Solve Job Shop Scheduling Problem with High-Performance Computer

The Job Shop Scheduling Problem (JSSP) is a classical NP-hard optimization problem that arises in manufacturing, production planning, and service systems. It involves scheduling a set of jobs, each consisting of a sequence of operations, on a set of machines while optimizing objectives such as minimizing makespan, tardiness, or machine idle time. Due to its combinatorial complexity, exact methods become impractical for large-scale instances, motivating the use of heuristic, metaheuristic, and parallel computation techniques.

This thesis investigates how High-Performance Computing (HPC) can be leveraged to efficiently solve large and complex instances of the Job Shop Scheduling Problem. The main goal is to design, implement, and evaluate parallel and distributed solution approaches that exploit modern HPC architectures such as multi-core CPUs, GPUs, or computing clusters.

The student will investigate how HPC techniques can be applied to JSSP by focusing on the following aspects:

- parallelization of classical JSSP solution methods (e.g., branch-and-bound, tabu search, genetic algorithms),
- design of scalable parallel metaheuristics for large problem instances,
- efficient task and data decomposition strategies for distributed memory systems,
- performance evaluation on different HPC architectures, and
- analysis of solution quality, speedup, scalability, and robustness.

The research includes implementing selected algorithms, adapting them for parallel execution, and benchmarking their performance on standard JSSP datasets. Experimental results will be analyzed to identify trade-offs between computation time and solution quality, as well as the impact of different parallelization strategies.

This work aims to contribute to both scheduling theory and practical HPC applications by demonstrating how high-performance computing can significantly improve the solvability of complex job shop scheduling problems encountered in real-world industrial environments.

For application please send me an email with title “Master Thesis Application: Job Shop Scheduling ”. Please also attach your resume and transcript of records in the email. A motivation letter is NOT required.

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Research project:
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Type:
MA

Research area:
Scheduling Optimization, High-Performance Computing, Parallel Algorithms

Programming language:
C/C++ or Python

Required skills:
Parallel Programming (MPI/OpenMP/CUDA), Optimization Algorithms, C/C++ or Python

Language:
English or German

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