An Adaptive Multi-Agent System for Architectural Sketch Interpretation

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1. Introduction

Despite the large availability of powerful and innovative computer tools, freehand sketch remains used by most designers to support their creative work. Consequently, automatic sketch interpretation offers many opportunities for the exploitation of CAD tools and evaluation algorithms from the early stages of a design project.
A sketch contains by nature many ambiguities that arise mostly from the inaccuracy of freehand drawing and from the omnipresence of implicit meanings. Therefore, the interpretation space (the set of possible interpretations) may quickly become very large, making any exhaustive exploration impossible.
Starting from existing works on cognitive models of the human visual system, we propose a new computer model for automatic sketch interpretation.

2. Results and Discussion

The computer model we propose takes some inspiration form the Copycat architecture (Mitchell 1990), a cognitive architecture aiming to discover analogies between letter strings. Our model uses the multi-agent paradigm: domain knowledge is distributed between several agents. These agents cooperate and compete to build the global sketch interpretation. This multi-agent architecture allows parallel execution of several processes: bottom-up processes that build interpretation hypotheses in an hierarchical way; and top-down processes that use high-level knowledge to bias the competition between hypotheses and to drive the interpretation process.
Interpretation hypotheses are built in a global workspace. This shared structure allows indirect communication between agents: hypotheses built by one agent will use, reinforce or compete with hypotheses built by other agents. The workspace is an active structure where competition between hypotheses happens continuously. Winning hypotheses gain activation, others lose it.
A main feature of the model is its adaptive behavior. Unlike conventional deterministic systems, this behavior is not planned beforehand but depends on the agent population. At each step of the interpretation process, an agent is chosen in a non-deterministic way and executed. Each agent has a priority value that influences its probability of being chosen. Agents searching for more common or more promising structures will have a higher priority value. This allows more promising hypotheses to be explored faster. For instance, a letter exists mostly in the context of a word; so, if a letter percept is instantiated in the workspace, agents searching for other letters close to it will be added to the system, increasing the probability that other letters be found in the neighborhood.

In order to achieve a more robust and flexible sketch interpretation, a computer system must be able to explore more efficiently the huge space of possible interpretations. The introduced model uses the multi-agent paradigm to embody within an adaptive architecture some important mechanisms identified in the workings of the human visual system. In future work, we will continue the implementation of this model in the software prototype NEMo that aims to interpret architectural sketches.

3. References

1. Mitchell M (1990) Copycat: a computer model of high-level perception and conceptual slippage in analogy making. Doctoral dissertation, University of Michigan, Ann Arbor.