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# Visualisation de Données spatiales

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# Articles

- A Descriptive Framework for Temporal Data Visualizations Based on Generalized Space-Time Cubes  
Felardos-Saint Jean, Melaine
- Generalized fisheye views  
Diana, Gaget
- Touching Transport - A Case Study on Visualizing Metropolitan Public Transit on Interactive Tabletop  
El Manany, Mornieux

# Plan

- Articles
  - Critique
  - Cours
  - Techniques de sketching
  - Tuto D3 maps
-

# 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



# Plan

- Articles
  - Critique
  - Cours
  - Techniques de sketching
  - Tuto D3 maps
-

# Cours

- Données spatiales
  - Types de cartes
  - Projections
-

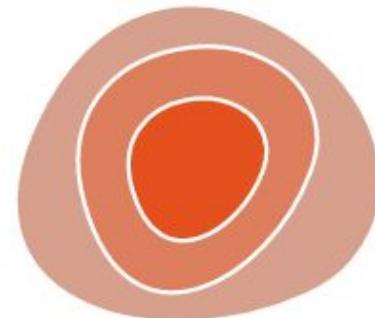
# Les données spatiales

Caractéristique principale : un mapping “direct”

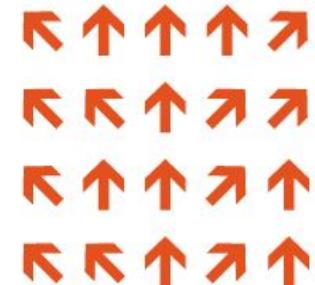
Données géométriques



Champs scalaires



Champs de vecteurs / tenseurs



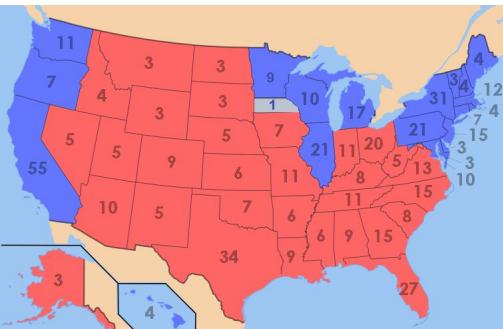
# Les données spatiales

Géométrie:

- Données géographiques
- Données dérivées



# Exemple : Carte choroplète



**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

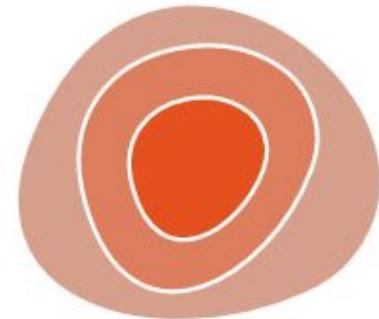
Codage

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

# Les données spatiales

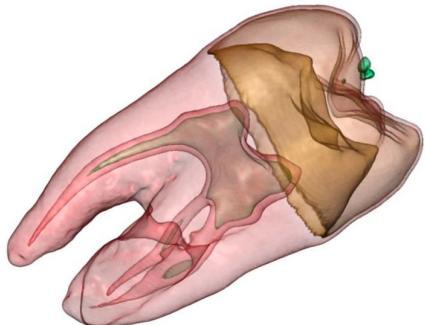
Champs scalaires :  
une valeur par cellule

- 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

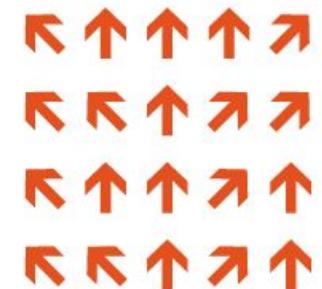
- Analyse de la structure spatiale 3D

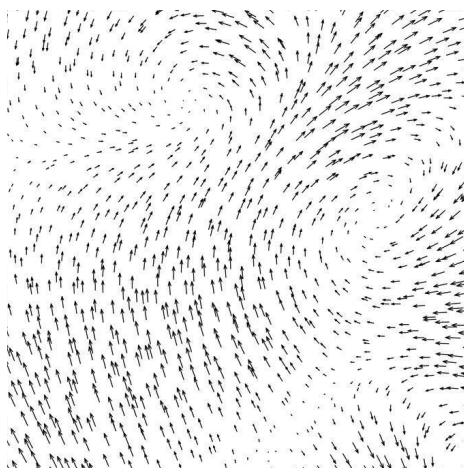
# Les données spatiales

Champs de vecteurs ou de tenseurs

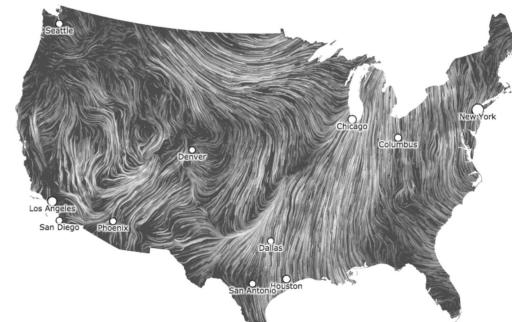
Plusieurs valeurs par cellule

- Glyphes de flux
- Geometries
- Textures
- Propriétés





[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/>

# Exemple : champ de vecteurs

## Données

- Champ scalaire : plusieurs attributs par cellule

## Tâches

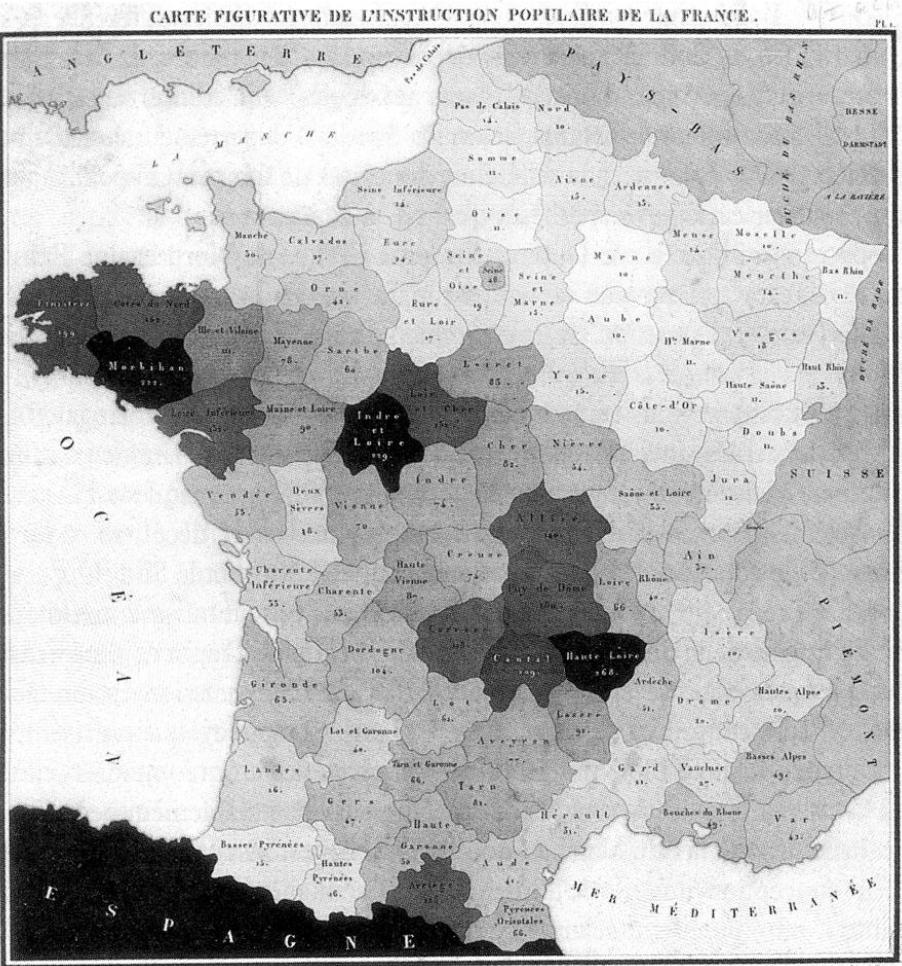
- Identifier des points critiques en une position donnée
- Prédire la position future d'un point
- Comprendre un déplacement

