PREDICTION OF DENGUE RISK INDEX IN A REGION USING GPS BASED ON DENGUE FEVER RECORDED AND CLIMATIC FACTORS

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ABSTRACT:

Dengue is a widely spreading disease. The Government of Tamil Nadu has taken many steps towards the prevention and cure, yet technology can also provide a solution. Henceforth our application will let you know the status of dengue risk index at your current location. This will use GPS to automatically navigate to the location, the user is located. The aim of this application is specifically for the medical industry to improvise their methods of preventing this disease.

INTRODUCTION:

Dengue is an infectious disease caused by a virus. The virus is transmitted by a type of mosquito (Aedes aegypti) that bites during daylight hours. The dengue virus belongs to the Flaviviridae family of viruses that cause diseases in humans. Dengue is the most common infection caused by viruses transmitted by mosquitoes. Dengue is transmitted by the mosquitoes Aedes aegypti and Aedes albopictus, which are found throughout the world. Symptoms range from mild to severe. Severe symptoms include dengue shock syndrome (DSS) and dengue hemorrhagic fever (DHF). These usually require hospitalization. There are currently no vaccines. The best method of prevention is to avoid mosquito bites. Treatment is possible if diagnosis occurs before the patient develops DSS or DHF. The Centers for Disease Control and Prevention (CDC) estimate that 400 million people are infected each year. The spread of the dengue virus cannot happen directly from one person to another. It is not contagious and cannot spread through direct human contact. It needs an Aedes mosquito for the virus to be transferred. These days many people are suffering from dengue. This fever has infection that comes from several sources which causes all four related dengue viruses. This condition used to be called high temperature break bone, because sometimes leads to severe combined and muscle discomfort. Dengue fever is transmitted from Aedes Aegypti mosquito that also causes yellow fever. Worldwide, dengue disease becomes again especially in European countries. Studies have shown that several factors are responsible for the revival of dengue heat such as uncontrolled urbanization, improving travel around the world, inefficient socio-economic conditions, and finally, climate change. The only treatment is rest and intake of plenty of fluids. Fuzzy logic was suggested by Zadeh as a method for mimicking the ability of human reasoning using a small number of rules and still producing a smooth output via a process of interpolation. With fuzzy logic an element could partially belong to a set represented by the set membership. Example, a person of height 1.79 m would belong to both tall and not tall sets with a particular degree of membership. A fuzzy logic system is one that has at least one system component that uses fuzzy logic for its internal knowledge representation. Fuzzy system communicate information using fuzzy sets. Fuzzy logic is used...
purely for internal knowledge representation and externally it can be considered as any other system component. Hence fuzzy logic is being used in our system.

BACKGROUND:

The root cause of dengue fever is the Aedes mosquito. Human Beings who live by the mosquito breeding area are more vulnerable to the fever. The Aedes mosquito is found in residential areas. Aedes mosquitoes prefer to breed in the new housing and old residential places, the two main areas.

<table>
<thead>
<tr>
<th>S.No</th>
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<th>Year</th>
<th>Author</th>
<th>Remarks</th>
</tr>
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<td>1</td>
<td>k-step ahead prediction models for dengue occurrences</td>
<td>2017</td>
<td>LoshiniThiruchelvam</td>
<td>Uses weather variables of mean temperature humidity, cumulative rainfall, and dengue feedback data</td>
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<td>2</td>
<td>Estimation of reproduction number of dengue transmission in a partially</td>
<td>2016</td>
<td>Chunqingwu,Patricia J.Y.Wong</td>
<td>It is partially susceptible to the disease</td>
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<td>3</td>
<td>Predictive model of dengue focus applied to geographic information systems</td>
<td>2015</td>
<td>Maximiliano Baez GonzAlez,Guiliermo Gonzalez Rodas</td>
<td>Estimates from the rate of development,mortality,reproduction and spread of the AedesAegypti.</td>
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<td>4</td>
<td>Dengue notification system using fuzzy logic</td>
<td>2014</td>
<td>TajulRosli Bin Razak,Rosmawatia bd.wahab,muhammad adhermiramli</td>
<td>Fuzzy logic does not give accurate reasoning but acceptable reasoning</td>
</tr>
</tbody>
</table>

Table1: Literature survey

However, the large population in urban and rural areas are considered as the main contribution to the dengue vector. Major dengue vector is caused by Aedes mosquitoes especially in outdoor condition. The unmonitored cleanliness and sanitation at environment area may cause the Aedes mosquitoes to breed widely and infect human with dengue. Therefore, it is not easy to monitor the environment condition as it is under responsibility of the municipal, community and others. Most people (dengue patients) recover within a week or so. In some cases, symptoms worsen and can become life-threatening. Blood vessels often become damaged and leaky. And the number of clot-forming cells (platelets) in your bloodstream drops. The incidence of dengue has grown dramatically around the world in recent decades. The actual numbers of dengue cases are underreported and many cases are misclassified. One recent estimate indicates 390 million dengue infections per year. Climatic conditions play an important role in extrinsic incubation period. An average temperature of 17-18 degree Celsius results in longer incubation periods. Hence more the temperature, more will be the comfort for the mosquitoes to breed during rainfalls. A increase in temperature (generally beyond 17 degree Celsius and below 30 degree Celsius) will be more favorable for the mosquitoes to feed.

