Ain Shams University
Faculty of Engineering
Computer and Systems Eng. Dept.
CHEP- Fall 2025

CSE355: Parallel and Distributed Algorithms
Research Project (Automatic Parallelization)

Introduction

Automatic parallelization is a technique used in parallel computation to transform sequential code into parallel code automatically, without programmer intervention. It involves analyzing the code to identify opportunities for parallelism, dividing the computation into parallel tasks, and coordinating their execution to achieve performance increases. Automatic parallelization is a complex procedure that necessitates sophisticated algorithms and tools to guarantee that the parallelized code is correct and efficient. As the demand for high-performance computation increases and parallel architectures become more prevalent in modern computing systems, its significance has grown. Automatic parallelization can be used to maximize the potential of parallel architectures, reduce computation time, and enhance application scalability. However, it presents several challenges, such as the need to balance workload distribution and reduce communication overhead, making it a subject of ongoing research in the field of parallel computing.

Accordingly, the objective of this project is to introduce undergraduate students to the concept of automatic parallelization in parallel computing. The project will require students to **implement an auto parallelization technique** in a given codebase, measure the performance gains achieved, and report their findings.

- To help you to start, you can read the references available through this link.

Requirements:

- Understanding of parallel computing and programming concepts.
- Knowledge of programming languages such as C/C++, Python, or Java.
- Familiarity with tools like OpenMP, MPI, and ISPC.
- Access to a computing environment with multiple cores or processors.

Objectives:

- Understand the codebase provided for the auto parallelization exercise. The codebase should be a non-parallel code written in a programming language such as C/C++, Python, or Java.
- Identify opportunities for parallelization in the codebase. This can be achieved by analyzing the code and profiling it using tools such as Gprof, Perf, and VTune.
- Implement auto parallelization techniques using tools such as OpenMP, MPI, or ISPC.
- Measure the performance gains achieved using tools such as Gprof, Perf, and VTune. Compare the performance of the original code with the parallelized code and report their findings.
- Document their findings in a report that includes a description of the codebase, the identified opportunities for parallelization, the implemented auto parallelization techniques, the performance gains achieved, and a discussion of the results.

Deliverables

The main deliverable in this project is a term paper. You are expected to write a 4–6 page (in 10pt IEEE style) paper on any topic relevant to Automatic parallelization. You can work in groups of 4-6 students on the project.

- Term Paper - 100%
  - Phase I: Research Proposal – 5 Marks
  - Phase II: Final Term Paper – 10 Marks
  - Phase III: Presentation and Discussion – 5 Marks

➢ Phase I: Research Proposal (5 Marks)

The research proposal should be at most 3 pages with a cover page containing the names and IDs of the team members, double-column in 10-point font. Here is a guideline to structure your paper.

1. Introduction: Motivate why the problem you choose is important, and what has been done before.
2. Problem Definition: Define the problem as precisely as possible, and explain the problem with a well-chosen example
3. Proposed Evaluation: how you will evaluate your approach, planned benchmarks, etc.

➢ Phase II: Final Term Paper (10 Marks)

Each group is expected to submit a 4-6 page paper describing their progress in 10pt IEEE format (PDF). The paper should clearly address the following questions:

1. Title and Abstract (summarize the paper's main insights and be catchy)
2. Introduction (e.g., motivation for the problem, problem definition, main contributions)
3. Related Work
4. Proposed Solution
5. Evaluation and Results
6. Conclusion and Future Work

➢ Phase III: Presentation and Discussion (5 Marks)

1. Time management
2. Presentation Clarity
3. Q and A.

Tools and links

➢ Search for Published Research

- EKB
- IEEE Xplore Digital Library
- ACM Digital Library
- ScienceDirect
- SpringerLink
- Google Scholar

➢ Figures and flowcharts

- Gliffy
- Draw.io

➢ Writing

- Mendeley
- Overleaf
- EndNote
- Ms Word

➢ Spelling and grammar

- Grammarly

Important Dates

- **Sunday, November 30, 2025** - Submission of research proposal
- **Sunday, December 21, 2025** - Submission of final term paper
- **TBD** - Presentation and Discussion

Best wishes

Dr. Islam Tharwat Abdel Halim

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PPT marking criteria

Course Code:	.....	**Course Name:**	.....	**Assignment No.**	.....	**Date:**	.....
Student Name:	.....			Student ID:	.....		

	A (89-100)				B (76-88)				C (67-75)				D (60-66)				F (0-59)			
	100	96	92	89	88	84	80	76	75	72	69	67	66	64	62	60	59	40	20	0
Relevance & Organization of Ideas (50%)	• Materials cover the topic widely & deeply. • All main points fully developed. No repetition				• Materials cover the topic widely & deeply. • Clearly structured. All main points valid but not always fully developed. Minor repetition or deviation.				• Most of the materials cover the topic reasonably. • Some structure. Most but not all main points valid & developed. Some repetition.				• Some of the materials are relevant and slightly cover the topic. • Structure not clear. Few valid main points. Repetition or deviation.				• Materials do not cover the topic. • Unstructured. Few, if any, valid main points. Material mostly deviated from the task. Inaccurate or absent.			
Answering Questions (30%)	• Answers are correct and to the point.				• Most answers are correct.				• Some answers are correct.				• Few answers are correct.				• Most answers are incorrect.			
Presentation Language (20%)	• Excellent ability to express ideas with proper language and technical vocabulary.				• Good ability to express ideas with proper language and technical vocabulary.				• Normal ability to express ideas with proper language and technical vocabulary.				• Low ability to express ideas with proper language and technical vocabulary.				• Difficult to express ideas with proper language and technical vocabulary.			

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Report marking criteria

Course Code:	.....	**Course Name:**	.....	**Assignment No.**	.....	**Date:**	.....
Student Name:	.....			Student ID:	.....		

	A (89-100)				B (76-88)				C (67-75)				D (60-66)				F (0-59)			
	100	96	92	89	88	84	80	76	75	72	69	67	66	64	62	60	59	40	20	0
Literature survey (25%)	• Critical evaluation and synthesis of relevant issues and materials				• Critical evaluation of relevant issues and materials				• Accurate description of main relevant issues				• Limited evaluation and description of main issues				• Insufficient and largely irrelevant material			
Research Objectives (25%)	• Clearly defined research problem with well-structured research objectives				• Complete set of research objectives				• Limited research objectives				• Poorly defined objectives				• Research problem lacking clear objectives			
Research Methodology	• Clear and relevant research methodology with complete implementation				• Clear and relevant research methodology missing few components				• Clear research methodology missing several components				• Inappropriate research methodology				• Lack of clear research methodology			
Analysis of Results & Conclusions	• Excellent analysis of results and complete relevant conclusions				• Good analysis of results missing some minor conclusions				• Normal analysis of results missing some basic conclusions				• Incomplete analysis or results with some conclusions				• Missing proper analysis or results and no conclusions at all			

Assessment Method	LO1	LO2	LO3	LO4	LO5
Project		■	■		