Global Consulting

Two-step Bayesian hyperparameter optimisation to efficiently build insurance market price models

Can Baysal – Insurance Data Science Conference, 15 June 2023

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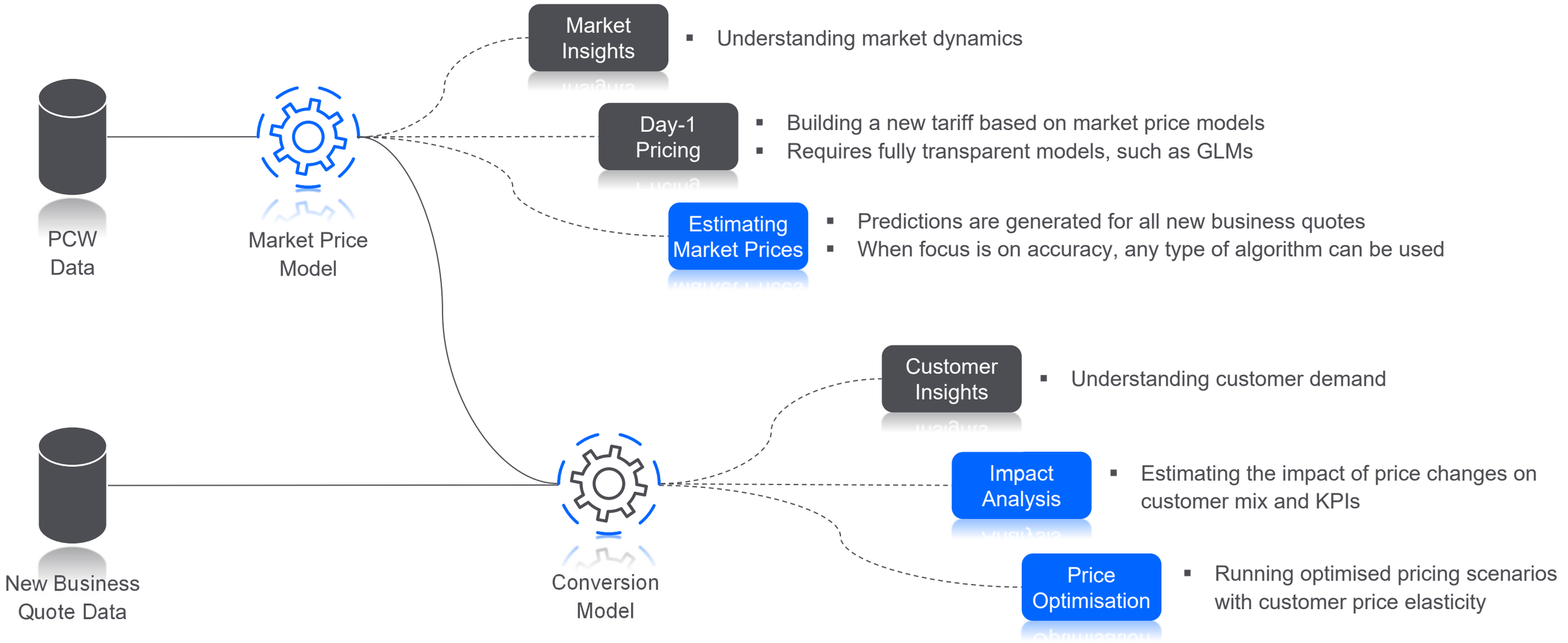
Market price models contributes significantly to pricing process

