Distributed Matrix Computation (DMaC)

A Distributed System for Matrix Multiplication

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Introduction

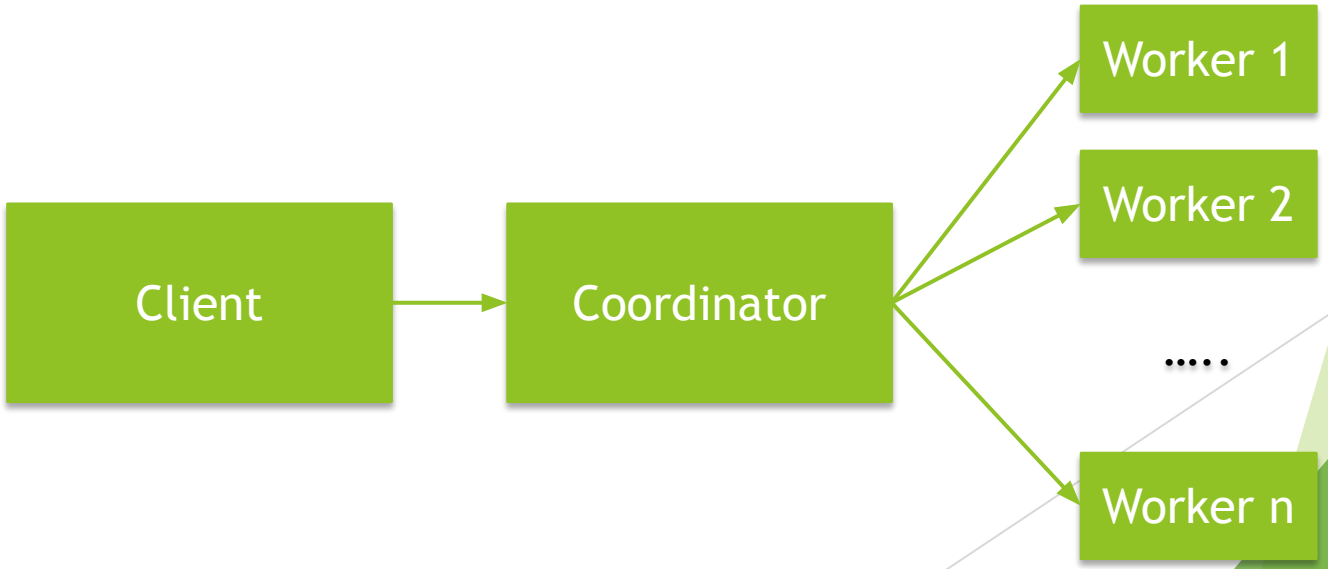
- Distributed matrix multiplication
  - Strassen's Algorithm
- Heterogeneous nodes
- Coordinator-worker architecture
- Client for User-Interface
- Scalable and transparent

Motivation

- Single-threaded shortcomings
- Time consuming large-scale matrix multiplications
- Improve performance
- Provide scalability

