CS-171, Intro to A.I. — Final Exam — Winter Quarter, 2014

NAME AND EMAIL ADDRESS: ____

YOUR ID: ________ ID TO RIGHT:________ ROW:_____ SEAT NO.: _____

The exam will begin on the next page. Please, do not turn the page until told.

When you are told to begin the exam, please check first to make sure that you have all 10 pages, as numbered 1-10 in the bottom-left corner of each page.

The exam is closed-notes, closed-book. No calculators, cell phones, electronics.

Please clear your desk entirely, except for pen, pencil, eraser, an optional blank piece of paper (for optional scratch pad use), and an optional water bottle.
Please turn off all cell phones now.

This page summarizes the points available for each question so you can plan your time.

1. (20 pts total, 5 pts each) Train/Test Sets, Accuracy, Overfitting.

2. (15 pts total, 5 pts each) Bayesian Networks.

3. (10 pts total) Mini-Max, Alpha-Beta Pruning.

4. (10 points total, 2 pts each) Constraint Satisfaction Problems.

5. (10 pts total, 2 pts each) Execute Tree Search.

6. (10 pts total) The Horned And Magical Unicorn.

7. (10 pts total, 1 pt each) ENGLISH TO FOPC CONVERSION.

8. Logic Concepts (6 pts total, 1 pt each).

9. Probability concepts and formulae (9 pts total, 1 pt each).

The Exam is printed on both sides to save trees! Work both sides of each page!

1. (20 pts total, 5 pts each) Train/Test Sets, Accuracy, Overfitting.

You are working on Face Recognition Problem, and you got the following result.

Table 1. Accuracies for each algorithm

	Nearest Neighbor	Decision Tree	Neural Network	Support Vector Machine
Accuracy on training data	70%	80%	85%	75%
Accuracy on testing data	65%	70%	60%	75%

1a. (5 pts) Which algorithm is the best algorithm (choose from 1-4 below)? ________________.

1) Nearest Neighbor
2) Decision Tree
3) Neural Network
4) Support Vector Machine

1b. (5 pts) Which algorithm is overfitting the most (choose from 1-4 below)?________________.

1) Nearest Neighbor
2) Decision Tree
3) Neural Network
4) Support Vector Machine

1c. (5 pts) Next you decided to use 3 fold cross validation method on your data. You split your data into three parts, data1, data2, and data3. You need to run your machine learning algorithm three times with different training/test data for 3 fold cross validation. Please select three training/testing data for each run from the below.

1) data1
2) data2
3) data3
4) data1 and data2
5) data1 and data3
6) data2 and data3
7) data1, data2, and data3

Run 1: Training Data ________________. Test Data ________________.

Run 2: Training Data ________________. Test Data ________________.

Run 3: Training Data ________________. Test Data ________________.

1d. (5 pts) After running 3 fold cross validation on you data, you got the following result.

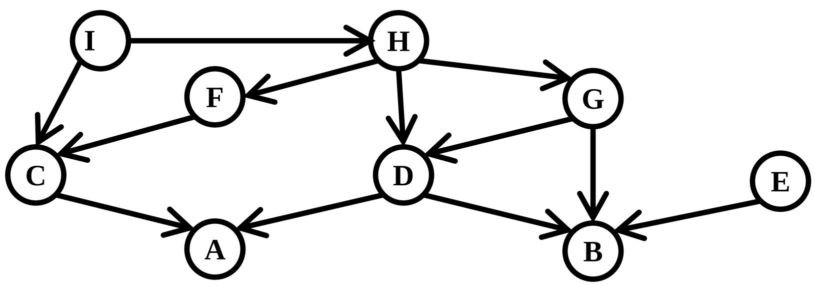
Table 2 Cross validation results

	Run1	Run2	Run3
Accuracy on Training data	78%	80%	79%
Accuracy on Test data	76%	78%	77%

What is the cross validation accuracy for the result? _________________.

2. (15 pts total, 5 pts each) Bayesian Networks.

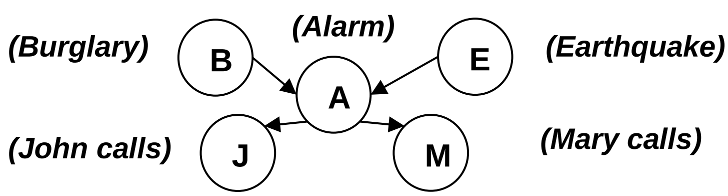
2a. (5 pts) Write down the factored conditional probability expression that corresponds to the graphical Bayesian Network shown.



