

Trajectory Indexing And Retrieval

--- An overview

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Preliminary

■ Trajectory Data Management

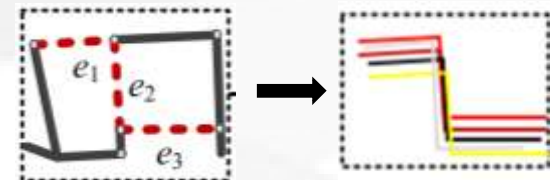
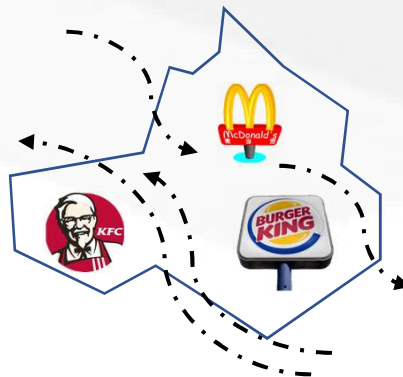
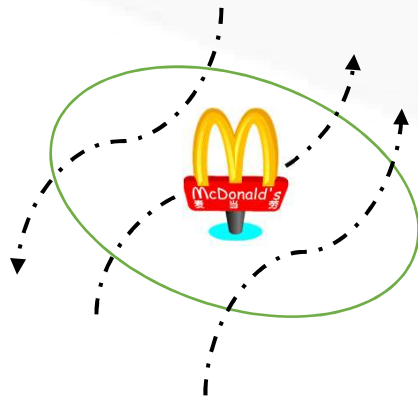
- Massive trajectories
- Travelling history of moving objects



Preliminary

■ Trajectory Query

- TP: trajectories and points
e.g. the trajectories within 500m of a JGM between 8:00am-9:30am
- TR: trajectories and ranges
e.g. the region which is passed by τ trajectories between 9:00pm-9:30pm
- TT: trajectories and trajectories
e.g. the travelers who may take a similar path in the coming 30mins



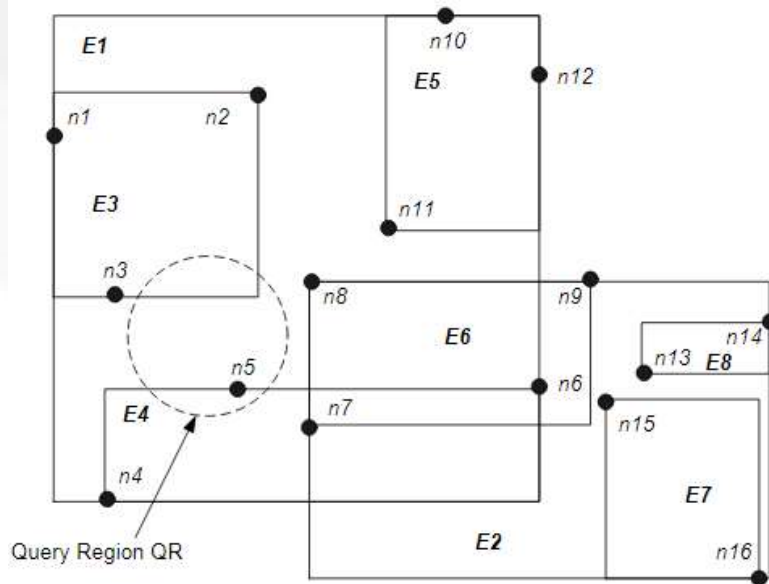
Problems

- A very large database
- Continuous long-time query windows
- Similarity of trajectories
- ...

