

# Session 12: Episode 3(4)

## Wrapping up the Web and the history of cognitive technologies

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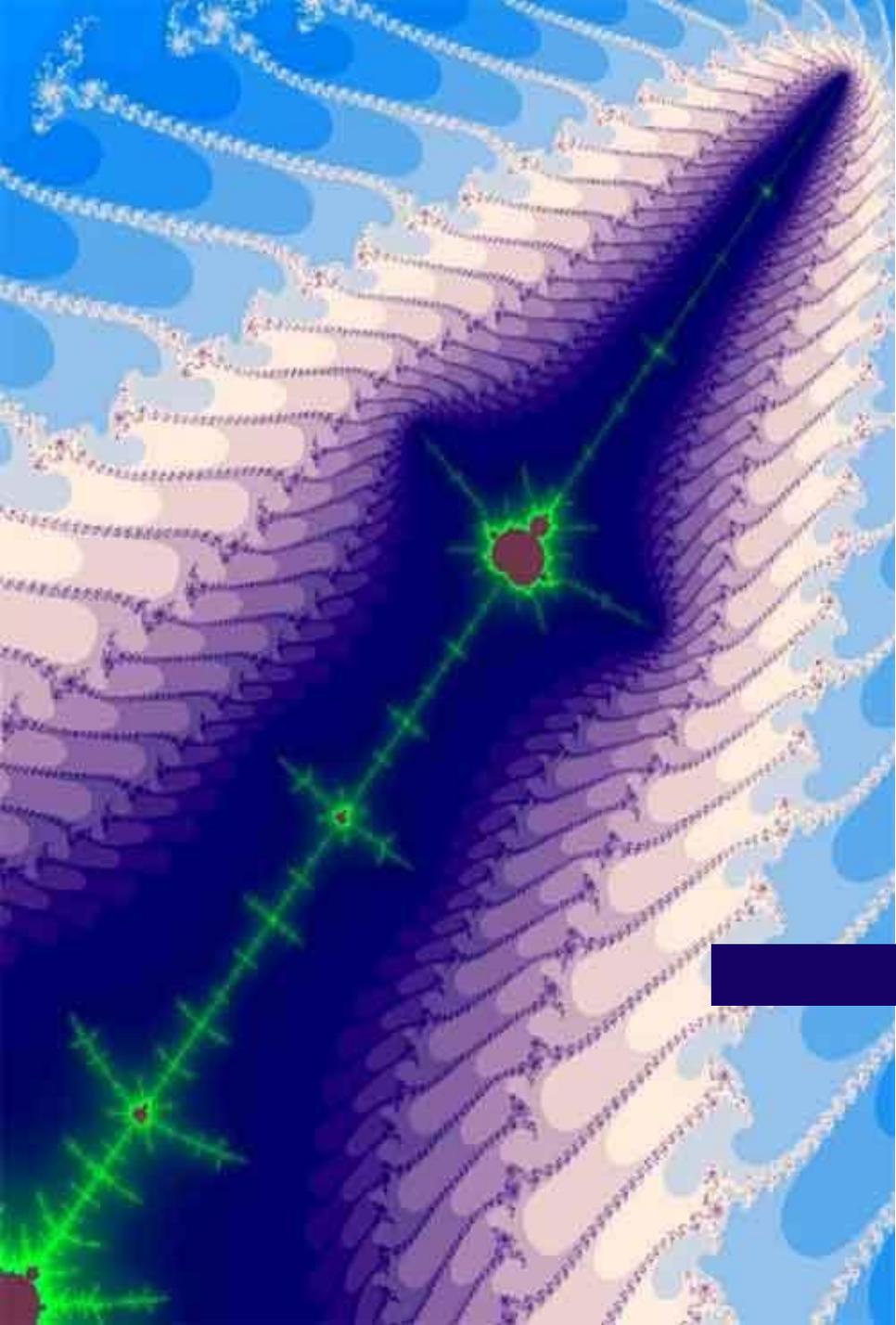
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<http://www.orgs-evolution-knowledge.net>

