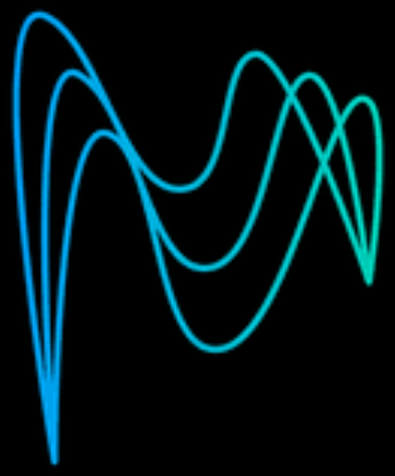


Introduction to Spatial Databases

Agenda

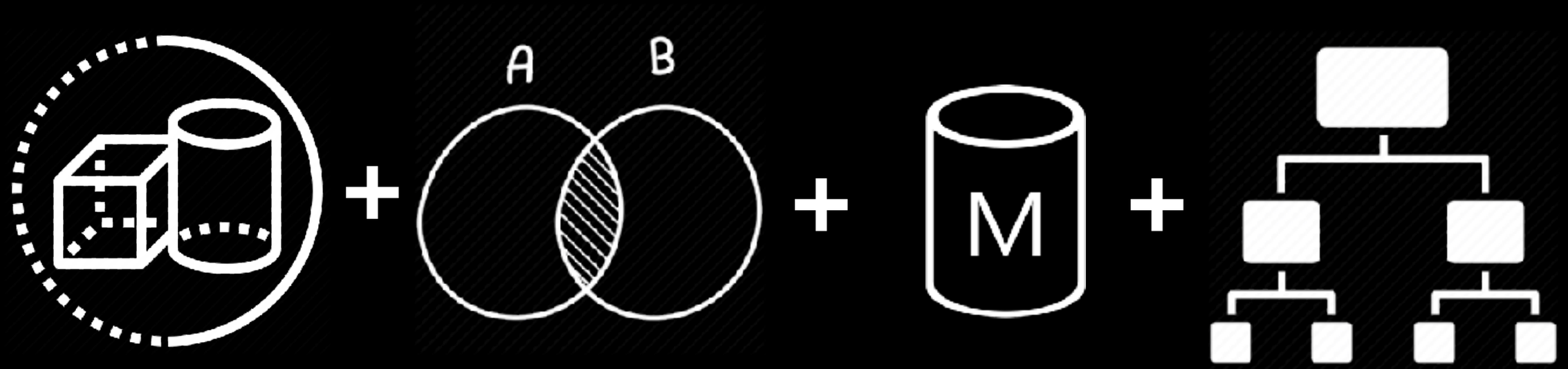
1. What is a Spatial Database?
2. Spatial Reference Systems
    - Coordinate Systems
    - Datums
3. A brief Spatialite Demo
4. Hands-on Exercises

What is Spatial Database?

Database

Geometry

In this context geometry means…



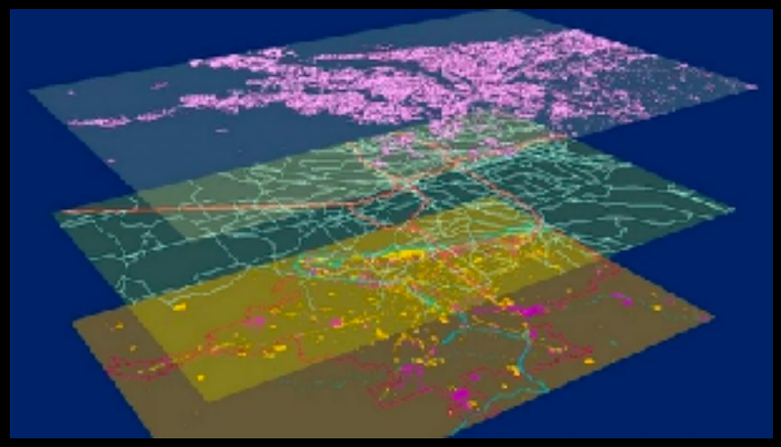
Geometry Primitives

Geometry Operations

Spatial Reference System

Spatial Indexes

Why do we need Spatial Databases?

