Software Lab
Modelling the Wageningen Propeller Design Series using the machine learning techniques Random Forests and Artificial Neural Networks.

Main Objective:

Build and compare machine-learning models that predict propeller thrust coefficient K_t, torque coefficient K_q, and efficiency η from inputs J (advance coefficient), P/D (pitch-to-diameter ratio), Ae/A_0 (expanded area ratio), and Z (number of blades). Use a synthetic dataset generated from established empirical relations for the Wageningen B-series for training and validation. Develop and validate a Random Forest regressor and a feed-forward Artificial Neural Network (ANN), and provide a rigorous comparison of accuracy, robustness, and interpretability.

Tasks	Estimated duration
Dataset Synthesis & Baseline. Implement pseudo-dataset generator for K_t and K_q, both as functions of $J, P/D, Ae/A_0, Z$; compute $\eta = (J \cdot K_t)/(2\pi K_q)$. Define parameter ranges and sampling; create train/validation/test splits with blocked holdouts by P/D (e.g., 0.6 and 1.0).	2 Weeks
Random Forest Regressor (RFR). Train RFR for η. Explore hyperparameters: $n\_estimators$, max depth, min samples leaf, max features, bootstrap, max samples. Use out-of-bag (OOB) estimates and cross-validation. Model interpretation: permutation importance, partial dependence (PDP) and ICE plots, tree-variance as predictive-uncertainty proxy.	5 Weeks
Neural Network (ANN). Prepare data (normalization; one-hot for Z if needed). Train ANN for η (Adam optimizer, ReLU activation). Explore hyperparameters learning-rate, network size (layers/width) and regularization strength (dropout, weight decay).	5 Weeks
Error Analysis and Model Comparison. Compare error across J and P/D; study behavior near peak efficiency and at low/high J. Robustness: extrapolation to held-out P/D slices. Compare accuracy, interpretability, training time and extrapolation between RFR and ANN.	4 Weeks
Reporting & Packaging. Curate figures; provide reproducible code: notebooks/scripts, environment file, saved models, how-to-run. Final report and 10-minute slide deck.	4 Weeks
Summation:	**20 Weeks**

Meeting Schedule:
Weekly Meeting with the supervisor:
Day: Every Wednesday, Time: 14:00, Location: Room 104
Progress Report Meetings with Prof. Kornev:
Frequency: Twice every month on Wednesday at 14:00

Contact information:

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Suggested Software Stack (Python):
Core: Python ($\geq$ 3.10), `numpy`, `pandas`, `scipy`.
Modeling: `scikit-learn` (RandomForestRegressor), `fastai.tabular` (ANN)

Notes:
- The routines to generate the Wageningen-dataset will be provided by the supervisor.