Analyses of Experimental Heuristics for Package-Handoff Type Problems

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Contents

Chapter 1

Overview

How do you get a package from point A to point B with a fleet of drones each capable of various maximum speeds? This is the question we try to answer in all its various avatars by developing algorithms, heuristics, local optimality heuristics and lower-bounds.

To be more specific, we are given as input the positions P_i of n drones in the plane each capable of a maximum speed of u_i. Also given is a package present at S that needs to get to T. Each drone is capable of picking up the package and flying with speed u_i to some other point to hand it off to another drone.

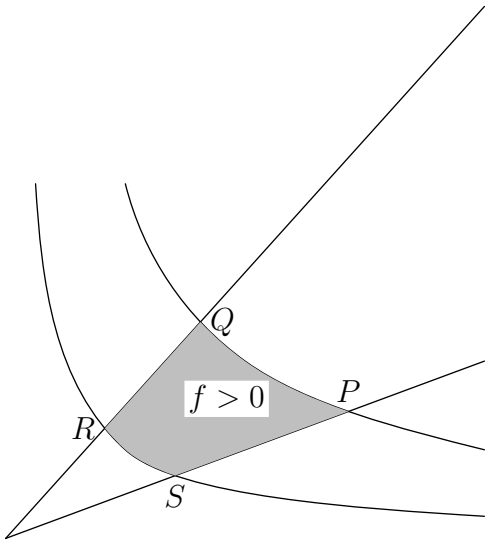

Figure 1.1: An example of the Package Handoff Problem

The challenge is to figure how to get the drones to cooperate to send the package from S to T in the least possible time.

To solve the problem we need to be able to do several things

- Figure out which subset of the drones are used in the optimal schedule.
- Find the order in which the handoffs happend between the drones used in a schedule.
- Find the "handoff" points when drone k rendezvous with drone $k+1$ to give it the package.

This category of problems is a generalization of computing shortest paths in $\mathbb{R}^2$ between two points. As far as we know such problems have not been considered before in the operations research literature; it is, however, reminescent of the Weighted Region Problem (`WRP`) where one needs to figure out how to compute a shortest *weighted* path between two points in the plane that has been partitioned into convex polygonal regions, each associated with a constant multiplicative weight for scaling the euclidean distance between two points *within* that region.

The distinctive feature of this problem and its generalizations is figuring out how to make multiple agents of *varying* capabilities located at different points in $\mathbb{R}^2$ (such as maximum capable speed, battery capacity, tethering constraints etc.) *cooperate* in transporting one or more packages most efficiently from their given sources to their target destinations.

Each chapter in this document is devoted to developing algorithms for a specific variant of the package handoff problem (henceforth abbreviated as `PHO`), beginning with the plain-vanilla single package handoff problem described above. For most algorithms we will also be giving implementations in Python described in a literate style.

You can check out the code from the following online GitHub repository: https://github.com/gtelang/PackageHandoff_Python

Chapter 2

Single Package Handoff

Chapter Index of Fragments

None.

Chapter Index of Identifiers

Appendices