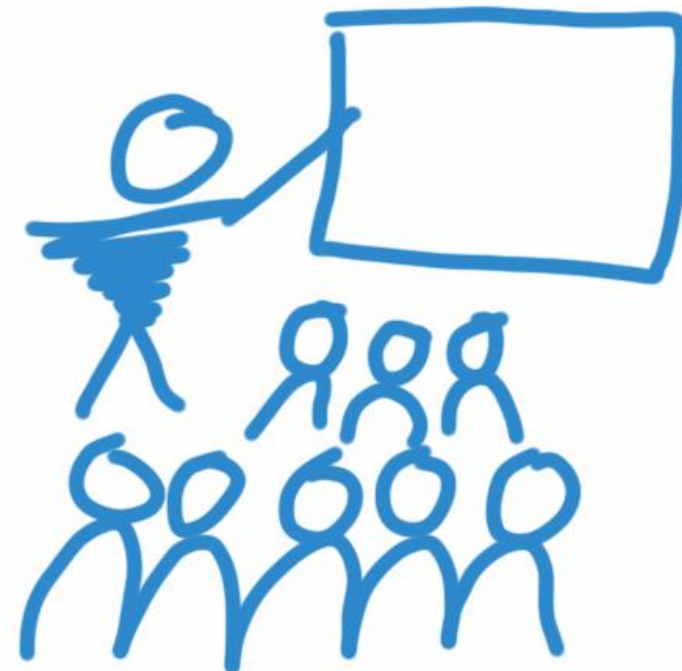
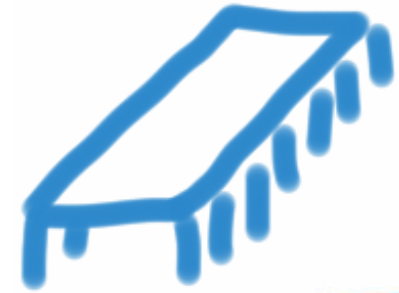


Learning Goals

What?

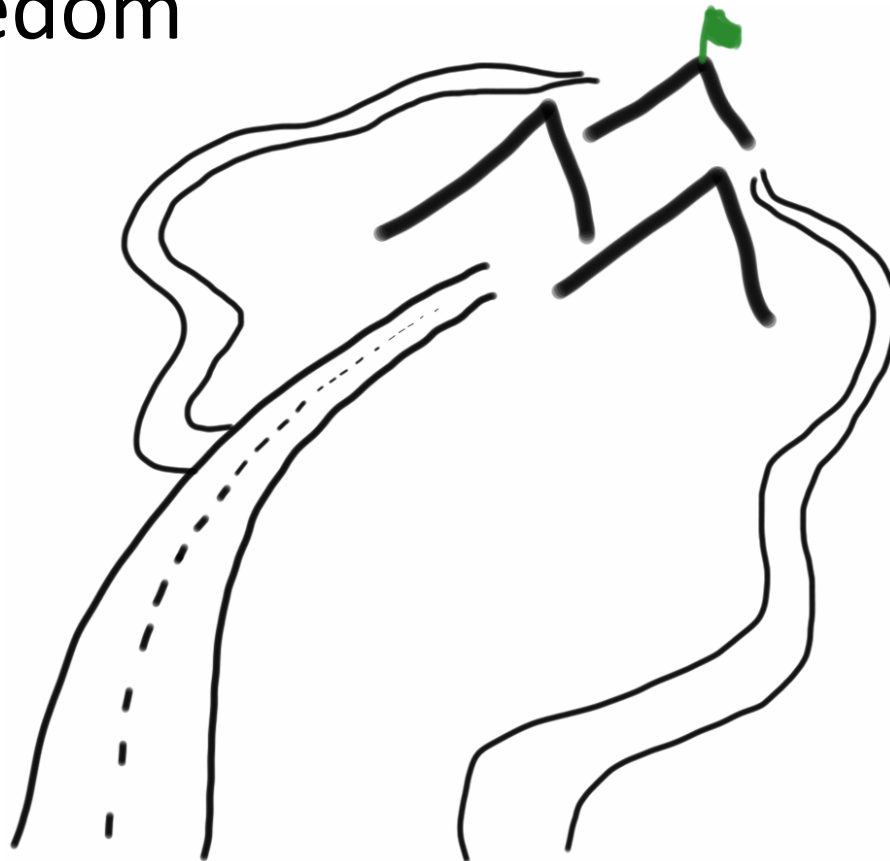
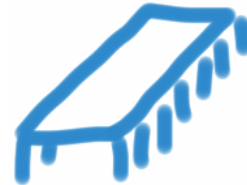
Ok?

How?



