Optimising the Design of Inflow Control Device for Lower Completions in Horizontal Wells Utilizing Machine Learning

DEVEX 2020

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Decision Making

Decision-making is such a seamless brain process that we're usually unaware of it — until our choice results in unexpected consequences.

Then we may look back and wonder, "Why did I choose that option?

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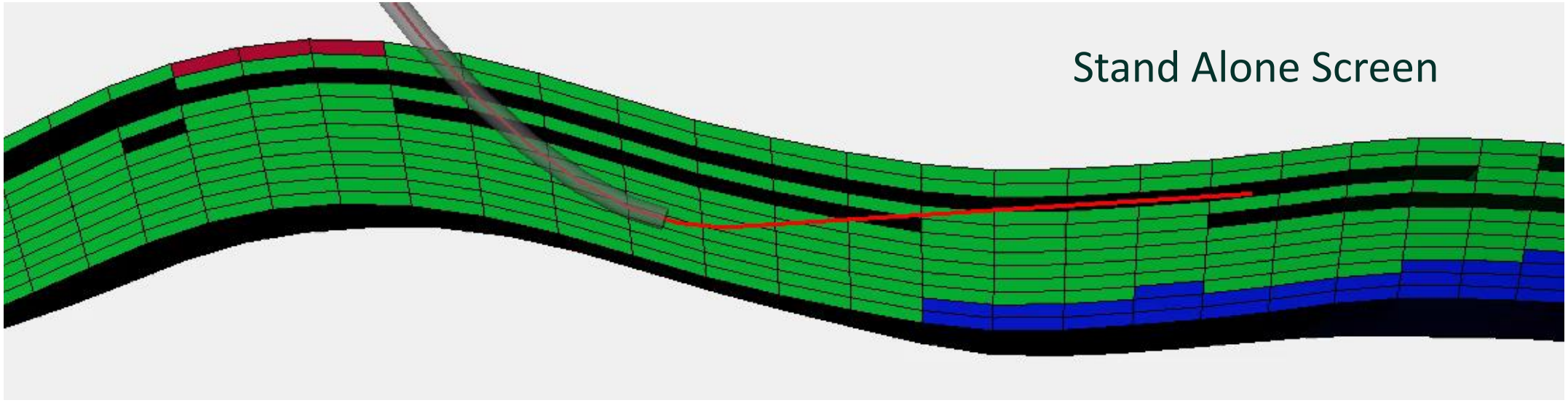
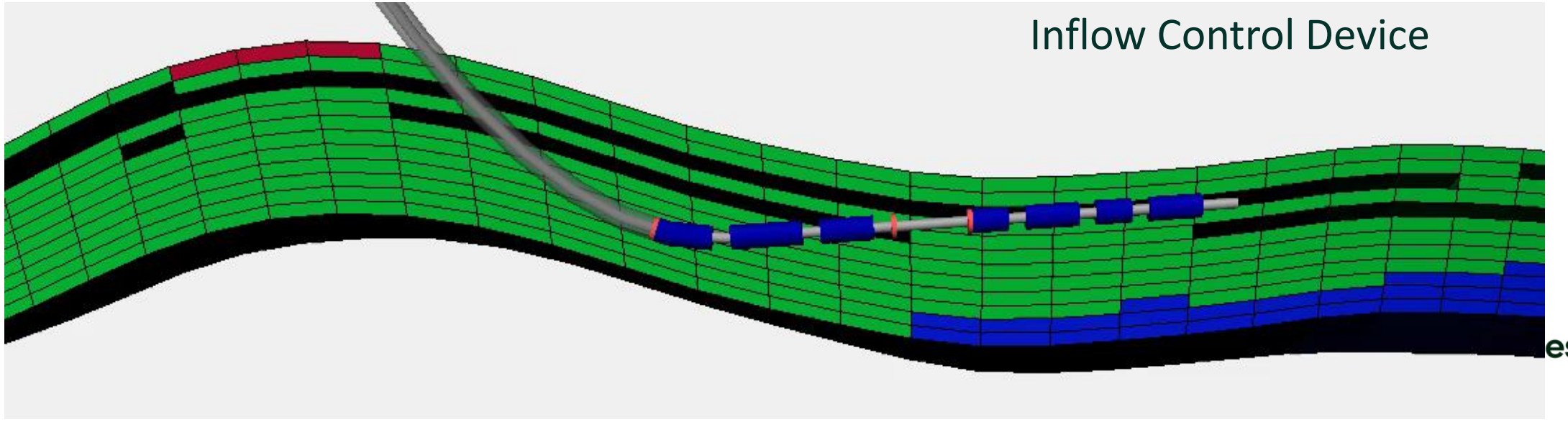
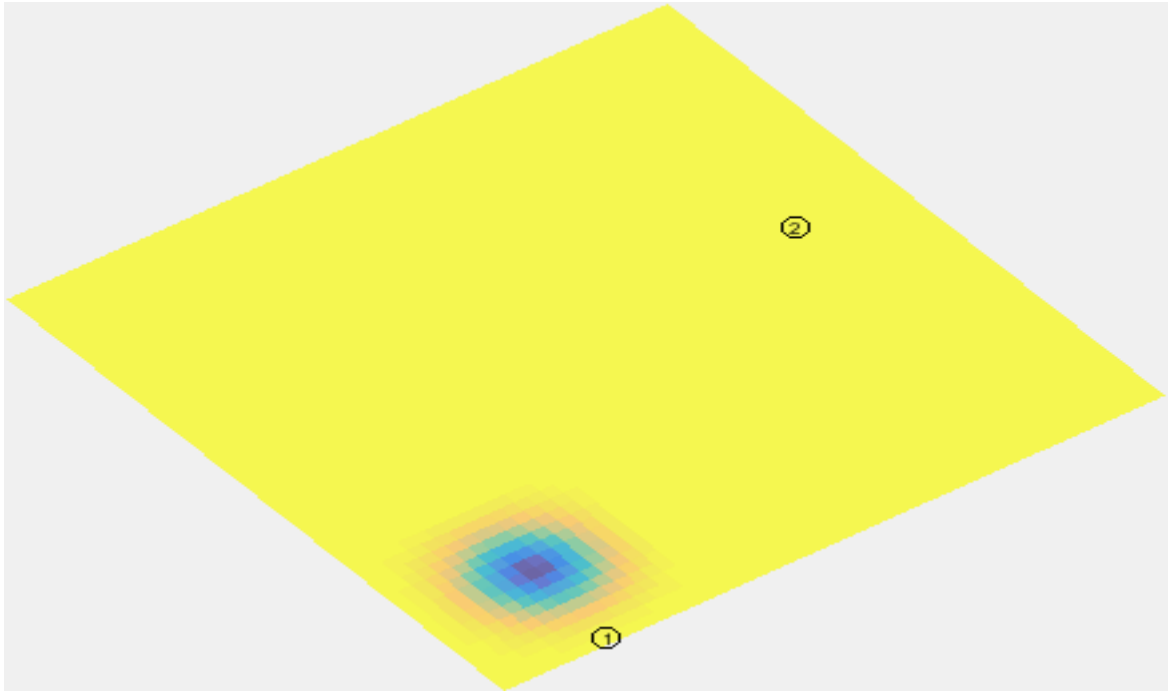
Flow control devices





