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Hamburg

Master-Studiengang Big Data & Business Analytics

3. Semester

Development of a system to control and monitor blood pressure measurements to prevent cardiovascular disease

Betreuer: Prof. Dr. Kai Brüssau

Autor: Jacqueline Franßen

Matrikel-Nr: 496804

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1 Abstract

Business Case: 1) With the developed solution, doctors are getting an overview of the patient's blood pressure values. This makes them react more precisely to any special values. 2) Since the patient is lead through a tutorial and the chatbot is 'controlling'/'checking' his measured blood pressure values, all measurements are taken more accurately. This improves the process of documentation. 3) With the service of sending a report via email every two weeks to the doctor. The doctor has always the current value and can interprete them faster. (now they are only getting a long list of all measured values of their patients which they have to interprete on their own and

4) Recommendation system of the nearest doctor helps the patient to directly go to his doctor Jack: 'Hey, i found these nearest doctors/specialists in your neighbourhood. Just select one of them and make an appointment with them.

2 Introduction

2.1 Problem statement

2.2 Aim and scope of this work

Aim of this scientific work is to develop a solution to document blood pressure in order to react preventively against heart disease. To recommend an appropriate doctor in one's surrounding (approximately 5 kilometers of distance). The application shall send every week/every two weeks a report (including a diagramm of all measured blood pressure values of the patient) to the doctor so that the doctor will be informed in real-time. In the diagrams/frontend, it is possible to select different scales, e.g. like the values of last week/last month/last year. At the beginning of using the Chatbot, the user is being led through a tutorial which shows him how to measure correctly his blood pressure. One instruction is for example not to drink coffee before measuring your blood pressure or to sit for at least 5 minutes.

3 Fundamentals

3.1 Reporting and Big Data

3.2 Software Architecture: Best Practices

As can be seen in figure 3.1, medical systems need many resources from which all relevant medical data iare loaded. As described by Talukder et al. [1], all medical data is processed by Natural Language Processing (NLP) techniques, evidence based medicine as well as big data anayltics (see figure 3.1).

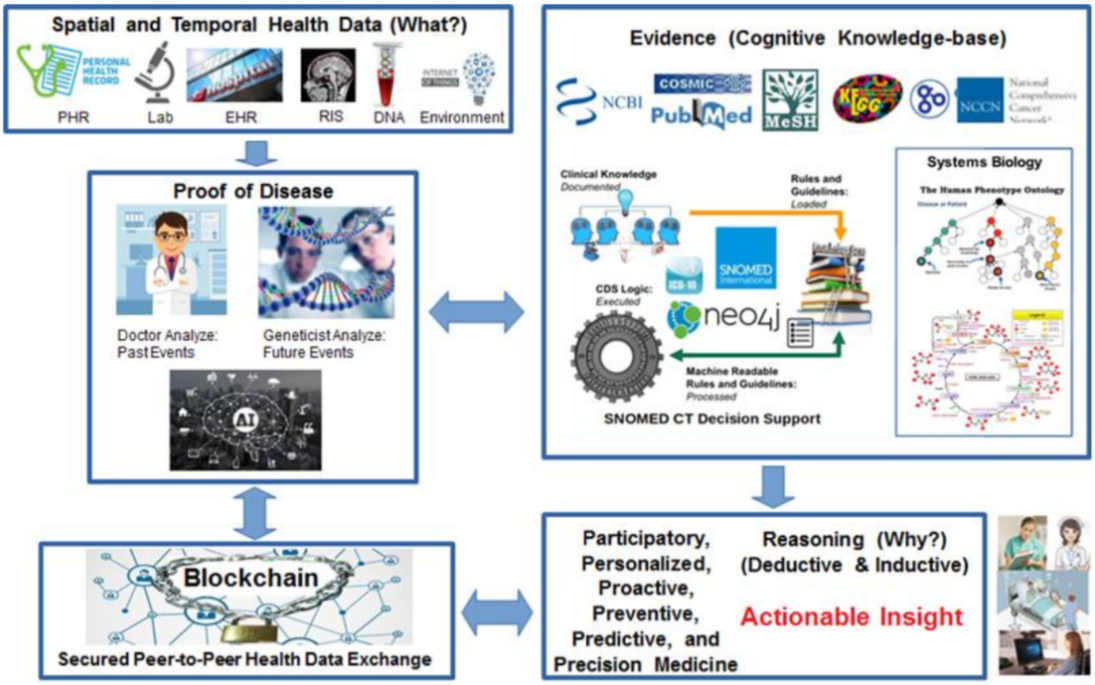

Figure 3.1: Example software architecture cf.[Talukder et al. 2018]

[1] cf.[Talukder et al. 2018]

3.3 Medical Documentation Apps

As stated by Lupton et al.[2] the current technical 'era' we are living in is the web 2.0 or social web . Social web includes sharing health and medical information with each other, e.g. patients and caregivers write about experiences and the individual health status. Often, the aim of these social webs is to control the health status by using online information and imaging. Conforming to Lupton et al.**??**[0], in healthcare projects, big data can be used to generate knowledge about healthcare, health behaviours and disease patterns. Such applications can assist in calculating diagnosis, identifying risks, facilitating health, fitness self-tracking as well as patient self-care regimes. As reported by a study which surveyed American doctors**??**[0] medication interaction are the first most-used app and diagnosis apps are the second most used category of apps. Moreover, pregnancy apps offer greater opportunities, such as that women can engage obsessive self-surveillance because of producing detailed data, such as heart rates, in real-time **??**[0]. Pursuant to Lupton et al., the future potential of medical application lies in systems which enable lay people to access medical information (such as the electronic medical record) that was previously only available to healthcare practitioners or students.

