



FIU Project 3 – Waste and D&D Engineering and Technology Development

Presented: August 26, 2020

Dr. Himanshu Upadhyay

FLORIDA INTERNATIONAL UNIVERSITY





FIU Personnel and Collaborators



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DOE-EM: Dinesh Gupta, Genia McKinley, Jean Pabon, Jonathan Kang

SRNL: Aaron Washington, Connor Nicholson

PNNL: Vicky Freedman, Rob Mackley



Project Tasks and Scope

Task 1 - Waste Information Management System (WIMS)

- Manage complex-wide waste forecast information for planned treatment/disposal
- Provide web-based system to receive, organize, and report DOE waste forecast streams via a common application

Task 2 - D&D Support for Technology Innovation, Development, Evaluation and Deployment

- Address high priority fire resiliency and safety requirements in support of SRS 235-F D&D project in collaboration with SRNL
- Implement phased approach for standards development, testing/evaluation, and deployment of D&D technologies
- Identify broader applications for intumescent coatings to meet other challenges across DOE complex

Task 3 - Knowledge Management Information Tool (KM-IT)

- Maintain and preserve D&D knowledge by enhancing communication, information sharing, and distribution to assist future D&D projects and workforce



Project Tasks and Scope

Artificial Intelligence Support to DOE-EM – D&D and Soil & Groundwater

Task 6 - Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

- Develop a pilot-scale infrastructure using machine learning/deep learning and big data technologies for structural health monitoring of facilities using imaging technologies with D&D mock up facilities at FIU

Task 7 – AI based Evaluation of Cr (VI) Concentrations in Groundwater in a Dynamic Pump and Treat Remediation Scenario (New)

- Development of machine learning and deep learning models to identify patterns, address knowledge gap and ultimately predict transport of Cr(VI) in the subsurface of the 100-H Area

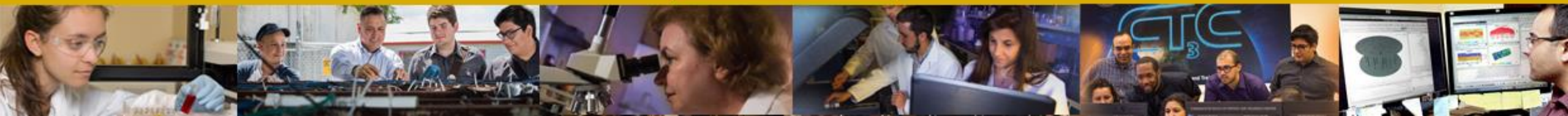


Knowledge Management Information Tool (KM-IT)

www.dndkm.org

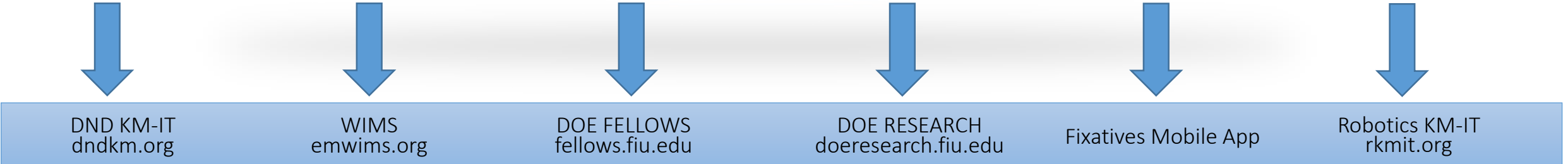
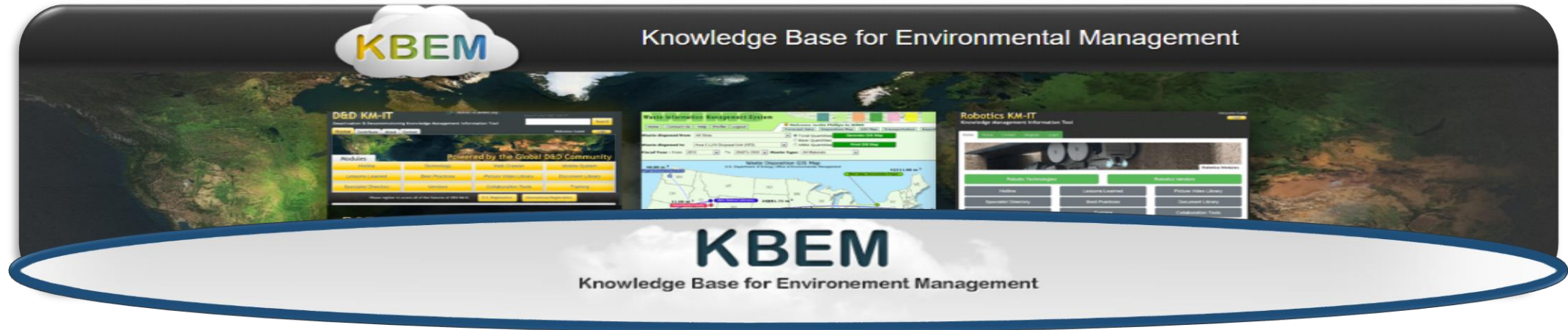
Dr. Himanshu Upadhyay

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Knowledge Base for Environmental Management



DND KM-IT
dndkm.org

WIMS
emwims.org

DOE FELLOWS
fellows.fiu.edu

DOE RESEARCH
doersearch.fiu.edu

Fixatives Mobile App

Robotics KM-IT
rkmit.org





Knowledge Base for Environmental Management





Knowledge Base for Environmental Management



D&D Knowledge Management Information Tool

D&D KM-IT is a web-based knowledge management information tool custom-built for the deactivation and decommissioning



Waste Information Management System



Robotics Knowledge Management Information Tool



Fixative Native App

Deactivation and Decommissioning Mobile Platform



DOE / FIU Cooperative Agreement Research



DOE / FIU Science & Technology Workforce Development Initiative

About KBEM

The KBEM provides a common interface for all IT applications for DOE EM developed and maintained by the Applied Research Center at Florida International University. The Knowledge Base for Environmental Management (KBEM) provides a unified system of knowledge management (community of knowledge) for the Department of Energy Office of Environmental Management (DOE EM) and includes the following major areas: Deactivation and Decommissioning (D&D), Soil and Groundwater (S&GW), Waste Processing, and International Knowledge

<https://kbem.org/>





KM-IT Modules

- D&D Hotline
- Technology Module
- Vendor Module
- D&D Research
- Mobile applications
- Lessons Learned
- Documents
- Pictures/videos
- Search tools
- Training
- Specialists
- Best Practices

www.dndkm.org

The screenshot shows the D&D KM-IT website interface. At the top, it displays the title "D&D KM-IT" and the subtitle "Deactivation & Decommissioning Knowledge Management Information Tool". There is a search bar and a "Search" button. Below the search bar are navigation tabs: "Home", "Contribute", "About", and "Contact". A "Welcome Guest" message and a "Login" button are also present. The main content area features a large banner with a world map and the text "Powered by the Global D&D Community". Below the banner is a grid of yellow buttons for various modules: Hotline, Technology, Web Crawler, Mobile System, Lessons Learned, Best Practices, Picture Video Library, Document Library, Specialist Directory, Vendors, D&D Research, and Training. A registration prompt is visible: "Please register to access all of the features of D&D KM-IT." with buttons for "U.S. Registration" and "International Registration". The "Additional Features" section includes "D&D RESEARCH", "Fixative Module", "ITSR Module", "Search SRS ISSC Reports", and "Prioritization Tool". A "Quick Links" section lists "DOE EM D&D", "SRS ISSC", "ALARA Center", "EFCOG", and "COGENTUS". The "Industry News" section features a photo of workers in hazmat suits and several news items. A "Contribute" section encourages users to share their knowledge and experience through D&D KM-IT.



