When Portfolio Optimization Fails in Upstream Oil and Gas: AI to the Rescue

Agenda

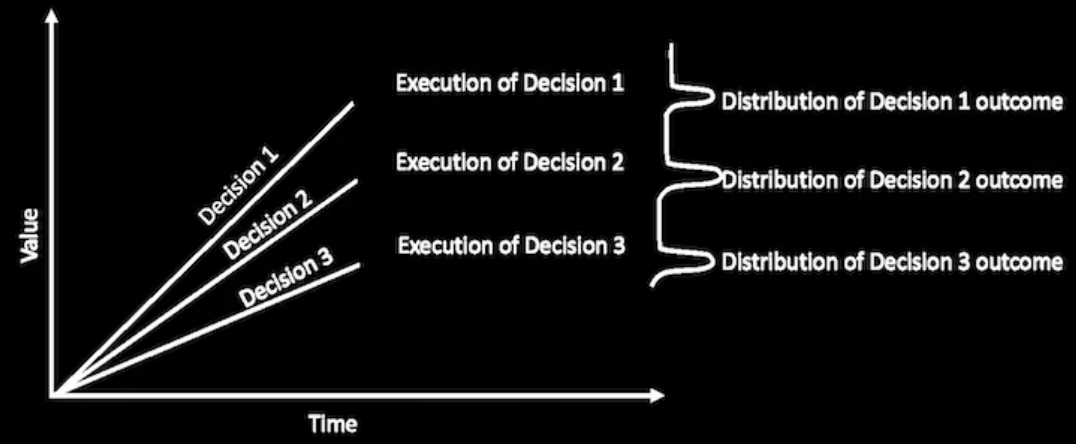
- Portfolio optimization framework
- Structural challenges
- What we offer
- Software demo
- The plan
- Performance-based pricing

What's the value of enhancing forecasting around your objectives?

- Maximise Free Cash Flow
- Maximise Earnings
- Etc.

Framing this portfolio optimisation problem:

Value: f(Geology$_{(Inventory)}$, Price of Oil, Cost of Inputs, Production)



Framing this portfolio optimisation problem:

Value: f(Geology$_{(Inventory)}$, Price of Oil, Cost of Inputs, Production)

Distribution of Decision 1 outcome

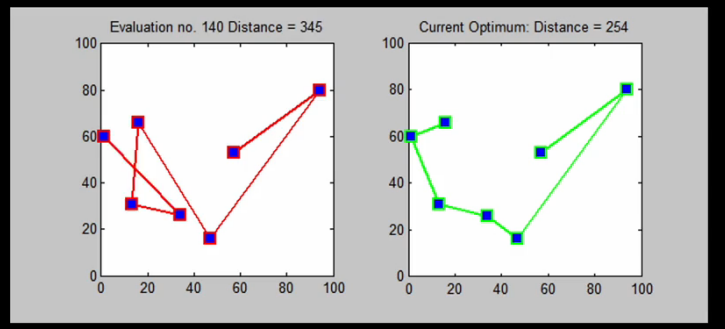
Distribution of Decision 2 outcome

Distribution of Decision 3 outcome

The Traveling Salesman Problem:

Given a list of cities and distances, determine the shortest closed path visiting each city once

Permutations = (n-1)!/2



https://en.wikipedia.org/wiki/Travelling_salesman_problem

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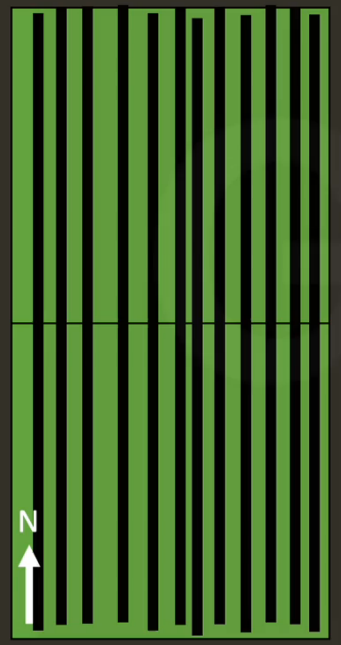
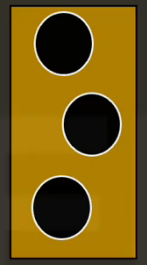
Map view

