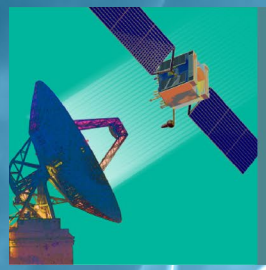
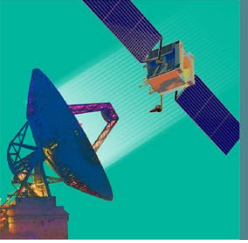


Ground System Architectures Workshop
Driving Innovation for Enterprise Integration
February 23–March 3, 2022 | Virtual Event

Intelligent Systems and Machine Learning for Space Ground Systems

Leads:
Dr. Jon Neff and Dr. Max Spolaor,
The Aerospace Corporation

February 28, 2022



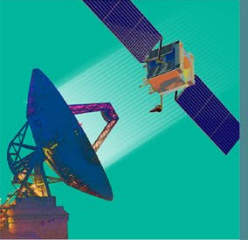
Session Goals

- Adaptive, reliable automation and intelligent decision making are essential for the success of our space ground systems. One big challenge is migrating capabilities out of the lab to supporting critical mission operations. In the past, these approaches were often misunderstood, misapplied, too complex or costly to sustain, or insufficient for mission needs. Applied intelligent systems and machine learning technologies have begun to address this challenge through self-evolving, efficient, and value-focused capabilities. In addition, un-realized opportunities exist for applying established, or rapidly emerging technologies, solutions and architectures to the area of ground systems, space control and mission processing.

- This year the GSAW "Intelligent Systems / Machine Learning for Space Ground Systems" working group will explore deeper the themes of:
  - *Where do intelligent systems and machine learning currently exist in space ground systems?*
  - *What underlying parts of the space ground systems, enterprise and operations are suited to intelligent systems and machine learning?*
  - *What emerging capabilities and technologies are being developed in the community?*
  - *What are real-world impediments for adoption in operations?*
  - *What capability and technology gaps exist and might seed further research and investment?*

- The goals of the Working Group are:
  - *To inform adopters, researchers and stakeholders to help integrate intelligent systems into operations.*
  - *To establish an enduring community for long-term collaboration.*

Working Group C



Presenters/Panelists

"Recap of Past Years' IS/ML WG" - Dan Balderston (The Aerospace Corporation)

Panel Discussion

- Jon Neff – Moderator (The Aerospace Corporation)
- Erik Linstead (Chapman University / The Aerospace Corporation)
- Pamela Wood (The Aerospace Corporation)
- Phil Feldman (ASRC)
- Scott Leonard (NOAA)

Session 1

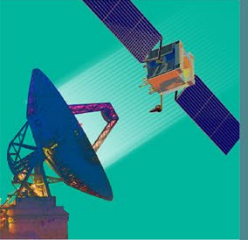
- Max Spolaor – Moderator (The Aerospace Corporation)
- "Space Vehicle Onboard Cyber Defense using AI/ML" by Jacquelyn Andrade, Winston Li, Nick Cohen (The Aerospace Corporation)
- "SatNet: A Benchmark for Satellite Scheduling Optimization" by Edwin Goh (JPL)

Session 2

- Max Spolaor – Moderator (The Aerospace Corporation)
- "How we Innovate Data Science at ASRC" by Philip Feldman (ASRC)
- "Efficient out-of-distribution detection for reliable deployment of DNNs" by Apoorva Sharma (Stanford University)
- "Application of Unsupervised Deep Learning for Smoke Plume and Active Fire Identification" by Erik Linstead (Chapman University)

- "Recap and Summary" by Jon Neff and Max Spolaor (The Aerospace Corporation)

Working Group C



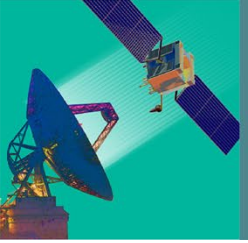
Key Points

- Importance of Data
  - *Diverse and complete datasets remain a critical component to enable AI/ML solutions.*
  - *Bayesian-based techniques to solve out-of-distribution data during deployment.*
  - *Data fusion of diverse dataset to obtain greater gains.*

- Challenges in Deployment
  - *How to integrate AI/ML into existing systems vs. building a new system from scratch.*

- AI/ML Workforce
  - *Importance of building inter-disciplinary teams.*
  - *Attract and retain talent leaving for commercial industry.*
  - *Leadership to inspire and motivate, highlighting the opportunity to make a difference.*

- Explainable and Trusted AI
  - *Importance of re-defining the Verification and Validation (V&V) process.*



Conclusions

- AI/ML solutions are showing to be effective tools in secure onboard and on-the-ground space applications from cyber intrusions via anomaly detection techniques.

- Deep Reinforced Learning (DRL) can be successfully leveraged to solve advanced satellite scheduling optimization. DRL can create semi-automated scheduling solutions by learning policies via trial and error and developing a learning strategy.

- Future directions
  - *"Easy" AI/ML applications have been built. Next development will have to focus on deep interdisciplinary collaboration.*
  - *Commercial Industry driving the transformation. Contracting out instead of building out.*
  - *AI/ML for embedded systems.*
  - *Using Physics-Informed ML for speeding simulation.*
  - *AI/ML algorithms on-demand. API options to facilitate easy adoption.*
  - *Next generation of AI-enabled solutions will see Cognitive Adaptive systems.*