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Strategic sensor placement for the identification of disinfection by-products from chlorinated drinking water

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Innovative Integrated Tools and Technologies to Protect and Treat Drinking Water from Disinfection Byproducts (DBPs)

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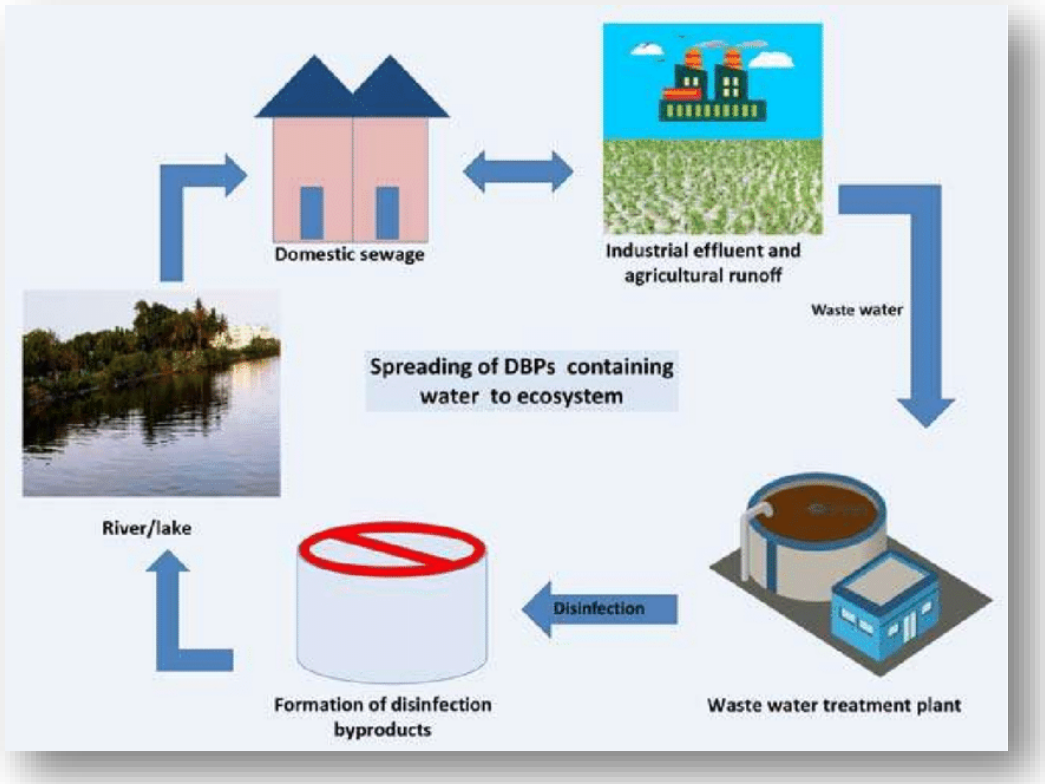
Why is **smartly** detecting disinfection byproducts important?

- Placement is *time consuming* – knowing beforehand the best locations for sensor can be beneficial for multiple objectives.
- By running multiple placement simulations with different objectives, it is possible to cover *all expected contamination scenarios*.
- Number of sensory equipment can be *limited* – placing sensors at dead-end nodes, for example, does not bring in good results.



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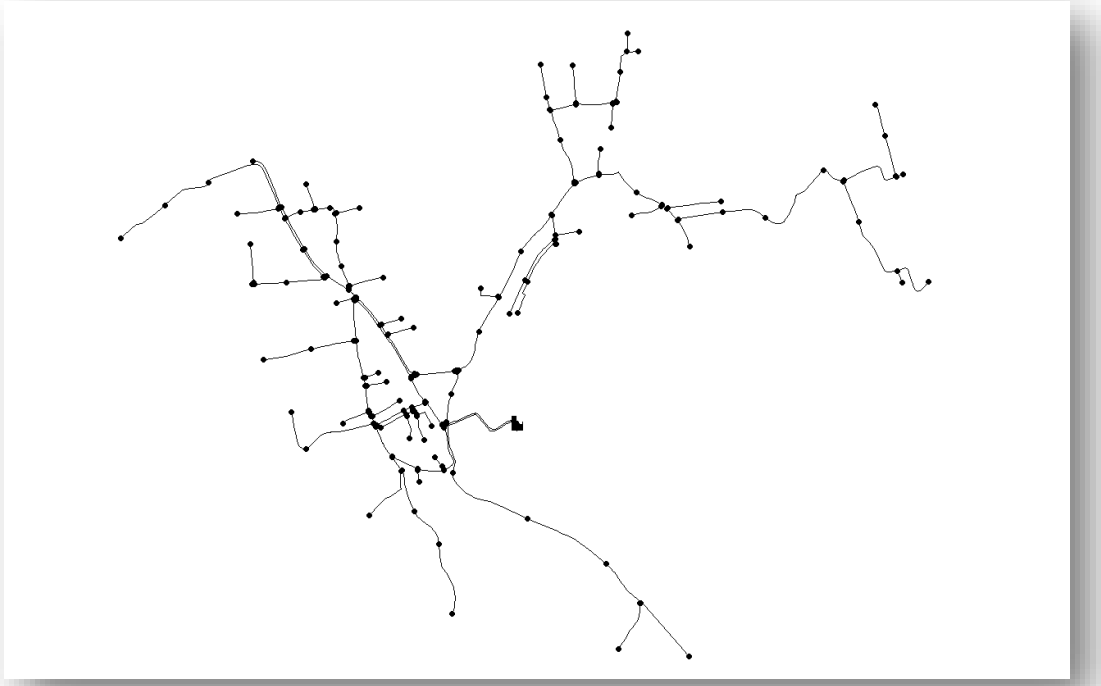
How to achieve **smart placement**: the data-driven methodology

