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## Automated gathering and analysis of cannabinoids treatment data

Rachita Chugh, Nidhi Chawla, Rochelle Maria Gracias, Jitender Singh Padda, Songyan Li, Minh Tuan Nguyen, Maria Spichkova\*, Nitin Mantri

*School of Science, RMIT University, Melbourne, Australia*

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### Abstract

The paper presents an open source platform to integrate and analyse the cannabinoids research data gathered from academic publications, industrial and clinical trials as well as patients. The project focuses on the analysis of the usability aspects important for the applications collecting the treatment data as well as data on diverse cannabinoids strains. The collected data will be used to estimate the efficiency of cannabinoid treatment of various disorders, which will provide an evidence-based assistance for doctors, researchers and industry to identify the right cannabinoid profiles for various conditions.

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**Keywords:** Software Engineering, Usability, eHealth Systems, Biomedicine, Bioinformatics

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### 1. Introduction

Cannabinoids have a huge therapeutic potential: they are anti-bacterial and neuro-protective, inhibit cancer cell growth, promote bone growth, reduce convulsions and seizures, reduce blood sugar levels, etc., see [1, 2, 3, 4, 5]. A number of clinical studies indicate that cannabinoids are effective in easing symptoms of a wide range of difficult-to-control conditions, including epilepsy, schizophrenia, tumours, diabetes, and many other conditions, see for example [6, 7, 8, 9, 10, 11, 12]. However, currently there is no integrated platform which would collect all the data from diverse clinical studies, academic publications, patients' feedback, etc. If all cannabinoid research data would be integrated within a single platform, this would provide a solid basis to analyse the efficiency of cannabinoid treatment of various disorders.

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\* Corresponding author.

E-mail address: [Maria.Spichkova@rmit.edu.au](mailto:Maria.Spichkova@rmit.edu.au)

