



# GEOCURRENT

the technology division of Magnolia River

## The Role of AI in Natural Gas Software Solutions

# Introduction



- Dan Sasser
- Software Product Manager
- Magnolia River - 2014
  - GIS – 2014-2020
    - Technician, Coordinator, Production Manager, Project Manager
  - Software – 2021 – present
- Field-to-office workflows, GPS Hardware and Software, Construction Inspection Documentation

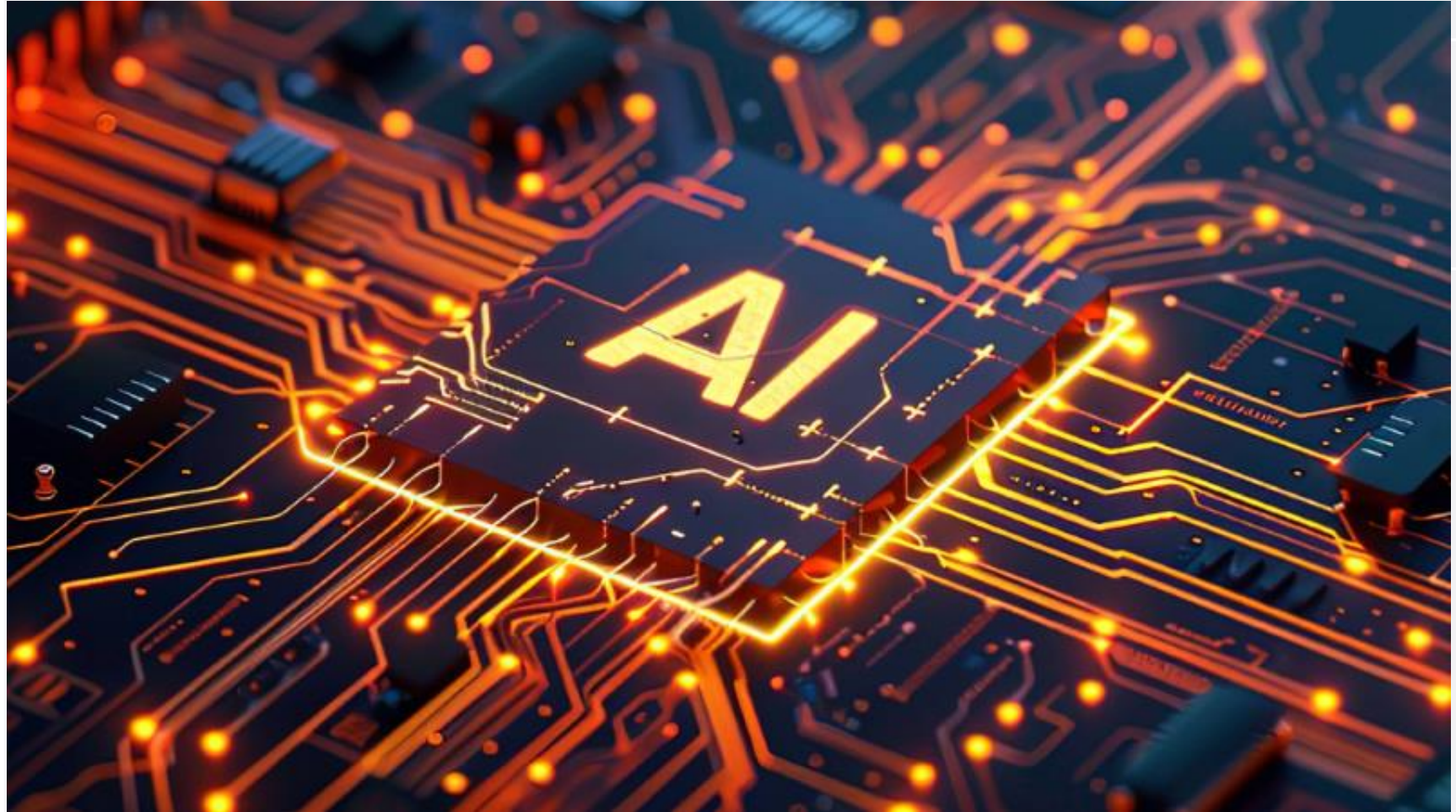
# Agenda



- **What is Artificial Intelligence?**
- **Types of Artificial Intelligence**
- **Identifying the ‘Why’**
- **Magnolia River Research and Development**
- **Analytics and Data**



# What is Artificial Intelligence (AI)?



“The term ‘artificial intelligence’ means a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations or decisions influencing real or virtual environments.”

- *National Artificial Intelligence Act of 2020*

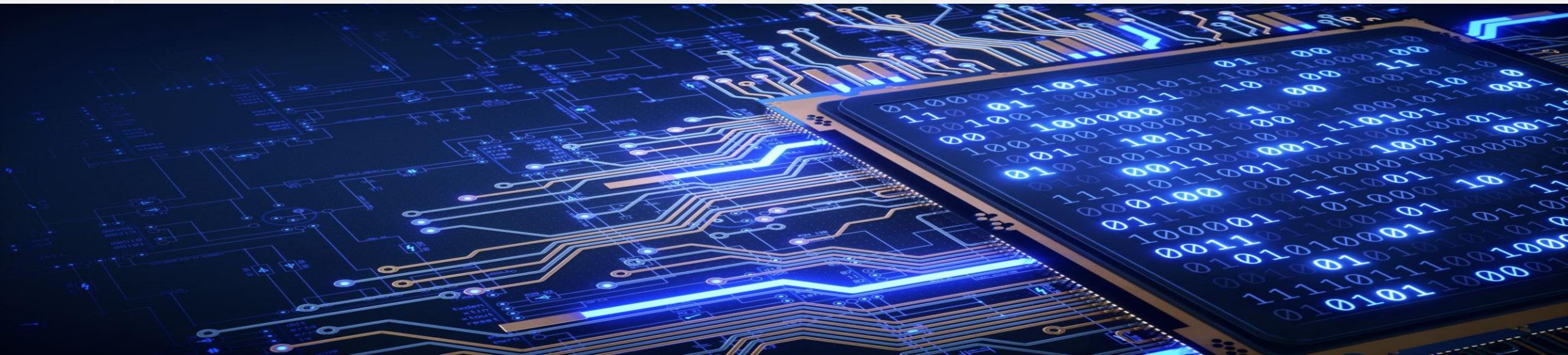
“a technical and scientific field devoted to the engineered system that generates outputs such as content, forecasts, recommendations or decisions for a given set of human-defined objectives”

- *ISO/IEC 22989:2022*



# In Simple Terms...

Artificial Intelligence is the process of building intelligent machines from vast volumes of data



# Types of Artificial Intelligence

## Based on Capabilities

- Narrow AI (weak AI)– designed to perform a narrow/niche task
  - Facial recognition, internet searches, driving a car
- General AI (strong AI) – broad human-like cognitive capabilities. Enables it to take on new and unfamiliar tasks autonomously
  - Resolve challenges without human guidance
- Superintelligent AI – future form where machines could surpass human intelligence across all fields
  - Speculative and not yet realized

