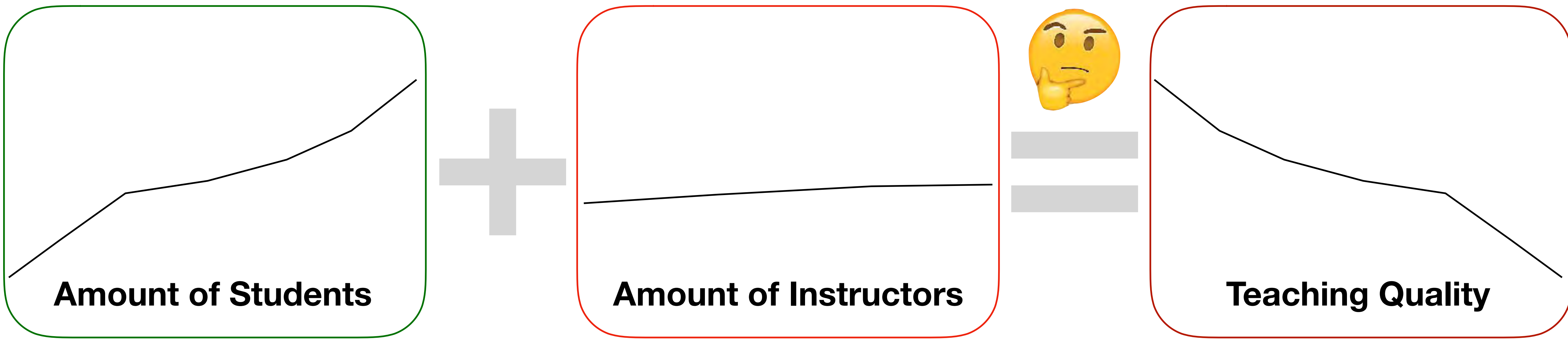


A large bronze statue of a man in a suit, looking through oversized binoculars. The statue is the central focus, set against a background of a modern city square with a curved building and a harbor. The scene is captured during sunset or sunrise, with a warm, golden light. The text 'The iLab Experience - Making Teaching Better, at Scale' is overlaid in large white letters across the middle of the image.

The iLab Experience - Making Teaching Better, at Scale

Marc-Oliver Pahl
pahl@tum.de
Jacobs University Bremen
2018-04-09

University Teaching in Germany



Marc-Oliver Pahl

<https://s2labs.org/>

- Studied Informatics with emphasis on **Computer Graphics and Media Science** in **Tübingen**.
- Holds a **PhD** from **Technical University in Munich (TUM, 2014)**.
- Currently works on his **Habilitation** at **TUM**.
- **Director Digital Teaching** Académie Franco-Allemande.
- **Research Focus:**
 - **Secure and Autonomous Management of Internet of Things (IoT) Systems**
 - **Digital Teaching** (Ernst Otto Fischer Teaching Prize 2013)

Some of my Digital Teaching

Format: Lab courses
Content: Computer Networks & Distributed Systems
Teaching Style: Blended Learning
Reach: >2000 students



iLabX

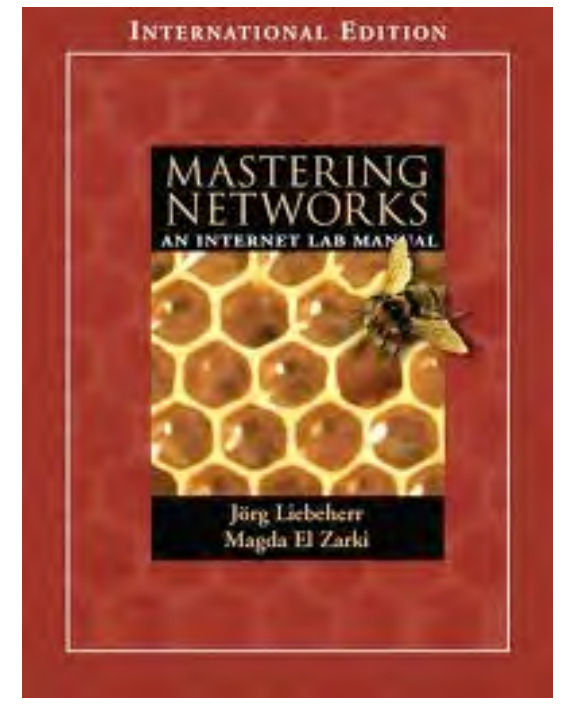


iLab2

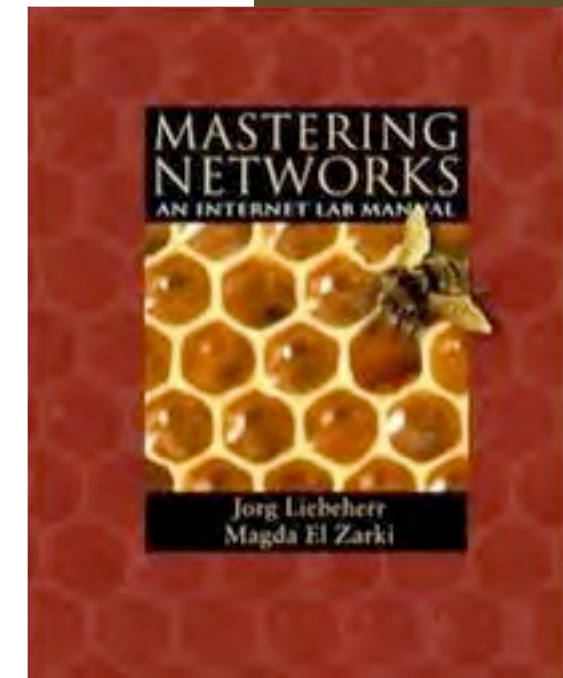
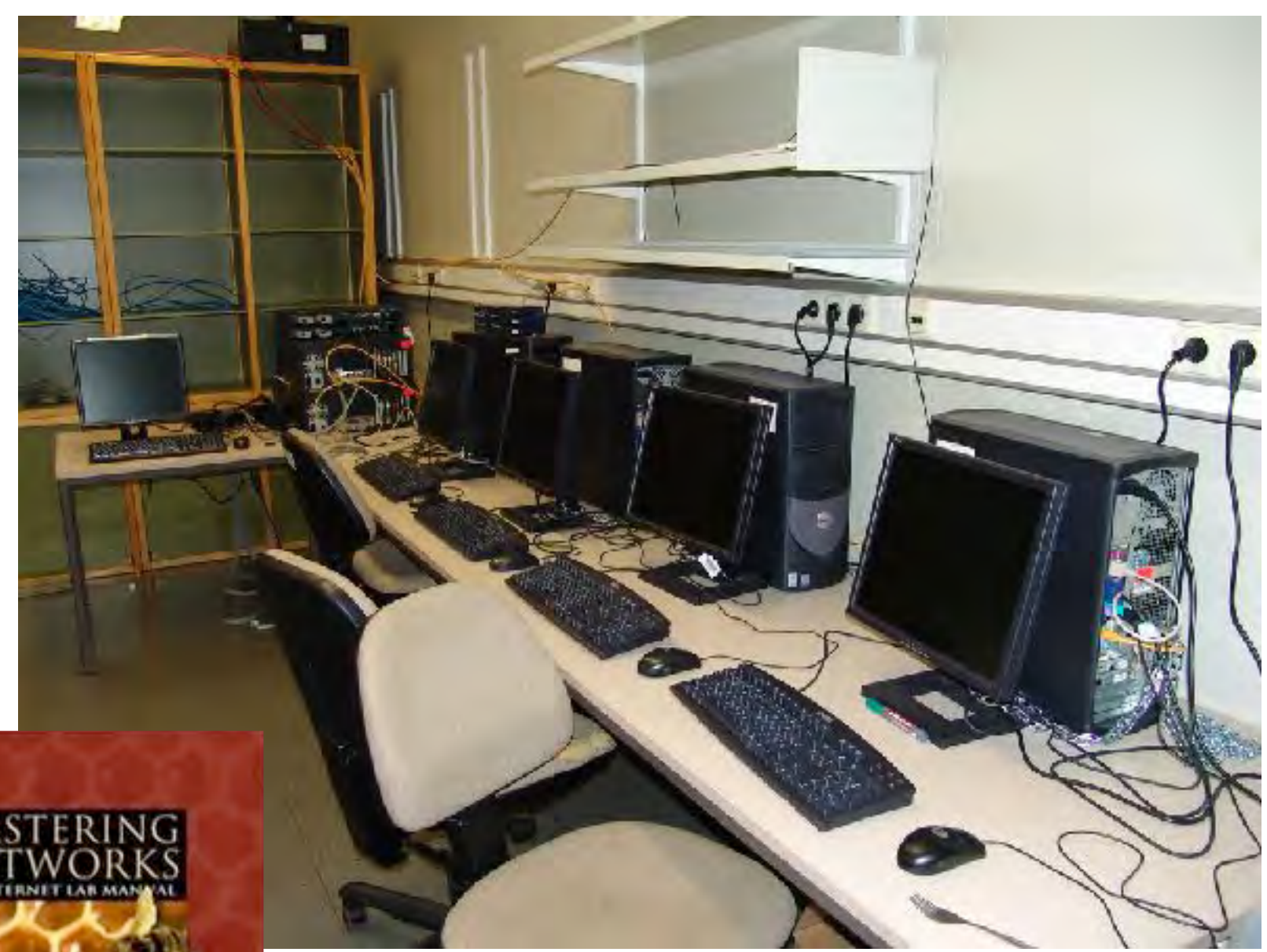


iLab

Internet-
praktikum



Why?



The command to add a host route to IP address 10.0.2.1 with the next hop set to 10.0.2.2:

```
PC1#route add -net 10.0.2.1 gw 10.0.2.2
```

The command to set the IP address 10.0.2.4 as the default gateway is done with the command:

```
PC1#route add default gw 10.0.2.4
```

The commands in this sequence create the above configuration:

```
PC1#route del -net 10.0.2.1 netmask 255.255.255.0 gw 10.0.2.1  
PC1#route del -net 10.0.2.1  
PC1#route del default
```

There is an simple way to delete all entries in the routing table. First method is with the routing table also delete the interface and then create the interface, see it:

```
PC1# ifconfig eth0 down
```

When the commands are issued interactively in a Linux Shell, the added entries are valid until Linux is rebooted. To make static routes permanent, the routes need to be entered in the configuration file `/etc/sysconfig/route`, which is read each time Linux is started.

The following commands are helpful to get information on routing and to find mistakes in the routing table:

```
play #ipAddress Test if IP address can be reached.  
#route #Address Display the route to the interface #Address.
```

1. Configure the routing table entries of PC1 and PC2. You can either specify a default route or you must specify routing entries for each remote network. For the routers, add a route for each individual remote network. As a hint, here is the configuration information for PC1:

```
PC1#route add -net 10.0.2.0 netmask 255.255.255.0 gw 10.0.2.2  
PC1#route add -net 10.0.2.1 netmask 255.255.255.0 gw 10.0.2.1
```

2. Configure the routing table entries of the routers. (In this case, the routing entries will be tested after Router1 has been setup.)
3. Display the routing table of PC1, PC2, and PC4 with `netstat -m` and save the output.

Lab Report:
Include the correct output of the routing table. Explain the entries in the routing table and discuss the values of the tests for each entry.

