Scalable Processing of Moving Flock Patterns

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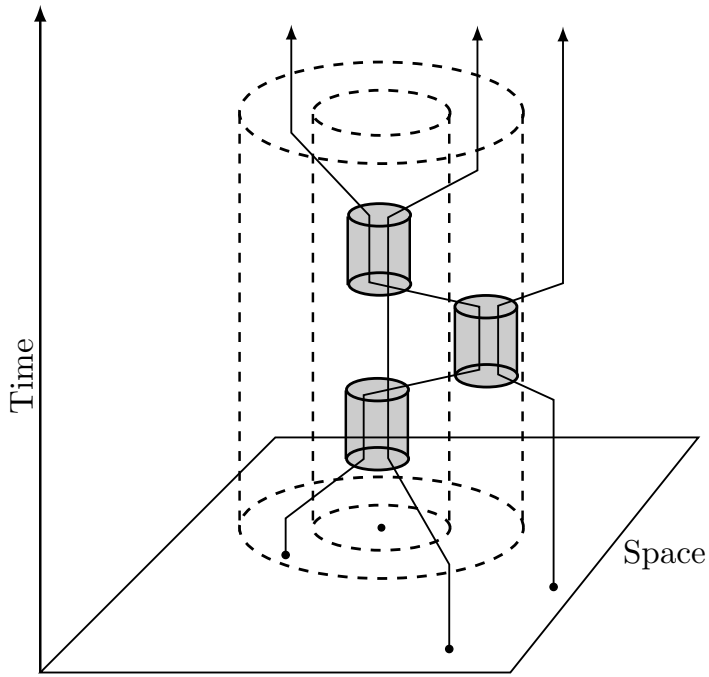
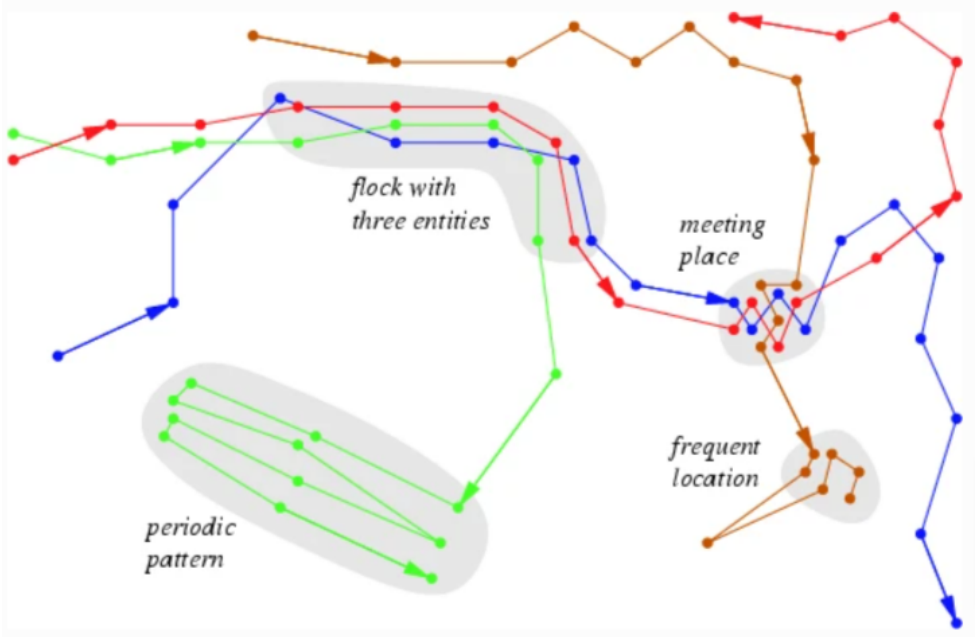
Large trajectory databases

- A spatial trajectory is a trace in time generated by a moving entity in a geographical space.
- i.e. $p_1 \rightarrow p_2 \rightarrow \cdots \rightarrow p_n$
- A trajectory is stored as a set of points, $p_i = (x, y, t)$ (spatial coordinate + time stamp).



(Shoval, 2017)

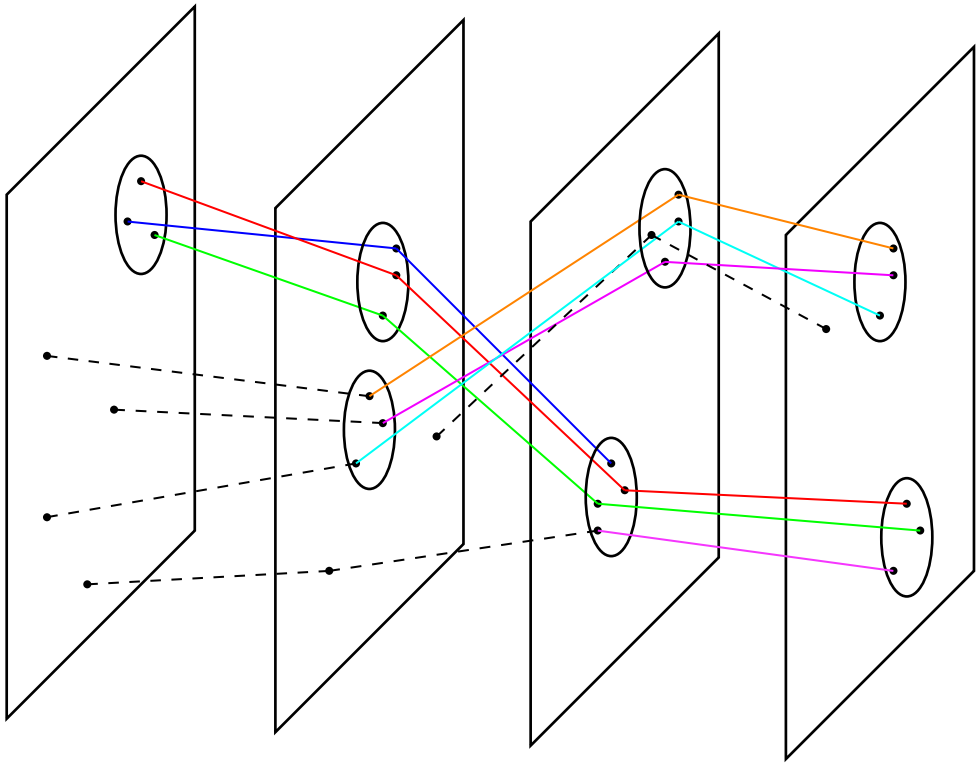
Movement patterns



(Gudmundsson, et al. 2008)

- i.e. convoys, moving clusters, swarms, gatherings, **flocks**, ...

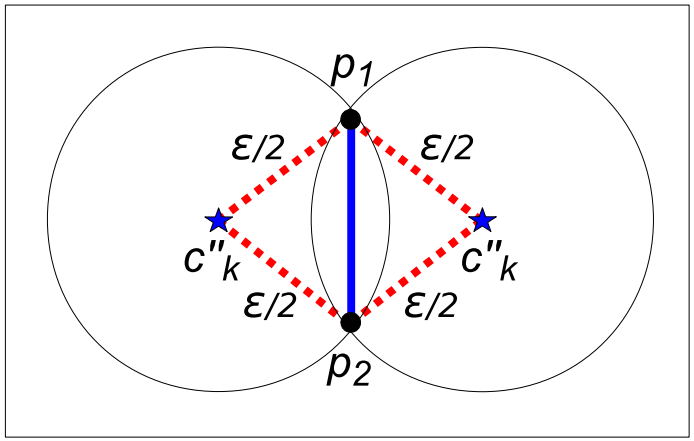
Flocks



- ε: Maximum distance between objects.
- μ: Minimum number of objects.
- δ: Minimum time the objects keep ‘together’.

Basic Flock Evaluation algorithm

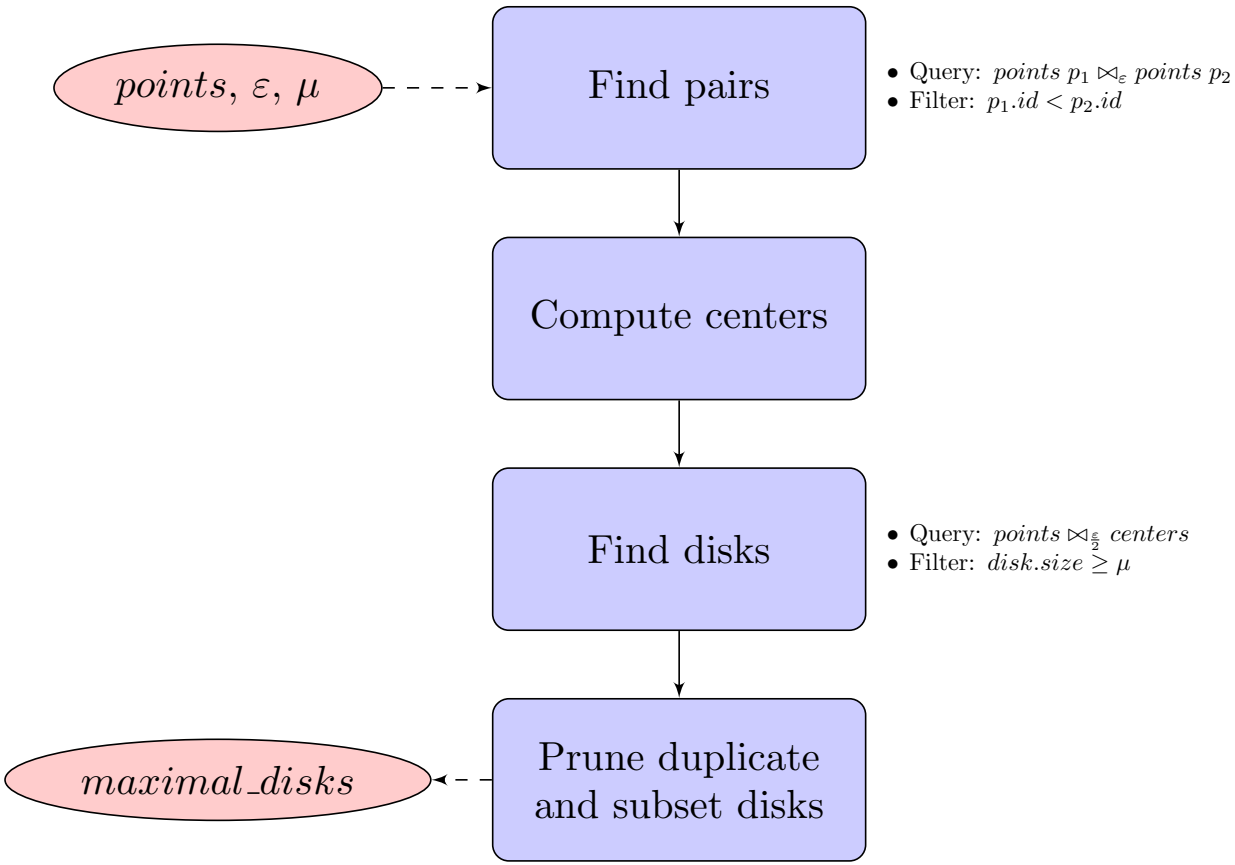
- Vieira, et al. 2009.
- The first polynomial-time solution for determining disk locations.
- Under fixed time duration it has polynomial time complexity $O(\delta|\tau|^{(2\delta)+1})$



