Solution Seeker

Accelerating the research on data-driven methodology

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Solution Seeker

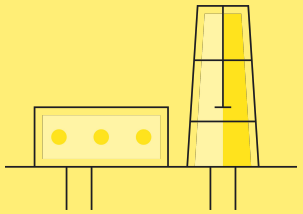
1. **Introduction**
2. Research on data-driven methodology

Solution Seeker: Unmatched competence & technology on production optimization

Years of experience

15

Unparalleled experience in O&G data-driven production optimization



Wells

2000

Our experience spans 2000 wells, 15 assets and multiple operators across the world

Data

300B+

5.5M operating points
150k well tests
6.8M/h from assets
50k data mining alg.

Publications

70+

Our cutting-edge research resulted in 70 scientific publications and 9 patents

Clients in South America, Asia and Europe

3-5% prod. increase

15+ assets
2000+ wells

Optimal production through robust use of real-time data assuring good, safe and timely decisions

Value proposition

2-10% better utilization of your production asset

Problem statement

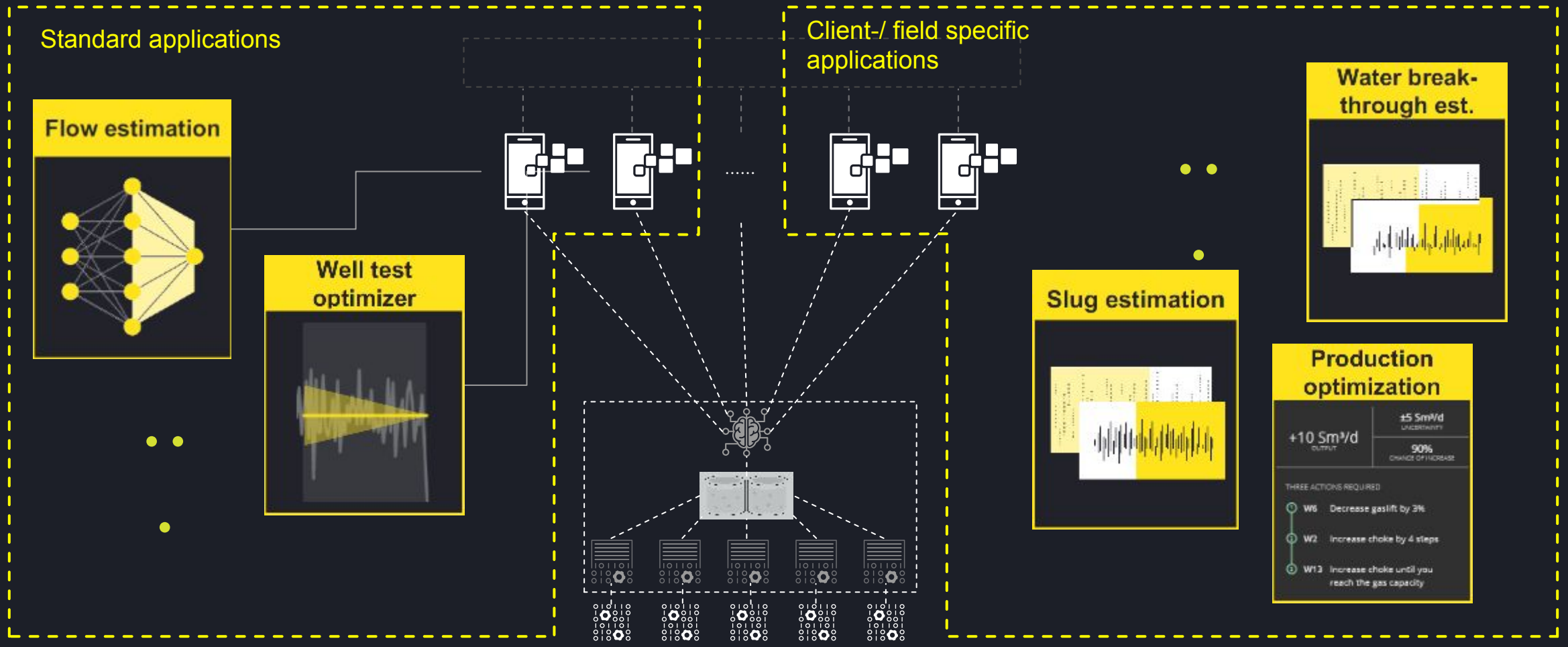
Using data in real-time to support production decisions in a timely manner, and thereby staying optimal over time, is non-trivial. The difficulties of robustly converting data into information and value is underappreciated.

