

# Locality-Preserving Spatial Partitioning for Geo Big Data Analytics in Main Memory Frameworks

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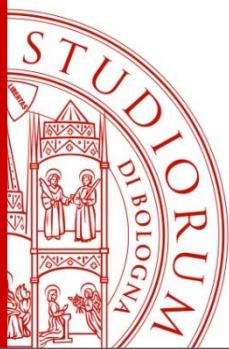
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ALMA MATER STUDIORUM - UNIVERSITÀ DI BOLOGNA

IL PRESENTE MATERIALE È RISERVATO AL PERSONALE DELL'UNIVERSITÀ DI BOLOGNA E NON PUÒ ESSERE UTILIZZATO AI TERMINI DI LEGGE DA ALTRE PERSONE O PER FINI NON ISTITUZIONALI



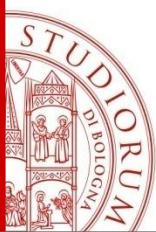


# Agenda

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- *Spatial Partitioning*: Background and Motivations
- *QoS-aware Spatial partitioning for in-memory systems*
  - SCAP (Spatial Co-locality-aware Partitioner)
  - Supported spatial queries: proximity-alike
- Deployment
  - Baselines
  - Testing setup
- Results and Discussion
  - Azure Cloud Spark Test
- Concluding remarks





