About

Self-Organisation
Emergent Behaviour
Self-Management

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Self-Organisation

- Definitions
  - Swarms: coordination and regulation through environment without central control (stigmergy)
    - Self-org occurs results from behaviour inside the system
  - Thermodynamics: open systems decrease entropy when external pressure is applied (decrease of entropy)
    - Self-org is the result of pressure applied from the outside
  - Cells: self-maintenance of system of system through self-generation of system's components (autopoiesis)
- Essentially: *capacity to spontaneously produce a new organisation in case of environmental changes*

Emergent Behaviour

- Definition
  - Structure (pattern or function), not explicitly represented at a lower level, appears at a higher level
- Essentially
  - Observed pattern or function but it has no causal effect on the system itself (stones ordered by sea)
  - Observed function which has a causal effect on the system
    - This function can be desired or not!! (in both cases it has an effect)
- Not always needed or required or good for the system

When Self-Org meets Emergence

- Self-Org can be independent of Emergent behaviour
  - Self-Org can happen without emergent behaviour
    - If central control
  - Emergent Behaviour can happen without self-organisation
    - No (re-)organisation
- Self-Org + Emergent Behaviour when:
  - Dynamic Self-Organising Systems
  - Decentralised Control
  - Local Interactions

Self-Management

- Decentralised control
- Adaptation to changes (re-organisation?)
- Local knowledge of individual components
- Desired result: self-management
  - Then … self-org + emergent behaviour

- Maybe more complex …
- Three aspects:
  - Self-managing system itself
  - Any additional resource this system manages (self-managed system)
  - Interaction with human administrator
- Ex. Self-managing distributed operating system

Current Solutions for Self-Org/Emergence

- Reproducing natural self-org mechanisms
  - Biology or Social Behaviour (insects, humans, etc.)
  - Direct interactions / Reinforcement / Adaptive Agents / Cooperation / Middleware
- Strengths
  - Robust / Adaptive / Simple individual components
- Limits
  - Controlling emergent behaviour
  - Designing those systems
  - Implementing supporting infrastructures

Issues for Self-Management

- Software engineering of systems with both
  - Self-org and Emergent Behaviour
  - Needs: to define a global goal and to design local behaviour (making the global expected behaviour to happen)
- Control / Design of decentralised behaviour
  - Good properties have to emerge
  - Bad properties to be avoided!
  - Control and emergence are contradictory
  - Which kind of self-organisation do we need?

Issues for Self-Management

- What about environment
  - Where is the border?
  - How to take into account the environment?
- 3 Aspects of Self-Managing(ed) Systems
  - Managing itself
  - Managing resources (environment?)
  - Human interaction with self-managing system (2 directions)
    - From Human to System (decomposition of high-level goal)
    - From System to Human (coherent global info produced by local decentralised info)