Uniqueness

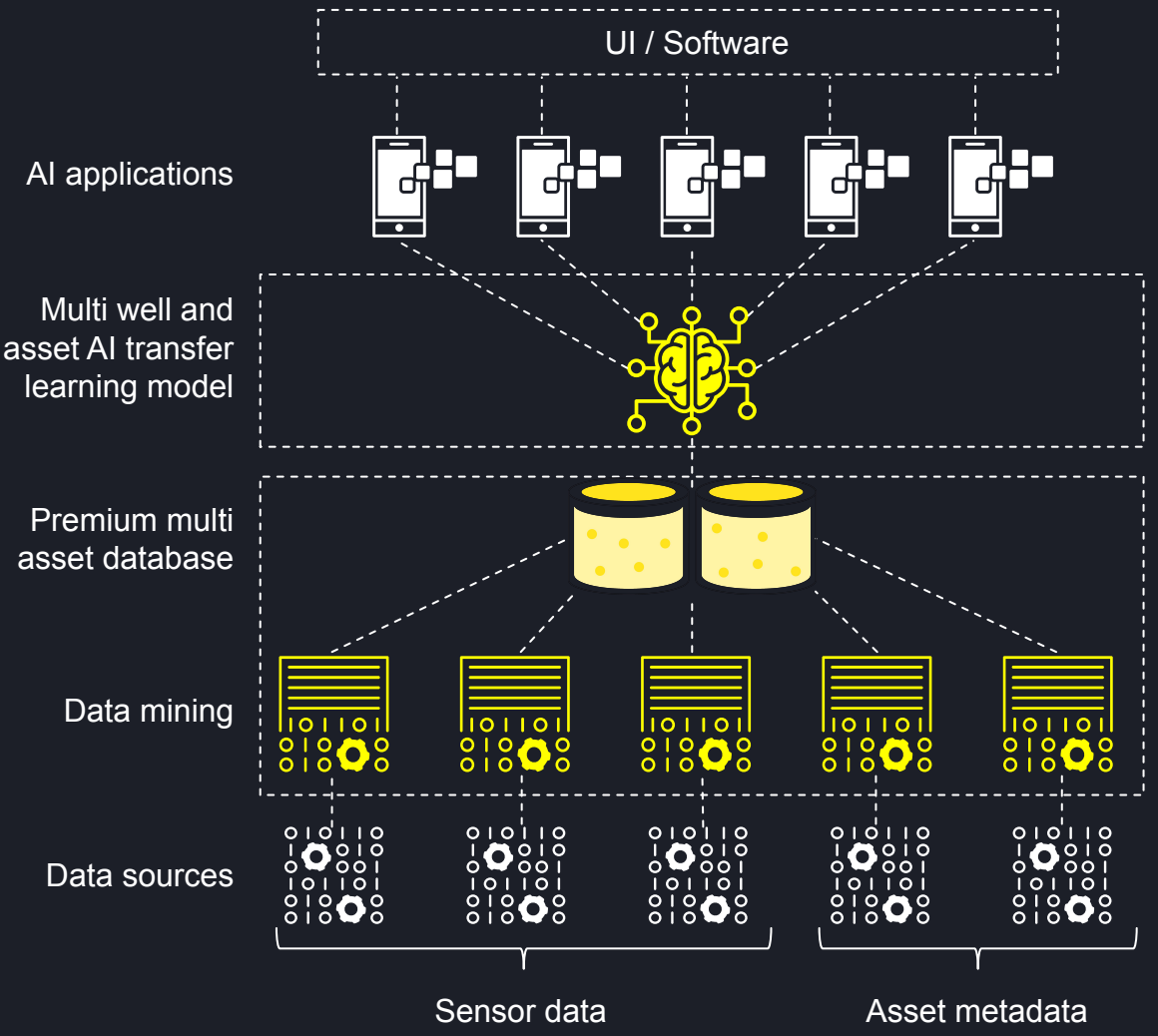
Our ability to at scale:

- ***Prepare production data in real-time*** for decision support and automatic ML
- Apply ML on sensor data to find and ***model patterns of physical systems*** that often has low observability
- ***Build and operate tailored applications*** that fuse operator workflow with data transformation flow, to enable faster and better decisions that taps into asset specific value pools

Deploying both standard and tailored apps



The data feed and modeling provides the basis for insight



- Library of flagship use cases (with UI)
  - Data-driven Virtual Flow Metering
  - Well test Optimization

- Modeling (multi-patented)
  - Cross asset learning from thousands of wells through patented transfer learning technology
  - Model development, deployment, maintenance, operation, and with online learning

- Automated Data Mining (multi-patented)
  - Identification of asset events, slicing of data set (time interval) and computation of event statistics (e.g., mean value, pressure build-up transient, dynamic responses)
  - Cleaning, ingestion and compacting of raw data to produce optimal data set / database

- Sensor data and asset metadata:
  - Pressure, temperatures, flow rates, valve position, ESP speed, gas lift rates...