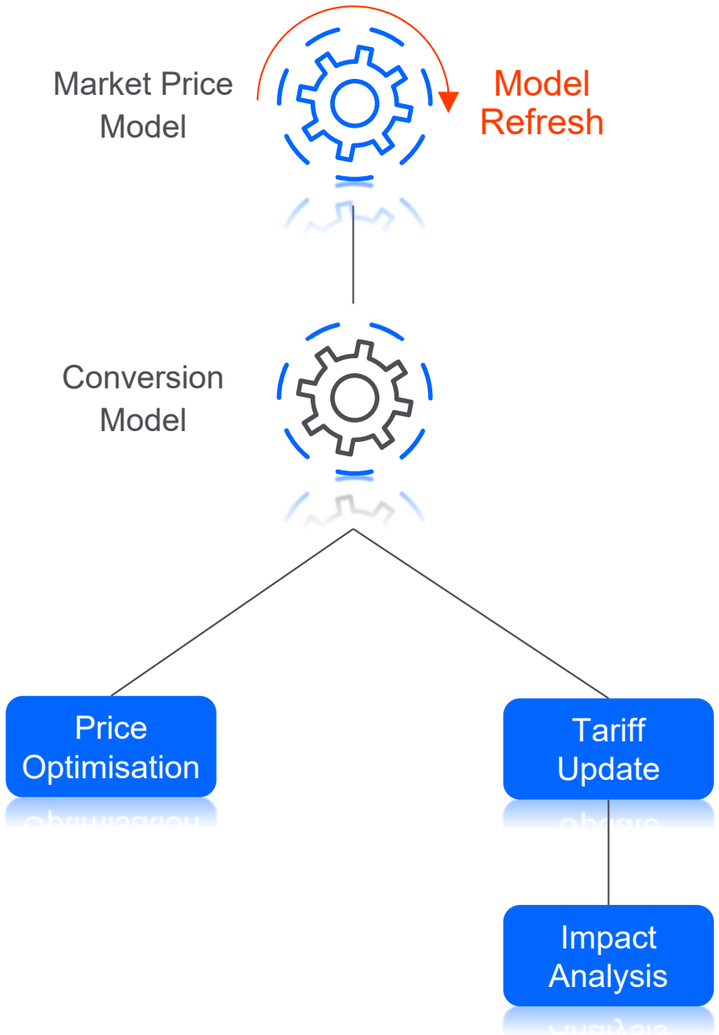
Use cases of market price models



PCW: Price comparison website

Instantly react to market changes with frequent model updates

Need for speed and automation



Why market price models require higher refresh rate?

- Market price models are mostly used in personal lines motor and home insurance markets.
- These markets are highly dynamic and are affected by changes in factors such as macroeconomic indicators, customer behavior and regulations.
- As a result, the predictive performance of market price models deteriorate much faster than technical risk and customer demand models.
- Consequently, market price models benefit more from frequent updates, as technical risk and customer demand models do not deteriorate at the same pace.

GBMs over GLMs, when explainability is not the top priority

Selecting the appropriate algorithm for the model

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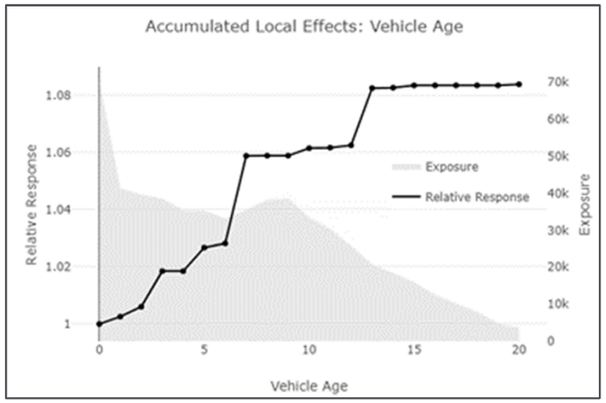
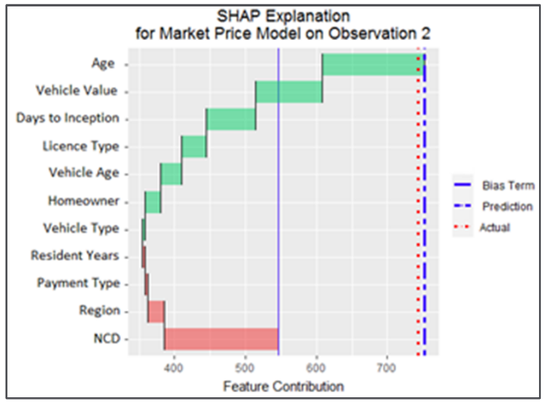
Exploration of Model Outputs

Vehicle Brand		Age		Region	
Modality	Coefficient	Modality	Coefficient	Modality	Coefficient
Audi	1.0	18–25	2.5	Region 1	1.0
BMW	1.0	26–50	1.0	Region 2	1.3
Nissan	0.8	>50	0.9	Region 3	1.1