Basic Flock Evaluation algorithm

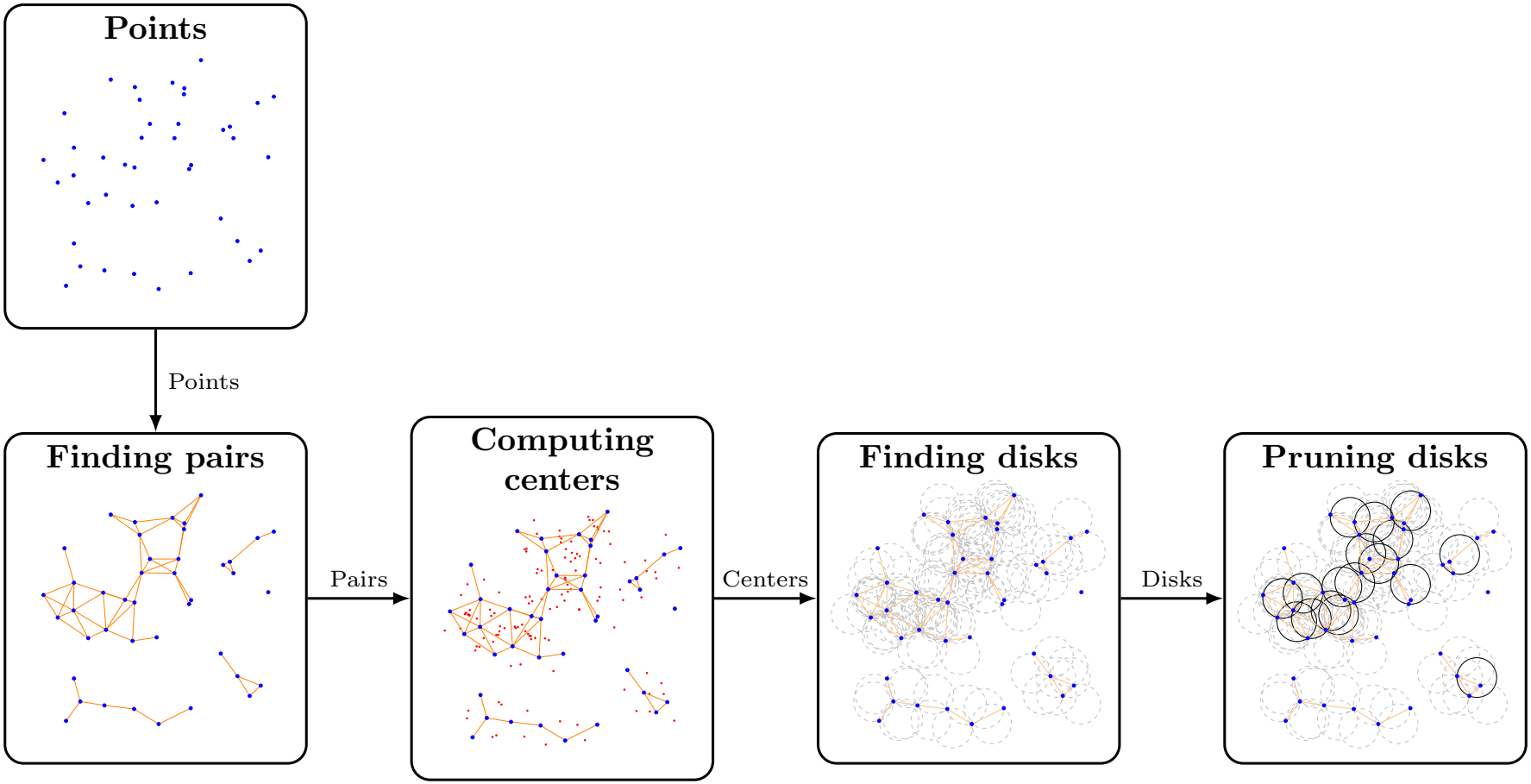
- Two main parts:
  - In the spatial domain it finds maximal disks at each time stamp.
  - In the temporal domain it joins consecutive times to match set of maximal disks.

- BFE overview...

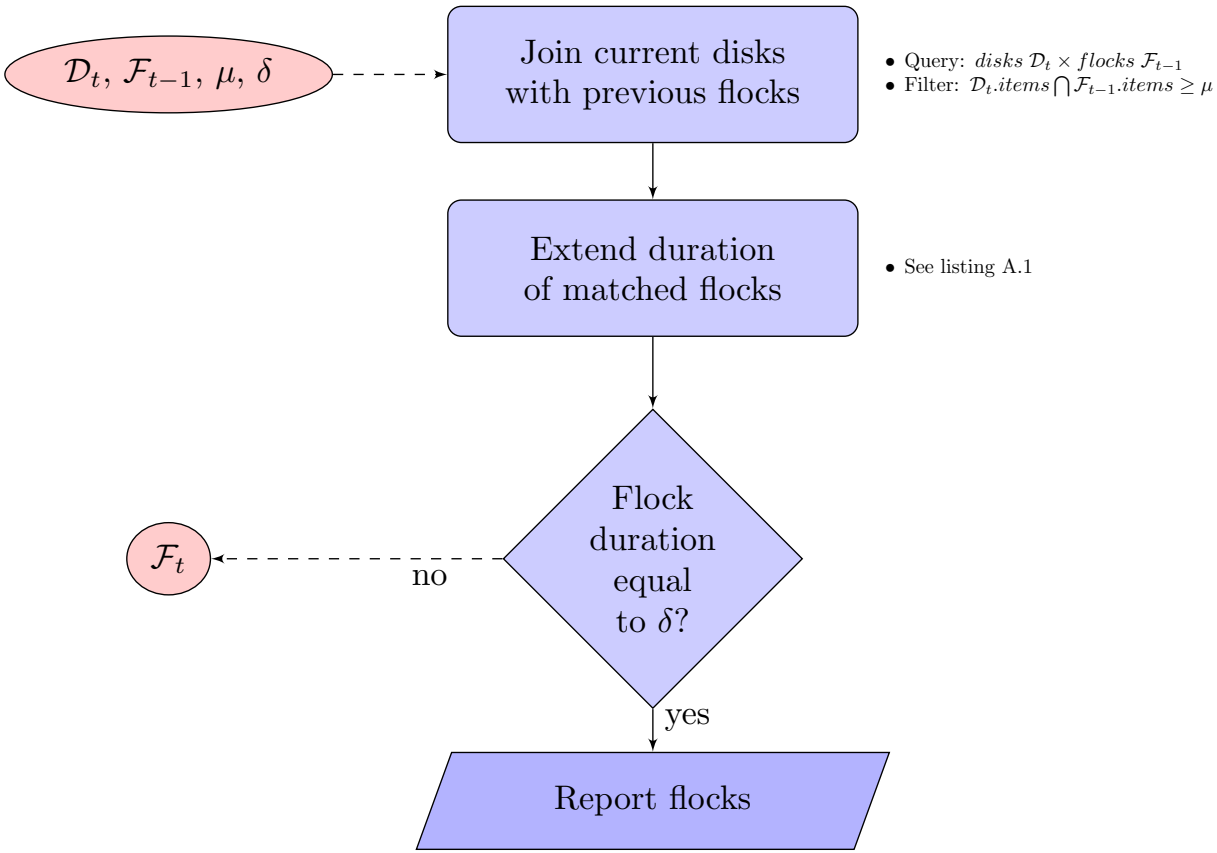


On the spatial domain

- BFE overview...

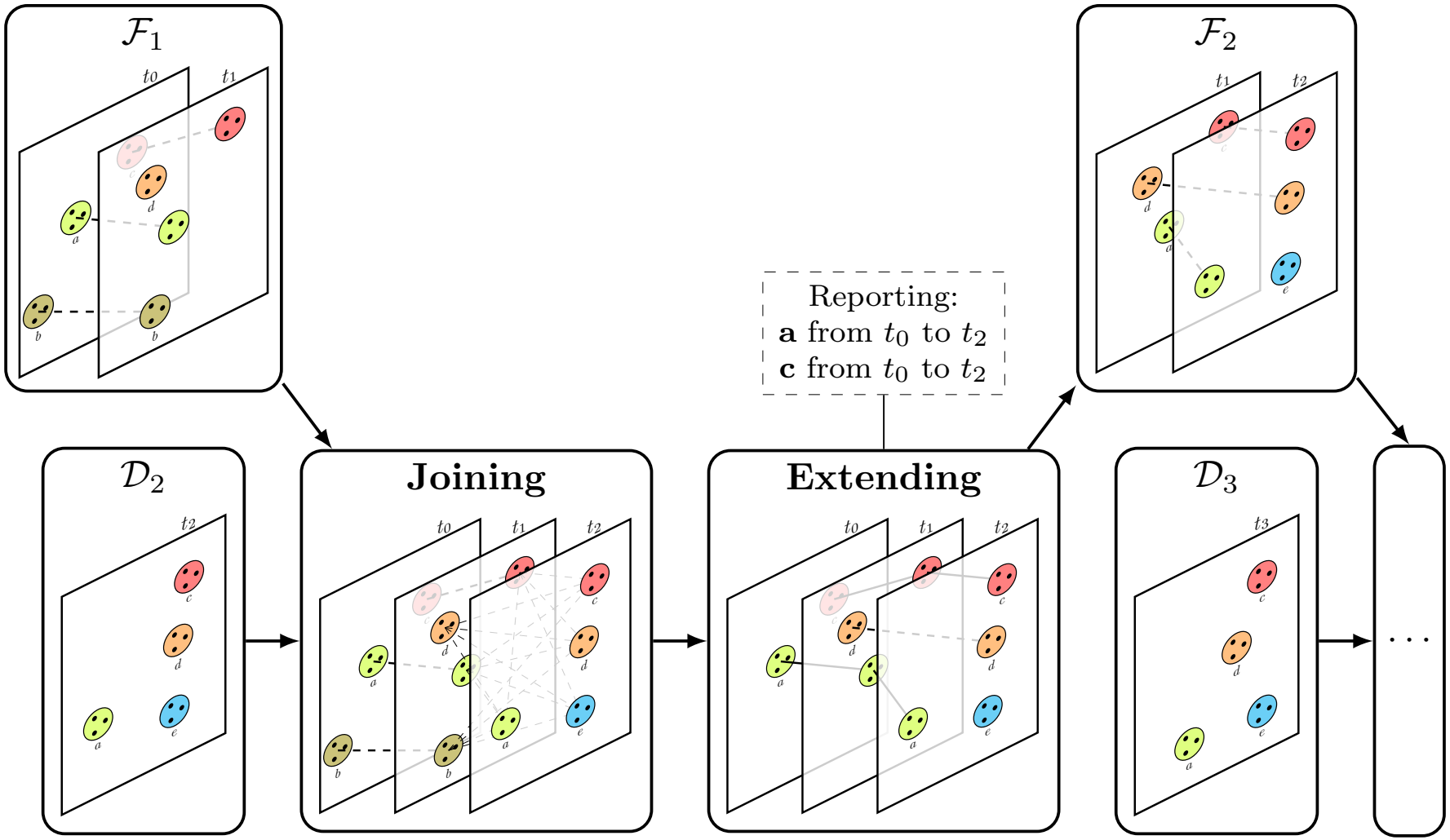


- BFE overview...

