A PROPOSAL FOR DATA COLLECTION AND PROCESS AUTOMATIZATION FOR UBIQUITOUS ENGAGEMENT WITH MENTAL HEALTH ORGANIZATIONS

PREPRINT

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ABSTRACT

Mental health is one of the most significant public health challenges. In recent years, several motivational applications have been proposed to help users maintain good mental health. However, many times these applications focus on uplifting messages or general resources that are not tailored to the specific needs of their users. In contrast, non-profit organizations implement effective methods to support people based on their real needs and set concrete attainable objectives. Unfortunately, these organizations tend to be saturated by the number of clients and the lack of automatization in their processes. In this paper, we present a proposal to improve mental health organizations' data collection and decision processes through a web application, allowing workers to store, access, and modify client data more efficiently. Regarding the final users, the computerized model is exploited by an intelligent conversational assistant to provide around-the-clock personalized and ubiquitous interaction with clients to encourage engagement with the organization.

***K*eywords** Mental health · Conversational assistants · Personalized dialogues · Web applications · Android applications.

1 Introduction

Mental health is defined in [12] as a "state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community". Its key importance is acknowledged by the United Nations with the addition of "promoting mental health" to the sustainable development goals which are an urgent call for action by all countries [8]. In the World Health Organization (WHO) European Region, mental health disorders are one of the most significant public health challenges with 970 million or 12.5% of the population suffering some type of disorder in 2019, with anxiety and depressive disorders the most common [10]. Global prevalence rates have been more dramatically increased with the COVID-19 pandemic [11].

An effective way of promoting mental health and assisting people with mental ill health (mild depression and anxiety) is through mental health organizations where clients can participate in a wide range of activities such as accredited qualifications and work placements in the areas of personal development, vocational skills and employability training tailored to their individual needs [2]. However, data collection and client tracking are time-consuming and challenging tasks for the counselors at these organizations with many of them using paper-based forms and having too many clients.

The work proposed in this paper attempts to support the efforts of these organizations by providing them with real-time data via a web application and engaging clients with the organization using a conversational assistant. Client engagement in activities is essential and the organization's effort can be supported with a conversational assistant that clients can interact with to obtain information about their activities, calendar, or targets.

Our proposal includes the design and implementation of a web application to input and store clients' data, a conversational assistant to provide personalized and ubiquitous dialogues with clients, and an Android application for clients to communicate with the conversational assistant. An initial phase focused on discussing the project with mental health experts was completed to clarify objectives, study current solutions, and define requirements.

One of the main benefits of our proposal is that, by having implemented a web application to manage client information, data is accessible in real-time and can be analyzed easily allowing workers to be more productive and use their time more effectively with clients. Clients are also impacted thanks to the web application to obtain relevant information and the conversational assistant to have personalized dialogues regarding their involvement. Keeping clients engaged in the organization is essential to achieve mental health through the proposed activities.

The work presented has also the potential to benefit people beyond the collaborating mental health organization because this technology could be adapted and used at other mental health institutions or even other sectors with the same needs to manage data from users and make it available via a conversational assistant. Some examples where the technology could be applied include schools to manage and track participation in courses while keeping students engaged, companies to manage and track attendance to events while keeping employees informed, and so on.

The remainder of the paper is as follows. Section 2 presents the context and objectives of our proposal. Section 4 describes the design, implementation, and analysis of the web application. Section 5 describes the conversational assistant developed to enable personalized and ubiquitous mental health dialogues. Section 6 describes the Android app created as an interface for the conversational assistant. Finally, Section 7 presents the main conclusions and future research lines.

2 Context

Conversational assistants have the potential to improve the quality of life and well-being of individuals suffering from mental health issues [4, 9, 3, 5, 6]. These assistants are an emerging and promising technique in the mental health field as discussed in [1, 7, 5].

Understanding how mental health organizations work and support their clients is the starting point for obtaining use cases and requirements that help design the different components of the system to be implemented, as well as the information to be stored by the web application and used by the conversational assistant.

As already mentioned, our proposal is intended to help people with mental ill health, specifically mild depression and anxiety, by supporting the effort and work done at mental health organizations.

