

What is the role of noise and uncertainty in neural network modelling?

Almost 30 years of research and applications to karst aquifer modelling and flash-floods forecasting

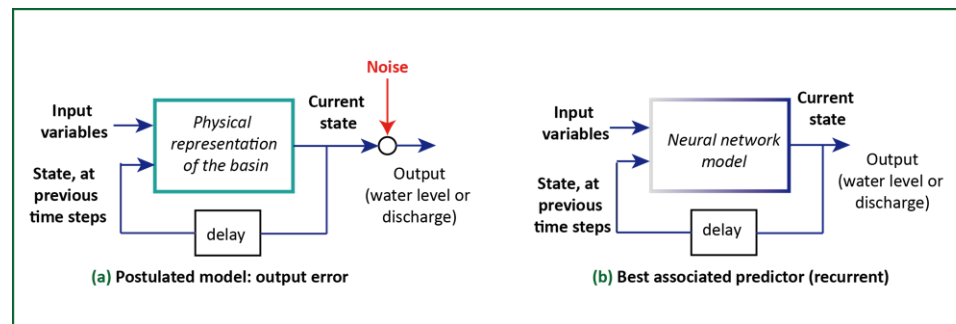
Neural networks to model watersheds or karst basins

Multilayer perceptron are universal approximators:

- ▶ The main challenges in data-driven modeling are the inaccuracy, the variability, and the statistical significance of the data,
 - Important to consider the relevant hypothesis relative to the noise impact [Nerrand et al, 1993, Taver et al, 2014]
- ▶ Two hypothesis: “output error” and “state error”

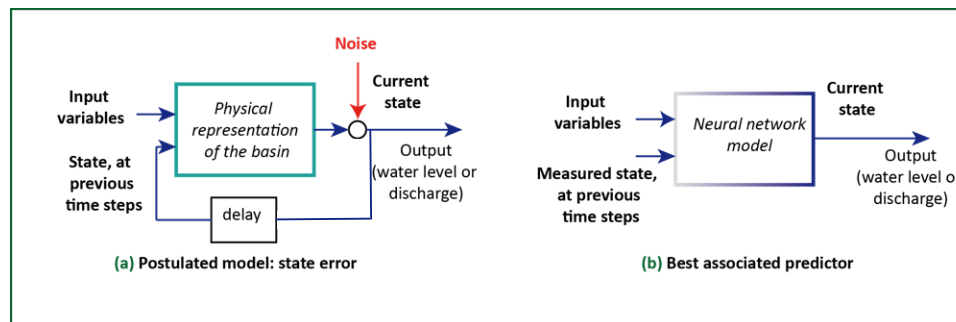
Output error

The hypothesis of output error supposes that uncertainties are essentially due to output measurement errors (for example rating curve). The best predictor to choose is a **recurrent model**. As the output is corrupted by noise, it is better to inform the model about its state using the estimated output at previous time steps.

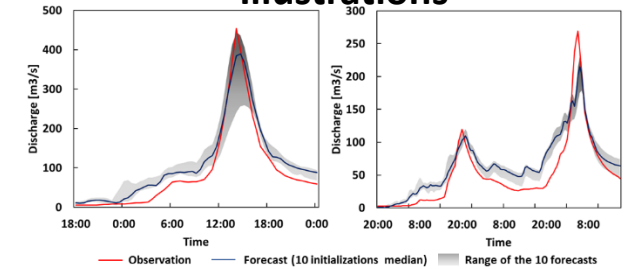


State error

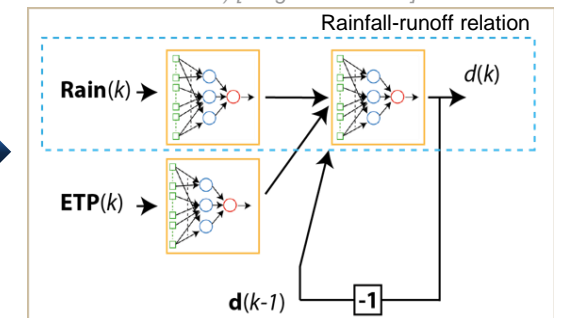
The state of the postulated model is corrupted by noise or uncertainties that can originate from the model (parameters, function) or from rainfalls (forcing data). As the state estimated by the model is corrupted, it is thus logical to use as inputs the observed state of the basin (discharge or water-level) within a **feedforward model** (non recurrent).



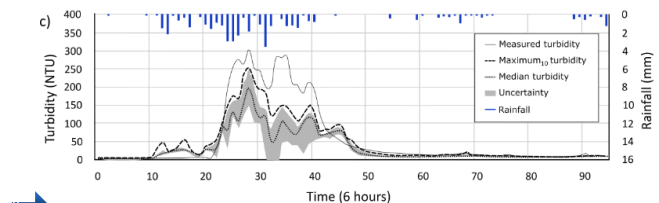
Illustrations



2 hour ahead prediction of 2 flash floods (Mialet basin, France) [Artigue et al 2012]



Two Branches deep model for discharge prediction in climate change context (up to 2070)



24h turbidity prediction using 6h time-step and mean rainfall. Yport karst aquifer (Normandy, France). [Savary 2021]

- Artigue G., Johannet A., Borrell V., Pistre S., (2012). Flash flood forecasting in poorly gauged basins using neural networks: case study of the Gardon de Mialet basin (southern France). *In Nat. Haz. and Earth Syst. Sc.* (12)11 3307-3324.
- Nerrand, O., Roussel-Ragot, P., Personnaz, L., et al (1993). Neural networks and nonlinear adaptive filtering: Unifying concepts and new algorithms. *In Neural Computation*, 5(2), 165-199.
- Savary, M., Johannet, A., Massei, N., et al. Karst-aquifer operational turbidity forecasting by neural networks and the role of complexity in designing the model: a case study of the Yport basin in Normandy (France). *Hydrogeology Journal*, Springer Verlag, 2021, Special Issue "Five decades of advances in karst hydrogeology", (10.1007/s10040-020-02277-w). (hal-03105289)
- Taver, V., Borrell-Estupina, V., Johannet, A., Pistre, S., (2014) Feed-forward vs recurrent neural network models for non-stationarity modelling using data assimilation and adaptivity. *In HSJ*. DOI: 10.1080/02626667.2014.967696.

¹HSM, Univ Montpellier, IMT Mines Ales, CNRS, IRD, Ales, France

²HSM, Univ Montpellier, CNRS, IRD, Montpellier, France

Authors

Anne Johannet¹,
Guillaume Artigue¹,
Séverin Pistre²,
Marc Vinches¹,
Alain Dezetter²,
Carole Delenne²
Yves Tramblay²

Affiliations



Cofunded by:

