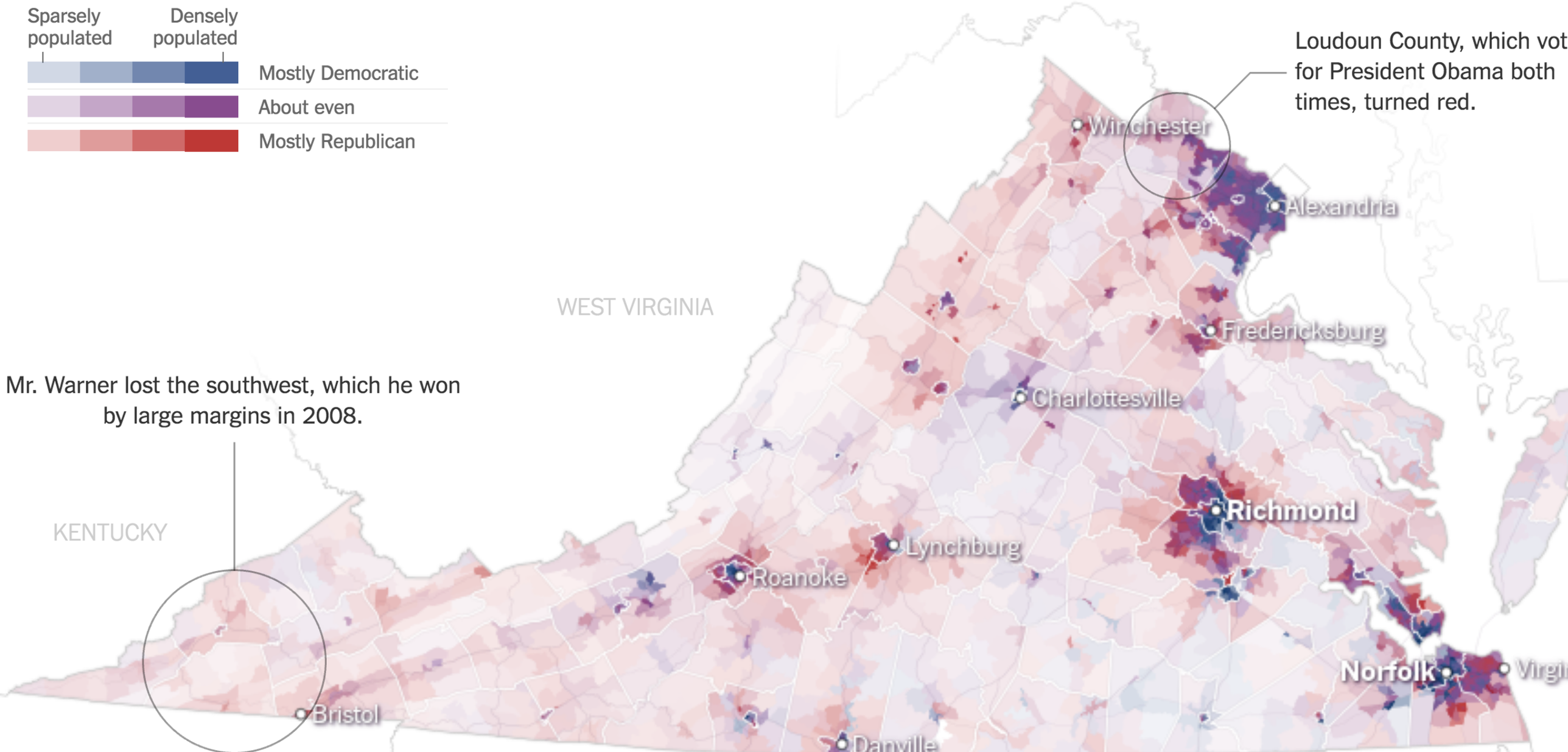
Cartography

CSC444

Announcements…

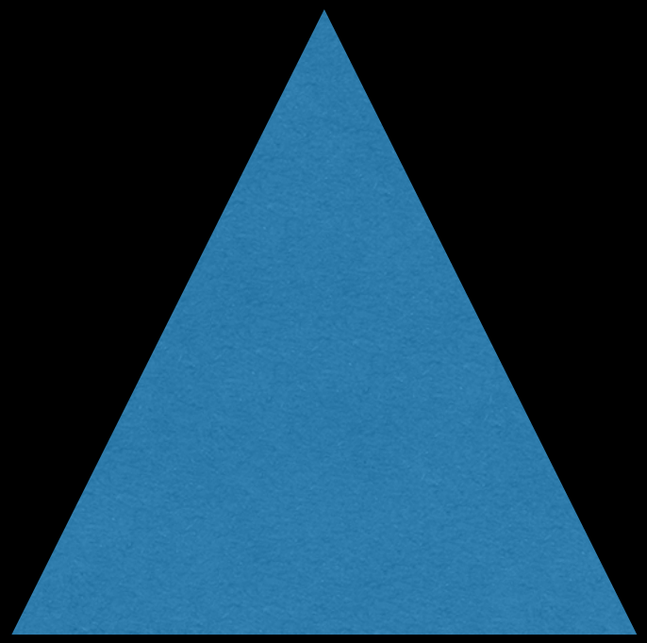
- TCE website open - please fill it out!

Why draw a map, and why isn’t it trivial?



The world is not flat!

What do the internal angles of a triangle sum to?



The world is not flat!

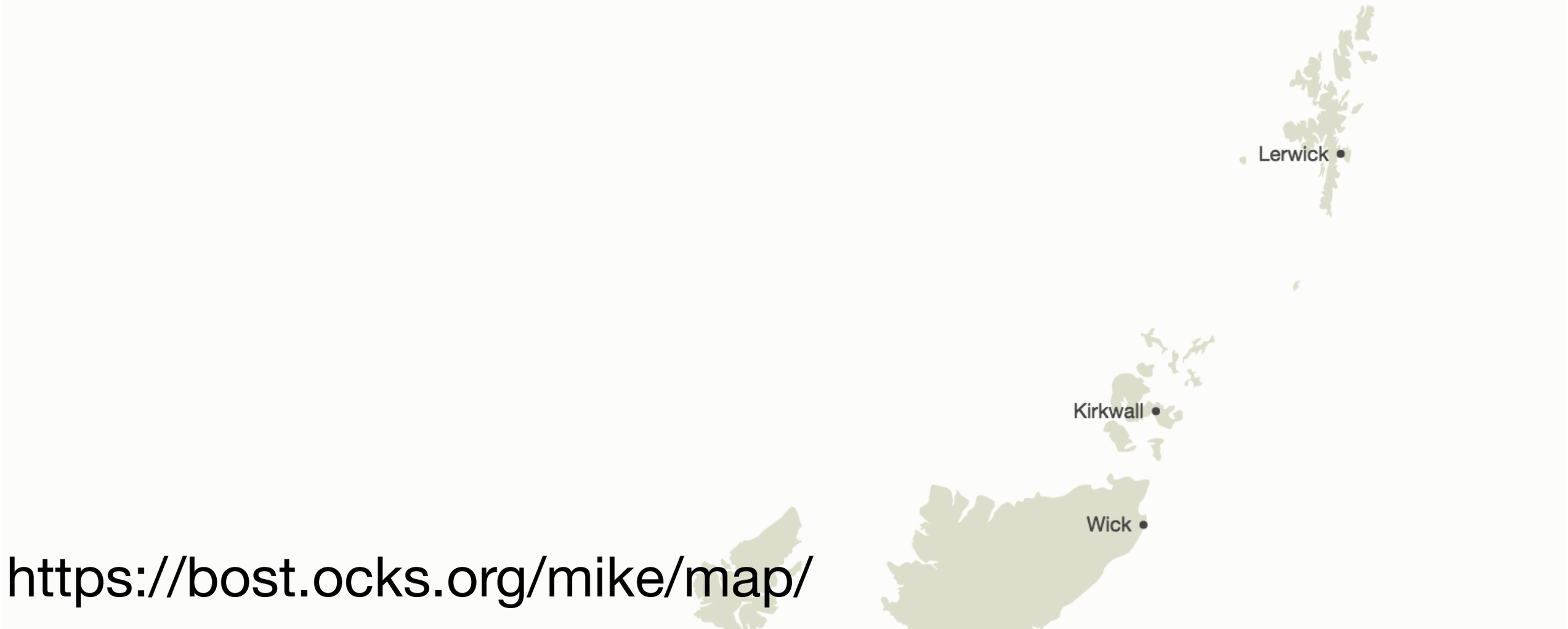
If you walked your way out of Tucson, forever going east, would you be walking in a straight line?

The world is not flat!

Let's Make a Map

In this tutorial, I'll cover how to make a modest map from scratch using D3 and TopoJSON. I'll show you a few places where you can find free geographic data online, and how to convert it into a format that is both efficient and convenient for display. I won't cover thematic mapping, but the map we'll make includes labels for populated places and you can extend this technique to geographic visualizations such as graduated symbol maps and choropleths.

Without further ado, here's the map:



https://bost.ocks.org/mike/map/

Map Projections

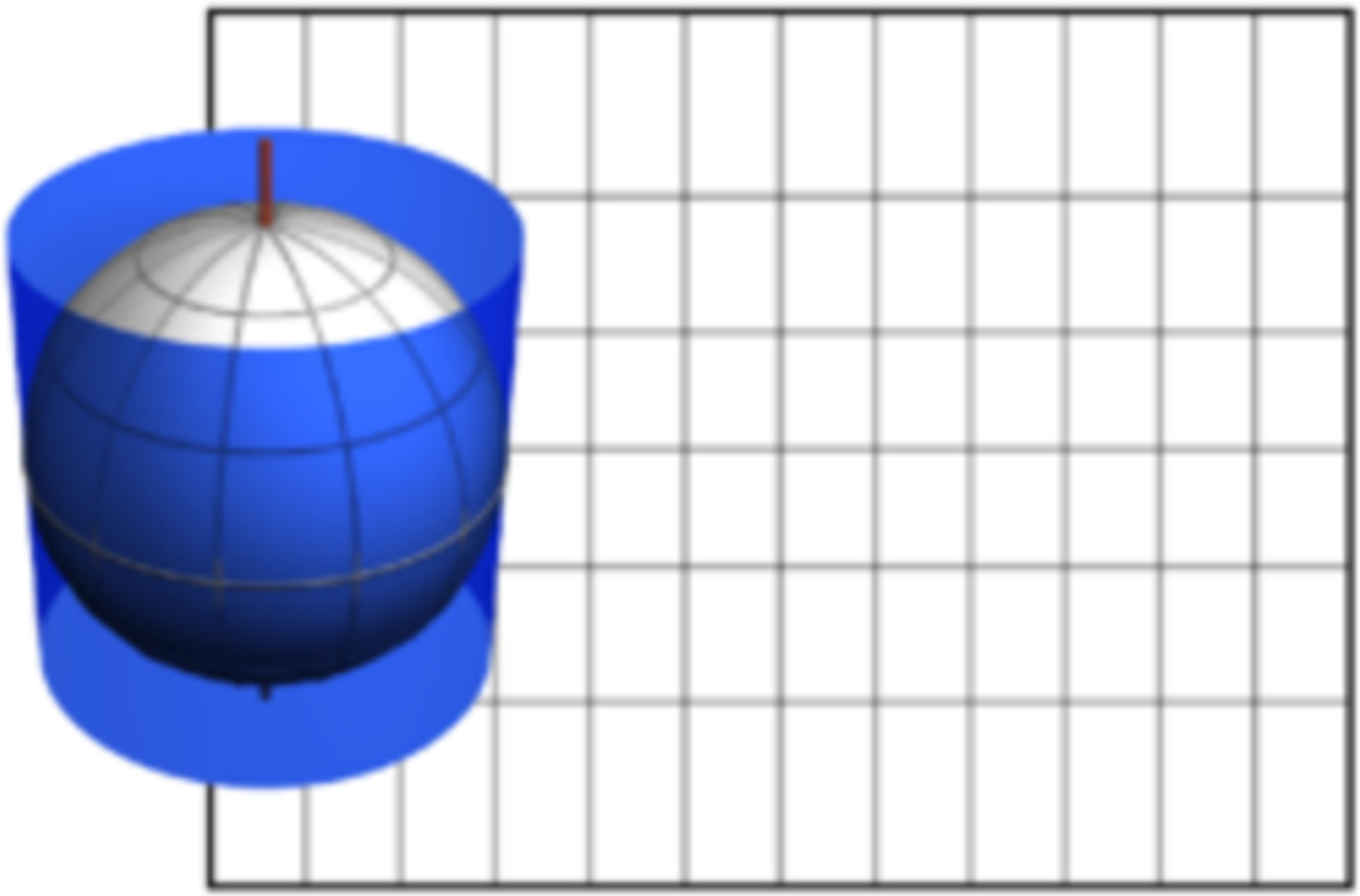
https://www.jasondavies.com/maps/transition/

What properties do we want projections to preserve?

