Department of Energy

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Machine Learning:

Going Beyond the Hype and Making it Work for Earth Science

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ePower Mo Conference
Baguio City
24 April 2018

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Outline

AI – Is it Magic, or Math?

Making AI Work for Earth Science

Leveraging on AI for Energy Efficiency

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Industrial Revolutions and Efficiency

1.0
Mechanical

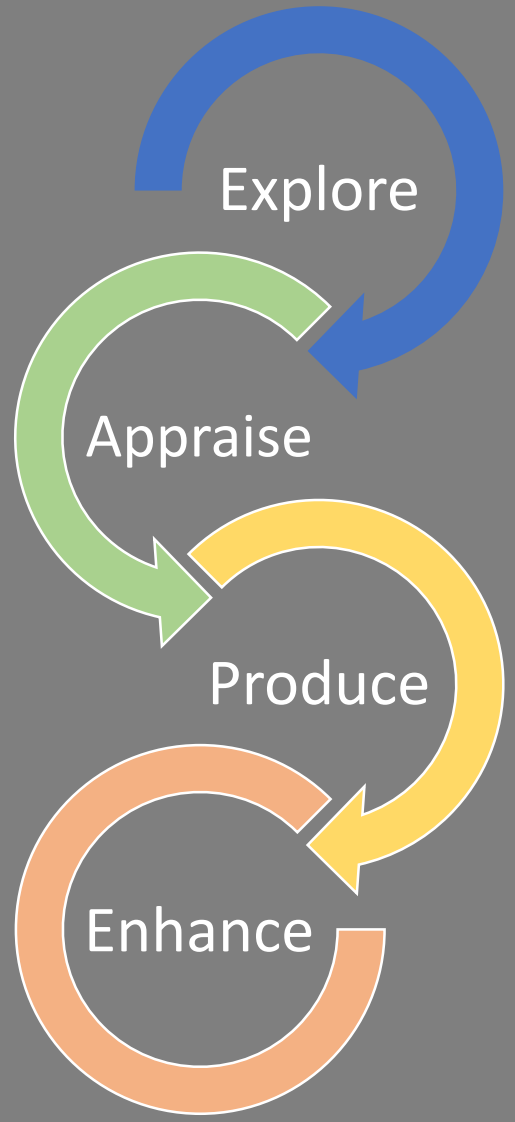
2.0
Electrical

3.0
Internet

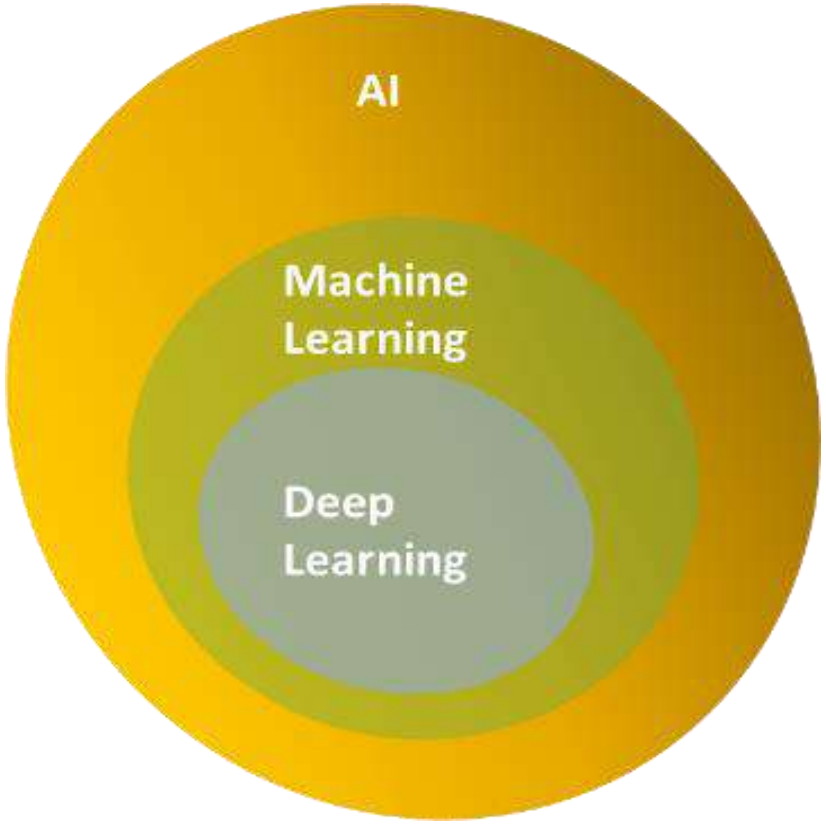
4.0
Digital

Source:
World Economic Forum, 2016
Samsung

Energy Exploration and Production Cycle

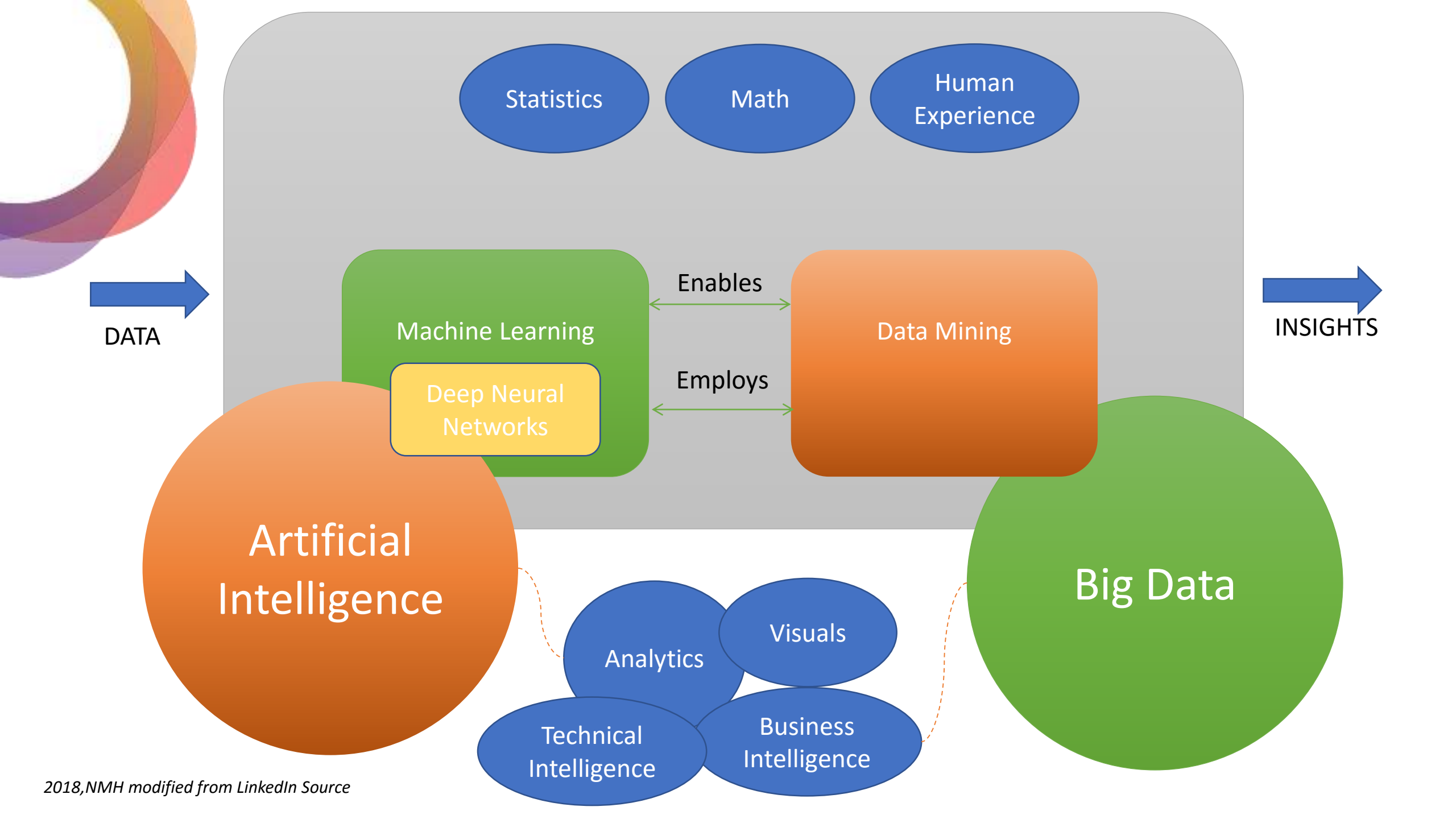


AI & ML - What is it?



Arthur Samuel (1959) on **Machine Learning**:

The field of study that gives computers the ability to learn without being explicitly programmed.



2018,NMH modified from LinkedIn Source

History of Artificial Intelligence

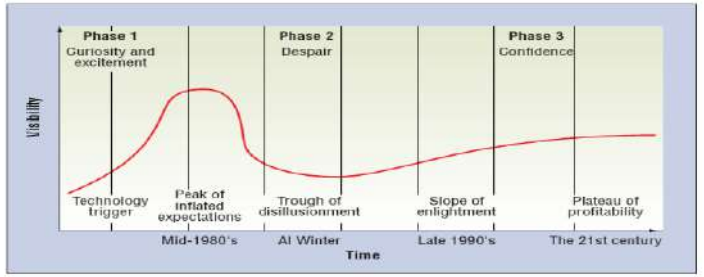


Figure 1. The Hype Cycle and AI winter [Menzies03]

1950

1950: TURING CAN MACHINE THINK?