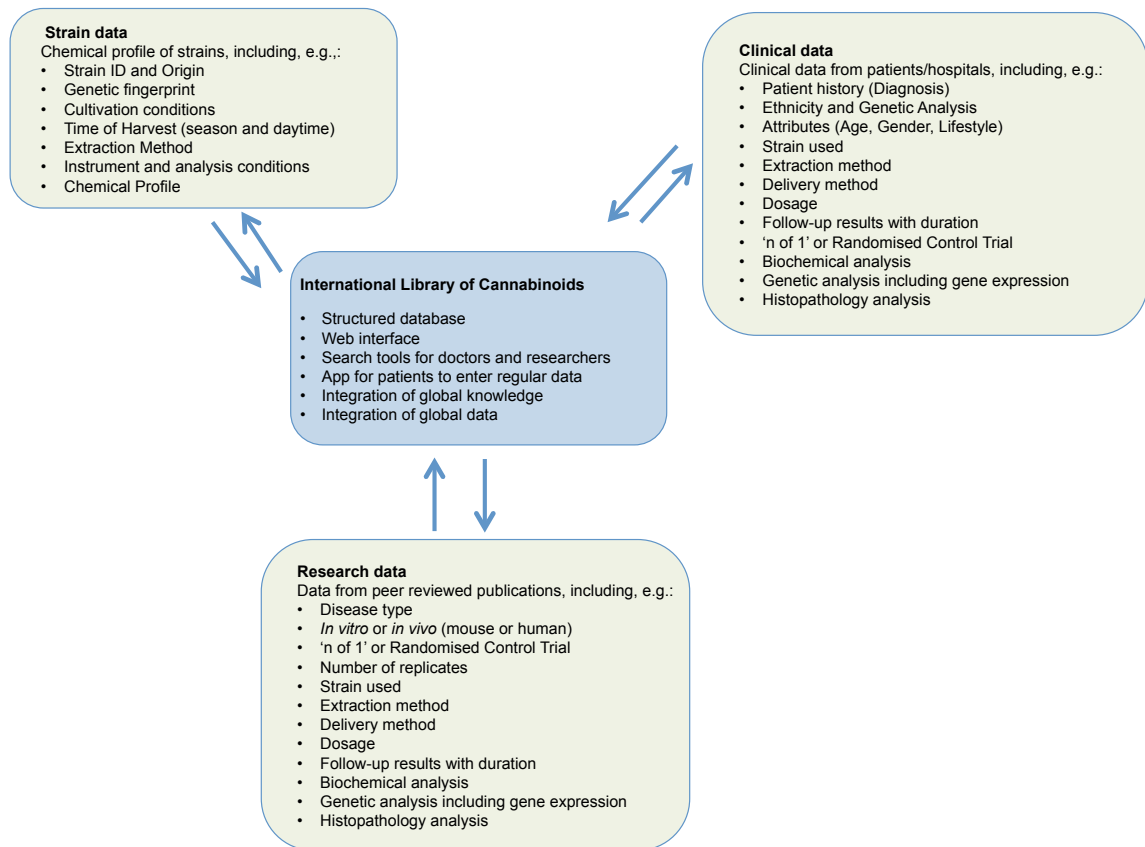


Fig. 1. ILC platform: Core data sources

Our previous research on automated management and analysis of heterogeneous data within cannabinoids domain was introduced in [13]. Our goal was to elaborate a solution that would allow us to integrate data from several cannabinoids data sub-domains (including hospital, research, and growers) in order to provide means for higher quality research analysis. Thus, in [13], we proposed a platform for automated collection, management and analysis of cannabinoids data, where the overall goal is to develop an International Library of Cannabinoids (ILC) platform, see Figure 1.

*Contributions:* In this paper, we elaborate a part of the ILC platform: the Clinical Trial application, which include

- iOS and Android mobile applications that allow patients to enter and track their treatment data, as well as
- a Web-based application for doctor and treatment coordinator that allow them to track and analyse the data provided by the patients (see Figure 2 for an example of implemented interface).

Our focus is on analysis of usability aspects of the applications to collect the treatment data.

The project was conducted in collaboration with MGC Pharmaceuticals Ltd, who used to apply manual methods to collect and analyse the data. As a result, a large number of research findings go undocumented since they are not structurally archived in a way to enable scientific evidence-based data mining. Therefore, it is crucial to have a platform to collect and analyse treatment data for clinical trials.

*Outline:* The rest of the paper is organised as follows. Section 2 introduces the background and related work. Section 3 presents the architecture and the core functionality of the proposed Clinical Trial Application. Finally, Section 4 summarises the paper and introduces directions of our future work.

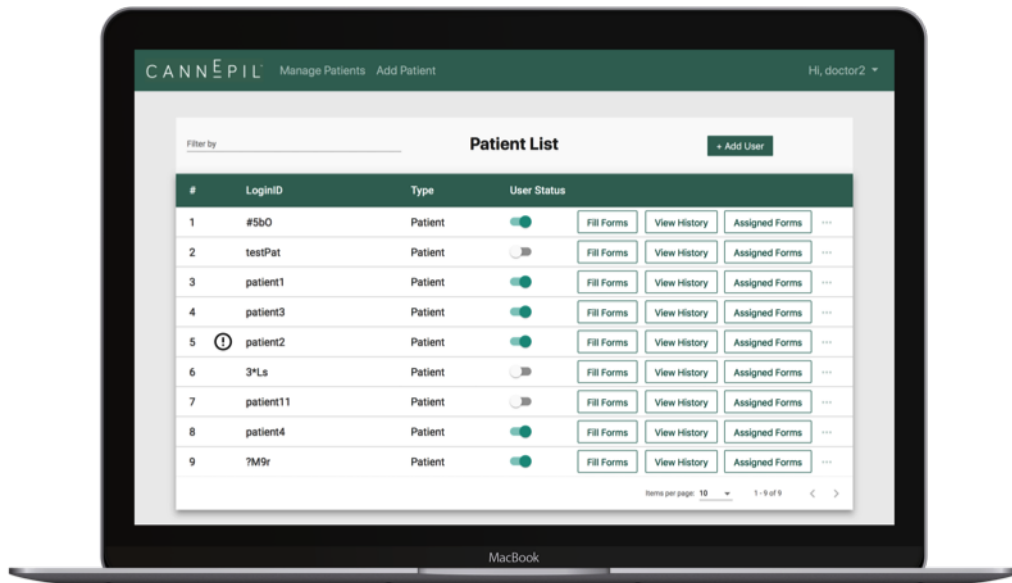


Fig. 2. Clinical Trial application: Web interface for clinicians

## 2. Background and Related work

A review of cloud-based applications focusing on healthcare, biomedicine and bioinformatics questions was presented in [14]. The focus of the review was on the core issues related to the platforms for the storage and analysis of patients data.

