EDS 223: Geospatial Analysis & Remote Sensing

USGS via Unsplash

Welcome!

- Introductions

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- Course overview

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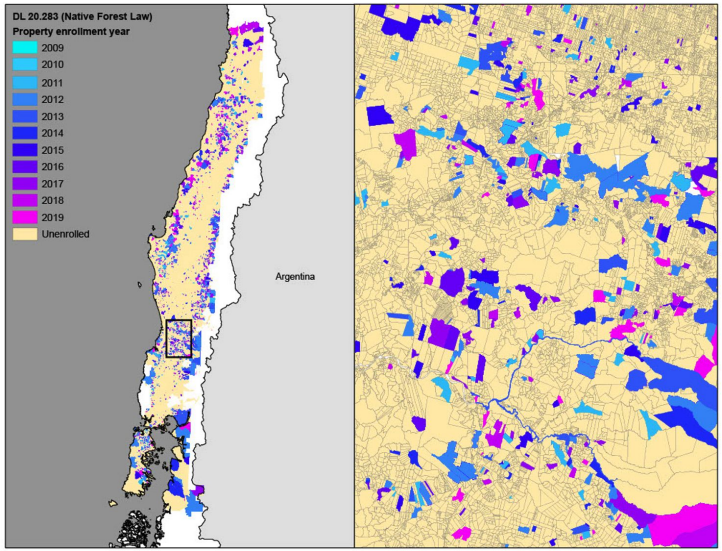
- Course overview
- Models of our world

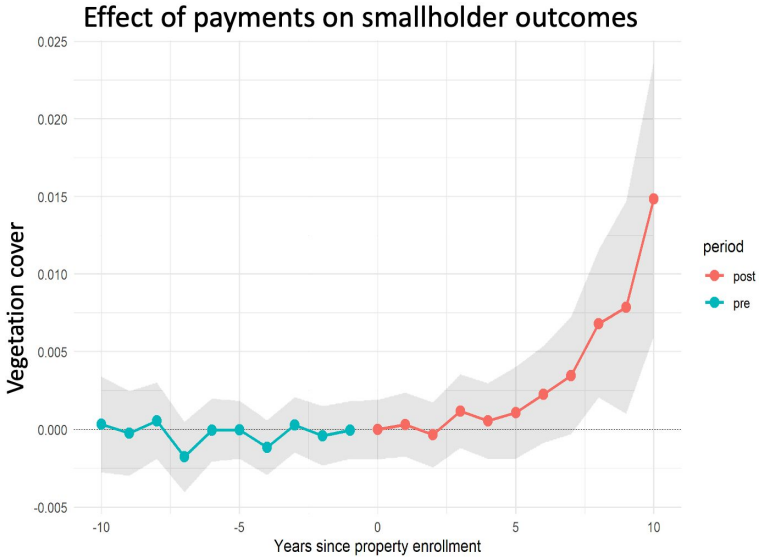
Instruction team

- **Ruth Oliver**
  - Email: rutholiver@bren.ucsb.edu
  - Office: Bren Hall 4512
  - Student hours: Wednesday 11-12 @ NCEAS
  - Contact me via: email
- **Albert Garcia**
  - Email: agarcia@bren.ucsb.edu
  - Student hours: Wednesday 3:30-4:30 @ NCEAS
  - Contact me via: email

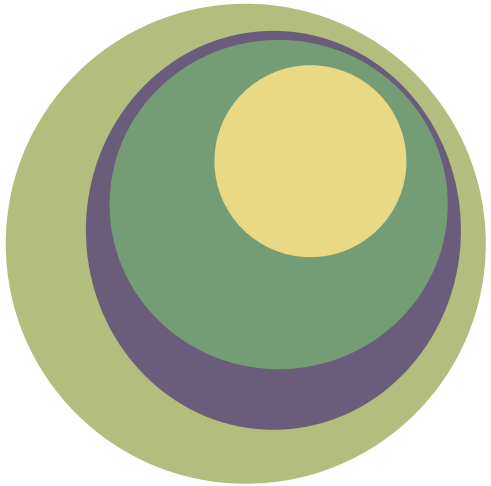
Albert Garcia

- **Bren PhD student studying environmental economics**
- **Research:**
  - Causal inference using satellite data
  - Payments for reforestation





Growth mindset



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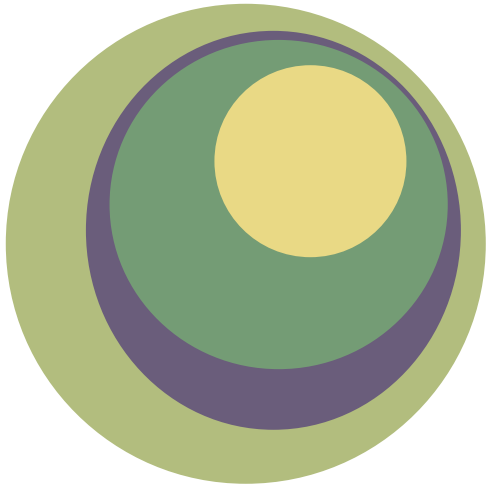

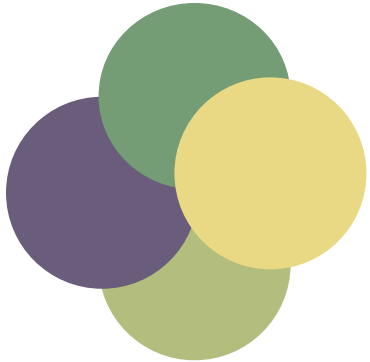

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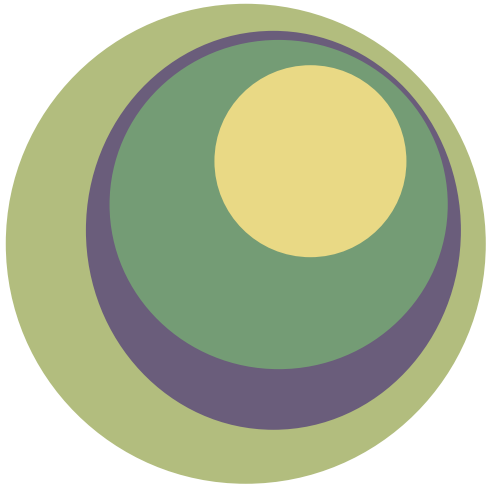
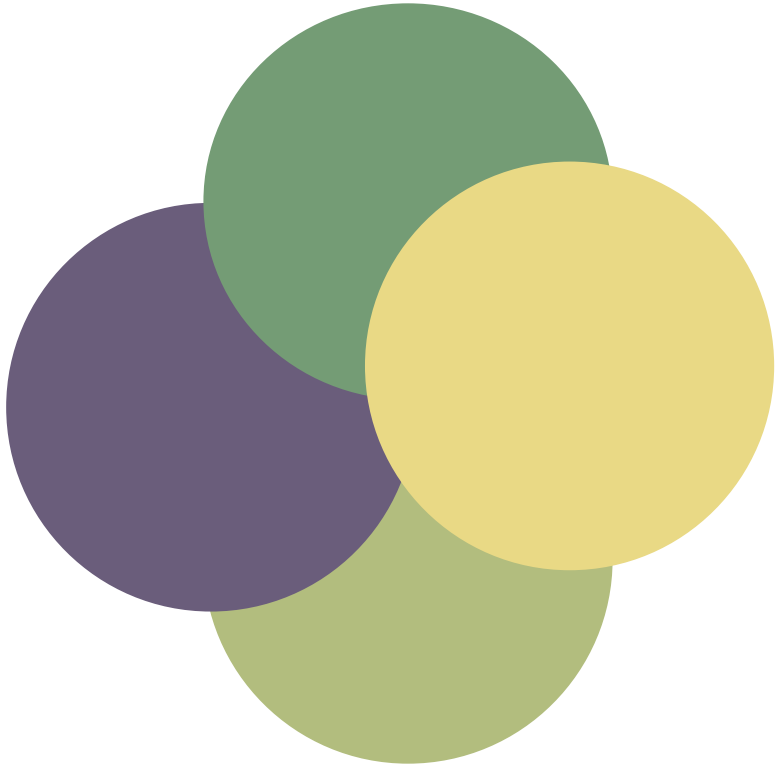




Typos are the pedagogy

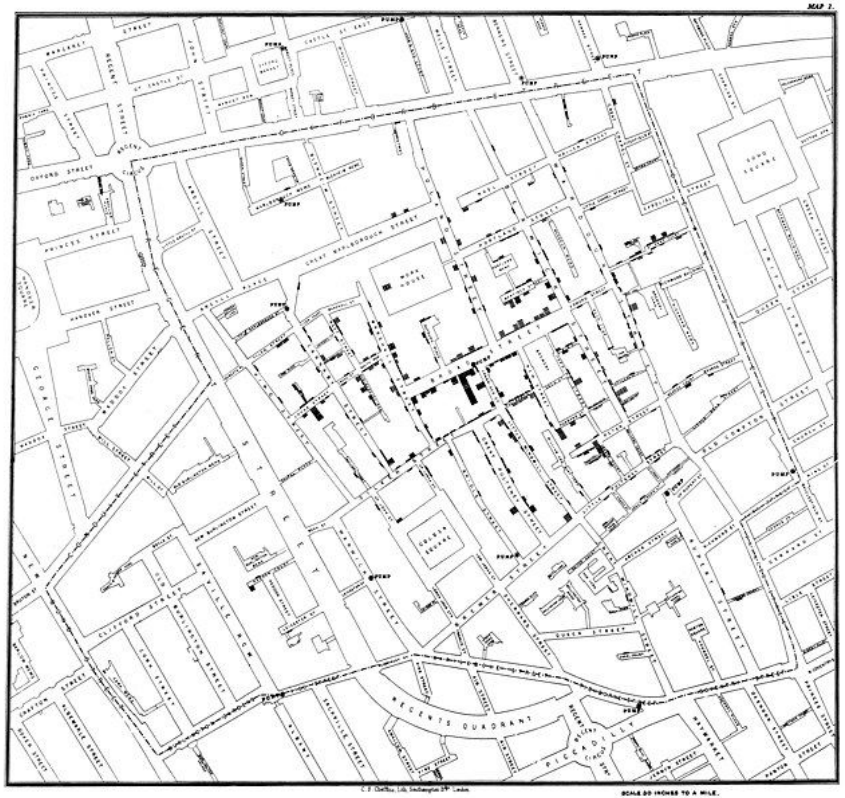
- Emily Jane McTavish

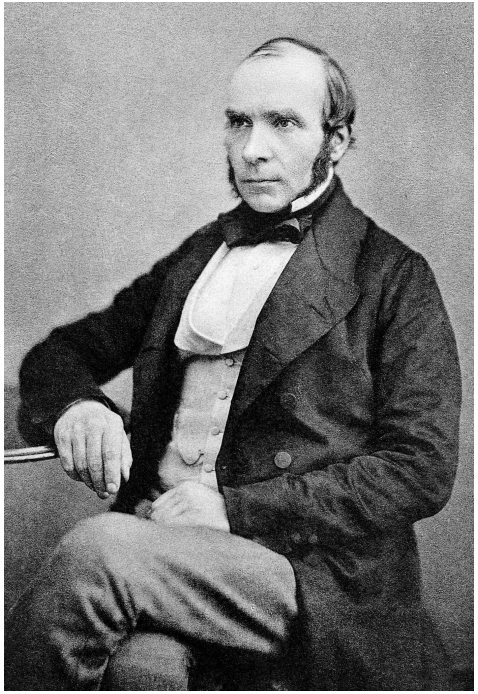
Why spatial?

