



PARTIAL GUIDE TO CONTENTS OF COGAFF/MISC DIRECTORY

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/>
(And some other things listed at the end)

[Aaron Sloman](#)
[School of Computer Science, University of Birmingham, UK](#)
[Google Scholar entry](#)

This file HTML:

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/AREADME.html>

PDF version:

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/AREADME.pdf>

Part of this larger project

[The CogAff \(Cognition and Affect\) Web site.](#)

Since late 2011, this also includes

[Discussions arising in the Turing-inspired Meta-Morphogenesis project](#)

Most of the contents are html files. Some are PDF and some plain text (.txt).
(This list will be extended and reorganised from time to time.)

[JUMP TO MAIN CONTENTS LIST \(Below Other Sources\).](#)

GOOGLE SEARCH

Use Google to search this site.

(Thanks to Dave Parker for help.)

OTHER RELATED SOURCES (contents of this directory [below](#))

- <http://www.cs.bham.ac.uk/research/projects/cogaff/talks/>
Presentations (mostly detailed enough to be self-contained for reading), mostly in PDF format, since about 2000. About philosophy, biology, psychology, animal cognition, language, mathematics, AI, robotics, evolution (e.g. of language, mathematical competences, information processing architectures, consciousness), development, vision, the nature of science.
 - <http://www.cs.bham.ac.uk/research/projects/cogaff/>
Originally the site for the Cognition and Affect project (started with Glyn Humphreys in 1991), but now includes most of my formally published papers, and some unpublished ones, 1978 book, 1962 DPhil thesis, and other things. [Origins](#), [overview](#), [architectures](#). It also includes [video presentations](#), [demos](#), [tutorials](#), [recorded lectures](#).
 - <http://www.cs.bham.ac.uk/research/projects/cosy/papers/>
The repository for some of the Birmingham-produced papers, discussion notes and presentations for the EU-funded cognitive robotics project [CoSy](#)
 - <http://www.cs.bham.ac.uk/research/projects/poplog/freepoplog.html>
<http://www.cs.bham.ac.uk/research/projects/poplog/examples>
<http://www.cs.bham.ac.uk/research/projects/poplog/packages/simagent.html>
Free open source materials (software and documentation) related to research and teaching in AI, Cognitive Science, Philosophy of Mind, and other things, based on use of programming to develop, test and communicate ideas. Some of the ideas and facilities in Poplog are demonstrated in these video tutorials:
<http://www.cs.bham.ac.uk/research/projects/poplog/cas-ai/video-tutorials.html>
 - <http://www.cs.bham.ac.uk/~axs/my-doings.html>
An attempt to organise the work I have done since about 1960 in terms of topics -- provoked by an interview in 2005 by a journalist (Linda World). Occasionally updated, but usually incomplete and out of date.
 - **This directory:**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/>
Discussion notes, draft papers, relics of discussions on usenet, proposals, and other things -- mostly either plain text or html (some converted into rather messy PDF). Some of the materials are listed (chaotically) -- in this document:
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/AREADME.html>
Contents list [below](#).
-

DISCLAIMER:

Neither the University of Birmingham nor the School of Computer Science should be held responsible for any of the content of this web site. This is a university that supports freedom of expression and public debate (as far as I know).

Everything I post on this web site is licenced under a

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and may be used by anyone without charge or permission.

Acknowledgement is a welcome courtesy, and may help others find related material.

For a time, many of the items on this web site were accessible via the [US OSTI eprints web site:](http://www.osti.gov/eprints/topicpages/documents/starturl/16/025.html)
<http://www.osti.gov/eprints/topicpages/documents/starturl/16/025.html>
30 Dec 2017: They seem to have been removed now!

Contents Of This Web Site (Constantly changing) **(A partial list -- to be extended and reorganised.)**

Separately available: [Full ordered list of contents of this directory](#)
(Your browser should give option of sorting by file name or by date.)
(It may include some junk I have forgotten to delete.)

SELECTED CONTENTS BELOW

(Recently added or modified items are near the top)

ADDED OR UPDATED DURING 2017-18

Many of the html files also have pdf versions.

Many of the papers have been updated since the dates listed here.

2018

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/information-difference.html>

Updated notes on what Bateson (and some of his misguided admirers) might have meant by claiming that information is "A difference that makes a difference".

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/sloman-compositionality.html>

Biologically Evolved Forms of Compositionality

Structural relations and constraints vs Statistical correlations and probabilities

Expanded version of paper accepted for *First Symposium on Compositional Structures* (SYCO 1)

Sept 2018 School of Computer Science, University of Birmingham, UK

<http://events.cs.bham.ac.uk/syco/1/>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/austen-info.html>

Further updates on Jane Austen's concept of information (contrasted with Claude Shannon's).

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/turing-intuition.html>

REPLACES:

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/turing-quotes.html>

Alan Turing's 1938 thoughts on intuition vs ingenuity in mathematical reasoning, with some comments and questions.

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/triangle-sum.html>

Added note that Mary Pardoe's wonderful proof of the triangle sum theorem was anticipated in 1809 by Bernhard Thibau. (Thanks to Tim Penttila, Univ. of Adelaide.)

Comments on the Joint CRC/CPHC Response to Consultation on the REF
(Research Evaluation Framework)

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/uk-research-publication-policy.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/sloman-compositionality.html>

Biologically evolved forms of compositionality (Workshop submission)

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/youtube.html>

Some Youtube video presentations by me on topics related to AI, philosophy, biology, mathematics, ...

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-morphogenesis.html>

The Meta-Morphogenesis project, updated from time to time.

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/multirc-problem.html>

Problem: Areas formed by intersecting circles (Solved on another page.)

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/multirc.html>

Solution to intersecting circles problem.

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/construction-kits.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/the-self.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/diagrams-tutorial.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/infinity.html>

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

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/emotions-affect.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/anger.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/impossible.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/super-turing-geom.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/super-turing-phil.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/chewing-test.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/deform-triangle.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/apollonius.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/cardinal-ordinal-numbers.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/diagrams-tutorial.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/fully-deliberative.html>

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/family-resemblance-vs-polymorphism.html>

Family Resemblance vs. Polymorphism

A comparison: Wittgenstein's Family Resemblance Theory

vs. Ryle's Polymorphism and Polymorphism in Computer Science/Mathematics

And perhaps Kant's notion of "schema"?

.

.

. To be completed

30 Dec 2017

[What are cardinal and ordinal numbers?](#)

Not what most scientists think they are

Explaining some generally unnoticed features of cardinal and ordinal numbers as used outside of mathematics, including pointing out that ordinal structures can include repeated elements whereas cardinality applies only to sets with no repetitions.

[What Sort of Information-Processing Machinery Could Ancient Geometers Have Used?](#)

Conference submission, under review. (PDF)

See also 2017 Entries on the CogAff web site

<http://www.cs.bham.ac.uk/research/projects/cogaff/17.html>

Nov 15 2017

[Multiple Foundations For Mathematics \(Biological, cosmological, etc.\)](#)

[The Meta-Configured Genome](#)

[What is information? Meaning? Semantic content?](#)

What's information, for an organism or intelligent machine?

[Non-Monotonic angle size change as a vertex moves on a line](#)

A challenge for AI, psychology, neuroscience, robotics, and computer science.

[A Super-Turing Membrane Machine for Geometers](#)

(Also for toddlers, and other intelligent animals)

[Seeing Possibilities For a Cup And Saucer](#)

[What can't be done with a chain of linked rubber bands?](#)

Why can't (current) machines reason like Euclid or even human toddlers?

(And many other intelligent animals)

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/ijcai-2017-cog.html>

Notes and video lecture for remote presentation at IJCAI Workshop, Melbourne, 19 Aug 2017

Workshop: Architectures for Generality and Autonomy

<http://cadia.ru.is/workshops/aga2017/>

[Some \(Possibly\) New Considerations Regarding Impossible Objects](#)

[Beyond SensoriMotor Contingencies: Mirror neurons vs Abstraction neurons](#)

[Stewart Shapiro on Self Evidence](#)

Oct 3 [The theory of evolved construction kits](#)
 Earlier version published as chapter in Springer Book Jan 2017
 Oct 3 [The meta-morphogenes project updated](#)
 Oct 2 [Old paper on orthogonal competences updated](#)
 Sep 30 [Hidden depths of triangle qualia, updated.](#)
 Sep 26 [The chewing test for intelligence](#)
 Sep 23 [Triangle sum theorem -- updated](#)
 Sep 17 [Actual possibilities 1996](#)
 Sep 9 [Gaps in AI](#)
 Sep 9 [Multiple functions of vision](#)
 Sep 8 [Perceiving Impossibility \(updated\)](#)
 Sep 8 [P-geometry updated \(Pardoe-inspired geometry\)](#)
 Aug 29 [AISB Computing and Philosophy symposium talk April 2017](#)
 Aug 28 [Notes on "the cognitive revolution"](#)
 Aug 24 [Notes on logical geography vs logical topography updated](#)
 Aug 23 [Toddler theorems updated](#)
 Aug 6 [Evolved levels of information processing machinery](#)
 Jul 28 [Why government controls should be smooth not discontinuous](#)

Main Entries

- [Several talks on evolution of mathematical capabilities](#)
 Including a 40 Minute video presentation for IJCAI Workshop August 2017
<http://www.cs.bham.ac.uk/research/projects/cogaff/movies/ijcai-17>
 These ideas were also used for a tutorial at BICA, August 2017
 ICCM Conference July 2017
 presentation in Geneva June 2017
[An example: reasoning about deforming a triangle and the effects on size of the vertex.](#)
- Added 3 Nov 2017
 A Super-Turing Membrane Machine for Geometers
 (Also for toddlers, and other intelligent animals)
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/super-turing-geom.html>
- [The Meta Configured Genome \(Oct 2017\)](#)
- [The Creative Universe](#)
 Updated June 2017
 Notes on Creativity and Artificial Intelligence in the creativity in biological evolution.
- [Update on family-resemblance](#)
 Family Resemblance vs. Polymorphism A comparison
 Consciousness as a polymourmous concept (extending Gilbert Ryle's ideas)
- June 2017 [Topological Reasoning About Rings and Chains](#)
 (Possible and impossible linking and unlinking)

