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CHANGE THE WORLD FROM HERE

Geospatial Data

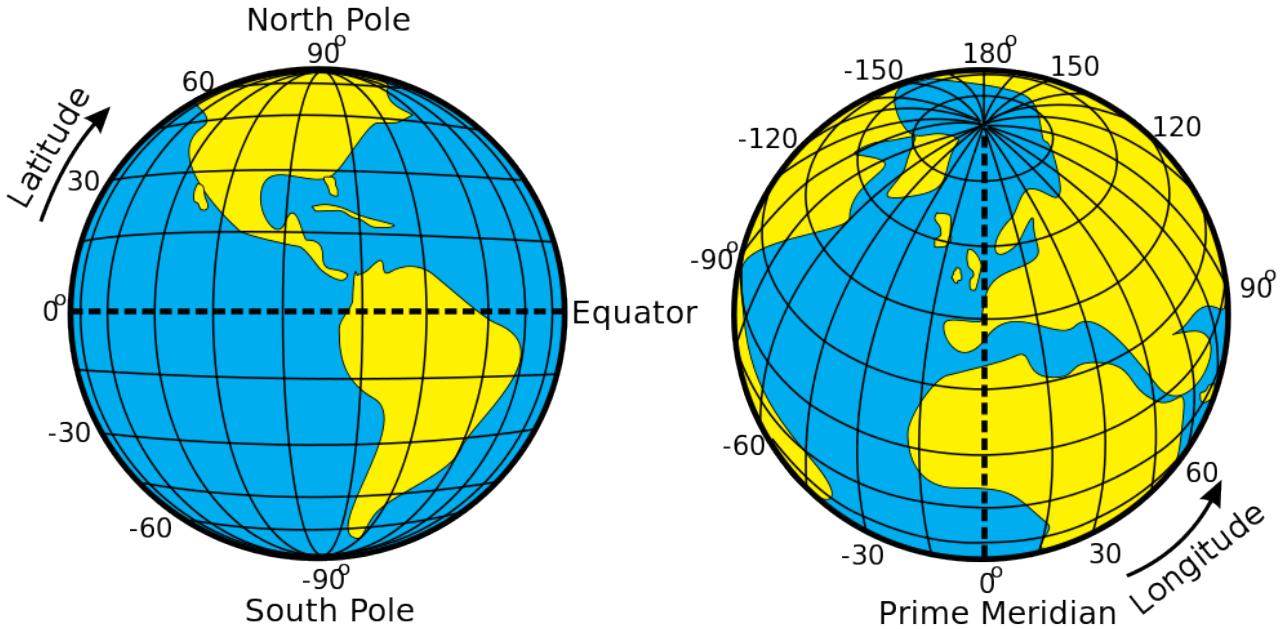
Data Formats and Map Projections

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science

GEOSPATIAL DATA

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

Latitude and Longitude



http://en.wikipedia.org/wiki/File:Latitude_and_Longitude_of_the_Earth.svg

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

Latitude and Longitude

- **DMS (Degree, Minutes, Seconds):**
  - Latitude: 40°26'47"N
  - Longitude: 79°58'36"W
- **Decimal Degree:**
  - Latitude: 40.446195
  - Longitude: -79.948862

