Creative-IT Project Title: A computational model of creative problem solving
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Progress Report for Creative-IT Principal Investigators Meeting

Extract from the SGER proposal project summary

Objectives. This project will develop a computer system which will solve problems creatively and will be based on the extension, abstraction and generalization of the cognitive processes that people use. By building and experimenting with such a system, original insights will be gained into the nature of creativity, which will help improve the development of creativity in our schools and workplaces. In order to develop such a system, it will be necessary to understand the different cognitive processes involved in creativity and how they can cooperate.
Methods. The model will be developed by extending an existing computational model which has been developed over the past several years by the principal investigator. This model already exists as a computer program for simple knowledge-based problem solving. It has a highly parallel architecture with components for processing goals, plans, memory and perception. In order to extend this model it will be necessary to extend its various components to incorporate new types of knowledge that are to be used creatively. It will be necessary to introduce new mechanisms for conceptual representations and their manipulation. This will need a method of representing knowledge allowing it to be flexibly abstracted or constrained as required to discover new problem solutions. The highly parallel nature of the existing model will allow many different kinds of knowledge to be activated together concurrently thereby allowing a large set of potential solutions to be considered, but it will also allow a large set of constraints to be applied together concurrently to find the best solutions.
Intellectual merit. The intellectual merit of the project will be in advancing our understanding of the important area of creativity by showing how different knowledge-based processes work together to creatively solve problems.

Progress

I have made steady process in implementing the system, which involves (i) extension of visual mental imagery mechanisms, (ii) development of an episodic memory mechanism, and (iii) generalization of the plan execution mechanism.

My main focus in research into creativity is the combination of two or more different sources of knowledge to achieve novel conclusions. This has divided into three levels:

1. Interagent cooperation. With two agents having different representations of the problem, how can they engage in a cooperative dialog to solve the problem, where each contributes information and actions from their own perspective and vantage point. We have experimented with a simple dialectic logic system. We based this on logic programming, i.e., SL-resolution or Prolog. The main problem has been the treatment of negation in the dialectic case. We tried to develop a different approach to negation but eventually decided to use two negation operators, "not" for closed world negation or negation as failure, and "¬" for open world negation.

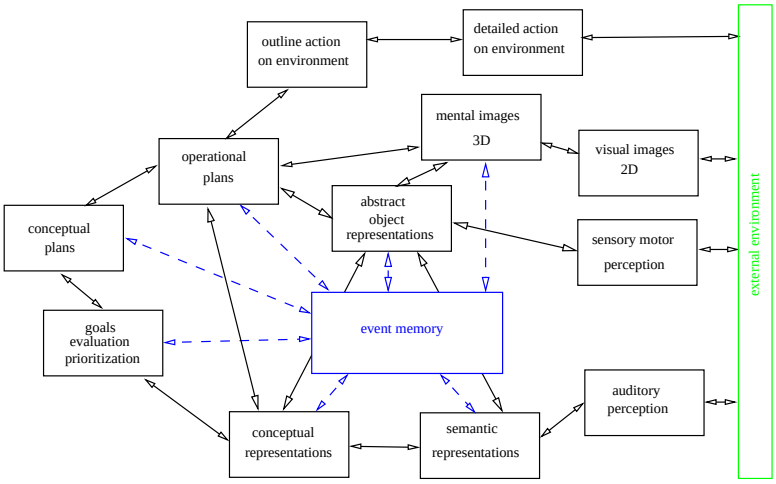

Figure 1: The architecture of the system

2. Cooperation between system modules or modalities. This was our first idea, that the problem solving system could have a salience/overall attention system which could switch attention or dominance to different modalities during the course of solving a problem. One difficulty is in finding how modules for different modalities can obtain usable information from each other, in addition to providing usable information to the planning/executive system.

3. I have been drawn to a new area which is quite topical namely the creative construction of plans and solutions using episodic memory components or fragments. This is needed in order to generalise the plan execution mechanism to be highly parallel if it is to believably correspond to an abstraction of a brain mechanism. It has also recently been researched as a constructive mechanism for memory "retrieval", and also for the development of novel future plans, by Daniel Schacter's cognitive psychology group at Harvard. This involves defining episodic memory in terms of sets of memory components which can be evoked using associative keys, and then developing a highly parallel plan/memory mechanism for the construction of a desired plan or fact from retrieved components. My idea is that there is a basic mechanism which iterates between a working data set and an associative store of episodic memory components, until it constructs a data set or structure which satisfies all the constraints in the working data set.

My idea on applications is to organize the system to use knowledge source modules held on the web, using some standard format such as an XML/RDF version of a logic programming language. In the case of interagent cooperation or intermodule cooperation, a knowledge source module would be a set of logical assertions, or logic program. In the case of constructive memory, it would again be a set of logical assertions but these would represent episodic memory, or "experience" components.