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Balancing Model Complexity and Data Availability for Hydrologic Prediction

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Hydrologic predictions are affected by both errors in the models used to make the predictions and errors in the data used to run and calibrate the models. This is especially true at large scales, where our understanding and direct observation of hydrologic processes is most limited. When only limited and noisy data are available, the application of complex models with many parameters leads to problems of parameter non-uniqueness and equifinality, which may negatively affect prediction uncertainties. Our objective is to (i) illustrate the intuitive relation between data availability and model complexity, and (ii) discuss the application of several methods to systematically control model complexity given limited and noisy data. Complexity control of hydrologic models results in unique parameters and selection of the simplest model that explains the data, thereby providing a means of hydrologic generalization and classification. Structural Risk Minimization (SRM) is a promising technique for this purpose, as it (i) provides analytic upper bounds on prediction uncertainty, hence avoiding the computational burden of resampling methods, and (ii) extends the applicability of classic methods such as Akaike's Information Criterion to finite data. The main hurdle in applying SRM is the need for an a priori estimation of the complexity of the hydrologic model, as measured by its Vapnik-Chernovenkis (VC) dimension. Further research is needed in this area.