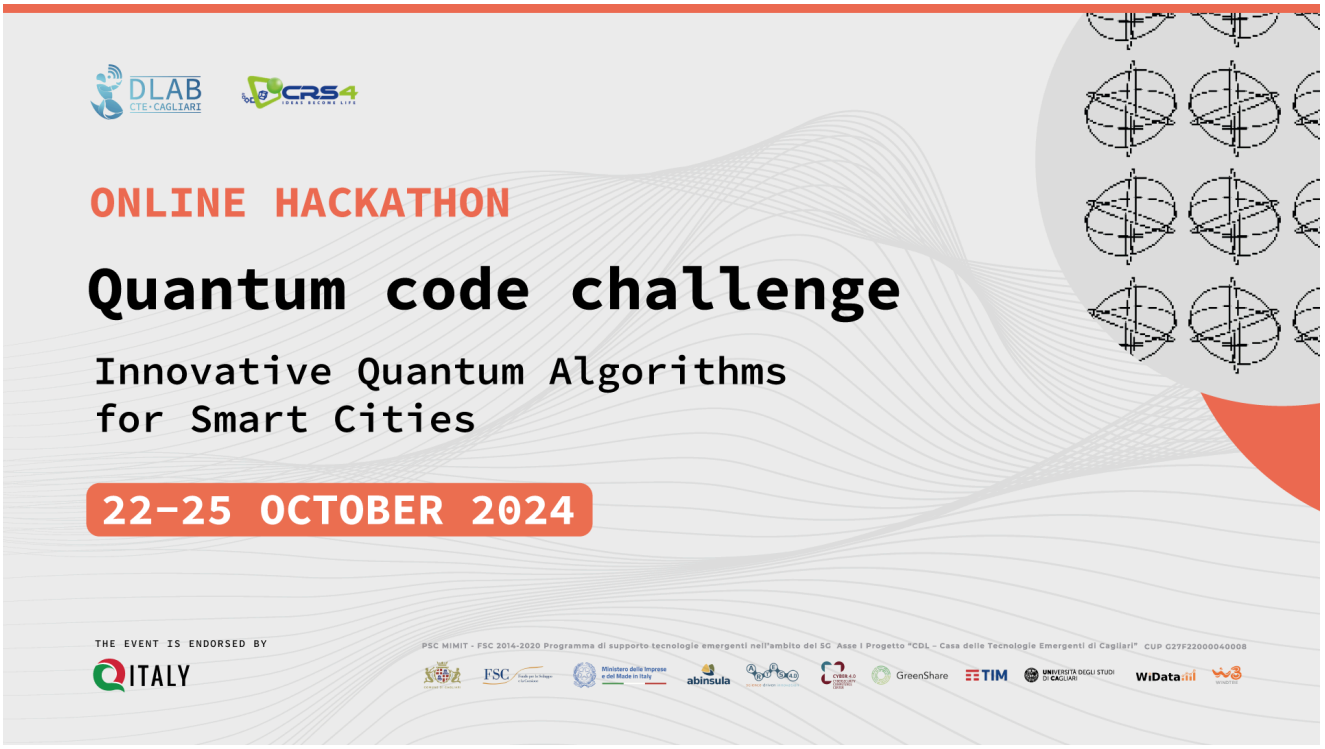


Smart City QC Wizard Challenge

Background

The Quantum Code Challenge Hackathon is a specialized event where technology professionals and enthusiasts engage, form a team and collaborate on innovative ideas to develop practical solutions.

This event is organized by **CRS4** and **Open Campus** in the **CTE- Cagliari Digital Lab Project** framework and takes place entirely online from October 22 to 25. The event is endorsed by QItaly, the Italian representative of the international network of working groups of the QWorld organization for the dissemination of quantum computing.
The main theme of this event is Quantum Computing, specifically its application in real-world contexts for solving complex problems and making smart cities more efficient. The hackathon is designed for those who already have some expertise in the field, but also for beginners and basic knowledge owners.

