CS 421: OutLab: Lithium Ions: MPI basics

- Released: Wed Feb 7 5:30 PM. Due: Sunday Feb 11 21:50 AM

- Please do not forget the honor code.

Overview

This is an individual assignment. Any discussions should be constrained to public Piazza postings. You are not to discuss with ANY other person (same class, same batch, different batch, unknown person, ...). The only exception is your professor.

Task A

In trying to design safer Lithium Ion batteries, scientists are trying to estimate the speed of propagation across a barrier, after the Samsung Note 7 fire incident. To better study non-uniform propagation due to anisotropic and non-homogeneous temperatures arising from unconventional usages, the Lithium ions are bombarded across an amorphous semiconductor with a cathode held across a rectangular substrate. See picture.

```
Positive Lithium Ion
.^^*@--^@^+-..@^+.*@-*.^...-*!.@+!@!@+@^--*x+@*-+^
@..@!^.*++^@!-+!-x!xx.@.-x.!x*.xx@+x***-x^@!*x@^^-
-^+!.!!+.^+-+^.@*+*-x^-@x@-*@*x@!@^@.^-@xx@..+@+!^
.+.-+@+*+!x!.-!@-.@-@@^@+.x!.+.-.+++!!x!x.*-@^.*xx
@x^x+.*-+^+*x.x@**@@.!^+@.!+.!xx!!x!@-@+x---*^++x+
.+.!x*@*!..@^x+x!-.@*.x+@+..@x-^!*.*.@x.*.!-!^@@*@
@+-.**x*@-*+!-*!^!.!x@.^^+.*xx@x*@@-@.x--!.!+-.-*-
!x+.@-!xx*.+*^!-x+!*^@*.!**-xx!**.x+!x@*@*^.-*.+@+
Negative voltage
```

In the picture above, each of the symbols: `*, ^, ., -, , !, @, x+` correspond to the (value of) impedance caused by the substrate to the ion.

You will be given a matrix of real numbers that model the heterogeneous rectangular regions. The task is to compute the fastest way (i.e., the path of least resistance) of reaching the cathode across (essentially) a rectangular matrix of real numbers (modeling impedance).

Lithium ions can move down (south), to the left and down (south west), or to the right and down (south east). They do not move east or west. Also collisions between Li ions are not modeled due to mutual repulsion. However, there are a humongous number of atoms and ions even in a small substrate; thus, there are a billion plus real numbers hidden in the substrate. Thus, a parallel processing algorithm is desired.

Note that the ion chooses to take a path to the cathode by visiting "cells" in the matrix such that the total cost is minimum. For example, if the ion visits two cells in the south direction with values 0.25 and 0.4,the cost of this path 0.65, so this ion is going to be slower than another that takes the values 0.25 and 0.3.

The program works on a two dimensional matrix of real numbers. The first line of output is the cost of the fastest path. Next subsequent lines print the column ids of the fastest path, starting from anode to cathode (top to bottom). In case of multiple fastest paths, print any one of them.

Task

Please note the following constraints

1. The program should adhere to the general style of mpi odd even sort that has been given to you in the lec9 programs folder (The code is included in the outlab assignment's template code as *mpisort.c*). For example, you should be ready to either generate the matrix test input, or read from standard input.

2. No process has the ability to store the large input matrix A, in other words the matrix A must be chunk stored by all the processes.

3. All I/O must be done by processor 0

4. Storage other than the input matrix A should be kept to the minimum

5. Obviously we want a fast program

6. The reflection essay should explain what are good solutions and what are not, and why you chose the solution you did.

7. All functions that you write must be in a separate file, i.e., other than given file on class-room.github.com

How We will Grade You

Your program would be tested on matrices of various size and values. You shall be awarded partial credit for getting either cost of the fastest path or for outputting a fastest path.

Submission

Essential submission: To be specified. See below for general guidelines.
Your group number is the last two digits of your roll number with some exceptions.

Submission Guidelines

As always, stay tuned on Piazza for clarifications

1. Do include a readme.txt (telling me whatever you want to tell me). Do include group members if any (name, roll number), group number, honour code, citations, etc.

2. As mentioned, you should periodically commit to GitHub.

3. As usual, submit to Moodle. Grading is based on Moodle submission. The folder and its compressed version should be similarly named. (For example: the folder is `lab02_group07_outlab` and the related `tar.gz` is `lab02_group07_outlab.tar.gz`

4. Your submission should look something like (to be updated)
   `lab02_groupXY_outlab`
   ├── `mpi_outlab.c`
   ├── `reflection.txt`
   ├── `makefile`
   ├── `readme.txt`