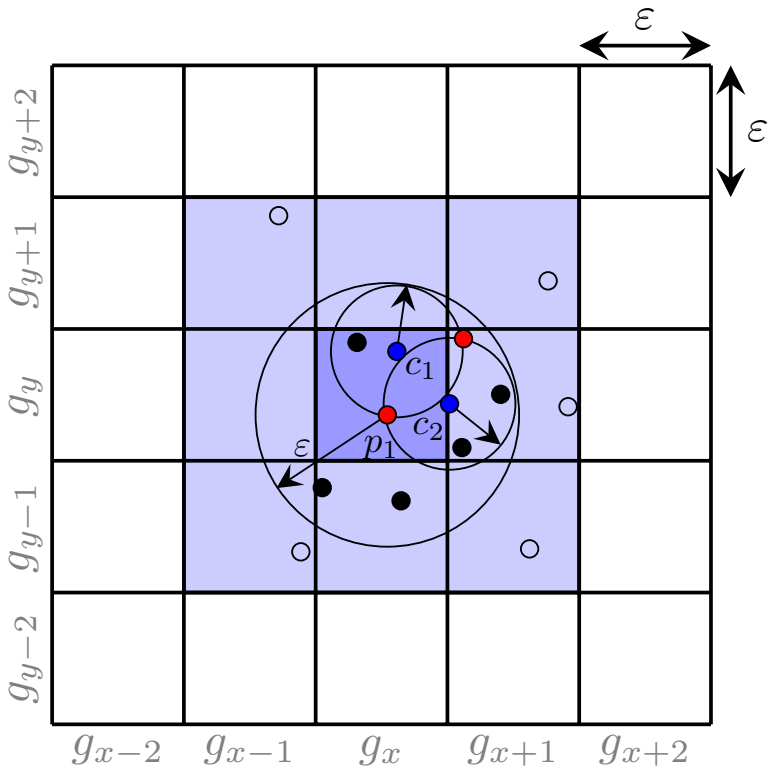


On the temporal domain

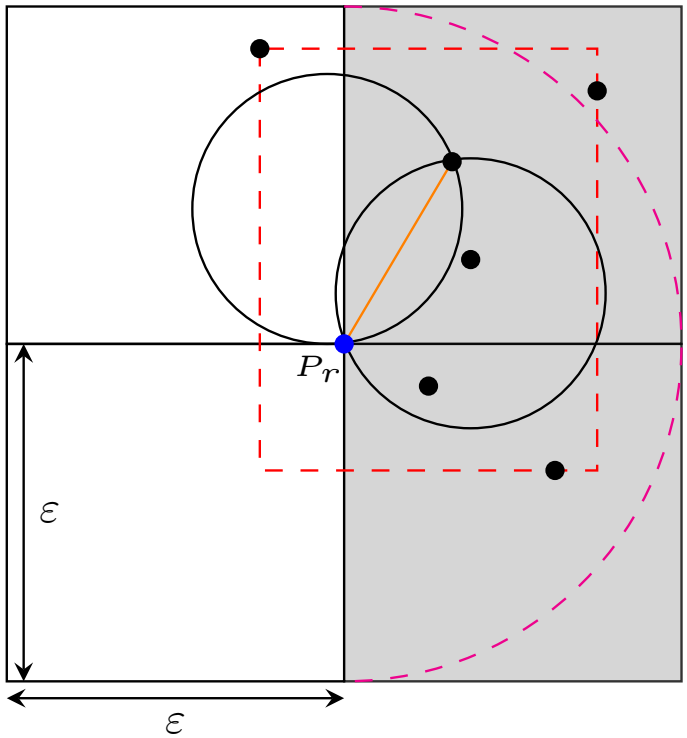
- BFE overview...



PSI ALGORITHM



(Vieira, et al. 2009)

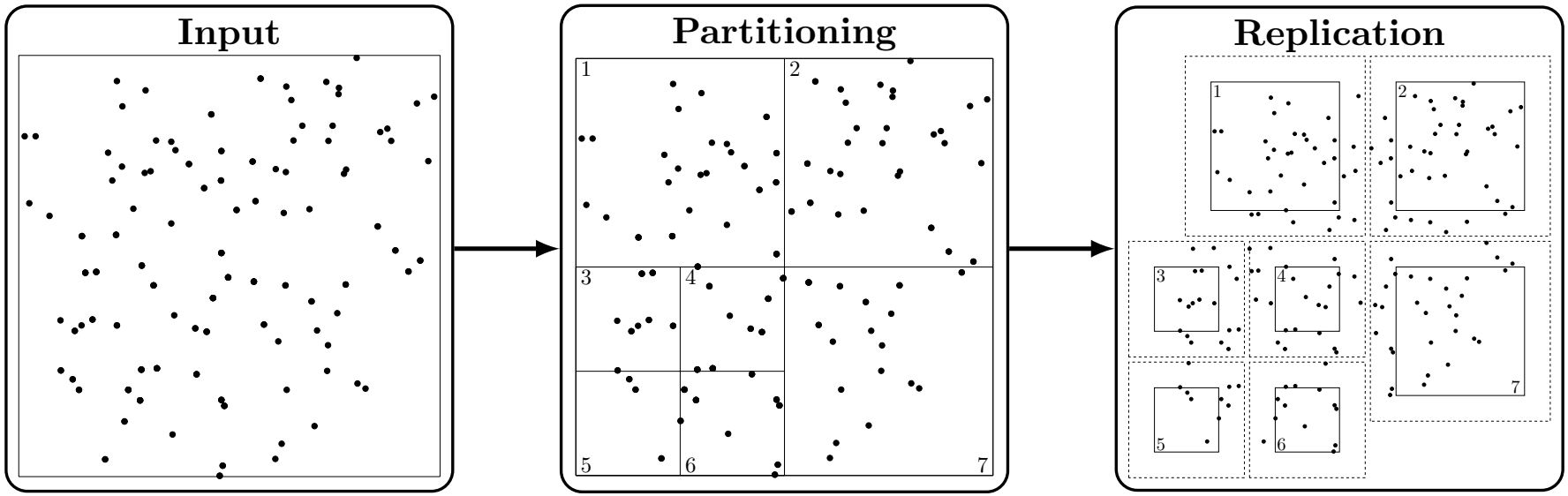


(Tanaka, et al. 2016)

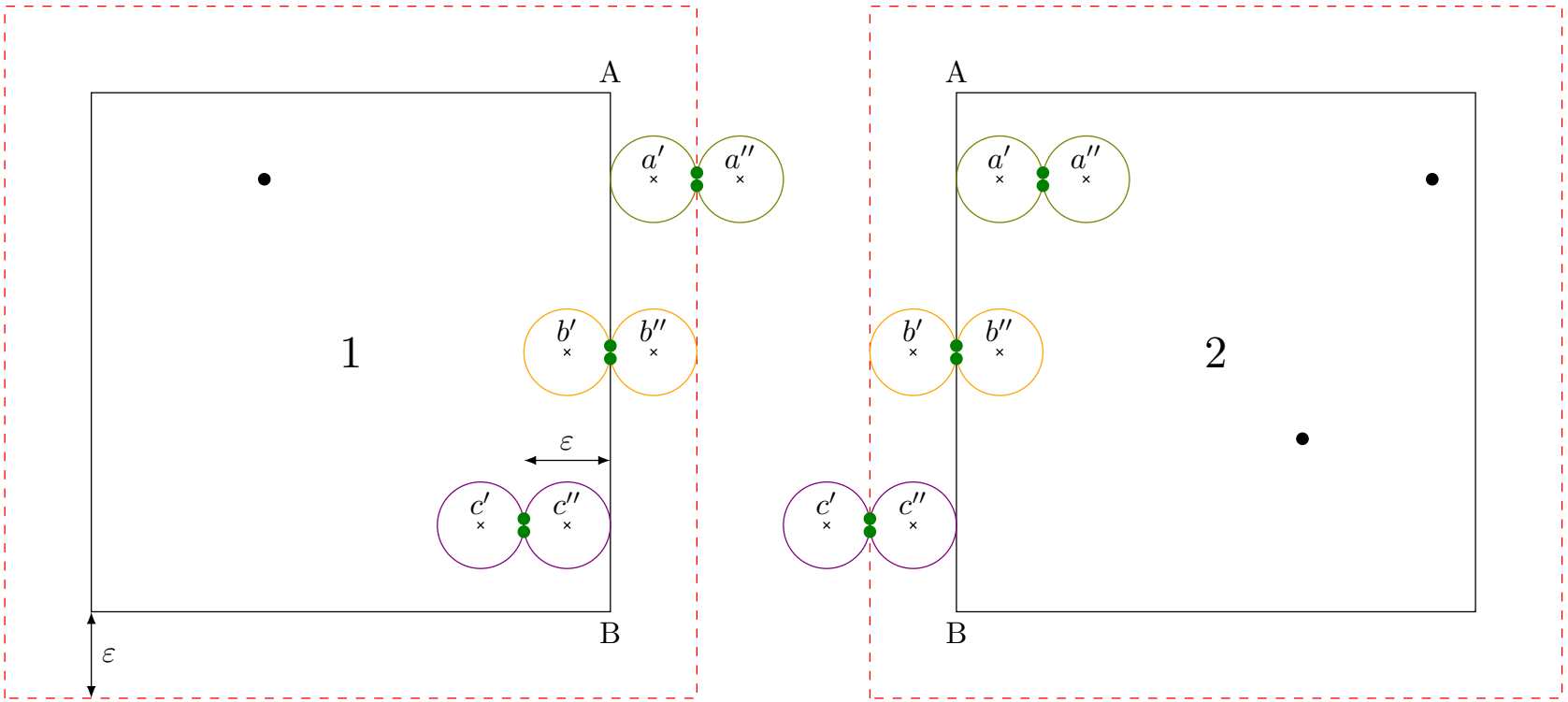
Challenges and contributions

- Due to high complexity it does not scale well.
- In databases with a large number of moving entities per time stamp it has a direct impact.
- Just sequential implementation yet.
- We propose a parallel solution in both domains.

