OraGIST – How to Make User-Defined Indexing Become Usable and Useful

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The Situation (+)

Object-relational DBMSs are extensible by:

- **user-defined datatypes (UDT)**
- together with corresponding query **operators**
- **user-defined indexing**
- together with corresponding user-defined optimizer tuning

⇒ ”data blades”, ”cartridges”, ”extenders”, ...

The Situation (–)

But user-defined indexing

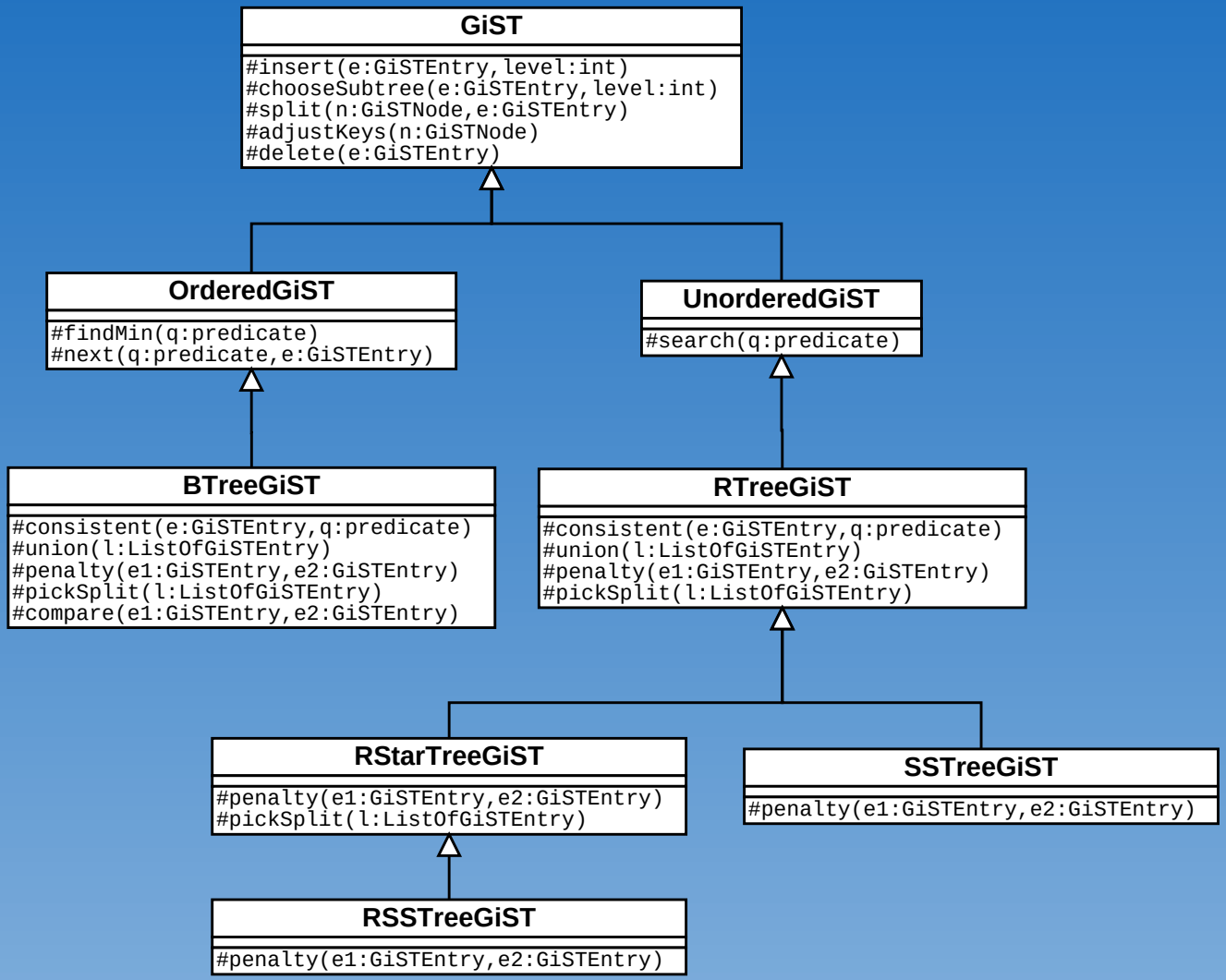
- needs expensive implementation
- needs experimental selection for new query scenarios
- is restricted:

  a user-defined index supports only single operators, no combinations
- assumes that an operator is supported by at most one index