1954: RUSSIAN TRANSLATION

1956 FIRST USE OF WORD AI

1970

1961 FIRST COMPUTER FOR SEISMIC DATA PROCESSING

1973- COMPUTER CHESS

1980- EXPERT SYSTEMS

AI WINTER 1980s-1990

2000

1997 – IBM DEEP BLUE BEATS KASPAROV

2000 – ANN PREDICTION

2018

MACHINE LEARNING IN GEOSCIENCE

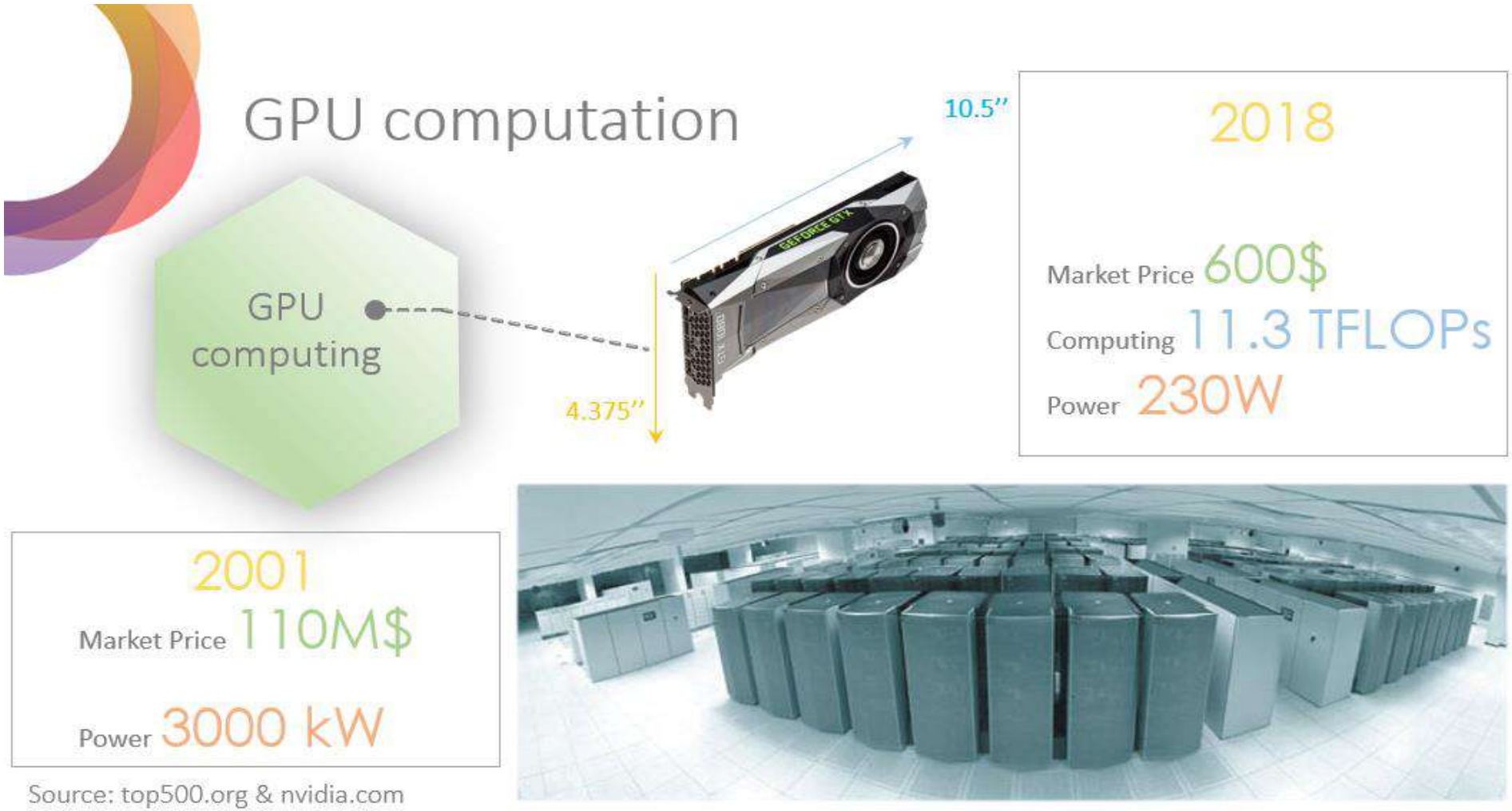
AUTONOMOUS CARS

ALPHA GO

FACE RECOGNITION

EAGE PARIS 2017 ML

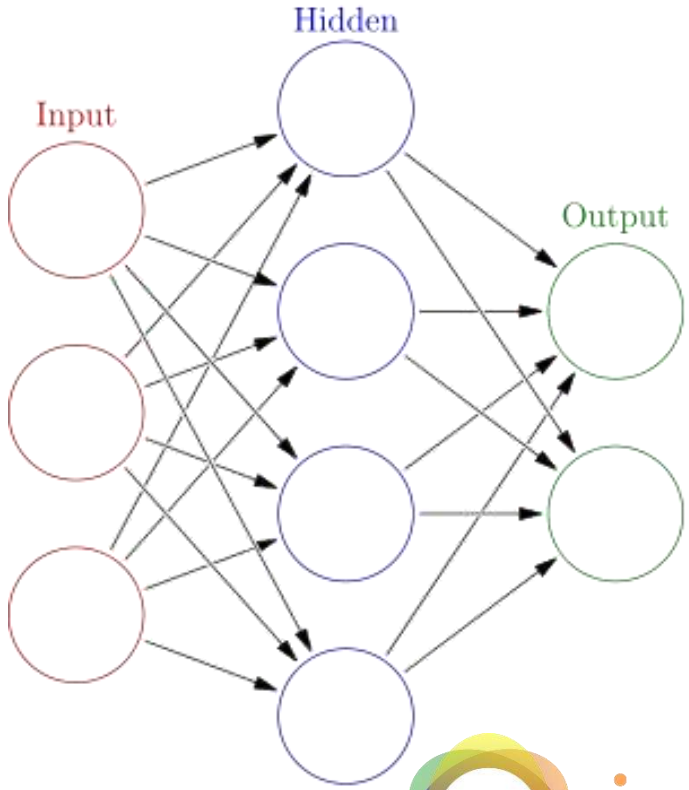
AI explosion in 2018



Nature as an inspiration

Artificial neural networks (ANN) mimic neurons in a brain

- Layers of nodes with weighted connections between layers
- Information through network changes its structure – **it learns**



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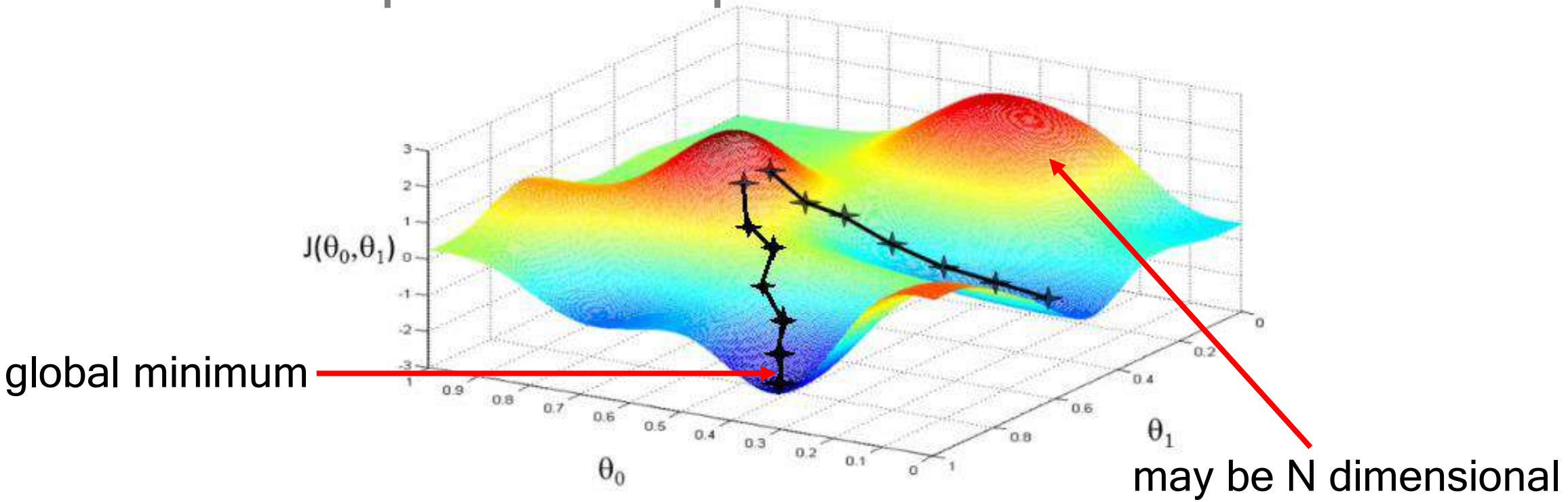
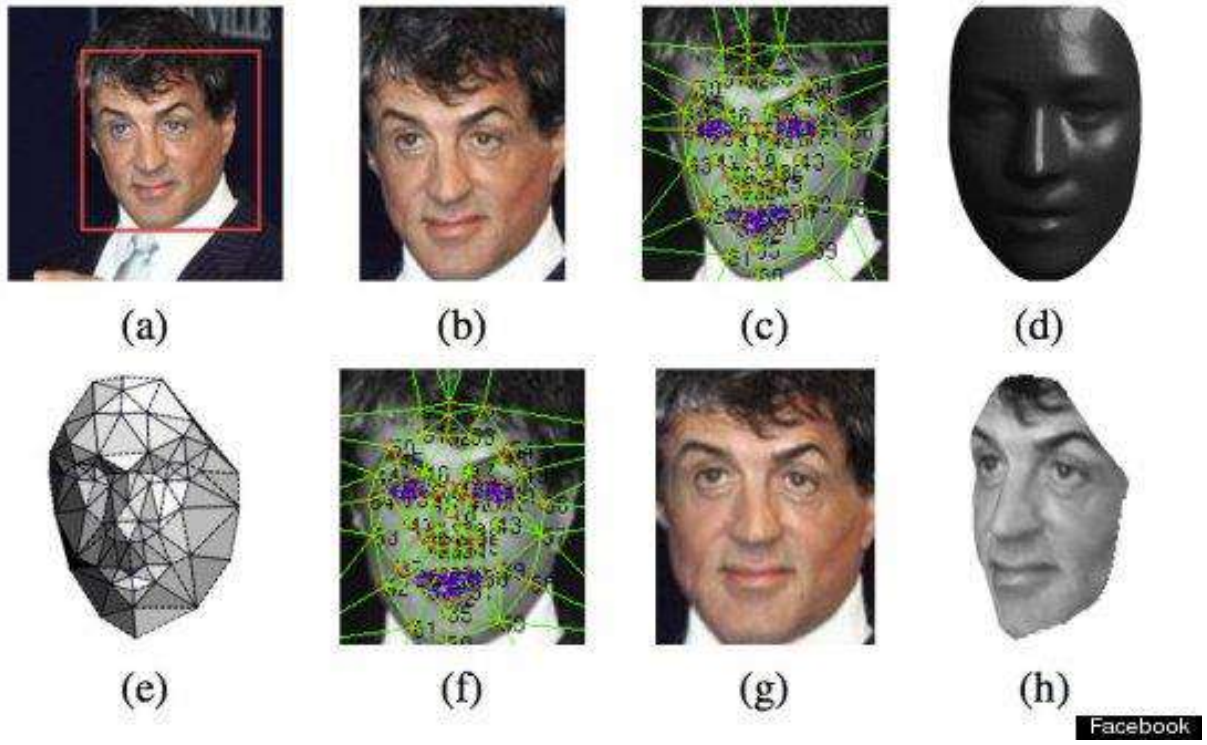
Mathematically, training a neural network is an optimization problem



