DOE-FIU Cooperative Agreement Annual Research Review – FIU Year 3

Wednesday, August 23, 2023		
9:00 - 9:05 am EDT	Kick-Off /Welcoming Remarks (DOE-EM)	Rod Rimando (Acting Director, Technology Development) – DOE EM-3.2
9:05 - 9:10 am EDT	Welcoming Remarks (DOE-LM)	Ms. Jalena Dayvault (Site Manager) – DOE LM
9:10 - 10:40 am EDT	Project 2: Environmental Remediation Science & Technology	FIU, DOE HQ, SRNL, PNNL, ORNL, LANL, LBNL, CBFO
10:40 am - 12:10 pm EDT	Project 1: Chemical Process Alternatives for Radioactive Waste	FIU, DOE HQ, PNNL, WRPS, SRNL, SRS
LUNCH BREAK [12:10 – 1:30 pm]		
1:30 - 3:00 pm EDT	Project 3: Waste and D&D Engineering & Technology Development	FIU, DOE HQ, SRNL, PNNL, LBNL, INL, ANL
Thursday, August 24, 2023		
9:00 - 10:30 am EDT	Projects 4 & 5: STEM Workforce Development and Training	FIU, DOE HQ (EM & LM), SRNL, PNNL, WIPP, SRS, ORP, LBNL, WRPS, INL, Grand Junction
BREAK [10:30 – 10:35 am]		
10:35 - 12:00 pm EDT	Wrap Up (FIU Projects 1, 2, 3, 4 & 5)	FIU, DOE HQ (EM & LM)

PROJECT 3

Waste and D&D Engineering & Technology Development

FIU Applied Research Center

FIU Personnel and Collaborators

- **Project Manager:** Leonel Lagos
- **Faculty/Researcher:** Himanshu Upadhyay, Joseph Sinicrope, Walter Quintero, Clint Miller, Jayesh Soni, Santosh Joshi, Masudur Siddiquee, John Dickson, Mellissa Komninakis, Kexin Jiao*
- **DOE Fellows/Students:** Roger Boza, Aurelien Meray, Alejandro De-La-Noval, Aris Duani Rojas, Fabiola Rivera-Noriega, Bryan Torres, Nicholas Espinal
- **DOE-EM:** Nancy Bushman, Dinesh Gupta, Genia McKinley, Jean Pabon, Jonathan Kang, Douglas Tonkay, Jennifer McCloskey, Nick Machara, Rod Rimando, Daniel Scott Boyd
- **SRNL:** Nixon Peralta, Jeff Crenshaw, Hansell Gonzalez-Rayma, Thomas Danielson, Jennifer Wohlwend, Austin Coleman, Justin Kidd*, Connor Nicholson, Carol Eddy-Dilek
- **SRS:** Jack Musall
- **PNNL:** Rob Mackley, Xuehang Song
- **LBNL:** Haruko Wainwright

*Former staff/student contributors

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Project Tasks and Scope

TASK 1: WASTE INFORMATION MANAGEMENT SYSTEM (WIMS) (HQ)	
Subtask 1.1	WIMS System Administration - Database Management, Application Maintenance & Performance Tuning
Subtask 1.2	Waste Stream Annual Data Integration
Subtask 1.5	Cyber Security of WIMS Infrastructure
TASK 2: D&D SUPPORT TO DOE EM FOR TECHNOLOGY INNOVATION, DEVELOPMENT, EVALUATION AND DEPLOYMENT	
Subtask 2.1	Development of Uniform Testing Protocols and Standard Specifications for Fixative Technologies in Support of Complex-Wide D&D Activities
Subtask 2.2	Test and Evaluation of Down-Selected Intumescent Foams/Foam Plug Technologies to Mitigate Contaminate Release during Nuclear Pipe Dismantling in Support of a Hot Demo at F/H Labs in FY25
Subtask 2.3	Certifying Fixative Technology Performance when Exposed to Impact Stressors as Postulated in Contingency Scenarios Highlighted in Safety Basis Documents
Subtask 2.4	Multi-functional 3D Polymer Micro-Ribbons for Mercury Abatement
TASK 3: D&D KNOWLEDGE MANAGEMENT INFORMATION TOOL (KM-IT) (HQ, SRNL, INL, ANL)	
Subtask 3.4	Content Management
Subtask 3.5	Marketing and Outreach
Subtask 3.6	D&D KM-IT System Administration
Subtask 3.7	Cyber Security of D&D KM-IT Infrastructure
Subtask 3.8	KM-IT Tech Talks

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Project Tasks and Scope

TASK 7: AI FOR EM PROBLEM SET (SOIL & GROUNDWATER) - EXPLORATORY DATA ANALYSIS & MACHINE LEARNING MODEL FOR HEXAVALENT CHROMIUM [CR (VI)] CONC. IN 100-H AREA (PNNL)	
Subtask 7.3	Algorithm Development for Spatiotemporal Relationship Identification
Subtask 7.4	Publishing AI/ML models on AAML System (NEW)
TASK 8: AI FOR EM PROBLEM SET (SOIL AND GROUNDWATER) - DATA ANALYSIS AND VISUALIZATION OF SENSOR DATA FROM WELLS AT THE SRS F-AREA USING MACHINE LEARNING (LBNL, SRNL)	
Subtask 8.6	Publishing AI/ML models on AAML System (NEW)
Task 9: AI for EM Problem Set (Waste Processing)- Nuclear Waste Identification and Classification using Deep learning (SRNL) (NEW)	
Subtask 9.1	Algorithm and Model Development to Identify and Classify Nuclear Waste (NEW)
Subtask 9.2	Transition Previously Trained Deep Learning Models to the Advance Automated Machine Learning (AAML) System (NEW)

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Task 1

Waste Information Management System (WIMS)

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Subtask 1.1: WIMS System Administration - Database Management, Application Maintenance & Performance Tuning

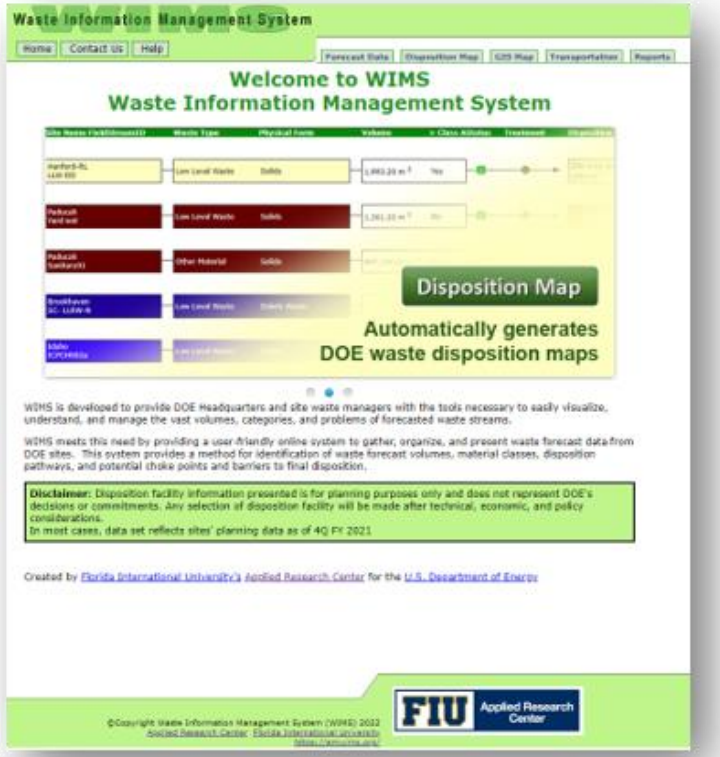
Research Highlights & Accomplishments:

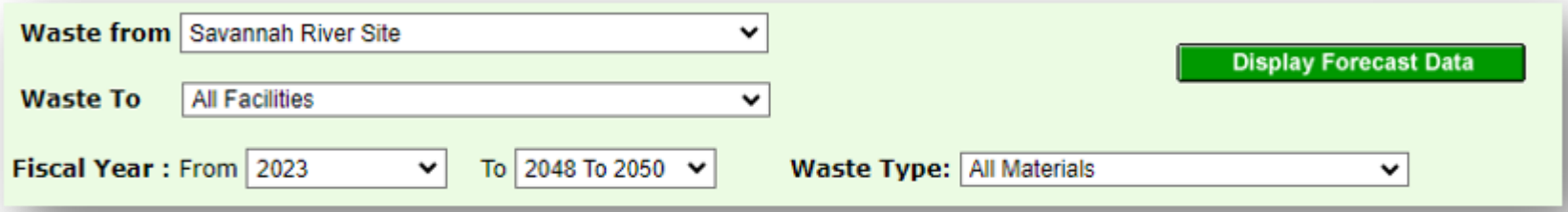
- Continue to perform day-to-day maintenance and administration to ensure consistent high level of performance of WIMS application.
- Updating patches and OS fixes, updating antivirus engines and definitions, updating drivers and assuring that the network is working properly.
- Hardware upgrades (memory, hard drives, video cards, routers, firewall, etc.).
- Updating backup scripts and backup repository hardware.
- Updated reporting server that supports WIMS Report module.

Subtask 1.2: Waste Stream Annual Data Integration

Research Highlights & Accomplishments:

- FIU received the revised waste forecast data from DOE HQ and incorporated the data on the system.
- Completed integration of 2023 waste forecast and transportation data into WIMS system (Milestone 2022-P3-D5).
- Published 2023 Forecast Waste stream information and DOE was notified on May 5, 2023.
- Status: 6 waste types, 708 waste streams, 36 reporting sites and 36 disposition facilities.





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Subtask 1.5: Cyber Security of WIMS Infrastructure

Research Highlights & Accomplishments:

- Cyber security of WIMS involves securing the network infrastructure that is deployed, secured and maintained in the FIU facility.
- This involves coordination between the FIU security team and DOE Fellows who learn cyber security skills while assisting staff do penetration testing and other tasks to test the overall security of the system at the application, database and infrastructure levels.
- Renewed and configured the yearly Secure Socket Layer (SSL) on WIMS website/server.

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The Waste Information Management System (WIMS) Development, Maintenance and New Data Integration

FIU Year 4 Projected Scope

- **Subtask 1.1: WIMS System Administration & Cyber Security - Database Management, Application Maintenance & Performance Tuning**
  - This subtask includes the day-to-day maintenance and administration of the application and the database servers.
  - Administrator will monitor the network and server traffic and performs updates necessary to optimize the application performance.
  - FIU will provide application and database security as well as help desk support to DOE site managers, HQ managers and other users who need assistance with WIMS.
  - Provide cyber security to WIMS infrastructure, application, database server and reporting server.
- **Subtask 1.2: Waste Stream Annual Data Integration**
  - Update WIMS modules – Forecast Data , Waste Stream and GIS map.
  - Update and publish reports.
  - Update and publish transportation module.

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Task 2

D&D Support to DOE EM for Technology Innovation, Development, Evaluation and Deployment

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Subtask 2.1: Development of Uniform Testing Protocols and Standard Specifications for Fixative Technologies in Support of Complex-Wide D&D Activities

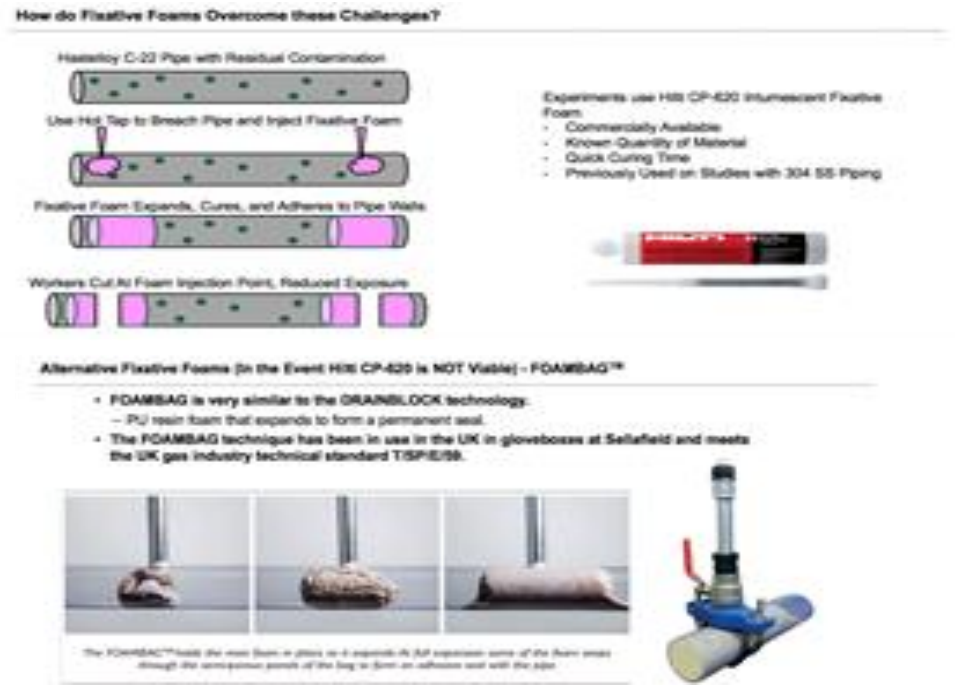
Research Highlights & Accomplishments:

