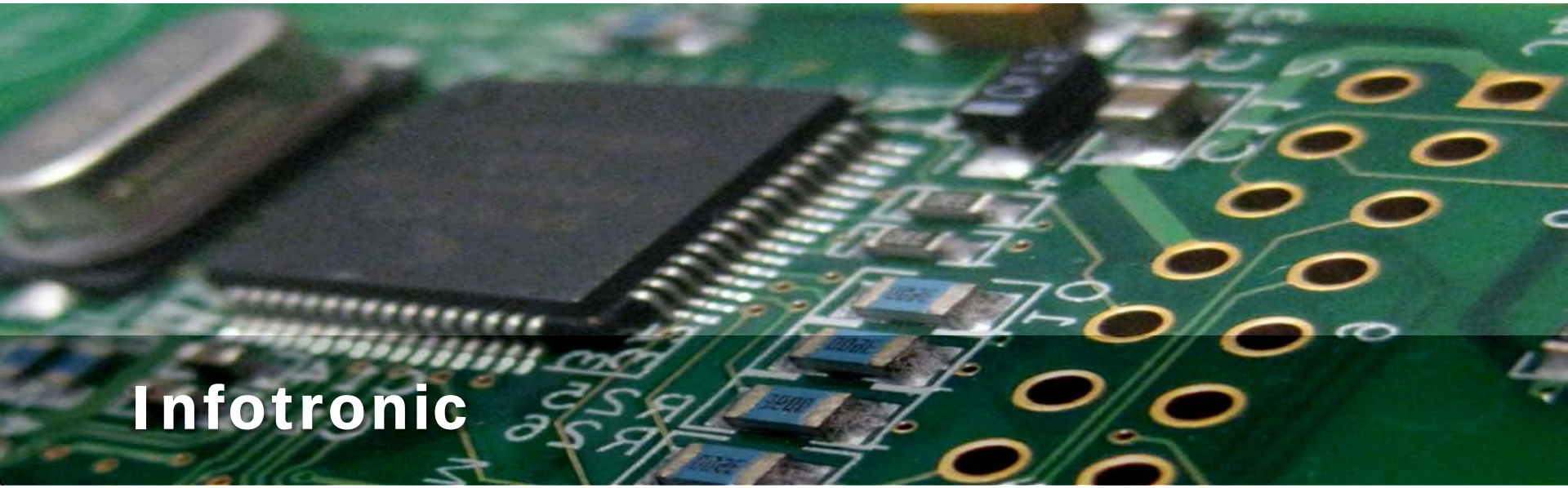
Lucerne University of
Applied Sciences and Arts
HOCHSCHULE
LUZERN
Technik & Architektur



Infotronic

“Welcome! Glad you joined us! Let's build something for fun!”

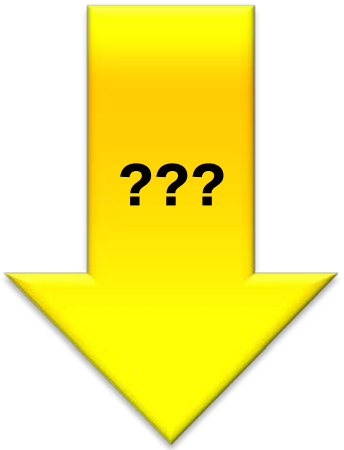
Prof. Erich Styger
erich.styger@hslu.ch
+41 41 349 33 01

Scriptum: Requirements

Learning Goals

- Your Goal?: You want to earn 6 ECTC credits

- Course overview and philosophy
- Exam admission (Testat)
- Exam rules
- Hardware/Kits
- Tips and Tricks

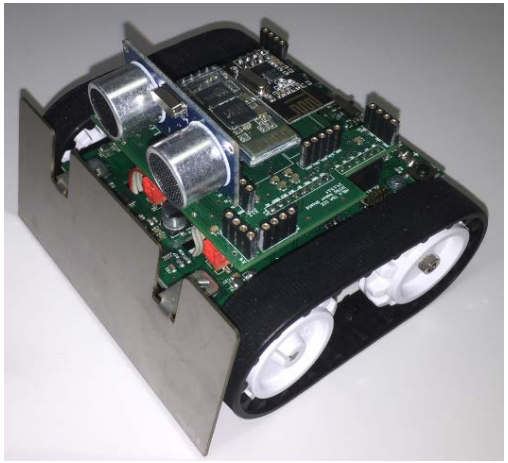


Course Outcome

- Successfully demonstrating the ability to build an embedded real-time cross-platform application

- Usage of hardware/software, multiple sensors and actuators to control multiple real-time embedded systems

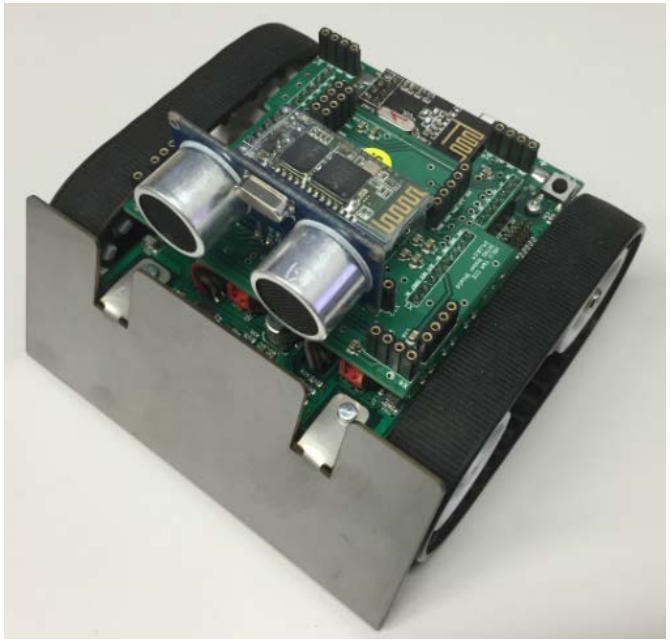
- Software creation with tools and middleware, in a multi-user collaborative environment



Stick

Application Goals

- DC Motor closed loop control + Wireless Controller
- Remote Controller for Robot
- Robot is able to perform autonomous tasks



MEP / Examination

- 4 hours total, in writing (1h+3h), English
  - 1h: no supporting material allowed
    - Simple pocket calculator allowed
  - 3h: up to 16 A4 pages written summary
    - Summary does not have to be in handwriting
    - Pocket calculator allowed
- Multiple Choice questions
- Evaluation questions (+/-)
- Programming Quizzes
- Discussion (Pros/Cons) questions
- Bonus Points and Lab Points

- MEP example(s) provided during the course
- See script/lab assignments for questions, …

Exam Admission (Attestation)

1. 'Recap' of Previous Week

- ~5-10" short presentation/session
- What have you learned a week ago?
  - Or: your own subject related to course
- 5 Quiz Questions (in writing!) with solutions (no need to go through them during recap)
- Register for your time slot in advance