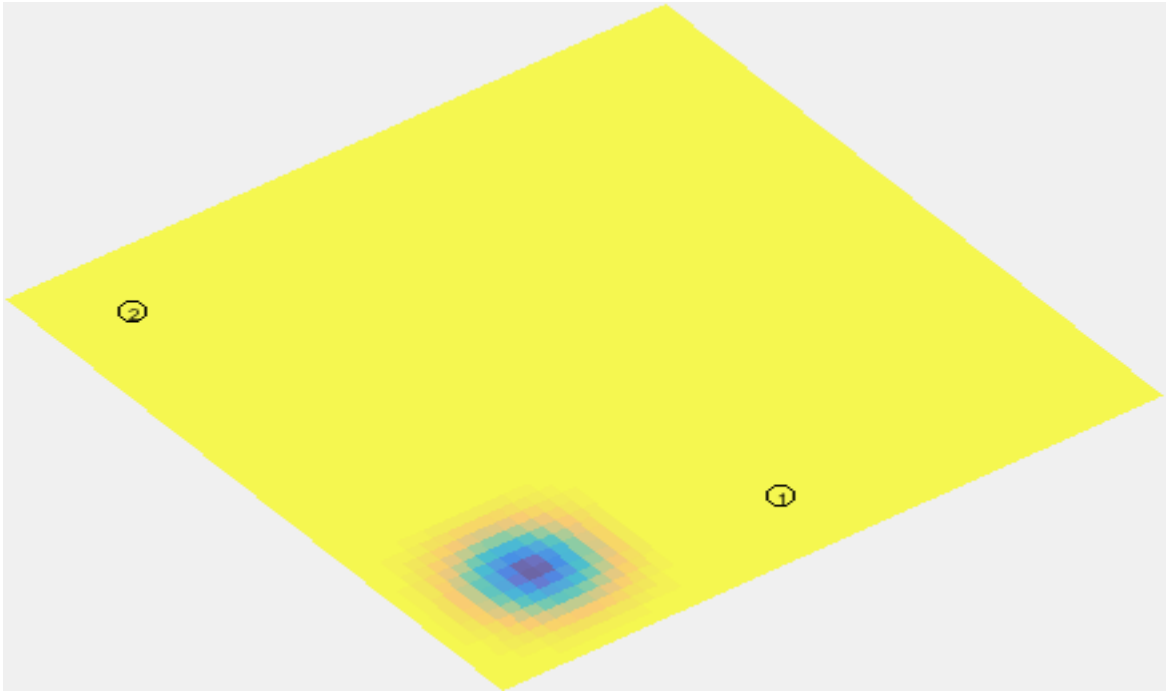
Machine learning is a form of AI that enables a system to learn from data rather than through explicit programming