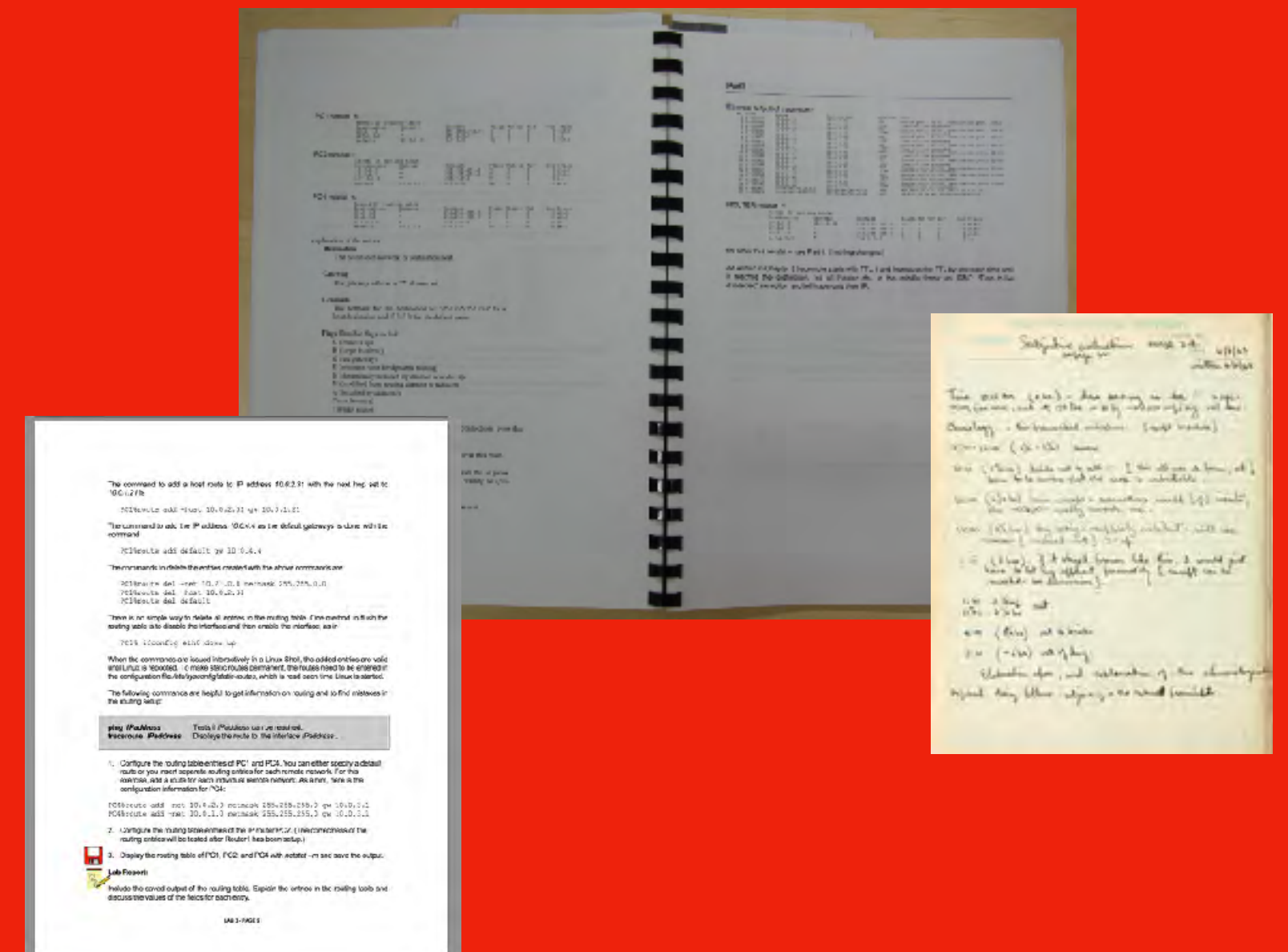
LAB 3 - PAGE 1

The notebook contains printed diagrams of network topologies and handwritten notes in German. The diagrams show PC1, PC2, and PC4 connected to routers. The notes discuss the configuration of static routes and the use of the `netstat -m` command to verify the routing table.

2003 Universität Tübingen: Internetpraktikum 2003

Concrete Problems I address

- Does not scale.
- Inefficient:
 - Takes too much time for **students**.
 - Takes too much time for **correctors**.
- Not enough **guidance** to learn successfully.



How?

Methodology

Tools

Content



listen



improve

How?

Methodology

Tools

Content



listen



improve

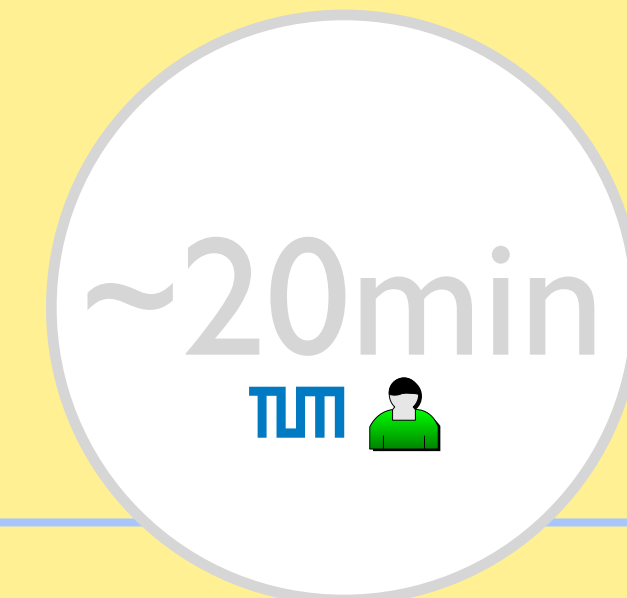
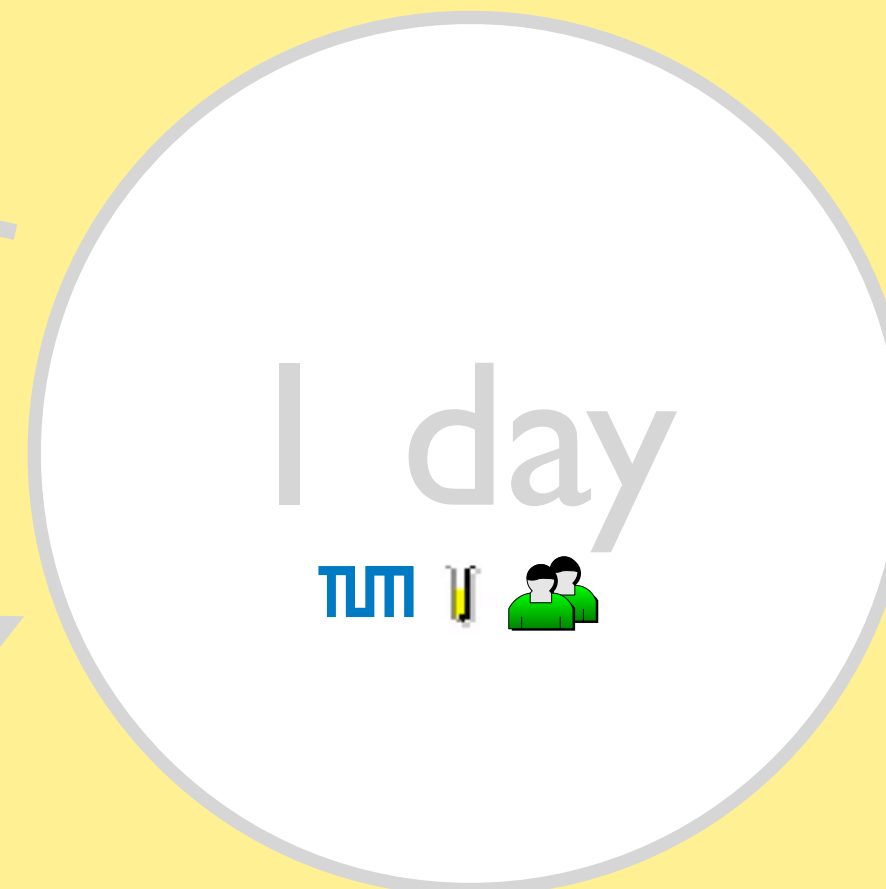
Motivate, Motivate, Motivate

- Reward during learning
- Diversity in Teaching
 - Methods (discussion, multiple choice, free text, ...)
 - Tools (eLearning, feedback, moderation, ...)
 - Settings (group, individual, team, ...)
 - Formats (lecture, self-preparation, practical exercise, ...)

Overview

Practical Teamwork

Lecture



Time

no additional reports

2x Individual Oral Exam

Individual Preparation



1 all

Demonstration lab

1. Demonstration PreLab content

So how does it work?

Hello The Tester (DemoUser), this lab is just for getting you familiar with the lab environment. You find all elements you'll find in a "real" lab here to get a better understanding of the lab environment. In a "real" prelab you will find many information that will help you to understand the lab environment.

All labs have two parts:

- The prelab
- The lab

The **prelab** should give you the **theoretical background** of the lab. If you read the texts, the easier the lab will be for you. There are multiple choice questions after most of the prelab sections. These questions cover the most important aspects of the topics you have just learned.

You won't have to wait until someone corrects your mistakes (after the entry of the prelab) you find a button "**check prelab**". This button will tell you what was wrong and what was right and sometimes you will also get a hint. You have multiple attempts to answer the questions. (The number of attempts depends on the config file).

