Course TÖL401G: Stýrikerfi / Operating Systems 0. Preface

Ingólfur Hjörlefsson

ingolfuh@hi st. TG225

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Teacher. Ingólfur Hjörleifsson

- M.Sc. in Electrical and Electronical engineering &Telecomunication, Aalborg University, DK
  Master of Project Management, LM Ericsson
- Currently: **Adjunct lecturer and independent contractor**, e.g.:
  - Teacher (University of Iceland): *Distributed systems, Operating systems, Software development A, Computer Science 1A, IoT smart devices , Project management*
  - Research areas: *ICT-Telecom modelling, IoT (distributed systems), Operating systems*

- Before (ICT and telecom related):
  - **Government**. ICT security
  - **Teris hf** (program manager financial ICT),
  - **Private comp**.Telecom network for large fishing boats
  - **CTO** at **Netverk** hf. (Telecom Applications),
  - **Ericsson** AB, Stockholm & Copenhagen:
    - Program- and total project manager. Technical manager. Developing and production of telco exchanges, routers and Network Management Systems.
  - **Ericsson R&D lab**, Stockholm:
    - Researcher and developer. Distributed OS: system- and *kernel functions. Applications: ISDN, GSM, UMTS, NMS-CORBA.*

About this course

- Administrative information from the course catalogue:

Course Number:
TÖL401G

Adjunct Lecturer

Type:
Course

Credits:
6 credits

Min. grade:
5,0

Level:
Undergraduate

Jóhannes Nordal
jon8@hi.is

Organisation and classes

Teaching assistants
(assignment grading and questions concerning grading, dæmatími)

Prerequisites

- You need to be familiar with a programming language, preferably Java:
  - TÖL101G Tölvunarfræði 1 / Computer Science 1
  - (or TÖL105G Tölvunarfræði 1a / Computer Science 1a)
- You should know about bits and bytes:
  - TÖV201G Greining&hönnun stafrænna rása /Digital Circuit Design&Analysis
- While not being a formal prerequisite, it does not hurt:
  - TÖL309G Tölvutækni og forritun, computer architecture and programming
    - Innri gerð tölva og hvernig best er að haga forritun. (**Bottom-up strategy**)
  - TÖV301G Tölvuhögun to know about Computer Organization.
    - But I will briefly cover the needed hardware foundations.
  - TÖL203G Tölvunarfræði 2 / Computer Science 2 to know about data structures, e.g. linked lists.
  - Knowing about pointers in C would be nice

General contents of this course

- Course better called: "Operating System Concepts". **Top-down** strategy.
  - Mainly concepts common to operating systems (but no implementation details) are taught.
  - Existing operating systems (e.g. sometimes aspects of MS Windows, Mac OS X, Linux, Oracle Solaris are mentioned)

Usage of C programming language

- Operating systems are usually implemented using C.
  - ⇒ Low-level operating system functions that may be called by applications are C functions.
    - As we do not consider implementation details, we will not cover the implementation of these C functions.
    - However, we will cover the interface (API) of these functions:
  - ⇒ You should be able to read the signature of C functions (i.e. C header files),
    e.g. "`int`" is integer, "`int *ip`" designates that variable `ip` is a pointer to a memory location that contains an integer, etc.
- For understanding high-level concepts, this course uses the Java programming language (or some pseudo-code).
  - ⇒ You should have some understanding of Java.

Chapters of this course (1)

Introduction

1. Introduction/Overview on OS'es
2. Operating-System Structures

Processes

3. Processes
4. Threads
5. CPU Scheduling
6. Process Synchronisation
7. Deadlocks

Memory

8. Main Memory Management
9. Virtual Memory

Mass storage

10. File-System Interface
11. File-System Implementation
12. Mass-Storage Structure
13. I/O Systems

14. Review of topics and information concerning the final exam

Chapters of this course (2)

- Distributed Systems (which is often covered in Operating Systems literature) will not be covered in this course as there is a course e.g TÖL503M Distributed Systems and Cloud computing on its own for MSc. and advanced BSc. students.
  - However, we will cover some network programming as part of processes and interprocess communication in Chapter 3.
- Security will only be only briefly covered.

