Integrating a Simulation-Visualisation Environment in a Basic Distributed System Course:

A Case Study Using LYDIAN

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Overview

- Motivation
- Background
- LYDIAN
- Evaluation
- Conclusion

Motivation

- Often teaching requires to involve students into activities
  - Theoretical and practical assignments
  - Reflection on the learnt and receive a deeper understanding
- Distributed algorithms involve
  - large amount of data describing local state information
  - complex interactions between elements
- Simulation and Visualisation
  - Avoids the overhead of the students using a real tool
  - Pause and execute an instance several times
  - Trace and illustrate critical behaviour which rarely occurs

Motivation

- Many teaching environments for learning distributed algorithms evolved

BUT:

- Little known how they are used in class
- Evaluation Studies
  - mostly teacher and provider are the same person
  - Does not reflect the time and overhead for others
- Perspective of the provider of such tools (like LYDIAN)
  - Users reluctant to give feedback
  - Difficult to evaluate the usefulness

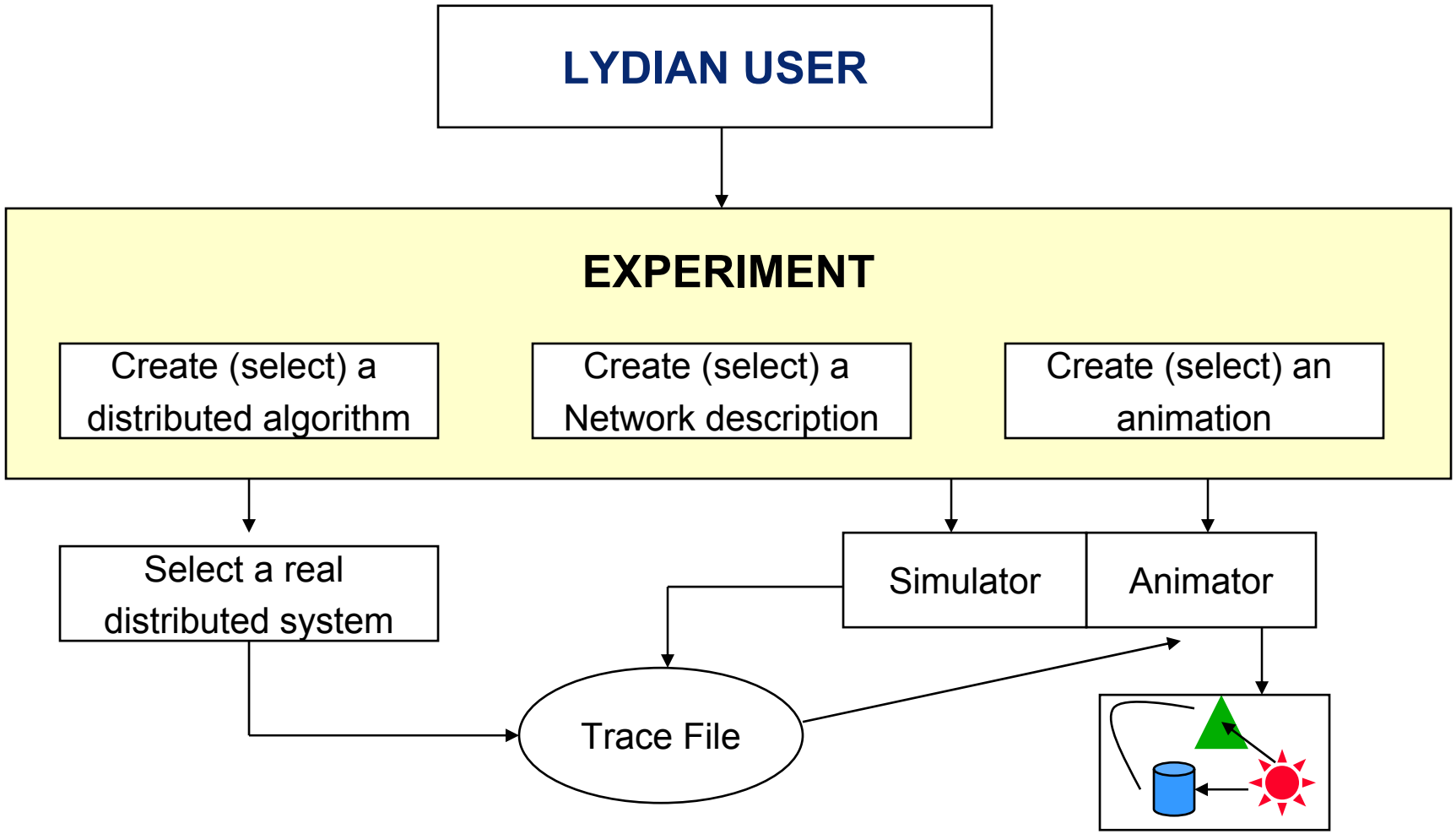
Background

- LYDIAN
  - Feedback in order to evaluate LYDIAN
  - What should learning environments provide?
- Teachers
  - Not familiar with LYDIAN
  - Distributed Systems Course
    - Compulsory for CS Students at Chalmers
  - Requirement to add assignments to the course structure
  - Selected as a tool LYDIAN
  - Allowed us to perform a user study

