KONT EKSAMEN AUGUST 2021--- QUESTIONS

Weighting: There are 5 questions in this exam. The weights are as following: Q1:25 points, Q2:25 pts, Q3: 25pts, Q4: 10pts, and and Q5 15 pts each

PROBLEM 1 - LOGIC

Given the following three sentences, you will prove ¬ S is true.

$P \land Q$ (1)
$P \rightarrow \neg(Q \land R)$ (2)
$S \rightarrow R$ (3)

a) Show $\neg S$ is true by using the inference and the re-writing rules.

b) Show that $\neg S$ is true by enumeration method on a Truth Table.

c) Show that ¬ S is true by resolution refutation.

d) Use resolution refutation to prove Green(Sophie) given the information below. You must first convert each(all) sentence into CNF. Clearly show Skolemizations. Show only the applications of the resolution rule that lead to the desired conclusion. For each application of the resolution rule, show the unification bindings, θ.

- Electric(Tesla)
- Drives(Sophie, Tesla)
- ∀x Green(x) ↔ Bikes(x) ∨ [∃y : Drives(x, y) ∧ Electric(y)]

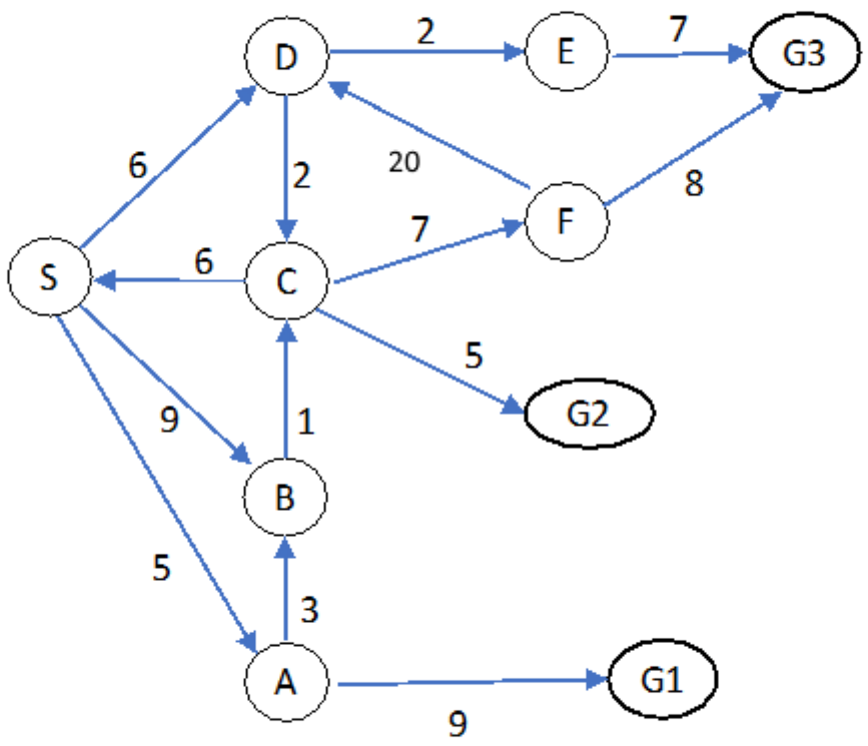
PROBLEM 2 --INFORMED AND UNINFORMED SEARCH

You are given the following graph in the figure where S is the start node and there are three goal nodes, G1, G2 and G3. You are asked to use some search algorithms on this graph (algorithms a-d listed below.) You will use tree search versions of these algorithms that avoid re-expanding the nodes that are already expanded. In case of a tie, break will be done in alphabetical order. In all the algorithms, you don't need to continue after finding a goal, i.e, you don't need to search for more than one goal.
For each of the asked algorithms,

- write down the expanded nodes in the order of expansion,
- write down the solution path and its cost.
- Is the found path optimal? Discuss the optimality of the algorithm.

The algorithms are:

a) Uniform cost search
b) Breadth first search
c) Depth first search
d) A* search. The heuristic values are as follows:
   h(S)=5
   h(A)=7
   h(B)=3
   h(C)=4
   h(D)=6
   h(E)=5
   h(F)=6
   h(G1)=h(G2)=h(G3)=0



PROBLEM 3 ---CSP CROSS WORD PUZZLE

A **crossword puzzle**, is a popular type of puzzle that uses words.