Our Proposal

- Use **combined datatypes and operators** to allow index support for attribute combinations
- Provide medium-dimensional index structures
- Apply a **generic indexing framework**
  - ⋆ based on **generalized search trees (GiST)**
  - ⋆ easily specializable into indexes for particular UDTs and operators
  - ⋆ coupled with DB storage and index definition
  - ⇒ prototypical tool **OraGiST** (GiST for Oracle)

Generalized Search Trees (GiST) — Class Hierarchy

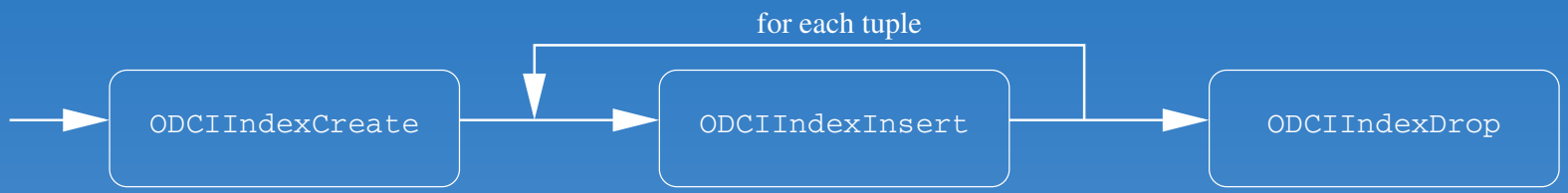


Index Usage

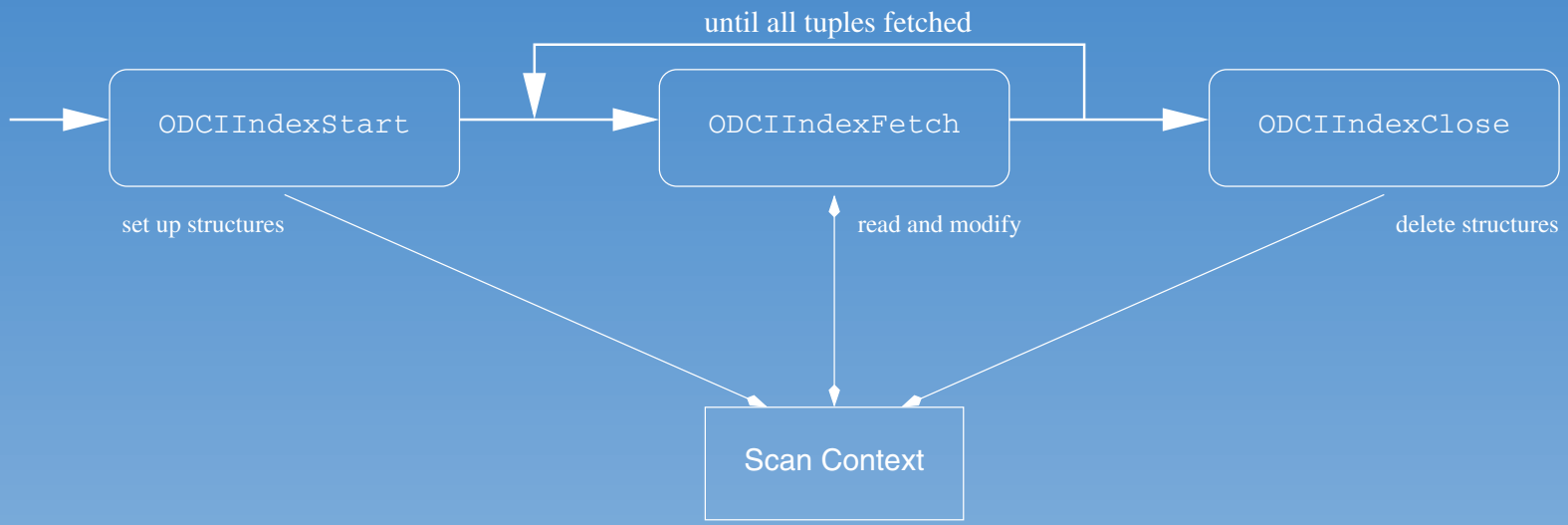
```
CREATE INDEXTYPE polygonRTree
  FOR overlaps(polygon,polygon) USING overlaps_fct;

CREATE TABLE county
  (id NUMBER, population NUMBER, ...
   shape polygon, ...);

CREATE INDEX idx_geoCounty ON county(shape)
INDEXTYPE IS polygonRTree PARAMETERS(...);

SELECT * FROM county
  WHERE overlaps(shape,polygon(rectangle(0,0,20,10)))
          = true;
```

