Fleets of autonomous robots, such as automated forklifts in warehouses, must move through shared spaces without colliding. This thesis addresses the problem of planning collision-free motions for multi-robot systems with non-holonomic dynamics, in environments with static obstacles, while minimizing a user-defined cost. The dynamics are non-convex and have no closed-form solution, and collision avoidance couples the robots' decisions, so the search space grows exponentially with the size of the fleet.

The thesis shows that the interplay between discrete and continuous spaces is a defining characteristic of multi-robot planning, and proposes a framework that combines graph search with trajectory optimization. A graph-based planner abstracts the problem into transitions on a robot-polygon occupancy graph, reduced in polynomial time to a dynamic network that yields discrete plans minimizing polygonal transitions, path length or makespan. This plan splits the fleet into smaller subproblems that are solved concurrently by DiMOpt, a distributed consensus optimization method that pairs single-robot sequential convex programming with a proximal consensus scheme for inter-robot collision constraints. Because decisions are deferred to later phases, the framework bridges graph-based and optimization-based planning without committing early. Experiments show that the methods scale to tens of non-holonomic robots in environments with hundreds of polygons while finding locally optimal trajectories.

João Salvado carried out his doctoral research at the School of Science and Technology, Örebro University. His industry experience includes developing a depalletizing manipulator as a Robotics Software Engineer in the Emerging Technologies department at Ocado Technology, and planning and coordinating the motions of fleets of Scania trucks as a Motion Planning and Decision Making Software Engineer at TRATON Group. He is now CTO and Founding Engineer at Antoniq Robotics in Porto, Portugal, where he leads the development of autonomous mobile robots for precision agriculture.

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