In this document we provide a description of the **Smart City QC Wizard** challenge. The dataset provided in the challenge is related to the smart cities of Cagliari and most datasets are provided by the partners of the CTE-Cagliari Dlab project funded by the italian Ministry (MIMIT).

If you want to use the data for research or development of solutions, please cite the references of the project in the outcomes of your work.

The challenge

The municipality needs a way to detect potential alert situations that can arise. The alerts can be of different degrees, so quantum machine learning in the future might be the best option to find patterns in data and start the alert procedure.

The dataset is quite heterogeneous, it provides different sensor streams that will be described below. Participants are absolutely free to single out a set of different acquisitions and **build their Quantum Machine Learning application to provide alerts useful for the Municipality** . Universal and adiabatic quantum computing solutions are welcome. Moreover during the hackathon the **Qbraid** portal will provide the availability of the **NEC Vector Annealer Service** digital annealer for the teams who wish to develop an adiabatic solution.

Both supervised and unsupervised learning approaches are welcome, participants can select their favorite approach. Teams that choose the supervised learning path, are in charge of creating their own labels for the dataset subset they consider, and label creation python workflows must be enclosed in the github repo that features the solution for the challenge.

Teams are asked to submit their solution in a public github repository that might be a fork of the CRS4 repository for the challenge.

- In the readme file they will list the name of the team members, their email, their github id and their discord id.
- We suggest using a dual license (like a MIT one) at the moment of the repository creation in order to allow reuse while maintaining copyright. That would make it easier for each team to commercialize their project later if they develop a very smart solution.
- In the repository, the readme from the original QCWizard repo must be enclosed and completed with the missing data.
- The submission repository will contain the data subset, all source codes and results and a slide deck that describes the solution.
- Participants will be asked to quote other's work usage appropriately.

The data.

The data for the challenge were collected in the time frame from August 1, 2024 to October 8, 2024 and are split in five different stores. In that time frame Sardinia transitions from dry, hot summer to rainy autumn, so participants can be creative about the alert they want to detect (for instance fire alert, traffic jam alert, rainfall alert, pollution alert...). The data are gathered for the CTE-Cagliari Digital Lab project and are mostly provided by the partners in the project.

Heterogeneous data are provided:

- particulate matter counts for PM10 and PM2.5, acquired by CRS4 sensors

- unique attendance via SIM card counts, recorded every 15 minutes in 12 different districts of the town provided by TIM through their Urban Genius platform
- pollutants greenhouse gas (GHG) acquired by ESA satellites, streamed through the Urban Genius platform by TIM.
- weather datasets by AccuWeather

Particulate Matter

Particular matter acquisition featuring PM2.5 and PM10 are collected during the above mentioned time frame by a set 3 of sensors by CRS4, whose locations and GPS coordinates are listed below.

- sensor1 - Piazza di Chiesa, Elmas. -: (39.2669992, 9.0502909)
- sensor2 - Via dell'Acquedotto Romano, Elmas - (39.2664162, 9.0659321)
- sensor3 - Via Santa Maria Goretti, Pirri (Cagliari) . (39.2521669, 9.1256483)

In Figure 2 you can see a plot of non dimensional data frames for block 4.

