

# PREDICTING THE IMPACT OF COVID-19 ON THE EMERGENCY MEDICAL SERVICE IN LOMBARDY, ITALY

ANGELA ANDREELLA<sup>1</sup>, SPYROS BALAFAS<sup>1</sup>, ANTONIETTA MIRA<sup>1,2</sup>,  
GIULIA GHILARDI<sup>3</sup>, GRETA CARRARA<sup>3</sup>, FABRIZIO RUGGERI<sup>4</sup>, ERNST  
WIT<sup>2</sup>, GUIDO BERTOLINI<sup>3</sup>, GIOVANNI NATTINO<sup>3</sup>

<sup>1</sup>UNIVERSITY OF INSUBRIA, VARESE, ITALY

<sup>2</sup>UNIVERSITY OF SVIZZERA ITALIANA, LUGANO, SWITZERLAND

<sup>3</sup>INSTITUTE OF PHARMACOLOGICAL RESEARCH MARIO NEGRI, MILAN, ITALY

<sup>4</sup>NATIONAL RESEARCH COUNCIL, INSTITUTE OF APPLIED MATHEMATICS  
AND INFORMATION TECHNOLOGY, MILAN, ITALY

JSM - AUGUST 2021



The Lombardy region in Italy relies on the emergency medical service called **AREU**.

**PROBLEM:** The number and type of **calls** to the emergency call center changed dramatically due to **COVID-19** pandemic.

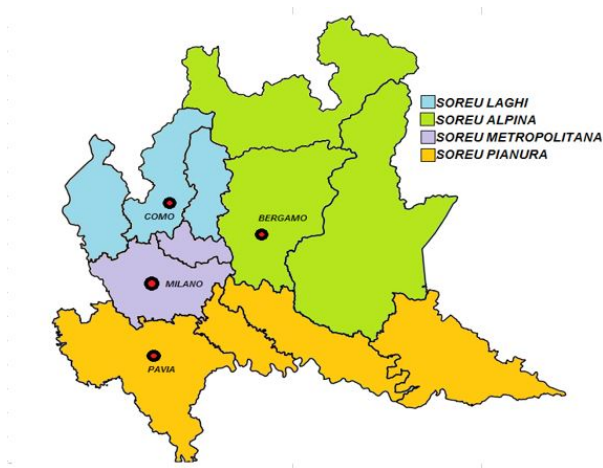
**AIM:** Predictive model of the upcoming ambulance trips is crucial to **organize** the available emergency response resources.



**TSUNAMI PROJECT**

Supported by Lombardy region - Italy

AREU is organized in four regions: Lakes, Alps, **Metropolitan**, Plane.



AREU can use: daily-seasonal variations, social and demographic factors, weather circumstances, and epidemiological factors.

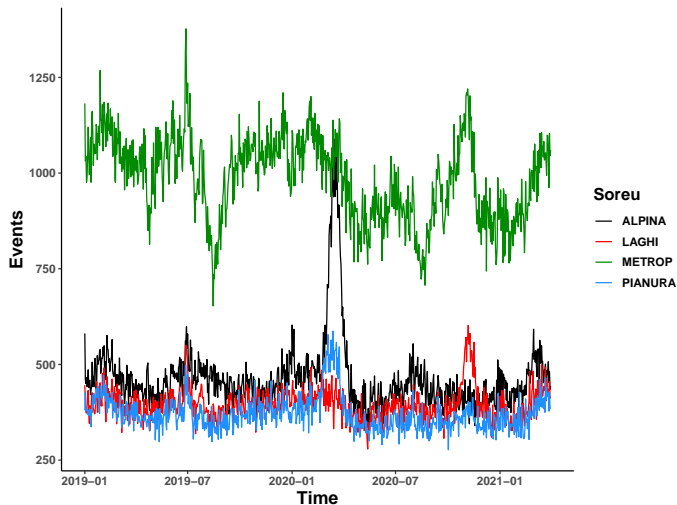
- **AREU data:** information about all the calls received → Region, Time, if the calls activated an aid, i.e., it becomes an event, etc;
- **ARPA data:** weather data collected from sensors located across the Lombardy → Temperature, rainfall, snowfall;

- **ISTAT and ISS data:** demographic and epidemiological data  
→ Flu incidence, number of car accidents, etc.

