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Discovery and Conscious/Unconscious Processing

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Discovery and Conscious/Unconscious Processing

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Some of the major open problems in artificial intelligence are:

- Dynamic extraction of related knowledge from a large knowledge base;
- Knowledge elicitation from human experts;
- Modeling the process of discovery.

We believe that the key idea for handling these problems is to notice the existence of conscious processing and unconscious processing. We accordingly proposed a cognitive model of conscious/unconscious processing (C/U model) [1]. Figure 1 shows the structure of the model. The model consists of two closely interactive parts: symbol processing and pattern processing. One of the parallel symbol processes is executed consciously (conscious processing), and all the other processes are executed automatically (unconscious processing).

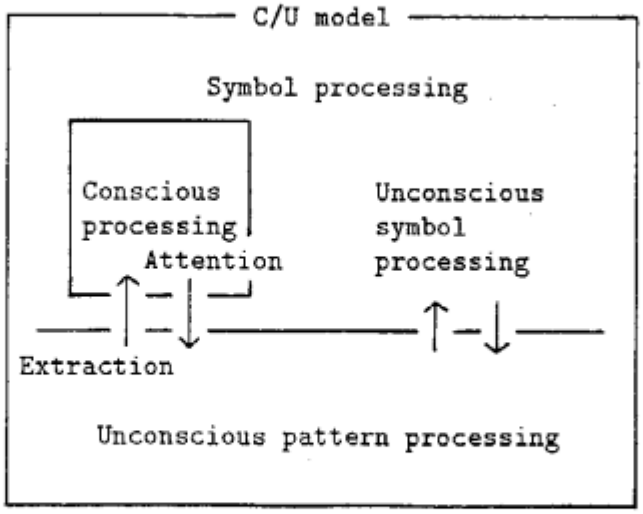

Fig. 1: Structure of the C/U model

We have implemented some small examples in a parallel logic programming language. We noticed the correspondence between the basic characteristics of the model and the characteristics of the language: AND-parallelism, choice nondeterminism, and the suspension rule. Choice nondeterminism means that one of the OR candidates is selected and other candidates are discarded; therefore, the selection cannot be made again. We utilized these characteristics of the language as is and added the following functions:

- Narrowing down OR candidates with pattern processing;
- Enabling pseudo-backtracking with recent memory.

Pattern processing can be simulated using the language as a process description language.

Currently we are trying to simulate the process of discovery with the model. As an example, we took up the process of doing a task of selecting a disparate one of a few items, for example, {speak, run, walk, write}. The process of doing this kind of task consists of conscious processing and unconscious processing as stated below.

We believe that there are three phases in the task. In phase I, the solver's attention is set. For example, he pays attention to the items of the problem. In phase II, a property for selecting a disparate item associatively occurs to him by unconscious pattern processing, according to his attention, his implicit knowledge which reflects his experience, the context and so on. In phase III, the property of each item is examined consciously using the solver's explicit knowledge. If exactly one item is disparate in the property, it can be an answer. If not, his attention is altered (phase I) according to the state of the failure and his explicit knowledge which contains strategies for problem solving, hierarchical relations of some properties and so on, and then phase II is repeated with the attention.

When the given problem is difficult, the task can be regarded as an example of discovery, that is, the process of discovery also includes those three phases. We believe that differences of discovery from ordinary problem solving are:

1. Long unconscious suspension of the goal to solve the problem which is enabled by an earnest effort to solve it;
2. The necessity of unconscious processing in phase II which is free from attention to solve the problem.

These differences give rise to the feeling of discovery.

Knowledge which can be accessed from conscious processing is associatively narrowed down by unconscious pattern processing. It enables efficient conscious processing in ordinary problem solving. However, it makes it difficult to obtain free and new ideas. Thus condition 2, that is, free unconscious processing, is necessary for discovery.

We are going to complete the simulation of the example and to evaluate the model. We also plan to study learning methods on the model. We expect efficient learning in symbol processing and pattern processing by utilizing the interaction between these two parts.

References

[1] Oka, N., Cognitive Model of Conscious/Unconscious Processing and Its Simulation in a Parallel Logic Programming Language, *ICOT Technical Report TR-415*, Institute for New Generation Computer Technology, Tokyo, 1988.