LYDIAN

- Educational environment for teaching and learning distributed algorithms
- Lydian provides extensible components:
  - Library of distributed algorithms
  - Simulator
  - Animator
- Lydian uses a concept called *experiments*:
  - Protocol
  - Network structure
  - Trace file
  - Animation

User Interaction



An assignment using LYDIAN

- Teachers were on their own
- Teacher designed a programming assignment
  - Students could choose to implement
    - Leader election
      - Echo-broadcast
      - Voting
    - Resource allocation
      - Logical clocks
  - Assignment intended to take a maximum of five days
  - Building blocks including respective animations available
- First year assignment ...

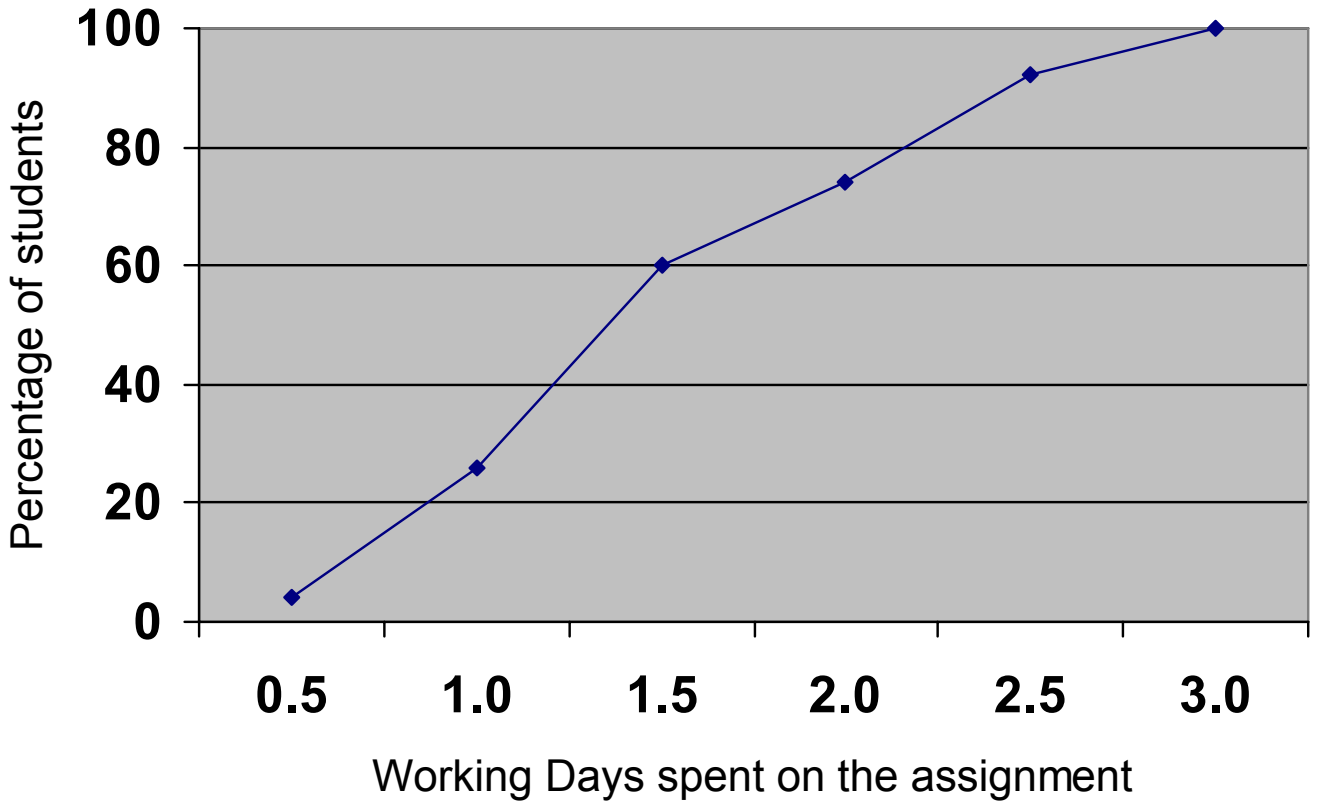
Study and Evaluation

- Students performance
- How students test and reason?
- How helpful is LYDIAN to receive an insight into distributed algorithms?
- What do students think?
- General feedback