Learning Goals

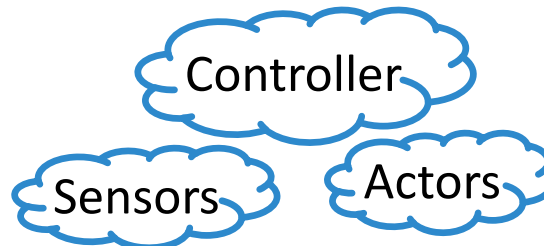
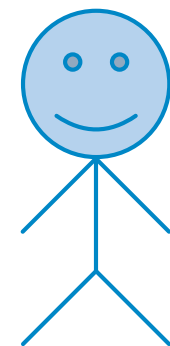
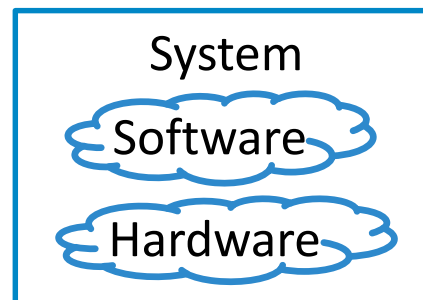
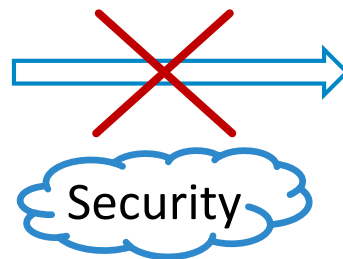
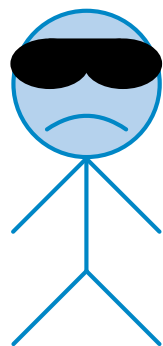
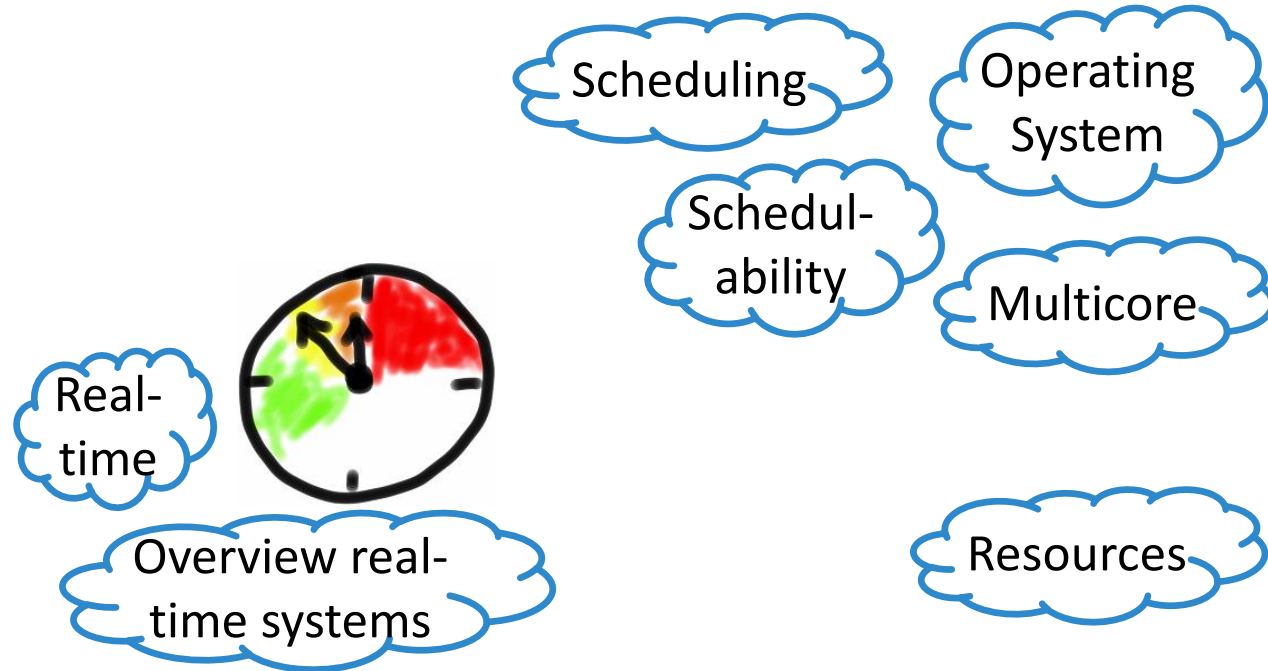
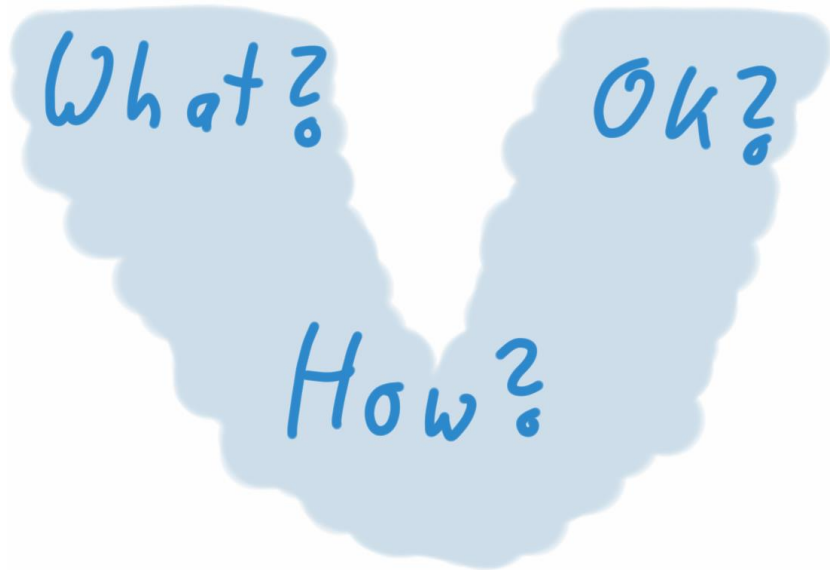
- Development for special hardware
- Efficient creation of good documentation
- Experiencing freedom in development
 - Results are demanded, not the way of fulfilling them



Content of the Course

- Foundation: Lectures about selected topics
 - Experts from industry will share their knowledge
- Your project
 - Development of a real-time system or comparable other topics
 - Paper about your project topic
 - Presentation of your project topic

Selected Topics



Project Details

- Different possibilities for your project topic – all are related to real-time systems
- Some ideas on the next two slides
- Any other (acceptable) topic related to real-time systems – the lecturer has to agree to the topic
- You might have to share equipment with other groups with the same topic

Project Details

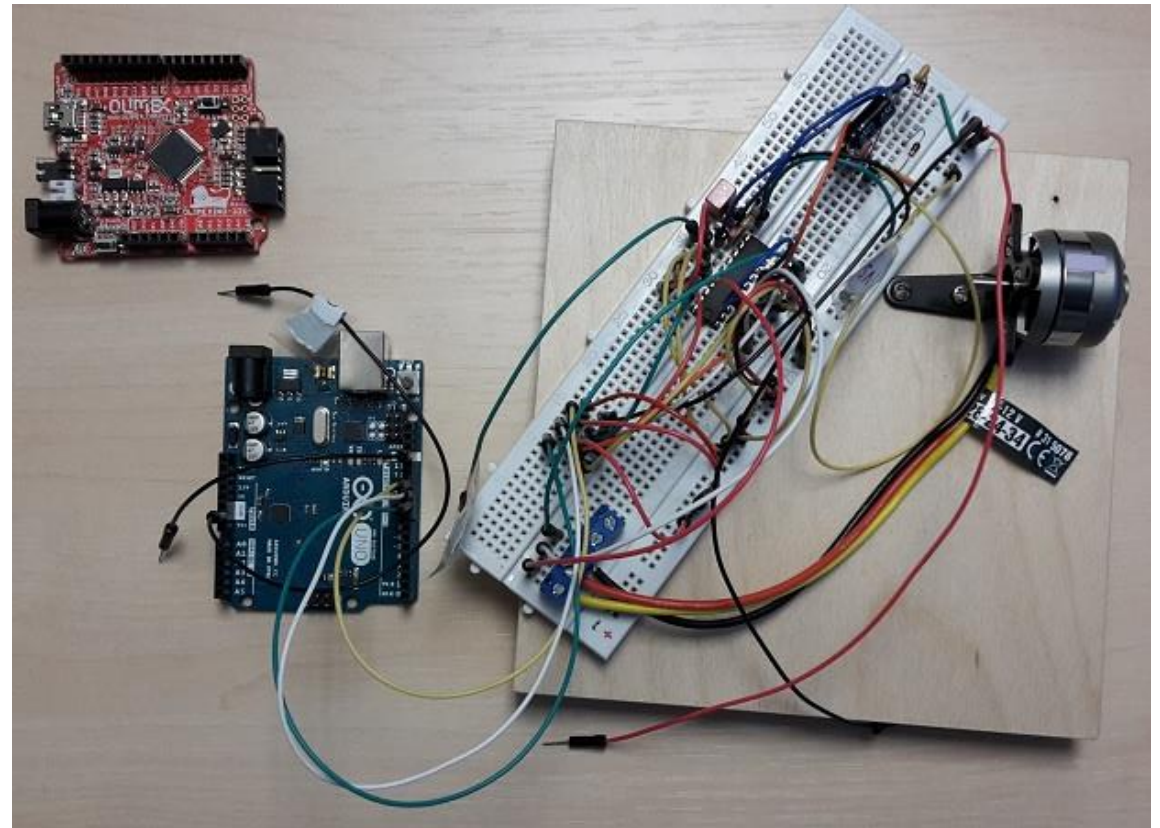
- Work with embedded hardware
 - Control of a BLDC motor (4 groups)
 - Profiling on the Arduino (4 groups)
 - Converter for RS-232 signals (2 groups)
- Multicore (4 groups)
- Simulators
 - Flight arrival and departure simulator (2 groups)
 - Antilock-Braking-System simulator (2 groups)

Project Details – Lego Mindstorms

- Autonomous vehicles (3 groups)
 - Only Autonomous Vehicle 2
- Sound detection (1 group)
- Obstacle detection (1 group)
- Balancing robots (3 groups)

Project Details – BLDC motor

- Hardware
 - BLDC motor
 - Arduino controller
 - Several electronic parts, especially a three phase motor driver IC

