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Downscaling daily station precipitation amounts using deterministic and stochastic regression models generated by multi-objective genetic programming

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A multi-objective optimization technique is used create downscaling models that are not purely aimed at minimizing the Root Mean Square Error (RMSE), but simultaneously aim to reproduce the probability distribution of the predictand, here precipitation. When dealing with such conflicting objectives there is not one single solution that is optimal in some absolute sense, but a set of Pareto optimal solutions – the best achievable trade-offs between the objectives considered. In Evolutionary Computation, which deals with a wide range of machine-learning/optimization algorithms inspired by biological evolution, multi-objective optimization techniques are common. In the presented work Multi-Objective Genetic Programming (MOGP), one technique from Evolutionary Computation, is used to evolve nonlinear regression downscaling models for station precipitation using predictors from the ERA-Interim reanalysis, largely following experiment 1(a) designed by the COST Action VALUE. What distinguishes GP from classical regression techniques is the ability to simultaneously evolve both the structure and the parameters of the regression models.
In the first MOGP version (results have been contributed to the COST Action VALUE) the evolved downscaling models are fully deterministic, i.e. station precipitation is deterministically derived from the large-scale (reanalysis) predictors. Hence, such a setup might be interpreted as a kind of variance inflation technique. With a new setup we can now evolve stochastic downscaling models with MOGP. This is done by introducing a simple grammar that forces MOGP to generate downscaling models which sample from gamma distributions. The parameters of the gamma distributions are learned during the evolutionary process. Hence, the downscaling models generated with this new setup are in principle simple weather generators.
In the presentation we analyze and compare the performance of deterministic and stochastic downscaling models generated by MOGP – Are there any systematic differences? Results are further compared to standard gamma generalized linear models, gamma generalized linear models combined with variance inflation and simple gamma distribution based weather generators.