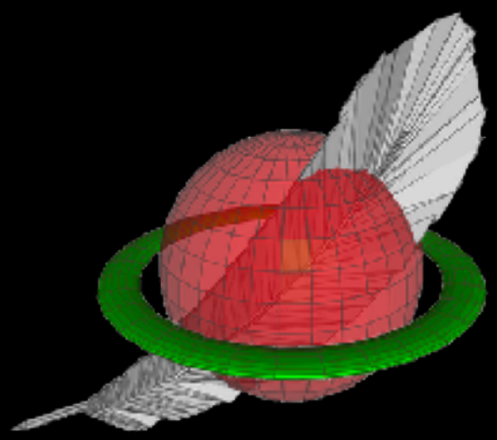


GIS Applications

Surveying and Cartography

Emergency Planning

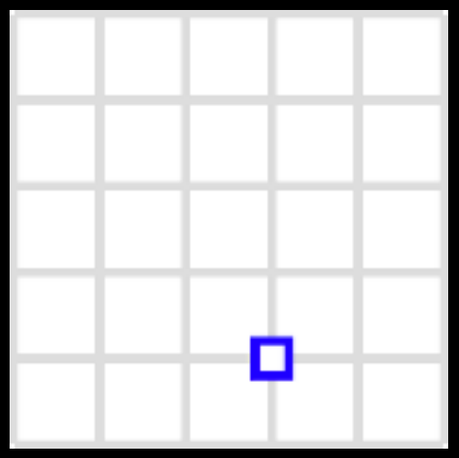
Some of the popular Spatial Databases…



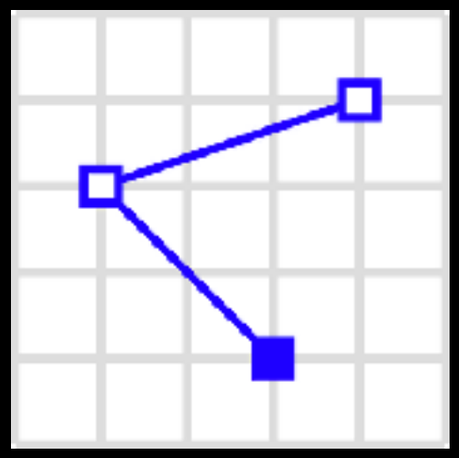
SpatiaLite

Geometry Primitives

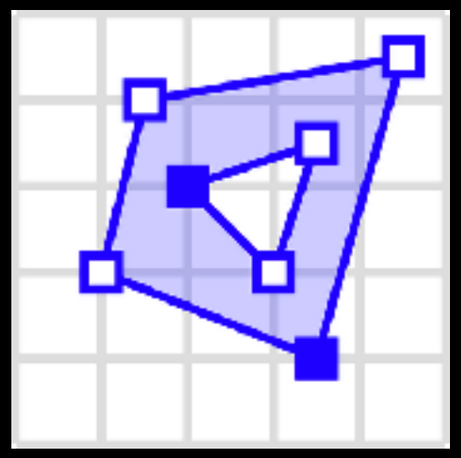
POINT



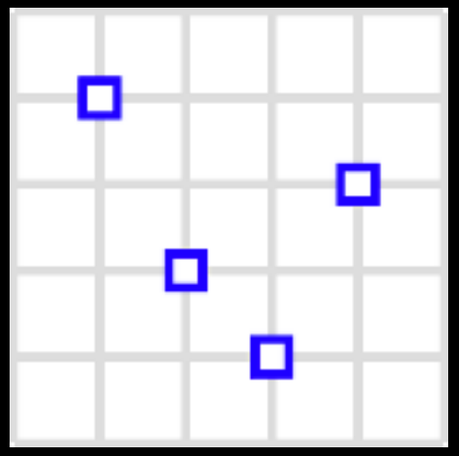
LINESTRING



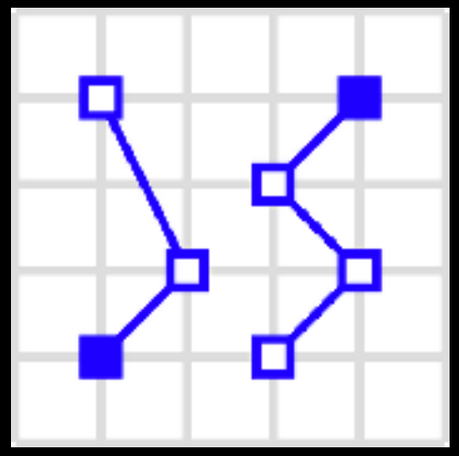
POLYGON



