PostGIS: A Standards Based Geographic Extension for PostgreSQL

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Overview

- Brief background
- PostGIS Details
- PostGIS Examples
- Survey of Simple Features 1.1 Geometries
- Simple Features 1.2 Geometry
- A survey of simple features based software
- Commentary

What is a Spatial Database?

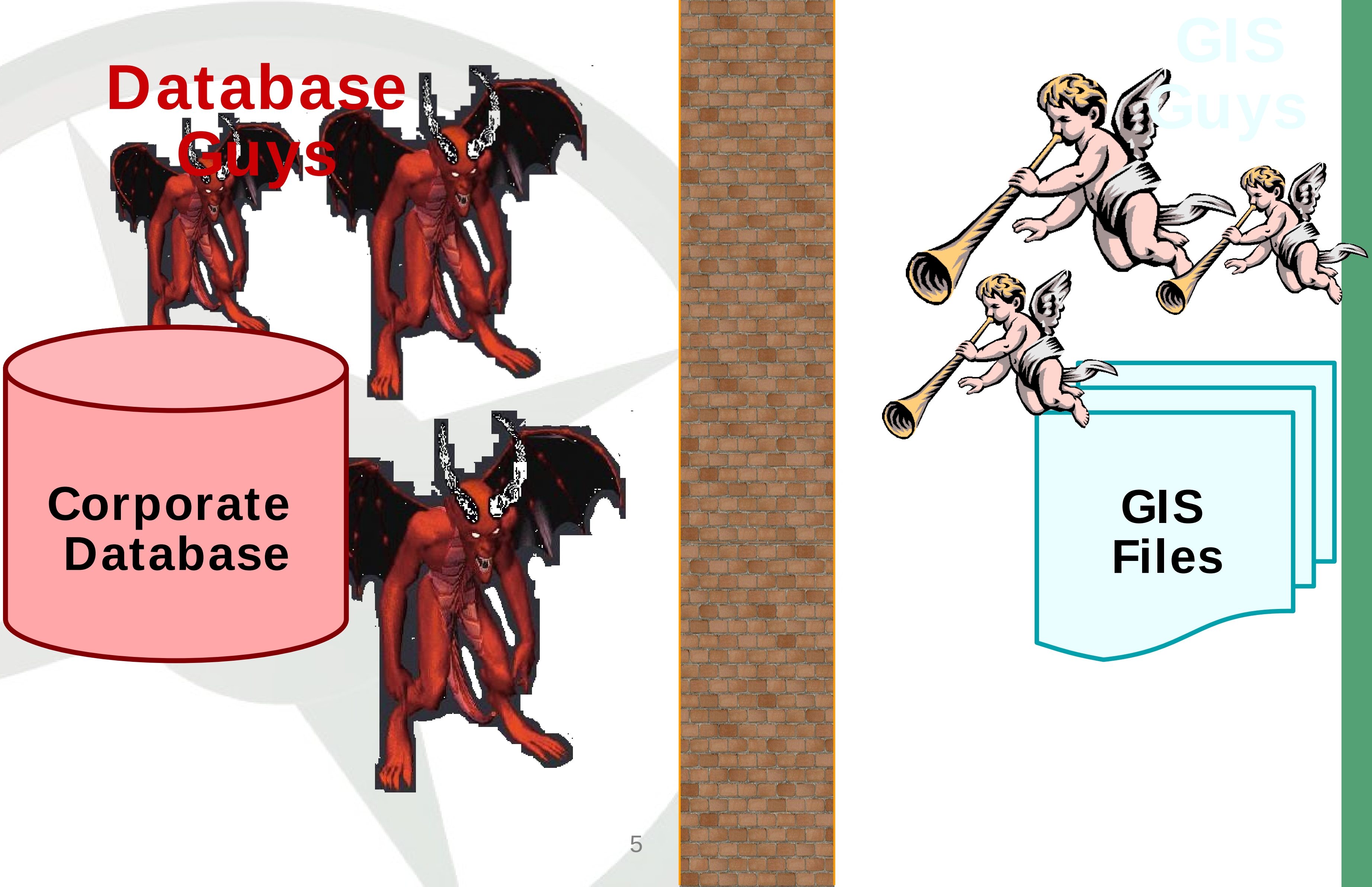
- Support for a “Geometry” Type
- Indexing for the Geometry Type
- Functions for the Geometry Type
- Database that can answer GIS questions:
  - quickly
  - on large volumes of data

Why a Spatial Database?
(instead of just using files)

- Transactional Integrity
  Multiple Users, Multiple Edits
- Unified Storage, Management, Access
  SQL Everywhere

- Because Databases are Better than Files
  NOT!

