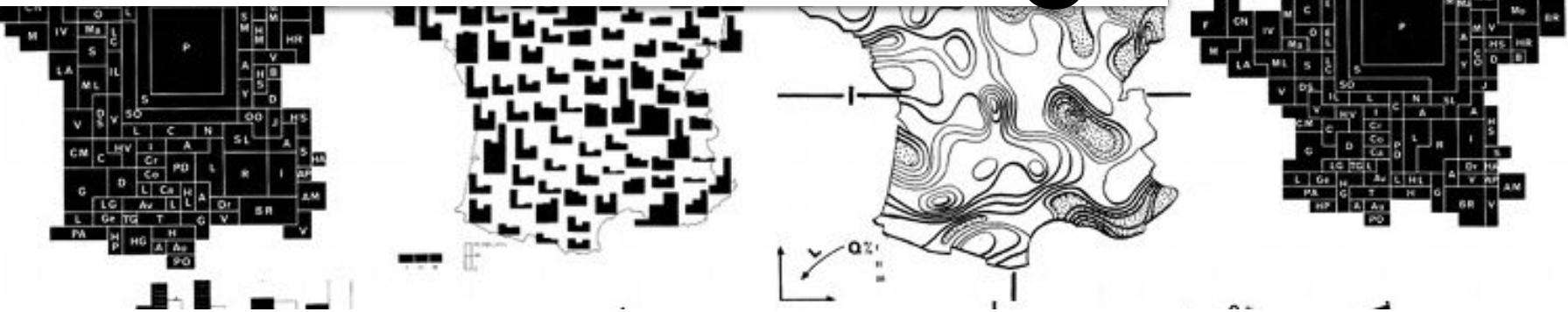


Session 21

Visualization Design



Online Course
**Data Visualization
for Professionals**



THE UNIVERSITY
of EDINBURGH

Benjamin Bach

June 2020

<http://benjbach.me>
<https://datavis-online.github.io>

-- Not for external use --

Encoding: designer

1

Data

What is my data?

Which data type?

Ordinal / numerical / categorical?

2

Visual Mapping

What is my visual representation?

Which visual variables am I using?

How am I encoding my data?

3

Rendering

What is my medium?

monoscopic/stereoscopic?

Tangibility?

Print / digital?

6

Decoding: user

5

Interpreting

What does it mean?

What does color mean?

What does 'up' mean?

What do these patterns show?

4

Perceiving

What does it show?

Where is big, medium, small?

How do things compare?

What relationships exist?

View

Encoding: designer

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Outline

What are the building blocks for effective visualizations and visualization designs?

1. Visual perception
2. Gestalt Laws
3. Data types
4. Visual Variables
5. Color (extra)
6. Visualization Guidelines (extra)

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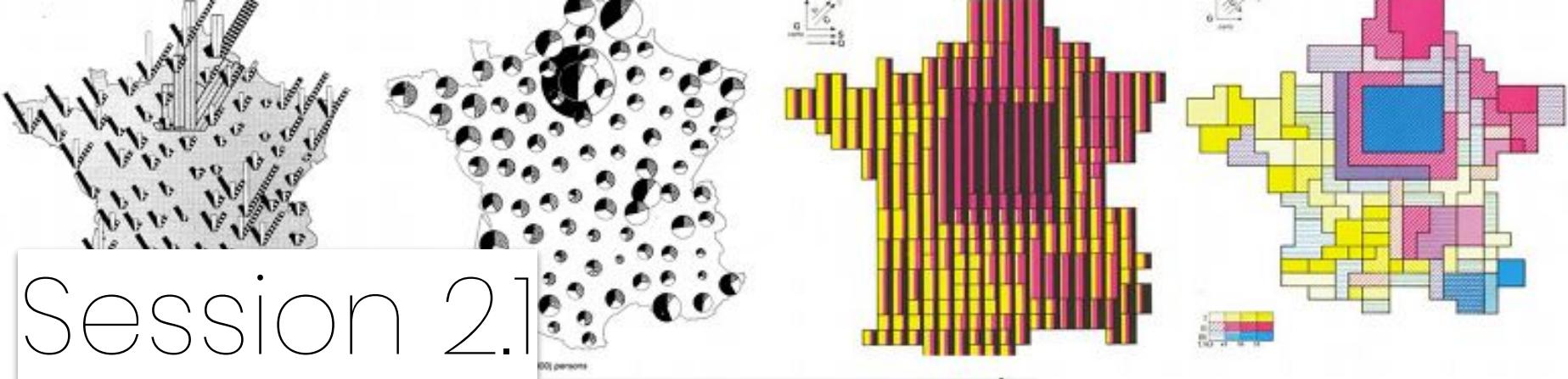
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What are the building blocks for effective visualizations and visualization designs?

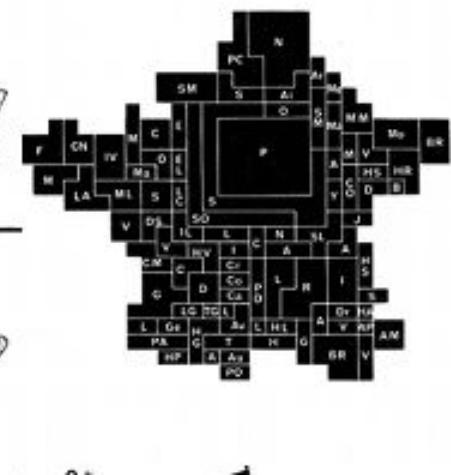
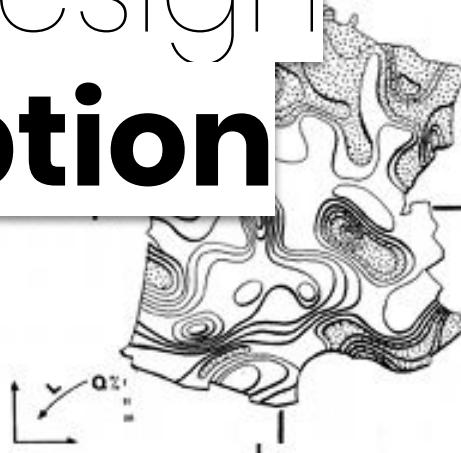
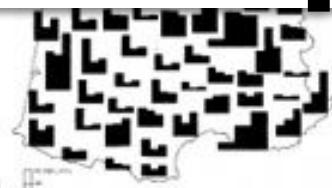
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Session 2.1

Visualization Design

Visual Perception



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Find every '5'

9176867991960386255930486551443
9353652502752141394912668766013
5095444663473545993604636448078
6425620171155906710121069218701
0584448205561385902503573068845
1172102391879794238892669764599
6987227951015948926017759166604
8436204036527029291707742717051
3280506428553158863136868380421
4055135906770329783671748392874

Find every '5'

9176867991960386255930486551443
9353652502752141394912668766013
5095444663473545993604636448078
6425620171155906710121069218701
0584448205561385902503573068845
1172102391879794238892669764599
6987227951015948926017759166604
8436204036527029291707742717051
3280506428553158863136868380421
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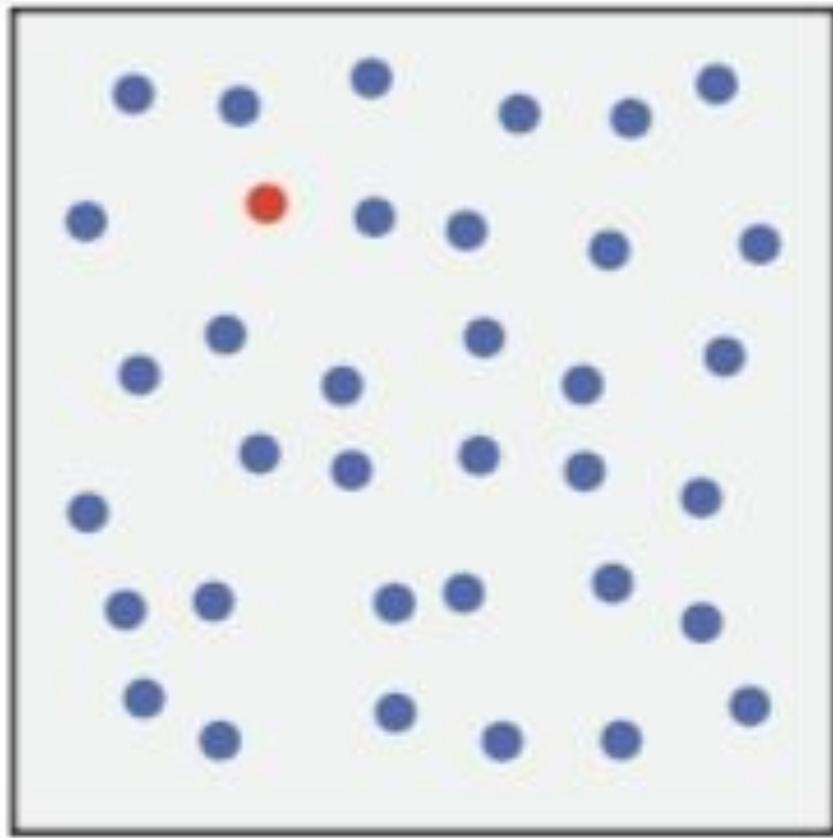
Pre-attentiveness:

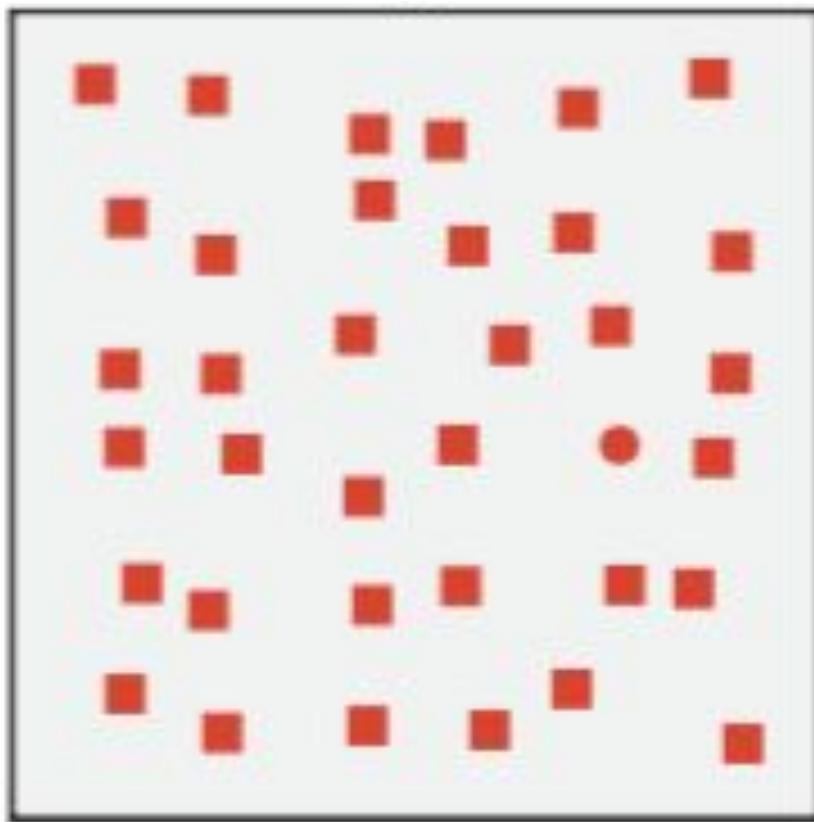
- "is the subconscious accumulation of information from the environment"
- realizing something before you think

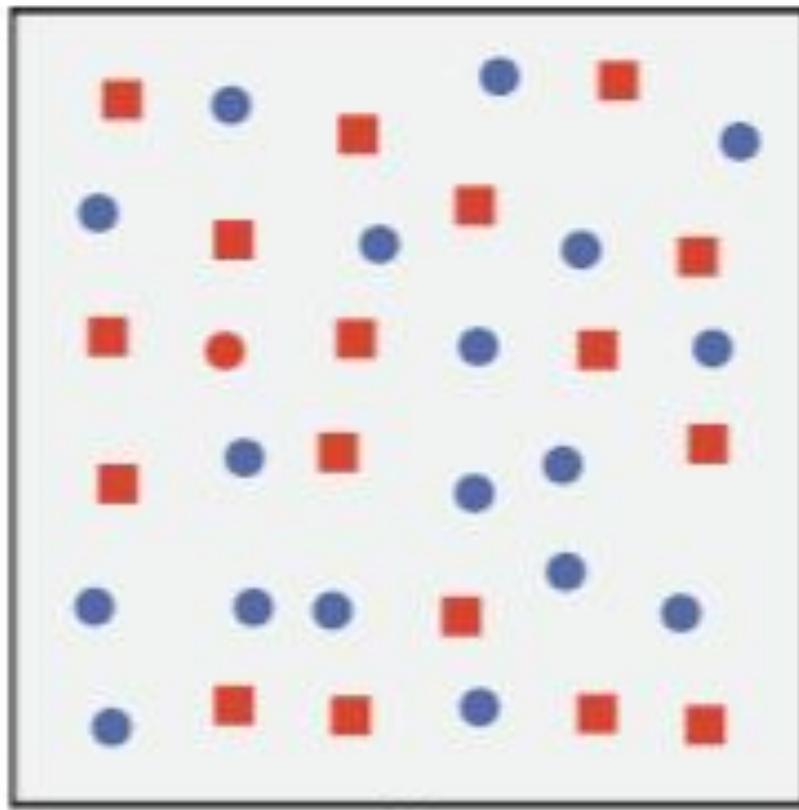
Parallelity:

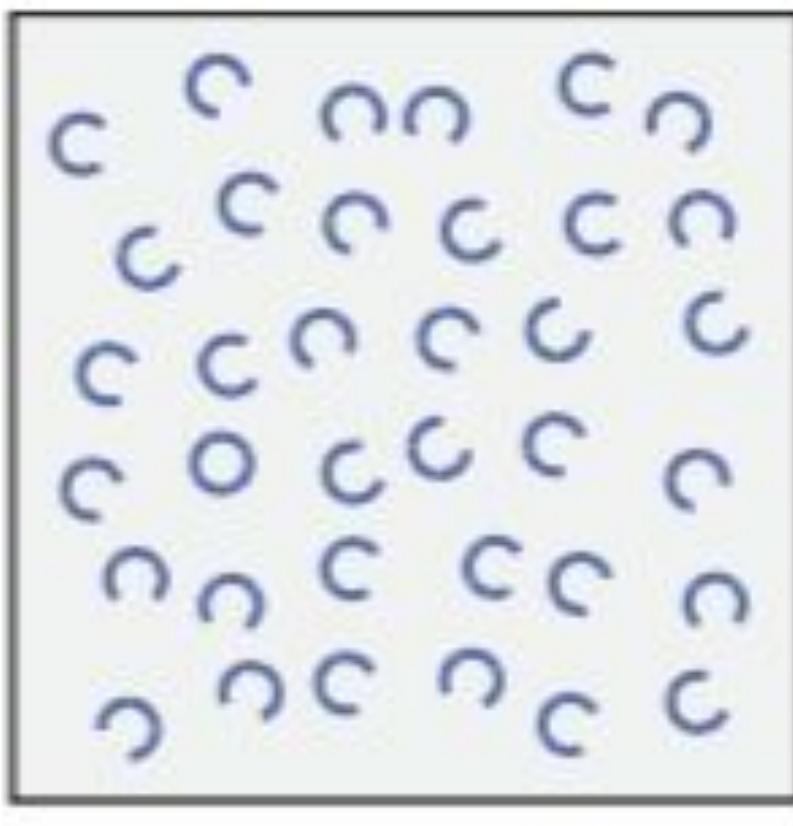
- Perceiving stimuli in parallel











Preattentiveness



Length



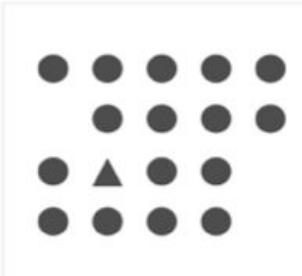
Width



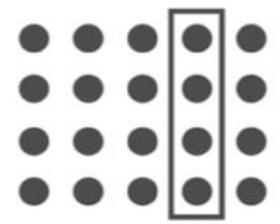
Orientation



Size



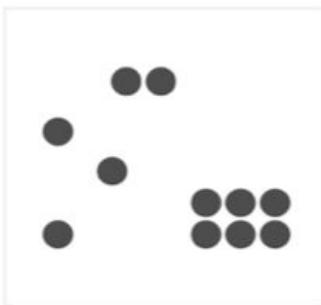
Shape



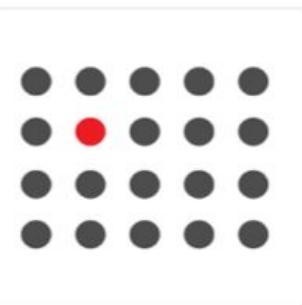
Enclosure



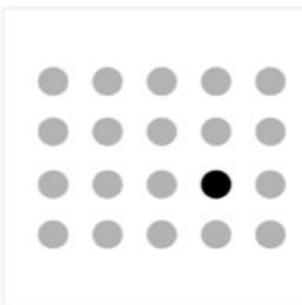
Position



Grouping



Color Hue



Color
Intensity

Example:

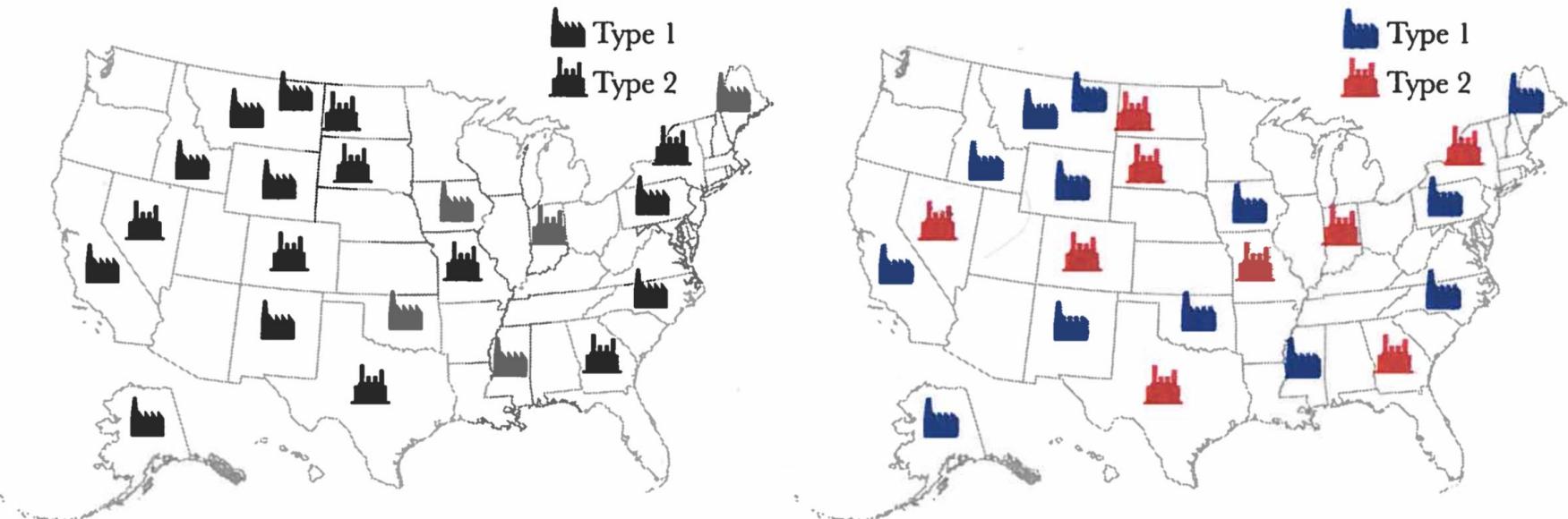
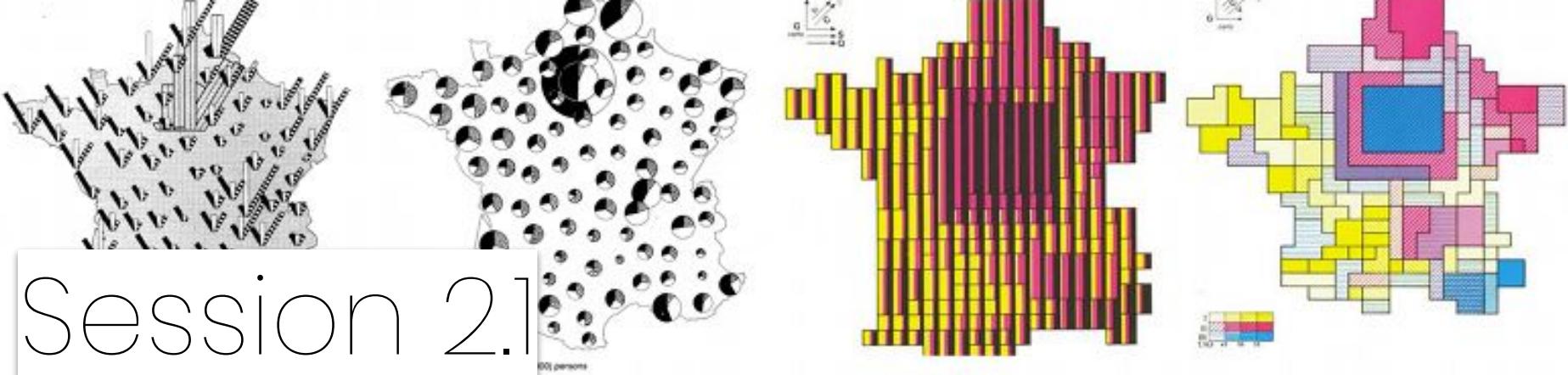


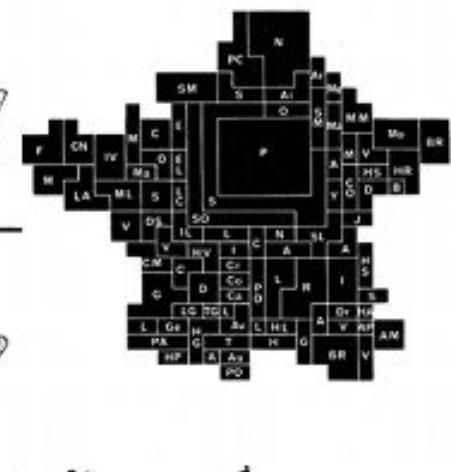
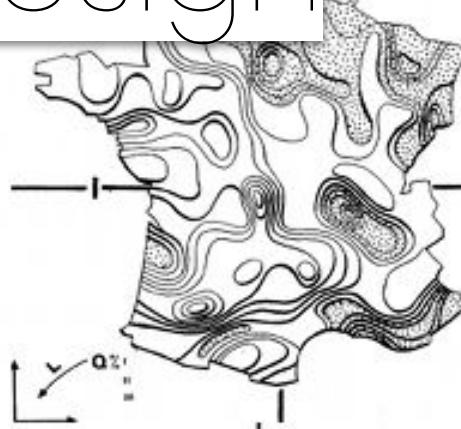
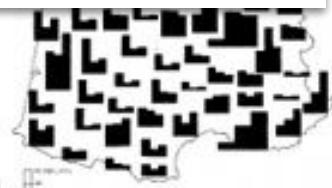
Figure 6.3 On which of these maps is it easier to identify the number of factories of each kind?



Session 2.1

Visualization Design

Gestalt Laws



Online Course
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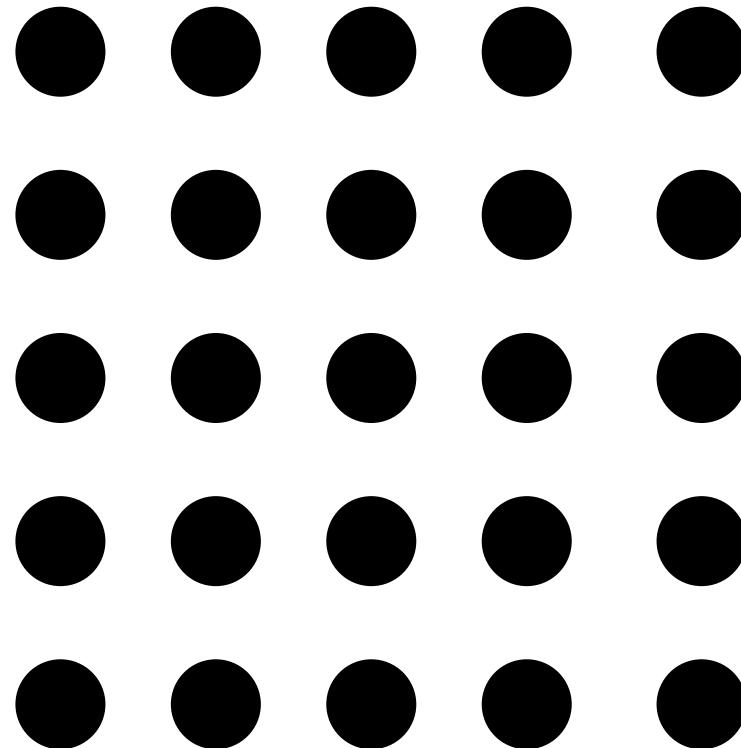
Benjamin Bach

June 2020

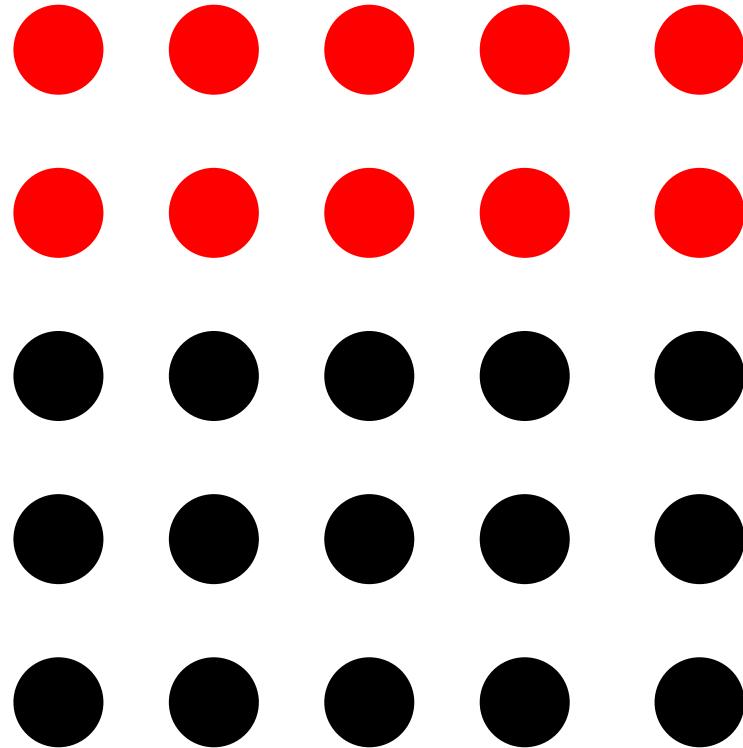
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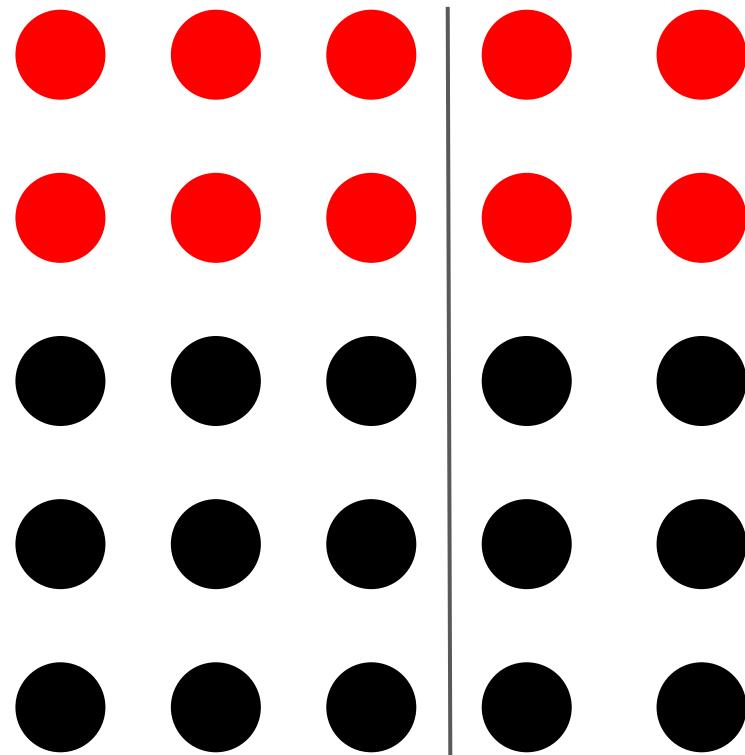
Gestalt Laws



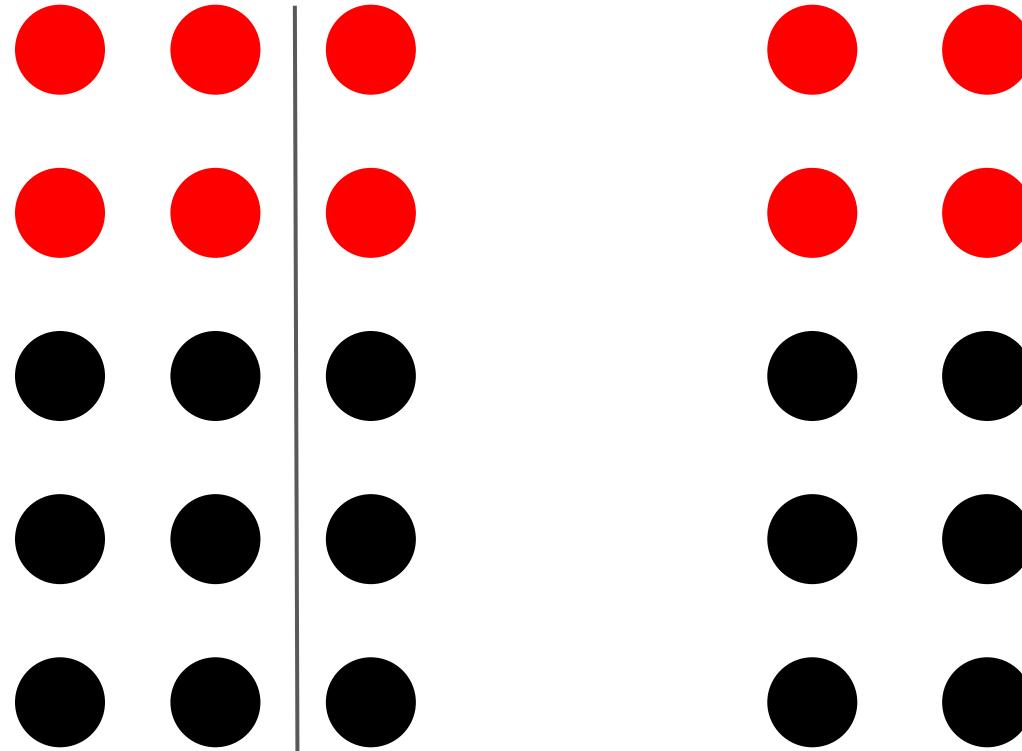
Law of Similarity



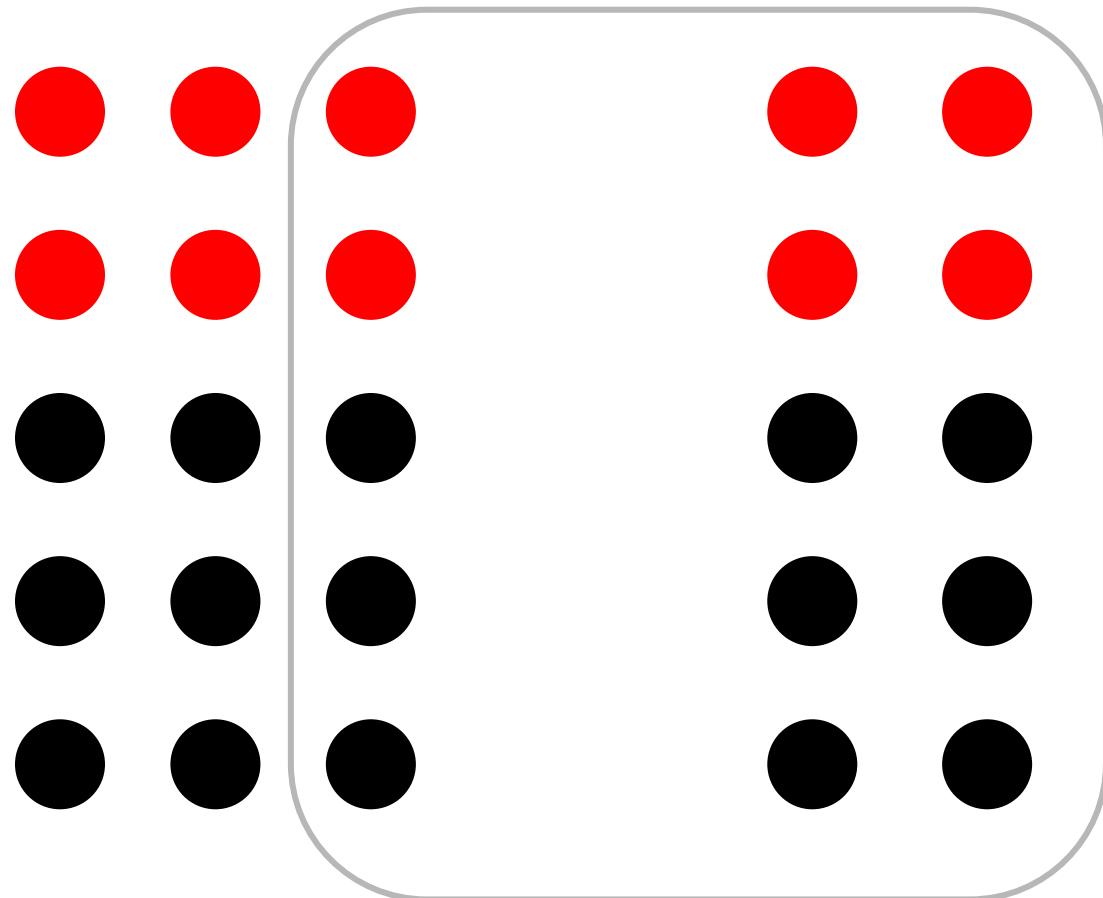
Law of Closure



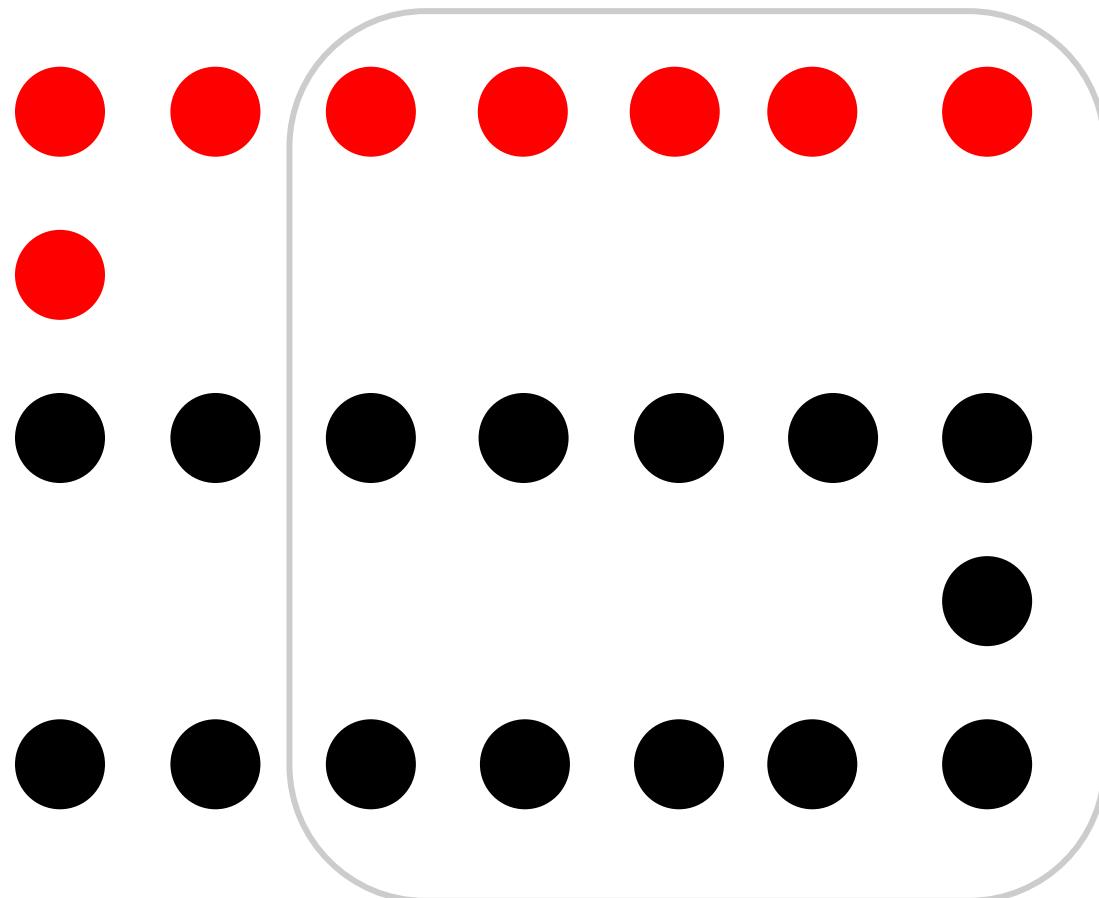
Law of Proximity



Law of Enclosure

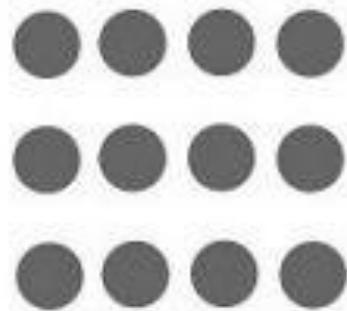


Law of Continuity

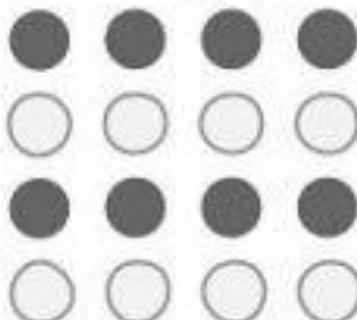


Gestalt Laws

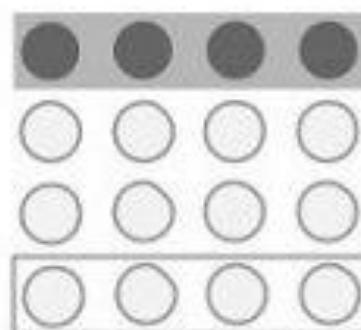
Proximity



Similarity



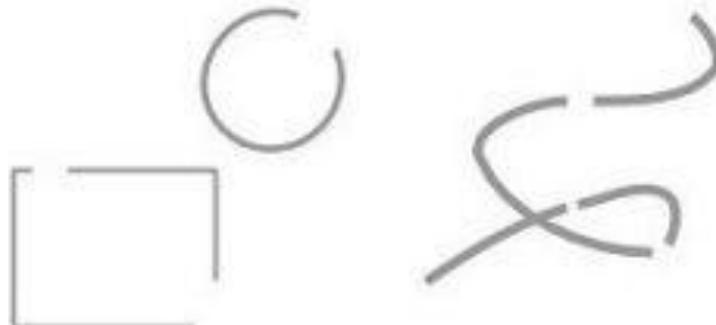
Enclosure



Symmetry



Closure



Continuity

Connection

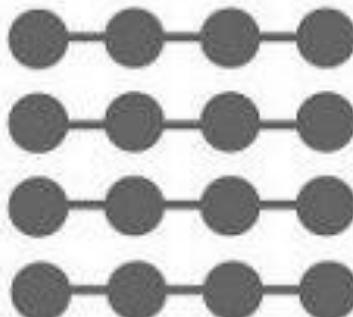


Figure & ground



Gestalt Laws

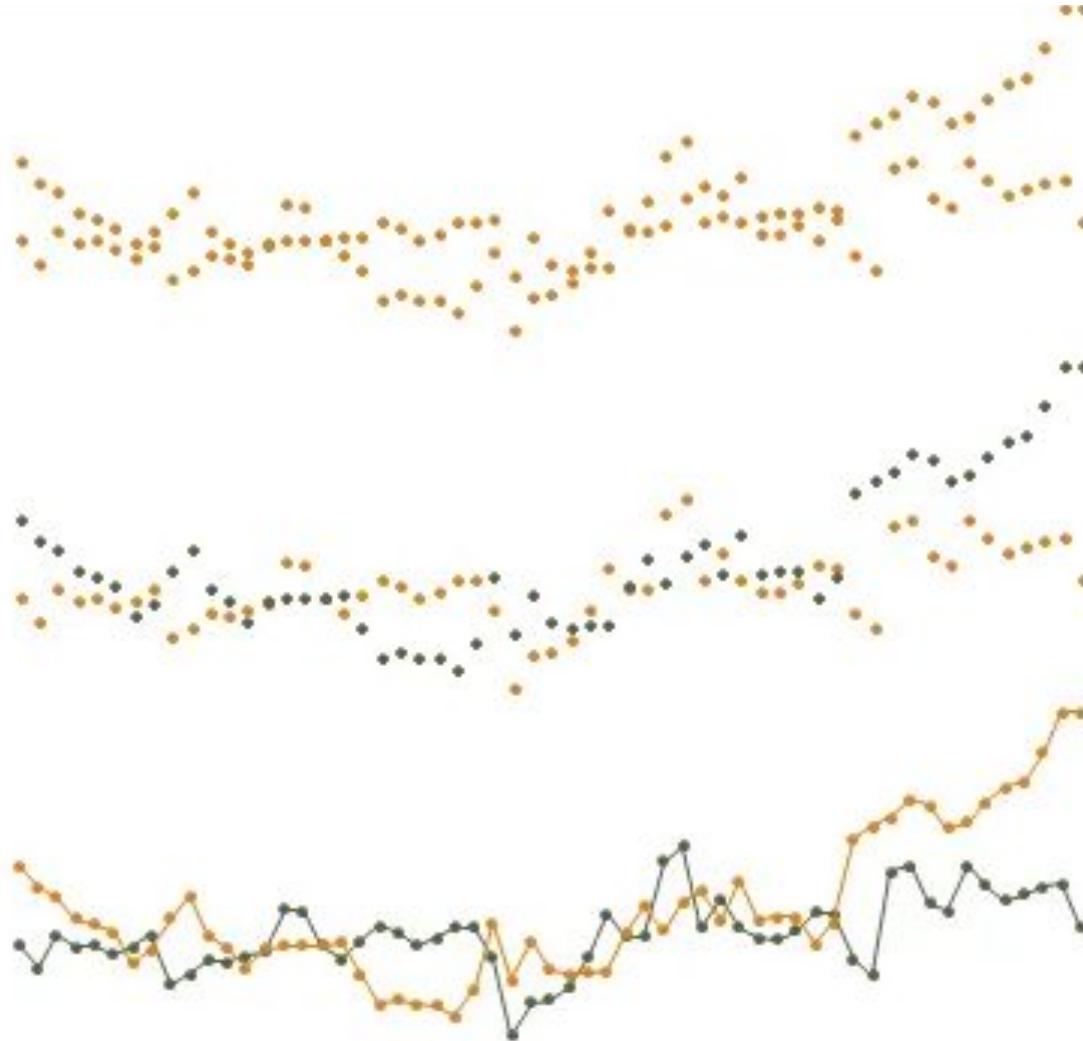


Gestalt Laws



Law of
Similarity

Gestalt Laws



Law of
Connection

Gestalt Laws

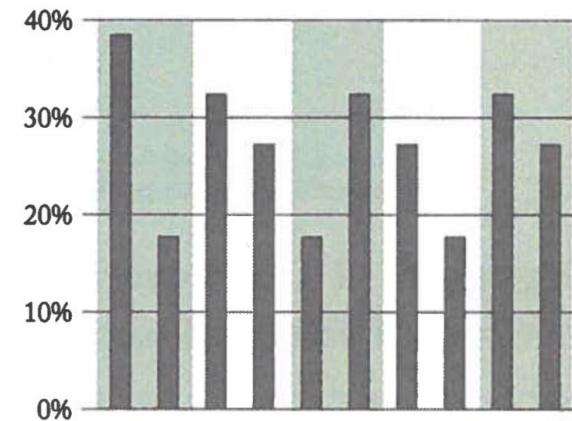
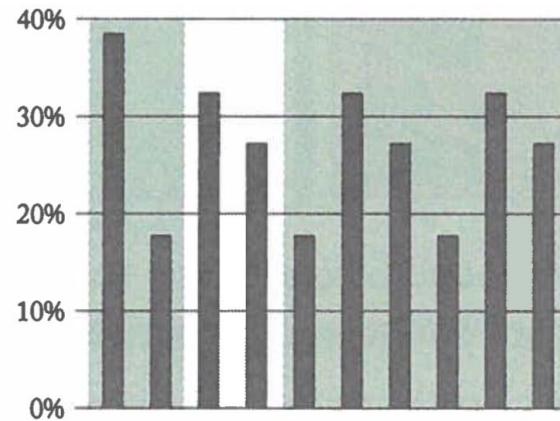
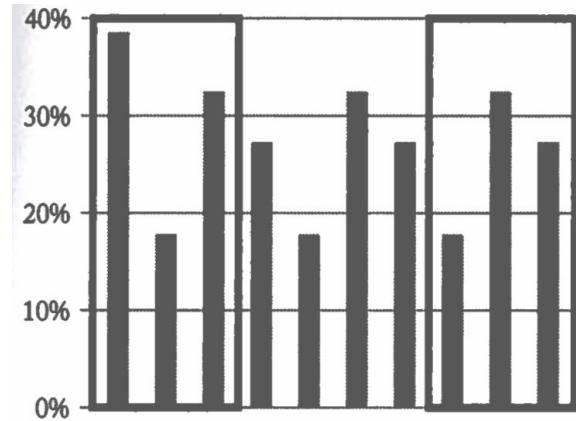


Figure 6.10 Boxing bars helps readers identify groups.

