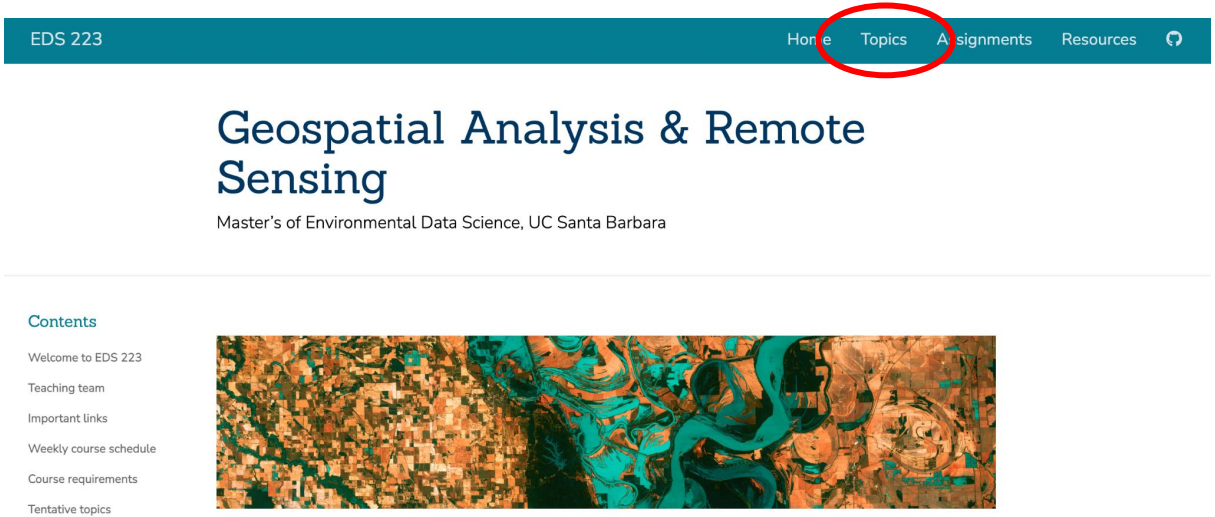
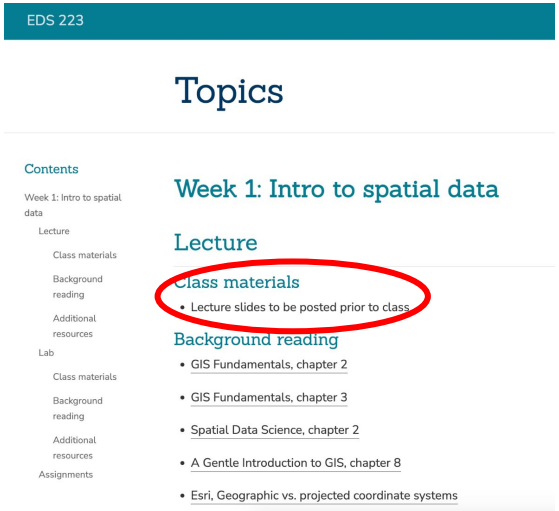
EDS 223: Geospatial Analysis & Remote Sensing

USGS via Unsplash

Course website

https://ryoliver.github.io/EDS_223_spatial_analysis/





Welcome!

- Introductions

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- Course logistics + overview

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- Models of our world

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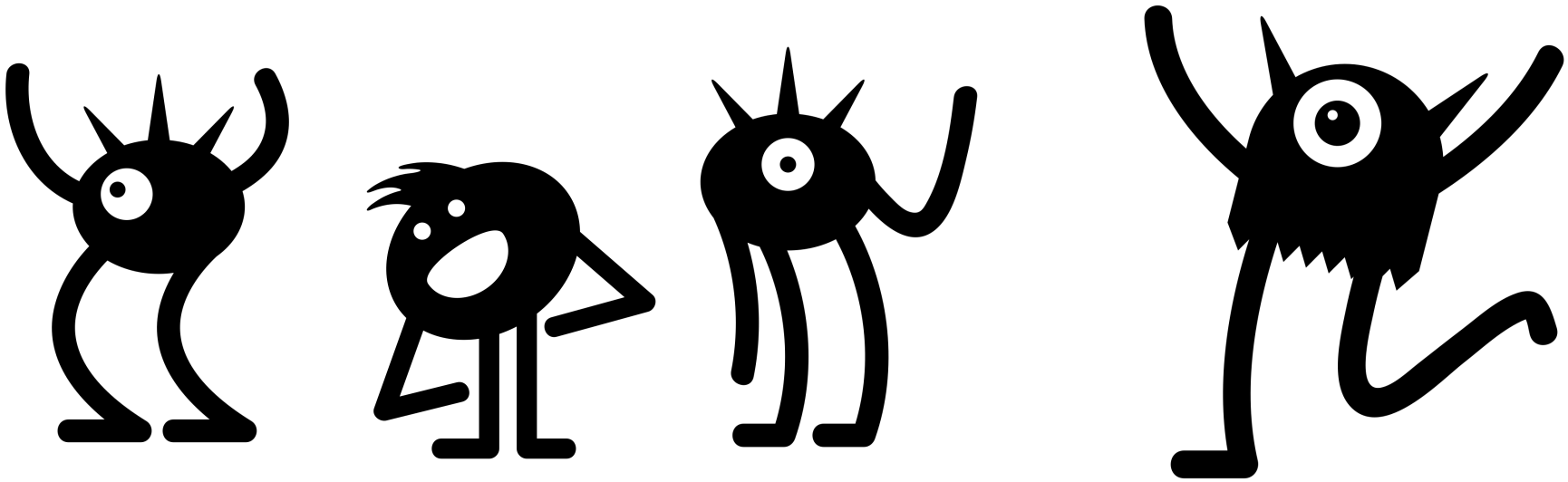
- Models of our world
- Map making in R

Instruction team

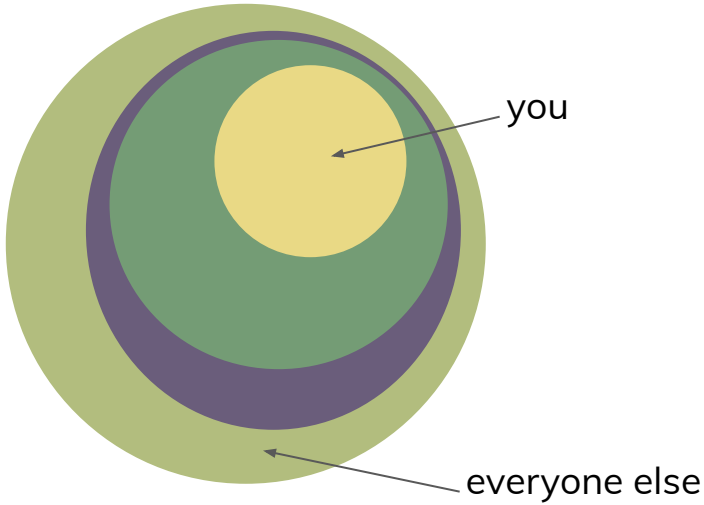
- **Ruth Oliver**
  - Email: rutholiver@bren.ucsb.edu
  - Office: Bren Hall 4512
  - Student hours: Friday 3-4 @ Bren
  - Contact me via: email
- **Allie Caughman**
  - Email: acaughman@bren.ucsb.edu
  - Student hours: Tuesday 12:30-1:30 @Bren
  - Contact me via: email

Introductions

- Name
- Pronouns
- Program



Growth mindset



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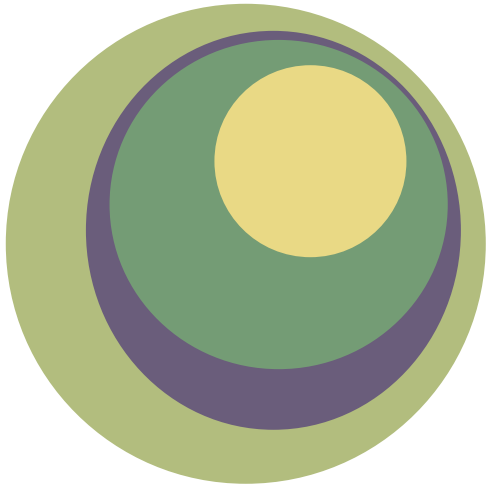

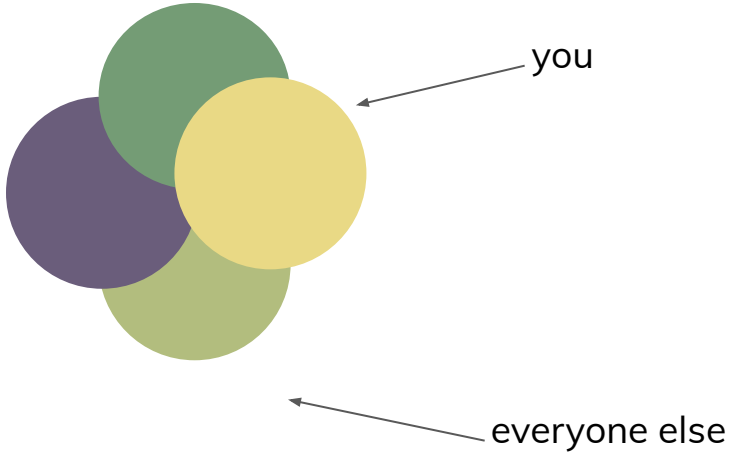

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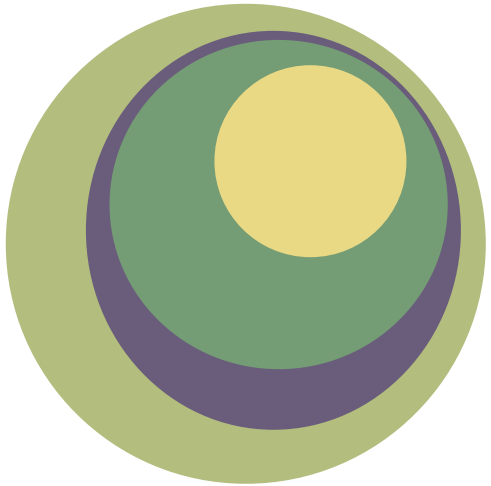
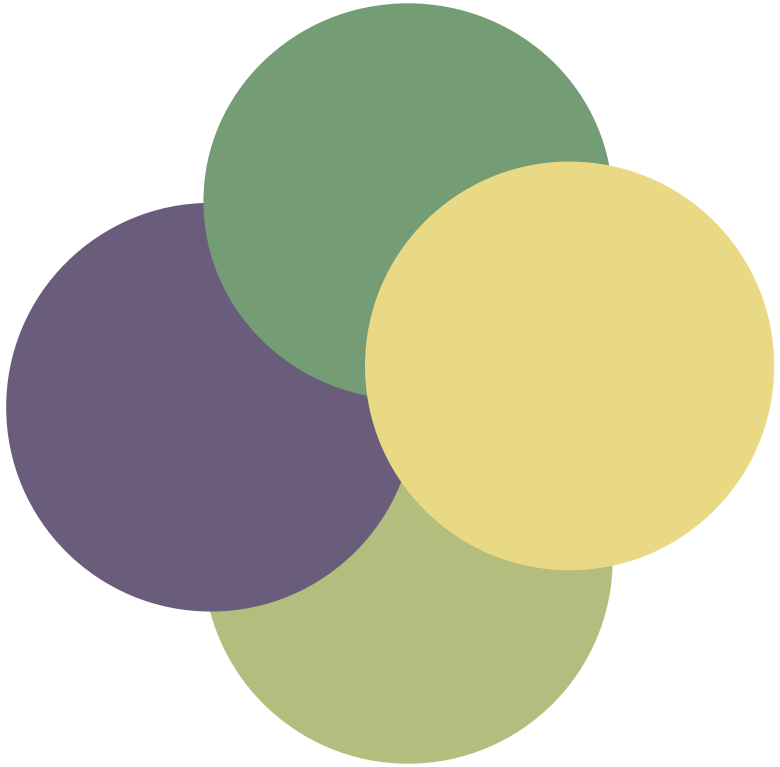




Typos are the pedagogy.

