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DATA VISUALIZATION AND VISUAL ANALYTICS

An image is worth 1000 words





Data Visualization

Convey Information through
graphical representation of data

Motivations

- Data everywhere
- No value for raw data
 - Need to extract valuable information
- **Information overload:**
 - Irrelevant for current task
 - Processed in an inappropriate way
 - Presented in an inappropriate way

Attention

“What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention, and a need to allocate that attention efficiently among the overabundance of information sources that might consume it”

-- Herb Simon

Visualization Goal

- Record Information
 - Sketches, photographs, ECG,...
- Analyze data to support decisions (**exploration**)
 - Create and verify hypotheses
 - Identify Patterns
 - Identify Outliers
- Communicate (**explanation**)
 - Share or highlight insights on data
 - Persuade

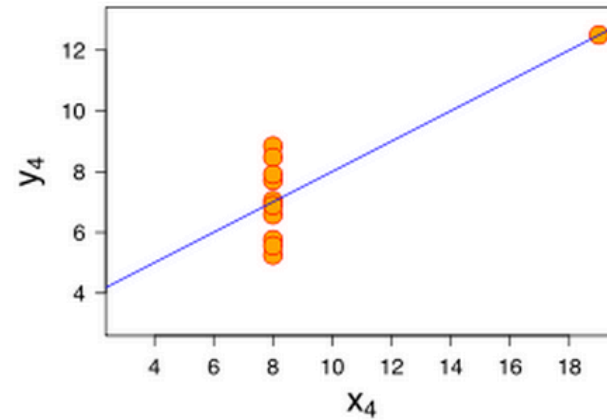
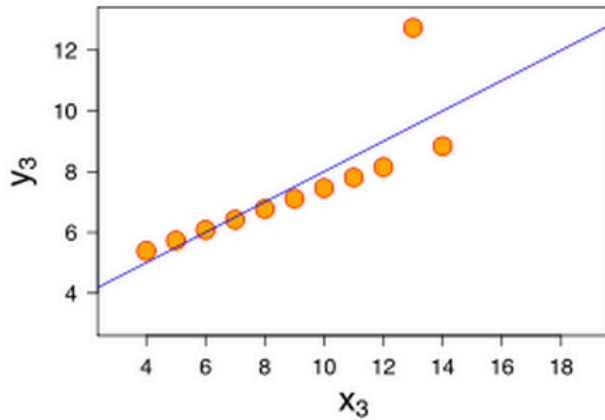
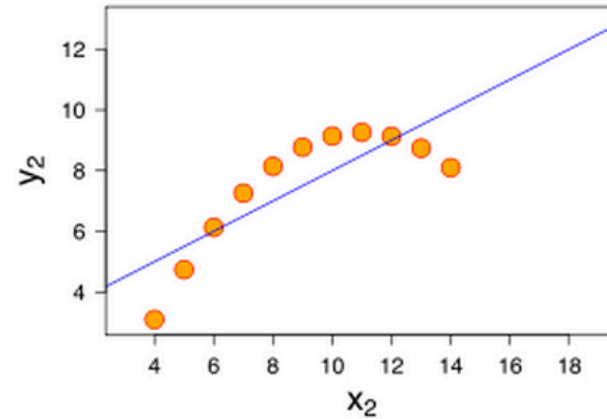
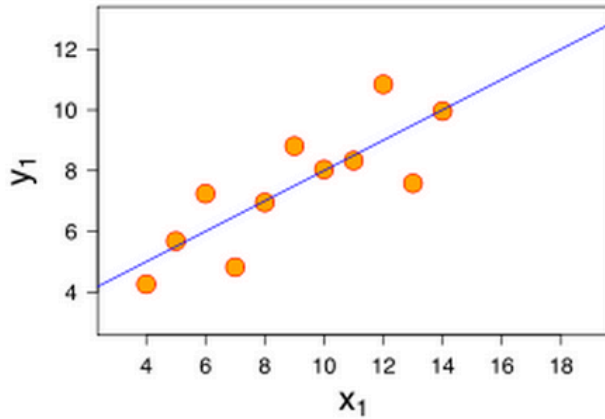
Analyze: Anscombe's quartet - datasets

<i>Data Set A</i>		<i>Data Set B</i>		<i>Data Set C</i>		<i>Data Set D</i>	
X	Y	X	Y	X	Y	X	Y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

