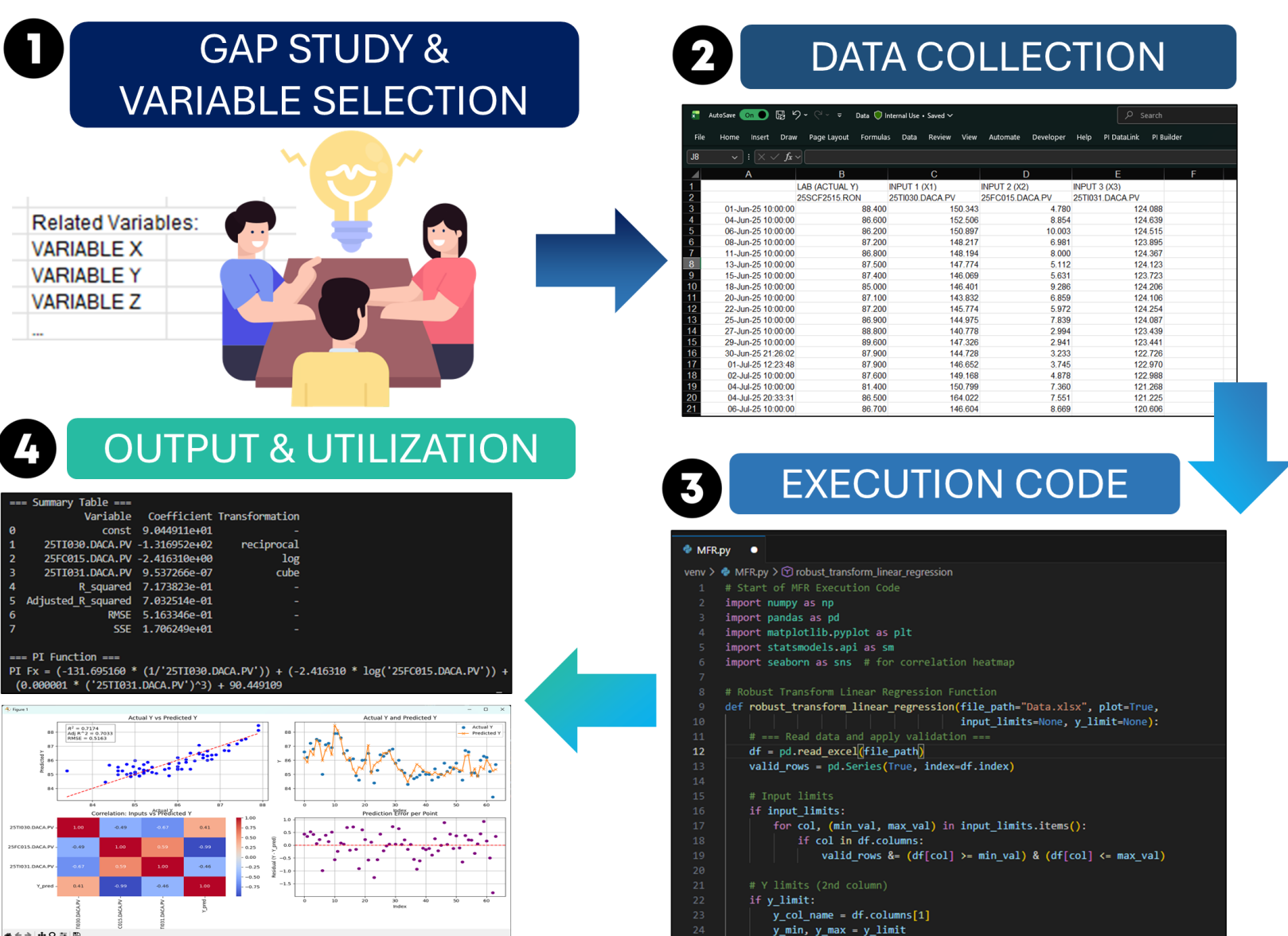
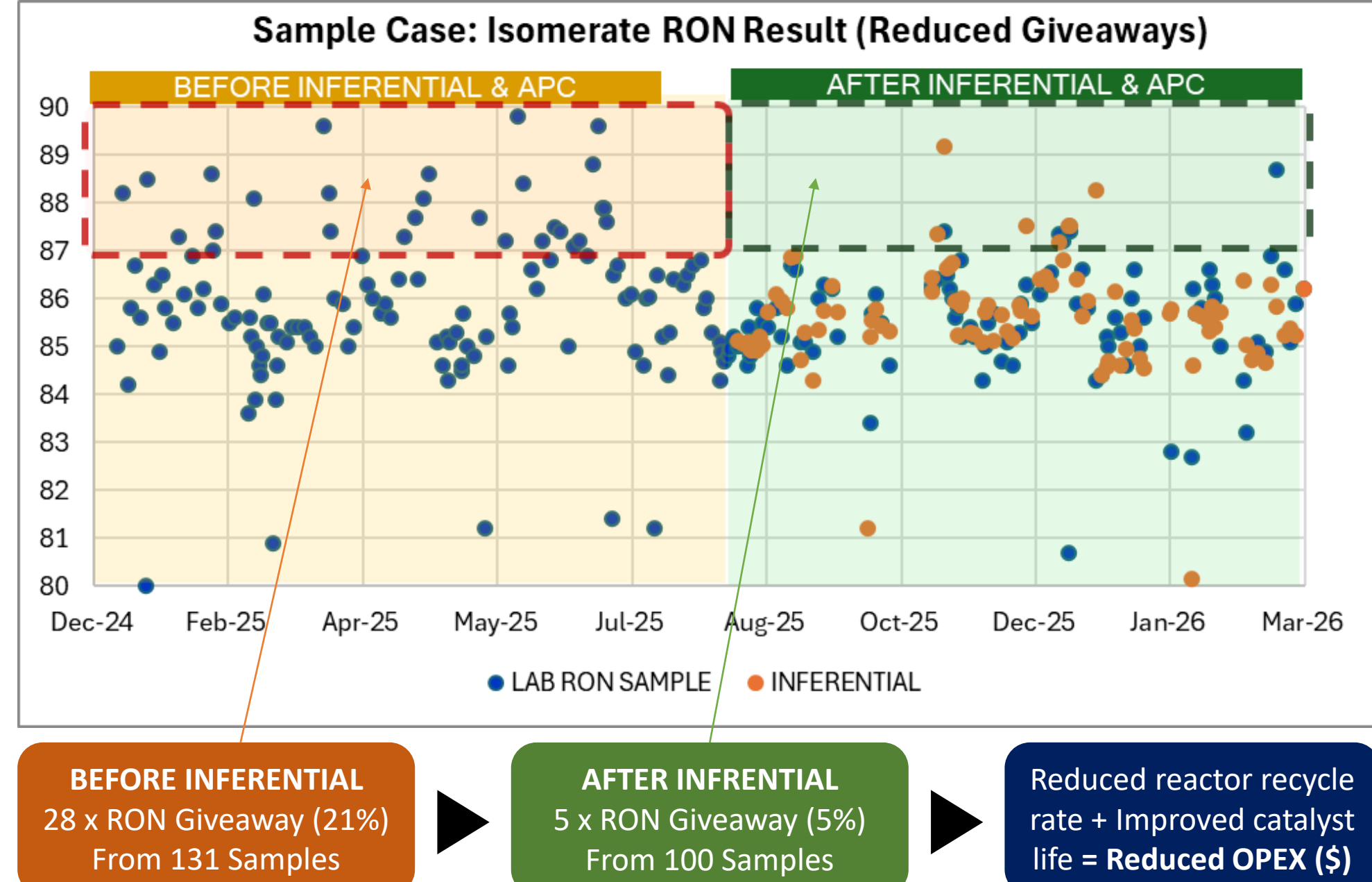


