ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Condense

Managing Data in CGSNs

Sebastian Cartier,
Saket Sathe,
Dipanjan Chakraborty,
Karl Aberer

IEEE SECON 2012, Seoul

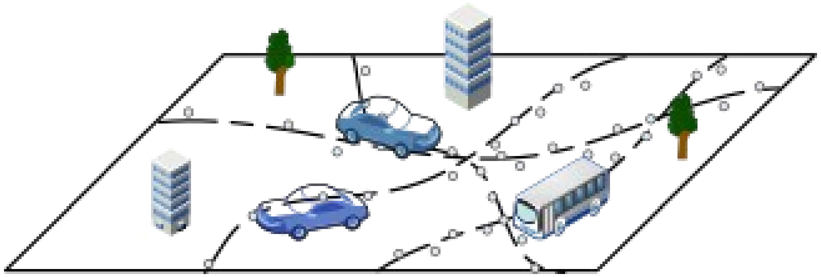
Content

1. CGSNs
2. Condense
3. Model Cover Estimation
4. Adaptive Methods
5. Datasets
6. Experiments

Motivation

- Community-driven Mobile Geo-Sensor Network
- Community-driven → No central authority
  - Different sensor quality
  - Different update rate
  - Unreliable readings
  - Uncontrollable movement of sensor nodes
- Irregular Data
  - Daytime, Season
  - Geographic situation
- Sensed Values
  - Pollution, Temperature, Radiation
- Challenge: Produce homogenous view on this data

Sensor Layer

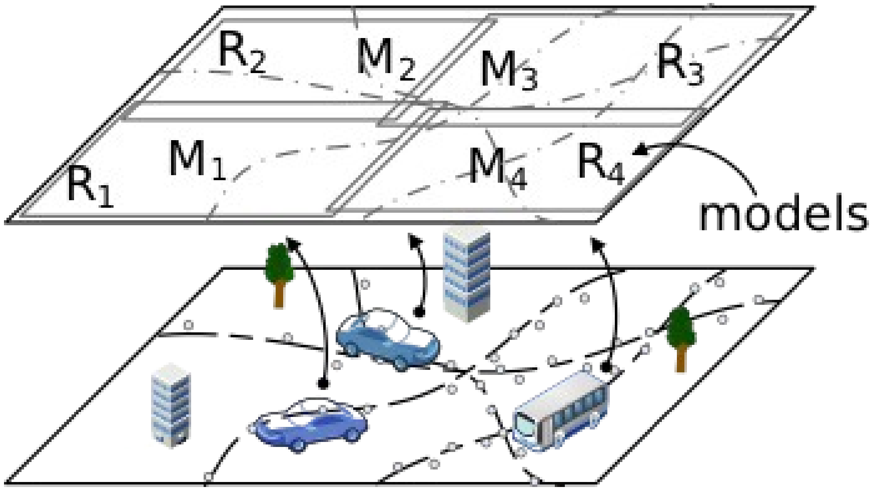


- Deployment by data distributor
- Sensor readings are continuously updated in Database
- Each reading is represented in a tuple:

$$b_i = (t_i, x_i, y_i, r_i)$$

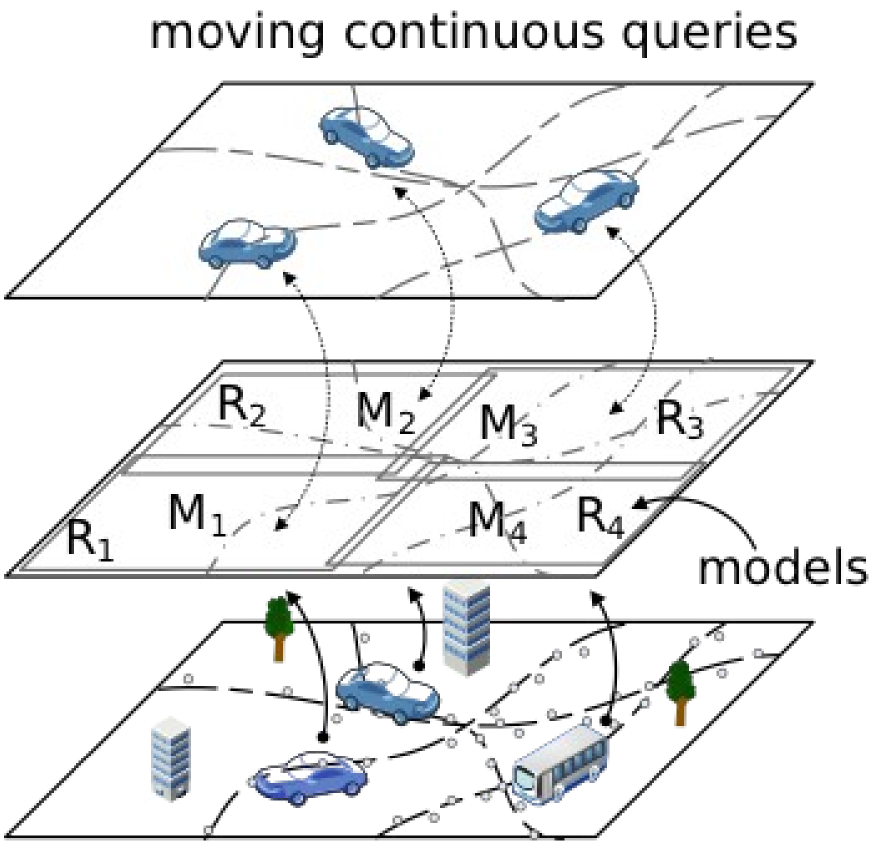
  - Timestamp
  - Position
  - Reading value

Model Layer



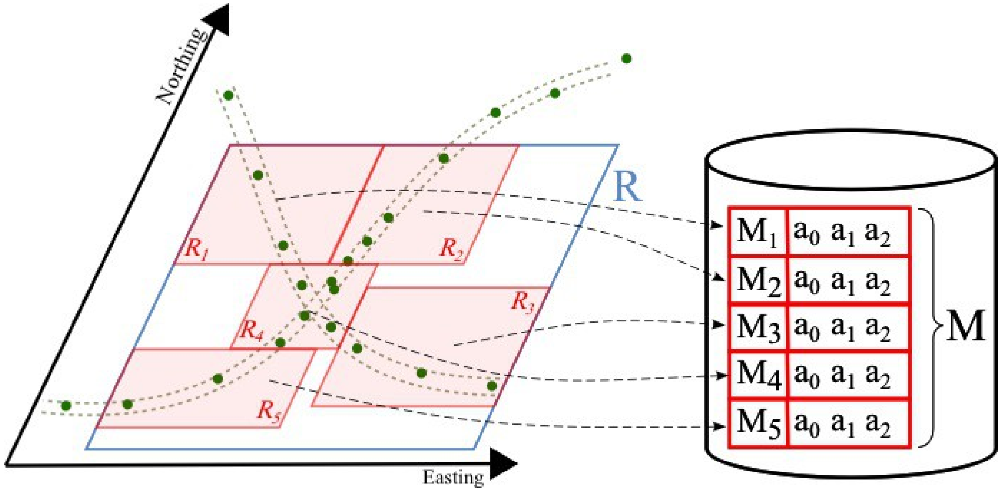
- Abstraction level for raw data
- Model cover
  - More than one model
  - Single models are less complex
- Continuous update of models
- Model layer is main focus of this Project