- Show different input values and compute error
- Adjust weights in direction where error is minimized (along gradient)
- Eventually reach minimum value

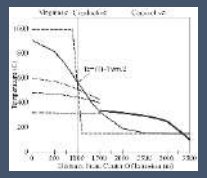
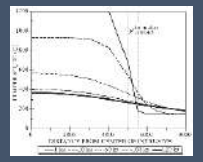
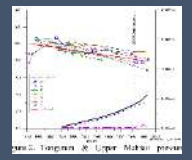
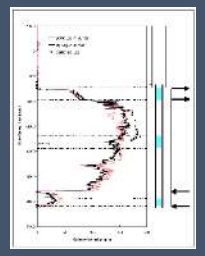
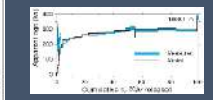
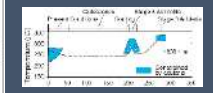
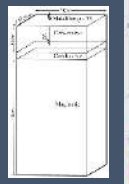
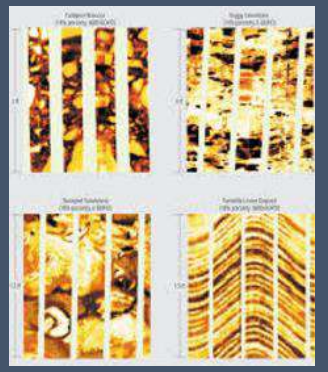
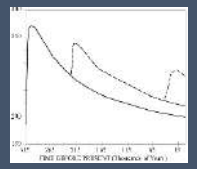
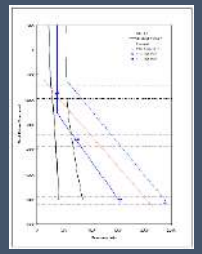
Deep learning has found many applications in image processing

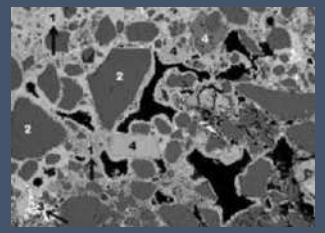
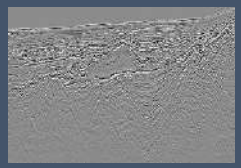
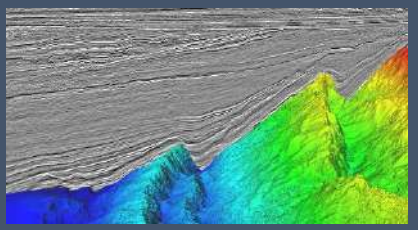
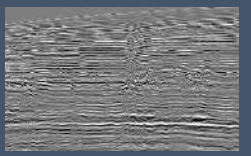
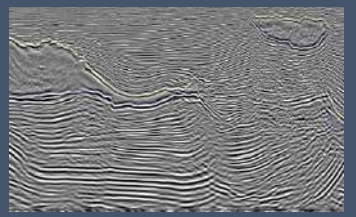


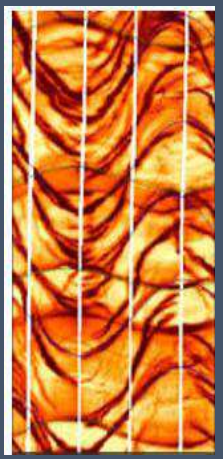
- Facebook's DeepFace for facial verification
- DNN with 9 layers
- Trained using millions of images uploaded by users
- Accuracy reaching 97.35%

What do geoscientists do on a daily basis?
We make (image) files

EARTH PROBLEMS

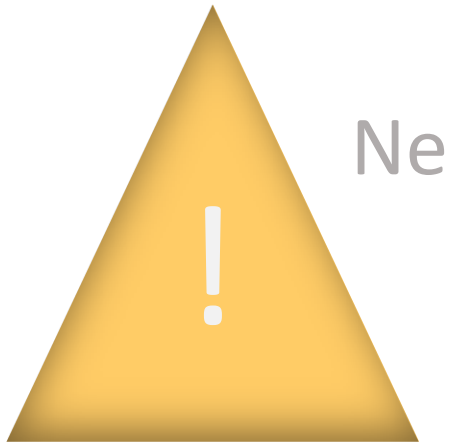












Making AI work for Earth Science

Use AI to (classify, predict, learn from) **archived, historical megadata**



New Data Acquisition is very costly

Optimize efficiency during exploration and early development phase

Learn Effectively

10 vs 1,000 wells

20 vs 2,000 seismic lines

Yet-to-Find becomes Easy-to-Find

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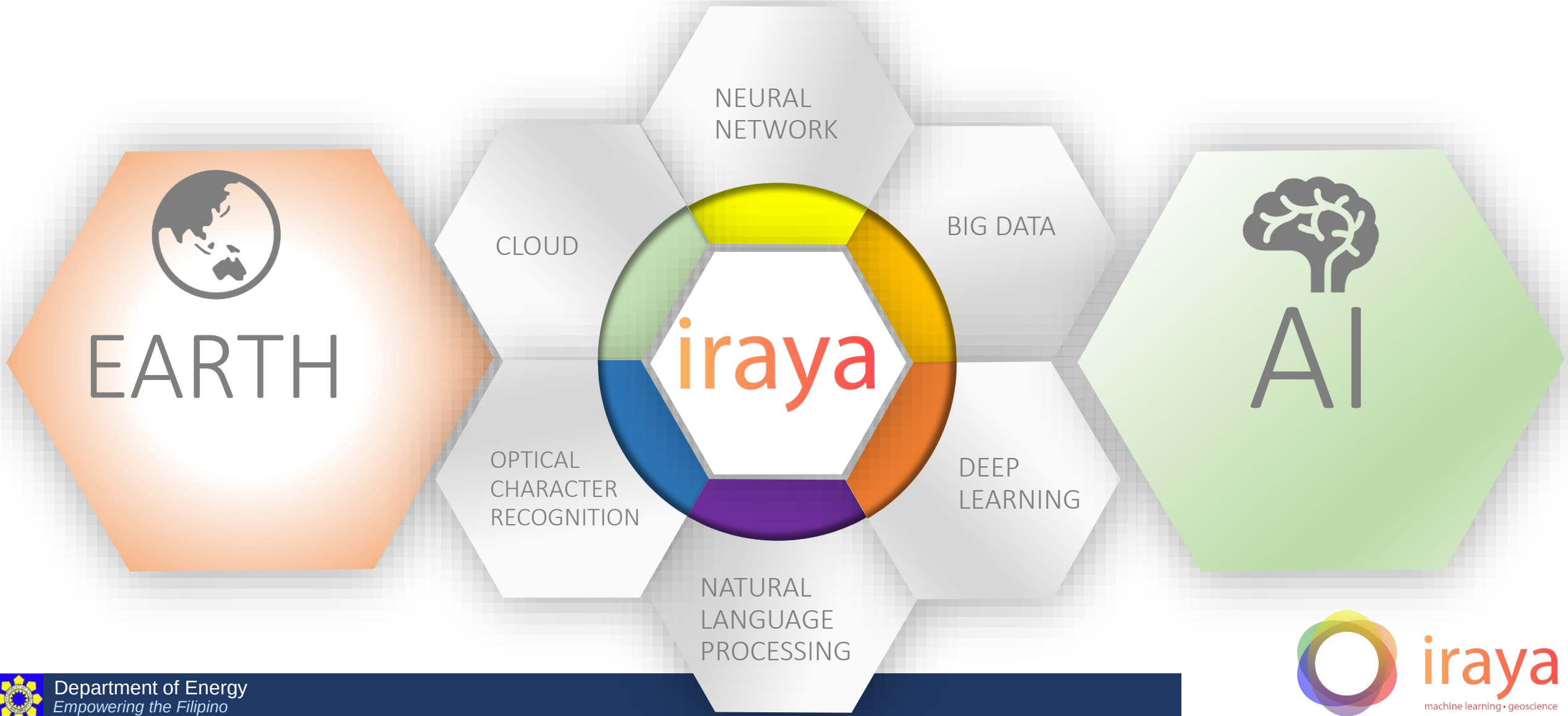
Making AI work for Earth Science



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Iraya Use Cases of AI

- Use Case # 1 : Data Mining
- Use Case # 2: Well Twinning
- Use Case # 3 : Clustering
- Use Case # 4: Deep Resolution

Actual AI examples in geoscience performed by Filipino scientists

Use Case #1: Data Mining

- **Problem Definition**:

Extract information from a unstructured dataset

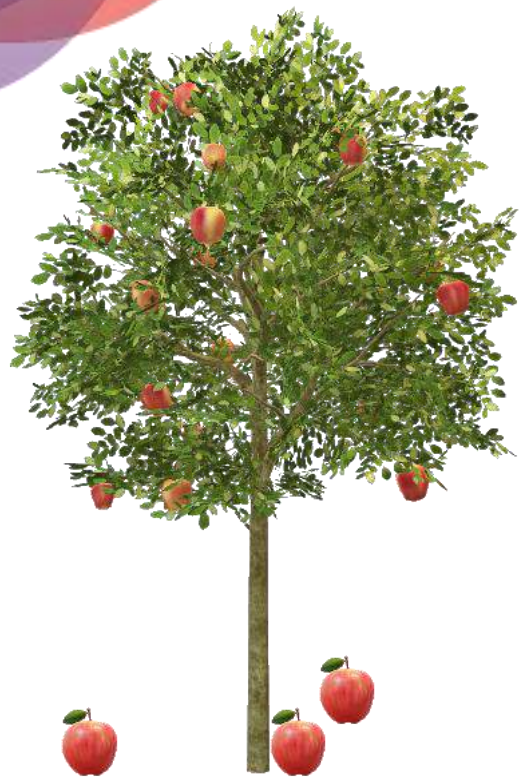
- **Standard Solution:**

Download data, manually read metadata and load in a spreadsheet

- **Machine Learning Solution:**

Apply mining robots, elastic search, natural language processing, optical character recognition to reduce timeframe by a factor of 100.

