## **Parallel Implementation of Proximity Criteria**

## Final project

## Course 10130, Parallel and Distributed Computation

## 2022 Spring Semester

A set of **N** points is placed in two-dimensional plane. Coordinates **(x, y)** of each point **P** are defined as follows:

**x = ((x2 – x1) / 2 ) \* sin (t\*π /2) + (x2 + x1) / 2)**

**y = a\*x + b**

where **(x1, x2, a, b)** are constant parameters predefined for each point **P**.

## **Problem Definition**

We will say that some point P from the set satisfies a **Proximity Criteria** if there exist at least **K** points in the set with a distance from the point **P** less than a given value **D**.

Given a value of parameter **t,** we want to find if there exist at least 3 points that satisfies the Proximity Criteria

## **Requirements**

* Perform checks for Proximity Criteria for **tCount + 1** values of t:

**t = 2 \* i / tCount - 1, i = 0, 1, 2, 3, …, tCount**

where tCount is a given integer number.

* For each value of **t** find if there is three points that satisfy the Proximity Criteria. If such three points are found – don't continue evaluation for this specific value of **t**.
* The input file **input.txt** initially is known for one process only. The results must be written to the file **output.txt** by the same process.
* The computation time of the parallel program must be faster than sequential solution.
* Be ready to demonstrate your solution running on VLAB (two computers from different pools when using MPI)
* **No code sharing between students is allowed.** Each part of code, if any, which was incorporated into your project must be referenced according to the academic rules.
* Be able to explain each line of the project code, including those that were reused from any source.
* **The project that is not created properly (missing files, build or run errors) will not be accepted**

## Input data and Output Result of the project

The input file contains **N** in the first line - the number of point in the set, **K** – minimal number of points to satisfy the Proximity Criteria, distance **D** and **TCount**. The next **N** lines contain parameters for every point in the set. One or more blanks are between the numbers in a file.

**Input.txt**

N K D TCount

id x1 x2 a b

id x1 x2 a b

id x1 x2 a b

…

id x1 x2 a b

For example

4 2 1.23 100

0 2.2 1.2 2 45.07

1 -1 26.2 4,4 -3.3

2 -43.3 12.2 4.7 20

3 11.0 -6.6 12.5 23.

**Output.txt**

The output file contains information about results found for points that satisfies the Proximity Criteria.

* For each **t** that 3 points satisfying the Proximity Criteria were found, it contains a line with the parameter **t** and ID of these 3 points

**Points pointID1, pointID2, pointID3 satisfy Proximity Criteria at t = t1**

**Points pointID4, pointID5, pointID6 satisfy Proximity Criteria at t = t2**

**Points pointID7, pointID8, pointID9 satisfy Proximity Criteria at t = t3**

* In case that the points were not found for any t, the program outputs:

**There were no 3 points found for any t.**

## **Grade Policy**

* **60 points** for the effective **proper** parallel implementation of the problem with two components: ***MPI+OpenMP*** or ***OpenMP+ CUDA*** or ***MPI+CUDA***. The project that produces wrong results will not be accepted.
* **10 points** for implementation of full ***MPI+OpenMP+CUDA*** configuration.
* **10 points** for the documentation of your solution – clear explanation of what and how the problem was parallelized, what is a rational of choosing the specific architecture, complexity evaluation.
* **10 points** for the code quality – modularity, generality, self-explanatory, organization.
* **10 points** for the Load Balancing.

## Additional Bonus for the project grade

**5 points** for implementation with OpenCL instead of CUDA

**5 points** for use of OpenMP task construct

**5 points** for use CUDA multi-streaming

**5 points** for your own proposal (must be approved by lecturer).

# הפרויקט יוגדר כמטלת הקורס עם הגשה עד 1.09 יוגש רק דרך אתר הקורס

# נדרשת הגנה על הפרויקט בפגישה עם המרצה לפי לוח הגשות שיתפרסם.

# יישום והגשת הפרויקט בקבוצית עד שלושה סטודנטים בלבד.

# בהצלחה