System Architecture

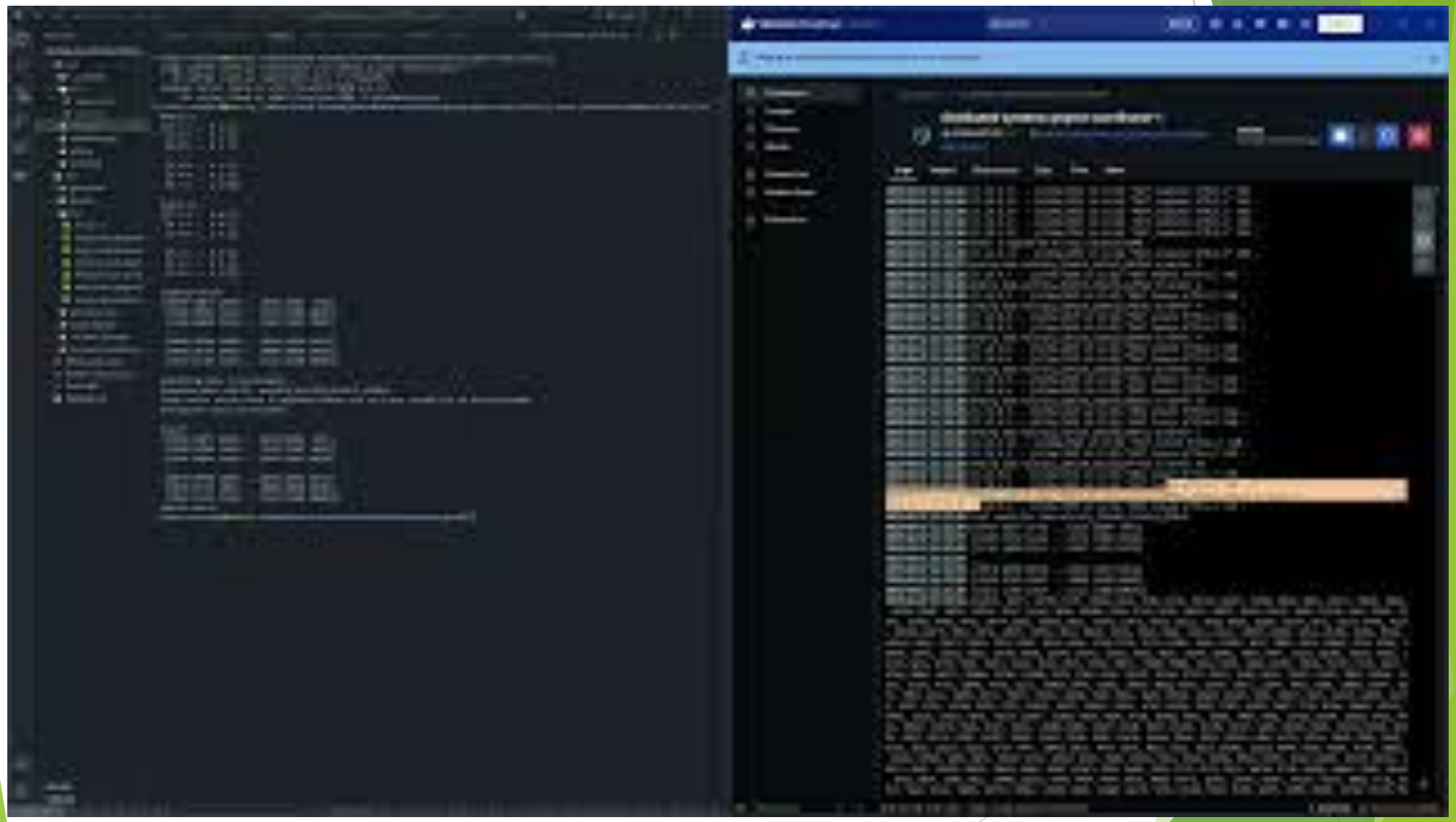
- Client: Submits jobs and verifies results
- Coordinator: Distributes tasks, collects results
- Workers: Compute using Strassen's Algorithm



Implementation Details

- Failure handling with retry mechanisms
- Python with Flask, NumPy, and threading
- Docker simulates a distributed environment
- **Strassen's Algorithm** for matrix multiplication ($O(n^{2.807})$ vs. $O(n^3)$)