# Smart City and Big Data Context

## Smart City

Advanced technological services



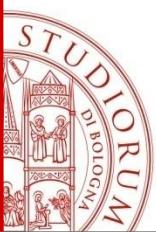
## Geographic Big Data

Huge amount of information

## Mobile Sensing

Automatic collection of data

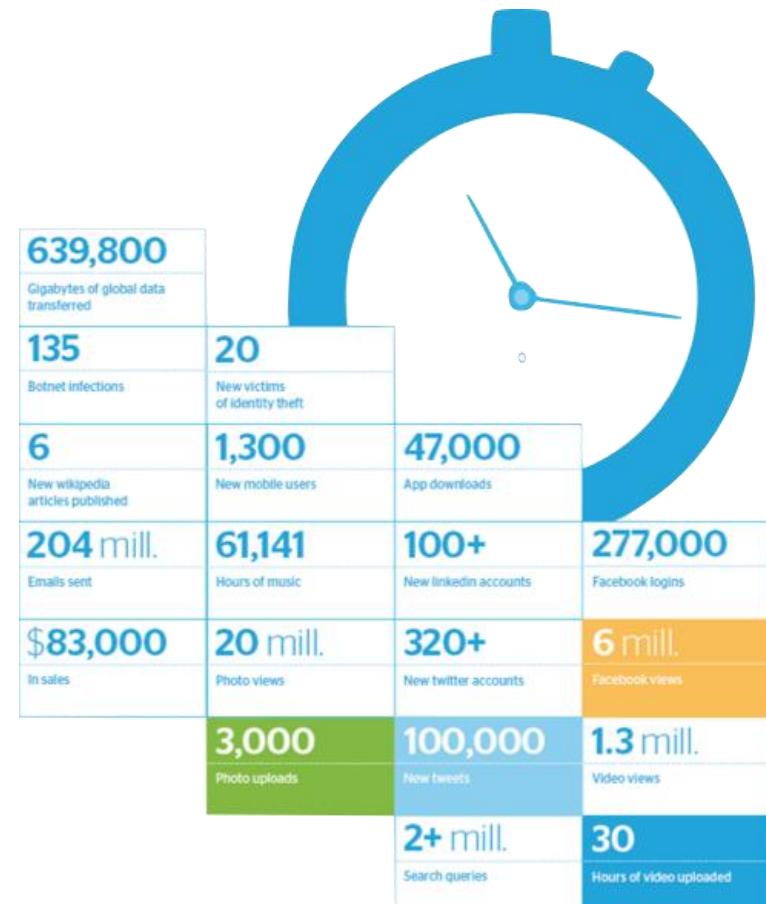


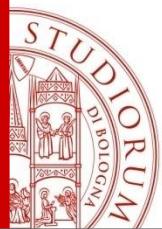


# Geo-located Big Data

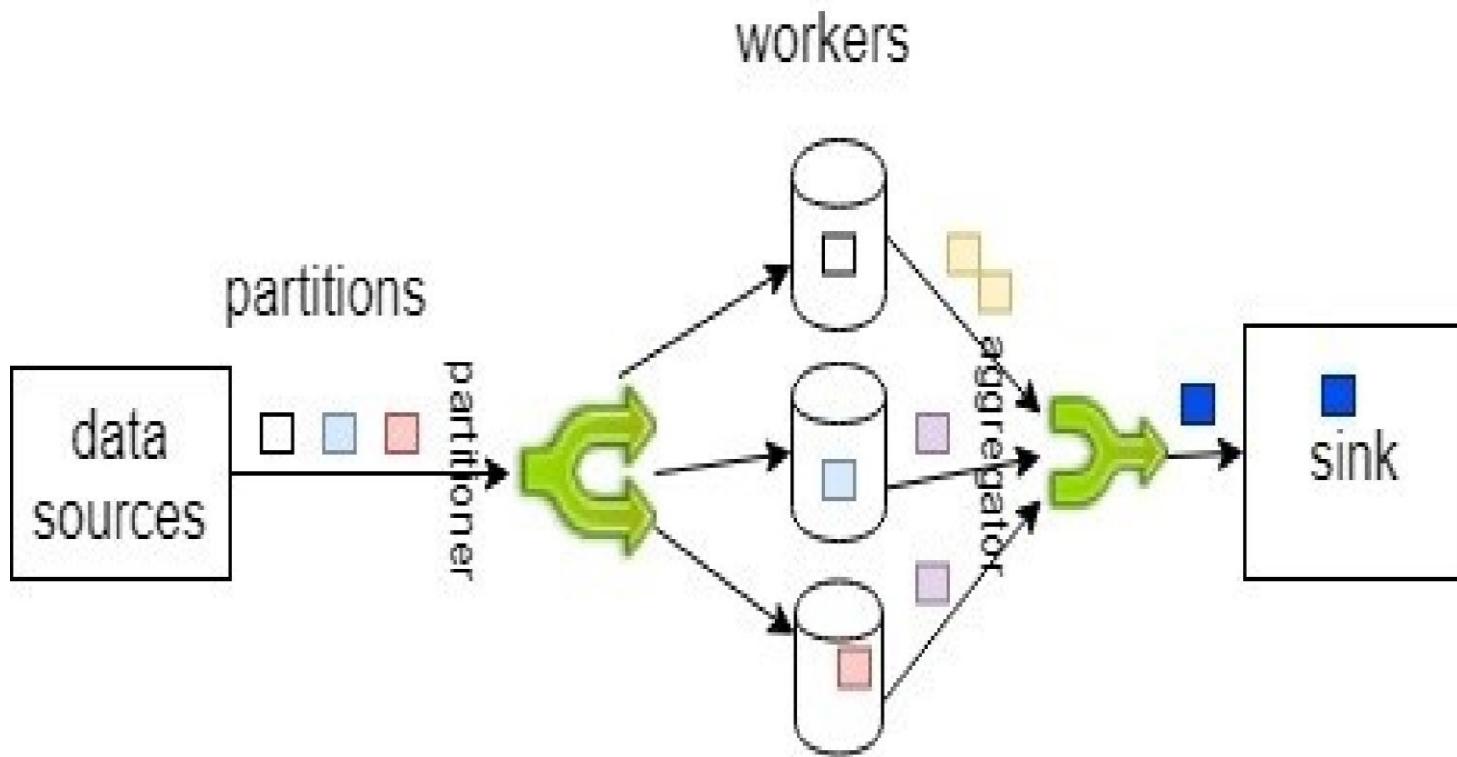
- Large amounts of geolocated data, **exceeding processing capability** of traditional database management systems
- Characteristics
  - **Volume:** amount of data
  - **Velocity:** streaming data
  - **Variety:** multiple sources, heterogeneous data

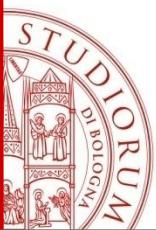
Requires distributed data processing systems





