AISB50: ARTIFICIAL INTELLIGENCE AT A NEW BRANCH POINT

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1. Introduction

> *It should be noted that from now on 'the system' means not the nervous system but the whole complex of the organism and the environment. Thus, if it should be shown that 'the system' has some property, it must not be assumed that this property is attributed to the nervous system: it belongs to the whole; and detailed examination may be necessary to ascertain the contributions of the separate parts.*
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> **W. Ross Ashby, 1952** [1]

An oft repeated aphorism is that the universe is constantly changing and hence that our world is in a perpetual state of flux. In order to behave intelligently within this varying natural environment, any system - be it man, machine or animal - faces the problem of perceiving invariant aspects of a world in which no two situations are ever exactly the same. Cartesian theories of perception can be broken down into what Chalmers [5] calls the 'easy problem' of perception - the classification and identification of sense stimuli - and a corresponding 'hard problem' - the realisation of the associated phenomenal state[1]. The difference between the 'easy' and the 'hard' problems - and an apparent lack of link between theories of the former and an account of the latter - has been termed the 'explanatory gap' [10] and this [unbridgeable] gap is symptomatic of the underlying dualism.

Many current theories of natural visual processes are grounded upon the idea that when we perceive, sense data is processed by the brain to form an internal representation of the world. The act of perception thus involves the activation of an appropriate representation. The easy problem reduces to forming a correct internal representation of the world and the hard problem reduces to answering how the activation of a representation gives rise to a sensory experience.

In machine perception progress in solving even the 'easy' problem has so far been unexpectedly slow; typical bottom-up (or data driven) methodologies involve the processing of raw sense data to extract a set of features; the binding of these features into groups then classifying each group by reference to a putative set of models. Conversely, in top down methods, a typical set of hypotheses of likely perceptions is generated; these are then compared to a set of features in a search for evidence to support each hypothesis.

[1]David Chalmers introduced the term 'hard problem' to investigate "Why is all this [neural] processing accompanied by an inner life?" [5]; I deploy the phrase 'hard problems of consciousness' to additionally encompass related problems pertaining to Levine's 'explanatory gap' [10].

To date successes in machine perception have been limited to a relatively small subset of the possible [human] perceptual gamut[2].. Hence, at this 50th Anniversary Convention of the AISB, AI once again finds itself, pace Dreyfus [8], at something of a branch point; a choice, not as Dreyfus imagined in 1988, between 'making a mind' or 'modelling the brain', but a choice at a much more fundamental level between neo-classical paths (e.g. GOFAI; connectionism; dynamic theories of mind; swarm intelligence etc) that are fundamentally (i) dualist and (ii) essentially formal and representational[3], and the more radical 'Embodied, Embedded, Ecological, Enactivist' - the so called '4Es' - framework.

In this context, it was a particular delight that at this golden anniversary convention of the AISB both paths towards AI were well represented: the 'classical' approaches being championed by symposia such as: *Computational Creativity; Computational Intelligence; Computational Scientific Discovery; and Evolutionary Computing*; and the 4Es being championed by symposia such as: *Varieties of Enactivism; Consciousness without inner models; Reconceptualising mental illness, and Embodied Cognition, Acting and Performance*[4]. The foundations of classical AI are by now very well known; the foundations of the 4Es approach perhaps a little less so, therefore a few words of contextualisation may be helpful.

2. The 4Es: 'Embodied, Embedded, Enactive and Ecological' Cognition

Rooted at the heart of the emerging 4Es framework is [radical] *enactivism*; a theoretical approach to understanding the mind derived from work by Humberto Maturana, Francisco Varela, Evan Thompson, and Eleanor Rosch. In contrast to classical computational (cognitivist) or bottom-up (cybernetic) approaches to machine intelligence, the emerging enactivist framework emphasises the way that mentality emerges through self-organising processes *interacting* with their environment.

At a fundamental level enactivism is non-dualist: the self arises as part of the process of an embodied entity interacting with its *umwelt* in precise ways determined by its physiology. In this sense, individuals can be seen to "grow into", or arise from, their interactions with the world. The self does not represent the world, but *produces it* through the nature of its unique way of interacting with its environment[5].