Task 3 – Knowledge Management Information Tool (KM-IT)

FIU
Applied Research
Center

Accomplishments Year 10:

- FIU continued to conduct outreach and community support for KM-IT
- Participating in conferences and workshops
- FIU continues to publish current and relevant information into the KM-IT system such as news, vendors, technologies, lessons learned & best practices related to D&D.
- Development of articles, newsletters and infographics for the D&D community.



D&D KM-IT Knowledge Management Information Tool

In this issue...

As we mark over 100 days since the enforcement of coronavirus academic and lockdown policies began in the US, FIU has remained busy at work. Here are just a few of the tasks that have kept us occupied during this time.

- [2019-2020 Waste Stream Forecast Data on WIMS](#)
- [New Technologies Added to KM-IT](#)
- [What is YOLO?](#)
- [DOE Fellow Experience at Waste Management Symposia 2020](#)

2019-2020 Waste Stream Forecast Data on WIMS

In May, FIU collaborated closely with DOE HQ personnel to publish new forecast data on the Waste Information Management System (WIMS). WIMS tracks forecast data from 36 sites, 33 facilities, and 5 different waste types. The goal of WIMS is to provide a user-friendly online system to gather, organize, and present waste forecast data from DOE sites. The new data recently added contains data from 2020-2050. The new data can be accessed at <https://emwims.org/>.



New Technologies Added to KM-IT

In May, 24 new technologies were added to the [Deactivation & Decommissioning Knowledge Management Information Tool \(D&D KM-IT\)](#) with an additional 40 published in April. Among these technologies were face masks, detection devices, sensors, and heavy machinery for demolition. These technologies were added by the [DOE Fellows](#) working on this project as well as various vendors supporting the D&D mission. [Contact us](#) if you are a D&D vendor and would like your technology listed/showcased in KM-IT. You can also [browse our technology page](#) to see if your technology is already featured.

**D&D
KM-IT**



Task 3 – Knowledge Management Information Tool (KM-IT)



Accomplishments Year 10:

- 281 technologies were published on this platform in this fiscal year, bringing the total technologies published to 1259
- This is an increase of over 40% over the previous year when 196 technologies were added



Porter-Cable Circular Saw with Vacuum System



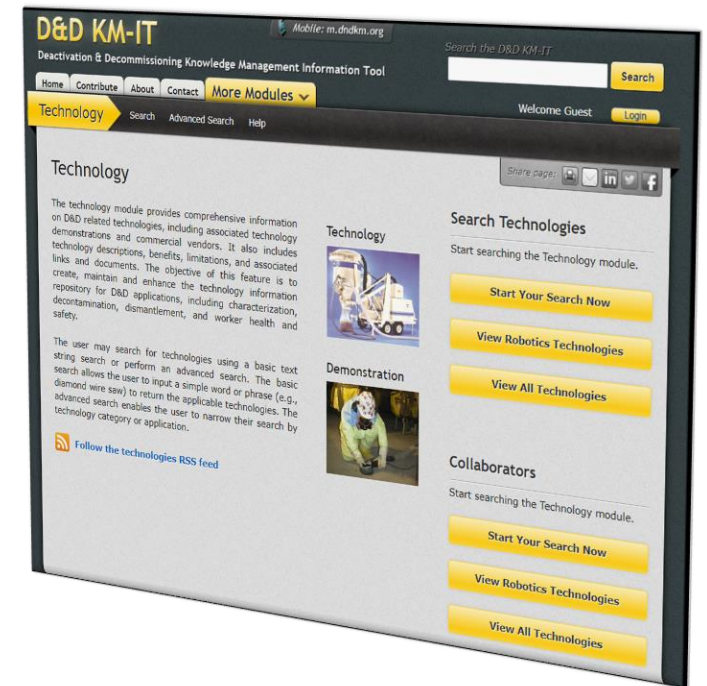
110 First Look Robot



Brokk 400



Anti-Contamination "BLU" Suit



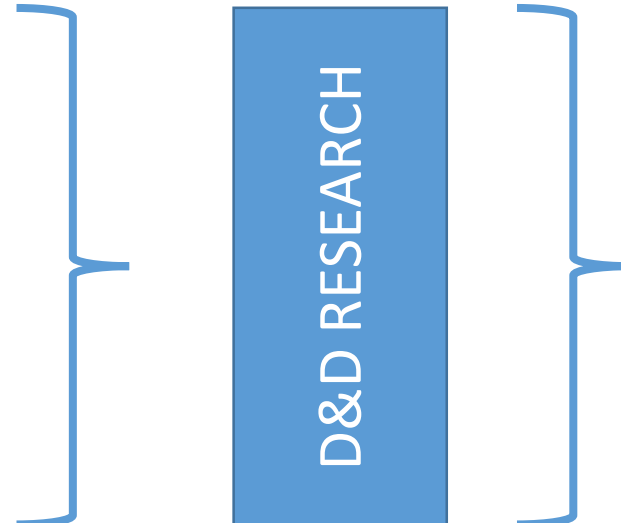


Task 3 – Knowledge Management Information Tool (KM-IT)

Accomplishments Year 10:

- FIU is working to enhance the D&D Research module by collaborating with universities, national labs and DOE sites.
- 10 potential entities are being followed. They include:

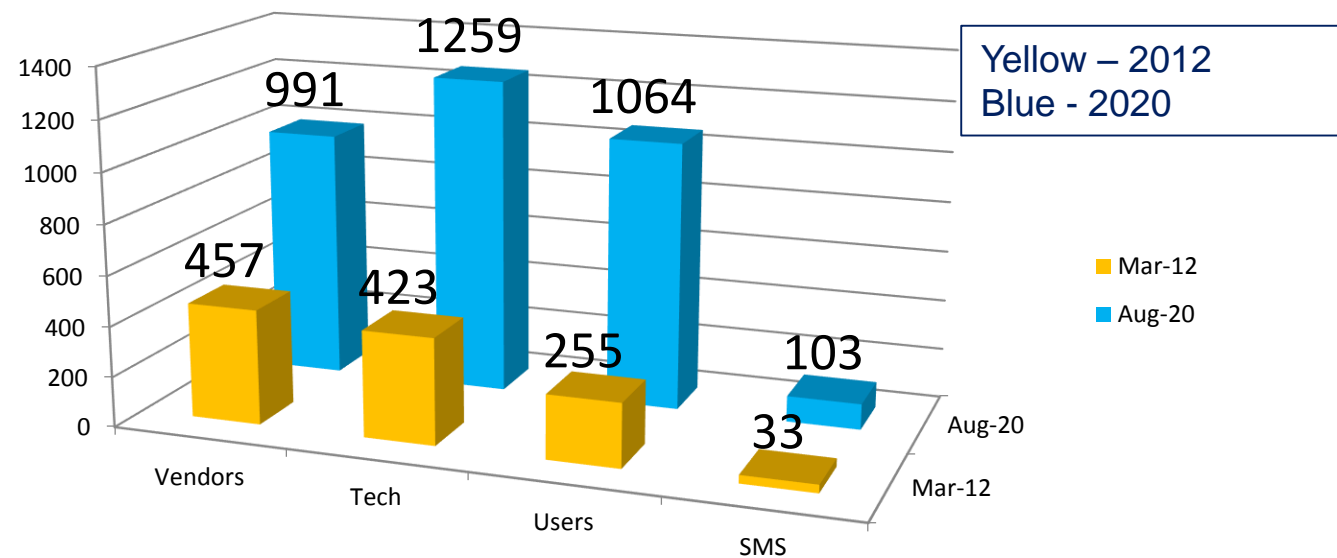
- Idaho National Laboratory
- NAC International
- Gilbane, Inc.
- Perdue University
- Florida A&M University
- University of Leeds
- University of Bristol
- Polestar Technical Services, Inc.
- John Wood Group PLC
- Los Alamos National Laboratory





