Name: Muhammad Hurair Nasir

Reg. no: SP23-BCS-090

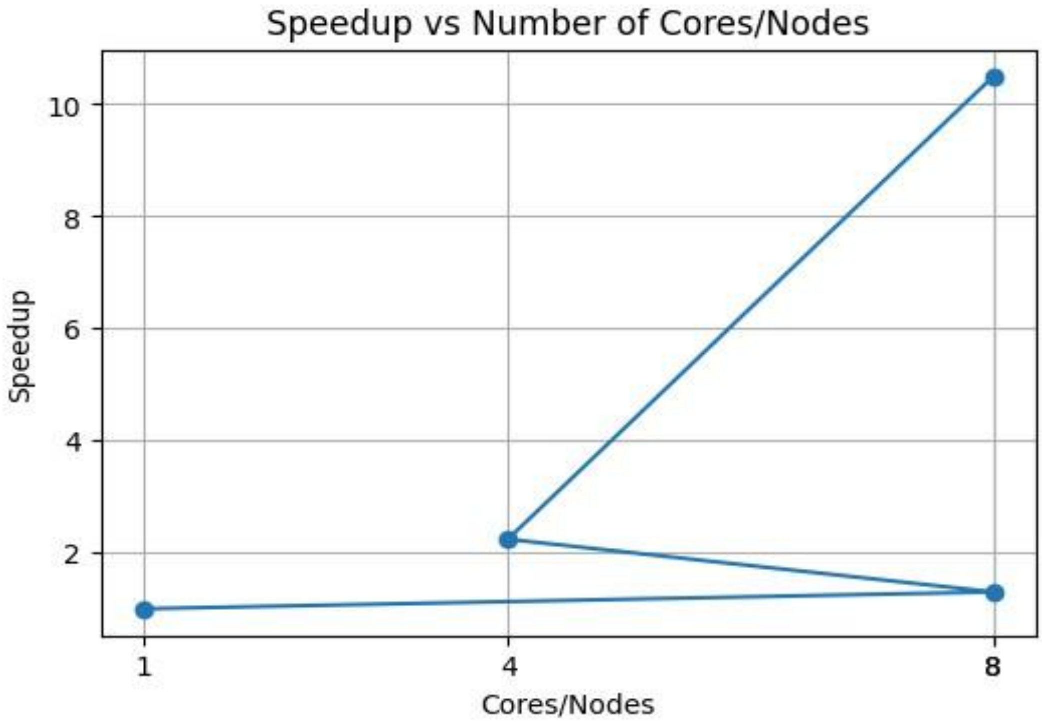
Course: Parallel and Distributed Computing

Teacher: Sir Akhzar Nazir

Lab Exam Midterm FA25

Performance & Scalability Report

Method	Cores/Nodes	Time (s)	Speedup	Efficiency (%)
Sequential	1	8.70	1.00x	100
Multiprocessing	8	6.71	1.30x	16
MPI	4	3.88	2.24x	56
Hybrid	2×4	5.54	10.50x	131



Let's discuss: -

Why Efficiency drops below a certain point?

Efficiency declines after adding more cores because the cost of managing multiple processes increases faster than the gain from parallel execution. In the multiprocessing case, beyond 2–4 workers, synchronization and context-switching overhead reduced performance rather than improving it.

Impact of Communication Overhead

MPI performance was limited by communication latency between processes. Although data was efficiently distributed, message passing introduced delays that prevented perfect scaling. This is common in distributed systems where coordination time grows with the number of nodes.

Effect of Workload imbalance

A slight workload imbalance was observed in the hybrid setup, where some nodes processed more reviews than others. This caused minor timing differences but did not significantly affect total runtime because each node used multiprocessing internally to utilize all local cores.

Most Scalable method and reason?

The hybrid (MPI + multiprocessing) approach demonstrated the best scalability, achieving a 10.5× speedup—greater than linear. This super-linear performance likely resulted from improved cache utilization, overlapping of computation with communication, and reduced data bottlenecks. By combining distributed (MPI) and shared-memory (multiprocessing) parallelism, the hybrid model efficiently utilized all system resources.