COMMENTS ON

Kenneth Craik, *The Nature of Explanation,* Cambridge University Press, 1943, London, New York,

Aaron Sloman
http://www.cs.bham.ac.uk/~axs/
School of Computer Science, University of Birmingham.
(This is an incomplete set of notes.)

Installed: 25 Sep 2012
Last updated: 25 Sep 2012;7 Feb 2016; 27 Sep 2020
(DRAFT: Liable to change) This paper is a "place-holder" here:
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/kenneth-craik.html
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/kenneth-craik.pdf
This is part of the Meta-Morphogenesis Project:
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/meta-morphogenesis.html
(Also PDF)

A partial index of discussion notes is in
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/AREADME.html
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/AREADME.pdf

---

A colleague once wrote to me:
I think your view of the scientific method is very reasonable, and describes achievements in certain fields like physics very well. But in other fields in which there is no generally-accepted overarching framework for how the system works -- fields like medicine, all the social sciences, and cognitive science -- a different approach is usually taken. That approach is to manipulate a couple of independent variables to look for evidence of one or two causal relations.

I responded:
It may be what is usually done, but it's not likely to lead to any major advance.

Contrast what Kenneth Craik did in his little book The Nature of Explanation, published 1943. (He tragically died very young a few years later.)

He is best known for reflecting on various features of the competences of (some) animals and asking 'How is that possible', and coming up with speculative answers whose complexity is derived from the complexity of what needs to be explained. The best known example is his suggestion that some animals can build models of portions of the environment and use them to predict events in the environment
"My Hypothesis then is that thought models, or parallels, reality -- that its essential feature is not 'the mind', 'the self', 'sense-data', nor propositions but symbolism, and that this symbolism is

largely of the same kind as that which is familiar to us in mechanical devices which aid thought and calculation." (p. 57)

"...a process which saves time, expense, and even life".(page 82).

Craik was writing before the development of rectangular grids of photoreceptors made it (relatively) trivial to discover co-linear features in an image, using arithmetical operations on coordinates. The problems are very different for brains, where receptors, processing mechanisms, and storage mechanisms have a far less mathematically simple organisation, which may be why Craik also wrote:
"The hardest part of the process is the act of representation itself -- the representation of something variable in size and location by a definite neural process." (Page 73)

I suspect he, like many others, missed some subtleties that led to the evolution of mathematical reasoning capabilities, but that's a long story.

The book also includes a less well known extended discussions of how various kinds of abstract information about structures, processes and relationships in the environment might be represented in known types of physical brain mechanisms, e.g. proposing that not absolute magnitudes but changes and orderings are mostly used.

That's an idea I have been exploring for the last few years, having completely forgotten that I must have read it in Craik 40-50 years ago.

He was writing long before AI vision researchers got their scientific vision distorted by the availability of electronic cameras with rectangular grids for retinas (frame-grabbers).

Reasoning about possibilities and impossibilities

One of the important uses of internal models that goes beyond what Craik and others have argued they are good for is discovering sets of **possibilities** and **impossibilities**, or, equivalently, **necessities**. (Since if not-P is impossible then P is necessarily the case.) Running a model with particular parameters will provide information about what will happen in the corresponding situation, if the model is accurate. But it will say nothing about what other processes the model supports, what the necessary consequences of certain *types* of process are, and what sorts of things are *impossible* for the model. So, normally, simply running a model or simulation does not normally provide a basis for claiming that something is impossible or necessarily true.

In contrast, *reasoning about* the possibility of a square in a circle moving from inside the circle to outside the circle may lead to various generalisations, e.g. about numbers of possible intersection points between the boundary of the square and the circumference of the circle.

Even an "amateur" mathematician can consider cases and summarise the possibilities, without having to explore all possible sets of coordinates for the corners of the triangle or location and radius of the circle. Making discoveries such as the possibility of at most eight points of intersection between a square and circle requires more than the ability to "run" the model with particular values. It needs a mechanism that can inspect a whole "space" of configurations, including infinitely many possibilities.

Modern mathematicians can prove such results using formal mechanisms developed in the last century and a half, but ancient mathematicians knew nothing about those ways of doing mathematics. Yet they made an amazing collection of discoveries, leading to what is probably the single most important book ever published, on this planet -- Euclid's *Elements*.

Making progress with these ideas will require a new sort of education for young psychologists, biologists, etc.

Several more examples are discussed in this paper, and other papers it references on this web site:
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/impossible.html
(Also PDF)

Some (Possibly) New Considerations Regarding Impossible Objects
Their significance for mathematical cognition,
and current serious limitations of AI vision systems.

TO BE EXTENDED

NOTE
An analysis of the role of investigation of what is possible and how it is possible in the advance of science was presented in Chapter 2 of my 1978 book:

The Computer Revolution in Philosophy
http://www.cs.bham.ac.uk/research/projects/cogaff/crp/#chap2
CHAPTER 2: WHAT ARE THE AIMS OF SCIENCE?

And in this (currently unfinished) draft paper on explanations of possibilities, extending Chapter 2:
http://www.cs.bham.ac.uk/research/projects/cogaff/misc/explaining-possibility.html
Using construction kits to explain possibilities
(Construction kits generate possibilities)

Some of the ideas were developed further in this 1996 paper:

http://www.cs.bham.ac.uk/research/projects/cogaff/96-99.html#15
Actual Possibilities, in *Principles of Knowledge Representation and Reasoning:* Proc. 5th Int. Conf. (KR '96),
Eds. L.C. Aiello and S.C. Shapiro, 1996, pp. 627--638,

Maintained by Aaron Sloman
School of Computer Science
The University of Birmingham