

Enhancing (Real-Time) Production Forecasting Through Batch Auto-Forecasting Algorithms

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Reserves | Economics | Visual Analytics



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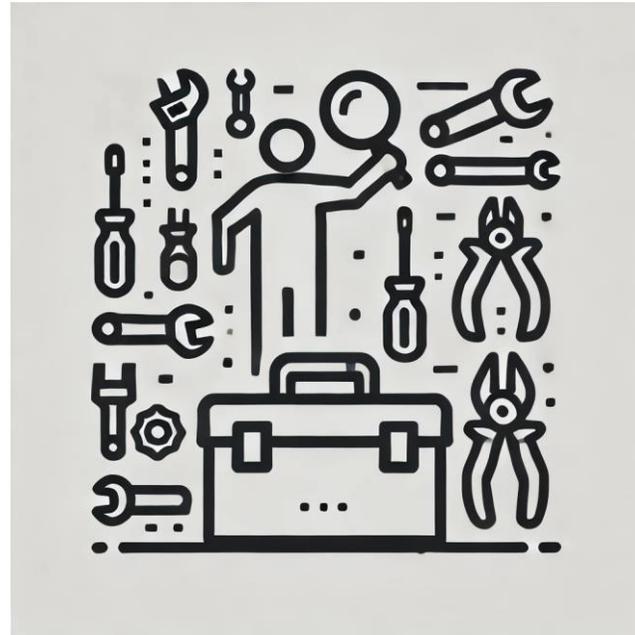
02 Workflow

03 Q&A

04 Live Demo



Define and Analyze the Problem



Identify the Tools and Solutions



Execution and Review

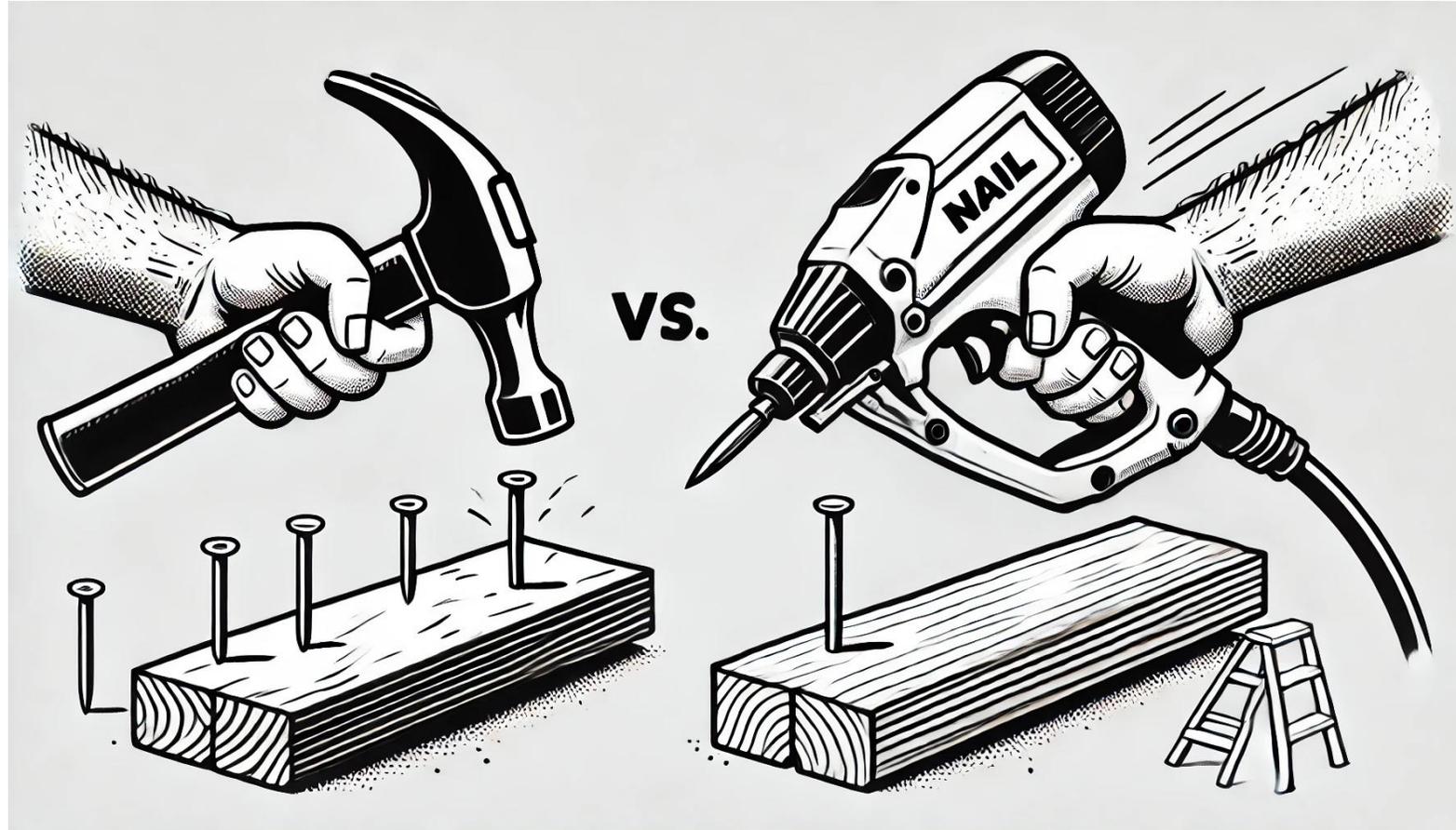


Define and Analyze the Problem

- **Generating Type Well Profiles for PUDs**
- **Need to adapt Analog Wells Methods**
- **10k wells... need to be forecasted**

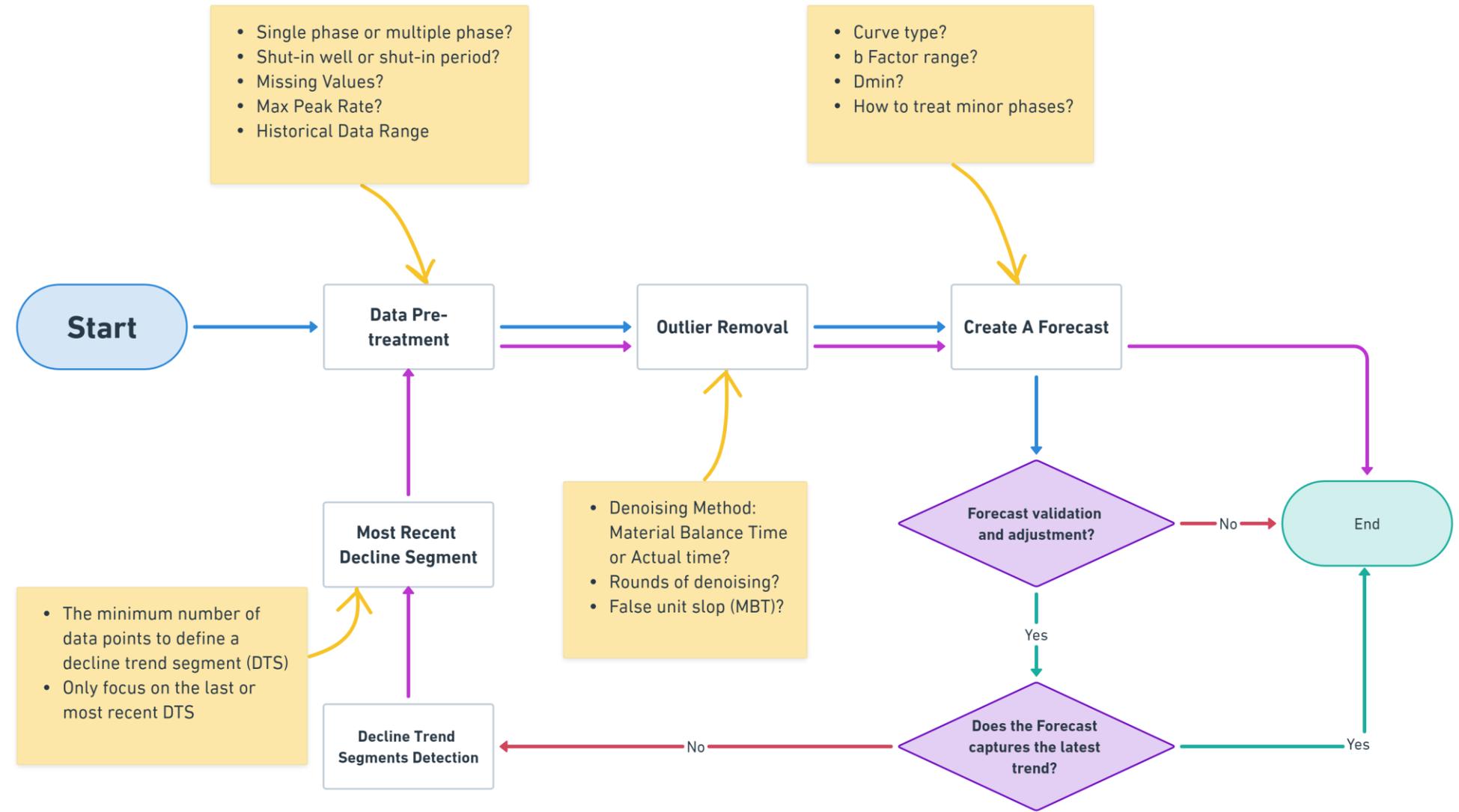
**10,000 wells x 30s/well =
300,000s = 83.34 hrs > 2 Weeks...**

- Probit Plot...
- Bubble Maps...
- Box Plot...