Query Layer



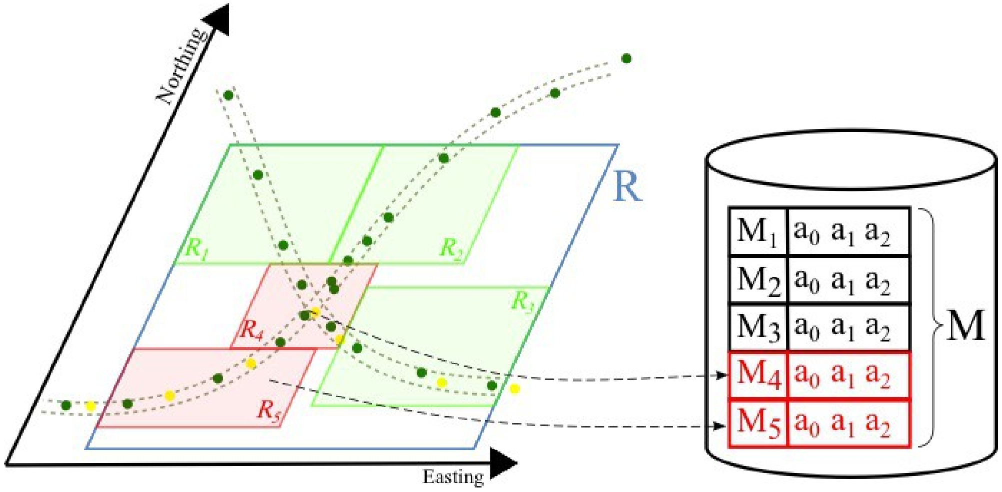
- No direct access to raw data
- One ore more model responsible for each query position
- Possible queries:
  - Single position
  - Continuous queries
  - Moving continuous queries

Model Cover Estimation



- One mathematical Model is not enough!
- Given: Region of interest R and raw tuples of one time window W_s
- Partition of region R: R_1,R_2,...R_p
- Raw tuples are distributed among regions
- For each Region R_α we want to create a Model M_α
-

