Universität Münster

ERCIS

Course Overview

(Usage hints for this presentation)

IT Systems, Summer Term 2026

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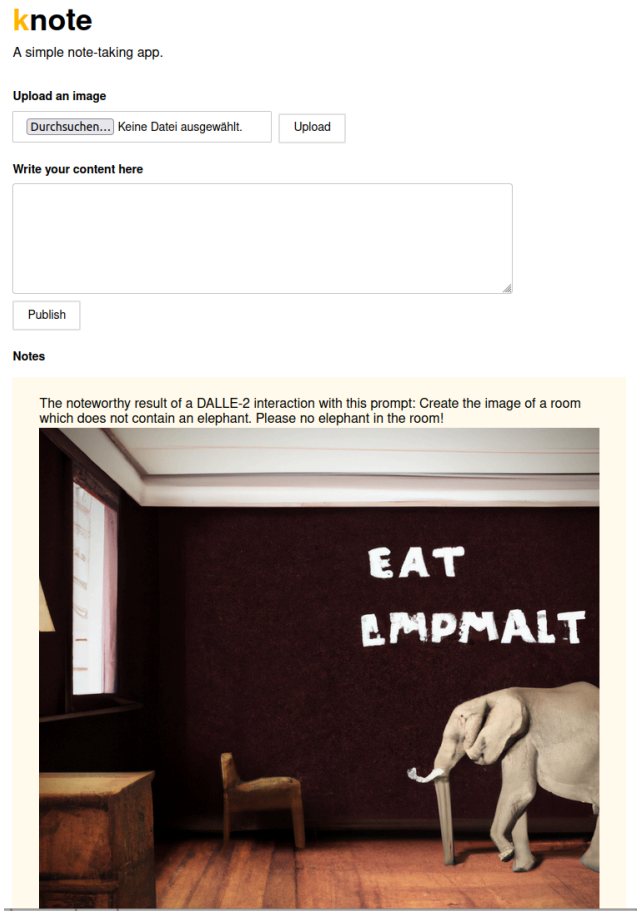
(Author and License Information)

1. Assorted Topics

- Fire alarms
  - Keep calm, leave swiftly, but leave no one behind
- IT Systems is the successor module to CSOS
  - CSOS students are very welcome, relevant is Learnweb course of 2023
- eLectures recordings
  - Available if no technical problems, but please use only in exceptional cases
- Exchange students?

2. Motivation

- What do you see?
- What might be happening?
  - From a systems' perspective?
  - Abstractions?



"Screenshot of knote web application" under CC0 1.0; from GitLab

Speaker notes

This is a screenshot of the note taking application knote that is usable in a web browser and runs “in the cloud”.

Clearly, just as every other application, this application requires some computers to do something. Throughout the course, we will revisit this application in a bottom-up fashion as explained next, starting from individual computers over operating systems to cloud environments.

2.1. Course Objectives and Goals

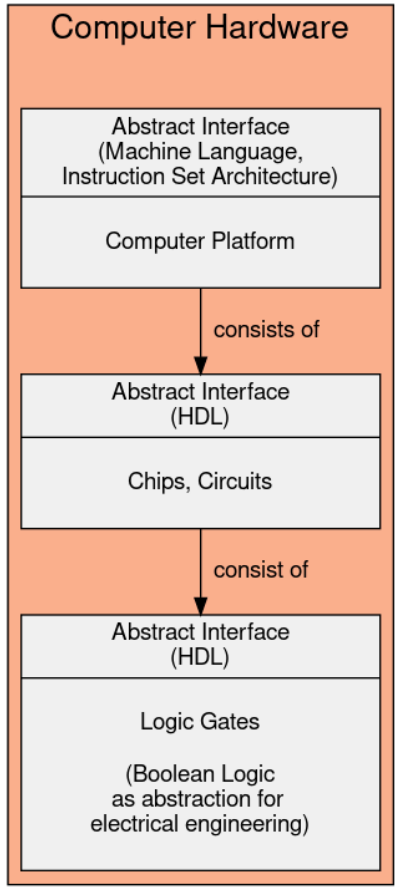
- **Objectives**
  - Discuss how hardware and software systems are built, using **abstraction**, and how they work together
  - What is happening underneath?
    - **Cloud Infrastructure**: Explain basic concepts, deploy simple containerized system
    - **Operating System** (OS): Explain how OSs do their job, use them, inspect what is happening
    - **Computer Architecture**: Build (simulated, yet realistic) computer by breaking task into simpler ones
- **(Long-term) Goals**
  - Inspect and **control** any computer, at any level of interest
  - **Digital sovereignty, sustainability**
    - Knowledge empowers to use/build better solutions that serve our interests
    - E.g., end-of-life for 240 million PCs with Windows 11, more millions when Apple ends support for Intel CPUs
      - Campaign End of 10 offers help with GNU/Linux

