Intelligent Health Referral Model using Hybrid Recommender System

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ABSTRACT
A health referral model using hybrid recommender system is a research work that will help build an effective information management for patient and doctors. The involvement of information technology is essential to guide people to find a Specialist (doctor) with whom they can build trust and confidence to discus personnel health issues with and medical treatment within locality. The increase in sickness and diseases has left several people helpless with no one to give a good suggestion on where to go and who to meet for solution and this has made Patients to sort for specialist Doctors in wrong places and hospitals, which has cost several patients a waste of time, money, and even loss of life. Hybrid recommender was applied . Hybrid recommender apply techniques that can filter information and narrow that information down based on user preferences or user needs and help users choose what information is relevant The methodology adapted was Object Oriented Analysis, Prototype Design Specification and Unified modeling language as the design tool. In this project, we developed a Doctors-to-Patients Recommender system using a hybridized algorithm. The referral process is done based on doctor specialization. The doctor have to enter is profit including the current place of work and pass achievement, the system will use it to automatically referral a patient that have that illness to that specialist. The Content-based filtering and Success Credibility Score model to ensure credible recommendations of Doctors to Patients. the implemented was done with hyper preprocessing language, JavaScript, Json and hyper text make-up language with the Apache web server to manage the Database developed using MySql. In the system 50 patient visit the site and the system was able to referral 46 to a specialist at different time interval. The result of the system has prove that hybrid recommender model is accurate and credible to referral patient to Specialist Doctors and the result shows that Patients can effectively be guided on the choice of specialist for consultations. In deduction, this study offers tools for assessing the performance of patient to doctor activity which are useful for both hospital management and healthcare administration

General Terms
Intelligent Health Model

Keywords
Referral, Hybrid, Recommender, patient

1. INTRODUCTION
Health, according to the World Health Organization, is "a state of complete physical, mental and social well-being and not merely the absence of disease and infirmity".[1] Primary care serves as patients' first point of contact with the healthcare system and is a continuing focal point of comprehensive, accessible, and community-based care. More than just a gate-keeping process for specialist referrals, it has been widely recognized for its focus on caring for the long term health of patients rather than solely for treating specific diseases or conditions. As such, primary care helps deliver more equitable health outcomes across populations and meets 80-90% of individuals' health needs throughout their lives [2]. To this end, a recent special report from the Economist stated that "good primary care is an essential precondition for a decent healthcare system" [3] However, it is very challenging for patients to find the right family doctors with whom they can build trusting relationships, particularly when an appropriate matchmaking mechanism is not available. On the one hand, healthcare providers often lack the infrastructure and service design implementations to transform their services to morew person-centered approaches, e.g. enabling patients to choose their doctor [4]. On the other hand, patients face significant search costs in understanding the competencies of all available doctors and thus resort to word-of-mouth recommendations from friends, relatives, or online reviews to resolve the uncertainty. The barrier between the rapidly changing institutional environment and increasing patient autonomy complicates matchmaking between patients and family doctor

Hybrid recommender systems combine two or more recommendation methods to gain better performance. Most commonly, collaborative filtering is combined with some other technique in an attempt to avoid the ramp-up problem.

A recommender system is a class of information filtering system that seeks to predict the fidelity or preference that a user has for an item or entity. It has been widely used to recommend books, videos, or news articles on the Internet. In the healthcare domain, applications of recommender systems include assisting the decision-making process in the provision of personalized care, identifying key opinion leaders among medical practitioners, supporting patients to find preventative healthcare help in planning personalized therapy, providing personalized healthcare guidance and, more recently, recommending patients with doctors based on their previous consultation history. We do so by proposing a hybrid recommender system that automates the matchmaking process between patients and family doctors. In particular, we model patients trust in family doctors using a large-scale dataset of consultation histories, while accounting for the temporal dynamics of their relationships. We further combine patient and doctor metadata to model similarities between patients and doctors across social dimensions. This is especially useful when patients have limited prior consultations with family

doctors. As such, we can generate personalized doctor recommendations for each patient that they may trust the most. To the best of our knowledge, this work is among the first Data Collaborative initiatives in this European country that exchanges data from a private entity in the health sector to create socially desirable value. The hybrid recommender resolves resolves the limitations of traditional fixed-time control for passing vehicles. It employs a dynamic system to control the traffic light system that monitors two sets of parameters: the vehicle and upstream and downstream lane queues behind a red light and the number of vehicles that passes through a green light. In recent time, many researchers have been focusing on reducing the waiting time spent on the medical referrals which is mainly caused by the long time spent in finding the proper specialist for a particular ailment. The ability to meet with the right specialist in health care industries can give a speedy solution to every health challenges.