- A calibrated water distribution network is required to achieve a strategic sensor placement result.
- Environmental data is mandatory in order to calculate the concentration of disinfection by-products in each node in the network.
- Identifying which performance objectives are important to the needs of the water utility operators.



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Lack of data – how to combat such an issue?

- Data for strategic sensor placement is required from all the nodes in the network, as well as frequent measurements for consistency.

- If data is lacking, by generating synthetic data it is possible to cover the gaps and create a dataset to allow the model to run a simulation for proper strategic placement.

Timestamp	Node	Contracts	Chlorine (mg/L)	Temperature (	pH	TOC (mg/L)	DON (mg/L)	BR (mg/L)
20-10-24 0:00	1_1000	0	3.61	19.06	7.7	4.18	7.04	3.21
20-10-24 0:00	1_1001	5	2.86	16.05	7.82	2.25	8.43	3.94
20-10-24 0:00	1_1002	0	0.19	17	7.19	9.99	12.07	4.38
20-10-24 0:00	1_1003	12.5	3.76	14.94	7.35	9.76	10.68	3.97

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Algorithmic approach to this methodology

For each node in the network, analyze the values of the environmental parameters

Use equations for each family of disinfection byproducts to calculate the concentration on each node

When exceeding the regulatory limits, count it as an event

Normalize the number of events and multiply them based on a weight value given on each DBP

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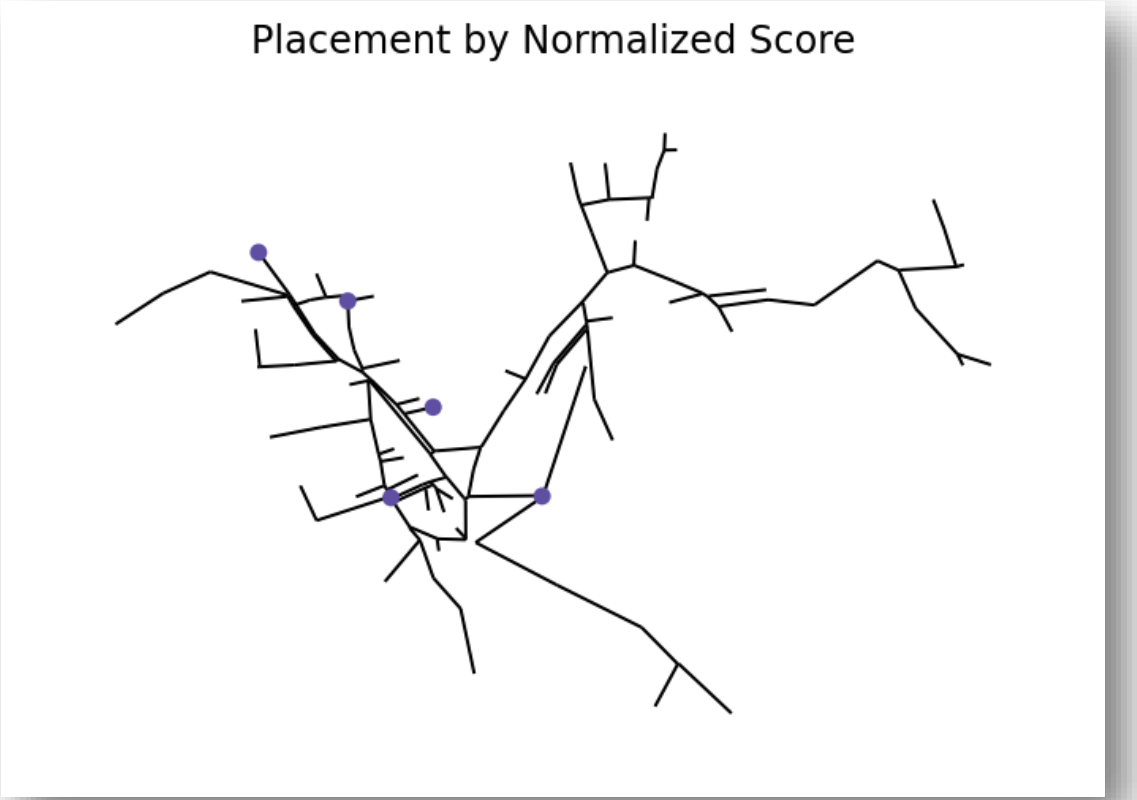
Performance objectives

