Reconstructing the Elevation Attributes of Montpellier's Sewer & Storm-Water Network

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Introduction

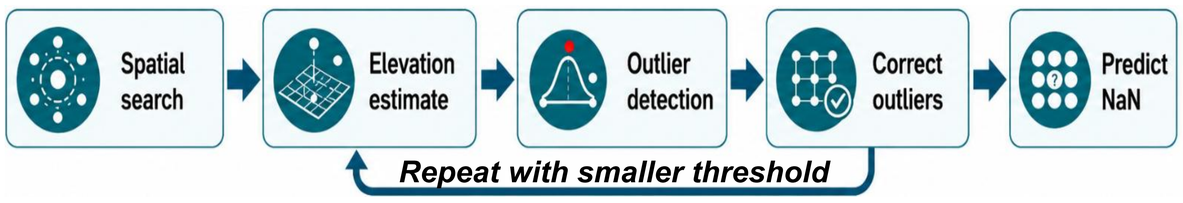
Urban network management depends on the quality of the databases that describe it. In practice these databases are **incomplete and partly erroneous**. The objective is twofold: **correct the aberrant values** in the existing data, and **predict the missing values**, while preserving physical and hydraulic consistency.

- **Two attributes, two challenges**
- **rimElevation** – surface elevation at manholes. Well documented (~7% missing)
- **invertElevation** – pipe-bottom elevation. ~66% missing and concentrated in the city centre.

A rimElevation

Surface elevation — predicted from spatial neighbours

A.1 Methodology



- **3 models:** Inverse distance weighting, Linear regression and Quadratic regression. Each method estimates elevation from nearby nodes — weighted by distance (IDW) or fitted as a local surface (regression).

A.2 Experimental protocol

- **Test with injected errors.**
- **Test against an external elevation reference.**

A.3 Results

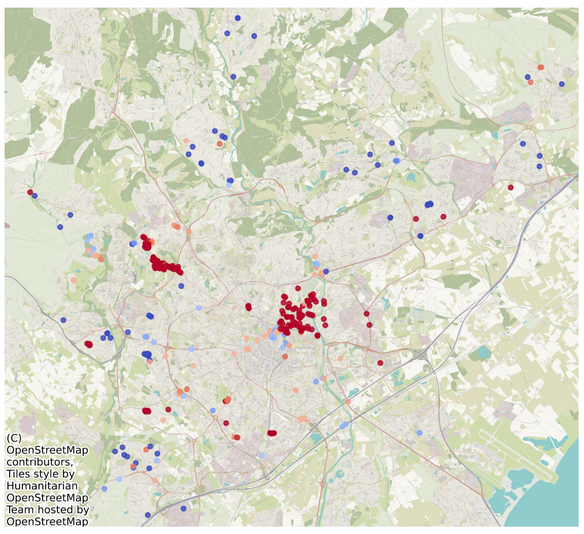
Best result on injected errors:

F1 score: 0.94 | **MAE TP: 0.77 m** | **MAE FP: 4.56 m**

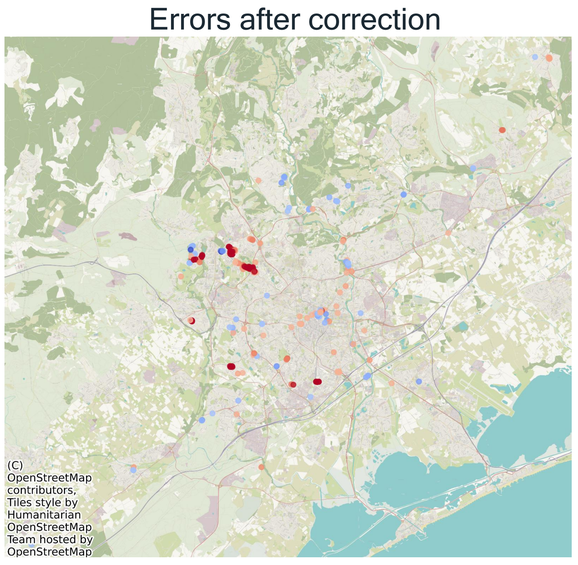
Results against the elevation reference:

Red points: database elevation above the reference.
Blue points: database elevation below the reference.

