OntoSEC: Cloud Service Recognition

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Nowadays, the use of cloud services is increasing. They allow small businesses, but not only them, to save money and effort by providing software infrastructure or even the entire software cheaper and better. However, the choice of appropriate service is subject to many requirements for data security, safety, guaranteed availability and reliability. These requirements come from businesses' own needs, as well as laws in countries they operate in.

In addition to the fact that different countries have different laws on how they are allowed to manipulate with data, the laws tend to change. This, in combination with various certificates, which individual cloud service providers can meet, causes a lot of unnecessary work and ambiguity, which can prevent the use of these services. For a small business, it is often difficult to judge whether a cloud service is good for them or even appropriate. Public administration cannot use a service at all until strict requirements are met. And a cloud service provider, who wants to capture new customers, would have to be certified according to every possible certificate and study the laws of each country.

Cloud services prove their qualities to the customers by being certified according to different standards. These standards are captured in the form of certification schemes requirements. The current approach is to take all the relevant documents, where the necessary requirements are specified, start comparing each with every other and after any change in either one of them start the comparison all over again. This creates lots of combinations and manually checking every single one of them is significantly inefficient. Therefore, we are proposing an ontology-based approach, where the cloud service characteristics requirements are described using a common dictionary – ontology [2, 3]. A person processes each change only once, formalizes it and our application is able to work algorithmically with these formalized records. The user is able to display, compare, create, review, modify, publish, export and import formalized data. This optimizes monotonous human work by ultimately automating the recognition of appropriate cloud services based on the evaluation of matching and overlapping of cloud service characteristics with demand [1].

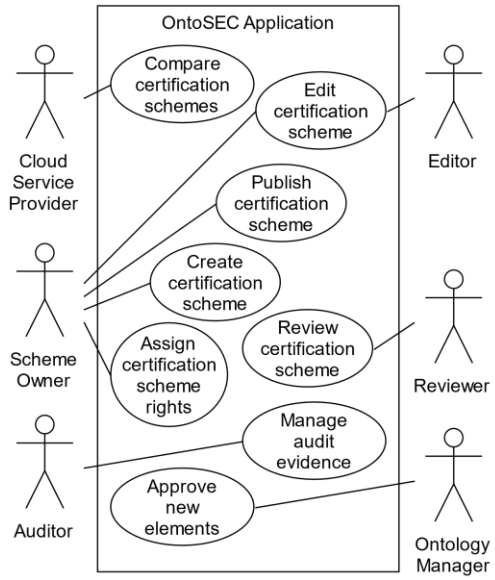

Figure 1. Roles in our application.

Consider the following example. Peter is a cloud service provider. His cloud service has a certificate X according to the respective scheme. There has appeared a new big company on the market that needs exactly the service Peter provides. But this company requires the service to have a certificate Y

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according to the respective scheme. In order to satisfy the new company's requirements, Peter wants to know if there are some things he lacks in providing his cloud service.

As shown in Figure 1, our application offers exactly what Peter is looking for. He can compare schemes X and Y and find out if by fulfilling the requirements of scheme X he fulfils scheme Y as well. Additionally, when two certification schemes are compared, the application also provides information on the number of requirements which the first certification scheme fulfils from the second one and vice versa. It is possible Peter discovers he does not need to meet any new requirements. This means the whole Y scheme is contained in the X scheme he is already certified by. Either way, after comparing schemes X and Y in our application, Peter determines the differences between them. He now knows if and which new requirements he has to fulfil in order to get certified by scheme Y and can request for an audit, based on which the required certificate can be granted.

Certification schemes are the core of our application. They consist of controls, which are complex sentences written in natural language, used for checking whether the requirements imposed on a cloud service are met. In order for our application to be able to compare and evaluate certification schemes, we need them to be present in our application in certain format – ontology. This way every newly added certification scheme is automatically compared to every other scheme already in the application. However, manually rewriting hundreds of complex sentences into a common format is very time consuming. This is why we provide a functionality that speeds up and simplifies the process of rewriting certification schemes by automating the transcription into ontology. Our application divides every certification scheme's control's complex sentence into separate simple sentences using natural language processing (NLP), suggesting the wording of control objectives to which are searched and assigned security attributes and metrics that already exist in the application. Our application also provides support for performing audits by allowing auditors to collect and store audit evidence and to monitor the parts of schemes that have already been checked.

Every certification scheme has an owner who has the right to edit and publish it, and a list of reviewers, editors and auditors. The rights to a scheme are specified by the owner of the scheme. Editors can make changes to the entities which have not been approved yet. Whoever has a right to edit cannot be a reviewer and vice versa.

After adding a new certification scheme and its entities, every entity that was newly created needs to be approved by the scheme's reviewer in order for the scheme to be published. This is done to ensure uniqueness of every entity. The hierarchy from the bottom to the top of the approval process is as follows:

- at the lowest level a newly added metric needs to be approved,
- when the security attribute's metric is approved, the security attribute can be approved,
- the control objective to which a security attribute belongs can be approved after approval of that security attribute,
- in order for a control to be approved, all of its control objectives need to be approved,
- the scheme can be published only when all of its controls have been approved.

Every entity, which has been already approved, is blocked for editing.

In conclusion, the vision of our application is to formalize the description of cloud services using ontology, which not only allows comparison but also automates it. As a result, cloud services will be easier to use by customers from different countries.

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Votter: A Web Tool for Managing Decisions

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1 Introduction

Making right decisions is an essential part of our everyday life. For an individual it is easy to make a suitable one, but making group decisions is a great burden for people, and often, despite the time and energy invested, the result is not satisfactory. Traditionally, group decision-making includes the following steps: option collection, group voting and result evaluation. Before the voting begins, group members suggest items that are aggregated into a list of options. After that the voting process occurs, during which options are rated by each member of the group. There are many possible ways to rate the options as well as to evaluate the results of the voting. The combination of rating and result evaluation approaches is called a voting strategy [1].

The last few years saw the appearance of services that attempt to facilitate this process (e.g. Doodle[1], NeedToMeet[2], Rally[3]). However, most of them focus on collaborative scheduling rather than voting. They do not provide users with a great deal of flexibility in choosing a strategy to evaluate their votes. This can significantly reduce efficiency, as different approaches to evaluation are appropriate for different occasions.

Therefore, we are in need to create a solution that gives a user the freedom to choose the voting strategies exactly for his needs. What makes achieving a definitive decision in group voting much more difficult is the need to somehow compare votes and preferences of its individual members. It is clearly because a group as the whole tries to settle on the best option, but individual members' private preferences make it impossible to globally define, which one is really the best. This is the reason why we decided to create our own solution that will provide more ways on how to achieve an ultimate decision within a group.

The main goal of our application, called Votter, is to give users an ability to try and figure out, which ways of evaluation are the most suitable for their problems. Under problems we understand decisions about which film we want to watch, what restaurant we want to eat, or which game we will play, etc. Some of the provided voting strategies are integrated into electoral systems of several democratic states and used during different types of elections, but there are also voting strategies, which are more closely related to a particular problem or a particular group of people.

2 Voting strategies

Generally known voting strategies provided by our solution (we chose so far twelve of them) are basically divided into four categories: basic, rate, points and surprise.

Basic category contains most simple strategies well known to majority of people. An example of basic strategy is cumulative voting, in which group members give each option a positive or negative vote.

Rate category consists of voting strategies, where users rate options by their mutual ordering. Usage of this category of strategies allows users to express their priorities. For instance one of such strategies, least misery, involves calculation of average of users weighted votes, as well as elimination of worst rated option for every user.

Points category also allows users to express their priorities, but in a different way. Every user is given

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[1] http://doodle.com

[2] http://www.needtomeet.com/

[3] http://rallly.co

IIT.SRC 2018, Bratislava, April 18, 2018, pp. 363–364.

a certain amount of points or tokens, and then every user has to divide them between desired options. Option with the most points could be considered as the best one.

The last category called surprise is a little bit different than the previous categories. This category contains a few extraordinary evaluating strategies, which are not suitable for serious decision-making, but their main purpose is to have fun. Even if the decision is not very important, somebody has to make it, and that is a goal of this category.

3 Architecture

Our application utilizes Docker and consists of three main containers:

- Django REST backend container for business logic and communication with PostgreSQL database,
- Angular frontend container, which is responsible for user interface generation,
- NGINX server, which serves as a proxy HTTP server and allows communication between containers via API calls.

Figure 1 illustrates the architecture of our system.

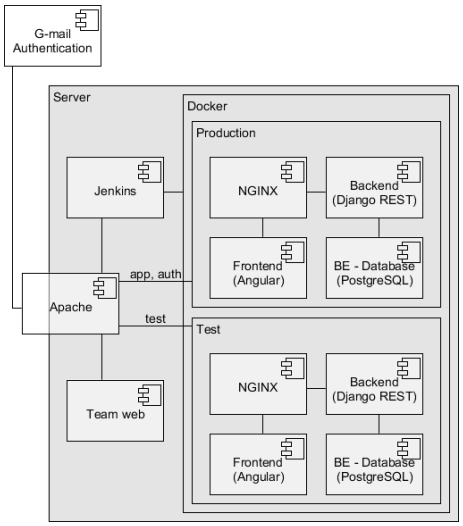

Figure 1. Architecture of the server.