Gestalt Laws

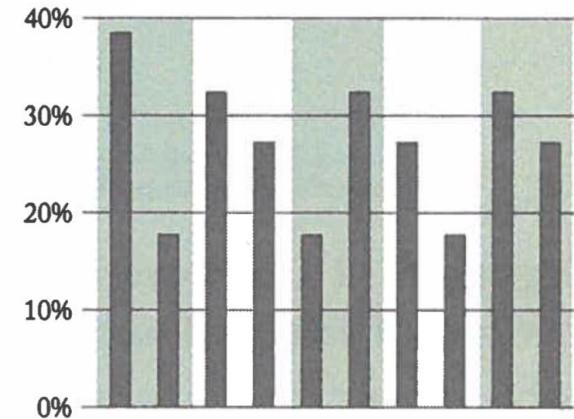
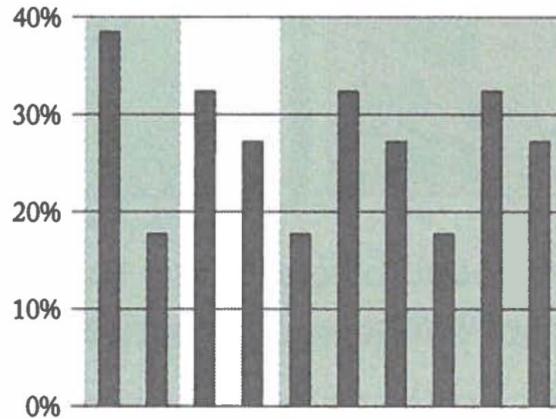
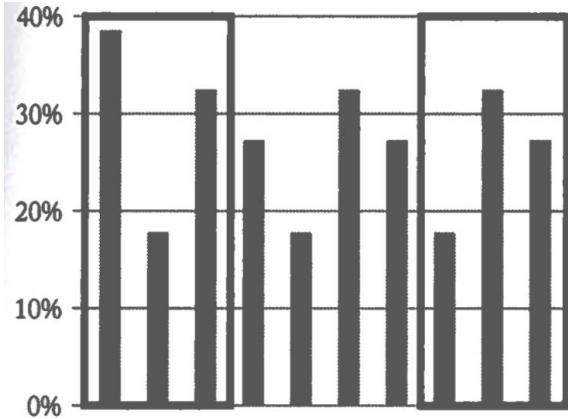


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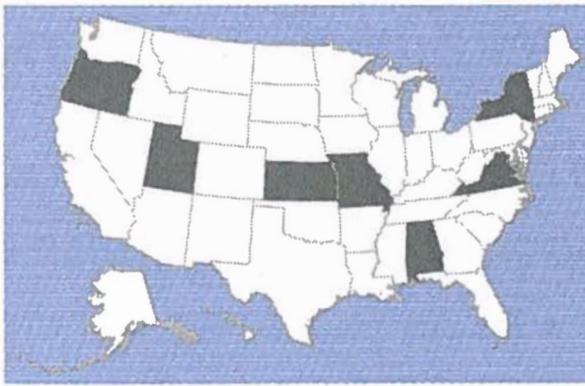
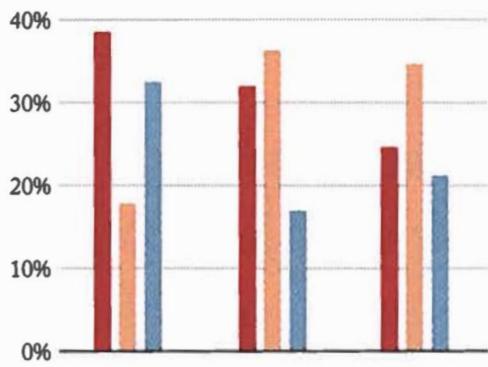
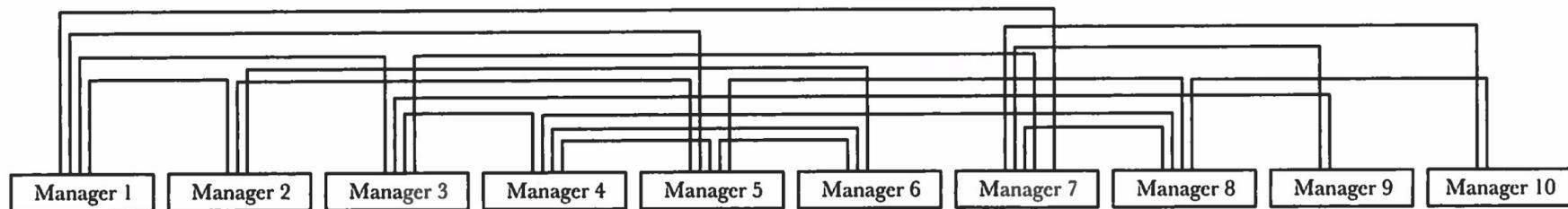
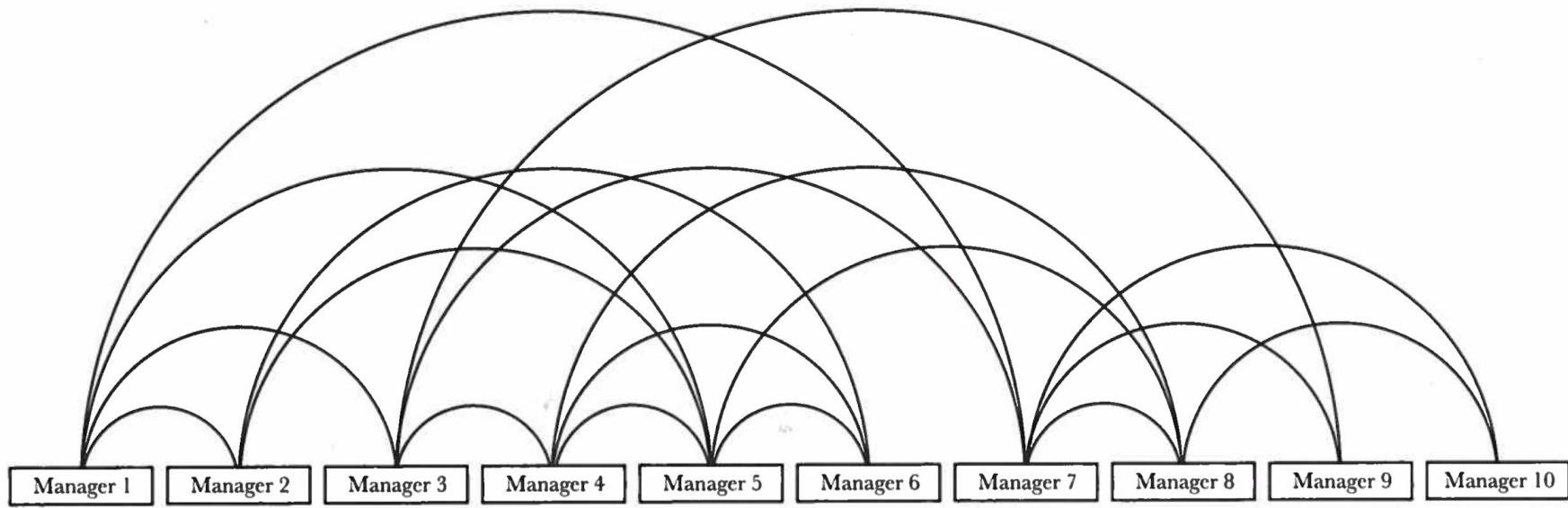


Figure 6.7 Objects that look alike will be identified as parts of a group.

Continuity for line following

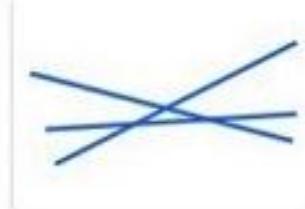


Visual Patterns

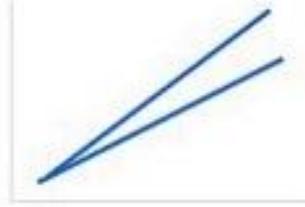
High, low and in between



Going up, going down and remaining flat

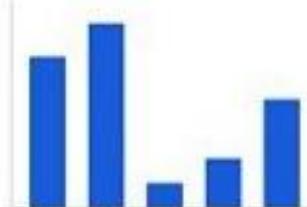


Steep and gradual

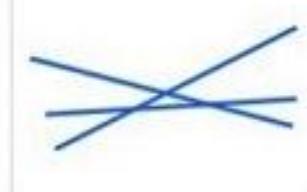


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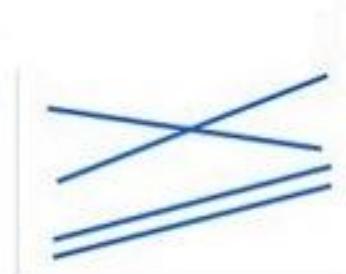
Going up, going down and remaining flat



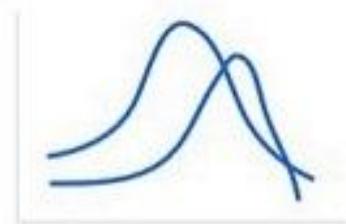
Steep and gradual



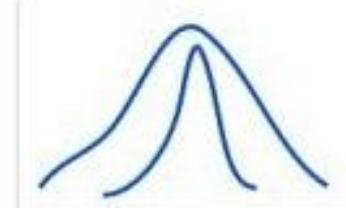
Non-intersecting and intersecting



Symmetrical and skewed

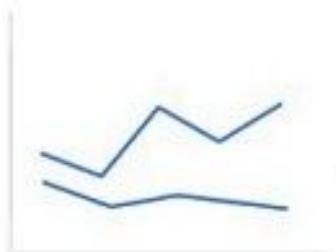


Wide and narrow

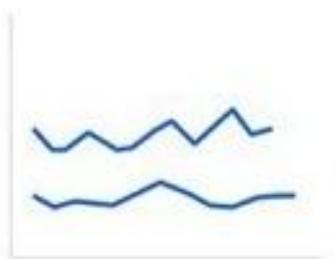


Visual Patterns

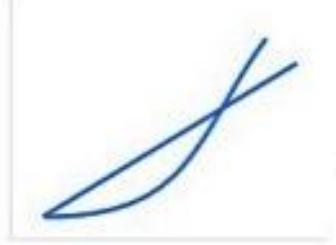
Steady and fluctuating



Random and repeating



Straight and curved

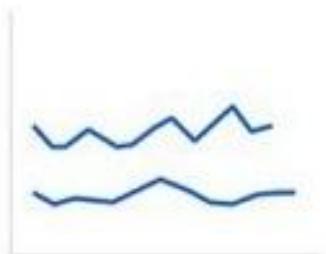


Visual Patterns

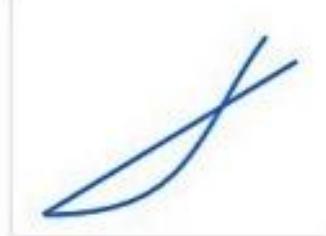
Steady and fluctuating



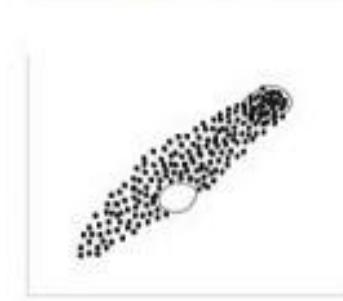
Random and repeating



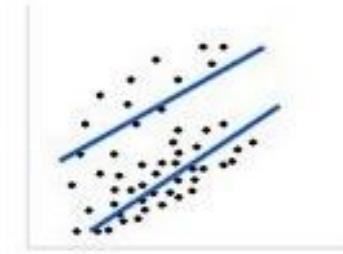
Straight and curved



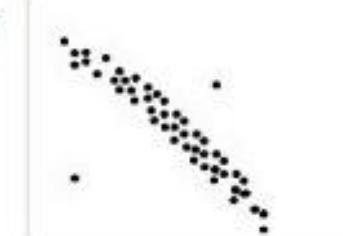
Clusters and gaps

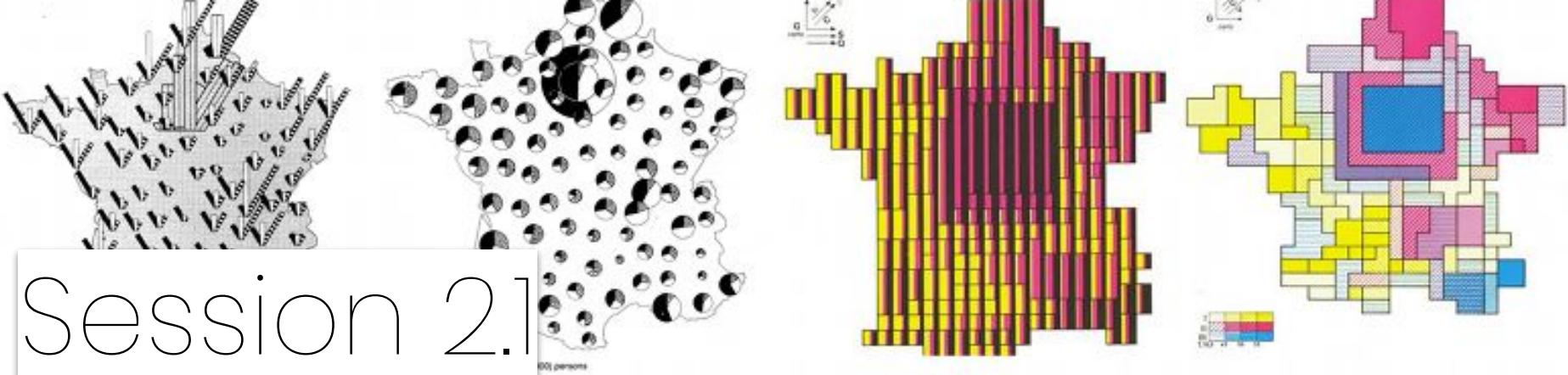


Tightly and loosely distributed



Normal and abnormal

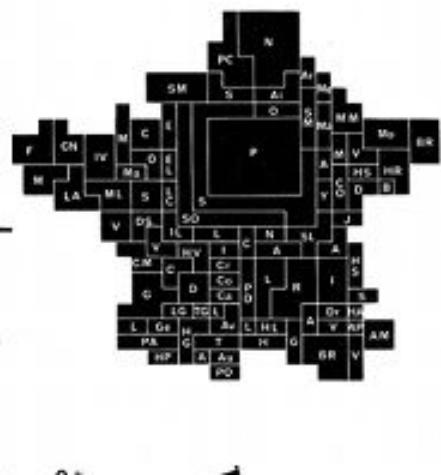
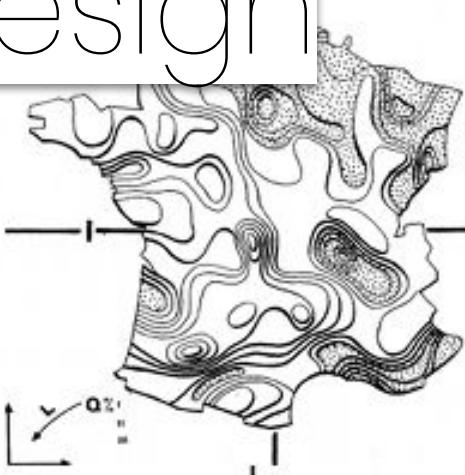
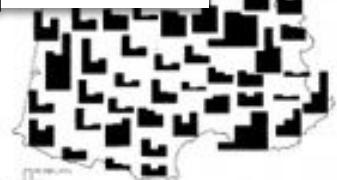




Session 2.1

Visualization Design

Data types



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View

Data Types

Categorical
(Qualitative)



Ordered

Numerical
(Quantitative)



Data Types

Categorical
(Qualitative)



Ordered



Numerical
(Quantitative)



Data Types

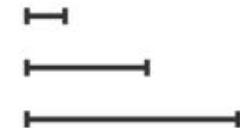
Categorical
(Qualitative)



Ordered



Numerical
(Quantitative)



A	B	C	S	T	U
Order ID	Order Date	Order Priority	Product Container	Product Base Margin	Ship Date
3	10/14/06	5-Low	Large Box	0.8	10/21/06
6	2/21/08	4-Not Specified	Small Pack	0.55	2/22/08
32	7/16/07	2-High	Small Pack	0.79	7/17/07
32	7/16/07	2-High	Jumbo Box		7/17/07
32	7/16/07	2-High	Medium Box		7/18/07
32	7/16/07	2-High	Medium Box	0.65	7/18/07
35	10/23/07	4-Not Specified	Wrap Bag	0.52	10/24/07
35	10/23/07	4-Not Specified	Small Box	0.58	10/25/07
36	11/3/07	1-Urgent	Small Box	0.55	11/3/07
65	3/18/07	1-Urgent	Small Pack	0.49	3/19/07
66	1/20/05	5-Low	Wrap Bag	0.56	1/20/05
69	item	5 4-Not Specified	Small Pack	0.44	6/6/05
69		5 4-Not Specified	Wrap Bag	0.6	6/6/05
70	12/18/06	5-Low	Small Box	0.59	12/23/06
70	12/18/06	5-Low	Wrap Bag	0.82	12/23/06
96	4/17/05	2-High	Small Box	0.55	4/19/05
97	1/29/06	3-Medium	Small Box	0.38	1/30/06
129	11/19/08	5-Low	Small Box	0.37	11/28/08
130	5/8/08	2-High	Small Box	0.37	5/9/08
130	5/8/08	2-High	Medium Box	0.38	5/10/08
130	5/8/08	2-High	Small Box	0.6	5/11/08
132	6/11/06	3-Medium	Medium Box	0.6	6/12/06

attribute

item

cell

Cat.

A	B	C	S	T	U
Order ID	Order Date	Order Priority	Product Container	Product Base Margin	Ship Date
3	10/14/06	5-Low	Large Box	0.8	10/21/06
6	2/21/08	4-Not Specified	Small Pack	0.55	2/22/08
32	7/16/07	2-High	Small Pack	0.79	7/17/07
32	7/16/07	2-High	Jumbo Box		7/17/07
32	7/16/07	2-High	Medium Box		7/18/07
32	7/16/07	2-High	Medium Box	0.65	7/18/07
35	10/23/07	4-Not Specified	Wrap Bag	0.52	10/24/07
35	10/23/07	4-Not Specified	Small Box	0.58	10/25/07
36	11/3/07	1-Urgent	Small Box	0.55	11/3/07
65	3/18/07	1-Urgent	Small Pack	0.49	3/19/07
66	1/20/05	5-Low	Wrap Bag	0.56	1/20/05
69	item	5 4-Not Specified	Small Pack	0.44	6/6/05
69		5 4-Not Specified	Wrap Bag	0.6	6/6/05
70	12/18/06	5-Low	Small Box	0.59	12/23/06
70	12/18/06	5-Low	Wrap Bag	0.82	12/23/06
96	4/17/05	2-High	Small Box	0.55	4/19/05
97	1/29/06	3-Medium	Small Box	0.38	1/30/06
129	11/19/08	5-Low	Small Box	0.37	11/28/08
130	5/8/08	2-High	Small Box	0.37	5/9/08
130	5/8/08	2-High	Medium Box	0.38	5/10/08
130	5/8/08	2-High	Small Box	0.6	5/11/08
132	6/11/06	3-Medium	Medium Box	0.6	6/12/06

attribute

item

cell

Cat. Num.

A	B	C	S	T	U
Order ID	Order Date	Order Priority	Product Container	Product Base Margin	Ship Date
3	10/14/06	5-Low	Large Box	0.8	10/21/06
6	2/21/08	4-Not Specified	Small Pack	0.55	2/22/08
32	7/16/07	2-High	Small Pack	0.79	7/17/07
32	7/16/07	2-High	Jumbo Box		7/17/07
32	7/16/07	2-High	Medium Box		7/18/07
32	7/16/07	2-High	Medium Box	0.65	7/18/07
35	10/23/07	4-Not Specified	Wrap Bag	0.52	10/24/07
35	10/23/07	4-Not Specified	Small Box	0.58	10/25/07
36	11/3/07	1-Urgent	Small Box	0.55	11/3/07
65	3/18/07	1-Urgent	Small Pack	0.49	3/19/07
66	1/20/05	5-Low	Wrap Bag	0.56	1/20/05
69	item	5 4-Not Specified	Small Pack	0.44	6/6/05
69		5 4-Not Specified	Wrap Bag	0.6	6/6/05
70	12/18/06	5-Low	Small Box	0.59	12/23/06
70	12/18/06	5-Low	Wrap Bag	0.82	12/23/06
96	4/17/05	2-High	Small Box	0.55	4/19/05
97	1/29/06	3-Medium	Small Box	0.38	1/30/06
129	11/19/08	5-Low	Small Box	0.37	11/28/08
130	5/8/08	2-High	Small Box	0.37	5/9/08
130	5/8/08	2-High	Medium Box	0.38	5/10/08
130	5/8/08	2-High	Small Box	0.6	5/11/08
132	6/11/06	3-Medium	Medium Box	0.6	6/12/06

attribute

item

cell

Cat. Num. Ord. /
 Cat.

A	B	C	S	T	U
Order ID	Order Date	Order Priority	Product Container	Product Base Margin	Ship Date
3	10/14/06	5-Low	Large Box	0.8	10/21/06
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32	7/16/07	2-High	Small Pack	0.79	7/17/07
32	7/16/07	2-High	Jumbo Box		7/17/07
32	7/16/07	2-High	Medium Box		7/18/07
32	7/16/07	2-High	Medium Box	0.65	7/18/07
35	10/23/07	4-Not Specified	Wrap Bag	0.52	10/24/07
35	10/23/07	4-Not Specified	Small Box	0.58	10/25/07
36	11/3/07	1-Urgent	Small Box	0.55	11/3/07
65	3/18/07	1-Urgent	Small Pack	0.49	3/19/07
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69	item	5 4-Not Specified	Small Pack	0.44	6/6/05
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70	12/18/06	5-Low	Small Box	0.59	12/23/06
70	12/18/06	5-Low	Wrap Bag	0.82	12/23/06
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97	1/29/06	3-Medium	Small Box	0.38	1/30/06
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130	5/8/08	2-High	Small Box	0.37	5/9/08
130	5/8/08	2-High	Medium Box	0.38	5/10/08
130	5/8/08	2-High	Small Box	0.6	5/11/08
132	6/11/06	3-Medium	Medium Box	0.6	6/12/06

attribute

item

cell

Cat.

Num.

Ord. /
Cat.

Ord. /
Cat.

A	B	C	S	T	U
Order ID	Order Date	Order Priority	Product Container	Product Base Margin	Ship Date
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32	7/16/07	2-High	Medium Box		7/18/07
32	7/16/07	2-High	Medium Box	0.65	7/18/07
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35	10/23/07	4-Not Specified	Small Box	0.58	10/25/07
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65	3/18/07	1-Urgent	Small Pack	0.49	3/19/07
66	1/20/05	5-Low	Wrap Bag	0.56	1/20/05
69	item	5	Small Pack	0.44	6/6/05
69		5	Wrap Bag	0.6	6/6/05
70	12/18/06	5-Low	Small Box	0.59	12/23/06
70	12/18/06	5-Low	Wrap Bag	0.82	12/23/06
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130	5/8/08	2-High	Small Box	0.37	5/9/08
130	5/8/08	2-High	Medium Box	0.38	5/10/08
130	5/8/08	2-High	Small Box	0.6	5/11/08
132	6/11/06	3-Medium	Medium Box	0.6	6/12/06

Cat.	Num.	Ord. / Cat.	Ord. / Cat.	Num.
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A	B	C	S	T	U
Order ID	Order Date	Order Priority	Product Container	Product Base Margin	Ship Date
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32	7/16/07	2-High	Jumbo Box		7/17/07
32	7/16/07	2-High	Medium Box		7/18/07
32	7/16/07	2-High	Medium Box	0.65	7/18/07
35	10/23/07	4-Not Specified	Wrap Bag	0.52	10/24/07
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66	1/20/05	5-Low	Wrap Bag	0.56	1/20/05
69	item	5 4-Not Specified	Small Pack	0.44	6/6/05
69		5 4-Not Specified	Wrap Bag	0.6	6/6/05
70	12/18/06	5-Low	Small Box	0.59	12/23/06
70	12/18/06	5-Low	Wrap Bag	0.82	12/23/06
96	4/17/05	2-High	Small Box	0.55	4/19/05
97	1/29/06	3-Medium	Small Box	0.38	1/30/06
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130	5/8/08	2-High	Small Box	0.37	5/9/08
130	5/8/08	2-High	Medium Box	0.38	5/10/08
130	5/8/08	2-High	Small Box	0.6	5/11/08
132	6/11/06	3-Medium	Medium Box	0.6	6/12/06

attribute

cell

Cat.	Num.	Ord. / Cat.	Ord. / Cat.	Num.	Num.
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A	B	C	S	T	U
Order ID	Order Date	Order Priority	Product Container	Product Base Margin	Ship Date
3	10/14/06	5-Low	Large Box	0.8	10/21/06
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35	10/23/07	4-Not Specified	Small Box	0.58	10/25/07
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130	5/8/08	2-High	Small Box	0.6	5/11/08
132	6/11/06	3-Medium	Medium Box	0.6	6/12/06

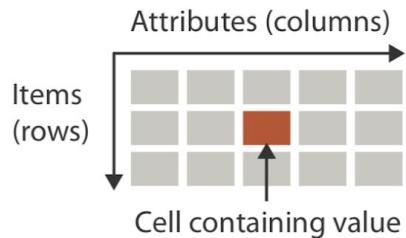
attribute

cell

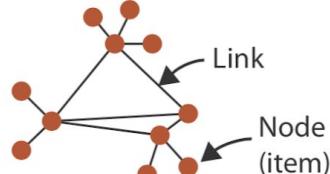
More data types

Dataset Types

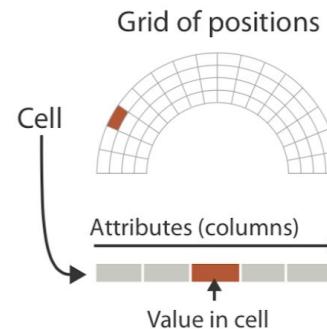
→ Tables



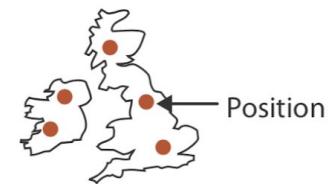
→ Networks



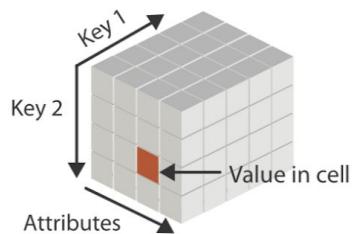
→ Fields (Continuous)



→ Geometry (Spatial)

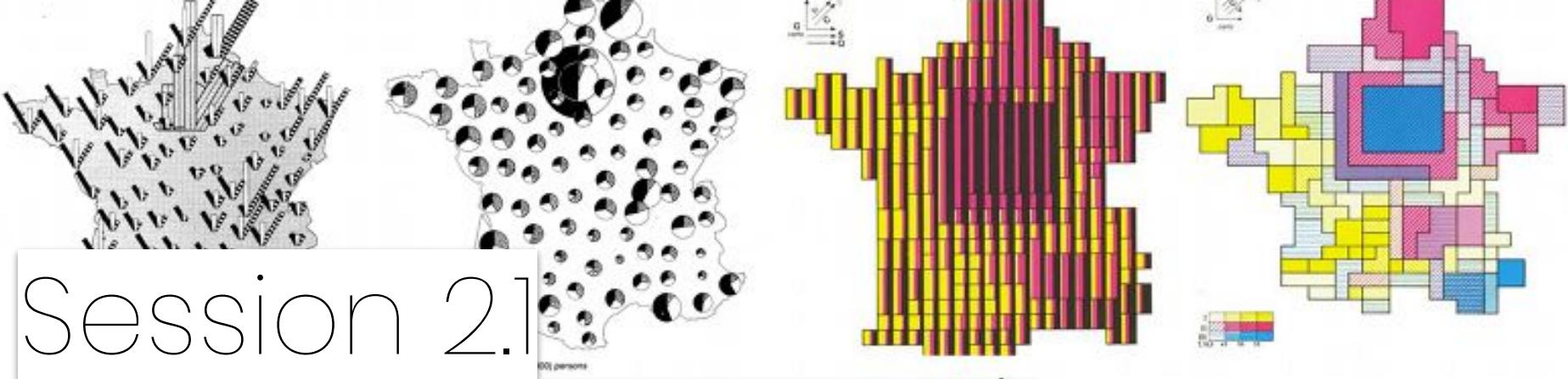


→ Multidimensional Table



→ Trees

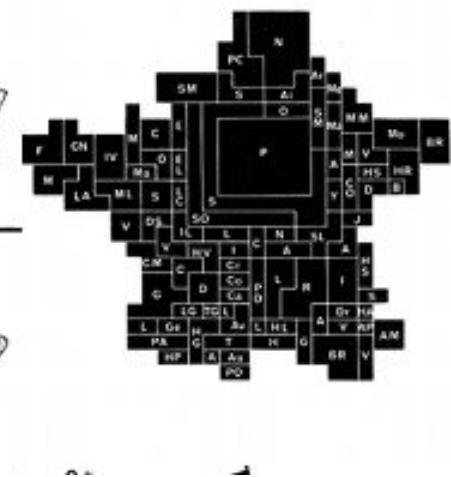
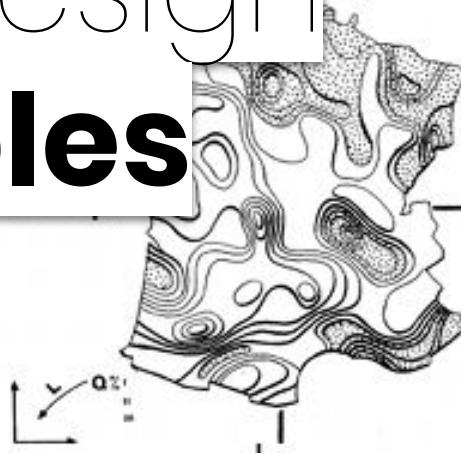
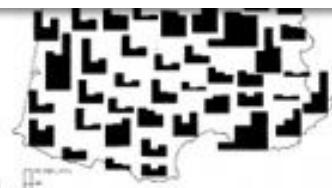
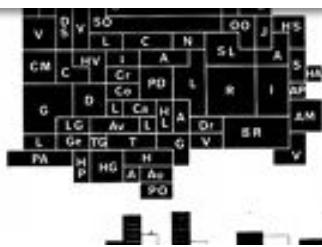




Session 2.1

Visualization Design

Visual Variables



Online Course
**Data Visualization
for Professionals**



THE UNIVERSITY
of EDINBURGH

Benjamin Bach

June 2020

<http://benjbach.me>
<https://datavis-online.github.io>

-- Not for external use --

Encoding: designer

1 Data

What is my data?

Which data type?

Ordinal / numerical / categorical?

2 Visual Mapping

What is my visual representation?

Which visual variables am I using?

How am I encoding my data?

3 Rendering

What is my medium?

monoscopic/stereoscopic?

Tangibility?

Print / digital?

View

Decoding: user

6

Comprehending

What does it mean for me?

What shall I do now?

Is this all true?

What do I learn?

5

Interpreting

What does it mean?

What does color mean?

What does 'up' mean?

What do these patterns show?

4

Perceiving

What does it show?

Where is big, medium, small?

How do things compare?

What relationships exist?

Visual Marks



Points



Lines

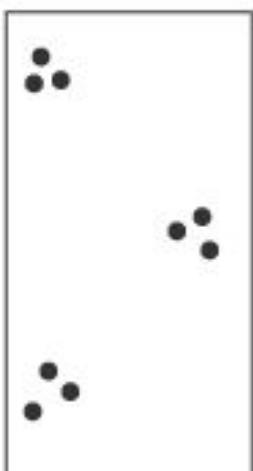


Areas

Visual Variables

Bertin's Visual Variables

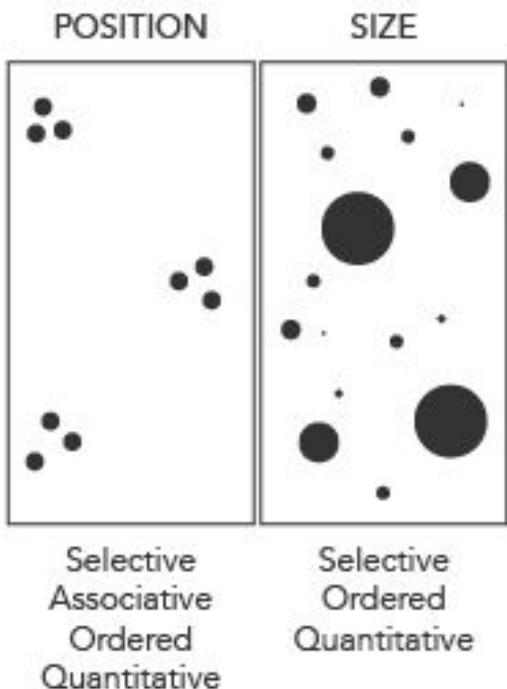
POSITION



Selective
Associative
Ordered
Quantitative

Visual Variables

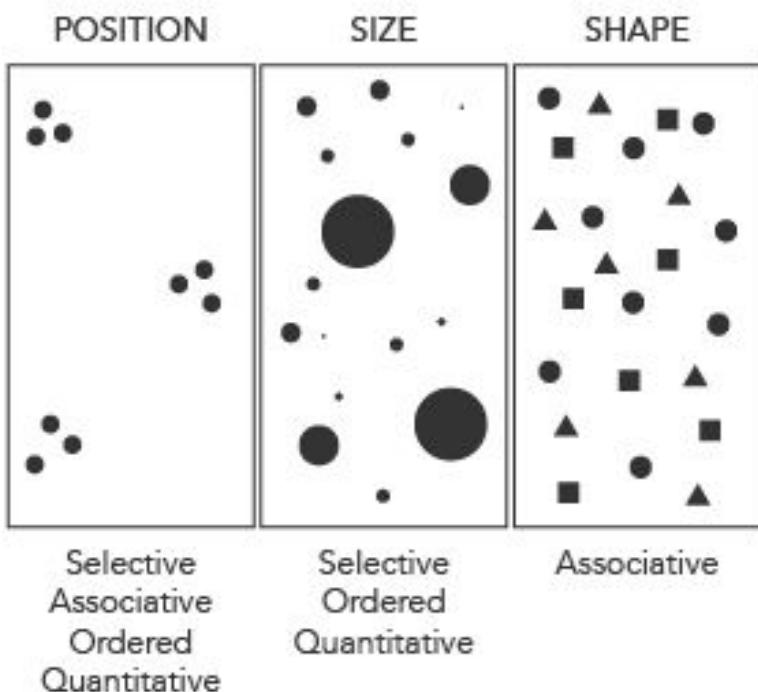
Bertin's Visual Variables



Bertin, Jacques. "Semiology of Graphics: Diagrams." *Networks, Maps* 10.00690805.1987 (1983): 10438353.

Visual Variables

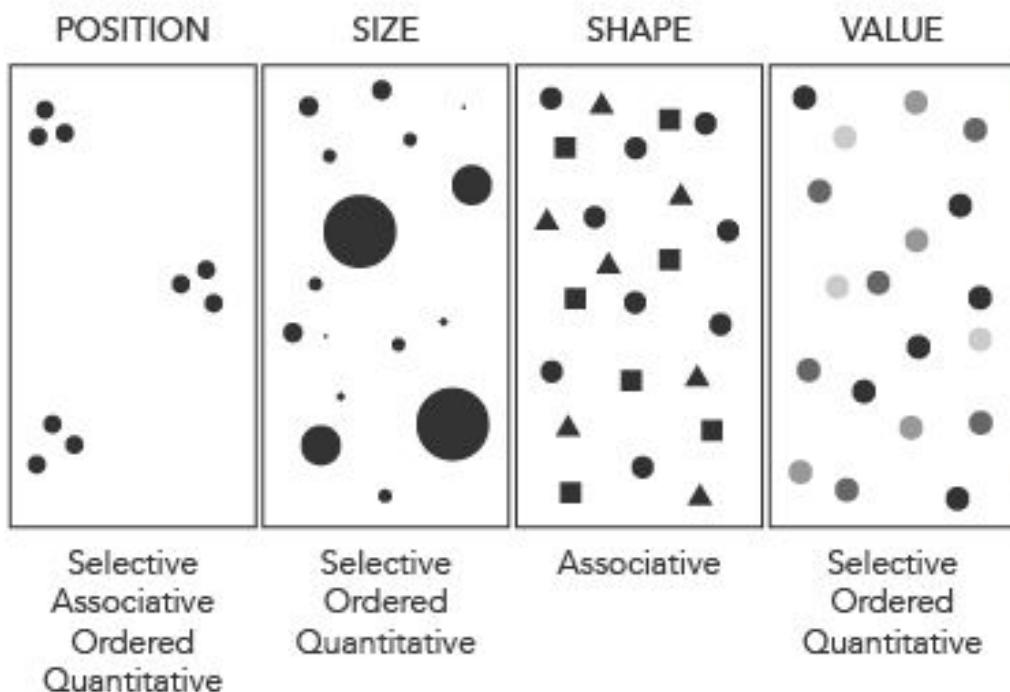
Bertin's Visual Variables



Bertin, Jacques. "Semiology of Graphics: Diagrams." *Networks, Maps* 10.00690805.1987 (1983): 10438353.

Visual Variables

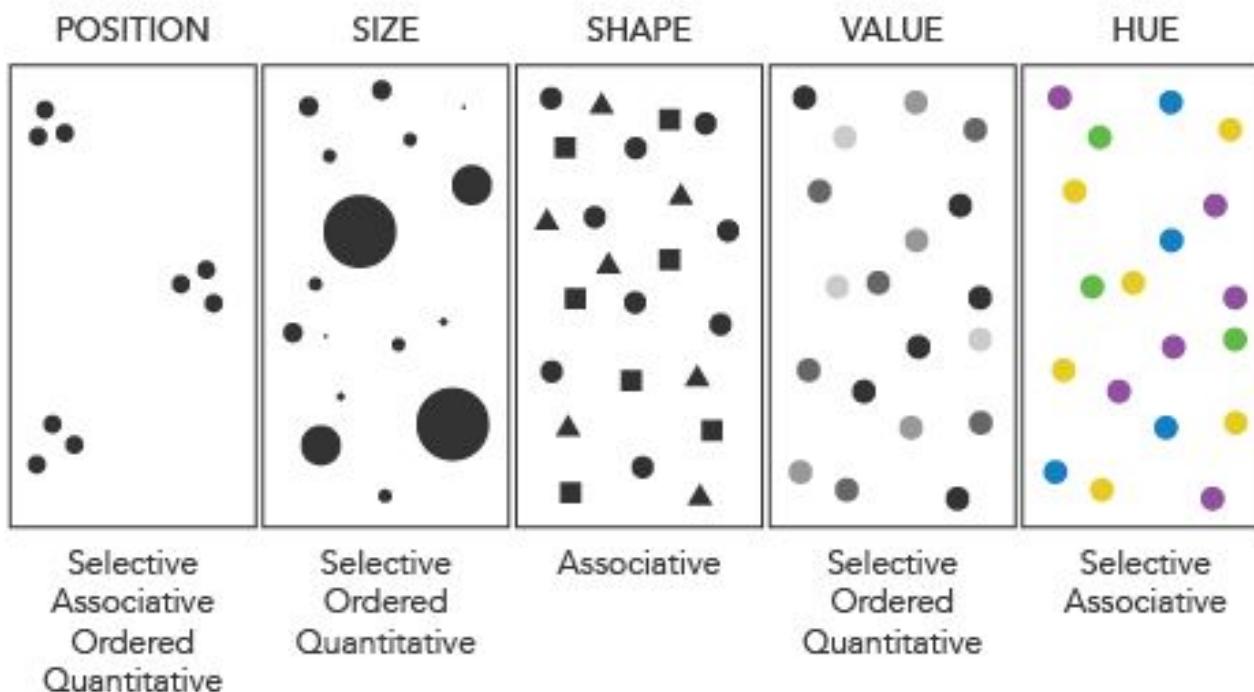
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Visual Variables

Bertin's Visual Variables



Bertin, Jacques. "Semiology of Graphics: Diagrams." *Networks, Maps* 10.00690805.1987 (1983): 10438353.

