AI Challenge Problems
USAF-MIT AI Accelerator

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USAF-MIT AI Accelerator: Bringing world-class research to Air Force Missions

AI Researchers

Example Air Force Missions

10 Mission-ready Projects

USAF-MIT AI Accelerator

MIT Campus

MIT Lincoln Laboratory

US Air Force

Computing and Cyber

ISR and AI Assistants

Healthcare and Disaster Response

Foundational AI Research

AI Challenge Problems

AI Education and Training

• Foundational
• Foundational Applications
• Applications
• Systems
## AI Accelerator (AIA) Research Projects

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<tr>
<th>Foundational</th>
<th>Guardian Autonomy for Safe Decision Making</th>
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<tr>
<td>Foundational/Applications</td>
<td>Transferring Multi-Robot Learning through Virtual and Augmented Reality for Rapid Disaster Response</td>
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<td>The Earth Intelligence</td>
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<td>Robust Neural Differential Models for Navigation and Beyond</td>
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<td>AI-Enhanced Spectral Awareness and Interference Rejection</td>
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<td>Applications</td>
<td>Recommendations in Context over Multimedia</td>
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<td>Multimodal Vision for Synthetic Aperture Radar (SAR)</td>
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<td>AI-Assisted Optimization of Training Schedules</td>
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<td>Objective Performance Prediction &amp; Optimization Using Physiological and Cognitive Metrics</td>
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<tr>
<td>Systems</td>
<td>Fast AI: Datacenter and Edge Computing</td>
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150+ researchers across MIT & Lincoln working closely with dozens of AF stakeholders
### AI Challenges are Critical to Breakthroughs in AI

<table>
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<th>Year</th>
<th>Breakthroughs in AI</th>
<th>Datasets (First Available)</th>
<th>Algorithms (First Proposed)</th>
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**Average No. of Years to Breakthrough:**
- 3 years
- 18 years

Winning AI

1 Team 1 Problem  Win Probability

~20%

10 Teams 10 Problems  Win Probability

~200%
(~2 solutions to 10 problems)

10 Teams 10 Problems 10 Challenges 100s of Teams  Win Probability

>>1000%
(many solutions to each problem)
AIA Challenge Problems

• Goal of AIA challenge problems is to drive innovation in the wider AI ecosystem
  – Other academic institutions
  – Government Laboratories
  – Small and medium-sized businesses

• Each AIA team is putting together a series of challenge problems that they will make available to the wider community
  – Developed in collaboration with Air Force stakeholders, research collaborators

• Challenge problems consist of:
  – Relevant datasets
  – Mathematical specifications
  – Baseline implementations
  – Evaluation criteria
AIA Challenge Problem Examples

SEVIR Nowcasting Challenge
Signal Enhancement for Magnetic Navigation
RFChallenge
Pilot Performance Assessment Challenge
Datacenter Challenge
Air Force Arcade
Air Force Problem

- Various systems throughout the Air Force that support multiple mission objectives
  - E.g., datacenters, airframes, radars, …

- Integrating disparate data sources to look for outliers or anomalies is a major challenge

- Desired end state of proactive system maintenance through behavioral understanding to improve security, fault predictability, usage efficiency.
Challenge Name: Datacenter Challenge
Project: Fast AI

- AI challenge that enables datacenters to:
  - Predict and identify system failures from multi-modal data
  - Leverage AI to improve datacenter operations
  - Identify and stop policy violations

- Challenge Website: datacenterchallenge.mit.edu

Air Force Stakeholders
- 412th Test Wing
- Kessel Run

Data Collected from LL Supercomputing Center Systems
- Computing snapshots
- Jobs and workload scheduling
- Network Traffic
- Building Management

Challenge Specification
- Dataset Development
- Data Anonymization
- Data Release
- Challenge Release

Fast AI Challenge Problem Team: Siddharth Samsi, Daniel Edelman, David Bestor, Vijay Gadepally, Benjamin Price
• AI workloads are complex and rely on a deep hardware/software stack.

• High performance computing centers increasingly support AI/ML as well as traditional compute workloads.

• Goals:
  - Optimize system scheduling for improved resource consumption
  - Suggest optimization pathways for users
  - Predict and identify system failures
  - Identify and stop policy violations

The Fast AI Datacenter Challenge aims to foster innovation in AI approaches to the analysis of large scale datacenter monitoring logs
Building management:
- Electrical data
- Water detection
- Power supply alarms
- Smoke/Fire alarms
- Exhaust fan alarms

Environmental data:
- Humidity
- Temperature
- Air flows

Node level data:
- Username
- Job name
- Job status
- Job start time
- Nodes assigned to the job

System level data:
- Number of jobs running vs queued
- Job breakdown by user
- Job breakdown by resource (GPU vs CPU)

Network traffic data: (tentative)
- Host level tcpcdump
- Network Flows
- Interface counters/packet corruption

Job level data:
- Node name
- Number of processes
- MAC address of node
- Average load on the system
- Memory usage on node
- Number of Lustre calls
Data Example: Time Series Data and GPU Statistics

Statistics from data distributed training on 4 nodes and 8 GPUs
• Challenge specification and links to dataset will be available on https://datacenterchallenge.mit.edu

• Initial announcement at IEEE HPEC 2020
  – Formal challenge specification underway

• Other dissemination venues being considered: Workshops/BoFs at conferences such as IEEE/ACM Supercomputing, IPDPS and others
AIA Challenge Problem Examples

- SEVIR Nowcasting Challenge
- Signal Enhancement for Magnetic Navigation
- RFChallenge
- Pilot Performance Assessment Challenge
- Datacenter Challenge
- Air Force Arcade
• Overview of Challenge Problem
  - Use reinforcement learning and other techniques to solve Air Force-related game scenarios in continuous control space.
  - Provide RL environments to the research community that cover underrepresented control and observation schemes.

• Target challenge audience
  – Reinforcement learning and autonomous flight community

• Challenge release target: December 2020
US Air Force – MIT AI Accelerator project teams are developing a series of AI challenges.

Each challenge is designed to drive innovation in applying AI to different missions and problems.

Keep an eye on https://aia.mit.edu for more updates!

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