AI for Natural Resources

transforming knowledge intensive processes with AI

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“By 2018, 75% of all Oil and Gas companies will have at least one digital transformation initiative in full operation deploying cloud, big data and analytics, process automation, or IoT for the organization to advance their IT environment”

Source: IDC FutureScape: Worldwide Oil and Gas 2018 Predictions, December 2017

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Digital transformation is addressing key industry challenges

Cloud & Data	IoT	AI/Cognitive	Blockchain

Developing new solutions for E&P to accelerate improved decision making with greater certainty

Optimizing supply chain and capital usage through secure transactions

Leveraging insights to drive safe, efficient and effective operations

Driving sales through both systematic and unsystematic customer insight

Delivering superior customer service through multi channel experiences

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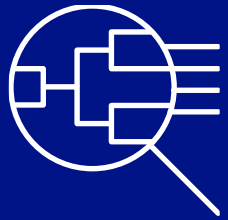
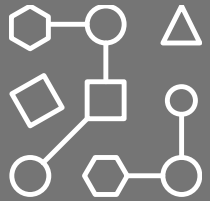
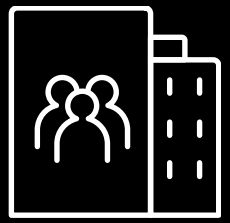
AI, a business imperative for Natural Resources Industries



Rapid analysis of massive volumes of divergent data



Fact based, traceable hypothesis/ reasoning



Insight and expertise retained within the company

Accelerates improved decision making with greater certainty

Democratize innovation by scaling knowledge

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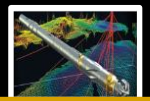
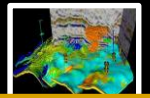
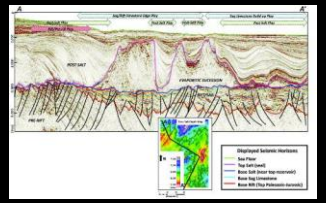
Towards Broad AI in E&P

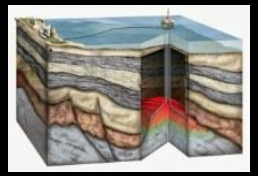
Transform the industry's knowledge intensive processes that rely on data interpretation to understand the subsurface



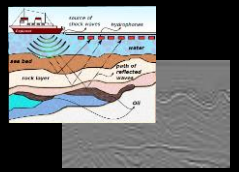


New ventures & appraisals | Exploration | Field development | Production and Operations | Asset Optimization

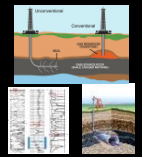




Main sources of information and knowledge



seismic data



well log data & core samples

analogues

technical literature

experts' tacit knowledge

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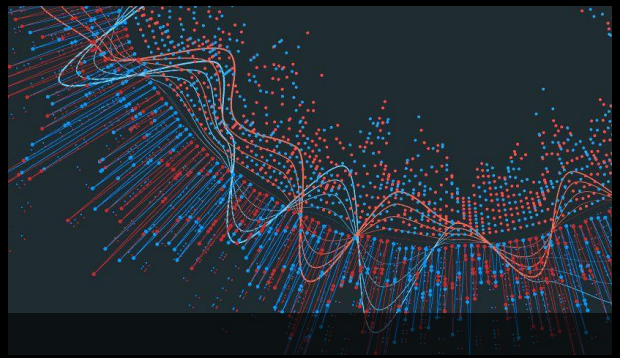
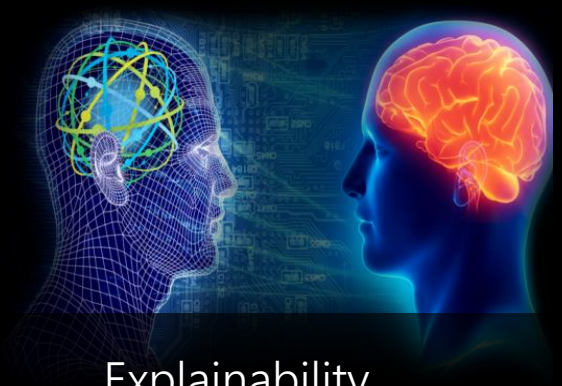
Challenges for AI in O&G