- Emily Jane McTavish

Course logistics

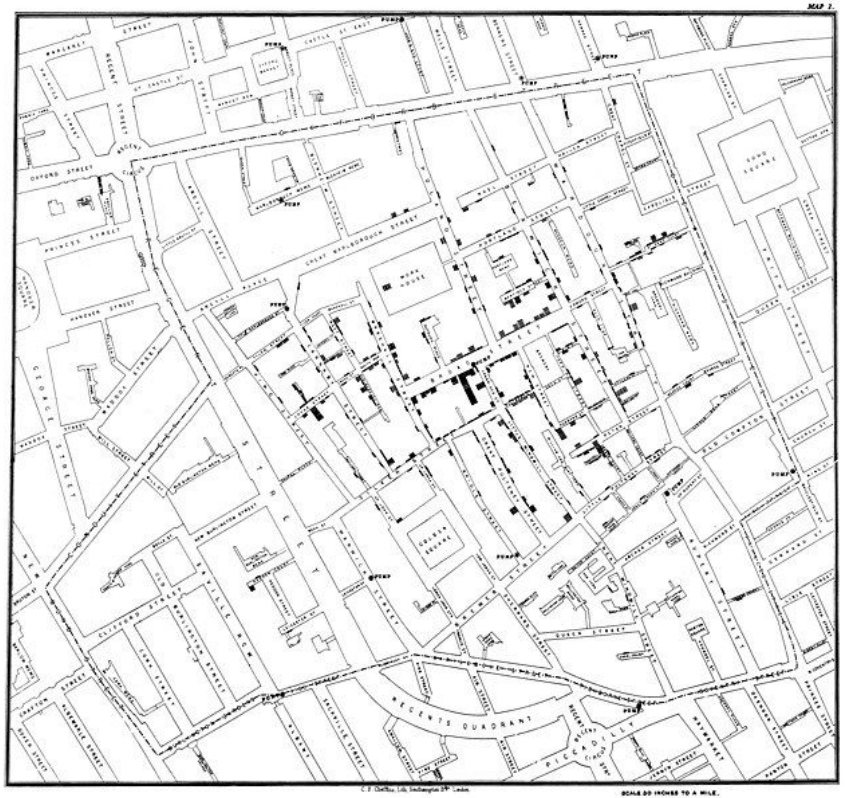
ryoliver.github.io/EDS_223_spatial_analysis

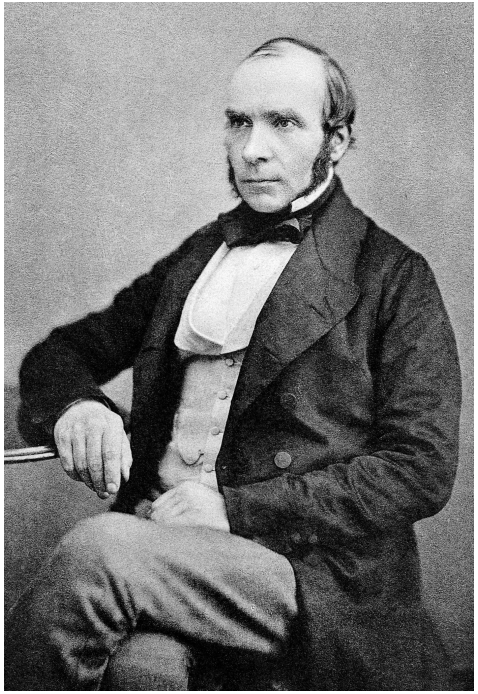
Why spatial?

Everything is related to everything else, but near things are more.

- Waldo Tobler

We live in space, and so does everything else





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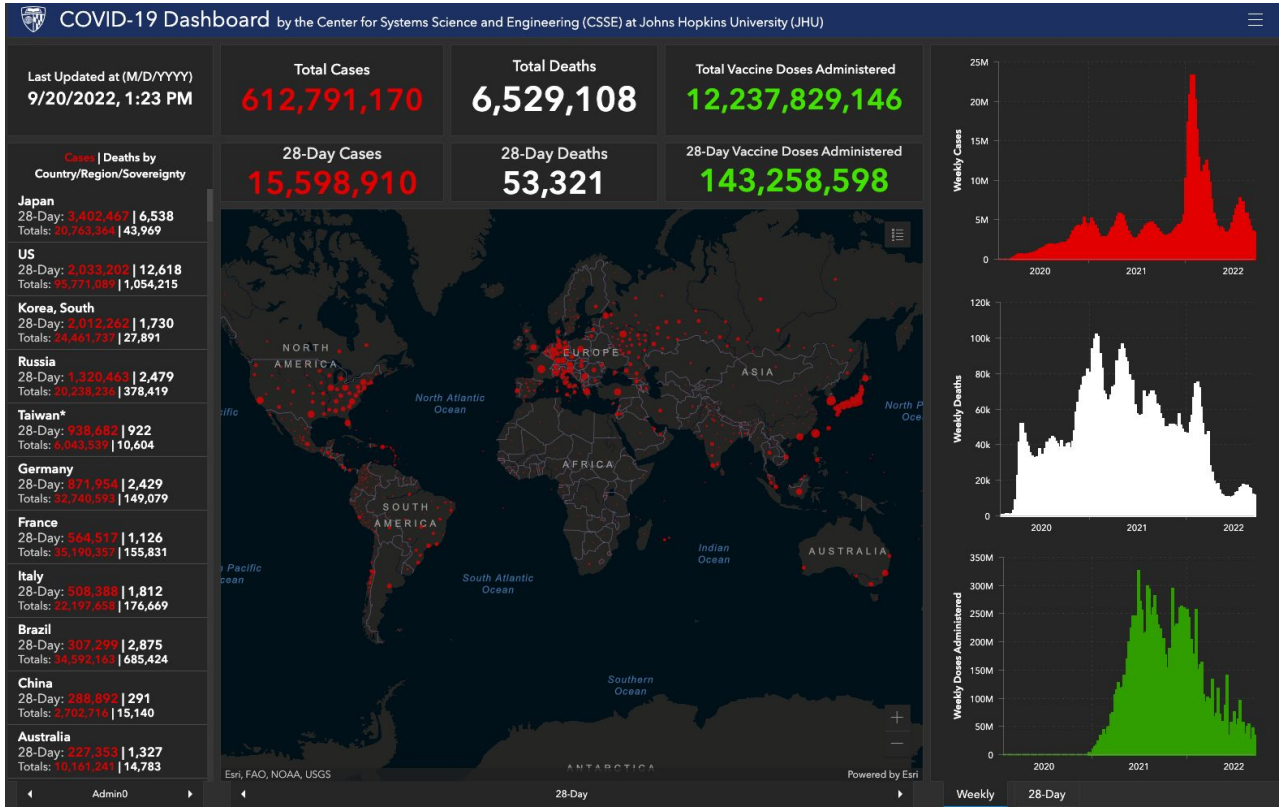


Our approach

(very, very) Brief intro to remote sensing

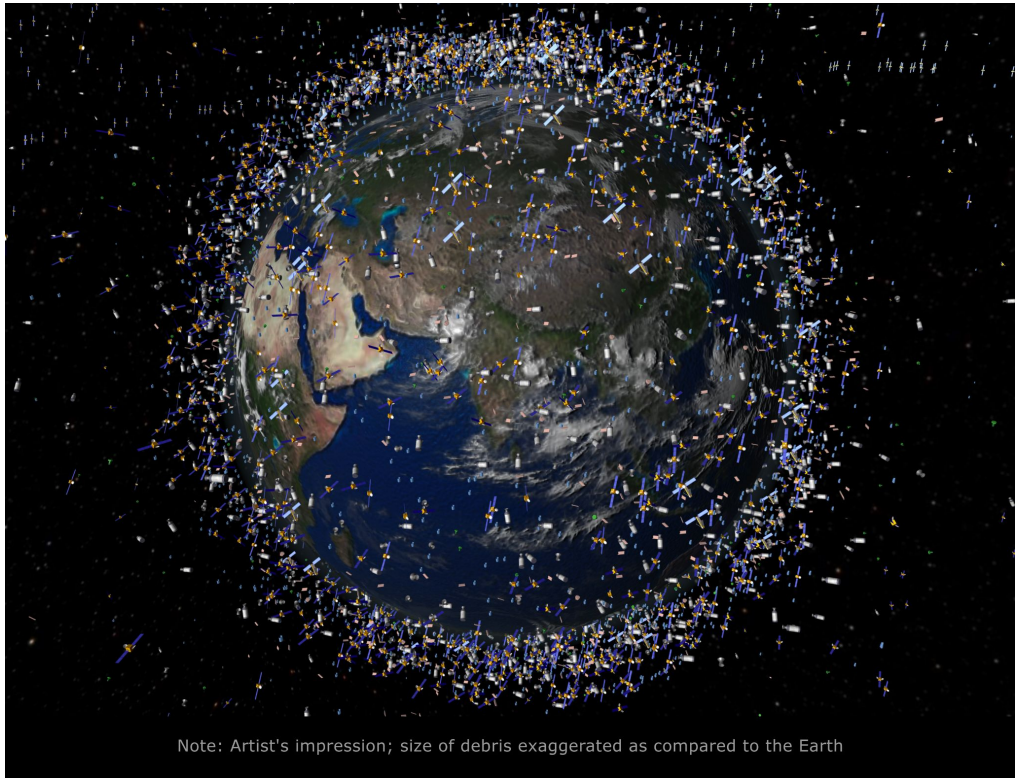
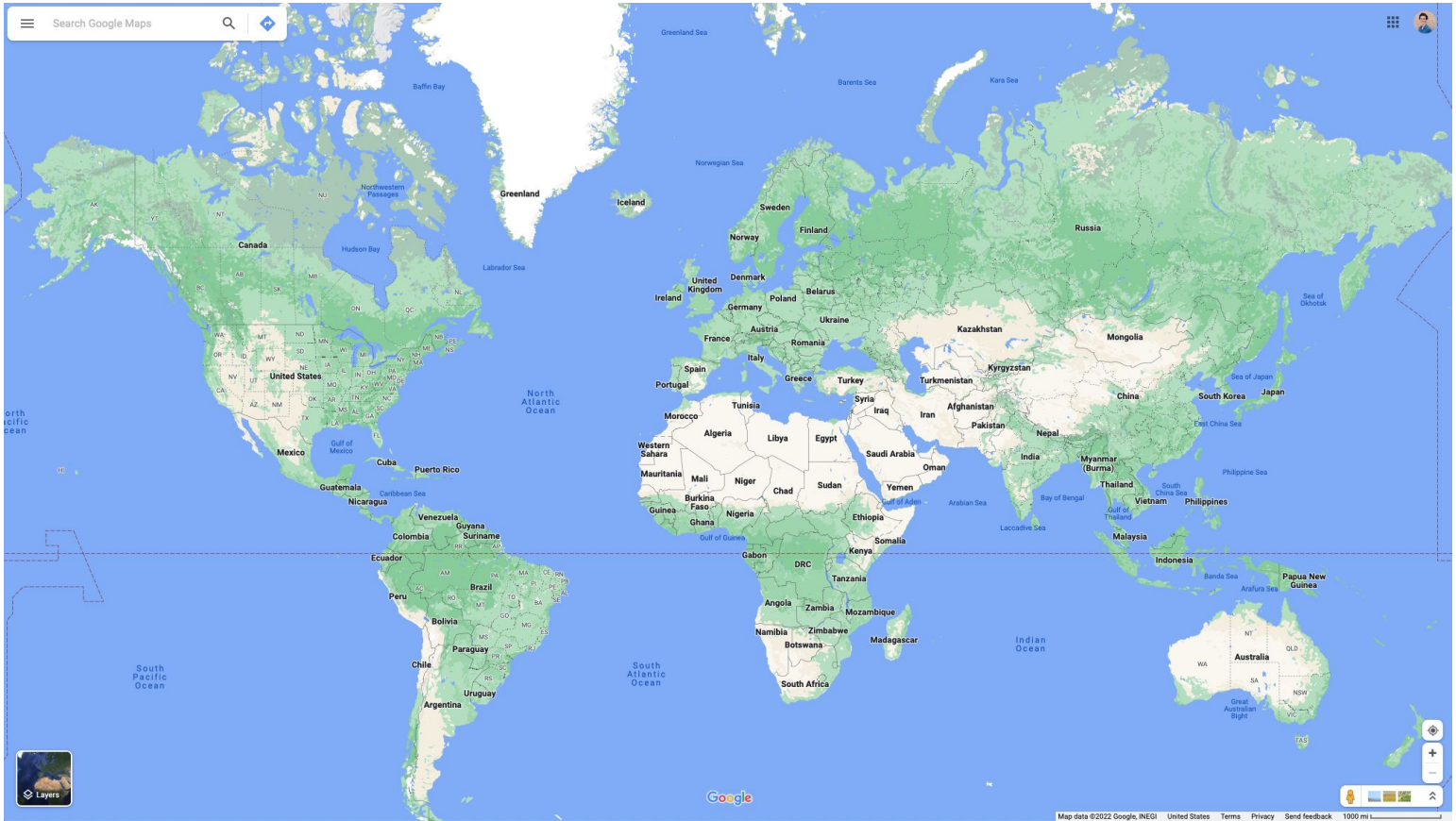