- Shape
- Bearing
- Area
- Distance

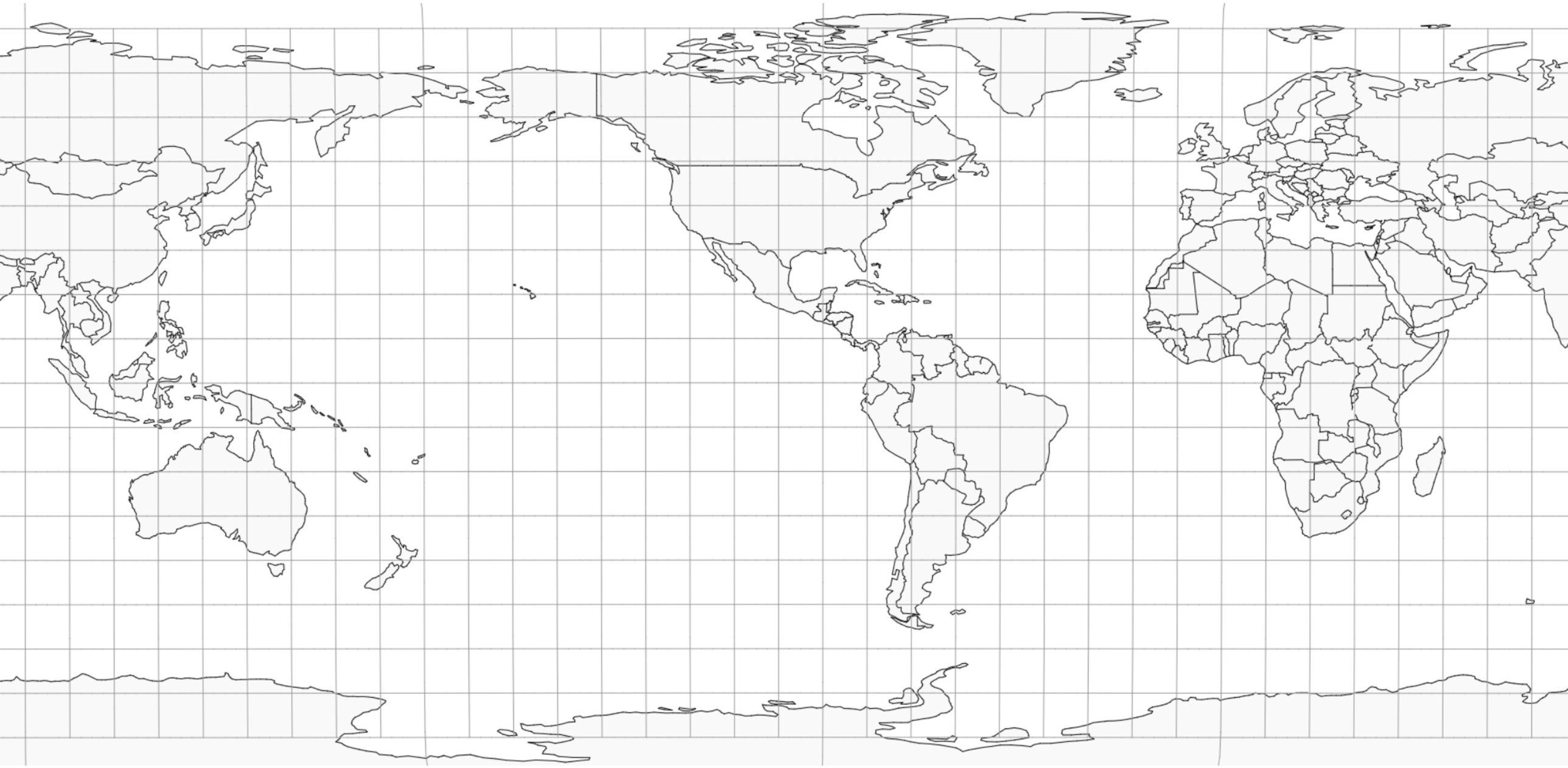
Can we preserve all of these at once?

