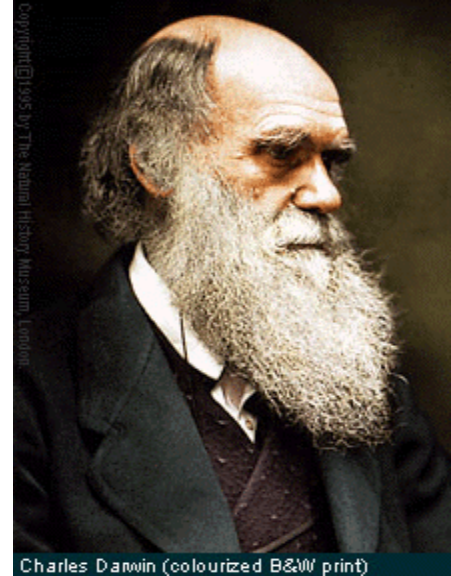


Who and why

- Associate professor @ TUD at day
- Dad, blacksmith and hacker at night

Evolution in Nature



Charles Darwin (colourized B&W print)

- Charles Darwin, 1859
“ The Origin of Species”
- “Live, vary, multiply, let the strongest live and the weakest die”
- Darwin had no notion of DNA and genes, no idea of “information” ...



Evolution – An algorithm

- Evolution is an algorithmic process of replication, variation and selection.
 - Answers to the “How did we get here?” question
 - Not the “why we are here” or “where we are going” !

(Dennet, DC, Darwin's Dangerous Idea: Evolution and the Meanings of Life, Simon & Schuster; Reprint edition (June 12, 1996), ISBN: 068482471X)

General Properties of Evolution

- Evolution is NOT teleological
 - No “*Grand Purpose*”
 - Every living thing is as advanced as any other
- Evolution is a local optimizer
 - Survival of the most suited organism for the current / most recent past situation

