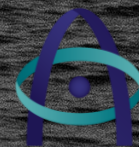


How to avoid a black-out





European

Green Deal

A climate-neutral continent by 2050

The Brussels Times

**Kraainem and Zaventem suffer
two-hour long blackout**

Friday, 2 September 2022

**Thousands of solar panels in
Flanders cut out on sunny days
due to overvoltage**

Monday, 11 October 2021

The Brussels Times

**Fluvius to invest €4 billion into
preparing grid for green
transition**

Wednesday, 8 June 2022





Replace **40%** of the low-voltage grid
or **30 000 km** of underground cable

How to do so efficiently?



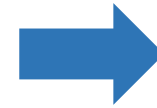
Grid layout



Electricity consumption
profiles



Statistical power
flow engine

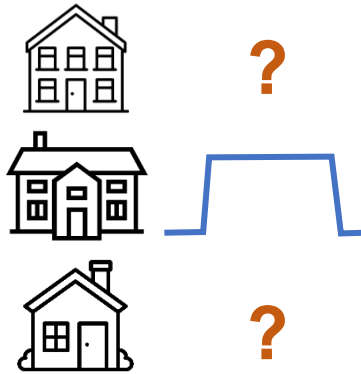


Grid operation
statistics

Simulation enables 'smart' reinforcement planning ...



Grid layout



Electricity consumption
profiles



Statistical power
flow engine



Grid operation
statistics

Simulation enables 'smart' reinforcement planning ...

But consumption profiles are **unavailable** for most households

Given



household
metadata

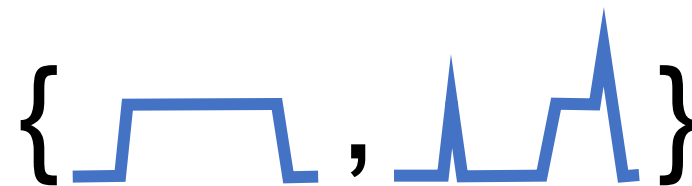


day info



weather

generate



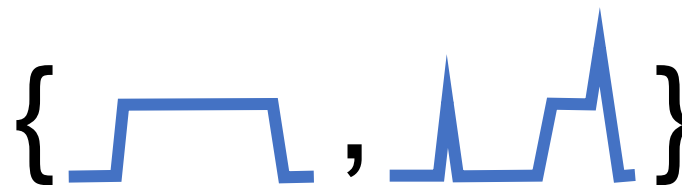
plausible electricity
consumption time-series

