How to lie with Graphics?

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FOREWORD: What’s Data Visualisation?

What do you see?
[FOREWORD-] : **What's Data Visualisation?**

And here, what do you see?

Some other points (N = 500)
“DATA VISUALISATION” AS A STATISTICAL TEST

The human eye acts as a broad feature detector and general statistical test. Buja et al. (2009) tested:

$H_0$: {There is "nothing"} = {No relation}

$H_1$: {There is "something"} = {There is some relation (Correlation, linearity, heterogeneity, groups...)}
“Data visualisation” as a statistical test

“The human eye acts is a broad feature detector and general statistical test”. Buja et al. (2009)
"Data visualisation" as a statistical test

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**Test:** $H_0 : \{\text{There is "nothing" } \} = \{\text{No relation}\}$
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$H_1 : \{ \text{There is "something" } \} = \{ \text{There is some relation (Correlation, linearity, heterogeneity, groups..) } \}$
[- WHAT WE DO : -] : **Implicit Comparisons**

What does this curve tell you?

![Graph showing Global Fossil CO₂ Emissions from 1960 to 2018 with a projection for 2018. The graph indicates an increase in emissions with a peak in 2018.](image)

- **Projection 2018**
- **37.1 Gt CO₂**
- **Δ 2.7% (1.8%–3.7%)**

© Global Carbon Project • Data: CDIAC/GCP/BP/USGS
[- WHAT WE DO : -]: EXPLICIT COMPARISONS

We compare: surfaces...
[- WHAT WE DO : -] : EXPLICIT COMPARISONS

lines...

Global GDP (in current USD)

German GDP (in current USD)

- 80 trillion
- 70T
- 60T
- 50T
- 40T

- 4.0 trillion
- 3.5T
- 3.0T
- 2.5T

[[- What we do : -]] : Explicit Comparisons

length...

European Parliament election results 2019
Percentage of votes won in Scotland

- SNP: 37.9%
- Brexit Party: 14.7%
- Lib Dems: 13.9%
- Conservative: 11.7%
- Labour: 9.3%
- Green: 8.3%
- Change UK: 1.9%
- UKIP: 1.8%
- Independent: 0.5%

(After 31 of 32 council results)
[- What we do : -] : Explicit comparisons

colors...
What if all of this was a lie?
Should we learn to lie?!
Definition :
Definition:

“Lie” : What You See (on a screen) Is Not What You Have (in the data)
Definition:

"Lie" : What You See (on a screen)
Is Not
What You Have (in the data)

Fact:
Many (conflicting) " rules" on dataviz
Definition:

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My goal:
Decipher graphics and identify visual lies
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10+ rules for "lying" in a future paper?
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At least, it is fun!
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“Lie” : What You See (on a screen) Is Not What You Have (in the data)

Fact:
Many (conflicting) “rules” on dataviz

My goal:
Decipher graphics and identify visual lies

Outcome:
10+ rules for “lying” in a future paper?
At least, it is fun!
...really fun!
“I’ll pause for a moment so you can let this information sink in.”

Source: New Yorker
[-**Rule #1: Use devilish (truncated) axis!** -]

[**Rule #1: Use devilish (truncated) axis!**]

**[-Rule #1 : Use devilish (truncated) axis!-]**

Example: SNCF (2018)

Source: Les Décodeurs (le Monde)
**Rule #1 : Use devilish (truncated) axis!**

Example : SNCF - Corrected (2018)

Source : Les Décodeurs (le Monde)
[-Rule #1: Use devilish (truncated) axis!-]

Example: Fox news

Source: Techna Verba Scripta
Rule #1: Use devilish (truncated) axis! -

So this is bad:

![Bar chart showing tax rates]

If Bush Tax Cuts Expire

- Now: 34.0%
- Jan 1, 2013: 39.6%

The chart is deceptive, with the y-axis truncated to make the difference appear larger than it actually is.
[Rule #1: Use devilish (truncated) axis!]

