

# Understanding the Limits of Artificial Intelligence for Warfighters

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## ISSUE

Mission planning involves the assignment of discrete assets to prioritized targets, including the dynamic routing of those assets to their destinations under complex environmental conditions. Because of the value of quick turnaround and the relative simplicity of the simulated operational environment, there has been considerable interest in improving the mission planning process with the addition of reinforcement learning techniques for artificial intelligence (AI), which could produce better, faster, or simply unique solutions for human consideration.



## APPROACH

For background research, we interviewed subject-matter experts, examined academic literature and government and industry publications, and investigated a compelling state-of-the-art model trained on a similar domain (AlphaStar).<sup>1</sup> As a result of the lessons learned from AlphaStar, we embarked on two lines of original research that focused on applying AI to narrow route-planning missions. We experimented with in-house modeling software to quantify and better understand the relative strengths and weaknesses of AI models in general. We also implemented a solution to a substantial barrier (the lack of systems integration) to understand that barrier more precisely and what could be done to overcome it.



## KEY FINDINGS

It is very difficult to predict how fast AI will advance. Even so, there are some areas in which AI will be relatively capable and for which building capacity, experience, and user trust are important steps in its further adoption. One example is the area of mission planning.

The current mission planning process is human intensive but sufficient for a peacetime tempo: No subject-matter expert or practitioner thought that the demands exceeded the capacity for planning. Although mission planning at the scale of an entire theater's assets is relatively rare, efforts to build capacity to automate the entire

<sup>1</sup> The interviews were conducted from September 2021 to May 2022 and took place primarily by phone or video call. The interviews were not for attribution, so no names are provided.

process would be beyond current AI capabilities and would struggle from severe data limitations.<sup>2</sup> On the basis of our subject-matter expert interviews and a case study, AI will be relatively weak at rapidly adapting to new enemy strategies and tactics. However, there are specific applications, such as rapidly responding to new information (e.g., unknown threats), for which AI can provide a substantial advantage.

Key issues in the adoption of AI are likely to be software integration and data availability, as those issues already impose substantial constraints on existing human processes. We validated that this assessment holds: Demand was strong for our solution to a software integration issue to link two popular software systems. We found that AI, even when it cannot provide optimal solutions, has a substantial speed advantage over alternatives and can tolerate changing conditions.

Table S.1 shows the difference between a mathematical approach that is commonly incorporated in operations research and our AI approach.

**TABLE S.1. COMPARISON BETWEEN OPERATIONS RESEARCH AND ARTIFICIAL INTELLIGENCE APPROACHES FOR ROUTE PLANNING**

	Operations Research	AI
Enemy detection	Average risk level: 1.12	Average risk level: 2.91
Path length	Average: 5,070 km	Average: 3,938 km
Cost to develop	Low	High
Response time	Seconds to minutes	Milliseconds
Predictability	Fixed given a utility function and the situation	Varies with each run

The average risk of enemy detection was substantially lower for the traditional (operations research) method; the cost of development was lower, but it was more predictable, took longer to generate a response after new information, and charted longer paths.



## RECOMMENDATIONS

We have three primary recommendations for the Department of the Air Force’s AI work for mission planning:

- AI implementation for mission planning should target areas of relative human weakness, particularly reacting quickly to new situations, and plan to expand from there
- The DAF should prioritize creating not just useful tools and software but enabling those resources to be extended by others (both government and third parties) and connecting them to existing systems
- The DAF should continually monitor the AI landscape: paradigm shifts have happened before in AI and likely will again.

<sup>2</sup> The mission planning process includes the commander’s intent; the selection of targets; the evaluation of threats and environmental considerations, such as inclement weather; the selection of air assets to observe points of interest and to neutralize targets; the mapping of how U.S. and allied air assets will accomplish their missions; the processing of all information generated by those mission flights; and all the information flows and iteration required to make the mission function (since the availability of assets can limit which targets can be addressed on a given day).



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