Assignments of this course (1)

- 1: Discussion: Are operating systems needed at all?
- 2: What is standardised by POSIX standard?
- 3: Virtual machines
- 4: How the kernel boots the full OS
- 5: Pseudocode of a CPU scheduler
- 6: Microsoft Windows API for process creation & termination
- 7: Producer-consumer using interprocess communication (Java)
- 8: Multithreaded connection-oriented server (Java)
- 9: Applying CPU scheduling algorithms (FCFS, SJR, SRTF, RR)
- 10: CPU scheduling with I/O bursts and CPU bursts.
- 11: Demonstrate race condition (Java Threads)
- 12: Avoid race conditions using Peterson's algorithm (Java)
- 13: Swimmer process synchronisation using semaphores (pseudocode)
- 14: Avoid race conditions using semaphores (Java)

Note: all topics are tentatively and may change.

Assignments of this course (2)

- 15: Baker process synchronisation using semaphores (pseudocode)
- 16: Simulate semaphores using monitors (Java)
- 17: Deadlock analysis of Dinning philosophers implementations
- 18: Deadlock analysis using resource allocation graph, safety algorithm
- 19: Dynamic memory allocation (Best fit, Worst fit, First fit, Next fit)
- 20: Calculating no. of pages/frames, page table sizes, mapping of logical to physical addresses with PMMU
- 21: Page replacement algorithms (FIFO, Second Chance, NRU,LRU,OPT)
- 22: Page usage/page faults of a given program
- 23: File Allocation Table (FAT)
- 24: I-nodes

There might be bonus assignments, e.g.:

- 25: I/O bottleneck, Programmed I/O vs. DMA

Learning outcomes (i. Hæfniviðmið)

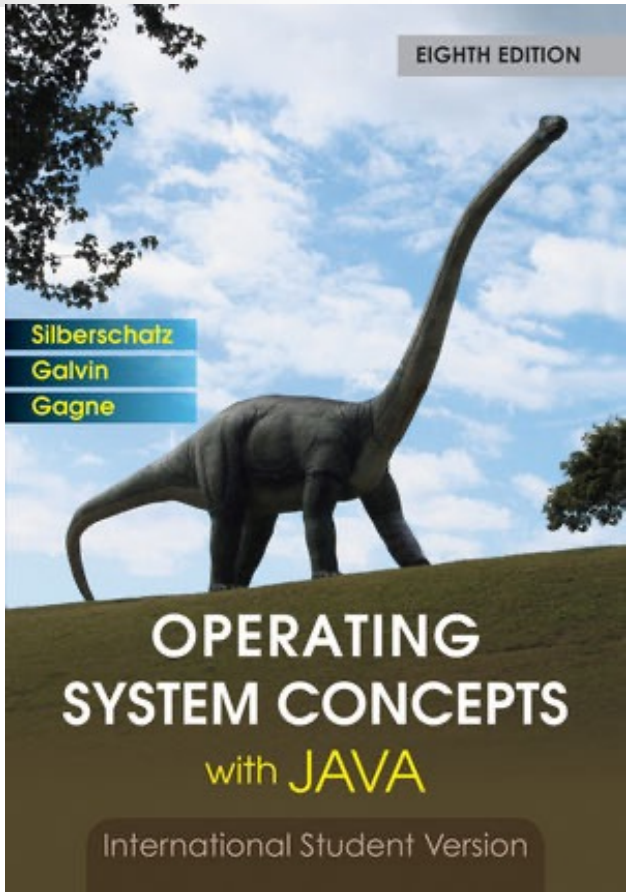
Increasing levels of cognitive complexity:
Explain (explaining important information),
Apply (solving closed-ended problems),
Analyse (solving open-ended problems),
Create (creating 'new' answers to problems),
Evaluate (making critical judgments based on a sound knowledge base).

- After completing the course, students are able to
  - Explain basic computer HW structures and general operating system architectures.
  - Explain concepts and differences of processes and threads, apply associated system calls and APIs to create concurrent programs in high-level programming languages.
  - Explain CPU scheduling principles, apply, analyse and evaluate scheduling algorithms.
  - Explain and apply methods for process to create synchronised concurrent programs.
  - Explain conditions for deadlocks, analyse and evaluate whether deadlocks may occur, apply algorithms for their detection and handling.
  - Explain memory management and virtual memory concepts, apply, analyse and evaluate memory allocation strategies and page-replacement algorithms.
  - Explain concepts of file-system interfaces, file-system implementation, I/O systems, and mass-storage structures, use files system API calls to create file-based application programs in high-level programming languages, analyse and evaluate file-system and mass-storage implementations.
  - If some of the additional topics (e.g. protection) are covered: explain basic aspects

Literature

While this course is based on this book, you do not need to have that book: the slides are pretty extensive.