Solution Seeker

1. Introduction
2. **Research on data-driven methodology**

Solution Seeker tech backed by more than 70 research publications

Products & Solutions Careers Journal Book a demo Log in

Research

We are proud of our R&D effort and routinely publish our content in various journals, or through Master's and Doctorate theses.

2022

Publications

Passive learning to address nonstationarity in virtual flow metering applications
Hotvedt, M., Grimstad, B. & Imsland, L.S. Expert Systems With Applications
Link

On a hybrid approach to model learning applied to virtual flow metering
Hotvedt, M. Supervised by Imsland, L.S., Grimstad & B. Ljungquist, D. Ph.D. Thesis.

When is gray-box modeling advantageous for virtual flow metering?
Hotvedt, M., Grimstad, B. Ljungquist, D. & Imsland, L.S. IFAC-PapersOnLine.
Link

On gray-box modeling for virtual flow metering
Hotvedt, M., Grimstad, B. Ljungquist, D. & Imsland, L.S. Control Engineering Practice.
Link

2021

Publications

Multi-task learning for virtual flow metering
Sandnes, A.T., Grimstad, B. & Kolbjørnsen, O. Knowledge-Based Systems.
Link

Bayesian Neural Networks for Virtual Flow Metering: An Empirical Study
Grimstad, B., Hotvedt, M., Imsland, L.S., Kolbjørnsen. O. & Sandnes, A.T. Applied Soft Computing.
Link

Identifiability and physical interpretability of hybrid, gray-box models - a case study
Hotvedt, M., Grimstad, B. & Imsland, L.S. 16th IFAC Symposium on Advanced Control of Chemical Processes: Venice, Italy.
Link

MLOps - challenges with operationalizing machine learning systems
Kjetså, T.I.S., supervised by Grimstad, B. MSc thesis.

2020

Publications

Mathematical programming formulations for piecewise polynomial functions
Grimstad, B. & Knudsen, B.R. Journal of Global Optimization.
Link

Developing a Hybrid Data-Driven, Mechanistic Virtual Flow Meter - a Case Study
Hotvedt, M., Grimstad, B. & Imsland, L.S. Conference, 21st IFAC World Congress: Berlin, Germany.
Link

Real-Time Data-Driven and Hybrid Modeling of Two-Phase Flow in Oil and Gas Wells
Almås, I.V.A. & Sjulstad, C.F., supervised by Grimstad, B. MSc thesis.

A spatial branch-and-bound method for ReLU network-constrained problems
Masdal, E., supervised by Grimstad, B. MSc thesis.

Probabilistic deep learning with variational inference - Uncertainty quantification using variational inference for deep neural networks modelling oil and gas production
Hegnar, E., supervised by Grimstad, B. MSc thesis.

2019

Publications

Application of online learning to Bayesian neural networks for petroleum optimization
Baugstø, S.W., supervised by Grimstad, B. MSc thesis.

Integrating Machine Learning Techniques in Real-Time Production Optimization
Andreassen, R.S. & Westby, E.M., supervised by Grimstad, B. MSc thesis.

Slug Flow Root Cause Analysis A Data-Driven Approach
Sandnes. A.T., Uglane, V. & Grimstad, B. Offshore Technology Conference: Rio de Janeiro, Brazil.
Link

ReLU Networks as Surrogate Models in Mixed-Integer Linear Programs
Grimstad, B. & Andersson, H. Computers & Chemical Engineering.
Link

Dynamic Real-Time Optimisation of a CO2 Capture Facility
Hotvedt, M., Hauger, S.O., Gjertsen, F. & Imsland, L. Conference, 12th IFAC Symposium on Dynamics and Control of Process Systems, including Biosystems: Florianópolis, Brazil.
Link

2018

Publications

Data Driven Real-Time Petroleum Production Planning Using Optimization and Neural Network
Malvik, A.G. & Witzøe, B., supervised by Grimstad, B. MSc thesis.

Petroleum production optimization – A static or dynamic problem
Foss, B.A., Knudsen, B.R. & Grimstad, B. Computers & Chemical Engineering.

A MIQCP formulation for B-spline constraints
Grimstad, B. Optimization Letters.

2017

Publications

Predictive modeling with applications in decision support systems for oil and gas production
Cenar, U.A., supervised by Grimstad, B. MSc thesis.

