Hospital Queueing Management System with Automatic Appointment Generation

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***Abstract*—Healthcare is a delicate sector and the service they provide is more significant and even life-saving. One of the major problems faced by the today's hospital is the lack of effective technique to manage the patient queue. The long waiting problem led to the patient overcrowding thereby increases patient frustration. The queue management system is the automated process of handling queue. We collect the patient data from various hospitals to calculate the waiting time for every treatment tasks. We design an online appointment system to reduce the entry fluctuation. The appointment system encourages Hospitals to efficiently achieve their registration procedure and to monitor the patient's flow. The proposed algorithm elevates the process by considering direct patient feedback combine that with detailed analytics, the effective treatment plan is recommended that helps to discern total waiting time in the hospital in advance. Patient Treatment Time Prediction (PTTP) is proposed to estimate the waiting time of the patient for each of the treatments. On the basis of the waiting time calculated by the PTTP, a system called Hospital Queuing-Recommendation (HQR) is deployed whose task is to mention an efficient treatment scheme for every patient in the queue, thereby minimizing the patient waiting time delays.**

***Keywords*—PTTP, HQR, RF, Hadoop.**

I. INTRODUCTION

A healthcare system comprises of all organizations, people, and actions whose major intent is to convey health care services to maintain health needs of target populations. However, patients accept that they must wait for service, as each patient might have need of different tasks such as regular checkup, various tests like sugar level, blood tests, CT scan. In which, some tasks are independent whereas some tasks are holding up to complete other dependent tasks. Most patients must need to wait in various queues for various treatments. Lab waiting times were long; patients don't know how long the wait will be. This consequence leads to unstructured, long wait; many patients simply got tired of waiting in the queue. By estimating the overall waiting time of each task in real time, an automatic queuing system can be developed, ensuring to complete required treatment in the shortest duration.

The waiting time period of every treatment task can be anticipated by PTTP. The PTTP model is implemented based on hospitals' past data. The RF algorithm used to predict total time consumption of every task based on both patient and task completion time features. The HQR system provides an effective treatment queuing recommendation for each patient. An online appointment system has been proposed, in which a scheduling system is provided for patients and it is illustrated in figure 1.

Big Data in hospital system generates huge health-related datasets, handling these health-related datasets with the conventional system are very challenging. Big Data in healthcare comprises of bulk data including various data type. Big Data analytical technology is challenging in terms of database design, data knowledge representation, clinical decision support and data querying. Big data and cloud computing models are employed to ensure efficiency and scalability

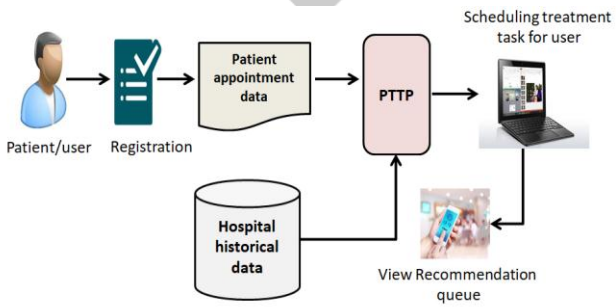

Fig. 1 Basic Flow Diagram

The Hadoop platform supports the healthcare system work capably with Big Data. Without Hadoop, healthcare service system framework could not envision working with unstructured data. Hadoop technology allows storing healthcare data in its native form. Hadoop guarantees fast and interactive analytics of data. The PTTP model is realized in Hadoop platform.

The rest of the paper is sorted as follows. Section 2 audits related work. Section 3 describes a PTTP algorithm and an HQR system. Section 4 details Appointment system. Implementation is explained in Section 5. Finally, Section 6 concludes the paper with future work advice.

II. LITERATURE SURVEY

To predict the waiting time for each treatment task, the random forest algorithm is implemented to train the patient treatment time consumption based on both patient treatment task and the time period required for each task and then build the PTTP model [1]. The barriers in big data management are analyzed for reducing healthcare costs and adversarial events. The cost-effective technique for big data management is realized [2]-[3] Big data and cloud computing models are employed to ensure efficiency and scalability.