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# Tonight

- Tonight's session was originally intended to explore various cognitive processes implemented in the Web itself
- Time will be much better spent summing up the what I think are the main messages so far and looking to the future
  - Knowledge defines what we are as humans and confers strategic power on those who apply it
  - Humans have invented a range of tools that improves the quantity and quality of knowledge people can control and apply by extending, externalizing, and even replacing human cognition
  - The capacities and rates of change of these technologies are growing exponentially
- Future topics
  - Theoretical Interlude looking through the lenses of physics and biology at the intertwined natures of life, knowledge and growing organizational complexity
  - The emergence of post-human humano-technical cyborgs
  - The pre-historical co-evolution of technology and human cognition and the emergence of humano-technical organization
  - Case study of organizational KM and Coda - the sting in the tail



Summing up the first  
half

# Knowledge-based revolutions repeatedly changed the ecological nature of the human species

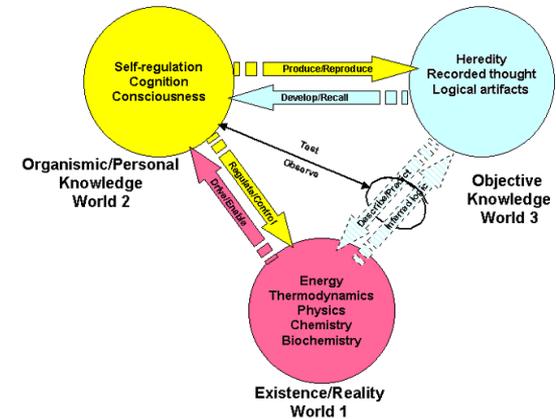
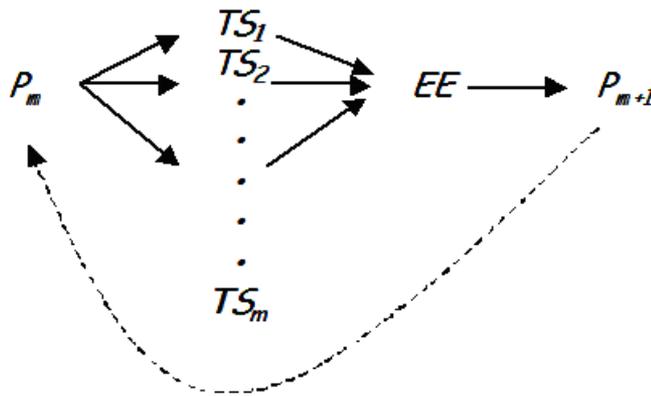
- What is knowledge and how does it grow
  - Karl Popper: knowledge is solutions to problems
  - Thomas Kuhn: knowledge revolutions fundamentally change the way we see and deal with problems
  - The punctuated evolution of technology, adaptation & cognition
- Knowledge to make tools extending anatomy and physiology
  - Making and using simple mechanical tools to interact with the environment: sticks, stones, clubs, levers and fire
  - Ropes, shovels and domesticated animals to manage the environment
  - Machines to replace metabolic power with industrial power
  - Microelectronics to extend & automate cognitive power
- Knowledge to make tools extending cognition and knowledge
  - Speech & teaching extend the capacity to transfer cultural knowing
  - Mnemonic technologies extend the capacity of living memory
  - Counting, writing, & reading enable external storage of knowledge
  - Printing & universal literacy enable the industrial revolution growth of scientific knowledge
  - Knowledge automation and the Web enables hyperexponential growth

