

MobilityDB - A Moving Object Database

Moving Objects



moving objects

 All Images

 Videos

 Shopping


News

⋮ More


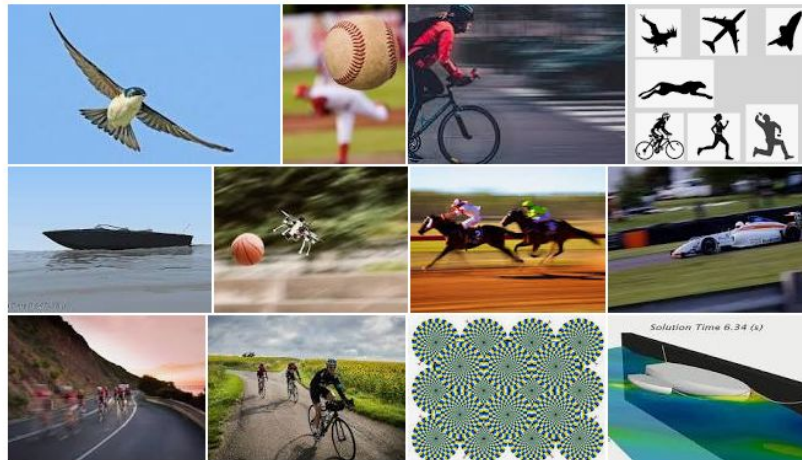
Settings

Tools

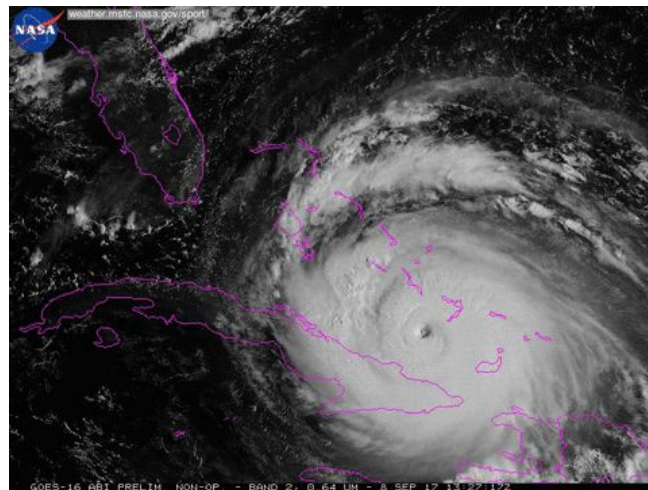
About 726.000.000 results (0,59 seconds)

