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Model for Active Recognition

Most of the models for recognition rely on bottom-up analysis of the sensory information which is then compared to some kind of memory traces (templates or structural descriptions).

Instead, we started from several principles we assume to be fundamental for the cognition and then we tried to model recognition processes based on these principles. The presented model integrates an associative organization of memory, high context sensitivity, and the assumption that analogy-making (in particular mapping) is not just an isolated human capability, but is the very core of cognition. For the debate about the role of analogy-making for recognition processes see Chalmers, French, & Hofstadter, 1992; Forbus, Gentner, Markman, & Ferguson, 1998.

It seems natural to use the dynamic and context-sensitive cognitive architecture DUAL (Kokinov, 1994), which combines all these principles as a basis for modeling. In this way, the model of recognition is integrated with other cognitive processes rather than being considered in isolation. Of course, we are far from the full accomplishment of this ambitious task. However, this is the driving force behind this study.

The input of the model is a small set of features that serve as a source of activation. The activation spreads in the long-term memory through the relevant concepts and than back to some of their instances. Locally, and a-synchronically, some hypotheses for correspondences between the input features and some memory traces emerge. These correspondences capture their neighbors and spread even further. Hypotheses for recognition emerge by the same mechanisms. At the same time, the relevant relations are transferred from the long-term memory to the scene description as anticipations (Petkov, Naydenov, Grinberg, Kokinov, 2006) for what is out there. All these anticipations are checked sequentially, in order of their relevance. If the simulated perceptual system confirms certain anticipation, the representation of the environment is enriched a bit. At the same time, another role of the verification process is to bind together the hypotheses for recognition that correspond to the arguments of the checked relation.

The result is that with very few modifications of the existing AMBR mechanisms and holding all principles of the DUAL architecture, the model is able to recognize objects not only on the basis of their features, but on the basis of the relational structure of these features as well. In addition, the structural representation of the objects is an automatic process based on the processes of analogical mapping, anticipation, and binding. In a few simulations, it was demonstrated that the system not just recognizes objects, constructed from primitives, but also it is able to recognize hierarchical objects, constructed from other complex objects. Both top-down and bottom-up processes interplay and as a consequence often the system recognizes the whole objects before their parts. Finally, the model for recognition is integrated with the AMBR model and thus, the whole process from perceptions to problem solving is simulated.

This is the first step of a long-term project. Many improvements are necessary, in particular, psychologically plausible attentional mechanisms and set of primitives in order to achieve higher ecological validity and generality.

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