## Based on Functionalities

- Reactive Machines – analyze and respond to different situations
- Limited Memory – make informed and improved decisions by studying past data
- Theory of Mind – advanced and still in progress – entails making decisions based on understanding and remembering emotions
- Self-aware AI – futuristic, machines have own consciousness, sentience and self awareness

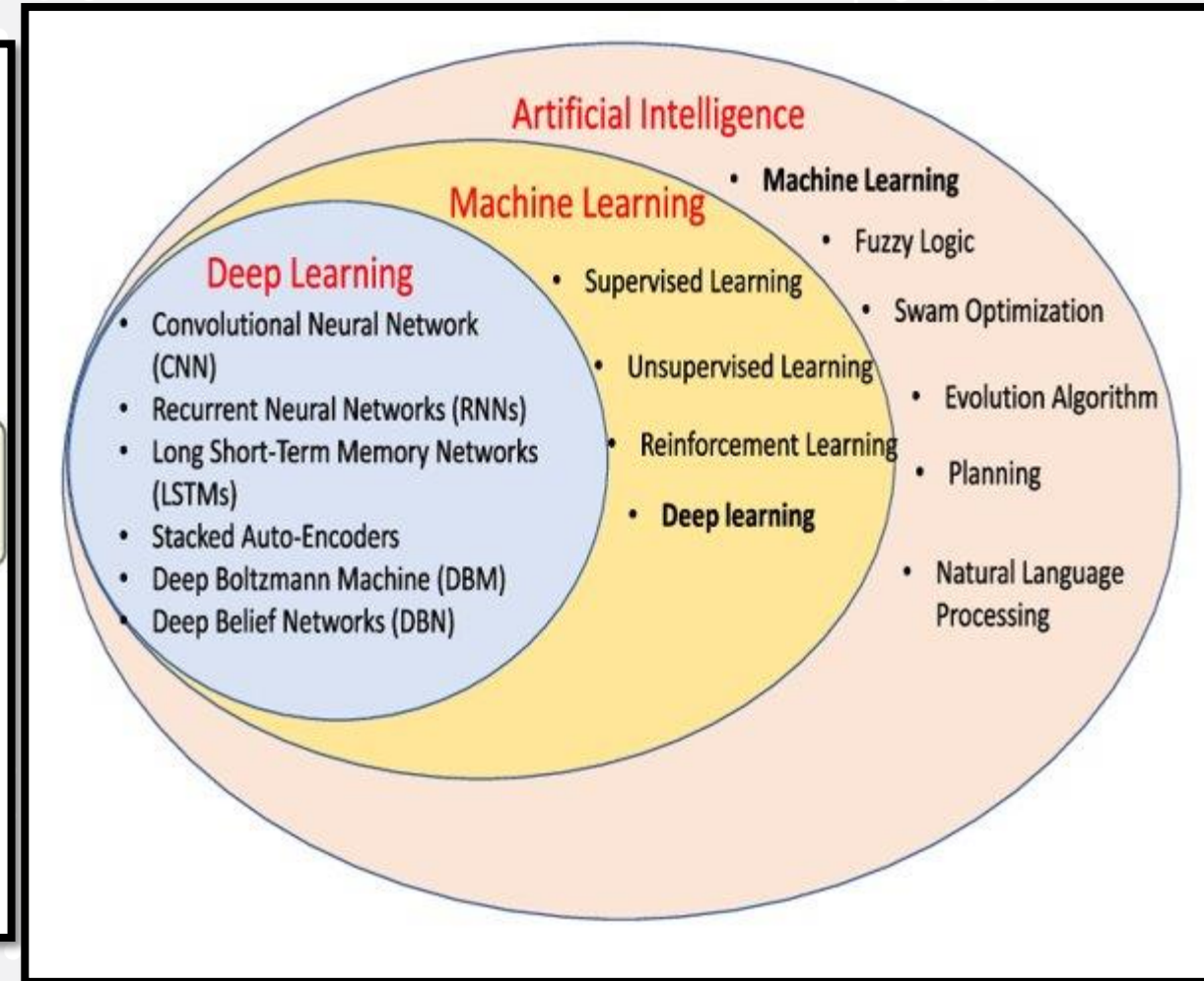
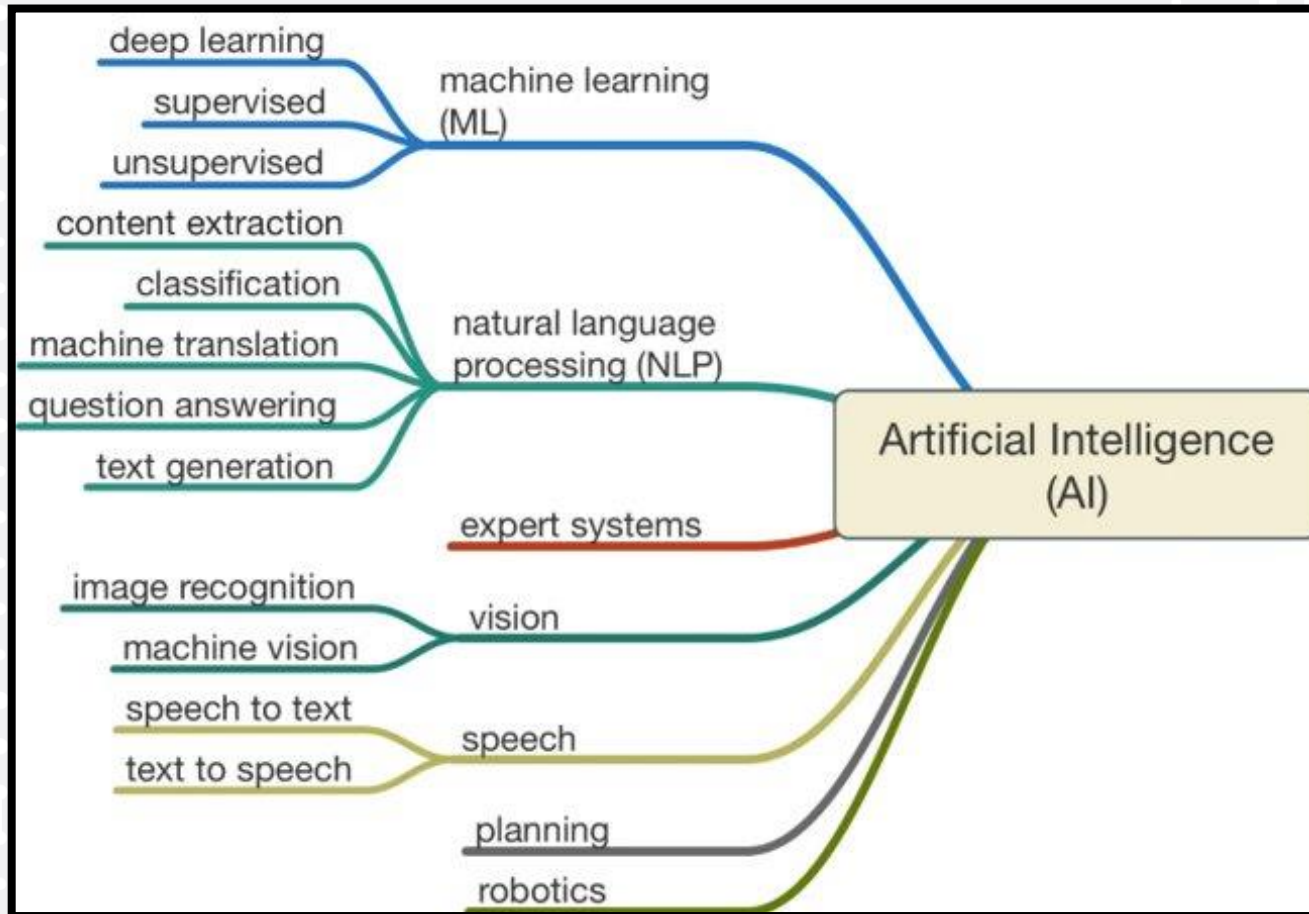
## Based on Technologies