In another article, Lupton et al. reported that the potential lies in automation of news or notifications which can be personalized or targeted so that doctors could contact patients directly to remind them to adhere to their tratment programs [3]. A further example of medical applications are 'smart pillboxes' for patients suffering from diabetes[4]. 'Smart pillboxes' re wireless devices that remind patients to take their medication and alert a doctor if the patient had failed to conform to their medication regimen.

5 6 7 8

9 10

[2] cf.[Lupton 2014]
[3] cf.[Lupton 2012]
[4] cf.[Lupton 2012]
[5] cf.[Akhtar, Neidhardt, and Werthner 2019]
[6] cf.[Kawohl and Haß 2019]
[7] cf.[Zini et al. 2019]
[8] cf.[Zimmermann et al. 2013]
[9] cf.[White 2007]
[10] cf.[Beevers, Lip, and O'Brien 2001]

[11] https://www.heart.org/en

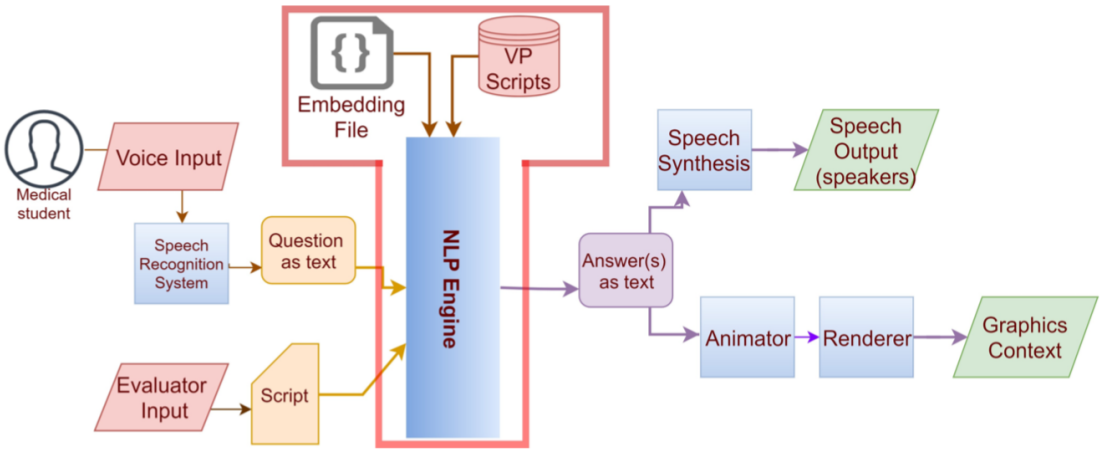

Figure 3.2: Virtual patient software architecture cf.[Zini et al. 2019]

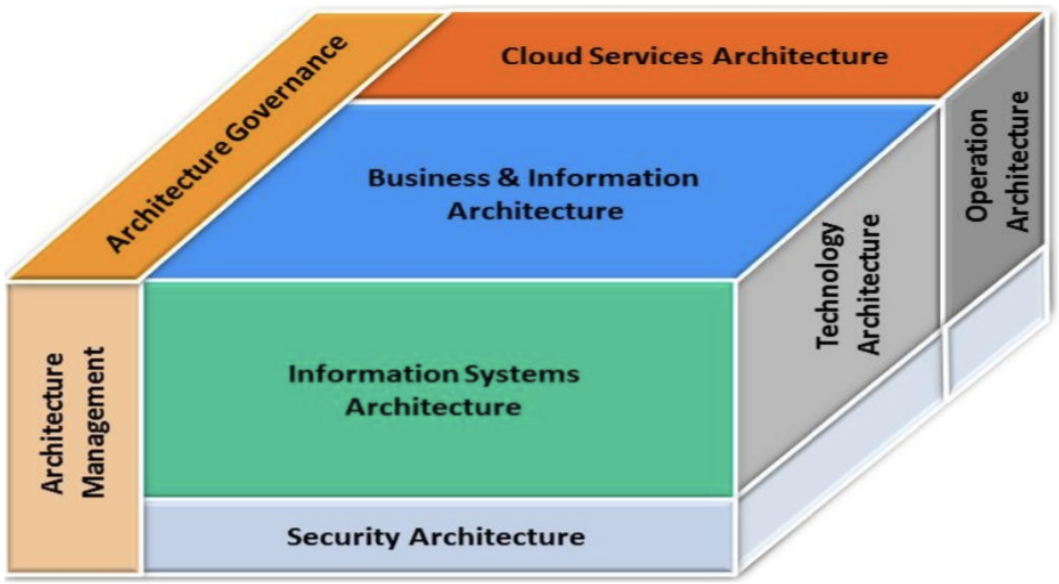

Figure 3.3: ESARC as an example for big data architecture cf.[Zimmermann et al. 2013]

Blood Pressure Apps: Was können die schon ?

