The focus of this seminar is "*Evolution – necessities, mechanisms, transitions*".

Evolution is the emergence of something fundamentally new that could not possibly be represented in the antecedent system. Formally, it corresponds to an increase of the dimension of a system's state space. Guided by the origin of life on Earth and its unfolding, we aim to address the following questions:

1. What is evolution and how does it differ from ordinary development?
2. What are general necessities for a system to evolve and for the unfolding process?
3. What are key mechanism, naturally emerging obstacles and limitations, and ways to overcome them?
4. What types of spheres emerge in the unfolding and what is the character of the transitions between them?

While life on Earth yields the backdrop, most of the concepts, and the language for understanding evolution – it is the deepest known cascade of unfolding –, we aim for the fundamental concepts that are applicable also to other evolving systems.

Topics may be chosen from different fields: (i) phenomenology of a particular real system, (ii) abstract representations of real systems or illustrations of underlying concepts, e.g., evolutionary game theory, and (iii) explicit implementation of a numerical simulation of an interesting aspect, typically as a cellular automaton. Following is a non-exclusive list of possible topics, which will be subdivided into several presentations:

- chemical evolution and the origin of life (quasi-species, information threshold, replicase-parasite systems,...)
- RNA world and current molecular-biological machine
- evolutionary game theory (distributed prisoner's dilemma,...)
- evolutionary transitions (great oxygenation event,...)
- evolving evolution (co-evolution of a system and its environment,...)

Format

1. In general, 2...3 students form a team, ideally with different individual strengths. They explore and work out a topic or sub-topic together and present their part individually.
2. Exploration: A starting point will be provided. It contains at least some research papers, in some cases also a simulation code or code fragment. Further insight is to be gained from the internet (Google Scholar, Wikipedia,...) and through own thinking and exploration.
3. Working out: Acquire, understand, and condense the material. Depending on the specific focus, different weight may be put on phenomenology, formulation of process models, theoretical background, or numerical simulation.
4. Oral presentation: An in-depth talk of some 50 minutes followed by an intensive 40 minutes discussion. Active participation in the discussions by all participants is an integral part of this seminar.

5. A report in one of three forms:
   (a) a traditional report, 5...20 pages per author (a team may hand in a joint report),
   (b) a documented code, including a short description of the scientific background, the algorithm, discussed exemplary runs, and an operational implementation in Python or C++,
   (c) a 5...10-minutes movie of a TED-like talk including a transcript with background material.
6. The seminar will start with an introduction into the general theme, its concepts, and some basic methods.

All the material will eventually be available electronically.

Grading

This seminar has three essential aspects that are graded individually: (i) presentation and discussion (40%), (ii) participation in discussions (20%), (iii) report or equivalent (40%).

Schedule

This is one of the possible Master seminars to choose from in environmental physics. It is concurrent with the other ones, all on Thu 16:15–17:45.

Registration

The seminar has about 10 slots. Registration is required either at the first meeting on Oct. 20, 2016, or by sending email to `kurt.roth@iup.uni-heidelberg.de` before.
You may opt for an early date for your presentation by choosing the topic beforehand and already start working on it in September. This works best if the team exist already. Let me know.

Mandatory Prerequisites

Solid understanding of *at least one* of

- environmental physics, or
- chaotic, complex, and evolving environmental systems, or
- numerical methods including solution of differential equations.

As the weight on different aspects of a topic can be chosen, one field of expertise suffices even if the others are blank. "Cross-learning" is one of the goals of this seminar.