Missouri University of Science & Technology   Department of Computer Science
Spring 2024   **CS 2500: Algorithms (Sec: 102)**

Homework 5: Dynamic Programming

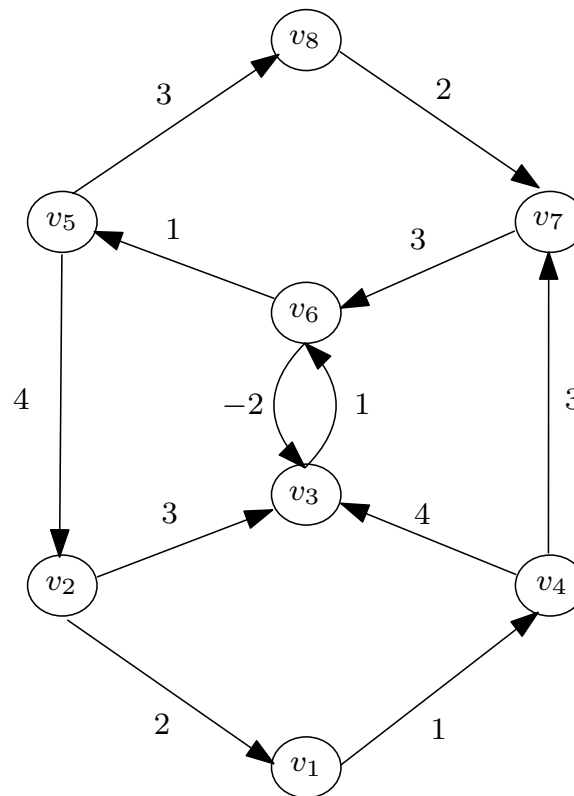**Instructor:** *Sid Nadendla*   **Due:** *April 29, 2024*

Problem 1 Bellman-Ford Algorithm   *5 points*

Demonstrate the value iteration at each subproblem within Bellman-Ford algorithm on the following graph, and clearly print the final output. Assume v_1 is the start node.

In each stage of the algorithm, clearly state the shortest distance estimate at each node from the source.

Problem 2   String Edit Problem   *5 points*

The *string edit* problem is to find the cheapest way to modify two strings so that they are the same. The permitted operations are *deletions*, *insertions* and *substitutions*.

Example: Consider two strings: ALKHWARIZMI and ALGORITHM. We need to perform the following sequence of operations in order to modify ALKHWARIZMI into ALGORITHM:

- Substitute K with G

- Substitute H with O

- Delete W

- Delete A

- Replace Z with T

- Insert H

- Delete I

Let the two strings be denoted as $a_1 a_2 \cdots a_m$ and $b_1 b_2 \cdots b_n$, where each a_i and each b_j are characters in the set S. If s_i and s_j are any two characters in S, let

- the cost of deleting $s_i = D_i > 0$

- the cost of inserting $s_i = I_i > 0$

- the cost of substituting s_i with $s_j = C_{ij} \geq 0$.

Assume $C_{ij} = C_{ji}$ for all i, j and $C_{ij} = 0$ if and only if $i = j$.

Then, present the following four stages of your design approach to this problem:

1. Model the above problem as a multi-stage decision problem, identify the state and decision variables, define the state transitions and derive the Bellman equation.

2. Using the Bellman equation, write a pseudocode to compute the optimal solution using dynamic programming approach.

3. Write down the pseudocode for the greedy solution to this problem.

4. Implement in Python, both the dynamic programming and greedy solutions to this problem and compare the value of the solutions returned for random pairs of strings.