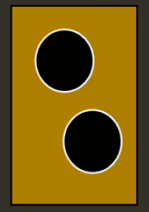


Cross-section

Drilling Unit



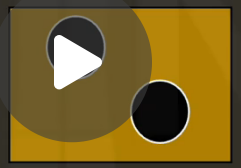
Drilling Unit



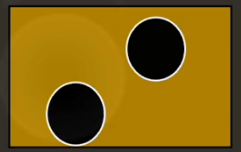
Drilling Unit

Completion Unit

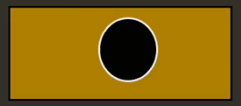
Completion Unit



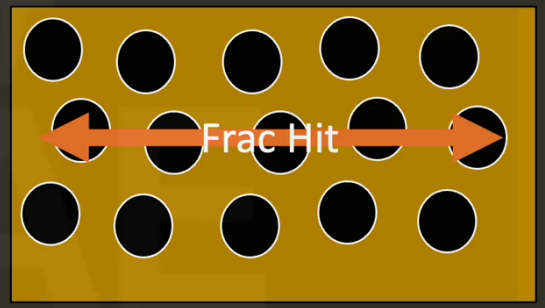
Completion Unit



Completion Unit



Pressure Unit



Timing, production, constraints, prices, costs, etc.

Focus, Love, Persistence, Frugality

The top 1% of operators:

(how do they do it?)

- Data/models are updating, accurate, accessible, and consistent
- Estimating uncertainty in models
- Real-time discussion of dynamic financial forecasts
- Real-time discussion around model inputs and uncertainty

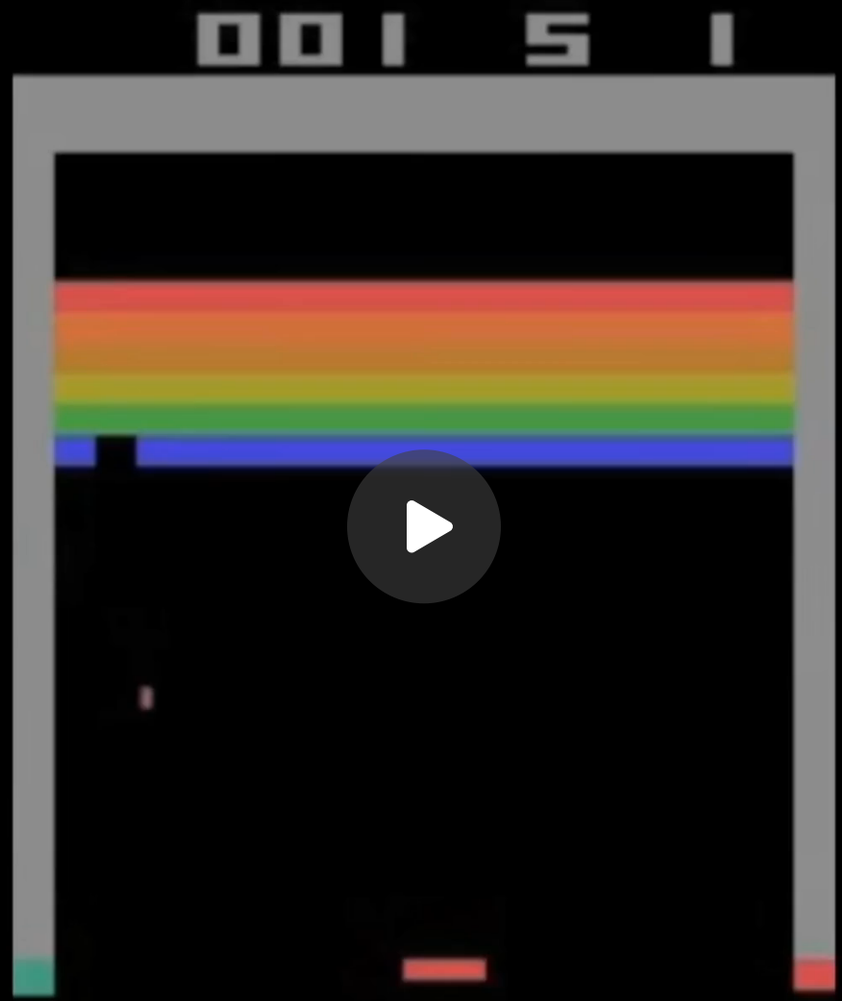
Typical structural challenges:

- Siloed Data and Disconnected Software
- Obstacles to efficient data flow and sharing
- Narrow-focused Optimizations
- Unmodeled Uncertainty (Risk)