Healthcare system in Nigeria lacks systems for matching and making recommendation between Patients and various specialist healthcare providers. Referral and recommendation system is a machine-learning technique use for connecting or directing two people together or item to a customer. This has resulted in a dire need of an effective reliable online smart referral recommender system to recommend health care facilities and specialist doctors around the world that are best suited for a particular patient with limited time. In this project, a hybrid smart referral matchmaking model using recommender system is proposed as an essential.

2. LITERATURE REVIEW

[5] proposed a Recommender systems in the healthcare domain: state-of-the-art and research issues. Nowadays, a vast amount of clinical data scattered across different sites on the Internet hinders users from finding helpful information for their well-being improvement. Besides, the overload of medical information (e.g., on drugs, medical tests, and treatment suggestions) have brought many difficulties to medical professionals in making patient-oriented decisions. These issues raise the need to apply recommender systems in the healthcare domain to help both, end-users and medical professionals, make more efficient and accurate health related decisions. In this article, the author provide a systematic overview of existing research on healthcare recommender systems. Different from existing related overview papers, our article provides insights into recommendation scenarios and recommendation approaches. Examples thereof are food recommendation, drug recommendation, health status prediction, healthcare service recommendation, and healthcare professional recommendation. Additionally, we develop working examples to give a deep understanding of recommendation algorithms. Finally, we discuss challenges concerning the development of healthcare recommender systems in the future.

[6] In this paper, a novel multitask healthcare management recommendation system leveraging the knowledge graph is proposed, which is based on deep neural network and 5G network, and it can be applied in mobile and terminal device to free up medical resources and provide treatment programs. +e technique we applied is referred to as KG-based recommendation system. When several experiments have been carried out, it is demonstrated that it is more intelligent and precise in disease prediction and treatment recommendation, similar to the state of the art. Also, it works well in the accuracy and comprehension, which is much higher and highly consistent with the predictions of the theoretical model. the fact that our work involves studies of multitask healthcare management recommendation system, which can contribute to the smart healthcare development, proves to be promising and encouraging. In conclusion, it is shown that our multitask healthcare management recommendation system is intelligent and promising, which can free up and alleviate the medical resources to be more convenient and efficient. In addition, it has advantages compared to other common methods in propagating and generalizing the data to obtain the high value and useful information for the patients and the doctors. However, due to lack of the doctors data, our system is not able to recommend the appropriate doctor corresponding to the disease. Besides, there are still some limitations in comprehensive professional guidance in our recommendation system. In the future, abundant doctors data should be added and processed, accompanied by more professional guidance to support out healthcare management recommendation system to make it more comprehensive.

[7] proposed a New enhanced clustering algorithms for patient referrals in medical consortia. A clustering algorithm based on Fuzzy-C Means (FCM) is proposed to solve the problem, with patients clustered for each hospital based on their characteristics and preferences. Solution-enhancing strategies are developed to improve the schedule quality, including a virtual patient moving strategy (VPMS) and local search algorithms (LSA). Three spatial distributions of patients, central clumped, random and uniform distributions, are used to validate the performance of the algorithms. From the experimental results, the FCM-VPMS algorithm yields patient referral solutions at the lowest treatment cost, while the FCM-LSA performs better on minimizing total patient tardiness. On the cost efficiency of the algorithms, VPMS performs well with a central clumped distribution, while the LSAs show higher efficiency with the random and uniform distributions respectively. This is to initialize the patient assignment solution based on the membership degree when using the clustering algorithm. Once the patient assignment is completed, the patients of each hospital are sorted by their due dates using the EDD scheduling rule. Thus, an initial patient referral solution is obtained, and a bi-criteria solution in terms of the patient total treatment costs and tardiness is found.

