A survey on ensemble learning

Xibin DONG, Zhiwen YU, Wenming CAO, Yifan SHI, Qianli MA

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Problems & Ideas

- Problems: Ensemble learning includes supervised ensemble classification, semi-supervised ensemble classification, clustering ensemble, semi-supervised clustering ensemble, and we want to give a summary for ensemble learning through this survey.

- Ideas: We shall give summary for ensemble learning from different aspects such as sample processing ,feature processing, etc. Besides, we propose challenges and potential research direction for each mainstream of ensemble learning. In addition, we give introduction for the combination of ensemble learning and machine learning hot spots such as deep learning, reinforcement learning, transfer learning, *etc*.

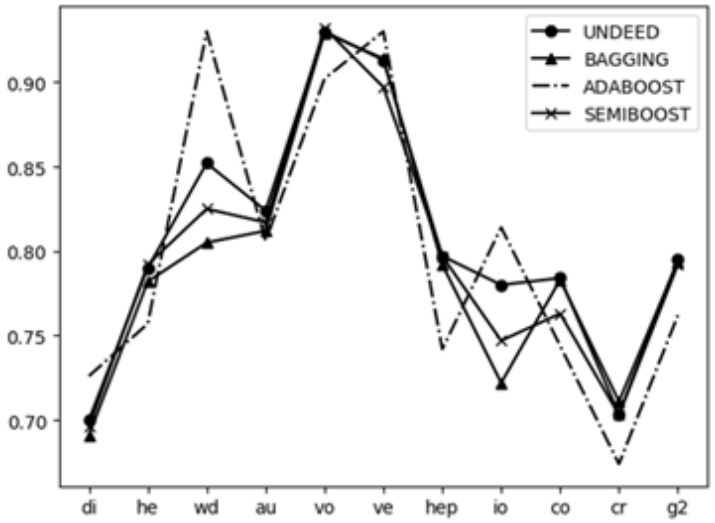

Fig. 1 Comparison of supervised and semi-supervised ensemble classification.

Main Contributions

- We review 174 research works on progress of mainstream ensemble learning approaches and classify them based on characteristics, such as feature level, sample level, ensemble level, *etc*., to provide a introduction framework.

- We summarize each category of mainstream ensemble learning approaches and present challenges and possible research directions.

- We discuss the feasibility of combining ensemble learning with other machine learning hot spots like deep learning, reinforcement learning, transfer learning, *etc.*, thereby providing inspiration for readers who focus on ensemble learning.

Table 1 Semi-supervised clustering ensemble compared with clustering ensemble

	Voting	CECH	SCECH0%	SCECH5%	SCECH10%
Iris	0.8853	0.8853	0.8847	0.9172	**0.9412**
Wine	0.9564	0.9548	0.9552	0.9583	**0.9613**
Glass	0.4714	0.4849	0.4862	0.5256	**0.5418**
Ionosphere	0.7177	0.7177	0.7175	0.7253	**0.7295**
Vehicle	0.4224	0.4456	0.4455	0.4455	**0.4518**
Diabetes	0.6656	0.6656	0.6681	0.6752	**0.6911**
Cmc	0.4319	0.4761	0.4760	0.4802	**0.4898**
Segment	0.5101	0.6903	0.6909	0.6915	**0.6918**
Sonar	0.5579	0.5556	0.5556	0.5623	**0.5686**