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# Cartographie

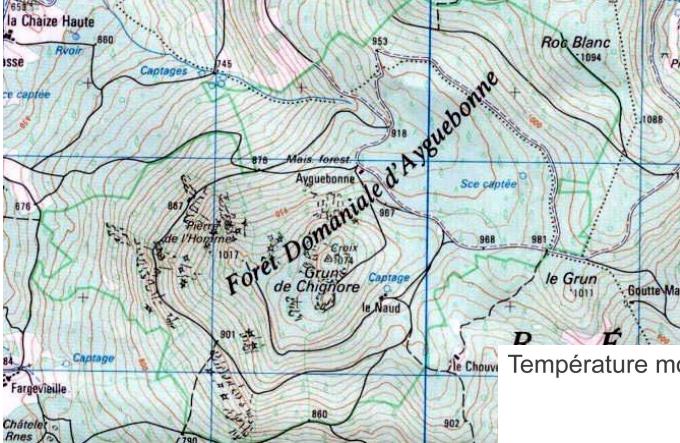
# Carte choroplète

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

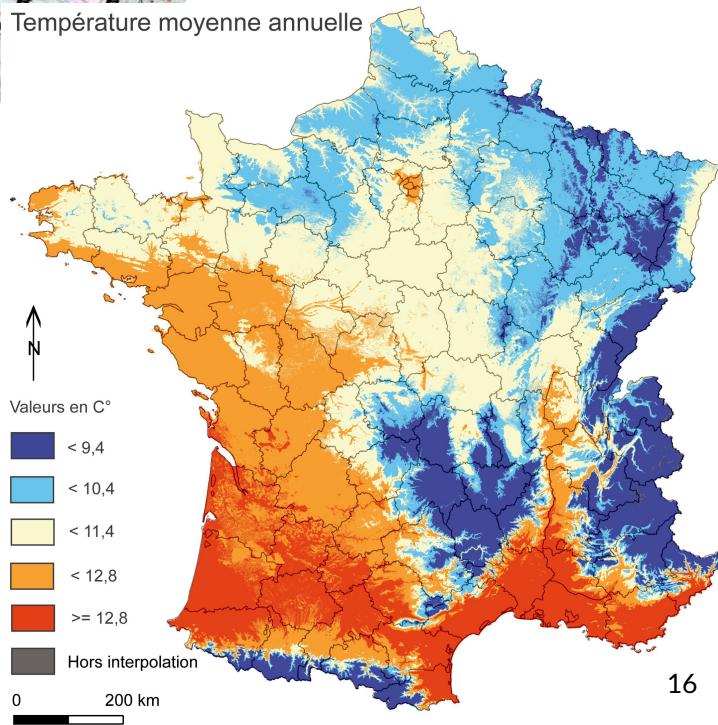


# Carte de topographique contour

## Pas de région prédefinies

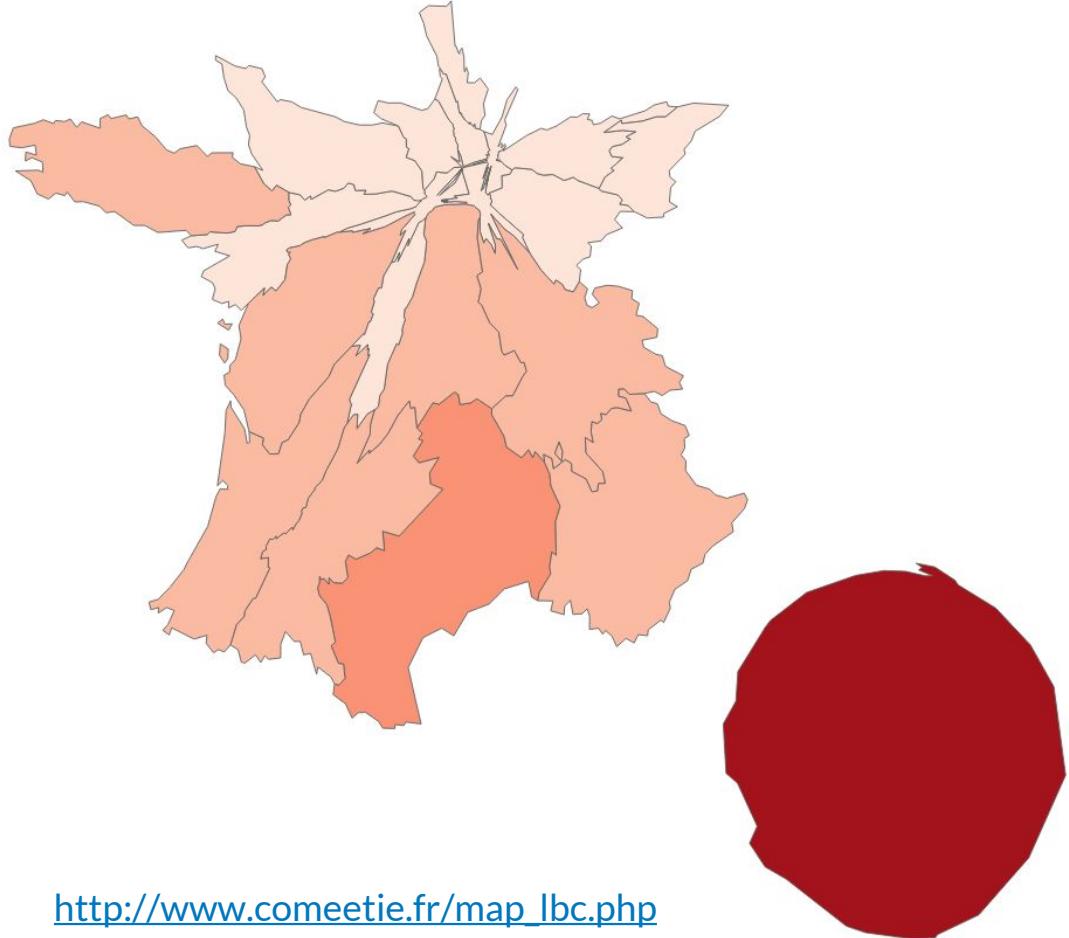


## Température moyenne annuelle



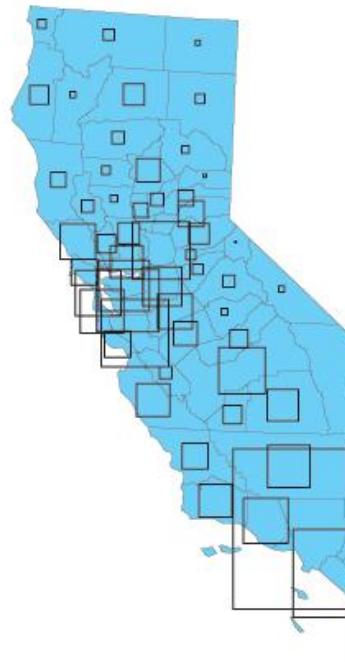
# Cartogrammes

Locations de vacances sur Le Bon Coin, ajusté par habitants

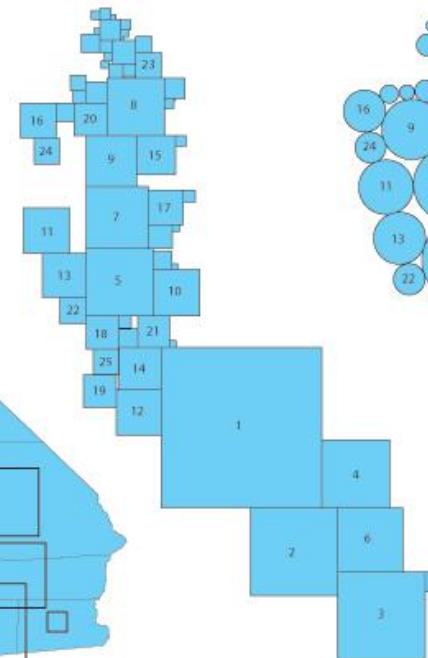


# Autres formes de cartogrammes

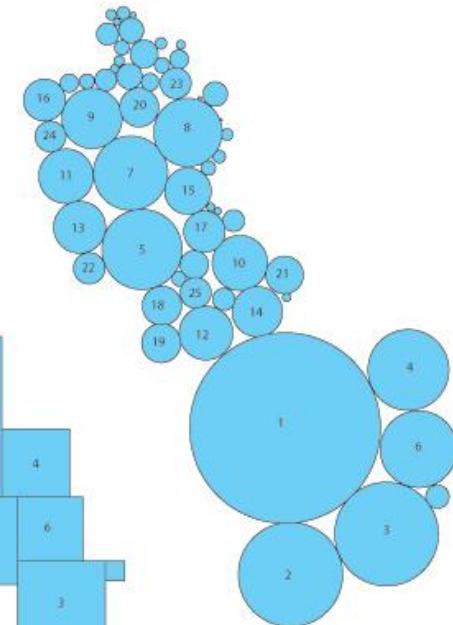
Graduated Symbol Map



Demers Cartogram



Dorling Cartogram

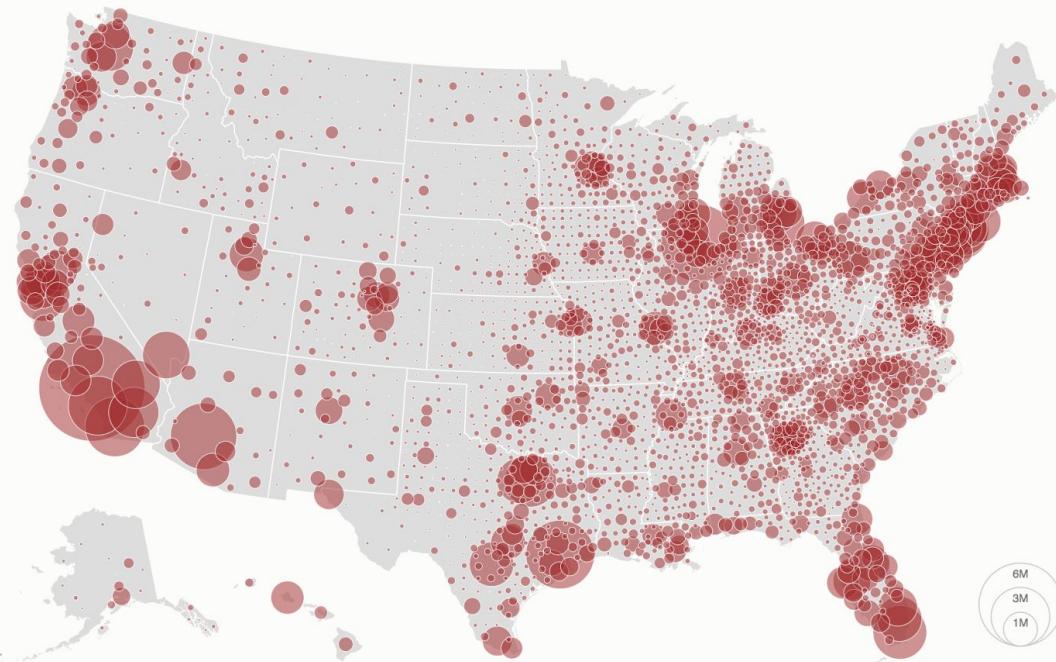


[http://www.ncgia.ucsb.edu/projects/Cartogram\\_Central/types.html](http://www.ncgia.ucsb.edu/projects/Cartogram_Central/types.html)

