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Hospital Locator and Bed Availability Detector For Emergency Cases

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Abstract
A major contributing factor to staffing shortages and overcrowding in tertiary hospitals is the scarcity of available hospital beds. This not only poses a challenge for some tertiary healthcare facilities in terms of accommodating inpatient beds, but it also creates a deficit of qualified medical personnel such as doctors and nurses who are unable to provide care to more patients than the hospital can manage. The COVID-19 pandemic has caused significant concern among-est healthcare professionals and the general public alike. One of the most significant challenges faced by many countries during the pandemic is a shortage of medical resources. While the number of patients has increased significantly, hospitals must send them to emergency care as quickly as possible. Consequently, the demand for ambulances has also grown. Today, many ambulance services cater to anonymous users, and in some situations, locating the nearest ambulance becomes extremely challenging. We have developed a piece-wise model that illustrates the impact of the shortage of hospital beds during an emergency outbreak. By utilizing Google Map API, patients can identify the nearest hospital and available resources such as open beds and specialists with specific expertise. The program's server, which utilizes PHP and SQL databases, is designed as a client-server model. Technology can be incorporated into ambulance services to assist people in locating hospitals quickly, particularly in emergencies.

Index Terms - Forecasting Bed Availability, Patients, Hospitals, Google Maps API, Ambulance.

Introduction

The objective of this project is to create an online application that will facilitate the identification and location of patients, enabling the retrieval of information on bed occupancy and necessary supplies. The key focus of this initiative is to implement a GPS tracking system in ambulances, which will enable the public to track the locations of nearby ambulances. In the event of an emergency, this will allow for the closest ambulance to be contacted, leading to significant time savings. Utilizing GPS technology's the shortest route to the hospital can be determined, ensuring patients reach their destination as quickly as possible.

In the quickly evolving technology world of today, mobile computing has reached a point where a user may access all of the information on a device with just a single touch. People carry mobile devices like laptops, tablets, and cell phones around with them all the time in today's modern world. The user can benefit from a variety of contextual services and have their overall mobile computing experience improved by utilizing the user's geographic location. type of contextual service that aids in pinpointing the user's precise location and then provides them with information based on it to improve their overall experience. You can access this location-based data in a variety of ways, including position, vicinity, maps, routes, places etc.

Background of Study

According to WHO data, India has only 0.5 hospital beds for every 1,000 residents, which is a cause for concern given the country's population of almost 1.5 billion. While India currently has 1.25 lakh ICU beds and an estimated 2 million hospital beds, there is an impending shortage of beds. Predicting and optimizing hospital bed occupancy is becoming more common as productivity and business operations must be enhanced in the healthcare sector. As a hospital in one of the world's largest cities, you are likely aware of the shortage of hospital beds. Forecasting bed occupancy and utilizing these forecasts to optimize patient placement is a vital matter, given the current challenging circumstances. Moreover, it forecasts bed availability for the next 72 hours.

B. Scope of Study

In emergencies, it is essential to locate nearby hospitals efficiently. The proposed approach entails searching and sorting hospitals based on their proximity, required facilities, and infrastructure in a pandemic scenario. We leverage Google Maps APIs to determine the distance between patients' locations and nearby hospitals. This tool is ideal for scheduling same-day appointments, as it provides quick access to contact information for specialists and comprehensive data on each hospital. This application has the potential to create a real-time network of available professionals who can assist patients in the future.

C. Problem Statement

The focus of this research is to address the challenge of accurately forecasting the availability of hospital beds in the upcoming weeks. Effective management of bed utilization is crucial since overcrowded hospitals can cause delays, rescheduling, or transfer of patients to other hospitals, while underutilized beds lead to missed opportunities to treat patients. To facilitate the process of obtaining information on bed occupancy and required patient commodities, particularly in emergency scenarios, a client-server application is necessary to identify patients and streamline their location.

D. Objective

The primary objective of the Hospital Locator and Bed Availability Detector for Emergency Cases is to develop a web services-based system that delivers optimal services for emergency cases. This system aims to achieve the following objectives:

a) Provide a user-friendly application with comprehensive details about hospital facilities and doctor availability.

b) Utilize Google Maps API to identify the best routes to the nearest hospitals.

c) Enhance the availability of specialist consultants, hospitals with beds, and emergency room admissions through the application service.

To improve the system's daily efficiency, a neural network will be employed to forecast bed availability and optimize bed utilization. The output of the forecasting system will be an estimate of the expected number of beds and a corresponding tolerance range for 1-48 hours in the future. Our proposal includes a tool that locates the closest hospitals with the required medical resources and specialists. Utilizing the Google Maps Application Program Interface, the shortest route from the current location to the nearest hospital can be determined using GPS.