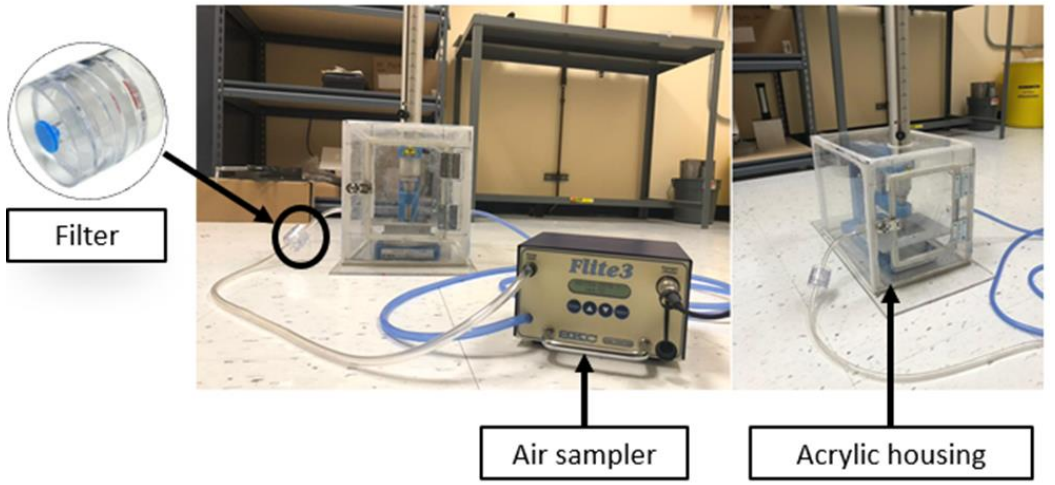
- ASTM E3104 (Decon Gels) and E3105 (Permanent Fixatives) were successfully balloted, approved, and renewed.
- Formal integration of ASTM standards related to fixative technology development, testing and evaluation is becoming mainstream (test plans, RFPs, peer-reviewed articles, etc.).
  - SRNL-STI-2023-00005, “Radiation Hardened Foam Cold Test Plan - Phase II: Foam Characterization Testing and Environmental Chamber Testing of FoamBag Fixative Foam”, 2023
    - **Supporting Foam Fixative Plug site deployment for F/H Labs**
  - Lee, E. H., et al., “Removable coatings: Thermal stability and decontamination of steel surfaces from 241Am,” Chemosphere, Vol 301, August 2022, 134680
  - FY 22 Minority Serving Institutions Partnership Program (MSIPP), RFP 000749

Subtask 2.1: Development of Uniform Testing Protocols and Standard Specifications for Fixative Technologies in Support of Complex-Wide D&D Activities

FIU Year 4 Projected Scope

- ASTM E 3191 (Foam Fixatives) updated and balloted
  - **Supporting Foam Fixative Plug site deployment for F/H Labs**
- ASTM Working Group established to codify experimental design developed in support of “certifying fixative technologies under impact stressors” into a formal testing practice





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Subtask 2.2: Test and Evaluation of Down-Selected Intumescent Foams/Foam Plug Technologies to Mitigate Contaminant Release during Nuclear Pipe Dismantling in Support of a Hot Demo at F/H Labs in FY25

Research Highlights & Accomplishments: Identify & Down-select Most Compatible Foam Technology

Hilti

- A two-component polyurethane (PU) intumescent foam that expands up to six times in volume upon application.
  - Meets ASTM E84 standard.
- Foam is applied through a dispenser and a mixer nozzle attachment.

FoamBag™

- Expanding PU resin foam.
  - Used in the UK in gloveboxes at Sellafield & meets the UK gas industry technical standard T/SP/E/59.
- Injected into a semiporous bag via an injection tube which passes up through the standpipe assembly.

The FOAMBAG™ holds the resin foam in place as it expands. At full expansion some of the foam seeps through the semi-porous panels of the bag to form an adhesive seal with the pipe

Research Highlights & Accomplishments: Technology Comparison to Support Down-selection

	Curing Time	Max Curing Temp.	Average Plug Strength	Adhesion to Wetted Surface	Fire Retardant	Environmental Chamber	Headspace	Hot Tap Compatible
Hilti	1-3 mins	276°F	7733 lbf	**888 lbf**	YES	PASS	PASS	**FAIL**
FoamBag	15-45 mins	277°F	9684 lbf	**4741 lbf**	YES*	In progress (SRNL)	In progress (SRNL)	**PASS**

*Fire retardant with addition of Exolit AP 750 additive

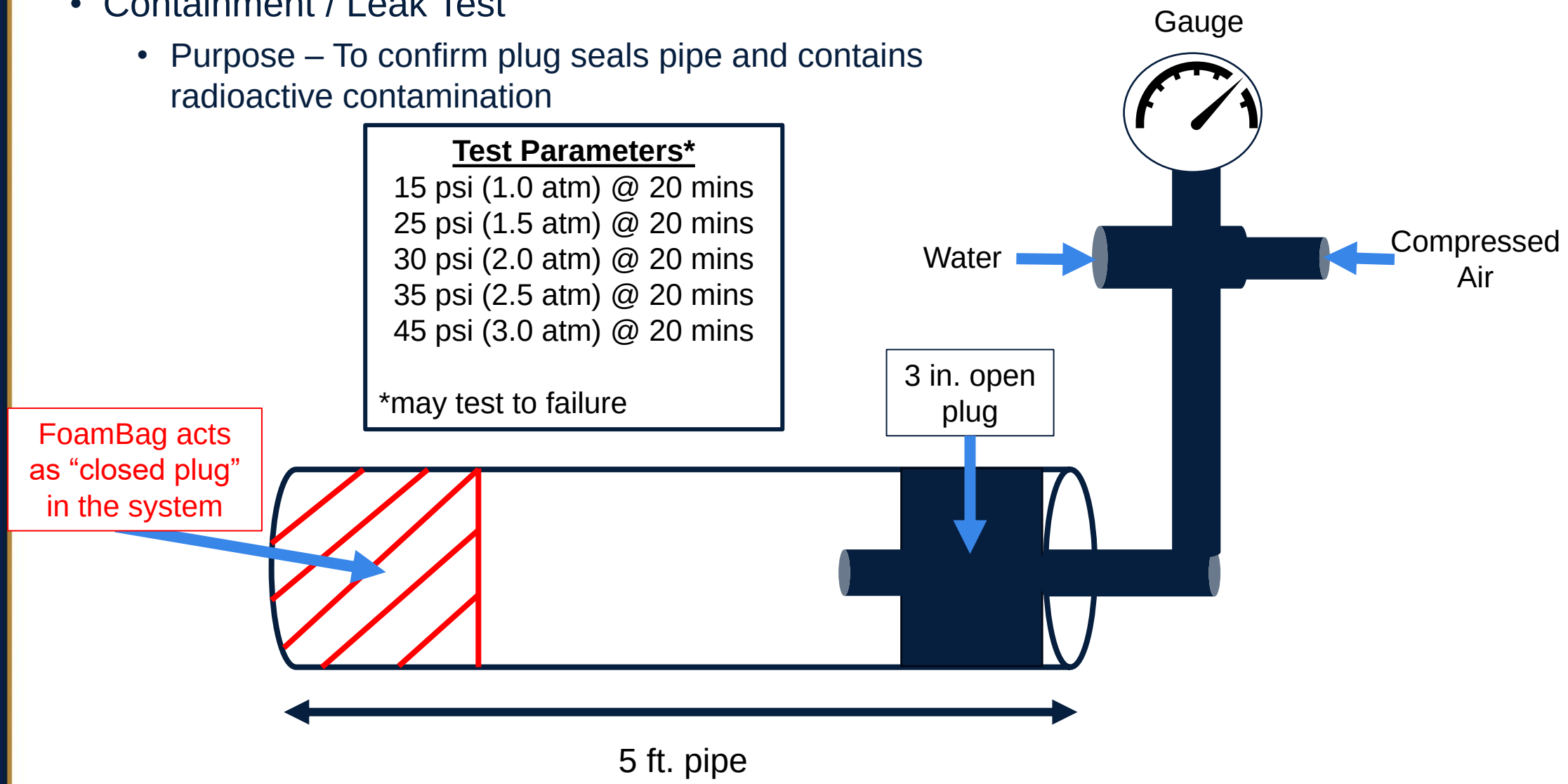
Subtask 2.2: Test and Evaluation of Down-Selected Intumescent Foams/Foam Plug Technologies to Mitigate Contaminant Release during Nuclear Pipe Dismantling in Support of a Hot Demo at F/H Labs in FY25

FIU Year 4 Projected Scope

- Containment / Leak Test
  - Purpose – To confirm plug seals pipe and contains radioactive contamination

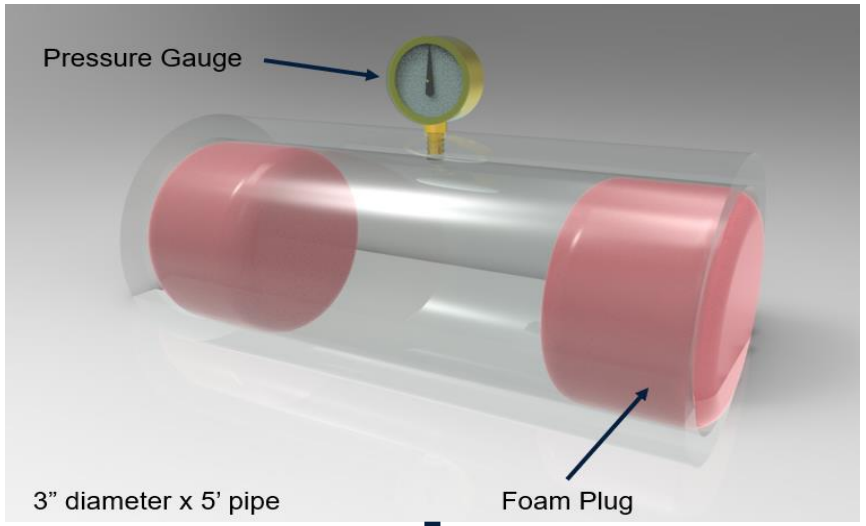
Test Parameters*
15 psi (1.0 atm) @ 20 mins
25 psi (1.5 atm) @ 20 mins
30 psi (2.0 atm) @ 20 mins
35 psi (2.5 atm) @ 20 mins
45 psi (3.0 atm) @ 20 mins

*may test to failure



FIU Year 4 Projected Scope

- Confirm Internal Pipe Pressure Conforms to SRS Manual under the following conditions:
  - During curing process (potential heat generation up to 277°F for 5 mins.)
  - During cutting process (heat generation from mechanical and/or torch cutting methods)



- SRS Manual 1S LLW WAC section 5.3 identifies the **maximum** amount of **allowable pressure** within a pressurized container to be **1.5 atm** (22 psi).
- Pressure will be monitored for 24 hours.

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Subtask 2.3: Certifying Fixative Technology Performance when Exposed to Impact Stressors Postulated in Contingency Scenarios Highlighted in Safety Basis Documents

Research Highlights & Accomplishments:

- ARF for loose powder contamination under impact produced an average ARF of 3.47e-04 – **reconfirmed the validity of the value presented in the DOE-HDBK-3010, 4e-04.**

	Impact (in-lb) / (kg-cm)	Average Airborne Release Fraction
Powder	320 / 368	2.23E-04
	240 / 276	1.08E-04
	200 / 230	1.05E-05
	160 / 184	6.32E-07
Total Average		**3.47E-04**

- Applying fixative technologies significantly reduced ARFs under impact stressors.
  - **Supports the addition of a new designation: "Fixative / Polymer State"**

Contaminant Form	Impact ARF
Gas / Vapor	1.0
Powder	**4e-4**
Liquid	4e-5
Metal / Solid	No significant airborne release is postulated for this accident configuration.

High Risk

Low Risk

	Impact (in-lb) / (kg-cm)	Average Airborne Release Fraction
FD	320 / 368	5.55E-07
	240 / 276	6.78E-07
	200 / 230	8.34E-07
	160 / 184	3.33E-08
Total Average		**5.25E-07**

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Subtask 2.3: Certifying Fixative Technology Performance when Exposed to Impact Stressors Postulated in Contingency Scenarios Highlighted in Safety Basis Documents

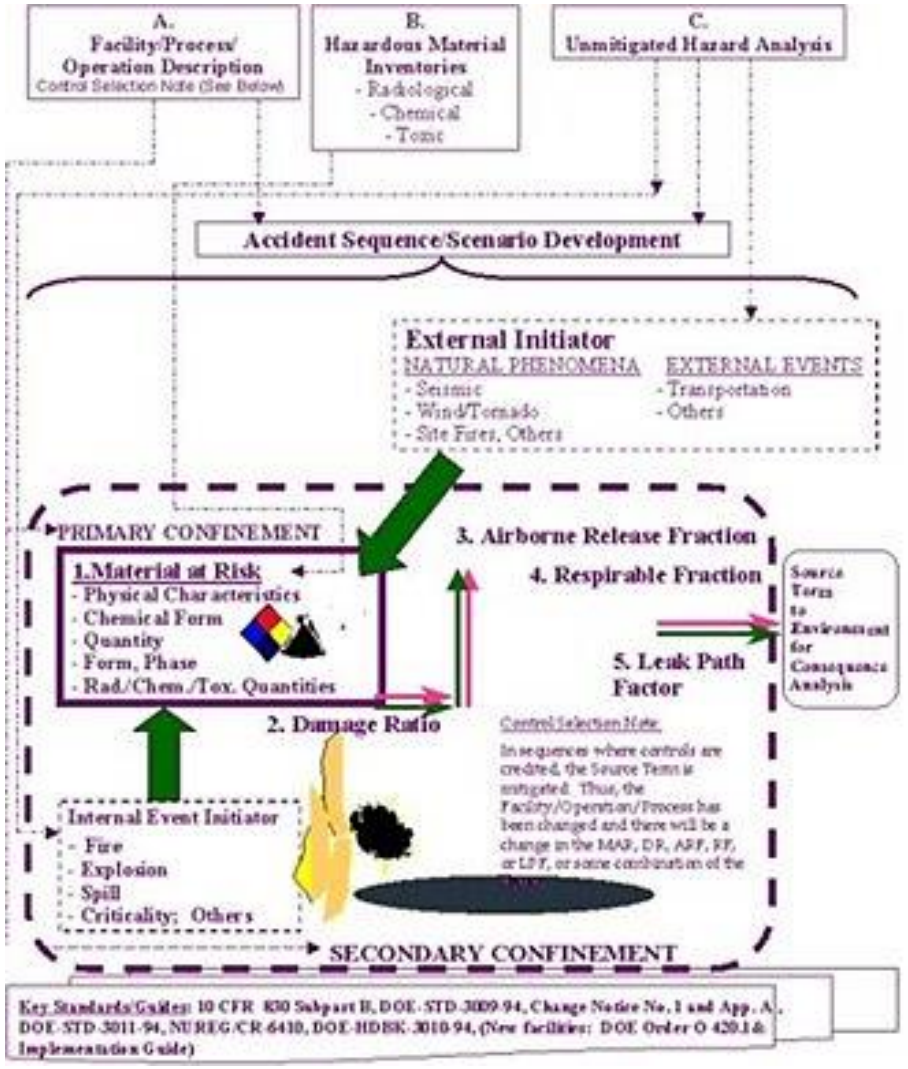
FIU Year 4 Projected Scope

ASTM Testing Practice

- Draft ASTM Testing Practice and submit to E10.03 for review and publication

Standardize Methodologies for Direct Comparison of Fixative Technologies for Impact Stressors

Provide Empirical Data to Support Potential Update to DOE HDBK



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Subtask 2.4: Multi-functional 3D Polymer Micro-Ribbons for Mercury Abatement (Discontinued)

Site Needs:

- Development of novel technologies that support Hg remediation in water.
- Address the adsorption of various forms of Hg contaminants.
- Enable an easy, cost-effective method to recycle the used sorbent.