Concretely, in the H2020 MENHIR project, we collaborate with Action Mental Health[1], with which we have ellaborated the requirements for the proposed technology. The first contact with the client involves the elaboration of an action plan with the set of goals, identified needs, and agreed activities and courses to improve their employability, personal, and vocational skills.

While it is expected that clients improve their mental health by attending courses, sometimes they tend to stop attending events, and key-workers must contact clients to understand the reasons for their absence. In the case of a crisis or psychological assistance needed, clients are referred to a mental health center.

The collection and storage of the clients' information at appropriate times is thus key to keep clients engaged. Regarding data collection and storage, the action plans and related forms are usually paper-based or in a digital format that is difficult to read and interpret automatically. With respect to keeping clients engaged, having a technology to help workers would allow a more frequent monitoring.

To solve these two problems and support their efforts to promote mental health, our proposal focuses on designing and implementing a web application to store information from action plans. It is important to emphasize that the user model required a thorough analysis and design to understand how different paper forms and documents are related, how workers enter and use the information, and the possible data modifications that can be applied. On the other hand, to improve client engagement and tracking, a conversational assistant is proposed to answer questions from clients based on each client's action plan. This conversational assistant has been developed to obtain information from the web application and be used in an Android application.

3 Proposal Overview

As detailed previously, our proposal includes the development of a web application, a conversational assistant, and an Android app. The purpose of the Android app is to provide personalized and ubiquitous mental health dialogues with clients at mental health institutions. The questions asked by the user on the Android app are analyzed by the conversational assistant, which displays an answer with the information available provided by the mental health institution and stored on the web application. In addition, the web application serves as a tool to have client and client-related information available in real time to be analyzed or modified easily by the key-workers.

Figure 1 provides an overview of the different modules that interact with each other for the correct functioning of the system. While details on each module are provided in the respective sections, the purpose and interaction of each module are listed below:

3.0.1 Web Application

It includes the back-end and front-end development of a web application to store all clients' data and related information. The data stored is represented with a class diagram. The back-end connects to a MongoDB database and returns a JSON for each configured endpoint using a REST API. The front-end connects to the back-end and displays the information to the users on the browser.

3.0.2 Conversational assistant

The assistant interacts with the Android app using its own API to reply to messages from the user via the Android app. At the same time, it is connected to the back-end of the web application to obtain the data needed to elaborate answers.

[1] https://www.amh.org.uk/

3.0.3 Android Application

The Android app connects to the back-end of the web application to verify users and connects to the conversational assistant's API to obtain answers to the messages sent by the users.

