Applications of Multi-Criteria Decision Making System in Multiple Instance Active Learning

多重准则决策系统在多示例主动学习中的应用

Contents

目录

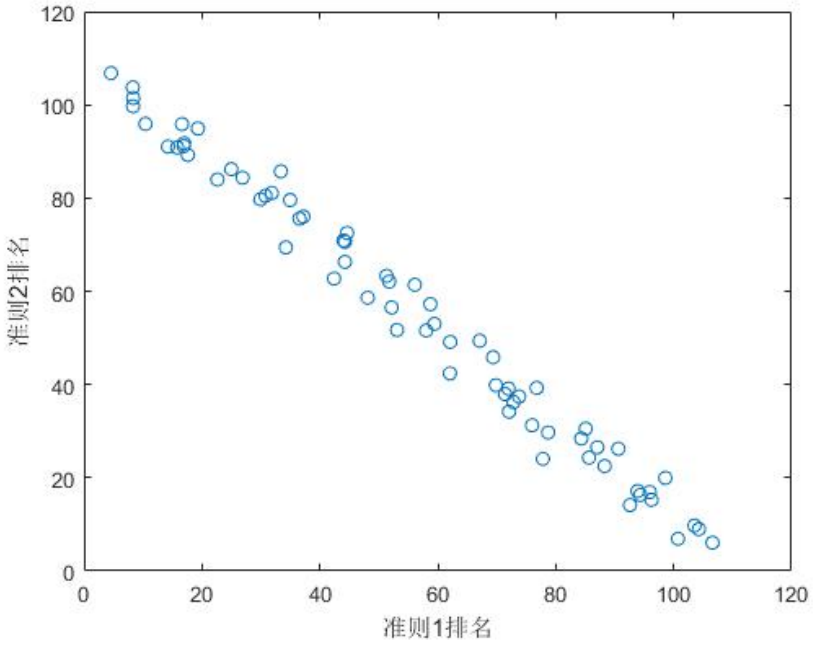
01

Background and Significance

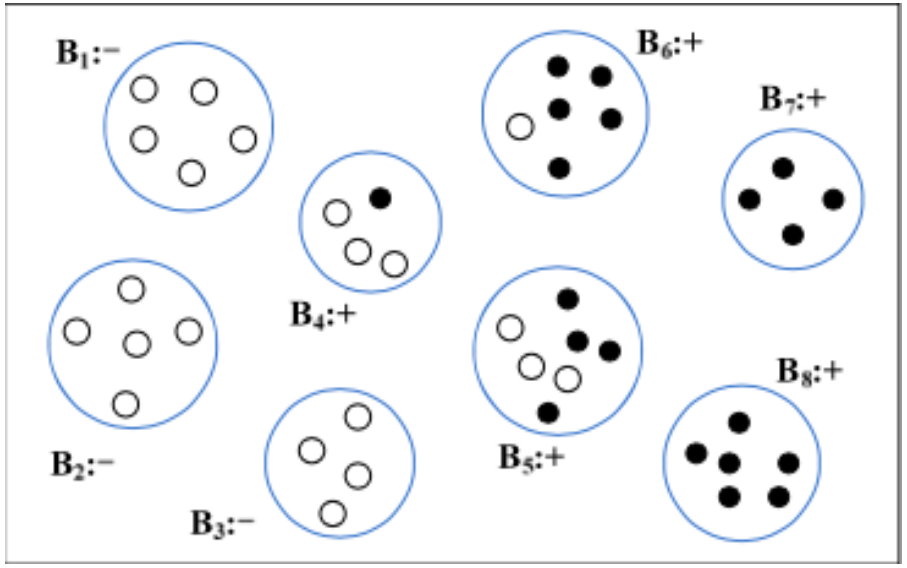
选题的背景和意义

Multi-Criteria Decision Making

Multi-criteria decision making (MCDM) is a well known branch of decision making, which evaluates a finite set of alternatives on the basis of two or more criteria. MCDM tasks include choosing the best alternative from the set of candidates, or sorting the alternatives into a preference preorder.