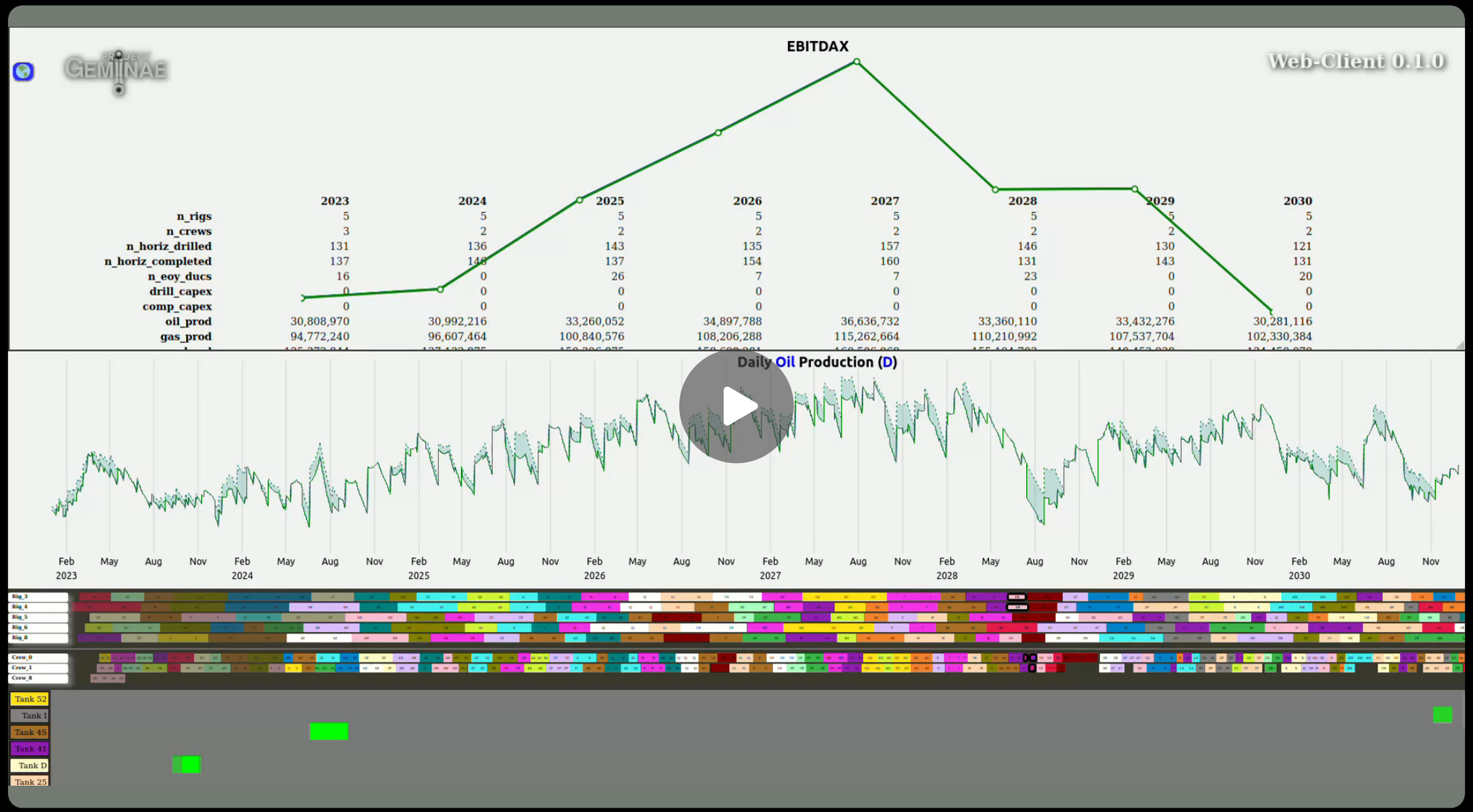
What we offer:

- Data/models are updating, accurate, accessible, and consistent
- Estimating uncertainty in models
- Real-time discussion of dynamic financial forecasts
- Real-time discussion around model inputs and uncertainty

DeepMind (Breakout)



Geminae 1.0



	2023	2024	2025	2026	2027	2028	2029	2030
n_rigs	5	5	5	5	5	5	5	5
n_crews	3	2	2	2	2	2	2	2
n_horiz_drilled	131	136	143	135	157	146	130	121
n_horiz_completed	137	146	137	154	160	131	143	131
n_eoy_ducs	16	0	26	7	7	23	0	20
drill_capex	0	0	0	0	0	0	0	0
comp_capex	0	0	0	0	0	0	0	0
oil_prod	30,808,970	30,992,216	33,260,052	34,897,788	36,636,732	33,360,110	33,432,276	30,281,116
gas_prod	94,772,240	96,607,464	100,840,576	108,206,288	115,262,664	110,210,992	107,537,704	102,330,384

