CS4341 ARTIFICIAL INTELLIGENCE. A97 **FINAL EXAM**
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Instructions

- Show your work
- Justify your answers
- Use the space provided to write your answers
- Write your name on each page
- Ask if you have any questions

Problem 1. Constraints and Constraint Propagation (20 points)

Consider the problem of seating 6 people at a round table in such a way that the following constraints are satisfied:

(C1) Spouses (if any) sit next to each other.

(C2) People who hate each other don't sit next to each other.

Construct a constraint net to represent this problem, assuming that spouses don't hate each other.

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Problem 2. Logic Systems (20 points)

Consider the following set of axioms:

(1) $\forall x[reads(x) \Rightarrow literate(x)]$

(2) $\forall y[dolphin(y) \Rightarrow \neg literate(y)]$

(3) $\exists z[dolphin(z) \wedge intelligent(z)]$

Construct a proof by refutation (using resolution) of the sentence:

(4) $\exists w[intelligent(w) \wedge \neg reads(w)]$

(**Hint:** Remember to negate (4) before translating it into clausal form.)

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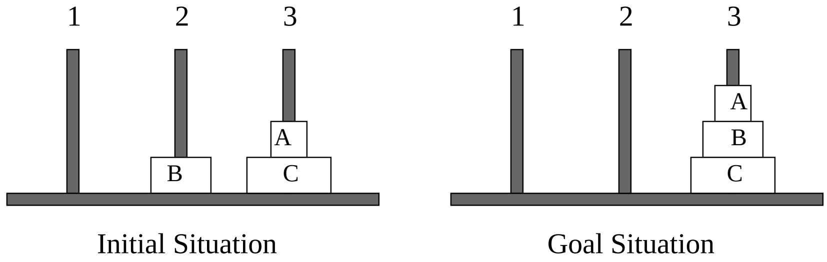
Problem 3. Planning (20 points)



Consider the towers-of-Hanoi puzzle. In this puzzle there are three disks A, B, and C no two of which are of the same size, and three pegs 1, 2, and 3. Each disk has a hole in its center and can be placed over any peg. Each disk must be placed on one peg, and several disks can be piled up on any peg as long as no disk is placed on top of a smaller disk.

There is just one operator to move disks:

Operator: Move disk x to z:

IF	on(x,y)
	clear(x)
	clear(z)
	smaller(x,z)
ADD LIST	on(x,z)
	clear(y)
DELETE LIST	on(x,y)
	clear(z)

Using backward chaining, construct a plan to go from the initial situation to the goal situation described below. **Show** *establishes, threatens,* **and** *before* **links.**

Initial Situation				Goal Situation
clear(1)	on(B,2)	on(A,C)	on(C,3)	on(A,B)
smaller(A,B)	smaller(B,C)	smaller(A,C)		on(B,C)
smaller(A,1)	smaller(A,2)	smaller(A,3)		on(C,3)
smaller(B,1)	smaller(B,2)	smaller(B,3)		
smaller(C,1)	smaller(C,2)	smaller(C,3)		
clear(A)	clear(B)			

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Problem 4. Learning (20 points)

Run	Operator	Machine	Overtime	Output
1	Patrick	a	no	high
2	Patrick	b	yes	low
3	Thomas	b	yes	low
4	Patrick	b	no	high
5	Sally	c	no	high
6	Thomas	c	no	low
7	Thomas	c	no	low
8	Patrick	a	yes	low

Construct the smallest identification tree possible for predicting **the output** in a factory setting using the data recorded in the table above. Use the average disorder formula to select which attribute to use at each step of the construction. Show your work.

$$\text{Average Disorder Formula:} \sum_b \left(\frac{n_b}{n_t}\right) * \left(\sum_c -\frac{n_{bc}}{n_b} \log_2 \frac{n_{bc}}{n_b}\right)$$

x	1	1/2	1/3	2/3	2/5	3/5
$\log_2(x)$	0	-1	-1.6	-0.6	-1.33	-0.74

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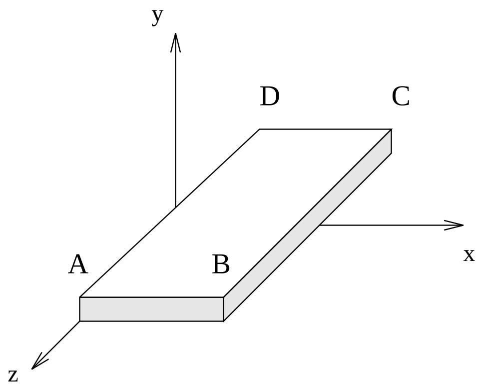
Problem 5. Machine Vision (20 points)



Consider the thin rectangle I_1 shown in the figure. Let I_2 be the same thin rectangle rotated by a certain angle around the y–axis. Using I_1 and I_2 as templates, determine whether or not the unknown object I_0 is the same as the template rectangles (up to a rotation around the y–axis). In other words, determine if I_0 "fits" the templates. Explain your answer.

The values of the x coordinates for the four corresponding vertices A, B, C, and D of the objects are given below. Remember that, for any given point P of the rectangle, the x coordinates of the corresponding points PI_0 (of the unknown object), PI_1 (of the template I_1), and PI_2 (of the template I_2), are related by the following linear equation:

$$x_{PI_0} = \alpha \, x_{PI_1} + \beta \, x_{PI_2}$$

Object	x coordinate of point A	x coordinate of point B	x coordinate of point C	x coordinate of point D
Template: I_1	0	1	1	0
Template: I_2	1	1	-2	-2
Unknown: I_0	0.8	1.4	-1	-1.8

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