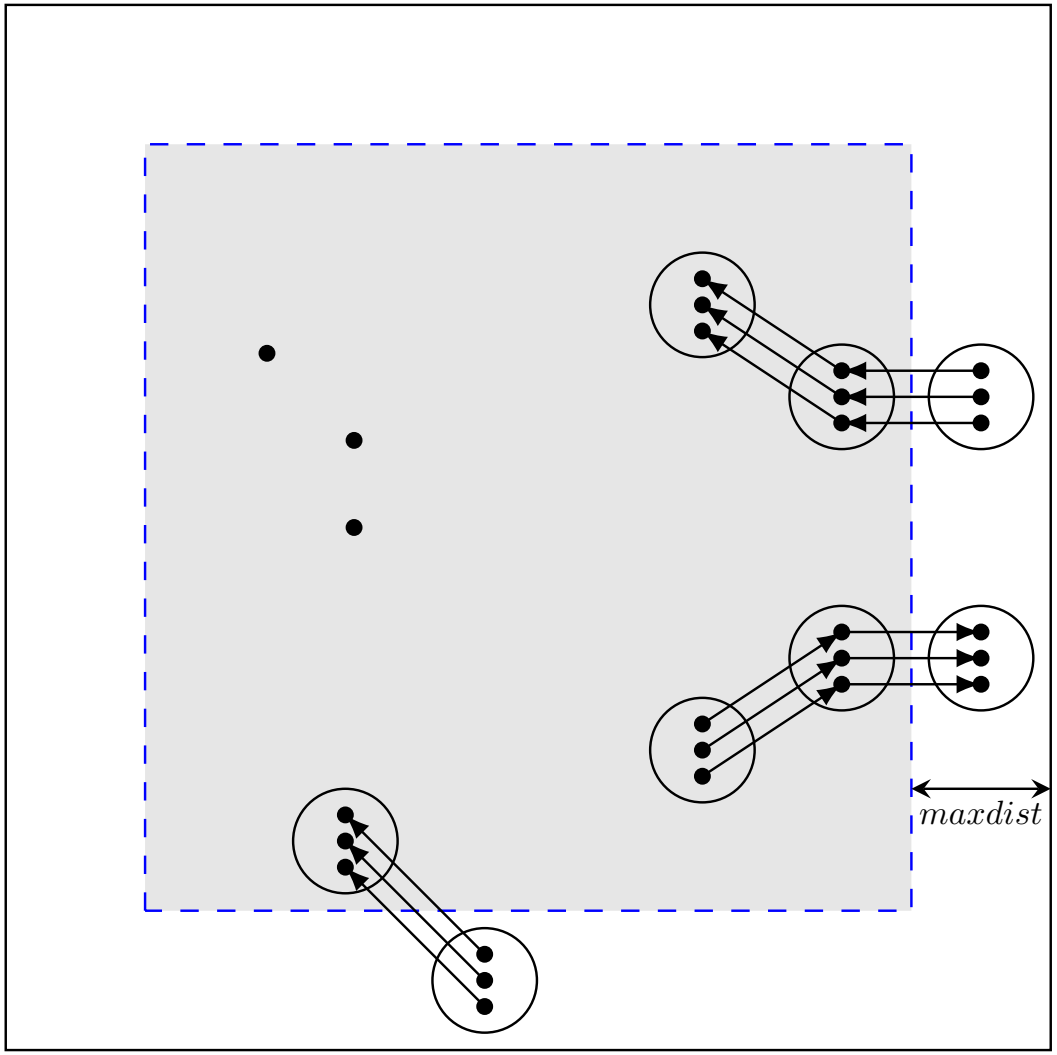
- Parallel overview...



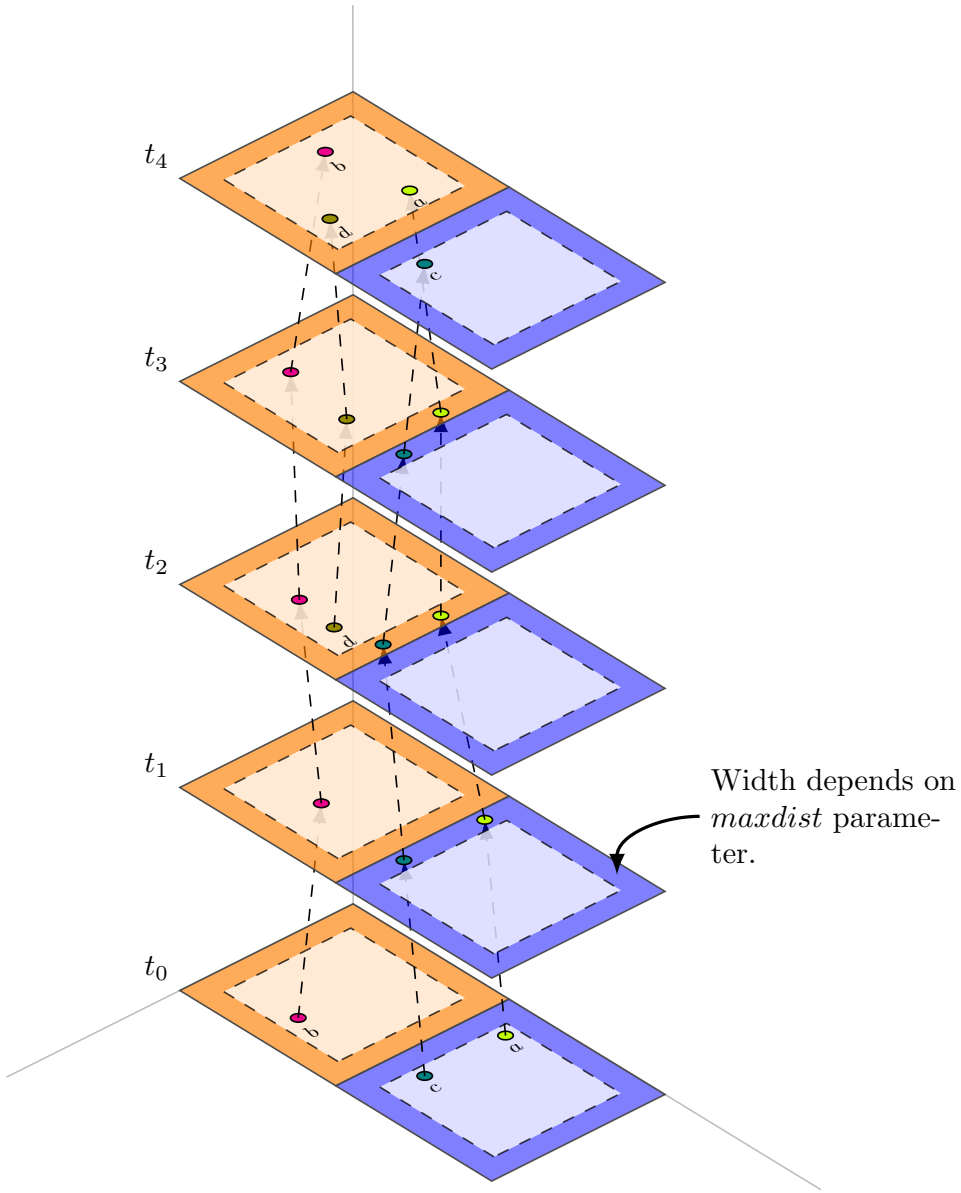
- Parallel overview...



On the temporal domain

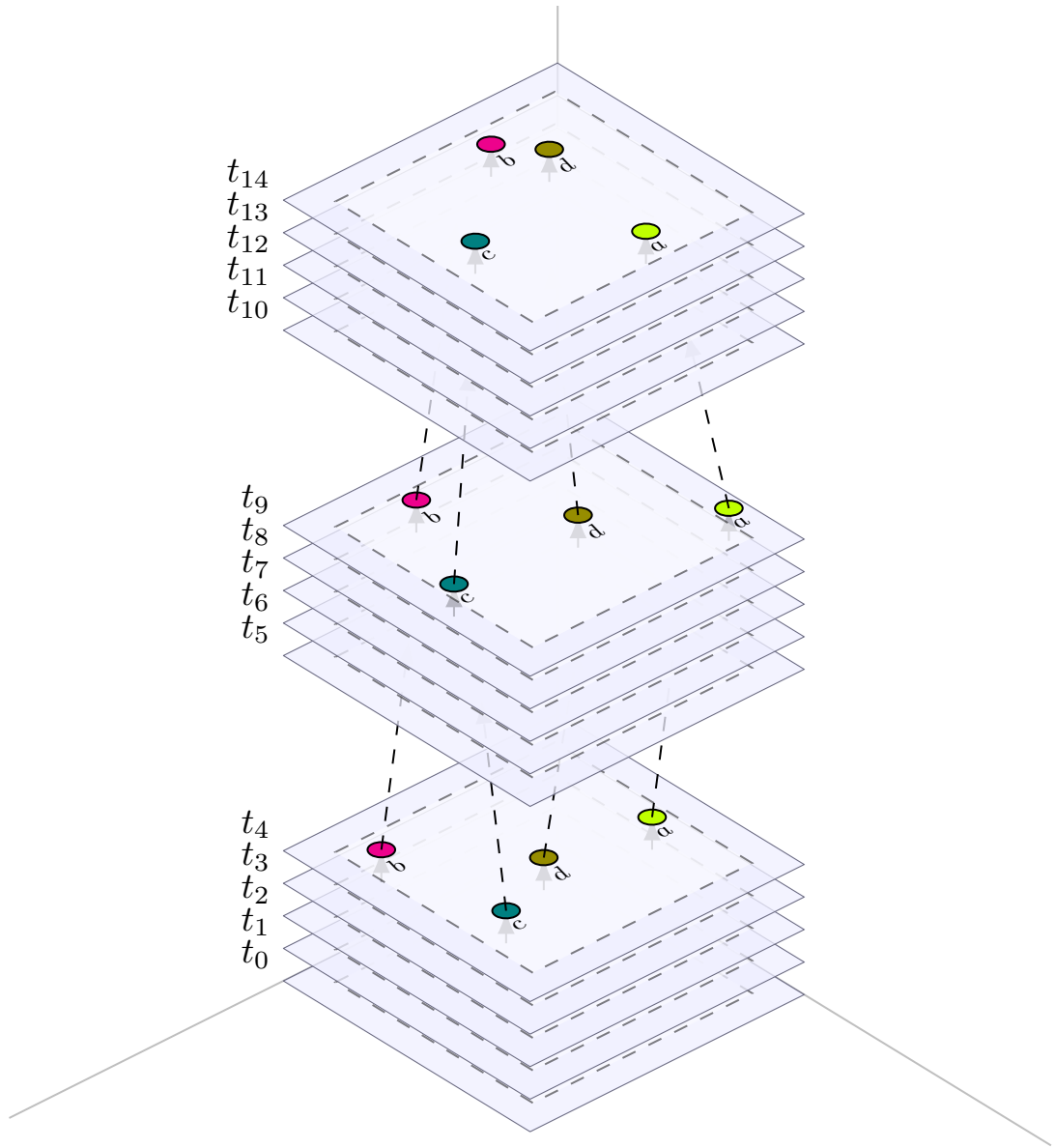


On the temporal domain



*a,b,c and d are flocks moving along time.

