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Towards Smart, Resource-Constrained Environmental Sensor Networks

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In the era of Internet of Things, sensors are connected and increasingly smart. Sensors are connected through a fusion center, and do not only observe and deliver data but can also receive information and make autonomous decision based on calculations and decision schemes. To be affordable, sensors need to be deployed wirelessly, off-the-grid. This implies that their energy budget is often quite constrained, powered by batteries and maybe solar panels. At the same time, there are often additional information (e.g., weather forecast) as well as spatio-temporal dependency in the process of interest. In this work, we aim to take advantage of this additional information together with dependencies to meet the energy constraints set by the sensors.

Our motivating case is a spatial network for temperature observations, where a probabilistic weather forecast (e.g., ensemble forecast) is available, and it energy consumption of observing is low compared to that of transmission. To reduce the number of transmission instants, sensors transmit when the observations fall outside an interval set by the fusion center, and guided by the weather forecast.

In this work, we first set up a spatial model that utilizes both observations transmitted and the information hidden in observations not transmitted (they are within the given interval). We demonstrate that the predictive uncertainty decreases when hidden-information about the missing transmissions is incorporated into the solution. Further, we study spatial designs with several sensors, and show how to optimize the thresholds with respect to predictive variance by utilizing the spatial dependency. For given sensor locations, the optimal thresholds varies both with the dependency between the sensors and the dependency for the location(s) we optimize for.