Visual Variables

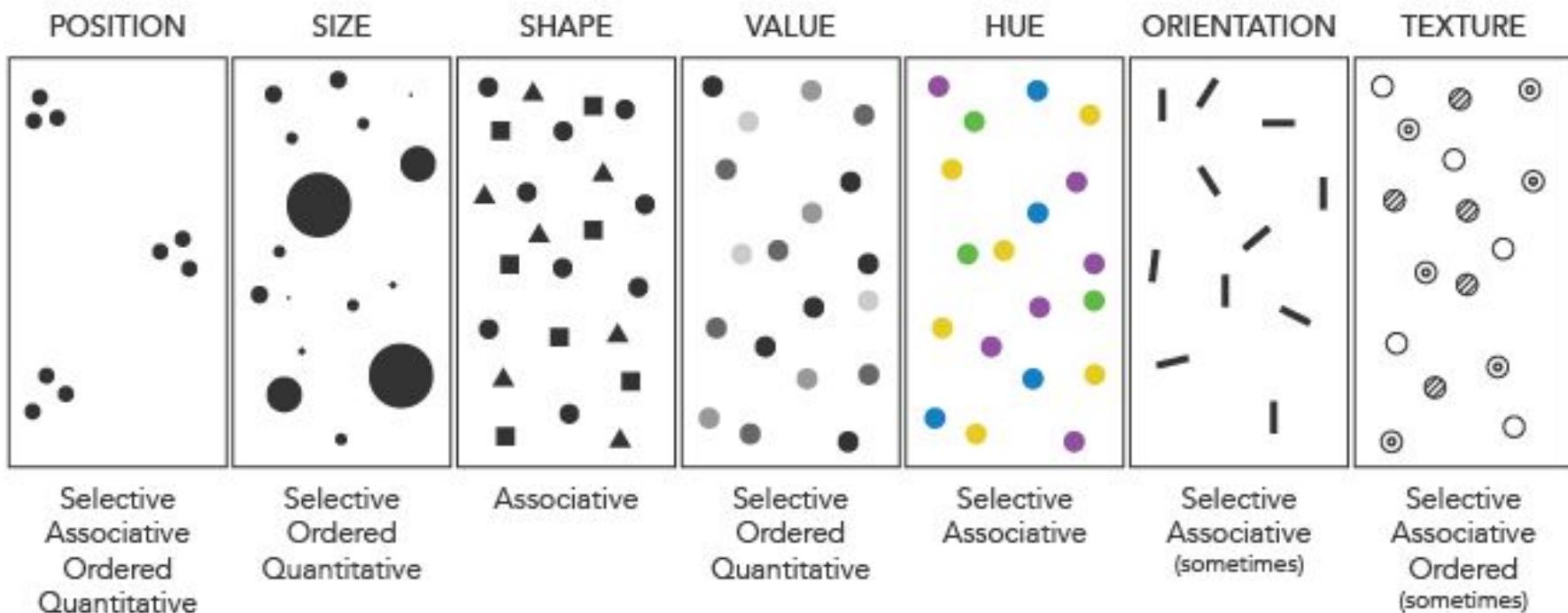
Bertin's Visual Variables

POSITION	SIZE	SHAPE	VALUE	HUE	ORIENTATION
Selective Associative Ordered Quantitative	Selective Ordered Quantitative	Associative	Selective Ordered Quantitative	Selective Associative	Selective Associative (sometimes)

Bertin, Jacques. "Semiology of Graphics: Diagrams." *Networks, Maps* 10.00690805.1987 (1983): 10438353.

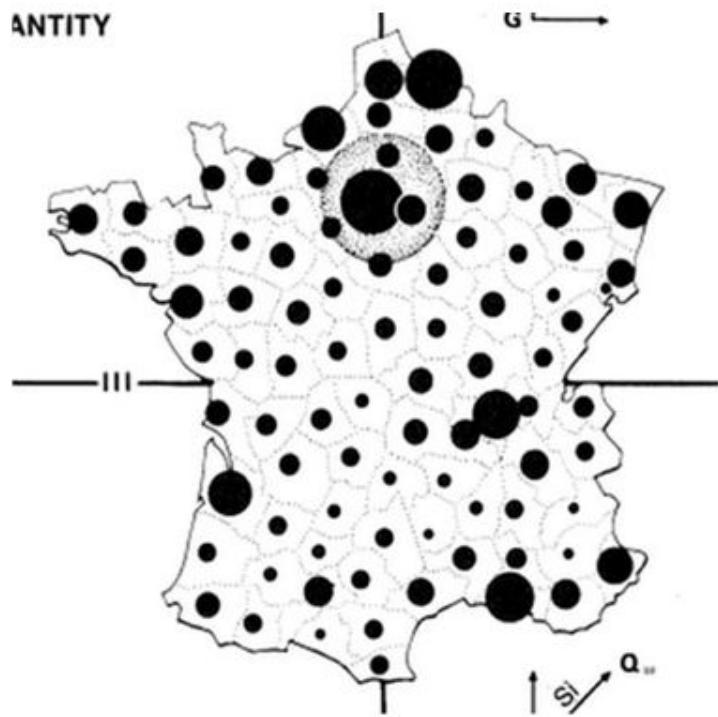
Visual Variables

Bertin's Visual Variables



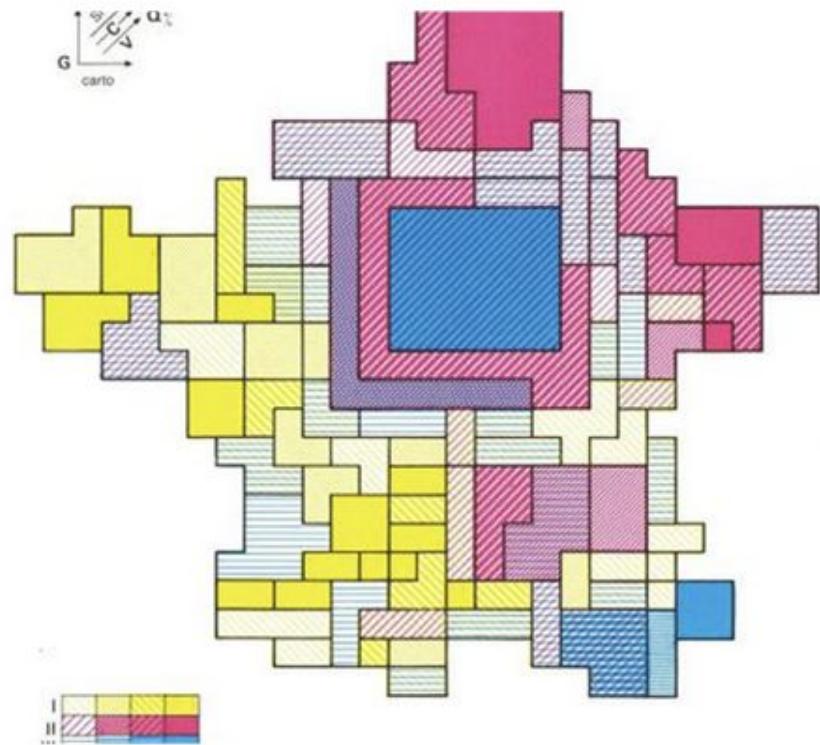
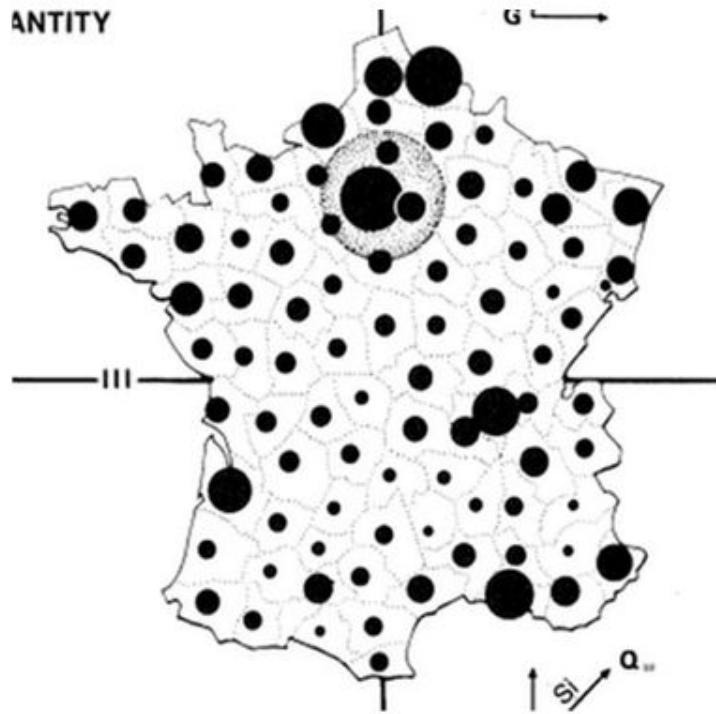
Bertin, Jacques. "Semiology of Graphics: Diagrams." *Networks, Maps* 10.00690805.1987 (1983): 10438353.

Visual Variables



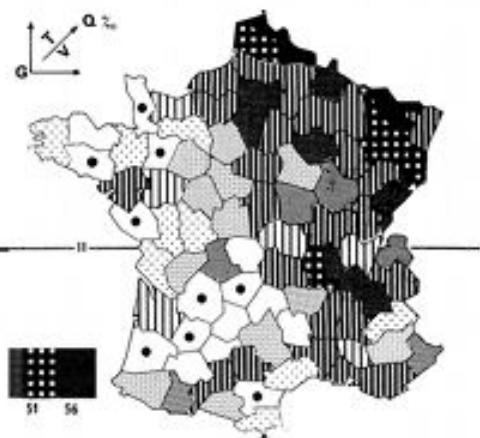
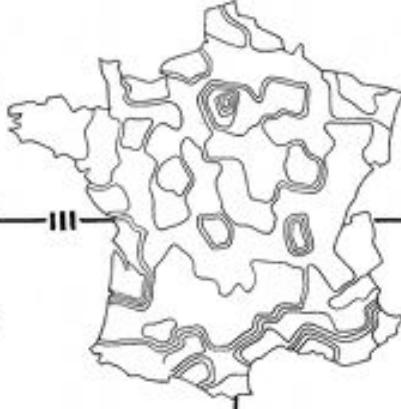
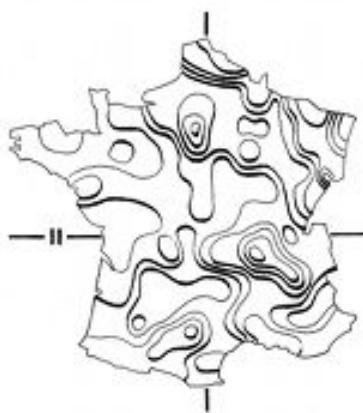
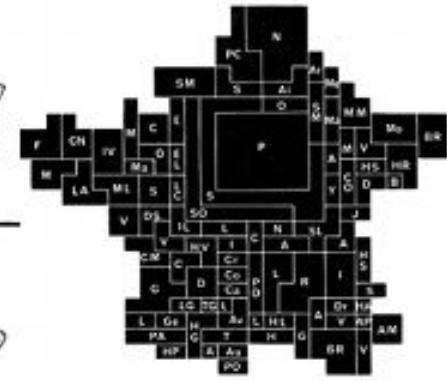
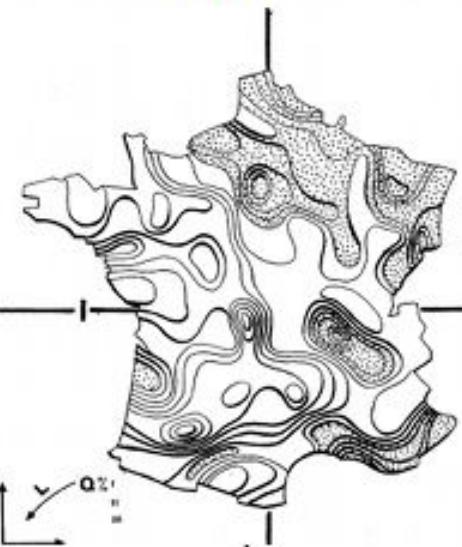
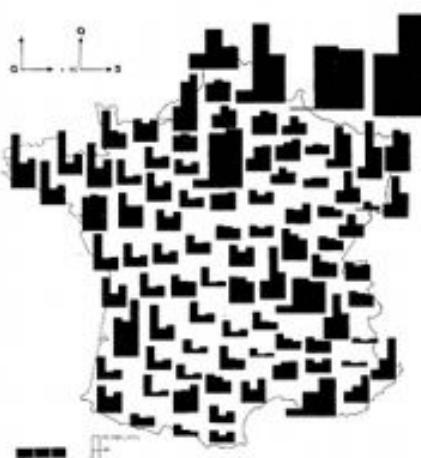
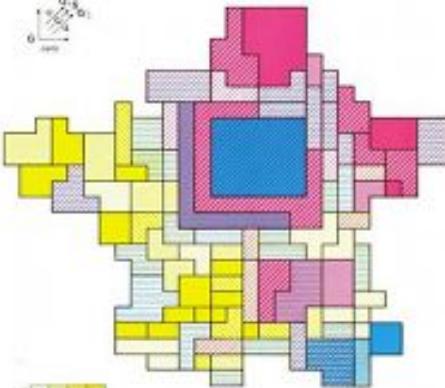
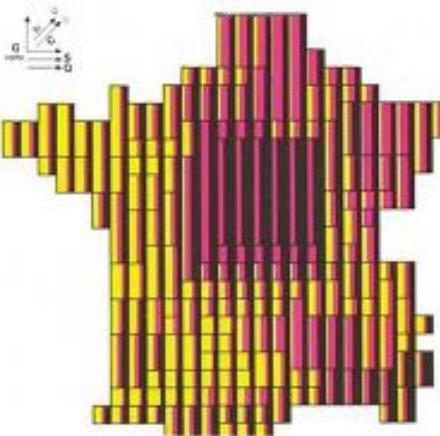
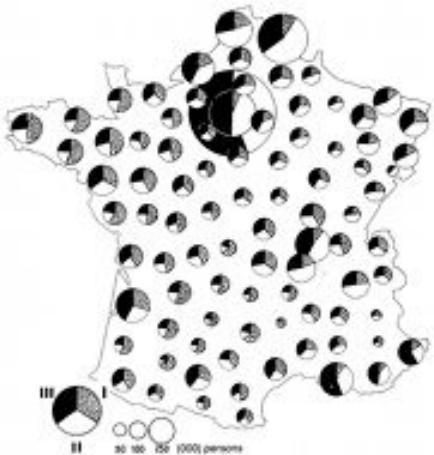
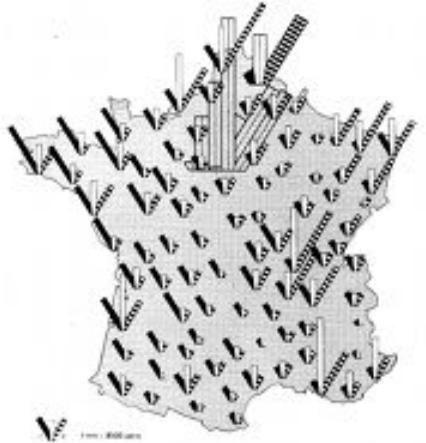
- Points
- Size

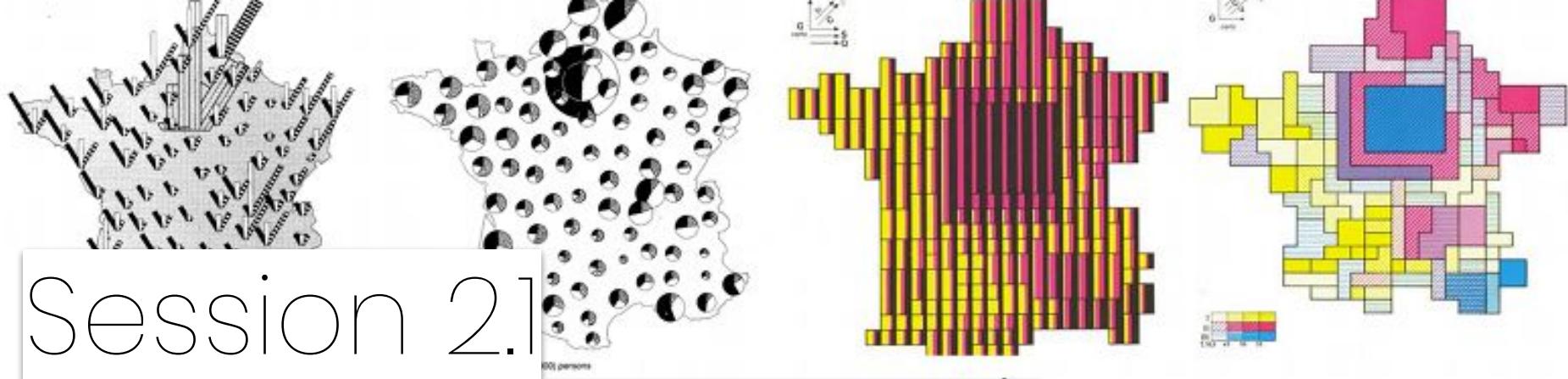
Visual Variables



- Points
- Size

- Areas
- Size
- Hue
- Texture

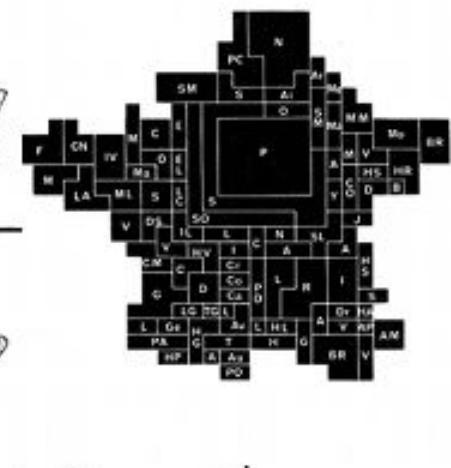




Session 2.1

Visualization Design

Characteristics of Visual Variables



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THE UNIVERSITY
of EDINBURGH

Benjamin Bach

June 2020

<http://benjbach.me>
<https://datavis-online.github.io>

-- Not for external use --

Characteristics of Visual Variables

Selective: Does it make a mark distinguishable?

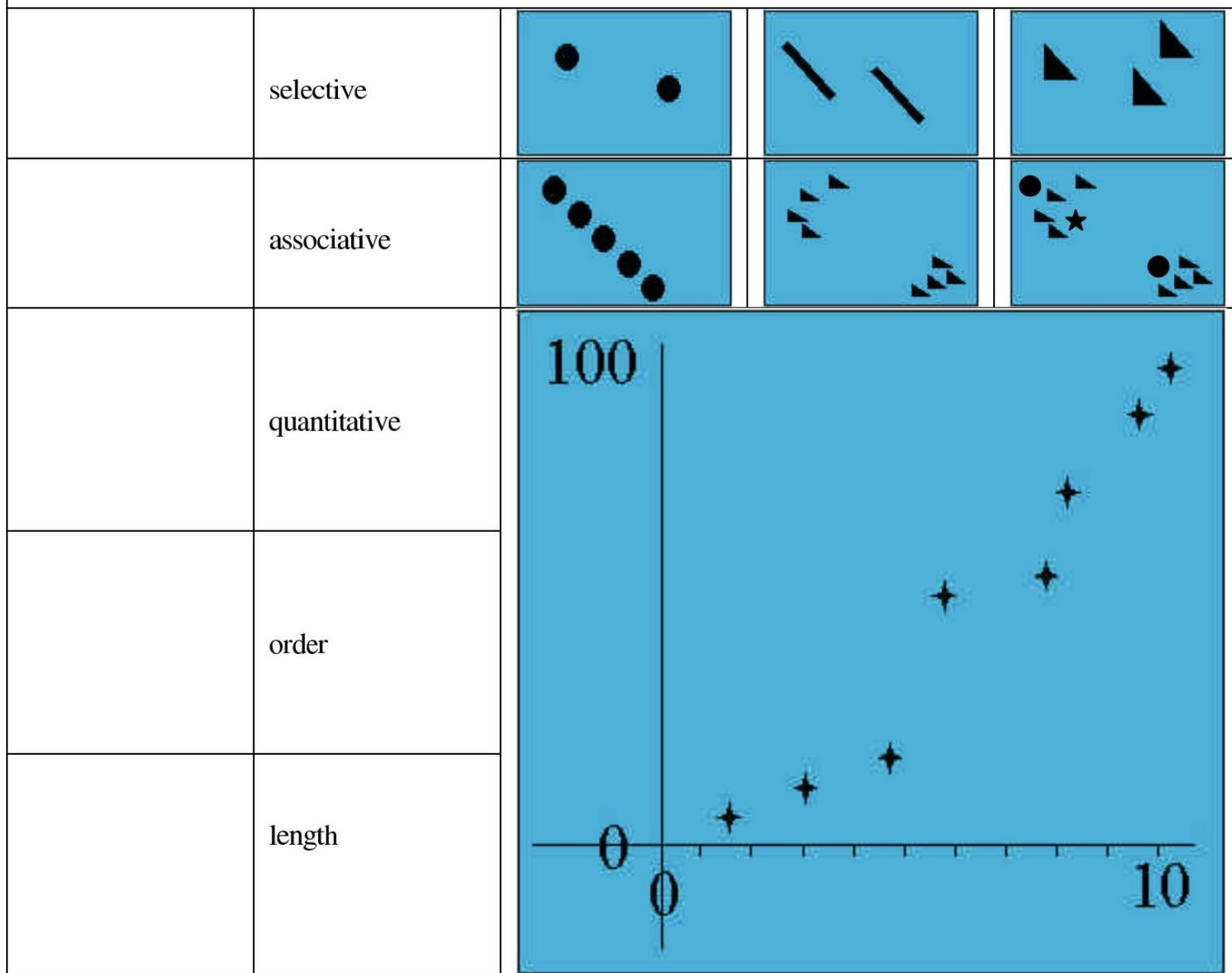
Associative: Can I group marks?

Quantitative: Can I do maths with it?

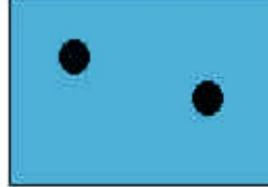
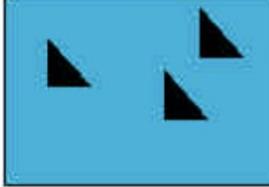
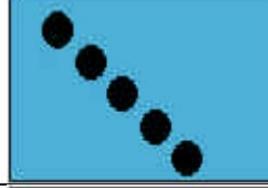
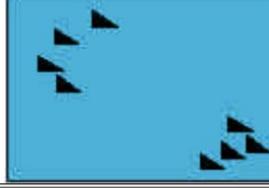
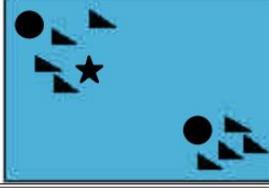
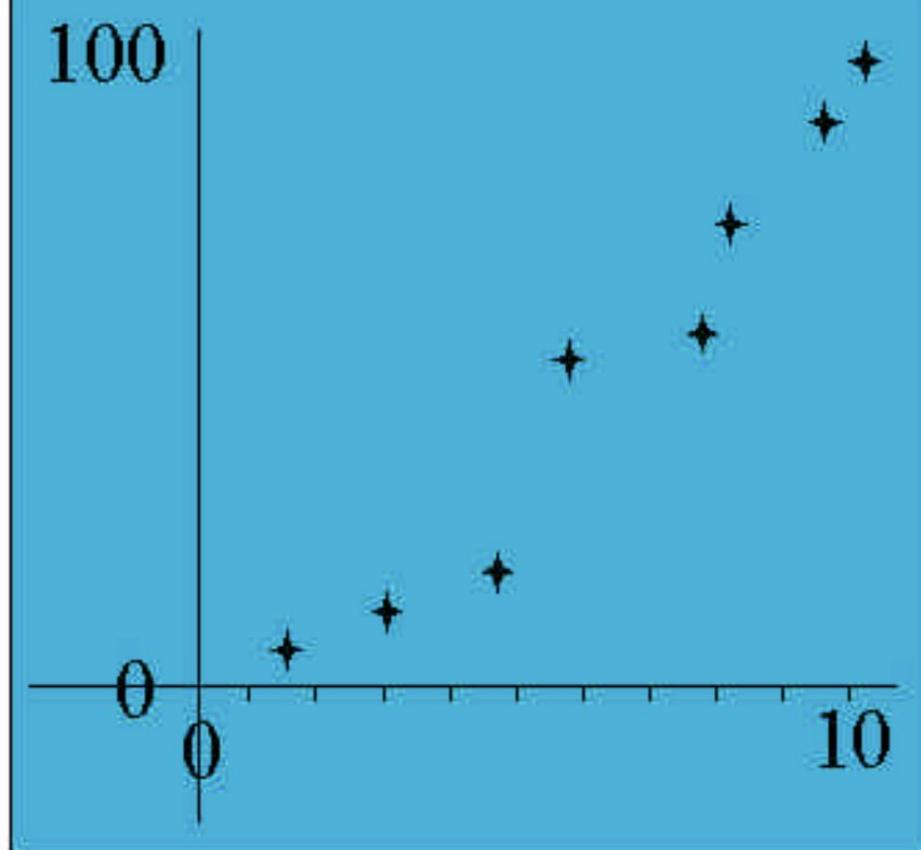
Order: Does it imply an order on the marks?

Length: How many values does the variable has?

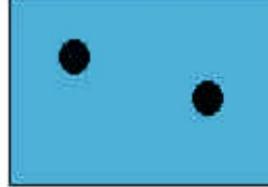
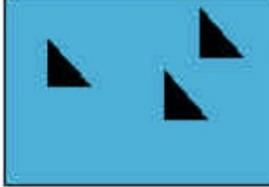
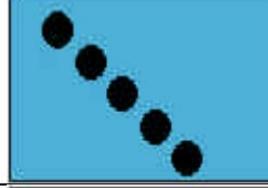
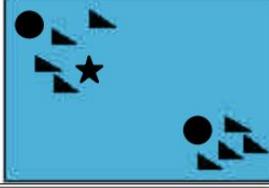
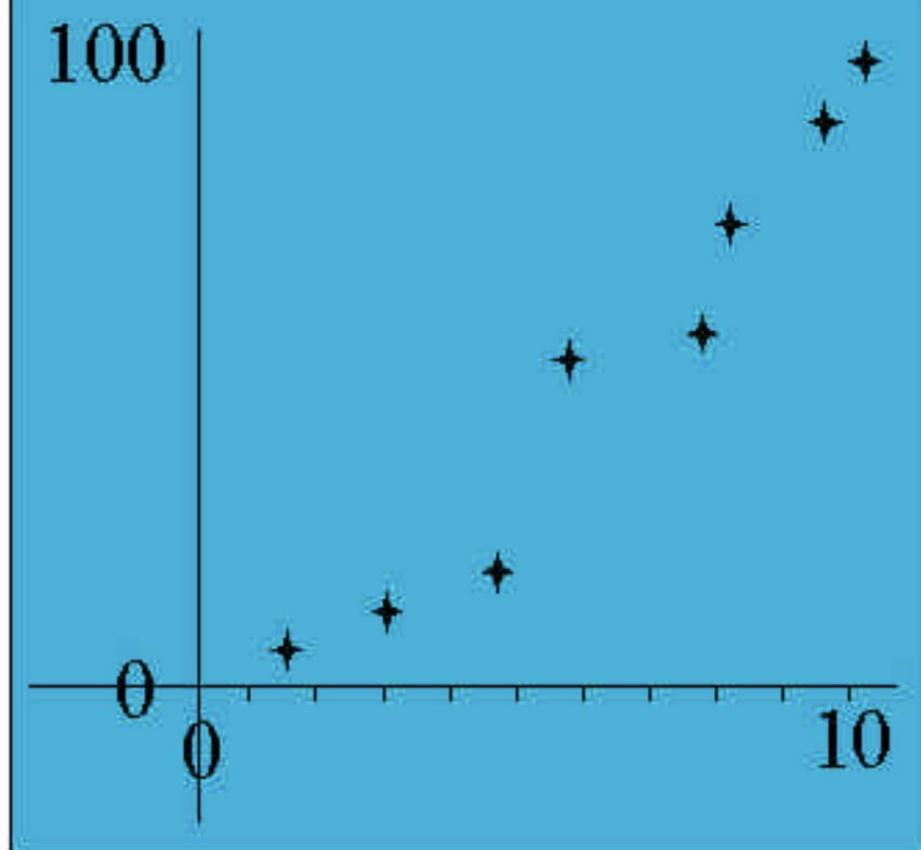
Visual Variable: Position



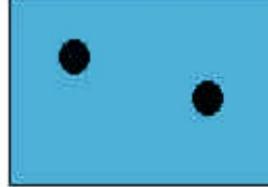
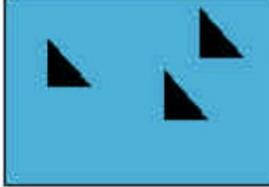
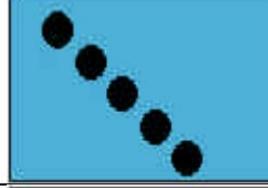
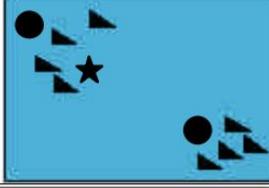
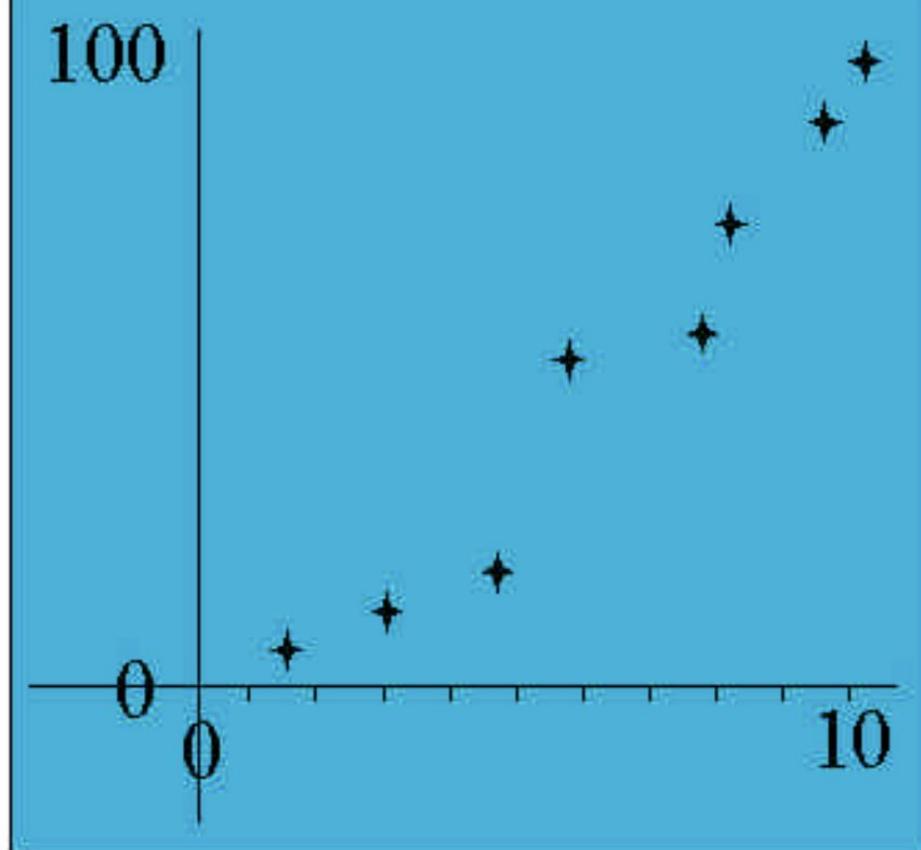
Visual Variable: Position

✓	selective			
	associative			
	quantitative			
	order			
	length			

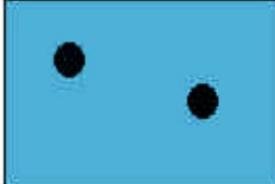
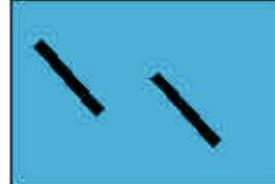
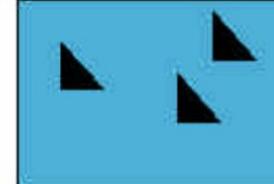
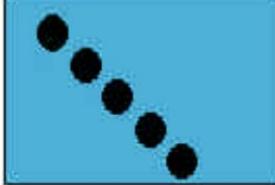
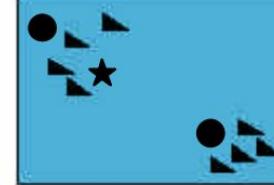
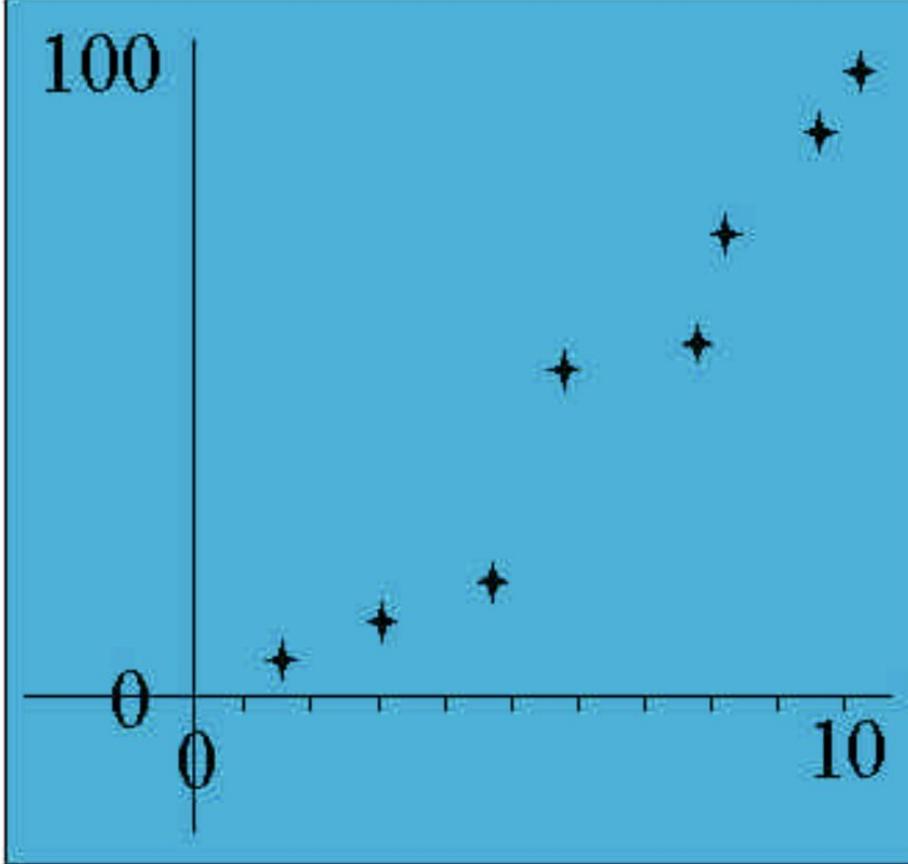
Visual Variable: Position

✓	selective																								
✓	associative																								
	quantitative	 <p>A scatter plot illustrating a quantitative relationship. The horizontal axis (x) is labeled with 0 and 10, and has tick marks every 1 unit. The vertical axis (y) is labeled with 0 and 100, and has tick marks every 10 units. The data points, represented by asterisks (*), show a clear positive correlation, starting near (1, 10) and ending near (9, 90).</p> <table border="1"><thead><tr><th>x</th><th>y</th></tr></thead><tbody><tr><td>1</td><td>10</td></tr><tr><td>2</td><td>20</td></tr><tr><td>3</td><td>30</td></tr><tr><td>4</td><td>40</td></tr><tr><td>5</td><td>50</td></tr><tr><td>6</td><td>60</td></tr><tr><td>7</td><td>70</td></tr><tr><td>8</td><td>80</td></tr><tr><td>9</td><td>90</td></tr></tbody></table>				x	y	1	10	2	20	3	30	4	40	5	50	6	60	7	70	8	80	9	90
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	length																								

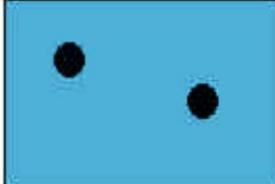
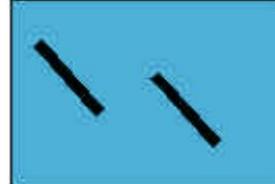
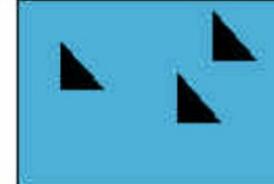
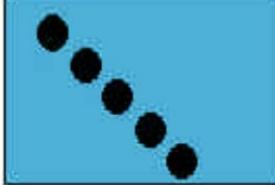
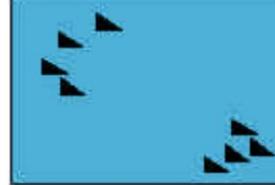
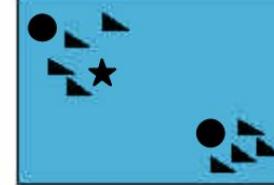
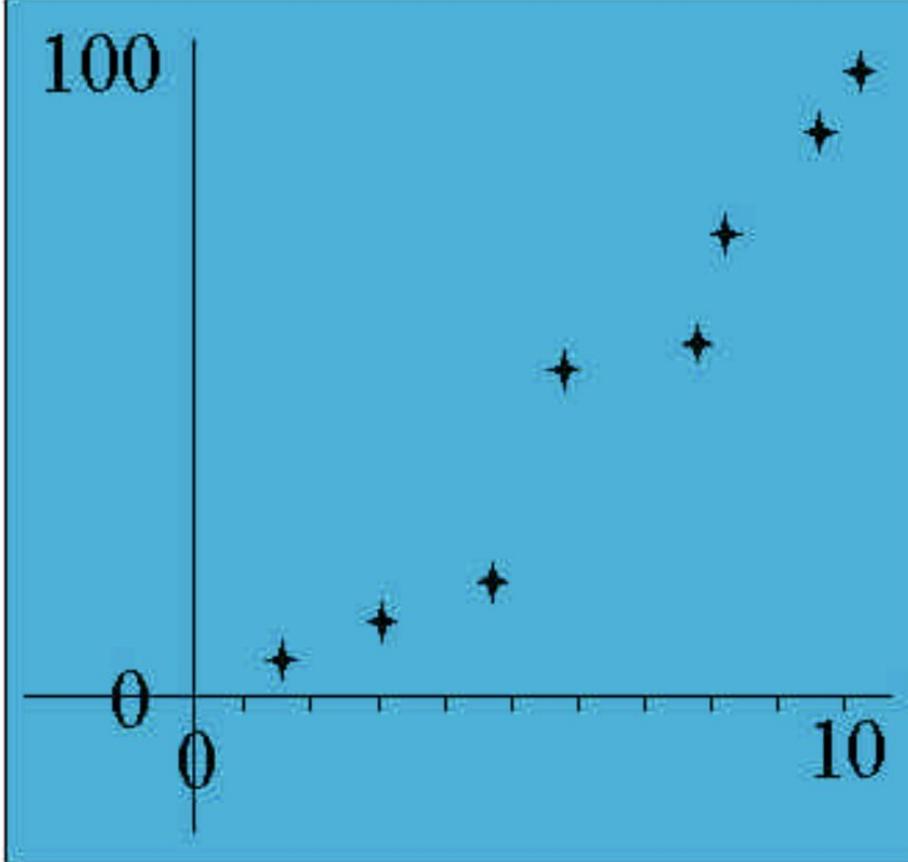
Visual Variable: Position

✓	selective																								
✓	associative																								
✓	quantitative	 <p>A scatter plot illustrating a quantitative relationship. The horizontal axis (x) is labeled with 0 and 10, and has tick marks every 1 unit. The vertical axis (y) is labeled with 0 and 100, and has tick marks every 10 units. The data points, represented by asterisks (*), show a clear positive linear trend starting near (1, 10) and ending near (9, 90).</p> <table border="1"><thead><tr><th>x</th><th>y</th></tr></thead><tbody><tr><td>1</td><td>10</td></tr><tr><td>2</td><td>20</td></tr><tr><td>3</td><td>30</td></tr><tr><td>4</td><td>40</td></tr><tr><td>5</td><td>50</td></tr><tr><td>6</td><td>60</td></tr><tr><td>7</td><td>70</td></tr><tr><td>8</td><td>80</td></tr><tr><td>9</td><td>90</td></tr></tbody></table>				x	y	1	10	2	20	3	30	4	40	5	50	6	60	7	70	8	80	9	90
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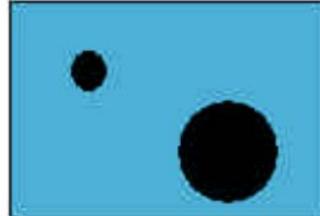
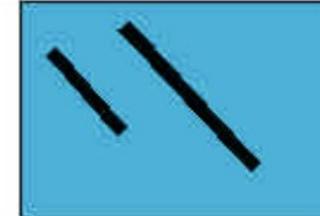
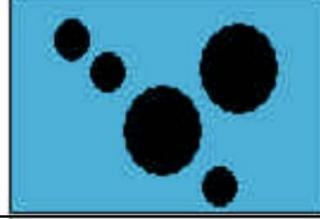
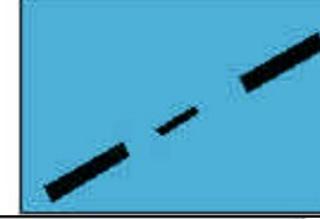
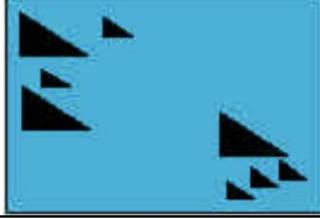
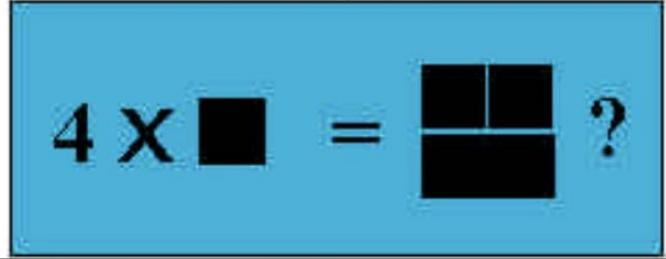
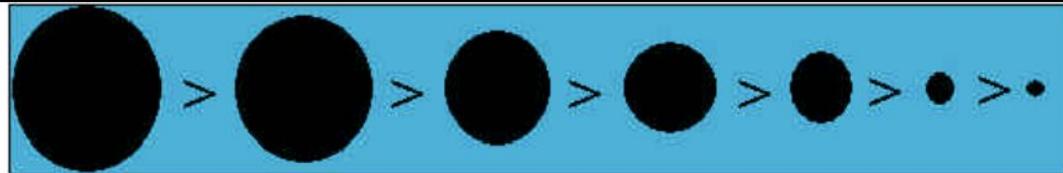
Visual Variable: Position

