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Designing and Implementing an Educational Support System

Bachelor's Thesis

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HALLGATÓI NYILATKOZAT

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Budapest, 2015. december 6.

Szepes Nóra
hallgató

Kivonat

honnan->hova
látszon az eredmény

Abstract

Chapter 1

Introduction

During the summer of 2015 my advisor, Sándor Gajdos contacted me to provide him with feedback about his course, Software Laboratory 5. I advised him the strength and weaknesses of the course. I also shed a light on the administration portal which did not have e-mail notification. I offered Sándor Gajdos to develop that feature into the current portal. All I knew that it was written in PHP. After telling him my ideas he contacted Bence Golda, the creator of the old portal, to ask for some information about the portal's code and József Marton to create a "noreply" e-mail address for the notification module. József Marton suggested that we could create a new portal and other members of the team, Bence Golda, Gábor Szárnyas and I agreed with him.

Before our first meeting in early August I decided to look up all the different homework portals I have used during my student years. I asked for an account to Zoltán Czirkos's InfoC [9], because that website was started after I have finished the Basics of Programming 1 course. After the information gathering, I prepared a preliminary specification for an ideal homework portal and some recommendations of how we could use the same portal for more than one course.

During the meeting, we talked about this topic, and also about what others may expect from a new portal. It started as a departmental project but József Marton asked for some ideas about what students would like to gain from a portal. The project sounded exciting and I wanted to participate but since I had to prepare for my thesis I would not have sufficient time to work on the portal. At the point Sándor Gajdos offered me the topic for my thesis and he agreed to serve as my advisor. I accepted his offer as this is an appealing engineering task from design to implementation, and – in addition – the final portal will be used by hundreds of students.

1.1 The Old Administration Portal

The old portal was developed during the spring semester of 2003 by Bence Golda and three other students. In that year the course Software Laboratory 5 had database themed and network themed laboratories. This project was available for some students as advanced database laboratories. The students did not have much software developing experience.

Sándor Gajdos wrote the specification and the students designed and implemented the portal. They used version control, but did not wrote any formal tests. The portal has Oracle SQL basics with a PHP engine and an XSLT templating system.

The first expansion, the repeated laboratory practice handling was added three years later. Around 2008 Bence Golda made Ruby scripts to handle some more related tasks, e.g., initialization.

A group of developers from the university and two intern groups tried to design and implement a new portal before, but they did not succeed.

Bence Golda spends about 30-40 hours every semester doing operational tasks.

1.2 Purpose of the Thesis

mit tudok, mit fogok végrehajtani, mi az elérendő cél

1.3 ?

hogy álltam neki a fejlesztésnek - melyik fejezetben mit fogok bemutatni

Chapter 2

Specification

Before the team's first meeting in August, I looked up all the homework portals I've used during my student years to write up a preliminary specification [69] about what I expect from a homework portal as a student. Since September 2015 we had weekly meetings where we discussed the following related topics:

- the old portal's features we want to keep without modifications
- the old portal's features we want to keep with modifications
- the old portal's features we want to eliminate, and
- new features we want to add

After a couple of meetings we had a list of functional features as the starting point for our specification. A functional feature describes what a user can do while he uses the portal. At this point I wanted to find the common roots of the features. When there are many features with the same common root, then I know I should focus on implementing these features first, because these features are mandatory features, and without them the portal will be useless for the users. I used the 5 Whys technique to find the common roots of the features.

2.1 Specification Phase

In this section I am going to introduce what kind of techniques I used to create the final specification. Some of these techniques serve as the basics of functional testing and acceptance testing. A functional test verifies that the software or features meets the specification. An acceptance test validates that this is the software or feature the customer wanted. I explain the testing in chapter 7.

2.1.1 The 5 Whys

The 5 Whys technique [6] was recommended by Bence Golda.

The 5 Whys is a technique to find the root cause of a problem (in my case a feature) simply by asking the question "Why?" multiple times. With this technique I can find out what does the user would like to achieve by using a feature. Why would the user like to use

this feature? Does the user really want to use this or should the portal do this by default instead of the user? The 5 Whys also helps to decide when I should implement only one general feature instead of many specific features. For example, if the user wants to have 15 specific analytic features, I could consider making a general one instead of specific ones.

Example:

The student wants to list his commits from every branch in the laboratory's repository.

- *Why?* – Because the student wants to tag one commit as final version.
- *Why?* – Because the evaluator will know which commit contains his homework.
- *Why?* – Because the evaluator has to correct the student's homework.
- *Why?* – Because the evaluator has to give the student a grade.
- *Why?* – Because the student has to pass the laboratory in order to pass the course.

In consequence of the 5 Whys, I also filtered out some features. Then I started to write the user stories to establish the basics for test automation.

2.1.2 User Story

A user story is a description of how can the user interact with the system, and what does the user have to do to use a certain feature. User stories are written in everyday language, and I can use them to run automated tests with a software tool.

Given When Then

In test-driven development (TDD) a developer first writes tests and then write then implements. A test is based on the specification, and the purpose of implementation is to pass the tests.

In behavior-driven development (BDD) a developer first writes behaviors and then implements. A behavior describes how the software should behave in certain situations. Tests and behaviors are similar, but behaviors are written in a ubiquitous language. This language helps focusing on the behavior of the software and makes the tests fluidly readable [56] [10].

The Given When Then [49] [50] technique is a convention to write user stories in BDD. It was made by Dan North and Chris Matts.

The *Given* describes a state of the system. The *When* describes an event. The *Then* describes the result. If there are multiple Givens, I can use *And* or *But*. If you have the same Given statement for many stories, you can combine them as a *background* section. A *scenario* is an example of an executable action [46].

Example:

Background:
    Given a logged in student named "Jakab"
    And the settings page is loaded

Scenario: Setting a new SSH public key
    Given I am logged in as "Jakab"

And I have entered a new SSH public key
When I press the save button
Then I should see "Your settings have been saved."

At first I wrote simple user stories without backgrounds and scenarios. I wrote them for all modules, and then I focused only on the student module, because that's the first module I will implement. I finished writing scenarios for only that module (see appendix B).

Cucumber

User stories are good starting points for acceptance test. For testing I will use Cucumber [47].

Cucumber is a software tool to run automated tests with user stories written in the Given When Then convention. Cucumber uses a parser named Gherkin [48] to parse feature files. A feature file contains user stories written in everyday language in a specific structure. Gherkin can parse user stories written in 65+ languages [**?**]. In this project I will use English user stories. The usage is described in section 7.2.

2.1.3 Contract

Design by Contract is a software development methodology made by Bertrand Meyer. A contract describes how a software's components a collaborates with each other. A contract has obligations and benefits. An obligation for a component is a benefit for the other component, and vice versa [51] [68].

I use this methodology to describe the communication between the back end and the front end. I was looking for an API specification tool to design the communication between the back end and the front end and a mock server tool, that implements that API specification.

Mock Server

Because I only develop the front end, I wanted to make sure that I can work on the implementation without waiting for back end modules to be finished. To do that, I have to write an API specification and use a mock server.

A *mock server* simulates the behavior of the back end and offers mock data to work with. With a good API specification it will offer the same data as the future back end, and gives the opportunity to test the developed front end modules before the back end is finished.

API Blueprint

I want to use my API specification as a readable documentation for humans and as a mock server specification. *API Blueprint* [3] is an open source project, that gives me the option to write my specification in Markdown. Markdown [8] is a markup language to write plain text format and it can be converted into HTML. Markdown is often used to style messages on forums and readme files.

Drakov

The API Blueprint [3] team offers some tools, that implements API Blueprint specification. *Drakov* [44] is one of these open source mock server tools. Its usage is described in section 7.1.

2.2 The Final Specification

The final specification was made by me and finalized by the team (see subsection 2.2.1).

During the specification phase I eliminated dispensable features. Although we wanted to keep some of the old portal's feature, we wanted to add new ones too. Some of these new features were already supported by the old portal, but in a different way. I have decided to eliminate one of these features to prevent duplication.

For example, the first version of the specification included file uploading for the reports via the portal. This feature is dispensable, because the user can store the reports in the git repository too. I could eliminate the git repository feature and keep the file uploading feature, but the course's goal is to teach the students how to use version control, and file uploading is not a version control system. Eliminating this feature leads to less task for the user, because he does not have use two features to submit his homework.

2.2.1 User Roles

In the new portal there will be four different user roles: student, demonstrator, evaluator and administrator.

Student Role

The student can:

- see general information about his classes
  - when will it be
  - where will it be
  - who will be the teacher
  - when is the deadline for submitting the homework
  - how much time is left until the deadline
  - what is the Git remote URL
    - The portal doesn't have an option to upload files, because students use Git repositories to upload their homeworks.
    - With every laboratory they get a new Git repository in the Database Laboratory GitLab.
- check his results
  - his entry test grade
  - his laboratory report grade
  - his laboratory report review

  - who was the evaluator
  - his laboratory grade
  - his laboratory review
- list his commits from every branch in the laboratory's repository
- tag a commit as a final version
  - When the deadline is over, the back end will tag every branch's last commit.
  - If the student didn't tag any commit as final version, the evaluator will check the solution only the master branch's commit, that was tagged by the back end.
- see a summarized view of his grades

Teacher

The teacher can be a demonstrator and/or an evaluator (see appendix A). If a teacher is both a demonstrator and an evaluator, then the portal will give an option to choose between the roles, e.g., the menu will contain a button for switching roles.

Demonstrator Role

The demonstrator can:

- see his current class with a list of students, who attended that class
  - This list also contains the students' laboratory report grades and reviews.
- give the students entry test grades
- give the students laboratory grades
- give the students laboratory reviews
- choose another class to list the students, who attended that class
  - save the student's results as a draft
  - continue writing a saved review draft
  - publish the results for the student

Evaluator Role

The evaluator can:

- see a maximum of 4 lists of homeworks
  - If a list doesn't have any element, it won't appear on the page.
  - The first list contains the homeworks, that are waiting for evaluation and are booked by the evaluator.

  - The second list contains the homeworks, that are waiting for evaluation and not booked yet.
  - The third list contains homeworks booked by another evaluator, who evaluates the same type of homeworks.
  - The fourth list contains the evaluated homeworks.
- book homeworks for himself for evaluation
- choose a homework to start the evaluation
- see the student's name and the Git remote URL as a general information for a homework
- give a laboratory report grade for a homework
- write a review for a homework
  - save the review as a draft
  - continue writing a saved review draft
  - publish the grade and the review for the student
  - If the student didn't tag any commit as final version, the evaluator will check the solution only in the last commit in the master branch.

Administrator Role

The administrator role is a teacher role expanded with additional features.

The administrator can:

- run SQL queries
- search for users
  - with name
  - with username
  - with id
- can change a user's e-mail
- can change a user's password
- can impersonate any user
- modify an evaluator's homework types
- add a new entry test question
- modify an entry test question
- delete an entry test question
- add a new event
- modify an existing event

- delete an existing event
- see the statistics
  - list the unpublished reviews
  - list the homeworks that are waiting for evaluation

Default Options

Any type of user can:

- upload a new SSH public key
- set a new e-mail address
- set a new password
- change his mailing list subscription
- change his e-mail notifications subscription

2.3 Design Sketches

For the graphic design I need to know how many pages are needed for each user roles in each modules. In this thesis I present the implementation of the student module. This module is only available for users with student role. In the student module I will implement the following features in priority order:

1. see the general information about the classes
1. see the results
2. list of commits and tagging a commit as final version
2. set new password, e-mail and SSH public key
3. summarized view of student's grades

The features with priority level 1 are mandatory, because without these features the portal will be useless for the students.

The features with priority level 2 are important, but the portal is not useless without it. The students can still tag a commit with a Git client, or merge the final commit with the master branch to make it the master branch's last commit.

The features with priority level 3 are not important, but can be useful for students. The portal is useful without this feature, because the students can check their grades on the educational event's page.

In chapter 7, I will test the features with priority levels 1 and 2.

To be able to draw design sketches, we need to know when will a user login to use the Educational Support System and what kind of information is he looking for. As a student, there are 5 possible scenarios:

1. Before a laboratory
    - To get information about the laboratory
        - When will it be
        - Where will it be
        - Who will be the demonstrator
    - To read general information about the course
2. During a laboratory
    - To upload an SSH public key
    - To get his Git remote URL
3. After a laboratory, before the deadline for submitting the homework
    - To see the date of the deadline
    - To see how much time is left until the deadline
    - To see the pushed branches, commits and tags
    - To tag a commit as final version
4. After a laboratory, after deadline
    - To check the grades
    - To check the reviews
    - To check the evaluator's name
5. Other scenarios
    - To set a new e-mail address
    - To set a new password
    - To change the mailing list subscription
    - To change the e-mail notification subscription
    - To see a summarized table of his grades

With the scenarios and list of actions, we can see how many pages is needed for the student modules and how many states will one page have based on the scenarios. This module will have a laboratory page, a summarized view page and a settings page.