Photo credit: ESA

Models of our world

Photo credit: Wikipedia

Models of our world



A non-historian’s brief history of North

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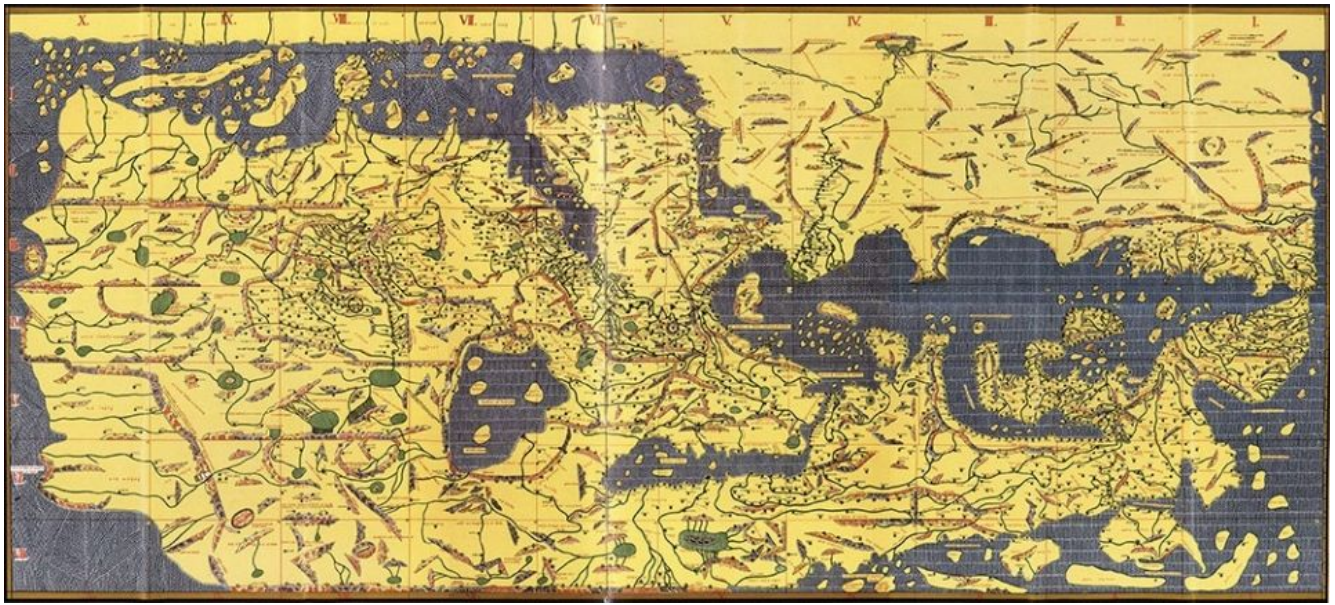
Recreation of Moroccan cartographer's Muhammad al-Idrisi's Tabula Rogeriana (1154)



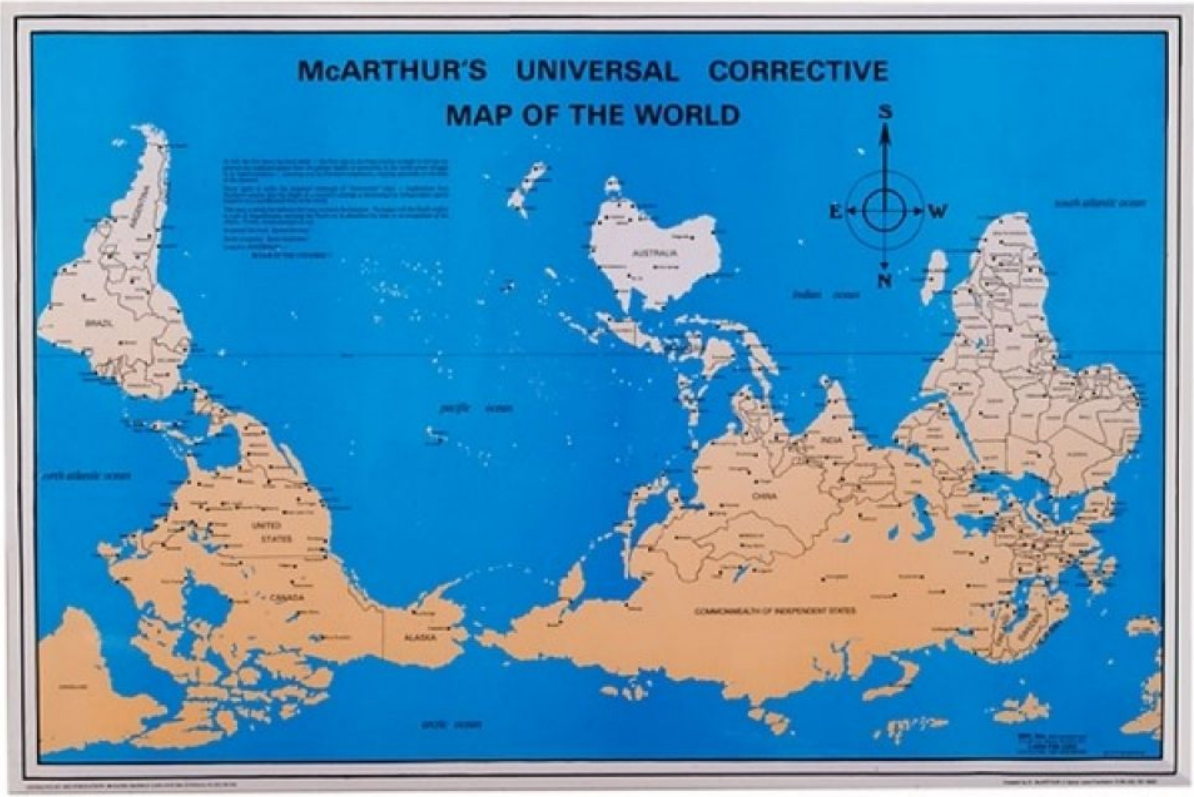
Source: Bibliotheque nationale de France/Wikipedia

A non-historian's brief history of North

Recreation of map (1407) based on the work of Ptolemy (c. 100-178)

Source: The British Library Board/Getty Images

A non-historian's brief history of North



Source: Flickr

We need a system!

4 (main) challenges to spatial analysis

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1. **We perceive geography in two dimensions, but live in three**

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- Coordinate system
- Datum
- Geodetic datum

Coordinate reference system

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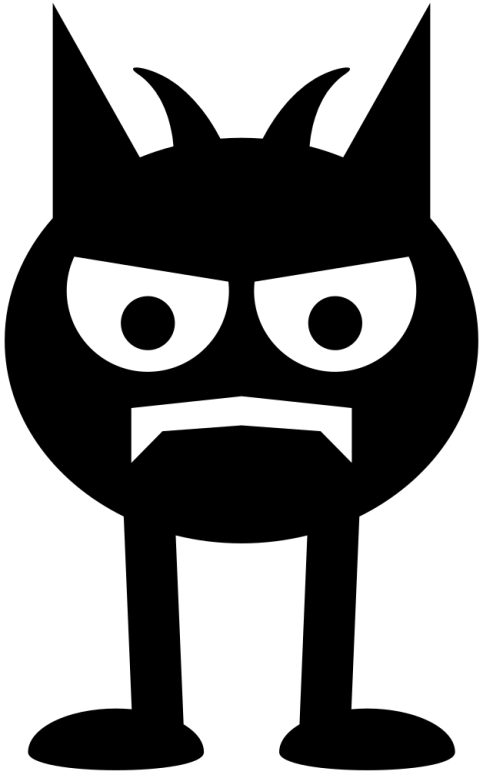

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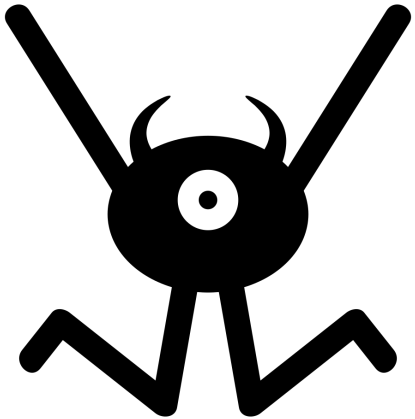

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- **A set of mathematical rules for specifying how coordinates are to be assigned to points** (Lott 2015)

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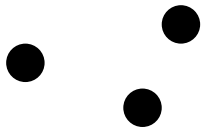

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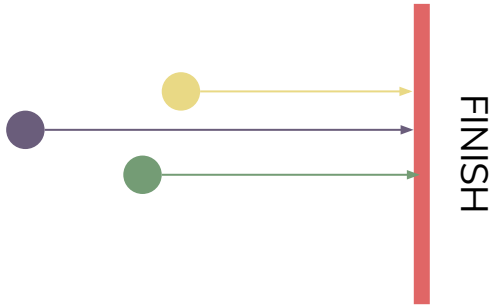

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Coordinate systems

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  - Define points as a pair of numbers that specify signed distances from coordinate axes

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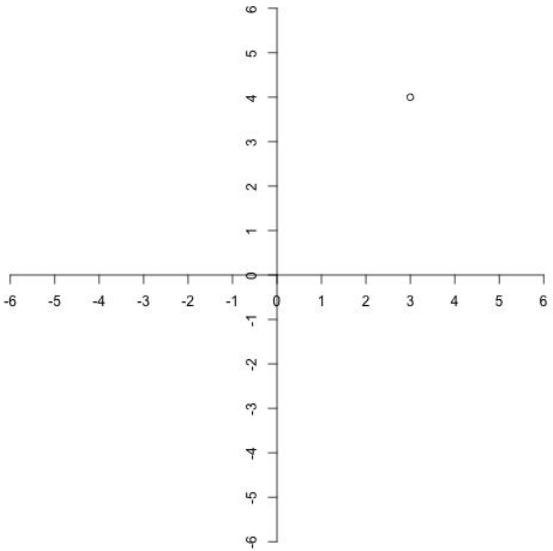

Modified from: Spatial Data Science, chapter 2

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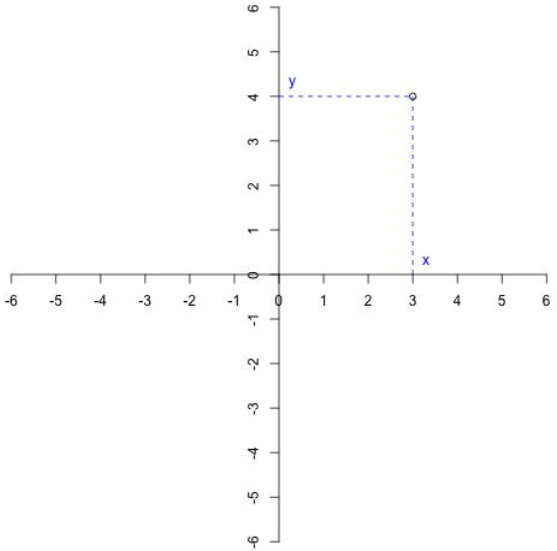