On the temporal domain



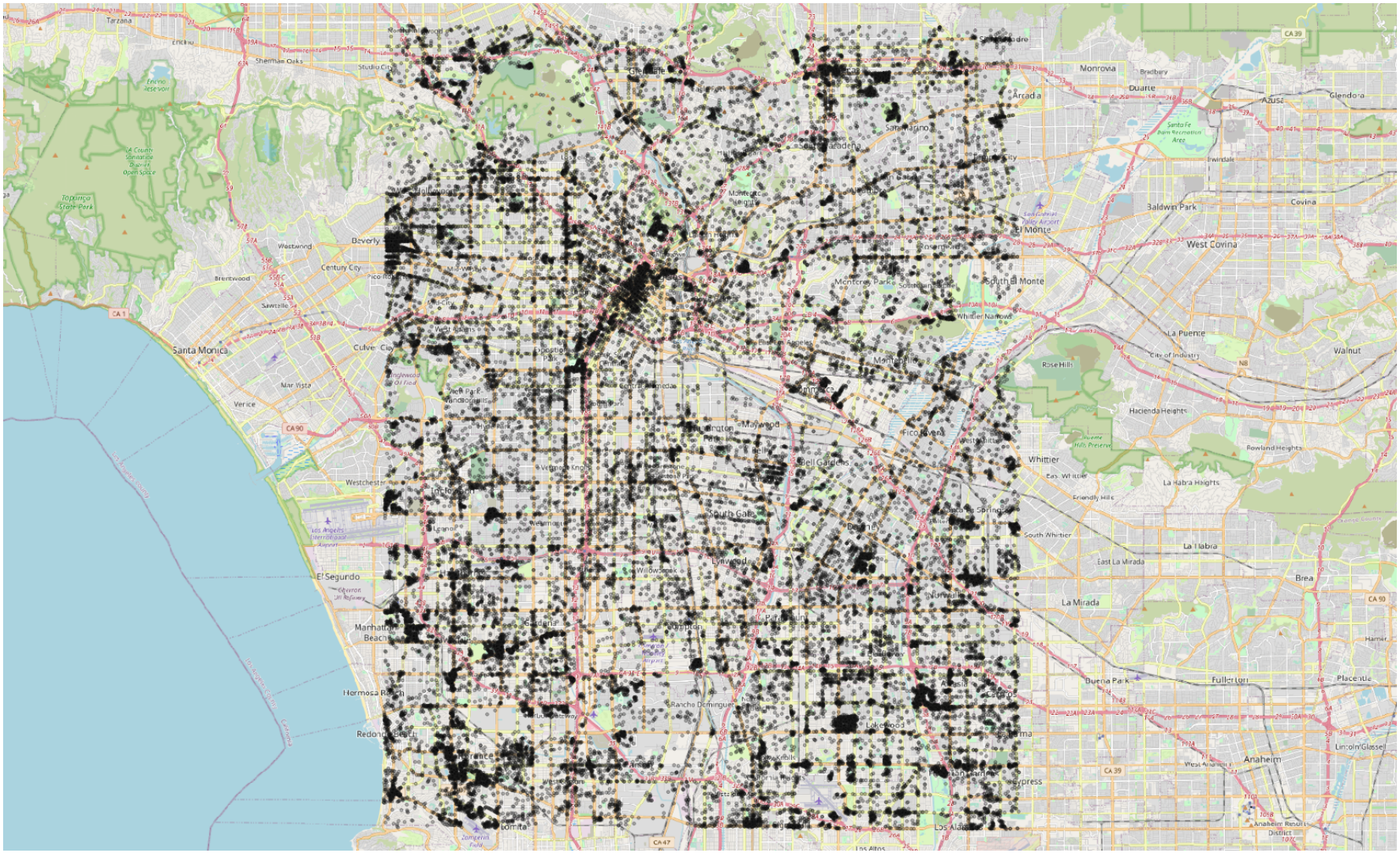
*a,b,c and d are flocks moving along time.

Datasets

Dataset	Number of Trajectories	Total number of points	Maximum Duration (min)
Berlin10K	10000	97526	10
LA25K	25000	1495637	30
LA50K	50000	2993517	60

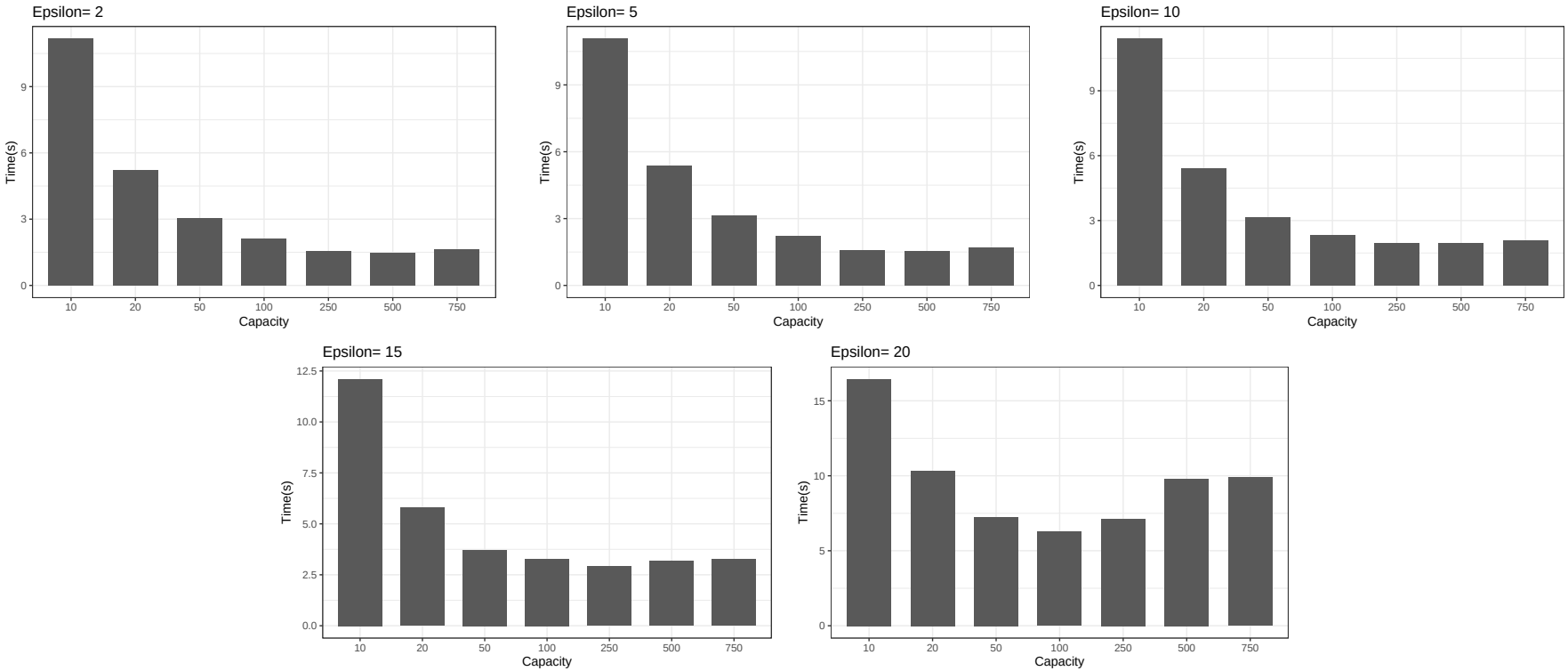
Datasets

- Synthetic dataset [LA: 50K objects]



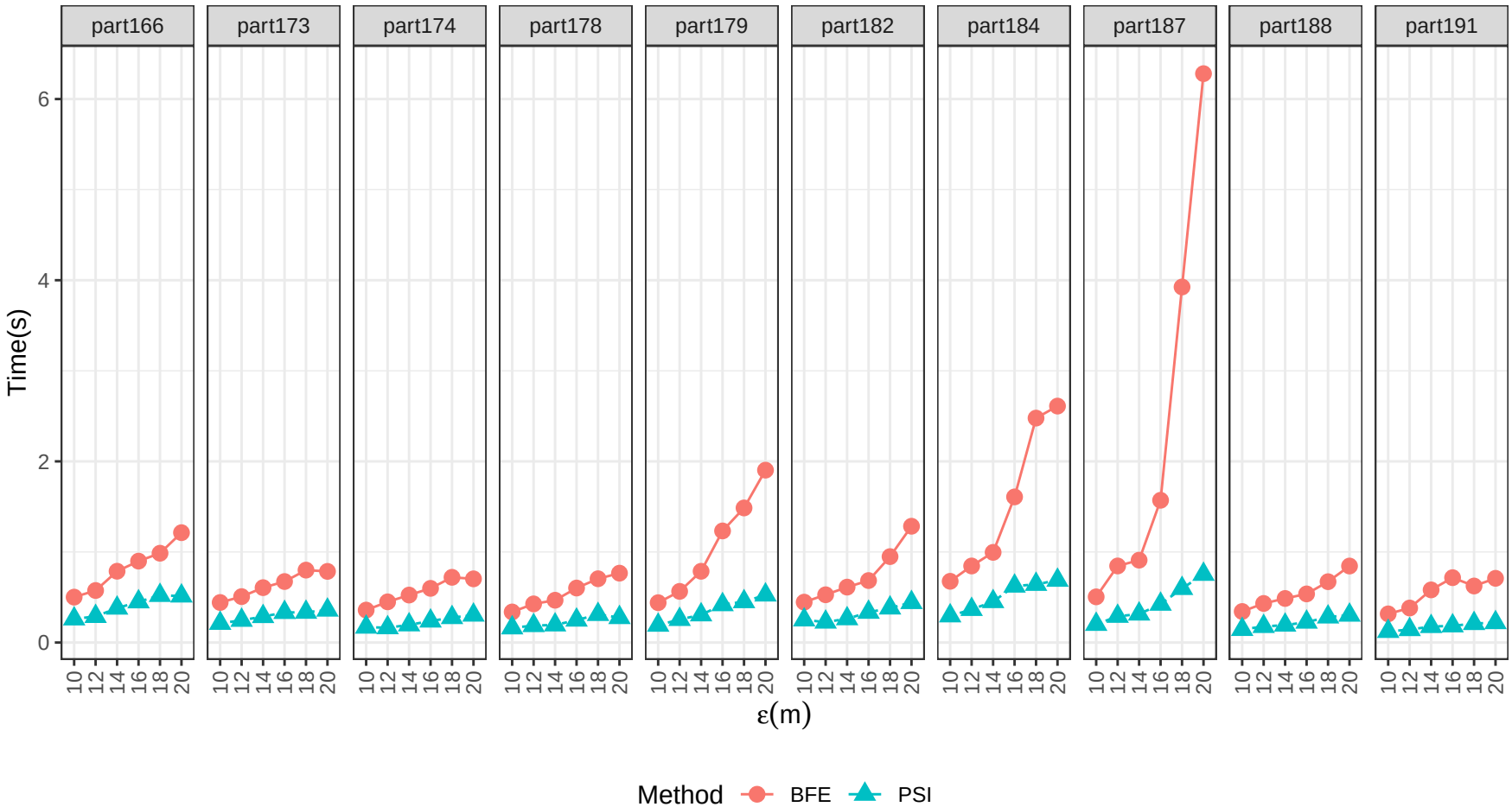
Experiments

- Optimizing the number of partitions for Phase 1.

