Artificial Intelligence for Mission Planning and Execution

In 2016, the Defense Science Board stated that “autonomy, fueled by advances in artificial intelligence (AI), has attained a ‘tipping point’ in value”, and that the Department of Defense “must take immediate action to accelerate its exploitation of autonomy.” The 2018 National Defense Strategy commits the DoD on a path toward advanced autonomous systems and a plan to “invest broadly in military application of autonomy, artificial intelligence, and machine learning, including rapid application of commercial breakthroughs, to gain competitive military advantages.”

The Air Force can gain military advantage by applying advanced AI approaches to both the planning of complex mission sets and the real-time execution of actions across many battlefronts. The Air Force has national responsibility for air, space, and cyber operations and by 2030 the Air Force needs to expertly combine and coordinate assets and actions across all these fronts. The vital military need is to assure that battlespace decision-making has the ability to account for complexity and the speed to maintain advantage in fast evolving conflict.

Mission planning is often complex for a variety of reasons. First, multiple and often conflicting objectives must be pursued that may include reconnaissance, re-supply, support, strike, damage assessment etc. There will be a set of implicit constraints such as fuel carrying capacity, munitions capability, platform performance capabilities, etc. There will also be explicit constraints such as those imposed by a higher authority which may include a required probability of mission success, navigation constraints, and availability of assets, etc. The successful mission plan must account for uncertainty in the planner’s current state of knowledge of the current and future state of activities. As a result, formulation of detailed mission planning too far into the future is not viable. There may also be unforeseen contingencies requiring response in real-time for the successful execution of the mission, such as a change in threats, weather, sustained damage, or new opportunities. Consequently, an onboard or networked capability to quickly re-plan the mission is essential for piloted and autonomous platforms as well as space based missions, especially in poorly characterized environments where long endurance is required.

Advanced AI needs to support decision making in 2030 on two distinct time scales: in minutes for mission planning and seconds for mission execution. Advances in computing power, networking speed, and algorithmic efficiency will contribute to meeting these urgent time goals. Increases in networking and computational power makes possible the development of a wide range of mission planning systems from small portable systems to systems that can be distributed over both deployed platforms and ground control stations. Such systems are likely to use distributed processing and advanced AI techniques to aid in mission planning and re-planning. As we build the Air Force of the future, we will need to exploit emerging methods to solve otherwise intractable combinatorial optimization problems in mission planning. Such methods may include the use of Machine Learning, Expert Systems, Neural Networks, and other modern AI techniques. It is expected that in the Air Force of 2030, these types of computational techniques will take on increased importance, as the urgency and complexity of mission planning increases.

The expected value of AI for mission planning and execution is clear, however the many possible approaches for 2030 are not. To harness the breadth of this multidisciplinary opportunity, we solicit your expertise and insight to help the Air Force forge the path ahead.