In [4] time prediction for a particular task is performed by comparing different techniques used to implement hospital queuing system, such as an extension to RF algorithm, structured data storing in database etc. The random forest algorithm [5] is to predict the patient treatment time and to reduce time delay for each particular task by providing a cost-effective and easy way for estimating the time for each treatment task. The random forest algorithm based on class weights are deployed in the processing of imbalanced medical data on considering the empirical error measurements [6], the uncertainty in hospital dataset is predicted [7] and unrelated data are removed to provide a very accurate and precise interface.

The automated healthcare management system presented with Apache Hive, with the concept of Map-reduce semi-structured data is analyzed and computerized Hospital Management System is developed [8]. Apache Spark cloud environment is proposed with PTTP algorithm [9] to predict the queue waiting time for each patient treatment task and a well-organized and suitable treatment plan is suggested for each patient [10] Waiting Time in Maternity Emergency Care by means of Data Mining [11]. In [12] described the full-text search engine Solr which indexes content, analyzes the query requests that considerably change regular medical preparation in patient care.

The overwhelmed patient waiting times and treatment difficulties, synchronization of treatment processes along with the connected clinics were estimated and a new appointment system with patient-centered appointment scheduling[13] and patients flow change processed and modeled via the Arena 13.5 Simulation Program [14], by using actual data. The logistic regression models [15] to predict no-show risk among scheduled radiology appointments in a hospital setting and no-show predictive and modeling methodology is observed to outperform comparable cancellation and no-show predictive emergency condition [16] models developed for use in general practice settings.

III. AUTOMATED QUEUING-RECOMMENDATION SYSTEM

The queue management system is the automated process of handling queue. The queue management system is deployed to avoid overcrowding and to help patients to finish their treatment tasks at a specified time. The treatment time scheming is developed using realistic data from various hospitals. The collected data is analyzed carefully by considering significant parameters, take account of patient age, the total duration required for each treatment featured for every different treatment task. The total waiting time for every patients is identified in view of circumstances and tasks carried out during treatment.

A. Patient Treatment Time Prediction Algorithm

An approach to deal with settle delay in waiting time and anticipate the waiting time for every independent and dependent task. Parallel PTTP algorithm is proposed where it will compute every treatment assignment time depending on the queue of patients waiting for similar treatment. The PTTP algorithm is structured as a learning algorithm for computing the patients waiting time to benefit any service.

a. Data gathering and creating the same dimension

The data produced from various treatment assignments have dissimilar contents and changing dimensions. To prepare the patient time utilization model for every treatment undertaking, some part of information are preferred, for example, the patient data (gender, age, and so on.), the treatment task data (treatment task name, task undertaking, specialist name, and so on.), and the time data (task begin time and end time). Data set composed of singular, non-overlapping data elements. Functionalities provide by dimensions are filtering, grouping and labeling. The historical data collected from various treatment tasks containing dissimilar contents and changing dimensions should be unique and consistent. Thus, same features are necessary to be chosen to evaluate trained data set to PTT input model for each patient treatment task,

b. Remove Incomplete And Inconsistent Data

The PTTP model requires calculating various features of data, such as range of treatment time, treatment time consumption record. Subsequent to processing new featured data, the noisy and error information need to be displaced. The treatment records with missing values are considered as inadequate information and records with negative estimations of time utilization are removed as inconsistent data.

B. PTTP model based on the RF algorithm.

The target feature variable of the dataset is total treatment time consumption and is the continuous value. In RF model the single decision tree is a regression tree. Thus, every training subset requires the utilization of CART regression tree model.

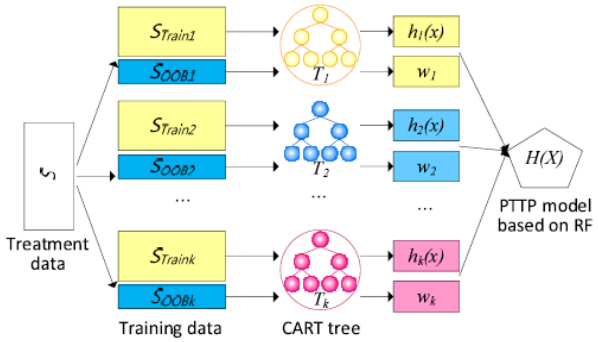

Fig. 2 PTTP model based on the RF algorithm.

