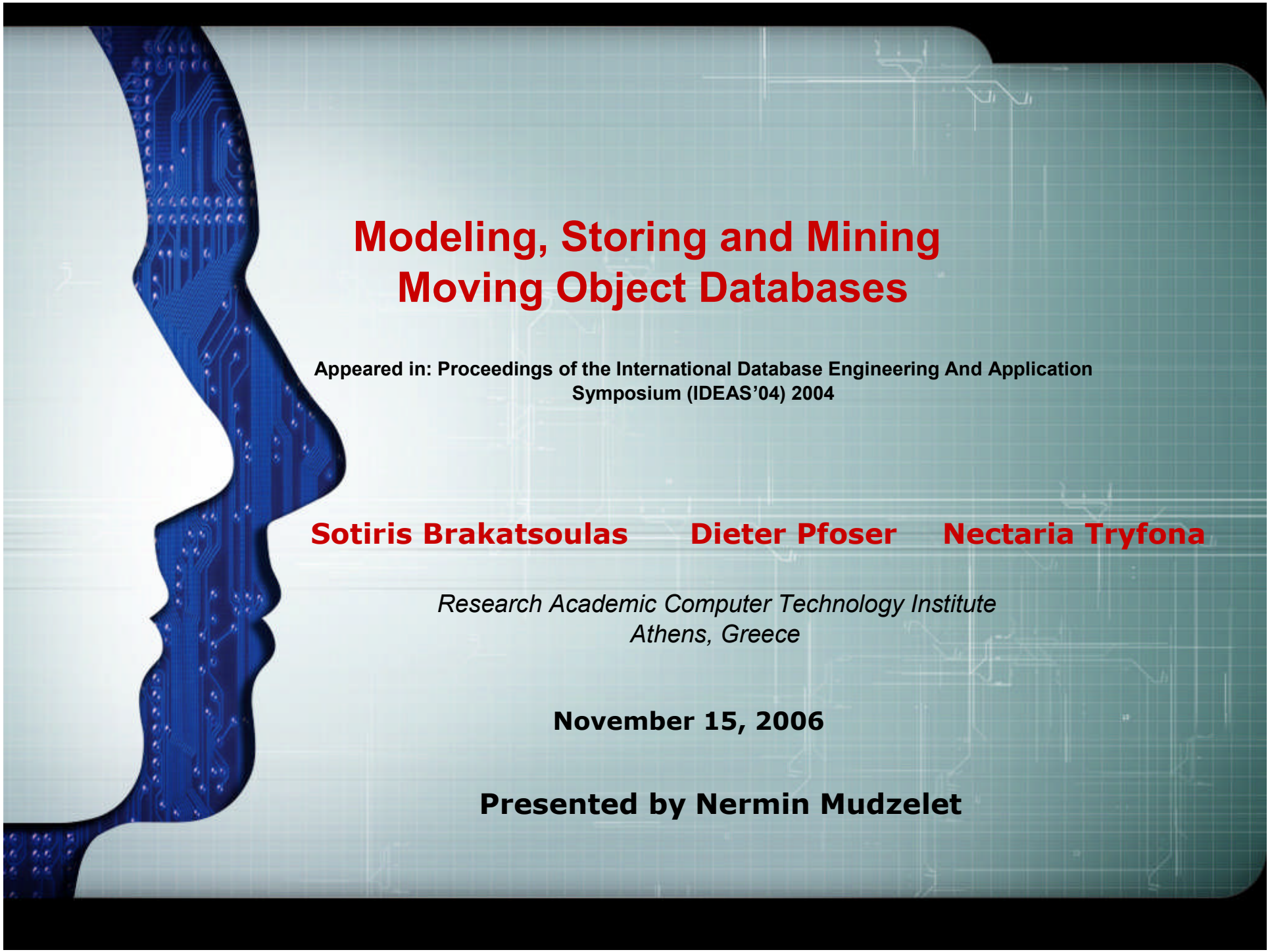

Modeling, Storing and Mining Moving Object Databases

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Motivation

- **Problems in traffic management**
  - Find alternatives for troublesome situations (e.g. traffic jams)

(picture)