Laboratory page, before laboratory: For this information I will use only labels (see figure 5.1).

Laboratory page, during laboratory, after laboratory and before deadline: For the information, like deadline and entry test grade I will use labels. For the list of commits I will use a dropdown menu. When the page is loaded, the last final commit will be the chosen one. If the user did not chose a final commit before, the last commit in the master branch will be the chosen one (see figure 5.2).

Laboratory page, after laboratory and after deadline: For these information I will use labels. The reviews can be long, and I want to keep the design simple. Because of this, there will be a size limit for the label on the view, and the rest of the text will be hidden with an ellipsis. The user can click on the text to show the rest of the review in a pop up window (see figure 5.3).

Settings page, other scenarios: The new e-mail address, password and SSH public keys will have input fields. The subscription will be changeable with check boxes (see figure 5.4).

Summarized view page, other scenarios: The summarized view will be a simple table with the grades in it (see figure 5.5).

Menu: Because the user is looking for a specific set of information, the page will only contain the important information, and the previous, but still relevant information will be accessible with tabs on the laboratory page. To be able to switch between the pages, I will use a navigation bar on the top of the page. The bar will have the logo of the portal, student's name and neptun code and one button for each pages.

I drew sketches (see appendix C) for every scenarios with placeholder data.

2.4 Meh, kene ide egy jo alcim

*****TODO***: hibaágak -> fogalmam sincs mire gondoltam, amikor ezt leírtam**

***Bence*: - 2.3: ha a "hibaágak" tekintetében a specifikáció "zöltutas" megközelítését szeretnéd kiegészíteni hibaágakkal, akkor korábban ezt a megközelítést is definiálnod kéne,**

*****TODO***: mi az én feladatom?**

***Bence*: a hallgatói modul esetében a lehetséges hibautak felderítése a fenti "zöld" utak mellett. pl. mi történik, ha a hallgató email-cím beírása nélkül nyom a profil mentése gombra...**

Chapter 3

Comparing JavaScript Frameworks

For the project, I preferred to choose a JavaScript framework for faster development than using plain JavaScript with jQuery. Writing every component from scratch needs a lot of time. Hundreds of developers contribute in open-source frameworks, and developers can utilize their reviewed and tested work. This leads to getting more tasks done in less time. Because this project follows the MVC pattern (see section 3.8), only JavaScript MVC frameworks will be compared. The TodoMVC [1] website helps developers to select a JavaScript MVC framework for their project. It provides the same example written in JavaScript using different JavaScript MVC frameworks.

During comparison I checked the followings:

- **AJAX requests:** the client and the server (see figure 4.1) will communicate via REST using JSON format.
- **data binding:** to connect the data from the model to the view (see figure 3.1).
- **routing:** to build a single-page application.

***Bence*: 4. eleje: amiről még beszéltünk, hogy ellenőrizni kéne: különböző tesztelési módszerek alkalmazhatósága,**

In a single-page application (SPA) when the user opens the web site in a browser, all the resources will be downloaded with a single page load. From that point when the user interacts with the web site, it will dynamically update previously downloaded single page [52].

In JavaScript with *AJAX requests* we can send requests to a server asynchronously without reloading a page. In a SPA we want to make the browser think it is always on the same page. When the user clicks on a new link, the browser will not reload the whole page, it will just simply load the new view into the old frame. Everything happens in the background so the application will not force the user to wait while it sends data to a server. If the application is retrieving data, then when it arrives, the application can process it and show the result to the user.

The classic *data binding* model is when the view template and the data from the model are merged together to create the to be displayed view. Any data changes in the view will not automatically sync into the model. The developer has to write the controller that syncs the changes between the model and the view [24].

Upon URL change an SPA will not download a new page. It will navigate to the right part of the application. *Routing* takes care of this automatically. The SPA needs a routing table to know which URL belongs to which controller or view.

During the comparison I made a small test program in every JavaScript framework to try AJAX requests, data binding and routing. The source codes are publicly available on Github with a gulp file (see section 8.1) and an API blueprint test file for Drakov (see subsection 2.1.3).

3.1 React

My first choice was React [42]. It is developed by Facebook and Instagram since 2013.

React creates a virtual DOM instead of always updating the browser's actual document object model (DOM) [71]. The DOM provides a structured representation of HTML and XML documents. The objects are the nodes of the tree, and the tree structure is the DOM tree. In this case the DOM connects the HTML page to the JavaScript code. The virtual DOM is like a blueprint of the real DOM. Instead of containing a div[1] element, the virtual DOM contains a React.div element that is just data and not a rendered content. React is able to find out what has changed on the real DOM. It makes changes to the virtual DOM, because that is faster and then re-render the real DOM [43].

To create DOM elements, we can choose between JavaScript and JSX [41]. If we use JavaScript, then the code will render the HTML code for us. If we choose JSX, then we can mix JavaScript and HTML-like syntax, and we can insert the desired HTML code as the return statement.

For data binding React has a one-way data flow called Flux [40]. Flux supports data flow only in a single direction, downstream. This means if something is changed in the component tree, then it will cause the element to re-render itself and all of its descendants.

React focuses only on building views. The core React version does not have an option for routing and AJAX requests. If I want to support those in my application, then React should be combined with other frameworks or libraries to have a full MVC experience.

Test Program [67]
The components are separated into different JavaScript files. JSX was used to represent the views. Before the concatenation a JSX transformer converts the inline HTML-like JSX to JavaScript code. The React components' states were used as a model. Because React has not got an option for AJAX requests, jQuery was used to download some mock data from the mock server. React Router was used [64] for routing.

3.2 AngularJS

AngularJS [21] is one of the most advanced JavaScript frameworks nowadays. It has been maintained by Google for 6 years. It focuses mostly on dynamic views in web-applications.

Creating a website is done with an extended HTML vocabulary, like Android Layouts where we declare everything in XML. It uses a two-way data binding template [24] which means whenever either the View or the Model is changed, it will update the other one automatically.

[1] A div is a generic container in HTML. It helps structuring the HTML document [70].

Angular AJAX requests are similar to the AJAX methods in jQuery, but Angular takes care of setting headers and converting the data to JSON string. It can also be used in unit tests with ngMock [22], because it can create a mock server.

For routing Angular uses a special listener. It binds these listeners to links. If the user clicks on a link, Angular will simply push the page to the browser's history and replace the view with the new page. This will even allow the back button to operate. This method works only if the website is loading from a server, because it allows Angular to load into the memory otherwise the listeners cannot navigate through the pages [23] [25].

Test Program [65]
The controllers are separated into different JavaScript files and the views into different HTML templates. The routing connects the right HTML template to the right controller. The JavaScript files are concatenated using gulp. The HTML templates are in different HTML files. Variables inside the controllers were used as a basic model. The routing is not included in the core Angular framework, but Google provides a library for it.

3.3 Mithril

Mithril [31] is a small MVC framework created by Leo Horie. It uses a similar virtual DOM like React, but also implements controller features like routing.

When we are creating a website, Mithril first creates virtual DOM elements, that is a JavaScript object that represents a DOM element. Rendering will create a real DOM element from the virtual one [32] [34]. If we prefer using HTML syntax, we can use MSX [4]. It uses JSX, but transforms the output to be compatible with Mithril.

Mithril has one-way data flow, from the model to the view. It has an auto-redrawing system to ensure that every part of the UI is up-to-date with the data. It uses a diff algorithm to decide which parts of the DOM needs to be updated and nothing else will be changed. Mithril automatically redraws after all controllers are initialized and will diff after an event handler is triggered. It also supports non-Mithril events to trigger auto-redrawing [36]. If we need view-to-model direction, Mithril provides us an event handler factory. This returns a method that can be bound to an event listener [38].

Mithril provides a utility for AJAX requests. We can set an early reference for the asynchronous response and queue up operations to be performed after the request completes. [37] [33].

For routing Mithril needs a key-value map of possible routes and Mithril modules to connect the routes to the modules. Upon routing the module's controller will be called and passed as a parameter to the view. [35].

Test Program [66]
A Mithril module contains a model, a controller and a view. A controller is a JS constructor and the view is a function, that returns a virtual DOM. Modules are separated into different JavaScript files and concatenated with gulp. MSX transformer converts the HTML-like MSX to JavaScript code.

3.4 Comparison Table

	React	**Angular**	**Mithril**
AJAX requests	Not part of the core framework. Requires an external library or framework.	Provides simple AJAX methods. It can be used for unit tests, because it can create a mock server.	Provides a simple utility. An early reference can be set for the response to qeue up operations to be performed after the request completes.
data binding	One-way data flow, downstream. if something is changed in the component tree, it re-renders itself and all of its descendants.	Two-way data binding. Either the model or the View is changed, it will update the other one autimatically.	One-way data flow. Uses a diff algorithm, that decides which part of the DOM needs to be updated. It is triggered by event handlers.
routing	Not part of the core framework. Requires an external library or framework.	A special listener is binded to the links. It pushes the page to the browser's history.	Uses a key-value map as a routing table, that connects the URLs with Mithril module controllers.

Table 3.1. Framework Comparison Table

3.5 Conclusion

In performance both React and Mithril are faster than Angular, because they use virtual DOM. Angular's public API interface is much bigger than React's or Mithril's. React does not have routing and AJAX requests in its core library, so it depends on other libraries. I choose Mithril for this project, because it is self-contained, so it does not have to depend on other libraries. It has utilities built-in for routing and AJAX requests. And it has a small API with great documentation.

3.6 Supported Web Browsers

At first I am aiming to develop the portal for desktop browsers. The portal will support every browser, that is supported by Google [28]. The supported browsers are:

- Chrome
- Internet Explorer
- Firefox
- Safari

3.6.1 Internet Explorer

The portal will support Internet Explorer 10 and every newer version [27].

Because there are some features, that Mithril depends on and are not part of earlier Internet Explorer version, I added a shim JavaScript file to the project [39].

To force Internet Explorer to render in the highest available mode, I added a special meta tag in the html file [54] [7] (see section 6.3).

3.7 Frontend System Design

The front end system design depends on the chosen framework's behavior and it also depends on which software architecture pattern is used. This project follows the MVC pattern. In this section I am going to introduce the general MVC pattern and the final front end system design.

*****TODO***: Marshalling helyett talán jobb a "serialization" -> ábrán kijavítani**

3.8 MVC Pattern

The Model-View-Controller (MVC) is a software architecture pattern for user interface implementation, where the application logic is separated from the user interface.

In object-oriented programming the Model is the objects where the data from the database is stored. The View is the presentation layer. The user sees and interacts with the View. The Controller will process and respond to the user requests and invoke the changes in the Model.

3.8.1 MVC Web Applications

*****TODO***: Marshalling helyett talán jobb a "serialization" -> ábrán kijavítani**

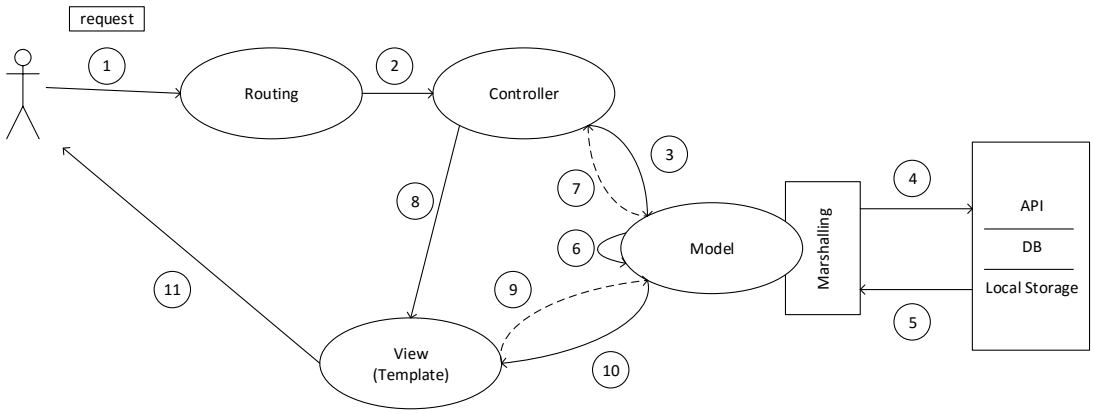

Figure 3.1. Classic MVC Web Application [2]

In web applications the browser communicates with a controller. When the user sends a request, routing will decide which controller will handle the request. The chosen controller talks to the model to get the relevant data. If it is necessary, the model will send data to or ask for data from the database, the API or the local storage. During this process, the data has to be transformed via serialization. serialization is the process, that transforms the data between storable and sendable dataformats. When the model returns the desired data to the controller, it will forward the data to the view. The presentation layer will decide which page has to be returned to the browser, binds the data to the view template and returns it.

3.8.2 Final Front End System Design

The final design is based on the classic MVC Web application (see figure 3.1) and the behavior of Mithril [30]. It describes the design of the client, but does not describe how the clients communicate with each other, because the different clients cannot communicate with each other.

