RESEARCH SUMMARY

Exploring the Feasibility and Utility of Machine Learning-Assisted Command and Control

Volume 1, Findings and Recommendations

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ISSUES

- A key priority for the U.S. Air Force is to use artificial intelligence (AI) to enhance military command and control (C2).
- The academic and commercial contexts in which AI systems have been developed and deployed are qualitatively different from the military contexts in which they are needed.
- The Air Force lacks an analytical framework for understanding the suitability of different AI systems for different C2 problems and for identifying pervasive technology gaps.
- The Air Force lacks sufficient metrics of merit for evaluating the performance, effectiveness, and suitability of AI systems for C2 problems.

APPROACH

The RAND team reviewed the computer science, cognitive science, and operations research literature to create a taxonomy of C2 problem characteristics and a taxonomy of AI solution capabilities. These taxonomies were refined through interviews with military C2 subject-matter experts and with experts in AI. To determine the solution capabilities essential for dealing with each problem characteristic, the RAND team conducted an online expert panel. Finally, the RAND team demonstrated the framework for evaluating the suitability of different AI systems for C2 problems through three technical case studies developed in conjunction with active-duty and retired AF personnel.

CONCLUSIONS

The RAND team proposes a structured method for determining the suitability of an AI system for any given C2 process (see the figure). The methodology involves (1) evaluating the C2 problem characteristics, (2) evaluating the AI system capabilities, (3) comparing alignment between problem characteristics and solution capabilities, (4) selecting measures of merit, and (5) implementing, testing, and evaluating potential AI systems. In addition

continued

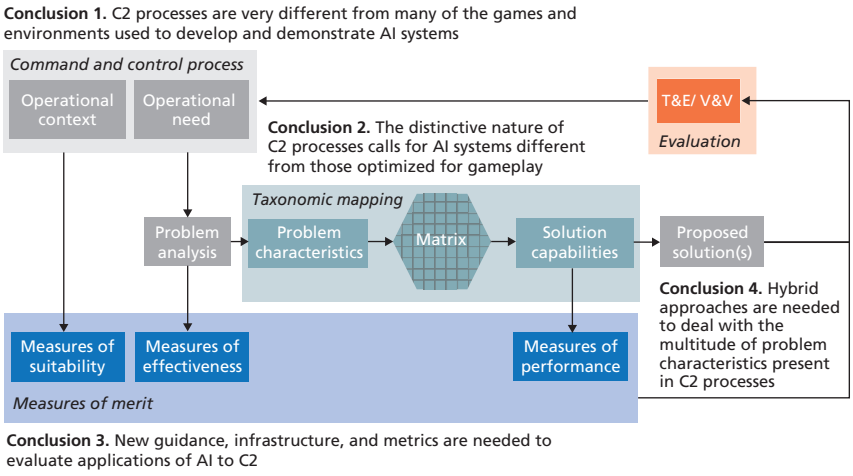
to providing a methodology to determine alignment between C2 problems and AI solutions, this research supports several conclusions shown in the figure below, along with associated recommendations.

1. C2 processes are very different from games and environments used to develop and demonstrate AI systems.
2. The distinctive nature of C2 processes calls for AI systems different from those optimized for game play.
3. The distinctive nature of C2 processes calls for measures of merit different from those typically used in AI research.
4. Hybrid approaches are needed to deal with the multitude of problem characteristics present in C2 processes.

RECOMMENDATIONS

1. Use the structured method described in this report to systematically analyze the characteristics of games, problems, and C2 processes to determine where existing AI test beds are representative and nonrepresentative of C2 tasks.
2. Develop new AI test beds that are more representative of C2 tasks.
3. Use the structured method described in this report to identify and invest in high-priority solution capabilities called for across a wide range of C2 processes and not currently available (e.g., *robustness* and *assuredness*).
4. Use the structured method described in this report to evaluate alignment between the characteristics of potential AI systems and particular C2 processes to prioritize which systems to develop.
5. Develop metrics for AI solutions that assess capabilities beyond algorithm soundness and optimality.
6. Use the structured method described in this report to identify key measures of performance, effectiveness, and suitability for a given C2 process and to comprehensively assess candidate AI solutions.
7. Identify, reuse, and combine algorithmic solutions that confer critical AI system capabilities.

ARTIFICIAL INTELLIGENCE SYSTEM CAPABILITY MAPPING AND COMMAND AND CONTROL PROCESS EVALUATION



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