There are a number of solutions aiming on collecting cannabinoid data. For example, Open Cannabis Project<sup>1</sup> and SeedFinder<sup>2</sup> work on collecting and dissemination of the information regarding cannabis strains. However, both of these projects do not have any objectives on elaborating the effective cannabinoids treatment by integration of the collected data with further medical data. In contrast to them, the Strainprint<sup>3</sup> project focuses on keeping track of the effectiveness of treatments by data collection from user profiles, ingestion methods and dosages. In our work, we aim to go further, by combining both goals.

Pharmacogenomics Knowledgebase [15] and Public Health Genomics Knowledge Base [16] provide a solution similar to our target within the ILC research sub-domain, but within the research area of genomics. These open knowledge bases (1) collect and share data about human genetics and population health, (2) periodically extract data from scientific publications, using manual and automated techniques. A Cloud Health Information Systems Technology Architecture was introduced in [17]. Another integration framework for data and schema variability in Biomedical Information Systems was presented in [18]. The authors preferred a manual solution for semantic analysis of collected data that were collected from several providers, hence had a different structure. The question of a full automation was still open in that approach. In contrast to these approaches, we aim to have a fully automated solution, as well as cover not only the sub-domain of research publications but also the sub-domain of data collected from hospitals, patients, and doctors, as well as sub-domain of data collected from growers.

<sup>1</sup> <http://opencannabisproject.org>

<sup>2</sup> <https://en.seedfinder.eu>

<sup>3</sup> <http://strainprint.ca>

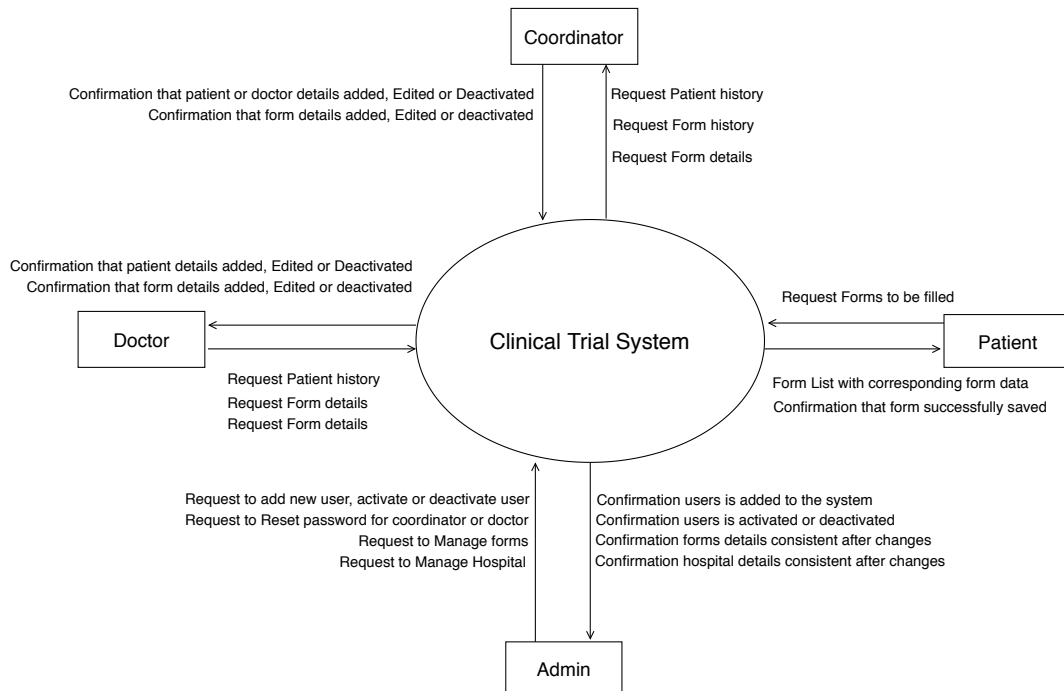


Fig. 3. Clinical Trial application: Context Diagram

### 3. Clinical Trial application

Figure 3 presents a context diagram for the proposed Clinical Trial application. Context diagrams (also sometimes called data flow diagrams of level 0, see [19, 20]) illustrate the scope of a system at a high level of abstraction and the environment in which the software system exists. Thus, system was elaborated to support the following core types of the users:

- doctors, who can work in a number of hospitals,
- academic researchers,
- treatment and for clinical trials coordinators,
- patients and caretakers (as some patients have health-related problems that require a caretaker to fill out the dairy study on their behalf),
- system administrators.

The core usability goal for the Clinical Trial application was to have an interface that is simple and easy to use, so that the patients can use it intuitively and without having any learning curve.