# Valuing Knowledge

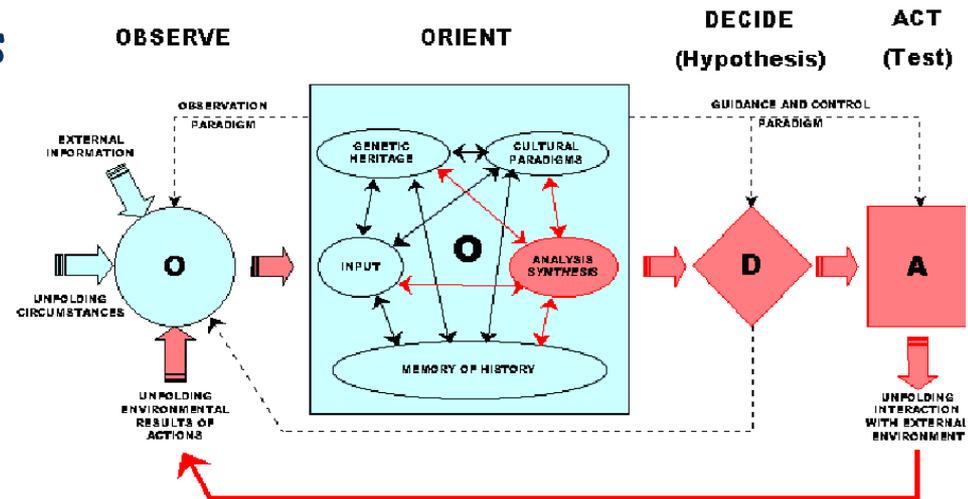
- What are data, information and knowledge?
- Quantifying knowledge/information?
  - Can measure the volume of information/text in bits, bytes and terabytes
  - What does this tell us?
- Qualitative values for different kinds of information
  - Utility value of knowledge
  - WIKID Power
- Knowledge transformations:
  - Data →
  - Information →
  - Knowledge →
  - Intelligence →
  - Wisdom →→
  - Epistemic & Strategic Power