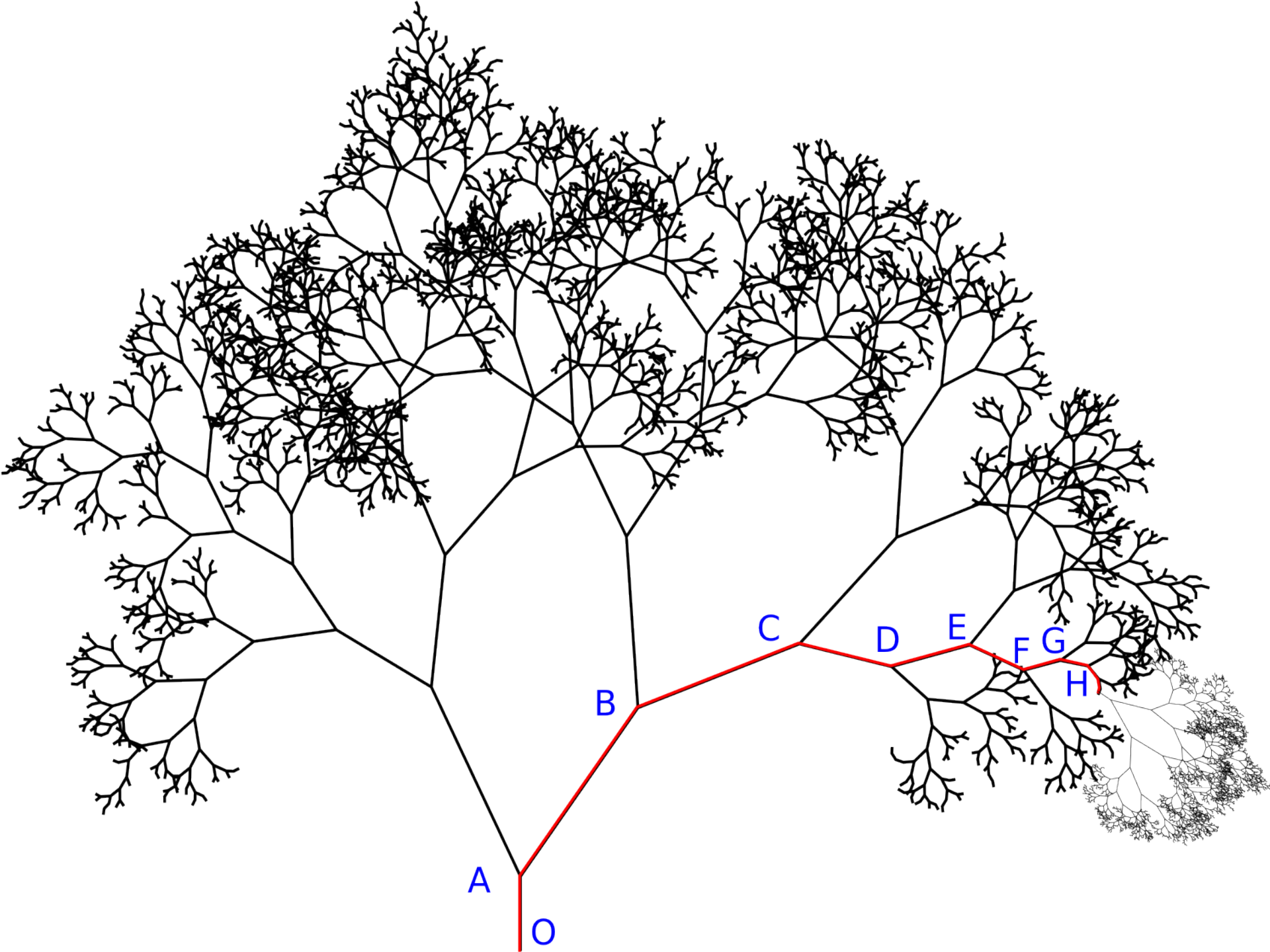


Evolution is *Intractable*

Problems that can be solved, but not fast enough for the solution to be usable

(Hopcroft, et al, Introduction to Automata Theory, Languages, and Computation 2007: 368)

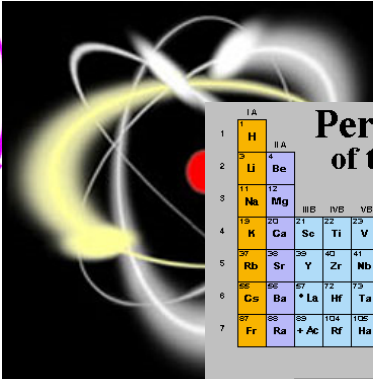
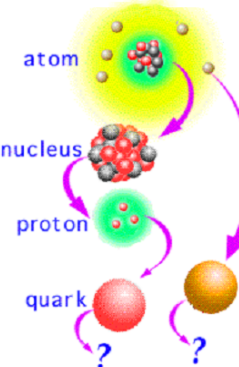
- That is, evolution is not NP complete...
 - It exists in the EXPTIME/space
 - Chess, Go, Checkers are examples of EXPTIME problems
-
- Issue of perfect prediction vs. understanding patterns



No way to predict !