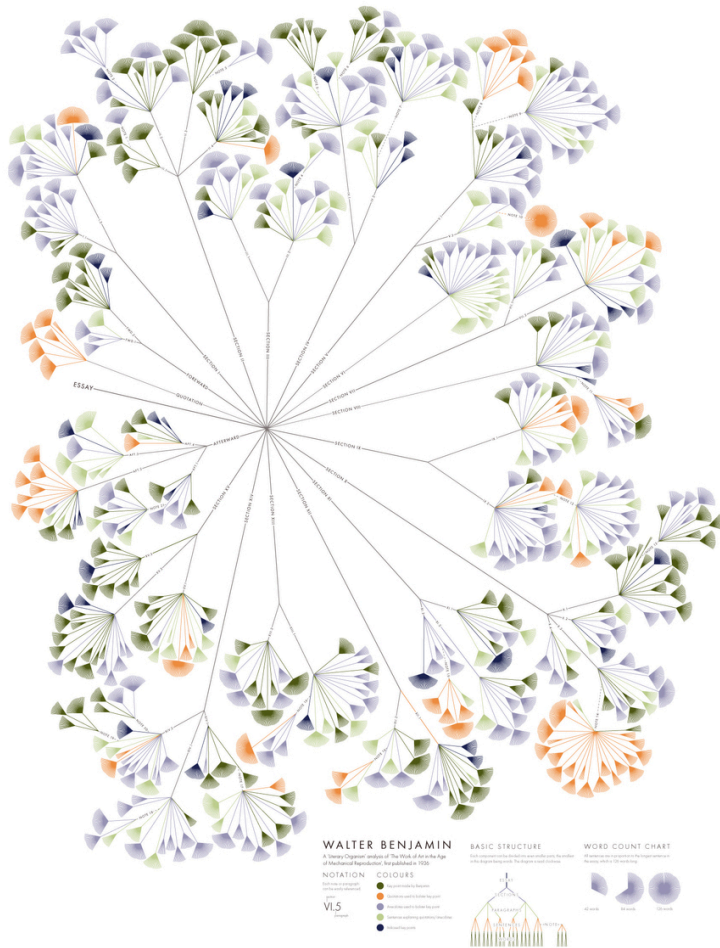
Analyze: Anscombe's quartet - properties

Property	Value
Mean of x in each case	9 (exact)
Sample variance of x in each case	11 (exact)
Mean of y in each case	7.50 (to 2 decimal places)
Sample variance of y in each case	4.122 or 4.127 (to 3 decimal places)
Correlation between x and y in each case	0.816 (to 3 decimal places)
Linear regression line in each case	$y = 3.00 + 0.500x$ (to 2 and 3 decimal places, respectively)