3.4 Chatbots

[11] cf.[Alessa et al. 2019]

Figure 3.4: ESARC business and information reference architecture cf.[Zimmermann et al. 2013]

4 Analysis and Development

First of all, the developed chatbot includes information about blood pressure and was built to remind patients of their measurements. Secondly, based on the measured data, analysis can be done in order to react earlier to outliers. Thirdly, a generated report is sent to the doctor so that he can get more insights about the blood pressure values of his patients and improve the treatment. One of the main challenges during development was the process of providing information about the disease to the patient. Is it possible to include information about different types of blood pressure into the automated conversation with a chatbot? Or does it overwhelm the conversation's use case? Is it useful to let the user ask questions like: 'What are the different types of hypertension? Am i a high-risk patient?' Or should these information be provided as a video or a simple web page with long articles to read? Might the patient or user be aborred after a while of talking to a chatbot who only knows answering his questions in the same way? Of course, a chatbot can be developed more intelligent to never provide the same answer and to answer more precisely to a users' intent. But this requires a lot of training and testing. For that reason, in the first version of this chatbot, five simple intents and dialogs have been designed and implemented with the focus of the instructions to measure correctly and regularly. In a second or third version, it is possible to focus more on the improvement of providing information about the disease (by not doing this in the style of question and answering).

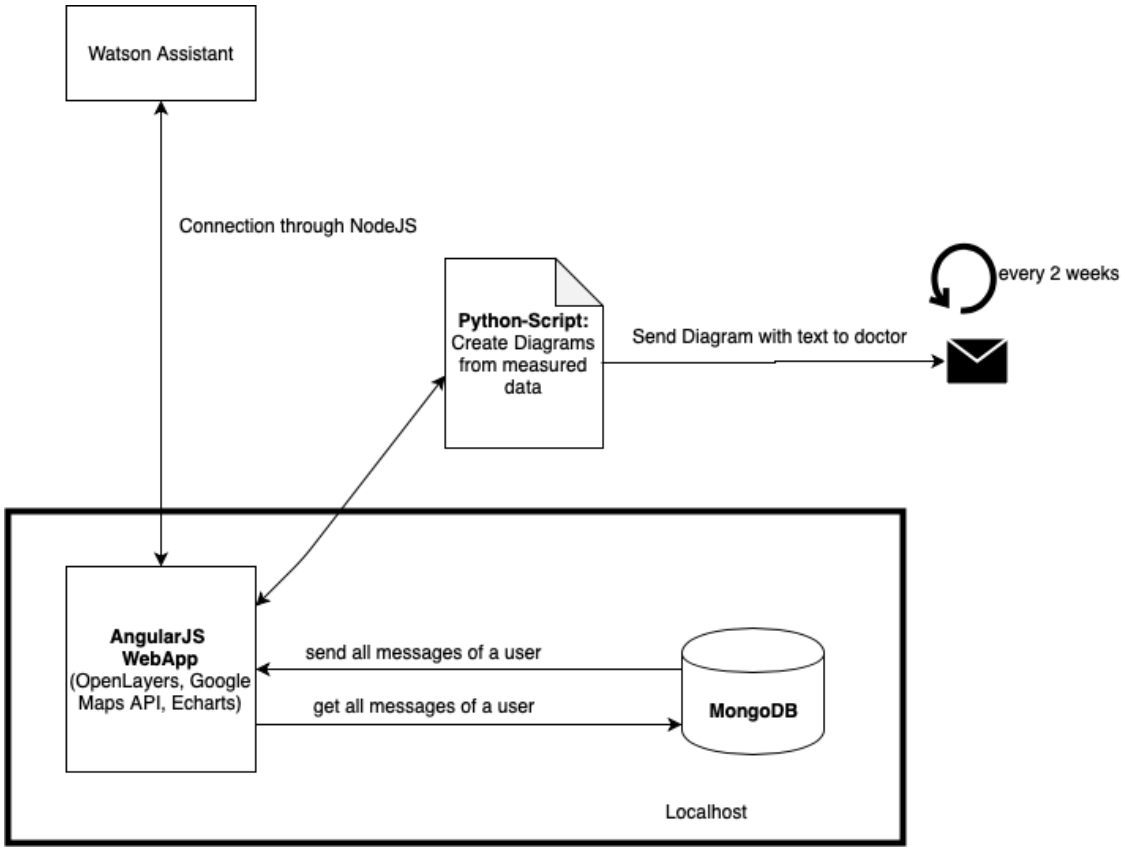

Figure 4.1: Component diagram of developed solution

4.1 Experimental set-up

4.1.1 Software architecture

4.1.2 Components

Kaggle Dataset

Development of Watson Assistant Dialog

Intent model The chatbot was built according to the description of ”Deutsche Hochdruckliga”, a german organization for patients with hypertonia [1]. To better understand the users and patients a basic intent model with four intents was developed. The four intents include

[1] cf.[*Bluthochdruck vermeiden, behandeln und senken - Aktiv gegen Bluthochdruck* 2019]

Intent	User input
Definition of hypertonia	What is hypertonia?
Curses of hypertonia	What are the implications or curses of hypertonia?
Blood pressure measurement	I am measuring my blood pressure.
Measurement tutorial	How should i measure my blood pressure?

