Working with Geospatial Data

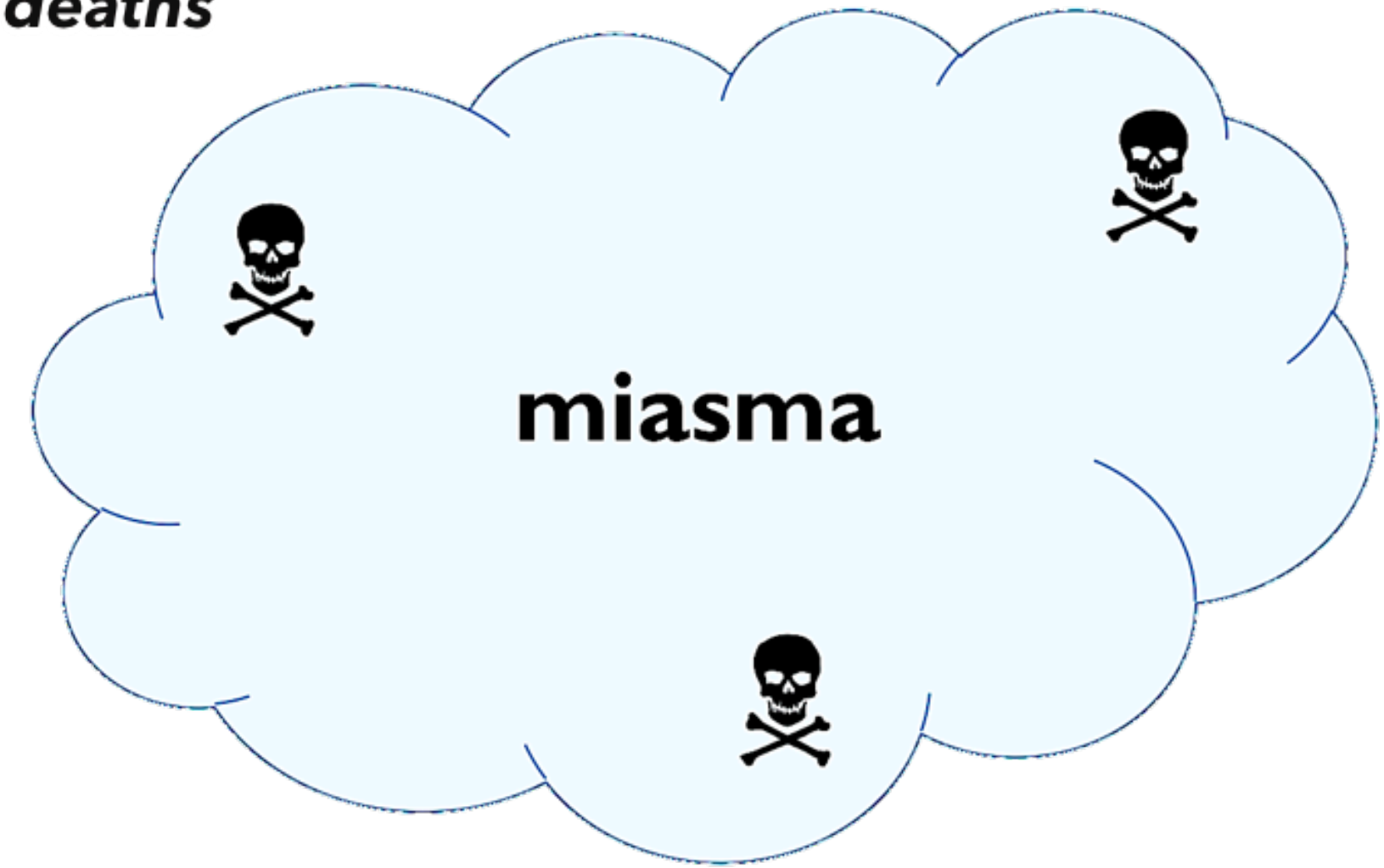
Concepts:

1. Location
2. GeoDataFrames
3. Geometry
4. Coordinate Reference Systems
5. Spatial Joins
6. Adding context with a street map

Why does an Analysis of Location Matter?

first, a bit of history….