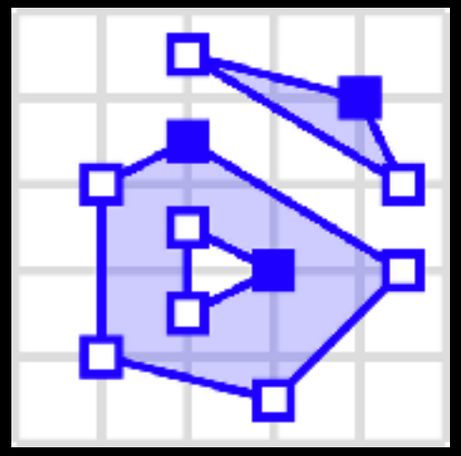
MULTIPOINT



MULTILINESTRING

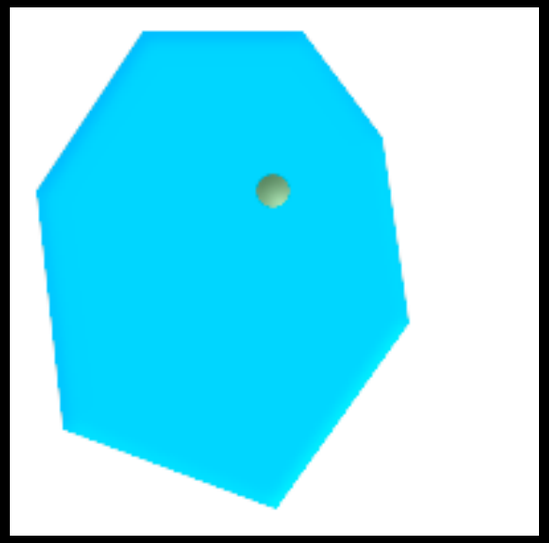


MULTIPOLYGON

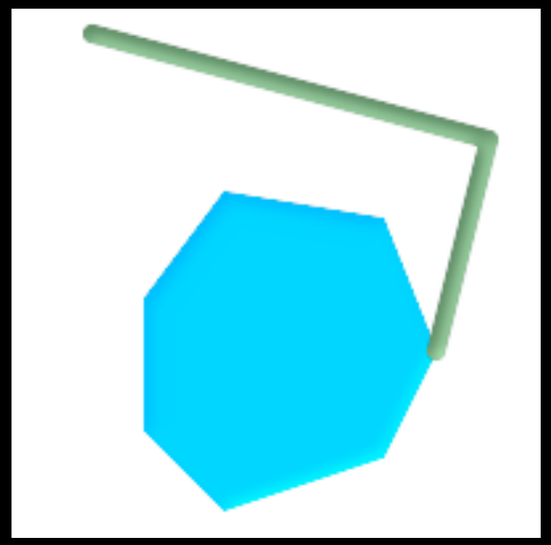


Geometry Operations

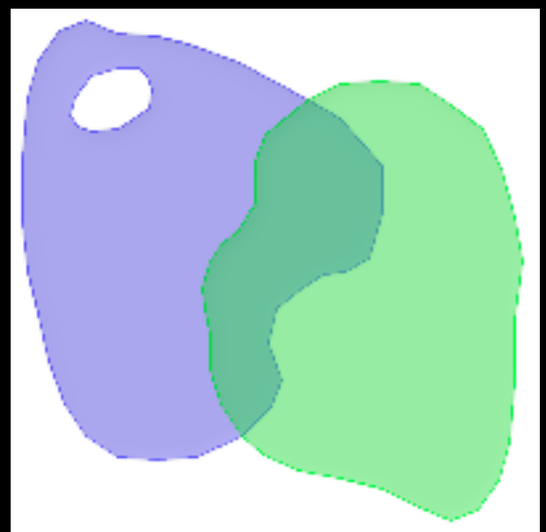
CONTAINS



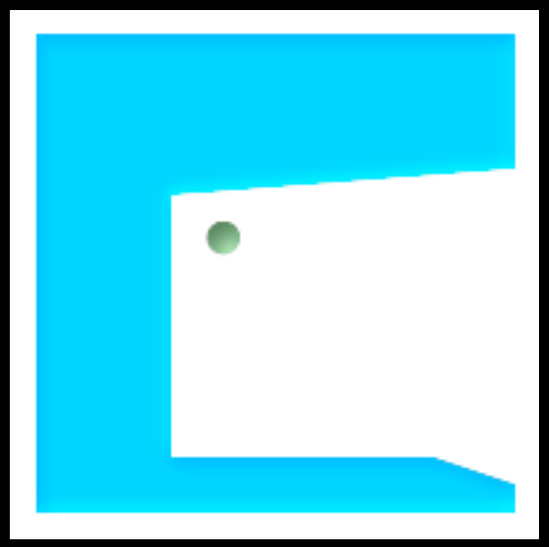
TOUCHES



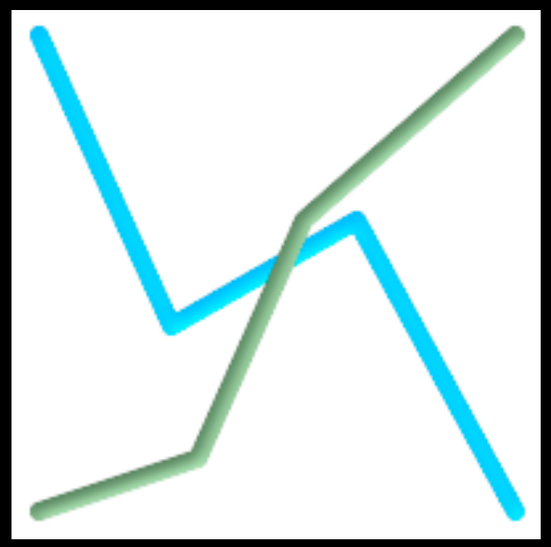
OVERLAPS



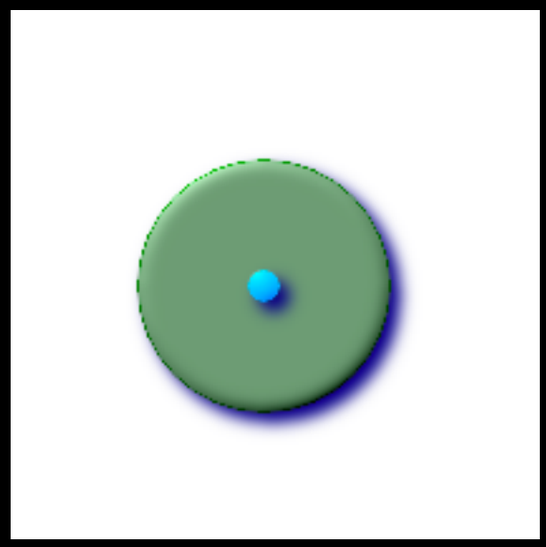
CENTROID



TOUCHES