http://en.wikipedia.org/wiki/Geographic_coordinate_conversion

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

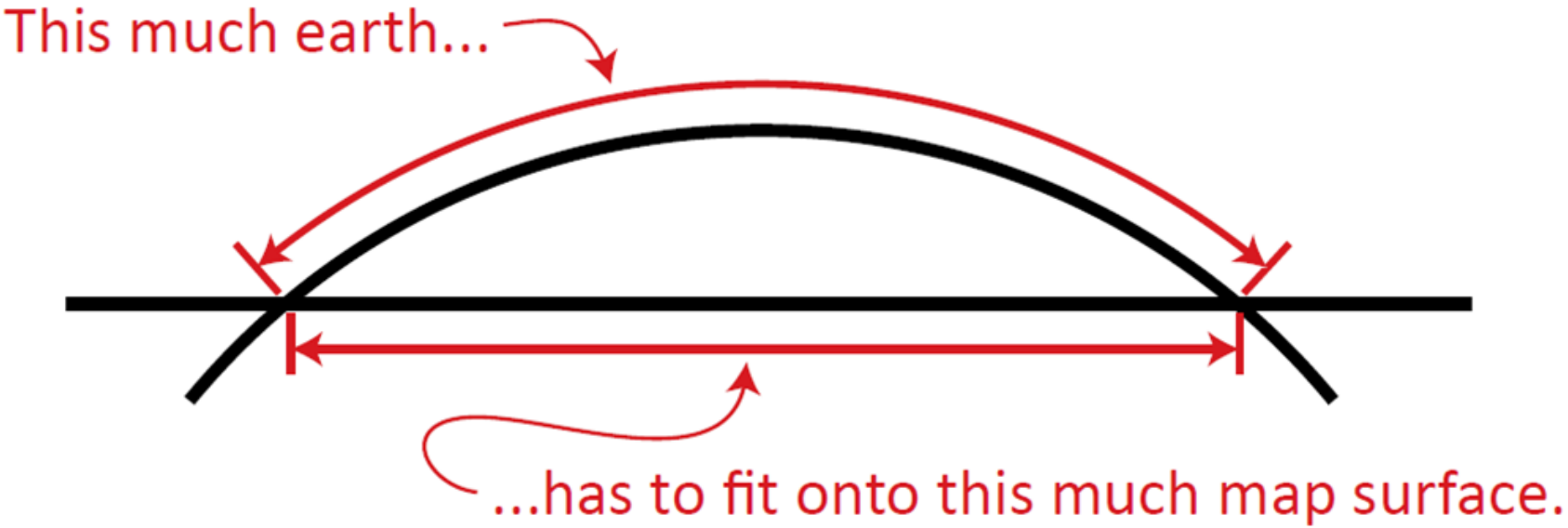
MAP PROJECTIONS

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science

Map Projections

- World is 3D, maps are 2D
  - Earth is a *ellipsoid(ish)*, not a perfect *sphere*
- Must project 3D coordinates onto 2D surface
  - True of rendering any 3D object in 2D
- All projections cause some sort of distortion

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO



http://mjfoster83.github.io/projections/index.html#/38

Projection Distortion

- **Distance** between two points
- **Direction** between two points
- **Shape** of regions
- **Area** of regions

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

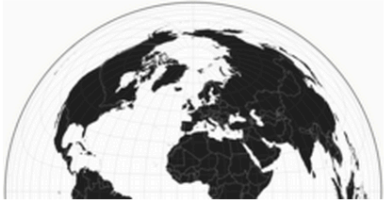
Types of Projections

- **Azimuthal**
  - Preserves the azimuth (direction) from center
- **Conformal**
  - Local angles are correct, preserving small shapes
- **Equal-Area**
  - All regions have correct area
- **Equidistant**
  - Distances from center (or along certain lines, like along meridians) are correct

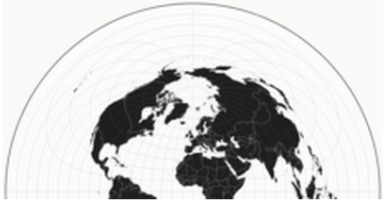
http://egsc.usgs.gov/isb/pubs/MapProjections/projections.html