- Machine Learning – capable of self improvement through experience and can independently learn
- Deep Learning – subset of ML – used to learn from large amounts of data
- Natural Language Processing – understand and interpret human language
- Robotics – designing, constructing, operating, and using robots and computer systems to process feedback
- Computer Vision – interpret the world visually
- Expert Systems – answer questions and solve problems



# Main Areas of Artificial Intelligence

Artificial Intelligence (AI) encompasses a variety of subfields and techniques



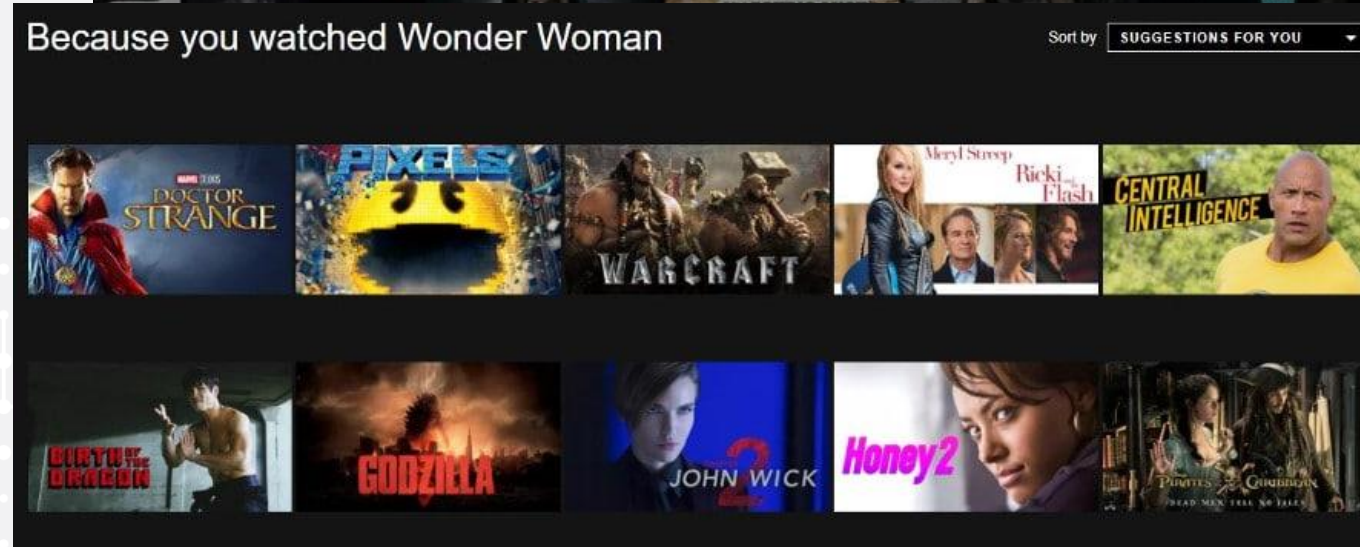
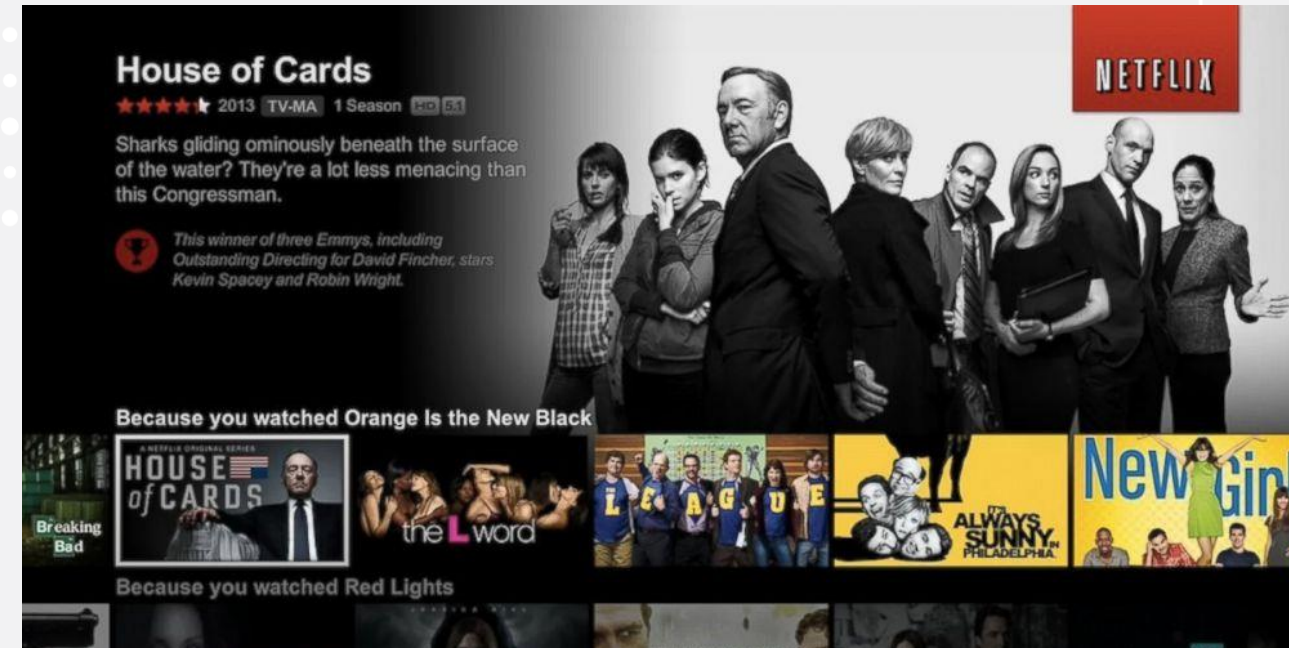


# Main Areas of Artificial Intelligence

- **Machine Learning** – use and development of computer systems are able to learn and adapt without following explicit systems, by using algorithms and statistical models to analyze and draw inferences from patterns in data
- **Deep Learning** – based on artificial neural networks in which multiple layers of processing are used to extract progressively higher level features from data
- **Computer Vision** – enables computers to derive information from images, videos, and other inputs
- **Robotics** – designing, building, and operating robots that perform physical tasks.
- **Natural Language Processing** – allows computers to understand, manipulate, and generate human language

# Machine Learning

- **Supervised Learning** – involves training an algorithm using labeled data, where the desired output is already known
- **Unsupervised Learning** – relies on unlabeled data, allowing the algorithm to identify patterns and structures within the dataset
- **Reinforcement Learning** – models learn by interacting with their environment and receiving feedback in the form of rewards or penalties



