Electronic Medical Record of University Hospital Based on Deep Learning

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Electronic Medical Record of University Hospital Based on Deep Learning

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Abstract. Because the traditional paper medical record has the disadvantages of illegible handwriting and being difficult to save, we design the electronic medical record system for the university hospital. Additionally, the neural network model is used to realize auxiliary diagnosis and help doctors make decisions, which can provide effective reference for preventive health care, health education, and medical services in school hospitals. The system is putting into use in our university and has effectively improved the work efficiency of our school hospital.

1. Introduction

The electronic medical record (EMR) is electronic information of traditional paper medical record, which not only records the examination, diagnosis and treatment information of patients in paper medical records but also includes online registration, auxiliary diagnosis, treatment and so on.

Currently, many works focus on the EMR system. The paper [1] studied the application of three types of machine learning algorithms to EMR. The paper [2] contributed to the EMR information extraction from text using keyword search, rule-based algorithm, and machine learning algorithms. The paper [3] gives experience in developing and using EMR search engines (EMRSE). The current development of EMR system faces many challenges. For example, most domestic EMRs only contain basic application functions and do not pay attention to the value of intelligent assessment [4]. In addition, the EMR is universal in large hospitals, while most school hospitals still use traditional paper medical records which exist some problems. For instance, there are bad handwriting on paper medical records and they are easily lost. Patients are also easy to forget to take their medical records when seeing a doctor at the next time, etc.

To settle these problems, we design an EMR suitable for university hospitals. In the system, we use SpringBoot [5], Mybatis [6] framework for the back-end, and Vue [7] framework, WeChat Mini Program [8] for the front-end. In this way, patients can register online conveniently, and doctors also can query patients' medical records and give treatments. In the process of treatment, patients and doctors do not need to repeatedly write information on paper medical records, which saves a lot of time and materials. Furthermore, medical records can be well preserved, which makes medical treatment more efficient. At the same time, we use the TensorFlow framework [9] and neural network model [10] to provide auxiliary diagnostic functions for skin diseases, heart diseases, hepatitis, and other diseases, to facilitate doctors to make a diagnosis.

The rest of this article is organized as follows. Section II introduces the architecture of the system. Section III introduces the function of the system. Section IV describes the system design. Section V presents the key technology used in the system. Section VI concludes this paper.

2. System architecture design

The system uses an architecture of B/S [11], the popular SpringBoot and Mybatis framework for platform development, the MySQL database for storing data, and the TensorFlow framework for diagnostic and disease prediction functions. The system is mainly divided into three layers according to the MVC design pattern: the controller application layer, service layer, and DAO persistence layer. The controller application layer is responsible for receiving user requests, distributing the request to the corresponding service layer, and transmitting the data returned by the service layer back to the front-end page. The service layer is responsible for the processing of specific business logic. The DAO persistence layer is aimed at manipulating the database.

The architecture of the EMR system is shown in Figure 1.