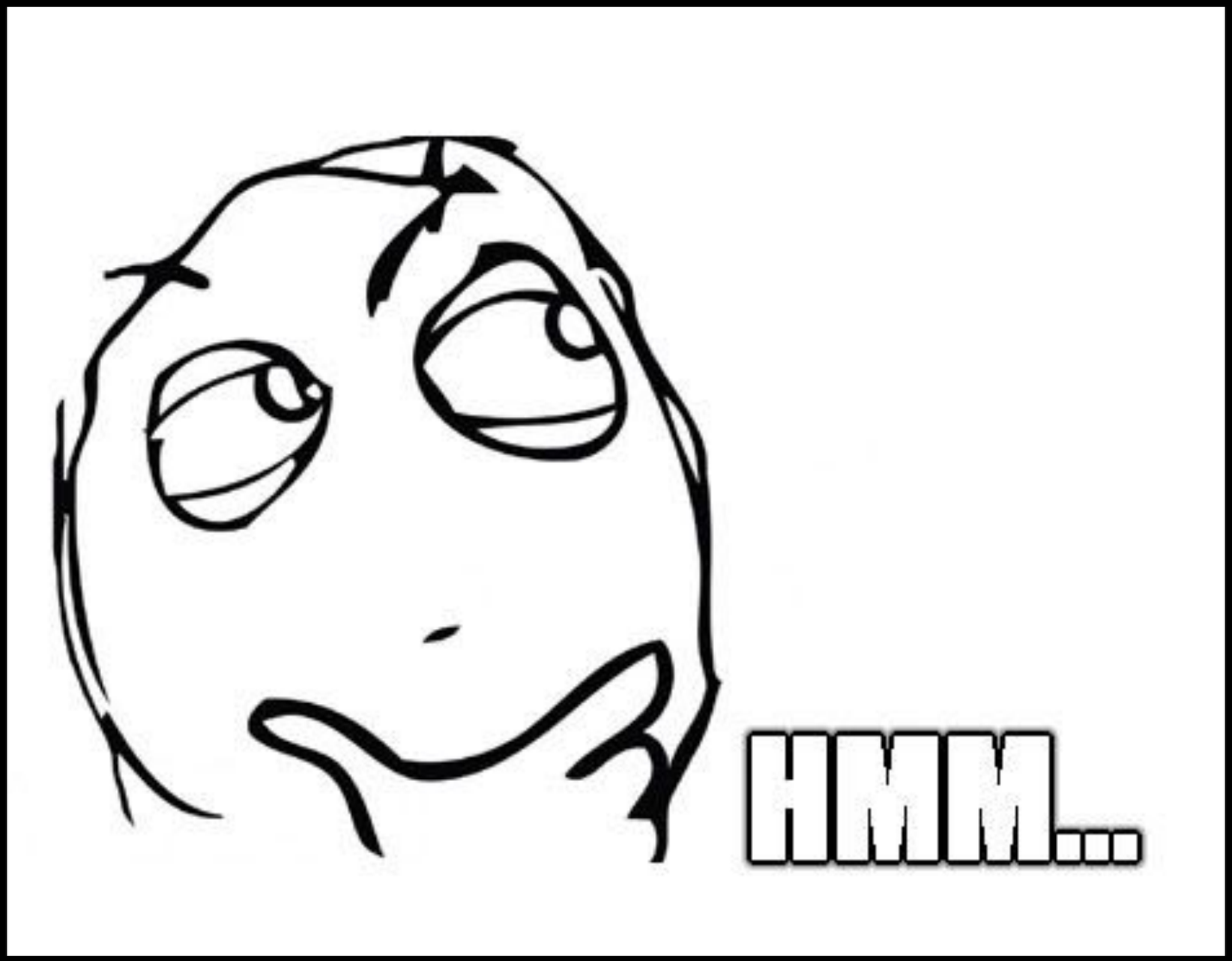
BUFFER



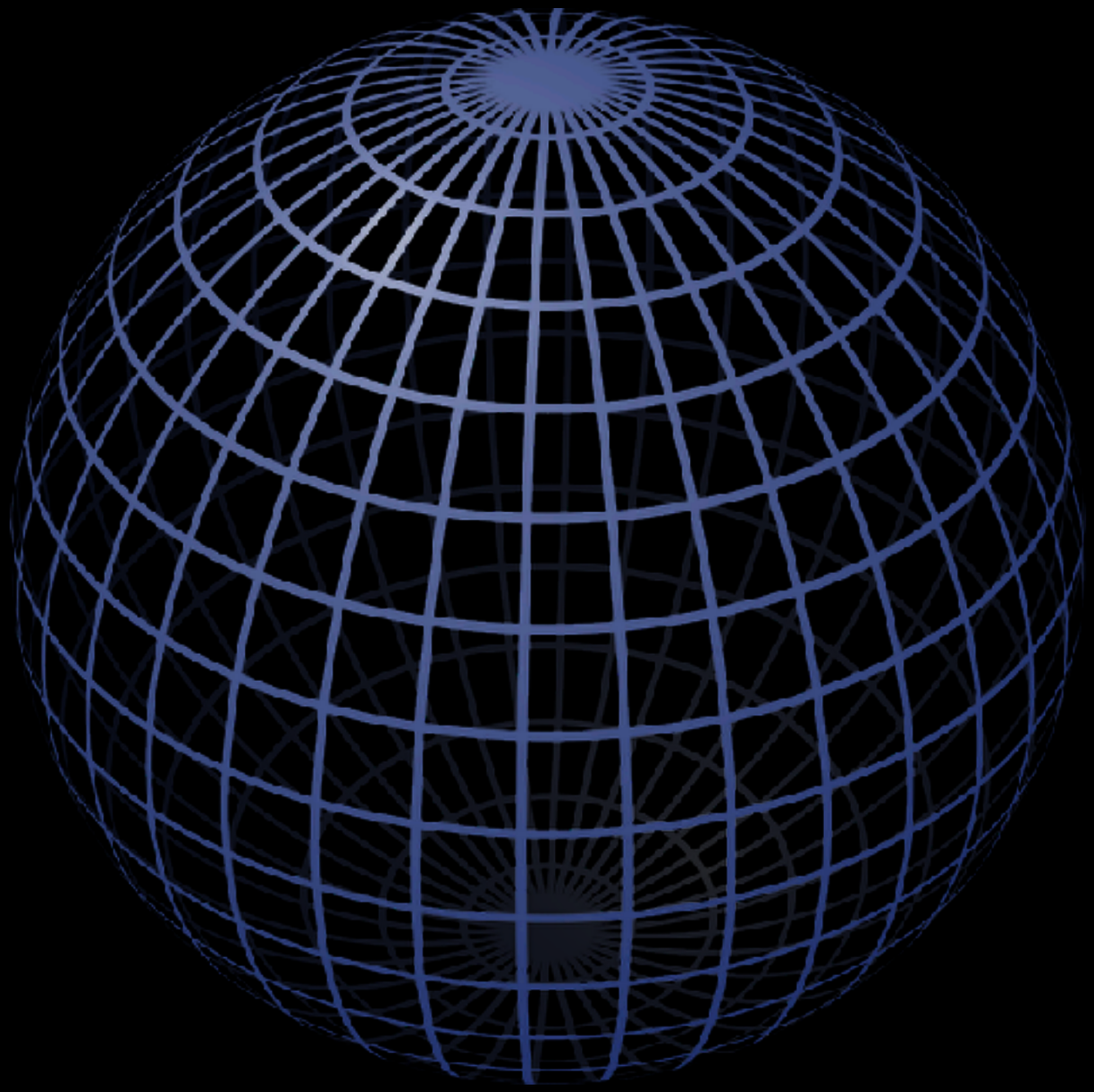
Simple Features

- Simple Features is both an **Open Geospatial Consortium (OGC)** and **International Organization for Standardization (ISO)** standard ISO 19125 that specifies storage and operations of geometries (Point, LineString, …) used by geographic information systems.

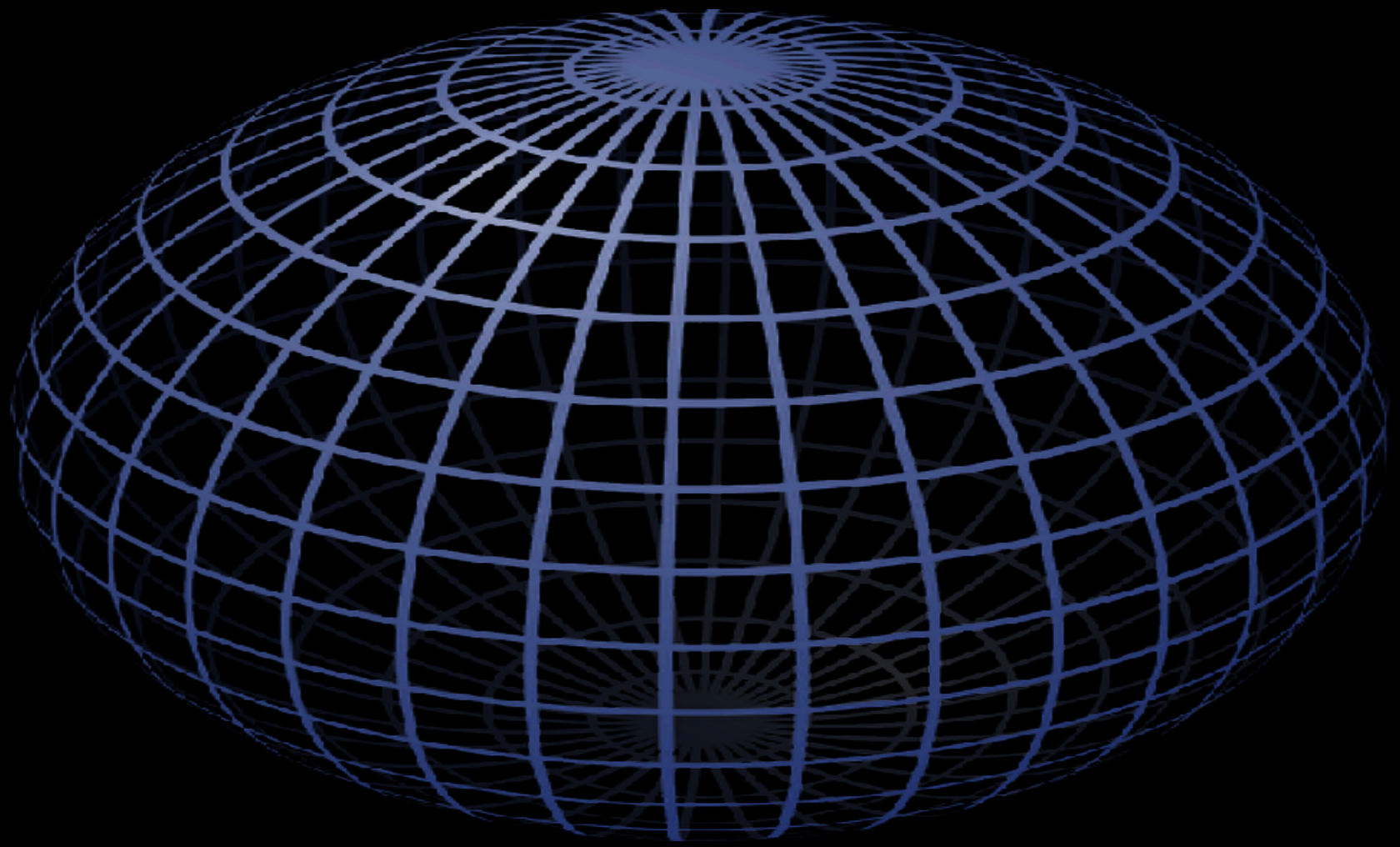
Spatial Reference Systems?