Data Mining Analogy



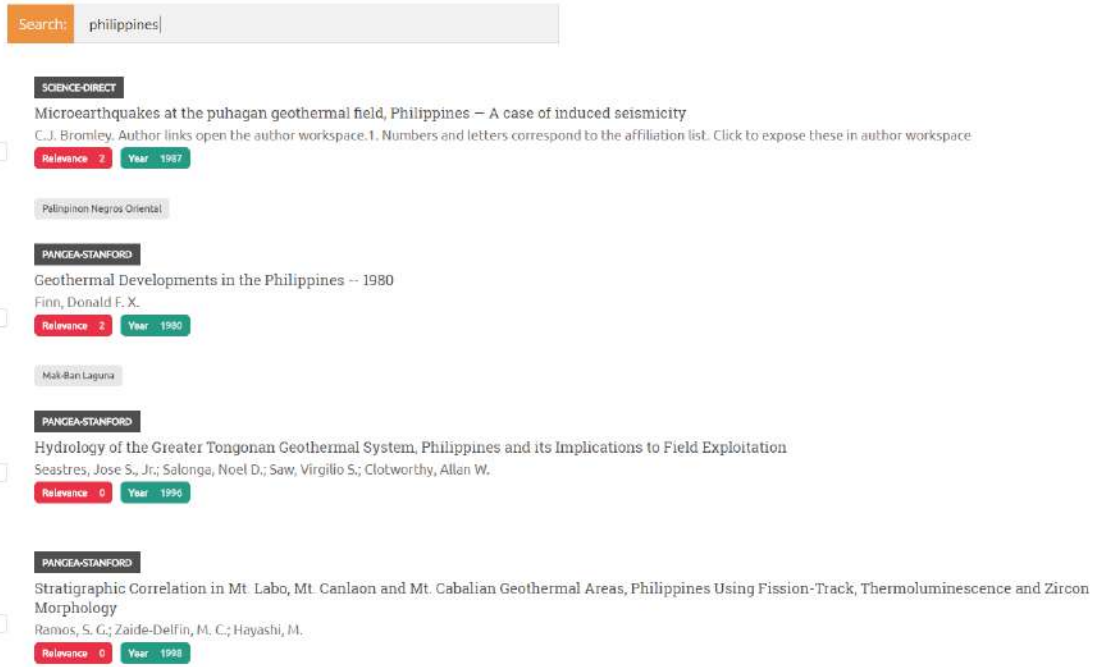
Harvesting

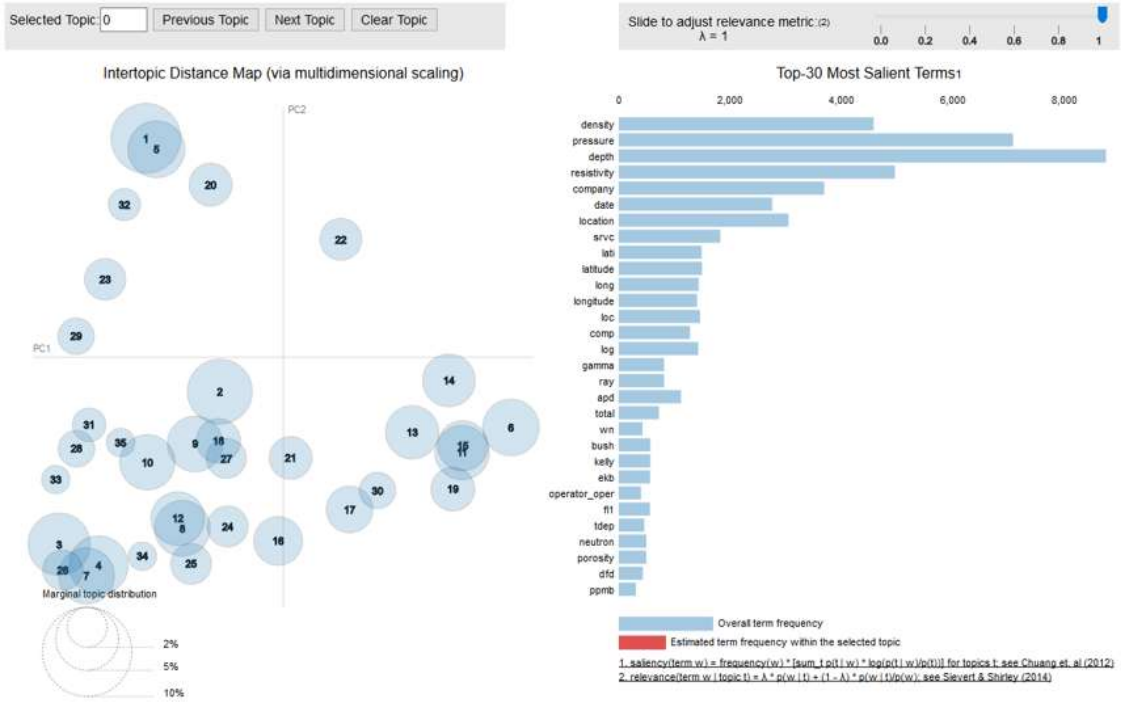
Transform

Sort

Enhance

Sentiment Analysis Beyond Twitter





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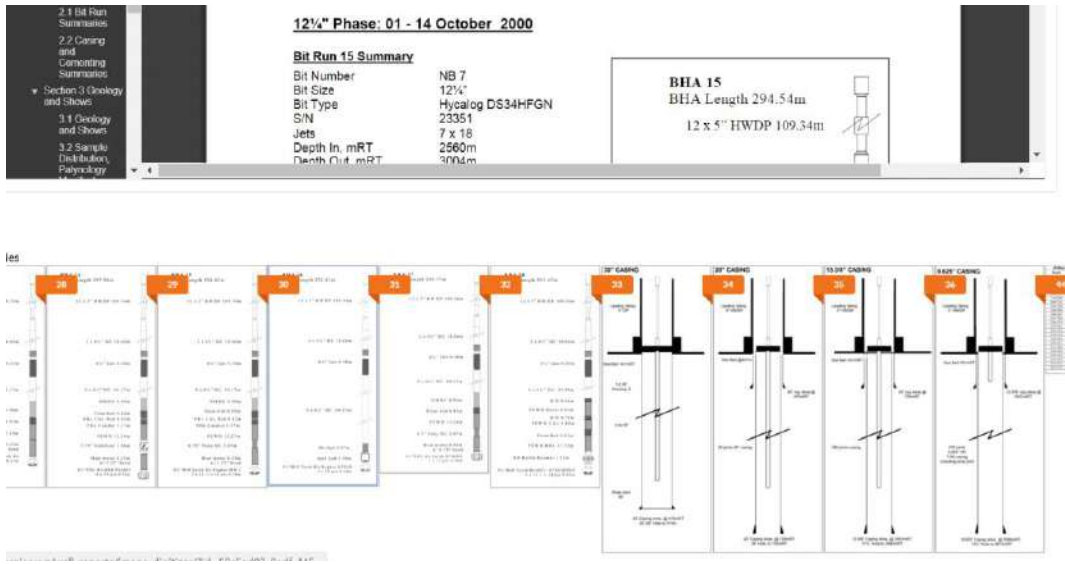
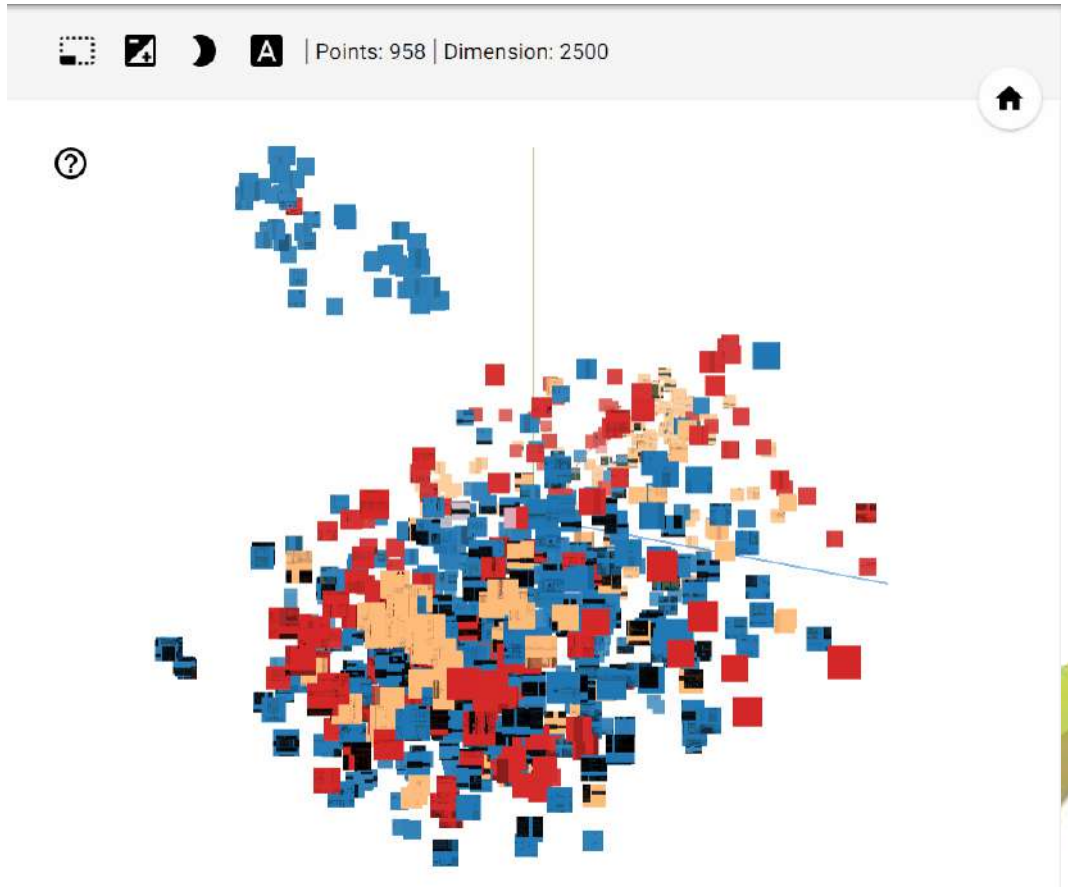
Elastic Docs beyond Google