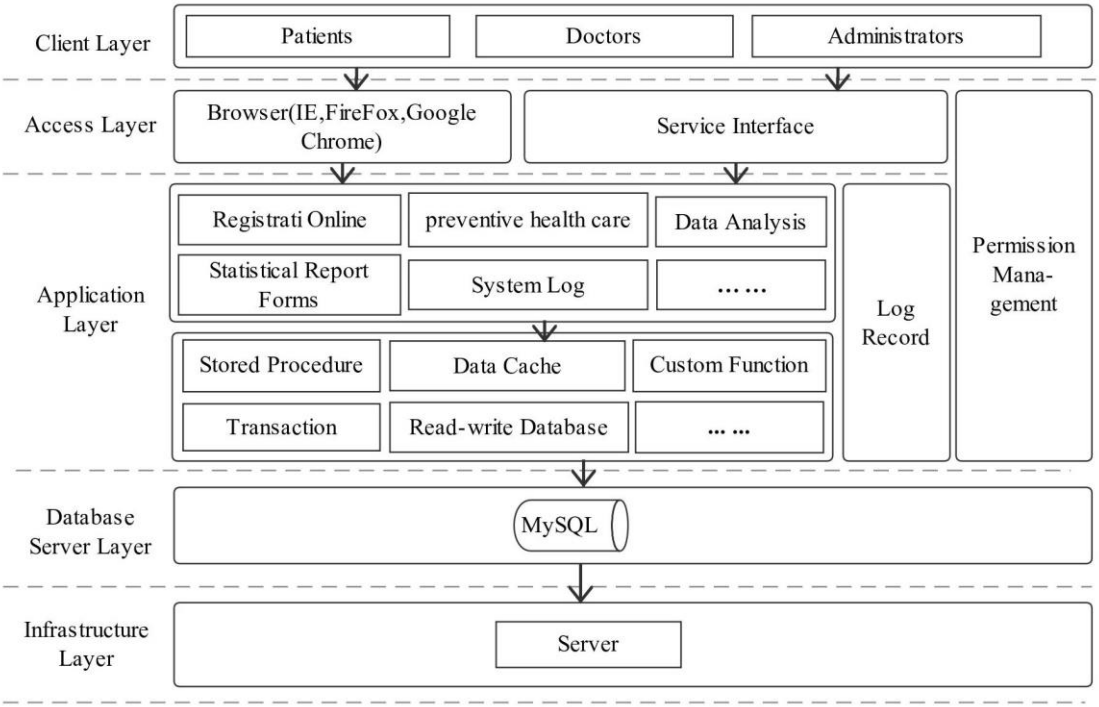

Figure 1. Architecture of the EMR system.

3. Main functions of the EMR system

There are three roles: doctor, student, and administrator in the EMR system. The system includes five modules: administrator authority module, user module, medical record module, registration module and Diagnosis module as shown in Figure 2.

3.1. Registration and login

This module is a prerequisite for using the system. All users can continue using the system after entering their username and password to log in. To ensure the safety of the system, we design the registration and login module. The module performs authentication, authorization, password and session management, which can resist the brute force attack.

This module adopts the traditional design method and directly calls the universal interface code. The user interface adopts the page style which is simple and unified with the main interface.

3.2. Patient management

Patient management module includes patient information management, registration information management, diagnose information management and medical record information management. In the patient information management, patients can edit, update, delete their personal information. In the registration information management, doctors can select the next patient from the registration queue. In the diagnose information management, doctors can fill in diagnostic information and record the patient's visit after diagnosis. In the medical information management, administrators or doctors can manage the patient's medical information.

This module is one of the core modules of the system. Patient information management is an important way for hospitals to standardize medical record. The interface provides many optional input items to reduce verbatim input of doctors and patients and improve the efficiency of treatment.

3.3. Medical record management

Medical record management mainly includes adding and deleting the medical records of patients. Adding a patient's medical record means adding a new medical record object to the patient in the system to facilitate the corresponding management of the medical record later. Deleting patients' medical records means that doctors can delete patients' medical records when they are not necessary to reduce data storage space. This module is aimed at the management of electronic medical records, and the interface style is consistent with the module above. The deletion of patient's medical records needs to be confirmed twice to prevent the wrong deletion. The function of the recycling station is also provided so that the deleted patient's medical records can be revoked in the recycling station.

