Every
intelligent ghost
must contain
a machine
an information-processing machine

School of University of
Computer Birmingham
Science UK

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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

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This file HTML:
Last updated: 10 Feb 2020
    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

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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.)

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JUMP TO MAIN CONTENTS LIST (Below Other Sources).
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GOOGLE SEARCH
Use Google to search this
site.
(Thanks to Dave Parker
for help.)

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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Affect project (started with Glyn Humphreys in 1991), but now includes most of my formally published papers, and some unpublished ones, 1978 book, 1962 DPhil thesis, and other things.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
Creative Commons Attribution 4.0 License,
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
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. Most recently added items have clickable links.
The others are updates of older documents.

ADDED OR UPDATED DURING 2018-2020
Many of the html files also have pdf versions.
Many of the papers have been updated since the dates listed here.

```
2020
Feb 10 20:19  philosophy-of-ai.pdf
Feb 10 20:19  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/philosophy-of-ai.html
Feb  5 02:23  meta-morphogenesis.pdf
Feb  4 21:41  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-morphogenesis.html
Feb  5 02:22  FranklinSlomanFreewill.pdf
Feb  3 18:11  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/FranklinSlomanFreewill.html
Feb  3 18:00  FranklinSlomanFreewill-extra-notes.html
Feb  3 00:51  impossible.pdf
Feb  3 00:50  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/impossible.html
Jan 31 01:54  trisect.pdf
Jan 30 23:31  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/trisect.html
Jan 24 11:41  dna-uses.pdf
Jan 24 11:40  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/dna-uses.html
Jan 24 11:27  m-m-related.pdf
Jan 24 11:25  m-m-related.html
Jan 23 22:01  construction-kits.pdf
Jan 23 21:59  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/construction-kits.html
Jan 23 10:23  m-m-overview.pdf
Jan 22 17:57  files.txt
Jan 22 11:08  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/intelligence-varieties.html
Jan 20 21:52  consciousness-varieties.pdf
Jan 20 21:52  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/consciousness-varieties.html
Jan 18 21:50  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/tangle-test.html
Jan 18 21:54  architecture-based-motivation.pdf
Jan 18 19:08  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/architecture-based-motivation.html
Jan  5 19:43  maths-foundations.pdf
Jan  5 19:43  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/maths-foundations.html
2019
Dec 26 04:19  meta-configured-genome.pdf
Dec 26 01:32  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-configured-genome.html
Dec 12 01:36  kant-maths.pdf
Dec  8 03:04  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/kant-maths.html
Nov 20 01:15  cardinal-ordinal-numbers.pdf
Nov 18 21:22  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/cardinal-ordinal-numbers.html
Nov 12 16:18  vm-functionalism.pdf
Nov 12 16:18  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/vm-functionalism.html
Nov 11 21:16  http://www.cs.bham.ac.uk/research/projects/cogaff/misc/squirrel-intelligence.html
Nov  9 03:05  consciousness-talk.pdf
```

```
Nov  7 17:52 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/consciousness-talk.html
Nov  6 21:09 chewing-test.pdf
Nov  6 21:09 chewing-test.html
Oct 30 10:30 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/sloman-eastside-2018.html
Oct 26 17:52 emotions-affect.pdf
Oct 26 17:14 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/emotions-affect.html
Oct 18 12:15 schrodinger-life.pdf
Oct 18 12:09 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/schrodinger-life.html
Oct 18 10:55 rubber-bands.pdf
Oct 18 10:21 rubber-bands.html
Oct 15 08:17 compositionality.pdf
Oct 15 08:14 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/compositionality.html
Oct  7 14:57 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/consciousness-origins.html
Oct  4 22:41 sloman-ai-draft.pdf
Sep 30 21:07 consciousness-origins.pdf
Aug 29 20:26 alevel-ai.html -> courses/alevel-ai.html
Jan 22 17:34 family-resemblance-vs-polymorphism.pdf
Aug 27 21:07 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/family-resemblance-vs-polymorphism.html
Aug 27 02:24 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/oxford-cchm-sloman.html
             oxford-cchm-sloman.pdf
Aug 26 17:05 wib2013.html  (World Inside Brain)
Aug 29 21:44 fully-deliberative.pdf
Aug 26 16:13 fully-deliberative.html
Aug 23 11:26 creativity.pdf
Aug 23 11:23 creativity.html
Aug 19 15:19 self-aware.pdf
Aug 19 15:17 self-aware.html
Aug 19 15:14 the-self.pdf
Aug 19 15:12 the-self.html
Aug 16 16:44 evo-framephys.pdf
Aug 16 16:42 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/evo-framephys.html