# Typical data parallelization for IoT in Cloud





# Conflicting Partitioning Challenges

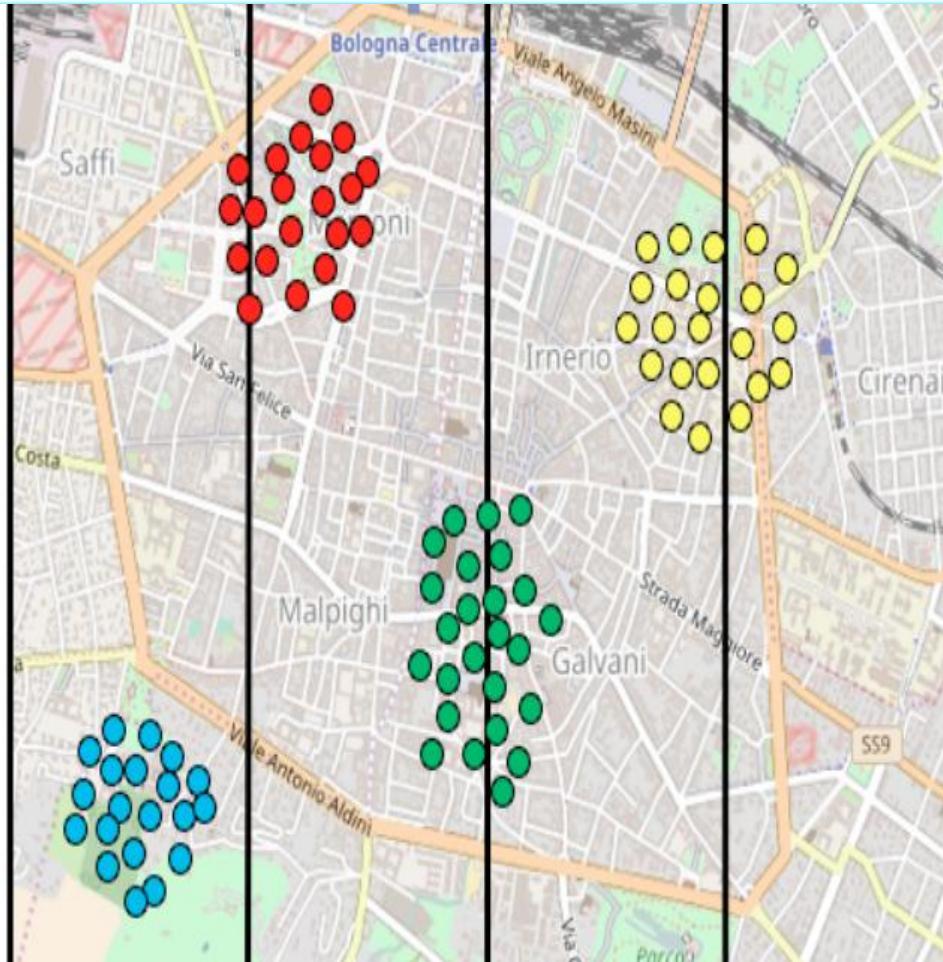
Load  
Balancing

Spatial co-  
locality

Boundary  
objects

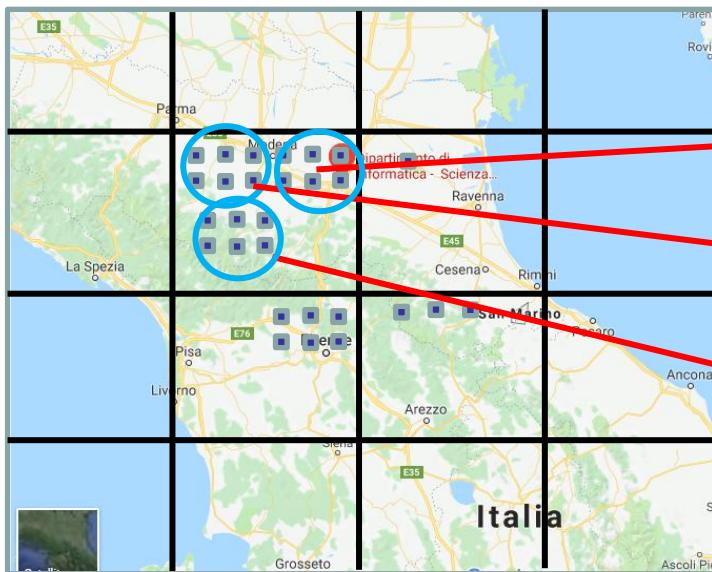


# Example: Boundary Spatial Objects (BSO)





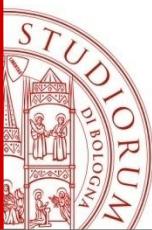
# Load Balancing



**In Spark join  
requires data to  
reside on the same  
partition.**