- This course is based on the book:
  - Silberschatz, Galvin, Gagne: "Operating System Concepts with Java", Publisher: Wiley
  - Latest edition: 2010 8th Edition.
    - Some mix in updates from the recent non "with Java" (i.e. "C") 2018 10th edition.
    - Access to the non "with Java" (i.e. "C") edition, you can also use it.
      - 95% of content is same,
      - only difference: Java vs. C examples.
  - Also available as e-book: if you download it illegally, the authors will get no money and it is less likely to have good textbooks in future!
    - Already the fact of no recent Java edition indicates lack of revenue.



Course material

- Slides will be available via Canvas.
  - Microsoft PowerPoint 2003 file format version.
    - Can also be processed by e.g. OpenOffice or LibreOffice.
      - (However, often not 100% same layout).
  - You will also have PDFs of them.
- Assignments: In Canvas and PDF only.
  - Often, students want to copy text from the assignment PDFs:
    - Open it in an external PDF viewer.

Data protection disclaimer:
Be aware that access to files in Canvas and videos in Panopto is logged.

Discussion forum

- The course plans to have a discussion forum at **`Canvas`**→ "University of Iceland"

  → **`and other`** Under construction

  - All currently registered students will be enrolled
    - You will get an announcement in the next days.
  - Also:
    - let me know where you have problems.
    - help each other: if you know the answer, please answer – do not wait for teachers to answer (you will be endorsed for correct answers).

Final Grade/Exam

- Final grade:
  - 30% grade of weekly home assignments
  - 10% Lecture assignments
  - 60% grade of exam.
  - However, it is not sufficient to deliver good assignments, but to fail in the exam: for passing the course as a whole, you need to pass the exam on its own (i.e. ≥**5.0**)!
- One written (on-site) exam at the end of the semester
  - Based on lecture slides, videos, and assignments.
  - Closed book exam: Some OS cheat sheets will be included
  - You are not allowed to take any written helper material into the exam. But you can have a look at exams from last years to get an impression what you need to learn.

Assignment organisation

- Weekly home assignments published on Tuesdays
  - Consists of applications of the topics from the slides.
  - Sometimes paper work, sometimes programming.
  - To be solved within one week until next Tueseday.
  - Typically: two assignments per week.
    - Twelve weeks usable for assignments $\Rightarrow$ 24 assignments.
    - Maybe: 1 bonus assignments at the end of the semester.
- Weekly lecture assignments end of Thursday lecture

Assignments: Grading

- Each weekly home assignment gets a grade.
  - Graded by teaching assistants (dæmakennari).
  - The 12 best out of all solution submissions count and each of these 12 best grades contributes by 2.5% to the final overall grade.
- Lecture assignments get graded at end of lecture
- Summing up to 40% contribution for the final overall grade, leaving 60% contribution to the final exam grade.
- Not submitting counts as 0.0.

Assignments handling: Gradescope

- We use Gradescope, i.e. submit PDF, photo or source code to Gradescope web page.
- You will be added to Gradescope based on your registration for a dæmatími group (email will be sent)
  - info on registration for dæmatími is done in Canvas, later!
- Assignment handling via Gradescope:
  - Upload your solution,
  - Retrieve the grade you got
  - Re-grade request.
  - **`https://www.gradescope.com/help`** → Student workflow
- For some assignments, templates (LaTeX & PDF) to fill in solution will be applied.

Assignments: Work As a Pair of Two

- Allowed and encouraged to submit as a pair of two (but alone as a single student is also possible)!
  - Gradescope supports group submission: just add the name of the second student during submission.
    - Allowed to change pairs from assignment to assignment as long as you stay with the same teaching assistant (dæmakennari).
  - If you are looking for a second student to team up: use Canvas discussion forum.

Assignments: Deadline & Presentation/Discussion of solution

- 1 week after an assignment has been published, you have to submit the solution.
  - Deadline: Tuesday (time changes ongoing, more later) via upload to Gradescope.
  - After the submission deadline, solutions will be presented and discussed by the teaching assistants (dæmatími).
    - By comparing your solution with the presented one (and by waiting for the grade that you will get approx. 1 week later), you can see whether your solution was correct or not.
    - There may be different ways of solving a problem: If you have an alternative solution, you are encouraged to ask about and discuss your solution.

