Introduction

''Decision-Driven Data Analytics for Fast Well Placement in Field Development Scenario-Powered by Machine Learning''

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Outlines

1 Development of Proxy Model Utilizing Machine Learning Algorithm for Reservoir Simulation

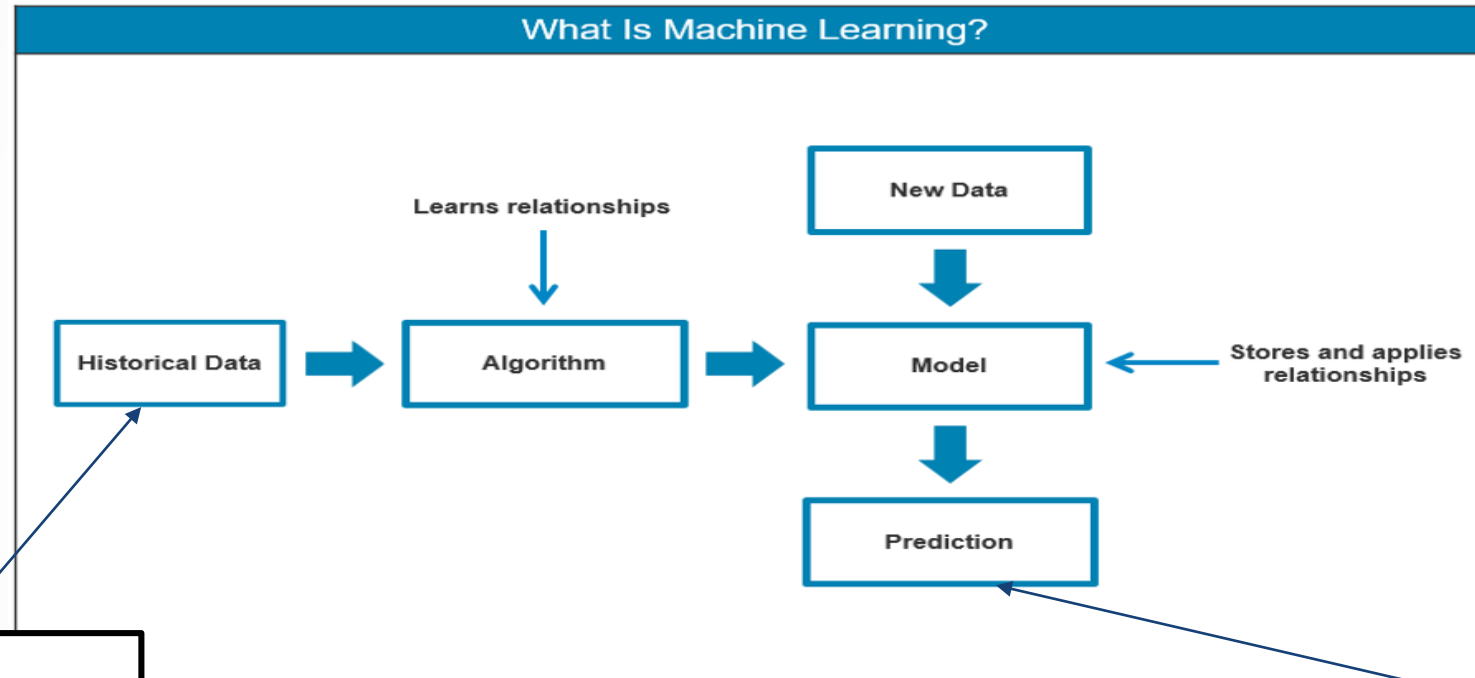**2** Value of Information in Data Analytic Project

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1. Proxy Model

Numerical Reservoir Simulator

Vs.

Machine Learning Based Simulator

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1. Proxy Model
ML Based Simulator:

What Is Machine Learning?

