Aalto University

Distributed Algorithms 2023

1 Warm-up

Welcome!

- You should have already done this:
  - register in **Sisu**
  - read instructions in **MyCourses**
  - join our **Zulip workspace**
  - watch two **pre-recorded videos**
  - solve this week’s **quiz**

This week: extra time to solve the quiz until midnight tomorrow!

Our weekly routine

- **Mon:** prerecorded videos
- **Tue:** quiz (noon), lecture (12:15pm)
- **Wed:** 1 exercise (midnight)
- **Thu:** exercise session (10:15am)
- **Fri:** 2 exercises (midnight)

**Workload:
10–11 h/week**

Quiz

- One quiz per week, in **MyCourses**
- Solve by ***Tuesday*** at noon
- Automatically graded
  - 2 points for correct answer
  - 0.5-point penalty per wrong answer

Exercises

- 5+ exercises per week, in the **textbook**
- Solve 1 by ***Wednesday***, 2 more by ***Friday***
- Submit your answers in **MyCourses**
  - preferably as an easy-to-read PDF file
- ***The answers need to be complete***
  - full details, complete proofs
  - e.g. why does your algorithm work correctly?

Challenging exercises

- In the textbook, marked with a star ★
- Solve ***at any point*** during the course
- ***Again, the answers need to be complete***

Grading

- **To pass the course:**
  - you need to pass both ***exams***
- **For a good grade:**
  - you need to ***solve exercises***
  - quiz + exercises = max 96 points in total
  - challenging exercises = 4 extra points each
  - 80 points = grade 5/5

Learning objectives

- Understand models of distributed computing
- Design and analyze efficient distributed algorithms
- Prove impossibility results
- Use standard graph-theoretic concepts

Practiced in exercises

Tested in midterm exams

This is a theory course

- **100% mathematics**
  - definitions
  - theorems
  - proofs …
- **0% practice**
  - programming
  - hardware
  - protocols …

