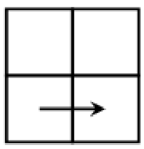
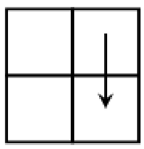
CSC 323 Algorithm Design and Analysis, Spring 2018
Instructor: Dr. Natarajan Meghanathan
Project 5: Dynamic Programming Algorithm for Optimum Coin Collection in a Two-Dimensional Grid

Due: March 29th, 1 PM (Submission through Canvas)

In this project, you will extend the dynamic programming algorithm that we discussed in class for the Coin Collection problem in a two-dimensional grid and implement the same.

The conditions for the robot movement are as follows: at any time, the robot can move one cell down or one cell to the right


One cell to the right


One cell down

Each of you are assigned a grid of dimensions n (rows) x m (columns) as specified in the next page. You are required to randomly distribute P number of coins (where P < n*m) across the cells of the grid (at most one coin per cell). The value for a coin assigned to a cell is randomly chosen from the range 1 ... V. The P and V values are also assigned specifically for each student.

Your tasks are as follows:
(1) Implement the dynamic programming algorithm to calculate the optimum (maximum) value of the coins that a robot could collect as it traverses from cell (0, 0) to any cell in the grid such that at any time, a robot can have one of the two movements mentioned above.
(2) Extend the dynamic programming algorithm to also keep track of the path traced by the robot to reach any target cell in the grid starting from cell (0, 0). Clearly explain the logic of your algorithm to keep track of the path traced.
(3) As output, your code should print the following:

- (i) The optimum value of the coins that a robot could collect to reach any target cell in the grid starting from cell (0, 0), as shown in the table sample output (see next page).
- (iii) The sequence of cells that the robot should visit to collect the optimum value of the coins starting from cell (0, 0) to cell (n-1, m-1).
- (ii) The total number of horizontal movements (one cell to the right) and the individual horizontal movements as well as the total number of vertical movements (one cell down) and the individual vertical movements that the robot needs to make to collect the optimum value of the coins starting from cell (0, 0) to cell (n-1, m-1).

Submission (Report uploaded through Canvas):
The report should include your entire code, your explanation for the various sections of your project code. Focus more on explaining the following: Your logic to randomly distribute the assigned number of coins to the cells in the grid, the implementation of the dynamic programming algorithm to compute the optimal value for the coins collected, the sequence of cells that the robot should visit from cell (0, 0) to cell (n-1, m-1) and the individual horizontal as well as vertical movements traced as part of this path. Also, include a screenshot (as shown in a sample output displayed in the next page) of the output for the input values assigned to you.

<u>Assignment of Input Values</u>

Student Name	# rows (n)	# columns (m)	# coins (P)	Max value per coin (V)
Leon Anderson	10	12	40	25
Ujjwal Baskota	10	12	35	35
Albert Boateng	10	12	30	25
Nissi Campbell	10	12	25	35
Samuel A. Dagne	9	10	40	30
James Daniel	9	10	35	20
Zakeia Davis	9	10	30	30
Justin Epps	9	10	25	20
Amanuel E. Gebre	8	10	30	40
Melrondarius Groom	8	10	25	50
Yoseph Hailemariam	8	10	40	35
Antonie Hobson	8	10	35	30
Portia Junius	12	10	40	22
Justin McGuffee	12	10	35	28
Ryun Moore	12	10	30	30
Keara Rogers	12	10	25	32
Timothy Stewart	10	9	37	24
Nebiyou Tadesse	9	11	35	45
Phat Tran	11	9	25	50

<u>A sample screenshot</u> of the execution of the program expected from you is shown below.

```
Enter the number of rows: 10
Enter the number of columns: 7
Enter the number of coins: 40
Enter the max. value for a coin: 30

Distribution of the Coin Values
25      16      4       6       0       18      0
26      0       0       7       0       3       0
0       0       0       26      2       11      21
5       0       0       0       17      0       0
0       4       0       14      0       0       17
0       20      27      0       12      1       26
0       26      29      22      6       0       0
0       13      14      8       0       23      0
0       20      0       0       24      25      12
13      0       12      27      0       28      27


Dynamic Programming Table
25      41      45      51      51      69      69
51      51      51      58      58      72      72
51      51      51      84      86      97      118
56      56      56      84      103     103     118
56      60      60      98      103     103     135
56      80      107     107     119     120     161
56      106     136     158     164     164     164
56      119     150     166     166     189     189
56      139     150     166     190     215     227
69      139     162     193     193     243     270


Path Traversed: [0 0, 1 0, 2 0, 3 0, 3 1, 4 1, 5 1, 5 2, 6 2, 6 3, 7 3, 7 4, 8 4
, 8 5, 9 5, 9 6]


Number of Horizontal Movements: 6
[3 0 --> 3 1, 5 1 --> 5 2, 6 2 --> 6 3, 7 3 --> 7 4, 8 4 --> 8 5, 9 5 --> 9 6]


Number of Vertical Movements: 9
[0 0 --> 1 0, 1 0 --> 2 0, 2 0 --> 3 0, 3 1 --> 4 1, 4 1 --> 5 1, 5 2 --> 6 2, 6
 3 --> 7 3, 7 4 --> 8 4, 8 5 --> 9 5]
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