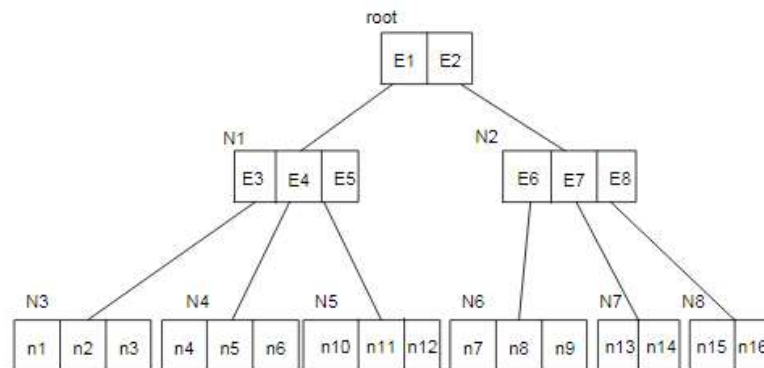
Trajectory Indexing

■ R-tree

- MBBs (Minimum Bounding Box/Blocks)
- Efficient and simple
- Widely recognized in the spatial database



(a) Objects and Minimum Bounding Region

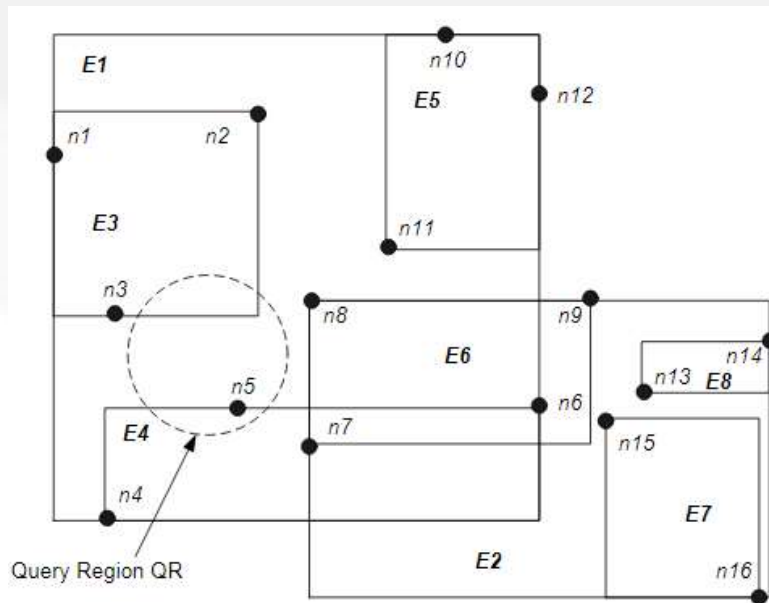


(b) R-tree

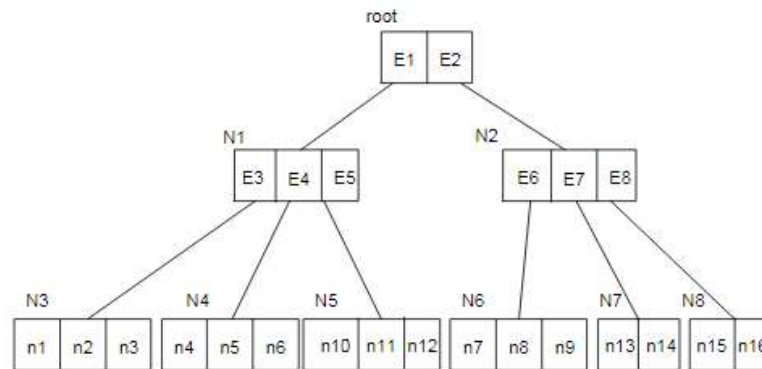
Trajectory Indexing

■ R-tree: query

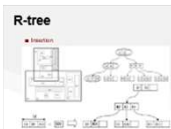
- Query Region
- Query Nearest Neighbors: depth-first / best-first



(a) Objects and Minimum Bounding Region



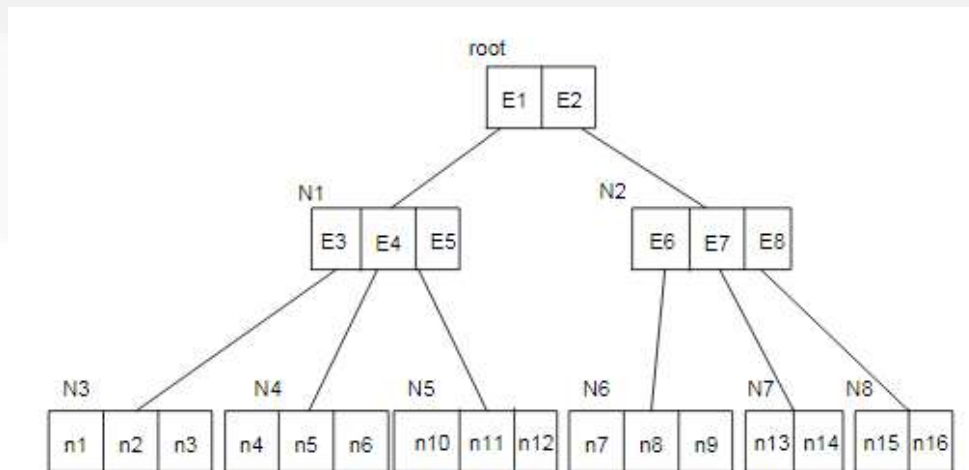
(b) R-tree



Trajectory Indexing

■ R-tree: query

- Query Region
- Query Nearest Neighbors: depth-first / best-first



The distance is maintained between MBBs and the point

Best-first:

1. Beginning from the root
2. Matching the nearest MBB in each node

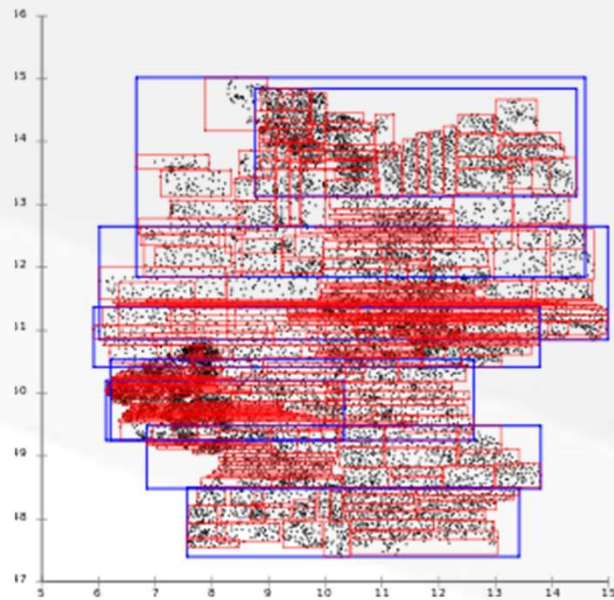
Depth-first:

1. Beginning from a leaf node
2. A threshold is maintained

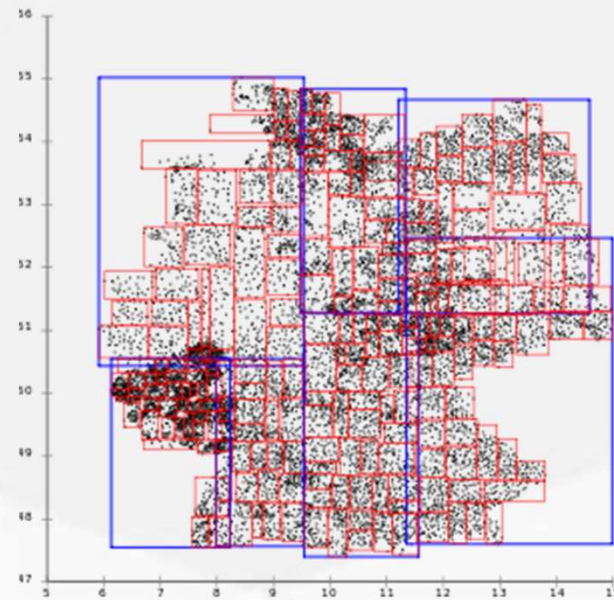
Trajectory Indexing

■ R-tree: drawbacks

- MBBs of R-tree nodes overlapping and multiple searching paths



R-tree



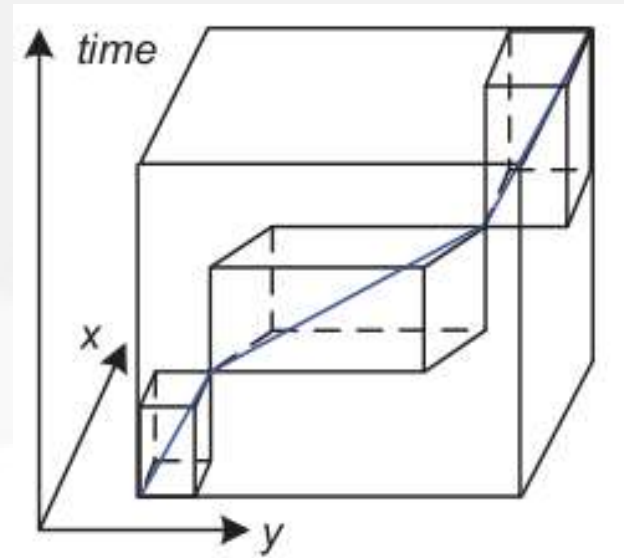
R*-tree

Trajectory Indexing

■ R-tree with augmentation in temporary dimensions

- 3D R-tree

- Timestamp queries and interval queries
- 3D-MBB bounding line segments
- Drawbacks: MORE frequent overlapping duo to points update

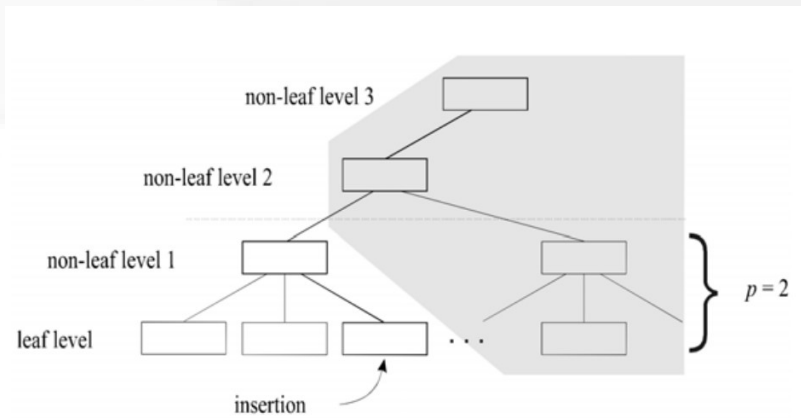


Trajectory Indexing

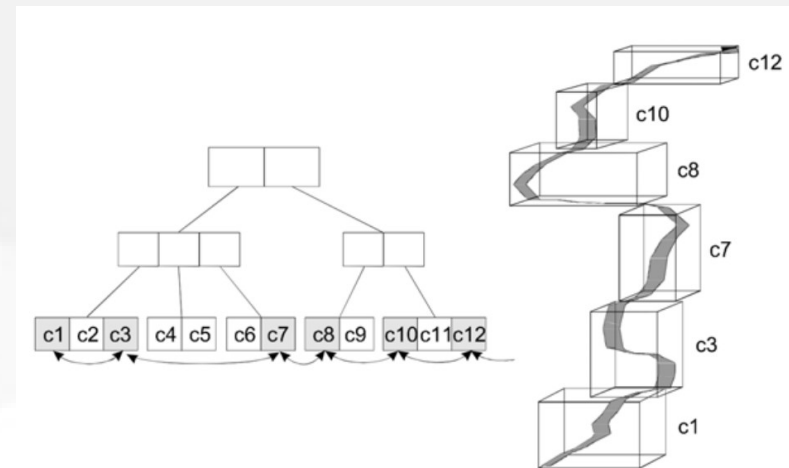
■ R-tree with augmentation in temporary dimensions