These five intents were used to define and develop four typical dialogs.

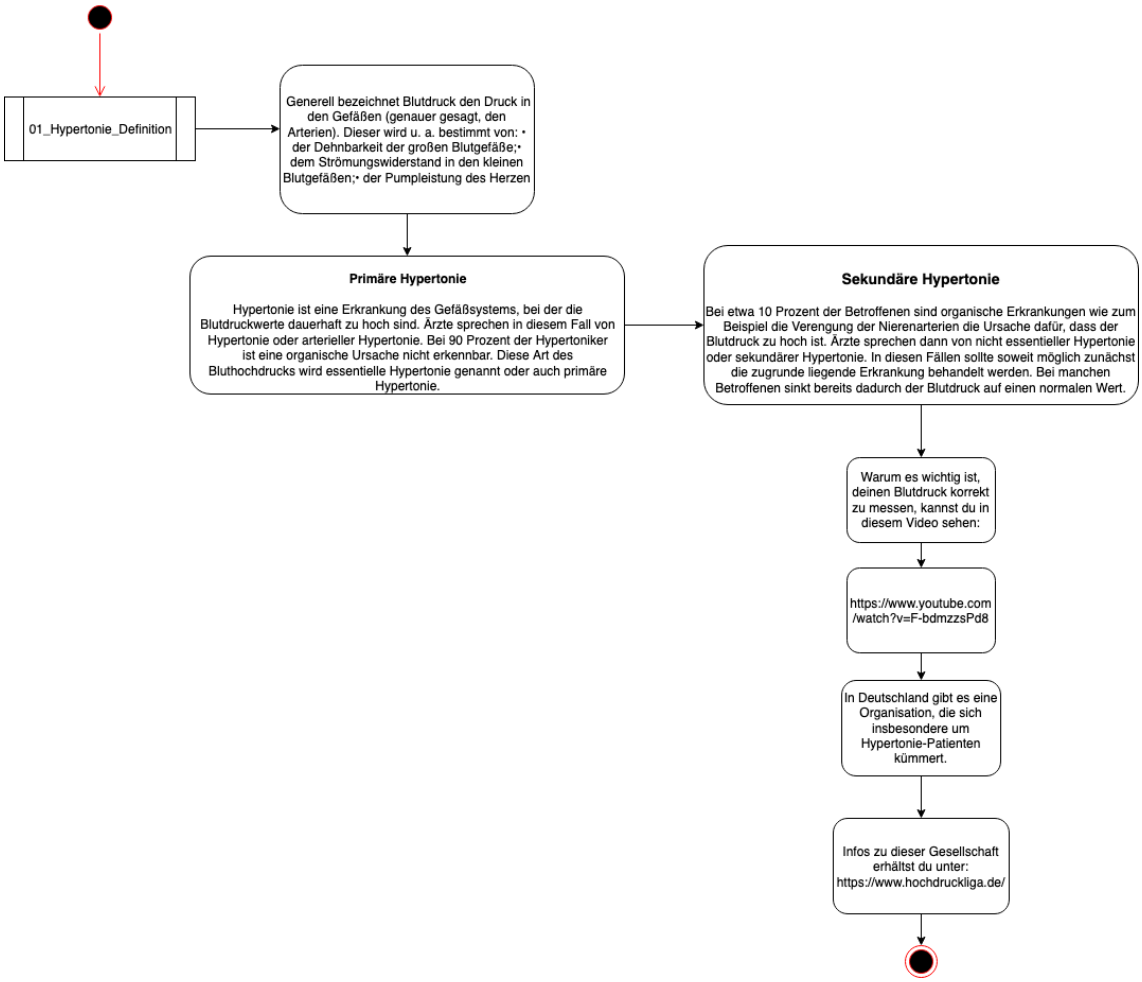

Figure 4.2: Dialog diagram: definition of hypertonia

Watson Assistant implementation In the following, the implemented dialog as well as all entities and intents are described. They have been developed according to the Watson Assistant documentation [2].

Setup of MongoDB and basic AngularJS Frontend

[2] cf.[*Übersicht über die Watson Assistant-API* 2020]