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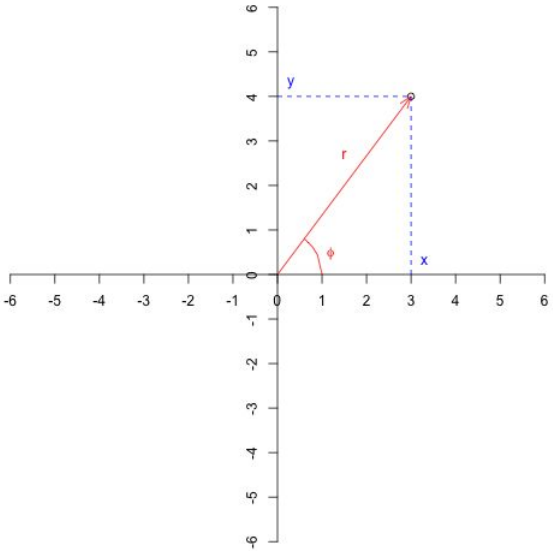

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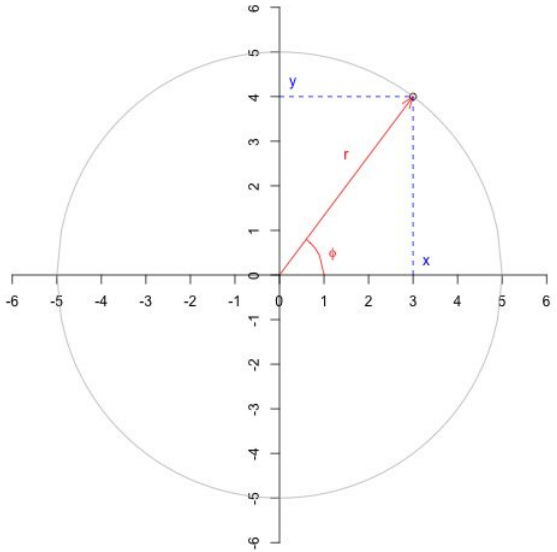

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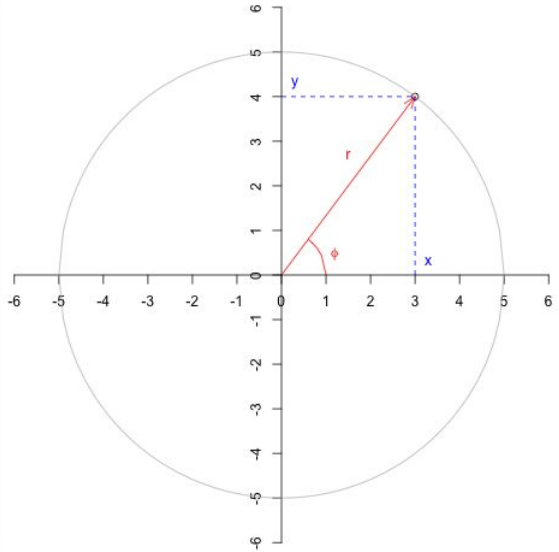

$$x = r\cos\phi$$
$$y = r\sin\phi$$

$$r = \sqrt{(x^2 + y^2)}$$
$$\phi = \arctan(y,x)$$

Modified from: Spatial Data Science, chapter 2

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    - **What do we need to update?**

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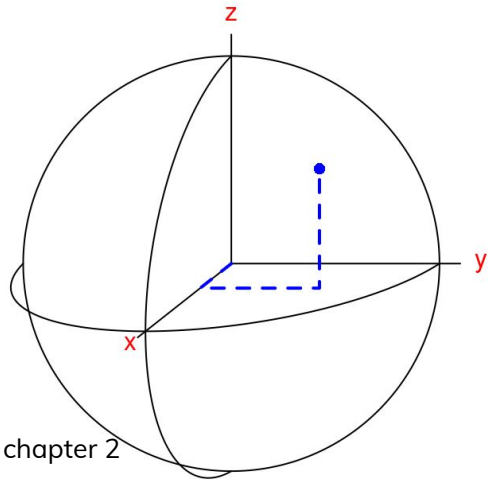

Modified from: Spatial Data Science, chapter 2

Coordinate systems

- **Planar (or Cartesian) coordinates**
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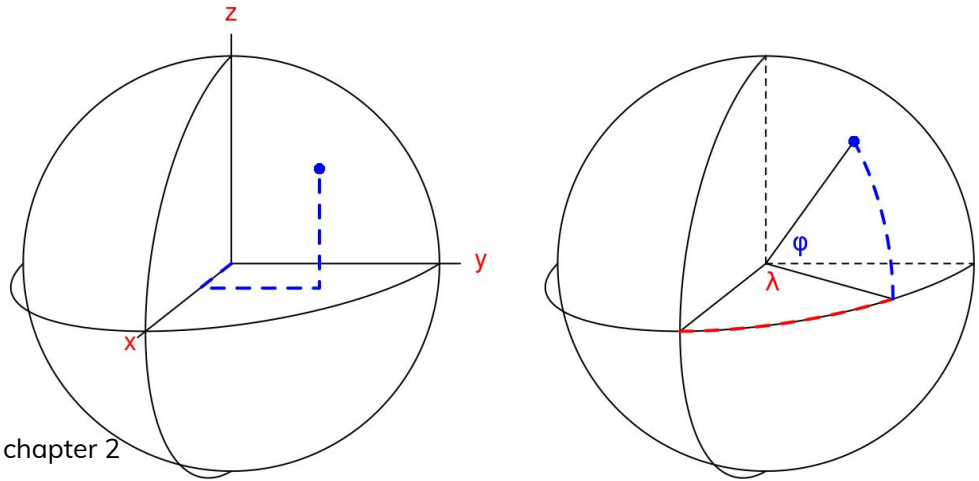
  - r is the radius of the sphere
  - λ angle measured between the point and z plane
  - φ angle measured between the point and the (x,y) plane



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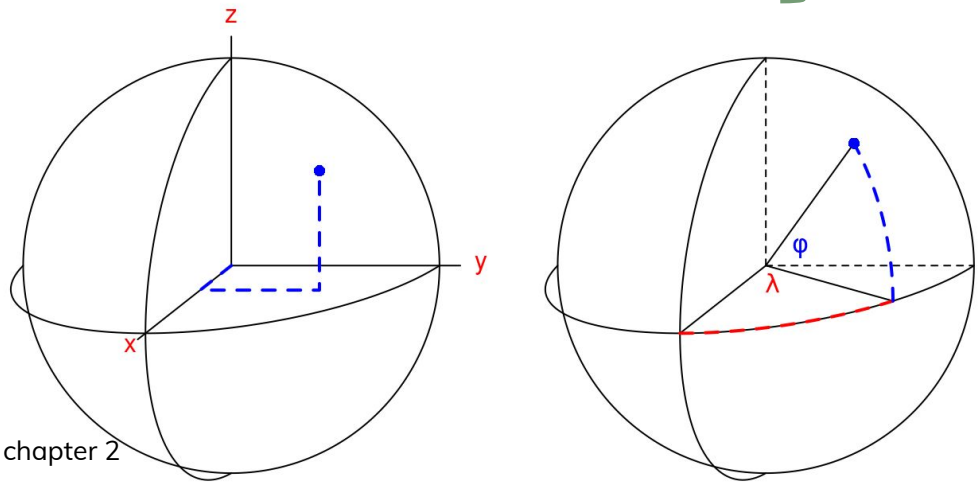
Do these sound familiar?



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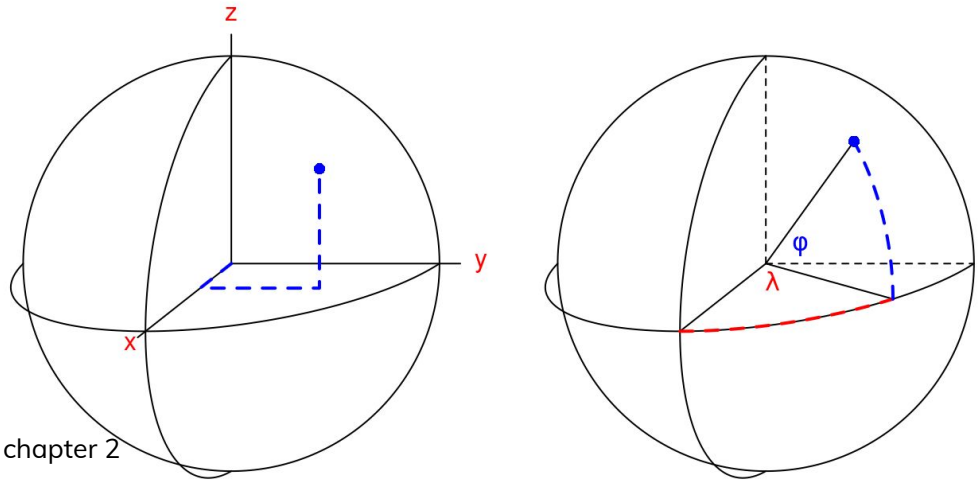
  - λ **longitude**
  - φ **latitude**



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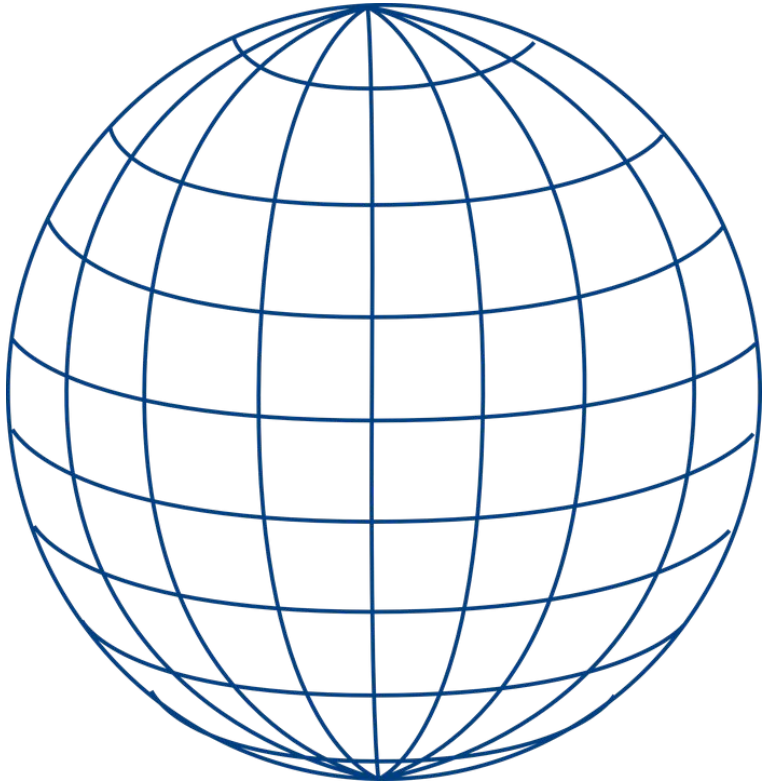
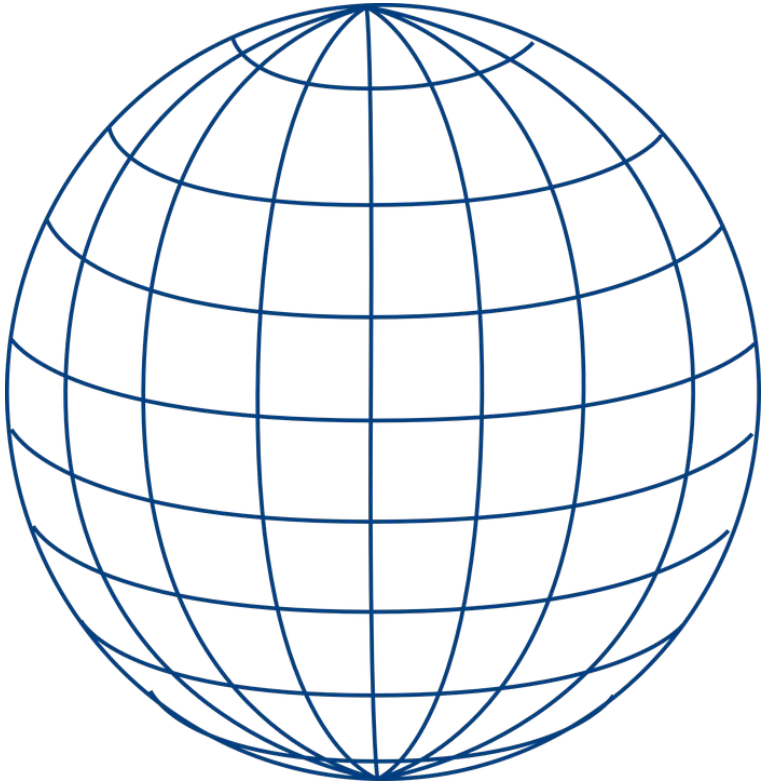
Mini latitude/longitude refresher