Extensible Indexing in ORDBS

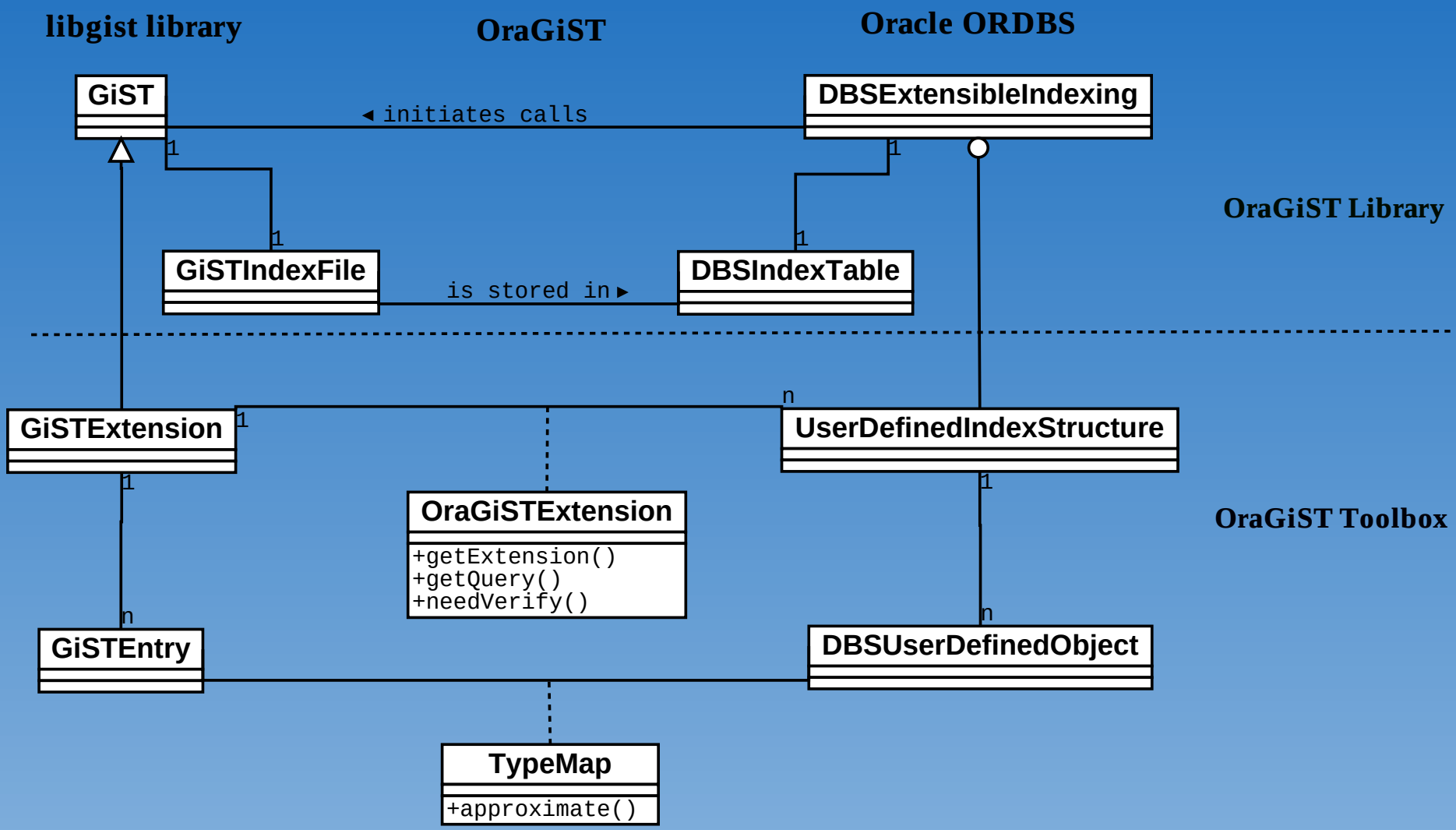
- Sequence of index operations over index lifetime (e.g.):