Interpretation of Machine Learning Models





Fastest way to minimise validation error

Hyperparameter optimisation methods

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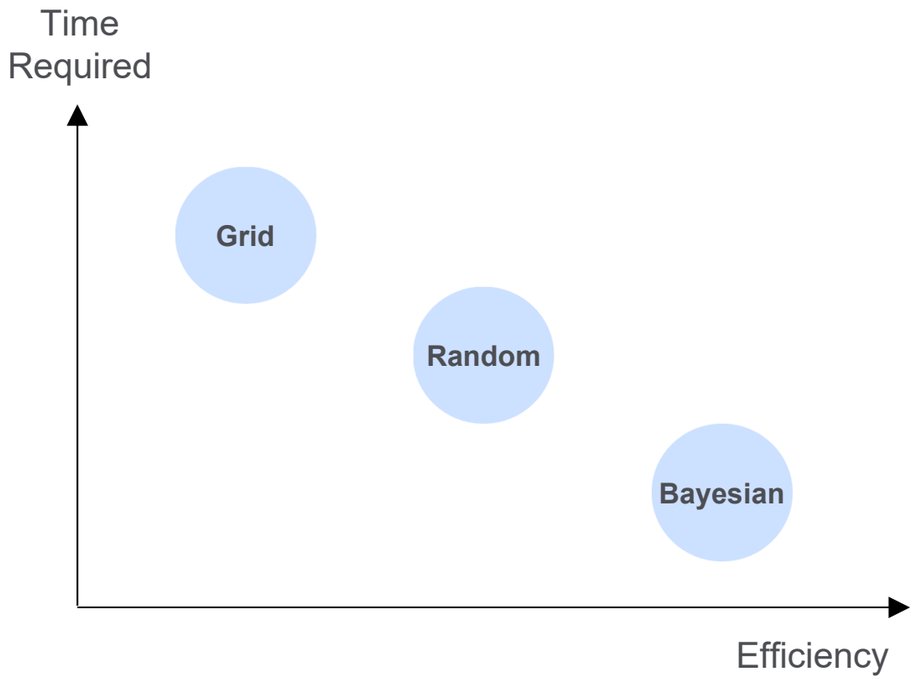
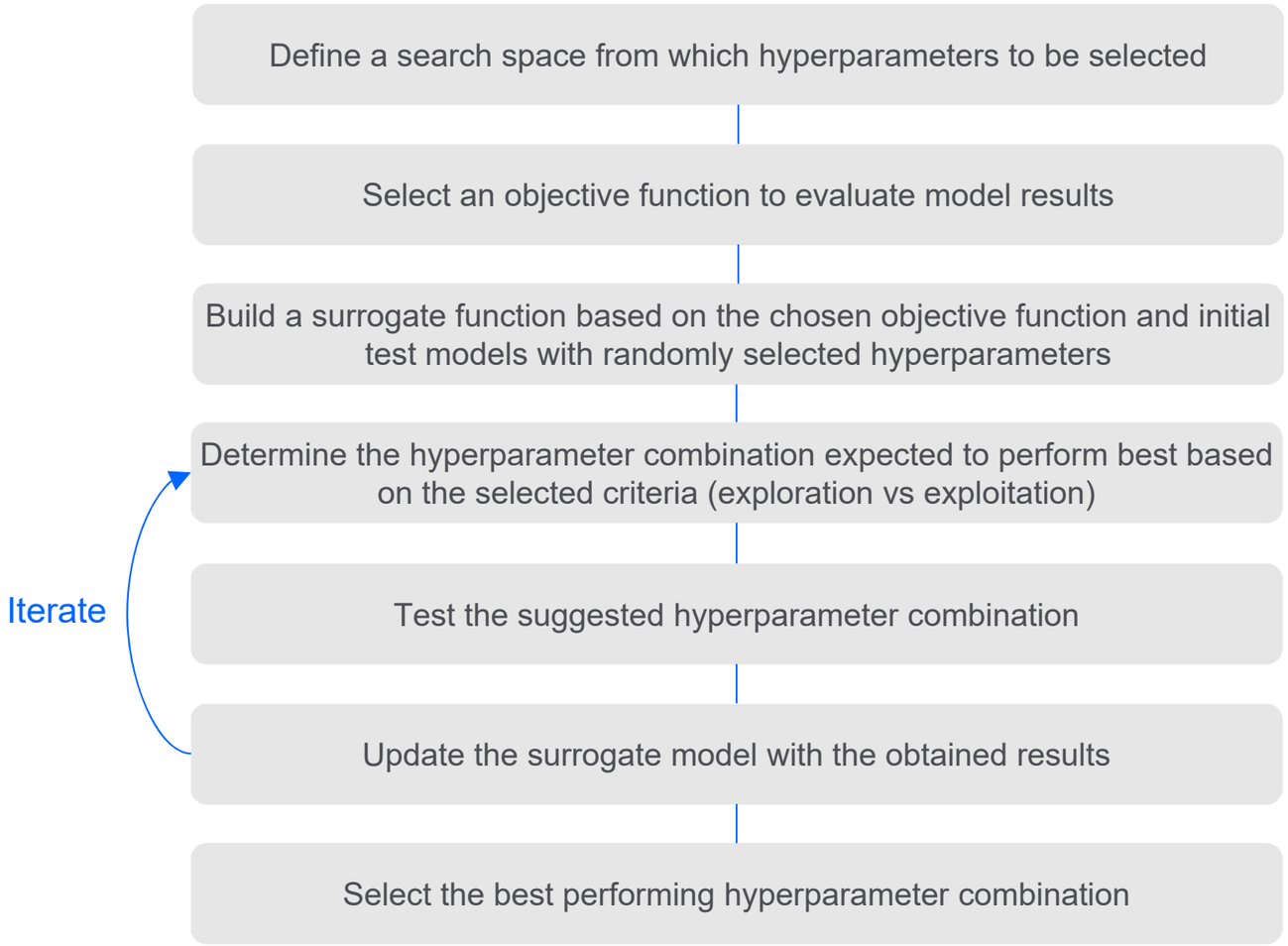
Hyperparameter optimisation methods

- Manual tuning > requires manual work from modeler
- Grid search > does not use prior evaluations
- Random search > does not use prior evaluations
- Bayesian optimisation

