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# Visualisation de Données spatiales

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# Plan

- Articles
  - Critique
  - Cours
    - Données spatiales
    - Types de cartes
    - Projections
  - Tuto D3 maps
-

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# Articles : Données spatiales

- Generalized fisheye views  
Ganofsky et Denier
- Touching Transport - A Case Study on Visualizing  
Metropolitan Public Transit on Interactive Tabletop  
Joual et Belande
- Rendering Effective Route Maps: Improving Usability  
Through Generalization  
Aubret et Moisson-Franckhauser
- Stenomaps: Shorthand for shapes  
Bettinelli et Jaunet

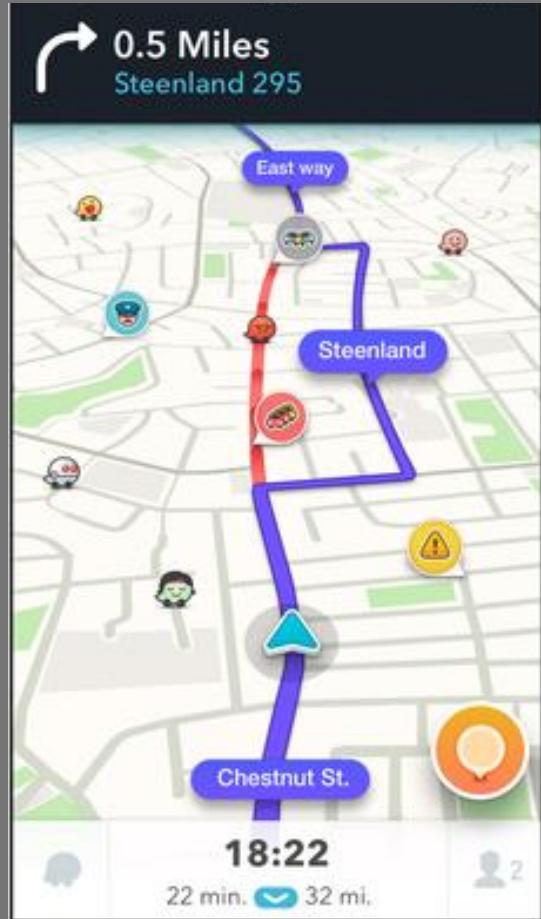
# Plan

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# Critique

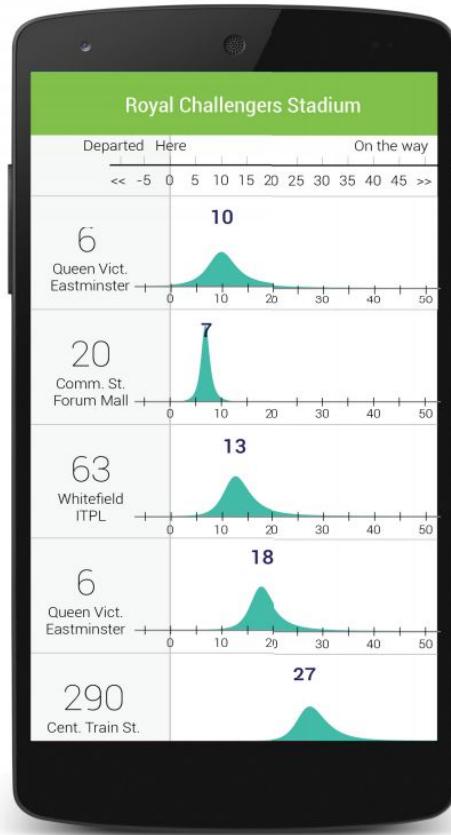
- À qui s'adresse la visualisation ?  
-> 1 proposition
- À quelle question la visualisation permet elle de répondre ?  
-> 1 proposition
- Pourquoi (n')aimez vous (pas) cette visualisation ?  
-> 2 raisons
- Quelles améliorations apporter ?  
-> 3 propositions



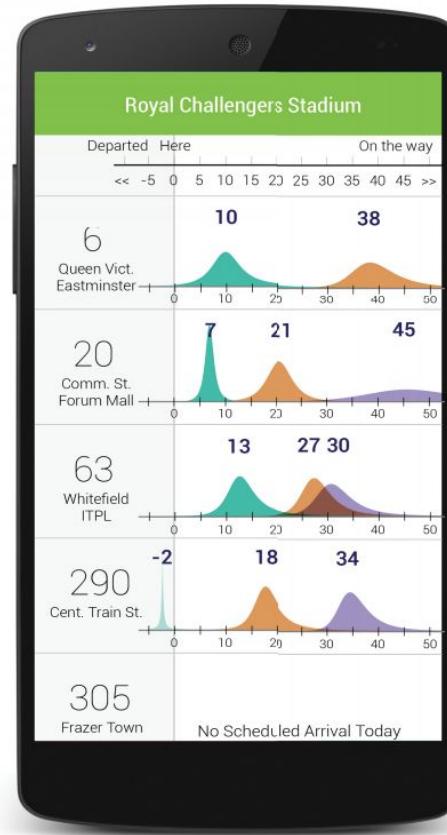


<https://hi.stamen.com/msnbc-hurricane-maps-are-live-54c304c9abc1#.89isxhqvj>

## Bus Timeline



## Route Timeline



Kay, M., Kola, T., Hullman, J. R., & Munson, S. A. (2016, May). When (ish) is My Bus? User-centered Visualizations of Uncertainty in Everyday, Mobile Predictive Systems. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (pp. 5092-5103). ACM.

from Hôtel de Ville

to Bâtiment Nautibus, 69100 Villeurbanne

1 h 12 min (109 km)

via A48 and A43

Fastest route, the usual traffic

⚠ This route has tolls.



## Hôtel de Ville

▼ Get on A48 in Saint-Egrève from N481

12 min (6.5 km)

↑ Head northeast on Boulevard Jean Pain/D1090

45 m

↳ Turn left onto Rue Joseph Chanrion

140 m

↳ Turn left onto Place Bir Hakeim

99 m

↑ Continue onto Rue Eugène Fauré

210 m

↑ Rue Eugène Fauré turns slightly right and becomes Pl. de Verdun

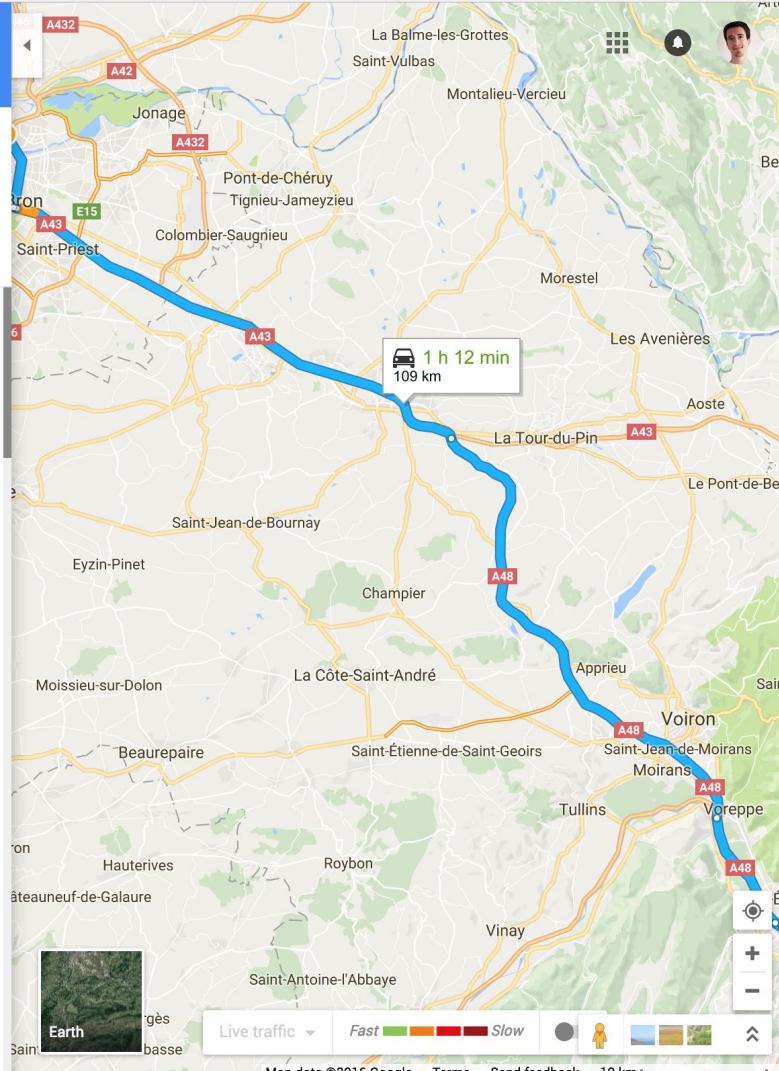
130 m

↳ Turn left to stay on Pl. de Verdun

51 m

↳ Slight left to stay on Pl. de Verdun

98 m



Live traffic

Fast

Slow

Normal

Slow

Very slow

Stop

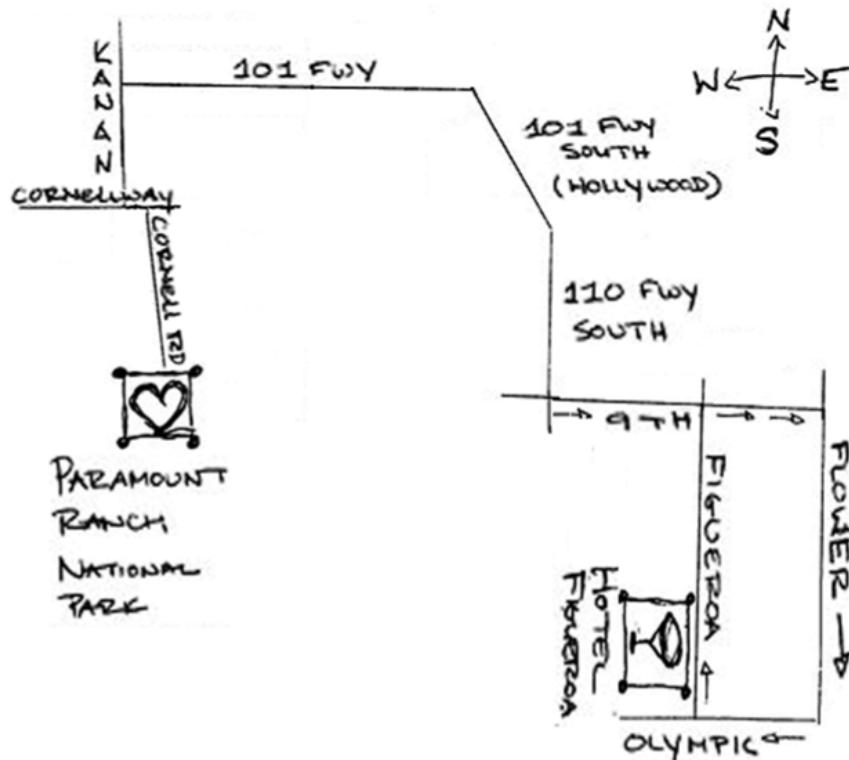
Unknown

Normal

Fast

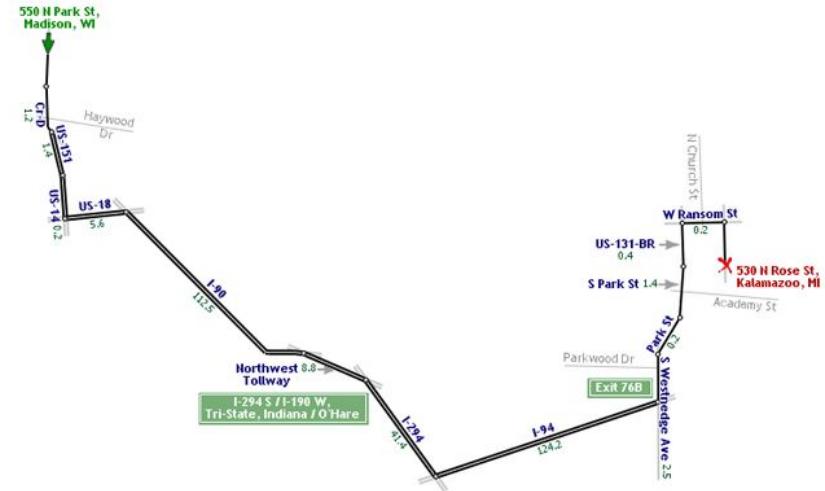
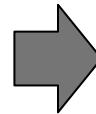
Normal

9



Extrait de :

Agrawala, M., & Stolte, C. (200). Rendering effective route maps: improving usability through generalization. In *Proceedings of the 28th annual conference on Computer graphics and interactive techniques* (pp. 241-249). ACM.



