A Case Study on Multi-Criteria Optimization of an Event Detection Software under Limited Budgets

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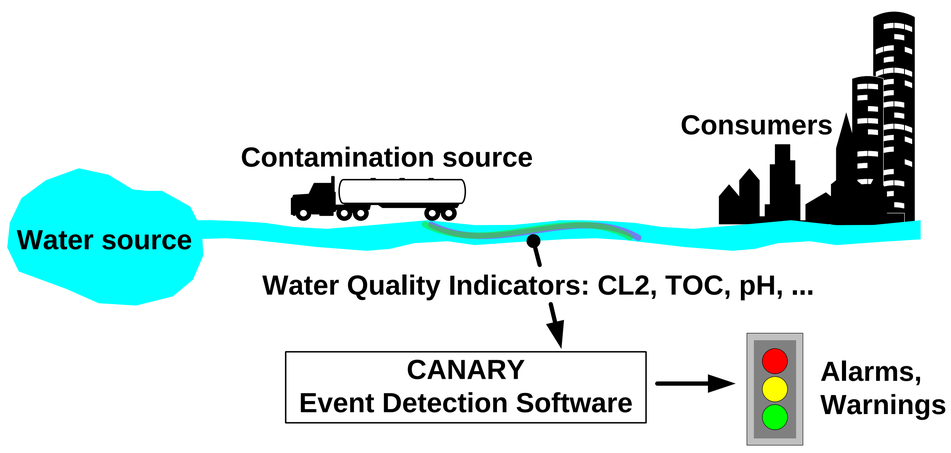
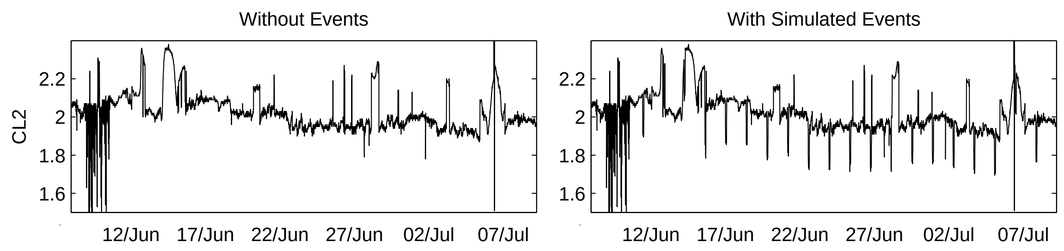
The Problem: Tuning an Event Detection Software

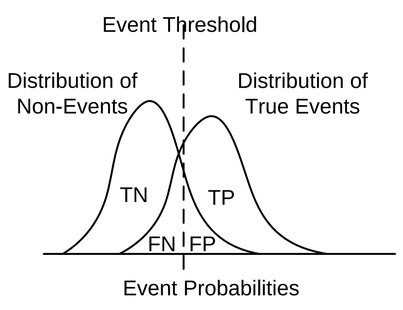


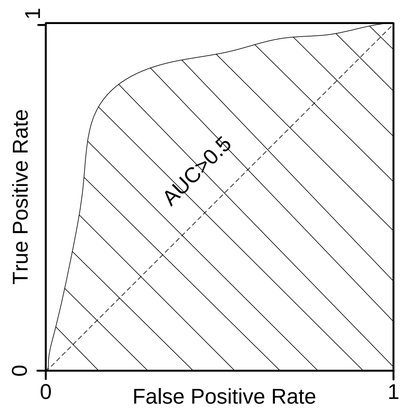
Detect events in multivariate water quality data