Our server employs two types of Docker-compose environments: production environment for our application and test environment for automatic and manual testing. Both environments are managed by Jenkins, which also provides continuous deployment and integration.

Our backend consists of Django REST Python framework and PostgreSQL database. Django REST framework provides simple way of communication with frontend through serialization of objects and easy database model creation with migrations. The main tasks of our backend are to monitor correctness of all requests, to create and evaluate user votes using various voting strategies, as well as to ensure their persistence.

As for frontend, we have decided to use a JavaScript Angular frontend framework to be able conveniently implement all voting strategies. The application is made of multiple reusable components in order to avoid duplication of code.

Testing is provided by Dockerized Protractor which runs Selenium tests in a Google Chrome browser. Tests can be run both manually in local development environment as well as automatically by Jenkins before deployment (using headless mode).

4 Conclusion

Currently, Votter allows users to create votings based on four basic voting strategies. The creator of the voting can stop it, which will prompt application to calculate and visualize results. In the future iterations we plan to add more strategies and support for user profiles that will allow users to easily create and manage recurrent votings. Innovation we bring to the market lies in those strategies.

At the moment, one of our major objectives is UX testing. The biggest challenge for future users is to be able to understand the idea of a particular voting strategy from a brief description or picture. This may prove to be difficult, when dealing with more complex strategies. Therefore we need to test different solutions to this problem, evaluate the results and choose the best one. The second objective is a marketing campaign. The main goal here is to present the product as a flexible solution for voting in groups of young people. Our target audiences for this are students at two universities (one is in Slovakia, another is in Norway).

We would like Votter to be an application that would be used by groups of young people who want to solve their problems in the most suitable and intuitive way. In order to achieve this goal, we would continue to implement the mentioned functionality and test it in an appropriate way.

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Open Contracts: Linking Open Public Data

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The government and public institutions publish a large amount of open data about contracts, companies, entrepreneurs and many others. Since the year 2011, the government is obliged to disclose these data about contracts otherwise they would be automatically invalid. For this reason, the state began to publish contracts using its interface[1]. However, the interface was not easy to work with. In order to allow easy access to this data, the project otvorenezmluvy[2] (Open Contracts) was created. The project started as a collaboration of Aliancia Fair-play[3] and Transparency International[4] with the main goal of analyzing this data via public crowdsourcing and to find suspicious contracts. This can increase the level of state management of its budget and reduce corruption.

However, after the project started, any work on the project was inactive for several years, until we started working on it within the Team Project. During this inactive time, the technologies the project was using became outdated and the state also changed its publication methods of contracts and the existing method was not functional anymore. Since the downloading of contracts is a key part of the project, it had to be repaired.

Nowadays the state is publishing even more data. None of this data is linked. Therefore, all the necessary information is not available when analyzing it. Linking this data would greatly improve its analysis and the detection of fraudulent contracts. Also, providing the people channel of a communication about contracts can be helpful for connecting people and also increase public awareness. Our main goal in this project is updating outdated technologies, adding new data sources and to provide a convenient and simple way to work with this information.

One of the datasets that can greatly increase the amount of information that the project offers is the Register of Legal Subjects. It is one of the key registers in public administration. It allows us to obtain specific information about the companies that are part of a contract. All contracts contain the identification number of the organization. We can therefore connect that company from the contract with the data from the register. This way, we can get valuable information about the company, for example its official company name, since the names on contracts can vary. Another information we can gain is the residence or economic activity of company. Although the state provides its own API, it is preferable to use API from slovensko.digital[5], which integrates multiple registers and provides a way to synchronize data.

Another dataset is the Register of Public Sector Partners[6]. This dataset contains information about business end owners. With this information, the contract can be associated with a particular person standing behind the company and gaining profit.

The Registry of Financial Statements[7] contains data about the economic activities of subjects such as its turnover, profit, liabilities or assets. It could also increase the chance of detecting fraudulent contracts. For example, if a company signs a contract with a high value, it is expected that it has an adequate turnover and assets.

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1 https://www.crz.gov.sk
2 http://otvorenezmluvy.sk
3 http://fair-play.sk/
4 http://transparency.sk
5 https://ekosystem.slovensko.digital/otvoreneapi
6 https://rpvs.gov.sk/rpvs
7 http://www.registeruz.sk

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We already managed to add the Register of Legal Subjects during the winter semester and are currently working on adding another new data source and connecting them with existing ones. All these newly added data sources will not just increase the amount of information provided but will also allow for more accurate and easier searching of contracts or companies. So, the next step after adding new data sources is making sure to properly integrate them into the project and linking them with the original data to enhance transparency. For example, by enabling a new and more specific search method or adding new user screens.

Not all public data is of equal quality. Anomalies when the contract value is zero, but it is worth millions in reality, are very common. The detection of these anomalies is another challenge which can increase data transparency. Another problem is the quality of the contracts that are published by the government. Some contracts have incorrect or missing metadata. One of our goals is to give administrators of the site more options in editing this metadata and also the option to directly edit the scanned contract. Because of changing laws, the option to hide certain contracts is also a useful feature for administrators that we want to add to the project.

Since the project started in the year 2012 and was not updated since then, the technologies it uses are outdated. The project is using Ruby on Rails, Elasticsearch and PostgreSQL as a database. Sustainability is one of the important properties of software projects. It is therefore important to update these technologies for easier future maintenance and extensions. The technologies that the project is using evolved during the inactive period of the project and newer versions are not completely compatible with older versions. It is one of our main goals to update them. There is a great possibility that other teams within the Team Project might continue working on this project and updated technologies will allow them to focus on delivering new functionality and improving already existing ones.

The project otvorenezmluvy.sk allows citizens to conveniently and comfortably read, search and evaluate contracts concluded by the state and state institutions. This will improve the state's state management of its budget, increase transparency and reduce corruption.

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Invest: Investment Portal for Laics

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Investing in financial products has gradually become widely spread among ordinary people. Gaining profit from investments requires domain knowledge and evaluation of large amount of available data.

Investment Portal provides a simple solution for potential stock traders, who desire to keep track of their portfolios and get systematic help with their trading strategies. Our goal is to provide simple and easy to understand application for tracking investments, compensating the lack of knowledge of laic users.

This paper provides an overview of the application, describing the architecture model and common usages of our system. It shows how users can manage their own portfolios with automatic investment tracking or use one of our model portfolios for virtual experimenting with their investments.

Investing in financial market is becoming more and more accessible to everyone. People lacking domain knowledge are in disadvantage and are potentially vulnerable to great losses. This knowledge gap can be significantly closed by available technologies.

Investment Portal is an application for people who desire to start investing and who lack required knowledge. The application provides an easy way to track your investments, profits and losses, all through an easy to understand user interface made to suit laics. Investment portal is the application designed to close the knowledge gap of these potential investors and to ease their first steps.

Using automated daily calculations, the system keeps track of changes in stock markets and provides up-to-date information to their users, who are not required to execute any additional actions.

Several other applications provide similar, though not the same, functionality as Investment portal. One of the most popular investment tracking applications, Google Finance, stopped providing their services by November 2017. Other apps such as Yahoo Finance[1] or Personal Capital[2] provide an option to track your investments. The main difference between them and our application is in the laic oriented design and investing assistance.

Architecture of Investment portal is divided in two distinguished part – client and server applications, as pictured in Fig. 2. The client application is user interface implemented as web application, based on Angular 5 technology. It provides easy to use interface, where even investor-beginner can learn to track their portfolios and make educated decisions about their next step.

Secondly server side is Spring Boot based application, which handles all required communication with client application, PostgreSQL and InfluxDB databases, and a calculation module. The server side serves the information through REST API and provides the service of notifying user about changing market trends by Web sockets.

As a part of the server module, the calculation module is the main base for calculating different metrics of the stock markets and for predicting statistical changes. It is implemented as Spark application which gathers data from several market exchanges and manages calculations over these data by R and Python scripts.

The most important part for understanding the financial and investment potential of user's portfolios, is the visualization of the past, present and possible future states of their assets. To achieve these objectives we created Dashboard page, as pictured in Fig. 1, for users to see all their portfolios' activity in one place. A

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[1] https://finance.yahoo.com/

[2] https://www.personalcapital.com/

IIT.SRC 2018, Bratislava, April 18, 2018, pp. 367–368.

