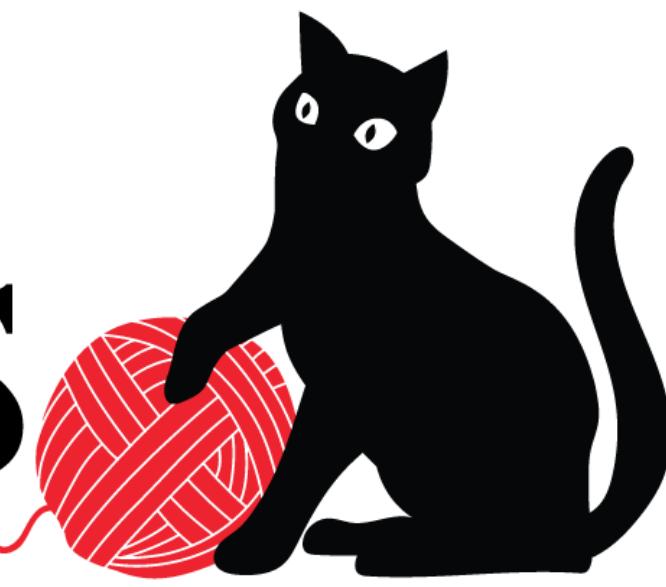


AutoTS and the M6



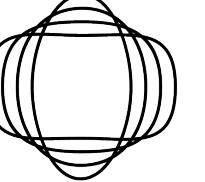
Winning the Investment Decision Category Overall

Colin Catlin, 2023

About Me

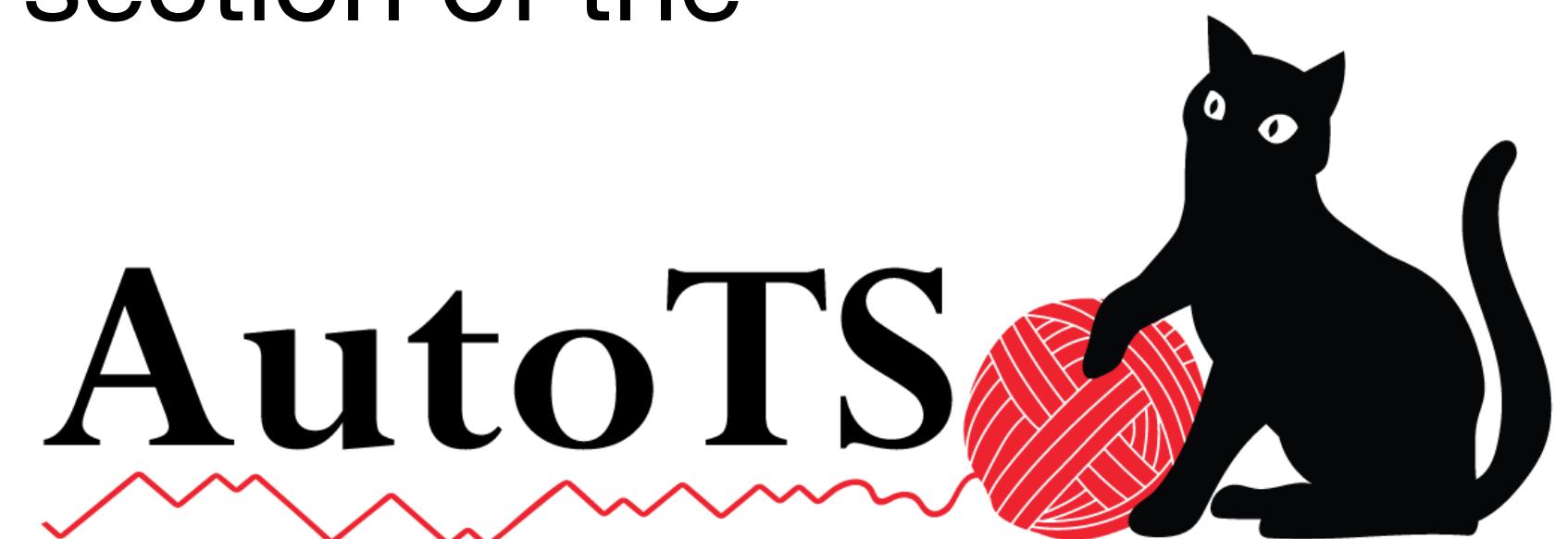
Colin Catlin



- Data Scientist, Cyclist/Runner, Globe-Traveling Digital Nomad, Gardener
- Minnesotan, U of M (BS Neuroscience, BA Classics-Latin, MS Data Science)
- Lead Data Scientist at  nousot
 - Nousot is a small consulting firm which would be quite happy to sell you all lots of forecasting engagements, or anything else you need
- Primary engagement has been app metric forecasting at Meta
- Sole author and developer of AutoTS

