"Integration" of Social Sciences with Cognitive and Computational Sciences

Mark Finlayson[1], Ph.D.
Massachusetts Institute of Technology (MIT, USA)

23 January 2014
Abridgement

1. Why to "integrate" cognitive and computational sciences with social sciences; why now?

"Integration" of cognitive and computational sciences with social sciences, or else application of cognitive and computational research findings to social sciences, allows to address social sciences issues at completely new levels which generate more comprehensive and in-depth explanations of social phenomena. Why?

The cognitive science component considers the human brain, which is the mental and biological foundation of human behavior and subsequently produced processes. Noam Chomskyan revolution in the 1960ies set a new direction of research based on innate human abilities and structure of the human brain and since then the western science has been oriented towards research incorporating the cognitive component. The last few decades have witnessed proliferation of this type of research due to the rapid technological progress (e.g. the development of due methodology and invention of proper equipment). The prior behaviorism school of Burrhus Skinner, based on the concepts of tabula rasa and resulting copying behavior, was "transformed" into a questionable line of research to pursue. One aspect of the difference between the two schools could be illustrated by the following exemplification:

> Is it really possible to meticulously, in-depth and reliably account for and predict all types of aircraft landing in strong side surface winds, including surviving and fatal emergency landings, based on a set (limited) number of previously observed landings under various conditions without consideration of aerodynamics, aircraft design and the pilots' brains that direct pilots' actions?

[1] For full information, watch Mark Finlayson's talk at BIA

However, the application of the cognitive component without the computational one might not always be possible or indeed reasonable in issues that address the relationships that exist at levels of interaction of larger groups of a population. The following figure provides abridged descriptions of the tasks that cognitive and computational levels attempt to address, which subsequently reveals the necessity of application of both disciplines in concert.

