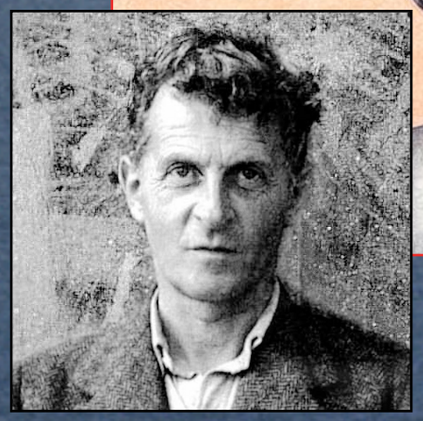
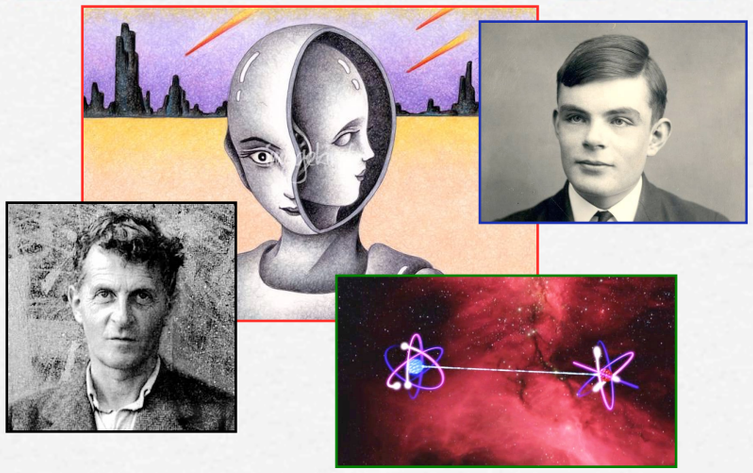
Typecasting Non-Locality



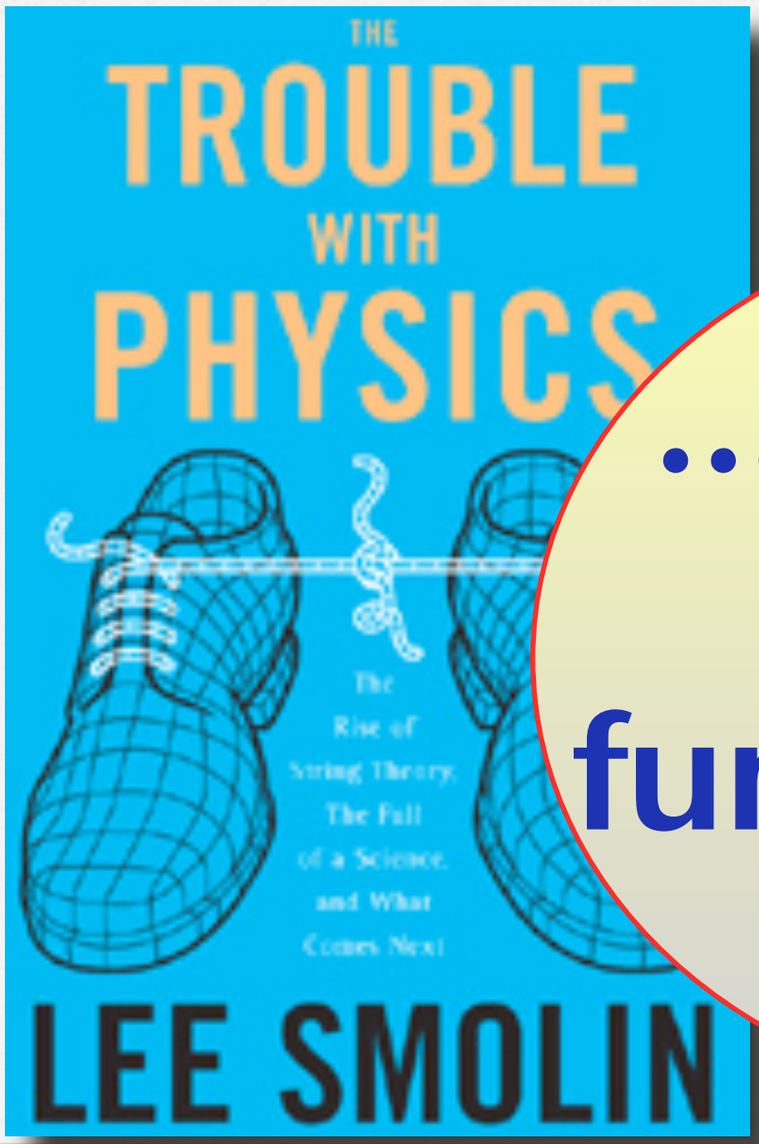
S Barry Cooper, Logic, Relativity and Beyond - 2nd International Conference, August 9 - 13, 2015, Budapest.

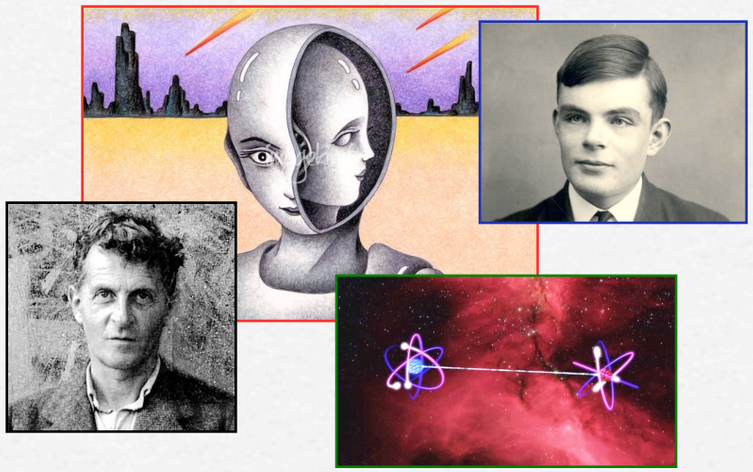


A Good Place to Start ...

– from 'The Trouble With Physics', p.241

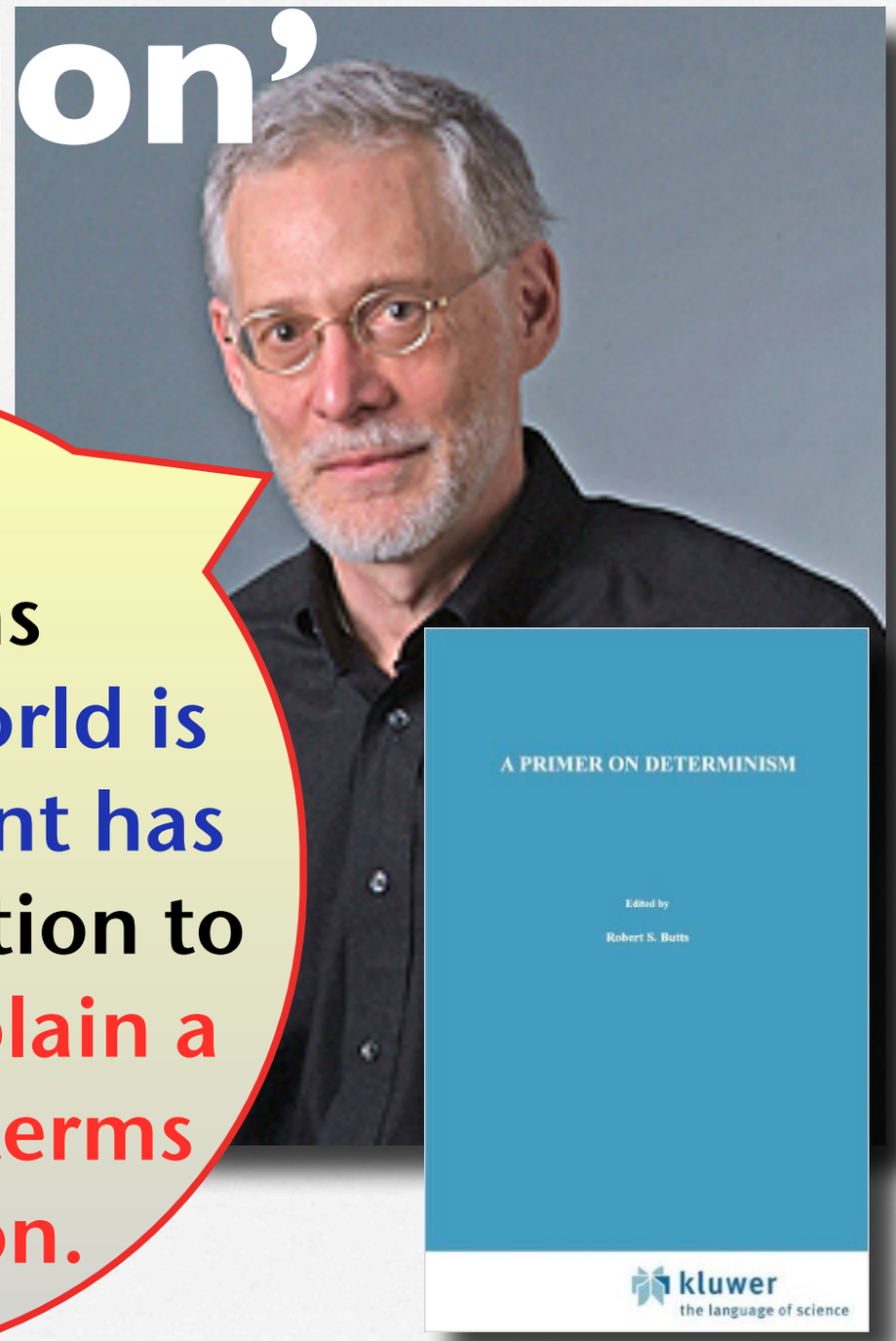
...causality itself is fundamental



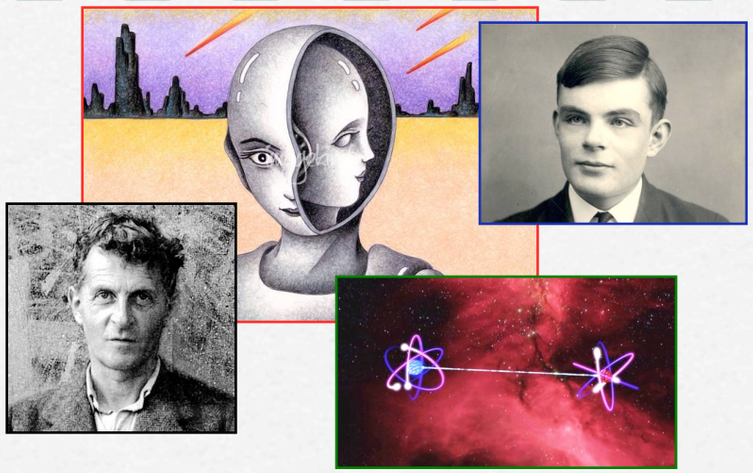


‘a Truly Obscure Causation’