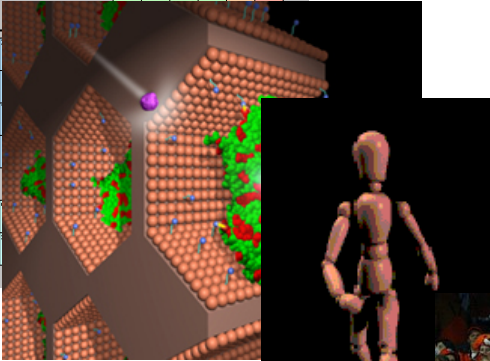


Levels of emergence

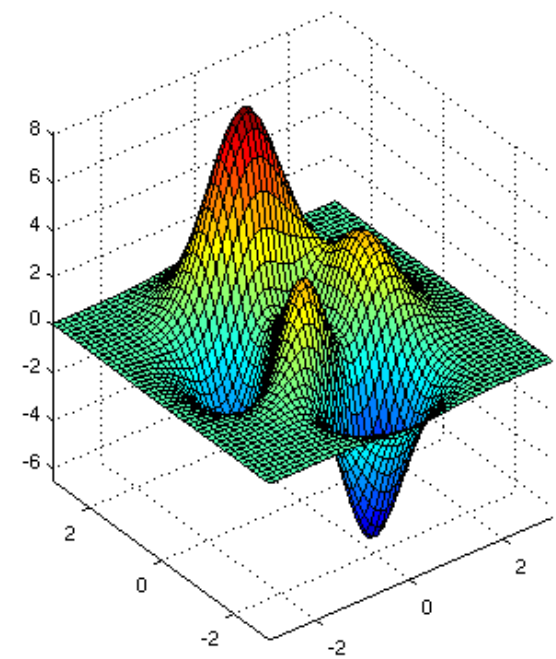
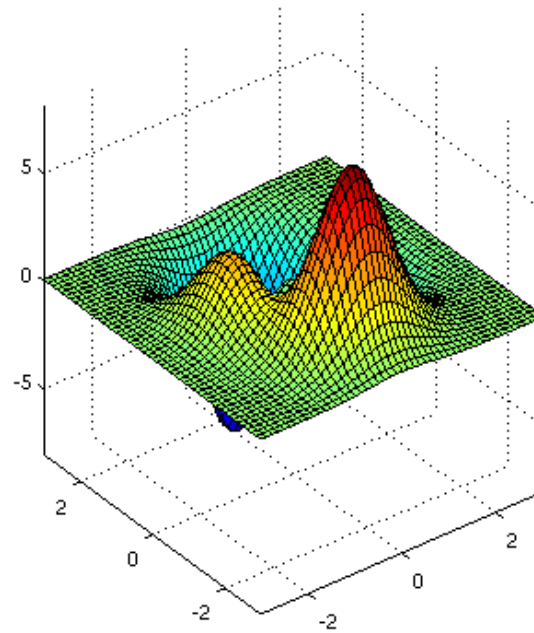
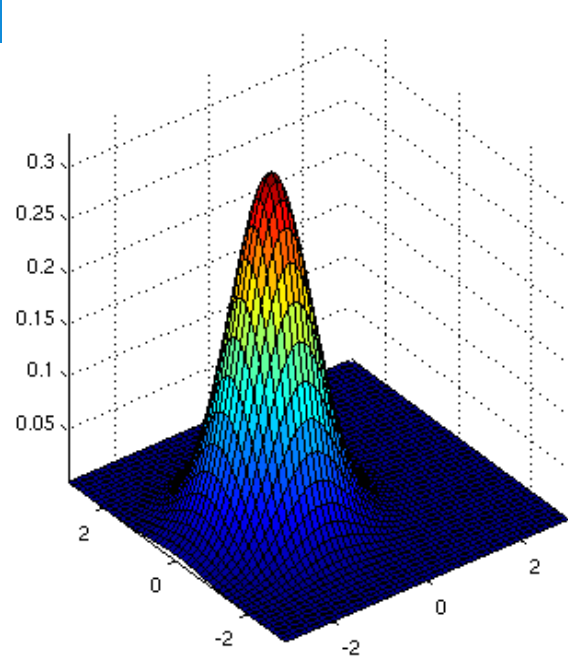


Periodic Table of the Elements

1																	0														
1	I A										II A					III A	IV A	V A	VI A	VII A	VIII	IX	X	XI	XII	He					
2	Li		Be										B	C	N	O	F	Ne													
3	Na		Mg																												
4	K		Ca										Sc	Ti	V	Cr	Mn	Fe													
5	Rb		Sr										Y	Zr	Nb	Mo	Tc	Ru													
6	Cs		Ba										* La	Hf	Ta	W	Re	Os													
7	Fr		Ra										+ Ac	Rf	Ha	106	107	108													

