Prediction of Dengue using Machine Learning Techniques – A comprehensive Study

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Abstract : Dengue is a mosquito-borne viral disease that has predominately increased around the world in recent years. Early prediction of dengue is crucial based on the availability of clinical data . Dengue can not be controlled because of the unavailability of universal vaccination, but can be predicted early to prevent fatality . The transmission of this disease is influenced not only by the climatic factors like rainfall, temperature, wind speed and humidity, but also by non-climatic factors like socio-environmental factors such as the population density, land use activity, vector control and transportation This comprehensive study shows that this approach is classified under three categories clinical, climatic and demographic . The study focuses on the Dengue modeling using Machine Learning Techniques such as RF, SVM , DT, ANN,NN, GA and J48. It was found that Random Forest (RF) yielded better results under all the three categories of data.

Keywords : Dengue, support vector machine (SVM), Decision Tree (DT), Artificial Neural Network (ANN), Neural Network (NN),Genetic Algorithm(GA)

I. INTRODUCTION

The dengue vector-borne diseases is highest in tropical and subtropical areas. It accounts for more than 17% of all infectious diseases globally, resulting in a death toll of more than 700,000 annually. The term "vector" is analogous with mosquito-borne illness, as vectors are the living organisms that can transmit infectious diseases caused by bacteria, viruses, and parasites across humans or from animals to humans. Among the deadly diseases such as yellow fever, Zika fever, Chikungunya, and dengue fever are transmitted mainly by the mosquito's genus, Aedes Aegypti. The female Aedes Aegypti mosquito feeds on humans and it is responsible for spreading the highly infectious dengue disease. The only way of combating mosquito-borne disease is the complete eradication of mosquitoes, which may sound feasible and easy theoretically. In its early stages, dengue is a 'flu-like' syndrome because it is often misdiagnosed .

Among many diseases, Chikungunya, malaria, enteric fever, and meningococcemia conditions that exhibit similar symptoms to dengue clinically preserve another challenge in dealing with this disease. The time period between the exposure and the onset of symptoms ranges from 2 to 14 days, but most often, it is 4–7 days. Hence, travelers returning from epidemic zones are likely to have dengue if fever or any other symptoms start within 3–14 days after reaching their homeland. Studies shows that the whole infection cycle's survivability increases as the temperature increases and concluded that they can hardly withstand cold temperatures, showing from periodic incidences where the dengue epidemic always peaks during the rainy season.

II. LITERATURE REVIEW

In this review research paper, explored different prediction techniques and classified them under three categories a. clinical .b. climatic c.. demographic. Out of the forty research papers which it shows the timeline, methodologies or tool, datasets, conclusion, location and research gap or future scope of that research work has been identified.

