Detection of electric vehicles at household level from half-hourly smart meter data

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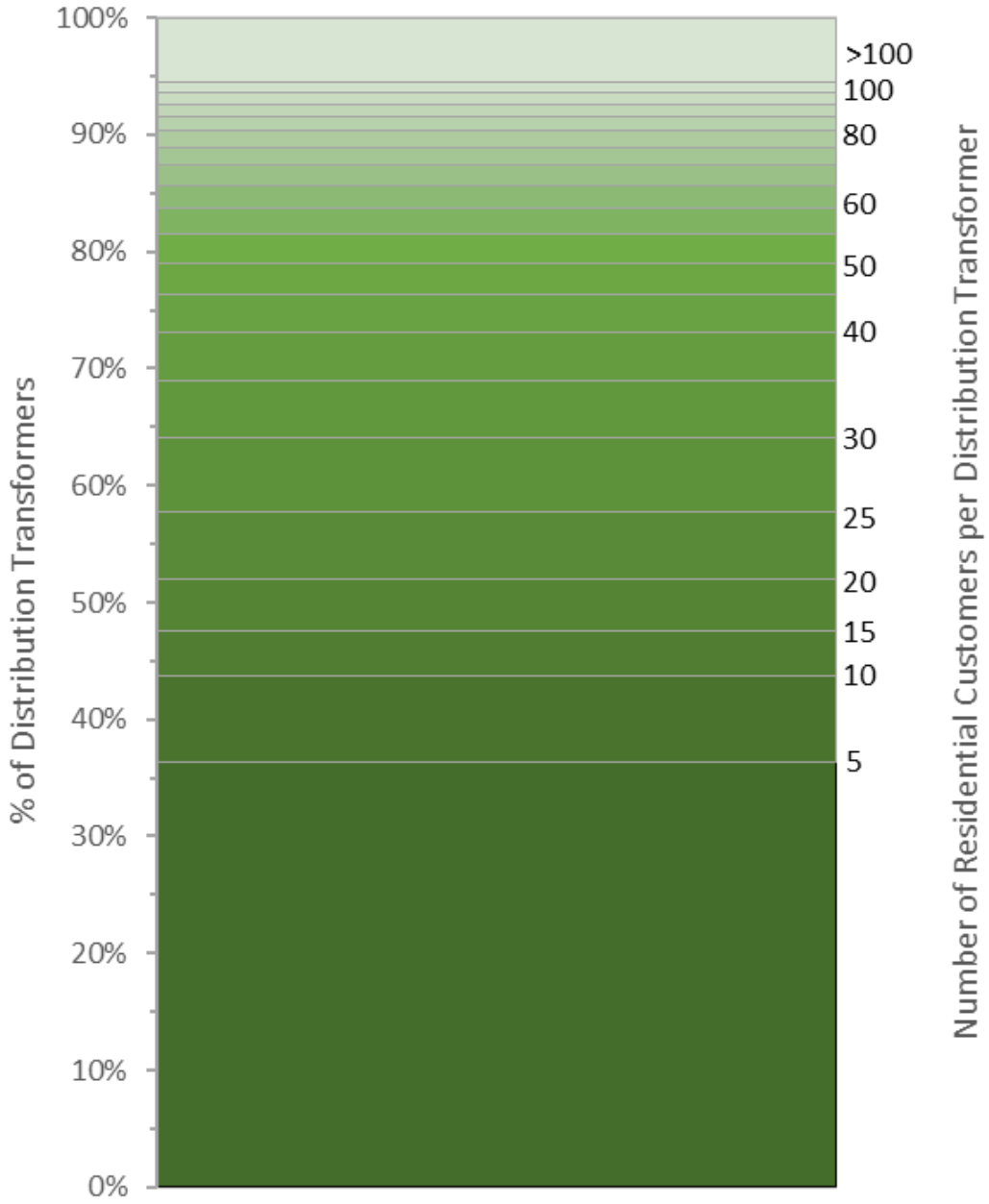
Project motivations

- Customer focus
  - Which segments of our customer base are driving EVs?
  - How is this likely to change over time?
- Why EVs?
  - Large energy users
  - Rapid rate of uptake
  - Localised clustering may trigger infrastructure upgrades

Why location matters

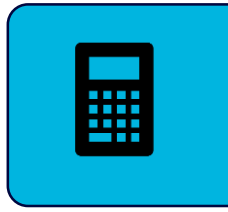
- Vector's EV trial demonstrated that due to diversity effects, impacts on infrastructure servicing a large number of households will be lower than anticipated
- At fewer numbers of households, the likelihood of a high % of customers charging concurrently increases
- Our scenario model predicts a 2032 EV demand of:
  - 0.5MW in Otahuhu
  - 1.8MW in Remuera