# Deep Learning

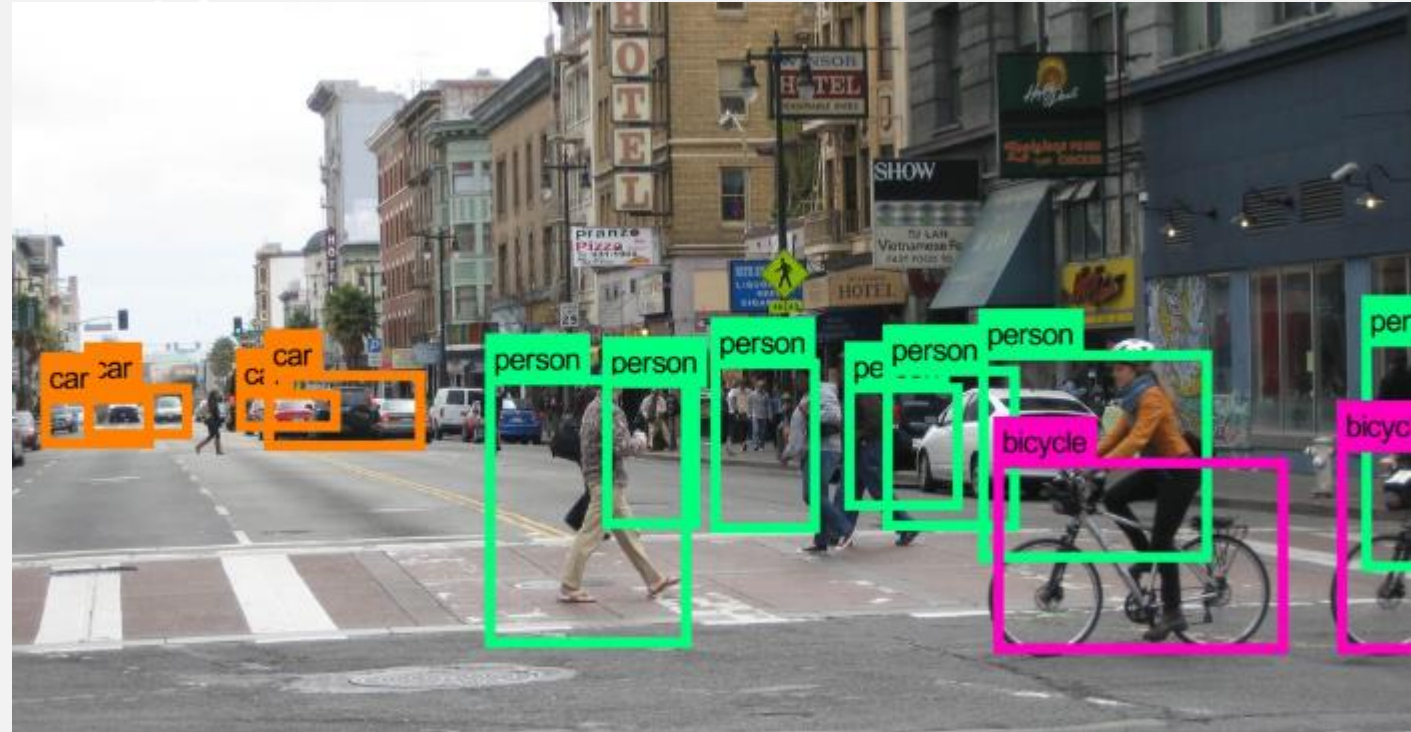
- **Image Recognition** – techniques such as Convolutional Neural Networks (CNNs) have revolutionized computer vision, enabling object detection, facial recognition, and image classification
- **Natural Language Processing (NLP)** – techniques such as Recurrent Neural Networks (RNNs) and Transformers have significantly improved language understanding, translation, and generation
- **Generative Adversarial Networks (GANs)** – capable of generating realistic images, videos, and other types of data by learning from existing datasets





# Computer Vision

- **Object Detection and Recognition** – identifying and classifying objects within images or videos, with applications in surveillance, manufacturing, and retail
- **Optical Character Recognition (OCR)** – converting printed or handwritten text into machine-readable format, facilitating digitization and data extraction
- **Scene Reconstruction** – creating 3D models of scenes or objects from 2D images or videos, used in virtual reality, gaming, and architectural modeling



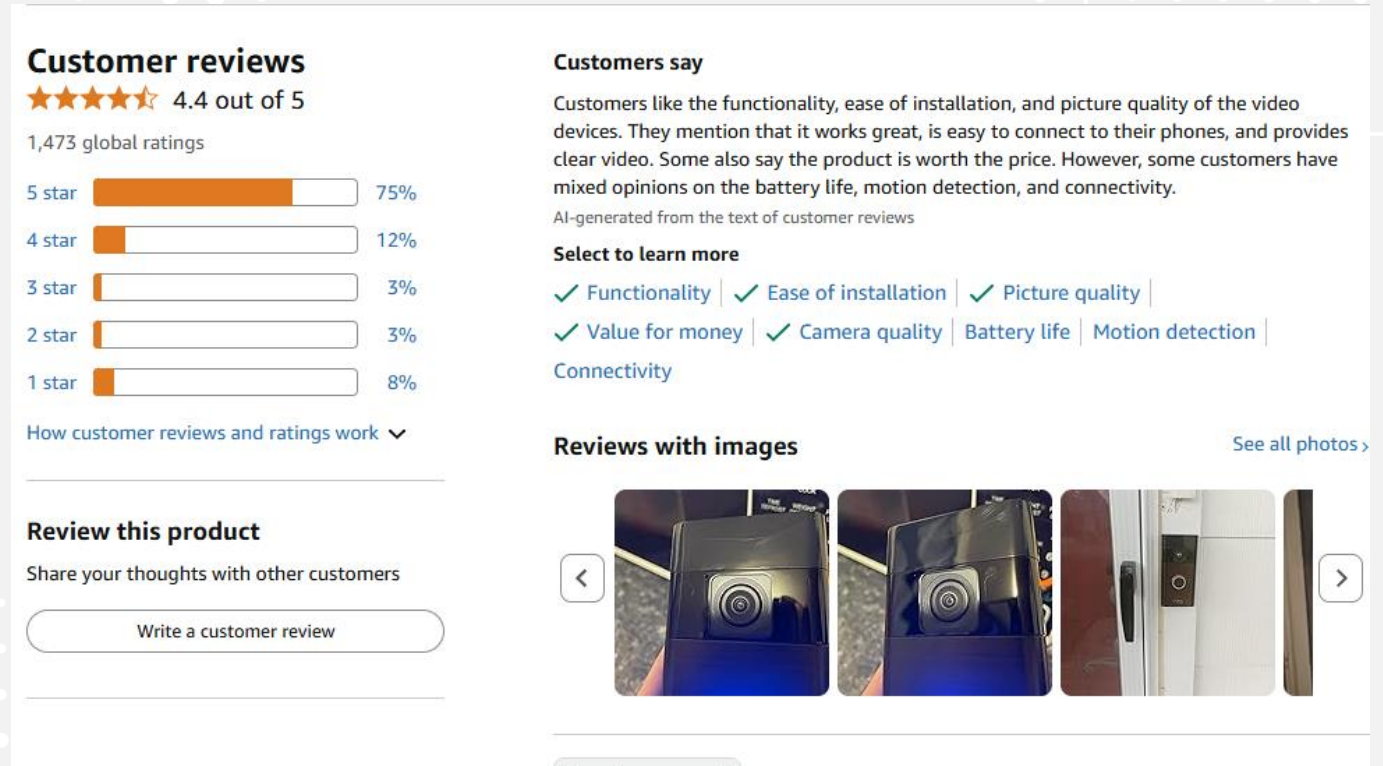
# Robotics

- **Autonomous Vehicles** – self-driving cars and drones utilize AI for navigation, obstacle detection, and decision-making
- **Humanoid Robots** – mimic human appearance and behavior, enhancing their ability to interact and collaborate with people
- **Robotic Process Automation (RPA)** – employs software bots to automate repetitive, rule-based tasks, improving efficiency and reducing human error



