



**TEXAS A&M**  
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# Transformative Impact of Artificial Intelligence and Digital Technologies to Shape the Future of the Energy Industry

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# | Big Data Utilization in Oil and Gas Industry

- In the 1980s and 1990s, the oil and gas industry was a leader in the development of advanced geostatistics and 3D seismic models, long before advanced analytics and big data were widely used.
- More than 60 distinct sensors are currently in use, and they are all capturing various metrics as drilling operations progress. More than 40,000 data tags are common on offshore production platforms.

**A Second Digital Age**

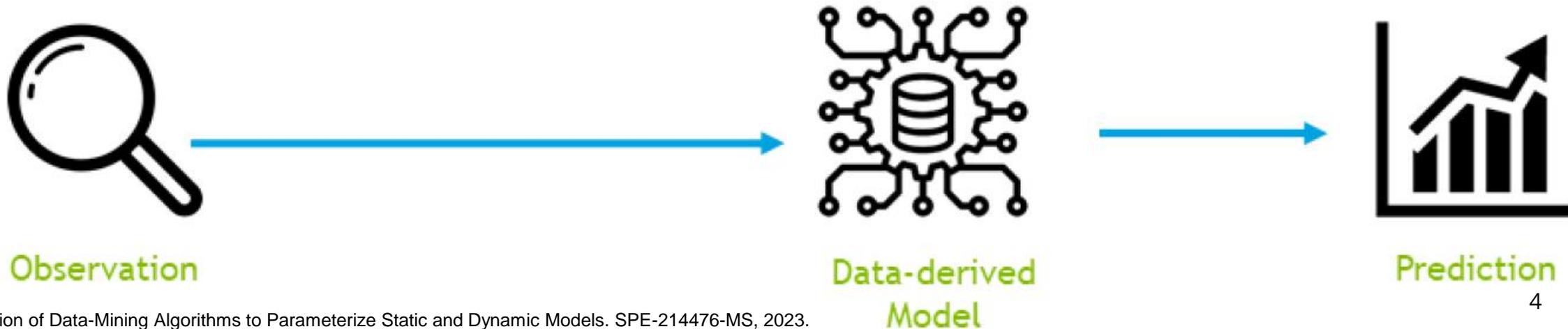
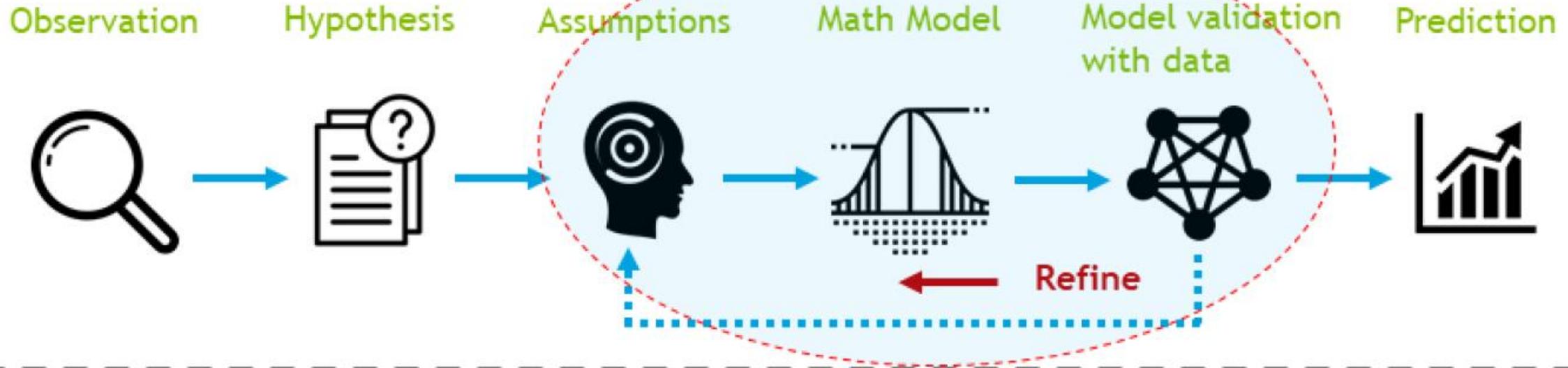
# | What is Big Data?

Big Data is characterized by 6Vs:

1. **Volume:** A large volume of data.
2. **Velocity:** High speed of accumulation of data.
3. **Variety:** Data is structured, semi-structured, and unstructured data. And data is received from heterogeneous sources.
4. **Variability:** Structure and meaning of data.
5. **Veracity:** Quality and accuracy of data is difficult to control.
6. **Value:** Data has the ability to be converted into something valuable to extract information.