Learns relationships

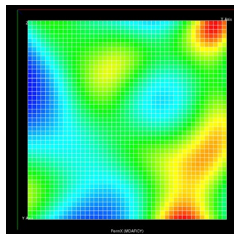New Data

Historical Data → Algorithm → Model ← Stores and applies relationships

Prediction

1. Porosity
2. Permeability
3. Distanse
4. Compressibility
5. Geological Model,…

45×45 Grid Size

2025 Perm Values
2025 Porosity Value
2025 Compressibility values,…

$$NPV = \sum_{k=1}^{n_T} \frac{[(q_o^k P_o - q_w^k P_w - I^k P_{wi} \triangle t_k)]}{(1+b)^{t_k/D}} - \text{CAPEX}$$

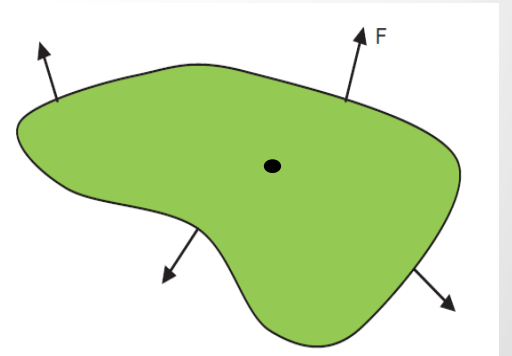Universitetet i Stavanger

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1. Proxy Model
Connectivity: Fast Marching Method

Eikonal Form of Equation:

The equation to track advancing surfaces on grid based reservoir:
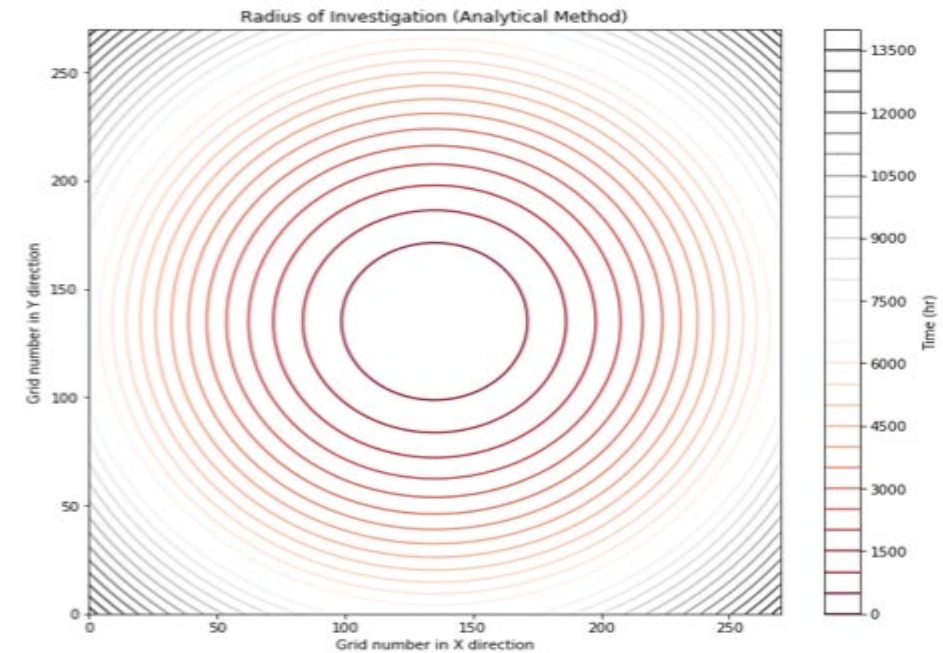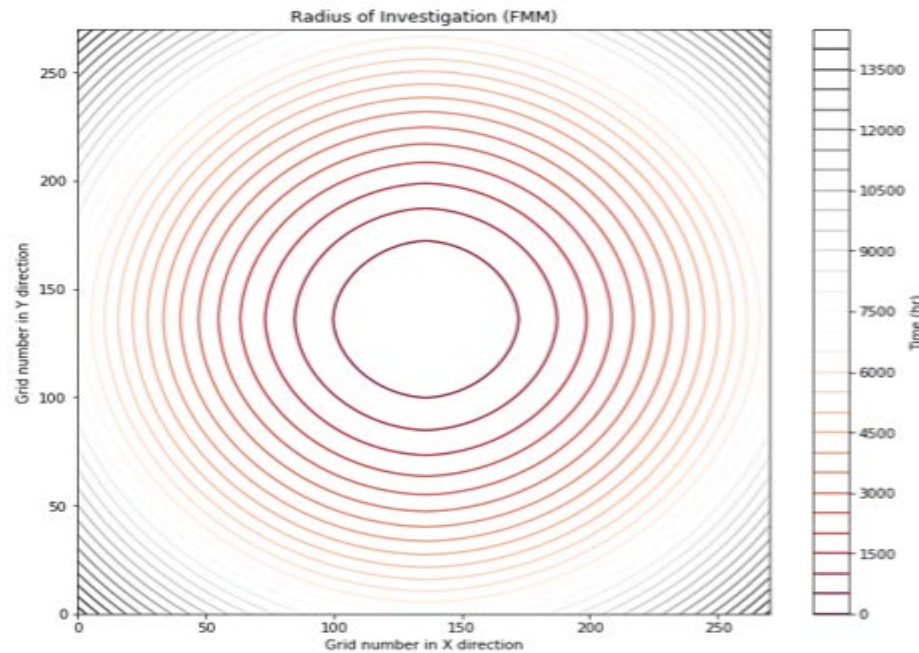
$$F(x)| \nabla \tau(x)| = 1$$