 Images for moving objects

 animated

 photography powerpoint shutter speed fast

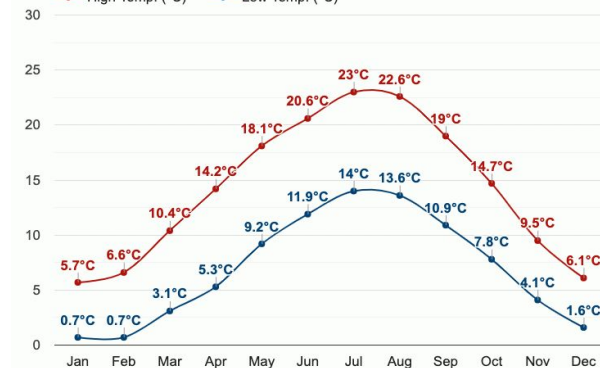
Report images



giphy.com

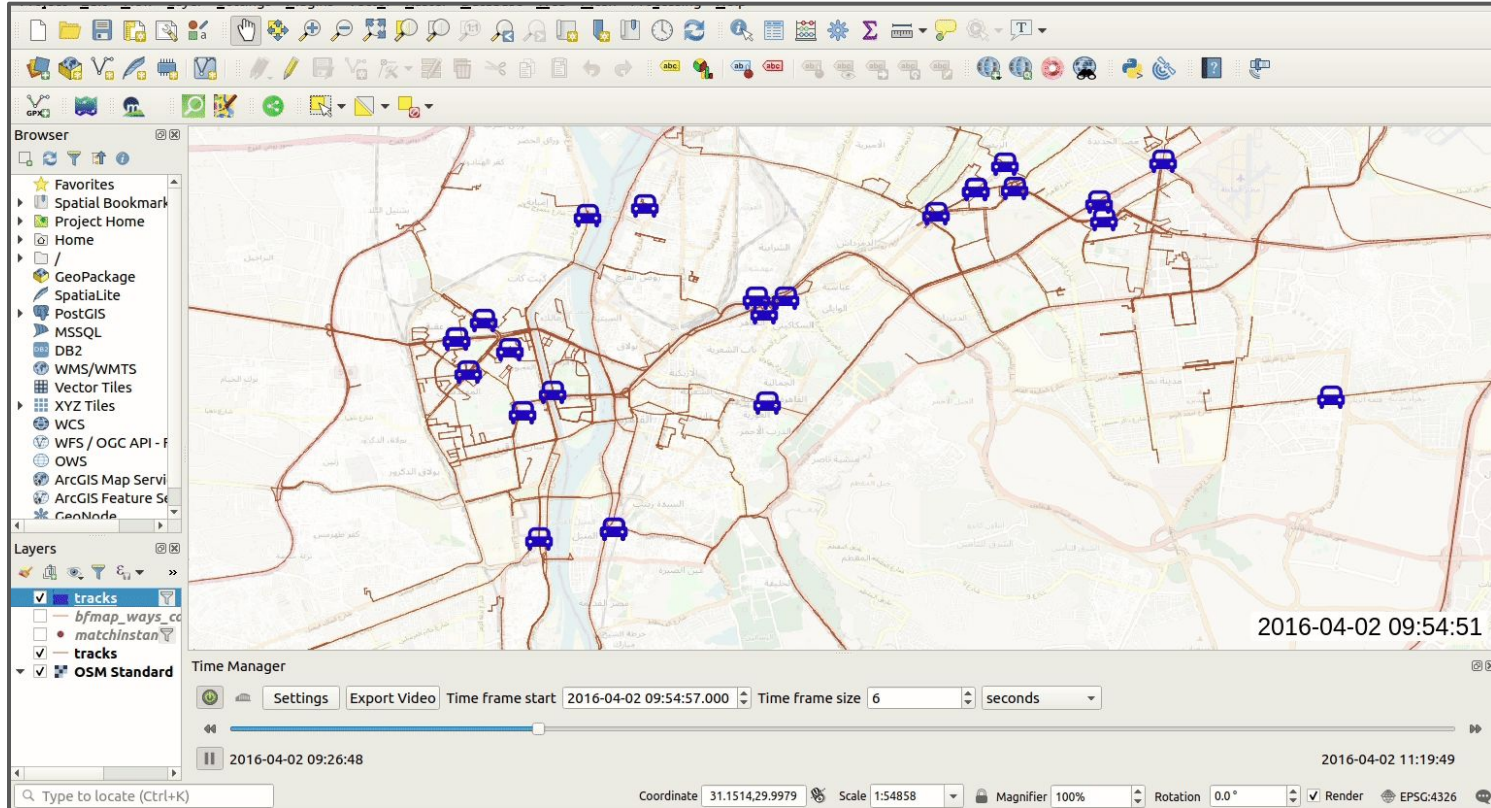
Temperature - Brussels, Belgium

—●— High Temp. (°C) —●— Low Temp. (°C)





weather-atlas.com

Moving Object Databases




<https://github.com/MobilityDB/MobilityDB>


 README.md

 Main Build

passing

 coverage

97%


 code quality

A

[chat](#) [on gitter](#)