- ***London cholera epidemic - 1854***
- ***600+ deaths***



John Snow

MARLBOROUGH STREET
POLAND STREET
D'ARBLAY ST
BERWICK STREET
WARDOUR STREET
DEAN STREET
Soho
Carnaby
KINGLY STREET
BEAK STREET
BROADWICK STREET
LEXINGTON STREET
HOPKINS ST
PETER ST
GREAT PULTENEY STREET
BRIDLE LANE
GOLDEN
REGENT
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Some Use Cases for Geospatial Data Analysis:

- Marketing and Sales (demographics and customer segmentation)
- Transportation and Logistics (Route optimization)
- Sociological (crime tracking)
- Epidemiology (Disease risk factors)

GeoDataFrames

- Inherit many of the methods and attributes of pandas DataFrames
- Implemented by GeoPandas (https://geopandas.org/)
- Have two additional requirements:
  - A geometry column
  - A CRS (coordinate reference system) attribute

- Have useful methods and attributes
  - .area()
  - .centroid

3 basic types of geometry

Coordinate Reference Systems

What type of projection?
What unit of measurement ? Degrees? Meters?

WHAT YOUR FAVORITE MAP PROJECTION SAYS ABOUT YOU

MERCATOR

YOU'RE NOT REALLY INTO MAPS.

VAN DER GRINTEN

YOU'RE NOT A COMPLICATED PERSON. YOU LOVE THE MERCATOR PROJECTION; YOU JUST WISH IT WEREN'T SQUARE. THE EARTH'S NOT A SQUARE, IT'S A CIRCLE. YOU LIKE CIRCLES. TODAY IS GONNA BE A GOOD DAY!

HOBO-DYER

YOU WANT TO AVOID CULTURAL IMPERIALISM, BUT YOU'VE HEARD BAD THINGS ABOUT GALL-PETERS. YOU'RE CONFLICT-AVERSE AND BUY ORGANIC. YOU USE A RECENTLY-INVENTED SET OF GENDER-NEUTRAL PRONOUNS AND THINK THAT WHAT THE WORLD NEEDS IS A REVOLUTION IN CONSCIOUSNESS.

PLATE CARRÉE (EQUIRECTANGULAR)

YOU THINK THIS ONE IS FINE. YOU LIKE HOW X AND Y MAP TO LATITUDE AND LONGITUDE. THE OTHER PROJECTIONS OVERCOMPLICATE THINGS. YOU WANT ME TO STOP ASKING ABOUT MAPS SO YOU CAN ENJOY DINNER.

ROBINSON

YOU HAVE A COMFORTABLE PAIR OF RUNNING SHOES THAT YOU WEAR EVERYWHERE. YOU LIKE COFFEE AND ENJOY THE BEATLES. YOU THINK THE ROBINSON IS THE BEST-LOOKING PROJECTION, HANDS DOWN.

DYMAXION

YOU LIKE ISAAC ASIMOV, XML, AND SHOES WITH TOES. YOU THINK THE SEGWAY GOT A BAD RAP. YOU OWN 3D GOGGLES, WHICH YOU USE TO VIEW ROTATING MODELS OF BETTER 3D GOGGLES. YOU TYPE IN DVORAK.

A GLOBE!

YES, YOU'RE VERY CLEVER.

WATERMAN BUTTERFLY

REALLY? YOU KNOW THE WATERMAN? HAVE YOU SEEN THE 1909 CHILL MAP IT'S BASED— ...YOU HAVE A FRAMED REPRODUCTION AT HOME?! WHOA. ...LISTEN, FORGET THESE QUESTIONS. ARE YOU DOING ANYTHING TONIGHT?

WINKEL-TRIPEL

NATIONAL GEOGRAPHIC ADOPTED THE WINKEL-TRIPEL IN 1998, BUT YOU'VE BEEN A WT FAN SINCE *LONG* BEFORE "NATGEO" SHOWED UP. YOU'RE WORRIED IT'S GETTING PLAYED OUT, AND ARE THINKING OF SWITCHING TO THE KAVRAYSKIY. YOU ONCE LEFT A PARTY IN DISGUST WHEN A GUEST SHOWED UP WEARING SHOES WITH TOES. YOUR FAVORITE MUSICAL GENRE IS "POST-".