Figure 4 presents a general architecture of the Clinical Trial application.

The back-end part of the solution, MySQL Database to store all resource data and ASP.NET Application Programming Interface (API), is hosted in Nectar Cloud<sup>4</sup> that provides free cloud services for researchers in Australia. This choice also allows us to consider as a future work the connection of ILC platform with a research-oriented cloud computing platform Chimney, which is also Nectar-based. Chimney provides user-friendly interface for the computation and analysis set up, as well as visualisation of the calculation results as 2D or 3D graphs, see [21] and [22].

<sup>4</sup> <https://nectar.org.au/research-cloud>

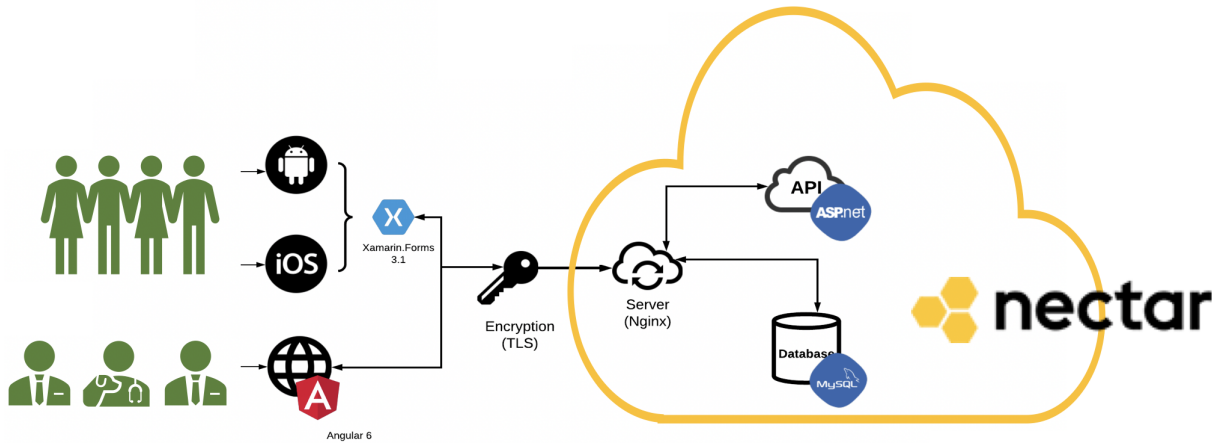


Fig. 4. Proposed system architecture

The front-end is implemented as two types of user interfaces:

- Web interface to be used by doctors, academic researchers, administrators as well as treatment and for clinical trials coordinators, see Figure 2 for an example: a Web-based application implemented with Angular 6, an open-source front-end web application platform<sup>5</sup>.
- Mobile interface to be used by patients and caretakers, see Figure 5 for examples: Android and iOS mobile applications implemented with Xamarin<sup>6</sup>, which provides cross-platform compatibility between Android and iOS.