D&D KM-IT Statistics as of August 2020

- D&D KM-IT web analytics to track usage metrics.
- 1259 D&D technologies
- 1064 registered users
- 991 D&D vendors
- 195 Hotline questions/solutions
- 103 subject matter specialists



Growth from March 2012 to Aug 2019

Fully searchable resources – Original sources no longer available

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



Task 3 – Knowledge Management Information Tool (KM-IT)



Accomplishments Year 10:

- FIU presented D&D KM-IT research at WM2020, demonstrated at FIU booth and D&D KM-IT Poster

Title: D&D Research on KM-IT platform

Authors: Walter Quintero, Himanshu Upadhyay, Leonel Lagos

Session: D&D Technology Application - Posters



D&D Research on KM-IT platform
 Developed by: FIU Applied Research Center
 Powered by the Global D&D Community

W. Quintero, H. Upadhyay, L. Lagos, P. Shoffner
 Applied Research Center, Florida International University
 10555 West Flagler Street, Suite 2100, Miami, FL 33174

Objective
 Knowledge management deals with the processes and practices used within the organization to identify, collect, distribute and store experiences. Deactivation and Decommissioning (D&D) work within the Department of Energy - Office of Environmental Management (DOE-EM) complex is a high-priority area. The Applied Research Center at Florida International University, working in collaboration with DOE-EM has developed a web-based Deactivation and Decommissioning Knowledge Management Information Tool (D&D KM-IT) to preserve the knowledge that the community has gathered through experiences on various projects.

Methodology - Modular Design
 The D&D Research module or D&D KM-IT is a repository of DOE-EM research in the industry including research being done by research centers such as FIU ARCC. The main objective of this module is to include relevant research information being part of these repositories.

Results
 The D&D Research module was launched on the DOE-EM IT framework to include extensive research information across past and current activities. This module highlights current EM research efforts and activities in support of D&D being performed at FIU/ARCC, associated with features and prominent products as well as robotic technologies developed at FIU/ARCC.

Conclusions & Future Work
 Result: A validated solution for the D&D community to access DOE-EM research across the DOE-EM platform.

Future Work
 Enhance D&D Research module for multiple DOE-EM sites, universities and national labs.
 DOE-EM Outreach - Community Support
 DOE-EM Maintenance & Administration
 Cybersecurity & Administration of KM-IT Infrastructure
 Content Management
 KM-IT Application and Database hardware upgrade

D&D KM-IT Focus Areas
 Decontamination: Solutions that address the challenges and problems to dismantle and reduce contaminated facilities process equipment, support equipment, and ventilation ducts.
 Characterization: Solutions that address the challenges and problems to assist in the accurate location, identification, and/or quantification of radiological contamination of DOE facilities.
 Decommissionation: Solutions that address the need to improve the decommissionation of DOE facilities including process equipment and ductwork.
 Worker Safety: Solutions that address the need to improve the protection of the health and safety of workers in contaminated DOE facilities.

D&D Research for DOE EM
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Physical Research
 • A highly technical content to include DOE-EM research in the industry including research being done by research centers such as FIU ARCC.
 • A highly technical content to include DOE-EM research in the industry including research being done by research centers such as FIU ARCC.

Public Research
 • DOE-EM research in the industry including research being done by research centers such as FIU ARCC.
 • DOE-EM research in the industry including research being done by research centers such as FIU ARCC.

Conclusions & Future Work
 Result: A validated solution for the D&D community to access DOE-EM research across the DOE-EM platform.

Future Work
 Enhance D&D Research module for multiple DOE-EM sites, universities and national labs.
 DOE-EM Outreach - Community Support
 DOE-EM Maintenance & Administration
 Cybersecurity & Administration of KM-IT Infrastructure
 Content Management
 KM-IT Application and Database hardware upgrade

FIU Applied Research Center
 dndkm.org



Task 3 – Knowledge Management Information Tool (D&D KM-IT)

Proposed Scope for FY20/FY21

- Subtask 3.1: D&D KM-IT Enhancement
 - Enhancement will include user interface responsive design and development.
- Subtask 3.2: Software Upgrades (Database and .NET Framework)
 - Migration of the existing database to SQL Server 2017 and KM-IT modules to .NET Framework 4.2
- Subtask 3.3: Content Management
 - Publishing D&D Technologies, vendors, lessons learned, best practices, D&D News and conferences with the assistance of DOE Fellows
- Subtask 3.4: Marketing and Outreach
 - Participation in industry conferences and workshops
 - Newsletters and mass communications
 - Reaching out to sites/national labs/universities to increase KM-IT user involvement



Waste Information Management System (WIMS)

<https://www.emwims.org>

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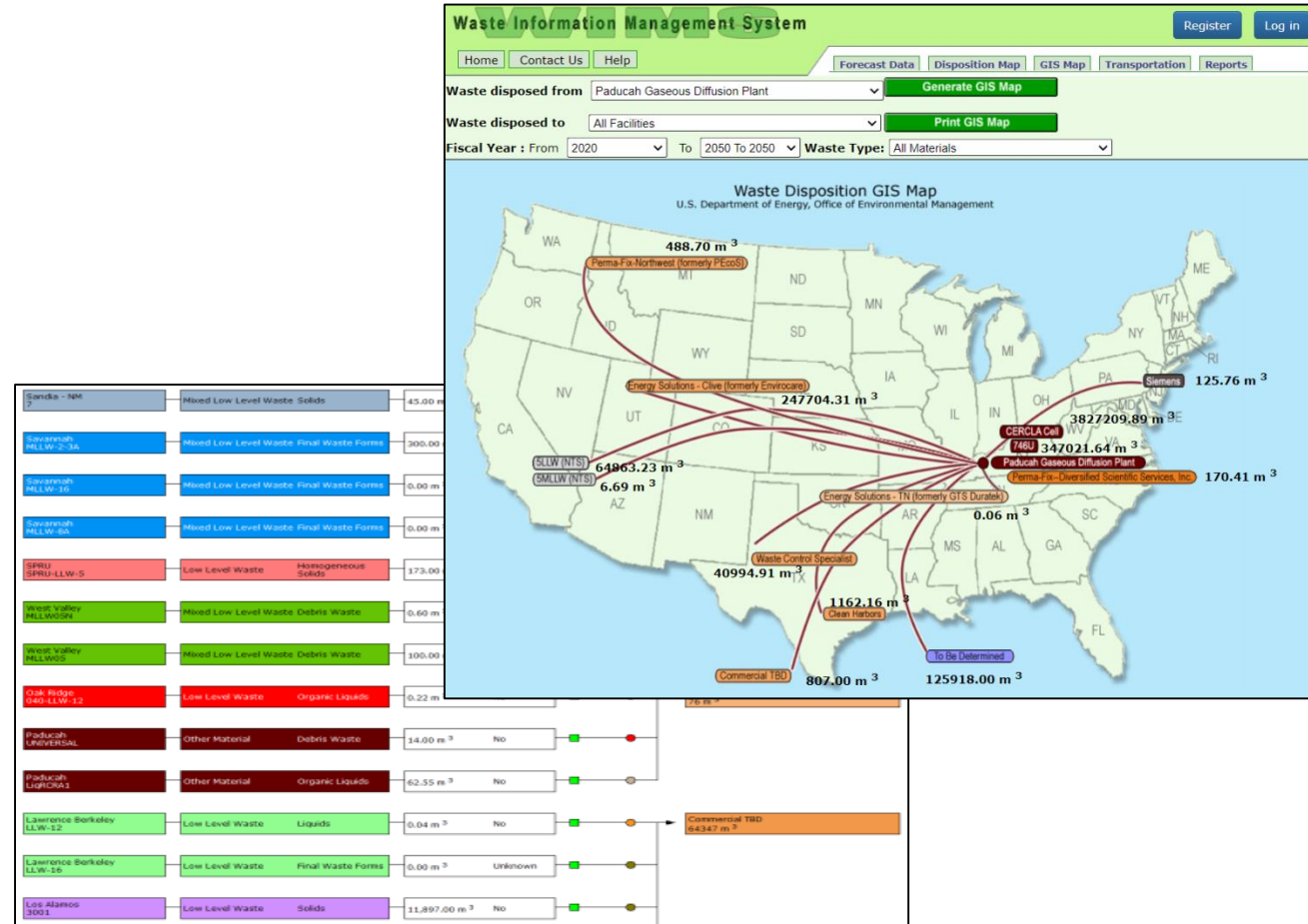


