



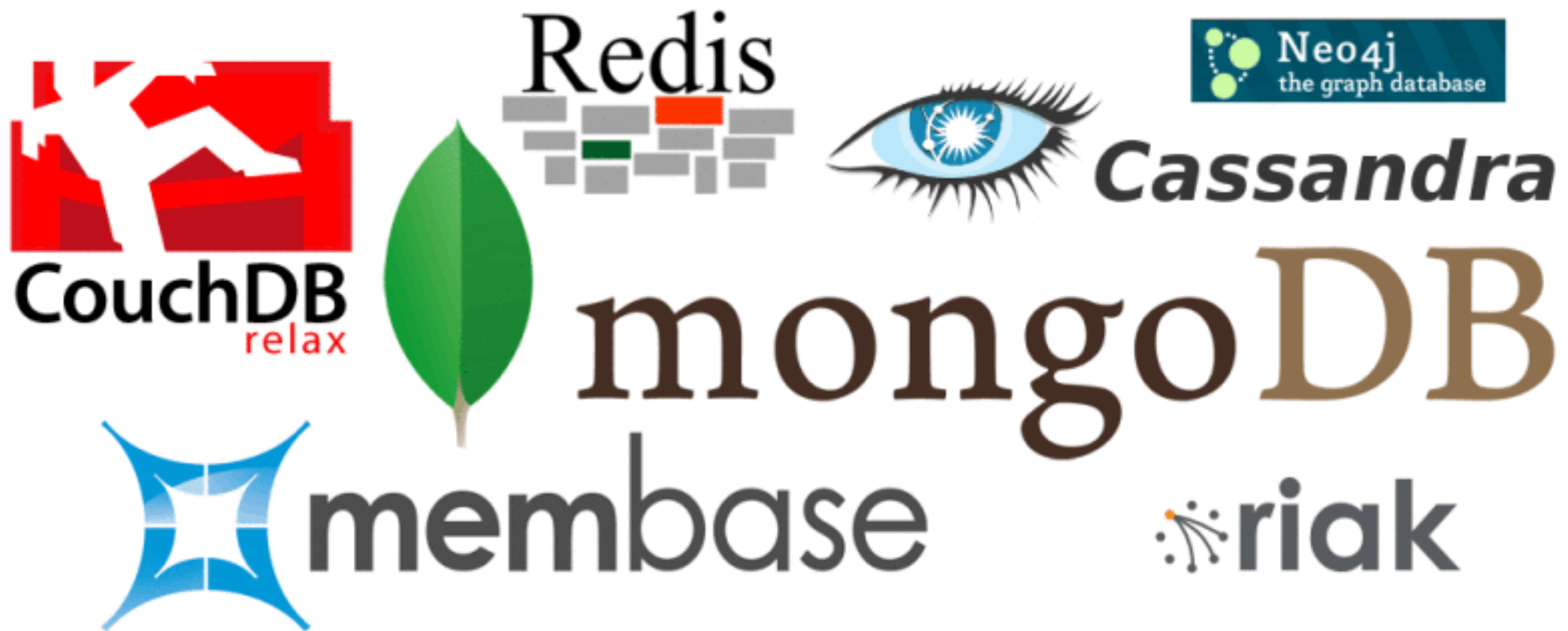
## WORKING WITH GEOLOCATION DATA

DR. MICHAEL FIRE



# Not Only SQL (NoSQL)

- Handles large volumes of structured, semi-structured, and unstructured data
- Scale horizontally on commodity hardware
- No predefined schema



# NoSQL DataTypes

- **Key-value databases** are the simplest NoSQL databases, also known as Dictionaries/Hash Tables. Notable examples: *Redis*, *Dynamo*, and *Memcached*
- **Document databases** are designed for storing, retrieving and managing document-oriented information, also known as semi-structured data. Notable examples: *Elasticsearch*, *MongoDB*, and *Solr*.
- **Graph databases** use graph structures for semantic queries with nodes, edges and properties to represent and store data. Notable examples: *Neo4j* and *Titan*
- **Columnar databases** store data tables by column rather than by row. Notable example: *Cassandra*

Data model ↕	Performance ↕	Scalability ↕	Flexibility ↕	Complexity ↕	Functionality ↕
Key-value store	high	high	high	none	variable (none)
Column-oriented store	high	high	moderate	low	minimal
Document-oriented store	high	variable (high)	high	low	variable (low)
Graph database	variable	variable	high	high	<a href="#">graph theory</a>
Relational database	variable	variable	low	moderate	<a href="#">relational algebra</a>