E. Limitations of Study

The effectiveness of this web-based solution is dependent on a reliable internet connection. The use of GPS and the Google Map Application Program Interface to locate the nearest hospitals and determine the optimal route may yield suboptimal results in the absence of a stable internet connection.

Literature Review

[1] Y. Dian Harja and R. Sarno, "Find the best option for nearby medical services using Google maps API, Haversine, and

TOPSIS algorithm," 2018 International Conference on Information and Communications Technology (ICOIACT), 2018, pp. 814–819, doi: 10.1109/ICOIACT.2018.8350709. To create a location-based service for medical use, this paper takes into account two key factors: travel time and distance. To locate medical facilities nearby within a predetermined radius, this system uses the Haversine algorithm. then calculating travel duration and distance using the Google Map API. The TOPSIS algorithm is used to decide which choice is the best given the outcomes. Using this method, the entire system demonstrates that this study provides a better method for making decisions than previous studies.

[2]This convention is used in the works of Isken, Ward, and McKee (1999), Cahill and Render (1999), Harper and Shahani (2002), and others. In hospital simulations, doctors, nurses, and other hospital personnel are frequently portrayed as resources.

[3]Through the use of computer simulation, Bagust, Place, and Posnett (1999) investigate hospital bed usage and the impact of emergency admissions on the system. The authors are able to draw important conclusions on bed availability and usage by modelling an entire hospital and enable the tracking of numerous variables of interest: more particularly, that the risk of running out of beds became high and had long-term effects when the hospital in this trial was more than 85% full.

[4]In order to forecast emergency patient demands, Walczak, Pofahl, and Scorpio (2003) used "information that is available within the first 10 min (without the use of invasive testing) of the patient's arrival" (p. 446). This is a second important example of a neural network use in forecasting. Again, two distinct networks are utilised here. However, rather than modelling two different measures of interest, the two networks in this work address two distinct patient types (patients with paediatric trauma and patients with pancreatitis) who require qualitatively different sorts of care.

[5]The simulation programme then makes it simple to monitor how these resources are used, enabling analysis of the findings. Resource features, including entity qualities and arrivals, are controllable to a wide range of desirable values, enabling the modelling of resource efficiency, downtimes (or work breaks), and timetables of resource capacity.

[6]Deschepper, M., Eeckloo, K., Malfait, S. et al. Prediction of hospital bed capacity during the COVID− 19 pandemic. BMC Health Serv Res 21, 468 (2021). The planning tool combined a Poisson model for the number of newly admitted patients on each day with a multistate model for the transitions of admitted patients to the different wards, discharge or death. These models were used to simulate the required capacity of beds by ward type over the next 10 days, along with worst-case and best-case bounds.

[7]Leclerc, Q.J., Fuller, N.M., Keogh, R.H. et al. Importance of patient bed pathways and length of stay differences in predicting COVID-19 hospital bed occupancy in England. BMC Health Serv Res 21, 566 (2021). Predicting bed occupancy for hospitalized patients with COVID-19 requires understanding of length of stay (LoS) in particular bed types. LoS can vary depending on the patient's "bed pathway" - the sequence of transfers of individual patients between bed types during a hospital stay. In this study, we characterize these pathways, and their impact on predicted hospital bed occupancy.

[8]V. K. Prasad et al., "ABV-CoViD: An Ensemble Forecasting Model to Predict Availability of Beds and Ventilators for COVID-19 Like Pandemics," in IEEE Access, vol. 10, pp. 74131-74151, 2022, doi: 10.1109/ACCESS.2022.3190497. in this paper, we propose a scheme, ABV-CoViD (A vailibility of B eds and V entilators for COVID -19 patients), that

forms an ensemble forecasting model to predict the availability of beds and ventilators (ABV) for the COVID-19 patients.

[9] Baykov D, Skeldon A, Whyte M. Analysis of bed occupancy data on the acute medical unit. Future Healthc J. 2020 Feb;7(Suppl 1):s84-s85. doi: 10.7861/fhj.7.1.s84. PMID: 32455309; PMCID: PMC7241199. Understanding patterns of ward admission and discharge from acute medical units (AMU) can help inform resource allocation. Discharges early in the day are advocated as a means to improve bed management, but delays may arise from post-AMU bed availability. It is unclear whether any change in AMU discharge patterns pre-dates hospital-wide pressure or whether it is a reaction to it.

