr a)

ii) (setq a (cons 'b (cons 'c nil)))

iii) (setq v (list a 34 25))

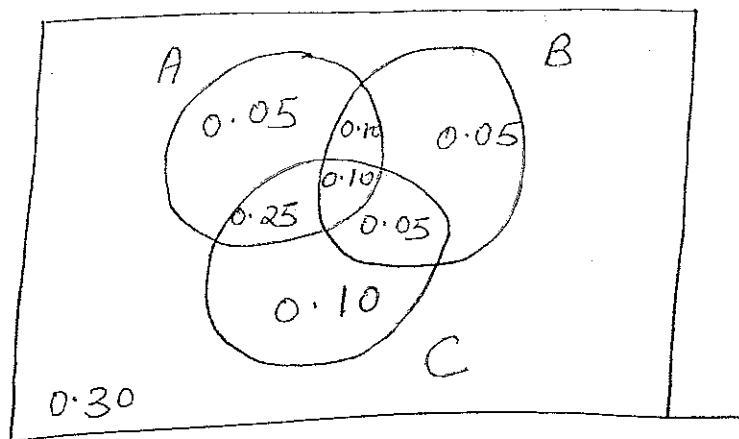
iv) (setq bar '(a b c))

(setq foo (cdr bar))

0.5 X 4 = 2M

4. Represent the following facts about the garment business. Each of these garments is manufactured by a manufacturer. The manufacturer supplies the finished products to retailers as well as to the whole sale market. A specific manufacturer manufactures a certain brand. Each brand can have a number of different items (e.g. pant, shirts, t-shirts etc) and each of these items have certain attributes (e.g. colour, fabric, size, cost etc) 3M

5. Given the following Venn diagram draw the joint probability distribution table. 3M



6. A survey is conducted on a mixed population of a sample size of 50 people to study the cause for increased hypertension in the present day. The different factors considered are specified in one sample survey given in page 3. Draw the decision tree to represent the study of your survey, remember you need not consider all attributes you can ignore attributes you consider insignificant. 3M

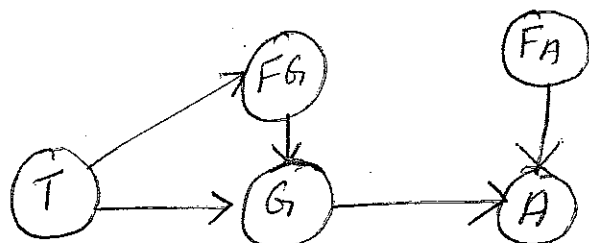
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Community Health Survey: Hypertension Study (California, USA)	
Gender	<input checked="" type="checkbox"/> Male <input type="checkbox"/> Female
Age	<input type="checkbox"/> 18-34 years <input type="checkbox"/> 35-50 years <input checked="" type="checkbox"/> 51-64 years <input type="checkbox"/> 65 or more years
Race	<input checked="" type="checkbox"/> Caucasian <input type="checkbox"/> African American <input type="checkbox"/> Hispanic <input type="checkbox"/> Asian or Pacific Islander
Marital status	<input type="checkbox"/> Married <input type="checkbox"/> Separated <input checked="" type="checkbox"/> Divorced <input type="checkbox"/> Widowed <input type="checkbox"/> Never married
Household income	<input type="checkbox"/> Less than \$20,700 <input type="checkbox"/> \$20,701-\$45,000 <input checked="" type="checkbox"/> \$45,001-\$75,000 <input type="checkbox"/> \$75,001 and over
Alcohol consumption	<input type="checkbox"/> Abstain from alcohol <input type="checkbox"/> Occasional (a few drinks per month) <input checked="" type="checkbox"/> Regular (one or two drinks per day) <input type="checkbox"/> Heavy (three or more drinks per day)
Smoking	<input type="checkbox"/> Nonsmoker <input type="checkbox"/> 1-10 cigarettes per day <input checked="" type="checkbox"/> 11-20 cigarettes per day <input type="checkbox"/> More than one pack per day
Caffeine intake	<input type="checkbox"/> Abstain from coffee <input checked="" type="checkbox"/> One or two cups per day <input type="checkbox"/> Three or more cups per day
Salt intake	<input type="checkbox"/> Low-salt diet <input checked="" type="checkbox"/> Moderate-salt diet <input type="checkbox"/> High-salt diet
Physical activities	<input type="checkbox"/> None <input checked="" type="checkbox"/> One or two times per week <input type="checkbox"/> Three or more times per week
Height	<input type="text" value="178"/> cm
Weight	<input type="text" value="93"/> kg
Blood pressure	<input type="checkbox"/> Optimal <input type="checkbox"/> Normal <input checked="" type="checkbox"/> High
Obesity	<input checked="" type="checkbox"/> Obese <input type="checkbox"/> Not obese