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S.No . Paper Name and Year of Publication	Author Name	Methodology	Inference Made/Research Gap
1. A Three-Component Biomarker Panel for Prediction of Dengue Hemorrhagic Fever(2012)	Allan R. Brasier, Hyunsu Ju, Josefina Garcia, Heidi M. Spratt, Sundar S. Victor, Brett M. Forshey, Eric S. Halsey, Guillermo Comach, Gloria Sierra, Patrick J. Blair, Claudio Rocha, Amy C. Morrison, Thomas W. Scott, Isabel Bazan, Tadeusz J. Kochel	Random Forest	logistic regression is a classification approach that provides probabilistic information for the development of DHF, a feature selection that will aid in future validation studies.
2.A Comparison among Support Vector Machine and other Machine Learning Classification Algorithms(2015)	Motaz M. H. Khorshid , Tarek H. M. Abou-El-Enien , Ghada M. A. Soliman	Support Vector Machine,	The research can be extended with hybridization between GA and SVM to improve the classification accuracy and convergence speed.
3.Morbidity Rate Prediction of Dengue Hemorrhagic Fever (DHF) Using the Support Vector Machine and the Aedes aegypti Infection Rate in Similar Climates and Geographical Areas(2015)	Kraisak Kesorn, Phatsavee Ongruk , Jakkrawarn Chompoosri, Atchara Phumee , Usavadee Thavara , Apiwat Tawatsin , Padet Siriyasatien	Support Vector Machine	SVM-R-based model has high generalization performance and obtained the highest prediction performance compared to classical models as measured by the accuracy, sensitivity, specificity, and mean absolute error (MAE).
4.Machine Learning Models for Early Dengue Severity Prediction(2016)	William Caicedo-Torres, Angel Paternina ´ and Hernando Pinz´	Support Vector Machine with Gaussian Kernel	Research gap was found that Recursive Feature Elimination feature selection procedure was performed to improve predictive accuracy.10-Fold Stratified Cross Validation to show good prediction .
5.A Literature Review of Methods for Dengue Outbreak Prediction(2016)	Duc Nghia Pham , Syahrul Nellis , Arun Anand Sadanand , Juraina binti Abd. Jamil , Jing Jing Khoo , Tarique Aziz , l Dickson Lukose , Sazaly bin Abu Bakar and Abdul Sattar	Local Indicators of Spatial Autocorrelation, Autoregressive Integrated Moving Average , Artificial Neural Network , Alternating Decision Tree Method, Support Vector Machine, Adaptive Neuro-Fuzzy Inference System .	The combination between spatial, statistical and mathematical analysis together with machine learning system can become a holistic solution to hybrid application
6.Feature Selection Algorithms for Malaysian Dengue Outbreak Detection Model(2017)	Husam, I.S., Abuhamad, Azuraliza Abu Bakar, Suhaila Zainudin, Mazrura Sahani & Zainudin Mohd Ali	Particle swarm optimization , genetic algorithm and rank search . Based on the selected features, three predictive modeling techniques J48, Decision Table Naive Bayes and Naive Bayes were applied for dengue outbreak detection.	PSO has reached the best accuracy revealing new set of features to represent dengue data.
7.Machine learning for dengue outbreak prediction: An outlook(2017)	Naiyar Iqbal, Mohammad Islam	Decision Tree ,Neural Network,,Evoilutionary Based Classifiers,Ensemable	A novel ensemble model designed Would aid the prediction of Dengue outbreak
8.Early Detection of Dengue Using Machine Learning Algorithms(2018)	N.Rajathi, S.Kanagaraj, R.Brahmanambika and K.Manjubarkavi,	Naive Bayes, J48, Random forest, Reduces Error Pruning tree, Sequential minimal optimization, Locally Weighted Learning, AdaboostM1, and ZeroR.	Random forest algorithm gave better classification accuracy.
9.Classification of Dengue using Machine Learning Techniques(2018)	T.Sajana , M.Navya, YVSSV .Gayathri , N.Reshma	Simple Classification and Regression Tree, Multi-layer perception, C4.5 algorithms	CART showed the best results in all performance metrics like Accuracy, Precision, Recall and Fmeasure metrics which is the best classifier
10 .Kernel PCA and SVM-RFE based feature selection for classification of dengue microarray dataset(2019)	lke Annisa Octaria, Titin Siswantining, Alhadi Bustamam, et al.	Kernel Principal Component Analysis Support Vector Machine – Recursive Feature Elimination and Support Vector Machine	Kernel PCA requires a short computational time than SVM-RFE in feature selection .
11. Finding the Best Feature Selection Method for Dengue Diagnosis	R Lathesparan, RMKT Rathnayaka and WU Wickramaarachchi	Artificial Neural Networks with Principal Component Analysis,	ANN with PCA resulted in the higher accuracy of 72.47% and