2b. (5 pts) Draw the Bayesian Network that corresponds to this conditional probability:

P(A | B,C,E) P(B | D,E) P(C | F,H) P(D | G) P(E| G,H) P(F | H) P(G) P(H)

2.c. (5 pts) Shown below is the Bayesian network corresponding to the Burglar Alarm problem, P(J | A) P(M | A) P(A | B, E) P(B) P(E).



P(E)
.002

P(B)
.001

A	P(M)
t	.70
f	.01

A	P(J)
t	.90
f	.05

B	E	P(A)
t	t	.95
t	f	.94
f	t	.29
f	f	.001

The probability tables show the probability that variable is True, e.g., P(M) means P(M=t). Write down an expression that will evaluate to P(j=t ∧ m=f ∧ a=f ∧ b = f ∧ e = t). Express your answer as a series of numbers (numerical probabilities) separated by multiplication symbols. You do not need to carry out the multiplication to produce a single number (probability). **SHOW YOUR WORK.**

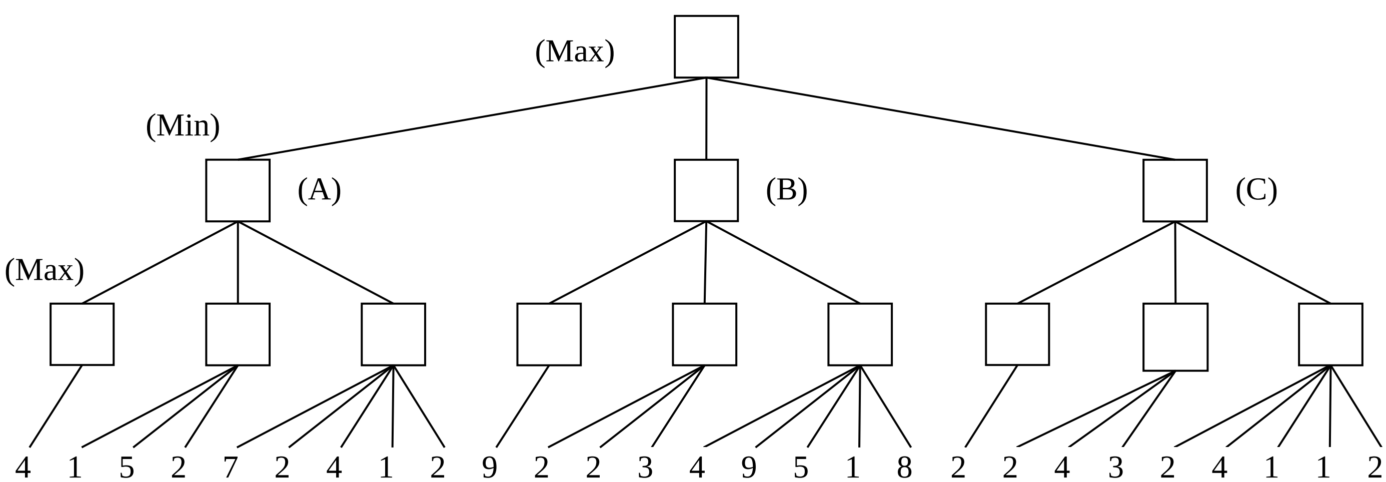
P(j=t ∧ m=f ∧ a=f ∧ b = f ∧ e = t)
=

3. (10 pts total) Mini-Max, Alpha-Beta Pruning. In the game tree below it is **Max**'s turn to move. At each leaf node is the estimated score of that resulting position as returned by the heuristic static evaluator.

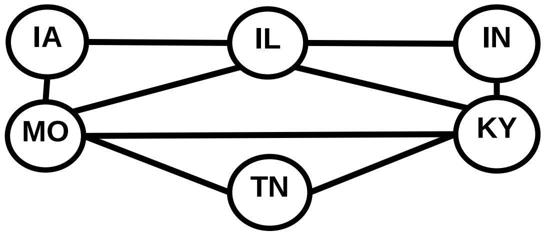
(1) Perform Mini-Max search and label each branch node with its value.

(2) Cross out each leaf node that would be pruned by alpha-beta pruning.

(3) What is Max's best move (A, B, or C)? _____________



4. (10 points total, 2 pts each) Constraint Satisfaction Problems.



TN=Tennesse
IN=Indiana
IA=Iowa
IL=Illinois
MO=Missouri
KY=Kentucky

You are a map-coloring robot assigned to color this Midwest USA map. Adjacent regions must be colored a different color (R=Red, B=Blue, G=Green). The constraint graph is shown.