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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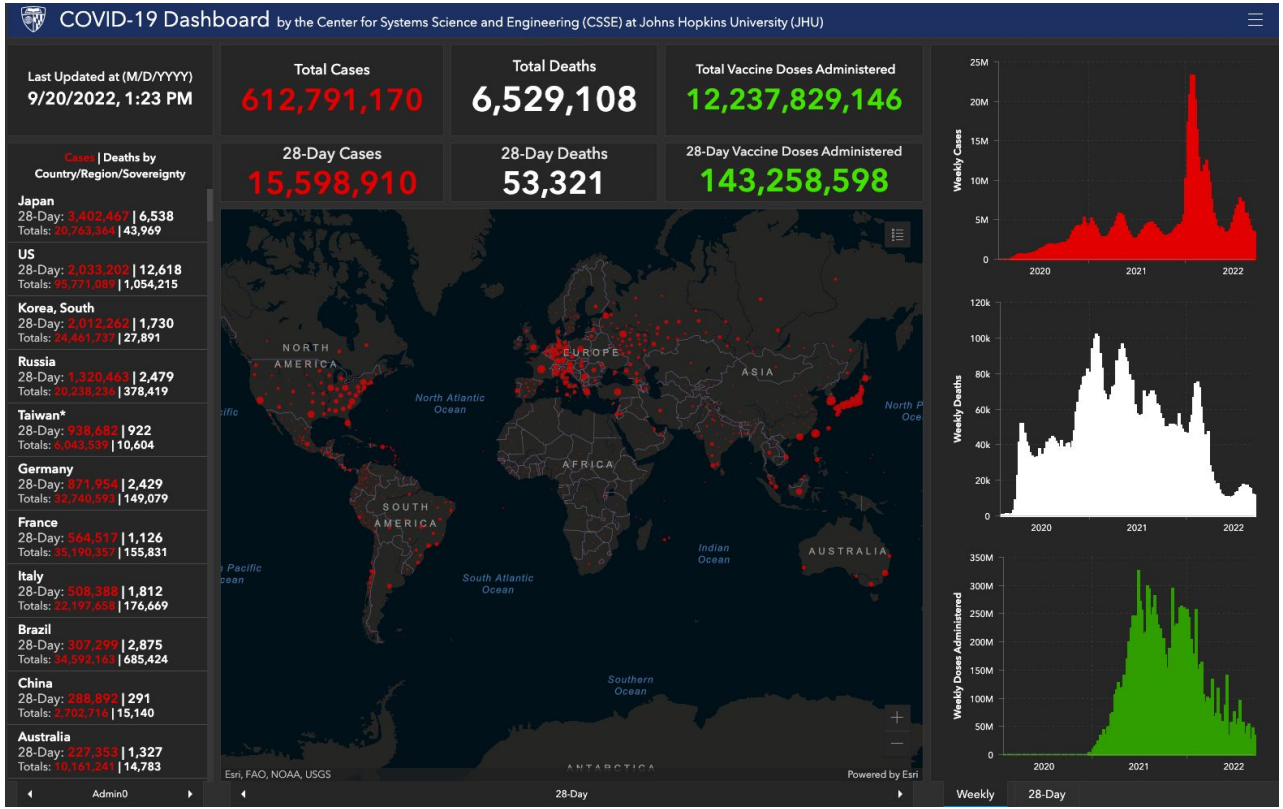

Our approach

(very, very) Brief intro to remote sensing

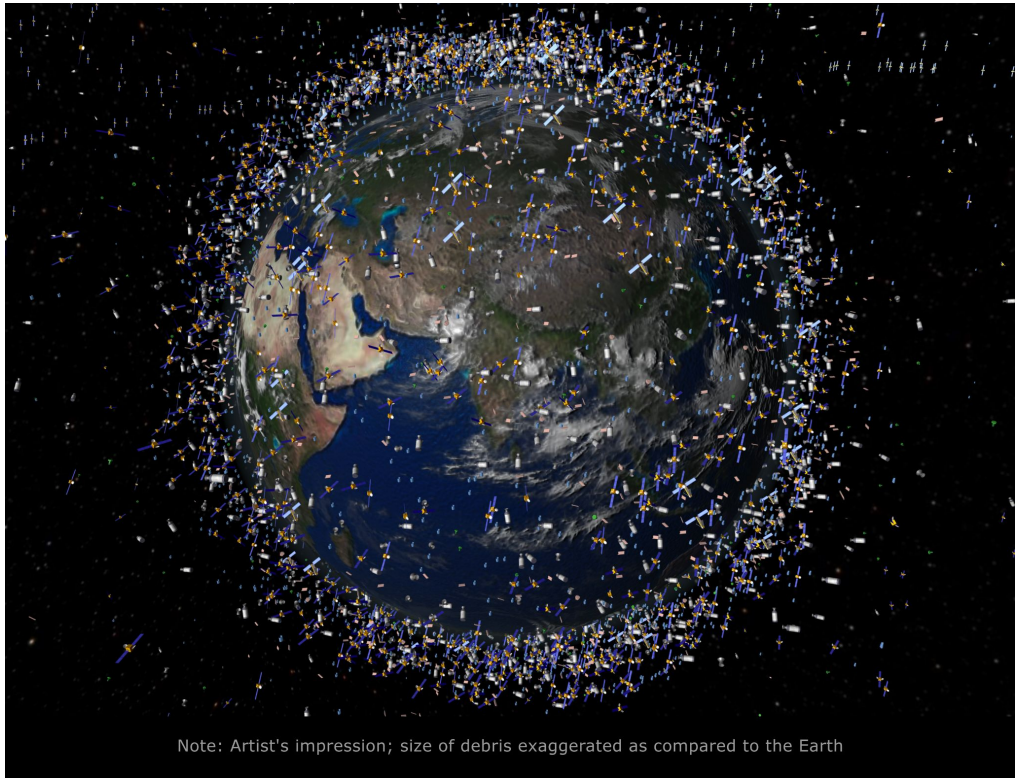

Photo credit: ESA

A non-historian’s brief history of North

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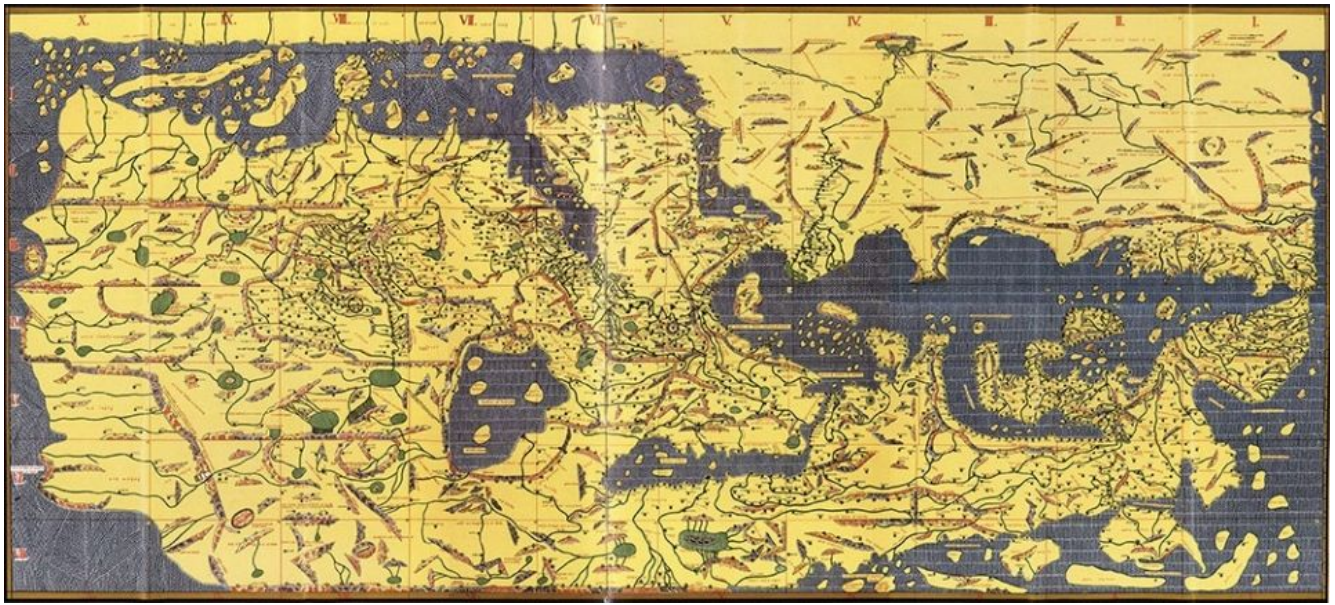
Recreation of Moroccan cartographer’s Muhammad al-Idrisi’s Tabula Rogeriana (1154)