# Natural Language Processing

- **Sentiment Analysis** – analyzing the sentiment or emotion behind text data, useful in areas such as customer feedback and social media monitoring
- **Text Summarization** – automatically generating concise summaries of large documents or articles, enhancing information retrieval and comprehension
- **Chatbots and Virtual Assistants** – AI-driven conversational agents that can understand and respond to user queries in a natural, human-like manner





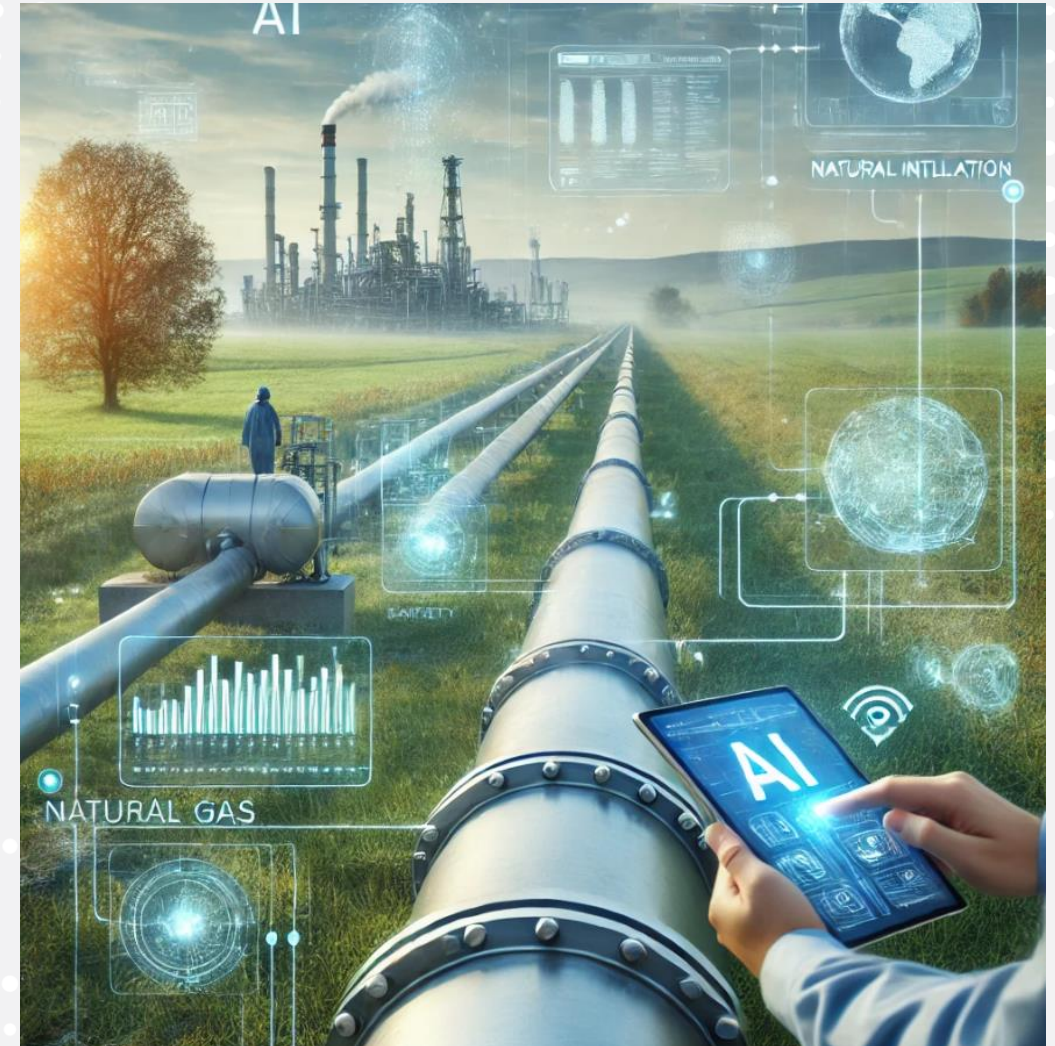
# Identifying the 'Why'

**How can this technology be useful in our industry?**

- **Data and Analytics**
- **Key Performance Indicators**
- **Quality Control**
- **Pattern Recognition**
- **Safety**

# Practical Uses for AI in the Natural Gas Industry

- **Pipeline Monitoring and Maintenance**
  - Predictive Maintenance
  - Leak Detection
- **Regulatory Compliance**
  - Data Validation
  - Environmental Monitoring
- **Inspection Automation**
  - Drone and Robot Inspections
  - Corrosion Analysis
- **Safety**
  - Risk Assessment
  - PPE




**Anyone currently using AI in their organization?**



# ChatGPT

I need to design a natural gas regulator station. What steps should be taken and considerations made during design?

 Designing a natural gas regulator station requires careful planning, engineering, and adherence to industry standards and regulations. Here's a step-by-step guide and key considerations:

## Steps for Designing a Natural Gas Regulator Station

### 1. Define the Purpose and Scope

- Identify the station's role in the gas distribution system (e.g., pressure reduction, flow regulation, odorization).
- Determine the flow rates, inlet/outlet pressures, and future capacity needs.

### 2. Gather Site Data

- Conduct a site survey for physical, environmental, and legal constraints.
- Ensure the location is accessible for maintenance and operation but away from high-risk areas like flood zones.

### 3. Regulatory Compliance

- Review applicable standards (e.g., ASME, ANSI, DOT 49 CFR 192 in the U.S.).
- Ensure compliance with local building codes, fire safety standards, and environmental regulations.

### 4. Determine Station Configuration

- Choose a layout based on required components, such as:
  - **Inlet valves** for isolation.
  - **Filter/separators** to remove particulates.
  - **Regulators** for pressure control.
  - **Pressure relief valves (PRVs)** or **slam-shut valves** for safety.
  - **Metering equipment** for flow measurement.
  - **Heaters** if gas temperature needs stabilization.
  - **Odorization units** if odorant injection is required.
- Design redundancy (e.g., parallel regulator runs) for reliability.

### 5. Pressure and Flow Analysis

- Perform detailed calculations for:
  - Pressure drop across the system.
  - Flow velocities to prevent noise or erosion.
  - Thermal effects on materials and gas flow.

### 6. Select Equipment

- Choose equipment suitable for operating pressures, flow rates, and temperature ranges.
- Specify materials compatible with natural gas and expected environmental conditions.