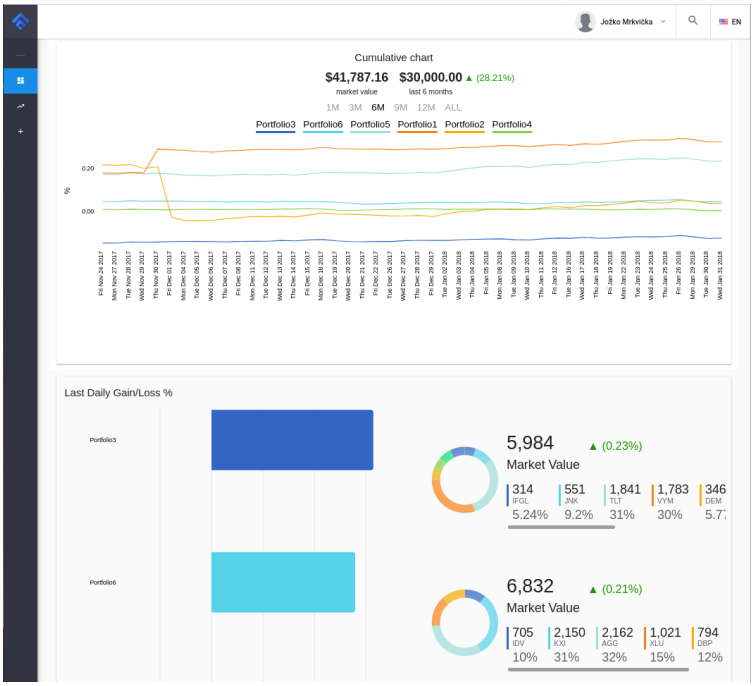

Figure 1. Dashboard screen user interface.

specially for novices we provide Help tools, that guide users' experience through the client application.

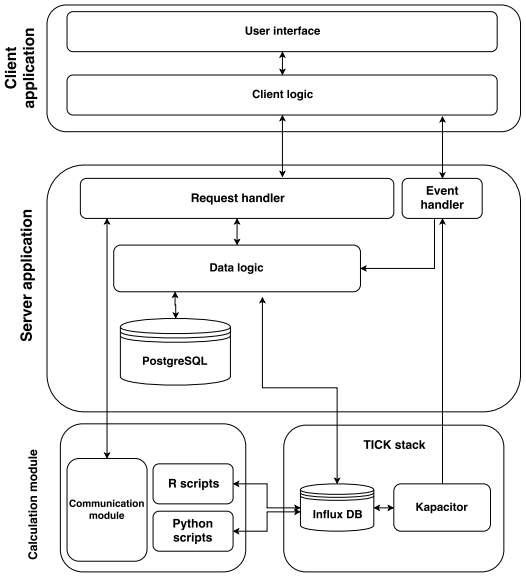

Figure 2. Architecture model of the Investment Portal.

Investors have different objectives and for example, they accept different degree of risk. Their skills make different tactics and strategies appropriate as well. Users can therefore customize a set of rules, behaviours or procedures that the investment system will use to guide selection of the user's investment portfolio.

Investment Portal gathers data and calculates metrics above them. These are then used for recommendation of best possible strategies, that users can choose from or can edit as see fit in a portfolio management.

In the future there is potential to incorporate customizable levels of the visibility of user's portfolios and therefore provide similar services to professional investment agents, who could work with their clients more efficiently.

The Investment Portal is an online application for tracking your investments in stock market. The application is oriented to assist laic investors and help them to keep track of their investments despite their potential lack of knowledge. The application can also be used to simulate your potential investments and to see how the stock market evolves in easy to understand charts and visualizations. Our system also provides investment recommendations based on everyday financial calculations.

Behavioral Biometrics on Mobile Devices

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There are a large number of different applications of various types, which collect raw data from sensors of mobile devices. However, the integration of such applications and data collection methods with other applications for the purpose of research is problematic. There are a few implementations of a logger for collection of sensor data from mobile devices, such as the one in [1], our implementation offers an easy to use library, integrable into various kind of mobile applications, allowing the logging of any kind of mobile sensor data, including touch events, all configurable by the user.

The three main goals of the project are:

1. Making the work of any researcher working in the field of biometrics, or needs user data for other type of research easier, by the integration of our library into their own application. Individual implementations of similar logging solutions is a significant waste of time, so by using our library, they can utilize their time more effectively.
2. Creation of a simple to use framework for machine learning, containing predefined methods for preprocessing, feature extraction and model creation, to be used by researchers.
3. Finally, by combining these two solutions, the creation of a new layer of security and a new method of protection of mobile devices against misuses by unauthorized user, using behavioral biometrics for the identification of the user. Developers can integrate our solution with their applications to improve the security of these applications.

We propose a project called Behametrics, consisting of two main parts: *Logger* - the module intended for the collection of data from the sensors of mobile devices such as accelerometer, gyroscope or events from touch screen.

User authentication - creates the overall solution of our project using machine learning, along with the logger.

For proving the validity of our project and ensuring credibility both by the professional community and by the general public, we aim to:

- publish the proposed solution as an open source project, so anyone would be able to see how does it work, without hiding any part of the implementation,
- provide a simple method for integration, making the testing of and working with the project easier and more accessible,
- provide base use cases and suggest further possible scenarios for the usage of the library.

At the current stage of the project implementation, we are able to collect and send data to a storage device from individual sensors and the touch screen of a mobile device, using the logging library. This functionality was tested by the product owner, using an independent application integrating our library. The stored data is further processed and separated into bunks applicable for machine learning. Currently data from the accelerometer, gyroscope and the touchscreen events are collected. The data then undergo feature extraction and feature explosion, to obtain usable information from the raw data. These features are the ones consumed by the models, providing us the results of the authorization, which is sent back to the client (Figure 1). The security response depends on the application implementation, the simplest being locking of the application and possibly asking for a specific se-

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curity question. With the completion of the project a demo application will be created, which demonstrates the functionality of the solution as data collection and user authentication library. The demo application also shows how simple and fast is to integrate the Behametrics library into a mobile application. The data collected is measurements at different time intervals, consisting of numeric attributes. The individual attributes depend on the sensor collecting it. Most sensors send data in the form of x, y, z coordinates at a timestamp, but the touch events send a larger number of attributes, so this data has to be handled differently from the other sensor data. Different sensor hardware can also send different data for the same type of sensor, so these data have to be handled accordingly.

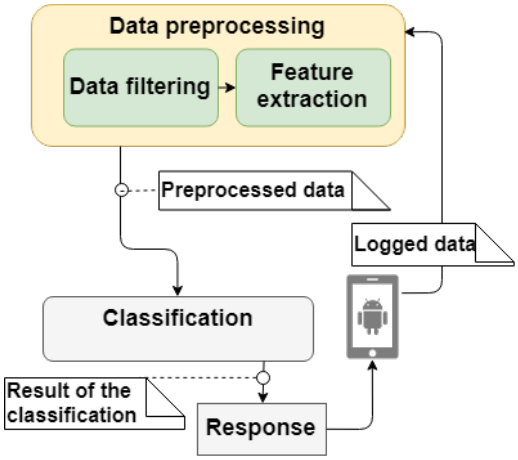

Figure 1. The dataflow of Behametrics.

The final project will provide the following features:

- an open source publication and license of the library, for making future development possible and providing easy access to our library,
- easy usage and a simple way of integration of the library into applications,
- a separate logging library, containing the data collection aspects of the project,
- a new security measure, using biometric user authentication.

The area of using machine learning models in biometrics for identification is difficult and still under intense research, so we cannot ensure at the current time that our solution will work as proposed and that it will provide satisfactory results.

However, the main goal of the project is research, so the knowledge gained during it is more important than the practicality of the final solution.

Acknowledgement: This work was partially supported by the Slovak Research and Development Agency under the contract No. APVV-15-0508 Human Information Behavior in the Digital Space.

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Bee-hives Monitoring using Internet of Things

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1 Introduction

In our project, we focus on bee-hives, perform their monitoring, hive control and thereafter notice the beekeepers about important changes that affect the quality and quantity of the honey production. The goal of the project is to simplify the beekeeper's work. Our solution is suitable for a professional and a hobby beekeeper. We use innovative technologies such as the Internet of Things, the Sigfox network, and various sensors to identify the amount of honey, bee swarming or to detect hive movement. We create an easy-to-use system for young and old people who are not familiar with modern technologies.

In comparison to our life, the bee´s life is just a minute, but it´s importance is enormous. According to this, we have decided to use modern technologies to help beekeepers perform the regular actions necessary for keeping the colony of bees. A professional beekeeper or one who takes bees as a hobby, needs to have an overview of the conditions of their hives. In most cases, the colony of bees is not located near the home, their place is in the nature, outside of the everyday civilization. Therefore, the great advantage would be to have this information without the need of the personal check. Those, who do not have regular access to their hives, will appreciate the possibility of remote control and early notifications of the unusual situations, that have would occurred.

One of the basic elements of our solution is to provide information about temperature inside the hive and outside. By monitoring the temperature, the beekeeper is able to detect a situation, when there is a lack of eggs, when is the right time to treat bees against pests or to detect the presence of mother. The most important moment in the life of the colony of bees is the presence of a healthy and fertile mother. Another element which we bear in mind is the weight of the hive. For laic it is just a number signing the presence of honey. For the beekeepers it is much more complicated. Last but not least, it is important to provide information about overturning of the hive or nowadays also about stealing the entire hive.