Unified Storage



Database Guys

Corporate Database

GIS Guys

GIS Files

PostGIS

- Geographic Extension for PostgreSQL
- Based on OGC Simple Features for SQL
- By Refractions Research (Victoria,BC)
- First release in 2001
- GPL licensed (likely why not in main src tree)
- R-Tree-over-GiST used for spatial index
- Introduces:

  new geometry types
  many new functions
  new support tables

http://www.postgis.org

Some Geometry Functions

- Area(POLYGON)
- Distance(GEOMETRY,GEOMETRY)
- Contains(GEOMETRY,GEOMETRY)
- Intersection(GEOMETRY,GEOMETRY)
- Intersects(GEOMETRY,GEOMETRY)
- Union(GEOMETRY,GEOMETRY)
- Buffer(GEOMETRY,double)
- ConvexHull(GEOMETRY)
- Perimeter(GEOMETRY)
- Crosses(GEOMETRY,GEOMETRY)
- Transform(GEOMETRY,integer SRID)

Some Accessor Functions

- Dimension(GEOMETRY)
- AsText(GEOMETRY)
- ST_X(POINT)
- ST_Y(POINT)
- NumPoints(GEOMETRY)
- PointN(GEOMETRY,integer)
- NumGeometries(GEOMETRY)
- GeometryN(GEOMETRY,integer)
- GeometryType(GEOMETRY)

GIS Questions

“How many people live within 5 miles of the toxic gas leak?”

```
SELECT sum(population)
FROM census_tracks
WHERE
  distance(census_geom,
                 'POINT(210030 3731201)')
                < (5 * 1609.344)
```

GIS Questions

“What is the area of municipal parks inside the Westside neighbourhood?”

```
SELECT sum(area(park_geom))
FROM parks, nhoods
WHERE
  contains(nd_geom,park_geom)
  AND nhood_name = 'Westside'
```

GIS Questions

“What is the maximum distance a student has to travel to school?”

```
SELECT
 max(distance(student_location,
                         school_location))
FROM students, schools
WHERE students.school_id =  schools.id;
```

Create a Table Simply

```
CREATE TABLE ROADS
    (ID int4,
     NAME varchar(255),
     GEOM geometry)
```

Create a Table Properly

```
CREATE TABLE ROADS
      (ID int4,
       NAME varchar(255))

SELECT AddGeometryColumn
  ('roads','geom',423,'LINESTRING',2)
```

'roads': Table name
'geom': Geometry column name
423: SRID (coordinate system)
'LINESTRING': geometry type constraint
2: Dimension

Insert Data

```
INSERT INTO roads
( road_id, road_geom, road_name)
VALUES
(1,
 GeomFromText(
  'LINESTRING(19123 24311,19110 23242)',
  242),
 'Jeff Rd.')
```

Spatial Index

```
CREATE INDEX roads_geom_index
ON roads
USING GIST(geom)
```

geometry_columns

```
CREATE TABLE geometry_columns (
  f_table_catalog    VARRCHAR(256) NOT NULL,
  f_table_schema     VARCHAR(256) NOT NULL,
  f_table_name       VARCHAR(256) NOT NULL,
  f_geometry_column  VARCHAR(256) NOT NULL,
  coord_dimension    INTEGER NOT NULL,
  srid               INTEGER NOT NULL,
  type               VARCHAR(30) NOT NULL
)
```

part of OGC specification

important to spatial applications

from AddGeometryColumn()

spatial_ref_sys

```
CREATE TABLE spatial_ref_sys (
  srid        INTEGER NOT NULL PRIMARY KEY,
  auth_name   VARCHAR(256),
  auth_srid   INTEGER,
  srtext      VARCHAR(2048),
  proj4text   VARCHAR(2048)
)
```

Defines Coordinate System

Part of OGC specification

Important to spatial applications

List is prepopulated

PostGIS Application Support

Web Mapping:

- MapServer, MapGuide, GeoServer

Desktop GIS:

- Udig, QGIS, JUMP, GRASS

Proprietary GIS:

- Cadcorp SIS, ArcGIS 9.3(?)

ETL:

- FME, GDAL/OGR

PostGIS Installation

- Included in standard PostgreSQL Win Installer (buried back in the extra packages)
- PostgreSQL+ PostGIS MacOS X binaries available
- Elsewhere installing from source pretty easy
  - Optionally depends on GEOS and PROJ.4
  - Two SQL scripts need to be run to setup postgis types, and setup support tables