Small Data

Transfer Learning



Explainability

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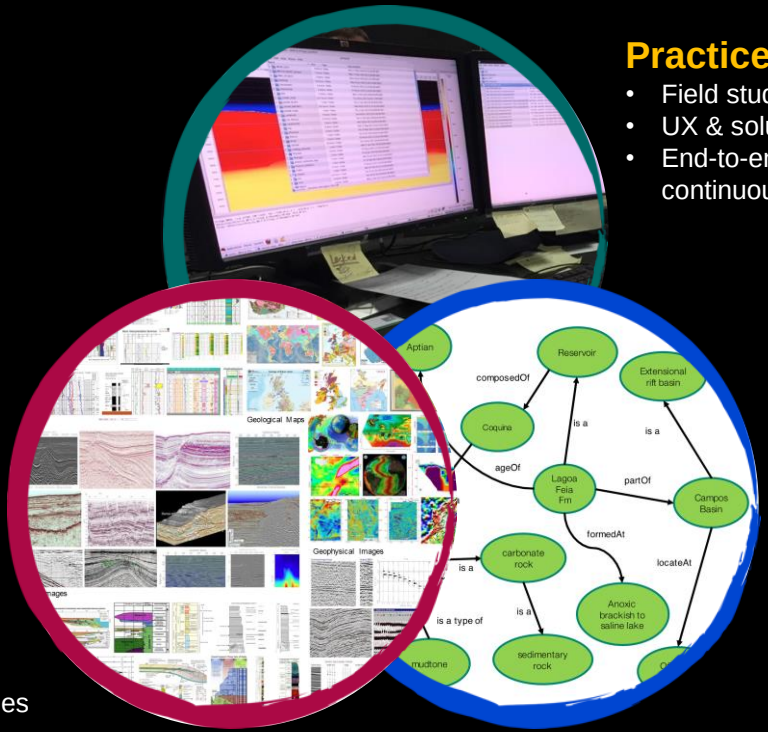
AI for NR Industry Approach

AI Technologies + Knowledge Representation/Modeling + Domain & Context Understanding



Practice & Context Understanding

- Field studies of expert decision-making processes
- UX & solution integration of work practices
- End-to-end AI Solutions lifecycle support for continuous learning

AI Technologies for Vision & Data-Driven Models

- Deep-learning for Seismic Image Understanding
- Machine-learning for geo-special data
- Machine-learning for Reservoir Analogues
- Data-driven well-logs analytics
- AI for Model-blending: physical-based and data-based model integration

Fit-for-purpose Knowledge Engineering

- Construction and evolution of domain ontologies
- Improved interpretability and causal analysis
- Training with small data
- Hyper-knowledge: KR + multi-categorical data
- NR Knowledge extraction & representation from documents

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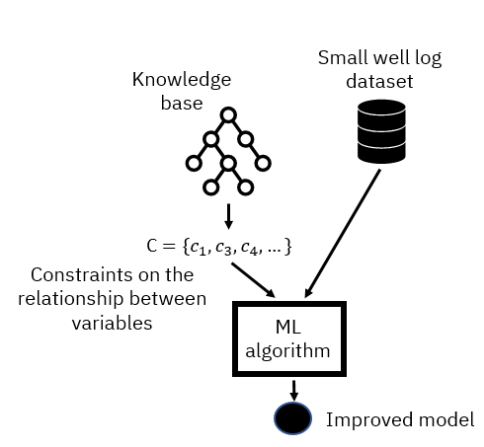
Knowledge-enhanced ML

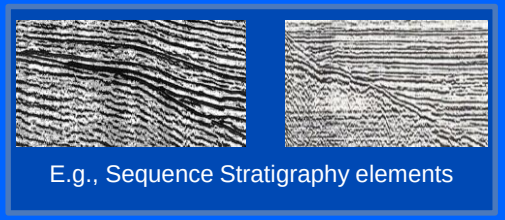
Small Data

- **Data Augmentation**
  - Knowledge from analogs
  - Creation of synthetic data
- Use learning from small data set to train AI for annotation (AI 4 AI)
- Generative Adversarial Networks (GANs)

