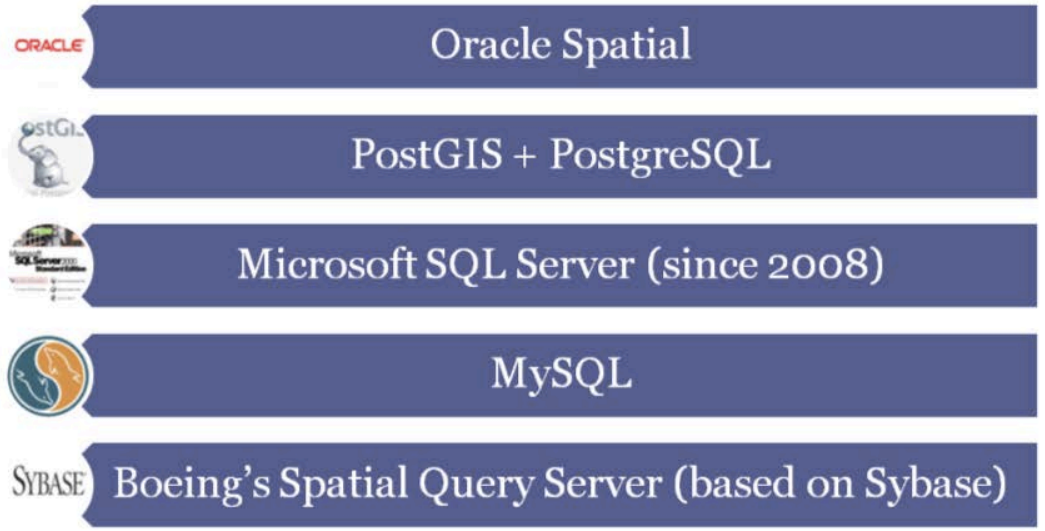
# Spatial databases

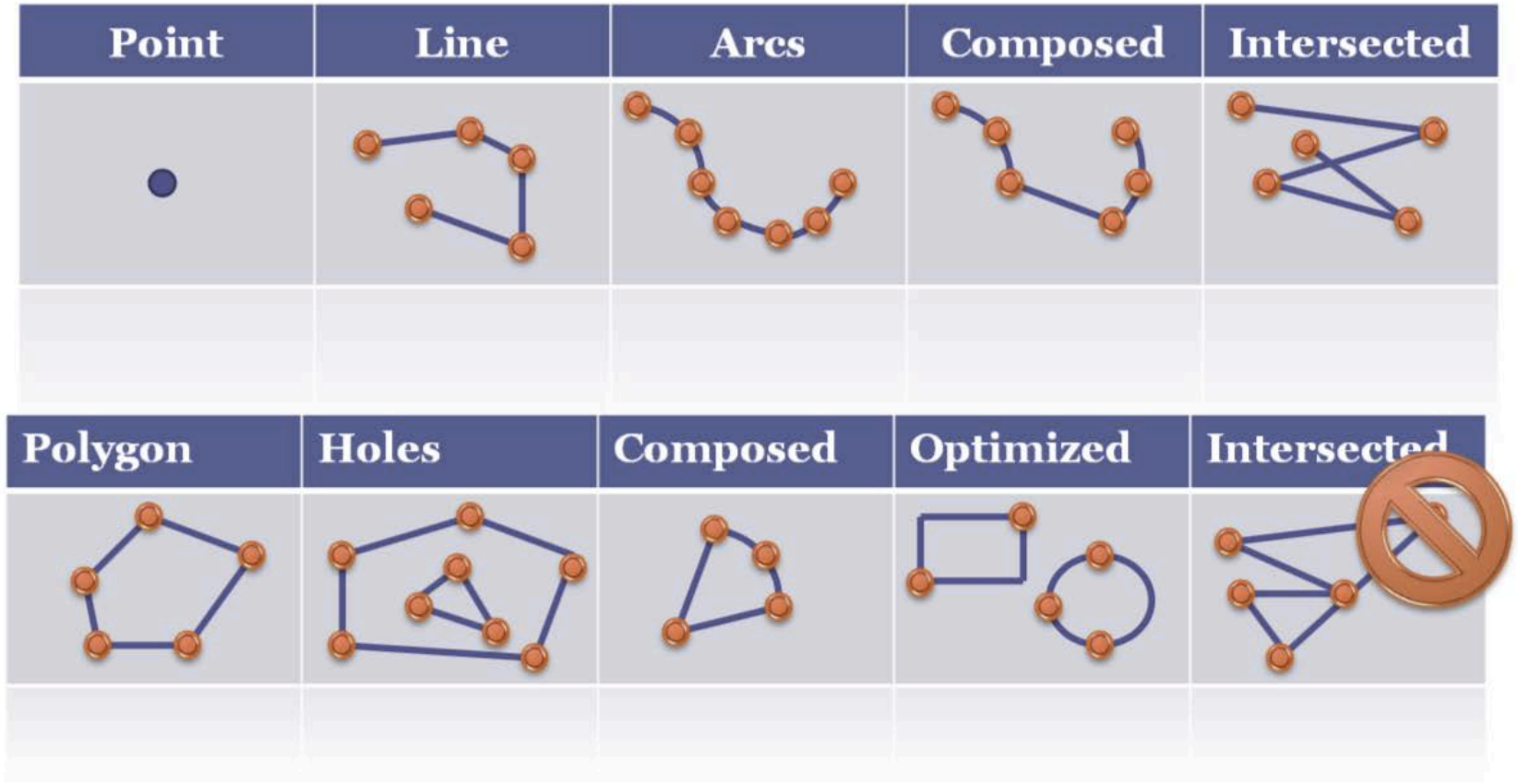
- A spatial database is a database optimized to store and query data related to objects in space, including points, lines and polygons.
- Up to now the market proposes:



