Distributed Algorithms 2022

CONGEST model: Bandwidth limitations
LOCAL model = port-numbering model + unique identifiers

Nodes have distinct labels from \( \{1, 2, \ldots, \text{poly}(n)\} \)
CONGEST model  
=  
LOCAL model  
+ bandwidth limitation

Messages at most $O(\log n)$ bits
LOCAL · unbounded messages

• everything trivial to solve in $O(\text{diameter})$ rounds: gather full input and solve locally

CONGEST · bounded messages

• gathering everything is way too expensive
• $O(\text{diameter})$ and $O(n)$ is nontrivial
Designing efficient algorithms in CONGEST model
Pipelining

Washing machine

Dryer
Pipelining

• Multiple operations in progress *simultaneously*
• Using *different resources*

• In APSP algorithm:
  • multiple waves
  • using different communication links
Pipelining

- Does not reduce the total number of messages
  - only removes idle periods between messages
- If all communication links are already sending useful data every round, no room for pipelining
What kind of problems cannot be solved fast in CONGEST model?
Typical hard problems

• **A**: complicated, lots of information
• **B**: bottleneck
  • can only send small number of bits per round from A to C
• **C**: need to know A
Proving hardness

• Counting argument
• Many possible inputs in A
• Few possible messages across bottleneck B
Proving hardness

• Counting argument

• \textit{Many} possible inputs in A

• \textit{Few} possible messages across bottleneck B

• Contradiction:
  • \textit{different} inputs in A
  • \textit{same} messages across B
  • \textit{same} output in C