Extrait de :

Agrawala, M., & Stolte, C. (200). Rendering effective route maps: improving usability through generalization. In *Proceedings of the 28th annual conference on Computer graphics and interactive techniques* (pp. 241-249). ACM.

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# Cours

- Données spatiales
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  - Projections
-

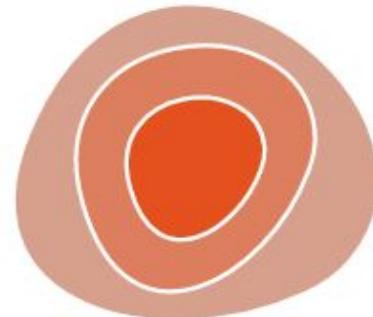
# Les données spatiales

Caractéristique principale : un mapping “direct”

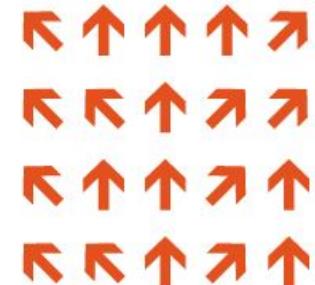
Données géométriques



Champs scalaires



Champs de vecteurs / tenseurs



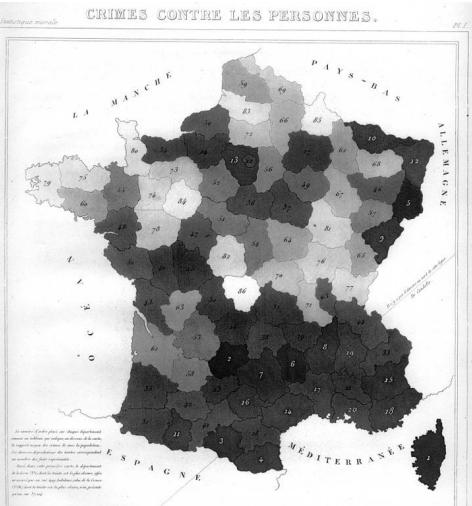
# Les données spatiales

Géométrie:

- Données géographiques
- Données dérivées



# Exemple : Carte cloroplèthe



**Utilisation** de la spatialité des données

La tâche principale est de comprendre la distribution spatiale

Données

- Géométrie / géographie
- Table avec un attribut quantitatif par région

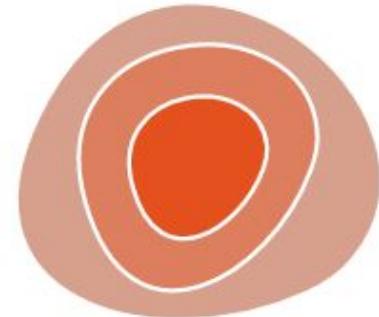
Codage

- Utilisation de la géométrie pour délimiter des zones
- Couleur séquentielles pour les valeurs <http://colorbrewer2.org/>

# Les données spatiales

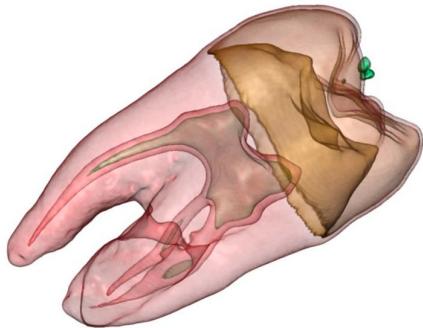
Champs scalaires :  
une valeur par cellule

- Isocontours
- Rendu de volumes



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# Exemple : isosurfaces



Interactive Volume Rendering Techniques. Kniss. Master's thesis, University of Utah Computer Science, 2002.]

## Données

- Champ scalaire : 1 attribut quantitatif par cellule

## Données dérivées

- Géométrie de l'isosurface : isocontours calculés à partir des valeurs scalaires

## Tâche

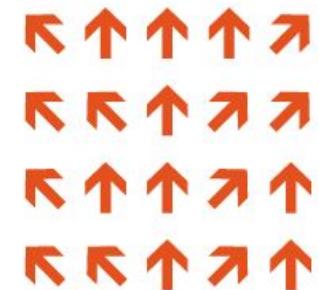
- Analyse de la structure spatiale 3D

# Les données spatiales

Champs de vecteurs ou de tenseurs

Plusieurs valeurs par cellule

- Glyphes de flux
- Geometries
- Textures
- Propriétés



# Exemple : champ de vecteurs

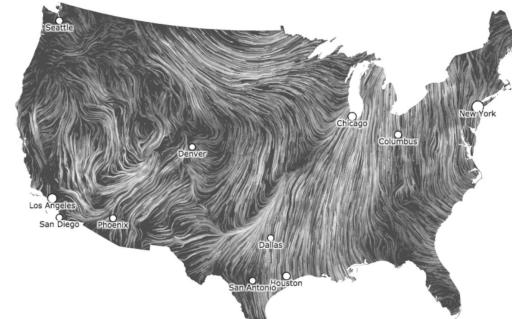
Données

- Champ scalaire : plusieurs attributs par cellule

Tâches

- Identifier des points critiques en une position donnée
- Prédire la position future d'un point
- Comprendre un déplacement

[http://vis.cs.brown.edu/results/images/  
Laidlaw-2001-QCE.011.html](http://vis.cs.brown.edu/results/images/Laidlaw-2001-QCE.011.html)



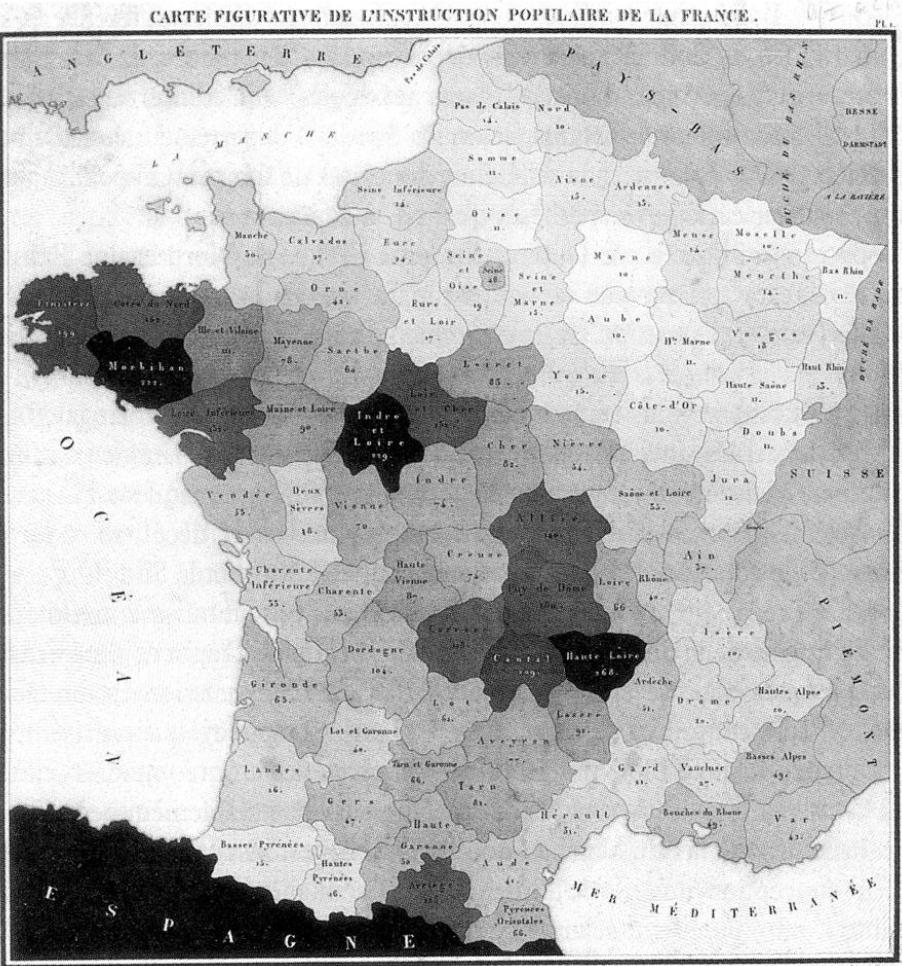
<http://hint.fm/wind/>

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# Cartographie

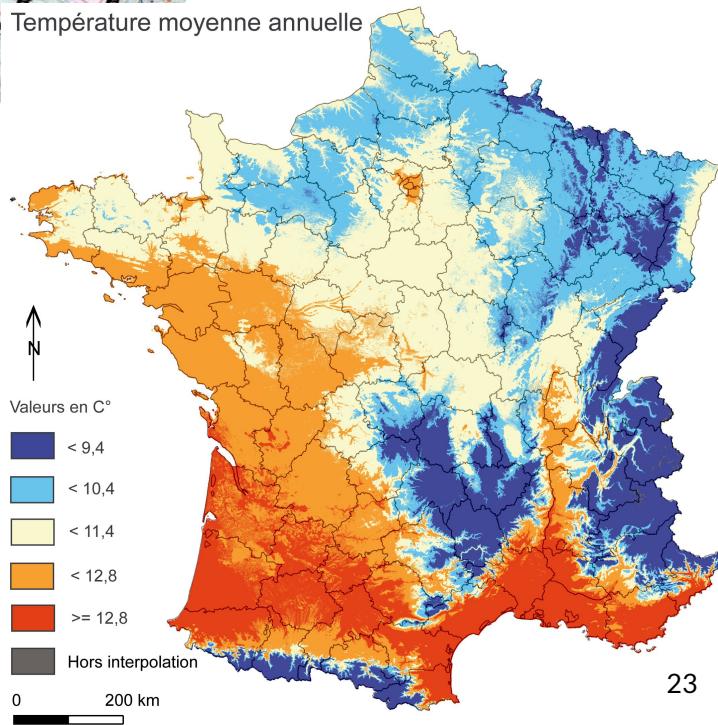
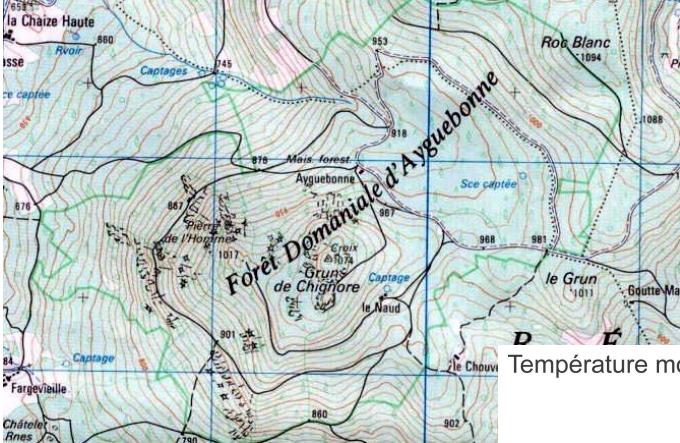
# Carte choroplète

Carte figurative de l'instruction populaire de la France, par Charles Dupin, 1826.