Aug 16 16:32 entropy-evolution.pdf
Aug 16 16:32 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/entropy-evolution.html
Aug 16 16:34 emergent-physics.pdf
Aug 16 16:28 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/emergent-physics.html
Aug 16 02:32 sharif-talk-old.pdf -> sharif-talk.pdf
Aug  6  2019 mathematical-consciousness.pdf
Aug  6  2019 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/mathematical-consciousness.html
Jul 15  2019 unconscious-seeing.html
Jul  8  2019 toddler-theorems.html
Jul  1  2019 maths-multiple-foundations.pdf
Jun 30  2019 maths-multiple-foundations.html
Jun 30  2019 austen-info.pdf
Jun 29  2019 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/austen-info.html
Jun 23  2019 sciam-robots-gates.html
Jun 20  2019 symb-consc-comp.pdf
Jun 20  2019 symb-consc-comp.html
Jun 16  2019 turing-intuition.pdf
Jun 16  2019 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/turing-intuition.html
Jun 13  2019 triangle-sum.pdf
Jun 13  2019 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/triangle-sum.html
Jun  7  2019 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/diagrams-tutorial.pdf
Jun  7  2019 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/diagrams-tutorial.html
May 30  2019 sharif-talk.pdf
May 30  2019 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/sharif-talk.html
May 10  2019 creative-universe.pdf -> creativity.pdf
May 10  2019 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/creative-universe.html
May  8  2019 super-turing-geom.pdf
May  8  2019 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/super-turing-geom.html
Apr 26  2019 zurich-talk.pdf
Apr 26  2019 http://www.cs.bham.ac.uk/research/projects/cogaff/misc/zurich-talk.html
Apr 26  2019 ijcai-2017-cog.html
Apr 15  2019 toddler-theorems.pdf
Apr 15  2019 evolved-requirements-for-cognition.html
Apr 11  2019 meta-descriptive-metaphysics.pdf
Apr 11  2019 meta-descriptive-metaphysics.html
Apr  4  2019 mathstuff.html
Apr  1  2019 beyond-modularity.pdf
Apr  1  2019 beyond-modularity.html
Mar 29  2019 bio-math-phil.pdf
Mar 28  2019 bio-math-phil.html
Mar 25  2019 m-m-overview.html
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Mar 21  2019 pt-ai-abstract.html
Mar 14  2019 dsc.html
Feb 27  2019 spatial-prepositions.pdf
Feb 27  2019 spatial-prepositions.html
Feb 26  2019 sorites.html
Feb 26  2019 information-difference.pdf
Feb 26  2019 information-difference.html
Feb 26  2019 evolution-of-language.html
Feb  6  2019 binocular-rivalry.txt
Feb  4  2019 Rationality_Robot_emotions.pdf
Jan 13  2019 what-is-maths.pdf
Jan 13  2019 what-is-maths.html
Jan 12  2019 ai-singularity.html
```
2018
```
Dec 21  2018 turing-quotes.pdf
Dec 21  2018 turing-quotes.html
Dec 21  2018 royalsoc-deep-learning.pdf
Dec 21  2018 quantum-evolution.pdf
Dec 21  2018 royalsoc-deep-learning.html
Dec 21  2018 quantum-evolution.html
Dec 20  2018 turing-intuition-sloman.html -> turing-intuition.html
Dec 19  2018 turing-intuition-sloman.pdf
Dec 11  2018 super-turing-phil.pdf
Dec 11  2018 super-turing-phil.html
Dec  4  2018 cogaff-sem-apr-2017.html
Dec  1  2018 shirt.pdf
Dec  1  2018 shirt.html
Nov 24  2018 evolution-info-transitions.pdf
Nov 24  2018 evolution-info-transitions.html
Nov 13  2018 ijcai-2017-cog.pdf
Nov 11  2018 ai-future.html
Nov  9  2018 explaining-possibility.pdf
Nov  8  2018 explaining-possibility.html
Nov  6  2018 youtube.html
Oct 22  2018 creativity-boden.html
Oct 22  2018 rings.pdf
Oct 20  2018 rings.html
Sep 29  2018 compositionality-syco-1.pdf
Sep 29  2018 compositionality-syco-1.html
Sep 29  2018 sloman-compositionality-21-sep.pdf
Sep 25  2018 folded-paper-theorem.html
Sep 21  2018 sloman-compositionality-21-sep.html
Sep 11  2018 einstein-religion.html
Sep  8  2018 multicirc.pdf
Sep  7  2018 multicirc.html
Sep  5  2018 multicirc-problem.pdf
Sep  5  2018 multicirc-problem.html
Sep  5  2018 two-faces.html
Sep  4  2018 two-faces.pdf
Aug 19  2018 uk-research-publication-policy.pdf
Aug 19  2018 uk-research-publication-policy.html
Aug 19  2018 index-2018.txt
Aug 13  2018 aiforschools.html
Aug  9  2018 multi-vision.html
Jul 31  2018 infinity.html
Jul 22  2018 p-geometry.pdf
Jul 22  2018 p-geometry.html
Jul 20  2018 anger.pdf
Jul 15  2018 aisb-emot.html
Jul  8  2018 robot-rumble.txt
Jul  3  2018 online-and-offline-creativity.html
Jun 15  2018 deform-triangle.pdf
Jun 15  2018 deform-triangle.html
Jun  6  2018 self-evidence.html
Jun  1  2018 cknotes.html
May 30  2018 security.html
May 26  2018 apollonius.pdf
May 26  2018 apollonius.html
May 26  2018 emotions-affect-extras.txt
May 15  2018 sloman-diagrams-tutorial.pdf -> diagrams-tutorial.pdf
Apr 18  2018 sloman-diagrams-tutorial.txt
Apr 15  2018 sloman-pacs-2016.pdf
```

```
Apr 15  2018 sloman-pacs-2016.html
Apr  9  2018 mcls-notes.html
Mar 29  2018 sloman-mathcog18.html
Mar 22  2018 real.possibility.html
Mar 22  2018 actual.possibilities.html
Mar 16  2018 nursemaid-scenario.html
Feb 24  2018 global-innovation.txt
Feb 19  2018 affordances-types.html
Feb 19  2018 between-form-and-function.html
Feb 19  2018 changing-affordances.pdf
Feb 19  2018 changing-affordances.html
Feb 18  2018 diag-18-sloman.pdf
Feb 16  2018 another-singularity.html
Dec 31  2017 design-based-approach.pdf
Dec 31  2017 design-based-approach.html
```