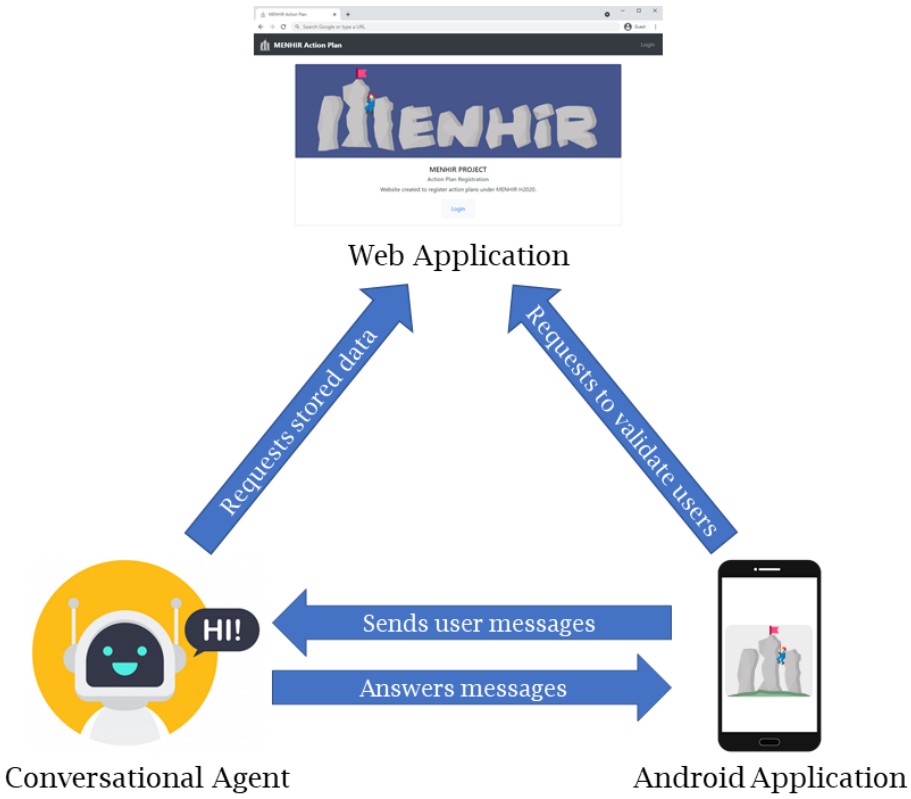

Figure 1: Overview of the proposed system architecture

Use cases have been defined considering different users: unauthenticated, clients, workers, and administrators. Unauthenticated users can only log into the web application or Android app. Clients can mainly obtain contact information, check their personalized calendar, verify their attendance, and interact with the conversational assistant. Workers can add, view, edit, and remove information regarding clients, programmes, and calendar events, record clients' attendance, configure drop-downs in the forms, and validate conversations between the conversational assistant and clients. Administrators are workers with advanced privileges who, in addition to having the same privileges as a key-worker, can grant and revoke access to the applications.

Regarding software requirements, functional and non-functional requirements have been studied for the different modules. Functional requirements mainly include secure systems with role-based access control, role-based data visualization and manipulation, personalized calendar with event details, attendance tracking, filtering and searching to increase productivity, interaction with the conversational assistant via Android app, storage of conversations with the assistant, and generation of client-specific answers. Non-functional requirements detail system language, time zone management, data verification and error messages, real-time refreshing, reliability, security, and appearance.

4 Web Application

This section focuses on the design, implementation, and analysis of the web application developed. Even though it is the source of information for the conversational assistant, it has also been designed to help the mental health organization to have all information accessible, editable, and available in real-time in one place. The development of the web application involves a thorough study of the technologies or stacks available, the design of the data model and user interface, and testing and debugging. The main objectives for the web application include:

- Store information from clients including their qualifications, goals, needs, and activities.

- Register and modify programme courses offered by the mental health institution.
- Track clients' attendance to events.
- Manage information for qualifications from other official organizations.
- Securely store all information collected under password and control access based on roles.
- Provide an interface for the conversational assistant to obtain clients' data.

4.1 Architecture

Figure 2 shows the architecture of the web application with the different technologies. The web application has been implemented as a MERN application. The MERN stack involves MongoDB, Express, Node, and React, and it is a combination of technologies commonly used to create Single Page Applications (SPA) that do not need to refresh the web page as often in order to display new content. MongoDB is a cross-platform, non-relational, and document-oriented database with a flexible schema and a JSON-based query language. ExpressJS is a web-server framework to specify actions when an HTTP request matching a certain pattern is received. React is a JavaScript library for building user interfaces managed by Facebook Open Source, well-known for being declarative and component-based. Finally, Node.js is an asynchronous event-driven JavaScript runtime.