# 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.

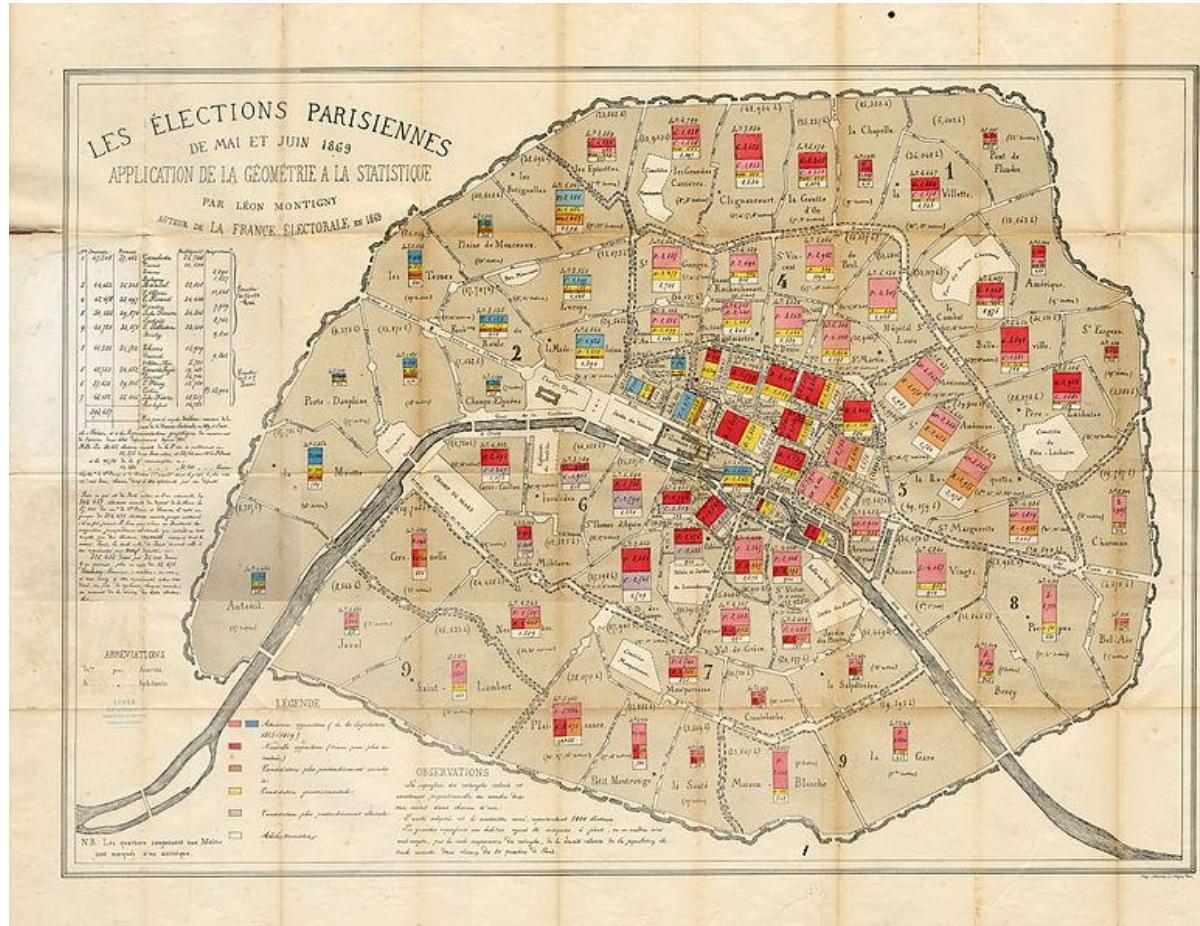


Source: American Community Survey, 2012 5-Year Estimate

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

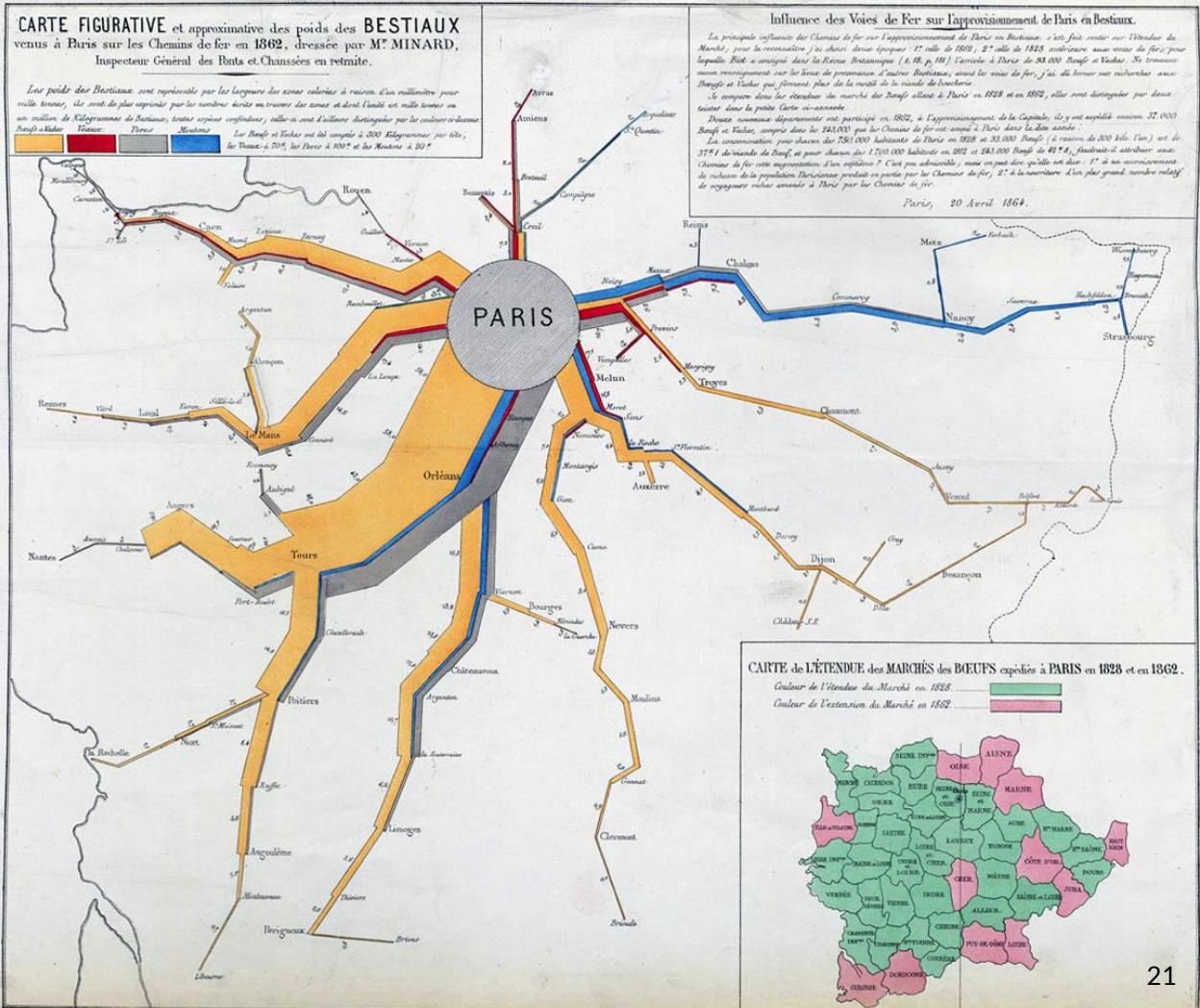
# Carte symbolique

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



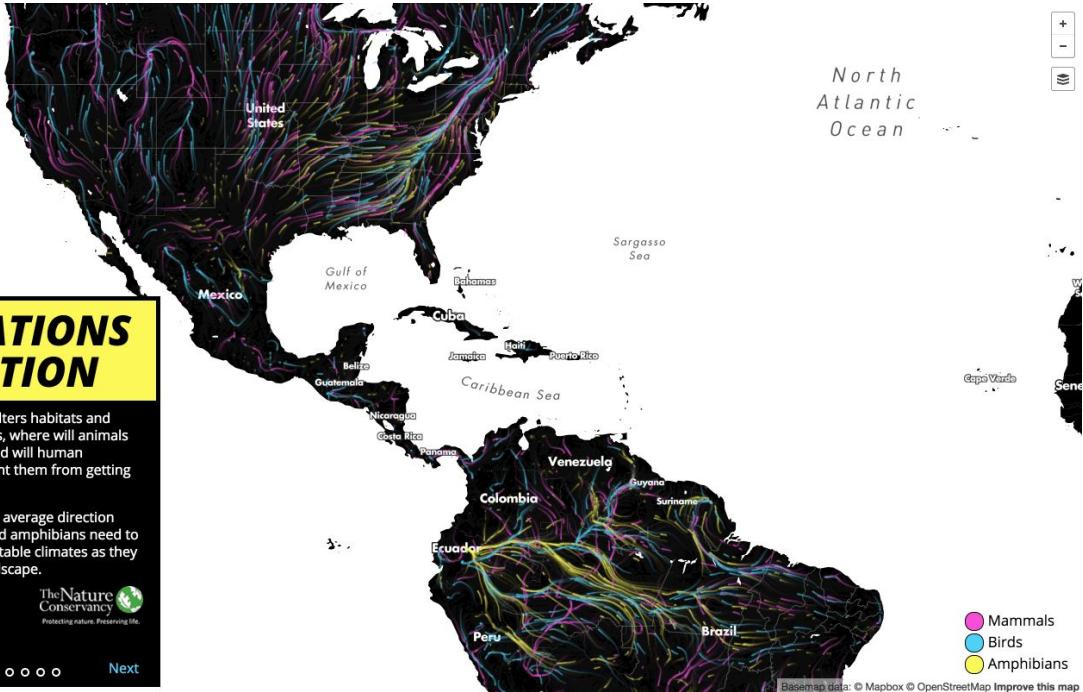
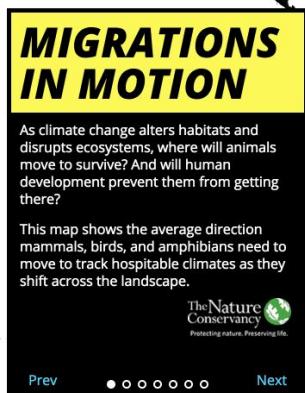
# Carte de flux

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