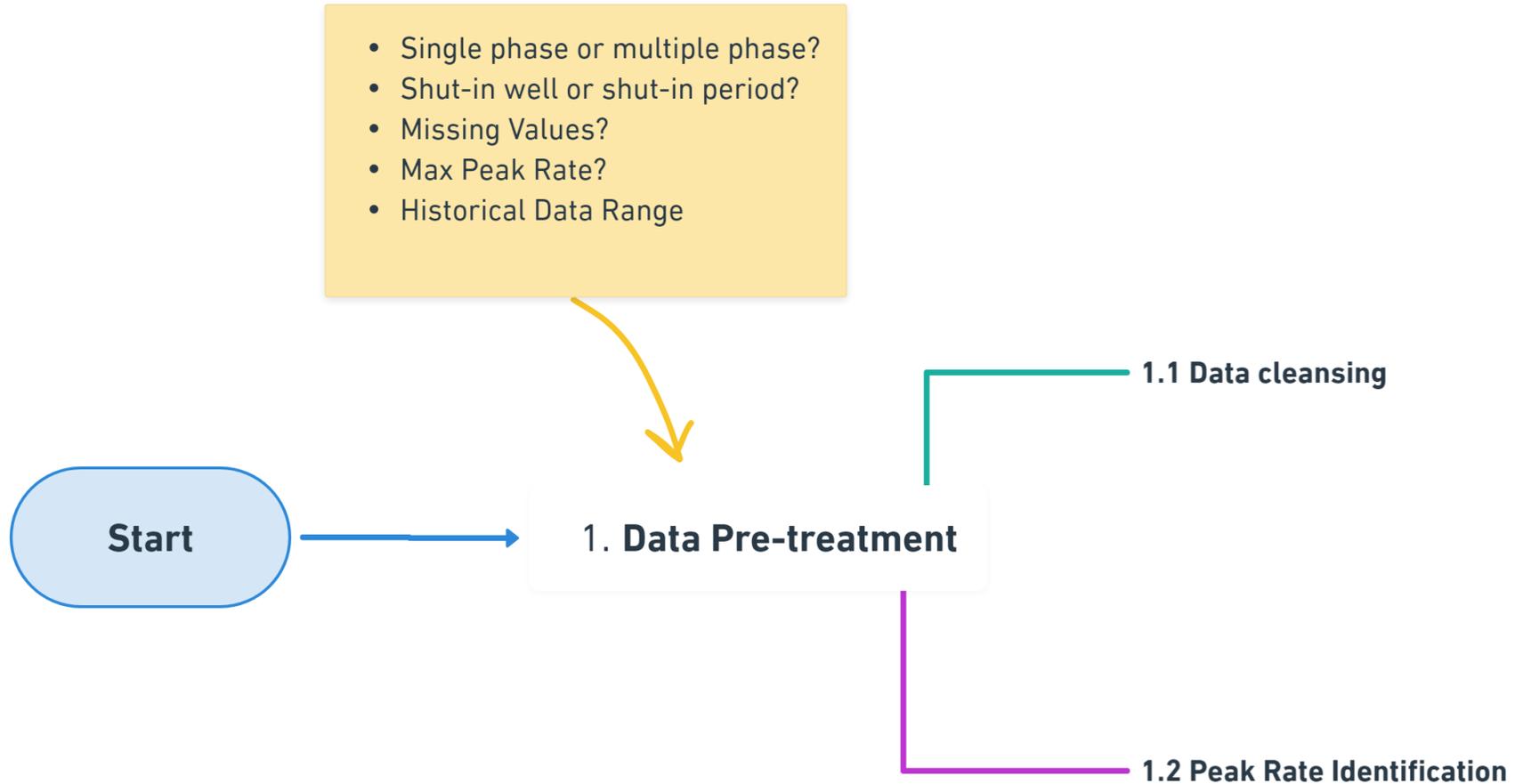


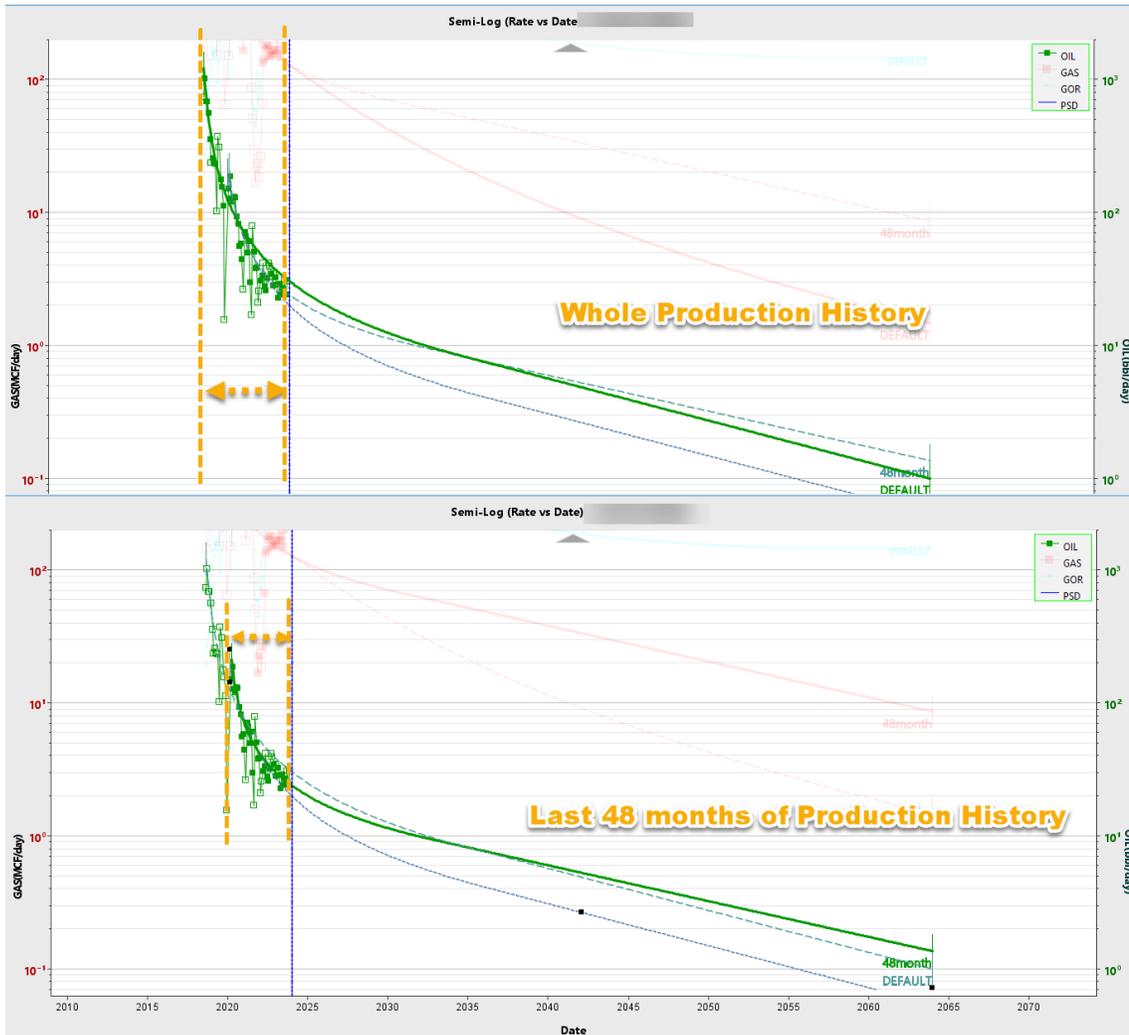
Automation of What?