Mini latitude/longitude refresher

- **Latitude**
  - ranges from -90 to 90
  - “y”
  - Parallel
- **Longitude**
  - ranges from -180 to 180
  - “x”
  - converge



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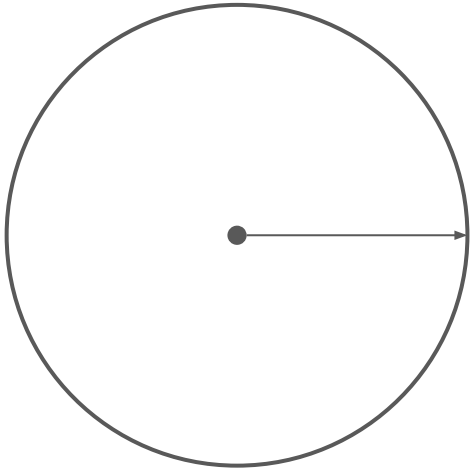

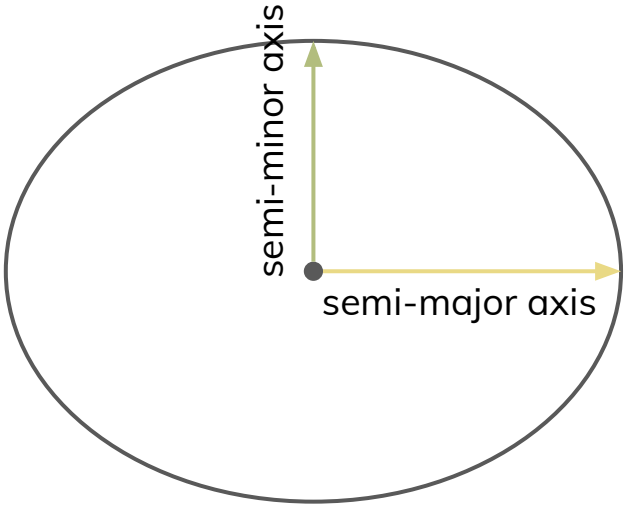

We need a system!

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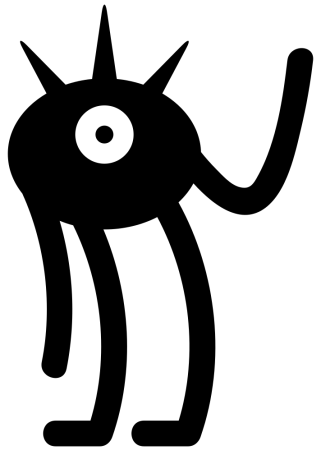
How are we feeling?



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Datum

- **A parameter or set of parameters that define the position of the origin, the scale, and the orientation of a coordinate system** (Lott 2015)

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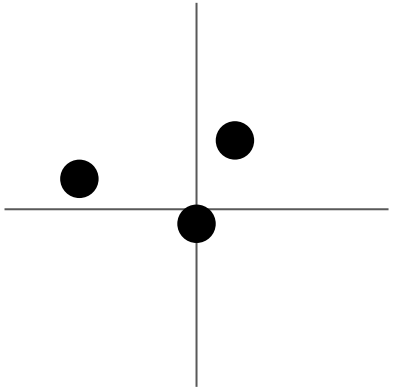

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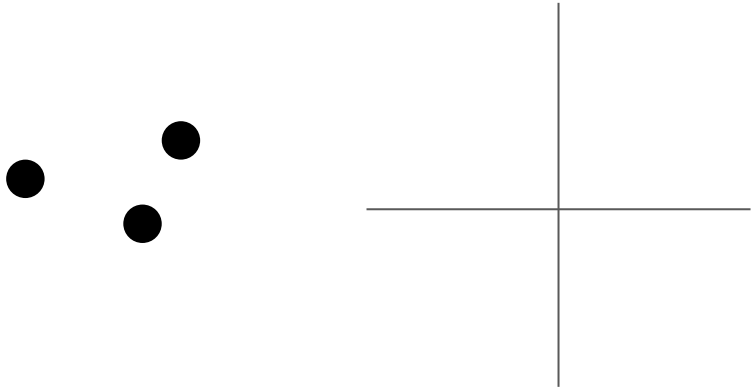

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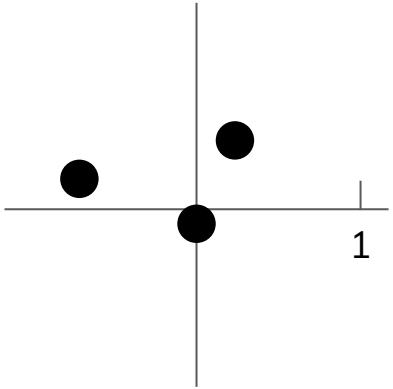

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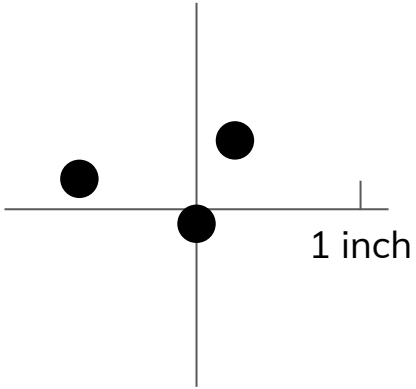

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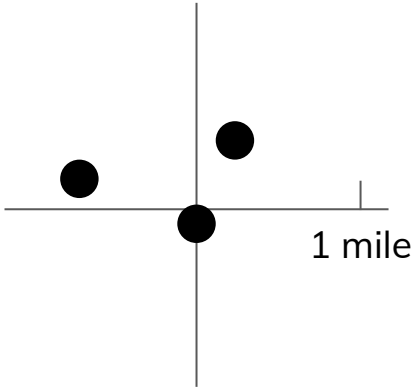

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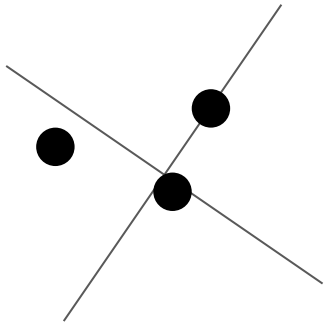

We need a system!

- **Coordinate system**
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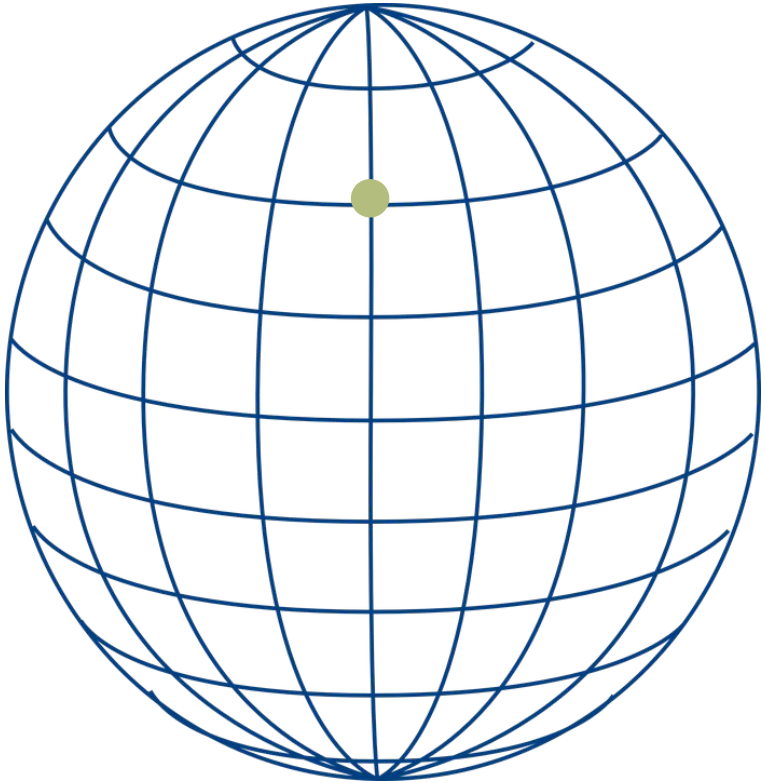
Coordinate reference system

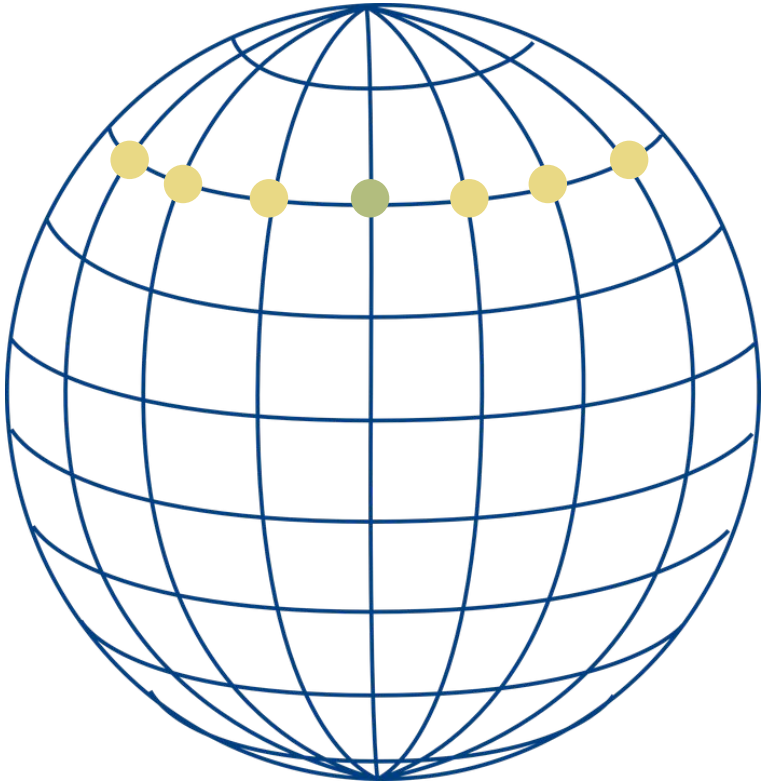
Geodetic datum

- **A datum describing the relationship of a two- or three- dimensional coordinate system to Earth** (Lott 2015)