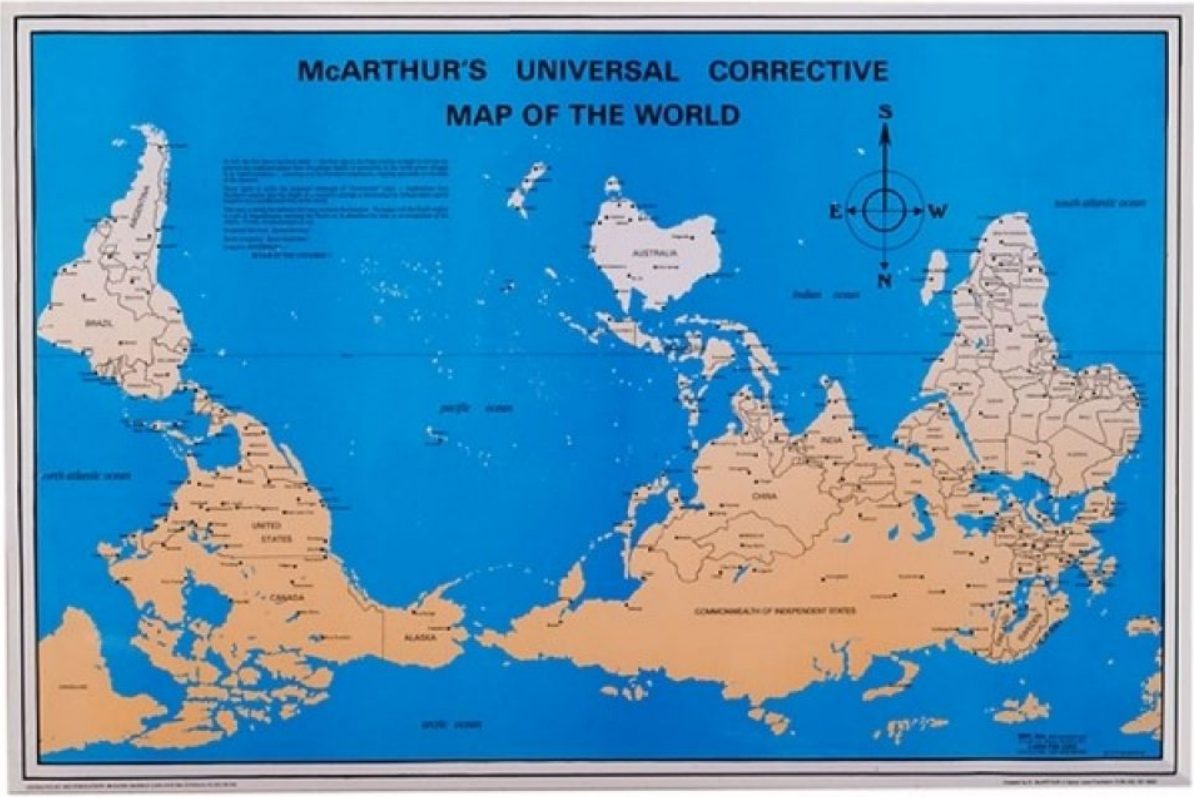
Source: Bibliotheque nationale de France/Wikipedia

A non-historian's brief history of North

Recreation of map (1407) base 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

Models of our world

Photo credit: Wikipedia

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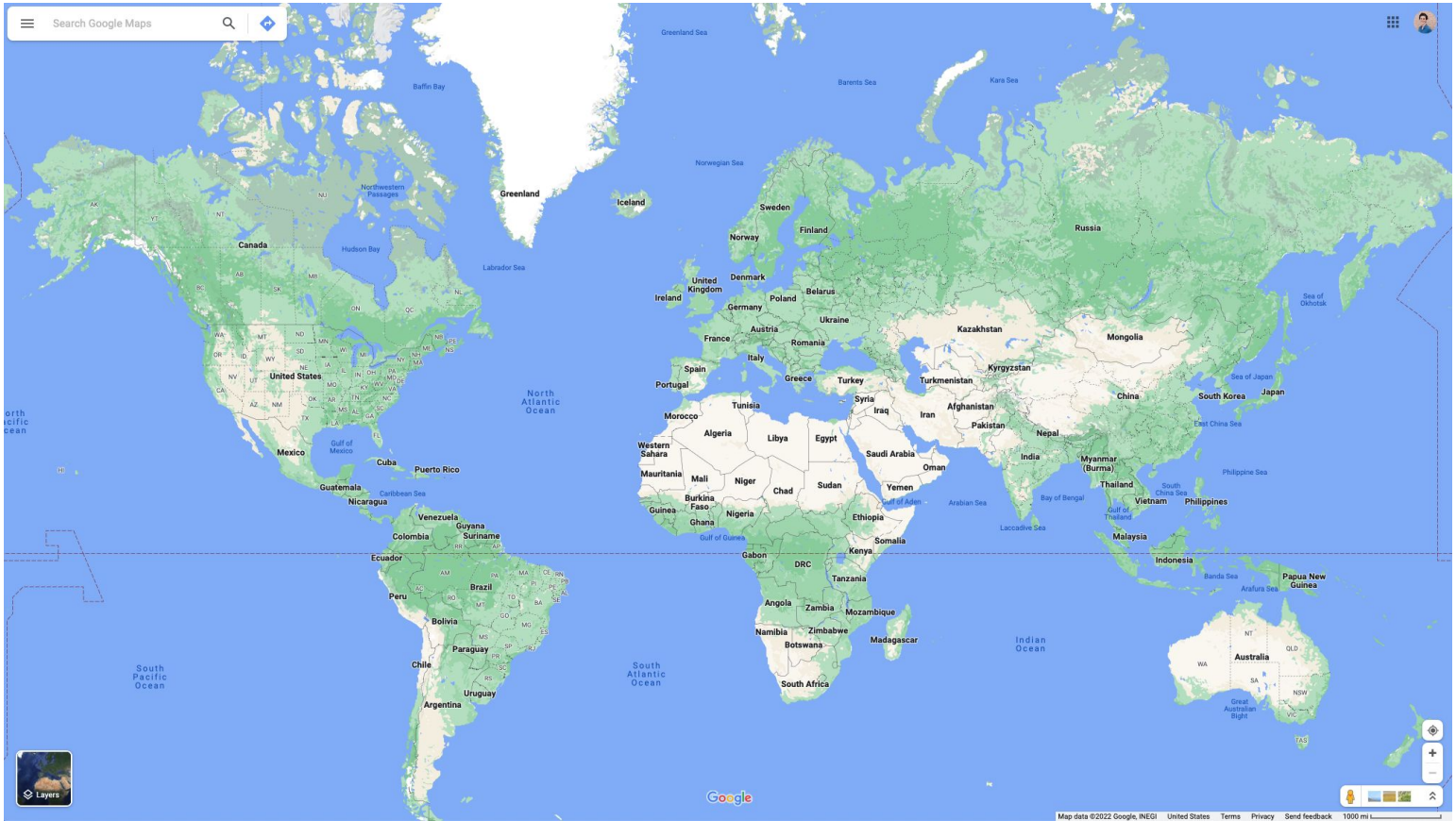

Models of our world

Source: Map Company Limited

We need a system!

4 (main) challenges to spatial analysis

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We need a system!

- Coordinate system
- Datum
- Geodetic datum

Coordinate reference system

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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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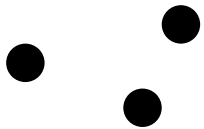

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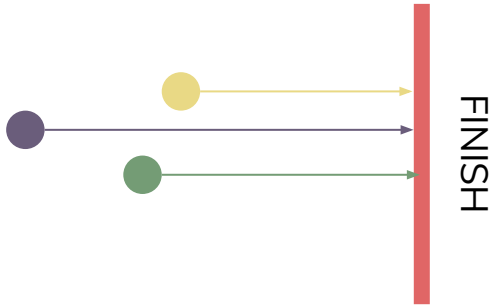

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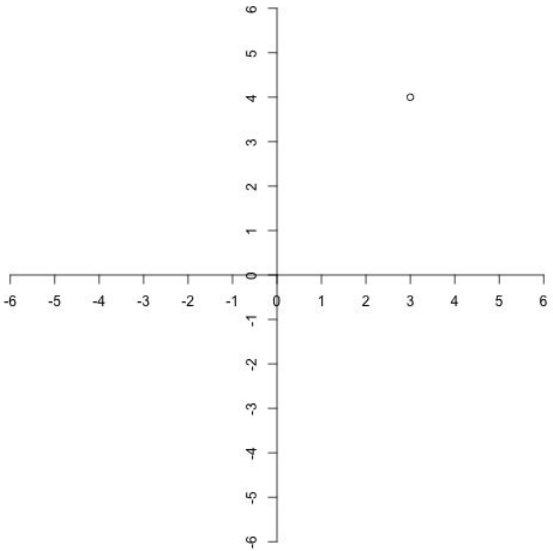

Modified from: Spatial Data Science, chapter 2

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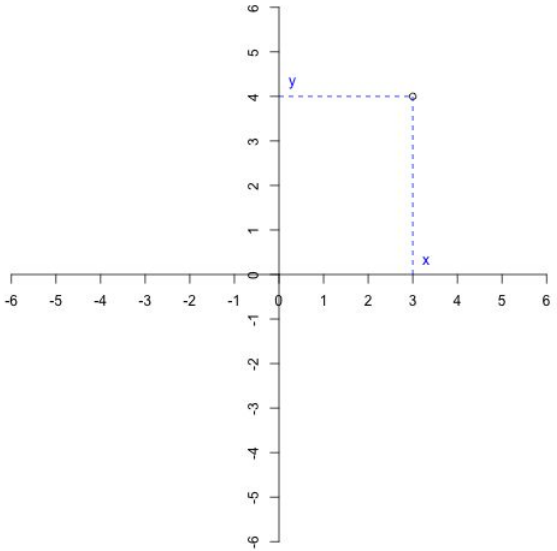

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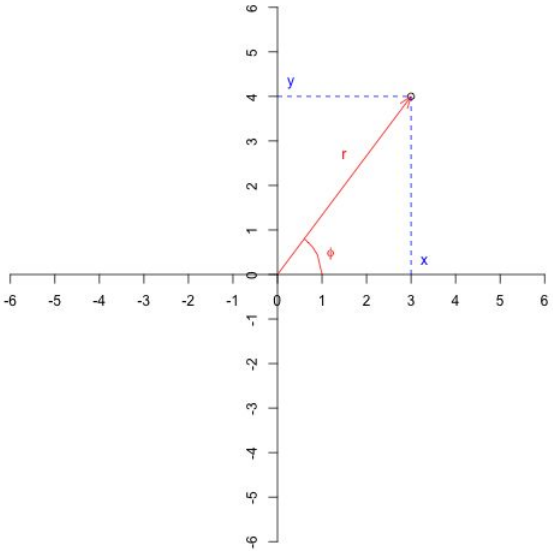

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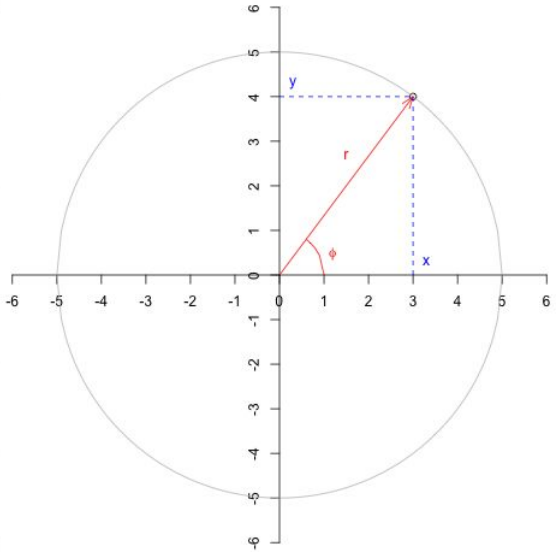

