Thesis proposal for the Chair **Bayesian Active Learning Techniques for Energy EfficienCy** in buildings (BALTEEC) funded by MIAI (Multidisciplinary Institute in Artificial Intelligence) Cluster

Bayesian active learning and optimisation for non-Euclidean geometries -- application to building energy audits

This thesis is part of the BALTEEC Chair, funded by the MIAI Cluster. Bayesian active learning (BAL) is an efficient framework for learning model parameters, in which input stimuli are selected so as to maximise the mutual information between the observations and the unknown parameters. The use of a BAL strategy generally makes it possible to drastically reduce the amount of data (measurements and/or simulations) required to produce reliable predictions, thereby reducing the associated costs (computing time, memory space, etc.).

Although there is now a vast literature on the subject, work has focused on models taking as input variables of the same nature (vector data, images, graphs, etc.). The aim of this thesis is to develop approaches that can be applied in more general contexts, where the model takes as input mixed variables (both discrete and continuous variables), time series that are often highly correlated, tree-structured data, etc. In a Bayesian active learning context, it is possible to choose a Gaussian a priori, characterised by its mean and its covariance structure, defined by a kernel. The choice of kernel must allow a good exploration of the space of input variables. A major effort will be made to construct kernels adapted to complex variables such as those described above, and to develop and implement optimisation algorithms on a non-Euclidean space.

These algorithms will use mixed integer optimisation techniques. These results will be applied to the energy monitoring of buildings to improve their energy performance. This includes energy performance diagnostics prior to renovation (learning about actual heat dynamics from in situ measurements), the optimisation of renovation with objectives of consumption and comfort criteria, and the verification of performance. Building monitoring data includes weather data, envelope and HVAC properties, and occupancy schedules.

Key words: active learning, uncertainty quantification, optimisation, experimental design, energy audit

Thesis supervising:

Clémentine PRIEUR, LJK, INRIA Airsea, UGA
Simon Rouchier, LOCIE, USMB
Renaud Chicoisne, LIMOS, UCA

Doctoral school:
ED MSTII, Université Grenoble Alpes

Location:
Campus Saint-Martin-d'Hères, Grenoble, France

Duration and starting date: 3 years, to be started by the end of 2025

Qualifications: Master's degree in Mathematics and/or Computer Science
Language skills: French or English level B2
Other qualifications: statistical learning, optimisation, programming (C, Python or R)

To apply, please send your cover letter, CV and transcripts (L3, Masters and/or engineering school) to clementine.prieur@univ-grenoble-alpes.fr