✓	selective																						
✓	associative																						
✓	quantitative	 <p>A scatter plot illustrating a quantitative relationship. The horizontal axis (x) is labeled with 0 and 10, and has tick marks every 1 unit. The vertical axis (y) is labeled with 0 and 100, and has tick marks every 10 units. A series of seven data points, each marked with an asterisk (*), shows a clear positive linear trend starting near (1, 10) and ending near (8, 90).</p> <table border="1"><thead><tr><th>x</th><th>y</th></tr></thead><tbody><tr><td>1</td><td>10</td></tr><tr><td>2</td><td>20</td></tr><tr><td>3</td><td>30</td></tr><tr><td>4</td><td>40</td></tr><tr><td>5</td><td>50</td></tr><tr><td>6</td><td>60</td></tr><tr><td>7</td><td>70</td></tr><tr><td>8</td><td>80</td></tr></tbody></table>				x	y	1	10	2	20	3	30	4	40	5	50	6	60	7	70	8	80
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8	80																						
✓	order																						
	length																						

Visual Variable: Position

✓	selective				
✓	associative				
✓	quantitative				
✓	order				
✓	length				

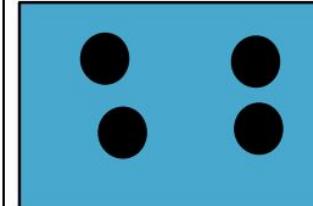
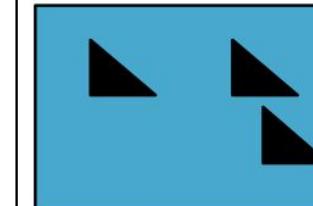
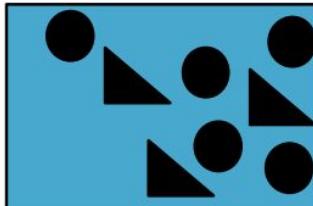
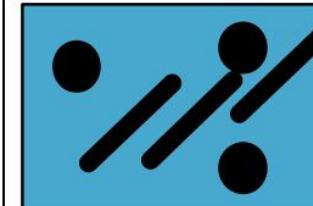
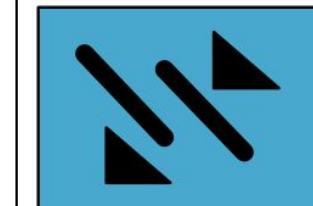
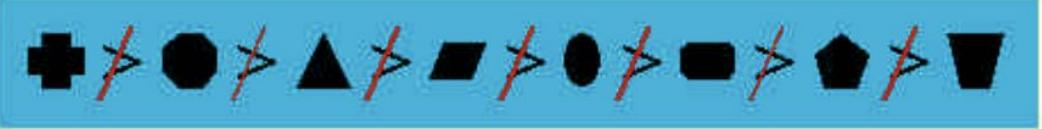
Visual Variable: Size

	selective			
	associative			
	quantitative			
	order			
	Length		<ul style="list-style-type: none"> • theoretically infinite but practically limited • association and selection ~ 5 and distinction ~ 20 	

Visual Variable: Size

	selective			
	associative			
	quantitative			
	order			
	Length		<ul style="list-style-type: none"> • theoretically infinite but practically limited • association and selection ~ 5 and distinction ~ 20 	

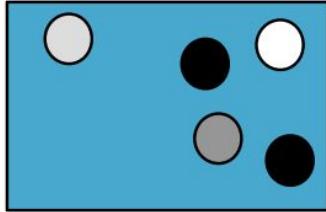
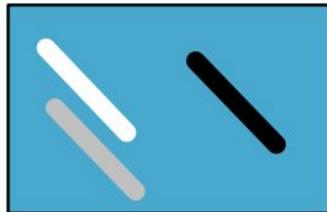
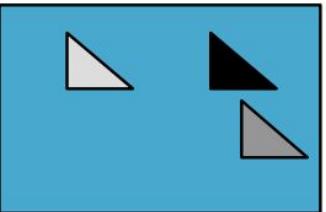
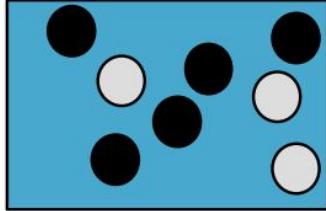
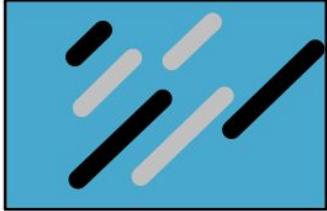
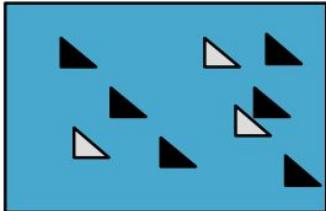
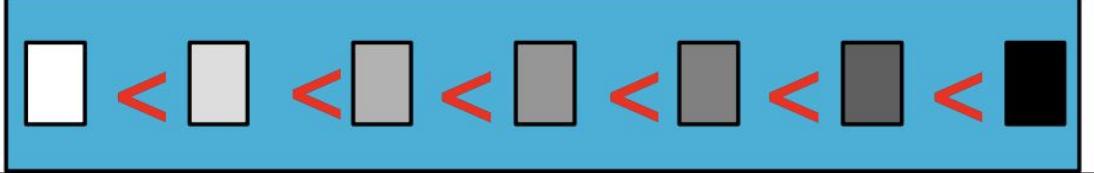
Visual Variable: Shape

	selective			
	associative			
	quantitative			
	order			
	length		theoretically infinite	

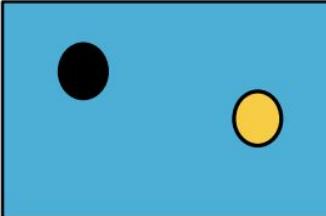
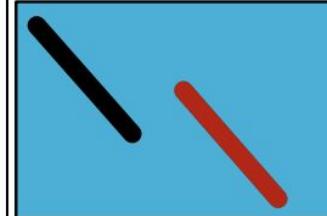
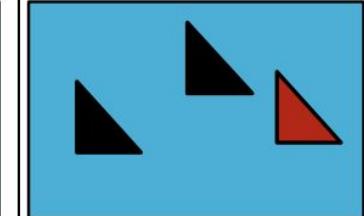
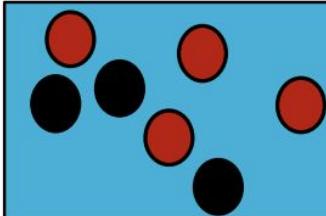
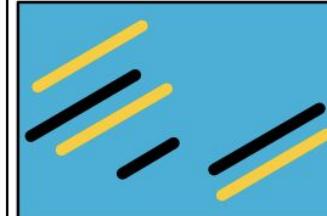
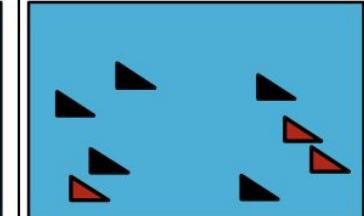
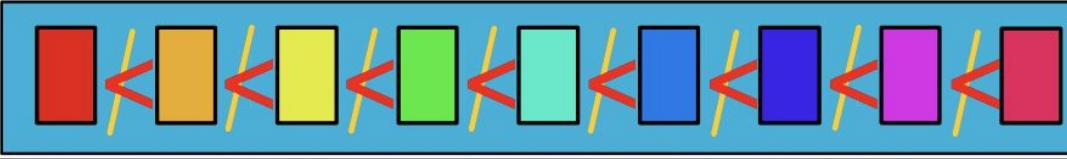
Visual Variable: Shape

	selective			
	associative			
	quantitative			
	order			
	length		theoretically infinite	

Visual Variable: Value

✓	selective			
✓	associative			
✗	quantitative			
✓	order			
✓	length	<ul style="list-style-type: none">• theoretically infinite but practically limited• association and selection ~ < 7 and distinction ~ 10		

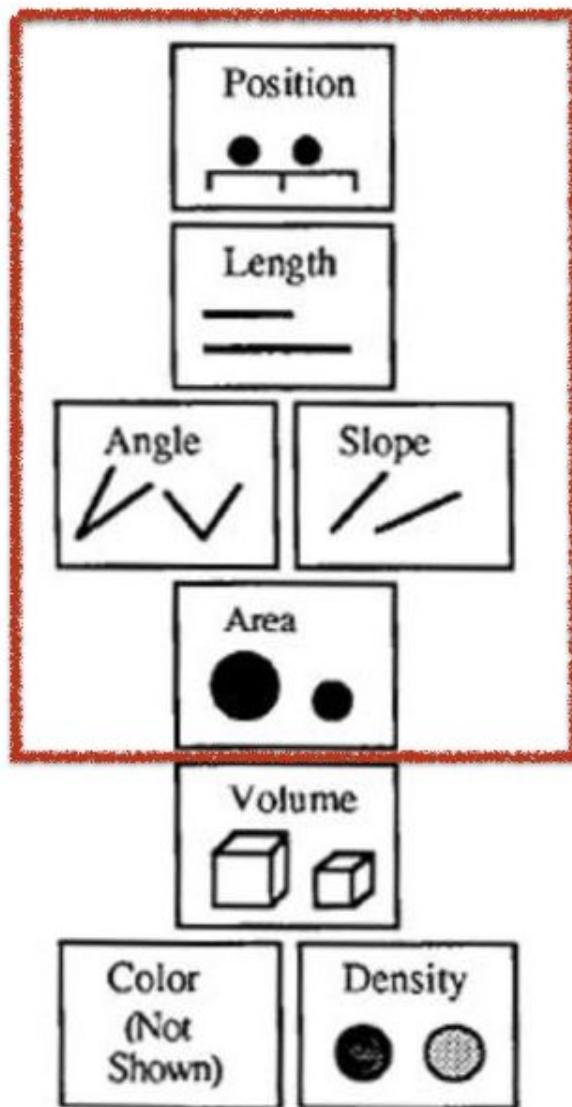
Visual Variable: Colour

	selective			
	associative			
	quantitative			
	order			
	length	 <ul style="list-style-type: none"> • theoretically infinite but practically limited • association and selection ~ < 7 and distinction ~ 10 		

More accurate



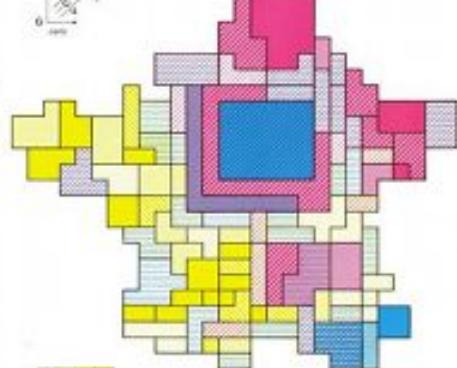
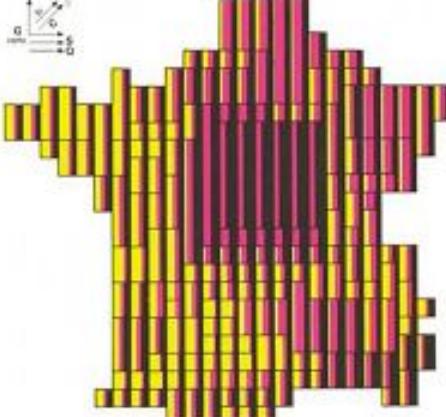
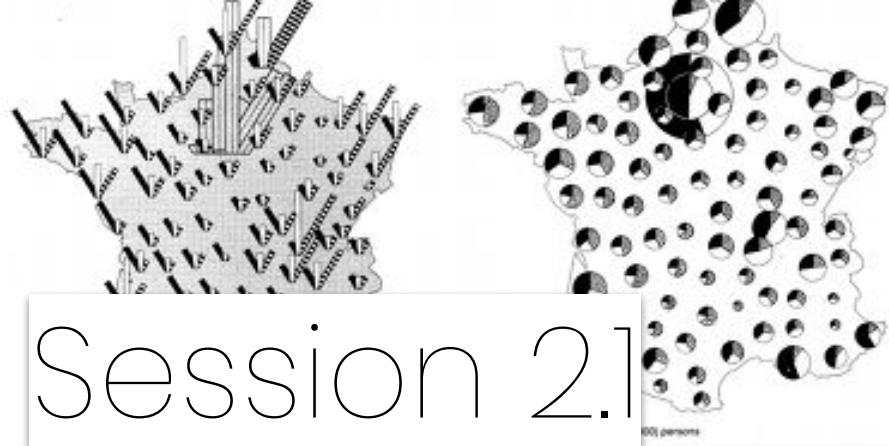
Less accurate



Mackinlay, APT (A Presentation Tool), 1986

Recommended Reading

- Tamara Munzner: **Visualization Analysis and Design**
 - Chapter 2. What: Data Abstraction
 - Chapter 5. Marks and Channels
- Alberto Cairo: **The Functional Art**
 - Chapter 1: Why Visualize: From Information to Wisdom
 - Chapter 2: Forms and Functions: Visualization as Technology
- Andy Kirk: **Data Visualization**
 - Chapter 1: Defining Data Visualization
- Jaques Bertin: **Semiology of Graphics**
 - II.C: The retinal variables
- Cleveland & MaGill: **Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods**, 1984

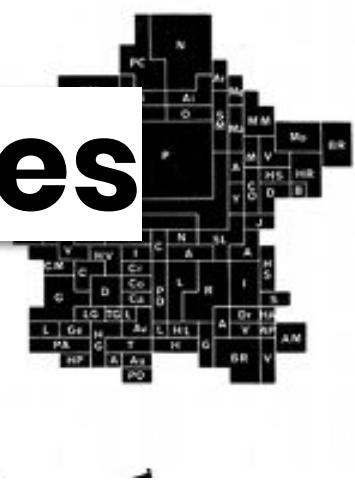
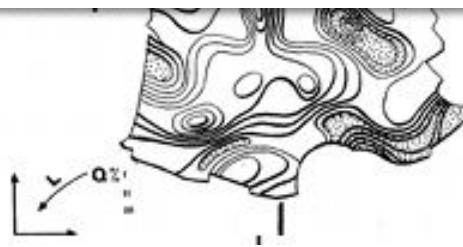
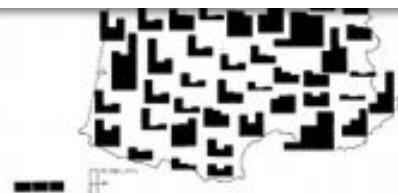
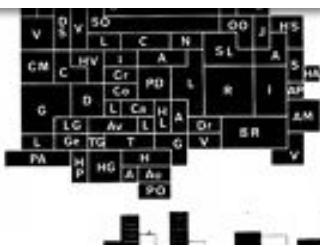


Session 2.1



Visualization Design

Visualization Guidelines



Online Course

Data Visualization for Professionals



THE UNIVERSITY
of EDINBURGH

Benjamin Bach

June 2020

<http://benjibach.me>
<https://datavis-online.github.io>

-- Not for external use --

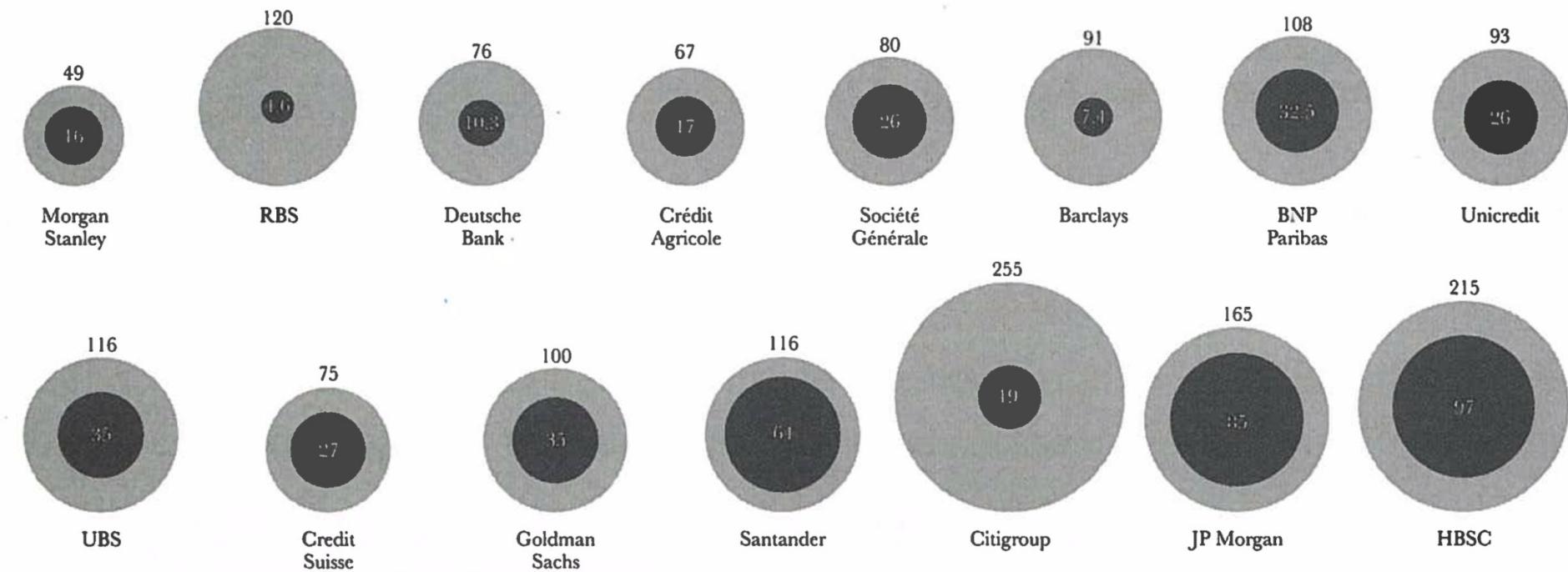
Market Capitalization of the World's Biggest Banks

In billions of dollars

January 2007

January 2009

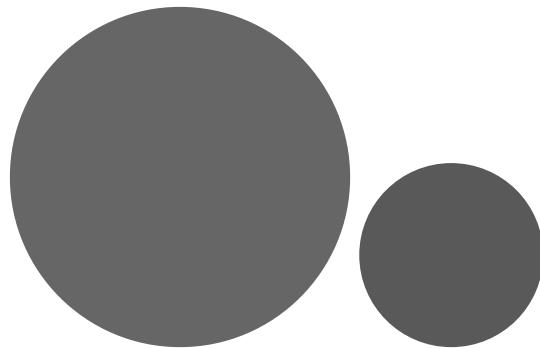
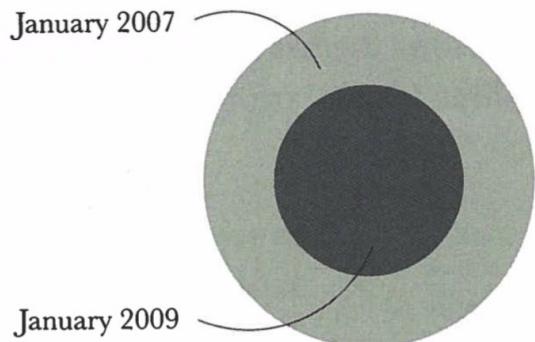
Source: Bloomberg



How to decode bubbles?

Billions of dollars

Source: Bloomberg



a)



b)



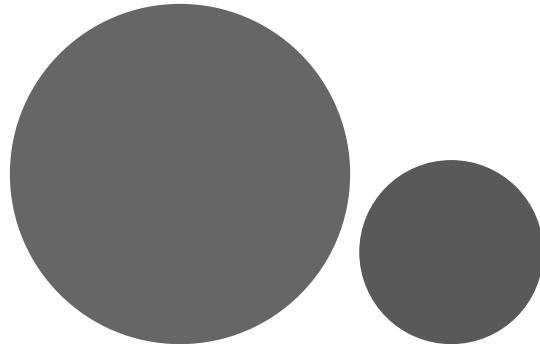
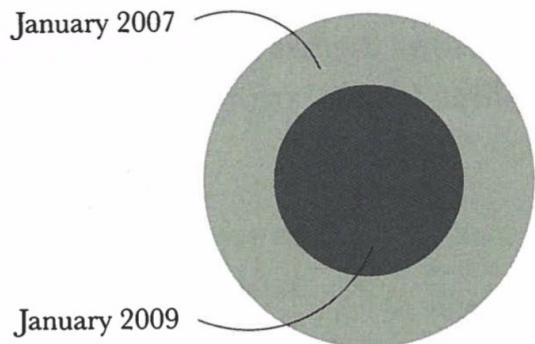
c)



How to decode bubbles?

Billions of dollars

Source: Bloomberg



a)



b)



c)

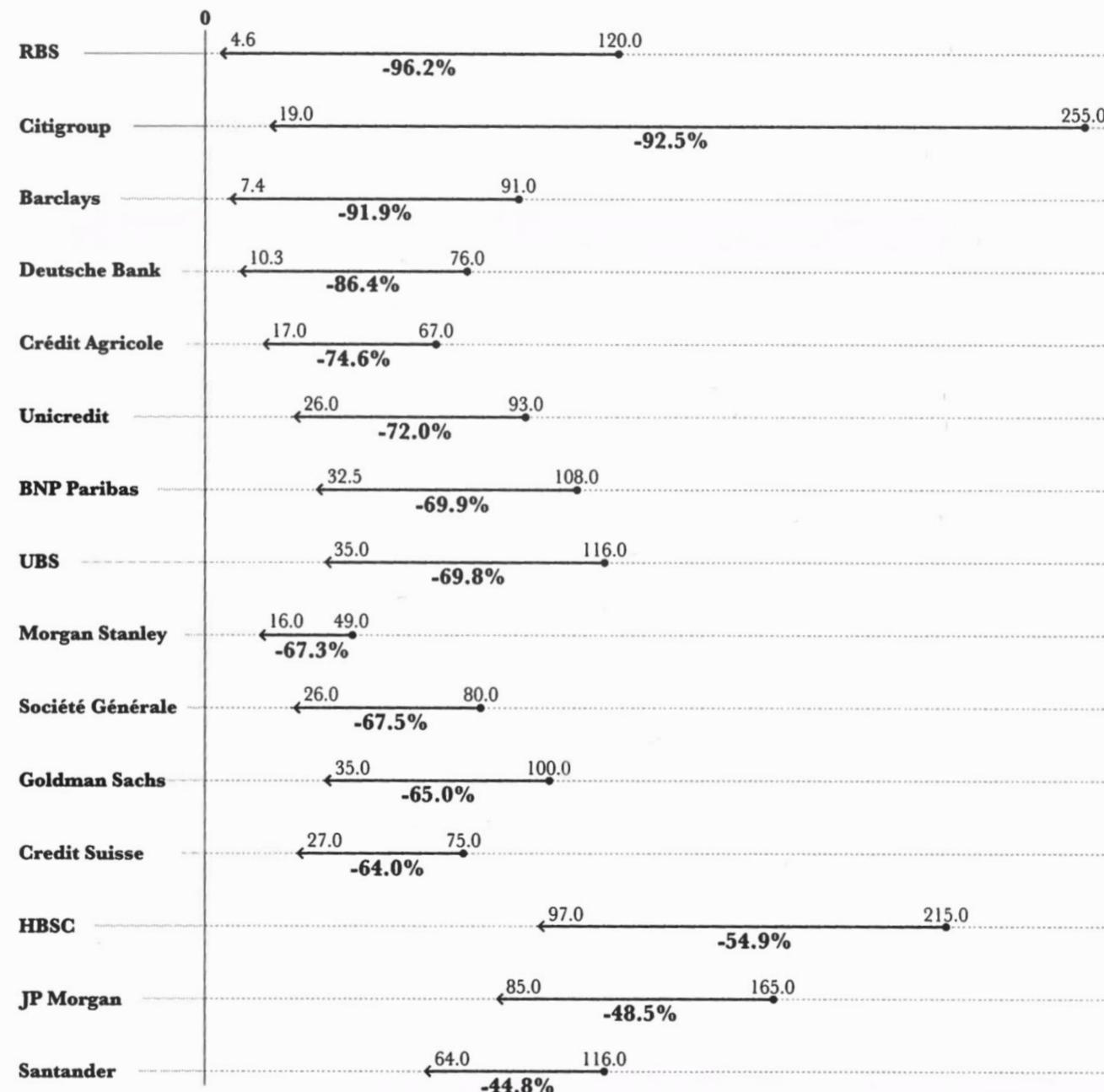


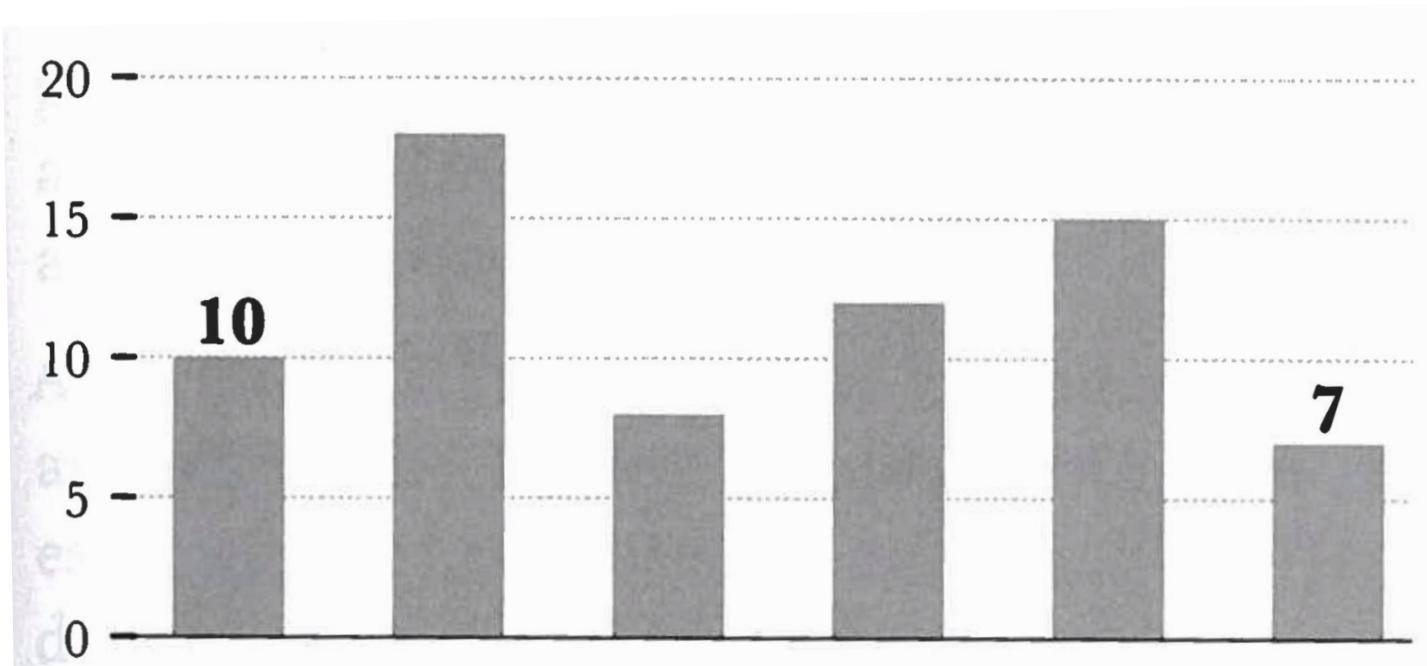
Market Capitalization of the World's Biggest Banks

Billions of dollars

January 2009 ← → January 2007

Source: Bloomberg





10



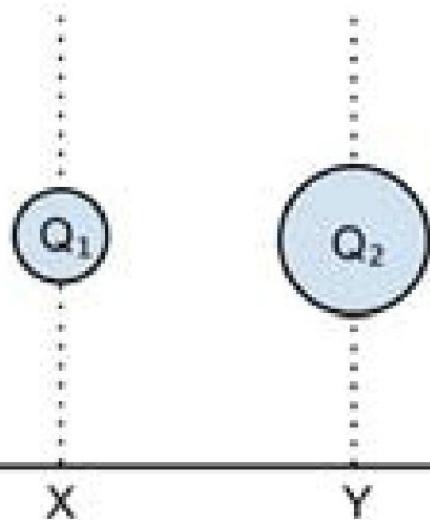
7



10

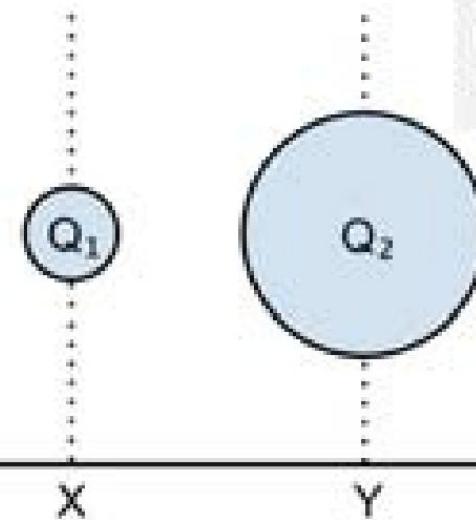


Wrong sizes



*quantity
= Area*

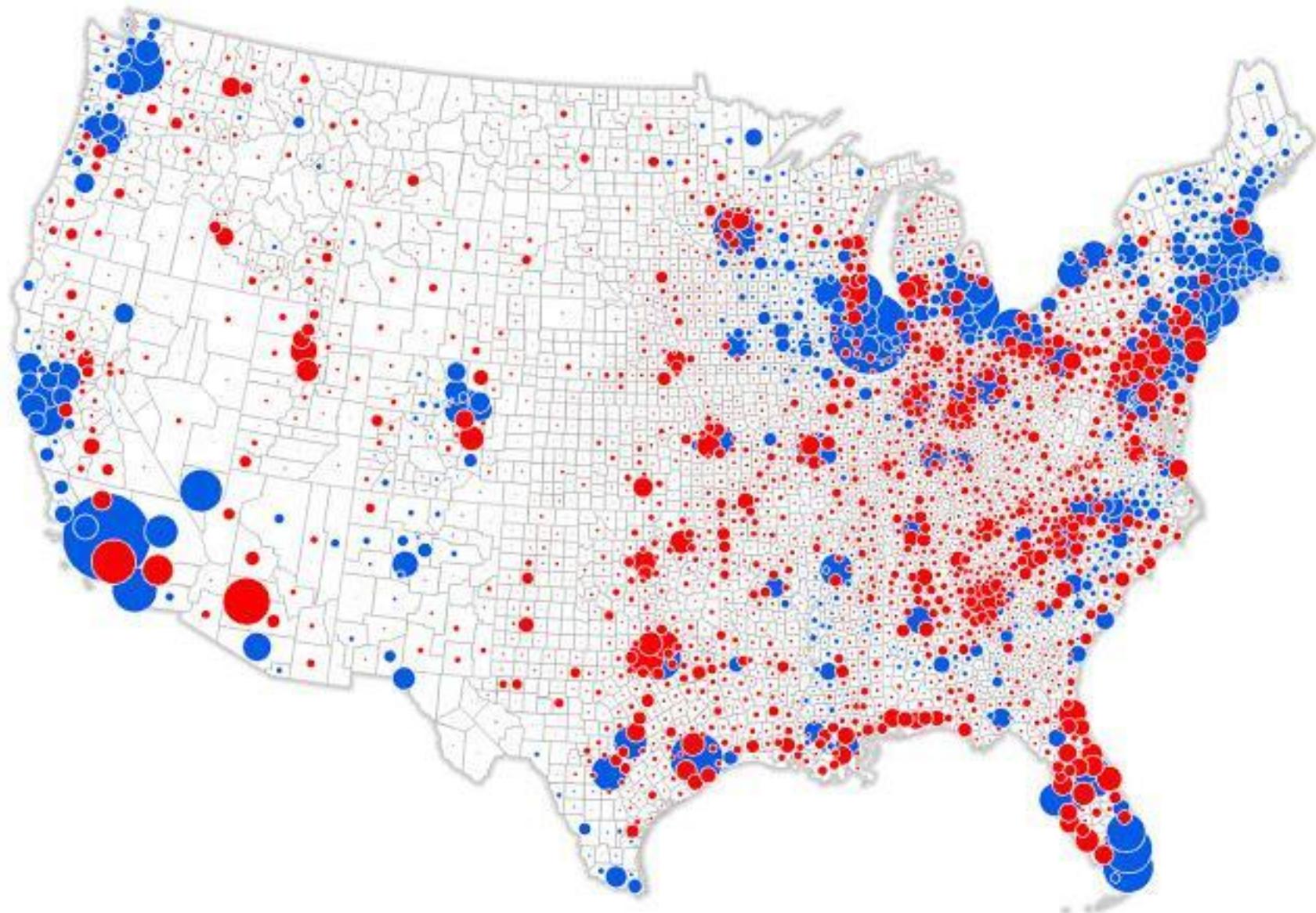
vs.



*quantity
= Radius*

Control

Deceptive

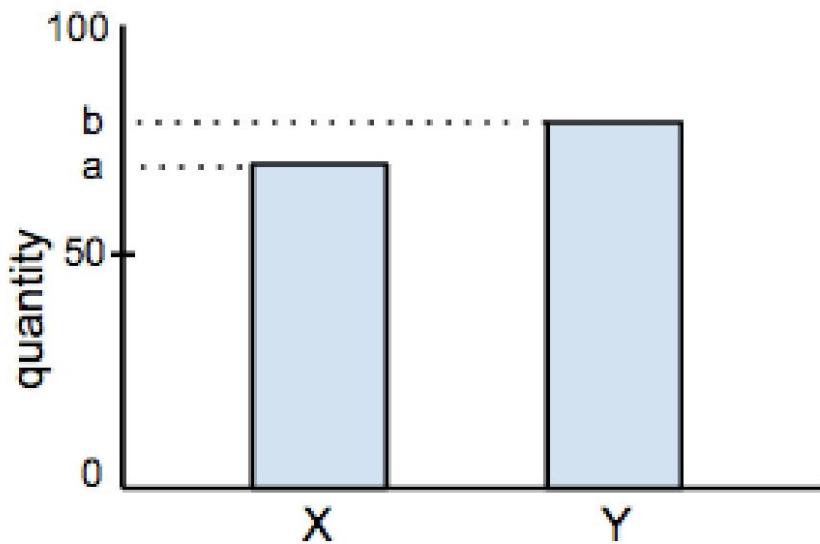


Guideline #1

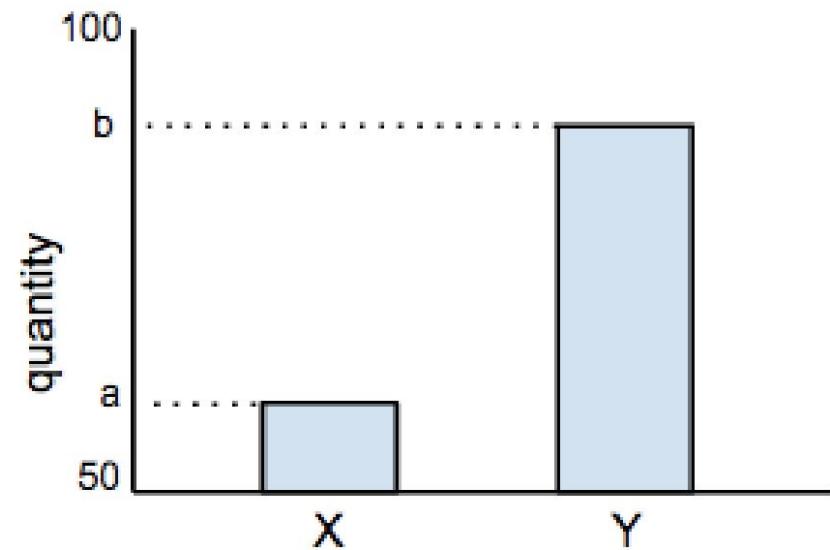
"Don't use area size to compare quantities."

Exception: *It can work on maps.*

Truncated Axes



vs.



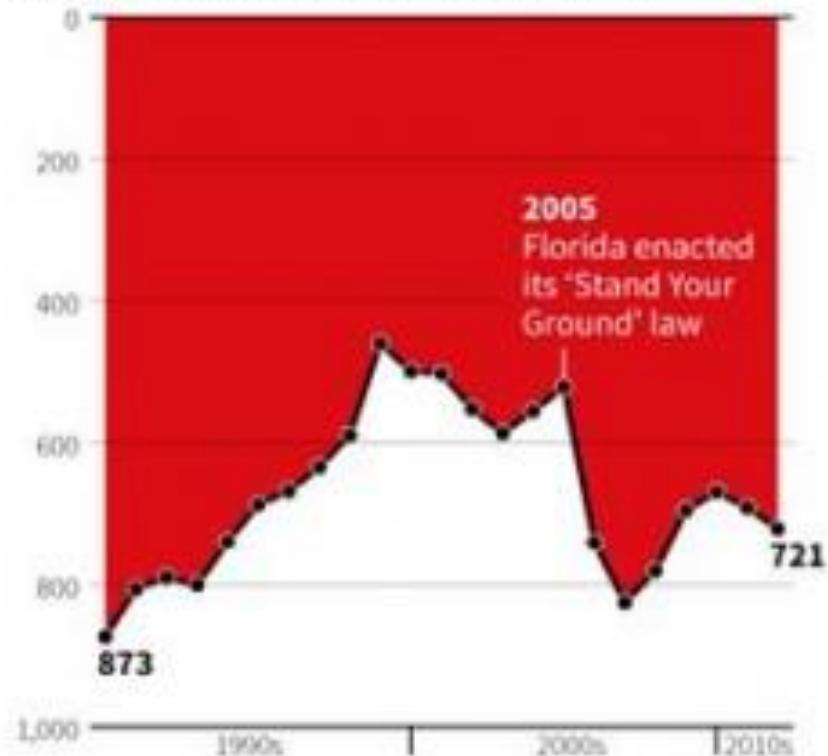
Guideline #2

"Don't truncate chart axes."

Exception: *Except you tell the reader.*

Gun deaths in Florida

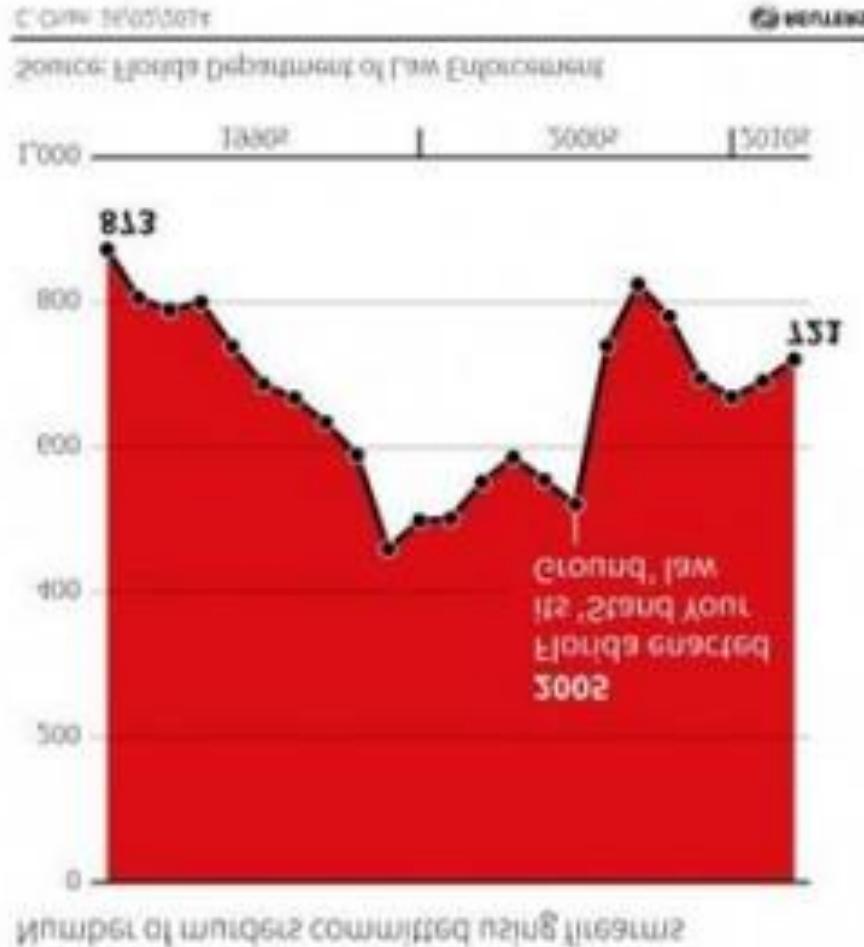
Number of murders committed using firearms



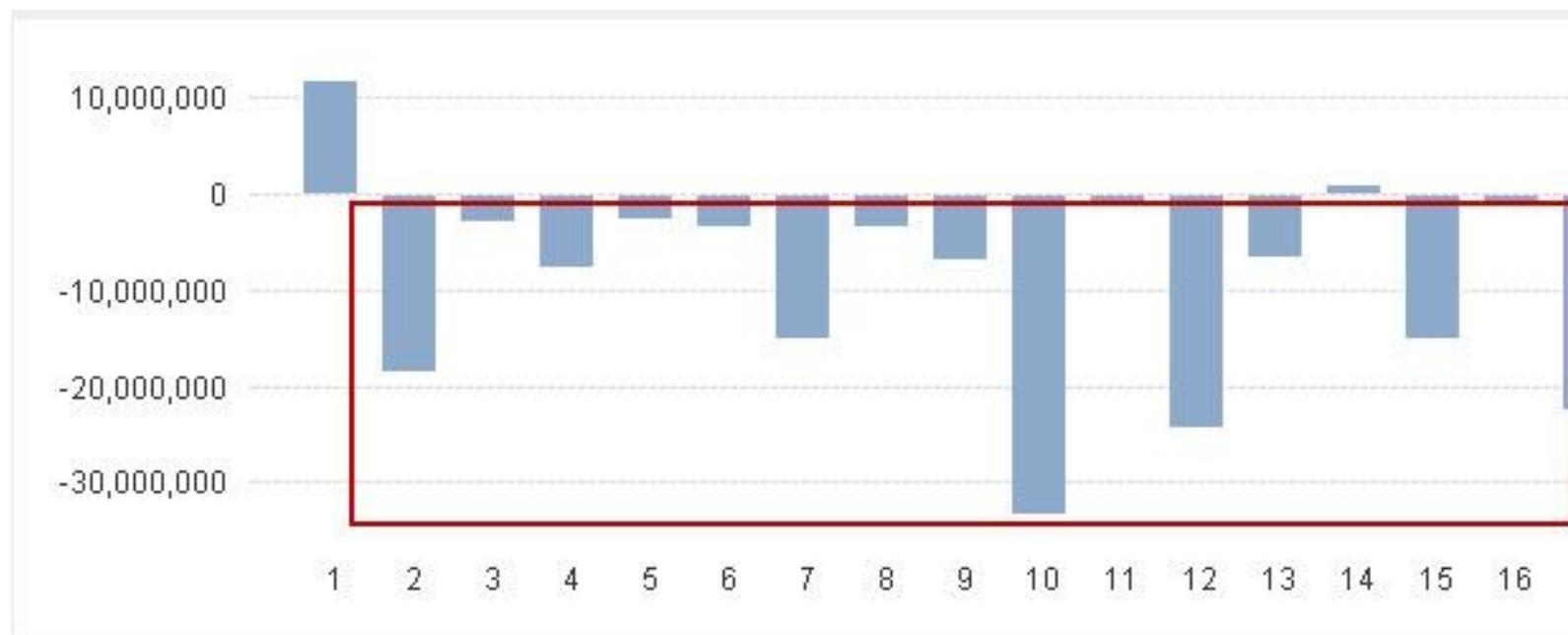
Source: Florida Department of Law Enforcement

C. Chan 16/02/2014

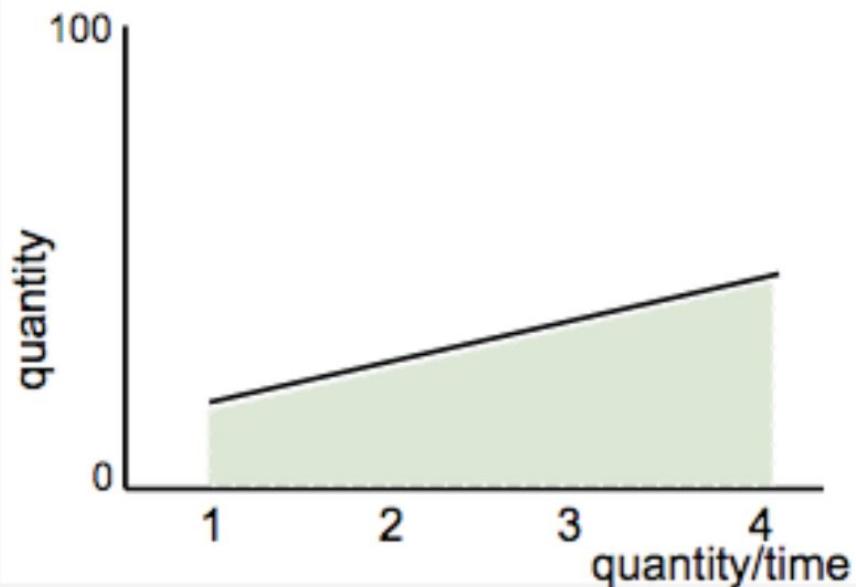
REUTERS



REUTERS

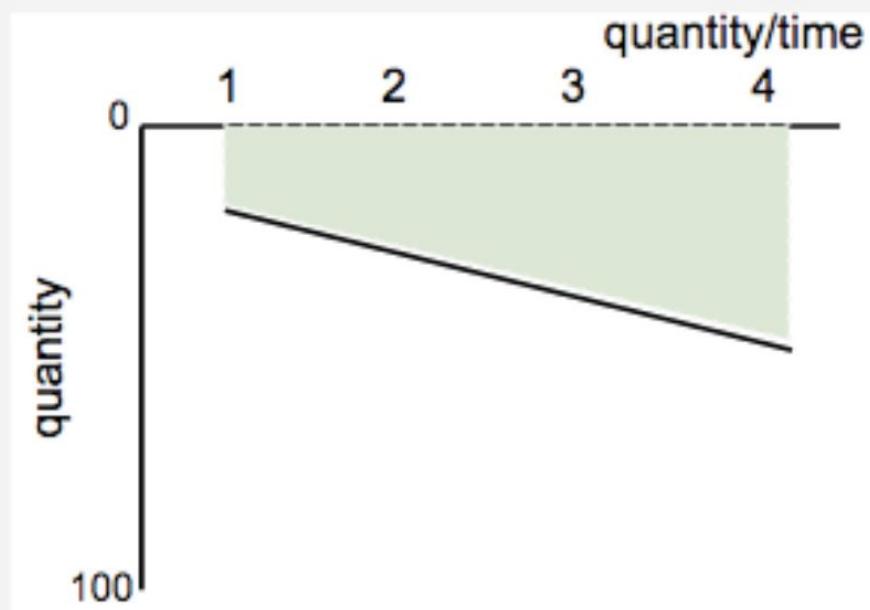


Inverse charts



Control

vs.