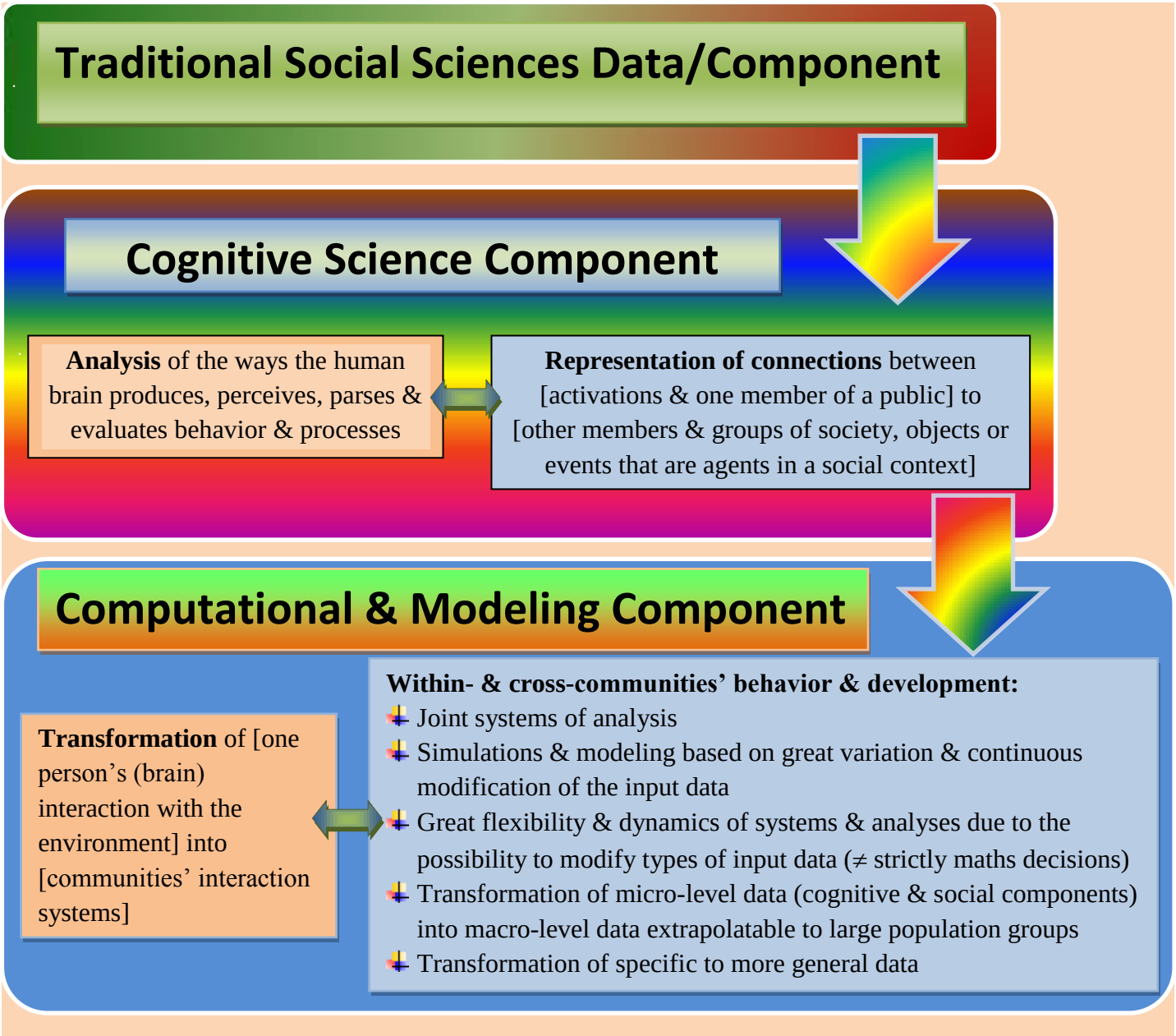

Figure 1: Connections between Social, Cognitive & Computational Sciences

Undoubtedly, social sciences can continue to operate within the framework of their traditional methodology and research areas. This approach, however, limits not only the depth and types of questions that can be posed; it also halts the development of the field and types of competences that social sciences students are in fact in the position to acquire in the contemporary world of advanced computerized technologies and widespread interest in the structure of the human brain.

2. "Integration" of cognitive science and computational components: David Marr' theory

The necessity to link the cognitive/neural level of analysis with computational was advanced by David Marr, a deceased professor of MIT. Although his endeavors concentrated on the development of the theory of human representation and processing of visual information (in particular, he was intrigued by how a two-dimensional image received by retina is transformed into a three-dimensional image in the brain), his approach can be extrapolated to other types of human representations and processing operations. Marr identified three levels of analysis that is required to conduct the perception, processing and transformational functions to construe a form and its meaning in the brain. The following figure provides an abridged description of it.