Objectives:

- Design recyclable polydimethylsiloxane micro-ribbons (PDMS-MRs) to achieve Hg^{2+} and CH_3Hg^+ abatement.
- Confirm application of PDMS-MRs for Hg^{2+} remediation in water.
- Confirm application of PDMS-MRs for CH_3Hg^+ remediation in water.
- Synthesis of magnetic PDMS-MRs (mPDMS-MRs).
- Confirm the recycling of mPDMS-MRs in water.

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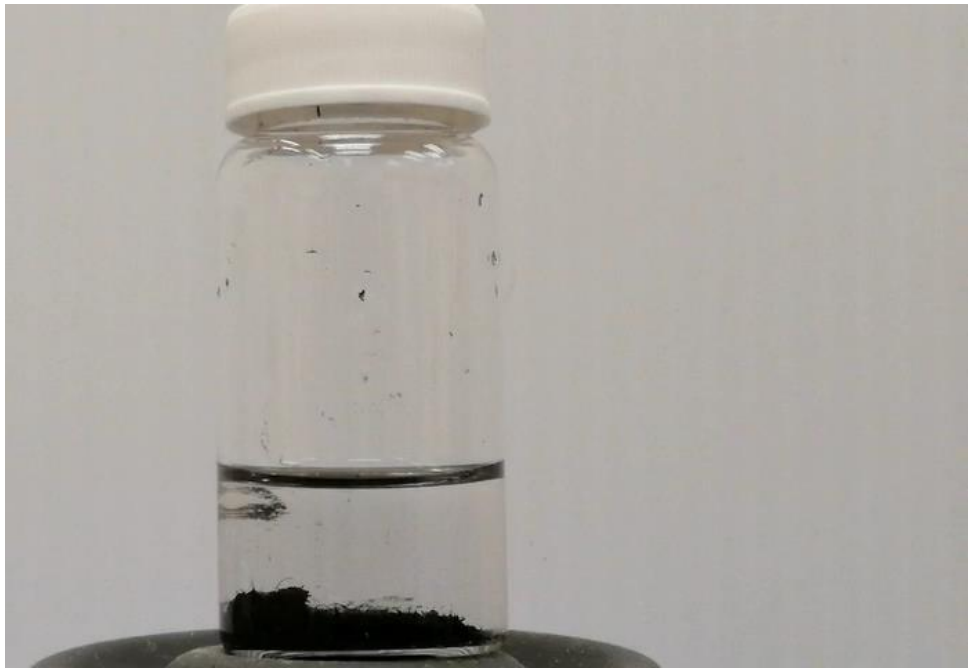
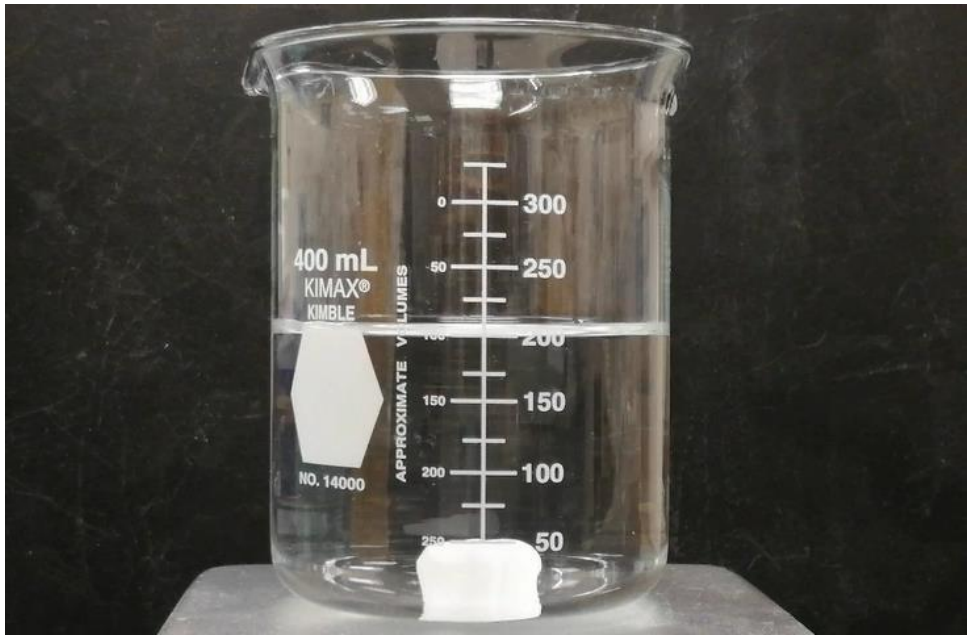
Subtask 2.4: Multi-functional 3D Polymer Micro-Ribbons for Mercury Abatement (Discontinued)

Research Highlights & Accomplishments:



Recycling m-PDMS-MRs from water



m-PDMS-MRs in Oil/Water separation

Conclusion:

1. The mPDMS-MRs demonstrated excellent capability for Hg remediation.
2. Cost effective method when compared to other technologies being investigated.
3. Recommend further investigation if correct resources/personnel can be identified.

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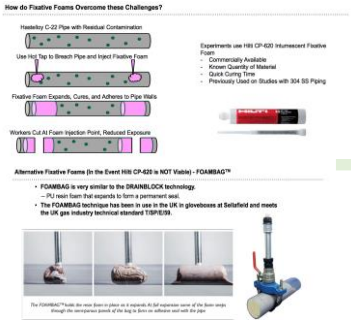
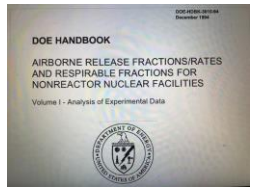
Technology Development and Deployment Road Map

D&D Roadmap

Activity	2022	2023	2024	2025
Foam Fixatives ISO F/H Labs Pipe Dismantling		Completed Phase I Test Plan (T&E of Foam Technology 1)	Complete Phase II Test Plan (T&E of Foam Technology 2)	Complete Phase III Test Plan (Pressure / Leak Testing and Cold Demo of Hot Tap compatibility)	F/H Lab Site Deployment
DOE EM Complex-wide		ASTM E3104 Updated ASTM E3105 Updated	ASTM E3104 Balloted and Approved ASTM E3105 Balloted and Approved	ASTM E 3191 (Foam Fixatives) updated and balloted	ASTM E 3191 Approval & Promulgation as Formal Standard
		Technical Progress Report	Final Technical Progress Report	Propose DOE-HDBK-3010 Update
		Proof-of-Concept for Hg Remediation	Project Ended	

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DOE EM Citations Referencing ASTM E10.03 Fixative Technology Standards and Impact Performance

- ASTM E10.03 standards have established a recognized, community-wide, uniform methodology for testing, evaluating, certifying and crediting fixative technologies for use in support of D&D activities and have been extensively cited. A few recent examples include:
  - SRNL-STI-2021-00115, “A Novel Approach to Mitigating the Potential Release of Radioisotopes Under Fire Conditions - Enhancing Fire Resiliency of Radiological Contamination Fixatives During Deactivation & Decommissioning Activities”, 2021.

    *Integrated into SRS 235-F PUFF Facility Work Plan for Incombustible Fixative site deployment
  - SRNL-STI-2023-00005, “Radiation Hardened Foam Cold Test Plan - Phase II: Foam Characterization Testing and Environmental Chamber Testing of FoamBag Fixative Foam”, 2023.

    *Supporting Foam Fixative Plug site deployment for F/H Labs
  - Lee, E. H., et al., “Removable coatings: Thermal stability and decontamination of steel surfaces from 241Am,” Chemosphere, Vol 301, August 2022, 134680.
  - FY 22 Minority Serving Institutions Partnership Program (MSIPP), RFP 000749
    - PA3: Incombustible fixatives and decontamination agents
    - RN3: R&D leading to the development of these fixatives and agents for a nuclear facility. Also, the development of testing protocols to demonstrate their acceptance.
    - C3: Meets ASTM standard from E10.03. Protocols should be applicable to various DOE facilities

- Certifying Fixative Technology Performance Under Impact Stressors
  - Technical Progress Report, “Certifying Fixative Technologies – Impact” – submitted for upload to OSTI.
  - Technical Progress Report submitted as Peer-reviewed manuscript, “Determination of Airborne Release Fractions from Loose Powder Contamination under Impact Stress” – submitted to the Nuclear Technology Journal, Aug 2023.

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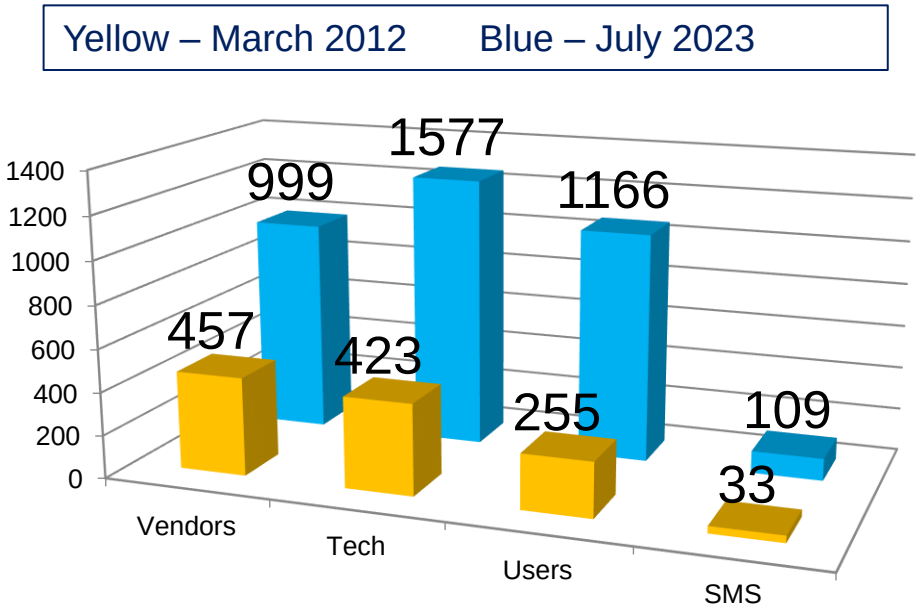
Task 3

D&D Knowledge Management Information Tool (KM-IT)

Subtask 3.4: Content Management

Research Highlights & Accomplishments:

- Published D&D technologies, vendors, lessons learned, best practices, D&D news, conferences and other content to KM-IT
- Performed QA/QC of existing content in the system
- 33 technologies, 41 articles, 23 events were published on this platform in this fiscal year
- D&D KM-IT web analytics to track usage metrics.
- 1577 D&D technologies
- 1166 registered users
- 999 D&D vendors
- 109 subject matter specialists



Growth from March 2012 to July 2023

<u>Fully searchable resources – Original sources no longer available</u>

- 169 ALARA Center reports archived (Hanford and SRS)
- 231 Innovative Technology Summary Reports archived

Subtask 3.5: Marketing and Outreach

Research Highlights & Accomplishments:

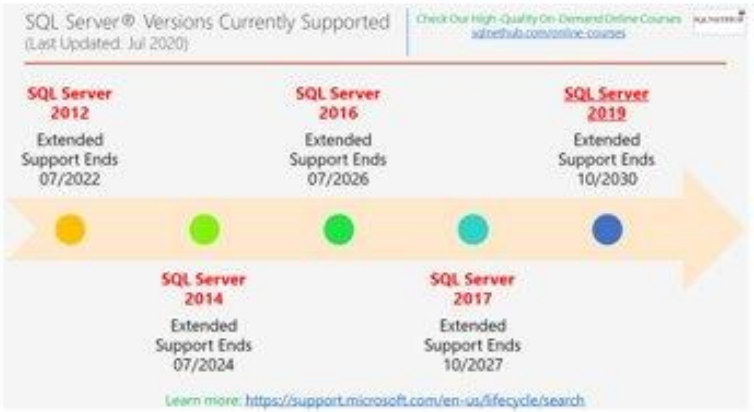
- Reached out to sites/national labs to increase KM-IT user involvement
- Development of newsletters, post cards and factsheets
- Other marketing and outreach to introduce the system to SME who may not be aware of its features and capabilities
- Participation at workshops and conferences such as Waste Management
  - FIU ARC Booth
  - Presented KM-IT poster at WM2023

Dr. Himanshu Upadhyay (FIU), Nancy Bushman (DOE) and Walter Quintero (FIU) in front of the D&D KM-IT poster at WM2023.