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Predictions(2019)		Artificial Neural Networks with Wrapper feature selection K-Nearest Neighbor	ANN with Wrapper feature selection (KNN) showed the lowest accuracy of 54.47%. initial 22-dimensional system was reduced to an 8-dimensional system with a cumulative variance of 59%.
12 .Predictive Models for the Medical Diagnosis of Dengue: A Case Study in Paraguay(2019)	Jorge D. Mello-Roma´n , Julio C. Mello-Roma´n, Santiago Go´mez-Guerrero, and Miguel Garc´ ıa-Torres	Artificial Neural Network - multilayer perceptron, Polynomial support vector machine.	The research can be extended with more exhaustive investigations with controlled data capturing systems.
13.Evaluating The Performance of Machine Learning using Feature Selection Methods on Dengue Dataset(2019)	Subhram Dasgupta, Naman Sharma, Sweta Sinha, Raghavendra S	Random Forest Classifier, Decision Tree Classifier, Linear Support Vector Machine	Among the techniques RFC, DTC, LSVM, RFC produced higher accuracy results.
14.Evaluation and comparison of eight machine learning models in land use/land cover mapping using Landsat 8 OLI: a case study of the northern region of Iran(2019)	Ali Jamali	Random Forest, Decision Tree,DTNB,J48, Multilayer Perceptron, Neural Network, Simple Regression	key factor are various climate change impacts including increasing temperature of the earth due to pollutant emissions like carbon dioxide and also their influence on the land cover are also one key factors ,NN Produced higher accuracy
15.A Competent Approach to Predict Dengue Diseases using a Hybrid Approach in Machine Learning algorithm(2019)	R. Vijay Sai, S Madhiarasi, S Keerthana, S Preethi	Sequential Minimal Optimization	The prognostic accuracy determined by SMO formula suggested that parameters used in area unit reliable indicators to predict the presence of break bone fever diseases.
16.Dengue fever prediction using classification techniques(2019)	R. Sanjudevi, D. Savitha	Decision Tree , Support Vector Machine	it has concluded that SVM is the top performance classifier technique by the way that, it has achieved that an accuracy of 99% takes fewer time to run and it has smallest error rate.
17. Prediction for Dengue Fever in Indonesia Using Neural Network and Regression Method(2019)	T H F Harumy , H Y Chan, and G C Sodhy.	K-Nearest Neighbor, Support Vector Machine ,Linear Regression	Thet step is to determine seven variables consisting of temperature (x1), humidity (x2), rainfall index (x3), wind (x4), Air Pressure (x5), Sunlight (x6), Population density (x7) are to be used in predicting dengue cases and determining the factors that most influence in the spread of dengue using regression.
18.A Multi-Stage Machine Learning Approach to Predict Dengue Incidence: A Case Study in Mexico(2020)	Annalisa Appice , Yulia R. Gel , Iliyan Iliev , Vyacheslav Lyubchich , And Donato Malerba	AutoTiC-NN cluster model	same research direction, can be achieved promising results in spatio-temporal feature extraction by combining convolution neural networks and long short-term memory, and improving the accuracy of both classification and regression tasks.
19.Predicting Dengue Outbreaks with Explainable Machine Learning(2020)	Robson Aleixo, Fabio Kon, Rudi Rocha, Marcela Santos Camargo, Raphael Y. de Camargo	CatBoost	A significant improvement over the use of black-box results from models such as Support Vector Machines and Neural Networks .
20. Dengue Fever Classification Tool Using Machine Learning(2020)	Khaing Thanda Swe, Phyo Thu Zar Tun	Support Vector Machine	Support Vector Machine, outputs whether the patient suffers from severe fever or dengue fever. If the patient suffers the dengue fever, the system assigns the level of the dengue: (i) Febrile (ii) Critical (iii) Recovery.
21.Optimal Feature Selection with Neural Network-Based Classification Model for	Lokesh Nelligere , Sameswari Vadivel, Sudha Kothandapani, Jenifer	Genetic Algorithm	Uncertain Neural Network model is used to create a classification