2.2. Course at a Glance (1/4)

- Method: Explore **abstractions bottom-up**

1. Computer Architecture

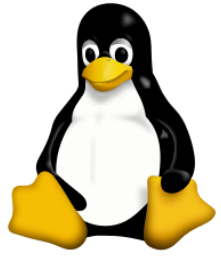
- **Build** a complete, general-purpose, programmable computer system, called **Hack**, from ground up, starting with elementary logic gates
  - Simulated, Nand2Tetris
  - Sequence of projects
- Play and experiment with this computer, at any level of interest
- (Prerequisite: Binary numbers; tutorial with self-tests)



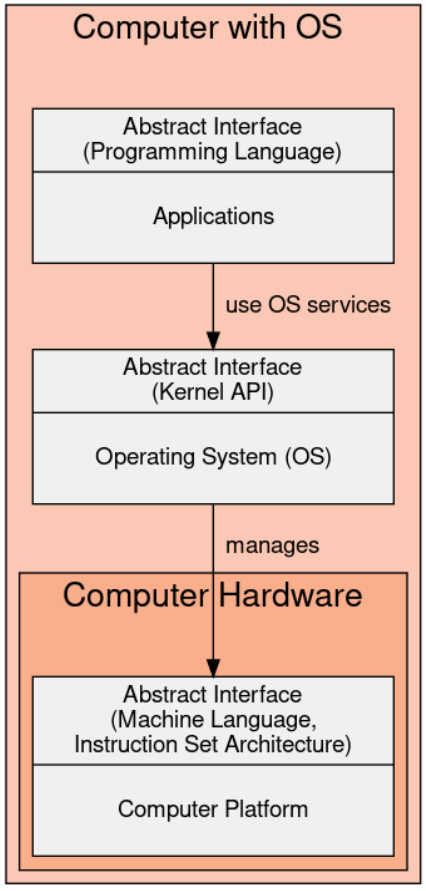
2.3. Course at a Glance (2/4)

- Method: Explore **abstractions bottom-up**

1. Computer Architecture
2. **Experiment with OS concepts**
   - Explain core OS **management** concepts, e.g., processes, threads, virtual memory
   - Use GNU/Linux command line and explore system
     - OS part starts with The Command Line Murders
   - Explore sample Java code
     - (Prerequisite: Java programming, compilation, execution)



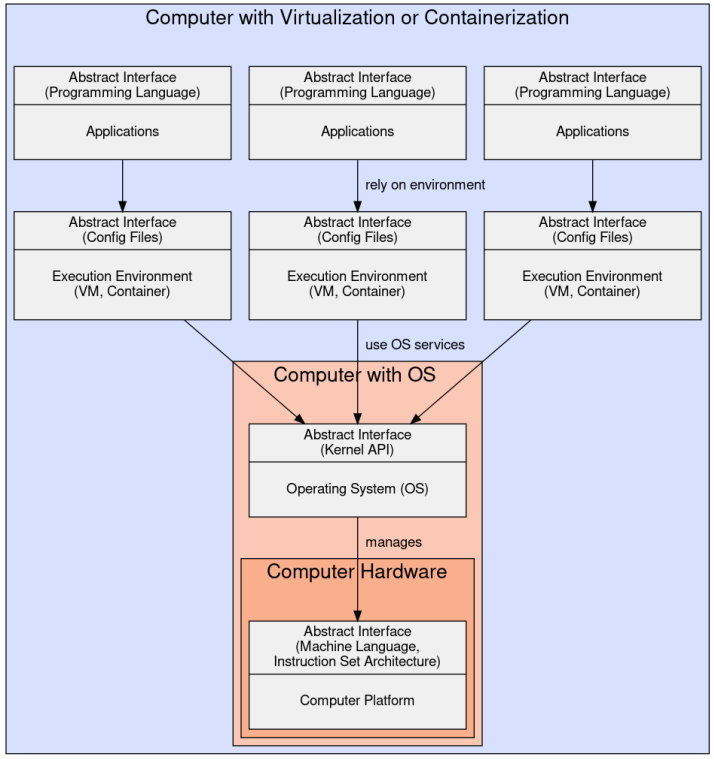
"Tux, the Linux mascot" under CC0 1.0; from Wikimedia Commons