Subtask 3.6: D&D KM-IT System Administration

Research Highlights & Accomplishments:

- D&D KM-IT System Administration is an ongoing task, which involves day-to-day administration of servers that house the KM-IT databases and web applications.
- This task includes updating patches and OS fixes, updating antivirus engines and definitions, updating drivers and assuring that the network is working properly.
- Under this task, hardware upgrades are also conducted (memory, hard drives, video cards, routers, firewall, etc.).
- Migration/backup of the existing databases and KM-IT modules to latest .NET Framework.
- Testing application before moving to production on staging servers
- This constant administration improve performance, security, stability and long- term support of the system



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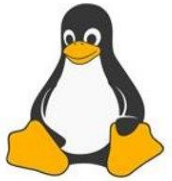
Subtask 3.7: Cyber Security of D&D KM-IT Infrastructure

Research Highlights & Accomplishments:

- Cyber security of D&D KM-IT involves securing the network infrastructure maintained in the FIU facility.
- Updating of Secure Socket Layer (SSL) for dndkm.org domain.
- Maintaining and optimizing firewall rules.
- Regularly performed penetration testing on network, KM-IT database and application servers.
- Trained DOE Fellows in DOE-EM Cybersecurity lab on advanced security tools commonly used in the industry.



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Subtask 3.8: KM-IT Tech Talks

Research Highlights & Accomplishments:

- Conduct D&D related Tech Talk every quarter on the D&D KM-IT platform.
- Collaborate with National Laboratories and/or DOE sites to identify and present technical topics of interest to the community.
- Tech Talks are conducted virtually using an online meeting platform that can be accessed via KM-IT
- Promoted Tech Talks via newsletters, website, emails and flyers developed by FIU.
- Conducted 4 Tech Talks (https://www.dndkm.org/TechTalk)
  - October 19, 2022
    University R&D and Deployment of Robotics Systems at DOE Facilities
  - January 24, 2023
    International Perspective on Decommissioning with focus on 3D hazard aware digital and robotics technology-based transformation
  - April 25, 2023
    DOE's ALTEMIS Project: Advanced Long-Term Monitoring of Complex Groundwater Plumes
  - July 18, 2023
    AI/ML Research support for Advance Long-Term Environmental Monitoring Systems (ALTEMIS)

D&D KNOWLEDGE MANAGEMENT INFORMATION TOOL (KM-IT) (HQ, SRNL, INL, ANL)

FIU Year 4 Projected Scope

- **Subtask 3.4: Content Management**
  - Publishing D&D technologies, vendors, D&D technologies, lessons learned, best practices, D&D news, conferences and other content to KM-IT
  - Perform QA/QC of existing content in the system with assistance of DOE Fellows
- **Subtask 3.5: Marketing and Outreach**
  - Reaching out to sites/national labs to increase KM-IT user involvement
  - Participation at workshops and conferences such as Waste Management and engagement with other agencies such as the IAEA.
  - Introduce the system to SME who may not be aware of its features and capabilities
  - Development of newsletters, post cards, factsheets and other print material to promote KM-IT

D&D KNOWLEDGE MANAGEMENT INFORMATION TOOL (KM-IT) (HQ, SRNL, INL, ANL)

FIU Year 4 Projected Scope

- **Subtask 3.6: D&D KM-IT System Administration & Cyber Security**
  - D&D KM-IT System Administration is an ongoing task which involves day-to-day administration of servers that house the KM-IT databases and web applications.
  - This task includes updating patches and OS fixes, updating antivirus engines and definitions, updating drivers and assuring that the network (firewall, routers and switches) is working properly.
  - Securing the network by conducting routine cyber security tasks to test the network's vulnerability.
  - Coordination between the FIU security team and DOE Fellows who learn cybersecurity skills while assisting staff do penetration testing and other tasks to test the overall security of the system at the application, database and infrastructure levels.
- **Subtask 3.8: KM-IT Tech Talks**
  - Conduct D&D related Tech Talk every quarter on the D&D KM-IT platform.
  - Collaborate with National Laboratories and/or DOE sites to identify and present technical topics of interest to the community.
  - Tech Talks will be performed virtually using an online meeting platform (KM-IT)
  - Promote Tech Talks via newsletters, website, emails and flyers developed by FIU.

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Artificial Intelligence Support to DOE-EM

Advanced Automated Machine Learning System (AAMLS) Transition to DOE-EM

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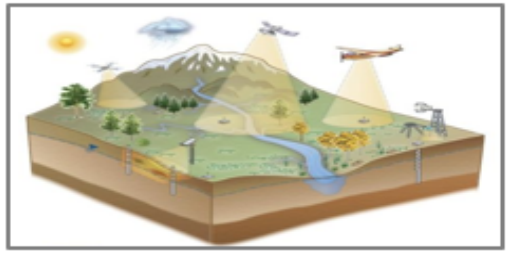
Advanced Automated Machine Learning System (AAMLS)

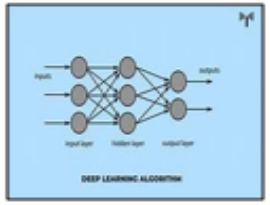
ARTIFICIAL INTELLIGENCE / MACHINE LEARNING

APPLICATION DOMAIN



SENSOR / IMAGERY DATA FROM DOE-EM SITES

AI / ML TECHNOLOGY



AI / ML FRAMEWORKS AND ALGORITHMS

OPERATIONALISE AI / ML MODEL

DATABASE / MACHINE LEARNING SERVERS / BIG DATA CLUSTER

IT INFRASTRUCTURE AND APPLICATIONS

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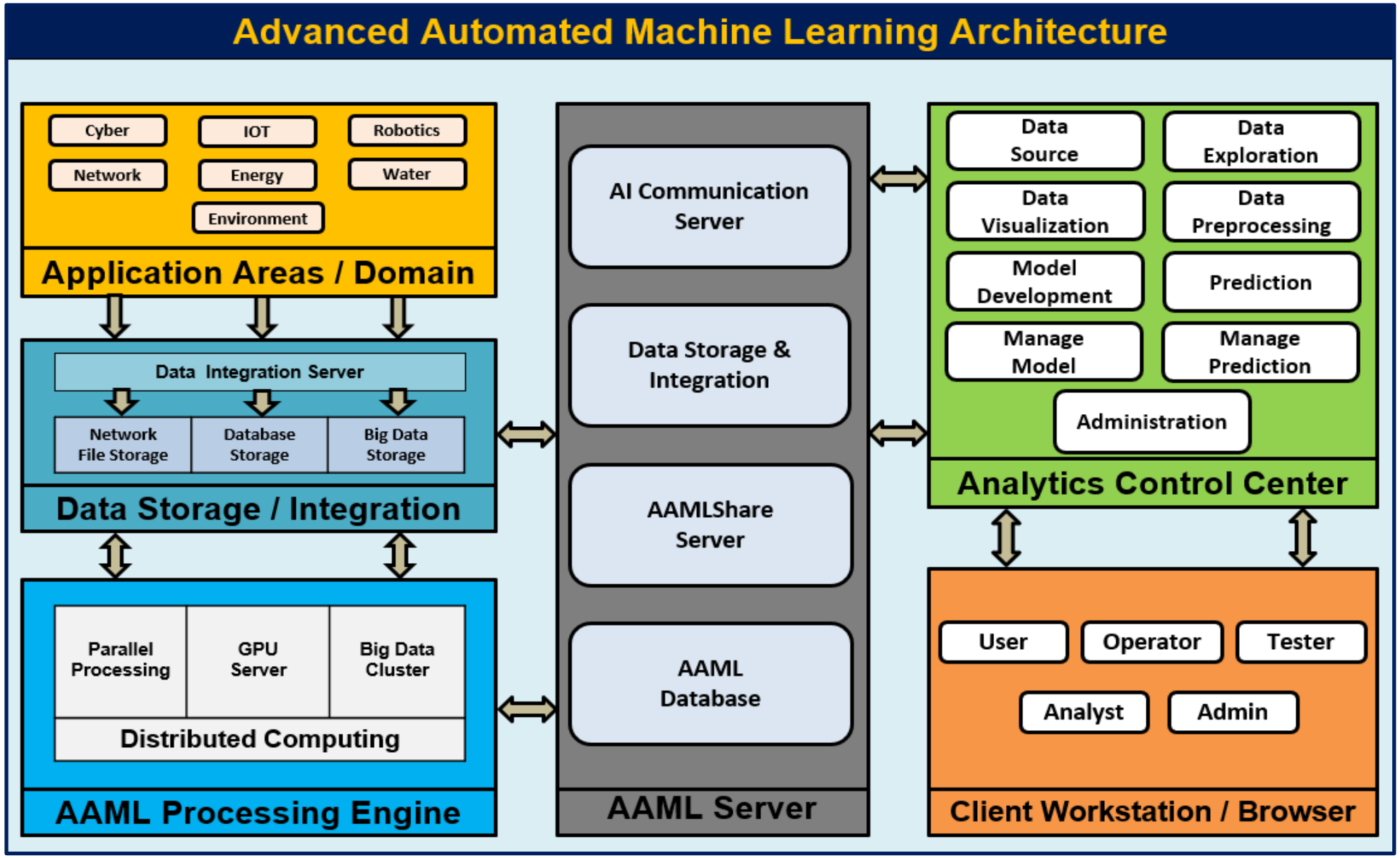
Advanced Automated Machine Learning System (AAMLS)



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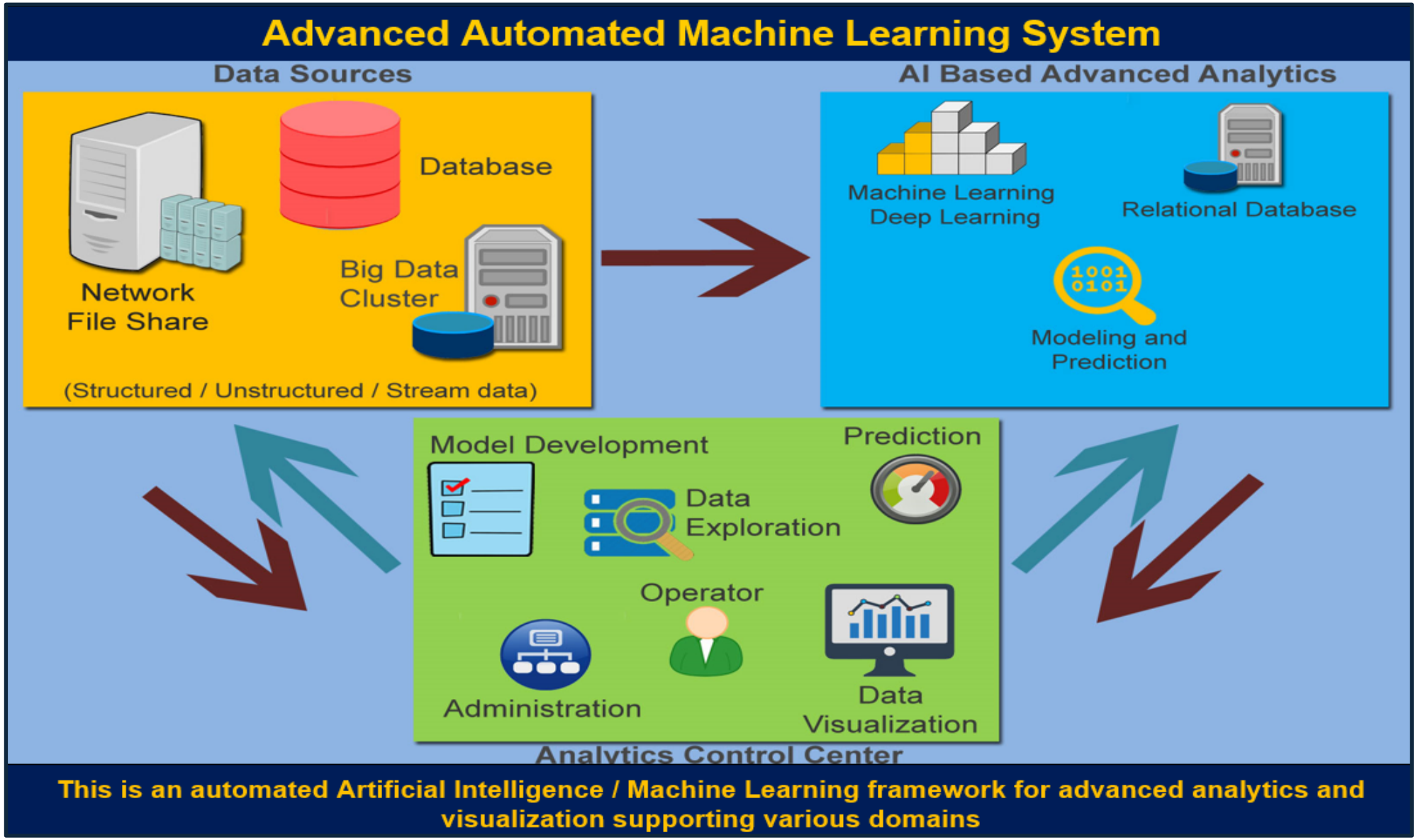
Advanced Automated Machine Learning System (AAMLS)