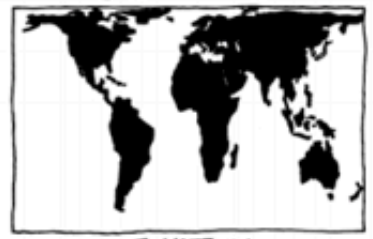
GOODE HOMOLOSINE

THEY SAY MAPPING THE EARTH ON A 2D SURFACE IS LIKE FLATTENING AN ORANGE PEEL, WHICH SEEMS EASY ENOUGH TO YOU. YOU LIKE EASY SOLUTIONS. YOU THINK WE WOULDN'T HAVE SO MANY PROBLEMS IF WE'D JUST ELECT *NORMAL* PEOPLE TO CONGRESS INSTEAD OF POLITICIANS. YOU THINK AIRLINES SHOULD JUST BUY FOOD FROM THE RESTAURANTS NEAR THE GATES AND SERVE *THAT* ON BOARD. YOU CHANGE YOUR CAR'S OIL, BUT SECRETLY WONDER IF YOU REALLY *NEED* TO.

PEIRCE QUINCUNCIAL

YOU THINK THAT WHEN WE LOOK AT A MAP, WHAT WE REALLY SEE IS OURSELVES. PETER, YOU FIRST SAW *INCEPTION*, YOU SAT SILENT IN THE THEATER FOR SIX HOURS. IT FREAKS YOU OUT TO REALIZE THAT EVERYONE AROUND YOU HAS A SKELETON INSIDE THEM. YOU *HAVE* REALLY LOOKED AT YOUR HANDS.