John Earman in “A Primer On Determinism”,
D. Reidel/Kluwer, 1986, p.5:

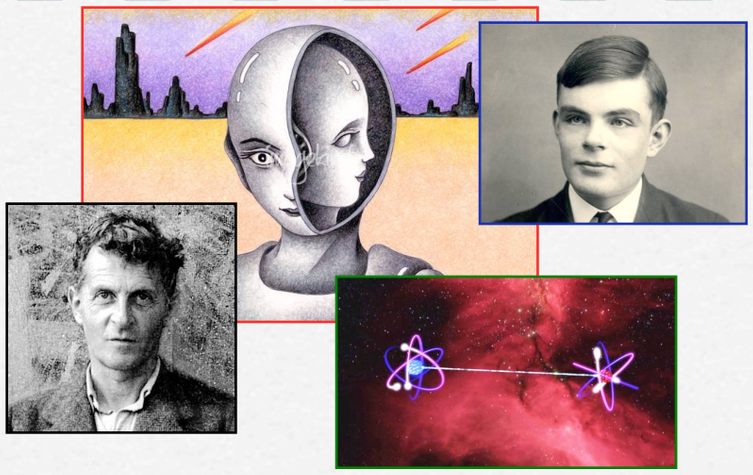


... the most venerable of all the philosophical definitions [of determinism] holds that the world is deterministic just in case every event has a cause. The most immediate objection to this approach is that it seeks to explain a vague concept - determinism - in terms of a truly obscure one - causation.



a Newtonian Paradigm …

- 3 laws of motion (to describe planetary motion)
- Defined via basic mathematical language …
- … encouraging expectation of predictive computation …
- … and a more general Laplacian determinacy

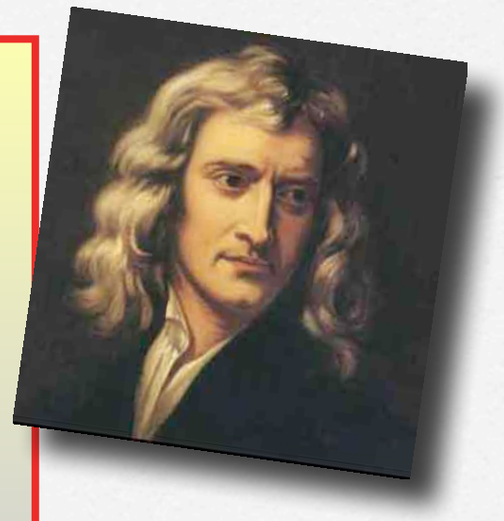


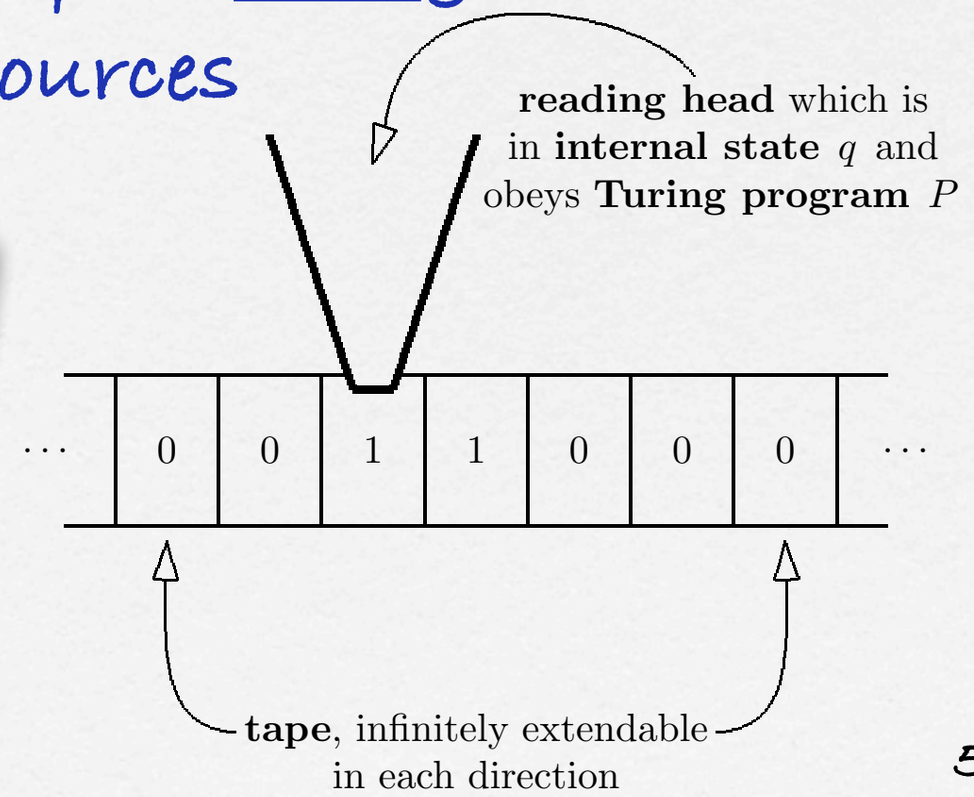
Computationally Abstracted

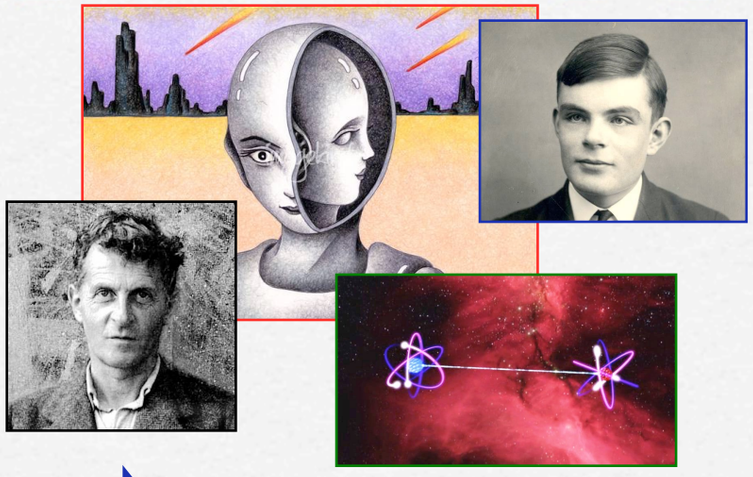
- Turing, 1939 - Oracle Turing Machines ...

- Provide a model of how we compute using data given to us from unknown sources

- A model within which Newtonian dynamics etc comfortably fit ...







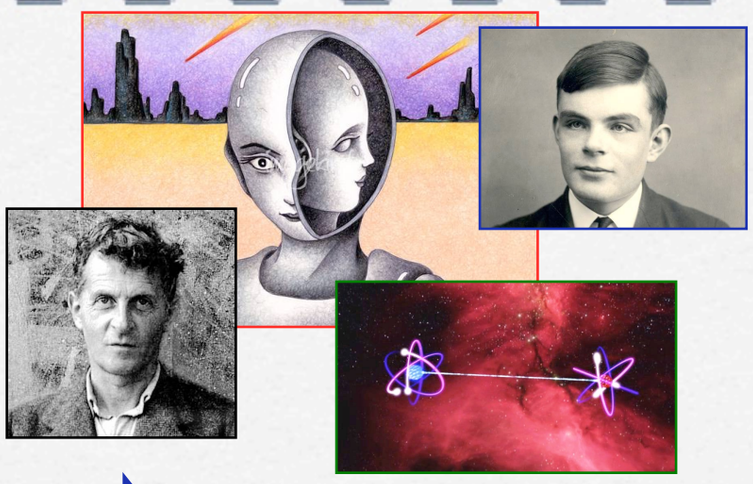
SEMANTICS of the MACHINE

Turing, 1936: Build a UNIVERSAL (Oracle) TURING MACHINE, which can simulate ANY other machine

Can computably code, and so list, the Turing programs, giving:

$$\varphi_e^{(k)} = \text{ the } k\text{-place partial function computed by } P_e.$$

$$\varphi_e = \varphi_e^{(1)} \textit{ the } \mathbf{e^{th}} \textbf{ partial computable (p.c.) function}$$



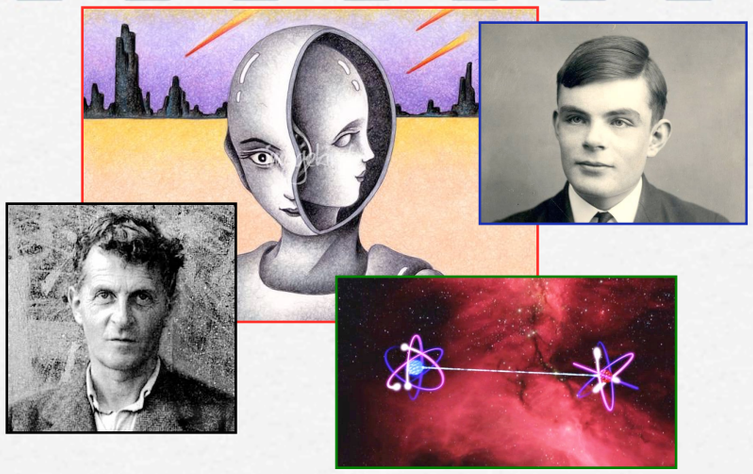
SEMANTICS of the MACHINE

Turing, 1936: Build a UNIVERSAL (Oracle) TURING MACHINE, which can simulate ANY other machine

Depends on TYPE 0 description of e^{th} Turing machine

There exists a Turing machine U — the **Universal Turing Machine** — *which if given input (e, x) simulates the e^{th} Turing machine with input x.*

That is, $\varphi_U^{(2)}(e, x) = \varphi_e(x)$.

