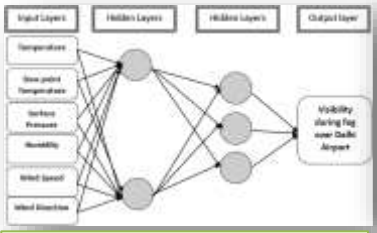
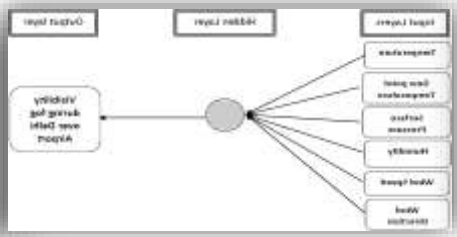
Adaptive neuro-fuzzy inference system to estimate the predictability of visibility during fog over Delhi, India

Dr. Sayantika Mukherjee
Amity University Kolkata
sgmukherjee@kolamity.edu

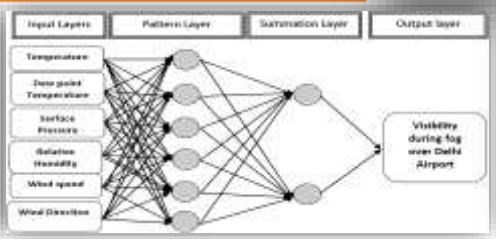
In the present research it was attempted to estimate the predictability of visibility during fog over the airport of the most polluted city Delhi (28 ° 38 ′ N, 77 ° 12 ′ E), India, with an adaptive neuro-fuzzy inference system (ANFIS). The investigation started with the evaluation of fuzzy membership to categorize the data into different ranges. The output variables of fuzzy membership are used as the input in the multilayer perceptron model of artificial neural networks. In this hybrid computing system, the ANFIS was trained with the data from 2000 to 2010 for estimating the predictability of visibility during fog over Delhi airport. The results show that the ANFIS provides minimum forecast errors (9.09%) with 12 hr lead time in comparison to other neural network models and the existing forecast models. The results were validated with observations from 2011 to 2015. The coupled model ANFIS shows minimum error in visibility forecasting during fog over Delhi airport with validation from observations as well. The study therefore suggests that the ANFIS may be adopted as an alternative operational model for forecasting visibility during fog with 90.91% accuracy for a 12 hr lead time.



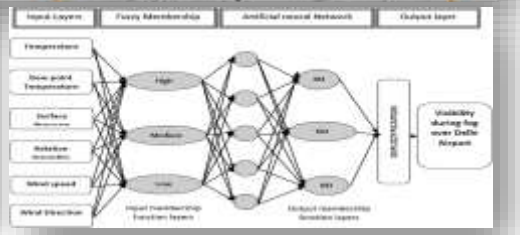
Architecture of the multilayer perceptron model for forecasting visibility during fog over Delhi airport with 12 hr lead time



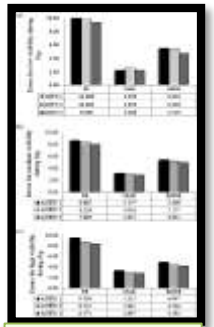
Architecture of the radial basis function neural network model for forecasting visibility during fog over Delhi airport with 12 hr lead time



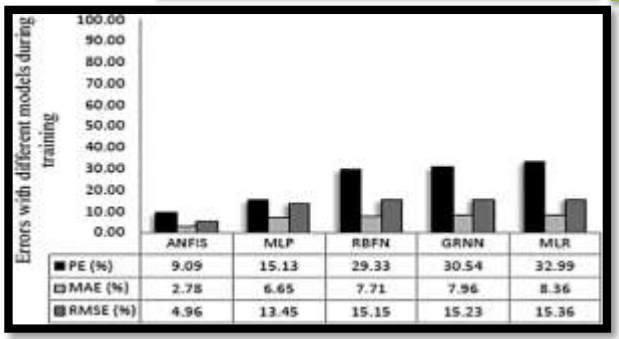
Architecture of the generalized regression neural network model for forecasting visibility during fog over Delhi airport with 12 hr lead time