OGC and Simple Features

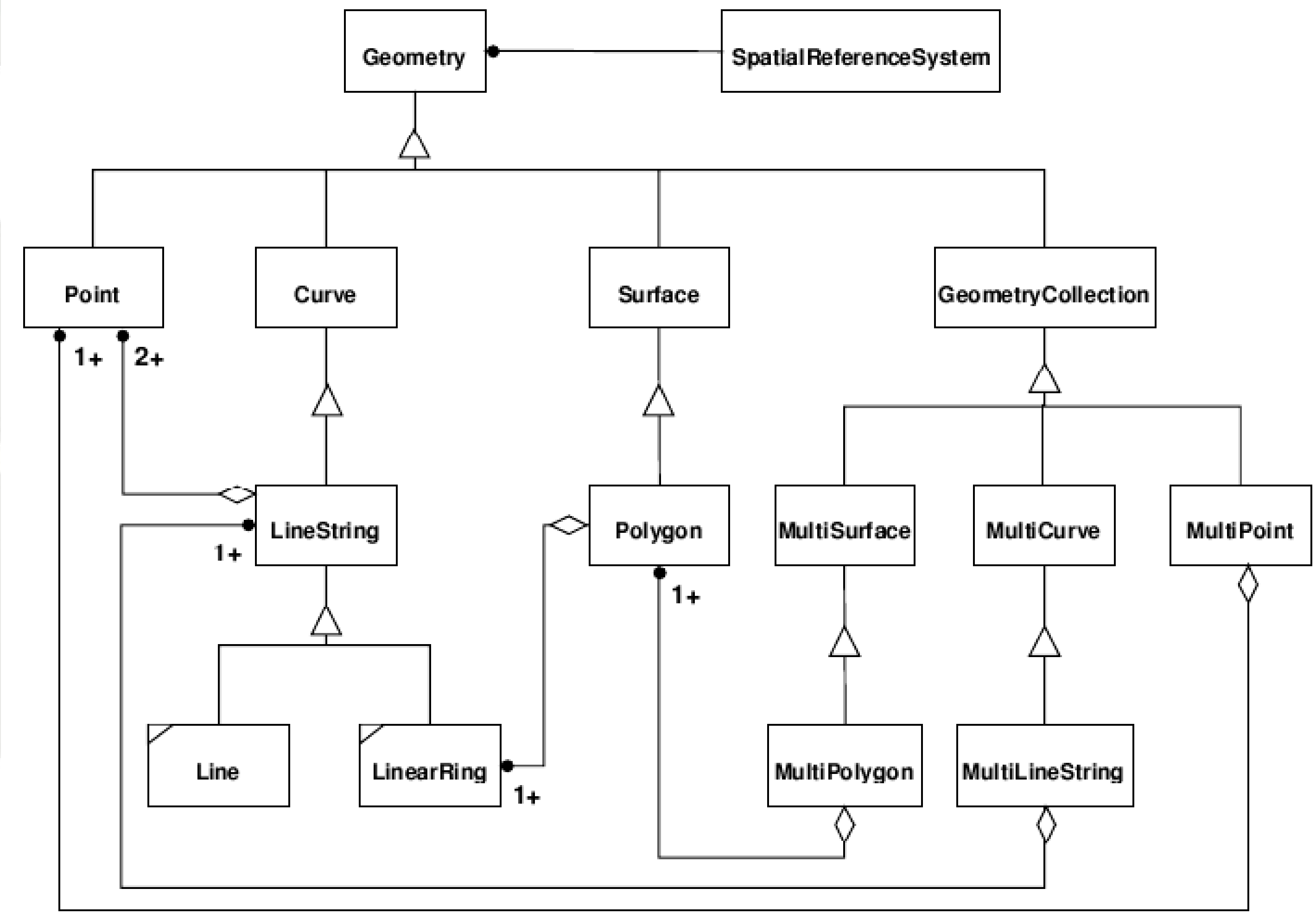
OGC is the “Open Geospatial Consortium”

- Collaborative development of specifications for geospatial services
- Industry driven
- About Open Standards, not Open Source

Simple Features

- Abstract geometry model
- Base of “Simple Features for SQL”
- First concrete OGC spec (mid 90's)

Simple Features Geometries (1.0)



Point

- 2D (x,y) point location

WKT (Well Known Text) Representation:

POINT(-117.25 35.0)

Line String

- Chain of point location
- No restrictions on self-intersection
- Duplicate points ok

```
LINESTRING(0 10, 20 15, 30 15)
```

