Distributed Algorithms 2021

Conclusions
Recap:
Key ideas from previous weeks
Models of computing

• PN
• LOCAL — unique identifiers
• CONGEST — bandwidth constraints
• Deterministic and randomized algorithms
Canonical problems

• Vertex coloring
  • coloring = schedule
  • coloring breaks symmetry

• Used to solve many other problems

• Used to show that other problems are hard

• Demonstrates different algorithm design ideas and lower-bound techniques
Algorithm ideas

• Conflict avoidance & coordination
• Process nodes by color classes
• Send proposals one by one
• Random subset of nodes is active
• Pipelining
• Algebraic techniques
Lower bound proofs

• Covering maps — PN model
• Local neighborhoods — any model
• Round elimination
• Simulation arguments
• Reductions
Key lessons learned
New kinds of challenges

- **Unknown systems**
  - algorithms that work in any network

- **Partial information**
  - making decisions based on local information

- **Parallelism**
  - many nodes act simultaneously
What else is there?
Networks vs. big data

• Models for computer networks
  • PN, LOCAL, CONGEST

• Models for big data systems
  • congested clique
  • BSP (bulk-synchronous parallel)
  • MPC (massively parallel computation)
  • $k$-machine model
Asynchrony & failures

• Asynchronous networks
  • no failures → can use synchronizers

• Tolerating failures
  • crash faults, Byzantine faults ...

• Recovery from failures
  • self-stabilization
And a lot more...

- **Different kinds of models**
  - shared memory — message passing
  - physical models (e.g. radio networks)
  - mobile agents (e.g. robot navigation, exploration)
  - security and privacy

- **Different kinds of questions**
  - solving — proving — verifying — fixing
  - #rounds — #messages — #bits
What next?
Exercises this week

• **Exercises 12.1–12.4:** small research project
  • *what are possible distributed complexities?*
  • LOCAL model
  • locally verifiable problems
  • cycles

• **Exercise 12.5:** an example of an open research question
Exam next week

• Take-home exam
• Setup and rules exactly like the first exam
• Focus: proving impossibility results
Course feedback

• Feedback form opens on December 9
• 1 extra point for everyone who fills in the form!
After this course

• Ask us if you are interested in doing more:
  • thesis topics
  • research projects
  • summer jobs
  • doctoral studies ...