Priority Topic Area: Digitalisation and Artificial Intelligence

1 – A Real Time Property Inferential Development Tool

Petroleum properties are critical to refinery operations, directly influencing product quality, specification compliance, unit performance, and yield optimisation. Accurate inferential prediction improves profitability by enabling better control, reducing quality giveaway, and minimising off-spec production, as demonstrated by Isomerate RON optimisation shown in the figure.

Current practices face key limitations, including laboratory sampling delays that prevent real-time action, complex and resource-intensive first-principles models, and simple linear regression methods that fail to capture nonlinear behaviour. These constraints create gaps in real-time decision-making, highlighting the need for a faster, more reliable, and adaptive inferential solution. And here's where comes in our Multifunctional Regression (MFR) Tool for property inferential development.



2 – Multi-Functional Regression using Python for Inferential Development in 10 minutes

The inferential model is developed using Python and differs from conventional linear regression through a structured, automated workflow:

1. Data Validation – Imported data are screened using defined operating limits on input and output variables, ensuring only meaningful and reliable data are used.
2. Multiple Transformations Tested – Seven mathematical transformations (original, log, exponential, square, cube, square root, reciprocal) are evaluated for each input, with the best selected using Adjusted R^2 .
3. Robust Model Development – A Weighted Least Squares (WLS) regression model is developed using the selected transformations and assessed using R^2 , RMSE, and error checks.
4. Easy Deployment – The output is converted into an equation that can be directly fitted in Advanced Process Control (APC) engineering software, ready to use.

3 – Fast, Reliable and Result Focused

Multi-Functional Regression inferential models were successfully developed and validated for several light product quality parameters, including Isomerate RON, Isomerate Reid Vapor Pressure (RVP), and Isopentane (iC5) RVP. The models demonstrated reliable predictive performance and were translated into deployment-ready inferential for real-time application.

By integrating these inferential into Advanced Process Control (APC), operators gain earlier visibility of product quality trends, enabling timely intervention to maintain specifications and reduce quality giveaway. This supports improved unit stability, tighter control, and enhanced yield optimisation. In addition, the availability of reliable real-time inferential allows optimisation of laboratory sampling frequency, reducing manual intervention, laboratory workload, and operator exposure to hazardous process areas.

With this tool, inferential development can now be completed in less than 10 minutes. Engineers only need to identify the relevant parameters based on process knowledge, collect the data, import them into the code, execute the code, and obtain the results in both visual and equation form.

4 – Benefit to Society

This solution enables safer, more efficient, and more sustainable refinery operations by providing reliable real-time product quality information. Early visibility of quality trends allows timely corrective actions, reducing off-spec production, material wastage, and unnecessary energy consumption and produce environmentally safe products. Reduced reliance on frequent laboratory sampling lowers operator exposure to hazardous process areas and decreases manual workload. By replacing complex first-principles modelling with a fast, data-driven approach, engineering effort and development costs are significantly reduced.

5 – Way Forward

Looking ahead for broader adoption of this tool in inferential development of cold crude properties such as Sulfur content, Cloud Point, Benzene and etc, which is difficult to be inferred through first principle or other approach. By doing so, refineries can unlock higher benefit margin at the same time promoting sustainable production practice.