Geodetic datum



Geodetic datum



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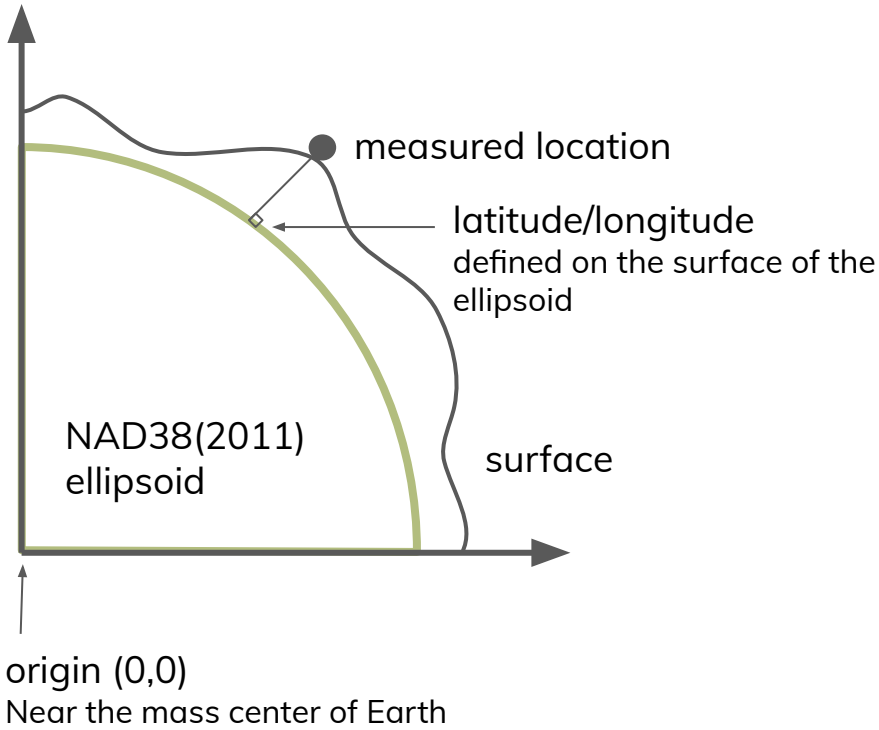
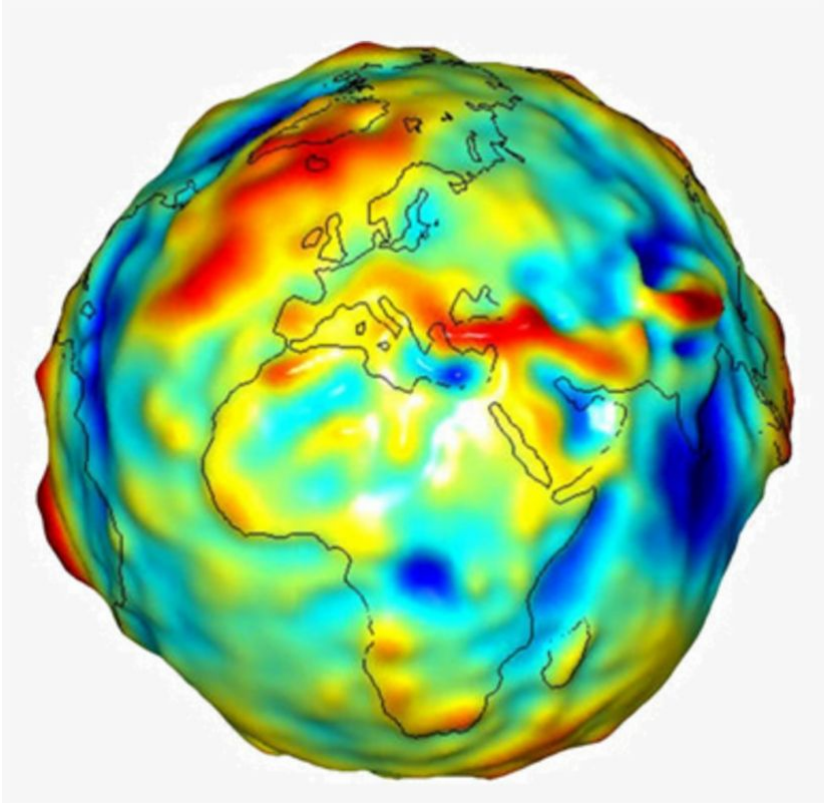


Modified from: GIS Fundamentals, Paul Bolstad

Geodetic datum



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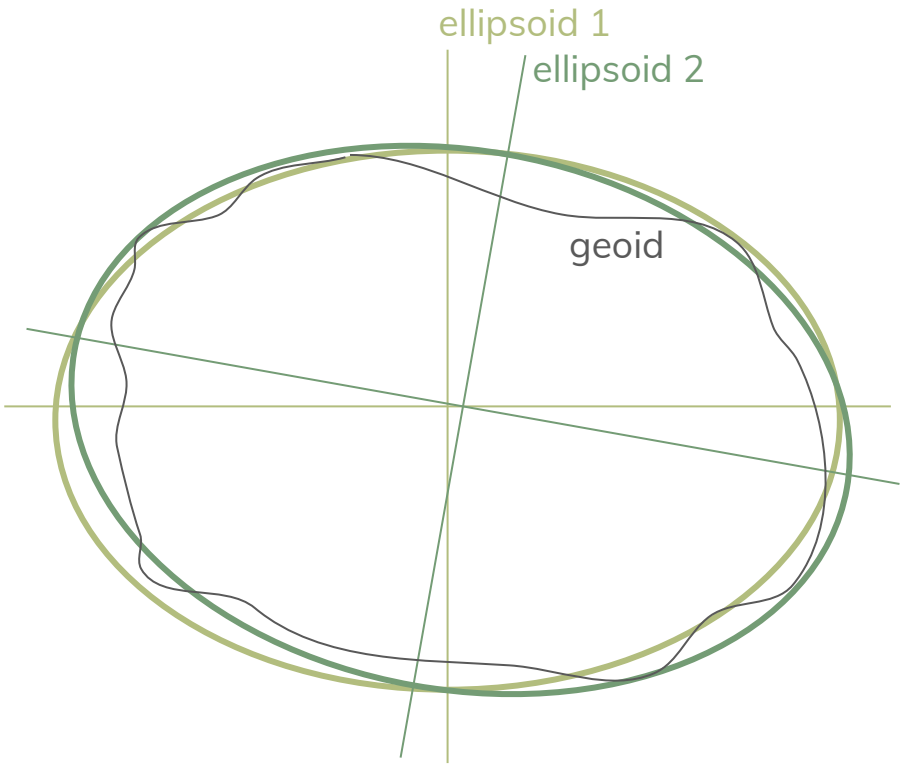

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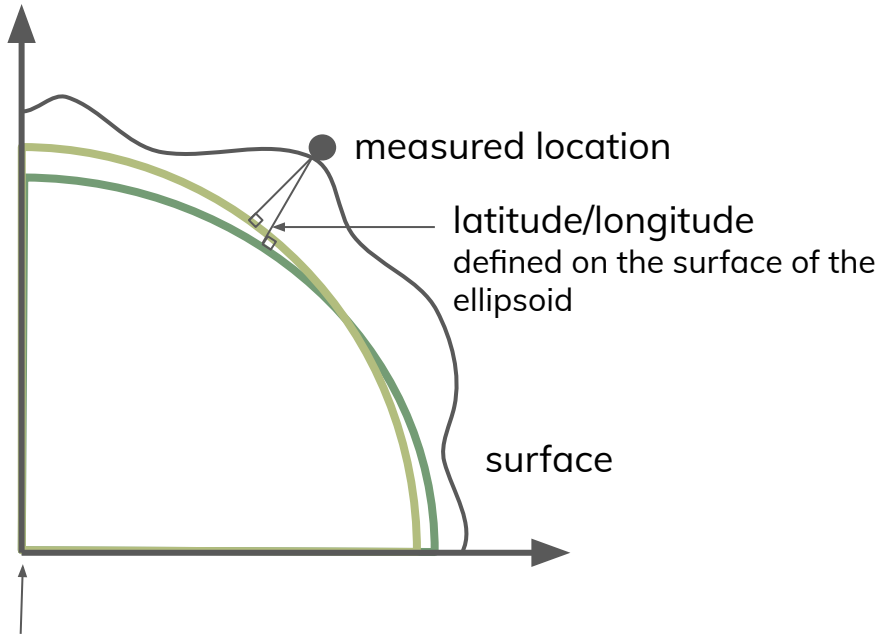

Modified from: GIS Fundamentals, Paul Bolstad

Coordinate reference systems

What does this look like in the real world?

Coordinate reference systems

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Modified from: esri.com

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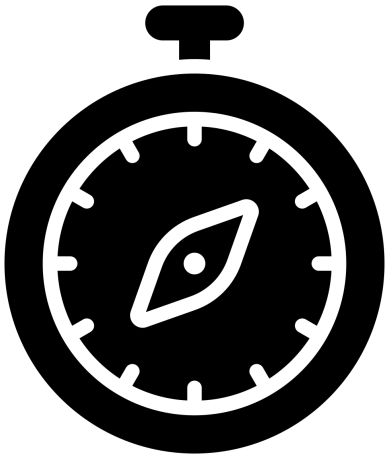

134.577°E, 24.006°S

Modified from: esri.com

Coordinate reference systems

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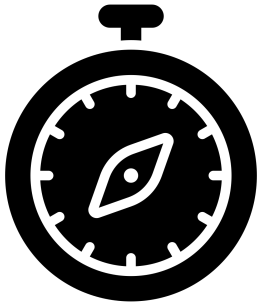
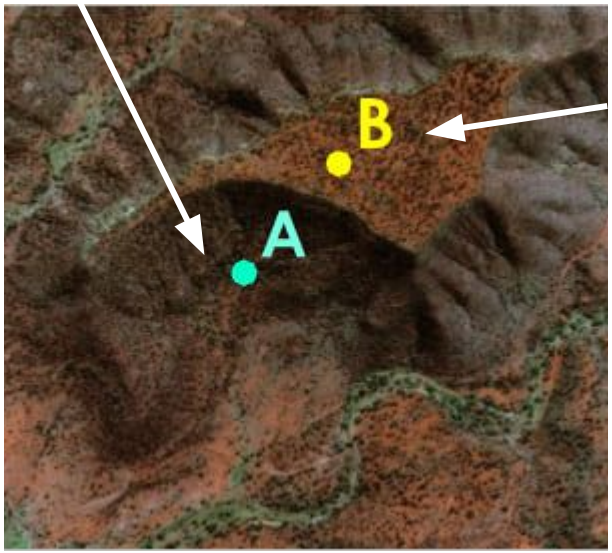


134.577°E, 24.006°S

Australian Geodetic Datum 1984



WGS 1984

Modified from: esri.com

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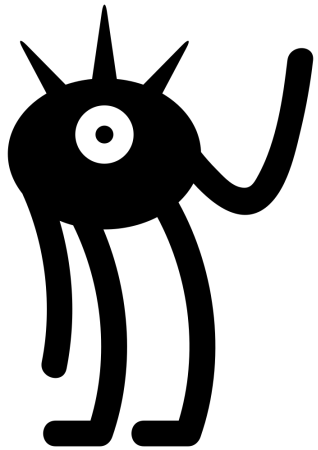


How are we feeling?

Coordinate reference system

- A framework to measure locations on Earth as coordinates

Coordinate reference system

- **Framework to measure locations on Earth as coordinates**
- **A specific CRS comprises the following:**
  - Earth ellipsoid
  - Geodetic datum
    - Origin point
    - Unit of measure
  - Map projection (in most but not all cases)

4 challenges to spatial analysis

1. We perceive geography in two dimensions, but live in three
2. Earth is irregular
3. Measurements are imperfect
4. Earth's surface is constantly changing

Projection

- **Mathematical transformation employed to translate a curved surface of a globe on a two-dimensional plane**

