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CS 581 Spring 2024 Written Assignment #02

Due: **Monday, February 19, 2024, 11:59 PM CST**

Points: **35**

Instructions:

1. Use this document template to report your answers. Name the complete document as follows:

`LastName_FirstName_CS581_Written02.doc or pdf`

(only MS Word or PDF files accepted!)

2. Submit the final document to Blackboard Assignments section before the due date. No late submissions will be accepted.

Objectives:

1. (10 points) Demonstrate your understanding of the concept of admissible heuristic.
2. (25 points) Demonstrate your understanding of a CSP and related heuristics.

Problem 1 [10 pts]:

Consider the following state space S with ACTION COSTs (you can assume action cost to be driving distance) shown (fig. 1).

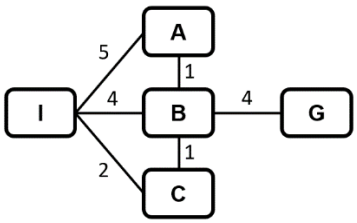


Figure 1: State space S.

Both $\mathbf{h_1(i,j)}$ and $\mathbf{h_2(i,j)}$ are heuristic functions for S. Populate tables below with $\mathbf{h_1(i,j)}$ and $\mathbf{h_2(i,j)}$ values in such a way that:

a) **[5 pts]** $\mathbf{h_1(i,j)}$ is admissible, and

b) **[5 pts]** $\mathbf{h_2(i,j)}$ is admissible and dominates $\mathbf{h_1(i,j)}$.

$h_1(i,j)$					
State	**A**	**B**	**C**	**I**	**G**
A	0	1	2	5	4.12
B	1	0	1	4	4
C	2	1	0	2	4.12
I	5	4	2	0	8
G	4.12	4	4.12	8	0

$h_2(i,j)$					
State	**A**	**B**	**C**	**I**	**G**
A	0	1		5	
B	1	0	1	3	4
C		1	0	2	
I	5	3	2	0	
G		4			0

Problem 2 [10 pts]:

Consider the following CSP problem:

Variables: $X = \{A, B, C, D, E, F, G\}$
Domains: $D_A = D_B = D_C = D_D = D_E = D_F = D_G = \{1,2,3\}$
Constraints: $C = \{A \neq B, A \neq C, A \neq E, B \neq E, B \neq G, C \neq E, C \neq G, D \neq G, E \neq G, F \neq G\}$

Your CSP search is exploring a tree and the **current PARTIAL assignment** is:

A = 1,
B = 2,
C = 2,
D = 1

Use the **MRV heuristic** to decide **which variable to explore (assign a value to) next**. In case of ties, use degree heuristics (if that does not help: alphabetic ordering). Justify your answer.

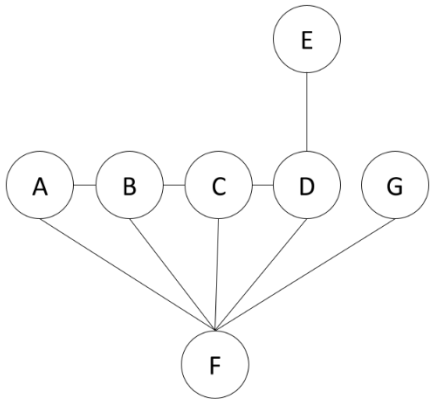
Your answer:
E = {3} - A ≠ E - B ≠ E - C ≠ E - E ≠ G F = {2, 3} - F ≠ G G = {3} - B ≠ G - C ≠ G - D ≠ G - E ≠ G - F ≠ G E would be the next explored variable

Problem 3 [5 pts]:

Consider the following **Constraint Satisfaction Problem (CSP)**. Note that all variables share the same domain D:

X = {A, B, C, D, E, F, G}
D = {0, 1}
C = {A ≠ F, B ≠ F, C ≠ F, D ≠ F, F ≠ G, A ≠ B, B ≠ C, C ≠ D, D ≠ E}

Draw a **constraint graph** (or its adjacency matrix representation if it is easier) for this CSP.

Your solution [4 pts]:


What is the degree of the most constrained vertex (variable) in this graph?

Your answer [1 pt]:
F has a degree of 5

Problem 4 [10 pts]:

Consider the Australia map coloring **Constraint Satisfaction Problem (CSP)** from the lecture.

Variables:

X = {WA, NT, Q, NSW, V, SA, T}

Variable Domains:

D_{WA} = {RED, GREEN, BLUE}
D_{NT} = {RED, GREEN, BLUE}
D_{Q} = {RED, GREEN, BLUE}
D_{NSW} = {RED, GREEN, BLUE}
D_{V} = {RED, GREEN, BLUE}
D_{SA} = {RED, GREEN, BLUE}
D_{T} = {RED, GREEN, BLUE}

CONSTRAINTS = C = {SA ≠ WA, SA ≠ NT, SA ≠ Q, SA ≠ NSW, SA ≠ V, WA ≠ NT, NT ≠ Q, Q ≠ NSW, NSW ≠ V}

Assuming:

- static variable ordering: WA, NT, Q, T, V, SA, NSW,
- static value ordering: GREEN, RED, BLUE

Complete the CSP search tree using pure/plain backtracking approach for the subtree rooted at:

If solution is found, stop. If not, show entire subtree.

Solution was not found -> Visited/dead ends -> Complete, but inconsistent assignments