We proposed our system with usage of Sigfox technology, which cover much larger area than GSM base stations. Comparing to others, using Sigfox is very cheap and has lower consumption of the energy. On the other side, we use knowledge of existed works thus we use Arduino Mega 2560. We designed the system for web application and for android application. The main benefit is an early warning when something unexpected happens in the bee hive.

2 Related Works

Authors of *Honey Bee Colonies Remote Monitoring System* [1] designed a low-cost, reliable bee-hive-monitoring system based on wireless-sensor networks to measure the temperature, relative humidity, and weight of beehives in real time and non-intrusively. WBee as it is called, saves the data in each part of the network if there are failures in the communication.

The purpose of the device in the work *Telemetric measurement system of beehive environment conditions* [2] is to perform measurements of parameters such as ambient or internal temperature, atmospheric pressure, humidity and sound level. To accomplish the study, they decided to use the base module Arduino Mega 2560. The measured values were transferred to the MySQL database, which is located on an external server, with the use of GPRS protocol.

3 Solution Design and Technologies

Our proposed architecture consists of multiple components. Complete flow of data is shown in the Figure 1. The first part is Hive Monitor. It is composed of microcontroller - Arduino Mega 2560 with Sigfox antenna and sensors. Sensors perform

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measurements of the ambient and internal temperature, humidity, hive position and weight

DHT22 is accurate digital temperature and humidity sensor. To filter the noise from the environment, the producer recommends connecting the pull-up resistor to the DATA pin. The accelerometer includes a 3-axis gyroscope along with a 3-axis accelerometer. The sensor is based on a chip MPU-6050. For weight measurement we use TMOEC 200kg electronic load weight sensor.

Sigfox Transmitter communicate with devices connected to Sigfox network. It sends data from devices to the Sigfox Cloud Server. This server collects data from devices and by using HTTP Callbacks send data to our Bee Web Server.

On one side it hosts our website and on the other hand it is place, where the database is stored with all measured data. After receiving twelve bytes, the server parses these data and stores them. Despite this, the functionality of user login and registration is also implemented on the server. For providing measured data to beekeepers REST API is implemented on Bee Web server. It also provides authentication and registration of new users.

On our web page, we can find all information about project and about related technologies. Next, there is a simple form in section order, where the customer can order one or multiple devices. After registration, the beekeeper is able to follow up all new collected data or historical data. Web and mobile applications get data in JSON format using API calls. For better visualisation we have decided to use charts. Once the threshold limit is reached, the page displays a notification describing the problem. Whole this functionality is also implemented in Android application.

In Sigfox technology there is implemented protocol that allows you to transmit a small amount of data and has low power consumption, which is ideal for IoT. Each message is sent three times due to unreliable connection, each time at another randomly selected frequency. Maximum length of message is 12 bytes and each Sigfox end device sends up to 140 messages a day. This represents one message in about 10 minutes, so total daily capacity is 1680 bytes. IoT devices can communicate through Sigfox network. It uses Ultra-Narrow Band for communication and cells of this network allow to cover a much larger area than GSM base stations. Therefore, this technology is built on a cellular system similar to GSM and uses the star topology. The network operates in the 868 MHz band in Europe and 902 MHz in the USA. The maximum allowed transmit power is 25mW. The main advantage of this approach is that network can support large number of IoT devices. In Slovakia, Sigfox is provided only by one mobile operator – SimpleCell Networks Slovakia.

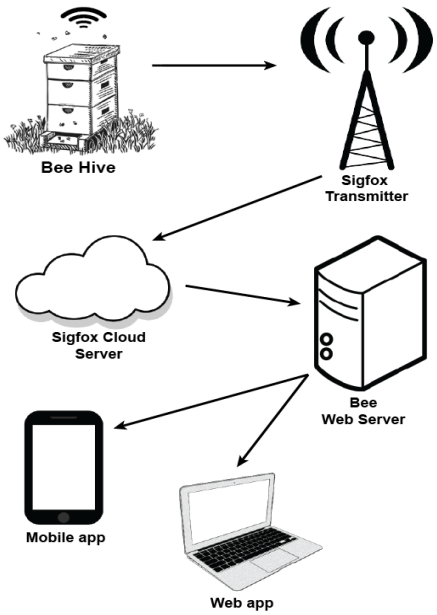

Figure 1. Suggested Solution Architecture.

4 Conclusion

Our solution provides real-time bee-hive monitoring through Sigfox network. Communication is realized using Ultra-Narrow Band and cells of this network allow to cover a much larger area. Sigfox technology limits us to use only small messages which could be sent 140 times a day. Despite this limitation, the beekeeper regularly receives all actual information which are displayed on a web or Android application. With this in mind, our mobile application implements a notification feature, which triggers when an unexpected situation happens. For instance, when inside temperature is too high, or hive's position has changed. Above all, our future work could be focused on audio and video analysis for better prediction of the bee´s colony needs. Furthermore, it can be focused also on sending SMS message in case of exceeding the defined values.

Acknowledgement: This project was partially supported by SimpleCell Networks Slovakia.

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MedPix: Simplifying the Analysis of Complex Medical Image Data

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Health is a precious thing and a key attribute in leading a prosperous and quality life. The health is always threatened by a substantial number of factors including diseases that are hard to diagnose. A correct early diagnosis is essential in providing the right treatment and thus ensuring the health and satisfaction of the patient.

Medical image data analysis is one of the vital processes in providing a patient with a diagnosis. Doctors, radiologists and medical specialists have to analyze several different scans (e.g. MRI, CT, X-Ray scans) that help them to map the health condition of scanned body parts, find potentially harmful masses and evaluate the possibility of treatment.

A doctor usually has to go through several types of scans and analyze them under different conditions (e.g. lighting, contrast, filters) that help him to spot differences between healthy tissue and potentially harmful tumors or other signs of diseases. Collaboration between medical specialists is also necessary, because different body parts may be influenced in different ways and a diagnosing doctor may have to consult a specialist to ensure that the diagnosis and treatment he proposes is correct.

Such effort requires very specific tools, skills and training. The software tools have to provide a variety of instruments and views to work with the medical images. Current software choices are therefore either very robust, rigid applications that offer exhausting number of settings, require large computational power and specific working conditions at the cost of portability and flexibility, or, in the other case, provide only a very limited view and tools and are too slow in image processing and viewing for real life usage during diagnosis.

We propose a solution – MedPix – to solve some of the described limitations and to merge benefits from both approaches.

MedPix aims to create a simple, flexible and portable tool to simplify the collaborative aspects of medical image data analysis by providing a joinable work-in-session environment with a cloud-based storage system. MedPix application allows displaying the complex medical scans and provides standard tools for analysis, such as notation, all while working on a portable device - tablet.

We challenge the current solutions in several ways, merging the fast image processing with portability and viewing on devices with less computational power, by moving the processing almost entirely to the server. This also allows us to create an interactive environment supporting easier collaborative analysis and interdisciplinary consults for specific health conditions.

MedPix allows a doctor to sign in and upload new patient scans or to search for patients and medical trials in database. The application can handle all types of medical scans (e.g. CT, MRI, X-Ray) as long as they are in a valid DICOM[1] format. After patient lookup, a doctor can select patient's trial to start a new analytic session or to re-open an older session already performed on the image data.

Figure 1. Loaded brain scan prepared for analysis.

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[1] DICOM is a standardized format commonly used for medical image data

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After the trial selection, a doctor can start its analysis by using fast scrolling through the images and annotation tools from the provided toolbox. Metadata for the patient's trial are displayed on demand (See Figure 1).

Each segmentation, note, drawing or other tool used creates a bookmark in the session for the scan for a quick and easy finding if and when needed. The doctor can invite specific colleagues into his working session and give them the opportunity to support him in the analysis by providing their own notations, drawings and other insights into the process. A doctor can always see, who is joined to his session and all the bookmarks that were created by the collaborating experts.

In summary, MedPix provides tools for the diagnosing doctor to:

- Annotate data and share annotations with other medical experts.
- Load and examine any medical image data.
- Collaborate with other experts in real time.

The server side provides all the communication, image data processing, storage and session persistence for all the clients joined to a session. We chose to use a modular python server with a database, indexing and search engine, and an email module when registering a new user. For the communication between client and server, REST APIs and websockets are used. APIs are to provide metadata and other information, while websockets are used to transmit image data, commands and image processing objects to provide speed and fluent undisrupted image views while scrolling through the images. Once a session is created or activated, the requested image data are loaded from the database and cached in-memory in Redis to allow collaborative work and fast processing.

The search through patients and trials is powered by Elasticsearch which allows full-text search in patient data, trial data and also metadata of the medical scans.

Mongodb was chosen as a database to store the image data for performance reasons, outperforming other possible database options when storing large image data.