**Only load balancing = shuffling (huge toll) for co-location queries.**

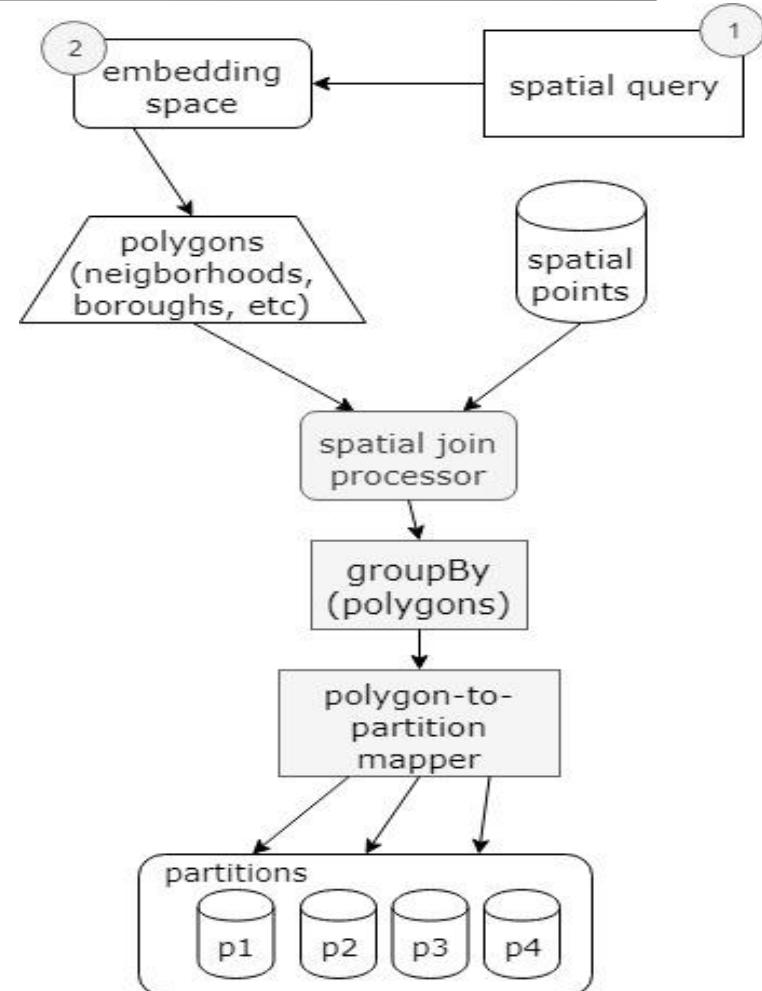




# Spatial Co-locality-aware Partitioner (SCAP)

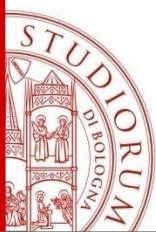
- **SDL** preservation is a priority
- **BSOs and load balancing** to a lesser extent

- **Clump** geometrically co-located objects into single chunks
- **Split** overloaded chunks
- **Map** chunks to partitions