Modified from: esri.com

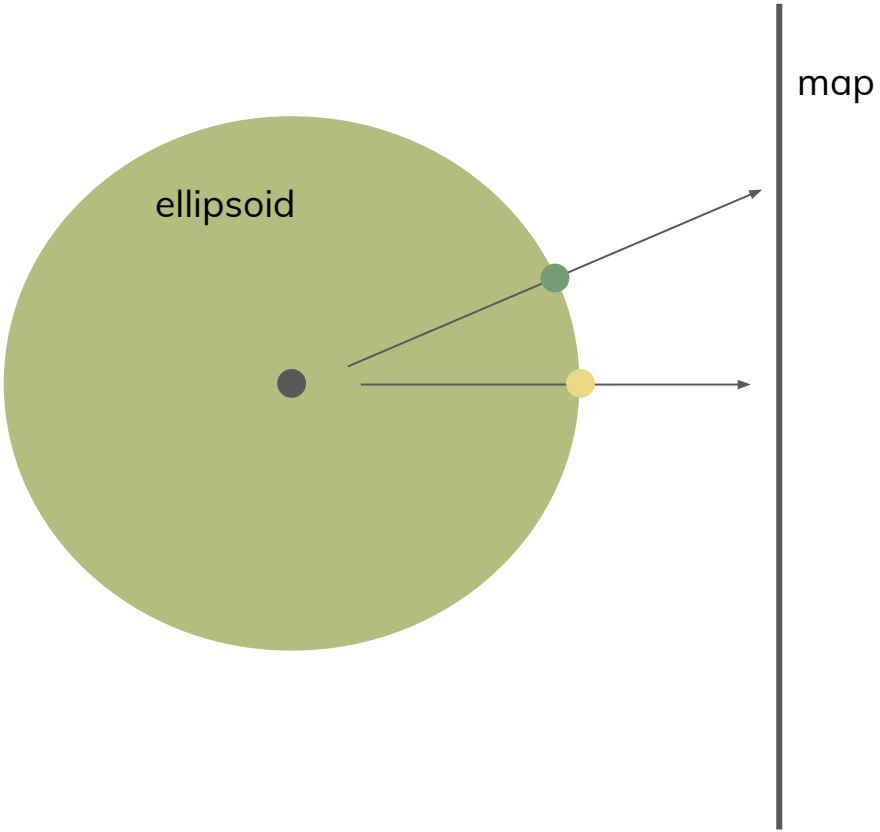
All maps are wrong

https://www.youtube.com/watch?v=kIID5FDi2JQ&t=3s

Projections

Modified from: GIS Fundamentals, Paul Bolstad

Projections



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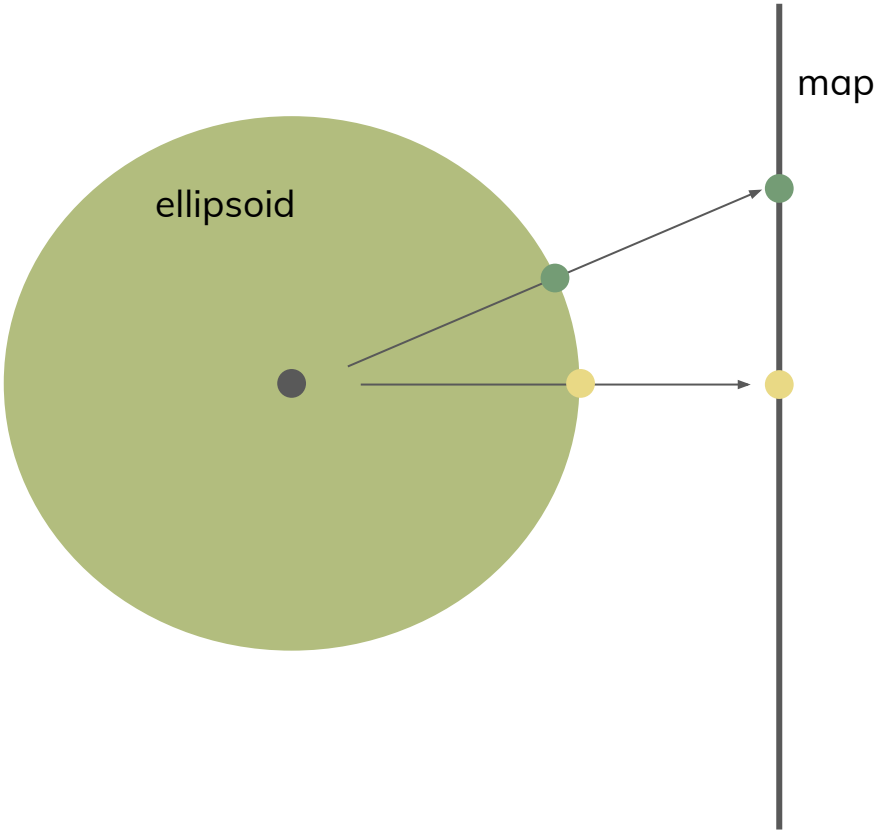

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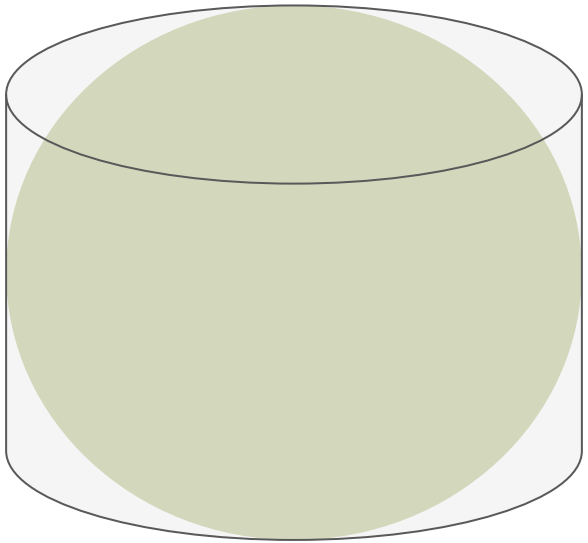
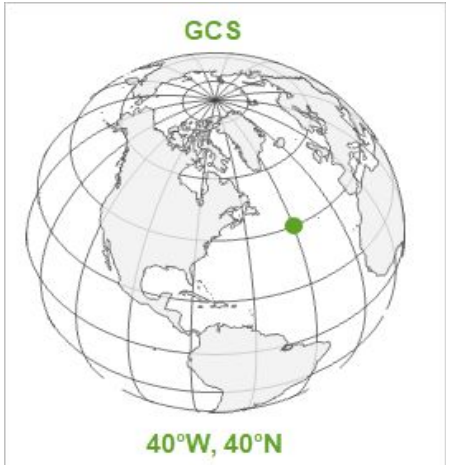


Modified from: GIS Fundamentals, Paul Bolstad

Geographic vs. projected coordinate system

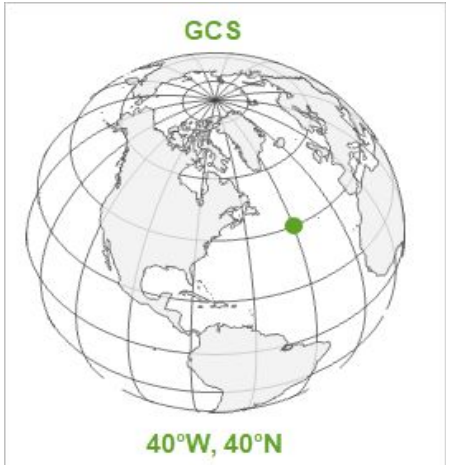
Geographic
Defines where the data is located on Earth
3D
Describes locations as angles



Modified from: esri.com

Geographic vs. projected coordinate system

Geographic	Projected
Defines where the data is located on Earth	Provides instructions on how to draw the data onto a flat surface
3D	2D
Describes locations as angles	Describes locations in linear units



Modified from: esri.com

Geographic vs. projected coordinate system

- A PCS is a GCS that has been flattened using a map projection

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Modified from: esri.com

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- Picking a PCS depends on where you are mapping AND the nature of the map you want to make

Modified from: esri.com

Projections

- **Distortion is inevitable, so it’s all about compromise**
- **Properties**
  - Area
  - Form
  - Distance
  - Direction

Projections

Changing between projections using the same datum and version:

Projected coordinate system

UTM WGS84(G1762), zone 15

Projected coordinate system

Iowa State Plane North, WGS84(G1762)

Modified from: GIS Fundamentals, Paul Bolstad

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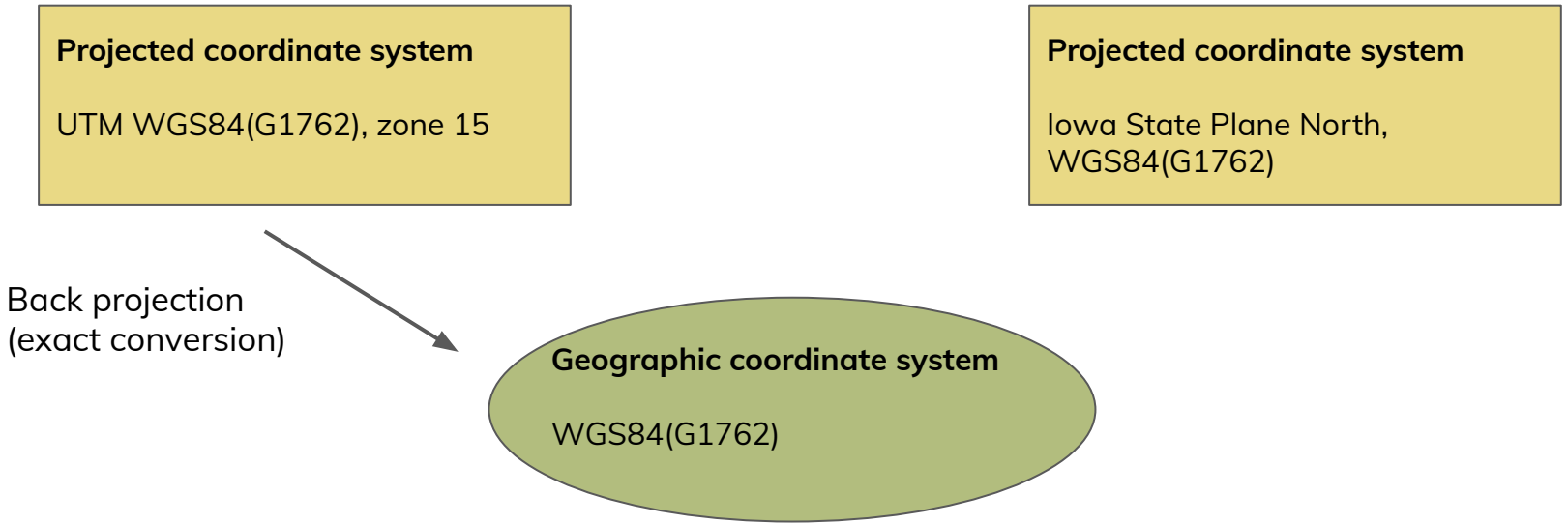

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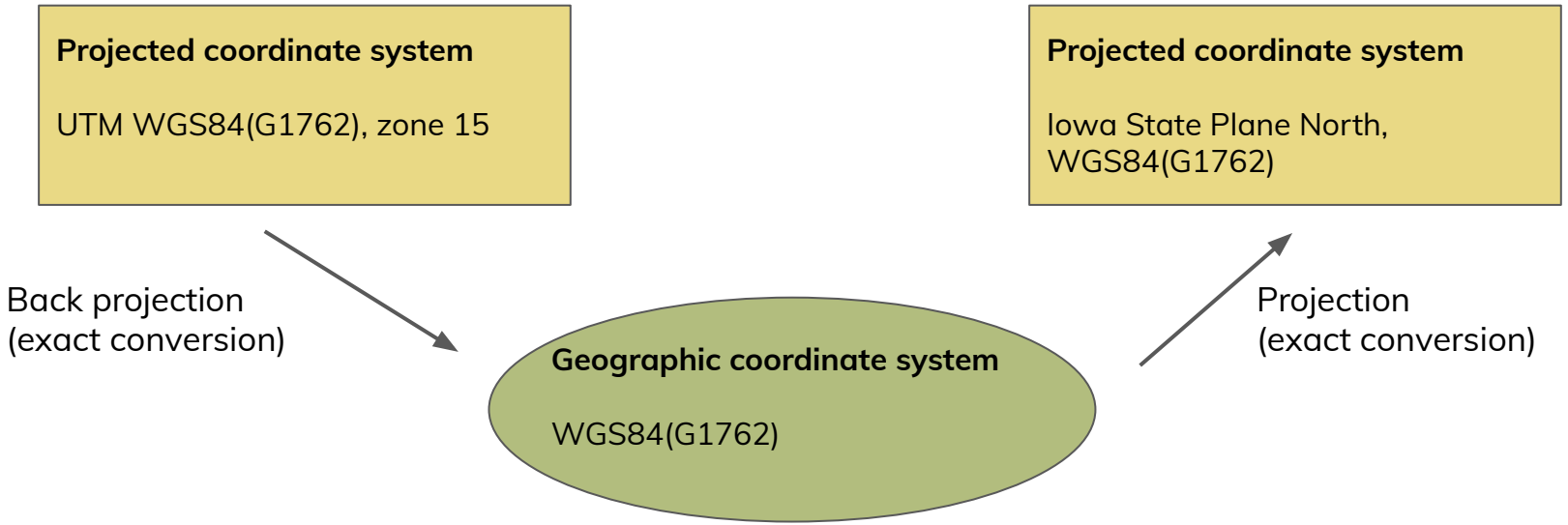