The MedPix solution is implemented using smart architecture allowing it to scale and be flexible in both development and deployment:

- Docker for Elasticsearch, Mongodb, Redis and python environment (See Figure 2).
- Model-view-presenter on the frontend side.
- Modular architecture of the server.

MedPix application opens the door to fast and portable medical image data analysis. It provides the means for a specialist to perform his or her analysis of medical scans, consult and collaborate with a colleague, propose a diagnosis and have it confirmed by another specialist with less effort thus ensuring greater accuracy and ultimately better healthcare. We created a tool to deal with some of the limitations of current software and it is not only usable for the specialists, but also, possibly, for education. With MedPix, we provide the opportunity for a teacher to perform an analysis of a medical scan in medical class and each student can see the teacher's process and notes on his or her own device in real-time.

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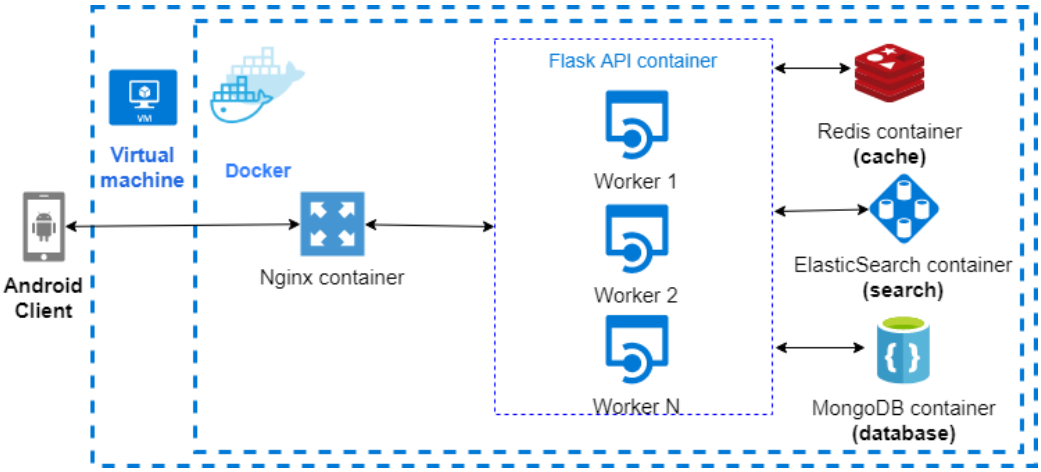

Figure 2. MedPix backend architecture.

DeepSearch: Building Ontologies from Unstructured Biographies

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Great amount of information is stored in historical books. However, majority of this knowledge is hidden within long texts. At this moment, the extracted information only describes main concepts, for example date of birth or death. Lots of data describing connections between people or communities remain undiscovered. Nowadays, with accessibility of digitalized texts, many opportunities for automating discovery of these connections arise.

In this paper, we focus on building ontologies from unstructured biographies using named entity recognition. Result is visualized as a graph of entities and connections between them. Using our tool for building ontologies, one can easily search through processed biographies and review potential interesting information.

Text data mining on unstructured data was always challenging topic. Nevertheless, methods for entity recognition within English language are constantly being improved. Unfortunately, these methods cannot be applied on other languages without tweaking. Even though there are languages, which are fairly similar, grammar differences tend to require major adjustments for successful entity recognition.

In the context of Czech language, there are only few papers published on this matter. Strakova et al. published Czech Named Entity Recognizer [3] in 2013. In the paper, the authors present a new named entity recognizer which outperforms previously published Czech entity recognizers. Other notable recognizers were published in [1] and [2].

Mining of relevant information from biographies is usually done by manual processing. Results are then represented into various digital formats. This process takes a lot of resources, including multiple revisions by many authorities for possible mistakes. Even after successful processing of unstructured data is finished, other problems arise. Not all formats are mutually compatible, therefore some kind of bridge or translator must be utilized. All of these points prove, that manual text processing is highly inefficient.

Even though, textual digitalization is a way to go, some obstacles still need to be overcome. Existing ontology representations, for example MARC21, are not always user friendly. Because of that, institutions like museums, galleries, libraries and authorities representing cultural heritage have problem sharing this information.

In addition to that, user interfaces of data search systems have limited capabilities of searching for connections between students, professors, communities and dates. At this moment, a user can search through digitalized documents by browsing, or by executing queries, which include only limited amount of data. This data usually consist of persons name, work or information about birth or death. Besides museums and cultural institutions, there are many personal authorities like historians, anthropologists or ethnologists, which have data on their own. This prevents recognition of lesser known personalities like writers or artists representing cultural heritage. Furthermore, it complicates sharing any information on local, national or international level.

Our goal is to build simple, easily extensible ontology on relationship between named entities and authorities. Discovered ontologies are presented in comprehensible graph structure showing relations within recognized entities (shown in Fig. 1). Digitalizing this data makes it easier for users to get familiar with their area of interest. Furthermore, users will be able

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to filter the data and limit the scope to chosen people or authorities. Final product aims to be a web portal for cultural heritage authorities to build and try to complete knowledge database. Together with graph visualization luring people to view discovered connections.

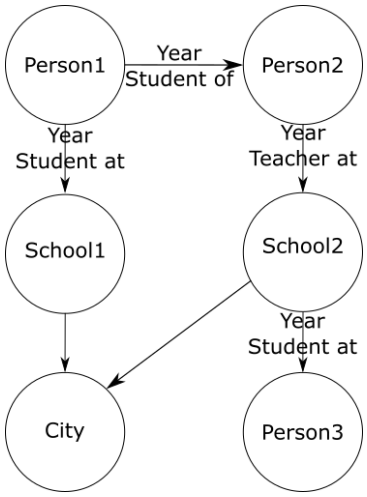

Figure 1. Graph illustration of entities and connections

At the very core of our method lies pipeline processing of unstructured biographies. Steps of the entity identification process follow:

1. Parse biography from input
2. Tokenize sentences
3. Tag words (using MorphoDiTa [1])
4. Extract sentences by rules
5. Recognize named entities (using NameTag [2])

Thenceforth, recognized entities, formatted as triplets, are stored within Neo4j graph database. These triplets can be easily visualized. Persons, institutes are presented as graph nodes, while years and employment status form connections between them. Users can efficiently search for entities, which are afterwards displayed in the graph alongside related entities. Communities and associations can be discovered more easily.

This paper presents a way of discovering various artists or further increasing user's knowledge by revealing connections between them. Our tool can be used for educational purposes as well as specialized research projects. Data mining within digitalized texts can furthermore enhance databases which specialize on historical figures, artists, authors.

Processing biographies still bears many obstacles. They are usually written by different authors, which causes differences in sentence structures. This ultimately complicates extracting information from the documents. To process input from various sources, we had to utilize filtering based on chosen identifiers to improve information extraction. This enhancement allowed us to reduce unstructured text to few sentences with entities. With help of MorphoDiTa and NameTag services, we successfully extracted approximately 70% of entities and stored them into graph database which is connected to web interface.

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reCommers - Recommendation for E-commerce

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In modern society, usage of information and communication technologies has spread to almost every part of everyday life. Number of electronic transactions is growing every year. It is comfortable buying products of different kinds online with just few clicks. With growing numbers of customers, new e-shops come to markets every year. To attract more customers, provide better user experience and increase customer satisfaction, they often use recommendations [3].

Recommendation. Recommendation can make online shopping for customers easier and faster. It can find top rated books according to our past preferences on genres or authors, help discover new music albums and musicians or suggest perfect vacation on exotic island. On the seller's side, it increases profit and provides information and opportunities for improvement. Many large companies, such as Amazon [2] or Netflix [1], develop their own recommendation systems, which helps them to improve their positions on markets and provide better quality service for their existing and new customers.

There is, however, large number of smaller companies for which is development of their own recommendation services not affordable. Therefore, they need to focus on external solutions, generally referred to as Recommendation as a Service (RaaS). In addition to recommendation algorithms, they provide support, monitoring and visualizations of various metrics.

In our project, we develop our own RaaS platform for e-commerce. Whole recommendation process is a complex sequence of various steps. At first, data about users of e-commerce service (customers of e-shop, music service listeners, etc.) must be collected. This involves capturing of user behaviour online, i.e. events such as searching, listing categories or viewing product details. These events are substantial for consequent recommendation process.

Next step is processing and modification of customer data in form suitable for the recommender system. They are stored and used by recommendation algorithm for generating recommendation personalized for a specific customer. When this customer is using service (for example, he is viewing site of e-shop or looking for movie on video streaming site), he is provided with generated recommendations.

reCommers platform. Our solution is based on an existing platform, which has been used in real production environment for e-shop in Slovakia. Our tasks is not to create a new recommender system, we are focusing on development of complex RaaS platform that provides following additions and improvements to the existing infrastructure:

- Multiple business customers. Service can be easily used by more than one e-shop. Definition of data modification rules for specific e-shops is achieved through configuration files without unnecessary effort.
- Visualization and evaluation of recommendation results through key metrics. Web application is provided to customers of our service (e-shops), where they can inspect values in tables or graphs. They can choose metrics and times, for which visualization and statistical evaluation is provided. Configurable dashboards present quick overview of current state.
- Integration and selection of multiple recommender systems. New recommender system can be integrated with the platform in any time. E-shops are able to select most suitable recommender, even change it whenever they want.
- Error monitoring and debugging. This can be done easily using web interface, where history for recommendations is provided.