Figure 1: geo-location of particulate matter sensors

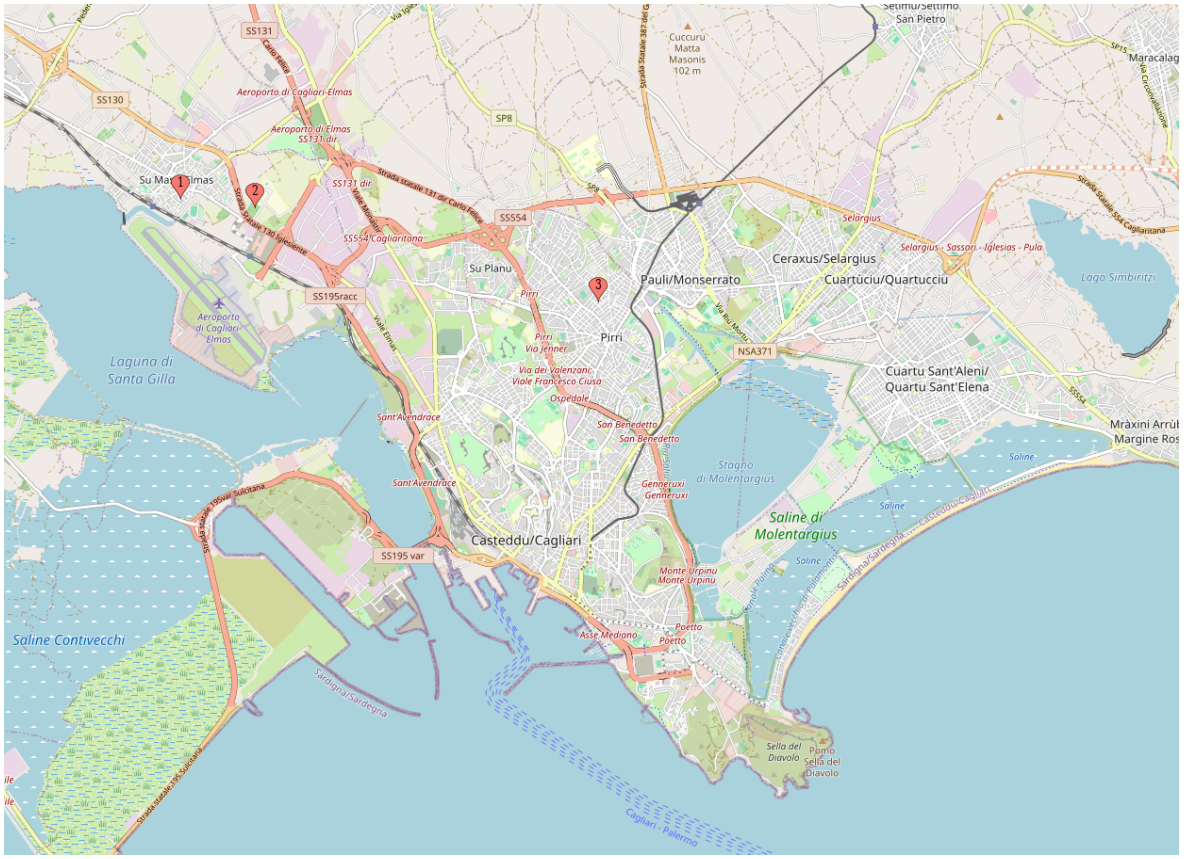
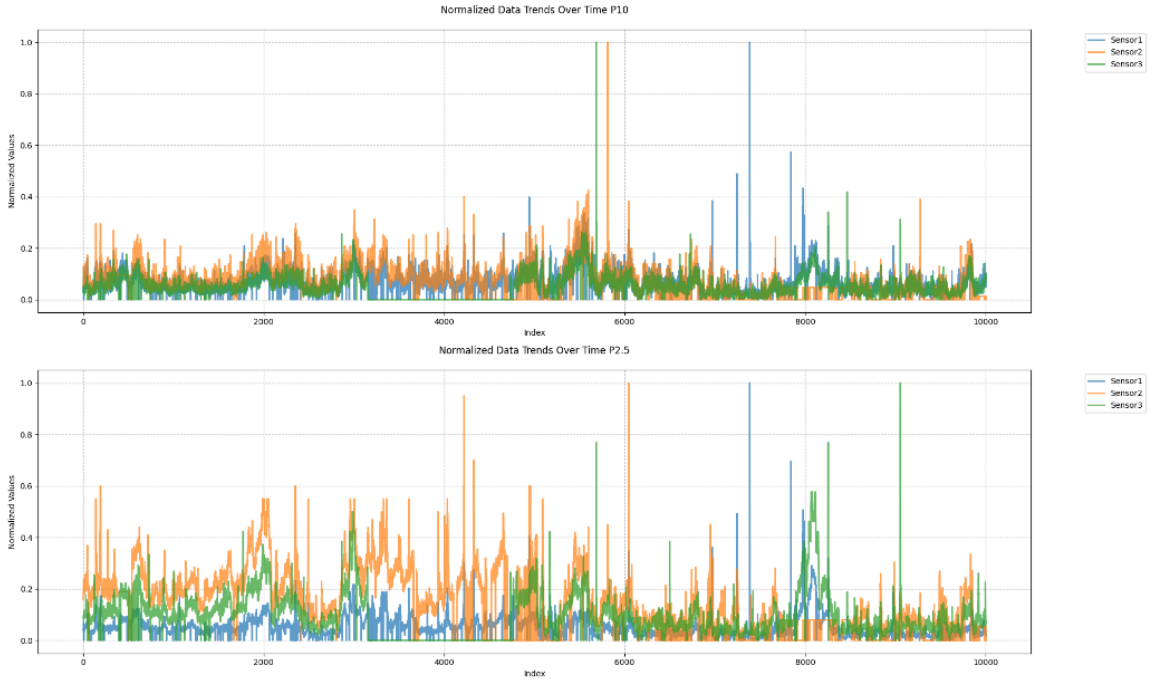