Given



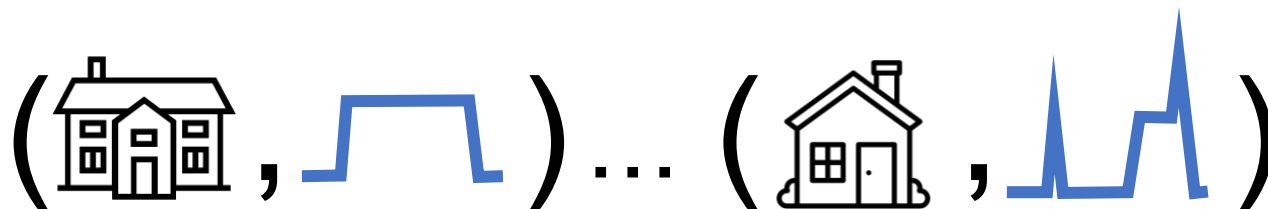
household
metadata

generate



plausible electricity
consumption time-series

Using

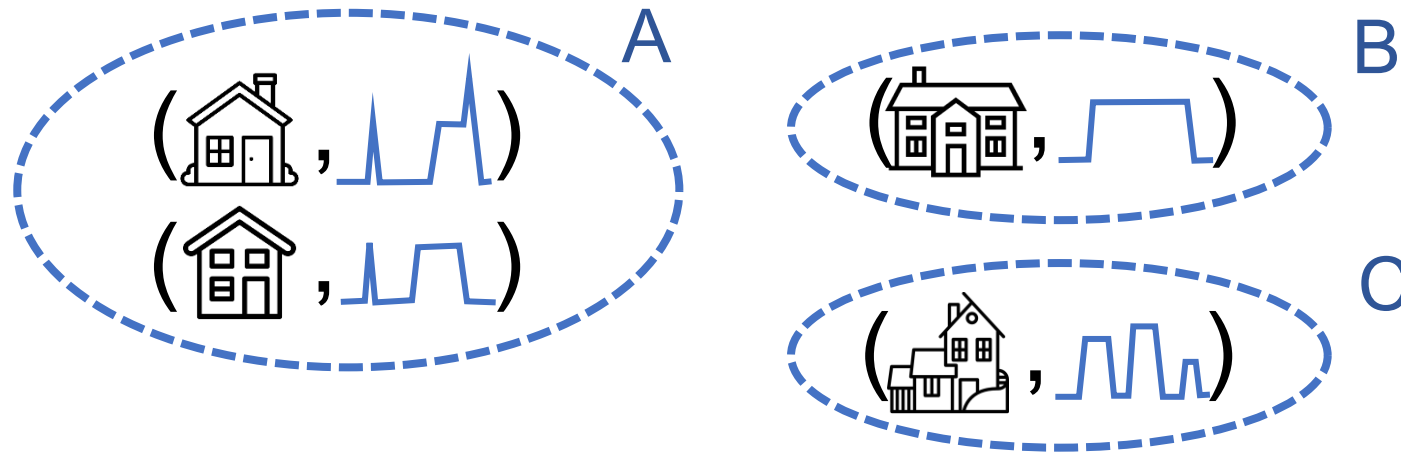





available metadata-consumption pairs

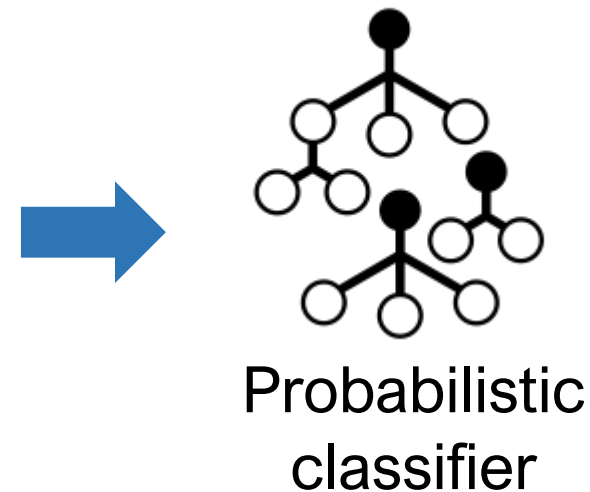
Cluster households based on consumption



Cluster households based on consumption
Learn a classifier to predict the cluster from metadata