Figure 10.27 A data set for a hypertension study

Marking Scheme

i)



2M

ii) Not a polytree because there are 2 ways to reach node G 1M

iii)

	T = Normal		T = High	
	F_G	$\neg F_G$	F_G	$\neg F_G$
$G = \text{Normal}$	y	x	$1-y$	$1-x$
$G = \text{High}$	$1-y$	$1-x$	y	x

3M

2. E - Event that rugby team member tests +ve
F - Event that rugby team member uses steroid

$$P(E|F) = 0.95$$

$$P(F) = 0.1$$

$$P(E|F') = 0.15$$

$$P(F') = 0.9$$

3M

$$\begin{aligned}
 P(F|E) &= \frac{P(E|F) \cdot P(F)}{P(E|F) \cdot P(F) + P(E|F') \cdot P(F')} \\
 &= \frac{0.95 \times 0.1}{0.95 \times 0.1 + 0.15 \times 0.9} = \underline{\underline{0.4130}}
 \end{aligned}$$

3. i) (car a) \rightarrow John 0.25

(cdr a) \rightarrow Peter 0.25

ii) (b c) 0.5

iii) (b c 34 25) 0.5

iv) (b c) 0.5

4. Semantic N/w representation — 3M

5.

A	B	C	Prob
0	0	0	0.30
0	0	1	0.05 0.10
0	1	0	0.10 0.05
0	1	1	0.05
1	0	0	0.05
1	0	1	0.10 0.25
1	1	0	0.25 0.10
1	1	1	0.10

6. Decision tree — 3M

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Second Semester 2012-13
Test – 1(Closed Book)

No. of Questions: 4

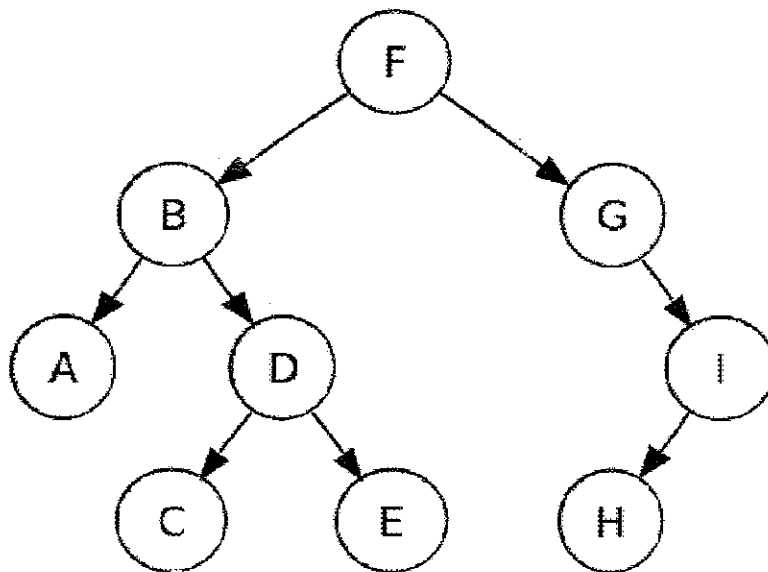
No. of Pages : 2

Course Number& Title : EA C461 – Artificial Intelligence Marks : 25 Weightage : 25%

Duration : 50 minutes Date: 13- 3-2013 Time:7.30 AM – 8.20AM Year : IV year

Note : Answer All Questions

1. Consider the following graph, where F indicates the start state and C, E, H are goal states, give the order in which nodes are expanded in each of the following techniques and indicate the goal state reached. The heuristic values are as specified. $h(f)=5$, $h(a)=3$, $h(b)=4$, $h(c)=0$, $h(d)=2$, $h(e)=0$, $h(g)=9$, $h(i)=5$, $h(h)=0$. Assume that the path cost of each move is 1.