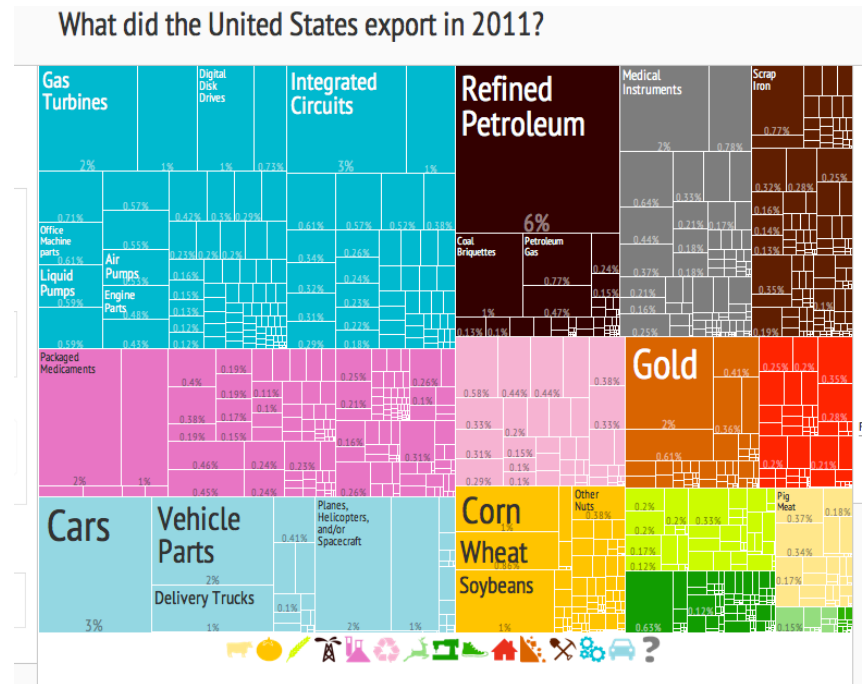
Analyze: Anscombe's quartet – graphics



Communicate: Hierarchical Structures

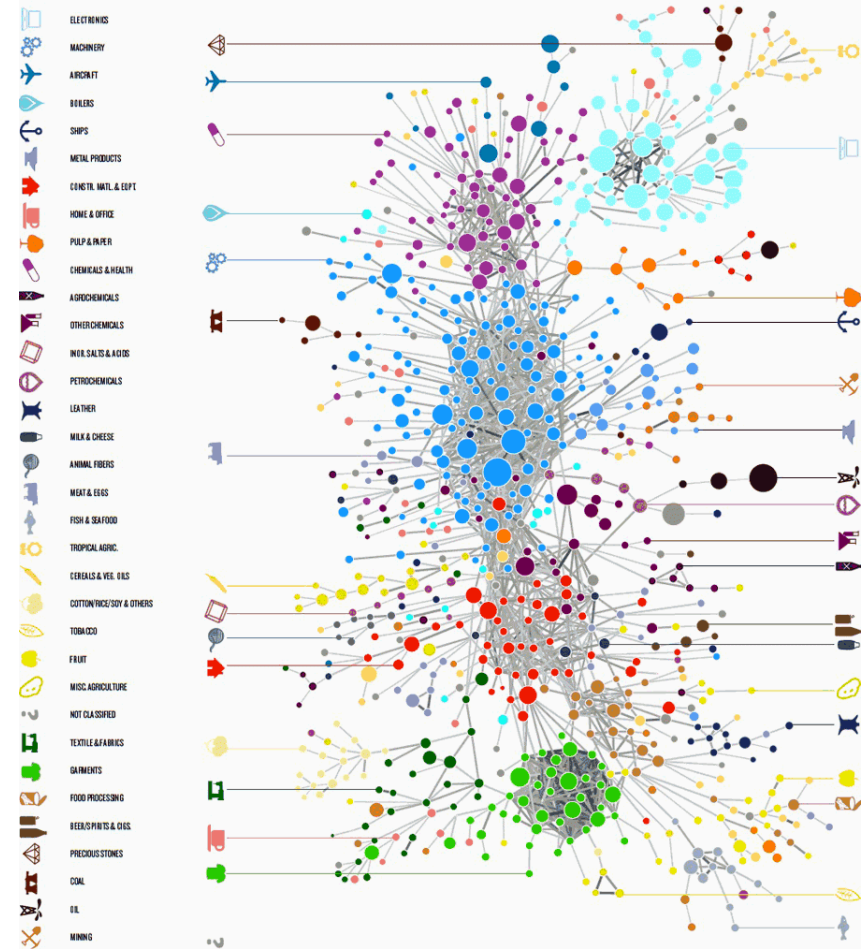
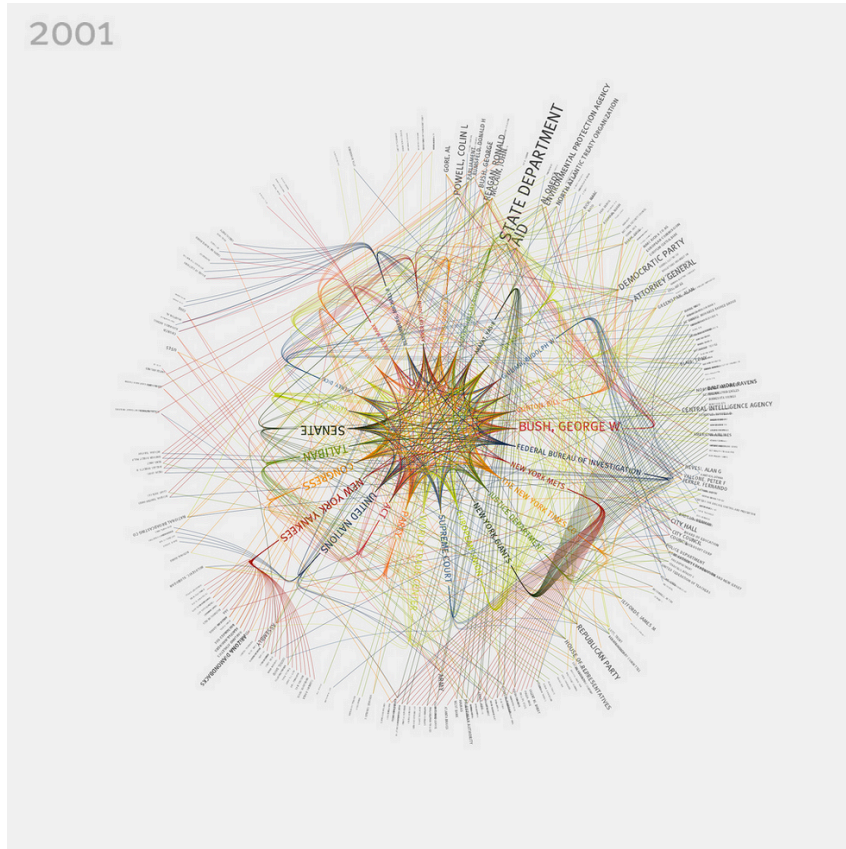


