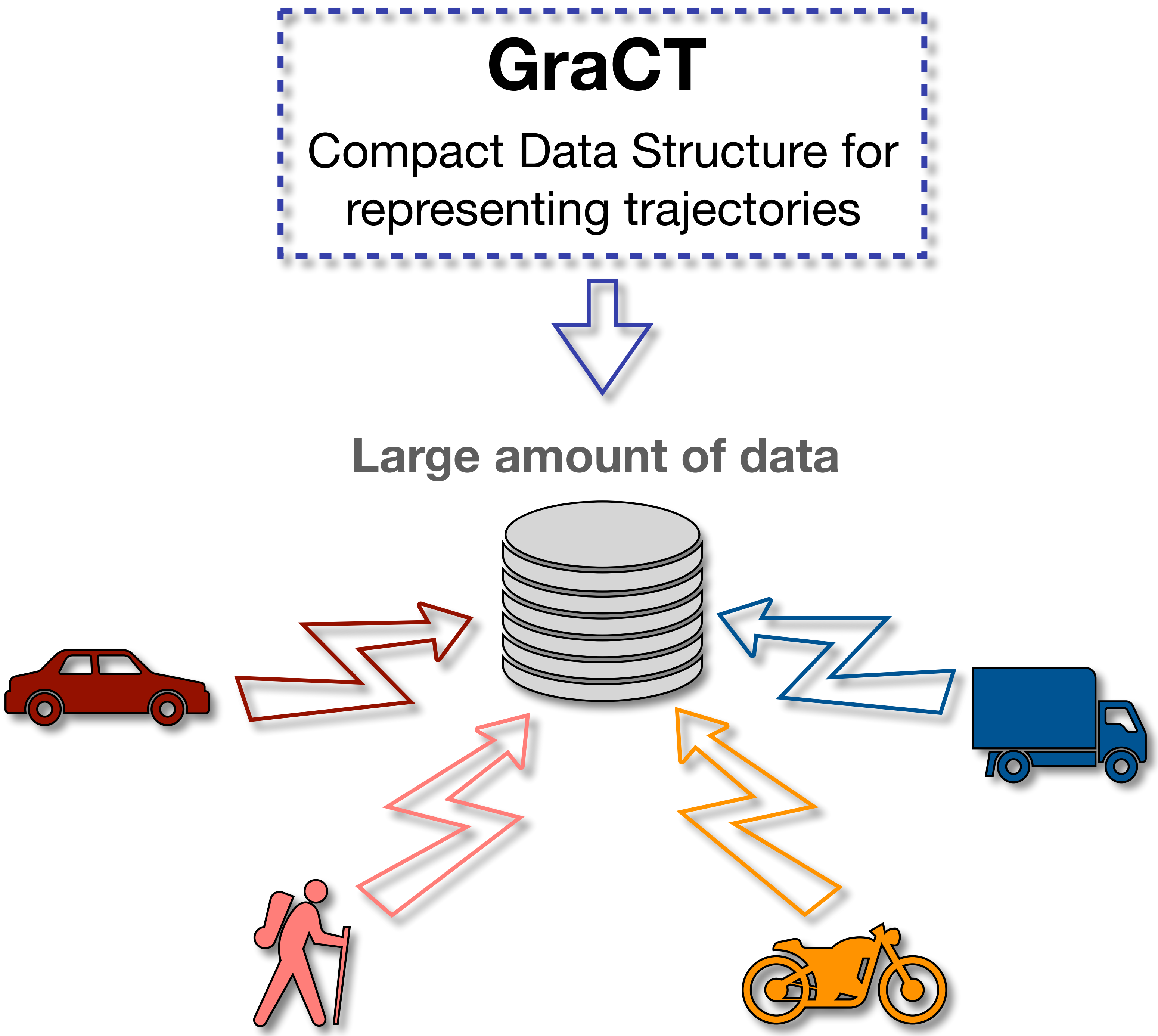
A Disk-Based Index for Trajectories with In-Memory Compressed Cache

Daniela Campos, **Adrián Gómez-Brandón**, Gonzalo Navarro

IMFD, Dept. of Computer Science, University of Chile, Chile.
Laboratorio de Bases de Datos, Universidade da Coruña, Spain.

