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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!)**

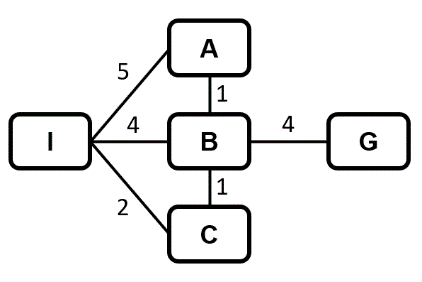
1. Submit the final document to Blackboard Assignments section before the due date. No late submissions will be accepted.

**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 **h1(i,j)** and **h2(i,j)** are heuristic functions for S. Populate tables below with **h1(i,j)** and **h2(i,j)** values in such a way that:

1. **[5 pts]** **h1(i,j)** is admissible, and
2. **[5 pts]** **h2(i,j)** is admissible and dominates **h1(i,j)**.

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| **h1(i,j)** | | | | | |  | **h2(i,j)** | | | | | |
| **State** | **A** | **B** | **C** | **I** | **G** | **State** | **A** | **B** | **C** | **I** | **G** |
| **A** | 0 | 1 | 2 | 5 | 4.12 | **A** | 0 | 1 |  | 5 |  |
| **B** | 1 | 0 | 1 | 4 | 4 | **B** | 1 | 0 | 1 | 3 | 4 |
| **C** | 2 | 1 | 0 | 2 | 4.12 | **C** |  | 1 | 0 | 2 |  |
| **I** | 5 | 4 | 2 | 0 | 8 | **I** | 5 | 3 | 2 | 0 |  |
| **G** | 4.12 | 4 | 4.12 | 8 | 0 | **G** |  | 4 |  |  | 0 |

**Problem 2 [10 pts]:**

Consider the following CSP problem:

Variables: X = {A, B, C, D, E, F, G}

Domains: DA = DB = DC = DD = DE = DF = DG = {1,2,3}

Constraints: C = {A ≠ B, A ≠ C, A ≠ E, B ≠ E, B ≠ G, C ≠ E, C ≠ G, D ≠ G, E ≠ G, F ≠ 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.

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| **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.

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| **Your solution [4 pts]:** |
|  |

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

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| **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:**  DWA = {RED, GREEN, BLUE}  DNT = {RED, GREEN, BLUE}  DQ = {RED, GREEN, BLUE}  DNSW = {RED, GREEN, BLUE}  DV = {RED, GREEN, BLUE}  DSA = {RED, GREEN, BLUE}  DT = {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

A diagram of a tree

Description automatically generated