i) BFS ii) DFS iii) Iterative Deepening Search iv) Best First Search (using $f=h$) v) A* using ($f=g+h$)
5M

b. Compare the following four algorithms on basis of the following four evaluation factors used to compare algorithms. Complete, Time, Space and Optimal.

i) BFS ii) DFS iii) Depth limited search iv) Bidirectional search 4M

2. Consider a 3 X 3 tic tac toe game. Where alternate players take turns and play, there is an additional possibility of a player passing his turn, draw the search space up to a depth of three . You need not represent states which are reflections of siblings nodes are already shown.

i) The evaluation function is given by the number of O's – the number of X's, show the evaluation function for each node.

ii) Indicate how minmax algorithm would have decided its moves.

iii) Indicate any nodes that will be pruned by the alpha beta pruning technique.

iv) Explain how the efficiency of Alpha Beta pruning can be improved if there is some ordering of the nodes. 4M

3. a. Represent the following facts using propositional logic, use a truth table to show these facts and justify if the statement is valid, satisfiable or contradiction, justify your answer.

If philosophy is hard, then logic is hard .

If logic is hard, philosophy is interesting .

Therefore

If philosophy is hard then philosophy is interesting. 3M

b. State if the given proposition is true or false using truth tables.

$(C \vee (\neg A \wedge \neg B)) = ((A \rightarrow C) \wedge (B \rightarrow C))$. 3M

4. a. Explain the working of the Hill Climbing Search Technique with the example of a 8 tile problem, consider the state to be as given below. Assume evaluation functions for each state and explain the following terms i) Plateau ii) local maximum iii) current state iv) under what condition would the algorithm stop. 4M

1	3	5
2	6	
4	7	8

b. Explain the working of three player games with an example. 2M

EA C461

Test 1

13.3.13 Open Book

i) BFS - F, B, G, A, D, I, C → stop

ii) DFS - F, B, G, A, D, C → stop

iii) Iterative Deepening Search

F

F B G

F B G A D I

F B G A D I C - stop

iv) ~~BFS~~ (Best First Search)

B, D, / either C or E

1 x 5 = 5m

v) A*

open : F

closed []