One particular 'variety of enactivism' is *sensorimotor theory* and the conference was also fortunate to host one of its founders - Kevin O'Regan - leading both a symposium on *Consciousness without inner models* and presenting at several symposia. Contemporary Sensorimotor Theory [4] offers a new *enactive approach*[6] to perception that emphasises the

[2] As is no surprise to long term critics of 'classical' AI such as Searle [17], Dreyfus [**?**] and Penrose [15]; for extended critical reflection on the impact of Searle's 'Chinese Room Argument' see, for example, [16].

[3] In describing a symbol, representation or process as purely formal, I mean both that it has no intrinsic content (semantics/meaning), and that it is 'hardware independent'.

[4] E.g. The *Embodied Cognition, Acting and Performance' symposium* featured in a post-conference 'New Scientist' article on the use of principles from embodied cognitive science in the treatment of autism, *Drama helps kids with autism communicate better* [New Scientist: April 17th 2014].

[5] Francisco Varela defined the term, "to evoke the view that what is known is brought forth, in contraposition to the more classical views of either cognitivism or connectionism".

[6] Here the term 'enactive approach' is taken from Noë [12] where he states, "What I call here the enactive approach was first presented in [13]. I refer to the view as the sensorimotor contingency theory. Hurley

role of motor actions and their effect on sensory stimuli. The seminal publication that launched sensorimotor theory is the target paper co-authored by J. Kevin O'Regan and Alva Noë and published in Behavioral and Brain Sciences (BBS) for open peer commentary in 2001 [13].

In the central argument of their paper, O'Regan and Noë suggest radically shifting the nexus of research in visual perception away from analysis of the raw visual patterns of stimulation, to refocus on the law-like changes in visual stimulation brought about as a result of an agent's actions in the [light-filled] world. In so doing it shifted the problem of vision away from that of construction of rich internal representations of an 'out there' world, to that of active exploration of the environment 'on demand'; conscious experience being *brought forth* via a series of [saccadic] movements that either confirm (or disabuse) the notion that the world *actually is* of the form currently anticipated.

In contrast to classical approaches to cognition and AI, O'Regan and Noë's sensorimotor theory - and more broadly enactivism in general - potentially account for *why* our conscious experience of the world appears to us as it does; if correct this is a significant achievement and one that may offer new insight into at least some of the *hard problems of consciousness*[7].

3. The plenary talks and keynotes

It was not coincidental that the keynote speakers at AISB50 offered talks presenting new insights on both classical and 4Es related AI and cognitive science: emerging from the classical branches of AI, John Barnden presented the first public lecture of the conference entitled *Creative Metaphor, Mind Out! Or Rather, Mind In.* John Barnden is Professor of Artificial Intelligence at the University of Birmingham where his research is centrally concerned with investigating figurative language, metaphor and Artificial Intelligence [2].

The second evening public lecture, *The Painting Fool: Weak and Strong Computational Creativity Research in Action*, was presented by Simon Colton. Simon is Professor of Computational Creativity at Goldsmiths, University of London. Computational Creativity is a sub-area of Artificial Intelligence research, which involves the study of software that can take on some of the creative responsibility in arts and science projects. In his talk Simon demonstrated the "thepaintingfool.com" in action - an artificial intelligence that he hopes will one day be accepted as an artist in its own right.

The third public lecture stemmed from a recent collaboration between 'The AISB', Dr. Kate Devlin (Goldsmiths) and 'The Colour Group of Great Britain'; a collaboration that resulted in the launch of a new AISB50 symposium entitled *New perspectives on Colour.* To celebrate, closing the AISB50 Convention on Friday evening, Dr. Hannah Smithson (Oxford) presented a special lecture entitled *New perspectives on colour from a 13th century account of light, material and rainbows.*

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and I, in joint work, deploy another term: the dynamic sensorimotor account. I borrow the term enactive from Francisco Varela and Evan Thompson (Varela, Thompson and and Rosch 1991 [19]), although I may not use it in exactly their sense. I use the term because it is apt, and to draw attention to the kinship of our view and theirs."