Auto Forecast - Workflow

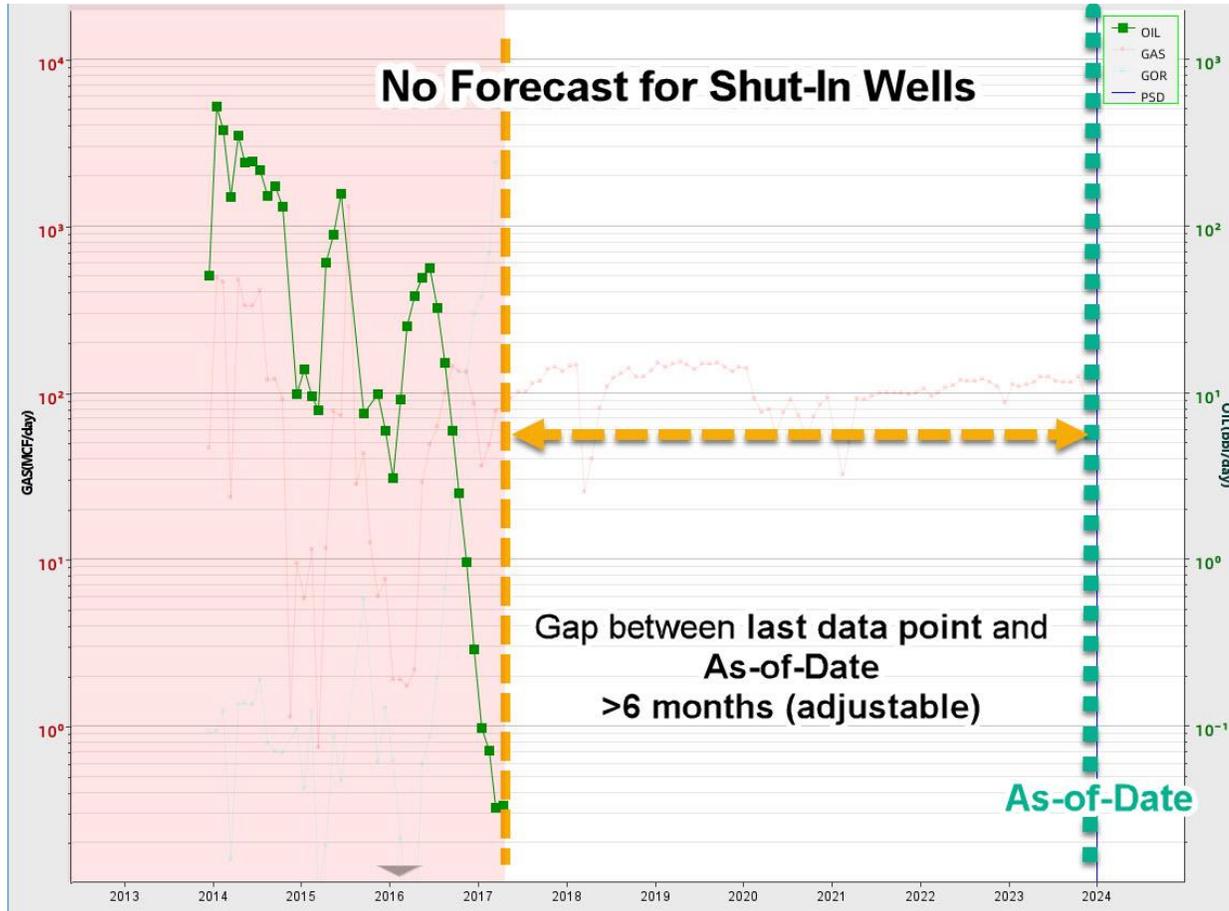


STEP 1: Data Pre-treatment

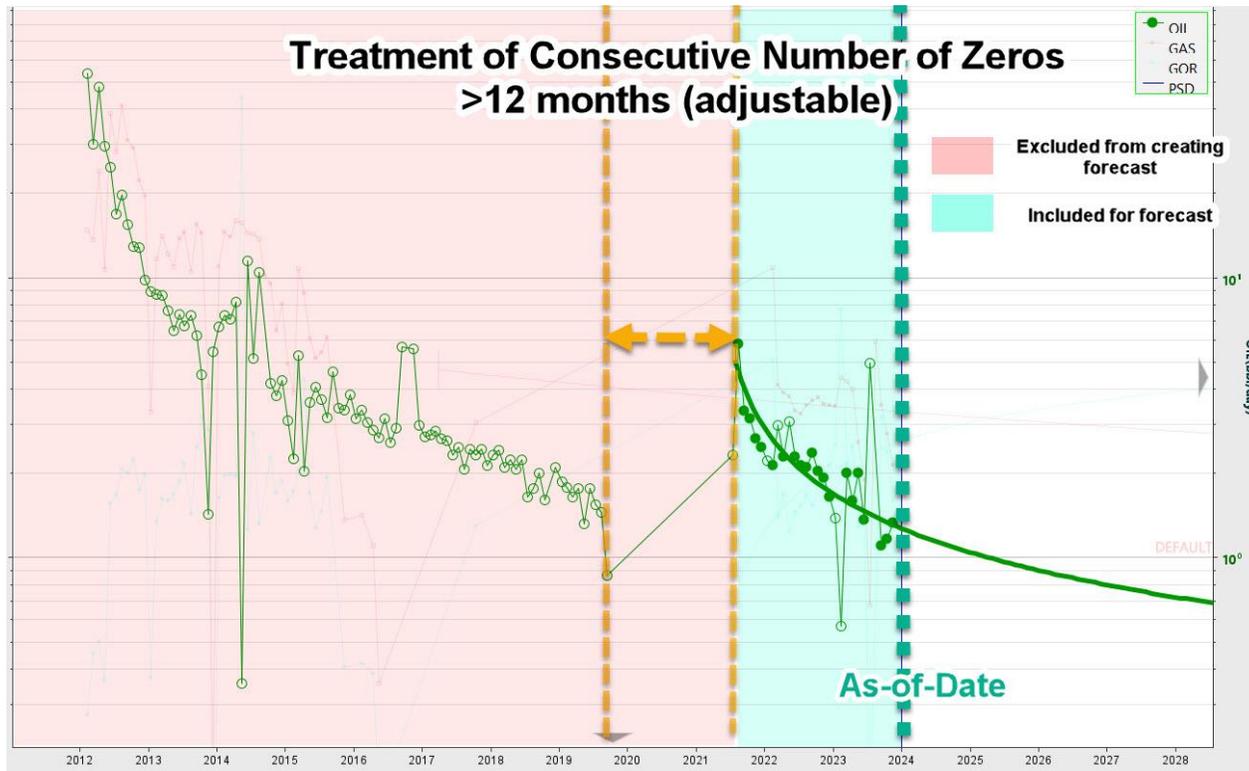




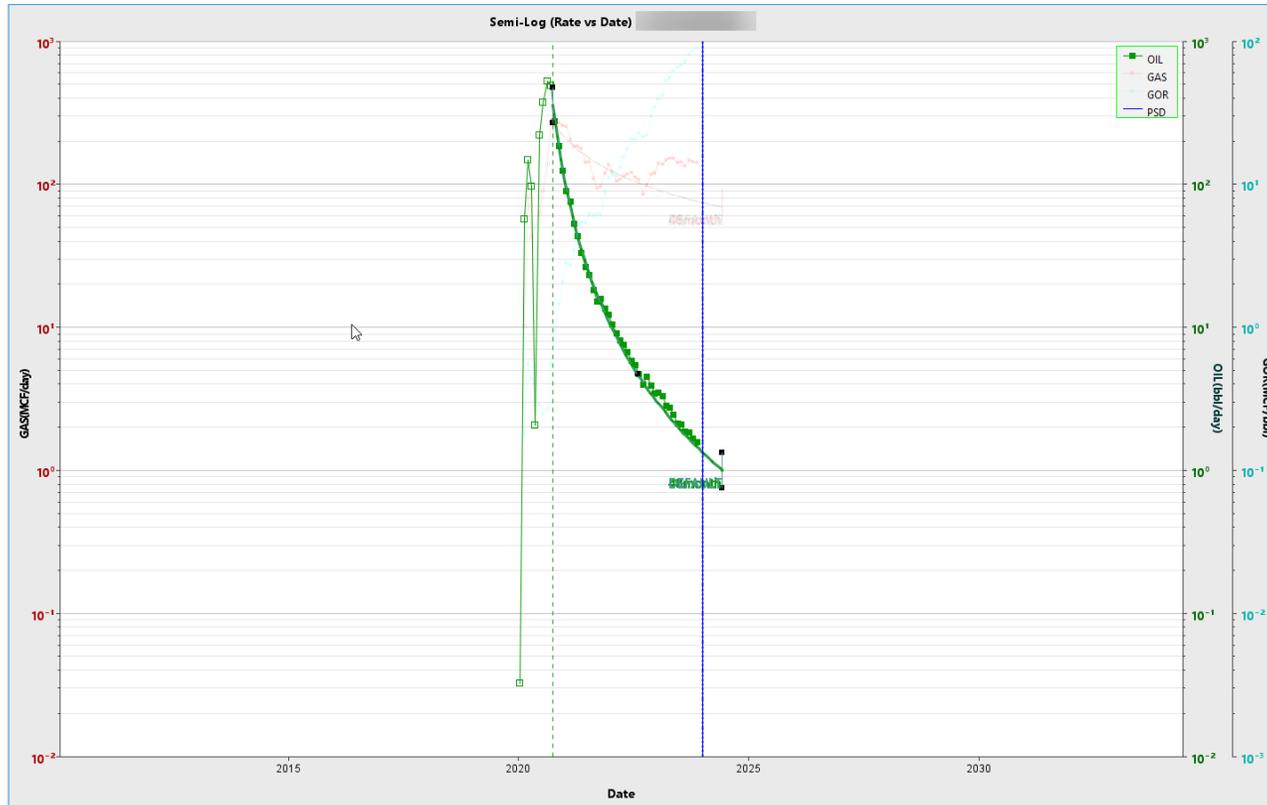
Range Setting of History Points



Shut-in Wells Detection and Setup



Shut-in Wells Detection and Setup



**Peak Rate Identification
Ramp-up effect eliminated**

STEP 2: Outlier Removal



- Limitations:
- MBT should follow the same chronological order as actual time
 - "False" unit slope

2. Outlier Removal

Method selection

2.1 log-log Rate-MBT

2.2 log-log Rate-Actual time

- Denoising Method: Material Balance Time or Actual time?
- Rounds of denoising?
- False unit slop (MBT)?



Material Balance Time

(MBT)

Log(q) vs log (MBT)

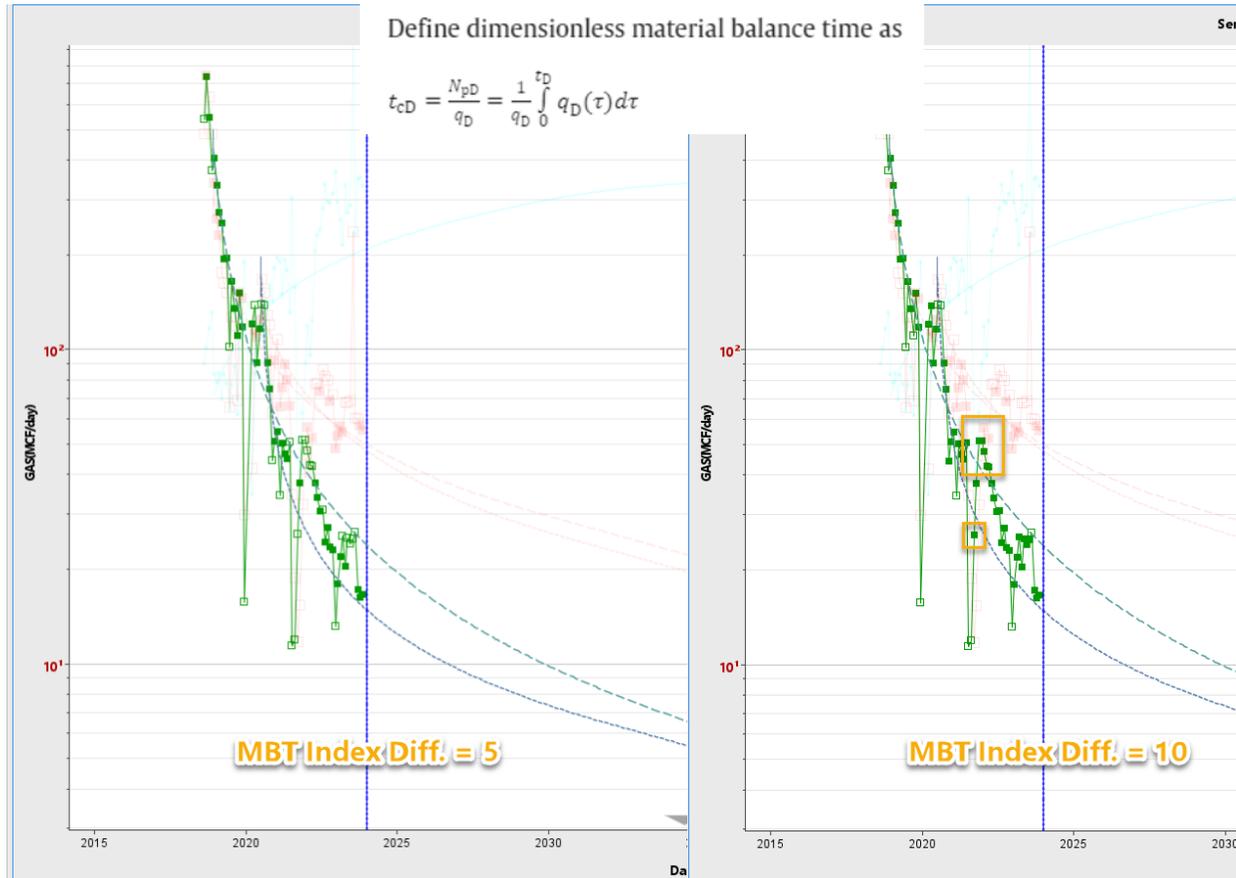


Actual Time

(t)