2016

Publications

Data driven analysis in oil and gas operations
Nordmo, M., supervised by Grimstad, B. & Sandnes, A.T. MSc thesis.

Contributions to production optimization of oil reservoirs
Codas, A., supervised by Foss, B.A. & Gunnerud, V. PhD thesis.

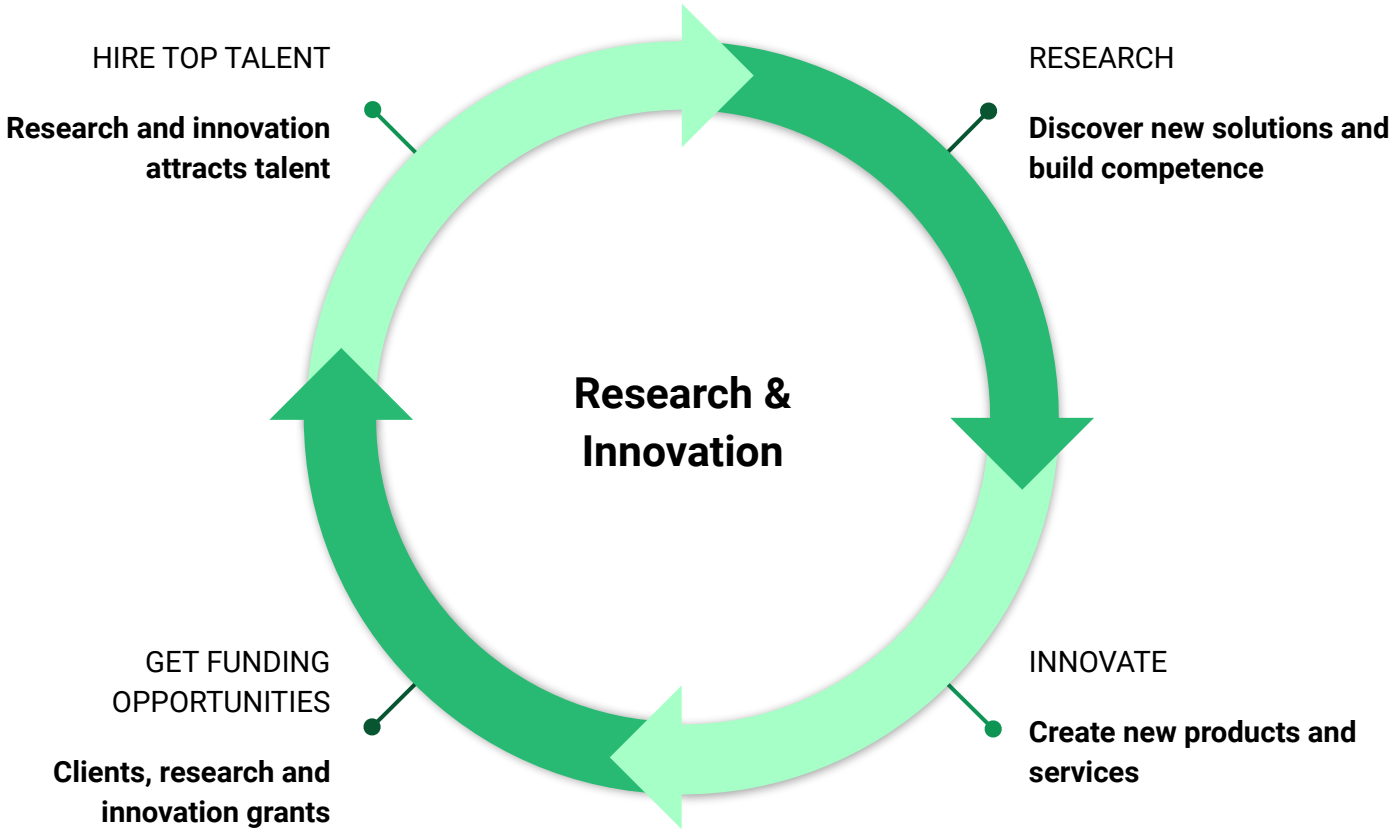
Global optimization of multiphase flow networks using spline surrogate models
Grimstad, B. et al. Computers and Chemical Engineering.
Link

A Simple Data-Driven Approach to Production Estimation and Optimization
Grimstad, B., et. al. Conference, SPE Intelligent Energy International Conference and Exhibition: Aberdeen, Scotland, UK.
Link

Modelling and Optimization of Real-Time Petroleum Production Using robust regression, bootstrapping, moment matching, and two-stage stochastic optimization
Morken, M.L. & Sandberg, P.T., supervised by Grimstad, B. & Gunnerud, V. MSc thesis.

https://www.solutionseeker.no/company/publications/

Why do we invest in research?