[10] Barado J, Guergué JM, Esparza L, Azcárate C, Mallor F, Ochoa S. A mathematical model for simulating daily bed occupancy in an intensive care unit. Crit Care Med. 2012 Apr;40(4):1098-104. doi: 10.1097/CCM.0b013e3182374828. PMID: 22067625. To develop a mathematical model for simulating the daily bed occupancy in an intensive care unit..

Methodology

Predicting the availability of hospital beds in the short term has been a challenging task. However, with the use of artificial neural networks and computer modelling, reliable solutions have been developed. These simulation models are capable of mimicking the arrival of different patient types, their lengths of stay, and the complexity of hospital systems. This type of modelling has proved effective in estimating the number of beds required for different wards, such as ICU, during epidemics like COVID-19. The planning tool combines a multi-state model for patient transitions between wards, discharge, and death with a Poisson model for the daily number of new admissions. The simulation accurately predicts the required number of beds by ward type for the next 10 days, along with the best- and worst-case scenarios. The results have been highly effective in anticipating the number of beds required for different hospital wards.

A. Google Maps API

This research aims to provide a solution to the problem of patients not knowing how to reach hospitals or medical facilities during emergencies. The proposed solution is an online hospital locator system that utilizes Google Maps to show users the ratings of different hospitals, traffic updates, and directions. The system also features automatic navigation functions that can calculate the shortest route from the user's current location to their desired destination. The Google Maps application programming interface (API) are a set of tools that enable interaction with the service. These API can be used to develop location-based applications for various platforms, ranging from simple to complex. Google Maps is a comprehensive online mapping resource that offers detailed information on locations, street maps, route planners, aerial and satellite views of various destinations across the globe. With the Google Maps API, users can create customized maps. However, to utilize any of the Google Maps API Services, a user must first obtain an API Key from Google Cloud Platform.

- Create an API Key
- Protect your libraries and API key by activating billing.
- Enable Desired Libraries

The Google Map APIs comprise a number of APIs, including the Places API, Distance Matrix API, Directions API, and Geo-fencing API.

B. Directions API

The Google Directions API is a tool that uses an HTTP request to determine directions between two points.

You can look up directions for a number of forms of transportation, including driving, taking public transportation, walking, and cycling [6]. The same process as for obtaining a Google Maps API key must be followed in order to use the Directions API in an Android program.

C. Direction Requests

An HTTP URL specified as a Directions API is as follows: Google Maps API Directions Output URL: maps.googleapis.com where the result could be in XML or JavaScript Object Notation (JSON).

Arguments	Description
Start Point	The location from which we want to calculate directions, such as an address or a textual latitude/longitude number. If In order to calculate directions when an address is supplied as a string, the Directions service geocodes the string and converts it to a latitude/longitude coordinate. When passing coordinates, it must be assured that there is no gap between the latitude and longitude numbers.
Destination Point	The address or textual latitude/longitude value that we want to use to determine directions. When an address is supplied to the Directions service as a string, the service geocodes the string and converts it to a latitude/longitude coordinate to determine directions. If coordinates are given, it must be assured that there is no space between the values for latitude and longitude.
Sensor	Whether or not the device with a location sensor is the source of the directions request is indicated. This argument's value can only be true or false.
Mode	defines the mode of transportation that will be used to calculate directions.
Language	The dialect used to return results
API Key	API credentials for the application. The identification of your application is determined by the key.
Units	defines the unit system that will be used to show results.

Table1: Parameters of Direction Requests

D. Components and Service Process

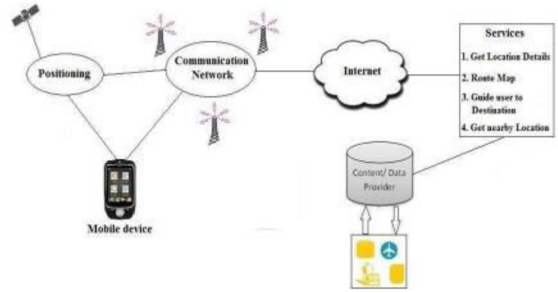

Fig1: Components & Services

Step 1: Using a Web application, the user submits a service request to the service server.

Step 2: The user's current location data is obtained from the positioning component and submitted to the service server via communication network along with the service request.

Step 3: The service server now analyses the geo-specific data that the user has requested and requests the pertinent information from content or data providers (such as geographic databases).

Step 4: The final step involves returning the required data to the user's web application.

