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From Imperfect Sewer Data to Coherent Topology: A Graph-Based Approach

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Urban sewer networks are critical infrastructures that support residents' everyday life and ensure the collection and transportation of wastewater and stormwater. Yet operational datasets describing these networks are frequently imperfect: pipes may be missing, connectivity may be fragmented, and flow direction may be inconsistent due to incomplete attributes (e.g., invert levels, slope) or digitizing errors. We present a topology-focused study that transforms sewer data into a directed network by combining (i) graph-based representation and (ii) geometry-based consistency checks and rules. Starting from a directed (multi)graph built from available pipe and node geometries, which represent the edges and nodes in the graph, we detect topological anomalies including disconnected components, missing connections, dead ends, and closed loops.

When two pipes converge at a manhole with no outgoing pipe, it forms a non-outlet sink. To resolve this, we apply a two-stage methodology: edge orientation to reduce flow inconsistencies and resolve any sink nodes, followed by targeted edge addition to reconnect remaining disconnected components when reversals alone are insufficient. We test feasibility of the approach on a large open-access urban sewer dataset. The results illustrate how topology-oriented methods can still be applied to establish a well-connected network when data attributes are missing or unreliable.