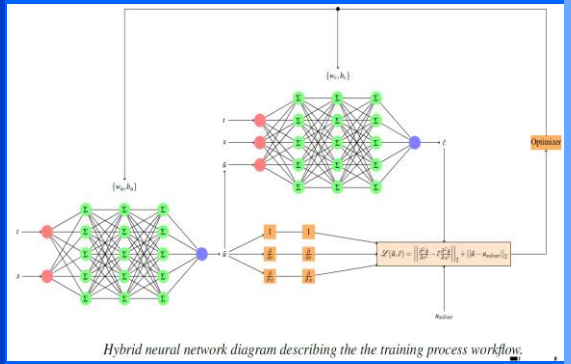


Transfer Learning

- Reuse knowledge acquired in other areas



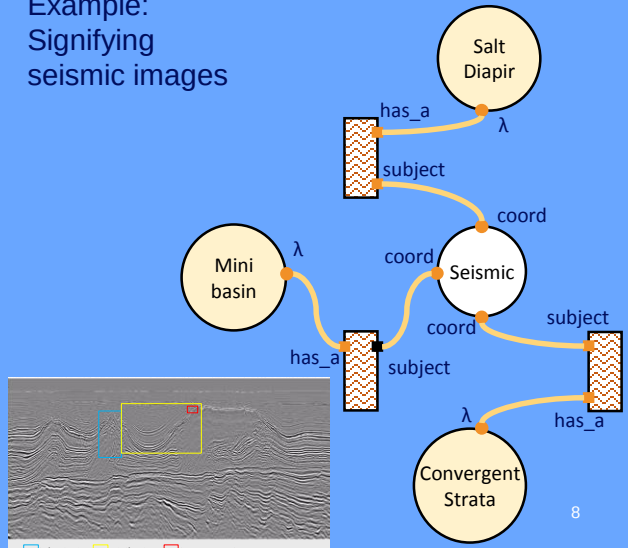
- Imbed knowledge from physical models (PiNNS)



Interpretability

- **Hyper-Knowledge Representation**
  - Extending the traditional knowledge representation techniques to connect concepts with multimodal content/representation

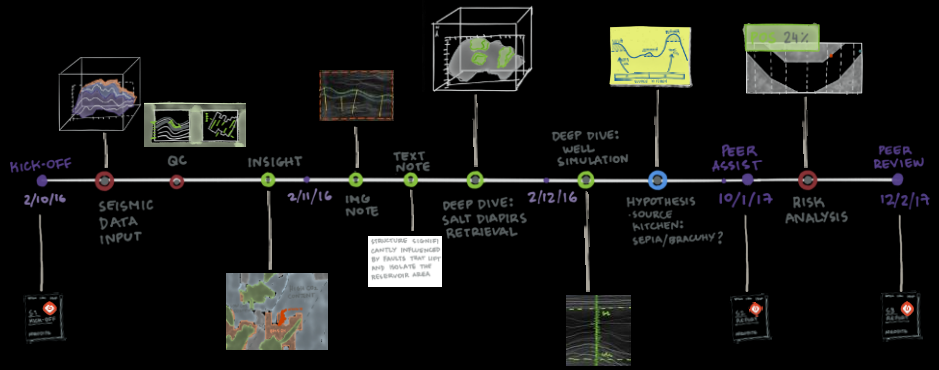
Example: Signifying seismic images

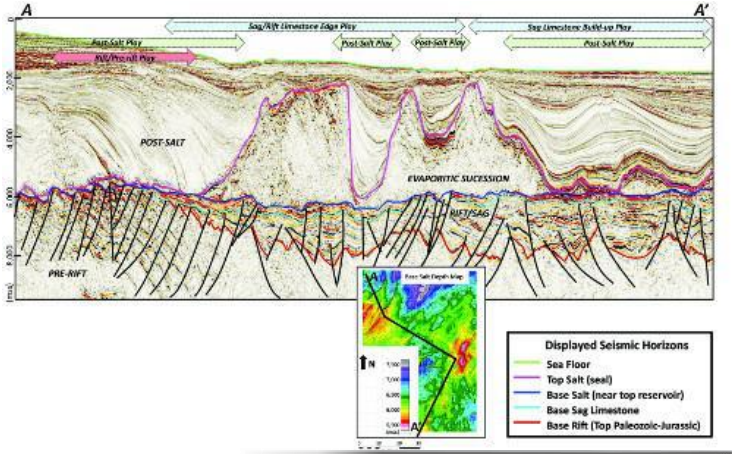


Galp Project: AI-assisted Seismic Interpretation for O&G

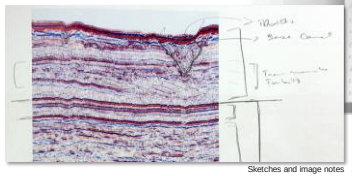
Seismic interpretation is the science (and art) of inferring the geology at some depth from the processed seismic record. – such as structural horizon geometry, depositional environment, sequence stratigraphy, and so on. High quality seismic interpretation is critical for the success of oil exploration and production.