- [Origins of Many Types of Consciousness](#)
Updated May 2017
- ["THE SELF" -- A BOGUS CONCEPT? YES AND NO!](#)
Updated May 2017 (including reference to Thagard)
- [Notes on Virtual machine functionalism. Updated 2017](#)
- [Old notes from 2008](#) Requirements for a Human-like Information Processing Architecture that Builds Itself by Interacting with a Rich Environment
This was originally an extended abstract for an invited talk at
The 8th Understanding Complex Systems Symposium,
UIUC, Illinois, May 12-15 2008.
- [Multiple foundations for mathematics](#)
Including evolved biological foundations.
- [Invited talk for symposium on emotions at AISB 2017 Bath University](#)
Architectures underlying cognition and affect in natural and artificial systems
[Followed by a workshop on Modelling of Emotions:](#)
School of Computer Science, University of Birmingham Monday 24th April 2017

[\(Homework\) How to analyse anger and related states](#)
[Feedback from a researcher attending.](#)
- [Research Skills Talk to PhD students \(March 2017\)](#)
Introduction to some aspects of the Meta-Morphogenesis project
- **Added 6 Apr 2016, Updated Mar 2017**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/schrodinger-life.html>
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/schrodinger-life.pdf>
Erwin Schrödinger on the Chemical Basis of Life
Annotated extracts from his deep, visionary, little book:
Erwin Schrödinger, *What is life?* CUP, Cambridge, 1944.

It seems to me that what Schrödinger tried to do in this book could be described as attempting to characterise key features of the *Fundamental Construction Kit* (FCK) required to support the many types of *Derived Construction Kit* (DCK) required for biological evolution to have produced the many and varied forms of life we now have on our planet, as discussed in
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/construction-kits.html>
- [IJCAI 2016 TUTORIAL](#)
International Joint Conference on AI New York, July 24th 2016 Tutorial T24

If Turing had lived longer, how might he have investigated what AI and Philosophy can learn from evolved information processing systems?

Including homage to John McCarthy and Marvin Minsky, two of the founders of AI, both recently deceased (McCarthy in 2011, Minsky in 2016)), both interested in connections

between AI and philosophy.

- Update
[Using construction kits to explain newly emerged possibilities.](#)
Update on why explaining possibilities is a major aim of science(1978)
- [The "Big conversation"](#) about what should be taught in universities in 2017
- Update
[Varieties of atheism \(including analytical atheism\)](#)
and
[Why intelligent design should be taught \(and criticised\)](#)
As part of a scientific education. Compare the Ptolemaic theory of planetary motion.
- [Evolved Cognition and Artificial Cognition](#)
Updated: Some genetic/epigenetic trade-offs for organisms and robots
Or: Notes on how to do AI-Inspired Biology
[\(AIIB\)](#)
- [Notes on squirrel intelligence](#)
- [High level overview of the Meta-Mophogenesis project](#)
- [Draft extended abstract 2007](#)

Invited talk for Symposium on AI and Consciousness: Theoretical Foundations and Current Approaches
At AAAI 2007 Fall Symposia November 9-11 2007
Why some machines may need qualia and how they can have them
(Including a demanding new Turing test for robot philosophers.)

The final version of the paper is available at:
<http://www.cs.bham.ac.uk/research/projects/cogaff/07.html#716>
- Updated in 2017
[On creative learning by INCREASING dimensionality](#)
- [Notes on Moto G3 TO BE UPDATED](#)
- **Added November 2016**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/sloman-pacs-2016.html>
(Also PDF)
Presentation at PACS symposium Seoul, 27-28 October 2016

Robot Intelligence vs. Biological Intelligence?
A discussion based on Physics, Chemistry, Biology, Mathematics, Mind-Science and Philosophy

This was an invited talk at the International Symposium on Perception, Action, and Cognitive Systems (PACS) held in Seoul, Korea, Oct. 27-28, 2016. PACS aims to be a common venue for integrated research in cognitive science, brain science, artificial intelligence, robotics, and human-computer interaction and their practical applications.

The full symposium programme is available at http://www.kiise.or.kr/pacs/2016/lecture_material.htm including the lecture material for all the speakers.

- **Added June 2016, Updated November 2016**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/inf-2016-sloman.html>

Invited lecture Thursday 2nd June 2016, Hebrew University, Jerusalem

What's information? An Answer from Physics, Biology, Mind-Science and Philosophy

*Workshop on Information and Information-Processing in Science:
Biology, Physics & Brain & Cognitive Sciences.*

Video of the presentation:

https://www.youtube.com/watch?v=y2BcQHqqvQA&list=PLHgwT2MoGd81SDAYeaEp_ZCjF2uIKVBp2&index=19

Also a 'local' version of the video, here:

<http://www.cs.bham.ac.uk/research/projects/cogaff/movies/#information-2016>

Video recordings of all the presentations at the workshop:

https://www.youtube.com/playlist?list=PLHgwT2MoGd81SDAYeaEp_ZCjF2uIKVBp2

(Particularly recommended Irun Cohen's talk (video 3):

https://www.youtube.com/watch?v=3JXsNwQjNhc&list=PLHgwT2MoGd81SDAYeaEp_ZCjF2uIKVBp2&index=3

"An Informational View of the Evolution of Living Systems")

Unfortunately some names of speakers on the first day are missing, but are available in the schedule: <http://edelstein.huji.ac.il/events/past-events/conferences/2016-2/information-2>

Abstract:

What's information? An Answer from Physics, Biology, Mind-Science and Philosophy

Like most of my talks this emphasises the fact that focusing on information as something to be *transmitted* or *encoded* is a serious error: information is important for living things and in engineering primarily because it is *used*, e.g. for various types of control. Requirements for acquisition, encoding, storage, transformation, and manipulation are all derived from the need to **use** information, ever since the very simplest biological organisms. One of the implications is that languages used for internal purposes evolved long before languages for communication, but this has largely been ignored by linguists, philosophers, engineers, etc., though it should have been recognised long ago by all who develop computer programs.

- **Added July 2016 (Updated 2017)**

Tutorial at International Joint Conference on AI (IJCAI) 2016

Sunday July 10th, 2016, New York, USA

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/sloman-tut-ijcai-2016.html>

Tutorial T24: If Turing had lived longer, how might he have investigated what AI and Philosophy can learn from evolved information processing systems?

Presents a subset of my tentative, partial answer: [The Meta-Morphogenesis Project](#)

Including homage to John McCarthy and Marvin Minsky, two of the founders of AI, recently deceased, both interested in connections between AI and philosophy.

- **Marvin Minsky (Died 14 Jan 2016): A partial personal appreciation**
<http://www.cs.bham.ac.uk/research/projects/cogaff/sloman-minsky-tribute.html>
- **John McCarthy (Died 2011) - Some Reminiscences Tribute to John McCarthy**
<http://www.cs.bham.ac.uk/research/projects/cogaff/sloman-jmc-aisb.html>
Expanded version of tribute originally published in AISB Quarterly.
- **Added 2 Aug 2016:**
Notes on why I (mostly) ignore the much discussed AI Singularity.
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/ai-singularity.html>
(Incomplete draft)
- **Added 22 Jan 2011. Minor edits 6 Apr 2016**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/information-difference.html>
Bateson did not define "information" as "a difference that makes a difference"
(And would have been silly if he had done so.)

It is widely believed that the polymath Gregory Bateson defined "information" as "a difference that makes a difference". I think this is a myth, and he did no such thing.

This alleged definition is often quoted with approval by thinkers of different backgrounds, as can be seen by searching for occurrences of the phrase "a difference that makes a difference" in conjunction with "information". Sometimes the definition is attributed to others, presumably because they have quoted or used it. Searching through what he actually wrote, I found that in the 1972, Chandler Paperback edition of *Steps to an Ecology of Mind: Collected Essays in Anthropology*, Bateson described "a bit of information" and later "**the elementary unit of information**" as "a difference that makes a difference".

He does this in at least two of the essays, namely in "The Cybernetics of 'Self': A Theory of Alcoholism" and in "Form Substance and Difference".
etc., etc.

The paper discusses various interpretations and possible justifications for what he wrote and why the standard quotation is seriously misleading.

- **Installed here: 26 Jan 2016**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/self-aware.html>
Notes for DARPA workshop on self-aware machines
Organised by John McCarthy and Pat Hayes, Virginia 2004
Original submission: <http://www.ai.sri.com/~chaudhri/saw/submissions/aaron-sloman.txt>
- **Installed: 25 Sep 2012**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/kenneth-craik.html>
This paper is a "place-holder" here.