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Dengue Fever Prediction(2020)	Mahilraj, P Sivaram and Vidhyavathi Ramasamy		model. Accuracy (A), Specificity (Sp) and Sensitivity
22.Dengue Prediction Using MLp (Multilayer Perceptron) – A Machine Learning Approach(2020)	Dr. V. Janani M.E., Ph.D. N. Maadhuryaa D. Pavithra S. Ramya Sree	Multilayer Perceptron - Sequential minimal optimization	SMO Produced higher accuracy. Backward logistic regression, MLP is used in the feature reduction
23.Neural Network Enhancement Forecast of Dengue Fever Outbreaks in Coastal Region(2020)	THF Harumy Dewi Sartika Br. Gintin	Neural Network Back propagation Algorithm	Multiple Linear Regression can be used in the prediction of dengue.
24.Predicting dengue importation into Europe, using machine learning and model-agnostic methods(2020)	Donald Salami , CarlaAlexandra Sousa, Maria do Rosário Oliveira Martins & César Capinha	Random Forest	A numeric outcome prediction can be achieved by modifying our model training approach from a classification model to a regression model.
25.Prediction of Dengue Fever Using Intelligent Classifier(2020)	M. Ganthimathi , Dr. M. Thangamani , C. Mallika , V. Prasanna Balaji	Support Vector Machine and K-Nearest Neighbor	By applying SVM it is produced 100% accuracy
26.Assessing the risk of dengue severity using demographic information and laboratory test results with machine learning(2020)	Sheng-Wen HuangID1 , Huey-Pin Tsai, Su-Jhen Hung , Wen-Chien KoID , JenRen Wa	Artificial Neural Network	Further validation using external cohorts in future research can be enhanced
27.Early Detection of Dengue Hemorrhagic Fever (DHF) using Feed Forward Neural Network with Gravitational Search Algorithm Optimization(2020)	Nur Azmi Prasetyo, Hasbi Yasin, Budi Warsito	Feed forward neural network, Gravitational Search Algorithm	Advanced research using GSA and to combine it with unbalanced data handling, or to combine it with hybrid method to obtain better result.
28.Dengue Prediction using Machine Learning Algorithm(2021)	Dhiman Sarma, Sohrab Hossain, Md. Abdul Motaleb Bhuiy, Ishita Saha, Ravina Chakma	Decision Tree , Random Forest	Study seek additional attributes and risk factors for dengue fever which are to be included in the dataset. Besides, climate and location-based data for effective rule generation and classification.
29.Forecasting Dengue Fever Using Machine Learning Regression Techniques(2021)	Qanita Bani Baker, Dalya Faraj, Alanoud Alguzo	Multilayer Perceptron, Neural Network, RT, Naïve Bayes , Decision Tree , Precision-Recall, Support Vector Machine , K-Nearest Neighbor, Bagging with Decision Tree .	The Poisson Regress ion model obtained the lowest error ratio by 25.6. , the target can be increased in collaboration with ML techniques could be applied to gain a more accurate prediction.
30.Early Diagnosis for Dengue Disease Prediction Using Efficient Machine Learning Techniques Based on Clinical Data(2022)	Bilal Abdualgalil , Sajimon Abraham , Waleed M. Ismael	K-Nearest Neighbor , Gradient Boosting Classifier,, Extra Tree Classifier , eXtreme Gradient Boosting, and Light Gradient Boosting Machine .	SMOTE+ENN hybrid method of finding out the important feature selection methods which can be improved further with framework's accuracy in making clinical decisions with large data sets
31.Recurrent Neural Networks for Feature Extraction from Dengue Fever(2022)	Jackson Daniel, S. Irin Sherly, Veeralakshmi Ponnuramu, Devesh Pratap Singh, S.N. Netra, Wadi B. Alonazi, Khalid M.A. Almutairi, K.S.A. Priyan, and Yared Abera9	Random Forest , Support Vector Machine, Neural Network.	Further, the methods can be improved on neural network can be studied to avoid the problem of over fitting due to the inputs from the previous layers
32.Dengue Prediction Using Machine Learning(2022)	Dr. Latha Jothi V, Rajasri S, Ramya Vipashinhi MSR	Decision Tree , Random Forest, Support Vector Machine, K-Nearest Neighbor	additional attributes and risk factors for dengue fever may be included, Climatic changes can also be taken for the consideration in future enhancements
33.Predicting Infection Positivity, Risk Estimation, and Disease Prognosis in Dengue Infected Patients by ML Expert System(2022)	Supreet Kaur , Sandeep Sharma , Ateeq Ur Rehman , Elsayed Tag Eldin , Nivin A. Ghamry , Muhammad Shafiq , and Salil Bharany	Random Forest	This paper has predicted the effect of dengue infection on vital organs such as the liver, kidney, and general hematology of the patient.
34.Machine learning algorithms for dengue risk assessment: a case study for São Luís do Maranhão(2022)	Fernanda Paula Rocha1 · Mateus Giesbrecht	logistic regressions, linear discriminant analyses, Naive Bayes, decision tree, and random forest classifier	The technique allows the usage of policies to define the possible spatial distribution of vectors, geographically recognize areas of interest, and concentrate the building infestation index to