Random Sampling



14% samples in interesting region while maintaining general coverage
(Latin Hypercube Sampling)

Smart Sampling



40% samples in interesting region while maintaining general coverage

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Intelligent Sequential Sampling Algorithm

Bayesian optimization

- Next steps based on prior knowledge
- Uncertainty quantified by Gaussian distributions
- Acquisition function (AF) used to select next sample

Optimization methodology

Define objective function seed space with a few simulation runs

1. Update statistical model of NPV_0-space
2. Evaluate AF and select next case based on max AF
3. Run simulation case and evaluate NPV_0
4. Repeat steps until NPV_0 is maximized

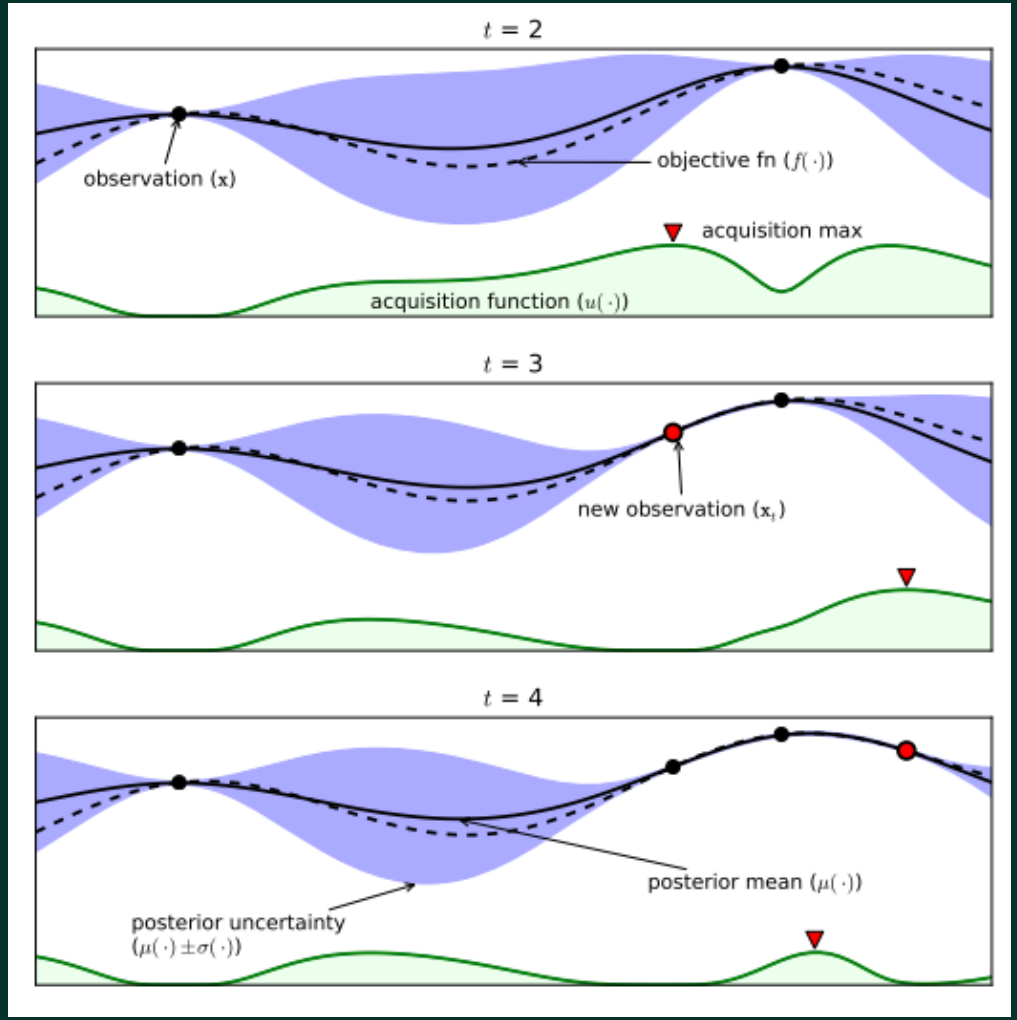

Illustration of 3 iterations of a Bayesian Optimization of a single variable objective function (solid black curve)

Brochu, Cora, and Freitas (2010)

Ref: OTC-30716-MS

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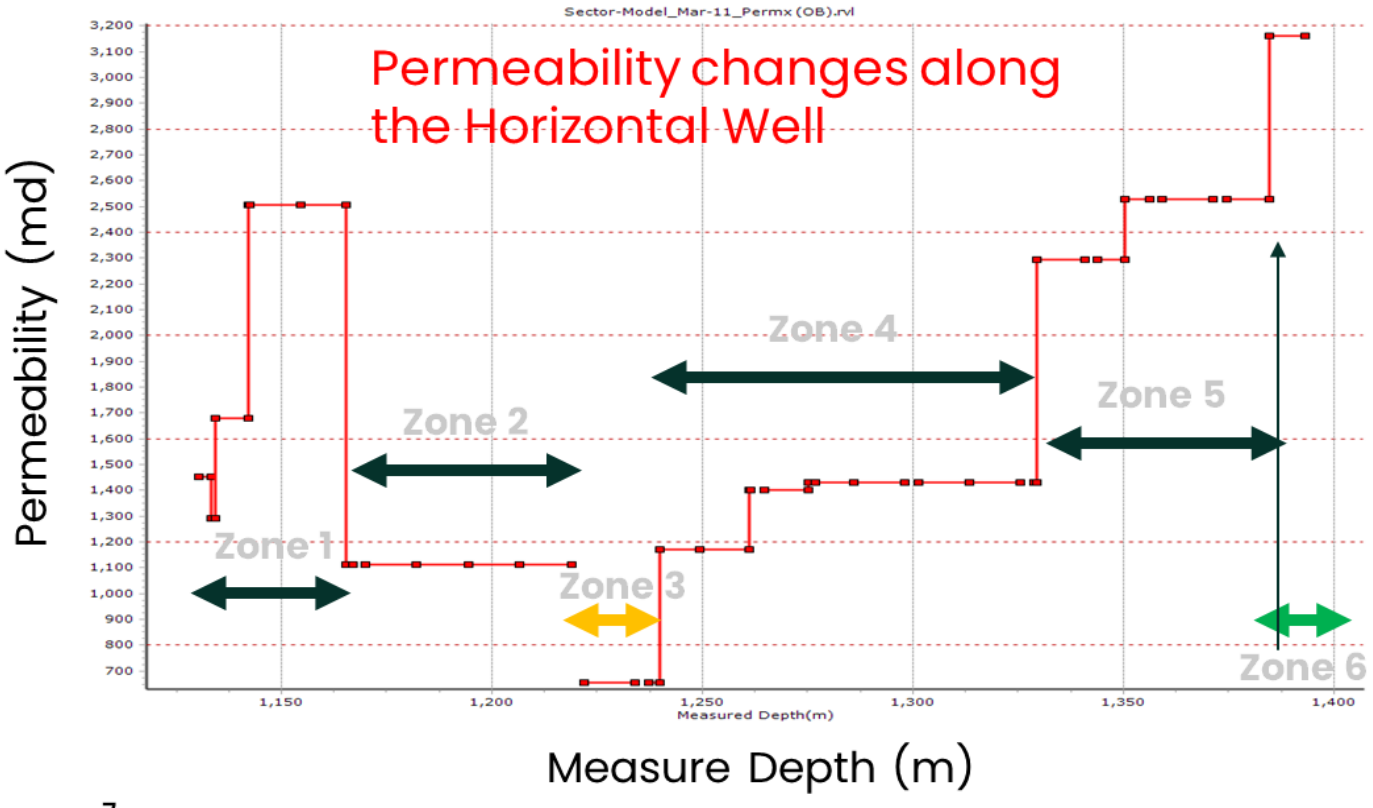
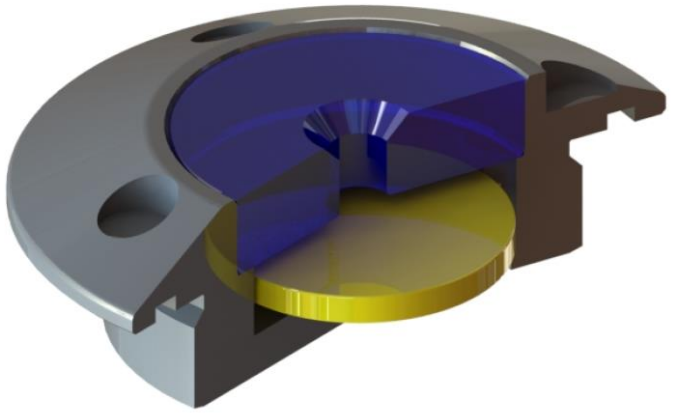
Case Study: Background

Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
1 Com., 1-2 ICD, Orifice Size (2.5, 5)	1-3 Comp., 1-4 ICDs, Orifice Size (2.5, 5)	1 Com., 1ICD, Orifice Size (2.5, 5)	1-5 Comp., 1-5 ICDs, Orifice Size (2.5, 5)	1-3 Comp., 1-3 ICDs, Orifice Size (2.5, 5)
115 ft	183 ft	64 ft	293 ft	180 ft



Autonomous ICD



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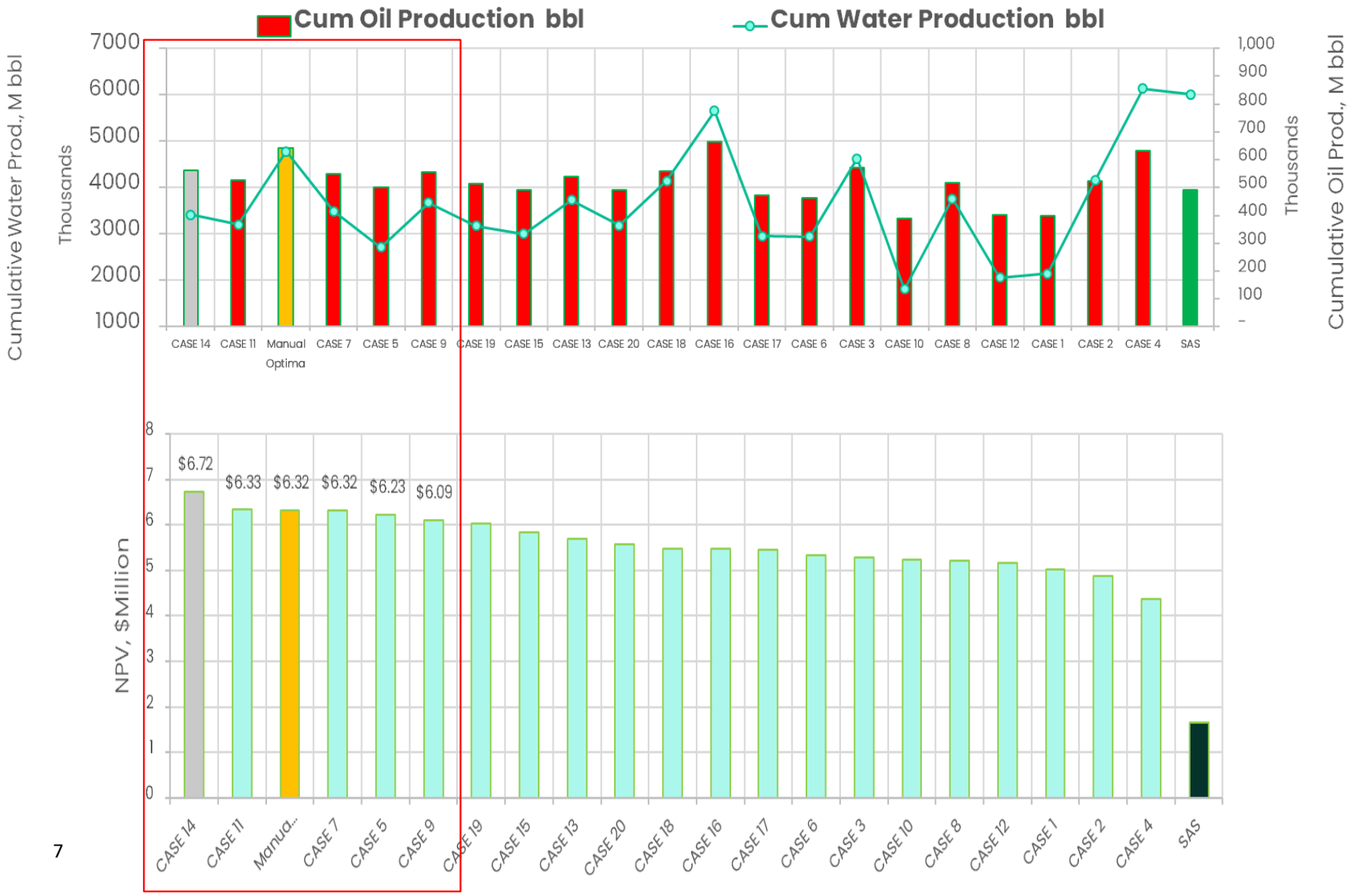
Result Summary