However in Chennai, an average temperature recorded in the last few months during rainfall was 28 degree Celsius. Hence dengue has increased it's host in the city comfortably. The population density also counts to the transmission of dengue. More the population, more to feed on for the mosquitoes. Hence Chennai has witnessed more dengue cases recently.

METHODS AND MATERIALS:
A. Location:

The number of dengue cases is on the rise in Tamil Nadu. About 30 fresh cases are recorded in Chennai every day, according to the state health department. State health secretary J. Radhakrishnan said that as many as 35 people have died due to dengue in the state. The city is 6m above sea level. With this condition, it has high potential of mosquito density. Geographically, the city has a higher potential being an endemic area for the mosquito. Therefore Chennai is more prone to Dengue.

B. Dataset:

The data has been collected from various hospitals across Chennai, Tamil Nadu. Dataset comprises of various attributes which includes data from the medical history of the dengue patients and their respective test reports. The attributes are certain numerical values which includes the patient’s temperature, age and other past chronological record values. The attributes taken for environmental factor are water conditions and climatic temperature.

C. Preprocessing:

Preprocessing generally consists of cleaning of data. When large amount of data is being gathered from various resources, there are high probability of data containing noise, missing values, incorrect values. Hence preprocessing is a must in such cases. The data we collected had noises such as a yes for fever attribute, which is not necessary here. So that had to be removed. Missing values was a common concern found in the data. There were repeated data, data with different formats which had to be transformed to a homogeneous format. Certain hospitals had Madras instead of Chennai which was changed to a single value Chennai.

D. Risk Index Architecture:

The architecture diagram contains two major parts hence they are explained below. Identification of predictor variables: The predictor variables are usually the measure taken from the data which is the frequency of dengue patient (calculated per area) of the whole population and the climatic conditions needed for dengue mosquito to breed and the water body conditions of that area.

Database: The data stored is collected from various hospitals from various regions. It also stores the various temperature recorded per area and the water conditions in that location. Historical data: Is used to process the current prediction. The historical data contains the number of patients until the time of retrieval of data. The two most commonly used variables are the location name along with it's count of dengue patient.

Data processing: The main processing of the application lies here. After the cleaning of data, it is interpreted and the data is moved to the application. This data is used to calculate the probability and fuzzy logic is being applied on value of the risk index calculated which is the ratio of how many people are affected from dengue on a scale of hundred.

The risk index is divided to three factors having a weightage of 30+30+40. The first 30 is for the atmospheric condition for the mosquito to breed. The second 30 is for breeding season and climatic conditions. The 40 is for the infected population out of total population.
Three predictor variables are used. \(x_0\) is the climate condition, \(x_1\) is the population density and the atmospheric condition and \(x_2\) is the dengue patients history. The climate condition is rated and converted to a scale of 30. Every climate possible in the city is given values with rainfall being valued the highest.

![Figure 1: Value determination of \(x_0\)](image)

The population and atmospheric condition is rated and converted to a scale of 30. More the population, more will be its value.

\[
x_1 = \frac{PA \times SA}{LA} \times 30 \quad \text{--- (1)}
\]

PA = area covered by population
SA = area covered by stagnant water
LA = area of the location

The main weightage in the calculation of risk index is the dengue patients history. This is calculated as,

\[
x_2 = \left( \frac{DP}{TP} \right) \times 40 \quad \text{--- (2)}
\]

Where DP is the number of dengue patients in that area and TP be the population of that area.

Risk Index (RI) = \(\sum x_i\) \quad \text{--- (3)}

Where \(i\) takes the values 0,1,2

Rule Extraction: The knowledge extracted from the methodology used for calculating the probability measures is being applied on the current data that will be updated. Building a classifier: The classification of data is location wise and the calculated measure is grouped along with it. Current data: This will need a vast network to be working on the updating of data on a regular basis periodically. This current data will be fetched every now and then whenever the application needs it.
Prediction model: The current data is being given as input to the prediction model so that the data will be up-to-date and the risk index will be more accurate. The fuzzy logic is used, based on which the risk index will be predicted. Basically three ranges are used which is Yes, No and Maybe. If the risk index is very low, eventually the probability of getting affected by dengue also becomes low and when the risk index is moderate, one may or may not get affected and finally when the risk index is high, the user is highly prone to the disease.