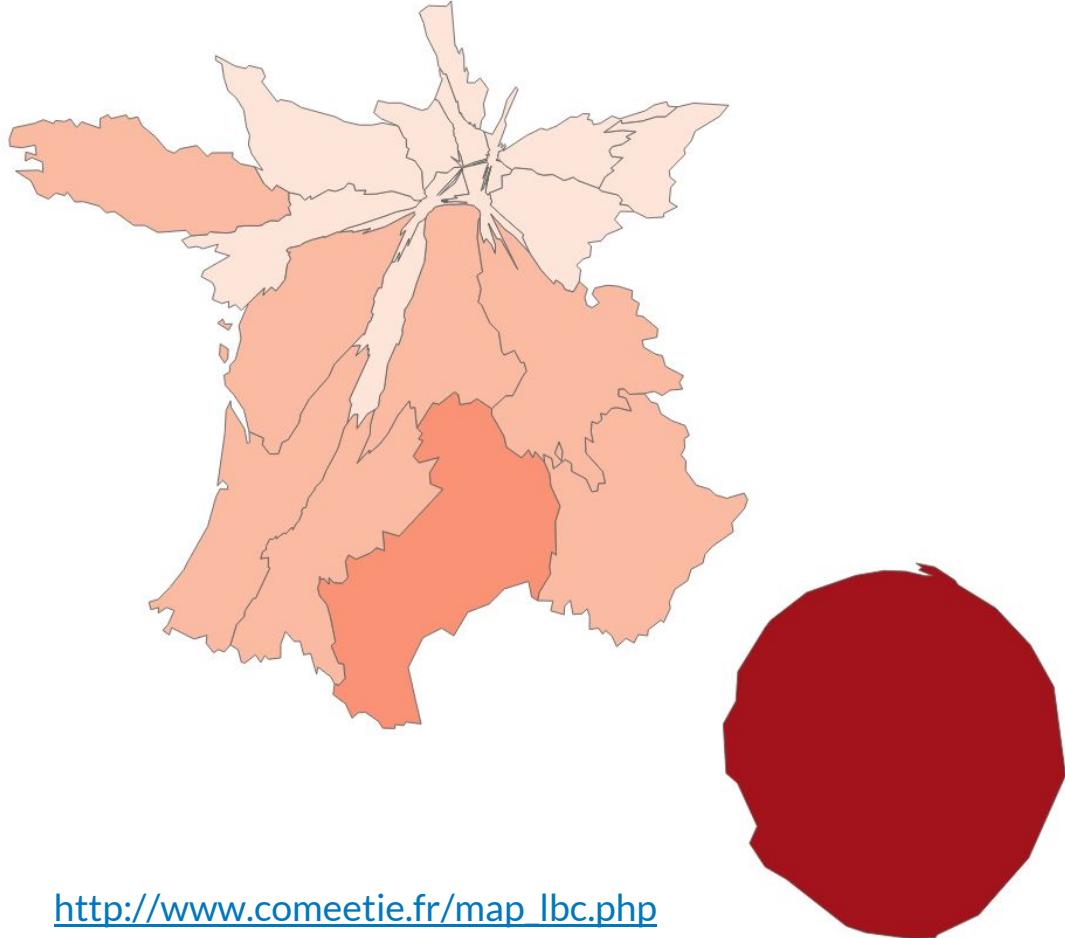
# Carte de topographique contour

## Pas de région prédefinies



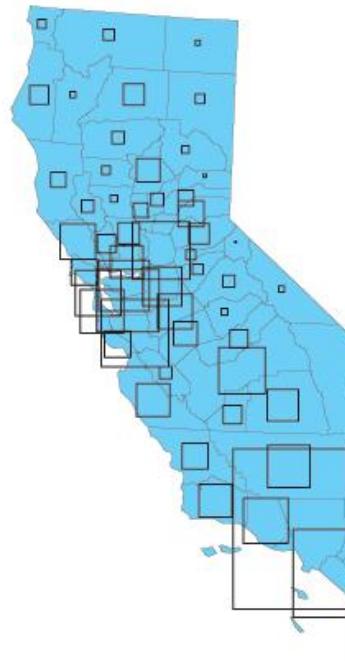
# Cartogrammes

Locations de vacances sur Le Bon Coin, ajusté par habitants

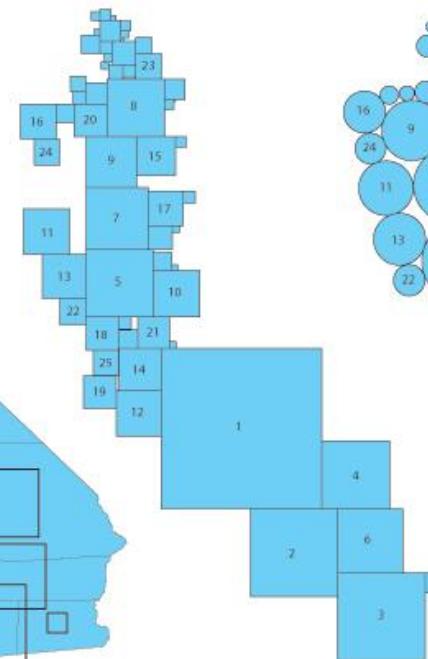


# Autres formes de cartogrammes

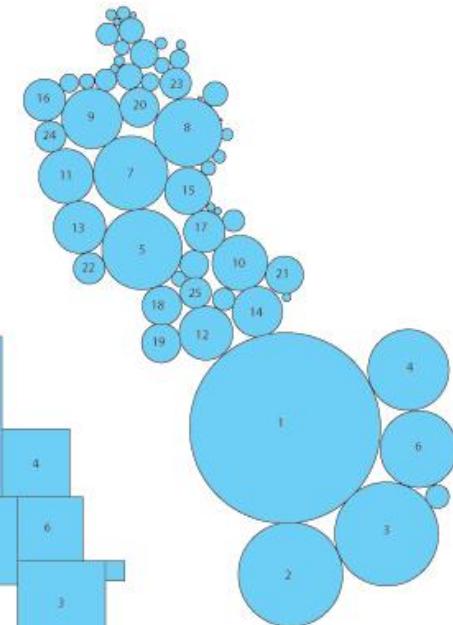
Graduated Symbol Map



Demers Cartogram



Dorling Cartogram

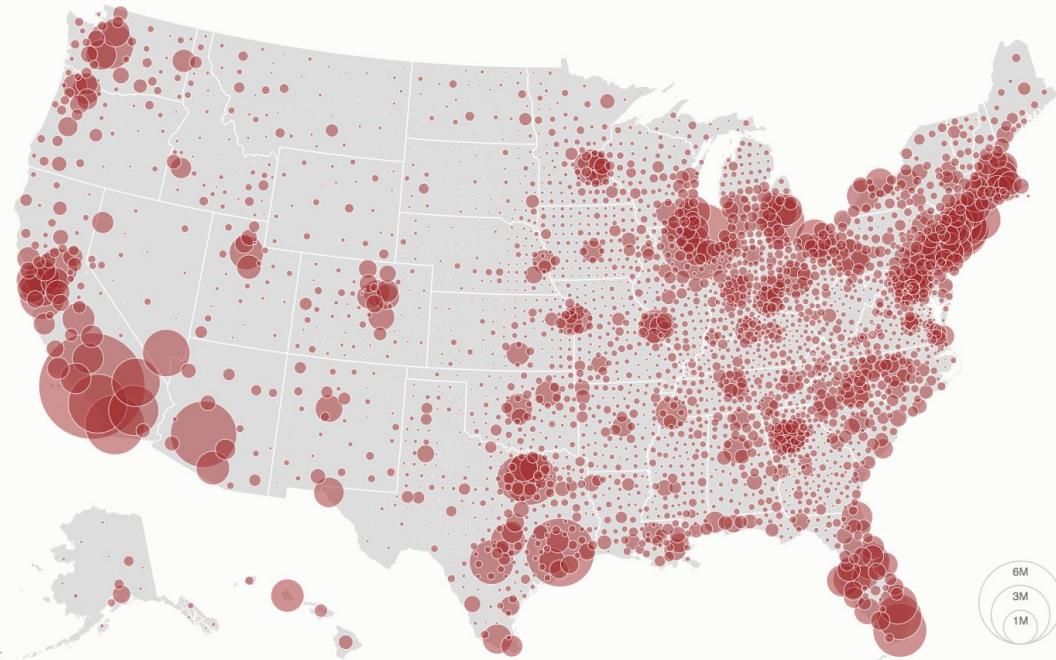


[http://www.ncgia.ucsb.edu/projects/Cartogram\\_Central/types.html](http://www.ncgia.ucsb.edu/projects/Cartogram_Central/types.html)

# Carte symbolique

## Let's Make a Bubble Map

My previous [Let's Make a Map](#) tutorial describes how to make a basic map with [D3](#) and [TopoJSON](#); now it's time to cover thematic mapping in the form of a [graduated symbol map](#). The simplest graduated symbol is a circle, or *bubble*, whose size is proportional to the associated data. In this tutorial, we'll make a bubble map of [population](#) by U.S. county.