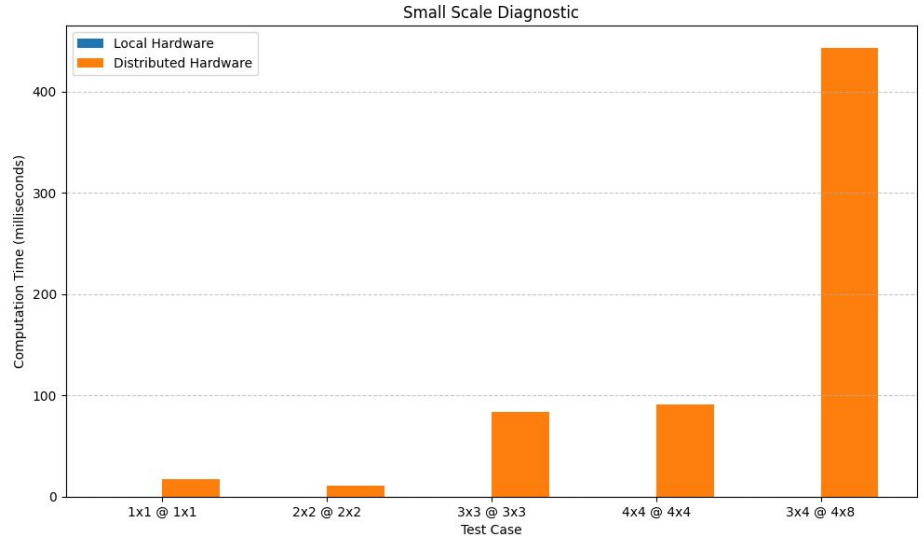
Demo

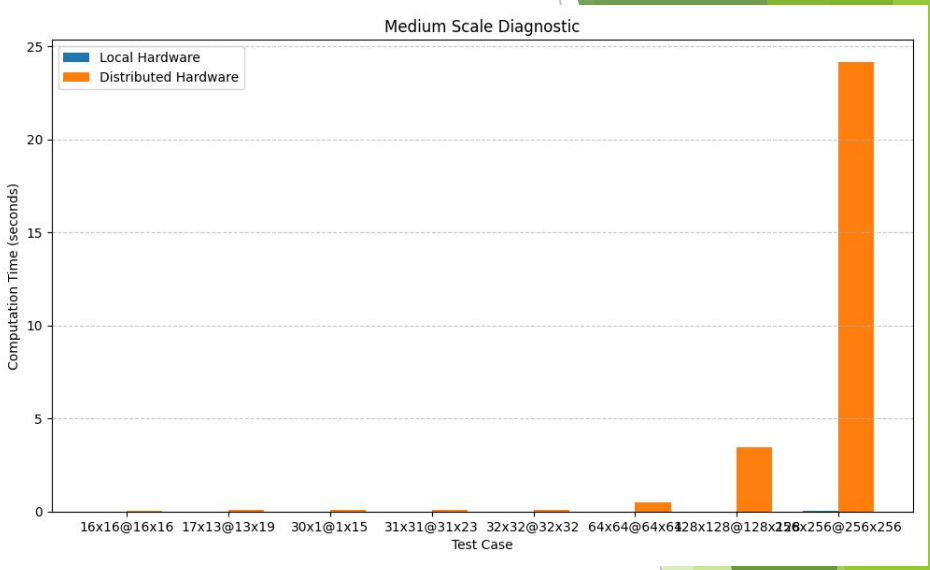


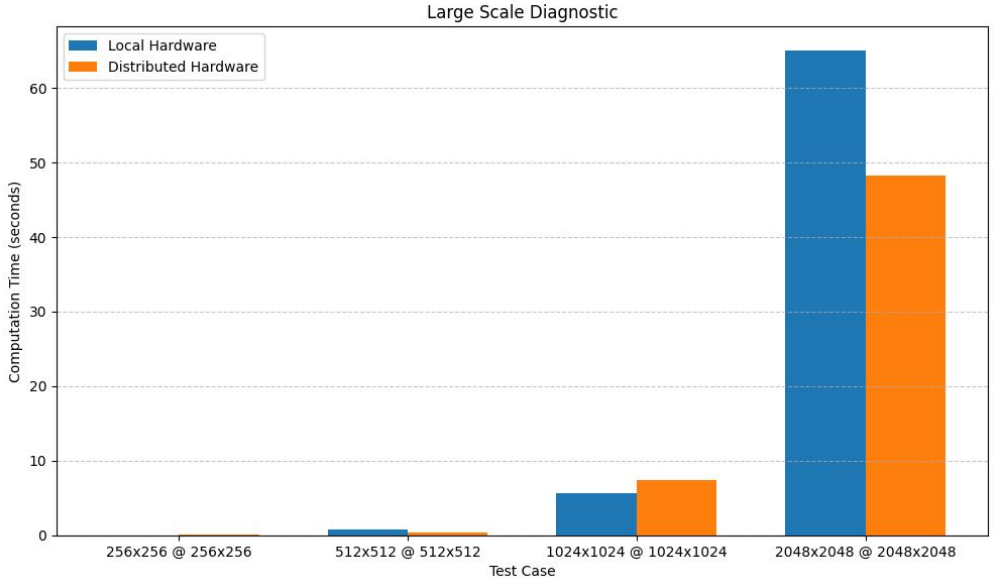
Simulation & Testing

- Performance benchmarks and test cases
  - Simulated heterogeneous setup with Docker (Alpine, Debian, Fedora)
  - Three scales: Small (4 workers), Medium (10 workers), Large (20 workers)
  - Compared local vs. distributed performance
- Metrics
  - Accuracy
  - Performance
  - Scalability
  - Transparency