Data Mining

LAS DATA IN DIFFERENT FORMAT

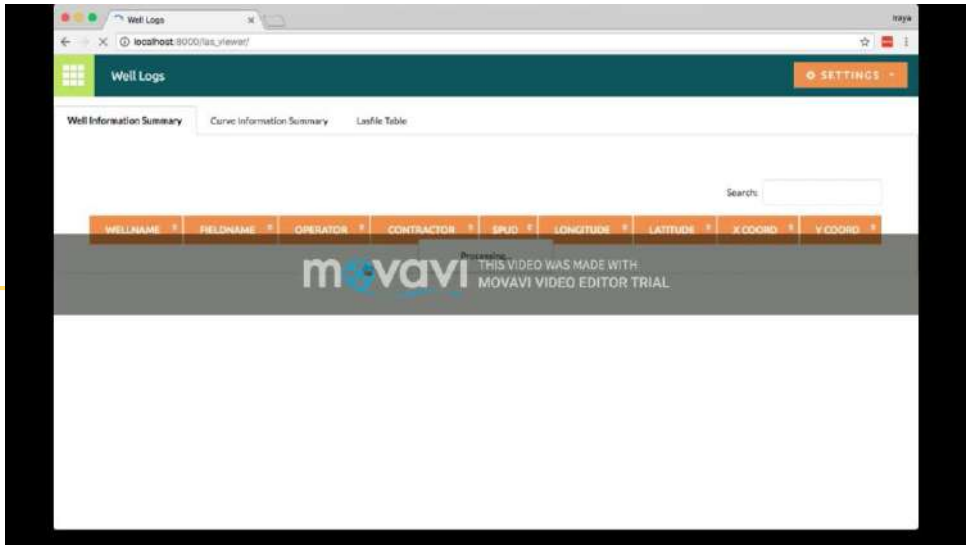
1,595 files

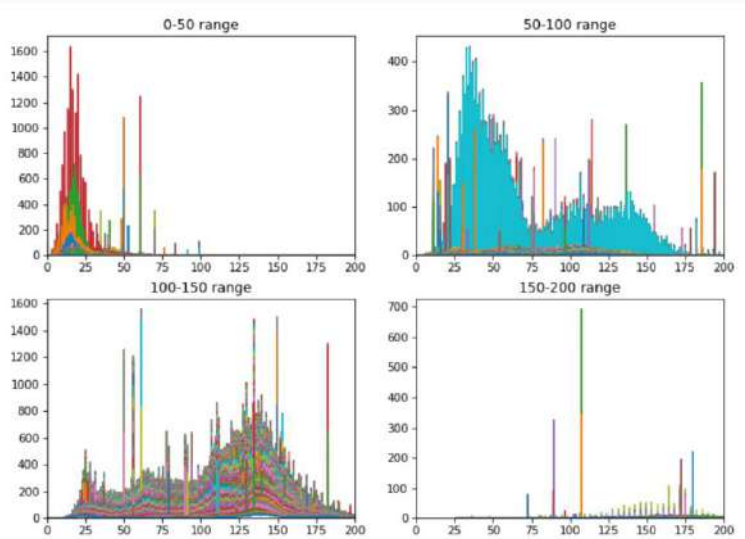
2 hrs 33.66 mins of Data Mining

Identified:

66,515 curves

5,681 most used (10% of data)





90% of DATA REMAINS TO BE TAPPED

Use Case #2: Well Twinning

- **Problem Definition**:

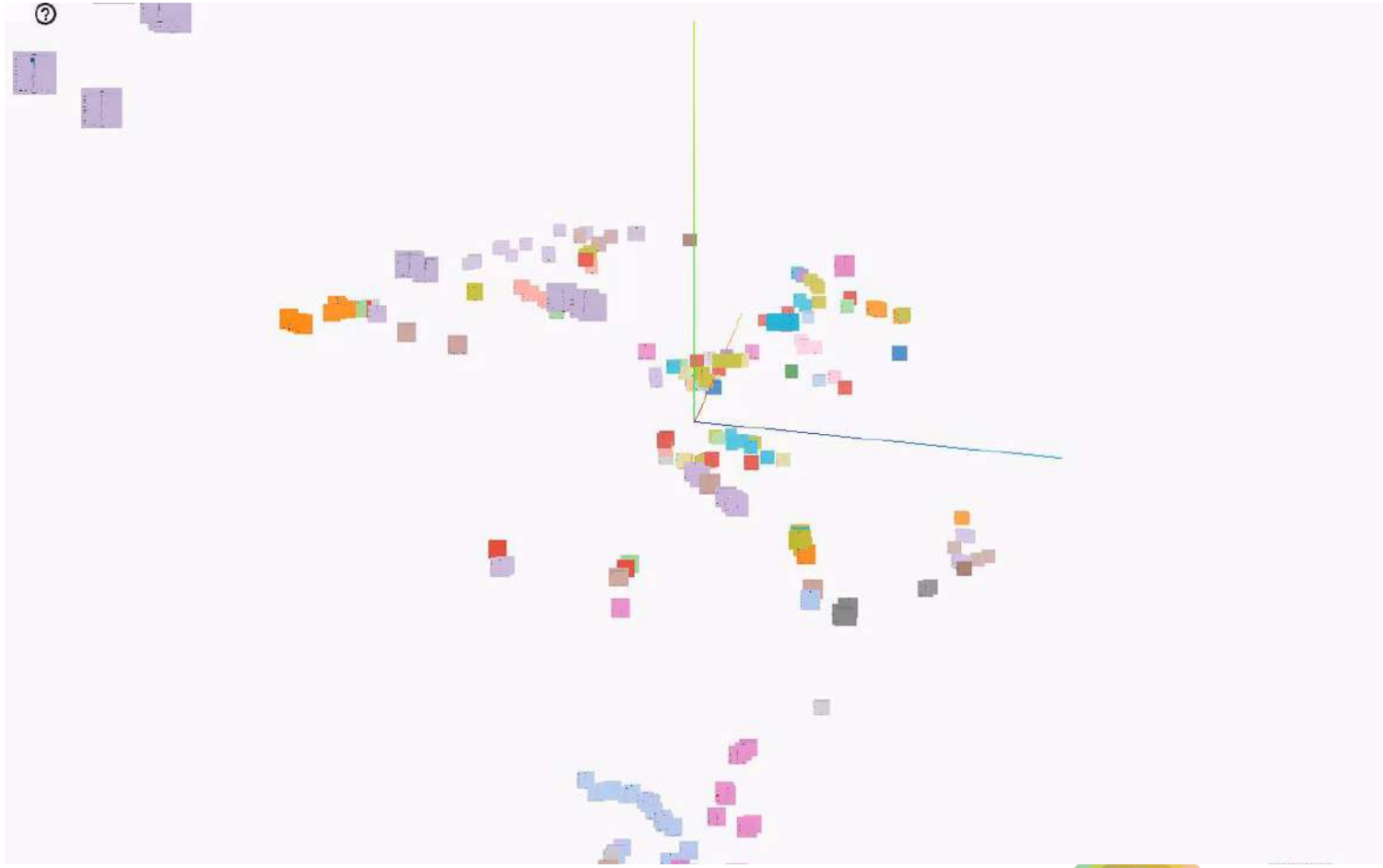
Find analog wells of a wildcat exploration area

- **Standard Solution:**

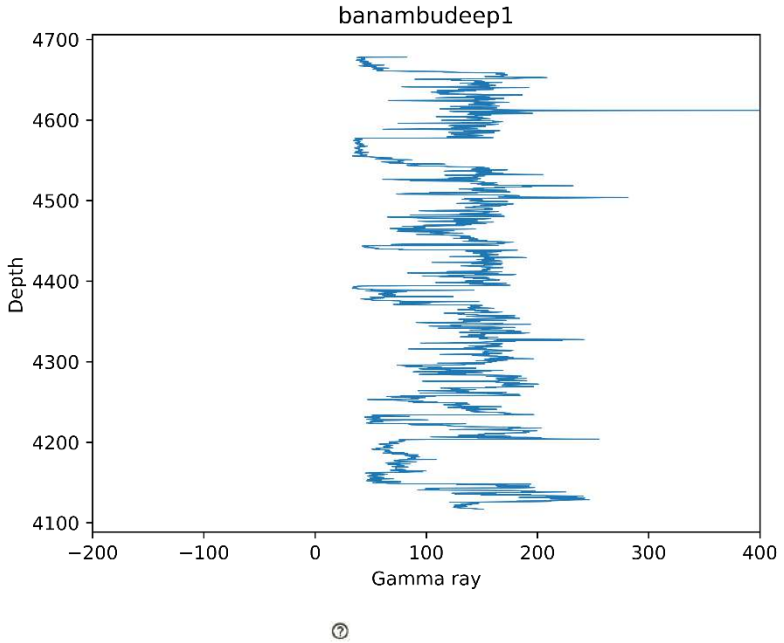
Find the nearest 1 or 2 wells in the nearest field (highly risky, does not capture all variabilities)

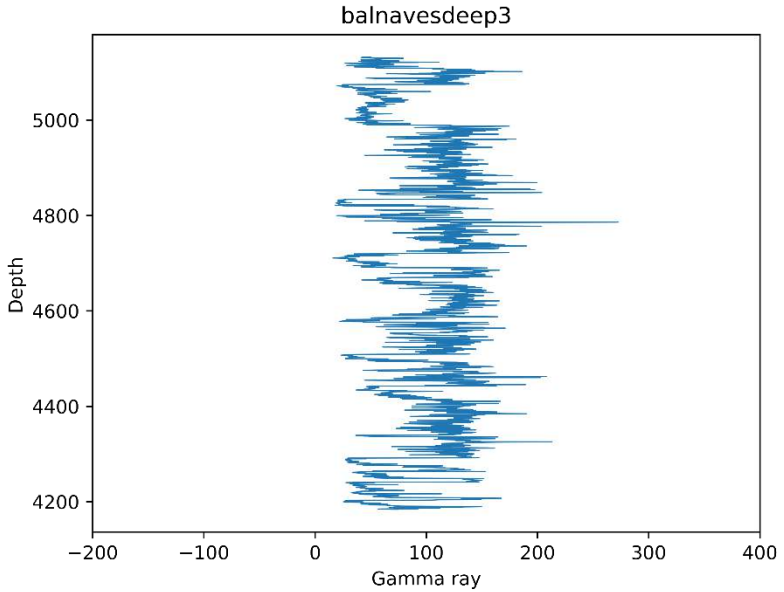
- **Machine Learning Solution:**

Leverage on big volume dataset to find geological analogs and de-risk potential prospect