Line String

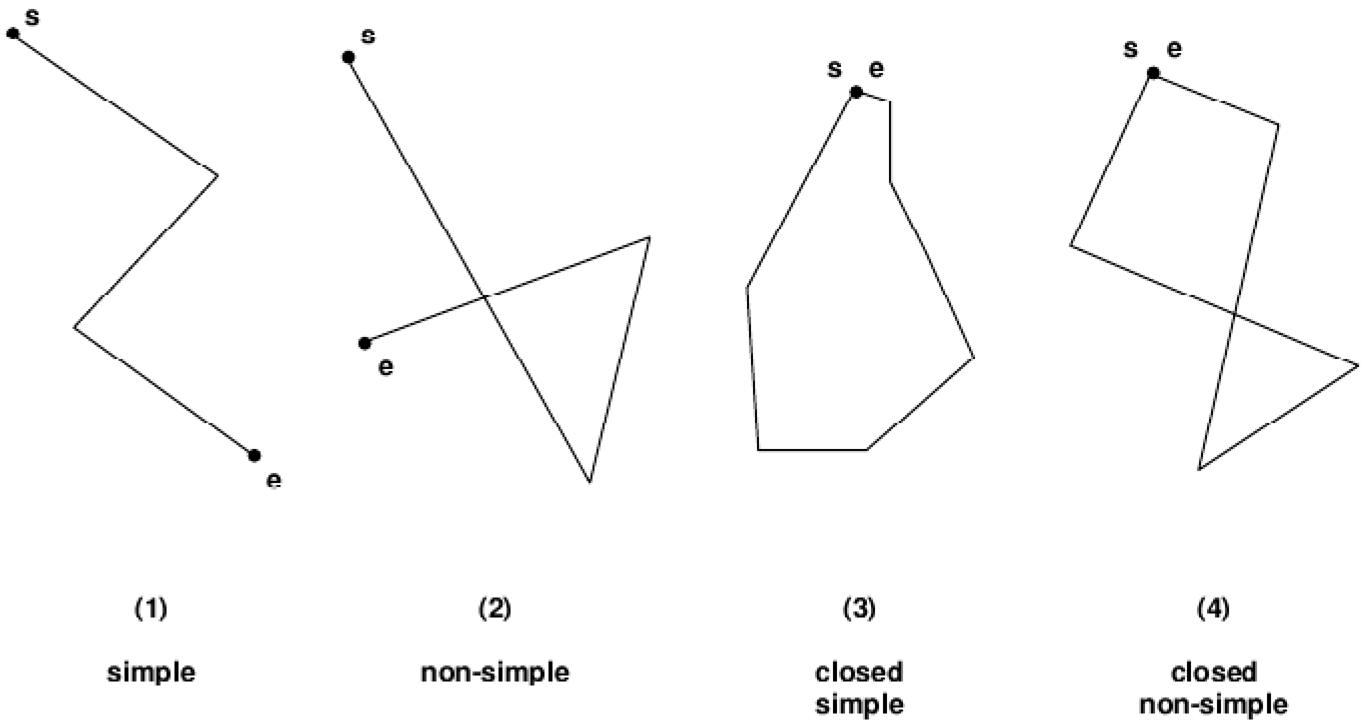


Figure 2.2—(1) a simple LineString, (2) a non-simple LineString, (3) a simple, closed LineString (a LinearRing), (4) a non-simple closed LineString

Polygon

- Polygon with one outer ring, and zero or more inner rings (holes)
- Polygons are closed (last point of ring equals first point)
- Rings may not cross
- Rings may touch
- Polygon interior is a connected point set
- Winding direction of rings not significant

```
POLYGON((0 0,10 10,10 0,0 0),
                   (3 1,4 1,4 2,3 1))
```

Polygon

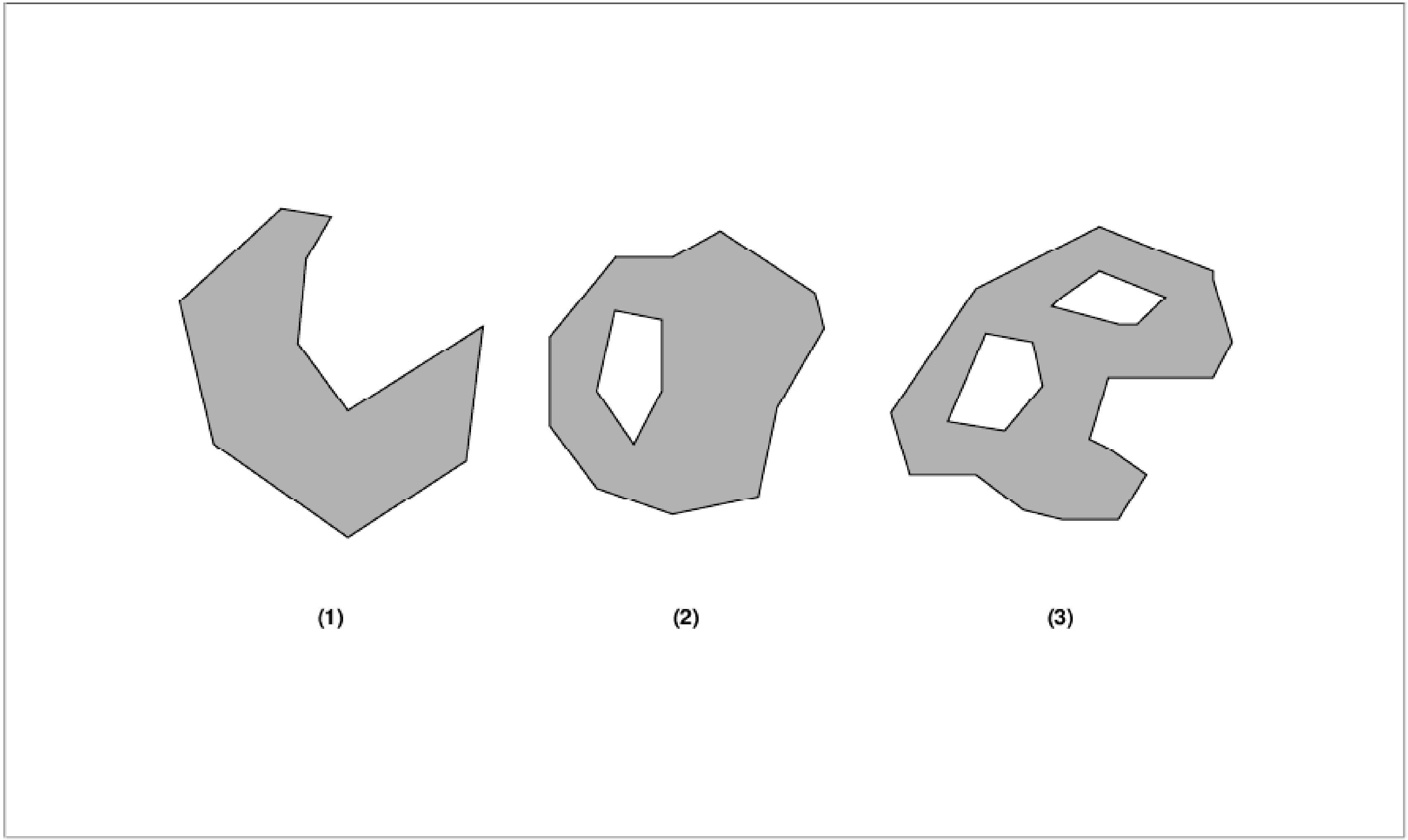


Figure 2.4—Examples of Polygons with 1, 2 and 3 rings respectively.