Performance and scalability comparisons (from [Wikipedia](#))

# SQL vs. NoSQL

The following are some SQL benefits and strengths:

- Mature
- Use SQL support complex queries
- ACID (Atomicity, Consistency, Isolation, Durability)

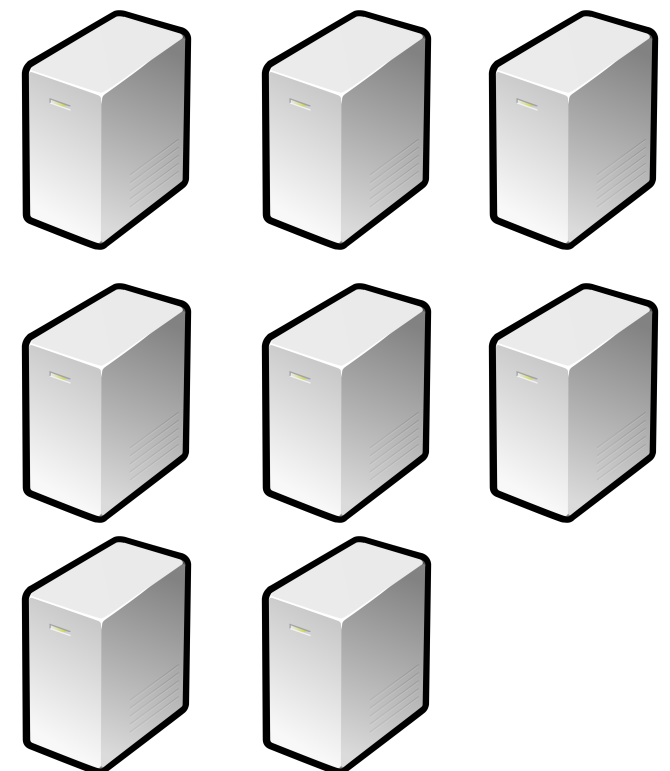
The following are some NoSQL benefits and strengths:

- Horizontally scalable (usually is cheaper than vertically scalable)
- Can have very high performance
- No need for schema

**Vertically Scalable**



**Horizontally Scalable**



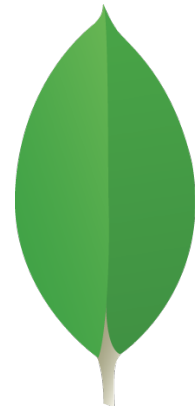
# MongoDB

MongoDB is a **document-oriented database**.

MongoDB uses JSON-like documents

Some of MongoDB features:

- **Rich query model** - supports field, range query, regular expression searches, geospatial queries
- Fields in a document can be **indexed**
- **High availability** with replica sets. A replica set consists of two or more copies of the data.
- **Horizontal scalability**