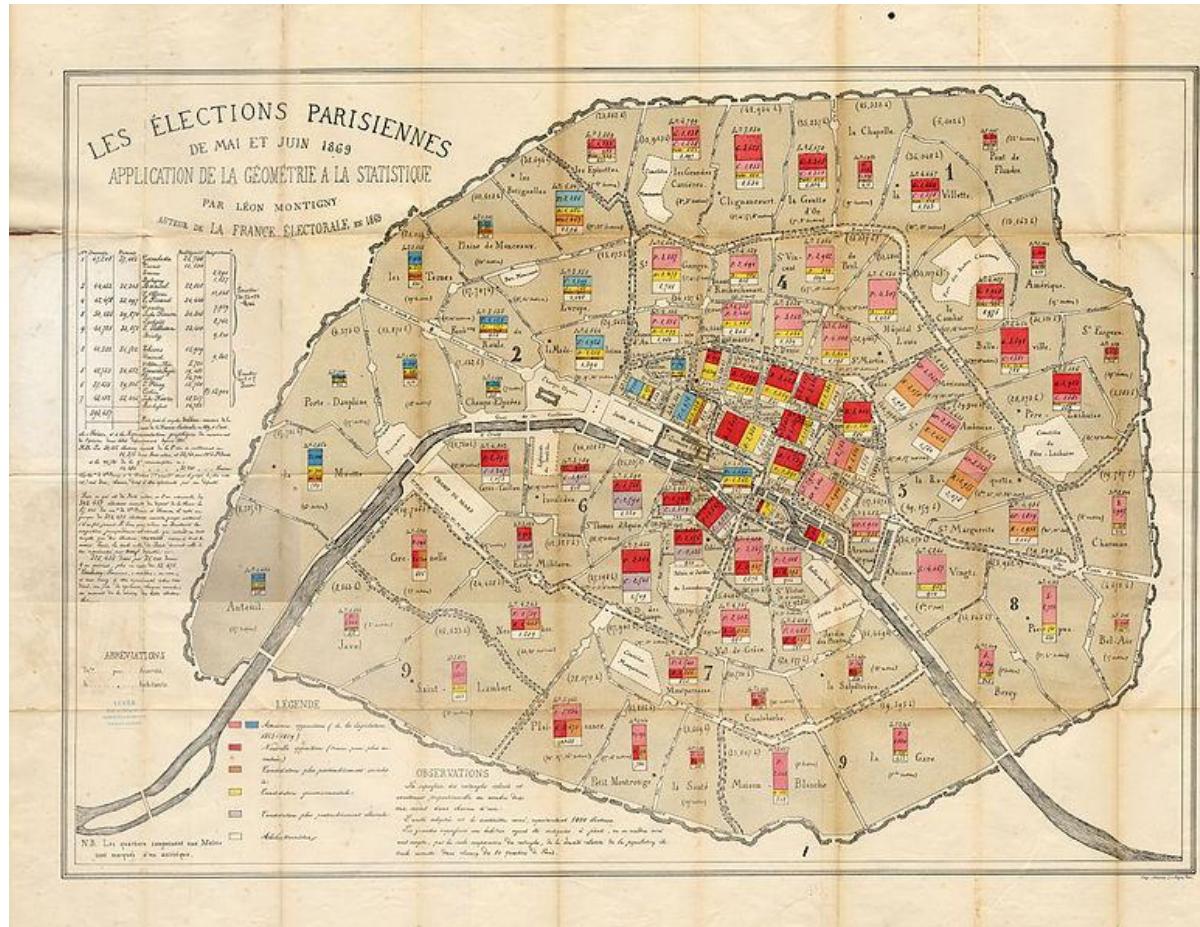


Source: American Community Survey, 2012 5-Year Estimate

<https://bostocks.org/mike/bubble-map/>

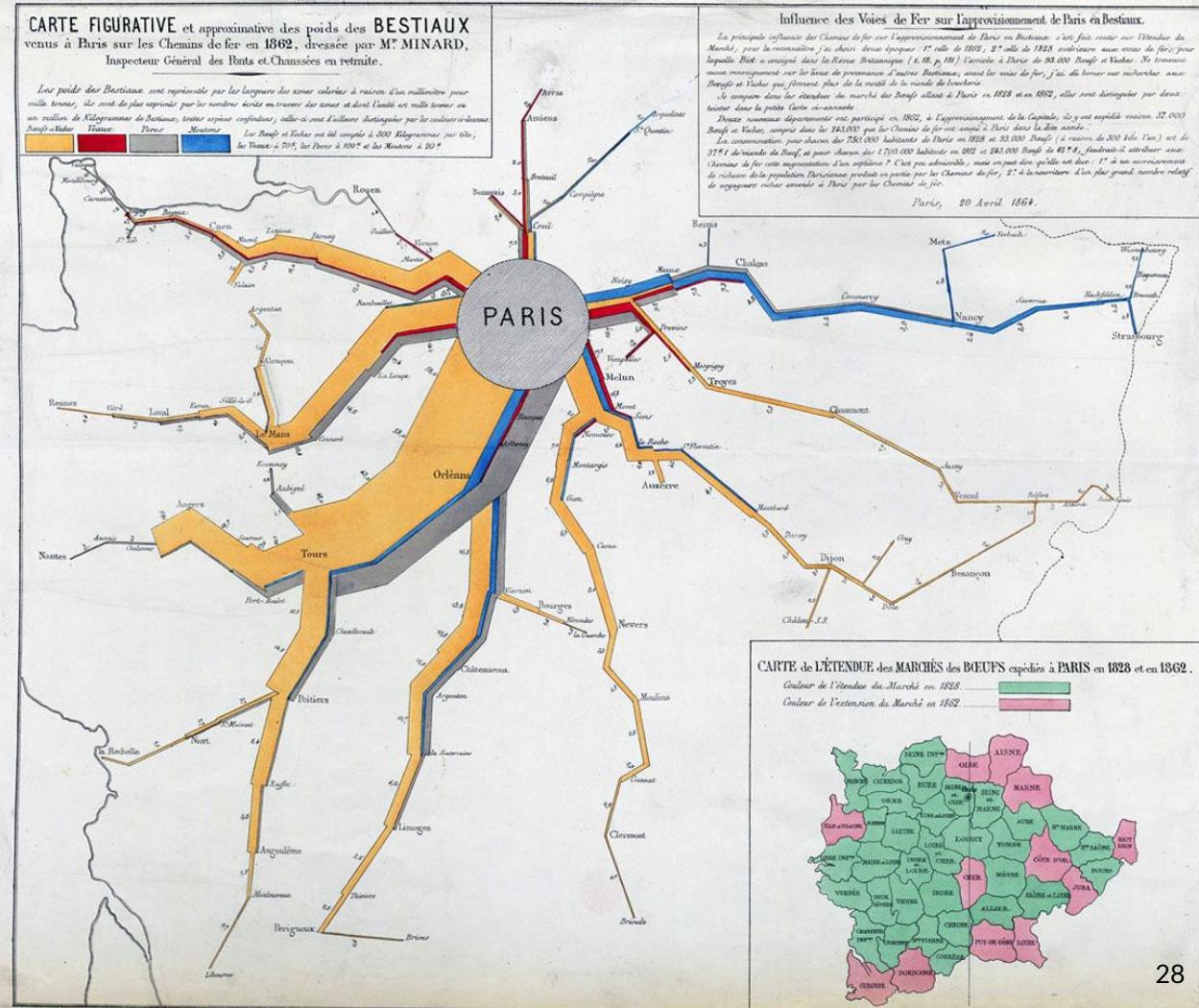
# Carte symbolique

<http://visionscarto.net/charles-joseph-minard-cinquante-cartes>



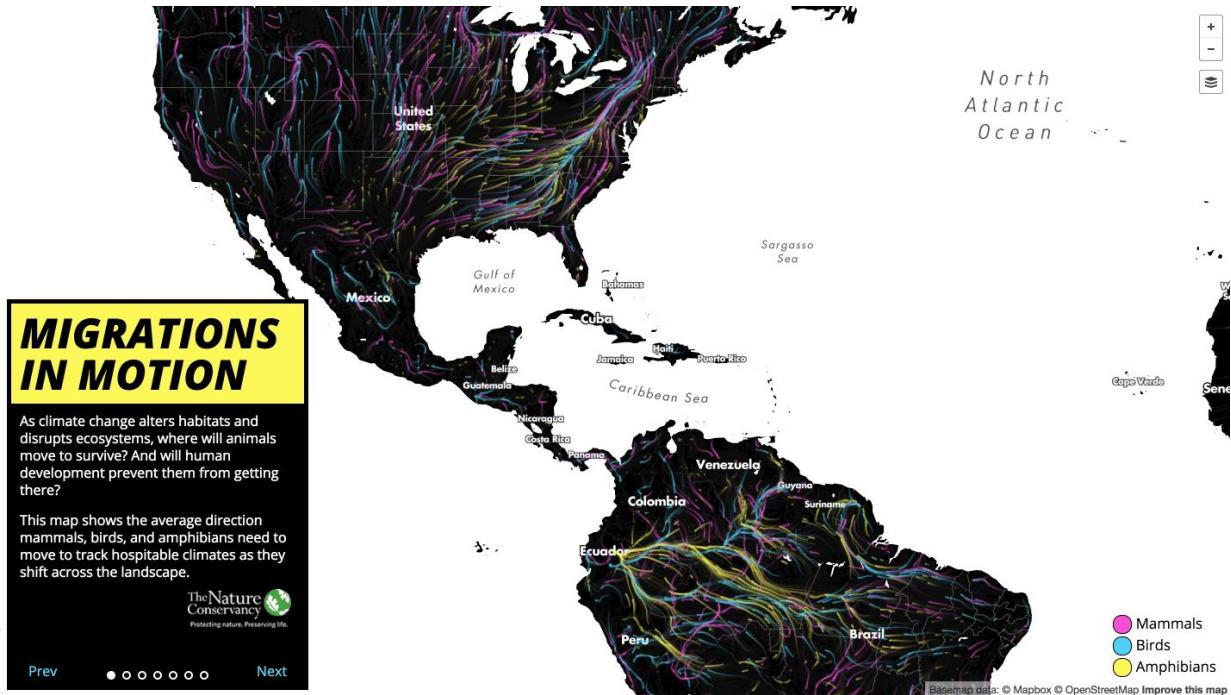
# Carte de flux

<http://visionscarto.net/charles-joseph-minard-cinquante-cartes>



# Carte de flux animées

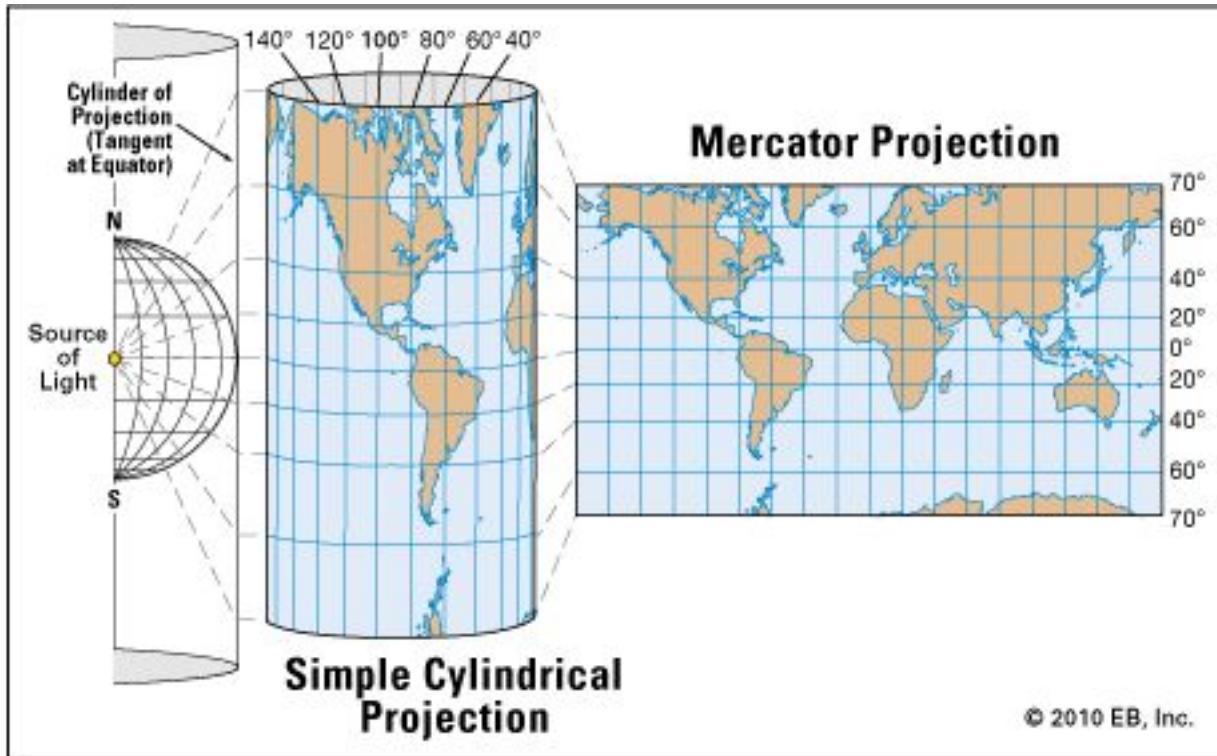
[http://maps.tnc.org/  
migrations-in-motion/](http://maps.tnc.org/migrations-in-motion/)



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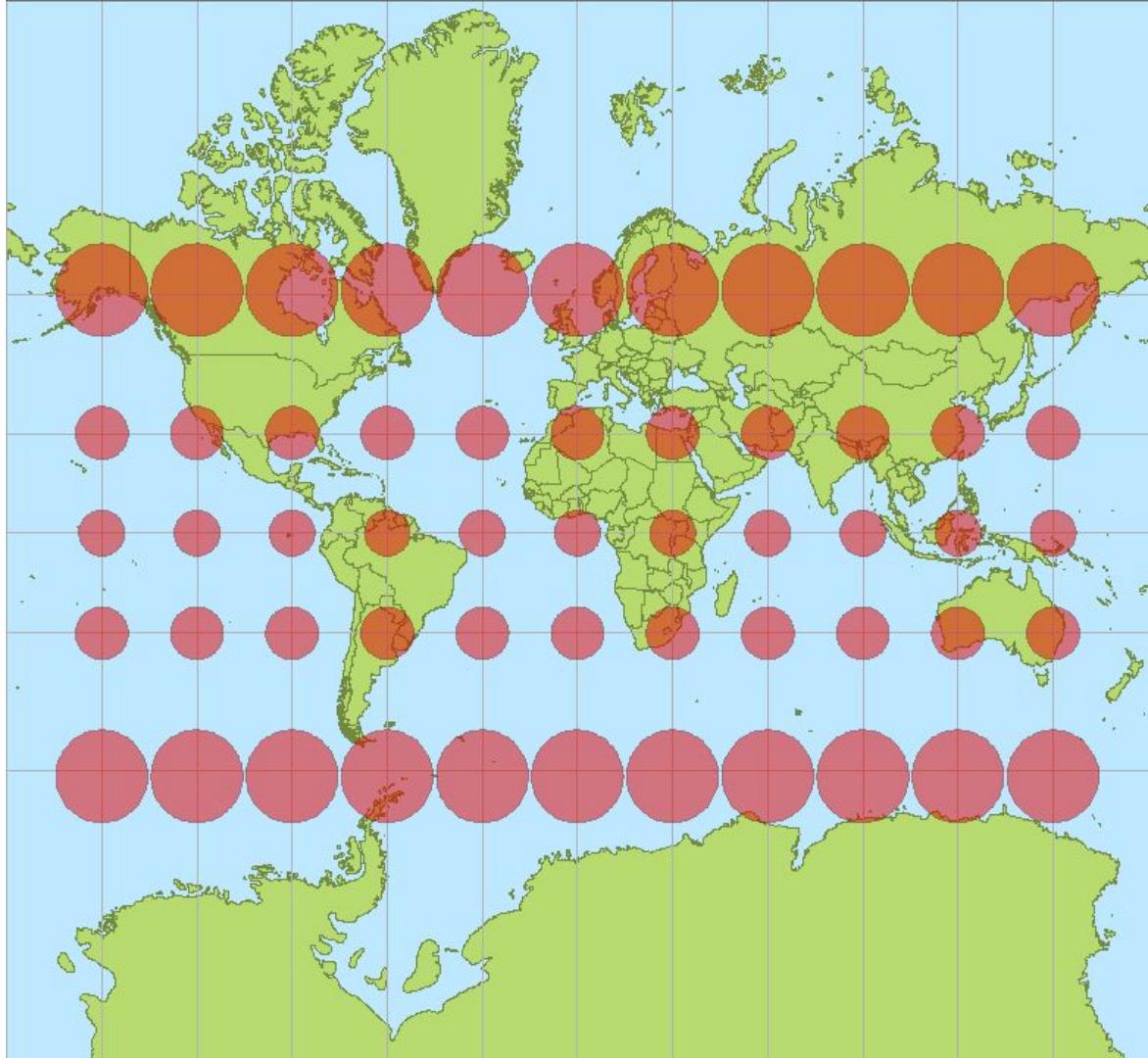
# Projections

# Projection de Mercator



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# Projection de Mercator avec indicateurs de déformation de Tissot.





