Automomous Control of Communications Aircraft During Combat: The Promises of Recent Artifical Intelligence Literature

Sean Carver, Ph.D. at Data Machines Corporation

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Abstract

We pose a novel problem in autonomous control of communications aircraft and provide pointers to the literature offering an approximately optimal solution in many diverse scenarios. The problem lies within the field adversarial Multi-Agent Reinforcement Learning (MARL) and Active Sensing. Two factions (labeled "blue" and "red") exist within this zero-sum game. The blue side tries to keep ground-based assets in communication with the headquarters via a fleet of comms (unmanned aerial vehicles, or UAVs fitted for communication); whereas the red side tries to jam this network with a fleet of jammers (also UAV's). Each faction lacks full access to the state of the opposing side, and must infer this state through positioning its fleet for best sensory performance (active sensing) while simultaneously achieving the objective of keeping units on the ground in communication. Within each faction, different units/UAVs can fall out of communication making each of the blue and red factions a multiagent collection, fully cooperating among themselves but with different information, to fight its adversary (the other side). Our contribution poses the problem while pointing to literature for possible ideas for implementation.

1 Introduction

If unfortunate circumstances compel our leaders to order our armed forces to take a city from an adversary, the command center on the ground would benefit from constant two-way communication with all its other units during the war. In the fog that accompanies such conflicts, our forces cannot rely on cell phones to keep in touch. Instead, two way radios, connected by a network of comms (unmanned arial vehicles, or UAVs, fitted for communication) will allow the friendlies to stay connected.

While better than cell phones, a network of radios has it own problems: our adversaries clearly prefer that we not speak to each other. To this end they may send up jammers (UAVs blocking communication) to get in our way.

We study the question of how each side can control its fleet by autonomously ordering and carrying out positioning and communications-eletronics operation instructions (CEOI) to optimally achieve objectives. We are interested in the strategies for both sides, because we want our systems to defeat our enemy, even if they do something intelligent. Moreover, in a real war, our side may decide to put up both comms and jammers, requiring strategies for both roles.

Much recent literature has talkled the problem of optimal search and rescue. This effort clearly relates to the problem at hand because each side wants to optimally infer the positions of the other to counter their stategy. But there is a difference between search and rescue and our problem. The people being rescued presumably want to be rescued and will cooperate with the effort, whereas our factions presumably act to avoid being localized, with various strategies. The search and rescue problem allows a purely optimal control and active sensing and control problem, we must resort to learning our opponents strategy with artificial intelligence (adversarial multiagent reinforcement learning).

This paper reviews the literature relevant to the comms and jammers problem just posed. At the end of the paper, a discussion will present ideas for applying this work to other domains, notably cyber-security.

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