Task 1 – Waste Information Management System



Accomplishments Year 10:

- Easy-to-use system to visualize and understand the forecasted DOE-EM waste streams & transportation information.
- WIMS is deployed and available at <https://www.emwims.org>
- Various modules of WIMS are Forecast Data, Disposition Map, Successor Stream Map, GIS Map, Transportation, Reports and Help.





Task 1 – Waste Information Management System



Accomplishments Year 10:

- Completed integration of 2020 waste forecast and transportation data into WIMS system.
- Published 2020 Forecast Waste stream information in May 2020.

Waste from	<input type="text" value="All Sites"/>	<input type="button" value="Display Forecast Data"/>			
Waste to	<input type="text" value="All Facilities"/>				
Fiscal Year : From	<input type="text" value="2020"/>	To	<input type="text" value="2050 To 2050"/>	Waste Type:	<input type="text" value="All Materials"/>

Waste Information Management System

[Register](#) [Log in](#)

[Home](#) [Contact Us](#) [Help](#)

[Forecast Data](#) [Disposition Map](#) [GIS Map](#) [Transportation](#) [Reports](#)

Welcome to WIMS
Waste Information Management System

Waste Disposition GIS Map
U.S. Department of Energy, Office of Environmental Management

GIS Map

Automatically generates DOE waste pathway GIS maps

WIMS is developed to provide DOE Headquarters and site waste managers with the tools necessary to easily visualize, understand, and manage the vast volumes, categories, and problems of forecasted waste streams.

WIMS meets this need by providing a user-friendly online system to gather, organize, and present waste forecast data from DOE sites. This system provides a method for identification of waste forecast volumes, material classes, disposition pathways, and potential choke points and barriers to final disposition.

Disclaimer: Disposition facility information presented is for planning purposes only and does not represent DOE's decisions or commitments. Any selection of disposition facility will be made after technical, economic, and policy considerations.
In most cases, data set reflects sites' planning data as of 4Q FY 2019

Created by [Florida International University's Applied Research Center](#) for the [U.S. Department of Energy](#)

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 Applied Research Center Florida International University
<https://emwims.or>



36 Supported Sites

- Ames Laboratory
- Argonne National Laboratory
- Bettis Atomic Power Laboratory
- Brookhaven National Laboratory
- Energy Technology Engineering Center
- Fermi National Accelerator Laboratory
- Hanford Site-RL
- Hanford Site-RP
- Idaho National Laboratory
- Kansas City Plant
- Knolls Atomic Power Laboratory - Kesselring
- Knolls Atomic Power Laboratory - Schenectady
- Lawrence Berkeley National Laboratory
- Lawrence Livermore National Laboratory
- Los Alamos National Laboratory
- Naval Reactor Facility
- Nevada Test Site
- NG Newport News
- NG Newport News
- Norfolk Naval Shipyard
- Nuclear Fuel Services, Inc. (cleanup site)
- Oak Ridge Reservation
- Paducah Gaseous Diffusion Plant
- Pantex Plant
- Pearl Harbor Naval Shipyard
- Pacific Northwest National Laboratory
- Portsmouth Gaseous Diffusion Plant
- Portsmouth Naval Shipyard
- Princeton Plasma Physics Laboratory
- Puget Sound Naval Shipyard
- Sandia National Laboratories - NM
- Savannah River Site
- Stanford Linear Accelerator Center
- Separations Process Research Unit
- Thomas Jefferson National Accelerator Facility
- Waste Isolation Pilot Plant
- West Valley Demonstration Project



33 Disposition Facilities

- 200 Area Burial Ground (HANF)
- 746-U Landfill(Paducah)
- Alaron
- Area 5 LLW Disposal Unit (NTS)
- Area 5 MLLW Disposal Cell (NTS)
- Clean Harbors
- Commercial TBD
- E-Area Disposal (SRS)
- EMWMF Disposal Cell (ORR)
- Energy Solutions-Clive (formerly Envirocare)
- Energy Solutions-TN (formerly GTS Duratek)
- ERDF (HANF)
- Impact Services-TN
- INL CERCLA Cell (INL)
- Integrated Disposal Facility (HANF)
- New RH LLW Vaults (INL)
- ORNL Liquid LLW System
- OSWDF(Portsmouth)
- Paducah CERCLA
- Perma-Fix Gainesville
- Perma-Fix--Diversified Scientific Services, Inc.
- Perma-Fix--Northwest (formerly PEcoS)
- Perma-Fix/Materials & Energy Corp
- River Metals
- RMW Trenches (MLLW/LLW) (HANF)
- RMW Trenches/IDF (HANF)
- RWMC (LLW disposal) (INL)
- Siemens
- Smokey Mountain Solutions
- Studsvik/RACE , LLC
- TA 54/Area G (LLW disposal) (LANL)
- To Be Determined
- Waste Control Specialists



Task 1 – Waste Information Management System

Accomplishments Year 10:

- FIU presented WIMS research in 2020 Waste Management Symposia.

Title: Waste Information Management System with 2019-20 Waste Streams

Session: LLW/ILW Characterization

Authors: Himanshu Upadhyay, Walter Quintero, Leonel Lagos



Himanshu Upadhyay presenting WIMS at the 2020 Waste Management Symposia Phoenix, AZ



Task 1 – Waste Information Management System

Proposed Scope for Year 10

- Subtask 1.1: WIMS System Administration - 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.
- 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
 - Publish updated application on secured socket layer for cyber security



Task 1 – Waste Information Management System

Proposed Scope for FY20/FY21

- Subtask 1.3: Upgrade GIS module with Google Map API
 - The current GIS module will be upgraded to reduce the development time when adding new disposition sites and facilities to the module. With Google Map API, the module will be more interactive and will provide richer user experience.
- Subtask 1.4: Deploy Power BI Reporting Server for Waste Stream Reports
 - Power BI is a powerful new reporting server which is reliable and efficient. This task will replace the existing SQL reporting server.
- Subtask 1.5: Cyber Security of WIMS Infrastructure
 - Provide cyber security to WIMS infrastructure, application, database server and reporting server.
 - Cybersecurity training and support of DOE Fellows while working with pen testing & forensics tools used with WIMS system.