1. Proxy Model Validation of FMM

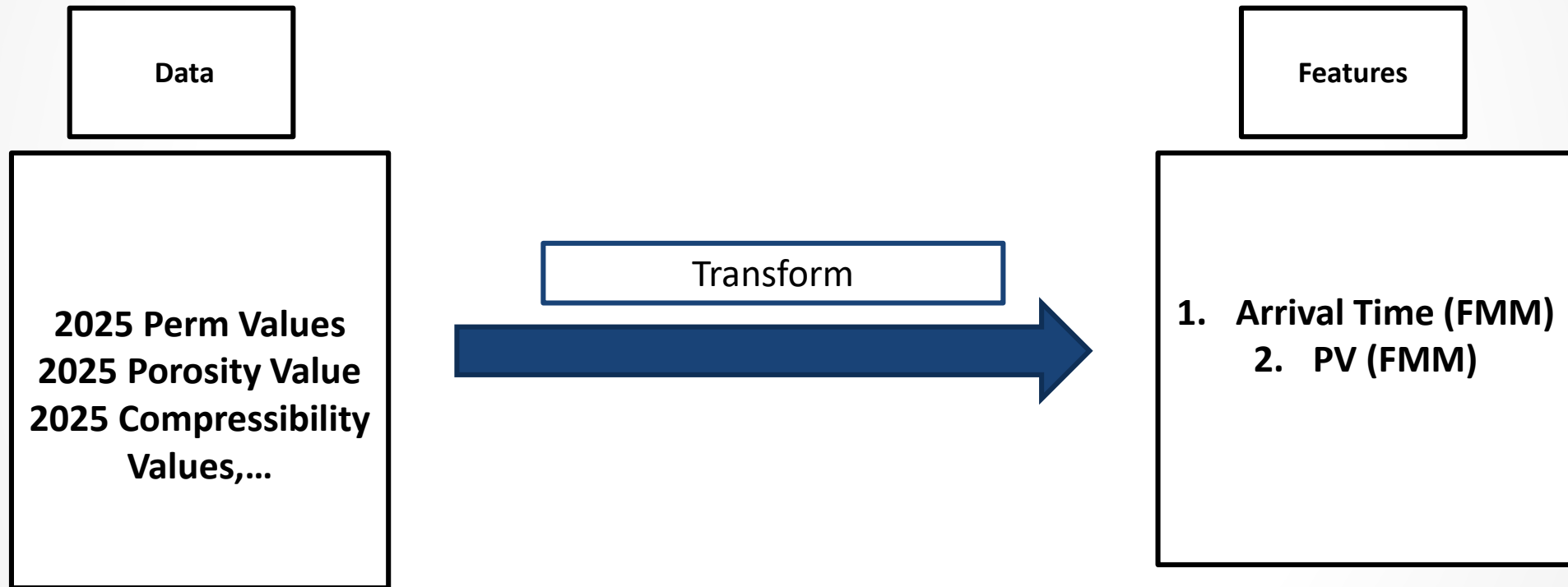**Radius of investigation as a radius of impulse –response. (Lee 1982)**