2.4. Course at a Glance (3/4)

- Method: Explore **abstractions bottom-up**

1. Computer Architecture
2. Experiment with OS concepts
3. **Explain virtualization, experiment with containerization**
   - Explain core concepts
   - Understand images, run Docker **containers**
     - Build and run knote web application ◂ seen initially

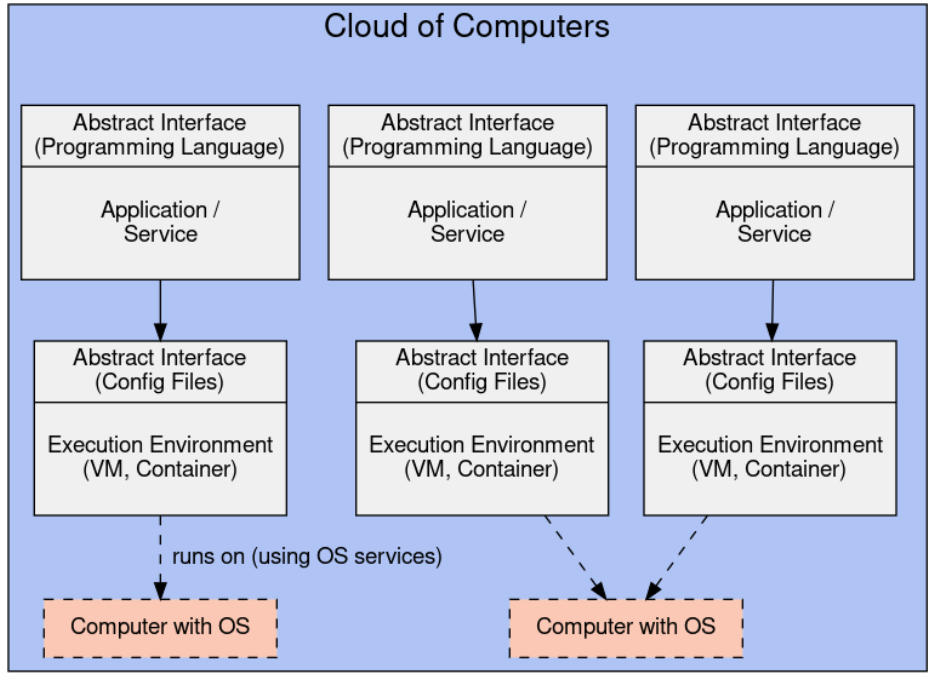


"Docker logo" under Docker Brand Guidelines

2.5. Course at a Glance (4/4)

- Method: Explore **abstractions bottom-up**

1. Computer Architecture
2. Experiment with OS concepts
3. Experiment with containerization
4. **Set up simple cloud application**
   - Run Kubernetes cluster on local machine
   - Deploy knote web application ◂ seen initially



"Kubernetes logo" under Kubernetes Branding Guidelines; from

2.6. Learning: Retrieve Taking

- What important topics are we going to cover?
- What do you want to study (maybe on your own)?