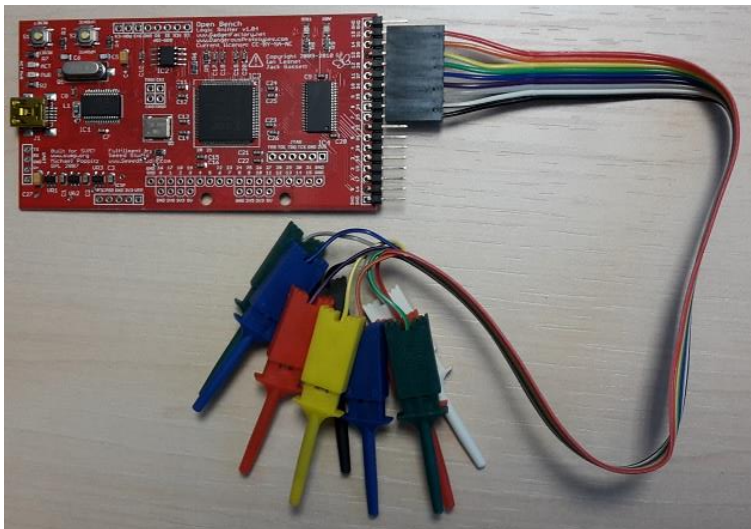


Project Details – BLDC motor

- The system shall control a BLDC motor in different speeds and in both directions.
- The speed shall be changed by two buttons for turning slower and faster.
- The direction shall be changed by another button.
 - The direction can be changed only if the motor is switched off. – Alternatively it is slowed down automatically, stops, and is accelerated again into the other direction.
- Another test program shall move the motor in a predefined way, e.g. half a turn clockwise, then wait one second, then three and a quarter turn counter-clockwise, ...
- Introduction to electrical motors on 6.11.2017

Project Details – Profiling

- Hardware
 - Arduino Controller
 - ARM Cortex-M3 development board with touchscreen
 - Logic Analyzer



Project Details – Profiling

- Sometimes profiling is useful during development
- How can profiling be done on the Arduino?
- Identify and try out at least two completely different approaches
- Available hardware
 - Arduino controller (with display, if necessary)
 - Logic analyzer
- Write a cyclic program with some calculations and functions and apply your profiling approaches to analyze it

Project Details – Profiling

- Optimize the given program ProfilingProgram.py for the Arduino
 - Translate it from python first
 - Find appropriate constructs with similar runtime
 - Analyze and optimize it in the second step using
 - your profiling approaches
 - your knowledge about simplification of algorithms
 - Test it

Project Details – Multicore

- The focus of that task is on multicore
 - This can also be done in a non-real-time environment
- Hardware: Raspberry Pi 3 Model B
- Software: Parallel programs from different domains
- Select an appropriate programming environment
 - Programming language
 - Multicore support
 - Runtime measuring

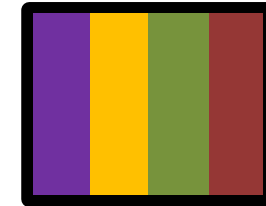
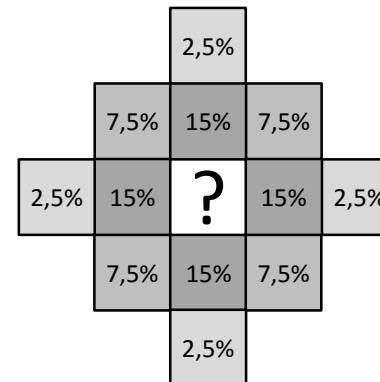
Project Details – Multicore

- Image-Processing ideas

- Each core processes a part of the picture

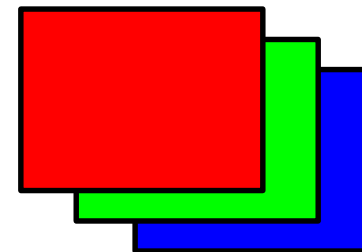
- Reformat picture by averaging the new color based on the colors of the neighbors?

- What about unavailability of pixels at the edges?



- Each core processes one aspect for the whole picture

- Calculate the average RGB-values



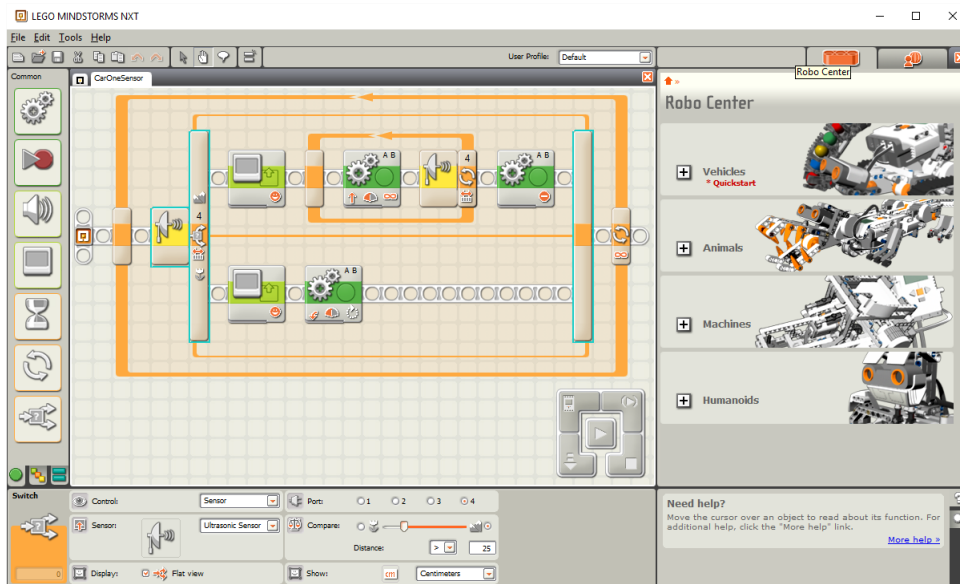
- Further computer science or mathematical problems
- ProfilingProgram.py

Project Details – Multicore

- The task in detail
 - Compare the runtime of (at least three) programs from three different domains when using 1, 2, 3, and 4 cores in each experiment
 - Explain the kind of parallelization
 - Explain the measured values
 - Can race conditions happen in the respective case?
 - Implement (at least two) synchronization mechanisms
 - They certainly can be used by your programs
 - How to test or prove the correctness?
 - Implement a simple runtime measurement and use it

Project Details – Autonomous vehicles with Lego Mindstorms

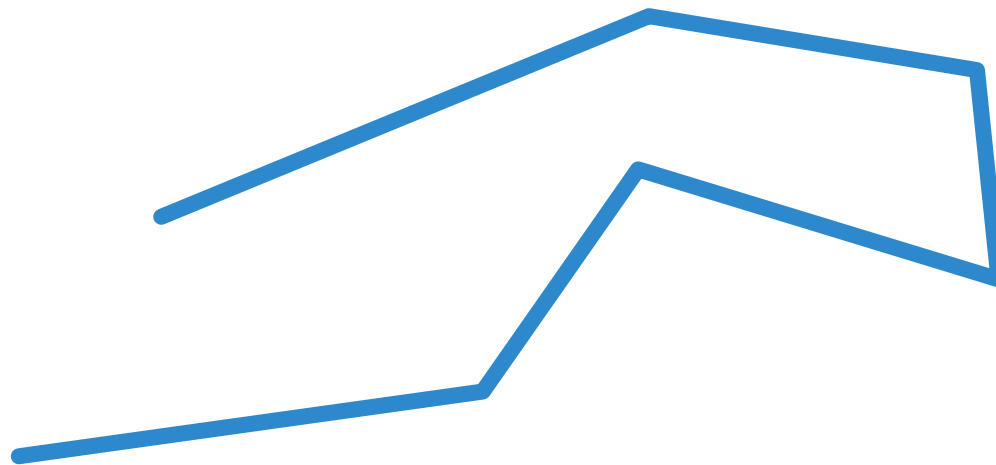
- These vehicles drive around and avoid collisions
- Programming language: LEGO NXT