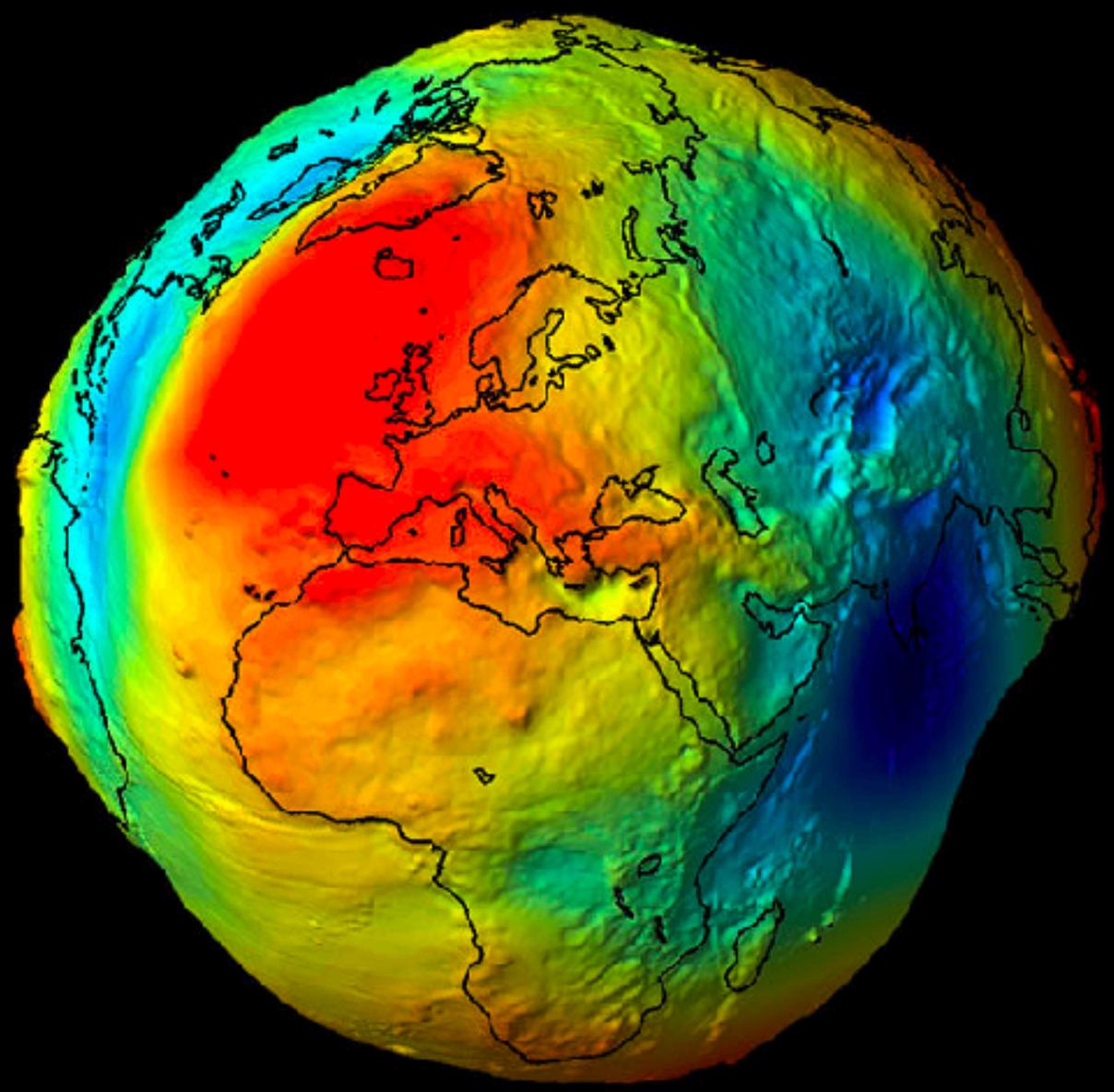
Planet Earth is a sphere?



Planet Earth is an ellipsoidal (spheroid)?