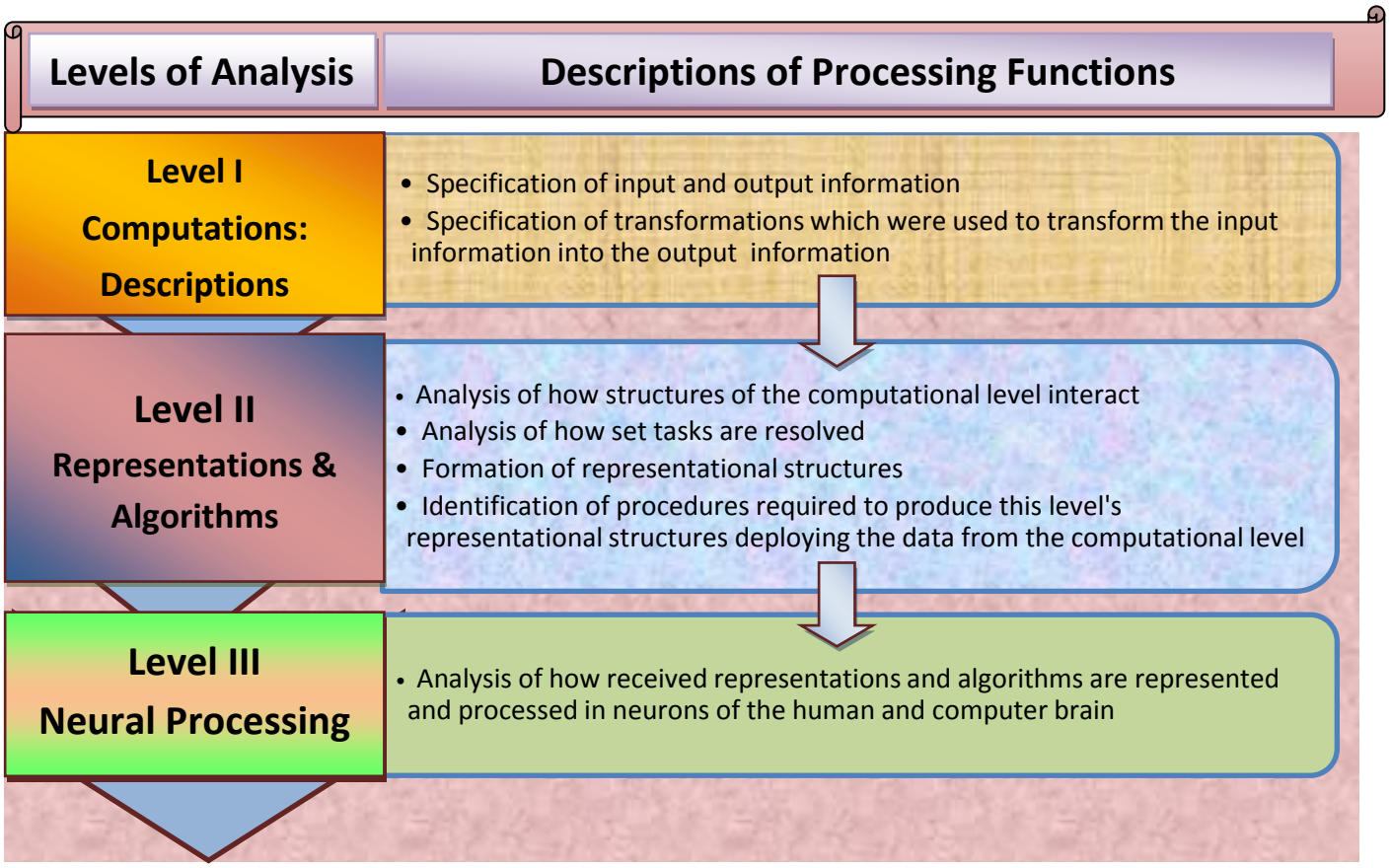

Figure 2: David Marr's Levels of Analysis

Consistently with Figure 2 representation, Marr's analysis of human processing of information is a top-down hierarchical structure of a somewhat modular nature. Specifically, tasks of a particular nature can be addressed only at one and not another level. In other words, the study of connections among neurons in the brain, which is Level III analysis, can generate neither descriptions of the Level I analysis nor representations and algorithms of Level II analysis. The products of processing mechanisms of all three levels are essential for the construction of a final image in the brain. For example, it is impossible for neurons to activate the image of a "bleakit" (non-word) or a horse as whole objects without the knowledge of their representations, in other words, its components, such as a tail, head etc, in the case of a horse.

3. Examples of "integration" of social sciences with cognitive and computational sciences

Narration is an important research constituent in social sciences because it creates systems of ideology, values, differences etc. One possible application of **"integration" of social sciences with computational sciences** can be the application of computerized systems, such as those used in natural language processing, for the discourse analysis of narration**.** Modern software programs are capable of identifying deeper semantic structures, such as thematic roles, including the implied ones and possible structures in multiple interpretation cases. Therefore, such systems can conduct both quantitative and qualitative (at least certain aspects of it) analyses. The result is the ability to construct integrity of narration as well as construe correlations and interactions of various components of both a particular structure of narration and narration overall.

Mark Finlayson also deploys natural language processing programs in his own work on corpus-recorded stories that globally dominate societies of the world and culture-specific adaptation strategies used by cultures to adjust such folklore narration to culture-specific systems of values and interests. In fact, Finlayson has designed a computer program the ***Story Workbench***, which identifies not only thematic roles and main conceptual structures of narration but also Vladimir Propp's components of folklore narration. Finlayson's program analyzes various sets of parameters, such as syntactic structures of various levels (including both the deep and surface structures), lemmas, events, time relations etc.

The application of cognitive science findings to explanation of socio-political events was demonstrated by Yuen Foong Khong in his book *Analogies at War* in which he exposed the lack of tools in the depository of social sciences methodology to account for survey data (survey of legislators) and revealed the reasonable strength of the cognitive theory of decision-making and analogies to explain the foundation of political decisions and their future development. In particular, legislators' prior political predispositions, grounded in the field of their specialization, at the time of immersion into a precedent context were found to affect political decisions subsequently passed. Thus, it was concluded that historic errors, similarly to motivation behind political decisions, tend to reoccur due to the activation of interfering analogies of newly set or already existing parameters.

4. Academic and student-oriented advantages of "integration" of social sciences with cognitive and computational sciences in academic programs

Implementation of cognitive and computational disciplines into humanities and social sciences undoubtedly enhances the competitiveness of academic programs, research activities and graduates due to the current and foreseeable future developments of various markets. Similarly to any other discipline, cognitive and computational sciences can be studied at various levels of complexity, including the ones adapted for non-specialists.

Useful links

http://www.mit.edu/~markaf/
http://projects.csail.mit.edu/workbench/