This is good:
**[-Rule #1: Use devilish (truncated) axis!-]**

Bad:
[Rule #1: USE DEVILISH (TRUNCATED) AXIS!-]

Bad or good?
Correll et al. (2019) show empirically that there is "no robust difference in the impact of truncation on bar charts and line charts: truncation serves to exaggerate effect sizes in both types of graphs."
[-Rule #1: Use devilish (truncated) axis!-]

Bad?

Average global temperature by year

Data from NASA/GISS.

Washington Post (December, 2015)
Rule #1: Use devilish (truncated) axis! -

Good?

Average global temperature by year, 50x scale

Data from NASA/GISS.

Washington Post, reproducing National Review (December, 2015)
[-Rule #0: Lying is easy! -]

Ruling is hard!

(a) 35.0% 39.6%
Now  Jan 1, 2013

(b) 35.0% 39.6%
Now  Jan 1, 2013

(c) Average global temperature by year

(d)
[\textbf{Rule \#0} : \textbf{Lying is easy!} -]\

\textbf{Discussing} it is easy:
[Rule #0: Lying is easy!]

So lying is easy:

From Huff (1993)
[-RULE #0 : LYING IS EASY! -]

Examples are common!

My 2017’ students (Jan & Mohamed), but also recent researchers’ presentations
[**Rule #0 : Lying is easy!** -]

**Examples are common!**

Source: My 2017’ students (Jan & Mohamed), but also recent researchers’ presentations
[\textbf{RULE #2-bis : PLAY WITH SCALES !-}]

Here is a graphic

Rule #2-bis: Play with scales!-

The same with a different Y-axis...

[-**Rule #2-bis** : **Play with scales**!-]

The same with a $Y$-axis that goes way beyond $\text{max}(Y)$...

[**RULE #2-bis : PLAY WITH SCALES !-**]

The same with a shrinked X-axis

[-Rule #2-bis : Play with scales !-]

The same with a widespread X-axis and a short Y-axis

[-Rule #2-bis : Example-]

**Figure** – Source: Tufte (2001) from Playfair (1786).
[-RULE #2-BIS : EXAMPLE-]

**Figure** – Source: Tufte (2001) from Playfair (1786).
[Rule #2-bis: Subtle things...!-]

Which sample has the highest correlation?

From Cleveland et al. (1982)
Rule #3: Use Double Axes!

An apparently harmless example:

Source: Lisa Charlotte Rost, data from World bank
[Rule #3: Use double axes! -]

Zero baseline are not aligned!

Source: Lisa Charlotte Rost, data from World Bank
[\textbf{- Rule #3 : Use double axes! -}]

Does aligned zero baselines solve the problem?

\begin{itemize}
  \item \textbf{Global GDP (in current USD)}
  \item \textbf{German GDP (in current USD)}
\end{itemize}

Source: Lisa Charlotte Rost, data from World Bank
[- **Rule #3 : Use double axes!** -]

When playing with scales, anything may happen...

Source: Lisa Charlotte Rost, data from World bank
Solution 1: Two graphs

Source: Lisa Charlotte Rost, data from World Bank
Solution: Indexes

The German GDP and the global GDP are not growing at the same rate since 2008!

Source: Lisa Charlotte Rost, data from World bank
[- Rule #3 : Examples -]

Glyphosate vs Senile dementia

Age Adjusted Deaths from Senile Dementia
(ICD F01, F03 & 290)

Plotted against glyphosate use on corn & soy
(R = 0.9942, p <= 1.822e-09)
Sources: USDA:NASS; CDC

Figure 24. Correlation between age-adjusted dementia deaths and glyphosate applications.

[- Rule #3 : Examples -]

Glyphosate vs Tyroid

Glyphosate vs Tyroid

Figure 10. Correlation between age-adjusted thyroid cancer incidence and glyphosate applications and percentage of US corn and soy crops that are GE.