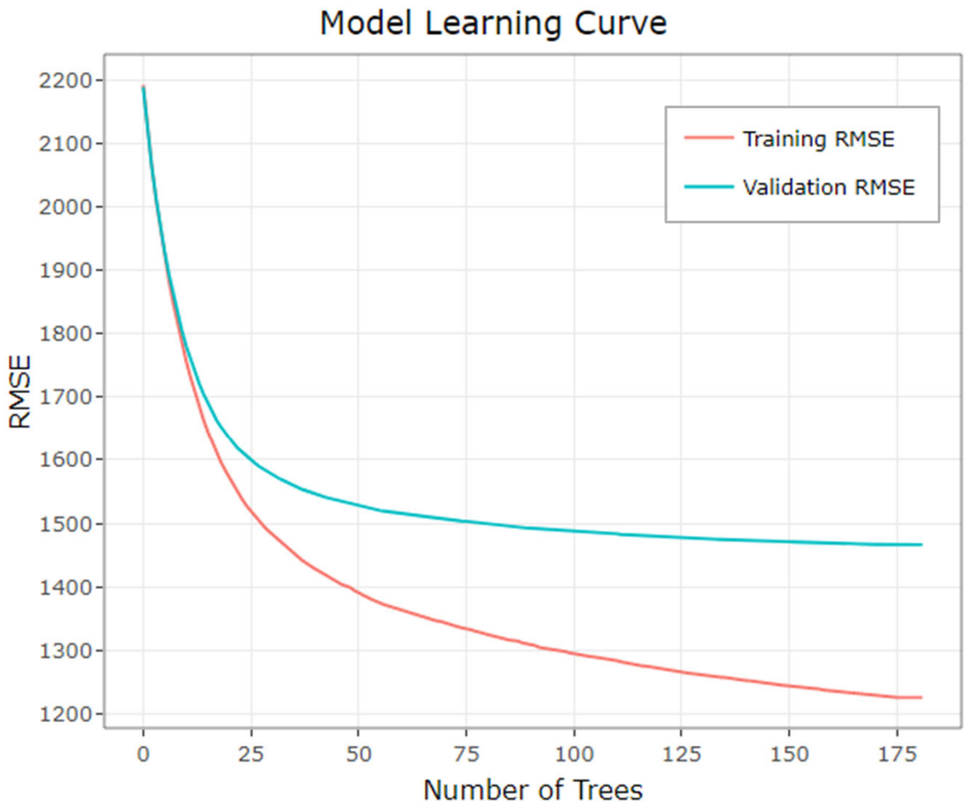


Steps of Bayesian hyperparameter optimisation



Each model is trained until properly developed

The number of trees and early stopping

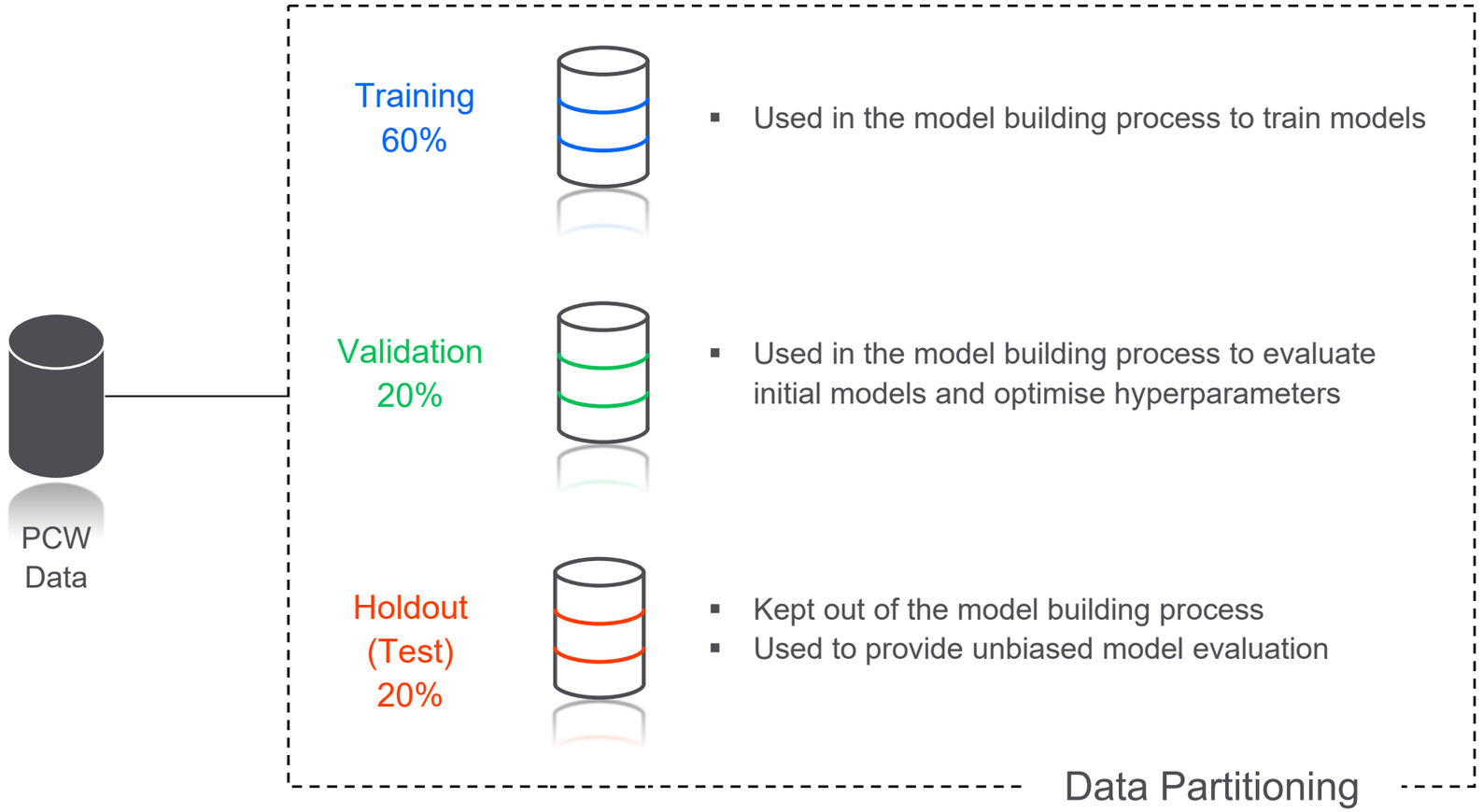


Things to consider in model training during hyperparameter optimisation

- To make a fair evaluation of hyperparameter combinations, overfitting should be avoided while each model is developed with an appropriate number of trees.