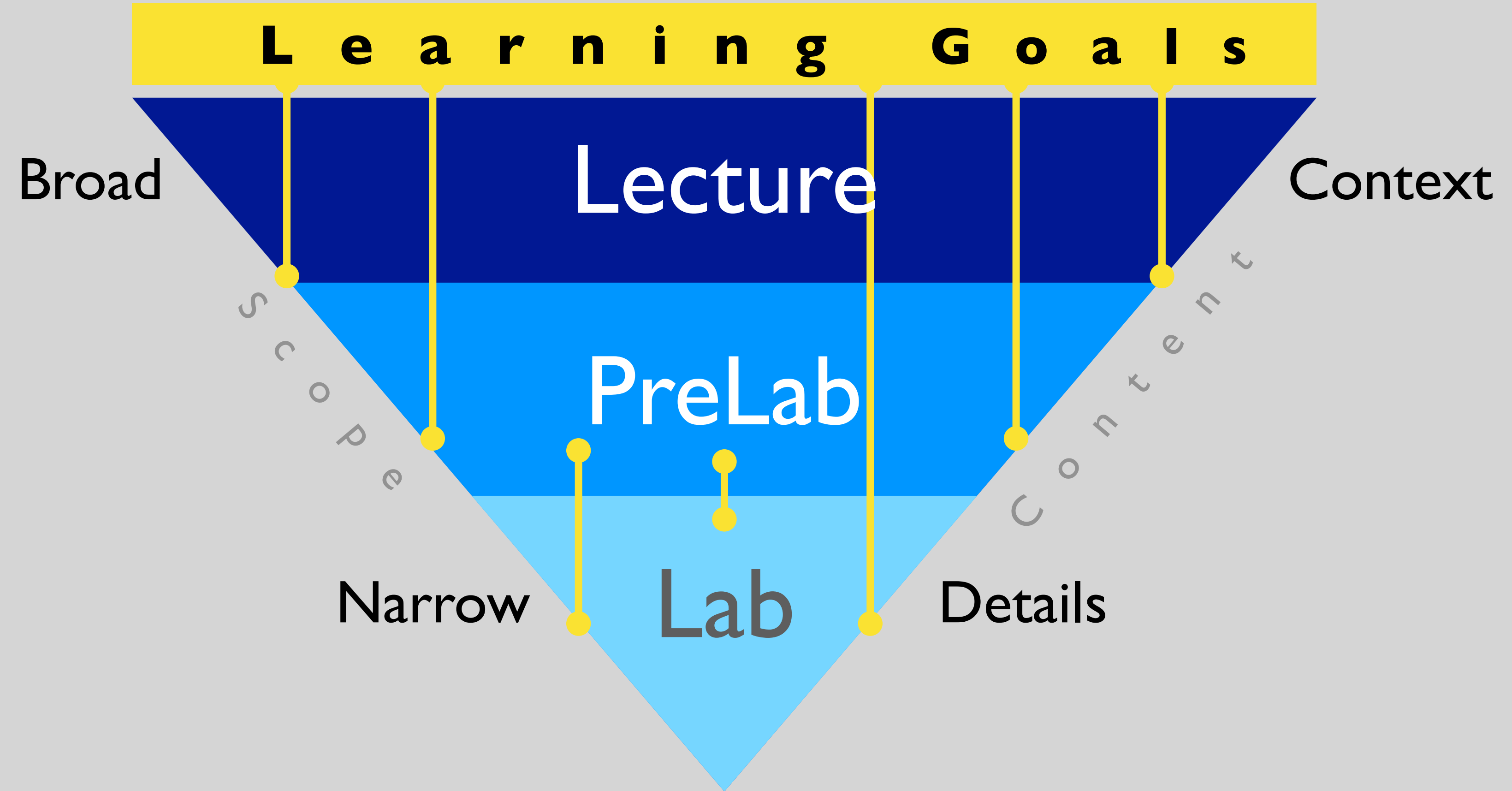
To be able to perform the lab, **each groupmember** has to be able to perform the lab. This means that each groupmember has to be able to perform the lab.

2 me



3 us

Focussing & Constructive Alignment



Source: Marc-Oliver Pahl, "The iLab Concept -- making teaching better, at scale," IEEE Communications Magazine, Nov 2017.

How should instructions be?

The exercises have a story!

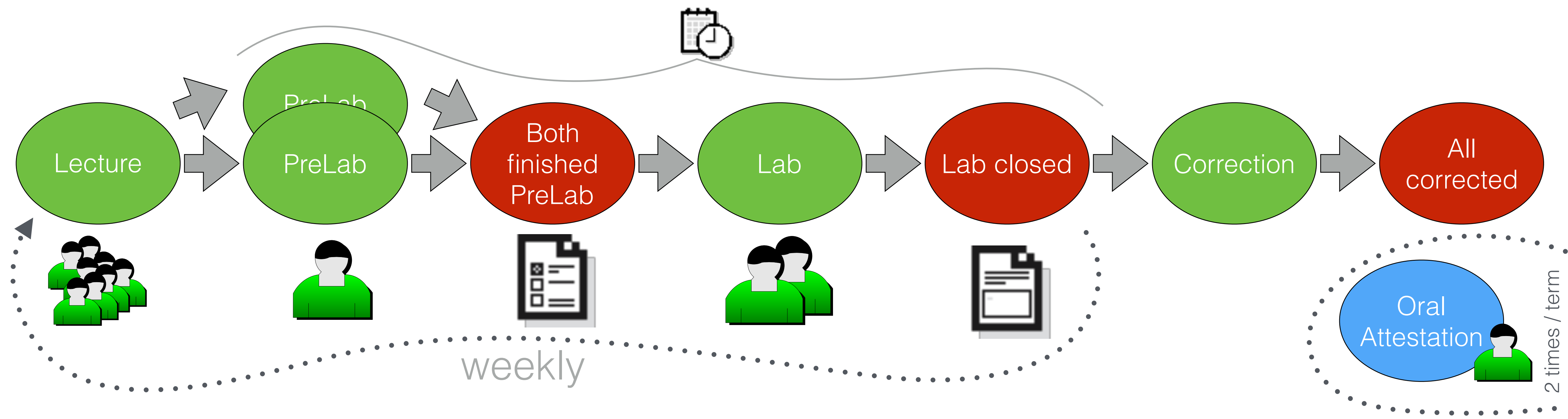


Learn from each other...



The iLab Blended Learning Concept

The “forced” good student.



90min	~1-3h within 1 week	~1 day within 1 week	~10h for <20 teams within 1 week
lecture room	where is Internet	lab room	where is Internet
group	individual	team of two	corrector team

How?

Methodology

Tools

Content



listen

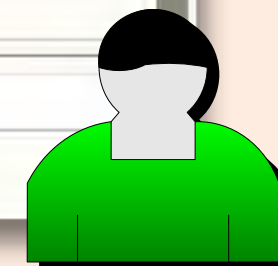
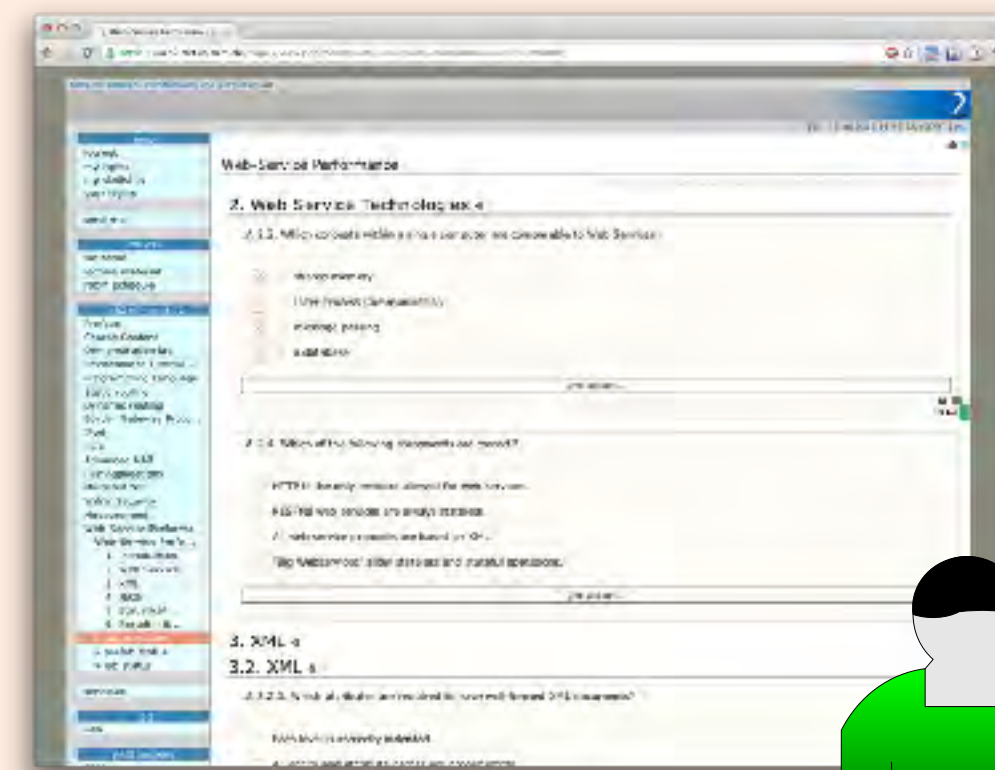


improve

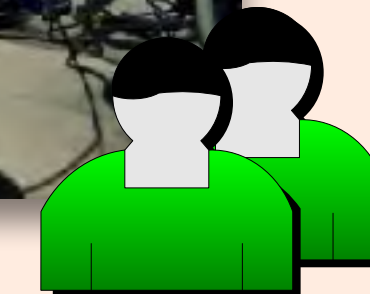
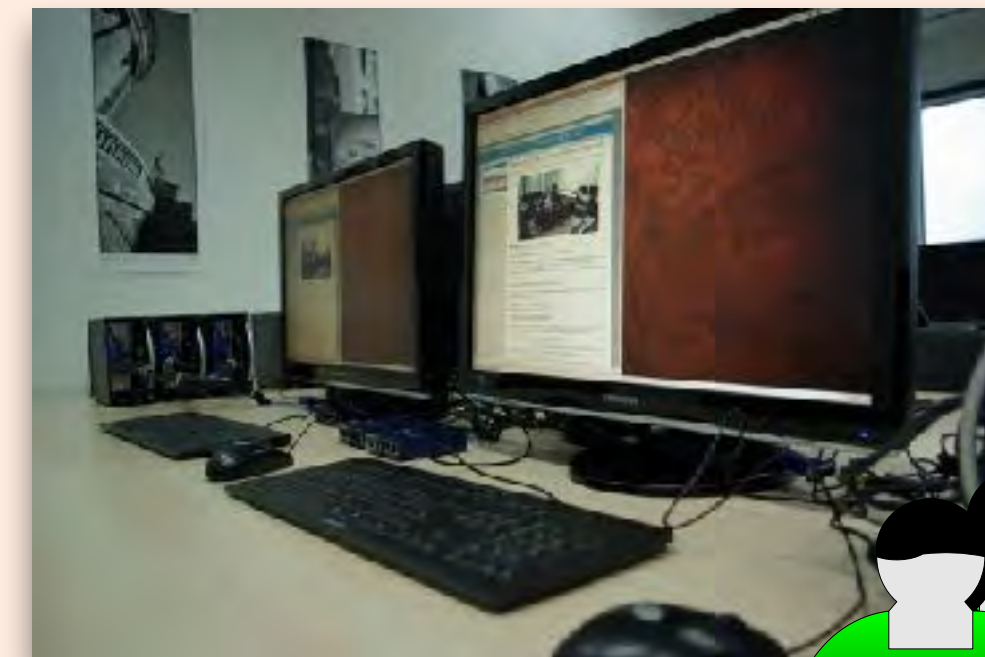
Settings