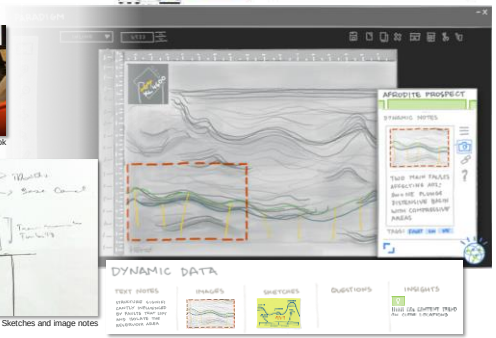
It is a very **knowledge intensive process**, in which one of the bottlenecks is the dependence on **interpreter's tacit knowledge** about the geological context. This tacit knowledge is what allows the interpreter to use and combine **contextual information** to "fill the blanks".





Interpreter's notebook


Sketches and image notes



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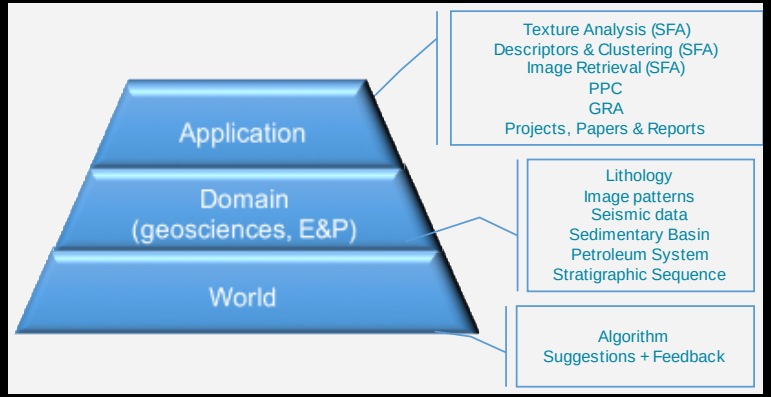
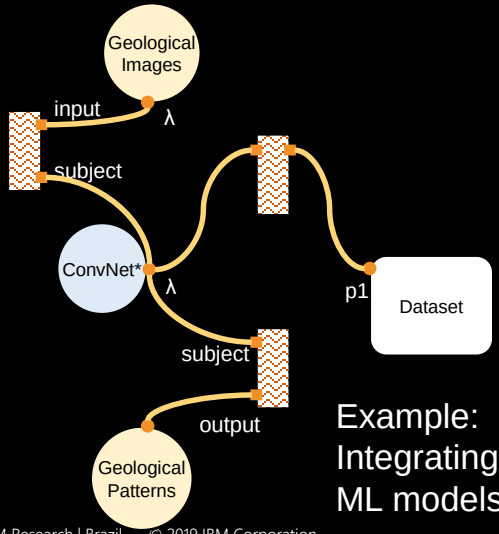
Hyperknowledge Representation

Extending the traditional knowledge representation techniques to connect concepts with multimodal content/representation

- Rich relationships between concepts and content segments
- Nested Context Model to structure knowledge graphs
- High-level abstractions for reuse of content and concepts
- Integration of formal knowledge and data-driven models

