

# Distributed Algorithms 2023

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, quantum)
- mobile agents (e.g. robot navigation, exploration)
- security and privacy

- **Different kinds of questions**

- solving — proving — verifying — fixing
- #rounds — #messages — #bits

# Our current research

- Is quantum-LOCAL any stronger than LOCAL?
- Locality in different settings:
  - online algorithms
  - dynamic algorithms
  - volume vs. distance
- Massively parallel matrix multiplication

**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

- **1 extra point** for everyone who provides feedback in the official Aalto course feedback system (in MyCourses)

# After this course

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