The Plan

Month 0: Start tomorrow. Given objectives, we scope:

- subsurface systems
- surface systems
- financial systems

Month 3: Value demonstration

- Diagnostic pilot

Month 6: Full implementation

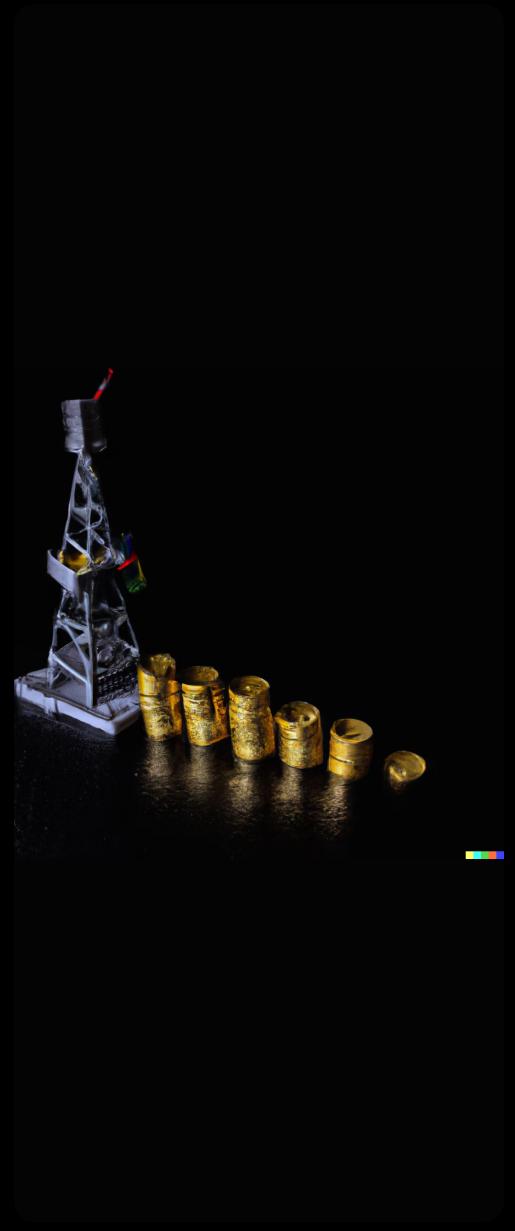
- On open architecture (anywhere)
- Custom GUI, AI Back-end, Data warehouse

Month 6+: Deeper customization using your team or ours.

Performance-Based Pricing

- Pilot program - try out our system before purchasing the full stack.

- Pay only for the results you see - our fee is tied to the success of our solution in delivering tangible value to your organization.



Summary

- Portfolio optimization framework
- Structural challenges
- What we offer
- Software demo
- The plan
- Performance-based pricing

Questions?