The routing component handles the incoming requests. It uses a routing table to decide which controller has to handle the request.

The controller talks to the model, if any data should be changed or needed. The model sends data to the API or asks for data from the API. Every data is converted between the representation suitable for the implementation and the AJAX requests by the serialization component. The communication between the API and the client is handled by the server communication component.

The controller provides helper methods (e.g. getting data from the model) and it is passed as the first parameter to the view [35]. The rendered view is forwarded to the browser, that visualized it for the user.

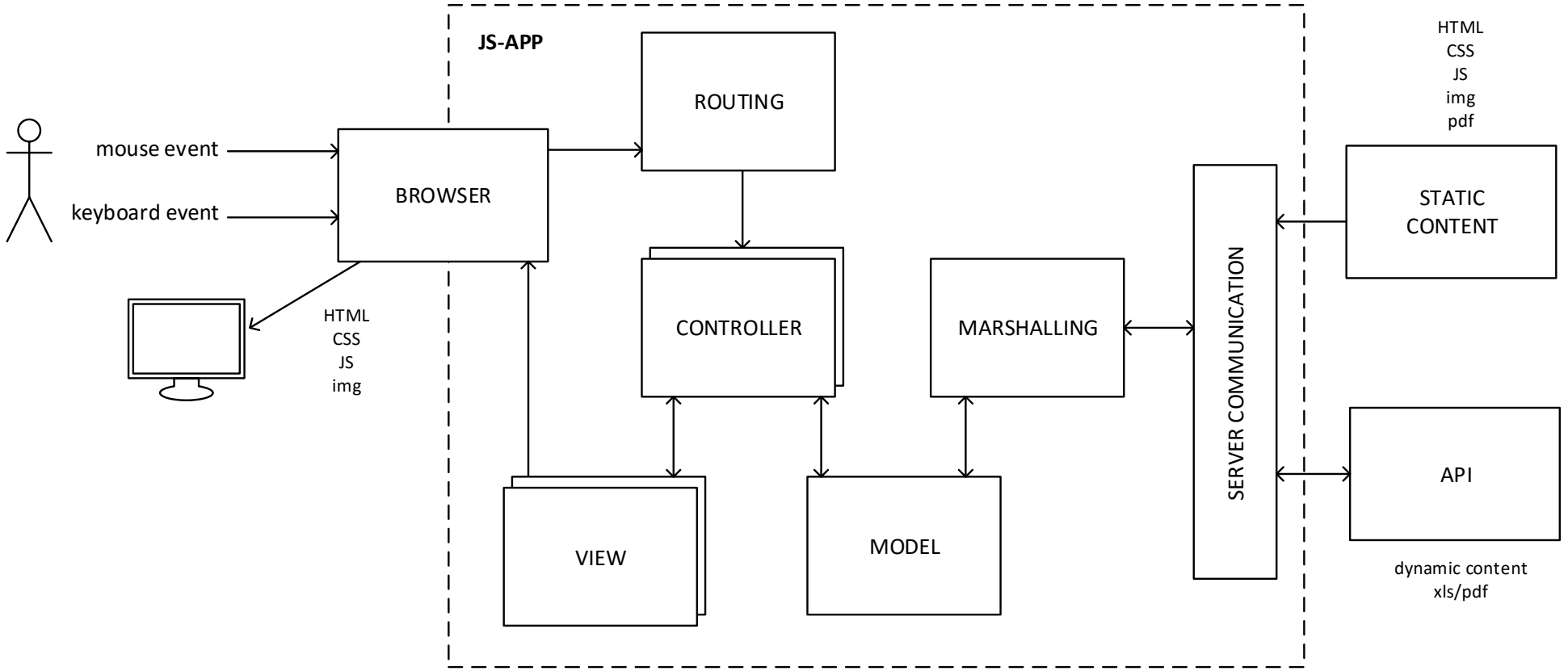

Figure 3.2. Front End System Design
The JS-APP was made by me and the outer layer was made by Bence Golda.

Chapter 4

Conceptual System Design

The conceptual system design represents a high level structure of the system's architecture. It defines the relations between the components. The components have to be separated from each other, because then every component is easily replaceable without changing any other components. The conceptual system design does not require the components to be implemented with the same technologies. The clients will be implemented in HTML, CSS and JavaScript (see chapter 3) and the back end components will be implemented in Ruby on Rails.

In this design the front end is represented as a basic component, because the front end system design was be introduced in section 3.7. About 15 percent of the model was created by me, 85 percent of it was created by Bence Golda and it was finalized by the team.

The main components are the followings:

- **Client:** A web portal, that is the communication bridge between the user and the web server. There will be three different modules: student, teacher and administrator. The different client modules can only communicate with the web server, and they cannot communicate with each other.
- **Database:** A database to store the system's data (see section 4.3).
- **Git:** A database to store the students' homeworks. Every student will get a different git repository for each laboratory.
- **Load Balancer:** It prevents the client from contacting the web server directly and solves the scalability problem. The client sends its requests to the load balancer, that will forward it to one of the web servers, depending on the client module, request type and the web servers' load.
- **Object-relational mapping:** It converts the data between the representation suitable for the implementation and the database.
- **Messaging:** A component, that supports messaging between the different components. The web server, the task manager and the workers will use this to send tasks to each other.
- **Task Manager:** A special worker. It gets tasks from the web server to decide which worker has to process it. After the decision it forwards the task through the message bus.

- **Web Server:** The server that runs the API's implementation. This component processes the incoming requests, creates tasks and forwards them to the task manager. It also provides its clients the data from the databases. The API is written in Ruby on Rails.
- **Worker:** This will process the task, e.g., changes the user's mailing list subscription.

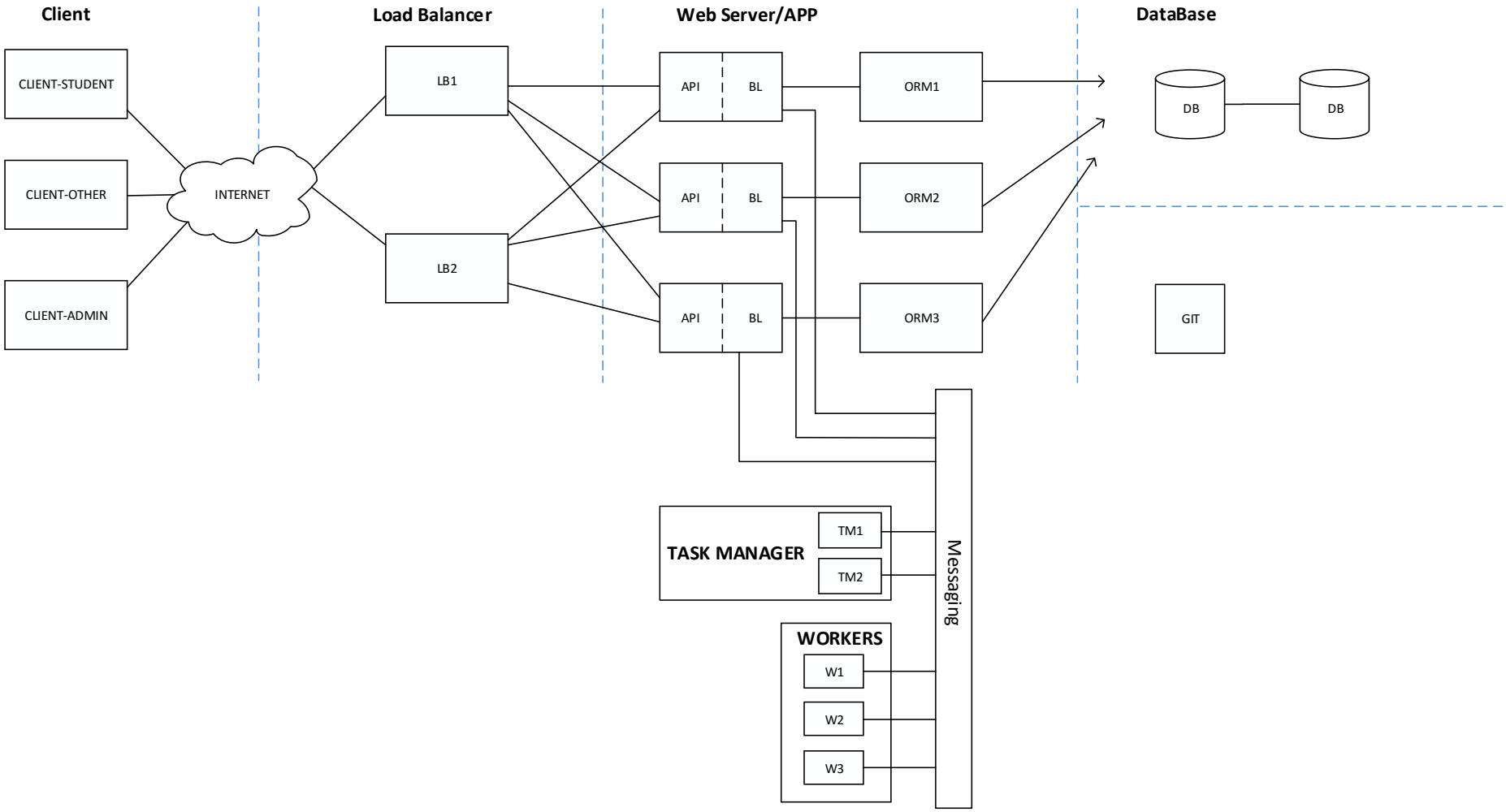

Figure 4.1. Conceptional System Design

4.1 Scalability

Client
To solve the scalability problem, the client's code will run in a web browser for every user. This way, resources for the client's code are provided by the user as he opens the web portal in a web browser.

Web Server
If there were not any load balancer between the client and the web server, then one server would get every request. With thousands of users this could lead to overload and high the response time. With a load balancer, the requests will first arrive at the load balancer, and it will decide which web server will handle that request and forwards it to that web server. The choice depends on the client module, request type and the web servers' load. The load balancer's purpose is to avoid overload and minimize the response time.

4.2 Data Security

Both the back end and the front end are divided into three big modules: student, teacher and administrator.

Web Server
This gives us the option to run the different modules on different computers or virtual machine instances.

Client
This ensures that one module's source code is not enough to deduce the available data, e.g., the student module will not include some API routing rules, that are included in the teacher module and the administrator module.

4.3 Entity–Relationship Model

A data model describes the structures in which the database stores the data. The *Entity-Relationship model* is a formal notation, that describes the data structure with entities and the relationships between them. An *entity* is an existing information, that needs to be modeled. *Properties (attributes)* describes the entities and makes them unique. A *relationship* describes a connection between entities [16].

The project's model uses Chen's notation. About 65 percent of the model was created by me, 35 percent of it was created by József Marton and it was finalized by the team. The attribute list is in appendix D.

The main entities are the followings:

- **Appointments:** An appointment connects the student groups with a date and a location.
- **Courses:** The courses, that use the portal.
- **Deliverables:** The things to be submitted by the students (e.g. homework).

- **Deliverables/Repositories:** A special type of Deliverables that is to be submitted through a repository.
- **Deliverables/Files:** A special type of Deliverables that is to be submitted as a file upload.
- **DeliverableTypes:** Describes the type of the submitted homework, e.g. documentation, source code.
- **Events:** An educational event is a class with a date for a particular student to participate.
- **EventTypes:** An event can be any type of class: lecture, laboratory or seminar. The Software Laboratory course has only laboratories.
- **ExerciseCategories:** Describes the type of the laboratory: DBMS, SQL, JDBC, XML technologies in databases or SOA.
- **ExerciseTypes:** Describe the topic and the language of the exercises.
- **RegisteredStaffs:** A many-to-many relationship between the Semesters and the Staffs. It describes the staff member's role in the semester.
- **RegisteredStudents:** A many-to-many relationship between the Semesters and the Students. It describes which Neptun course the student registered for in the semester.
- **Semesters:** An instance of the course in a particular academic term.
- **StudentGroups:** In Software Laboratory 5 the students are assigned to different groups. A group has one demonstrator and about 20 students.
- **Users:** People, that use the portal during a semester.
- **Users/Staffs:** A type of user, who is not a student. This user can be an administrator and/or a demonstrator and/or an evaluator.
- **Users/Students:** A type of user, who attends the laboratories and solves a list of tasks.