AutoTS: Automated Time Series Forecasting

- AutoTS is:
 - A collection of forecasting models
 - A collection of preprocessing and postprocessing data transformers
 - A method for evaluating and ensembling these together to create an optimal forecast
- There are many novel approaches in AutoTS and I don't have time to explain them all today. For all the things you don't get answered, feel free to contact me or post discussion questions on the Discussions section of the [winedarksea/AutoTS](#) GitHub page



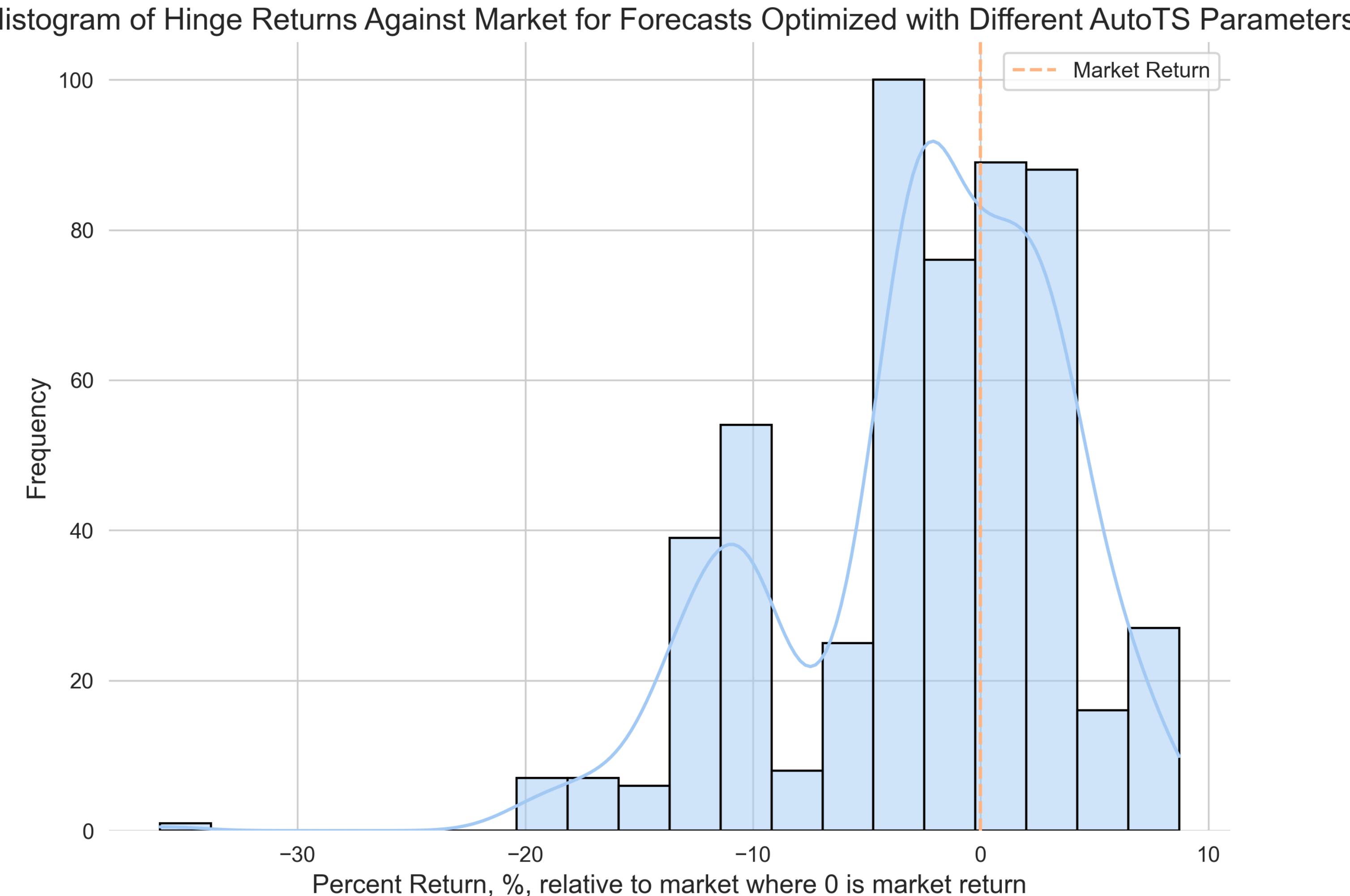
Applying AutoTS to the M6

Try to beat the stock market

- Collect data: 5 years of close prices at 4 week frequency
- Run AutoTS to generate a 1-step prediction for the close price 4 weeks away
- Take the point and upper/lower bound forecasts to generate competition outputs (ranks and decisions)
- The Challenges?
 - Tuning AutoTS to produce forecasts that best solve the business case
 - Trialing methods to best convert forecasts into the decisions