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Appendix

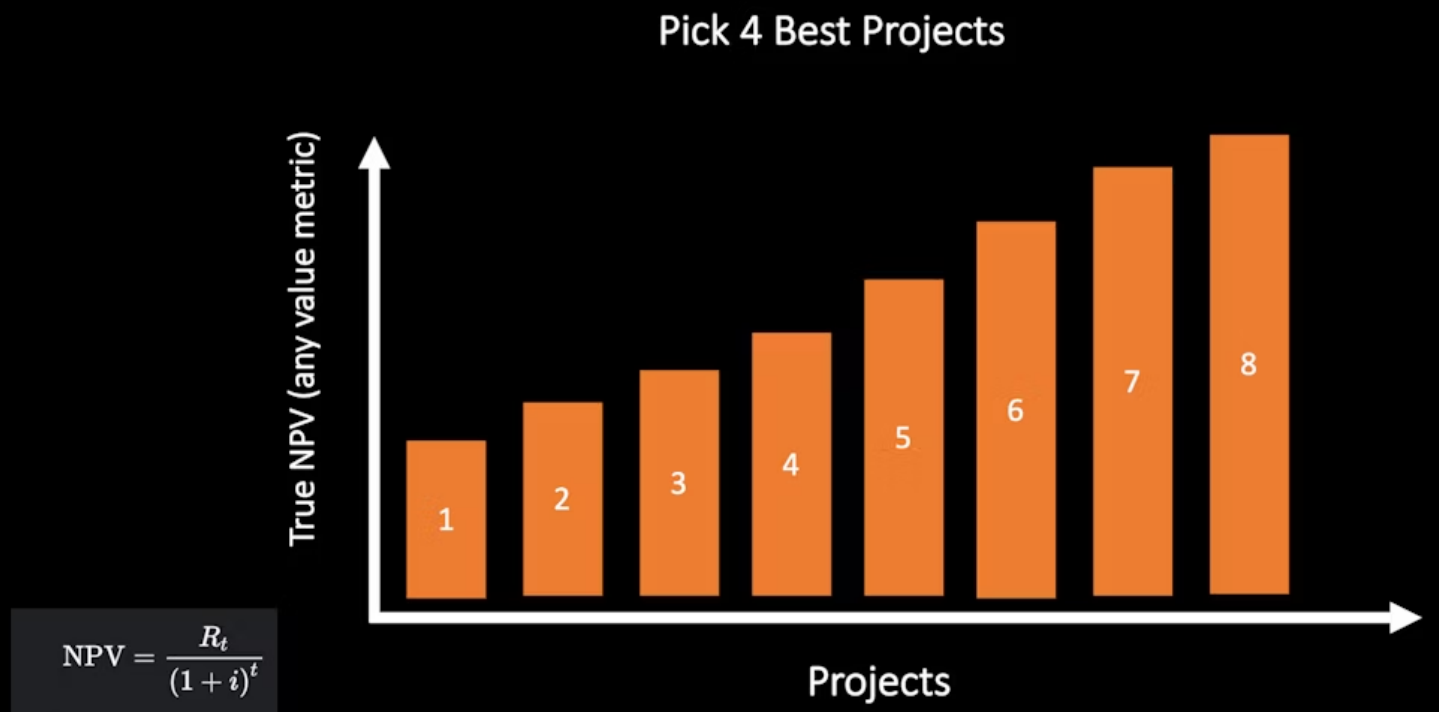
Synchronize data and models across the organization

Info. Tech.