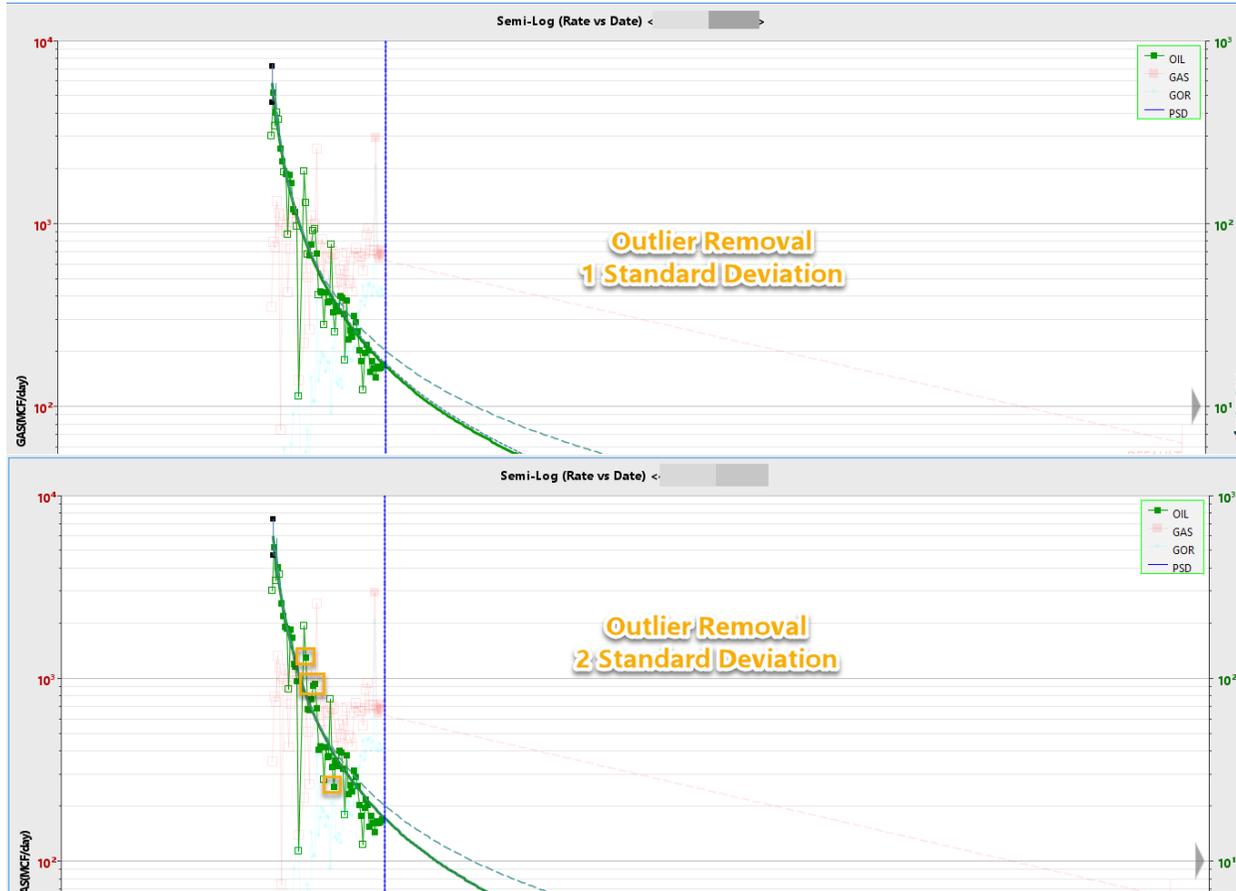
Log(q) vs log (t)

Material Balance Time (MBT) Method



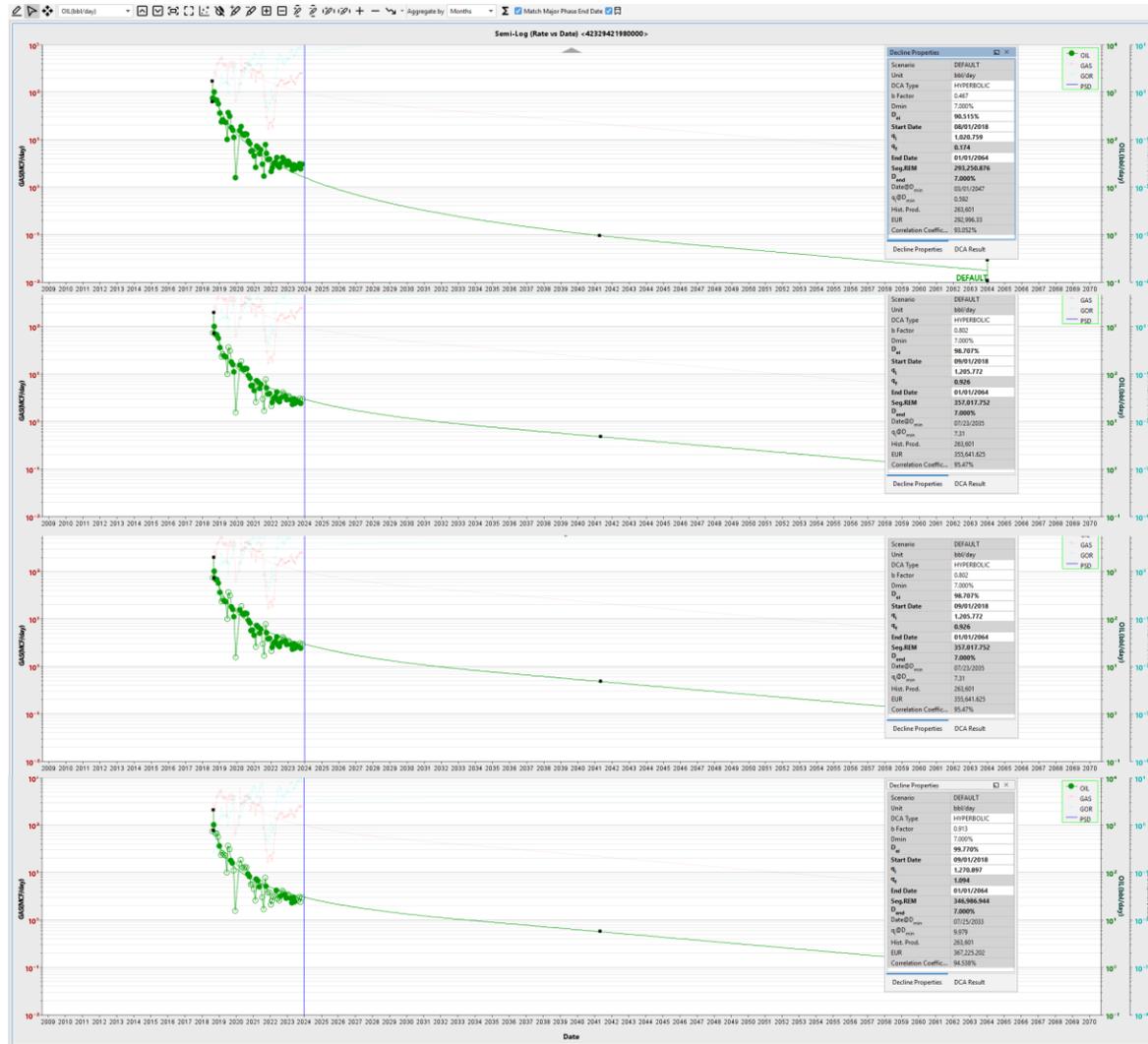
Material Balance Time (MBT) Method setting:
We calculated the material balance time based on production history. **When the production rate fluctuates significantly, it can cause deviations between the material balance time and the actual time.** Data points where the deviation value exceeds the parameter setting will be marked as **outliers**.

Material Balance Time (MBT) Method



1. Plotting $\log(q)$ vs $\log(\text{MBT})$
2. Apply polynomial fitting curves
3. Apply two (2) times **Standard Deviation (2σ)** as screen threshold. (Approx. 5% will be culled)
4. Identify the **outliers**.