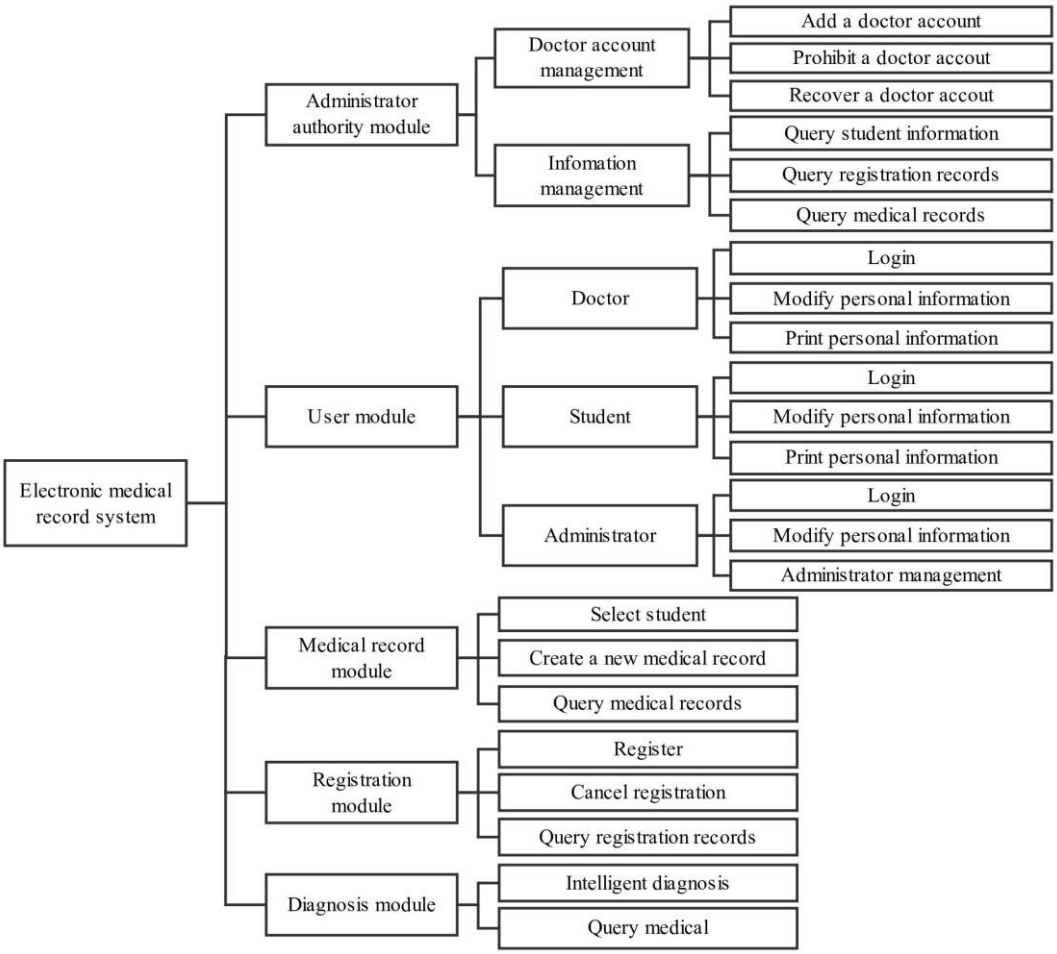

Figure 2. Functional chart of EMR.

4. System design of the EMR system

According to the system requirements, we mainly design five entity classes from the perspective of object-oriented design. They are Administrators class, Patients class, Doctors class, Registration class, Record class, and Rota class. Each class contains two parts: attributes and methods. The relationships of these classes are shown as Figure 3.