- Objective Fn: NPV
- 5 initial runs
- 15 smart runs chosen by Intelligent Sequential Sampling algorithm.

Result

- Case 14 was highest NPV achieved
- Better than manual case
- In 50% reduced time

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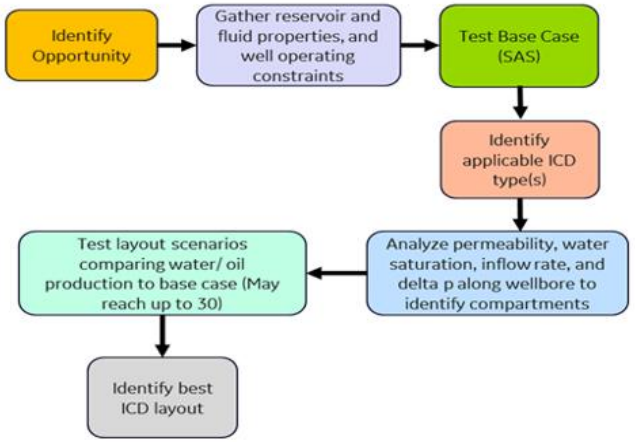
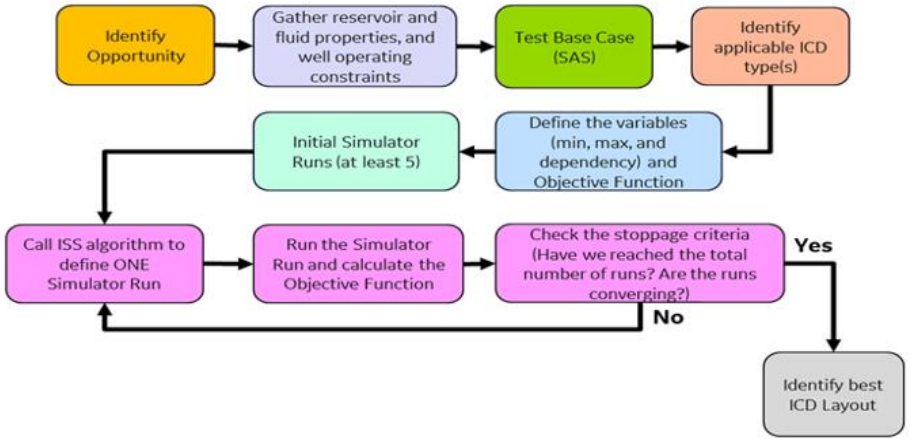
Conclusion: Manual vs Machine learning

Manual Workflow



SMART ICD Optimization Workflow



- Both workflows involve iterations
- Expertise cannot be ignored in both cases
- Manual workflow may miss potential optimised design due to time limitation & biased choices
- Correct objective function for Machine Learning should be identified
- Machine Learning reduces the time/cost to achieve Optimised design

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