POLITECNICO DI TORINO
Dipartimento di Automatica e Informatica

PhD in Computer and Control Engineering
XXXII cycle

Supervisor
Prof. Enrico Macii

Software architectures and algorithms to model and increase energy efficiency in Smart City and Smart Industry scenarios

PhD Candidate: *Alessandro Aliberti*

1. Context

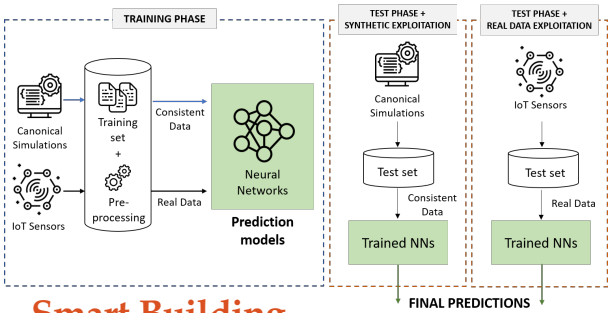
IoT devices are used in many contexts, to add smartness to cities, energy, and industrial processes. Their pervasiveness, combined to the recent development of machine learning techniques, allows to collect a **large amount of information**, enabling original opportunities to create **innovative modelling and optimization approaches**.

2. Objectives

My research focuses on **developing stream data processing and machine learning methods**, ranging from energy and environmental data and moving to data from industrial CPS systems, **creating and validating innovative modelling and control strategies** in specific application case studies: i) Smart Building, ii) Renewables and iii) Smart Health.

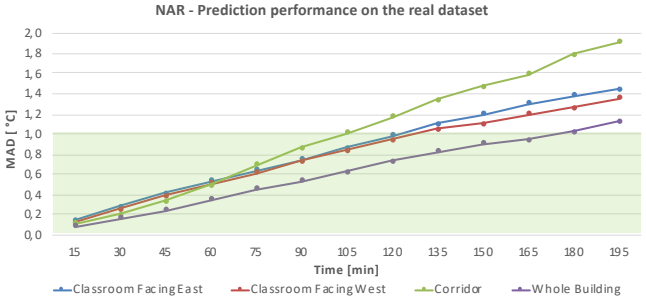
3. Methodology

The studies were conducted following a **bottom-up approach** starting from the analysis and appropriate pre-processing of IoT data, in order to **design neural models** suitable for the type of dataset and its characteristics.



4. Smart Building

I developed a **comprehensive methodology that allows thermal modelling** in both new generation and historic buildings [1]. This by exploiting the possibility of creating a very reliable synthetic dataset based on BIM technology.

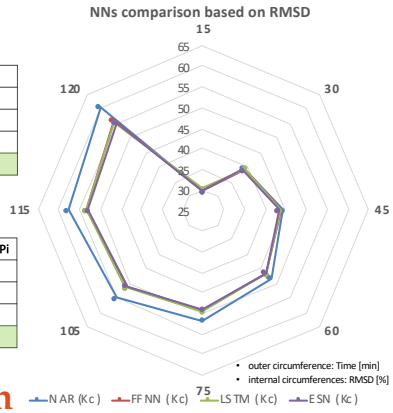


5. Renewables

I developed a **methodology that can make photovoltaic predictions starting from the physical phenomenon of GHI** [2]. I also started investigating how to properly exploit the opportunities provided by edge computing by bringing networks to embedded systems.

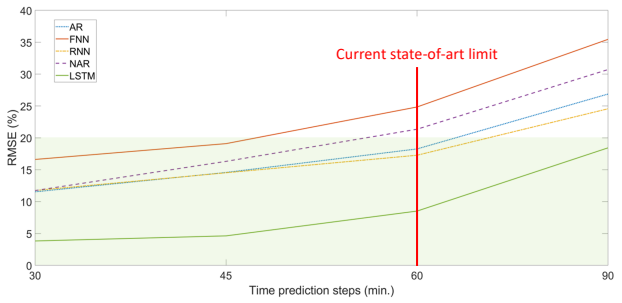
Training time and memory for Kc on Cluster		
	Time [hh:mm:ss]	Memory [GB]
FFNN	00:04:18	0.24
LSTM	00:19:44	0.32
ESN	00:01:02	0.51

Training time and memory for Kc on Raspberry Pi		
	Time [hh:mm:ss]	Memory [GB]
FFNN	00:08:09	0.33
LSTM	04:44:14	0.28
ESN	00:05:06	0.31



6. Smart Health

I addressed the problem of automated glucose level prediction leveraging multi-patient CGMS data. The objective is to create a **ready to use device**, without the need for initial tuning. This device learns a generalizable glucose level prediction model from a **multi-patient training set**, using this model to predict the **future glucose values** of a new patient [3].



In addition, I started evaluating techniques to specialize this methodology by integrating real-time information. This would allow the tool to specialize on the end-user.

7. References

1. Aliberti, Alessandro, et al. "A Non-Linear Autoregressive Model for Indoor Air-Temperature Predictions in Smart Buildings." Electronics 8.9 (2019): 979.
2. Aliberti, Alessandro, et al. "Non-linear Autoregressive Neural Networks to Forecast Short-Term Solar Radiation for Photovoltaic Energy Predictions." Smart Cities, Green Technologies and Intelligent Transport Systems. Springer, Cham, 2018.
3. Aliberti, Alessandro, et al. "A Multi-Patient Data Driven Approach to Blood Glucose Prediction." IEEE Access (2019).