Polygon

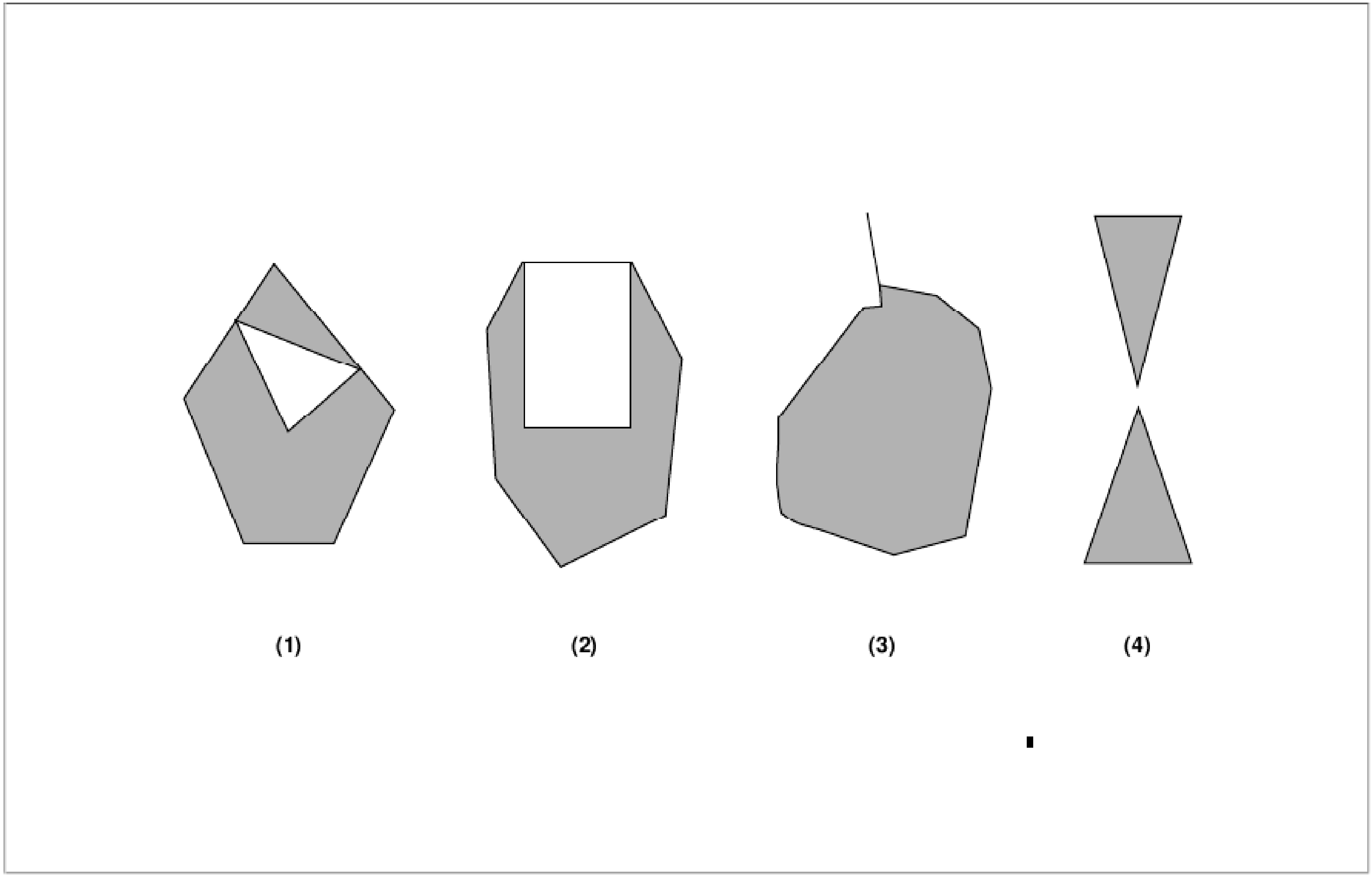


Figure 2.5—Examples of objects not representable as a single instance of Polygon. (1) and (4) can be

Multi-Polygon

- A collection of polygons
- May be nested (and island in a lake)
- May **not** be overlapping
- May touch at a point
- May **not** touch along an edge

```
MULTIPOLYGON(((0 0,10 10,10 0,0 0),
                    (3 1,4 1,4 2, 3 1)),
             ((20 20, 30 30, 30 20, 20 20)))
```