Cylindrical Projections

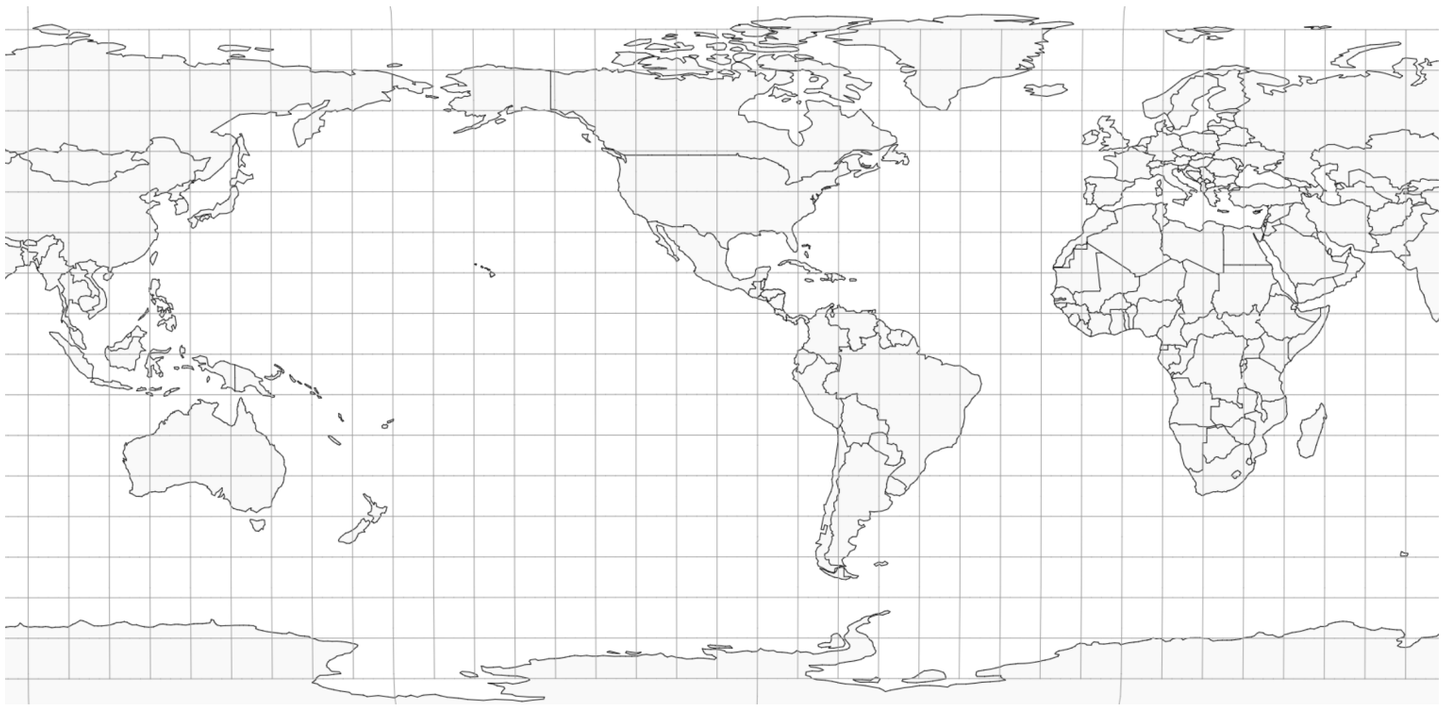


http://www.progonos.com/furuti/MapProj/

Equirectangular Projection



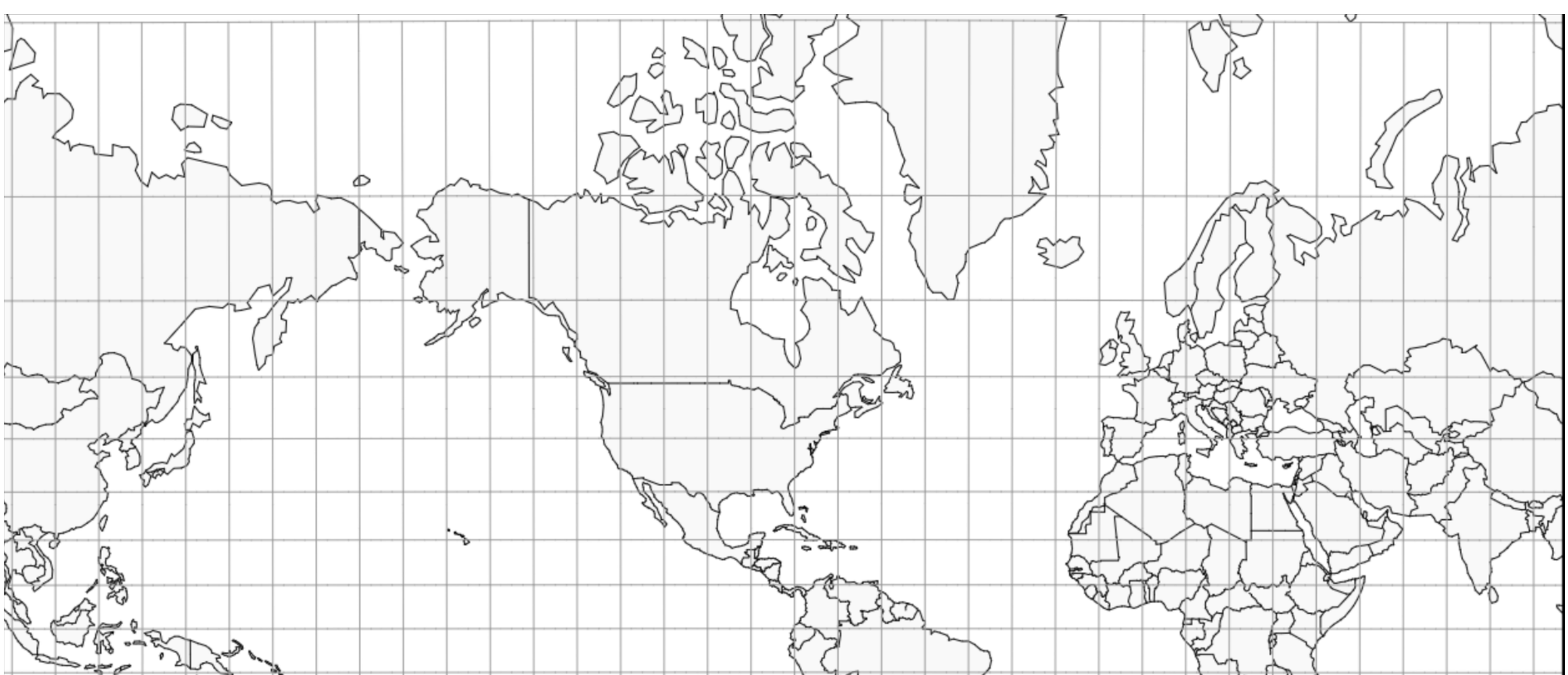
Equirectangular Projection



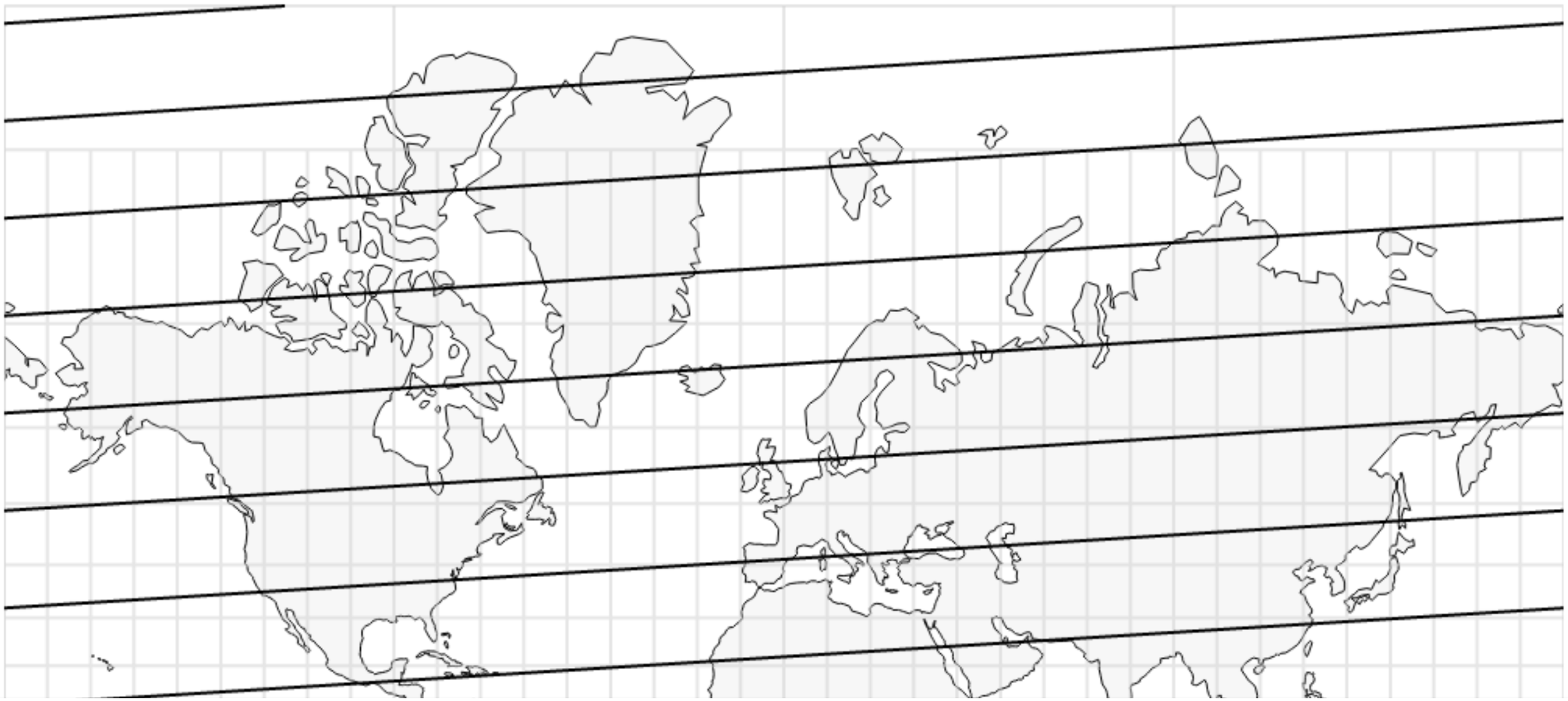
- y = lat
- x = long
- Preserves lat and long

Mercator Projection

- Preserves **local shape**
  - **“conformal”: angles are preserved**



- Bearing: following a compass direction makes a straight line in the Mercator projection



https://www.jasondavies.com/maps/loxodrome/

Sizes?

Arctic Ocean

Arctic Ocean

Greenland

Iceland

Canada

United States

Mexico

Venezuela

Colombia

Peru

Brazil

Bolivia

Chile

Argentina

North Atlantic Ocean

South Pacific Ocean

South Atlantic Ocean

Indian Ocean

Finland

Sweden

Norway

United Kingdom

Poland

Germany

Ukraine

France

Italy

Spain

Turkey

Kazakhstan

Mongolia

China

Japan

South Korea

Afghanistan

Iraq

Iran

Pakistan

India

Thailand

Algeria

Libya

Egypt

Saudi Arabia

Mali

Niger

Sudan

Chad

Nigeria

Ethiopia

Kenya

DR Congo

Tanzania

Angola

Namibia

Botswana

Madagascar

South Africa

Indonesia

Papua Guinea

Australia

Russia

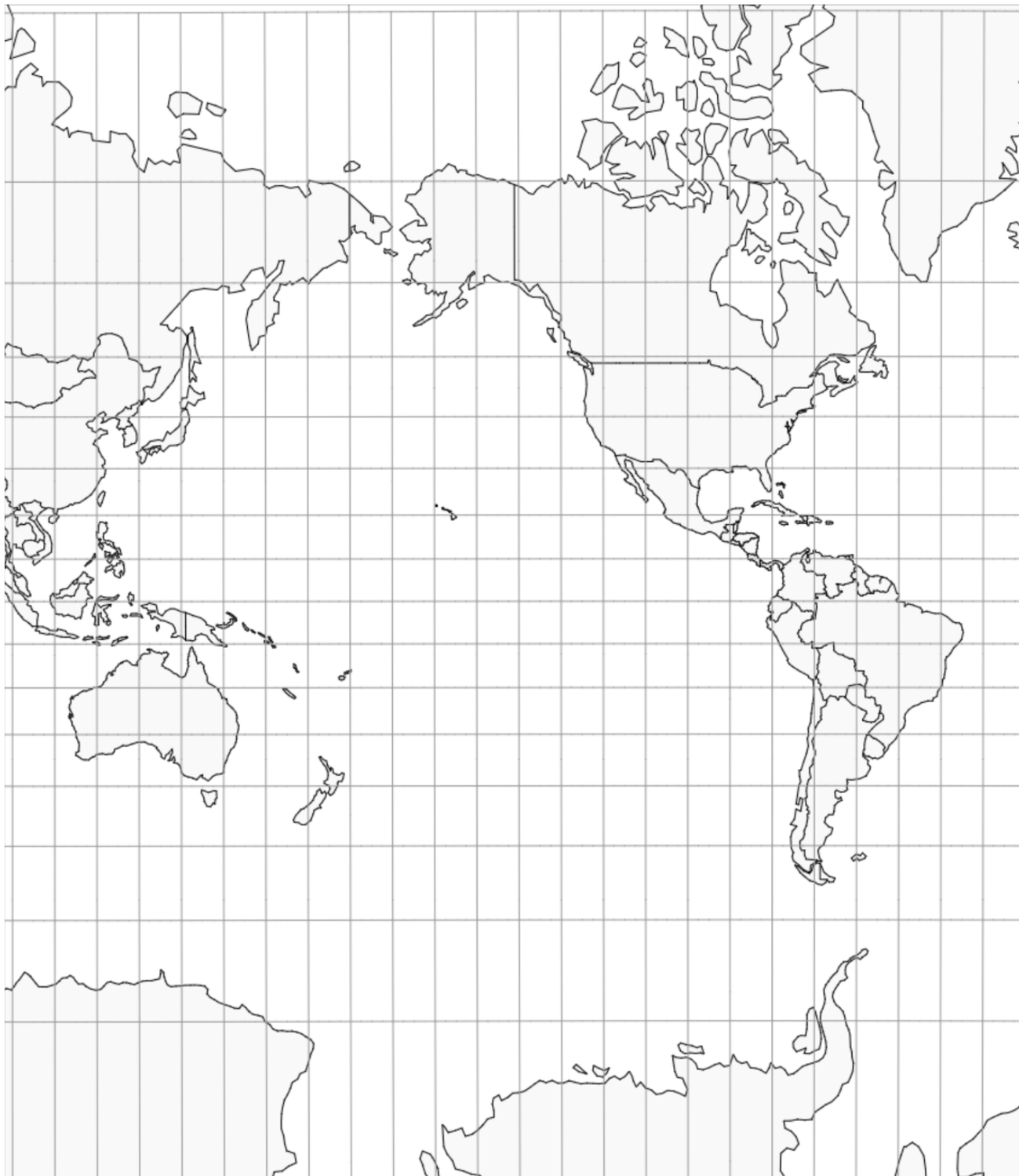
http://thetruesize.com/

Sizes?

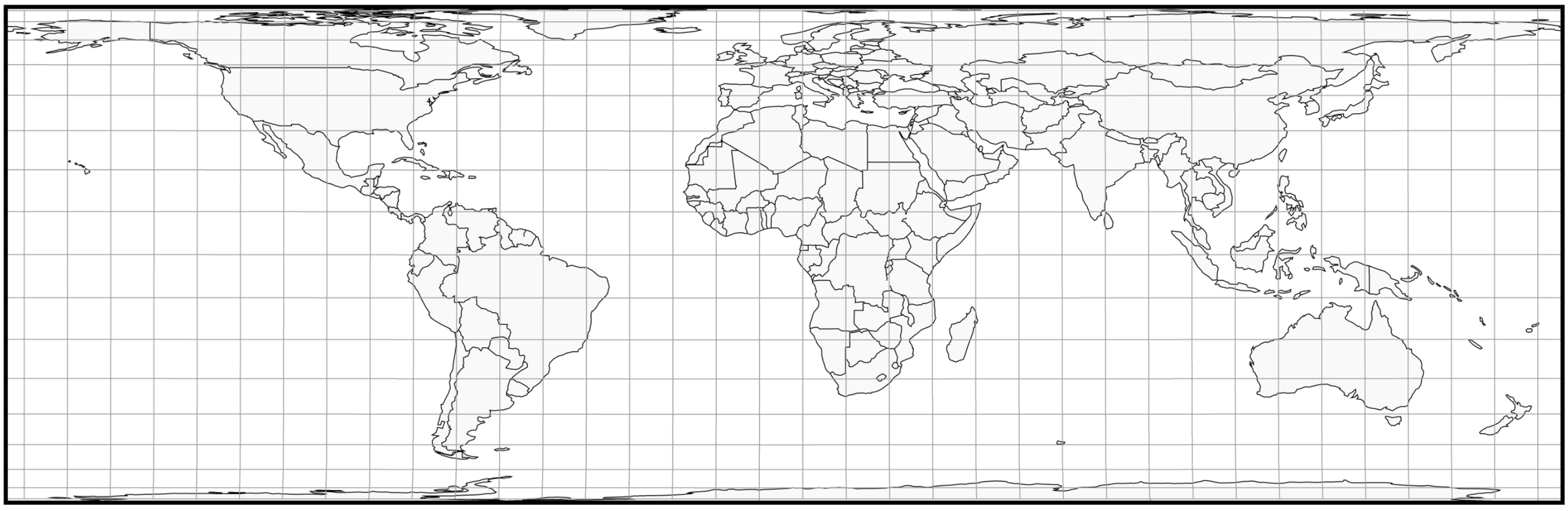

Arctic Ocean
Arctic Ocean
Greenland
Iceland
Finland
Sweden
Norway
Russia
United Kingdom
Poland
Germany
Ukraine
France
Italy
Spain
Turkey
Kazakhstan
Mongolia
China
Japan
South Korea
Afghanistan
Iran
Iraq
Pakistan
India
Thailand
Saudi Arabia
Algeria
Libya
Egypt
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Kenya
DR Congo
Tanzania
Angola
Namibia
Botswana
Madagascar
South Africa
Indonesia
Australia
Canada
United States
Mexico
Venezuela
Colombia
Brazil
Peru
Bolivia
Chile
Argentina
North Atlantic Ocean
South Atlantic Ocean
South Pacific Ocean
Indian Ocean