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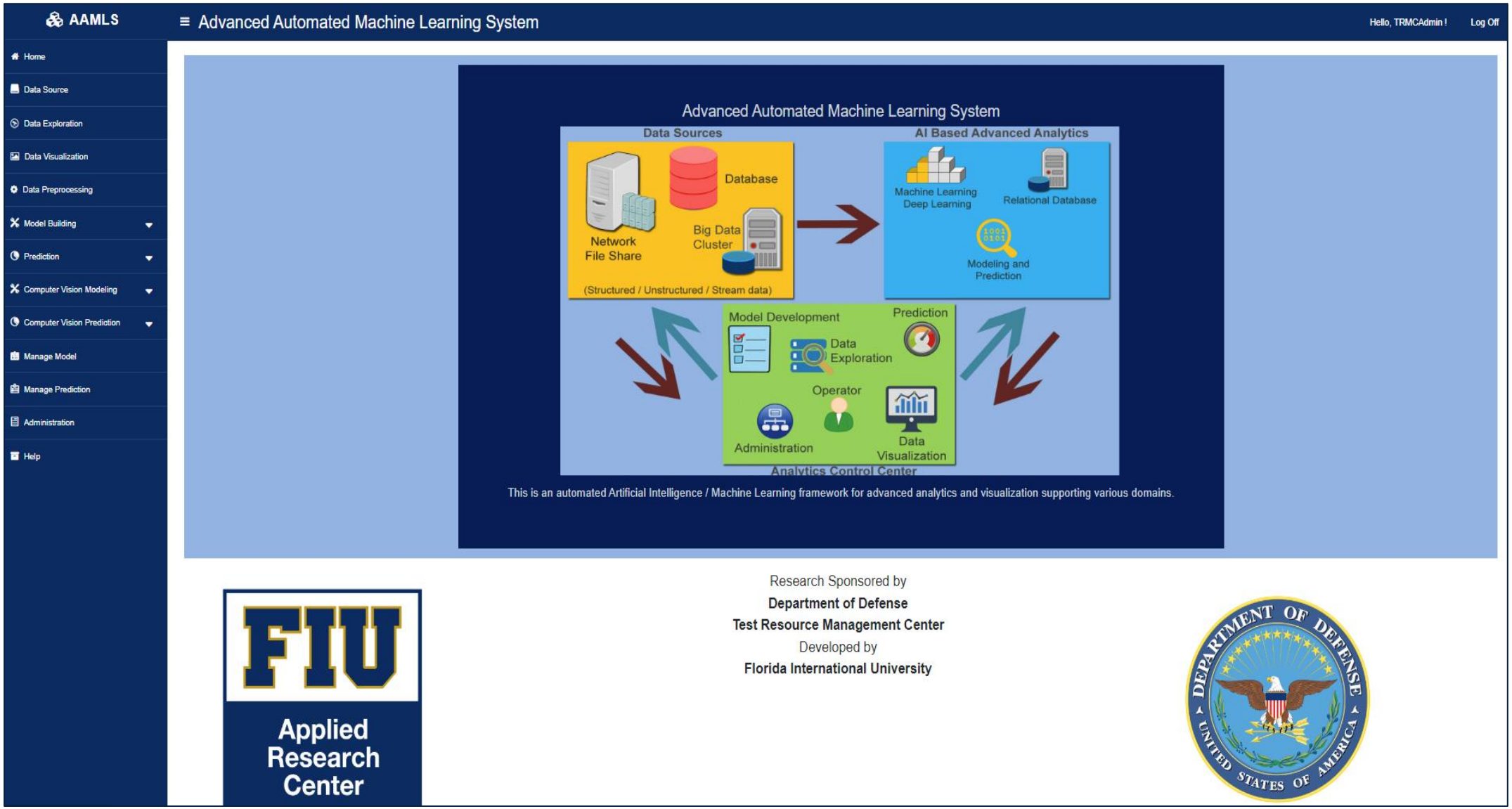
Advanced Automated Machine Learning System (AAMLS)



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Research Sponsored by

Department of Defense

Test Resource Management Center

Developed by

Florida International University

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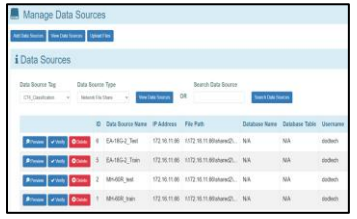
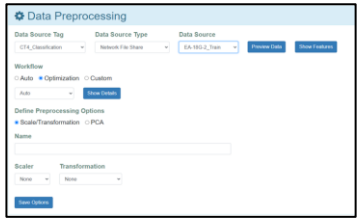
Advanced Automated Machine Learning System (AAMLS)

FIU Year 3 Research Highlights:

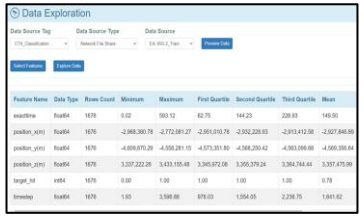
Data Source (1)



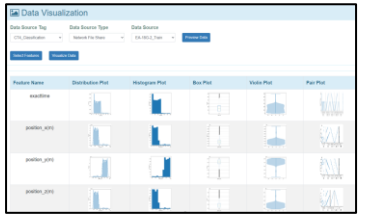
Pre-Processing (2)



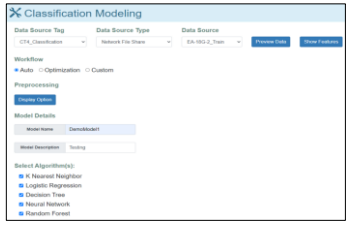
Data Exploration (3)



Data Visualization (4)

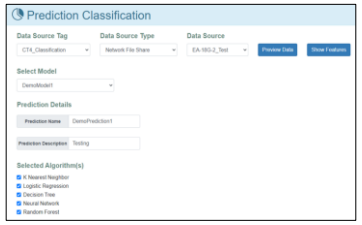


Model Building (5)



Model Validation (6)

Prediction (7)



Prediction Results (8)

AAMLS Workflow

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Advanced Automated Machine Learning System (AAMLS)

- Automation of Machine Learning model development and prediction in few steps
- Application can be used with minimal machine learning knowledge
- Dynamic connectivity to existing data sources in network file share, database and big data cluster
- Explore and visualize datasets prior to building model and prediction
- Access to the historical model and prediction results

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Task 7

AI for EM Problem Set (Soil & GW):

Exploratory Data Analysis and Machine Learning Model for Hexavalent Chromium [Cr (VI)] Concentration in 100-H Area (PNNL)

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Subtask 7.3: Algorithm Development for Spatiotemporal Relationship Identification

Research Highlights & Accomplishments:

- FIU team researched different algorithms to build ML/DL models to predict Hexavalent Chromium contamination concentration using historical Wells datasets.
- A 1-Dimensional Convolutional Neural Network (CNN) and LSTM-DENSE algorithms are employed to build models.
- Developed ML/DL model for prediction of chromium contaminant concentration based on historical data using LSTM-DENSE algorithm.
- Timeseries dataset for the chosen well with contaminant concentration was used to train the model and algorithm was executed 10 times to identify the best model with the desired metrics used for further analysis.

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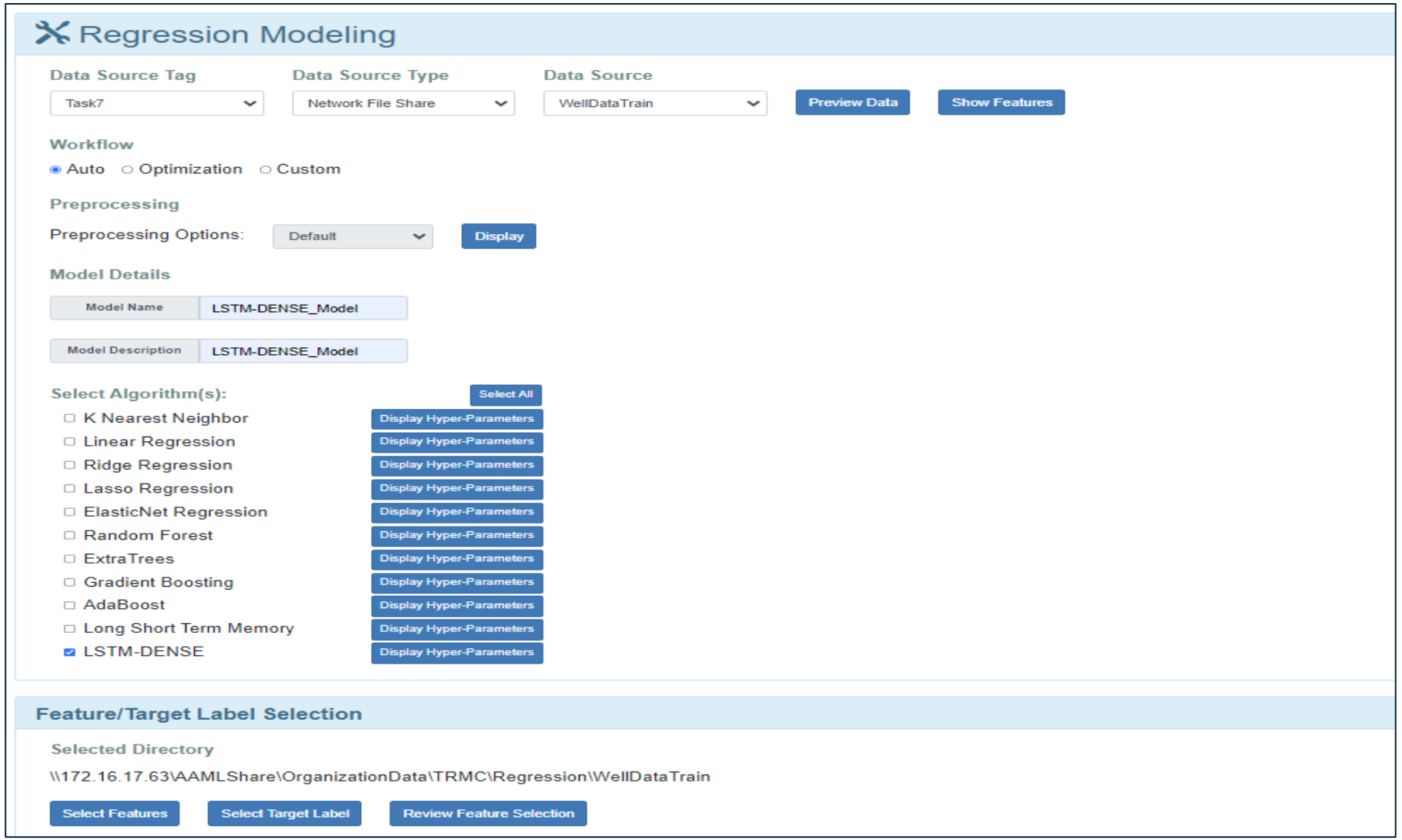
Subtask 7.4: Publishing AI/ML models on AAML System (NEW)

Research Highlights & Accomplishments:



AAMLS - Model Building

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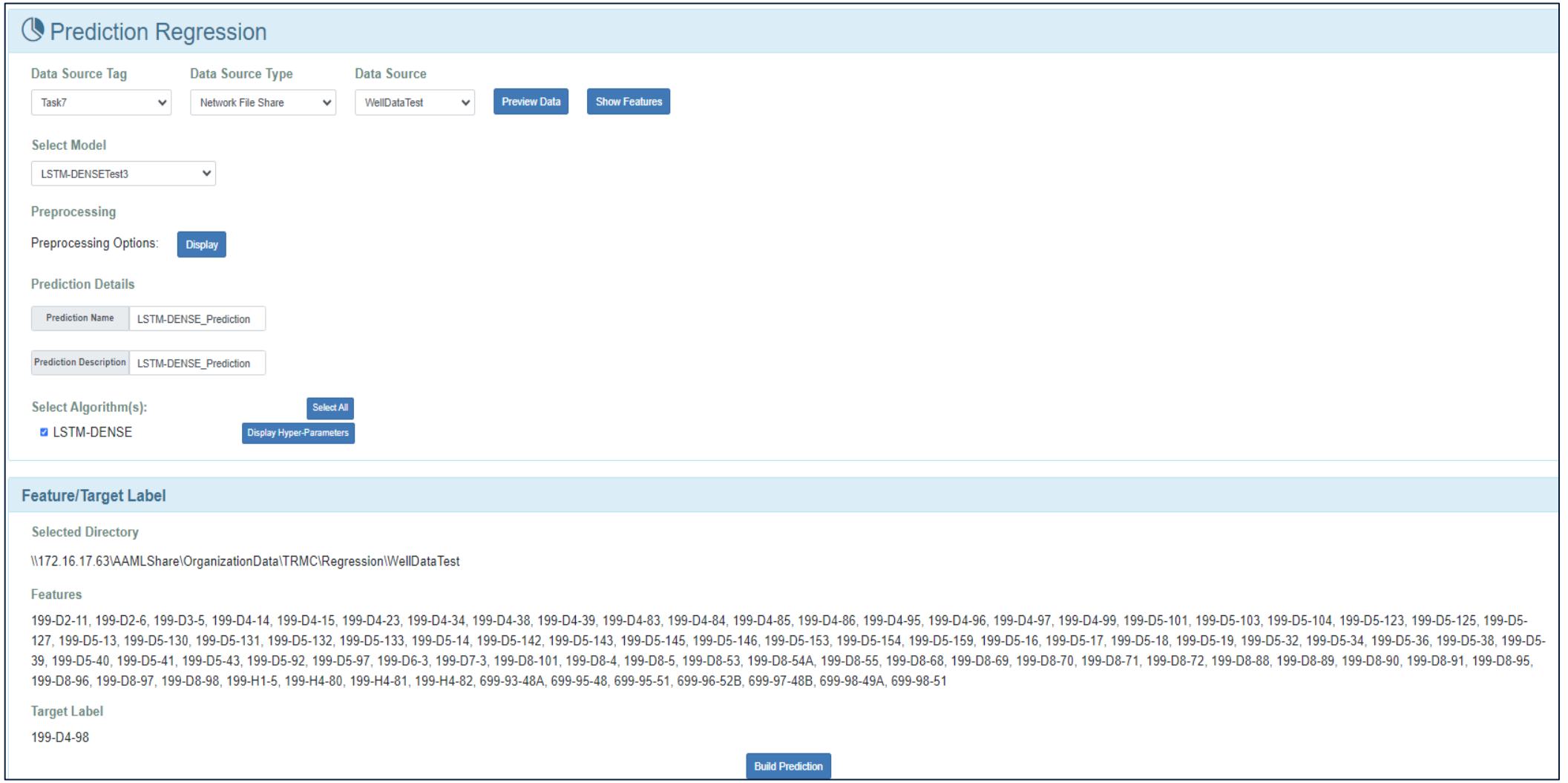
Subtask 7.4: Publishing AI/ML models on AAML System (NEW)