Multi-Polygon

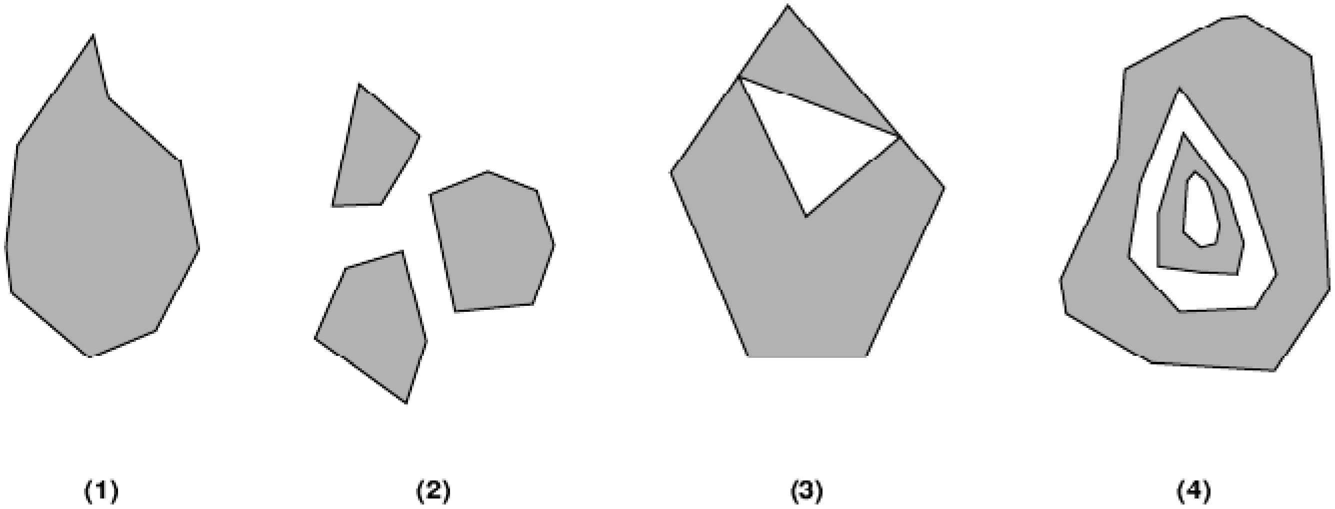


Figure 2.6—Examples of MultiPolygons

Multi-Polygon

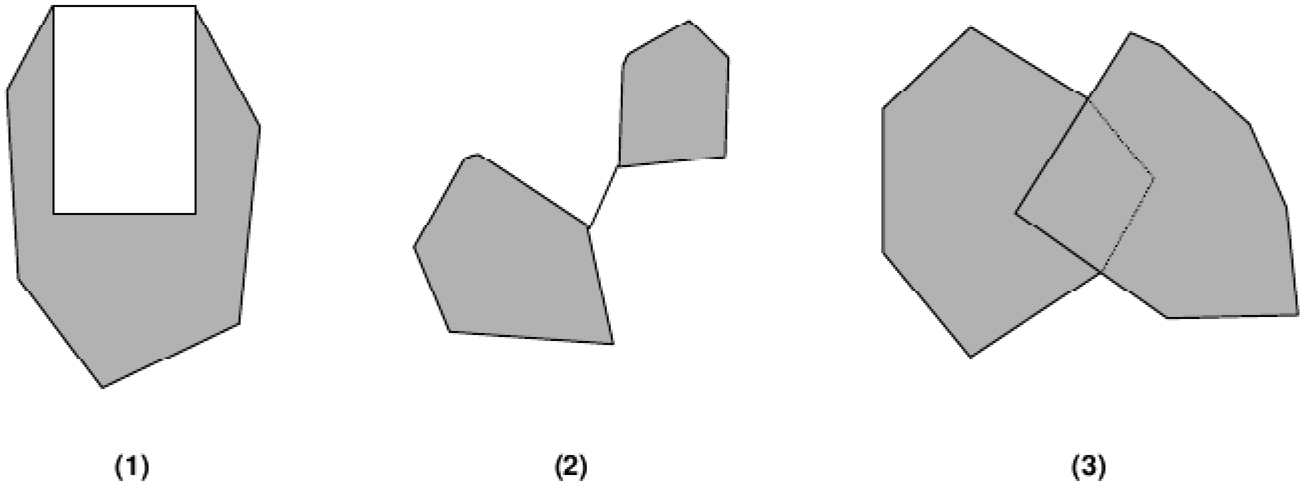


Figure 2.7—Geometric objects not representable as a single instance of a MultiPolygon.

Multi Line String

- A collection of linestrings

```
MULTILINESTRING((0 0,10 10,10 0),
                (3 1,4 1,4 2,5 1))
```

