Blockchain and AI to build an Alzheimer's risk calculator

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Abstract. The problems affecting healthcare databases and medical records are numerous, although the potential of the data stored in them is high. However, medical records are hidden across hospitals, and data sharing processes fail to provide accountable data control. Blockchain technology has been successfully applied in various fields to support distributed data management and data quality. This article evidences how Blockchain is expected to be leveraged to better organize and sharing of healthcare's big data with mixed EHR (Electronic Health Records) and imaging (CAT, RX, etc.) sources. The aim is to exploit these data through Artificial Intelligence methods in order to build an Alzheimer's risk calculator based on neuro-images.

Keywords: Blockchain· Artificial Intelligence· Recommander System· Alzheimer's disease· E-Health.

1   Introduction

Nowadays, we are inundated with tons of data coming from every aspect of our lives, such as social activities, science, work, health, etc. Advances in technology have helped us generate more and more data, up to a level where it has become unmanageable with currently available technologies. This has led to the creation of "big data", term that describes big, unmanageable data. To meet our current and future social needs, we must develop new strategies to organize this data and derive meaningful information [1]. This problem is particular crucial in the health domain. In this field, in addition to the above mentioned problems, each hospital collects data in a "independent" way, and this leads to having large amounts of data, inhomogeneous and often inconsistent with a waste of hardware resources that are exploited in the centralized data servers. In fact, healthcare providers routinely enter clinical and laboratory data [2] into healthcare databases. One of the most commonly used forms of healthcare databases is electronic health records (EHRs). Physicians enter routine clinical and laboratory data into EHRs as a record of patient care [3]. All of this data is collected in a proprietary manner, thus to share and reuse it in hospitals other than those

collecting it is difficult. Therefore, it is necessary to find solutions that allow transparency and, at the same time, ensure privacy as the use of the Blockchain, considered a cryptographically secure, reliable, and fast digital technology. It creates a decentralized database for which there is a copy for each center that participates in its creation. Each time a center enters a new piece of data, it appears in all copies of the registry itself. On the one hand, it allows doctors and researchers at the different centers to access all new data and stay up-to-date, and on the other hand, it allows for early intervention if a database is breached: only the database that is no longer secure can be closed, and the others kept operational. This process would facilitate data retrieval and exchange for research use. In addition, such data could be used to develop web applications based on artificial intelligence that the National Health System could use for diagnosis, screening, or research studies.

2   Proposed work

2.1   Aims and objectives

The aim of this project is twofold: i) to create a platform based on blockchain technology in the healthcare system [4], ii) to design and implement a E-Health Recommender System [5, 6]. The first part will deal with the storage of medical records in Blockchain, patients will be allowed to upload their clinical data through a specific app in order to create a network that can facilitate data for diagnostic and research purposes. Privacy is guaranteed upstream by the Blockchain. The platform will need to ensure sharing of healthcare's big data with mixed EHR (Electronic Health Records) and imaging (CAT, RX, etc.) sources [7].This technology is helpful to medical institutions to gain insight and enhance the analysis of medical records. It can help avoid the fear of data manipulation in healthcare and supports a unique data storage pattern at the highest level of security. It provides versatility, interconnection, accountability, and authentication for data acces. The Blockchain platform will be used for health data sharing, electronic health record keeping to provide easy access to data for research and screening. The second aim is to use artificial intelligence techniques [8] for developing AI-based diagnostic tools [9] using data collected by the Blockchain platform. A personalized risk calculator(E-Health Recommender System)[5, 6] will be developed for Alzheimer's disease[10] in order to detect the onset of diseases at an earlier stage and intervene with specific treatment to retard cognitive decline. The population to be used in the project is the population of Puglia (Bari), between 40 and 60 years old[11].

2.2   Methods

For development of the E-Health Recommender System, it will be necessary to focus on the procedures to be implemented in the two parts of the project. In the development of the first part of the project, a preliminary investigation will