Assignments:
Extent of weekly solution / Working in bigger groups

- Solution typically fits on 1 or 2 A4 pages for each assignment.
  - If you write more, you are probably doing too much.
    ⇒Be concise: do not write too much (speeds up grading).

- Sometimes students have a learning group that consists of more than two students:
  - It is OK to develop the solution together in a big group – but when you write down the solution, do it in pairs of two that write independent from the other pairs.
    - By this means you end up with different wording and avoid the suspect of cheating (=simply copying from someone).

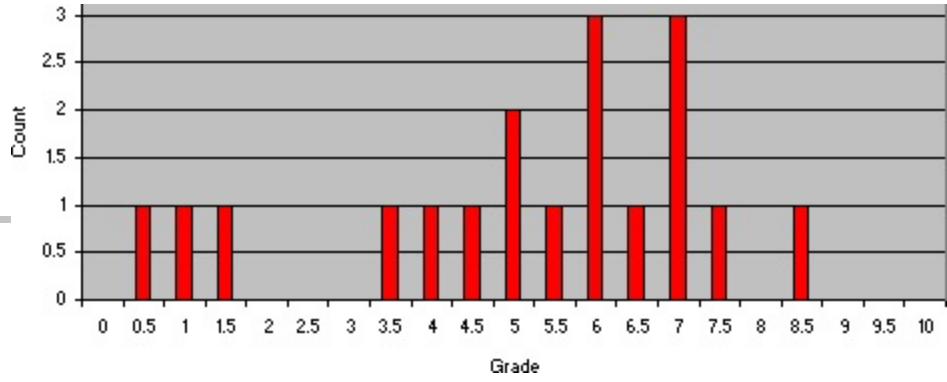
University of Iceland Code of Ethics / Siðareglur Háskóla Íslands

- "Honesty https://www.hi.is/haskolinn/sidareglur
  2.1.4 Teachers, specialists and students do not present the intellectual property of others as their own. When they use the intellectual property of others they always cite the source according to accepted scientific methods."
  - Copying assignments solutions not giving the source is a violation.
    - You are anyway cheating yourself by copying, instead of learning.
    - (For the nitpicker: Copying with giving the source would not a violation of article 2.1.4, but will neither give any points because you are supposed to find the solution on your own.
  - Creating a solution by reading different sources and creating something new out of it is **OK**. This is how research works!

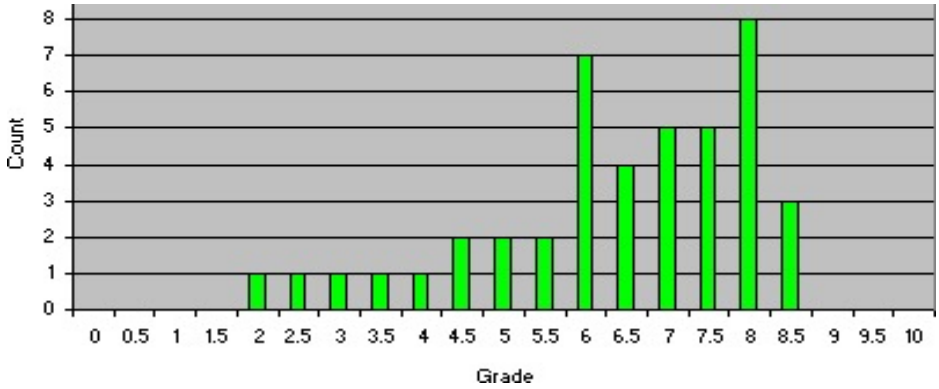
Assignments: Statistics

- Experience from past: Correlation between exam grade and number of assignment submissions (from last year):
  - The more assignments solved, the more the distribution of final exam grades is shifted towards good grades.
  - (Of course, correlation does not imply causality: just submitting a lot assignments does not guarantee that you pass.)

