

Auction-based Decision Fusion Technique for Multiple Classifier Combiners



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ABSTRACT

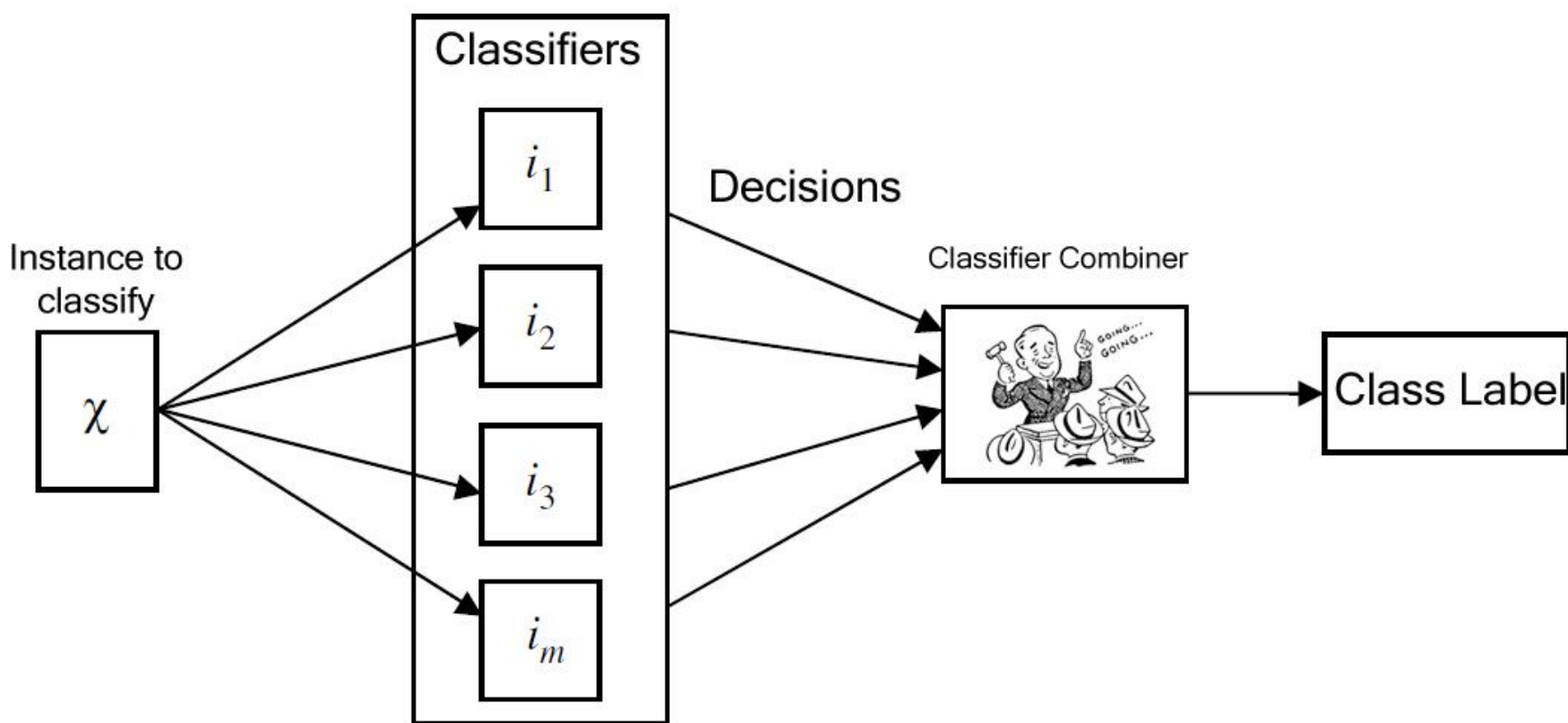
Decision fusion performs a data-reduction mapping from multiple inputs to a smaller number of outputs. In this process, several inputs from different experts or classifiers are combined to make an overall decision. Since the natures of the classification problems are different, not all classifiers perform the same on different types of domains; hence, each classifier has a specific error. It is desired to have some classifiers cover the others' errors, so decision fusion techniques are employed to use a set of different classifiers in order to improve the accuracy and efficiency of the overall results. We propose an auction-based multiple classifier combiner method which does not need offline training data and outperforms the average (AVG), product (PROD), majority vote (MAJ), minimum (MIN) and maximum (MAX) combining rules.