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			these locations.
35.Diagnosis classification of dengue fever based on Neural Networks and Genetic algorithms(2022)	Martselani Adias Sabara , Oman Somantri, Heru Nurcahyo , Nanang Kurnia Achmadi , Ulfatul Latifah and Harsono	Genetic Algorithm on the Neural Network	By using the Genetic algorithm, optimization of the best neural network parameter values is the level of learning and momentum can be obtained from the results.
36.Dengue Fever Prediction using Machine Learning Analytics(2022)	Sandeep Kumar Rana, Arpita Nath Boruah, Saroj Kr. Biswas, Manomita Chakraborty, Biswajit Purkayastha	Synthetic Minority Oversampling Technique, Decision Tree and Random Forest	A combination of clinical as well as symptomatic data could also help in creating a robust model and also other latest class imbalance techniques can also be used
37.Performance evaluation of artificial neural networks for feature extraction from dengue fever(2022)	Yared Abera Ergu	Random Forest -based feature extraction,, Support Vector Machine , Artificial Neural Network, Neural Network	When using the RF approach, the ANN achieved 88% accuracy and 89.9% recall, but the NN achieved 72% accuracy, 77% recall, and a 0.27 error rate.
38.A Hybrid Model using Genetic Algorithm and Neural Network for Predicting Dengue Outbreak(2022)	Nor Azura Husin, Norwati Mustapha, Md. Nasir Sulaiman, Razali Yaakob	Genetic Algorithm of hybrid model on the Neural Network,	The model can be enhanced by incorporating time series, location and rainfall data to define the best architecture for early prediction .
39.Data-driven methods for dengue prediction and surveillance using real-world and Big Data: A systematic review(2022)	Emmanuelle Sylvestre, Clarisse Joachim, Elsa Cecilia-Joseph, Guillaume Bouzille, Boris Campillo-Gimenez, Marc Cuggia, André Cabié	NLP, Support Vector Machine, Decision Tree	two observations suggested that unsupervised learning and NLP might become more prominent in dengue research. It is important to note that despite the use of real-world data, these statistical methods were employed to analyze only retrospective data
40.Machine Learning-Based Detection of Dengue from Blood Smear Images Utilizing Platelet and Lymphocyte Characteristics(2023)	Hilda Mayrose , G. Muralidhar Bairy , Niranjana Sampathila , Sushma Belurkar and Kavitha Saravu	Support Vector Machine , Decision Tree	The future scope involves the derivation of features from the lymphocyte cytoplasm in addition to nucleus features, which intends to involve pre-trained CNNs for classification purposes.

III. OBJECTIVE OF THIS RESERCH

Different machine learning techniques were used , we see that the predominant technique were the diagnostic models, are categorized as clinical such technique was frequently used were based on the clinical data and laboratory results. Dengue Fever is considered one of the diseases that spread mostly in tropical and semi-tropical regions and affects many countries. In the last 50 years, the incidence of dengue disease has increased dramatically. Dengue Fever is a critical disease that affects human life and countries' economies.

The spread of this disease is higher in frequency in several places that are related to climatic conditions such as rainfall ,humidity , temperature and other environmental. Studying the climatic conditions using environmental data is essential and such prediction are categorized as climatic.

Using Dengue historical data, facilitates at capturing the relations and patterns within the data and enhancing the predictive accuracy of dengue outbreaks. Based time series data, age group of the population over a particular region were to be Categorized as demographic.

IV. RESULTS AND DISCUSSION

Based on the review of forty paper it was inferred that the machine learning techniques such as Random Forest (RF) showed higher Accuracy in all the three category of data such as clinical, climatic and demographic , followed by support vector machine (SVM), Decision Tree (DT), Artificial Neural Network (ANN), Neural Network (NN), Genetic Algorithm(GA), J48.

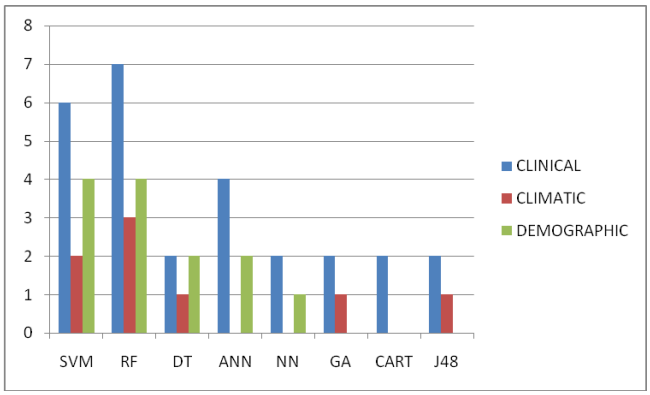

Fig .1 Comparison of Machine Learning Techniques under categories clinical, climatic and demographic.

Dengue is the fever which is difficult to be identified without the indications for its symptoms. Dengue can

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begin from the fever which would further mellow up to deadly state which would prompt to the casualty under severe condition. Using the early diagnostic system would enable faster and better prediction system. It was found that Radom Forest was most suitable for prediction which yielded higher accuracy when compared all the other techniques.

V. CONCLUSION

A comprehensive evaluation of various machine learning classifiers has helped us to choose the best performing classifier for Dengue outbreak prediction. Keeping insight of the evaluation made that the Radom Forest Technique which yielded highest result can be enhanced to a novel Ensemble Hybrid classifier to make better prediction system at the early stage and hence prevent the severity in the dengue patients.

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