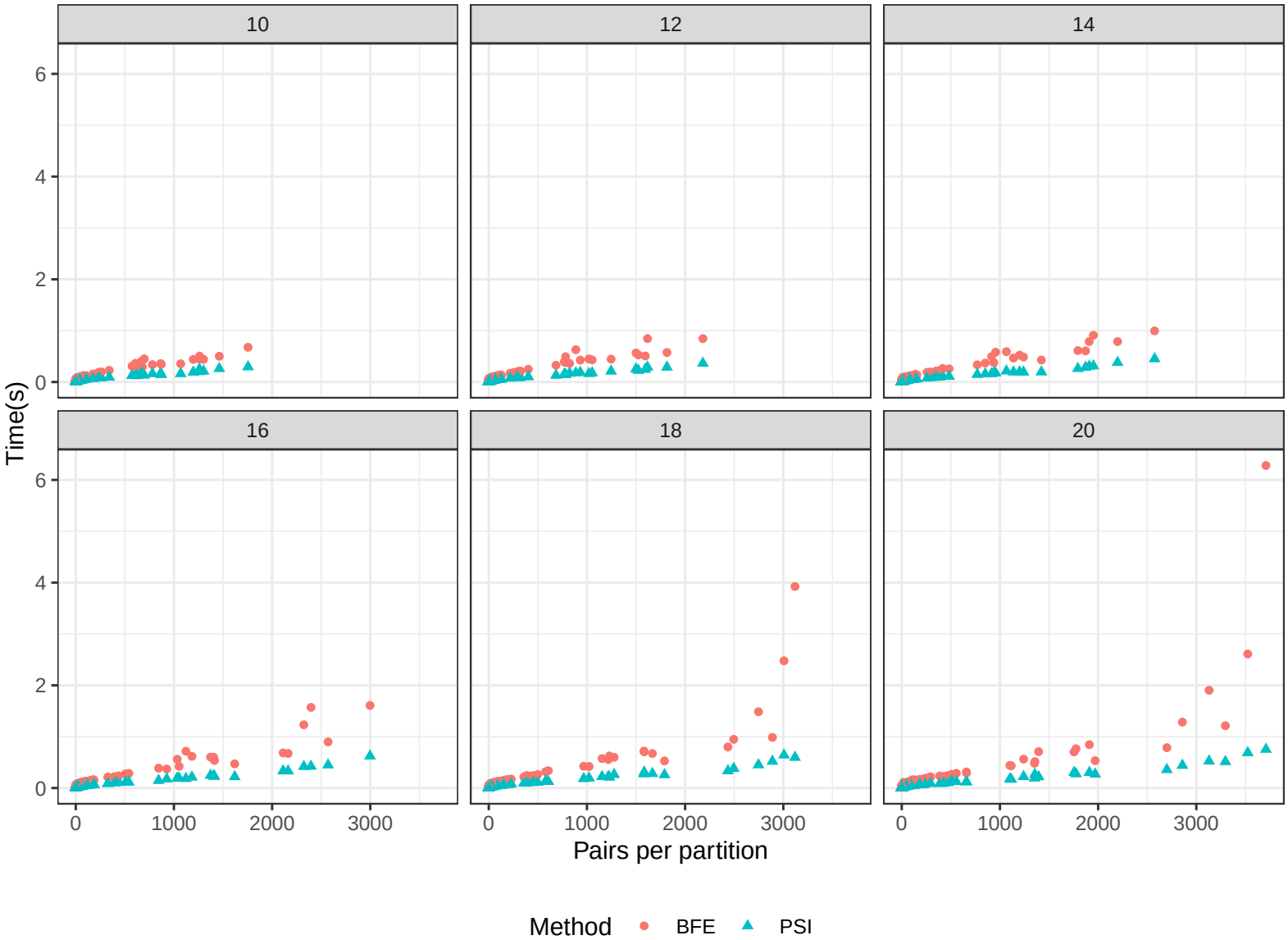


Experiments

- Analyzing most costly partitions.



Experiments



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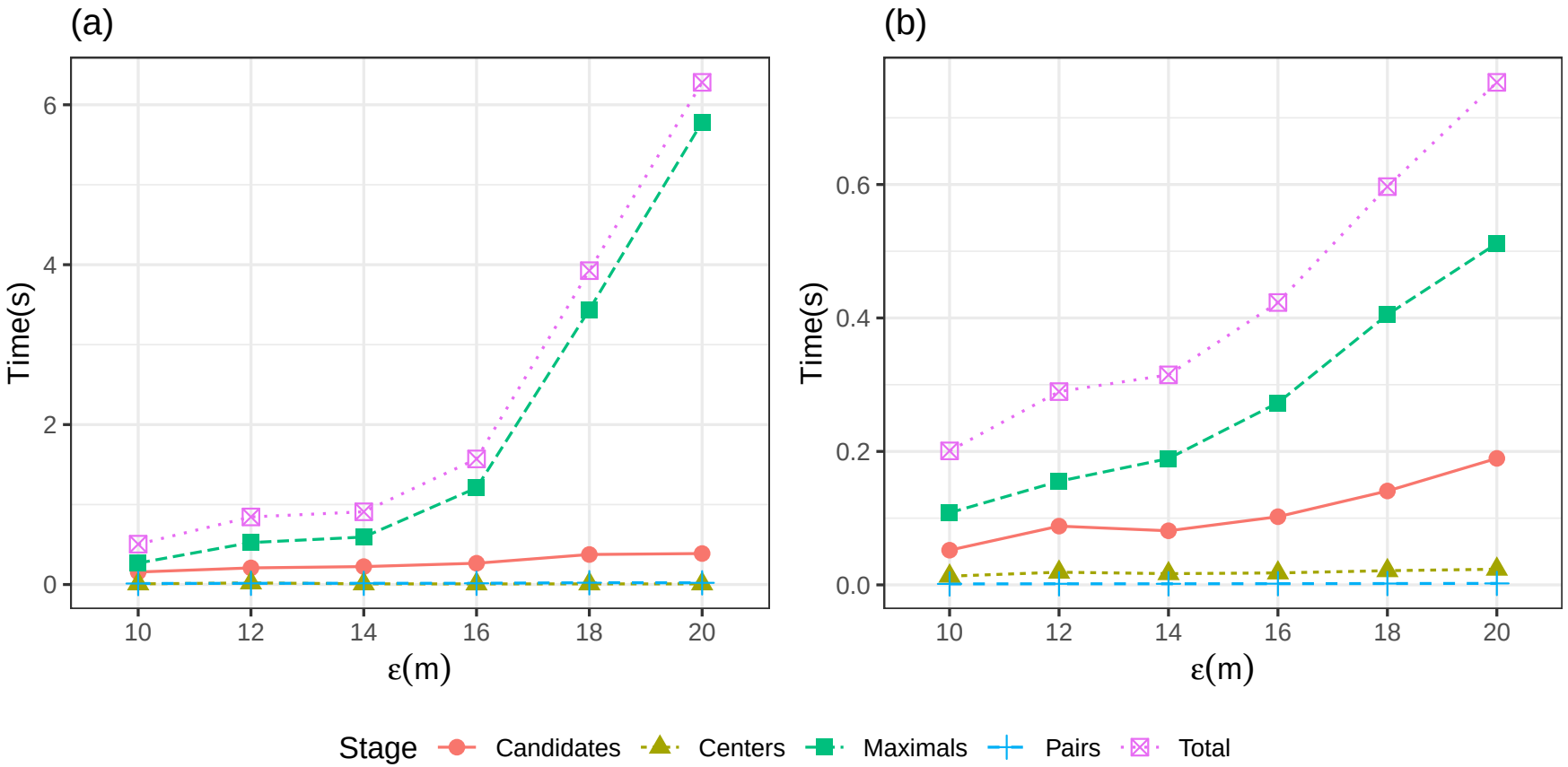

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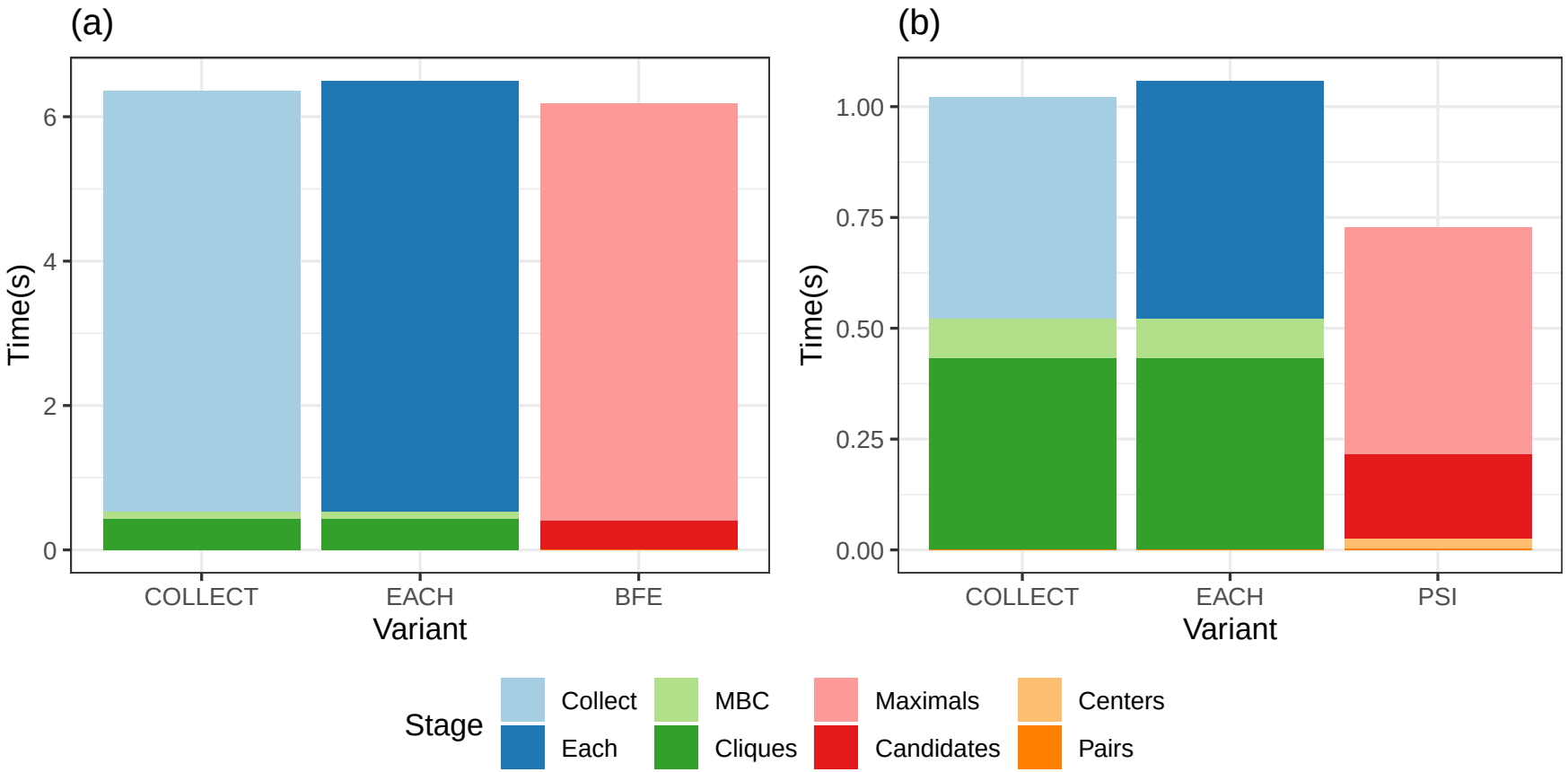