- Still, a hard cap on maximum number of trees can be applied to avoid selecting models that takes long time to train.
- To achieve this, the hyperparameter controlling the number of trees is removed from the search space and set to a high value.
- Overfitting is prevented by applying early stopping during model training.

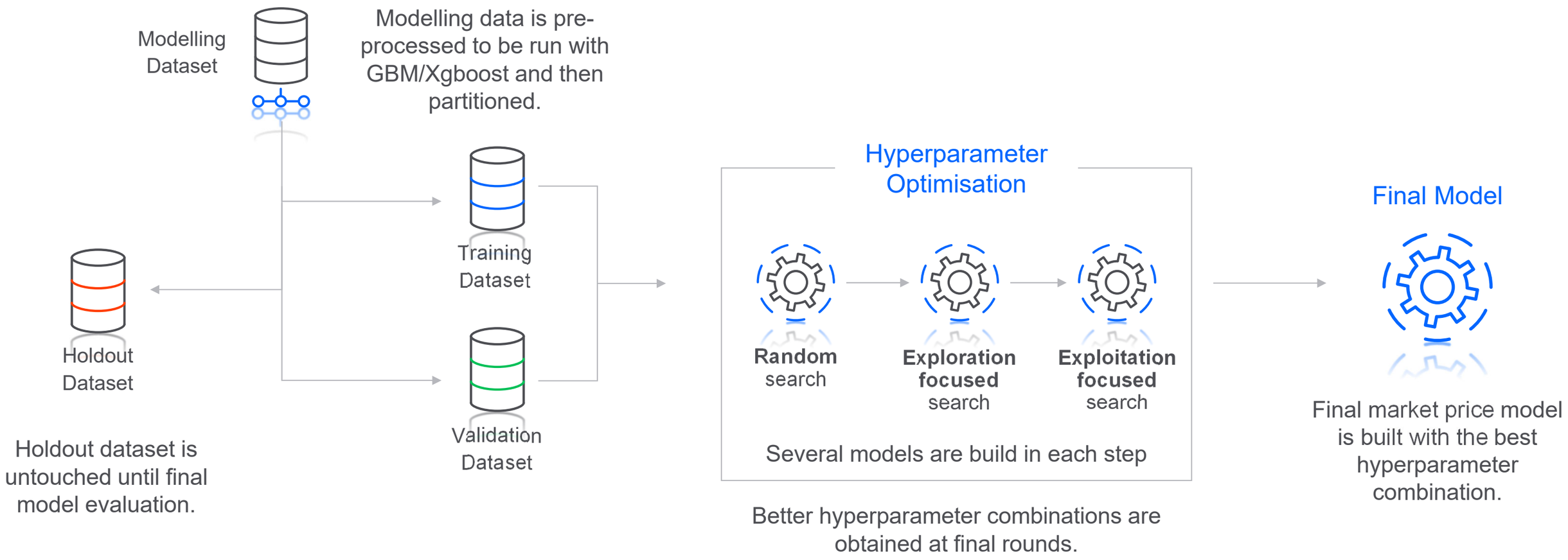
Dataset split to optimise hyperparameters and model evaluation