Figure 1: Rush hour

Motivation

- **Build MOD(Moving Object Database)**
  - Spatial data (roads, buildings, obstructions)
  - Non-spatial data (attributes, texts, pictures)
  - Trajectory data
- **Spatial Mining Language (SML)**
- **ΙΧΝΗΛΑΤΗΣ (Pathfinder) – Traffic Management System**
  - General Secretariat of Research and Development, Greece
  - Use real data from a fleet of moving vehicles to analyze, model, process and extract further knowledge
  - Routing optimization

Concepts

- **Moving object**
  - e.g. delivery truck, public transport, taxi
- **Trajectory (trace of the vehicle in time)**
  - Properties (*speed, heading, covering area*, etc.)
  - Relations (*stay within, leave, enter, cross, bypass*)

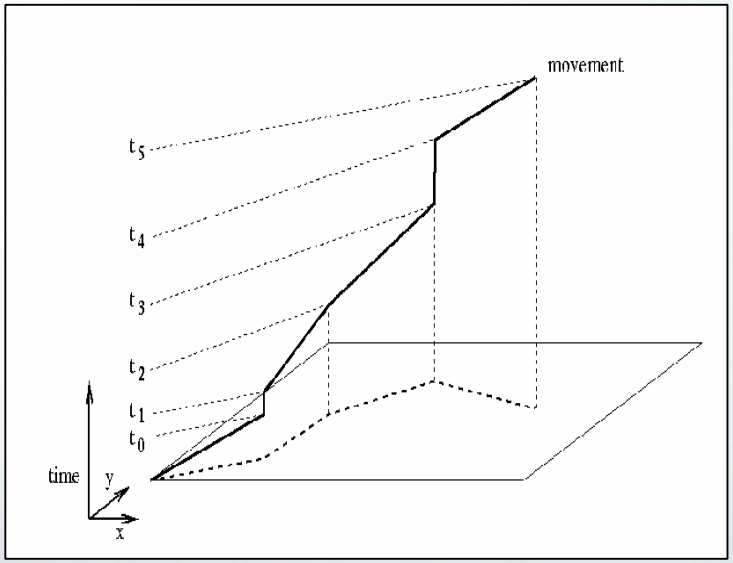


Figure 2: Trajectory of moving object

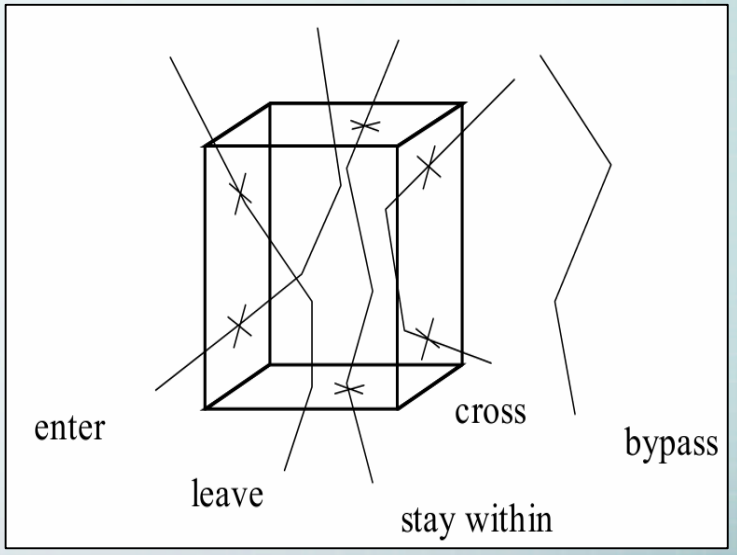
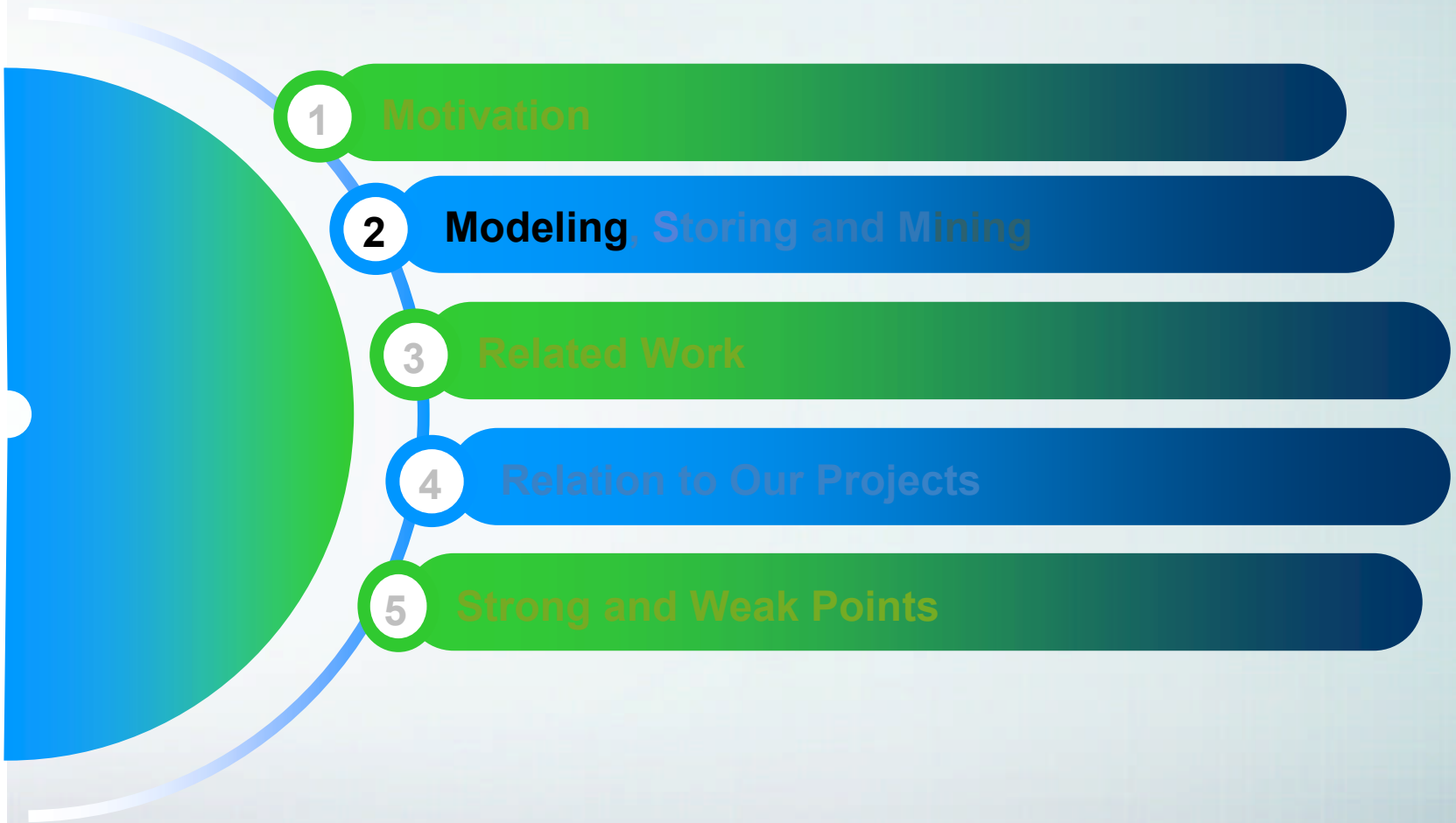