Figure 2: nondimensional plot of PM2,5 and PM10 dataframes



UniqueAttendance_15

Unique attendance via SIM card counts, recorded every 15 minutes in 12 different districts of the town provided by TIM through their Urban Genius platform. You can find a basic notebook for data mangling in the uniqueAttendance_15 subdirectory. The districts, named as ACE (Aree CEnsuarie) are labeled with a number in the range 1-12 and correspond to the areas plotted in figure 3.

A basic data mangling workflow to get access to the specific ACE datasets is enclosed in the data subdirectory.

Figure 4 displays the normalized trends of the unique attendance every 15 minutes for the entire town end for the ACE districts. The plot is made for stock #4 as an example.

Figure 3: ACE districts for the town of Cagliari, as colored areas displayed as a overlay for the map of the town

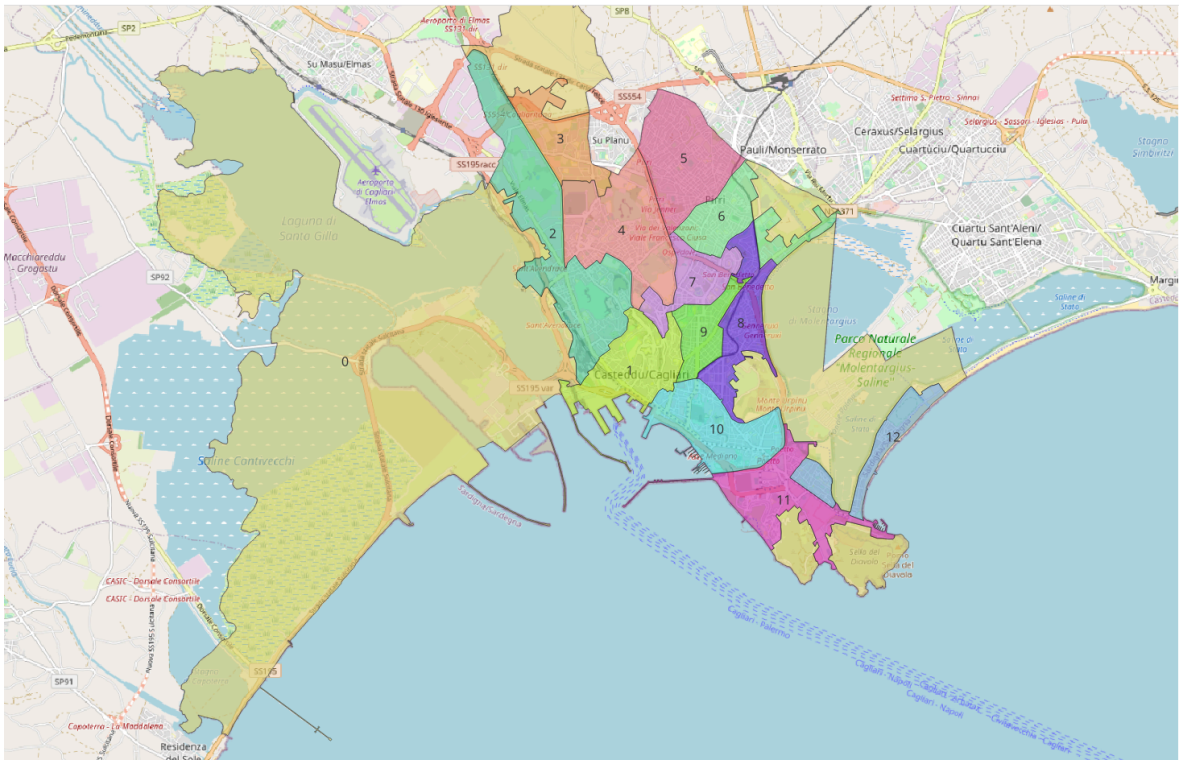
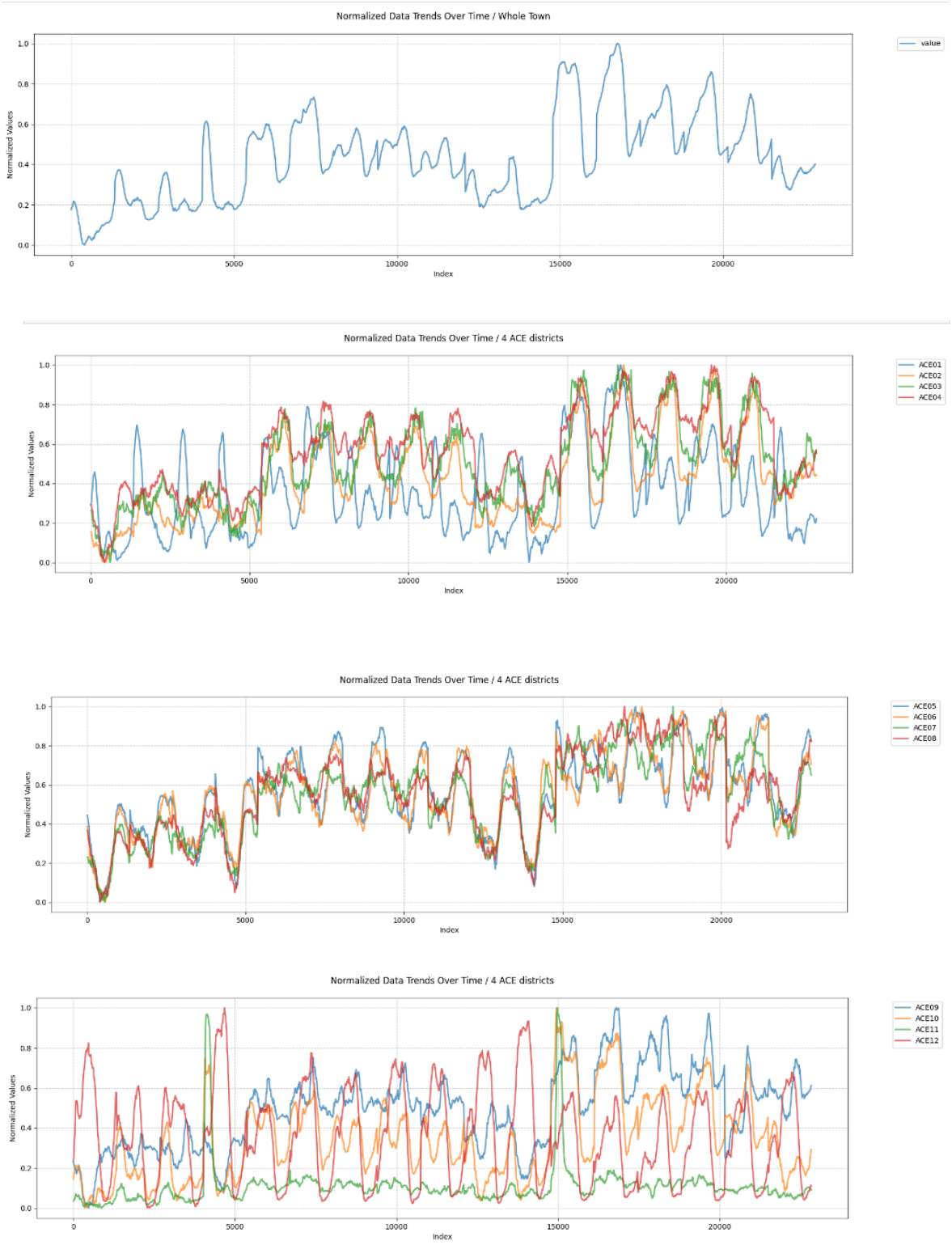


