MULTI-TASK INTER-TURBINE POWER PREDICTION

Simon Brealy, CEng, Final year PhD

Authors: S. M. Brealy, L. A. Bull, P. Beltrando, A. Sommer, N. Dervilis, K. Worden

BACKGROUND

- UK target to quadruple offshore wind capacity by 2030
- Operations and maintenance are 40% of wind farm costs[1]
- This motivates the efficient use of data for monitoring

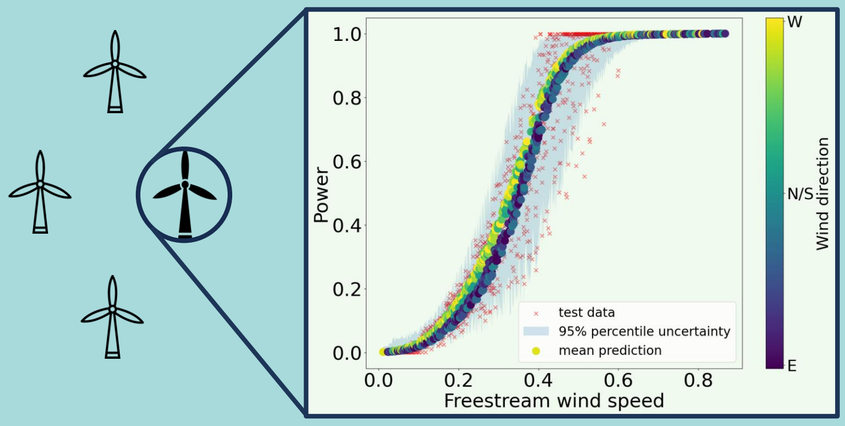
KNOWLEDGE GAP

- Limited "damage" data and environmental variability hinder robust model development[2]
- Novel probabilistic machine learning approaches may provide a solution, leading to lower consumer bills

METHOD

Step 1

A probabilistic model was developed to predict turbine power using wind farm data, that adjusts for wind-direction

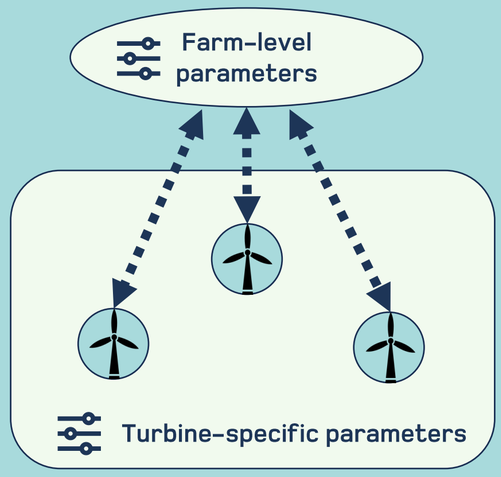


Step 2

This is used to learn turbine-specific parameters, allowing for differences in turbine behaviour

Simultaneously, shared farm-level parameters are learnt, capturing similarities between turbines. This approach can be described as Multi-Task Learning (MTL)[3]

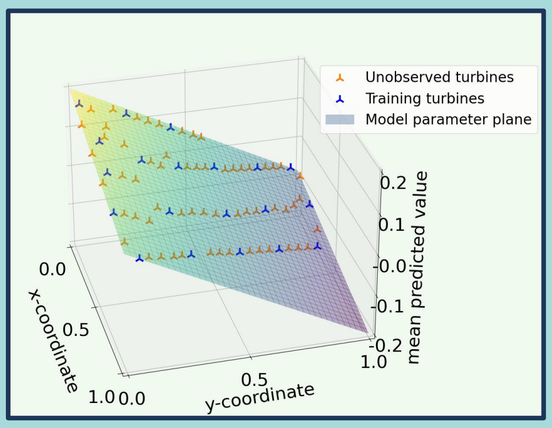
MTL enables the sharing of "statistical strength" and the capture of spatial patterns, allowing one to predict power accurately even for previously unobserved turbines



Graphical representation of the multi-task "metamodel"

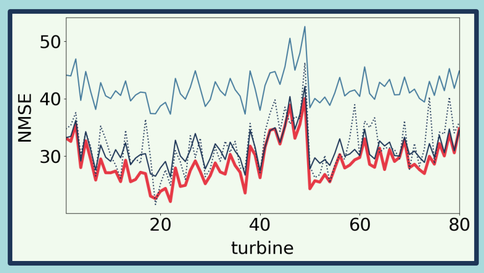
RESULTS

Turbine-specific parameters are determined by their coordinates and the farm-level parameters