<http://www.stefanieposavec.co.uk/entangled-word-bank/>



<http://atlas.media.mit.edu/>

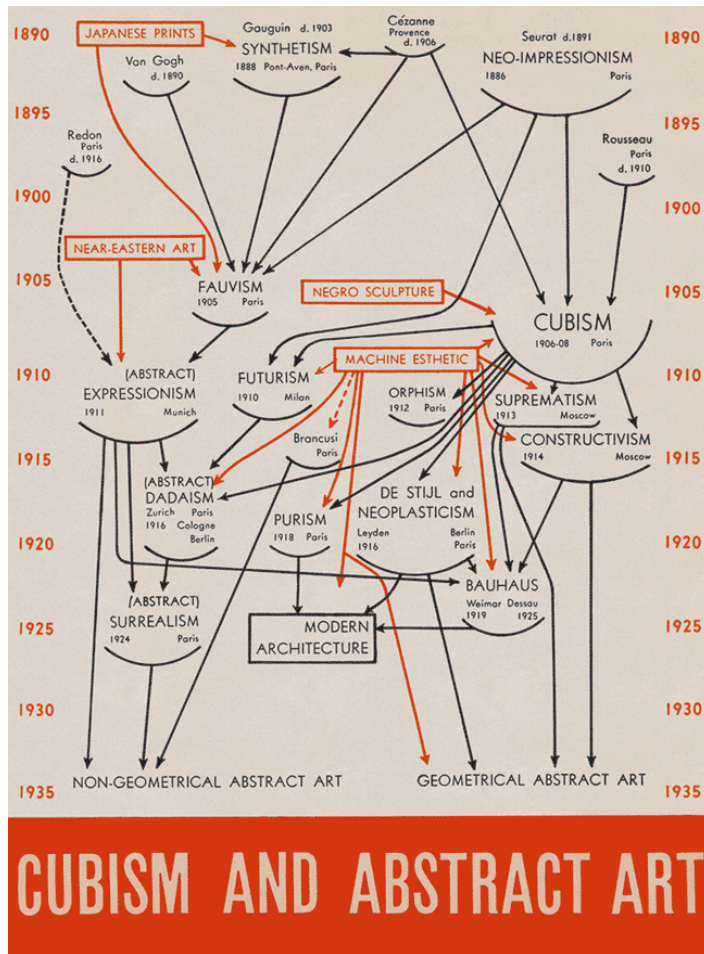
Communicate: Networks



<https://www.flickr.com/photos/blprnt/sets/72157614008027965/>

<http://atlas.media.mit.edu/>

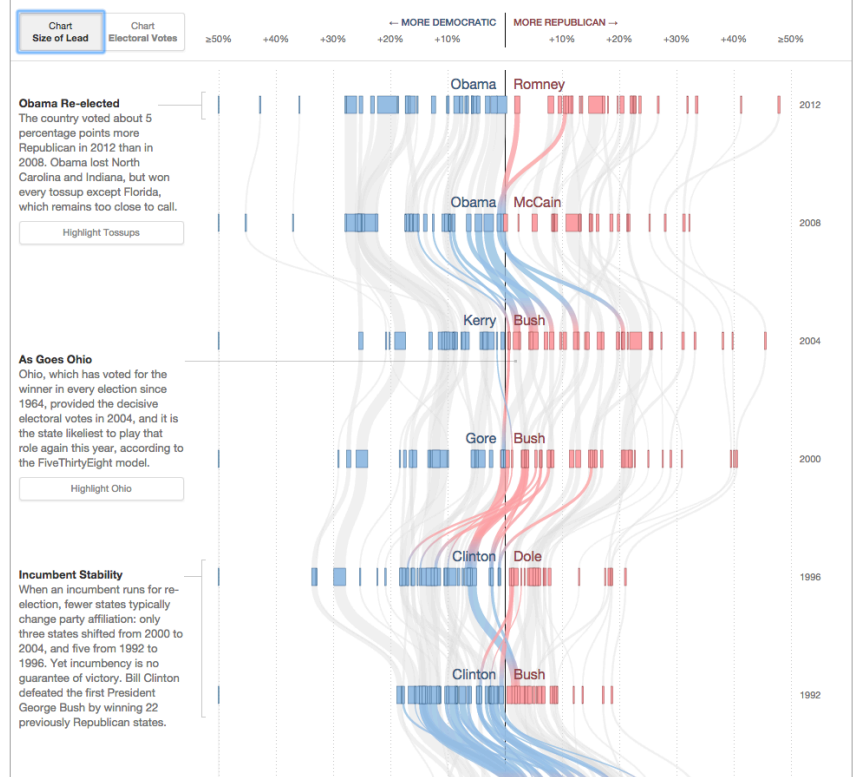
Communicate: Temporal Structures



Cubism And Abstract Art (Alfred H. Barr 1936)