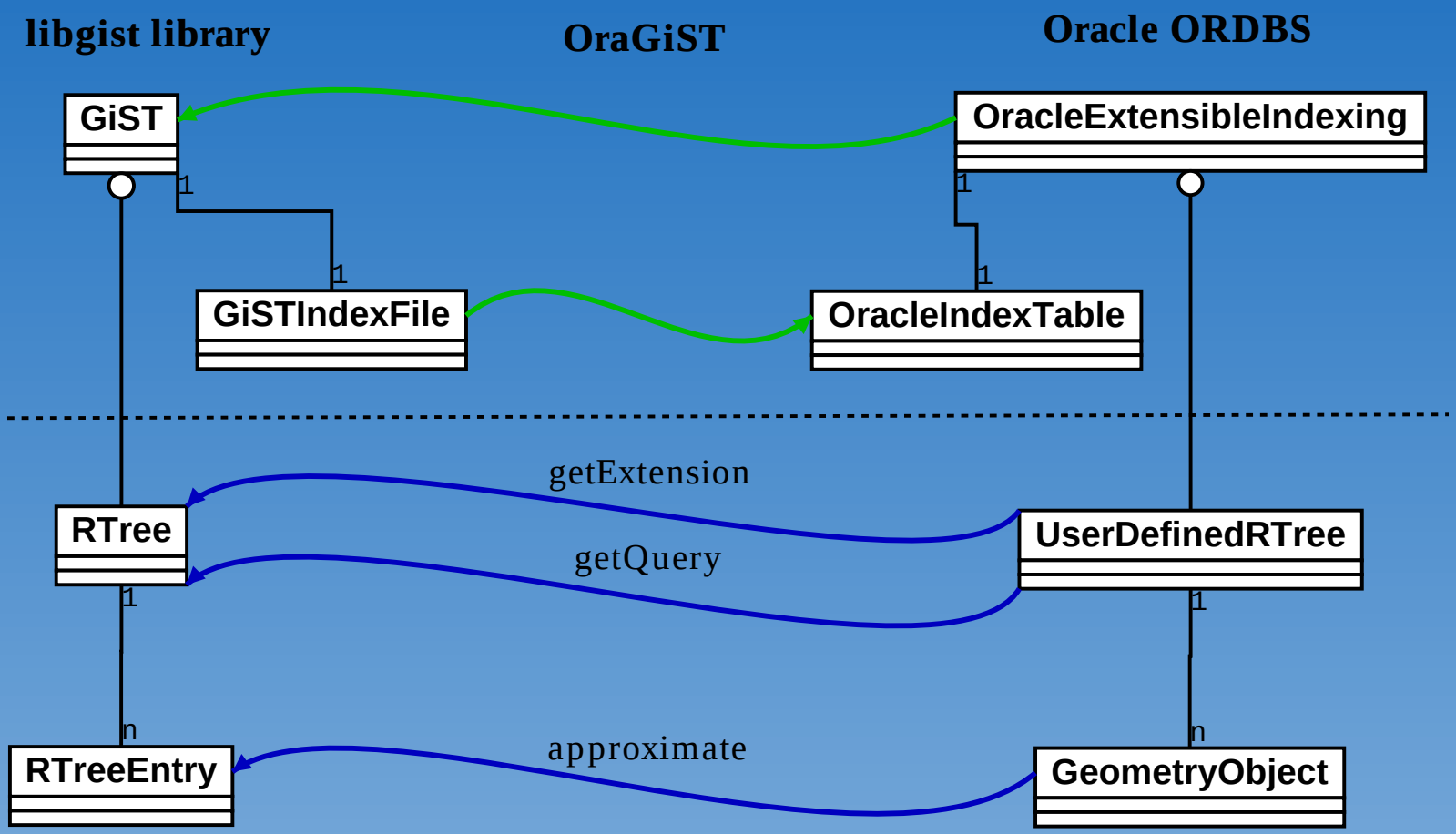
- Sequence of index operations in query execution:



OraGiST — Architecture and Functionality



OraGiST — Architecture and Functionality

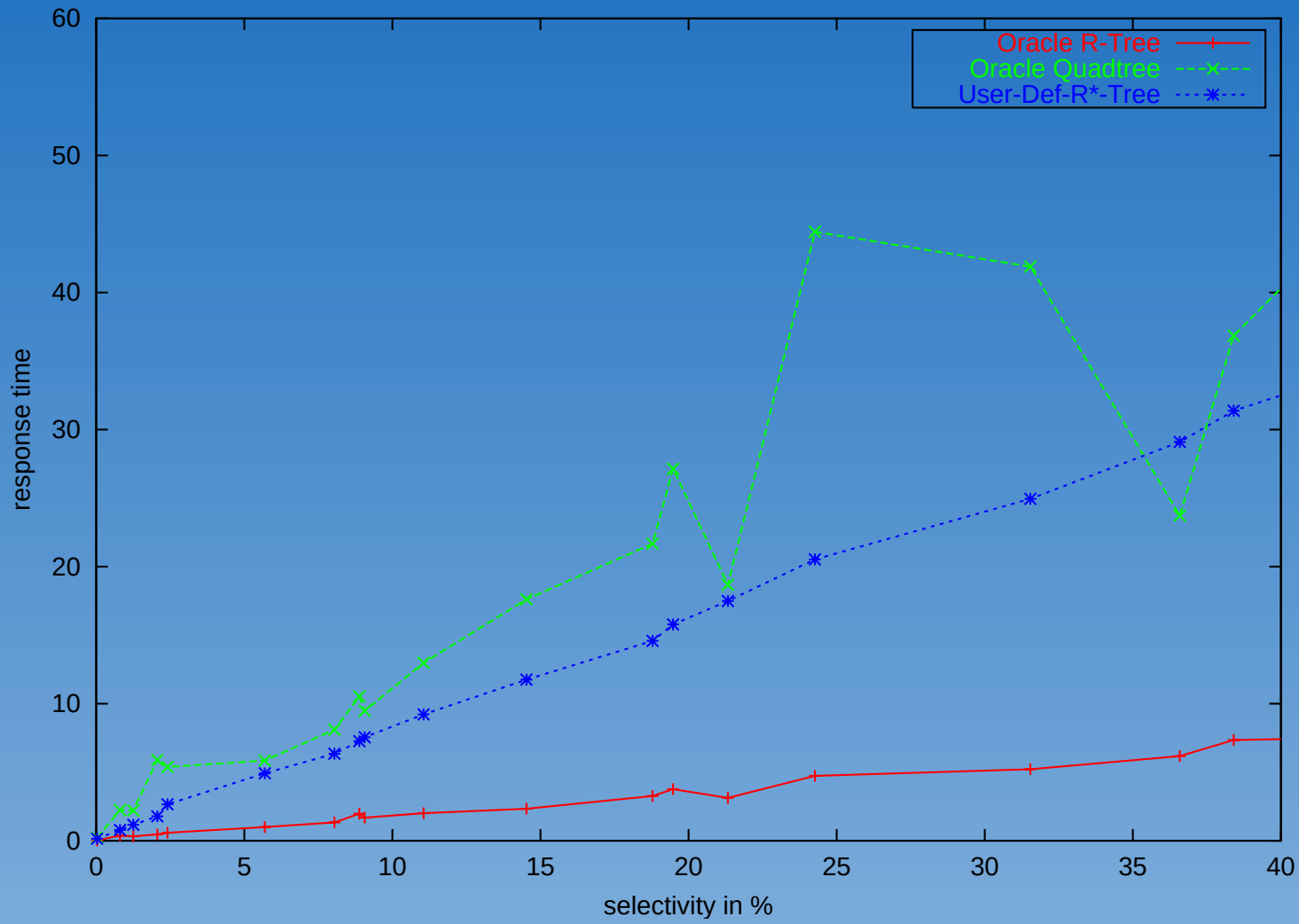


Case Study — Spatial/Thematic Analysis

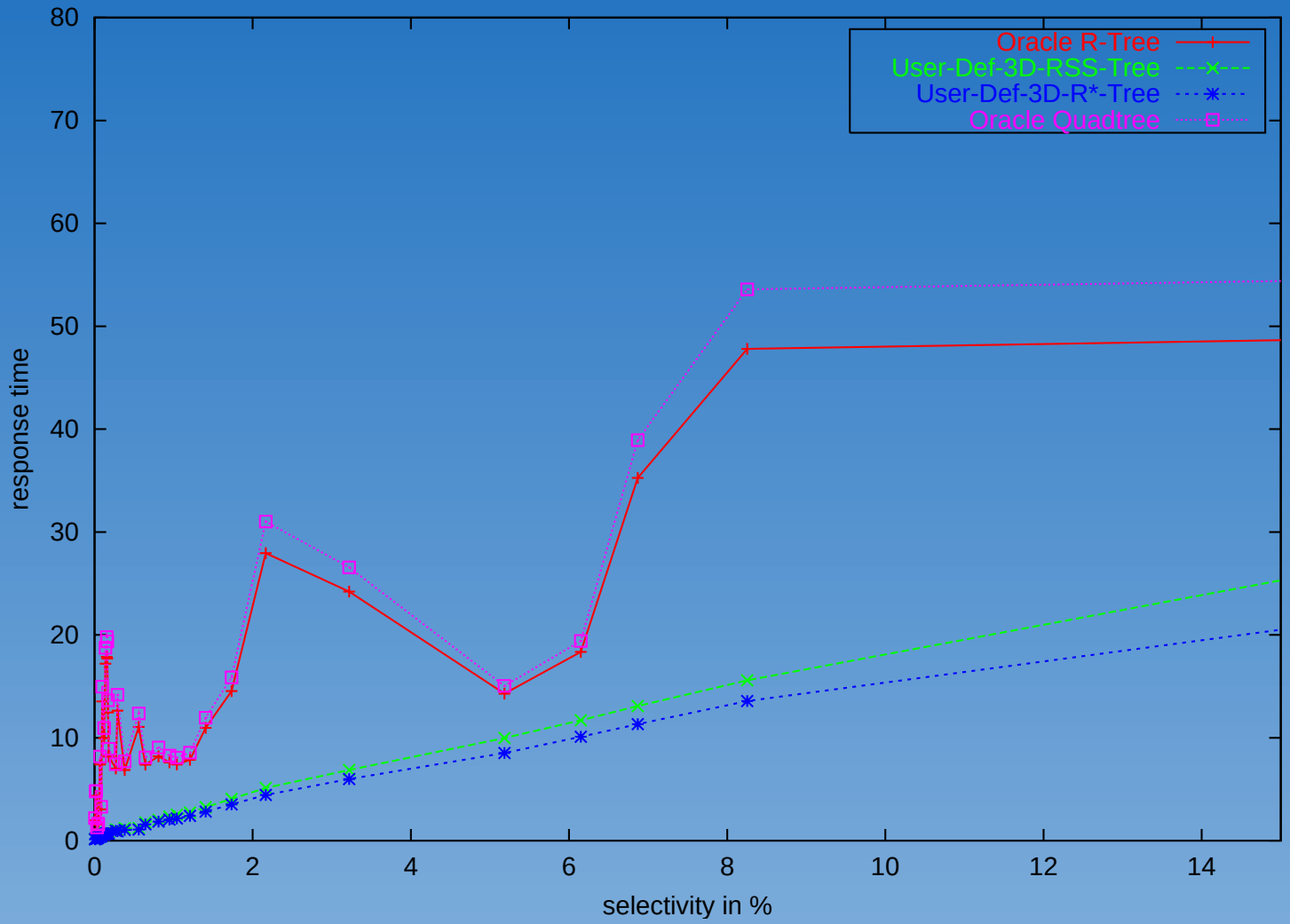
- Typical query: *Find all counties overlapping a given window where the median rent is below ... and the population is higher than ...*
- Definition of combined datatypes and operators:

```
CREATE TYPE integerGeometry AS OBJECT
  (shape OGCGeometry, theme INTEGER);

CREATE TYPE twoIntegerGeometry AS OBJECT
  (shape OGCGeometry, theme1,theme2 INTEGER);

CREATE OPERATOR [two]BetweenOverlaps ... ;

CREATE TABLE county OF [two]IntegerGeometry;
```