Rounds of Denoising



Denoise disabled

1st Round Denoising

2nd Round Denoising [default]

3rd Round Denoising



D_{\min}
6%

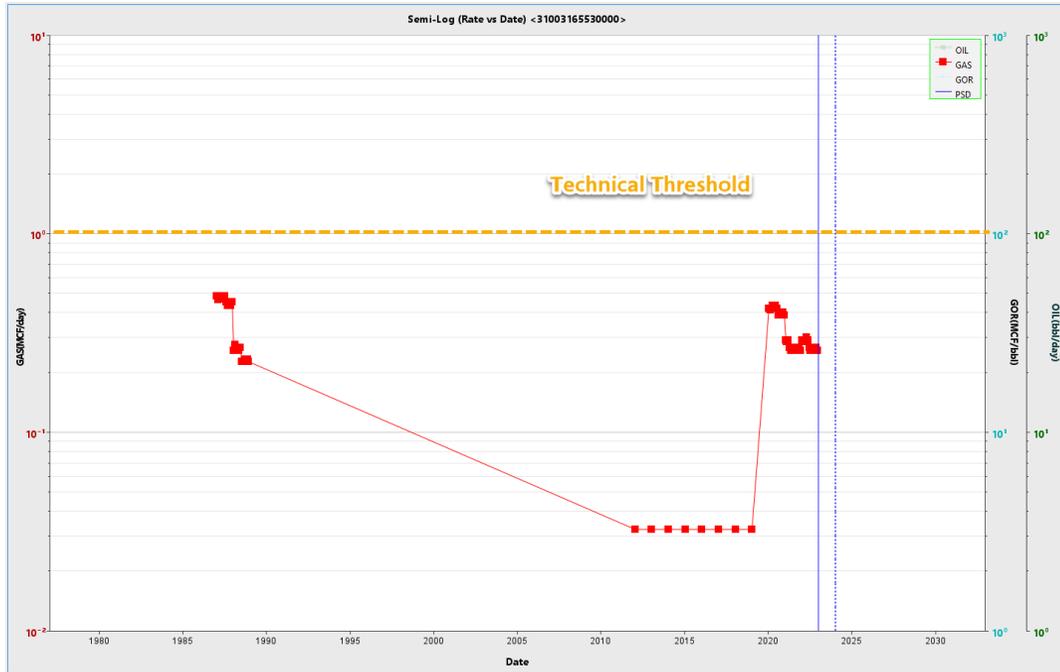


b-Factor Min./Max.
0.1 ~ 1.2



Cutoff Time Interval
50 yrs

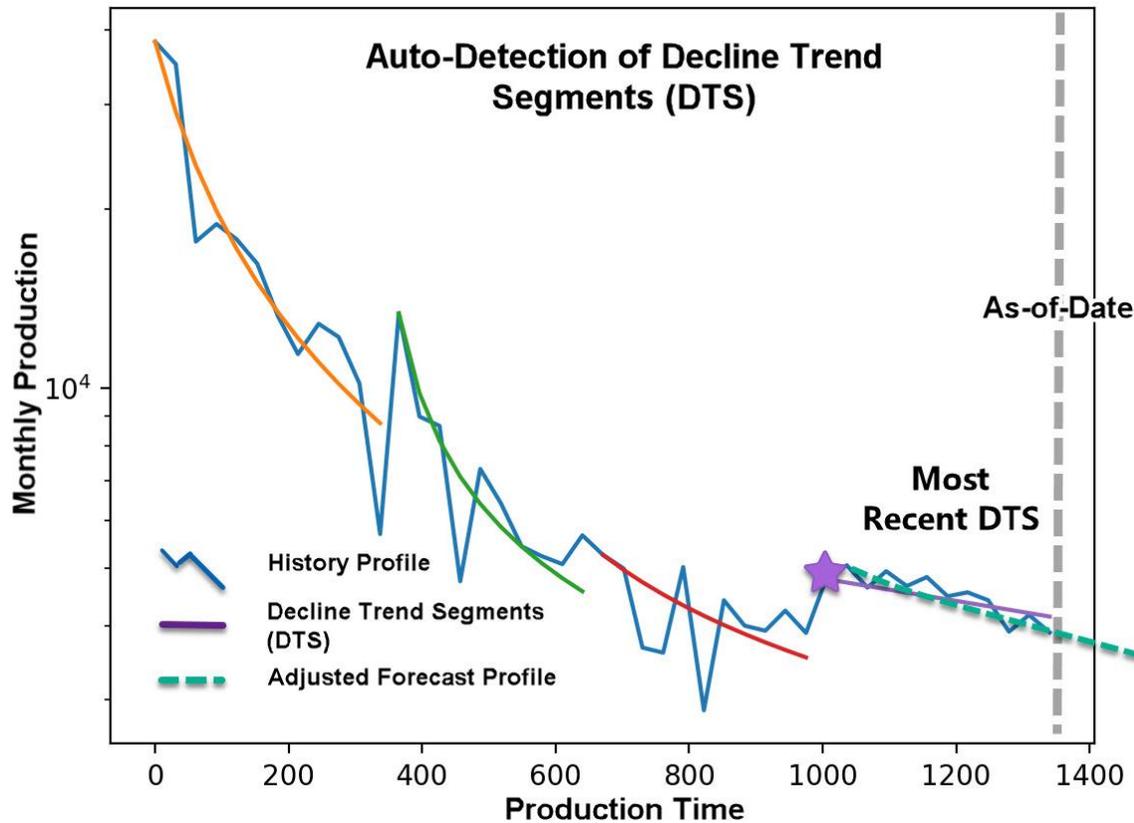
Other Adjustable Parameters



Technical Threshold

Data points with a production rate lower than the technical limit will be excluded and will not generate a forecast profile.

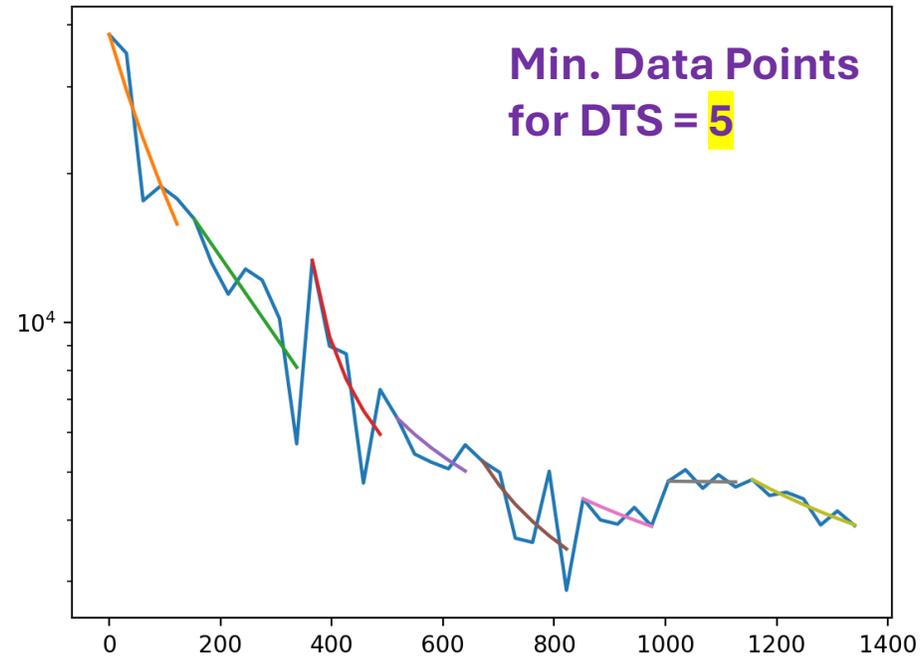
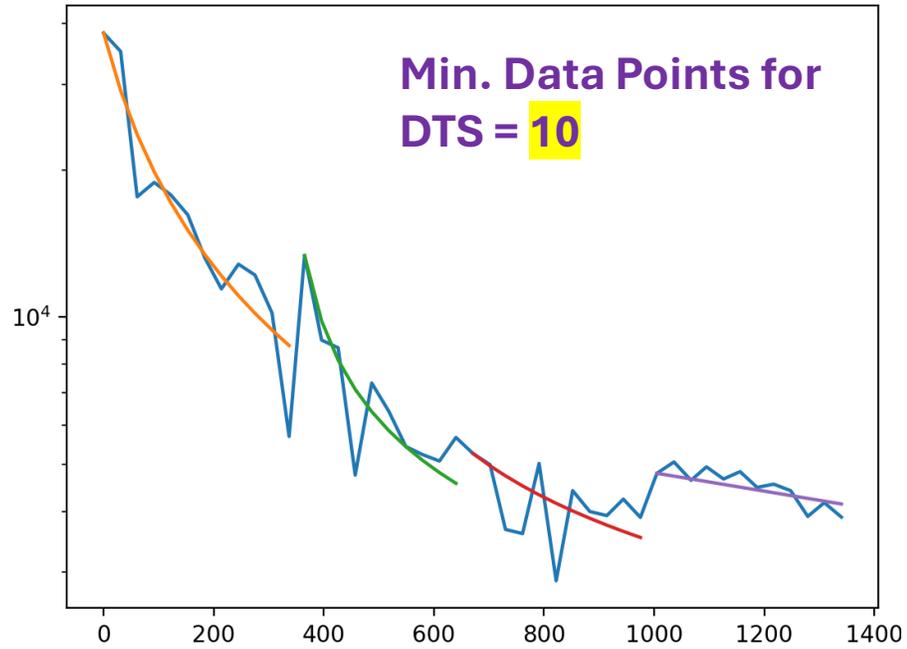
Auto-Detection of Decline Trend Segments (DTS)