Bonus: Good recap questions will be in MEP ☺

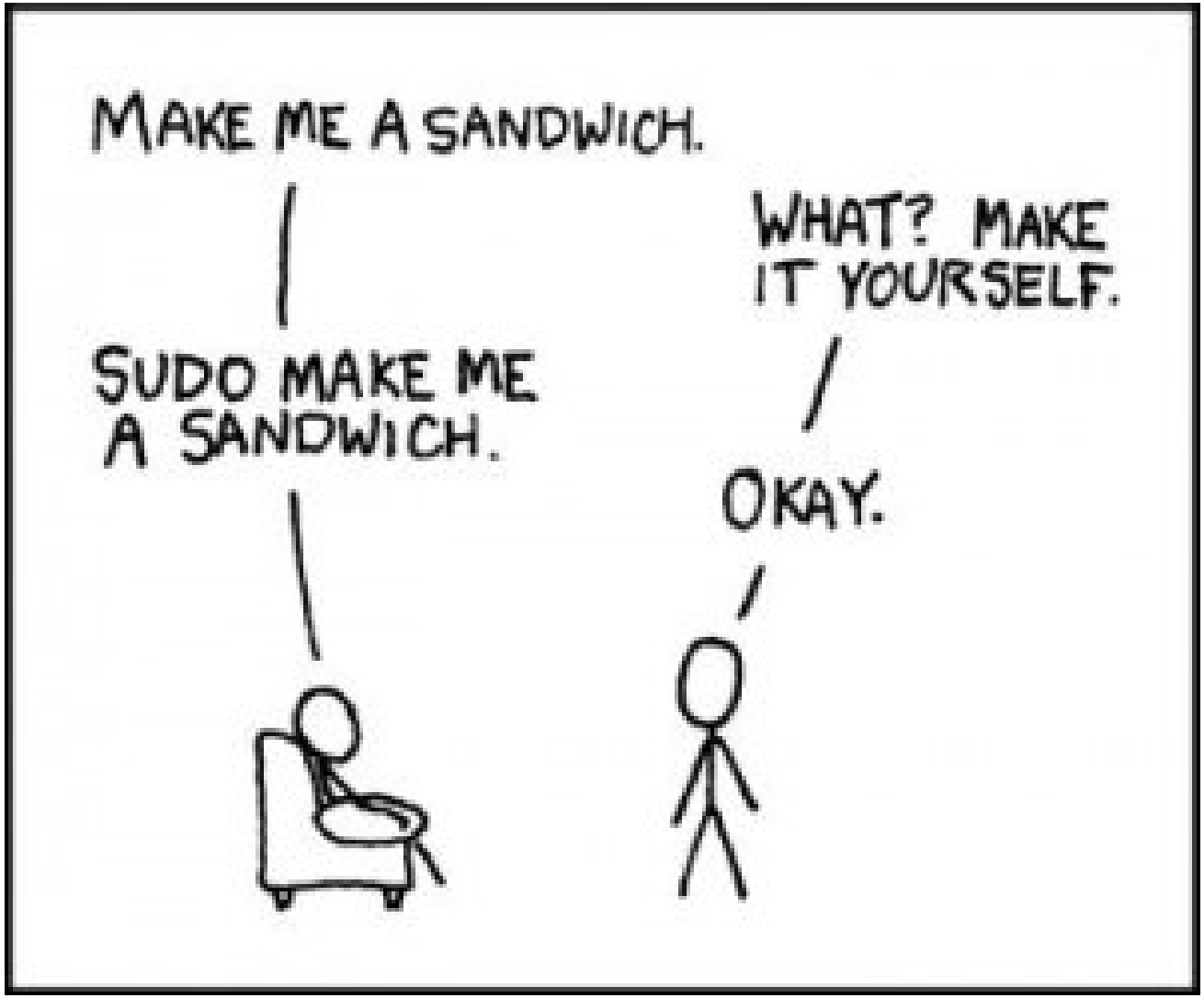
2. Tips for next students (until SW13)

- What to do, not to do (see example), in English

3. Maze (until SW13)

- Demonstration of Sumo requirements fulfilled
- Successfully running Sumo Robot in Competition

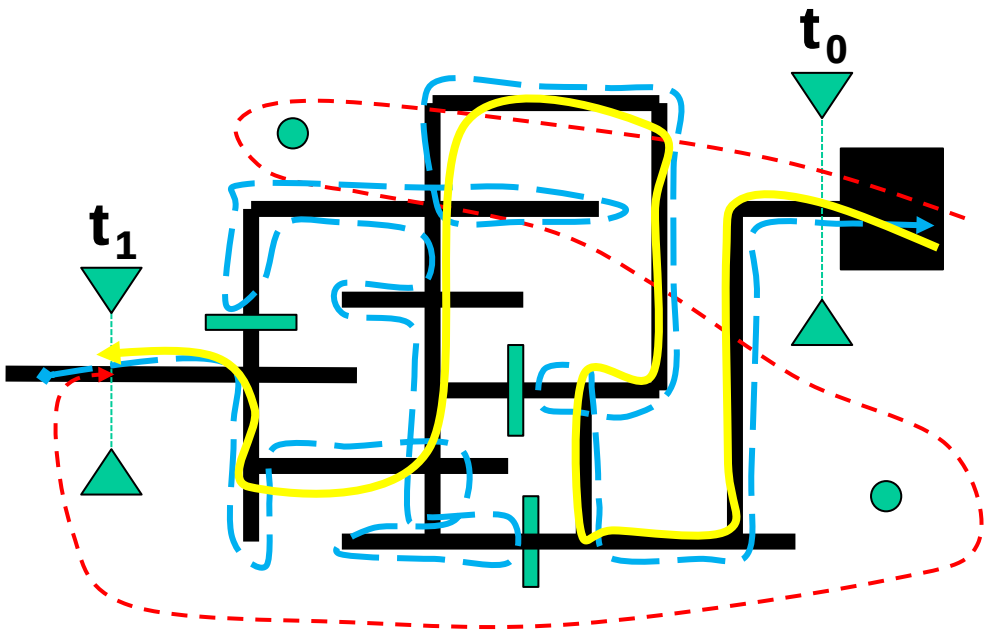
Sudo!



