Software Programming for Performance
Spring-2021
Assignment-1
Posted on: 12/03/2021
Due on: 11:55PM, 22/03/2021

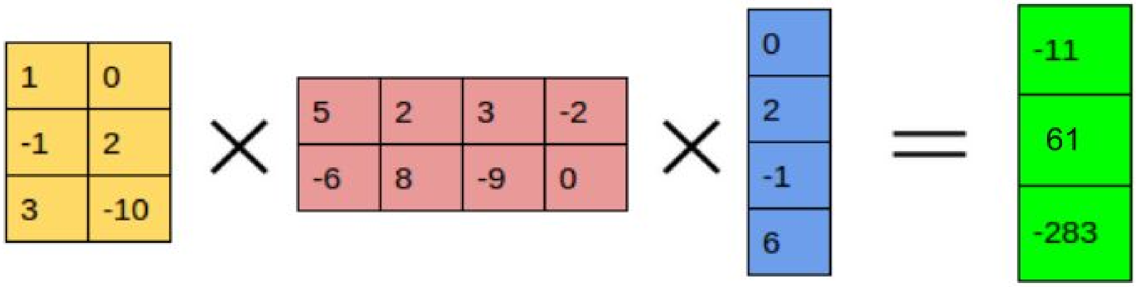
Questions:

0) Getting Started:

Get yourself acquainted with **perf, cache grind, gprof, and clock_gettime,** and include your understanding in the report. Also, evaluate the performance of the following questions using these.

1) Matrix Chain Multiplication:

Given a sequence of n matrices, find an efficient way to multiply these matrices together. For any two adjacent matrices A and B given in the input sequence, it is guaranteed that they can be multiplied together (i.e. the number of columns in A is the same as the number of rows in B).



$$\begin{bmatrix} 1 & 0 \\ -1 & 2 \\ 3 & -10 \end{bmatrix} \times \begin{bmatrix} 5 & 2 & 3 & -2 \\ -6 & 8 & -9 & 0 \end{bmatrix} \times \begin{bmatrix} 0 \\ 2 \\ -1 \\ 6 \end{bmatrix} = \begin{bmatrix} -11 \\ 61 \\ -283 \end{bmatrix}$$

An example with n = 3

INPUT :

The first line contains one number n ($1 \le n \le 5$) — the number of matrices to multiply.

The following lines will describe the n matrices in the order that they need to be multiplied.

The first line of the k^{th} matrix description contains two integers x_k and y_k ($1 \le x_k$, $y_k \le 1000$) — the dimensions of the k^{th} matrix.

The next x_k lines contain y_k space-separated integers $a^k_{i,j}$ ($-10 \le a^k_{i,j} \le 10$) — the values of each cell of the k^{th} matrix.

It is guaranteed that any two adjacent matrices in the sequence of n matrices can be multiplied together ($x_k = y_{k-1}$, $2 <= k <= n$).