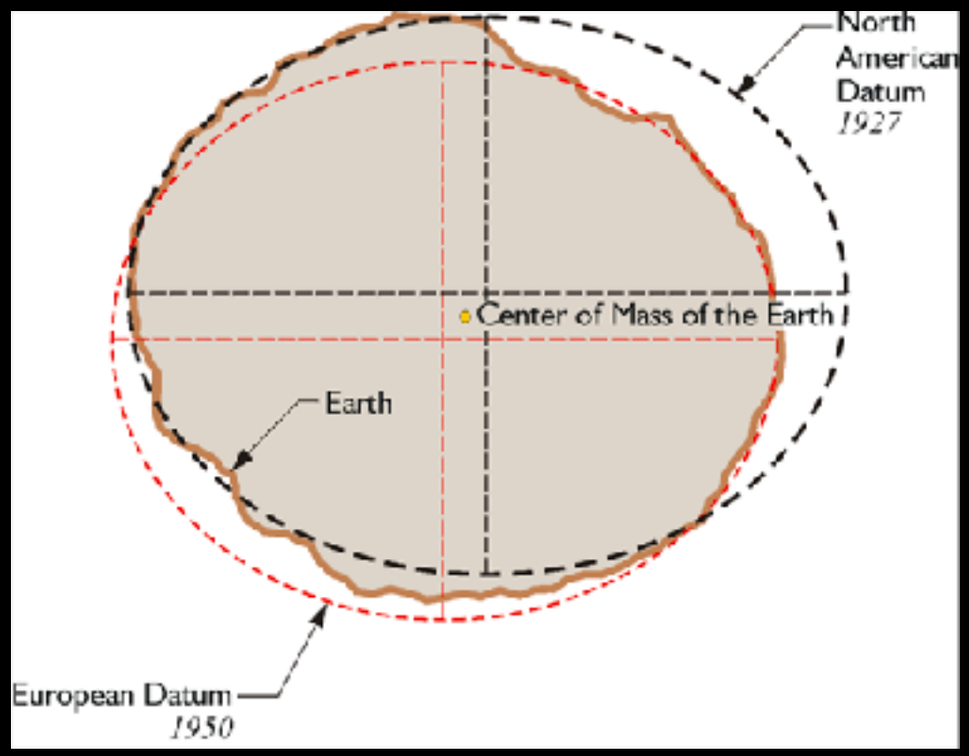


Planet Earth is actually geoid…

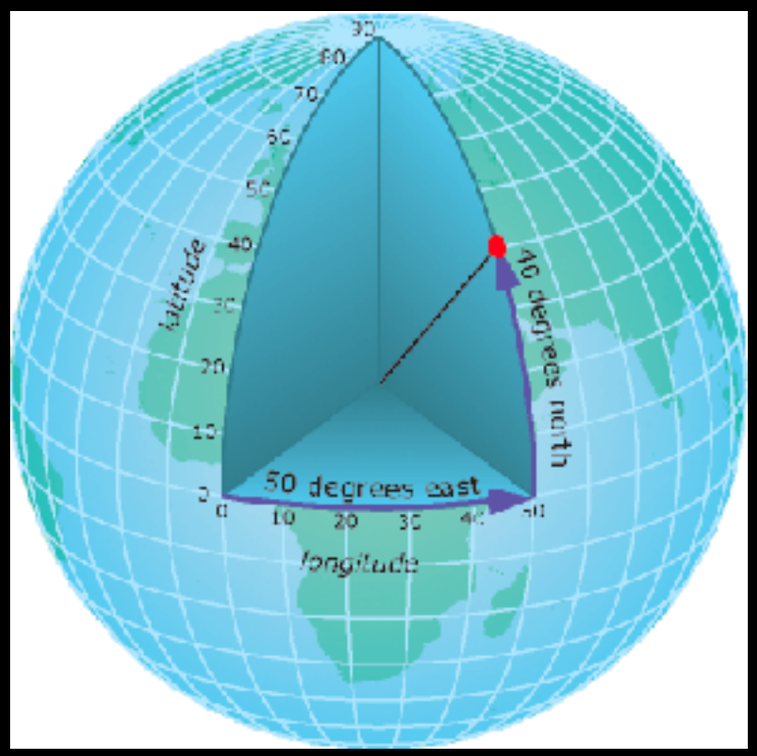


All the previous assertions can be assumed to be “true”, but at different approximation levels