Research Highlights & Accomplishments:



AAMLS - Prediction

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Subtask 7.4: Publishing AI/ML models on AAML System (NEW)

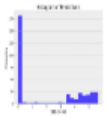
Research Highlights & Accomplishments:

Predictions

Data Source Tag: Task7 | Data Source Type: Network File Share | ML Problem: Regression | View Predictions | OR | Search Prediction | Search Predictions

	Test Name	Description	Preprocessing	Status	Username	Label(s)	Inserted On	
View Features / View Results	Test9	Prediction	Show Options	Completed	TRMCAdmin	199-D4-98	5/31/2023 8:28:42 PM	Delete
View Features / View Results	Test8	Prediction	Show Options	Completed	TRMCAdmin	199-D4-98	5/31/2023 8:22:35 PM	Delete
View Features / View Results	Test5	Prediction	Show Options	Completed	TRMCAdmin	199-D4-98	5/31/2023 8:16:16 PM	Delete
View Features / View Results	Task7WellData_Prediction	Prediction	Show Options	Completed	TRMCAdmin	199-D4-98	5/31/2023 8:04:15 PM	Delete
View Features / View Results	Predtest	Prediction	Show Options	Completed	TRMCAdmin	199-D4-98	5/31/2023 7:55:16 PM	Delete
View Features / View Results	Test4	Prediction	Show Options	Completed	TRMCAdmin	199-D4-98	5/31/2023 5:17:52 PM	Delete
View Features / View Results	Test3	Regression	Show Options	Completed	TRMCAdmin	199-D4-98	5/31/2023 5:06:03 PM	Delete
View Features / View Results	Test2	Prediction	Show Options	Completed	TRMCAdmin	199-D4-98	5/31/2023 4:39:42 PM	Delete
View Features / View Results	Auto_WellPred	Regression	Show Options	InProgress	TRMCAdmin	199-D4-98	5/31/2023 2:03:36 PM	Delete

Prediction Results

Test Result	Algorithm Name	Hyper-Parameters	Algorithm Group	Status	Frequency	TimePlot
View Test Result	LSTM-DENSE	View Parameters	Regression	Success		

AAMLS - Manage Prediction

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Task 7: AI for EM Problem Set (Soil & GW): Exploratory Data Analysis and Machine Learning Model for Hexavalent Chromium [Cr (VI)] Concentration in 100-H Area

FIU Year 4 Projected Scope

- Achieve more consistent accurate prediction performance with current pipeline with the inclusion of more well characteristics other than contaminant concentration.
- Other well characteristics from the sensor data such as specific conductance and/or Ph of water will be explored. Characteristics could also include spatial coordinates of the well and/or water depth level for indication or river stage.
- This work would involve pre-processing features from simple values into vector representations, the addition of another dimension to o input data.
- Explore the use of generative models to create a pipeline that can predict contaminant concentration at a given coordinate point, as opposed to a well.
- These algorithms would include Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), and SMOTER (Synthetic Minority Over-sampling TEchnique for Regression).
- Continue to deploy the implemented models on the AAML System.
    - Deep Learning Models will be deployed on the AAML System for automating the contaminant concentration predictions.

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Task 8

AI for EM Problem Set (Soil and Groundwater) - Data analysis and visualization of sensor data from the wells at the SRS F-Area using machine learning (LBNL, SRNL)

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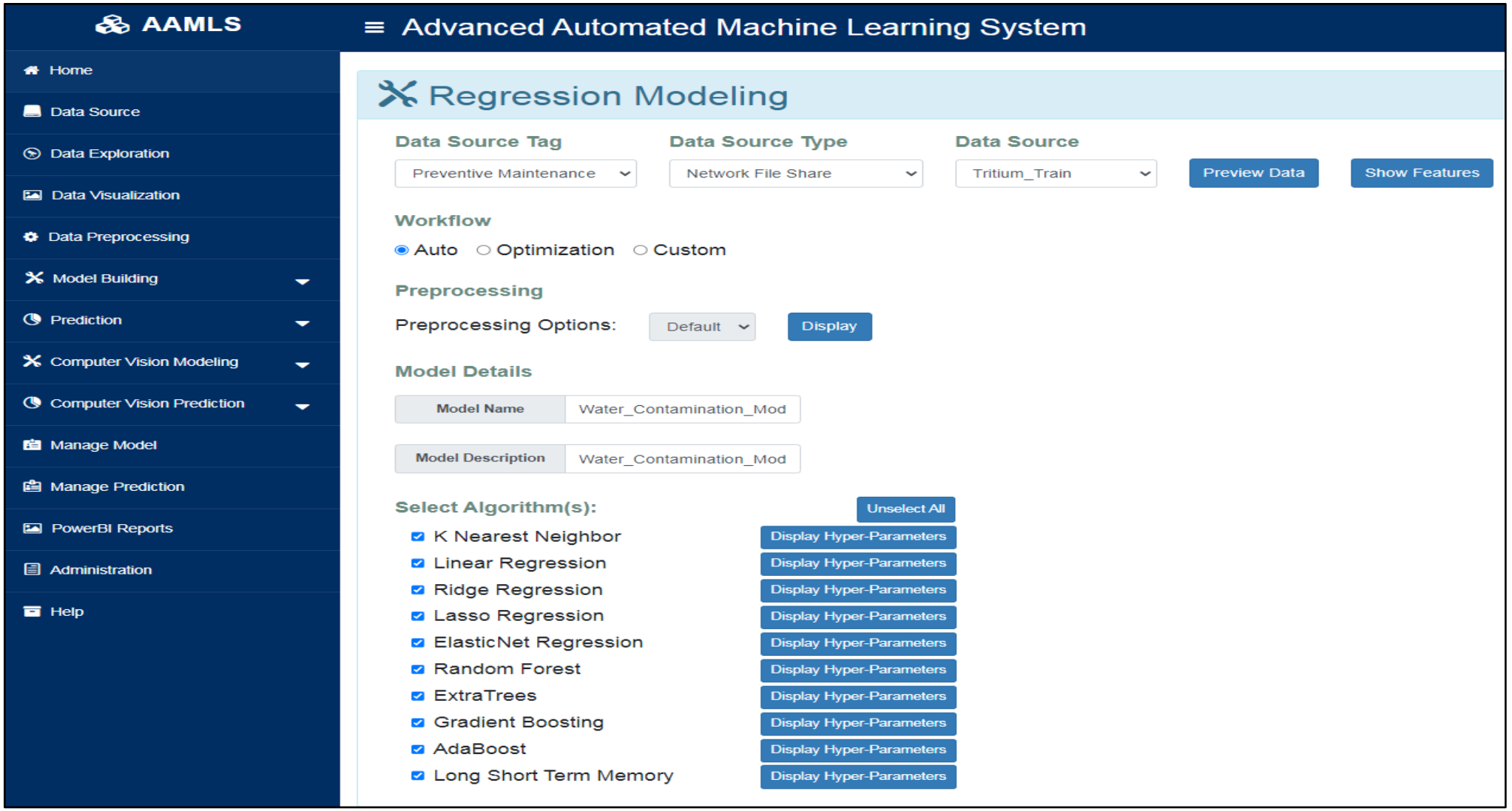
Subtask 8.6: Publishing AI/ML models on AAML System (NEW)

Research Highlights & Accomplishments:



AAMLS - Model Building

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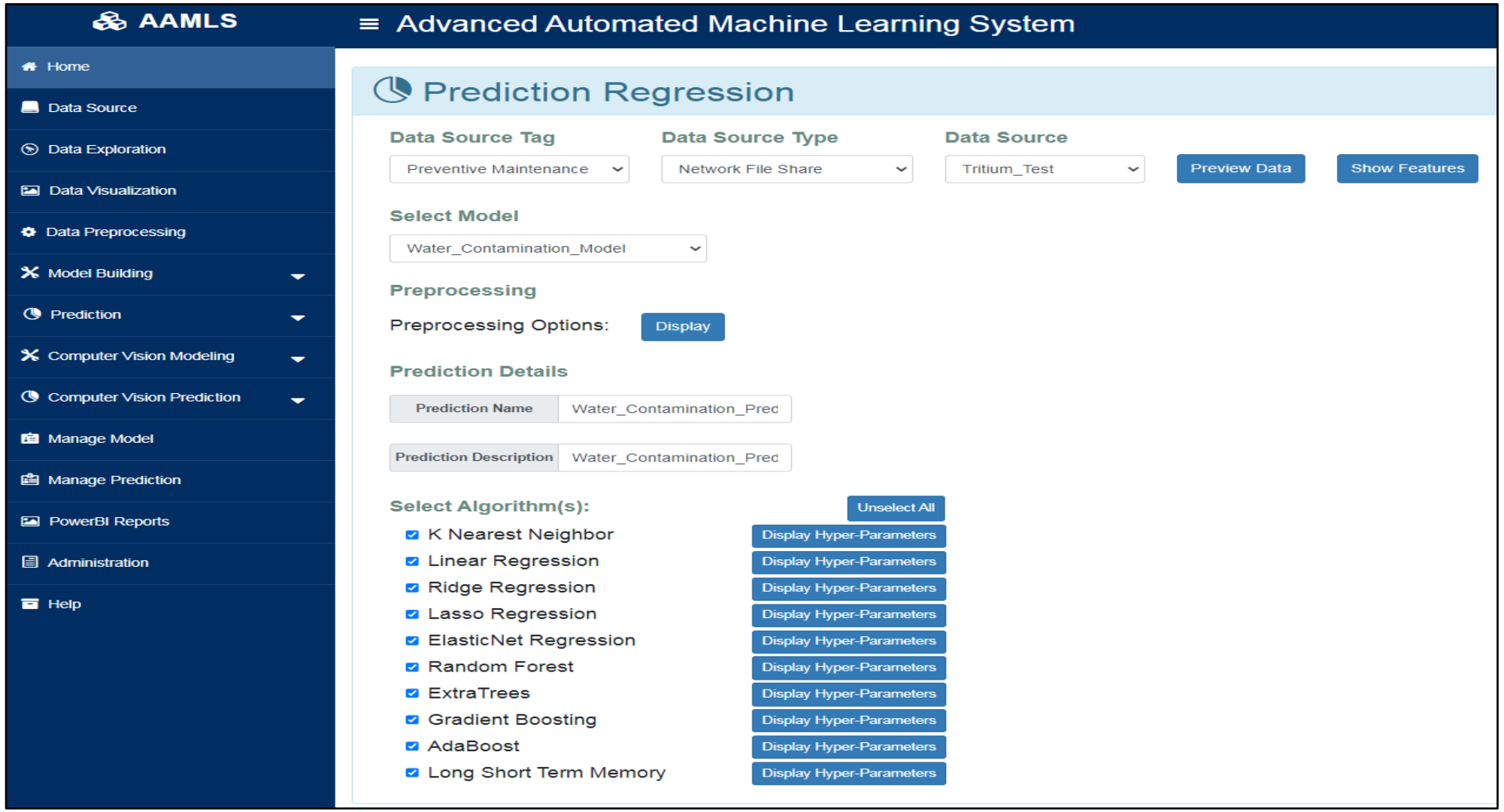
Subtask 8.6: Publishing AI/ML models on AAML System (NEW)

Research Highlights & Accomplishments:



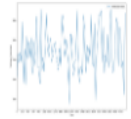
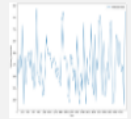
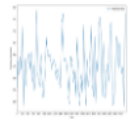
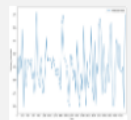
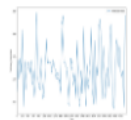
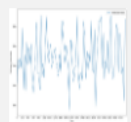
AAMLS - Prediction

FIU Applied Research Center

Subtask 8.6: Publishing AI/ML models on AAML System (NEW)

Research Highlights & Accomplishments:

Prediction Results

Test Result	Algorithm Name	Hyper-Parameters	Algorithm Group	Status	Frequency	TimePlot
View Test Result	K Nearest Neighbor	View Parameters	Regression	Success		
View Test Result	Linear Regression	View Parameters	Regression	Success		
View Test Result	Ridge Regression	View Parameters	Regression	Success		
View Test Result	Lasso Regression	View Parameters	Regression	Success		
View Test Result	ElasticNet Regression	View Parameters	Regression	Success		
View Test Result	Random Forest	View Parameters	Regression	Success		

AAMLS - Prediction Results

FIU Year 4 Projected Scope

- Research and implement advanced deep learning models for time series data:
  - Develop a transformer model for learning temporal and spatial features from in-situ real-time sensor data of various analytes from the SRS site. The model's self-attention mechanism can assign significance to different sensor readings, capturing short-term fluctuations and long-term dependencies. This empowers the model to discern temporal dynamics, detect patterns, trends, and anomalies in real-time sensor data.
  - Develop an AutoEncoder model for effectively capturing both temporal and spatial dependencies of various analytes from the SRS site. The model is trained to reconstruct normal sensor data, effectively learning a compressed representation of the input. This approach holds promise for anomaly detection in real-time sensor data, providing a valuable research for early warning systems, fault detection, and maintenance optimization.
- Continue to deploy the implemented models on the AAML System.
  - Deep Learning Models will be deployed on the AAML System for automating the contaminant concentration predictions.