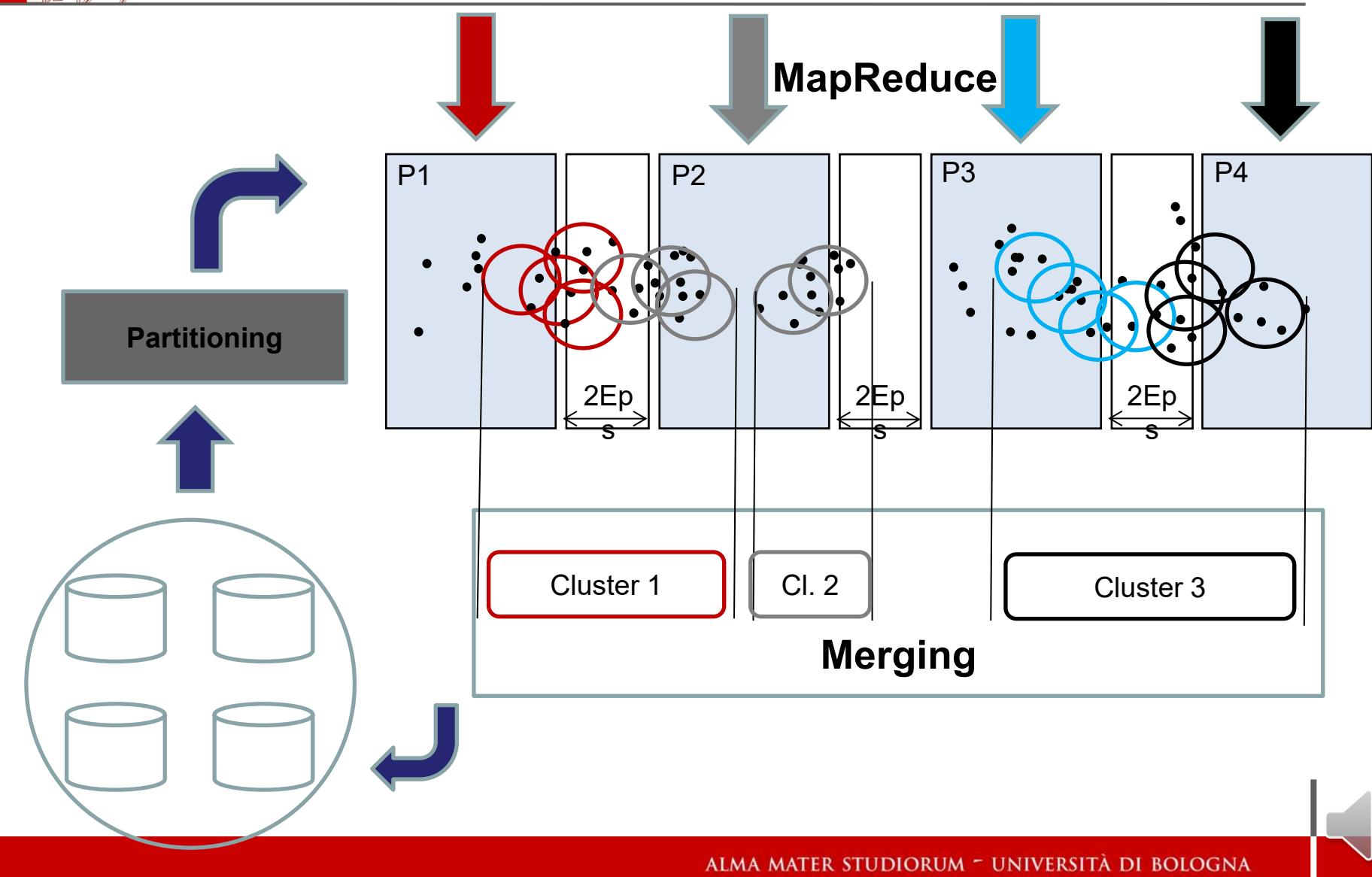


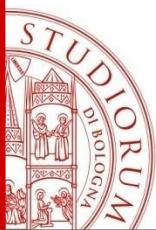
**SCAP**





# DBSCAN-MR





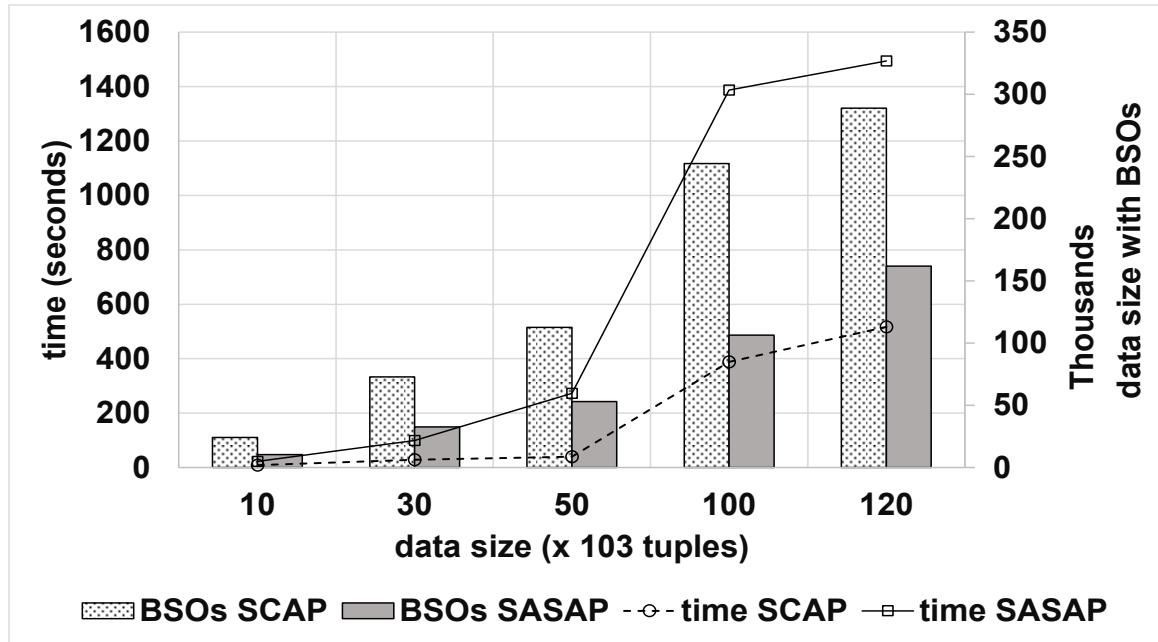
## Experimental setup

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- Evaluation questions
  - Data size vs Accuracy & BSOs count
  - Adaptability effect
- Testbed
  - Cluster: 6 nodes (Microsoft Azure HDInsight Cluster )
  - Datasets:
    - NY City taxicab trips datasets. 150k points representing a portion of data captured through taxi rides for the first half of 2016