Project Details – Mindstorms

Autonomous Vehicle 2

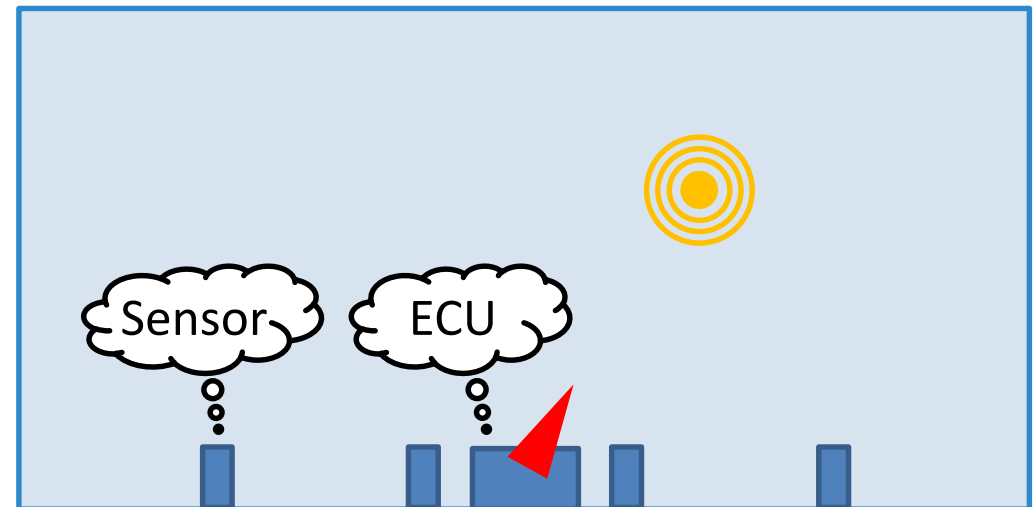
- Vehicle that follows a colored line or an illuminated line on the ground
 - Autonomous steering is required
- The vehicle shall be as fast as possible
- Sensors: Two light or RGB sensors



Project Details – Mindstorms

Sound Detection

- The system shall point into the direction with the highest volume within an area of 180 degrees
- Sensors
 - 4 Sound sensors – calibration of sensors necessary?



Project Details – Mindstorms

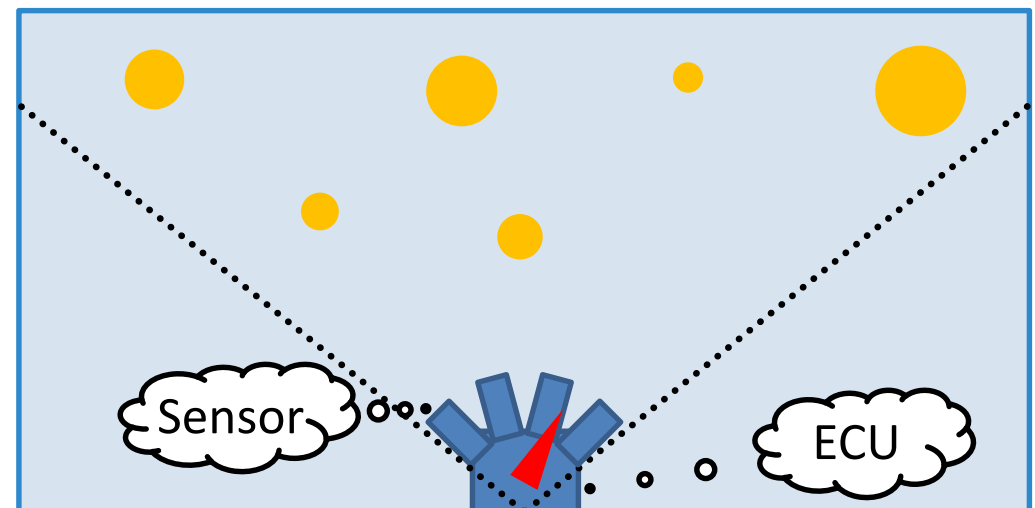
Sound Detection

- Analyze the quality of the sensors – this is necessary for the implementation
 - Detection range
 - Detection error
 - Differences of the sensors
- Think about how to test this
 - Realize the test

Project Details – Mindstorms

Obstacle Detection

- The system shall point into the direction with the largest distance to an obstacle within an area of 120 degrees
- Sensors
 - 4 ultrasonic sensors – calibration of sensors necessary?



Project Details – Mindstorms

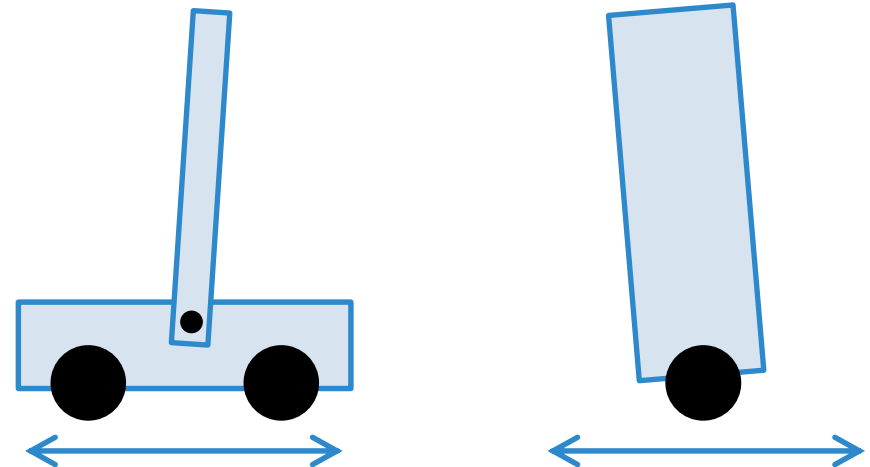
Obstacle Detection

- Analyze the quality of the sensors – this is necessary for the implementation
 - Detection range
 - Detection error
 - Differences of the sensors
- Think about how to test this
 - Realize the test

Project Details – Mindstorms

Balancing Robots

- Create some moving object balancing around one axis, e.g.
 - Sketches below (balancing by wheel rotation)
 - Let the vehicle move and stop with keeping the object in balance
 - Bike (balancing by steering)
- Hardware
 - Motor(s)
 - Gyro sensor