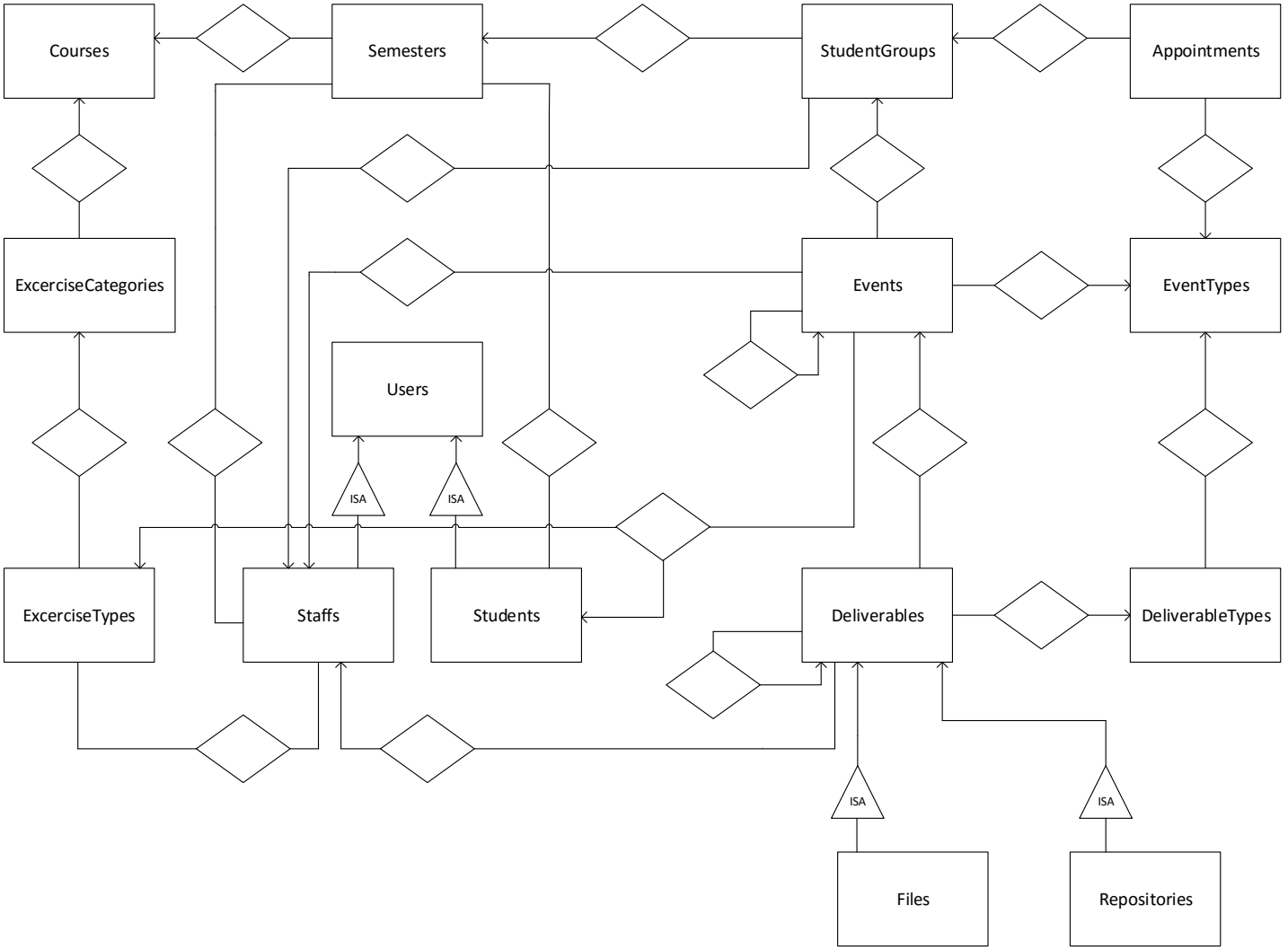

Figure 4.2. Entity–relationship model

Chapter 5

Graphic Design

During the specification phase I prioritized the features and planned how many pages are needed and what kind of components are needed to provide the features for the user (see section 2.3). Then I drew some sketches to see how these components would look like altogether (see appendix C). The next step was to decide what kind of design elements and templates I want to use to create the planned layouts.

5.1 Design template

To show only a specific set of information I have decided to use a minimalist design. A minimalist design is a clear design, focusing on typography, space, color and basic design elements. This way the portal will show as much information as the user needs with as few elements as possible.

To look for templates and ideas I read the Designmodo blog [11] and checked all the popular websites, e.g., Facebook, Github, Twitter and Medium. Designmodo also have purchasable website builders, like Slides [12], but I prefer the simple design of the Bootstrap elements [62].

Bootstrap is a free and open source HTML, CSS and JS framework to create responsive design. It was originally a part of Twitter as Twitter Blueprint, but in 2011 it was released as an open source project. Bootstrap contains elements for responsive web design and mobile design. Bootstrap 4 alpha was launched in August 2015 alongside with a new side project, Official Bootstrap Themes [63]. Bootstrap Themes are purchasable redesigned collections of Bootstrap components with new components and plug-ins. Although I really like these themes, I will use the free components, because it does not worth buying any theme if I will change some parts of the included components.

5.1.1 Colors

After deciding what kind of design framework will I use, I had to choose the colors of the portal. Both the Budapest University of Technology and Economics [57] [58] and the Faculty of Electrical Engineering and Informatics [60] [61] have their own Visual Identity Guidelines. A visual identity guideline contains the description of which color is the official color of the institution and in what kind of text which fonts and why that specific font should be used.

I consulted with my advisor, Sándor Gajdos and he advised me that I should not follow any of these visual identity guidelines. Following any of the strict guidelines can be a problem in the future, if someone would like to use this portal for another course that does not belong to the faculty or the university. Based on my subjective opinion I have decided to use green as the main color of the portal. I used the Google Color palette [26] to choose a nice green, changed it a bit, and I got the final color, #2a623d.

