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OpenSense RTD 2010

FNSNF

OptiMoS: Optimal Sensing for Mobile Sensors

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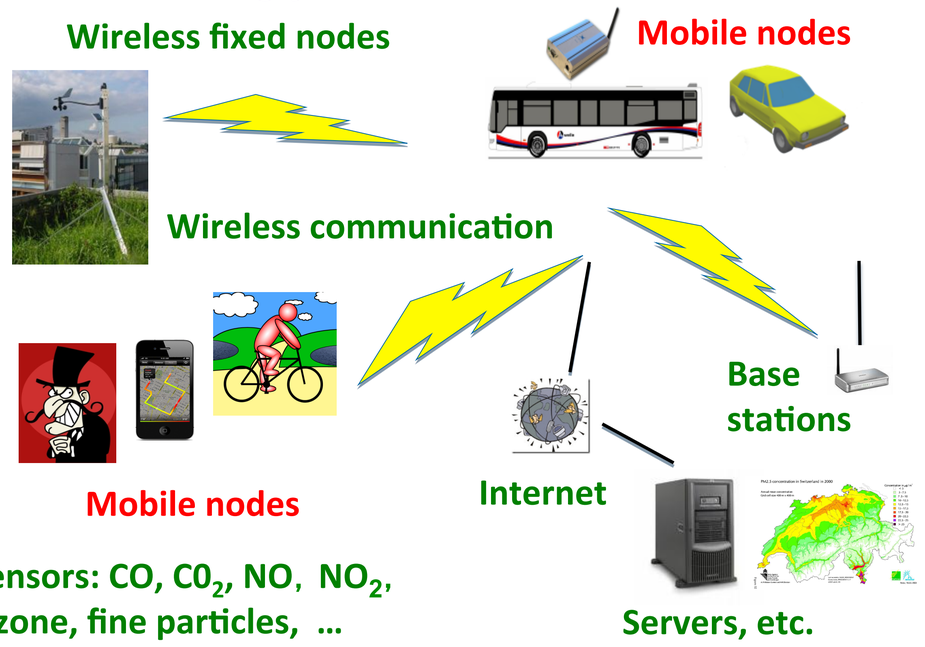
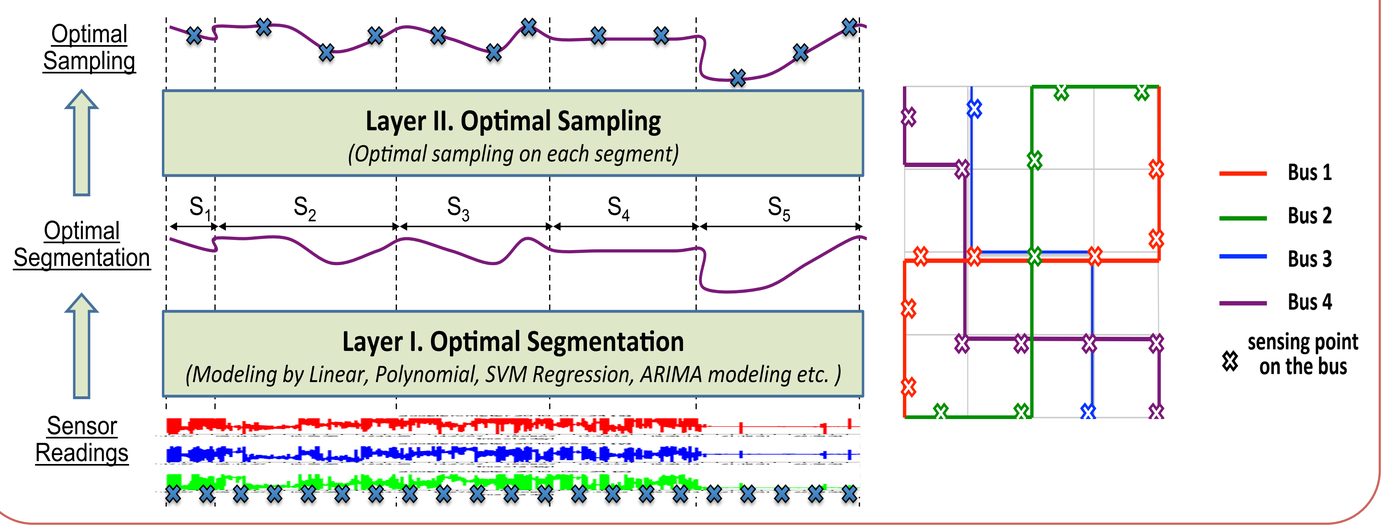
OpenSense: An open environmental sensing platform with massive, heterogeneous, mobile and increasingly miniaturized sensors.