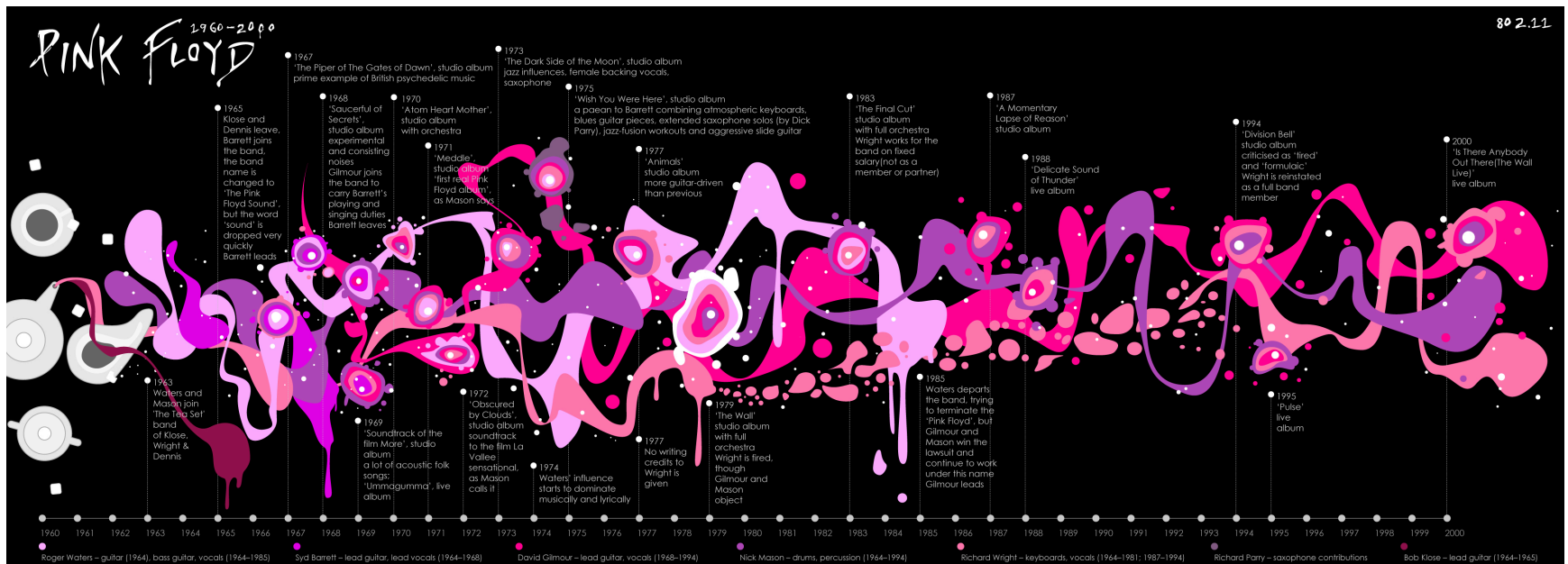
Over the Decades, How States Have Shifted

Recent elections have placed a heavy emphasis on "swing states" – Ohio, Florida and the other competitive states. Yet in the past, many more states shifted between the Democratic and Republican parties. A look at how the states stacked up in the 2012 election and how they have shifted over past elections.



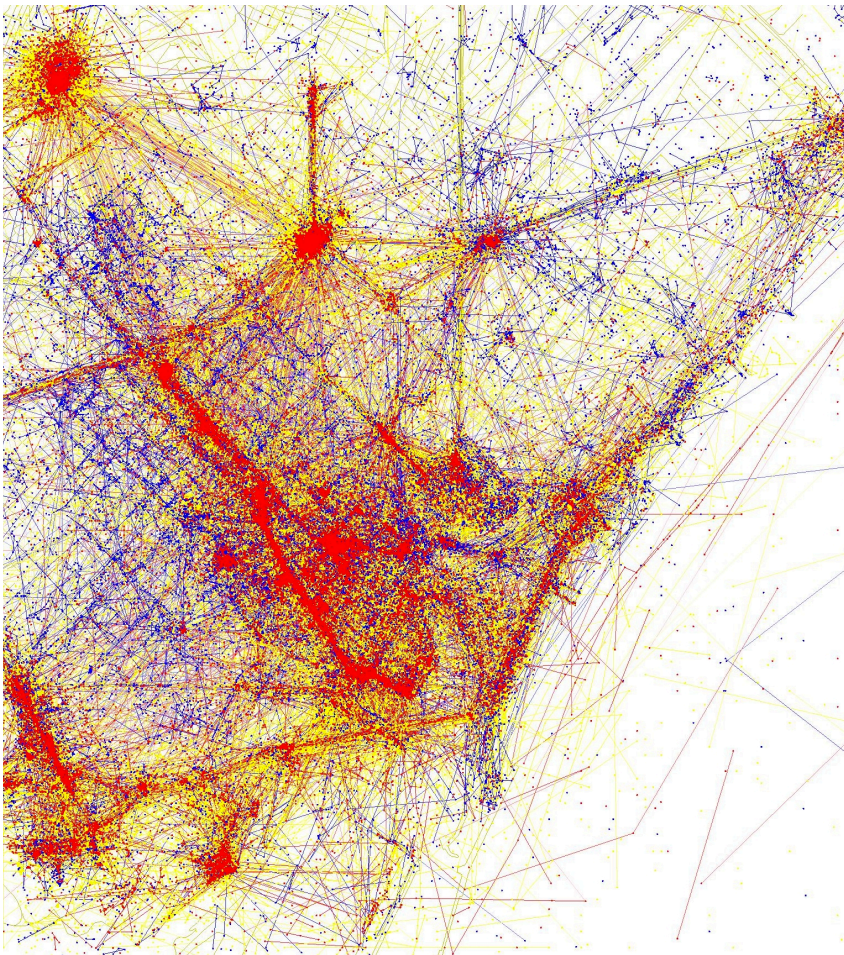
<http://www.nytimes.com/interactive/2012/10/15/us/politics/swing-history.html>