$$r = \sqrt{\frac{kt}{948\mu c_t \phi}}$$

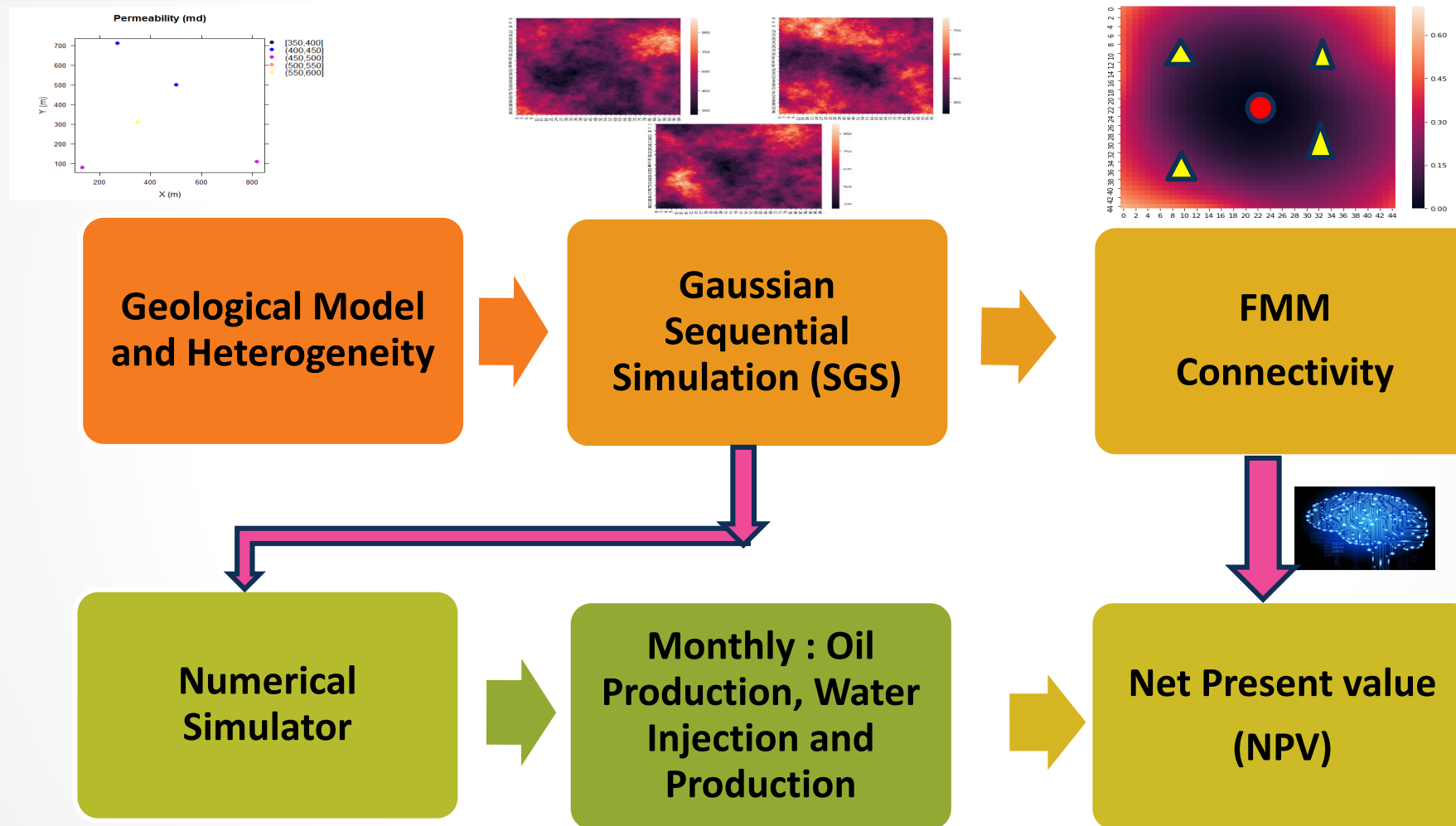|	
Grid block Size	20 by 20 by 20 ft
Grid block numbers	271 by 271
Porosity	10%
Permeability	1 md
Compressibility	10^{-5} (1/psi)
Viscosity	1 cp
Initial Pressure	4000 psi