**BUT** also COVID-19 related factors.

- **Department of Civil Protection:** number of hospitalized patients with symptoms, swabs, etc;
- **ISS:** reproduction number  $R_t$ .

**Events:** Dispatch of transport and/or equipment.



**GOAL:** Predict number of **events** for each of 4 regions.

- We focus here on **Metropolitan** area (Milan and Monza).

**METHOD:**

- **Generalized Additive Model** with **negative-binomial** family;
- The data were aggregated at **hour** and **region** levels;
- Final predictions were aggregated at the **day** level.

We select model with best **mean absolute prediction error**.

■ **Prediction error:**

$$\left| \frac{\hat{y}_i - y_i}{y_i} \right|,$$

where  $y_i$  is the observed value and  $\hat{y}_i$  the predicted one at day  $i$  level.

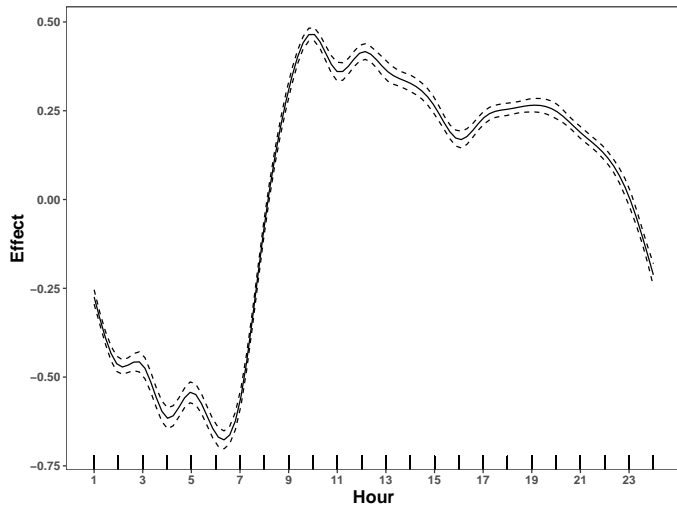
■ Using 4 fold **Cross-validation** across 2020 and 2021.