MobilityDB

An open source geospatial trajectory data management & analysis platform



<https://www.osgeo.org/projects/mobilitydb/>



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MobilityDB

An open source geospatial trajectory data management & analysis platform

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SQL Optimization

Scalar statistics & selectivity estimation

Grid-based statistics

Spatial grid + period bound histograms

Operations

Comparison, transformation, casting, ...etc

topological, CRS, properties, overlay, ...etc.

trajectory, temporal properties, lifted predicates, aggregations

Indexes

B-tree, hash, GiST, SP-GiST, GIN, BRIN

GiST, SP-GiST, BRIN

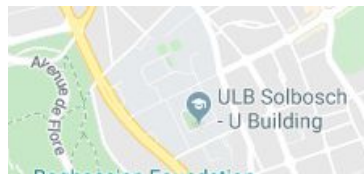
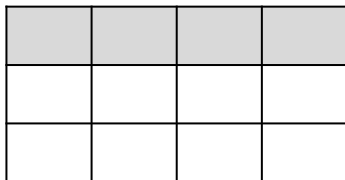
GiST, SP-GiST

Type System





















numeric, character, date/time, bool, xml, json

Geometry, geography

tgeompoint, tgeogpoint, tint, tfloat, ttext, tbool



MobilityDB Ecosystem

MobilityDB Network	MobilityDB Geometry	MobilityDB MapMatch	MobilityDB Stream	MobilityDB View	MobilityDB Generator
 pgRouting	 MobilityDB Cloud 		 kafka	MobilityDB Python	MobilityDB Java
 docker	 kubernetes	 citusdata	 psycpg	asyncpg	 PostgreSQL JDBC
 kepler.gl  mapbox		 Grafana	 plotly	 python™	 Java
 MobilityDB		 PostGIS	 PostgreSQL	 ubuntu	

Using MobilityDB

- How is MobilityDB packaged ? Which files constitute the package ?
- How to use MobilityDB ?

The scientific and engineering foundations

- The data model.
- The operations.
- Lifted operations
- Temporal aggregations.
- Indexing.
- Optimizer statistics, and selectivity estimation.
- Internal architecture.
- Eco system.
- OGC standards.

MobilityDB Data Model

TEMPORAL(timeType, baseType): time → value

timestamptz

timestampSet

period

periodSet



geometry(point)

geography(point)

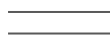
bool

float

int

string

...



TEMPORAL(timestamptz,
 geometry(point))

//database of car accidents

TEMPORAL(timestampSet,
 geometry(point))

//foursquare check-ins

TEMPORAL(period,
 geometry(point))

//car trajectory

...