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1. Proxy Model
Connectivitys as Features

Data

2025 Perm Values
2025 Porosity Value
2025 Compressibility
Values,...

Transform

Features

1. Arrival Time (FMM)
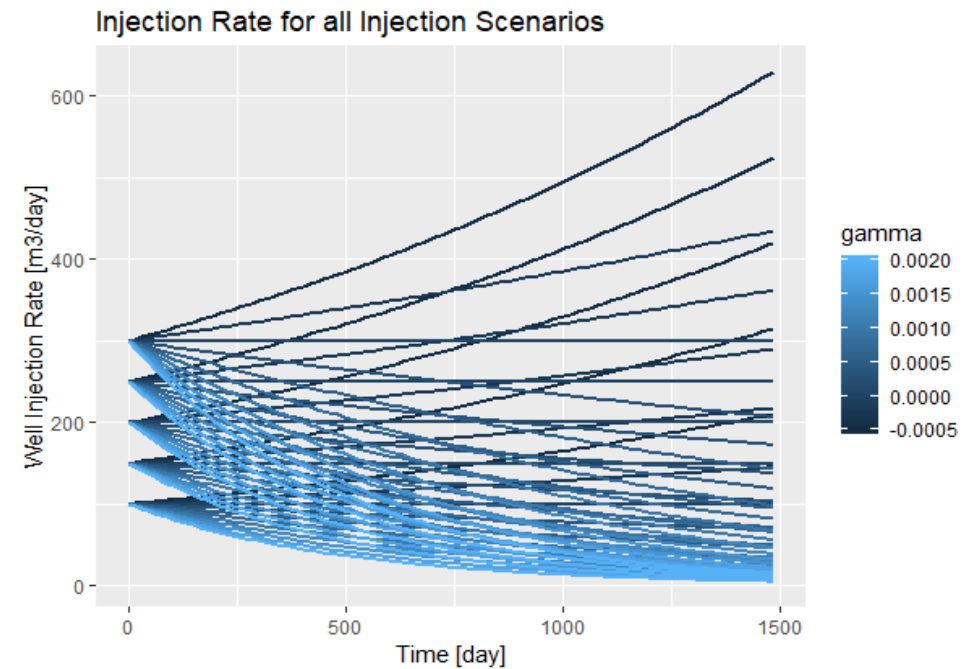2. PV (FMM)

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1. Proxy Modeling Workflow

1. Proxy Modeling
Injection Rate Scenarios:

$$Inj = Aexp(-\gamma t)$$

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1. Proxy Modeling
Injection Rate Scenarios:

EMW Presentation
Krakow, Poland

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1. Proxy Modeling
5-spot pattern result- (25 Features)

Test Data vs. ML Prediction (5-spot pattern)

R²=0.945

NPV of theTest Data ($MM)

NPV predicted by ML ($MM)
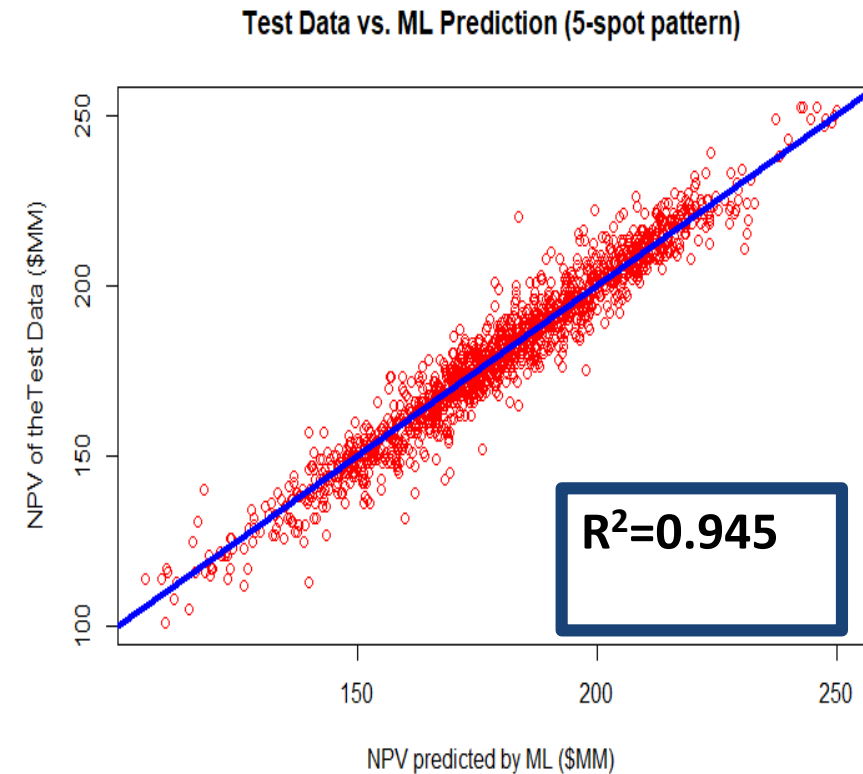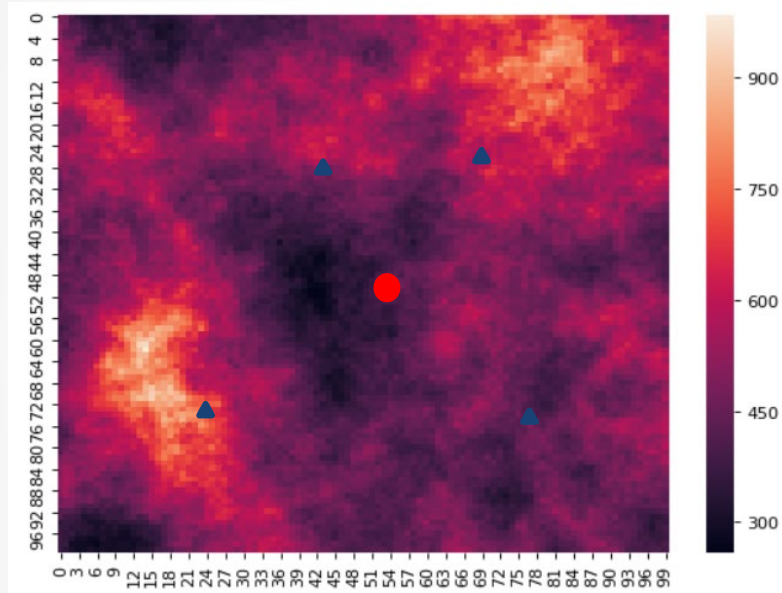
Tuning parameter of (Xgboost) Algorithm