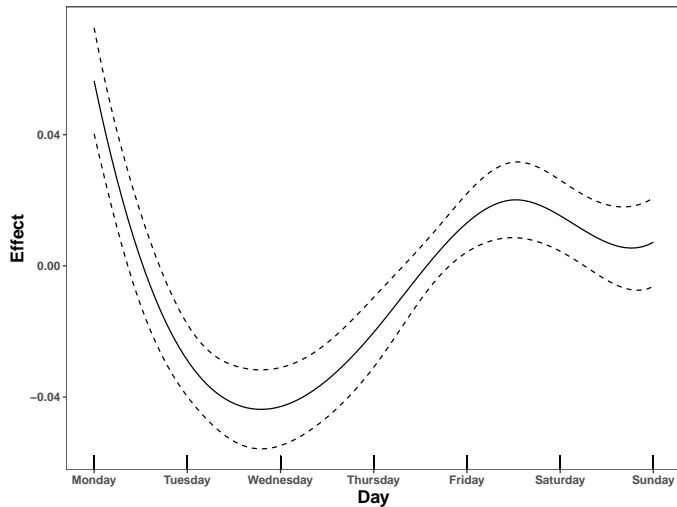


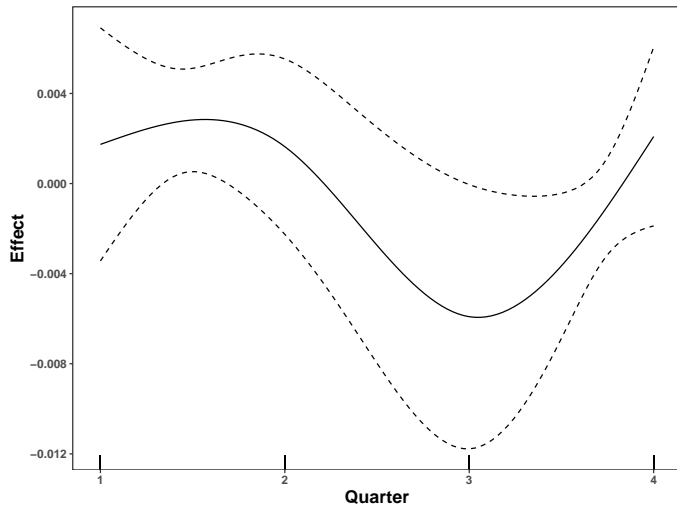
The following covariates were then selected:

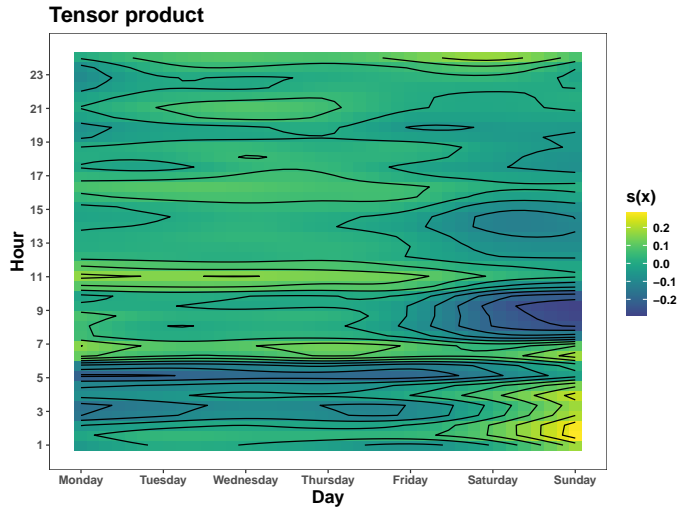
- cubic regression spline for **Hours** with 24 basis;
- cubic regression spline for **Quarter** with 4 basis;
- P-spline for **Day** with 7 basis;
- Tensor product smooths between **Day** and **Hour**;
- **Temperature** lagged one day;
- **Events** of the day before lagged 1-2-3 by hour;
- **Events** aggregated by day and lagged 1, 2 and 7 days;
- $R_t$  lagged one day;
- **Flu** incidence lagged one day.