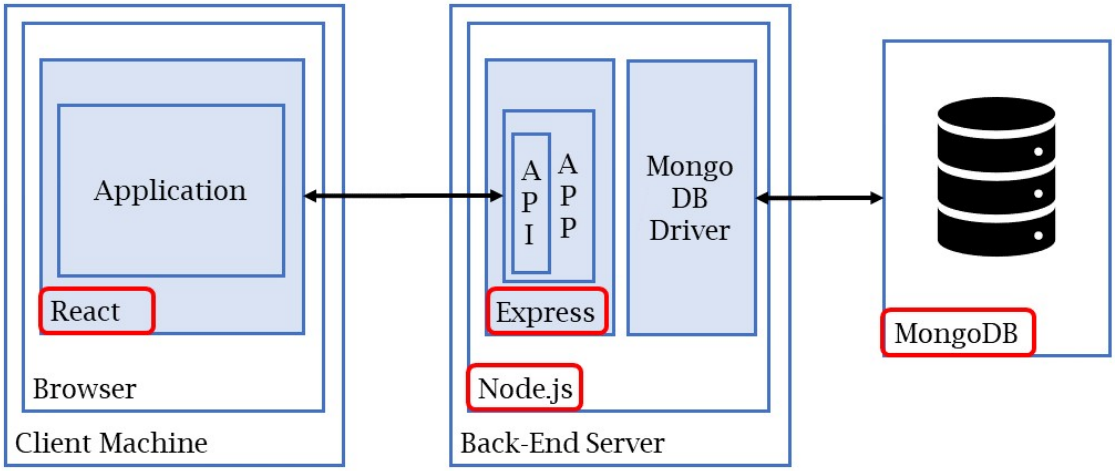

Figure 2: Architecture of MERN stack

The main advantages of choosing this stack include that it uses JavaScript as the only programming language, every object is represented in JSON format, Node.js is fast due to its event-driven, asynchronous, and non-blocking model, Node Package Manager is very complete and reliable, and React allows server-side rendering.

4.2 User model

A class diagram has been designed and improved multiple times to decide what information to handle in the web application and how to store it. A general overview of the data that needs to be stored includes:

- Client information and associated action plans. Each action plan also has a set of support areas that the client needs to work with some proposed actions or courses. Other data for the client includes long-term goals or qualifications achieved.
- Programme and course information in order to be able to recommend courses and register clients for activities. While the course information is important, it is also required to obtain details on the different sessions for each course and the attendance.
- Information on the official qualifications available and the courses offered in those qualifications including details such as learning outcomes, assessment criteria, and assessment guidance among others.

Additionally, for the correct operation of the web application, other data needs to be stored such as users to manage access control, configuration information with predefined options for drop-downs, and history of deleted items in order to be able to reference old data and maintain referential integrity.

4.3 Backend Development

The back-end development of the web application consists of implementing the connection to the MongoDB database and creating the REST API for the front-end and other systems like the conversational assistant or Android app to use. The implementation focuses on the development of the entry point, MongoDB integration, and design of the endpoints for the API. The integration with MongoDB is enhanced with Mongoose, which allows to define models or schemes for the different objects with types, parameters, and middleware to update records.

The designed endpoints include at least *get*, *add*, *update*, and *delete* operations for each model to be able to manipulate the database with the RESTful API. Implementation of these endpoints uses middleware with JSON Web Tokens to enforce authenticated role-based permissions on data exploration and modification. Additionally, checks for duplicates, correct inputs in forms, and other requirements have been considered.

4.4 Frontend Development

The front-end or client-side has been implemented in React to allow users to interact with the web application in the browser with a user interface. Development of the front-end includes implementation of React components, actions to use the back-end API, and reducers to manage the state of the application.

With respect to the designed components, they can be divided into four categories: *item components* for individual records with details, *list components* for collection of items that can be filtered and sorted, *modal components* for adding or modifying record details, and *calendar components* for the different calendar views with events and clients' attendance.

5 Conversational Assistant

The conversational assistant has been developed to enable personalized and ubiquitous mental health dialogues through an Android app with the information stored via the web application. The main objectives for the conversational assistant include:

- Identify user intent from messages and extract key values or entities.
- Obtain client-specific data from the web application to elaborate answers.
- Review real conversations between the conversational assistant and clients.
- Train the conversational assistant with real data obtained from clients.
- Interact with the conversational assistant via API.

Different solutions have been analyzed to find the software more appropriate to generate the conversational assistant considering privacy, reliability, customization, and available documentation. Regarding privacy, given that confidential data is stored, it is decided that the conversational assistant should run locally on-premises without sharing any data with third-party providers.

A thorough analysis of the available software to develop conversational applications has been performed including Google Dialogflow, Amazon Lex, IBM Watson, Rasa, Deep Pavlov, and OpenDial and is summarized in Figure 3. Aspects considered for the analysis include privacy, reliability, customization, and available documentation. Regarding privacy, given that confidential data is stored, it is decided that the conversational assistant should run locally on-premises without sharing any data with third-party providers.

Rasa[2] has been selected given that data can be kept on-premises and secured, it is trusted by multiple companies, it is open-source and allows understanding and modifying the software, and it is well documented.