Figure 3: Relationships: trajectory/environment

Overview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Modeling

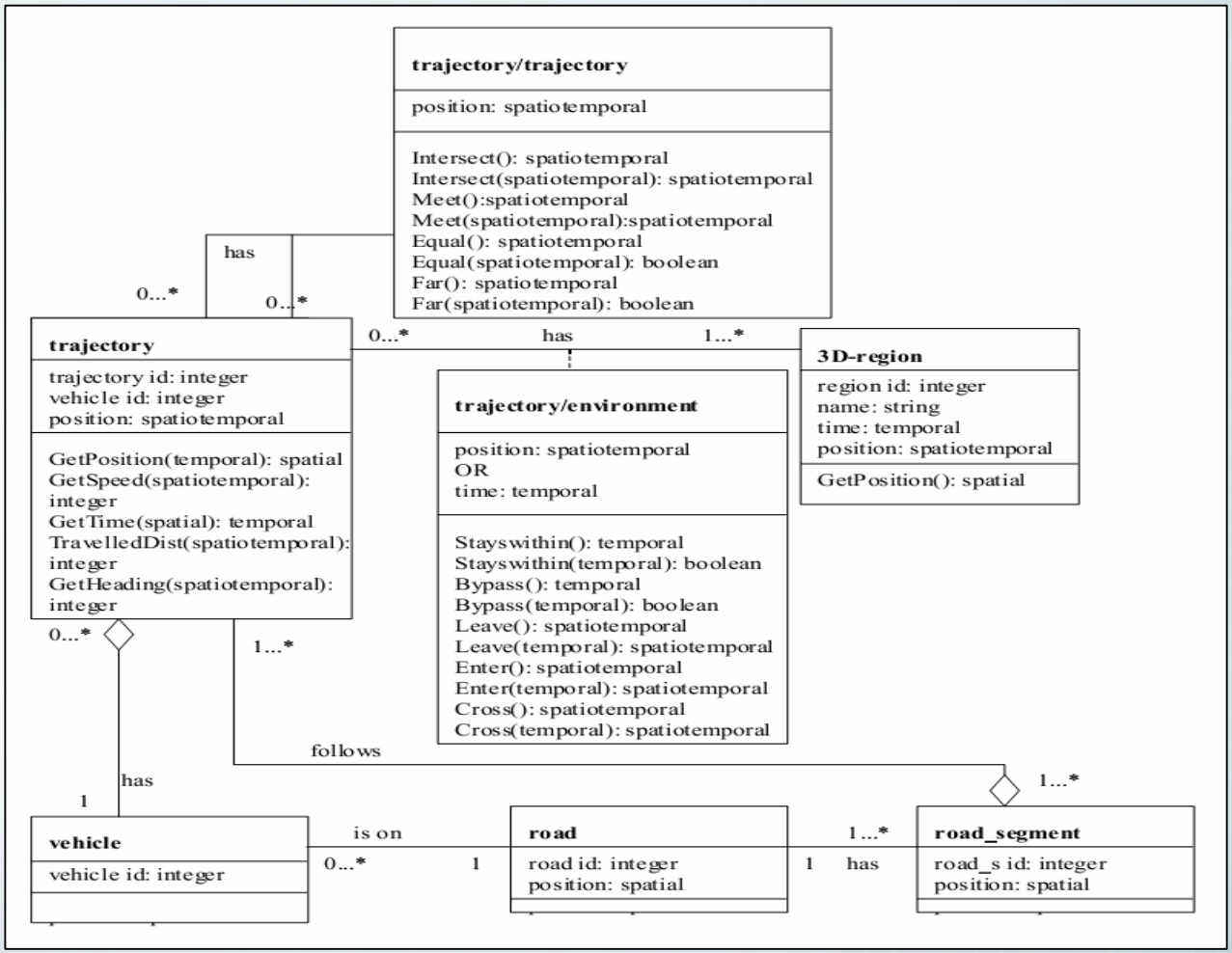

Figure 4: Database scheme of MOD

Storing

Trajectory data storage

- NW_TRAJECTORY(trajectory_id,edge_id, time1, time2)
  - records trajectory segments
- NODE(node_id, 2D-point)
  - represents the spatial aspect of the street network
- EDGE_NODES(edge_id, node_id1, node_id2)
  - start/end nodes for each network edge
- NODE_EDGES(node_id, edge_id)
  - capture the incident edges of nodes

