LEAP: Lernende Erforschen Adaptive Phänomene

Terminology

The ***Leap*** project uses agent-based modelling (ABM) to investigate the influence of four processes on *rheolectic search* (*RS*): *mutation*, *recombination*, *exploration* and *construction*.

We use the term ***rheolectic*** to refer to systems are adaptive in the following sense: (i) They possess both structure and dynamical flow; (ii) their structure determines their dynamical flow; (iii) flow determines the system's stability against stochastic structural perturbations.

RS is a rheolectic process that achieves "success" by attaining metastable states that fulfil some success criterion such as minimising an objective function. Examples are genetic algorithms (GA), back-propagation learning and the dynamical stabilisation of an ecosystem.

Mutation is stochastic perturbation of structures (e.g. genetic mutation, synaptic decay).

Recombination merges two structures into one (e.g. genetic recombination, endosymbiosis).

Exploration is the set of flows generated by a particular structure (e.g. development, feeding).

Construction is the inertia of dynamical flows against change over time (e.g. a persisting house, dam, anthill, cellular or multicellular body, or tribe).

Leap research group (LRG)

LRG will optimise the *mepi* (*maximally epistatic*) function, which Watson (2007) specifically designed to be as difficult as possible to optimise using basic GAs. LRG will use *mepi* as a benchmark for comparing a sequence of RS models with increasing exploratory emphasis:

1. ***Basic GA***: Mutates and recombines purely genetic search. (Control model)
2. ***Exploratory GA***: Mutates and recombines exploratory processes that perform search. This model seeks to reproduce Hinton and Nowlan's (1987) finding that exploratory GAs optimise deceptive functions like *mepi* more efficiently than basic GAs.
3. ***Exploratory SEAM*** (Symbiogenic Evolutionary Adaptation Model): Mutates and recombines exploratory solutions defined genetically across multiple agents.
4. ***RS***: Exploratory SEAM defined across multiple agents within a spatial neighbourhood.

Leap development group (LDG)

LDG will develop the infrastructure for the research. It will construct course materials based on past ABM courses to enable *fourth-semester novices* to understand and reproduce the work of LRG. This course will provide a thorough pedagogical grounding in ABM in Julia, incorporating themes of emergence, chaotic motion, complexity, adaptation and rheolecsis.

Performative quality assessment

LDG and LRG will meet regularly to conduct continuous assessment of the content and quality of each other's work. Both groups have the mutual responsibility of ensuring that all LRG and LDG code and course materials are pedagogically transparent, that LRG products motivate all LDG materials, and LDG materials explain all LRG products.

References

Hinton, G.E. & Nowlan, S.J. (1987). How learning can guide evolution. *Complex Systems, 1*, 495–502.

Watson, R.A. (2007). *Compositional evolution*. MIT Press.