Glyphosate vs Parkinson

Age Adjusted Deaths from Parkinson's disease
(ICD G20 & 332.0)

plotted against glyphosate use on corn & soy (R = 0.8754, p <= 1.631e-06)
and percent GE corn & soy planted (R = 0.9516, p <= 5.398e-06)
sources: USDA: NASS; CDC

[- Rule #3 : Examples -]

Glyphosate vs Diabetes

Figure 14. Correlation between age-adjusted diabetes incidence and glyphosate applications and percentage of US corn and soy crops that are GE.

[ Rule #3 : Examples - ]

Glyphosate vs Strokes

*Figure 12. Correlation between age-adjusted hemorrhagic stroke deaths and glyphosate applications and percentage of US corn and soy crops that are GE.*

[Rule #3: Examples -]

Glyphosate vs Hypertension

Figure 11. Correlation between age-adjusted hypertension deaths and glyphosate applications and percentage of US corn and soy crops that are GE.

[- **Rule #3**: *Examples in Economics* -]

Assets *vs* Working Time

![Graph showing life-cycle in the benchmark equilibrium](image-url)

*Figure 8. Life-cycle in the benchmark equilibrium.*

Source: Mateos-Planas (2010) - AER!
[ Rule #3 : Examples in Economics ]

Capital vs Income tax rate

Source: Mateos-Planas (2010) - AER!
[- Rule #3 : Examples in Economics -]

Retail price (quantiles?) vs gas price

Source: Li et al. (2014) - AEA-Eco. Pol.
[Rule #3: Examples in Economics

Nearly as funny:

Per capita cheese consumption correlates with
Number of people who died by becoming tangled in their bedsheets

Correlation: 94.71% (r=0.947091)

Data sources: U.S. Department of Agriculture and Centers for Disease Control & Prevention

Source: Vigen (2015) - Spurious Correlations
[**Rule #4:** Select your scope -]

**Figure** – Are you looking at the right thing?
[-Rule #4 : Select your scope-]

LIMITED SCOPE

It looks like something increased a lot...

...but maybe that’s just what always happens, and it happened less so during the selected time period.

Figure – Cherry picking?

Source: Flowing data
[-Rule #4 : Example-]

Ignore climate hysteria & look at the facts: Global temperature has been falling for the last 3 years.
[**Rule #4 : Example**-]

**FIGURE – Cherry picking!**

[**Rule #4 : Example**]

**Figure** – Cherry picking!

[- Rule #5: Use 3D pie charts -]

Do as Steve Jobs!

(Macworld 2008 keynote lecture)
[- **Rule #5: Use 3D pie charts** -]

Do as Steve Jobs!
[- RULE #5 : USE 3D PIE CHARTS -]

Do as Steve Jobs!

![Pie chart with 21.2% and 19.5% sections]
[- Rule #5: Use 3D pie charts -]

Do as Steve Jobs: Lie!

- **21.2%** = 20 cm²
- **19.5%** = 30 cm²
[- **Rule #5-bis : Use pie charts** -]

From WTF Visualisations
[- **Rule #5-bis : Use pie charts** -]

From FOX News
[- Rule #5-bis : Use pie charts -]

From XKCD
[**SO YOU REALLY WANT TO DO A PIE CHART? -**]

Do it right (unlike your software!)

from Wong (2010)
[**Rule #6: Use several pie charts**]

From Freakeconometrics
[- **Rule #6 : Use several Pie Charts** -]

From Freakeconometrics
[- Rule #6: USE SEVERAL PIE CHARTS -]

People use it.
Rule #7: Use areas

Maximize your intakes: One big or two smaller pizzas?

Source: Fermat’s library
Rule #7: Use areas

One big > two smaller pizzas!