Preparation for model training: Data partitioning



Hyperparameters are optimised to achieve higher accuracy

Model training methodology



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Model training methodology

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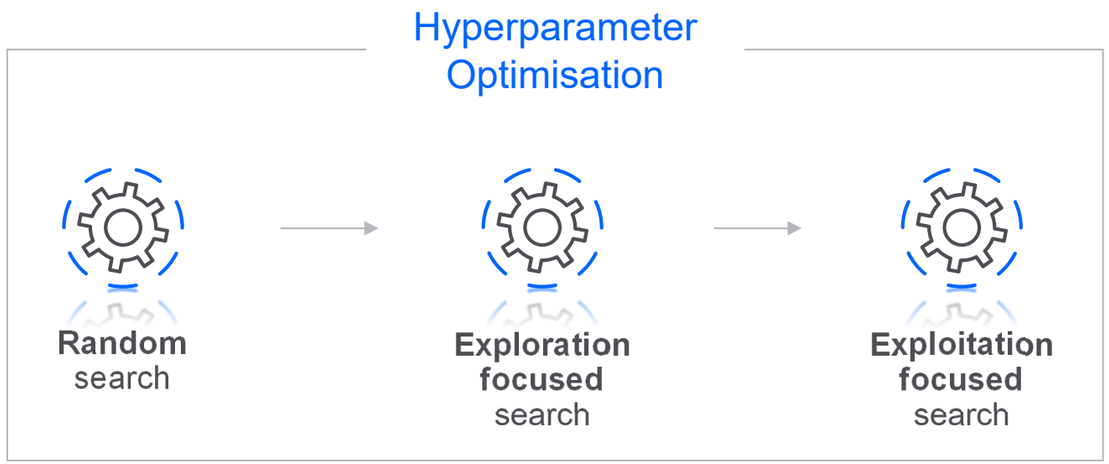
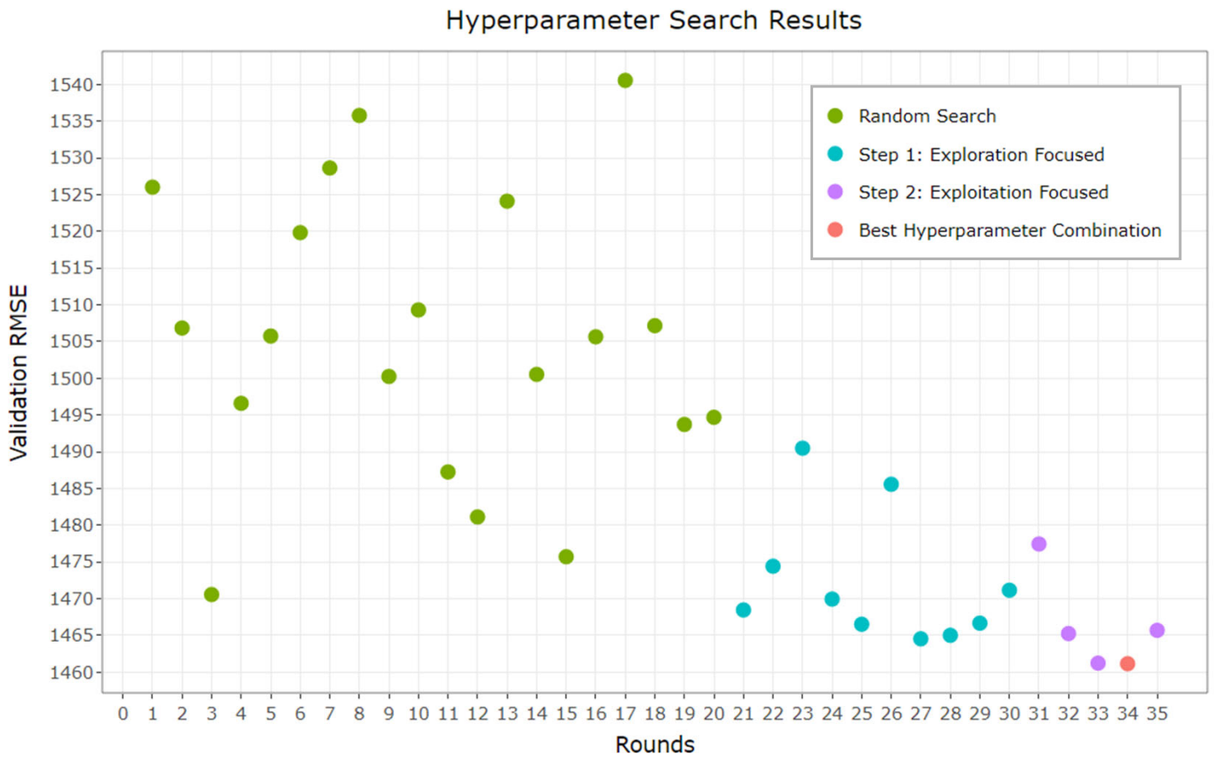




