SIMATS ENGINEERING

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Efficient Prediction of Water Inundation Frequency using Long Short-Term Memory Algorithm in comparison with Radial Basis Function Neural Network Algorithm for Enhanced accuracy

INTRODUCTION

- Water inundation frequency refers to the recurrence interval at which an area experiences flooding or inundation by water.
- The project aims to enhance flood prediction accuracy by improving forecasts of water inundation frequency through the utilization of deep learning techniques such as Long Short-Term Memory (LSTM) and Radial Basis Function Neural Network (RBFNN).
- This project's significance lies in its use of deep learning techniques to enhance flood forecasting, it aims to mitigate risks, save lives, and reduce the socio-economic impact of flooding, fostering resilient communities.
- The applications include resilience of infrastructure, urban planning, and catastrophe management.
- LSTM networks excel in capturing temporal dynamics and long-term dependencies crucial for flood prediction, while RBFNN utilizes radial basis functions to uncover hidden patterns.
- The dataset used in this project is associated with the 2018 Kerala floods, covering information on casualties, warnings, district-wise warnings, and rainfall, with self-explanatory column names.

Inundation Insight (Floods Occurred in Kochi)

MATERIALS AND METHODS

Data Collection
Gather historical data on water inundation events

Data Preprocessing
Clean the collected dataset to ensure data integrity

Model Training
Train both the LSTM and RBFNN models to learn patterns and relationships between input features and the target variable

Model Evaluation
Assess the performance of the trained LSTM and RBFNN models by evaluating metrics.

Hyperparameter Tuning
Fine-tune hyperparameters such as learning rate, batch size, and network architecture

Model Optimization
Improve Model Efficiency by Quantization and Pruning

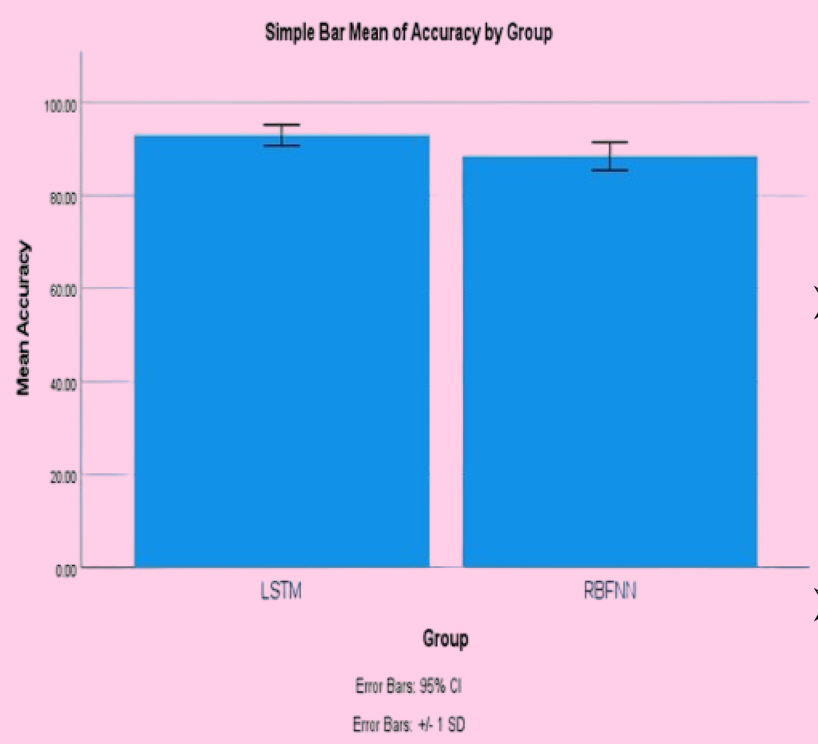
Deployment and Monitoring
Implementation of model for predicting water inundation frequency

To address the research gap in predicting water inundation frequency, the project will determine the most efficient approach by comparing the predictive performance of LSTM and RBFNN architectures. This comparison will consider factors such as accuracy, computational efficiency, and robustness in forecasting water inundation frequency.

RESULTS

		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	Upper
Accuracy	Equal variance assumed	0.998	0.32	5.41	38	0.00	4.5285	0.836	2.835	6.22125
	Equal variances not assumed			5.41	35.13	0.00	4.5285	0.836	2.831	6.22580

The independent sample t-test for Equality of Means is provided under two assumptions: Equal variances are assumed and Equal variances are not assumed.



Mean accuracy comparison between LSTM algorithm and RBFNN algorithm.

- To conduct SPSS analysis, gather a sample size of 20 accuracies for each algorithm. Compare them using a paired sample t-test in SPSS. Calculate mean accuracy, standard deviation, and plot them using a graph.
- The obtained significance value, 0.324, indicates a statistically significant difference between the mean accuracies of the two algorithms in predicting water inundation frequency.
- This suggests that one algorithm significantly outperforms the other, emphasizing the preference for choosing the algorithm with higher accuracy for practical implementation or further development.

DISCUSSION AND CONCLUSION

- The mean accuracy obtained for the LSTM model is 93.0095 with a standard deviation of 2.23460, whereas for the RBFNN model, it is 88.4810 with a standard deviation of 2.99839.
- The future implications of this project's findings could significantly impact flood prediction methodologies, leading to broader applications in climate modeling, disaster preparedness, and infrastructure risk assessment.
- Despite its potential, the accuracy of predictive models may be constrained by the availability and quality of historical flood data, while training deep learning models like LSTM and RBFNN may require substantial computational resources.
- In conclusion, LSTM's ability to capture long-term dependencies in time series data conferred an advantage in forecasting water inundation frequency, especially concerning historical hydrological patterns and natural catastrophes.

BIBLIOGRAPHY

- Kumar, Vijendra, Hazi Azamathulla, Kul Vaibhav Sharma, Darshan J. Mehta, and Kiran Tota Maharaj. 2023. “The State of the Art in Deep Learning Applications, Challenges, and Future Prospects: A Comprehensive Review of Flood Forecasting and Management.” Sustainability: Science Practice and Policy 15 (13): 10543. DOI:10.3390/su151310543
- Hayder, Israa M., Taief Alaa Al-Amiedy, Wad Ghaban, Faisal Saeed, Maged Nasser, Ghazwan Abdulnabi Al-Ali, and Hussain A. Younis. 2023. “An Intelligent Early Flood Forecasting and Prediction Leveraging Machine and Deep Learning Algorithms with Advanced Alert System.” Processes 11 (2): 481. DOI:10.3390/pr11020481
- Bentivoglio, Roberto, Elvin Isufi, Sebastian Nicolaas Jonkman, and Riccardo Taormina. 2022. “Deep Learning Methods for Flood Mapping: A Review of Existing Applications and Future Research Directions.” Hydrology and Earth System Sciences 26 (16): 4345–78.DOI:10.5194/hess-26-4345-2022
- Cho, Minwoo, Changsu Kim, Kwanyoung Jung, and Hoekyung Jung. 2022. “Water Level Prediction Model Applying a Long Short-Term Memory (LSTM)–Gated Recurrent Unit (GRU) Method for Flood Prediction.” WATER 14 (14): 2221. DOI:10.3390/w14142221