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STR-tree

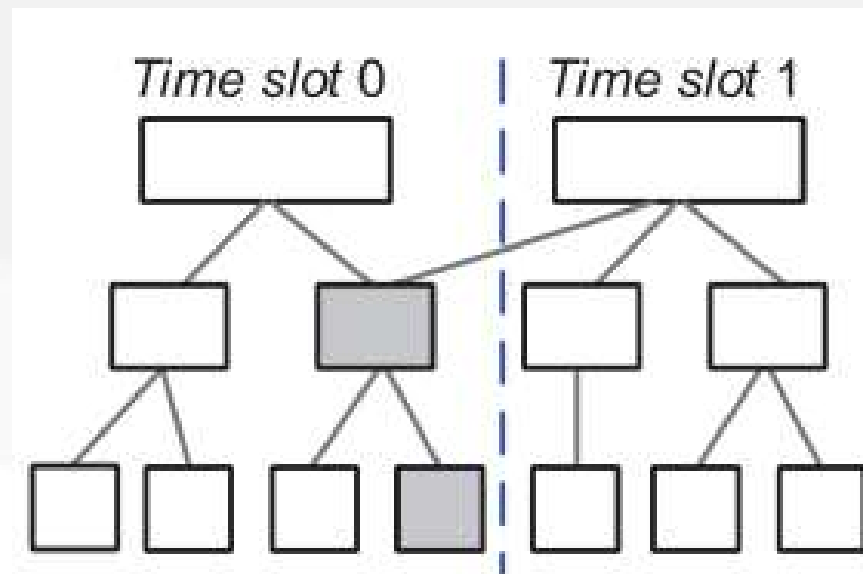


TB-tree

Trajectory Indexing

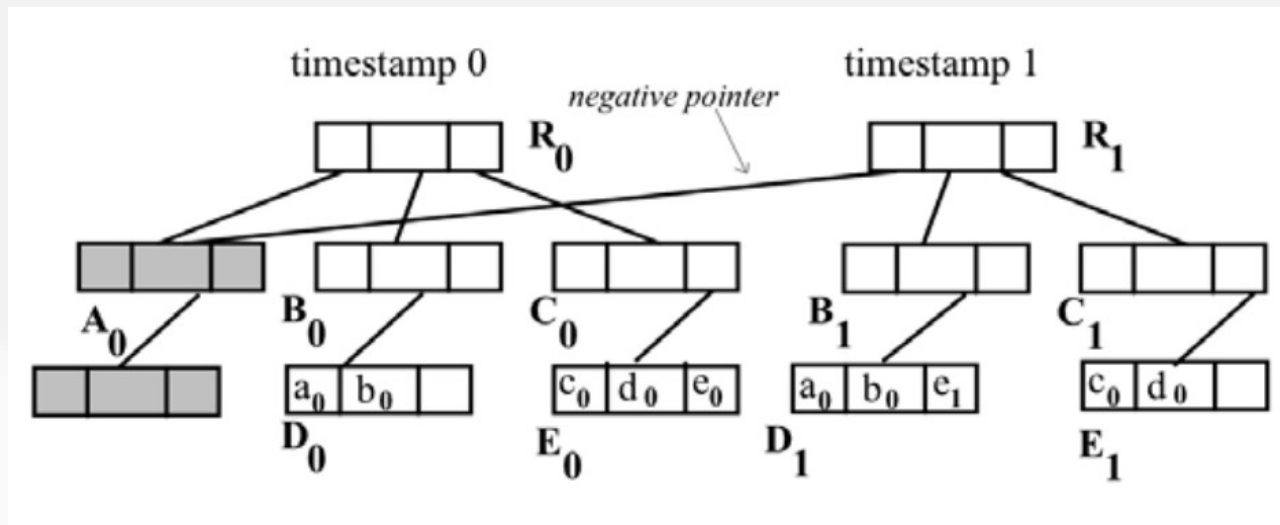
■ Time slot + Spatial index

- Dividing a time period into multiple time intervals
- Building an individual spatial index for the trajectories generated in each interval
- The stable part is shared by two time slots