Individual Preparation

Lecture



Practical Teamwork



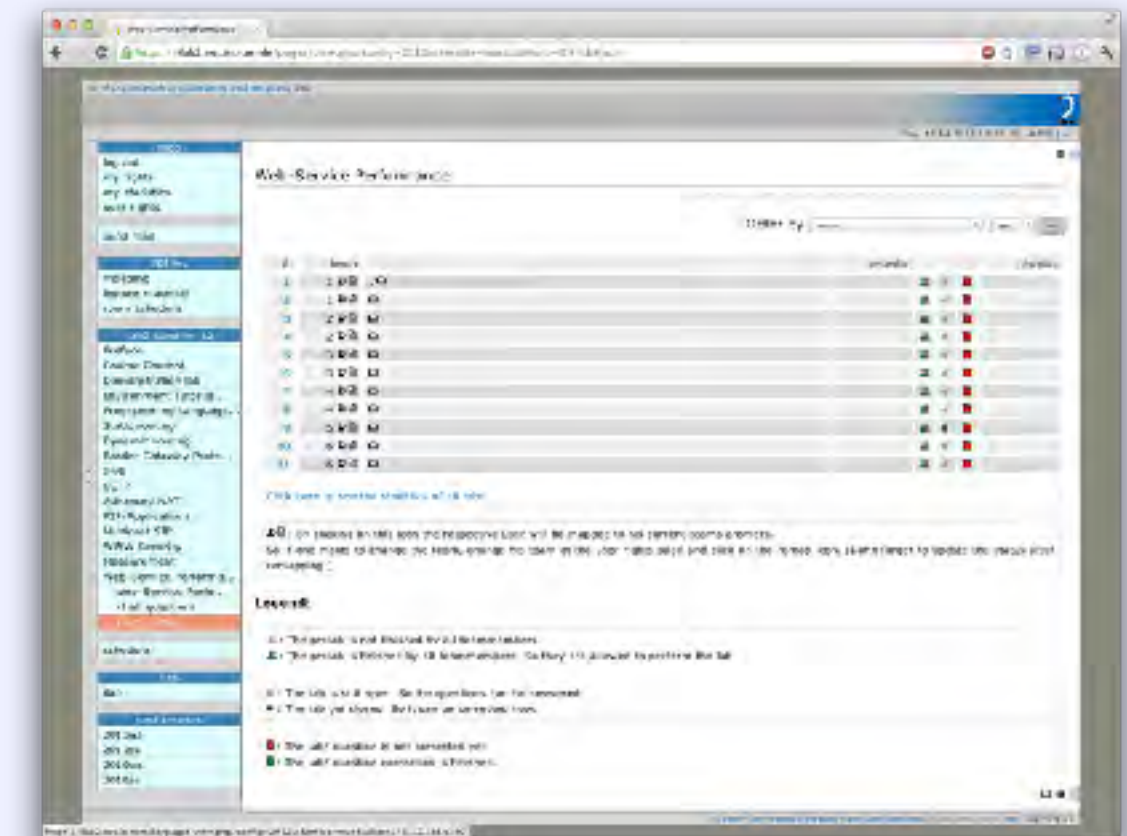
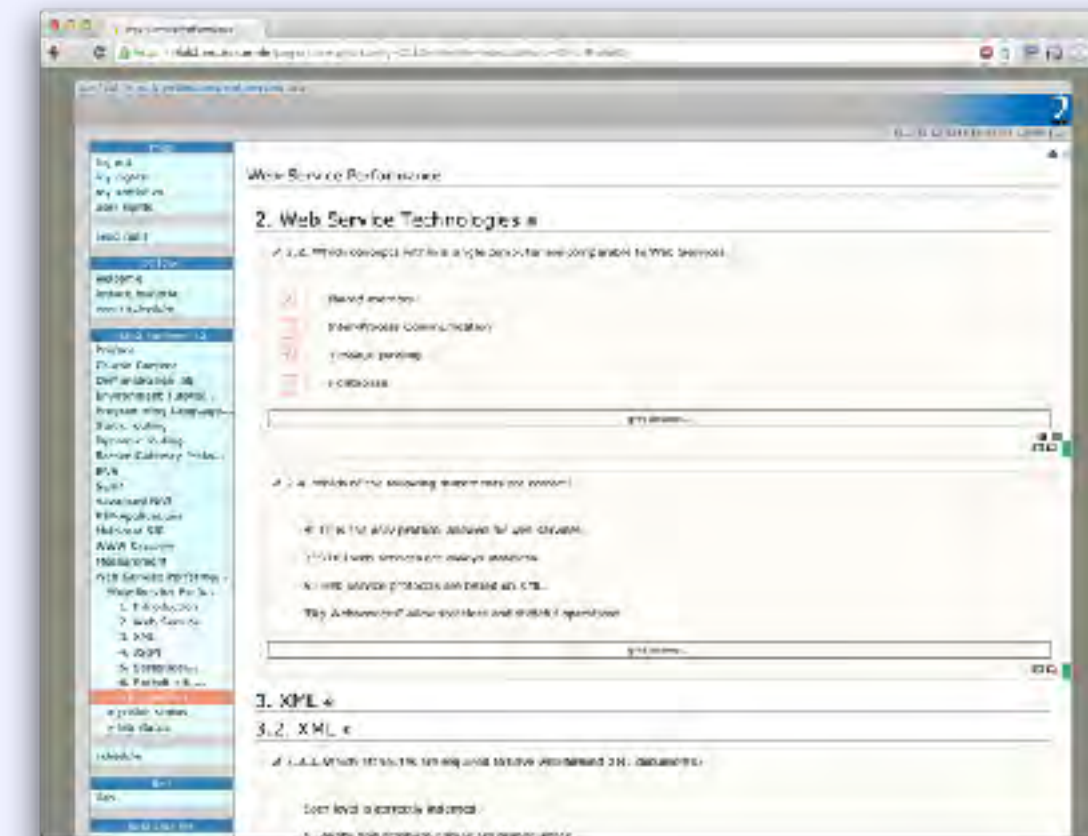
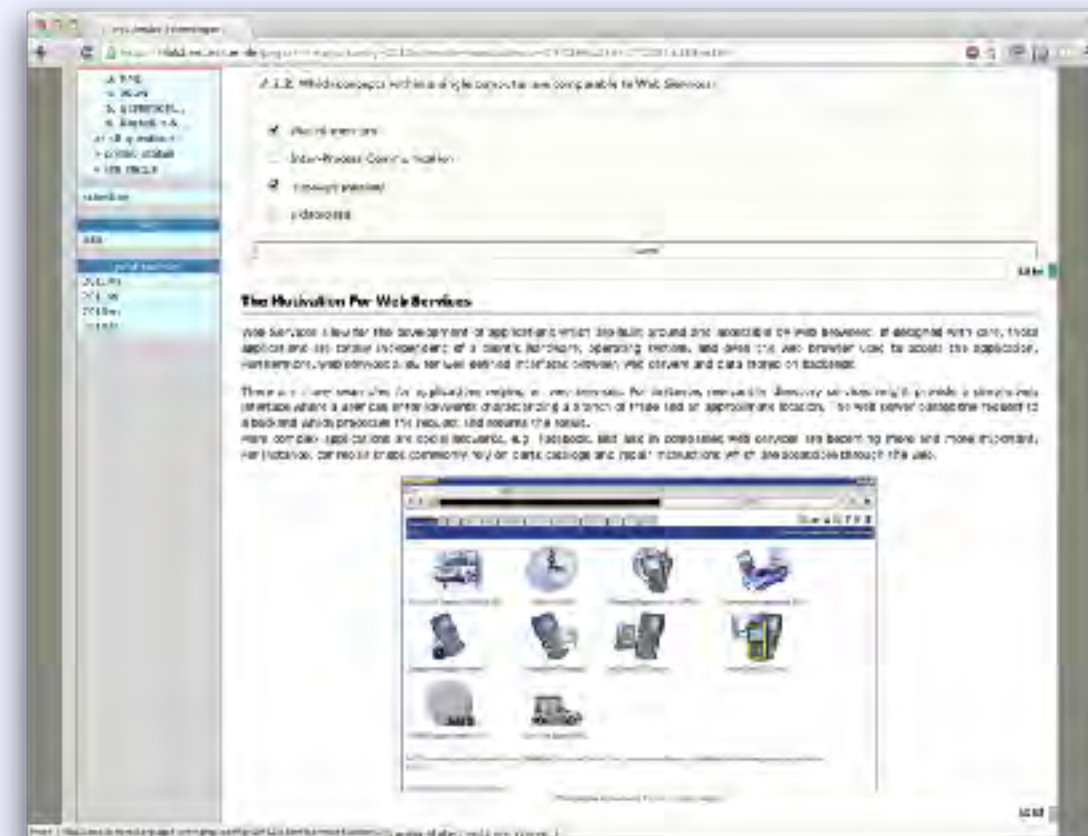
Cosy working environment





eLearning prelab

not taken into account for grading
(directly learn from errors)



lecture recording

preparation texts

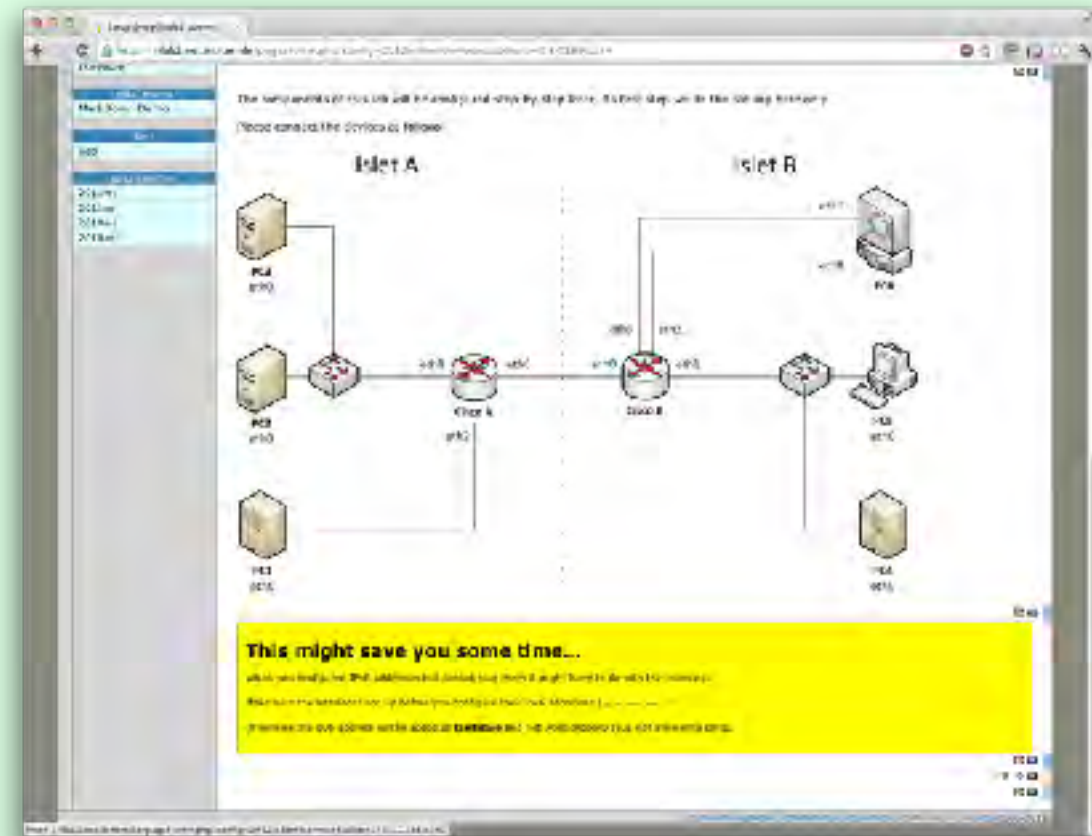
multiple-choice
motivation

ranking +
who did not
finish?