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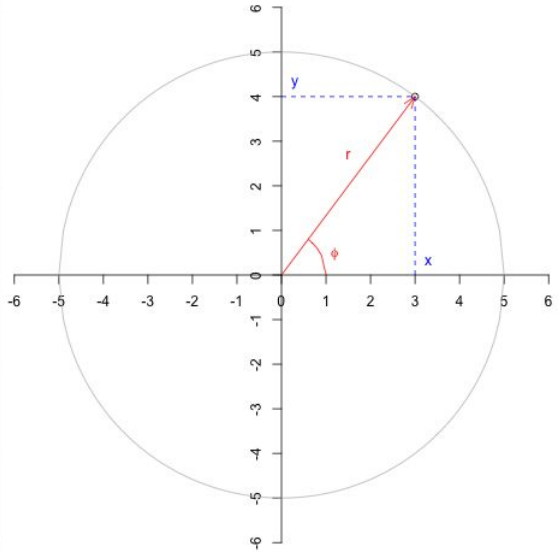

$$x = r\cos\phi$$
$$y = r\sin\phi$$

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

Modified from: Spatial Data Science, chapter 2

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

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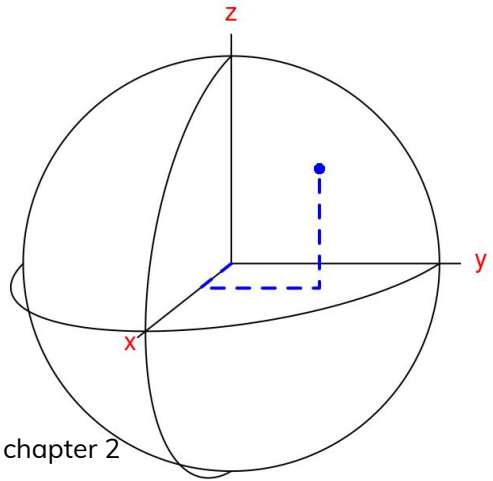

Modified from: Spatial Data Science, chapter 2

Coordinate systems

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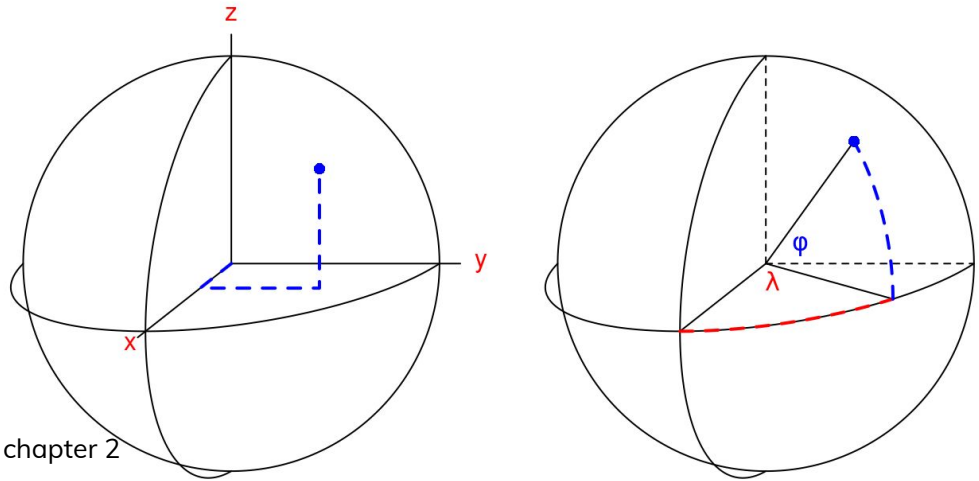
- **Polar coordinates**
  - r is the radius of the sphere
  - λ angle measured between the point and z plane
  - φ angle measured between the point and the (x,y) plane



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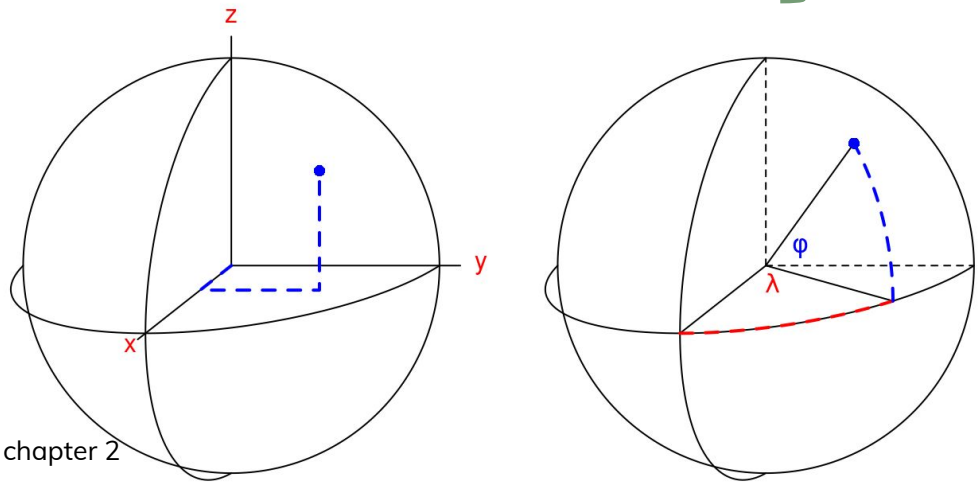
Do these sound familiar?



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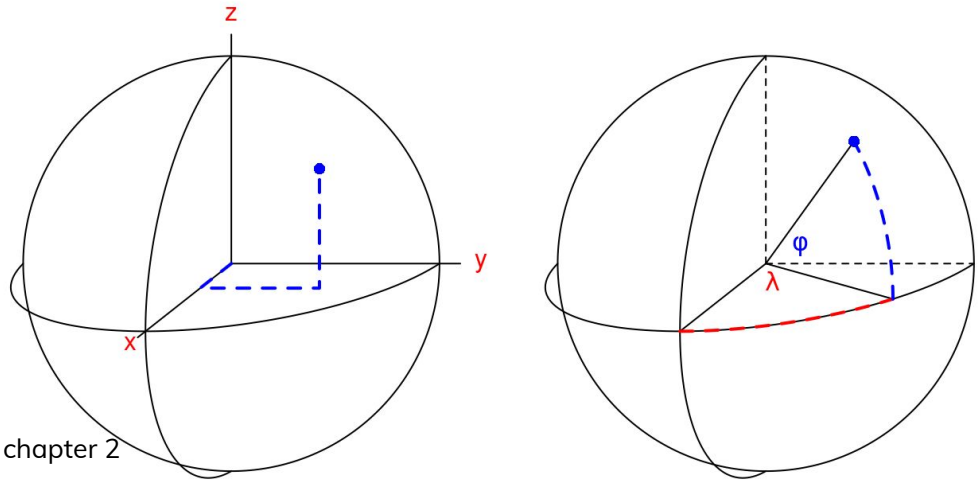
  - λ **longitude**
  - φ **latitude**



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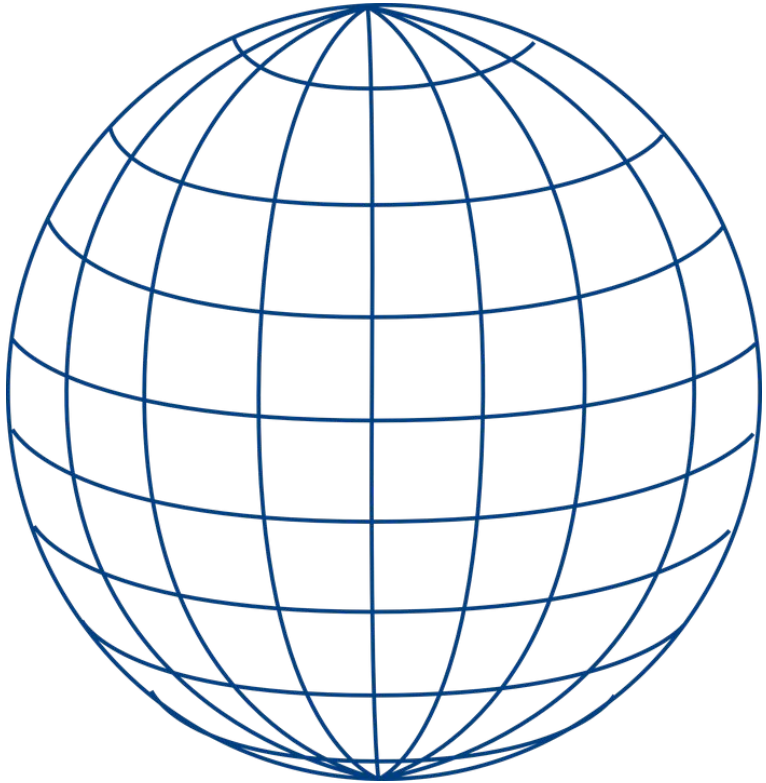
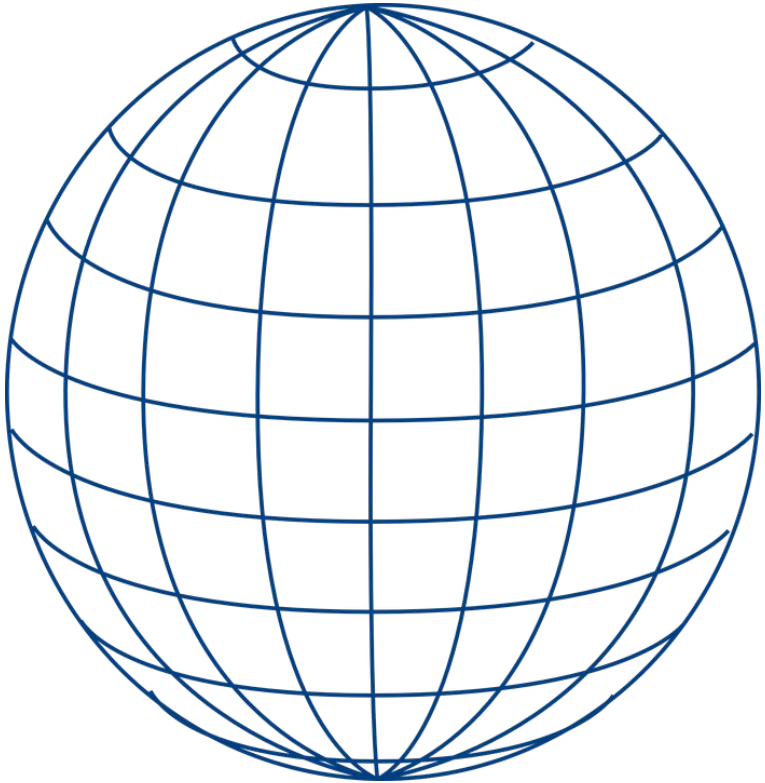
Mini latitude/longitude refresher



