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Development of a demand- and network-based tool for automatic detection of post meter leakages

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Water losses are one of the main challenges posed worldwide to an efficient management and maintenance of urban potable
water distribution networks. Large effort has been devoted in the literature to design algorithms to detect and localize water losses via physically-based hydraulic modelling, data-driven modelling, and probabilistic approaches. Most of the state-of-the-art research looks at developing such tools to prevent or mitigate both physical and apparent water losses in water networks and help utilities reduce water waste and costs due to non-revenue water. Along with the digital transition of urban water networks, the deployment of intelligent meters, and the acquisition of high-resolution data of water consumption at the household scale, a few data-driven methods have been also developed to detect post meter leakages, i.e. those leakages that occur within a residential property and that generate extra costs for water consumers. Yet, most of these studies consider single-household water use time series as taken individually and not connected within a network model. Thus, potential correlations among different water use time series, due, for instance, to location-based or behavioural similarities among different water consumption patterns are disregarded. Moreover, the limited availability of accessible water use time series observed via intelligent meters limits the scope and the data-driven nature of such methods to small-scale or theoretical experiments.

In this work, we propose a demand- and network-based method for post meter leakage generation and detection. Our method integrates (i) the STREaM stochastic simulation model to generate synthetic time series of residential water demand at the scale of single fixtures (i.e. toilet, washing machine, tap, etc.), (ii) a module for pressure-driven simulation of water supply networks and generation of realistic leakages, and (iii) a data-driven learning algorithm for the automatic detection of post meter leakages. We test our method both with synthetic water demand data including post meter leakages, as well as in a lab-controlled setting where leakage values are set at the end-use notes in order to be comparable to real-world fixture leakages. Numerical results show that by integrating both water demand patterns and a network model, our method exploits spatial and temporal correlations among fine-resolution water demand time series to achieve improved accuracy and reduced amount of false alarms as benchmarked against state-of-the-art algorithms.