U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND –
ARMAMENTS CENTER

Systems Engineering, Artificial Intelligence, and Machine Learning at the Systems Engineering Directorate

SE4AI & AI4SE

2021-10-20

Roshan Patel, roshan.r.patel2.civ@mail.mil

HELLO

Roshan Patel

Systems Engineer, Data Scientist

- MS Computer Science, Rutgers University. BS Mechanical and Aerospace Engineering, Rutgers University.
- Engineer at CCDC Armaments Center focusing on systems engineering infrastructure, statistical modeling, and the analysis of weapon systems
- System Engineering Directorate's AI lead
  - Point of contact for SED's AI activities
  - Strategist and project coordinator

SYSTEMS ENGINEERING DIRECTORATE'S HIGH LEVEL GOALS

AI4SE

- Utilize AI/ML in systems engineering best practices to improve CCDC AC's lifecycle support to weapon system projects and initiatives.

SE4AI

- Provide effective systems engineering support to AI/ML focused weapon system projects and initiatives.

ACTIVE TASKERS

SE4AI

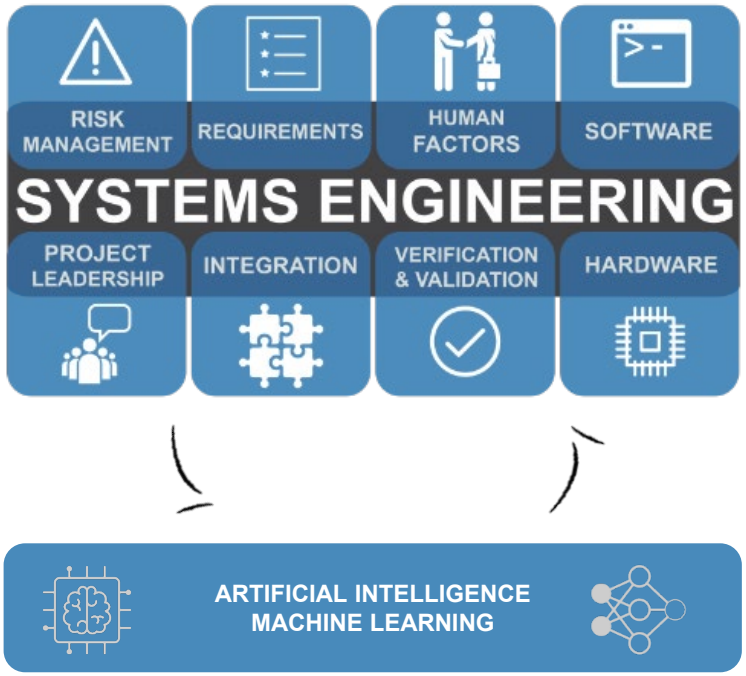
- Ontologies and semantic web technology
- AI data management strategy

AI4SE

- System analysis and data science
- Reinforcement learning for operational modeling

- Workforce development
- Systems engineering methodology

SE4AI AND AI4SE



Purpose:

- Provide effective systems engineering support to AI/ML focused weapon system projects and initiatives
- Utilize AI/ML in systems engineering best practices to improve CCDC AC's lifecycle support to weapon system projects

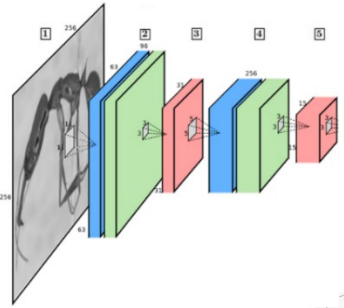
Products:

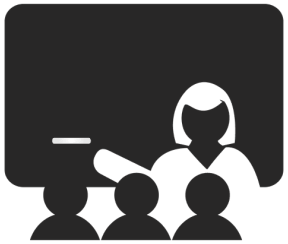
- SE best practice accommodates AI/ML specific challenges in requirements development, system architecting, SE technical management, configuration management, product data management, and system analysis
- Expanded set of SE activities that are enabled by AI/ML tools and techniques
- The Key Parameter Development & Management (KPD&M) structured design process incorporates statistical tools and techniques from machine learning

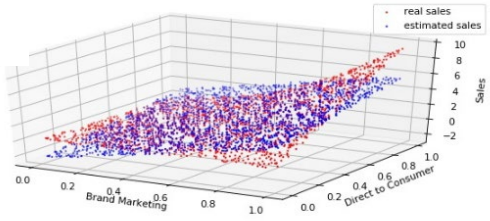
Payoffs:

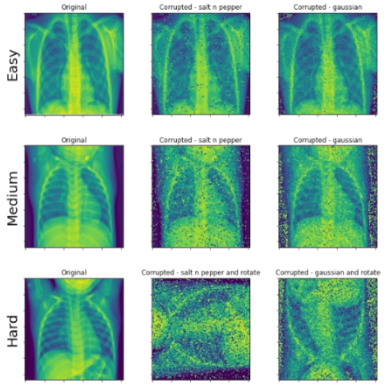
- AI/ML handled as specialized software components in systems engineering processes for more effective technical management
- Systems engineering methodology is advanced by cutting edge technology in data science, natural language processing, and data visualization to produce higher quality technical artifacts

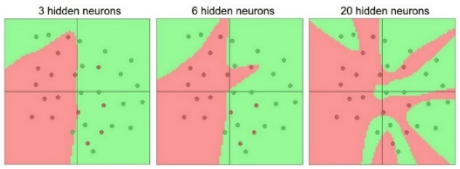
WORKFORCE DEVELOPMENT











Purpose:

- Improve workforce competency and knowledge in machine learning and artificial intelligence tools and techniques
- Provide theory and application of machine learning and statistical inference techniques to analyst community
- Shed light on the interface of AI and SE and begin expanding the domain

Products:

- Overview Artificial Intelligence and Machine learning course for systems engineers
- Technical machine learning using Python course for analysts and statisticians

---

Developmental assignments

- Recruited team develop technical background in AI/ML and assist projects as ML/data science consultants

AI/ML overview training

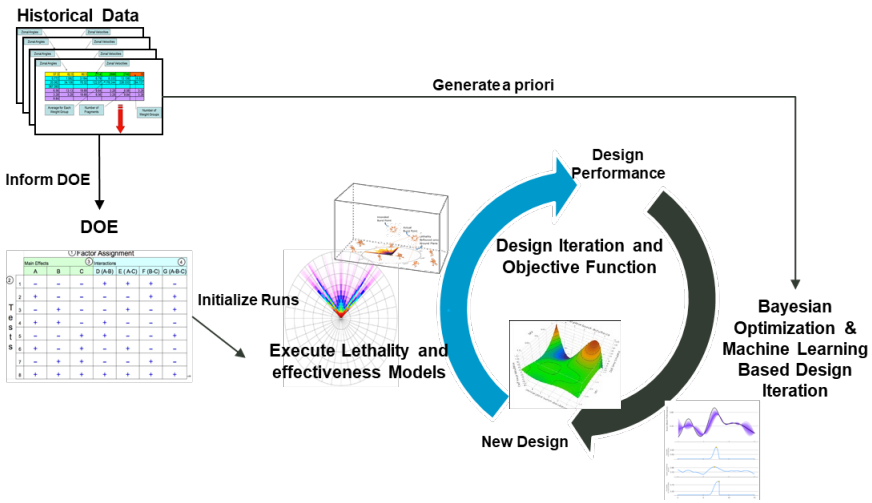
- 8 hour training on high-level AI/ML foundational concepts
- Expand to include SE4AI material in FY22

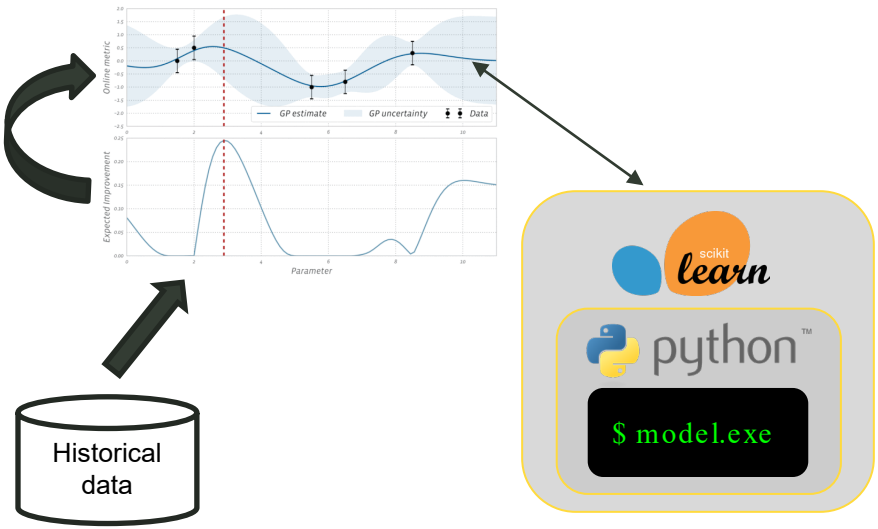
Machine learning and statistical inference with Python

- 23 two-hour biweekly sessions on ML theory and implementation using Python
- Lecture content, take-home projects, and hands-on working sessions

Training developed in-house, administered by coworkers, and catered for the SED workforce

DATA SCIENCE & ML-ENABLED TERMINAL EFFECTS OPTIMIZATION





Purpose:

- Apply AI/ML tools and techniques to lethality and effectiveness workflows
- Existing procedures utilized to perform warhead design and performance optimization do not fully leverage the exponential growth in data science, machine learning, and computational optimization
- Current practices are laborious and computationally expensive, and thus, limit the ability to fully explore the trade space of all potentially viable solutions

Products:

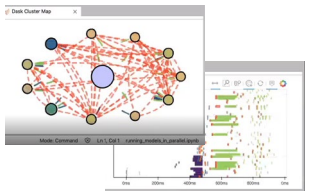
- Modern warhead design process that leverages machines learning and computational optimization
- Data driven workflow based process that enables design insight and discovery through advanced visualization and optimal integration of multiple engineering domains

Payoffs:

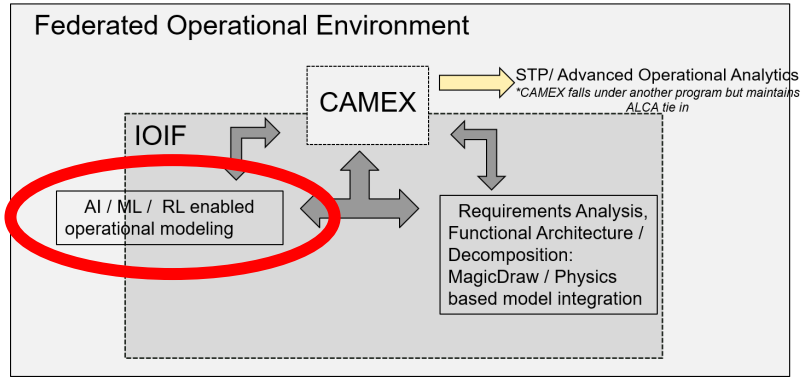
- Novel warhead designs
- Rapid warhead conceptualization
- Framework to exploit past studies/designs to better inform future developments

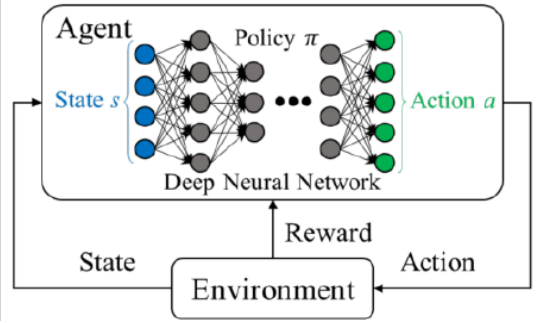
Improve existing analysis workflows using data science tools and methods

DASK HoloViews jupyter



ADVANCED LETHALITY CONCEPTS ANALYSIS (ALCA)
ONESAF REINFORCEMENT LEARNING





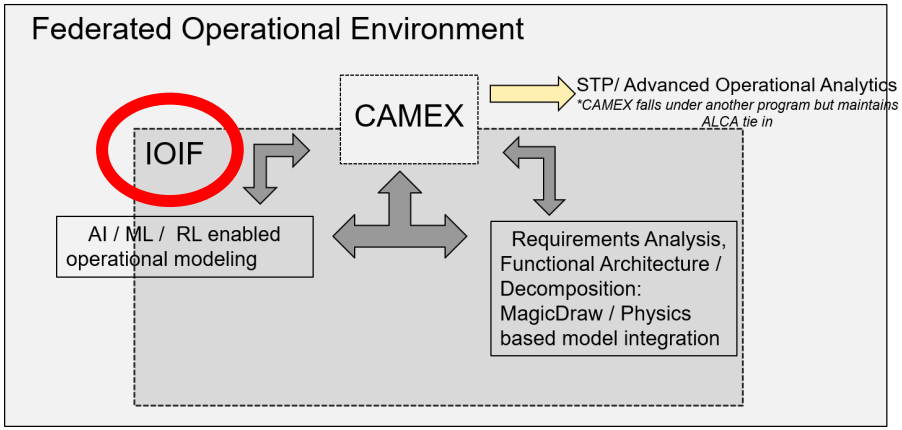
Purpose:
- Apply AI/ML tools and techniques to operational modeling using the OneSAF modeling platform.
- Develop closed-loop operational modeling simulation in which actor decisions are automated.
- Leverage semantic web technology and ontological modeling

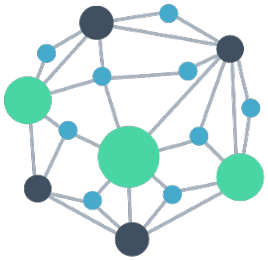
Products:
- Open AI/ML interfaces in OneSAF
- Sophisticated data-driven agent behavior in OneSAF simulations
- Refined data collection scheme from OneSAF simulations