Proprietary Apps Target Each Business Value Driver

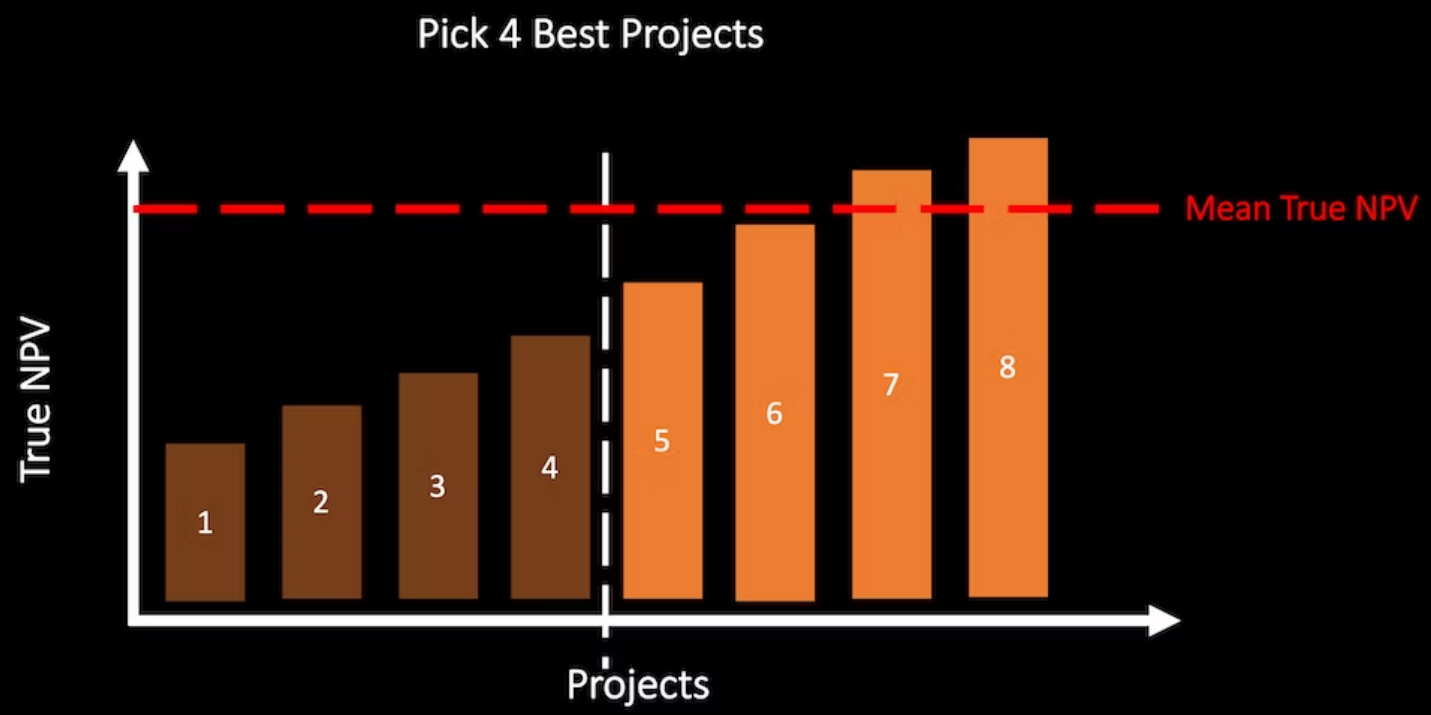
eog

GLOPT SM	i/miSell SM	iTypeCurves SM	REVENUE	Operating Revenues and Other Crude Oil and Condensate Natural Gas Liquids Natural Gas
PLOPT SM	Flash SM	iProduction SM		
i/miSOO SM	i/miPlay SM	iVolumes SM		
iLOE SM	i/miRoute SM	i/miDetect SM	OPEX	Operating Expenses Lease and Well Transportation Costs Gathering and Processing Costs Exploration Costs Dry Hole Costs Impairments Marketing Costs Depreciation, Depletion and Amortization General and Administrative Taxes Other Than Income Total
GLITER SM	iMeter SM	SkyCirc SM		
myEOG SM	myTime SM	i/miPeople SM		
i/miSteer SM	iDD SM	iWellPlanner SM	CAPEX	Expenditure Category Capital Exploration and Development Drilling Facilities Leasehold Acquisitions Property Acquisitions Capitalized Interest Subtotal Exploration Costs Dry Hole Costs Exploration and Development Expenditures Asset Retirement Costs Total Exploration and Development Expenditures Other Property, Plant and Equipment Total Expenditures
i/miRig RT	iDC SM	i/miCompletions RT SM		
iMotor SM	iProg SM	i/miApprove SM		
iPermit SM	iRes SM	iInventory SM		
iSupply SM	iLog SM	iInvest SM		
i/miHaul SM	iPay SM	i/miCapital SM		
Trident SM	iRock SM	i/miFacilities SM		