Source: https://kings2027.files.wordpress.com/2014/09/sudo-make-me-a-sandwich-300x249.jpg

Lab Points (Max 30)

- Course: manual, 5 Points + time ranking (max 10 Points)
- Maze exploration: autonomous robot, 5 Points
- Maze solving: Time ranking (max 10 Points)
- Penalty time for hitting walls/pillars

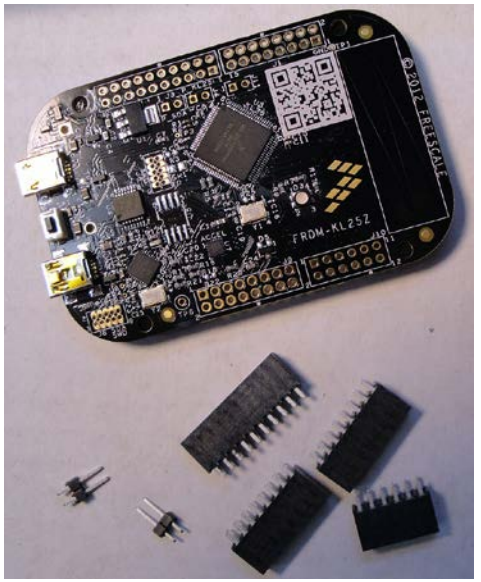


K22 Zumo Robot

- ARM Cortex-M4F
- 120 MHz
- 512 Kbyte of FLASH
- 64 Kbyte of RAM
- USB (Device)
- I^2C Accelerometer + Magnetometer
- 2 LEDs
- Buzzer
- Reset + user button
- 1:75 DC Motors
- Quadrature Encoder
- IR Line Sensor
- Arduino Headers

FRDM-KL25Z Board and Shield

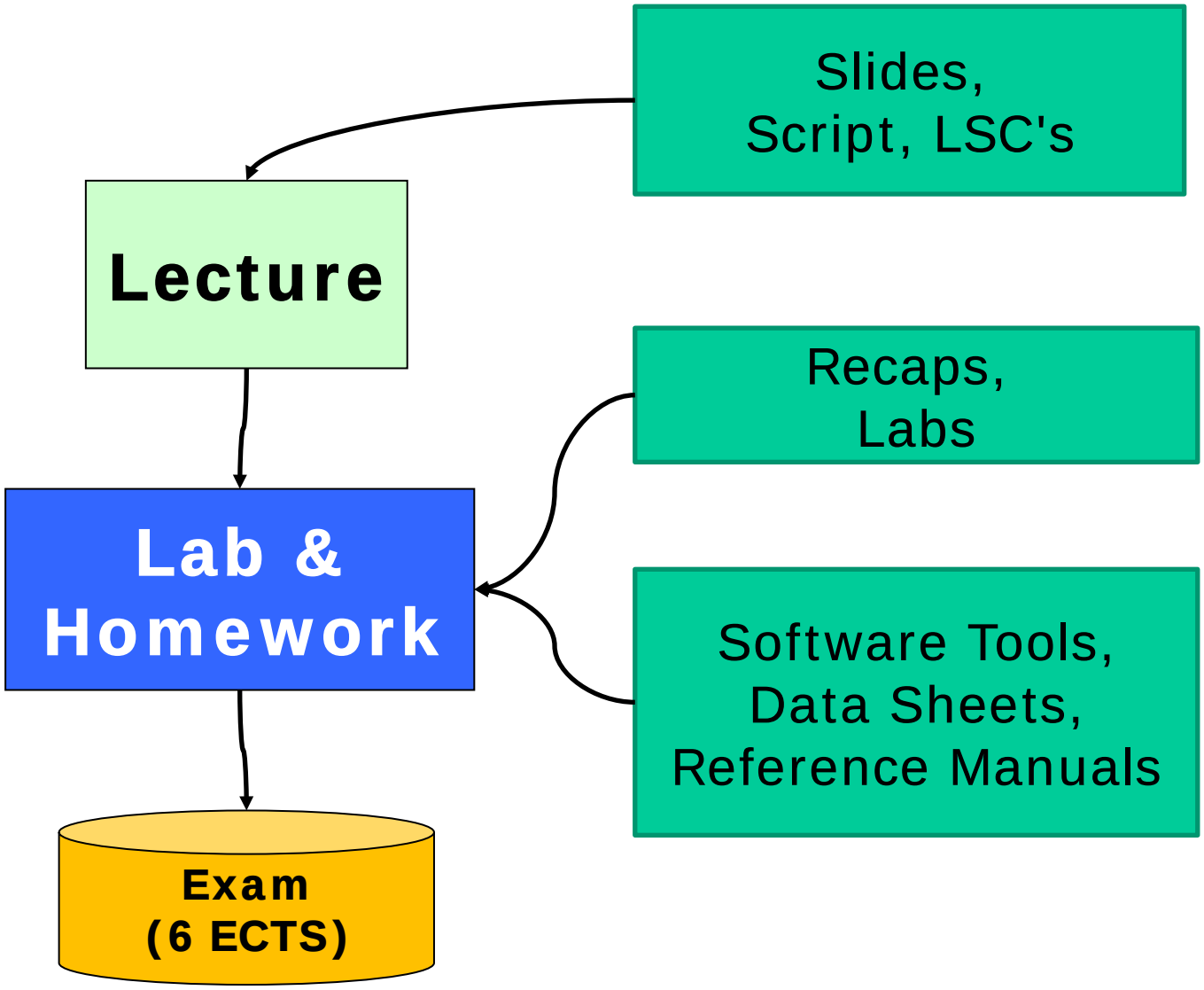
- ARM Cortex-M0+
- 48 MHz
- 128 Kbyte of FLASH
- 16 Kbyte of RAM
- Debug Interface (USB)
- OpenSDA (K20) USB CDC
- KL25Z USB (device)
- Accelerometer (I^2C)
- RGB LED
- Reset /user button
- Capacitive touch slider
- Joystick Shield
  - 4 XY Buttons, Analog Joystick with Button, 2 User buttons
  - nRF and LCD Connector



Software and Hardware Challenges

- Cross-Platform:
  - Multiple microcontrollers
  - BitIO, LED, push button, MEMS, LCD, DC Motor, Encoder, Sensor, ...
  - Same/shared source base
- Development Tools
  - Eclipse + VCS
  - Low Level Driver Code Generator (Processor Expert)
- Design Patterns
  - Events, Triggers, Queues, FSM's
  - Reentrancy, Priorities, Realtime
  - Closed Loop Control
- Middleware
  - USB, RTOS, Trace, PEx Components