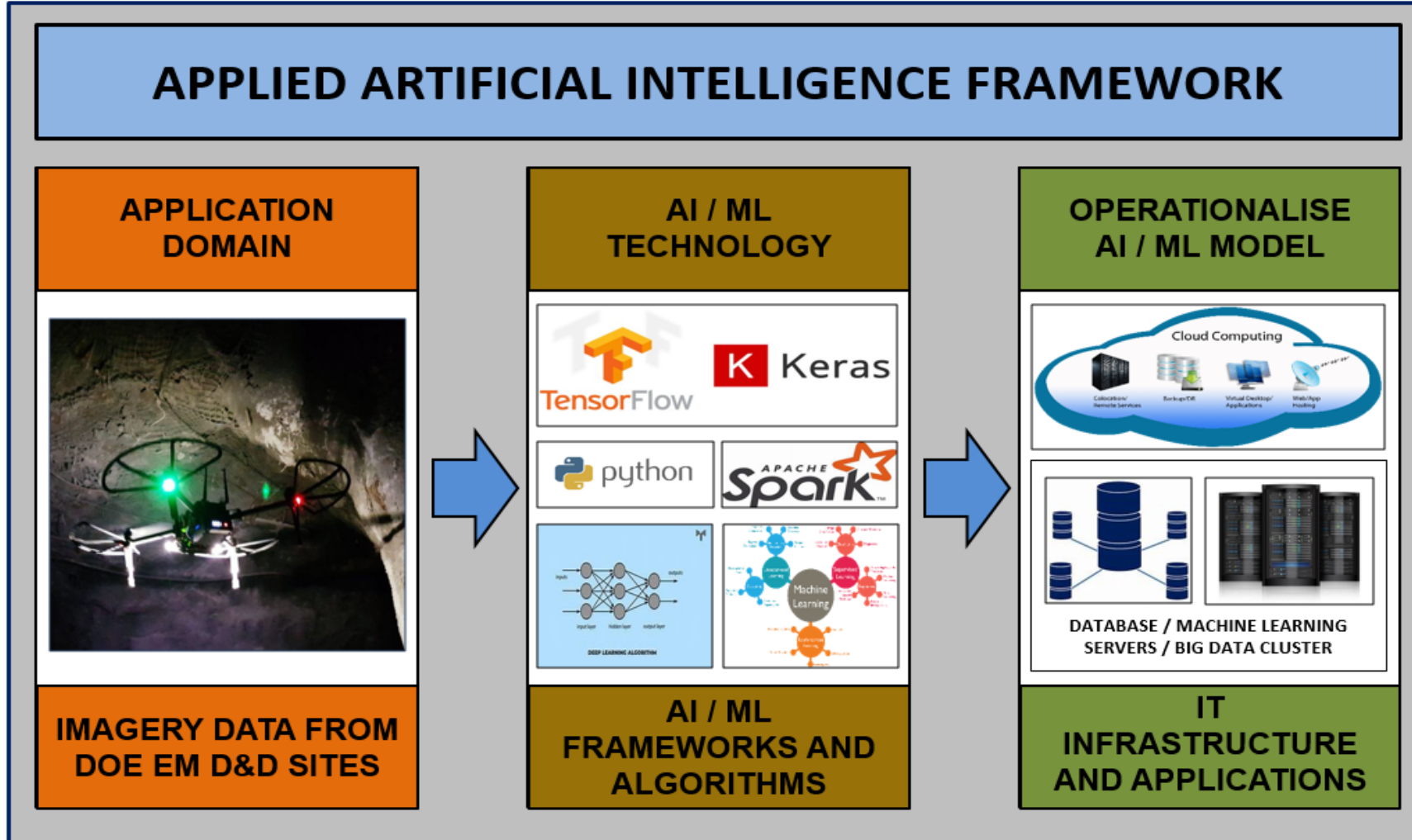
Artificial Intelligence Support to DOE-EM

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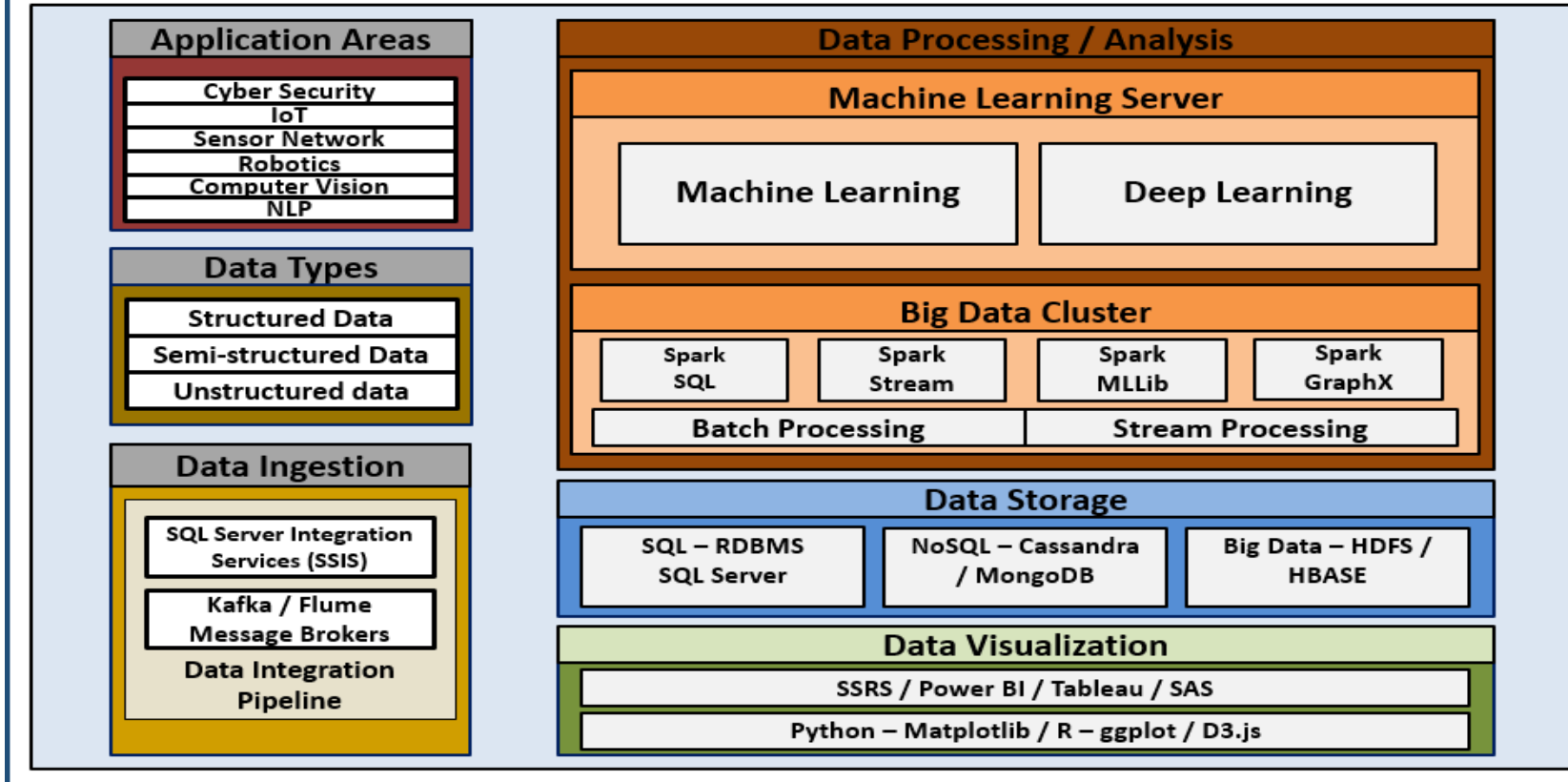
Artificial Intelligence Support to DOE-EM