Figure 4: Plot of nondimensional unique attendance values for the entire town and for the 12 ACE districts for block 4.

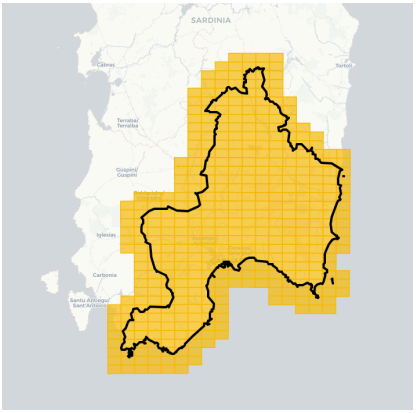
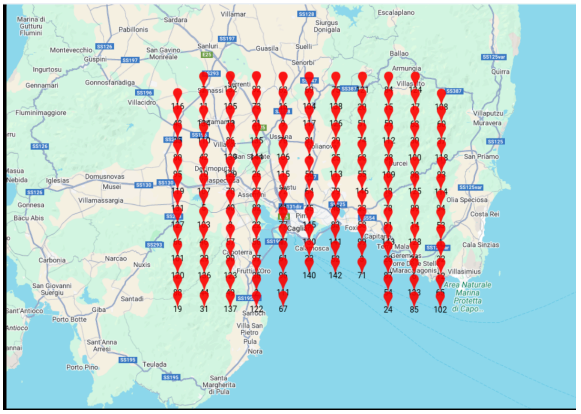


Pollutants

Satellite data on greenhouse gas (GHG) pollution, streamed through the Urban Genius platform that the telco company TIM developed. The data gathered in the time frame are made available as TIM is a partner in the CTE-Cagliari Digital Lab project.

The file *pollutants/monitoraggio_aria_01_010824-140824.csv* does not contain any data as, during the time frame corresponding to the first stock, apparently the streamed data was not available.The recording starts from 2024-08-23 (the second chunk).

record	data type	meaning
row	int	Row
col	int	col
entry_date	date	date of entry
geometry	Polygon	Geospatial geometry
centroid	np. array	coordinates
CH4	float	value in ppb
CO	float	value in mol/m^2
HCHO	float	value in mol/m^2
NO2	float	value in mol/m^2