3. Course Organization

3.1. Course Components

- Course with 6 CP, at least 8h per week
  - **Joint sessions** in class (no traditional lectures, details below)
    - Tuesday (10:15 a.m.): Recap of lecture material
    - Thursday (2:15 p.m.): Exercises
    - 2x90 minutes = 3h
  - **Self-study**, 5h per week
    - Flipped classroom (details below)
    - Including quizzes in Learnweb: Published as course progresses
      - Self-study quizzes to support your learning
      - Quizzes for **study work** (50% of total points required), **deadlines** on Thursdays (except public holidays, then Friday). Passed study work from earlier term remains valid.
- **Final exam** for 100% of final grade
  - You **must pass both**, study work and exam, for credits
    - Not recommended, but can be done in different terms/years

3.1.1. Registration at Examination Office

- Students are responsible for **registering** for **all required components** of their courses (e.g., study work, examination). Procedures vary by program. If you have questions, contact your student council or the Examinations Office well in advance.
- For the Information Systems (Wirtschaftsinformatik) program, the Examinations Office publishes key exam dates and registration/deregistration deadlines: https://www.wiwi.uni-muenster.de/pam/en/examinations/schedule-examination-offer-examination-rooms

3.2. Course Material

- Everything provided in or linked from Learnweb
  - Material developed and published as OER on Gitlab
- Computer Architecture
  - (Nisan and Schocken 2005) The Elements of Computing Systems, MIT Press
    - Book chapters, project material at https://www.nand2tetris.org/course
      - (Book chapters hyperlinked from icon for reading person)
    - Gratis course at Coursera
- Operating Systems
  - (Hailperin 2019) Operating Systems and Middleware
- Cloud Infrastructures
  - Variety of papers and software documentation

3.2.1. OER on GitLab

- Presentations such as this one are maintained as Open Educational Resources (OER) on GitLab
  - Sources: https://gitlab.com/oer/oer-courses/it-systems
    - Please, contribute with bug reports (issues) or merge requests!
  - Presentations: https://oer.gitlab.io/oer-courses/it-systems/
    - Note: **PDF formats**
  - Usage hints: https://oer.gitlab.io/hints.html
    - Note: **URL parameters**
      - https://oer.gitlab.io/oer-courses/it-systems/03-Boolean-Logic-I.html?audio-advance=-1&audio-speed=1.5
  - Work in progress, presentations “ready” when link in Learnweb

3.3. Tentative Schedule

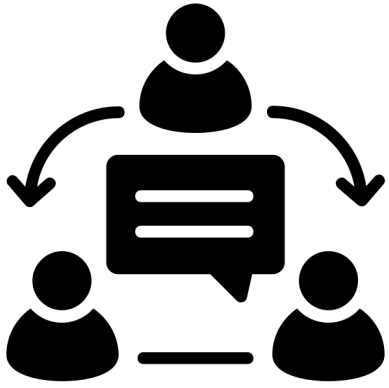
- April 14/16: Course Introduction
- April 21/23: Boolean Logic
- April 28/30: Combinational Circuits
- May 5: Machine Language
- May 12: Computer Architecture
- May 19/21: OS Introduction
- Pentecost
- June 2: Interrupts and I/O
- June 9/11: Threads and Scheduling
- June 16/18: Mutual Exclusion
- June 23/25: Virtual Memory
- June 30/July 2: Processes
- July 7/9: Virtualization and Containers
- July 14/16: Cloud Computing and Kubernetes
- July 21: Course Recap

3.4. Prerequisites

- We suppose that you can **convert** between decimal, binary, and hexadecimal **numbers**
  - Tutorial with self-tests
- We suppose that you can **program in Java**
  - Including compilation and execution
    - Which requires installation of JDK
- Quickstart with Nand2Tetris software tomorrow (requires JRE)
  - Please install ahead of time and come with Laptop

3.5. Past Course Evaluations and Results

- IT Systems is a new module
  - First incarnation in 2024
    - **Nominated for teaching award** by student council
  - Successor to Computer Structures and Operating Systems (CSOS)
    - CSOS evaluation in 2023 highly positive
- Students usually report that our type of interaction and work is unknown to them
  - Please trust me and overwhelming scientific evidence (alluded to next), and try this out

