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”

non-linear science / non-classical computation

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