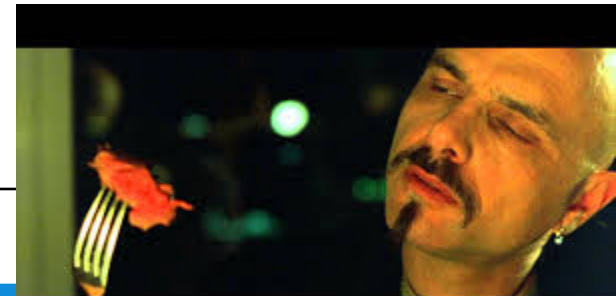


Coupled fitness landscapes



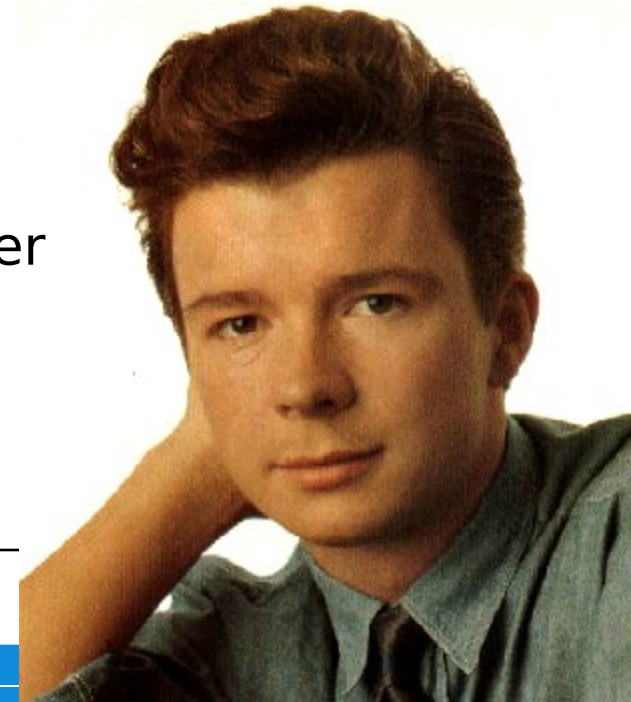
Information in Meat

- Information coded in DNA
 - quaternary base digital information → 27 amino acids → universal to all life
- Analog fitness function
 - physical environment
 - vertical information transfer
 - digital result - Yes/no reproduction



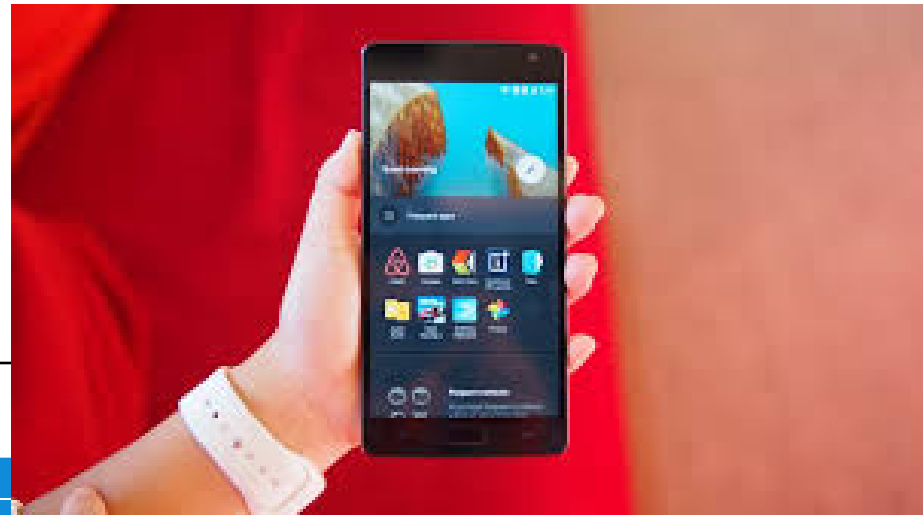
Information in Culture

- Memetic information
 - shared mental space - culture
- Reflexive fitness landscape
 - We collectively determine the fitness
 - Embedded in meat
- Horizontal & vertical information transfer