OptiMoS: An optimal mobile sensing for achieving appropriate tradeoff between "sensor coverage maximization" and "energy cost (sampling) minimization".

- Two-Tier Sensing Platforms: Segmentation and Sampling
- Optimal sensing for one bus line (a single mobile node), or multiple bus lines
- Optimal co-sensing among different sensors, e.g., CO, CO_2, NO_2 …



Model-Driven Segmentation of Mobile Sensing

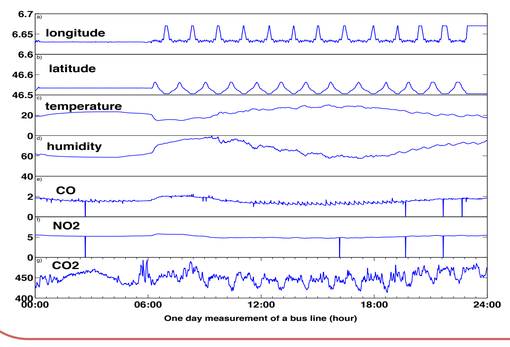
Problem Statement of Segmentation

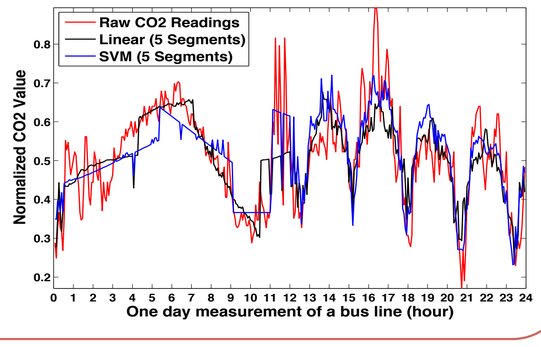
- **Initial Sensor Readings**
  - Sensor reading records
  - Each record with time, location, measurements

$$\mathcal{R} = \{R_1, \cdots, R_N\}$$
$$R_i = \langle t, l, x_1, \cdots, x_m \rangle$$

- **Data-driven Modeling**
  - Various models: linear, SVM regression, etc.
  - Model errors RSS – Residual Sum of Square
- **Optimal Segmentation**

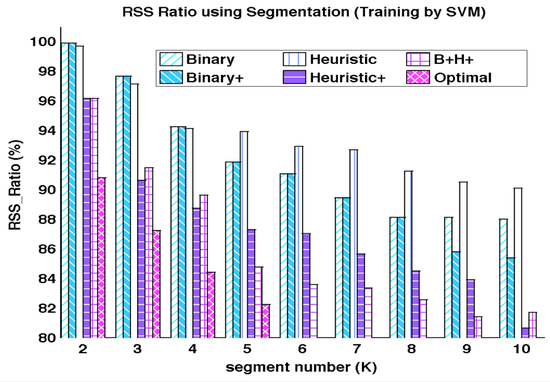
$$\underset{K, d_1, d_2, \cdots, d_{K-1}}{argmin} \sum_{i=1}^{K} RSS(\mathcal{M}(\{R_{d_{i-1}}, \cdots, R_{k_{d_i}}\}))$$

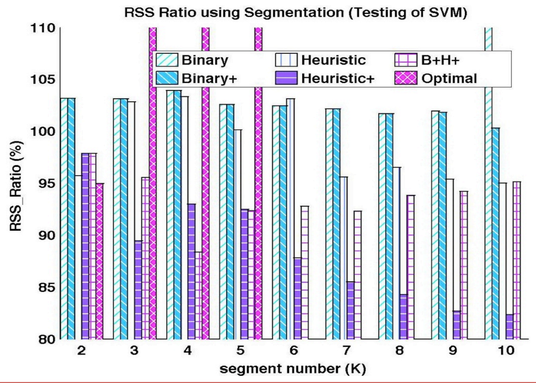




Segmentation Strategies

- **Optimal Segmentation**
  - Dynamic programming, expensive O(K*N^2), over-fitting
- **Top-down Binary Segmentation**
  - Binary: O(K*logN)
  - Binary$^+$: better strategy in finding division segment
- **Error-based Heuristic Segmentation**
  - Heuristic: division by absolute errors
  - Heuristic+: division by relative errors
- **Near-Optimal Segmentation**
  - B$^+$H$^+$: Binary$^+$ with Heuristic$^+$, O(K*N*logN)