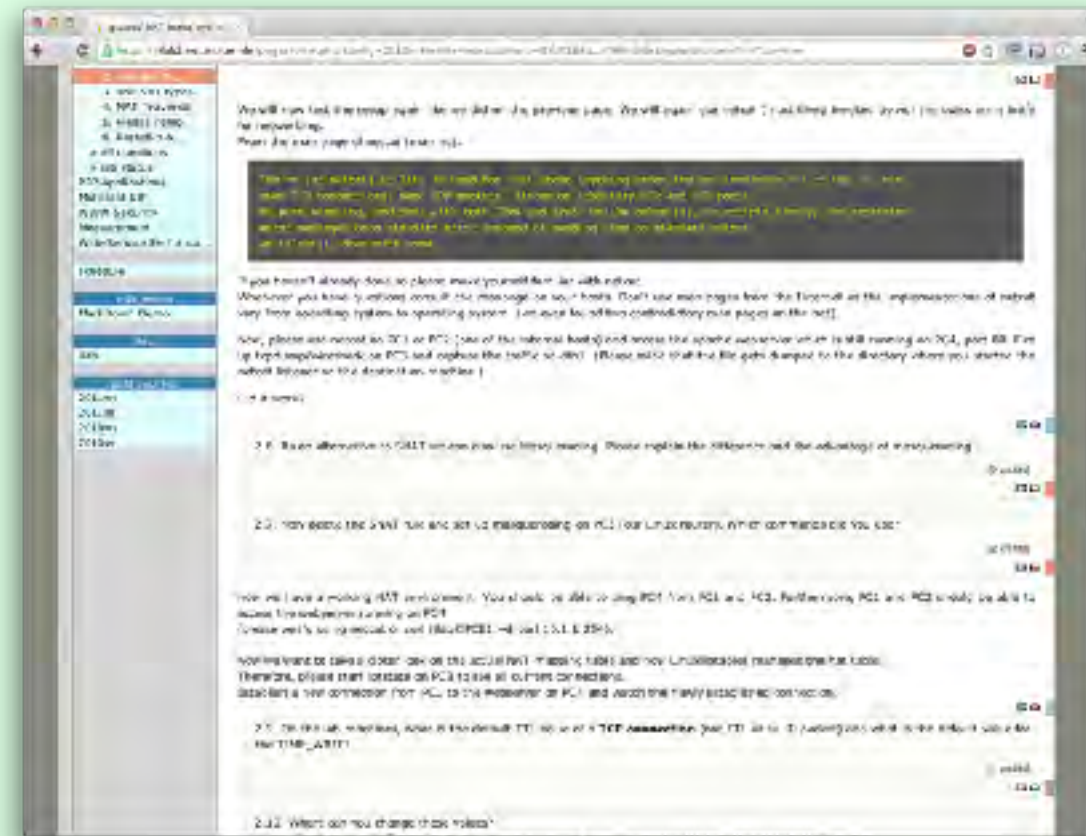


eLearning lab

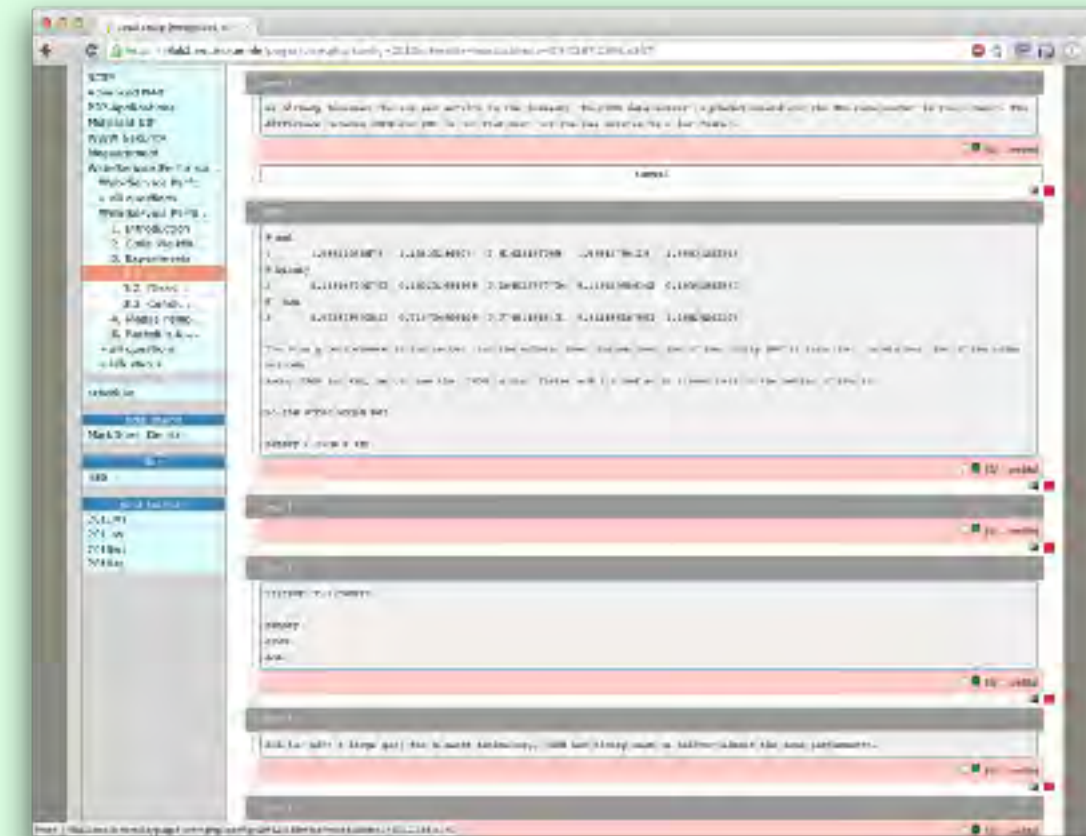
credits for grading



all instructions
online



free text inputs
inline



cross correction



course management

no additional reports

fast feedback

lumi/ cs/ network architectures and services/ lab

[mop log out] [Show pseudo names] [Hide example solutions] Fri, 22 Jan 2016 01:11:28 +0100 | en

mop

- log out
- my rights
- my statistics
- user rights
- send mail
- room schedule

iLab2 winter 15

- Welcome to the iLab2!
- Lecture Material
- Course Content
- Programming Language...
- Cisco IOS Tutorial
- Lab Slot Preference
- Demonstration Lab**
- Demonstration Prelab
- > all questions
- Demonstration Lab
- > all questions
- > lab status
- Static routing
- Dynamic routing
- IPv6
- Border Gateway Protocol
- Evil Twins - Wifi SSID S...
- Create your own dynD...
- Advanced Wireless LAN...
- WWW Security
- DIY 1: Hardware
- Your Exercise
- DIY 2: Software

schedule

edit_menu

- Do-It-Yourself Smart D...
- Getting to Know the Vir...
- Service Development f...
- Evil Twins - Wifi SSID S...
- AirHopper: Bridging the...
- IP Multicast
- SCTP
- Advanced NAT
- Measurement
- IPv6 Firewall
- OpenVPN in restricted ...
- Defeat the Lag
- Honeypots
- SNMP Network Element...
- Traditional vs Software ...
- RADIUS
- IPv6 Multicast or How t...
- Poisoning Networks
- Virtual Private Network...
- Create your own dynD...
- TCPStealth
- Using Tor as a road wa...
- Kerberos - The three h...
- Multi-level Prefix Delag...
- Quality of Service (QoS...
- Heartbleed reconstructi...
- ICMP Tunneling
- Sniffing the Air with SDR
- Google's TCP successor...
- Let's Encrypt, just anot...

past courses

- 2015ss
- 2014ws
- 2014ss
- 2013ws

Demonstration Lab

This lab module makes you familiar with the web-based learning system and the didactical principles behind the course.

Demonstration Prelab

- Demonstration Prelab Content
- PasteBin & Feedback
- Go to all questions...

Demonstration Lab

- Demonstration Lab content...
- Leaving the room the way you want to find it next time...
- PasteBin & Feedback

Here you can download the ePub version of your lab. The ePub will always contain the data you currently have access to.

Demonstration Prelab

- Demonstration Prelab Content
- PasteBin & Feedback
- Go to all questions...

1. Demonstration Prelab Content

Hello Marc-Oliver Pahl (mop), the aim of this lab module is getting familiar with the didactical concept behind the practical exercise and the lab system (this web portal)!

You find all elements you'll find in a "real" lab module in this demonstration lab.

So how does it work with this system?

A lab module usually consists of two parts:

- A so-called "prelab" for theoretical preparation
- A so-called "lab" with the practical part of the exercise

The part you are currently in is the prelab. In a "real" prelab you will find much information that will help you (and is necessary) during the lab.

The **prelab** should give you the **theoretical background** of what you will do later on in the lab session. The more careful you read the texts, the easier the lab will be for you.

There are **multiple choice questions** after most of the prelab sections. These questions should help you to recover and memorize the most important aspects of the topics you have just read about.

You won't have to wait until someone corrects your multiple choice questions. On the page with **all prelab questions** (last menu entry of the prelab) you find a button "**check prelab**". Clicking it makes the system check your answers. You'll **see immediately what was wrong and what was right** and sometimes you will also get some information why that is the answer.

You have multiple attempts to answer the questions. By default you have three (3) attempts (that value can be changed in the config file).

- up-to-date content
- Diversity
- Clear flow of the exercises
 - Getting the expected result is guaranteed
- Questions inline; no additional reports
- Learning support
 - Mandatory PreLab
 - Instantly correcting multiple-choice questions
 - Fast correction
 - Redundancy
 - Oral exams
- Teamwork - help each other!
- English
- Additional skills (esp. iLab2)

wrong and what was right and sometimes you will also get some information why that is the answer.

You have multiple attempts to answer the questions. By default you have three (3) attempts (that value can be changed in the config file).

To be able to do the lab, **each group member** has to have finished the prelab by having answered **all prelab-questions**. When all your teammates are finished with the prelab session, the lab session will automatically become visible to each team member. Before one can see on the "lab status" page if other course members already finished.

In **the lab** you will use the tools and methods you read about in the prelab. You solve interesting challenges as a team. The available lab text gives you some instructions. During the lab you'll have to **answer questions**. You do this as a team (as you will see all of you have the same answer fields). You should switch formulating the answers so that each group member writes down some of the answers. It is one of the courses learning goals to become able to formulate one's thoughts clearly...

1.3 This is a multiple choice question. Click on "give answers" to set the check marks. Don't forget to "save"...

This answer is **correct**.
This answer is wrong.

This answer is **correct**.

Here you might find some remarks why the solution is correct.

Multiple-Choice answers shuffle themselves...

When you have a look at your team partner's screen you will see the answers to the multiple-choice question in a different order there. This is included to not taking you the joy of doing the prelab by exchanging the answer vectors (3,5,7 are correct) with others.

The aim of the prelab questions is to support you in your individual learning process by setting a focus helping you to memorize the important things better. Cheating there is only cheating yourself...

1.5 This is another multiple choice question. Now I don't give you the answers ;) When was the first web based internet lab held in Tübingen?

winter semester 2003/ 2004

summer semester 2004

winter semester 2004/ 2005

summer semester 2005

winter semester 2005/ 2006

Well the lab started in winter 2003/ 2004 based on a book of Jörg Liebeherr. It was maintained by Uwe Bigger then. In summer 2004 it got totally renewed by Marc-Oliver Patil and Uwe Bigger. The later prelabs were edited by Heiko Niedermayer. All was put on the predecessor of this system you are just using. The current system was introduced in summer 2005.

Navigation elements

⇐ ⇨ If you have multiple pages you can navigate with the arrows. The ⤴ links to the table of content.

📖 For each element there exists a **history**.
For instance you can see who edited the answer above by clicking on the lower book. Information on who corrected your question will be found there too.
The upper one tells you who edited the question and when this was done. Similar information can be found next to the texts etc.

2. PasteBin & Feedback

You find this page **at the end of every prelab and lab**. It is **shared between all team members** and between prelab and lab. So all of you see the same files and information.

