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RBF NEURAL NETWORK ENSEMBLE METHOD AND AERODYNAMIC OPTIMIZATION

Abstract

Surrogate model if suggested to evaluate objective function and reduce the expensive computational cost in optimization. In this paper in order to avoid misleading caused by prediction error, neural network ensemble method is used to reduce prediction of single RBF neural network. An effective management method of optimization algorithm and surrogate model is presented. I. RBF Neural Network Ensemble The basic idea of neural network ensemble is that constructing a number of networks and predicting with these networks together effectively. The most prevailing approaches are Bagging and Boosting. Bagging generates several training sets from the original training set. Boosting generates a series of individual neural networks whose training sets are determined by the performance of former ones. II. Mesh Adaptive Direct Search Algorithm Mesh Adaptive Direct Search Algorithm(MADS) algorithm is a variation of GPS(Generalized Pattern Search) metho for numerically solving nonlinear and mixed variable optimization problems with general nonlinear inequality constrains. III. Optimization Process Surrogate model predicts objective function much more rapid than CFD method. However, error exits between the objective functions predicted by surrogate and evaluated by original model. Appropriate management of surrogate model and optimization method is also required so as to ensure optimization quality. In MADS, step Search searches globally. In this step, surrogate model is used to search for better solution so as to reduce computational cost. In step Poll surrogate model is used to predict objective function. We can sort the trial points according to predicted objective function and calibrated trial points one by one. Therefore the trail point with lower objective function is calibrated with higher probability. IV. Numerical Examples A.Comparison of neural network ensemble method 200 samples are selected with LHS(Latin Hypercube Sampling) method in design space as ONERA M6 wing as initial geometry. Bagging performs better than Boosting in prediction of lift coefficient and lift-drag-ratio. Prediction error reduces about 15% with Bagging when predicting lift coefficient. B.ONERA M6 Wing Optimization Total number of design variables is 20. 200 samples are selected with LHS method. The number of individual is 70 and Bagging is used to ensemble individual networks. The prediction error are 1.2% and 1.73%(%RMSE) respectively for lift coefficient and lift-drag-ratio by cross validation. Optimization runs 11 iterations and calls original model 23 times. After optimization the wings lift-drag-ratio is improved 22.8%.