4a. (2pts total, -1 each wrong answer, but not negative) FORWARD CHECKING. Cross out all values that would be eliminated by Forward Checking, after variable TN has just been assigned value R as shown:

TN	IN	IA	IL	MO	KY
R	R G B	R G B	R G B	R G B	R G B

4b. (2pts total, -1 each wrong answer, but not negative) ARC CONSISTENCY. TN and MO have been assigned values, but no constraint propagation has been done. Cross out all values that would be eliminated by Arc Consistency (AC-3 in your book).

TN	IN	IA	IL	MO	KY
R	R G B	R G B	R G B	G	R G B

4c. (2pts total, -1 each wrong answer, but not negative) MINIMUM-REMAINING-VALUES HEURISTIC. Consider the assignment below. IA is assigned and constraint propagation has been done. List all unassigned variables that might be selected by the Minimum-Remaining-Values (MRV) Heuristic:____________________________.

TN	IN	IA	IL	MO	KY
R G B	R G B	G	R B	R B	R G B

4d. (2pts total, -1 each wrong answer, but not negative) DEGREE HEURISTIC. Consider the assignment below. (It is the same assignment as in problem 4c above.) IA is assigned and constraint propagation has been done. List all unassigned variables that might be selected by the Degree Heuristic:._____________________________.

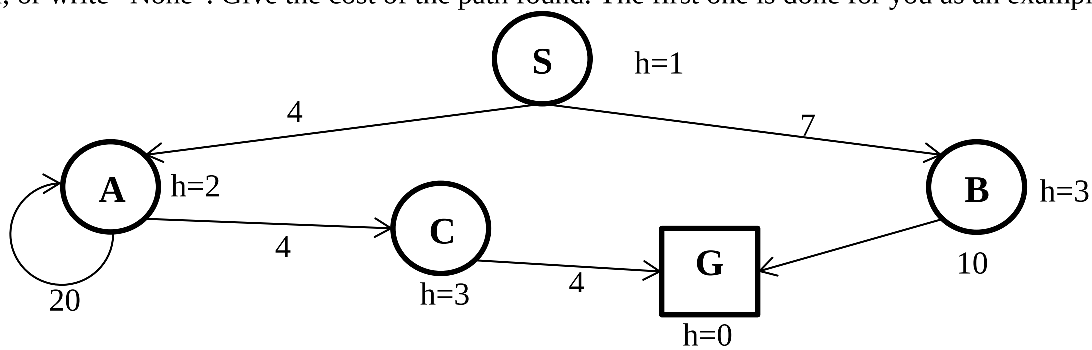
TN	IN	IA	IL	MO	KY
R G B	R G B	G	R B	R B	R G B

4e. (2pts total) MIN-CONFLICTS HEURISTIC. Consider the complete but inconsistent assignment below. IA has just been selected to be assigned a new value during local search for a complete and consistent assignment. What new value would be chosen below for IA by the Min-Conflicts Heuristic?.________________________________.

TN	IN	IA	IL	MO	KY
B	G	**?**	G	B	B

5. (10 pts total, 2 pts each) Execute Tree Search through this graph (i.e., do not remember visited nodes). Step costs are given next to each arc. Heuristic values are next to each node (as h=x). The successors of each node are indicated by the arrows out of that node. Successors are returned in left-to-right order.

For each search strategy, show the order in which nodes are expanded (i.e., to expand a node means that its children are generated), ending with the goal node that is found. Show the path from start to goal, or write "None". Give the cost of the path found. The first one is done for you as an example.



***5*.a. BREADTH FIRST SEARCH:**

Order of node expansion: S A B G

Path found: S B G Cost of path found: 17

***5*.b. (*2* pts) DEPTH FIRST SEARCH:**

Order of node expansion: ______

Path found: ______ Cost of path found: ______

***5*.c. (*2* pts) UNIFORM COST SEARCH:**

Order of node expansion: ______

Path found: ______ Cost of path found: ______

***5*.d. (*2* pts) GREEDY (BEST-FIRST) SEARCH:**

Order of node expansion: ______

Path found: ______ Cost of path found: ______

***5*.e. (*2* pts) ITERATED DEEPENING SEARCH:**

Order of node expansion: ______

Path found: ______ Cost of path found: ______

***5*.f. (*2* pts) A* SEARCH:**

Order of node expansion: ______

Path found: ______ Cost of path found: ______

Is the heuristic admissible (Yes or No)? ______

Is the heuristic consistent (Yes or No)? ______

6. (10 pts total) The Horned And Magical Unicorn.