    - 150k spatial points collected during the ParticipAct project



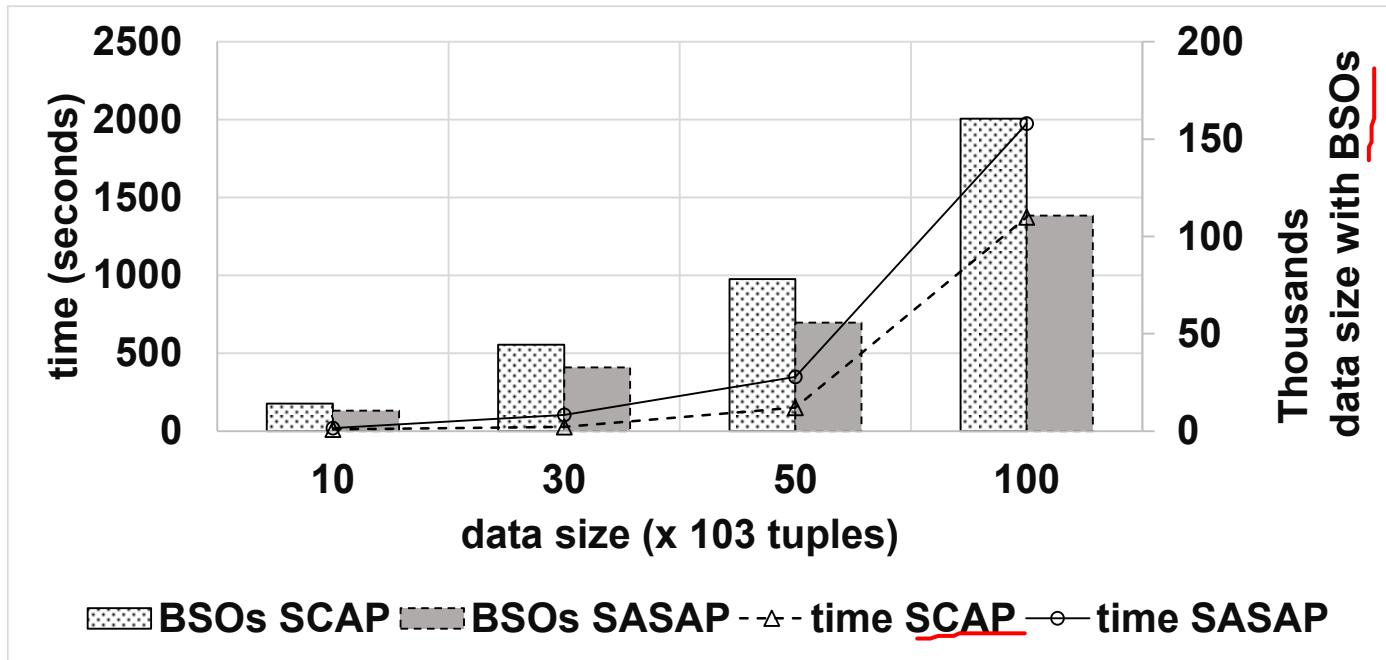
# Data size vs Accuracy & BSOs count



- Running times and number of BSOs of our retrofitted version of DBSCAN-MR over SCAP against SASAP-based version tested on NYC taxicab datasets. Parameters: eps 0.15, minPts 300, geohash 30.
- Better time, but an increased number of bordering replicated points (i.e., BSOs)