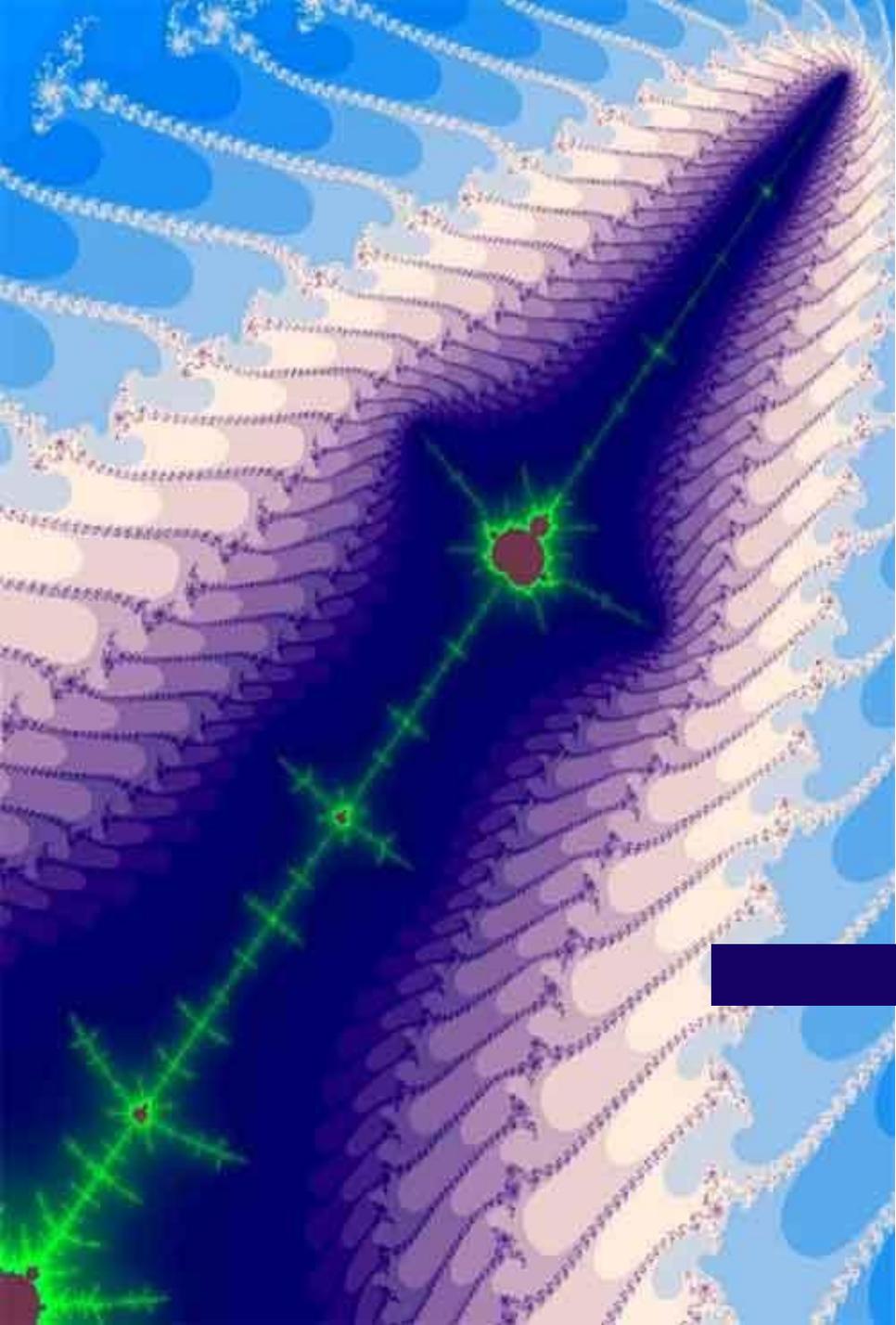
# Constructing knowledge and power

- Popper and Polanyi in the KM world
- Popper's evolutionary theory of knowledge and 3 worlds



- Boyd's OODA loop process
- The importance of iteration and selective feedback!
- Evolutionary vs revolutionary adaptation





**Episodes 1-3**

—

**Technological  
enhancement of  
cognition**



# Episode 1 — Augmenting & Externalizing Memory

- Prehistoric knowledge management - enhancing memory with mnemonics
  - A significant topic for Episode 5
  - See [Emergence Meetup - Knowledge & Power in Prehistoric Societies](#)
- Counting and writing
  - Tokens
  - Media
  - Books
  - Libraries
- Printing
  - Paper
  - Presses
  - Typesetting
  - Automation
- The Reformation and Scientific and Industrial Revolutions
  - Rise of universal literacy
  - Rise of the universal library

## Episode 2 – Automating & externalizing cognition

- Ancient and forgotten technologies for prophecy and magic
  - Analog computing in ancient Greece
  - Automated temples and toys
  - Forgotten knowledge is lost knowledge
- The short life of analog computing
- Clockwork toys become clocks and calculators
  - Gear-driven calculators
  - Weaving and process control - the punch-card era
- The generations of electronic calculation
  1. Binary electronics and stored programs
  2. The rise of magnetic cores and storage
  3. The solid state, Moore's Law and exponential growth
- From flipping switches to casting spells
  - Revolutions in programming languages x speed x storage capacity
  - Arthur C. Clarke's third law: Any sufficiently advanced technology is indistinguishable from magic