Mercator Projection

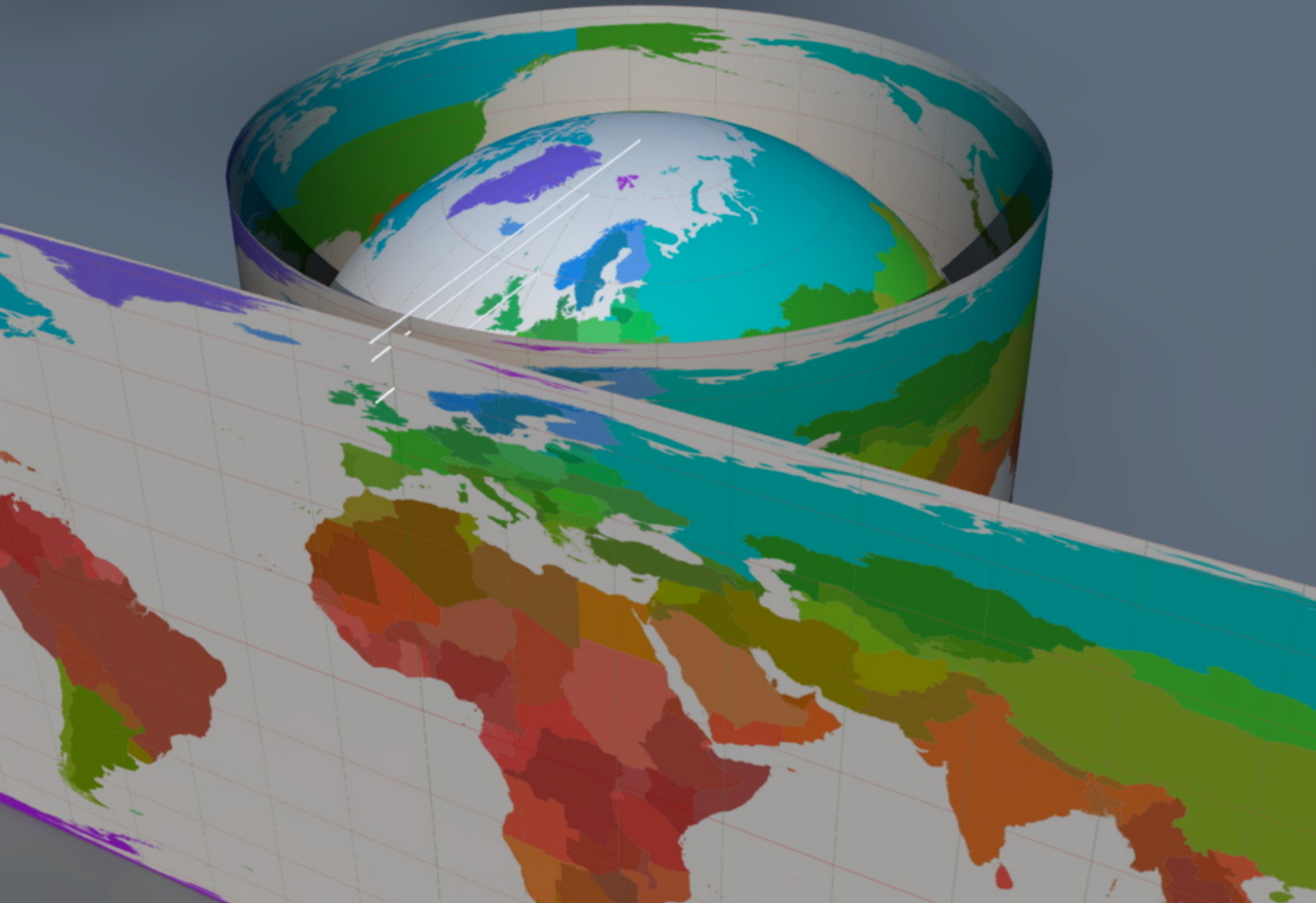
- y = log (tan (45 + lat/2))
- x = long



Lambert’s Cylindrical Equal-Area Projection



- y = sin (lat)
- x = long

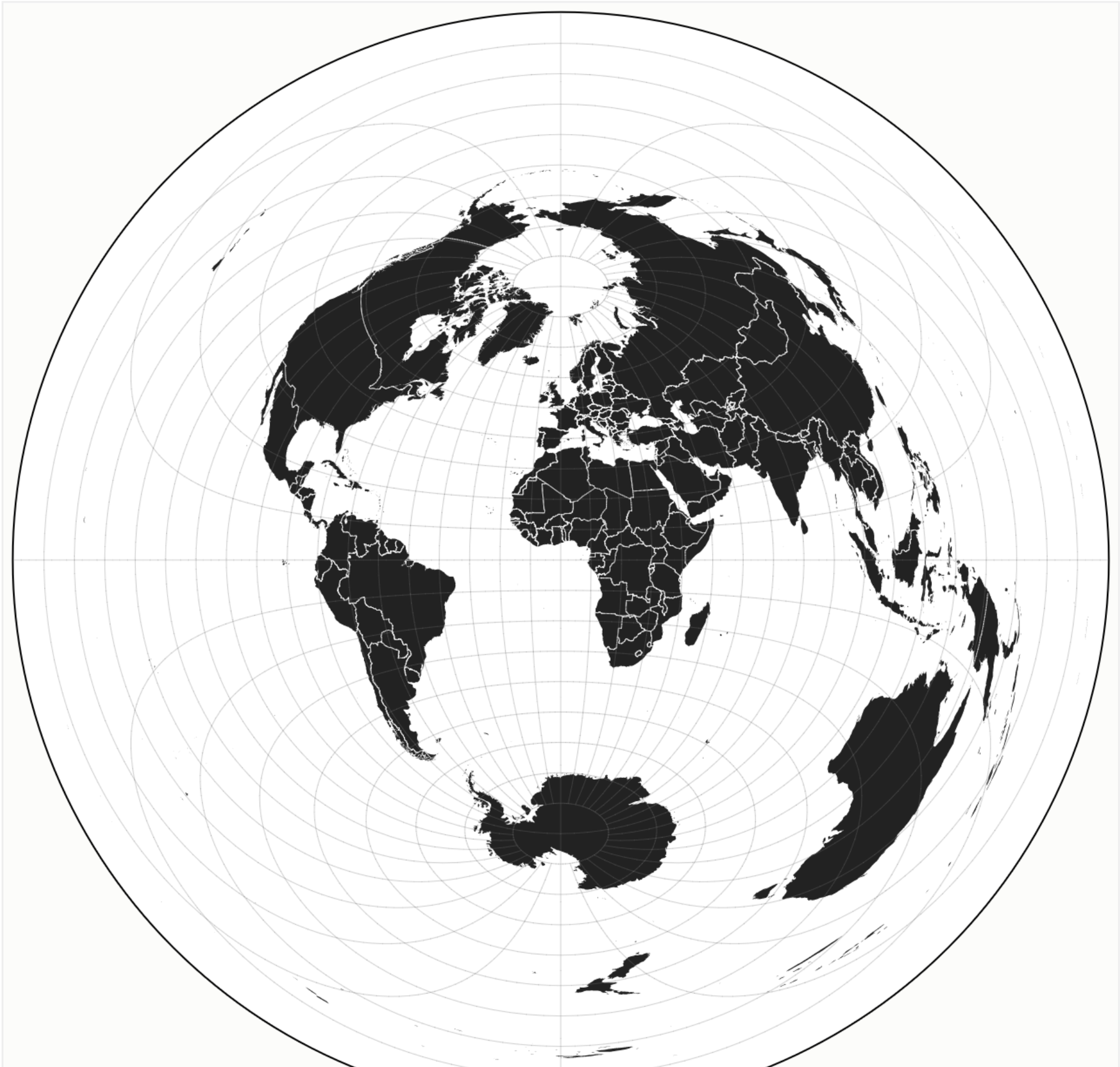


Azimuthal Projections
(“Directional” Projections)