PasteBin

Sometimes you might want to **save some text snippets or files to have them available** when you restart with the lab or on another computer.

This section is exactly intended for this. You can **temporarily store your configurations, commands, etc. here**.

2. Paste your texts and store your files here...

This input is intended to be used as a PasteBin for texts and files by the teams (could replace a home directory).

- Up-to-date content
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- English
- Additional skills (esp. iLab2)

Students should always be encouraged to offer their opinions and findings here!

Valuable suggestions that lead to improvement of the lab can be rewarded with bonus credits.

[0 credits]

Next go to the **all questions** page in the menu to **check the prelab up** and get access to the lab!

You will see a summary page of all multiple choice questions there. The system will tell you which answers are right and which are wrong. As this is a demo lab make errors to see what happens...

When you did the maximum amount of checks or you answered all questions correctly, the lab will appear in the menu. In a real lab you will have to wait for your team partner to finish at this step. On the status page you can see who finished when. Especially if your team partner did finish yet...

Demonstration Lab

1. Demonstration Lab content...
2. Leaving the room the way you want to find it next time...
3. PasteBin & Feedback

1. Demonstration Lab content...

Well done Marc-Oliver Pahl, you and all your teammates finished the prelab!

Now you have access to this lab part. Here you will find the exercises.

You can answer the questions **during the schedule**. If the schedule is up the answers will close automatically. If **you finish the lab earlier** than the schedule end is set **you should close** the lab to enable the correctors to correct your answers earlier...

How to do this? Just as with the prelab: Click on all lab questions in the menu and press the close lab button on top.

So in a real lab here would be some instructions on how to perform a cool experiment...

1.2. ...and here will be an interesting question to the experiment. You can answer this demo question by clicking on "give answer" below. Maybe there are some answers yet. How come? Well probably another teammate inserted something yet...

Well here will be what you should have answered...

[0 credits]

An important part of an exercise is that you learn to formulate and express yourself as a team. Discuss about the answers. Formulate them together. Rotate the one finally writing the answer so that every one of you does it regularly.

Then you learn the most! And these skills count independent of the topic you are currently working on...

Do **not** copy & paste here! If you do it you are not only plagiarising of you do not cite correctly but you also take yourself the chance of learning how to formulate and answer...

2. Leaving the room the way you want to find it next time...

At the end of each practical part (lab) you find this hint to "reset" your workplace after using it and before leaving. Please leave your workspace as proper as possible. The next team will highly appreciate it.

Thank you!

Please remove the Cables

Please leave the place as clean as you want to find it the next time. If the last team did not clean up properly please do so anyway. The

- Up-to-date content
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Thank you!



If the space you leave looks like this: great ;)

3. PasteBin & Feedback

You find this page **at the end of every prelab and lab**. It is **shared between all team members** and between prelab and lab. So all of you see the same files and information.

PasteBin

Sometimes you might want to **save some text snippets or files to have them available** when you restart with the lab or on another computer.

This section is exactly intended for this. You can **temporarily store your configurations, commands, etc. here**.

2. Paste your texts and store your files here...

This input is intended to be used as a PasteBin for texts and files by the teams (could replace a home directory).

List of uploaded files

No files uploaded yet.

[0 credits]

Please give us feedback!

What did you (dis-)like most about this lab? Do you have suggestions on what could be improved? Did you find any errors? If you have any suggestions or comments about the prelab or lab please let us know! This question has **no bearing on your prelab completion**.

2. Please submit your comments here:

Good student answers to this question contribute greatly to the further improvement of the lab. Students should always be encouraged to offer their opinions and findings here!

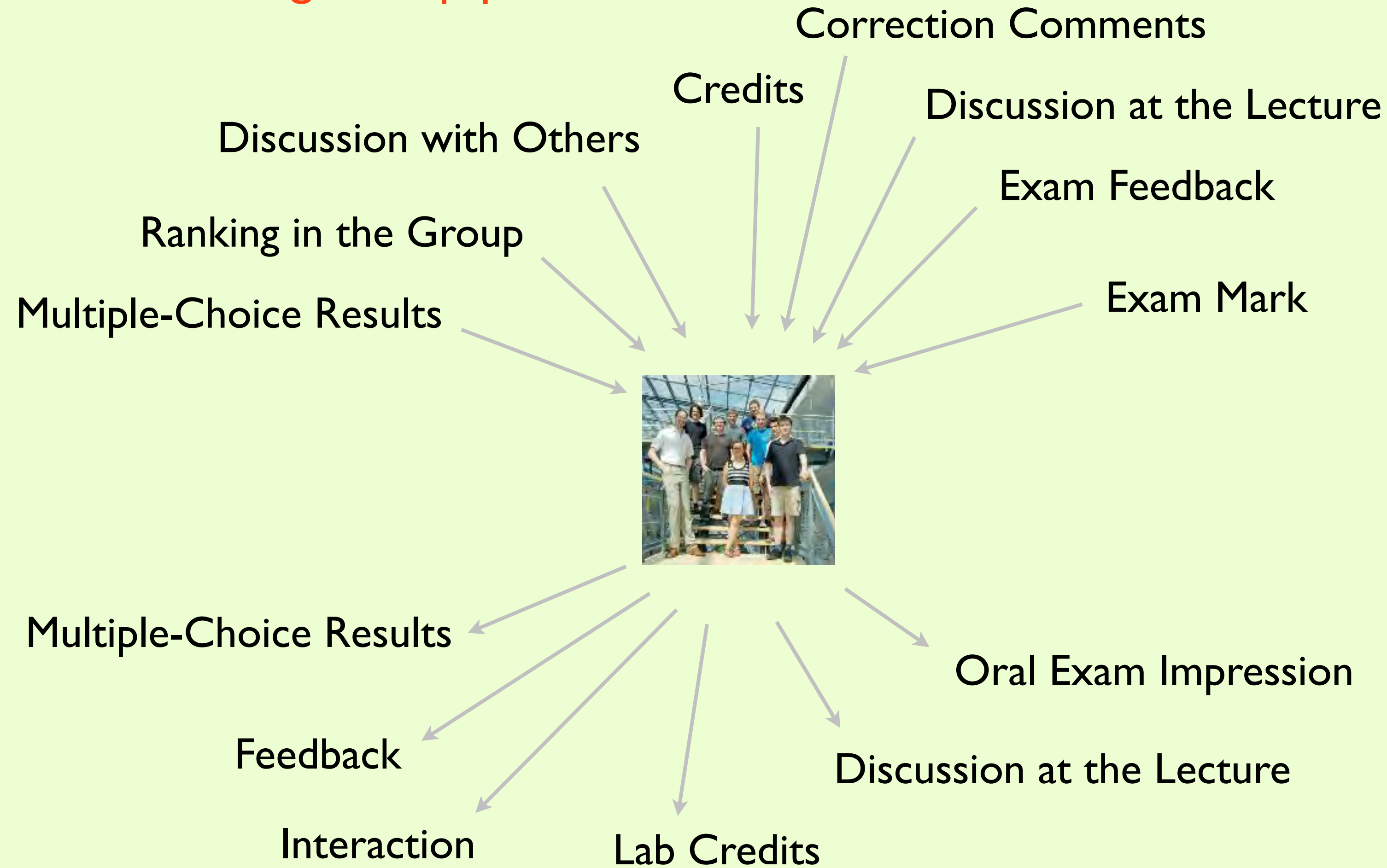
Valuable suggestions that lead to improvement of the lab can be rewarded with bonus credits.

[0 credits]

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Feedback

Self-Learning Support



Feedback is important to encourage the learners to continue learning. It is a main mean for motivation. Feedback is important for the teachers as well as it helps them to adapt to the needs of the current student group. The student feedback is continuously used to improve the exercises.

Feedback to the Teachers

How?