5.2 Final Graphical Design

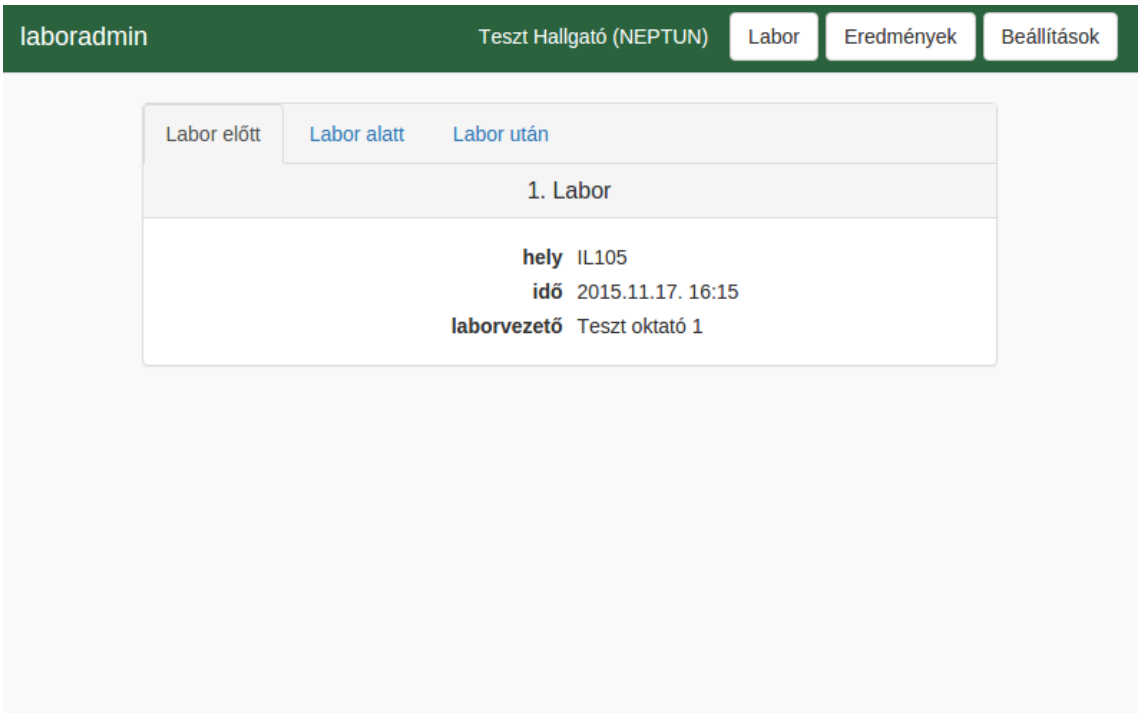

Figure 5.1. Before laboratory

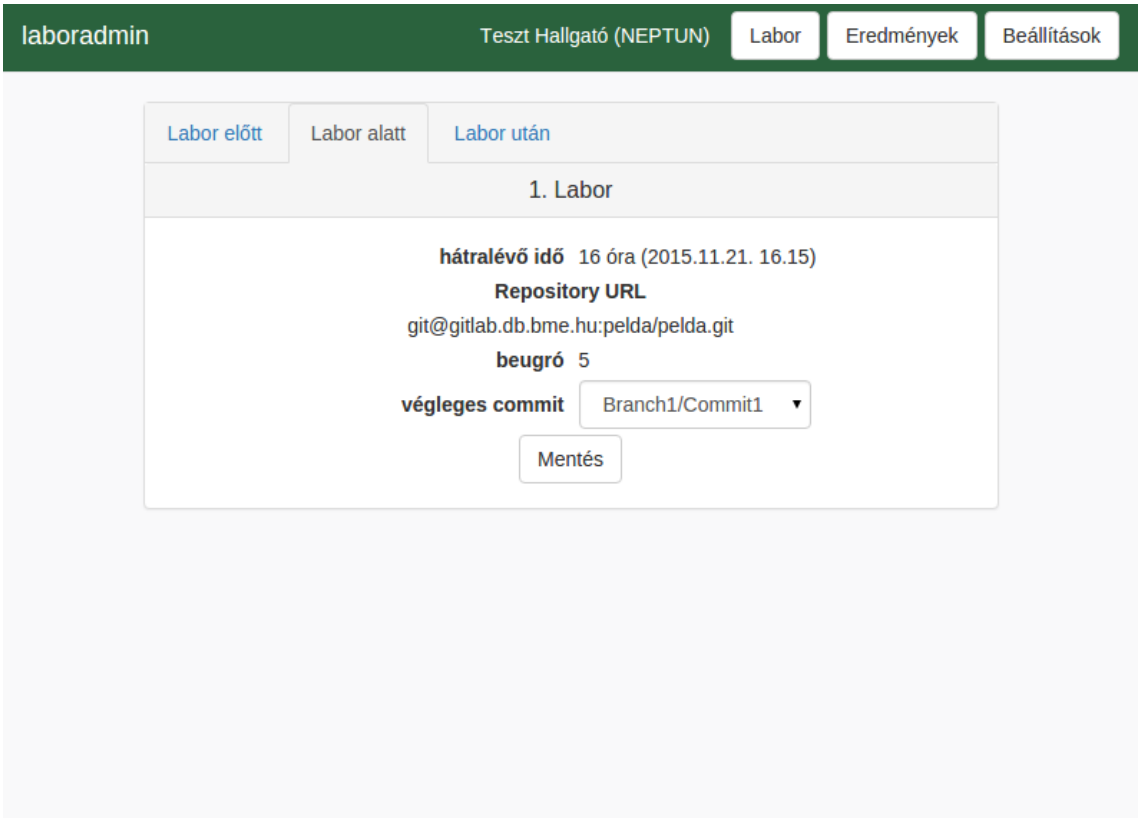

Figure 5.2. During laboratory

TODO: popup screenshot

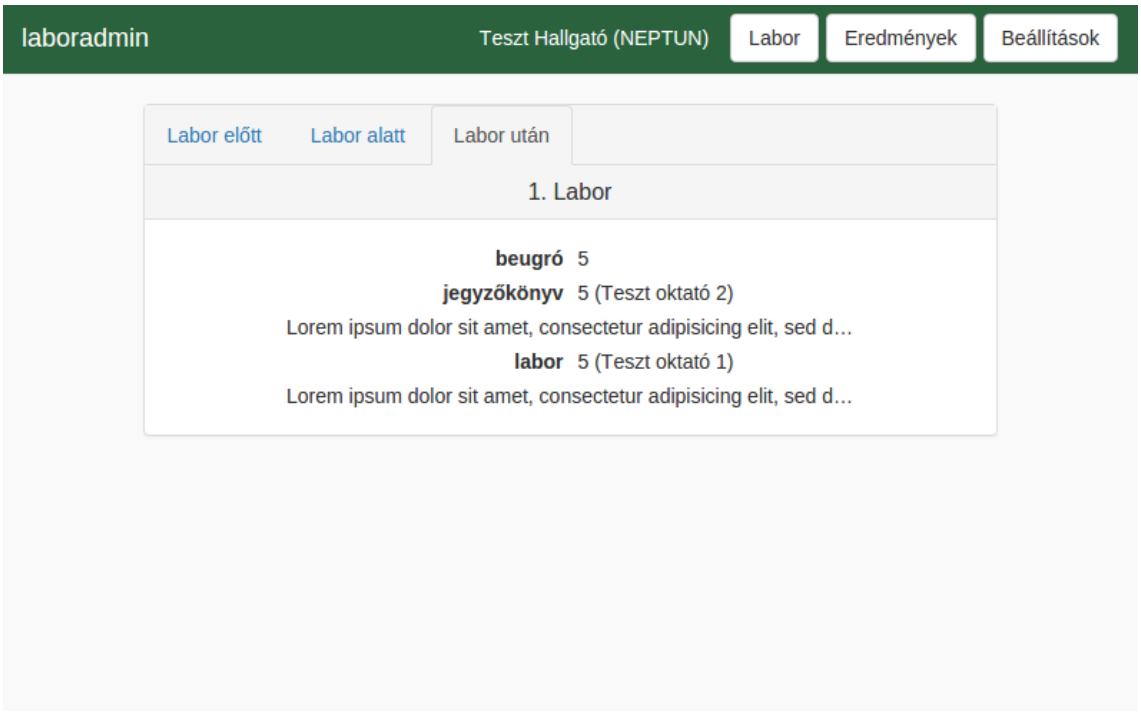

Figure 5.3. After laboratory

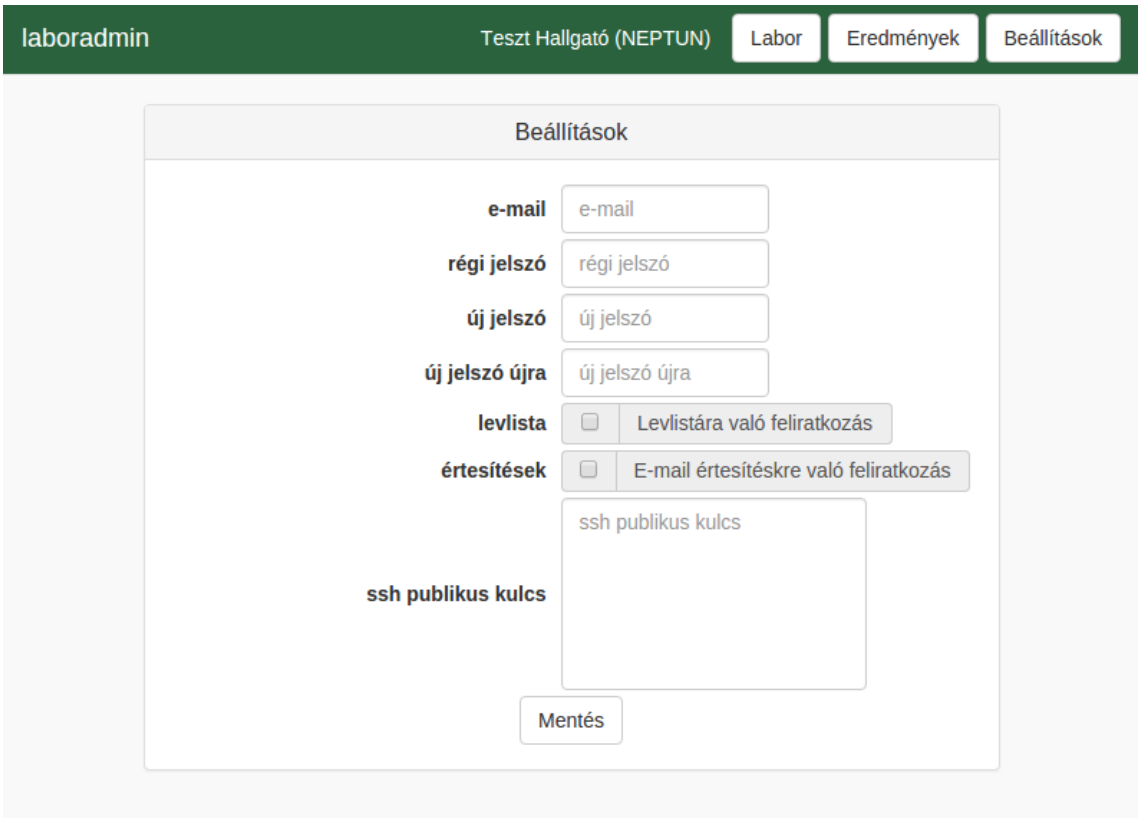

Figure 5.4. Settings

*****TODO***: életlenséggel valamit csinálni kell, hogy fog ez kinézni nyomtatva?**

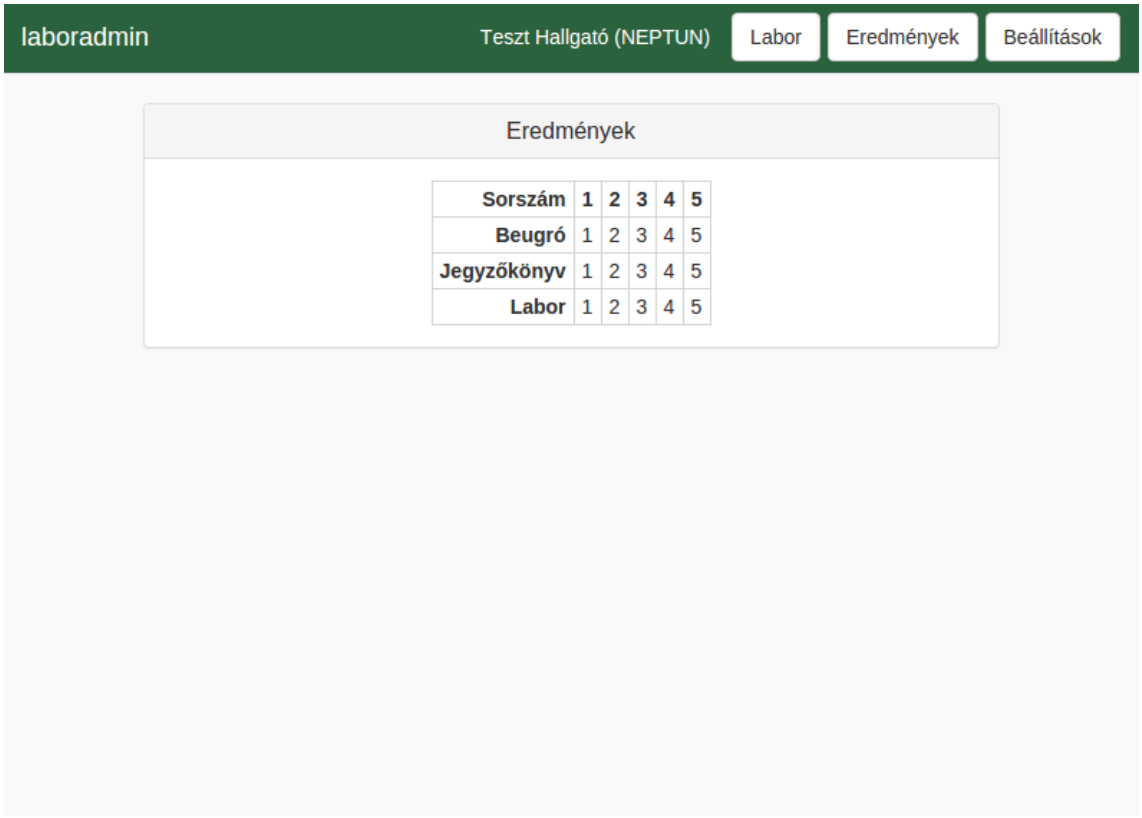

Figure 5.5. Summarized results

Chapter 6

Implementation

The team has decided, that the portal is an open source project. The source code is available on GitHub. This offers an opportunity for new students and staff to contribute in the project.

*****TODO***: github link**

6.1 Version Control

GitHub [19] is an online Git repository service. Git is a version control system. In a new commit, it stores snapshots of the file system. If a file did not change, then Git links it to the previous version [17]. GitHub offers private and public repositories too. In this project we use public repositories and the Git Workflow [20].

6.1.1 Git Workflow

When many developers work on the same project, their aim is to keep the master branch clean. A branch is a pointer to one of the commits (snapshots). The default branch is the master branch. To keep the master branch clean, developers can create a new branches. While developing a feature, the developer commits into a second branch. These changes does not affect the master branch. When the feature is finished, then the developer has to merge it into the master branch. If the master branch did not change, it will move the pointer to the new commit. At this point the new branch can be deleted, because the master branch points at the same commit [18].

If the master branch changed before, Git can do a three-way merge between the common ancestor, the last commit in the master branch, and the last commit in the second branch. Git can do this automatically, if a same part of a same file is not changed. In that case the developer can either accept one of the files or merge them by hand [18].

6.2 Used Software Tools and Open Source Projects

The front end uses the following open source projects and software tools:

- **API Blueprint:** API Blueprint [3] is an open source project, that gives me the option to write my specification in Markdown. I use it to describe the contract between the back end and the front end.

- **Bootstrap:** Bootstrap [62] is a free and open source HTML, CSS and JS framework to create responsive design. I use it as a template for the portal's design.
- **Cucumber:** Cucumber [47] is a software tool to run automated tests with user stories written in the Given When Then convention.
- **Drakov:** Drakov [44] is a mock server tool, that implements API Blueprint specifications. I use it as a mock server for the features, that are not provided by the back end yet.
- **GitHub:** GitHub [19] is an online Git repository service. The project's source code is available on GitHub.
- **Gulp:** Gulp [29] is a software tool to automatize tasks. I use it to concatenate and minimize files, transform HTML-like syntax in JavaScript files and move them to another directory and then to start the mock server.
- **Mithril:** Mithril [31] is a small JavaScript MVC framework. The front end is implemented in Mithril.

6.2.1 Documentation

This thesis and all the documents for this project were written in LaTeX [45]. LaTeXis a markup language to create scientific documents. A TeX distribution produces the PDF output.

The thesis template [15] for LaTeXwas created by the Fault Tolerant Systems Research Group (FTSRG) at the Department of Measurement and Information Systems, and was recommended by an FTSRG team member, Gábor Szárnyas.

All the figures were made by me in Microsft Visio 2013 [53]. Visio is free for students via DreamSpark [59].

6.3 Method of Implementation

***Nóri*: Bence kommentek jó része idáig feldolgozva**

During implementation I used HTML, CSS and JavaScript to create the web application. For deployment I used a gulp script written by me (see section 8.1).

HTML is a standard language to create websites. CSS describes the style of the HTML elements. The styles are binded to the elements within the class attribute. JavaScript is a script language to make websites interactive. Web applications use JavaScript for AJAX requests and event action handling.

HTML

As the first step I created a basic HTML page. An HTML page has a head and a body section. All the meta data belong to the head section, and anything I want to display on the page goes to the body section.

In the *head section* I included a charset option and set it to utf-8 for Unicode character encoding. I added one more important meta data, the *http-equiv="x-ua-compatible"*. I use this meta tag to force Internet Explorer to render in the highest available mode [54] [7].

This solves the problem, that Internet Explorer wanted to open the website in IE10 Compatibility Mode. I also included a title and linked the main CSS file in the head section.

In the *body section* I created an empty div with an id attribute. The pages are rendered into this div. To make sure that JavaScript can render elements into this div, I included the JavaScript code after the closing tag of this div.

CSS

As the main CSS file I concatenate the Bootstrap CSS file with my own CSS file, called *laboradmin.css*. During concatenation I had to make sure that my CSS code will be after the Bootstrap code. This is important, because in CSS the last style rules overrides the previous ones. The Bootstrap CSS file contains the basic Bootstrap component styles. In the *laboradmin.css* file some parts of the Bootstrap CSS are overwritten, to make the components to have a different appearance than the basic Bootstrap appearance, e.g., font colors, background colors and border visibility.

JavaScript

***Bence*: Miért másolod össze a JS állományokat? Miért jó ez? Milyen nehézségeket okoz a fejlesztésnél, hogyan lesznek kiszolgálva éles környezetben? Mi az előnye ennek? ... Stb. Nem érzem megindokoltnak azt, hogy ez miért történik és mivel jár végül.**

As the main JavaScript file I concatenate all the JavaScript files into one file. This includes the following files:

- the shim file, because Mithril relies on some features what are not part of the previous Internet Explorer versions,
- the Mithril framework's minimized JavaScript code,
- the Moment [55] framework's minimized JavaScript code,
  - I use this framework to calculate the time difference between the current time and the deadline.
- the Bootstrap JavaScript file, because some components require it,
- jQuery, because Bootstrap depends on jQuery, and
- my JavaScript files.

***Bence*: Most össze vannak másolva vagy szét vannak választva? Nem értem. ((Tudom, hogy mit csinálsz, de a szövegből ez nem derül ki.))**

I separated my JavaScript files based on if it is a part of the model's, the controller's or the view's code.

I use MSX in my *view* codes. To make the inline HTML-like syntax more simple, I created different widgets, and use them as HTML tags. To build a page the followings are needed:

- a page, that contains the menu and the panel,
- a panel, that contains all the widgets, and

- the widgets, that contain the basic HTML elements.

The MSX transformer converts this HTML-like syntax into Mithril JavaScript code during the concatenation. In the HTML-like code, I add classes for every element. These class attributes will make the element's style look equal. Every class's style is defined in the CSS files.