Area = $\pi (18/2)^2 = 254 \text{ in}^2$

Area = $2\pi (12/2)^2 = 226 \text{ in}^2$

Source: Fermat’s library
[- Rule #7 : Use Areas -]

How to compare?

L'extrême droite européenne en 2019
Résultats des partis d'extrême droite aux élections législatives (% des votants)

2015 Danemark 21,1 %
Parti populaire danois (DF)

2017 Allemagne 12,6 %
Alternative pour l'Allemagne (AfD)

2017 Royaume-Uni 1,8 %
Parti pour l'indépendance du Royaume-Uni (UKIP)

2017 France* 13,2 %
Front National (FN)

2019 Espagne 10,3 %
Vox

2018 Suède 17,5 %
Démocrates de Suède (SD)

2015 Pologne 37,6 %
Droit et Justice (PiS)

2017 Autriche 26,0 %
Parti de la liberté d'Autriche (FPÖ)

2018 Hongrie 19,1 %
Jobbik

2018 Italie 17,4 %
Ligue

2015 Suisse 29,4 %
Union démocratique du centre (UDC)

En date du 29 avril 2019, Dernières élections législatives tenues à cette date.
* Score au premier tour. Au second tour : 8,8 %.
Sources : Statista, El País

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[- RULE #7 : USE AREAS -]

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Source : Statista, el pais
Rule #7 bis : Works also with squares-

If 100% of the US prisoners are represented by the big green square...what is the percentage for each group?

Figure – Ethnic composition of prisoners in Jail in 2008 in the USA.
(Le Monde 5/12/2014)
If 100% of the US prisoners are represented by the big green square...what is the percentage for each group?

**FIGURE** – Ethnic composition of prisoners in Jail in 2008 in the USA.  
*Le Monde 5/12/2014*
[- **Rule #8**: **Use [unaligned] bars** -]
[- Rule #8 : Use [unaligned] bars -]

Source: Cleveland and McGill (1984)
[ Rule #8: Use [unaligned] bars ]

Répartition de la population par catégorie socio-professionnelle par zone d'emploi en 2011

- Agriculteurs
- Artisans, commerçants, chefsonta.
- Cadres et prof. Int. Sup.
- Professions intermédiaires
- Employés
- Ouvriers
- Retraités
- Autres personnes sans activité prof.
[\textbf{- Rule \#8-bis: Use Stacked BarCharts -}]
[- Solution #8-bis : Align the bars! -]

**Figure** – From Dix and Ellis (1998) example

See also the dynamic version
[- Rule #8-bis : Use Stacked Barcharts -]

Kind of stupid example:

Source: The TSEconomics Journal (TSE)
[Rule #9: Use lines (lots of them!)]

Observe this graphic carefully:

**Figure** – Major Cause of Worker Disability (1975-2010) (J. Schwabish, 2014).
Legitimate Questions:

- In 2010, what is the major cause of disability?
LEGITIMATE QUESTIONS:

- in 2010, what is the major cause of disability?
- in 1975, what was the major cause of disability?
LEGITIMATE QUESTIONS:

- in 2010, what is the major cause of disability?
- in 1975, what was the major cause of disability?
- In the recent years, which causes have increased/decreased the most?
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▶ in 1975, what was the major cause of disability?
▶ In the recent years, which causes have increased/decreased the most?
▶ . . .
LEGITIMATE QUESTIONS:

▶ in 2010, what is the major cause of disability?
▶ in 1975, what was the major cause of disability?
▶ In the recent years, which causes have increased/decreased the most?
▶ ...
▶ You do not remember a damn thing of this graph!
[- SOLUTION #9 : USE small multiples -]

[- R U L E #9bis : U S E l I N E S (C O M P A R E) -]  

For each graph, compute the difference between the 2 lines.
[- **Rule #9bis**: Use lines (Compare) -]

For each graph, compute the difference between the 2 lines.
[**Rule #9bis : Use lines (Compare)** -]

For each graph, compute the difference between the 2 lines.