Importance of Tuning AutoTS

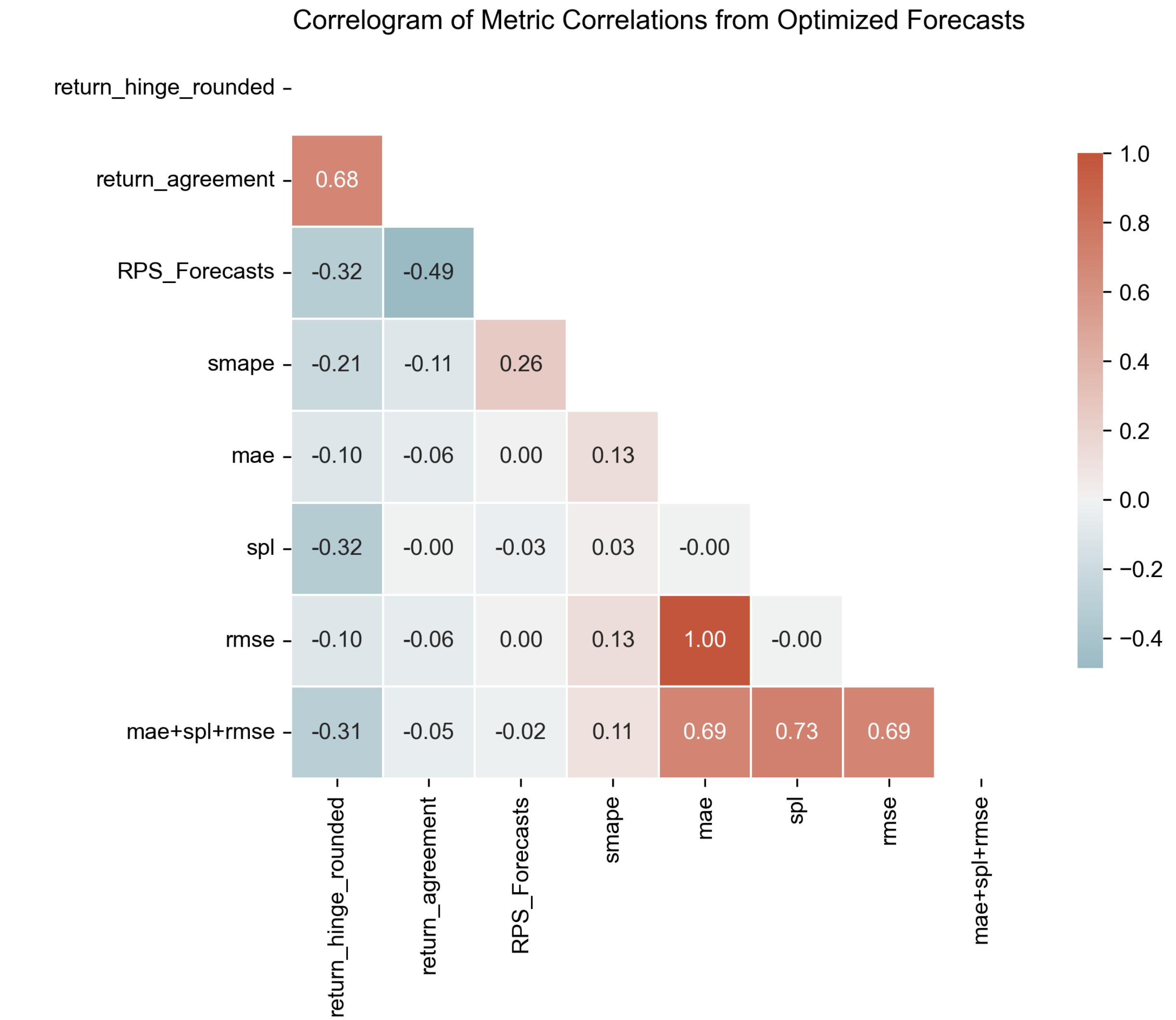
Most model selection criteria don't beat the market