d3.geo.albersUsa

d3.geo.azimuthalEqualArea



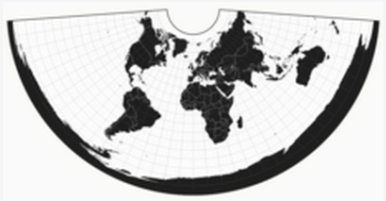
d3.geo.azimuthalEquidistant



d3.geo.conicEqualArea

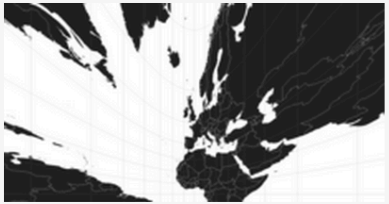
d3.geo.conicConformal

d3.geo.conicEquidistant



d3.geo.equirectangular

d3.geo.gnomonic



d3.geo.mercator

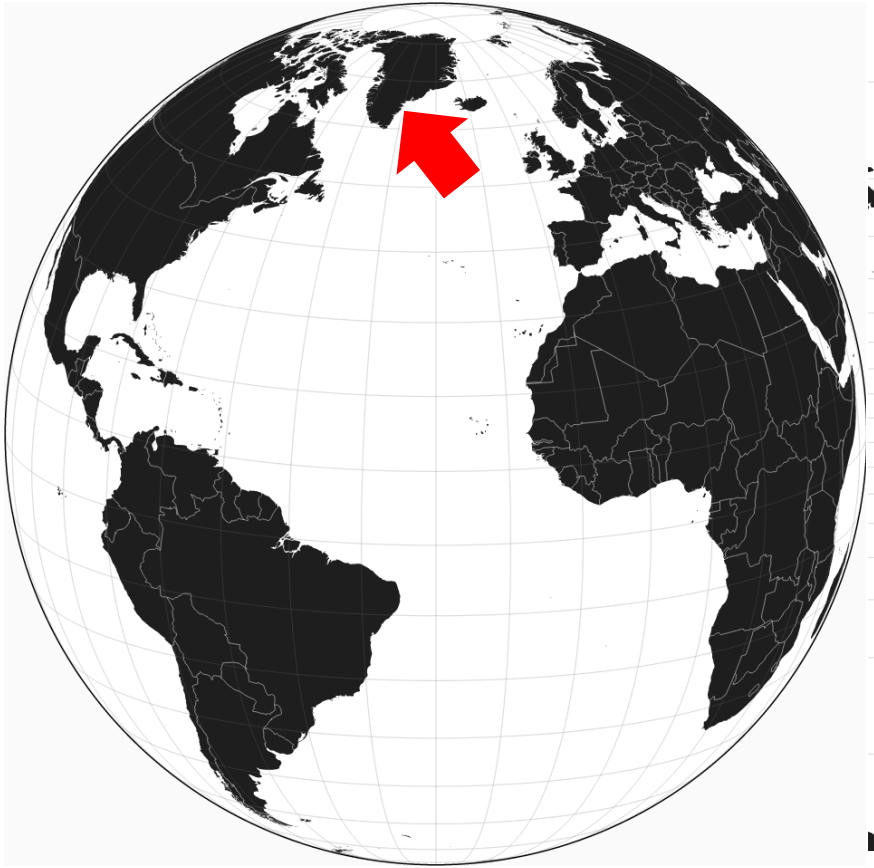
d3.geo.orthographic

d3.geo.stereographic

d3.geo.transverseMercator

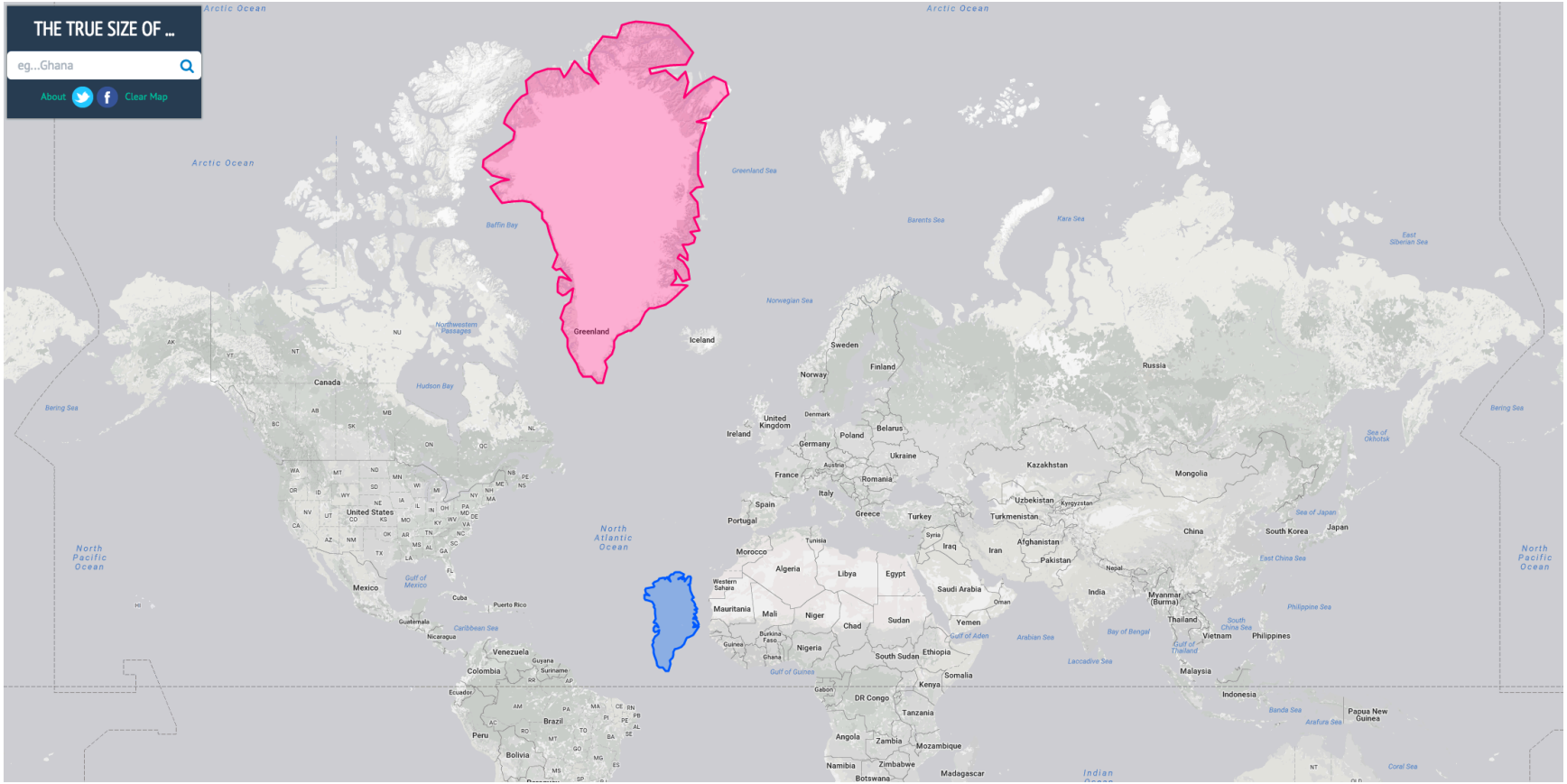
https://github.com/d3/d3-geo and https://github.com/d3/d3-geo-projection

