Automated feature selection for fuzzy neural networks: An application for urban flood prediction

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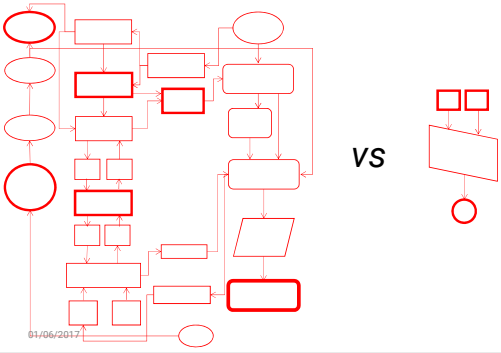
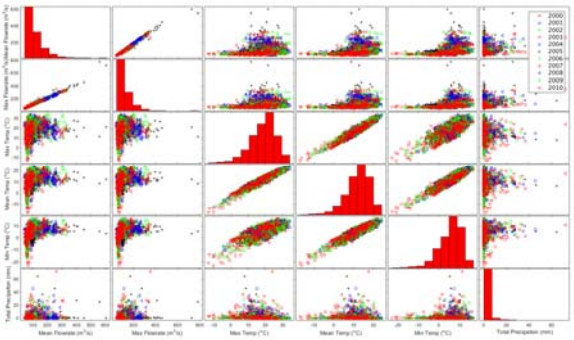
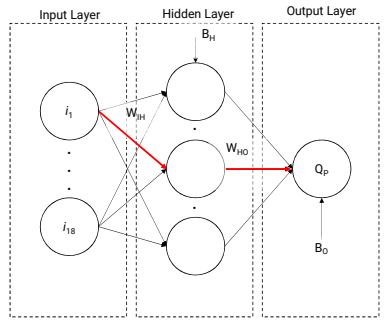
Physical *vs* data-driven models





Artificial Neural Networks



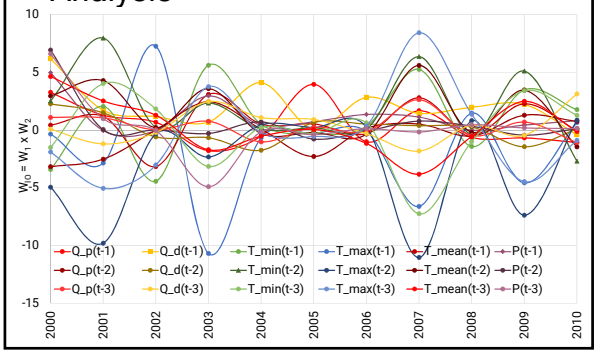
Combined Neural Pathway Strength Analysis

The strength of a pathway from the input to output:

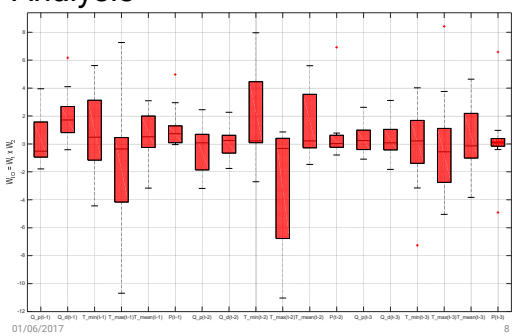
$$W_{IO} = W_{IH} \times W_{HO}$$

- 18 different W_{IO} values for each year
- The larger the value of the W_{IO} the more influential the input

Combined Neural Pathway Strength Analysis



Combined Neural Pathway Strength Analysis



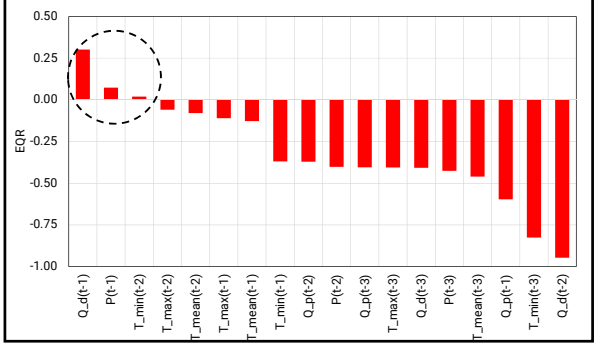
Combined Neural Pathway Strength Analysis

The ensemble interquartile range (EQR):

