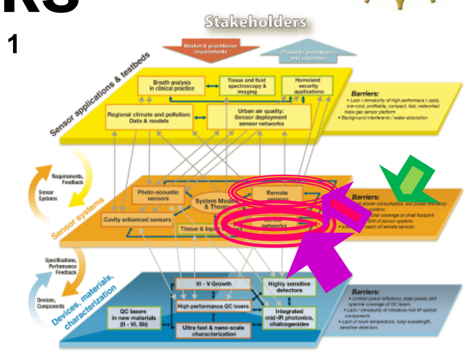
Exploiting Spatiotemporal Correlations in Environmental Monitoring Networks

Marcus Chang,[1] Jayant Gupchup,[1] Doug Carlson,[1] Andreas Terzis [1]
Kathy Szlavecz, [2] and Alex Szalay [3]

1 – Department of Computer Science, Johns Hopkins University
2 – Department of Earth and Planetary Sciences, Johns Hopkins University
3 – Department of Physics and Astronomy, Johns Hopkins University

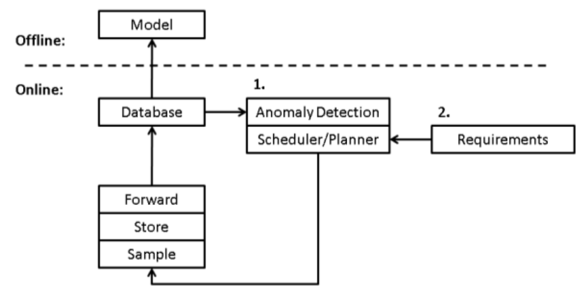


Data from real deployments

- Data from real deployments tends to contain faulty readings and missing values
- Scientists require fault-free and gap-corrected data to work with
- Spatiotemporal correlations in data allow us to identify anomalies and interpolate missing values
- Principal component analysis based methods are employed to "repair" the data [1]

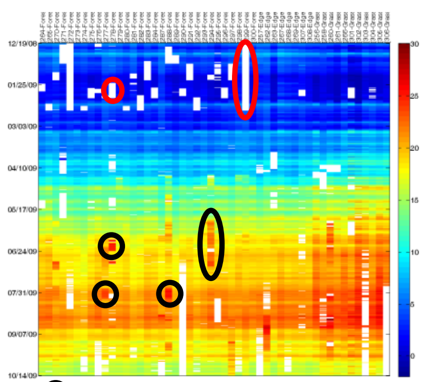
Cub Hill deployment near Baltimore

Autonomous data acquisition [2]



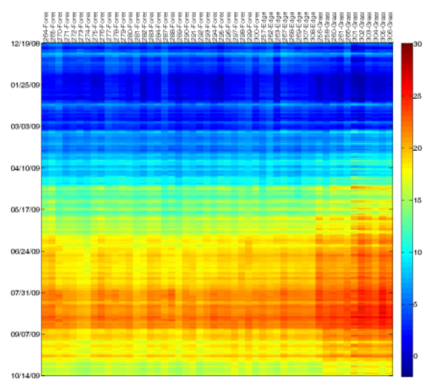
- Artificial Intelligence (AI) planner transforms ecologists requirements into a constraint optimization problem
- Online anomaly detection system suggests sampling locations
- AI solver finds optimal sampling strategy

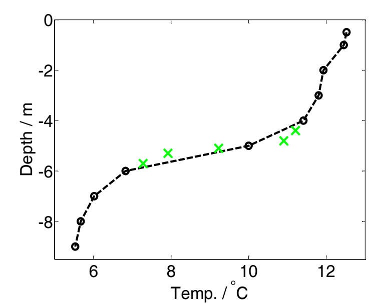
Soil temperature dataset

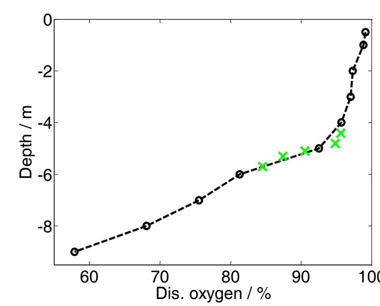


Fault Examples   Missing Values Example

Fault-free and gap-filled dataset







Adaptive sampling successfully tracks moving stratification layer and yields accurate oxygen distribution

References:

[1] : A Robust Classification of Galaxy Spectra: Dealing with Noisy and Incomplete Data,Connolly, A. J. and Szalay, A. S., *The Astronomical Journal, vol. 117, pp.*2052–2062, May 1999.

[2] : Meeting ecologists' requirements with adaptive data acquisition, M. Chang, P. Bonnet, In Sensys 2010

www.mirthecenter.org

This material is based upon work supported by the National Science Foundation under Grant No. EEC-0540832.