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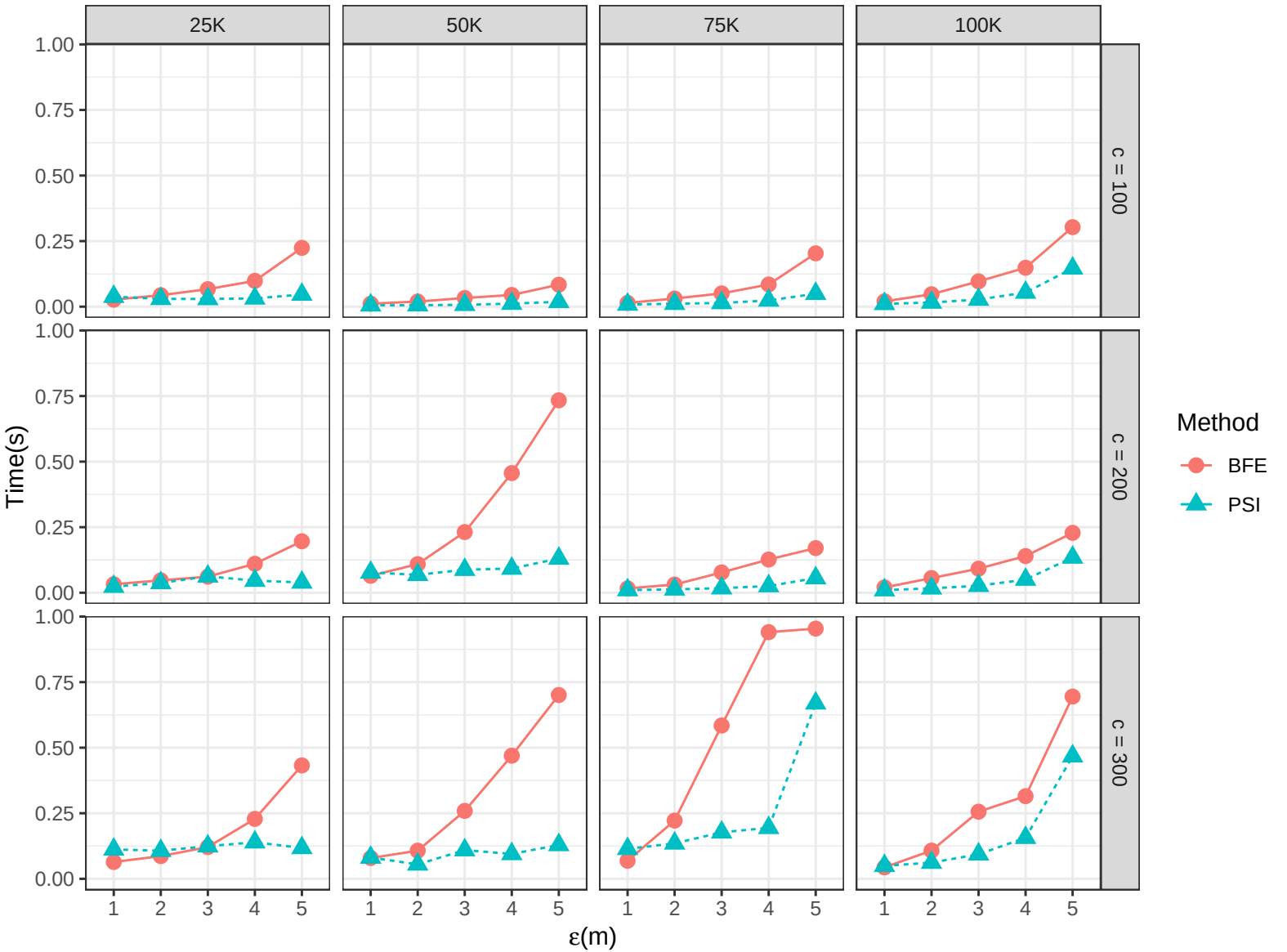

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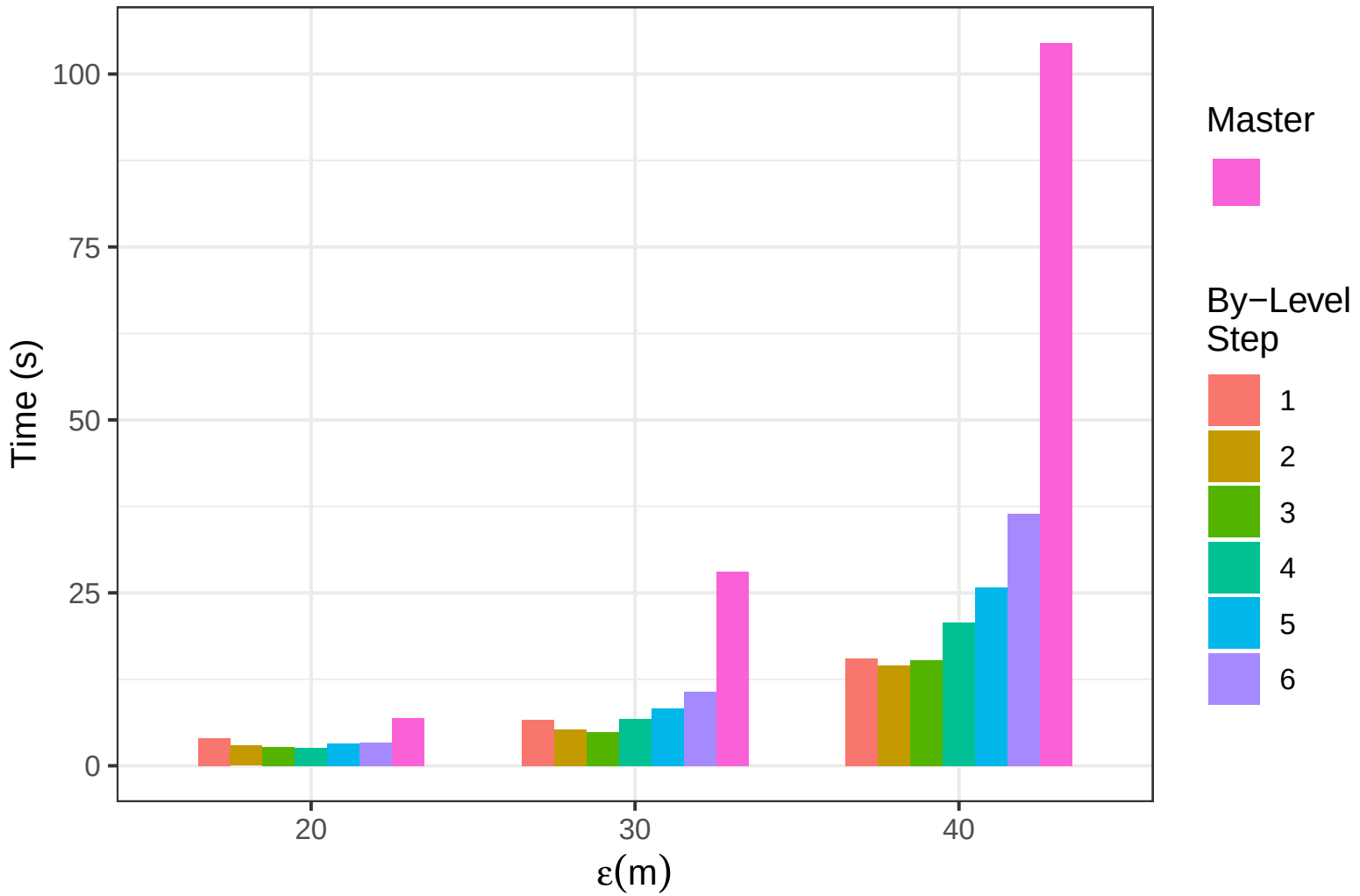

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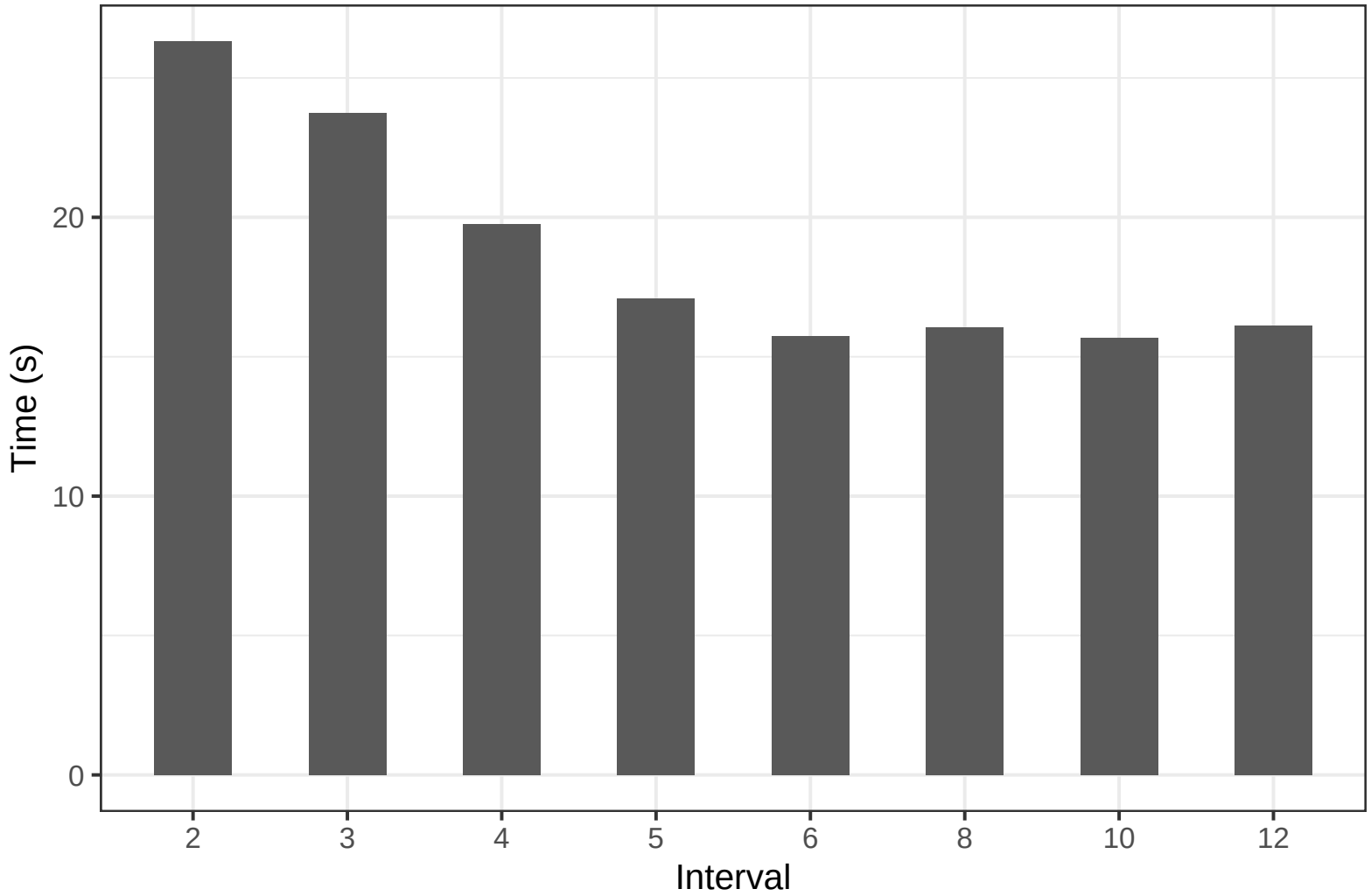