Mini latitude/longitude refresher

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



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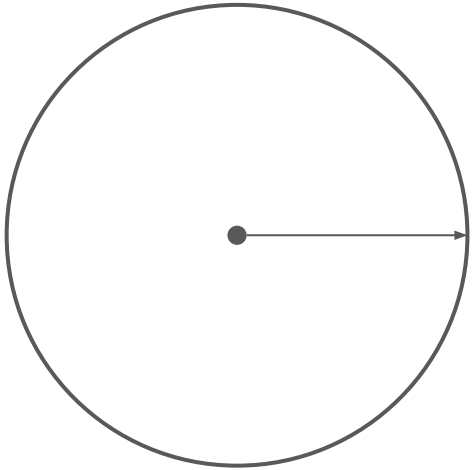

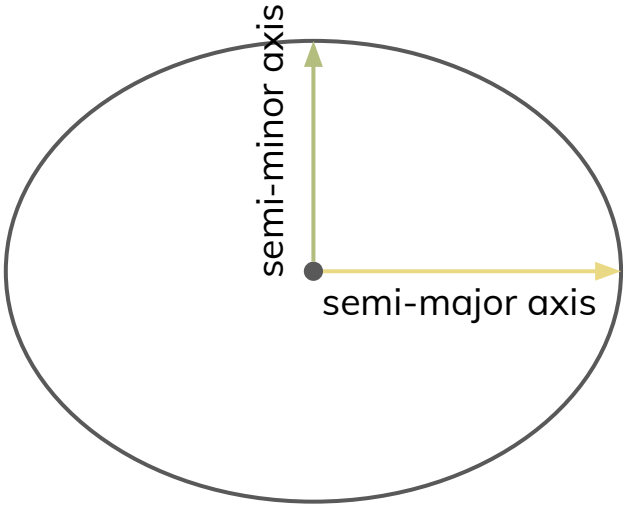

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Datum

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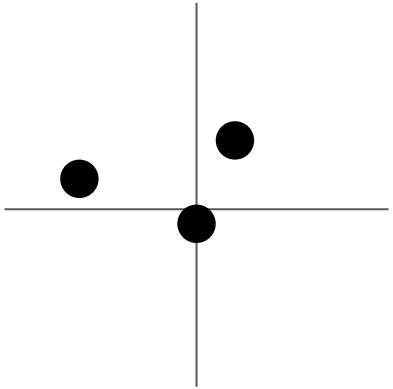

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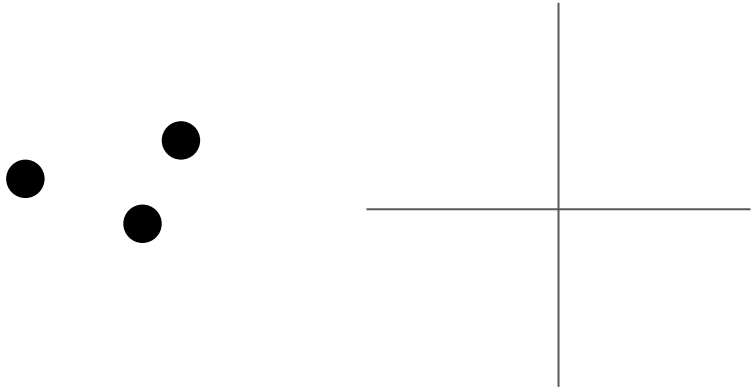

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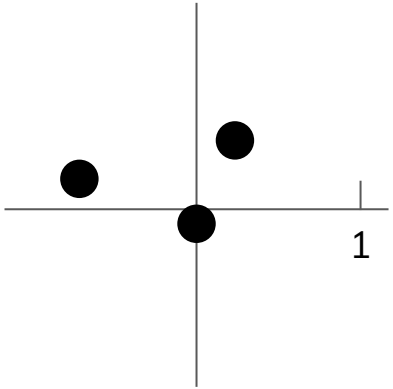

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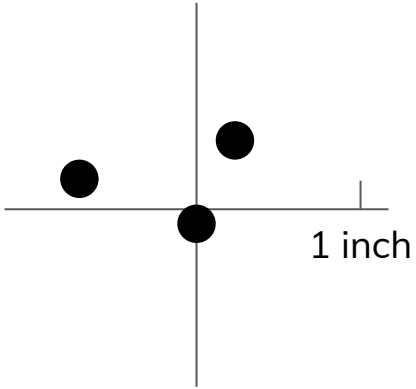

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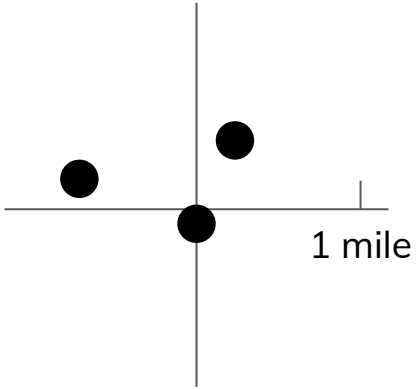

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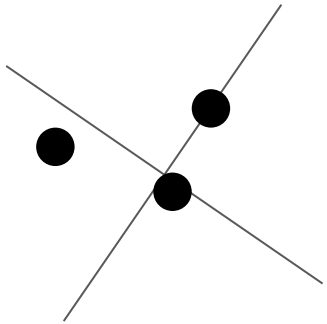

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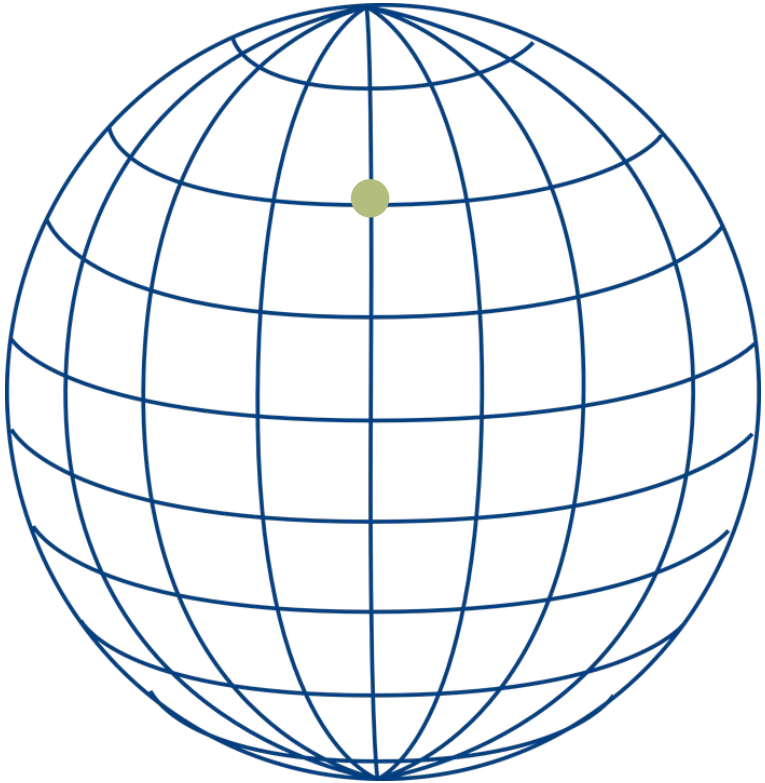
Geodetic datum

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

Geodetic datum



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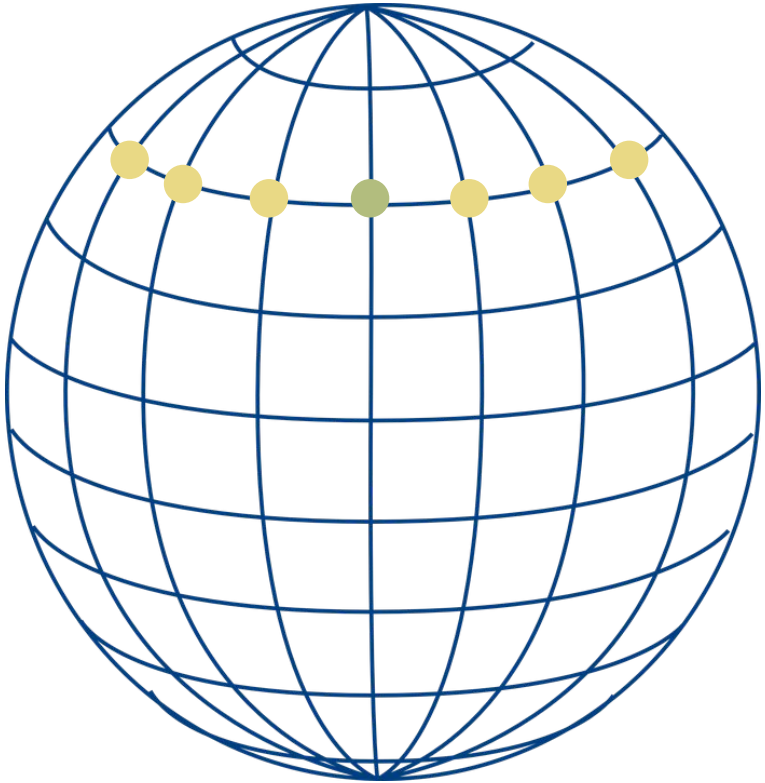