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Task 9

AI for EM Problem Set (Waste Processing):

Nuclear Waste Identification and Classification using Deep learning (SRNL) (NEW)

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Subtask 9.1: Algorithm and Model Development to Identify and Classify Nuclear Waste (NEW)

Research Highlights & Accomplishments:

- Implemented YOLOv7 model for Object Detection.
- Implemented YOLOv7 model for Instance Segmentation.
- Implemented STEGO model for Unsupervised Semantic Segmentation.
- Implemented Mask RCNN model for Disparity Image Segmentation.

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Subtask 9.2: Transition Previously Trained Deep Learning Models to the Advance Automated Machine Learning (AAML) System (NEW)

Research Highlights & Accomplishments:

- **Implemented Anomaly Detection Models (Wall Crack Detection).**
  - Added a custom model with good performance on detecting cracks on walls.
  - Implemented the ability to customize the models with different number of layers, activation functions, etc., to enhance the performance of the model on new data.
- **Implemented Object Detection Models.**
  - Added YOLOv3 model that has high performance and low latency when predicting.
  - Implemented the ability to customize the model's confidence and IoU thresholds. Also implemented transfer learning to reduce training time while maintaining a high performance.

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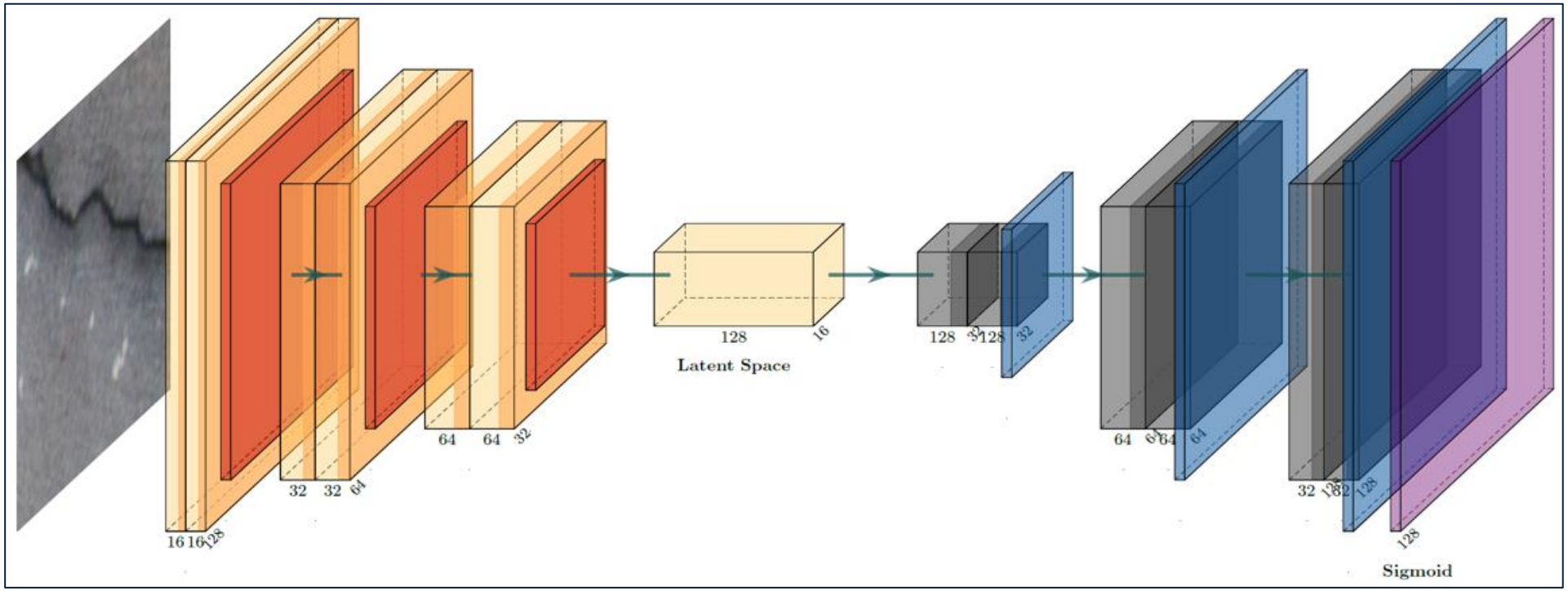
Subtask 9.2: Transition Previously Trained Deep Learning Models to the Advance Automated Machine Learning (AAML) System (NEW)

Research Highlights & Accomplishments:

- The models developed as part of the Task 6 in the previous year (2022) are deployed on the AAML System.



Convolutional AutoEncoder (CAE) Deep Learning Architecture

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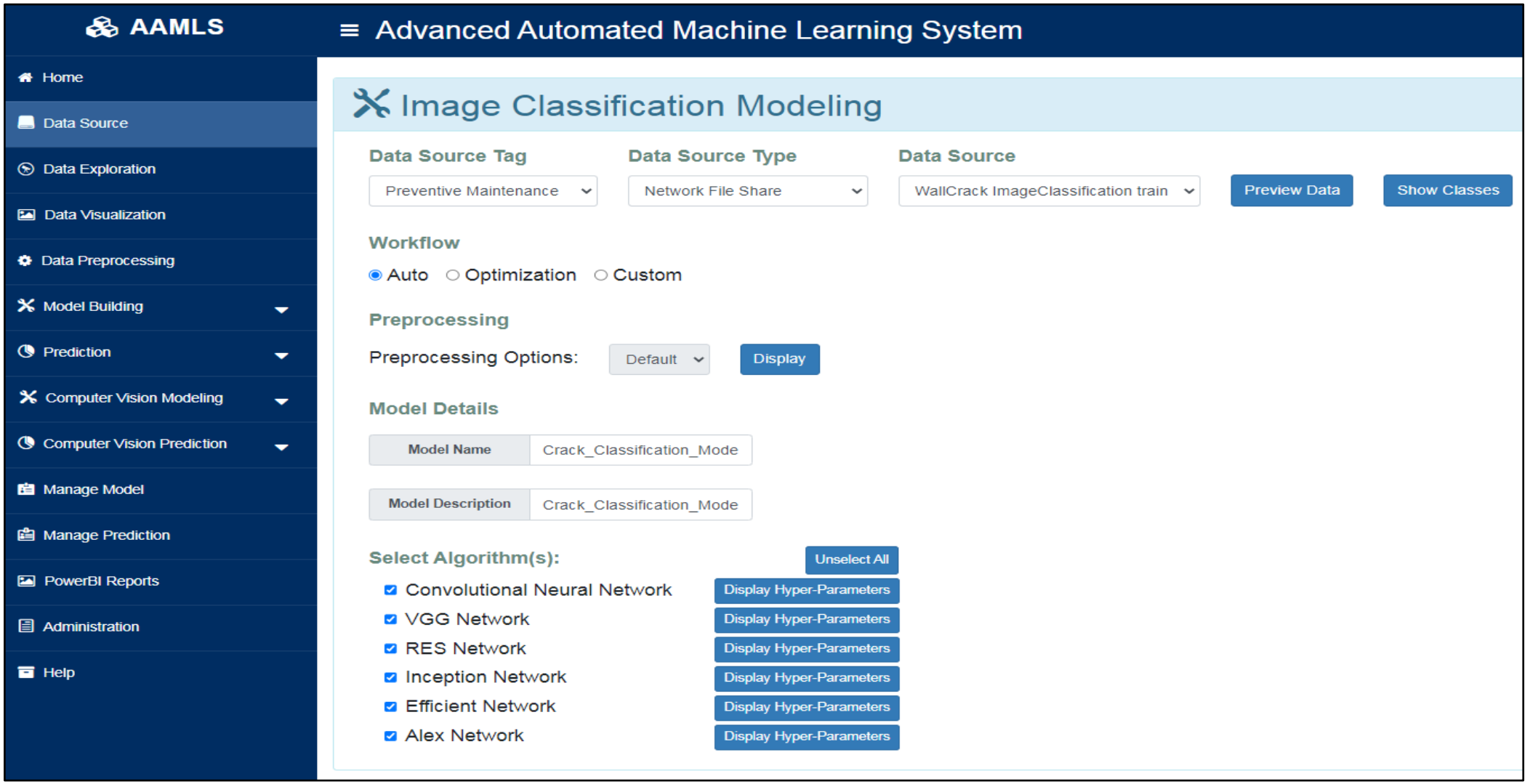
Subtask 9.2: Transition Previously Trained Deep Learning Models to the Advance Automated Machine Learning (AAML) System (NEW)

Research Highlights & Accomplishments:

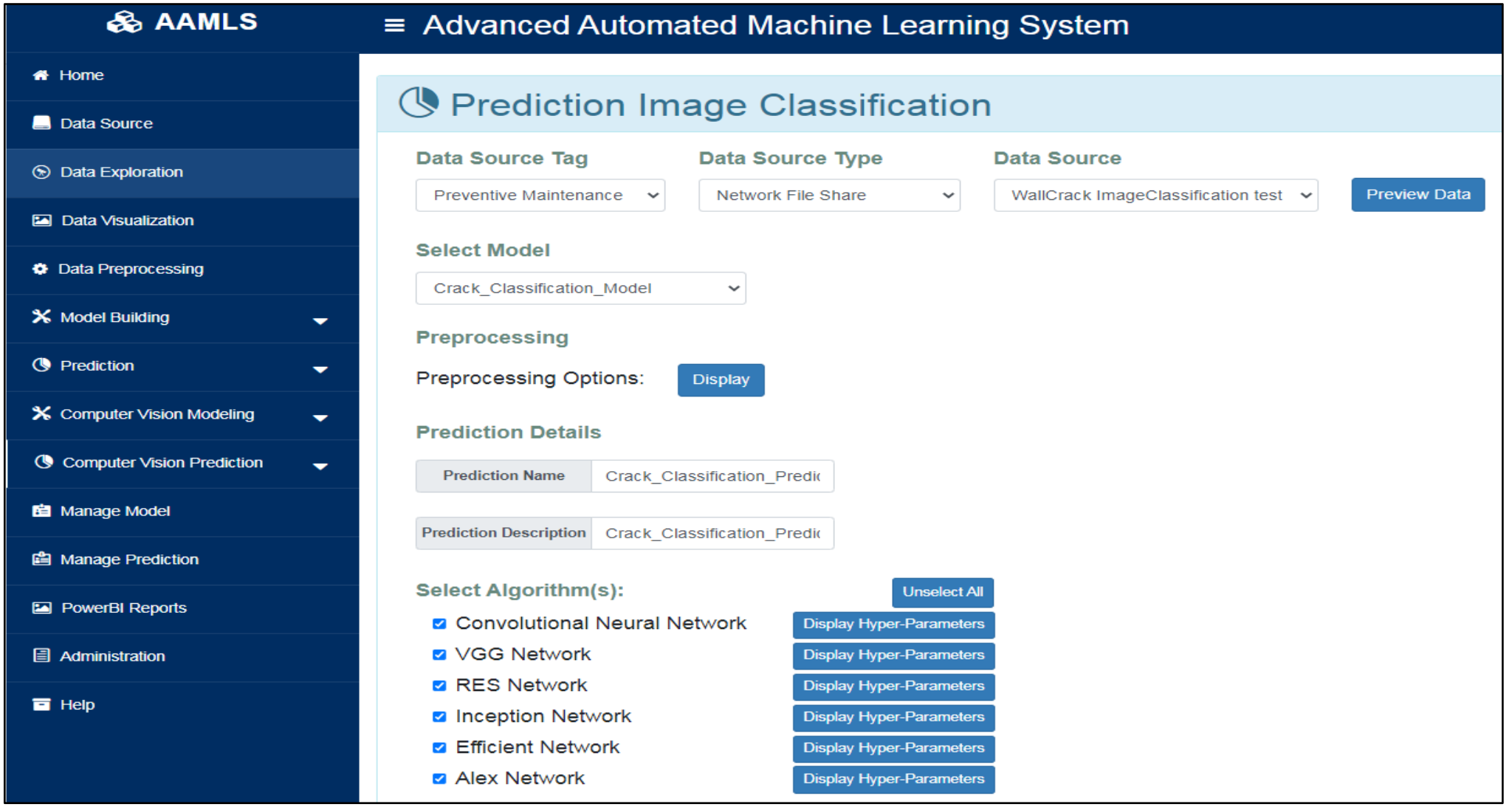


AAMLS - Computer Vision Modeling - Classification

FIU Applied Research Center

Subtask 9.2: Transition Previously Trained Deep Learning Models to the Advance Automated Machine Learning (AAML) System (NEW)

Research Highlights & Accomplishments:



AAMLS - Computer Vision Prediction - Classification

FIU Applied Research Center

Subtask 9.2: Transition Previously Trained Deep Learning Models to the Advance Automated Machine Learning (AAML) System (NEW)

Research Highlights & Accomplishments:

Prediction Results

Test Result	Algorithm Name	Hyper-Parameters	Algorithm Group	Status	Distribution	Frequency
View Test Result	Convolutional Neural Network	View Parameters	Image Classification	Success		
View Test Result	VGG Network	View Parameters	Image Classification	Success		
View Test Result	RES Network	View Parameters	Image Classification	Success		
View Test Result	Inception Network	View Parameters	Image Classification	Success		
View Test Result	Efficient Network	View Parameters	Image Classification	Success		
View Test Result	Alex Network	View Parameters	Image Classification	Success		

Algorithm Name: Convolutional Neural Network Download Results

Predicted	Filename	Image
CrackedWalls	data\00242.jpg	
SmoothWalls	data\00356.jpg	
CrackedWalls	data\00480.jpg	