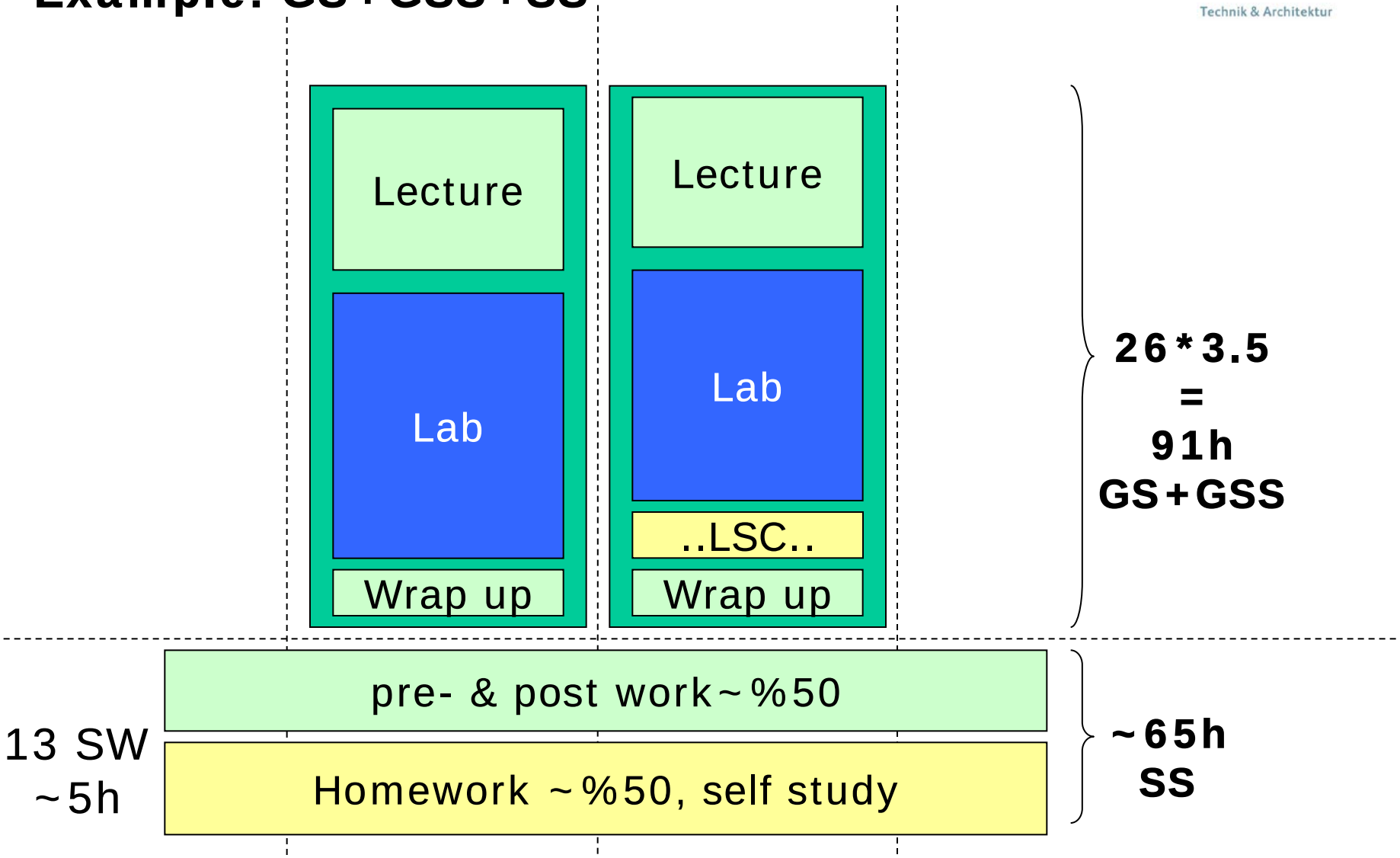
Lecture & Lab Organization



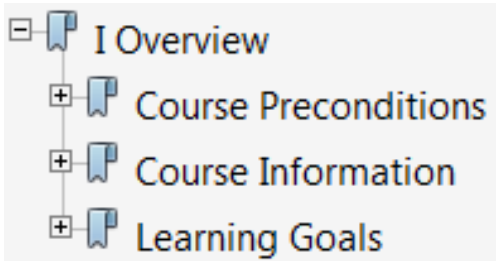
Course Philosophy

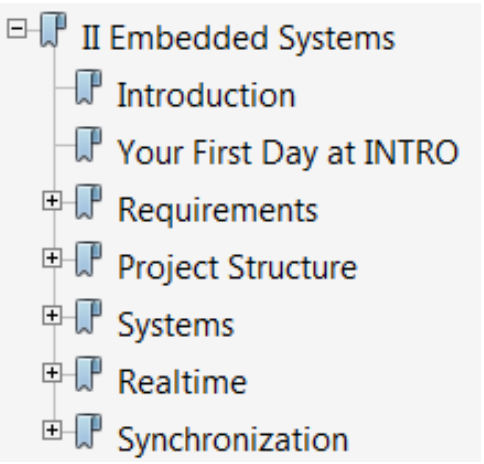
- We learn by doing
- We learn from each other
- Students
  - Working in groups of 2
  - Projects can be shared, not copied (!)
  - Copyright/IP/work is respected
- Instructor
  - Shares most parts (!!) of his project
  - Publishes material in advance
- Material
  - ILIAS (first week only): script, software)
  - GitHub: components, projects, sources, documents,
  - Blog articles
  - ...