A. Computer Simulation

Computer simulation is a valuable tool in studying and improving real-world systems, providing a streamlined process model that can simulate multiple metrics. In healthcare, simulation models typically focus on patients as the primary entities. This approach enables the analysis of various metrics, such as resource consumption, queue lengths, and patient wait times. Given the latest techniques in engineering and systems analysis, simulation is expected to play an increasingly important role in healthcare administration. In particular, simulation can be used to investigate different hospital cost centers.

Examples include:

1. Admission of Patients.

2. Laboratory.
3. Surgical Suites.
4. Healthcare Services.
5. Visiting Hospitals.
6. Ambulance Services

Computer simulation models are highly reliable and can accurately forecast the future performance of complex systems. As such, simulation is an ideal tool for learning about interrelated systems. Resource queues are a critical component of simulation models, as they help determine system performance and the amount of time entities will wait for resources to become available. By combining entities, resources, and queues, a wide range of systems can be modeled using simulation techniques, achieving high levels of realism as desired.

B. Neural Network for bed availability forecasting

This thesis describes the development of a neural network forecasting system that projects the expected value of the hospital bed availability one time step into the future. The mean squared error of a test data set is used to construct a tolerance interval, which can be modified while the network is used. The investigation of a second network to determine the first neural network's forecast error is also covered.

a. Network Input

The expected value network (EVN) takes in three inputs to forecast the number of available beds in a hospital. The first input is a 168-element vector that represents the current weekday, the current number of available beds, and the number of each type of patient in the hospital. This input structure enables the network to model availability trends by assigning weights to neurons for each hour of the week. The second input is a 12-element vector that represents the number of patients of each type currently enrolled in the hospital. This variable has been found to have a significant impact on bed availability, with an increase in longer-staying patients leading to a decrease in available beds. The third input is the present number of available beds, which has been shown to be an excellent predictor of the number of available beds one hour ahead. In the generic hospital forecasting system, this input is utilized as the third and final input to the EVN.

b. Network Architecture

The aim of the network's architecture was to provide a simple and efficient framework for predicting bed availability one step ahead. To achieve this, a single processing layer consisting of 168 linear neurons was utilized, along with a non-learning output neuron that summed the output from the processing layer. The choice of linear neurons was made to keep the architecture simple. The inputs mentioned earlier were used, and the only output generated was the predicted bed availability one hour ahead. The network was tested using this architecture.

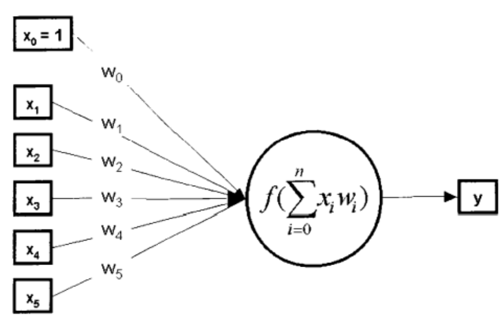

Fig2: A representative neuron in neural network

Thus, a neural network is a collection of neurons that are arranged as earlier said, increasing in number from one node to many nodes in many layers. Hidden layers, which are located between the input and output layers, are what allow neural networks to correctly model a wide variety of systems.

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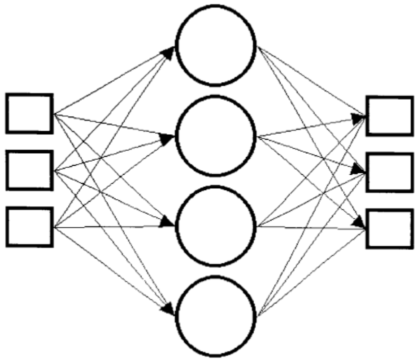

Fig3: Neural Network

c. Network Training

Error back-propagation serves as the EVN's training algorithm. Back-propagation is a technique for training our model.

I'll list the steps for you in brief:

1) Determine the inaccuracy by comparing the output of your model to the actual output.
2) Minimum Error - Determine whether or not the error has been minimized.
3) Refresh the parameters - Refresh the parameters if the error is significant (weights and biases). Check the mistake once more after that. Continue until the mistake is at its lowest point.
4) The model is prepared to make a forecast - When the error is at its lowest, you may give your model some inputs, and it will generate the result.

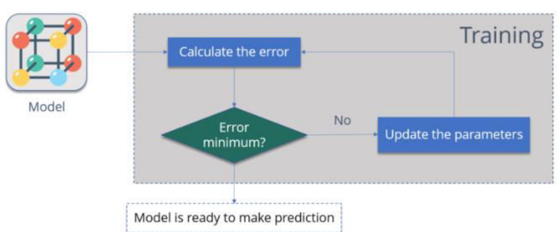

Fig4: Back-propagation for training neural network

Results and Discussion

In an experiment, three neural networks were constructed with different numbers of hidden neurons: 168, 84, and 107. Each of these networks was trained on the same set of data using the same number of training passes, which was set to 200. Since the 84-node network was half the size of the original network, it was chosen as a compromise between the other two networks. The 107-node network was also selected as a size compromise between the other two networks. The results of the training were recorded in a table, which showed that the largest network had the lowest mean squared training error and the smallest maximum training error.

