**Convergence Analysis of Gossip and Push-Sum Algorithms in Various Network Topologies**

1. **Introduction**

The project implements Gossip and Push-Sum algorithms using the Pony programming language. These algorithms are used for information dissemination and distributed sum computation in various network topologies.

1. **Methodology**

Implemented topologies: Full Network, 3D Grid, Line, and Imperfect 3D Grid

Algorithms: Gossip and Push-Sum

The program allows specifying the number of nodes, topology, and algorithm via command-line arguments.

1. **Implementation Details**

**3.1 Gossip Algorithm**

Each actor starts with heard count of 0. Upon receiving a rumor, the heard count increases. An actor is considered converged when the node has listened to the rumor 10 times. Actors continue to spread rumors at regular intervals.

**3.2 Push-Sum Algorithm**

Each actor maintains two values: s (initially set to the actor's ID) and w (initially 1). Convergence is determined when the ratio s/w remains unchanged (within 10^-10) for 3 consecutive rounds. After convergence, actors continue participating for a short cooldown period.

**3.3 Network Topologies**

1. Full Network: Every actor is connected to every other actor
2. 3D Grid: Actors arranged in a three-dimensional grid
3. Line: Actors arranged linearly with two neighbors each (except endpoints)
4. Imperfect 3D Grid: 3D grid with an additional random connection for each actor
5. Results and Analysis

4.1 Gossip Algorithm

* 1. Push-Sum Algorithm

4.3 Topology Comparison

1. Full Network: Fastest convergence expected due to high connectivity
2. 3D Grid: Moderate convergence speed, balanced connectivity
3. Line: Slowest convergence due to limited information flow
4. Imperfect 3D Grid: Improved convergence over regular 3D Grid due to additional random connections
5. Interesting Findings

The implementation uses a timeout mechanism (1000 seconds) to handle cases without convergence. Both algorithms continue to operate after individual actor convergence, which helps in achieving global convergence. The Imperfect 3D Grid showcases how a small change in topology (adding one random connection per actor) can potentially improve convergence significantly.

1. Conclusion

The implementation provides a flexible framework for studying Gossip and Push-Sum algorithms across various network topologies. The actor-based model in Pony allows for efficient parallel execution, mimicking real-world distributed systems.

1. Team Members

Sashank Boppana, 4171-9973

Tejesh Boppana, 1234-0626