Modified from: GIS Fundamentals, Paul Bolstad

Projections

Changing between projections using *different* datums:

Projected coordinate system

UTM WGS84(G1762), zone 15

Projected coordinate system

Iowa State Plane North, NAD83(2011)

Modified from: GIS Fundamentals, Paul Bolstad

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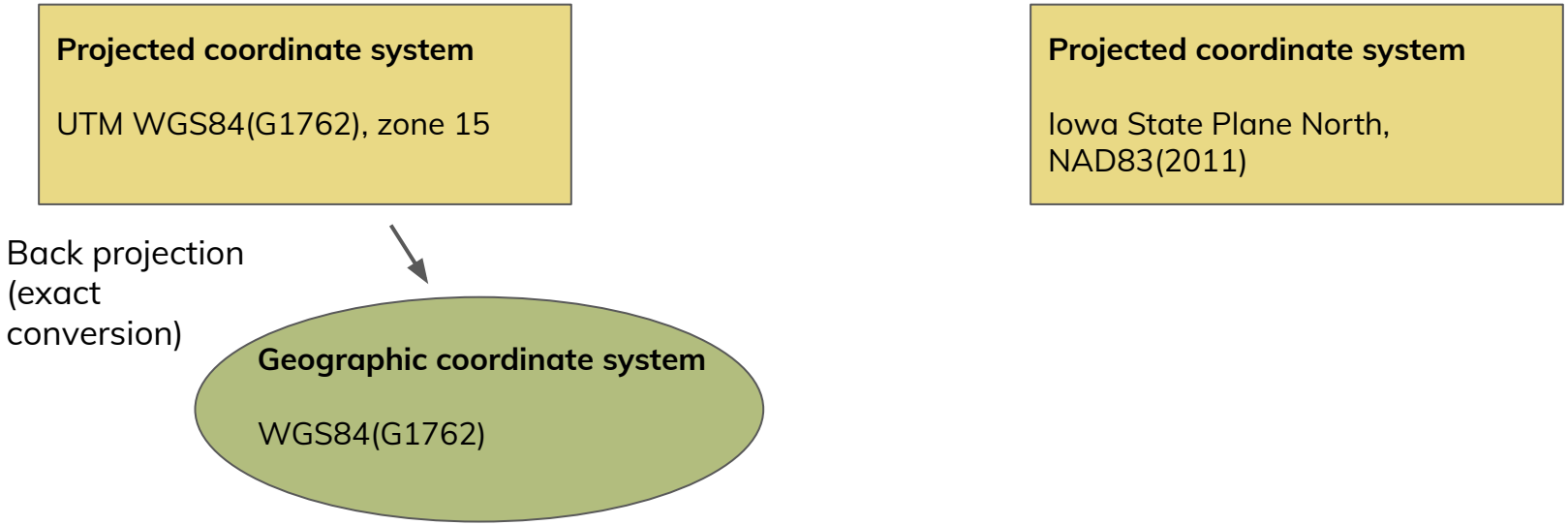

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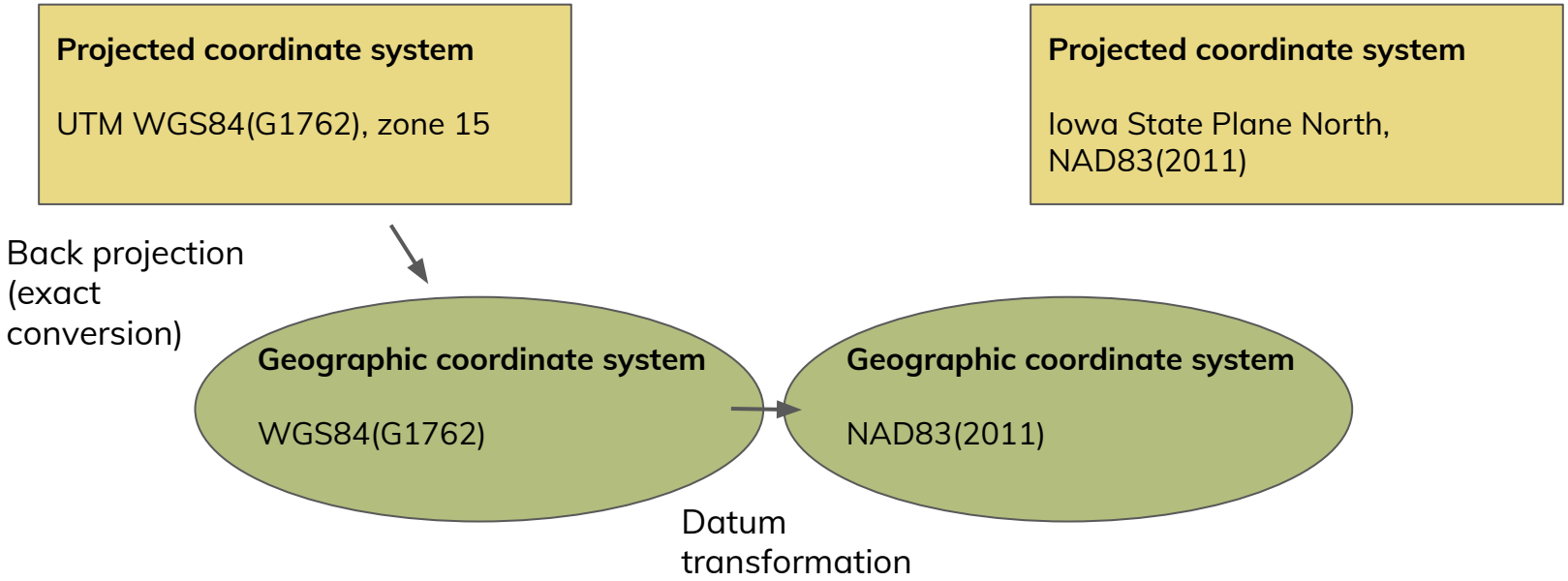

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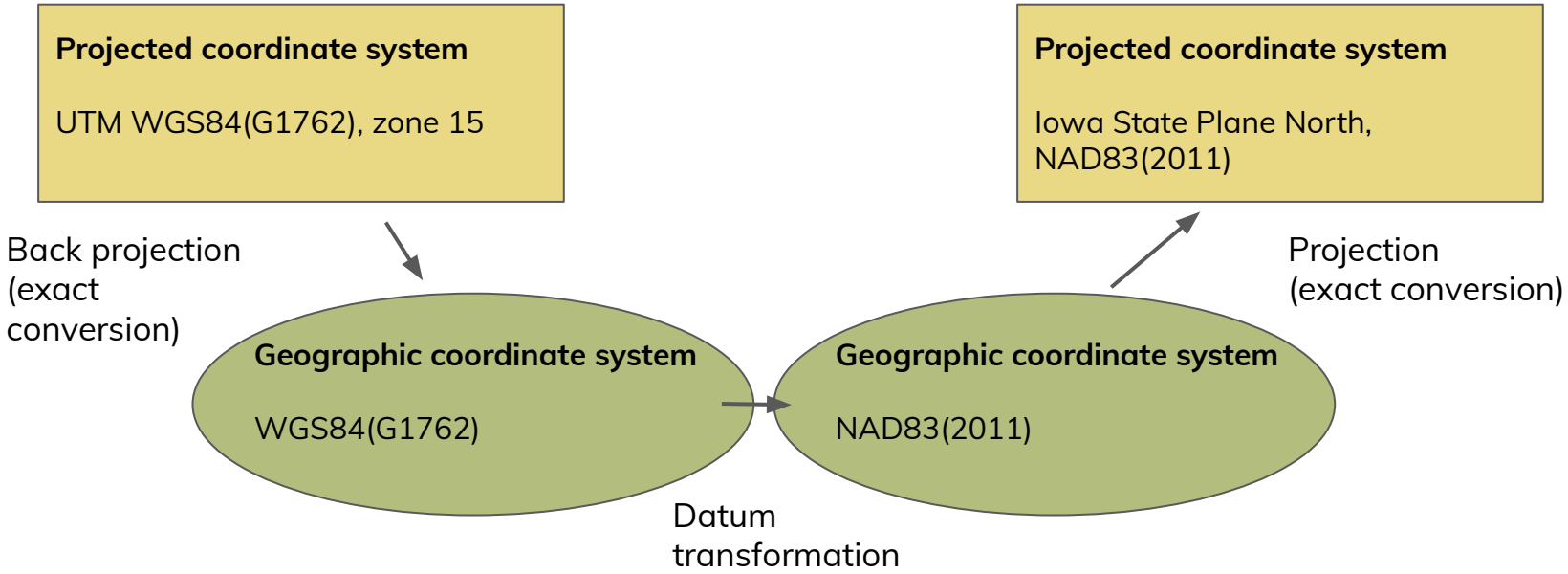

Modified from: GIS Fundamentals, Paul Bolstad

Summary

- Coordinate reference systems

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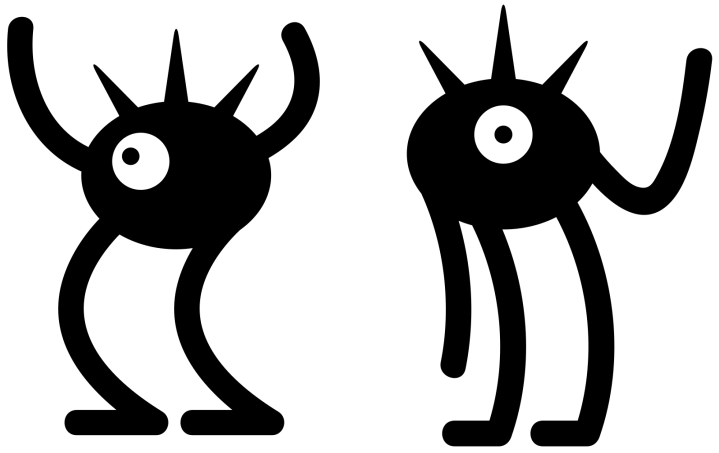
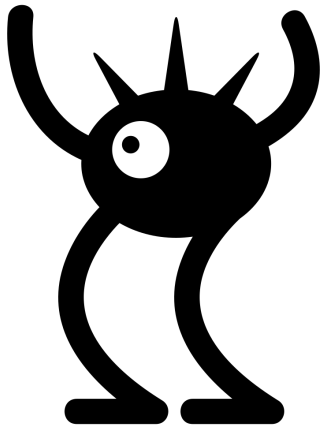
- **North isn't up and all maps are wrong!**

How are we feeling?

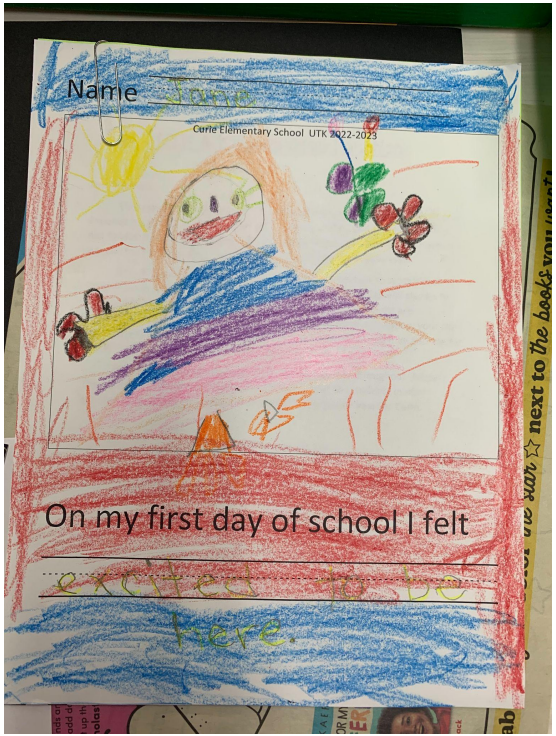


BREAK



Plan for today?

Jane Oliver
Curriculum Development Consultant



Pedagogical aspiration
“On my first day of school I felt excited to be here”

Assignment 1

US EPA definition of environmental justice:

Environmental justice (EJ) is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies.

Fair treatment means no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental and commercial operations or policies.