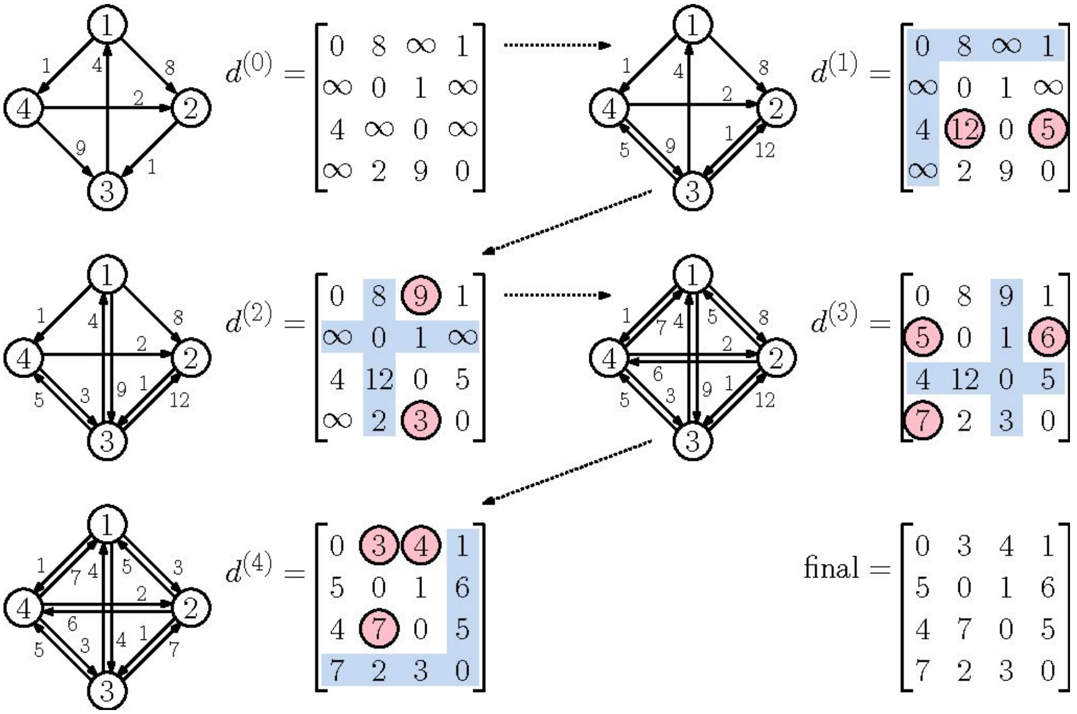
OUTPUT :

The first line should contain two numbers *a, b* — the dimension of the result matrix after multiplying the n matrices in the given order.

Then *a* lines should follow containing *b* space-separated integers $a_{i,j}$ describing the result matrix.

2) Floyd Warshall Algorithm:

For a given Adjacency list of the graph. Find the shortest path between every pair of vertices in the graph. There can be vertices to which no path is possible, print -1 in all such cases. Usage of **ONLY Floyd Warshall** Algorithm is allowed.



INPUT :

The first line contains two numbers V ($1 \leq V \leq 2500$) and E ($1 \leq E \leq 10^5$) — the number of Vertices and Edges in the given graph.

The following E lines contain three inputs each X ($1 \leq X \leq$ V), Y ($1 \leq Y \leq$ V), and W ($1 \leq W \leq 10^5$), where X denotes the starting node and Y denotes the terminal node and W denotes the weight of the edge between those vertices.

OUTPUT :

The matrix of size *(V * V)* denoting the shortest distance between each node. Element A_{ij} in the output matrix should denote the shortest distance from the i^{th} vertex to the j^{th} vertex in the graph.

Special Note:

- In case there is no edge between the two vertices, the output should be **-1**.
- There can be cases where multiple edges can exist between two vertices or a vertex has a self-loop, So handle them carefully.
- Consider indexing of vertices will be done from 1.

Submission Format:

```
rollnumber
        ├──── q1.c
        ├──── q2.c
        └──── Report.pdf
```

zip the directory ‘rollnumber’ as ‘rollnumber.zip’ and submit.

Report:

- There’s no fixed format to write the report.
- It should cover (at least) your approach and performance analysis.
- It is recommended to use visualization tools like plotly, matplotlib to present the different performance comparisons you think are worthy of highlighting.

Grading:

- Your code is more optimized than the baseline (simple not so optimized solution) => **15%**
- Report => **30%**
- Performance relative to the best submitted solution => **55%**

Instructions:

1) You are supposed to code in C language only.
2) Your code will be run with -O0 flag. i.e. zero compiler optimization.
3) Strictly follow the submission format. The final submission should be a zip file.
4) The report should be a pdf file. It should be concise and self-explanatory.
5) Evaluations will be automated. In case of the wrong submission format, you will get a straight zero.
6) Deadline will not be extended in any case so start early.
7) Plagiarism will be seriously dealt with. DO NOT COPY (EVEN THE REPORTS).