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ChoveuRIO: Data Interpolation and Graph Theory for Real-Time Rainfall Visualization in the Rio de Janeiro city

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This abstract presents the ChoveuRIO platform, an open-source initiative developed to visualize real-time rainfall data in Rio de Janeiro by applying advanced interpolation techniques, such as Inverse Distance Weighting (IDW) and Kriging. Integrating the data from automatic pluviometers, the platform also provides a view of the city's road graph and optimizes routes between two points considering both the current precipitation and the total distance traveled. Developed with a stack including Svelte [5], Leaflet [3], and D3 [1], ChoveuRIO serves as a critical tool for public use, disaster management, and research. Our platform integrates with DataRio [2] to provide accurate administrative regions and OpenStreetMap [4] for the highway network. This work presents the potential of combining mathematics, technology and environmental science to enhance urban resilience against climatic adversities.

Figure 1: Homepage of the ChoveuRIO platform. Available at: `https://choveu-rio.netlify.app/`.

Environmental disasters have become increasingly frequent and severe, prompting the need for efficient disaster management tools. ChoveuRIO, developed in collaboration with CEMADEN, aims to address this challenge by providing real-time access to rainfall data in Rio de Janeiro, supporting both preventative measures and immediate responses to environmental threats.

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The methods used for interpolation are based on two different approaches: the IDW provides a deterministic approach, while Kriging takes into consideration the uncertainty of the data. By implementing both techniques, the platform aims to provide the user the possibility of choosing between two approaches and comparing interpolation results.

We specify IDW interpolation formula as:

$$v(p) = \frac{\sum_{i=1}^{n} w_i(p) \cdot v_i}{\sum_{i=1}^{n} w_i(p)}, \tag{1}$$

where $v(p)$ is the interpolated value at point p, v_i are the known values at sample points, and $w_i(p)$ are the weights. The weight $w_i(p)$ is calculated using the distance between the unknown point p and the known point p_i, typically using:

$$w_i(p) = \frac{1}{d(p, p_i)^2}, \tag{2}$$

with $d(p, p_i)$ being the distance between points p and p_i. The exponent "2" can be adjusted to change the weighting effect. As a second approach to the interpolation problem, our work also used Kriging, which estimates the value at an unmeasured location as a weighted sum of known values. The formula is:

$$Z^*(x_0) = \sum_{i=1}^{n} \lambda_i Z(x_i), \tag{3}$$

where $Z^*(x_0)$ is the estimated value at location x_0, $Z(x_i)$ are observed values, and λ_i are weights determined based on the spatial autocorrelation model, described by:

$$2\gamma(h) = \frac{1}{N(h)} \sum_{i=1}^{N(h)} (Z(x_i) - Z(x_i + h))^2, \tag{4}$$

where $\gamma(h)$ is the semivariogram, h is the lag distance, and $N(h)$ is the number of pairs of locations separated by h.

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