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/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/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/multicirc-problem.html
Problem: Areas formed by intersecting circles (Solved on another page.)

http://www.cs.bham.ac.uk/research/projects/cogaff/misc/multicirc.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-morphogenesis 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 polymorphous 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 Schr&oumldinger 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 (and slug intelligence)
  How both get at nuts intended to be out of reach.

- High level overview of the Meta-Morphogenesis 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 bi**t 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
  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 FoundationFor 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:

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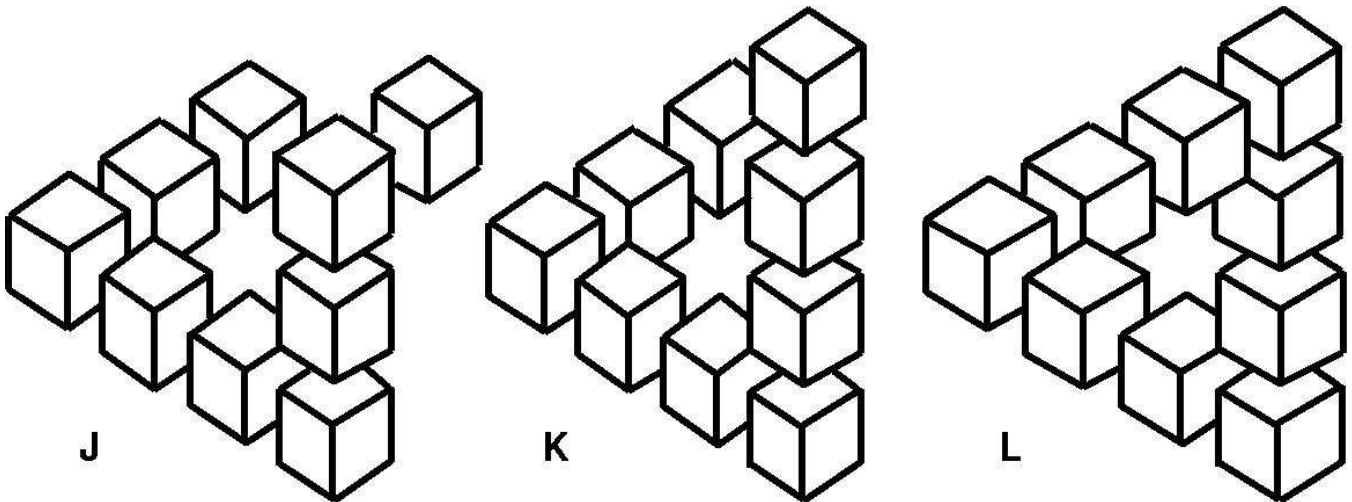
What's going on here? How can a collection of blocks be arranged in space?
(With thanks to Oscar Reutersvard)

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=iuH8dC7Snno

- **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, Fenb 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)

- 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=BNul52kFI74
  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 (AIIB)

- 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 AAAI'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

List of files latest first (excluding sub-directories)
(Likely to be out of date by the time you read this)

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Aug 25  2011 links.html
Aug 22  2011 virtual.cause.pdf -> ../sloman.virtual.slides.pdf
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