Quality prediction based on Gaussian process model with selective ensemble kernel

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Abstract: Gaussian process model plays a vital role in quality optimization with computer experiment. However, due to the uncertainty in selecting kernel functions, the hyperparameter estimation in likelihood function may not approximate the real value, and then it is difficult to obtain reliable quality prediction results. Therefore, focusing on the selection of kernel functions in Gaussian process model, a construction strategy based on selective ensemble kernel learning algorithm is proposed. Firstly, the bootstrap method is used to repeatedly extract the training samples, and then the hyper-parameters in each kernel are obtained based on each training sample to construct a multi-dimensional Gaussian process model. Secondly, the quality tool Pareto Diagram is used to analyze the prediction performance of Gaussian process model in different kernels, so as to determine the elements of an ensemble kernel. Then, an improved likelihood function is constructed by considering the ensemble parameters. We can obtain the optimal parameters of the ensemble kernel in Gaussian process model. Finally, the effectiveness of the proposed method is verified by simulation studies and industrial examples. The analysis results illustrate that the Gaussian process model based on the ensemble kernel not only provides a feasible optimization path for the kernel selection problem, but also improves the accuracy and precisely of quality prediction, which provides a superior model for the quality optimization or Bayesian optimization.

Key words: quality prediction; Gaussian process model; Ensemble kernel learning; parameter optimization