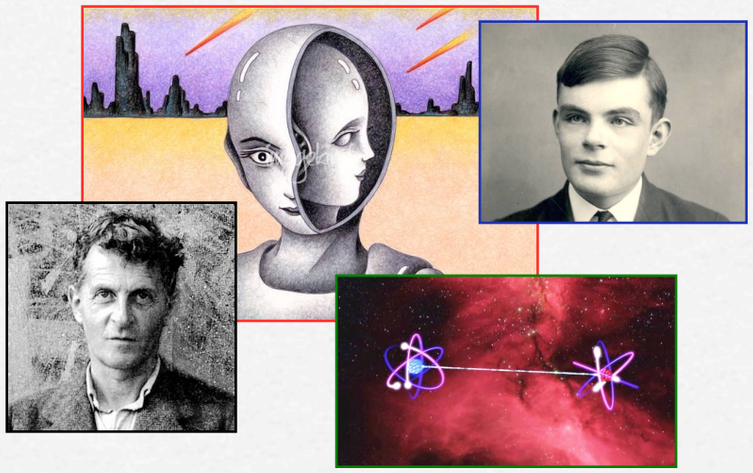


SEMANTICS of the MACHINE

- Turing (1936): Take a Universal Turing machine **U**:

Unsolvability of the Halting Problem for U:
No computer can tell us, for each given input x, whether U will compute - where, remember - we allow an input to U to include a coded program ...

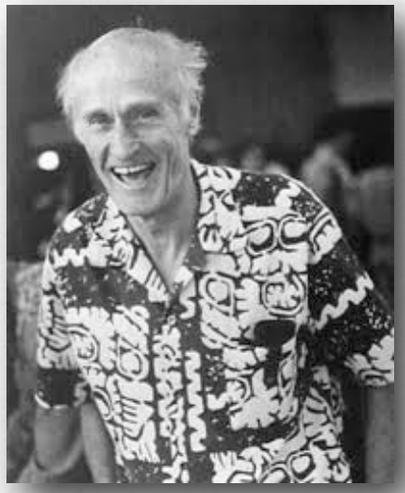
'Church's Theorem':
No computer can tell us, for each given first-order sentence, whether it is logically valid or not.



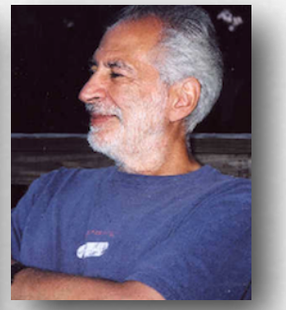
COLLATING & TYPING data

By the theory of simple types I mean the doctrine which says that the objects of thought ... are divided into types, namely: individuals, properties of individuals, relations between individuals, properties of such relations, etc. ... , and that sentences of the form: " a has the property φ ", " b bears the relation R to c ", etc. are meaningless, if a, b, c, R, φ are not of types fitting together. Mixed types (such as classes containing individuals and classes as elements) and therefore also transfinite types (such as the class of all classes of finite types) are excluded. That the theory of simple types suffices for avoiding also the epistemological paradoxes is shown by a closer analysis of these.

(Kurt Godel: *Russell's mathematical logic*, 1944)



Stephen Kleene



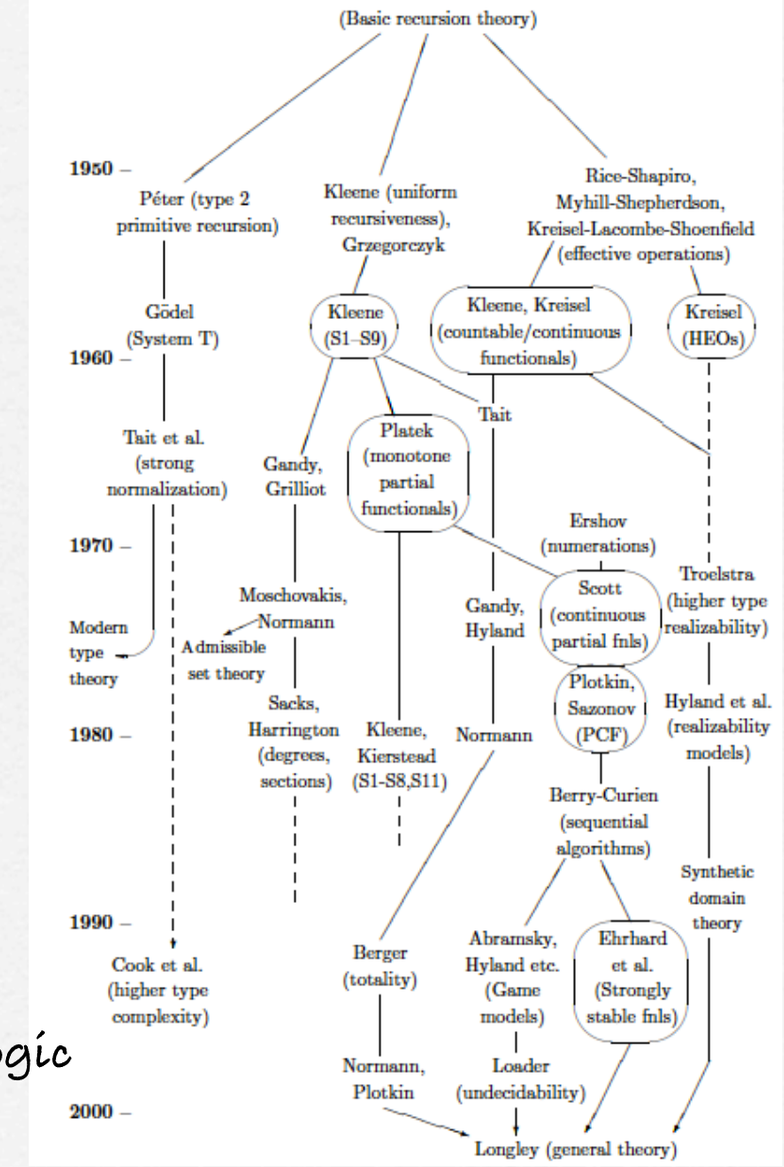
Gerald Sacks

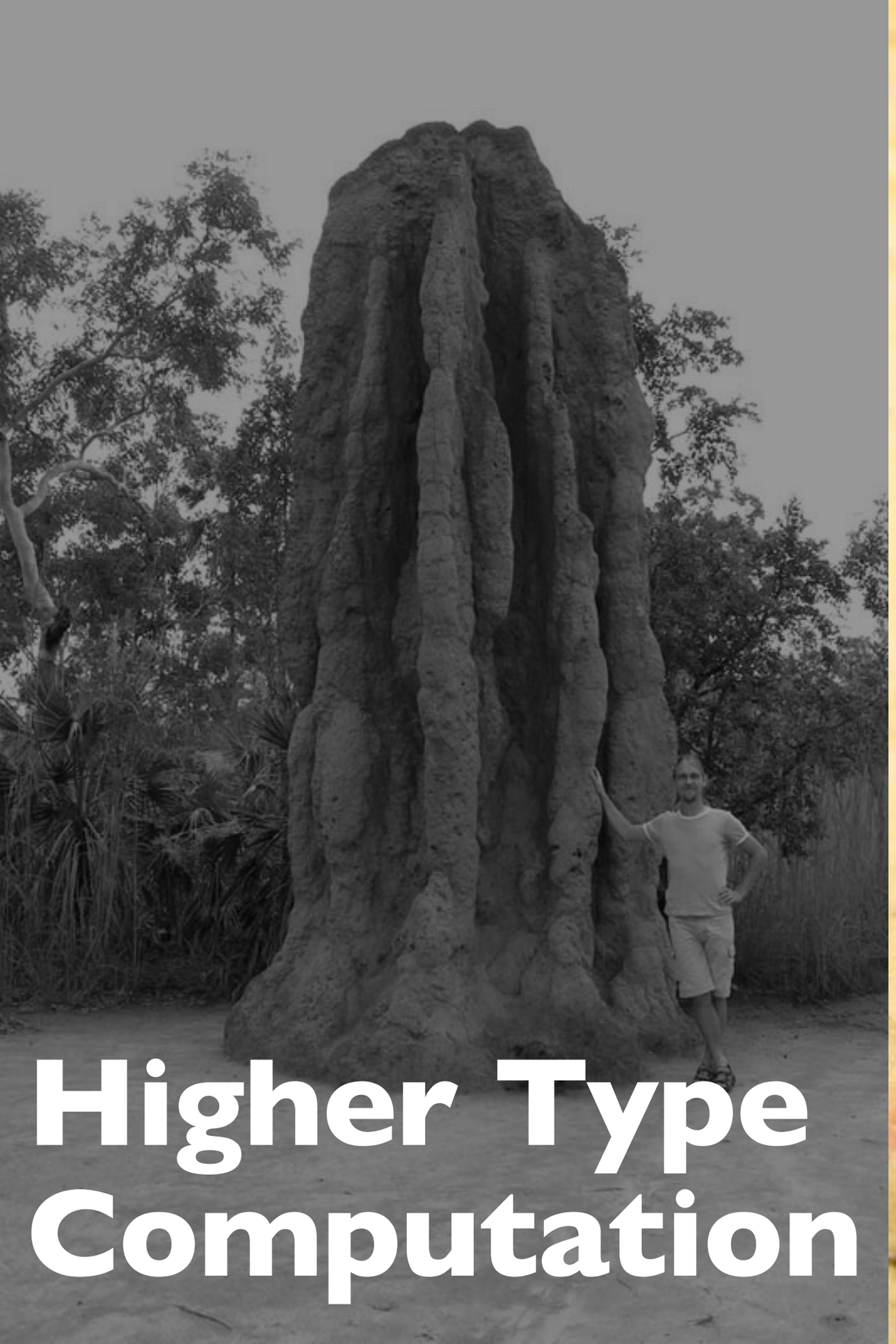
Computing and Higher Types

It is ... clear that very many approaches to defining higher type computability are possible, but it is not obvious *a priori* whether some approaches are more sensible than others, or which approaches lead to equivalent notions of computability. In short, it is unclear in advance whether at higher types there is really just one natural notion of computability (as in ordinary recursion theory), or several, or no really natural notions at all.