Particularly Tuning of the Metric Weighting

How to choose models is more important than which models

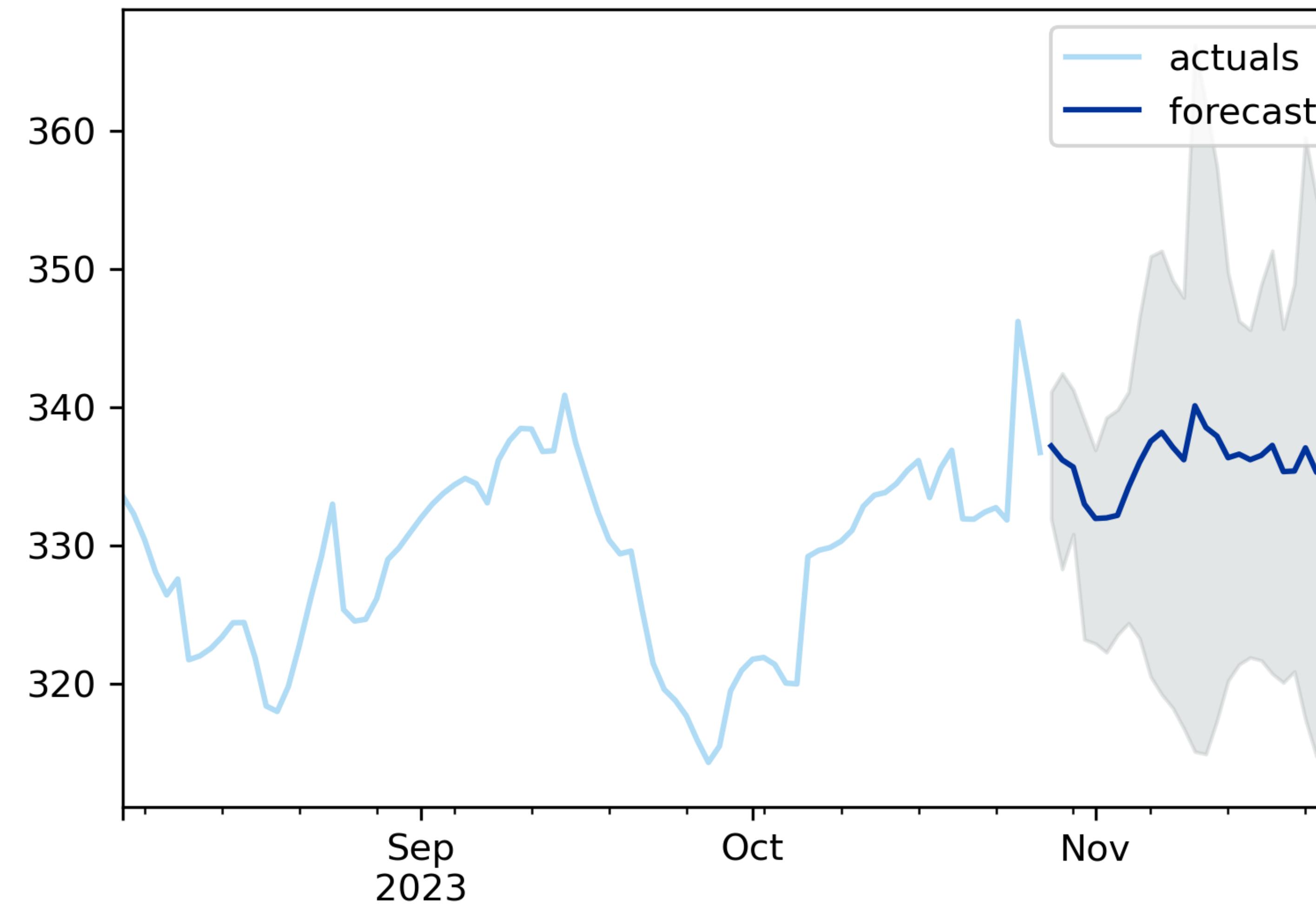
- Tuning mostly focuses on which collection of AutoTS metrics to select forecasts on during internal cross validations results
- An external cross validation was performed to evaluate many different AutoTS params and see which led to best performance on the market



