Insert here your thesis' task.

Czech Technical University in Prague

Faculty of Information Technology

Department of Software Engineering

Master's thesis

Application for Entering and Evaluation of Written Exams

Bc. Adam Havel

Supervisor: doc. Ing. Tomáš Vitvar, Ph.D.

25th April 2014

Acknowledgements

THANKS

Declaration

I hereby declare that the presented thesis is my own work and that I have cited all sources of information in accordance with the Guideline for adhering to ethical principles when elaborating an academic final thesis.

I acknowledge that my thesis is subject to the rights and obligations stipulated by the Act No. 121/2000 Coll., the Copyright Act, as amended, in particular that the Czech Technical University in Prague has the right to conclude a license agreement on the utilization of this thesis as school work under the provisions of Article 60(1) of the Act.

In Prague on 25th April 2014 .....

Citation of this thesis

Havel, Adam. *Application for Entering and Evaluation of Written Exams*. Master's thesis. Czech Technical University in Prague, Faculty of Information Technology, 2014.

Abstrakt

V několika větách shrňte obsah a přínos této práce v českém jazyce.

Klíčová slova Replace with comma-separated list of keywords in Czech.

Abstract

Summarize the contents and contribution of your work in a few sentences in English language.

Keywords Replace with comma-separated list of keywords in English.

Contents

List of Figures

Introduction

Chapter 1

Realisation

1.1 Authentication

No part of the system is accessible without authentication. Upon loading, the client makes a `GET` request to a resource defined at `/api/user` and appends a session identifier if a cookie is found. The server then tries to look up the identifier in MongoDB-backed session store. If successful, it checks whether the session has not expired—if that is not the case, it sends the client a *JSON* object containing information about the particular user. The information is obtained by deserializing the user identifier from the session and using it to fetch relevant data from the database. The client application then fills its `User` service with the received object and the user is onward recognized as authenticated.

1.1.1 Logging in

In the opposite case—either no session was found or it has already expired—the server responds with a 401 status code which forces the client to redirect the user to a login form page. After filling in the form, the client makes a new request to the `api/user` resource, this time using the `POST` method, sending along user credentials. These credentials are then checked against a faculty *LDAP* server running at `ldap.fit.cvut.cz` using a secure connection. If user's identity is verified, the *LDAP* server responds with basic information about the user. Back at the application server, the database is queried with the user

identifier for additional data. It either finds a relevant entry or not. In the former case, the entry is updated with a new timestamp, representing the last login time, and the server sends it to the client as a *JSON* object, the same as before. If the latter is the case, it means that the user is logging in for the first time.

A new instance of `User` model is then created and filled with the available data. What remains unknown is the user's role—that is, if he or she is a student or a teacher. That information can be obtained by making a request to *KOSapi*, a faculty service that provides a *REST API* over the university information system *KOS*. To find out the role of a person with a given user identifier we can utilize the resource `/people/{uid}`. With that issue resolved, we can continue by looking up all courses the user either studies or teaches by using the resources `/students/{uid}/enrolledCourses` and `/teachers/{uid}/courses`, respectively. It is worth noting that *KOSapi* returns the data formatted as *XML*, which means the server has to transform it into a *JSON* object using an external library called *x2js*. After obtaining all the neccessary data, the new user can finally be saved in the database and sent to the client.

But since both the role and the subjects of a user can change, the server has to periodically request the current states of the aforementioned resources and make neccessary changes in the application database. This is one of the reasons the last login time is saved in the `User` model—using this information, the server makes sure not to ask for new data more than once a day. And since the majority of these changes occur at the start of a semester, long before any exam takes place, it should be frequent enough for most cases.

1.1.2 Client-side verification

When the client receives the authentication data and stores it in the appropriate service, the user can start to use the application with the scope assigned to his role. Whenever he navigates to a different state an event listener checks whether the `User` service is properly set. If it is empty, the user is redirected to a login form page and any navigation elsewhere is disabled until he successfully logs in. The authentication is thus verified only via the client-

side service which might not be up to date with the server. This is sufficient for some operations and serves to mitigate any latency that would arise from communication between the client and the server.

When the user logs out, the `User` service is unset and the client sends a `DELETE` request to the `/api/user` resource which prompts the server to discard the session. Nonetheless, the client session might also be terminated at the server end, either by force or because it has expired. It is therefore neccessary that the client recognizes this situation and acts accordingly. This is ensured by using a HTTP interception service that monitors every response the client receives from the server when it tries to reach a resource. In case the response contains a status code of 401, it means the user is not authenticated and is then redirected to a login form page.