Directions from **center point** are preserved

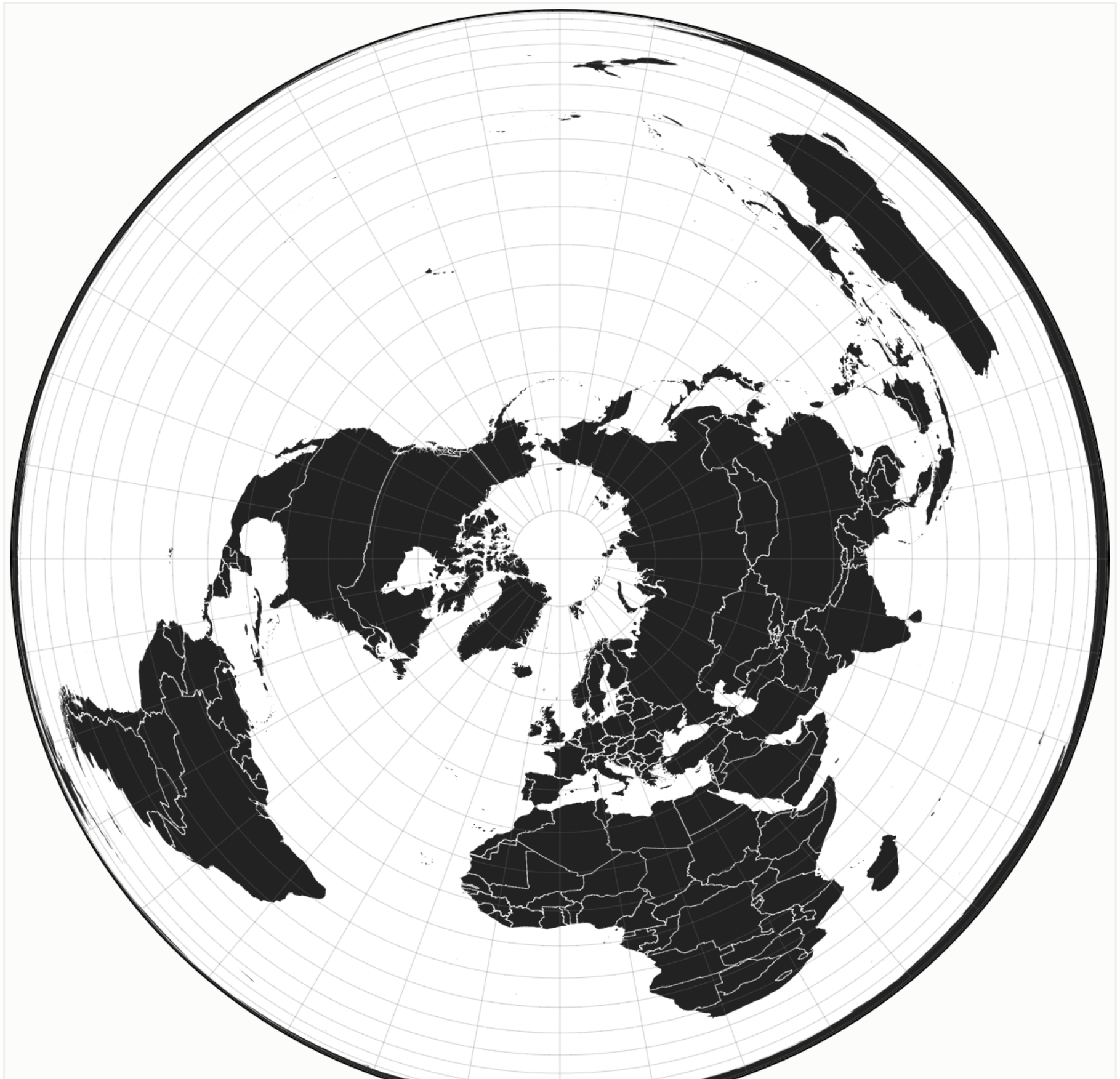
http://bl.ocks.org/mbostock/

Azimuthal Equidistant



Lambert Azimuthal Equal-Area

Polar Azimuthal Equal-area

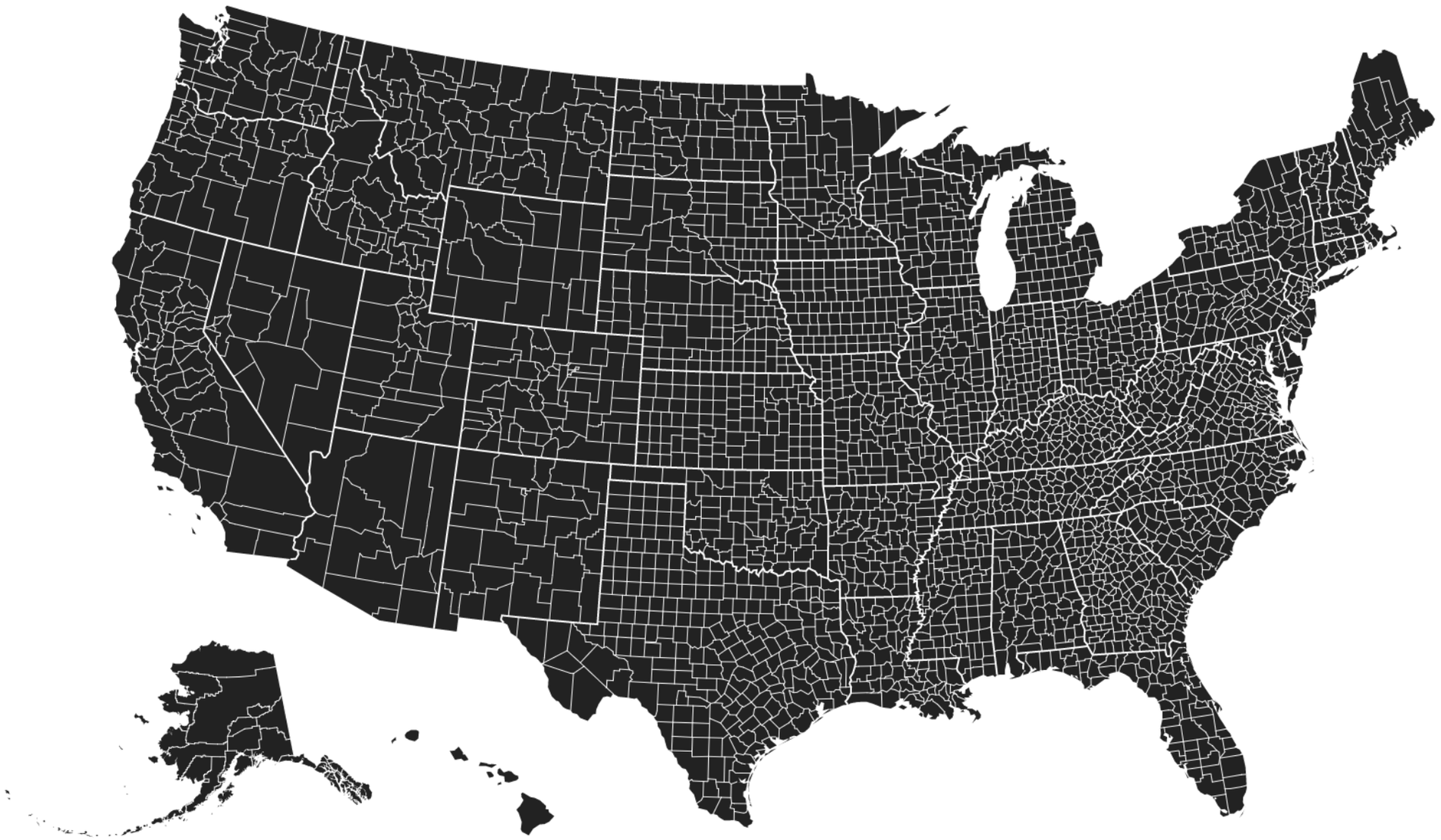


More complex projections

Albers: Conic, equal-area

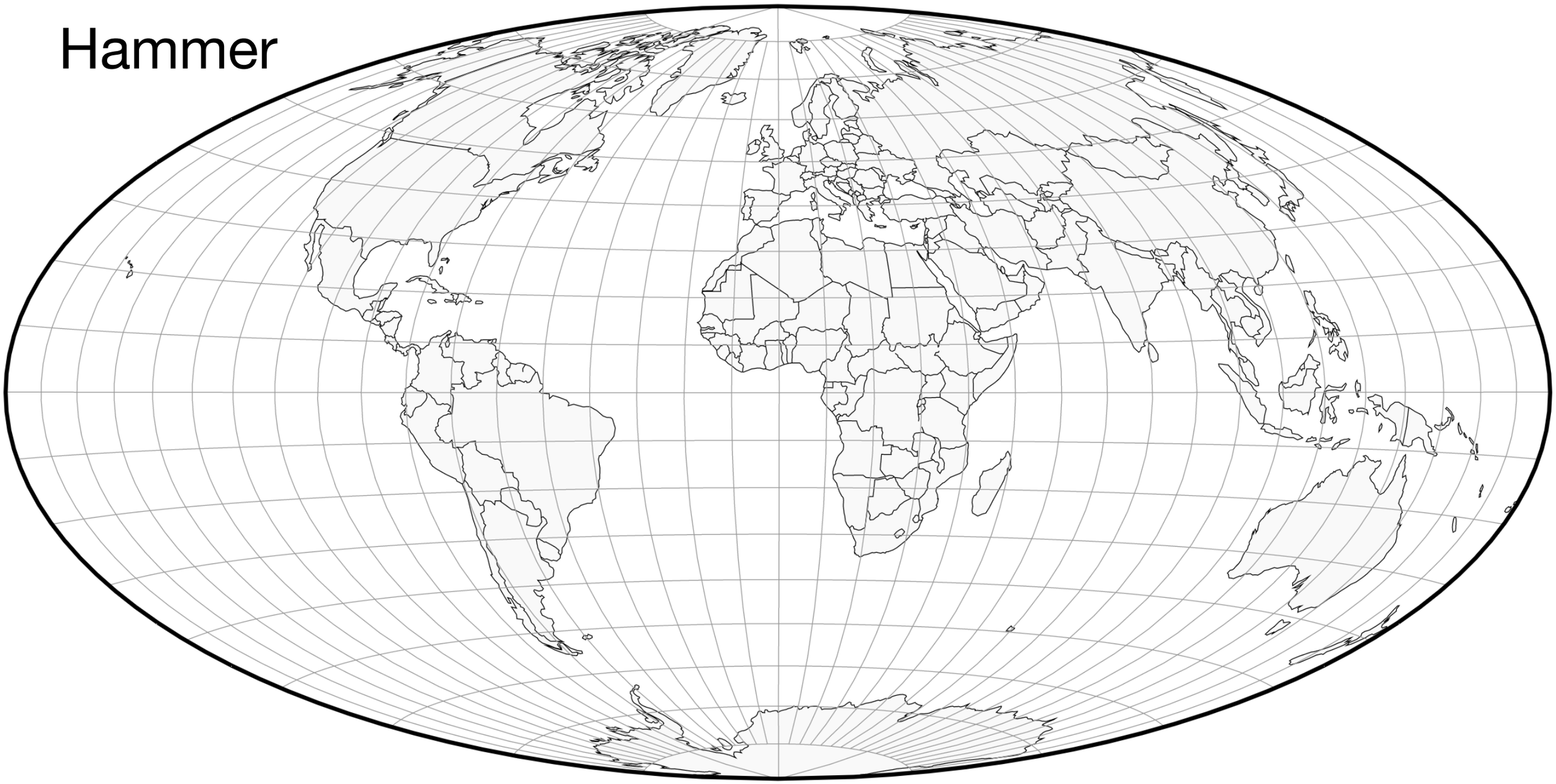
More complex projections

Composite Albers projection
used by the USGS and Census Bureau



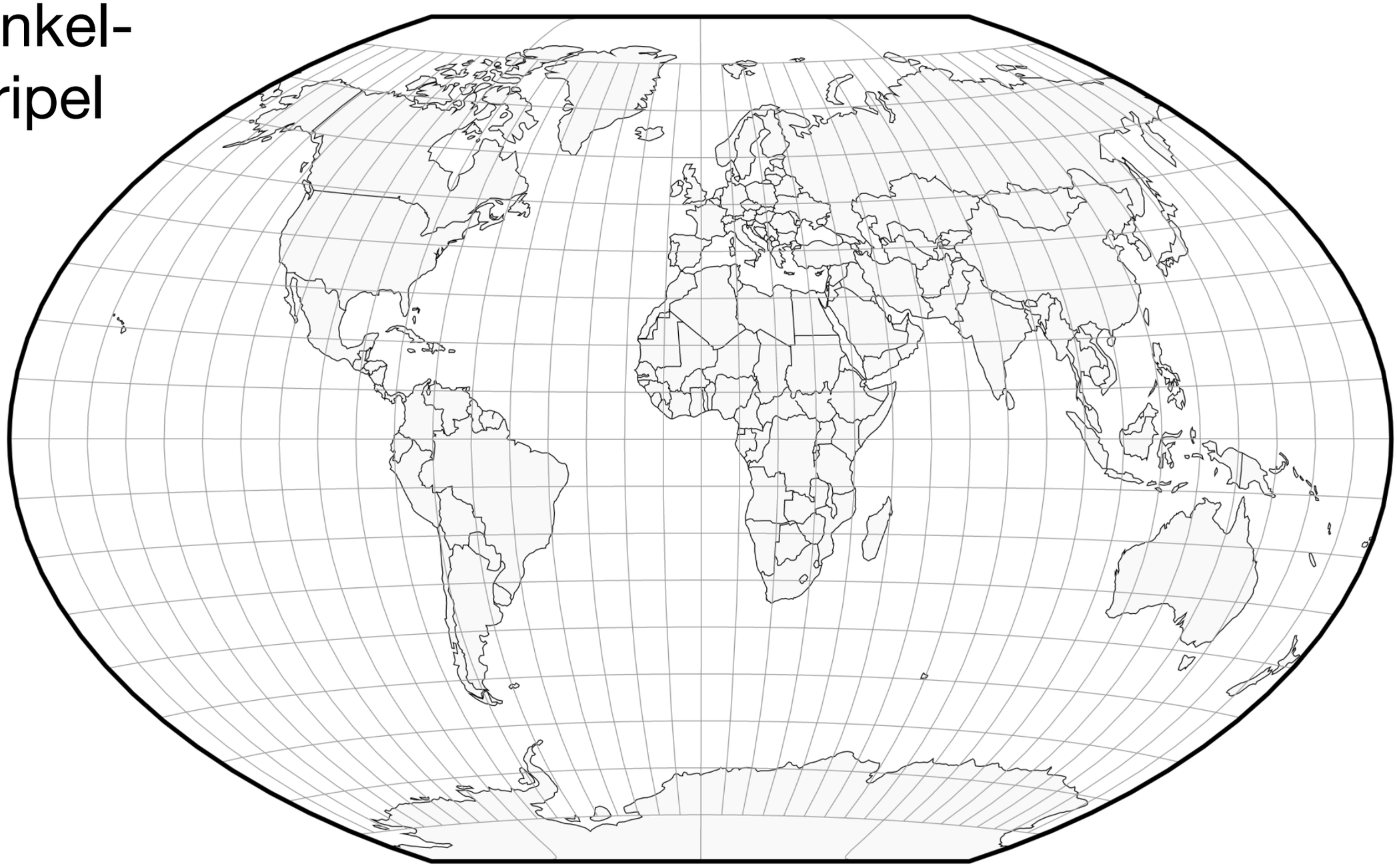