open B4, G9

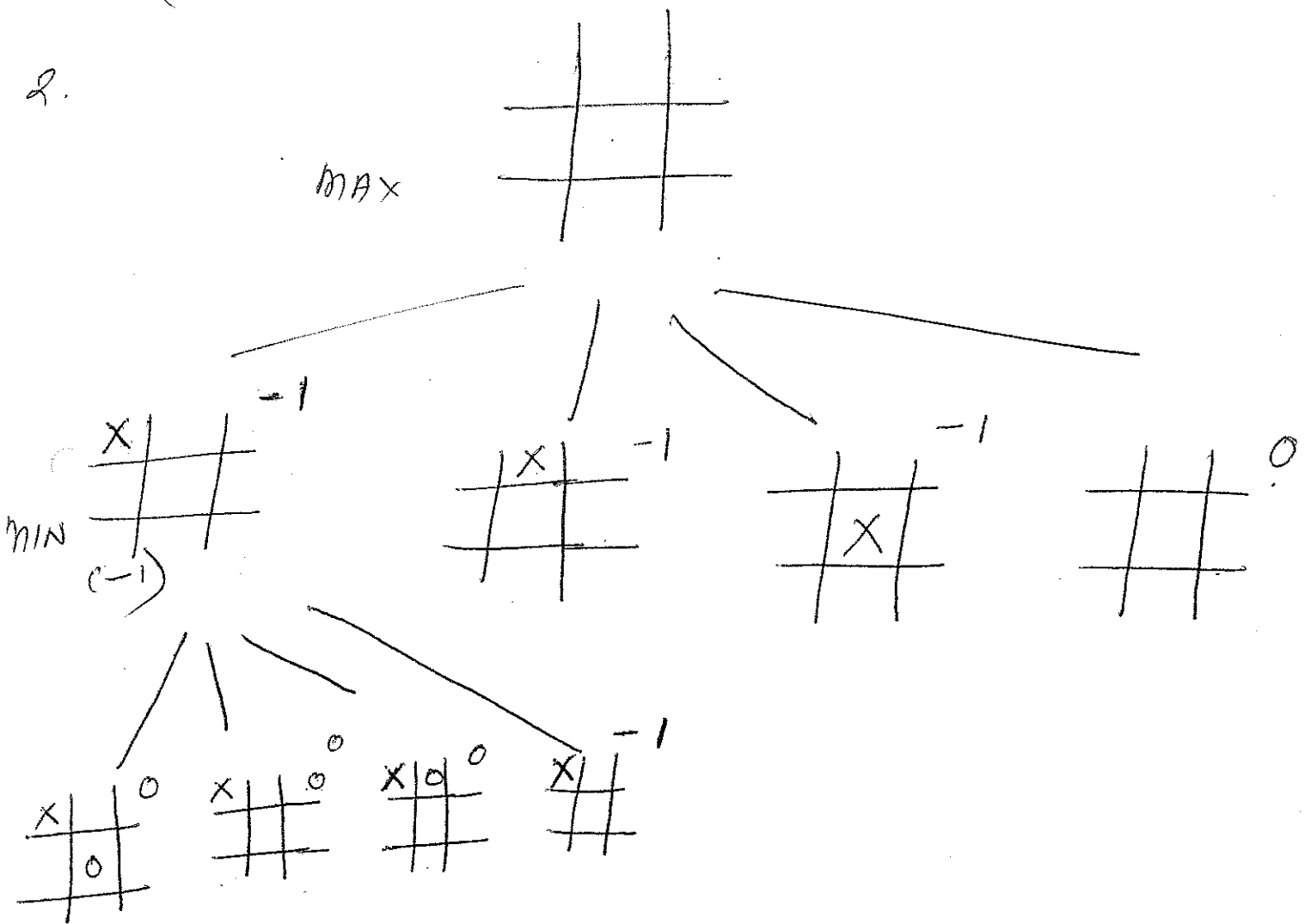
closed F

open D2, A3, G9

closed ~~B~~F, B

open C/E → goal state.

b) Table to compare 4 methods on 4 criteria
 $(4 \times 0.25 = 1m) \times 4 = 4m$



i) Minimax — Selects 0 and then

ii) Alpha Beta - Pruning

iii) If nodes are ordered pruning is more efficient
 if the first node itself helps pruning.

3. Philosophy is hard : P
 Logic is hard : L
 Philosophy is interesting I
 $P \rightarrow L$

$L \rightarrow I$

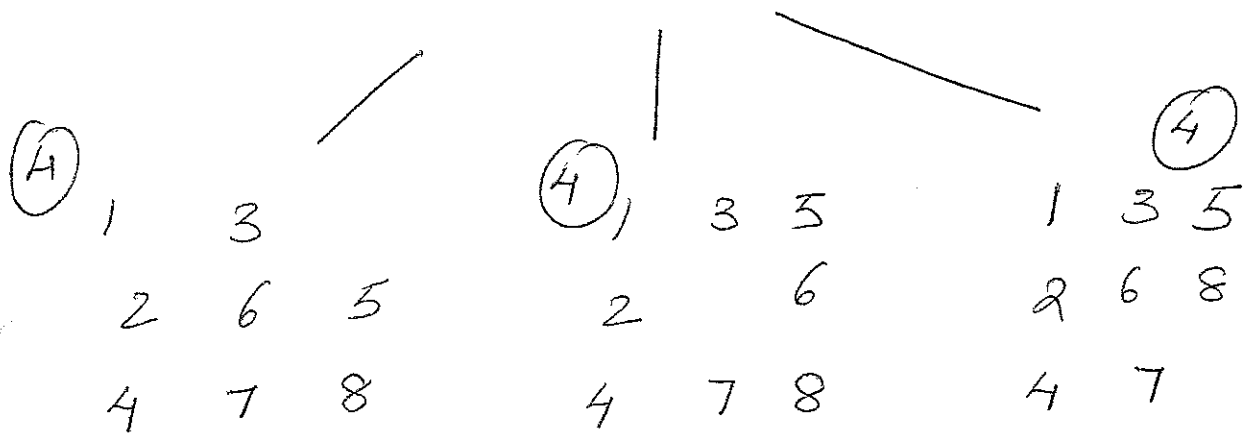
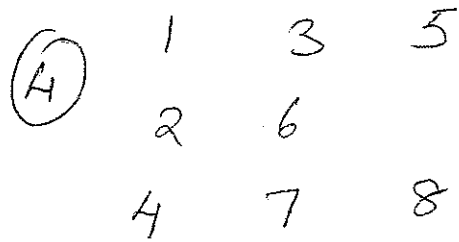
$\therefore P \rightarrow I$