The *controllers* are the communication bridges between the model and the views. The controllers have helper methods to get the necessary data from the model, or send data to the model and to change the behavior of the elements, e.g. disable buttons. The view uses these helper methods to bind data or event listeners to the elements.

Because I did not want more dependencies I have decided to implement a simple JavaScript class as the *model*. The model loads the necessary data from the server and stores it. The model can also send data to the server. All data flow between the model and the server go through a marshalling module for conversion.

6.4 mire figyeltem a kódolásnál

6.5 kód metrika

6.6 teszt lefedettség

6.7 eredmény

kód hol érhető el, melyik commit verziót mutatom be, gulpra hivatkozás

Chapter 7

Test

7.1 Mock Server Usage

7.2 Cucumber Tests

szerver oldali api felületek definiálása automata teszthez
automata rendszert keresni - drakov, api blueprint
teszt környezet leírása és használata

Chapter 8

Deployment

***Bence*: Megy az Windowson is, irreleváns a Linux rész**

I wrote a gulp script on Linux to automatize the deployment. This script creates the three downloadable files from the source codes.

8.1 Gulp

Gulp is a software tool to automatize tasks. I use it to concatenate and minimize files, transform HTML-like syntax in JavaScript files and move them to another directory and then to start the mock server.

To install gulp on Linux, I used the npm package manager from a terminal, that was opened in the project's root folder. Gulp can be installed as a global package with the following command:

***Bence*: Hívható parancsokat és konzolos kimeneteket nem dőlt betűvel szokás megjeleníteni. Monospace betűtípust használj és legyen egyértelmű, hogy melyik rész a meghívott parancs, mit kell root és mit lehet sima felhasználóként meghívni. És az is legyen egyértelmű, hogy mi a kimenet. Ha az túl hosszú, akkor illik rövidíteni**

npm install -g gulp

8.1.1 Gulp Plugins

I use the following Gulp plugins:

- drakov
- gulp-concat
- gulp-minify-css
- gulp-minify-html
- gulp-plumber
- gulp-uglify
- gulp-util

- msx
- through2

Use the following code to install plugins:

npm install [plugin1 plugin2 plugin3]

8.1.2 The Gulp File

The client's gulp file is added in the root directory.

First gulp uses the msx plugin, to transform the HTML-like syntax in the JavaScript files, then concatenates them. The concatenated JavaScript file is minimized and moved to the *dist* folder. I used the MSX plugin's example code for the msx transformation task [5]. Then gulp minimizes the HTML file and moves it to the *dist* folder. At last the CSS files are concatenated, minimized and the minimized file is moved to the *dist* folder.

Use the following command to run it:

gulp

The final three files are in the *dist* folder. These files will be downloaded from the server, when a user opens the portal in a browser.

Chapter 9

Conclusion

9.1 mit értem el

9.2 további tervek

Acknowledgements

leírni, hogy mindenkit nagyon szeretek.

List of Figures

List of Tables

Bibliography

[1] TodoMVC. http://todomvc.com/. Accessed: 2015-10-18.

[2] Suprotim Agarwal. The MVC Pattern and ASP.NET MVC - Back to Basics. http://www.dotnetcurry.com/aspnet-mvc/922/aspnet-mvc-pattern-tutorial-fundamentals. Accessed: 2015-12-06.

[3] apiblueprint. API Blueprint - API Documentation with powerful tooling. https://apiblueprint.org/. Accessed: 2015-12-01.

[4] Jonny Buchanan. MSX. https://github.com/insin/msx. Accessed: 2015-10-20.

[5] Jonny Buchanan. MSX Gulp Example. https://github.com/insin/msx/blob/master/gulpfile.js. Accessed: 2015-12-02.

[6] Karn Bulsuk. An Introduction to 5-why | Karn G. Bulsuk: Full Speed Ahead. http://www.bulsuk.com/2009/03/5-why-finding-root-causes.html. Accessed: 2015-12-06.

[7] Mathias Bynens and Hans Christian Reinl. html5-boilerplate/html.md at 5.2.0 · h5bp/html5-boilerplate. https://github.com/h5bp/html5-boilerplate/blob/5.2.0/dist/doc/html.md. Accessed: 2015-11-30.

[8] The Daring Fireball Company. Daring Fireball: Markdown. http://daringfireball.net/projects/markdown/. Accessed: 2015-12-01.

[9] Dr. Zoltán Czirkos. InfoC. https://infoc.eet.bme.hu. Accessed: 2015-10-18.

[10] Josh Davis. The Difference Between TDD and BDD - Josh Davis. https://joshldavis.com/2013/05/27/difference-between-tdd-and-bdd/. Accessed: 2015-12-06.

[11] Designmodo. Slides Framework: Beautiful Website Builder - Designmodo. http://designmodo.com/. Accessed: 2015-10-30.

[12] Designmodo. Slides Framework: Beautiful Website Builder - Designmodo. http://designmodo.com/slides/?u=2134#mobile. Accessed: 2015-10-30.

[13] Dictionary.com. Dictionary.com | Find the Meanings and Definitions of Words at Dictionary.com. http://dictionary.reference.com/. Accessed: 2015-11-18.

[14] Dictionary.com. Thesaurus.com | Find Synonyms and Antonyms of Words at Thesaurus.com. http://www.thesaurus.com/. Accessed: 2015-11-18.

[15] FTSRG. Thesis work · FTSRG/cheat-sheets Wiki. https://github.com/FTSRG/thesis-template-latex. Accessed: 2015-12-06.

[16] Sándor Gajdos. *Adatbázisok*. A-SzínVonal 2000 Nyomdaipari Kft, 2015. Language: Hungarian.

[17] Git. Git - Git Basics. https://git-scm.com/book/en/v2/Getting-Started-Git-Basics. Accessed: 2015-12-02.

[18] GitHub. Git - Basic Branching and Merging. https://git-scm.com/book/en/v1/Git-Branching-Basic-Branching-and-Merging. Accessed: 2015-12-02.

[19] GitHub. GitHub. https://github.com/. Accessed: 2015-12-02.

[20] GitHub. Understanding the GitHub Flow · GitHub Guides. https://guides.github.com/introduction/flow/index.html. Accessed: 2015-12-02.

[21] Google. AngularJS. https://www.angularjs.org/. Accessed: 2015-10-19.

[22] Google. AngularJS, API Reference, http. https://docs.angularjs.org/api/ng/service/$http. Accessed: 2015-10-19.

[23] Google. AngularJS, API Reference, location. https://docs.angularjs.org/api/ng/service/$location. Accessed: 2015-10-19.

[24] Google. AngularJS, Developer Guide, Data Binding. https://docs.angularjs.org/guide/databinding. Accessed: 2015-10-19.

[25] Google. AngularJS, Tutorial 7, Routing and Multiple Views. https://docs.angularjs.org/tutorial/step_07. Accessed: 2015-10-19.

[26] Google. Color - Style - Google design guidelines. https://www.google.com/design/spec/style/color.html#color-color-palette. Accessed: 2015-11-25.

[27] Google. Google Apps update alerts: End of support for Internet Explorer 9. http://googleappsupdates.blogspot.hu/2013/11/end-of-support-for-internet-explorer-9.html. Accessed: 2015-11-30.

[28] Google. Supported browsers - Google Apps Administrator Help. https://support.google.com/a/answer/33864?hl=en. Accessed: 2015-11-30.

[29] Gulp. Gulp. https://github.com/gulpjs/gulp. Accessed: 2015-12-06.

[30] Leo Horie. Getting Started - Mithril. https://lhorie.github.io/mithril/getting-started.html. Accessed: 2015-12-06.

[31] Leo Horie. Mithril. http://mithril.js.org/. Accessed: 2015-10-20.

[32] Leo Horie. Mithril, m. http://mithril.js.org/mithril.html. Accessed: 2015-10-20.

[33] Leo Horie. Mithril, m.request. http://mithril.js.org/mithril.request.html. Accessed: 2015-10-20.

[34] Leo Horie. Mithril, Render. https://lhorie.github.io/mithril/mithril.render.html. Accessed: 2015-10-20.

[35] Leo Horie. Mithril, Routing. http://mithril.js.org/routing.html. Accessed: 2015-10-20.

[36] Leo Horie. Mithril, The Auto-Redrawing System. http://mithril.js.org/auto-redrawing.html. Accessed: 2015-10-20.

[37] Leo Horie. Mithril, Web Services. http://mithril.js.org/web-services.html. Accessed: 2015-10-20.

[38] Leo Horie. Mithril, withAttr. http://mithril.js.org/mithril.withAttr.html. Accessed: 2015-10-20.

[39] Leo Horie. Tools - Mithril. http://lhorie.github.io/mithril/tools.html. Accessed: 2015-11-30.

[40] Facebook Inc. Flux website. https://facebook.github.io/flux/docs/overview.html. Accessed: 2015-10-19.

[41] Facebook Inc. JSX Specification. https://facebook.github.io/jsx/. Accessed: 2015-10-19.

[42] Facebook Inc. React. https://facebook.github.io/react/. Accessed: 2015-10-19.

[43] Facebook Inc. React, Working With the Browser. http://facebook.github.io/react/docs/working-with-the-browser.html. Accessed: 2015-10-19.

[44] Yakov Khalinsky and Marcelo Garcia de Oliveira. drakov. https://www.npmjs.com/package/drakov. Accessed: 2015-12-01.

[45] LaTeX. LaTeX – A document preparation system. https://www.latex-project.org/. Accessed: 2015-12-06.

[46] Cucumber Ltd. Cucumber. https://cucumber.io/docs/reference#scenario. Accessed: 2015-11-23.

[47] Cucumber Ltd. Cucumber. https://cucumber.io/. Accessed: 2015-11-23.

[48] Cucumber Ltd. Cucumber. https://cucumber.io/docs/reference#gherkin. Accessed: 2015-11-23.

[49] Cucumber Ltd. Given When Then · cucumber/cucumber Wiki. https://github.com/cucumber/cucumber/wiki/Given-When-Then. Accessed: 2015-12-06.

[50] Robert C. Martin. The Truth about BDD - Clean Coder. https://sites.google.com/site/unclebobconsultingllc/the-truth-about-bdd. Accessed: 2015-12-06.

[51] Bertrand Meyer. *Touch of Class: Learning to Program Well with Objects and Contracts*. Springer, 2009. Corrected printing 2013.

[52] Microsoft. ASP.NET - Single-Page Applications: Build Modern, Responsive Web Apps with ASP.NET. https://msdn.microsoft.com/en-us/magazine/dn463786.aspx. Accessed: 2015-10-19.

[53] Microsoft. Professional Flow Chart Diagram Software | Microsoft Visio. https://products.office.com/en-US/visio?legRedir=true&CorrelationId=95b14d1b-87e4-46b6-b02a-cba7af78dfd6&omkt=en-US. Accessed: 2015-12-06.

[54] Microsoft. Specifying legacy document modes (Internet Explorer). https://msdn.microsoft.com/en-us/library/jj676915.aspx. Accessed: 2015-11-30.

[55] Moment.js. Moment.js. http://momentjs.com/. Accessed: 2015-12-06.

[56] Dan North. Introducing BDD. http://dannorth.net/introducing-bdd/. Accessed: 2015-12-06.

[57] Budapest University of Technology and Economics (BME). BME Visual Identity Elements. http://www.bme.hu/mediakit-arculati-elemek?language=hu. Accessed: 2015-10-19, Language: Hungarian.

[58] Budapest University of Technology and Economics (BME). BME Visual Identity Guidebook. http://intranet.bme.hu/arculat/. Accessed: 2015-10-19, Language: Hungarian, Accessible only via BME Intranet.

[59] Budapest University of Technology and Economics (BME). DreamSpark (MSDNAA) @ BME. http://msdnaa.bme.hu/. Accessed: 2015-12-06.

[60] Budapest University of Technology, Faculty of Electrical Engineering Economics (BME), and Informatics (VIK). BME VIK Visual Identity Elements. https://www.vik.bme.hu/page/523/. Accessed: 2015-10-19, Language: Hungarian.

[61] Budapest University of Technology, Faculty of Electrical Engineering Economics (BME), and Informatics (VIK). BME VIK Visual Identity Guidebook. https://www.vik.bme.hu/files/00006209.pdf. Accessed: 2015-10-19, Language: Hungarian.

[62] Mark Otto and Jacob Thornton. Bootstrap. http://getbootstrap.com/. Accessed: 2015-10-30.

[63] Mark Otto and Jacob Thornton. Bootstrap Themes. http://themes.getbootstrap.com/collections/all. Accessed: 2015-10-30.

[64] rackt. React/Router. https://github.com/rackt/react-router. Accessed: 2015-11-15.

[65] Nóra Szepes. Angular test program. https://github.com/lordblendi/angular-test. Accessed: 2015-11-12.

[66] Nóra Szepes. Mithril test program. https://github.com/lordblendi/mithril-test. Accessed: 2015-11-12.