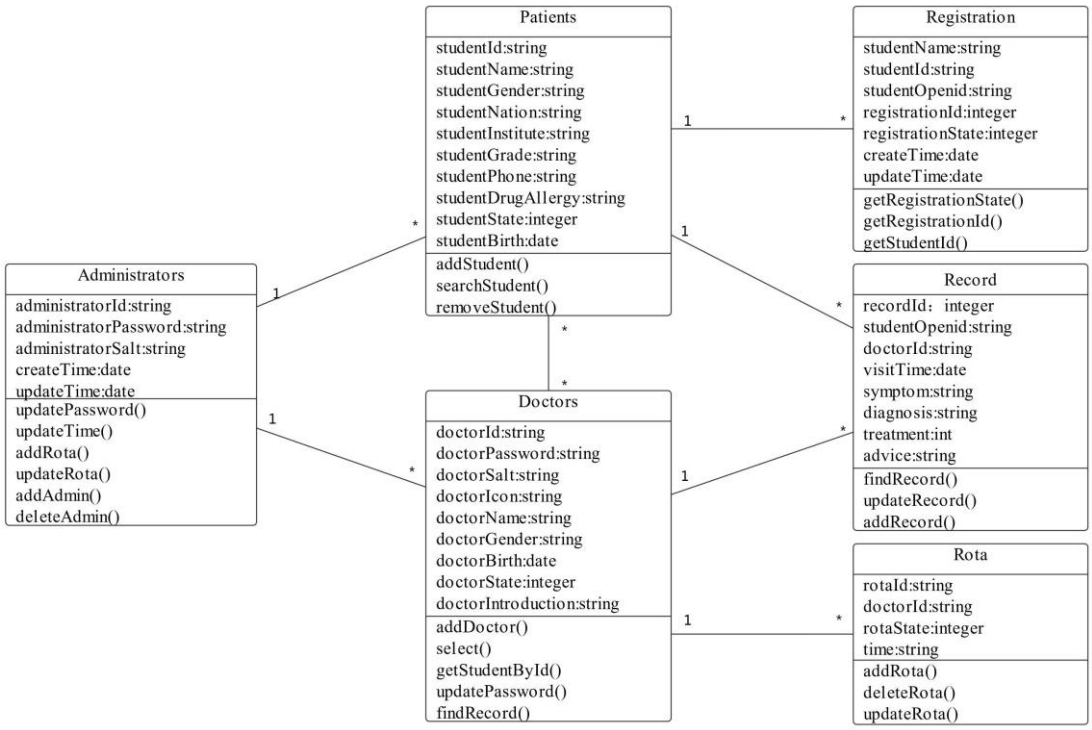

Figure 3 Class diagram of the EMR system.

5. The key technology

5.1. Data modeling

The modeling study of patient medical records is the foundation and core content of establishing an EMR data center. The information model adopted in this system is based on the medical records of Guangdong Ocean University Hospital. We construct the concept model of the entire EMR dataset from Guangdong Ocean University Hospital, which matches the actual situation of university hospitals nowadays. Finally, we ensure the practicability of the EMR system by organizing the data based on the concept model and supplementing the fields needed in the development on the Internet.

5.2. The data access

It is a difficult technical problem to design an open interface to make the system can flexibly adapt to all kinds of access requirements to the entire patient medical data set. We hope the system can be applied to support the outpatient services of the University hospital. Therefore, we develop a set of data access interfaces for patient's medical data sets. Additionally, we classify the interface into different modules, such as online registration, patient management, outpatient service, and medical record review. Each service interface provides outside services using Web Service. By this way, the system supports the medical business needs not only within the hospital but also over the long-distance and access-region access.

5.3. WeChat Mini Program

In order to improve the convenience of the system, we adopt the WeChat Mini Program in the student end, whose function is allowing students to register at any time and place. Mini program framework provides its own view layer description languages WXML and WXSS. It also provides a JavaScript-based logical layer framework, and a data transfer and event system between the view layer and the logical layer. Therefore, we can easily focus on data and logic. In this system, the student end mainly provides the function of online registration. After the user enters the information, the data will be sent to the back end through the Click event. When receiving the data, the back end stores the data into the database, and then sends the successful status code to WeChat end. Through calling the logical layer's setData() method, data interaction renders data in the view layer. Data interaction with parameters is an important method in the WeChat Mini Program. It can resolve the problem of too much data, not setting the same page for each group of data, but jumping to that with corresponding parameters. To query the records of visitors, we use the wx.request() method to initiate the https network request.

5.4. Neural network model

The system uses the TensorFlow framework and neural network model built by Keras to achieve disease prediction and auxiliary diagnosis. The diseases which can be predicted are as follows: skin diseases, heart disease, breast lumps, hepatitis, and thyroid disease. In the neural network model, supervised learning has been adopted. Each disease type has matched feature attributes and label. Moreover, data normalization has been performed to improve the convergence speed and accuracy of the model. The rectifier activation function is used in the hidden layers of the neural network model. The ReLU (Rectified Linear Unit) function can increase the nonlinear relationship between the hidden layers to solve the vanishing gradient problem in BP (Back propagation) algorithm with less computation.

