

Lesson 0

Concurrent Programming

Rinnakkaisohjelmointi (RIO)

581332

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<http://blueballfixed.ytmd.com/>

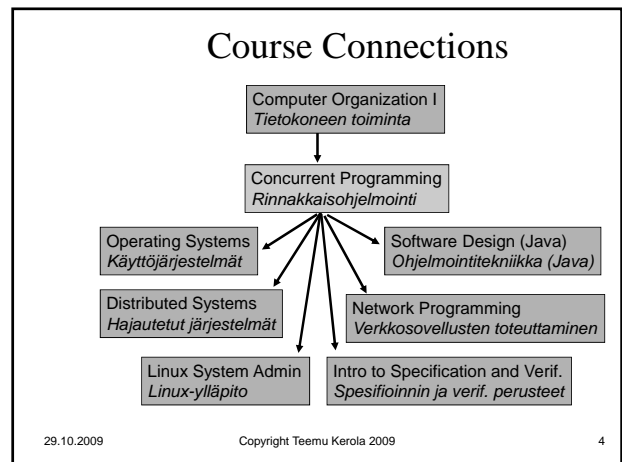
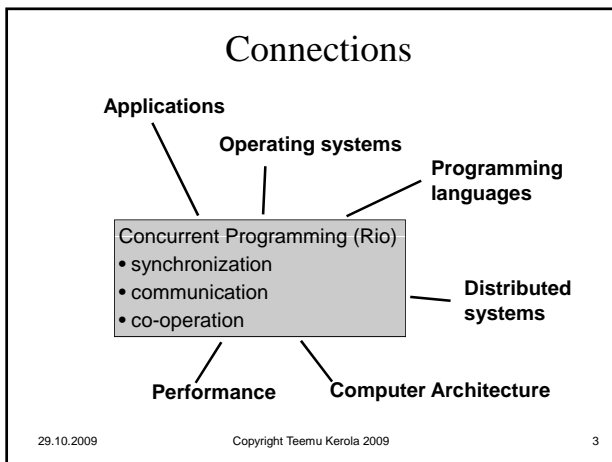
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Concurrent Programming

Autumn 2009

- Administration Lecture 0
 - Course area and learning goals
 - Learning methods
- Introduction to Concurrency Lecture 1
- Slides in English, lectures in Finnish
 - Non-Finnish speakers can read the slides even if they do not understand the lectures

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Motivation

- To know and understand ...
 - Why concurrency is important
 - What are the concurrency problems in your systems
 - How concurrency problems are usually solved
 - What are the usual tools for solving concurrency problems
 - How concurrency problems may be solved at different system levels
 - HW, OS, progr. language library, application

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Learning Goals

- Concurrency and problems caused by concurrency
 - Basics, fundamental ideas, background
- Fundamental concepts and models in concurrency
 - Main emphasis is here!
 - E.g., “can explain special features of semaphores and monitors and use them properly in applications”, or “can explain how deadlocks can be prevented”.
- Concurrent programming in distributed systems
 - Get taste of it, more in later courses
- Concurrent programming in practice
 - Discussed in lectures, practice in project

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What Good is Concurrent Programming for?

- All computer systems are inherently concurrent – one must understand concurrency to understand computer system operation
 - Concurrency allows huge speedups for properly designed systems
 - Concurrency causes complex problems that are not easy to solve without good understanding of concurrency
- Should I use threads in my Java application or not?
 - **Would it be better to use locks, semaphores, monitors or transactional memory to solve synchron. and communication problems in my application?**
 - Why doesn't it do what I thought it would do?
 - How can I show my boss that it really works?

What is Not Covered?