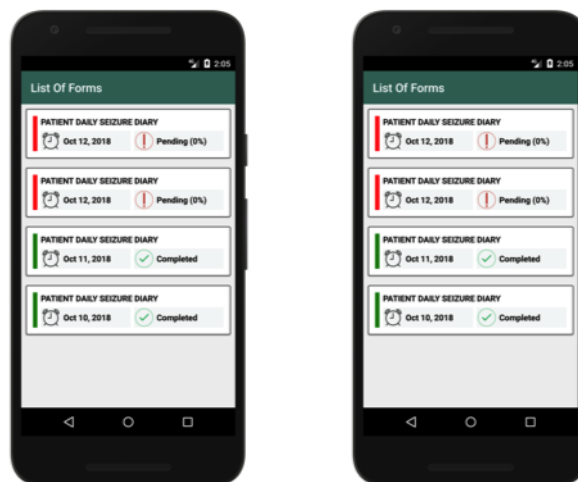


Fig. 5. Examples of a mobile interface for patients and caretakers

<sup>5</sup> <https://angular.io>

<sup>6</sup> <https://visualstudio.microsoft.com/xamarin>

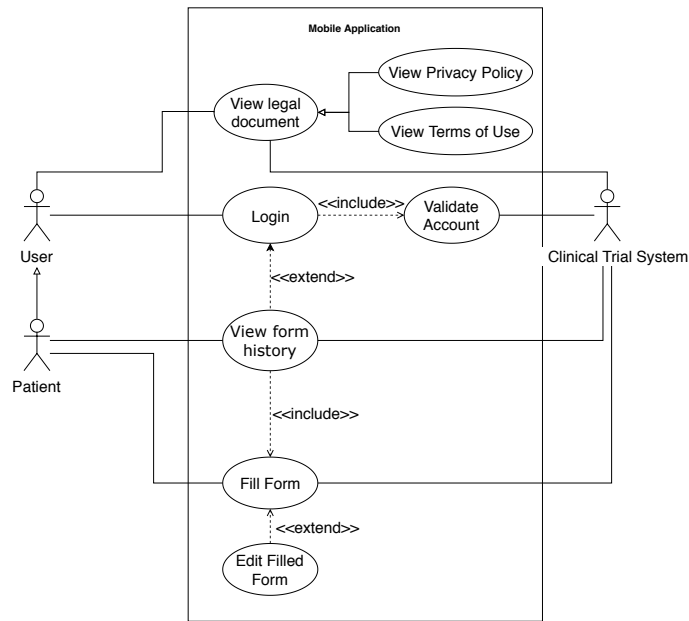


Fig. 6. Clinical Trial application (Mobile): Use Case Diagram

The Clinical Trial application provides various functionalities to support the process of data collection and analysis, such that,

- creating new forms,
- deactivate forms once the clinical trial is completed,
- assign the forms to the patients,
- fill out the assigned forms,
- notify if there are some pending forms to be filled out,
- edit existing forms if they are not currently assigned to any user to fill out,
- register new users (patients, doctors, coordinators, administrators),
- add new hospitals participation in the project,
- edit details of the hospitals added to the system,
- etc.

Figures 7 and 6 present Use Case Diagrams for the Web-based and mobile parts of the Clinical Trial application, respectively. When a form is assigned to a patient, the Clinical Trial mobile app will display the form to be filled by the patient. If the form is assigned to be filled daily, monthly, by-monthly or quarterly, the Clinical Trial application will automatically generate and display the assigned form to the patient periodically till the patient is deactivated. Once the patient successfully submits the form assigned, the patient has 15 days to modify the already submitted form.

The coordinator or doctor in charge of the treatment will get a notification if the patient hasn't filled 8 or more forms assigned to them. The application allows activate and deactivate a user profile in the system. If a patient's profile is deactivated, the patient will receive the message that their account has been deactivated and to contact their doctor if it was a mistake. If a coordinator, doctor or admin is deactivated from the system they won't be able to log into the web application. A message will be displayed to contact MGC pharma's admin.

The web application can reassign a patient to another doctor if the attending doctor is on vacation. The coordinator or newly assigned doctor can then reassign the patient back to the previous doctor. The admin can reset the password of coordinator or doctor. The coordinator can reset doctor or patient password. The doctor can reset their own patients' password. The logged in user can change their password. The system will help collect treatment data and help MGC pharma manage the patients currently active in the Clinical trial.