P	L	I	$\neg P \vee L$	$\neg L \vee I$	$\neg P \vee I$
F	F	F			T
F	F	T			T
F	T	F			T
F	T	T			T
T	F	F			F
T	F	T			T
T	T	F			F
T	T	T			T

\therefore Satisfiable since some conditions are true

b) True

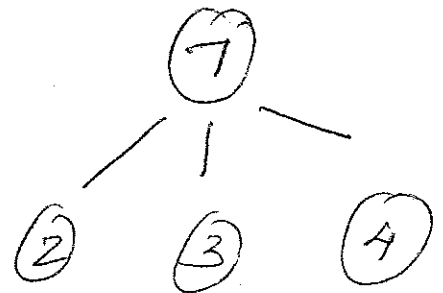
4. a. Hill Climbing Search.



plateau - Every successor state is only as good as the current state

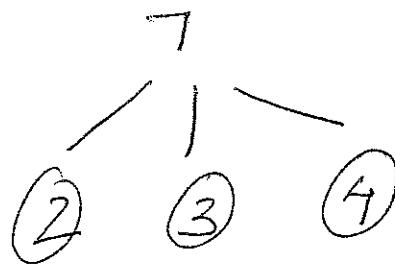
ii) local maximum.
if evaluation fn is

i.e the current state is better than the successive states



iii) current state - Is the state of the game space.

v) The algorithm stops if i.e the successive state is worse than the current state hence the game stops and restarts.



Three player game - explain qm

4

A	B	C	$\neg A \wedge \neg B$	$C \vee (\neg A \wedge \neg B)$ ($A \rightarrow C$)
F	F	F	T	T
F	F	T	T	T
F	T	F	F	F
F	T	T	F	T
T	F	F	F	F
T	F	T	F	T
T	T	F	F	F
T	T	T	F	T

$A \rightarrow C$	$B \rightarrow C$	$(A \rightarrow C) \wedge (B \rightarrow C)$
T	T	T
T	T	T
T	F	F
T	T	T
F	T	F
T	T	T
F	F	F
T	T	T

hence $C \vee (\neg A \wedge \neg B) \equiv (A \rightarrow C) \wedge (B \rightarrow C)$

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Quiz – 2(Closed Book)

No. of Questions: 3

No. of Pages : 2

Name: _____

ID NO: _____

Course Number & Title : EA C461 – Artificial Intelligence Marks : 7 Weightage : 7%

Duration: 20 minutes Date: 21 5-2013 Time: 11.30 AM – 11.50 AM Year: IV year

1. Explain the concept of specialization and generalization in learning with the help of a figure. Further explain how this concept is applied when knowledge is represented in predicate logic. 1 + 1 M

2. A Neural network is designed to identify if a car will start or not. The input parameters specified are a series of 5 inputs (fuel, battery, ignition, weather, spark plug,) . Draw only the fig for parts a and b.
- Design a network which uses the competitive learning algorithm.
 - Design the network for the above problem using the back propagation algorithm with two hidden layers. [1 + 1M]

3. Give a brief write up of an interesting application where Artificial Intelligence is used. [Roughly 50-60 words you can draw a fig if it will help in your explanation]
3M

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Second Semester 2012-13
Quiz – 2(Closed Book)

No. of Questions: 3

No. of Pages : 2

Name: _____

ID NO: _____

Course Number& Title : EA C461 – Artificial Intelligence Marks : 7 Weightage : 7%

Duration: 20 minutes Date: 21 5-2013 Time: 11.30 AM –11.50AM Year: IV year

1. Explain the concept of specialization and generalization in learning with the help of a figure. Further explain how this concept is applied when knowledge is represented in predicate logic. 1 + 1 M

Specialization – 0.5

Generalization – 0.5

Predicate logic – 0.5 + 0.5

2. A Neural network is designed to identify if a car will start or not. The input parameters specified are a series of 5 inputs (fuel, battery, ignition, weather, spark plug,) . Draw only the fig for parts a and b.
- Design a network which uses the competitive learning algorithm.
 - Design the network for the above problem using the back propagation algorithm with two hidden layers. [1 + 1M]

(Competitive) Design of n/w – 1m
Back Propagation " – 1m

3. Give a brief write up of an interesting application where Artificial Intelligence is used. [Roughly 50-60 words you can draw a fig if it will help in your explanation]
3M

Any application explanation - 3m

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Second Semester 2012-13
Quiz – 1(Closed Book)

No. of Questions: 3

No. of Pages : 2

Name: _____

ID NO: _____

Course Number& Title : EA C461 – Artificial Intelligence Marks : 8 Weightage : 8%

Duration: 20 minutes Date: 2- 4-2013 Time: 11.30 AM –11.50AM Year: IV year

1. Represent the following information using statements in predicate logic

Horses are faster than dogs. There is a greyhound that is faster than every rabbit.
Harry is a horse. Ralph is a rabbit.