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science



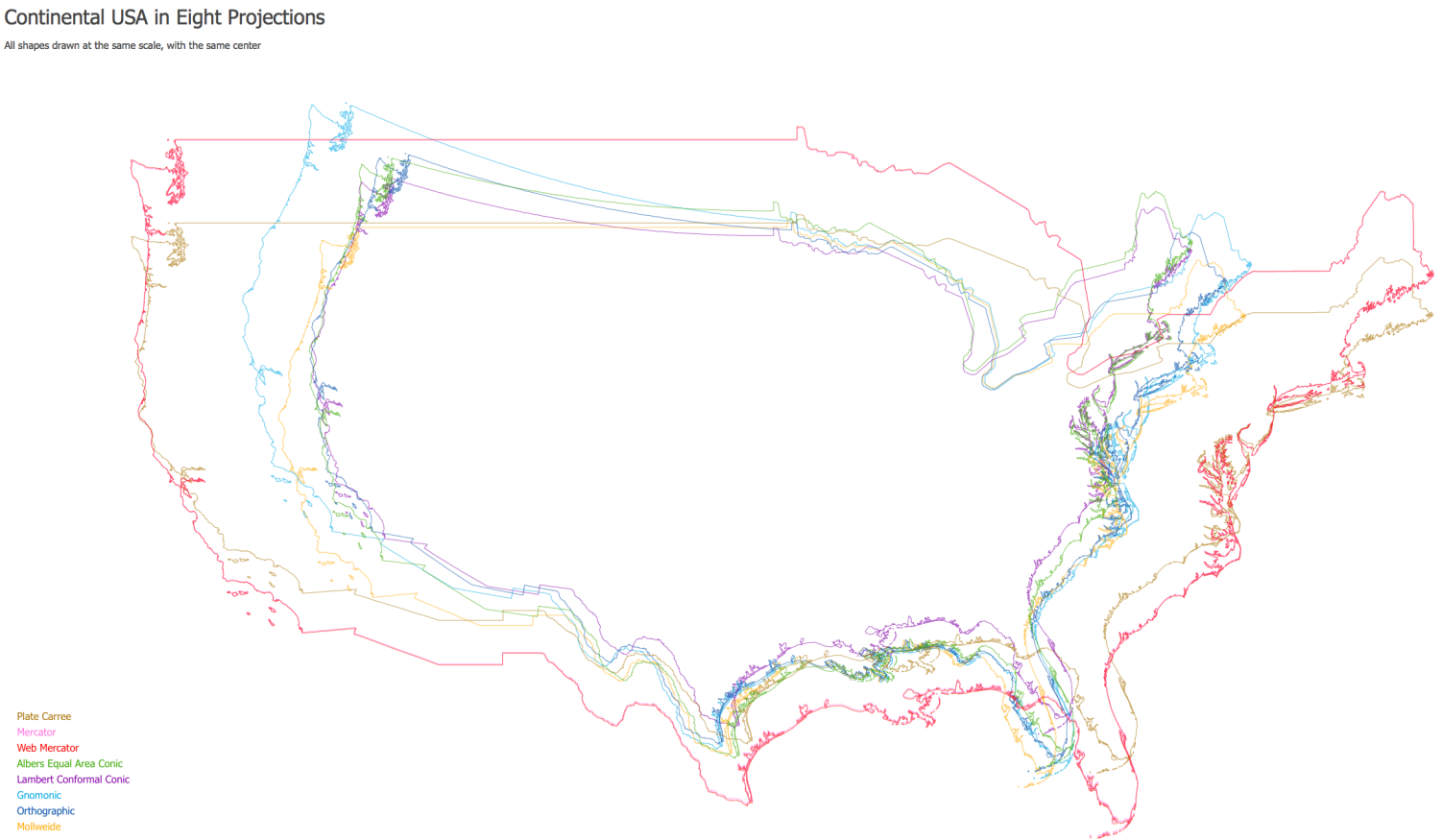
https://github.com/d3/d3-geo#geoOrthographic and https://github.com/d3/d3-geo#geoMercator