Expected: basic knowledge of university-level mathematics

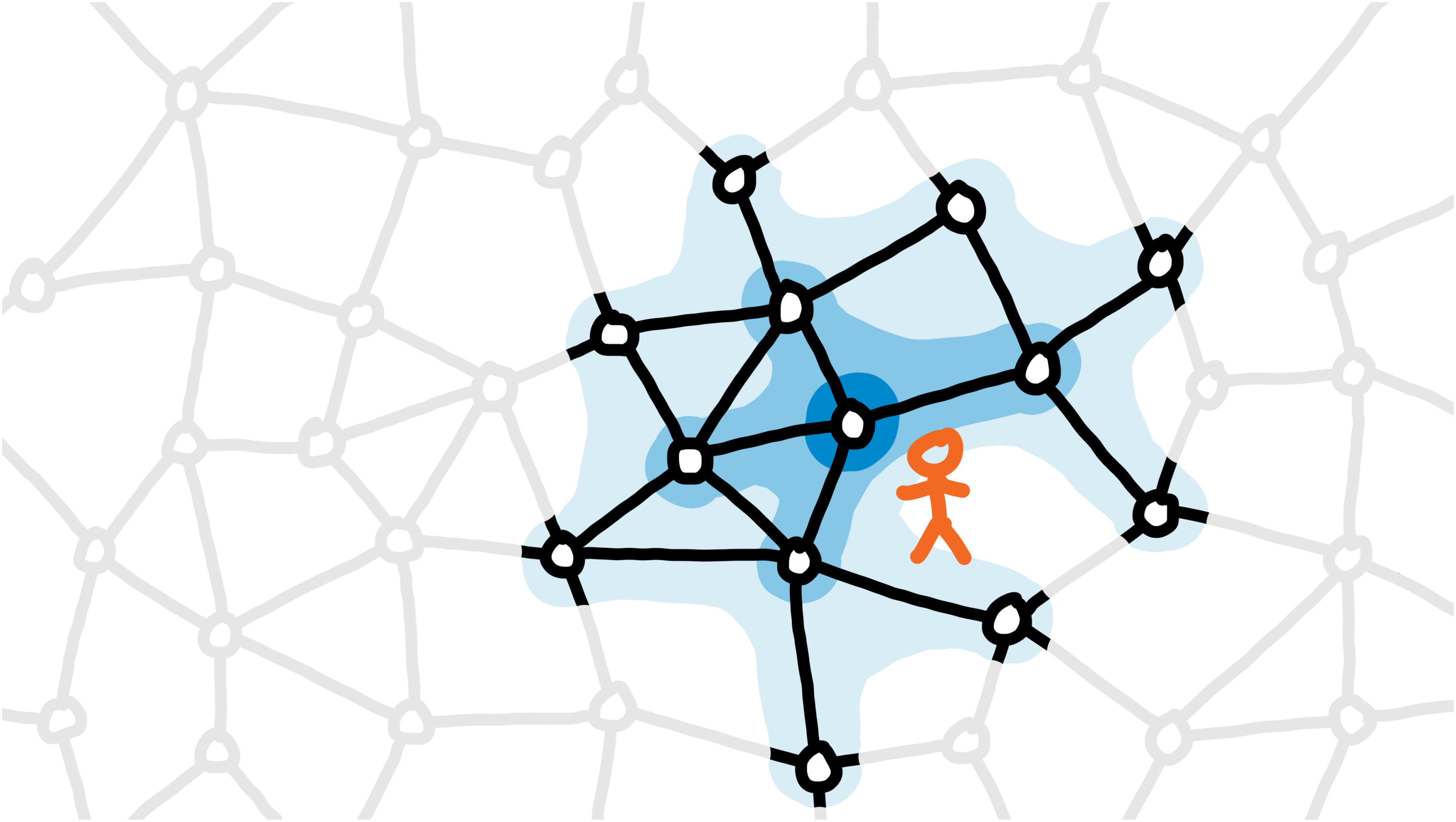
Example: what is a mathematical proof

Course practicalities

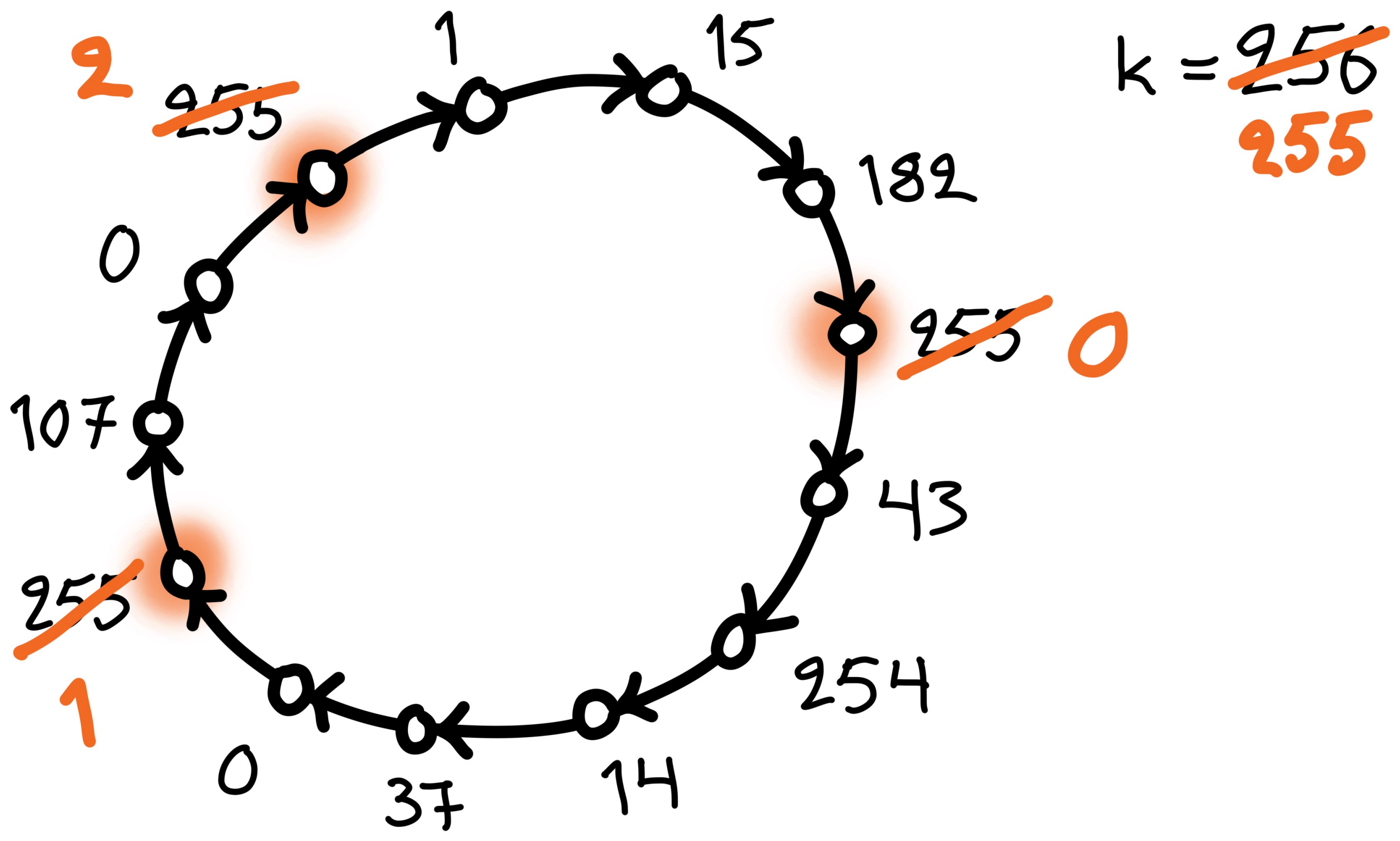
- Traditional on-campus course
  - on-campus lectures
  - on-campus exercise sessions
  - on-campus exams
- Primary tool for communication: **Zulip**
- Course material, submitting solutions: **MyCourses**