- How to write efficient code for multicore architectures?
- What types of applications are suitable for multicore architectures
- What programming paradigms exist to write efficient code for multicore architectures?
- How to write multicore code so that it would run in many multicore architectures?
- How to best utilize multicore GPU in your application?
 - CUDA - Compute Unified Device Architecture
 - How to partition your solution to multicore CPU & GPU?
- Programming distributed applications

Learning Methods

- Text book: Ben-Ari 2006 (& Stallings 2005)
- Lecture notes
 - Not perfect for self study – use with text book
- Summary lectures & discussions
- BACI – Ben-Ari Concurrency Interpreter
- Practice problems kertaustehtävät
- Homeworks kotitehtävät
- Project laskuharjoitukset
- Group meetings (practice sessions) study circle
- Learning diary (elective) opintopiirit
- Course exam teamwork



Mordechai Ben-Ari
<http://stwww.weizmann.ac.il/g-cs/benari/>



William Stallings
<http://www.acm.org/crossroads/xsds10-4/stallings.html>

Summary Lecture and Discussion

- Short summary lecture
 - Some of the slides for 2008 lectures
 - Assume: students have read the text book in advance
 - Basic knowledge of today's topic
- Discussion (*Socratic* discussion)
 - Goal: deeper understanding of today's topic
 - Students discuss
 - Starting points: questions, claims
 - Students, moderator
 - Goal: answer the question, verify the truth of the claim
 - Moderator may intervene to keep discussion on track

Nina Aremo (Faculty of Science) will attend some lectures and may make a short interview study on how well this learning method works for this course

BACI – Ben-Ari Concurrency Interpreter

- Write concurrent programs in C--
- Compile them to BACI PCode
- Execute them concurrently in BACI
- GUI, debugging environment

Java

- How to use Java for Concurrent Programming?
 - Threads
 - Messages säikeet
 - Semaphores viestit
 - Monitors semafori
- Lectures, projects monitori

Study Circles opintopiirit

- Group work, team work
 - It is better to study in a team than alone
 - Peer student support
 - Study circles formed in the first group meeting
- Student centered learning
 - The student has responsibility on learning
 - Instructor facilitated learning
 - Instructors give good environment for learning
- Three types of team work
 - Solving homework problems independently and then discussing them in study circles and in group meetings
 - Projects
 - Any other co-operative work for this course

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Creation of Study Circles

- Possibly the largest problem in study circle courses
 - "Ville promised, but did not do and he was not accessible. And then Maija did most of it. This is not right! Boohoo! ☹"
- Study circles are formed in the 1st group meeting
 - Goals should be similar
 - Easy in real life: "you will finish it or ..."
 - Think about your goals before the 1st group meeting
 - Do I want to learn a lot, or just pass the course?
 - Will I help others, or just concentrate on my own work?
 - Discuss and agree on common goals before agreeing on forming a study circle
 - Finally, sign the "Study Circle Contract"
- Keep up with your agreement
 - Inform the study circle immediately, if you will not continue
 - Get quickly rid of peer students who do not work as agreed on

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Practice Problems kertaustehtävät

- Practice problems
 - Self evaluation
 - Do them only after you think you know the material
 - Do I understand it now?
 - They check only some part of the material, no guarantees!
 - Use does not directly affect your grade
 - No bookkeeping on material use
 - No credit toward course grade
- More practice problems are made in the project

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Homework Problems

- Normal homework problems
- Learning happens when you *solve* the problems and *discuss* them
 - Study topic area first before trying out the problems
 - Work on the problems independently before discussing them
 - Reading a complete solution or giving one to peer student is wasting a good problem!
- Homework problems are discussed at
 - Study circle own meetings before group meetings
 - Group meetings with peer students at the table
- Affects your grade
 - You get homework points (hwp, lhp) for completed problems
 - Only for those present in group meeting

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Group Meetings Laskuharjoitus

- Mark down the problems you have completed
- Assistant will organize you in tables
 - Each table should have a student solution for each problem
 - One or more tables may be in English in English speaking practice session
- Discuss all problems in your own table
 - You should have at least tried to solve all problems beforehand
 - You should understand all solutions at end
 - Other students in your table should understand all solutions at end
 - Correct solutions available, consult assistant if needed
 - No presentations in front of class
- Discuss additional topics given in solutions paper
 - Open ended discussions, no "correct" answers given
- Common discussion of selected problems/solutions
- Advice students in other tables, if there is time for it

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Project 1 http://www.cs.helsinki.fi/u/kerola/rio/s2009/project1pr1.html