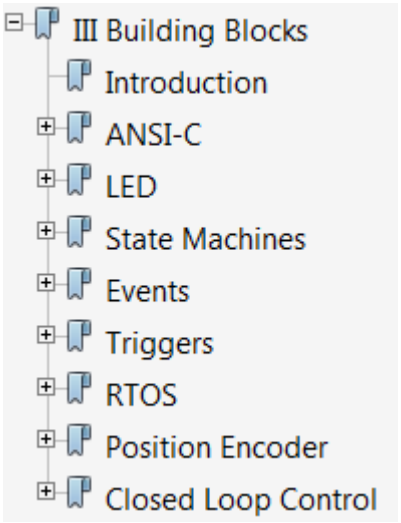
Example: GS+GSS+SS

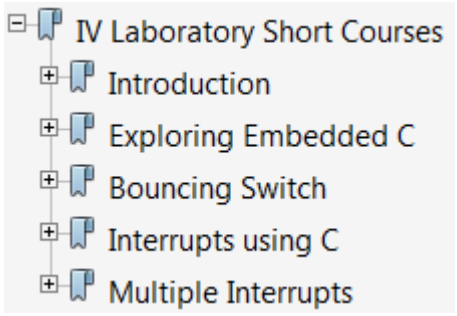


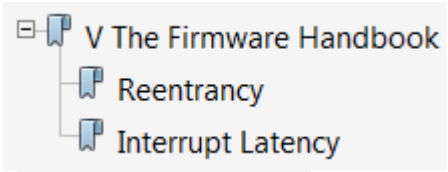
Script

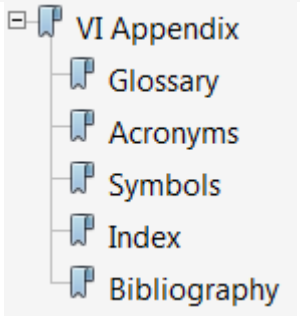












Version with 'Solutions' available

Schedule

Week		Topic (SUBJECT of CHANGE!)
1	17.09.2015	Intro
		Build & Debug
	18.09.2015	Project Structure
		VCS, Git
2	24.09.2015	Systems and Realtime
		Processor Expert
	25.09.2015	Robo Assembly
		LED, Preprocessor
3	01.10.2015	Synchronization
		Interrupts, FRDM Debug Probe
	St. Leodegar	
4	08.10.2015	ARM Cortex
		Events
	09.10.2015	Clock & Timer
		Keys, Statemachines
5	15.10.2015	Console, Shell
		Trigger, Buzzer
	16.10.2015	**Self-Study**
		Self-Study
6	22.10.2015	Debounce
		RTOS
	23.10.2015	FreeRTOS
		Task & Scheduler
7	29.10.2015	Kernel Awareness
		Shell & USB
	30.10.2015	Mutual Access
		Mem & Queues
8	05.11.2015	Sem & Mutex
		Reflectance
	06.11.2015	Motor Signals
		NVM Config
9	12.11.2015	Position Encoder
		Quadrature Encoder
	13.11.2015	Tacho
10	19.11.2015	Closed Loop Control
		Line Following
	20.11.2015	Radio
11	26.11.2015	Remote Control
	27.11.2015	Ultrasonic Sensor
		Turning
12	03.12.2015	Maze Solving
	04.12.2015	Maze Solving
13	10.12.2015	Working on Bots
	11.12.2015	*Competition*
14	17.12.2015	Q&A, MEP
		Wrap-up
	18.12.2015	Q&A
		Lab material return

(subject of change)

Lab Material: FRDM-Kit

- 1 Kit/Box per Group
  - 2 FRDM-KL25Z Boards
    - Might need to populate headers for shield
    - Headers from E workshop
  - 2 Mini-USB Cables
  - 1 Joystick Shield
  - 1 nRF24L01+ Wireless Transceiver Module

2nd FRDM-KL25Z Board used for 2nd Team Member during first half of the Course

Lab Material: Robot Kit

- 1 Kit/Box per group
  - 1 P&E ML + USB Cable
  - 1 Mini USB Cable
  - 1 Ultrasonic Module
  - 1 nRF24L01+ Module
  - 1 NiMH Charger with Power Supply
  - 4 NiMH AA Batteries

Options

- Use Lab/provided hardware
  - Standard robot and parts
  - Return material at end of course
  - Only reversible changes allowed!
  - 6 Pre-Built Robots available

- Build your own custom system!
  - Build/Buy what you want/need
  - It's yours!

- Support
  - Instructor assisted (orders, …)
  - ‘Trial’ hardware available

Robo Kit (CHF 90.--)

- K22 PCB
- Chassis Kit
- Optical Encoders
- Motors
- Headers
- Blade
- Reflectance Sensor
- Reflectance Sensor Headers
- USB Cable

Robo Sensor & Connectivity Kit (CHF 25.--)

- Sensor Shield with I^2C I/O Expander
- nRF24L01+
- Ultrasonic Sensor
- Bluetooth Module with cable
- *Option: additional Pololu 38 kHz IR Sensors* →

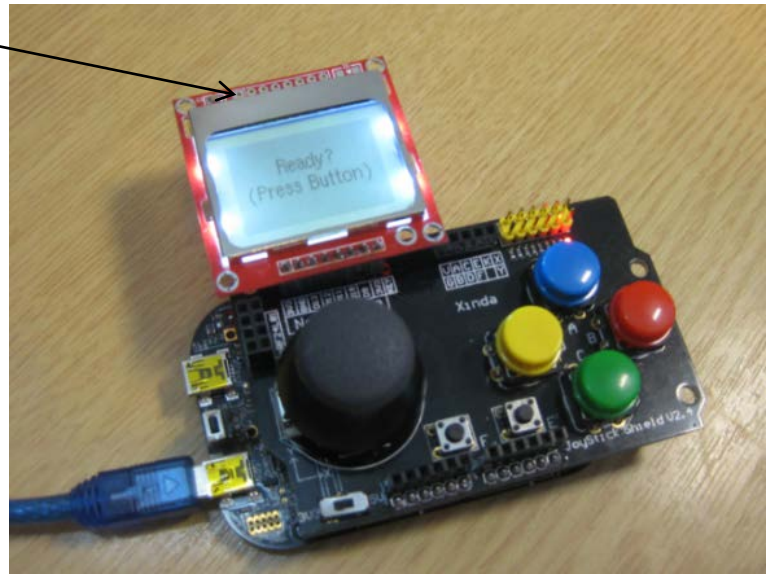
FRDM Kit (CHF 20.--)

- For programming Robot
- FRDM-KL25Z Board
- SWD Cable
- SWD Header
- USB Cable

Joystick Kit (CHF 25.--), LCD (CHF 5.--)