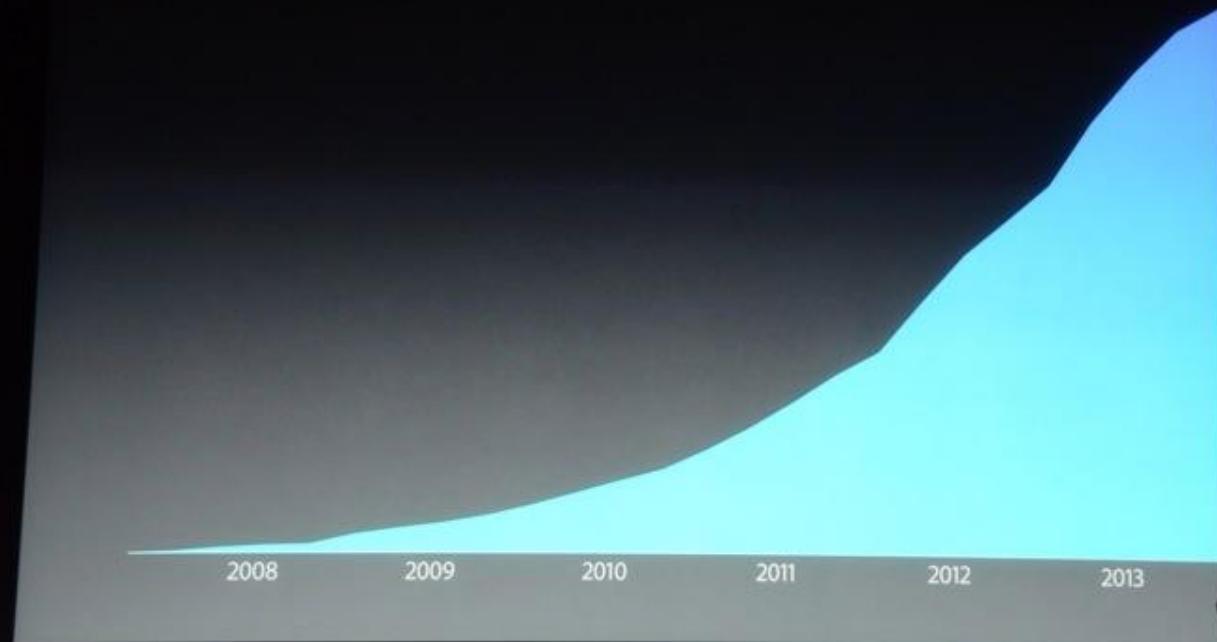
Deceptive

Guideline #3

"Don't inverse charts—it is deceiving."

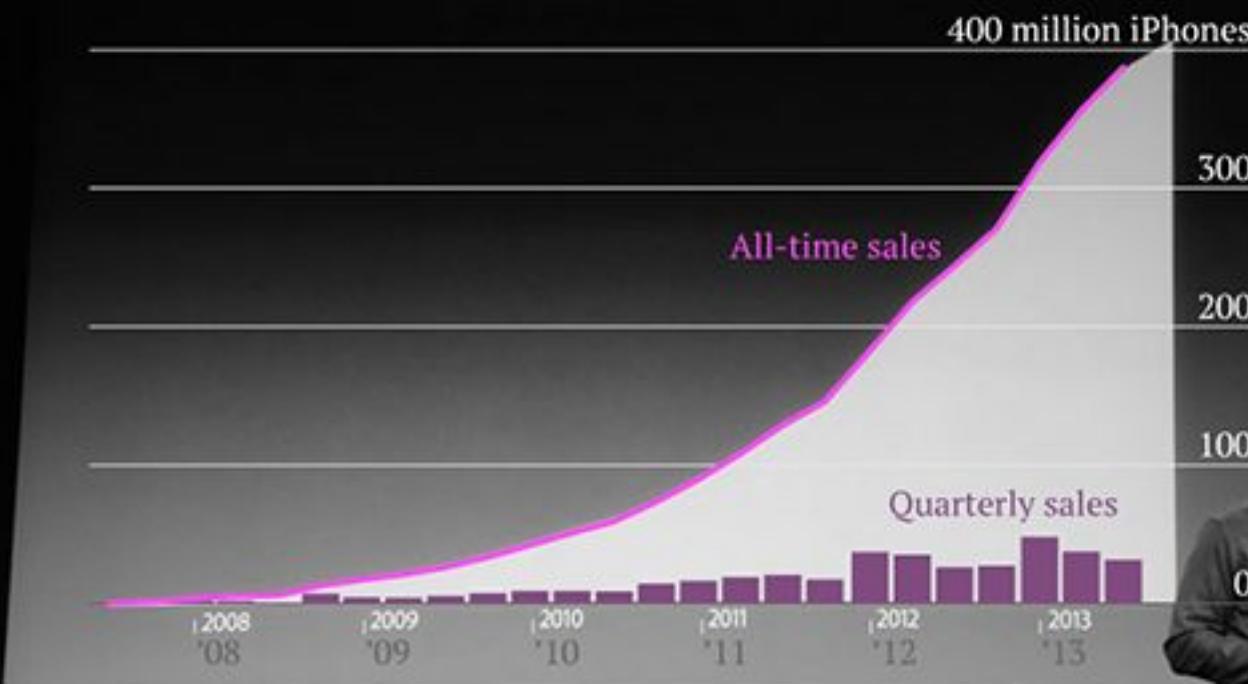
Exception: *Except you tell the reader and it serves your purpose.*

Cumulative iPhone sales



THE VERGE

Cumulative iPhone sales



Quartz | qz.com

Data: Apple

Photo: The Verge

THE VERGE

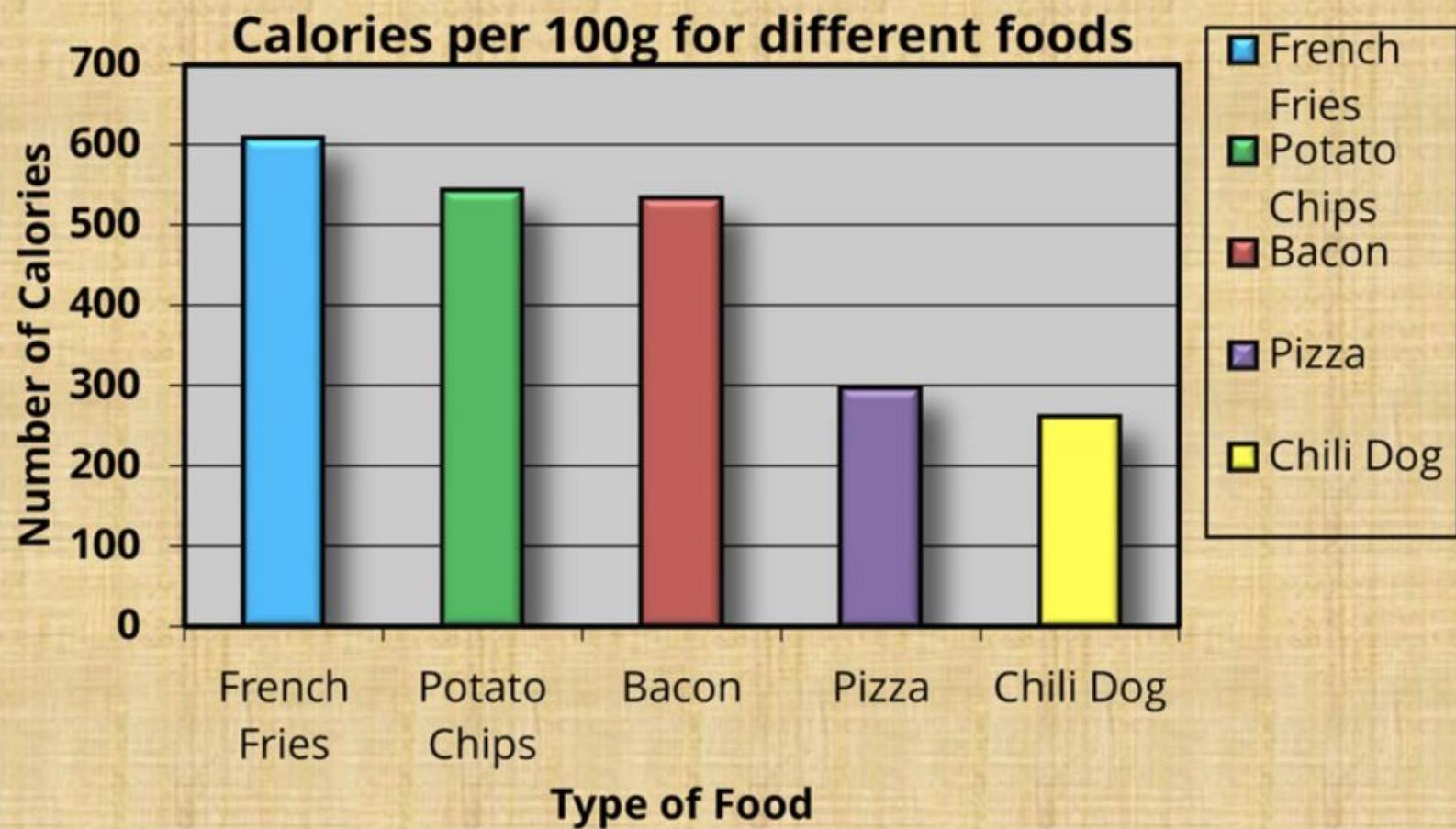
Guideline #4

"Be true about your intention."

Exception: none

Common flaws (from 8 graphics only..)

- 1. Missing **scales**
- 2. **3D** distortion
- 3. **3D** occlusion
- 4. Missing **color** contrast
- 5. **Colors** are too similar
- 6. Not B/W safe
- 7. overuse of **texture**
- 8. **Volume** as visual variable
- 9. Un-proportional **mappings**
- 10. Truncated **axes**
- 11. Missing **titles**
- 12. Missing axis **labels**
- 13. Unnecessary shapes/**ink**
- 14. Incomplete **data**
- 1. Wrong **legends**
- 2. Bad visual **mappings**
- 3. **Uncommon** / unknown design choices
- 4. Too much **clutter**
- 5. **Misplaced** data points
- 6. Long lines, which are hard to follow
- 7. Missing **legends**
- 8. **Too much** information in one graphic
- 9. **Missing** descriptions
- 10. **Overlapping** graphical elements
- 11. **Too many** charts in one