AAMLS - Computer Vision Prediction Results – Classification

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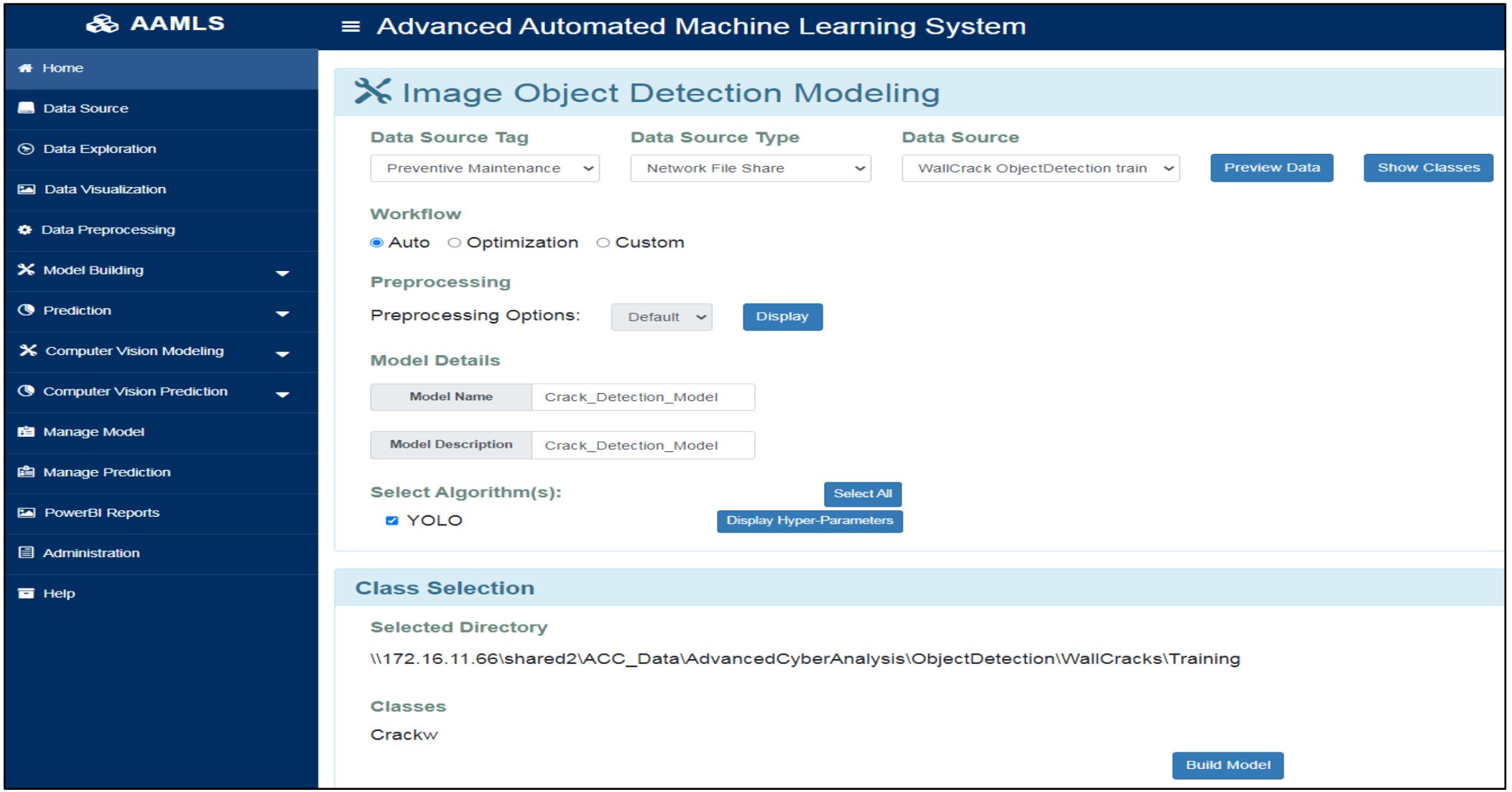
Subtask 9.2: Transition Previously Trained Deep Learning Models to the Advance Automated Machine Learning (AAML) System (NEW)

Research Highlights & Accomplishments:



AAMLS - Computer Vision Modeling - Object Detection

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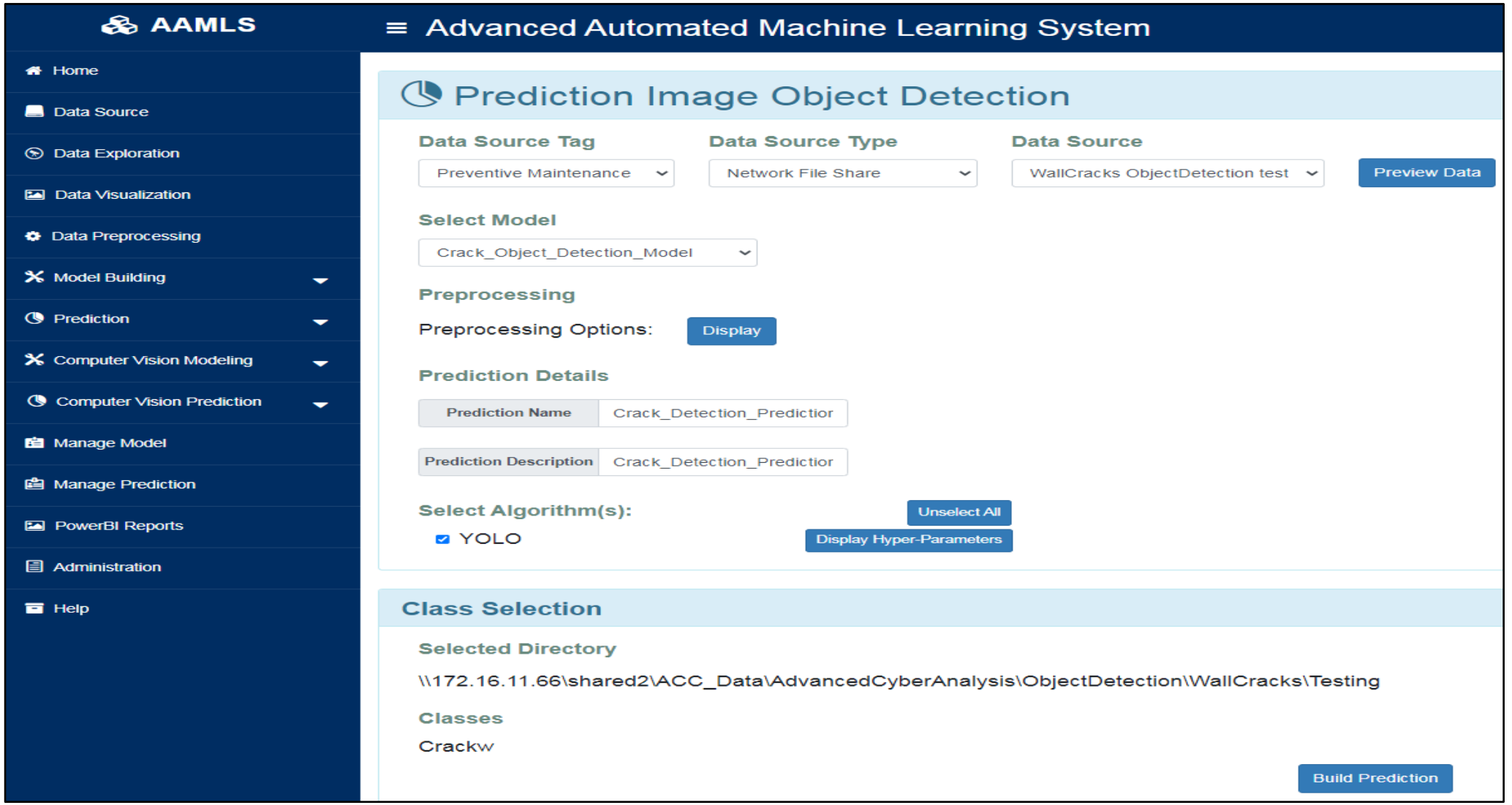
Subtask 9.2: Transition Previously Trained Deep Learning Models to the Advance Automated Machine Learning (AAML) System (NEW)

Research Highlights & Accomplishments:



AAMLS - Computer Vision Prediction - Object Detection

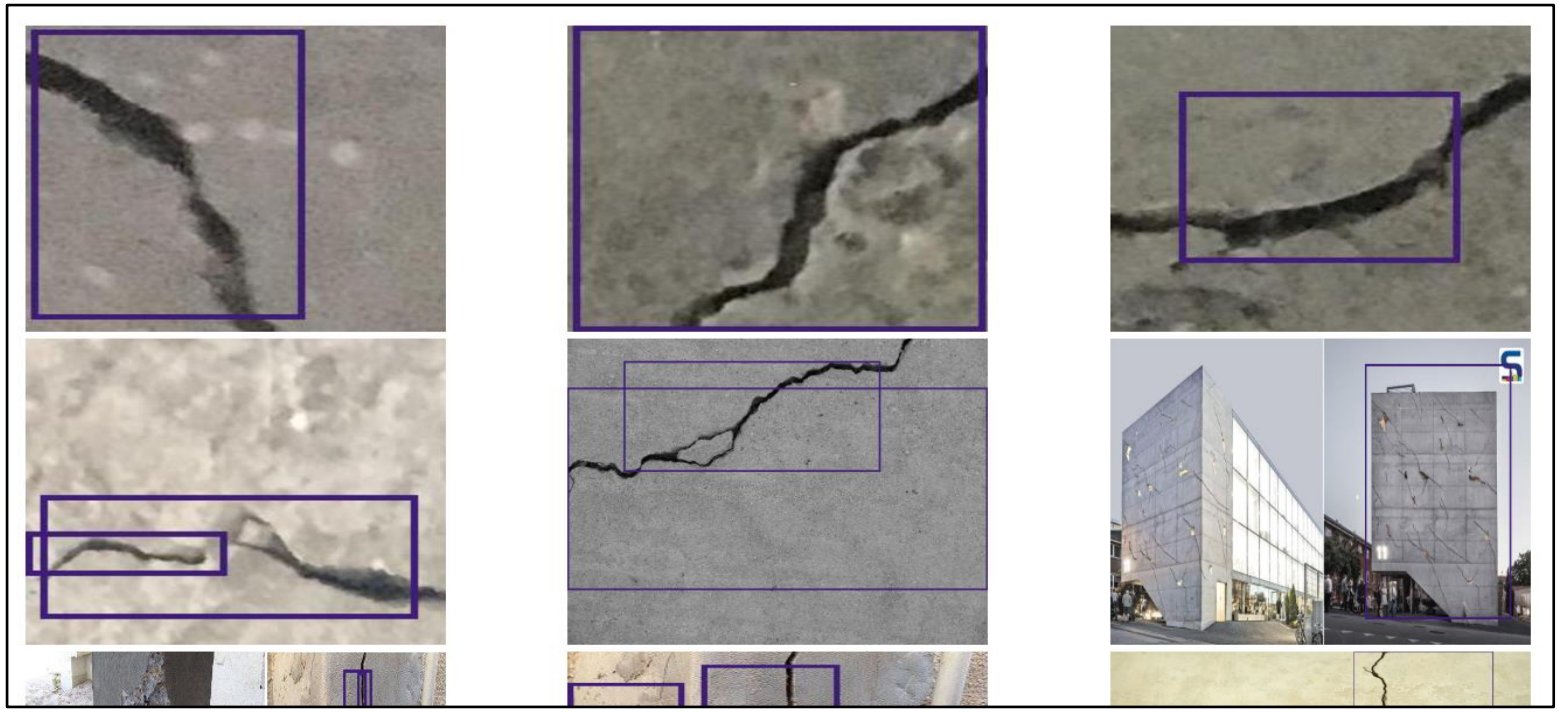
FIU Applied Research Center

Subtask 9.2: Transition Previously Trained Deep Learning Models to the Advance Automated Machine Learning (AAML) System (NEW)

Research Highlights & Accomplishments:

Prediction Results

Test Result	Algorithm Name	Hyper-Parameters	Algorithm Group	Status
View Test Result	YOLO	View Parameters	Image Object Detection	Success



AAMLS - Computer Vision Prediction Results - Object Detection

Task 9 - AI for EM Problem Set (Waste Processing): Nuclear Waste Identification and Classification using Deep learning

FIU Year 4 Projected Scope

- Research and implement an object detection algorithm with the following properties:
  - Does not require labeled data to learn to detect a new object.
  - Has the ability to choose which objects to detect, not just every foreground object.
  - Has real-time or close to real-time inference speeds.
- Continue to deploy the implemented models on the AAML System.

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DOE EM IT/AI Deployment Roadmap

	Technology	2020	2021	2022	2023	2024	2025
HQ All Sites	 WIMS	Site Deployment ✓					
HQ, SRNL, ANL, PNNL	 KM-IT	Site Deployment ✓					
PNNL	AI Soil & Ground Water	Data Exploration/ Visualization	Algorithm Development	Algorithm Optimization & Analysis	AI System Development & Integration	In-house Deployment	Site Deployment
LBNL, SRNL	AI Soil & Ground Water	Data Exploration & Visualization	Algorithm Development	Algorithm Optimization & Analysis	AI System Development & Integration	In-house Deployment	Site Deployment
SRNL	AI Waste Process				Algorithm Development	Algorithm Optimization & Analysis	In-house Deployment

DOE EM IT/AI Deployment Roadmap

HQ All Sites		WIMS
HQ, SRNL, ANL, PNNL		KM-IT
PNNL	AI Soil & Ground Water	
LBNL, SRNL	AI Soil & Ground Water	
SRNL	AI Waste Process	

- WIMS - Web application deployed at https://emwims.org - Used by DOE sites, disposition facilities and DOE HQ
- KM-IT - Web application deployed at https://www.dndkm.org - Used by DOE sites/facilities, National Laboratories, DOE HQ and D&D community
- AI PNNL (Soil & Ground Water) - AI Models will be deployed on AAMLS to be used by PNNL
- AI SRNL (Soil & Ground Water) - AI Models will be deployed on AAMLS to be used by LBNL, SRNL
- AI Waste Process (SRNL) - Site deployment

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DOE-FIU Cooperative Agreement

Upcoming Events Announcement

FIU Applied Research Center

DOE Fellows Poster Exhibition

DOE Fellows Induction Ceremony


Thank You. Questions?