Multi Point

- A collection of points

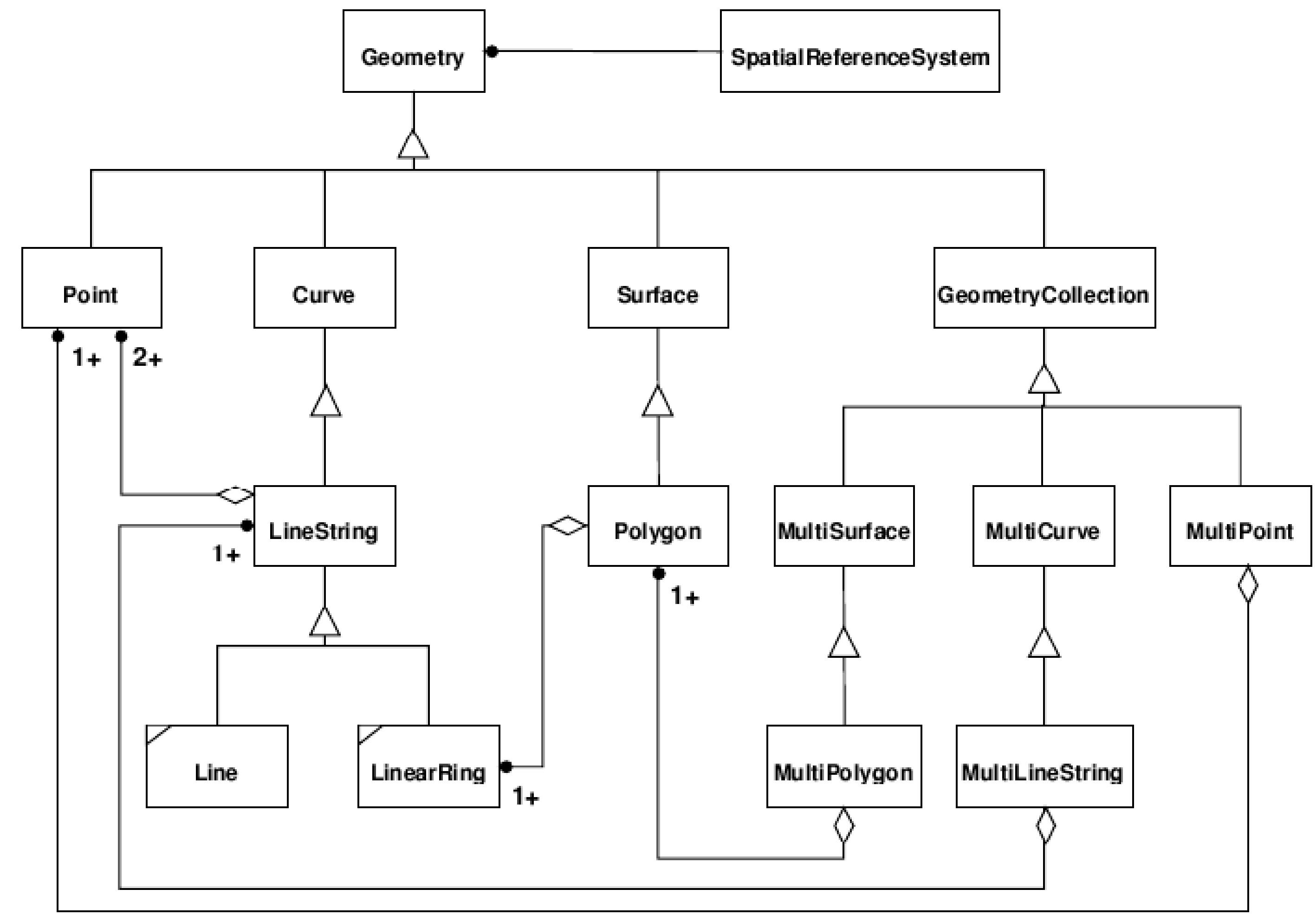
```
MULTIPOINT((0 0),(10 10),(10 0))
```

Geometry Collection

- A collection of geometries

```
GEOMETRYCOLLECTION(
    POINT(0 5),
    LINESTRING(3 5, 2 9, 1 3),
    POLYGON((0 0, 10 10, 10 0, 0 0)))
```

Simple Features Geometries (1.0)



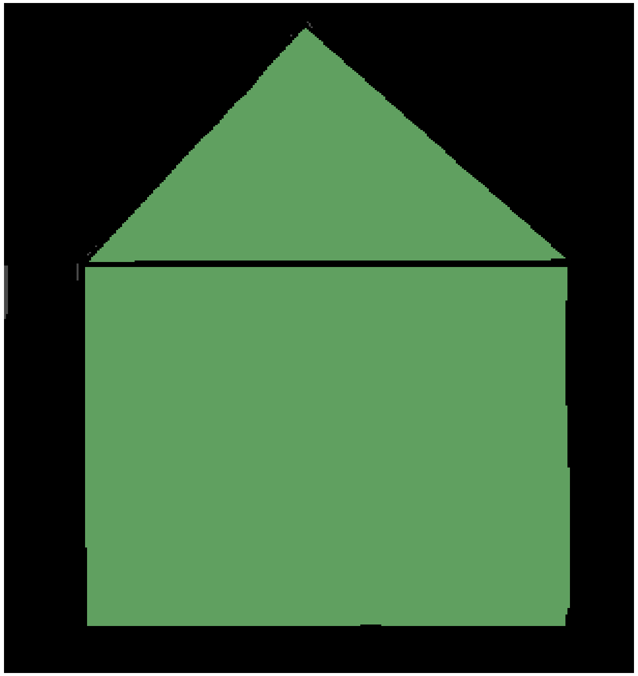
Simple Features 1.2

- Extends vertices to 3D/4D (Z/Measure)
- Geometric operations done in 2D
- Adds Polyhedral Surface
- Adds TIN
- Alters defacto 3D/4D WKT/WKB formats
- Adds Annotation Text to feature model

Polyhedral Surface

- A surface consisting of adjacent polygons
- Stored as collection of polygons
- TIN is special case, all triangles

```
POLYHEDRALSURFACE(
 ((0 10,0 0,10 0,10 10,0 10)),
 ((0 10,5 15, 10 10,0 10)))
```



SQL–MM

- ISO SQL Geometry Specification
- SF 1.2 aligned with SQL-MM
- PostGIS supports these SQL-MM types:
  CircularString (arcs of a circle)
  CompoundCurve (arcs+ linestrings)
  CompoundSurface (curved polygons)
  MultiCurve
  MultiSurface
- SQL-MM also addresses topology, networks, directions, angles, ...