Communicate: Temporal Structures

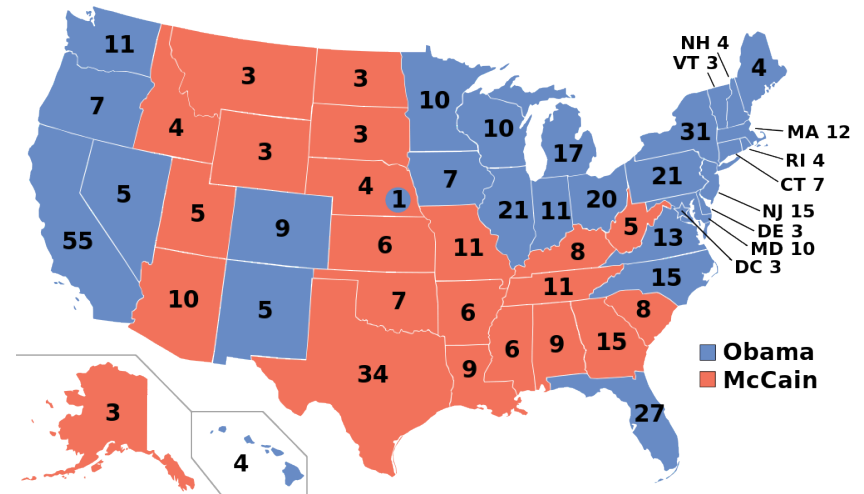


<http://www.80211.cc/>

Communicate: Maps

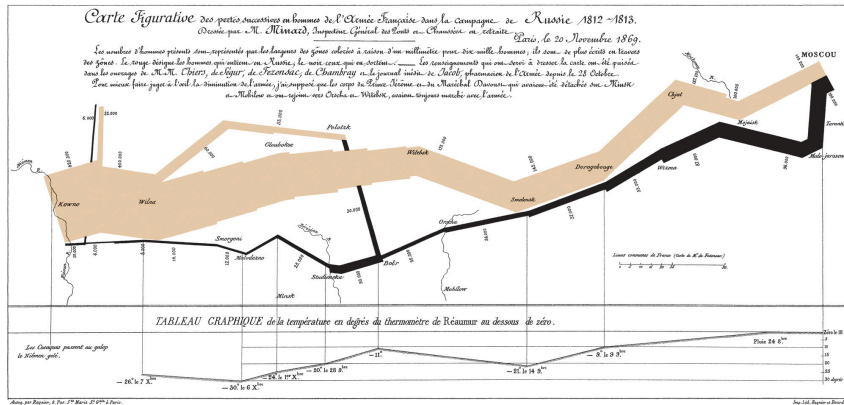


<https://www.flickr.com/photos/walkingsf/sets/72157624209158632/>

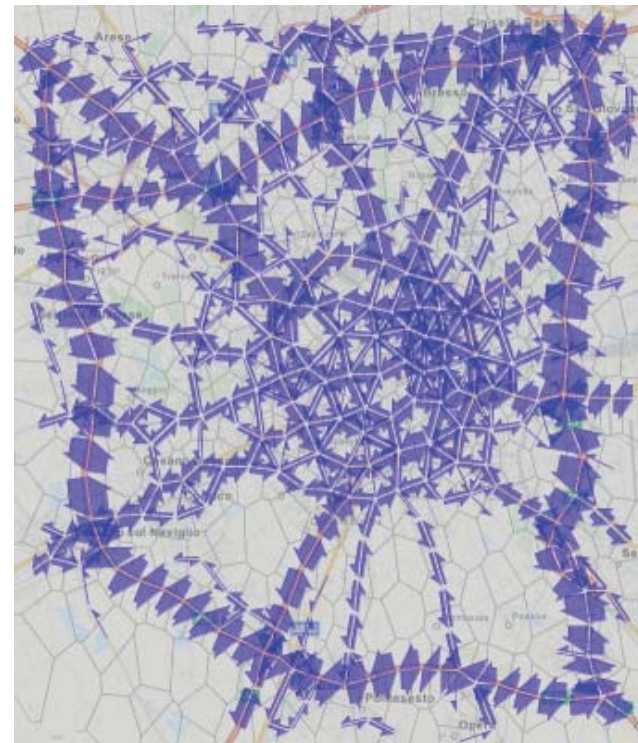


"ElectoralCollege2008" by Gage - Own work. Licensed under Public Domain via Wikimedia Commons - <http://commons.wikimedia.org/wiki/File:ElectoralCollege2008.svg#mediaviewer/File:ElectoralCollege2008.svg>

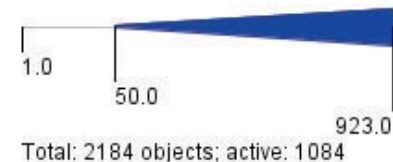
Communicate: Spatio-Temporal data



"Minard" by Charles Minard (1781-1870) - see upload log. Licensed under Public Domain via Wikimedia Commons - <http://commons.wikimedia.org/wiki/File:Minard.png#mediaviewer/File:Minard.png>