- Joystick Shield
- nRF24L01+ Transceiver

- Option:
  - Nokia Display
  - 84x48, B/W
  - CHF 5.--



Preorder form

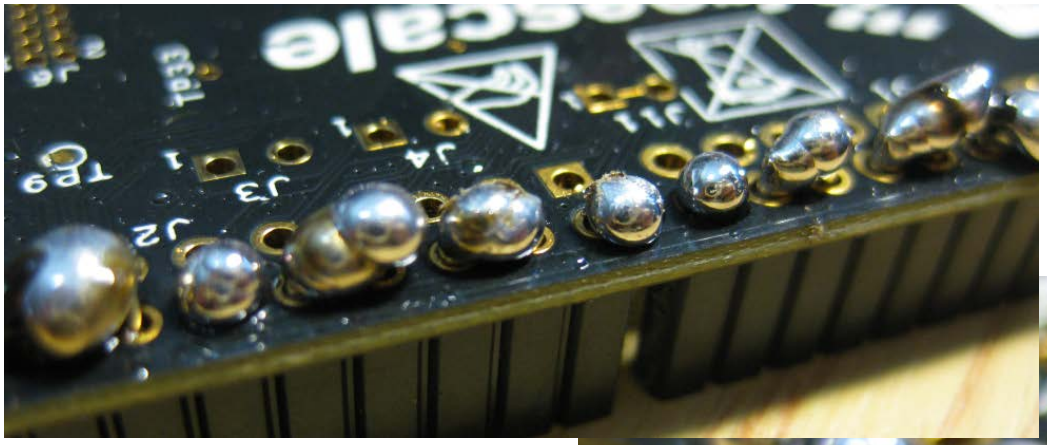
Tips and Rules

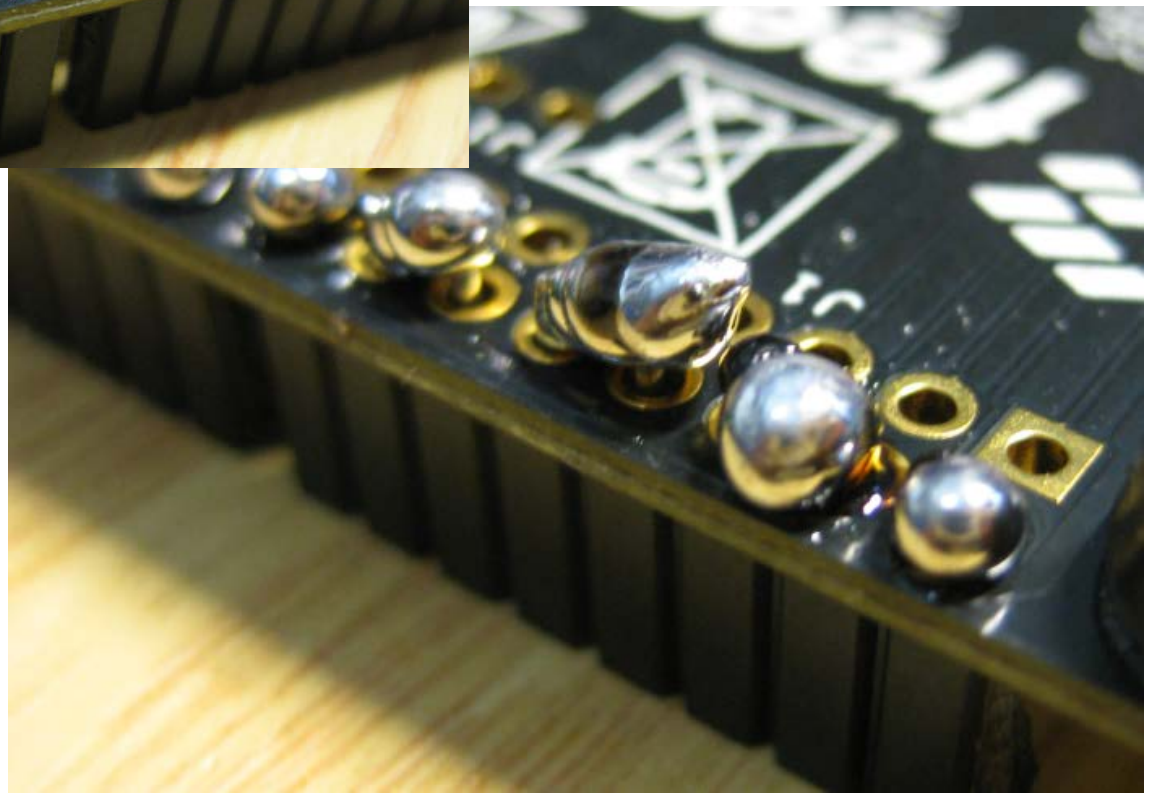
- Maintain your project
- Make backups / use VCS
- Only do small steps
- Maintain a lab journal (discussions, white boarding)
- **Not** everything is provided! (script, slides,…)
- Understand the lab code
- **Tips from previous INTRO!**
  - ➔ Exam admission element

- Classroom / Lab Rules
  - Do not disturb
  - Taking out hardware/boards
  - Breaks

Tips from previous students

Get HELP to avoid THIS!

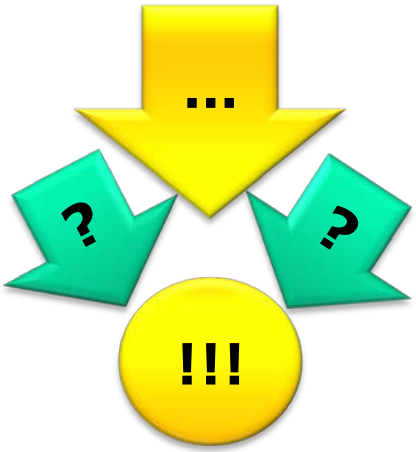




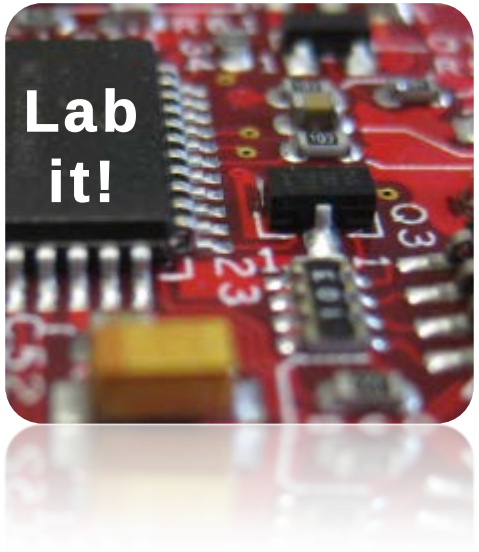
Summary

- Plan enough for self study
- Prepare things in advance
- Learn as you go
- Catch up!
- Ask if something is not clear!
- Maintain your project
- Read and follow tips from previous students

(I'm learning too ☺)



Lab 1: Start (15")



- Build Teams
- Fill out Team form
- Get Team Hardware
  - 2 FRDM boards
  - 2 Mini-USB cables
  - 1 P&E Multilink
- Fill out Preorder form
- Mem Stick
  - KDS Windows (32bit/64bit): 7, (8), 10 (???)
  - KDS Linux (Ubuntu, RHE, Centos), RPM/DEB
  - Mac OS X
  - Software/Datasheets

Lab #1

INTRO TEAM

Recap Schedule

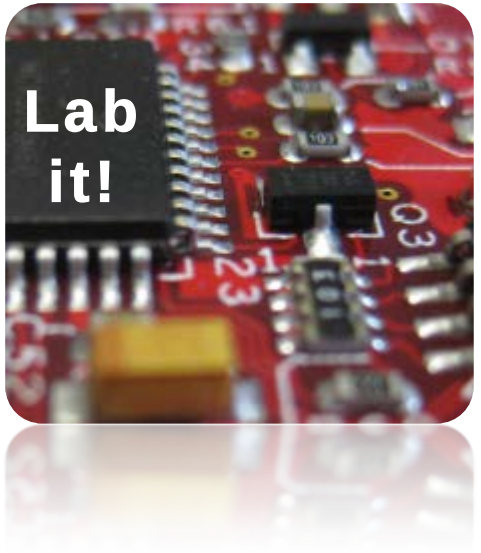
- Team of two
- Register for slot one week after lecture
- Material to cover from one week BEFORE
- Schedule your slot WHEN deliver

Week		Topic (SUBJECT of CHANGE!)	Recap schedule (Material from week before)	Recap
1	17.09.2015	Intro Build & Debug	[NO RECAP]	
	18.09.2015	Project Structure VCS, Git	[NO RECAP]	
2	24.09.2015	Systems and Realtime Processor Expert	17.9	
	25.09.2015	Robo Assembly LED, Preprocessor	17.9	
3	01.10.2015	Synchronization Interrupts, FRDM Debug Probe		
	St. Leodegar		[NO RECAP]	
4	08.10.2015	ARM Cortex Events	1.10	
	09.10.2015	Clock & Timer Keys, Statemachines	???	