Evaluation

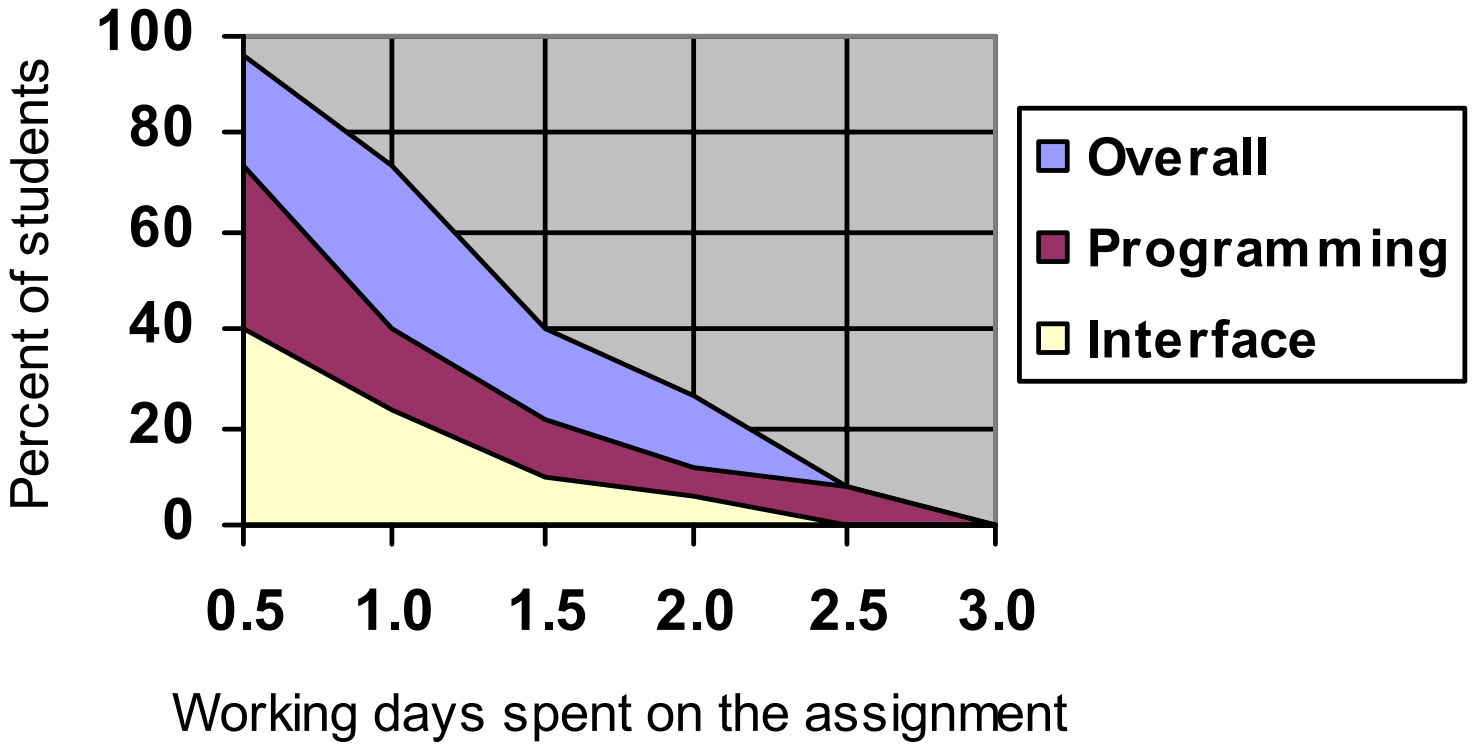
- Based on feedback from 50 students
- Answers were anonymous
  - Cannot relate
    - Success in the assignment
    - Answers of the questionnaire
- Students
  - 3rd or 4th year of their studies
  - Experienced in programming
  - Did not use LYDIAN before