The architecture of the adaptive neuro-fuzzy inference system model with three input membership functions, hidden layers with hidden logical nodes and the output membership function and output layer

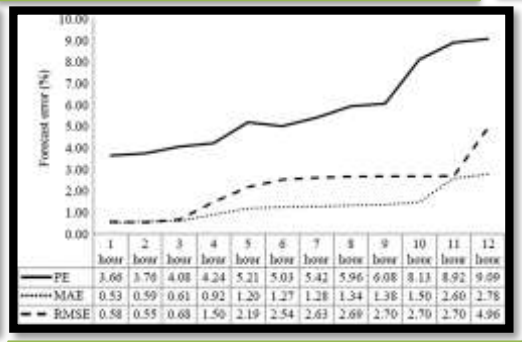


The estimated forecast error in predicting the visibility during fog over Delhi airport using the ANFIS 1, ANFIS 2 and ANFIS 3 models for low, medium and high ranges



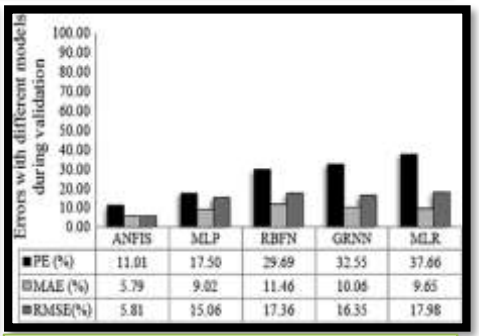
	ANFIS	MLP	RBFN	GRNN	MLR
PE (%)	9.09	15.13	29.33	30.54	32.99
MAE (%)	2.78	6.65	7.71	7.96	8.36
RMSE (%)	4.96	13.45	15.15	15.23	15.36

The forecast errors generated by different models in forecasting the visibility during fog over Delhi airport using surface parameters with 12 hr lead time during the training period



	1 hour	2 hour	3 hour	4 hour	5 hour	6 hour	7 hour	8 hour	9 hour	10 hour	11 hour	12 hour
PE	3.66	3.76	4.08	4.24	5.21	5.03	5.42	5.96	6.08	8.13	8.92	9.09
MAE	0.53	0.59	0.61	0.92	1.20	1.27	1.28	1.34	1.38	1.50	2.60	2.78
RMSE	0.58	0.55	0.68	1.50	2.19	2.54	2.63	2.69	2.70	2.70	2.70	4.96

Forecast errors including percentage of prediction error (PE), mean absolute error (MAE) and root mean square error (RMSE) in forecasting visibility during fog over Delhi airport using the adaptive neuro-fuzzy inference system model with 1 to 12 hr lead time



	ANFIS	MLP	RBFN	GRNN	MLR
PE (%)	11.01	17.50	29.69	32.55	37.66
MAE (%)	5.79	9.02	11.46	10.06	9.65
RMSE(%)	5.81	15.06	17.36	16.35	17.98

The forecast errors generated by different models in forecasting the visibility during fog over Delhi airport using surface parameters with 12 hr lead time during the testing (validation) period

Conclusion :From the perspective of aviation safety the forecasting of visibility during fog is an absolute necessity. An adaptive neuro-fuzzy inference system (ANFIS) has been developed to forecast the near surface visibility during fog over the airport of Delhi. The coupled model ANFIS shows minimum forecast error (9.09%) with 12 hr lead time in comparison with other neural network models. The skill of the coupled model was checked by comparing with other existing models (Table 1).The result of the study further shows that the forecast error is 3.07% with 1 hr lead time and the error increases with increasing lead time. Fog is a micro-scale phenomenon and thus the forecast of visibility during fog with the ANFIS over Delhi airport with 12 hr lead time is pragmatic for aviation safety. The model may thus be suggested as an alternative option for operational forecasting of near surface visibility during fog over Delhi airport.

Goswami, S., Chaudhuri, S., Das, D., Sarkar, I., & Basu, D. (2020). Adaptive neuro-fuzzy inference system to estimate the predictability of visibility during fog over Delhi, India. *Meteorological Applications*, *27*(2), e1900.