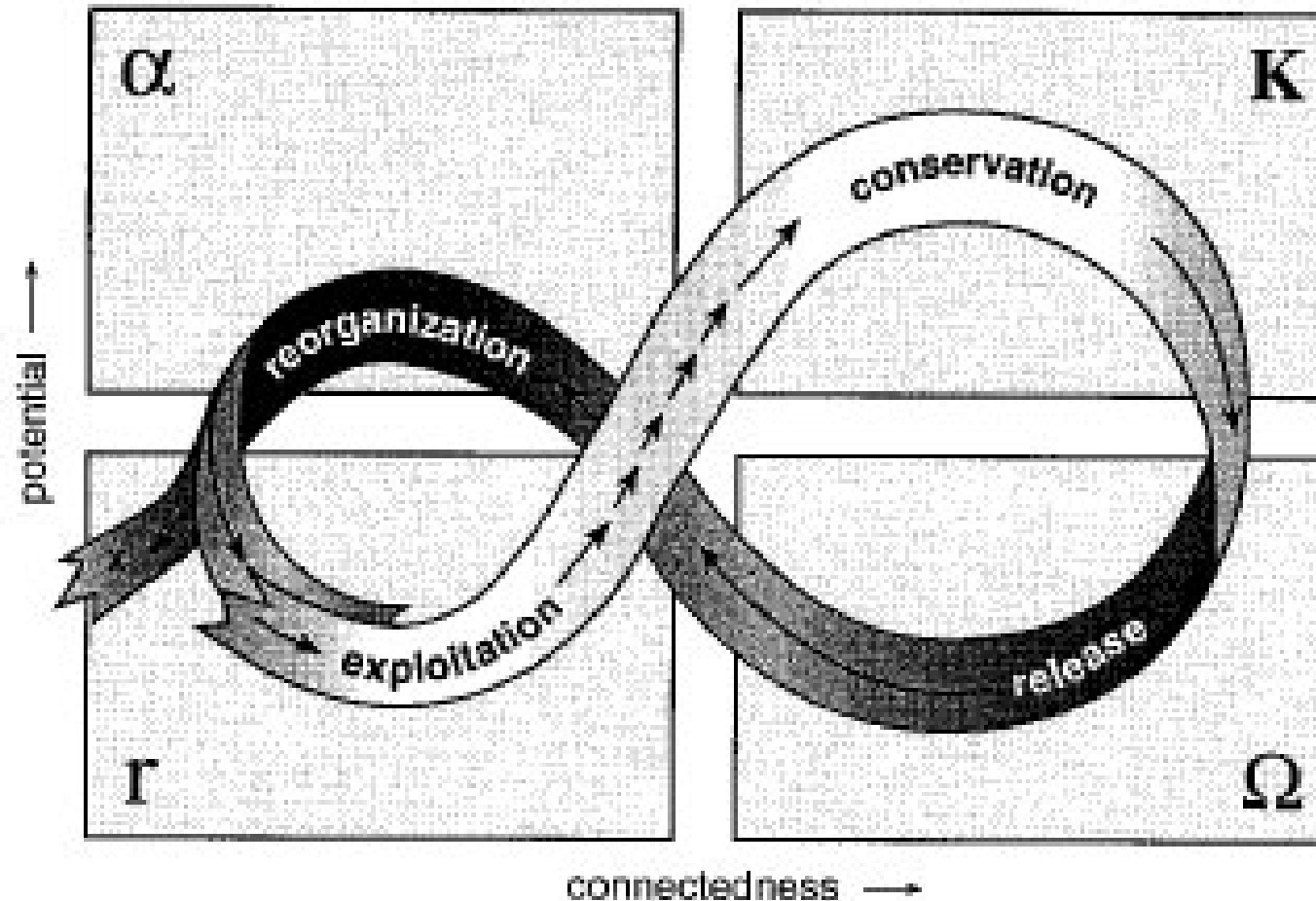


Information in Technology

- Temes proposed as a unit of replication
- Use us as replication and selection mechanisms
- Evolve ?