A crossword is made up of a black/blue and white squares, called a grid. Next to the grid is a list of clues. The answer to each clue is a word. The place in the grid where the answer to each clue should go is shown by a number and the direction in which the answer appears, for example "1 Across", or "4 Down".

You are given the 4x5 grid on the top of the page. Unlike traditional crossword puzzles, you are not given clues but a list of words to choose from to fill in the grid.

Here is the list of words: *astar, happy, hello, hoses, live, load, loom, peal, peel, save, talk, anon, nerd, tine, ant, oak, old, ten, run.*

There are 4 areas in the grid/puzzle with consecutive white squares where the words will be placed: 1-accross (i.e., from left to write), 2-down (write from top to downward), 3-down and 4-across. Blue squares are blocked out meaning that characters cannot be placed on them.

"Instructions" on the grid, e.g., 2-down, indicate the position where a word starts and the direction it will continue until it hits a blue square or the edge of the grid. Note that the number in an instruction does not indicate the length of the word. The length of the word is determined by the number of consecutive white squares in the given direction. For example, the word starting at 1-accross is five character long. A solution is a grid with correctly placed words -and no empty white squares. Each word will be used only once.

Consider this as a constraint satisfaction problem and:

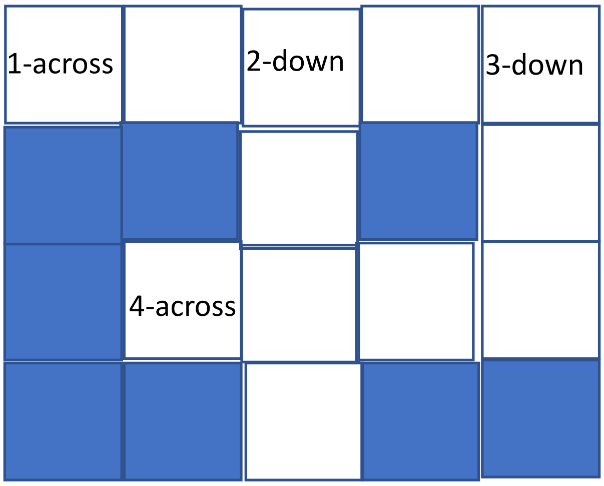
a) Write down the variables (V1, V2, ..) and describe what they correspond to in the grid shown in the figure. Draw the constraint graph.

b) How many constraints are there in this problem and what are they?