INTRODUCTION

Multiple classifier combination (MCC) is a technique which can be used to improve the classification performance in various classification problems by combining the decisions of multiple individual classifiers. We consider only a combination of classifiers in which each single classifier presents a unique label (target class) as the classification output. Although such an output is not very informative, it is considered as the most general output because all other kinds of outputs could be converted to this type. The combiner methods could be categorized based on whether they need training data. Some methods like AVG and MAJ do not need training data while some others like naïve bays (NB) and neural networks (NN) do. Experimental results generally indicate that MCC provides performance benefits and that the performance of MAJ and AVG methods is comparable or superior to that of methods requiring training. We propose an auction-based multiple classifier combiner method which does not need offline training data and outperforms the AVG, PROD, MAJ, MIN and MAX combining rules.

MATERIALS and METHODS

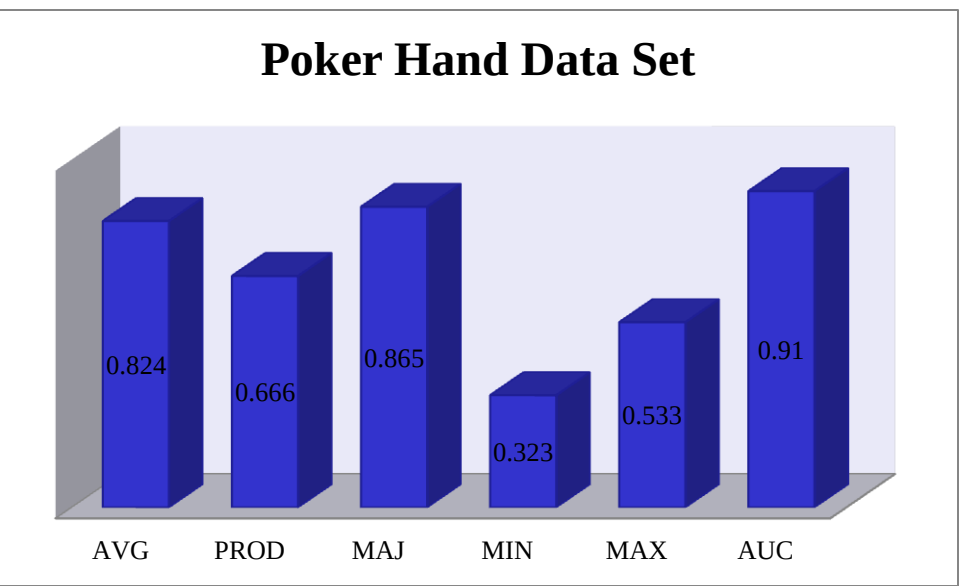
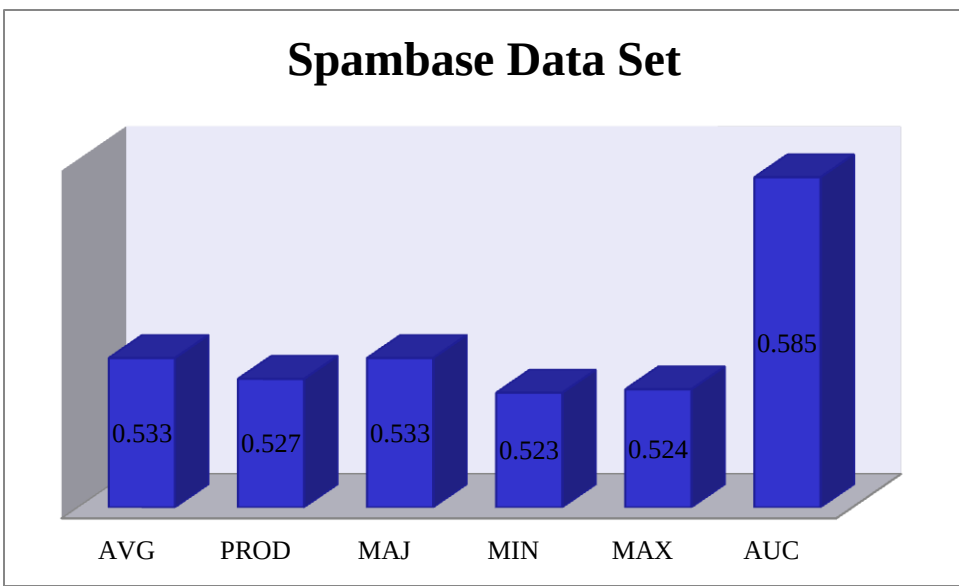
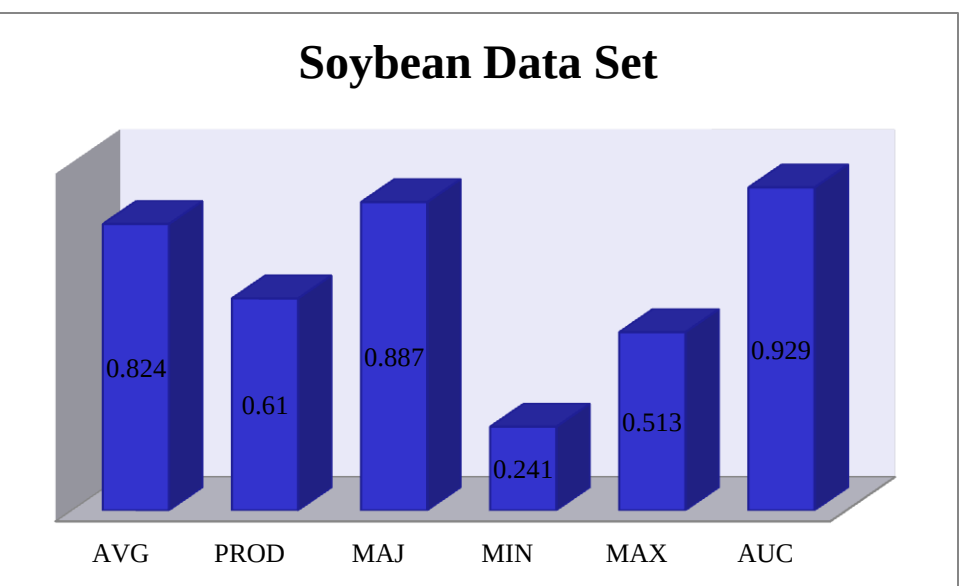
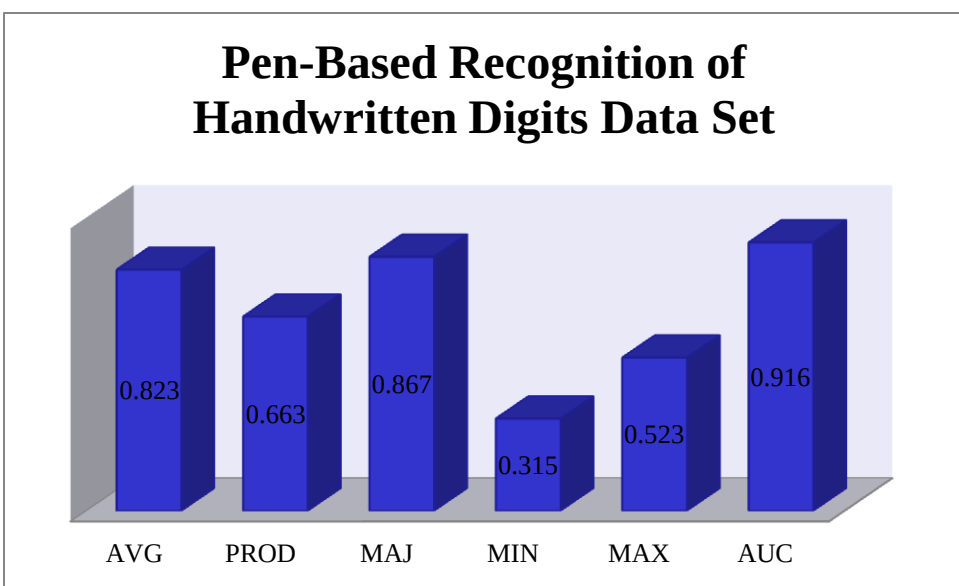
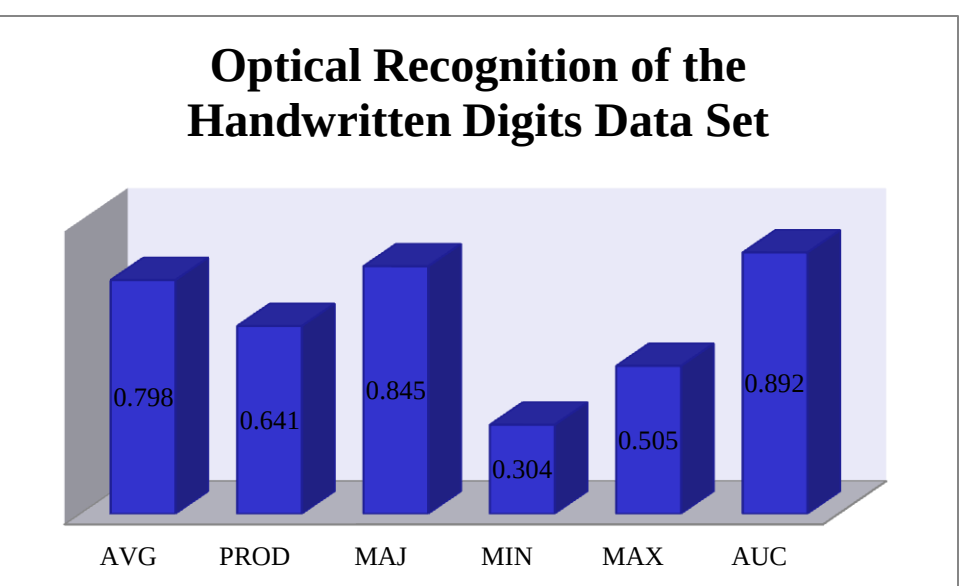
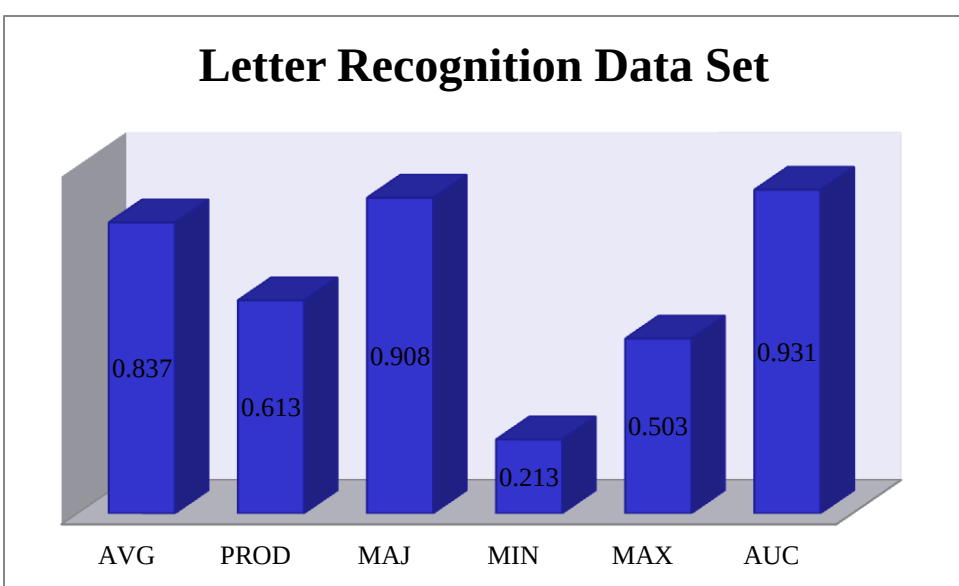
The outcome of individual classifiers are combined using an auction-based mechanism.