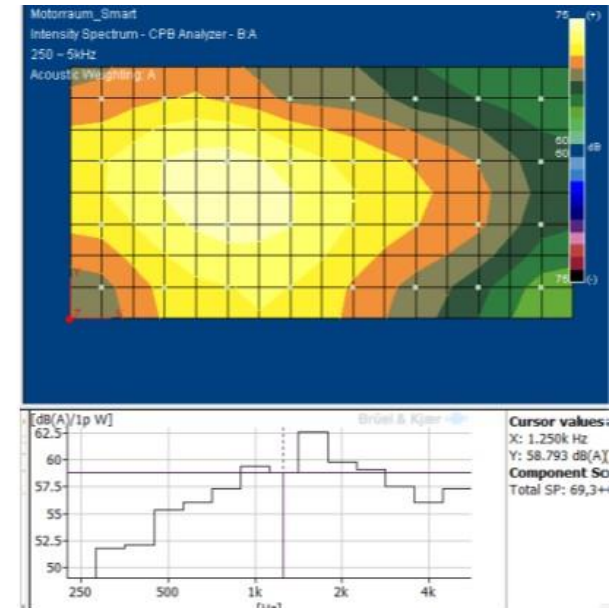
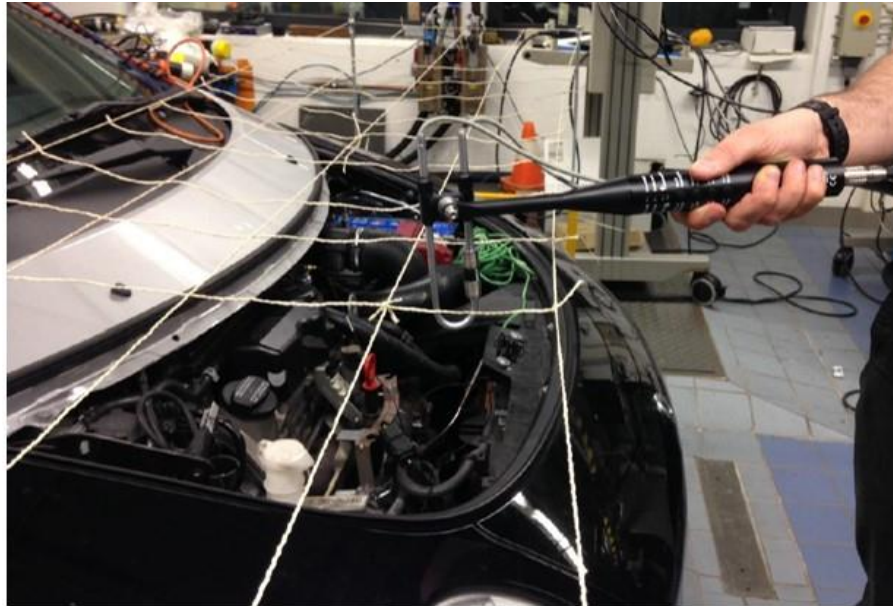


Project Details – Converter for RS-232

Real time noise analyses command transmitter

– by Alexander Pfaff

Current situation: In the laboratory for automotive engineering there is a sound intensity probe to create sound intensity maps. Once placed, the sound intensity at that point can be measured (middle image). For this purpose, a remote control is provided for facilitating the handling of the probe, whereby measurements can be started and stopped.



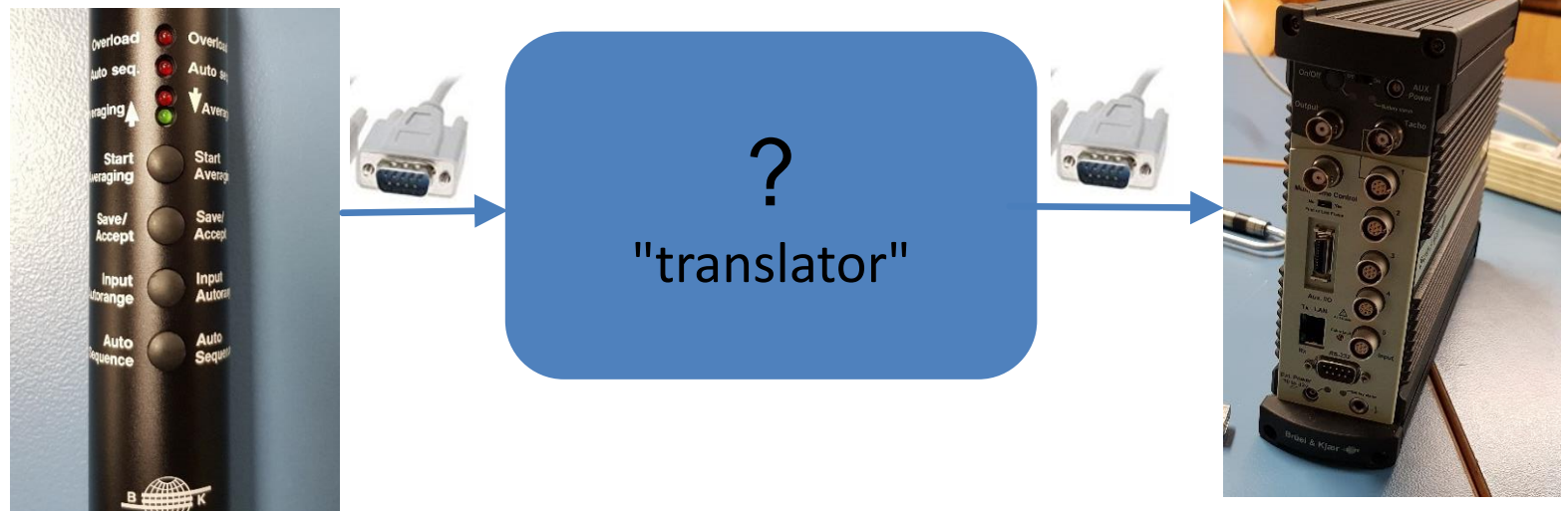
Project Details – Converter for RS-232

Real time noise analyses command transmitter

– by Alexander Pfaff

Problem: The commands of the remote control are no longer supported.

Task: Design and construction of a "translator", which enables the remote control function. The system shall finish sending the respective output-command after having detected the input-command within 15 milliseconds.



Project Details – Flight Arrival and Departure Simulator

- Write a simulation for arrivals and departures
 - Fair schedule decreasing the overall waiting time
- Parameters
 - Number of runways: 1, 2, or 3
 - Number, frequency, randomness, ... of arriving and departing planes
 - Scheduler (different algorithms?)
- Hardware: PC
 - Graphical user interface for setting the parameters
 - Graphical output

Project Details – Antilock-Braking-System Simulator

- Write a simulation for one wheel of a vehicle
 - When full braking, the brake pressure shall be as high as possible without locking of the wheel, i.e.
 - when locking is detected, then the brake pressure shall be decreased until the wheel is not locking any more
 - when no locking is detected, the brake pressure shall be increased until the wheel is locking

Project Details – Antilock-Braking-System Simulator

- The vehicle shall brake on a simulated road with changing frictional coefficient
 - Test it with different roads and measure the braking distance depending on the road
- Hardware: PC
 - Graphical user interface for setting the parameters
 - Algorithm
 - Road
 - Graphical output
 - Graph with friction data of the road, speed, and braking pressure and distances

Project Details – Other Topic?

- Perhaps you already have an idea ... ???
- The topic has to be related to real-time systems
- The topic must not be the same as other topic from preceding semesters
- The lecturer has to agree to the topic



Warning



- When working with electricity and movable parts assure the safety of all involved people, e.g.
 - Do not connect the poles of batteries (risk of fire)
 - Do not damage batteries (risk of fire)
 - Charge batteries only with the adapters you obtained (Lego) or let the lecturer load them (6 cell batteries)
 - Keep away from areas with movable parts



Warning



- When building electronic circuits and connecting them to power, parts of the circuits might get very hot, start burning, or even explode
- Stay away as far as possible from the circuits
- Approach
 - Test the circuit without high load (e.g. without motor) and current limited power (power supply, no battery)
 - Then increase the power stepwise and add the loads



Warning



- When soldering
 - take care, you work with high temperatures
 - not only the soldering iron
 - also the tin-solder and the wires and electronic parts
 - no soldering of parts that are connected to power
 - always use a wooden board, do not work on the desk
 - do not breathe in the steam