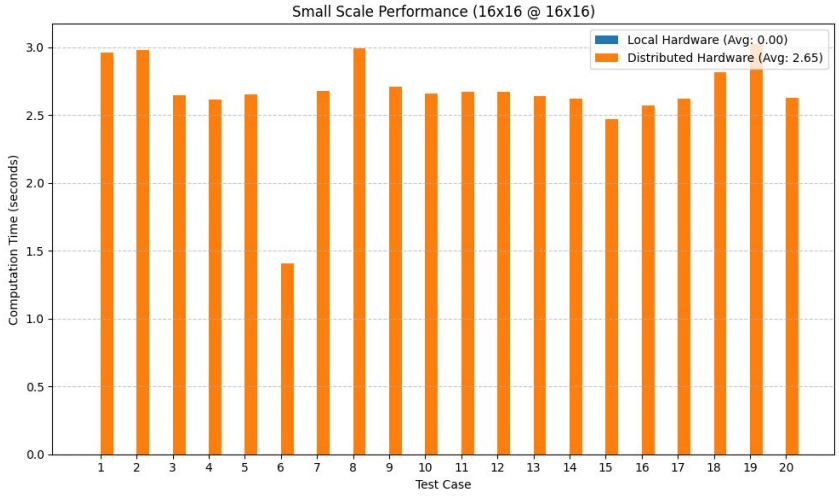
Results - Diagnostics

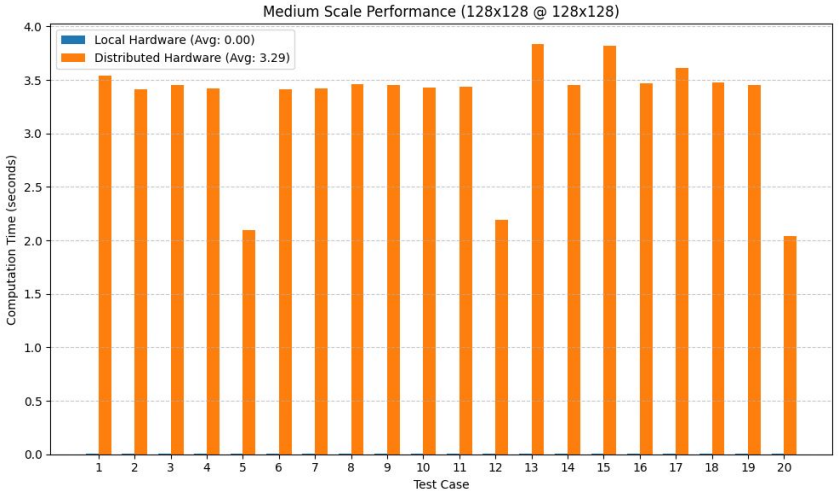


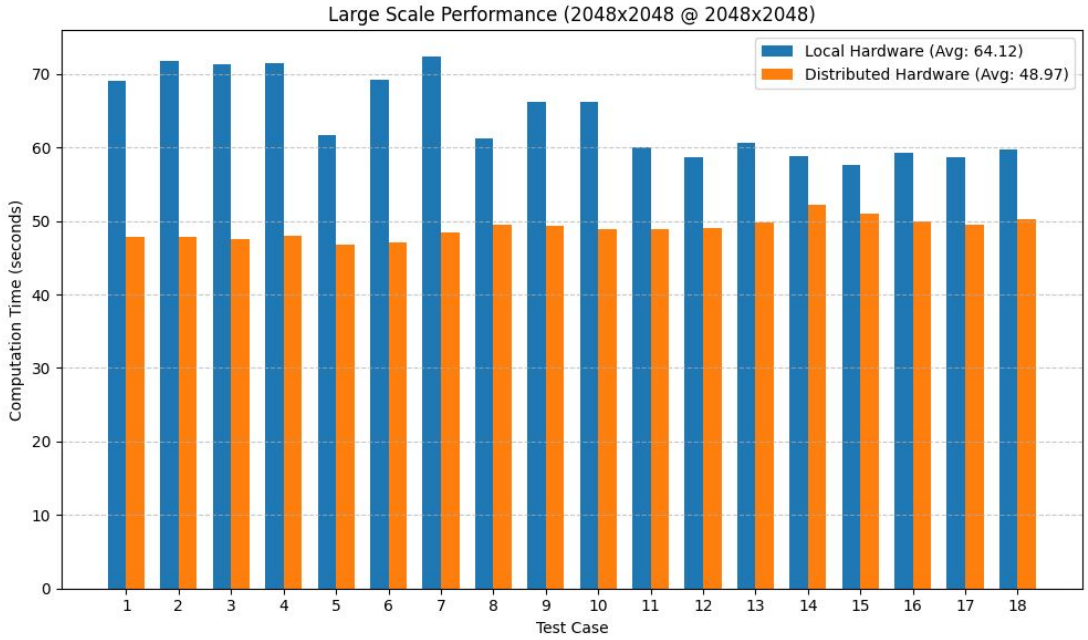




Results - Performance

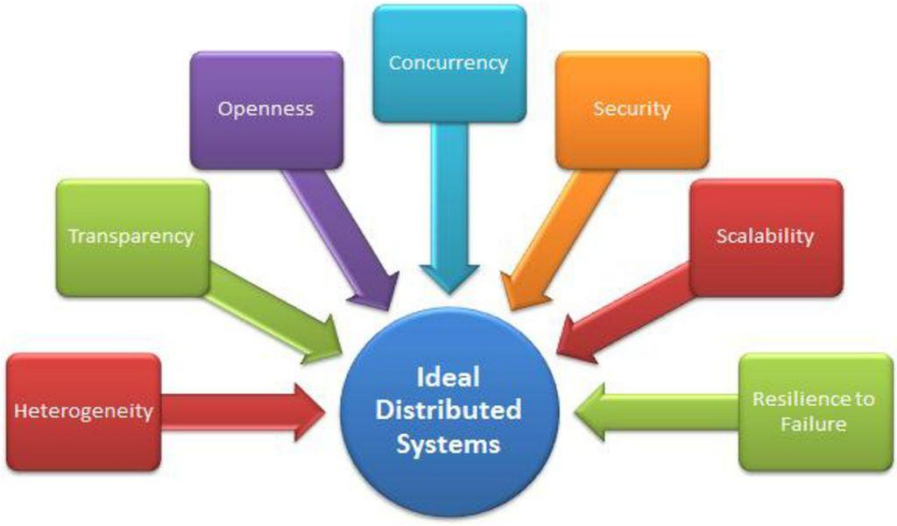






Distributed System Principles

- Scalability: Works across different worker counts
- Transparency: Hides distribution from user
- Resource Sharing: Tasks split across nodes



Lessons Learned

- Communication Overhead
- Single Point of Failure
- Effectiveness of Programming Tools
- Efficient Distributed Algorithms
- Fault Tolerance

Future Work

- Addressing the Single Point of Failure
- Improving Communication Efficiency
- Implement Worker Fault Tolerance

Conclusion

- Distributed computing for matrix multiplications
- Offers scalability, though overhead remains a challenge
- Future improvements can enhance real-world applicability

References

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