# Oracle Spatial Overview

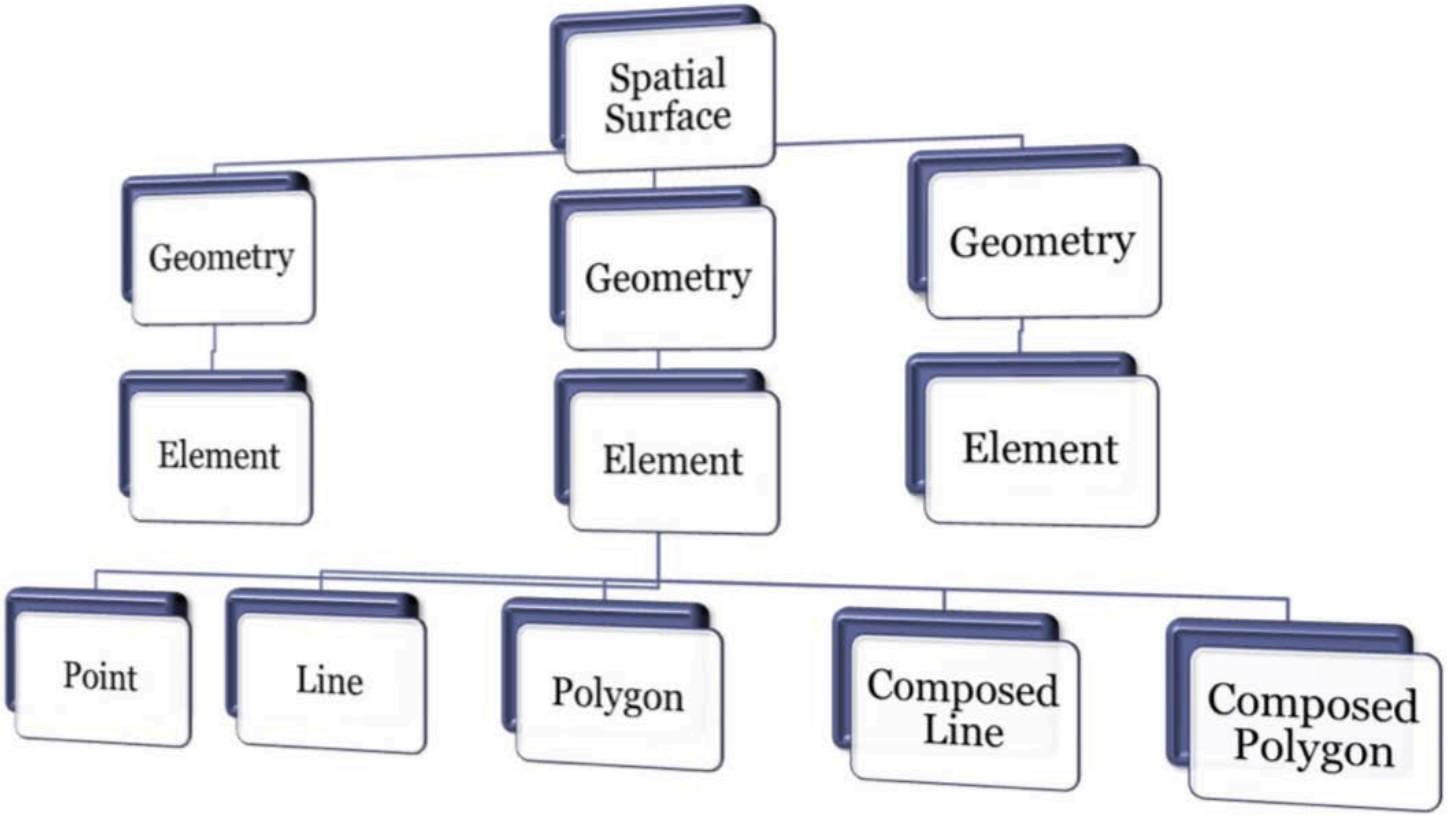
- “An integrated set of functions and procedures that enables spatial data to be stored, accessed, and analyzed quickly and efficiently in an Oracle database.”
  - A schema (MDSYS) that prescribes the storage, syntax, and semantics of supported geometric data types.
  - A spatial indexing mechanism
  - A set of operators and functions for performing area-of-interest queries, spatial join queries, and other spatial analysis operations.
  - Administrative utilities.