3. METHODOLOGIES

To achieve the aim of this work, the following methodologies were exploited;

Experimental Research

Experimental research method is the straightforward experiment, involving the standard practice of manipulating quantitative, independent variables to generate statistically analyzable data. Generally, the system of scientific measurements is interval or ratio based. When we talk about 'scientific research methods', this is what most people immediately think of, because it passes all of the definitions of 'true science'. The researcher is accepting or refuting the null hypothesis. This enables researchers to compare the two groups and determine the impact of the intervention following processes were considered: survey, questionnaires, and interview

3.1 Agile Method

Agile software design methodology is a combination of iterative and incremental process models with focus on process adaptability and customer satisfaction by rapid delivery of working software product. Agile Methods break the product into small incremental builds. These builds are provided in iterations [8]. Each iteration typically lasts from about one to three weeks. Every iteration involves cross functional teams

working simultaneously on various areas like

i. Planning
ii. Requirements Analysis
iii. Design
iv. Coding
v. Unit Testing and
vi. Acceptance Testing.

At the end of the iteration, a working product is displayed to the customer and important stakeholders.

4. HYBRID RECOMMANDER SYSTEM ARCHITECTURE

The proposed system is referral model using hybrid recommender system. The system consists of doctor profiles and patient information. In the matchmaking referral process requires the healthcare network to learn about the healthcare preferences of each patient and to generate personalized recommendations accordingly whether a patient would actually visit the recommended doctor. For each patient, we have demographic data, such as gender, age, region, as well as past behavioral data. For the doctor, the doctor have to register with the register their demographic data such as name, place of work, area of specialist, number of patients they have treated. When a patient visit the site type the name of the illness matchmaker will be the one to recommender patient to a particular doctor base on the patient illness

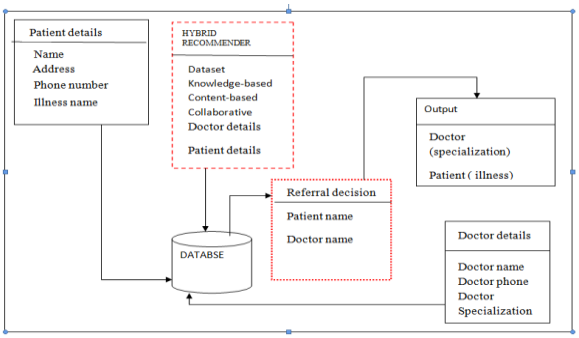


Figure 1: Architecture of the System

The architecture of the proposed is shown in figure 1 once a user logged on, the browser presents the main module of the system to the user. Based on the user's selection and successful authentication, the browser presentation logic redirects the user to the forms to perform the task selected by the user. Furthermore, a procedure provides the presentation logic for processing the service request, for example, submission of a form to register a new patient or update an already existing patient health history. The system architecture has some components that are used for Patient to doctor referral matchmaking system which include the patient details, doctor details, Hybrid recommender, Referral decision and database, the patient details and doctor details are input which both enter their personal information saved to the database. For the doctor the information is use to match a patient with that illness type while the patient enter the illness name. the hybrid recommender is the technology that loop though the database search for the doctor than send a response to the referral decision for any output. The system is further explained using a component diagram as shown in figure.2

Figure 2: Proposed Systems Component Architecture

The component of the system is made up of four parts:

i. Input Module (patient details): The input module collects the data of the patent; New users will have to sign up using the user interface provided on the website

ii. Content based Module (illness): The users will be asked to provide or enter the illness name or type based on the user input,

iii. Recommendation list (doctor specialization): the doctor information is stored in the database the system automatically searches for doctors that are specialist in the illness from the database display their information to the patient while an email is send to the doctor for an appointment.

iv. Output Module (doctor): connect the patient to doctor based on illness type

The snapshots of the various modules that make up proposed intelligent health referral model using hybrid recommender system along with a description of their functions are shown in figure 3, 4 and 5.