- from John Longley: "Notions of Computability at Higher Types I", in 'Logic Colloquium 2000', Lecture Notes in Logic 19, ASL (2005), pp.32-142

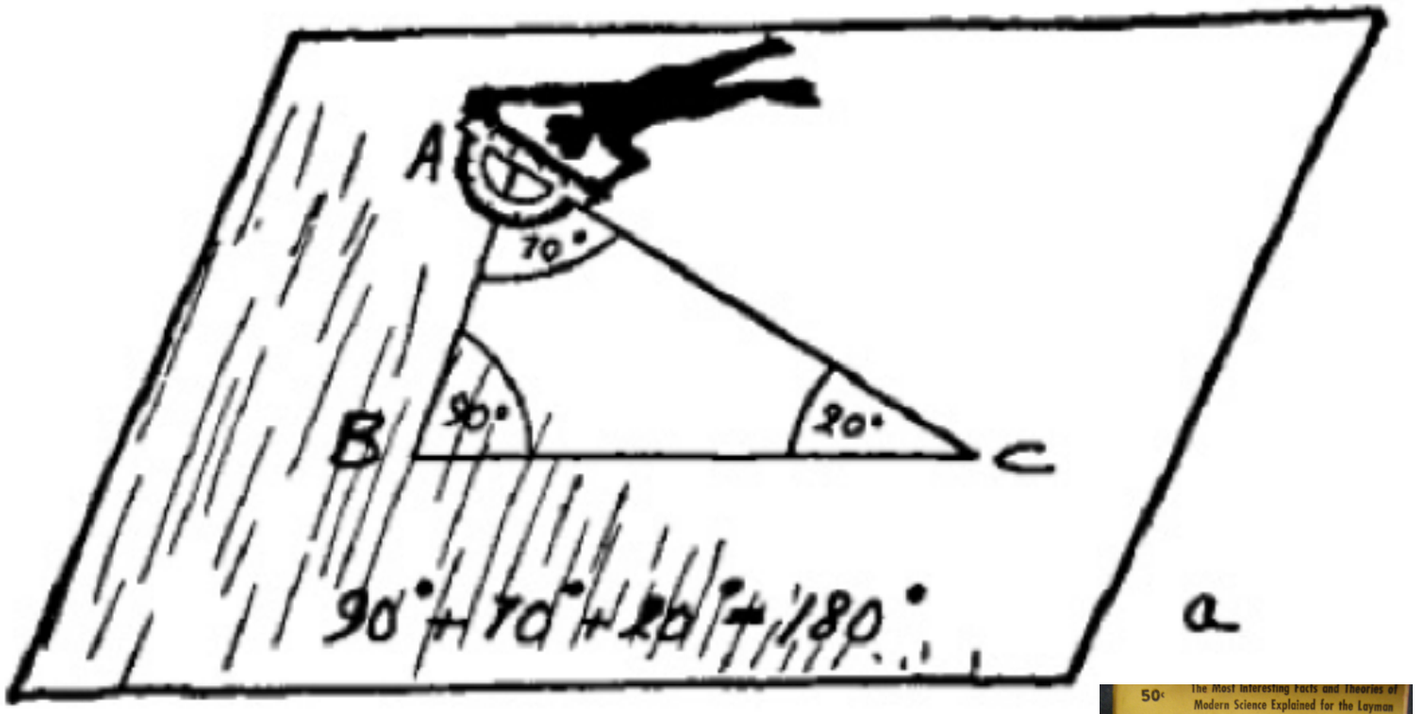
Figure 1: History of higher type computability: a selective outline.

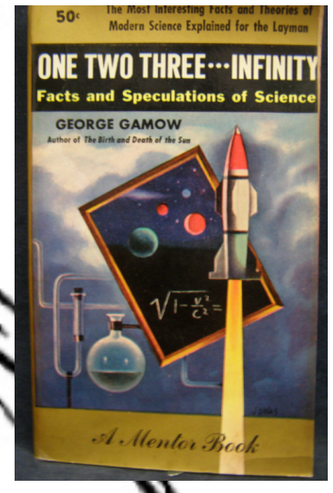


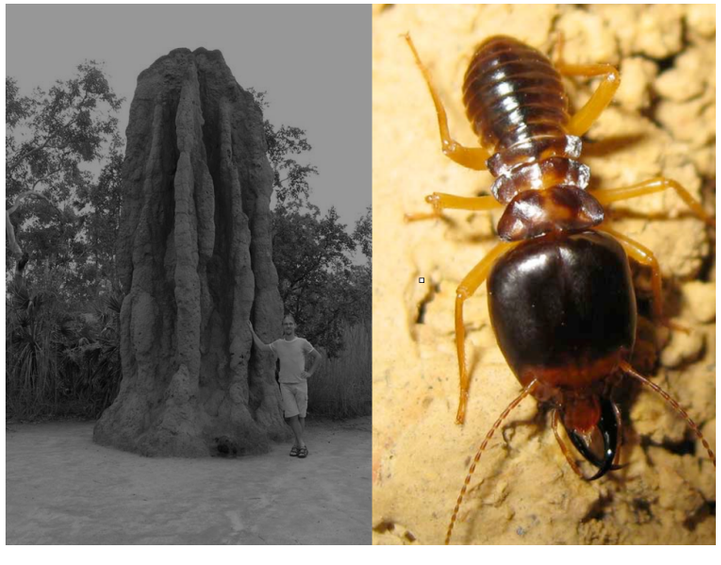


Higher Type Computation & Emergence

Types - hosting different but connected worlds- an Analogy







George Gamow

THE CHEMICAL BASIS OF MORPHOGENESIS

By A. M. TURING, F.R.S. *University of Manchester*

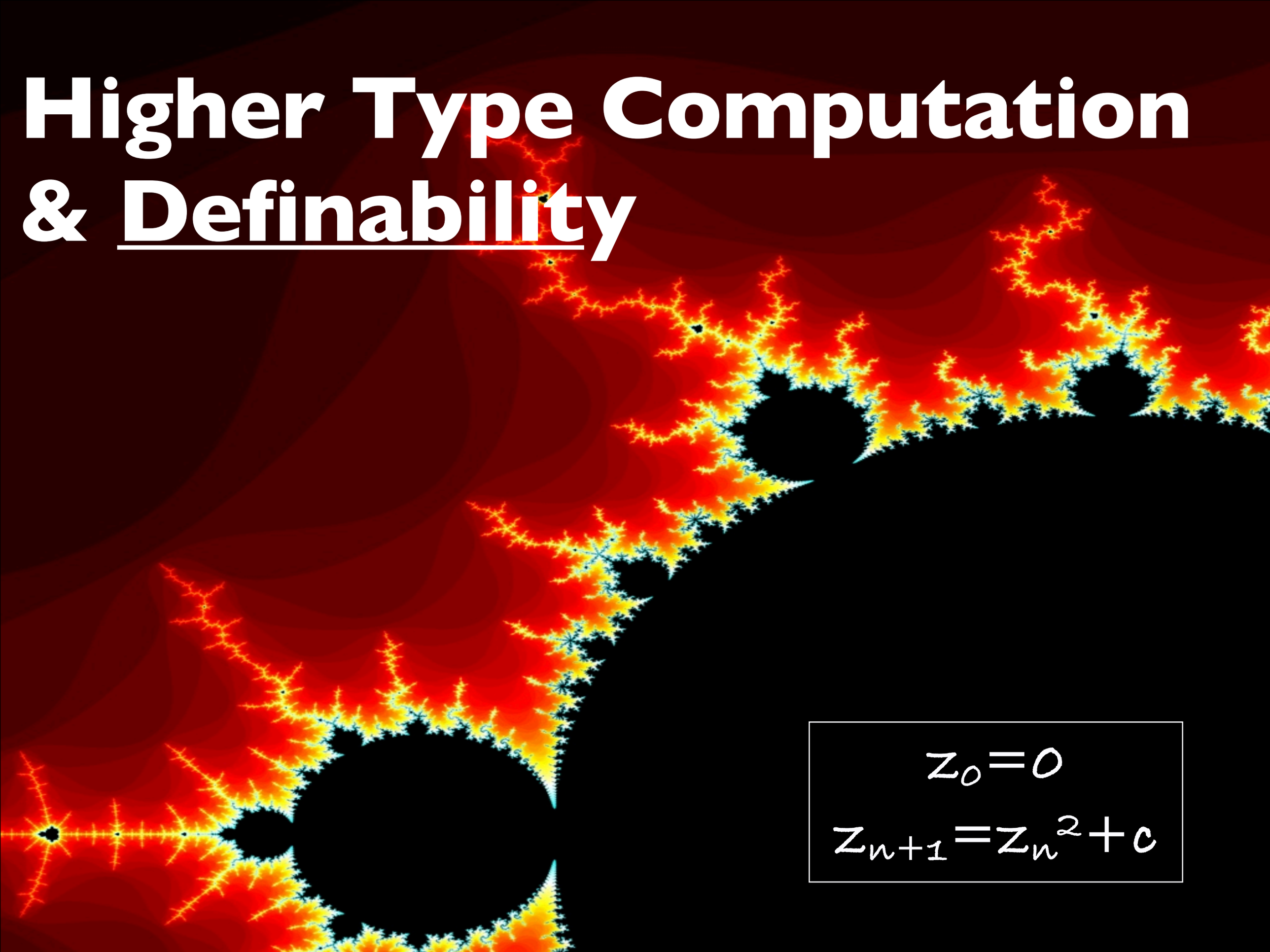
(*Received* 9 *November* 1951—*Revised* 15 *March* 1952)