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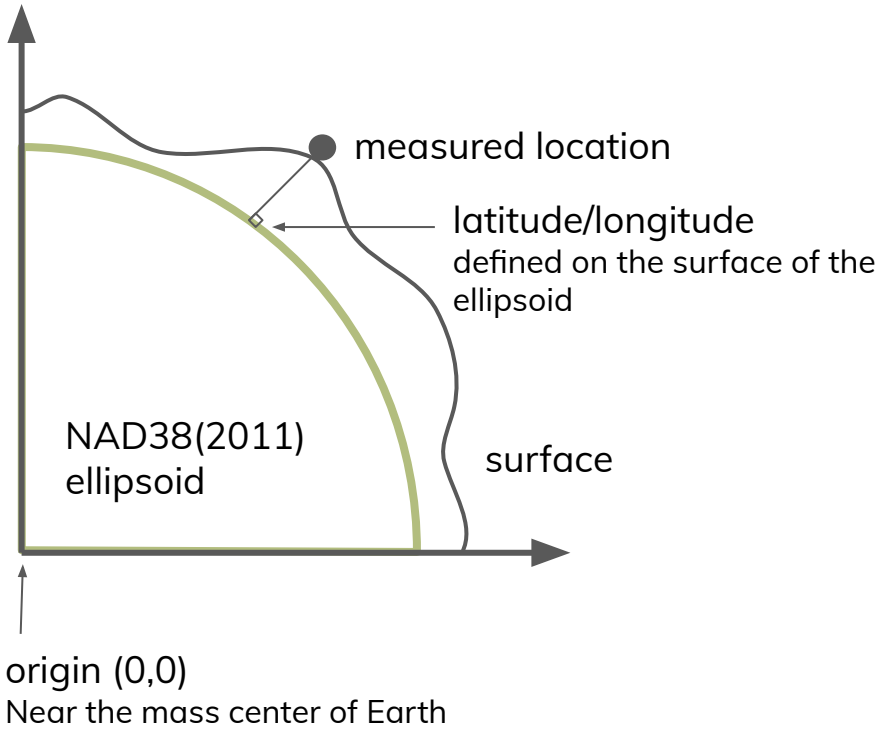
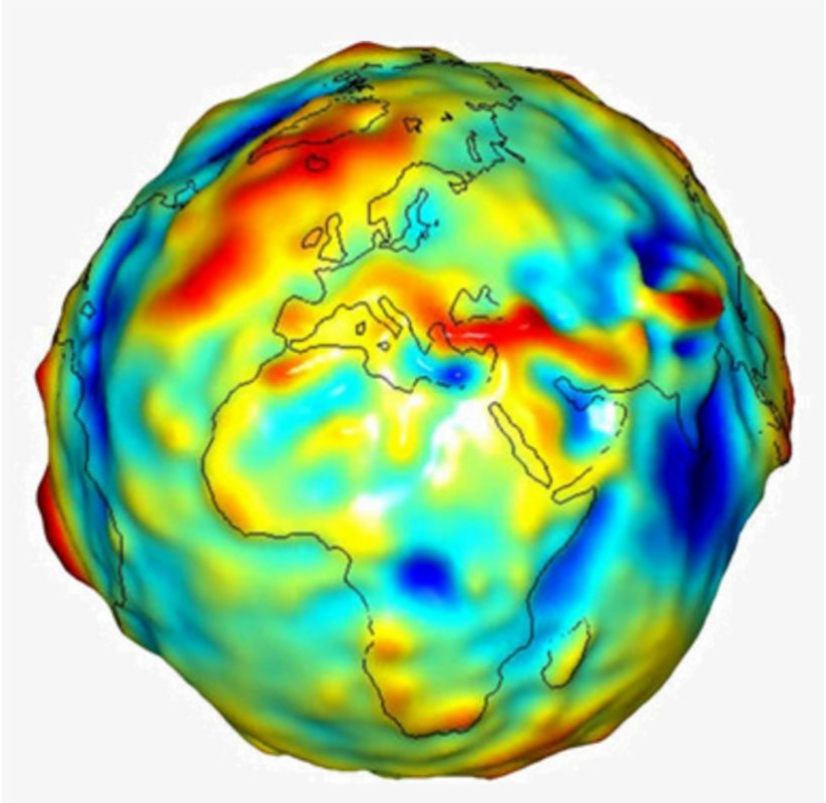


Modified from: GIS Fundamentals, Paul Bolstad

Geodetic datum



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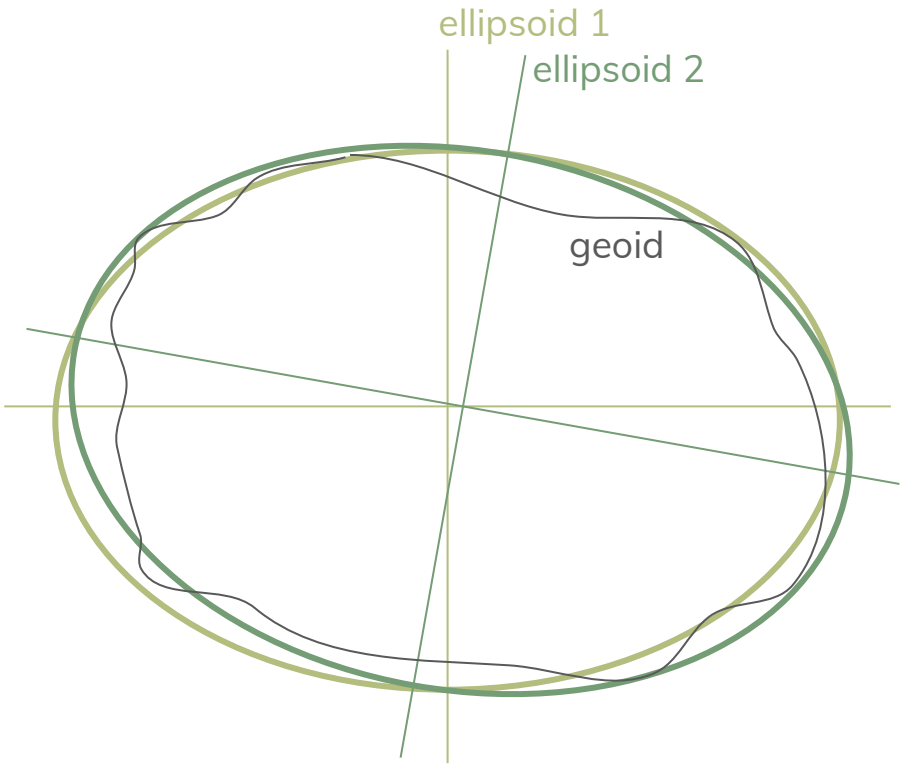

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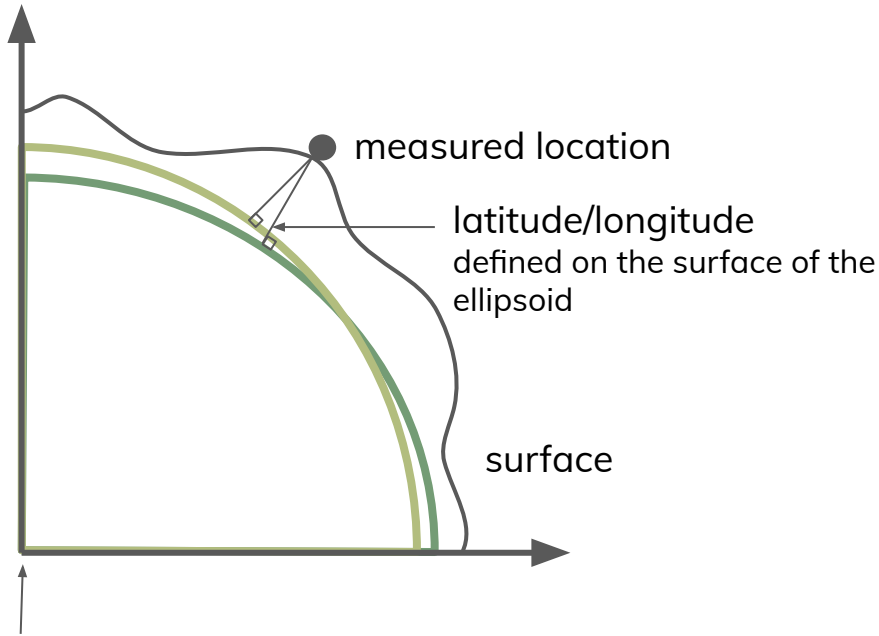

Modified from: GIS Fundamentals, Paul Bolstad

Coordinate reference systems

What does this look like in the real world?

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Modified from: esri.com

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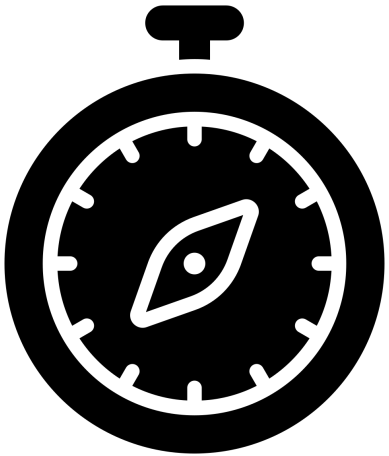

134.577°E, 24.006°S

Modified from: esri.com

Coordinate reference systems

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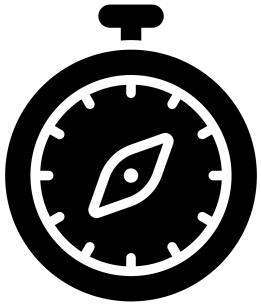
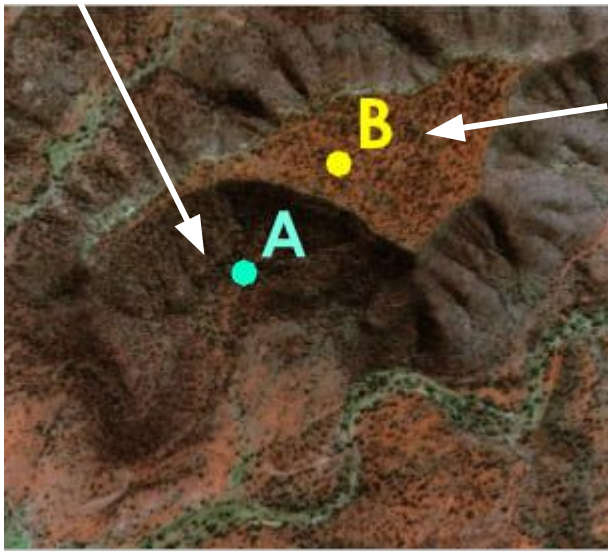


134.577°E, 24.006°S

Australian Geodetic Datum 1984



WGS 1984

Modified from: esri.com

We need a system!