conflict relation between two selection criteria

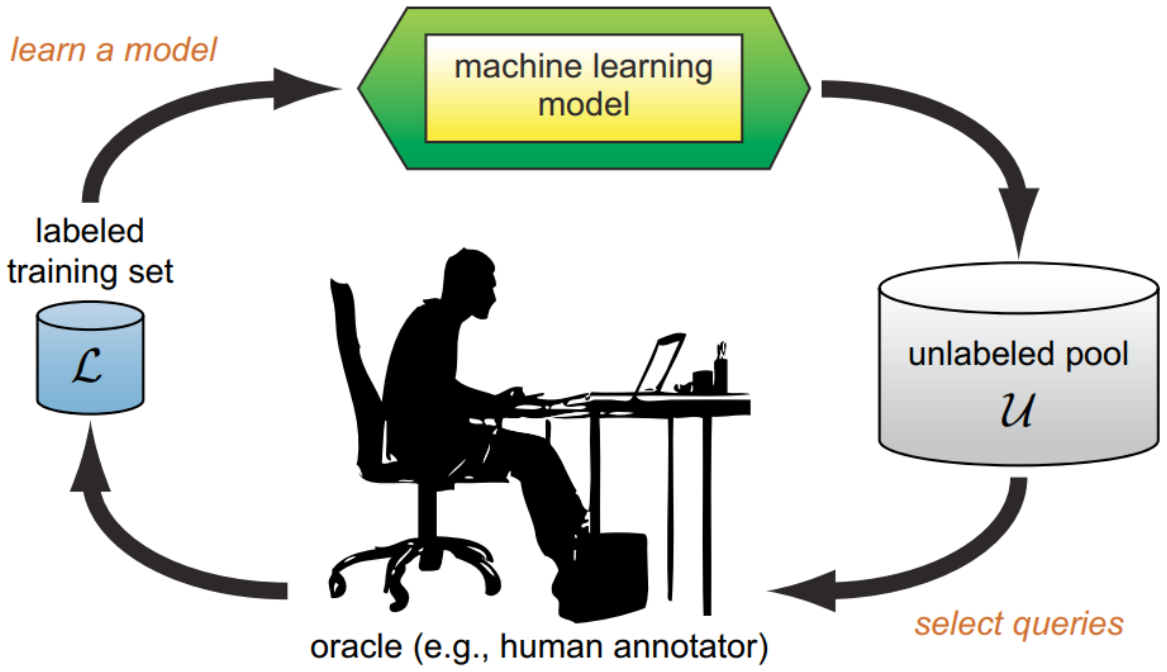


Multiple instance learning problem

Multiple Instance Learning

Multiple instance learning is a task that aims to train classification models from structured data. In MIL, the samples are grouped into bags, and each sample is taken as an instance of its bag. A bag is positive if at least one of its instances is positive, and is negative only if all of its instances are negative.The purpose of multiple instance learning is to predict the category of new packages.