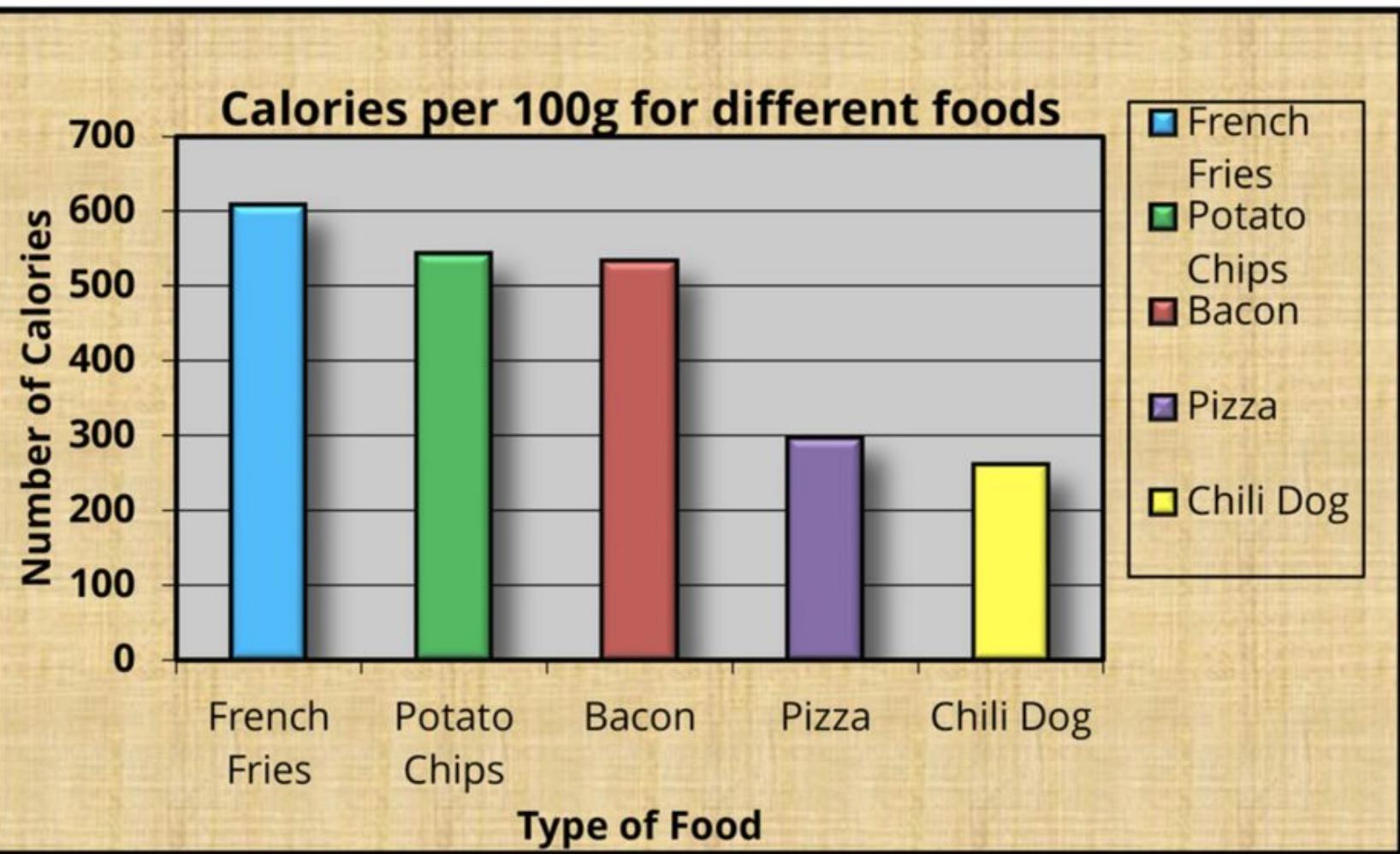


Data-Ink Ratio =

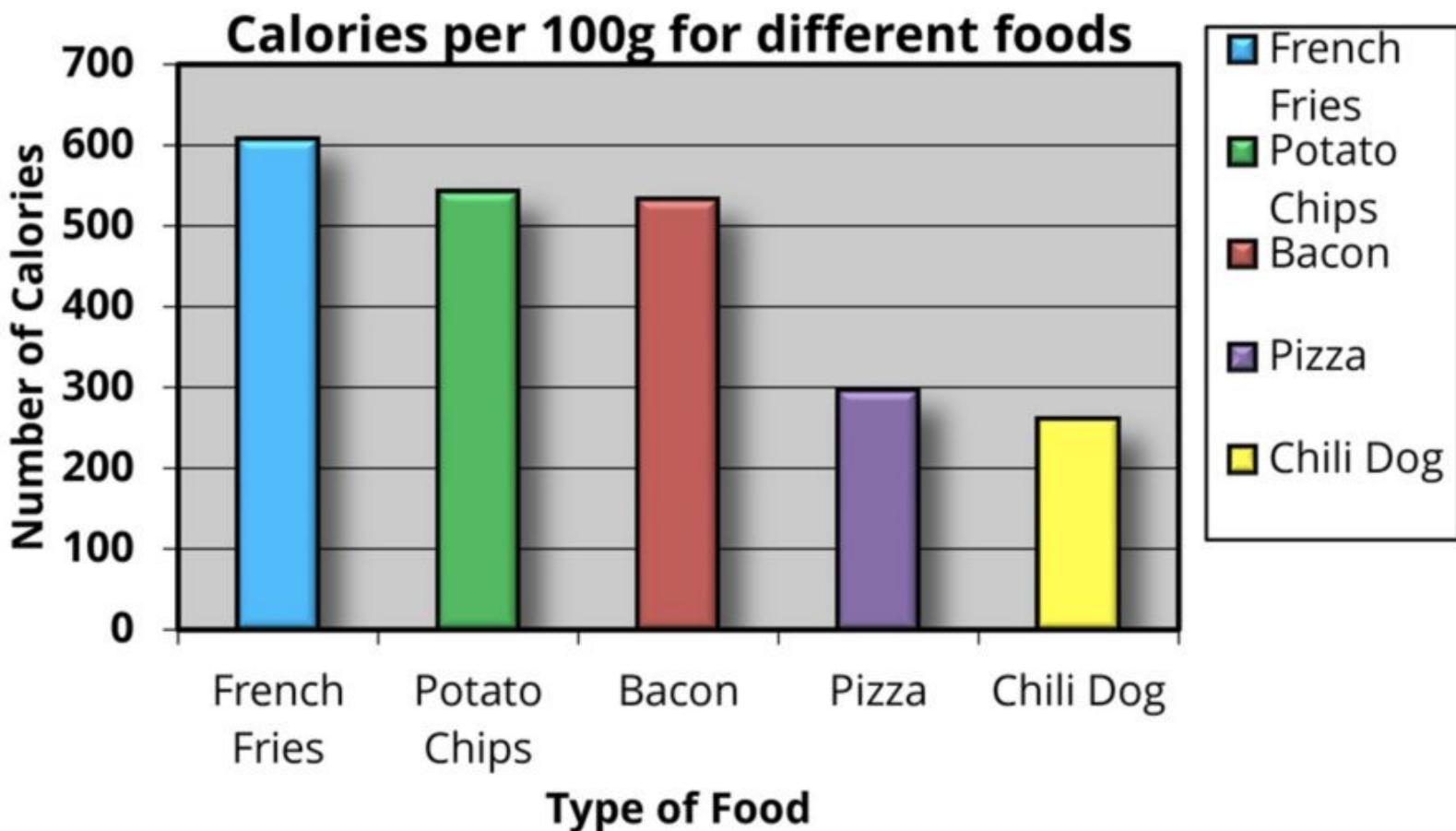
Data-Ink

Total Ink used to represent
the graphic

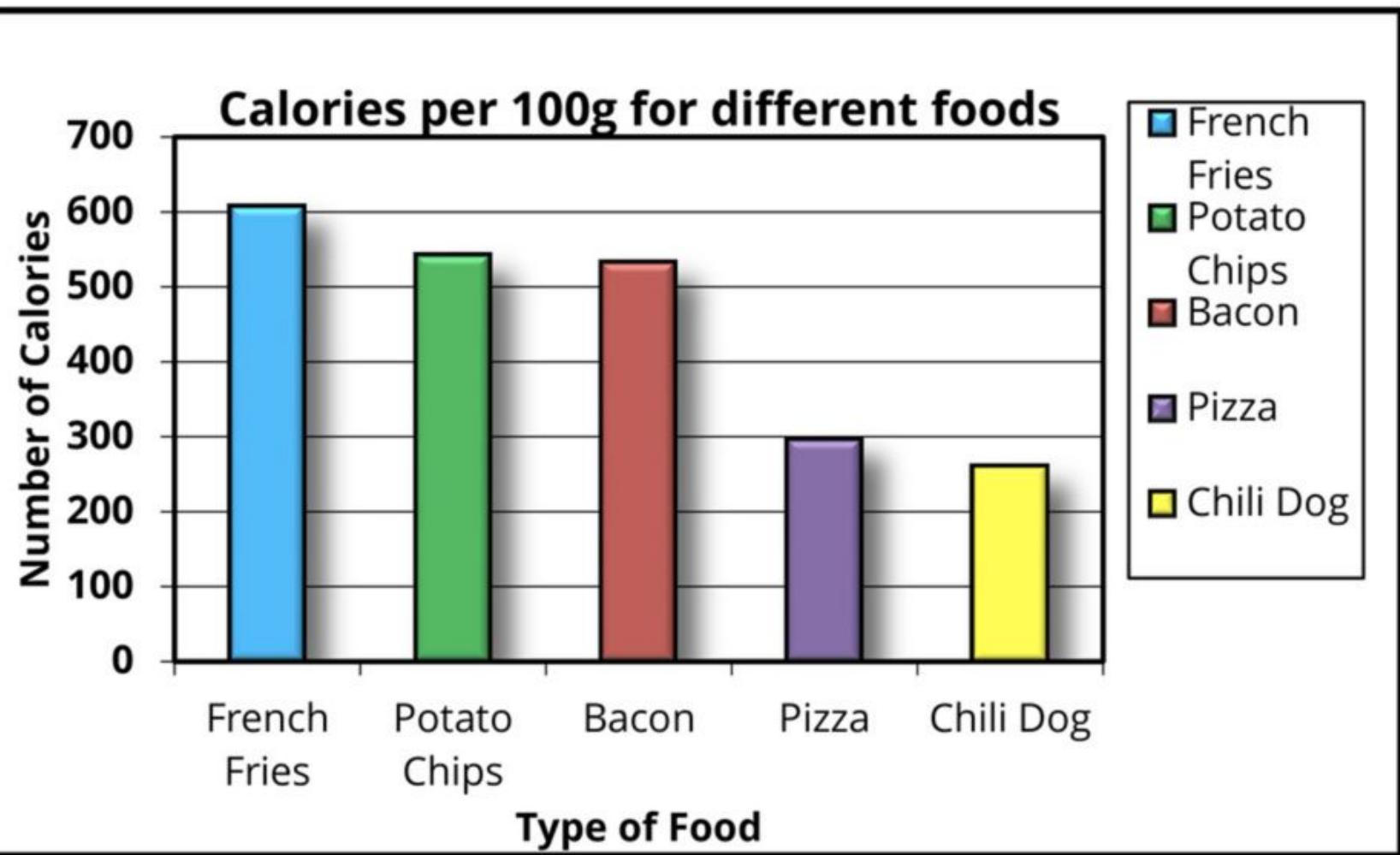
Remove backgrounds



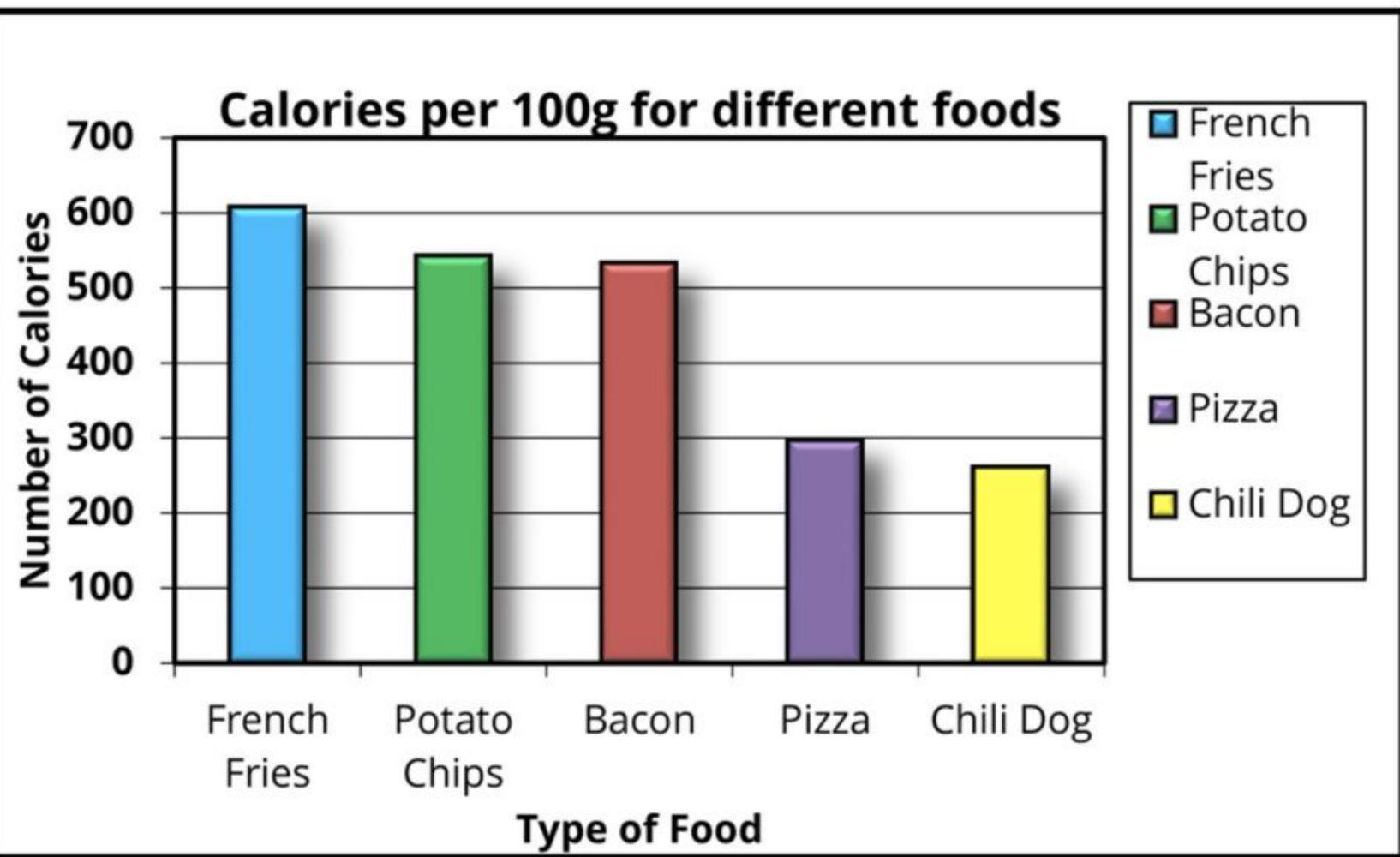
Remove backgrounds



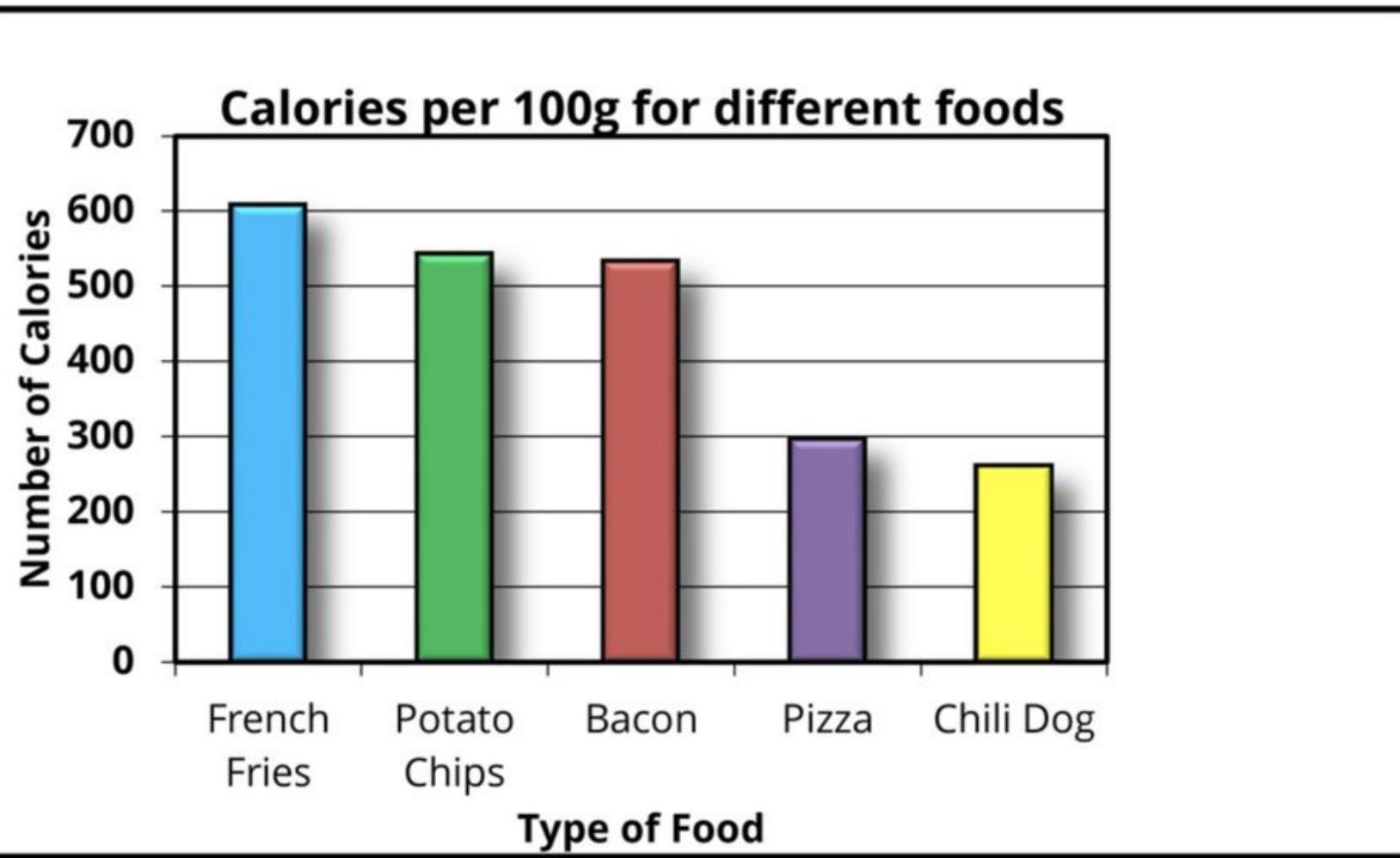
Remove backgrounds



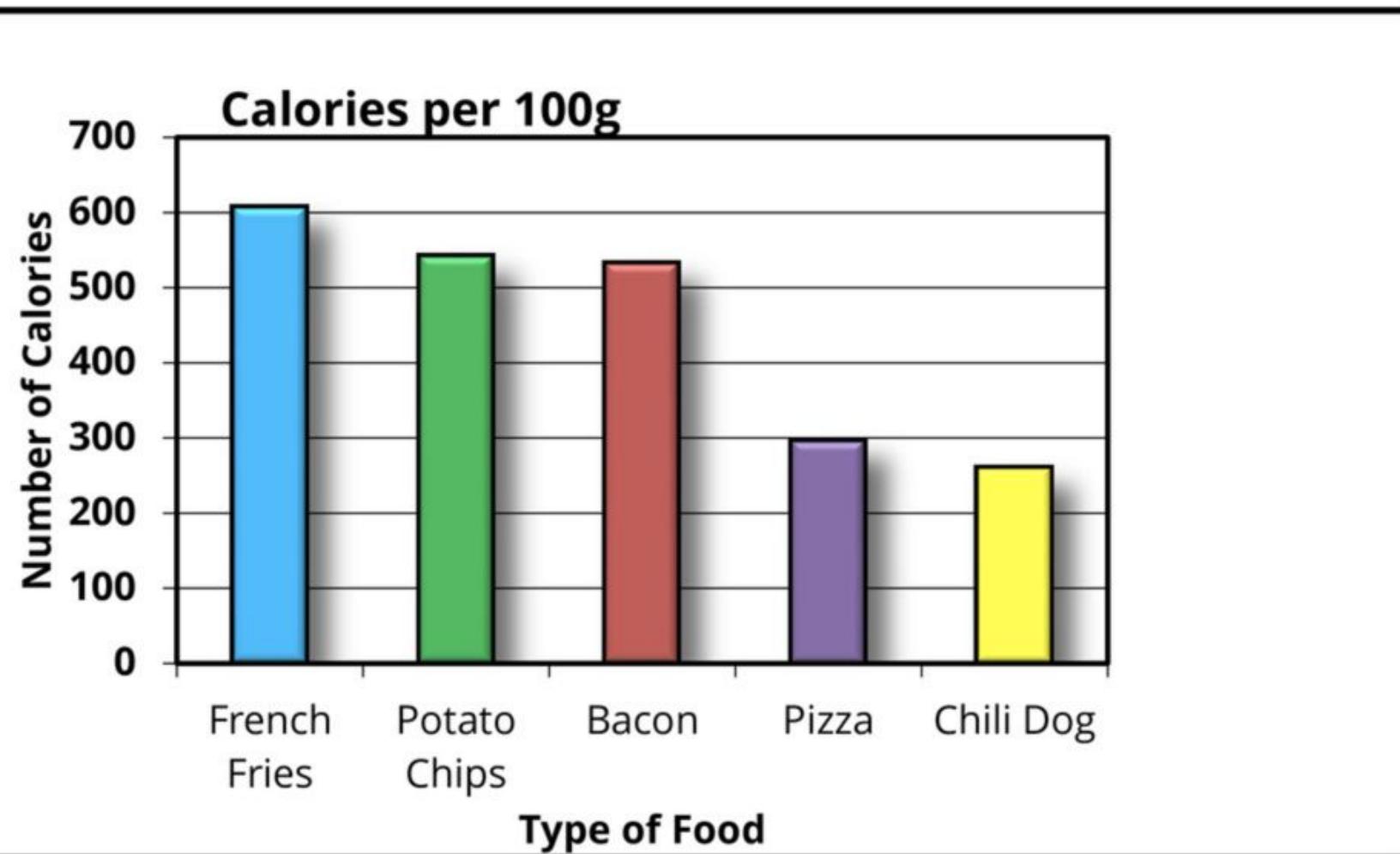
Remove redundant labels



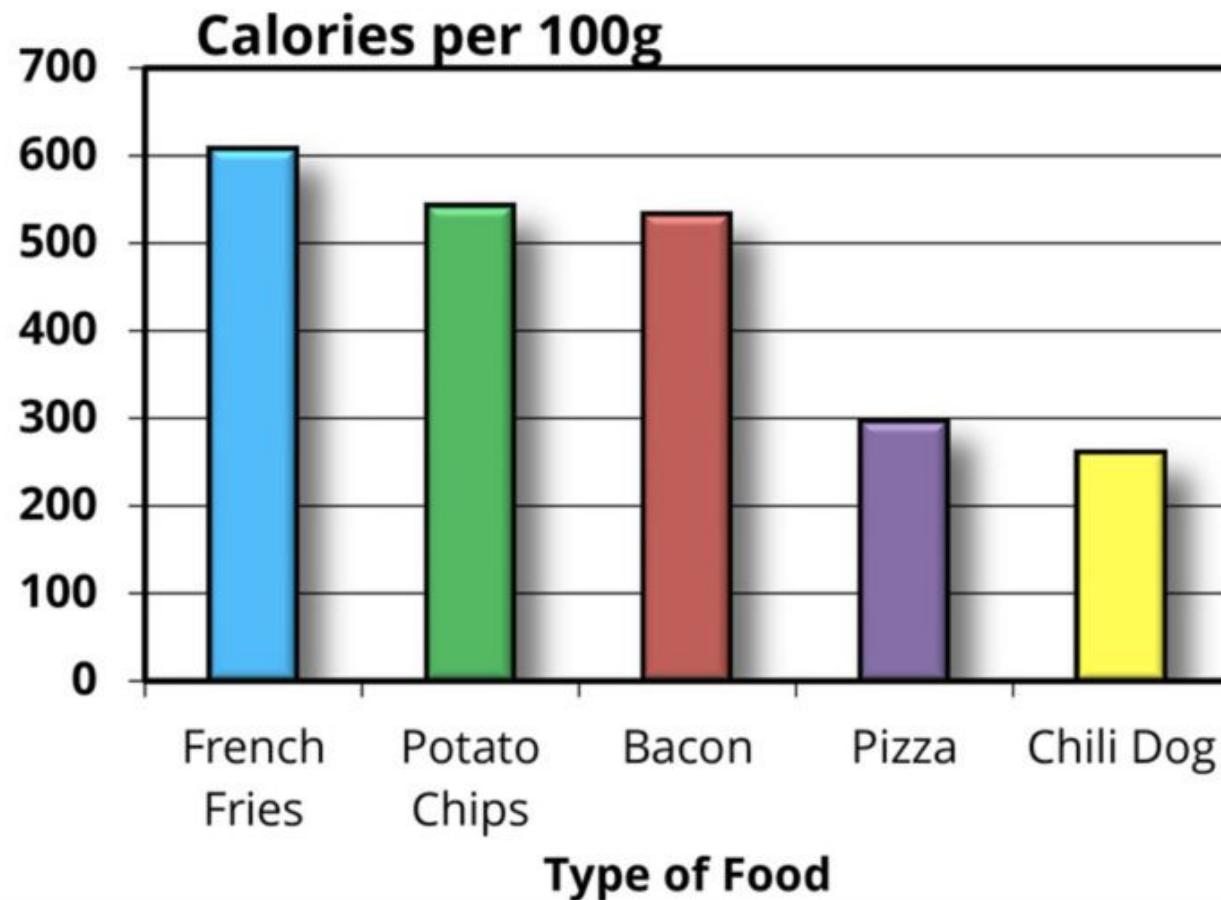
Remove redundant labels



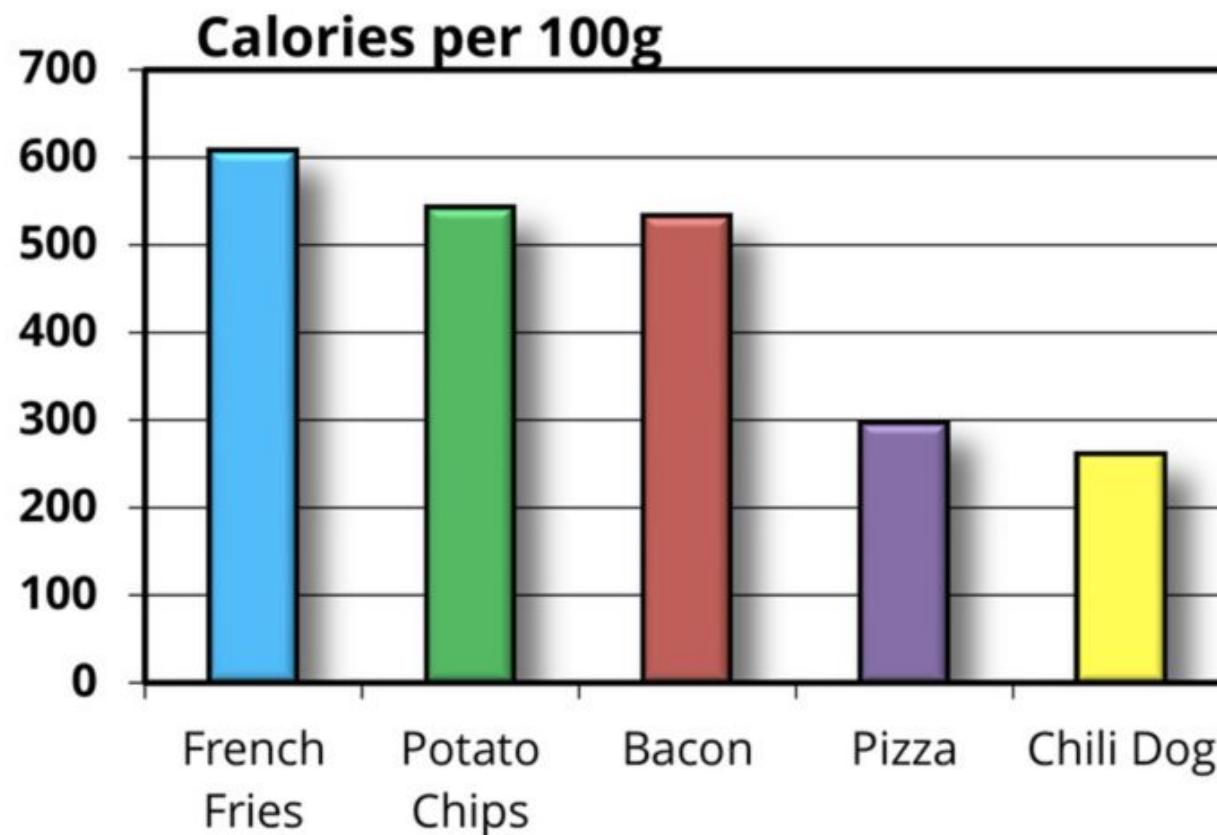
Remove redundant labels



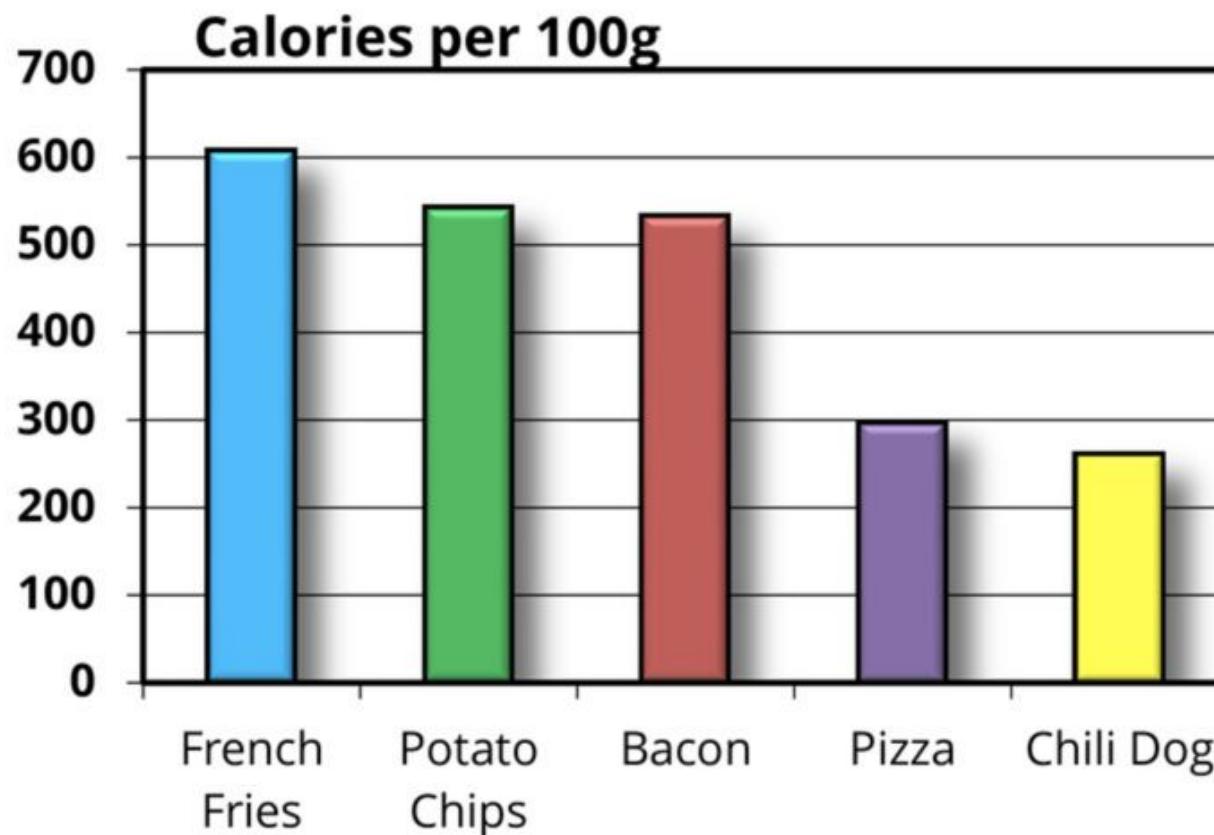
Remove redundant labels



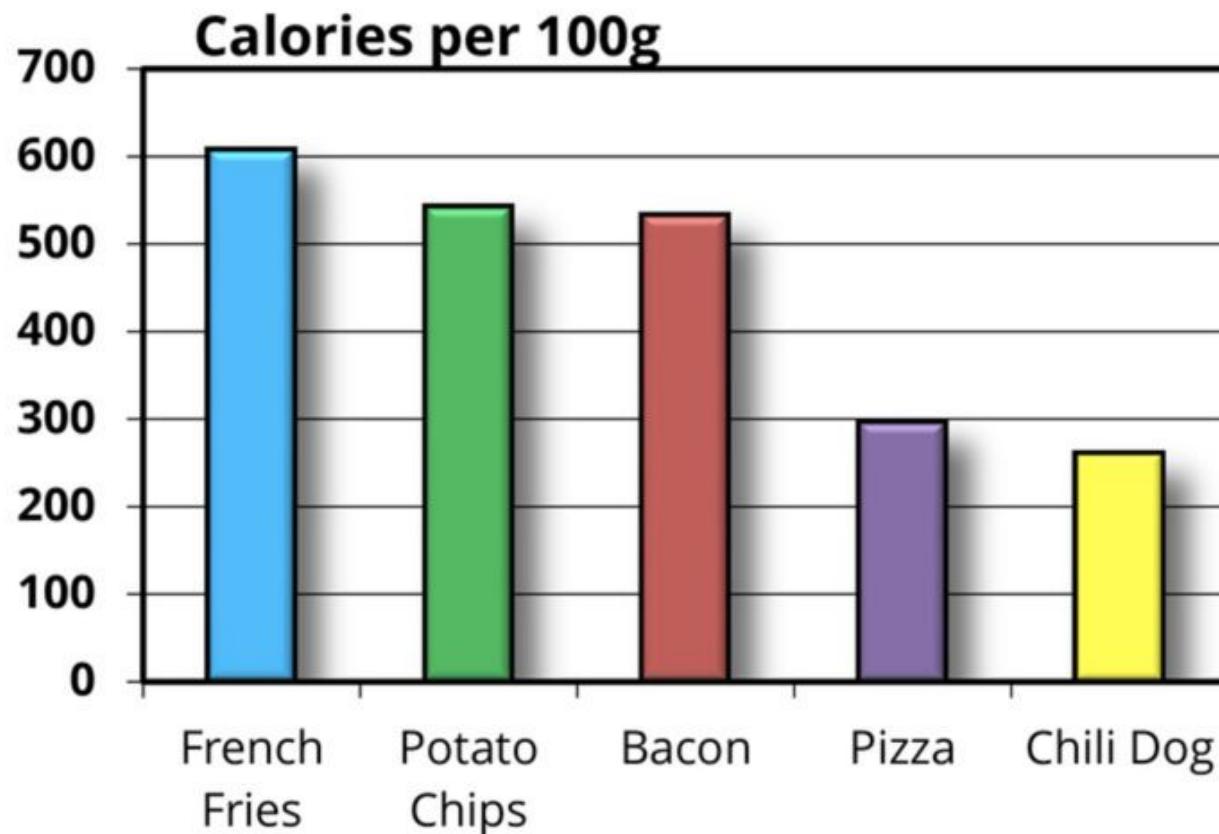
Remove redundant labels



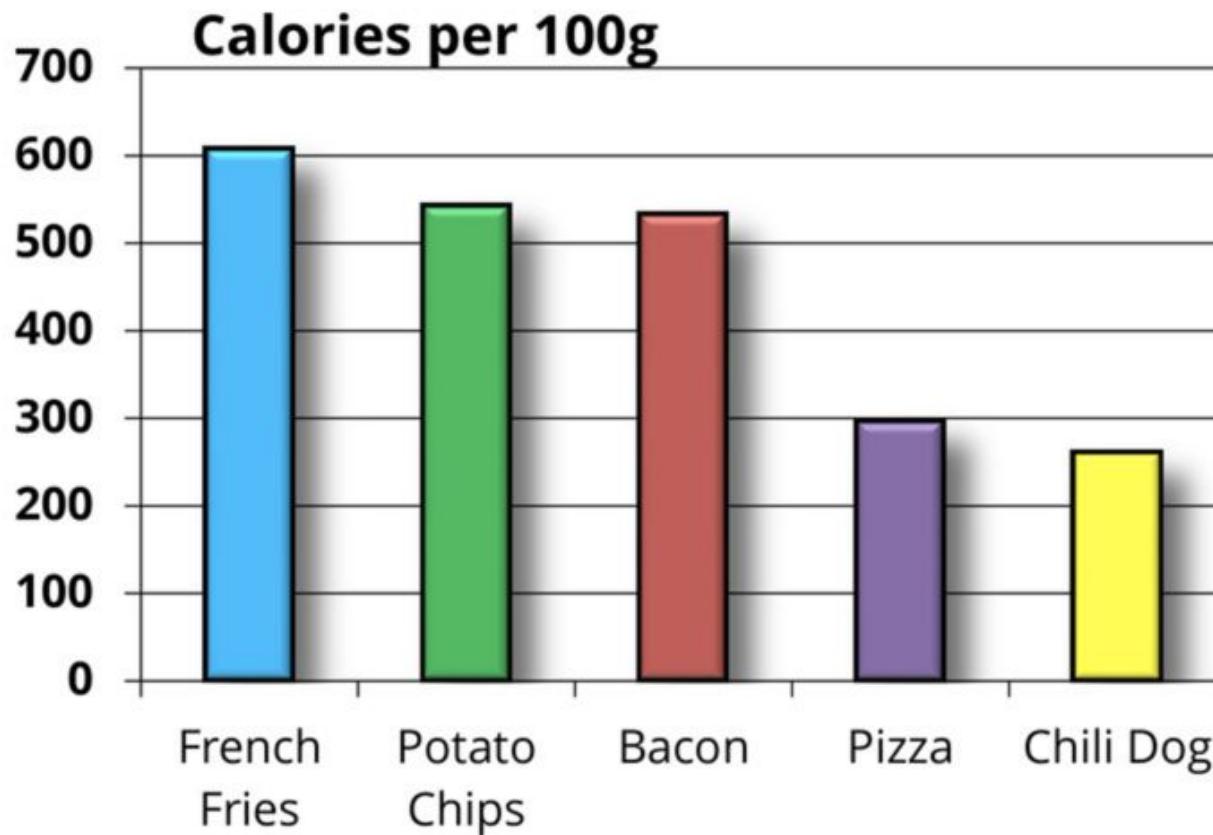
Remove borders



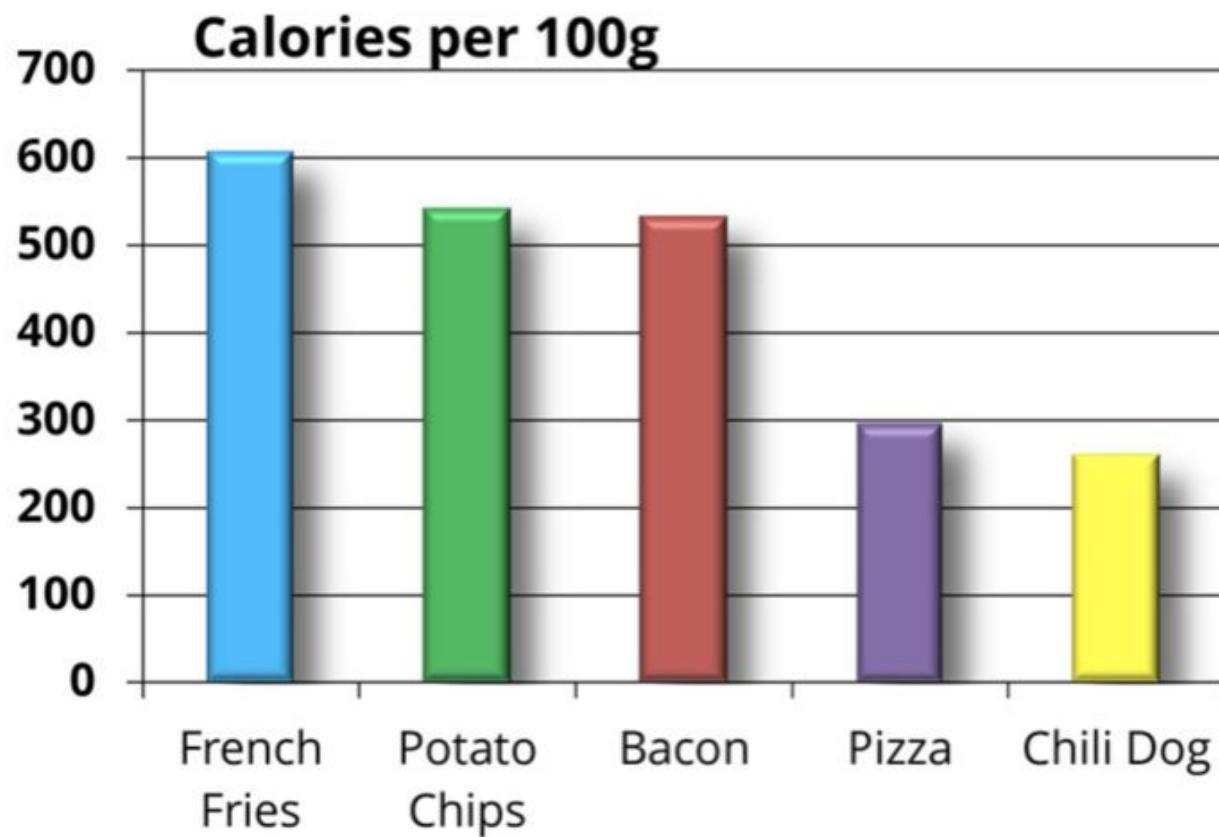
Remove borders



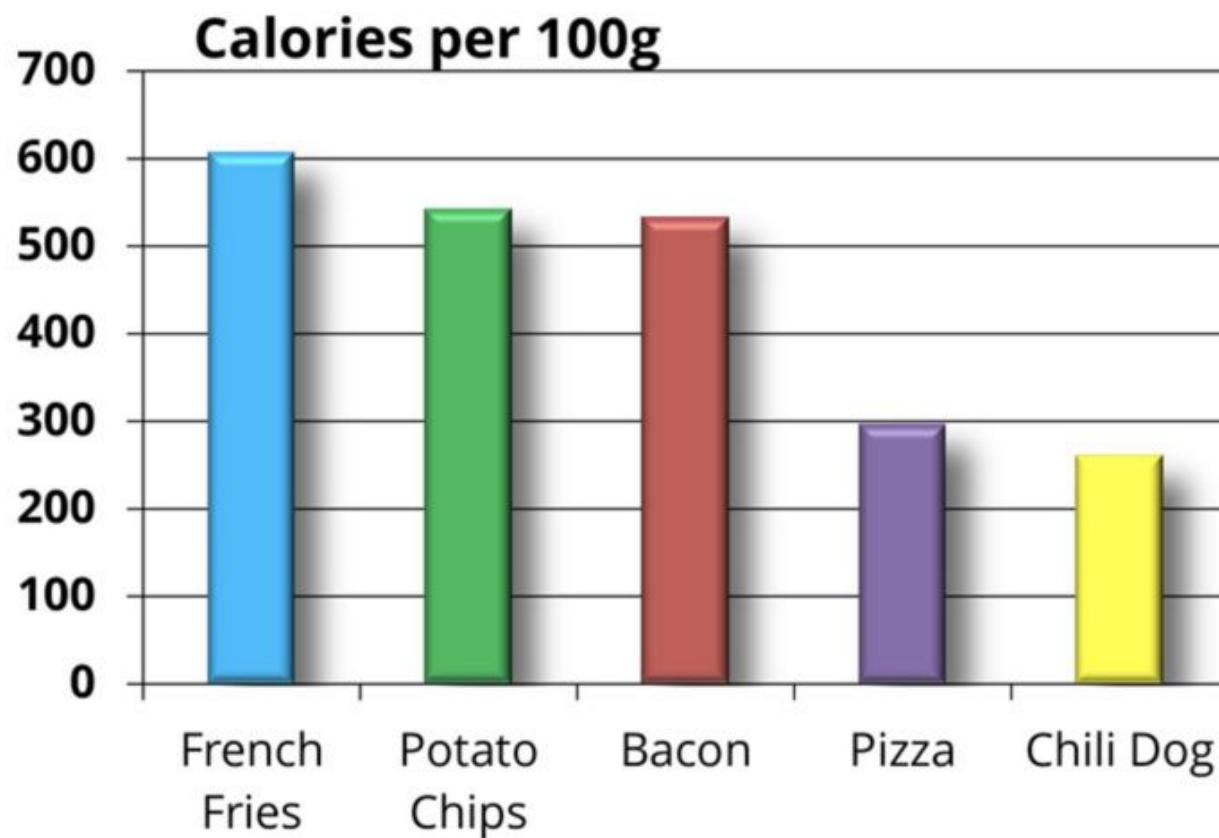
Remove borders



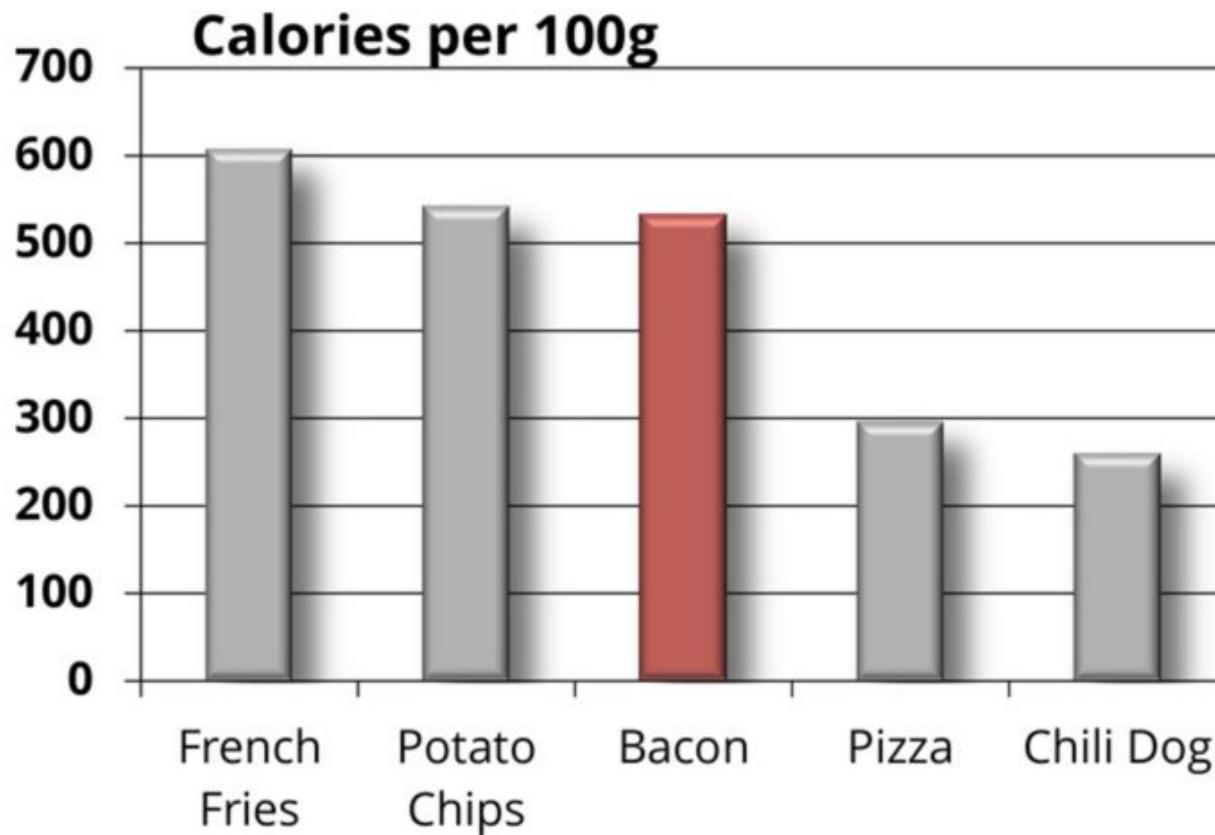
Remove borders



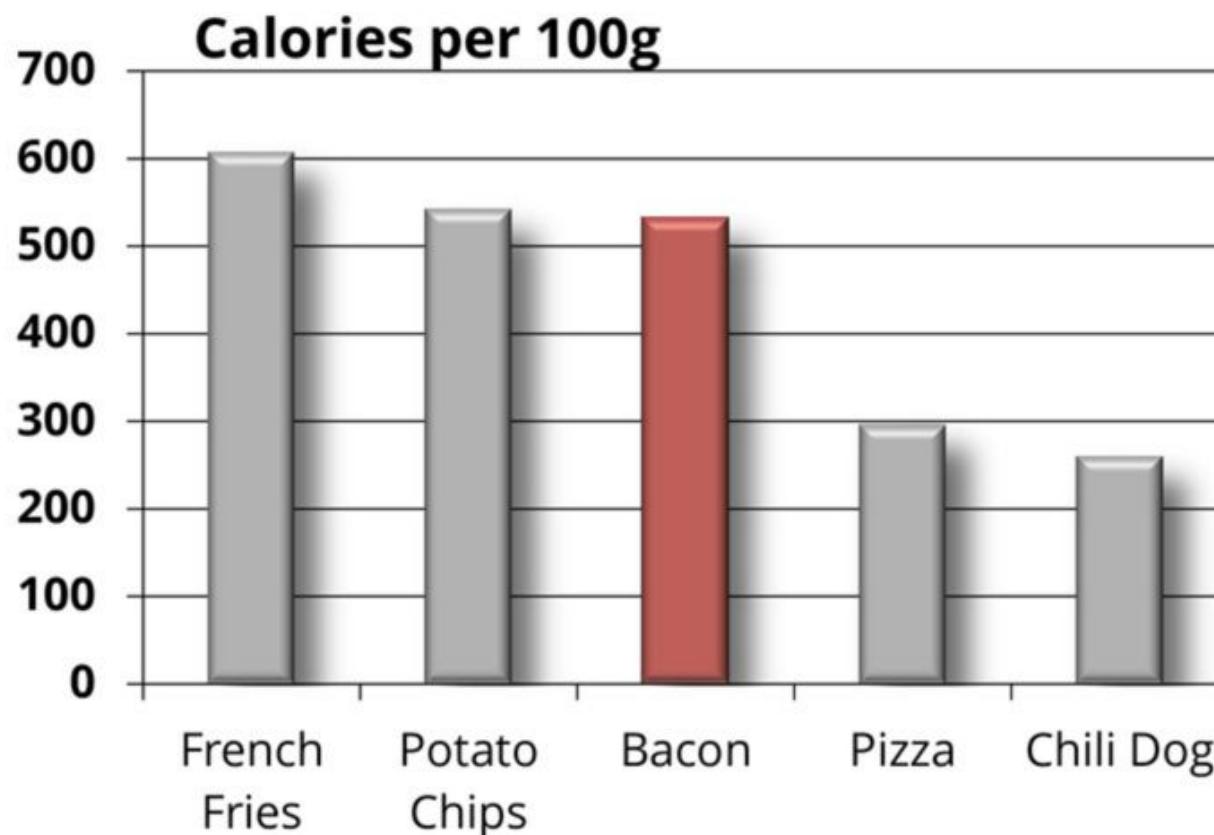
Reduce colors



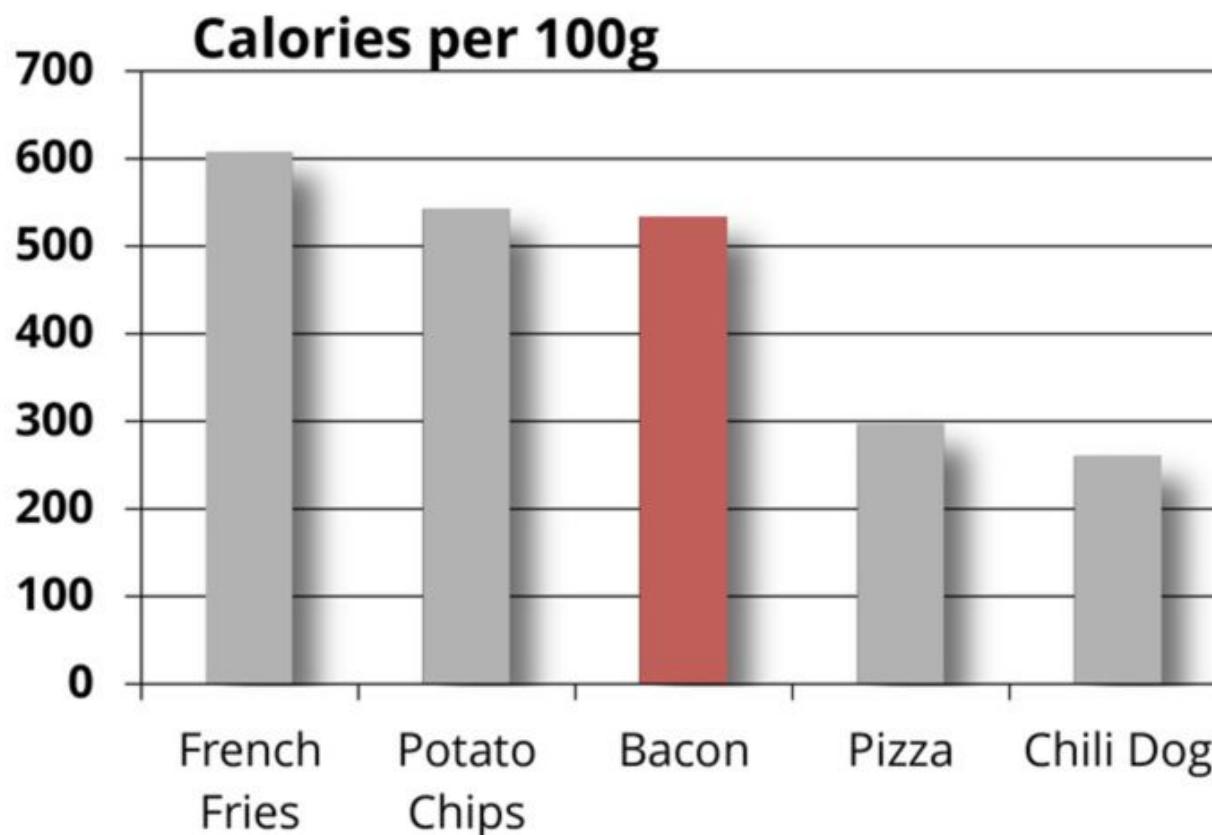
Reduce colors



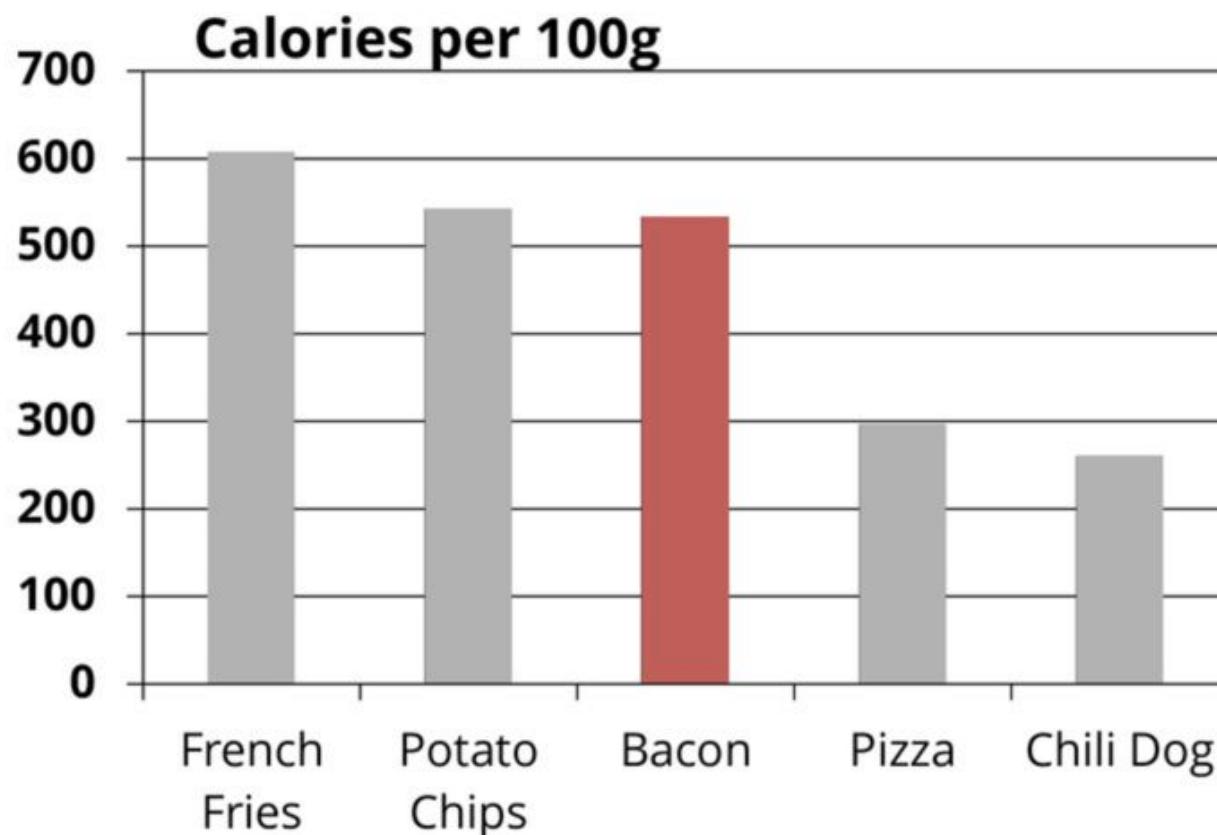
Remove special effects



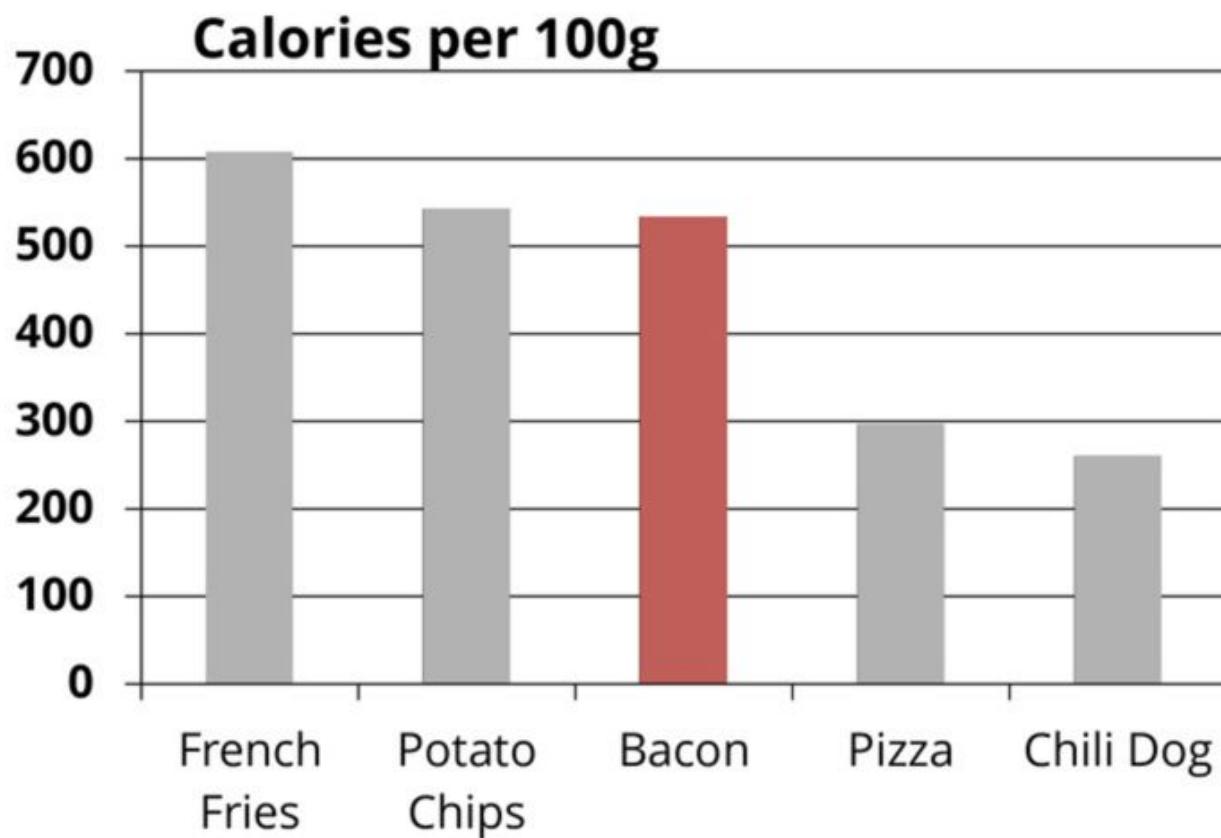
Remove special effects



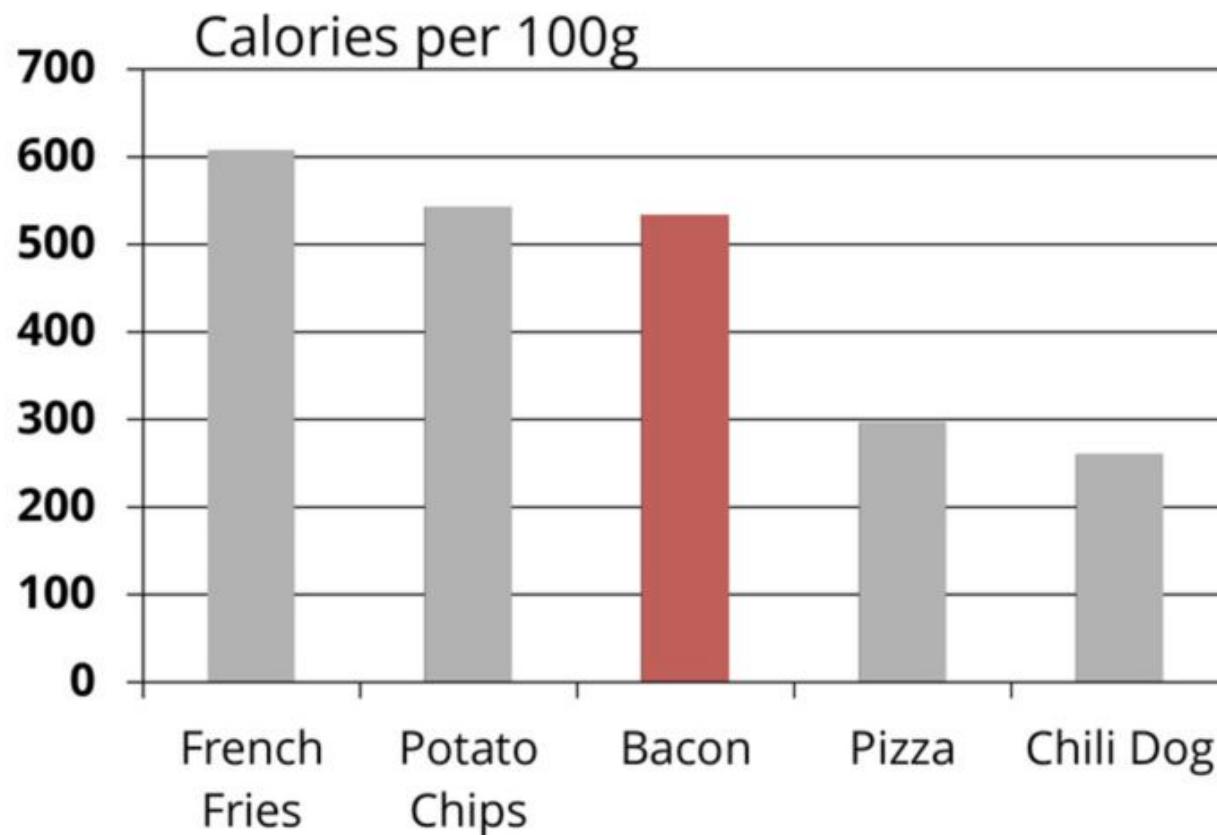
Remove special effects



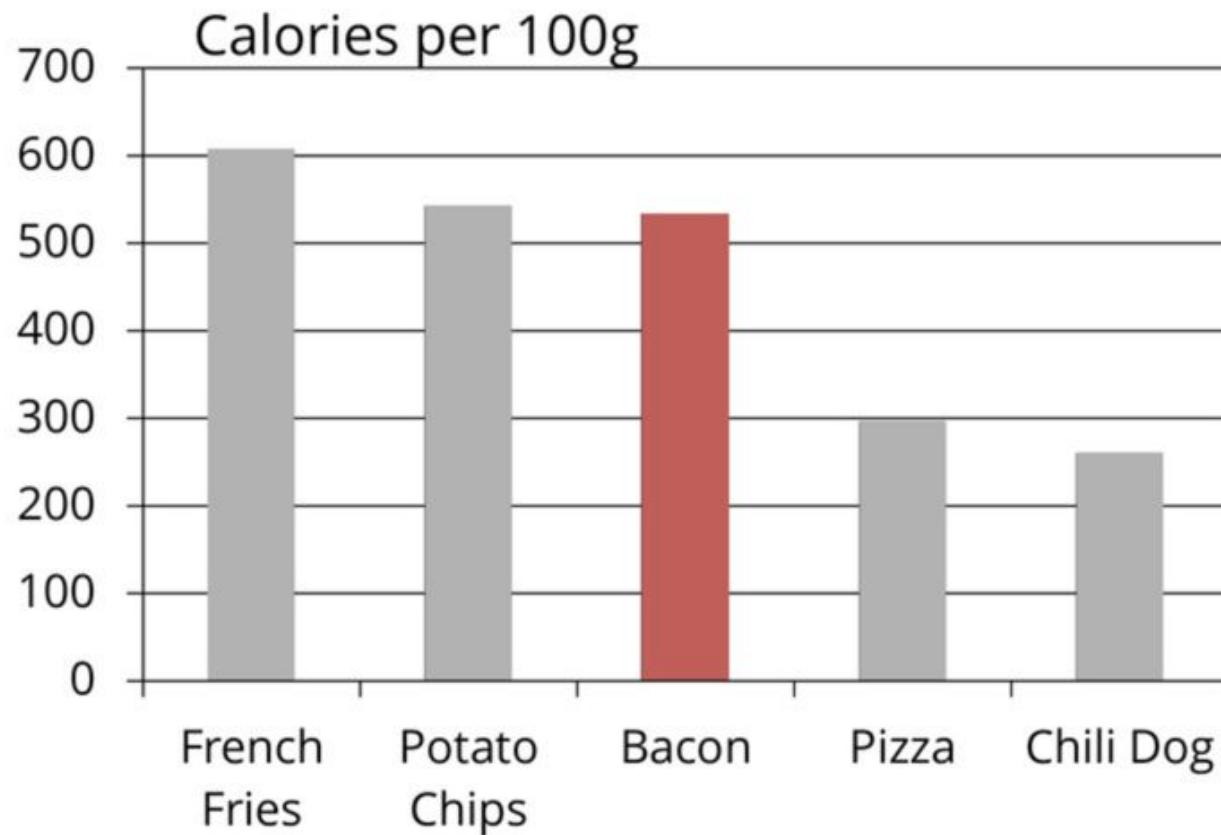
Remove bolding



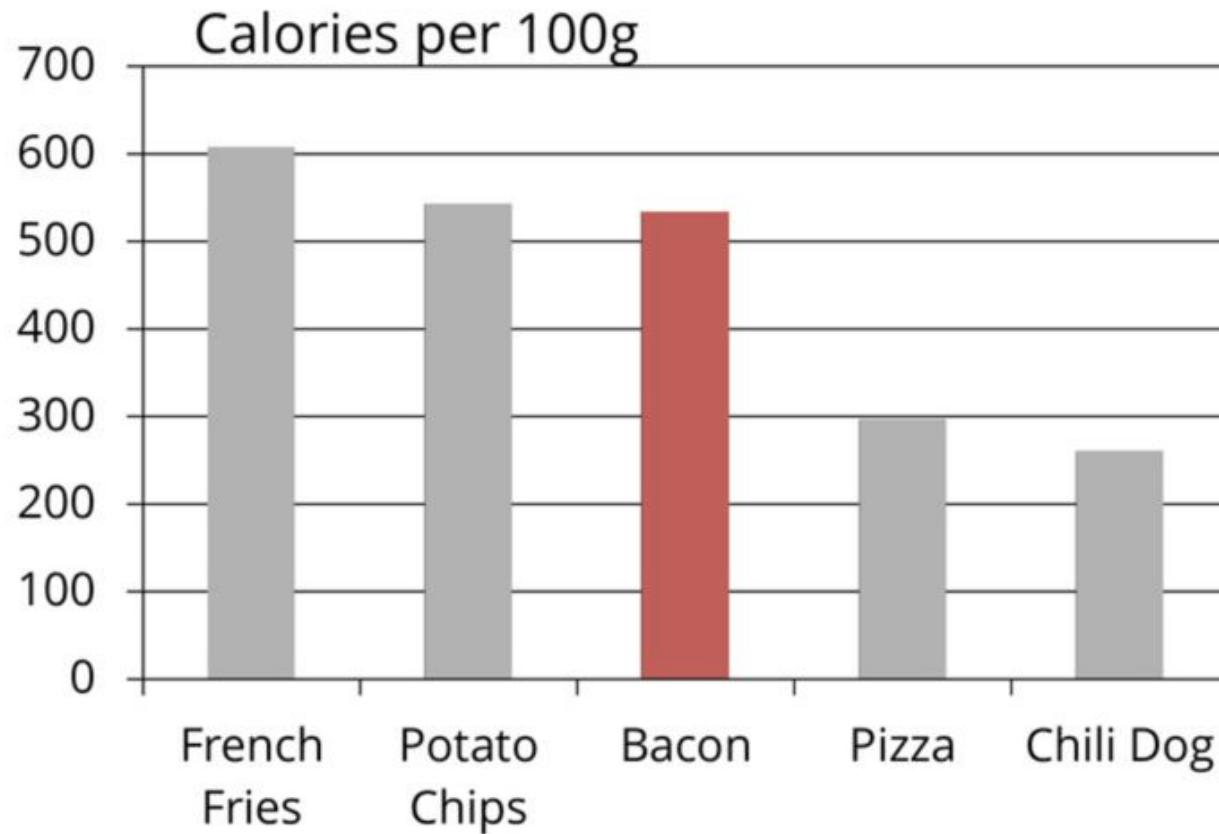
Remove bolding



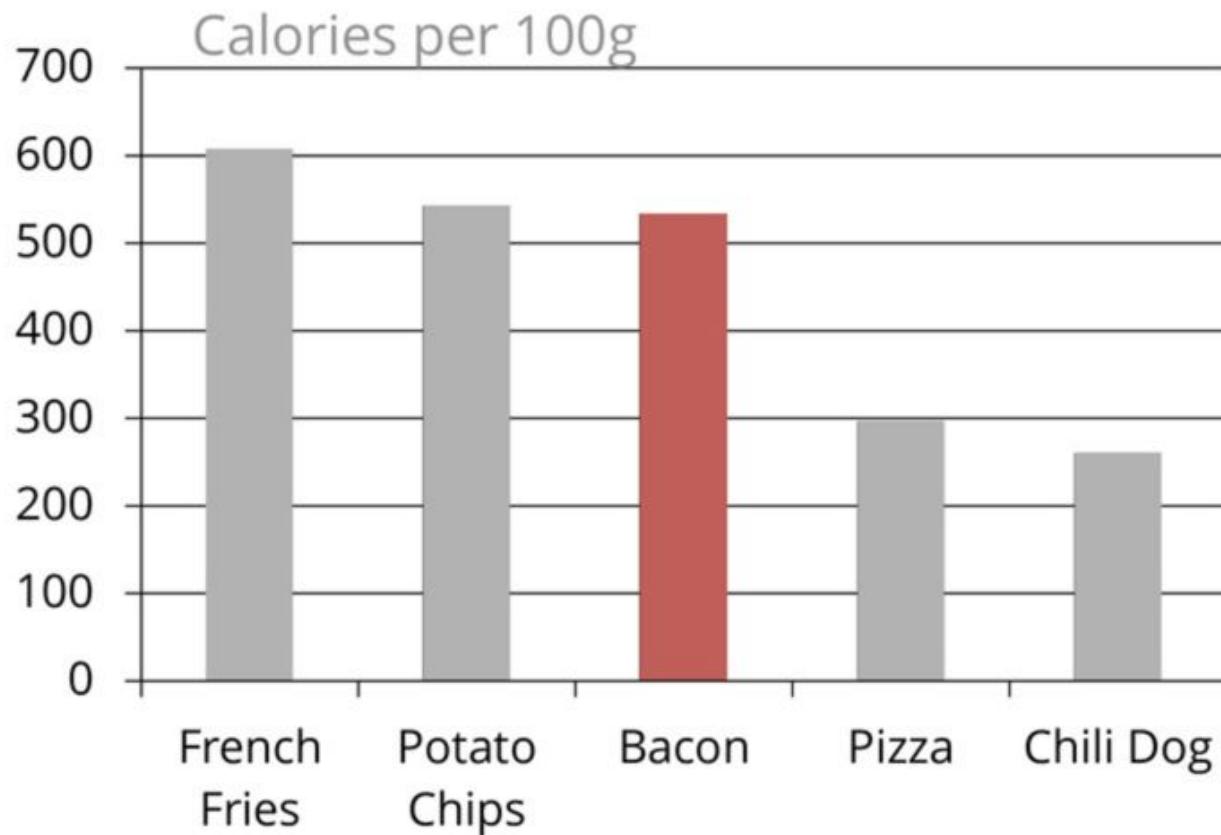
Remove bolding



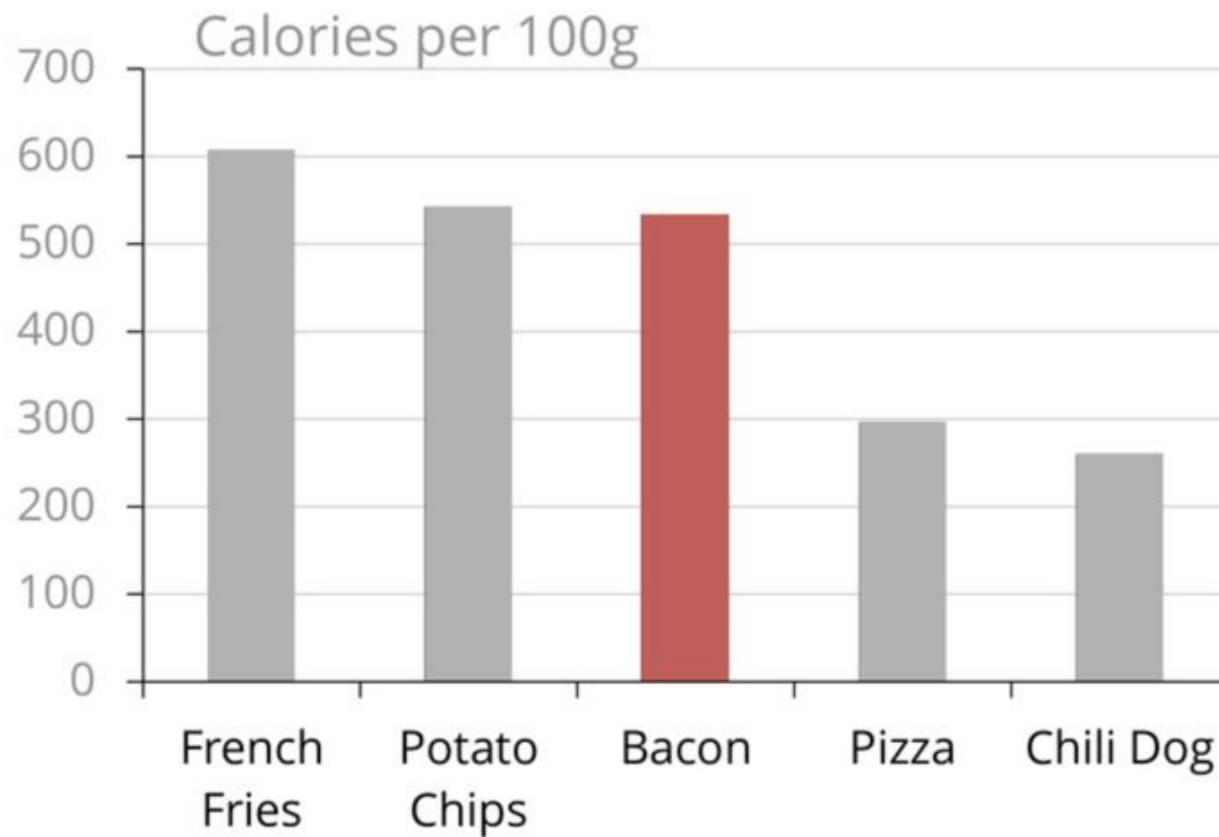
Lighten labels



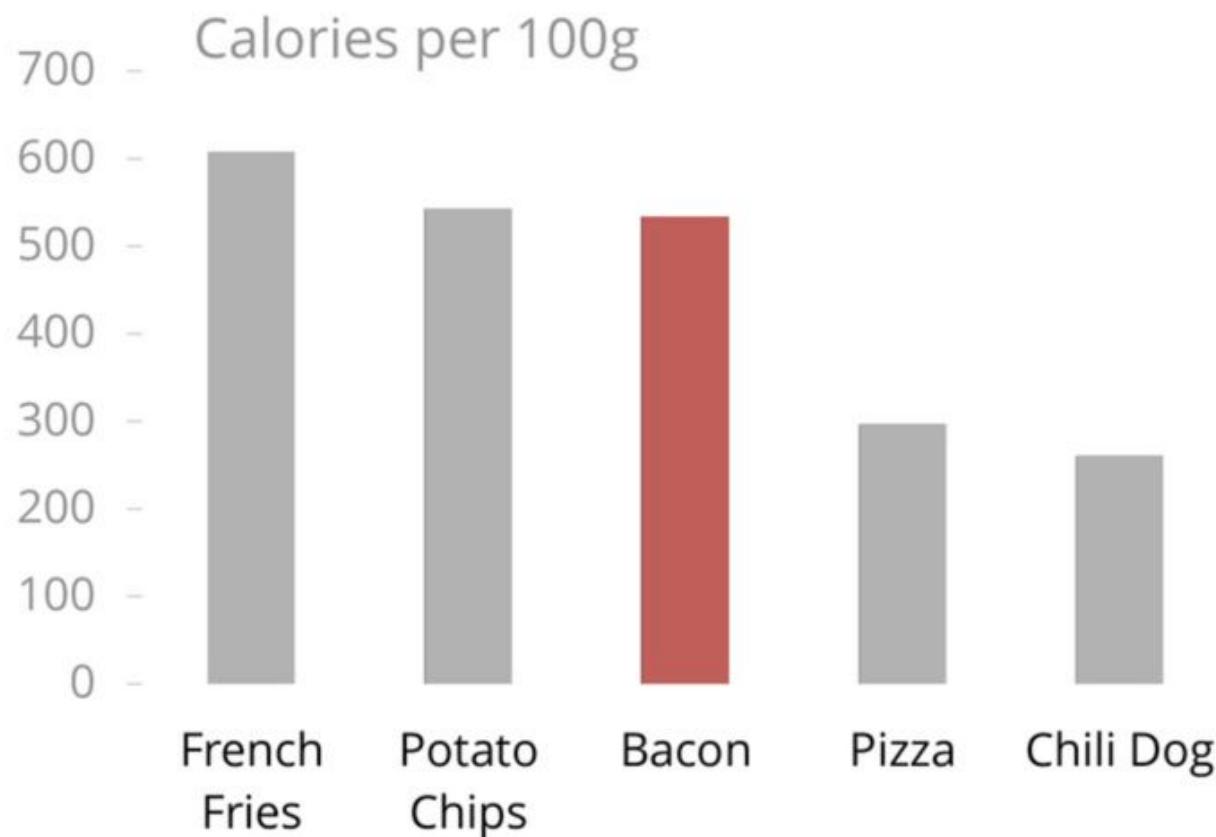
Lighten labels



Lighten lines

