The Minimal Cognitive Grid: A Tool to Rank the Explanatory Status of Cognitive Artificial Systems

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Building artificial systems able to exhibit human-like and human-level behavioral capabilities represents one of the main goals of the two Sciences of the Artificial, namely: Artificial Intelligence (AI) and Computational Cognitive Science (CCS) (see Simon (2019), Simon (1980)). While the first discipline, however, is nowadays (and in partial contrast with its early scientific ambitions) mainly interested in only the functional replication of such behavioral capabilities, computational cognitive science (including the field of computational neuroscience) additionally aims at using such models for explanatory purposes: i.e. to better understand the unknown biological and/or cognitive mechanisms underneath a certain behavior.
However, despite the enormous amount of literature devoted to the theme of "computational explanation" and to the so called "simulative method" (Cordeschi, 2002), a real methodological and practical operationalization of what such expression really meant was lacking. To fill this gap I have proposed the Minimal Cognitive Grid (MCG), (Lieto, 2021): a simple methodological framework that can be used to practically project, compare, and rank the epistemological and explanatory status of biologically and cognitively inspired artificial systems. The MCG relies on the following dimensions of analysis:

1. **"Functional/Structural Ratio"**: this dimension considers the ratio between "functional" and "structural" components (and heuristics) considered in the design and implementation of an artificial system (for the distinction between "functional" and "structural" see Lieto 2021). This ratio depends on the actual focus and goal of the model and can be used for both integrated systems performing different types of tasks and for narrow and task specific systems. This dimension enables, in principle, the possibility of performing both a quantitative and qualitative comparison between different biologically or cognitively inspired artificial systems.

2. "**Generality"**: this features aims at evaluating to what extent a given system/architecture can be used in different tasks, i.e. how much the model is general and can be used to simulate a set of cognitive functions and not just a narrow one. Also this element can be considered both from a quantitative (e.g. by counting how many cognitive faculties can be modelled within a single system) and qualitative point of view.

3. "**Performance Match**": this dimension involves a direct comparison between natural and artificial systems in terms of the obtained results for specific or general tasks. In addition, however, I suggest to take into account some of the main hints of *Psychometric AI* movement (Bringsjord, 2011) asking for the use of a battery of validated tests to assess the effective "match" between artificial systems and human beings. In this line, thus, I also propose to consider two additional specific requirements that refers to such aspect: 1) the analysis of the system errors (that, in human-like artificial systems, should result to be similar to those committed by humans) and 2) the execution time of the tasks (that, again should converge towards human performances).

In this paper I will show how the MCG can be applied both to the analysis of classical cognitive artificial systems (Lieto, Libere and Oltramari, 2018) and to the class of hybrid bionic systems (Lieto, 2022).

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