### 7. Layout and Piping Design

- Create a clear layout minimizing pressure drop and ensuring easy access for maintenance.

# ChatGPT

## Key Considerations During Design

1. **Safety:** Always prioritize safety in the design, ensuring proper venting, emergency shutdowns, and pressure relief systems.
2. **Scalability:** Design the station to handle future capacity increases with minimal upgrades.
3. **Environmental Impact:** Minimize emissions and noise, and comply with environmental regulations.
4. **Weather and Terrain:** Account for local climatic conditions and site-specific challenges like seismic activity or soil stability.
5. **Cost vs. Reliability:** Balance cost considerations with the need for reliability and redundancy.

Would you like more information about specific equipment or design standards?

# “What does the PHMSA manual require natural gas operators do?”



The PHMSA manual for natural gas operators requires the following key actions:

1. **Operations & Maintenance Plan:** Develop and implement procedures for inspections, leak surveys, and recordkeeping.
2. **Emergency Response:** Establish emergency plans, train personnel, and notify authorities in case of incidents.
3. **Operator Qualification:** Ensure workers are trained and qualified for safety-sensitive tasks.
4. **Pipeline Integrity Management:** Conduct risk assessments, inspect high-consequence areas, and manage threats like corrosion.
5. **Public Awareness:** Educate stakeholders about pipeline safety and emergency response.
6. **Gas Leak Control:** Perform regular leak detection and address hazardous leaks immediately.
7. **Reporting:** Submit incident reports and annual summaries to PHMSA.
8. **Damage Prevention:** Participate in one-call systems (811) and protect pipelines from excavation damage.
9. **Regulatory Compliance:** Follow federal safety standards for pipeline operation and maintenance.
10. **Incident Investigation:** Investigate failures and update safety procedures to prevent recurrence.

These steps ensure pipeline safety, environmental protection, and compliance with federal regulations.





**How do you know that the  
information is accurate?**

# How has Magnolia River leveraged AI?



- 2024 – R&D
- Key Goal: Personal Protective Equipment (PPE) Identification using AI
  - Computer Vision – Object Detection
- Requirements to accomplish:
  - Image acquisition – software and open source
  - Model Training and Labeling – identification of PPE
  - Beta Testing
  - Deployment

# Object Detection

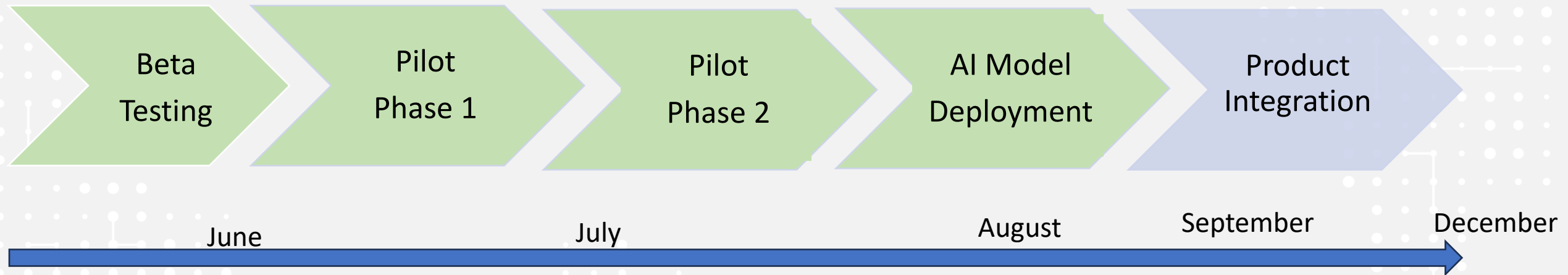
Train AI to analyze each image and detect presence/absence of certain PPE

- Person – any person in the image
- Hardhat – on person or elsewhere
- No Hardhat – person with no hardhat
- Vest – person wearing safety vest
- No Vest – person not wearing safety vest
- Other Hardhat – wearing different type of safety headwear
- Other Vest – wearing different type of safety equipment





# Project Phases



# Planning and Environment

- Data Sample
  - Extracted small sample of pictures from Field Software
- Infrastructure
  - Amazon SageMaker
- Model Selection
  - Ultralytics YOLOv8 – Object Detection
- Model Training Infrastructure Selection
  - SageMaker Notebook Instances
- Data Labeling Solution Selection
  - Amazon SageMaker Ground Truth
- Beta Testing Technology Assumptions
  - Image Labeling Process
  - GPU-based computing
  - Dedicated AWS Account Setup
  - Permissions to Various AWS Services

# Pilot Phase 1



- Dataset Selection (existing images from software)
  - 1,500 images
- Data Preparation
  - Setup image labeling jobs
  - Divide dataset in Train, Validation, Test subsets
  - Labeled 1,500 images
- Model Training
  - 10 Model Training Sessions
- Prediction – Testing and Evaluation
- Result – No sufficient Training Data for (no hardhat, no vest)

```
Validating runs/detect/train25/weights/best.pt...
Ultralytics YOLOv8.2.38 Python-3.10.14 torch-2.1.0 CUDA:0 (Tesla T4, 15102MiB)
CUDA:1 (Tesla T4, 15102MiB)
CUDA:2 (Tesla T4, 15102MiB)
CUDA:3 (Tesla T4, 15102MiB)
Model summary (fused): 168 layers, 11118293 parameters, 0 gradients, 28.5 GFLOPs
2.64it/s]

```

	Class	Images	Instances	Box(P)	R	mAP50	mAP50-95
	all	144	928	0.688	0.64	0.657	0.446
	Person	144	316	0.832	0.902	0.93	0.659
	Hardhat	141	270	0.851	0.837	0.894	0.618
	Vest	141	294	0.877	0.888	0.915	0.635
	No_Vest	14	16	0.584	0.438	0.439	0.263
	No_Hardhat	24	29	0.415	0.414	0.428	0.138
	Other_Helmet	2	2	0	0	0	0
	Other_Vest	1	1	0.752	1	0.995	0.796

```
Speed: 0.4ms preprocess, 5.9ms inference, 0.0ms loss, 1.2ms postprocess per image
Results saved to runs/detect/train25
```



# Pilot Phase 2



- Dataset Selection (open source images)
  - 1,500 pictures
  - Objective – Identifying ‘No Hardhat’, ‘No Vest’
- Data Preparation
  - Labeling images
  - Identified non-PPE objects in images
- Model Training
  - 11 model training sessions
- Prediction – testing and evaluation
- Result – model well-balanced to identify PPE objects and instances of non-PPE