SQL-MM: CircularString

- A string of partial circle arcs connected end to end (a LineString of arcs)
- Each arc defined by three points

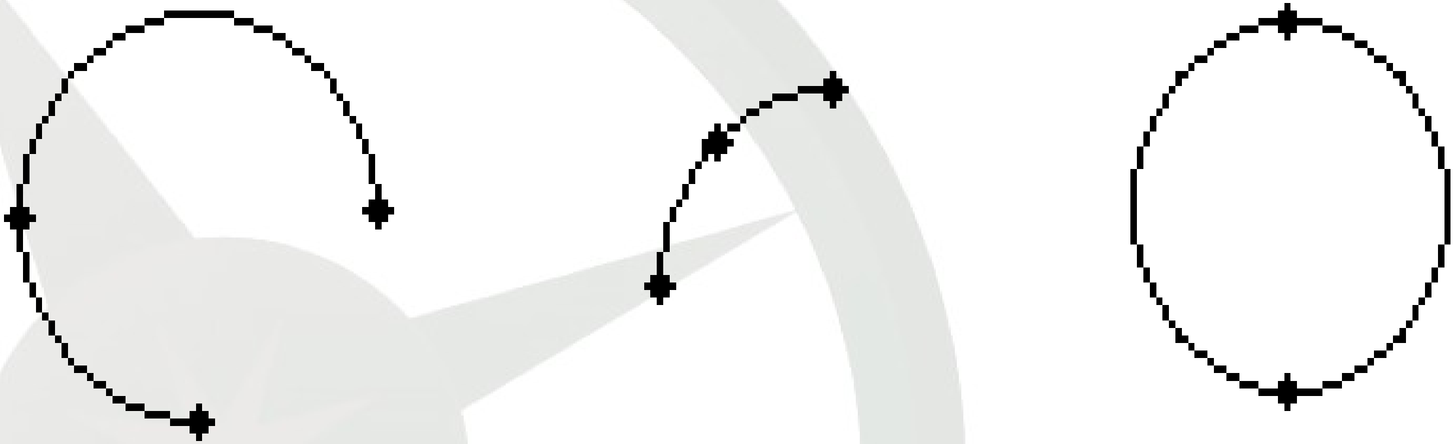
  arc start

  a point on the arc

  arc end
- Whole circles have same first/last and the middle point is opposite side of circle

CIRCULARSTRING(0 0, 1 1, 1 0)

SQL-MM: CircularString



Software Survey

OGC Simple Features 1.0 for SQL

- Postgres/ PostGIS:Full implementation including all geometry functions
- MySQL: Supports geometry, and spatial indexing, very limited additional functions
- Oracle: Apparently compliant, many extensions
- MSSQL: Supports geometry, spatial indexing, very limited additional functions
- SpatialLite: Partial SFSQL.
- Ingres: Being implemented! 1.2?

Software Survey

Simple Features based/ inspired:

- OGR: Geometry is Simple Features 1.0
- FDO: Geometry is extension of SF
- QGIS: Geometry is Simple Features 1.0
- SDE: Close to SF + extensions
- GEOS: SF 1.0 geometry model

Not Simple Features:

- MapServer, OpenEV, GRASS
- MapInfo, Microstation

Format Survey

- GML: Geometry is SF (+ extensions in 3?)
- Shapefile: Not simple features
- Mapinfo: Not simple features

Most major GIS products do not exactly map to Simple Features, though they may be similar.

SF: What is missing?

- Nonlinear curves (ellipse/ spline/ etc)
- 3D solids
- Topology
- Non- planar surfaces
- Representation

Universal Geometry Model for GIS?

No, because:

- lack of real curves, hampers CAD links
- lack of topology

Yes, because:

- Understandable
- Lingua franca for interchange/ discussion
- Wide adoption

Takeaway Lessons

- PostgreSQL+ PostGIS is the leading spatial database combination

- PostGIS is standards based

- OGC Simple Features is useful, widely adopted way of expressing geometry

Opportunities

- Dracones talk here at 1:30!
- OSBootCamp 6 (Geobootcamp)
  June2nd, Ottawa (Carleton)
  Free!
  www.osbootcamp.org

- OSGeo Ottawa
  Monthly meetings at a pub
  wiki.osgeo.org/wiki/Ottawa_Chapter

Questions?

PostGIS:
www.postgis.org

OGC (standards):
opengeospatial.org

OSGeo.org
The Open Source
Geospatial Foundation