Nrounds	Max_depth	Eta	gamma	Min_child_weight	subsample
2000	6	0.02	0	2.25	1

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Krakow, Poland

1. Proxy Modeling
Running Time, ML Vs. Eclipse

Numerical Reservoir Simulator Vs. Macine Learning

	Machine Learning	Eclipse
FMM	0,034 sc	
Execution	0,03 ml	
Total Time(sc)	0,034	7,63

Speed (ML vs. Eclipse)

■ Machine Learning   ■ Eclipse

~200X Faster

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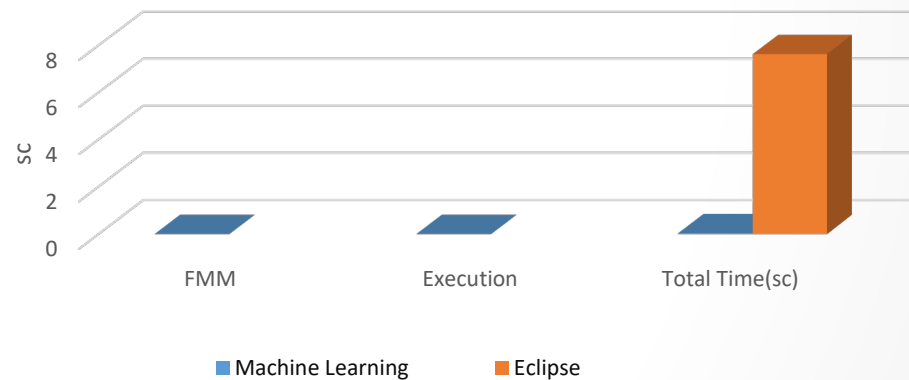
Value of Information in Data Analytic Project

2. Value of Information (VOI)
a. Expected Value without Information

2. Value of Information (VOI)
a. Expected Value with Information

Real Test Data Says

ML Says	H	M	L	Total	
"H"	0,133	0,083	0,017		0,233
"M"	0,117	0,300	0,083		0,267
"L"	0,000	0,117	0,150		0,500
Total	0,250	0,500	0,250		1,000

VOI = 8.52-0.45 = $8.07 M

EV=8.52 (M$)

NPV (M$)

