

Editorial

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A subset of six papers included in this issue of *BICA* resulted from presentations given in November 2013, when a AAAI fall symposium convened on the topic of *integrated cognition* – aimed at consolidating across the broad range of fundamental phenomena and functionality implicated in thought, both in natural minds and brains and in artificial cognitive systems. The symposium’s name was deliberately new, but the idea has roots that reach broadly and deeply into the originating grand challenges of neuroscience, cognitive psychology and artificial intelligence. Integrated cognition aims squarely at understanding the central question of those challenges: how complex cognition can arise from the interactions among simple adaptive mechanisms. It spans both the traditional cognitive functions that have been the focus of cognitive architectures, such as memory and learning, planning and problem-solving, knowledge representation and reasoning, but it also seeks a grand unification with aspects that have often been treated separately, such as perception and motor actions, personality and emotion, and motivation and meta-cognitive control.

The goal of the symposium was to initiate a dialogue across the diverse community of researchers concerned with this topic, including those focused on matching experimental human data; developing applications in complex environments; integrating neural constraints and models; achieving biologically inspired, human-level and artificial general intelligence; and building complex cognitive systems. The call for papers explicitly included both sides of such dichotomies as: high-level versus low-level cognition, natural versus formal inspiration, modeling natural systems versus creating artificial systems, cognitive architectures versus the relevant phenomena above and/or below them, embodied versus isolated cognition, working mechanisms versus abstract constraints, research versus applications, and mind versus brain.

A number of existing communities, conferences, and journals overlap substantially with integrated cognition but each originated from one particular perspective. As a result, some have traditionally welcomed only work that is consonant with their origins, and all have typically attracted only a limited segment of the entire community, even when – as with *BICA* – they have explicitly sought to become more inclusive. Our belief is that the most direct road to a true understanding of cognition is to integrate all these perspectives into a converging set of constraints and mechanisms. With the integrated cognition symposium, the intent was to provide a neutral ground where all would feel welcome, where ideas and results could be shared across existing boundaries, and where an open discussion could be held on

how best to support such activities going forward. The name was thus designed to be as unbiased as possible and to avoid an accompanying burden of past history.

The symposium succeeded in assembling a wide range of people and perspectives, with accepted papers and panels grouped into sessions on: social, emotional and motivational; metacognitive; neurocognitive; integrating language and cognitive architecture; knowledge and mechanism integration; and task-level integration. Six of the best papers were selected and adapted for inclusion in this issue of *Biologically Inspired Cognitive Architectures*.

Two of the articles connect the traditional level of cognitive architectures to processes below it. From the neurocognitive session, and a natural perspective, the article by Szabados, Herd, Vinokurov, Lebiere and O'Reilly on "Integrating systems and theories in the SAL hybrid architecture" integrates the ACT-R cognitive architecture with the Leabra neural architecture to examine the complementary benefits of the two classes of systems in challenging robotic environments. From the knowledge and mechanism integration session, and a more formal perspective, the article by Derbinsky, Bento and Yedidia on "Methods for integrating knowledge with the Three-Weight Optimization Algorithm for hybrid cognitive processing" proposes a novel optimization algorithm as an efficient and general tool for constructing the variety of cognitive mechanisms required in an architecture.

Two of the remaining articles, both from the knowledge and mechanism integration session, focus directly on cognitive architectures, and on how combinations of their mechanisms – plus the knowledge embodied in them – can yield intelligent behavior in complex scenarios. In "A case study of knowledge integration across multiple memories in Soar," Laird and Mohan investigate the combination of Soar's learning and memory mechanisms for situated instruction of commands for a robot arm, aiming to achieve increased autonomy in interaction with the world; and in "Integrating perception, narrative, premonition and confabulatory continuation," Bölöni investigates the ability of the Xapagy architecture to implement the thought processes that occur while understanding stories and other complex narratives. Both of these articles reflect perspectives that blend the natural and the artificial.

The final two articles, both from the task integration session, address the need to achieve coherence in integrating complex task constraints above the level of cognitive architectures (ACT-R in particular). In "The gap between architecture and model: Strategies for executive control," Taatgen explores the possibility of domain-independent control knowledge on top of the architecture; and in "The macro architecture hypothesis: A theoretical framework for integrated cognition," West proposes a coarser-grained SGOMS architecture layered on top of the traditional cognitive architecture. Both papers attempt to reconcile the strong constraints of detailed human performance in specific tasks with the goal of achieving general intelligence across a broad range of domains.

This selection of six articles cannot do justice to the full range of contributions at the symposium, but it does provide a significant taste of it. It also spans quite different degrees of biological inspiration. Fortunately, BICA's multidisciplinary nature makes it possible to publish them all in one place. One of the major recommendations to come out of the symposium was that others should follow this lead of being explicitly more open to important work on integrated cognition that pushes the boundaries of their original perspectives, irrespective of how they have come to be labeled. The expectation is that this would help accelerate progress across the board on the overall set of interrelated grand challenges by significantly improving crosstalk among communities and perspectives, by bringing to bear converging constraints on the complex design space of intelligent systems, and by ensuring that important integrative work on cognition does not fall between the cracks of the disparate perspectives.