Context

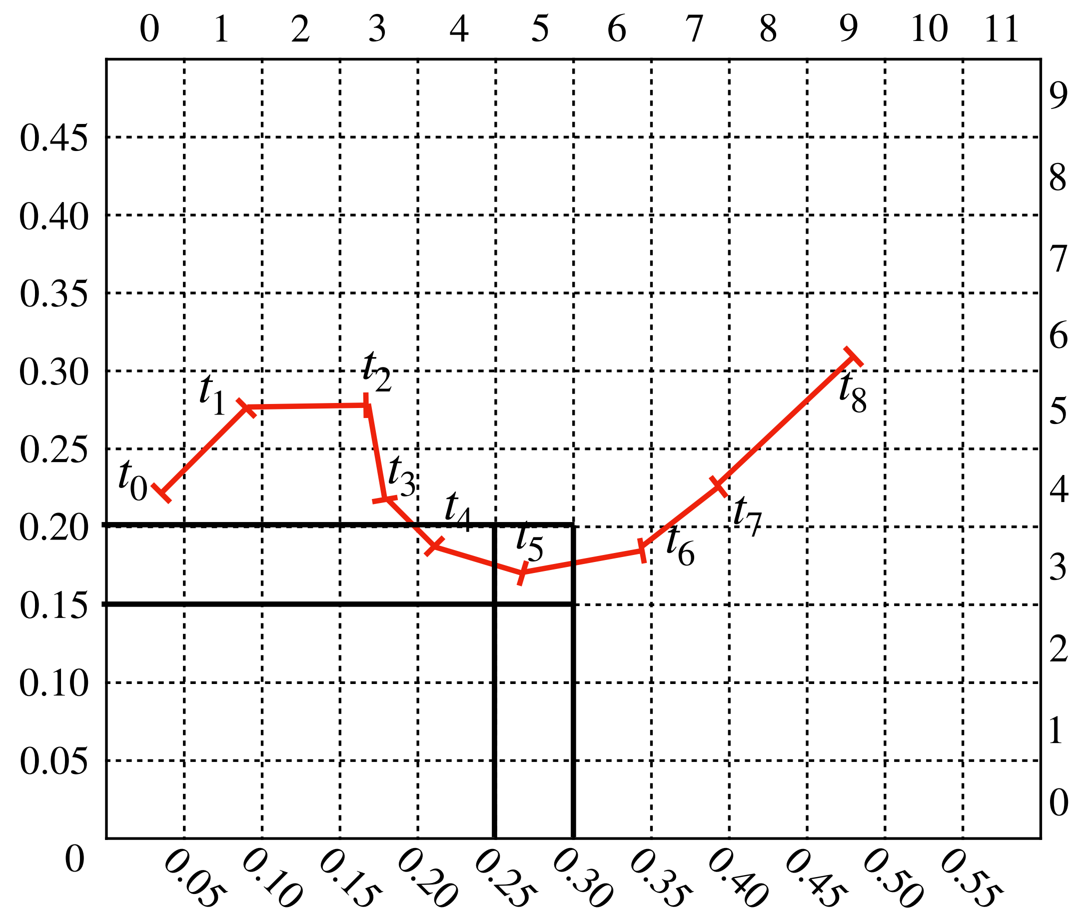

GraCT
Compact Data Structure for representing trajectories
Large amount of data

GraCT

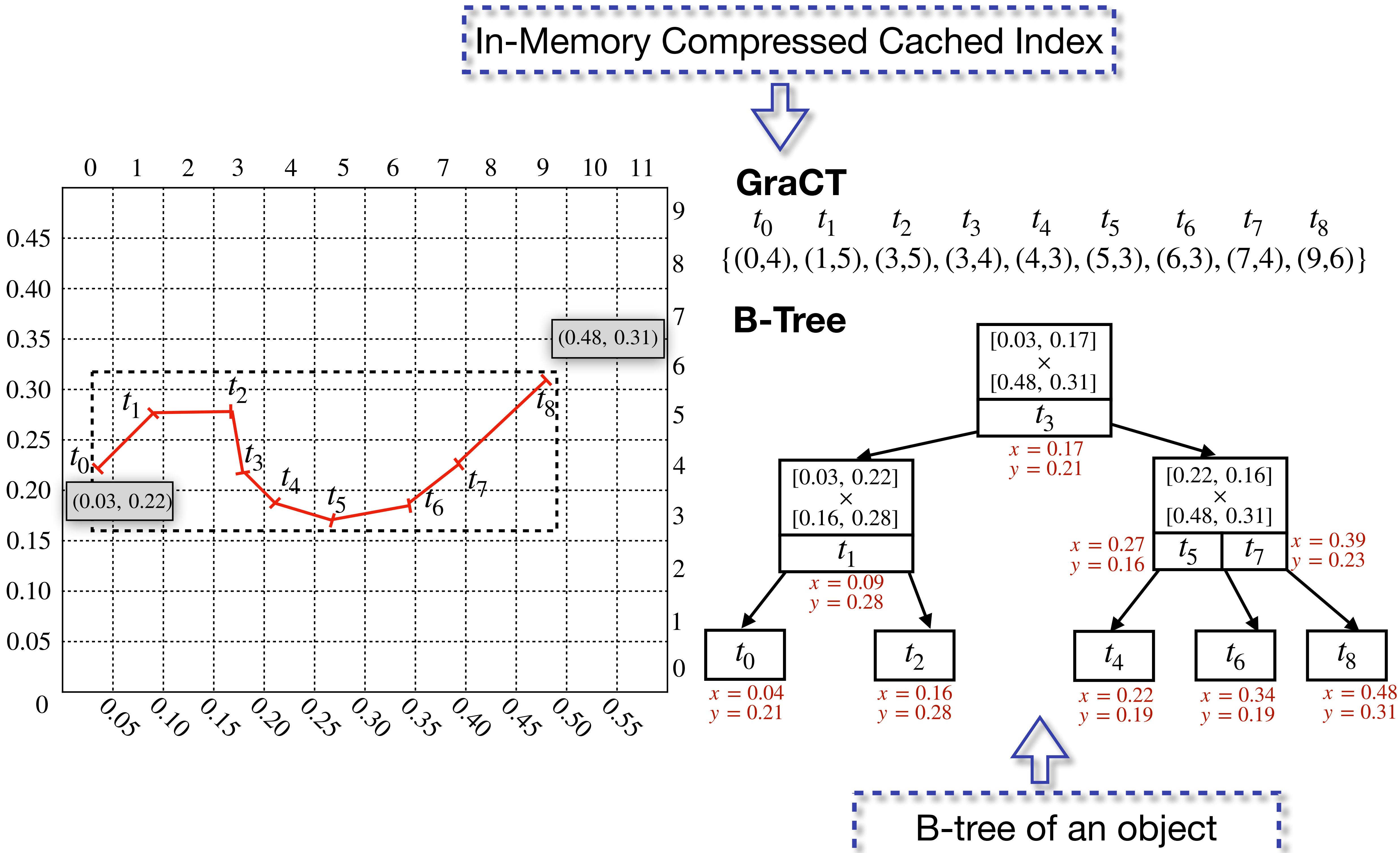
GraCT

Compact Data Structure for representing trajectories

- In-memory **spatio-temporal index** for the representation of trajectories.
- Efficient computation of **trajectory, spatio-temporal and nearest neighbor** queries.
- It uses a **raster** model, losing some precision.



GraCT-Disk



In-Memory Compressed Cached Index
GraCT
t_0 t_1 t_2 t_3 t_4 t_5 t_6 t_7 t_8
{(0,4), (1,5), (3,5), (3,4), (4,3), (5,3), (6,3), (7,4), (9,6)}
B-Tree
[0.03, 0.17] × [0.48, 0.31]
t_3
x = 0.17
y = 0.21
