Surrogate models for time-consuming building performance simulations and optimizations

Gonçalo Araújo

Goncalo.r.araujo@tecnico.ulisboa.pt

–

Paulo Ferrão[1], Ricardo Gomes[1]

1. IN+/ Center for Innovation, Technology and Policy Research

MIT Portugal

2022 Annual Conference

Lisbon C-TECH residential area – Urban Energy simulation results heatmap.

Building Performance Simulation (BPS) approaches have multiple advantages for stakeholders and policy-makers by providing valuable insights regarding a building's performance and its impact in the environment. Unfortunately, there are two important constraints in these approaches: simulation tools require extensive knowledge and are time-consuming. In this research, we combine Algorithmic Design (design process where shapes can be created through algorithms) and BPS to generate surrogate models capable of predicting buildings' energy use, daylight factor, and operations CO_2 emissions. These models not only considerably speed up simulations and optimizations, but also require less inputs and expertise to run. Afterward, we benchmark optimizations of building retrofits for minimum costs and maximum performance improvements. Both surrogate models and benchmarked optimization processes can be integrated in an easy to use Graphical-User-Interface that allows a quick optimization of a buildings' retrofit according to constraints such as cost, return on investment, energy certificate, among others.

Allow us to test multiple solutions
Provide insights to stakeholders

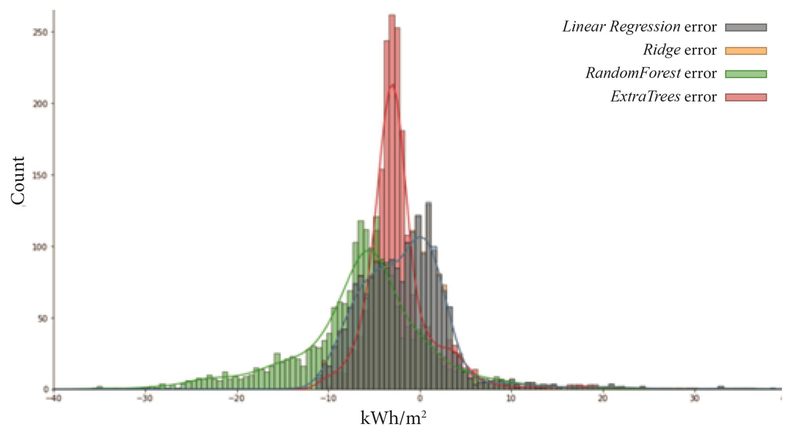
Are time-consuming
Require extensive knowledge

Building data

Algorithmic Design

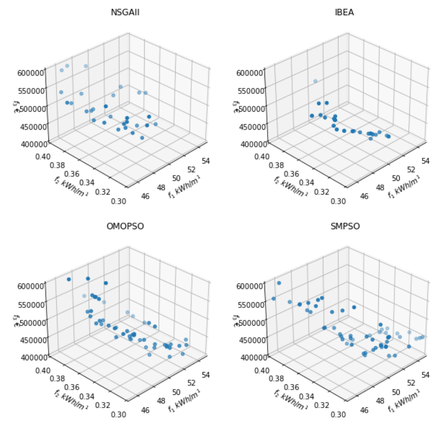
Simulation Tools

Machine Learning



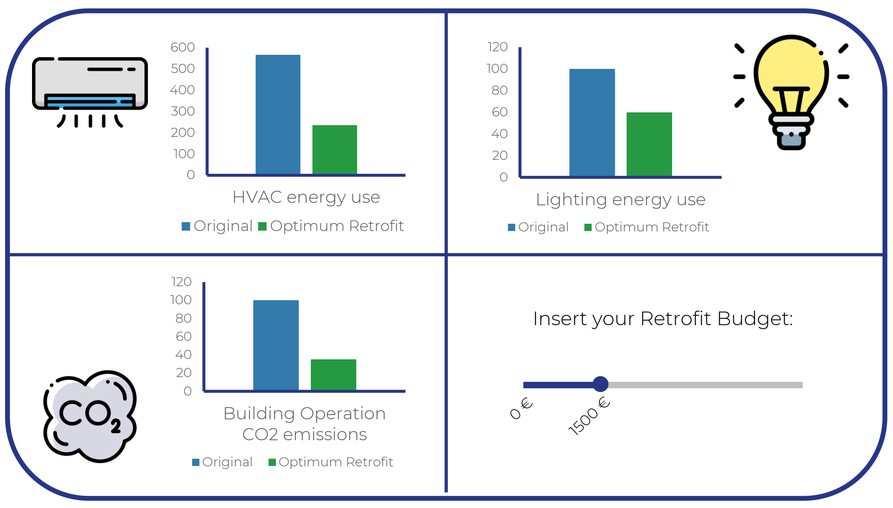
Error distribution plot for surrogate models of building energy simulation.

Surrogate models

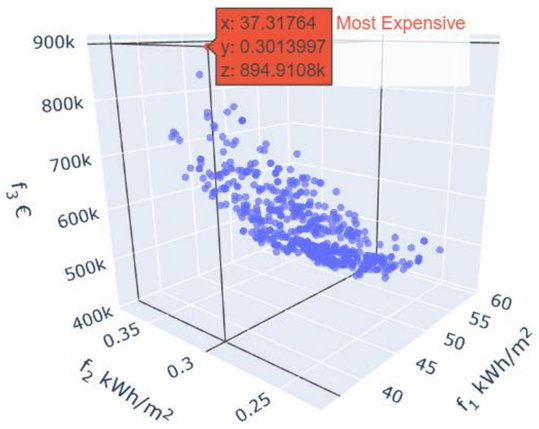


Benchmark of multi-objective optimization of the retrofit of a building sample for its minimum cost, energy use, and σ.

Benchmarked optimizations



Graphical-User-Interface



Results visualization

Up to **250** times faster simulations with **±7%** error.

Easier to use with less inputs and technical knowledge.

Co-funded by:

COMPETE 2020 PROGRAMA OPERACIONAL COMPETITIVIDADE E INTERNACIONALIZAÇÃO

PORTUGAL 2020

UNIÃO EUROPEIA
Fundo Europeu de Desenvolvimento Regional

FCT Fundação para a Ciência e a Tecnologia

MIT Portugal

under the Flagship Project: LISBOA-01-0247-FEDER-045919 | MIT Portugal Program Sustainable Cities