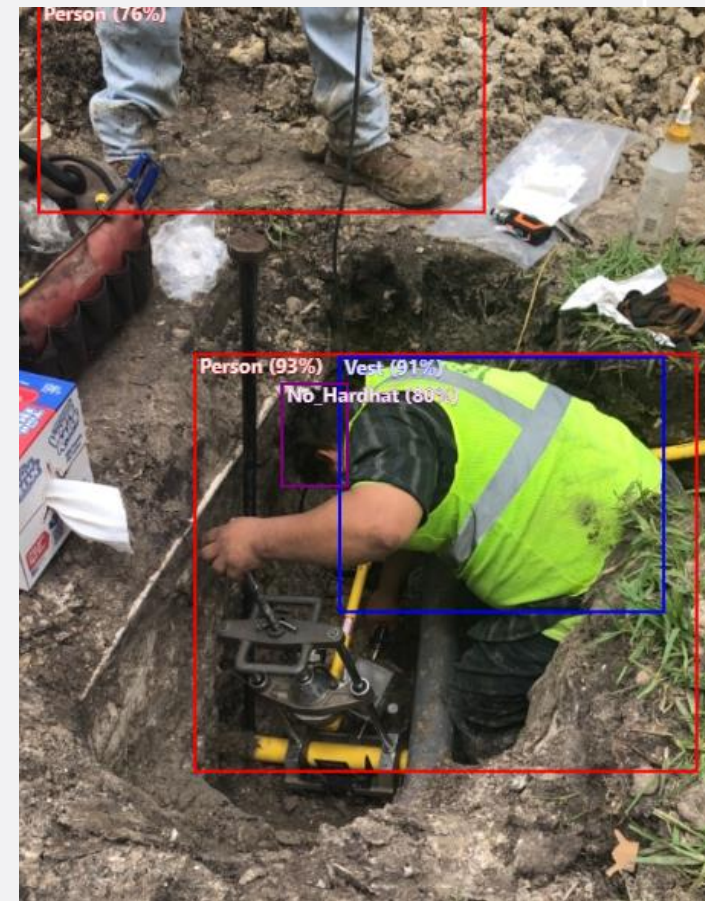
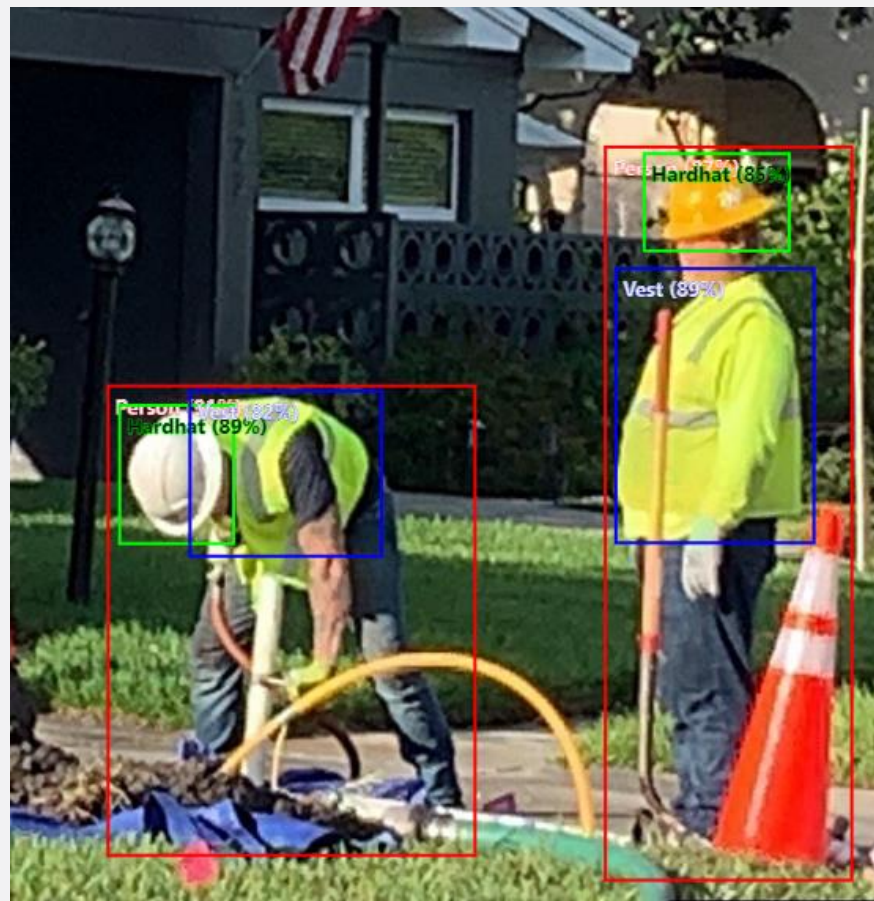
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95):
0, 1.54it/s]							
	all	300	2526	0.716	0.833	0.808	0.534
	Person	291	848	0.835	0.874	0.89	0.636
	Hardhat	142	272	0.873	0.875	0.923	0.643
	Vest	142	296	0.886	0.909	0.938	0.661
	No_Vest	169	543	0.865	0.838	0.882	0.5
	No_Hardhat	179	564	0.847	0.832	0.853	0.482
	Other_Helmet	2	2	0.218	0.5	0.176	0.0176
	Other_Vest	1	1	0.488	1	0.995	0.796
Speed: 0.5ms preprocess, 15.0ms inference, 0.0ms loss, 0.8ms postprocess per image							
Results saved to runs/detect/train33							

# Model Deployment



- Deployed Model in Amazon Sagemaker
- Architectural Solution Analysis factors:
  - Prediction Accuracy
  - Performance/Response Time
  - Cost
  - Integration Effort
- Testing on Prediction Accuracy
- Deployment to Software







# What kind of data can be gathered from PPE Detection?



## Detail

**File:** [REDACTED]\_file\_upload\_01102022123951698284.jpeg

**Group:** Pictures and Videos

**File Size:** 1.66 MB

**ID:** ATT-1030

**Show in Daily Activity?:** YES

**Activity Date:** 10/11/2024

**PPE Warning:** Detected 18 people but only 17 vest(s). Detected 3 case(s) where a helmet wasn't worn. Detected 1 case(s) where a vest wasn't worn.