From Cleveland and McGill (1984)
[- **Rule #10**: **Use radar plots (or Web plots)** -]
Rule #10: Use Radar Plots

Source: Xtophe’s blog: Why you should never use radar plots
Rule #10: Use radar plots

Source: Xtope's blog: Why you should never use radar plots
[\textbf{- Rule #10 : Use radar plots -}]

Source: Xtophe’s blog: Why you should never use radar plots
[- RULE #10 : USE RADAR PLOTS -]

Source: Xtophe’s blog: Why you should never use radar plots
[- Super Rule #1 : Use Maps -]

Which are the biggest “countries” in the world (in surface)?
SUPER RULE #1 : USE MAPS -]

True size of countries

Source: http://metrocosm.com/mercator/, see also https://thetruesize.com/
[- **SUPER RULE #1 : USE MAPS -]**

Use the Mercator projection!
[- SUPER RULE #1 : USE MAPS -]

Is Greenland greater than Brazil?
[- Super Rule #1 : Use Maps -]

Solution: Greenland \( \approx 2.1 \text{ M km}^2 \), Brazil \( \approx 8.5 \text{ M km}^2 \)!
Élections présidentielles aux USA en 2016 (par "counties")

Source : Trey Yingst (Fox News)
[Super Rule #2 : Use Electoral Maps -]

Élections présidentielles aux USA en 2016 (par counties)

Source : Lara Trump on Twitter (01/10/2019)
[- Super Rule #2 : Use Electoral Maps -]

Élections présidentielles aux USA en 2016 (Nombre de votes)

Source : @MInesCR (Twitter)
[- **SUPER RULE #2 : USE ELECTORAL MAPS -**]

Élections présidentielles aux USA en 2016 (Nombre de grands électeurs)

Source : Financial Times
[- **SUPER RULE #2 : USE ELECTORAL MAPS -**](-)

Élections présidentielles aux USA en 2016 (Nombre de votes)

Source : XKCD
- **Super Rule #2 : Use Electoral Maps -**

Élections présidentielles aux USA en 2016 (Chiffres)
"Welcome" version

Source: Françoise BAHOKEN & Nicolas LAMBERT
"Less welcome" version

Source: Françoise BAHOKEN & Nicolas LAMBERT
"Not welcome" version

Source: Françoise BAHOKEN & Nicolas LAMBERT
"Invasion" version

Source: Françoise BAHOKEN & Nicolas LAMBERT
"Relative to population" version

Source: Françoise BAHOKEN & Nicolas LAMBERT
"All of this is a lie!" The picture is zoomed!

Source: Françoise BAHOKEN & Nicolas LAMBERT
Be suspicious of maps, not of migrants!

Source: Françoise BAHOKEN & Nicolas LAMBERT
[- SUPER RULE #3 : EXTRAPOLATE -]

An example: The gender gap in 100-meters Olympics

Adapted from: Calling Bullshit
[- **Super Rule #3 : Extrapolate -] -

Let us reduce the y-axis scale

Adapted from : Calling Bullshit
Super Rule #3: Extrapolate

Now, let us draw a regression line

Adapted from: Calling Bullshit
Extrapolate: Women will run faster in 2156!

Adapted from: Calling Bullshit
No journal will publish this!

No journal will publish this!

[- Super Rule #3 : Extrapolate -]

No journal will publish this!

[- Super Rule #3 : Just for Fun -]

Reductio ad absurdum : Move forward : Year 2636!

Adapted from : Calling Bullshit
There are many visualisation that transform the data for clarity: **Subway maps** for example.

Source: The Guardian
[- LYING FOR A GOOD REASON -]

There are many visualisation that transform the data for clarity: *Subway maps* for example

Source: The Guardian
[- **LYING FOR A GOOD REASON** -]

**Subway maps** that match the physical reality are quite rare

Source Benjamin Schmidt
[- LYING FOR A GOOD REASON -]

Ski resort maps

Source Pierre Novat
[\text {- The truth... -}]

please consider this before talking/typing
[- COMFORTING LIES... -]

@Xtophe_Bontemps

http://data.visualisation.free.fr
**REFERENCES II**


REFERENCES III


Keep in Touch!