[0.03, 0.22] × [0.16, 0.28]
t_1
x = 0.09
y = 0.28
[0.22, 0.16] × [0.48, 0.31]
t_5
t_7
x = 0.27
y = 0.16
x = 0.39
y = 0.23
t_0
x = 0.04
y = 0.21
t_2
x = 0.16
y = 0.28
t_4
x = 0.22
y = 0.19
t_6
x = 0.34
y = 0.19
t_8
x = 0.48
y = 0.31
B-tree of an object
(0.03, 0.22)
(0.48, 0.31)
0 1 2 3 4 5 6 7 8 9 10 11
0.45 0.40 0.35 0.30 0.25 0.20 0.15 0.10 0.05 0
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55
9 8 7 6 5 4 3 2 1 0

Queries

GraCT-Disk supports the following queries:

- Trajectory
- Time Slice
- Time Interval
- K-Nearest Neighbors

} **Spatio-temporal and KNN queries**

Queries

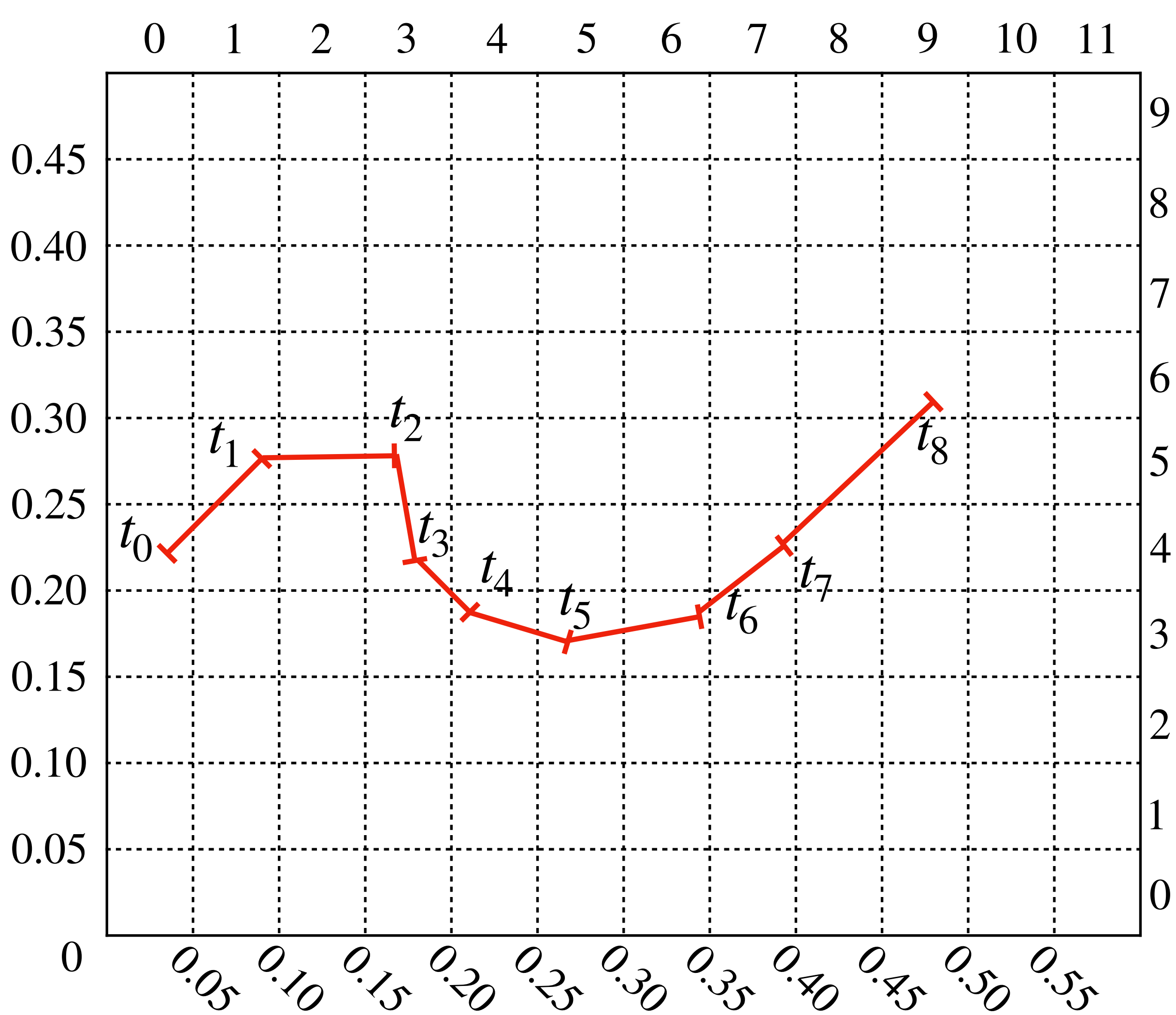
GraCT-Disk supports the following queries:

- **Trajectory**
- Time Slice
- Time Interval
- K-Nearest Neighbors

Spatio-temporal and KNN queries

Trajectory queries

Trajectory of the object from t_1 to t_5?

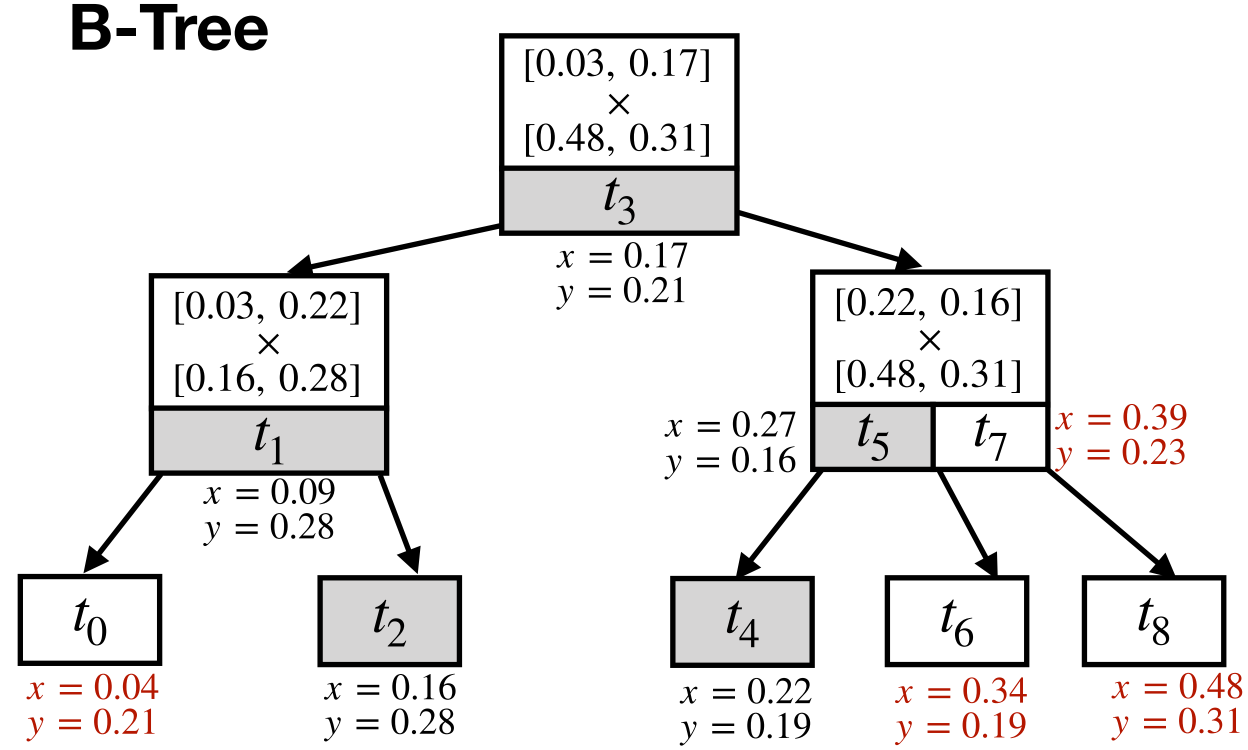


GraCT

t_0	t_1	t_2	t_3	t_4	t_5	t_6	t_7	t_8

{(0,4), (1,5), (3,5), (3,4), (4,3), (5,3), (6,3), (7,4), (9,6)}

B-Tree



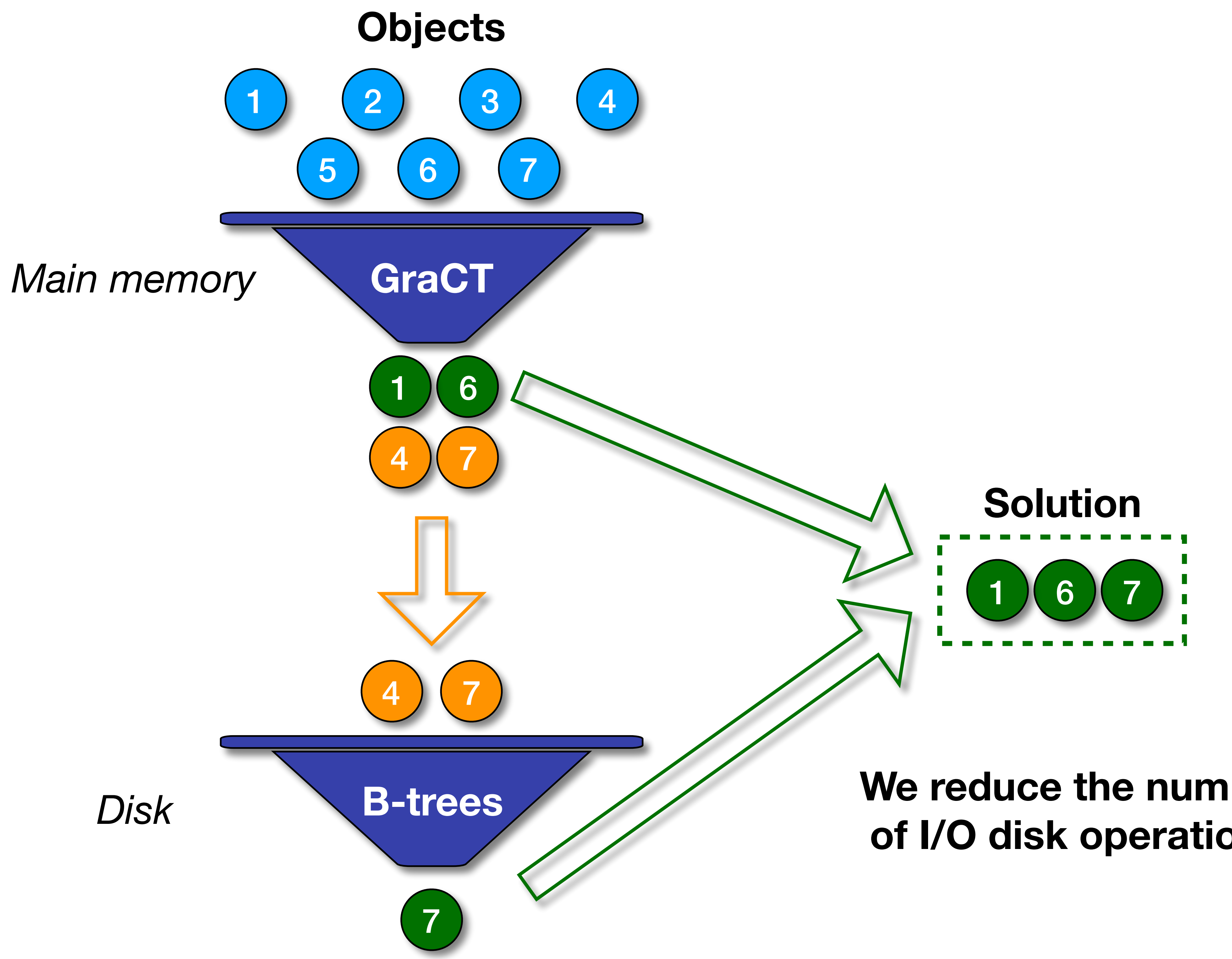
Queries

GraCT-Disk supports the following queries:

- Trajectory
- Time Slice
- Time Interval
- K-Nearest Neighbors

} **Spatio-temporal and KNN queries**

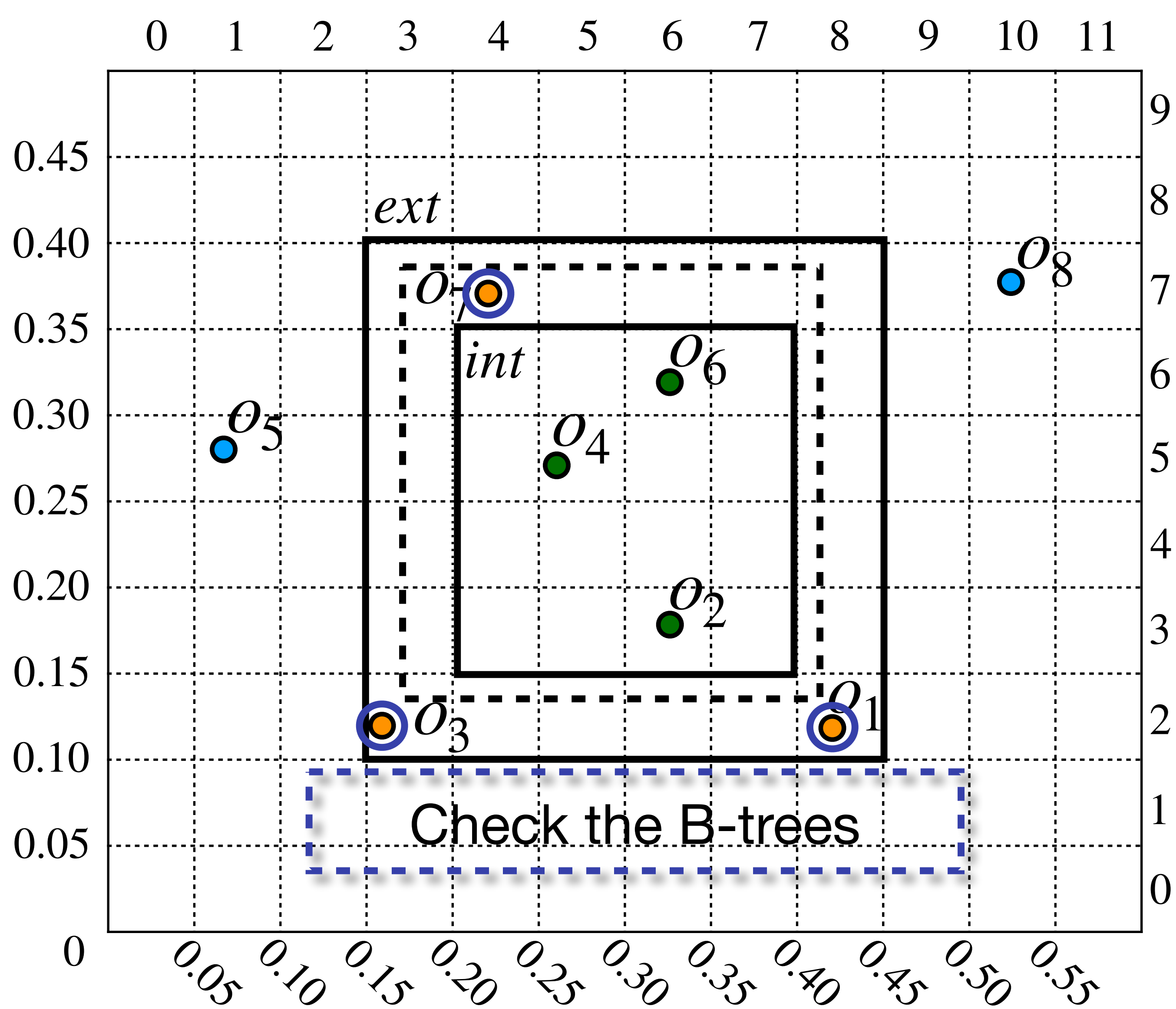