c) For each variable write down the domain satisfying the node consistency

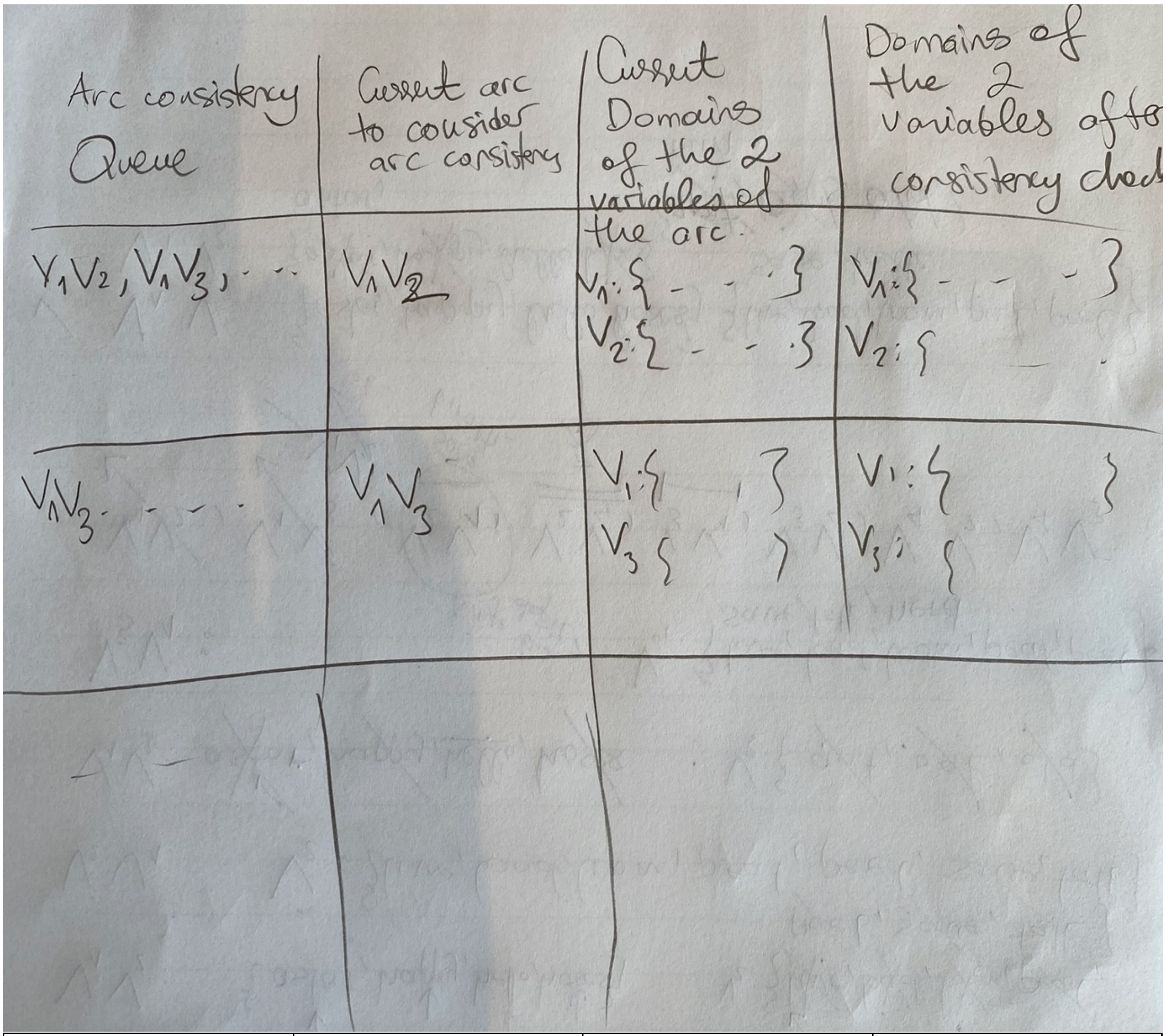
d) Apply arc consistency algorithm AC-3. Write down the domains of the variables after AC. Write down the domains of the variables after AC-3. When applying AC-3, assume a queue (FIFO) of edges of the constraint graph initially sorted in the ascending order, starting from V1, i.e. V1V2, V1V3,.... In order to show your work, fill in the table (similar to the one) in the figure on left.

e) If AC-3 finds a solution, what is it? Provide the filled-out crossword puzzle. If it does not find any solution, explain why



Consider this as a constraint satisfaction problem and:

a) Write down the variables (V1, V2,…), what each corresponds to on the grid shown in Figure xxxxxx, and draw the constraint graph.
b) How many constraints are there in this problem and what are they?
c) For each variable write down the domain satisfying the node consistency.
d) Apply arc consistency algorithm AC-3. Write down the domains of the variables after AC-3. When applying AC-3, assume a queue (i.e.,FIFO) of edges of the constraint graph initially sorted in the ascending order, starting from V1, i.e., V1V2, V1V3,… In order to show your work, fill in the table (similar to the one) below.



