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Mixtures of error models for characterizing time-varying hydrologic uncertainty

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It is increasingly recognized that uncertainty in hydrologic models is frequently non-stationary and/or time varying, and that residual errors are typically not well characterized by traditional statistical models of heteroscedasticity and autoregression. These problems are often exacerbated as models are used for predictions and extrapolated beyond the conditions in which they were optimized. One solution may be to propose a suite of residual error models, and simply predict the conditions under which different error models are preferred.

In this study, we make use of previous research aimed at developing Hierarchical Mixtures of Experts (HME) models for hydrologic predictions. The HME approach allows the combination of multiple models, with weights associated with each individual component models that vary depending on the catchment climatic or hydrologic conditions. In such a way, the approach has the potential to better represent heteroscedasticity or dynamic model error while being specified in a formally Bayesian framework. We demonstrate the methodology for several hydrologic case studies across different spatio-temporal domains, and discuss issues related to parameter identification, error predictability, and model overfitting.