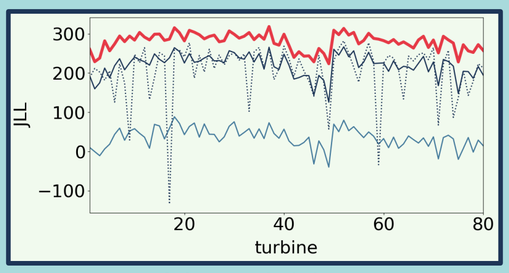


Map showing how the model infers parameter correlations across the wind farm

The metamodel outperforms a range of benchmark models in predicting turbine power – including on turbines it hasn't 'seen'



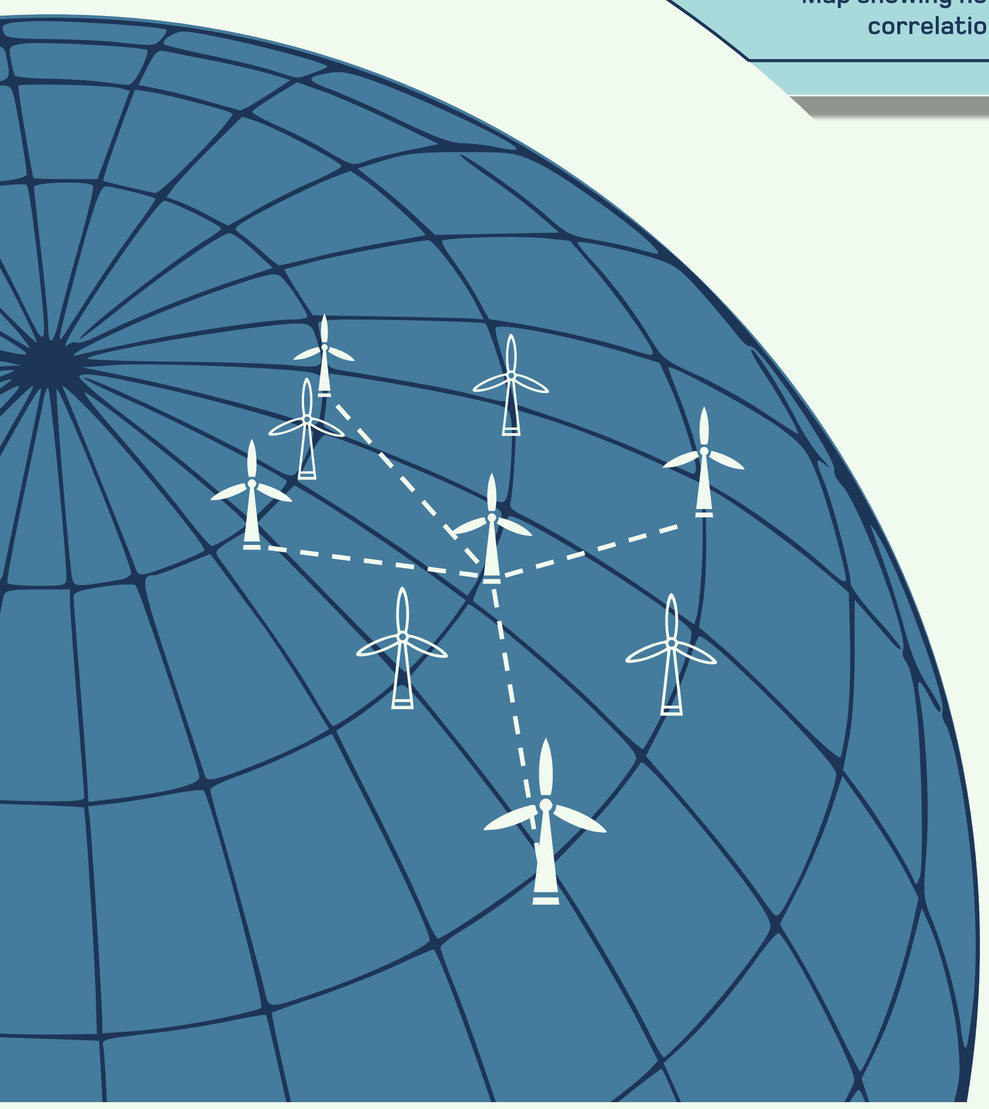
~ % model error



~ model uncertainty capture

metamodel

Benchmark MTL models
- complete-pooling
- partial-pooling
- no-pooling



CONCLUSIONS

Multi-task learning can overcome challenges with data scarcity and environmental variability, and has a range of applications for offshore wind farms

The developed approach helps extract the maximum insight from the data, enabling better decisions and reduced costs

References

[1] BVGA. Guide to an offshore wind farm, 2019;
[2] C. R. Farrar, K. Worden. Structural Health Monitoring: a Machine Learning Perspective. Wiley, 2012;
[3] K. P. Murphy. Machine Learning: A Probabilistic Perspective. MIT press, 2012

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University of Sheffield | Department of Mechanical Engineering

Contact