Two Data Models

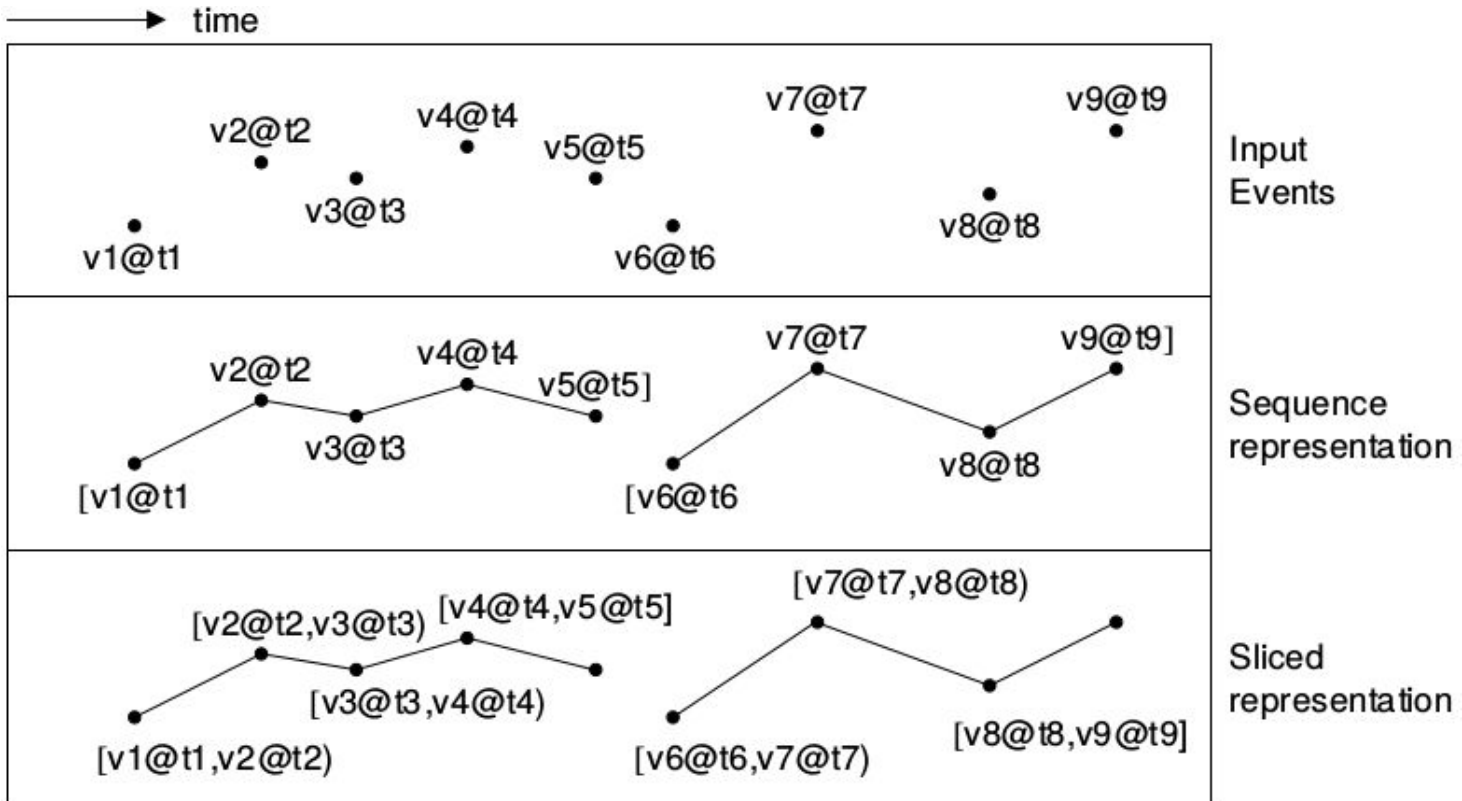
Sliced representation

Ralf Hartmut Güting, Michael H. Böhlen, Martin Erwig, Christian S. Jensen, Nikos A. Lorentzos, Markus Schneider, and Michalis Vazirgiannis. 2000. A foundation for representing and querying moving objects. *ACM Transactions on Database Systems*. 25, 1 (March 2000), 1–42. DOI:<https://doi.org/10.1145/352958.352963>