Mercator



Actual

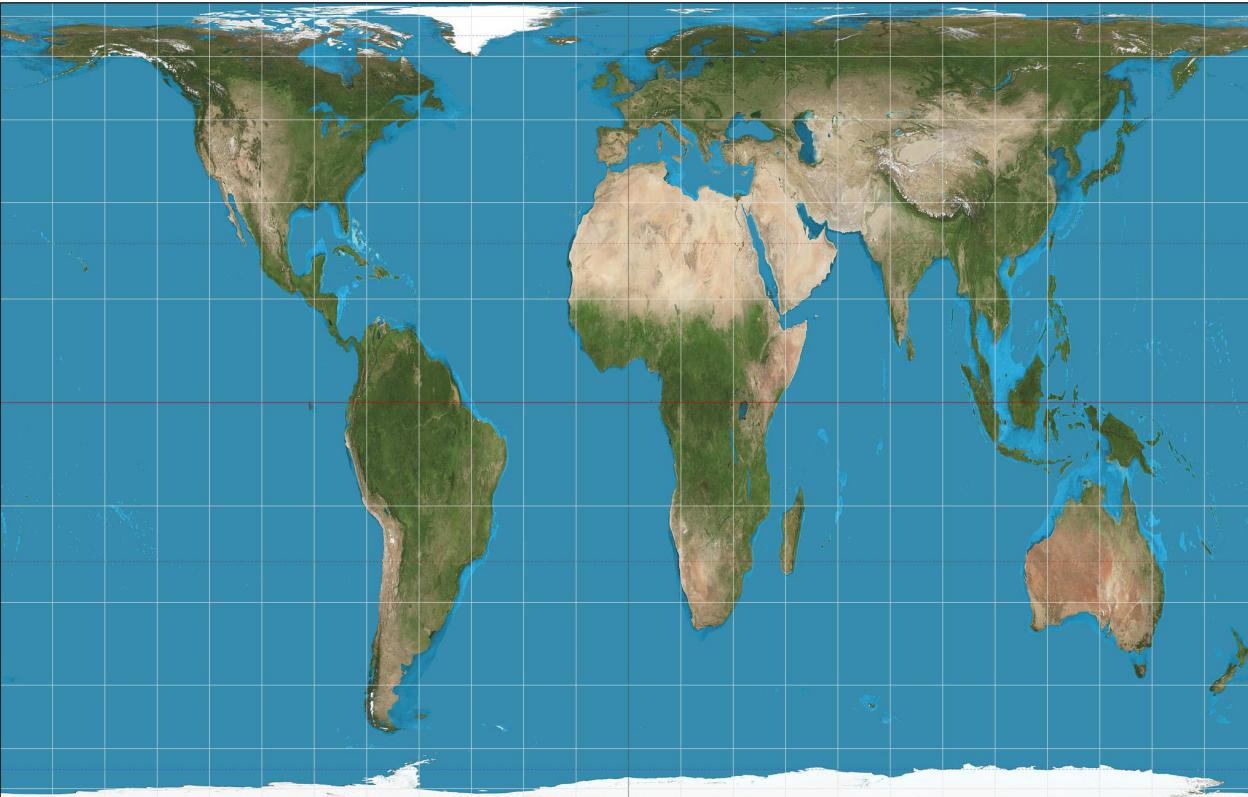
# Problème de Mercator

Traditionnellement utilisée pour enseigner la géographie

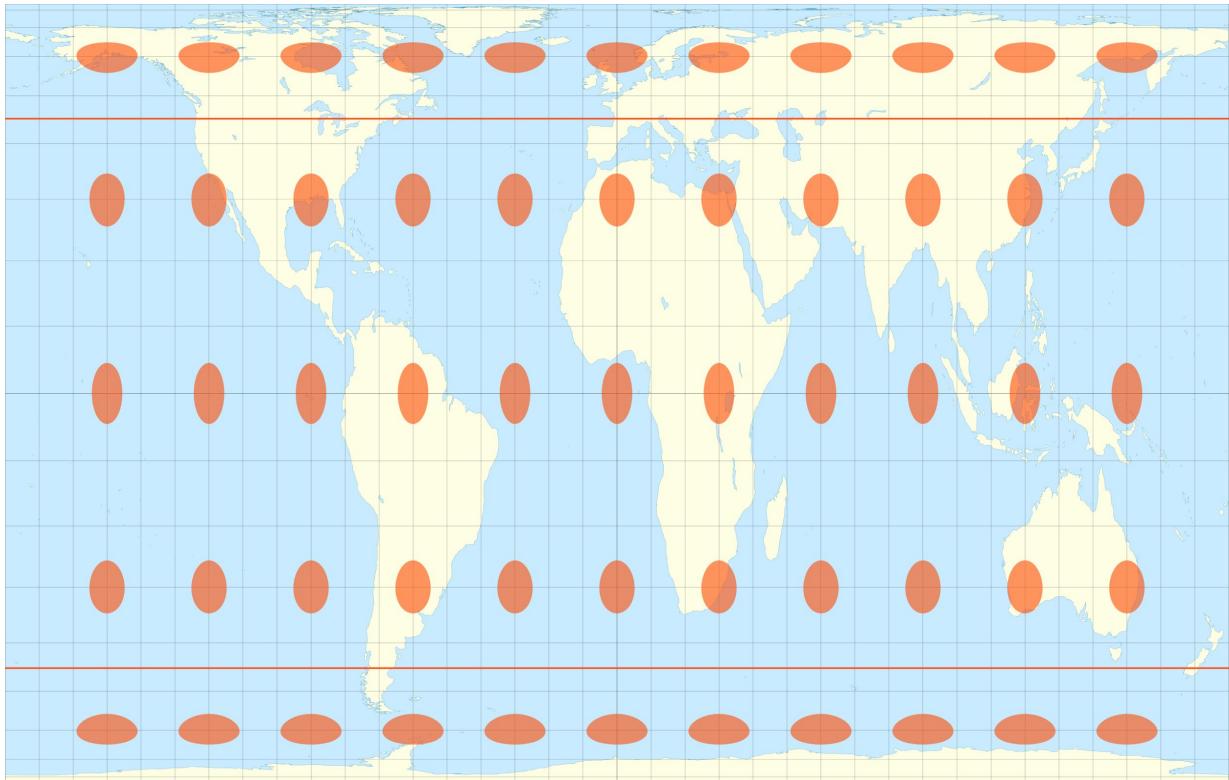
Distortion d'aires en fonction de l'éloignement de l'équateur