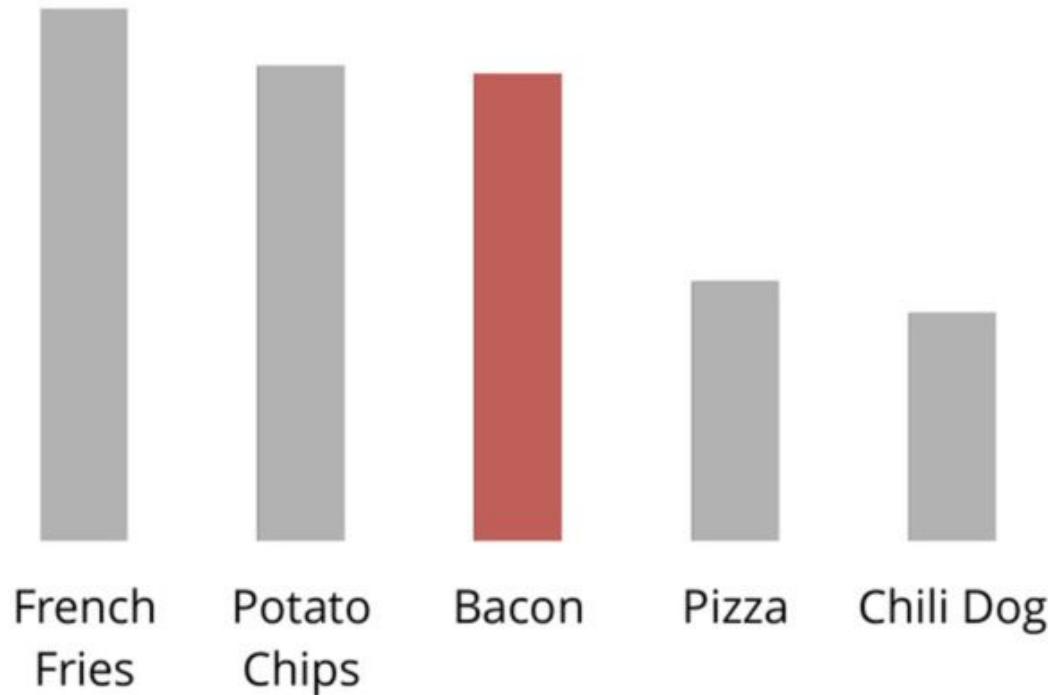


Direct label

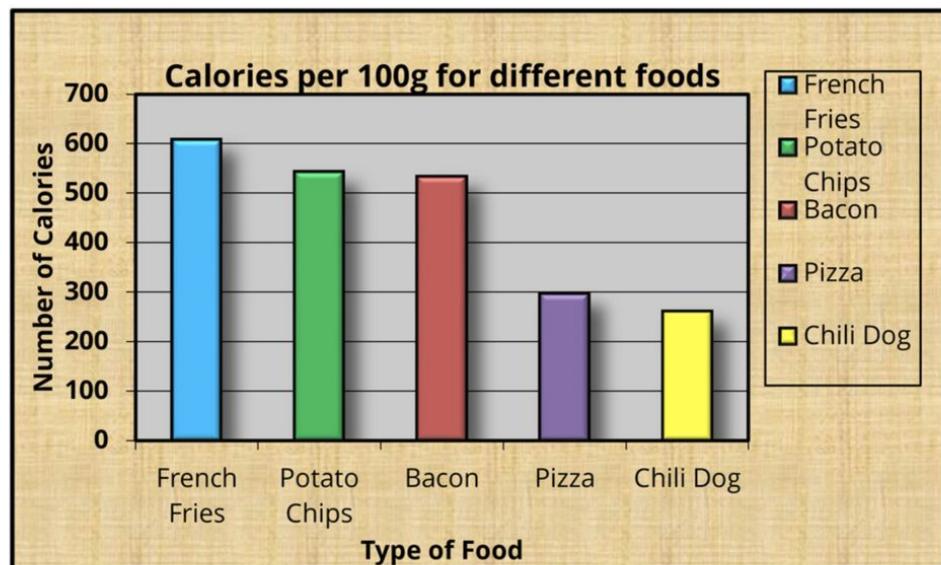


Direct label

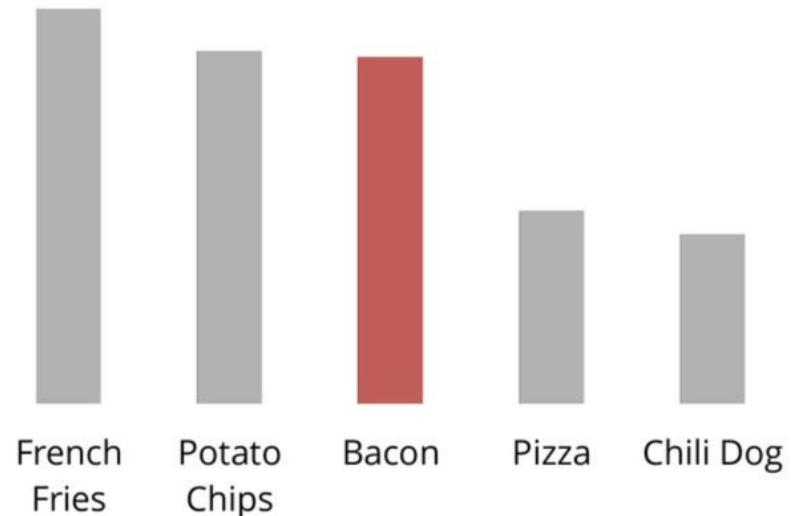
Calories per 100g



Data-ink ratio



Calories per 100g

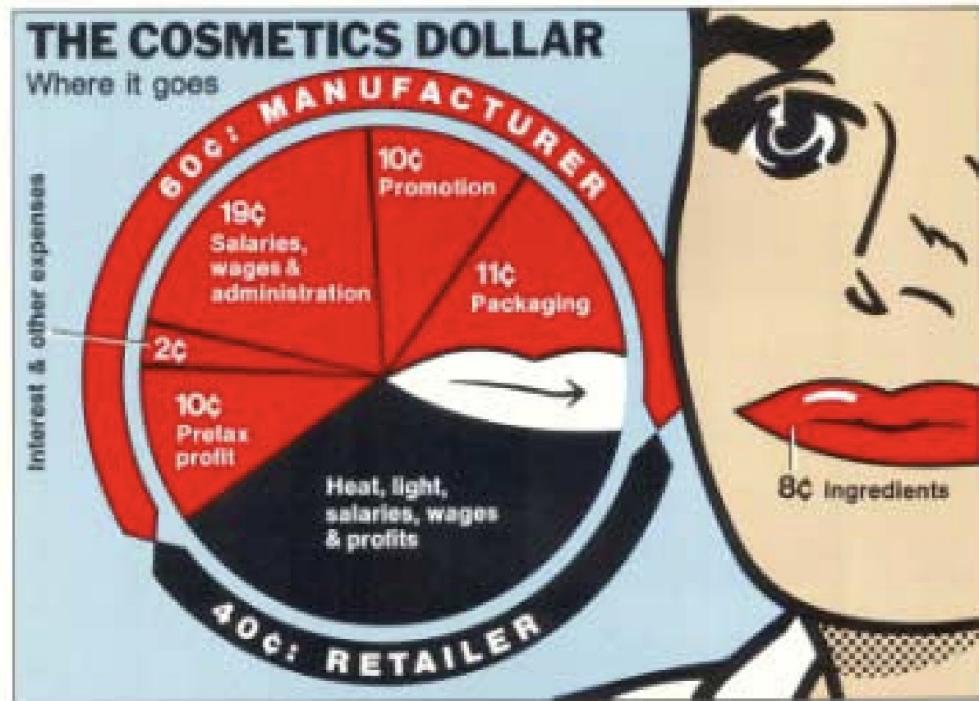
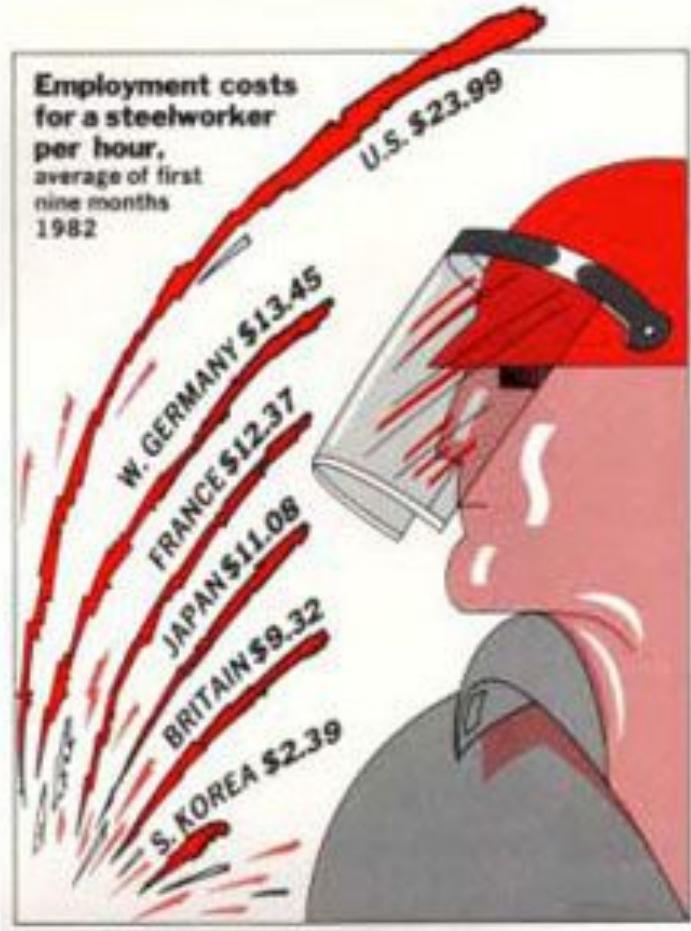


Guideline #5

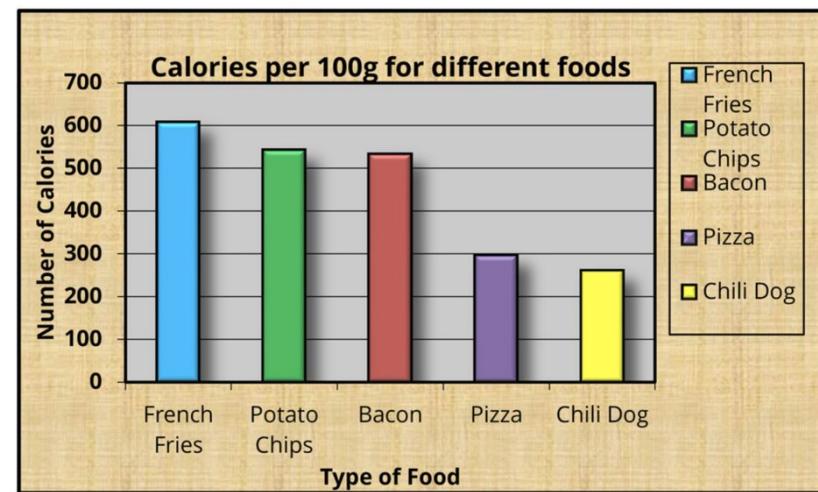
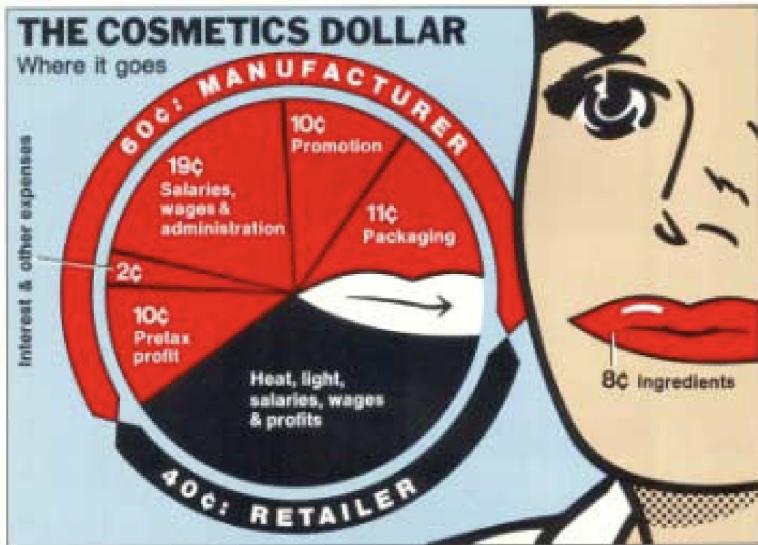
"Try to optimize your data-ink ratio"

Exception: ...

Embellishment: Metaphors



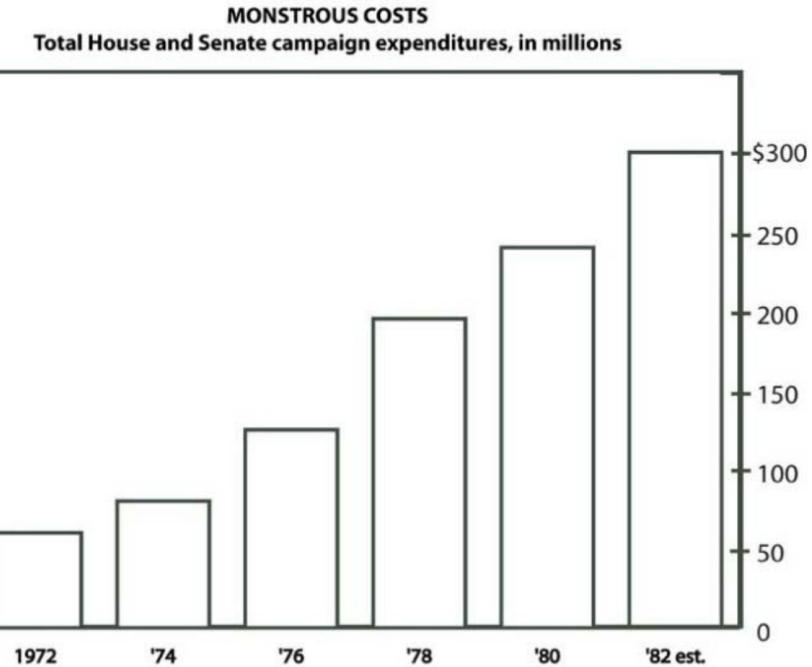
Embellishment



Metaphor

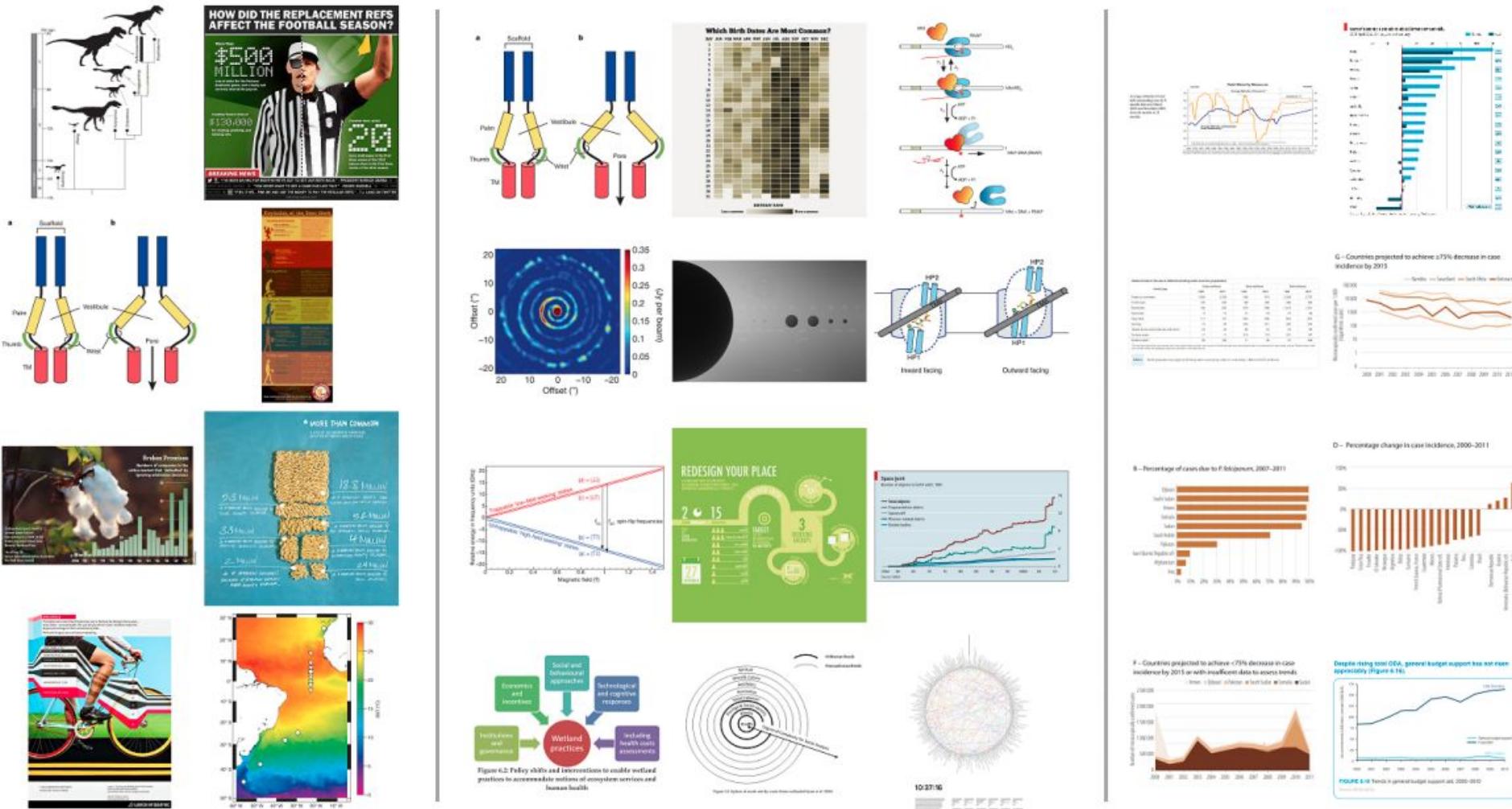
Distractors

Embellishment



Understanding of embellished charts not worse, but recall after some weeks, much higher.

What makes a chart memorable?



What makes a chart memorable?



Top 10 most memorable: top-left to bottom right for each category.

What makes a chart memorable?

- Color
- Human recognizable objects
- Low data-ink ratio
- Unique visualization types < common graphs

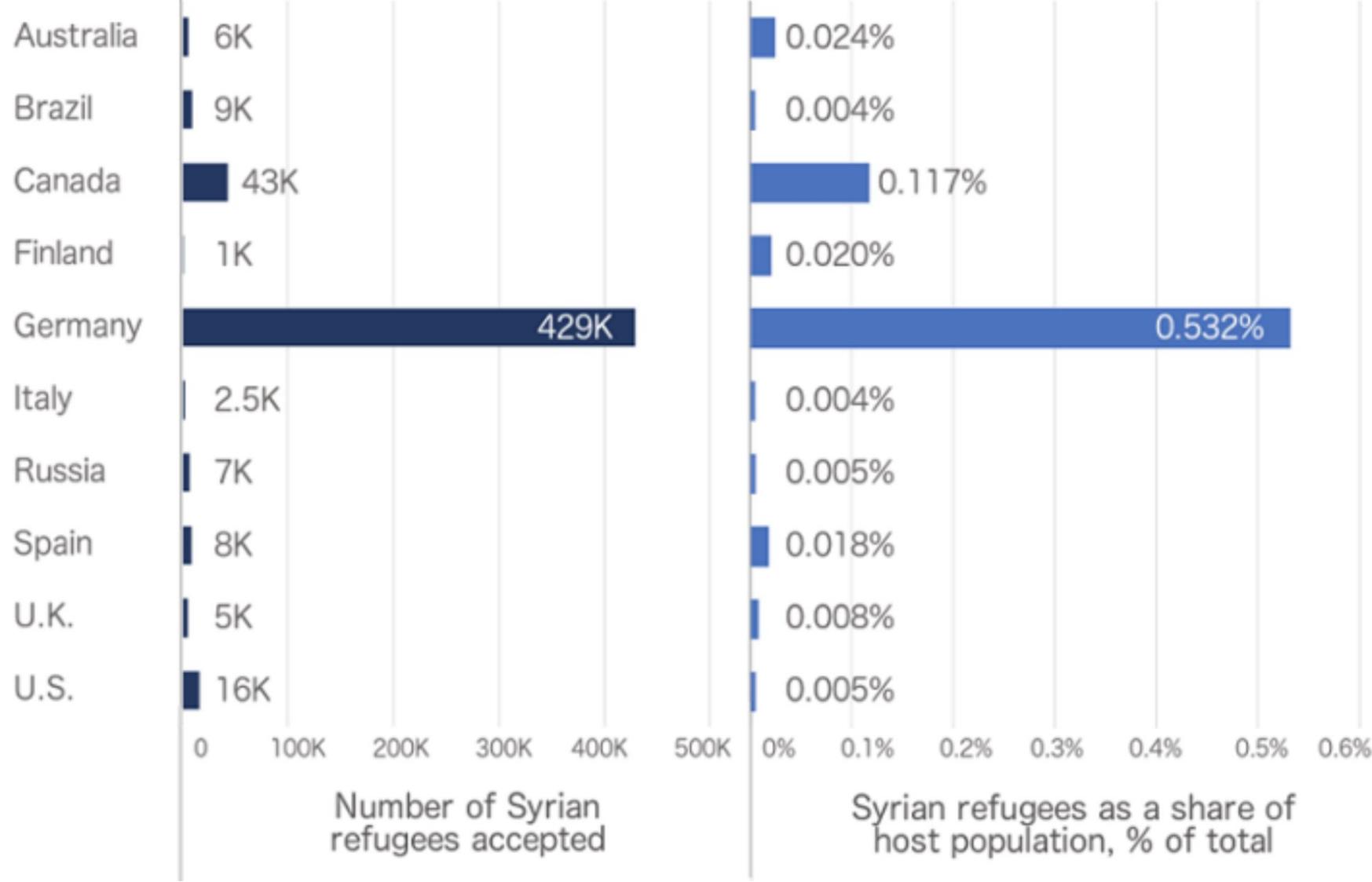
Guideline #6

"Add embellishment carefully to make your graphic memorable and enjoyable"

Exceptions: Unless it clutters your visualization and obstructs the message.

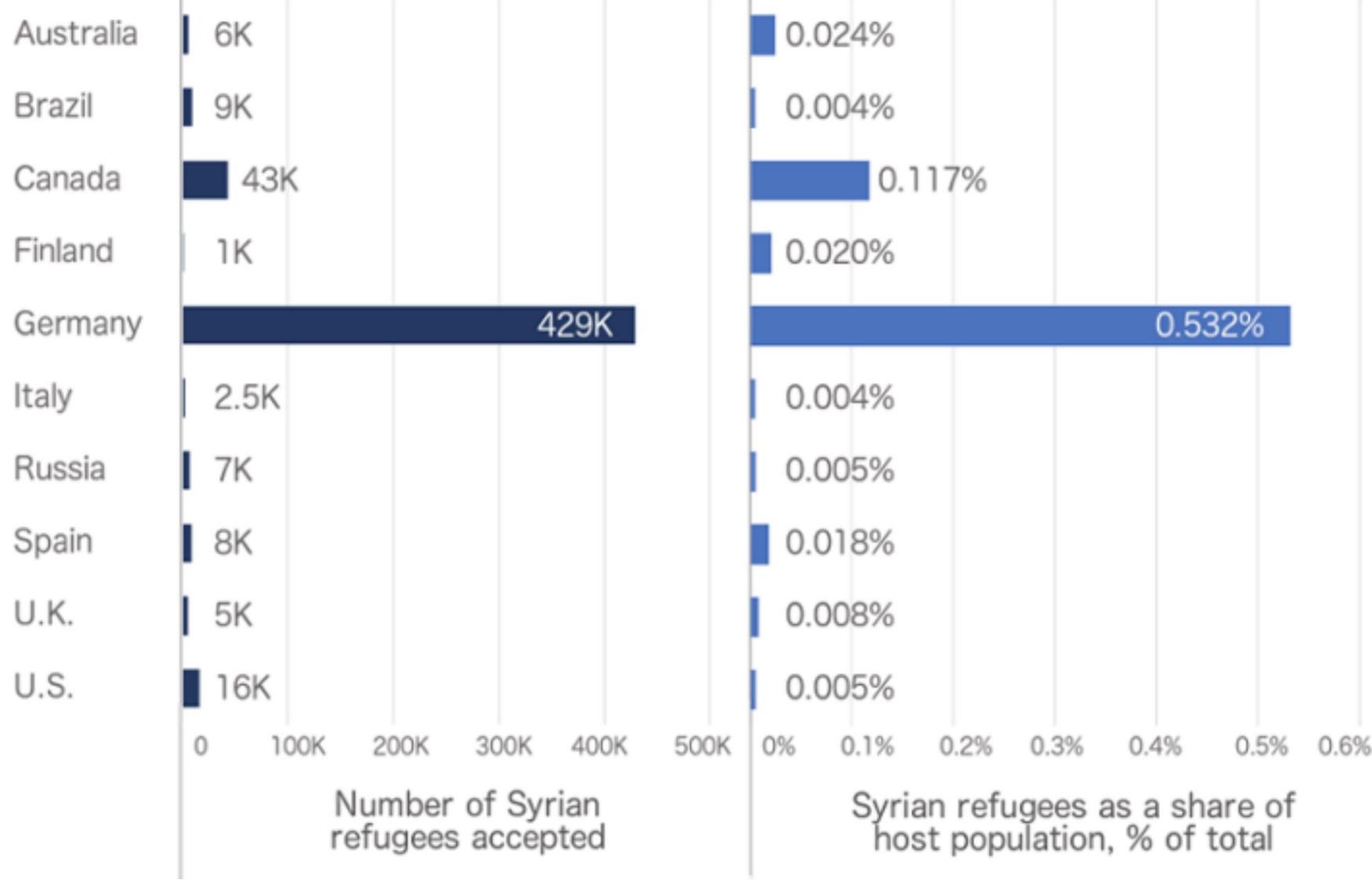
Letting in Potential Killers?

Non-neighboring countries



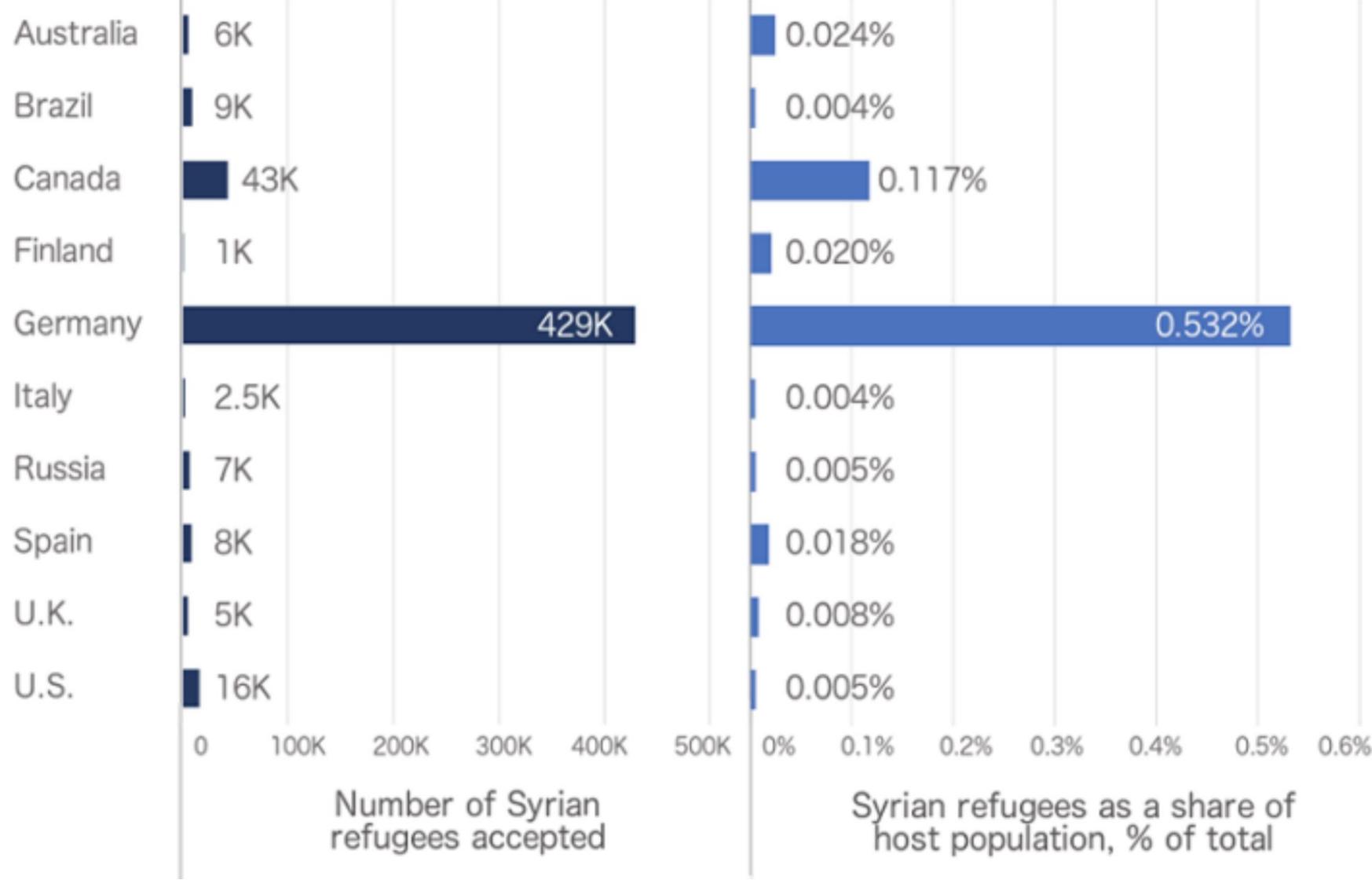
We must do our share!

Non-neighboring countries



Syrian Refugee Distribution:

Non-neighboring countries



Guideline #7

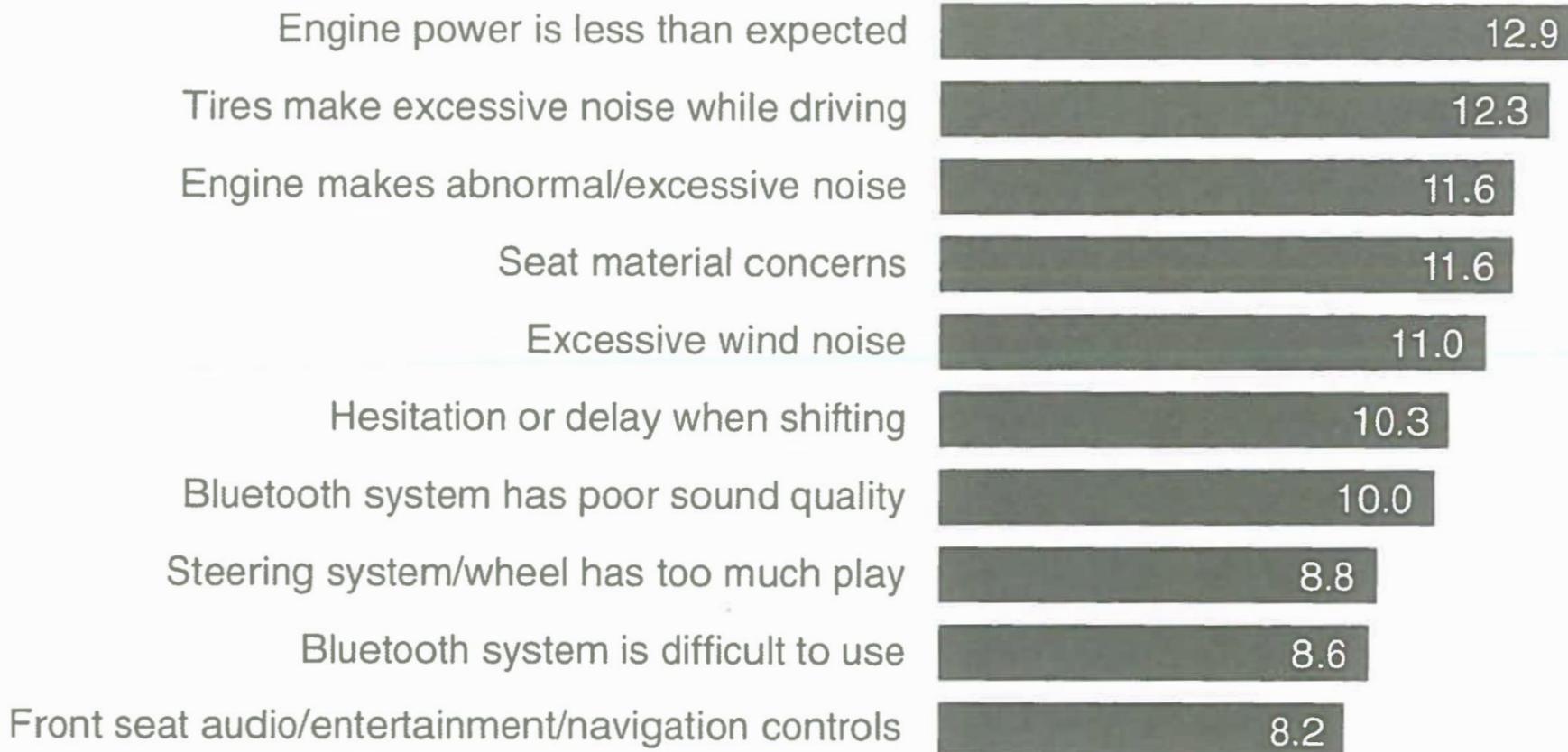
"Choose a title appropriate to your message or data – it will prime your reader."

