

# 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*, *development* and *construction*.

We use the term **rheolectic** to refer to systems that 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 native GAs. LRG will use *mepi* as a benchmark for comparing a sequence of RS models of increasing developmentality:

1. **Native GA**: Uses only mutation and genetic recombination as a control model.
2. **Exploratory GA**: Uses mutation and recombination to constrain developmental search. This model seeks to verify Hinton and Nowlan's (1987) suggestion that exploratory GAs optimise deceptive functions like *mepi* more successfully than native GAs.
3. **Exploratory SEAM** (Symbiogenic Evolutionary Adaptation Model): Recombination across exploring individuals that encode their own role in participatory solutions.
4. **RS**: Exploratory SEAM across spatially situated agent neighbourhoods.

## 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 constitute a pedagogically sound introduction to 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.