0.91 High NPV|"High NPV"   34.1
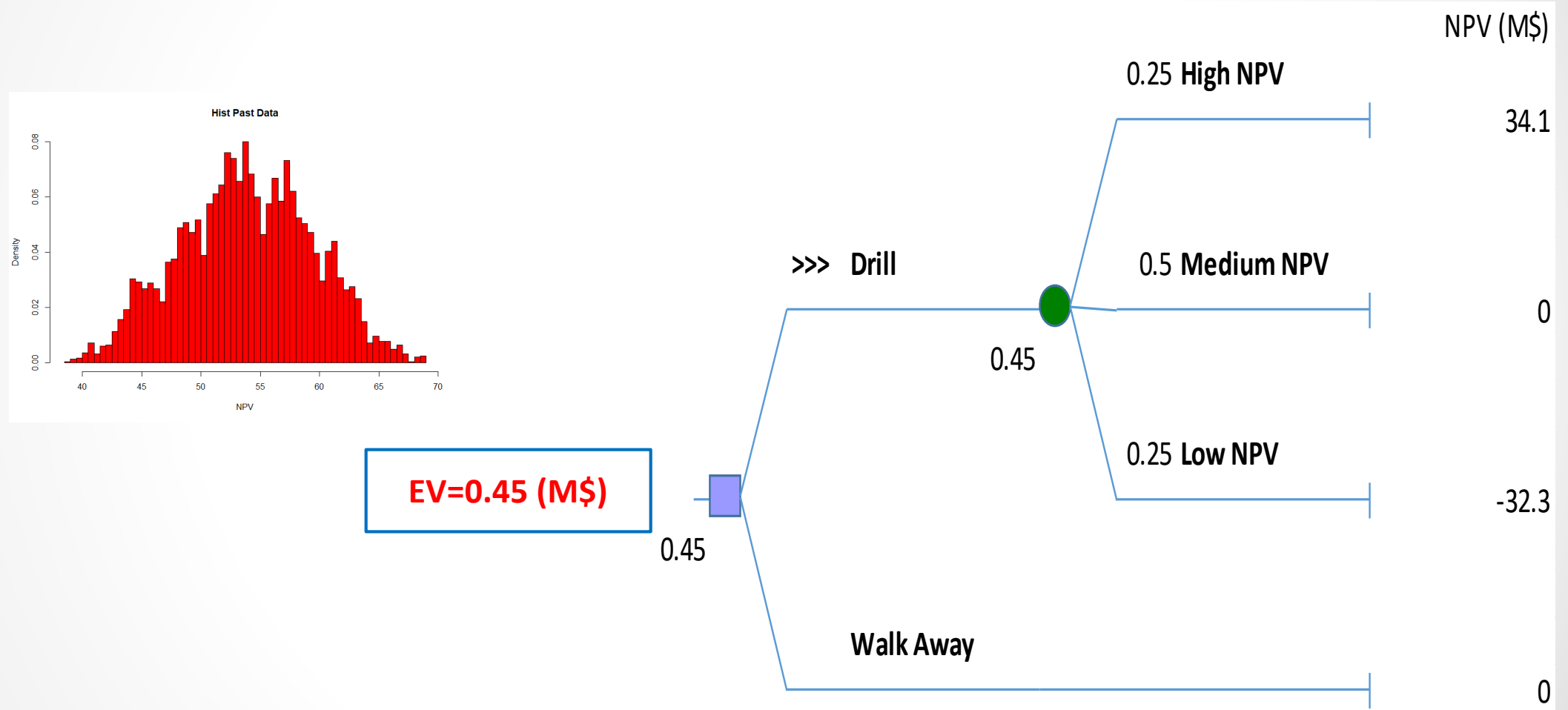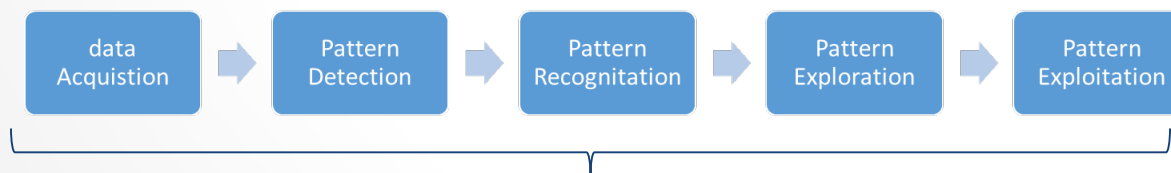
>>> Drill   0.09 Medium NPV|"High NPV"   0

0.18 "High NPV"   30.9969

30.9969   0 Low NPV|"High NPV"   -32.3

Walk Away   0

0.16 High NPV|"Medium NPV"   34.1

>>> Drill   0.84 Medium NPV|"Medium NPV"   0

5.3196

0.53 "Medium NPV"   0 Low NPV|"Medium NPV"   -32.3

50778   5.3196

Walk Away   0

0 High NPV|"Low NPV"   34.1

Drill   0.12 Medium NPV|"Low NPV"   0

-28.489

0.28 "Low NPV"   0.88 Low NPV|"Low NPV"   -32.3

0

>>> Walk Away   0

data Acquistion → Pattern Detection → Pattern Recognitation → Pattern Exploration → Pattern Exploitation

12/04/2019   **Data Analytic Project Cost!**