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- User management. Safe access to the web interface through logging for e-shop and maintainers is provided, too
- Technologies. Platform is built on a dozen of modern and perspective technologies, which are secure, reliable and used by many other well-known products in area of personal recommendation and data analysis.

Key factor of the recommendation service is speed. Recommendations for specific user is delivered in less than 150ms. It is consequence of well-designed architecture, scalable and fast technologies and advanced programming approaches.

Technologies. As mentioned before, we are developing our platform using current technologies. They are mainly open-source technologies, with large communities of developers and maintainers. System architecture is presented on *Figure 1. System architecture.*

RaaS platform is developed in Python programming language. Substantial part of whole project is web application, for which Django web framework is used. Django is free, secure, fast and scalable open-source web framework. In addition, we use a variety of open-source libraries for database migrations, asynchronous processing and other tasks.

There are two ways in which data from a customer can be send to the recommender through our middleware platform. In addition to http endpoints, on which data can be send from customer side, we are able to extract data from Apache Kafka topic. It is more secure, reliable and errorproof solution.

For visualizations of metrics and statistics, we use Metabase. It is a web-based platform, which provides means for better and more effective way of exploration, visualisation and manipulation with data stored in database. As a main database storage, PostgreSQL was chosen as the best alternative.

Monit is used for monitoring, maintenance and repair in runtime. Monit conducts automatic maintenance and repair and can execute various actions in case of error situation, such as sending email to maintenance team. To ensure better performance and quick response of recommendation requests, we are using Celery (asynchronous task queue based on distributed message passing) in combination with Redis. Finally, Sentry is used for error reporting.

As a result, platform is developed as easily maintainable, so next generations of students can improve our solution, add new ideas and provide better results for satisfied customers.

Educational benefits. In addition to commercial value, our platform brings new benefits in education and research. There are many students and employees on our faculty which are developing their own recommender systems in various projects or master theses. Many of them have already shown interest for this type of platform. From perspective of research tool, the platform is able to provide options for comparison of results with other recommender systems, monitor performance and evaluate metrics during longer time periods.

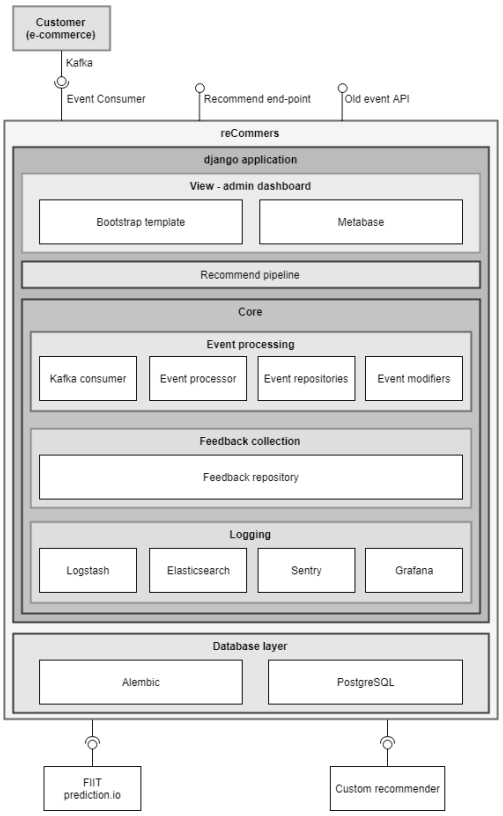

Figure 1. System architecture.

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Distributional System of Questionnaires

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There is a lot of competition in public transport sector, every company tries to be the best. To maintain a high level of their services, they need a feedback from their clients in order to limit existing problems and attract new customers. At this moment there is no such option for passengers to send their feedback via enquiry to carriers using the Funtoro-MOD [1] directly via the display in the bus seat. Here, space has been created to get feedback directly when traveling, when the feelings of the passengers are the most recent.

However, creating the questionnaires is not a sufficient solution. Tedious and lengthy questionnaires can often distract people, so we try to include the best possible gaming elements that will revive the questionnaires and motivate people to fill them up. Questionnaires should come in several types like for example, educational, fun or informative. The aim of the questionnaires is to make the journey enjoyable for passengers and also to provide feedback to bus companies that will use this system.
Gaming elements that can be included in the questionnaire system are:

- Keys and/or Rarities. This is a gamification element taken straight from video and PC games. Passengers must complete a questionnaire to earn a key. With this key they can either unlock the next level or they are required to save up a certain number of keys to unlock a reward. If we want to take it a step further we can even create keys that will give them access to "hidden" content, like treasure chests, or doors that lead to resources, like fun games or puzzles.

  For more adventurous passenger, or the ones who become easily distracted we created the idea of unlocking rarities. For example, let the passengers know that there is a few of very rare objects hidden throughout the questionnaires (e.g., bonus points or special badges). Passengers can unlock these items only by completing special tasks or outperforming their peers
- Give passengers the opportunity to earn free tickets during the questionnaire and then hold a raffle at the end where they can win prizes. This game mechanic can be tricky, since passengers aren't participating simply for the questionnaire, they are in it to win and earn reward. This is why it's always a good idea to pair it with another game mechanic.
- Points are earned by completing simple tasks or participating in questionnaires. Once passengers they have a certain amount of points they can trade them in for a reward or unlock new levels.
- Leaderboards are one of the most competitive gamification elements, as they encourage passengers to surpass the others in order to be the first. It's the ideal game mechanic for those who want to be recognized or praised.

  To get the most out of leaderboards, don't force passengers to compete if they aren't comfortable competing with their colleagues. This ensures that your introverted passengers won't feel alienated, but still gives others the chance to work their way to the top.

The project is divided into two parts. The first part is a web application that will allows a service provider to register their customers, which are carriers. The entire web part is under the authority of provider and hence can provide or withdraw access rights to functionality. With the help of the web application, bus companies can manage their buses and create questionnaires. The web part allows carriers to distribute questionnaires to individual buses, create roles for their employees, and process the results received from buses. Thanks to this solution, the companies can create questionnaires with any content and character that suit them the best. Within the web application, language variability has also been introduced, allowing you to change the language

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based on client requirements. Language variation was a necessary condition because provider has customers across Europe.

The second part of the project is to develop functionality for bus servers that works together with the web part. The questionnaires are sent to the servers on the buses from the web section and are processed on screens where they will be provided to customers. By virtue of its unique identification, the bus server connects through an Internet connection to a web server from where it can retrieve data and send data from previously completed questionnaires. Within the functionality of the bus server, gaming elements will also be incorporated. Each questionnaire on the bus server have its own time limit to evaluate its results at regular intervals and thus provide room for improvement of service.

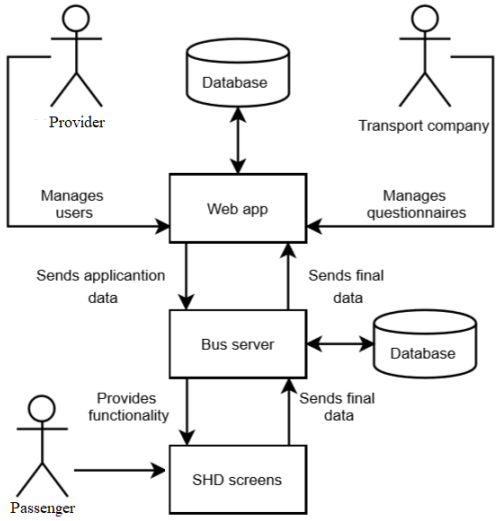

Figure1. Architecture of creating questionnaire.

Figure 1 shows an overview of the system. The product owner and the customer are accessing the web app [2]. The provider of the service manages users and the fleet of buses manages data for their fleet. The web application is linked to the database. This database stores data sent by fleet owners to their buses while at the same time providing feedback from passengers. The web app is linked to the server on the bus. From the web application, fleet owners send application data for their particular buses, and these data are further processed directly on the server on the bus. The bus server contains all the functionality. There is a database on the bus server that contains the data sent from the web application and information from the passenger's feedback. The server contains a functionality that pulls data from the database and transforms them into a form of questionnaire that is subsequently provided to the customer in the form of a knowledge game. The results of this game are saved in the database after it is completed and sent to a database linked to the web application where the bus owner can access it. The server runs a program that scans the database at specified times, adds new data to it, and sends it to a database linked to a web application if there are new items in the database. SHD screens are the screens in the bus that the passengers come in contact with. Passengers use the functionality of these screens, and if they decide to fill out the questionnaire, the data from the screen is stored in the database on the bus server.