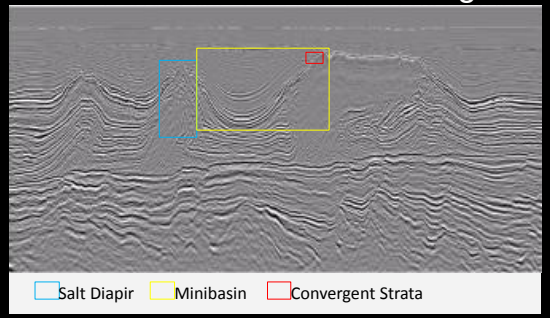
Ontology Engineering

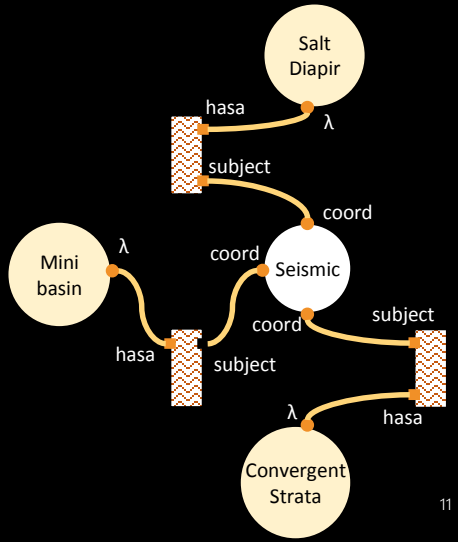




Example:
Integrating and signifying ML models

Example:
Signifying seismic images





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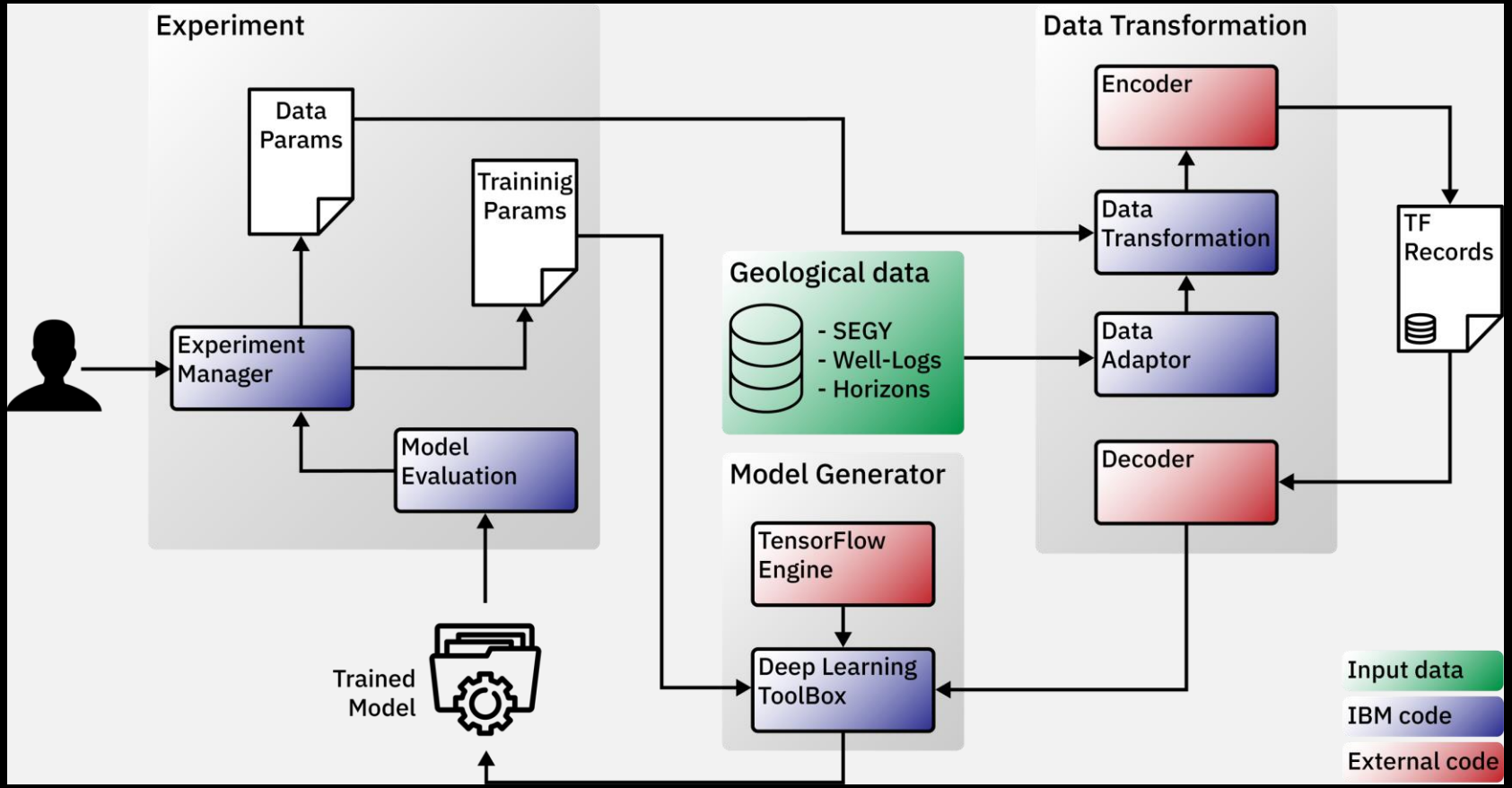
Deep Learning Toolbox for Geospatial Data