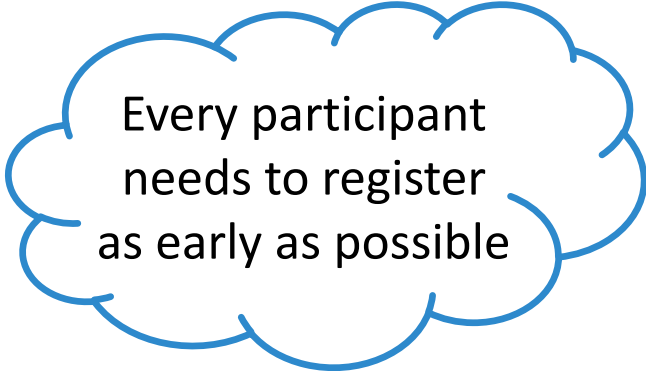
Reimbursement

- If you need some special parts for your project you can send an email to the lecturer
- After a confirmation you can buy the equipment
- The cost will only be reimbursed if
 - you handover the original bill to the university
 - the bill is addressed to Frankfurt University of Applied Sciences (the delivery address can be your home address)
 - you provide the reimbursement form and the bill in the year of purchase to the lecturer
 - if the bill is from outside the European Union it must not include value-added taxes (VAT) – just inform the shop about "USt-ID" (VAT-ID) of FRA-UAS (DE 114110370)

Work Products in Moodle

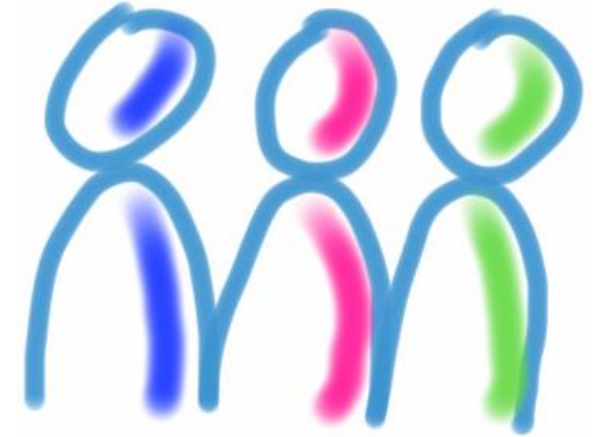


- Which ones?
 - Handouts by the lecturers
 - Deliverables by the participants
 - Language: English
- Where?
 - <https://moodle.frankfurt-university.de/>
 - Course: Advanced Real-Time Systems – Winter 2017/18
 - Access code: G4m7Ta



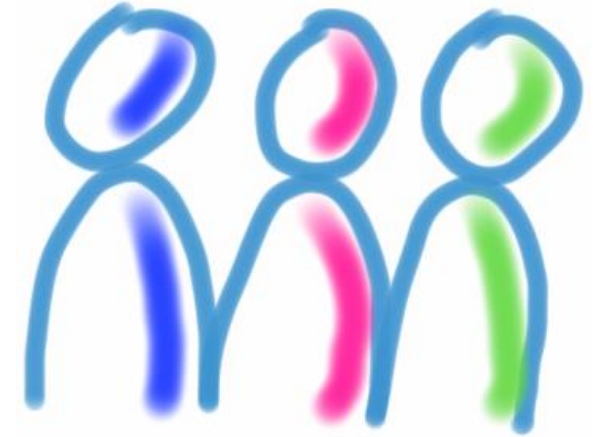
Every participant
needs to register
as early as possible

Grading

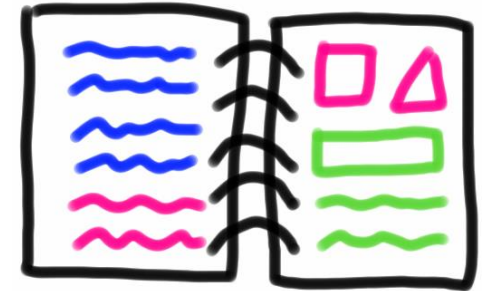


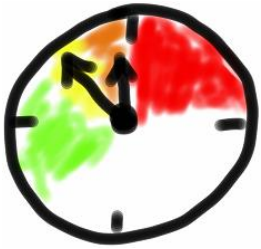
- One personal grade for every participant
- Each of the items counts as much as the others
 - Quality of written paper
 - Working project – based on the project type:
 - Running software(-system)
 - Working schedulability analysis
 - Quality of presentation

Grading

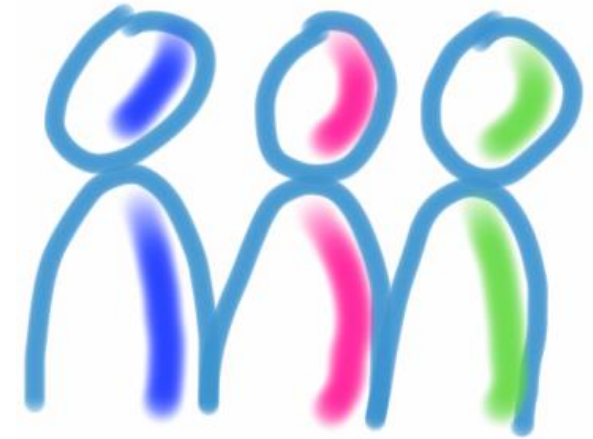


- Paper
 - Delivered by every participant
- Project
 - Delivered by the team
 - It has to be obvious who contributed to which part, e.g. add a simple file that describes who contributed to which part or mark the parts
- Presentation
 - Every participant presents one part in the team presentation



