Supplementary Information (Online Resource 1)

Article title: Explainable multi-output ensemble learning for early-stage prediction of building heating and cooling loads
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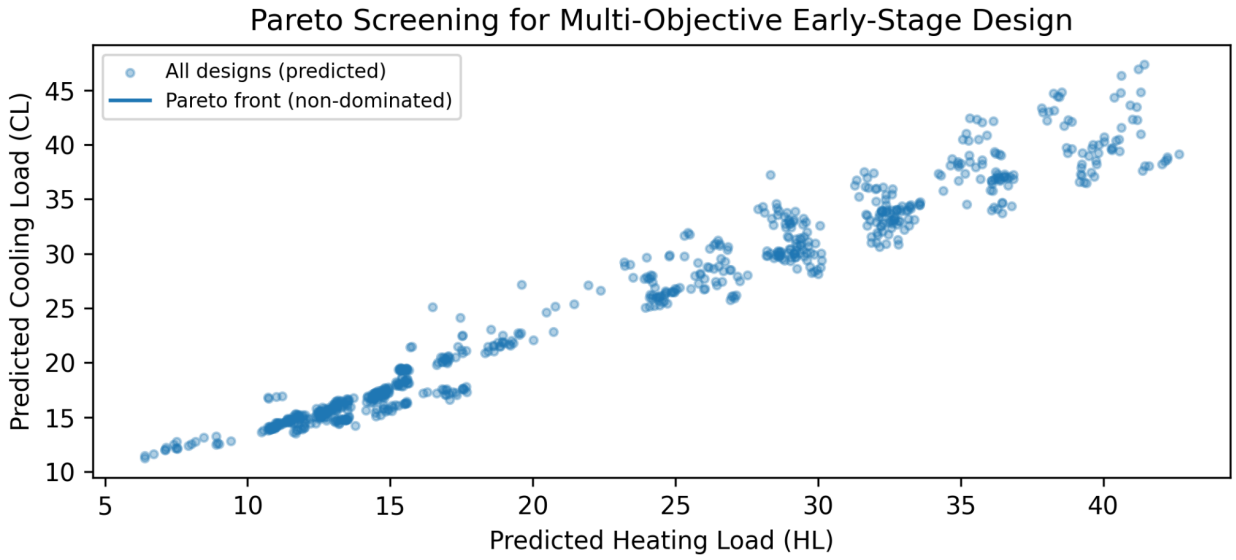
Caption: Online Resource 1 (ESM_1.pdf) contains supplementary appendices supporting the main manuscript.

Appendices

Appendix A. Pareto screening for multi-objective early-stage design

This appendix summarises the dominance logic used to identify non-dominated (Pareto-efficient) candidates in the predicted heating–cooling load space. For a two-objective minimisation problem (HL, CL), a candidate i dominates candidate j if $HL_i \leq HL_j$ and $CL_i \leq CL_j$ and at least one inequality is strict. The Pareto front is the set of candidates not dominated by any other candidate. In this study, the predicted HL and CL values from the trained multi-output model are used to screen the design space rapidly; non-dominated candidates are reported as the initial shortlist for engineering review and potential re-simulation using detailed dynamic models.

Figure A1. Pareto screening for multi-objective early-stage design (predicted HL versus predicted CL).



Appendix B. Reproducibility checklist (supplemental package)

A runnable Python script, the dataset file, and generated tables/figures are provided in the accompanying supplemental reproducibility package. The package includes a README with environment setup instructions, commands to reproduce the reported metrics and plots, and the exported publication figures in PNG and TIFF formats.