Performance



Assignment was intended to take at most five working days

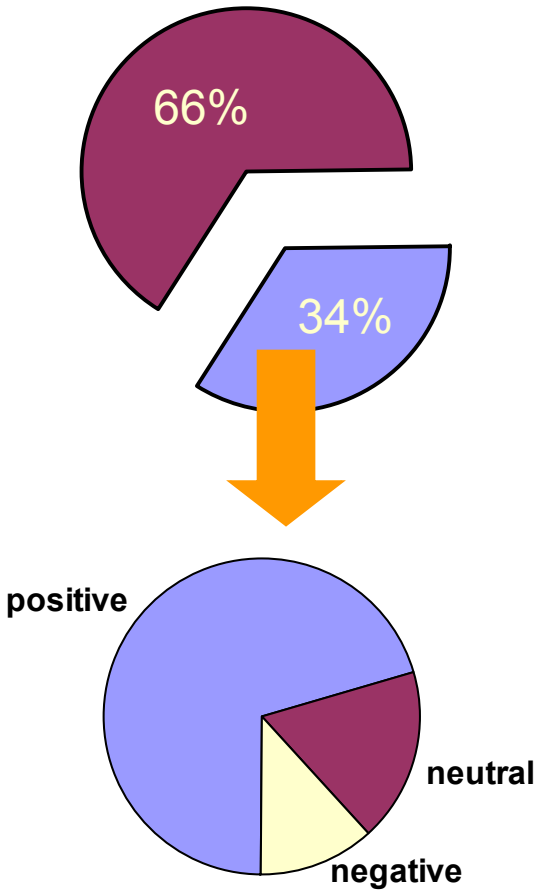
Performance



Assignment was intended to take at most five working days

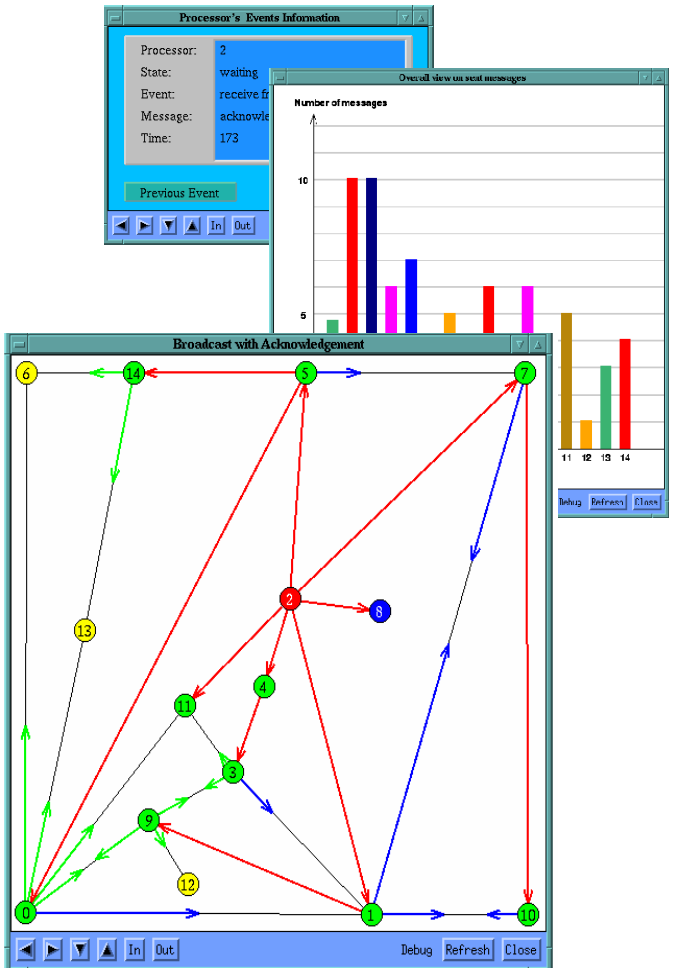
Testing

- Unexpected behaviour:
  - One third of the students experienced un-expected behaviour
  - These students mostly considered LYDIAN to be helpful
- Network structures
  - Important for testing the algorithm‘s behaviour
  - Most students tested multiple network structures
  - Using more network structures helps to reveal unexpected behaviour
- The way students tested did not relate to the use of animations



Role of animations

- Usage of animations
  - not required in the assignment
- Every second student experimented with animations
  - Most of these students thought they benefited from LYDIAN
  - Students more motivated?



Conclusion

- LYDIAN helpful for many students
- Tools in the area of distributed systems should provide
  - Users can modify system parameters
  - Visualisation of concurrency
  - Ability to trace the same execution multiple times
  - Good documentation and user guides
- To make learning happen
  - Instructors should
    - encourage the use of visualisation possibilities
    - Make students change parameters and test their implementation
      - Reveal unexpected behaviour

Future Work

- Evaluate further use of the assignment in coming courses
- Evaluate the impact of animations
  - Involve students more in using the animations
- Further studies with improved documentation
  - Feedback from other universities
- Use outcome for further development of LYDIAN