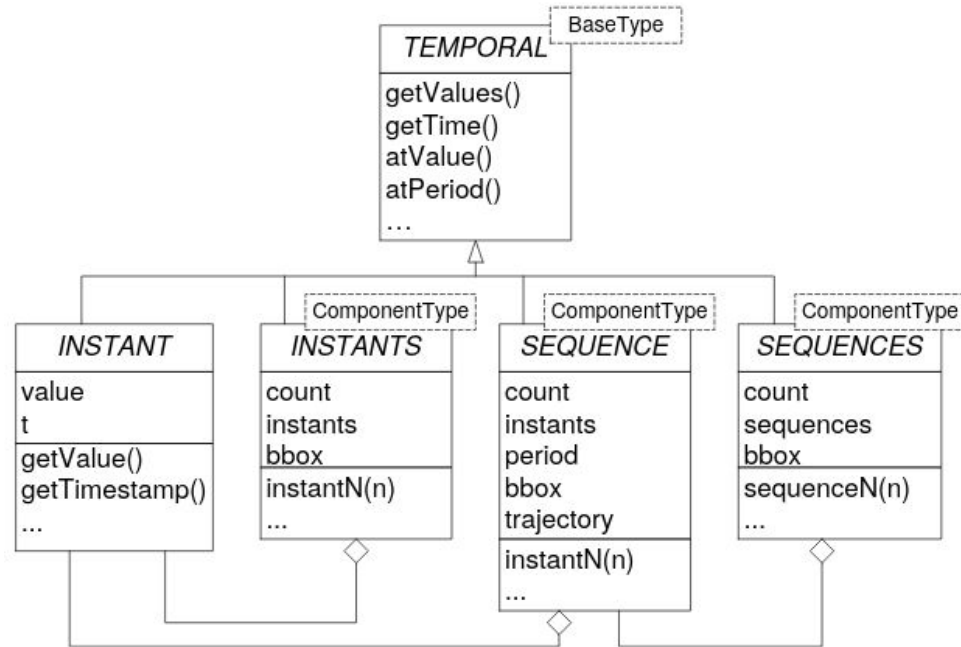
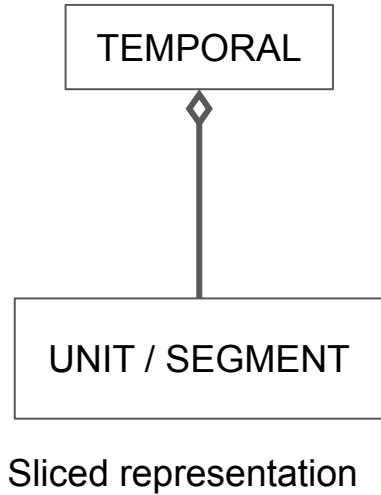
Sequence representation

[1] Esteban Zimányi, Mahmoud Sakr, Arthur Lesuisse, MobilityDB: A Mobility Database based on PostgreSQL and PostGIS. To appear in *ACM Transactions on Database Systems*, 2020. [Preprint](#)

