Opportunities and Challenges for AI-Enhanced Decision Making in Nuclear Proliferation Detection

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Detecting Nuclear Weapons Proliferation

Nuclear nonproliferation, counterproliferation, and counterterrorism prevent state and non-state actors from acquiring nuclear weapons or expanding weapons-usable capabilities

• Technologies and science-based capabilities to detect and monitor activities to develop nuclear weapons are key capability

New opportunities to transform nuclear proliferation detection

• Leverage advances in computing and new algorithms to enhance and expand monitoring and verification

• Exploit new data sources with AI to reveal early indicators of proliferation that push detection “left of boom” – and afford U.S. more options for intervention

PNNL’s Emily Mace uses AI to improve algorithms that help detect nuclear explosions around the globe
**Detecting Nuclear Weapons Proliferation**

Analyses and decisions enabled by nuclear proliferation detection

- Determine or verify the location and nature of an activity or facility
- Inform operations and strategies for intervention
- Enable broad and state-level assessments
- Inform National security and resourcing strategies
- Guide signature discovery and research and development to enhance and expand capabilities

Types of analyses and decisions

- Detection and prediction
- Characterization and inverse modeling
- Data fusion
- Generating and evaluating alternatives
- Resource allocation and orchestration

*Defense Nuclear Nonproliferation R&D*
Challenges and Requirements

Nature of the Decision Space
• Complex systems and noisy data
• Highly-technical missions demand specialized capabilities
• Limited pathways constrain decision space; some processes and responses are well-understood
• Observable indicators, signatures and patterns, latent behavior
• Data sparse; distributed across information sources, time, and space

Operational Conditions
• Cooperative and uncooperative operations, unknown unknowns, initiated adversary
• Constrained resources
• Uncertainty is a certainty
Opportunities and Methods

Decision-Centered AI

- “Law” of the Conservation of Information
- Human-centered and decision-obsessed AI
- Context, constraints, and operational conditions; usefulness and generalizability
- Decision-centered uncertainty, assurance, and validation
- Emerging techniques: Optimal control; HPC and alternative hypotheses
- Outstanding needs: Theories, practices, and methods that match the scale of complexity of the decision space
Myths, Misconceptions, and Lessons Learned

Building robust and useful systems

- Analysts, operators, and decision makers will not wait for your tech
- Design for the decision; understand the context
- Any new technique or capability will join an ecosystem of context and capabilities
- Specific makes a difference for trust, adoption, and usefulness
- Your work *will* make a difference

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