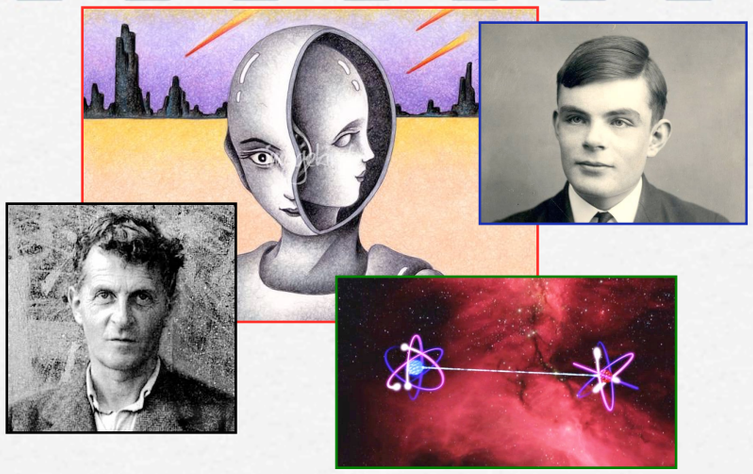
…ested that a system of chemical substances, called morphogens, reacting to…
…through a tissue, is adequate to account for the main phenomena of mo…
…stem, although it may original…
…are due to an instability of the…
…disturbances. Such reaction-diff…
…lated ring of cells, a mathemat…
…estigation is chiefly concerned wi…

1950s - Alan Turing proposes a simple reaction-diffusion system describing chemical reactions and diffusion to account for morphogenesis

Higher Type Computation & Emergence

Higher Type Computation & Definability



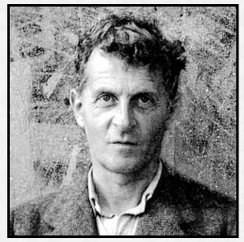


Some Faces of Definability

- Ontological - mathematics & beyond
- Epistemological - clarifying role in physics, science, more generally
- Cultural - codifying experience for use analogically, heuristically ...
- Taming Higher Type Information - Creatively in arts, or unreliably giving poisonous clothing to self-delusions
- Social - Natural Language in all its relativity and type-reductions

Alfred Tarski

Hans Reichenbach
(1891-1953)



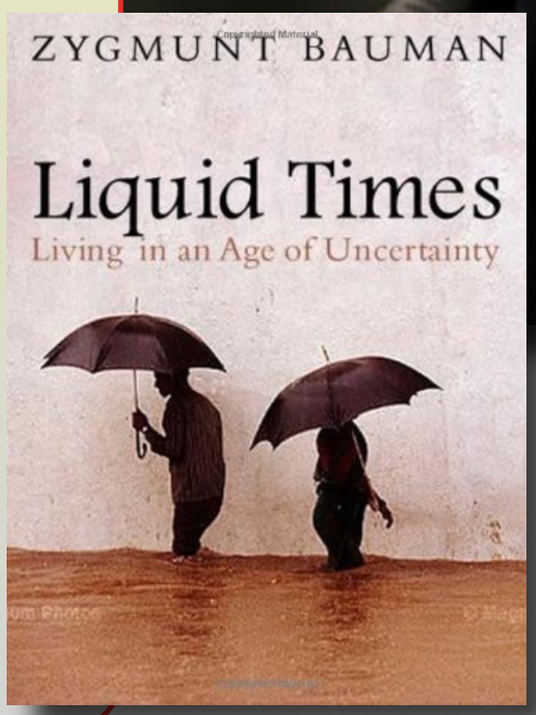
Hilary Putnam

Computational Semantics of Natural Language: what (if anything) does it have to do with logic?

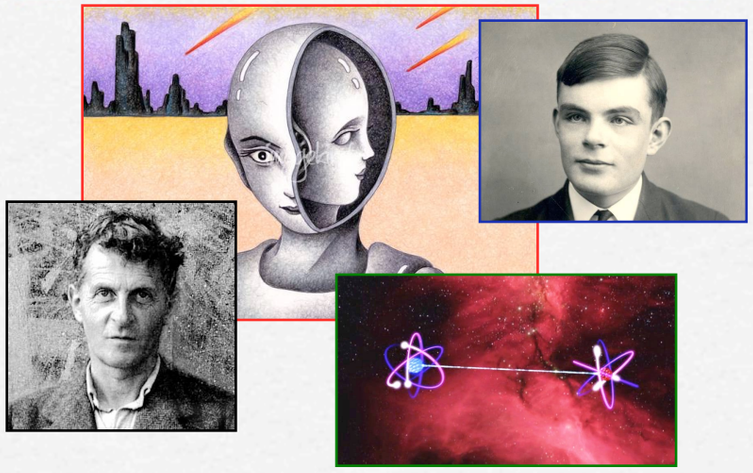
"The essential idea behind the computational models is that language is modelled using language. For instance, in a distributional model, the meaning of a word is modelled by the contexts in which it appears in some corpus of natural language. Both in terms of practical results and volume of current research, this tradition has been far more successful than the logic-based approaches ..."

Ann Copestake

If the idea of an 'open society' originally stood for the self-determination of a free society cherishing its openness, it now brings to most minds the terrifying experience of a heteronomous, hapless and vulnerable population confronted with, and possibly overwhelmed by forces it neither controls nor fully understands ...

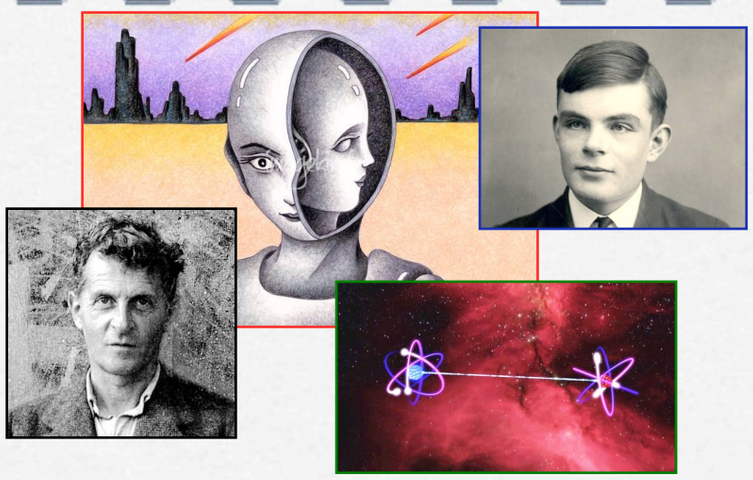


Zygmunt Bauman
2007



Where have we got to?

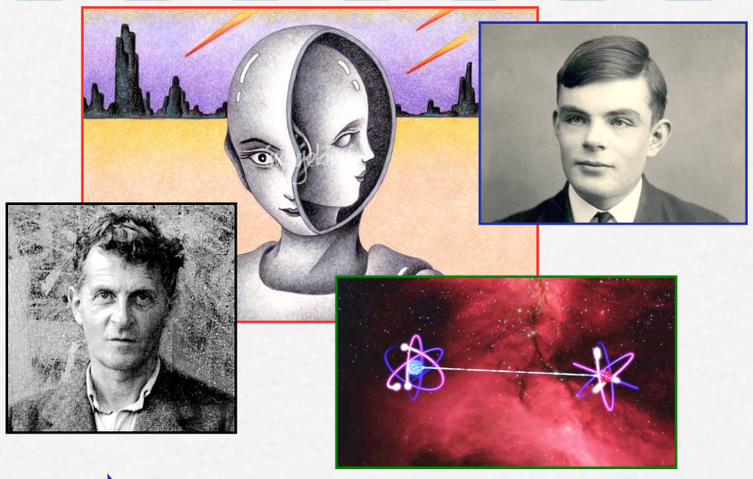
- Causality ‘obscure’ - but relative Turing computability models ‘basic’ causality
- Semantics of Turing model give incomputable higher type data & a computational world that is real & unruly
- Definability is natural, packaging computation through higher type contexts - via physical theories etc.
- But - Definability takes us via natural language beyond computation that is either reliable or practical
- Non-definability? - Real? Will it say something about quantum uncertainty, non-locality ... and mentality?



Turing Universe & Definability

- Turing's relative computability models basic causality via the "partial computable functionals"
- 1944 - Emil Post defines the "degrees of unsolvability" as a structuring of reals in terms of their relative computability ...
- Giving a landscape with a rich definable structure

Phyllis, Emil and Gertrude Post

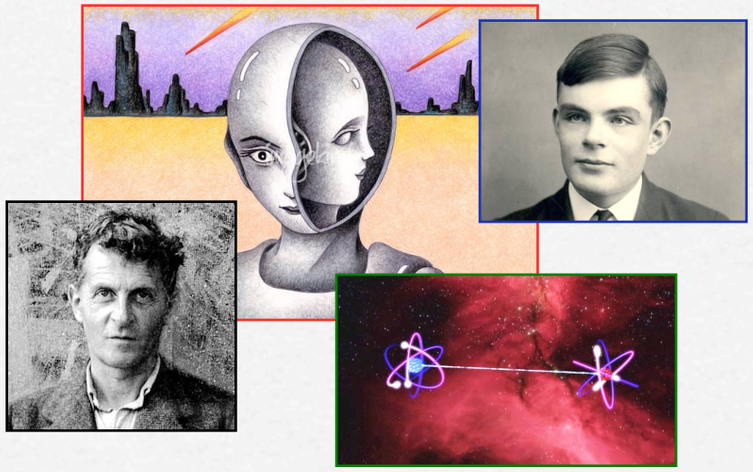


Turing Universe and Definability

Fundamental problem (Hartley Rogers):
Characterise the Turing definable and invariant relations.