[67] Nóra Szepes. React test program. https://github.com/lordblendi/react-test. Accessed: 2015-11-12.

[68] Nóra Szepes. Eiffel. Technical report, Budapest, 2014. Language: Hungarian. This document is not publicly available.

[69] Nóra Szepes. Házibeadó portál, hallgatói elvárások. Technical report, Budapest, 2015. Language: Hungarian. This document is not publicly available.

[70] W3C. The global structure of an HTML document. http://www.w3.org/TR/html401/struct/global.html#h-7.5.4. Accessed: 2015-10-20.

[71] W3C. What is the Document Object Model? http://www.w3.org/TR/DOM-Level-2-Core/introduction.html. Accessed: 2015-10-20.

Appendix A

Data Dictionary

The data dictionary describes the meaning of the words and terms used in the Educational Support System and the Software Laboratory 5 course. To search synonyms and write definitions I used an online synonym dictionary [14], and an online explanatory dictionary [13].

- **Administrator** A person, who is responsible for running the administration system.
- **Course, subject** A program of instruction in a university.
- **Demonstrator** A person, who teaches a group of students.
- **Entry test, short test, quiz** An evidence that verifies the preparedness of the student.
- **Entry test grade, mark** A number indicating the quality of the student's preparedness.
- **Evaluator** A person, who evaluates the laboratory reports.
- **Event, educational event** An educational event is a class with a date for students to participate.
- **Exercises, tasks** A list of exercises that provides experience to a student with a technology.
- **Laboratory** A type of class held in a computer laboratory by a demonstrator to a group of students.
- **Laboratory grade, mark** A number indicating the quality of the student's laboratory work.
- **Laboratory report, documentation** The documentation about how the student solved the list of exercises.
- **Review, remark** The evaluator's assessment of the quality of the solutions and submitted materials.
- **Semester, term** Half of a school year, lasting about five months.
- **Source code** The program code written by a student to solve a list of exercises.
- **Student, pupil** A person, who attends the laboratories and solves a list of tasks.

Appendix B

User Stories

Feature: Student module

As a student
I want to get information about my laboratories
to know where to upload my homework
And read the remarks of my homeworks
And change my basic settings

Before laboratory:

Background:

Given a student named "Jakab"
And his password and username are entered in the login fields
And it is one day before the laboratory
And a finished homework uploaded to the Git repository

Scenario: Getting information about the next laboratory

Given I open the Laboradmin page
When I press the login button
Then I should see the date of my next laboratory
And I should see the room number of my next laboratory
And I should see the name of my teacher

During laboratory:

Background:

Given a student named "Jakab"
And his password and username are entered in the login fields
And he is sitting at the laboratory

Scenario: Getting a Git remote URL

Given I open the Laboradmin page
When I press the login button
Then I should see a Git remote URL

Scenario: Check how many hours I have left

Given I open the Laboradmin page
When I press the login button
Then I should see a timer with a number between 96 and 92

After laboratory, before deadline:

Background:
Given a student named "Jakab"
And his password and username are entered in the login fields
And it's one day before the deadline
And a finished homework uploaded to the Git repository

Scenario: Getting a list of Git commits
Given I open the Laboradmin page
When I press the login button
Then I should see a list of branches, commits and tags

Scenario: Check how many hours I have left
Given I open the Laboradmin page
When I press the login button
Then I should see a timer with a number between 24 and 0

Scenario: Marking a commit as final
Given I open the main page
And I see a list of branches and commits
When I click on one of the commit in the list
Then I should see "The commit was marked as final."

Scenario: Removing a final mark
Given I open the main page
And I see a list of commits
And one commit is already marked as final
When I click on the master branch in the list
Then I should see "You have succesfully removed your final mark."

After laboratory, after deadline:

Background:
Given a student named "Jakab"
And his password and username are entered in the login fields
And it's one day after the deadline

Scenario: Getting my grade and review
Given I open the Laboradmin page
When I press the login button
Then I should see my grade and review

Other situations:

Background:
Given a student named "Jakab"
And his password and username are entered in the login fields

Scenario: Getting a summarized list of my grades
Given I am logged in as "Jakab"
When I press the summary button
Then I should see all of my grades

Background:
Given a logged in student named "Jakab"
And the settings page is loaded

Scenario: Setting a new SSH public key
Given I am logged in as "Jakab"
And I have entered a new SSH public key
When I press the save button
Then I should see "Your settings have been saved."

Scenario: Setting a new e-mail address
Given I am logged in as "Jakab"
And I have entered a new e-mail address
When I press the save button
Then I should see "Your settings have been saved."

Scenario: Changing my subscription for the mailing list
Given I am logged in as "Jakab"
And I clicked the checkbox next to "Subscription for mailing list
When press the save button
Then I should see "Your settings have been saved."

Scenario: Changing my subscription for notifications
Given I am logged in as "Jakab"
And I clicked the checkbox next to "Subscription for notification"
When press the save button
Then I should see "Your settings have been saved."

Appendix C

Design Sketches

I didn't use a tool, because the design is not standardized, and it's easier and faster drawing by hand then by a tool.

*****TODO***: szebben lerajzolni vonalzóval!!!!! vagy megcsinálni az egészet egy tool-lal, mert ez így csúnya és nem azért, mert nem tudok rajzolni, hanem mert scannelve van**

