Experimental forecasts of all-India Summer Monsoon Rainfall for 2002 and 2003 using Neural Network

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Alternative modelling and forecast methodology can complement/improve forecasts of complex atmospheric and oceanic processes by conventional method through enhancement of the range, scope and quality of forecasts. A very relevant example is long-range forecasting of monsoon rainfall; accurate long-range forecasting of monsoon rainfall can have manifold benefits for the country, from crop planning to power generation to policy planning. [1]However, conventional techniques still do not have adequate skill at long-range forecasting, especially at longer than a season. It was to address this issue that an alternative forecasting technique using neural networks[2] (NN) was explored by the author and his collaborator. However, the skill of conventional NN for forecasting rainfall were found to be inadequte; a generalized NN, termed cognitive network (CN) was designed and evaluated[3] for forecasting all-India summer monsoon rainfall (ISMR). The principle and the design of cognitive network (CN) were adopted from a generalization of conventional NN; in particular, a CN also carries out a cognitive summation in addition to conventional neuronal summation. Cognitive networks have proved to be a successful tool for generating long-range forecasts of all-India Summer Rainfall (ISMR). Hindcast experiments for more than 70 years of ISMR showed CN to have significant hindcast skill[3,4].

Using a 3-layer (input layer, hidden layer, output layer) CN configuration, the author and his collaborators have generated experimental forecasts of ISMR for the past seven years. It is noteworthy that all these experimental forecasts, generated well ahead of the season and several of them two seasons in advance, have been fairly accurate[4,5]. This is all the more remarkable since years like 1997, characterized by the presence of a warming event over the Pacific, were expected to be deficit monsoon years. Table 1 compares the observed and the predicted values of ISMR for the years 1995-2000. The basic data for ISMR used in their experiments have been received from the rainfall data published by Parathasaratly et al[6].

Table 1: A Summary of Performance of CN Forecast

Year	CN Forecast	Observation
1995	98	100
1996	95*	103
1997	98	102
1998	107*	106
1999	98	96
2000	91*	92
2001	95% - 97%	91

* Forecast made 2- seasons in advance, i.e. 1996 forecast made before 1995 monsoon
Percentage of Mean : Mean ISMR adopted in this table = 887 mm

The single scientific motivation behind generating and publishing these experimental forecasts has been to carry out an objective field evaluation of the proposed method. One of the major drawbacks of NN, (or, specifically CN) simulation is the absence of an (obvious and conventional) causal (dynamical) picture. The chief merit of the methodology therefore has to be derived from its forecast skill. The experimental forecasts, generated and published well ahead of the season, can help to build up a (statistically) acceptable estimate of the reliability and the skill of the method.

With this philosophy, we record here our experimental forecasts of ISMR for the years 2002 and 2003.

Table 2: Experimental CN forecasts of ISMR for 2002 and 2003

Year	Rainfall in mm	Percentage of long-period mean	Error Limit
2002	869	99%	3%
2003	919	104%	4.5%

The experimental forecasts recorded here is an ensemble average; the ensemble forecasts are generated by changing certain configurational parameters of the CN. The error bars in Table 2 thus represent ensemble standard deviations. The Long-period mean ISMR adopted here is 887 mm.

Thus, as per criteria of India Meteorological Department, both the years 2002 and 2003 are likely to be normal monsoon years. A peculiarity of the forecasts presented here is worth noting: observationally (over the past hundred years or so), the longest spell of consecutive normal monsoon years is 13; we are thus at the edge of a shift to draught/excess year. However, our forecasts for both 2002 and 2003 are quite close to the long-term mean. It is worth emphasizing, however, that our forecasts are precise numbers with error bars as indicated. In other words if the monsoon is normal, our forecasts may still be erroneous if the difference between the observed and the predicted values differed significantly from the indicated error bars.

We want to re-emphasize that the sole purpose of these experimental forecasts is to develop an objective and robust estimate of the skill of the CN forecast; they are not meant for any operational or commercial use. The CN model employed here uses only past ISMR as a predictor and, in that sense, quite simple. However, the goodness of such a model has to be judged from its forecast skill, and not necessarily from its complexity. On the other hand, however, none of the years of experimental forecasts has a departure of more than one standard deviation of the observed data; Thus the skill of CN for large departures is yet to be proved in field evaluation.

References

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