

# MEAM 620 Project 3A

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## 1 Description of Problem and Associated Algorithms

### 1.1 CAPT

The concurrent assignment and planning of trajectories problem, or CAPT, involves finding a method of assigning  $N$  homogeneous robots to  $M$  goals and generating collision-free paths in order to reach the goals. The linear assignment portion of this problem may be offloaded to the Hungarian Algorithm, which is of complexity order  $\mathcal{O}(N^3)$ . Robots are generally assumed to be point-set objects in a ball of radius  $R$ .

### 1.2 C-CAPT

C-CAPT is a centralized solution to the CAPT problem, via which trajectories are minimized via a cost functional encompassing valid assignment, resource utilization (with respect to the assignment matrix), initial conditions, terminal conditions, robot capabilities (the dynamics of each robot, generally assumed to be first-order), and collision avoidance. The trajectories have minimum velocity squared, which also leads to their being collision-free.

### 1.3 D-CAPT

D-CAPT is a mainly decentralized solution to CAPT, using communications between robots in radius  $h$  neighborhood of one another to coordinate local actions. [Turpin 2014] shows that this approach is successful in non-pathological examples where the number of robots is equal to the number of goals.

## 2 Implementation and Runtimes

### 2.1 C-CAPT (2D)

### 2.2 C-CAPT (3D)

### 2.3 D-CAPT

### 2.4 D-CAPT Examples

Figure 1: Example #1 Using C-CAPT

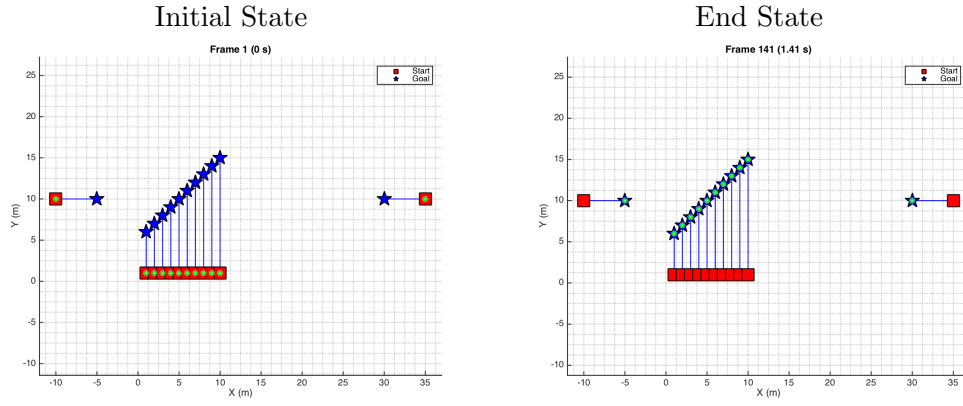


Figure 2: Example #1 Using D-CAPT

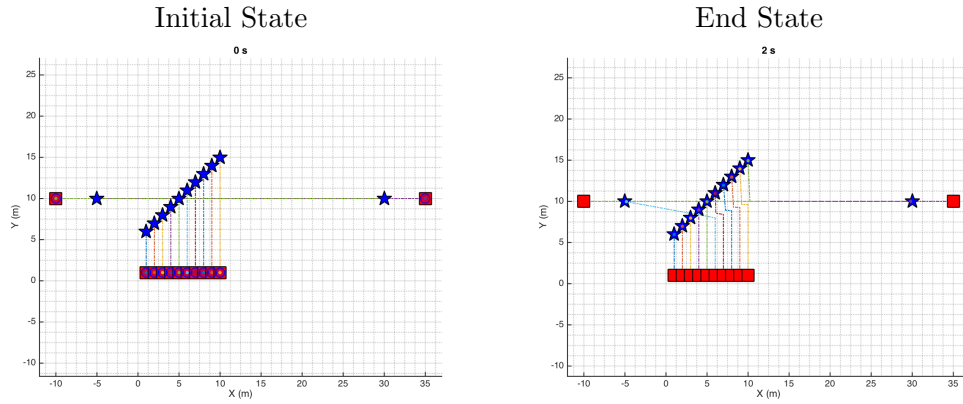


Figure 3: Example #2 Using D-CAPT

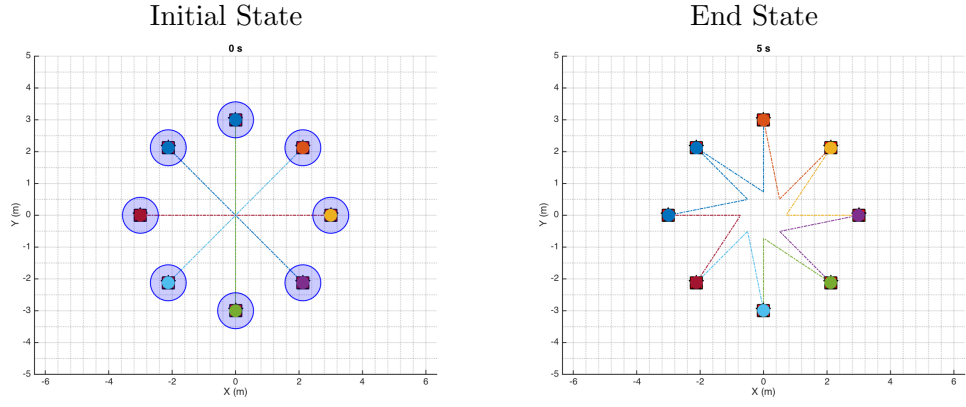


Figure 4: Example #3 Using D-CAPT

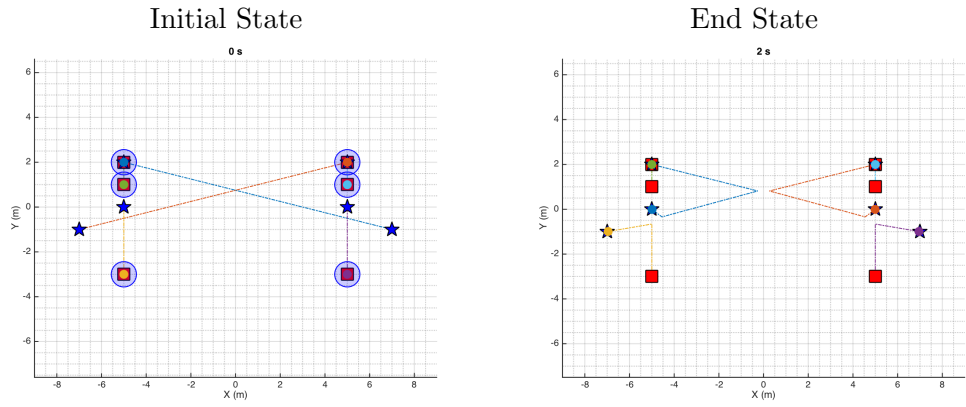
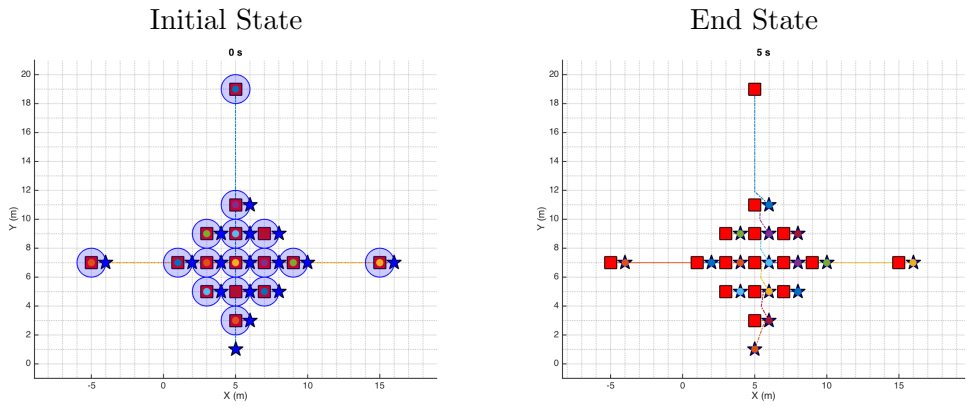


Figure 5: Example #4 Using D-CAPT



These four examples show the main drawback of D-CAPT compared to C-CAPT, which is that since points are not assigned optimally at the start, there can be extremely non-optimal paths. Other drawbacks include that the number of robots must equal the goal points (however we implemented a small extension to allow this), the initial assignment problem must be unique without a centralized controller, and that networking and goal-swapping precedence creates a layer of complexity in robot-to-robot communication.

### **3 Further Possible Work**