# Episode 3 - Cognitive tools for individuals

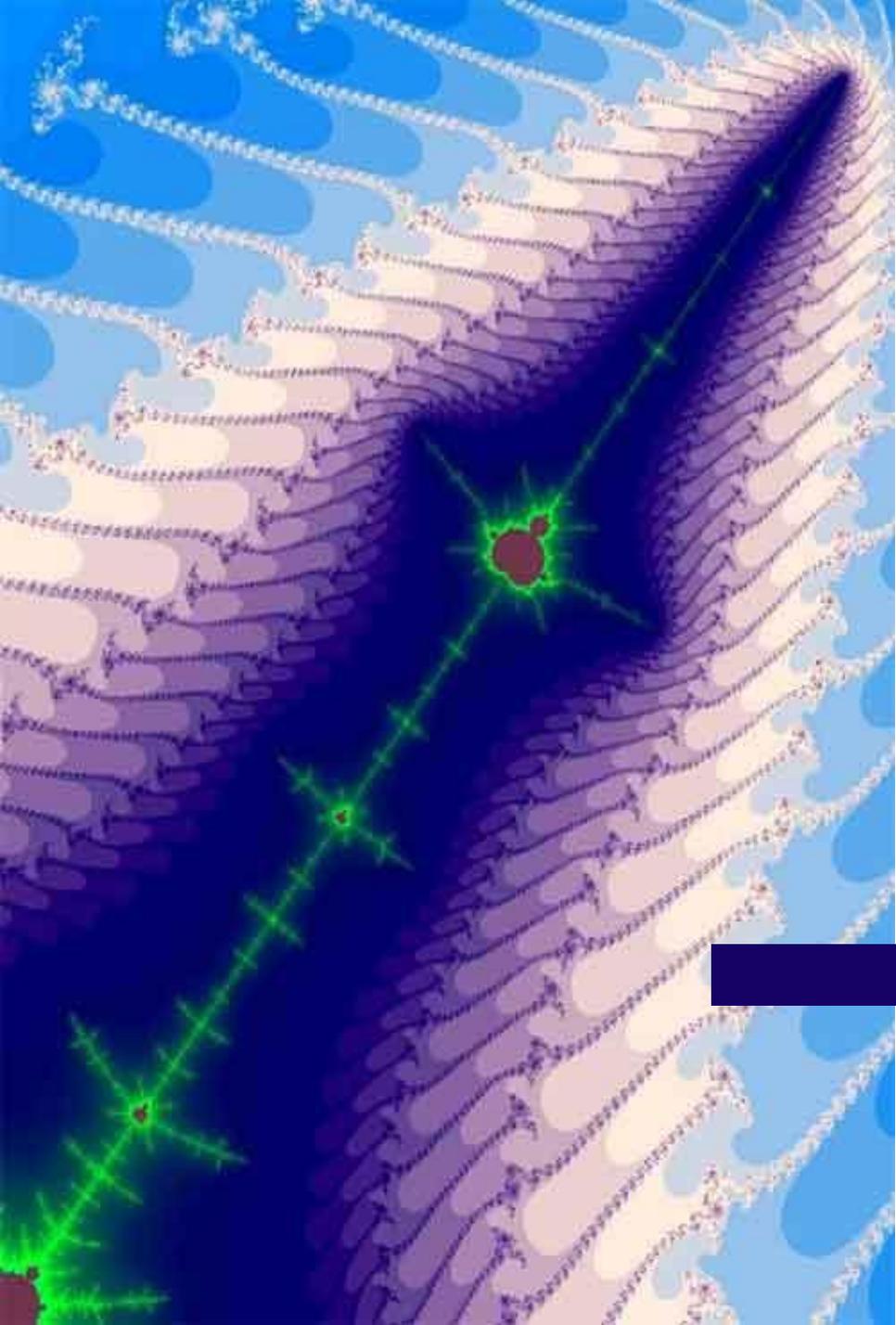
- Tools for making knowledge explicit and processing it externally
  - Knowledge moved to world 3 can be processed automatically
  - Killer apps
    - Word processing
    - Spread sheets
    - Databases
- Paradigms for world 3: paper vs structure
  - Typesetting and appearance vs logical structure and semantics
  - Structure facilitates higher order processing
- Tools to manage and retrieve useful from an exponentially growing body of scientific knowledge
- The Internet and Web revolutions
  - Exponential capacity increase puts the world of knowledge on-line
  - Search engines retrieve appropriate knowledge at light speed and completely revolutionizes humanity's relationship with knowledge
- Growing autonomy in the Web

# Phenomenal growth

- Some numbers (Witiger.Com)
  - Number of Internet devices:
    - 1984 → 1,000 (one thousand)
    - 1992 → 1,000,000 (one million)
    - 2008 → 1,000,000,000 (one billion)
  - To reach 50,000,000 (fifty million) users it took the
    - Telephone 38 years
    - Television 13 years
    - Internet = Web 4 years
    - iPod 3 years
    - Facebook 2 years