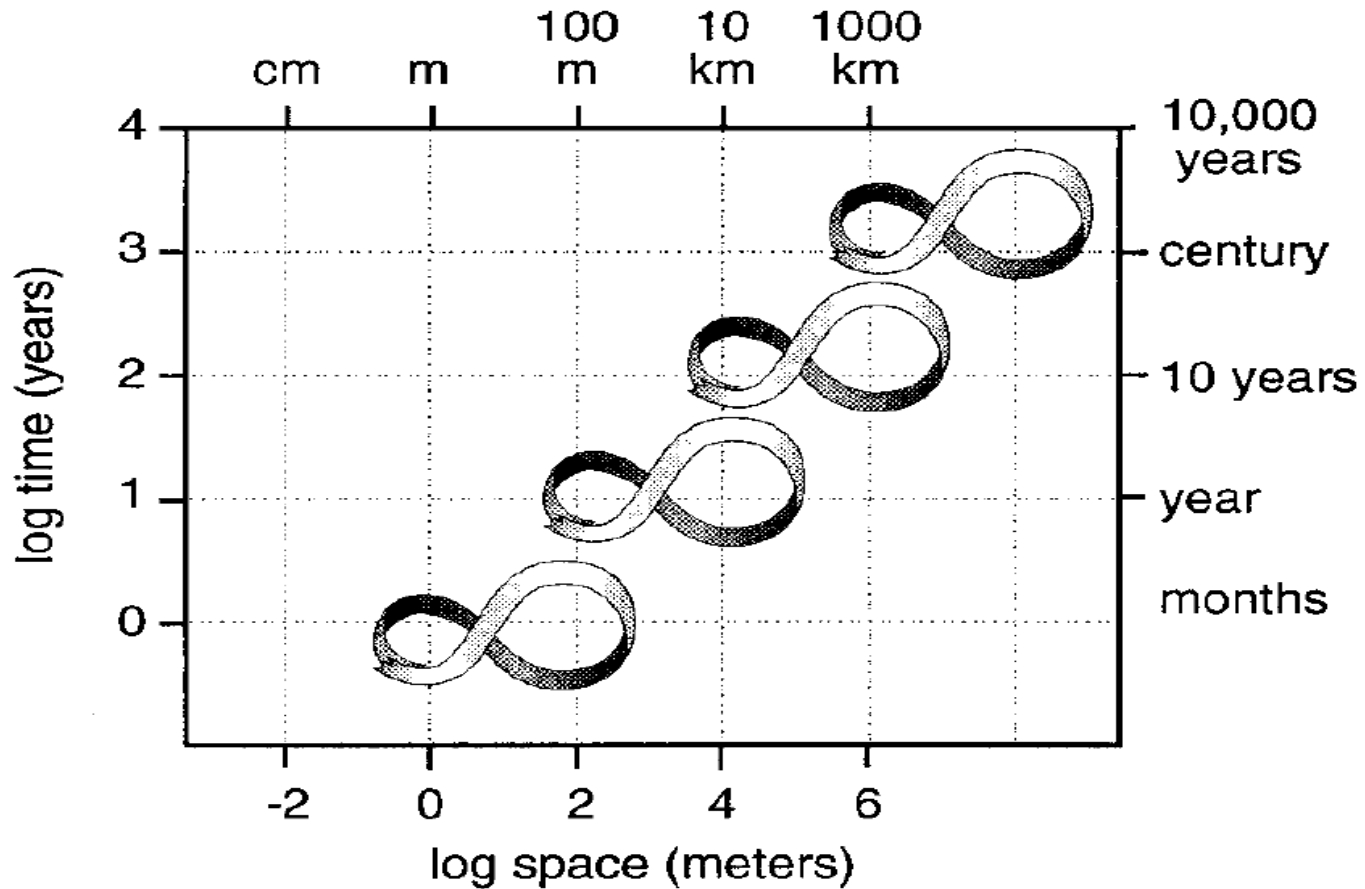


Adaptive cycles



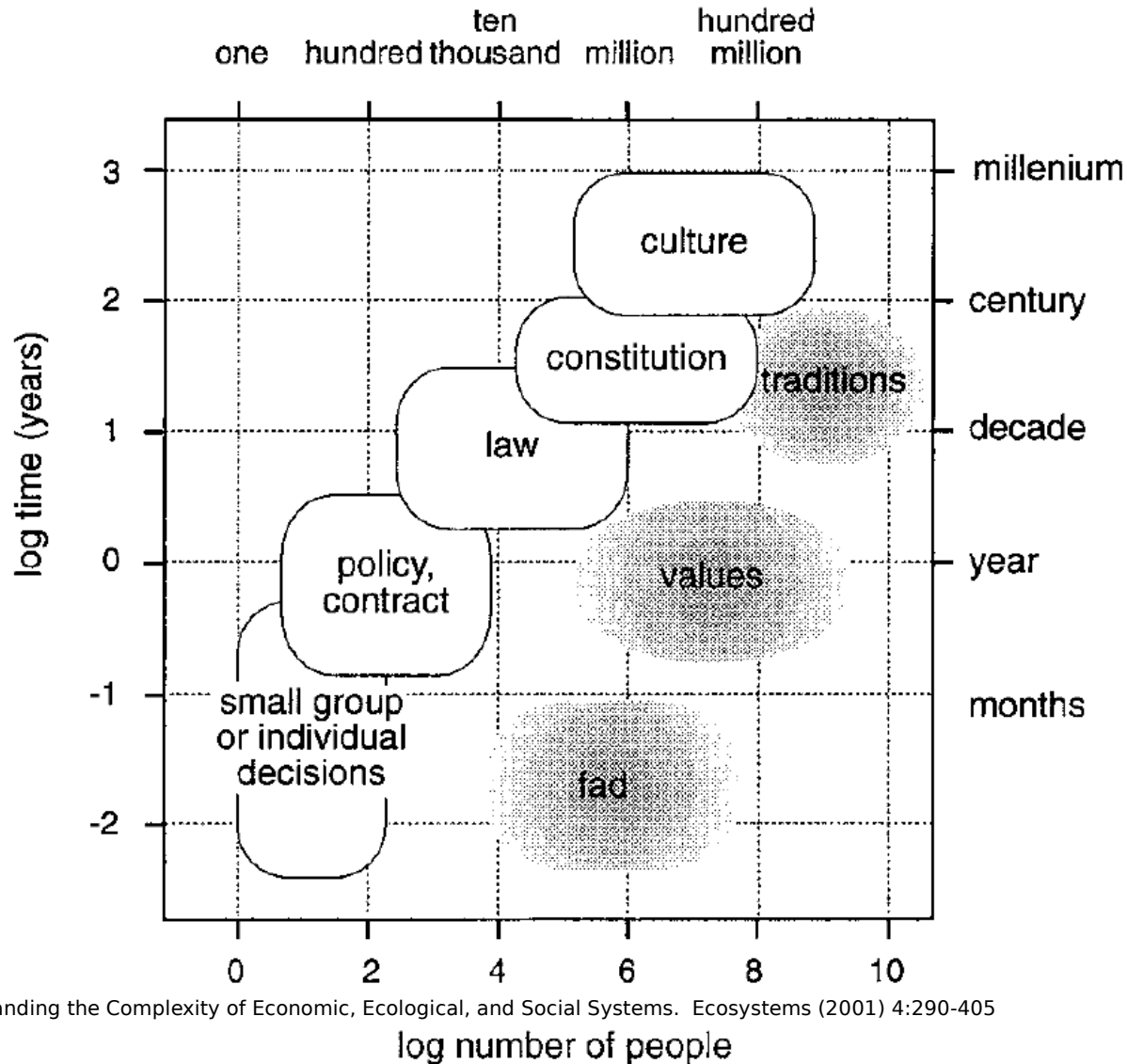
C.S. Holling. Understanding the Complexity of Economic, Ecological, and Social Systems. *Ecosystems* (2001) 4:290-405