# Carte de flux animées

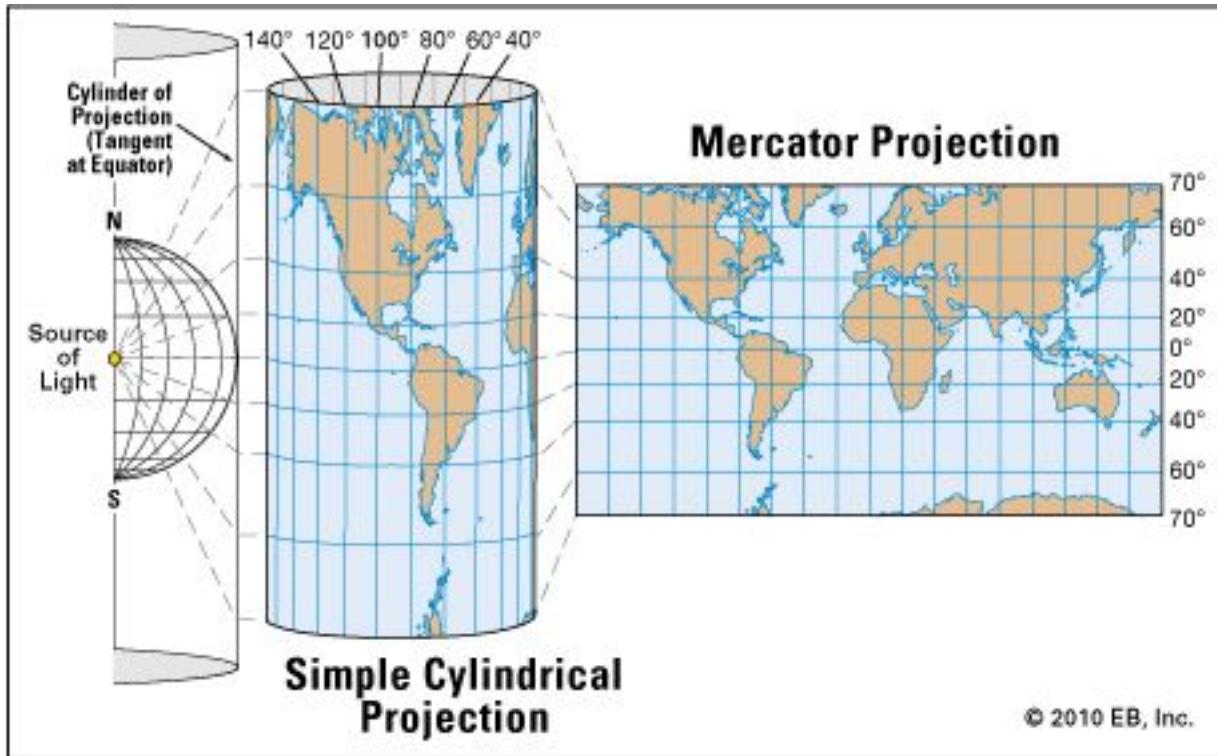
[http://maps.tnc.org/  
migrations-in-motion/](http://maps.tnc.org/migrations-in-motion/)



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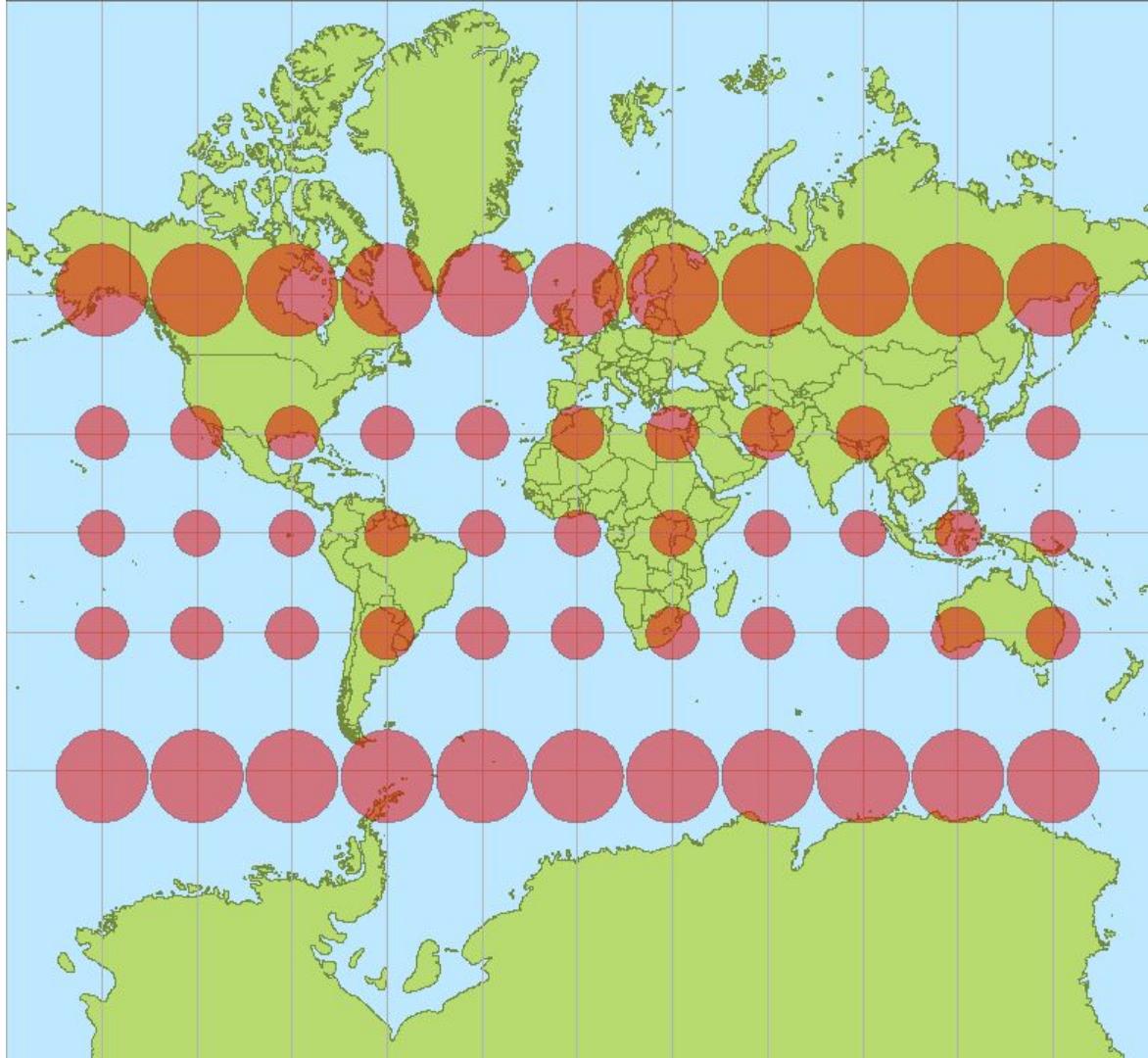
# Projections

# Projection de Mercator



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# Projection de Mercator avec indicateurs de déformation de Tissot.