Optimised Hyperparameters

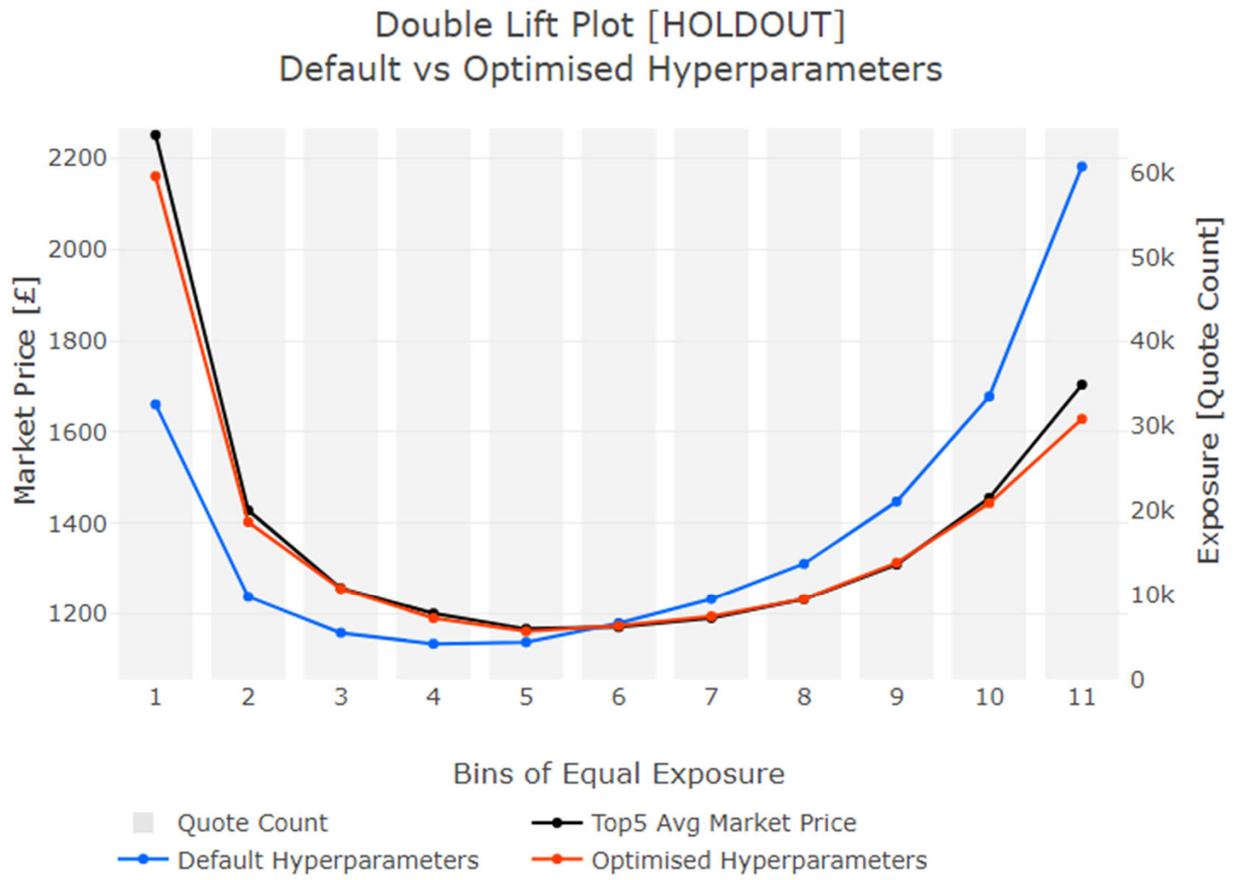
- max_depth
- sample_rate
- col_sample_rate
- min_rows
- nbins
- nbins_cats

Acquisition functions have tunable parameters to balance exploration against exploitation

- Higher values: more focus on exploration within the search space
- Lower values : more focus on accuracy with the guidance of previous rounds

Optimised hyperparameters provide better model accuracy

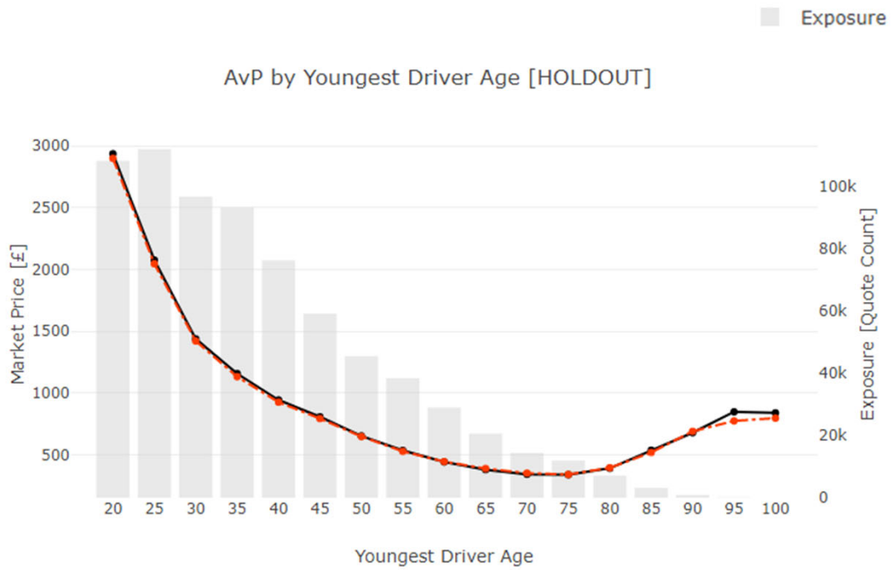
Comparison between default and optimised hyperparameters