Distortion minimisant le “Sud” :  
Afrique, Amérique du Sud, Océanie

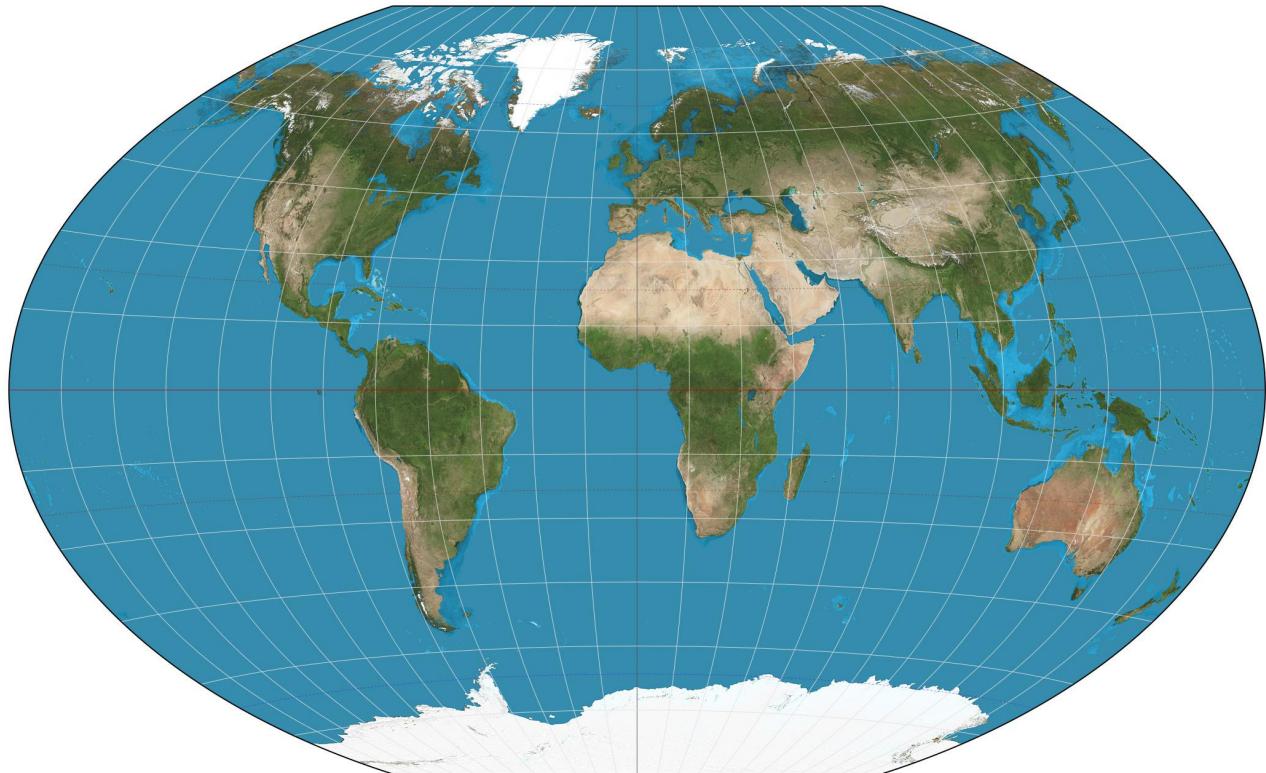
# Projection de Peters



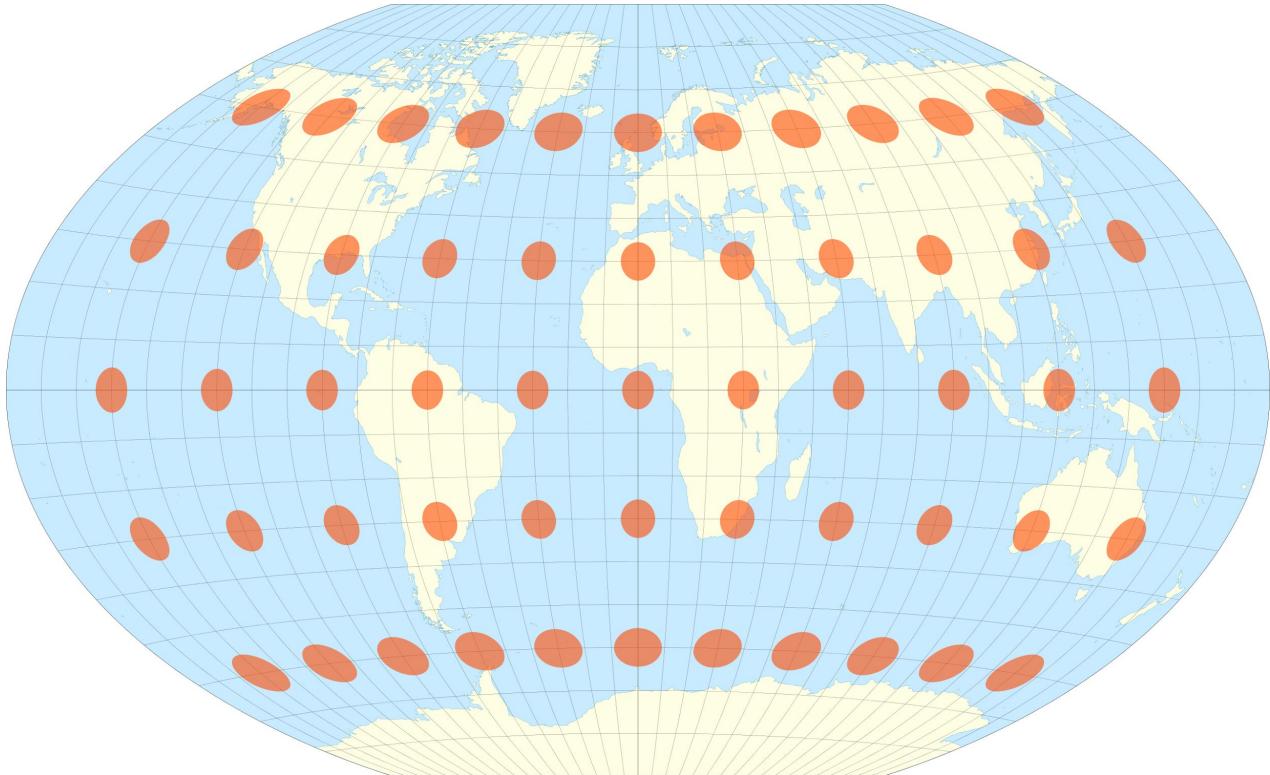
# Projection de Peters



# Projection de Winkel-Tripel



# Projection de Winkel-Tripel

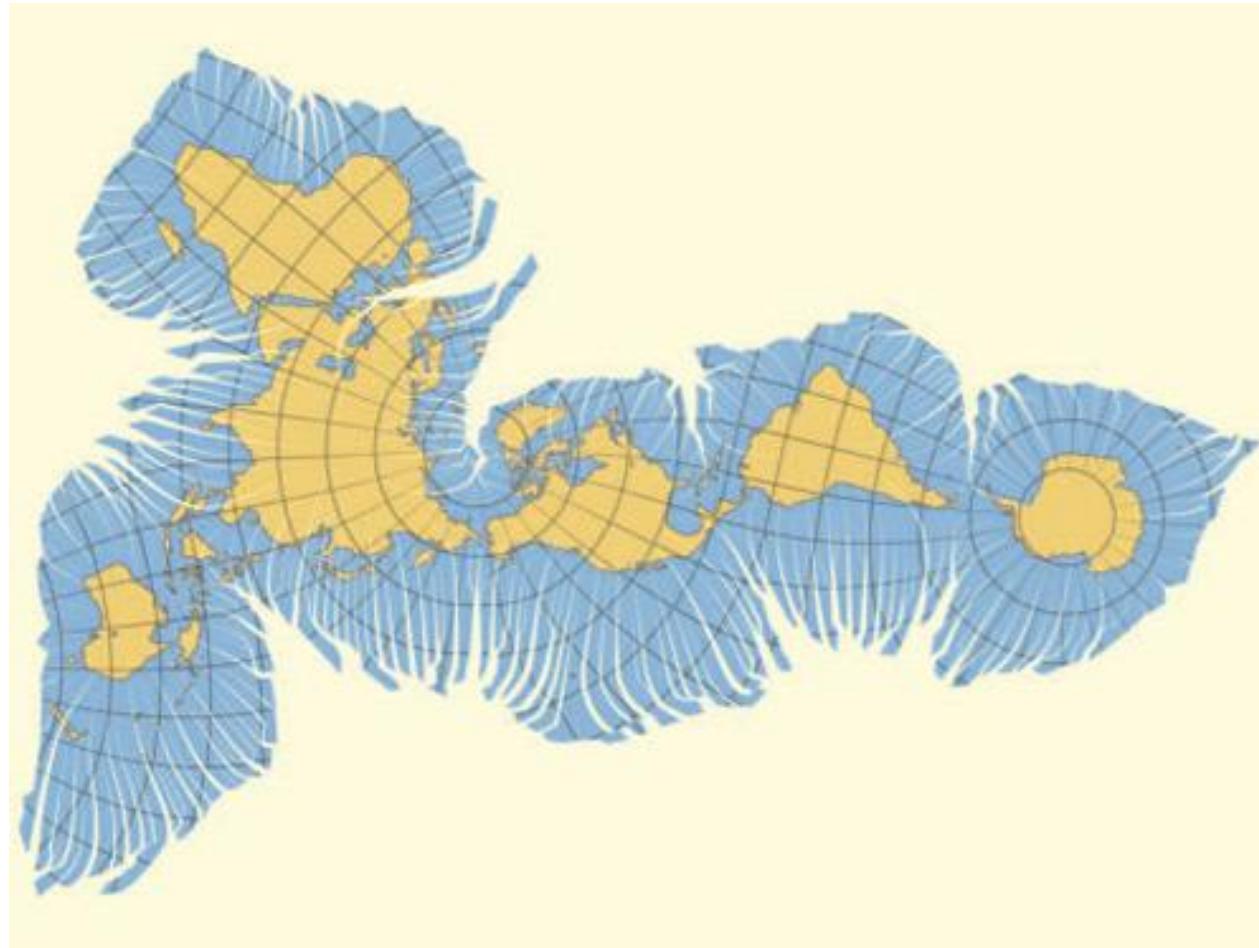


# Déplier la Terre

[http://www.win.tue.nl/~vanwijk/  
myriahedral/](http://www.win.tue.nl/~vanwijk/myriahedral/)

[http://www.bldgblog.com/2009/12/  
cracking-the-planet/](http://www.bldgblog.com/2009/12/cracking-the-planet/)

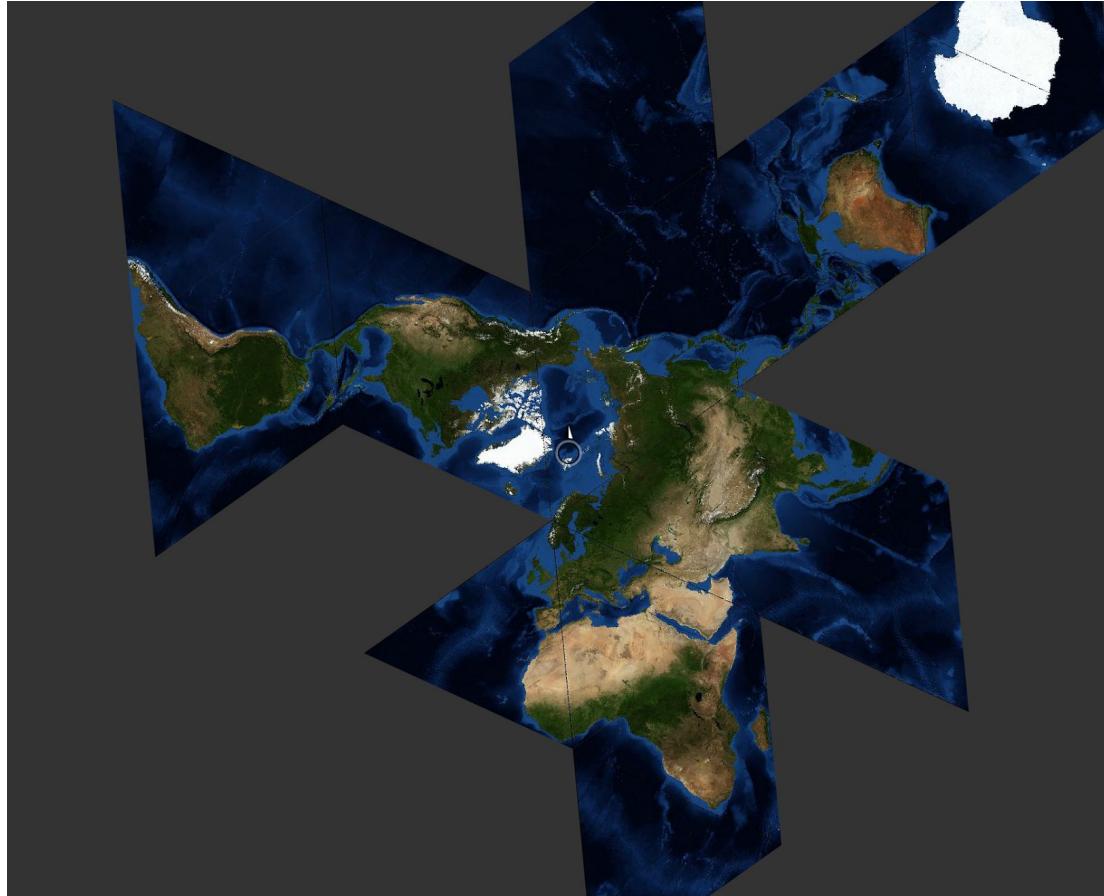
[https://www.youtube.com/watch?  
v=b1xXTi1nFCo](https://www.youtube.com/watch?v=b1xXTi1nFCo)



# Déplier la Terre

<http://teczno.com/faumaxion-II/>

Projection dymaxion  
de Buckminster Fuller



# xkcd.com/977

WHAT YOUR FAVORITE  
**MAP PROJECTION**  
SAYS ABOUT YOU

MERCATOR



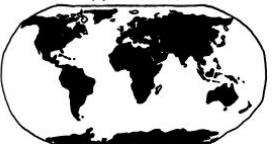
YOU'RE NOT REALLY INTO MAPS.

VAN DER GRIJNEN



YOU'RE NOT A COMPLICATED PERSON. YOU LOVE THE MERCATOR PROJECTION; YOU JUST WISH IT WEREN'T SQUARE. THE EARTH'S NOT A SQUARE, IT'S A CIRCLE. YOU LIKE CIRCLES. TODAY IS GONNA BE A GOOD DAY!

ROBINSON



YOU HAVE A COMFORTABLE PAIR OF RUNNING SHOES THAT YOU WEAR EVERYWHERE. YOU LIKE COFFEE AND ENJOY THE BEATLES. YOU THINK THE ROBINSON IS THE BEST-LOOKING PROJECTION, HANDS DOWN.

WINKEL-TRIPEL



NATIONAL GEOGRAPHIC ADOPTED THE WINKEL-TRIPEL IN 1998, BUT YOU'VE BEEN A WT FAN SINCE LONG BEFORE "NAT GEO" SHOWED UP. YOU'RE WORRIED IT'S GETTING PLAYED OUT, AND ARE THINKING OF SWITCHING TO THE KAVRAYSKY. YOU ONCE LEFT A PARTY IN DISGUST WHEN A GUEST SHOWED UP WEARING SHOES WITH TOES. YOUR FAVORITE MUSICAL GENRE IS "POST-".