# Oracle Spatial Supported Geometries



# Oracle Hierarchical Model

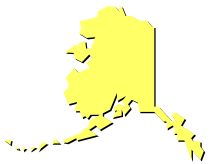
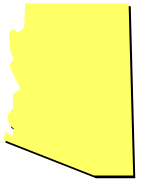
- Oracle data types have a hierarchical model



# Geometries and Spatial Indexing

- Geometries refer to spatial objects, they are collections of one or more elements
- Their distribution is not uniform but it follows the spatial location of real entities
- A Layer is a collection of Geometries having similar attributes such a state boundaries, roads, or rivers.
- Spatial indexes are needed to support efficient storage and querying of geometries
- Oracle Spatial uses R-Tree indexes, but can also support Quad-Tree indexes

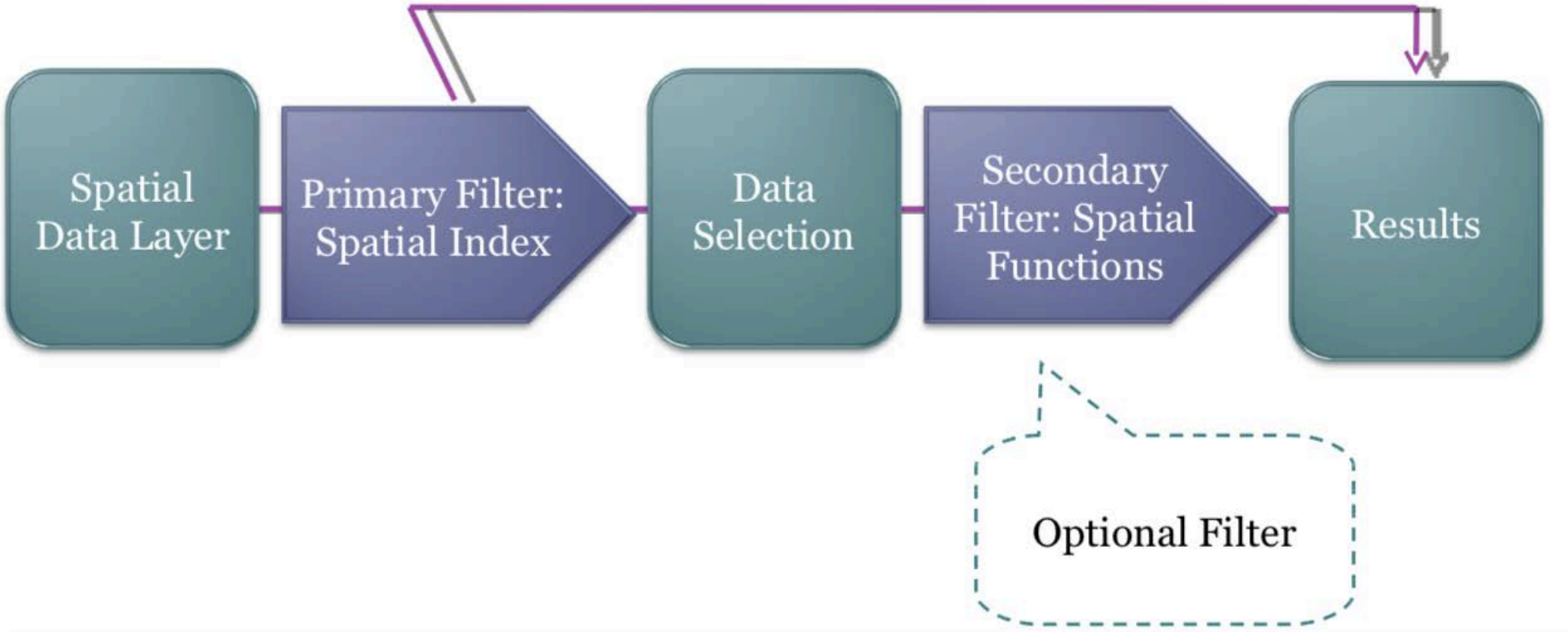
Table, STATES = LAYER

| | |
|---|---|
| Alabama |  |
| Alaska |  |
| Arizona |  |
| Arkansas |  |

A GEOMETRY (outline) of a state is in a single column of each row.

A GEOMETRY may contain more than one element.

# Spatial query processing



# Oracle Spatial data types: SDO_GEOMETRY

- Is composed of :
  - SDO_GTYPE Number
  - SDO_SRID Number
  - SDO_POINT SDO_POINT_TYPE
  - SDO_ELEM_INFO SDO_ELEM_INFO_ARRAY
  - SDO_ORDINATES SDO_ORDINATE_ARRAY

  Example:

```
CREATE TABLE forest(
 name VARCHAR2(30),
 animal_population NUMBER(9),
geom MDSYS.SDO_GEOMETRY);
```

# Oracle Spatial data types: SDO_POINT

- Used to store Point data
- It is ignored if SDO_ELEM_INFO and SDO_ORDINATES are not null

- It is of type SDO_POINT_TYPE (X:Number, Y:Number, Z:Number)