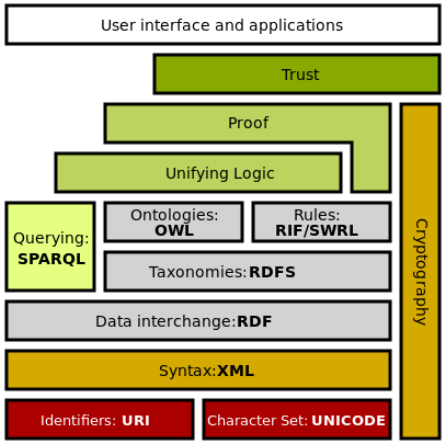
Payoffs:
- Higher fidelity analysis results from operational modeling workflows
- Availability of large datasets of simulated war-game scenarios for future AI/ML applications
- OneSAF acts as testbed environment for evaluating AI/ML programs in an operationally relevant context

Goal: OneSAF entity actions are driven by deep learning policy models trained on experiential simulation data

ADVANCED LETHALITY CONCEPTS ANALYSIS (ALCA)
ONTOLOGICAL MODELING AND SEMANTIC WEB TECHNOLOGY







Purpose:

- Apply AI/ML tools and techniques to operational modeling using the OneSAF modeling platform.
- Develop closed-loop operational modeling simulation in which actor decisions are automated.
- Leverage semantic web technology and ontological modeling

Products:

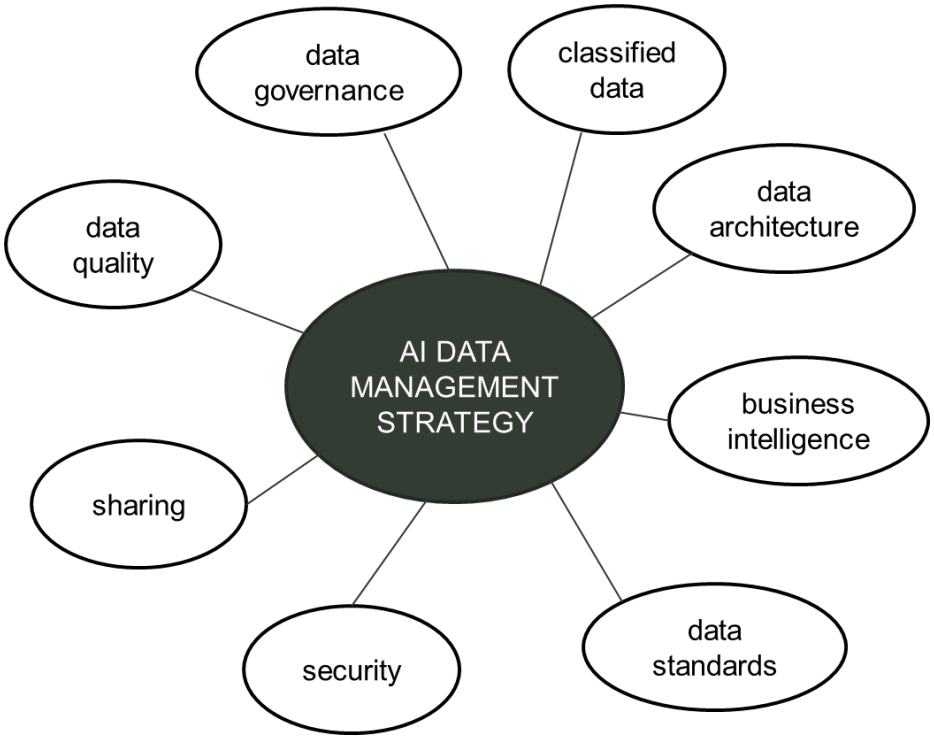
- Open AI/ML interfaces in OneSAF
- Sophisticated data-driven agent behavior in OneSAF simulations
- Refined data collection scheme from OneSAF simulations

Payoffs:

- Higher fidelity analysis results from operational modeling workflows
- Availability of large datasets of simulated war-game scenarios for future AI/ML applications
- OneSAF acts as testbed environment for evaluating AI/ML programs in an operationally relevant context

Goal: Ontologies and semantic web technologies support logical inferencing and knowledge generation for operational modeling

ARMAMENTS CENTER AI DATA MANAGEMENT STRATEGY



Purpose:

- Understand CCDC Armaments Center's management of AI related data
- Optimize AI data management to support the development of weapon systems
- Supports Armaments Center engineers and analysts by providing infrastructure that enables the development of AI and ML products

Products:

- Document best practices for AI data governance
- Pilot data governance strategy on reinforcement learning program

Payoffs:

- Provides Armaments Center engineers and analysts with infrastructure that enables the development of AI and ML products
- Future-proof data collection mechanics at the Armaments Center for future AI/ML programs