# How much knowledge held in the Web?

- My primary interest is meaningful "content" (web pages, documents, books), not data
- Three Webs
  - Surface web -freely accessible to a browser
    - Inktomi Jan 2000 1,000,000,000 pages
    - Notess (2006)
      - Dec 2000 600,000,000
      - Dec 2001 1,500,000,000
      - Nov 2002 3,000,000,000
      - Feb 2004 4,000,000,000
      - 2006 20,000,000,000
    - Wikipedia **current** 36,607,000 (~4 M for content)
    - Google (2008) Jul 2008 1,000,000,000,000 (w/o duplicates)
    - Indexed Web **current** ~47,000,000,000 (Google)
    - Web Archive **current** 8,083,803 (books & texts)
  - Deep/hidden Web - requires subscription or password to access, e.g.
    - e-Journals: University of Melbourne Library accesses 116,279
      - Some are available free to the web, most are not (Scholar indexes)
    - e-Book titles on Amazon: 6,911,733; (437,674 are free, rest are not)
    - Subscription news, financial reports, other databases, etc.
  - Dark Web - encrypted & deeply hidden content (TOR, privacy, hacking, ...)
    - See Dr Gareth Owen 2015 Tor: Hidden Services and Deanonymisation
    - Quantification difficult (~80% of access seems to be child abuse porn)



# What Next?

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But before that an  
*Interlude* to stretch  
your mind