- **Installed: 7 Nov 2015. Updated 20 Feb 2016;**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/old-cardinal-ordinal.html>
 (Partly superseded by a new file (30 Dec 2017):
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/cardinal-ordinal-numbers.html>
[cardinal-ordinal-numbers.html](http://www.cs.bham.ac.uk/research/projects/cogaff/misc/cardinal-ordinal-numbers.html)
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/cardinal-ordinal-numbers.html>
 Development of Cardinal and Ordinal Competences **[This is a stub]**
 Extending ideas in Chapter 8 of The Computer Revolution in Philosophy
<http://www.cs.bham.ac.uk/research/projects/cogaff/crp/#chap8>
 Note added to the end of Chapter 8 in Feb 2016:
<http://www.cs.bham.ac.uk/research/projects/cogaff/crp/#note-ch-8-20160217>
What needs to be explained
 The original version of that chapter did not make clear enough many of the features of number competences for readers unfamiliar with analyses of cardinal and ordinal number concepts by Cantor, Frege, Russell, Piaget, and others, and who lacked practical AI/software engineering experience.
 This paper is one of a collection of documents with "afterthoughts" about ideas and theories presented in my 1978 book (The Computer Revolution in Philosophy). That book was reorganised and re-formatted during 2015, to provide a single web document with many internal cross references and links to external related documents.
- **Added 26 Jan 2016**
 Following the death of Marvin Minsky on 24th Jan 2016 I've placed a copy of my contribution to his 80th birthday tribute in 2007 here:
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/marvin-minsky.html>
- **March 2006**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/beyond-sensorimotor.html>
 Beyond SensoriMotor Contingencies:
 Mirror neurons vs Abstraction neurons
 Aaron Sloman
 Working in the context of the CoSy project
 with help from several others.
 This note expands on a point made in the middle of the next file, discussing 'Orthogonal Recombinable Competences' acquired by some altricial species.
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/orthogonal-competences.html>
 Installed 2006, updated several times since.
 Orthogonal Recombinable Competences Acquired by Altricial Species
 (Blankets, string, and plywood)
- **Added 19 Dec 2014.**
Major revisions: 19 Apr 2015, 26 Jan 2016; 20 Feb 2016; 8 Apr 2016; Jan 2017
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/construction-kits.html>
 Provisional revised title (8 Apr 2016):
Construction kits for evolving life
 (Including evolved minds and mathematical abilities.)
 Previously:
 Construction kits for biological evolution

(Including evolution of minds and mathematical abilities.)

The scientific/metaphysical explanatory role of construction kits.

I'll present a partial outline answer to the question: How was it possible for the known and unknown varieties of life to evolve from lifeless matter, including some varieties that are able to make the mathematical discoveries assembled in Euclid's Elements? The answer proposed here is based on construction kits, both fundamental and derived. The fundamental construction kit (FCK) is provided by physics/chemistry. Derived construction kits (DCKs) are produced/discovered and used by natural selection, by individual development and learning, and by cultural changes. This leads to a (possibly) new account of the role of mathematics in biological evolution, including the implicit discovery by natural selection of mathematical theorems and proofs about what is possible. There are also implications for metaphysics, theories of grounding, and alternatives to possible world semantics for concepts of 'possible', 'necessary' and 'contingent'.

A shorter version of this paper was published in *The Incomputable*
Eds. Mariya Soskova and the late S Barry Cooper
(Springer, 2017)

See also the companion documents on:

[Explaining Possibilities](#) and

[Biological/Evolutionary Foundations of Mathematics \(BEFM\)](#)

24 Dec 2016; Updated May 2017

The latter is being superseded by a new document (Dec 2016, onwards)

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/maths-multiple-foundations.html>

Several Types of Foundation For Mathematics:

- Neo-Kantian (epistemic) foundations,
- Mathematical foundations,
- Biological/evolutionary foundations
- Physical/chemical foundations
- Metaphysical/Ontological foundations
- (Possibly to be further sub-divided)
- Others ???

Do we need to understand all of these (and more?)
in order to build artificial mathematical minds
comparable to ancient mathematicians?

- **Added 20 Nov 2016**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/square-circle.html>

How to draw a square circle: it's easy!

Not impossible as Wittgenstein suggested.

- **Added 20 Oct 2015; Updated ... 20 Nov 2016**

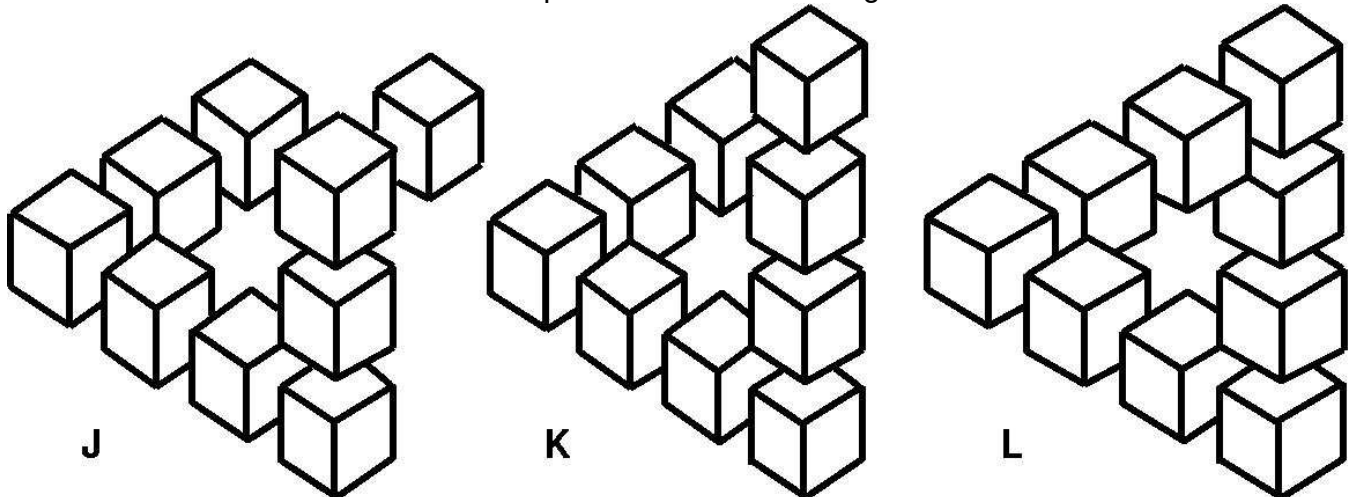
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/impossible.html>

Some (Possibly) New Considerations Regarding Impossible Objects

Their significance for mathematical cognition, and current serious limitations of AI vision systems.

(Those systems are not able to have mathematical qualia!)

Inspired in part by drawings of Oscar Reutersvard and James Gibson's ideas about perception of affordances. Here's a blue round square seen from the edge:



What's going on here? How can a collection of blocks be arranged in space?
(With thanks to Oscar Reutersvard)

This includes discussion of problems of explaining how Euclid and his predecessors made mathematical discoveries reported in Euclid's *Elements* which seem to be beyond the scope of current AI theorem provers, and AI vision systems.

Expanded version of notes prepared for an invited talk on vision at Bristol University, on 2nd October 2015.

- **Added 26 Jan 2016**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/lovelace-turing-jan-2016.html>

Notes for talk on Evolved construction-kits for building minds
(Evolution's deep learning)

A tutorial introduction to some aspects of the Turing-Inspired Meta-Morphogenesis Project
Thursday 21 Jan 2016 Morning lecture followed by discussion
Israel Institute for Advanced Studies, Givat Ram Campus, Jerusalem.

<http://ias.huji.ac.il/adalovelacelectures>

Video of lecture and discussion:

<http://www.cs.bham.ac.uk/research/projects/cogaff/movies/#lovelace>

Local versions and versions on HUJI web site.

- **Jan 2016**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/royalsoc-deep-learning.html>

WORK IN PROGRESS

Notes expanding

Comments on Royal Society Survey on Machine Learning

Some critical comments regarding deep-learning hype and remarks about important open problems.

Closely related: 8th May 2015

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/forum-deep.html>

Posting to BBC Forum Facebook Page commenting on Forum Programme on Deep Learning:

<http://www.bbc.co.uk/programmes/p02kvwpw>

- **INSTALLED 3 Jan 2016**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/family-resemblance-vs-polymorphism.html>

Family Resemblance vs. Polymorphism A comparison:

Wittgenstein's Family Resemblance Theory vs.

--- Ryle's Polymorphism and

--- Polymorphism in Computer Science/Mathematics

Philosophers, linguists, and no doubt many others, have been puzzled by the fact that some words that we all use effortlessly in everyday conversation are very difficult to define. Examples include "goodness", "truth", "knowledge", "science", "life", "consciousness", "experience", "belief", "game", "rationality", "normality", "intelligence", "pile", "heap", "big", and many more. Some of them are harder than others, and the causes of difficulty are not all the same.

This discussion paper briefly summarises some of the problems, and some of the solutions that have been presented by philosophers, and then attempts to relate the problems to deep ideas developed in Computer Science since the middle of the 20th century, ideas that appear to have been ignored by most philosophers, especially the concept of "parametric polymorphism". (I think it can be argued that the same concept is used, with different labels, by mathematicians, but will not pursue that now.) I shall also say a little at the end about how the notion of "virtual machine functionalism", which is related to complex and largely unrecognized developments in computer systems engineering, is relevant to some aspects of what we call "consciousness".

Philosophers, linguists, and no doubt many others, have been puzzled by the fact that some words that we all use effortlessly in everyday conversation are very difficult to define. Examples include "goodness", "truth", "knowledge", "science", "life", "consciousness", "experience", "belief", "game", "rationality", "normality", "intelligence", "pile", "heap", "big", and many more. Some of them are harder than others, and the causes of difficulty are not all the same.

- **Installed: 5 Jan 2016**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/aaai-consult-2015.html>

RESPONSE TO AAAI CONSULTATION

This was a critical response to a request for pointers to research on "robust AI", including robustness to unmodeled phenomena---the "unknown unknowns".

Closely related

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/ai-future.html>

OPEN LETTER ABOUT OPEN LETTER ABOUT AI

I considered signing this Open Letter about the future of AI but decided not to:

http://futureoflife.org/misc/open_letter

I've noticed that some well known Fellows of the AAAI have not signed, and I wondered whether any of them shared my concerns.

I did not sign, not because it included statements I disagree with, but because it says nothing about the most important long term aims of AI, and how far we still have to go.

- **Installed 26 Jan 2016**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/bvi-talk-2015.html>

Talk at the Bristol Visual Information Laboratory

Friday Oct 2nd, 4pm

Seminar Room, Life Sciences Building

Topic:

Why are the many recent results in statistics-based machine vision misleading?
Perhaps because none of the mechanisms used can account for the roles of vision in mathematical discoveries leading to Euclid's Elements 2.5 millennia ago?

Expanded notes [above](#).

● Installed 6 March 2013

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/two-faces.html>

Do the eyes in the left face and the right face look the same?

Most people say that the eyes in the two faces look different -- not geometrically different, but different in a way that appears to be part of the expression.