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO



http://thetruesize.com/

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO



http://sandbox.azavea.com/projection-overlays/contiguous-usa.html (no longer works)

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

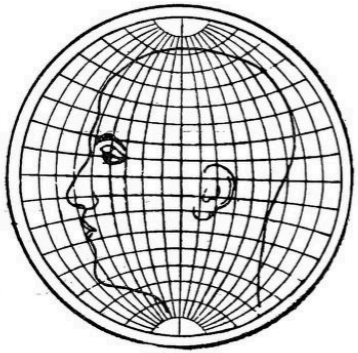


FIG. 42.—Man's head drawn on globular projection.

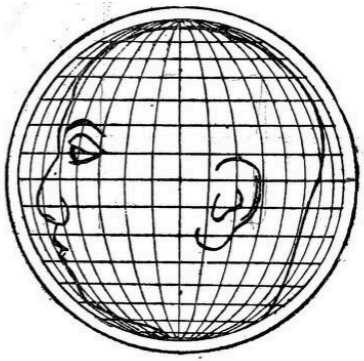


FIG. 43.—Man's head plotted on orthographic projection.

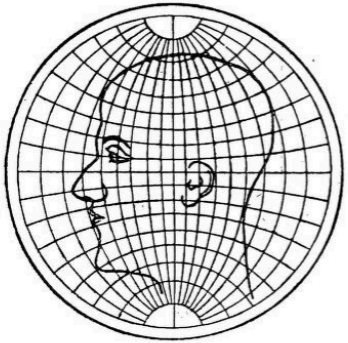


FIG. 44.—Man's head plotted on stereographic projection.

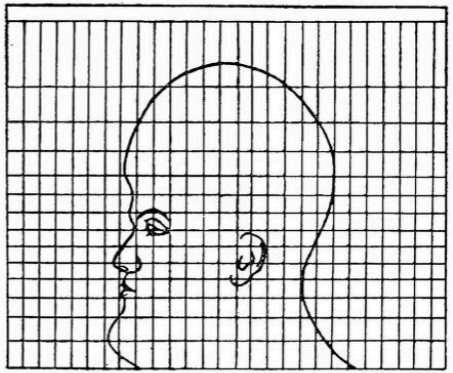
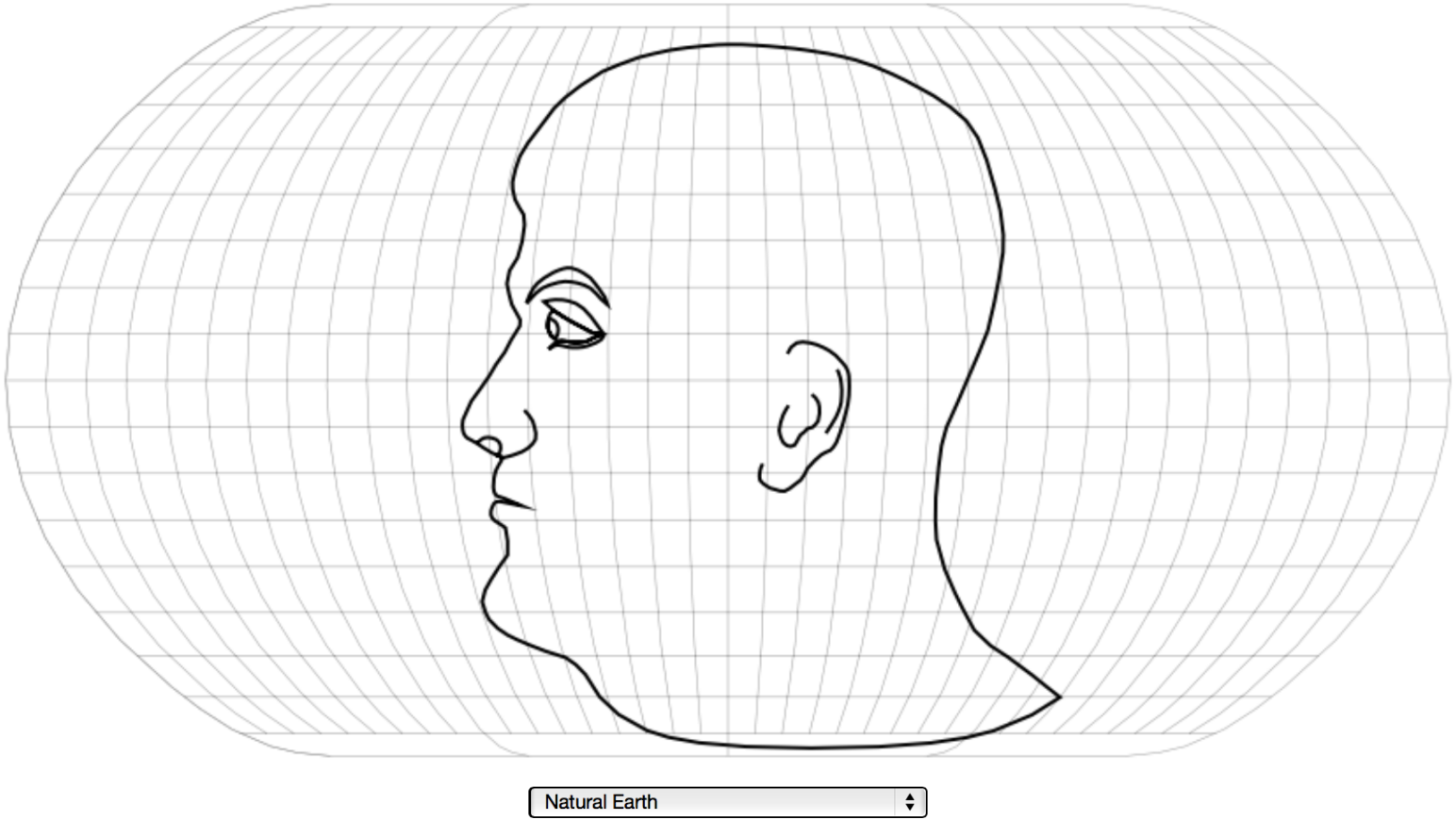