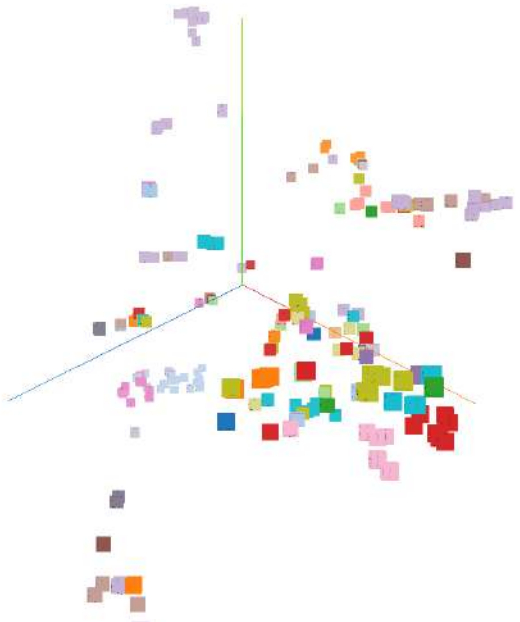


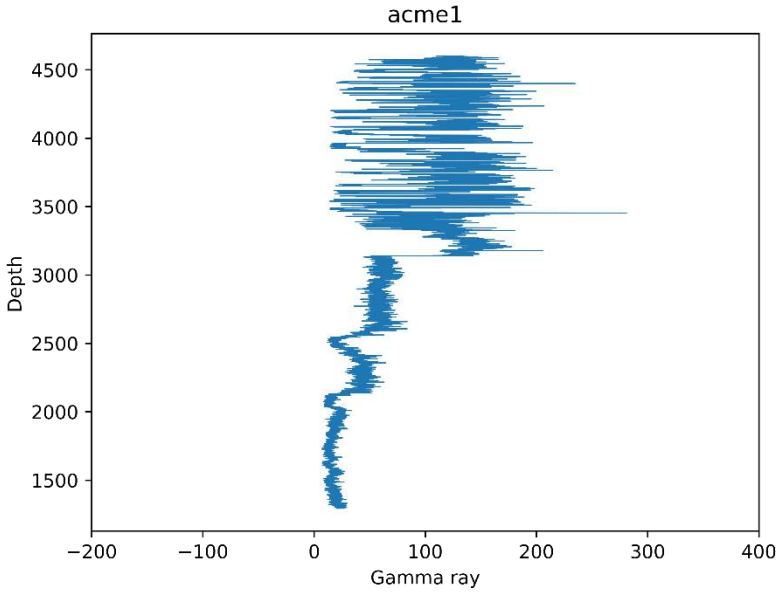
Automated Clustering of well data using t-SNE

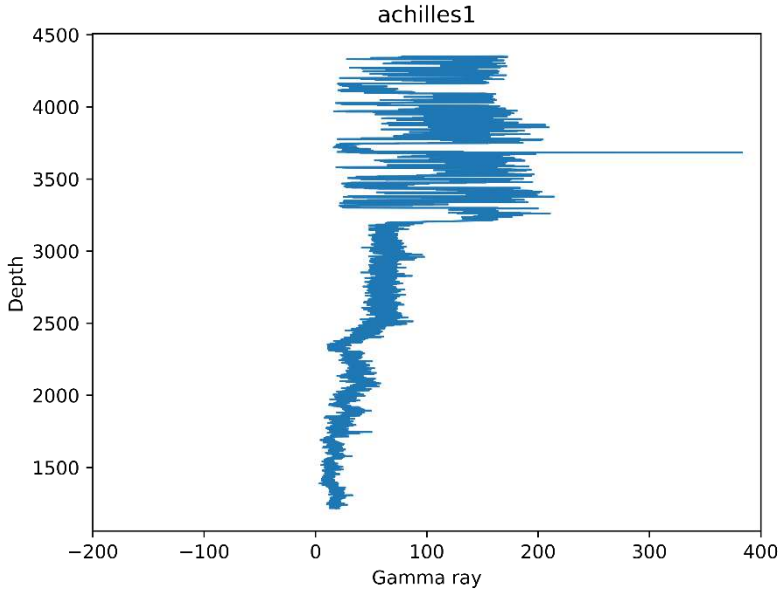




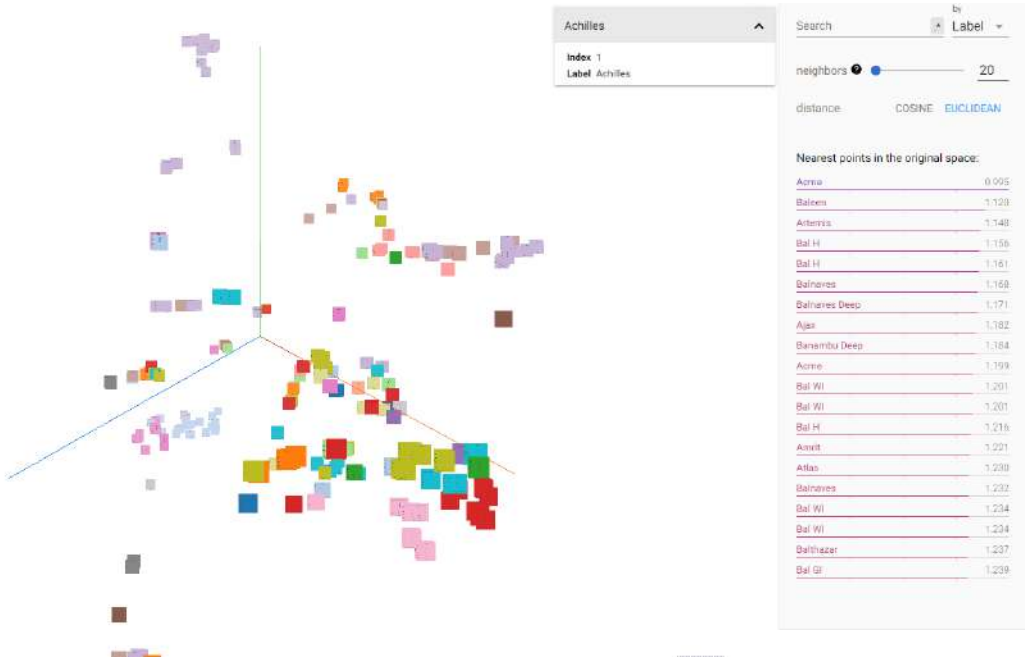
- Automated identification of the closest well “twin”, without prior geological knowledge
- Applicable in ultra-wildcat area or cross-country analog search







- Effective in automated identification of the closest genetic “twin” of the well
- Twin can provided valuable information on lithology, production history, drilling risks, etc.



Use Case #3: Clustering

- **Problem Definition**:

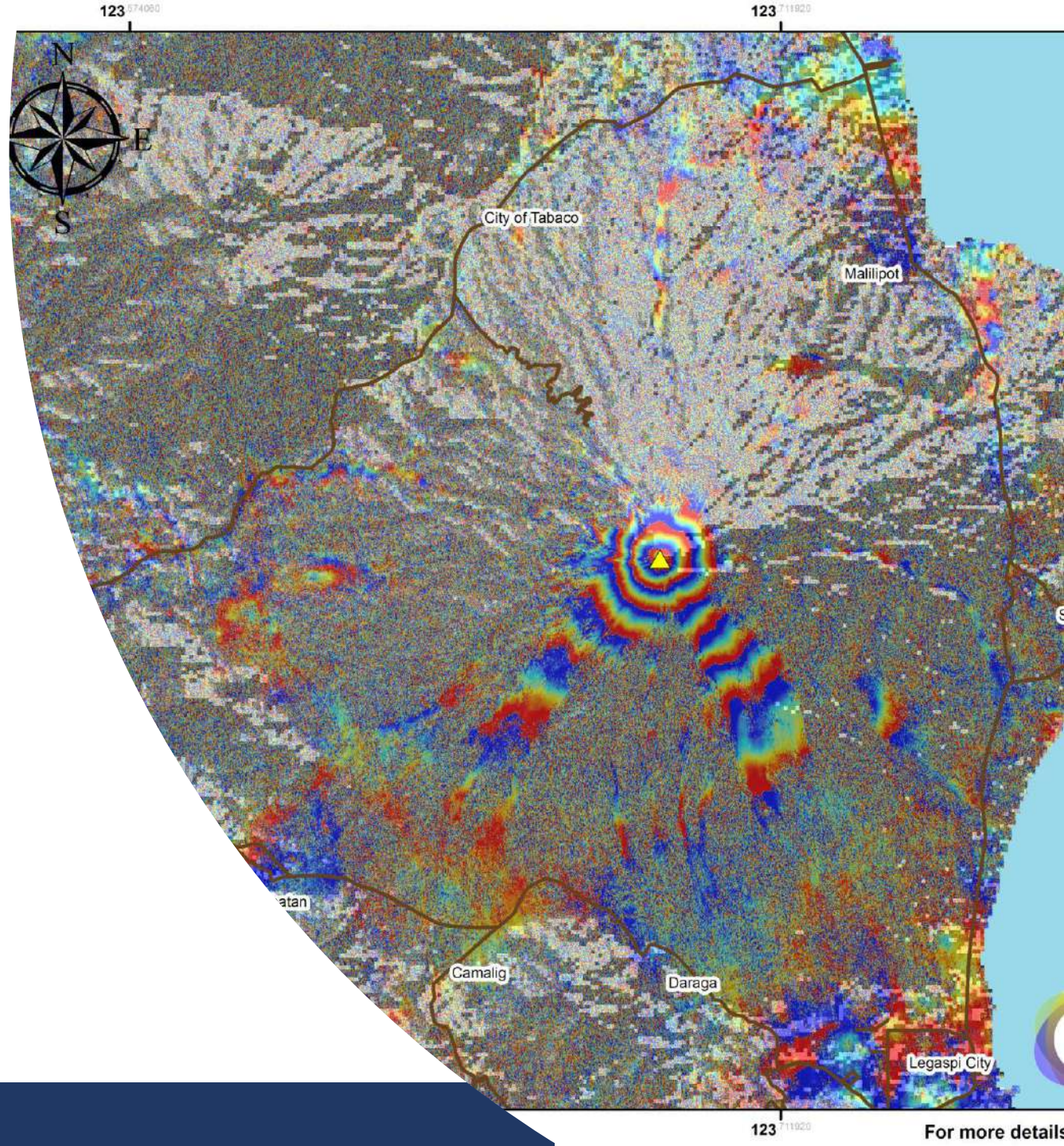
Identify surface features from satellite data