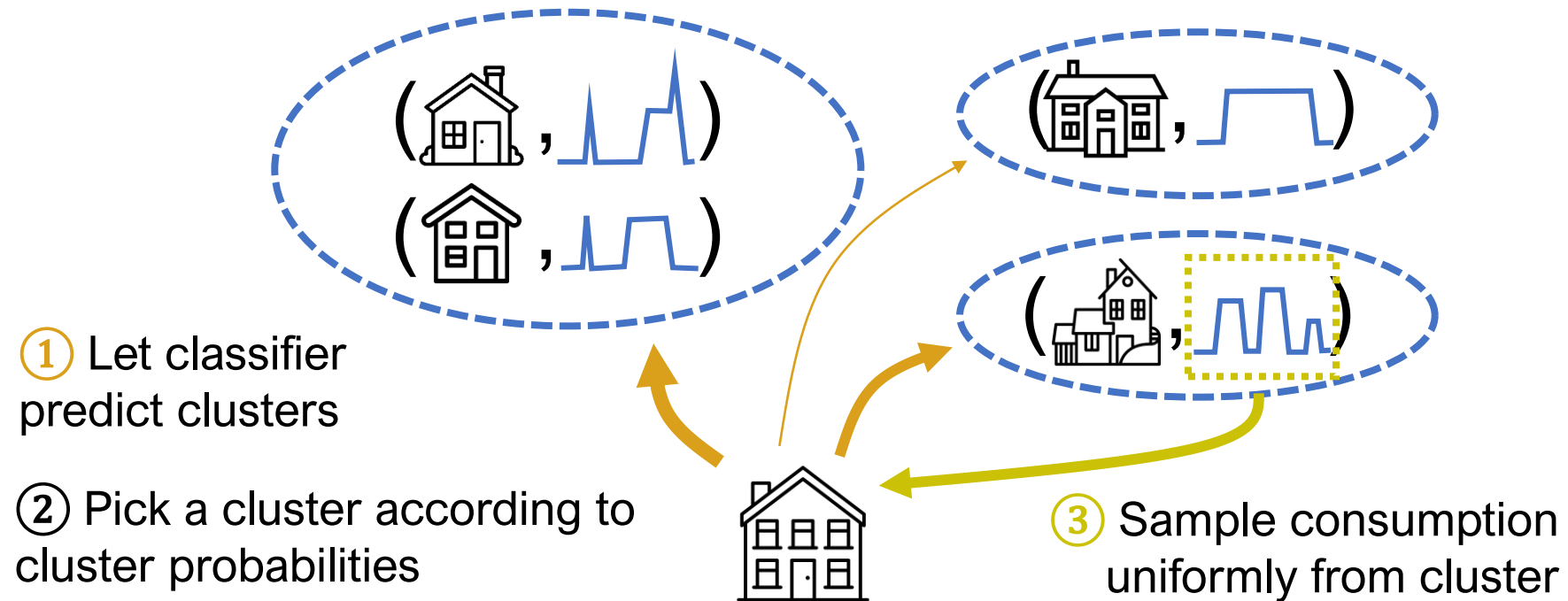


Input	Output
	A
	B
	C



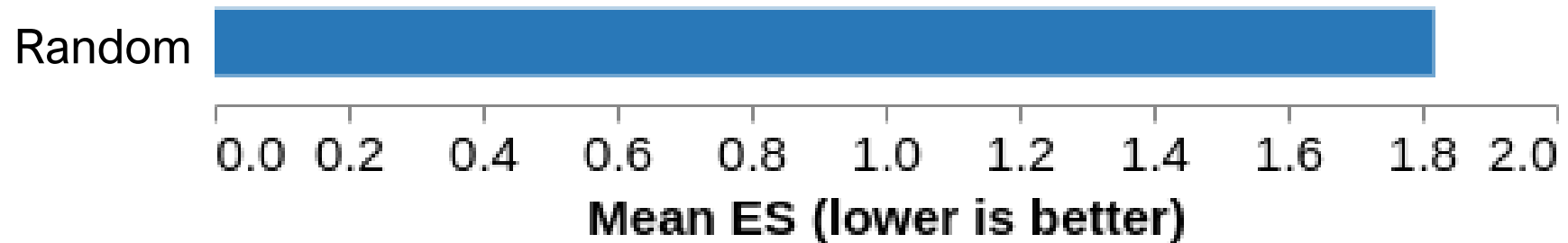
Cluster households based on consumption

Learn a classifier to predict the cluster from metadata




Classifier **learns** to associate metadata with consumption

On average, consumption clustering generates the best scenarios



For more details, experiments and background


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Scenario generation of residential electricity consumption through sampling of historical data



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Energy score

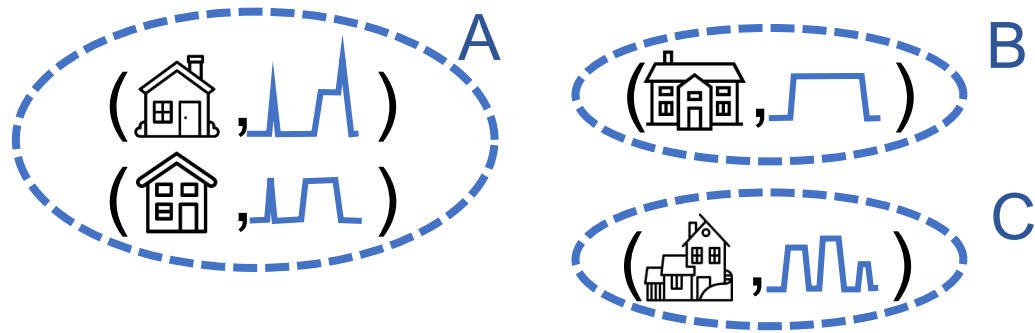
ABSTRACT

The low-voltage grid (LVG) needs to be reinforced to handle the increased load due to the transition towards renewable energy. Doing this optimally requires knowledge of typical currents and voltages throughout the grid, which are unknown. They can be calculated from the grid layout and electricity consumption time series of each consumer, but for many consumers this time series is unknown. To alleviate this problem, we have developed two techniques to generate accurate and realistic daylong electricity consumption time series (scenarios) for a given consumer. Both techniques generate scenarios by sampling from historical consumption measurements of a limited set of consumers, considering available information about consumers (e.g., total yearly consumption) and days (e.g., weather). The first technique uses expert knowledge to define this sampling procedure, whereas the second learns it automatically using machine learning. The quality of the generated scenarios is evaluated by estimating how well the distributions of predicted and observed time series match, conditional on the available information. The data-driven technique performs better than the expert-based technique and, contrary to the latter, can easily be applied to datasets with different attributes (e.g., total yearly consumption, daylong load). Both techniques generate scenarios for each day of the

Goal: train trees to predict timeseries

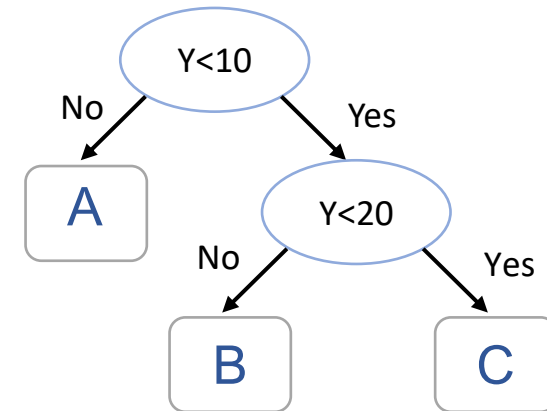
But we take a detour...