Data sources

- Survey of Auckland customers
  - Do you have an EV?
  - When did you purchase your EV?
  - Etc
- Auckland weather data
  - HDD calculated from temperatures
- Electricity smart meter data
  - Half-hourly resolution
  - Provided under DDA agreement by retailers and metering companies

Smart meter feature engineering



ICP: 00SD...NU

Row number	Date	Trading Period	kWh
1	20210101	1	0.12
2	20210101	2	0.11
3	20210101	3	0.08
4	20210101	4	0.09
...	...	...	...
...	...	...	...
...	...	...	...
17519	20211231	47	0.29
17520	20211231	48	0.26

17,520*3 = 52,560 data points

ICP	Feature1	Feature2	...	Feature149	Feature150
00SD...NU	0.32	123	...	42	0.42

150 data points

- Uses domain knowledge to extract high-level 'features' of the data
  - Statistical
  - Temporal
  - Ratios
  - 'Jumps' in demand
- Reduces dimensionality
  - Improves model accuracy
  - Increases speed of model training

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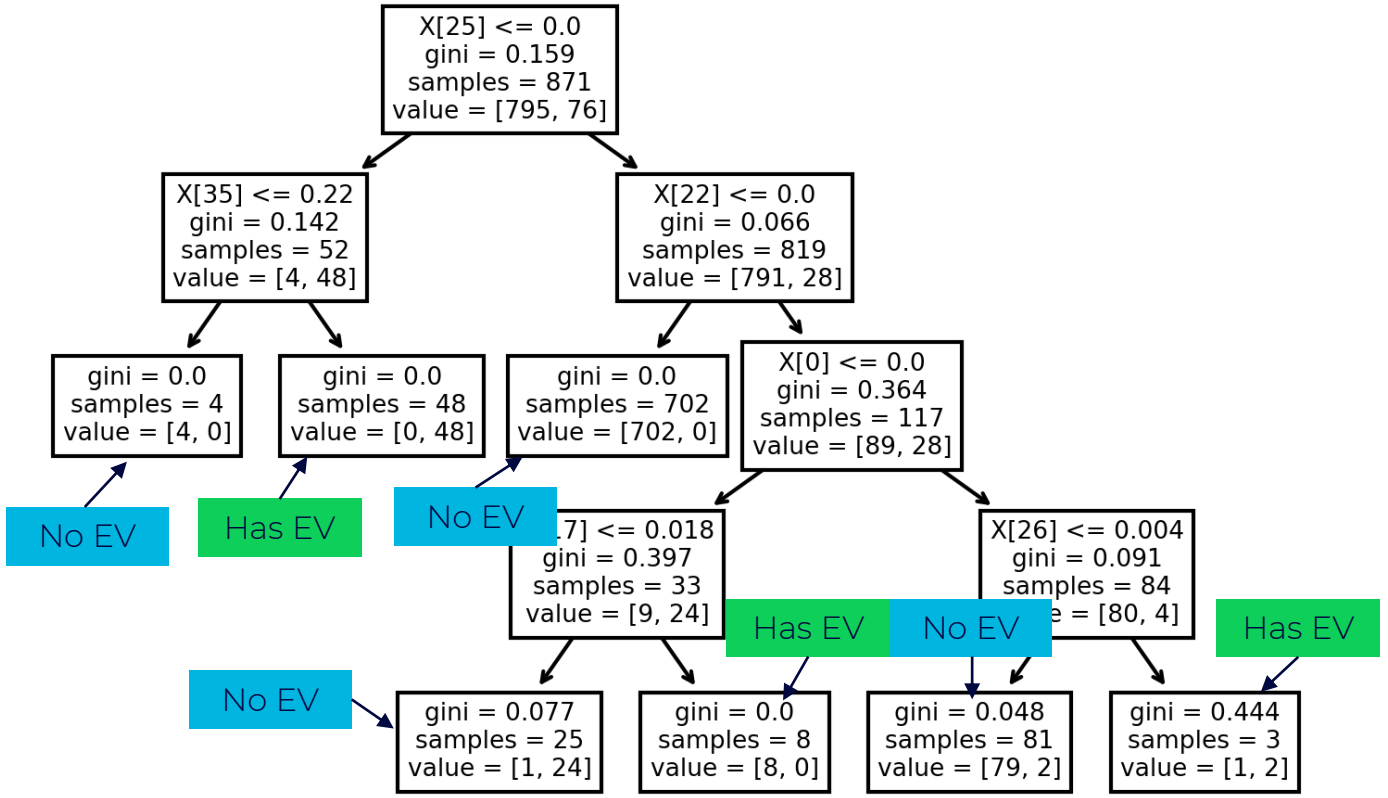
XGBoost algorithm: background

