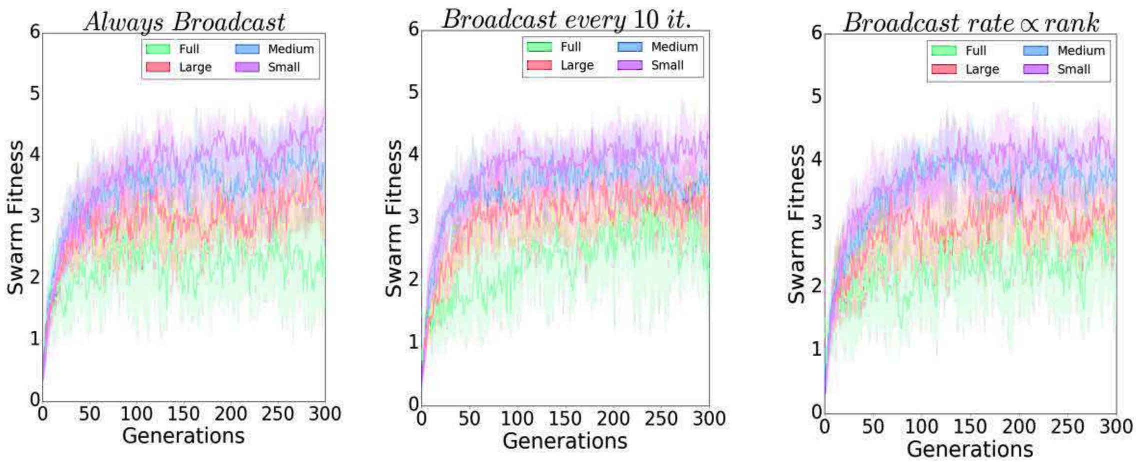
Influence of Mating Mechanisms in Distributed Evolution for Collective Robotics

Iñaki Fernández Pérez[1] and Stéphane Sanchez[1]

[1] *IRIT - University of Toulouse, France*

Distributed Embodied Evolution [1] is a compelling family of approaches to learning swarm robot behavior online that exploits the intrinsic parallelism of robot swarms: each robot in the swarm runs a separate instance of an evolutionary algorithm *onboard*, including an internal population, and robots locally exchange genomes when meeting, which is known as the *mating* operator or migration policy. Since the internal populations in different robots do not contain the same individuals, these approaches have been shown to naturally maintain diversity [2], which can improve search, especially in deceptive problems. Here, using a vanilla dEE algorithm (mEDEA with task-driven selection pressure), we evaluate the influence on the fitness of the evolved behaviors of 12 different mating operators, in terms of distance (short, medium, large, and full distance-based broadcast), and in terms of frequency (constantly broadcast every time step, every 10 time steps, or at a rate proportionate to the genome's rank in the local population). We perform a set of experiments running 20 independent runs for each one of the 12 algorithmic variants during 300 generations on a well-known swarm robotics task, item collection, and we measure the swarm fitness (average number of collected items over the robots in the swarm). Figure 1, 2 and 3 show the average swarm fitness over the swarm during evolution for each mating mechanism. The best results are obtained with the short mating range: this is explained by the fact that larger ranges tend to make homogeneous the local populations of different robots, thus reducing diversity in the evolving swarm, which leads to premature convergence. Regarding when mating is performed, there is no significant difference between always broadcasting and broadcasting every 10 timesteps: since the number of genome exchanges remains the same between these variants (not shown here), this may indicate that a mating rate of 1/10 still remains high enough not to limit genome propagation over the swarm. Finally, rank-based mating rate yields similar results to always broadcasting: since the local selection operator is elitist, low-fitness genomes are always discarded, and the performance reaches similar values, either during mating in the rank-based variant, or during local selection.



[1] Bredeche, N., Haasdijk, E., Prieto, A.: Embodied evolution in collective robotics: A review. Frontiers in Robotics and AI 5, 12 (2018)
[2] Fernández Pérez, I., Boumaza, A., Charpillet, F.: Maintaining Diversity in Robot Swarms with Distributed Embodied Evolution. To appear at ANTS 2018.