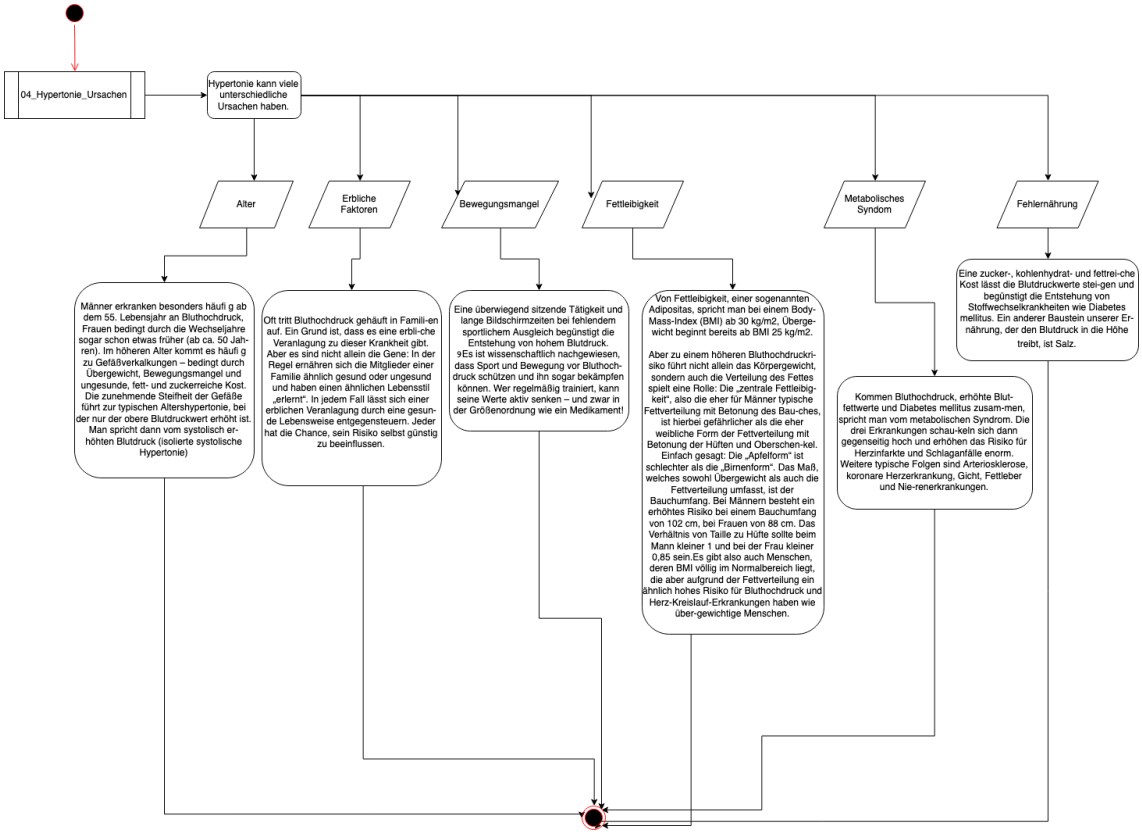

Figure 4.3: Dialog diagram: curses of hypertonia

Connect Watson Assistant to Frontend and MongoDB To be able to connect to the Watson Assistant instance on IBM cloud, the API Version 2.0 had to be called. First of all, the current sessionId has to be requested to be able to interact with Watson Assistant. After that, a simple get request is executed to let the chatbot start the conversation. Everytime, the user sends a message to Watson Assistant, a post request is sent to the API and the response is the best fitting answer (with the highest confidence value) from Watson, which is calculated [3].

Data visualization: Development of a Python Script to show all measured values

Development of recommendation of nearest doctors to patient outlook: maybe in future to connect to the doctors' calendar to directly make an appointment through the chatbot

[3] cf.[*Watson Assistant v2 - IBM Cloud API Docs* 2020]

