THE UNIVERSITY OF AUCKLAND

FIRST SEMESTER, 2005
Campus: City

COMPUTER SCIENCE

Foundations of Artificial Intelligence

(Time allowed: ONE AND A HALF hours)

NOTE: Closed book.
No calculators.
Attempt all questions.
Put the answers in the boxes below the questions.

MARKS	
HANS:	(out of 70)
MIKE:	(out of 30)
TOTAL:	(out of 100)

SURNAME:

FORENAME(S):

STUDENT ID:

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Section A: Prolog

1. Consider the following Prolog program:

```
behind_in_line(aaron,corey). behind_in_line(corey,doug).
behind_in_line(doug,greg). behind_in_line(greg,jerome).
behind_in_line(jerome,keven). behind_in_line(keven,greg).
served_after(X,Y) :- behind_in_line(X,Y).
served_after(X,Z) :- behind_in_line(Y,Z), served_after(X,Y).
```

   (a) What would be Prolog's answer to the query `behind_in_line(doug,keven).` [2 marks]

   no

   (b) What would be Prolog's answer to the query `served_after(aaron,corey).` [3 marks]

   yes

   (c) List Prolog's answer to the query `served_after(jerome,Y)` in the order that they are produced. [5 marks]

   Y = keven, Y = jerome, Y = jerome, ...

   (d) List Prolog's answer to the query `served_after(X,greg)` in the order that they are produced. [7 marks]

   X = doug, X = keven, X = corey, X = aaron, X = jerome, X = greg,
   X = doug, X = keven, ...

2. What is the first answer of the following Prolog program when queried with atoms as first and second arguments, a list as third argument, and a variable as fourth argument? [8 marks]

```
mystery(X,Y,[],[]).
mystery(X,Y,[X|L1],[Y|L2]) :- mystery(X,Y,L1,L2).
mystery(X,Y,[Z|L1],[Z|L2]) :- mystery(X,Y,L1,L2).
```

   The third argument with every occurence of the first argument replaced with the second argument.

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Section B: Search

3. Tick the search strategy which is complete, i.e., always finds a solution if there is one. [3 marks]

Breadth-first search	√	Depth-first search	

4. Tick the search strategy which is optimal, i.e., always finds the best solution. [3 marks]

Greedy search		Uniform-cost search	√

5. Tick the search strategy which in general requires less memory to run. [3 marks]

A* search		IDA* search	√

6. Which of the following statements are false?

   (a) Since A* never overestimates the cost of the path from the start through the current node to the goal, it always finds an optimal solution.

   (b) Since hill climbing always selects a state better than the current state, it always finds the optimal solution.

   (c) Uniform-cost search minimizes the estimated cost of the path from the start through the current node to the goal.

   (d) Simulated annealing is a variant of hill climbing in which a worse state is accepted as successor state from time to time.

   [6 marks]

(b), (c)

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Section C: Probabilistic Reasoning

7. Briefly explain why successful inference networks cannot usually be developed directly from Bayes's rule. [5 marks]

Because of the lack of knowledge of the exact conditional probability distribution for the various possible states of evidence given the various possible states of nature.

8. Which logic rules (probabilistic, possibilistic, either, or neither) might have been applied to obtain the following conclusions from the given assumptions?

(a) Assumptions: The 366 test is worth 20% (0.3) [3 marks]
Conclusion: The 366 test is not worth 20% (0.3)

Neither

(b) Assumptions: It is rush hour (0.8) [3 marks]
Traffic is heavy (0.3)
Conclusion: It is rush hour and traffic is heavy (0.8)

Neither

(c) Assumptions: Auckland needs another harbour bridge (0.5) [3 marks]
Auckland needs a tunnel under the harbour (0.2)
Conclusion: Auckland needs another harbour bridge or
a tunnel under the harbour (0.6)