FIG. 45.—Man's head plotted on Mercator projection.

http://flowingdata.com/2014/01/13/map-projections-illustrated-with-a-face/

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science



http://bl.ocks.org/awoodruff/9216081

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

Mercator Projection

$$x = \lambda - \lambda_0$$

$$y = \ln\left(\tan\phi + \sec\phi\right)$$

where λ is the **longitude** and ϕ is the **latitude**, and λ_0 is the center longitude of the projection

http://mathworld.wolfram.com/MercatorProjection.html

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

https://www.google.com/maps/

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

GEOSPATIAL DATA FORMATS

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

Shapefiles

- Used by GIS software in early 1990s
- Geometry given as points, polylines, or polygons
- Consists of several files
  - *.shp contains geometry information
  - *.shx contains index information
  - *.dbf contains attribute information
- Specified at different resolutions
  - 1:10m (state-level), 1:110m (world-level)

http://wiki.openstreetmap.org/wiki/Shapefiles

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

GeoJSON

- JSON-based standard for geospatial data on web
- May include a geometry, feature, or collection of features
- Geometry types include Point, LineString, Polygon, MultiPoint, MultiLineString, MultiPolygon, and GeometryCollection
- Can add additional data in JSON format

http://www.geojson.org/geojson-spec.html

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

GeoJSON

```
{ "type": "FeatureCollection",
  "features": [
    { "type": "Feature",
      "geometry": {"type": "Point", "coordinates": [102.0, 0.5]},
      "properties": {"prop0": "value0"}
      },
    { "type": "Feature",
      "geometry": {
        "type": "LineString",
        "coordinates": [
          [102.0, 0.0], [103.0, 1.0], [104.0, 0.0], [105.0, 1.0]
          ]
        },
      "properties": {
        "prop0": "value0",
        "prop1": 0.0
        }
      },
```

http://www.geojson.org/geojson-spec.html

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

Shapefiles to GeoJSON

- Shapefiles too large to load in web applications
- Use MapShaper to simplify files:
  - http://www.mapshaper.org/
- See steps to convert shapefiles at:
  - http://bost.ocks.org/mike/map/ (v3)
  - https://medium.com/@mbostock/command-line-cartography-part-1-897aa8f8ca2c (v4)