A particular auction is set up among the classifiers for every new coming instance. Each classifier bids on one of the existing target class labels based on its own confidence level, experience and expertise. All the classifiers have to pay a certain amount of money for participating in an auction (penny auction) while the winner gets rewarded or punished based on the accuracy of its prediction and the amount of bid. The bids will not be revealed to other bidders and the winner is the one who has bid the highest price (first price sealed bid auction)

RESULTS

We have used a set of eight different classifiers namely: Naïve Bayes, Nearest Neighbor With Generalization (NNG), Conjunctive rule learner, Decision stump, Alternating decision tree (ADTree), C4.5 decision tree, decision tree with naïve Bayes classifiers at the leaves (NBTree) and RandomForest .



We applied average (AVG), product (PROD), majority vote (MAJ), minimum (MIN) and maximum (MAX) combining rules along with our proposed auction-based decision fusion technique on aforementioned single classifiers using 6 different datasets. As it can be seen above, the auction based decision fusion technique outperforms other combining rules used in this experiment.

CONCLUSIONS

In this paper we have described a novel auction-based approach to fuse the outcome decisions of multiple classifiers. Each single classifier is considered as a single black-box, so no information is required about the classification algorithm. We have used the most common classifier output type which is just the assigned label of each new testing instance. Evaluation results shows that our approach outperforms the most popular multiple-classifier combiner rules such as AVG, MAJ, PROD. MIN and MAX .



A scientist is happy, not in resting on his attainments but in the steady acquisition of fresh knowledge. (Max Planck)

FUTURE WORKS

Using the auction notion in decision fusion is a novel idea which sounds quite promising in multiple classifier combiner application. We used a combination of first price sealed bid auction and penny auction to implement the auction mechanism. There is a wide range of auctions such as second-price sealed-bid auctions (Vickrey auctions), open ascending-bid auctions (English auctions), open descending-bid auctions (Dutch auctions) , etc. which need to get investigated as the auction mechanism in this application. A comprehensive comparison of different types of auctions in decision fusion application would be a very interesting potential research direction.

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