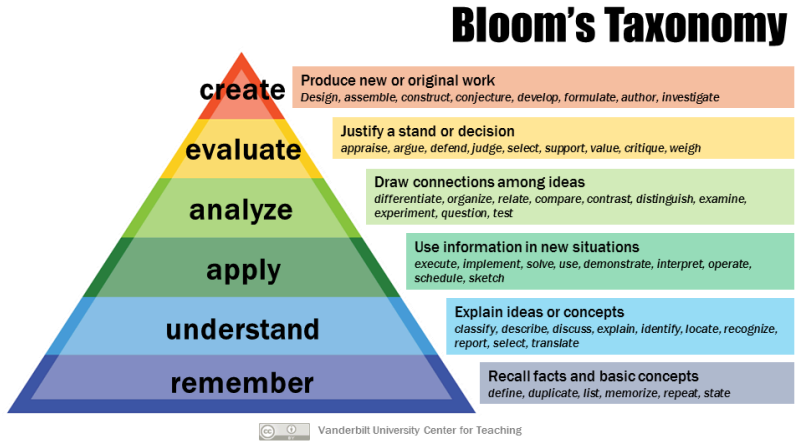


3.6. Q&A

4. On Learning and Teaching

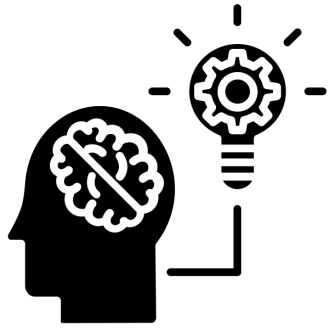
4.1. Learning Objectives

- Later presentations contain **Learning Objectives**
  - What we want you to have learned (after lecture and exercises)
- Content + action verb
  - Action verb specifies level of skill
    - Think of **exam question**!
  - Bloom's taxonomy
- Examples
  - Apply algorithm X in sample scenario
  - Argue about relative strengths and weaknesses of Y and Z
  - Course Objectives on ◂ earlier slide



4.2. Learning (1/2)

- Learning
  - Requires **active work**
    - To **change protein structures** in brains, just like muscles
    - E.g., deliberate practice, retrieval practice, spaced repetition
  - Getting information **out of heads**
    - Misconception: Learning = getting information in
    - Precondition for silent learning: **Writing material**
      - Preferably a **laptop** (for writing and experiments)
  - Suggestions to learn about learning
    - Learning Platform Information Systems (**student-driven**, in Learnweb, with videos)
    - See book Make it stick (student **recommendation**!)



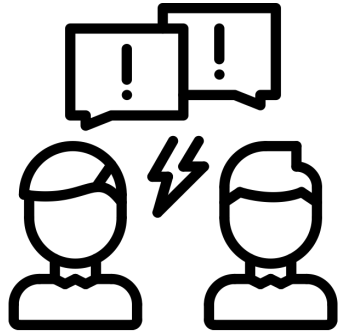
"Brain training" by Shocho under CC BY 3.0 US; cropped from the Noun Project

4.3. Learning (2/2)

- Consequences
  - During (traditional) lectures, I learn, you do not (much)
    - (Physics Nobel laureate Carl Wieman compares lecturing in education to bloodletting in medicine; both are bad approaches that were popular once)
  - This course provides **learning opportunities** during our meetings
    - Where you can **benefit from my presence**
    - Which requires your **preparation**
    - Which requires **active work** on your part, instead of passive listening
    - (Which may not meet your expectations and may contradict your feeling of learning …)
- (My teaching statement justifies the above with scientific references.)