# Tale of Two Techniques

DATA SCIENCE



# Business Impact of Adopting Digital Technologies

← Large part of the potential comes from **optimizing across silos** with an end-to-end value chain perspective →

## Exploration

Reduce seismic processing times by equipping **geophysicists** with **advanced analytics algorithms**

Improve consistency of seismic interpretation by augmenting **geophysics capabilities** with **machine learning**



>25%

Increase in discovered barrels at the same cost  
(speed to output and prospect definition)

## Field Development

Optimize field architecture through **engineers** who leverage **smart and integrated models**

Synchronize project build across **internal and external stakeholders** using **digital twin technology**



Up to 70%

Reduction in engineering hours, plus higher-value field concepts

## Drilling

Increase quality of well planning by having **well engineers** leverage **prescriptive analytics** to improve risk mitigation and compliance

Improve speed of well execution by equipping **drillers** with **real-time machine learning models**



20%-30%

Faster well delivery, and more productive wells

## Production Operations

Optimize production by combining **data analytics** and **multidisciplinary collaboration**

Improve uptime and reduce OPEX by providing **predictive algorithms** for asset integrity to **maintenance teams**



3%-5%

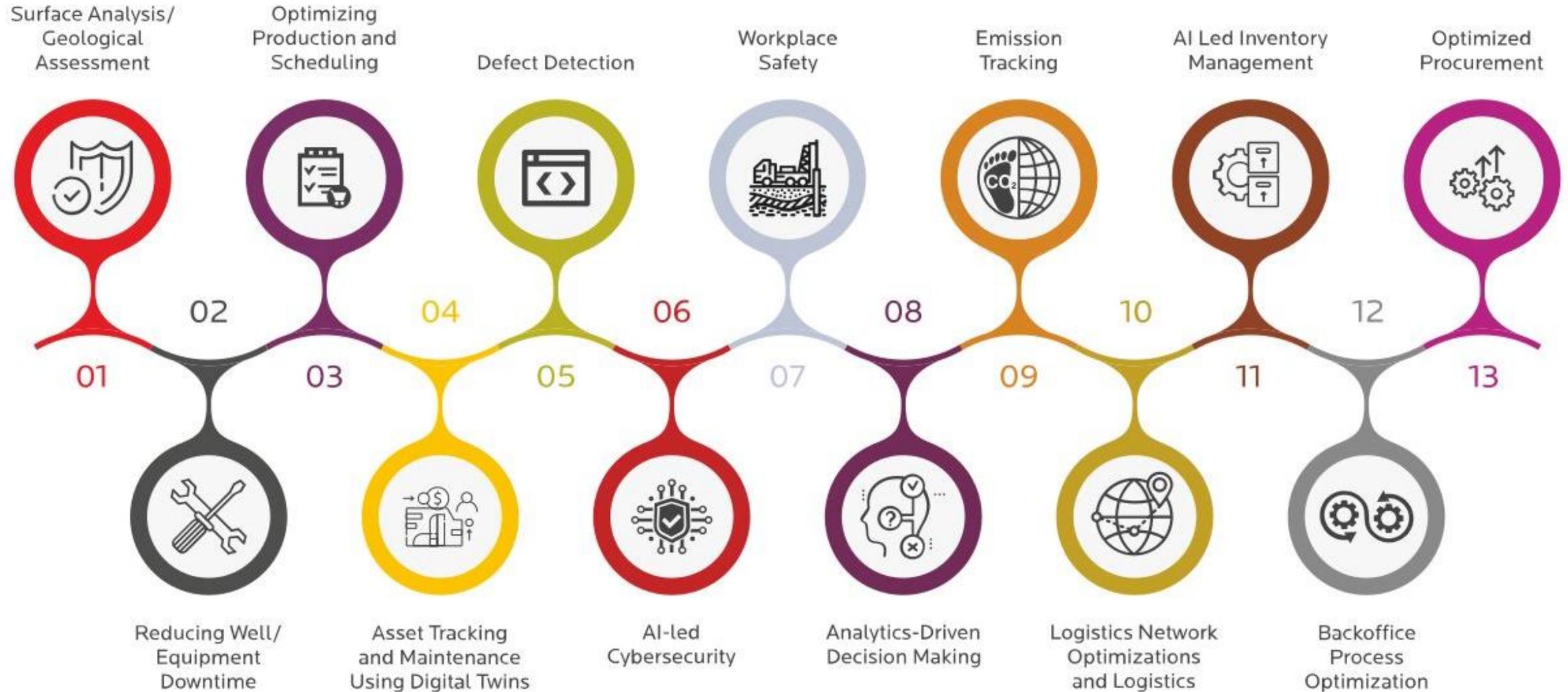
Increase in production

20%-40%

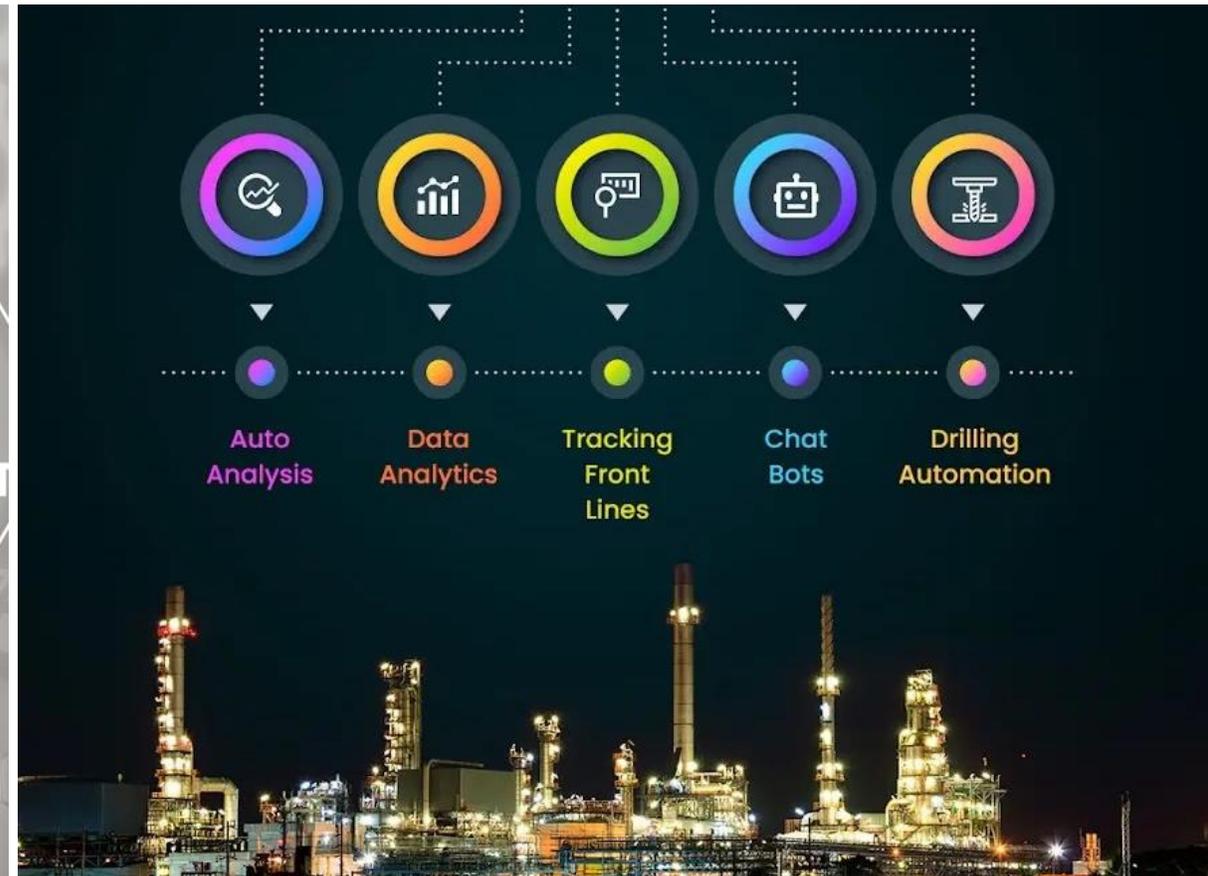
Reduction in maintenance cost

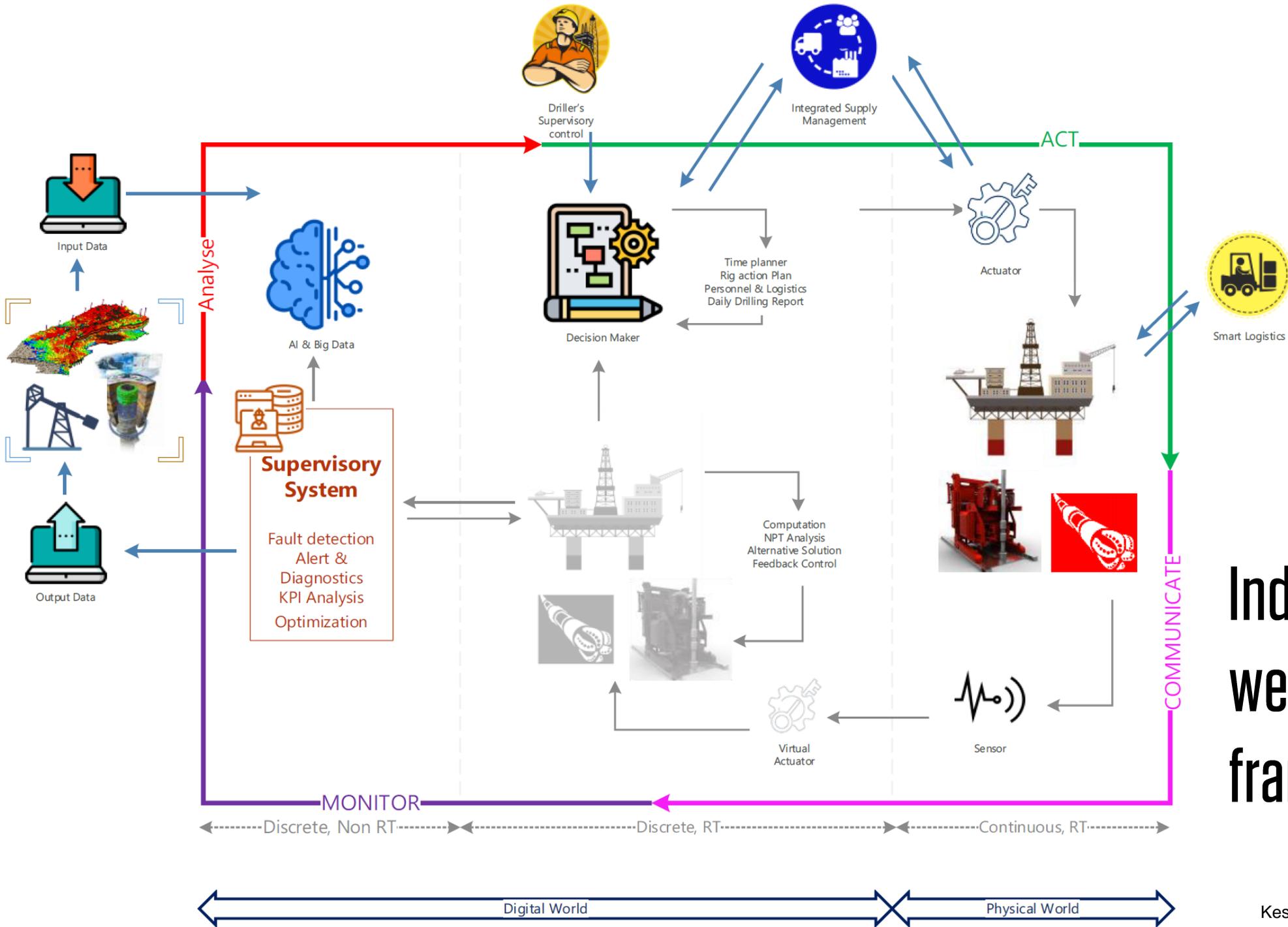