Christophe
http://data.visualisation.free.fr
@Xtophe_Bontemps
[- SUPER RULE #3 : USE ELECTORAL MAPS -]
USA election : 2016 results as a map : Washington Post
[= Super Rule #3 : Use Electoral Maps -]

USA election : 2012 results as a map : New York Time

The blue states reflect a total of 332 electoral votes for Barack Obama

[- Super Rule #3 : Use Electoral Maps -]

USA election : 2008 results as a map : New York Time

The blue states reflect a total of 365 electoral votes for Barack Obama

[- Super Rule #3 : Use Electoral Maps -]

Maybe a better map? From Financial Times blog

From Financial Times
[- Super Rule #3 : Use Electoral Maps -]

Maybe spatial information is not the most relevant!
[- **SUPER RULE #3 : USE ELECTORAL MAPS** -]

Maybe spatial information is not the most relevant! *(Back to maps)*
[- RÈGLE N° 9 : DESSINEZ VOUS-MÊME -]
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[- RÈGLE N° 9 : DESSINEZ VOUS-MÊME -]

Source : Washington Post
[- RÈGLE N° 10 : SOYEZ SUBTIL -]

Original
Corrigé

Le Français Fabio Quartarari, âgé de 20 ans, a obtenu la première pole position de sa carrière en catégorie MotoGP au Grand Prix d'Espagne.
Original

La satisfaction à l’égard de l’action d’Emmanuel Macron (1/3)

D’une manière générale, êtes-vous satisfait ou pas de l’action du président de la République Emmanuel Macron ?

- **PAS DU TOUT SATISFAIT** (0 à 1) 32%
- **PLUTÔT PAS SATISFAIT** (2 à 3) 17%
- **NI SATISFAIT, NI INSATISFAIT** (4 à 6) 34%
- **PLUTÔT SATISFAIT** (7 à 8) 14%
- **TRÈS SATISFAIT** (9 à 10) 3%

**Note moyenne** 3,6
Corrigé

La satisfaction à l’égard de l’action d’Emmanuel Macron (1/3)

D’une manière générale, êtes-vous satisfait ou pas de l’action du président de la République Emmanuel Macron ?

<table>
<thead>
<tr>
<th>Désaccordé</th>
<th>Pas satisfait</th>
<th>Ni satisfait, ni insatisfait</th>
<th>Satisfait</th>
<th>Très satisfait</th>
</tr>
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<td>17%</td>
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<td>49%</td>
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<td>17%</td>
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Moyenne : 3,6
[- RÈGLE N° 10 : SOYEZ SUBTIL -]

Original

European Parliament election results 2019
Percentage of votes won in Scotland

- SNP: 37.9%
- Brexit Party: 14.7%
- Lib Dems: 13.9%
- Conservative: 11.7%
- Labour: 9.3%
- Green: 8.3%
- Change UK: 1.9%
- UKIP: 1.8%
- Independent: 0.5%

(After 31 of 32 council results)
[ - RÈGLE N° 10 : SOYEZ SUBTIL - ]

Détection

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(After 31 of 32 council results)

Coloured areas on bars are incorrect
Vérification

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[- RÈGLE N° 10 : SOYEZ SUBTIL (OU PAS !) -]
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LOL !
[- RÈGLE N° 10 : SOYEZ SUBTIL (OU PAS !) -]

Correction ?
[- RÈGLE N° 10 : SOYEZ SUBTIL (OU PAS !) -]

Justification!
[- RÈGLE N° 10 : SOYEZ SUBTIL (OU PAS !) -]

LOL!
Les chiffres ne trompent pas...