Auto-Detection of DTS

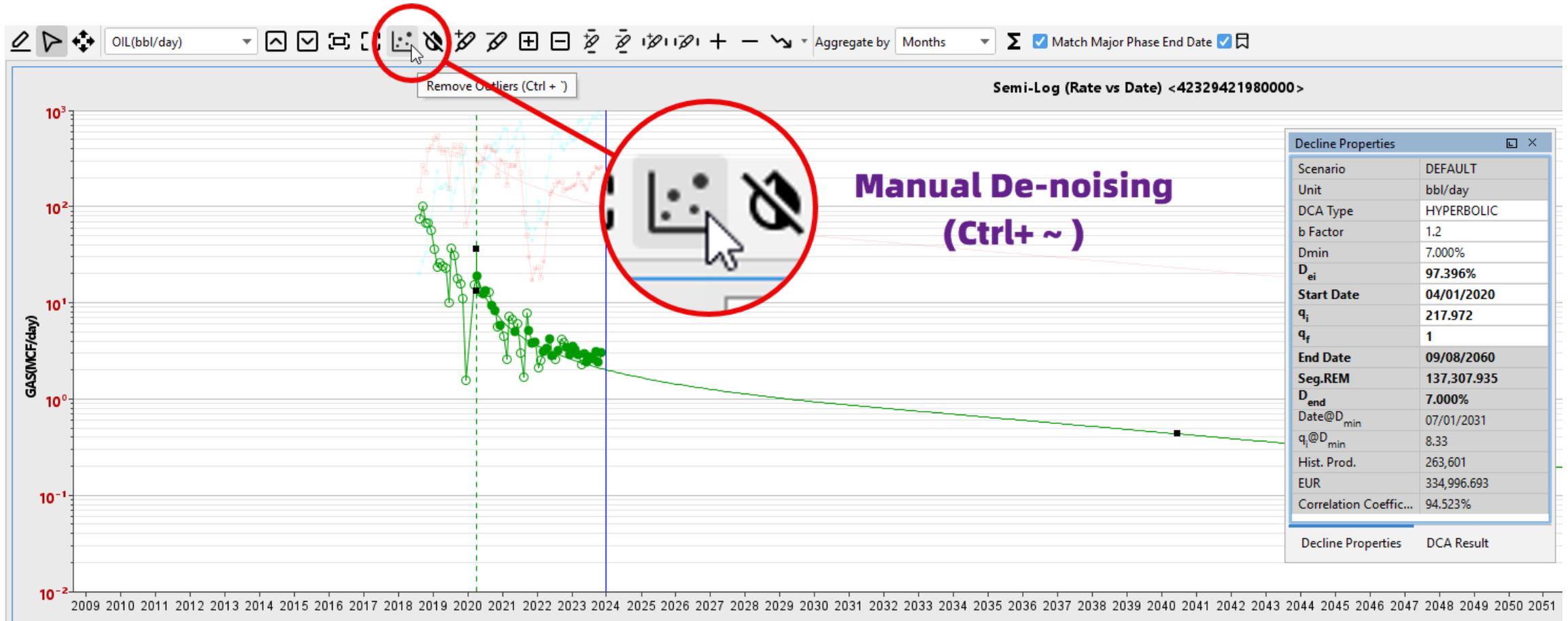
Validate the forecast using the latest data points. If a deviation from the trend is detected, adjust the forecast based on the most recent segment of the decline trend.

Other Adjustable Parameters



Define the minimum data points/counts limit for the trend correction

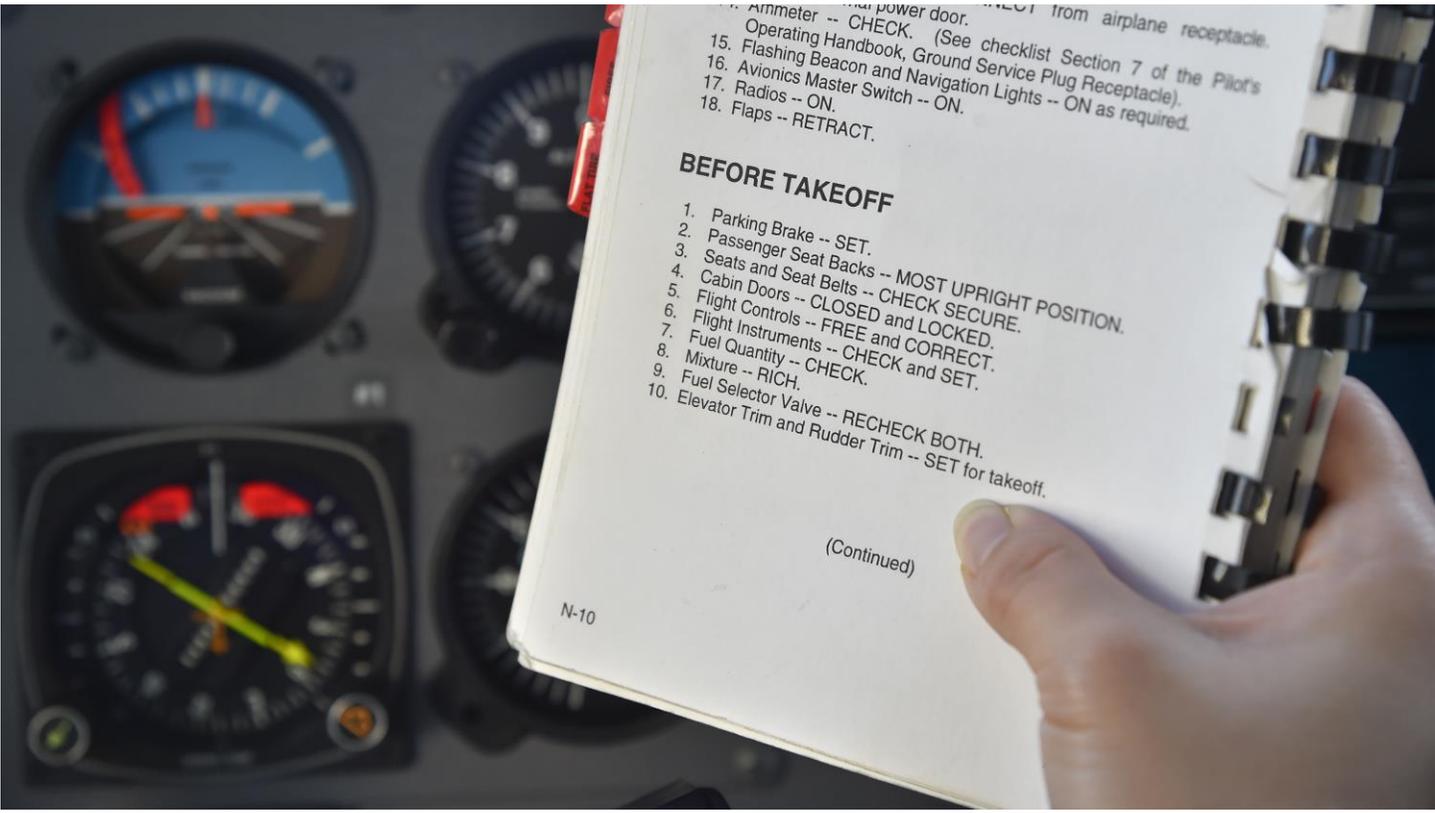
Adj. Parameters- Forecast



User Could Choose to de-noise Manually in Graphics with Shortcut key (Ctrl + `)

Before "Take-off" Checklist

		NORMAL PROCEDURES A320
BEFORE START		APPROACH
COCKPIT PREP.....COMPLETED (BOTH) GEAR PINS and COVERS.....REMOVED SIGNS.....ON / AUTO ADIRS.....NAV FUEL QUANTITY.....KG TO DATA.....SET BARO REF.....SET (BOTH)		BRIEFING.....CONFIRMED ECAM STATUS.....CHECKED SEAT BELTS.....ON BARO REF.....SET (BOTH) MDA/DH.....SET (BOTH) ENG MODE SEL.....AS RQRD
WINDOWS/DOORS.....CLOSED (BOTH) BEACON.....ON THR LEVERS.....IDLE PARKING BRAKE.....AS RQRD		LANDING
AFTER START		CABIN CREW.....ADVISED A/THR.....SPEED/OFF AUTO BRAKE.....AS RQRD ECAM MEMO.....LDG NO BLUE LDG GEAR DN SIGNS ON CABIN READY SPLRS ARM FLAPS SET
ANTI ICE.....AS RQRD ECAM STATUS.....CHECKED PITCH TRIM.....SET RUDDER TRIM.....ZERO		AFTER LANDING
BEFORE TAKEOFF		FLAPS.....RETRACTED SPOILERS.....DISARMED APU.....START RADAR.....OFF/STBY PREDICTIVE WINDSHEAR SYSTEM.....OFF
FLIGHT CONTROLS.....CHECKED (BOTH) FLT INST.....CHECKED (BOTH) BRIEFING.....CONFIRMED FLAP SETTING.....CONF (BOTH) V1, VR, V2/FLX TEMP.....(BOTH) ATC.....SET ECAM MEMO.....TO NO BLUE AUTO BRK MAX SIGNS ON CABIN READY SPLRS ARMED FLAPS TO TO CONFIG NORM		PARKING
CABIN CREW.....ADVISED TCAS.....TA OR TA/RA ENG MODE SEL.....AS RQRD PACKS.....AS RQRD		APU BLEED.....ON ENGINES.....OFF SEAT BELTS.....OFF EXT LT.....AS RQRD FUEL PUMPS.....OFF PARK BRK AND CHOCKS.....AS RQRD
AFTER TAKE OFF/ CLIMB		SECURING THE AIRCRAFT
LDG GEAR.....UP FLAPS.....RETRACTED PACKS.....ON BARO REF.....SET (BOTH)		ADIRS.....OFF OXYGEN.....OFF APU BLEED.....OFF EMER EXIT LT.....OFF SIGNS.....OFF APU AND BAT.....OFF Consider COLD WEATHER



Before "Take-off" Checklist



Pre-treatments

- Phases to be forecasted
 - Oil
 - Gas
 - ...
- Forecast Methods
 - M. Hyp
 - Exp.
 - ...
- Enable Denoising
 - Denoising Methods
 - MBT
 - log(q) vs log(t)
 - Max. MBT Index Diff.
 - # Rounds of Denoising
 - Reserve Peak Rate
 - ...

Forecast Setting

- Dmin (%)
- B-Factor Min.
- B-Factor Max.
- Cutoff Time Interval
- Fit Minor Phase as Flat Ratio
- Minor Phase uses Major' s culling
- Minor ends at Major' s
- Shut-in Wells Assessment
- Data "Gap" ...
- Consecutive zeros...
- Decline Trend Segment (DTS)
- Min. DTS Data Points
- Threshold Rate...
- ...

"...v1 Rotate..."