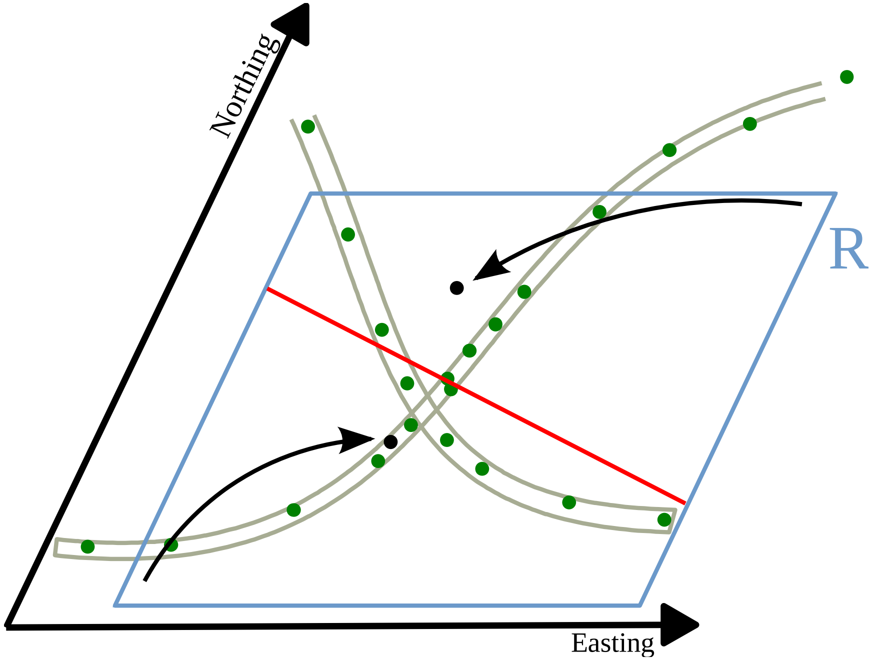
Model Cover Maintenance



M_1	a_0 a_1 a_2
M_2	a_0 a_1 a_2
M_3	a_0 a_1 a_2
M_4	a_0 a_1 a_2
M_5	a_0 a_1 a_2

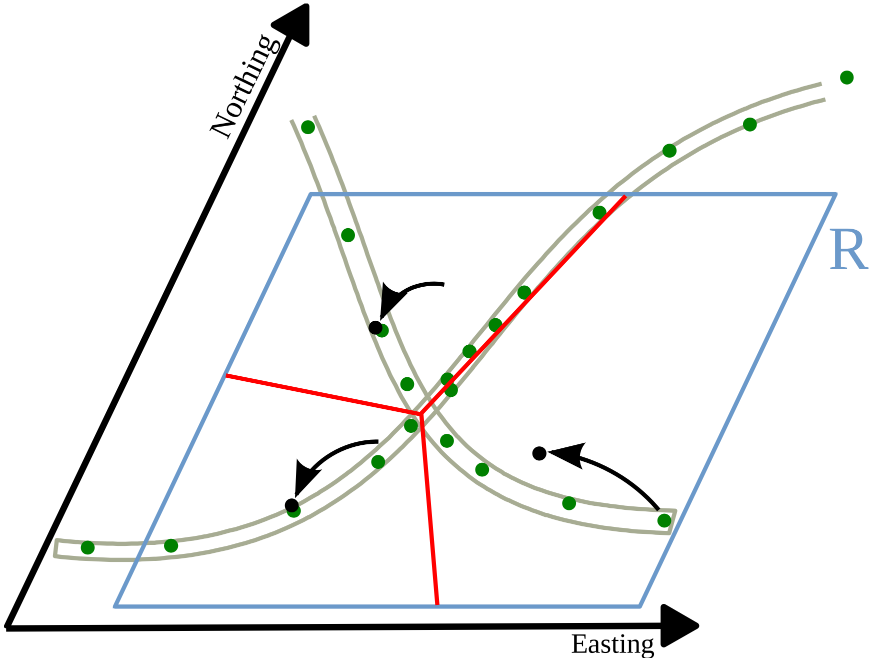
- New points are streamed into the system: W_{s+1}
- Which models have to be updated
- Only update these Models
- The other models are still valid from last time window
- Reduce cost by adapting the model cover, instead of creating new model cover for each new time window

Adaptive Method



1. Select 2 region centers
2. Run Simple K-Means
3. Check for each region if error criteria is met

Adaptive Method



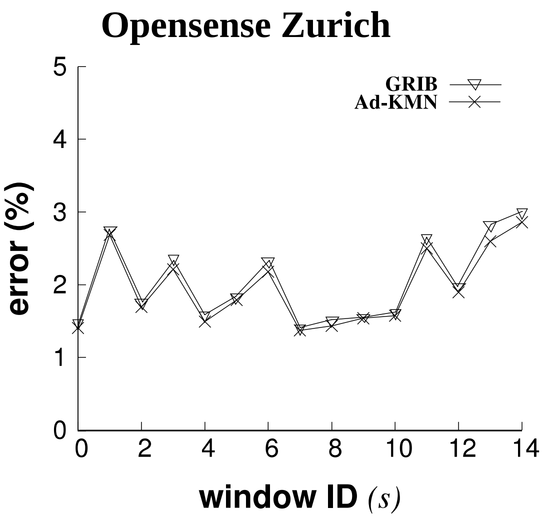
1. Select 2 region centers
2. Run Simple K-Means
3. Check for each region if error criteria is met
4. For each region, where error is too high:
   1. Select reading with highest error
   2. Create new region center
5. Jump to step 2, if new regions were created

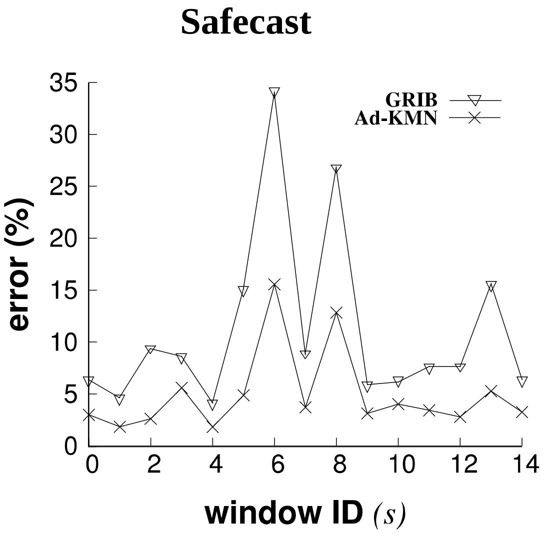
Datasets

	Records	Interval	Pollutant	Mounted on
Cabspotting	11 m	50 sec	-	Taxicab
Opensense Zurich	110 k	40 sec	Ozone	Public tram
Opensense Lausanne	70 k	60 sec	Ozone	Public bus
Safecast	970 k	5 sec	radiation	Car

- Cabspotting: only positioning data
- Zurich and Lausanne: clean environment
- Safecast: radiation is changing slowly and predictable in time