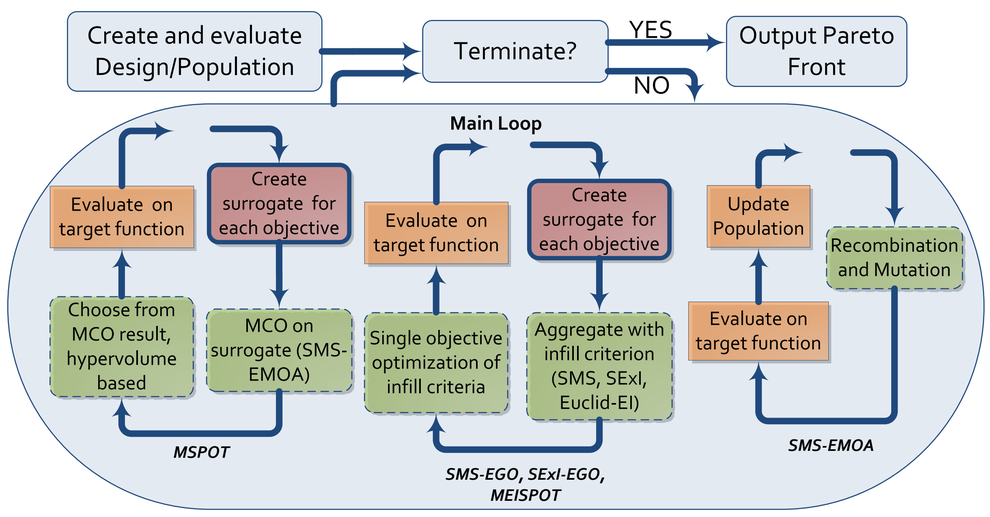
Optimization Problem Definition

- Two parameters: **Window Size** and **Threshold**
- Two objectives: **max. True Positive Rate** vs. **min. False Positive Rate**
- Hypervolume ≈ Area Under receiver operator characteristic Curve





Algorithms and Infill Criteria



SMS-EGO Hypervolume contribution of the lower confidence bound predicted by Kriging model. Use single objective optimization.

SExI-EGO Exact computation of the Expected Improvement in Hypervolume based on the multivariate predictive distribution. Use single objective optimization.

MEISPOT Euclidean distance based multi objective expected improvement. Use single objective optimization.

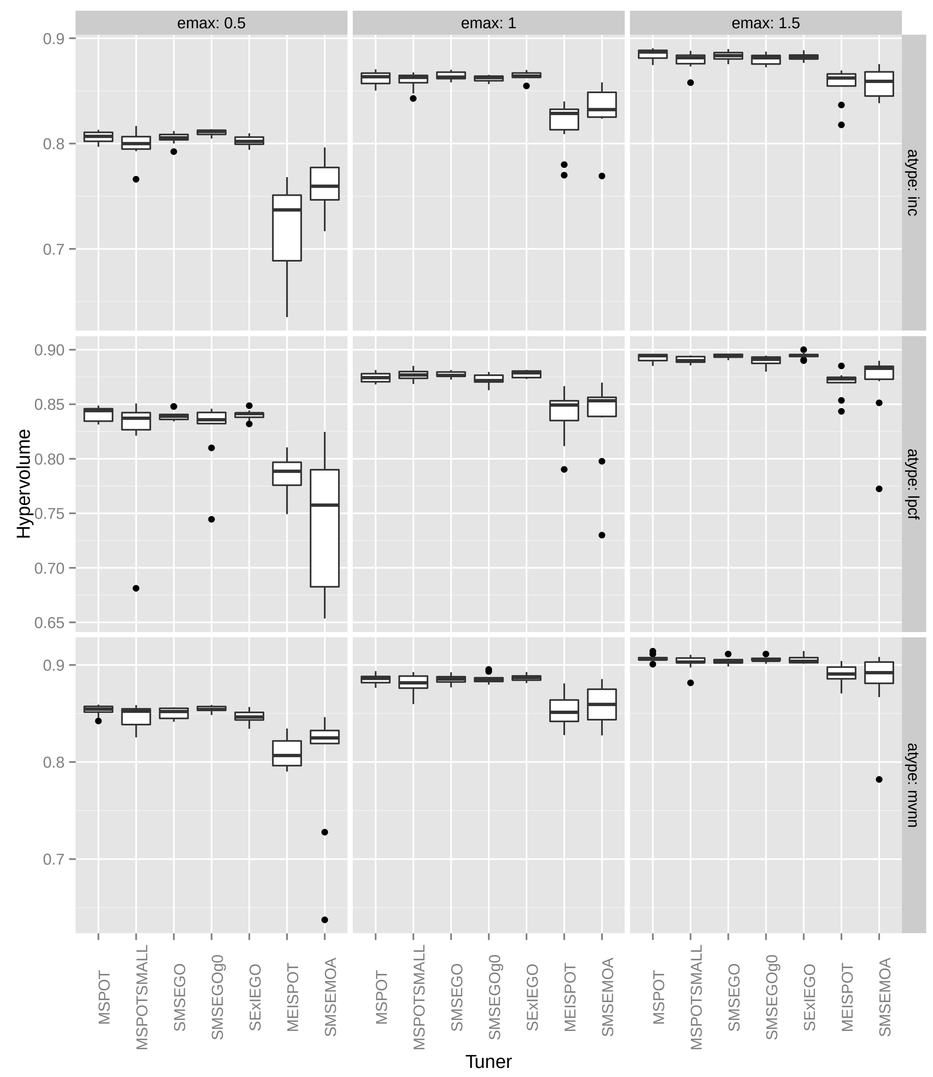
MSPOT Not aggregated, use SMS-EMOA to optimize directly on Kriging models predicted means.