- These are key to pinning down how higher order relations on the real world can be described - or - are not defined
- The richness of Turing structure discovered so far provides raw material for a multitude of definable - and hence unambiguously observable - relations

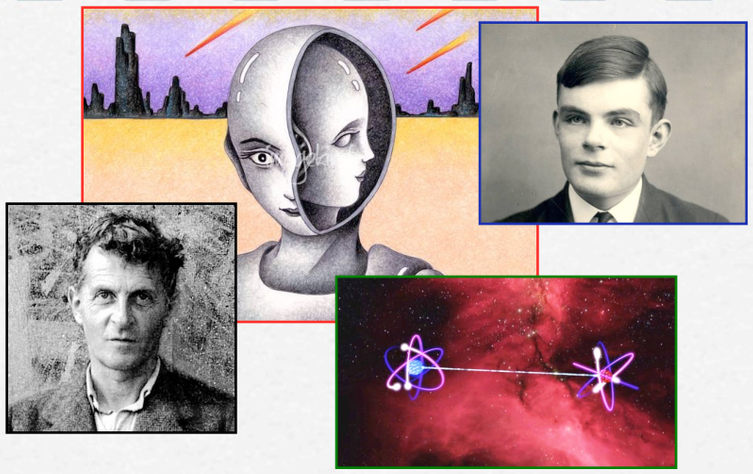
Hartley Rogers, Jr.



Turing Universe Bi-interpretable?

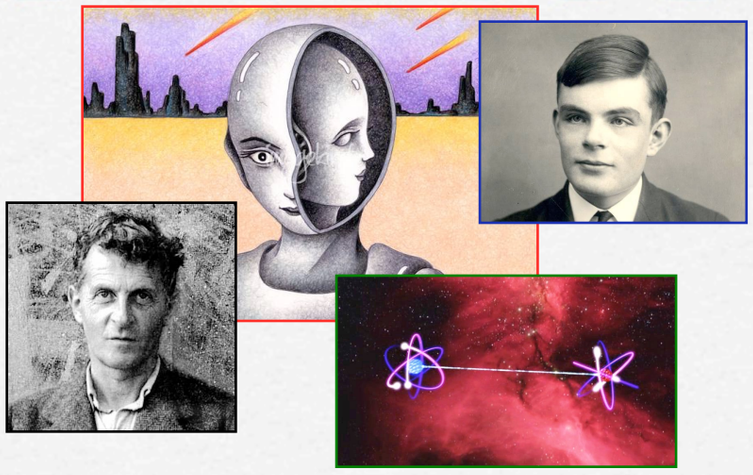
Bi-interpretability Conjecture:
The Turing definable relations are exactly those with information definable in second-order arithmetic

- Work over last 20 years points to a high degree of rigidity underpinning our familiar 'quasi-classical' world ...
- ... with global non-rigidity hosting quantum uncertainty, mentality etc.



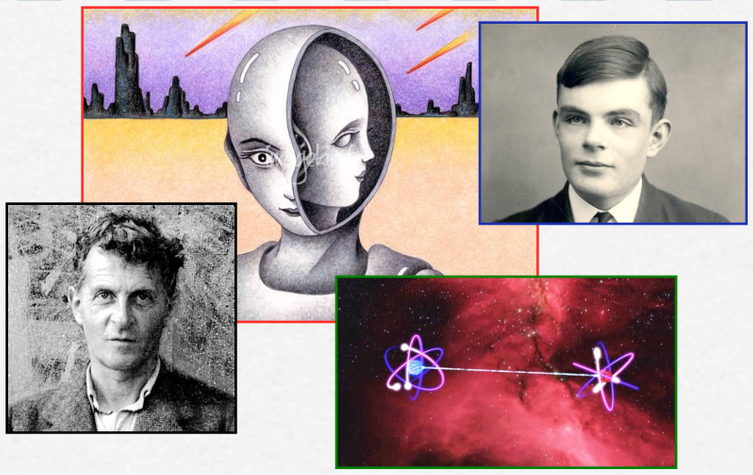
Definability with Parameters

- History of mathematics replete with definability obtained relative to fixing some undefined parameter ... while in physics ...
- Standard model of particle physics depends on fixing (as yet) undefined constants ...
- Can view quantum uncertainty as undefinability in valid model of basic causality
- Equivalent to enhancement via non-local "hidden variables" ... Turing definability takes us to type 3



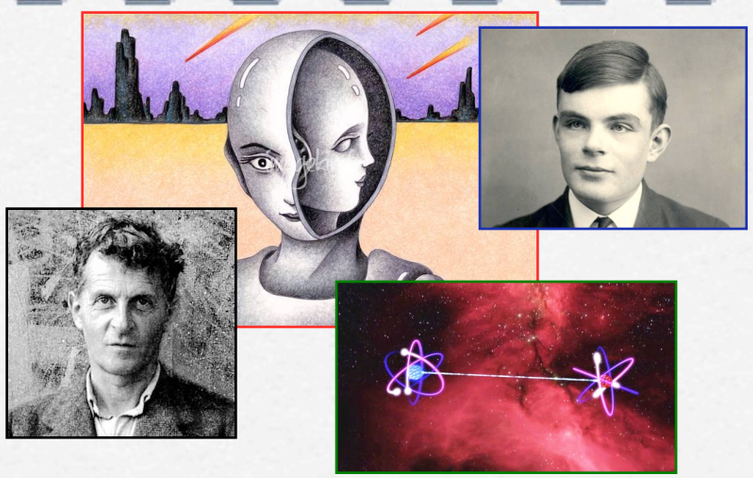
"QUANTUM HOLISM"

- The higher order character of Turing definability/ invariance allows it as basis for interpretation of the experimental verification of violations of Bell's Inequality
- AIM: Clarify collapse of wave function as instance of imposed definability - with the measurement interpreted as introduction of real defined data
- The probabilistic basis for the unmeasured non-locally entangled particles is reflected in the higher type view of an interactive complex system

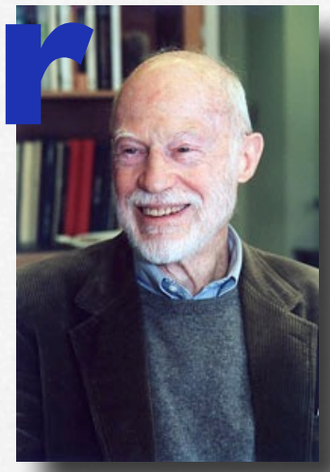


Typed Data and Non-locality

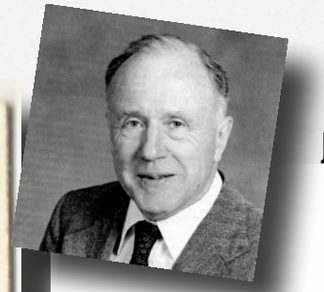
- Typing of data works hand-in-hand with definability - hosting emergence of new defined (even computable from within the higher level) relations, incomputability, uncertainty, non-locality etc.
- Aspects of different type levels sometimes reducible to the lower type origins ...
- Determinism survives, but not for inhabitants of a fixed level - data exchange in Aspect et al gets physical basis in complex systems, but still 'obscure'
- The view is compatible with structuralism & realism



Definability or Many Worlds



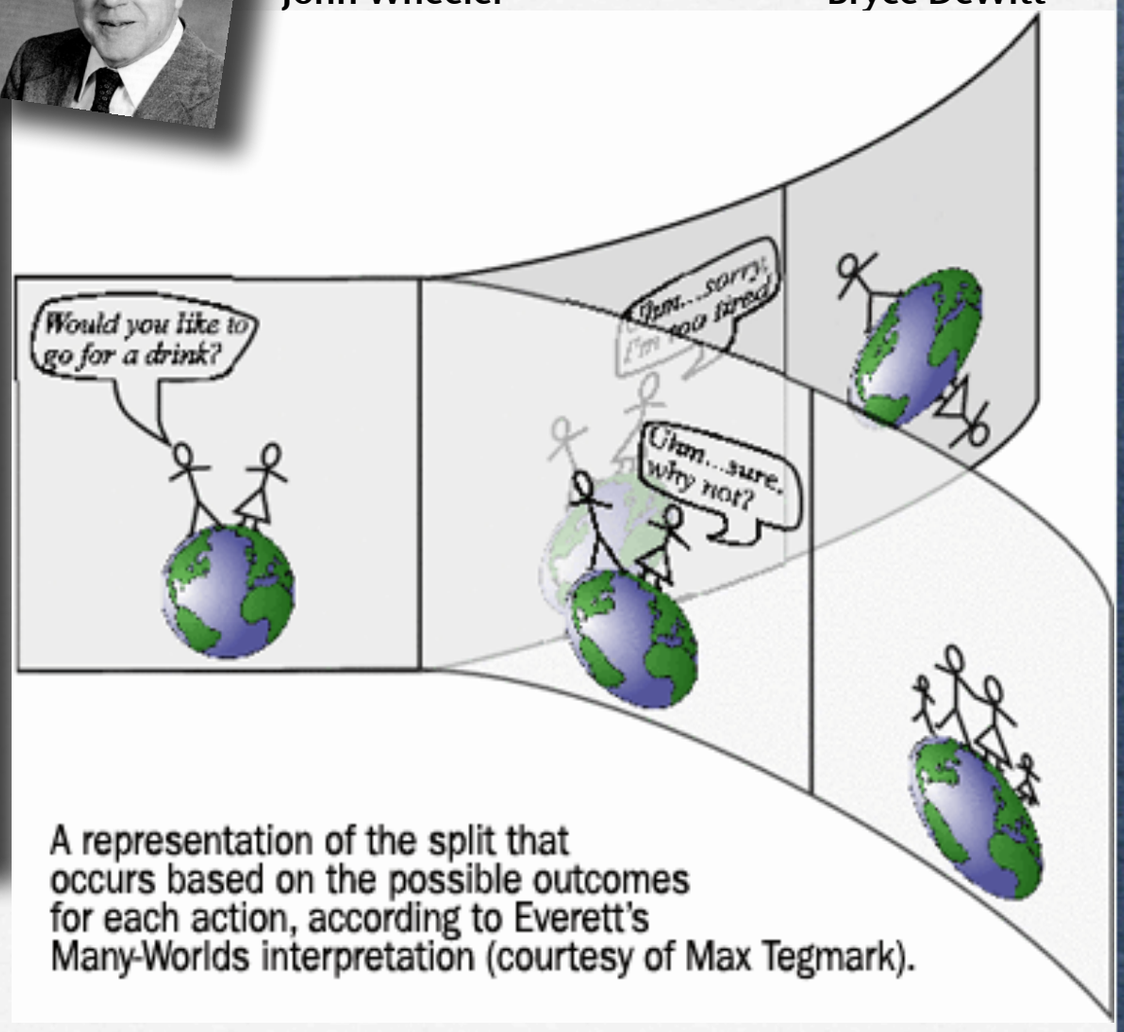
Bryce DeWitt



John Wheeler

Hugh Everett III

(Nov.11, 1930- July 19, 1982)



A representation of the split that occurs based on the possible outcomes for each action, according to Everett's Many-Worlds interpretation (courtesy of Max Tegmark).

