Near-neighbor or Mesh Based Paradigm

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Introduction

- Mesh based Cartesian topology is another popular model
- Canon’s algorithm (already covered)
- In this class: Floyd’s APSP

All-Pairs Shortest Paths Floyd's Algorithm

- Consider a subset S = {v1,v2,…,vk} of vertices for some k <= n
- Consider finding shortest path between vi and vj
- Consider all paths from vi to vj whose intermediate vertices belong to the set S; Let $p_{i,j}^{(k)}$ be the minimum-weight path among them with weight $d_{i,j}^{(k)}$

All-Pairs Shortest Paths Floyd's Algorithm

- If vk is not in the shortest path, then $p_{i,j}^{(k)} = p_{i,j}^{(k-1)}$
- If vk is in the shortest path, then the path is broken into two parts – from vi to vk, and from vk to vj
- So $d_{i,j}^{(k)} = \min\{d_{i,j}^{(k-1)}, d_{i,k}^{(k-1)} + d_{k,j}^{(k-1)}\}$
- The length of the shortest path from vi to vj is given by $d_{i,j}^{(n)}$.
- In general, solution is a matrix $D^{(n)}$

Parallel Formulation
2-D Block Mapping

- Processors laid in a 2D mesh
- During kth iteration, each process Pi,j needs certain segments of the kth row and kth column of the D(k-1) matrix
- For $d_{l,r}^{(k)}$: following are needed
  - $d_{l,k}^{(k-1)}$ (from a process along the same process row)
  - $d_{k,r}^{(k-1)}$ (from a process along the same process column)
  - Figure 10.8

Parallel Formulation
2D Block Mapping

- During kth iteration, each of the root(p) processes containing part of the kth row sends it to root(p)-1 in same column;
- Similarly for the same row
- Figure 10.8
- Time complexity?

Sources/References

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