Cluster the time series



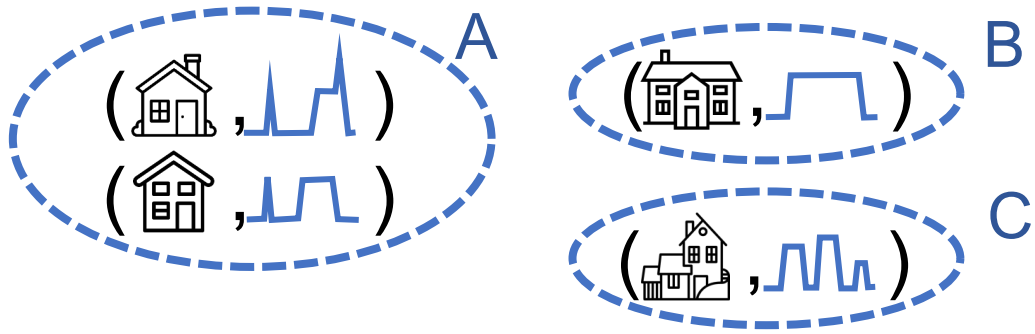
⚠ Ignores the metadata

Predict clusters from metadata

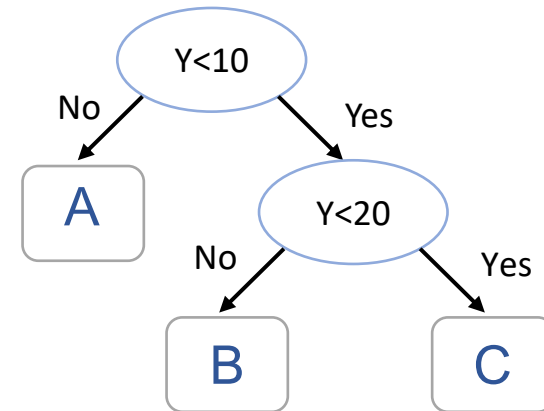


⚠ Ignores the time series

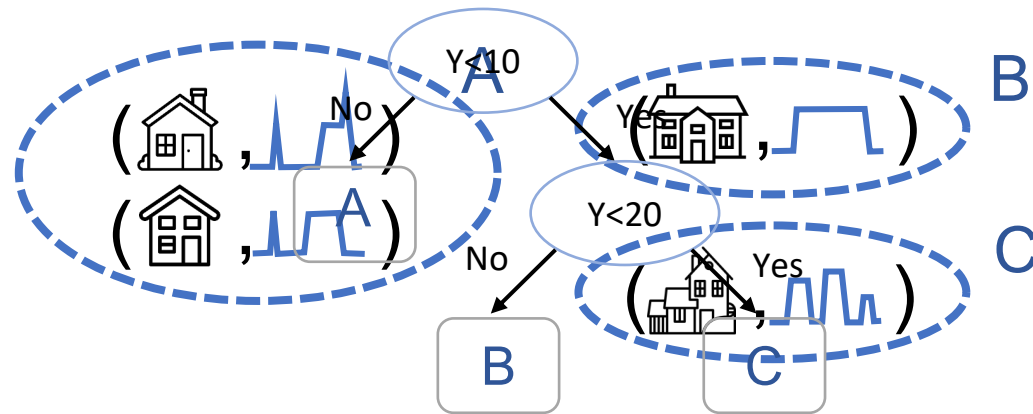
Clustering



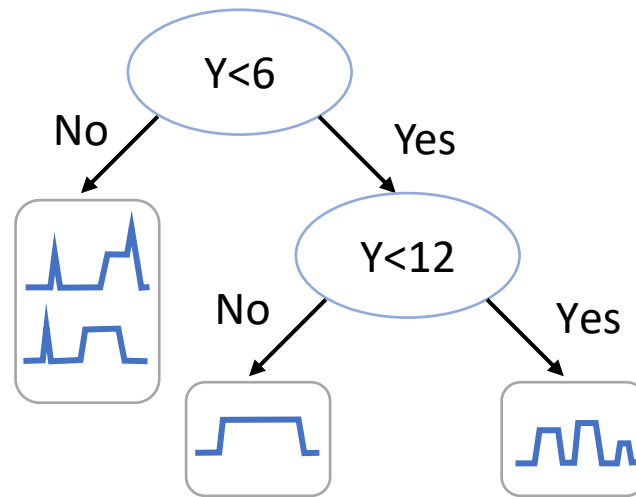
Classification



Clustering + Classification

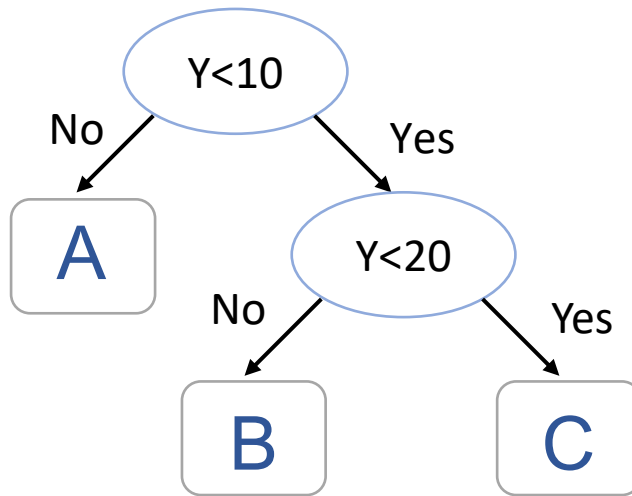


Clustering + Classification =
Predictive clustering

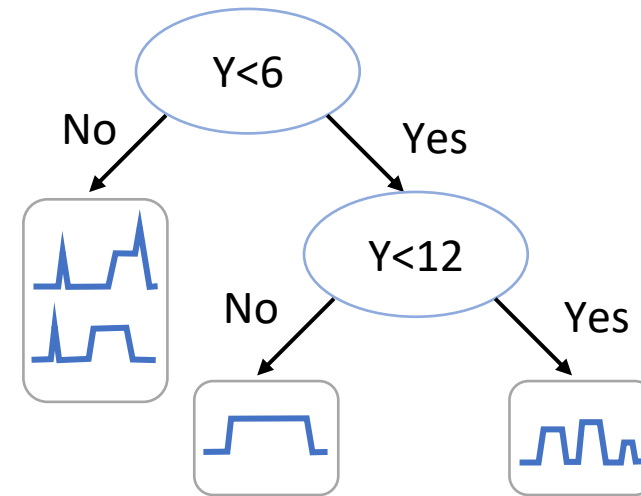


Predictive clustering integrates classification and clustering

Instead of learning