More complex projections

Hammer

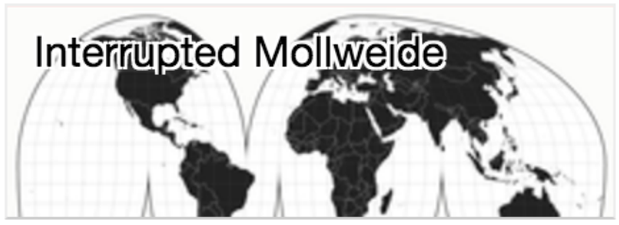


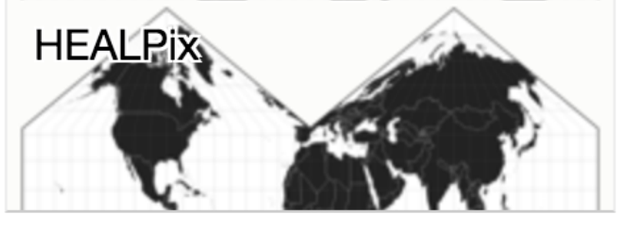
More complex projections

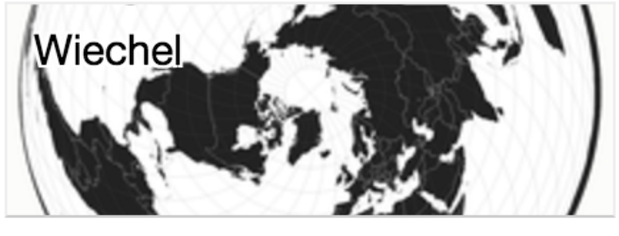
Winkel-
Tripel



Many, many, many more…



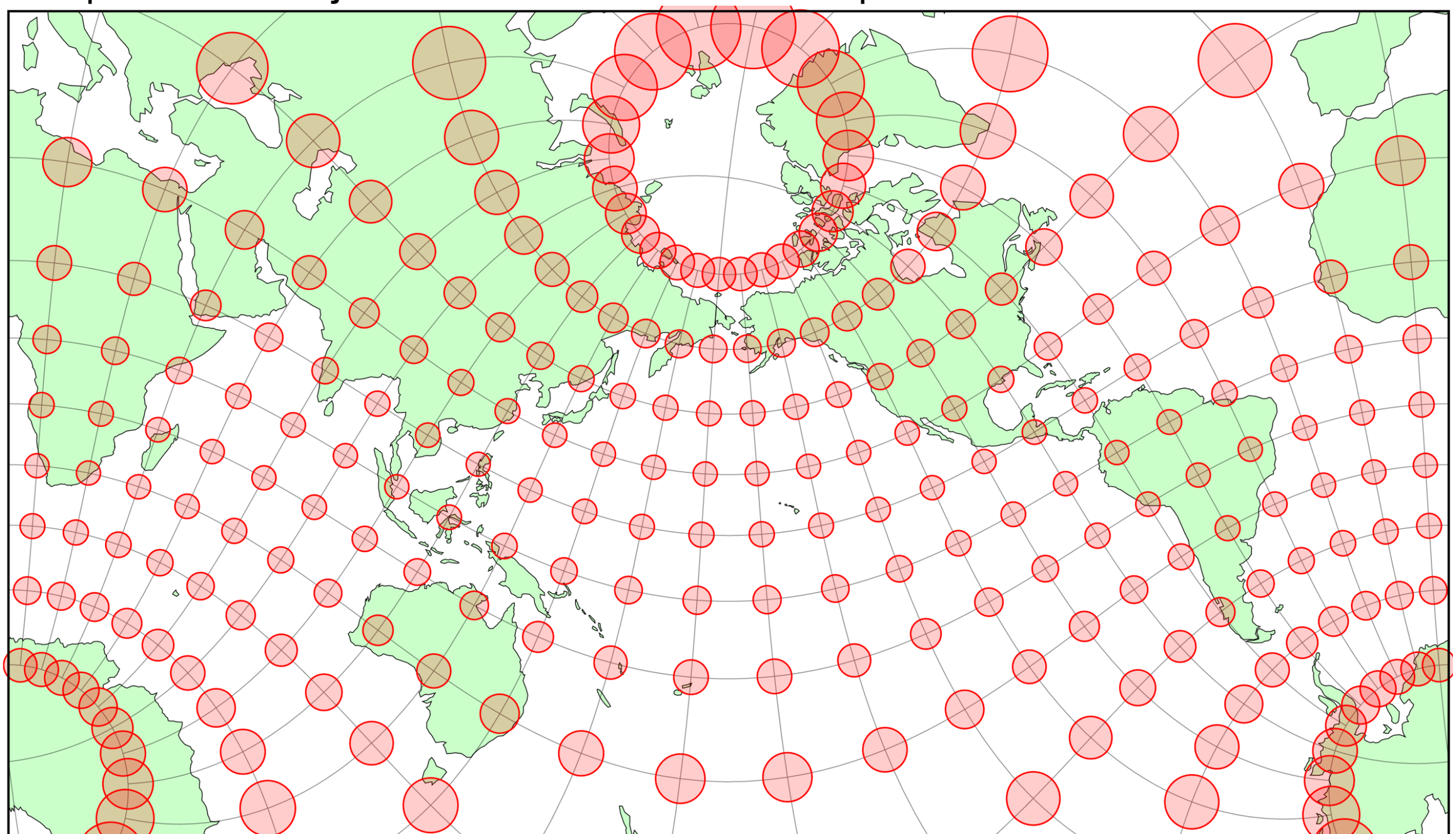




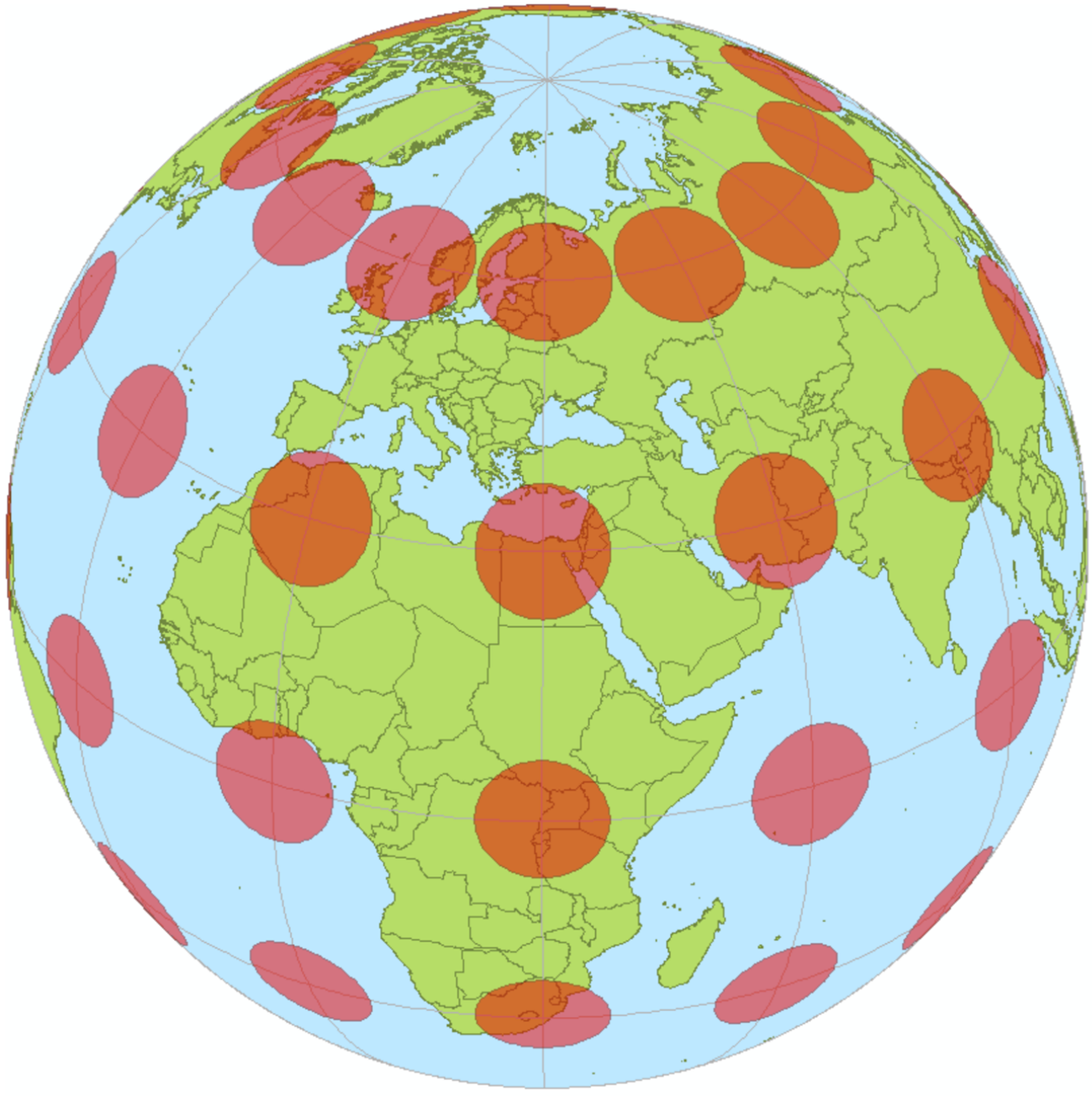
How do we compare projections?

Tissot’s Indicatrix

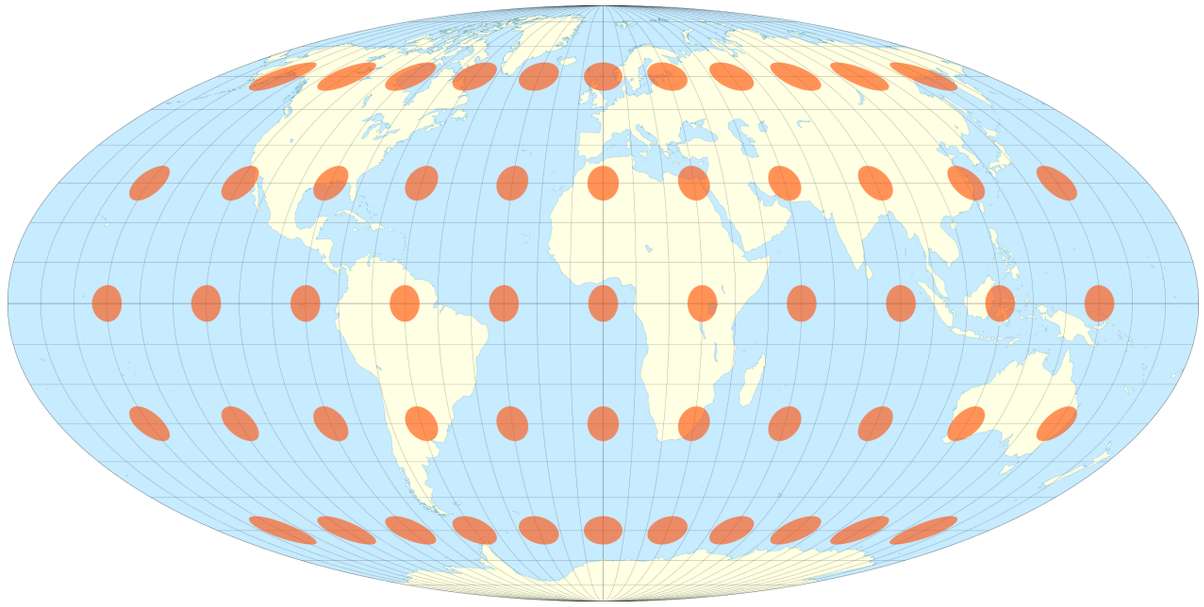
https://www.jasondavies.com/maps/tissot/