The questionnaires for achieving feedbacks from passengers are current used in planes, trains and buses too. The solution for feedbacks is provided by Opinion Plus from the Wavetec company. However, our solution differs in several innovations. To our clients is afforded opportunity to create their own questionnaires via the web interface and easily distribute them into entire bus network. Unlike the solution by other providers we introduce into questionnaires also gamification elements which aim is to hold passengers interest and make them to fill the questionnaire in.

The architectural is sophisticated and suitable for every conveyor. The great advantage of our system is the ability to send questionnaires generated through the web application to the buses the carrier wants. This makes it possible to locate questionnaires because different types of questions can be provided in different areas. This is why we differ from all of the current attempts to distribute questionnaires on buses, as transporters attempting to generate questionnaires were solutions nationwide and thus little variegated.

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Smart Parking

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Since the first car was invented hundreds of years ago, there has been a dramatic increase in cars number on the roads in the past 40 years. Our social lives became more dynamic than ever before and we have started to use cars on daily basis. One of main problems the increasing number of cars brought to our lives is that we are running out of possibilities to extend parking places in urban areas.

According to Global Innovation Series[1], up to 74% of all traffic jams in downtown areas are caused by cars cruising in order to find a free parking space. It means that a lack of free parking spaces does not mean only unsatisfied citizens but also high wastes of fuel and higher emissions. With a development of information technologies we are not able to provide cities with more land to build parking infrastructure, but smart parking systems and IoT (Internet of Things) can provide a critical component to a smart cities' infrastructure and help highly populated areas to make parking more effective.

Main goals. We think that the smart parking system proposed in this paper could improve traffic situation in urban areas, help drivers to reduce time spent by searching for a parking space and even municipalities in adapting parking infrastructure to real needs. According to this, the main goals of developing smart parking system is to make information about the usage of parking spaces with a division into streets and urban areas available to ordinary people and municipals in order to:

- quickly and efficiently park, reduce traffic jams and air pollution,
- help cities and city police to optimize parking through visualizations, statistics and predictive parking models, and subsequently, on the basis of the data obtained, propose a change in the parking prices in favour of the municipality and the drivers,
- maximize cities revenue from provided parking in order to better critical infrastructure funding.

Achieving these goals requires rational data gathering process and big data analysis along with data visualization.

Features. Created parking system supports visualization of municipals registered parking spaces along with real-time occupancy, history occupancy preservation and parking lot statistics. The occupancy data is collected in real time using physical devices located in the area of each parking space (drilled into the parking surface). Based on the stored historical parking lot occupancy we summarize parking lot statistics that can help people to plan when and where to park but also municipals to optimize parking infrastructure according to actual needs of city residents (reduction of areas with long-term parking unavailability due to high parking lots occupancy).

System architecture. The smart parking system is implemented as a web application optimized for both desktop and mobile devices based on React framework (JavaScript library for building responsive user interfaces). In development process we use UU5 and Plus4U5 React libraries provided by Unicorn Systems Slovakia in both front-end and back-end part of the application to ensure unified development process so the application can be easily maintained and developed in the future.

Gathering data about occupancy of a parking lot is accomplished by special parking sensors created by The Faculty of Electrical Engineering and Information Technology STU in Bratislava especially for the pur-

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[1] https://www.mashable.com/2011/04/13/smart-parking-tech

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pose of an intelligent parking system. These sensors are mounted in the pavement of every parking box and are based on LoRa network which offers a very compelling mix of long range, low power consumption and secure data transmission to send information about the parking box when a car parks in or it leaves it. Through LoRa network all the data are sent to Orange Live Objects platform from which all the parking data is transfered through MQTT connection and stored in our central MongoDB database (Figure 1). This data is then processed and available to users of our application. Users are allowed to see general parking lot information, current parking lot occupancy, historical occupancy and parking lot statistics.

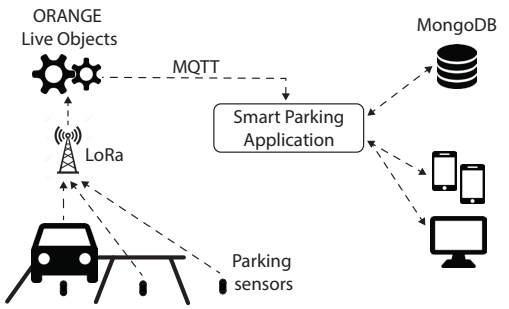

Figure 1. System overview.

For displaying maps to provide city and parking lot navigation we have integrated Google Maps API, which allows us to use all the benefits of advanced Google's maps technology (Figure 2).

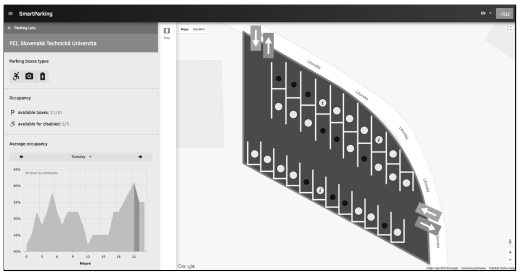

Figure 2. Application preview - parking lot.

Deployment & real usage. It turns out that there is a high demand for this type of parking system. In cooperation with Orange Slovakia and Unicorn Systems Slovakia we are now achieving the first possible co-operations and system deployments in two Slovak cities, which would like to use our system to monitor their toll-free parking limits in the city.

This type of system is becoming popular also to cities all around the world as according to few companies providing similar parking systems, cities have gained 30-60% increase in parking lot revenue by using it[2], so returns can be achieved easily.

Future work. Our system provides functionality which can be used in real life, but as we are still in development there are some features we plan to be implemented next.

For ease of use and its faster expansion to the public, it is necessary to cover as many parking spaces as possible. We aim to create the possibility of simply adding new parking spaces and managing them directly by municipalities or administrators of these areas.

As all parking spaces are not free of charge, created system should also allow making reservations and support payments for parking spaces where this is necessary. Also, real-time data collection can be useful for city police in toll parking service tracking to reduce illegal parking activity.

We also plan to enhance data statistics and big data analysis to support decision-making process in municipalities and to help people decide and organize parking in the cities.

Another feature we would like to support is advanced system personalization to fit needs of each user. In addition to occupancy monitoring and parking statistics, users will also be able to manage cars linked to their account, making them considerably easier to process a parking reservation or to access other system options that they will be able to freely use (e.g. built-in navigation system).

Conclusion. We have proposed a smart parking solution that could help cities to reduce enlarging traffic problems using IoT. By using our smart parking system we can now achieve improvement in quality of provided parking services, improve traffic situation in many cities as it helps drivers to find a free parking lot more quickly and support municipalities decision-making process by providing advanced data statistics to build a better parking infrastructure. We believe this system can help many cities to deal with parking problems more effectively and provide their citizens with a better life.

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[2] https://www.ipsgroupinc.com/smart-parking

Immersive Web

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1 Introduction

The result of the project is an easy-to-present, innovative solution for presentation of websites' content. The goal of the project is to design and create a prototype of a website that allows a user to browse the information space in an immersive virtual reality environment. Specifically, this site should serve to present the 3D Lab[1].

Information as such takes on a "tangible" form, allowing users to explore, navigate and interact within the information space in a more natural and effective way.

The main goal of the project is to design and create a new kind of website that allows a user to browse the information space in a virtual reality in 3D space. The site serves to present the 3D Lab, its equipment and projects emerging in it. In this 3D space, we provide complex information, which immerse the user and give him ability to move and to interact with few specific objects.

In the analysis of our problem area, we have found that the best way to create the necessary 3D models is the photogrammetry method.

During the development of our project we are using various technical devices and software to make photos of space that we present in virtual reality.

As Priolo remarked in his paper [1], technology of 3D virtual tours started to be popular for museums or big companies. Our project should not only support these tours but also transform whole web space to one big virtual tour.

2 Immersive Web Prototype

Our web application is converting ordinary websites into virtual reality. As the first prototype, we chose a website where we present a virtual tour of the lab in which we work.

Virtual space provides wide range of presenting information to users. The main functionality is to inform users about the space they are in, what they see and allow them to interact with surrounding objects. The way to interact in this particular space is to move around the room in a virtual tour, grab the objects in their vicinity, change the size of the objects and learn the details about them by clicking on them. Details can be displayed by text in pop-up window or video presentation captured by 360°camera to enhance the stimulation of the human senses. This gives the user the best experience of watching a recorded experiment.

The biggest problem so far has occurred when the user moves through the space. It is very difficult for a human brain to quickly realize the change of space that he sees when he actually did not move. This has often caused a dizziness or even nausea with some testers. We finally solved this problem by adding a few hundredths of a second between shifting the scene.

The other interesting part of the project is the ability for site administrators to modify content while being in the virtual space. By grabbing an existing object, it is easy to move to another location or change its size. Also, if the administrator needs to add a new object, it is not necessary to interfere with the source code of the website but simply fill in the object's parameters into a JSON file. In the same way (by editing a JSON file) objects can be easily deleted.