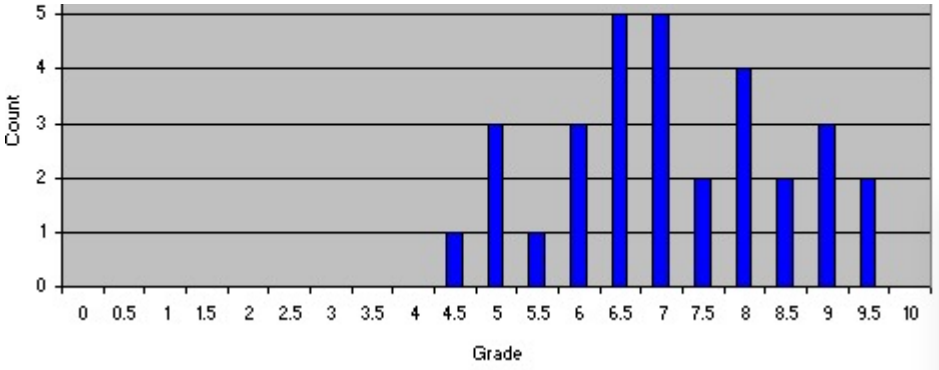
0–11 submissions (red):



12–15 submissions (green):



16–26 submissions (blue):



Assignments: You must be active to be admitted to the final exam

- To be admitted to the final exam, students must turn in at least 4 (out of 8 due until then) assignments after 4 weeks of assignment submission.
- This means: After assignment submission deadline 15. February 2022, 4 assignment solutions need to have been submitted.
  - Last chance to start submitting assignments: 1. February 2022 (assuming that you then submit each week two assignments).
- Otherwise, you will get de-registered from this course.

Dæmatími (1)

- Mandatory registration for dæmatími: how to do so published later.
- Three groups in your callender
  (only necessary to attend one of them):
- Timeplan
  - d1: Thursdays,
  - d2: Thursdays (unclear),
  - d3: Fridays,
- Start: week 4 (after deadline of first assignment).

Dæmatími (2)

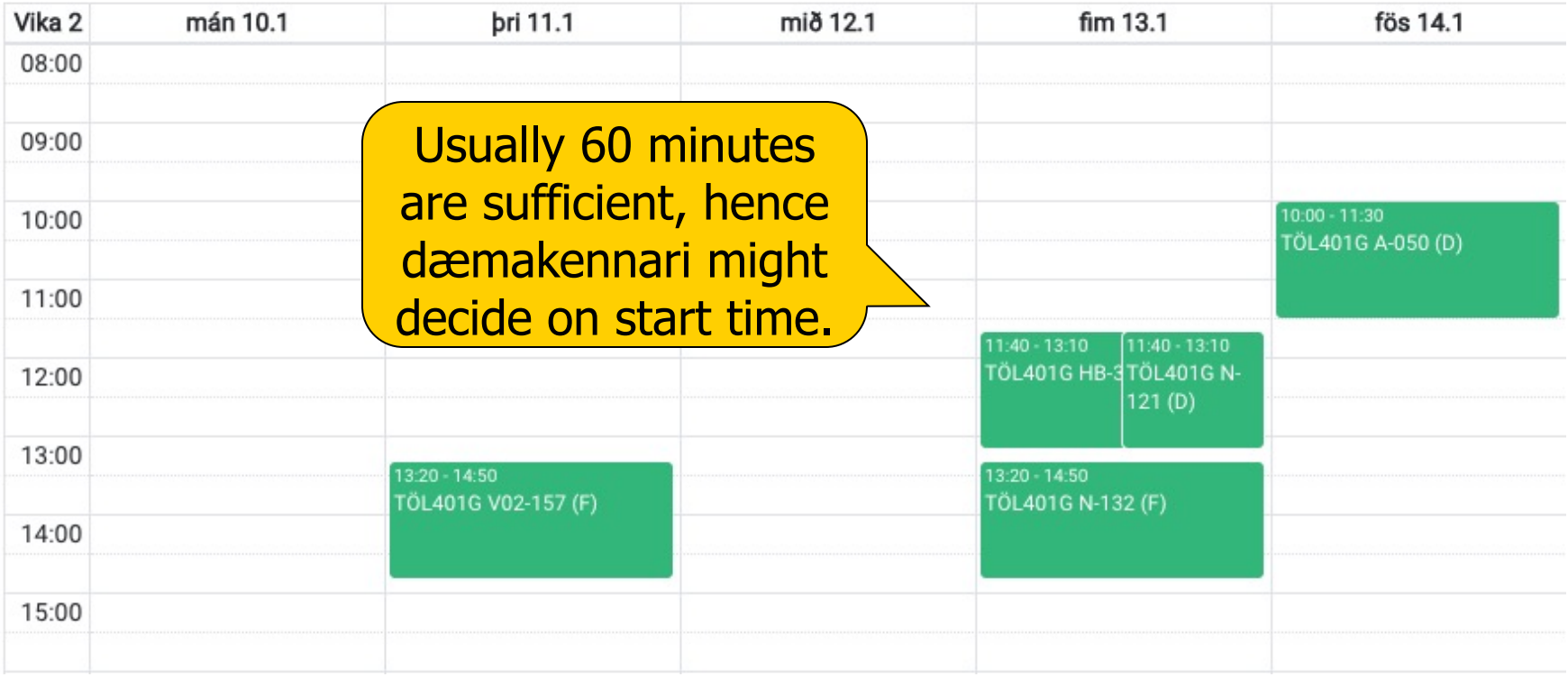
- Groups start after first assignment submission: from week 4 onwards.