Tissot’s Indicatrix



https://en.wikipedia.org/wiki/Tissot%27s_indicatrix

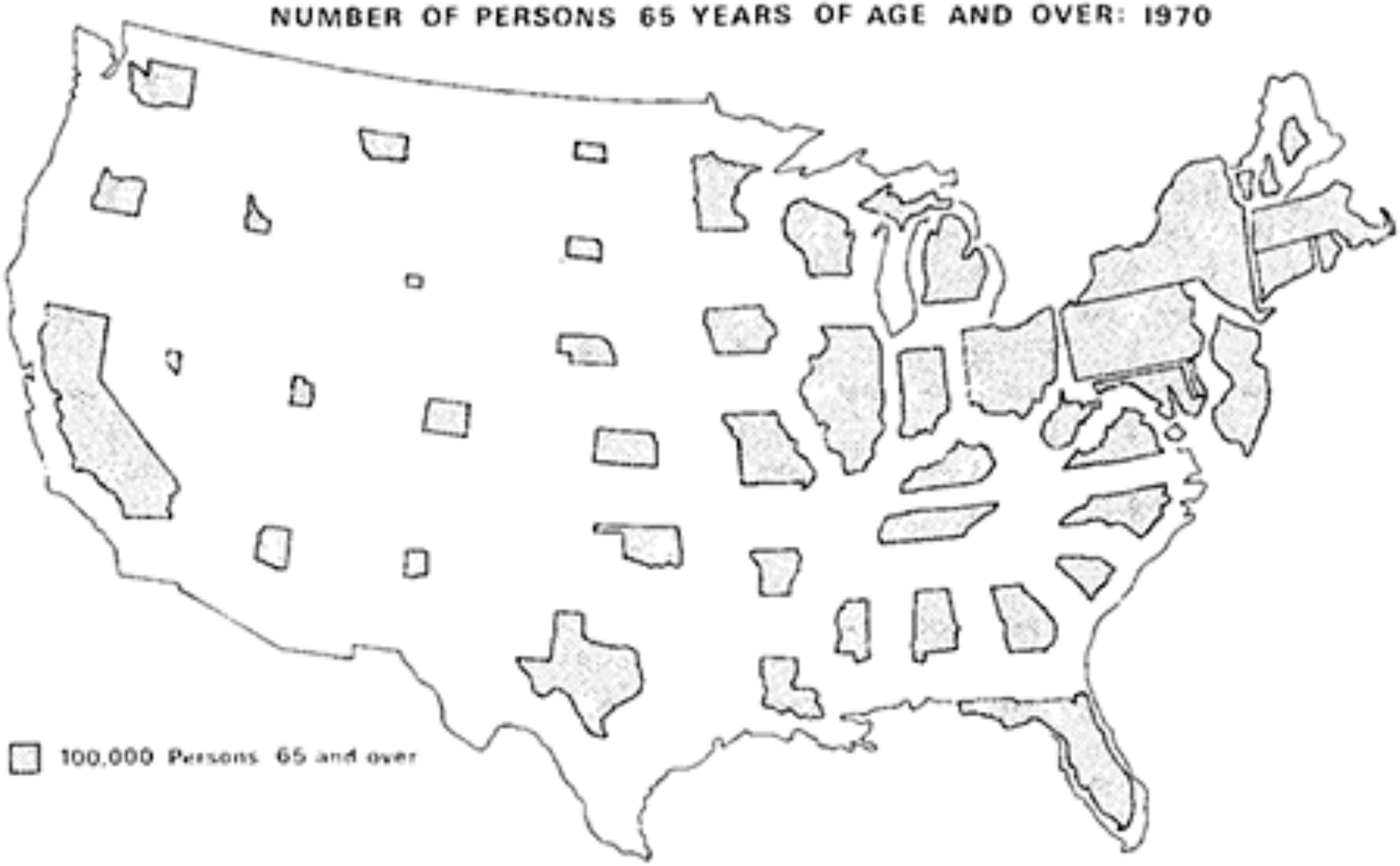


https://en.wikipedia.org/wiki/Mollweide_projection

Cartograms

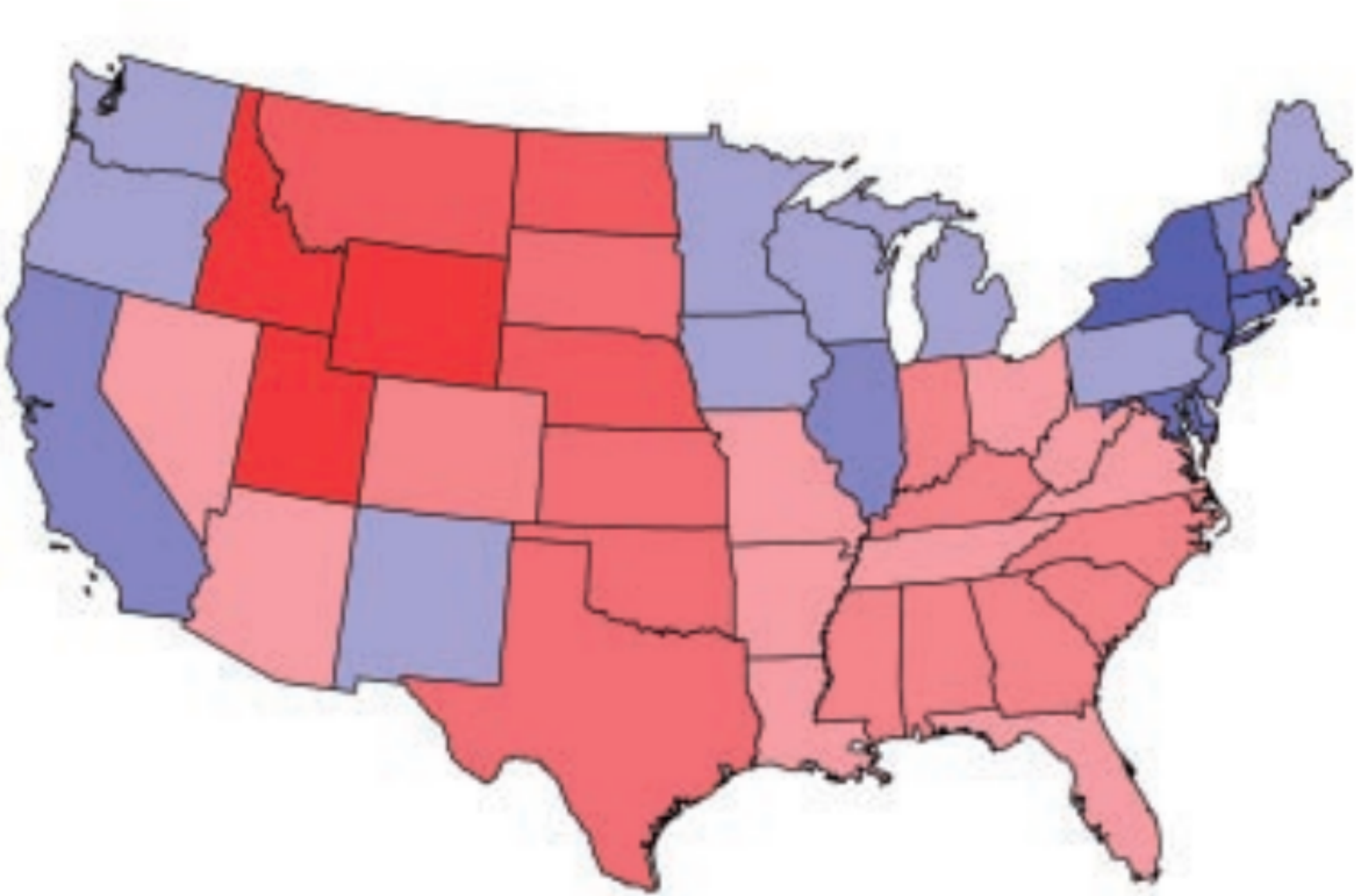
Distort maps explicitly to use area as channel

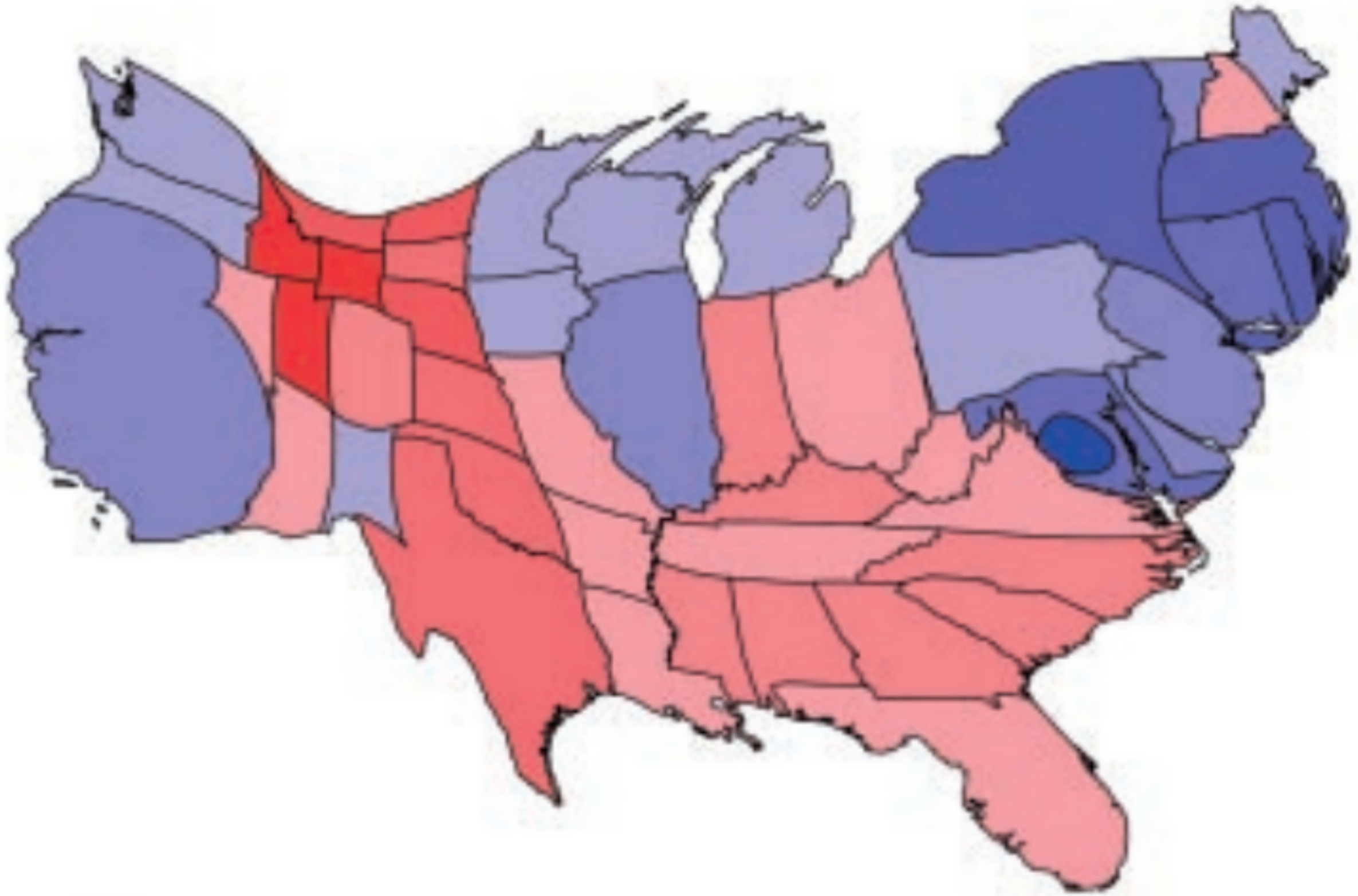
NUMBER OF PERSONS 65 YEARS OF AGE AND OVER: 1970



