Estimating pollution spread in water networks as a Schrödinger bridge problem with partial information

Michele Mascherpa
Kungliga Tekniska högskolan (KTH), Sweden
micmas@kth.se

Incidents where water networks are contaminated with microorganisms or pollutants can result in a large number of infected or ill persons, and it is therefore important to quickly detect, localize and estimate the spread and source of the contamination. In many of today's water networks only limited measurements are available, but with the current internet of things trend the number of sensors is increasing and there is a need for methods that can utilize this information. Motivated by this fact, we address the problem of estimating the spread of pollution in a water network given measurements from a set of sensors. We model the water flow as a Markov chain, representing the system as a set of states where each state represents the amount of water in a specific part of the network, e.g., a pipe or a part of a pipe. Then we seek the most likely flow of the pollution given the expected water flow and the sensors observations. This is a large-scale optimization problem that can be formulated as a Schrödinger bridge problem with partial information, and we address this by exploiting the connection with the entropy regularized multimarginal optimal transport problem. The software EPANET is used to simulate the spread of pollution in the water network and will be used for testing the performance of the methodology.

Joint work with Isabel Haasler (EPFL, Switzerland), Bengt Ahlgren (RISE Research Institutes of Sweden) and Johan Karlsson (KTH).