I think this provides indirect evidence for part of the architectural theory developed in the CogAff project, in particular the claims about "multi-window perception" contrasted with "peephole perception".

● Installed 24th December 2015:Challenges for vision researchers

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/vision/plants/>

Videos involving plant matter: Garden-process qualia

Or more generally: complex fast-changing qualia

A not very high quality video camera was moved around in a Birmingham garden. Several short video recordings were made, with the same settings, on different days, and not all in the same parts of the garden. The aim is, eventually, to use these and other examples, to help characterise what's missing from current AI/Robotic/psychological/neural research on motion perception, and more generally visual perception.

Challenges for vision researchers: by what criteria should an artificial vision system's ability to 'see' such moving scenes be evaluated? How can what humans see in these videos be compared with what a machine sees?

Most humans cannot produce a 3-D model of what they see and project it onto a variety of viewing planes -- one of the standard tests for an AI 3-D vision system. What would be a better test?

No normal human could produce a detailed verbal description of what is seen in the videos. (J.L. Austin: "Fact is richer than diction").

● Installed: 20 Oct 2015

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/folded-paper-theorem.html>

IMPOSSIBLE PAPER FOLDS

This paper is an appendix to the document on perceiving and understanding impossibilities, presenting an autobiographical report on an episode in which two people attempted to perform an impossible task involving papering a ceiling and did not notice that it was impossible until after the first attempt failed. I suspect that similar experiences may have preceded some of the discoveries presented by Euclid.

The paper also reports a mistake in my spatial reasoning that someone else had to correct. (Compare I. Lakatos *Proofs and Refutations*.)

- **Added 8 Nov 2014; Updated Jan 2016; 7 Nov 2018**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/entropy-evolution.html>

Tentative non-mathematical thoughts on entropy, evolution and construction-kits

What sort of construction-kit must the physical universe have provided to make it possible for life, mind, ecosystems, cultures, etc. to evolve on a planet formed from a cloud of dust?

How to deal with worries about entropy.

(What happened to Droguli?)

This document does not defend any theistic form of creationism, though it is about beginnings. More precisely: it addresses the question what must the world be like for life as we know it (including human minds) to be able to emerge in a physical universe without life? I shall attempt to map some of the detailed features common to wide ranges of living things onto requirements for the physical substrate. We can then ask what the physical substrate needed to be like at the birth of this planet (or earlier) in order to make possible evolution of known forms of life, and intelligence. But this is a first draft.

This is a first draft discussion, and will probably be revised in the light of further research and suggestions and criticisms from others more knowledgeable, especially about entropy and physics. (Email comments and suggestions welcome, including links to useful online resources.)

This is closely related to the paper on [Construction kits for biological evolution](#)

- **Added 26 Jan 2016**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/quantum-evolution.html>

Quantum Mechanical Construction Kits for Life?

(Possible roles in evolution of minds and mathematical abilities.)

Including a tentative discussion of a possible role for quantum mechanisms for control of perceptual processes:

There may be new things to be said about relationships between quantum mechanics and complex biological control mechanisms and perceptual processes, for example because visual processing requires very rapid coordination of complex and varied forms of information about different structures and processes in the perceiver's physical environment, as well as the perceiver's location and motion in that environment. In some cases, intentions of the user and/or other agents in the environment also need to be taken into account.

Nothing is said here about the arguments of Penrose and others concerning "consciousness" or Goedel's meta-mathematical theorems.

- **Added here 20 Oct 2015**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/sensorimotor.html>

Sensorimotor vs objective contingencies

Initially written in May 2006, and intermittently updated since then.

I have been trying, with limited success, to get people to understand the importance (for theories of mental processes including learning, perception, reasoning and communication), of a distinction between learning about sensorimotor contingencies (concerned with relations between states, events and processes within an animal or machine, also referred to below as 'somatic') and learning about objective condition-consequence contingencies (concerned with relations between states, events and processes in the environment, also referred to below as 'exosomatic').

The distinction is important for theories of infant development, for the design of robots that act in and learn about their environment, and for philosophical and other theories of embodied cognition. One way in which it is important is that it leads to the question whether, and under what conditions, an individual animal or robot starting only with information about the internal motor and sensor signals can use general learning mechanisms, e.g. self-organising nets, or compression algorithms, to derive, in a reasonable time, e.g. several months or a year or two (rather than evolutionary time scales), an ontology referring to external objects

- **UPDATED: 18 Oct 2015**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/post-publication-review.html>

Why Academic Research Communities Should Switch to Post-Publication Reviewing
Thoughts on blind reviewing vs post-publication reviewing

- **Added 26 Jul 2015**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/transcript-agi-interview.html>

Transcript of "Aaron Sloman interviewed by Adam Ford"

(Based on a draft transcript by Dylan Holmes)

Artificial Intelligence - Psychology

AGI Conference Oxford December 2012

Based on this 57 minute video on YouTube: <http://www.youtube.com/watch?v=iuH8dC7Snn0>

- **Added 20 Oct 2015**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/sgai-2015.html>

ABSTRACT FOR TUTORIAL AT SGAI-2015, Cambridge Tuesday 15th December 2015

Thirty-fifth SGAI International Conference on Artificial Intelligence.

Evolved construction-kits for building minds

Introduction to the Turing-Inspired Meta-Morphogenesis Project

- **INSTALLED 20 DEC 2015**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/concurrency.html>

Concurrency and computation

Being mathematically equivalent to a Turing machine may be important for a computer scientist but not so important for an engineer concerned with reliability.

Extract from:

Aaron Sloman, Beyond Turing Equivalence,

In *Machines and Thought: The Legacy of Alan Turing* (vol I),

Eds. P.J.R. Millican and A. Clark, The Clarendon Press, Oxford, pp. 179--219, 1996,

Originally presented at Turing90 Colloquium, Sussex University, April 1990,

"Even if all processes in intelligent machines are exactly mathematically equivalent to Turing computations, it remains possible that some processes cannot be simulated on a Turing equivalent machine except too slowly for practical use. Even if all can, there may be some important differences. For example, three synchronised machines doing the same task in parallel are mathematically equivalent to one machine, yet the difference in reliability is significant to an engineer."

- **Added 19 Oct 2015**
INCOMPLETE DRAFT
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/assessing-competences.html>
The relevance of explanations of possibilities to assessing competences
Can cognitive competences be assessed reliably?
A partial answer based on explanations of possibilities
- **Added 20 Oct 2015**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/essence-kits-tut.html>
NOTES FOR TUTORIAL PRESENTED AT THE ESSENCE-2015 SUMMER SCHOOL
on Construction kits for biological evolution
(Including evolution of minds and mathematical abilities.)
The scientific/metaphysical explanatory role of construction kits:
fundamental and derived kits; concrete, abstract and hybrid kits.
Tutorial Abstract:
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/essence-2015.html>
- **Added 11 May 2015/ Updated June 2017**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/rings.html>
Reasoning About Rings and Chains (Impossible linking and unlinking)
(See also the discussion of curves on a torus [below](#).)
- **Added 6 Jan 2017**
Chaining Rubber Bands problem (only loosely related)
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/rubber-bands.html>
What can't be done with linked rubber bands?
Some possibilities and impossibilities involving linked rubber bands.
- **Added 28 Apr 2015**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/magic-mirrors.html>
Myths and Mysteries about mirrors.
What mirrors really do
With [Alastair Wilson](#)
- **EDSEM Edinburgh Aug 2015**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/edsem-15.html>
Edinburgh Informatics Forum
Mathematical Reasoning Group Seminar 25th Aug 11-12.30

Biology, geometry, philosophy of mathematics and Kantian robotics?
The case of p-geometry and angle trisection
Aaron Sloman
School of Computer Science, University of Birmingham
Summary:
I shall use the example of angle trisection in what I've called P-geometry (as a tribute to Mary Pardoe, a former student, who gave me the idea) to illustrate a collection of issues relating mathematics, philosophy, psychology, evolution, development, and gaps in current AI, partly arising from serious gaps in the implicit requirements analysis behind much research in AI/Cognitive science/Neuroscience, and the long-term inadequacy of currently fashionable

statistical/probabilistic learning mechanisms.

- **Added 26 Feb 2015**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/trisect.html>

Demonstration of how to trisect an arbitrary angle using the mechanisms of P-geometry (Pardoe Geometry), introduced in:

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/p-geometry.html>

(Includes a brief criticism of Poincaré's conventionalist philosophy of mathematics.)

- **Added here 2 Jan 2015**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/chewing-test.html>

The Chewing Test for Intelligence

I first suggested in my 1978 book that human mouths are more important than generally appreciated for development of intelligence, even from birth, in ways that are relevant to debates about bottle-feeding vs. breast-feeding

I have also repeatedly argued not only that Alan Turing did not propose a behavioural test for intelligence (he was far too intelligent to do that). But various people keep on offering revisions of the supposed Turing Test, and others make the mistake of claiming that intelligence is deeply connected with sensory-motor morphology, ignoring most uses of human intelligence. This semi-serious paper argues that if they believe that they they should base their theories of intelligence on human mouths and their movable contents, and give their robots mouths with movable lips, cheeks, tongue, etc. Some of them might pass the "cherry pie" test allegedly used on competitors for fellowships at All Souls College Oxford. The paper also makes some serious points, e.g. about humans born with serious physical abnormalities, the importance of both online and offline intelligence in animals and machines. And criticises those who use a "passive walker" robot as evidence that intelligence does not require computation, only the right physical design.

- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/befm-sloman.pdf>

17 Dec 2014

Biological/Evolutionary Foundations of Mathematics (BEFM)

The ideas about roles of mathematics in biological evolution, and the role of evolution as contributing to the foundations of mathematics, are presented in this draft paper. This repeats and elaborates some of the ideas in the paper on [Construction Kits](#) above.

