Proposal for Half-Day Highly Interactive Tutorial
15 Dec 2017

TITLE

Were "Super-Turing" Diagrammatic Reasoning Mechanisms Ancient Products of Biological Evolution?

(Short title: Evolved "diagrammatic" spatial intelligence.)

Presenter: Aaron Sloman
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Biography (can be shortened if accepted):
1956 BSc Maths and Physics, CapeTown. Rhodes Scholarship Oxford, then Senior Scholarship St Anthonys Oxford. 1962 DPhil *Knowing and Understanding* – defending Kant's philosophy of mathematics against fashionable criticism.
1962-4 Lecturer in Logic and Philosophy of Science, Hull University.
1964-1991: Lecturer, then Reader then Professor at Sussex University, (1972-3 SRC Research Fellow, AI, Edinburgh University). Helped to start AI teaching and research at Sussex, then (mid-1980s) School of Cognitive and Computing Sciences (COGS).
1978 *The Computer Revolution in Philosophy* (Online free) https://goo.gl/AJLDih

1983-1991 Led development/marketing of Poplog https://en.wikipedia.org/wiki/Poplog
With colleagues, added SimAgent Toolkit while at Birmingham
http://www.cs.bham.ac.uk/research/projects/poplog/packages/simagent.html

1991-Present: School of Computer Science Univ. of Birmingham,
Professor, then Honorary Professor of AI and Cognitive Science.
1991, 1997, 1999: Elected fellow of AAAI, Honorary life fellow of AISB, Fellow of ECCAI (Now EURAI), 2006 Honorary DSc University of Sussex

Since 2011, working on the (unfunded) Turing-inspired Meta-Morphogenesis project
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-morphogenesis.html
(Inspired by an invitation to comment on Turing's work on morphogenesis, published shortly before his death.)

Time required: Half day tutorial.
Keywords/phrases
Evolution of ancient spatial mathematical competences using "diagrams in minds"
Evolved construction kits: concrete and abstract
Biological foundations for mathematics
Evolution: the blind mathematician
Forms of representation for intelligent machines
Examples of toddler and non-human mathematical competences.

(Draft abstract on next page.)

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Were "Super-Turing" Diagrammatic Reasoning Mechanisms
Ancient Products of Biological Evolution?
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Abstract for highly interactive half-day tutorial

Varied examples of natural intelligence will be used to introduce aspects of the Turing-inspired Meta-Morphogenesis project, investigating changes of information processing functions and mechanisms since the earliest proto-life forms. Evidence is sparse, so the project requires intelligent guess-work: interpolating functions and mechanisms. Changes in life forms (including changing needs, physical forms and control processes), kinds of terrain, opportunities, dangers, types of resource and types of information relevant to survival and reproduction require increasingly complex and varied mechanisms, and actions (internal and external), including, for example, spatial reasoning about structures and processes.

These evolutionary changes required increasingly complex *derived construction kits* based on the fundamental construction kit (physics/chemistry).

Some were needed for building new *information processing* systems, including spatial reasoning mechanisms that vary across species. E.g. human construction kits build layered meta-cognitive systems used in ancient mathematical discoveries – e.g. discoveries in geometry and topology, extending earlier forms of spatial intelligence.

The tutorial will discuss requirements for such mechanisms and whether all are implementable as virtual machines on digital computers. Could chemical computers help?

It will also add (interactively) much detail to my paper submitted to the main conference: http://www.cs.bham.ac.uk/research/projects/cogaff/sloman-diagrams.pdf

Participants will be invited to comment on several types of example, e.g.
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/impossible.html
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/ijcai-2017-cog.html
plus new material.

Historical background includes 1971 critique of logicist AI (McCarthy and Hayes 1969):
http://www.cs.bham.ac.uk/research/projects/cogaff/62-80.html#1971-02
now extended to a critique of deep learning and current neural models, which lack both the expressive powers required for some information contents (e.g. for modal categories like "impossible", "necessarily") and the mechanisms of discovery and proof used by ancient mathematicians, aspects of which are also in pre-verbal toddlers, and other intelligent species.

http://www.cs.bham.ac.uk/research/projects/cogaff/misc/toddler-theorems.html

A conjectured multi-layer "Super-Turing membrane machine" able to support ancient mathematical reasoning, with precursor versions in other species and pre-verbal human toddlers, will be presented for discussion and criticism.

Discussion should help to clarify differences from statistical learning. Contrast: discovery of *possibilities, necessities* and *impossibilities* (recognized in Kant's *Critique of Pure Reason* (1781) as central to mathematical knowledge).

Whether the "diagrammatic" mechanisms can be implemented as virtual machines running on digital computing machinery is not yet clear. I suspect Turing's interest in "The chemical basis of morphogenesis" (published in 1952, two years before his death) may have been related to these questions.

Additional links to online discussions of examples and mechanisms will be provided.

If the tutorial attracts very bright learners (of all ages and backgrounds) it is possible that new research results will come out of the interactions in the tutorial. These will be made available online with named contributors.

If the proposal is accepted.

I'll make available an expanded version of this document, with many more links and references, including examples (with diagrams!), here:
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/diagrams-tutorial.html