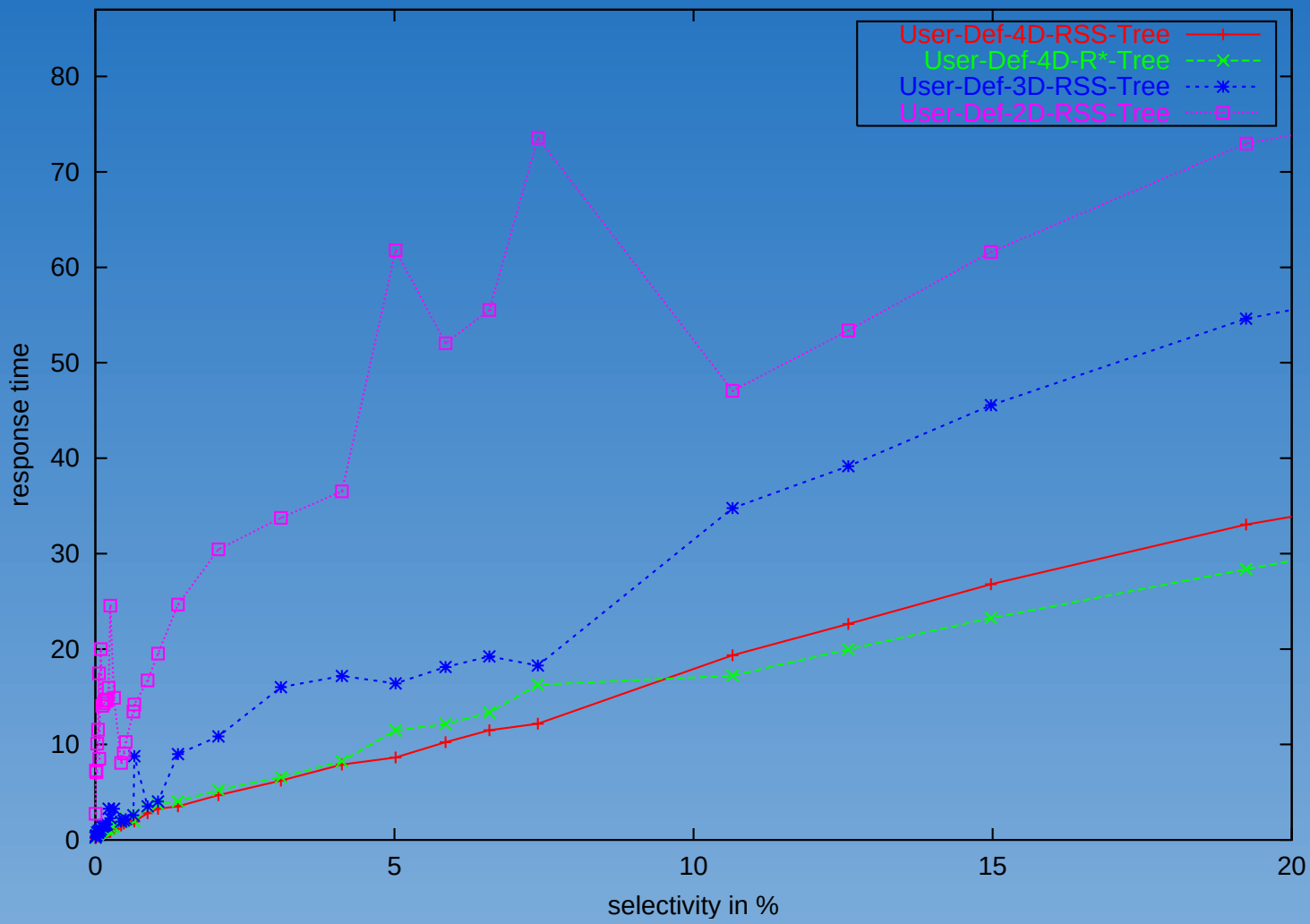
Performance Evaluation on 2D Spatial Data



... on 2D spatial data + one thematic dimension



... on 2D spatial data + two thematic dimensions



Conclusions

- R*- and RSS-trees can be recommended as (medium-dimensional) index types for combined query scenarios.
- Combined scenarios occur often in spatio-temporal-thematic DBS; think of, e.g., ”`validtimeInteger`”!
- For new UDTs/operators,
  for combined UDTs/operators,
  and for experimental index selection,

  a framework for **adaptable indexing in ORDBS** is required.

Conclusions (cont.)

- OraGiST is such an indexing framework:
  - ⋆ extensible library + toolbox
  - ⋆ coupling the GiST-family with an ORDBMS
  - ⋆ for adoption of existing index types
  - ⋆ for fast development of new index types by object-oriented specialization

Future Questions

- How to improve behaviour on 'complicated' objects ?
- How to include user-defined cost/selectivity estimation?
- How to generate and hide the combined operators ?