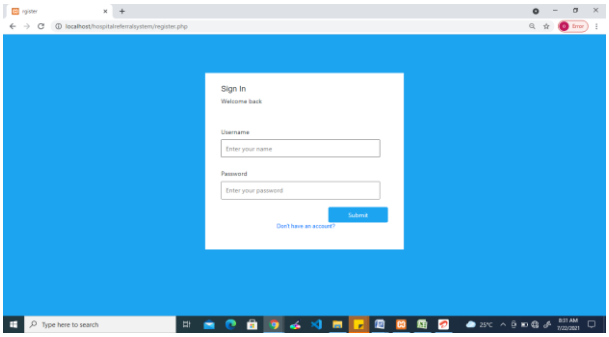


Figure 3: Login Page of the proposed system

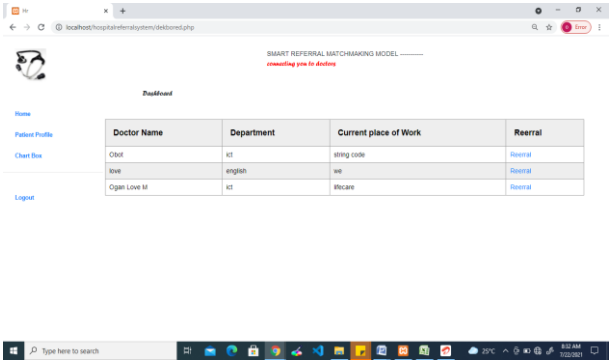
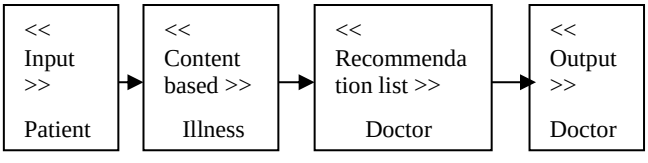


Figure 4: Referral Page



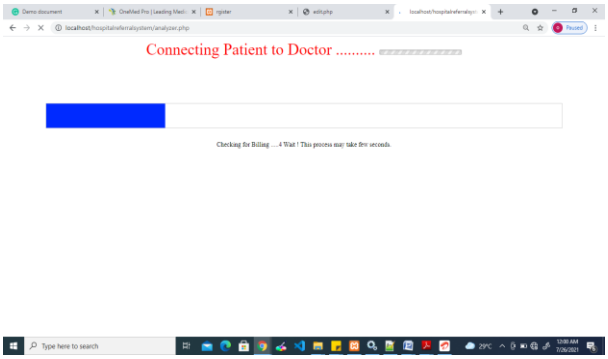


Figure 4: Page load

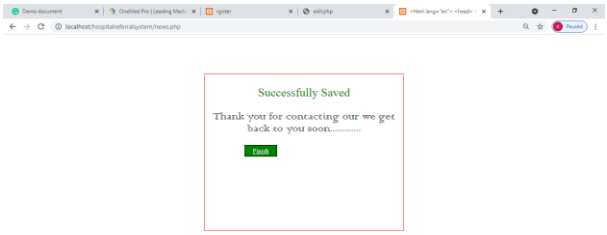


Figure 5: Notification Page

5. RESULTS AND DISCUSSION

In the proposed smart referral matchmaking model using hybrid recommender system. In the dataset used for training the system is the doctor details like demographic data (gender and age), as well as length of time working in the network, number of hospitals they have worked at, number of patients they have treated, and seniority level. The proposed system is a web base Application where the patients and the doctor can enter their data and register to avail the benefits of the system. If already registered, they can simply login using their contact number provided while signing up. After entering the mobile number, an OTP (One Time Password) is sent to the respective numbers for authentication purpose. After logging in, the patient can upload his/her medical data(reports, prescriptions, x-rays, etc) by simply scanning them through camera scanner. this data is then stored in the database. The patient can then select a doctor from the particular category based upon the doctors profile, rating, and the effectiveness of his treatment. The doctor then receives the medical data of the patient in the form of a folder. Then after studying the patient's case, the doctor can give remarks regarding the same, which helps the patient in further treatment. Furthermore, if need be, the system is provided with an option of video call which would be of great help if used by the patient to discuss his case in detail. The table 4. Below show the result of the system. The table show that every pointing time a doctor receive a request from a patient at different time interval and the doctor can attend to the patient without conflicting with other patient time The table 4. Below show the result of the system. The table show that every pointing time a doctor receive a request from a patient at different time interval and the doctor can attend to the patient without conflicting with other patient time.