This week's content…

Video 1a: introduction

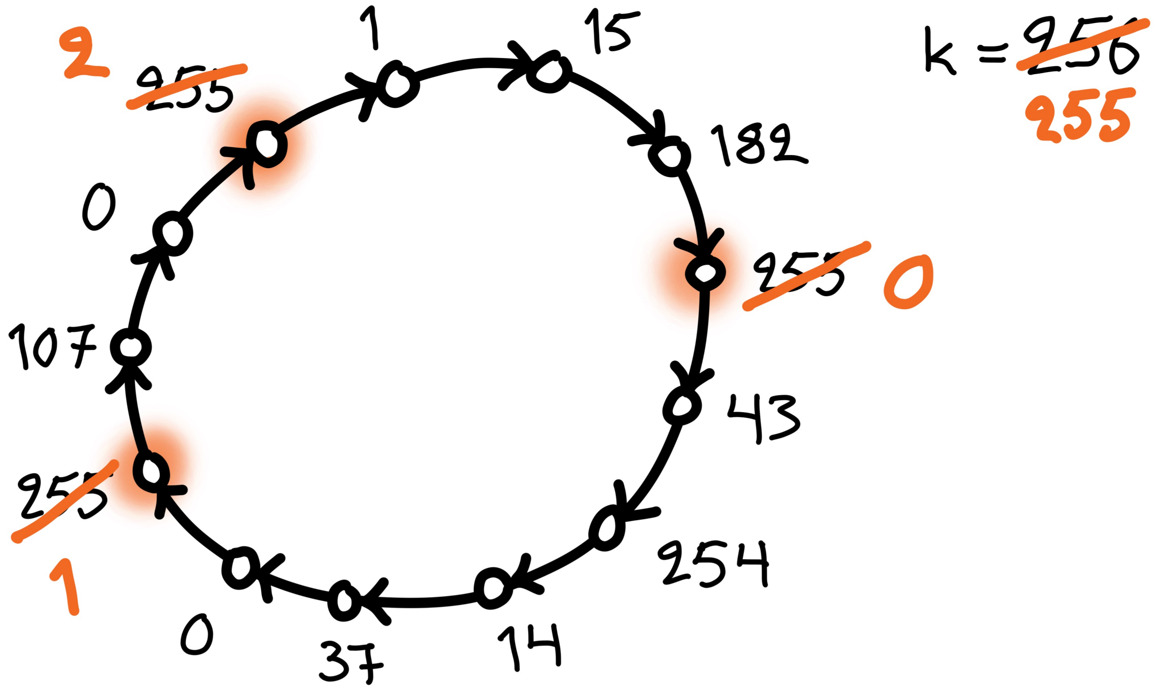


Video 1b: coloring



Slow color reduction

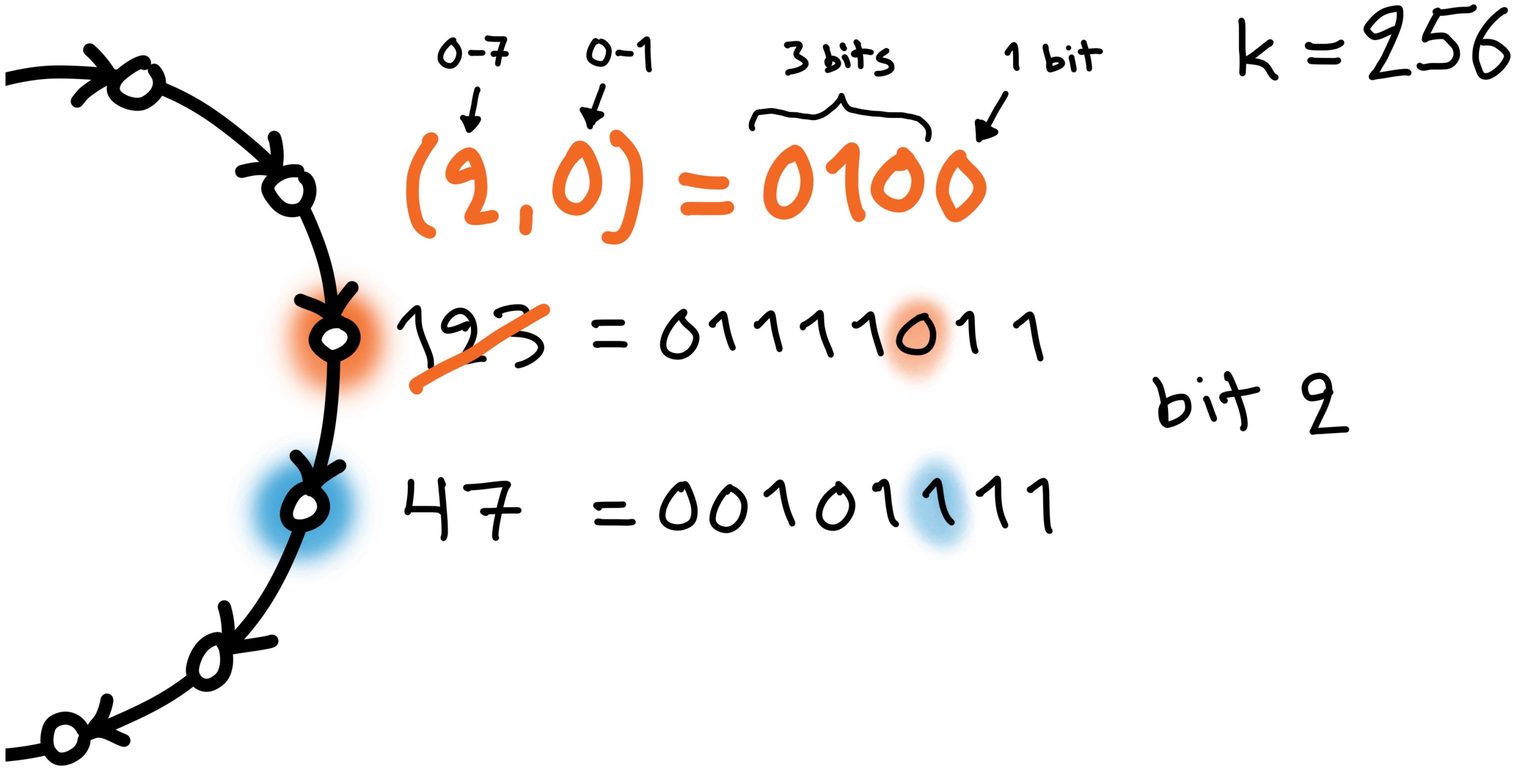
- Algorithm idea:
  - all nodes with the **largest color** are active
  - active nodes pick the ***smallest color that is not used by their neighbors***