Trajectory Indexing

■ Time slot + Spatial index: HR-tree



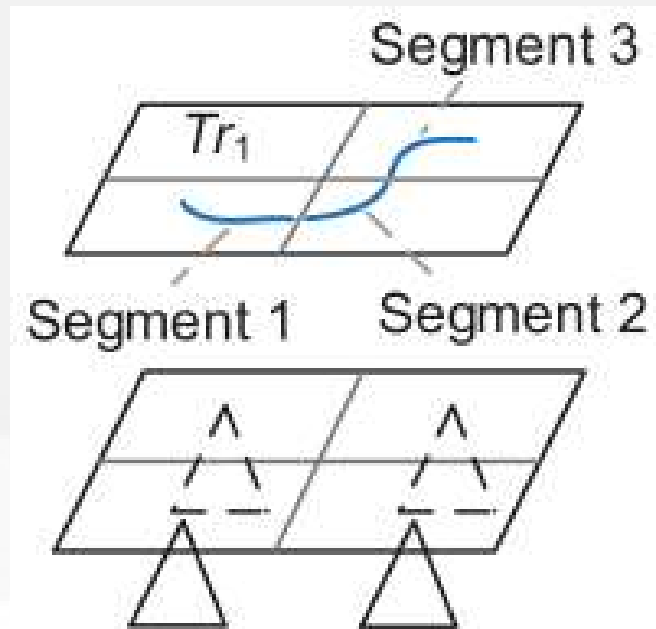
HR-tree

HR+-Tree: objects a smaller change of position may still be in the same nodes shared with different R-trees

Trajectory Indexing

■ Spatial grid + Temporal index

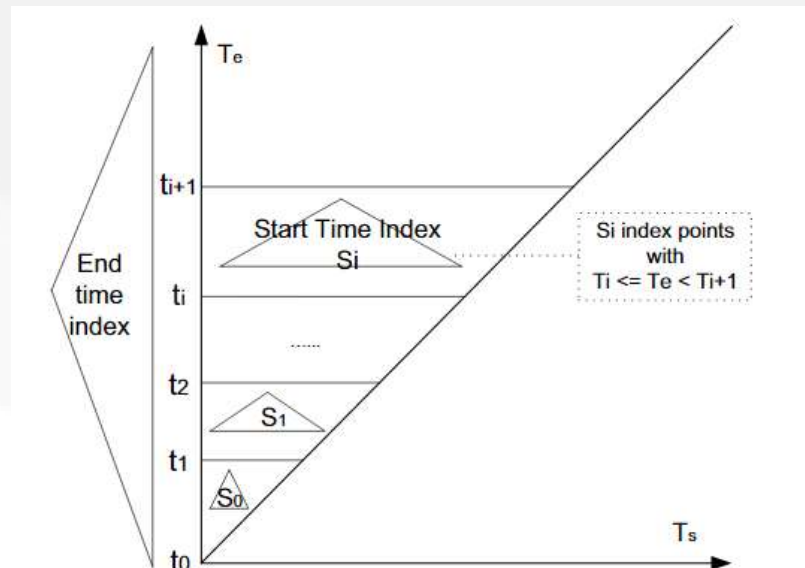
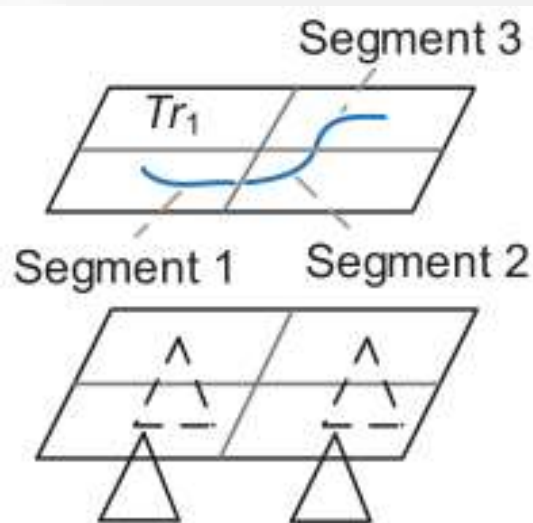
- Partitioning a geographical space into grids
- Builds a temporal index for the trajectories falling in each grid



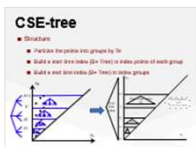
Trajectory Indexing

■ Spatial grid + Temporal index: CSE-tree

- A track is partitioned into segments by spatial grids
- Each segment is inserted into corresponding temporal
- Each segment represented by a 2D point whose coordinates are the starting time and ending time of the segment