■ Human elements ■ Technology elements

# AI applications in Oil and Gas Industry



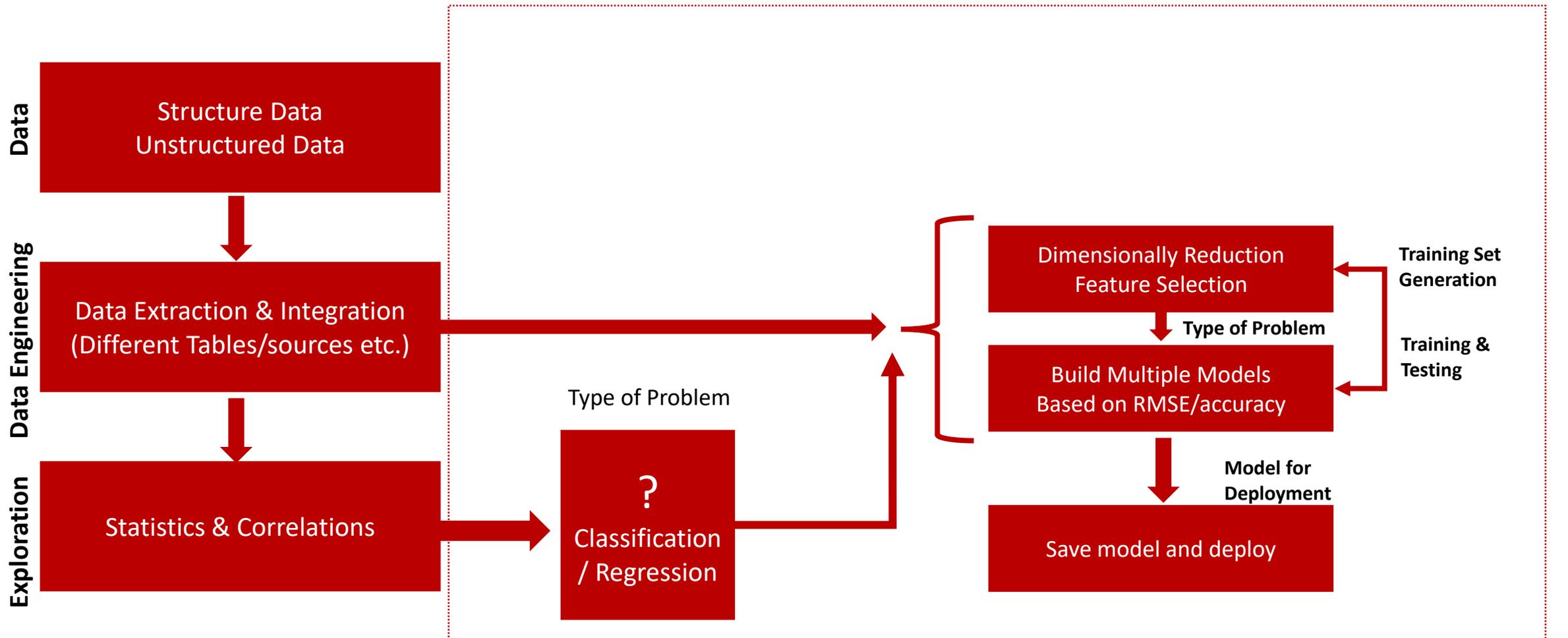
# Ways to use AI in Oil and Gas Industry



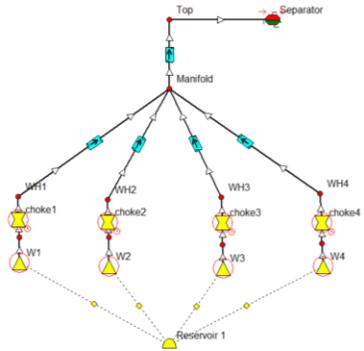


# Industry 4.0 in well construction framework

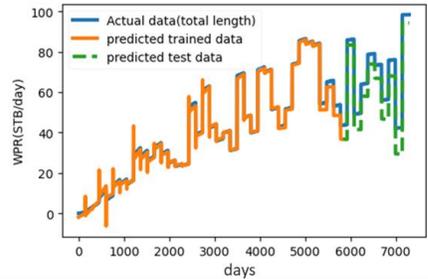
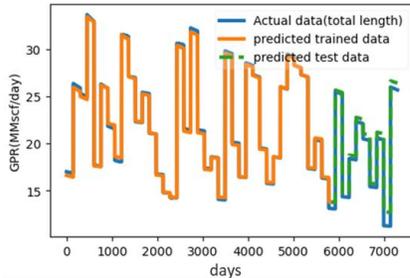
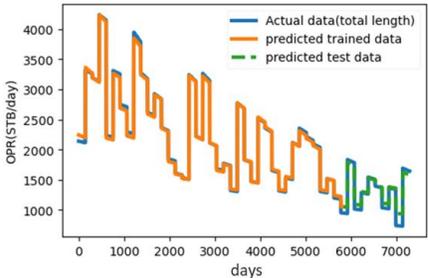
# Workflow for Machine Learning



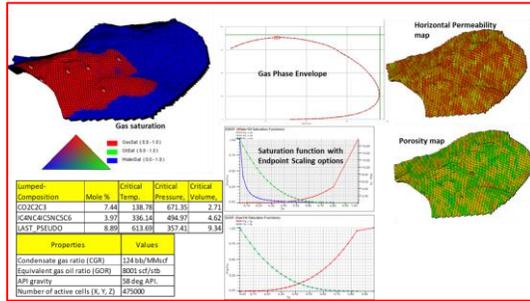
# Deep Learning-based Virtual Flow Meter (VFM)