Artificial Intelligence Support to DOE-EM

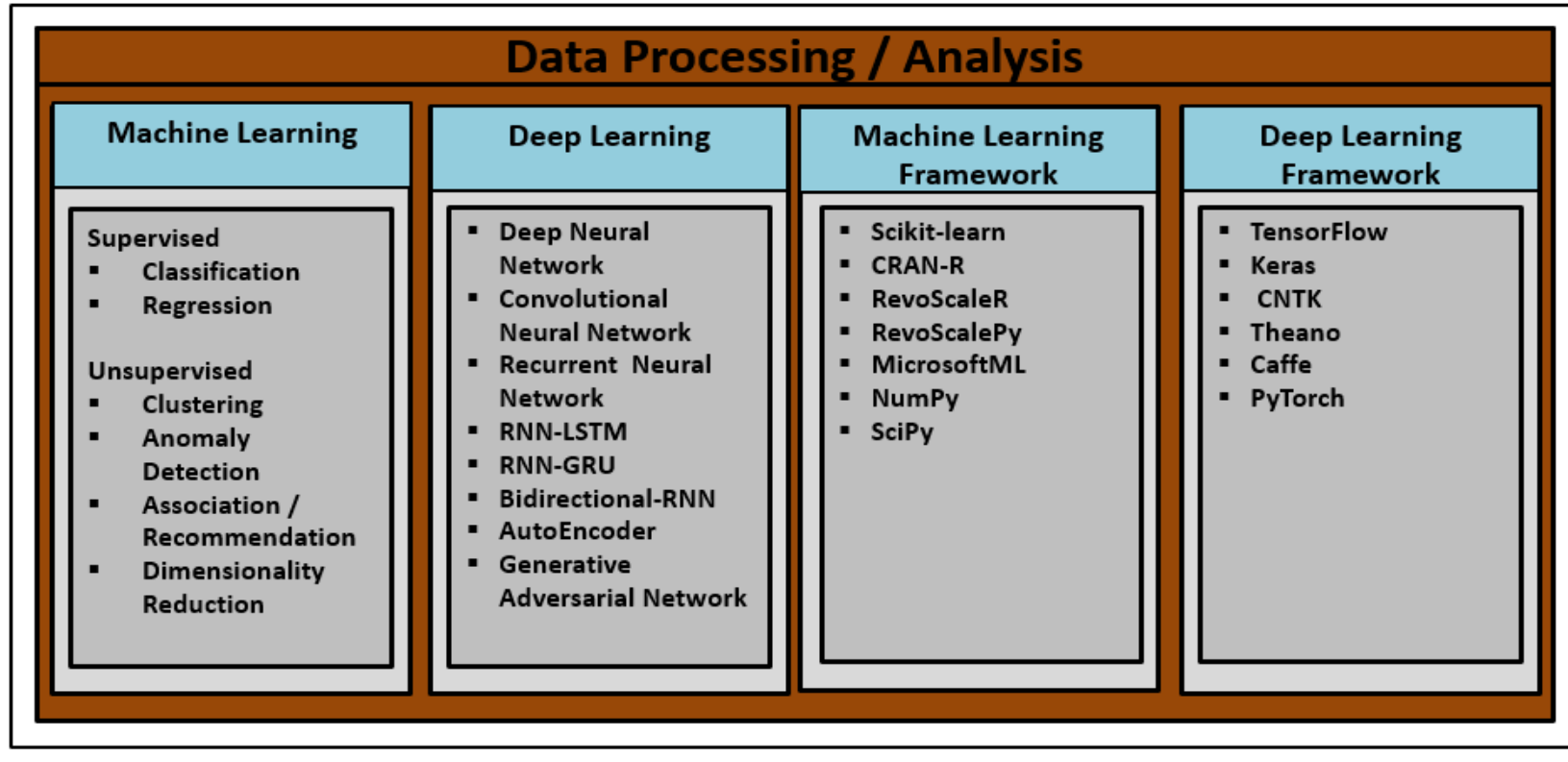
Artificial Intelligence & Big Data Hub On-Premise | Cloud | Hybrid





Artificial Intelligence Support to DOE-EM

Artificial Intelligence Algorithm & Framework





Artificial Intelligence Support to DOE-EM – D&D

Task 6- Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

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Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Site Needs:

Assess the structural integrity of aging facilities in support of ongoing surveillance and maintenance (S&M) across the DOE complex.

Objectives:

FIU is developing a pilot-scale infrastructure to implement structural health monitoring using scanning/imaging technologies, machine learning / deep learning and big data technologies. This pilot system is intended to serve as a starting point to engage the DOE field sites on related data sets and will help in their S&M decision making needs.



Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Accomplishments Year 10:

Object Detection using YOLOv3 Algorithm with Data from Camera Device:

Data Collection:

- Three image data sets were collected.
- Data set composition:
 - First data set contains 1,000 images
 - Collected with a digital camera and a green screen.
 - Second data set contains 65 images.
 - Images were taken in an outdoor environment.
 - Third data set contained 50 images.
 - Images were taken in an indoor environment.



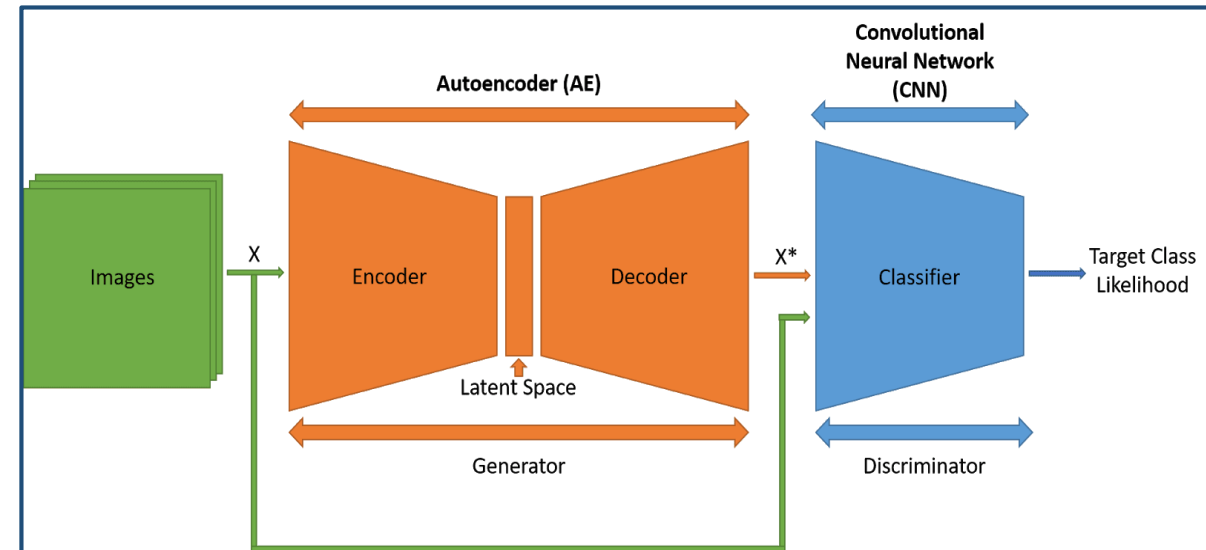


Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Object Detection using YOLOv3 Algorithm with Data from Camera :

