Technische Hochschule Ingolstadt

Development of a mobile application for the algorithmic attribution of symptoms to potential diseases

EXPOSÉ FOR THE BACHELOR THESIS

Angelina Petzold

First Examiner	Prof. Dr. Sebastian Apel
Second Examiner	Prof. Dr. Marc Aubreville
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1 General

1.1 Motivation

People are becoming more interested in matters concerning physical and mental health. This is most likely attributed to the COVID-19 pandemic that has been circulating in recent years. [2] Along with positive outcomes, such as increased care for fellow citizens [2] and greater awareness of health issues, the consistent growth of interest in health issues also caused problems. With an increasing number of anxious and concerned patients, medical practices and general practitioners have long since exceeded their capacity limits and have reached their breaking point. [5] This is also noticed by the patients: Overcrowded waiting rooms combined with long waiting periods and nerve-racking telephone loops are becoming the norm for doctor visits.

1.2 Conceptual Formulation

The conceptual formulation with which this bachelor thesis will deal can be traced back to the preceeding situation. The population is fearful, caused by the COVID-19 pandemic, and doctors are reaching their limits. The resulting problems are of great importance. General practitioners are being forced to order patient stops and issue access bans. [5] This also means that patients in need of immediate medical attention may be turned away and medical care may be denied. In addition to the concerned patients, the number of seriously (COVID-19) ill people has steadily increased: there have been approximately 146,000 deaths in Germany since the start of the pandemic (as of August 19, 2022). [4] This imposes the question on how to address patients' concerns while also relieving the burden on doctors.

1.3 Objective

Digitalization provides a solution to this problem. Online consultation hours and online appointment scheduling have recently helped relieve medical practices. Smartphones, in particular, are becoming an increasingly important part of our daily lives. The goal of this bachelor thesis is to provide a method for efficiently minimizing the aforementioned problems through the use of mobile applications. Such an application can provide advice to a worried user and help alleviate their fears. It should be noted that the goal of this application is not to replace a doctor. The application development goal is to create an optimal database structure as well as an accurate and high-performance algorithm for symptom and disease assignment.

1.4 Method

Dart is the programming language that will be used to develop this application, along with the Flutter framework. The following four sub-goals will form the basis for the processing method in order to

specify the objective of this bachelor thesis.

Determining an optimal data structure and implementing it in Firebase: A database in Firebase should be created at the start of the development process. This requires determining an optimal data structure and implementing it in the form of possible symptom and disease data. After that, the database can be built and integrated into the Flutter application.

Survey of application trustworthiness: A survey should reveal whether the people polled would put their trust in such an application. Furthermore, criteria that can have a positive impact on the question asked, such as a professional graphical user interface, are gathered. The information drawn from the survey can then be used to develop the graphical interface of the application accordingly.

Devolopment of the user interface: The database can then be used to create the application's graphical user interface. The most important aspect of this graphical interface is the questionnaire that allows the user to select and rate their symptoms on a scale.

Implementation and testing of the algorithms: This sub-goal will be the primary focus of the bachelor thesis. Three algorithms for symptom weighting and disease assignment are developed to evaluate disease detection. Their scalability and performance are compared and their correctness is determined. Finally, using an evaluation process, the best-performing algorithm is built into the application.

During processing, the methodology of qualitative utility analysis is used to determine the best algorithm and data structure.

1.5 Research Question

The context discussed raises two research questions. The first, more important one, is following:

Which algorithmic approach to symptom evaluation is appropriate to be used in a mobile application for identifying disease patterns?

While the algorithmic method is the core of the work, understanding how the user interface must be created in order to persuade users to utilize this application is equally crucial. This brings us to our second research question:

What are the most important requirements for a user interface in order for users to use it before going to the doctor?