**Last Modified Date:** 10/11/2024 03:51 PM

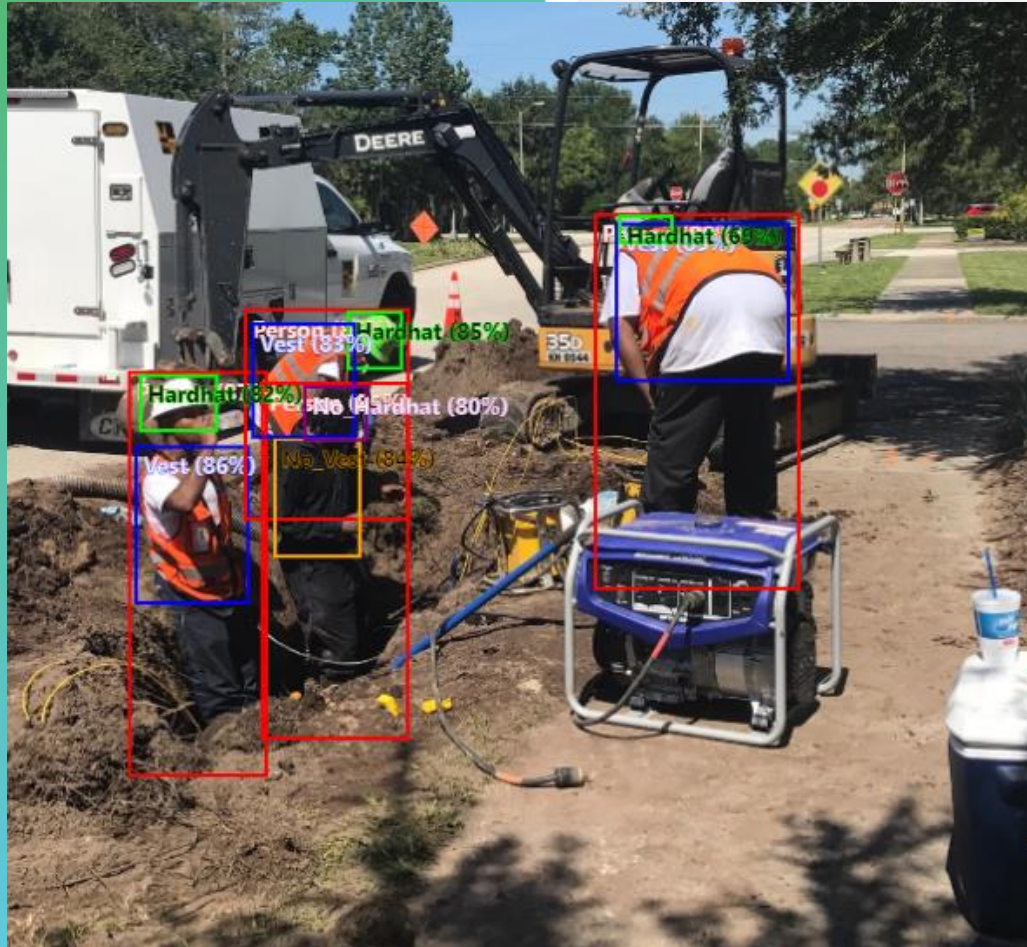
**Creation Date:** 10/11/2024 03:51 PM

**Edited By:** Dan Sasser

**Created By:** Dan Sasser

**Relation:** Project

# PPE Detection – KPIs and Analytics



- Results:
  - Overwhelmingly positive: 99%+
- Scalable approach to ensure safety and compliance
- Trend Identification – identify patterns or issues
- Regulatory Adherence – ensure PPE standards
- Transparent Records – offer reliable data for audits, investigations, and incident reports



# Ongoing Research and Development



## Object Detection on Video

- Continuous monitoring of PPE Compliance in work areas
- Identifying safety hazards or equipment failures in video surveillance



# Ongoing Research and Development



## Extracting information from Pipeline Pressure Test Charts

- Time savings in data entry and analysis
- Enable large-scale analysis of historical pressure test data

# Ongoing Research and Development

**CERTIFICATE OF TESTING**  
**IPSCO TUBULARS (KY) INC**

Page  
Certificate Number: 336329-2  
Wednesday, August 29, 2016, 10:27:58

Diameter: 8.625 in Gauge: 0.322 in Grade: X52M Mill Order No: 087868 Customer PO: S7SH200717

Specification: API 5L FORTY-FIFTH EDITION GRADE X52M PSL2 NACE MR0175 HARDNESS ONLY, 22 HRC MAXIMUM Customer: MRC GLOBAL (US) INC. ASTM A53/A53M-18

Heat	Product ID	Test Type	Orientation		Width (in)		YS (psi)		TS (psi)		Elong(2 in)		Y/T			
			P	S	Ni	Cr	Mo	Sn	Al	V	Cb	Ti		S		
A89892	WL-Z27	566 MILL CONTROL	PIPE TPA			1.516		63800		71700		40.0	0.8			
	WL-Z27	566B MILL CONTROL	PIPE TPA			1.515		63300		71700		38.0	0.8			
	WL-Z27	566BW MILL CONTROL	PIPE TWA			1.517				78000						
	WL-Z27	566W MILL CONTROL	PIPE TWA			1.516				77500						
	Heat	0.05	0.85	0.011	0.003	0.24	0.13	0.05	0.05	0.020	0.007	0.032	0.001	0.016	0.002	0.0002
	Product	0.04	0.83	0.011	0.003	0.21	0.13	0.05	0.05	0.015	0.006	0.026	0.002	0.012	0.002	0.0001
	Heat	0.04	0.83	0.011	0.003	0.21	0.13	0.05	0.06	0.015	0.006	0.026	0.002	0.012	0.002	0.0001
	Product	0.04	0.83	0.011	0.003	0.21	0.13	0.05	0.06	0.015	0.006	0.026	0.002	0.012	0.002	0.0001
	Heat	0.06	0.84	0.014	0.003	0.23	0.13	0.05	0.07	0.020	0.007	0.028	0.001	0.014	0.002	0.0004
	Product	0.04	0.82	0.013	0.003	0.20	0.13	0.05	0.07	0.014	0.006	0.025	0.001	0.010	0.002	0.0001
A89893	WL-Z27	564 MILL CONTROL	PIPE TPA			1.504		64800		73900		40.0	0.8			
	WL-Z27	564B MILL CONTROL	PIPE TPA			1.505		63800		72300		40.0	0.8			
	WL-Z27	564BW MILL CONTROL	PIPE TWA			1.511				78600						
	WL-Z27	564W MILL CONTROL	PIPE TWA			1.508				79200						
	Heat	0.06	0.84	0.014	0.003	0.23	0.13	0.05	0.07	0.020	0.007	0.028	0.001	0.014	0.002	0.0004
	Product	0.04	0.82	0.013	0.003	0.20	0.13	0.05	0.07	0.014	0.006	0.025	0.001	0.010	0.002	0.0001
	Heat	0.04	0.82	0.013	0.003	0.20	0.13	0.05	0.07	0.014	0.006	0.025	0.001	0.010	0.002	0.0001
	Product	0.04	0.82	0.013	0.003	0.20	0.13	0.05	0.07	0.014	0.006	0.025	0.001	0.010	0.002	0.0001
	Heat	0.06	0.84	0.014	0.003	0.23	0.13	0.05	0.07	0.020	0.007	0.028	0.001	0.014	0.002	0.0004
	Product	0.04	0.82	0.013	0.003	0.20	0.13	0.05	0.07	0.014	0.006	0.025	0.001	0.010	0.002	0.0001
C87765	WL-Z27	572 MILL CONTROL	PIPE TPA			1.513		63100		71500		40.0	0.8			
	WL-Z27	572B MILL CONTROL	PIPE TPA			1.513		63100		71500		40.0	0.8			

Signature 1 1 82%

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Paystub

Upload document  
Choose document Or drag and drop

Documents must be fewer than 11 pages, smaller than 5 MB, and one of the following formats: JPEG, PNG, or PDF.

3in\_STD\_LR\_90\_A2395C\_MTR\_Page1\_022  
12023192454692363.jpg  
0.260788 MB

Upload bulk documents  
Upload documents

Up to 150 documents in a single request and download the results as a CSV.

Extracting information from MTR documents

- Enable easy searchability and analysis of MTR data
- Reduces manual data entry errors and improves compliance tracking

# Summary

- AI's growing role – smarter, automated processes
- Applications in Natural Gas Operations
  - Safety PPE KPIs and Analytics
  - Data extraction from documentation
  - Pipeline monitoring and predictive maintenance
- Open source resources: ChatGPT
  - Better source for searching and information gathering



# Questions?

Dan Sasser

[dan.sasser@magnolia-river.com](mailto:dan.sasser@magnolia-river.com)

1.256.612.0542