Probabilistic logic rules

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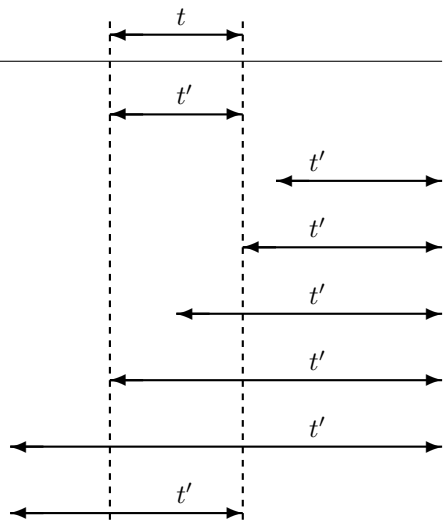
Section D: Qualitative Reasoning

9. Given the thirteen Allen relations as shown below, list all possible relations that answer the following questions. Use symbols for the relations in your answers (e.g., $<$), rather than their meaning (e.g., before).

Relation	**Short**	**Inverse**
$\text{Equal}(t, t')$	$=$	
$\text{Before}(t, t')$	$<$	$>$
$\text{Meets}(t, t')$	m	mi
$\text{Overlaps}(t, t')$	o	oi
$\text{Starts}(t, t')$	s	si
$\text{During}(t, t')$	d	di
$\text{Finishes}(t, t')$	f	fi



(a) If your lecture is before your lunch break and your lunch break is before your meeting, what is the relation between your lecture and your meeting? [2 marks]

$<$

(b) If your dinner starts with the movie on TV and the film credits finish the movie, what is the relation between your dinner and the film credits? [3 marks]

$<$, m, o

(c) If both the lecture and the lab are during the day, what is the relation between the lecture and the lab? [5 marks]

All thirteen relations

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10. An abstract, naïve way of calculating the difference between two numbers uses only the signs of the numbers to make a statement about the difference. For example, if the first number is positive and the second one in negative, then the difference between these numbers is positive. Fill in the following table (where $+$ means positive, $-$ means negative, and 0 means zero) such that it reflects the result of calculating the qualitative difference (rows indicate the values for the first number and columns the values for the second number). [6 marks]

	$+$	$-$	0
$+$	$+, -, 0$	$+$	$+$
$-$	$-$	$+, -, 0$	$-$
0	$-$	$+$	0

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Section E: Planning

11. Representational Assumptions

(a) What does the closed world assumption assume that the open world assumption does not assume? [5 marks]

The closed world assumes omniscience, i.e., that the truth of every literal is known, while the open world assumption does not assume this.

(b) How does this assumption affect how the world is represented? Specifically, what is explicitly represented and what is implicitly represented when:

i. Using the closed world assumption. [5 marks]

Using the closed world assumption. Explicitly the true positive literals are represented and implicitly the true negative literals.

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ii. Using the open world assumption. [5 marks]

Using the open world assumption. Explicitly the known true literals are represented and implicitly the literals with an unknown truth value.

(c) Draw an arrow from the items on the left to their associated item on the right. [8 marks]

state description (closed world assumption)	state update language
goals description (open world assumption)	closed world assumption
operator preconditions (open world assumption)	open world assumption
operator effects (state update language)	

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12. Forward Planning

```
Given:
 a domain only containing the following operator schema -
move(B, F, T)
  pre: [on(B,F), clear(T), clear(B), neq(B,T), neq(B,F)]
  eff: [not(on(B,F), on(B,T), not(clear(T)), clear(F)]

(where "neq/2" is the meta-level predicate that is true when its
arguments do not match each other, e.g., neq(a,b))

and given the state = [clear(a), on(a,b), on(b,c), on(c, table), clear(d),
on(d,e), on(e, table)]
```

(a) List all the states that would be considered as neighbors of the given state by a forward planner. [4 marks]

[clear(a), on(a,d), on(b,c), on(c, table), clear(b), on(d,e), on(e, table)], [clear(d), on(d,a), on(a,b), on(b,c), on(c, table), clear(e), on(e, table)]

(b) List all the operators that would be applicable in the given state. [3 marks]

move(a,b,d) move(d,e,a)