Exceptions: none

Highlight

Top 10 design concerns

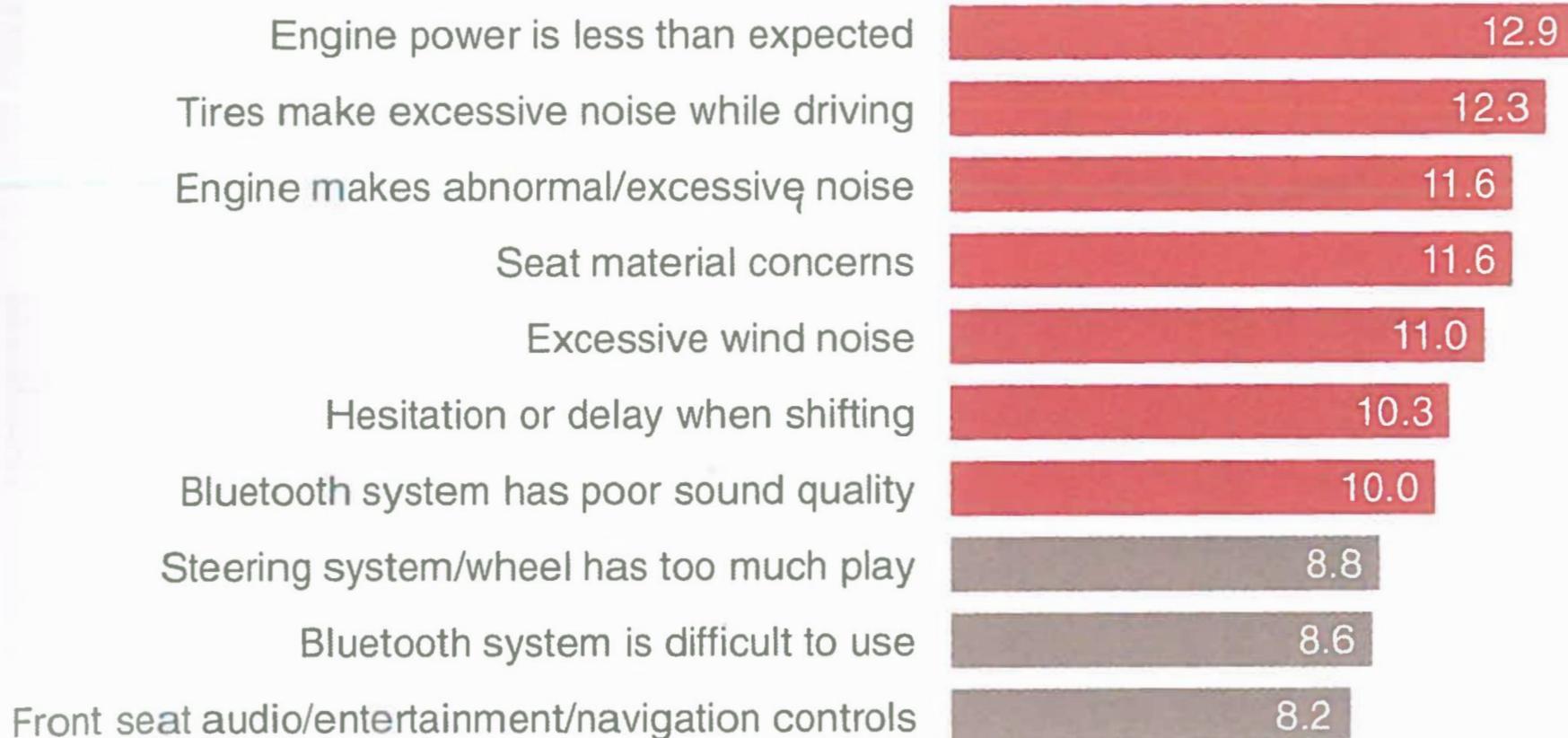
concerns per 1,000



Highlight

Top 10 design concerns

concerns per 1,000



Highlight

Top 10 design concerns

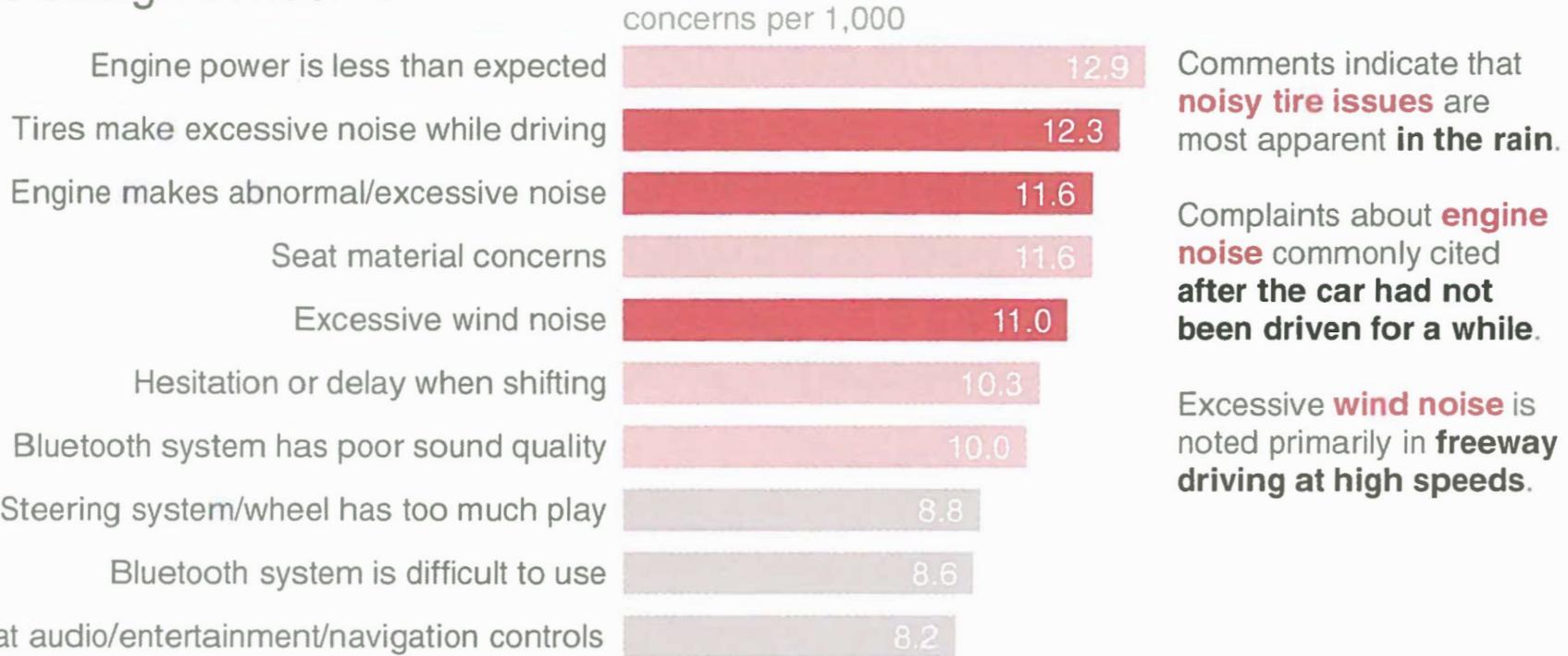
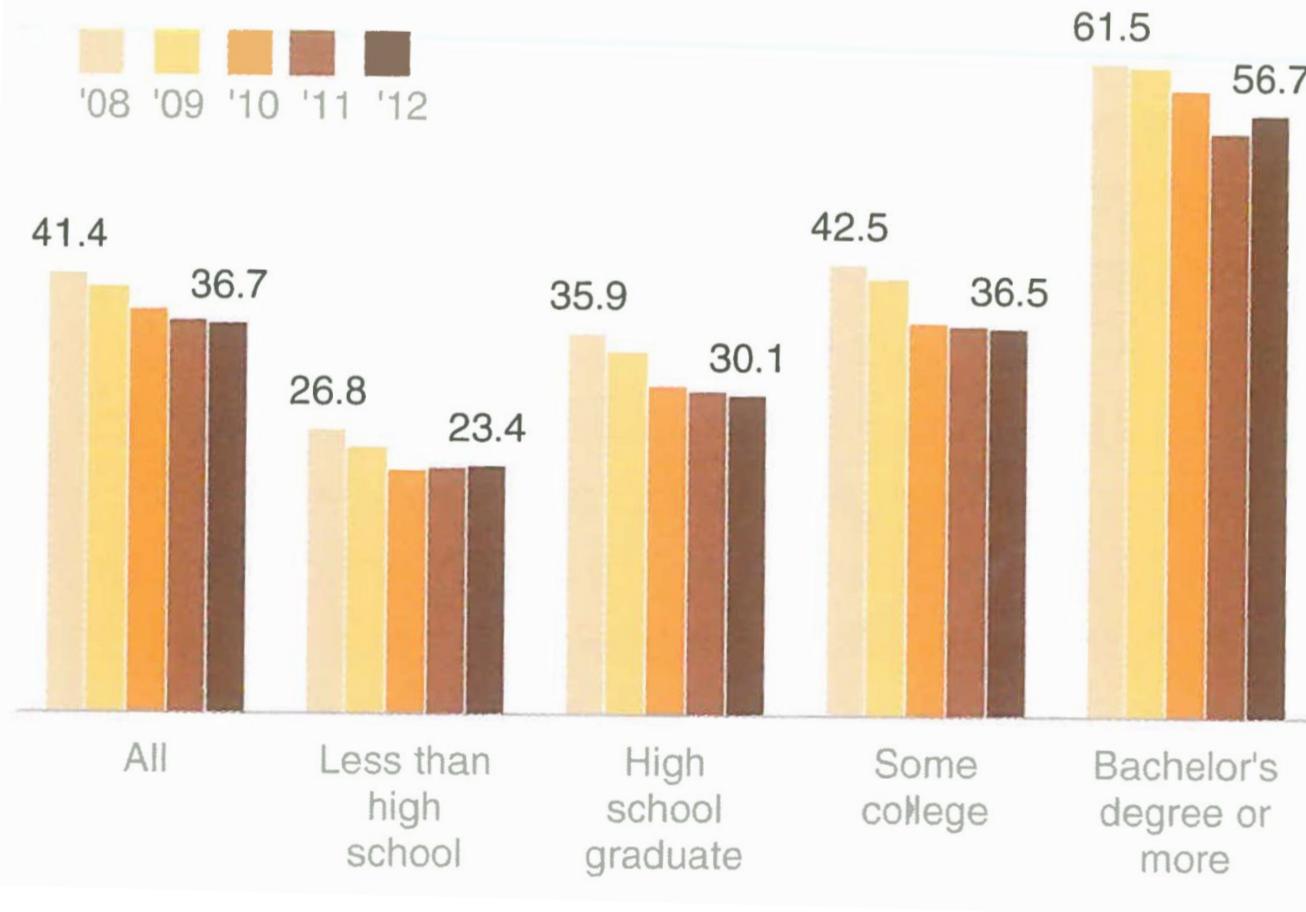


FIGURE 4.9 Create a visual hierarchy of information

Message

New Marriage Rate by Education

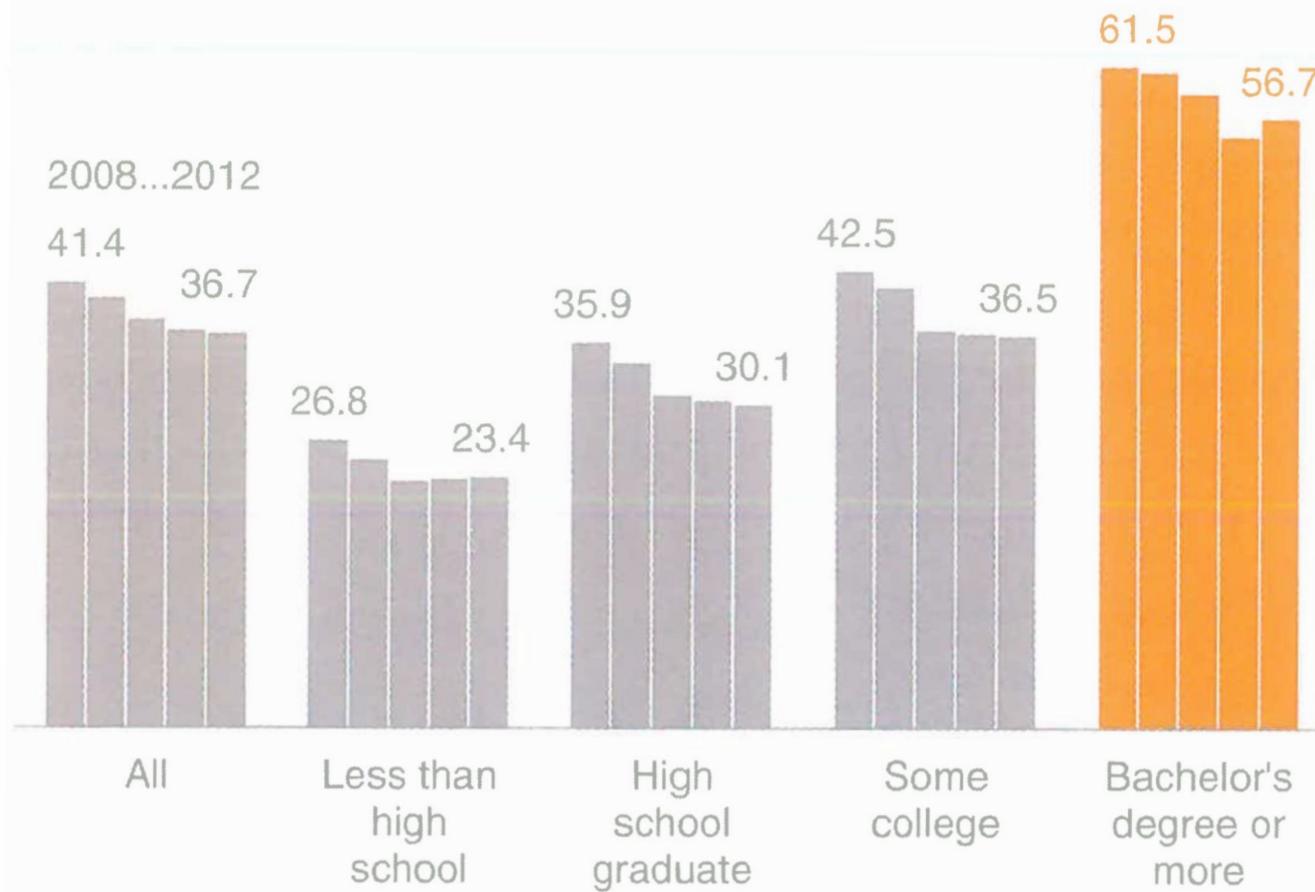
Number of newly married adults per 1,000 marriage eligible adults



Message

New Marriage Rate by Education

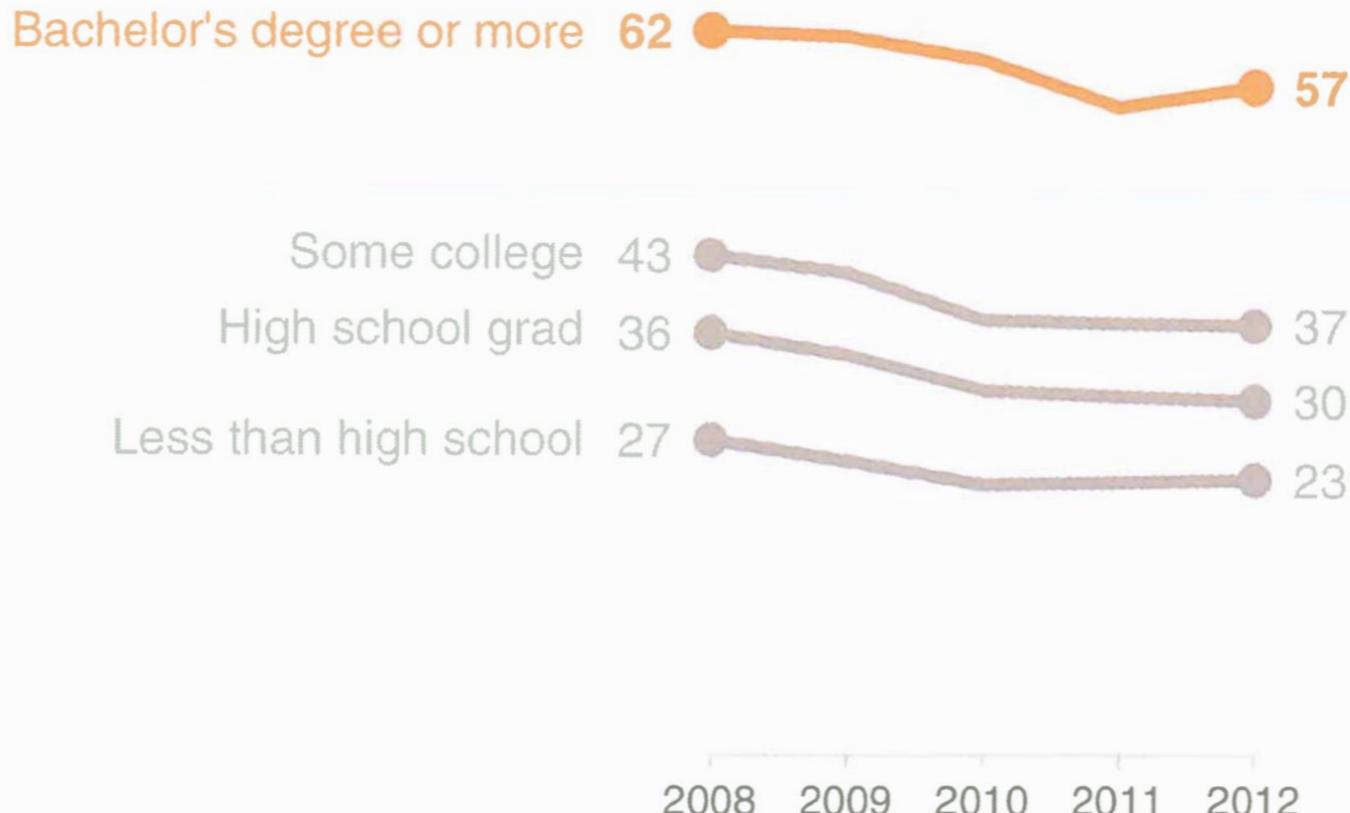
Number of newly married adults per 1,000 marriage eligible adults



Message

New marriage rate by education

Number of newly married adults per 1,000 marriage eligible adults



Guideline #8

"Highlight what is important"

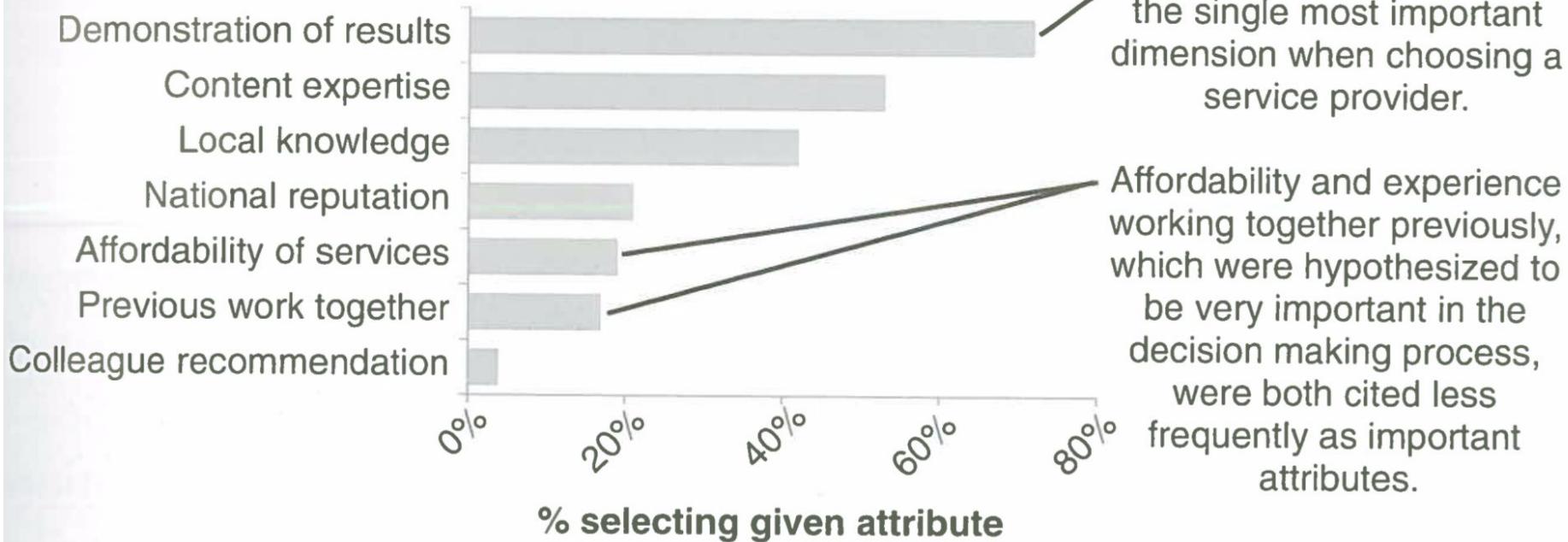
Exceptions: except you have too many important things to say:

Solution: show another chart (can be the same)

Layout

Demonstrating effectiveness is most important consideration when selecting a provider

In general, what attributes are the most important to you in selecting a service provider?
(Choose up to 3)



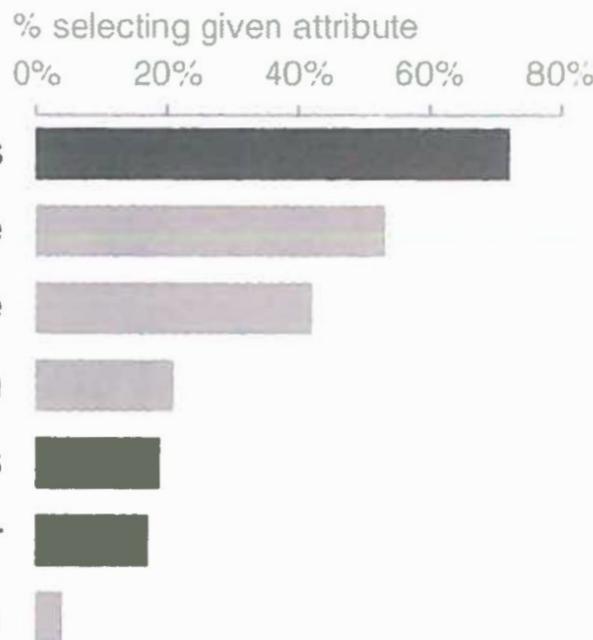
Data source: xyz; includes N number of survey respondents. Note that respondents were able to choose up to 3 options.

Layout

Demonstrating effectiveness is most important consideration when selecting a provider

In general, **what attributes are the most important** to you in selecting a service provider?

(Choose up to 3)



Survey shows that **demonstration of results** is the single most important dimension when choosing a service provider.

Affordability and **experience working together previously**, which were hypothesized to be very important in the decision making process, were both cited less frequently as important attributes.

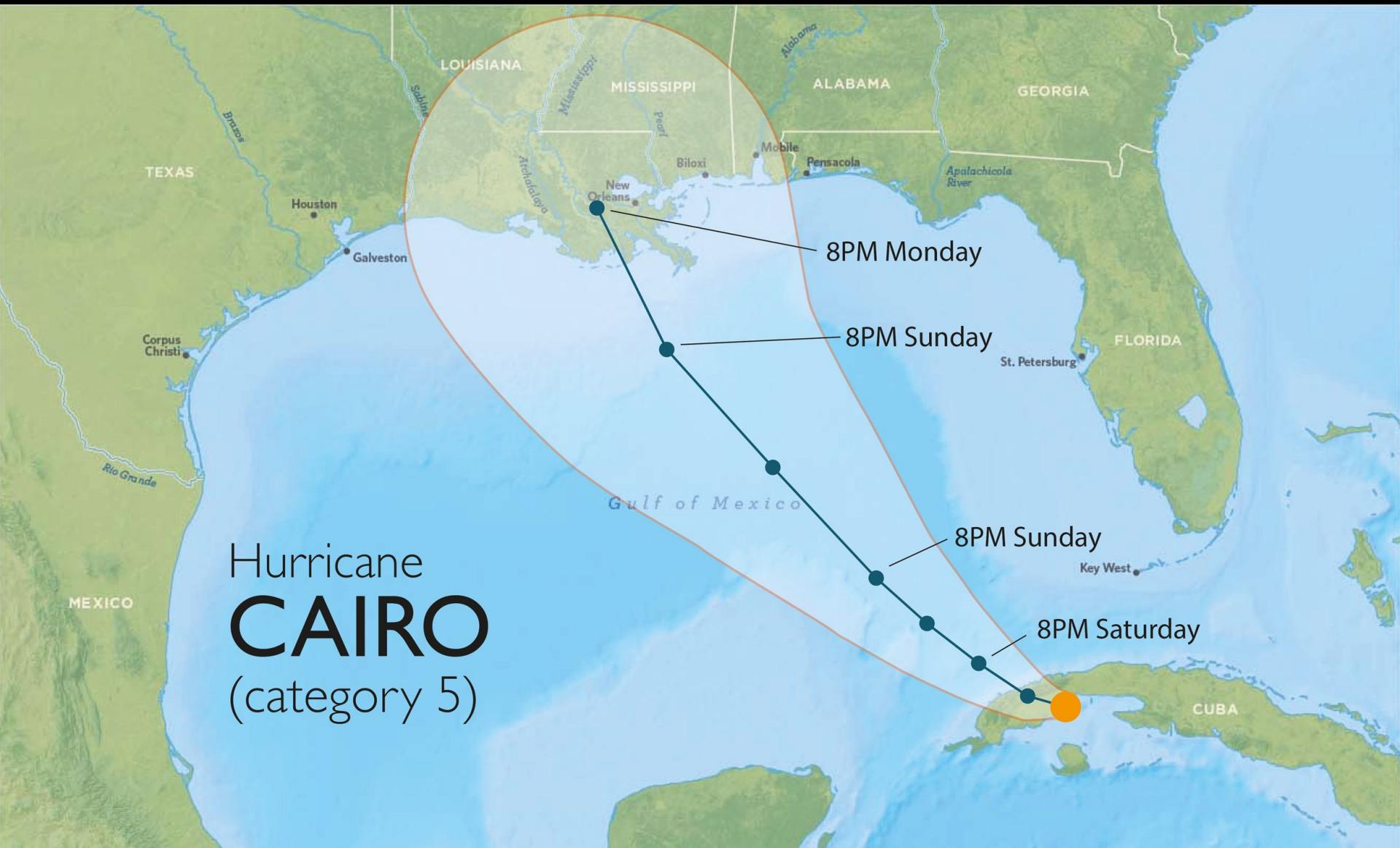
Data source: xyz; includes N number of survey respondents.
Note that respondents were able to choose up to 3 options.

Guideline #9

"Annotate what is important"

Exceptions: ?

Hurricane **CAIRO** (category 5)



What you show

Hurricane **CAIRO** (category 5)



What I think some people see

Hurricane **CAIRO** (category 5)



What the cone is based on

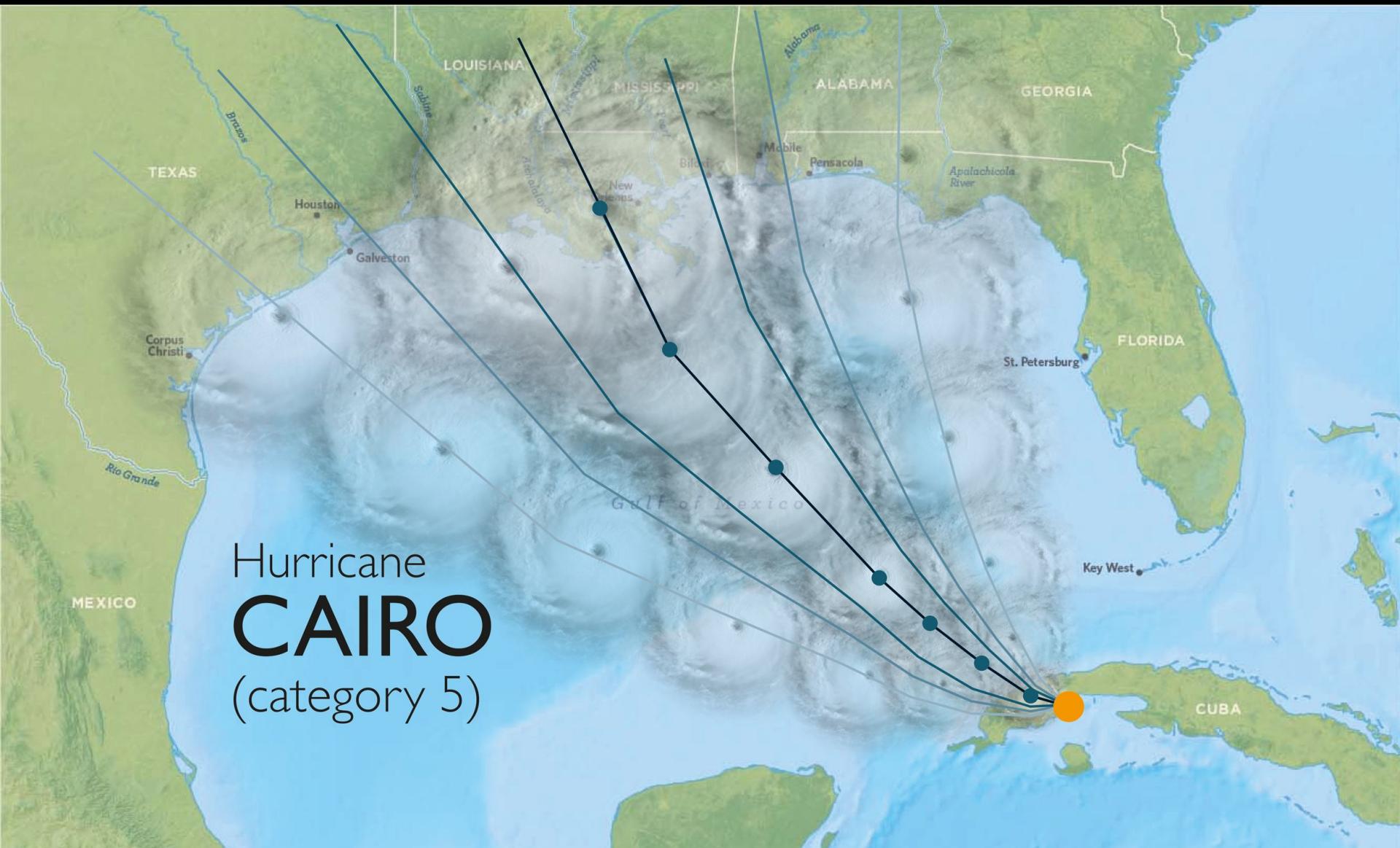


What non-scientists are not aware of (cone is just 66% probability)



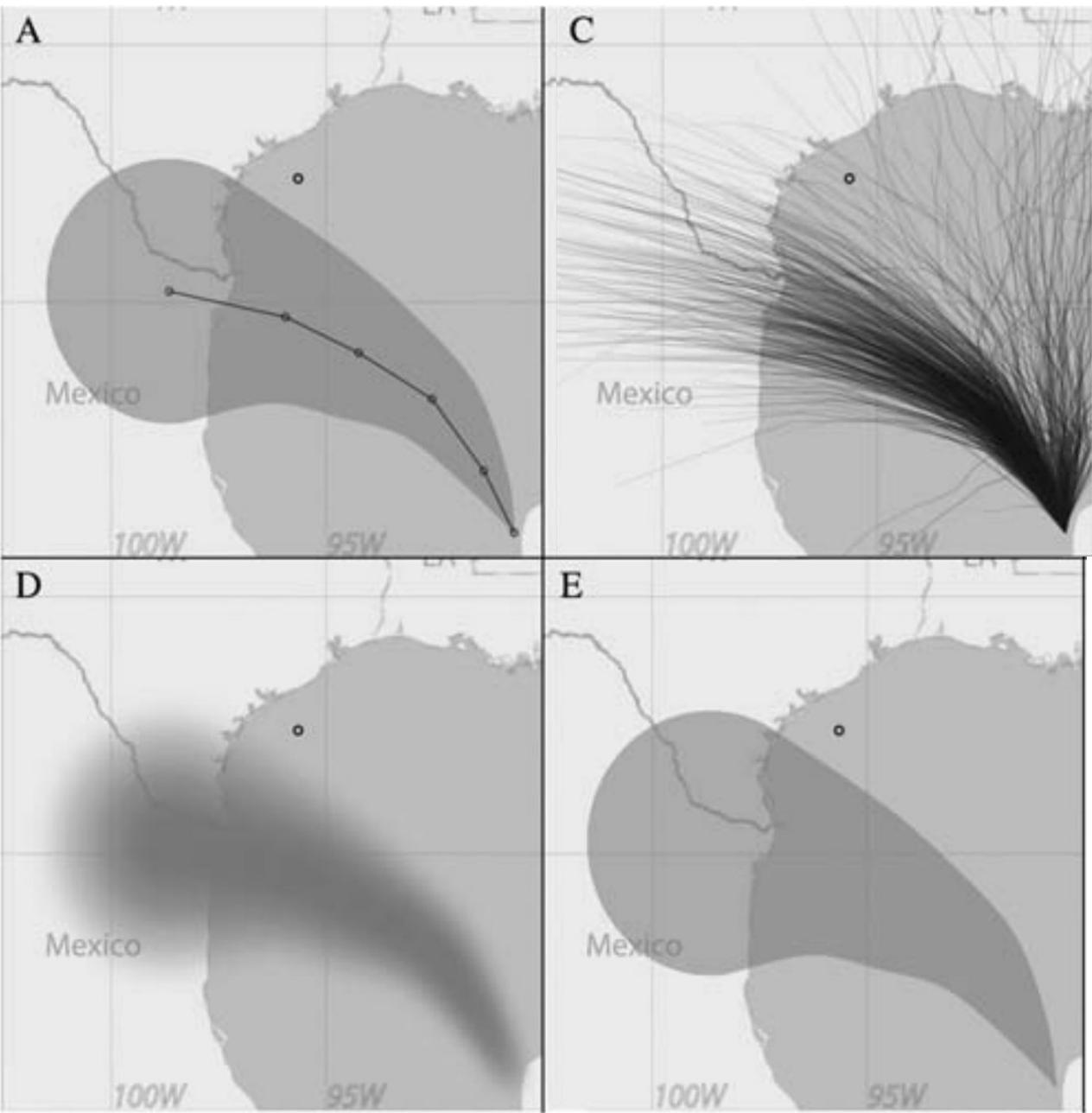
What we could be showing instead

Hurricane **CAIRO** (category 5)

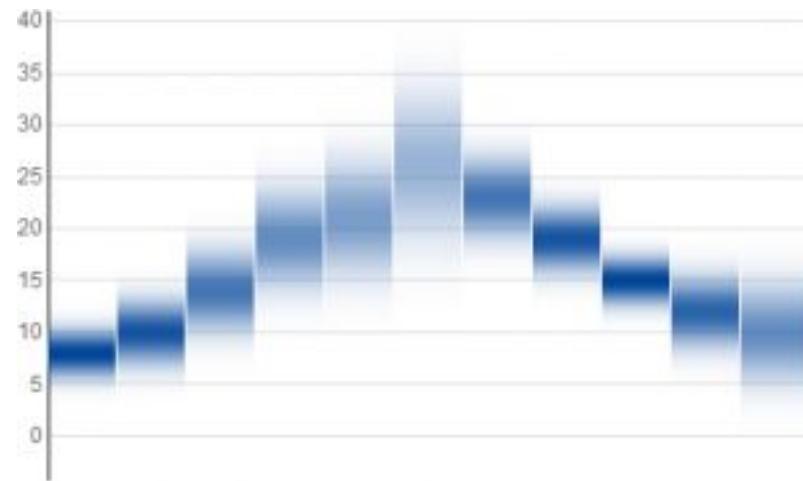
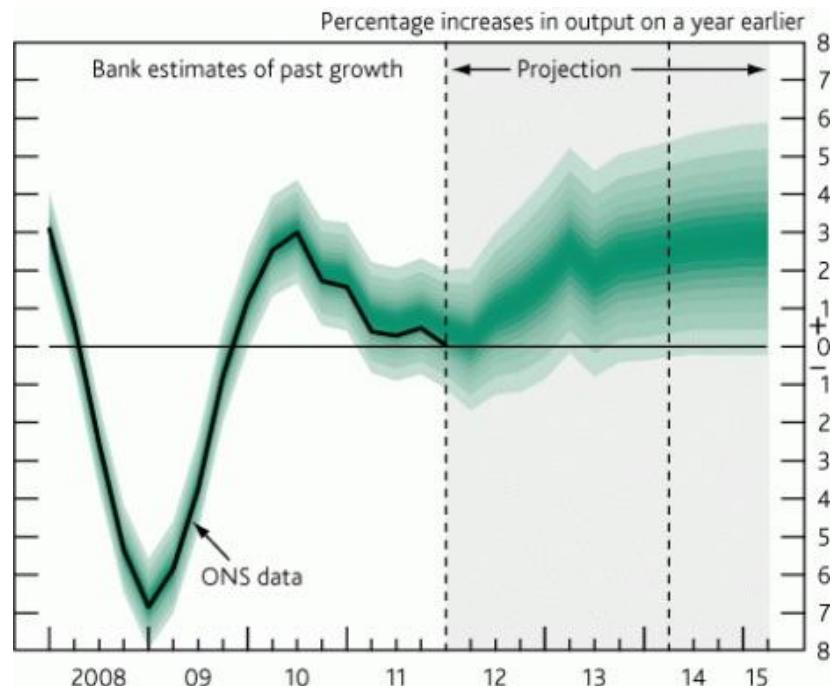
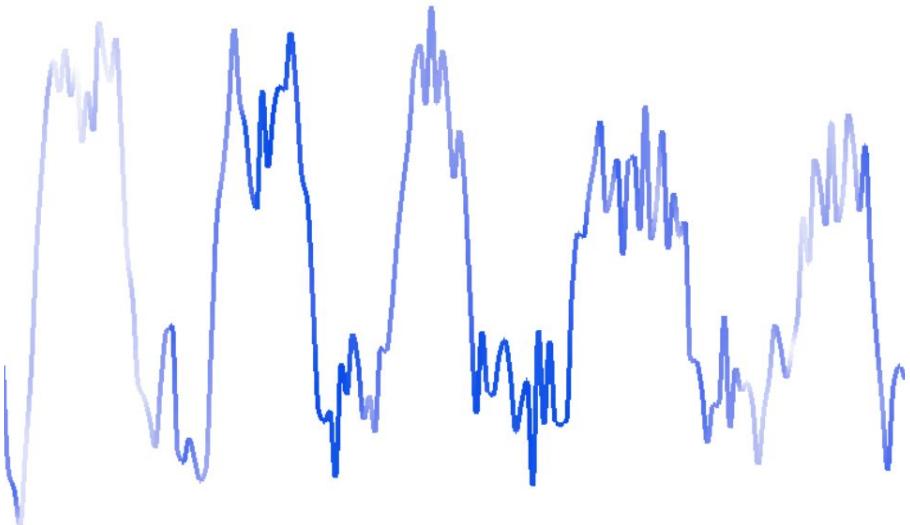


What all this may mean!

Uncertainty



Uncertainty



Guideline #10

"Be clear about uncertainty"

Exceptions: you are sure about it.

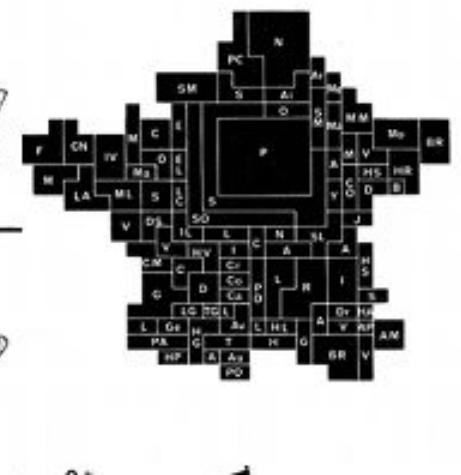
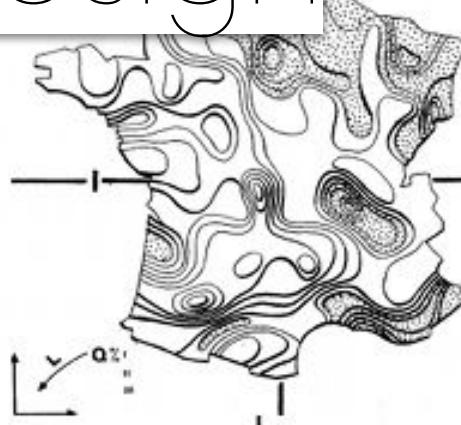
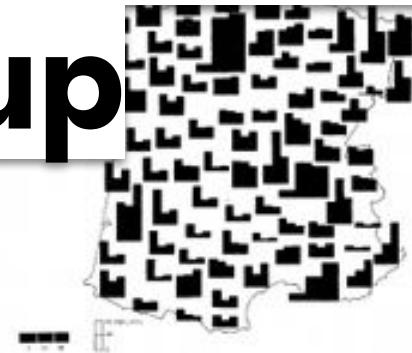
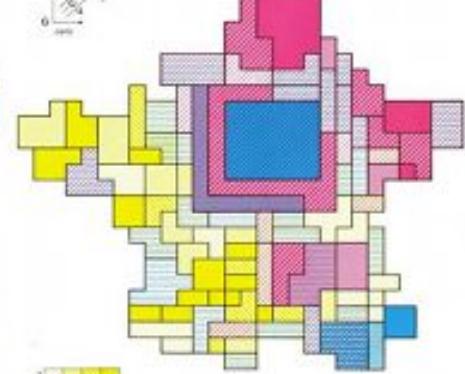
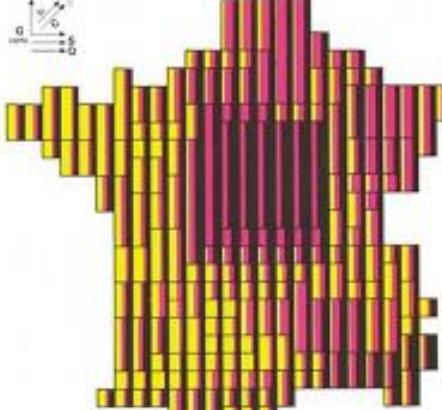
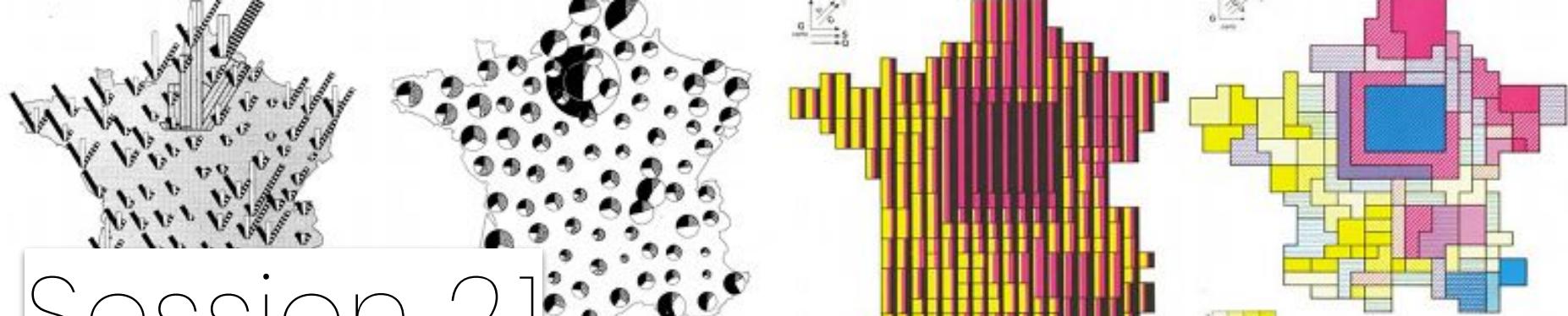
Session 2.1



100 persons



Wrap up



Online Course

Data Visualization for Professionals



THE UNIVERSITY
of EDINBURGH

Benjamin Bach

June 2020

<http://benjbach.me>
<https://datavis-online.github.io>

-- Not for external use --

Wrap up

- (Good) visualizations are perceived pre-attentively and in parallel
- Gestalt laws explain how we perceive higher level patterns in graphical representations
- 3 data types: categorical, ordered, numerical
- 3 visual marks: points, lines, areas
- 7 visual variables: position, size, shape, orientation value, hue, texture
- Color scales: sequential, diverging, categorical
- Guidelines: area-size, data-ink ratio, embellishment, titles, etc.

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