The independent variable data is considered as nominal data comprises of distinctive esteems, for example, time run (0-24) and day of the week (Monday-Sunday). The patient time utilization depends on various time and patient attributes. The total time required for the individual task is different, which varies from the content of task, different conditions of the patient. Thus, RF algorithm is based on both time and patient characteristics deployed to train PTTP model.

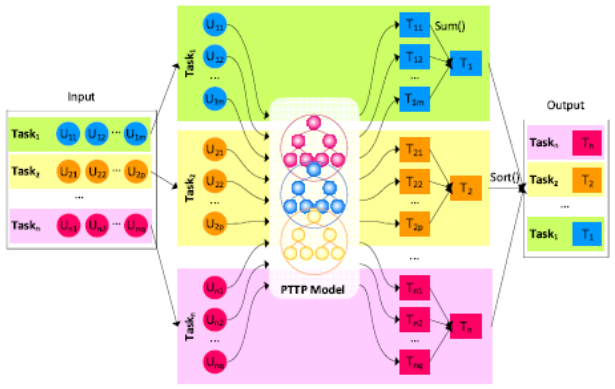

Fig. 3 HRQ system based on PTTP model

C. Hospital Queuing Recommendation System

The hospital queue recommendation system is employed to train the PTTP model for every treatment task by making use of historical hospital dataset. An HQR framework is proposed in view of the anticipated waiting time period. A productive and advantages treatment plan are developed to minimize the waiting for every patient. There are numerous treatment undertakings for each patient and is dependent on patient's condition, for example, examinations and checkups.

a. To Calculate the Waiting Time for Each Task

The total time consumption for every single patient is anticipated by the trained PTTP algorithm based on the time factor, patient characteristics and other factors (available machine, treatment divisions and so on)

b. Sorting the Treatment Task

Based on the waiting time of current patient treatment task and all treatment tasks are sorted in ascending order. In the event that any undertaking is reliant on another task, they are sorted in view of their dependencies instead of waiting times.

c. Provide Hospital Queuing Recommendation

An HRQ with the sorted treatment tasks is achieved for every single patient. Every patient can be welcome to finish his treatment exercises in the most beneficial way with the waiting time.

IV. PROPOSED APPOINTMENT SYSTEM

Compared to the framework without appointment system, the system with appointment reduces the entry fluctuation and waiting time. We outline an appointment framework to reduce the number of patients in the queue and thus reduce the waiting time for patients. The appointment time is assigned based on average patient treatment time and also requires the consultant must be on time.

A. Data collection

Data collection was part of a quality improvement. Patient features (age, gender, and the city of residence) are essential to the individual patient being treated. Test features (exam type, duration of the exam, and the hospital department) relate to the type and qualities of the tests examination that is ordered. Scheduling features (date and time of the scheduled appointment) include logistical aspects of the appointment. The month, weekday, an hour of the scheduled appointment are all considered as scheduling

features. The scheduling lead time is considered, the time duration between the particular treatment order date and the date of the appointment and estimates how far in advance the patient schedules their appointment. The amount of time dispensed for an appointment relies upon the purpose behind the visit. In general, the accompanying circumstances are designated (New patient, Regular patient and so on).

B. Data Retrieval using solr

Hospital database consists of primary medical records about specific patient's data and Secondary files are generated from primary records. Secondary databases facilitate reuse of data that have been gathered for another purpose. Solr search lets entire hospital database, explore and analyze data quickly and easily for a variety of patients' treatment tasks. Solr supports batch, real-time, and on-demand indexing and re-indexing of data of any type, hence faster to get required patient data from huge hospital dataset. Apache Solr is the open source platform for searches of data stored in Hadoop. Solr enabling powerful full-text search and near real-time indexing. Full-featured search is used to inspect the huge hospital dataset, which opens up big data for the fastest realization and better insight. Search using Solr also helps in analyzing the same data using tools like Apache Spark all within the single platform.

C. Short-notice systems

The propose of executing short-notice appointment frameworks in view of a queuing system analysis. A day before alert mail is sent to all applicants as intimating message. The notification mail enables patients to recall the correct date and time of their next appointment. The appointment reminder message/mail is sent with ensuring confidentiality. The system identifies patients who need periodic routine examinations. Thesse remainder might be an email created by the PC in view of appointment planned date.