01 Background and Significance
选题的背景与意义

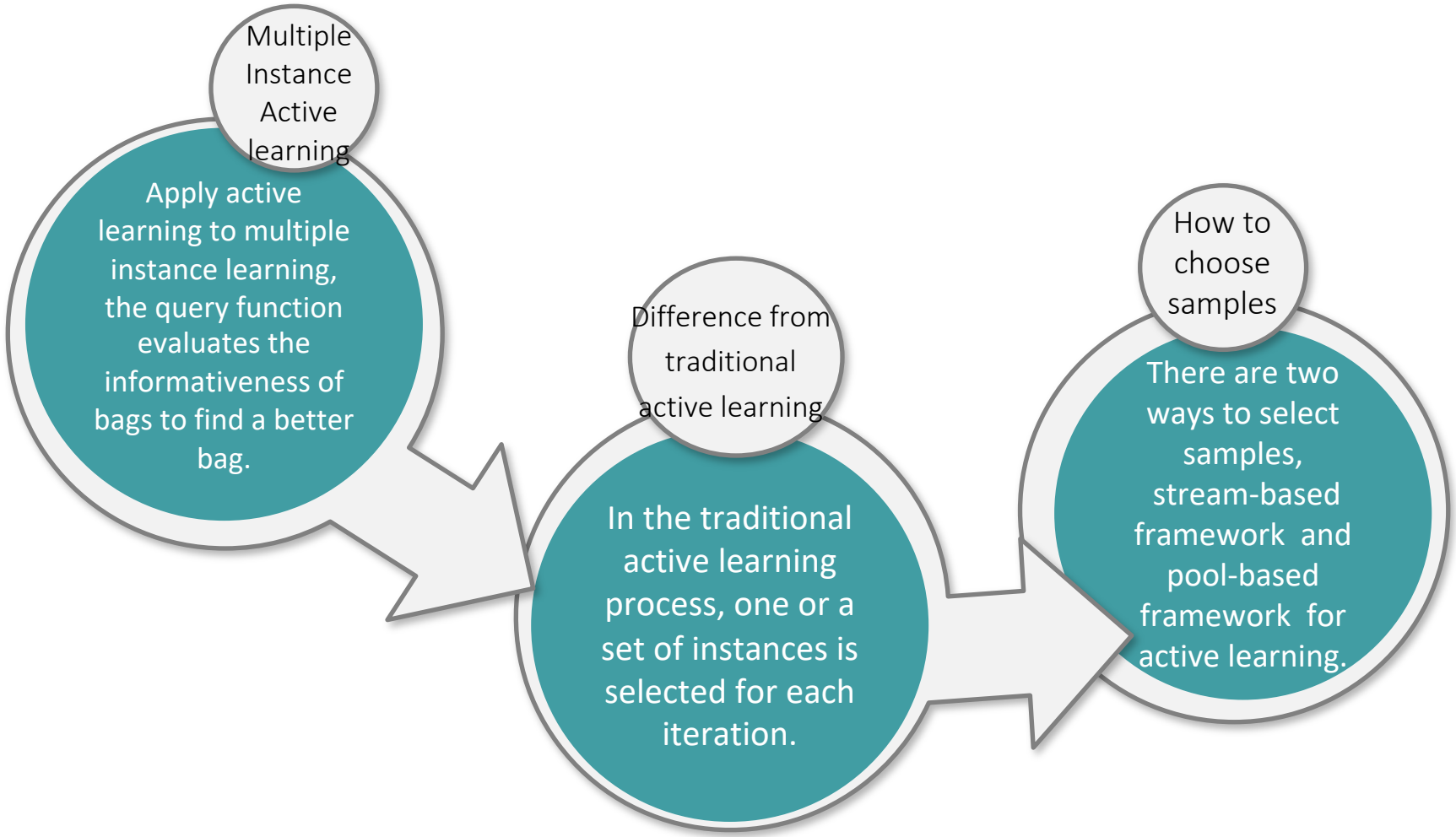


Active learning process

Active Learning

Active learning aims to train an accurate prediction model with minimum cost by labeling most informative instances. Including most informative instances to the labeled set can help improve the model performance with least labeling costs or reduce the computational cost for the succeeding mining procedures.

01 Background and Significance
选题的背景与意义



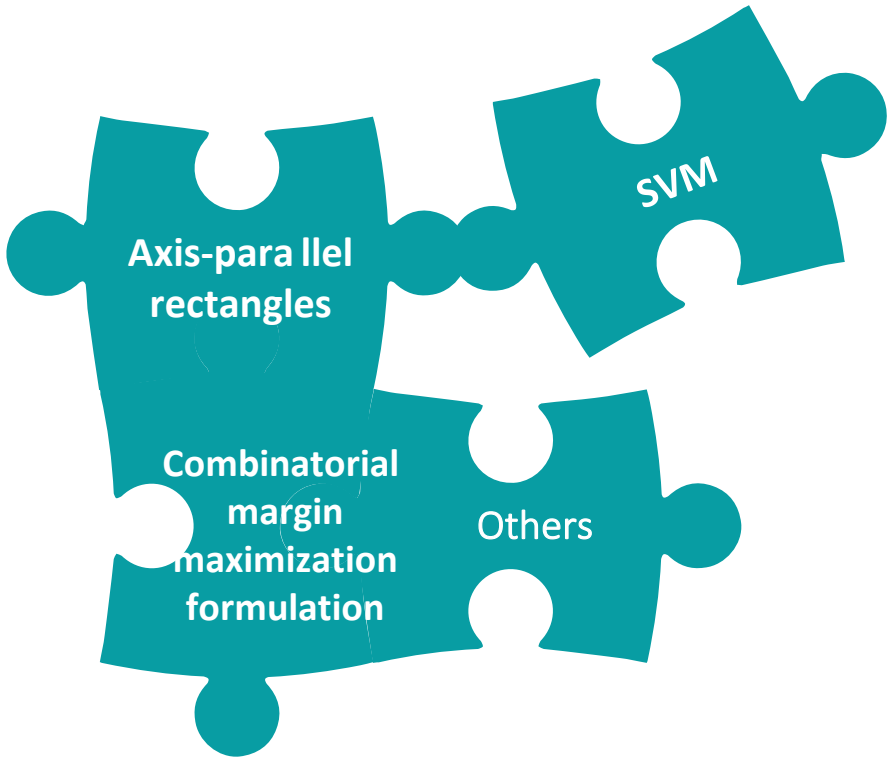
02

Ideas and Methods

课题研究的思路与方法

02 Ideas and Methods
课题研究的思路与方法

Alghorithm of MIL problems



This paper use the mi-SVM as base classifier, which are looking for an MI-separating linear discriminant such that there is at least one instance from every positive bag in the positive half space, while all instances belonging to negative bags are in the negative half space. The algorithm requires solving the following expression. This problem is a mixed integer optimization problem, thus we solve it by an heuristic optimization algorithm.