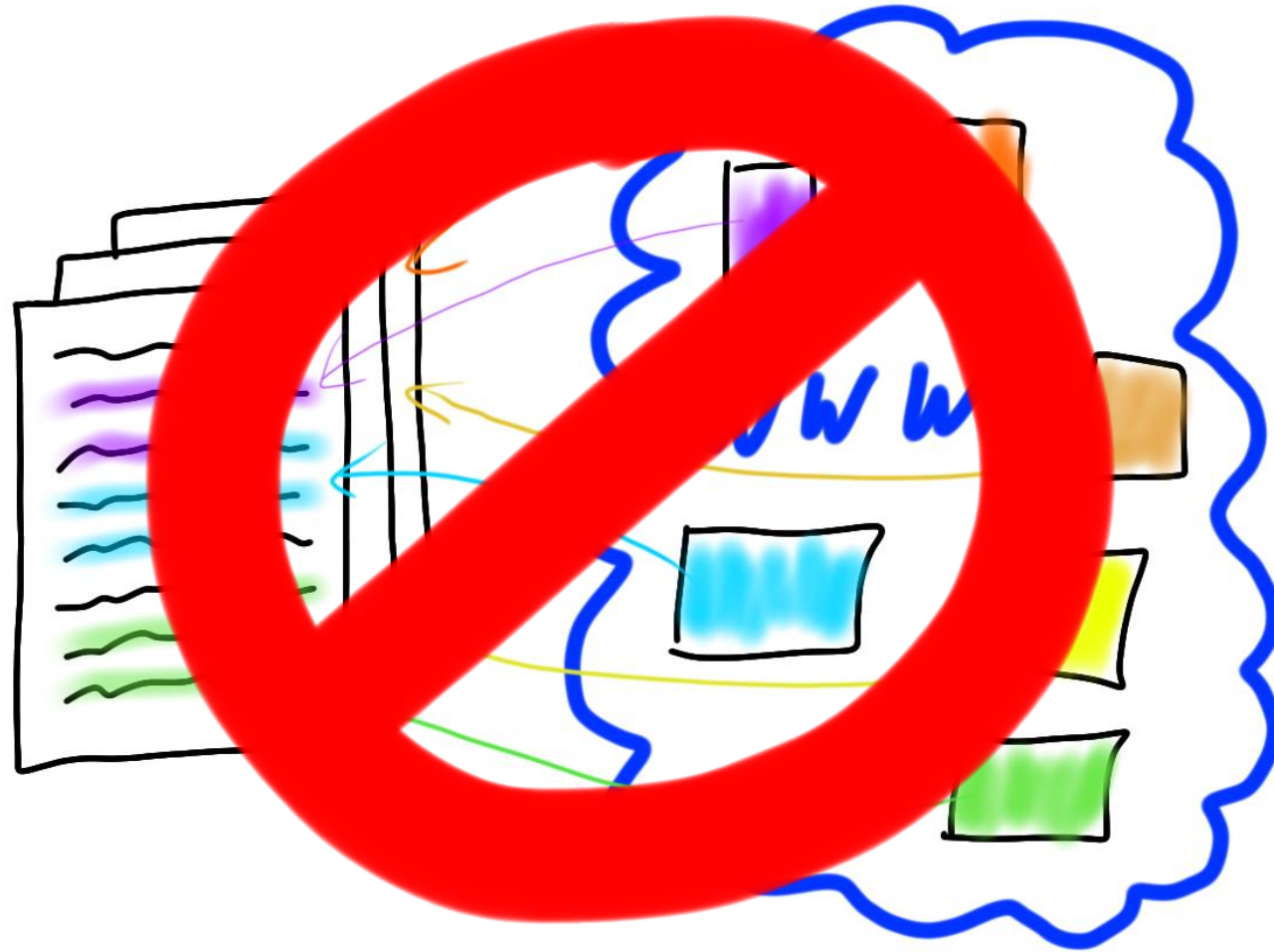


Grading



- Work products have to be delivered in time
- Language: English
- Work products have to be understandable
- Work products have to fulfill scientific standards
- Plagiarism is an attempt of deception
 - No copies of parts of relevant size from other resources (also not from other team members!)
 - Correct citations of used work products
- Deviations from these points influence the grade

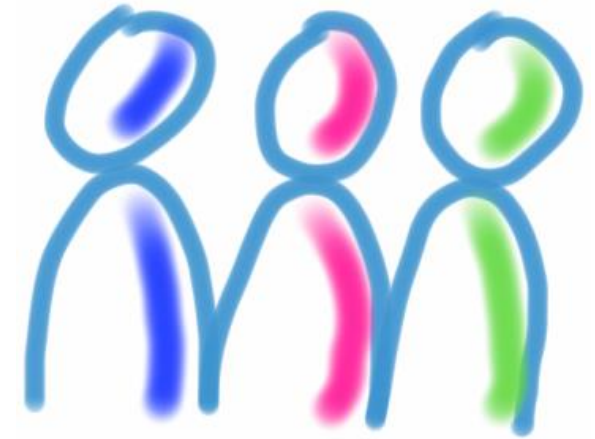
Plagiarism



NO

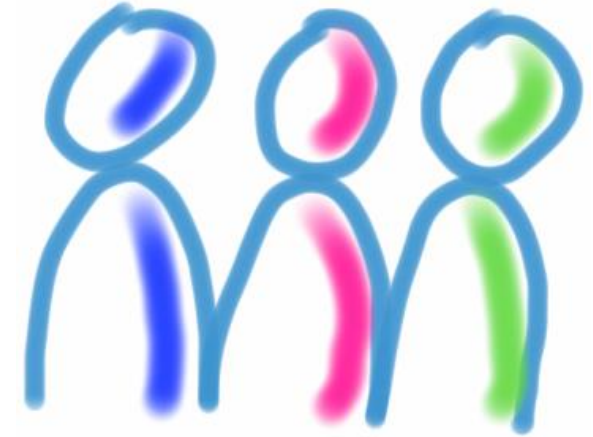
Plagiarism! ▽

Grading



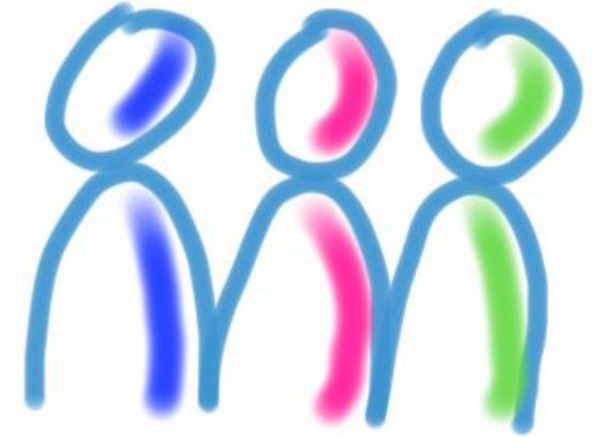
- Paper
 - Needs to include your name, matriculation number, group number and the name of the course
 - Well structured, e.g.
 - Abstract
 - Citation of necessary references
- Deviations from these points influence the grade

Grading



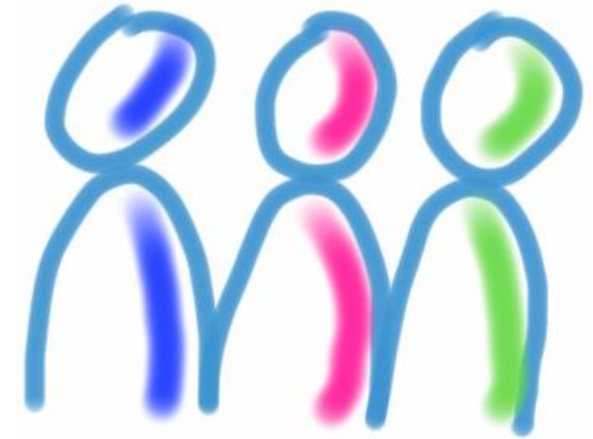
- Paper
 - Author's (not the group's) contribution to the project
 - Embed your contribution into a meaningful context, depending on the contribution, e.g.
 - Theoretical foundation
 - Software design
 - Testing
 - Visualization
 - Examples
- Deviations from these points influence the grade

Grading



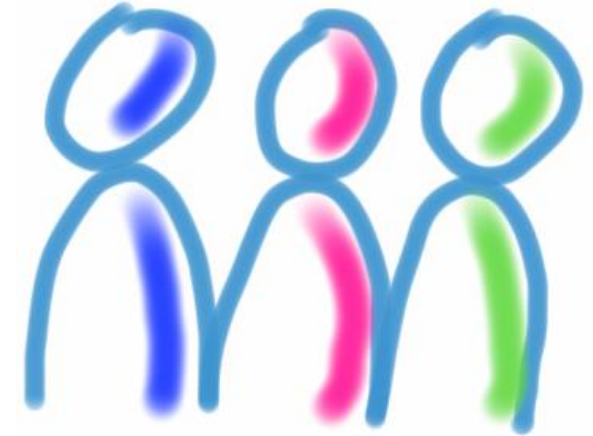
- Paper
 - Two-weekly reports to be included in the paper
 - Author's contributions to the project
 - Two-week-periods starting after the topic has been selected
 - Task for the group: Split topics for the papers such that every paper contains different aspects related to the project
- Deviations from these points influence the grade

Grading



- Paper
 - Maximum of 6 pages
 - Quality, not quantity!
 - If there are many figures and/or large tables in the paper, then up to 8 pages is acceptable
 - Font size: 12 pt
 - One or two columns
 - Format: pdf
- Deviations from these points influence the grade

Grading



- Delivered project has to fulfill its requirements
 - Implementation of the theoretical foundation in the papers
- Project presentation by the group
 - Based on the content of the papers
 - Includes practical presentation and theoretical foundation
 - Each participant: 5 to 7 minutes
 - Task for the group: Split topics for the presentation such that every person talks about different aspects related to the project
- Naming convention for deliverables to be used
- Deviations from these points influence the grade

