NSC & the von Neumann Paradigm

Group 2
Von Neumann Architecture

- Data and instructions stored in same memory unit
- Contrasts Harvard Architecture
- Foundation for a high percentage of modern machines
- Fetch-Decode-Execute Model

http://www.cise.ufl.edu/~mssz/CompOrg/Figure1.8-vonNeumannArch.gif
Examples of NSC Algorithms/Approaches

● Biologically Inspired Computing - Inspired by biological systems like
  ○ Swarm Intelligence
  ○ Evolutionary Algorithms

● Chemical Computing - Inspired by chemical reactions that perform operations on data

● Physics Inspired Computing - Inspired from physics
  ○ eg. Simulated Annealing
Inherent Differences

Emergence - hard to fully define see [1]. Simply put it is where complex behaviour is observed in several agents who behave simply.

Von Neumann architecture means that “it is difficult to get a computer to do something by chance” [2]. This makes emergence hard to emulate as they all rely upon some form of randomness.
Inherent Differences cont...

- Control and memory are centralised in von Neumann.
- Environment response time
- Communication between devices is extremely limited
Von Neumann allows Simulation

- Non-standard computation can be simulated with a von Neumann machine
  - An approximation

- We lose:
  - Accuracy
  - Real randomness
  - Efficiency
Attempts to overcome limitations

- Parallelism
  - More cores
  - Distributed computing

- Created specialist programming languages
  - occam-π [3]
[3] https://www.cs.kent.ac.uk/research/groups/plas/wiki/OccamPiReference

Supported by:
Stepney et al., Journeys in Non-Classical Computation
Questions?