GC7 : Journeys in Non-Classical Computation

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six classical paradigms to disbelieve before breakfast

1. Turing paradigm
   - finite discrete classical state machine, Halting, Universal
   - closed system, predefined state space
2. von Neumann paradigm
   - sequential fetch-execute-store
3. output paradigm
   - black-box isolated from the world
4. algorithmic paradigm
   - deterministic function from initial input to final output
5. refinement paradigm
   - a known specification is refined to provably correct code
6. pure logic paradigm
   - substrate (hardware/physics) is irrelevant

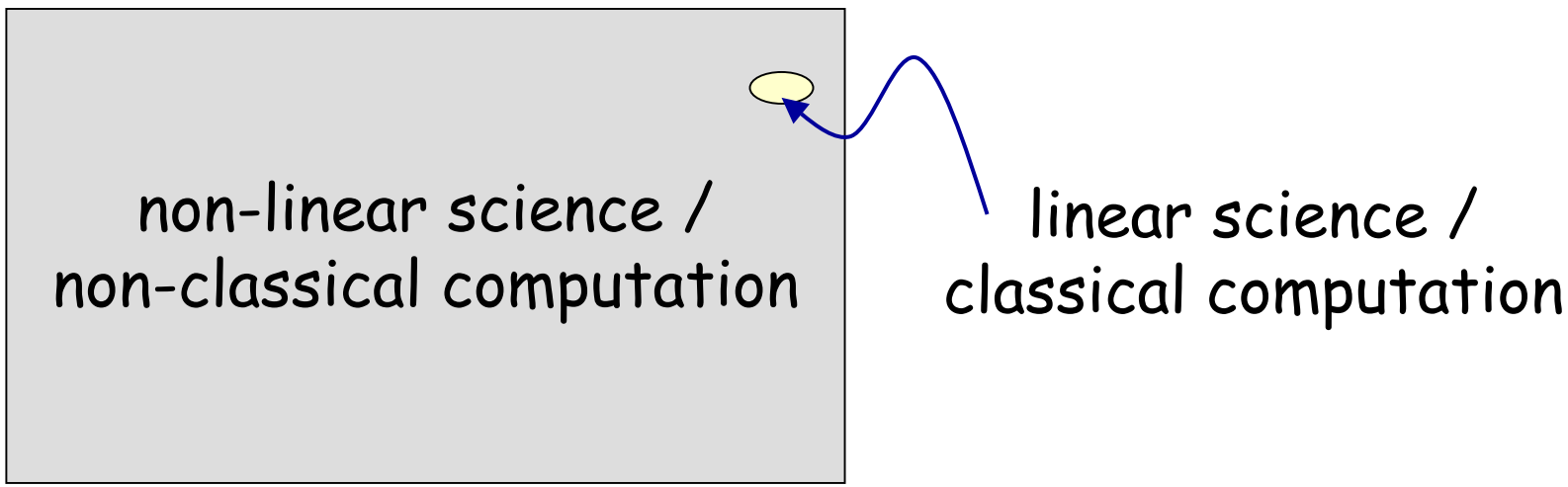
some non-classical views

- Real World as inspiration
  - natural computation : physics inspired, bio-inspired
    - neural, genetic, immune, developmental, social insects, …
- Real World as a computer
  - all computation and all data is embodied
    - physical effects – particularly quantum
  - analogue computation
    - the great missed opportunity of the 20th Century?
- open dynamic systems
  - no Halting, rather ongoing developing interactive processes
    - complex emergent properties
  - massive parallelism
    - "more is different"

"non-classical" computation?

like defining the bulk of zoology
by calling it the study of
'non-elephant animals'

- Stan Ulam (attrib)
on the name "non-linear science"



the Challenge

to journey through the gateway event obtained by breaking our current classical computational assumptions, and thereby develop a mature science of Non-Classical Computation

journeys / waypoints proposed so far

- the metaphor of a *journey* emphasises the importance of the entire process, rather than emphasising the end point

  - Quantum Software Engineering / Computational Models
  - Approximate Computation
  - Reaction-diffusion and excitable processors
  - Artificial Immune Systems
  - Open Dynamical Networks
  - Evolving Hardware
  - Molecular Nanotechnology
  - Computation with Dynamics and Attractors

progress to date

- suggestions for journeys
  - mainly influenced by individuals' interests …
- York discussion meeting
  - September 2003
  - summarised at

    http://www.cs.york.ac.uk/nature/…
- involvement in EPSRC's Novel Computation clusters
  - occupying the attention of many of the most interested …

next steps

- coherent flexible strategy
  - into which the proposed journeys, and other projects, can fit
  - this is a highly active research area
    - GC7 as an "umbrella" group, providing a broader perspective, linking otherwise diverse activities
- soliciting input for further journeys, etc
- preparing a EPSRC Network proposal
- awaiting results of Novel Computation call