Spatial Reference System



+



Datum

Origin, Scale, Orientation

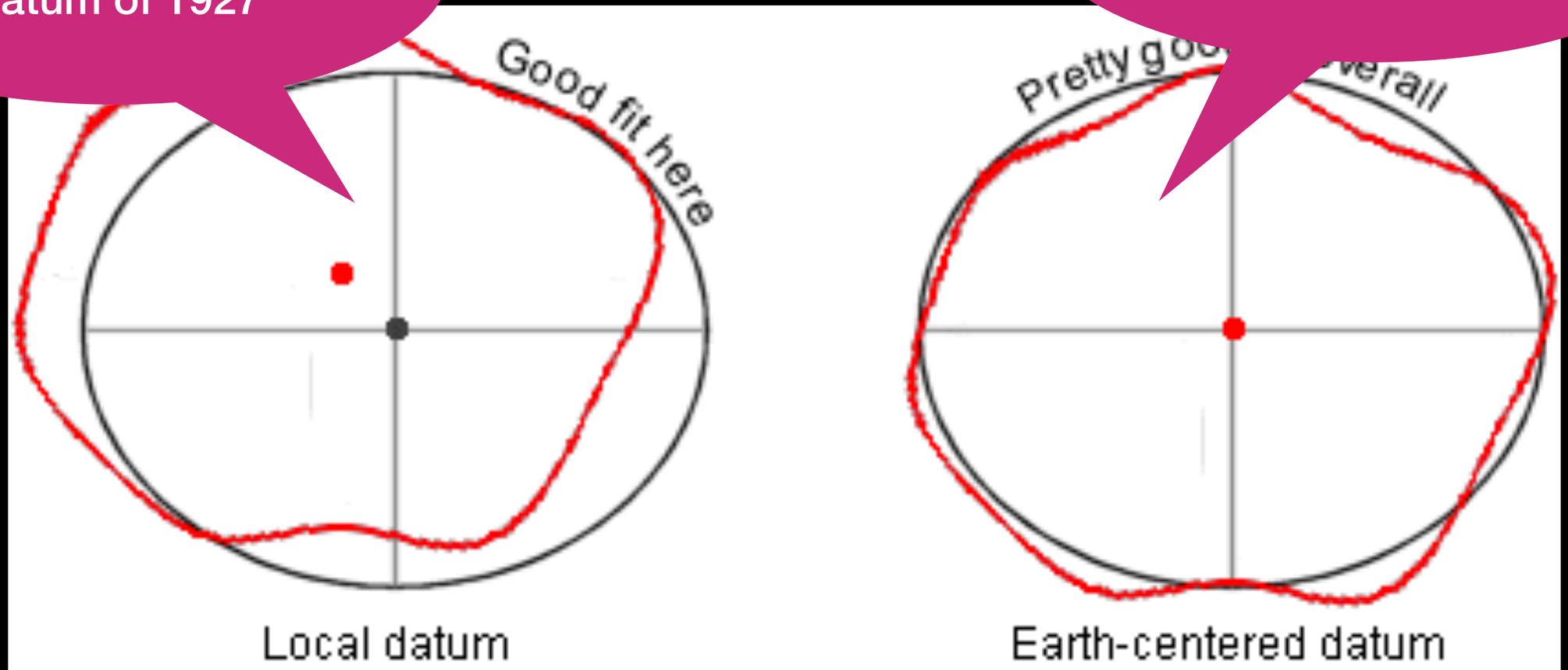
Coordinate System

XY, Angles + Radius

Datum

NAD27 - North American Datum of 1927

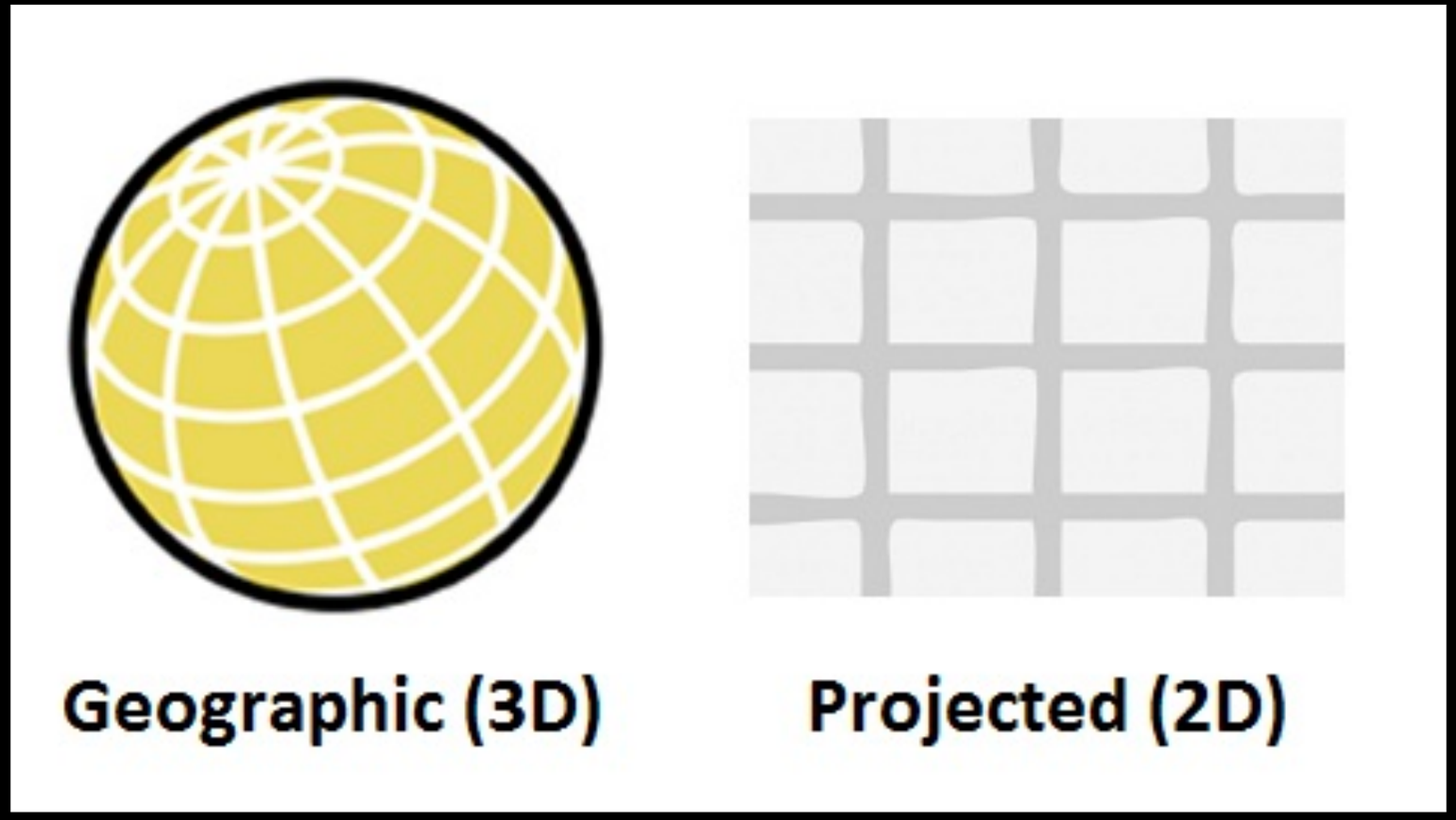
WGS84 - World Geodetic System 1984



A coordinate with an unknown datum is an approximate location at best…

Coordinate System

- Most **Spatial References** fall into two categories, **Geographic** and **Projected**.



Geographic Coordinate Systems

- Any Spatial Reference System based on longitude and latitude coordinates is known as a **Geographic System.**

WGS84 Datum

```
GEOGCS["GCS_WGS_1984",
    DATUM["D_WGS_1984",
        SPHEROID["WGS_1984",6378137,298.257223563]],
    PRIMEM["Greenwich",0],
    UNIT["Degree",0.0174532925199433295]]
```

Geographic Coordinate Systems

- Using a Geographic SRS surely grants you **maximum precision and accuracy**: but unhappily this fatally implies several **undesirable side-effects**:

- **Monitor screens are usually flat**; they don't look at all like a sphere…

- Using **angles makes measuring distances and areas really difficult** and counter-intuitive.