Figure 5: the plot displays the centroids for the pollutant dataset	
	
Original satellite coverage	Data provided bound in a specific area of interest

Weather

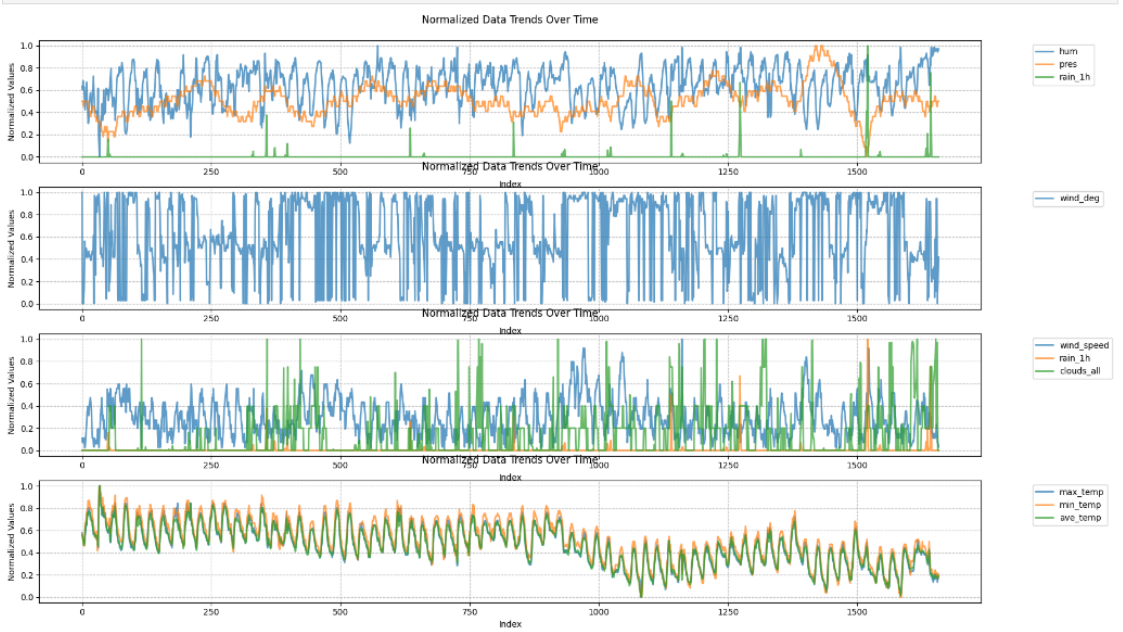
The weather dataset was extracted by the AccuWeather service-

Here is a description of the columns in the dataset

id	record ID
ts_get	timestamp record
hum	humidity, unit: %
pres	Atmospheric pressure on the sea level, unit: hPa
rain_1h	Precipitation, unit: mm/h
wind_speed	Wind speed. Units – unit: metre/sec
wind_deg	Wind direction, unit: degrees
clouds_all	Cloudiness, unit: %

max_temp	Maximum temperature, unit: celsius
min_temp	Minimum temperature, unit: celsius
ave_temp	Average temperature, unit: celsius
cod_weather	code convention to weather under the following schema: 2xx - thunderstorm 3xx - drizzle 5xx - rain 8xx - clouds 800 - clear i.e.: 200 - thunderstorm with light rain 211 - thunderstorm 800 - Clear 500 - light rain 502 - heavy intensity rain

Figure : nondimensional data plots for the weather along the entire time frame



Credits

This work was partially supported by the Italian Ministry of Enterprises and Made in Italy (MIMIT), within the 5G technology support program, on axis 1 “House of Emerging Technologies” (CTE), Project Name “Cagliari Digital Lab” (ID: G27F22000040008).

The data were made available by TIM and CRS4 within the CTE-Cagliari Digital Lab project framework. Other data are collected from public sources.

The above datasets were selected and pre-mangled at CRS4 by Carlo Impagliazzo.

The challenge design was created at CRS4 by Giuliana Siddi Moreau.