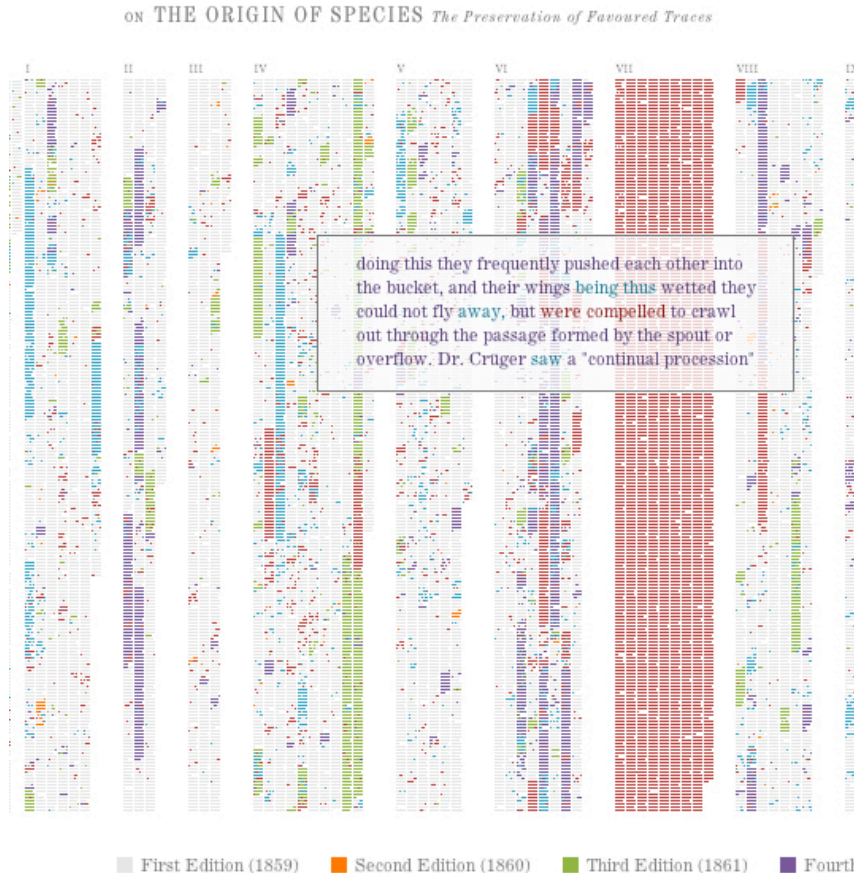
N of moves



Visual Analytics of Movement.