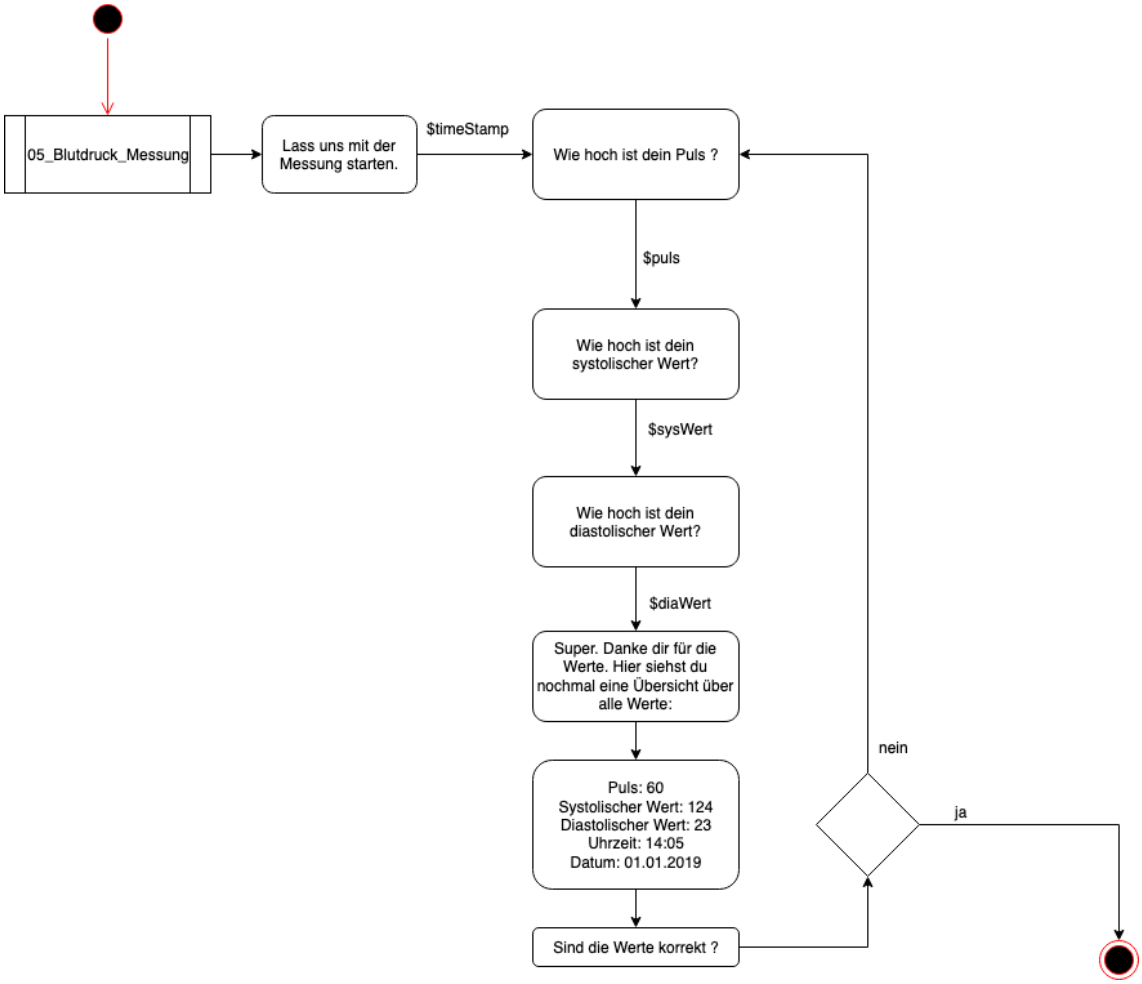

Figure 4.4: Dialog diagram: blood pressure measurement

Development of email service to send reports every two weeks to the doctor Another challenge was the way to automatically ask the user for his measured data. A 'usual' chatbot only helps in certain situations including precise user intents, e.g. the question 'When should i measure my blood pressure?'. But they are not constructed to ping a user every five hours or once a day in order to retrieve his measured data, analyze these and send them to a doctor. In order to face this problem or use case, a routine including a timer had to be implemented.

