

# Spatial data management

Reff :

Data Management  
Fourth Edition

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## Spatial data

- A spatial database is a data management system for collection, storage, manipulation, and output of spatially referenced information
- Also known as geographic information system (GIS), an extended form of DBMS
- Information appliances will lead to location based-services  $\Rightarrow$  the spatial data necessary to support location-based service

# Geospatial modeling

- Geospatial modeling is based on three key concepts : theme, geographic object, and map
- A **theme** refers to data describing a particular topic (e.g. rivers, roads, cities)
- A **geographic object** is an instance of a theme (e.g. a river). It has a set of attributes including spatial components that can describe both geometry and topology :
  - Geometry refers to the location-based data (shape, length)
  - Topology refers to relationships among object (adjacency)
- A **map** is a theme represented on paper or a screen. Color may be used to indicate different themes. It usually has a scale, legend, and some explanatory text

## Some PostgreSQL geometric data types

Geometric type	Representation	Description & Example
<b>BOX</b>	$((x1,y1),(x2,y2))$	Rectangular box $\Rightarrow ((1,2),(6,6))$
<b>CIRCLE</b>	$((x,y),r)$	Circle (center and radius) $\Rightarrow ((0,0),5)$
<b>LSEG</b>	$((x1,y1),(x2,y2))$	Finite line segment $\Rightarrow ((4,7),(12,6))$
<b>PATH</b>	$((x1,y1),...)$	Closed path (similar to polygon) $\Rightarrow ((1,1),(1,6),(4,9),(10,5))$
<b>PATH</b>	$[(x1,y1),...]$	Open path $\Rightarrow [(1,1),(1,6),(4,9),(10,5)]$
<b>POINT</b>	$(x,y)$	Point in space $\Rightarrow (2,8)$

## Some PostgreSQL geometric functions

Function	Returns	Description
<b>LENGTH</b> (OBJECT)	double precision	length of item
<b>AREA</b> (OBJECT)	double precision	area of item
<b>CENTER</b> (OBJECT)	point	center point of item
<b>WIDTH</b> (BOX)	double precision	horizontal size of box
<b>HEIGHT</b> (BOX)	double precision	vertical size of box
<b>NPOINTS</b> (PATH)	integer	number of points

Sample queries :

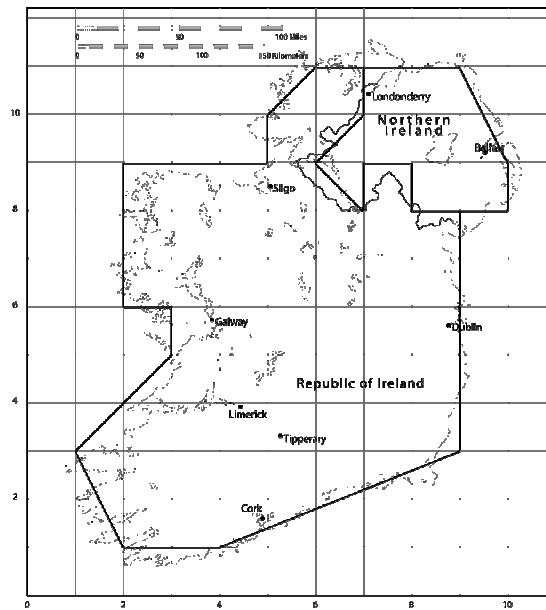
- `SELECT LENGTH (PATH '((0,0),(3,0),(3,3),(0,3)))'`
- `SELECT AREA (PATH '((0,0),(5,0),(5,5)))'`

## Some PostgreSQL geometric operators

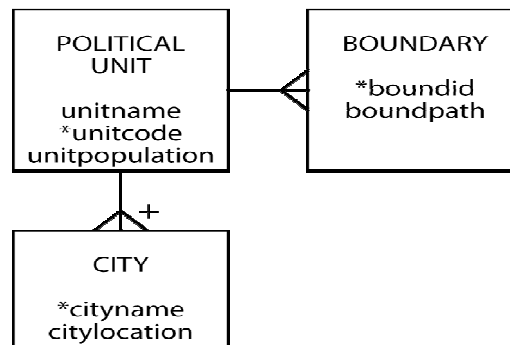
Operator	Description
<code>&lt;-&gt;</code>	Distance between
<code>&amp;&amp;</code>	Overlaps ?
<code>&lt;&lt;</code>	Is left of ?
<code>&lt;^</code>	Is below ?
<code>&gt;&gt;</code>	Is right of ?
<code>&gt;^</code>	Is above ?

Sample queries :

- `SELECT POINT '(7,7)' <-> POINT '(-7,-7)'`
- `SELECT POINT '(-3,3)' <^ POINT '(3,-3)'`



## Data model for political units



# Create tables

```
CREATE TABLE political_unit (  
    unitname VARCHAR(30) NOT NULL,  
    unitcode CHAR(2),  
    unitpop DECIMAL(6,2),  
    PRIMARY KEY(unitcode));  
CREATE TABLE boundary (  
    boundid INTEGER,  
    boundpath PATH NOT NULL,  
    unitcode CHAR(2),  
    PRIMARY KEY(boundid),  
    CONSTRAINT fk_boundary_polunit FOREIGN KEY(unitcode)  
        REFERENCES political_unit);  
CREATE TABLE city (  
    cityname VARCHAR(30),  
    cityloc POINT NOT NULL,  
    unitcode CHAR(2),  
    PRIMARY KEY(unitcode, cityname),  
    CONSTRAINT fk_city_polunit FOREIGN KEY(unitcode)  
        REFERENCES political_unit);
```

