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Quantile hydrologic model selection and model structure deficiency assessment

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A theory for quantile based hydrologic model selection and model structure deficiency assessment is presented. A mathematical formulation of the quantile model selection problem demonstrates that the Lagrange multipliers corresponding to model structure constraints of a selection problem quantify structural deficiency. This leads to a formal definition of model structure deficiency (or rigidity) and a formulation of a sufficient condition for model structure flexibility. Further it is shown that crossing of two quantile predictions is necessarily due to model structure deficiency since the latter introduces a bias in predicting an observed quantile. This bias is independent of model parameter dimensionality and is time invariant.

The notion that model structure deficiency can be measured in terms of the Lagrange multipliers of a quantile model selection problem is shown to hold for an application of a flexible hydrological model structure on the French Broad river basin dataset. It shows that quantile model selection encompasses other model selection strategies based on summary statistics, that it is "equivalent" to maximum likelihood estimation under certain likelihood functions and that quantile predictions are fairly robust.