The strategic sensor placement needs to have a specific cause in order to maximize results:

- Time of detection – placement based on minimizing time of detection of disinfection by-products.
- Mass consumption – minimization of consumers affected by polluted water, based on contracts provided by the water utility operators.
- Concentration based – placement based on high concentration of disinfection byproducts in the network



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What are the limitations this methodology?

- The perfect dataset will not exist, generating data is vital.
- Sensors are considered perfect in the simulations – something that is not true in real-life scenarios.
- The nodes that might be selected for a water distribution network through the strategic sensor placement, might not be accessible for actual sensor placement.

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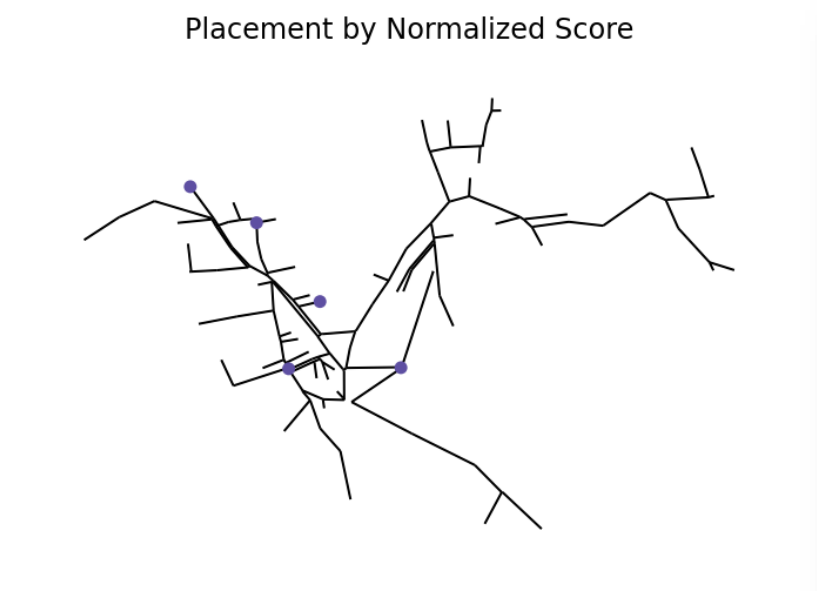
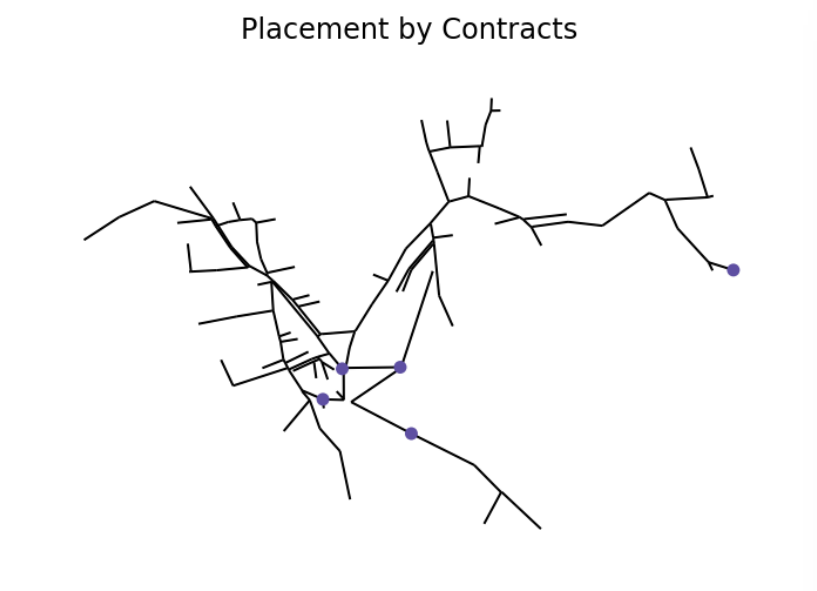
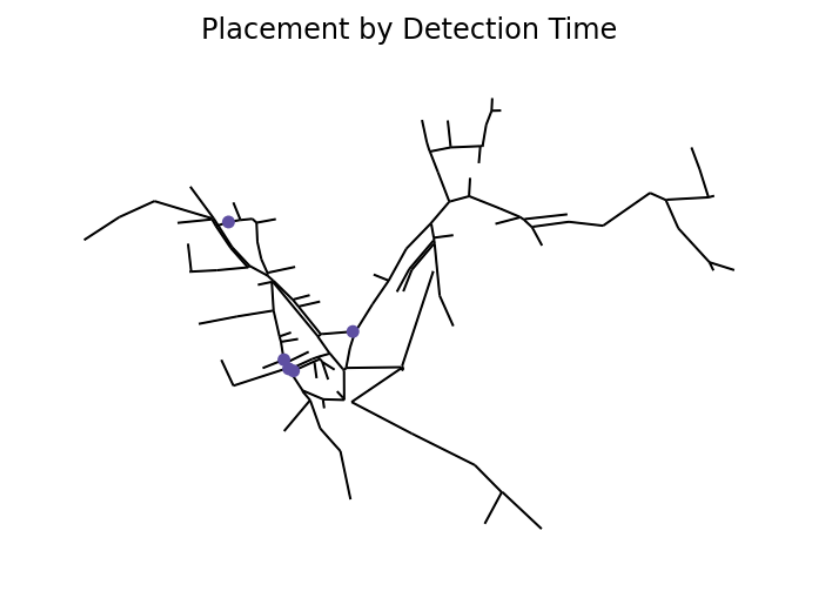
Examples of strategic sensor placement for a water distribution network in Coimbra, Portugal