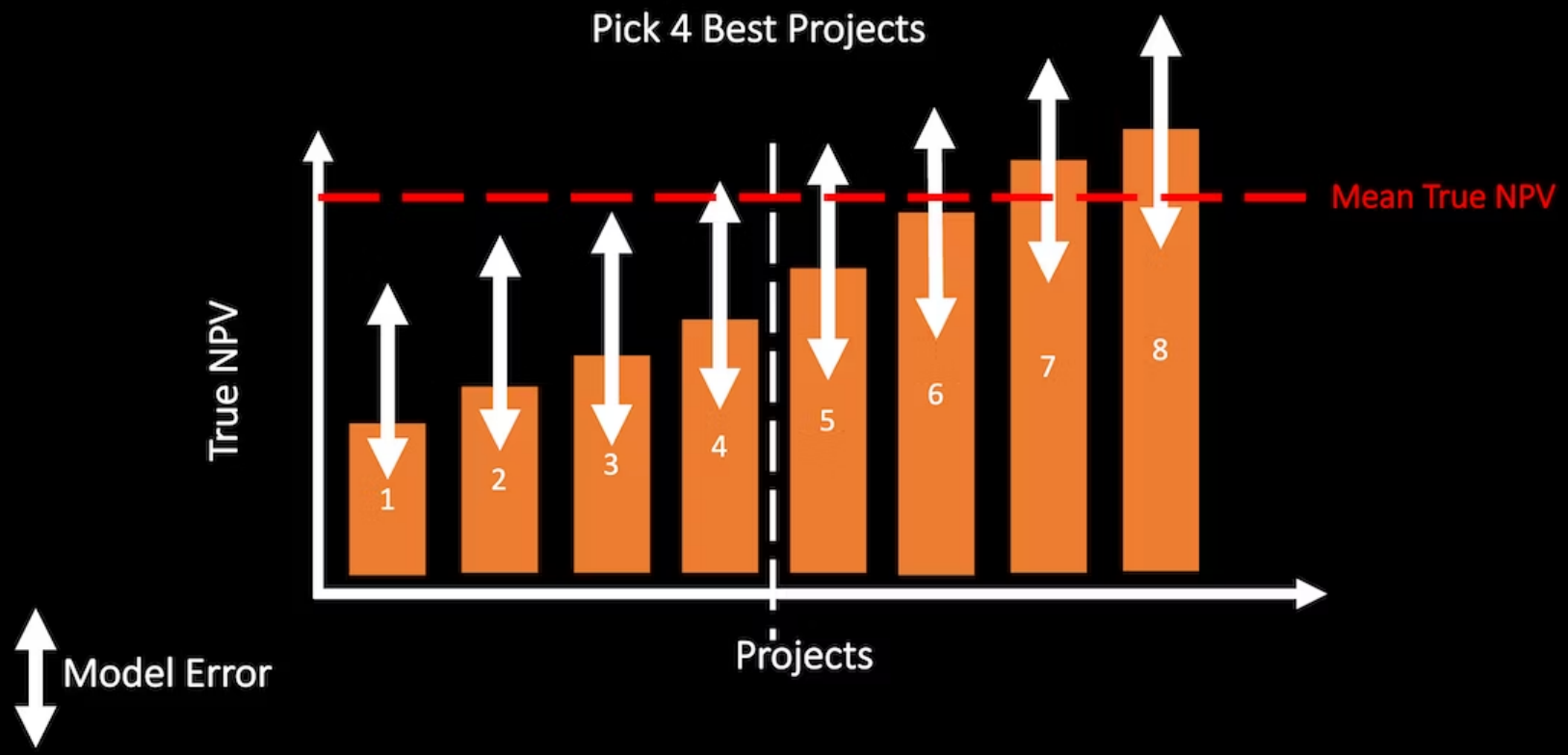
$$\mathrm{NPV} = \frac{R_t}{(1+i)^t}$$

NPV = net present value
R_t = net cash flow at time t
i = discount rate
t = time of the cash flow


Pick 4 Best Projects
True NPV
Mean True NPV
1
2
3
4
5
6
7
8
Projects

The Optimizer's Curse

https://pubsonline.informs.org/doi/10.1287/mnsc.1050.0451



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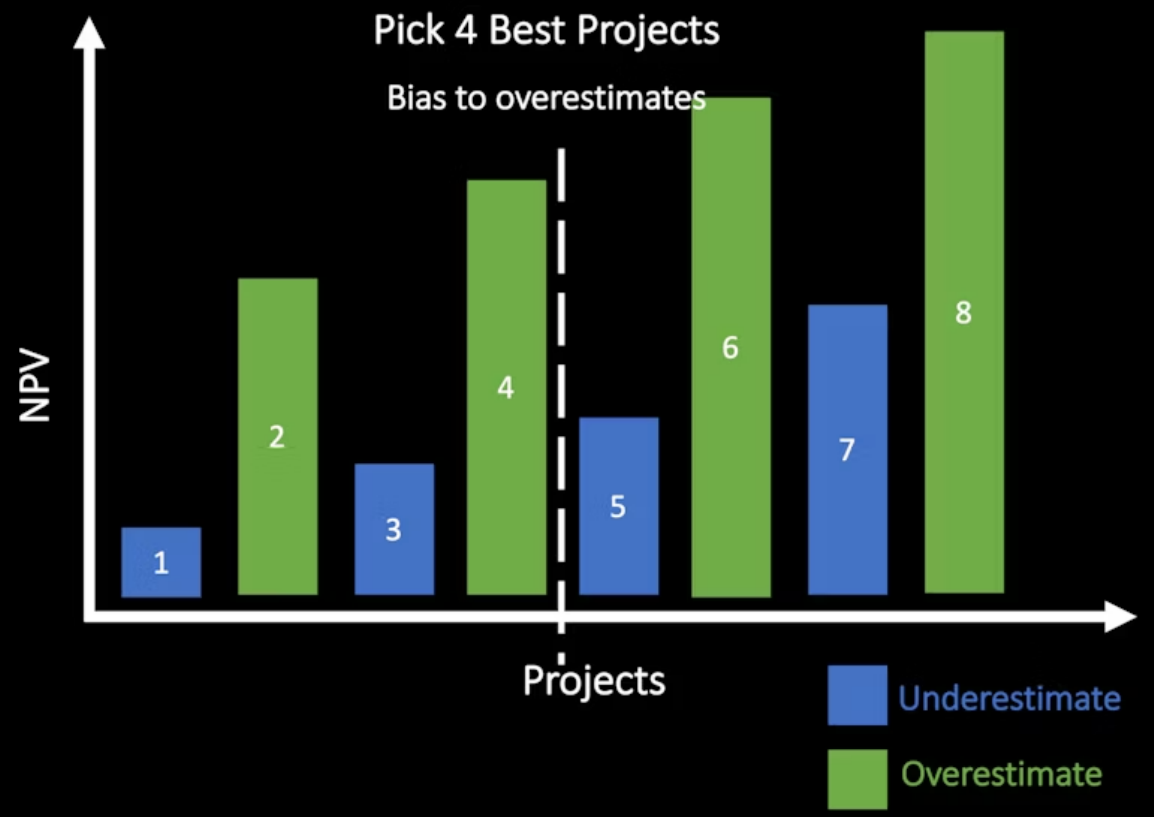