$$\min_{\{y_i\}} \min_{w,b,\xi} \frac{1}{2}||w||^2 + C\sum_i \xi_i$$

$$s.t. \forall i: y_i(< w, x_i > +b) \geq 1 - \xi_i, \xi_i \geq 0, \mathrm{y_i} \in \{-1,1\}$$

02 Ideas and Methods
课题研究的思路与方法

- **bagMargin**: The margin of the unlabeled bag could be measured either by its minimum instance margin or its average instance margin.
- **combinU**: The combinU Model is proposed by making the softmax approximation of the instance uncertainties, and define the informativeness as the approximation.
- **Noisy-Or**: The generalized Noisy-Or structure is a convenient tool for measuring uncertainty relationships.
- **Fisher information**: The Fisher information is a informativeness obtained based on the covariance matrix of the instance in each bag.

Since these four criteria do not have consistency in each bag, that is, one criterion ranks high in one bag but may rank low under another criterion.Thus we introduce multi-criteria decision making system to comprehensively consider these criteria.

02 Ideas and Methods
课题研究的思路与方法

In the multiple instance active learning based on MCDM system,we first investgate the relation between any two unlabeled samples, then a preference preorder is determined for each criterion. The dominated index and the dominating index are then calculated by the table on the right to evaluate the informativeness of unlabeled samples, which provide an effective metric measure for sample selection.

$d(\cdot,\cdot)$	$A_i > A_p$	$A_i < A_p$	$A_i ? A_p$	$A_i \approx A_p$
$A_i > A_p$	0	2a	(5/3)a	a
$A_i < A_p$	2a	0	(5/3)a	a
$A_i ? A_p$	(5/3)a	(5/3)a	0	(4/3)a
$A_i \approx A_p$	a	a	(4/3)a	0

distances between relations

03

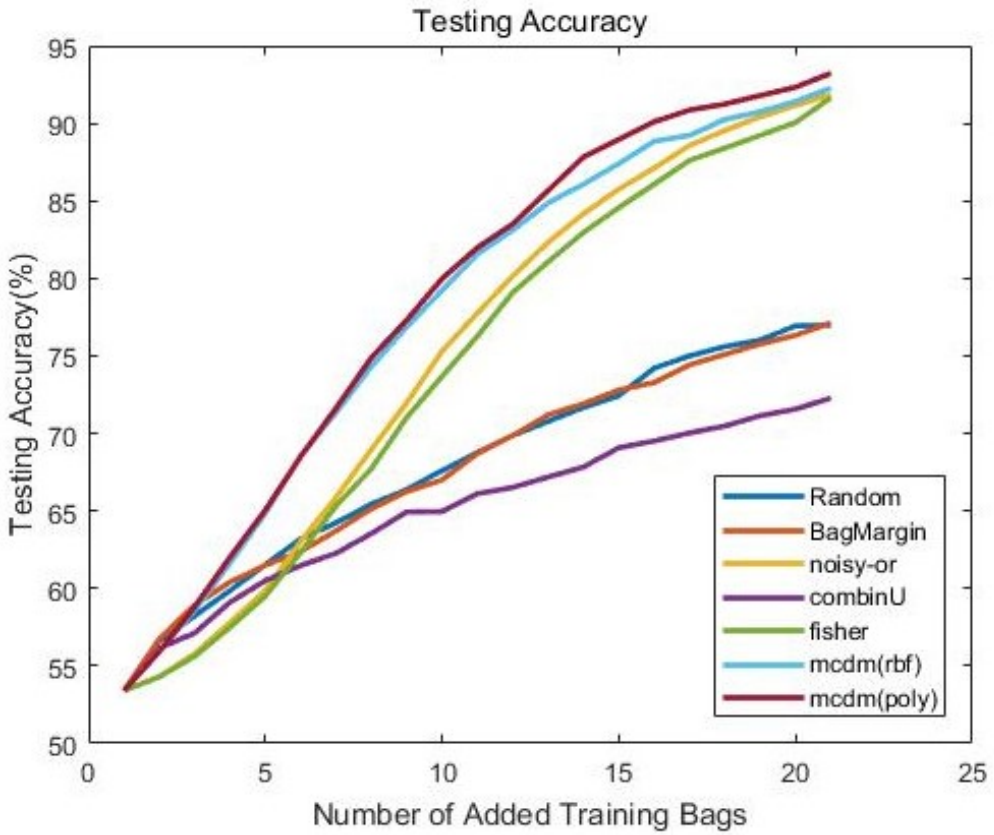
Analysis of Experiment Results

实验结果分析

03 Analysis of Experiment Results
实验结果分析

We test the learning strategies on the MNIST handwritten digit image recognition problem. For each class, we generate a single-digit MIL dataset with 100 positive bags and 100 negative bags, and randomly assign the number of instances in a bag from [10, 40].