D. Follow-up Appointments

The chance of rescheduling the planned requests occurs in case of emergency; this may include patients who arrived late or completing the treatment soon. The patients are scheduled at particular times during the first half of every hour, and second half hour is kept open for unique conditions. The traffic issues or different cases can cause a delay in arrival. In the event that a patient telephones to state that he will be unexpectedly delayed, the schedule can either be balanced or the patient can be offered another follow-up appointment.

E. No-show Appointments

Unattended appointments are a burden for our proposed system. Here, we define a no-show appointment for the unattended patient without prior notice. Appointments that are missed with no advanced notice blocks another patient in the appointment slot. Consequently, no-show appointments lead to delayed medical care and treatment for patients. Within the scheduling data extracted from the database, we identify no-show appointments and cancellation code is assigned. Appointments are labeled in this way when no prior notice is given prior to the patient's nonattendance.

F. Multi-site system

The site of exam describes which hospital site within the multi-site system the exam occurs. Some physicians see patients in more than one site. Appointments may be scheduled to the site which is nearby to the patient. In this case, if the patient clarifies which site the patient wants to visit, then it may easier to transport the medical record to the expected hospital site.

V. IMPLEMENTATION DETAILS

We outline an appointment framework to reduce the number of patients in the queue and thus reduce the waiting time for patients. The appointment time is assigned based on average patient treatment time.

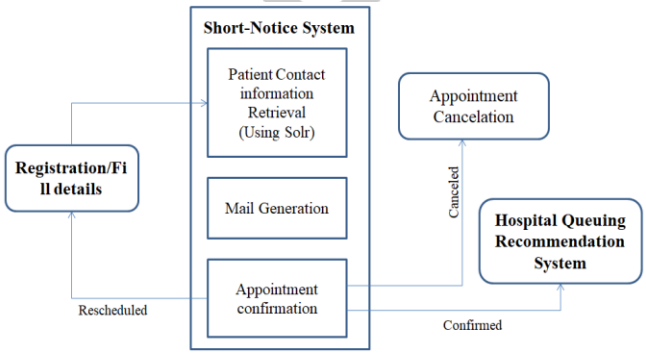

Fig. 4 Process flow.

A. Hospital database and Data retrieval

The appointment process is deployed to monitor the patient's flow. The appointment generation is based on patient's first direct visit to the hospital or recognized patient taking an online appointment. The proposed appointment system facilitates the registration process for first visit patient by filling details. The new and regular patient's data reside in the hospital database and

the changes can be made at the database. Solr search lets entire hospital database, explore and analyze data quickly and easily for a variety of patients'.

B. Appointment generation process

Appointment system models each feature group, including Patient features, Exam features. The patients who made appointments receive the confirmation e-mail automatically. A day before remainder mail is sent to all applicants as the short-notice message. In short-notice e-mail, the patients are allowed to confirm the appointment by clicking the approval link. The system also provides cancellation feature in the short-notice mail in which patient can cancel their appointments. The system also benefits the patients by assisting the nearby hospital site location in case of a multi-site hospital system.

C. Appointment Scheduling

The automated appointment scheduling system helps patients to view all available dates. The appointment confirmed patients are scheduled during the first half of every hour, and second half hour is kept open for other patients as the second slot. The late arrived patients are rescheduling to the second slot. The system is facilitated to identify the un-attended patients without prior notice and cancellation code is assigned.

VI. CONCLUSION AND FUTURE WORK

In this paper, an automated appointment generation system based on big data to reduce the number of patients in the queue is proposed. Apache Solr based data retrieval system is developed to inspects the huge hospital dataset and analyzes data quickly and easily for a variety of patients. An efficient and convenient appointment generation system is recommended to monitor the patients' entry fluctuations. The proposed appointment system facilitates automatic alert system with approval and cancellation appointment features. The system also benefits the patients by assisting the nearby hospital site location in case of the multi-site hospital system. The automated appointment scheduling system helps patients to view all available dates and also provide rescheduling feature based on patient conveniences. The web-enabled cloud-based appointment system with the mobile application is implemented as future work.

ACKNOWLEDGMENT

My sincere thanks to our guide, Asst. Prof. A V Krishna Mohan, for his valuable suggestions and guidance.

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