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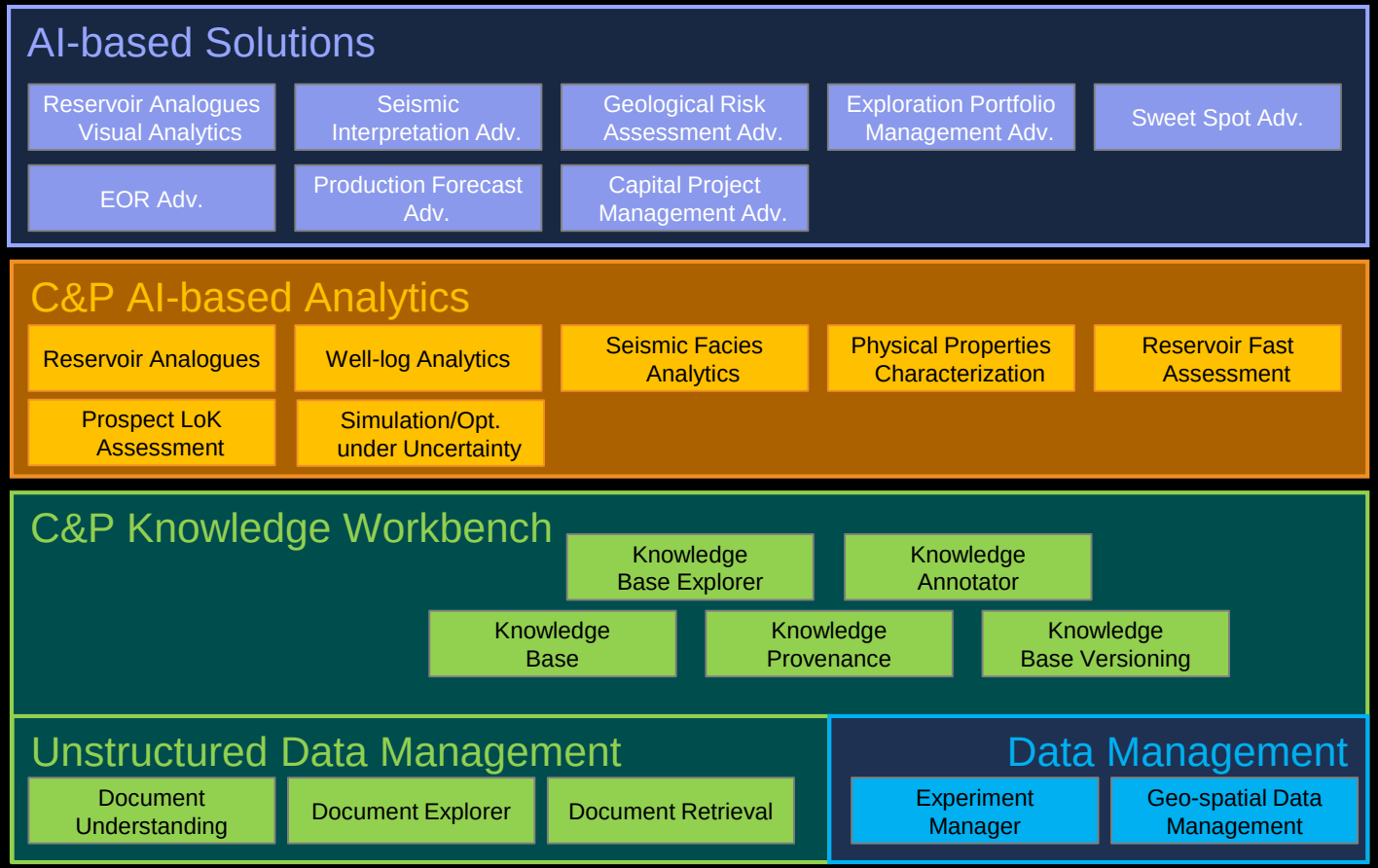
An AI Platform for Natural Resources



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AI for O&G – A Research Roadmap

2015

Industry Specific Cognitive Systems
- Knowledge extraction from text for O&G
- Knowledge extraction from seismic images and well logs
- Knowledge Engineering
- Industry Specific Q&A
- Cognitive assistants for smarter operations

2017

Practice-aware Cognitive Systems
- Dealing with small data
- Hybrid Knowledge Bases
- Managed evolution of domain models
- Learning through user interaction
- Learning through user sensing (e.g. eye tracking)
- Practice-driven knowledge engineering
- Context-aware conversational interfaces
- Cognitive assistants for interpretative processes

2019

Advanced AI & Cognitive Workplace
- Explaining AI models
- Excelling transfer learning
- Dataset Engineering
- Causality analysis
- Abductive reasoning
- Knowledge modules
- Cognitive environments
- Cognitive systems for collaborative work
- IoT-driven Reservoir Digital Twin

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Thank you!!