Mercator



Actual

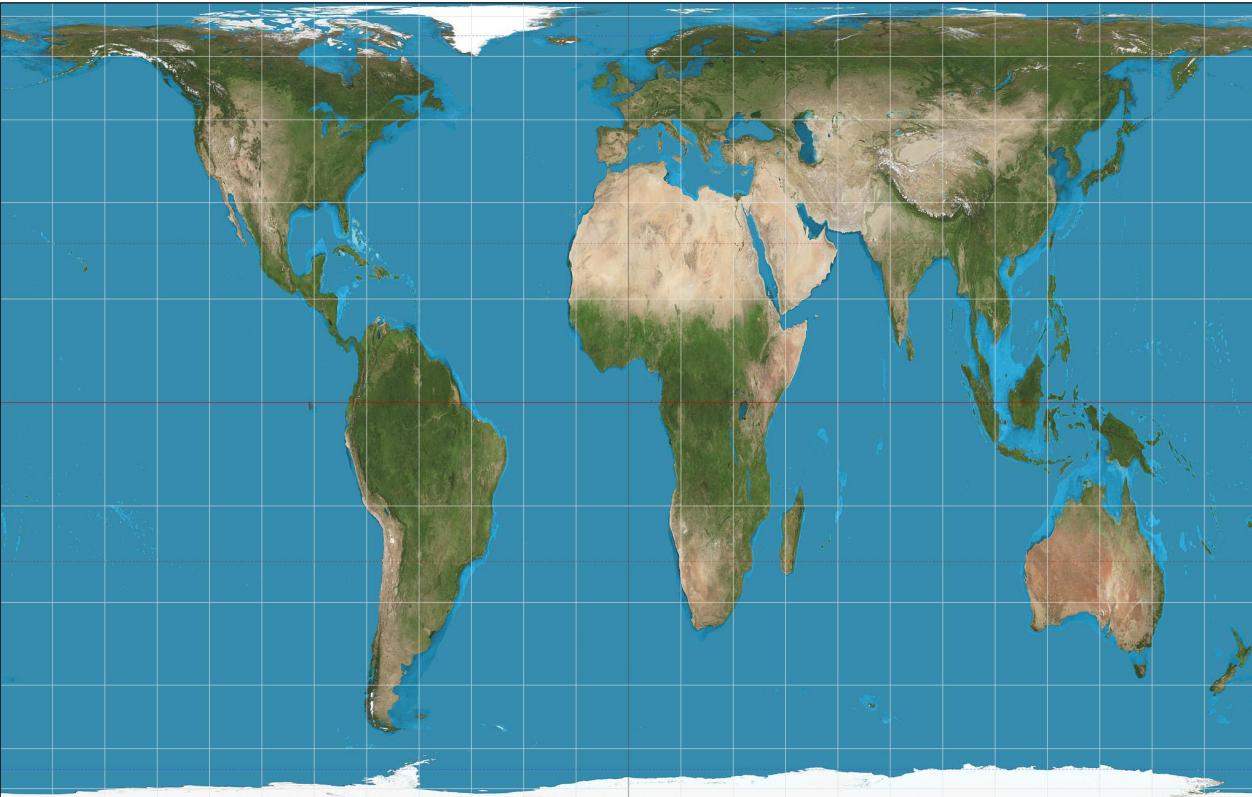
# Problème de Mercator

Traditionnellement utilisée pour enseigner la géographie

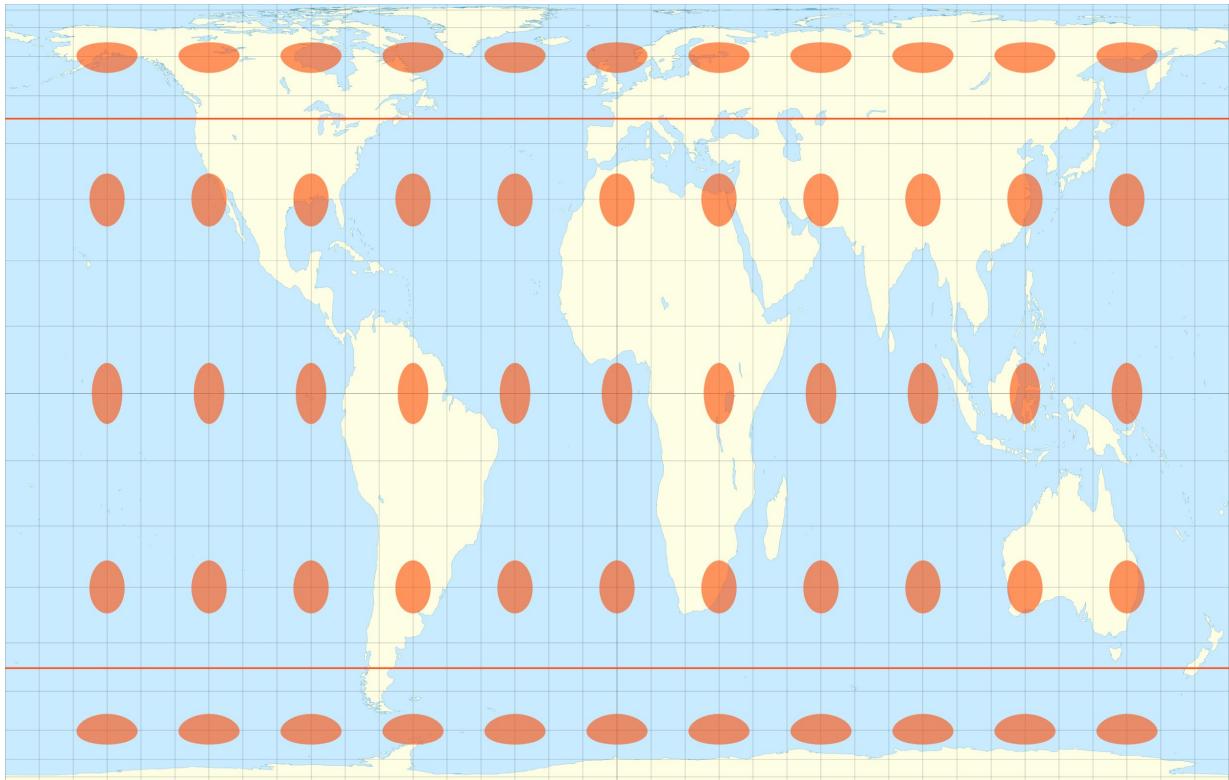
Distortion d'aires en fonction de l'éloignement de l'équateur