Spatio-temporal and KNN queries (I)



We reduce the number of I/O disk operations

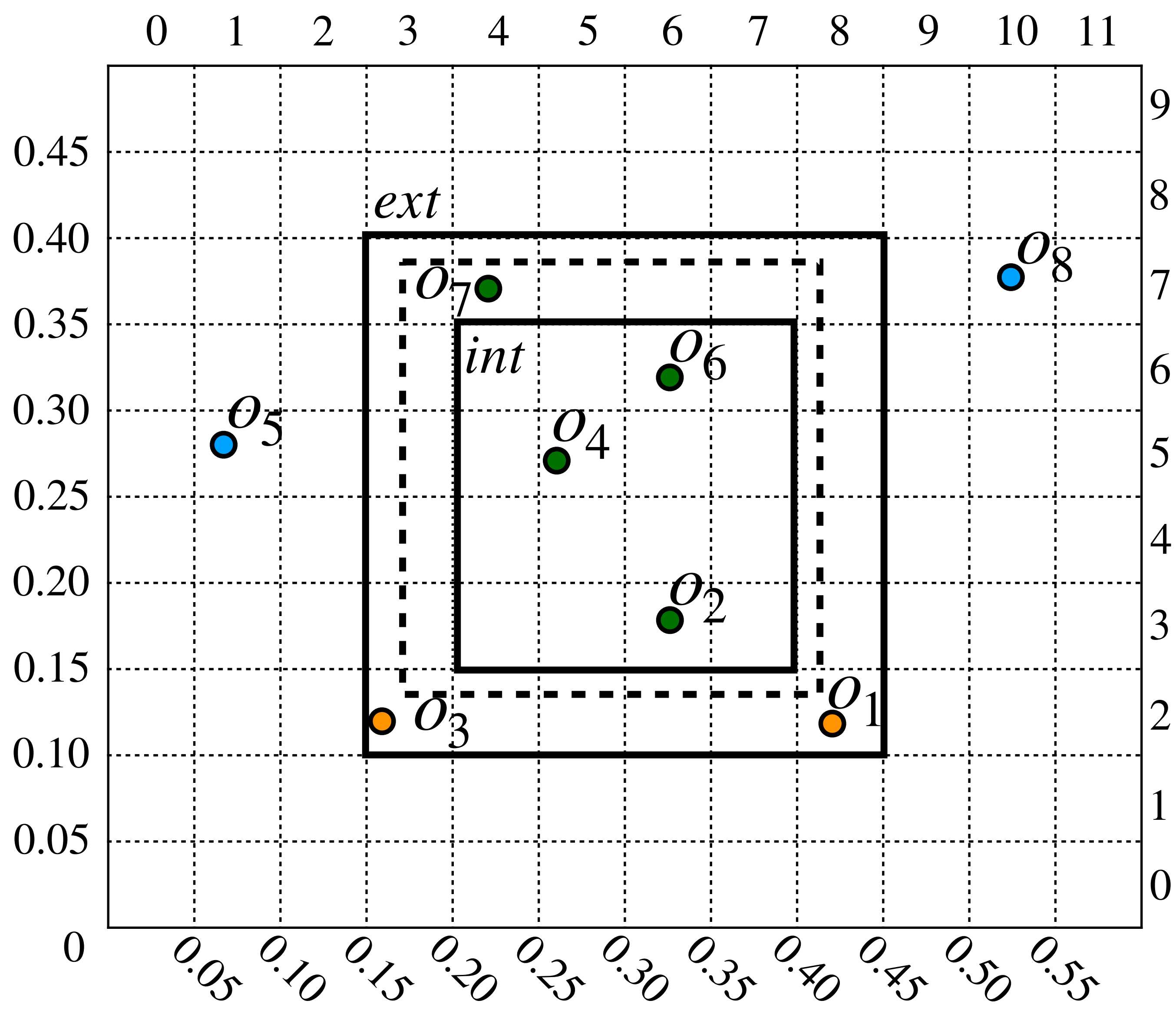
Spatio-temporal and KNN queries (II)

