MEi:CogSci

An Architecture for Universal Knowledge-based Agent (UKA Architecture)

Classical Approach

Typical approach to agent-oriented programming results in slight limitations of agent's usability. One agent is typically usable only in single environment type and for a small, strictly given set of tasks. We introduce a new term - Universal Knowledge-based Agent (UKA) - and propose an architecture and needed set of algorithms, providing complete methodology for its implementation.

UKA - Universal Knowledge-based Agent

One single implementation of this agent is usable in any environment and for various practical tasks, with modifications only in its hardware interface, thanks to environmentally independent knowledge representation and general motivational mechanism inspired by a psychological ERG model of human motivation [1]. Convenient formalism for symbolic knowledge representation and reasoning is also needed, together with significant modifications of classical AI approaches.

Besides environmental universality and task universality, our agent enlarges its knowledge base by observation and reasoning, learns new actions from repeated sequences of older ones, creates hypotheses about causes and their effects and later validates or falsifies them, makes plans - sequences of its next actions - in advance, and is autonomous.

Logic-based Knowledge Representation and IK-STRIPS

In order to be usable in complex real-world environments, our agent needs to be capable of reasoning with incomplete knowledge. As a knowledge representation language we have therefore chosen extended logic programs (ELP), which provide us with three truth values, thus allowing us to describe agent's knowledge more conveniently (without resulting in unbearable computational complexity). Performing practical tasks and ensuring agent's autonomy requires also an adequate formalism for representation of its actions, goals and plans. For this purpose, we introduce a modification of classical STRIPS formalism [2] called IK-STRIPS, which is better fit for usage with incomplete knowledge and together with knowledge represented by ELPs.

Modularity and Minsky's Society of Mind

Drawing an inspiration from Marvin Minsky's philosophy proposed in Society of Mind [3], each cognitive process in UKA architecture is performed by single individual unit. This approach keeps the complexity of each part of the system low, while resulting in intelligent behaviour of the system as a whole. UKA architecture is therefore composed of a multi-agent system, where individual sub-agents perform different cognitive processes. Only two of those sub-agents communicate directly with hardware, and therefore need to be modified for each

environment. Communication between all the other parts of the system is strictly independent on environment.

Future Research

Implementing an agent with UKA architecture is clearly not a trivial task and requires its time. However with theoretical methodology provided by this work it should not pose a significant problem. Next step in research concerning universal knowledge-based agents (planned for the following years of my PhD study) is naturally an implementation and testing of UKA architecture in various environments.

References

[1] Alderfer, C. P. (1969) *An Empirical Test of a New Theory of Human Needs*. Psychological Review: 1969.
[2] Fikes, R. E. - Nilsson, N. J. (1971) *STRIPS: A new approach to the application of theorem proving to problem solving.* Artificial Intelligence 2: 1971.
[3] Minsky, M. (1986) *The Society of Mind.* Simon and Schuster, New York: 1986.