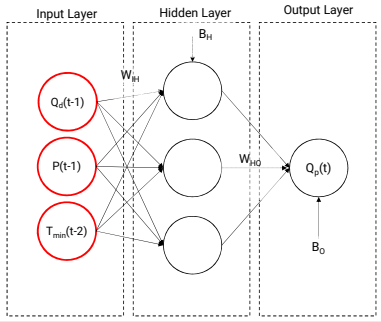
EQR = {min(|Q_1|,|Q_3|)/max(|Q_1|,|Q_3|)}.sgn(Q_1).sgn(Q_3)

where Q_1 & Q_3 are the first & third quartile of all W_{IO} for each input

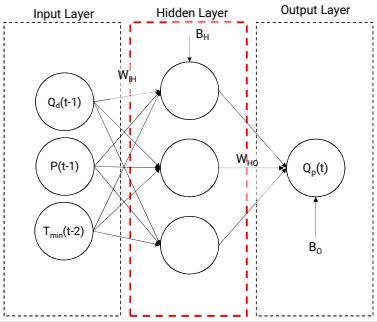
EQR for 18 input parameters



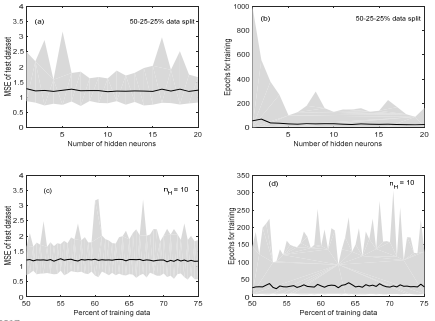
Artificial Neural Networks



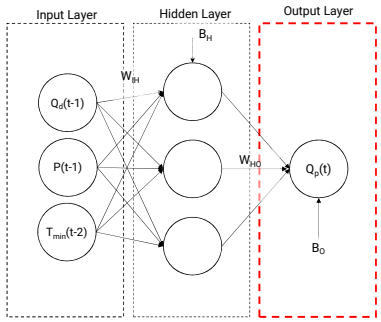
ANN architecture selection



ANN architecture selection

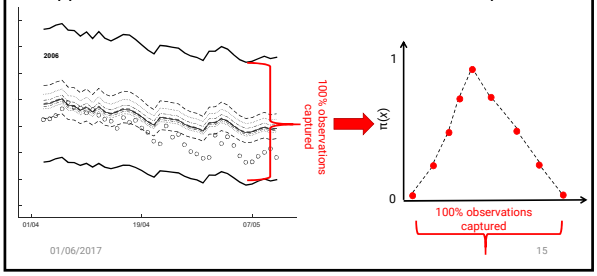


Training a Fuzzy Neural Network

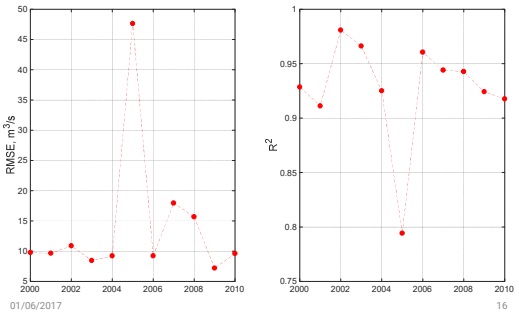


Fuzzy Neural Networks

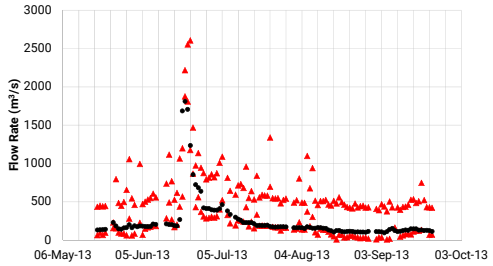
- Fuzzy number inputs, outputs, weights & biases used for uncertainty quantification
- Upper & lower bounds rather than deterministic output



Model performance



Test dataset: 2013 flood results



Future work

- Real-time updating capability to improve performance
- Compare with other Input Feature Selection methods
- Include complexity as a criteria for model selection

Further reading…

- Fuzzy Neural Networks:

Khan U.T., & Valeo, C. (2017). Optimising Fuzzy Neural Network Architecture for Dissolved Oxygen Prediction and Risk Analysis. *Water*, 9(6), 381.

Khan, U. T., & Valeo, C. (2016). Dissolved oxygen prediction using a possibility theory based fuzzy neural network. *Hydrology & Earth System Sciences*, 20(6), 2267.

- Data-driven methods for real-time flood prediction

Khan, U. T., & Valeo, C. (2016). Short-Term Peak Flow Rate Prediction and Flood Risk Assessment Using Fuzzy Linear Regression. *Journal of Environmental Informatics*, 28(2), 71-89.

- Combined Neural Pathway Strength Analysis:

Duncan, A. P. (2015). *The Analysis and Application of Artificial Neural Networks for Early Warning Systems in Hydrology and the Environment*. PhD Thesis, University of Exeter, UK.

Acknowledgements

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