Methodology

Tools

Content

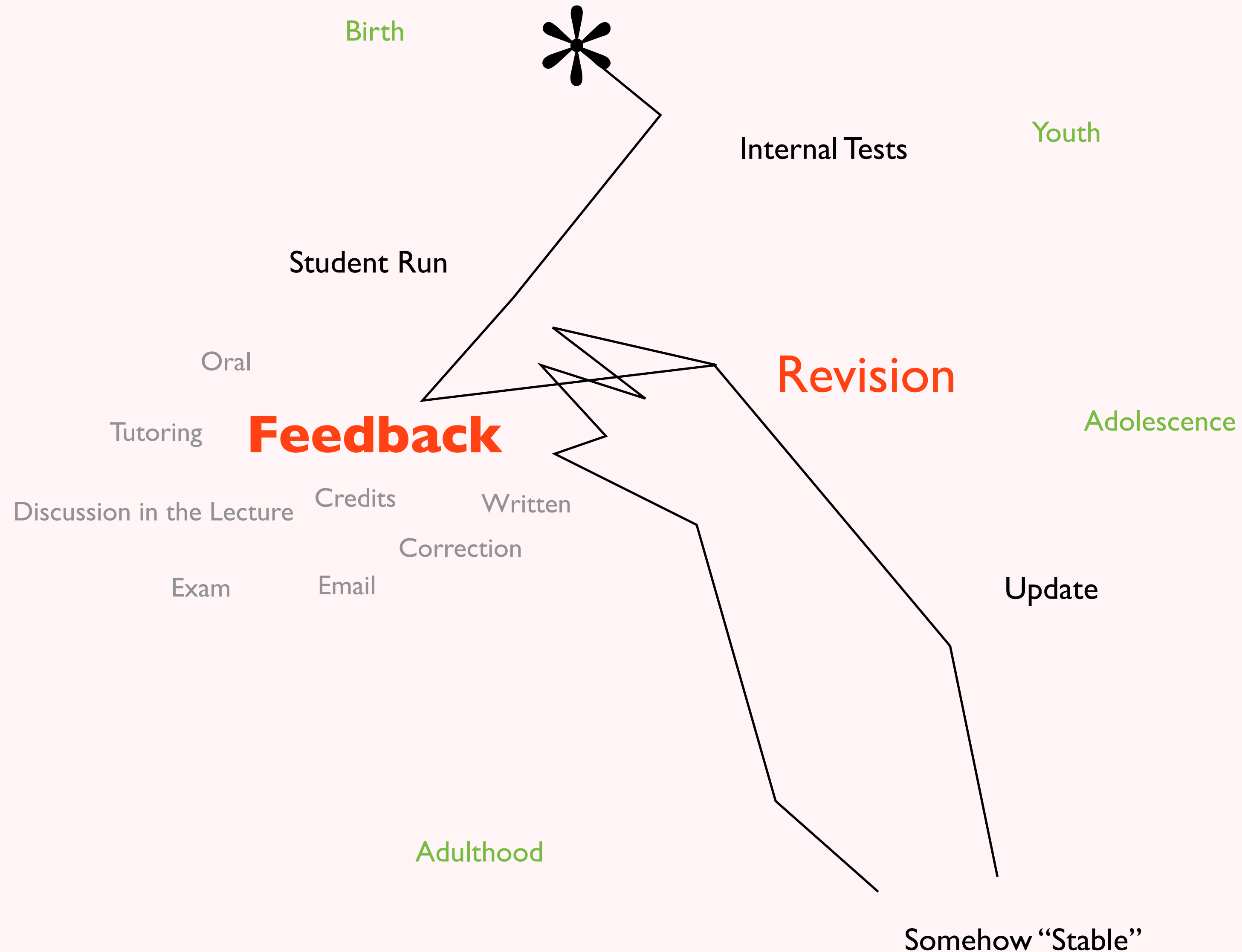


listen



improve

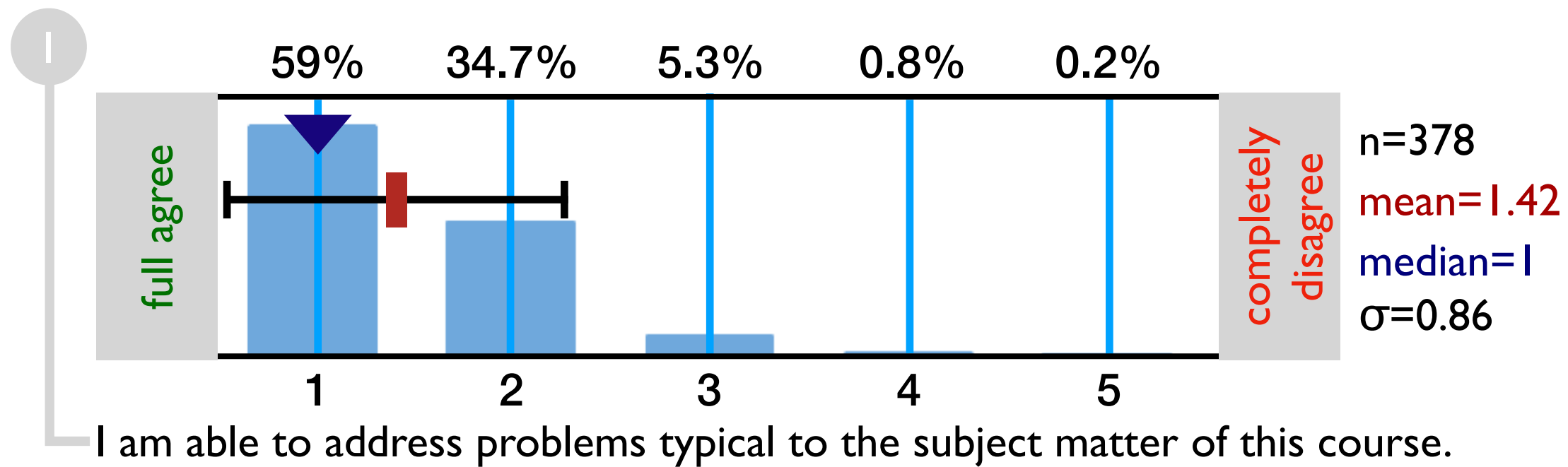
continuous evolution



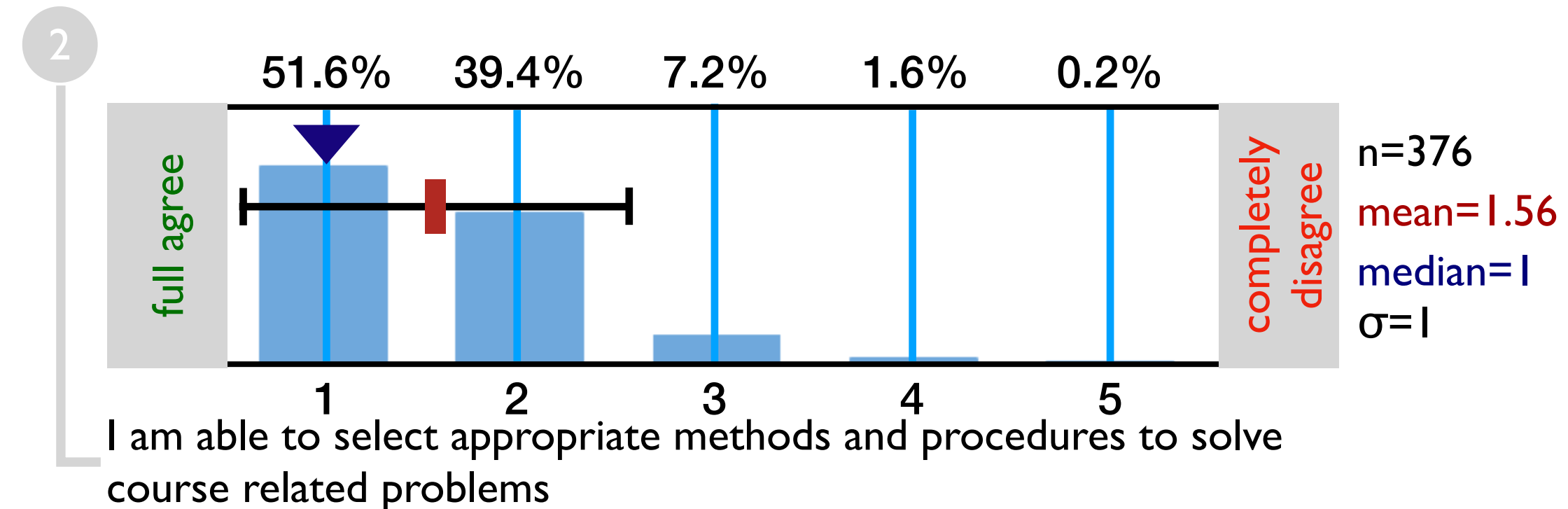
iLab exercises grow from continuous exchange. Exchange within the group of learners and between the students and the professors. The iLab encourages to exchange wherever possible. It is an important element of the success of the concept.

Evaluation

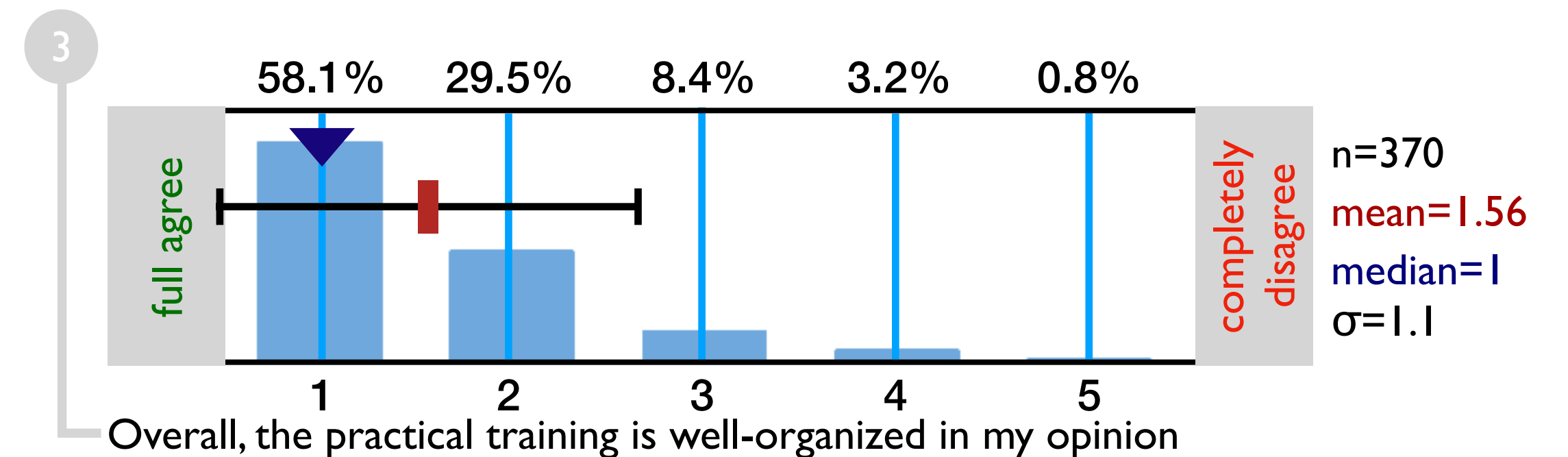
“Perfectly organized lab course with a good balance of team work, self-study and lecture.”

