

Preface to The AIIB 2010 Symposium: AI-Inspired Biology

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1 BACKGROUND TO THE SYMPOSIUM

This symposium is one of a series of events loosely related to the UK Computing Research Committee's Grand Challenge No 5: GC5 *Architecture of Brain and Mind*². GC5 is a multidisciplinary attempt to understand and model natural intelligence at various levels of abstraction, demonstrating the results of our improved understanding in a succession of increasingly sophisticated working robots. GC5 is one of a set of research grand challenges initiated in the UK in 2002.³ Several of the grand challenges are related to biology and/or natural intelligence, but most of them involve using what can be learnt from research on biological systems to drive research in computing and artificial intelligence, to solve engineering problems, including work on biologically inspired robotics. This is also true of most work in the GC5 area and also the EU's cognitive systems initiative.

In contrast, over the last few years, the four organisers have been discussing various ways in which ideas from research in AI/Robotics can influence biological researchers of various sorts. We are not unique in doing that but we felt that the importance of the influence of AI on biology has not been sufficiently widely recognised. We therefore used the opportunity provided by the AISB2010 convention to propose a symposium that would promote the idea that there is much to gain by emphasising ways in which studies of natural cognition could benefit from interaction with AI/Robotics, and including presenting examples of work already done, articulating general principles that are worth applying in such work, and exploring possible future directions for such work. This symposium emphasises the roles of AI in *contributing* to research on natural cognition, as opposed to research that attempts to *imitate* or *apply* aspects of how organisms work (e.g. their morphology, their neural mechanisms, their information processing architectures, their development, etc.) to solve engineering problems. Research in which the influence is bi-directional was also accepted.

2 AIIB vs BIAI

Work on AIIB (AI-Inspired Biology) can be contrasted with work on BIAI (Biologically-Inspired AI), although there is some overlap. The latter would include, for example:

- Attempts to mimic details of the morphology and behaviour of humans or other animals;
- Attempts to apply theories about how neural or evolutionary mechanisms work, to solve engineering problems;

- Applying techniques inspired by social behaviours of organisms, including swarming, flocking, use of pheromone trails, etc.;
- Attempts to understand the problems solved by biological evolution in order to clarify goals and requirements for AI/Robotics;

In contrast, AIIB research is concerned with influences in the opposite direction: from AI/Robotics to biology, i.e. using ideas from Computing and AI to help drive research on various aspects of natural cognition, e.g. in birds, primates, octopuses and humans, as well as research on aspects of evolution, general features of neural mechanisms, and social behaviours of various kinds. The process could use results from previous BIAI research, and may also suggest new BIAI applications.

3 A More General Phenomenon

The idea of AIIB is a special case of a more general scientific process in which developments in technology inspire advances in biology, for example: using ideas developed for asdic and radar to explain whale and bat echolocation, and using the science behind infrared heat sensing devices to explain the pit organ found in some vipers. Examples of research that might proceed in both directions include (a) the difficulty of getting AI vision systems to cope with reflections and specularities/highlights on reflective surfaces, which defeat standard stereo vision algorithms, but help humans see surface structure, and (b) the inappropriateness of using wavelengths associated with image regions in current vision systems as a basis for colour labelling, since that both fails to deal with colour constancies in changing lighting conditions, and also fails to explain colour illusions. These phenomena (and many more) suggest that effective (human-like) vision requires mechanisms that can do multiple (soft) constraint propagation from different sources of knowledge. That general idea has emerged in AI research, but may need to be informed by more research on natural systems. Attempts to deploy multiple constraint propagation mechanisms in multi-functional vision systems are likely to pose new research questions for psychologists and neuroscientists studying vision, as well as for AI vision researchers.

Additional example topics, including both research in progress and also future possible types of research are listed on the symposium web site <http://www.cs.bham.ac.uk/research/projects/cogaff/aiib/>, and more are reported in the papers in this volume.

4 CONTRIBUTIONS

The organisers invited the following researchers who have already made significant contributions to AI-inspired biology, or are doing

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² <http://www.cs.bham.ac.uk/research/projects/cogaff/gc/>

³ <http://www.ukcrc.org.uk/grand-challenge/>

research on natural cognition to which AI could make a contribution, to give presentations and take part in discussions.

- Prof Margaret Boden, Sussex University:
agreed to lead the “where next” discussion in the closing session.
- Prof Kim A. Bard, Portsmouth University:
Social Cognition: Views from developmental and comparative psychology, and robotics on the role of emotion in joint attention.
- Prof Nick Chater, University College London:
Biological and cultural foundations of human language: Insights from computer simulations.
- Dr. Richard P Cooper, Reader, Birkbeck College London:
“Forward and Inverse Models in Motor Control and Cognitive Control”
- Prof Richard L. Lewis, University of Michigan:
The Adaptive Nature of Reward: A Computational Framework for Understanding Intrinsic Motivation
- Prof Antje S. Meyer, School of Psychology, University of Birmingham and Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands:
The role of vision and attention in language processing
- Dr. Anil Seth Reader, School of Informatics, University of Sussex:
Causal Networks in Neural Systems: from Brain-Based Devices to Consciousness
- Prof Murray Shanahan, Imperial College London:
Why Can’t We Build Robots that are as Clever as Crows?

Two of the organisers will also give presentations, based on the first two papers in this collection. There was also a call for contributions in the form of papers or posters. The accepted papers and poster abstracts are included in this volume. Additional material has been posted on the symposium web site <http://www.cs.bham.ac.uk/research/projects/cogaff/aiib/> and it will be preserved after the event, with relevant contributions from researchers working on AIIB added later, whether they took part in the symposium or not. The symposium schedule will also be posted on the web site.

5 ORGANISATION

The four symposium organisers reflected the cross disciplinaryity of the symposium:

- **Biosciences**
 - Jackie Chappell (Biology)
Symposium Chair and Chief Editor: Symposium Proceedings
School of Biosciences, University of Birmingham
 - Susannah Thorpe (Biomechanicist)
School of Biosciences, University of Birmingham
- **AI/Robotics/Philosophy**
 - Nick Hawes (AI/Robotics)
School of Computer Science, University of Birmingham
 - Aaron Sloman (Philosophy/AI/Robotics)
School of Computer Science, University of Birmingham

Additional Committee members:

The following gave advice and support and most of them also helped with reviewing of submitted papers and poster abstracts.

- Alison Pease, Edinburgh
- Andrea Baronchelli, Universitat Politècnica de Catalunya, Barcelona

- Andrew Philippides, Sussex University
- Carole Beal, University of Arizona
- Chandana Paul, Harvard
- Chris Brown, Rochester
- Dietmar Heinke, University of Birmingham
- Frank Guerin, Aberdeen
- Hod Lipson, Cornell
- Jake Beal, BBN
- Jeremy Wyatt, Birmingham
- Joanna Bryson, Bath
- Jon Timmis, University of York
- Luc Beaudoin, Simon Fraser University
- Martin Huelse, Aberystwyth
- Michael Wheeler, Stirling University
- Owen Holland, Sussex University
- Paul Cohen, University of Arizona
- Srinandan Dasmahapatra, University of Southampton
- Yiannis Demiris, Imperial College
- Yorick Wilks, Sheffield University

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