Example AutoTS Forecast

Showing daily stock price predictions as output from AutoTS

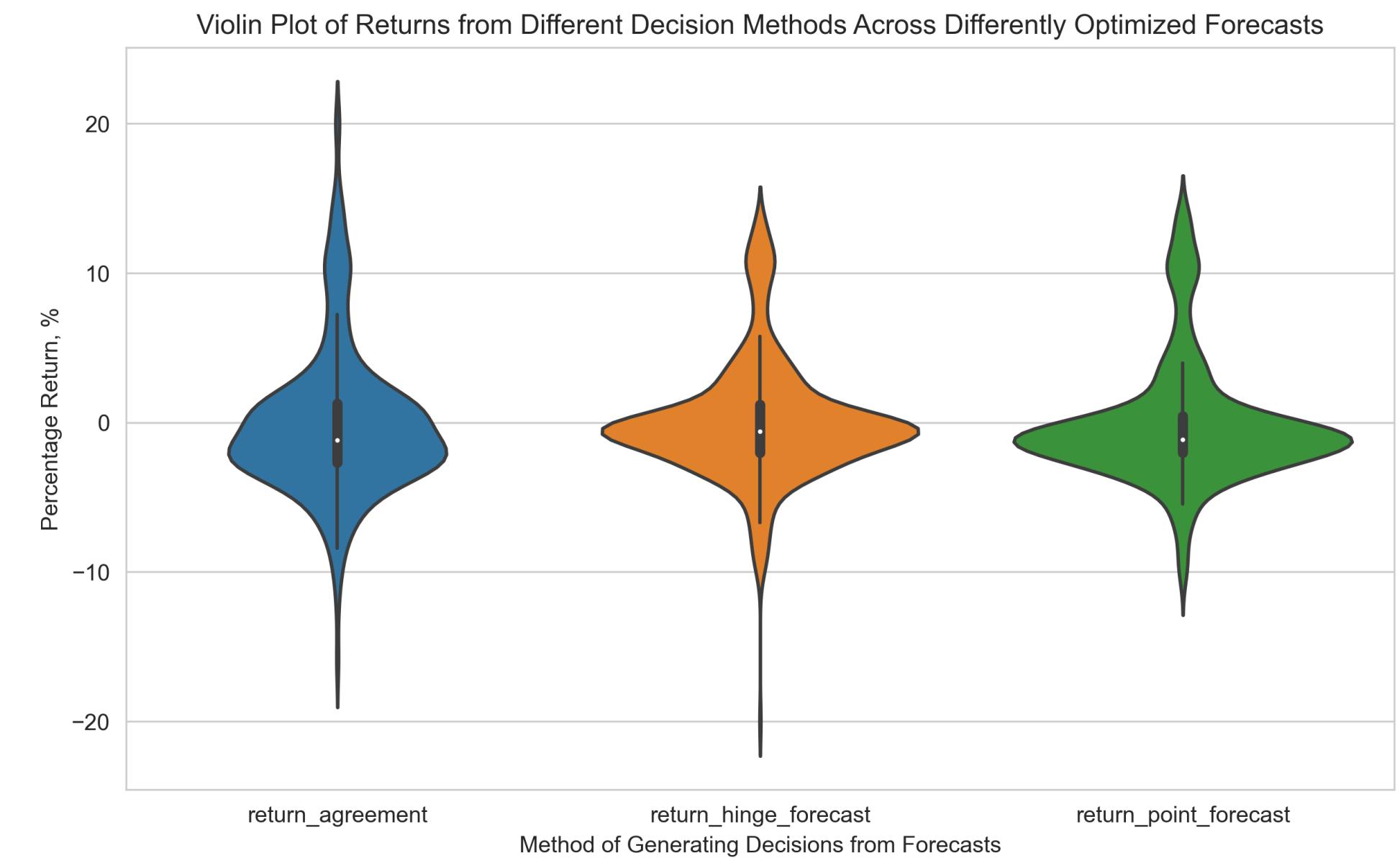
msft_high with model UnivariateMotif



Forecasts to Decisions

Turning probabilistic time series into simple decisions

- Various methods were tried for utilizing probabilistic/uncertainty bounds to try and indirectly incorporate some idea of risk into the investment decisions.
- Final method was fairly simple, to:
 - Take the hinge, the average of the lower and upper 90% forecasts as the final predicted price
 - Convert price into a percentage return
 - Normalize all the predicted percentage returns across the market to an absolute sum of 1, to use as the investment allocation for the competition