- **Coordinate system**
  - A set of mathematical rules for specifying how coordinates are to be assigned to points
- **Datum**
  - A parameter or set of parameters that define the position of the origin, the scale, and the orientation of a coordinate system
- **Geodetic datum**
  - A datum describing the relationship of a two- or three- dimensional coordinate system to Earth

Coordinate reference system

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

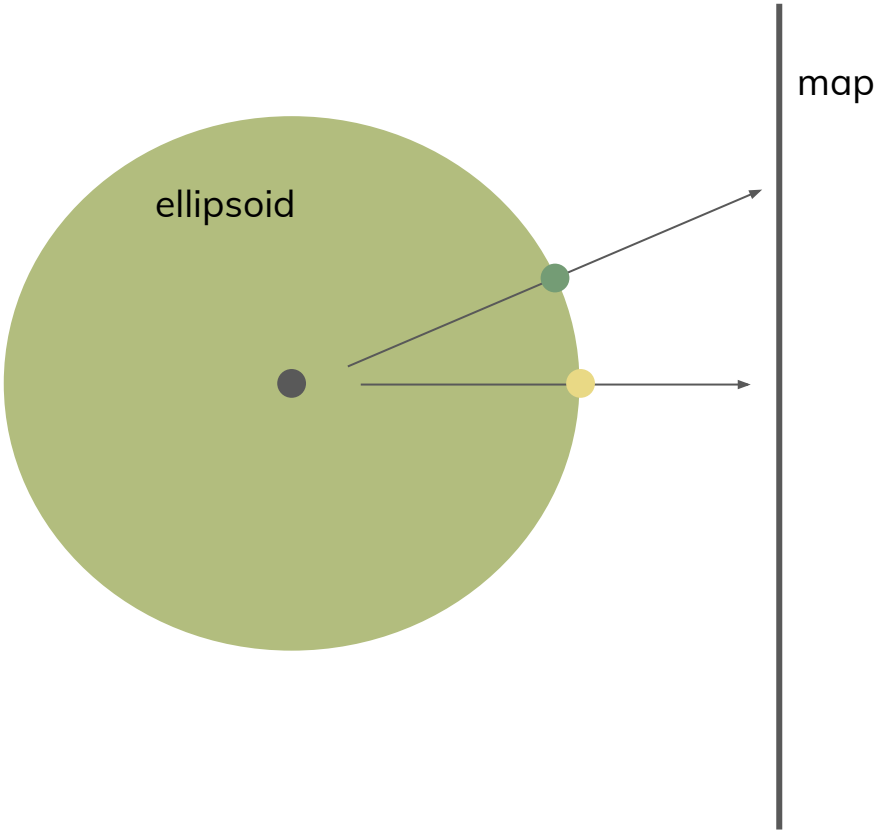
All maps are wrong

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

Projections

Modified from: GIS Fundamentals, Paul Bolstad

Projections



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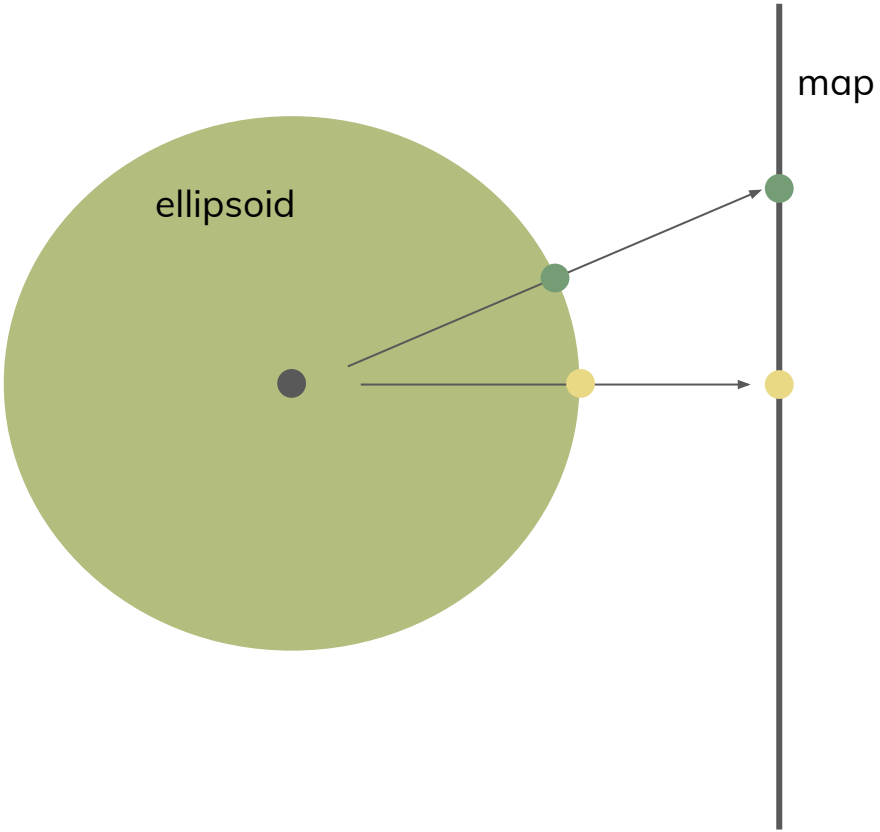
Projections



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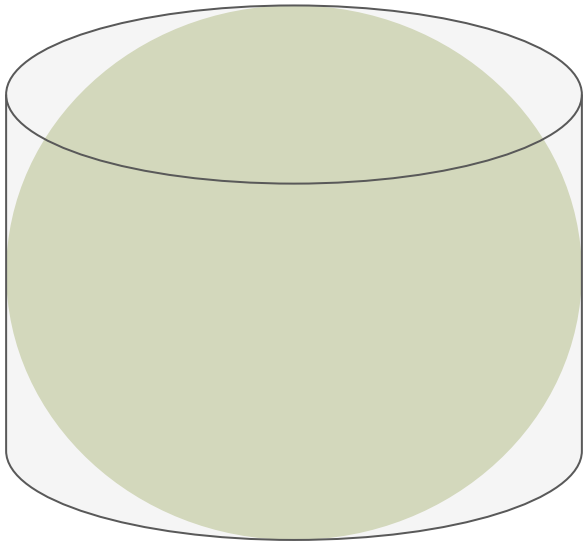
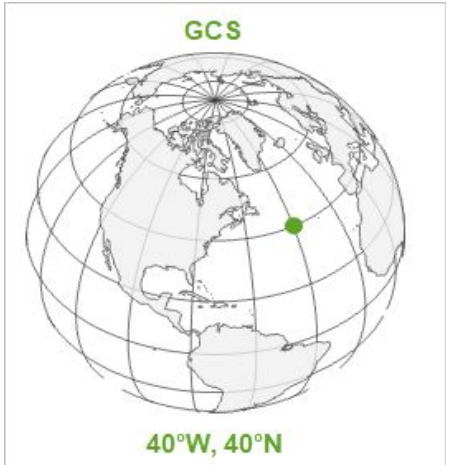


Modified from: GIS Fundamentals, Paul Bolstad

Geographic vs. projected coordinate system

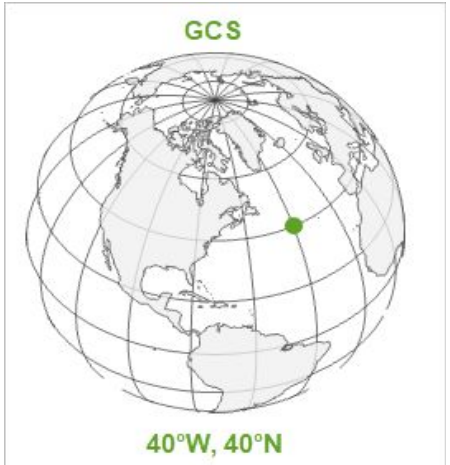
Geographic
Defines where the data is located on Earth
3D
Describes locations as angles



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

Geographic vs. projected coordinate system

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- You can store data in a GCS, but you can’t draw it on a flat map without a PCS
- Picking a GCS depends on where you are mapping
- 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

Projections

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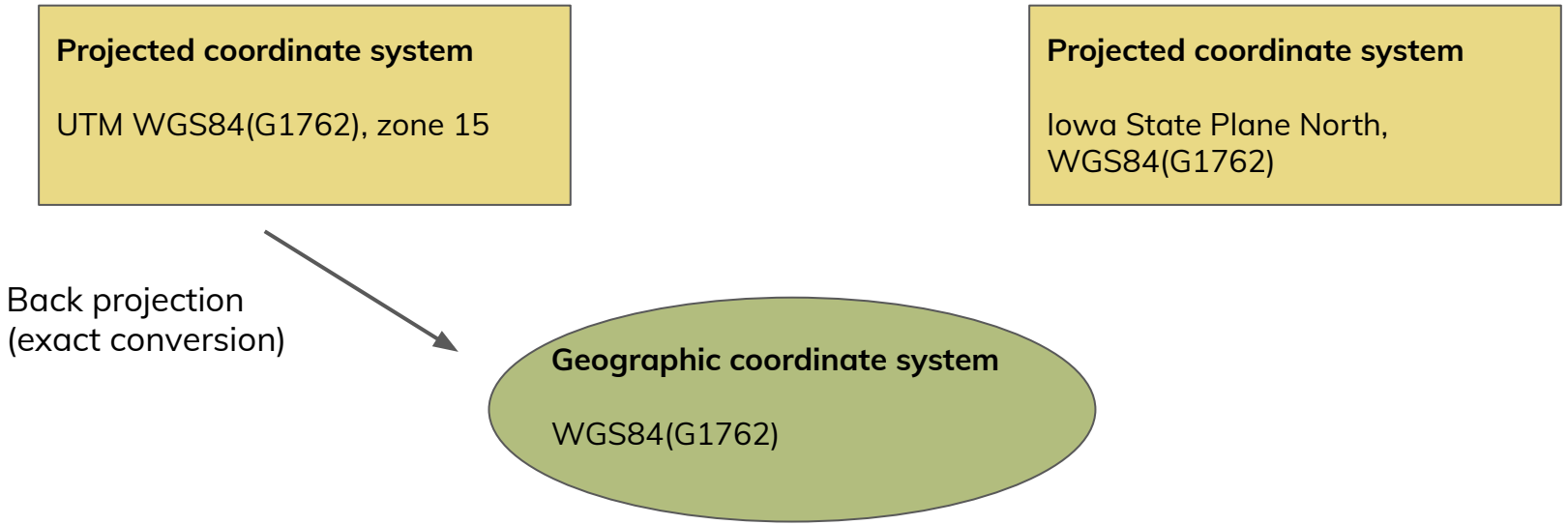