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

TopoJSON

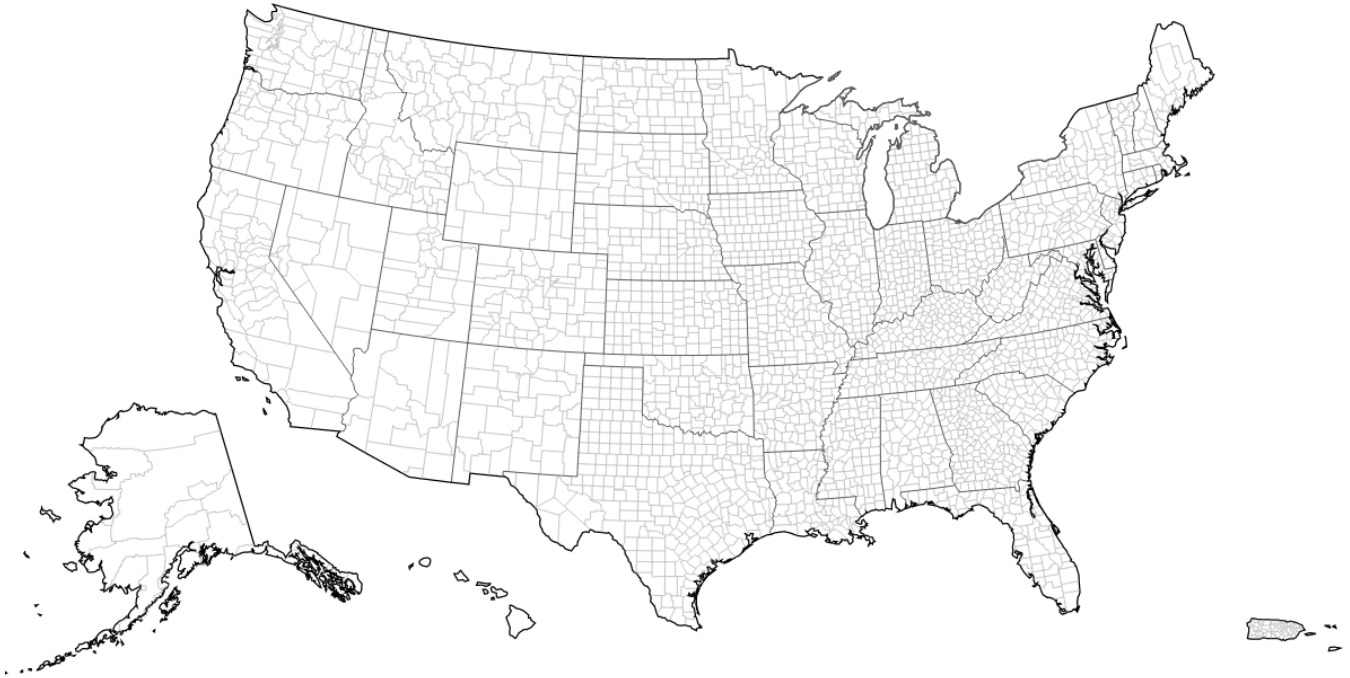
- Extension of GeoJSON that provides smaller files
- Details at https://github.com/topojson/topojson
- Works well with D3 (created by same person)