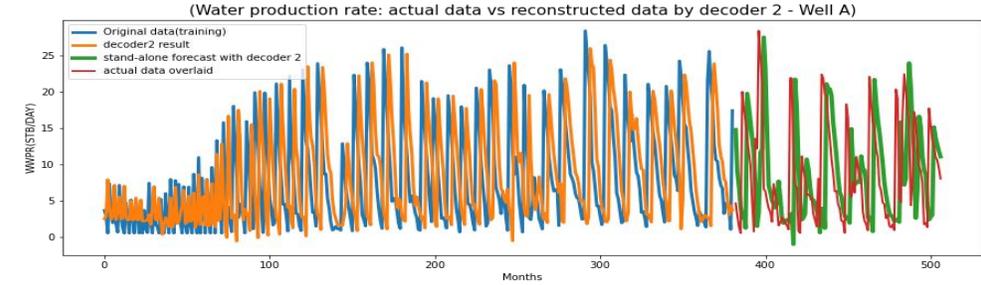
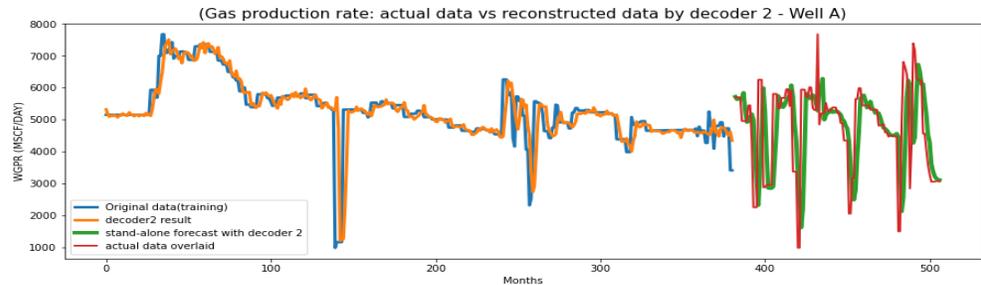
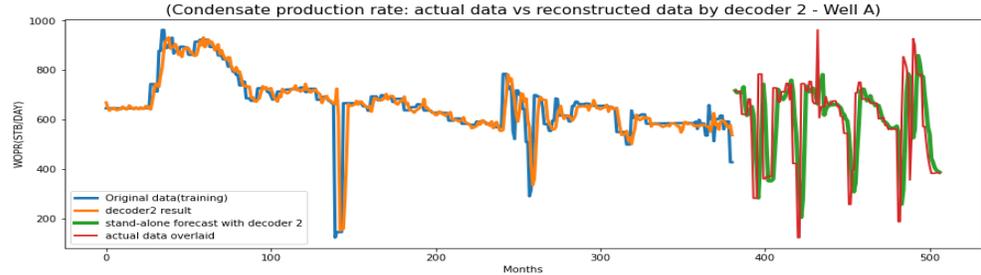
Simulation of a compositional system using IPSM Gap software for multiphase gas condensate production data



Good match for predicted (orange and green) vs. actual data (blue)

