

FROM THRESHOLD CONVERGENCE TO LEADERS AND FOLLOWERS

Stephen Chen, James Montgomery

Exploration and Exploitation are critical concepts that are poorly defined, and thus often misunderstood. We begin by defining an attraction basin as all of the search points that will lead to the same local optimum when greedy local search is applied. We then define exploration to be a search movement that involves multiple attraction basins and exploitation to be a search movement that involves (i.e. stays within) only one attraction basin. Assuming every point in the search space belongs to exactly one attraction basin, we can then accurately classify every search movement as one of either exploration or exploitation.

Based on the above definitions, many search techniques (e.g. PSO, DE, ES, EDA, Simulated Annealing, etc) allow concurrent exploration and exploitation. We will present experiments which show how concurrent exploration and exploitation weakens exploration and is a primary cause of (premature) convergence. We will then introduce “Threshold Convergence” in which convergence is “held” back through the use of a threshold function [1]. This focus on attraction basins has also led to the development of “Leaders and Followers” [2] – a new metaheuristic which focuses on how solutions are compared as opposed to how solutions are created.

This is an intermediate tutorial which is best suited for researchers already familiar with Particle Swarm Optimization, Differential Evolution, and/or other metaheuristics -- especially with their performance characteristics in unimodal and multi-modal search spaces.