Similar situation occurs when a user is not authorized to view a selected resource. This applies for example in the case when a user with the role of a student requests a different student's results. When such a thing happens, the server responds with a status code 403. Nevertheless, such request is never made on behalf of the client application and can only occur when the user tries to reach the server resource directly, via the provided API. That is why we do not have to handle this problem on the client side.

1.2 Blueprints

A blueprint represent what in real life would be the original copy of a written test. In the application, blueprints can be created, viewed and modified until the day of the exam. Quite obviously, all of these operations are allowed only for users that hold the role of a teacher. And even those can manage only the blueprints that belong to the courses they teach.

1.2.1 Resources

The blueprints are exposed as two resources, each of them designed for different use. The first one represents a collection of blueprints and is accessible via `/api/blueprints`. It supports optional query parameters for filtering by subject, date and language. When no subject is specified, the result is auto-

matically filtered using the list of subjects contained in the `User` service. If, on the other hand, a subject is given, it is tested against the same list and if no match is found, the server responds with a 403 code. Otherwise, the query is passed along. In the end, the resource returns a collection of all the blueprints in the database that satisfy the inherent or supplied conditions. Anyhow, the view on the collection is shallow, meaning only identifiers of a blueprint are returned, not an actual content. Since on the client side the resource is used only for listings, anything more than that would be a waste of bandwidth. For these reasons, it responds only to request of the `GET` type.

The other resource is used for operations dealing with a particular blueprint and can be found at URI `api/blueprint/{subject}/{date}/{language}`. Note that the variables are not optional and must be validated before any further processing, otherwise the server returns an error. The subject must be a valid subject code—starting with either `MI` or `BI` depending on the level of the subject, followed by a hyphen and ending with three word characters. The date must represent a string formatted as `YYYY-MM-DDThh:mm`, for example `2014-04-25T07:51`, and the language is validated against the standard *ISO 639-1* which allows only codes like `en` or `cs`.

The combination of these three variables is the only unique identifier of a blueprint in the application. There is a different type of key we might have used, which is the entry identifier assigned to every exam term in *KOS*, but because of the fact that an exam can be taken in different languages at once, it would not suffice. Even though such case is not very probable, it could still happen, and there is no reason for the application not to be as flexible as possible. It also helps retain a certain human-friendliness, as opposed to having to query the server API using generated identifiers.

1.2.2 Viewing blueprints

To view the blueprints, which only teachers are allowed to, the user must navigate to the state `Blueprints` which results in URL `/blueprints`. The items depicted are organized in stacks which reflect the logical distribution of blueprints among subjects. If only one subject is available, the user is presented directly with individual blueprints. Clear graphical distinction is made

between what is considered stack and what is an individual "sheet" so that the user quickly recognizes which is which. Apart from using the browser history, the user can navigate the blueprints using a breadcrumbs navigation. This is possibly excessive in this case but makes more sense in different listings, for example when viewing exams where the structure depth can reach four levels. Also important is the fact that the current level is shared among all listings, which should help with the workflow. Anyhow, the listing is empty so far because we have yet to create our first blueprint.

1.2.3 New blueprint

To create a new blueprint, the user must enter the state `NewBlueprint` which is reflected in the URL as `/new`. She is then presented with a listing similar to the one before, only this time with exam terms instead of blueprints. Terms are the particular dates on which an exam takes place—we can get those by reaching the *KOSapi* resource `/courses/{subject}/exams`, using each of the user's subjects as the variable. The client actually asks the application server resource `api/examterms/{subject}` whose only job is to delegate the request to the aforementioned endpoint and return the transformed result. But before sending the request

Conclusion

Bibliography

Appendix A

Acronyms

API Application Programming Interface

HTTP Hypertext Transfer Protocol

JSON JavaScript Object notation

LDAP Lightweight Directory Access Protocol

REST Representational State Transfer

XML Extensible Markup Language

Appendix **B**

Contents of enclosed CD

- `readme.txt` ..... the file with CD contents description
- `exe` ..... the directory with executables
- `src` ..... the directory of source codes
  - `wbdcm` ..... implementation sources
  - `thesis` ..... the directory of LaTeX source codes of the thesis
- `text` ..... the thesis text directory
  - `thesis.pdf` ..... the thesis text in PDF format
  - `thesis.ps` ..... the thesis text in PS format