Politecnico di Milano
Scuola di Ingegneria Industriale e dell'Informazione
Applied Statistics
Academic Year 2024/2025
Exam 2025-02-06 - Part B

Problem 3: Movie Ticket Sales Depending on Cinema Location and Weather Conditions

With over 280 cinemas, Paris boasts the most extensive cinema scene in the world. A study is conducted to analyze the impact of several factors on the daily sales of movie tickets in Paris. The dataset `moviesales.txt` includes the UTM geographical coordinates s_i of 100 cinemas in Paris, the standard ticket `price` in the cinema concerned (in €), and the number of tickets $y(s_i)$ (in thousands) sold during one day (which is not necessarily the same between the cinemas) of May 2024. Additionally, the boolean variables `rainy` and `cloudy` indicate whether the day during which the ticket sales were counted was cloudy and/or rainy.

Ticket sales are first modeled based on price using the following relationship:

$$y(s_i) = b_0 + b_1\texttt{price} + \delta(s_i), \tag{3}$$

where $\delta(s_i)$ represents a stationary residual modeled with a *spherical variogram with nugget*.

a) Report a plot of the fitted variogram. Indicate the estimate of the range and the sill.

b) Estimate the parameters b_0 and b_1 using the generalized least squares method.

c) Provide an estimate of the number of tickets that will be sold during a day of May 2025 (assuming spatial correlation) for the new cinema *Les Visionnaires*, located next to the *Basilique du Sacré-Coeur de Montmartre* (located at `x=514712`, `y=5033903`), with a ticket price of 8.50 €.

d) Modify the model in Eq. (3) as follows:

$$y(s_i) = b_{0,j} + b_{1,k}\texttt{price} + \delta(s_i) \tag{4}$$

where j represents the grouping induced by the variable `cloudy` and k the grouping induced by the variable `rainy`.

Provide an estimate of the parameters $b_{0,0}$, $b_{0,1}$, $b_{1,0}$ and $b_{1,1}$. How would you describe the effect of the `rainy` variable on the daily ticket sales?

Upload your results here: `https://forms.office.com/e/NRp2TfmcXk`