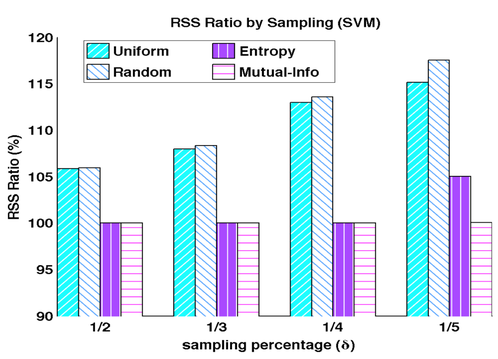
Near-Optimal Sampling for Individual Segments

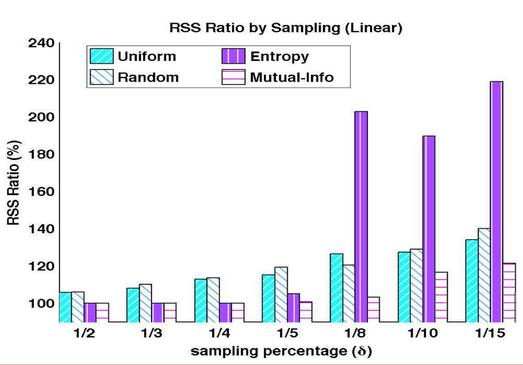
Sampling Strategies

- **Optimal Sampling**
  - NP-hard problem

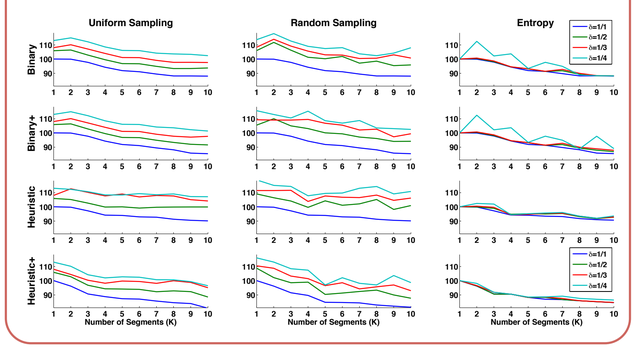
$$\underset{\mathcal{R}_{sub}}{argmin} \quad \mathcal{L}(\mathcal{R}, \mathcal{R}_{sub}) \quad s.t. \quad |\mathcal{R}_{sub}|/|\mathcal{R}| \leq \delta$$
$$\underset{\mathcal{R}_{sub}}{argmin} \quad |\mathcal{R}_{sub}|/|\mathcal{R}| \quad s.t. \quad \mathcal{L}(\mathcal{R}, \mathcal{R}_{sub}) \geq \epsilon$$

- **Distribution-based Sampling**
  - Uniform: regular duty cycle readings
  - Random: irregular duty cycle readings
- **Entropy (Error) based sampling**
  - Selecting points with top entropy
- **Mutual Information based sampling**
  - Remove information redundancy
  - Recalculate entropy after each selection/sampling

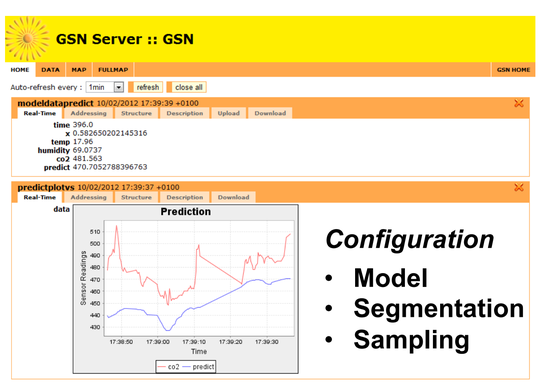




Two-tier Combinations



Integration with GSN for real-time data prediction



Configuration

- Model
- Segmentation
- Sampling

Visualization: create pollution map by model perdition from limited measurements.