ECE566

Spring 2010 – Exam

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Take Home

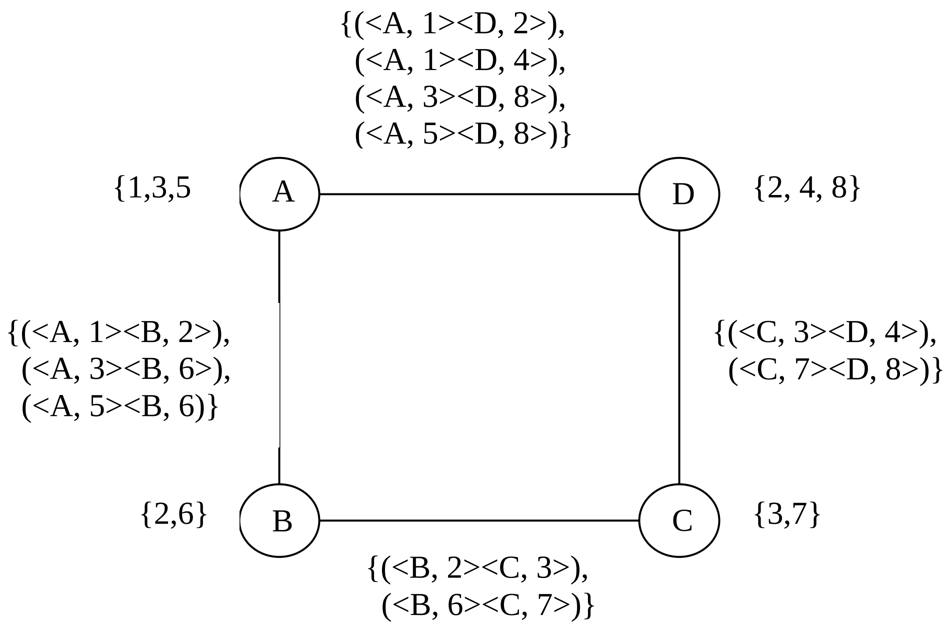
Name:

ID#:

1. (40 points)

The figure below shows the constraint graph for a binary CSP. The variables are shown within each node, the domain for each variable is shown by a set next to each node, and the constraints are represented by a set of compound labels on each arc.

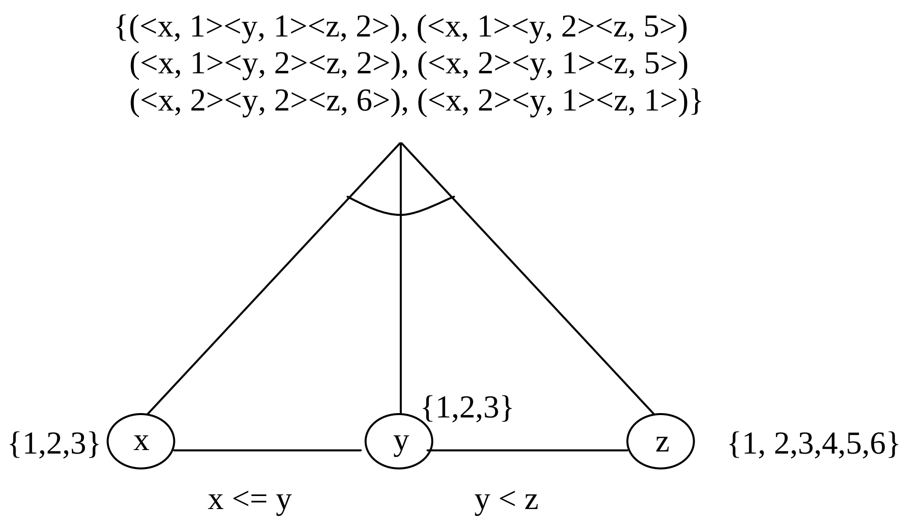
a. 1. Is this problem satisfiable? Justify your answer – If not why not, if yes state all solutions.
a. 2. Is the problem path consistent? Justify your answer



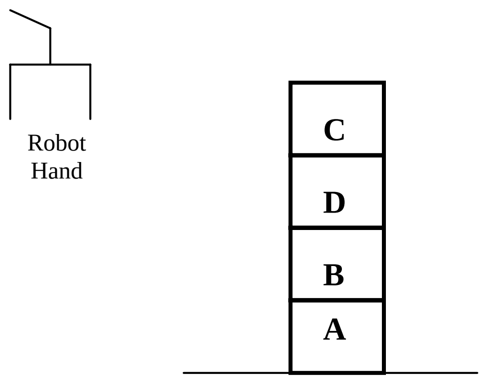
The figure below shows a constraint hyper-graph involving three variables. This hyper-graph has one constraint that relates three variables, this constraint is represented by a set of compound labels.

b. 1. Convert this problem to an equivalent binary constraint graph by introduction of a new variable. Show the equivalent binary constraint graph. What is the domain for each of the variables in the binary constraint graph?

b. 2. Describe the constraints involved in the binary constraint graph.



2. (40 points) This picture shows the initial state in a robots world:



(a). In predicate calculus, if we use the predicate On(?x ?y) to indicate object ?x is on object ?y, Block(?x) to indicate ?x is a block, and Below(?x ?y) to indicate object ?x is below object ?y, then show predicate calculus logic can be used to computationally represent the initial state.

(b) Now use predicate calculus to represent the general piece of knowledge that (i) "if some block is on a second block then the second block is below the first block", and (ii) 'If some block is below a second block, and the second block is below a third block, then the initial block is below the third block also'.

show how the robot can computationally reason using rules and generate the facts that blocks A and B are both below block C using either forward or backward inference with the predicate calculus representation. **Please state substitutions clearly**. (Note that in the initial state there is only the knowledge that C on D and D on B, but no knowledge that B is below C)

(c) Using frames (object) show how you encode the information Block C is on top of Block D. Encode the information in the initial state of the world using your frame representation.. (In the initial state there is no explicit knowledge that A is below D, nor that A is under C, etc. Only the relationships C-D, D-B, and B-A are explicit).

(d) Using frames show how you encode the general piece of knowledge that (i) "if some block is on a second block then the second block is below the first block", and (ii) "If some block is below a second block, and the second block is below a third block, then the initial block is also below the third block".
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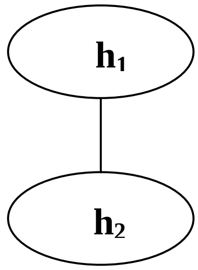
3. (20 points)

Hypotheses h_1 and h_2 are related as shown:



The prior probability, $Bel(h_1) = [\ 10^{-4}\ \ 1\text{-}10^{-4}]$ and $M_{h2|h1} = \begin{bmatrix} 0.95 & 0.05 \\ 0.01 & 0.99 \end{bmatrix}$

(a) Initialize Bel, π, and λ for h_1 and h_2

(b) A new evidence related to h_1 is obtained with $\lambda_e = \beta \begin{bmatrix} 20 \\ 1 \end{bmatrix}$. Compute the new $\lambda(h_1)$, $Bel(h_1)$, $\pi(h_1)$, $\pi_{h2}(h_1)$ (the π message sent to h_2 by h_1) and $\pi(h_2)$ (the updated π at h_2).