DY 18: Invited Talk: Andreas Zöttl (Vienna)

Time: Tuesday 9:00–9:30 Location: DYa

Invited Talk DY 18.1 Tue 9:00 DYa

Reinforcement learning of microswimmer chemotaxis using genetic algorithms — •Andreas Zöttl, Benedikt Hartl, Maximilian Hübl, and Gerhard Kahl — TU Wien

Many bacteria and eukaryotic cells are able to move in viscous fluids by performing nonreciprocal body deformations, such as rotating attached flagella or by distorting their entire body. In order to perform chemotaxis, i.e. to move towards and to stay at high concentrations of nutrients, they adapt their swimming gaits in a nontrivial manner.

We propose a model how microswimmers are able to autonomously adapt their shape in order to swim towards high field concentrations using an internal decision making machinery modeled by an artificial neural network. We present two methods to measure chemical gradients, spatial and temporal sensing. Surprisingly simple neural networks evolve by using the NEAT genetic algorithm which control the shape deformations of the microswimmer and allows them to navigate in static and complex time-dependent chemical environments [1]. By including noisy signal transmission in the neural network the well-known biased run-and-tumble motion emerges. Our work demonstrates that the evolution of a simple internal decision-making machinery, which we can fully interpret and is coupled to the environment, allows navigation in diverse chemical landscapes. These findings are of relevance for sensing mechanisms of single cells, or for the simple nervous system of small multicellular organisms such as C. elegans.

[1] B. Hartl, M. Hübl, G. Kahl, and A. Zöttl, under review (2021).