GOODE HOMOLOSINE



THEY SAY MAPPING THE EARTH ON A 2D SURFACE IS LIKE FLATTENING AN ORANGE PEEL, WHICH SEEMS EASY ENOUGH TO YOU. YOU LIKE EASY SOLUTIONS. YOU THINK WE WOULDN'T HAVE SO MANY PROBLEMS IF WE JUST ELECT NORMAL PEOPLE TO CONGRESS INSTEAD OF POLITICIANS. YOU THINK AIRLINES SHOULD JUST BUY FOOD FROM THE RESTAURANTS NEAR THE GATES AND SERVE THAT ON BOARD. YOU CHANGE YOUR CAR'S OIL, BUT SECRETLY WONDER IF YOU REALLY NEED TO.

HOBÓ-DYER



YOU WANT TO AVOID CULTURAL IMPERIALISM, BUT YOU'VE HEARD BAD THINGS ABOUT GALL-PETERS. YOU'RE CONFLICT-AVERSE AND BUY ORGANIC. YOU USE A RECENTLY-INVENTED SET OF GENDER-NEUTRAL PRONOUNS AND THINK THAT WHAT THE WORLD NEEDS IS A REVOLUTION IN CONSCIOUSNESS.

A GLOBE!



YES, YOU'RE VERY CLEVER.

PEIRCE QUINCUNCIAL



WATERMAN BUTTERFLY



REALLY? YOU KNOW THE WATERMAN? HAVE YOU SEEN THE 1909 CHILL MAP IT'S BASED ON... YOU HAVE A FRAMED REPRODUCTION AT HOME?! WHOA... LISTEN, FORGET THESE QUESTIONS. ARE YOU DOING ANYTHING TONIGHT?

GALL-PETERS



I HATE YOU.

YOU THINK THAT WHEN WE LOOK AT A MAP, WHAT WE REALLY SEE IS OURSELVES. AFTER YOU FIRST SAW INCEPTION, YOU SAT SILENT IN THE THEATER FOR SIX HOURS. IT FREAKS YOU OUT TO REALIZE THAT EVERYONE AROUND YOU HAS A SKELETON INSIDE THEM. YOU HAVE REALLY LOOKED AT YOUR HANDS.

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# Conclusion

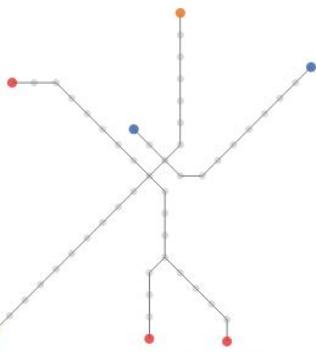
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# Visualizing MBTA Data

Visualisation du métro de Boston

<http://mbtaviz.github.io/>

Projet étudiant de  
M. Barry et B. Card (2014)

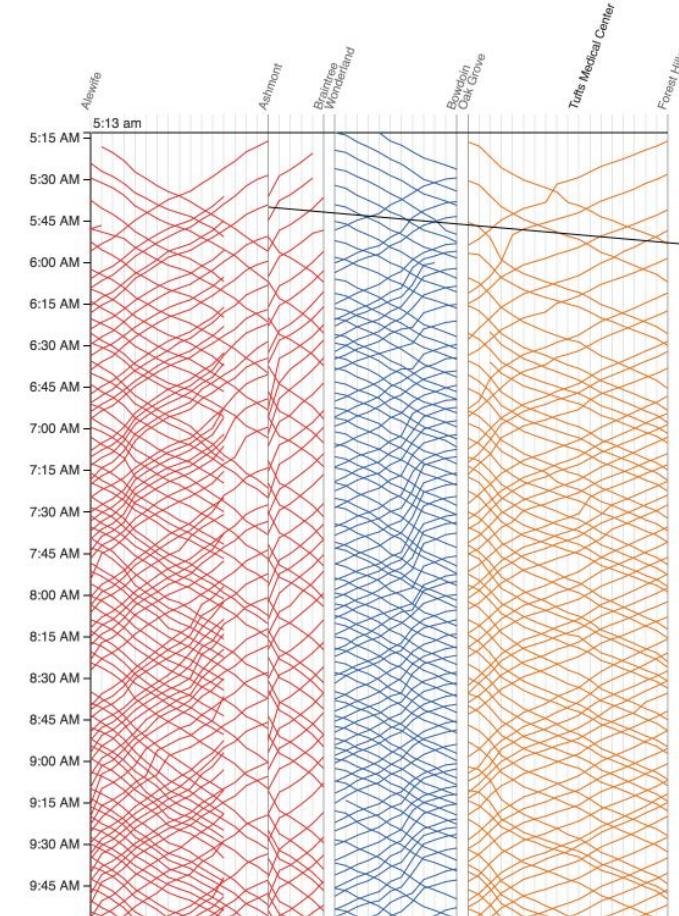


Locations of each train on the [red](#), [blue](#), and [orange](#) lines at 5:13 am. Hover over the diagram to the right to display trains at a different time.

Trains are on the right side of the track relative to the direction they are moving.

See the [morning rush-hour](#), [midday lull](#), [afternoon rush-hour](#), and the [evening lull](#).

Subway Trips on Monday February 3, 2014



Service starts at 5AM on Monday morning. Each line represents the path of one train. Time continues downward, so steeper lines indicate slower trains.

Since the red line splits, we show the Ashmont branch first then the Braintree branch. Trains on the Braintree branch "jump over" the Ashmont branch.

Train frequency increases around 6:30AM as morning rush hour begins.

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-

# 1. Charger un fond de carte

Attention on utilise d3.v4.js

Fichier de description des états américains :

[https://raw.githubusercontent.com/alignedleft/d3-book/master/chapter\\_12/us-states.json](https://raw.githubusercontent.com/alignedleft/d3-book/master/chapter_12/us-states.json)

<http://blockbuilder.org/aurelient/5bb9210591eb86882612a2002faab698>

<http://blockbuilder.org/aurelient/4d81a04af78878f6ff2f3bf64a6229fo>

```
<script>
    var width = 700,
        height = 580;

    var svg = d3.select( "body" )           // creation du svg
        .append( "svg" )                   // dans le dom
        .attr( "width", width )
        .attr( "height", height );

    var projection = d3.geoAlbersUsa() // definition de
        .translate([width/2, height/2]) // la projection

    var path = d3.geo.path()           // mapping des donnees
        .projection(projection);      // spatiales a la proj.

    // chargement des donnees
    d3.json("us-states.json", function(json) {

        svg.selectAll("path")
            .data(json.features)
            .enter()
            .append("path")          // "magie d3" : lien geojson
            .attr("d", path);       // -> coordonnees ecran

    });
</script>
```

## 2. Mapping de données

1. Chargement des données
2. Choix des couleurs

<http://colorbrewer2.org/>  
[https://bl.ocks.org/mbostock/  
5577023](https://bl.ocks.org/mbostock/5577023)

3. Construction de la carte  
chloroplète

<http://blockbuilder.org/aurelient/3bd4b19b6706617c1f4e4d53d3a5725e>

```
<script>
    var width = 700, height = 580;

    var svg = d3.select( "body" ).append( "svg" )
        .attr( "width", width )
        .attr( "height", height );

    var g = svg.append( "g" );

    var projection = d3.geoAlbersUsa()
        .translate([width/2, height/2]).scale([500]);

    var path = d3.geoPath().projection(projection);

    // On definit une echelle de couleur
    var color = d3.scale.quantize()
        .range(["rgb(237,248,233)", "rgb(186,228,179)",
        "rgb(116,196,118)", "rgb(49,163,84)", "rgb(0,109,44)"]);

    // Chargement des donnees
    d3.csv("us-ag-productivity-2004.csv", function(data) {
        //Set input domain for color scale
        color.domain([
            d3.min(data, function(d) { return d.value; }),
            d3.max(data, function(d) { return d.value; })
        ]);

        d3.json("us-states.json", function(json) {
```

## 2. Mapping de données

1. Chargement des données
2. Choix des couleurs

<http://colorbrewer2.org/>

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chloroplèthe

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```

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<http://colorbrewer2.org/>

[https://bl.ocks.org/mbostock/  
5577023](https://bl.ocks.org/mbostock/5577023)

3. Construction de la carte  
chloropltéthe

<http://blockbuilder.org/aurelient/3bd4b19b6706617c1f4e4d53d3a5725e>

```
// Chargement des donnees
d3.csv("us-ag-productivity-2004.csv", function(data) {
(...)

    d3.json("us-states.json", function(json) {
        //On fusionne les donnees avec le GeoJSON
        for (var i = 0; i < data.length; i++) {

            //Nom de l'etat
            var dataState = data[i].state;

            //Valeur associee a l'etat
            var dataValue = parseFloat(data[i].value);

            //Recherche de l'etat dans le GeoJSON
            for (var j = 0; j < json.features.length; j++) {
                var jsonState = json.features[j].properties.name;
                if (dataState == jsonState) {
                    //On injecte la valeur de l'Etat dans le json
                    json.features[j].properties.value = dataValue;

                    //Pas besoin de chercher plus loin
                    break;
                }
            }
        }
    }
})
```

## 2. Mapping de données

1. Chargement des données
2. Choix des couleurs

<http://colorbrewer2.org/>

[https://bl.ocks.org/mbostock/  
5577023](https://bl.ocks.org/mbostock/5577023)

3. Construction de la carte  
chloropltéthe

<http://blockbuilder.org/aurelient/3bd4b19b6706617c1f4e4d53d3a5725e>

```
// Chargement des donnees
d3.csv("us-ag-productivity-2004.csv", function(data) {

    //Set input domain for color scale
    ...

    d3.json("us-states.json", function(json) {
        ...

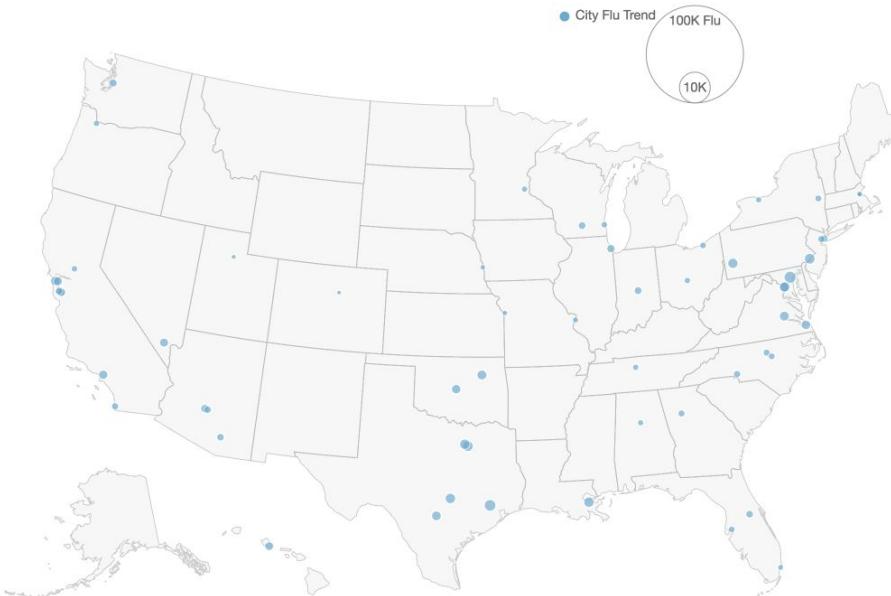
        g.selectAll("path")
            .data(json.features)
            .enter()
            .append("path")
            .attr("d", path)
            .style("fill", function(d) {
                //on prend la valeur recuperée plus haut
                var value = d.properties.value;

                if (value) {
                    return color(value);
                } else {
                    // si pas de valeur alors en gris
                    return "#ccc";
                }
            });
        });
    });

});
```

# Un exemple à remprendre

| SEP 2003 ▶



# Exo à faire en TP

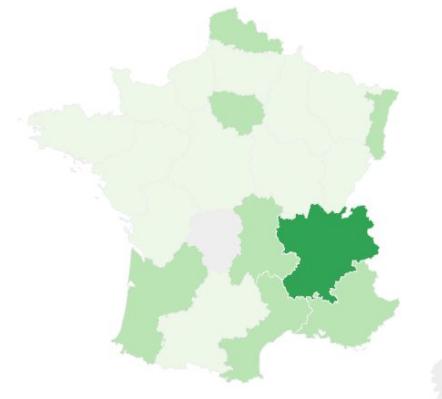
Adapté avec des données françaises :

