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Open-ended category learning for language acquisition.

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Summary: Motivated by the need to support language-based communication between robots and their human users, as well as grounded symbolic reasoning, this paper presents a learning architecture that can be used by robotic agents for long-term and open-ended category acquisition. To be more adaptive and to improve learning performance as well as memory usage, this learning architecture includes a metacognitive processing component. Multiple object representations and multiple classifiers and classifier combinations are used. At the object level, the main similarity measure is based on a multi-resolution matching algorithm. Categories are represented as sets of known instances. In this instance-based approach, storing and forgetting rules optimise memory usage. Classifier combinations are based on majority voting and the Dempster-Shafer evidence theory. All learning computations are carried out during the normal execution of the agent, which allows continuous monitoring of the performance of the different classifiers. The measured classification successes of the individual classifiers support an attentional selection mechanism, through which classifier combinations are dynamically reconfigured and a specific classifier is chosen to predict the category of a new unseen object. A simple physical agent, incorporating these learning capabilities, is used to test the approach. A long-term experiment was carried out having in mind the open-ended nature of category learning. With the help of a human mediator, the agent incrementally learned 68 categories of real-world objects visually perceivable through an inexpensive camera. Various aspects of the approach are evaluated through systematic experiments.

Keywords: vocabulary acquisition; open-ended category learning; instance-based learning; long-term learning; computer vision; multi-resolution analysis; metacognition
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