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Neural network modelling trade-offs: small might be beautiful but perhaps bigger is better?

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This paper considers the issue of parsimonious model building for applied purposes and suggests that in the production of simpler solutions important operational qualities might be lost. It is argued that a parsimonious model is a model with as few parameters as possible for a given quality of model output. The main concern in such cases is one of fitness for purpose and past papers have called for consistent measures of merit and trust. Hillel (1986: p42) advocated that hydrological modelling solutions should be: 'parsimonious' - each model should contain a minimum number of parameters that can be measured in the field; 'modest' - the scope and purpose to which a specific model can be applied must not be overstated; 'accurate' - the correctness of the forecast or prediction need not be better than the correctness of the input measurements; and 'testable' - the limits within which the model outputs are valid can be defined. This paper argues that other qualities and issues are also important with respect to practical operational implementations - in particular the properties of 'robustness' and 'graceful degradation'. To provide a robust solution each model must exhibit a consistent or stable behaviour and be insensitive to potential uncertainties in the construction and parameterisation process e.g. problems related to measurements that cannot be obtained with sufficient accuracies or are not constant over long(er) periods. To be reliable and trusted an operational model must also exhibit the properties of 'graceful degradation': a gradual and progressive reduction in overall performance such that the model continues to operate and function in a normal manner, but provides a reduced level of service, as opposed to taking incorrect actions or suffering a total collapse in processing activities. Four neural network hydrological modelling examples are used to illustrate that, in the drive to develop parsimonious neural network solutions based on superior accuracies, other important properties such as robustness - that are seldom tested - are in danger of being sacrificed.