# RESULTS

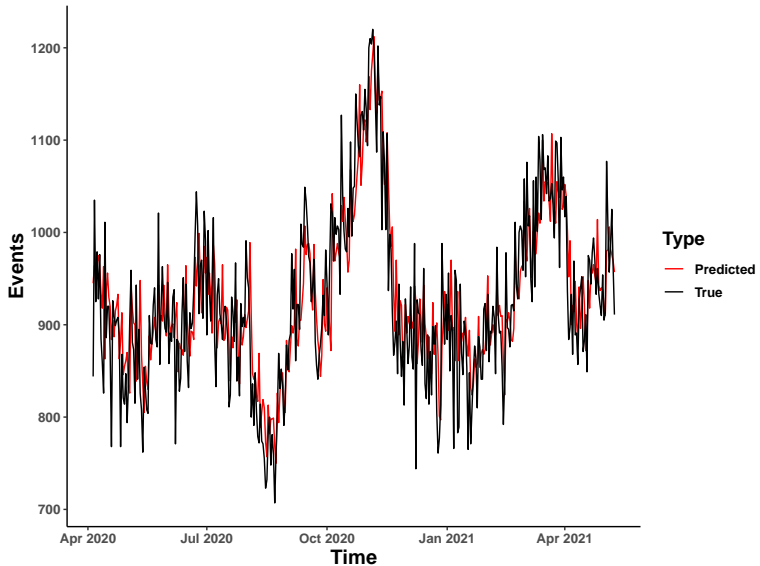




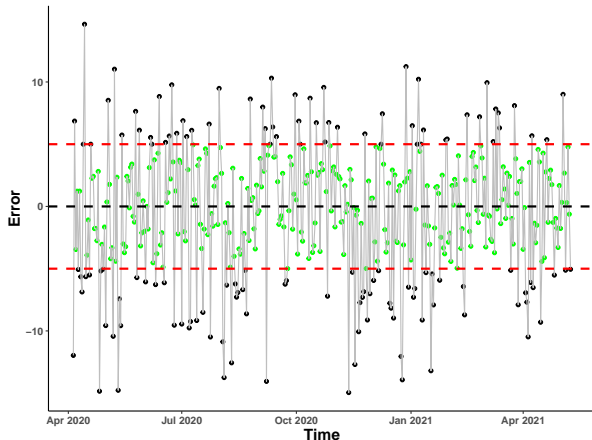




# RESULTS - ONE DAY AHEAD

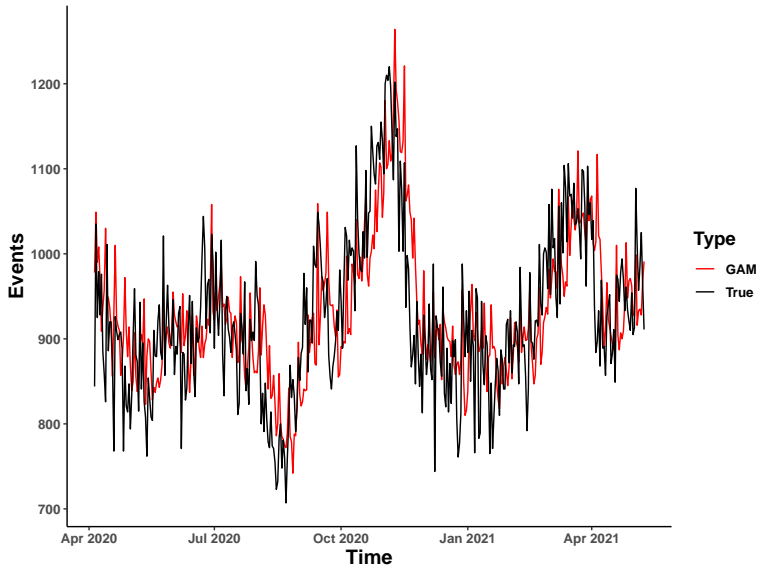


## RESULTS - ONE DAY AHEAD



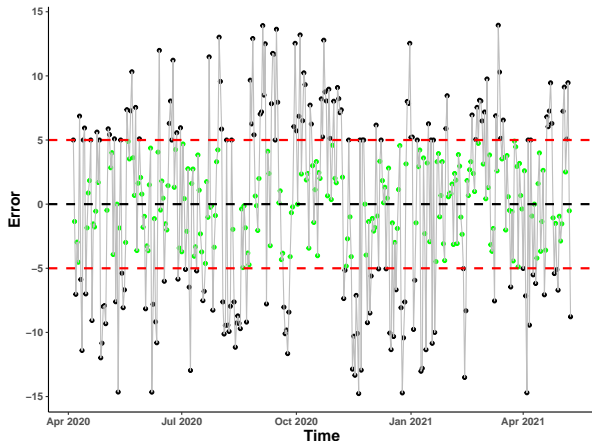
- 87% of predictions has absolute error below 5%;
- Mean absolute error equals 4.41.

# RESULTS - FIVE DAYS AHEAD





## RESULTS - FIVE DAYS AHEAD



- 55% of predictions has absolute error below 5%;
- Mean absolute error equals 5.24.

- We proposed a valuable model to predict number of events occurred in **Metropolitan**;
- capturing the **daily** and **seasonal** variation and incorporating **epidemiological** aspects as well as **weather** information.

and the model works well also for predicting the number of events for the other regions:

- **Plan** → mean absolute errors equals 4.13;
- **Lakes** → mean absolute errors equals 5.9;
- **Alps** → mean absolute errors equals 6.47.