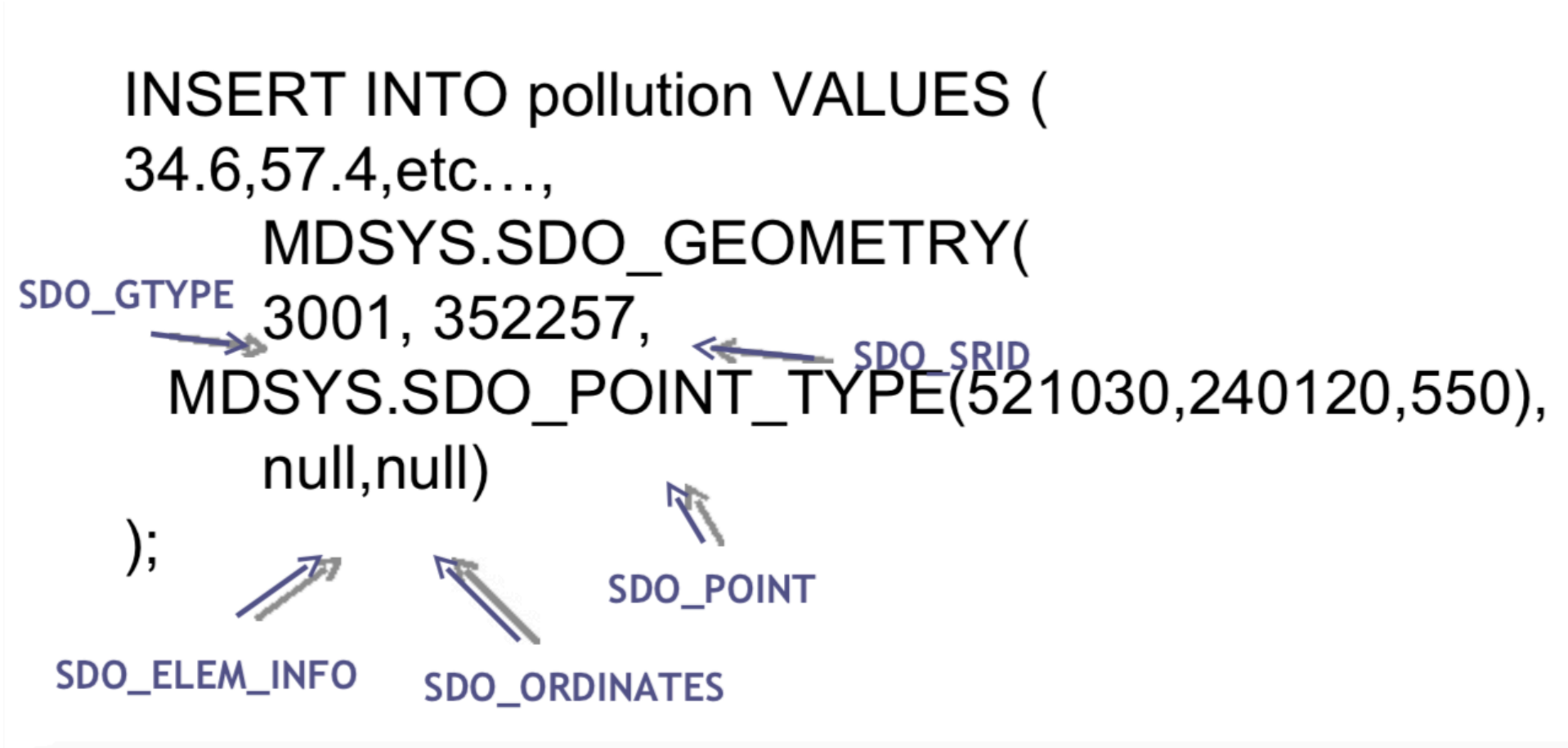
# Oracle data types: SDO_ORDINATES

- Stored as SDO_ORDINATE_ARRAY VARRAY () of NUMBER
- It contains a list of object’s coordinates

# SDO_SRID

- It is an INTEGER number that identifies which coordinate system is used by the SDO_GEOMETRY
- The tables MDSYS.CS_SRS is defining such reference systems

# Examples : Inserting a point



# Example : Inserting a line

```
INSERT INTO roads VALUES ('motorway','NYC',etc…,
   mdsys.sdo_geometry(
   2002,352257,null,
         mdsys.sdo_elem_info_array(1,2,1),
         mdsys.sdo_ordinate_array(10,10, 20,25, 30,10, 40,10))
);
```

# Oracle Spatial Operators

- Make use of spatial indexes
- They must have a spatial index defined at least for the first spatial type used
- They are only used within the WHERE clause

# SDO_FILTER

- SDO_FILTER(<geometry-1>,<geometry-2>,‘QUERYTYPE=WINDOW’) = ‘TRUE’;
- geometry-1 (searched object)
    - Must be a column table
    - Must be a SDO_GEOMETRY
    - Must be indexed
- geometry-2
    - Must be a variable or column table
    - Must be SDO_GEOMETRY