03 Analysis of Experiment Results
实验结果分析

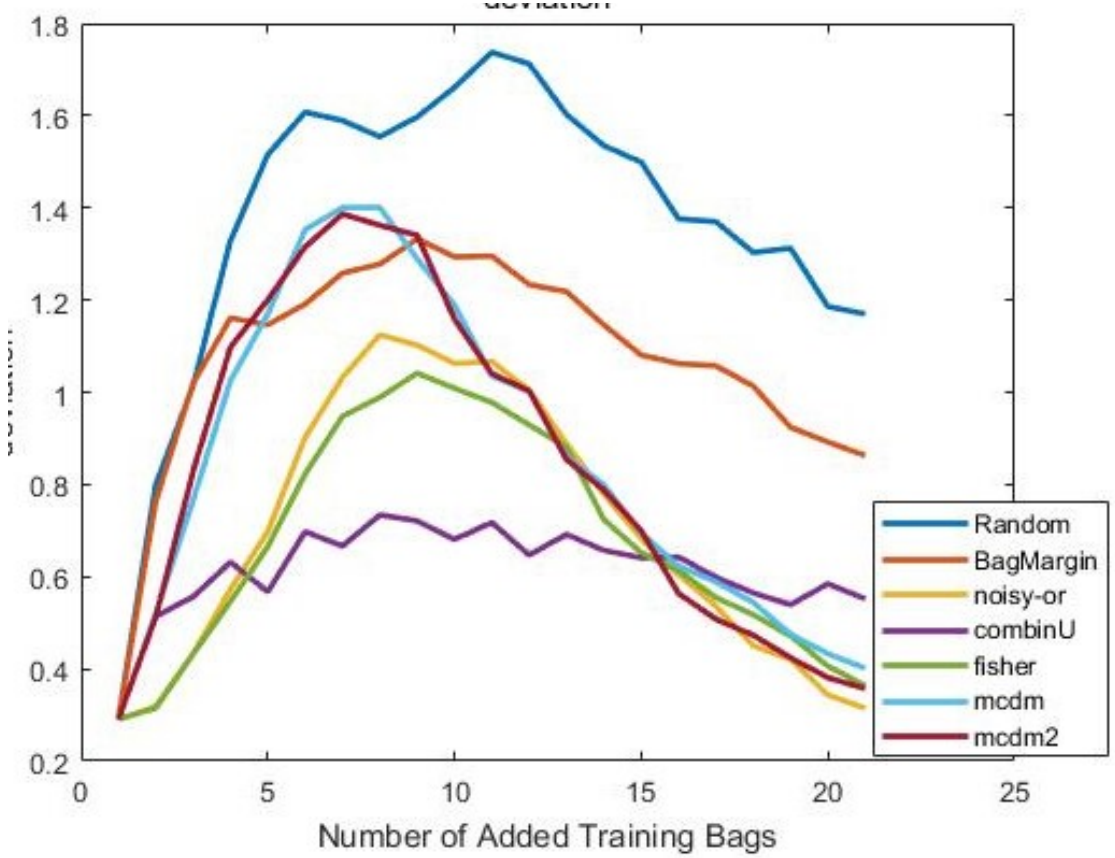


performance comparison of different learning strategies

The experimental results show that the performance of multiple instance active learning based on MCDM system is better than that based on single criteria. What's more, time complexity is in an acceptable range.

03 Analysis of Experiment Results
实验结果分析

The results shows that all the methods are unstable when the package is first added, and convergence begins when 5 packets are added. Finally, the stability of multi-criteria decision making system is second.The algorithm is also superior in terms of stability.



variance comparison of different learning strategies

04

Future Work

改进方向

04 Future Work
改进方向

How to design the weight?

In the papers of the multi-criteria decision-making system framework, multiple criteria are considered as equal weights, but the experimental results show that different criteria have different effects in different data sets. If the weights are equal, the important information may be weakened.

THANK YOU