To avoid overfitting, Dropout is used in the hidden layers, which would randomly drop out some units to improve the generalization ability of the model. On the output layer of the neural network, different activation functions are used based on whether the problem is a binary classification or multi-class classification task. Sigmoid is suitable as the activation function in the binary classification task. In this case, the corresponding loss function is the binary cross entropy loss function (binary_crossentorpy). Softmax function is used as the activation function in the multi-classification task and the corresponding loss function is the multi-class classification cross entropy loss function.

Last but not least, the neural network model adopts the Adam algorithm, which combines the advantages of Momentum and RMSProp, and is more robust to the selection of hyperparameter.

6. Conclusion

We design the EMR system suitable for university hospitals which is divided into the administrator end, the doctor end and the student end. The system allows the patient to register online, and records their disease occurrence, examination, diagnosis, and treatment. The system also provides doctors with the function of assisting diagnosis and decision by using TensorFlow framework and the neural network model. This system also can provide a strong basis for preventive health care, health education, and other work in school hospitals. Therefore, it can improve the efficiency of medical services to a certain extent. The system is putting into use in our university and has high utility value.

Acknowledgments

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References

[1] Ho, L. V., Ledbetter, D., Aczon, M., Wetzel, R. (2018). The Dependence of Machine Learning on Electronic Medical Record Quality. AMIA Annual Symposium proceedings., 2017:883–891.
[2] Elizabeth, F., John, A.C., Helen, E.S., Donia, S., Jackie, A.C. (2016) Extracting information from the text of electronic medical records to improve case detection: a systematic review. Journal of the American Medical Informatics Association., 23:1007–1015.

[3] David A.H., Mei, Q., James, L., Ritu, K., Zheng, K. (2015) Supporting information retrieval from electronic health records: A report of University of Michigan's nine-year experience in developing and using the Electronic Medical Record Search Engine (EMERSE). Journal of Biomedical Informatics., 55:290-330.
[4] Yang, Z., Huang, Y., Jiang, Y., Sun, Y., Zhang, Y.J., Luo, P. (2018) Clinical assistant diagnosis for electronic medical record based on convolutional neural network. Scientific Reports., 8: 6329.
[5] Suryotrisongko, H., Jayanto, D.P., Tjahyanto, A. (2017) Design and Development of Backend Application for Public Complaint Systems Using Microservice Spring Boot. In: 4th Information Systems International Conference 2017. Bali. pp. 736-743.
[6] Gao, Z., Chen, Y.F., Xiang, Z.T., Yan, R.K. (2018) Design and Implementation of Message Receiving and Storage System for Real-Time Vehicle Traffic Information. In: 2018 IEEE International Conference on Computer and Communication Engineering Technology. Beijing. pp. 260-264.
[7] Kuang, Z.G., Ji, T.T., Wu, X.L. (2017) Research and Practice of Single Page Application for Management System Based on Vue.js. Modern Computer., 2017(30): 51-55.
[8] Li, A.N. (2019) Design and Implementation of the Dental Clinic Service Platform Based on WeChat Applets. Software Engineering., 22:40-43.
[9] Cheung, B.L.P., Dahl, D. (2018) Deep learning from electronic medical records using attention-based cross-modal convolutional neural networks. In: 2018 IEEE EMBS International Conference on Biomedical & Health Informatics (BHI). Las Vegas. pp. 222-225.
[10] Abadi, M., Isard, M., Murray, D.G. (2017) A computational model for TensorFlow an introduction. In: 1st ACM SIGPLAN International Workshop on Machine Learning and Programming Languages. Barcelona. pp. 1-7.
[11] Qu, Y. (2019) Clinical Decision Support System based on electronic medical record. Electronic Technology & Software Engineering., 2019(05): 190-191+244.