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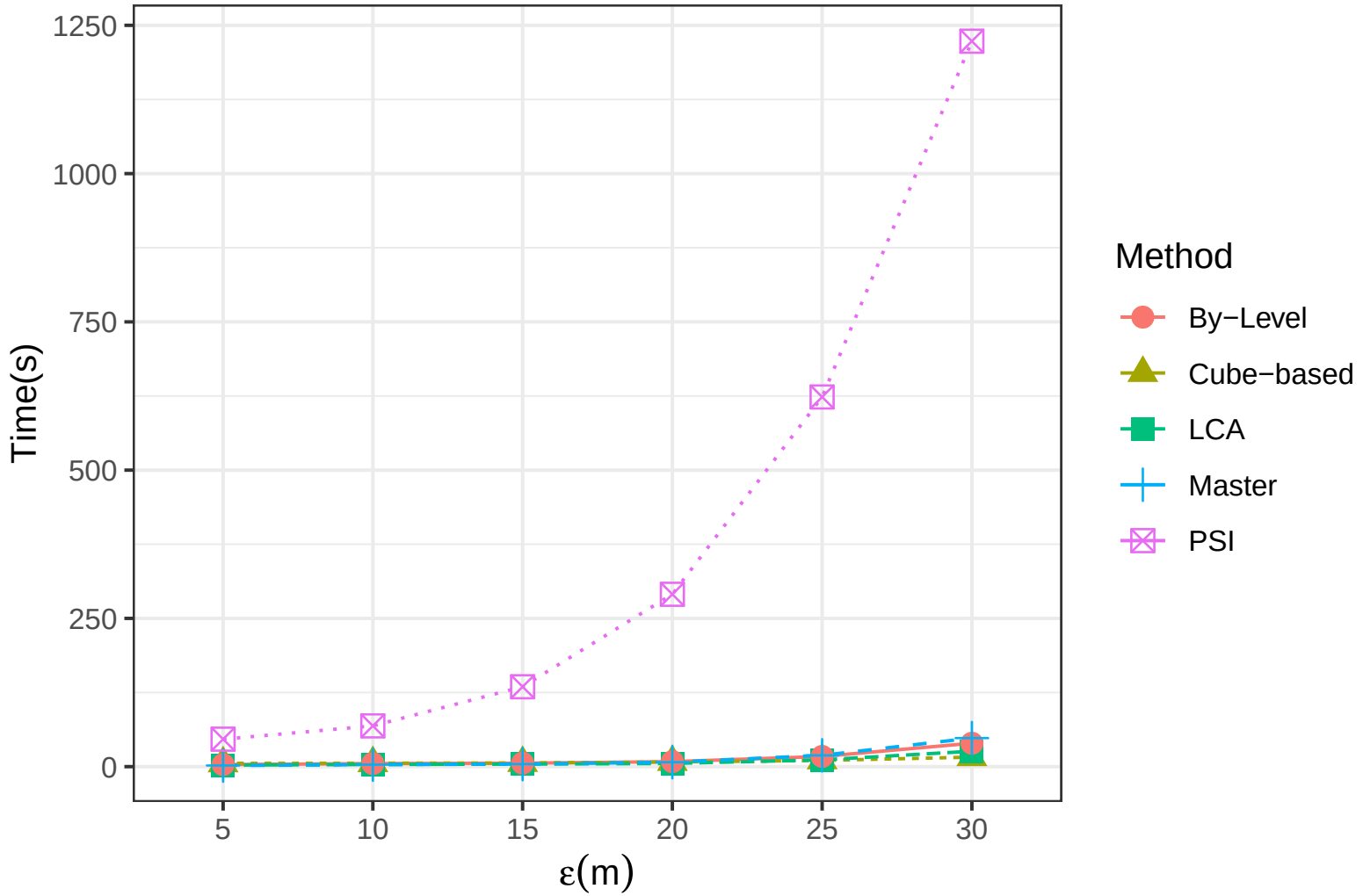

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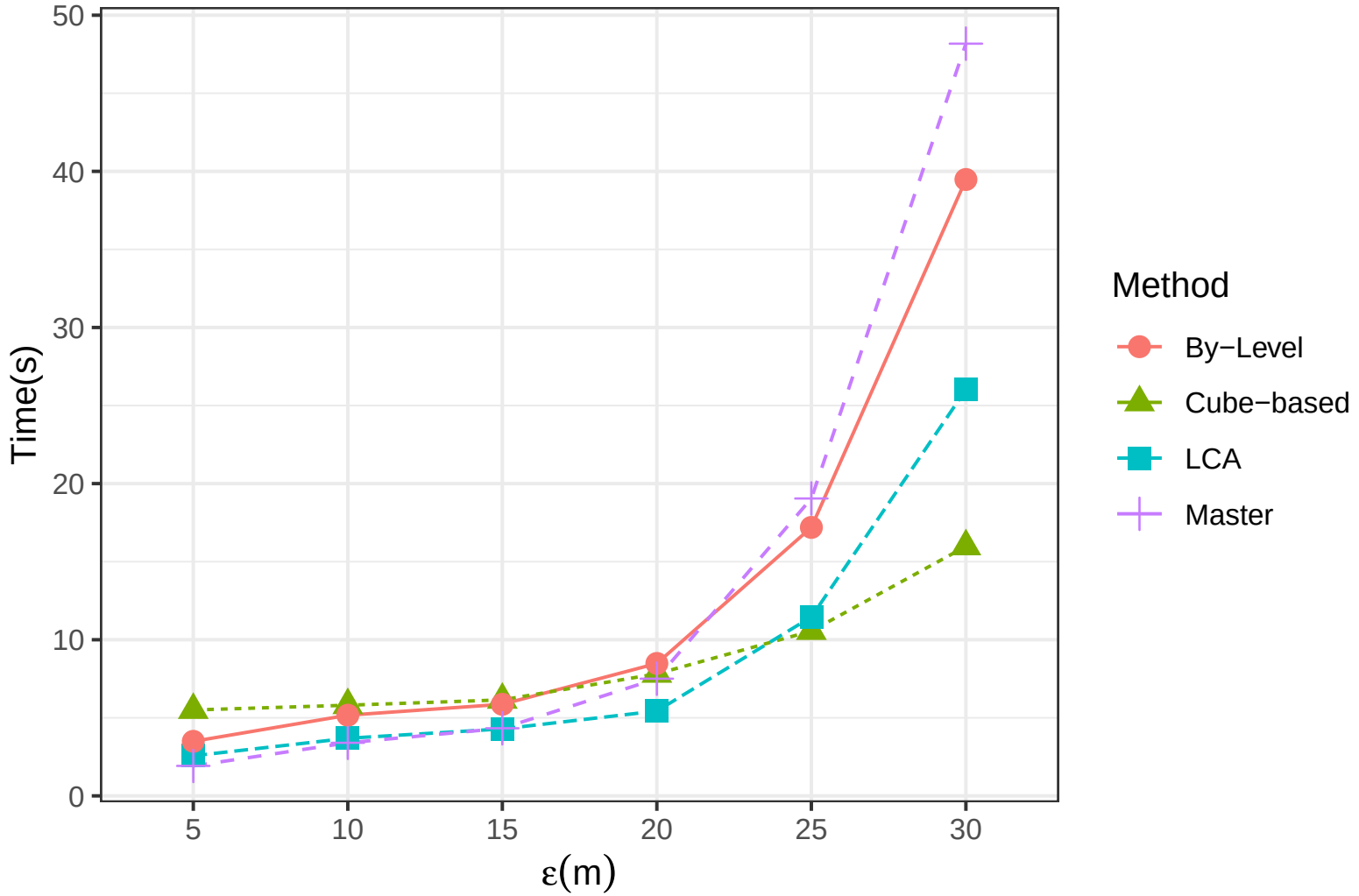

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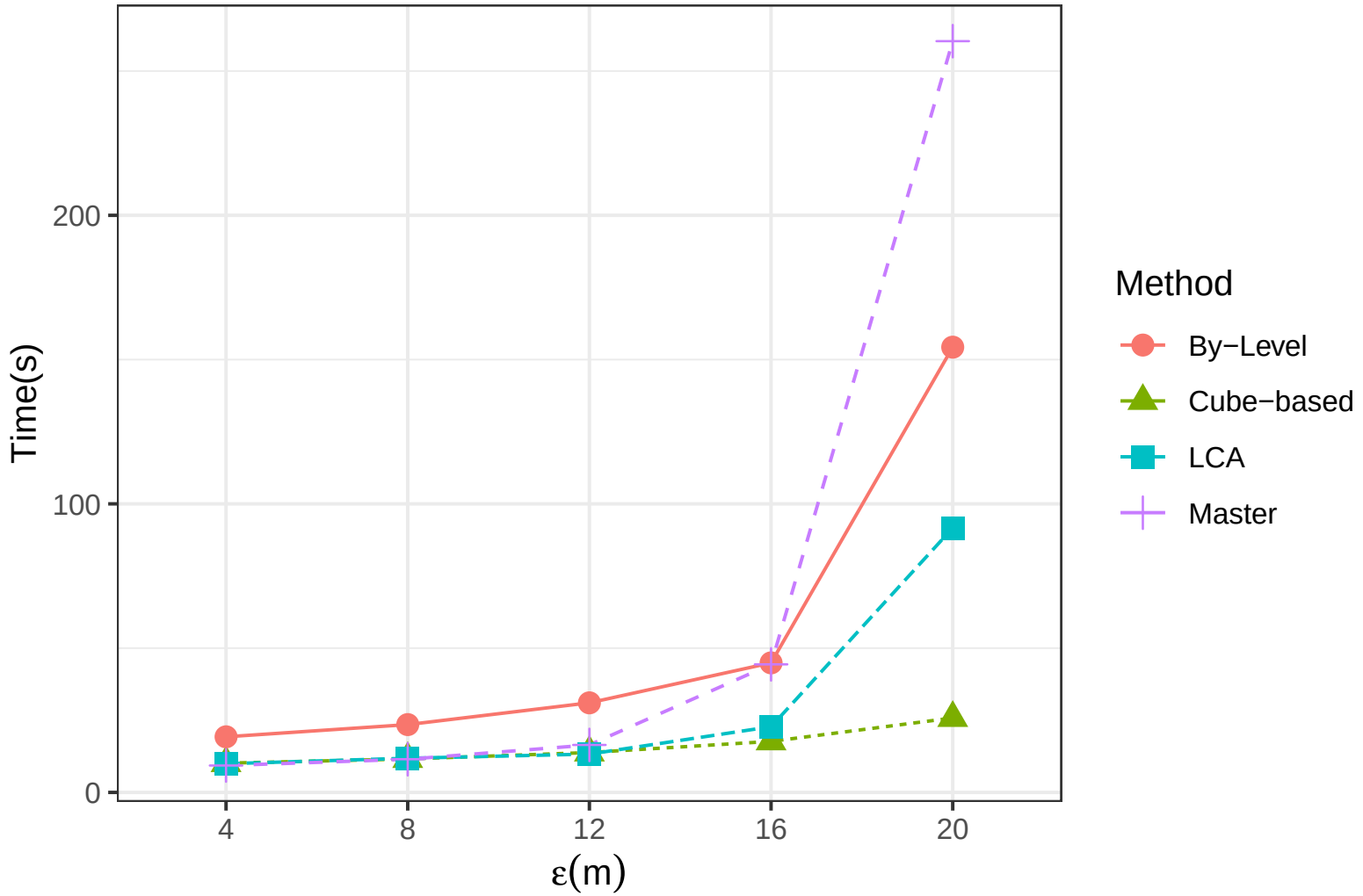

Thank you!