- ‘QUERYTYPE=WINDOW’
    - Necessary parameter
    - Oracle advises to use only WINDOW

# SDO_WITHIN_DISTANCE

- SDO_WITHIN_DISTANCE( <geometry-1>,<geometry-2>, ‘DISTANCE=<n>,[optional parameters]’) = ‘TRUE’;
- geometry-2
  - A buffer will be created starting from this object
- DISTANCE
  - Distance to be considered
- UNIT (optional)
  - Defines a specific unit measure

# SDO_WITHIN_DISTANCE example

- select a.name
  from buildings b, streets a
  where b.id= 2198376 and
  sdo_within_distance
  ( a.geom,b.geom,‘distance=1 UNIT=kilometer’)=‘TRUE’;

# SDO_NN (Nearest Neighbor)

- SDO_NN(<geometry-1>,<geometry-2>,[optional parameters]) = 'TRUE';
- SDO_NUM_RES (optional)
  - Number of neighbors to return (default=1)
- SDO_BATCH_SIZE (optional)
  - To be used instead of SDO_NUM_RES: it returns subsets of nearest neighbors until all the criteria defined by the "WHERE" clause are satisfied
- UNIT (optional)
  - Measure unit

# SDO_NN example

- select s.type
  from streets s, polls p
  where s.id = 1289 and
  sdo_nn(s.geom,p.geom,’sdo_num_res=5 unit=meter’,1) = ‘TRUE’;