Group work 1

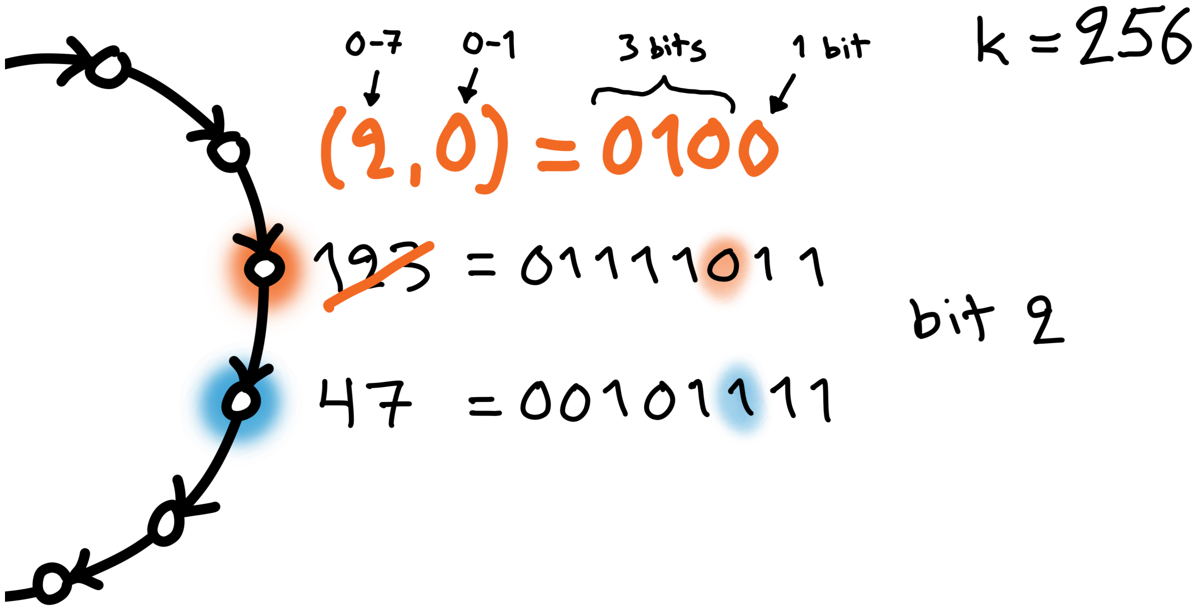
- Consider a simpler algorithm idea:
  - ***all nodes*** pick the smallest color that is not used by their neighbors
- **What would go wrong?**
  - *construct an example in which this algorithm fails!*

Video 1b: coloring fast



Fast color reduction

- Algorithm idea:
  - find the first bit that differs in successor
  - index ***i***, bit value ***b***
  - new color is (***i***, ***b***)



Group work 2

- Algorithm idea:
  - find the first bit that differs in successor
  - index ***i***, bit value ***b***
  - new color is (***i***, ***b***)
- **What would go wrong if the new color was just *b*?**
  - *construct an example in which it fails!*

Group work 3

- Algorithm idea:
  - find the first bit that differs in successor
  - index ***i***, bit value ***b***
  - new color is (***i***, ***b***)
- **What would go wrong if the new color was just *i*?**
  - *construct an example in which it fails!*

Group work 4

- Algorithm idea:
  - find the first bit that differs in successor
  - index ***i***, bit value ***b***
  - new color is (***i***, ***b***)
- **Why does the algorithm work correctly?**
  - *why is my new color always different from the new colors of my successor and my predecessor?*

Coming next

- **Week 2:** graph theory
- **Weeks 3–6:** models of distributed computing
  - examples of efficient distributed algorithms
- **Weeks 7–11:** proving impossibility results
- **Week 12:** conclusions, recap