These scenarios utilize 5 sensors and prioritize trihalomethanes for the placement. Injection point is the tank (fixed location).

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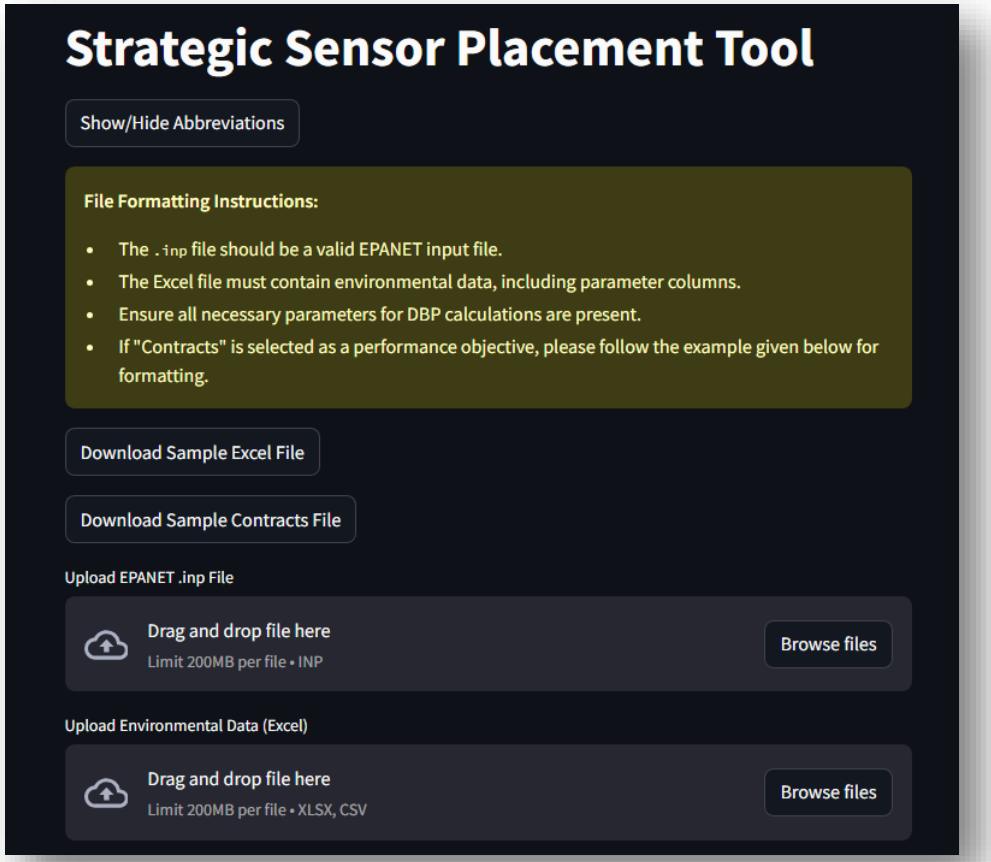
Currently in progress: Open software for strategic sensor placement

An open software is in development that will allow users to input a water distribution network and environmental data byproducts and get results for strategic sensor placement.

The users will be able to:

- Select performance objectives.
- Select equations for the selected disinfection byproducts or input their own.
- Select number of sensors to place.
- Adjust the weight of disinfection byproducts (priority).
- Select to either randomize the injection (random node) or not.



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Questions/Discussion

THANK YOU
FOR YOUR ATTENTION

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