ALFRED T. KAMAJIAN

By Max Tegmark

Parallel Universes

Not just a staple of science fiction, other universes are a direct implication of cosmological observations

Is there a copy of you

reading this article? A person who is not you but who lives on a planet called Earth, with misty mountains, fertile fields and sprawling cities, in a solar system with eight other planets? The life of this person has been identical to yours in every respect. But perhaps he or she now decides to put down this article without finishing it, while you read on.

The idea of such an alter ego seems strange and implausible, but it looks as if we will just have to live with it, because it is supported by astronomical observations. The simplest and most popular cosmological model today predicts that you have a twin in a galaxy about 10 to the 10^{28} meters from here. This distance is so large that it is beyond astronomical, but that does not make your doppelgänger any less real. The estimate is derived from elementary probability and does not even assume speculative modern physics, merely that space is infinite (or at least sufficiently large) in size and almost uniformly filled with matter, as observations indicate. In infinite space, even the most unlikely events must take place somewhere. There are infinitely many other inhabited planets, including not just one but infinitely many that have people with the same appearance, name and memories as you, who play out every possible permutation of your life choices.

You will probably never see your other selves. The farthest you can observe is the distance that light has been able to travel during the 14 billion years since the big bang expansion began. The most distant visible objects are now about 4×10^{26} meters away—a distance that defines our observable universe, also called our Hubble volume, our horizon volume or simply our universe. Likewise, the universes of your other selves are spheres of the same size centered on their planets. They are the most straightforward example of parallel universes. Each universe is merely a small part of a larger "multiverse."

By this very definition of "universe," one might expect the notion of a multiverse to be forever in the domain of metaphysics. Yet the borderline between physics and metaphysics is defined by whether a theory is experimentally testable, not by whether it is weird or involves unobservable entities. The frontiers of physics have gradually expanded to incorporate ever more abstract (and once metaphysical) concepts such as a round Earth, invisible electromagnetic fields, time slowdown at high speeds, quantum superpositions, curved space, and black holes. Over the past several years the concept of a multiverse has joined this list. It is grounded in well-tested theories such as relativity and quantum mechanics, and it fulfills both of the basic criteria

Mental Computation, Turing Model & Supervenience ...

- Emergence of semantics hosted by interactive infrastructure ...
- ... as embodied computation of large-scale neural formations

→ Formalised as definability or higher type computation relative to a relativistic computational base

→ Iterable using type reduction via sampling, language etc

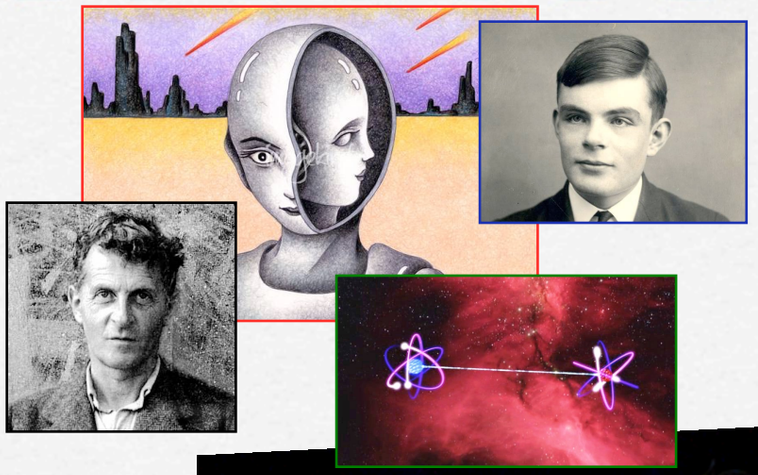
Antonio Damasio

"The Feeling Of What Happens" [1999], p.170:

"As the brain forms images of an object - such as a face, a melody, a toothache, the memory of an event and as the images of the object affect the state of the organism, yet another level of brain structure creates a swift nonverbal account of the events that are taking place in the varied brain regions activated as a consequence of the object-organism interaction.

The mapping of the object-related consequences occurs in first-order neural maps representing the proto-self and object; the account of the causal relationship between object and organism can only be captured in second-order neural maps ... one might say that the swift, second-order nonverbal account narrates a story:

that of the organism caught in the act of representing its own changing state as it goes about representing something else."



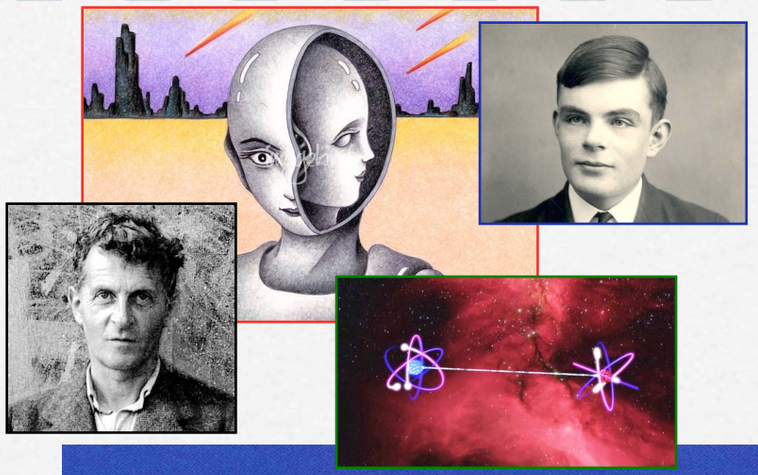
… Higher Order Data & ANALOGY

SURFACES AND ESSENCES

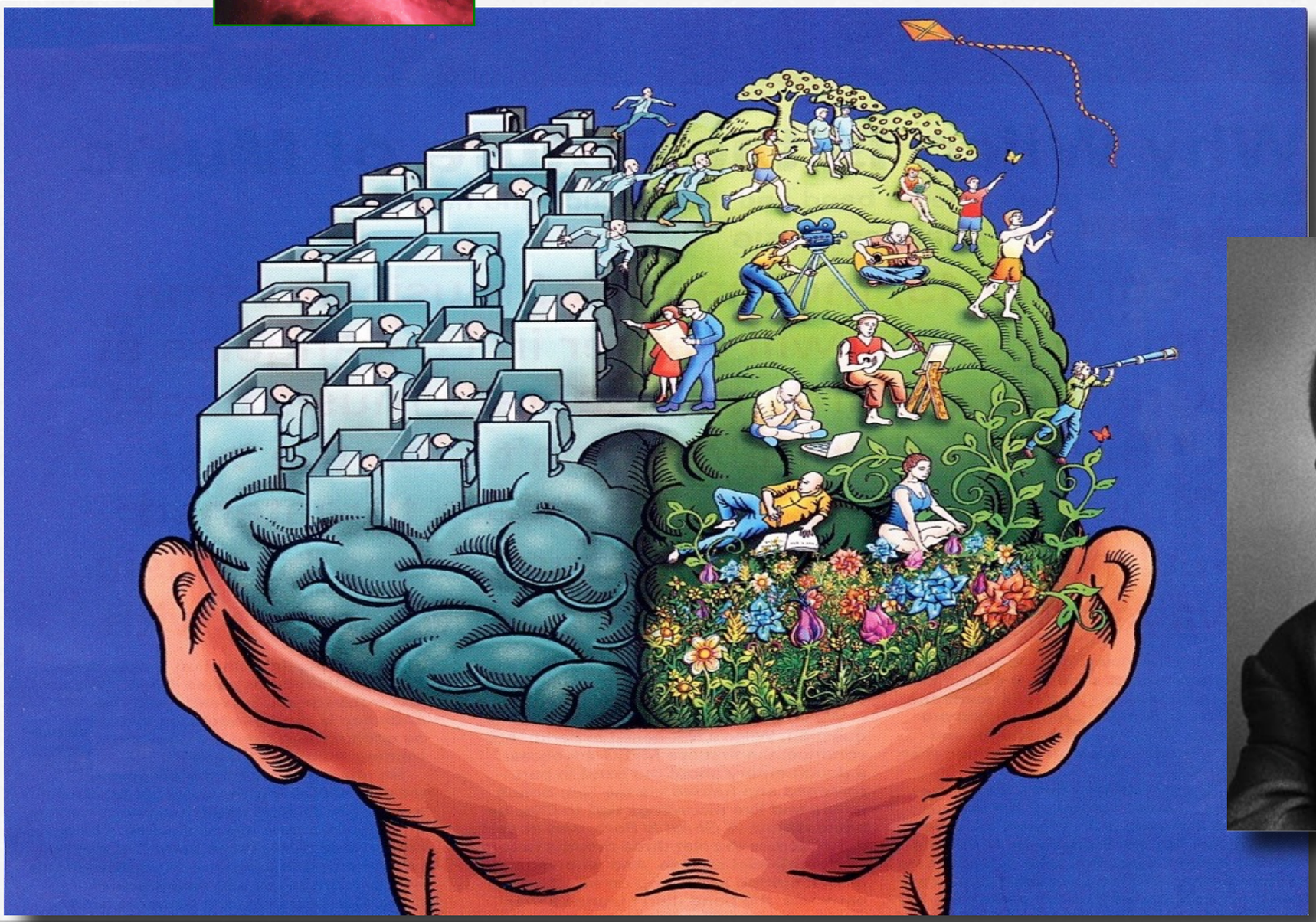
ANALOGY AS THE FUEL AND FIRE OF THINKING