Data Preprocessing:

- Implemented a One Class Classifier (OCC) for data preprocessing
 - Hybrid model approach between Auto Encoder (AE) and Convolutional Neural Network (CNN).
 - The AE model serves as a data generator.
 - The CNN works as a class discriminator.
 - Model is trained as a Generative Adversarial Network (GAN).
 - Hidden layers include Convolution Layers, Max Pooling, and Batch Normalization.
 - Latent space of 256 filters.



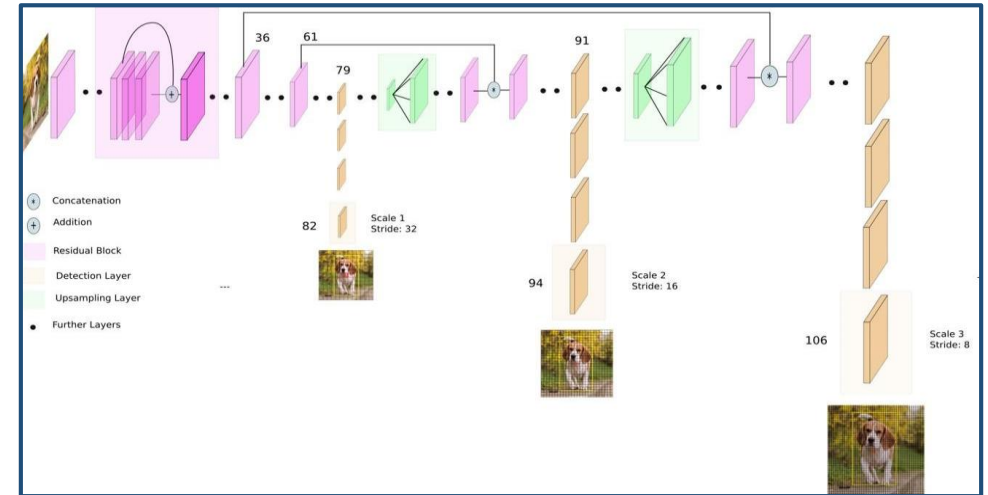


Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

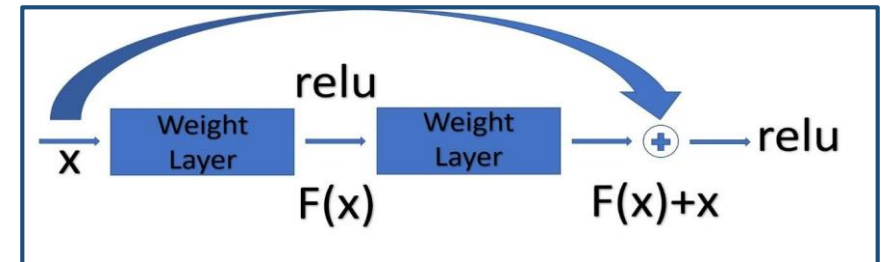
Object Detection Using YOLOv3 Algorithm:

YOLOv3 Algorithm Implementation:

- Implemented YOLOv3 (You Only Look Once V3) architecture.
 - Near-Time and Real-Time object detection.
 - Suitable for streaming videos, static videos, and still images.
 - Uses 53 convolutional neural networks layers (CNN).
 - Deep network for maximum feature extraction.
 - This network uses residual skip connections and up-sampling techniques.
 - Helps the neural network converge and generalize.
 - GPU server is used for the Real-Time object detection.



You Only Look Once version 3 (YOLOv3) architecture. Source: Reference: <https://towardsdatascience.com/yolo-v3-object-detection-53fb7d3bfe6b>



You Only Look Once version 3 (YOLOv3) Skip Connection Implementation

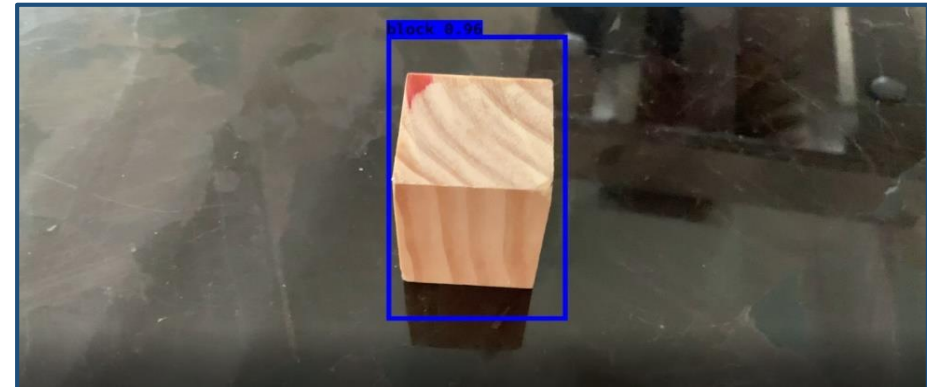


Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Object Detection Using YOLOv3 Algorithm:

Results:

- YOLOv3 model able to detect the wooden block on a countertop surface with 0.96 confidence score.
- YOLOv3 model able to detect the wooden block on outdoor test facility mock-up wall with 0.78 confidence score.





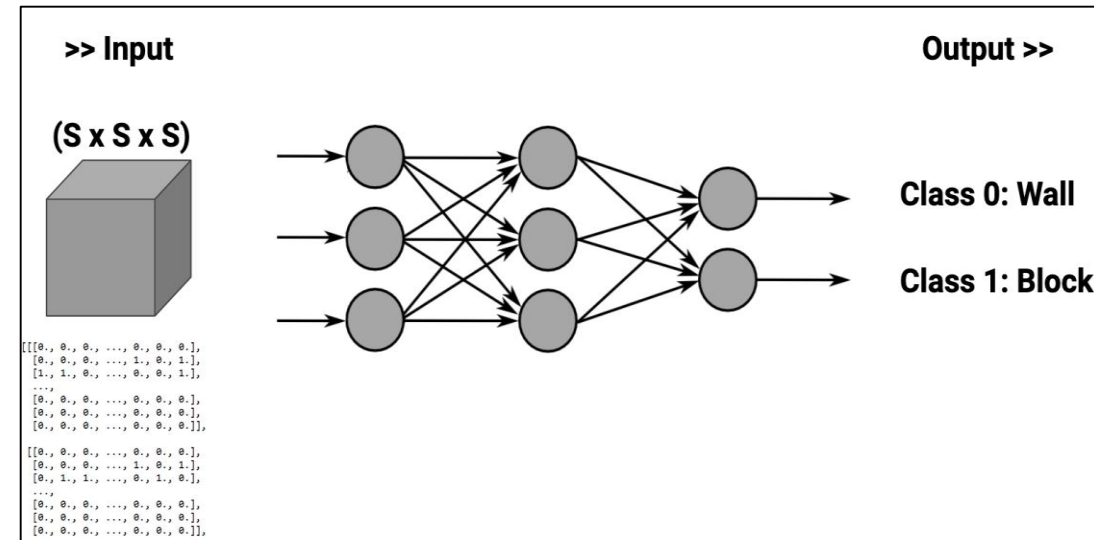
Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies



Object Detection using Lidar Scans:

Neural Network Algorithm Implementation:

- The following neural network layers are implemented
Input → Dense (8) → Dense (8) → Dense (16) → Flatten → Dense (2)
- The input to the network is a 3D array of 0s and 1s.
- The last layer of the network is a dense layer of 2 neurons since we want probabilities of the input belonging to either Class 0 (wall) or Class 1 (block).





Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies



Presented Artificial Intelligence Application to D&D Poster at WM2020 symposium. Conference attendees had a lot of interest in this research focused on Artificial Intelligence technologies in D&D area.

Title: Artificial Intelligence Application to D&D
Authors: Himanshu Upadhyay, Leonel Lagos, Santosh Joshi

Artificial Intelligence Application to D&D

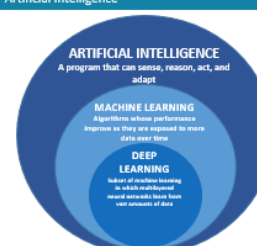
H. Upadhyay, L. Lagos, S. Joshi
 Applied Research Center, Florida International University, Miami, FL. 33174

Background

As the aging facilities at DOE Complex await decommissioning, there is an ongoing need to understand the structural health of these structures. Many of these facilities were built over 50 years ago and in some cases these facilities have gone beyond the operational life expectancy. In other cases, the facilities have been placed in a state of "cold and dark" and they are sitting unused, awaiting decommissioning. Especially challenging are the aging facilities that provide unique operational/production capabilities to support critical DOE missions and cannot be shut down.

- It is critical that adequate inspections be performed on a continual basis.
- The data collected from the nuclear infrastructure undergoes sufficient analysis to support timely identification of any new or worsening structural issues.
- Artificial intelligence framework to analyze the huge amount of data generated by the sensors, as well as imagery devices, to monitor the conditions of the building over a period of time.

Artificial Intelligence



Artificial Neural Networks

Artificial Neural Networks (ANN) are set of algorithms, loosely modeled and inspired by the biological human brain, which are designed to recognize patterns.

Deep Learning

Deep learning is a subset of machine learning based on ANNs that use multiple layers in succession to progressively extract features.

- Two major types of Deep Neural Networks are Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN).
- CNN is a class of deep neural network that is most commonly applied to visual imagery. CNNs have many applications in image and video recognition, image classification, and image analysis.
- RNN is a type of artificial neural network designed to recognize a data's sequential characteristics and use patterns to predict the next likely scenario. RNNs are mainly used in speech recognition and natural language processing.

Objectives

The primary goals of this research is to evaluate machine learning/deep learning algorithms and frameworks that can be effectively employed to solve EM challenges in surveillance and maintenance of the D&D facilities.

- FIU has performed extensive research in the area of Artificial Intelligence and its applications to D&D problem sets.
- Focused areas include Classification, Image Processing and Object Recognition.

Machine Learning

Machine Learning is the science of getting computers to learn and act like humans do, and improve their learning over time in autonomous fashion, by feeding those data and information in the form of observations and real-world interactions.


- Machine learning algorithms are often categorized as supervised or unsupervised.
- Supervised machine learning algorithms can apply what has been learned in the past to new data using labeled examples to predict future events.
- Unsupervised machine learning algorithms are used when the information used to train is neither classified nor labeled.

Case Study: D&D Structural Health Monitoring

FIU has developed pilot-scale infrastructure to implement structural health monitoring using AI technologies focused on machine learning and deep learning. This research implements Computer Vision and Image Classification areas of deep learning.

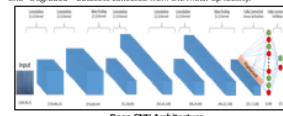
Data Collection:

- Over 28,000 images were collected from the outdoor test facility.
- Images form a baseline for the model to learn and validate.
- Images are labelled as either "Baseline" or "Degraded".



Results

- A 9-layer deep CNN architecture was designed to tackle the classification task between "Baseline" and "Degraded".
- 96% to 98 % classification accuracy was achieved with "Baseline" and "Degraded" datasets collected from the mock-up facility.



Introduction

Artificial intelligence is a broad field in which computer science techniques are applied to enable machines to mimic human behavior.

- AI performs the cognitive functions such as "learning" and "problem solving".
- AI has applications in wide range of industries such as Energy and Mining, Healthcare, Manufacturing, Finance, Marketing, Retail, Transportation, Agriculture, Nuclear industry etc.
- AI is a bigger umbrella which includes Machine Learning and Deep Learning.
- Main categories of machine learning algorithms include Regression, Classification and Anomaly Detection.

Applications of Deep Learning

Computer vision

Self-driving cars (object detection), Healthcare (improved diagnosis)

Natural language

Communication (language translation)

Finance

Algorithmic Trading, Fraud Detection, Research, Personal Finance, Risk Mitigation

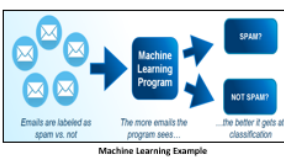
Energy

Oil & Gas Exploration, Smart Grid, Operational Improvement, Conservation

Government

Science, Data Insights, Safety & Security, Equipment, Smart Cities

Machine Learning Example



Future Work

FIU will continue the research on deep learning algorithms for object detection in 3-dimensional space. It will be used for locating cracks and determining if they have changed in size compared to the baseline. This approach will show D&D experts various cracks and their condition over time.

Acknowledgment

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Task 6 – Analysis of Image Data using Machine Learning/Deep Learning and Big Data Technologies

Proposed Scope for FY20/FY21

- Artificial Intelligence support for DOE-EM problem set – D&D
- FIU will continue to work on Surveillance & Maintenance of D&D Infrastructure by applying the AI technologies.
- FIU will work on Predictive Analysis using Machine Learning Models to detect cracks on the infrastructure. This will serve as an early notification to facility maintenance personnel to pay particular attention to the identified areas.
- FIU will continue work on One Class SVM, AE, CNN and GAN to improve on object detection leading to identifying cracks on the walls of D&D infrastructure.
- This task will lead to PhD work of DOE Fellow – Roger Boza focused on Computer Vision.



Artificial Intelligence Support to DOE-EM Soil & Groundwater

**Task 7 – AI based Evaluation of Cr (VI) Concentrations in
Groundwater in a Dynamic Pump and Treat Remediation
Scenario (New)**

FLORIDA INTERNATIONAL UNIVERSITY





Task 7 – AI based Evaluation of Cr (VI) Concentrations in Groundwater in a Dynamic Pump and Treat Remediation Scenario (New)

Proposed Scope for FY20/FY21

- Artificial Intelligence support for DOE-EM problem set – Soil & Ground Water
- Machine learning and deep learning models can be developed to identify patterns, address knowledge gap and ultimately predict transport of Cr(VI) in the subsurface of the 100-H Area.
- Exploratory data analysis of water quality and contaminant data
- Identify key master variables controlling Cr(VI) concentrations in groundwater/monitoring wells and the vadose zone
- Study the changes in precipitation patterns on Cr(IV) distribution
- Data visualization of contaminants and well distribution



Q & A

Thank You