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

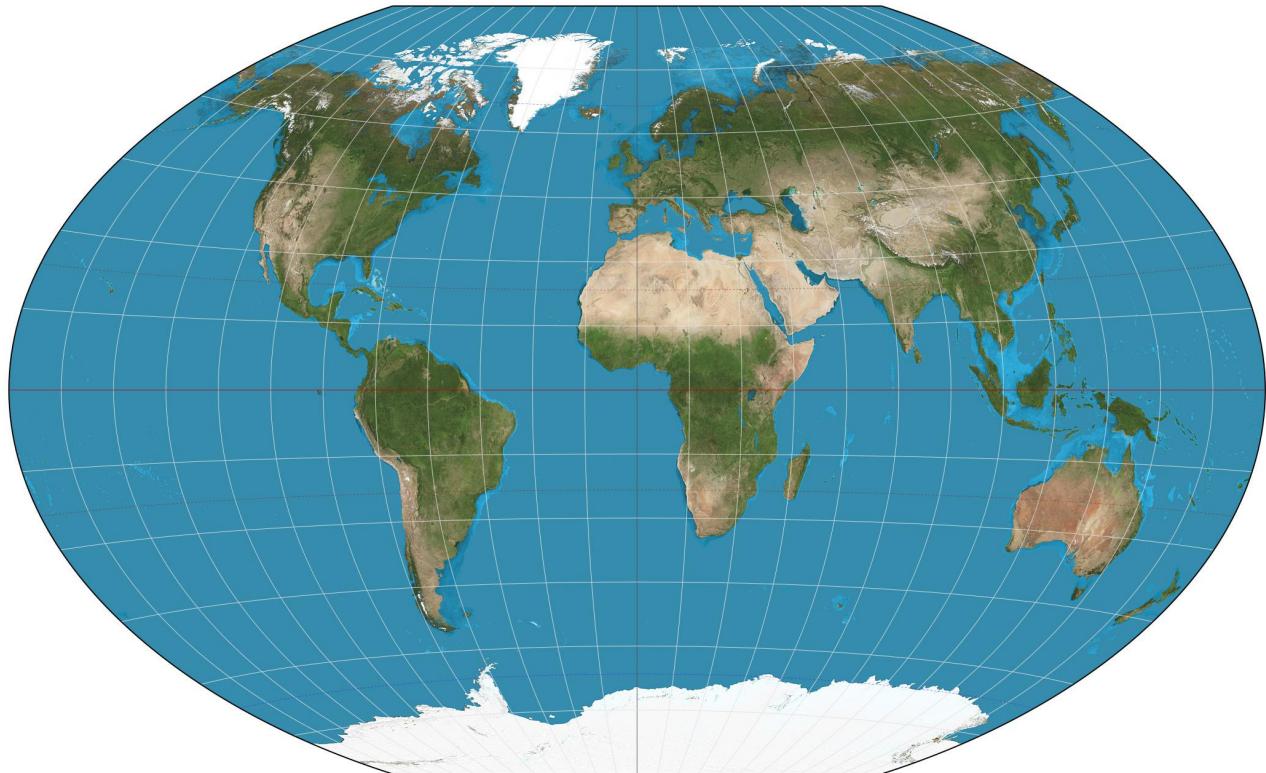
# Projection de Peters



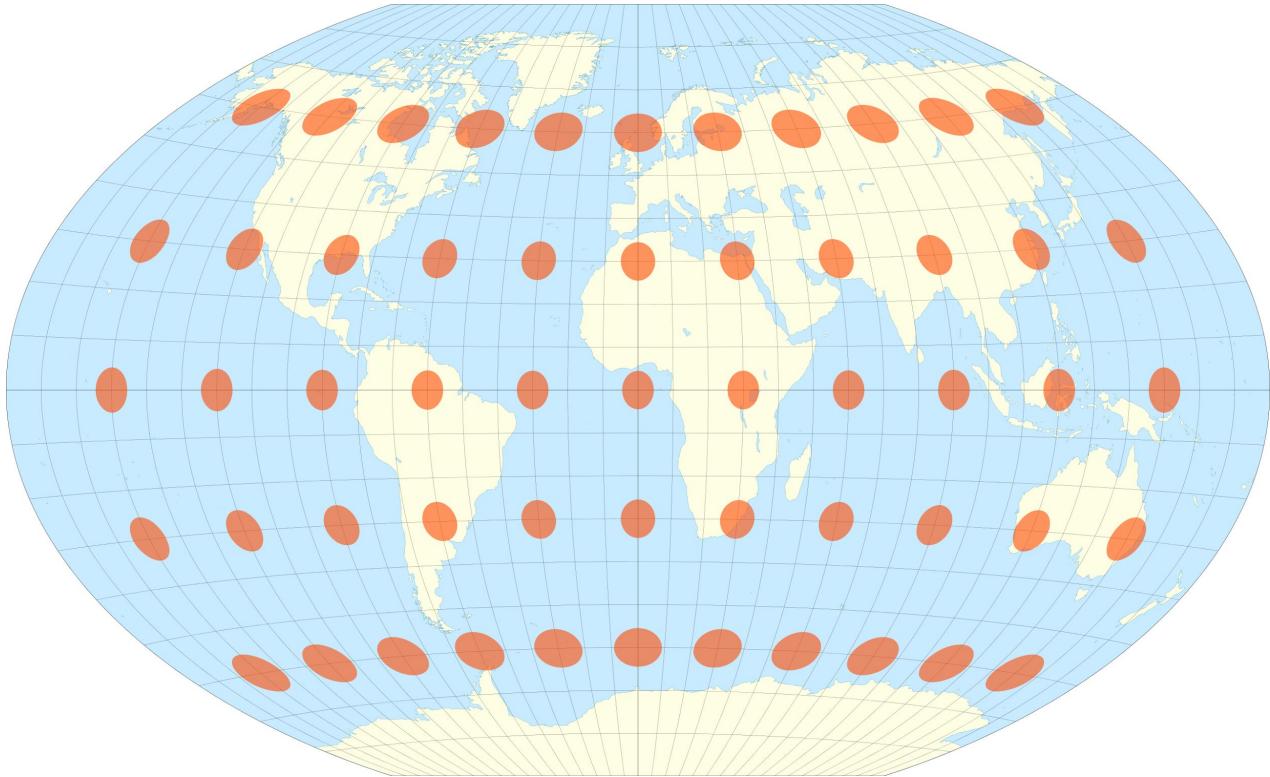
# Projection de Peters



# Projection de Winkel-Tripel



# Projection de Winkel-Tripel

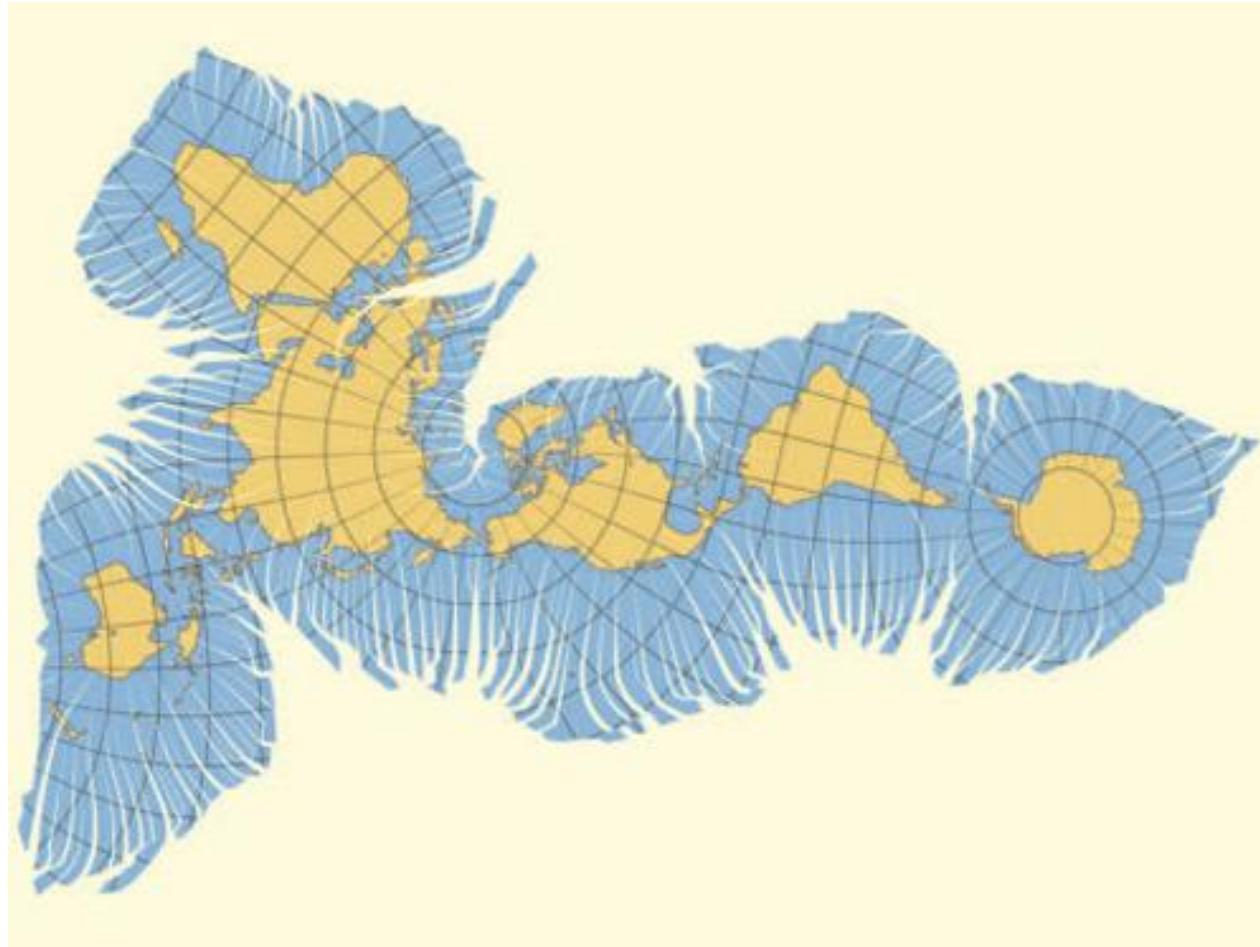


# Déplier la Terre

[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/)