Time Interval: Which objects are within a region at any time instant from the time interval [t_0, t_5]?



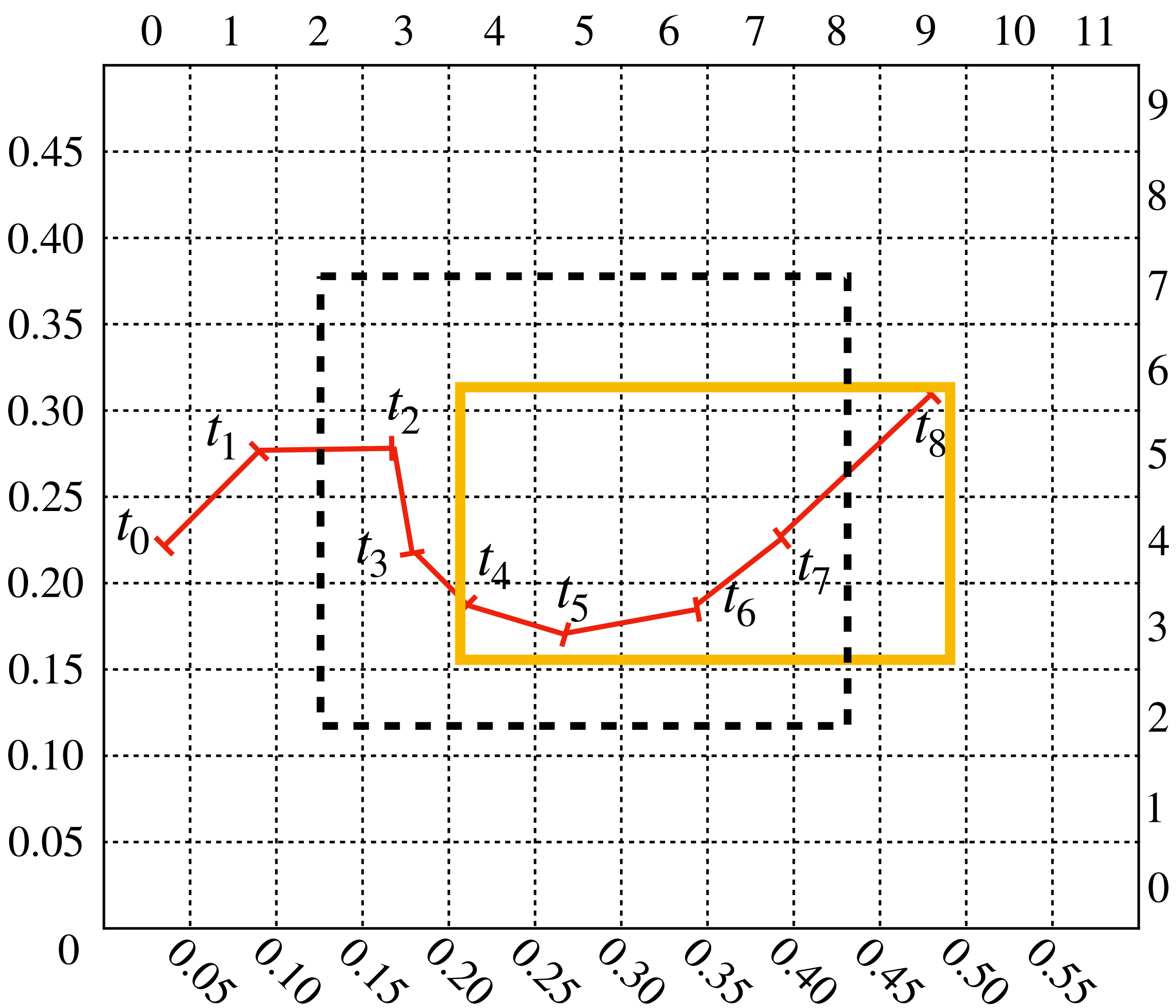
Spatio-temporal and KNN queries (II)

Time Interval: Which objects are within a region at any time instant from the time interval [t_0, t_5]?