Fundamental architecture based on **decision trees**

- Decision trees categorise using binary logic on variables
- Made up of nodes and branches
  - Root node at the top
  - Leaf nodes at edges (final classification)
  - Internal nodes in between
- Nodes determined based on lowest gini index at each split



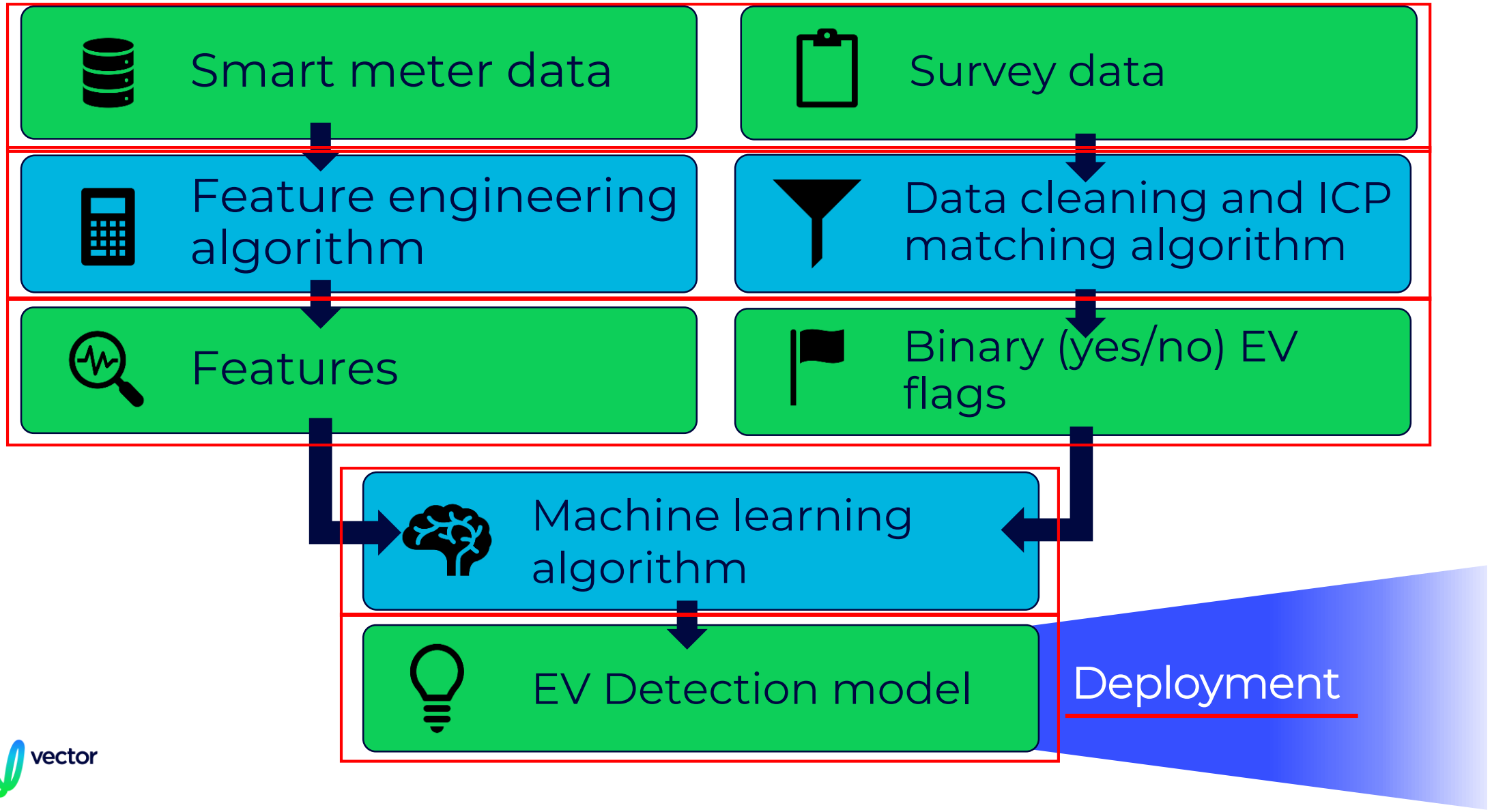
Decision tree for determining the presence or absence of EVs

Model accuracies

- Initial results with EV trial data (fast chargers) showed very high performance
- Detecting ‘trickle charging’ still performed well when using one full year of smart meter data, however performance deteriorated rapidly when features calculated using less data

	All chargers		Fast only	
	Precision	Recall	Precision	Recall
One month	0.55	0.62	0.69	0.77
Three months	0.63	0.5	0.71	0.83
Six months	0.65	0.5	0.75	0.83
One year	0.87	0.81	0.91	0.96

EV detection process



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