- **Standard Solution:**

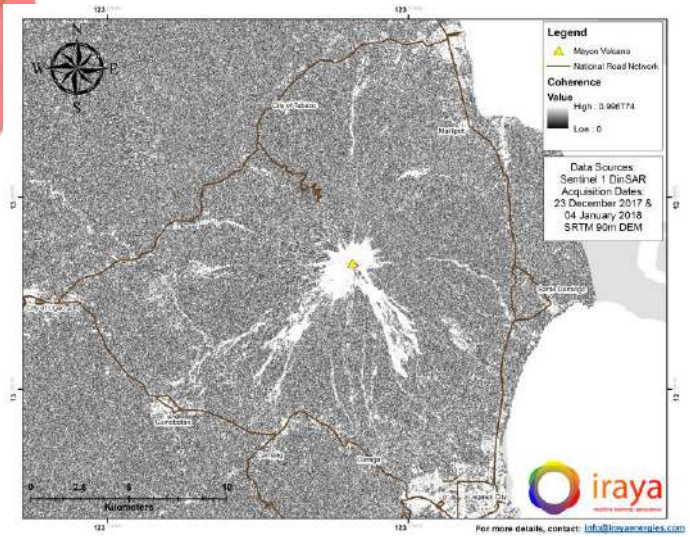
Manual Interpretation

- **Machine Learning Solution:**

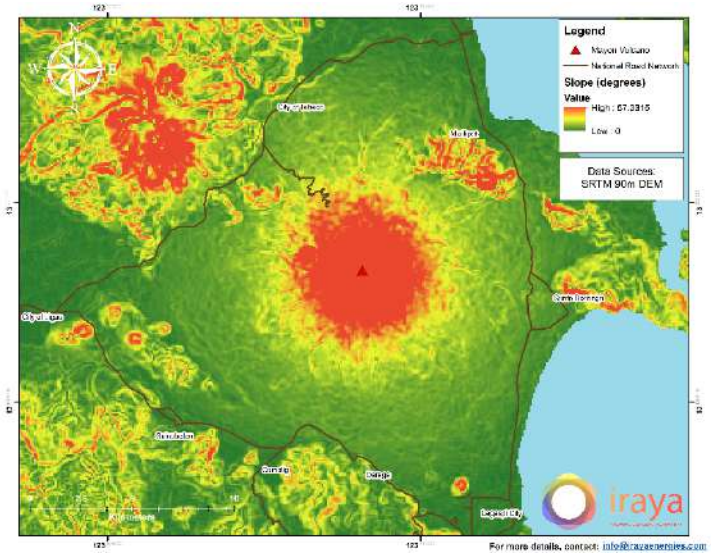
Unsupervised classification of multiple extracted features



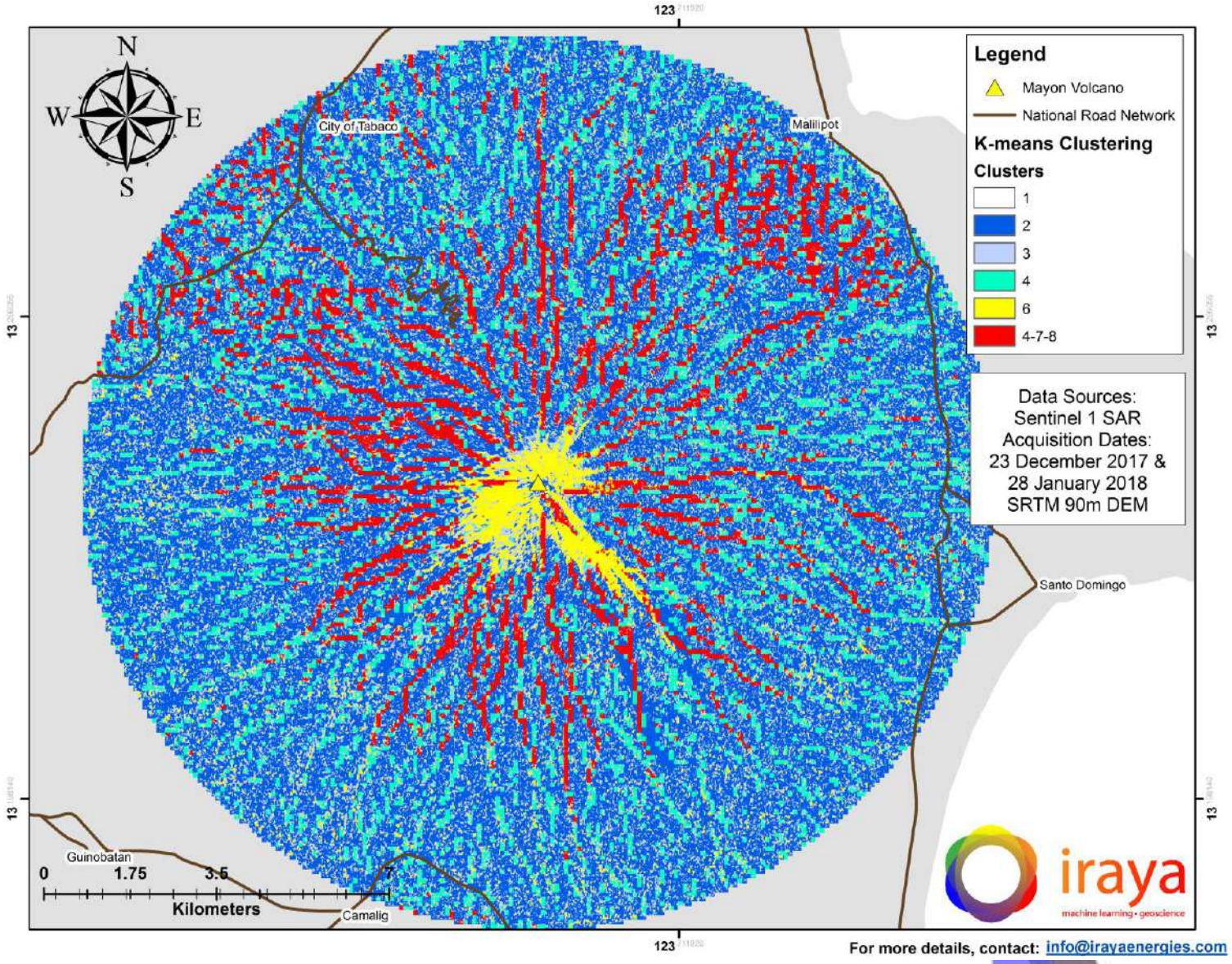
Coherence



Slope



K-means Cluster



Use Case #4: Resolution Enhancement

- **Problem Definition**:

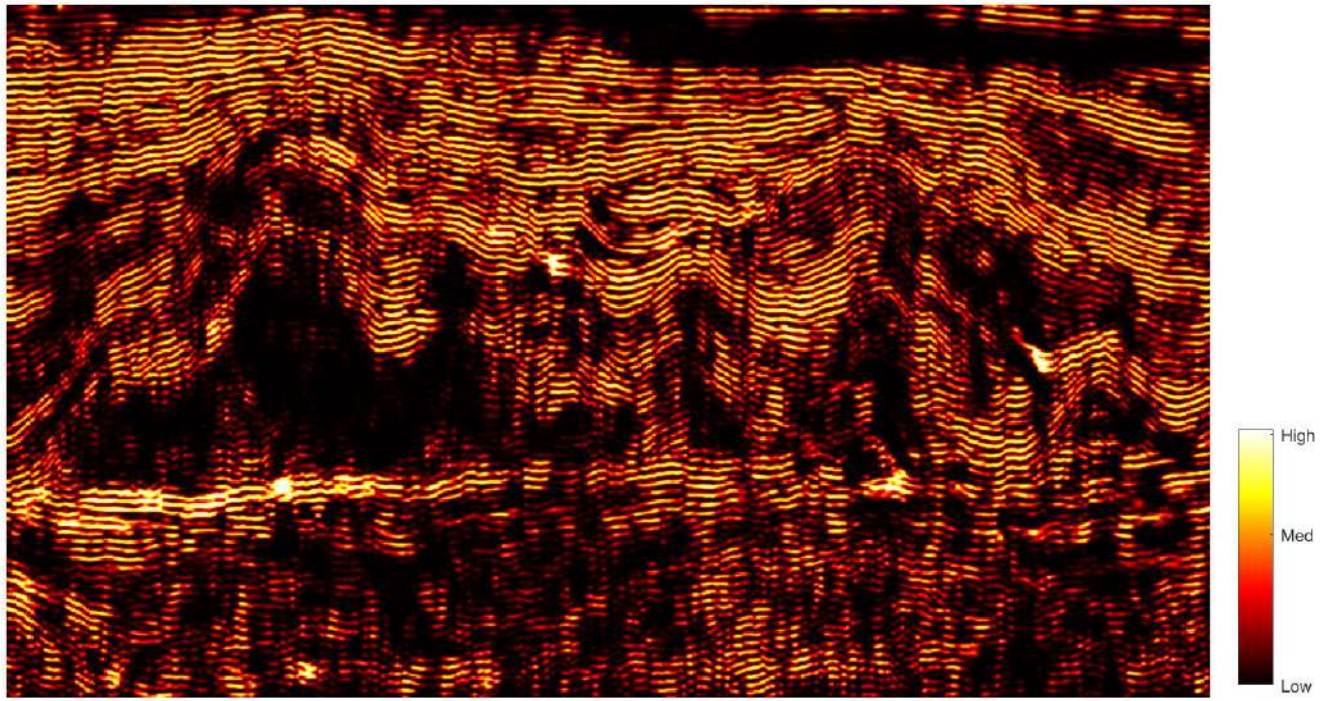
Increase seismic image Quality in Vintage Seismic acquisitions for better interpretation