- <https://www.google.org/flutrends/about/data/flu/fr/data.txt>
- <https://raw.githubusercontent.com/gregoiredavid/france-geojson/master/regions.geojson>

19/01/14

Carte chloroplèthe  
(pas symbolique)

Slider temporel  
lié à la carte



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# Références D3 cartographie

- Livre Interactive Data Visualization for the Web  
[Chapter 12. Geomapping](#)
- Données GeoJSON France :  
<https://github.com/gregoiredavid/france-geojson/>
- <https://maptimboston.github.io/d3-maptime/>
- M. Bostock : [Command Line Cartography](#)

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# Autres outils

[Leaflet](#) (Web)

[Unfolding maps](#) (Processing / Java)

[Mapbox](#)

[Cartodb](#)

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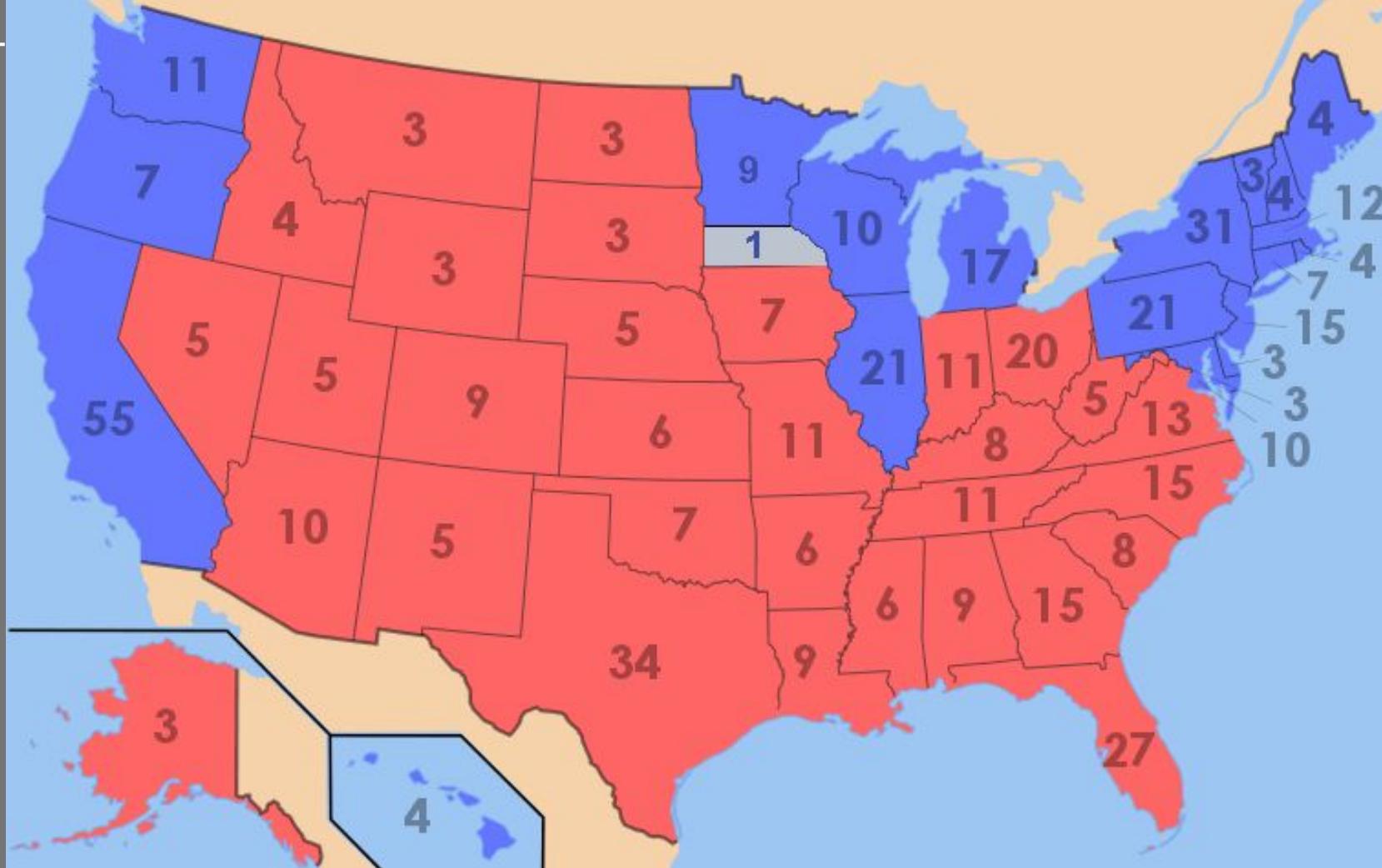
# Représentations non spatiales

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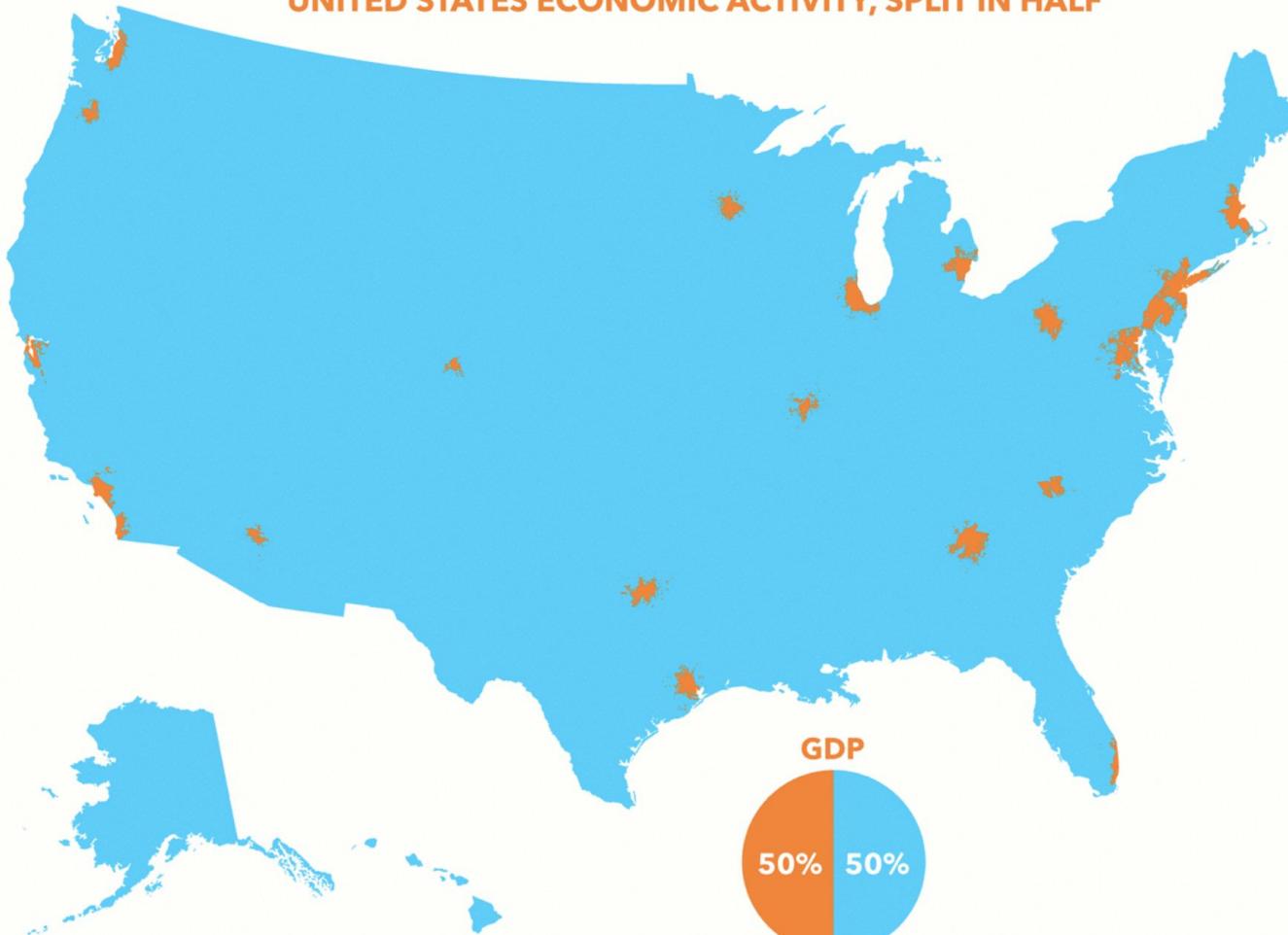
<http://www.ericson.net/content/2011/10/when-maps-shouldnt-be-maps/>

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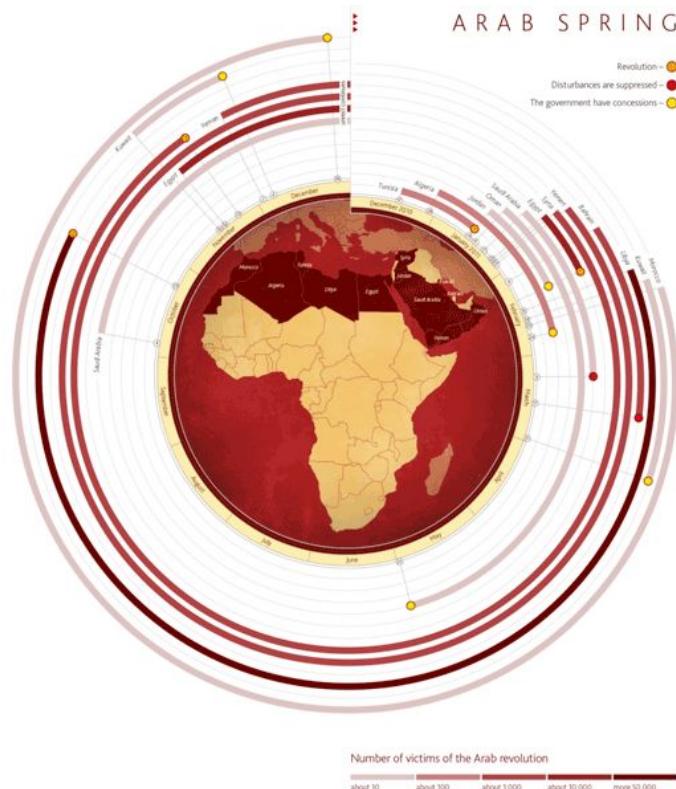
# Critiques alternatives



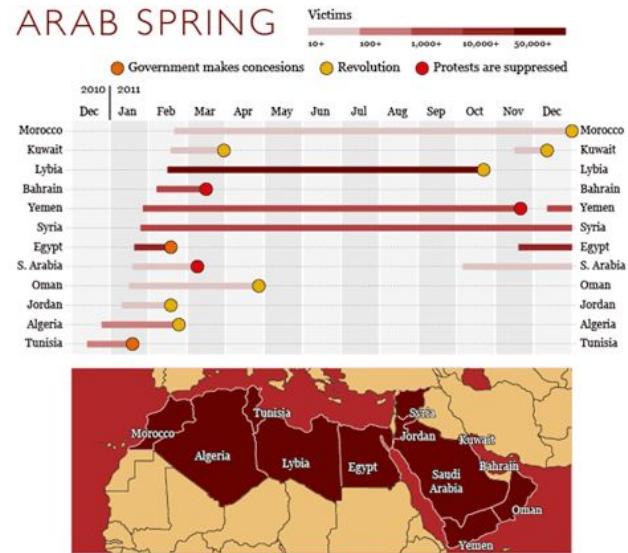
## UNITED STATES ECONOMIC ACTIVITY, SPLIT IN HALF



atrubetskoy on Reddit



Timeline of Arab Spring events in North Africa, by Alexander Katin and Kir Khachaturov.



Alberto Cairo's redesign of the same circular timeline. Posted on "The Functional Art" blog.

[https://medium.com/@hint\\_fm/design-and-redesign-4ab77206cf9#.3avyf29un](https://medium.com/@hint_fm/design-and-redesign-4ab77206cf9#.3avyf29un)