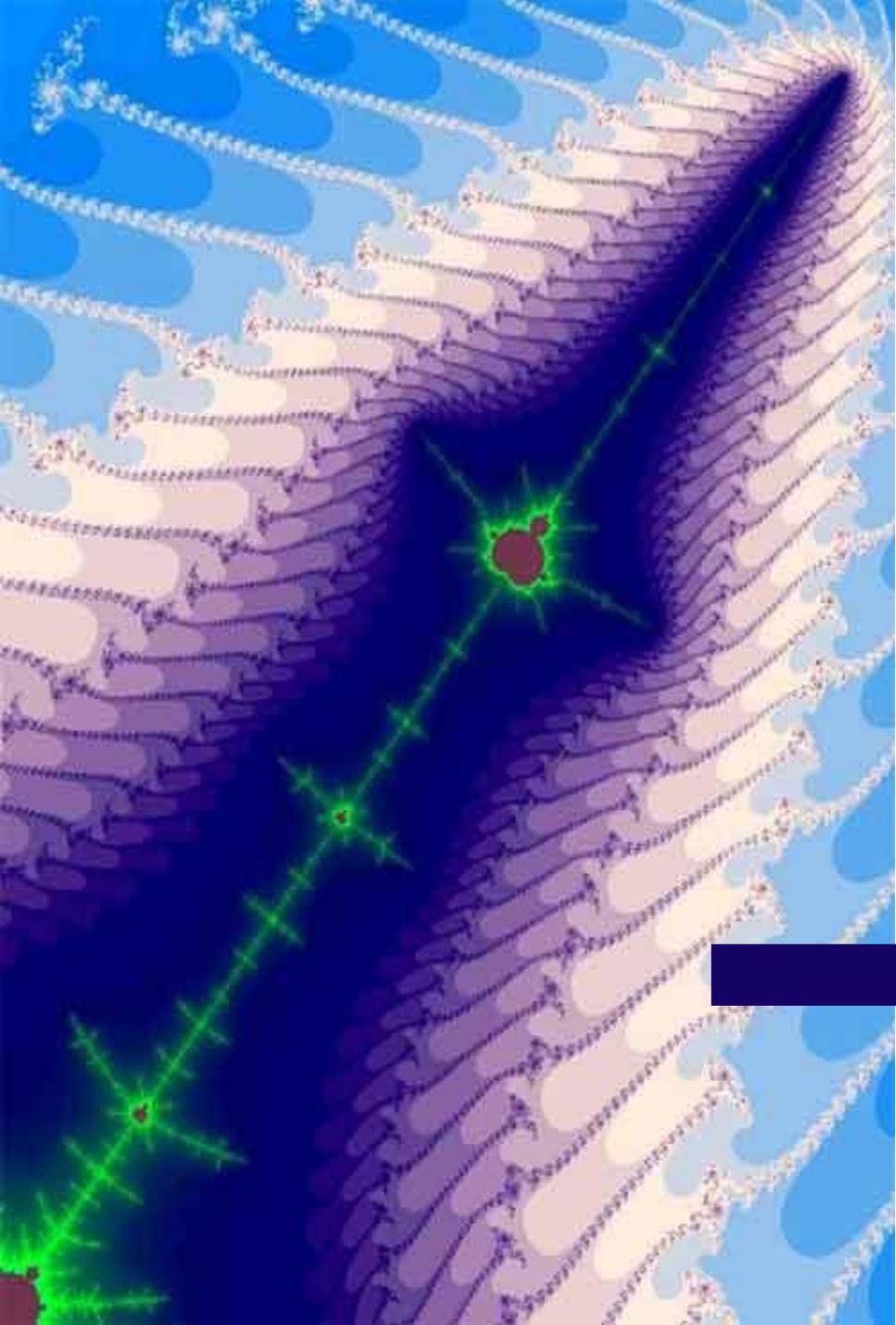


# Interlude 1 – Autopoiesis & physics of life, cognition & knowledge

- Physics and dynamics in world 1 - the “laws” of nature
  - Causation, change and causation at the quantum level
  - Thermodynamics drives emergence and evolution at the macroscopic level
- The likely emergence of world 2 and the inevitable entanglement of knowledge and life
  - What is life?
  - Autopoiesis, “circular organization”, survival and the propagation of adaptive structural organization
  - Structural knowledge in Popper's world 2
- The emergence of macromolecular knowledge in world 3
  - Selection and evolution in the RNA world
  - Sharing and mixing macromolecular knowledge in W3 across time and space
- Multicellularity & sexual reproduction
- Culture & the social sharing of knowledge at a higher level of organization

## Interlude 2 - Theory of hierarchically complex systems and knowledge at higher levels of organization

- Simon, Kauffman, Salthe and hierarchy theory
  - Complicated vs complex
  - Thermodynamically driven emergence
  - Systems, composite systems, subsystems and supersystems
  - Holarchies and focal levels
  - Levels of organization
- Hierarchical structure of living systems and the applicability of autopoiesis and knowledge to multiple levels of organization
  - Molecules
  - Organelles
  - Cells
  - Multicellulars
  - Organizations
  - Societies
- Emerging autopoiesis at higher levels of organization (i.e., autopoietic/living organizations)



# Final Episodes

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We can see the post human  
world now