- Canvas announcement concerning registration for groups will be send out.

Timetable

Only necessary to attend one dæmatími d1-d3!

10 - 16 jan 2022



Usually 60 minutes are sufficient, hence dæmakennari might decide on start time.

Break for Advertisement!

- If there are in future calls for dæmakennari, consider to apply.
  - In particular if you intend to get a letter of recommendation (e.g. to do MSc. abroad) from a teacher:
    - Your teacher can only reasonable recommend you if (s)he knows your from working as dæmakennari!

Learning science shows: Continuous learning is best

- Some students tend to postpone learning to exam period.
  - This is not healthy!
    - Both physically/mentally, but also wrt. the chance to pass.
  - To learn continuously, you should attend dæmatími (and of course come to class).
    - There you can ask and learn about solutions.
    - You anyway need to invest the time in understanding solutions, so instead of doing this in the exam period, do it continuously.

⇒Assignment solutions will not be posted, only shown in dæmatími! So attend!

Classroom on-line teaching

- At home:
  - Read slides (each week approx. 50-60 slides),
  - Watch supporting videos.
- During weekly class Thursday
  - Ask questions concerning read slides,
    - Anything that you want to clarify.
  - Work on assignments, discuss it with each other and get assist.
- At weekly Tuesday assignment submission deadline:
  - Submit assignment.
- At weekly assignment discussion groups/dæmatími:
  - Solution is presented & discussed, ask questions about grading.

You need to be prepared!

- Check for supporting videos:
  - Typically, for graphics and examples that are not further explained in the slide text.
- You get assistance while solving assignments.
  - Makes solving assignments faster and more correct.

⇒You save time working on the assignments and are likely to get better grades.

Programming assignments

- We will have some programming assignments:
  - Use Laptop to do real programming.
    - Many anyway use the laptop to write down the non-programming solutions (but also OK to use paper for and submit a photo of the non-programming solution).
- We recommend to install a modern Java development environment, not just an editor:
  - Makes programming much faster. E.g.
    - Eclipse IDE for Java Developers: **`http://www.eclipse.org`**
    - JetBrains' IntelliJ IDEA: **`https://www.jetbrains.com/idea`**
    - Apache NetBeans: **`https://netbeans.org`**
    - Atom editor with **`ide-java`** package: **`https://ide.atom.io`**

Exemplified Weekly Schedule

- New lecture slides published weekly
  - Until next class read slides and watch videos at home
  - Tuesday: new assignment published.
    - Based on slides published for that week.
- Thursday class in that week:
  - Work on the new assignment during class.
  - You have time to submit solution until the following Tuesday.
  - Lecture assignments
- In week after:
  - Deadline for submission of assignment on Tuesday.
  - Solutions to assignments presented during dæmatími.
    - available in Gradescope 1 week later **no garantees!**

Any other business

- That's all concerning organisational issues!
  - Once dæmatími registration is possible (will be announced via Canvas): take care to register for dæmatími!
    - Your assignments will not get graded otherwise!
    - Come to dæmatími: solutions will **only** made available there.
  - Any questions?
- Your homework is to read Chapter 1
  - Chapter 1 available later this week.
  - Video from Helmuth will also be available in Canvas
  - First assignment published Tuesday W3 will be based on ch. 1, so you need to have read it until class later that week.