Spatio-temporal and KNN queries (III)

We take advantage of the MBRs stored in the B-tree

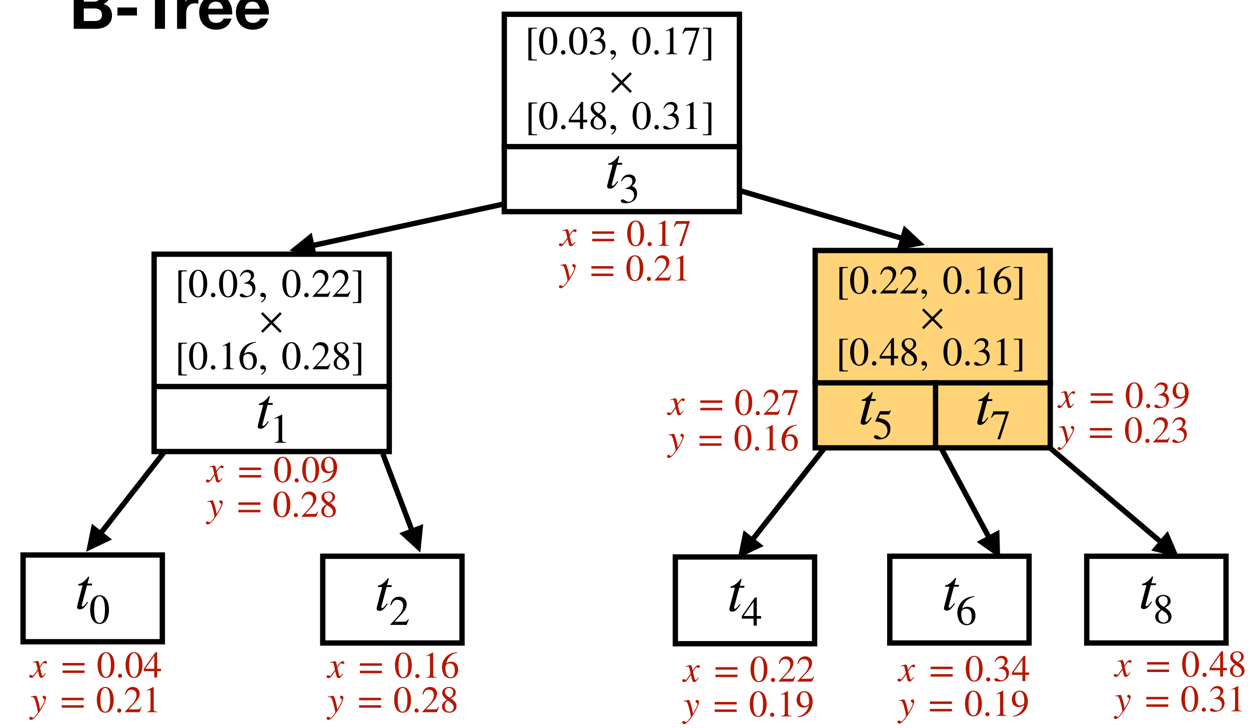


GraCT

t_0 t_1 t_2 t_3 t_4 t_5 t_6 t_7 t_8

{(0,4), (1,5), (3,5), (3,4), (4,3), (5,3), (6,3), (7,4), (9,6)}

B-Tree



Spatio-temporal and KNN queries (IV)

- **Time Slice** is solved as **Time Interval** but taking into account that the interval only lasts one time instant.

- **KNN queries** follow a similar procedure but considering:
  - *D* is the Euclidean Distance of the *K-th* object obtained by the In-Memory Compressed Cache.
  - The objects with distance lower than ***D-1*** cells are part of the **solution**.
  - We have to **check with the B-trees** those whose distance is in ***[D-1, D+1].***

Results

- We compared GraCT-Disk with a classical spatio-temporal index: **MVR-Tree**.

- **GraCT-Disk** :
  - Requires **24 times less space** than MVR-Tree.
  - Obtains **competitive times in Time Slice** queries.
  - Outperforms MVR-Tree in **Time Interval (40x)**.
  - Is **slower in K-Nearest Neighbors** by around 32%.

- **GraCT-Disk** can solve **Trajectory** queries, that cannot be said about the MVR-Tree

A Disk-Based Index for Trajectories with In-Memory Compressed Cache

Daniela Campos, Adrián Gómez-Brandón, Gonzalo Navarro

IMFD, Dept. of Computer Science, University of Chile, Chile.
Laboratorio de Bases de Datos, Universidade da Coruña, Spain.