Projected Coordinate Systems

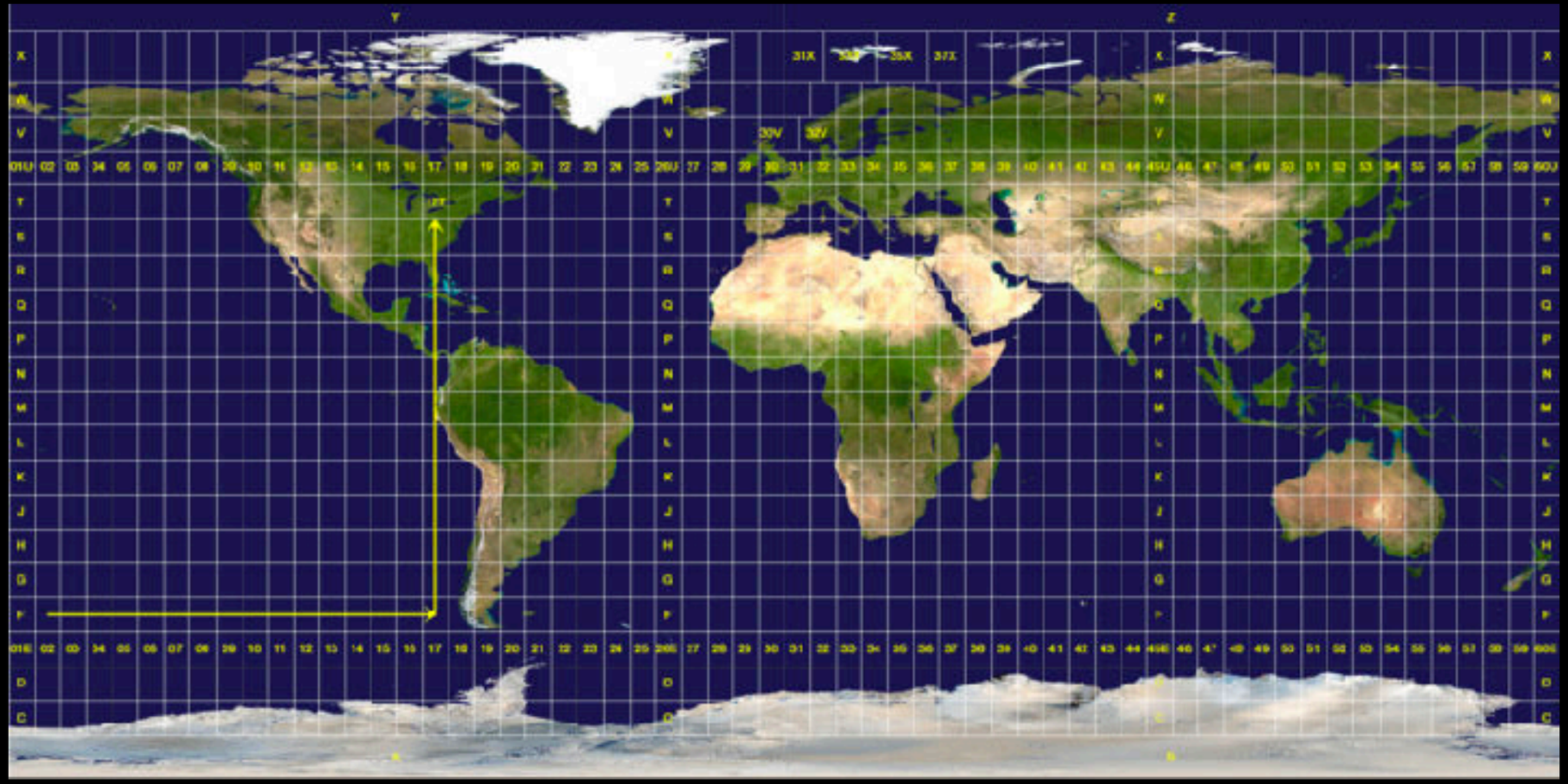
- **Projected coordinate systems** define a flat 2D Cartesian surface.

```
PROJCS["WGS_1984_Web_Mercator_Auxiliary_Sphere",
  GEOGCS["GCS_WGS_1984",
    DATUM["D_WGS_1984",
      SPHEROID["WGS_1984",63
    PRIMEM["Greenwich",0.0],
    UNIT["Degree",0.0174532925199
  PROJECTION["Mercator_Auxiliary_
  PARAMETER["False_Easting",0.0],
  PARAMETER["False_Northing",0.0],
  PARAMETER["Central_Meridian",0.0],
  PARAMETER["Standard_Parallel_1",0.0],
  PARAMETER["Auxiliary_Sphere_Type",0.0],
  UNIT["Meter",1.0]]
```

A projected coordinate system is always based on a geographic coordinate system that references a specific datum.

Projected Coordinate Systems

- All Projected coordinate systems introduce some degree of **approximation and deformation**.



Spatial Reference ID

- An international standard is widely adopted so to make easier correctly handling map Spatial Reference System: the **European Petroleum Survey Group [EPSG]** maintains a huge worldwide dataset of more than 3,700 different entries.

- **Any Spatial DBMS requires some SRID-value to be specified for each Geometry:** but such SRID simply is a Spatial Reference ID, and (hopefully) coincides with the corresponding EPSG ID…

Spatial Reference ID

EPSG SRID	Name	Notes
4326	WGS 84	Geographic [long-lat]; worldwide; used by GPS devices
23032 **23033**	ED50 / UTM zone 32N ED50 / UTM zone 33N	superseded and rarely used: European Datum 1950
32632 **32633**	WGS 84 / UTM zone 32N WGS 84 / UTM zone 33N	WGS84, adopting the planar UTM projection
25832 **25833**	ETRS89 / UTM zone 32N ETRS89 / UTM zone 33N	enhanced evolution of WGS84: official EU standard

How Spatial Reference Systems affects distances?

SRID		Distance
4326	WGS 84	4.857422 degrees
23032		477243.796305 meters
4326 **Great Circle**		477109.583358 meters
4326 **Geodesic**		477245.299993 meters

Measure corresponding to an *angle* expressed in **decimal degrees**, *not so useful…*

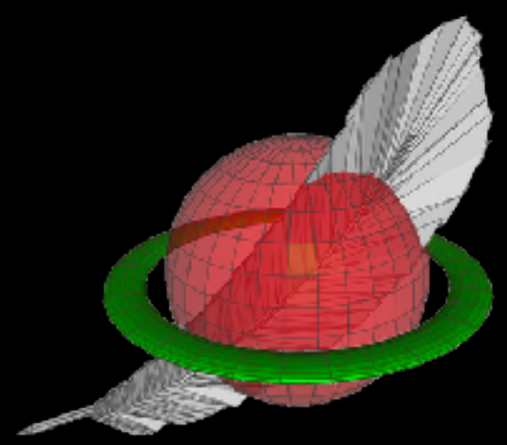
Assuming that the Earth is exactly a sphere: and this one obviously is the worst estimate we can get

Geodesic distances are directly calculated on the reference Ellipsoid

SpatiaLite

- SpatiaLite is an open source library intended to **extend the SQLite core** to support fully fledged **Spatial SQL capabilities**.

- SpatiaLite is developed and maintained by **Alessandro Furieri**.




NOW
LET'S CODE!
memegenerator.net

Run the Environment

```
cd /home/mbition/PycharmProjects/geospatial

source venv/bin/activate

jupyter notebook
```