Aalto University

Distributed Algorithms 2022

12 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

- Setup and rules exactly like the first exam
- Allowed: one A4-sized 2-sided **cheat sheet**
  - no other material or equipment
- Focus: proving impossibility results

Course feedback

- Feedback form opens on **December 1**
- 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 …