Who and why

• Associate professor @ TUD at day
• Hacker at night
Evolution in Nature

• 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” ...
The "Boy's Own Paper"

OUR FANCY PIGEONS.

33. Tringles or Mollmus. 34. Hymallet.

http://www.flickr.com/photos/seriykotik/8502873048/
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”!

General Properties of Evolution

• Evolution is NOT teleological
  • No “Grand Purpose”
  • Every living this is as advanced as any other

• Evolution is a local optimizer
  • Survival of the most suited organism for the current / most recent past situation
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?
Levels of emergence
Coupled fitness landscapes
Evolution is *Intractable*

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


• 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
Scale of intractability

- **Übercomputer**
  - Each electron in the universe ($10^{79}$)
  - Has the computational power of today's fastest supercomputer ($10^{12}$ instructions per second)
  - Each worked for the entire age of the universe ($10^{17}$ seconds)
  - Would equal $10^{108}$ computations
- Evolutionary process with 100 variables, evaluated over 100 time steps.
- Examine all possibilities, and thus be able to predict the outcome in advance = $2^{(100^{100})}$, or $2^{(10E199)}$ or:
  \[
  2^{100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000} calculations,
No way to predict!
Adaptive cycles

Adaptive cycles

Nestedness in time and population

Pace Layering / Shearing Layers

Pace Layering

FASHION
COMMERCE
INFRASTRUCTURE
GOVERNANCE
CULTURE
NATURE


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
The role of hackers

• Selection
  • Driving adoption and preservation of technology

• Replication
  • Open Source, Disclosure

• Variation
  • Duh...
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. Dennet, Freedom Evolves