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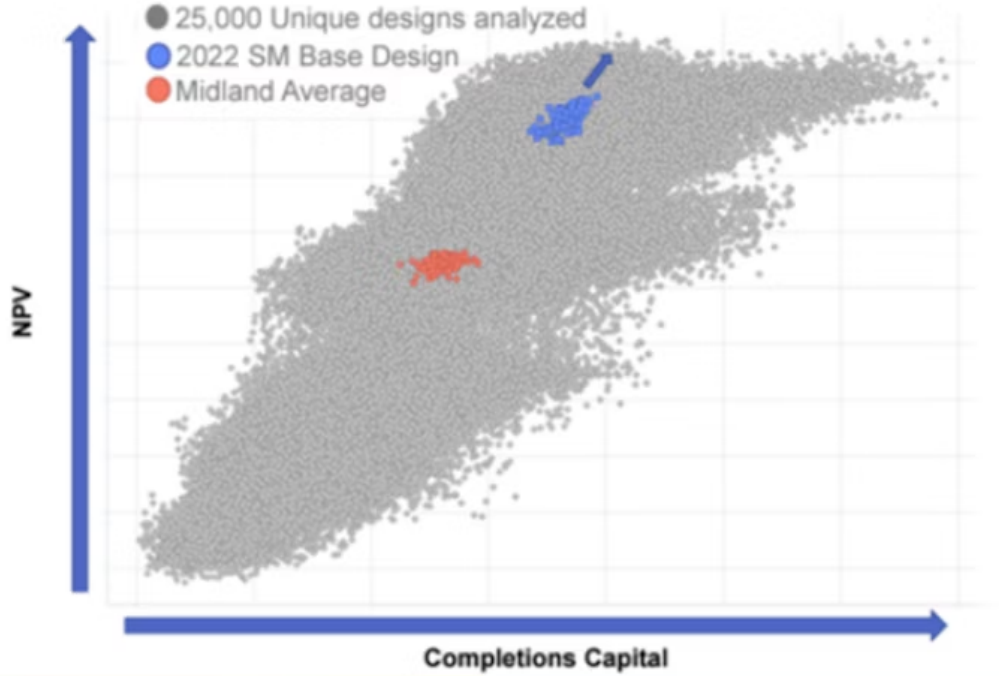
VALUE CREATION: SCIENCE, TECHNOLOGY & INNOVATION

MIDLAND BASIN EXAMPLE – OPTIMIZING THE VALUE OF EVERY COMPLETION



- SM Energy well data analysis creates confidence in multivariate model
- 25,000 unique completion designs modelled in multivariate analysis to evaluate optimum design
- More upside attainable from design optimization

A Fast Deterministic Model is Fundamental

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	Deterministic Optimization	Stochastic Programming	Robust Optimization	Chance Constrained Programming	Distributionally Robust Optimization
Uncertainty Handling	None	Probability Distributions or Discrete Inputs	Worst Case or Continuous Set	Probability Distributions	Ambiguity sets (families of distributions)
Objective	Maximise EBITDA, NPV, ROI, ROR, etc.	Maximise EBITDA, NPV, ROI, ROR, etc.	Maximise EBITDA, NPV, ROI, ROR, etc. given worst case uncertainty	Maximise EBITDA, NPV, ROI, ROR, etc. with given level of confidence	Maximise EBITDA, NPV, ROI, ROR, etc. given poor uncertainty estimates
Risk (Uncertainty with a probability model)	Ignorant	User defined	Averse	User defined	User defined
Implementation Difficulty	Outrageously hard	Reformulation of a fast deterministic model	Reformulation of a fast deterministic model	Reformulation of a fast deterministic model	Reformulation of a fast deterministic model
Comments	Optimizer's Curse	Must know exact distribution	Too conservative (Ben-Tal and Nemirovski [1998, 2000])	Rides on distribution shape	Hedge against poor uncertainty estimates