Recap Schedule

Lab 2: Recap Instructions (10")

- Register for Recap Slot
  - Paper form (for now)
  - Update on GitHub (later)
- Read Tips from previous students

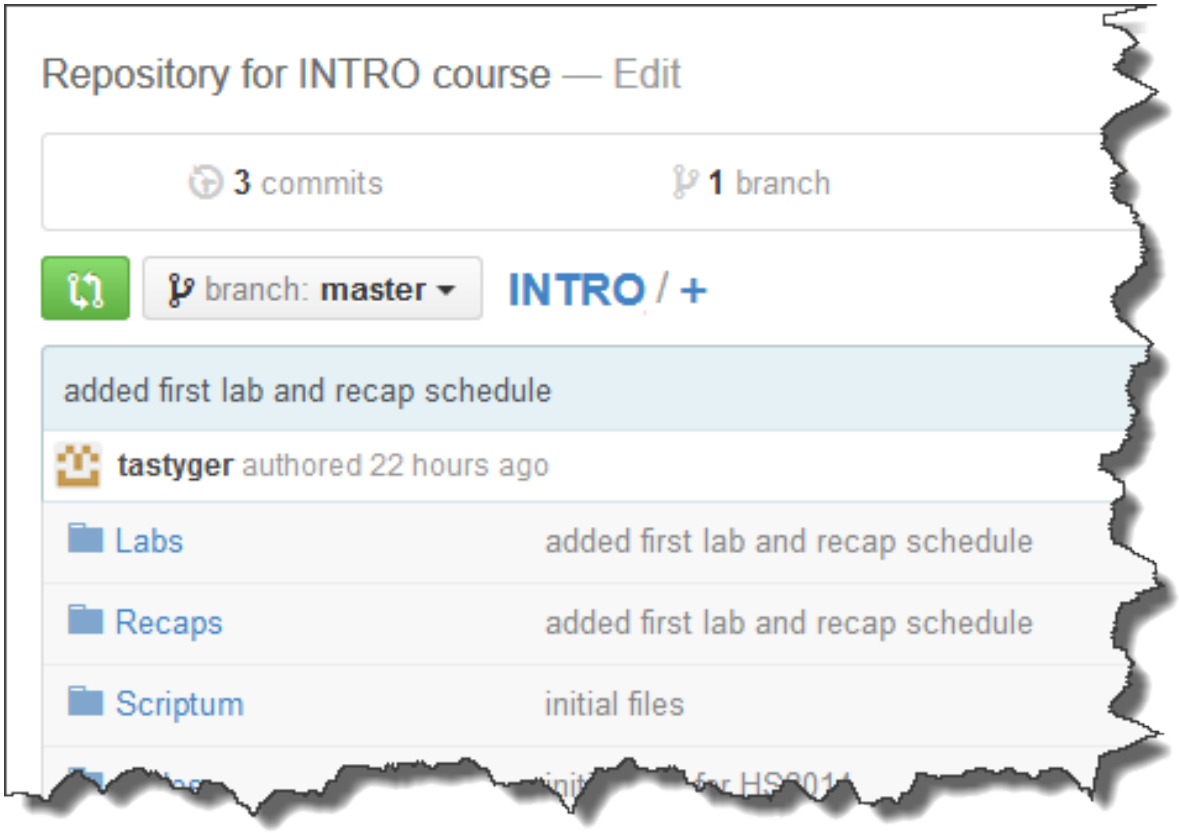


Lab #2

Tips

Lecture Material on GitHub

- All lecture material shared on GitHub
  - Private Repository, need to be added as user for access
  - You will need a (free) GitHub account