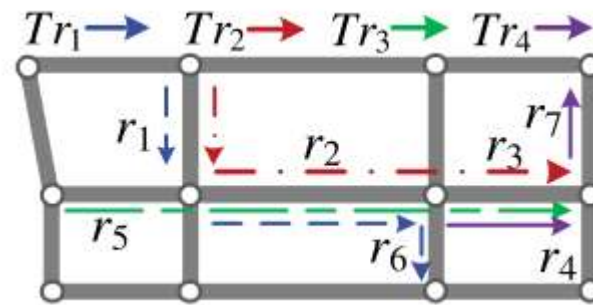
CSE-tree



Trajectory Indexing

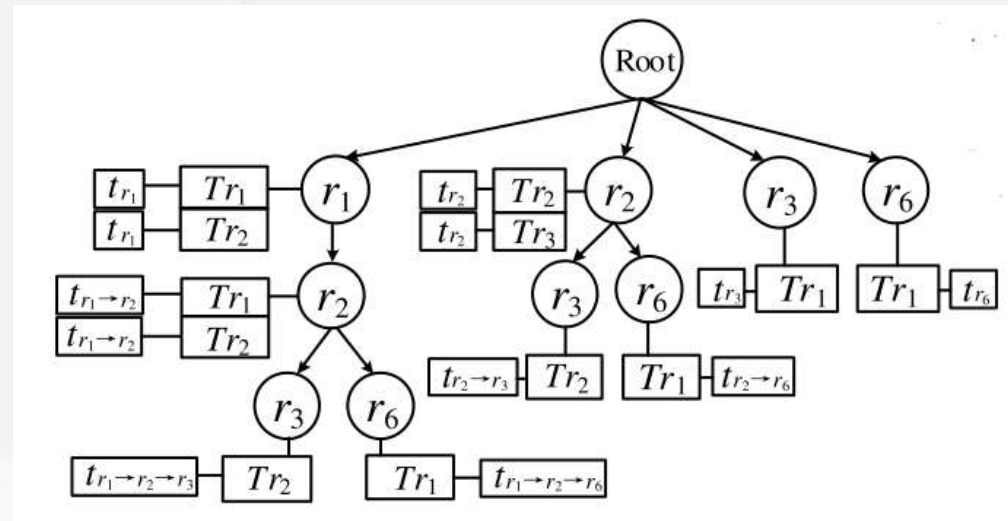
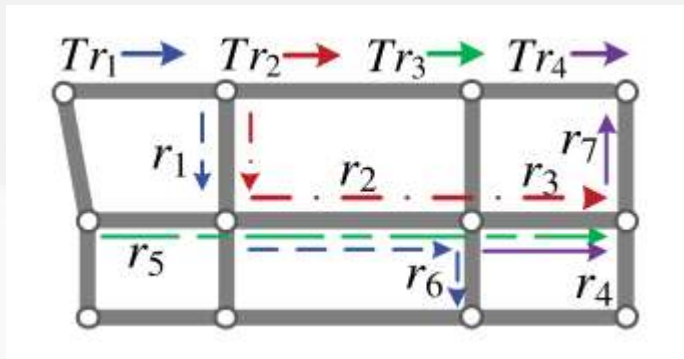
■ Indexing by road networks

- Regarding a path on a road network as a trajectory
- Or converting a trajectory by map-matching



Trajectory Indexing

- Indexing by road network: suffix-tree-based





Thank You !