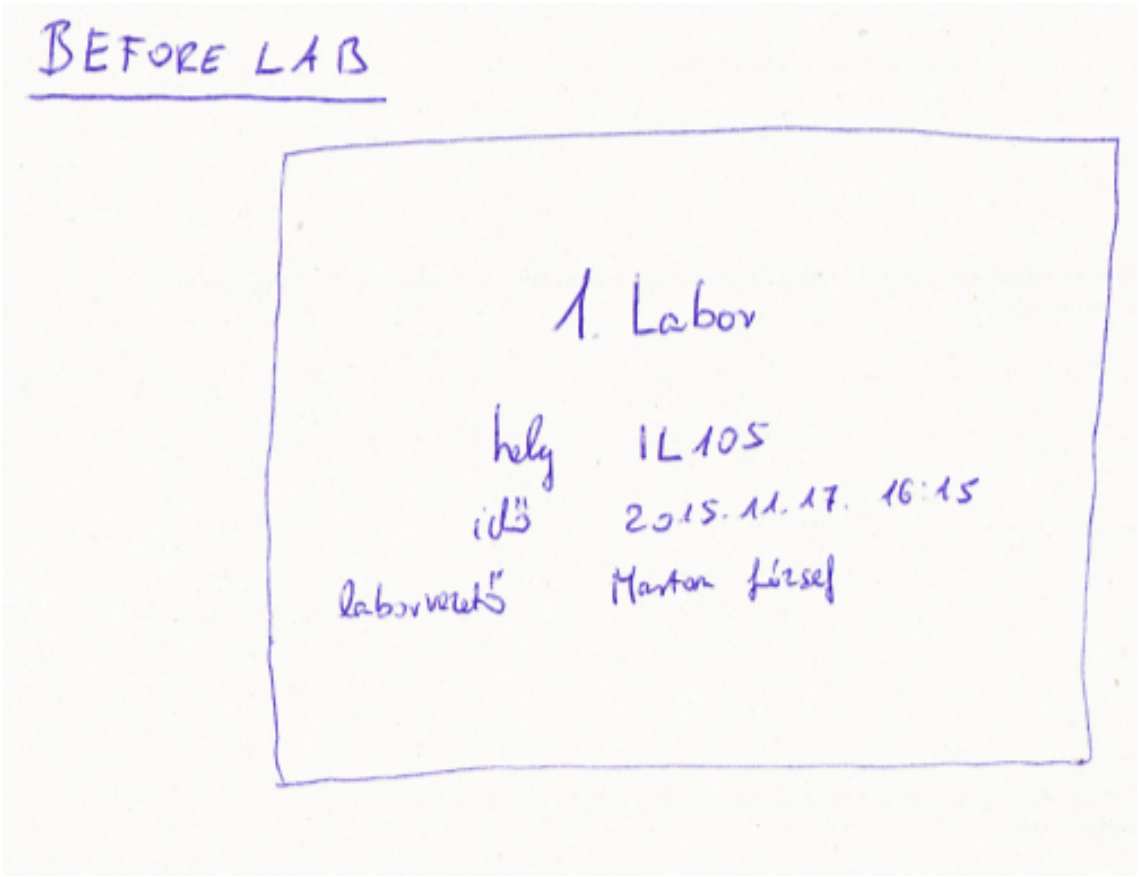

Figure C.0.1. Laboratory page sketch, before lab

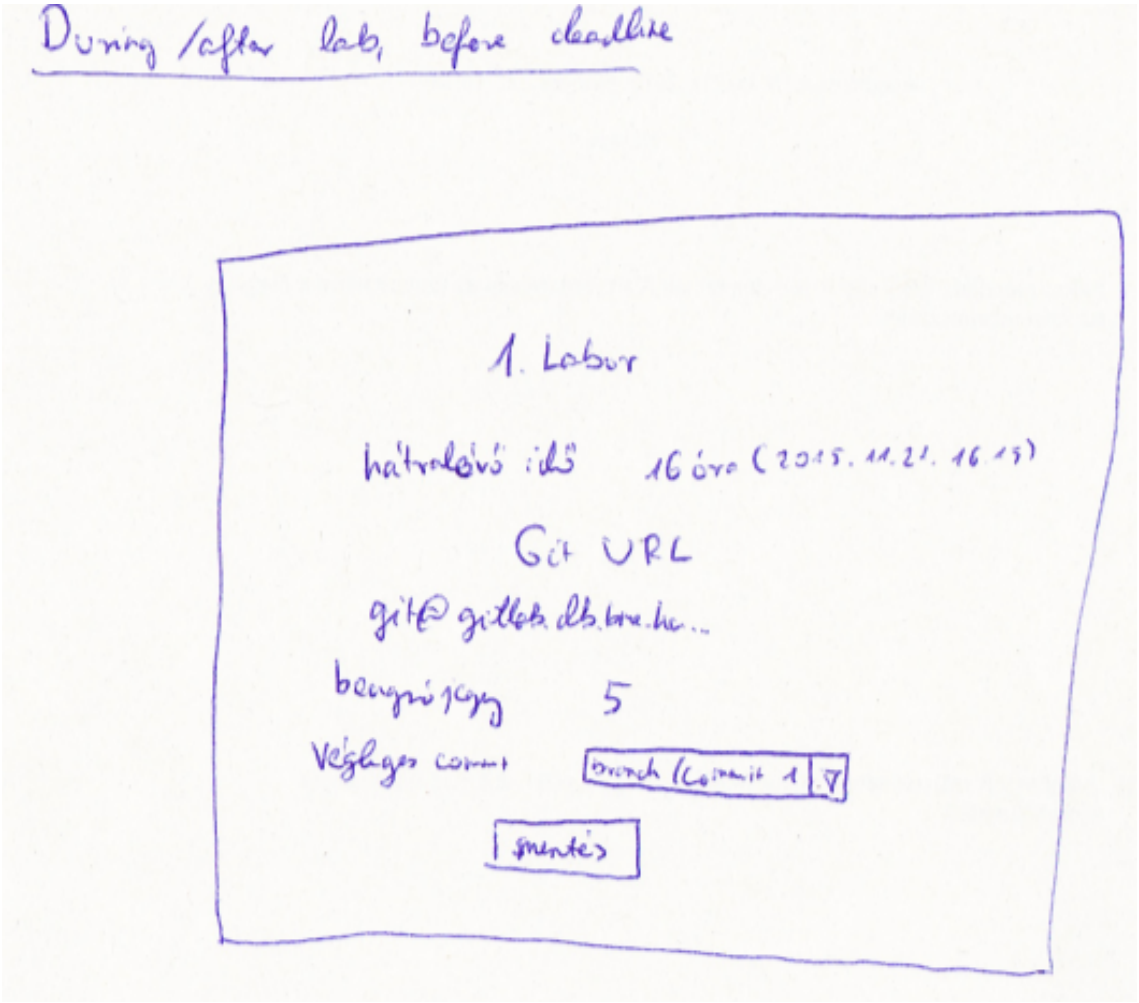

Figure C.0.2. Laboratory page sketch, during/after lab, before deadline

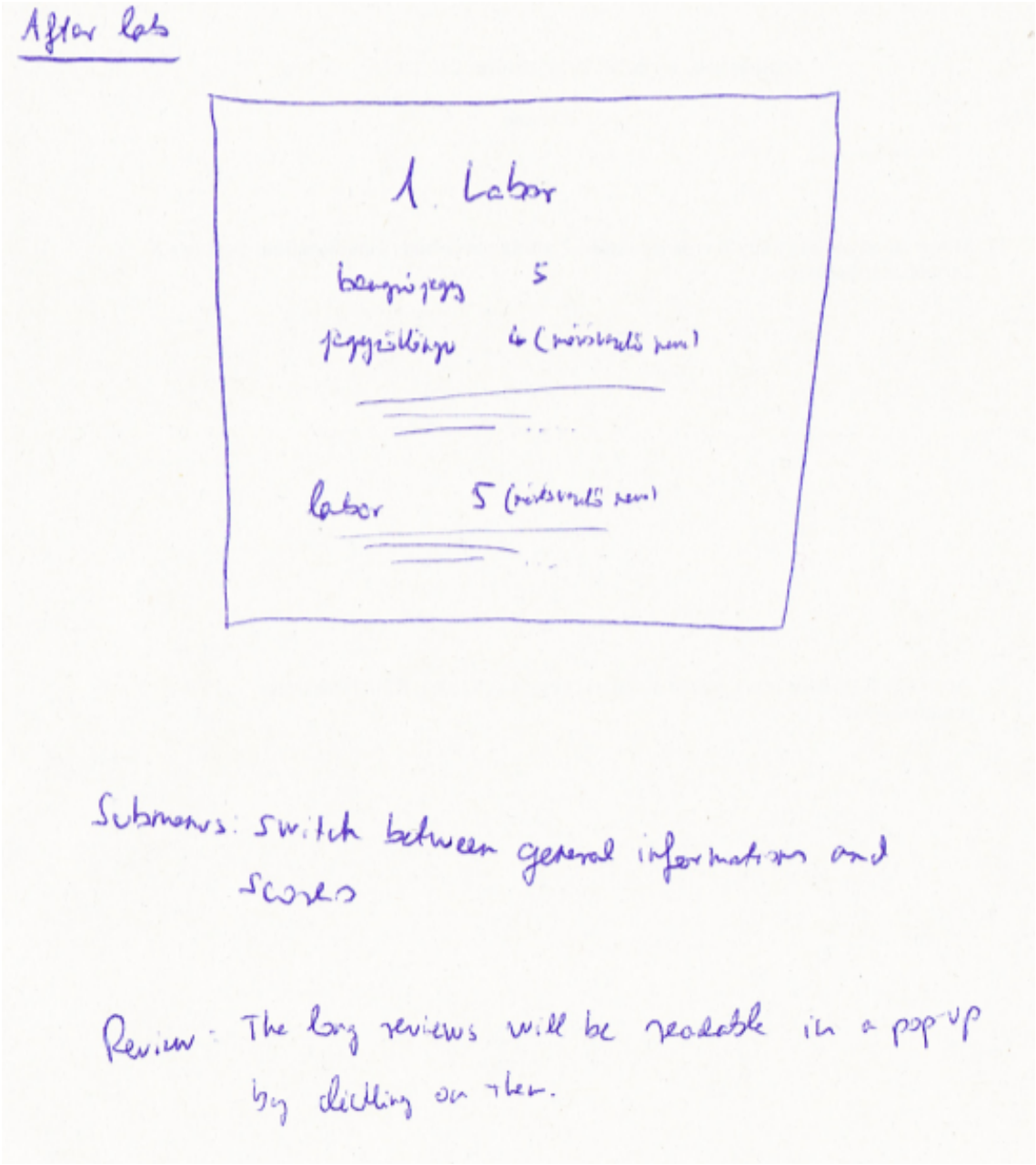

Figure C.0.3. Laboratory page sketch, after lab

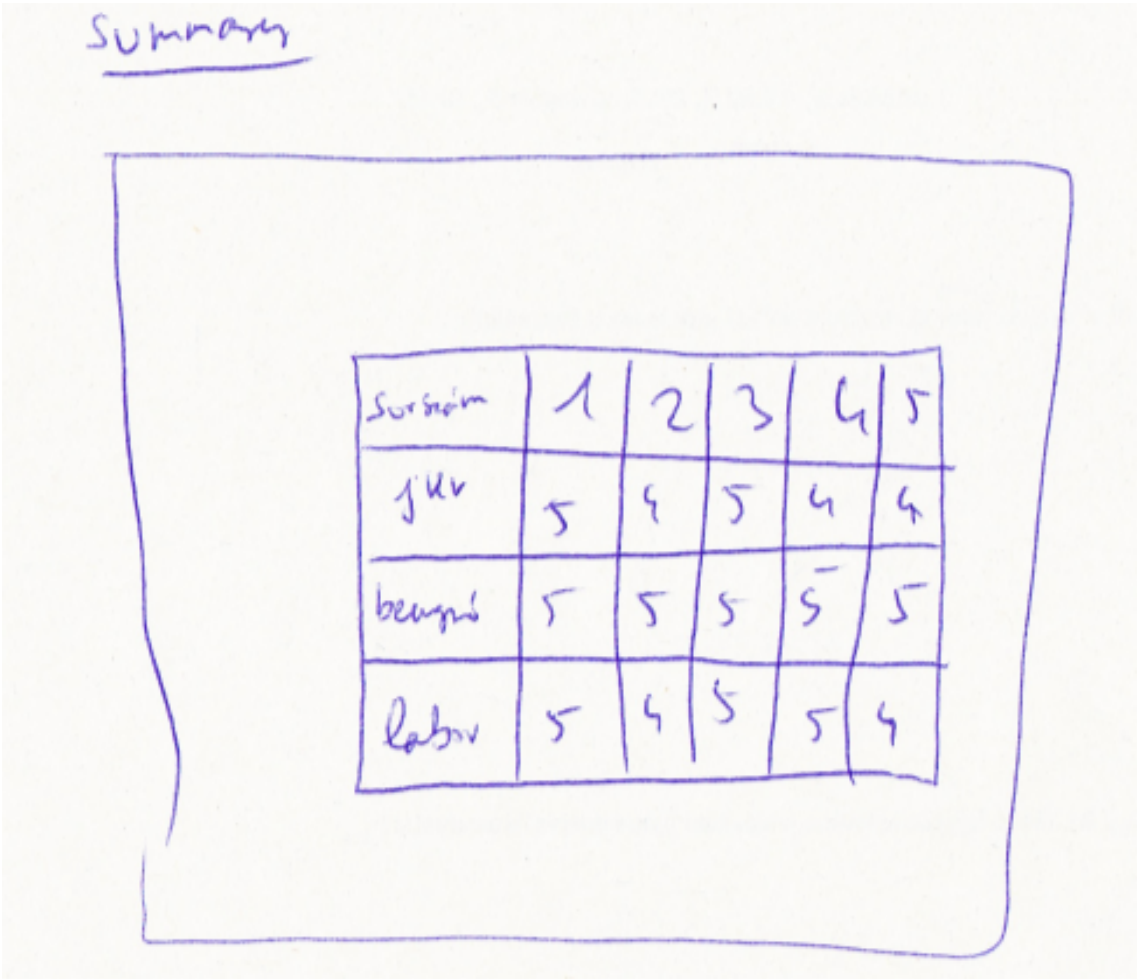

Figure C.0.4. Summary page sketch

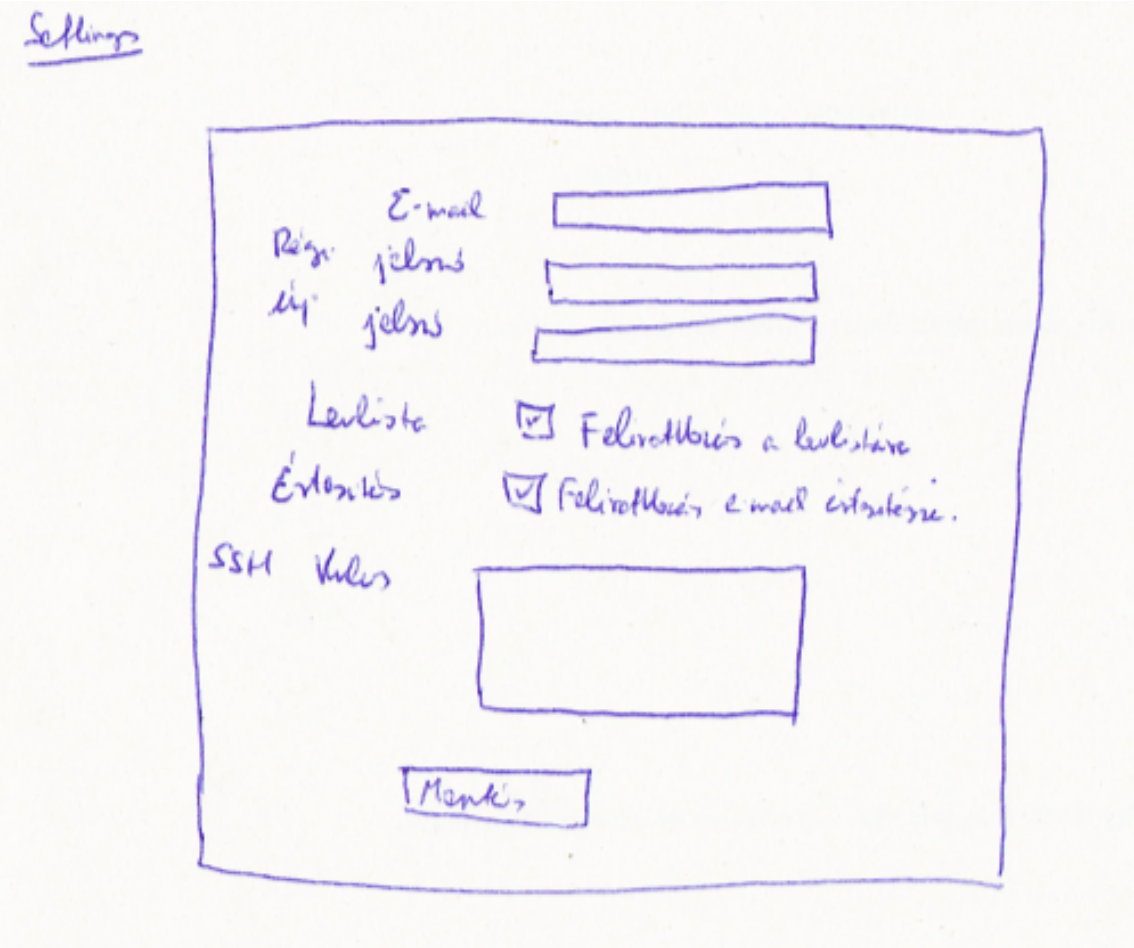

Figure C.0.5. Settings page sketch

Appendix D

Attribute List

- Appointments
  - attributes
    - id - number
    - date - datetime
    - location - text
  - foreign keys
    - eventtype - EventTypes
    - studentgroup - StudentGroups
- Courses
  - attributes
    - id - number
    - name - text
    - codename - text
- Deliverables
  - attributes
    - id - number
    - deadline - datetime
    - submitteddate - datetime
    - grade - number - 1-5
  - foreign keys
    - deliverabletype - DeliverableTypes
    - evaluator - Staffs
    - related - Deliverables
  - Deliverables/Repositories
    - attributes
      - url - text - type (svn, git) depends on the url
      - commit - text - chosen final commit
  - Deliverables/Files
    - attributes

        - size - number
        - sha256sum - text
        - filename - text

- DeliverableTypes
  - attributes
    - id - number
    - *****TODO***:**
  - foreign keys
    - *****TODO***:**

- Events
  - attributes
    - id - number
    - date - datetime
    - location - text
    - number - number - 1-5
    - title - text - DBMS, SQL, JDBC, X*, SOA
    - attempt - number - starting number: 1
    - shortdescription - text - generated
  - foreign keys
    - related - Events
    - eventtype - EventTypes
    - exercisetype - ExerciseTypes
    - demonstrator - Staffs
    - student - Students
    - studentgroup - StudentGroups

- EventTypes
  - attributes
    - id - number
    - *****TODO***:**
  - foreign keys
    - *****TODO***:**

- ExerciseCategories
  - attributes
    - id - number
    - *****TODO***:**
  - foreign keys
    - *****TODO***:**

- ExerciseTypes
  - attributes

        * id - number
        * *****TODO***:**
    - foreign keys
        * *****TODO***:**

- RegisteredStaffs
    - attributes
        * id - number
        * isadmin - boolean
        * isdemonstrator - boolean
    - foreign keys
        * staff - Staffs
        * semester - Semesters

- RegisteredStudents
    - attributes
        * id - number
        * neptunsubjectcode - text
        * neptuncoursecode - text
    - foreign keys
        * student - Students
        * semester - Semesters

- Semesters
    - attributes
        * id - number
        * academicyear - number
        * academicterm - number
        * description - text - generated
    - foreign keys
        * course - Courses

- StudentGroups
    - attributes
        * id - number
        * name - text
    - foreign keys
        * demonstrator - Staffs
        * semester - Semesters

- Users
    - attributes
        * id - number

    - givenname - text
    - surname - text
    - title - text
    - displayname - text - generated
    - loginname - text, unique
    - eppn - text - Sibboleth
    - email - text, unique
    - sshpubliykey - text
    - password - text
- Users/Students
    - attributes
        - neptun - text
        - university - text
- Users/Staff