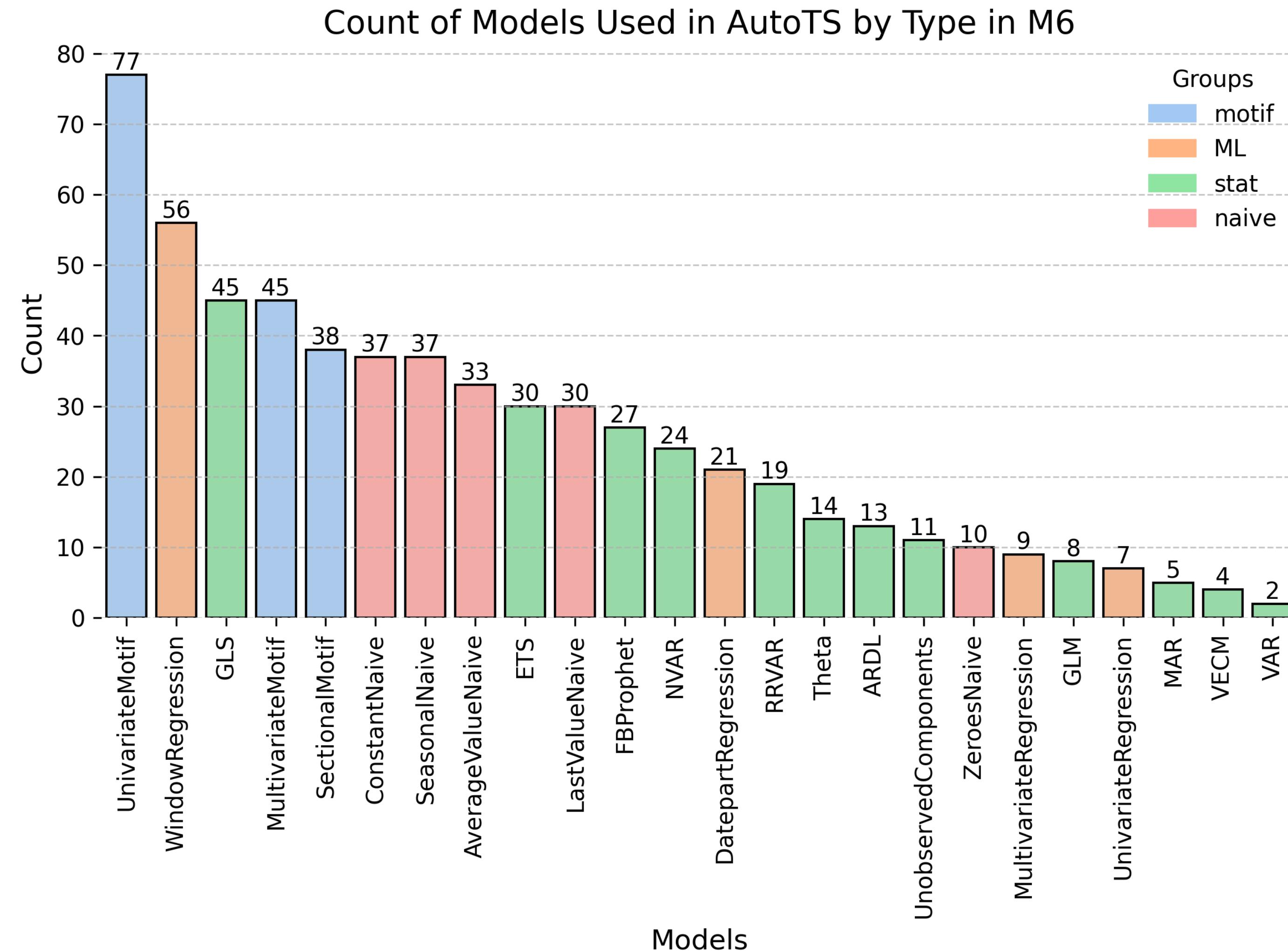
AutoTS Learns and Evolves

Artificial intelligence

- The parameter search space of AutoTS is too vast to search in a reasonable period of time, especially not the 48 hours of each submission deadline.
- Start with known good models to speed things up. Initially this was non-market optimized models, then for later submissions the starting template was the best models from the previous submissions.
- Accordingly each time there is a submission, run a search starting from this starting template but then searching beyond this, limited by the available time.
- This search allows AutoTS to adopt to changing market conditions, not strictly bound to a single rigid model, but still rooted in the past models.