Yi Zhao

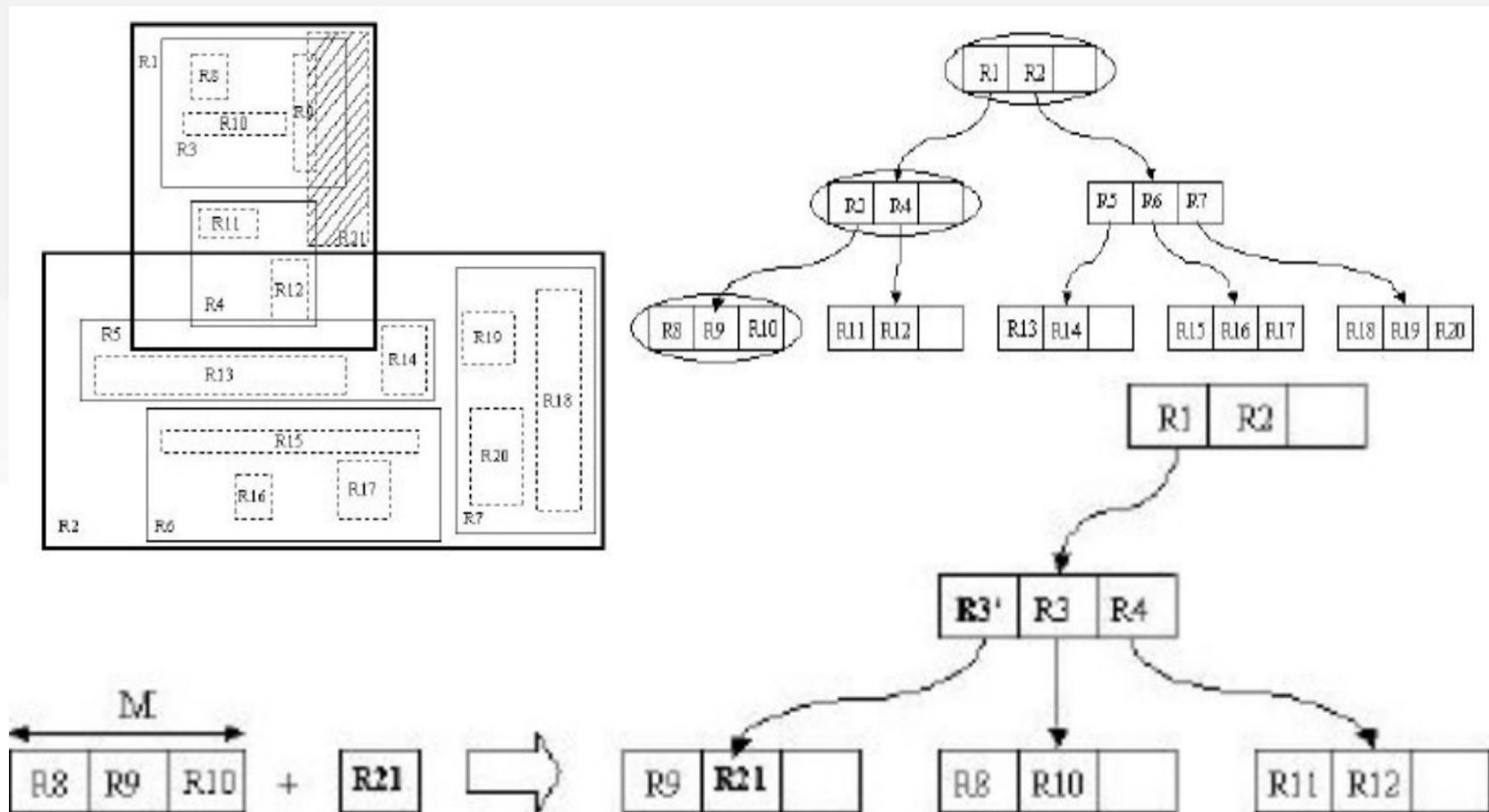
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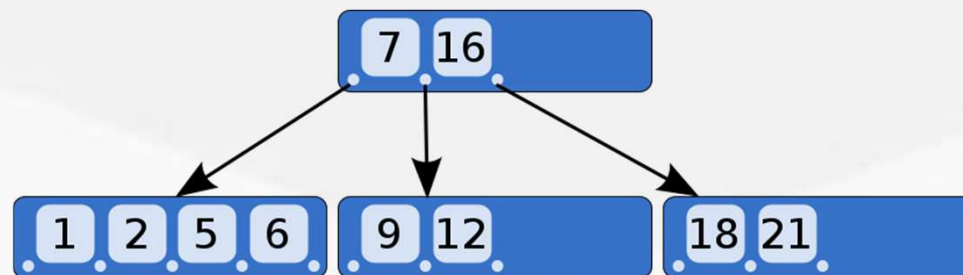
R-tree

■ Insertion



B-tree

- A binary search tree
- Self-balancing
- Keeping data sorted
- Logarithmic time



CSE-tree

■ Structure

- Partition the points into groups by T_e
- Build a start time index (B+ Tree) to index points of each group
- Build an end time index (B+ Tree) to index groups