mongoDB®

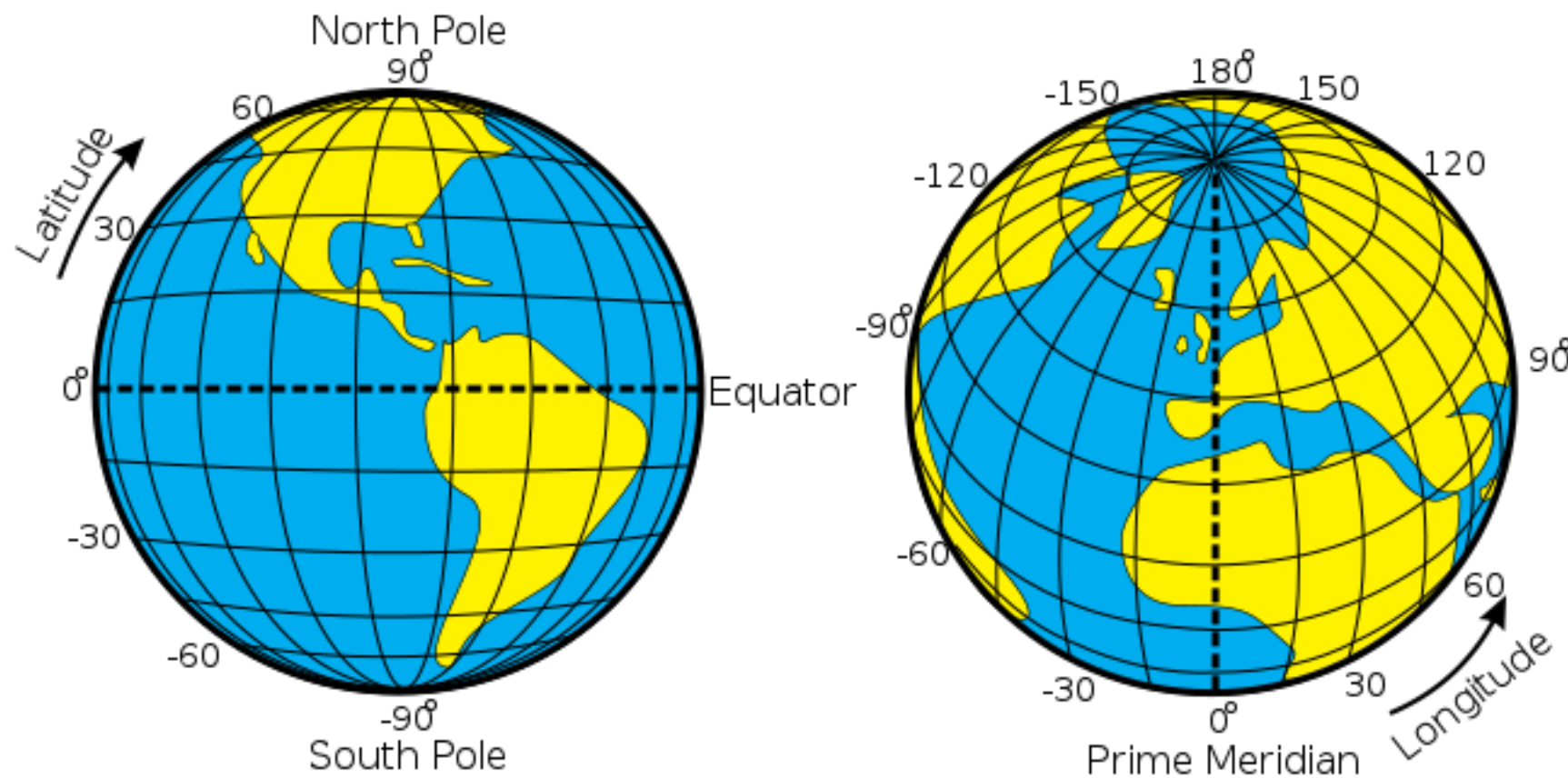


# WORKING WITH GEOGRAPHIC DATA





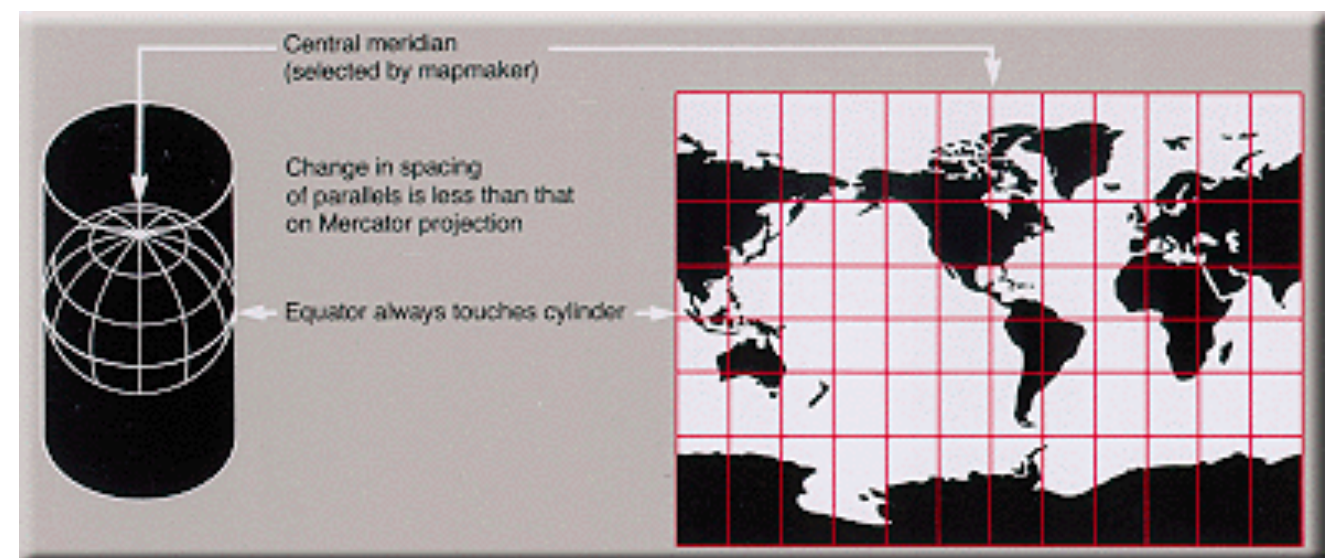
# Geographic Coordinate System



# Map