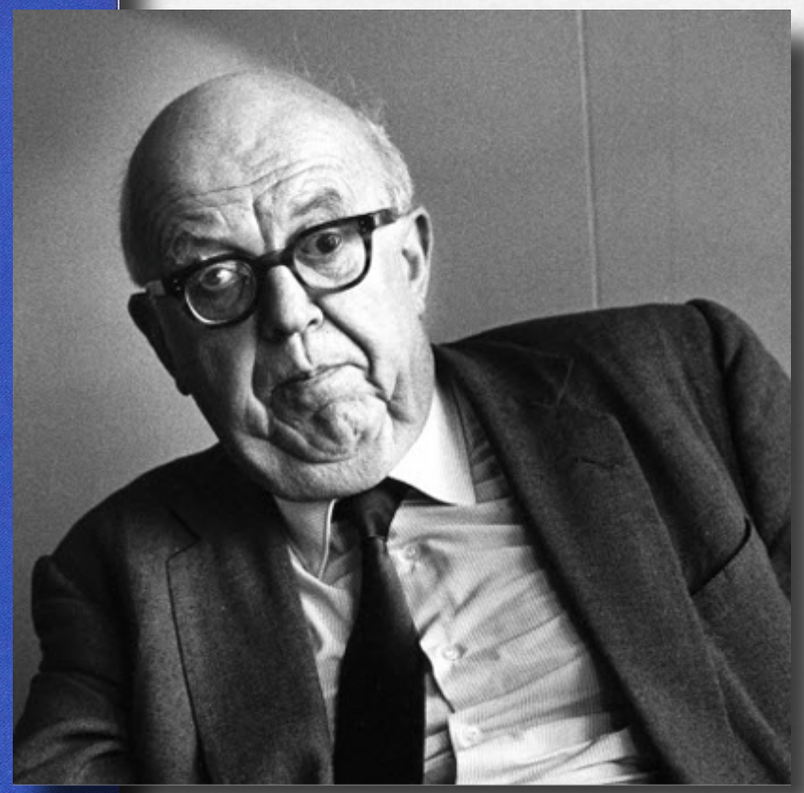
DOUGLAS HOFSTADTER

& EMMANUEL SANDER



Typed Mentality & “Two Cultures”

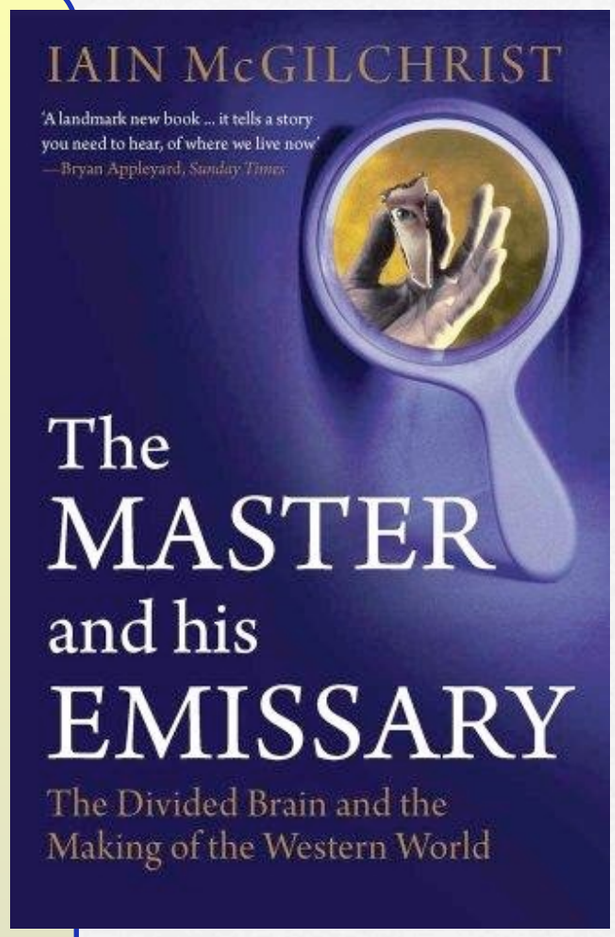


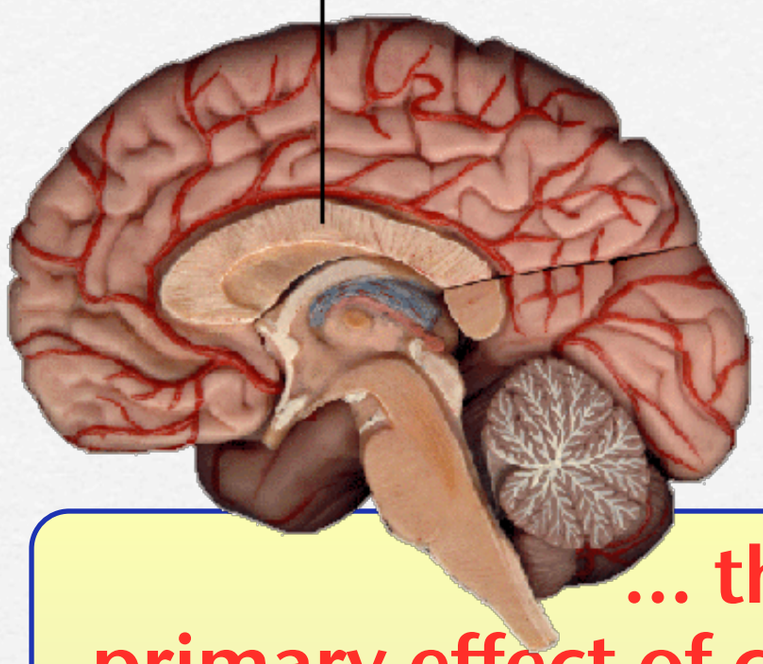


C. P. Snow

- **The world of the left hemisphere, dependent on denotative language and abstraction, yields clarity and power to manipulate things that are known, fixed, static, isolated, decontextualised, explicit, disembodied, general in nature**

- **The right hemisphere by contrast, yields a world of individual, changing, evolving, interconnected, implicit, incarnate, living beings within the context of the lived world, but in the nature of things never fully graspable, always imperfectly known ...**



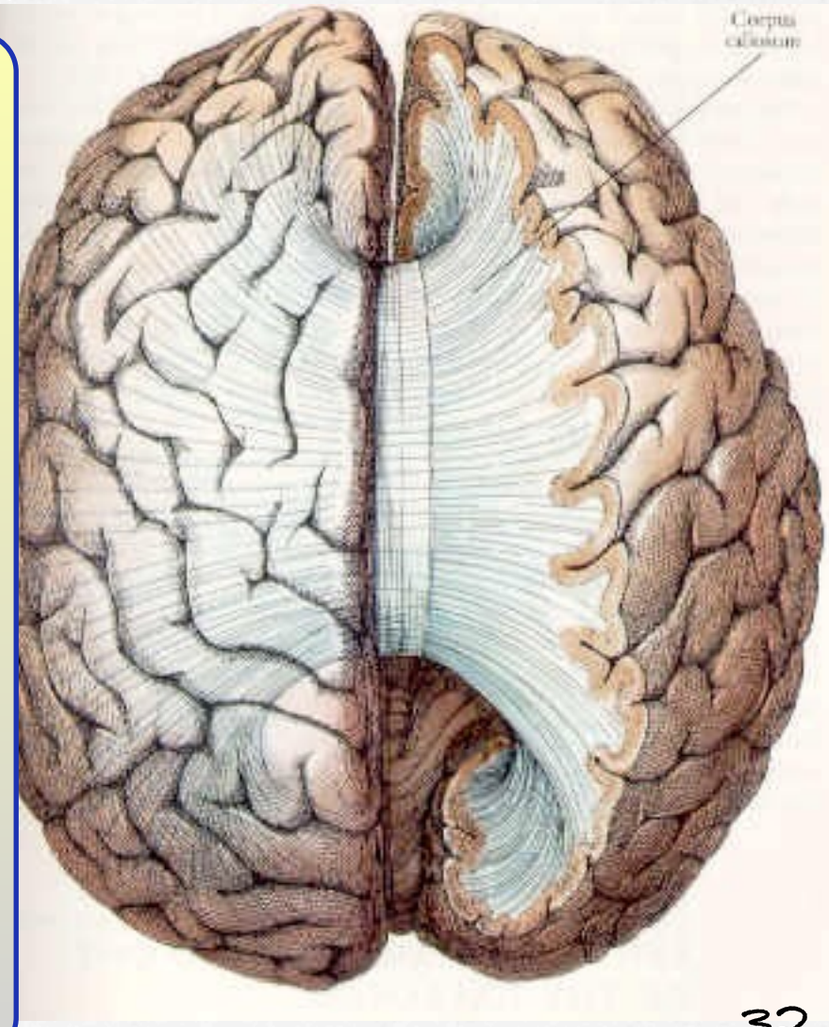


… a harmonious partnership?

- "The Master and his Emissary", pp.18-19

… the evidence is that the primary effect of callosal transmission is to produce functional inhibition.

… it turns out that the evolution both of brain size and of hemisphere asymmetry went hand in hand with a reduction in interhemispheric connectivity. And, in the ultimate case of the modern human brain, its twin hemispheres have been characterised as two autonomous systems.



Thank You!