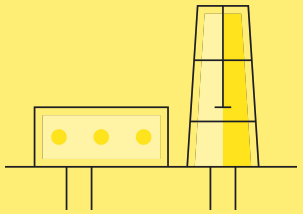


How do we conduct research?

Funding

NFR, IN, ERC, EIC, …

Competition and project quality assurance



Problem owner

Clients (companies in O&G, energy, fish farming, …)

Problem, data and domain knowledge

Research lead

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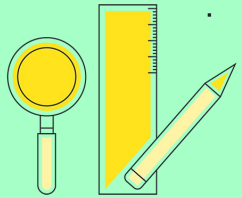
Technology (data collection and processing, ML, …) and competence



Research partner

Universities (NTNU, UiO, …) and business partners (BCG)

Research, education, competence

How do we accelerate our research?

Technology

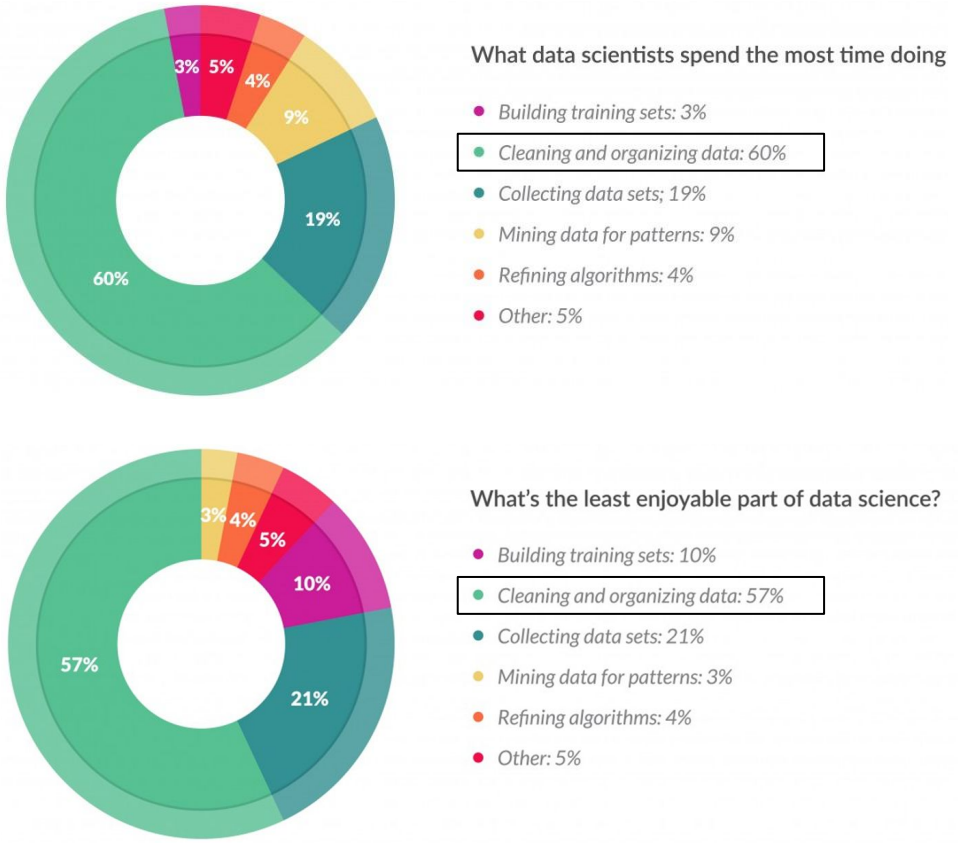
- Considerable SW & HW engineering is often a requirement for AI/ML research
- Data processing tech can speed up the research process considerably (produce large datasets of high quality data much faster – with built-in best practices)
- Infrastructure and software tools

Work practices

- Open research to avoid wasting resources
- Agile methodology to manage projects

Research quality

- Focus on high impact research
- Use large and rich (cross-asset) datasets to develop methods that generalize



Illustrations taken from Forbes

At our tenth anniversary in 2023, we established the non-profit company ***Solution Seeker Research***

Its purpose is to conduct ***ambitious research on data-driven methodology*** by

- Building a new Norwegian AI/ML competence hub
- Influencing the AI/ML research agenda
- Researching openly (sharing tools, methods, data)
- Competing for research funding (some problems are too hard to solve with poor funding)
- Simplifying research partnerships (sharing IP)

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