- **11,000 Wells** – Permian unconventional, 10yrs+
- **2 Phases,**
- **Selecting from Exp., M. Hyp, Har. Forecast Methods**
- **2 Rounds of Denoising**
- **DTS Correction Enabled**

7-10 mins depends on performance of various PCs

Results Overview – Who, Why, How and Where

Beginning Auto-Fitting Process

Overall: (Assets: 400/11001, Avg: 24.99 ms, Est. Time: 04 m 34 s)

Messages

42329430720000 - ProductionRate.oil#oil1
 42329430730000 - ProductionRate.oil#oil1
 42329430740000 - ProductionRate.oil#oil1
 42329430800000 - ProductionRate.oil#oil1
 42329430860000 - ProductionRate.oil#oil1

Asset	Forecast	Result
42383382580000	ProductionRate.oil#oil1	Gap between end of history and as of date is greater than 6 As Of Date: 2024-01-01 L
42383383780000	ProductionRate.oil#oil1	Gap between end of history and as of date is greater than 6 As Of Date: 2024-01-01 L
42383383780001	ProductionRate.oil#oil1	Failed to create history
42383384040001	ProductionRate.oil#oil1	Failed to create history
42383384180000	ProductionRate.oil#oil1	Gap between end of history and as of date is greater than 6 As Of Date: 2024-01-01 L
42383384310000	ProductionRate.oil#oil1	Failed to create history
42383384320000	ProductionRate.oil#oil1	Failed to create history
42383385610001	ProductionRate.oil#oil1	Failed to create history
42383385620001	ProductionRate.oil#oil1	Failed to create history
42383387810000	ProductionRate.oil#oil1	Gap between end of history and as of date is greater than 6 As Of Date: 2024-01-01 L
42383387840000	ProductionRate.oil#oil1	Gap between end of history and as of date is greater than 6 As Of Date: 2024-01-01 L
42383388080000	ProductionRate.oil#oil1	Gap between end of history and as of date is greater than 6 As Of Date: 2024-01-01 L
42383388140000	ProductionRate.oil#oil1	Gap between end of history and as of date is greater than 6 As Of Date: 2024-01-01 L
42383388850001	ProductionRate.oil#oil1	Failed to create history
42383388860001	ProductionRate.oil#oil1	Failed to create history
42383388880001	ProductionRate.oil#oil1	Failed to create history
42383388910001	ProductionRate.oil#oil1	Failed to create history
42383388920000	ProductionRate.oil#oil1	Gap between end of history and as of date is greater than 6 As Of Date: 2024-01-01 L
42383388940001	ProductionRate.oil#oil1	Failed to create history

Total: 11001 | Success: 10346 (94.05%) | Review: 655 (5.95%)

Show Only Failures

Auto Forecast Comparison 2

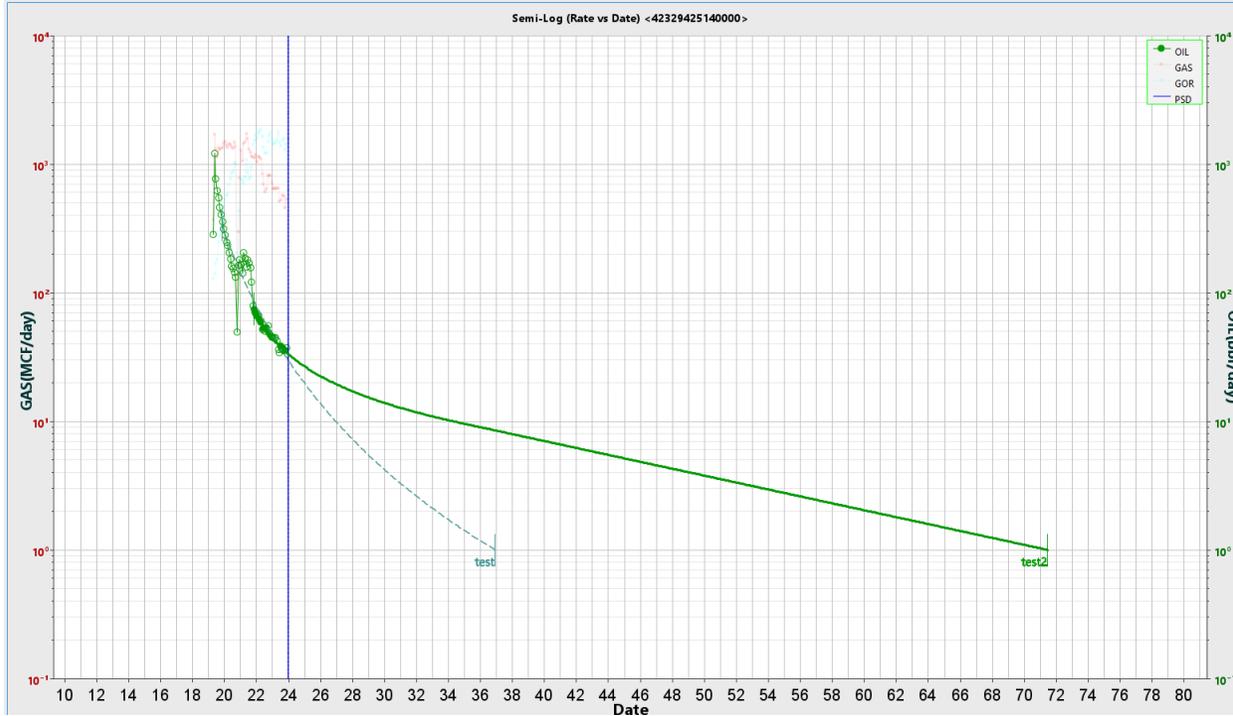


DTS Correction Disabled

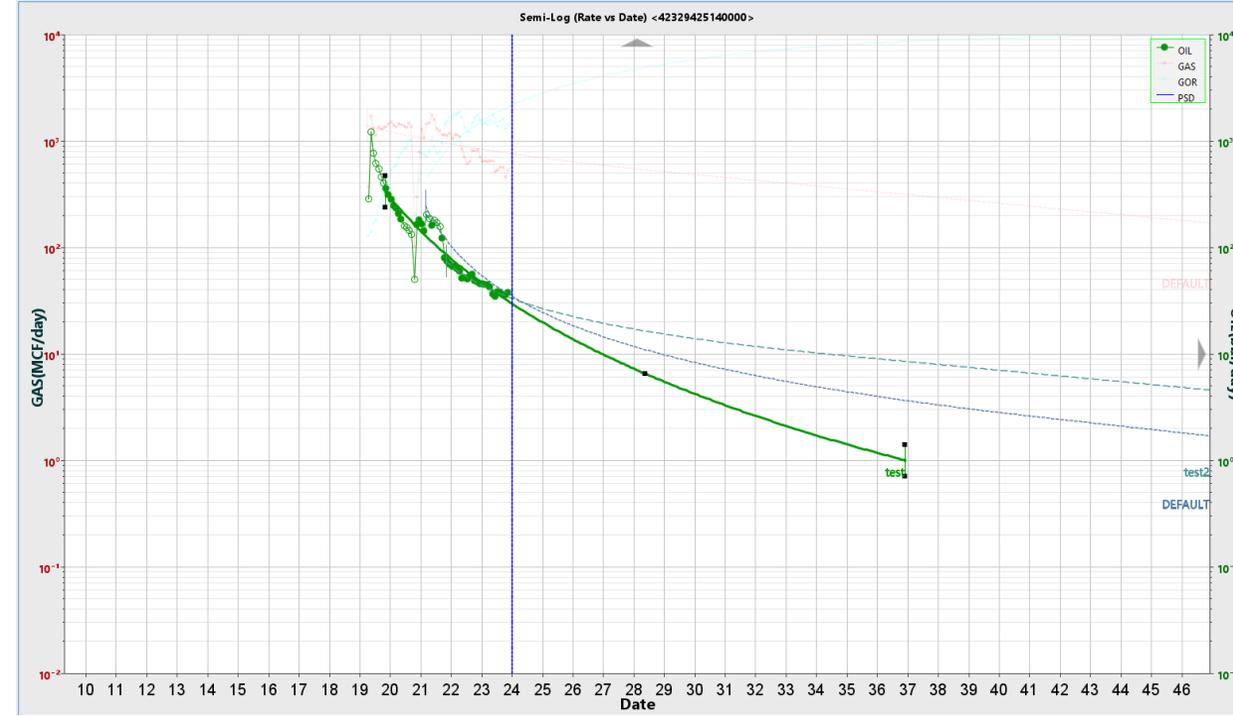


DTS Correction Enabled

Auto Forecast Comparison 3



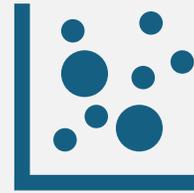
Test2: log(q) vs log(t)



Test: log(q) vs log(MBT)