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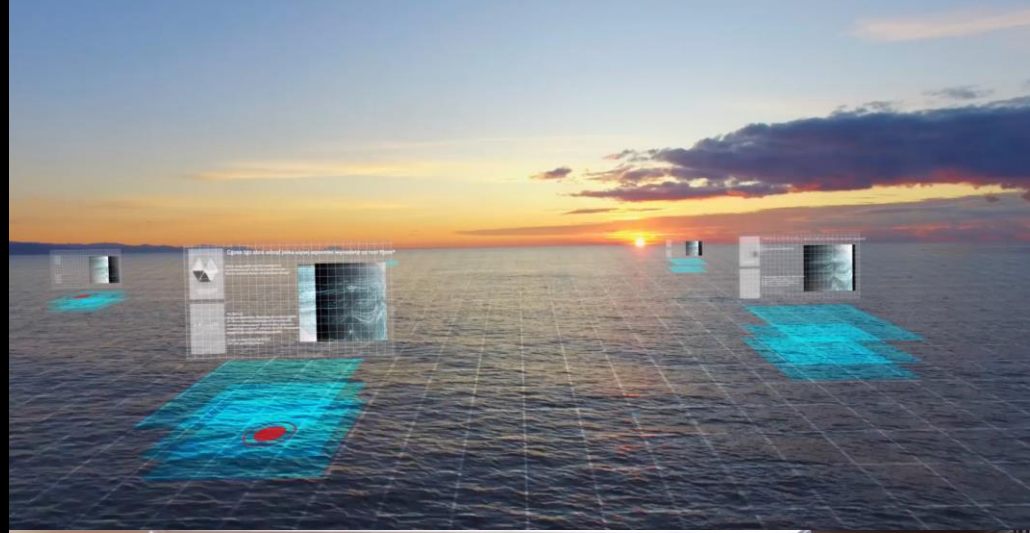
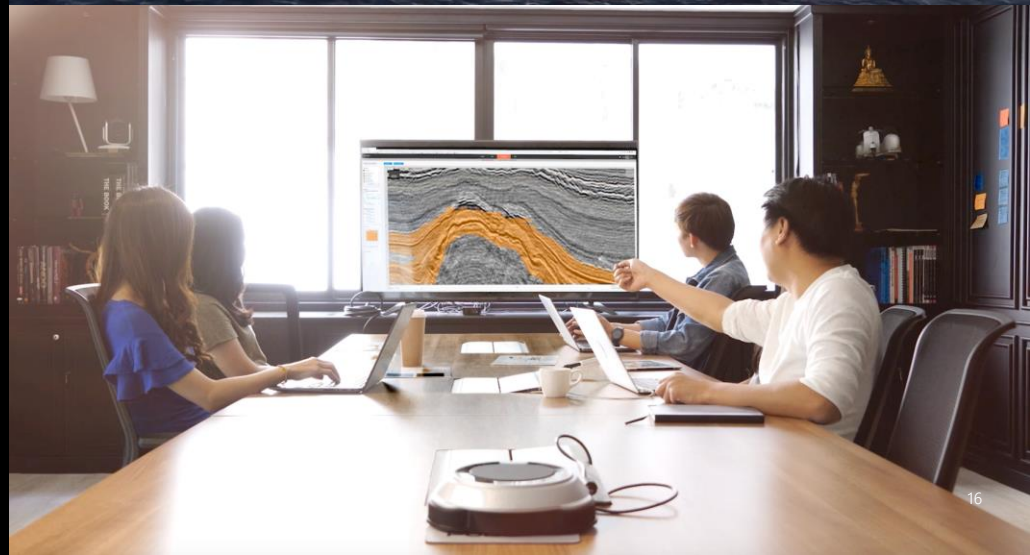
AI for Natural Resources

Reimagining Industry (O&G and Mining) digital transformation with focus on data and knowledge intensive processes, such as subsurface exploration and production management.