be carried out to identify all the problems in the healthcare database. A shared Blockchain platform will be developed that can provide a high level of security and privacy. Afterwards, a Blockchain-based computer network will be generated to interconnect the various hospitals to facilitate the sharing of patient data. The data that will be collected within the Blockchain will be in addition to textual data and images of instrumental examinations. This data will be used to develop an Alzheimer's risk calculator using federated learning techniques[12] in Python.[13]. For the development of the second part of the project, we will proceed initially with the research of the optimal parameters to insert in the algorithm to obtain best performance. An algorithm capable of calculating the risk of Alzheimer's will then be trained. The algorithm will be provided with a database of neuro-images, collected in the Radiological Informative Systems of a network of hospitals. These images will first be preprocessed and then used to train and test the algorithm.[14]. The performance of the developed system will be verified by comparing the values of the metrics during the training and testing phases.[15, 16] An Explainability[17] analysis will be performed to understand the final diagnosis. The last part of the project will instead focus on the development of a web platform for predicting Alzheimer's risk in order to employ it as a E-Health Recommender System in epidemiological studies or screening. Connection to this online platform will be restricted to employees only and allowed after entering a username and password.
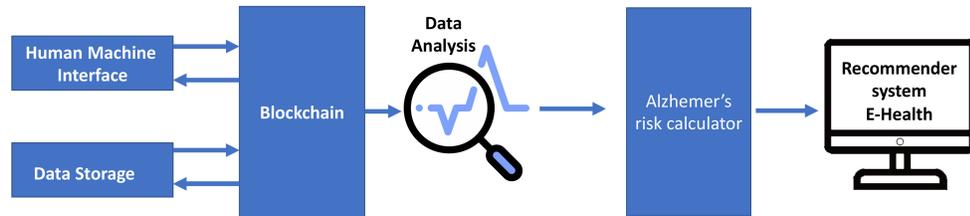

Fig. 1. Shown the project steps for the development of the E-Health Recommender System

2.3   Risk prediction model for Alzheimer's disease

The application to be developed allows the doctor to upload the CT or MRI brain image and receives as output the estimated patient's risk of developing Alzheimer's [18]. In addition, throw the different functions of the web app, the doctor can export the prediction, add notes, check the patient's medical history (medical records, laboratory tests, previous CT/MRI scans, medications taken), enter new patient data (update clinical tests, medications taken) or make a new prediction for a new patient. Each patient is identified with a unique ID.n Figure 2 a mockup of the Web App for Alzheimer's prediction is proposed. Several studies have proposed the use of AI in clinical practices to predict conditions such as heart disease, non-alcoholic fatty liver disease (NAFLD), or cancer[19, 9, 20]. The proposed application might be used for epidemiological studies or screening.
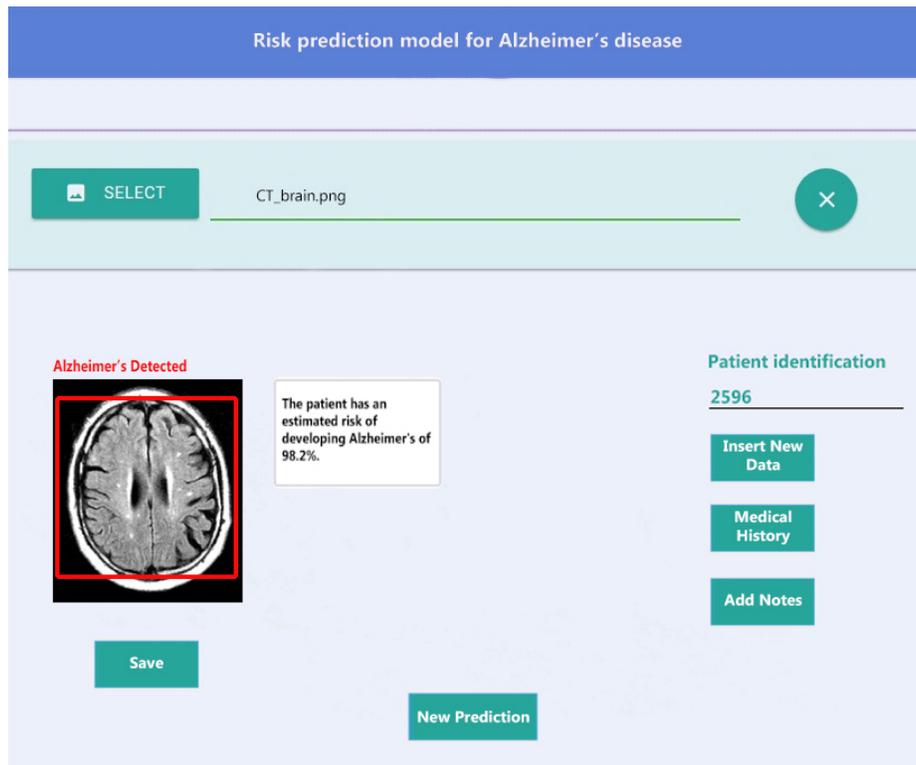

Fig. 2. Mockup of the Web App for Alzheimer's prediction

3   Contribution to Web Engineering

The proposed work provides an innovative contribution to web engineering as it involves the development of a Blockchain platform to improve data storage across hospitals and develop an image-based Alzheimer's risk calculator employing artificial intelligence techniques that are Web-Based in a way that makes it accessible and usable to the entire national healthcare system. The system receives MRI or CT images as input, analyses them and provides the risk of Alzheimer's disease and the accuracy with which the diagnosis was generated.

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