Neural Network Excel Add-in Overview

Overview

The Water Systems research group at the University of Adelaide School of Engineering has been researching the use of artificial neural networks (ANNs) for water resources modeling applications, such as flow forecasting, water quality forecasting, water treatment process modeling. A generic framework for the development of ANN models for water resources applications is outlined as below.

User-friendly software has been created to allow users to apply several ANN model development techniques that have been developed through this research. The software is an add-in for Microsoft Excel® that implements the main steps in ANN model development, from data pre-processing, through to ANN training and validation; all within the Excel application environment.

The core of the software has been developed in C++, so that the software combines fast computation with the ease and convenience of pre- and post- analysis of data within an Excel workbook.

Features

The Neural Network Excel Add-in currently implements the following modeling steps:

- **Data pre-processing**
    - Lagging of time-series data
    - Transformations (standardization, log transformation and scaling)
- **Input variable selection**
    - Partial mutual information (PMI) analysis
- **Data splitting**
    - Random
    - Block-wise
    - Systematic
    - DUPLEX
    - Self-organising map (SOM)
    - Hybrid SOM-DUPLEX
- **Basic neural network training and querying**
    - Three-layered perceptron (3LP) with back-propagation
    - Generalised regression neural network (GRNN) using Brent algorithm
    - Kohonen self-organising map (SOM)

Requirements

The software requires Microsoft Excel® 2003/2007/2010 and Microsoft Windows XP/Vista/7/10.

Terms of Use

The software is freely available to use under the terms and conditions of the Creative Commons license.

If you intend to use this software for an academic publication or report, we would appreciate your acknowledgement of the origin of the software by refencing either of the following related articles as appropriate:

For data splitting

- May R. J., Maier, H. R., Dandy, G. C. Data splitting for artificial neural networks using SOM-based stratified sampling. *Neural Networks, 23*(2), pp. 283-94, 201. Available for download at http://dx.doi.org/10.1016/j.neunet.2009.11.009

For input variable selection using PMI

- R. J. May, H. R. Maier, G. C. Dandy, nd T. M. K. G. Non-linear variable selection for artificial neural network development using partial mutual information. *Environmental Modelling and Software, 23*(10-11), pp. 1312-1326, 2008. Available for download at http://www.sciencedirect.com/science/article/pii/S1364815208000467

For further information on the application of artificial neural networks to water resources modeling and the methods, please refer to the following articles:

Overview / Review Papers

- Maier, H.R., Jain A., Dandy, G.C. and Sudheer, K.P. (2010) Methods used for the development of neural networks for the prediction of water resource variables in river systems: Current status and future directions, *Environmental Modelling & Software, 25*(8), 891-909, 2010 10.1016/j.envsoft.2010.02.003

- Maier H.R. and Dandy G.C. (2000) Neural networks for the prediction and forecasting of water resources variables: a review of modelling issues and applications. *Environmental Modelling and Software, 15*(1), 101-124.

- Wu W., Dandy G.C. and Maier H.R. (2014) Protocol for developing ANN models and its application to the assessment of the quality of the ANN model development process in drinking water quality modeling, *Environmental Modelling and Software, 54*, 108-127, http://dx.doi.org/10.1016/j.envsoft.2013.12.016.

Input Variable Selection

- Bowden G.J., Dandy G.C. and Maier H.R. (2005) Input determination for neural network models in water resources applications: Part 1 - Background and methodology. *Journal of Hydrology, 301*(1-4), 75-92.

- Bowden G.J., Maier H.R. and Dandy G.C.(2005) Input determination for neural network models in water resources applications: Part 2 - Case study: Forecasting salinity in a river. *Journal of Hydrology, 301*(1-4), 93-107.

- Fernando T.M.K.G., Maier H.R. and Dandy G.C. (2009) Selection of input variables for data driven models: An average shifted histogram partial mutual information estimator approach. *Journal of Hydrology, 367*(3-4), 165-176, doi:10.1016/j.jhydrol.2008.10.019.

- May R.J., Dandy G.C., Maier H.R. and Nixon J.B. (2008) Application of partial mutual information variable selection to ANN forecasting of water quality in water distribution systems. *Environmental Modelling and Software, 23*(10-11), 1289-1299, doi:10.1016/j.envsoft.2008.03.008.

Data Splitting

- Bowden G.J., Maier H.R. and Dandy G.C. (2002) Optimal division of data for neural network models in water resources applications. *Water Resources Research, 38*(2), 2.1-2.11.

- Wu W., May R.J., Maier H.R. and Dandy G.G. (2013) A benchmarking approach for comparing data splitting methods for modeling water resources parameters using artificial neural networks, *Water Resources Research, 49*(11), 7598-7614, DOI: 10.1002/2012WR012713.

ANN Training / Model Selection

- Kingston G.B., Maier H.R. and Lambert M.F. (2008) Bayesian model selection applied to artificial neural networks used for water resources modeling, *Water Resources Research, 44*, W04419, doi:10.1029/2007WR006155.

- Kingston G.B., Maier H.R. and Lambert M.F. (2006) A probabilistic method to assist knowledge extraction from artificial neural networks used for hydrological prediction. *Mathematical and Computer Modelling, 44*(5-6), 499-512.

- Kingston G.B., Lambert M.F and Maier H.R. (2005) Bayesian training of artificial neural networks used for water resources modeling. *Water Resources Research, 41*, W12409, doi:10.1029/2005WR004152.

- Kingston G.B., Maier H.R. and Lambert M.F. (2005) Calibration and validation of neural networks to ensure physically plausible hydrological modeling. *Journal of Hydrology, 314*(1-4), 158-176.

- Maier H.R. and Dandy G.C. (1999) Empirical comparison of various methods for training feedforward neural networks for salinity forecasting. *Water Resources Research, 35*(8), 2591-2596.

- Maier H.R. and Dandy G.C. (1998) The effect of internal parameters and geometry on the performance of back-propagation neural networks: an empirical study. *Environmental Modelling and Software, 13*(2), 193-209.

- Maier H.R. and Dandy G.C. (1998) Understanding the behaviour and optimising the performance of back-propagation neural networks: an empirical study. *Environmental Modelling and Software, 13(*2), 179-191.

ANN Model Deployment

- Bowden G.J., Maier H.R. and Dandy G.C. (2012) Real-time deployment of artificial neural network forecasting models - understanding the range of applicability, *Water Resources Research, 48*(10), doi:10.1029/2012WR011984.

Contacts

For further information on the software, bug reports, or queries related to the methods implemented in the software, please contact Dr Robert May .