a **classification** tree



Learn a tree that **splits on metadata**
to **reduce variance between TS's**

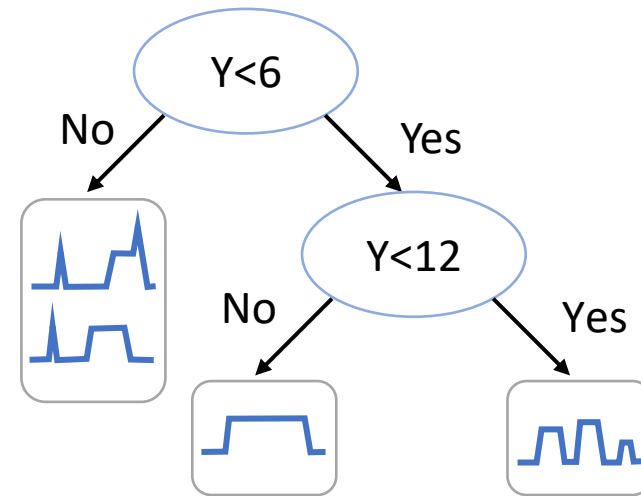


Predictive clustering integrates classification and clustering

$$var(node) = \frac{1}{|node|} \sum_{ts \in node} distance(\overline{node}, t)$$

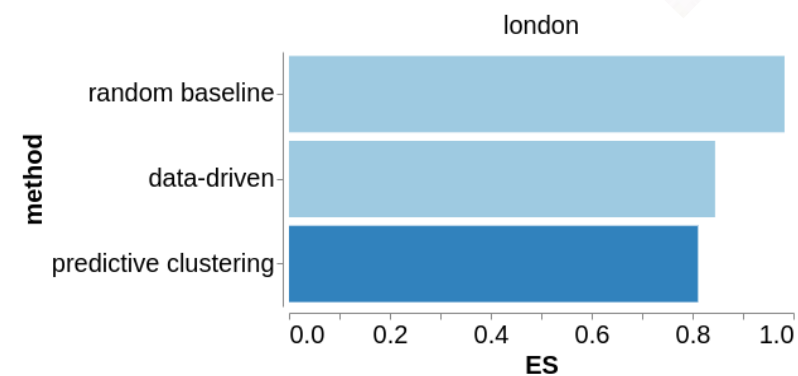
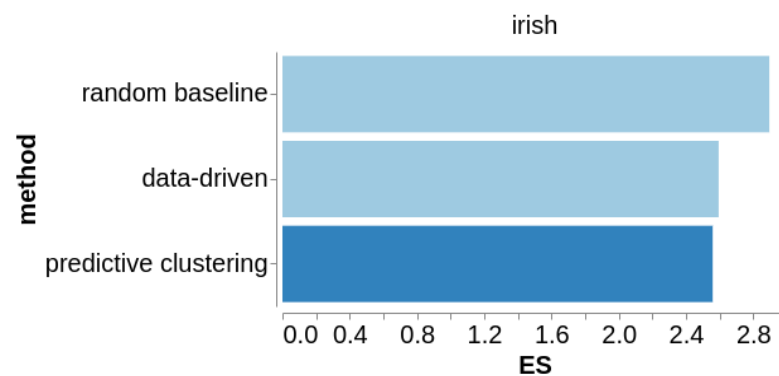
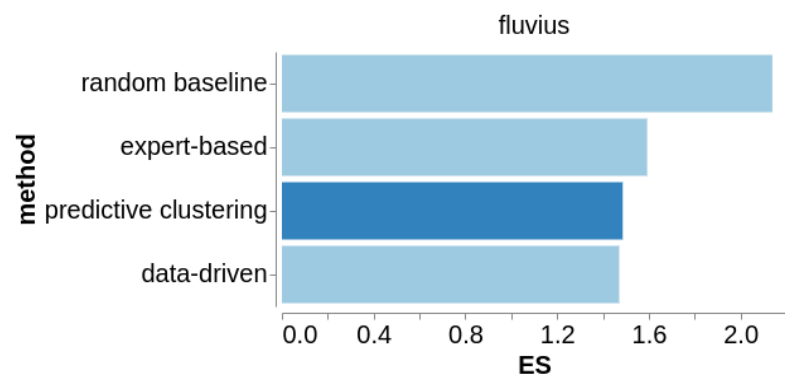
$$\begin{aligned} improvement = var(parent) \\ - \frac{|child_1|}{|parent|} var(child_1) \\ - \frac{|child_2|}{|parent|} var(child_2) \end{aligned}$$