Table 4.1 Simulation Result

Specialty	Time	Day
Psychiatry	10 am , 11pm	Monday
Dental	7am , 8am , 2pm, 4pm	
Optical eye doctor	9pm, 4pm , 7am , 8am ,	Tuesday
Physical therapy	7am , 8am	
Plastic Surgery	1pm, 2pm	Wednesday
Psychiatry	12am, 8pm	
Geriatrics	10px , 3pm	

6. GRAPHICAL REPRESENTATION

The graph of the proposed system is pilot in the using the table above. The color indicate different Specialty of doctor and the time interval a patient send a request to meet with the doctor With the graph it has show that different doctor can receive request from patient saving the time the patient to visits the hospital and still wait for long queue for doctor. At10 am and 11pm Psychiatry receive request from patient while at 7am , 8am , 2pm and 4pm a Dental receive request from patient on the same day Monday. By 9pm, 4pm , 7am and 8am receive request from patient Optical eye doctor and by 7am and 8am Physical therapy receive request from patient. From the evaluation it has shown that two doctors can be attending to different patients at the same time

7. DISCUSSION FINDING

However, the use of the referral system is lower In Eldoret. There are variations on reasons for seeking healthcare, as only about 26.5% of healthcare cases are as a result of being referred and 73.5% are as a result of other reasons including a first contact with a service provider. However, the results show that a greater proportion of the referral cases were formal referrals with written documentation representing 73.9% of the referrals, while26.1% indicated that they had self-referred. With Referral cases originating from the public healthcare outlets totaling about 33% of the overall share of the referrals, the bulk of the referral cases were from the private healthcare providers with about 67% of the referred cases coming from private healthcare outlets. It is important to note that no respondent indicated to have been referred from the national referral hospital.

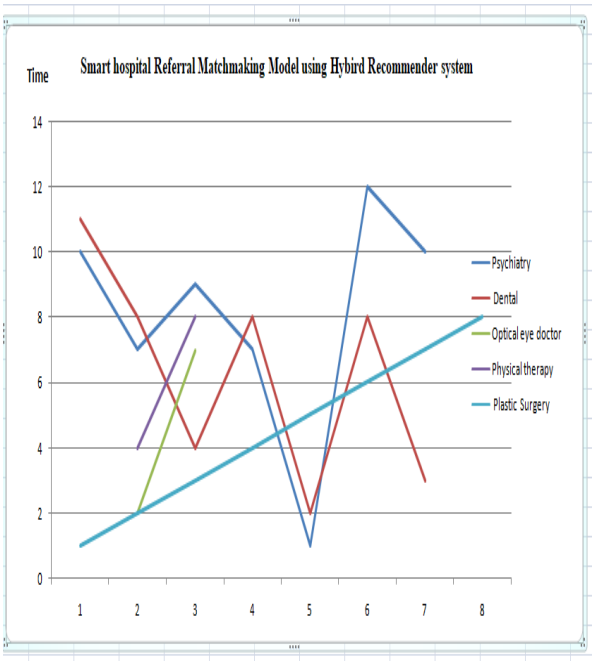


Figure 6: Graph of the new system

8. CONCLUSION

In this proposed approach, we have successfully smart referral matchmaking model recommender system. The following was achieved a smart matchmaking referral model for doctor to patient via the internet. The patient e-referral system automates the manual referral process by providing a platform in which patient can be recommended to a doctor has the comfort of their home via electronically. The patient and doctor can log access the information while the patient can send feedback to the system.. The administrator can view the details of the referral and then send the referral to the appropriate doctor in the referred-to hospital. It contains a 'Send To' bar to select the doctor in which the referral will be sent to. In the application the doctor can accept or reject the referral. Once the referral has been accepted or rejected by the referred-to provider, the status of the referral changes in the referring provider 'list of referrals' page. The status of the referral changes from pending to Accepted Object-Oriented Analysis and Design Methodology was used in the analysis and was implemented with PHP programming language with the Apache web server to manage the Database developed using MySql.

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