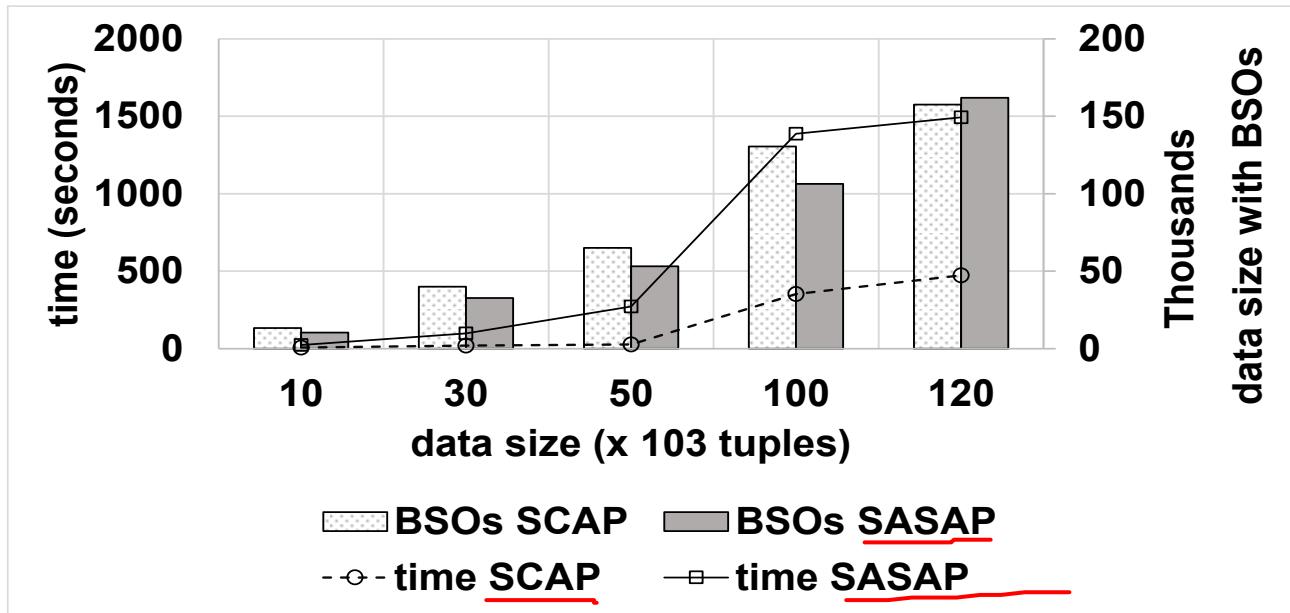
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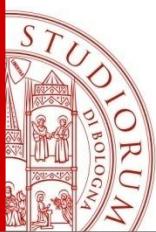


# Adaptability effect



- The effect of tweaking geohash precision on the number of BSOs generated by SCAP on NYC taxicab dataset. Parameters: eps 0.15, minPts 300, geohash 35
- Changing the geohash precision has a utility in determining the number of BSOs
- changing the tweakable geohash from 30 to 35 precision yields less BSOs for SCAP
- wider geohash precision implies a smaller size of the cells that this geohash order pass through, which then reduces the overlapping areas between bordering cells, thereby reducing the BSOs count.
- we obtain roughly 32% gain by changing the geohash precision.

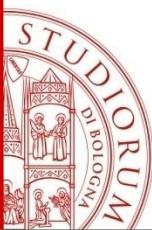




# Concluding remarks

- Communication service provisioning targets designing communication networks that serve as robust infrastructures for the management of huge amounts of data with QoS guarantees.
- Inappropriate configurations of parallel data processing frameworks may deteriorate the benefits we reap by the elasticity .
- Spatial data partitioning in Cloud computing frameworks is a determinant factor that should be prioritized.
- We have designed SCAP, a locality-preserving spatial partitioning scheme for quality spatial analytics in distributed main memory frameworks.
- Focusing on spatial locality problem to help in minimizing the data shuffling around the network while processing costly proximity-alike queries.
- As a future perspective, we could offload a portion of the data partitioning to IoT devices near the edge.
- Also, we plan to exploit porting parts of the spatial processing to Fog computing near the Edge, and possibly thereby sending only summaries to the Cloud for further processing, thus lowering the overall latency.





## ***Q&A and Contacts***

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*Thanks for your attention!*

**Questions time...**

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