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Who we are

Machine Learning
Bianca Zadrozny

Machine learning and statistical modeling on geospatial data

Mathematical Optimization & Simulation
Leonardo Martins

Optimization under uncertainty, risk modeling, AI-driven model blending

Industrial Technology & Science
Mathias Bernhard Steiner

Nanotechnology for enhanced oil recovery

Knowledge Engineering
Marcio Moreno

Knowledge representation and reasoning, hybrid knowledge base architectures

AI-based Systems Engineering
Renato Cerqueira

Methods and technologies to support the lifecycle of AI-based systems

Visual Analytics & Comprehension
Rogério de Paula

Knowledge-augmented image comprehension, visual insights and perception

Industry Cloud
Marco Netto

HPCaaS, HPC for AI

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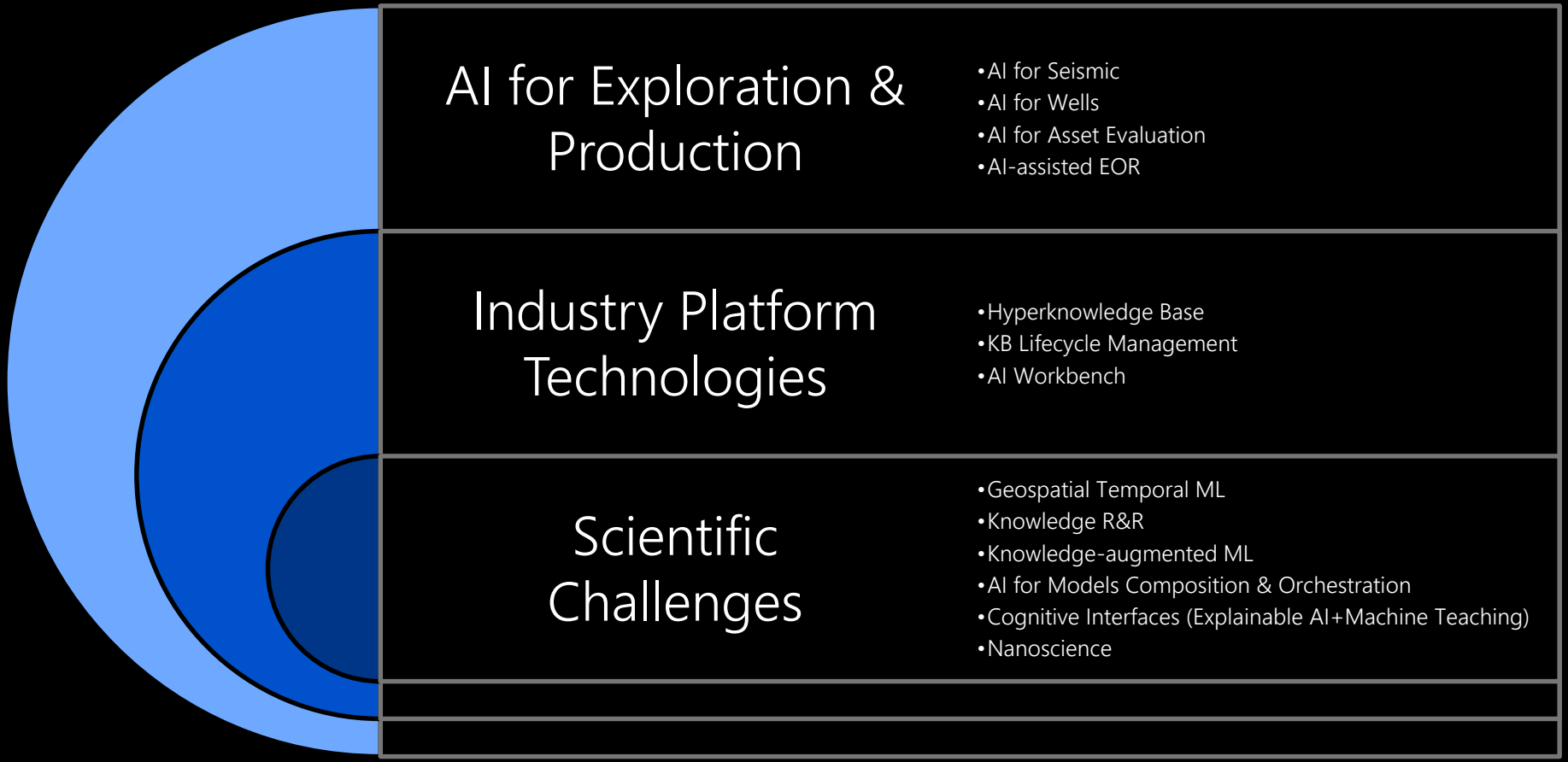
Research Agenda



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