How did we come to this

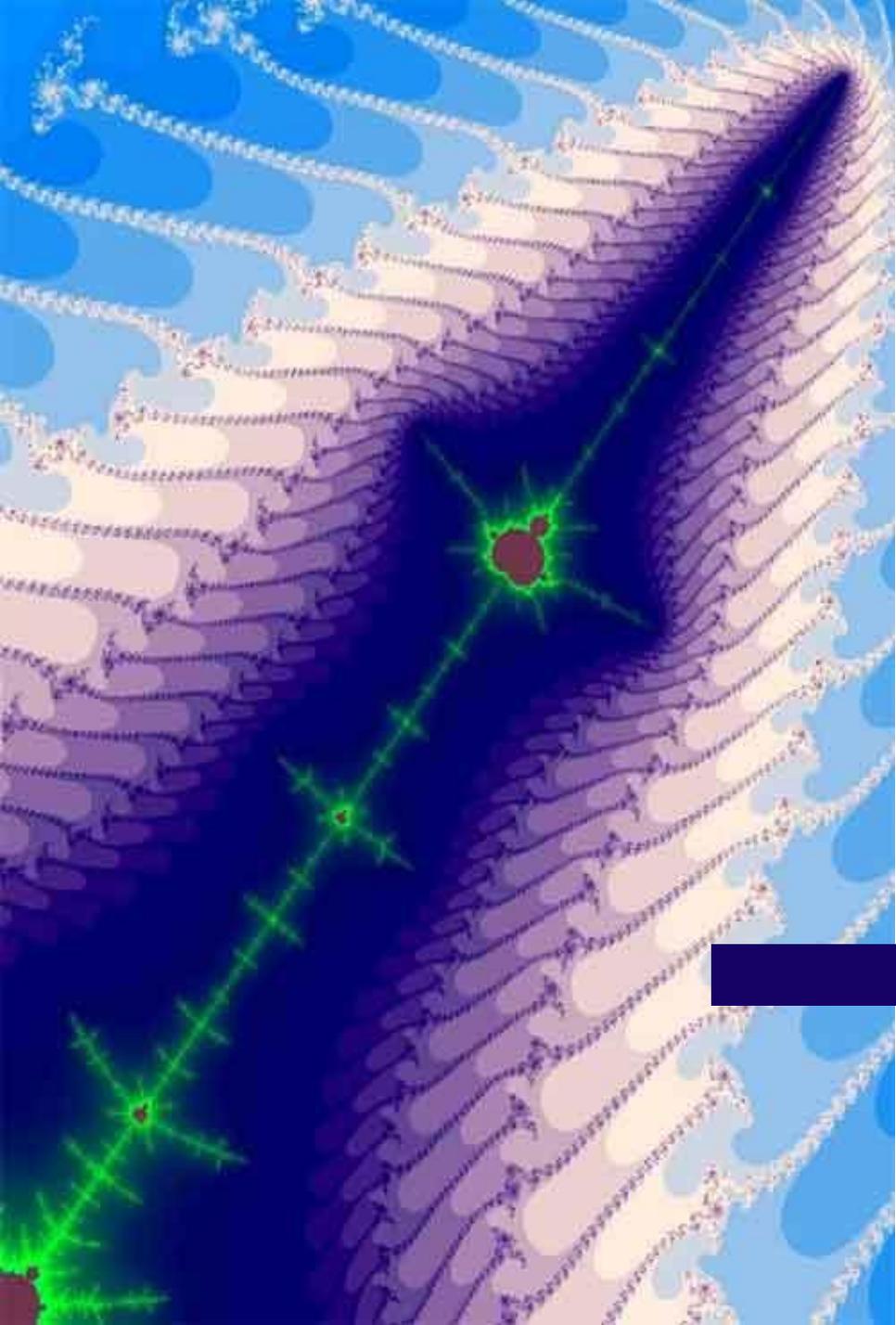


# Episode 4 - Rise of the trans-human cyborgs

- Applying Moore's Law
  - Technological convergence
  - Rise of the "intelligent" cloud
  - Apps on "smart" devices
  - Human machine interfaces
- Current human enhancements
  - Prosthetics
  - Google Glasses
  - Bionic eyes and ears
  - Drones
  - Neural interfaces (sensors and effectors)
- Understanding neural "wetware"
  - Mapping
  - Simulation
  - Cognitive convergence between wetware and hardware/software
- Emergent self-consciousness and autonomy

## Episode 5 - Reconstructing the evolutionary imperatives that made us what we are today

- Scope: Tracing evolutionary circumstances that transformed social, tool-making and using apes into what we are today
- Identifying our ancestors: paleontology and paleogenetics
- Changing roles of genetics and culture for transmitting knowledge heritage of nature and technology
- Technological revolutions radically enhance adaptive capabilities
  - Prehistoric technologies
  - Top carnivores on the African savanna
  - Hunting & gathering around the world
  - Mnemonics and the agricultural revolution
- Emergence of higher order living systems - organizations & societies
  - Emergence of knowledge-based autopoietic groups
  - Sociotechnical organizations and their cognitive processes
  - Still higher level social systems?



**Concluding the story**



# Cadenza: Emergence, life & death of a sociotechnical organization



## Socially Constructing Warships

Emergence, growth & senescence of a knowledge-intensive complex adaptive system

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Melbourne Emergence



# Coda: Where will it all end?

Will knowledge growth end in a singularity, spike or inflected S curve?