Region wise prediction: The data will however differ from one location to another. Hilly region will have less or no mosquitoes hence the probability of getting dengue will be very low or negligible comparing to a residential area in a metropolitan city. Hence this kind of data should be known to the user.

E. Methodology:

The prediction of dengue risk index must be accurate to an extent such that it differs from nearby places since the values could be similar. The predicted value will let us know on how the futuristic values might occur according to the current scalar value given. Hence the risk index will be a value to know the vulnerability of the area the user is located on how periled it is to the dengue fever.

Software: The software application used here is PyCharm. To locate the user current location. GPS package is imported. To calculate the probability and possible outcome, fuzzy logic is applied on the risk index found. Our application lets you know how vulnerable one can be to dengue in that location. Other existing solution for dengue prediction will state how a particular patient is about to get affected by dengue. The existing solution also requires more data about the patient including their medical history whereas our solution will need only the data about those patients of dengue, based on which the probability of getting dengue in that area is calculated.

Type-2 fuzzy set is being used here. Let us consider fuzzy set containing y0, y1, y2 and y3 and factor1 be the risk index. Let the value of y0 be 0-30 %, y1 be 30-50 %, y2 be 50-80% and y3 be 80-100%.

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Risk condition</th>
<th>No</th>
<th>Maybe</th>
<th>Yes</th>
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</table>

Figure 2: Architectural diagram for predicting the Risk Index
If factor1 < y0

If y0 < factor1 < y1

\[
\begin{align*}
(y1 - \text{factor1}) / (y1 - y0) & \quad \text{(factor1 - y0) / (y1 - y0)}
\end{align*}
\]

If y1 < factor1 < y2

If y2 < factor1 < y3

\[
\begin{align*}
(y3 - \text{factor1}) / (y3 - y2) & \quad \text{(factor1 - y2) / (y3 - y2)}
\end{align*}
\]

If factor1 > y3

Table 2: Risk Index conditions

F. Experimental Data Setup:

Sample of collected data is as shown in the figure. The different cities in India have a history of various numbers of dengue patients.

<table>
<thead>
<tr>
<th>Test Data</th>
<th>City</th>
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<th>Temp Main Blood Pressure</th>
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</table>

Figure 3: Sample Data for predicting the risk index

Many dengue cases were recorded and mostly all were in a place where the rainfall has occurred and open stagnant water was found which is most favorable condition for the mosquito to breed. The above is a sample data of patients being admitted for dengue. Chennai also has become a victim for dengue and recorded more cases this year than previously ever recorded. This is due to the recent floods and rainfall season occurring consequently which has made up the best place for Aedes aegypti. The population of people in the city is also very high, which is again making the mosquitoes breed comfortably in the city. Below are the few places stated by Deccan Chronical along with their status of Mosquitoes Breeding Atmosphere (MBA). The north Chennai is a region where even the water is not purified properly and hence the maximum number of cases of dengue was found here and it also rapidly increased everyday.

Figure 4: Actual MBA status of various locations in Chennai
G. Analyzing Performance:

Test data contains dengue patient from different places and their temperature along with their blood pressure level. The existing methodology use fuzzy logic to predict dengue in a particular patient. Our system will use certain historical data to predict the risk of a person in getting affected by dengue. Using our data a graph is plotted below, that states the city wise risk index of that location.

![Scatter Plot for different city wise risk index.]

Similarly, Chennai has three major sections, namely the north, south and middle Chennai. The north Chennai has more stagnant water and hence has recorded the highest number of dengue cases in the city. The number of patients were increasing everyday and also the areas in that part of the city is not clean enough which turned out to be more favorable for Aedes aegypti. Similarly south part of the city also faced lots of people being affected by dengue. The given below map was taken from the city's Government website. The different shaded region specify the various risk of getting affected by dengue.
The marked places are more dengue prone and their risk index is high. The probability of getting dengue also depends on the population of dengue patients alone out of total patient population.

CONCLUSION:

The reports generated can be of great use to the medical industry for seeking a relatively accurate measure on how vulnerable the people and their residential area is towards dengue. The predicting formula uses the ratio of patients who are affected by dengue to the total population. More the ratio, more is the dengue risk and hence the risk index. Age wise and gender wise prediction is also possible with the obtained datasets.

The limitation of our application is that it should be continuously updated on a regular time period bases. This can also be further enhanced for other diseases like Cancer, AIDS.
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