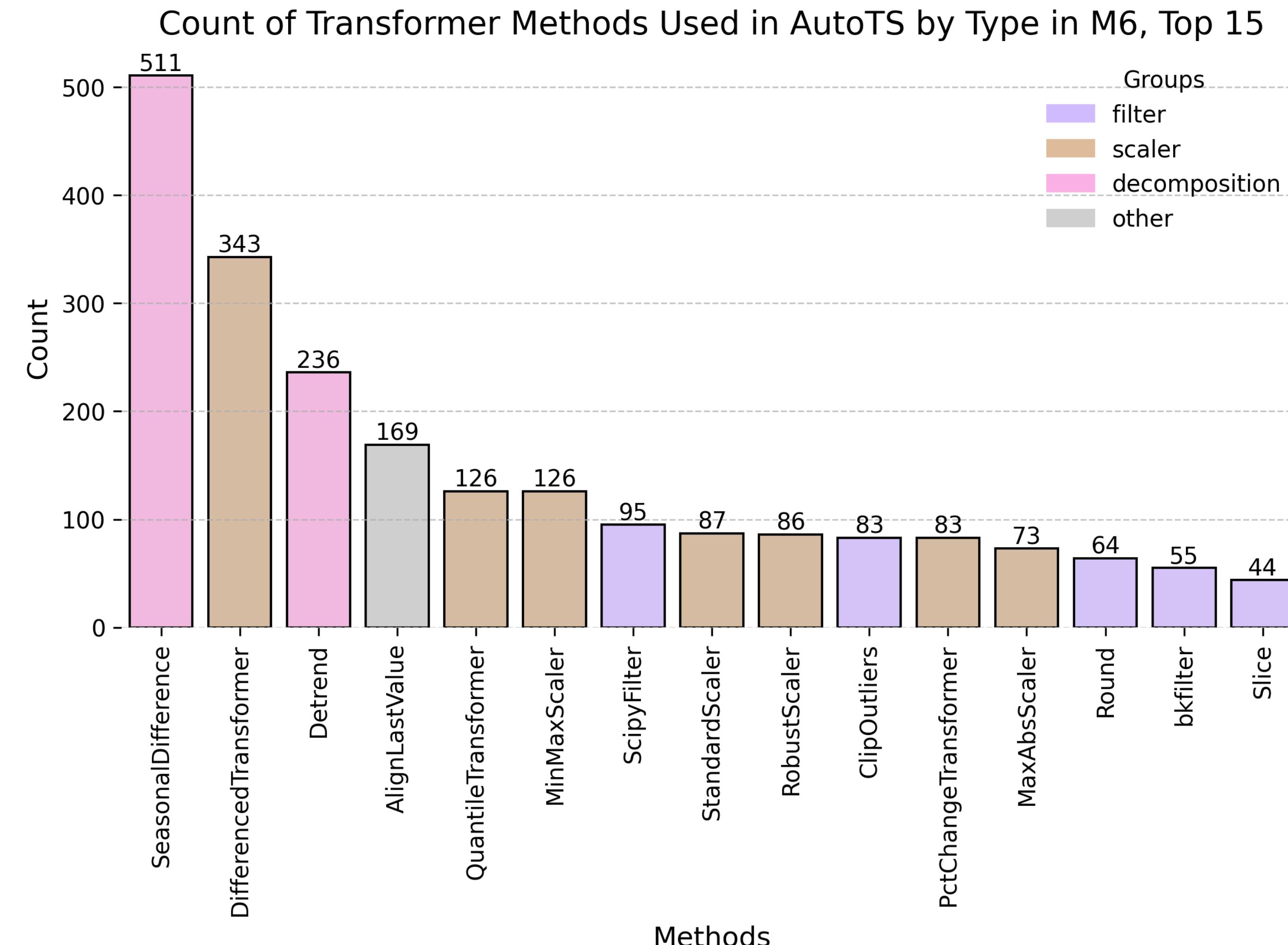
The Models

So what did the actual predictions? A bit of everything.



The Transformers

Lots of differencing was used to help the models



Questions?



Appendix

Chosen Hyperparameters for M6 Jan 2023

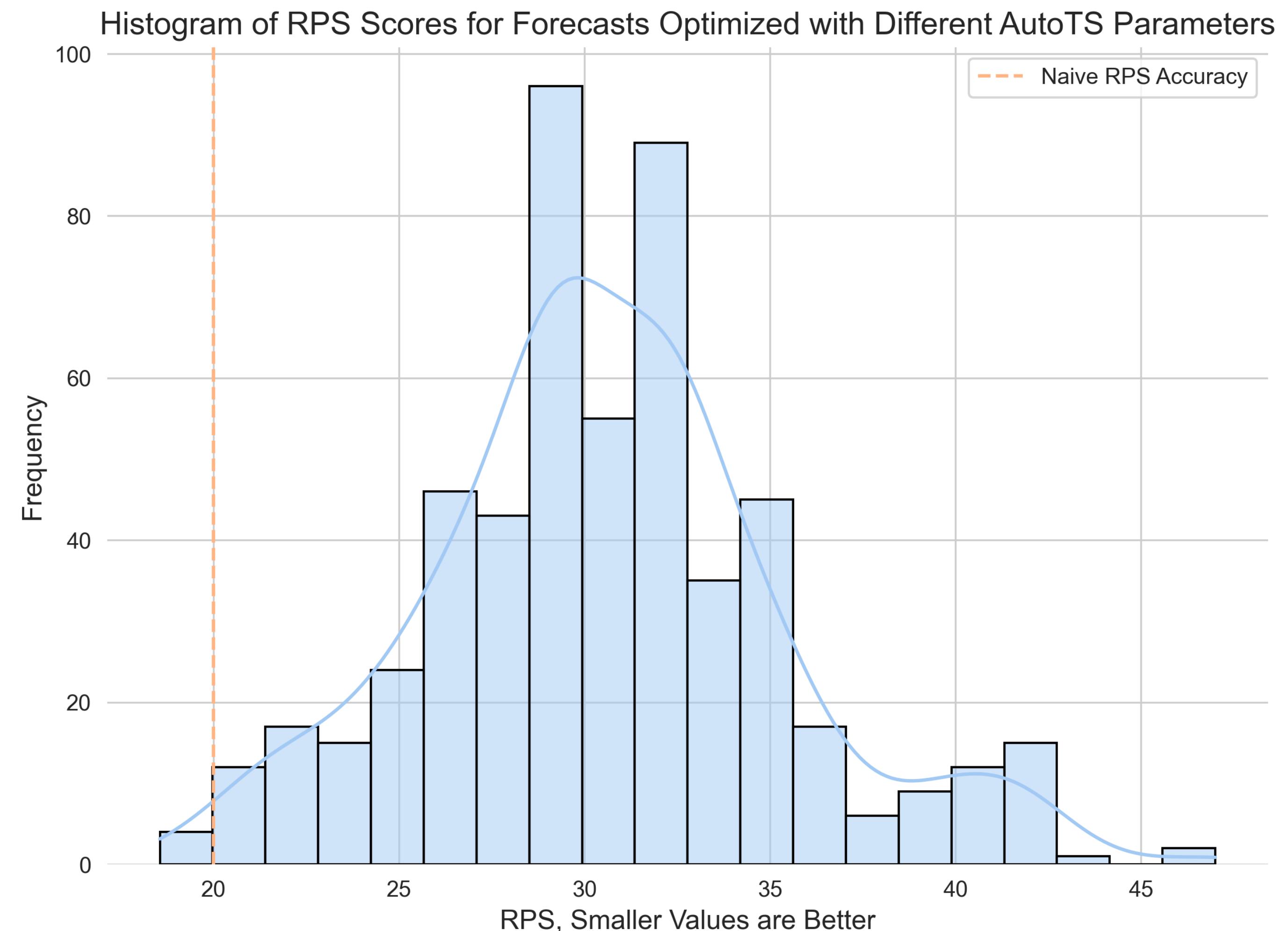
As an example, not the definite parameters for everything

```
metric_weighting = {  
    'smape_weighting': 1,  
    'mae_weighting': 3,  
    'rmse_weighting': 3,  
    'mle_weighting': 1,  
    'spl_weighting': 5,  
    'runtime_weighting': 0.05,  
    'dwae_weighting': 1,  
}
```

```
model_list = "fast_parallel"  
transformer_list = "fast"  
transformer_max_depth = 4  
models_mode = "random"  
num_validations = 2  
validation_method = "backwards"  
max_generations = 100  
models_to_validate = 0.15  
ensemble = None
```

