Master's Thesis

Equilibrium problem approaches for hyper-parameter selections of support vector machines

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Abstract

Support vector machines (SVMs) are a class of machine learning models, and they give a classification function for given data. Using kernel functions, SVMs can construct non-linear classification. SVMs and kernel functions involve some special parameters called hyper-parameters, which control the complexity of the learning models. We need to choose suitable hyper-parameters to get a high-performance classification function. Most of the existing hyper-parameter selection methods have to solve SVMs many times, and thus they take much time to choose reasonable hyper-parameters.

In this paper, we propose hyper-parameter selection models based on equilibrium problems. The proposed models regard both normal model parameters in SVMs and hyper-parameters as an equilibrium point of a non-cooperative game, where two players exist to avoid overfitting: one player determines the normal model parameters and the other determines the hyper-parameters. The models can be formulated as variational inequalities and mathematical programs with equilibrium constraints (MPECs). The number of variables in these problems is proportional to that of data, and hence the equilibrium problems tend to be very large. To solve such large-scale variational inequalities, we propose a new extra-gradient method. Finally, we conduct some numerical experiments to verify the performance of the proposed models.