Title: "Adaptive Gyrotactic Swimmers in a Taylor-Green Vortex Flow: A Reinforcement Learning Approach"

Abstract:
"For several species of phytoplankton and most zooplankton the ability to move vertically is important for survival. This capability is affected by hydrodynamic shear in the underlying flow, which can eventually cause accumulation of particles in specific regions and have a substantial effect on processes like competition for nutrients or reproduction. It is thus beneficial for these organisms to learn to actively control their spatial position in order to increase their adaptability. In this study we focused on gyrotactic swimmers, i.e. microorganisms for which the direction of motion depends on the balance between gravitational and viscous torques. We modeled the swimmers as point-like, neutrally buoyant, gyrotactic particles, immersed in a two dimensional steady Taylor-Green Vortex flow. The swimmers are able, using a reinforcement learning algorithm (Q-learning 1-step algorithm), to escape regions of high vorticity and swim upwards. We tested the algorithm at varying both the translational and rotational speed of the swimmer. We also assessed the robustness of the learning process results against different perturbations of the original flow. This work suggests that reinforcement learning algorithms represent a useful tool for modeling adaptability mechanisms observed in a number of real aquatic microorganisms."