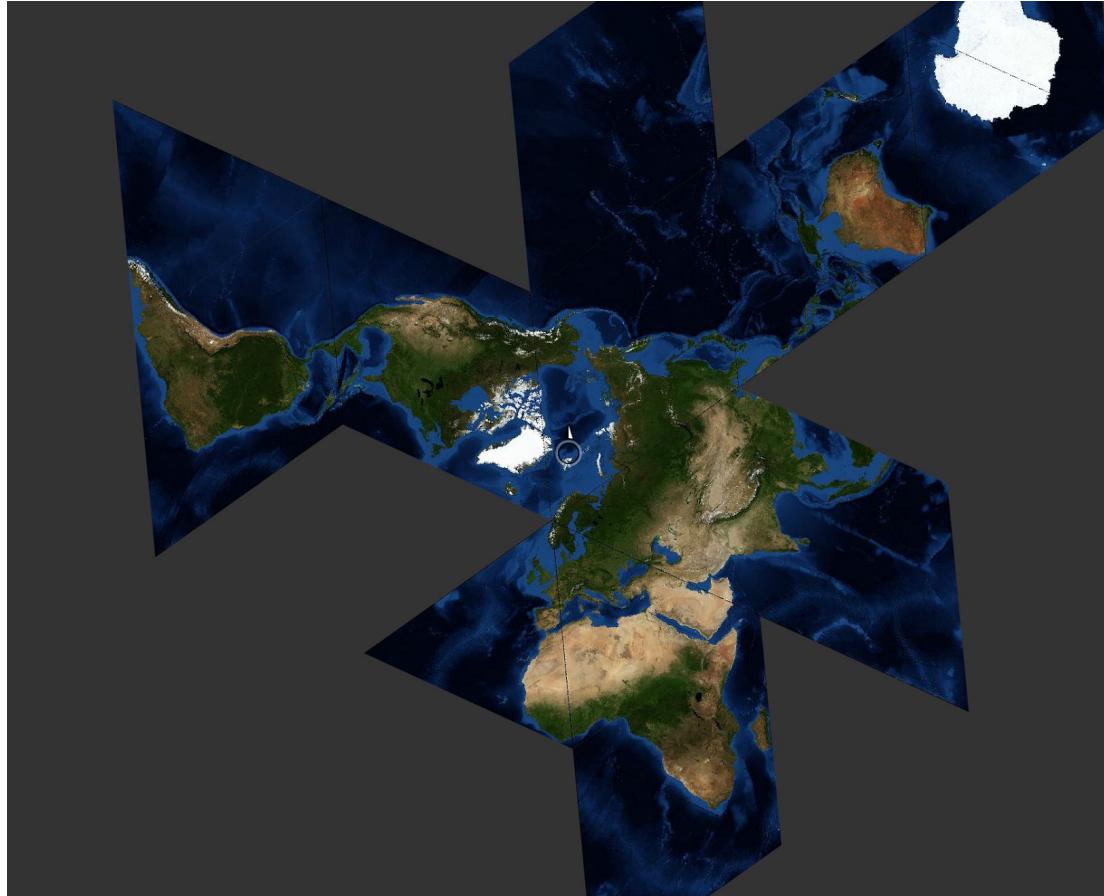
[https://www.youtube.com/watch?  
v=b1xXTi1nFCo](https://www.youtube.com/watch?v=b1xXTi1nFCo)



# Déplier la Terre

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

Projection dymaxion  
de Buckminster Fuller



# xkcd.com/977

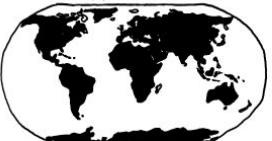
WHAT YOUR FAVORITE  
**MAP PROJECTION**  
SAYS ABOUT YOU

MERCATOR



YOU'RE NOT REALLY INTO MAPS.

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.

VAN DER GRINTEN



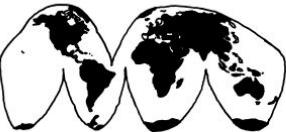
YOU'RE NOT A COMPLICATED PERSON. YOU LOVE THE MERCATOR PROJECTION; YOU JUST WISH IT WEREN'T SQUARE. THE EARTH'S NOT A SQUARE, IT'S A CIRCLE. YOU LIKE CIRCLES. TODAY IS GONNA BE A GOOD DAY!

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.

A GLOBE!

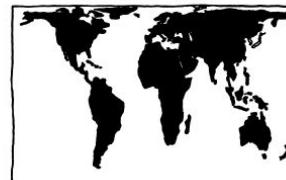


YES, YOU'RE VERY CLEVER.

PEIRCE QUINCUNCIAL

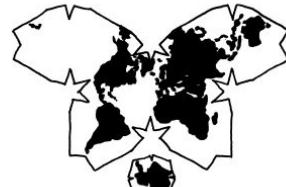


GALL-PETERS



I HATE YOU.

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?

HOB 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.

PLATE CARRÉE  
(EQUIRECTANGULAR)



YOU THINK THIS ONE IS FINE. YOU LIKE HOW X AND Y MAP TO LATITUDE AND LONGITUDE. THE OTHER PROJECTIONS OVERCOMPLICATE THINGS. YOU WANT ME TO STOP ASKING ABOUT MAPS SO YOU CAN ENJOY DINNER.

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

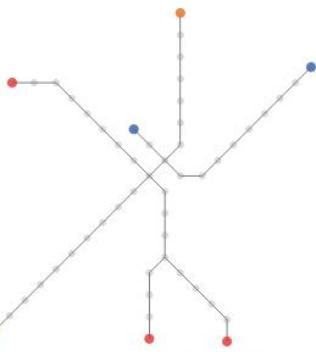
- Données spatiales
- Types de cartes
- Projections

# Visualizing MBTA Data

Visualisation du métro de Boston

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

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

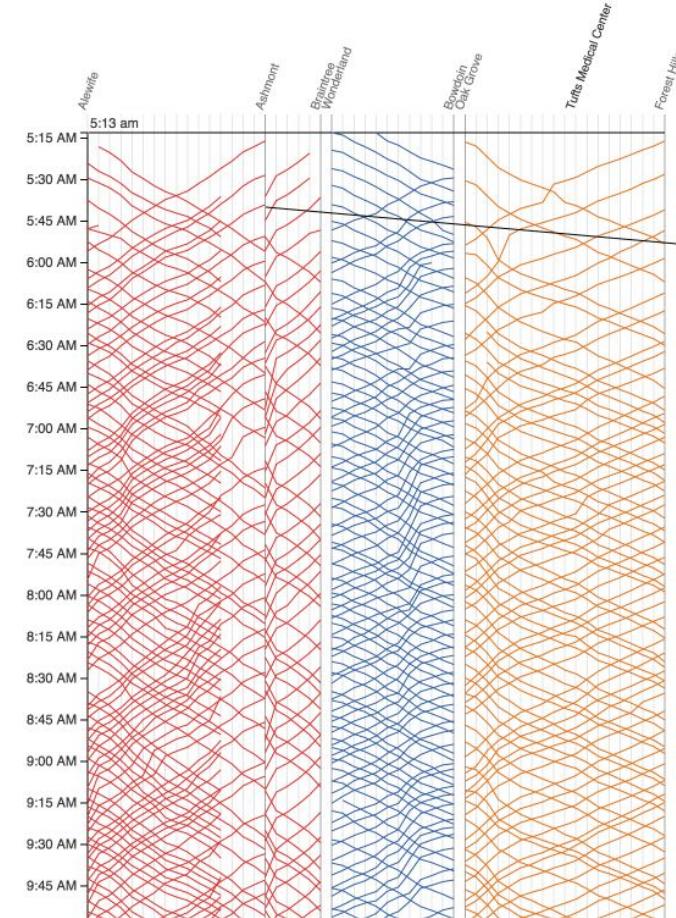


Locations of each train on the [red](#), [blue](#), and [orange](#) lines at 5:13 am. Hover over the diagram to the right to display trains at a different time.

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](#).

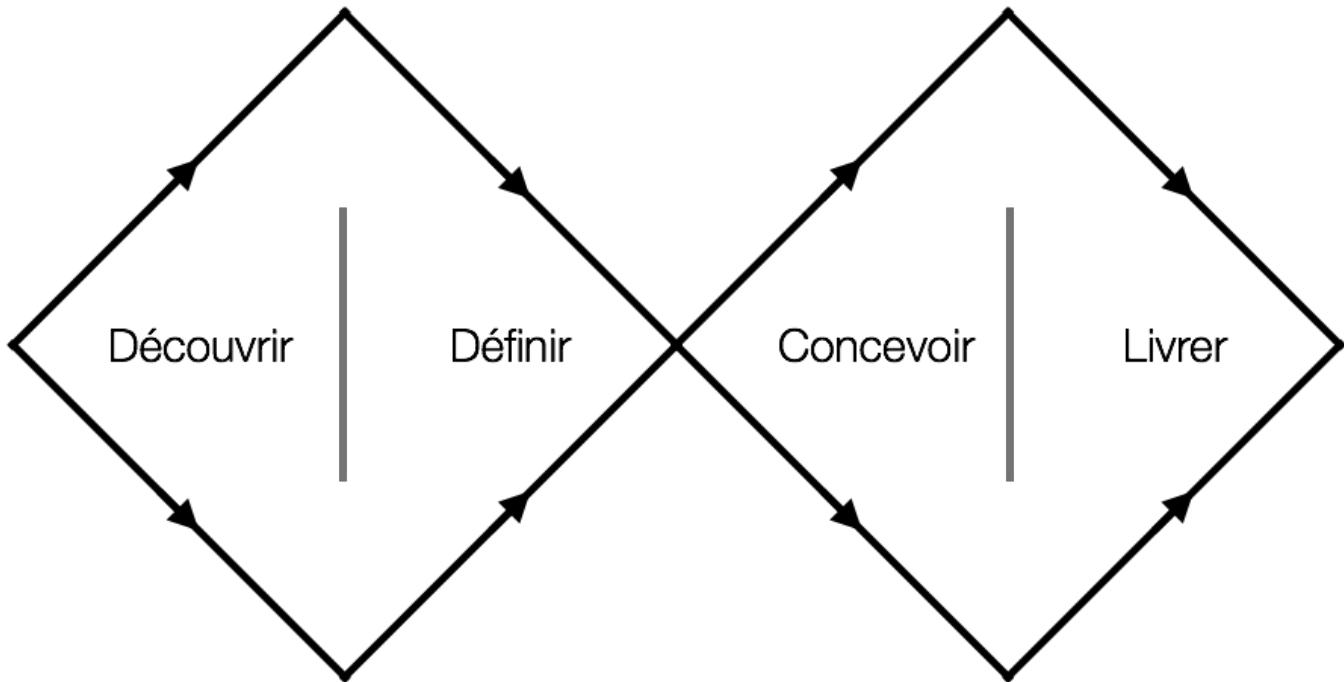
Subway Trips on Monday February 3, 2014



# Plan

- Articles
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  - Techniques de sketching
  - Tuto D3 maps
-