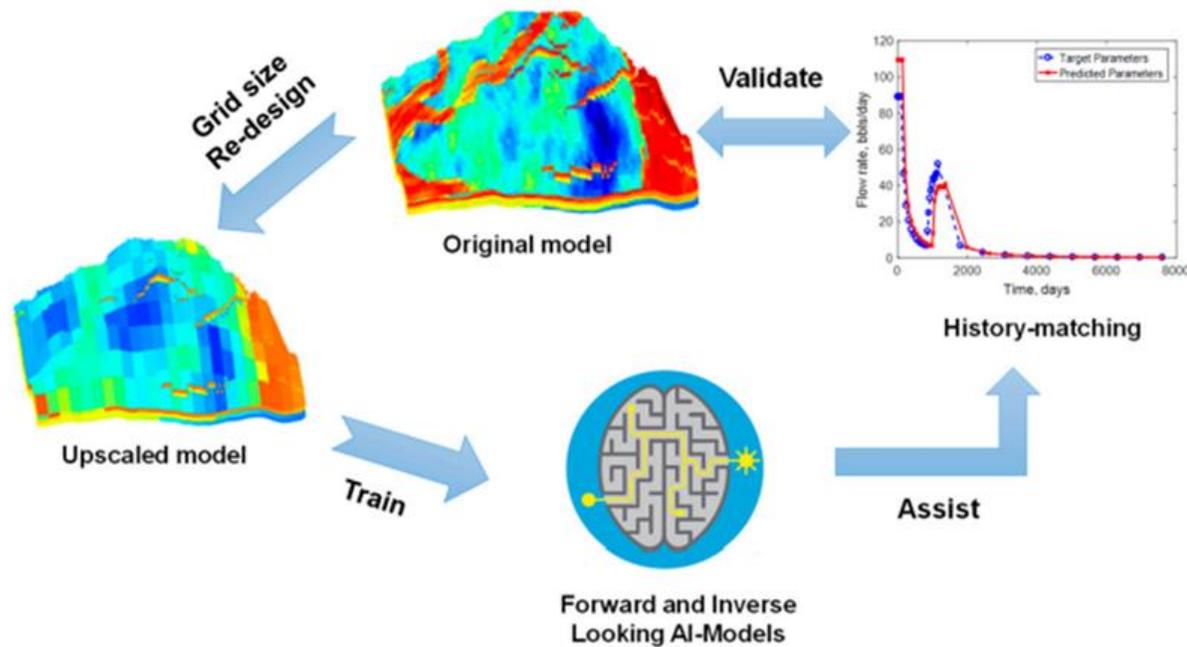


Simulation of a compositional system using Eclipse 300 for production data development

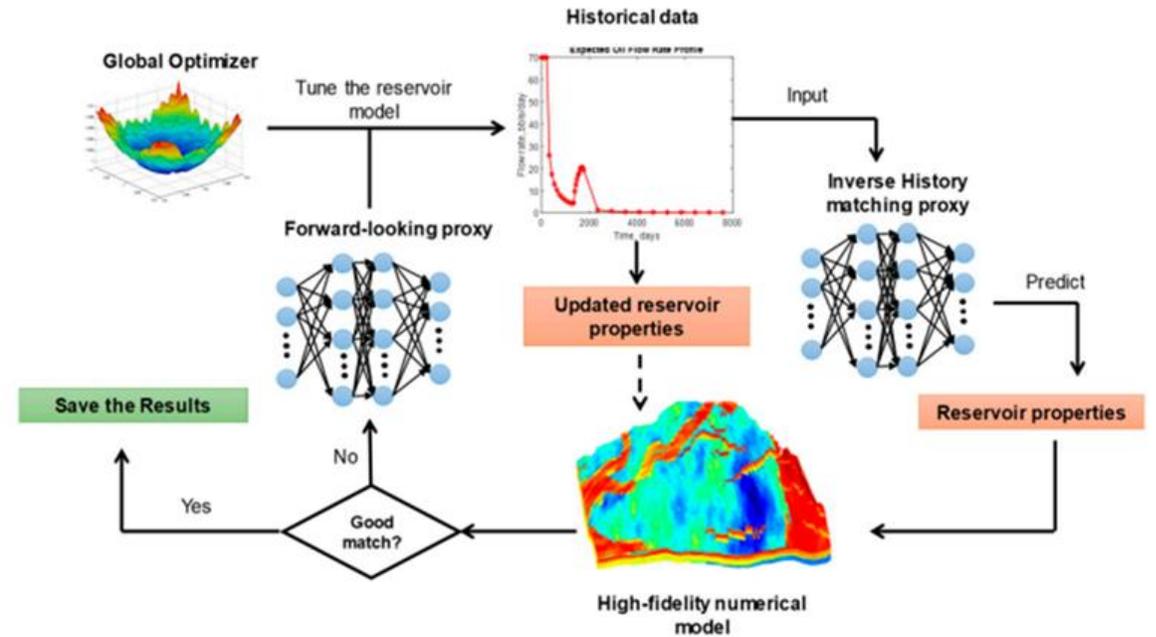


Good match for predicted (orange and green) vs. actual data (blue)