- **Standard Solution:**

Traditional Seismic Processing + Stochastic Static Modeling

- **Machine Learning Solution:**

Model-based residual processing using deep convolutional neural network



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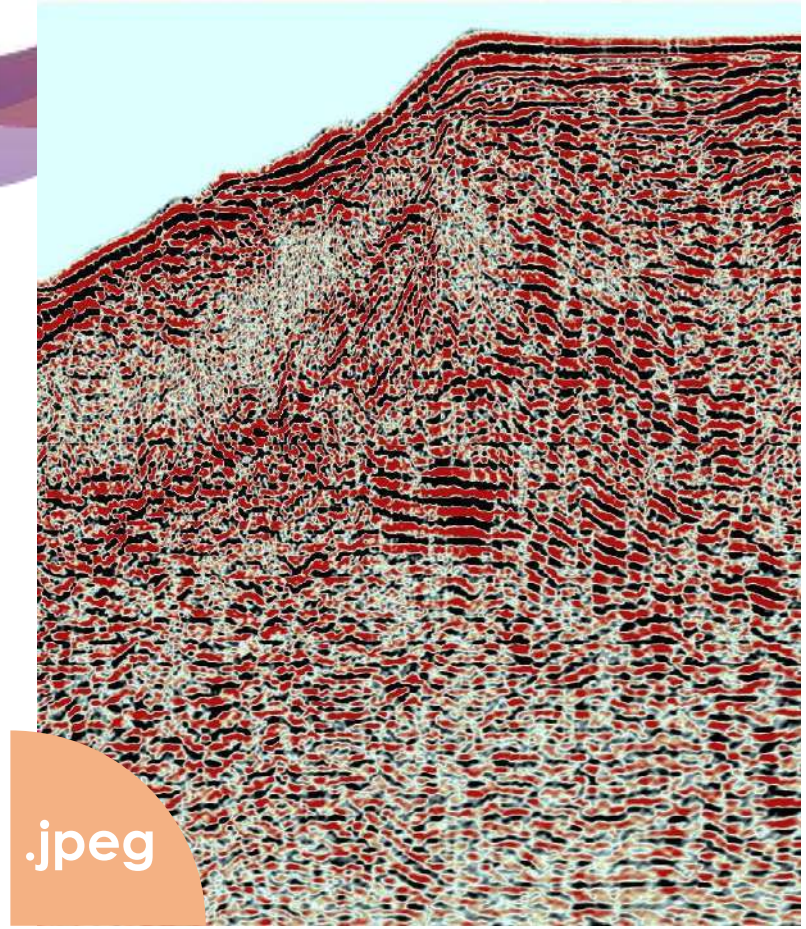
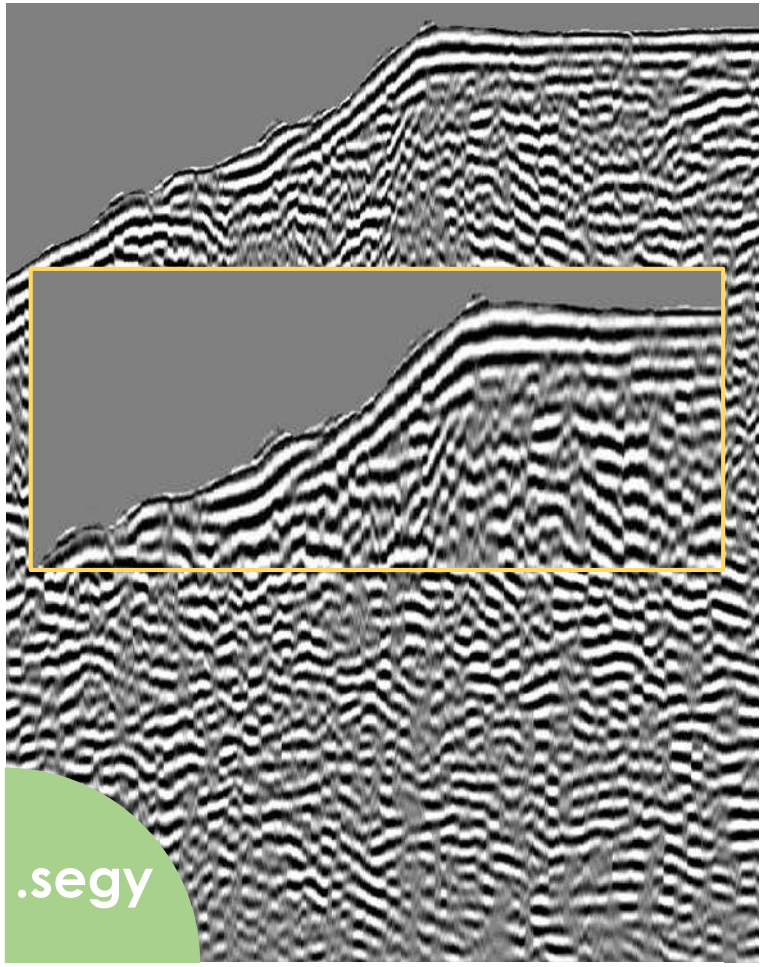
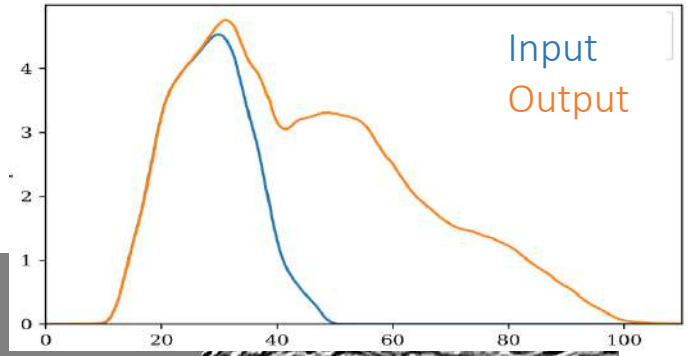
Let’s assume…

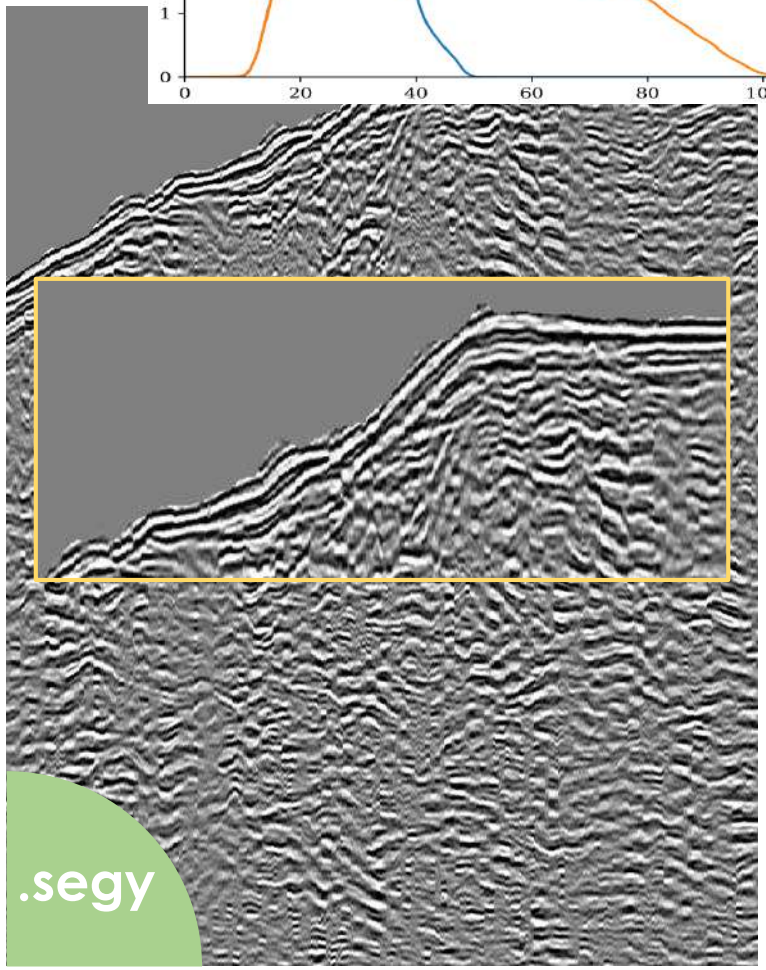


We have a powerpoint with somewhere a seismic image



We would like to find it, clean it and convert it into .segy





And why not enhance it at the same time

Fully automatic - AI driven

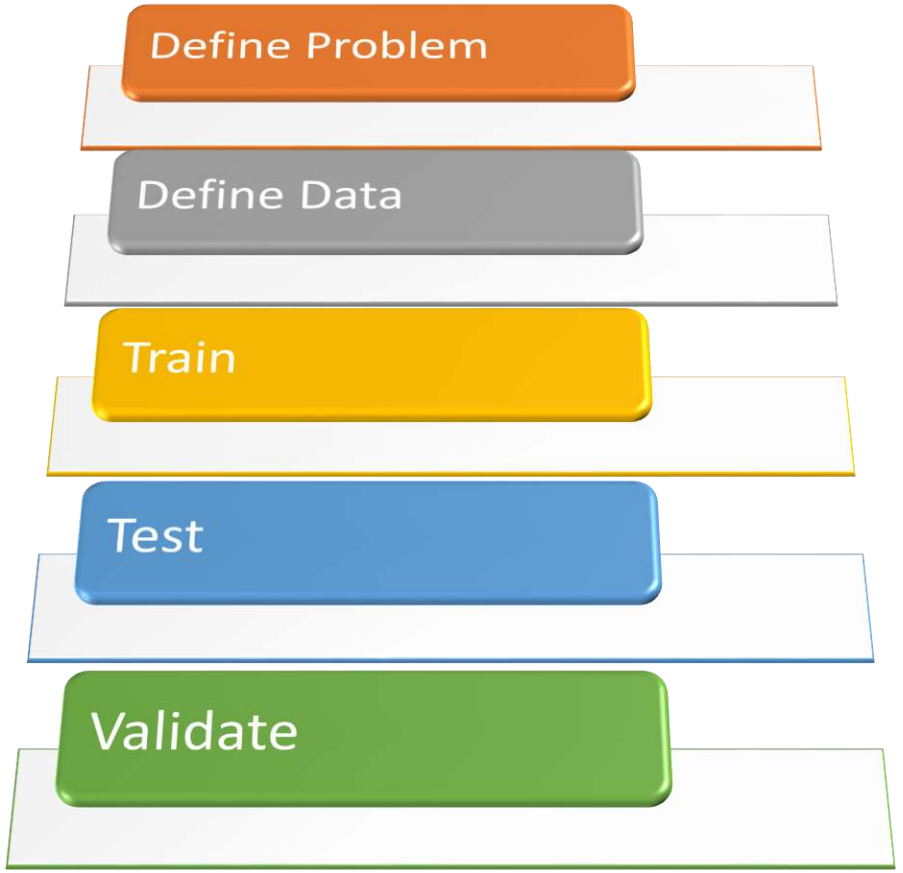
Conclusion:

Leveraging on AI for Energy Efficiency

Conclusion

Leveraging on AI for Energy Efficiency:

Tap into our inner scientist



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Conclusion

Leveraging on AI for Energy Efficiency:

Public and Private Investment in People and Technology

images source:web

Thank you!

For discussions on how AI can help increase efficiency in your organization’s processes, or AI investment opportunities pls contact:

info@irayaenergies.com or nmh@irayaenergies.com