# Double diamant

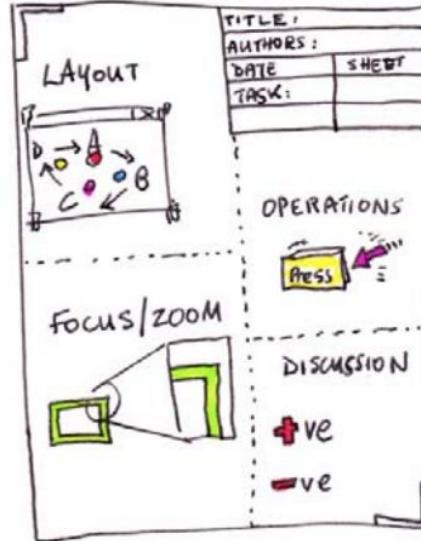


# Découvrir / Définir : Sketching

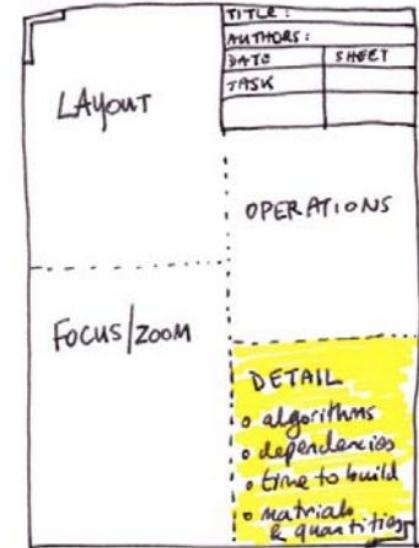
SHEET 1



SHEET 2,3,4



SHEET 5



<http://fds.design/>

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## Sketch      vs.      Prototype

Evocative → Didactic

Suggest → Describe

Explore → Refine

Question → Answer

Propose → Test

Provoke → Resolve

Tentative → Specific

noncommittal → Depiction

# 1. Brainstorming

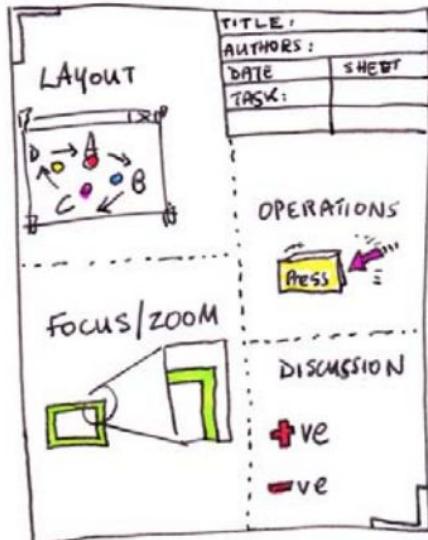
SHEET 1



1. Générer des idées
2. Filtrer les idées
3. Organiser les idées
4. Combiner et raffiner les idées
5. Synthèse : Les idées répondent elles aux besoins, quels sont les avantages/inconvénients, les compromis à faire ?

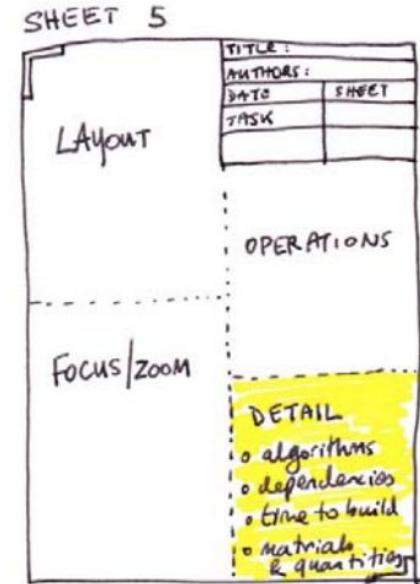
## 2. Alternatives

SHEET 2,3,4



1. Layout global
2. Focus sur certains éléments
3. Opérations / interaction
4. Discussion
5. Méta (auteur, etc.)

# 3. Réalisation (piste)



Choix finaux :

1. Layout global
2. Focus sur certains éléments
3. Opérations / interaction
4. Détails
5. Méta (auteur, etc.)

# Plan

- Articles
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  - Techniques de sketching
  - **Tuto D3 maps**
-

# 1. Charger un fond de carte

Attention on utilise d3.v3.js (pas v4)

Fichier de description des états américains :

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

<http://blockbuilder.org/aurelient/28e33c4fc0e1944dfoea72fe554b490c>

<http://blockbuilder.org/aurelient/5558cba3ba0b34f4895a1f9b25195cf4>

```
<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.geo.albersUsa()     // 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/550af  
e4822c58b83e4e5471112eadb12](http://blockbuilder.org/aurelient/550afe4822c58b83e4e5471112eadb12)

```
<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.geo.albersUsa()
        .translate([width/2, height/2]).scale([500]);

    var path = d3.geo.path().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/>

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

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chloroplète

<http://blockbuilder.org/aurelient/550afe4822c58b83e4e5471112eadb12>

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```

## 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/550af  
e4822c58b83e4e5471112eadb12](http://blockbuilder.org/aurelient/550afe4822c58b83e4e5471112eadb12)

```
// 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  
cloropltéhe

[http://blockbuilder.org/aurelient/550af  
e4822c58b83e4e5471112eadb12](http://blockbuilder.org/aurelient/550afe4822c58b83e4e5471112eadb12)

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

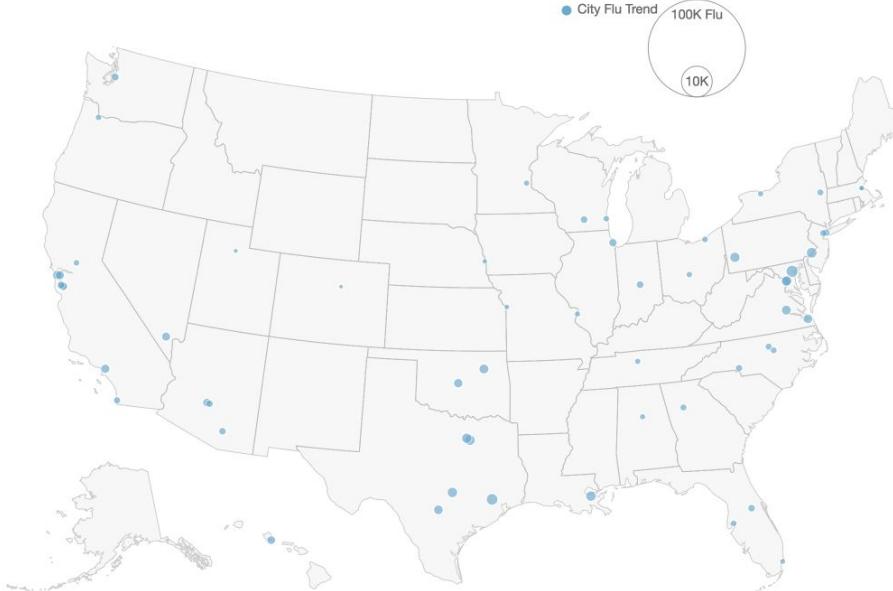
    //Set input domain for color scale
    ...
    d3.json("us-states.json", function(json) {
        ...

            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";
                    }
                });
            });
        });
});
```

# Exo à faire en TP sur 2 séances

| SEP 2003 ▶



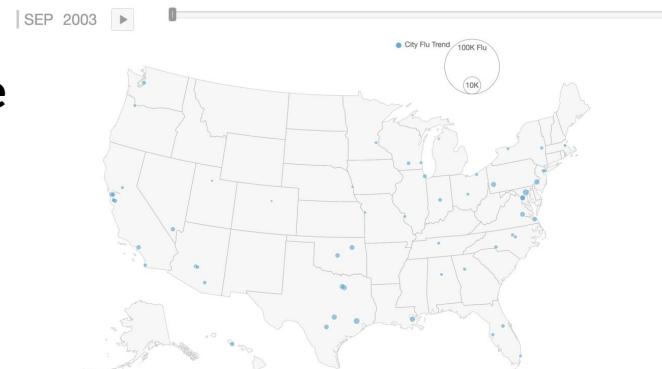
# Exo à faire en TP sur 2 séances

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>

Séance 1 : carte chloroplète  
(pas symbolique)

Séance 2 : 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 : [Let's Make a Map](#), [Let's Make a Bubble Map](#)

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# Autres outils

[Leaflet](#) (Web)

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

[Mapbox](#)

[Cartodb](#)