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To be added later

META-MORPHOGENESIS PROJECT OVERVIEW

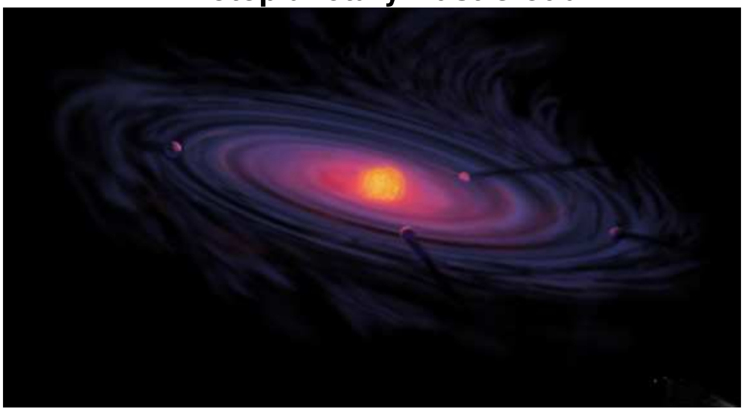
THE META-MORPHOGENESIS PROJECT
Could this be what Alan Turing would have worked on if he had not died two years after publishing his 1952 paper on Morphogenesis[*]

How can a cloud of dust give birth to a planet full of living things as diverse as life on Earth?

(Begun late in 2011.
Still being revised, expanded and split into sub-projects)

Aaron Sloman
http://www.cs.bham.ac.uk/~axs

A Protoplanetary Dust Cloud?



[NASA artist's impression of a protoplanetary disk, from WikiMedia]

This document is
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/m-m-overview.html
also available as
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/m-m-overview.pdf
See also the more detailed overview referenced below.

Overview

DRAFT SUMMARY
(To be extended)

The Meta-Morphogenesis project was triggered by questions about why Alan Turing was working on "The chemical basis of morphogenesis" (Published 1952) shortly before he died.[*]

The project is about the evolution of increasingly complex and varied information-processing mechanisms operating on increasingly complex and varied forms of information in increasingly complex and varied living organisms, as a result of still unknown processes that began in a lifeless universe billions of years ago.

What features of that lifeless universe made possible a collection of increasingly complex boot-strapping processes that produced not only a huge variety of physical forms of life, but also the still largely uncharted variety of types of information, and information-using mechanisms that made those life forms possible?

[Jane Austen's concept of usable information is relevant here, as explained below, not Shannon's concept.]

How can the huge diversity of life forms, with increasingly complex and varied combinations of physical forms, behavioural capabilities, habitats, types of information and information-processing machinery (including virtual rather than physical machinery) be encompassed in an integrated theory, which includes both descriptions and explanations of the details and explanations of how the details are constantly being extended, over time in the life of each individual, and over generations within (branching) species?

Many (most?) philosophies of learning and science assume there's a fixed type of world to be understood by a learner or a community of scientists, using fixed, general-purpose learning and discovery mechanisms, e.g. discovery of sometimes co-occurring features, and derivation of probabilities of co-occurrence.

In contrast, biological evolution, in collaboration with its products, is metaphysically creative, and constantly extends the mathematical diversity and complexity of the world to be understood, including constantly extending the types of learners with new powers, whose actions and, the products of their actions, contribute to extending what needs to be learnt by new members of the species. [Is this the first example of recursion?]

At first this happens mainly by change of environment and/or evolution of new species, leading to new genome/environment interactions expressed in individual behaviours that differ across generations.

In more advanced (late-evolved) learners, a multi-stage/multi-layered genome can extend the powers of each learner in different ways at different stages during epigenesis -- producing creative, self-modifying, developmental trajectories influenced by both the (possibly unique, or dynamically changing) local environment and also the epigenetic stage reached by the individual -- just as ancient genomes produced chemistry-based construction-kits for building different body parts at different stages of development, and different control mechanisms for producing different internal or external processes at different times.

(Compare the diversity of types of information and types of control involved in, breathing, sucking, grasping, kicking, crawling, walking, noticing an object, moving to an object, touching an object, grasping an object, manipulating an object in various ways, dismantling an object, causing two objects to interact, preventing interaction, combining objects into larger objects, ...)

Layered/staggered gene expression allows the same (or approximately the same) genome to produce very different developmental trajectories in different individuals or in different environments -- with resulting differences in physical development, behaviours, forms of learning, and individual actions on the environment.

So powers achieved by a learner at any stage in expression of a multi-layer genome, are influenced by a combination of
(a) general features of the environment,
(b) earlier learning powers, acquired during earlier stages of gene-expression, and products of resulting interactions with their environments
(c) new forms of gene-expression produced by interaction of later gene-expression with products of (a) and (b).

As a result, the gene-expression processes within a species can differ across co-existing individuals, with slightly different environments, and also across generations, across geographical locations, and across cultures, changing dramatically under the influence of new technology produced by the species, as humans demonstrate so clearly.

There were earlier "less creative" stages of the species where individual or group actions could not have such dramatic effects on gene expression -- e.g. ancient humans with relatively unchanging environments and cultures. For humans, especially those alive during and after the last few decades of the 20th century, the rate of production of new technology, with costs for users going down while powers and applications increase, and geographical availability accelerates, has produced unprecedented rates of change in what individuals can do, and thereby altered much of what they want to do.

Despite vast amounts of research, much is still unknown, including key features of the evolved biological mechanisms that underly many varieties of spatial reasoning in human and non-human species, including the mechanisms in human brains and minds, partly shared with other intelligent species, which, in humans, produced minds of ancient mathematicians whose discoveries laid foundations for much of what followed, using information processing mechanisms that (I claim) are not yet understood and not yet replicated in machines.