5.1 Rasa

Rasa is an open-source machine learning (ML) framework to automate text and voice-based conversations by providing the standard layer of infrastructure needed for conversational AI. It is developed in Python and also uses YAML files for

[2]https://rasa.com/

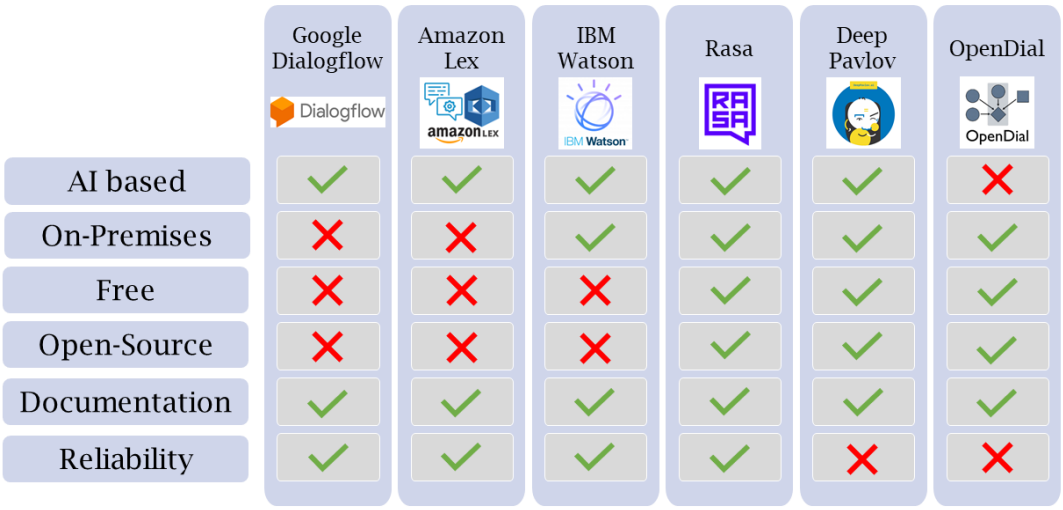

Figure 3: Comparison between the studied conversational tools

implementing conversational assistants. In addition to Rasa Open Source for generating conversational assistants, Rasa X is also provided for free to developers and allows to supervise and improve assistants based on actual dialogues.

Rasa's core includes the assistant as a central component, the NLU Pipeline responsible for classifying intents, extracting entities, and retrieving responses, and the Dialogue Management intended to decide the next action in a conversation. The NLU Pipeline is responsible for processing unstructured incoming messages and is composed of a sequence of components: tokenizers to extract tokens from text, featurizers to obtain numeric features from the tokens that the machine learning model can use, and intent classifiers and entity extraction from the features to associate messages to intents and detect key information in the message respectively.

NLU Data in Rasa is used to provide a set of sample user messages organized by intent to train the NLU machine learning model and be able to extract information from user messages including intent and entities. Entities and synonyms have been used to simplify data preparation.

Stories and rules have also been defined to design and guide conversations with the user by training the dialogue management component. While rules describe small parts of the conversation where the conversational assistant always executes the same set of actions, stories help the model to manage new conversation paths with the help of Machine Learning.

Once the message goes through the pipeline and the appropriate story or rule is selected, the conversational assistant must generate some response. It can be as a generic predefined message or a custom action that runs any code for elaborating more complex answers. Custom actions have been implemented for accessing the information stored in the web application and generating personalized messages regarding each client's action plan, goals, activities, contact information, and any other relevant information.

To integrate the conversational assistant, a custom REST connector has been created which allows to obtain message responses via API. In addition to the input message, the assistant requires some metadata such as a JSON Web Token to verify the user making the request and access protected information from the web application or the timezone to provide accurate times for the user's events. Figure 4 shows the previously described components in the architecture of the conversational assistants designed in Rasa.

6 Android Application

An Android app has been created in Java as an interface for the conversational assistant that can be used by clients. In order to satisfy the requirements collected, the app includes a login module to authenticate clients and provides a chat interface where the user asks questions and the app replies with the answers obtained using the conversational assistant's API.