Learn a tree that **splits on metadata**
to **reduce variance between TS's**



A classification tree with a clustering objective function

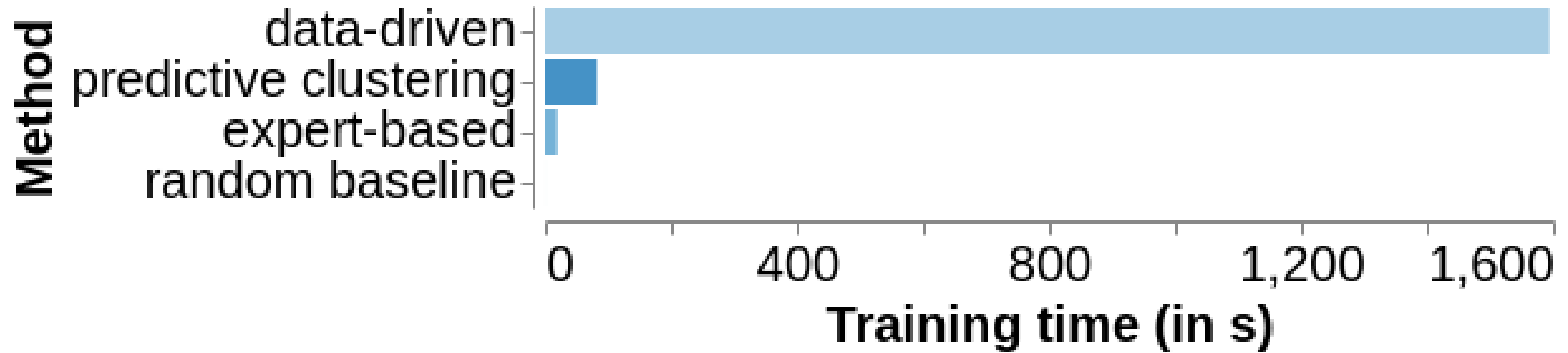