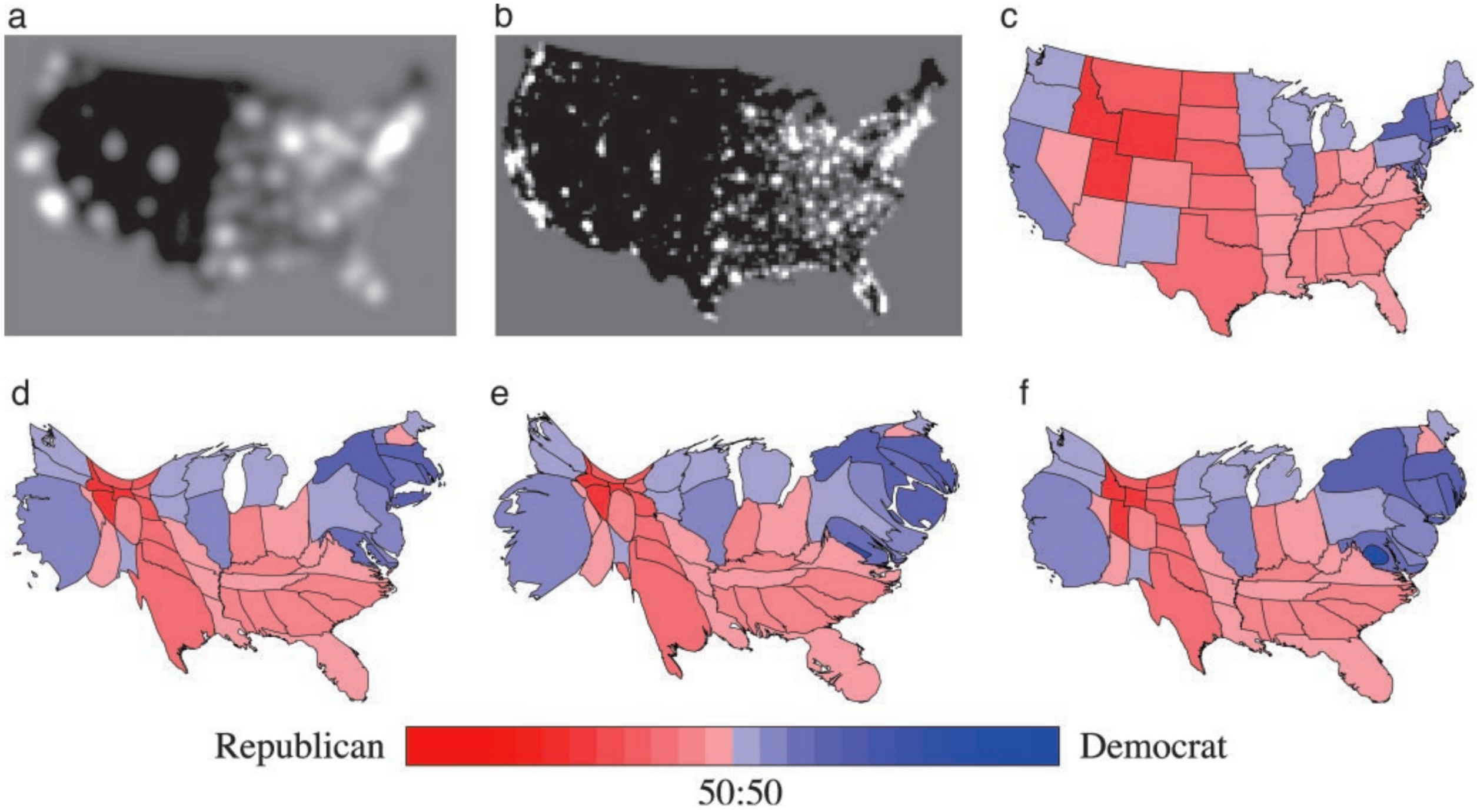
100,000 Persons 65 and over

Source: U.S. Bureau of the Census



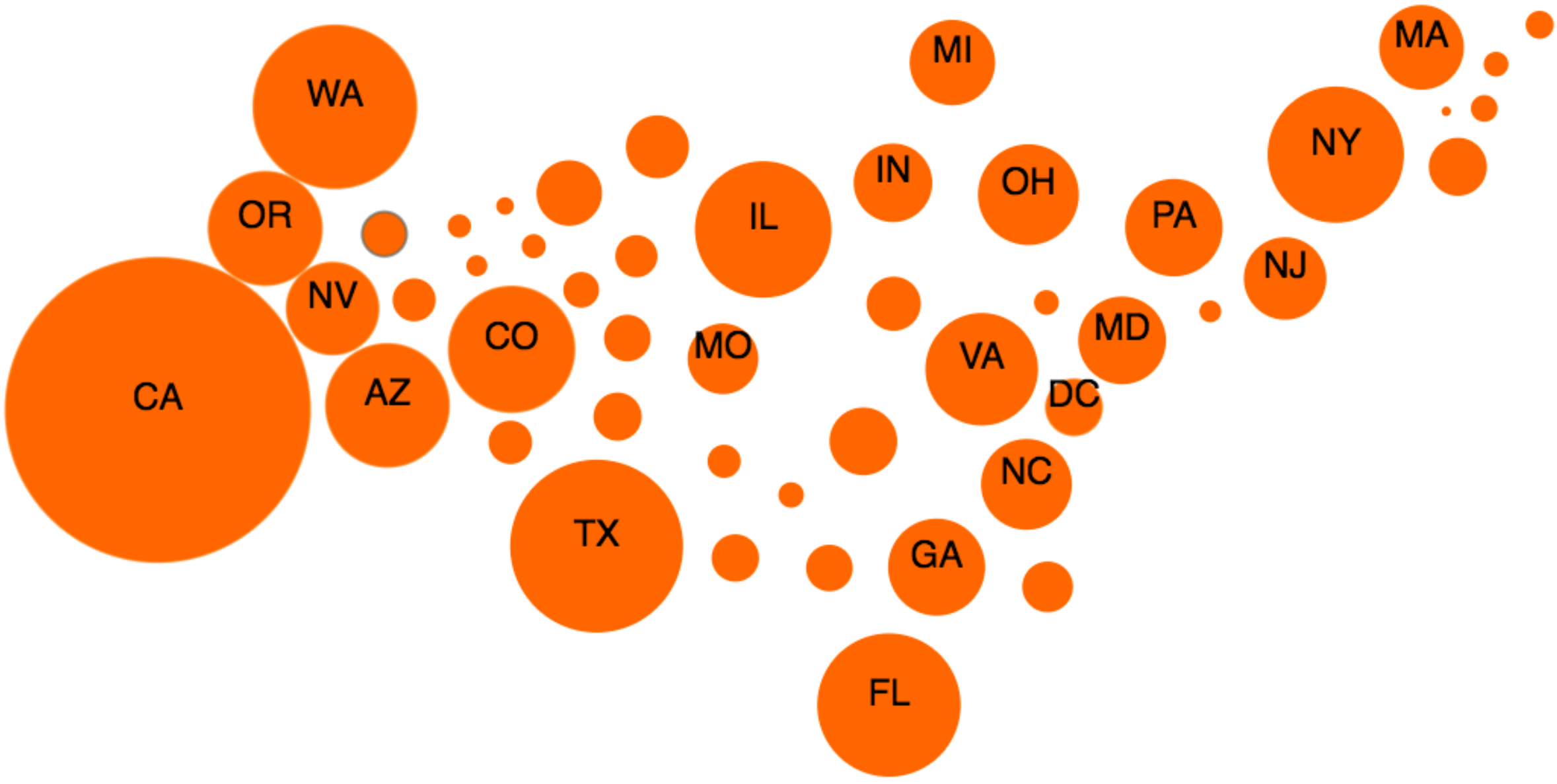


Gastner & Newman: Diffusion-based method for producing density-equalizing maps



http://www.pnas.org/content/101/20/7499.full.pdf

Dorling Cartograms: Turn shapes into Circles



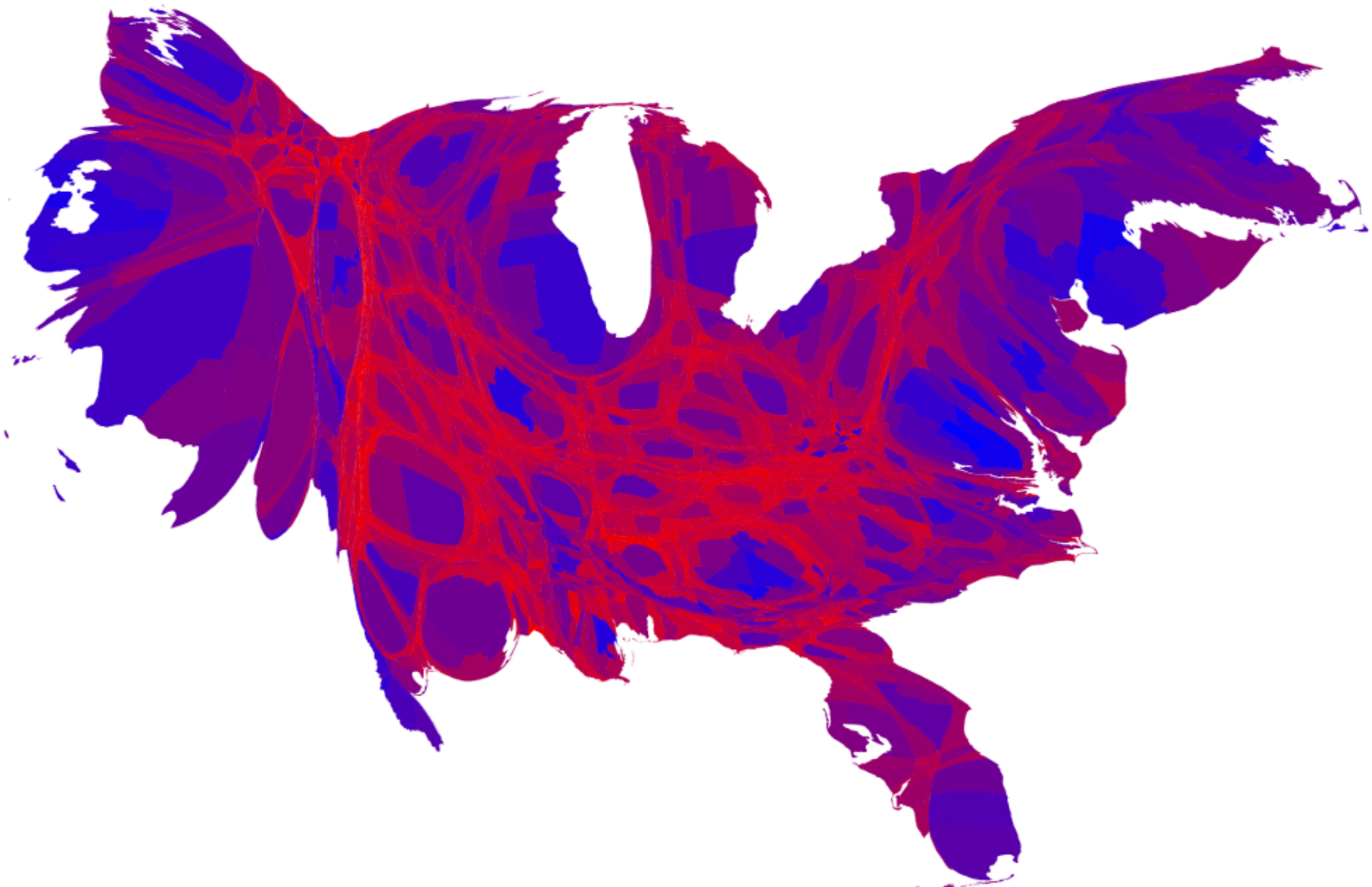
Starbucks per state in the US

Let’s implement Dorling Cartograms

Limitations

- What can we encode with area?
- What do we want to preserve?
  - What happens with extreme distortions?

Limitations



http://www-personal.umich.edu/~mejn/election/2016/

Limitations