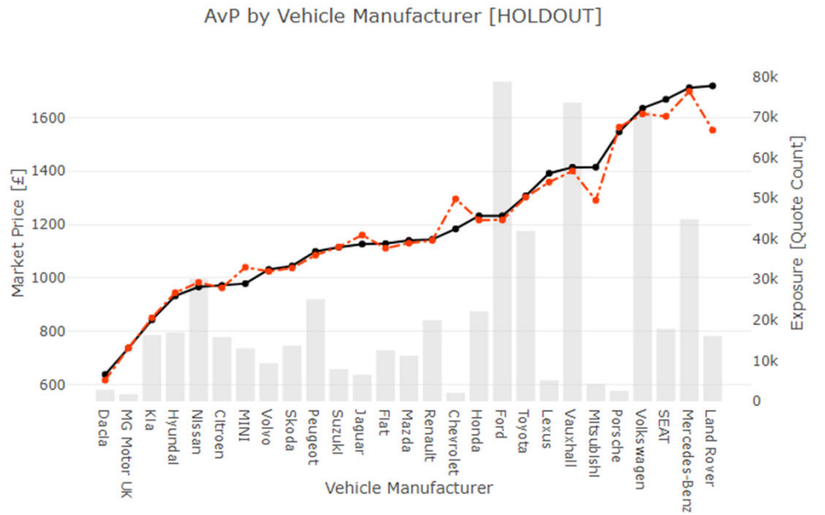


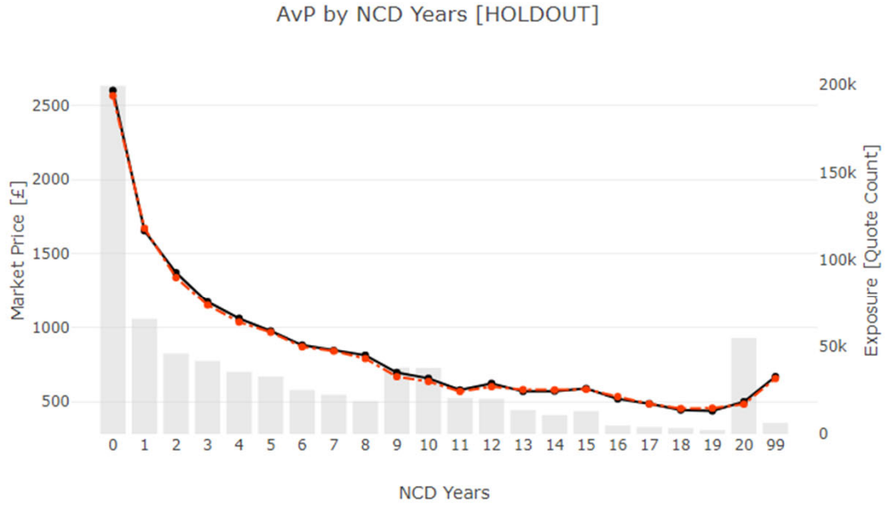
Models	RMSE	
	Train	Holdout
Default	1,436	1,465
Optimised	1,192	1,409

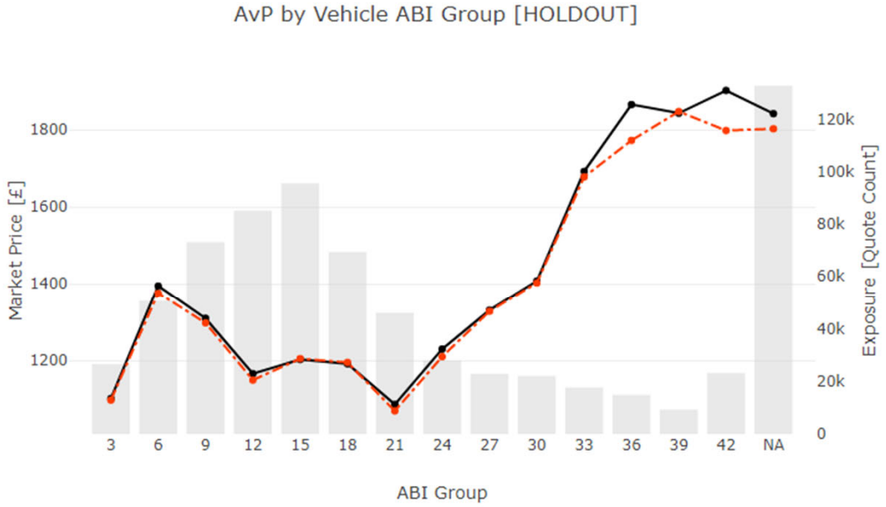
Model predictions are compared against actuals and validated

Model results









Thank you for you attention

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