COMP 4007: Parallel Processing and Computer Architecture
Programming Assignment 4

Due date: **16 November 2024 23:59**

Notes
1. The problem counts 10 points, which contributes 10% of the overall credit of the course.
2. All submitted code will be compiled and tested on the lab 2 machines to evaluate the assignments.
3. Points may be deducted if your programs consistently achieve no speedup over the serial program.
4. Please zip all your code and reports into one file, named "ID_Name_Lab4.zip" (node that ID and name are your student ID and Chinese name respectively), and send it to the TA's email (869259303@qq.com).

Problem 1:
Please use MPI and CUDA to solve the problem.
Suppose A and B are binary matrices whose dimension are both n*n.
Define $\otimes$ as a matrix multiplication under module 2. More specifically, if $C = A \otimes B$, it means

$$C[i][j] = \left(\sum_{k=0}^{n-1} A[i][k] * B[k][j] \right) \% 2,$$

Define $\oplus$ is matrix addition under module 2. More specifically, if $C = A \oplus B$, it means
$$C[i][j] = (A[i][j] + B[i][j])\%2,$$
where $i, j \in [0, n-1]$ and % is remainder operation as in C/C++. We define the power operation as follow. For all matrix A,
$$A^m = \begin{cases} A, & m = 1; \\ A^{m-1} \otimes A, & m > 1. \end{cases}$$
Given m, A, B, please use MPI and CUDA to calculate C by following formula:
$$C = (A \otimes B^m) \oplus (A \otimes B^{m-1}) \oplus (A \otimes B^{m-2}) \dots \oplus (A \otimes B^1) \oplus (A)$$
where $m \geq 1$.

Sample code
The sample code is multiple.cpp. The load data part, sequential calculation part and the test part has been implemented. Add your code in specified area. You can add some new functions but not to modify existing statements. Do not output extra debug information.

Some small sample input data and large sample input data are provided for debugging. When testing, we will use some large input data.

Compile and run
A makefile is provided. You can use it to run the program. For example, use the command "make test_small_1" can run a test with a small dataset.
Each machine will have only one process. The program is run in at most 4 machines.
The three arguments are "number_of_block_in_a_grid", "number_of_thread_in_a_block", "data_file_name"