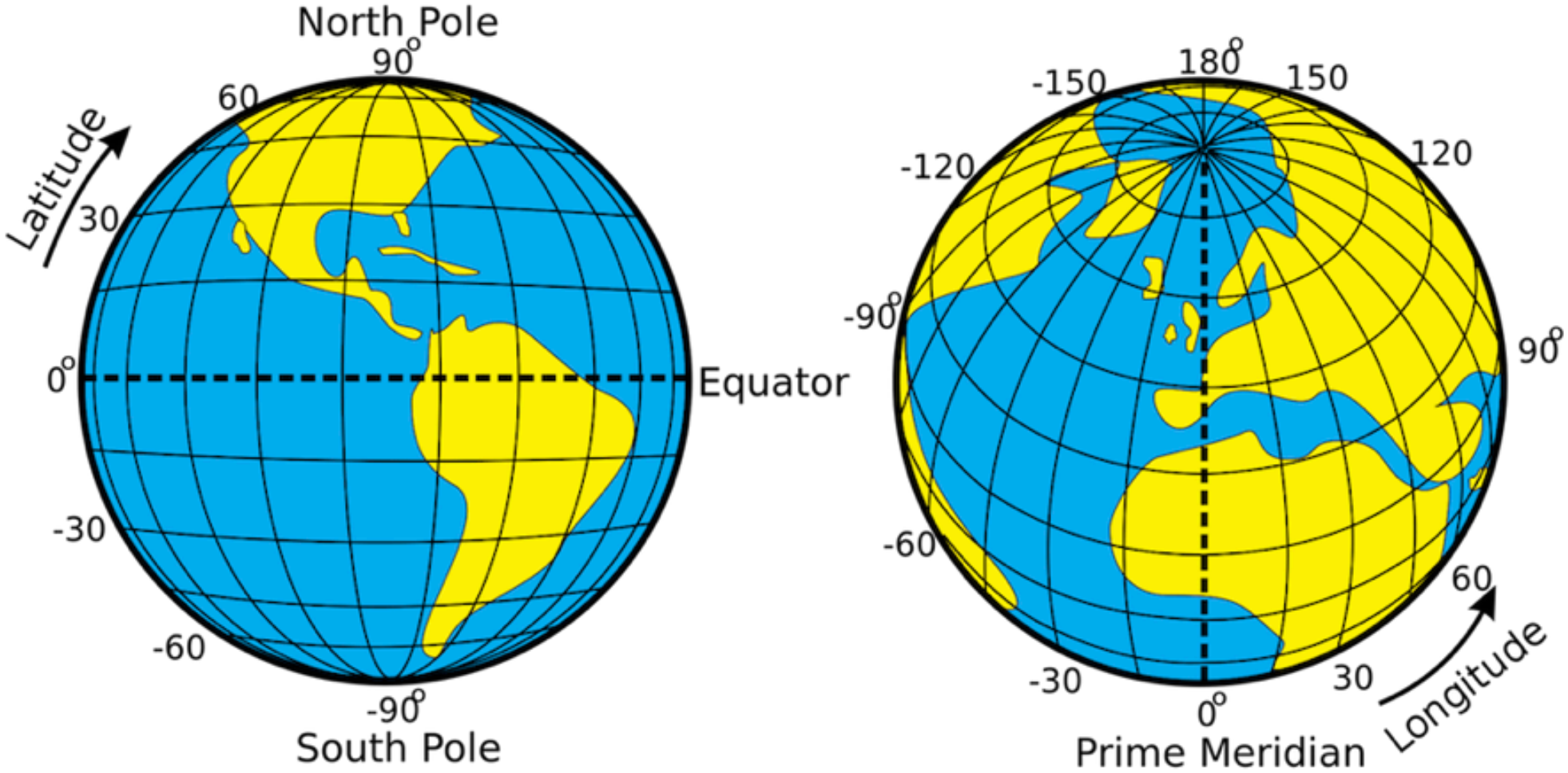
GALL-PETERS



I *HATE* YOU.

What's that? You think I don't like the Peters map because I'm uncomfortable with having my cultural assumptions challenged? Are you sure you're not...
::puts on sunglasses:: ... ***projecting?***

http://xkcd.com/977/ - http://bit.ly/explainxkcd-977



Projection

- ***Web Mercator/WGS 84***

Coordinate Reference System (use the WGS 84 projection)

- ***Google Maps - EPSG:3857***
- ***Google Earth - EPSG:4326***

There are different ways the projection string for a CRS may be stored in a geospatial dataset. The init proj4 string may need to be changed if your GeoDataFrame has init in the CRS.

https://geopandas.org/projections.html

Manually specifying the CRS

When specifying the CRS manually in your code (e.g., because your data has not yet a CRS, or when converting to another CRS), this might require a change in your code.

"init" proj4 strings/dicts

Currently, a lot of people (and also the GeoPandas docs showed that before) specify the EPSG code using the "init" proj4 string:

```
## OLD
GeoDataFrame(..., crs={'init': 'epsg:4326'})
# or
gdf.crs = {'init': 'epsg:4326'}
# or
gdf.to_crs({'init': 'epsg:4326'})
```

The above will now raise a deprecation warning from pyproj, and instead of the "init" proj4 string, you should use only the EPSG code itself as follows:

```
## NEW
GeoDataFrame(..., crs="EPSG:4326")
# or
gdf.crs = "EPSG:4326"
# or
gdf.to_crs("EPSG:4326")
```

Geojson is one type of geospatial data. Here is the result of

- reading in a geojson file of Nashville neighborhoods using the geopandas read_file() method,
- printing the crs, and
- looking at the first 5 rows with the .head() method.

In [3]:
```
neighborhoods = gpd.read_file('./data/Neighborhood Association Boundaries (GIS).geojson')
print(neighborhoods.crs)
neighborhoods.head( )
```

```
{'init': 'epsg:4326'}
```

Out[3]:

	name	geometry
0	Historic Buena Vista	(POLYGON ((-86.79511056795417 36.1757596496334...
1	Charlotte Park	(POLYGON ((-86.87459668651866 36.1575770268129...
2	Hillwood	(POLYGON ((-86.87613708067906 36.1355409894979...
3	West Meade	(POLYGON ((-86.9038380396094 36.1255414807897,...
4	White Bridge	(POLYGON ((-86.86321427797685 36.1288622289404...

Spatial Joins

Join two geodataframes to find (for example):

- Points within polygons
- Overlap between polygons
- More!

gpd.sjoin(gdfA, gdfB, op = 'within)

op (stands for operation)

- *within*
- *intersects*
- *contains*

by (which type of join)

- *inner (the default)*
- *left*
- *right*

Adding Context with a Street Map

Folium

- python package built on the leaflet javascript library
- create interactive maps
- markers and marker clusters
- easy to customize popups

Folium

- Python package built on the leaflet javascript library
- Create interactive maps with markers and marker clusters, choropleths
- Add easy to customize popups
- Save your interactive maps as HTML

To find geospatial data on data.Nashville.gov, search for GIS