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The role of cognitive processes in creative problem solving: a computational approach.
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Context: a multi-disciplinary perspective on ill-defined learning activities

Creativity, a phenomenon whereby something new and valuable is formed by a subject in a given context, plays a critical role in specific phases of learning activities. Here, we aim at analyzing creativity in the precise context of ill-defined problem-solving tasks, as it can be experienced during learning activities.

This study aims to contribute to a better understanding of creativity within ill-defined creative problem solving (CPS) tasks, including complex problem solving, through a multi-disciplinary approach using computational and neuro-cognitive formalisms. This approach allows us to propose a multi-factor theoretical description of such cognitive human activities. Based on this, we aim to operationalize a computational framework of creative processes during CPS learning tasks. We focus on an ill-defined CPS task performed by a unique learner, while even in this case sociocultural perspectives have to be considered to model prior knowledge and situational awareness aspects.

Problem solving as a trajectory generation

A problem space consists of:
- a set of goal states
- a set of path constraints

The problem is to find a path through the space that starts at any initial state, passes only along paths that satisfy the path constraints, and ends at any goal state.

Formalizing problem solving as a trajectory generation problem in an abstract state space. Here, the definition is extended to complex ill-defined problem solving and allows us to propose an operational specification of creativity in this context.

Neural basis of creative problem solving

A general view of the brain functional organization, discussed here. From (Keltner, 2005) adapted to our purpose. The default network (1) semantic representation (Cr) corresponds to the default posterior pathway, while the default/parietal (2) to regions of interest (3) representing the default posterior pathway.

In the anterior part of the brain, the default network (1) semantic representation (Cr) corresponds to the default posterior pathway, while the default/parietal (2) to regions of interest (3) representing the default posterior pathway.

To summarize, the lateral ventricles correspond to solving values calculation, while the frontal area corresponds to solving values representation.

The key point is that such concepts can also be considered as points in an abstract state space.

A computational framework for knowledge representation

Symbolic concepts anchored on sensorimotor features...

A symbolic knowledge graph providing multiple layers of abstraction as well as anchoring into sensorimotor feature spaces, inspired by (Michalkiewicz, 2005). (Gardent, 2004). (Wiggins, 2006). (Hommel, 2001) and (Dibattista, 2010) among others.

We hypothesize that solving such ill-defined problems requires creativity, in a sense of the competency to generate, select and implement ideas that are both
- novel (i.e., original, unexpected) and
- appropriate (i.e., useful, adequate regarding task constraints),

from the problem posing disambiguation to the problem solving evaluation within a specific task and sociocultural context.

Creative problem solving, step by step

General schema of creative problem-solving steps, adapted to our approach, from the componential model proposed by (Amabile 1996). The central part corresponds to the creative process itself.

References


The distance between the current state and the goal state can be estimated using a nil distance between two sent ordered abstract template (semantic structure).