4.2 Problem solving

4.2.1 Tests

4.2.2 Dataset

4.3 Results

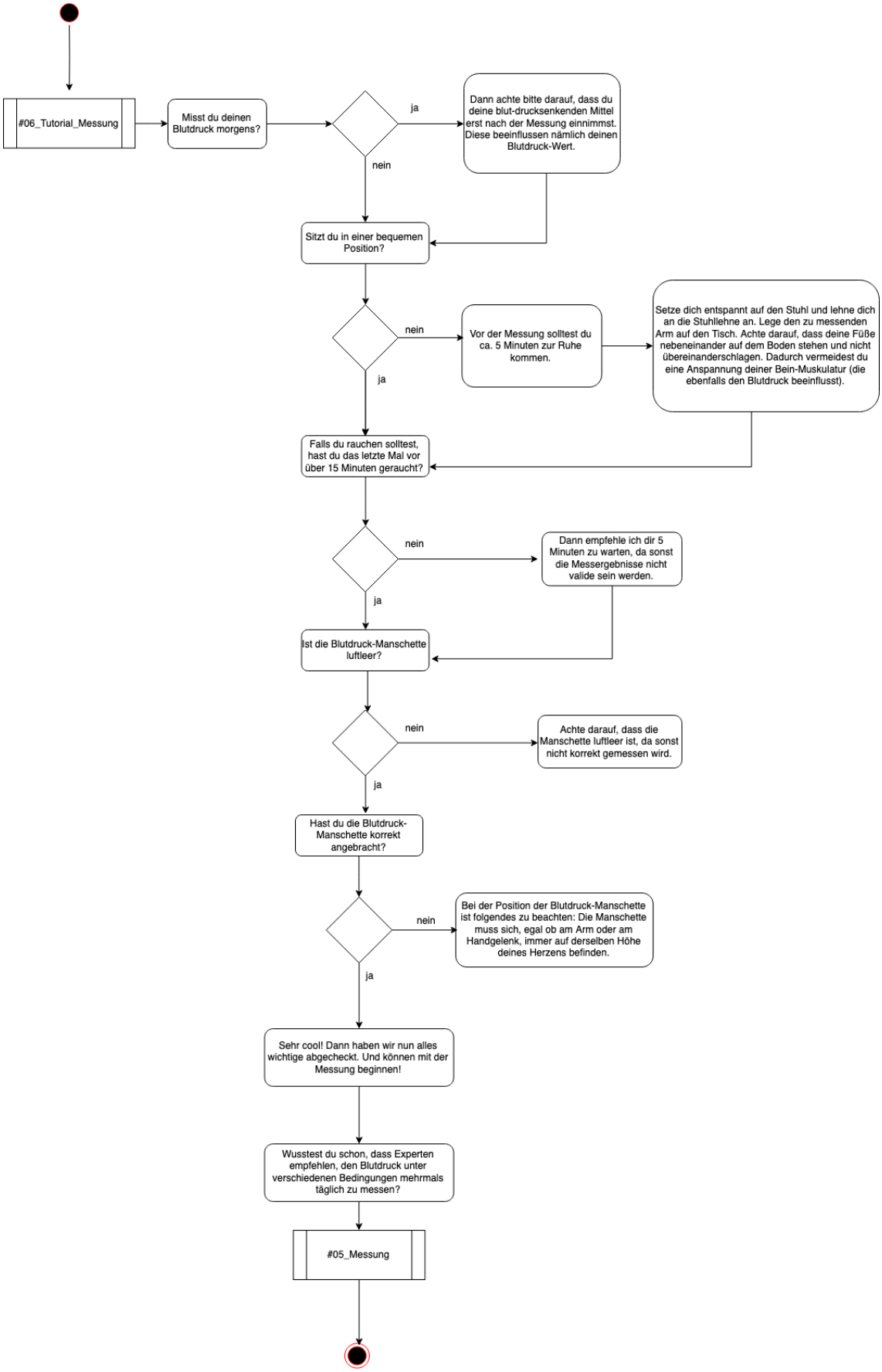

Figure 4.5: Dialog diagram: measurement tutorial

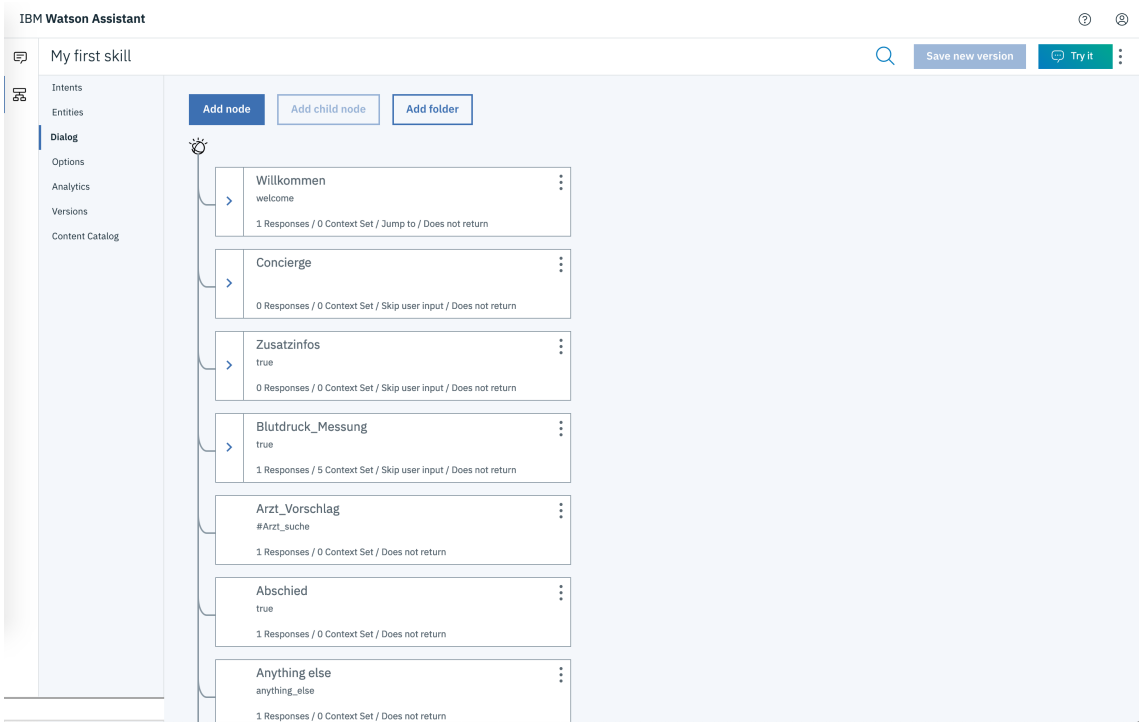

Figure 4.6: Watson Assistant dialog

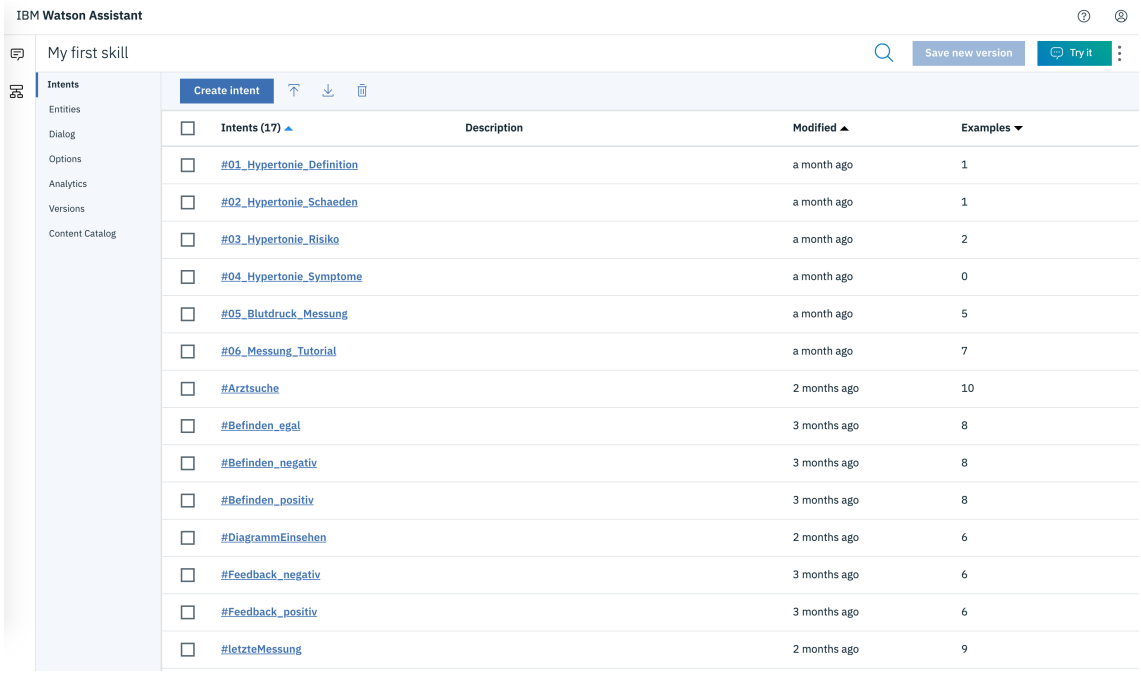

Figure 4.7: Watson Assistant intents

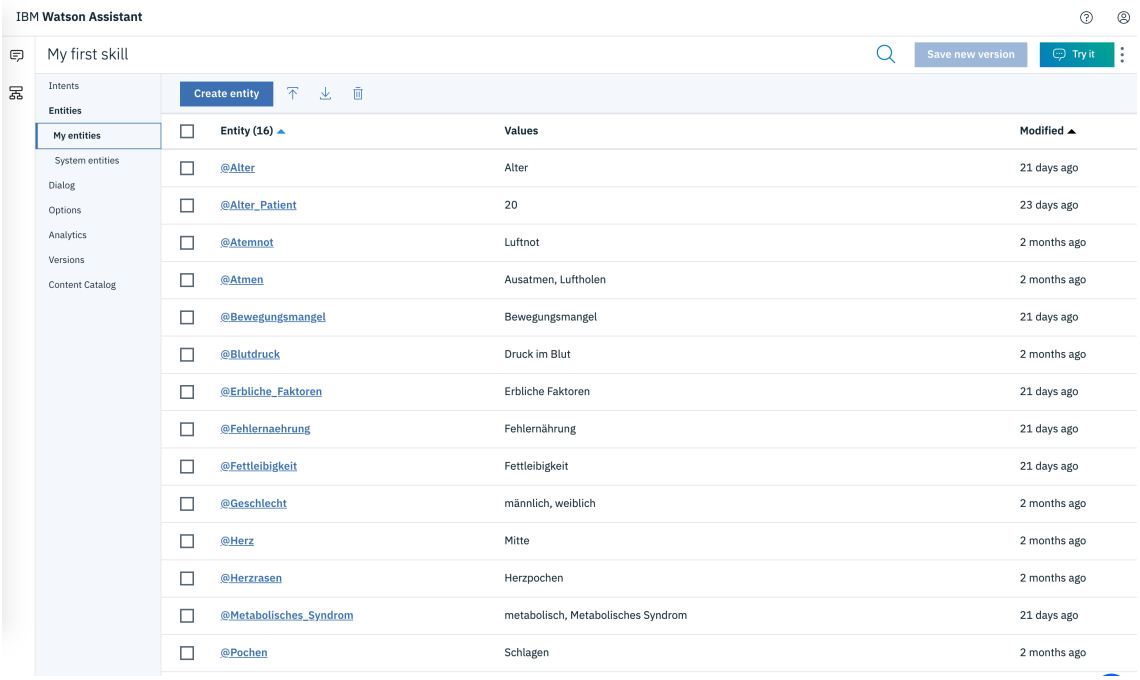

Figure 4.8: Watson Assistant entitities

5 Conclusion and Outlook

5.1 Conclusion

5.2 Outlook

Is a chatbot an appropriate solution for recording and reminding patients to measure their blood pressure ? In practice, most chatbots are created to solve and help multiple intents of their users and not to only 'retrieve' information. On the one hand, the retrieved information can be used to run several analysis and to find out trends in the data. But on the other hand, the developed solution supports users to never forget to measure and doctors to better understand trends in the measured data. During development and research, there came up another issue: To inform patients precisely about their illness. Most patients go to doctors and describe their symptoms, the doctor makes some diagnosis and provides them some medication. But in most cases, doctors do not have enough time to answer all the questions of their patients. For that reason it might be useful to provide a 24/7 service for patients with chronic disease to both record their symptoms and measurements and to answer all their questions.

connection frontend (angularjs webpage) to mongodb through socket.io connection. Connection between Watson Assistant and Frontend through mongodb and via socket.io connection.

6 Abbreviations

NLP Natural Language Processing

ESARC Enterprise Software Architecture Reference Cube

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7 Appendix A

Ehrenwörtliche Erklärung

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8 Appendix B