Added November 2016

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/maths-foundations-sem-sloman.html>

Notes for a seminar on

Physical/evolutionary foundations for mathematics vs logico/semantic foundations for mathematics

Notes for an informal seminar in the School of Computer Science,
University of Birmingham Friday 11th September 2016

Expanded in this (Work in Progress document):

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/what-is-maths.html>

- **Added 23 Nov 2014 (File re-named 15 Dec 2014. Updated Jan, Aug 2015, Feb 2017)**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/explaining-possibility.html>

Construction kits as explanations of possibilities

(Generators of possibilities)

"How is X possible?" was a question asked for various cases of X by Immanuel Kant (e.g. how is knowledge of synthetic necessary truths possible?). In the early 1970s I wrote a paper, expanding on my 1962 DPhil thesis, that attempted to show that claims about possibility and explanations of possibility are deeply connected with the most fundamental aims of science, and often require the current scientific ontology to be extended. As far as I knew no philosopher of science had addressed such claims and explanations. Moreover they are counter-examples to many philosophical accounts of how scientific theories are, or should be, evaluated. E.g. the claim that X (or something of type X) is possible can never be refuted by experiment or observation. So it was necessary to revise major philosophies of science, including the work of two whom I greatly admired and had learnt from, Karl Popper and Imre Lakatos. Moreover explaining how X is possible seemed to be particularly relevant to some of the newest sciences, including linguistics and artificial intelligence.

After rejection by at least one philosophy of science journal the paper was published in 1976 in *Radical Philosophy*, now online here: <http://www.radicalphilosophy.com/issues/013>
A slightly revised version was published as Chapter 2 of my (messy) 1978 book *The Computer Revolution in Philosophy: Philosophy, science and models of mind* (now freely available online [here](#).) Chapter 2 can be directly accessed [here](#).

To my surprise, several readers told me that they had found that chapter hard to understand, and could not see its relevance to the rest of the book, although a theoretical physicist colleague with a philosophical background, who later went on to receive a Nobel prize for physics, had approved the main ideas. In November 2014, I stumbled across a 1981 review of the 1978 book, by Stephen Stich, which made critical comments about Chapter 2, while approving of much else in the book, though highly critical (and rightly so) of much of the style of presentation. The text of his review is available here (added 19th Nov 2014):

<http://www.cs.bham.ac.uk/research/projects/cogaff/crp/stich-review-crp.html>

A review by Douglas Hofstadter was also unenthusiastic about Chapter 2, while endorsing most of the rest of the book. His review is referenced here:

<http://www.cs.bham.ac.uk/research/projects/cogaff/crp/crp-reviews.html#hofstadter-review>

This document attempts to extend Chapter 2 of CRP by providing a clearer introduction to the idea of a set of possibilities and the concept of an explanation of how something is possible, based on the idea of a construction kit (e.g. Lego, Meccano, plasticine, paper+scissors, a programming language, and many more) as a generator of a set of possibilities.

[A companion piece](#) discusses construction kits required for life and evolution.

A contrasting paper discusses discoveries and explanations of impossibilities: [here](#).

- [Mathematical phenomena, their evolution and development](#)
(Examples and discussions on this web site.)

- **Added 10 Nov 2014 (Updated July 2017)**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/shirt.html>

Shirt Mathematics

Illustrating topological and semi-metrical reasoning in everyday life. Which body-part should go into which opening first when you put a shirt on a child. Why?

- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/c-and-m-2014.html>
Disembodied Motionless Intelligence
Why offline intelligence is as important as online intelligence for many animals and future robots.

Short and long abstracts for invited talk at Computers and Minds Workshop
The Institute for Advanced Studies in the Humanities (IASH)
Edinburgh, Friday, 21 November 2014

- Added: 1 Oct 2014
How can we reduce the gulf between artificial and natural intelligence?
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/turin14.html>
Abstract and Extended Abstract for Invited talk at
[International Workshop on Artificial Intelligence and Cognition \(AIC 2014\)](http://www.cs.bham.ac.uk/research/projects/cogaff/misc/turin14.html)
- More work in progress: 23 Aug 2014
Mathematical structures in plant life: A very tiny subset
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/plants-maths/>
- New draft paper (Work in progress, Updated 23 Aug 2014; Dec 2016)
Meta-Descriptive Metaphysics
Extending P.F. Strawson's "Descriptive Metaphysics"
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-descriptive-metaphysics.html>
- **New Group (12 Mar 2013, Updated 4 Jul 2014, Jan 2015):**
Items concerned with virtual machinery and architectures.
 - **Updated: 4 Jul 2014...4 Feb 2015...May 2017**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/vm-functionalism.html> Virtual Machine Functionalism
(The only form of functionalism worth taking seriously in Philosophy of Mind and theories of Consciousness).
Also introduces Virtual Machine supervenience VM-supervenience.
(Links to Popper's ideas added 5 Apr 2014)
 - **Installed Feb 2012**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/clark-dennett-realisation.html>
Realisation and Virtual Machines
Provoked by my reading a letter to the New Scientist by Andy Clark and Daniel Dennett, published on 13th December 2008, and available online [here](#).
 - [Virtual Machines and the Metaphysics of Science](#)
Extended abstract for a talk given at [the conference on 'Metaphysics of Science'](#) in Nottingham Sept 2009.
 - To be extended ...
- **New Vision Group (3 Feb 2013)**
(expanded 3 Nov 2013; updated 10 Nov 2014):

Items concerned with vision (and mathematics), in humans, other animals, robots, etc.

- **Added 3 Nov 2013; 31 Mar 2014 (new video); Updated June 2014**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/vision/>
Discussion of some unsolved problems concerned with vision in humans, other animals, and machines/robots, including examples of hard challenges to be addressed.
- Moved here from [CoSy web site](#) and updated: March 2014
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/changing-affordances.html>
Discussion Paper: Predicting Affordance Changes (Including Video demonstrations)
(Steps towards knowledge-based visual servoing)
Updated with new video 31 Mar 2014
- Updated July 2017
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/torus.html>
What can we learn about the nature of mathematics, the functions of vision, and the inadequacies of current AI and robotics, by contemplating continuous deformations of closed curves on a torus?
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/knots/>
KNOTS OVERVIEW
Knotty Reflections: examples of perception and reasoning about strings and knots: part of a collection of examples of abilities of humans to reason in a mathematical way even if they don't know they are doing it.

It is also part of a survey of functions of vision not noticed by most vision researchers in AI/Robotics psychology and neuroscience [here](#). Installed 4 Jun 2014
- Added 3 Feb 2013: Updated 21 Nov 2016; July 2017 [Shepard's Rotated Table Illusion, and related illusions](#)
- [Vision and Action: Requirements for seeing the real world](#)
- Multi-Level vision: Possible empirical tests:
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/multi-vision.html>
In an email discussion Alain Berthoz asked me to suggest experiments that might be done on humans or other animals to test some ideas, instead of relying so much on analysis of design requirements.
- There are several PDF slide presentations on aspects of vision in [my 'talks' directory](#), especially
<http://www.cs.bham.ac.uk/research/projects/cogaff/talks/#gibson>
What's vision for, and how does it work?
From Marr (and earlier) to Gibson and Beyond

Also various published conference and workshop papers on vision in:

- [CoSy project papers](#) and
- [Cogaff Papers](#)
- some of them grouped together [here](#).

(End group)

- **The (mythical) Turing Test (2014 version)**

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/turing-test-2014.html>

- **Judging Chatbots at Turing Test 2014**

Comments following my experience as one of the judges at the "Turing Test" event at the Royal Society in London UK, on 6-7th June 2014:

The claim that the test had at last been passed (even though Turing proposed no test for intelligence) seems to have produced a world wide furore, and much controversy. Turing did not propose a behavioural test for intelligence, any more than he proposed a behavioural test for computation. Both are misguided ideas. What we need is not a **test** but a **theory** about varieties of intelligence, how they evolved, how they develop in individuals, what mechanisms they require, what costs and benefits they bring to organisms, and what developmental trajectories they support and build on.

[Skype interview with Adam Ford](#)

(in Melbourne, Australia) on 12th June 2014 (2am UK time!)

- **[Analysis of limitations of 'black box' tests](#)**

Showing futility of attempts to improve on the Turing Test by requiring richer interaction or more stringent conditions.

Proponents of behavioural tests for information processing power are often unaware of serious the flaws in such tests. Instead of such tests we need deep explanatory theories capable of explaining not just one individual, but whole species or even larger classes of behaving individuals.

- **<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/cas-2014-compthink.html>**

What forms of computational thinking will our children need when they grow up?

Abstract of presentation at [Computing at School conference June 2014](#).

[Partial Programme 20-21st June 2014](#)

Installed: 20 May 2014; Modified 16 Jun 2014 to include Turing Test Furore

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<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/family-resemblance-vs-polymorphism.html>

Wittgenstein's Family Resemblance Theory vs. Ryle's Polymorphism and Computer Science's notion of 'parametric polymorphism'.

Installed April 2011.

Updated April 2014:

The polymorphism of 'X is conscious of/that Y'.

Further updates: Oct 2015

- **Two related discussion notes about rotation and discreteness**

-

<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/quantum-non-quantum-rotation.html>

- **Letter to a quantum theorist**

Rotation in a discrete universe.

Help requested from quantum physicists

- [Incomplete note on problems of rotation in a discrete space](#)

- **Added 26 Apr 2013 (Modified Dec 2013, July 2017)**
[Jane Austen's concept of information](#)
 (As opposed to Claude Shannon's)
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/bbc-learning.html>
Letter to presenter, participants and producer of BBC Start The Week programme: "The Building Blocks of Life and Intelligence"
 Broadcast BBC Radio 4, on 9th Dec 2013
 Podcast: http://downloads.bbc.co.uk/podcasts/radio4/stw/stw_20131209-0808a.mp3
 Presenter: Anne McElvoy
 Participants: Alison Woollard, Roger Kneebone, Mark Elder & Kathryn Asbury
 Producer: Katy Hickman
 Anne McElvoy talks to the geneticist Alison Woollard about her Royal Institution Christmas Lecture; the psychologist Kathryn Asbury about the connections between genes and education; Professor Roger Kneebone about surgery; and the conductor Sir Mark Elder about rediscovering lost operas.
- **Added 29 Mar 2013 (modified Jan 2014)**
[Notes on autism and other developmental patterns](#) in the context of Meta-Morphogenesis.