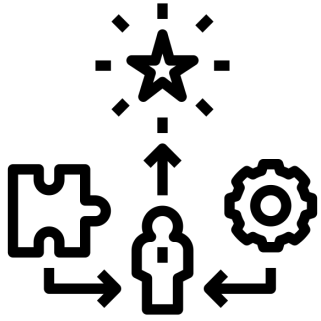
4.4. Flipping IT Systems

- CSOS has been **flipped** since 2017, IT Systems continues in that tradition
  - Since 2023 following (Kapur et al. 2022):
  - **Improved learning outcomes** based on productive failure, active learning, and instructor support: Fail, Flip, Fix, Feed
    - **Fail**
      - You attempt to solve a task before being instructed
      - Possibly without success
      - You activate prior knowledge, diagnose own learning, stimulate (meta-) cognitive processes
    - **Flip**: You work on self-study material ahead of meeting
    - **Fix**, **Feed**
      - Class meetings are shaped by you: **What are *your* goals?**
      - We discuss and work on tasks ("failed" and new ones, exercises and previous exam tasks)
      - This is where I am around and we spend limited, **valuable time**



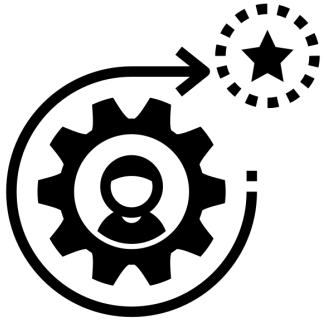
4.5. Course Rhythm

- On Thursdays
  - Publication of new course material and quiz for study work
    - **Unlocked** when you **submit fail task**
      - Unlocking suggested by students in 2023
    - New tasks on the “Completion Progress” in Learnweb
  - Session
    - Conclude current topic, **learn**, **work on tasks**
      - Including Q&A on current **study work**
    - Outlook on new material, initial work on **Fail** task
- **Flip**
  - Learn on your own, with self-study tasks
- On Tuesdays
  - Revisit **Fail** task, **Fix** jointly if necessary, **Feed**: **Learn**



4.6. Session Goals

- My goal: Support your learning
- My major challenge: Heterogeneity regarding knowledge and preparation
  - In particular for flipped classrooms, not so much for lectures
- Your **goals**?
  - Starting next week, I will ask you for your goals
    - Different students may work towards different goals
      - Individually or in small groups
      - See upcoming pads for suggestions; feel free to **add own goals**
    - I will be around to help

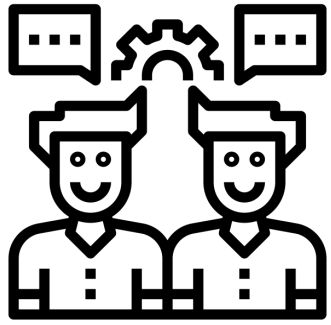


"training" by Nithinan Tatah under CC BY 3.0 US; cropped from the Noun Project

"Society" by Nithinan Tatah under CC BY 3.0 US; cropped from the Noun Project

4.7. Your Thoughts

- **Anonymous pads** in Learnweb for our sessions
  - For your input and notes as well as my session plans
- My questions
  - Why did you enrol in a presence university?
    - Why do you attend sessions? On Campus?
    - Why would you **like** to come to campus?
    - Is everything fine as it is?
      - Proposed rhythm?
    - What stresses you? What brings you joy?
  - How **should** learning at a presence university look like?
    - What are your and my roles?



5. Conclusions

- Let’s learn
  - What are the two most important aspects that you take away from this session?

Speaker notes

IT Systems investigates how hardware and software systems are built, using **abstraction**, in a **bottom-up** fashion:

- Build computers
- Explore OS
- Experiment with containers and container orchestration

We will use a flipped classroom approach, which might not meet your expectations but which is based on scientific evidence regarding learning.

Your instructor appreciates feedback and discussions.

Bibliography

Hailperin, Max. 2019. *Operating Systems and Middleware – Supporting Controlled Interaction*. revised edition 1.3.1. https://github.com/Max-Hailperin/Operating-Systems-and-Middleware--Supporting-Controlled-Interaction.

Kapur, Manu, John Hattie, Irina Grossman, and Tanmay Sinha. 2022. “Fail, Flip, Fix, and Feed – Rethinking Flipped Learning: A Review of Meta-Analyses and a Subsequent Meta-Analysis.” *Frontiers in Education* 7. https://doi.org/10.3389/feduc.2022.956416.

Nisan, Noam, and Shimon Schocken. 2005. *The Elements of Computing Systems: Building a Modern Computer from First Principles*. The MIT Press. https://www.nand2tetris.org/.

Speaker notes

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