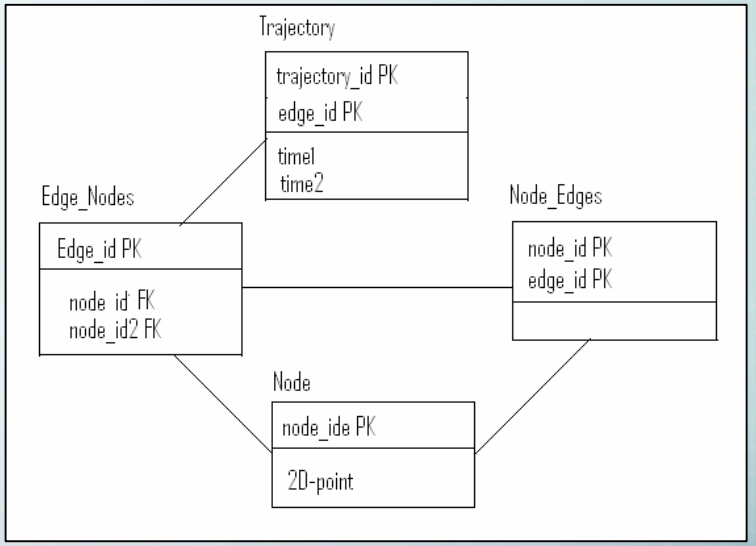

Figure 5: Relations between tables

Storing

- **For query optimization used various indexes**
  - Spatial, B-tree index
- **Stored 26000 trajectories**
  - Size in database 1GB

Network Schema	
Table or Index	**Size (MB)**
NW_TRAJECTORY	476.41
NW_TRAJECTORY_INDEX	480.2
NODE	5.95
NODE_INDEX	12.53
NODE_EDGES	6.12
NODE_EDGES_INDEX	9.22
EDGE_NODES	5.9
EDGE_NODES_INDEX	3.4
Total	**999.73**

Table 1: Trajectory data storage occupation

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Mining

- **Data mining functions – query existing information to extract knowledge**
  - Characterization
    - assigning a new attribute to a class based on some attribute values
  - Clustering
    - new object class based on the values of some attributes
  - Association
    - relationship between object classes

- **Spatial Mining Language (SML) of the ΙΧΝΗΛΑΤΗΣ system**
  - Generic syntax :

```
MINE mining function
ON/AMONG object class(-es)
AS composite spatial constraint
```

Mining

Example

- **Query :** *Find all vehicles with a traveled distance of 15 to 20 km from the center of Athens towards South, between 10:00 to 10:30 and cluster them as 'equivalent_routes'.*

```
MINE CLUSTERING 'equivalent_routes'
ON trajectory
AS (15 km < distance(GetPosition(10:00) -
GetPosition(10:30)) < 20 km) and (170 <
GetHeading(spatial extent: center±20km,
temporal extent: 10:00 - 10:30) < 190
(degrees))
```