1.6 State of Research

The state of research on symptom checker applications explicitly developed in the Flutter framework is very limited. Flutter, as a development kit released in 2018 [3], is still relatively new to the open source market. The current state of research on symptom checker applications will be described in general in the following section. If successfully developed, an assumption to be made is that a trustworthy application with a correct algorithm will positively (or possibly negatively) influence user concern and

thus save its users a trip to the doctor.
Doctor Andreas Sönnichsen, President of the Evidence-Based Medicine Network, strongly opposed the use of such apps in his article "Fluch oder Segen? Symptom Checker und Diagnostik-Apps." which was released in 2019. He cited several studies that showed such applications had a low level of correct diagnosis. He emphasized at the end of his work that symptom checker applications should only be used as a differential diagnostic tool in the hands of a doctor, if he is stuck with unclear symptoms that could possibly be due to a rare disease that the doctor does not identify due to a lack of knowledge. [1]
The goal of a current joint project at the University of Tübingen called "CHECK.APP" is to the use of a symptom checker application from multiple perspectives and derive recommendations for actions. This research has yielded no credible knowledge to this date.

2 Planning

2.1 Provisional Outline

1. Abstract
2. Introduction
    a) The Bachelor's Thesis Problem
    b) Motivation and Goals
3. Fundamentals
    a) Choosing the Development Language
4. Building a Database
    a) Choosing a Database
        i. SQL
        ii. NoSQL - Firebase
    b) Designing a Data Structure
    c) Constructing Data Contexts
    d) Inserting the Data into the Database
        i. Firebase Redundancy
    e) Integrating the Databse into the Flutter Project
5. Development
    a) Graphic User Interface
        i. Design of the Graphical User Interface
        ii. Development of the Graphical User Interface
    b) State Management
    c) Fundamental logic
        i. Conceptualiztation of Logical Connections
        ii. Implementation of the Logical Connections
6. Development of the Match Algorithms
    a) The Symptom Graph
    b) Weighting of the Symptoms within the Application
    c) Development of the Algorithms

   d) Evaluation of the Algorithms
      i. Performance Evaluation
      ii. Scalability Comparison
7. General Overview of the Application
   a) Testing the Application
   b) Survey: Would Respondents use this Application and put their Trust in it
8. Conclusion and Outlook
   a) Symptom Detection Applications in the Future
   b) Use of Flutter to Develop Applications
   c) Outcomes of the Performance Comparisons
   d) Overall Conclusion
9. Bibliography
10. List of Abbreviations
11. List of Tables
12. List of Figures

2.2 Time Schedule

The total processing time of the bachelor thesis is five months, i.e. about 21 weeks.

- Preparation: Week 1 and 2
  - Building a Database, Week 1 - 2
- Development: Week 2 to 8
  - GUI, Week 2 - 3
  - State Management, Week 2 - 3
  - Logic, Week 3 - 4
  - Algorithms, Week 4 - 8
- Survey: Week 8 to 10
  - Survey, Week 8 - 10
- Writing phase: Week 8 to 17
  - Writing the bachelor thesis, Week 8 - 17
- Final phase: Week 17 to 21
  - Proofreeding, Week 17 - 21

Bibliography

[1] Prof. Dr. Sönnichsen Andreas. *Fluch oder Segen? Symptom Checker und Diagnostik-Apps*. 9/2019. URL: https://www.ebm-netzwerk.de/de/medien/pdf/ebm-kolumne-09_19.pdf.

[2] *Corona macht rücksichtsvoller: Thema Gesundheit bei den Deutschen immer wichtiger*. Berlin, 8/4/2022. URL: https://www.bah-bonn.de/presse/bah-gesundheitsmonitor/presse-detailseite/corona-macht-ruecksichtsvoller-thema-gesundheit-bei-den-deutschen-immer-wichtiger/.

[3] Flutter, ed. *FAQ: Should I build my next production app with Flutter?* 17.08.2022. URL: https://docs.flutter.dev/resources/faq#what-is-flutter.

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[5] Sokollu Senada. "Überforderung der Arztpraxen: Corona-Überlastung: Patienten schildern Grenzsituationen bei Hausärzten". In: *SWR Aktuell* (5/1/2022). URL: https://www.swr.de/swraktuell/baden-wuerttemberg/patienten-im-stich-gelassen-in-corona-zeiten-100.html.