CS471 – Parallel Processing
Parallel Processing Comparative Study

2nd Semester – 2020 - Project Description v1.0

Cairo University, Faculty of
Computers and Artificial Intelligence

Course Contact

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Objectives

Professor: Fill in the objectives of doing this project or research

1- Design a parallel algorithm from a serial one.
2- Implement parallel algorithm in different environment with different APIs.
3- Evaluate parallel program performance with different performance measures.

Instructions

1- This project is to be solved by teams up to 5 students.
2- Students will submit one combined solution and must contribute equally to the solution.
3- Only submit original work. Any copied work will be severely penalized.
4- Please read the rest of this document very carefully and read the marking criteria.
5- You must choose one of the following two topics

Topic 1: Matrix Multiplication using Fine-Grained Parallelism

Topic 2: Matrix Multiplication using Coarse-Grained Parallelism

Introduction

Task Decomposition is an important phase in constructing a Parallel Algorithm for solving any problem. Task Decomposition is to divide the computation into smaller parts, which can be executed concurrently. Different task decomposition leads to different parallelism. There are two main types of task decomposition:

1. Fine-grained decomposition: large number of small tasks.
2. Coarse-grained decomposition: small number of large tasks.

Problem definition

Given two matrices A, B and C is the result of multiplication where:

- Matrix A(m ×r) of m rows and r columns and each of its elements is denoted aij with $1 \leq i \leq m$ and $1 \leq j \leq r$.
- Matrix B(r ×n) of r rows and n columns and each of its elements is denoted bij with $1 \leq i \leq r$ and $1 \leq j \leq n$.

- Matrix C resulting from the operation of multiplication of matrices A and B, C = A ×B, is such that each of its elements is denoted cij with $1 \leq i \leq m$ and $1 \leq j \leq n$, and is calculated as follows:

$$c_{ij} = \sum_{k=1}^{r} a_{ik} \times b_{kj}$$

Project Tasks (80 marks)

1- **Design** a **serial** program for the matrix multiplication problem.
2- **Apply Foster's methodology** steps for converting from serial to parallel algorithm showing the tasks communication graph.
3- **Construct** a **parallel** algorithm (Steps or Pseudo code) for matrix multiplication.
4- **Implement** the parallel algorithm with **MPI API**.
5- **Implement** the parallel algorithm with **OpenMP API**.
6- **Evaluate** the **performance** of each implementation in 4 and 5 using the following measures:
   - **Speedup**
   - **Efficiency**
   - **Scalability**
7- **Document** test results for your programs (in 4 and 5) as follows:
   i. Table for **run time** of **serial** program on different dimensions for matrices (up to 1024 x 1024 increasing with steps of 100).
   ii. Table for **run time** of **parallel** program using different number of processes/threads (from 1 to 100) on different dimensions for matrices (up to 1024 x 1024 increasing with steps of 100).
   iii. Table for **speedups** using different number of processes/threads (from 1 to 100) on different dimensions for matrices (up to 1024 x 1024 increasing with steps of 100).
   iv. Table for **efficiencies** using different number of processes/threads (from 1 to 100) on different dimensions for matrices (up to 1024 x 1024 increasing with steps of 100).
   v. Analysis for **scalability** (weakly or strongly).

8- Graph a comparison between the two solutions performance (with MPI and with OpenMP) and conclude what you found.

Deliverables and Assessment

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Your document must have a cover page with your team names, emails, document name, FCAI logo, course name, etc.

You will upload one zip file containing:

i. Algorithms in doc file.
ii. Code in notepad file.
iii. Tables and graphs in pdf format.