If the unicorn is mythical, then it is immortal, but if it is not mythical, then it is a mortal mammal. If the unicorn is either immortal or a mammal, then it is horned. The unicorn is magical if it is horned. Prove that the unicorn is both horned and magical.

Use these propositional variables **("immortal" = "not mortal")**:

Y = unicorn is m**Y**thical	**R** = unicorn is mo**R**tal	**M** = unicorn is a ma**M**mal
H = unicorn is **H**orned	**G** = unicorn is ma**G**ical	

You have translated your goal sentence, "*horned and magical,*" into (H ^ G), so the negated goal is:

(¬ H ∨ ¬ G)

You have translated the English sentences into a propositional logic Knowledge Base (KB):

(¬ Y ∨ ¬ R)	(Y ∨ R)	(Y ∨ M)
(R ∨ H)	(¬ M ∨ H)	(¬ H ∨ G)

Produce a resolution proof, using KB and the negated goal, that the unicorn is horned and magical. Repeatedly choose two clauses, write one clause in the first blank space on a line, and the other clause in the second. Apply resolution to them. Write the resulting clause in the third blank space, and insert it into the knowledge base. Continue until you produce ( ). If you cannot produce ( ), then you have made a mistake. The shortest proof I know of is only six lines. It is OK to use more lines, if your proof is correct.

Resolve ______________________ and _____________________ to give ____________________.

Resolve ______________________ and _____________________ to give ____________________.

Resolve ______________________ and _____________________ to give ____________________.

Resolve ______________________ and _____________________ to give ____________________.

Resolve ______________________ and _____________________ to give ____________________.

Resolve ______________________ and _____________________ to give ____________________.

Resolve ______________________ and _____________________ to give ____________________.

Resolve ______________________ and _____________________ to give ____________________.

Resolve ______________________ and _____________________ to give ____________________.

Resolve ______________________ and _____________________ to give ____________________.

7. (10 pts total, 1 pt each) ENGLISH TO FOPC CONVERSION.
For each English sentence below, write the FOPC sentence that best expresses its intended meaning.

7.a. (1pt) "All persons are mortal." [Use: Person(x), Mortal (x)]

7.b. (1pt) "Fifi has a sister who is a cat." [Use: Sister(Fifi, x), Cat(x)]

7.c. (1pt) "For every food, there is a person who eats that food."
[Use: Food(x), Person(y), Eats(y, x)]

7.d. (1pt) "Every person eats every food." [Use: Person (x), Food (y), Eats(x, y)]

7.e. (2 pts) "All greedy kings are evil." [Use: King(x), Greedy(x), Evil(x)]

7.f. (1pt) "Everyone has a favorite food." [Use: Person(x), Food(y), Favorite(y, x)]

7.g. (1pt) "There is someone at UCI who is smart." [Use: Person(x), At(x, UCI), Smart(x)]

7.h. (1pt) "Everyone at UCI is smart." [Use: Person(x), At(x, UCI), Smart(x)]

7.i. (1pt) "Every person eats some food." [Use: Person (x), Food (y), Eats(x, y)]

7.j. (1pt) "Some person eats some food." [Use: Person (x), Food (y), Eats(x, y)]

8. Logic Concepts (6 pts total, 1 pt each).

A .	Logic	A	Formal symbol system for representation and inference
	Valid	B	The idea that a sentence follows logically from other sentences
	Complete	C	True in every possible world
	Conjunctive Normal Form	D	True in at least one possible world
	Sound	E	A sentence expressed as a conjunction of clauses (disjuncts)
	Satisfiable	F	Inference system derives only entailed sentences
	Entailment	G	Inference system can derive any sentence that is entailed

9. Probability concepts and formulae (9 pts total, 1 pt each).

A .	Probability Theory	A	Assigns each sentence a degree of belief ranging from 0 to 1
	Conditional independence	B	Degree of belief accorded without any other information
	Independence	C	Degree of belief accorded after some evidence is obtained
	Product rule (chain rule)	D	Gives probability of all combinations of values of all variables
	Conditional probability	E	Takes values from its domain with specified probabilities
	Unconditional probability	F	A possible world is represented by variable/value pairs
	Factored representation	G	$P(a \wedge b) = P(a)\, P(b)$
	Random variable	H	$P(a \wedge b \mid c) = P(a \mid c)\, P(b \mid c)$
	Bayes' rule	I	$P(a \mid b) = P(b \mid a)\, P(a) / P(b)$
	Joint probability distribution	J	$P(a \wedge b \wedge c) = P(a \mid b \wedge c)\, P(b \mid c)\, P(c)$

****** THIS IS THE END OF THE FINAL EXAM ******