One of the key explanatory ideas, developed in collaboration with Jackie Chappell (Birmingham, Biosciences), is that evolution "discovered" the power of what we call "meta-configured" genomes -- relatively late products of biological evolution. in a universe with very deep and rich mathematical generative powers, expressed at different stages during individual development, as explained below.

One (unobvious) consequence is that besides including deep mathematical structures, the physical universe includes mechanisms that can be combined to form organisms capable of making increasingly complex mathematical discoveries and and creating or trying to create instances of new mathematical structures.

Such evolutionary mechanisms also require deep mathematical features that have proved hard to understand and to replicate in Artificial Intelligence -- perhaps because they make essential use of sub-neural, chemical, information processes that make essential use of a mixture of discrete and continuous processes that cannot all be replicated on digital computers (including Turing machines).
[This is very different from: "Ontogeny recapitulates phylogeny" (Haeckel)]

"Information" -- a key idea for this project (And for Jane Austen's novels!)

The concept of *"information used by organisms or machines or biological processes for various purposes"* is central to this project. But it is not the concept unfortunately labelled "information" by the great Claude Shannon and his many admirers. He understood the differences between the two concepts of information, but too many researchers ignore them. In fact many researchers think his is the **only** concept of "information" we have, or the only one relevant to science and engineering. But there is a much older one, used in everyday life and in science and engineering.

The older concept refers to information that has many causal roles, e.g. in evolution, in animal (including human) perception, learning, motivation, acting, interacting, thinking, asking, wondering, being puzzled, finding answers (etc.) Information of this sort is also used in processes of reproduction, though often in obscure, indirect ways.

This ancient concept was often used explicitly by Jane Austen over a century before Shannon's work, and by many others long before her. Several examples from her novel 'Pride and Prejudice' published in 1813, are presented here:

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http://www.cs.bham.ac.uk/research/projects/cogaff/misc/austen-info.html
Jane Austen's concept of information (contrasted with Claude Shannon's).
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Main Overview Documents for the M-M Project

Detailed Overview:
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-morphogenesis.html
The Meta-Morphogenesis project

Other core documents
(For each html file a corresponding pdf file is normally also available.)

http://www.cs.bham.ac.uk/research/projects/cogaff/misc/construction-kits.html
Construction kits for evolving life
(Including evolving minds and mathematical abilities.)
The scientific/metaphysical explanatory role of construction kits:
fundamental and derived kits, concrete, abstract and hybrid kits, meta-construction kits.
(All with deep mathematical properties, creating products with mathematical properties.)

http://www.cs.bham.ac.uk/research/projects/cogaff/misc/impossible.html
Examples of impossibilities and necessities of various kinds

http://www.cs.bham.ac.uk/research/projects/cogaff/misc/compositionality.html
Biologically Evolved Forms of Compositionality
Structural relations and constraints
vs Statistical correlations and probabilities

http://www.cs.bham.ac.uk/research/projects/cogaff/misc/turing-intuition.html
Alan Turing's 1938 thoughts on intuition vs ingenuity in mathematical reasoning
Did he unwittingly re-discover key ideas first presented in Immanuel Kant's philosophy of mathematics?

http://www.cs.bham.ac.uk/research/projects/cogaff/misc/kant-maths.html
Key Aspects of Immanuel Kant's Philosophy of Mathematics
Ignored by most psychologists and neuroscientists studying mathematical competences

http://www.cs.bham.ac.uk/research/projects/cogaff/misc/architecture-based-motivation.html
Architecture-based motivation vs Reward-based motivation
(Most thinkers fail to see the importance of the former.)

http://www.cs.bham.ac.uk/research/projects/cogaff/misc/vm-functionalism.html
Virtual Machine Functionalism (VMF)
(The only form of functionalism worth taking seriously
in Philosophy of Mind and theories of Consciousness)

http://www.cs.bham.ac.uk/research/projects/cogaff/misc/toddler-theorems.html
Some of the hidden geometrical and topological complexity in toddler (and pre-toddler) cognition.

The Meta-Configured Genome
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-configured-genome.html

In his *Mind* 1950 paper, Alan Turing wrote:
"Presumably the child-brain is something like a note-book as one buys it from the stationer's. Rather little mechanism, and lots of blank sheets. ... "Our hope is that there is so little mechanism in the child-brain that something like it can be easily programmed."
Using ideas co-developed with biologist Jackie Chappell http://jackiechappell.com/ the Meta-Configured genome thesis suggests that genomes of complex organisms have multiple evolved layers of specification timed to be activated after varying delays, with gaps in their specification to be filled by information acquired earlier by the individual, while driven by more "primitive" portions of the genome. In general, the layers activated later also evolved later, since they depend on functionality provided by layers that develop earlier, and must have evolved earlier, though their functionality may have been modified later.

All this contradicts what Turing wrote! (Tongue-in-cheek, perhaps?)

There are many more documents. More links will be added here later.

REFERENCES

A. M. Turing, (1952), 'The Chemical Basis Of Morphogenesis', in
Phil. Trans. R. Soc. London B 237, 237, pp. 37--72.
(Also reprinted(with commentaries) in S. B. Cooper and J. van Leeuwen, EDs (2013)). A useful summary for non-mathematicians is
Philip Ball, 2015, Forging patterns and making waves from biology to geology: a commentary on Turing (1952) 'The chemical basis of morphogenesis', *Royal Society Philosophical Transactions B,* http://dx.doi.org/10.1098/rstb.2014.0218

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