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

RESOURCES

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

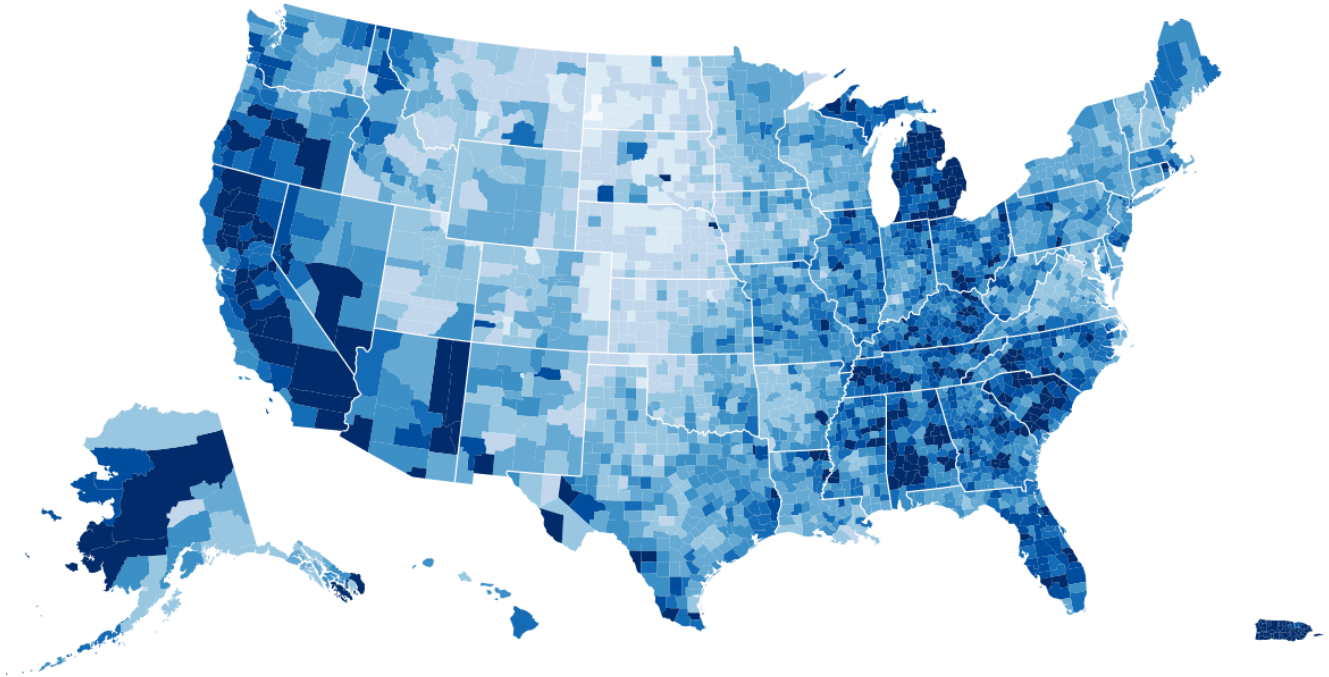
U.S. TopoJSON



http://bl.ocks.org/mbostock/4108203 (v4)

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

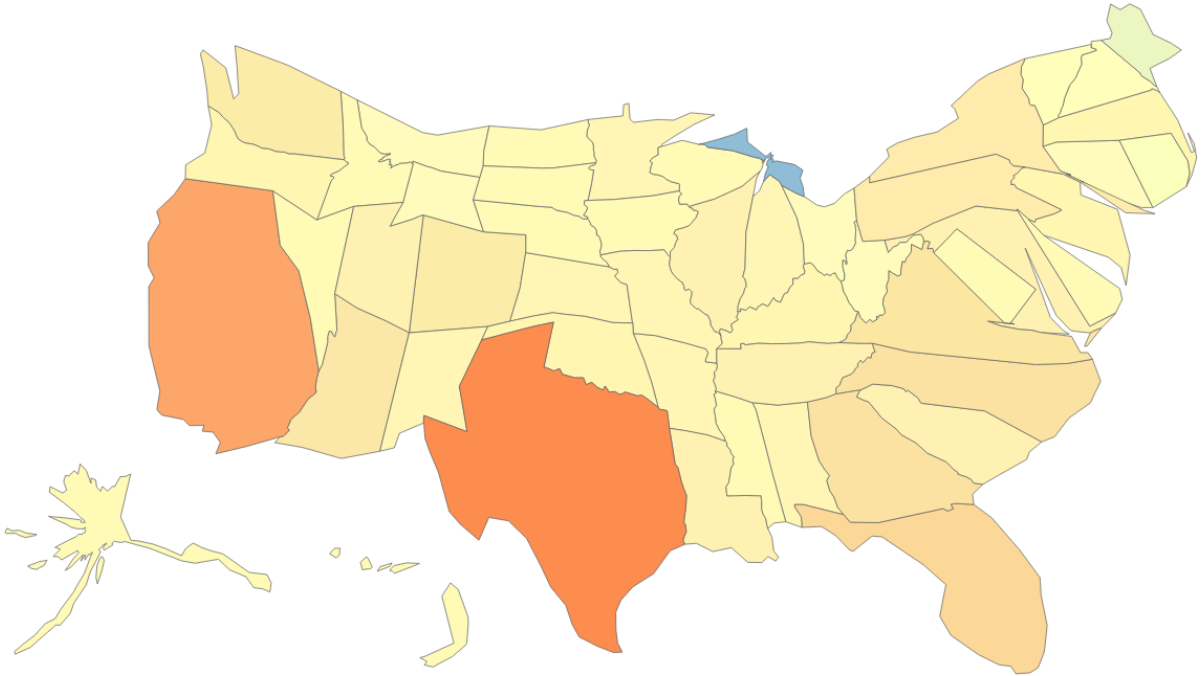
D3/TopoJSON Choropleth



http://bl.ocks.org/mbostock/4060606 (v4)

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

D3/TopoJSON Cartogram



http://prag.ma/code/d3-cartogram/

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

Other JavaScript Libraries

- Kartograph.js http://kartograph.org/
- Leaflet http://leafletjs.com/
- Polymaps http://polymaps.org/
- Google Maps JavaScript API https://developers.google.com/maps/documentation/javascript/tutorial

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

Data Sources

- TopoJSON
  https://github.com/topojson
- Earthquake GeoJSON Data Files
  http://earthquake.usgs.gov/earthquakes/feed/
- Geospatial Data.gov
  https://catalog.data.gov/dataset?metadata_type=geospatial
- Natural Earth
  http://www.naturalearthdata.com/

Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science
UNIVERSITY OF SAN FRANCISCO

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Sophie Engle ◆ sjengle@cs.usfca.edu
Department of Computer Science