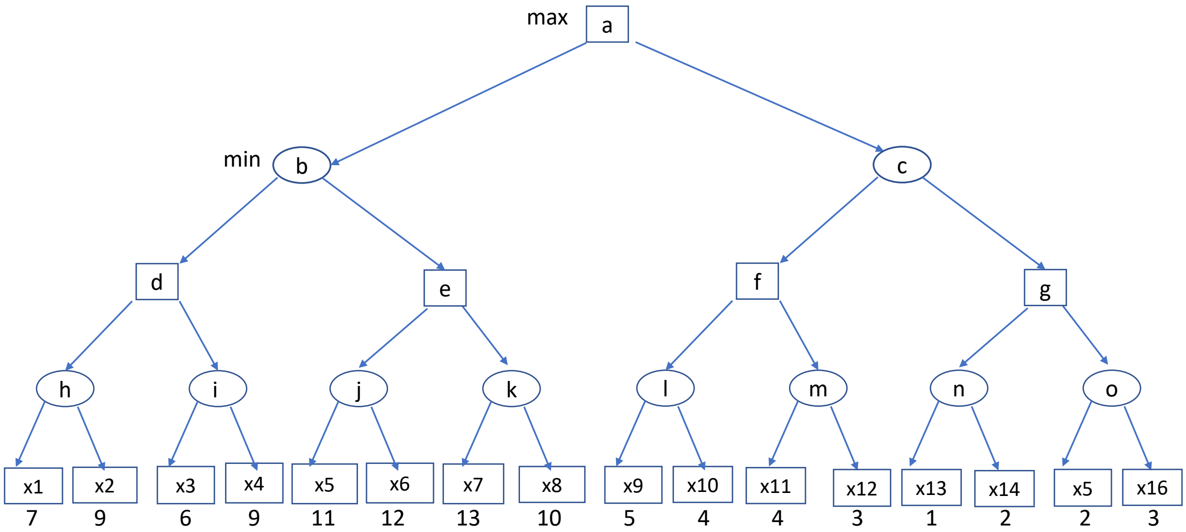
Arc consistency Queue	Current arc to consider arc consistency	Current Domains of the 2 variables of the arc.	Domains of the 2 variables after consistency check
$V_1V_2, V_1V_3, \ldots$	V_1V_2	V_1: { - - - } V_2: { - - - }	V_1: { - - - } V_2: { - -
V_1V_3 - - - -	V_1V_3	V_1: { } V_3 { }	V_1: { } V_3: {

Arc consisteny Queue	Current considered arc	Domains of arc variables before arc consistency check	Domains of arc variables after arc consistency check
V1V2, V1V3, … (but write out fully)	V1V2	V1:{Write out domain} V2:{…}	V1:{…} V2:{…}
V1V3, …	V1V3,	V1:{…} V3:{…}	V1:{…} V3:{…}

e) If AC-3 finds a solution, what is it (provide the filled-out crossword puzzle, if any)? If it does not find any solution, explain why.

PROBLEM 4 ---- ADVERSARIAL SEARCH

The following figure shows a game tree.



a) Apply Minimax algorithm and find the values of all the nodes above the leaf nodes. What is the value of the solution for the agent *max*?

b) Apply alpha-beta pruning algorithm to find which nodes can e pruned. Write down the names of the nodes (the letters in the square and ellipses), either leaves or the nodes of which all children are pruned. For example if 11 and 12 are pruned then it is sufficient to write node *j* only.

PROBLEM 5--- GAME THEORY

In an auction two agents are competing to obtain a porcelain vase. This is a type of auction where **all** bidders simultaneously submit **sealed bids** to the auctioneer so that **no** bidder knows how much the **other** auction participants have **bid.**

The allowed bids are \$0, \$10, \$20, \$30, \$40, \$50.
The porcelain is worth \$40 to the agent A1 and \$30 to the agent A2. The highest bidder wins the porcelain. In case of a tie, A1 gets the vase.
According to the rules of this auction, the winner pays a price *p* which is whatever the other agent bids. So, if the value of the porcelain for agent i is *x* and agent *i* wins the vase her payoff is x-p. If she does not win the vase her payoff is zero.
Answer the following questions:
a. Write down the payoffs of the agents as a matrix – illustrating agents, actions(bids), and the payoffs
b. Is there a strictly dominant strategy equilibrium of this game? Explain.
c. Is there a weakly dominant strategy equilibrium of this game? Explain.
d. What are the action profiles that survive Iterated Elimination of Strictly Dominated Actions? Explain how do the eliminations take place.
e. What are the action profiles that survive Iterated Elimination of Weakly Dominated Actions? Explain how do the eliminations take place.

f. What is the solution if the game is solvable using the ‘dominance’ concept. (i.e., dominance solvable). Explain your answer.