Presence Dates and Time in Room 1-250

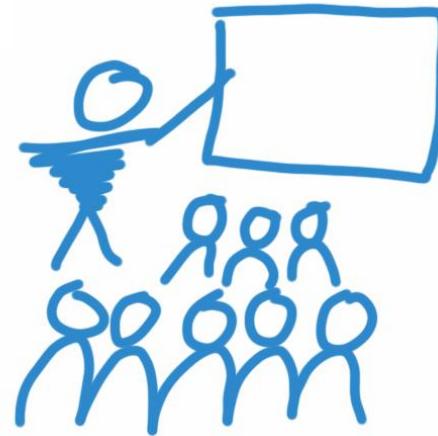
Group A

- Presence dates (Monday)
 - 23.10.2017
 - 30.10.2017
 - 06.11.2017
 - 13.11.2017
 - 20.11.2017
 - 27.11.2017
 - 04.12.2017
 - 11.12.2017
 - 18.12.2017
 - 15.01.2018
 - 22.01.2018
 - 29.01.2018
 - 05.02.2018
 - Presence time
 - 8:15 – 9:45
 - 10:00 – 11:30
 - It is possible to join the presence time of the other group, if we have enough space in the room
- Time for working on your project topic in the presence time.
- Lectures about selected topics by external guests on
- 06.11.2017
 - 13.11.2017
 - 04.12.2017
 - 11.12.2017
- Presentation of your results

Important Dates

Group A

- Selection of your topic: 13.11.2017, 8:30 (or earlier)
- Your presentation:
22.01., 29.01., or 05.02.2018
 - Date and time planning during the presence time
- Delivery dates
 - Work products of your project: 09.02.2018
 - Your paper: 09.02.2018



Presence Dates and Time in Room 1-249

Group B

- Presence dates (Tuesday)
 - 24.10.2017
 - 31.10.2017
 - 07.11.2017
 - 14.11.2017
 - 21.11.2017
 - 28.11.2017
 - 05.12.2017
 - 12.12.2017
 - 19.12.2017
 - 16.01.2018
 - 23.01.2018
 - 30.01.2018
 - 06.02.2018

Time for working on your project topic in the presence time.

Lectures about selected topics by external guests (together with group on Monday)

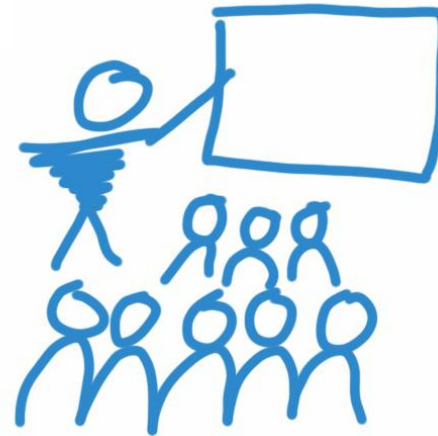
 - 06.11.2017
 - 13.11.2017
 - 04.12.2017
 - 11.12.2017

Presentation of your results
- Presence time
 - 14:15 – 15:45
 - 16:00 – 17:30
- It is possible to join the presence time of the other group, if we have enough space in the room

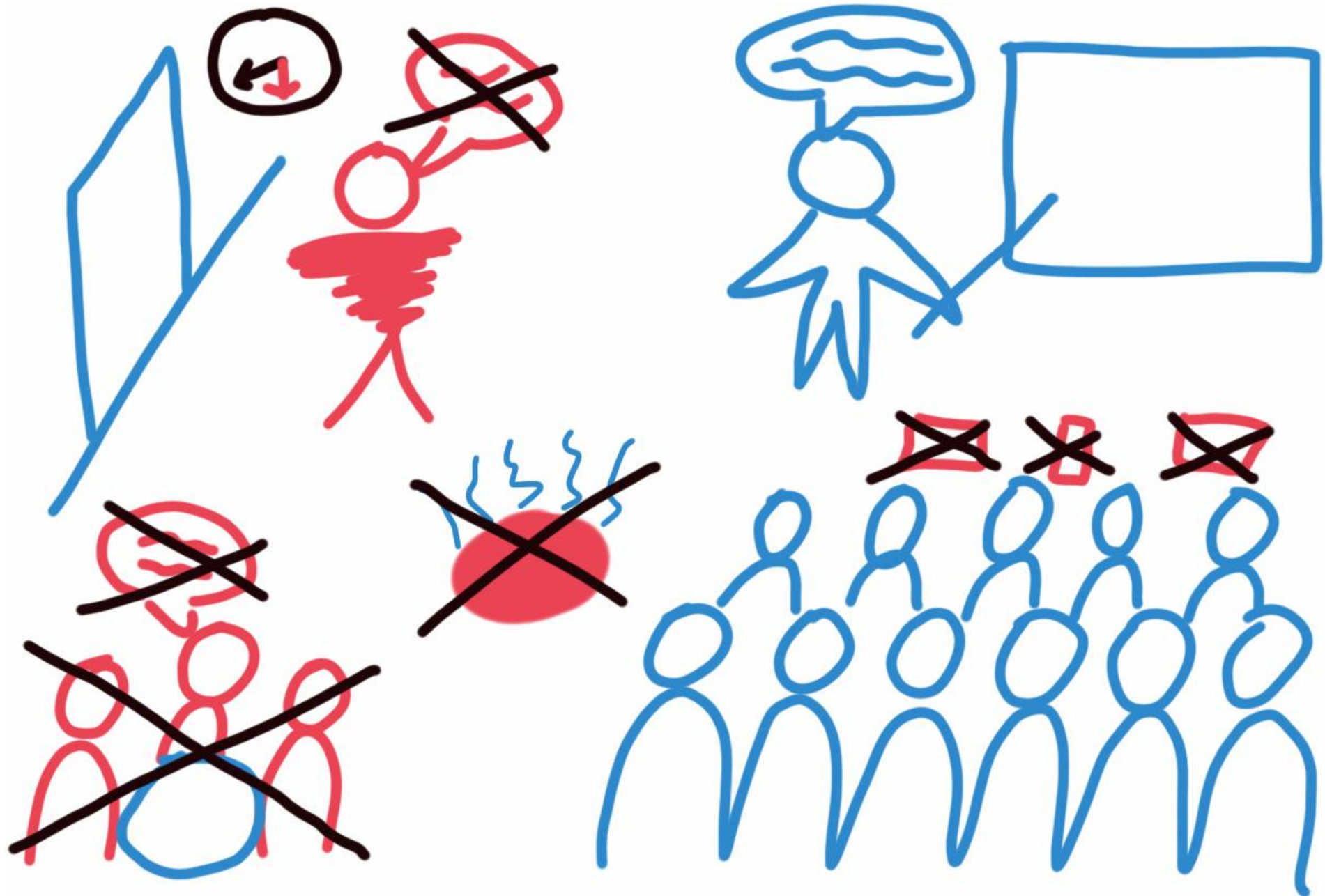
Important Dates

Group B

- Selection of your topic: 14.11.2017, 14:30 (or earlier)
- Your presentation:
23.01., 30.01., or 06.02.2018
 - Date and time planning during the presence time
- Delivery dates
 - Work products of your project: 09.02.2018
 - Your paper: 09.02.2018



Rules of the Game



Next Step: Grouping

- Form teams based on interests for the topics
 - The whole group works on one project
- Two or three people in a team
 - Not one, not four!
- Consensus of all participants
- Fill in your names etc. in the forms