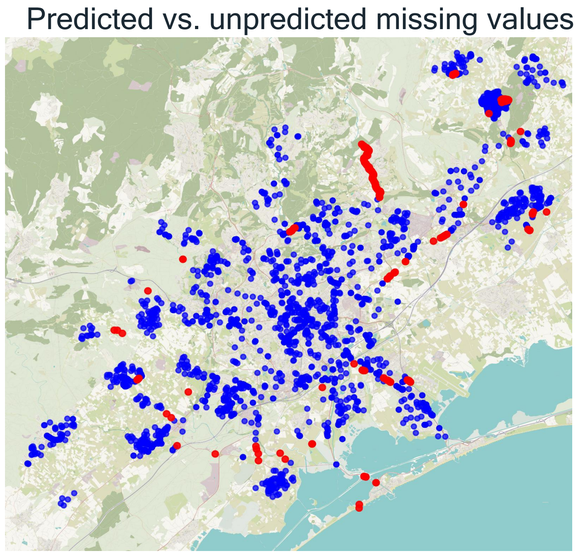
Errors before correction



Errors after correction



Predicted vs. unpredicted missing values



89% of missing rim elevations reconstructed, error reduced by 30%.

B invertElevation

Pipe-bottom elevation — topology-aware, physically constrained

B.1 Methodology

- **Method 1 —** Spatial prediction with **depth** and **slope constraints.**
- **Method 2 —** Graph propagation from known upstream/downstream nodes with **depth constraint**.

- **Role: Method 1** corrects outliers; **Method 2** predicts missing values.

B.2 Experimental protocol

- **Method 1 — test with injected errors.**
- **Method 2 — masking test on known invertElevation values.**

B.3 Results

Best correction result on injected errors - Method 1:

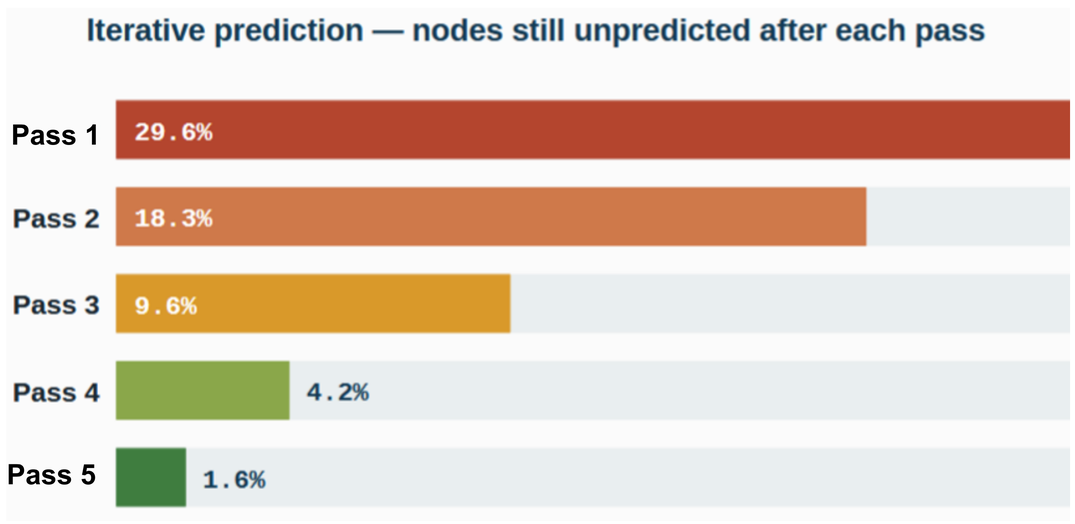
F1 score: 0.96 | **MAE TP: 0.37 m** | **MAE FP: 0.7 m**

Best one-pass prediction result on masked values - Method 2:

MAE: 0.40 m

The physical constraints are decisive – without the depth constraint the error is 58% larger. A single pass still leaves 29% of nodes unpredicted, so an iterative strategy is used.

Best result for correction and iterative prediction:



- Running prediction **after** correction lowers the masked-node MAE by 13% – though correction touches only 0.73% of nodes.

98.4% of network nodes now have a known invertElevation (MAE = 0.39 m)