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Uncertainty Learning of Rough Set-based Prediction under a Holistic Framework

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Abstract Uncertainty learning is an important research direction of rough set theory, wherein the most popular one is rough set-based prediction, whose goal is to extract decision rules from decision systems and then assign the corresponding decision labels for new samples in terms of **the decision** rules. To design efficient prediction algorithms, it is necessary and meaningful to measure the uncertainty of rough set-based prediction, especially the stability and generalization performance. In this paper, we analyze the generalization performance of rough set-based prediction algorithms in terms of algorithmic stability analysis **and give the generalization error bounds**. Firstly, we propose a general rough set-based prediction algorithm to predict the labels for new samples, and then define a scoring function and **the corresponding loss function**. Secondly, we define two kinds of algorithmic stability for this prediction algorithm in terms of their loss functions, by which two general generalization error bounds are obtained **according to two different kinds of stability: strong stability and pointwise hypothesis stability**. **The** bounds numerically imply the performance of the proposed rough set-based prediction algorithm is related to number of samples and stability parameter. Thirdly, we adopt the confidence and max confidence, min support algorithms as the specific scoring functions instead of general scoring functions. The results show the prediction performance of the confidence algorithm is related to the number of samples and stability parameter, as well as that of max confidence, min support algorithm is associated with the number of samples and minimum support threshold. Based on these discussions, a general framework of stability and generalization error bounds analysis for rough set-based prediction is established. Finally, several experiments are performed to test the previous conclusions.

Keywords Uncertainty learning; Rough set-based prediction; Scoring function; Strong stability; Pointwise hypothesis stability; Generalization error bound

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