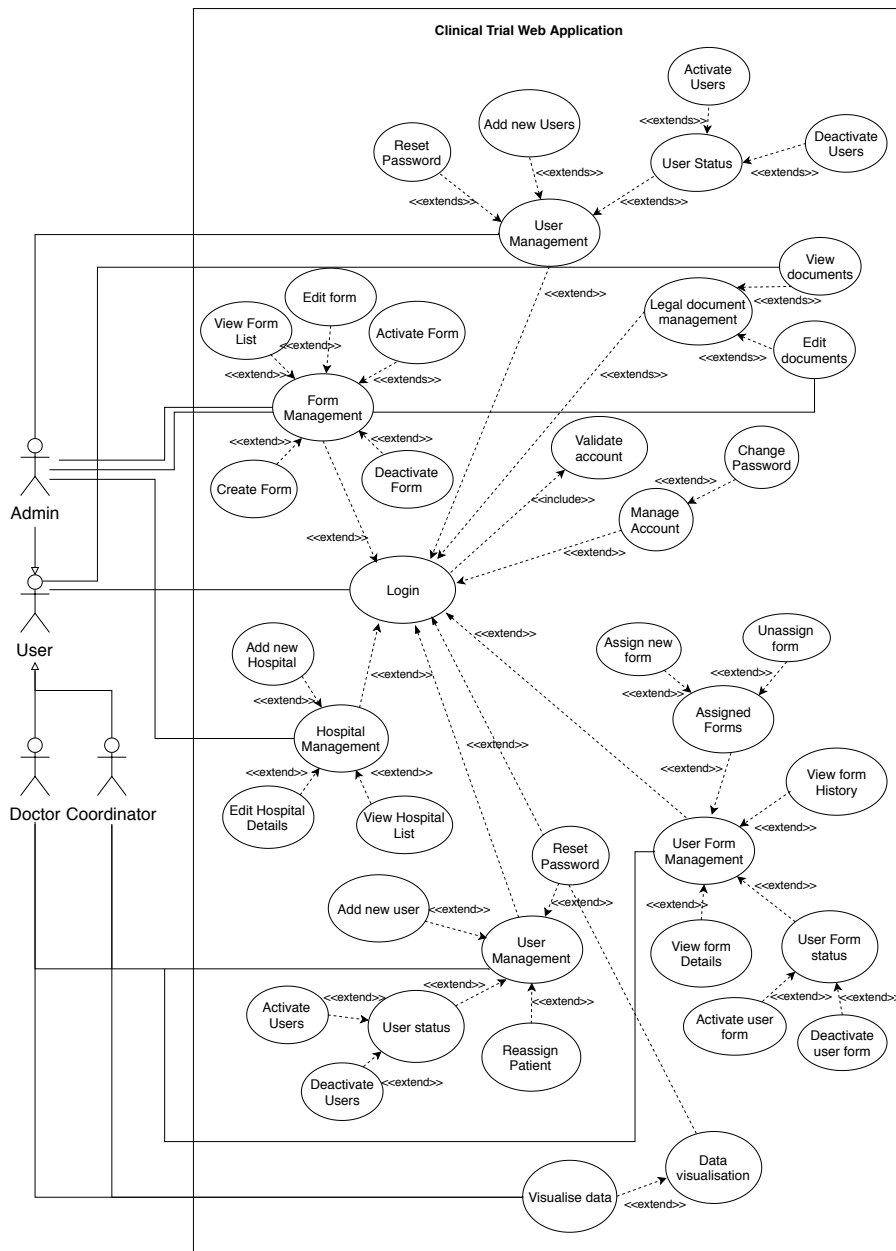


Fig. 7. Clinical Trial application (Web): Use Case Diagram

In order to analyse data collected from a particular patient, the Web interface of the Clinical Trial application also provides a dashboard (aimed to be used by doctors and researchers) to visualise the responses as a line chart, see Figure 8. The visualisation of responses as a simple chart might decrease the cognitive load of doctors and researchers analysing several treatment cases as well as help to identify the tendencies in the treatment results and outstanding values in the collected data. The chart includes all the responses to selected questions of a particular form within the indicated time period. As each question has several answer options, we also provide a corresponding table to show question details to avoid misunderstandings.



Fig. 8. Clinical Trial application: Data visualisation

The Clinical Trial application was elaborated within a research project under the initiative *Research embedded in teaching*, see [23, 24]. This initiative was proposed at the RMIT University (Melbourne, Australia) within the Software Engineering projects (SEPs) conducted in collaboration with industrial partners. The largest student cohorts were presented by the following courses:

- *COSC 2616 Postgraduate Software Engineering Project*, taught for Master of IT and Master of Computer Science students), and
- *COSC 2410/ 2411 Software Engineering Project*, taught for the Bachelor of Software Engineering students.

The aim of this initiative is to encourage students' curiosity for Software Engineering and Computer Science research. To reach this aim we include research components as bonus tasks in the final year projects (on both undergraduate and postgraduate levels), which typically focus on software and system development. Few weeks long research projects have been sponsored by industrial partners, who collaborated with the students and academic advisers through the final year projects. Respectively, the topics of these short research projects focus align the topics final year projects. The successful results of this initiative are presented in [25, 26, 27, 28, 29, 30].



## 4. Conclusion

In this paper we introduced the Clinical Trial application, elaborated as a part of the International Library of Cannabinoids (ILC) platform. The Clinical Trial application provides two types of user interfaces (UI):

- UI for patients and care takes is provided as iOS and Android mobile applications,
- UI for doctors, researchers, treatment and for clinical trials coordinators, and system administrators is provided as a Web-based application.

*Future work:* As our next step, we are going to extend the functionality of the Clinical Trial application to support gamification elements within the process of data collection: We are going to introduce Coins (Points) Reward. Thus, when a patient submits a form to completion for the first time, the system will add a coin (point) to the patients' coin balance. This functionality might encourage patients to complete the forms regularly on time.

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