	168 Neurons	84 Neurons	107 Neurons
MSE (training error)	6.37 beds	10.75 beds	8.33 beds
Maximum Absolute training error	12.21 beds	13.51 beds	13.83 beds

Table2: Test results for various network sizes, for determining network hidden layer size

To achieve a maximum absolute error of ten beds, the neural network training procedure was employed on the training data set. In addition to the training method, training data, and training volume used, the learning rate of the network is a critical requirement for effective training. The table below presents the outcomes of the training for the EVN, indicating how well the trained neural network performed in comparison to the training data set.

Maximum training error	11 beds
MSE (training error)	3.45 beds
Number of passes	400
Total input patterns presented	3.28 million

Conclusion

Short-term forecasting of hospital bed availability has been a challenging task, but computer modeling and artificial neural networks have proven to be effective solutions. A computer simulation model has been used to model the non-stationary arrivals, diverse patient types, and other factors that contribute to the complexity of hospital systems. The model has been validated using data on bed usage, patient type prevalence, and patient lengths of stay. To predict the availability of hospital beds one hour in advance, a neural network has been developed using data on the current count of patients and the number of available beds. In order to identify patients and their required supplies, an internet application must be used to locate them easily. The primary objective of the project is to develop a GPS system that includes a GPS tracker for ambulances. This will enable the public to track all local ambulances and, in an emergency, call the nearest ambulance to the patient, resulting in time savings. By leveraging GPS technology, the system identifies the shortest path, enabling patients to reach the hospital as quickly as possible.

References

[1] Geetha, Selvaraj, Samayan Narayanamoorthy, Thangaraj Manirathinam, and Daekook Kang. "Fuzzy case-based reasoning approach for finding COVID-19 patients priority in hospitals at source shortage period." Expert Systems with Applications 178 (2021): 114997.

[2] Ravaghi, H., Alidoost, S., Mannion, R. and Bélorgeot, V.D., 2020. Models and methods for determining the optimal number of beds in hospitals and regions: a systematic scoping review. BMC health services research, 20(1), pp.1-13.

[3] Kittipanya-Ngam, Panachit, Ong Soh Guat, and Eng How Lung. "Bed detection for monitoring system in hospital wards." 2012 Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE, 2012.

[4] McClean, Sally, and Peter H. Millard. "A decision support system for bed-occupancy management and planning hospitals." Mathematical Medicine and Biology: A Journal of the IMA 12, no. 3-4 (1995): 249-257.

[5] Junafan, Achmad. "Geographic Information System Locating Hospitals and Police Stations Based on Android." Journal of Intelligent Decision Support System (IDSS) 4, no. 2 (2021): 41-46.

[6] Waskito, A. A., Arifin, A., & Nuh, M. (2022, July). Optimization of Emergency Department Bed Availability using Patient Detection System. In 2022 International Seminar on Intelligent Technology and Its Applications (ISITIA) (pp. 48-51). IEEE.

[7] Inoue, M., Taguchi, R. and Umezaki, T., 2018, July. Vision based bed detection for hospital patient monitoring system. In 2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC) (pp. 5006-5009). IEEE.

[8] Pecoraro, F., Luzi, D. and Clemente, F., 2021. The efficiency in the ordinary hospital bed management: A comparative analysis in four European countries before the COVID-19 outbreak. Plos one, 16(3), p.e0248867.

[9] Wilson, J. T. (1981). Implementation of computer simulation projects in health care. *Journal of the Operational Research Society*, *32*(9), 825-832.

[10] Mielczarek, Bożena, and Justyna Uziałko-Mydlikowska. "Application of computer simulation modeling in the health care sector: a survey." *Simulation* 88, no. 2 (2012): 197-216.

[11] Eldabi, Tillal, Ray J. Paul, and Simon JE Taylor. "Computer simulation in healthcare decision making." *Computers & industrial engineering* 37.1-2 (1999): 235-238.

[12] Sobolev, Boris, Victor Sanchez, and Lisa Kuramoto. *Health Care Evaluation Using Computer Simulation: Concepts, Methods, and Applications*. Springer Science & Business Media, 2012.