Now prove that Harry is faster than Ralph. Check if the information specified in the statements is sufficient to derive the proof, else add the required information to complete the proof.

4M

P.T.O

2. Represent the following information using predicate logic and convert it into the conjunctive normal form. " Every person has a brain". 2.5M
3. Represent the following statement in predicate logic " All blocks which are on top of or attached to blocks which have been moved, have also moved". 1.5M

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Second Semester 2012-13
Quiz – 1 (Closed Book)

No. of Questions: 3

No. of Pages : 2

Course Number & Title : EA C461 – Artificial Intelligence Marks : 8 Weightage : 8%

Duration: 20 minutes Date: 2- 4-2013 Time: 11.30 AM – 11.50 AM Year: IV year

1. Represent the following information using statements in predicate logic

Horses are faster than dogs. There is a greyhound that is faster than every rabbit.
 Harry is a horse. Ralph is a rabbit.

Now prove that Harry is faster than Ralph. Check if the information specified in the statements is sufficient to derive the proof, else add the required information to complete the proof. 4M

1. $\forall x \forall y : \text{Horses}(x) \wedge \text{Dog}(y) \rightarrow \text{Faster}(x, y)$

2. $\exists y : \text{Greyhound}(y) \wedge \forall z : \text{Rabbit}(z) \rightarrow \text{Faster}(y, z)$

3. $\text{Horse}(\text{Harry})$

4. $\text{Rabbit}(\text{Ralph})$

Add information that "All Greyhounds are dogs"

$\forall y : \text{Greyhound}(y) \rightarrow \text{Dog}(y)$

Substituting in ①

$\text{Horses}(x) \wedge \text{Greyhound}(y) \rightarrow \text{Faster}(x, y) \rightarrow \textcircled{4}$

In ② Substituting $\exists y : \text{Greyhound}(y)$ with $\text{Greyhound}(\text{Greg})$

P.T.O

$\text{Greyhound}(\text{Greg}) \wedge (\text{Rabbit}(z) \rightarrow \text{Faster}(\text{Greg}, z))$

Substituting ③
 $\text{Greyhound}(\text{Greg}) \wedge \text{Rabbit}(\text{Ralph}) \rightarrow \text{Faster}(\text{Greg}, \text{Ralph})$

Substituting in ④
 $\text{Horses}(\text{Harry}) \wedge \text{Greyhound}(\text{Greg}) \rightarrow \text{Faster}(\text{Harry}, \text{Greg})$

From (5) and (6) we infer that:

Faster (Harry, Ralph)

2. Represent the following information using predicate logic and convert it into the conjunctive normal form. "Every person has a brain". 2.5M

$$\forall x: \text{Person}(x) \rightarrow \exists y \text{Brain}(y) \wedge \text{Has}(x, y)$$

To convert to CNF form

$$\forall x: \neg \text{Person}(x) \vee \exists y \text{Brain}(y) \wedge \text{has}(x, y)$$

Skolemize

$$\forall x: \neg \text{Person}(x) \vee \text{Brain}(B) \wedge \text{has}(x, B)$$

Drop \forall :

$$\neg \text{Person}(x) \vee (\text{Brain}(B) \wedge \text{has}(x, B))$$

$$\neg \text{Person}(x) \vee \text{Brain}(B) \wedge$$

$$\neg \text{Person}(x) \vee \text{has}(x, B)$$

3. Represent the following statement in predicate logic "All blocks which are on top of or attached to blocks which have been moved, have also moved". 1.5M

$$\forall x: \forall y: \text{Block}(x) \wedge \text{Block}(y) \wedge \text{ontop}(x, y) \wedge \text{attached}(x, y) \wedge \text{moved}(y) \rightarrow \text{moved}(x)$$