A not very accurate visualization of the two abstract models

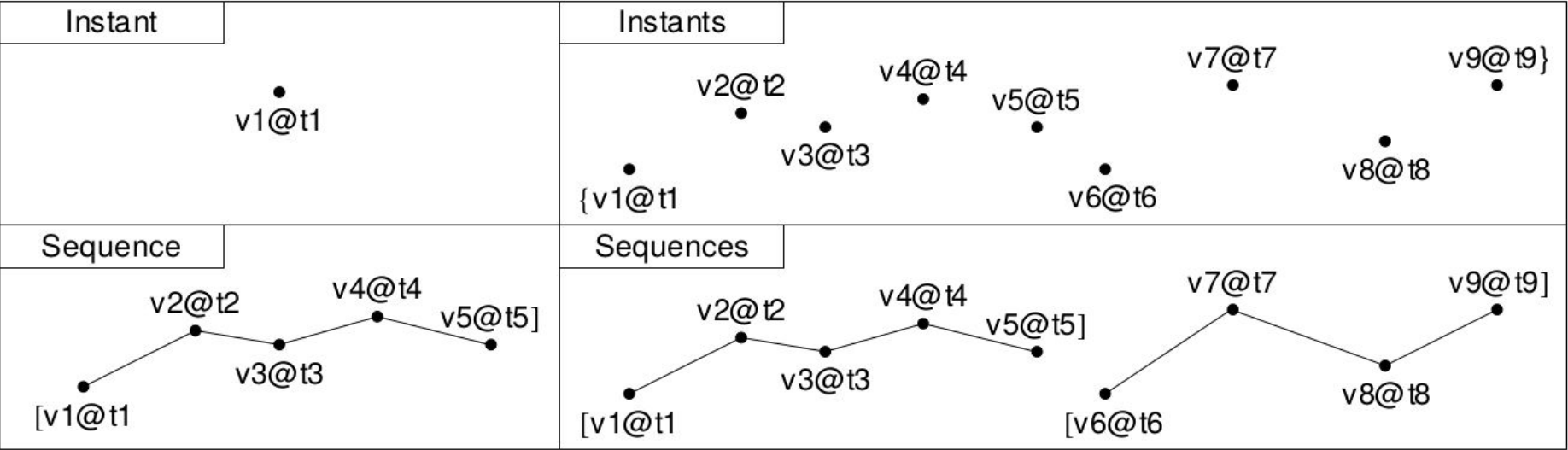


Type hierarchies of the two models



Comparison: storage, semantics

→ time



	Sliced representation	Sequence representation
INSTANT	[v1@t1, v1@t1]	v1@t1
INSTANTS	[v1@t1, v1@t1], [v2@t2, v2@t2], ...	{v1@t1, v2@t2, ...}
SEQUENCE	[v1@t1, v2@t2), [v2@t2, v3@t3), ...	[v1@t1, v2@t2, v3@t3, ...]
SEQUENCES	[v1@t2, v2@t2), ... [v4@t4, v5@t5], [v6@t6), ...	{[v1@t1, ..., v5@t5], [v6@t6, ..., v9@t9]}

Two abstract models: storage size

Algorithm 6: Generic strategy for a binary temporal operation on two temporal arguments α_1, α_2

begin

$result \leftarrow \emptyset;$

$syncPeriods \leftarrow \text{synchronize}(\alpha_1, \alpha_2);$

foreach $period\ p \in syncPeriods$ **do**

if α_1 is defined during p AND α_2 is defined during p **then**

$resultUnit \leftarrow$ apply the operation on α_1 and α_2 both restricted to the period p ;

$result \leftarrow result \cup resultUnit;$

foreach consecutive pair of units $u_i, u_{i+1} \in result$ **do**

if $\text{end timestamp of } u_i = \text{start timestamp of } u_{i+1}$ AND

$\text{the temporal functions of } u_i \text{ and } u_{i+1} \text{ are equivalent}$ **then**

merge u_i, u_{i+1} into one unit;

return $result;$

MOD Functions

- Synchronization [1]
- Normalization [1]
- Lifted Operations
 - <https://github.com/MobilityDB/MobilityDB/wiki/Lifting-a-Function-in-MobilityDB>
- Lifted Topological Predicates
- Temporal aggregations.
- ... [1]

Interfacing MobilityDB Types to Indexes

Access Methods

```
SELECT * FROM pg_am;
```

oid	amname	amhandler	amtype
oid	name	regproc	"char" (1)
2	heap	heap_tableam_...	t
403	btree	bthandler	i
405	hash	hashhandler	i
783	gist	gisthandler	i
2742	gin	ginhandler	i
4000	spgist	spghandler	i
3580	brin	brinhandler	i



Operator classes
Support functions



User types

period
tgeompiont
tfloat
...

An operator class contains a set of index strategies and a set of support functions for an index to manipulate a certain data type.

GiST (Generalized Search Tree)

Hellerstein Joseph, Naughton Jeffrey, Pfeffer Avi. [Generalized search trees for database systems](#). In: Proceedings of the 21st international conferences on very large data bases. 1995. p. 562–73.

“we present the abstract data type (or “object”) Generalized Search Tree(GiST). We define its structure, its invariant properties, its extensible methods and its built-in algorithms.”

Extensible methods: consistent, union, compress, decompress, penalty, picksplit

<http://gist.cs.berkeley.edu/> (last modified 1999)

SP-GiST (Space Partitioning Generalized Search Tree)

Eltabakh Mohamed, Eltarras Ramy and Aref Walid, "[Space-Partitioning Trees in PostgreSQL: Realization and Performance](#)," *22nd International Conference on Data Engineering (ICDE'06)*, Atlanta, GA, USA, 2006, pp. 100-100, doi: 10.1109/ICDE.2006.146.