BA: Scheduling Multiple Objects in Distributed Transactional Memory

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Transactional Memory in Distributed Systems

Modeled as a weighted graph $G$ with $n$ nodes

- Each transaction resides at a node
- Needs one or more shared objects for read/write

Data-flow model

- Objects are mobile
- Time to traverse an edge is equal to the weight of that edge

A transaction can execute when all requested objects are available at its node
We evaluate an execution schedule with two metrics:

- **Communication cost**: the total distance traversed by all the objects
- **Execution time**: the total time to execution all the transactions

Most of the previous works focused on schedules with only one shared object.
Communication Cost Results

- The problem of minimizing the communication cost is NP-Hard

- We give an $O\left(\frac{\log^4 n}{\log \log n}\right)$ approximation algorithm

- Both results are obtained using TSP techniques
  - Approximation algorithm is based on a universal TSP tour
Execution Time Results

- The problem of minimizing the execution time is NP-Hard.

- We give an $O(\Delta)$ approximation algorithm, where $\Delta$ is the maximum number of conflicts between transactions.

- Both results are obtained from vertex coloring techniques.

- An impossibility result: There are instances where it is impossible to have execution time close to optimal TSP tours of the objects.
Communication-Time Trade-offs

There are problem instances where

- It is impossible to simultaneously minimize communication cost and execution time

- In one schedule, optimal execution time is $O(n^{2/3})$ and lower bound for the communication cost is $\Omega(n)$

- In other schedule, optimal communication time is $O(n)$ and lower bound for the execution time is $\Omega(n^{2/3})$
Communication-Time Trade-offs

There are problem instances where

- Any schedule that achieves optimal communication cost must have sub-optimal execution time $\Omega(n)$

- Any schedule that achieves optimal execution time must have sub-optimal communication cost $\Omega(n^{4/3})$

- These results are obtained using a 2-dimensional grid network as $G$