Error Analysis



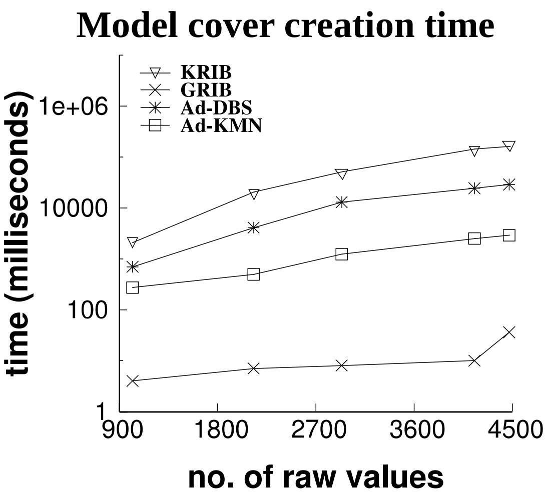


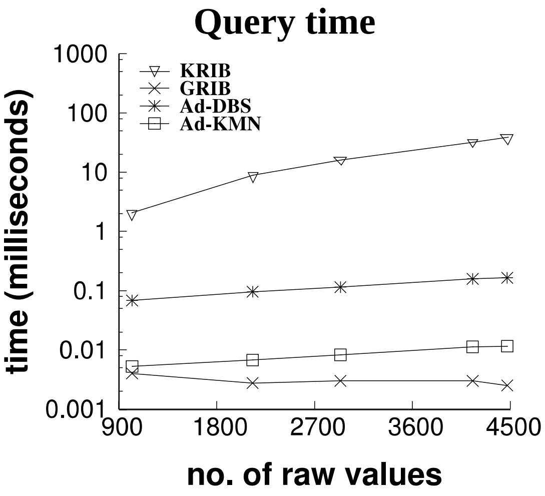
- H = 6 hours, P = 50
- Random time windows
- Plot normal percentage error

Observations

- No significant difference with Opensense
- DBSCAN: Number of Regions p is not controllable

Time Efficiency



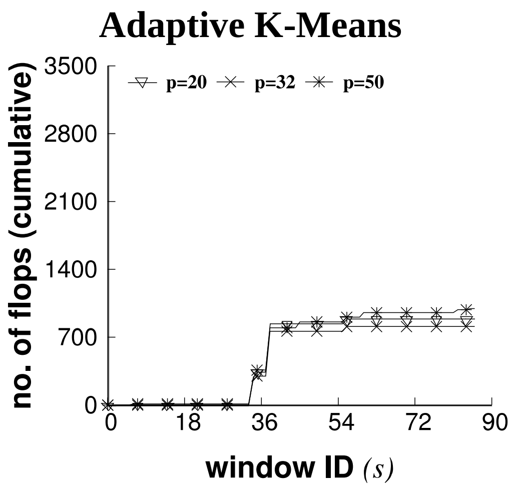


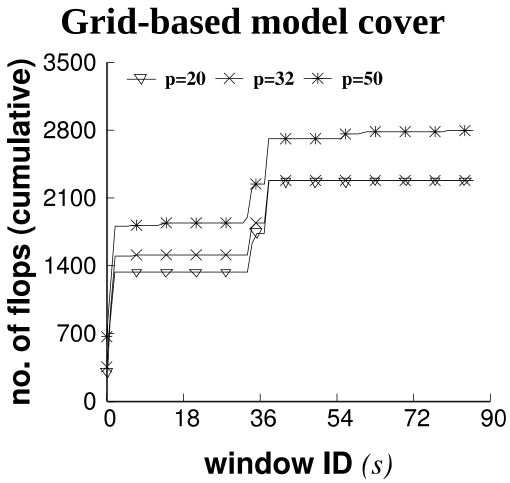
- Opensense Lausanne
- Start time of time window is constant
- Normal Percentage error is constant
- Increase of H → number of raw tuples

Observations

- Complex methods are slow
- Grid based modeling is the fastest

Model Cover Maintenance





- Training period of 6 hours
- H = 30 minutes, W_0,W_1,…,W_{88} streamed into Condense
- Updating only region with high normal percentage error
- Flops: rough estimate of update cost

Observations

- Adaptive K-Means is able to adapt to data