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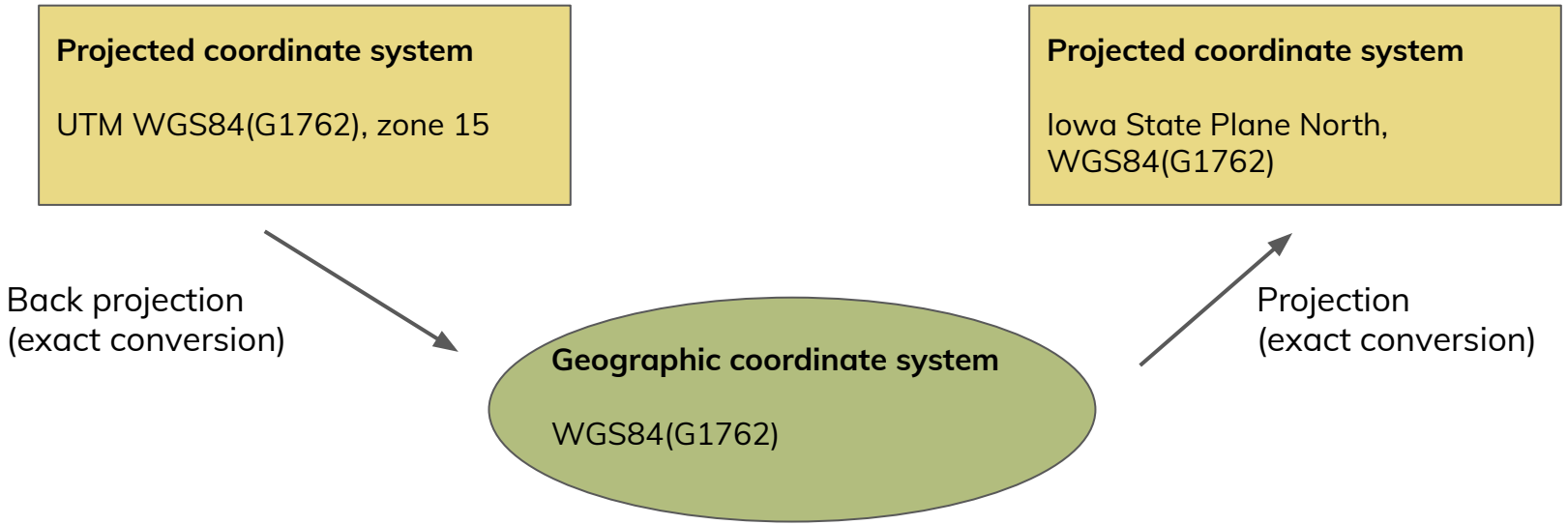


Modified from: GIS Fundamentals, Paul Bolstad

Projections

Changing between projections using *different* datums:

Projected coordinate system

UTM WGS84(G1762), zone 15

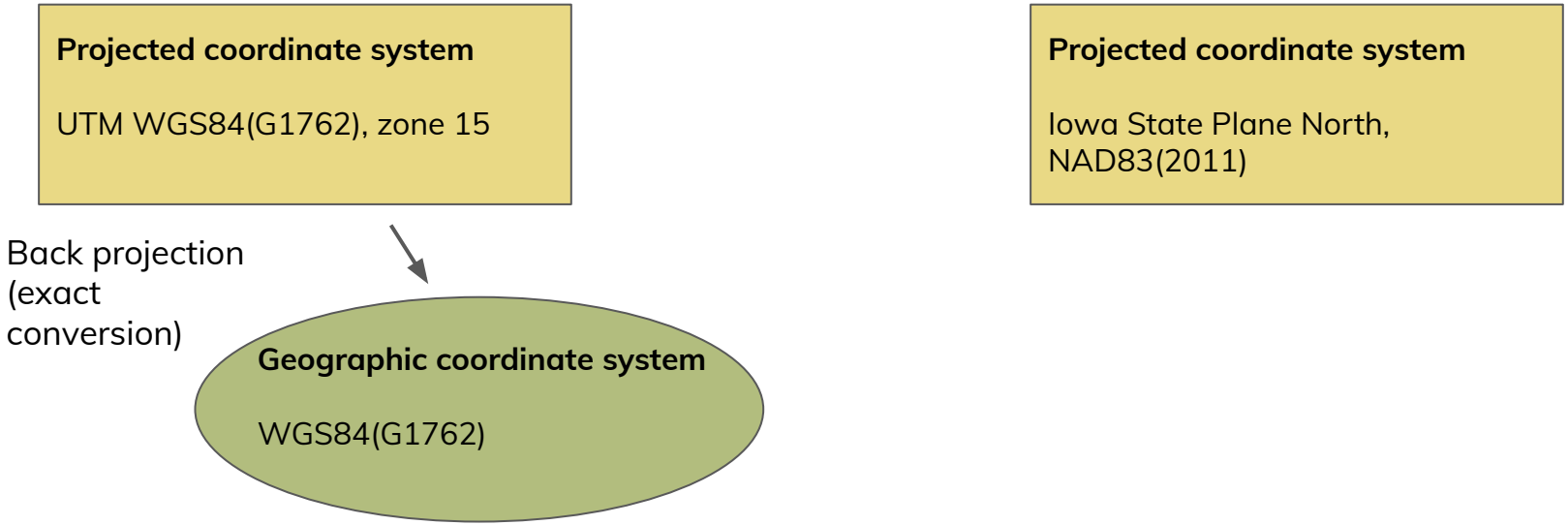
Projected coordinate system

Iowa State Plane North, NAD83(2011)

Modified from: GIS Fundamentals, Paul Bolstad

Projections

Changing between projections using *different* datums:



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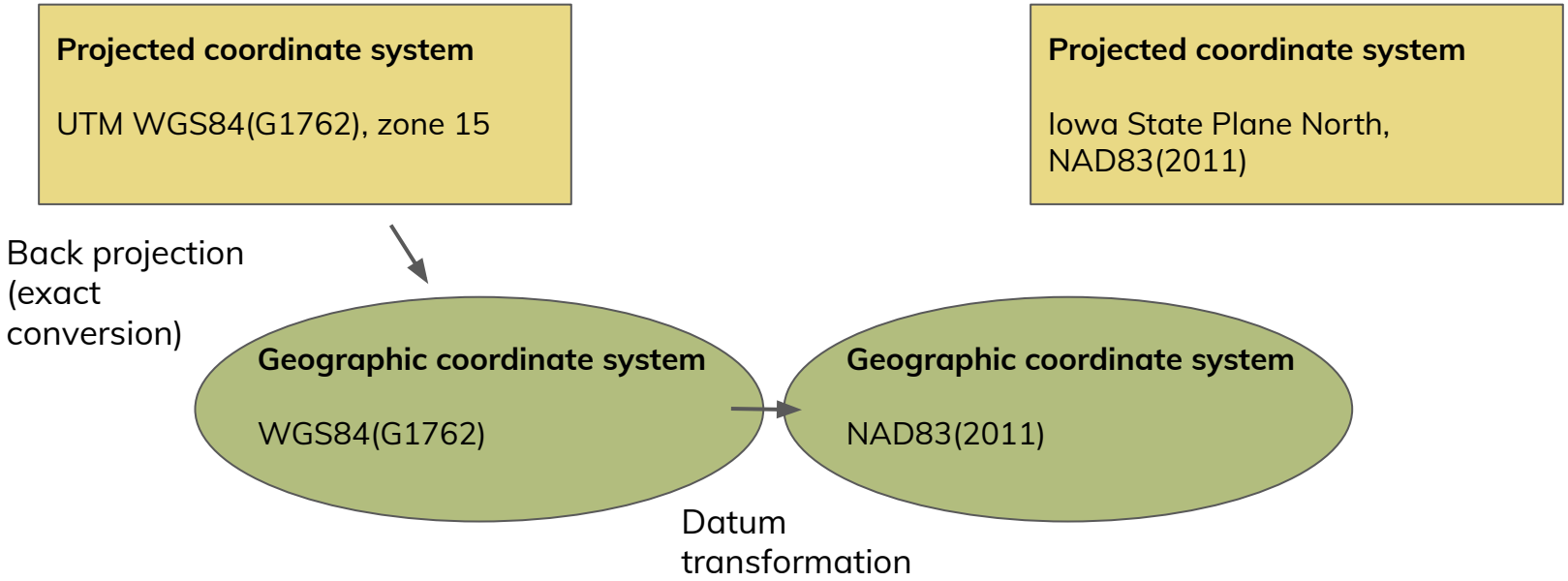

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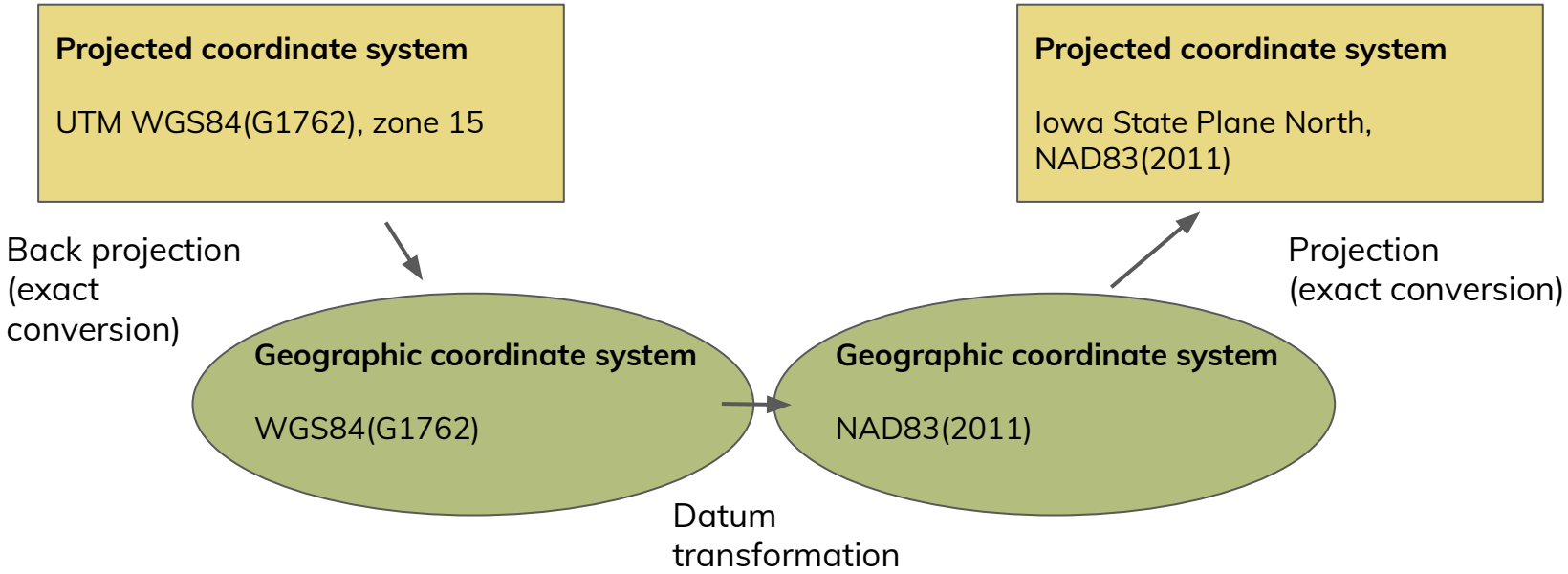

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Summary

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Summary

- **Coordinate reference systems**
  - Coordinate systems
  - Datums and geodetic datums
- **Projections**
  - Geographic vs. projected coordinate systems
  - Basic trade-offs in projections
- **North isn’t up and all maps are wrong!**

Course website

ryoliver.github.io/EDS_223_spatial_analysis