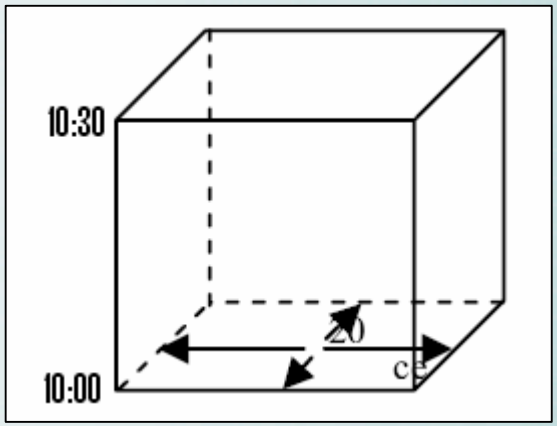
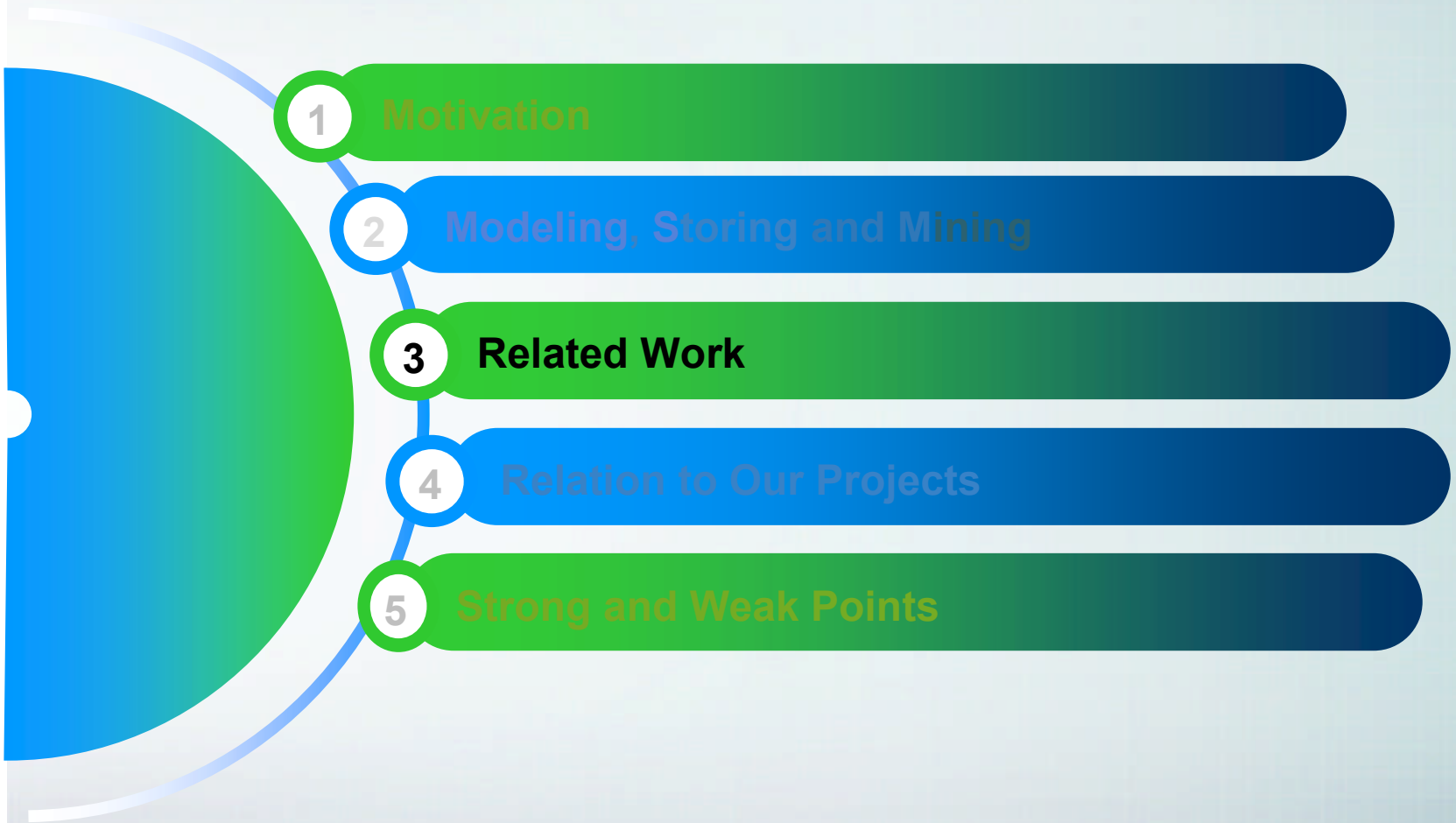


Figure 7: Spatiotemporal range

Overview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Related work

- **Most of the related work includes tools in spatial data mining and traffic management**
- **[7] ”A foundation for representing and querying moving objects in databases” by R.H. Güting at al.**
  - The paper provides abstract data type extension to a DBMS data model and query language for moving objects, and it is basis for data types in this paper
- **“Querying the Trajectories of On-Line Mobile Objects” by Dieter Pfoser and Christian S. Jensen**
  - The paper presents a technique for querying trajectories, and it is used as basis on this paper for manipulating trajectories

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Relation to our projects

- **Motivation close to ours**
  - Analyses and processing of traffic data
- **GPS data points are map matched to road segments**
- **We are using data warehouse**
  - Discrete spatial locations and trajectories approach
- **We can use storage model**

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Strong and weak points

- **Strong points**
  - Contribution of paper is clearly pointed out
  - Explanation of SML language includes examples
- **Weak points**
  - Actual implementation and performance of system not included
  - Explanation of Figure 3 in the paper not clear enough


Thank You !