The current version of our web application is available on our team website[2], where HTC Vive owners can try out all the features.

In *Figure 1* and *Figure 2* can be seen a sample of our current prototype. As can be seen in these images, the application is tested on the 3D Lab website with virtual tour in which we are working on this project. It can be also seen our feature of presenting details

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[1] http://3dlab.fiit.stuba.sk/

[2] http://team13-17.studenti.fiit.stuba.sk/

about objects in 3D space. After clicking on object in *Figure 1*, text representing details about it pops up above the controller (arrow), displayed in *Figure 2*.

During testing, several geometric shapes and also parts of furniture have been added into the space. These objects have been moved and their size have been changed.

Figure 1: Clicking with controller on 3D model of camera Samsung Gear 360 in virtual space.

3 Technologies Used

To achieve all of this, we use several technologies and methods.

Photogrammetry is the process which allow us to create the 3D models from a lot of photos of the object. To create 3D models by photogrammetry, process the special software is required. Photogrammetry process is very tedious and these steps need to be abide: all photos must be sharp, photos cannot be edited, stand has to be used, zoom cannot be used, photos have to be saved in JPEG format, flash has to be disabled.

Web Graphics Library (WebGL) is a JavaScript API for rendering interactive 3D computer graphics and 2D graphics within any compatible web browser without the use of plug-ins.

It is integrated completely into all the web standards of the browser allowing Graphics Processing Unit (GPU) accelerated usage of physics and image processing and effects as part of the web page canvas. Its elements can be mixed with other HTML elements and put together with other parts of the page or page background.

Three.js is an open-source JavaScript library used to create 3D graphics in a web browser. Three.js uses WebGL described above.

It allows create and render complex 3D objects display in the browser without the effort required for a traditional standalone application or a plugin.

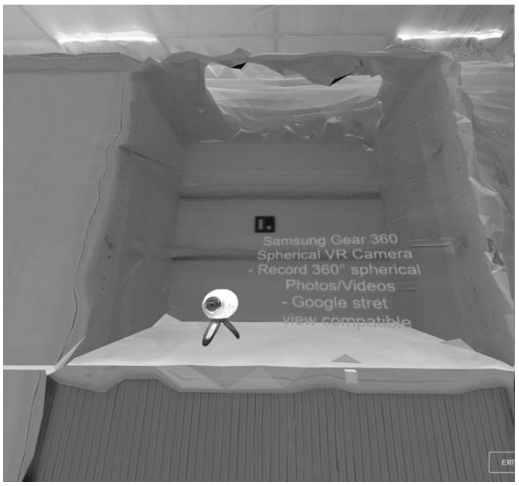

Figure 2: Displaying pop-up text representing details of model of camera Samsung Gear 360 after clicking on it.

4 Conclusion

The specific content of the website with our prototype serves the presentation of the 3D Lab at FIIT STU and its main goal is to provide information on the projects and equipment of this laboratory. However, the web application has many other uses for the future. The plan is to modify other 2D websites into this form, for example museum or sightseeing tours, e-shops into virtual market place or teaching purposes.

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Collab-UI: A Collaborative User Interface Prototyping Tool

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Nowadays, prototyping has become an integral part of the software development cycle. Functional prototypes can provide a valuable insight on the products characteristics and they are highly utilized in various agile development methods [2]. However, the process of designing a prototype from scratch and discussing its properties with the development team is often lengthy and overly complicated. Participants in this process have to rely on external communication tools and sequential workflow. The effectiveness of the prototyping team would be greatly improved by a collaboration-oriented prototyping tool that will let everyone contribute in real time.

Since no such solution of sufficient quality is currently publicly available, in this paper we present a new user interface prototyping tool named Collab-UI. It is designed to help user interface designers develop prototypes of applications utilizing HTML and CSS in their presentation layer.

Our goal is to provide a solution that is accessible from any device, regardless of its operating system. Therefore, we designed Collab-UI as a dynamic web application that integrates real time collaboration with browser-enabled communication channels and online management system of existing prototypes. We aim to develop an all-round solution that encapsulates all activities related to user interface prototyping in a single online platform.

Because functional prototypes are often kept and steered towards the final product quality instead of being discarded [1], we have designed Collab-UI to be able to export the prototypes as a fully functional source code.

To achieve this, we utilized an already existing browser-based prototyping solution based on JavaScript and gradually added more and more collaborative and communication oriented aspects to it. Currently, the core Collab-UI feature structure includes:

- User management
  - E-mail based user registration and verification
  - Project activity notification system
- Project management
  - Basic & detailed prototype overview
  - Prototype collaborators management
  - Collaborator privileges support
- Real-time prototyping
  - Interactive and customizable prototype editor (see *Figure 1*)
  - Immediate prototype change propagation and synchronization
  - Connected collaborators overview
- Source code export & versioning
- Means of real-time communication
  - Voice chat
  - Text messaging

In order to provide these features, our application relies on a number of specialized technologies and external libraries. The backend part of the application consists of a pair of databases (a relational and a non-relational one) and two dedicated application servers – each taking care of different tasks. These servers expose their REST APIs for clients to call upon.

The presentation layer is built on various specialized JavaScript libraries, all of which cooperate together in order to provide the desired functionality. Even though the technological stack is quite diverse, all the end user needs in order to start prototyping is a common web browser with JavaScript support.

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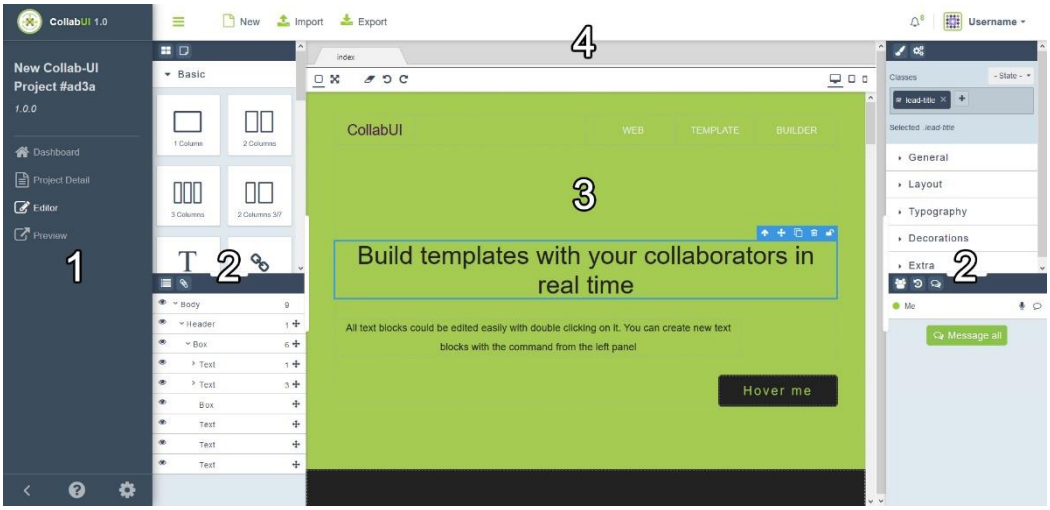

Figure 1. A screenshot of the Collab-UI interactive prototype editor. It consists of four main sections: (1) selected project overview and navigation, (2) editor panels containing the main editing tools, (3) prototype canvas, and (4) additional prototype actions toolbar.

Collab-UI is primarly aimed at UI/UX designers and frontend developers working together in development teams. However, it can be also used by any other person included in the user interface prototyping process – even by the product owner himself (e. g. to check on the progress of the team).

We designed a very straightforward prototyping process consisting of just two basic steps. First, every user needs to go through the registration process. Fortunately, this process is rather simple and it is no different from registering on other websites. The user will be registered under his e-mail address and after activating his account, he can immediately create a new project. A default Collab-UI project contains one predefined prototype and is characterized by its project name, owner and a set of user-defined tags.

After creating a new project, the user can start working on prototypes right away or he can invite some collaborators first. Each project collaborator is identified by his e-mail address and a privilege (edit or watch), which has been assigned to him by the project owner during the invitation process.

From this point on, any project member with sufficient privileges can work on the existing prototypes or create a new one. Since the application is not publicly available yet, there is currently no limit for the maximum number of user interface prototypes per project.

Every prototype change is synchronized across all connected clients by a dedicated NodeJS server in real time. This collaborative way of work can be considered the key feature of our application and we are constantly working on improving it even further.

The idea behind Collab-UI is to provide a universal tool which overcomes the notorious issues associated with user interface prototyping in teams. We have managed to address these issues by providing a way for individuals to communicate and collaborate in real time without the use of any external applications.

It is important to note that Collab-UI is accessible from any operating system via standard internet browser and it can be used to design user interfaces for both mobile and desktop devices.

As for the future work, there are numerous new features that could be added into the application in order to make it even more helpful and enjoyable to use. Moreover, it is built on technologies which are constantly evolving and therefore it offers a lot of possibilities for future work in this regard.

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