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A Computational Model for Creative Problem Solving

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Problem Solving may be classified into ordinary problem solving (OPS) and creative problem solving (CPS). Within our model, called INSPIRER, CPS is on a continuum with OPS, although we point out some differences in the properties of the solutions and in the process of producing solutions in those two kinds of Problem Solving.

The goal of CPS is to produce an appropriate and original solution (Boden, 1995). By appropriate we mean being useful and, internally and externally coherent. By original we mean being somehow unexpected or non-obviously novel. A non-obviously novel and appropriate solution causes surprise. On the other hand, we see OPS as the production of a solution that is just appropriate but not original, and therefore not surprising.

In our opinion the process of producing solutions in CPS and in OPS comprises a sequence of the following steps (Wallas, 1926): Preparation (problem acquisition and background knowledge assimilation), Incubation (attempt to construct a solution to the problem using background knowledge), Illumination (preposition of the solution) and Verification (validation and evaluation of the properties of the solution). In our approach, background knowledge (both episodic and theoretic) is represented by graphs. Each knowledge graph comprises a set of spatially, temporally, causally or hierarchically interconnected knowledge nodes (knowledge fragments). A problem is just a set of possibly interconnected knowledge nodes representing an incomplete solution. The system just has to complete it. Knowledge nodes iteratively retrieved from memory are adapted to fill the missing nodes of that incomplete solution. This retrieval is context-guided, i.e., candidate knowledge nodes are selected from prior knowledge structures taking into account the similarities between their neighborhood (set of knowledge nodes and relations that surround a knowledge node) and the neighborhood of the missing knowledge node.

In OPS the selected knowledge nodes are the ones with higher context similarities, and the adaptation strategies are the more obvious ones. However, considering the combination-theory of creativity, which says that creativity consists on relating previously unrelated things, then, within our approach, CPS is achieved relating previously unrelated knowledge nodes. This is performed using a retrieval process that does not select the highest context similar knowledge nodes from prior knowledge structures, and/or using an adaptation process that does not make the more obvious adaptations. The result is that a knowledge node is put in a different context, and thus new and probably non-obvious relations may be established between it and the knowledge nodes that belong to its new context. Within this process some cognitive risks are taken, which may lead to bizarre solutions (solutions without appropriateness). This way, CPS results of mechanisms like retrieval and adaptation, which are on a continuum with those used in OPS, as defended by Ram et al. (1995).

Guilford (1968) has claimed that the exploration of creative solutions is mainly due to the mind ability that he called divergent production. This ability involves the generation of a variety of solutions to a same problem, and differs from convergent production, which is used when reasoning logically to produce the sole appropriate solution for a problem. Within our approach divergent production of solutions is achieved by repeating the construction of an entire solution for a same problem several times, each time changing the threshold of context similarity used in the retrieval (divergent retrieval), and/or changing the adaptations applied to the retrieved knowledge node (divergent adaptation). Exploring the possible combinations of the different thresholds and different adaptation strategies for the several missing knowledge nodes of a solution may lead to the construction of an extremely great number of different solutions to a same problem. The user may control this process: for example, he/she may choose the threshold to be used in a specific selection of a knowledge node, and thus, he/she may control somehow the originality of the solution. Other way may be computing automatically the possible combinations. At the end, the user may choose the best solutions.

Convergent production is used to construct ordinary solutions: a convergent retrieval and convergent adaptation involves no cognitive risks.

References

Boden, M. (1995). Creativity and unpredictability. *SEHR*, 4, 2.

Guilford, J. (1968). *Intelligence, creativity and their educational implications*. San Diego, CA: Robert Knapp.

Ram, A., Wills, L., Domeshek, E., Nersessian, N., & Kolodner, J. (1995). Understanding the Creative Mind. *Artificial Intelligence Journal*, 79(1): 111-128.

Wallas, G. (1926). *The art of thought*. New York: Harcourt Brace.