 Autistic Information Processing
 Steps toward a generative theory of information-processing abnormalities.
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/fully-deliberative.html>
 Requirements for a Fully-deliberative Architecture
 (Or component of an architecture)
 Originally part of [the CoSy project web site](#).
- [Evolutionary transitions in information-processing](#)
 Updated Jan 2014; ... Jan 2017
 Far more and more varied than most people seem to have noticed?
 Over 80 transitions identified so far. A tiny subset!
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/hbp-robotics.html>
 Human Brain Project/NeuroRobotics Sub-Project: A slightly skeptical look from the standpoint of the Meta-Morphogenesis project.
 For Project meeting 8-9 Jan 2014, Munich (TUM)
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/mathsem.html>
 From Molecules to Mathematicians:
 How could evolution produce mathematicians from a cloud of cosmic dust?

 What might Turing have done if he had lived longer?
 How might it have helped us understand biological evolution,
 and how evolution produced mathematicians?

 Notes for a presentation to the Midlands Logic Seminar (November 2013)

- [Biology, Mathematics, Philosophy, and Evolution of Information Processing](#)

(Added: 12 May 2013. Modified: on or after 24 Sep 2013)

Ian Hacking recently reminded me that Wittgenstein wrote, in

Remarks on the Foundations of Mathematics (1978: VII '33, p. 399)

"For mathematics is after all an anthropological phenomenon."

I think that's a step in the right direction, but the step is much too short. I'll offer an alternative idea as background to the discussion of geometrical and other forms of mathematical and proto-mathematical reasoning capabilities in other documents.

Human mathematics is rooted in **biological** phenomena, concerned with a huge variety of different "domains" and grown in stages, initially mainly by natural selection, then later repeatedly extended through processes of learning, development, and social/cultural change, possibly with further evolutionary development -- all used to address increasingly complex challenges and opportunities presented by the physical world and its occupants, living and non-living, along with new challenges and opportunities continually presented by results of earlier evolutionary developments that have provided new sensors, new manipulators, new information-processing capabilities, new problems of learning and control, and new forms of mathematics implicit in the information-processing strategies.

Neither the domains nor the detailed mathematical facts about the domains are created by evolution or by humans who discover and use them, though evolution creates many new instances of increasingly complex mathematical domains, as do humans and some other animals -- e.g. spiders building webs that conform to certain species specific patterns. But creating instances, need not involve understanding.

- [Triangle Qualia/Triangle Theorems](#) (Part of this was split off to form [the triangle sum theorem paper](#) 29 May 2013)

New title (since 1 Mar 2013): Hidden Depths of Triangle Qualia

Theorems About Triangles, and Implications for Biological Evolution and AI The Median Stretch, Side Stretch, Triangle Sum, and Triangle Area Theorems (Old and new proofs.)

Incomplete discussion of various theorems relating to triangles, especially theorems requiring mechanisms not yet in AI systems and the resources required for discovering and proving them. Introduces the distinction between online and offline intelligence, and relationships to competences concerning affordances, found in pre-verbal humans (toddlers) and several non-human species. How did the ability to discover theorems in euclidean geometry arise from previously evolved competences? The pervasive biological relevance of spatial reasoning, with and without use of metrics for length, area, etc.

Including:

- The Median Stretch Theorem
- The Side Stretch Theorem
- The Median Containment Theorem (MCT)
- The Side Containment Theorem (SCT)
- The Perpendicular Stretch Theorem
- The Triangle Area Theorem (still incomplete)

- [The Triangle Sum Theorem](#)
(Old and new proofs, including Mary Pardoe's Proof, using a rotating arrow, or pencil.)
- [P-Geometry: a \(Possibly\) New Kind of Euclidean \(or nearly Euclidean\) Geometry](#)
Based on an idea by Mary Pardoe.
Do we need to assume the parallel postulate in order to reason about moving, rotating rigid objects, or line segments?

Other discussions relevant to mathematics and mathematical discovery

- [Toddler theorems -- what they are and some examples](#)
 - [Different relationships between genome and competences](#)
(Preconfigured vs meta-configured competences: Chappell and Sloman)
 - [What could have led to euclidean geometry?](#)
Why is it so hard to get machines to reason like our ancestors who produced Euclidean Geometry?
 - [Ideas about "Relational Redescription"](#)
in Annette Karmiloff-Smith's **Beyond Modularity** (1992)
 - [Abstract for talk to mathematics school leavers, updated for ASE Conference Jan 2014 \(Association for Science Education\)](#)
"Could a baby robot grow up to be a mathematician?"
(17 April 2013, updated 10 Jan 2014)
 - [Evolutionary transitions in information-processing](#)
Updated Jan 2014
Far more and more varied than most people seem to have noticed?
 - [Mathematical phenomena, their evolution and development](#)
(List of examples and discussions on this web site.)
(The role of mathematics in biology.)
-
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/wib2013.html>
Online vs Offline intelligence: how and why the latter evolved and develops --- or ---
Evolved connections between worlds inside and outside brains.
Talk for conference: The World Inside the Brain:
Internal Predictive Models in Humans and Robots
Thursday 23rd (09:30) - Friday 24th May 2013 The University of Birmingham
<http://www.birmingham.ac.uk/research/activity/cncr/news/24May-wib-conference.aspx>
 - [Architecture-based vs reward-based motivation and learning](#)
(Originally installed in 2009. Modified 31 Mar 2013:
pointing out differences from R.W.White's concept of "effectance motivation".
Also modified to explain difference from what many now call "intrinsic motivation".

- [My standard response when asked to evaluate the impact of research or researchers.](#)
Moved here from my home page 25 Jan 2013, and slightly expanded.
- Did life on earth start on dust particles?
The theory of Nasif Nahle, Mexico.
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/non-soup-early-life.html>
- DRAFT list of types of transitions in biological information-processing
Varieties of Evolved (Developed, Learnt,) Biological Computation
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/evolution-info-transitions.html>
- **Abstract for tutorial on Meta-Morphogenesis at AGI-2012 conference,**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/agi-2012-tut-sloman.html>
Oxford 8-11 December 2012 (<http://agi-conference.org/2012/>)
Meta-morphogenesis: How a planet can produce Minds, Mathematics and Music
(along with murder, religious bigotry, and other nastiness).
Video recording of the tutorial (about 2 hrs 30 mins, updated 14 June 2013 with sound
problem fixed):
<http://www.youtube.com/watch?v=BNuI52kFI74>
Also available on the CogAff web site:
<http://www.cs.bham.ac.uk/research/projects/cogaff/movies#m-m-tut>
- [Abstract for research lunch talk CS, Birmingham 21 Nov 2012](#)
[On the Origins of Biological Computations](#)
How can a cloud of dust containing only physical/chemical structures
produce musicians, mathematicians, metaphysicians, megalomaniacs,
monkeys, mice, microbes, music, mayhem, murder, munificence, marmite
and other wondrous products? Also [here](#).
- **Draft abstract for talk at Leeds (Mathematics Dept) 31st October 2012**
An introduction to the Meta-Morphogenesis project
**How can a cloud of dust give rise to a planet full of life and mental activity -- including
mathematics?**
<http://tinyurl.com/CogMisc/leeds-logic-abstract.html>
- **Scaling UP vs Scaling Out: In the design of intelligent systems (August 2012)**
<http://tinyurl.com/BhamCog/misc/scaling-up-scaling-out.html>
- **Overviews of aspects of Meta-Morphogenesis**
(To be expanded.)
 - **2012 onwards, revised and extended many times since 2012**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-morphogenesis.html>
The Meta-Morphogenesis (MM) Project (or Meta-Project?)
Alternative title: The Self-Informing Universe
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/m-m-related.html>
References related to the M-M Project
 - Coming: Meta-morphogenesis and information-processing architectures
 - <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/evolution-life-mind.html>
Evolution, Life and Mind: Some Startling Facts

- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/mm-conclusions.html>
Partial list of possible conclusions from various sub-projects of the M-M project.
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/evolution-info-transitions.html>
DRAFT list of types of transitions in biological information-processing or Varieties of Evolved (Developed, Learnt, ...) Biological Computation
- <http://www.cs.bham.ac.uk/research/projects/cogaff/12.html#1203a>
Paper for ECAI 2012 workshop on creativity:
Meta-morphogenesis and the Creativity of Evolution
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/keller-org.html>
A few notes on Evelyn Fox Keller on
Organisms, Machines, and Thunderstorms: A History of Self-Organization
- Possible domains for research in MM (A tiny sample)
 - Seeing a toy meccano crane:
<http://tinyurl.com/BhamCog/misc/crane>
 - [Meta-Morphogenesis and Toddler Theorems: Case Studies](#)
 - [Basics of the theory.](#)
 - **Installed May 2015**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/grasping-grasping.html>
Can a Robot Grasp Grasping? How can a robot understand what's going on when it grasps something?
 - **INSTALLED 2005**
<http://tinyurl.com/BhamCog/misc/polyflaps>
The Domain of Polyflaps and Other Domains for Acting and Learning, (Based on discussions with Marek Kopicki, in 2005)

This paper influenced a number of robot projects investigating robot abilities to perceive and manipulate polyflaps, in Birmingham and with partners elsewhere. However, the work has so far addressed only the simplest problems. (26 Jan 2016)
- [Reflections on **Beyond Modularity** by Annette Karmiloff-Smith \(1992\)](#)
A very personal (and favourable, but disorganised and intermittently expanding) review. (Work in Progress)
- [Simplicity and Ontologies](#)
The trade-off between simplicity of theories and sophistication of ontologies. Arguments against treating learning from experience as dimension-reduction -- with examples of benefits of **adding** a dimension.
- [Evolution of language and creativity](#)
Notes on evolutionary precursors to human language and creativity. Inspired by a seminar presentation by Rustam Stolkin on the work of Derek Bickerton on evolution of language.
See also <http://tinyurl.com/BhamCog/talks/#glang>
- [\(2011; Updated Jan 2017\) Evolved Cognition and Artificial Cognition](#)
[Some genetic/epigenetic trade-offs for organisms and robots](#)
Or: [Notes on how to do AI-Inspired Biology \(AIB\)](#)

- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/alchemy>
Is education research a form of alchemy?
Originally published in
<http://newsletter.alt.ac.uk/2012/06/is-education-research-a-form-of-alchemy/>
[Issue 27 of Association for Learning Technology Newsletter](#) (June 2012)
- [The Internet and Information-Suction Engines](#)
Thoughts provoked by the flotation of facebook 19 May 2012.
- [IRLAB Seminar abstract on Meta-Morphogenesis 30 Apr 2012](#)
- [Rules For The Application Of Rules](#)
Response to a philosopher's question posted in 2009.
- [Varieties of Meta-Morphogenesis in the Bootstrapping of Biological Minds.](#)
Draft Abstract For Invited Talk at [AISB/IACAP World Congress 2012 -- Alan Turing 2012](#)
- [The Mythical Turing Test](#)
It is widely believed that Turing proposed a test for intelligence. This is false. He was too intelligent to do any such thing.
- [Notes on a possible Artificial Intelligence/Cognitive Science GCE/A-level syllabus](#)
- [Short-Term Memory and Programming](#)
(Reflections on an aptitude test for programming)
- [Abstract for invited talk at PT-AI](#)
Philosophy and Theory of Artificial Intelligence, Thessaloniki, October 2011
<http://www.pt-ai.org/>
- [Education Grand Challenge: A New Kind of Liberal Education](#)
[Making People Want a Computing Education For Its Own Sake](#)
Also available in [PDF format](#).
(Originally posted here in 2004)
See also
 - [Summaries of Marvin Minsky's essays for the OLPC](#)
[\(One Laptop Per Child\) project](#)
 - [Comments on Lecture by Eric Schmidt \(Google\)](#)
[MacTaggart lecture Edinburgh Festival 2011](#)
(Criticising computing education in the UK)
- [A partial review and critique of "Zen and the Art of Consciousness"](#)
(previously published as "Ten Zen Questions") by Susan Blackmore.
- [Why scientists and philosophers of science should teach intelligent design \(ID\) alongside the theory of evolution](#)
Updated Feb 2017
If we don't present and analyse examples of mistaken theories, we'll fail to teach our students how to identify and criticise them.

(Originally written around 2006. Link added here 8 Apr 2011),

- [Dynamical Information-Processing Systems in Animals and Machines](#)
(Notes on varieties of dynamical systems)
- [Notes for a seminar on Piaget's last two books, on Possibility and Necessity](#)
- [The biological bases of mathematical competences: a challenge for AGI](#)
Notes for Invited talk for The Fourth Conference on Artificial General Intelligence
Google, Mountain View, California, USA, August 3-6 (Wed-Sat) 2011
<http://agi-conf.org/2011/>
- **Added 25 Jan 2011:** [Energy and Other Costs of HTML in Email](#)
- [Computing: the science of nearly everything](#)
The Science that's being left out of discussions of computing education.
- [Open source and Public Funds](#)
(A different reason for the benefits of open source: How to promote public, collaborative, mutually informative problem solving.
(See also [the iSoft/NHS document](#) below.)
- [The iSoft/NHS affair: Open Letter to my MP about government IT procurements](#)
(Is the EU about to make the same mistake about a monolithic global healthcare system? See <http://health.parlicentre.eu/>.)
- [Can a robot design a humane mouse trap?](#)
What competences would it require?
- [Reflections on Kinds of Value](#)
OR: What's the point of being (financially) rich if you can't have a good philosophical discussion, or appreciate music, or poetry, ...?
- ["The Self" -- A bogus concept](#)
Updated May 2017
Originally written in anticipation of a debate at the AAI'08 Workshop on Meta-reasoning.
- [Getting Virgin Media V+ Controller to Control Volume on Sony Bravia TV Using HDMI Connection](#)
- [Some AI links I have found useful in the distant past.](#)
- [Understanding how search spaces explode, defeating parallel computation.](#)
(How to take 30,000 decisions when designing something big.)
- [KINDS OF STUFF](#)
Learning about them, exploring them, seeing them...
- Discussions on ontologies and an ontology for questions
 - [Towards an ontology for factual information for a playful robot](#) (PDF)
 - [Towards an ontology for factual questions.](#) (PDF)

- [Why I hate using Microsoft Windows](#)
(most recently Windows 7, which came with [my Dell Latitude E6410](#))
Added 26 Jan 2013 Using a registry cleaner to fix the mess left behind after removing OpenOffice and installing LibreOffice, as described [here](#).
- [Misrepresenting Einstein's Views on Religion](#)
- [Yet Another Singularity: The Singularity of Cognitive Catch-up](#)
- [Use Free Open Access Journals](#)
- [Sorites -- A New Analysis Based on Context](#)
The paradox of the heap and related paradoxes resolved by showing how context determines what is a heap, or a pile, or a long piece of string.
- [The Design-Based Approach to the Study of Mind](#)
(in humans, other animals, and machines).
(The "designer stance". McCarthy.)
- [What is it like to be a rock?](#)
(Originally written January 1996 making fun of some discussions on the Psyche-D list that took seriously Nagel's question: "What is it like to be a bat?")
- [A demonstration of unconscious seeing \(20 Oct 2009\)](#)
- [Possibilities \(proto-affordances\) Between Form and Function](#)
Draft abstract for Dagstuhl Seminar October 2009.
- [Messages about types of emotion posted to](#) the discussion list of [The International Society of Research on Emotion](#) (ISRE) in 2005, in response to a question from Kristjan Kristjansson.
- [Letter to Stephen Fry \(20 Aug 2009\)](#) sent via BBC but bounced.
- [Survey questions about scope and prospects for AI \(Computational Cognitive Science\)](#)
- [Notes on research funding \(19 Mar 2009\)](#)
- [A Better Idea than Language Universals](#)
- [asimov-three-laws.html](#)
Why Asimov's three laws of robotics are unethical
- [embodiment-issues.html](#)
Computation and Embodiment: Three issues, not two.
Some notes on good and bad reasons for thinking embodiment is relevant to intelligence (or human-like intelligence).

- Discussions of supposed problems of "Free Will"
 - <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/four-kinds-freewill.html>
Four Concepts of Freewill: Two of them incoherent
 - <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/freewill.disposed.of>
HOW TO DISPOSE OF THE FREE WILL ISSUE
(Originally posted on Usenet in 1989. Later published in AISB Quarterly)
In the framework of analysis of different sets of requirements for animals and robots, and different possible designs of varying complexity, the pre-theoretical concept of freedom of the will needs to be abandoned and replaced with a host of different technical concepts corresponding to the capabilities enabled by different designs.
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/logical-geography.html>
Two Notions Contrasted: 'Logical Geography' and 'Logical Topography'
Variations on a theme by Gilbert Ryle:
The logical topography of 'Logical Geography'.
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/varieties-of-atheism.html>
VARIETIES OF ATHEISM
(Updated Feb 2017)
What is analytical atheism?
(Including a tutorial on how to use conceptual analysis to identify disguised nonsense.)
- GOOD AND BAD ELITISM
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/elitism.html>
In Defence of a Variety of Elitism (not understood by British (Labour) Government Ministers).
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/whats-information.html>
What is information? Meaning? Semantic content?
Later revised and published as a book chapter.
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-requirements.html>
A First Draft Analysis of Some Meta-Requirements for Cognitive Systems in Robots. (An exercise in logical topography analysis.)
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/actual.possibilities.html>
ACTUAL POSSIBILITIES (PAPER FROM KR'96)
We (well, some significant subset of humanity, probably including you!) have an intuitive grasp of a family of related concepts of "possibility", "causation" and "constraint" which we often use in thinking about complex mechanisms, and perhaps also in perceptual processes, which according to Gibson are primarily concerned with detecting positive and negative affordances, such as support, obstruction, graspability, etc.
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/compedu.html>
Why Computing Education has Failed and How to Fix it
[An alternative vision of computing in education.](#)

- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/cs-future.html>
The Future of Computer Science
(Peering into the murk -- via my googol ball.)
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/cs-research.html>
TYPES OF RESEARCH IN COMPUTING SCIENCE
SOFTWARE ENGINEERING AND ARTIFICIAL INTELLIGENCE
The Five Categories of Research distinguished (2001, later modified).
 1. *The study of what is possible -- and its scope and limits*
Including both mathematical and less formal modes of theorising.
 2. *The study of existing (naturally occurring) information-processing systems*
E.g. animals, societies, brains, minds,
Sometimes described as "Natural computation".
 3. *Research involving creation of new useful information-processing systems*
I.e. research directly related to engineering applications.
 4. *The creation and evaluation of tools, formalisms and techniques to support all these activities.*
 5. *Research on social and economic issues*
Including studies of the social and economic impact of computing and AI, ethical issues, changing views of humanity, etc.
- [defining-cognition.html](#)
Answer to circulated question on how to define "cognition". Answer: from the design standpoint -- the question is misguided.
(Also on the [euCognition](#) web site)
- **QUESTIONS ABOUT EMOTIONS**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/emotions-questions.html>
In December 2005 I was invited by a well known researcher on emotions, Carrol Izard, to contribute to a discussion by answering a few questions as briefly as possible. He asked for 'one-liners', but I was not able to comply with that condition. However, the answers were short for me!
Having taken the trouble to provide him with answers I thought I might as well put them here, in case anyone is interested.

Compare this reply to Deb Roy in 2002. He asked Finally, you said that you "make sharp distinctions between desires, attitudes, moods and emotions". Can you send me a pointer to your most relevant papers on this point? My reply was this document:
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/emotions-moods-attitudes.txt>
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/forms-of-representation.html>
What is a Form of Representation?
(Stub, to be expanded, regarding the different ways information can be encoded so as to be of practical use to someone or something.)

- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/evo-prob.html>
Some thoughts about evolution and probabilities
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/hawkins-numenta.html>
RESPONSE TO QUESTIONS ABOUT JEFF HAWKINS
(Not very well informed)
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/language-of-thought.html>
Evolution of minds and languages.
What evolved first and develops first in children: Languages for communicating, or languages for thinking (Generalised Languages: GLs)
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/nature-nurture-cube.html>
Rotating necker cubes and nature-nurture debates.
(Going beyond sensorimotor contingencies to perceive what's out there.)
Challenges for AI visual learning systems.
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/online-and-offline-creativity.html>
Online and Offline Creativity
- BILL GATES ON ROBOTS IN SCIENTIFIC AMERICAN
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/sciam-robots-gates.html>
- <http://www.cs.bham.ac.uk/research/projects/cogaff/misc/synthetic-biology.html>
Synthetic Biology: Information Engineering
A major challenge for engineering, science and education.
- **Other stuff**
<http://www.cs.bham.ac.uk/research/projects/cogaff/misc/>
A complete directory-listing of this directory, warts and all!
Later I'll add more of them to this list, and impose some structure.

Other collections

(Including papers by colleagues and collaborators and joint papers.)

- Cognition and Affect (CogAff) project
<http://www.cs.bham.ac.uk/research/projects/cogaff/>
- [Various online presentations, including tutorial lectures \(PDF\)](#)
- [Papers, discussion notes and presentations written for the CoSy project.](#)
- Software: [Poplog](#) and the [SimAgent Toolkit](#)
- [A first draft attempt to organise the material into topics](#)
- [Notes on Boden: Mind as Machine](#)

Installed: Feb 2009

Updated:

26 Jan 2016; 6 Apr 2016; 8 Apr 2016; 23 Jan 2017; 28 Jun 2017; 30 Dec 2017

5 Apr 2014; 16 Jun 2014; 30 Jul 2014; 11 May 2015

29 May 2013; 7 Jul 2013; 25 Sep 2013; 31 Oct 2013; 16 Jan 2014; 29 Mar 2014;

10 Nov 2009; 25 Jan 2013; 3 Feb 2013; 31 Mar 2013; 4 Apr 2013;

Maintained by [Aaron Sloman](#)

[School of Computer Science](#)

[The University of Birmingham](#)

List of files (excluding sub-directories)

136063 Aug 19 2018 10:56 AREADME.html
AREADME.pdf

replaced with:

146970 Feb 6 21:29 AREADME.html
296652 Feb 6 21:30 AREADME.pdf

129364 Feb 6 18:46 binocular-rivalry.txt
156712 Feb 6 01:03 emotions-affect.pdf
99156 Feb 6 01:03 emotions-affect.html
3374443 Feb 4 11:39 Rationality_Robot_emotions.pdf
140085 Jan 30 14:47 evo-framephys.pdf
93690 Jan 30 14:47 evo-framephys.html
197809 Jan 29 00:31 turing-intuition.pdf
124285 Jan 29 00:30 turing-intuition.html
136509 Jan 25 23:12 kant-maths.pdf
10350 Jan 25 20:51 unconscious-seeing.html
55019 Jan 25 11:05 kant-maths.html
670701 Jan 25 00:25 sloman-compositionality.pdf
163975 Jan 25 00:25 sloman-compositionality.html
37518 Jan 24 02:36 m-m-bib.html
149705 Jan 19 22:34 architecture-based-motivation.pdf
43068 Jan 19 22:33 architecture-based-motivation.html
406301 Jan 13 15:25 meta-morphogenesis.pdf
206702 Jan 13 15:24 meta-morphogenesis.html
666515 Jan 13 15:21 construction-kits.pdf
331138 Jan 13 15:19 construction-kits.html
133603 Jan 13 15:17 what-is-maths.pdf
118159 Jan 13 15:16 what-is-maths.html
161918 Jan 13 15:10 creativity.pdf
109278 Jan 13 15:09 creativity.html
10116 Jan 12 22:14 ai-singularity.html
118194 Jan 11 02:51 family-resemblance-vs-polymorphism.pdf
73736 Jan 11 02:50 family-resemblance-vs-polymorphism.html
12731 Jan 11 01:43 sloman-eastside-2018.html
1375181 Jan 7 00:52 impossible.pdf
243595 Jan 7 00:50 impossible.html
6426 Dec 24 18:19 zurich-talk.html
4297 Dec 24 11:38 template.txt
162439 Dec 21 01:56 turing-quotes.pdf
119096 Dec 21 01:55 turing-quotes.html
77941 Dec 21 01:51 triangle-sum.pdf
40194 Dec 21 01:51 triangle-sum.html
130031 Dec 21 01:49 super-turing-geom.pdf
94030 Dec 21 01:49 super-turing-geom.html
204151 Dec 21 01:35 royalsoc-deep-learning.pdf
221237 Dec 21 01:35 quantum-evolution.pdf
68875 Dec 21 01:34 royalsoc-deep-learning.html
75443 Dec 21 01:33 quantum-evolution.html
133049 Dec 21 01:22 m-m-related.pdf
297126 Dec 21 01:21 meta-configured-genome.pdf
112230 Dec 21 01:20 meta-configured-genome.html
63466 Dec 20 17:27 m-m-related.html
21 Dec 20 02:21 turing-intuition-sloman.html -> turing-intuition.html
162036 Dec 19 09:03 turing-intuition-sloman.pdf
101576 Dec 14 01:55 austen-info.pdf

53638 Dec 14 01:54 austen-info.html
127144 Dec 12 23:52 schrodinger-life.pdf
62692 Dec 12 23:51 schrodinger-life.html
65663 Dec 11 17:41 super-turing-phil.pdf
28255 Dec 11 17:38 super-turing-phil.html
98728 Dec 11 01:52 the-self.pdf
44578 Dec 11 01:52 the-self.html
17880 Dec 4 23:39 cogaff-sem-apr-2017.html
70609 Dec 1 18:25 shirt.pdf
13338 Dec 1 18:25 shirt.html
657910 Nov 27 23:11 vm-functionalism.pdf
165340 Nov 27 22:57 vm-functionalism.html
164082 Nov 27 22:54 entropy-evolution.pdf
78970 Nov 27 22:54 entropy-evolution.html
391377 Nov 24 22:51 evolution-info-transitions.pdf
139489 Nov 24 22:50 evolution-info-transitions.html
753596 Nov 13 20:30 ijcai-2017-cog.pdf
231367 Nov 13 20:29 ijcai-2017-cog.html
13642 Nov 11 10:50 ai-future.html
85237 Nov 9 21:17 explaining-possibility.pdf
50015 Nov 8 20:28 explaining-possibility.html
14343 Nov 6 23:48 youtube.html
21203 Oct 22 12:00 creativity-boden.html
207690 Oct 22 00:17 rings.pdf
15448 Oct 20 22:32 rings.html
64377 Oct 7 21:49 information-difference.pdf
39026 Oct 7 21:48 information-difference.html
138277 Oct 7 21:19 spatial-prepositions.pdf
75880 Oct 7 20:35 spatial-prepositions.html
439749 Sep 29 22:58 compositionality-syco-1.pdf
19542 Sep 29 22:56 compositionality-syco-1.html
227536 Sep 29 22:52 rubber-bands.pdf
15798 Sep 29 22:47 rubber-bands.html
643282 Sep 29 22:40 sloman-compositionality-21-sep.pdf
19900 Sep 25 23:42 folded-paper-theorem.html
138397 Sep 21 08:20 sloman-compositionality-21-sep.html
12510 Sep 11 22:59 einstein-religion.html
184024 Sep 8 08:53 multicirc.pdf
24049 Sep 7 14:27 multicirc.html
96810 Sep 5 18:32 multicirc-problem.pdf
24827 Sep 5 18:32 multicirc-problem.html
13491 Sep 5 09:25 two-faces.html
156665 Sep 4 11:33 two-faces.pdf
275883 Aug 27 23:50 s.pdf
46369 Aug 19 11:48 uk-research-publication-policy.pdf
12663 Aug 19 11:48 uk-research-publication-policy.html
27854 Aug 19 11:00 index-2018.txt
34713 Aug 16 12:22 sloman-compositionality.txt
29035 Aug 13 18:50 aiforschools.html
17065 Aug 9 21:51 multi-vision.html
101572 Aug 3 2018 diagrams-tutorial.pdf
25111 Aug 3 2018 diagrams-tutorial.html
11193 Jul 31 2018 infinity.html
230247 Jul 31 2018 toddler-theorems.html
279191 Jul 22 2018 p-geometry.pdf
56303 Jul 22 2018 p-geometry.html
142729 Jul 20 2018 anger.pdf
17823 Jul 17 2018 mathstuff.html
27399 Jul 15 2018 aisb-emot.html
91 Jul 8 2018 robot-rumble.txt
9333 Jul 8 2018 sciam-robots-gates.html
11215 Jul 3 2018 online-and-offline-creativity.html
232926 Jun 15 2018 deform-triangle.pdf
66859 Jun 15 2018 deform-triangle.html
16491 Jun 6 2018 self-evidence.html
1392654 Jun 3 2018 toddler-theorems.pdf
13299 Jun 1 2018 cknates.html
8580 May 30 2018 security.html
34818 May 28 2018 chewing-test.html
299826 May 26 2018 apollonius.pdf
53313 May 26 2018 apollonius.html
2385 May 26 2018 emotions-affect-extras.txt
34812 May 20 2018 cardinal-ordinal-numbers.html
21 May 15 2018 sloman-diagrams-tutorial.pdf -> diagrams-tutorial.pdf
6393 Apr 18 2018 sloman-diagrams-tutorial.txt

142620 Apr 15 2018 fully-deliberative.pdf
85956 Apr 15 2018 fully-deliberative.html
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