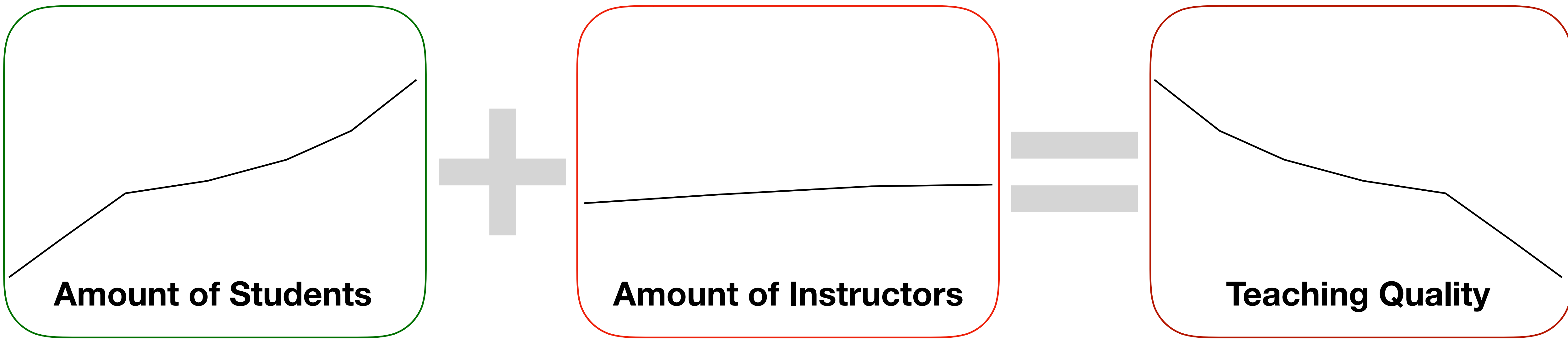


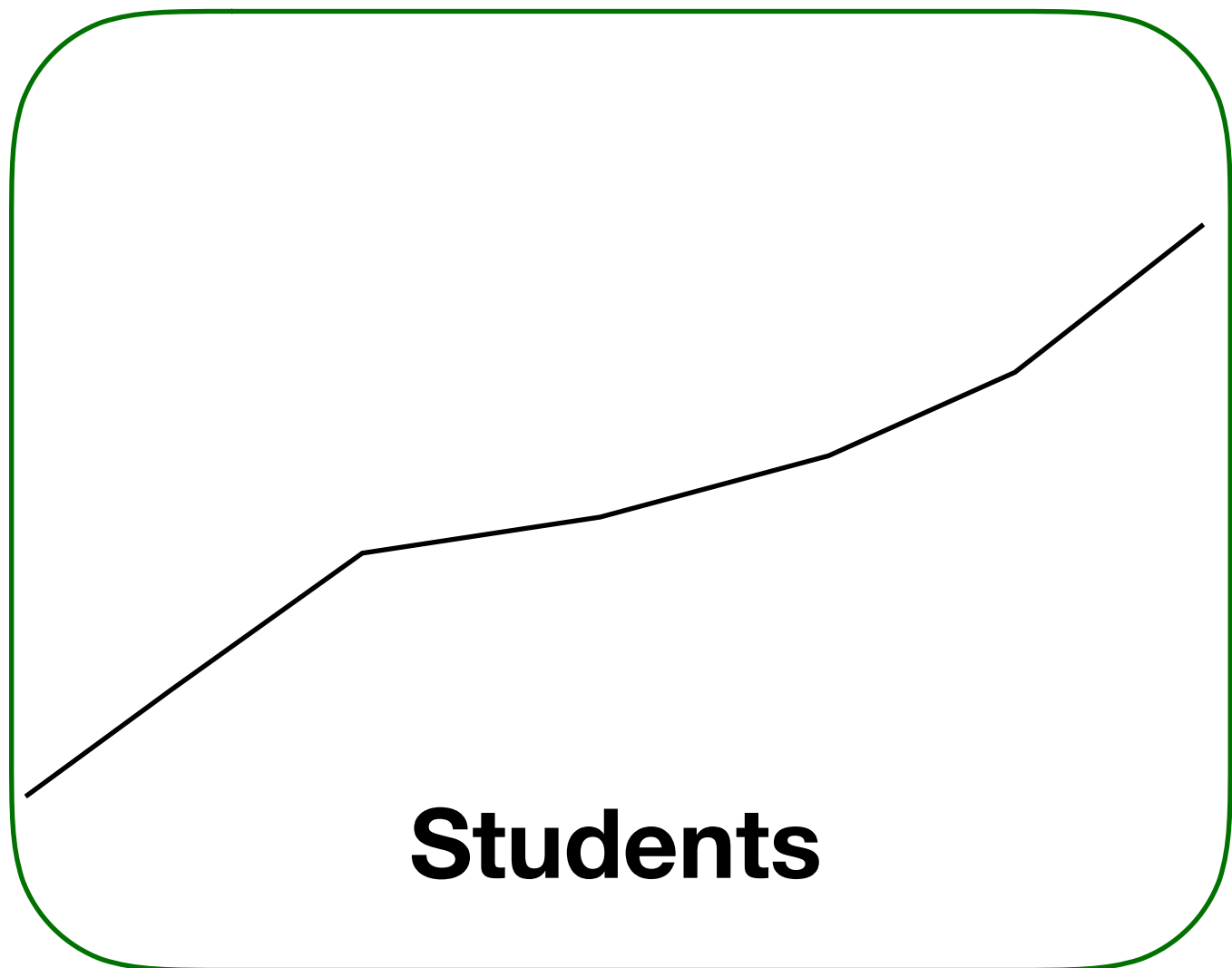
“[I like the] syllabus and the way the assignments are organized. The course content, paradigm, and the learning curve.”



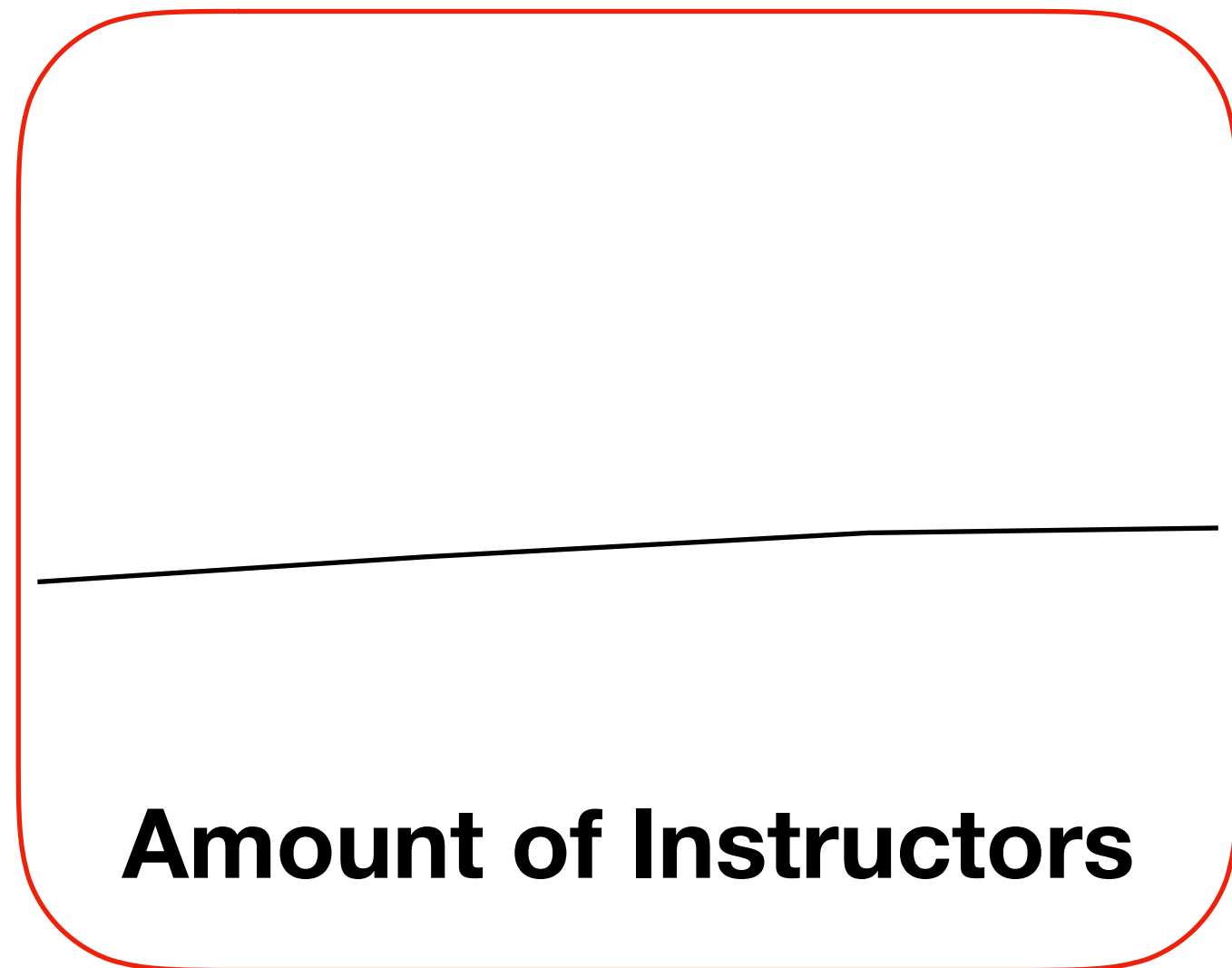
“Good insight into various technologies. Comprehensive exploration of the topics at hand. Nice e-Learning system!”



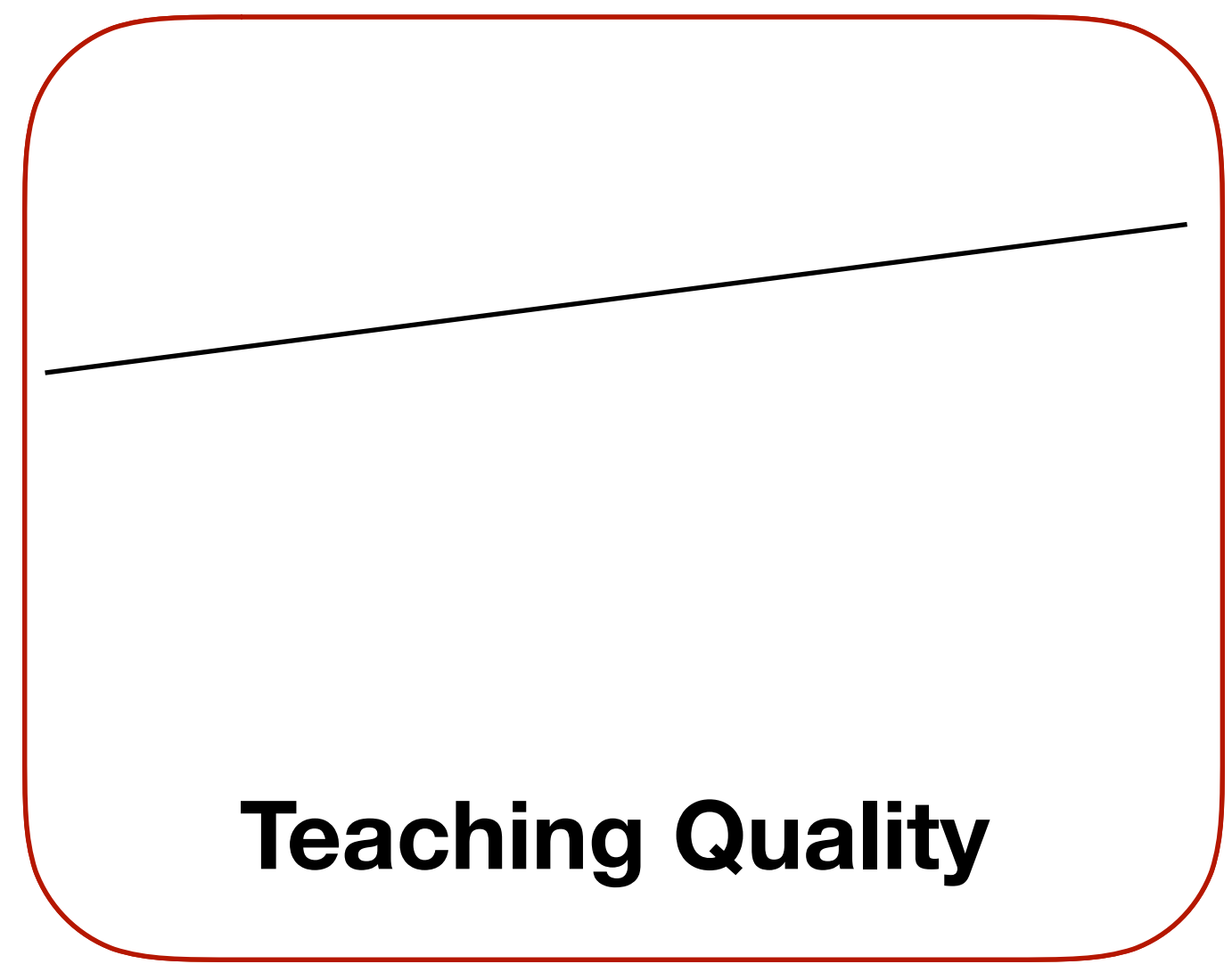




+



=



+iLab Concept

Big thanks to my team members!

- Uwe Bilger was of invaluable help in designing the initial new set of exercises, and in iterating through the material and the concept in the first years (~2004-2006).
- Joachim Schiele and Andreas Korsten did a great job for evolving the hardware setup back in Tübingen.
- Stephan Günther did the entire hardware and software setup for Munich in 2008.
- Benjamin Hof and Lukas Schwaighofer did invaluable contributions to both labs including the iLabOS software (with Markus Teich), the lab room hardware setup, and the exercises! Their great expertise and dedication are unforgettable.
- Also thank you to all advisors (chronological order):
 - Tübingen: Uwe Bilger, Heiko Niedermayer, Marc Fouquet, Ralph Holz, Dirk Haage;
 - Munich: Andreas Müller, Holger Kinkelin, Florian Wohlfart (!!), Benjamin Hof (!!!), Lukas Schwaighofer (!!!), Minoo Rouhi, Dominik Scholz, and Stefan Liebald.
- And all student tutors!

Methodology

Tools

Questions?

Content



Resources

- M.-O. Pahl, “The iLab Concept: Making Teaching Better, at Scale,” IEEE Communication Magazine, vol. 55, no. 11, pp. 178–185, 2017.
- Labsystem eLearning Environment <http://github.com/m-o-p/labsystem>
- iLab - Build your own Internet <https://ilab.net.in.tum.de/>
- iLab2 - You set the Focus <https://ilab2.net.in.tum.de/>
- iLabX - The virtualized Networking Laboratory <https://s2labs.org/?site=mooc4masters>