[7]E.g. In part it was this new, enactive, theory of visual perception that prompted AISB collaboration with 'The Colour Group' (Great Britain) on the symposium *New perspectives on colour.*

For the opening conference plenary address organisers were delighted to welcome Professor Susan Stepney from the University of York, UK, who enquired *When does a slime mould compute?* Susan's work in non-conventional computing sits somewhere between classical and the 4Es approaches to Artificial Intelligence and emphasises the importance of the *physical embodiment* of the *computational* substrate. At last year's AISB convention the 6^{th} Computing and Philosophy symposium was provocatively entitled, *The scandal of computing: 'What is computation?'* and further developing this theme Susan's plenary investigated precisely what it meant to say of a physical system 'that it computed'.

The second convention plenary was from Professor Lucy Suchman (Lancaster) who gave an elegant and wide-ranging lecture entitled *Human(oid) Robot Reconfigurations*. In seminal work, undertaken whilst she was based at Xerox's Palo Alto Research Centre between 1979 and 2000, Lucy fundamentally challenged common assumptions behind the design of interactive systems, with an incisive anthropological argument that human action is constantly constructed and reconstructed from dynamic interactions with the material and social worlds [18]; as such her strongly resonates with the 'embedded (or 'situated') theory of cognition (which emphasises the importance of the environment as an integral part of the cognitive process) and the broader 4Es approach[8].

Professor Terence Deacon's (Berkeley) recent high-profile monograph *Incomplete Nature* fundamentally challenges classical approaches to intelligence and cognition and in so doing it has won high praise from all quarters; perhaps most surprisingly from the philosopher Daniel Dennett. Over his lifetime Dennett has been a stalwart champion of computational theories of cognition against what he somewhat derisively labels its 'romantic challengers'[9], so on the surface it appears something of a volte-face to read his praise of Deacon's book promoting 'romantic" cognitive science, concluding that: "*Deacon, with his more ambitious exercise of reconstruction, has me re-examining my fundamental working assumptions*" [7]. In his plenary at AISB50 Terry outlined a new vision for a 'living machine' as one that instantiates principles of autogenesis - in which multiple self-organizing processes are linked by virtue of each producing the critical boundary constraints that maintain the others.

The final convention plenary *Ethical dilemma of the AnthropoRobotic* was from Professor Humberto Maturana (Instituto de Formacin Matriztica, Chile). Maturana first came to international fame with the 1959 paper "*What the frog's eye tells the frog's brain*" [9] one of the most cited papers in the Science Citation Index. Over seven decades Humberto's research has touched on cybernetics, languaging, autonomy and enactivism and extends to philosophy, cognitive science and even family therapy. These days, however, along with with his protege Francisco Varela, Humberto is perhaps best known for his work on *autopoiesis* [11] - a groundbreaking thesis about the nature of reflexive feedback mechanisms in living systems that led them both to conclude: "*Living systems are cognitive systems,*

[8] For an alternative analysis of related themes that makes the link (via autopoiesis) to the 4Es approach further explicit, see Winograd & Flores [20].

[9] For the so called 'romantic side' Dennett claims "Romanes and Baldwin, Kropotkin, Stephen Jay Gould, Humberto Maturana, Francisco Varela, Stuart Kauffman, Roger Penrose, Ilya Prigogine, Rupert Sheldrake, and the philosophers John Haugeland, Evan Thompson, Alicia Juarrero, John Searle, and - off the map, now - Jerry Fodor and Thomas Nagel" [7].

and living as a process is a process of cognition. This statement is valid for all organisms, with or without a nervous system".

Framed by seven apposite keynote talks, the A-Eye Computer Art exhibition and the theatrical premiere of *MIL-STD-1815*[10], the twenty-four symposia that comprised this 50th convention undoubtedly offered a unique, exciting and celebratory snap-shot of Artificial Intelligence at a pivotal branch point at this, the golden anniversary party of the AISB. Viewed in this context AI is clearly once again positioned at a pivotal branch point; time will tell along which stream future AI will most effectively flow.

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[10] A new production premiered during the conference at Goldsmiths' George Wood theatre on April 2nd 2014, connecting thoughts, ideas and biography relating to Alan Turing, Ada Lovelace, Charles Babbage and Snow White.

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