- Project (A&B or A&C) with team work
 - A. Come up with a new practice problems
 - B. Do a small project in Java from text book
 - C. Write a better guide on how concurrent programming is done with Java
- Goal is deeper understanding on some topics
 - Other course components may be needed as background knowledge
- Affects your grade
 - Instructor evaluates the report
 - You get project points (pp) in three parts
 - Basic points (3 pp) for just completing the project (for 8 pp project)
 - Grade (1-5 pp) depending on the quality of work
 - Participation points (max ±2 pp) based on you participation
 - Study circle determines this part! ←

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Learning Diary (Extra Project 2)

oppimispäiväkirja

<http://www.cs.helsinki.fi/u/kerola/cp2009/project02.html>

- Evaluate and reflect
 - Cover all learning events (lecture, homework, practice meeting, study circle meeting, etc.)
 - What did you do, observe, learn, and feel
- Affects your grade
 - Same way as other projects
 - Points (pp) are completely extra, and you can get an excellent grade also without this project
 - With learning diary you probably get a better grade!

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Studying for This Course

- Study weekly topics
 - Read the text book the same topics, with different approach
 - Use lecture slides if you find them useful
 - Attend summary lectures and actively participate discussions
- Check your learning with self evaluation
 - Do practice problems and homework
- Participate in study circle
 - Discuss homework
 - Weekly group meeting
 - Continue projects
 - Study circle meet face-to-face or in the web
- Finish project 1 in time
- Study for exam
- Take course exam
 - Do extra project

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Evaluation

- Self evaluation
 - Do practice problems after each topic
 - Does not affect your grade
 - Do homeworks each week
 - Do I understand or not?
 - What is there still to learn and how do I do it??
 - Affects your grade
- Course exam
 - Gives a fixed deadline for learning
 - Covers all topics
 - Topics learned in independent study as well as in study circles using various learning methods
 - Evaluates learning
 - Most of the grade based on this
 - Must reach certain level (50%) to pass the course

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Grading

- Good work is awarded
- Diligence and knowledge is awarded
- Course component maximum grade points

Homeworks (min 1p)	6 p
Study circle project (min 1p) (extra Project 2: study diary)	10 p (+5 p)
Course exam (min 22 p)	44 p
Total (min 30) (with project 2)	60 p (65 p)

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Course contents

- Lecture 0: Admin
- Lecture 1: Concurrency
- Lecture 2: Concurrency at Progr. Lang. Level
- Lecture 3: Critical Section Problem
- Lecture 4: Verifying Concurrent Programs
- Lecture 5: Deadlocks
- Lecture 6: OS Support for Conc: Semaphores
- Lecture 7: More on semaphores
- Lecture 8: Progr. Lang. Support for Conc: Monitors
- Lecture 9: Concurrency Control in Distr. Environment
- Lecture 10: Crit. Sections in Distributed Environment
- Lecture 11: Practical Examples on Concurrency Control
- Lecture 12: Current Research, Course Summary
- Project: Java programming

Concurrency and problems caused by concurrency

Fundamental concepts and models in concurrency, Concurrent programming in practice




Conc. progr. in distr. systems

Conc. progr. in practice

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Motto

- "It is not good exercise, if you do not sweat"
- This is not a marathon!
- Study-week approach
 - Altogether some 12 h / week + exam preparation + exam
 - Total some 80 h / 2 sw course (2 work weeks)
- Top-down approach
 - 5 yrs / 300 cu = 1 yr / 60 cu = 1600 h / 60 cu = 26.67 h / 1 cu = 107 h / 4 cu
 - Total some 107 h / 4 cu course

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Nina Aremo study 2007

- Questionare study, weekly basis
 - 40/121 student participated (14 women, 27 CS majors)
- Course workload opinion: 50% ok, 50% too much
 - Aver weekly work hours: 7, 8, 10, 9, 10, 11 (compare to 12)
 - Total work hours: most 50-70, max 136 (compare to 80 or 107)
- Comments
 - “Need model solutions to homework problems”
 - “Lecturer did not take questions”
 - “Difficult to do well, if you do not attend lectures and practice sessions”
 - “Web pages are incoherent”
 - “Study circles would need more guidance”
 - “Got real busy at end because of so many other courses”

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Summary

- Course administration
- Course components and learning methods
- BACI simulator
- Lecture format
- Projects

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