Predictive clustering is accurate



PRELIMINARY

Predictive clustering is fast

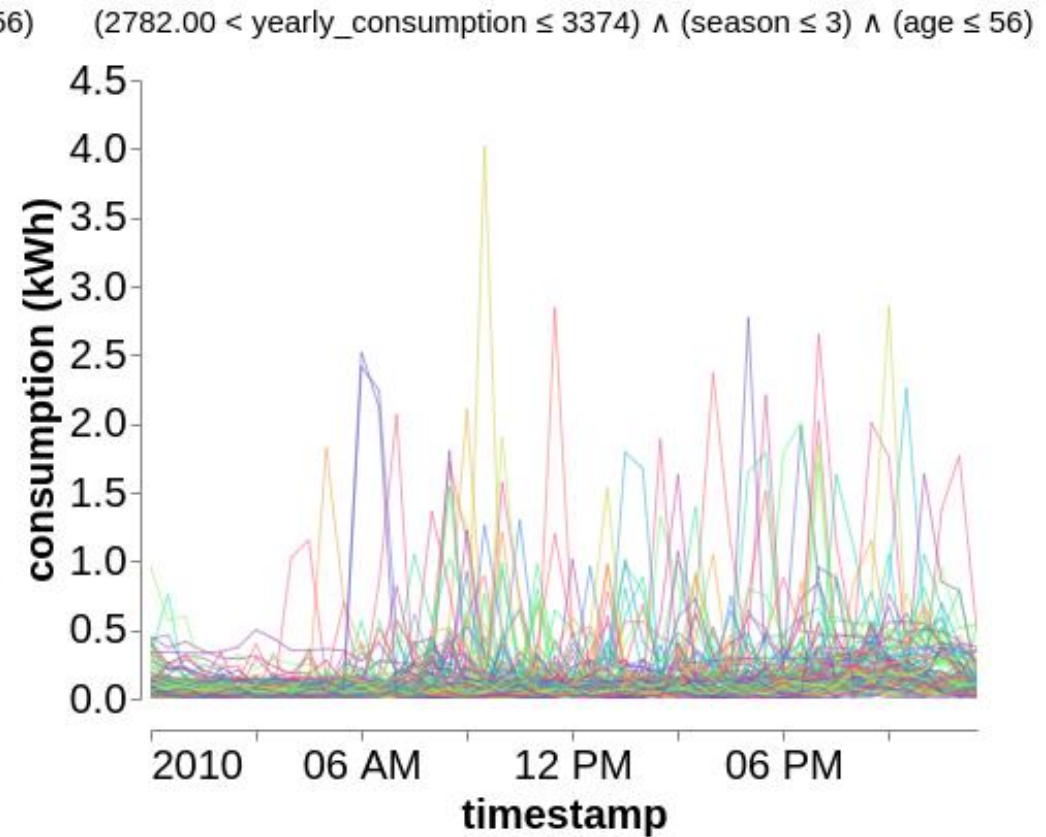
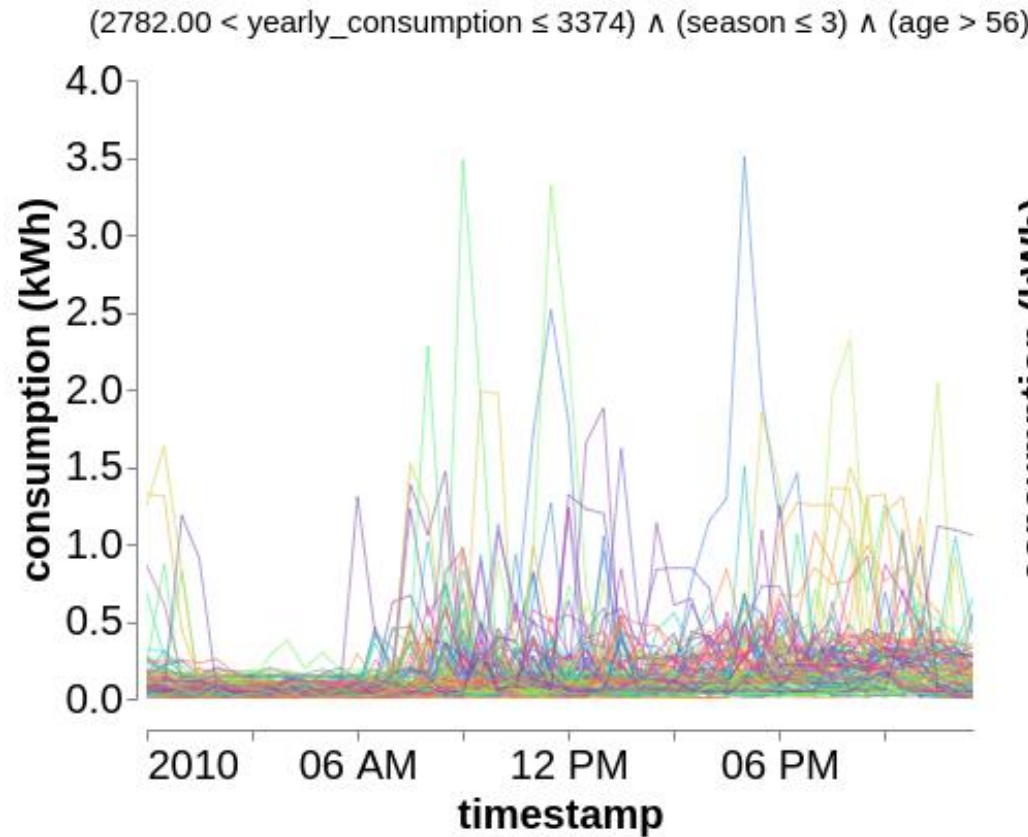
PRELIMINARY