The Android app connects to the back-end of the web application to verify and authenticate users and the conversational assistant's REST connector which allows to obtain responses for each message sent. To follow Android best practices,

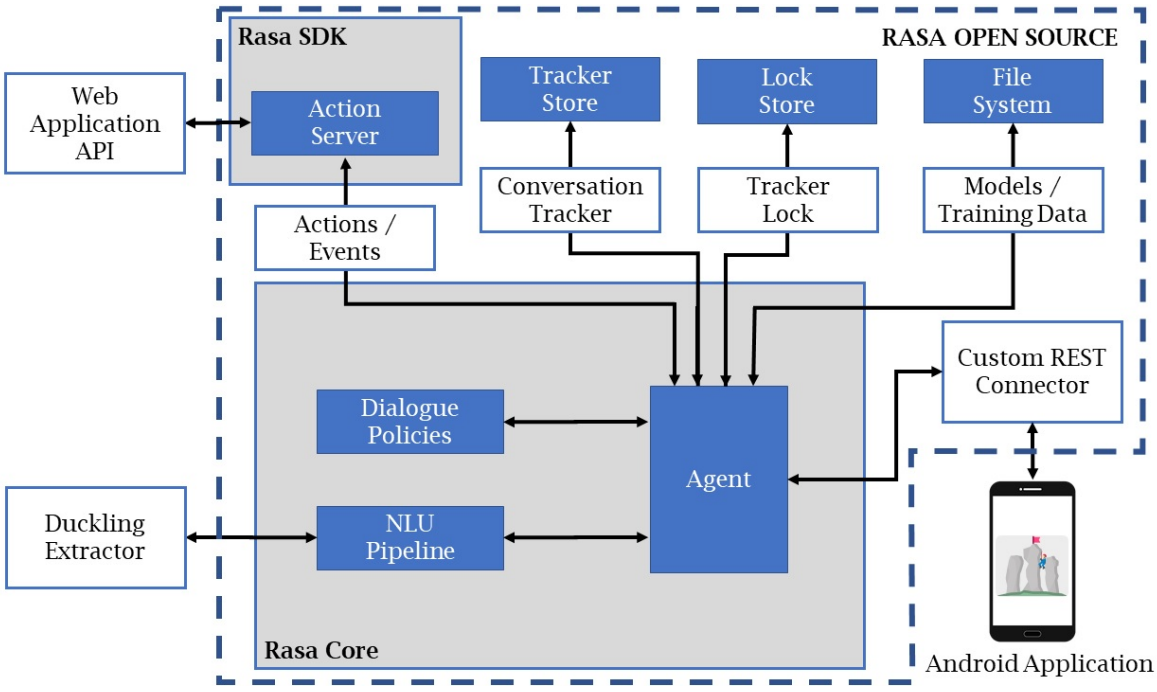

Figure 4: Detailed architecture for the Rasa conversational assistant

the application has been implemented following the Model-View-Controller (MVC) design pattern where models hold the state of the application, views display the information, and a controller manages the interaction between the views and the models.

A User model stores user-specific data such as personal information, tokens for APIs, and dialogues. Dialogues are represented with the Message model. Regarding views, a Login view has been created with a login form and a Chat view to allow messages to be displayed as sent or received. Implementing views requires designing the layout with the different visual components, as well as implementing the logic for updating the data when requested by the controller.

Finally, the controller handles login, logout, and message management taking advantage of the previously implemented APIs. Activities have been created to handle the callbacks invoked by the system on state changes when the app starts, pauses, or resumes, among others.

7 Conclusions and Future Work

Mental health is one of the most significant public health challenges and there are multiple non-profit organizations around the world supporting people to achieve mental well-being state. These organizations however tend to be saturated by the number of clients and paper forms required. Our proposal has been generated in collaboration with a mental health organization to provide ubiquitous data collection and automatize decision processes.

A web application integrates the user model to allow workers at the mental health organization to improve the organization's data collection and decision processes by storing, accessing, and modifying client data and related information quickly and in real-time.

Regarding the final users, the computerized model is exploited by an intelligent Rasa conversational assistant and an Android app on the clients' phones to provide around-the-clock personalized and ubiquitous interaction with clients, and encourage engagement with the organization through their action plans.

Future work includes the development of an iOS application similar to the Android application. We also want to improve the web application to allow data extraction to generate PDF-based forms, as well as the creation of a dashboard on the homepage of the web application to provide relevant insights. Regarding the conversational assistant, more diverse and advanced conversations will be implemented with the help of the mental health coordinators. Finally, improvements to the Android application include notifications on upcoming events without the user starting the conversation and other features, such as a calendar view similar to the one in the web application.

7.0.1 Acknowledgements

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