**Aggregation at
Top Level**



Probit Plot



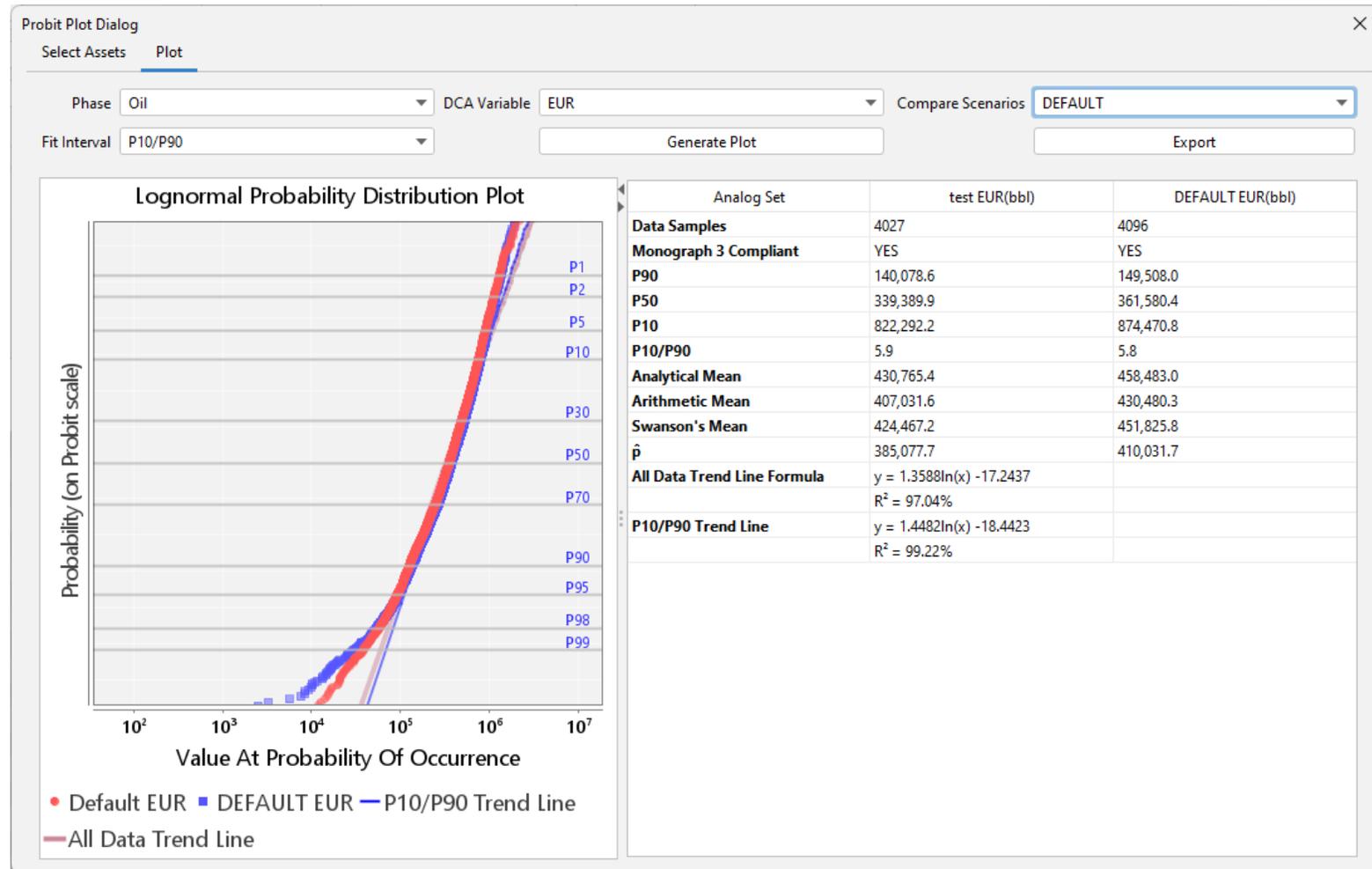
Visual Analytics

Summary Level – Validate Results



User Could Aggregate Leaf Assets/Cases Forecast to a Top Level for Review and Validation

Probit Plot – Validate Results



User Could Also Put Forecast Results (EURs) into Probit Plot for Review and Validation

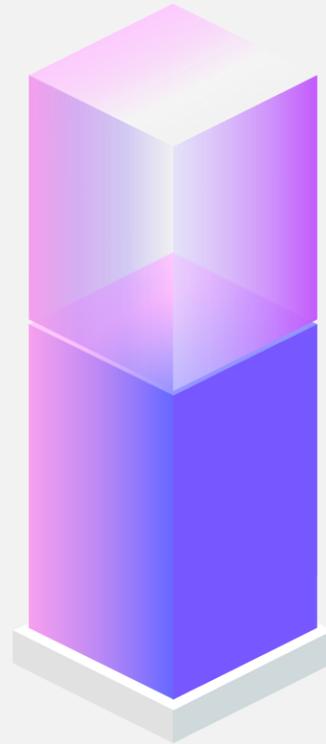
Highlights of Probit Plot

Type Well Profile Key Tool

SPEE Monograph III, IV and V

Recommended

Reliable Tool to Generate Reasonable Type
Well Tool



Probit Plot

Statistical Metrics Benchmark and Various Variables Included

EUR

b-Factors

qi

Export Statistic Results

One-click Export to
Excel

Scenario Supported

See Two
Scenarios'
Distribution

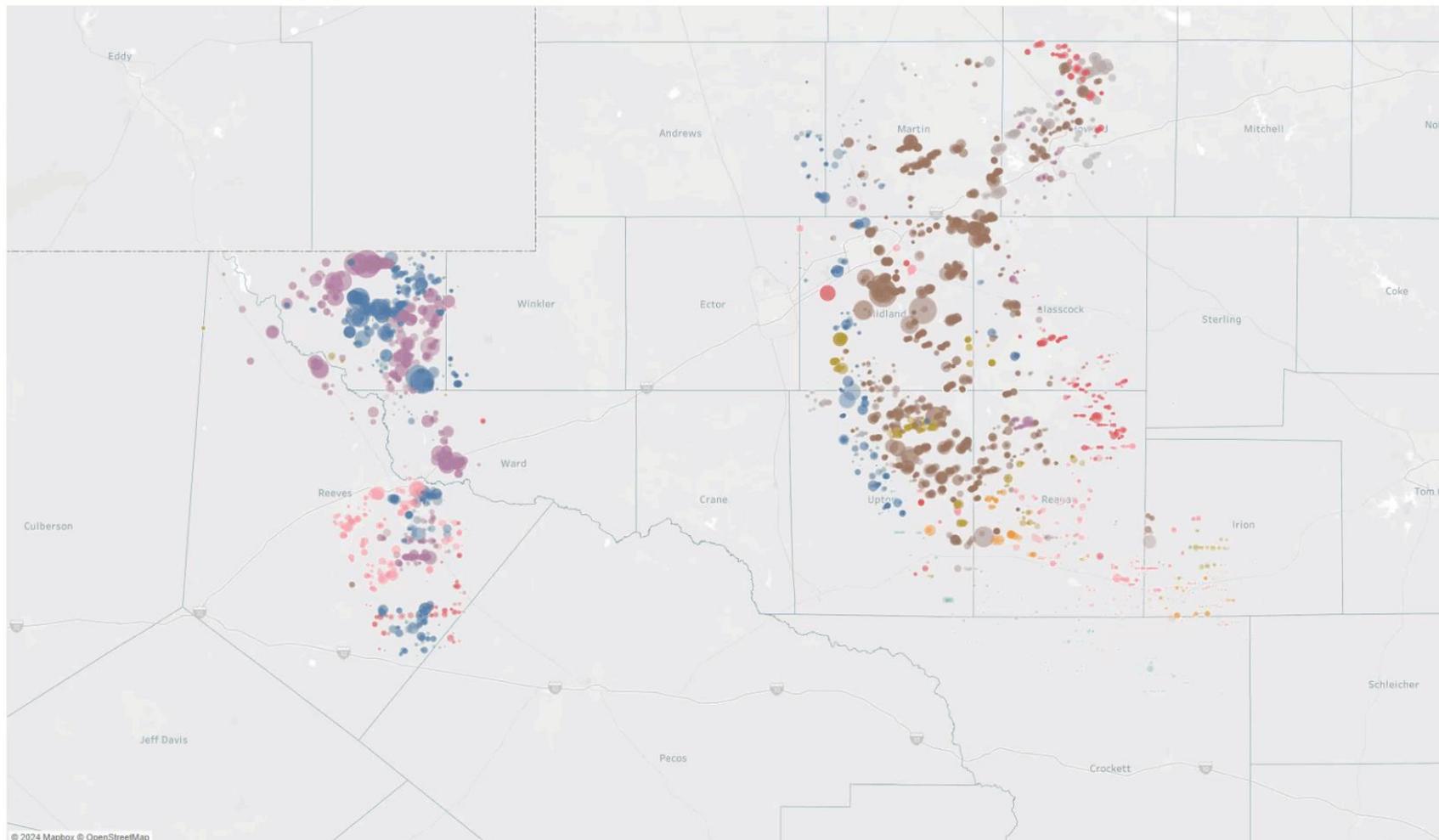
Copy and Paste Supported

Compare R3 Generated Dataset with
Users' own dataset side by side

Visual Analytics– Validate Results



EUR/ft Bubble Map of Year 2024
Color coded by operator

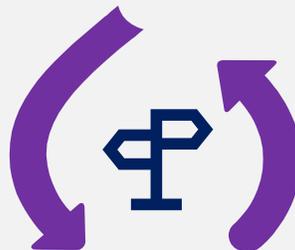


Auto Forecast & Denoising

Auto & Manual Denoising

Oil and Gas phase forecast

Multiple DCA Methods Supported



Auto Forecasting

10,000 Wells

2 Phases

Forecasts

Under

10 minutes

Anomaly

Flagging

Detect and Flag

Poorly-fitted wells

for review

Visualizing

Denoised Data

See why it got

culled out and ease

for re-visit

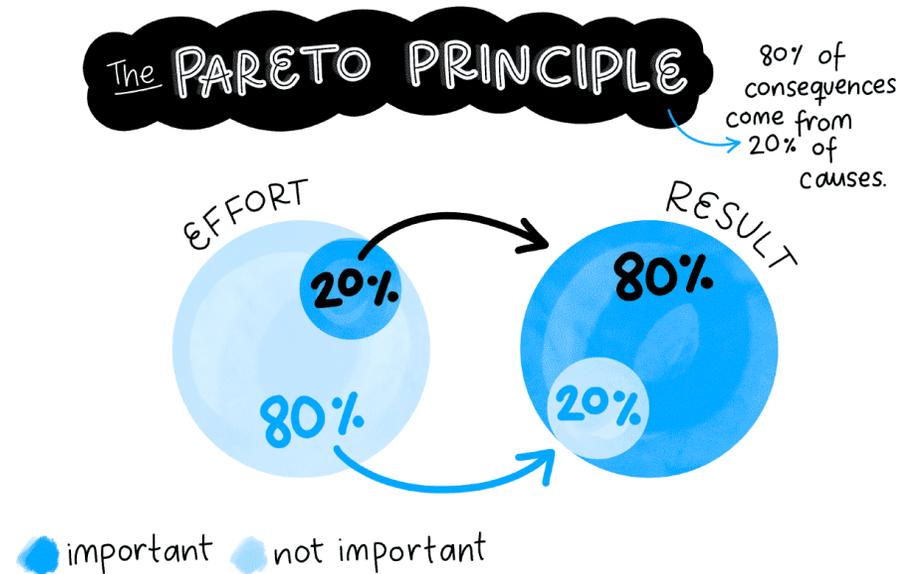
User Configurable Parameters

Define Ranges

Select Denoising Algorithms

Interactive Mapping & Visualization

We, the Batch Auto Forecast, do not compete with individual evaluators



We win by saving your time from tedious and repetitive works

03 Q&A

Q&A



Reserve | Economics | Data Analytics

04 Live Demo

Live Demo



Reserve | Economics | Data Analytics