Predictive clustering is interpretable

There is only a single tree, each leaf is defined by conditions on the input

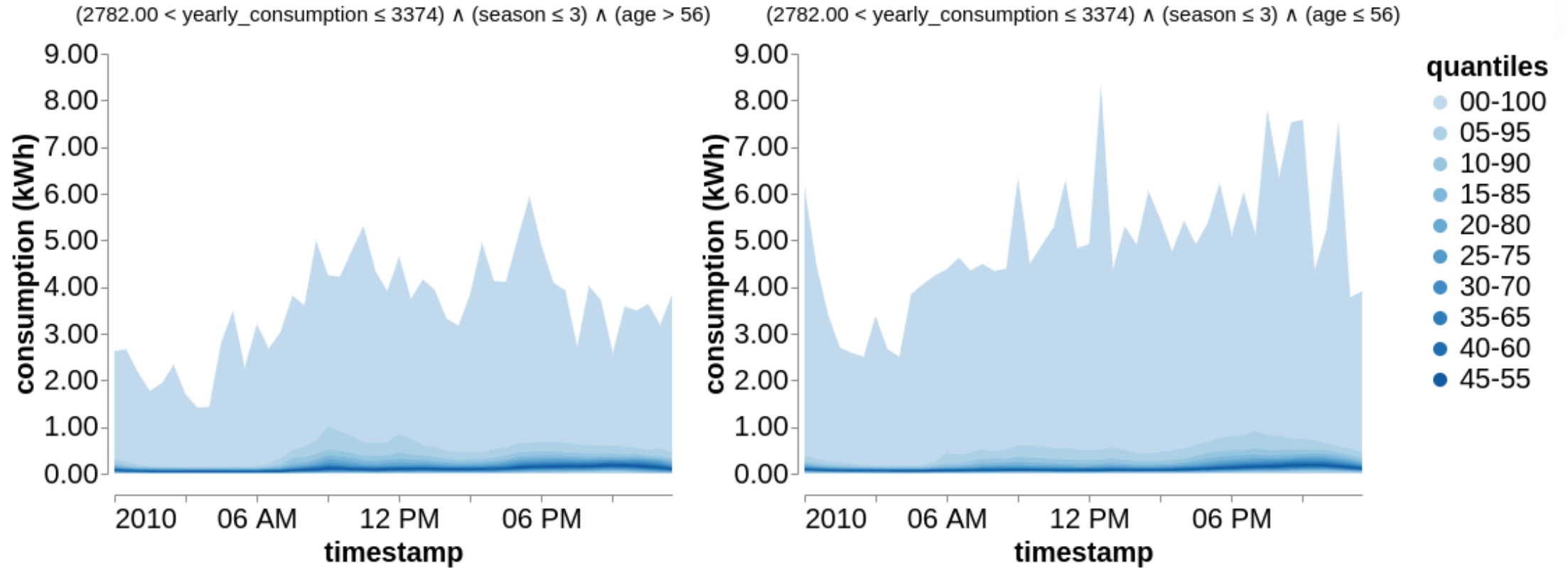
PRELIMINARY



Predictive clustering is interpreteable

There is only a single tree, each leaf is defined by conditions on the input

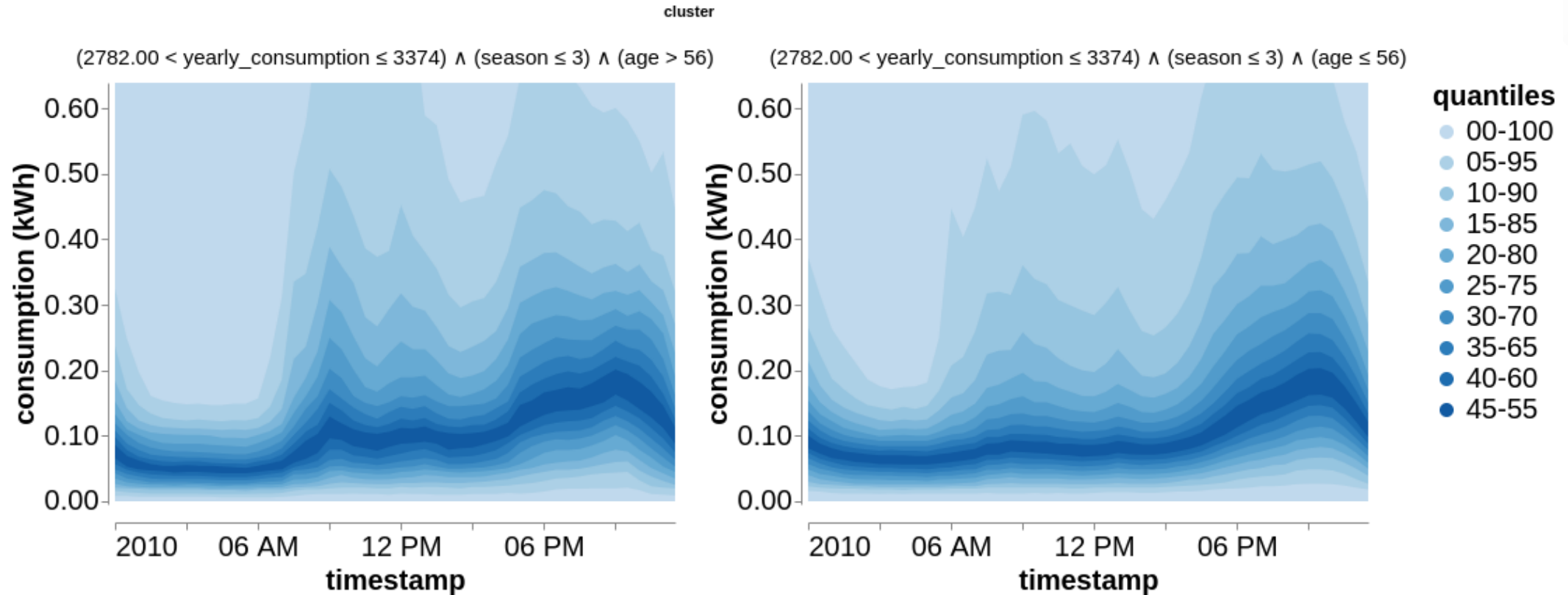
PRELIMINARY



Predictive clustering is interpretable

There is only a single tree, each leaf is defined by conditions on the input

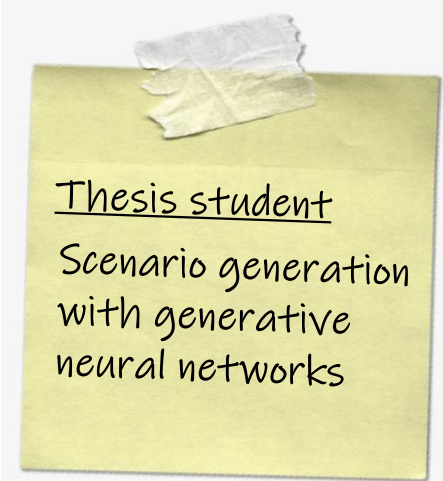
PRELIMINARY





Predictive clustering is

- **Accurate**
- **Fast**
- **Interpretable**



Thesis student
Scenario generation
with generative
neural networks