CS 312: Artificial Intelligence Laboratory
Lab 6 Report

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1 Introduction

The objective of this task is to solve the Optimal Matrix Multiplication Problem. Given a set of N matrices and their dimensions, find the least cost of multiplying the matrices. For the given problem, the input is a list of matrix dimensions of the length $N+1$. The output is the least cost for the order of multiplying the matrices.

2 Heuristic Functions Considered

The following functions are appropriately designed to satisfy the constraints as shown below. Here d is the list of dimensions of the N matrices.

2.1 Over-Estimate

$$h_1(d) = (d_0 * d_1 * d_2 ... * d_N) * N \tag{1}$$

2.2 Under-Estimate

$$x = min(d) \tag{2}$$

$$h_2(d) = (N-2) * x^3 \tag{3}$$

3 Observations and Analysis

The results obtained using AO* algorithm with various heuristics are summarized in the below table -

Input	**Optimal Cost**	**Least Cost Found**		**# states explored**	
		$h_1(u)$	$h_2(u)$	$h_1(u)$	$h_2(u)$
[1, 2, 3, 4]	18	18	18	3	3
[5, 1, 4, 6, 7]	101	328	101	3	9
[9, 8, 6, 5, 2]	300	600	300	3	12
[3, 10, 23, 43, 56]	10881	59938	10881	3	12
[9, 101, 22, 13, 4, 5, 6, 11, 245]	33652	41918	33652	996	45

We see least cost is always found when the underestimating heuristic($h_2(u)$) is used. As expected, overestimating($h_1(u)$) does not always guarantee optimal cost as the first heuristic is not admissible.

We can also observe that there is a trade-off between the number of states explored and getting the optimal solution.