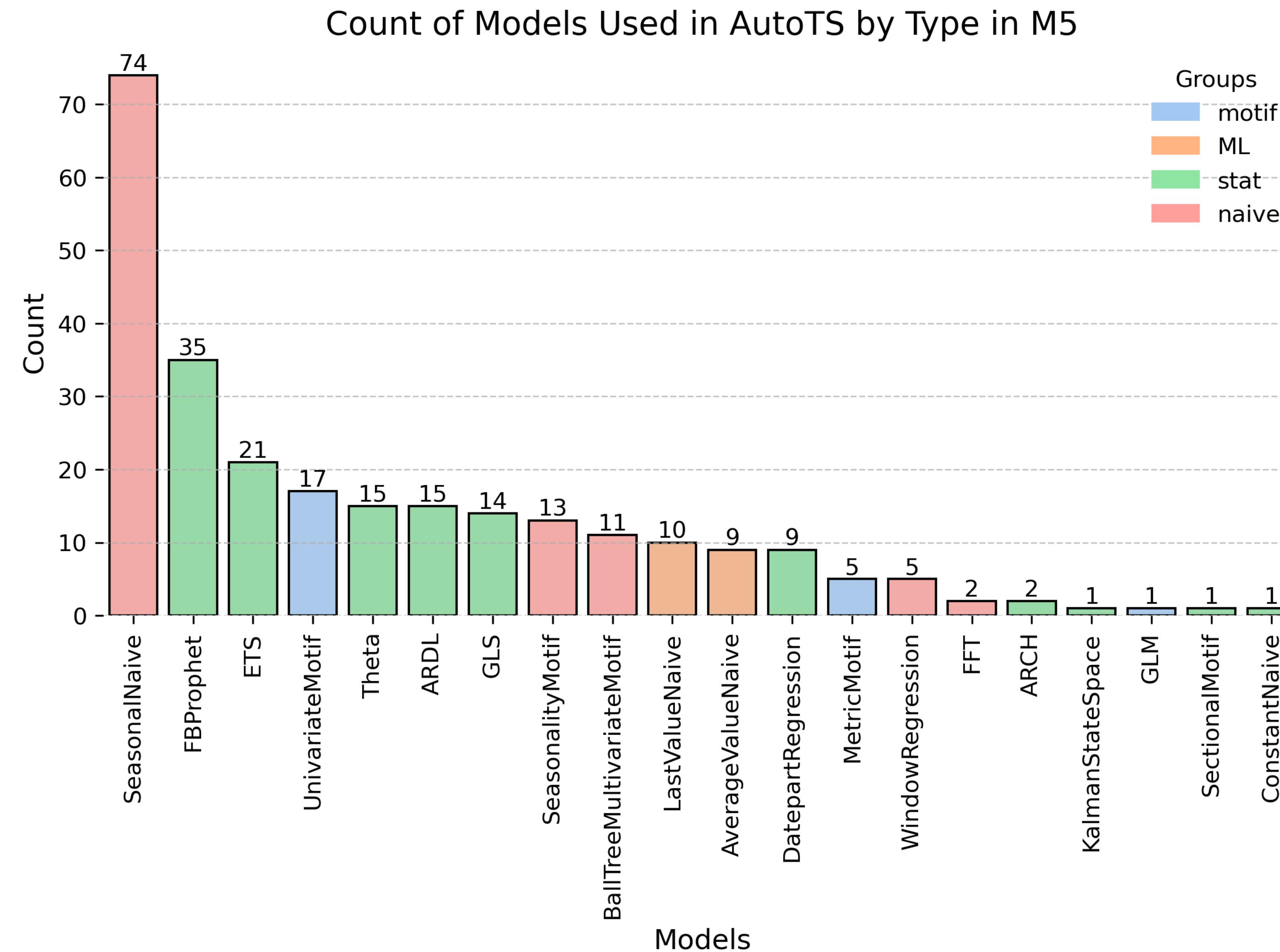
Beating the Market but not RPS

- Ranking doesn't make sense on highly correlated items, most stocks follow the market most of the time
- Differences in rankings will not be tractable as they will occur from tiny pieces of information that the model won't have and can't predict (mood of CEO in earnings call, etc.)
- Need to predict *all* stocks with *high* precision to make good rankings



Model Selection on M5 Dataset

Not actual M5 submissions, but a recent run for comparison



Transformer Selection on M5 Dataset

Not actual M5 submissions, but a recent run for comparison