# AI Assisted Modelling of Carbonate Reservoirs

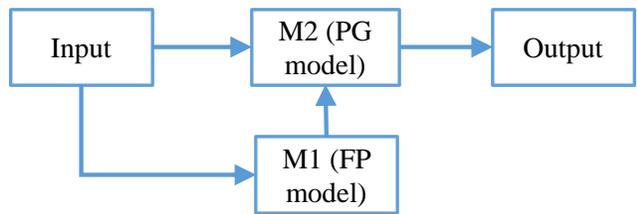


Developments of AI-model



Tuning of reservoir properties

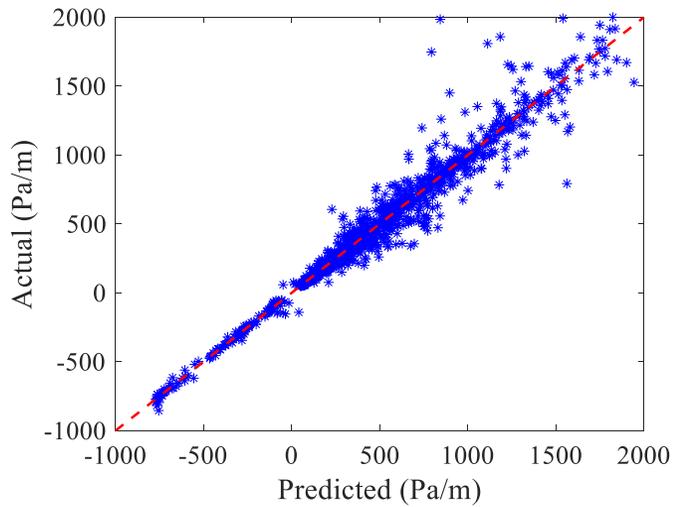
# Machine learning to predict pressure gradient for liquid-liquid flow in both horizontal and inclined pipes



- Machine learning
  - A machine learning -based hybrid model to predict the pressured gradient (PG) for the oil-water flow [1]
  - Two ML-based models were coupled in a series where M1 predicts the oil-water flow patterns (FPs) and M2 predicts the PG.

- Findings
  - The FPs for the liquid-liquid flow can be determined with greater than 91% accuracy.
  - The PG prediction error using the proposed hybrid model is: mean absolute percentage error (MAPE) 10.65%, much lower than the existing mechanistic or correlation-based models (MAPE: 26-69%).
  - The proposed hybrid model removes the dependency of FP identification to predict the PG for the oil-water flow.

Output Class	FP-1	FP-2	FP-3	FP-4	FP-5	FP-6	FP-7	
FP-1	3128 9.6%	82 0.3%	0 0.0%	46 0.1%	48 0.1%	141 0.4%	7 0.0%	90.6% 9.4%
FP-2	46 0.1%	3768 11.5%	67 0.2%	15 0.0%	52 0.2%	73 0.2%	32 0.1%	93.0% 7.0%
FP-3	1 0.0%	93 0.3%	5999 18.3%	187 0.6%	0 0.0%	12 0.0%	133 0.4%	93.4% 6.6%
FP-4	67 0.2%	27 0.1%	340 1.0%	8203 25.1%	180 0.6%	40 0.1%	277 0.8%	89.8% 10.2%
FP-5	26 0.1%	45 0.1%	0 0.0%	85 0.3%	2990 9.1%	26 0.1%	34 0.1%	93.3% 6.7%
FP-6	42 0.1%	26 0.1%	3 0.0%	16 0.0%	40 0.1%	1433 4.4%	0 0.0%	91.9% 8.1%
FP-7	13 0.0%	82 0.3%	118 0.4%	179 0.5%	27 0.1%	0 0.0%	4451 13.6%	91.4% 8.6%
	94.1% 5.9%	91.4% 8.6%	91.9% 8.1%	94.0% 6.0%	89.6% 10.4%	83.1% 16.9%	90.2% 9.8%	91.7% 8.3%
	FP-1	FP-2	FP-3	FP-4	FP-5	FP-6	FP-7	



Evaluation metrics	All variables				Selected variables				p-value
	Mean	Std	95% CI		Mean	Std	95% CI		
RMSE (Pa/m)	84.66	11.55	82.36	86.73	86.26	10.84	84.15	88.35	0.29
RMSE-CV (%)	17.56	2.44	17.07	17.99	17.99	2.29	17.54	18.44	0.19
MAPE (%)	10.52	0.67	10.40	10.67	10.65	1.27	10.43	10.95	0.99
MdAPE (%)	6.18	0.53	6.08	6.29	5.92	0.50	5.81	6.02	0.001
$R_{adj}^2$	0.963	0.011	0.961	0.965	0.961	0.010	0.959	0.963	0.19

[1] Wahid, M. F., Tafreshi, R., Khan, Z., & Retnanto, A. (2023). A hybrid model to predict the pressure gradient for the liquid-liquid flow in both horizontal and inclined pipes for unknown flow patterns. *Heliyon*, 9(4).

# | Summary

- Artificial intelligence (AI) is used for more than just "better" or "faster" procedures.
- It has the ability to increase efficiency throughout the entire value chain for oil and gas.
- It is motivating new methods to approach exploration, development, manufacturing, transportation, refining, and sales, from the first exploration operations all the way to the final consumer.