Adaptive cycles



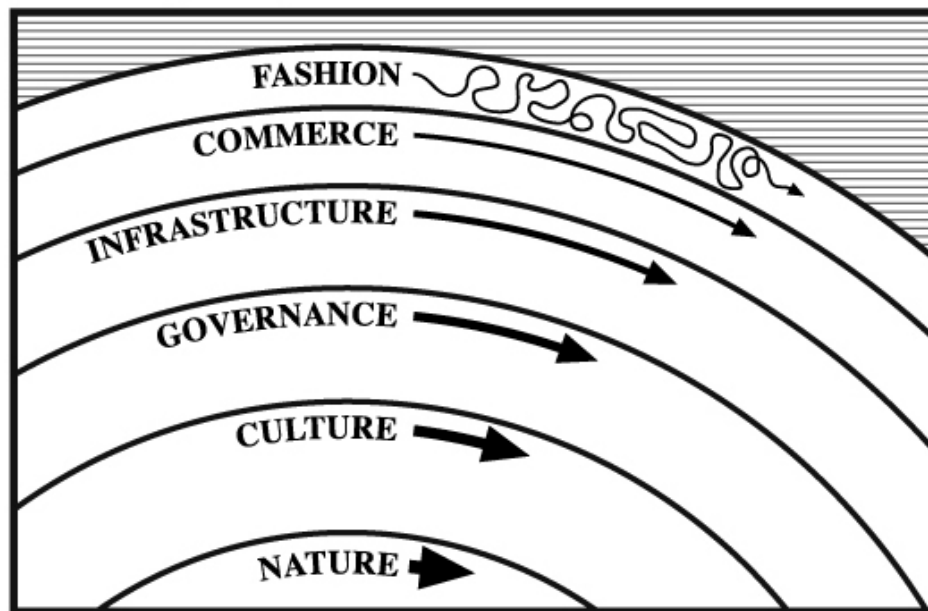
C.S. Holling. Understanding the Complexity of Economic, Ecological, and Social Systems. *Ecosystems* (2001) 4:290-405

Nestedness in time and population

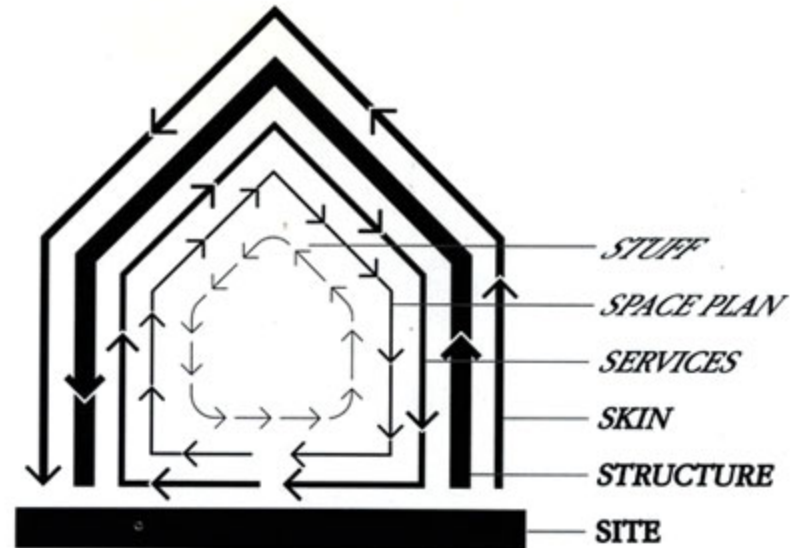


Pace Layering / Shearing Layers

Pace Layering



Source: Brand, S., 1999, *The Clock of the Long Now*, p. 37.



SHEARING LAYERS OF CHANGE. Because of the different rates of change of its components, a building is always tearing itself apart.

Socio-technical co-evolution

- Society creates technology to use in a certain way
- Technology gets used in novel ways and shapes society.
- Examples are
 - Horses and European cities vs Cars/Trains and US cities
 - Energy production and power markets
 - Internet / copyright laws / file sharing
 - Mobile phones and farmers in remote Indian villages

Effect of selection pressures

- Consistent and strong selection pressure creates specialists
 - High up the fitness peak
 - Impossible to find another peak → valley of death in between
 - i.e. everyone making a better facebook
- Inconsistent and weak selection pressure creates generalists
 - Many low peaks
 - Easy to explore others
 - EMG and the range of things we do here

The role of hackers

- Selection
 - Driving adoption and preservation of technology
 - Messing with the fitness landscape
- Replication
 - Open Source, Disclosure, Mods, events, etc...
- Variation
 - Exploring the adjacent possible...

Now, for the first time in its billions of years of history, our planet is protected by far-seeing sentinels, able to anticipate danger from the distant future - a comet on a collision course, or global warming - and devise schemes for doing something about it.

The planet has finally grown its own nervous system: **us**.



Daniel C. Dennett, *Freedom Evolves*

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