DOKUZ EYLUL UNIVERSITY

ENGINEERING FACULTY

DEPARTMENT OF COMPUTER ENGINEERING

CME2204 ALGORITHM ANALYSIS

ASSIGNMENT - II

Dynamic Programming

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14.05.2023

INTRODUCTION

Dynamic programming is a powerful technique that can be used to solve many problems in time $O(n^2)$ or $O(n^3)$ for which a naive approach would take exponential time. Dynamic Programming is a general approach to solving problems, much like "divide-and-conquer" is a general method, except that unlike divide-and-conquer, the subproblems will typically overlap.

Problem Definition:

The problem at hand involves managing a sports team over a given number of years. Each year, the team faces varying player demands and salaries. The objective is to determine the minimum cost of managing the team over the specified duration, while adhering to certain constraints regarding player promotion and coach hiring.

Inputs:

- Number of years (n): An integer representing the number of years to consider.

- Number of players to promote (p): An integer indicating the maximum number of players that can be promoted in a year.

- Coach cost (c): An integer denoting the cost of hiring a coach.

Player Demands:

- The player demands for each year are provided in a separate input file, "yearly_player_demand.txt". The file contains tab-delimited values, with each line representing a year's demand.

- Each line consists of two columns: the year and the corresponding player demand for that year.

Player Salaries:

- The player salaries for each year are stored in another input file, "players_salary.txt". Similar to the demand file, this file contains tab-delimited values with each line representing a year's salary.

- Each line consists of two columns: the year and the corresponding player salary for that year.

Outputs:

- The program will output the minimum cost required to manage the team over the specified number of years, considering player promotion, coach hiring, and keeping unrented players.

Constraints:

- The number of players promoted in a year cannot exceed the specified limit (p).

- The cost of hiring coaches is constant across all years.

- The cost of keeping unrented players is calculated based on the salary and the difference between the player demand and the number of promoted players for that year.

Objective:

The goal is to minimize the total cost of managing the team over the given number of years, subject to the constraints mentioned above. The dynamic programming approach used in the program ensures an optimal solution by iteratively computing and updating the minimum cost for each year based on the previous year's value.

Solution Strategies:

1. Dynamic Programming Approach: The implemented solution utilizes a dynamic programming approach to solve the team management problem efficiently. The following steps outline the solution strategy:

    a. Create an array **dp** of size **n+1** to store the dynamic programming values for each year, initialized to 0. b. Set **dp[0]** to 0 as the base case, representing no cost for year 0. c. Iterate from 1 to **n** to process each year:

- Retrieve the demand for the current year from the **demands** list.

- Determine the salary for the current year by either retrieving it from the **salaries** list if available or using the last available salary.

- Calculate the number of players to promote (**promote**) as the minimum of **p** and the demand for the current year.

- Calculate the number of coaches to hire (**hireCoaches**) as the maximum of 0 and the difference between the demand and **p**.

- Calculate the cost of keeping unrented players (**keepUnrented**) as the maximum of 0 and the difference between **p** and the demand, multiplied by the salary.

- Update **dp[i]** by taking the minimum between the previous year's cost (**dp[i-1]**) plus the cost of hiring coaches and keeping unrented players, and the previous year's cost plus the cost of promoting players. d. Return **dp[n]**, which represents the minimum cost of managing the team over **n** years.

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