Projection

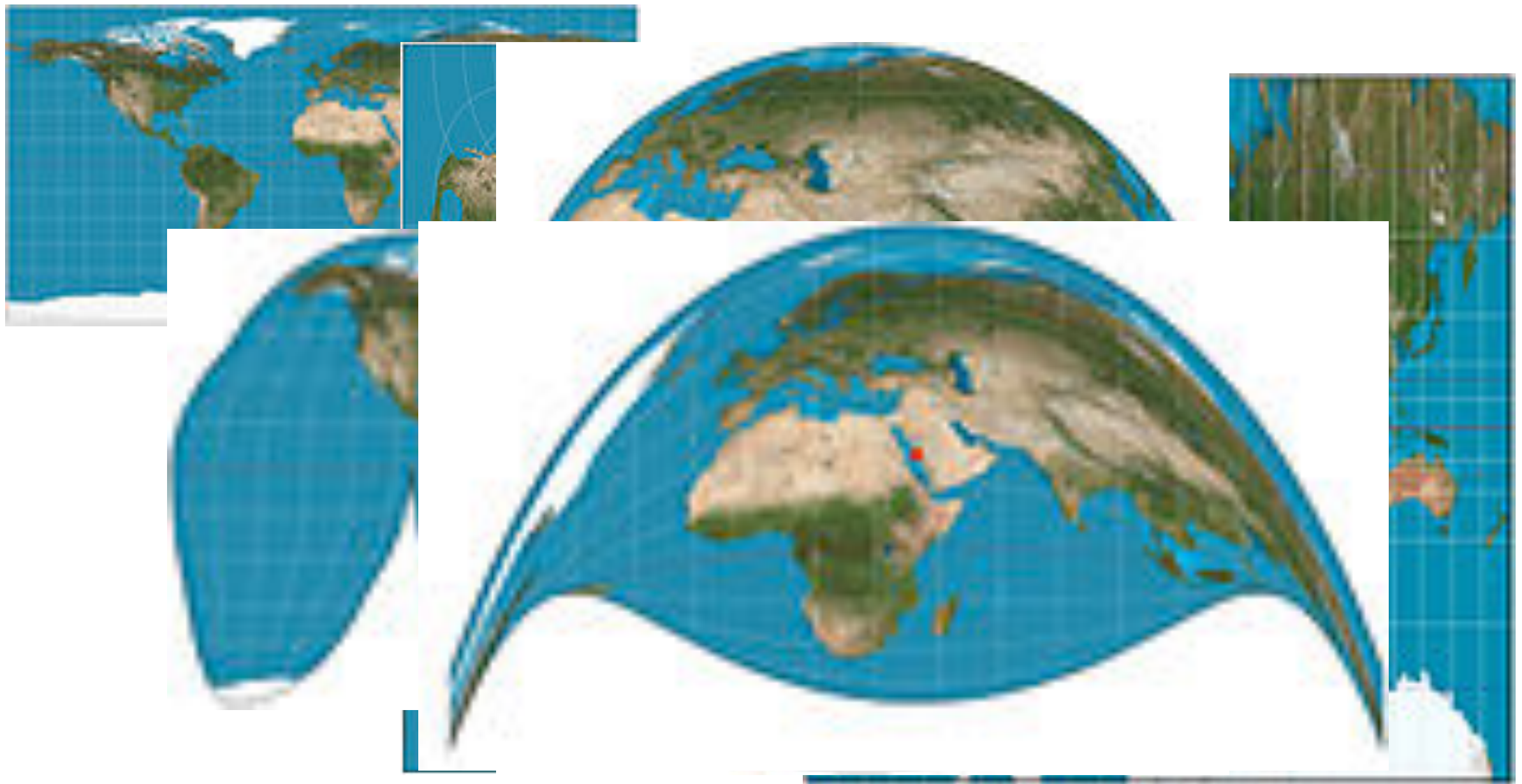
A map projection is a transformation of the latitudes and longitudes of locations from the 3D surface into locations on a plane