# Insert rows

```
INSERT INTO political_unit VALUES  
    ('Republic of Ireland', 'ie', 4.1);  
INSERT INTO political_unit VALUES  
    ('Northern Ireland', 'ni', 50.1);  
INSERT INTO boundary VALUES  
    (1, '((9,8),(9,3),(4,1),(2,2),(1,3),(3,5),(3,6),(2,6),  
    (2,9),(5,9),(5,10),(6,11),(7,11),(7,10),(6,9),(7,8),  
    (7,9),(8,9),(8,8),(9,8))', 'ie');  
INSERT INTO boundary VALUES  
    (2, '((7,11),(9,11),(10,9),(10,8),(8,8),(8,9),(7,9),  
    (7,8),(6,9),(7,10),(7,11))', 'ni');  
INSERT INTO city VALUES ('Dublin', '(9,6)', 'ie');  
INSERT INTO city VALUES ('Cork', '(5,2)', 'ie');  
INSERT INTO city VALUES ('Limerick', '(4,4)', 'ie');  
INSERT INTO city VALUES ('Galway', '(4,6)', 'ie');  
INSERT INTO city VALUES ('Sligo', '(5,8)', 'ie');  
INSERT INTO city VALUES ('Tipperary', '(5,3)', 'ie');  
INSERT INTO city VALUES ('Belfast', '(9,9)', 'ni');  
INSERT INTO city VALUES ('Londonderry', '(7,10)', 'ni');
```

## Length

- What is the length of the Republic of Ireland's border?

```
SELECT SUM(LENGTH((boundpath))) * 37.5
  AS "Border (kms)" from political_unit, boundary
  WHERE unitname = 'Republic of Ireland'
 AND political_unit.unitcode = boundary.unitcode;
```

Border (kms)
1353.99

## Distance

- How far, as the crow flies, is it from Sligo to Dublin?

```
SELECT (orig.cityloc <-> dest.cityloc) * 37.5
  AS "Distance (kms)"
  FROM city orig, city dest
  WHERE orig.cityname = 'Sligo'
  AND dest.cityname = 'Dublin';
```

Distance (kms)
167.71

## Closest

- What is the closest city to Limerick?

```
SELECT dest.cityname FROM city orig, city dest
WHERE orig.cityname = 'Limerick'
AND orig.cityloc <-> dest.cityloc =
  (SELECT MIN(orig.cityloc <-> dest.cityloc)
   FROM city orig, city dest
   WHERE orig.cityname = 'Limerick'
   AND dest.cityname <> 'Limerick');
```

cityname
Tipperary

## Westernmost

- What is the westernmost city in Ireland?

```
SELECT west.cityname FROM city west
WHERE NOT EXISTS
  (SELECT * FROM city other
   WHERE other.cityloc << west.cityloc);
```

cityname
Limerick
Galway

## Latihan A

NO	QUERY	MEANING	RESULT
1	SELECT LENGTH (LSEG '((5,0),(5,10))')	?	?
2	SELECT AREA (CIRCLE '((0,0),10)')	?	?
3	SELECT CENTER (BOX '((0,0),(6,8))')	?	?
4	SELECT WIDTH (BOX '((2,5),(10,8))')	?	?
5	SELECT HEIGHT (BOX '((2,5),(10,8))')	?	?
6	SELECT NPOINTS (PATH '[(0,0),(5,1),(4,4),(1,3)]')	?	?
7	SELECT CIRCLE '((0,0),1)' <-> CIRCLE '((5,0),1)'	?	?
8	SELECT BOX '((0,0),(1,1))' && BOX '((0,0),(2,2))'	?	?
9	SELECT POINT '(9,1)' << POINT '(7,1)'	?	?
10	SELECT POINT '(5,12)' >^ POINT '(5,11)'	?	?

## Latihan B

*Tuliskan QUERY dan NILAI OUTPUT-nya :*

1. Berapa jarak dari titik (-9,2) ke titik (5,-15) ?
2. Berapa luas daerah yang dibatasi titik (-10,-8), (-5,3), (7,7), (8,-1) ?
3. Berapa keliling segitiga dengan titik sudut (4,4), (10,4), (7,8) ?
4. Berapa jarak kotak A ((-10,-10), (-2,-2)) dengan kotak B ((5,5), (11,11)) ?
5. Diketahui lingkaran X berjari-jari = 7 dengan titik tengah (1,7) dan lingkaran Y berjari-jari = 3 dengan titik tengah (9,9). Apakah lingkaran X dan Y tumpang tindih ?
6. Diketahui kotak P ((0,5), (-7,11)) dan kotak Q ((-9,9), (-12,13)). Apakah posisi kotak P di sebelah kanan kotak Q?
7. Diketahui kotak S ((-2,5), (-8,11)) dan kotak T ((-10,12), (-12,15)). Apakah posisi kotak S di sebelah atas kotak T?



# Latihan C

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*Tuliskan QUERY dan NILAI OUTPUT-nya :*

1. Berapa panjang keliling Irlandia Utara ? Karena Irlandia Utara adalah bagian dari negara Inggris yang masih menggunakan satuan mil (1 grid = 23 mil), hitung kelilingnya dalam mil.
2. Berapa mil persegi luas Republik Irlandia ? Berapa luas Irlandia Utara ?
3. Berapa mil jarak dari kota Belfast ke Londonderry ?
4. Apa nama kota paling dekat ke kota Dublin ?
5. Apa nama kota paling jauh ke kota Cork ?
6. Berapa jumlah titik batas di Republik Irlandia ?
7. Apa nama kota paling utara, paling timur, dan paling selatan di Irlandia ?