SMS-EMOA No surrogate model. Iteratively add individuals by means of random variation and hypervolume-based selection.

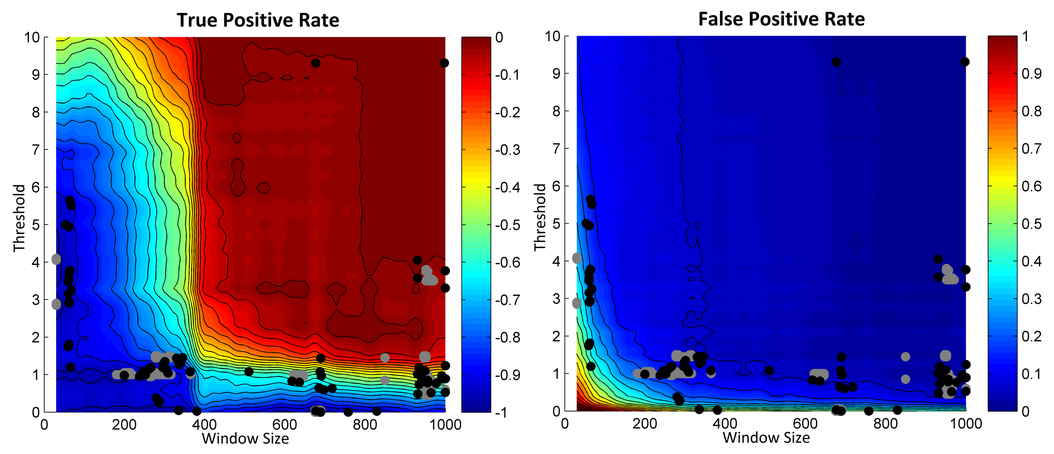
Research Questions

Q 1 Is Kriging a suitable surrogate model for the event detection software?
Q 2 Use predicted variance (or not)?
Q 3 If and how to aggregate the predicted objectives to an infill criterion?
Q 4 Can theoretical considerations be confirmed for this use-case?

Results



Fitness landscape



Problem Instance: Event Strength 1.5, MVNN
Black Dots: Pareto-optimal solutions found on the actual problem
Grey Dots: Pareto-optimal solutions found on the model using grid sampling

Answers

A 1 *Kriging works: Surrogate-based approaches outperform model-free SMSEMOA. Problems: approximating flat areas in fitness landscape.*

A 2 *Using the variance (i.e. enforcing exploration) does not yield improvement, but also no decrease in performance.*

A 3 *Hypervolume-based infill criteria work very well. MCO on the surrogate models is a viable alternative.*

A 4 *Confirmed: The violation of the dominance relation within MEISPOT results in a deterioration of the performance.*

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