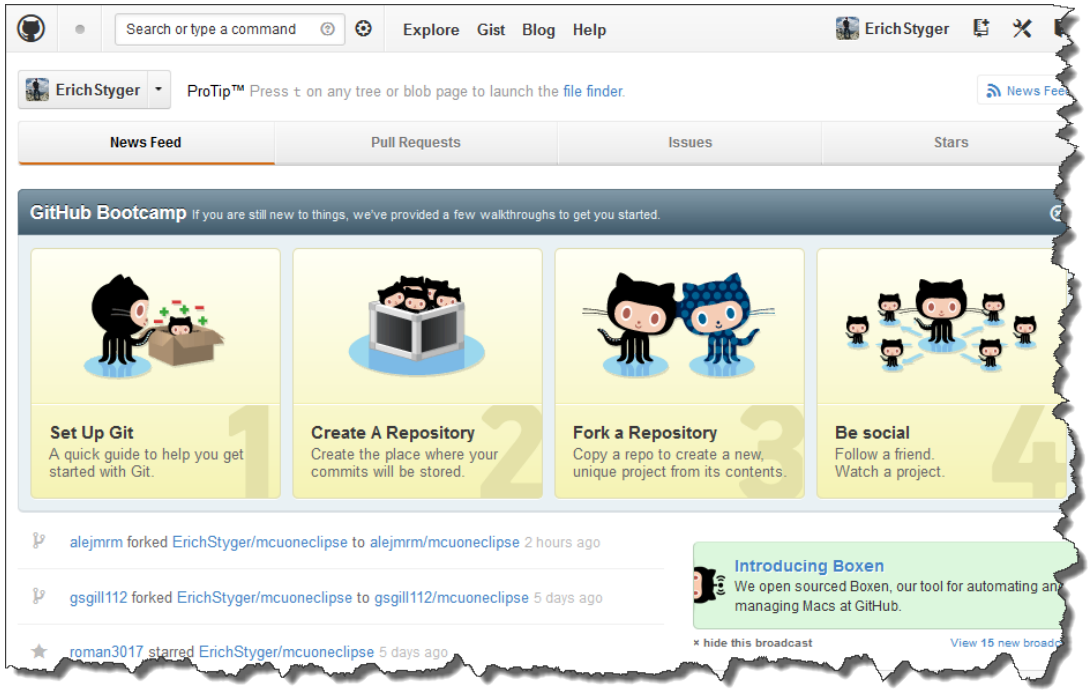
Git Provider

- Bitbucket
  - bitbucket.org

- GitHub
  - github.com

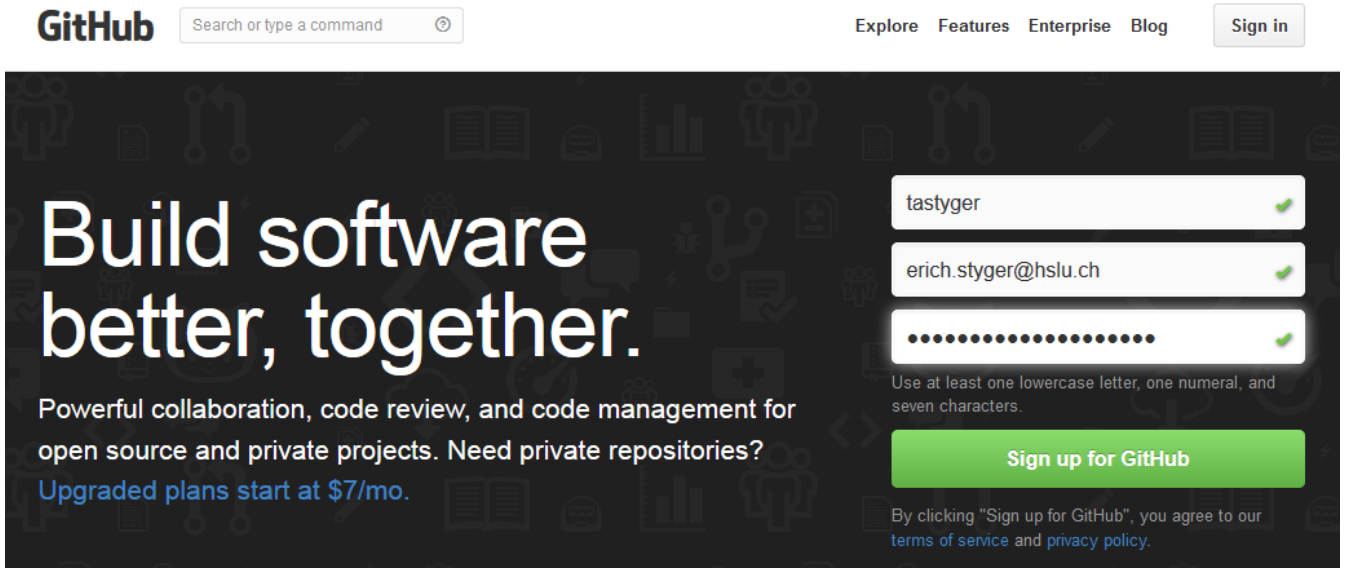
GitHub (https://github.com/)

- Open Source Collaboration Platform
- Free for ‚public' projects
- Wiki, Bug Tracking, Statistics, ...
- Example: https://github.com/ErichStyger/mcuoneclipse



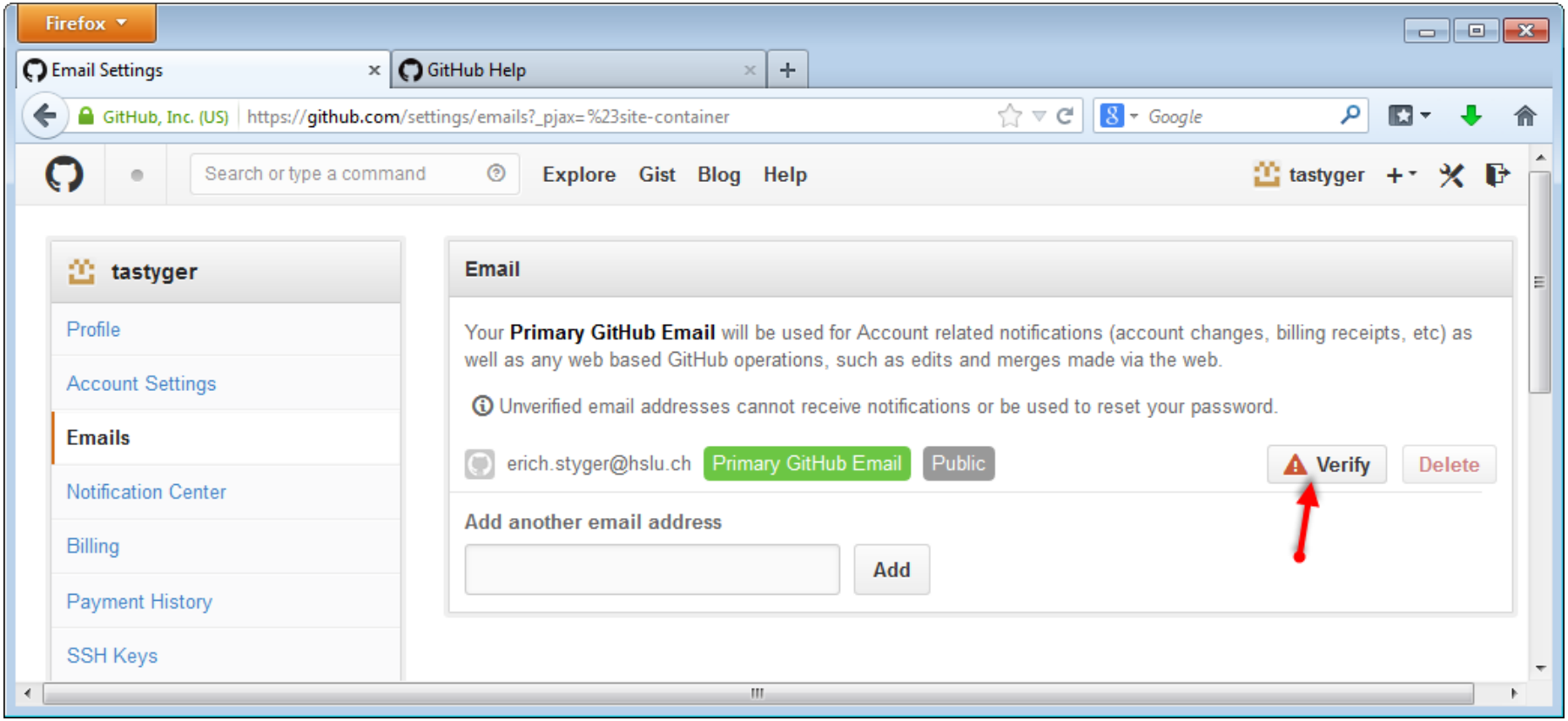
Creating GitHub Account

- Create new GitHub Account if you do not have one
- https://github.com/
- Provide user name, email address and password
- Use 'Free' plan and 'Finish sign up'
- Send your GitHub User Name to erich.styger@hslu.ch



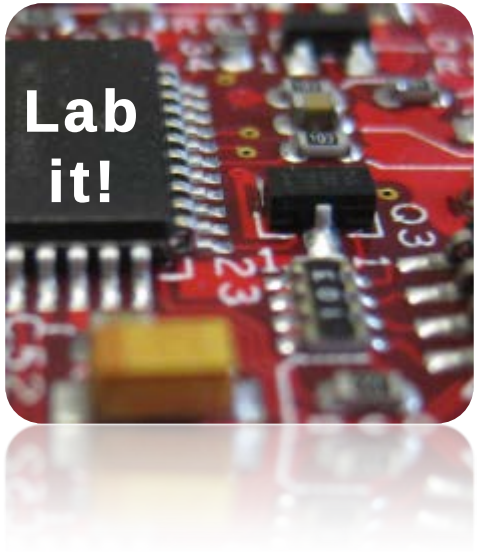
Email Verification

- Verify your email account
- Click on link in received email



Lab 3: GitHub (10")

- Create your GitHub Account
- Send GitHub User name to Erich Styger
- Verify Login/Account
- Browse INTRO GitHub repository content



Lab #3