**“Projections necessarily distort the surface in some fashion” ([Wikipedia](#))**





# No Limit to the Number of Possible Map Projections





# OpenStreetMaps

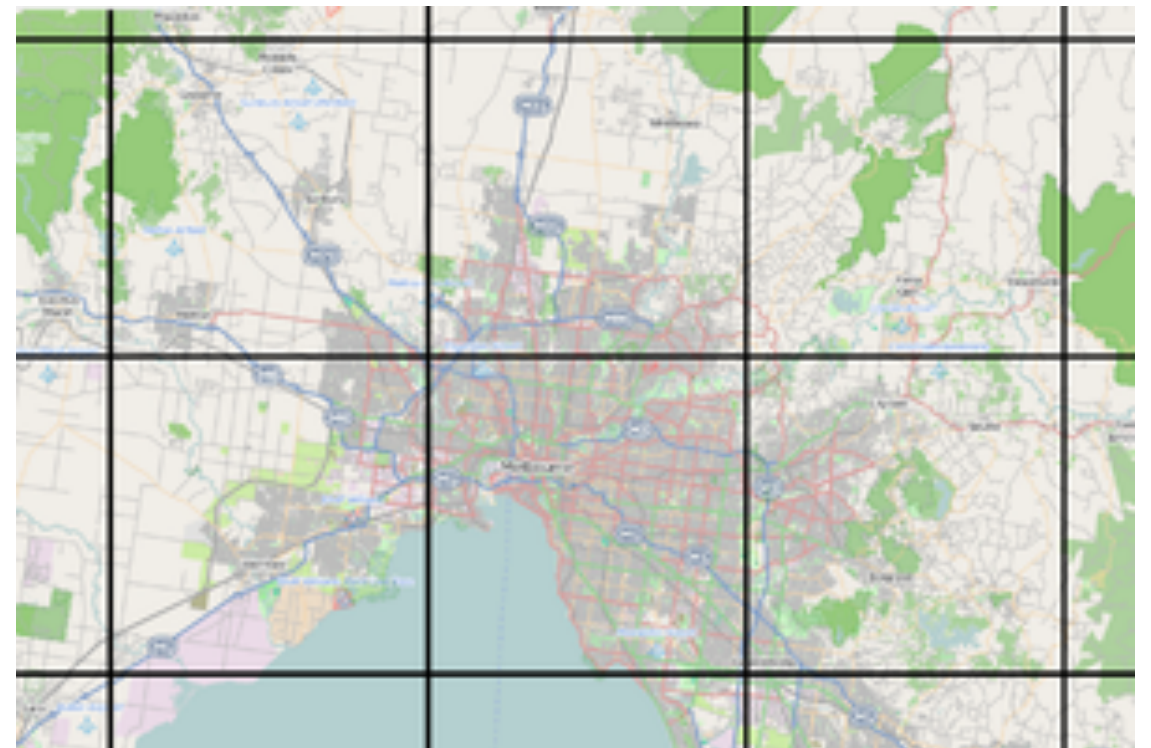
OpenStreetMap (OSM) is a collaborative project to create a free editable map of the world. The creation and growth of OSM has been motivated by restrictions on use or availability of map information across much of the world, and the advent of inexpensive portable satellite navigation devices ([Wikipedia](#))





# Tiled Web-Map

A tiled web map (in OpenStreetMap terminology) or tile map (raster or vector) is a map displayed in a browser by seamlessly joining dozens of individually requested image files over the internet ([OpenStreetMap](https://openstreetmap.org))





# GeoJSON/TopoJSON

**GeoJSON** is an open standard format designed for representing simple geographical features, along with their non-spatial attributes. It is based on JSON ([Wikipedia](#))

**TopoJSON** is an extension of GeoJSON that encodes topology. Rather than representing geometries discretely, geometries in TopoJSON files are stitched together from shared line segments called arcs. TopoJSON eliminates redundancy, allowing related geometries to be stored efficiently in the same file. ([Wikipedia](#))



# Tools for Visualizing Geographic Data

- [Cartopy](#)
- [GeoPandas](#)
- [Folium](#)
- [Altair](#)
- [Basemap](#)
- [keplar.gl](#)

# Recommended Read:

- [PyMongo 3.9 Tutorial](#)
- Python Data Science Handbook, [Chapter 4](#) by Jake VanderPlas
- [Interactive Maps in Python](#) by Earth Lab
- [Getting started with Google Maps in Python](#) by Elliott Saslow
- [Plotly Express Gallery](#)
- [Plotting with Geoplot and GeoPandas](#)