ICT for Building Design:
ICT1: Introduction

POLITECNICO DI TORINO

Lorenzo Bottaccioli

DIST – Interuniversity Department

of Regional and Urban Studies and Planning

Email: lorenzo.bottaccioli@polito.it

Phone: 011/0908503

Office: Second Floor Energy Center
        (via Paolo Borsellino 38-16)

Receiving and lecture support on appointment.

- Introduction to ICT technologies
  - IoT in buildings
  - Building Management System (BMS)
  - Building Information Modelling (BIM)
  - Databases for BMS
  - Visualization Tools for BMS

- Energy consumption in Buildings
  - Principles of thermodynamics
  - Heat transfer in Buildings
  - Energy balance in Buildings

- Energy simulations and surrogate design optimization

  - Simulation with Energy Plus

  - Automation of simulation with Energy Plus (eppy)

  - Edit Weather files (pyepw)

  - Surrogate modelling with with Eppy or Besos

  - Surrogate design optimization with Besos

Contents

- Building modeling and Characterization

  - Energy Signature

  - Withe Box Modelling

  - Black Box Modelling (e.g. Multivariate regression, Neural Networks)

  - Grey Box Modelling (e.g. Klaman Filter)

  - User behavior Modelling (e.g. Markov Chain)

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- Tutoring for exam project
  - During lasts lectures

Materials for the course and Project

Lectures:

- Slides

- Jupyter notebooks

- Python scripts

Project:

- Docker or Virtual Machine

- Ubuntu 22.04

- Energy Plus

- Python 3

- FMI-MLC

- InfluxDB

- Graphana

Materials for the course and Project

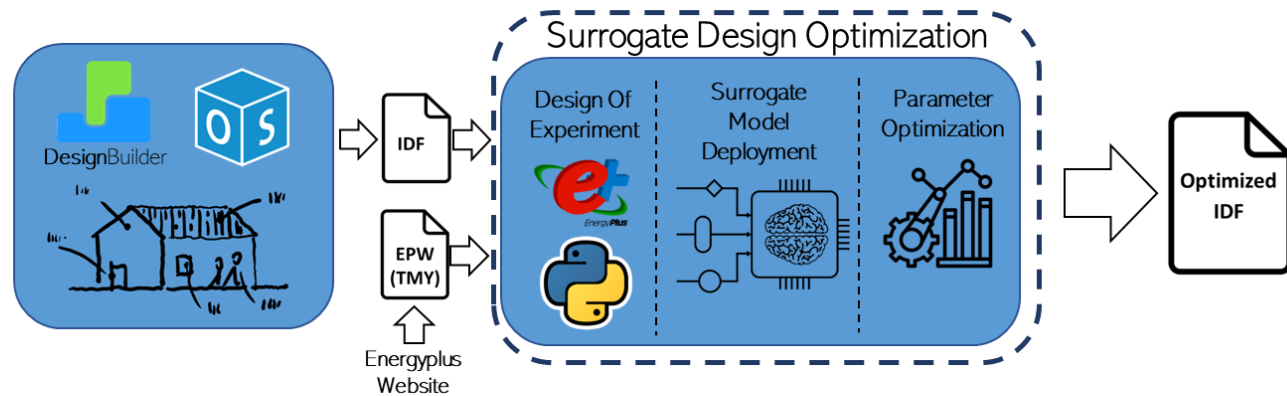Python libraries you will use for the Project:

- Numpy
- Pandas
- Matplotlib
- Eppy
- pyEpw
- Besos
- Influxdb

- Paho-mqtt
- Scipy
- Statsmodels
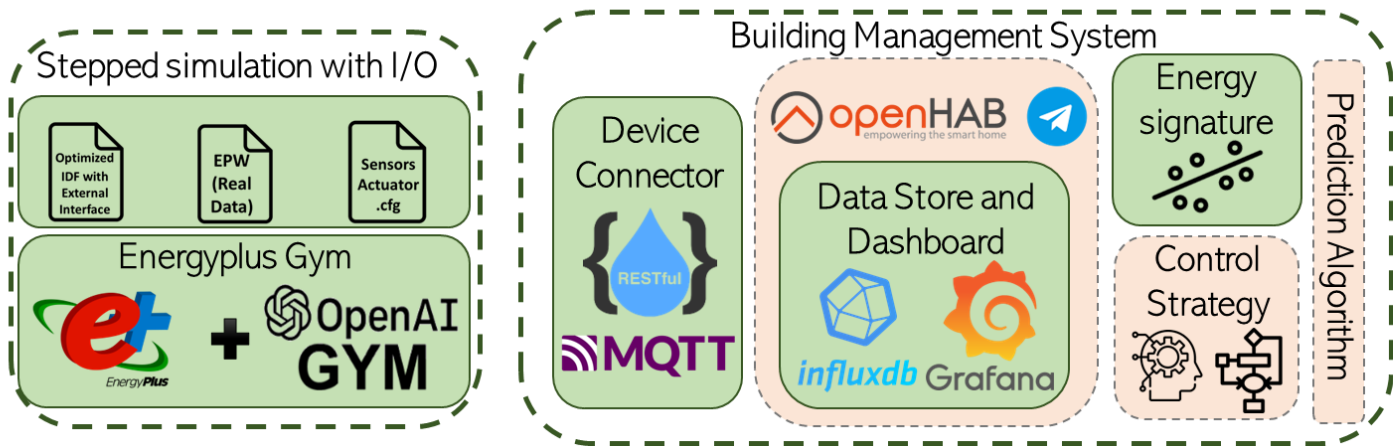- Sklearn
- Filterpy
- Tensorflow
- Keras

- PVlib
- ….

What each group will do in the Project for the ICT part:

- Develop a surrogate model over design parameters using or Eppy or Besos frameworks in order to find optimal design parameters

- Simulate the energy dynamics of the building using optimal parameters

- Emulate the presence of sensors and meter in building

• Eppy: یک کتابخانه python است برای کار با فایل های شبیه سازی Energ Plus (مثل IDF). با این کتابخانه می توان IDF را ویرایش کرده، پارامترهای مختلف ساختمان را تغییر داد و شبیه سازی بهینه ایجاد کرد.

• Besos: یک فریم ورک هست تا با الگوریتم های مختلف، پارامترهای ساختمان را بهینه کرد. این فریم ورک می تواند با Energ Plus تعامل داشته باشد.

Emulate the presence of sensors and meters in building:

- Using the FMI-MLC environment is possible to control step by step the simulation and retrieve data from "sensors" :

  - Temperature profiles in the rooms

  - Hearting and cooling consumption

  - Presence of people

  - Electricity consumption

  - …

What each group will do in the Project for the ICT part:

- Store the data in to an InfluxDB database
- Create dashboards to show the collected data using Grafana
- Perform the energy signature characterization over the simulated and collected data.

What each group will do in the Project for the ICT part:

Choose a possible prediction algorithm among the one shown in the course or from **literature review**

- Grey Box modelling (E.g. Kalman Filters, …)
- Black Box modelling (E.g. Neural Networks, Multivariate regression, …)

The objective will be the prediction of:

- Temperature profiles
- Heating/cooling power
- Air ventilation rate

Each group at the end will have to deliver us the :

- Python scripts for editing weather files
- Python scripts for find optimal values
- Python scripts for emulating the sensor presence
- InfluxDB data base with collected data
- Grafana service for the dashboards
- Python scripts for Energy signature characterization

A pdf report that presents the **literature review** on modelling techniques (min 3 papers) and the results of the project.