G. Andrienko, N. Andrienko, P. Bak, D. Keim, S. Wrobel

Communicate: Text



<http://benfry.com/writing/archives/529>

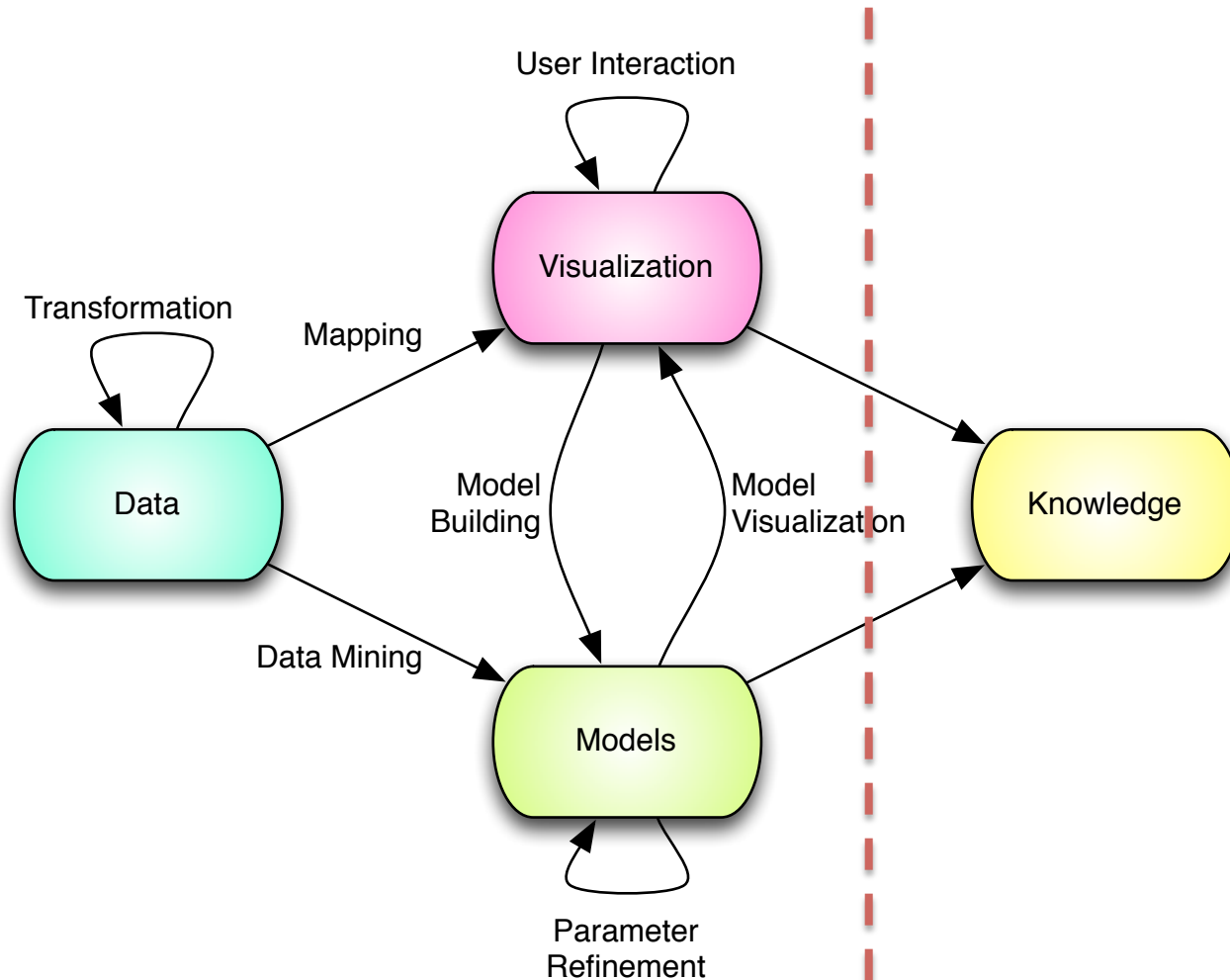
Visualization and Visual Analytics

- Make data and information processing transparent
- Combine strengths of humans and computers

**Computers are
incredibly fast,
accurate,
and stupid;
humans are
incredibly slow,
inaccurate
and brilliant;
together
they are powerful
beyond
imagination.**

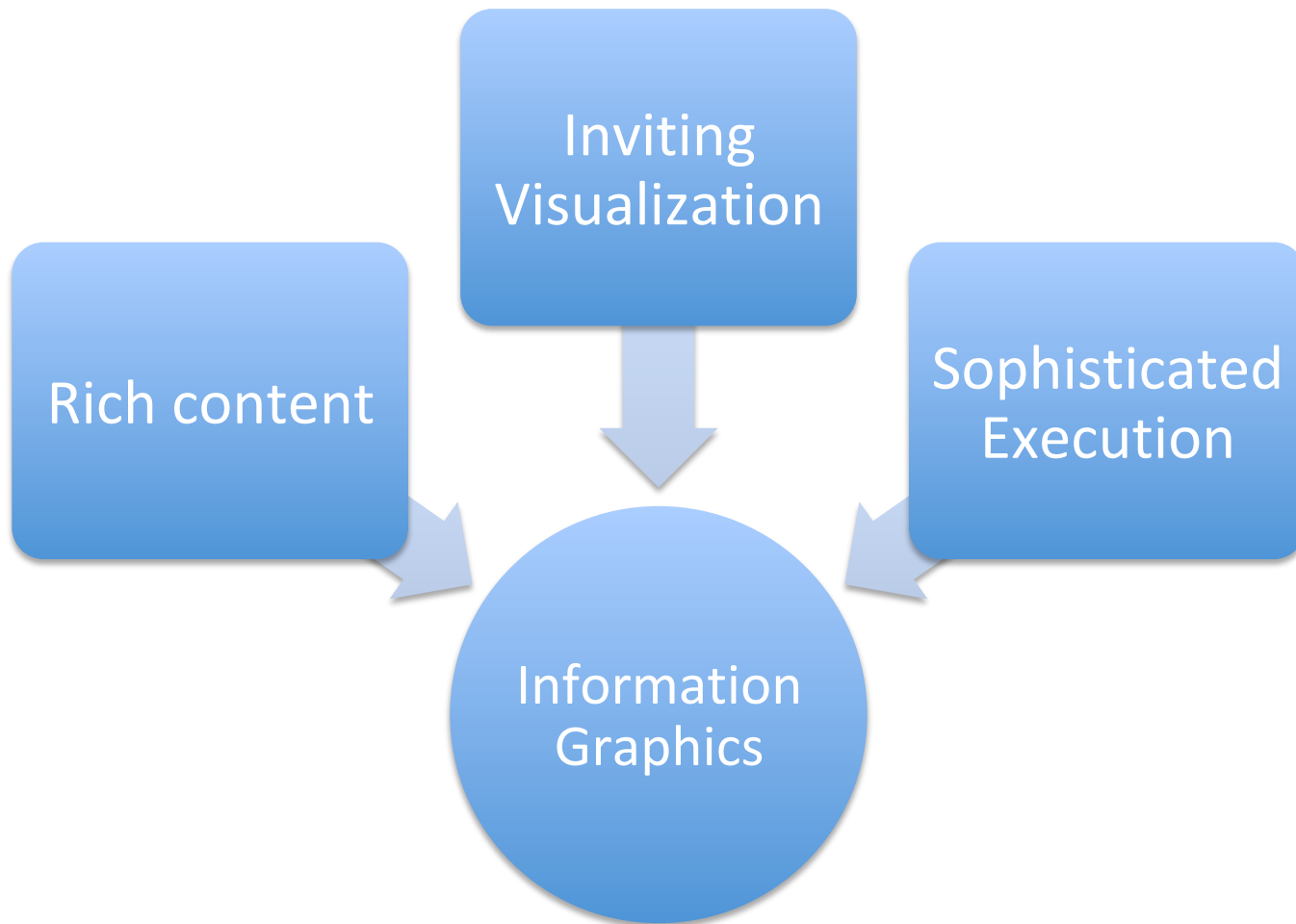
Albert Einstein

Visual Analytical Process



Exploration ! **Explanation**

Elements of Good Visualization

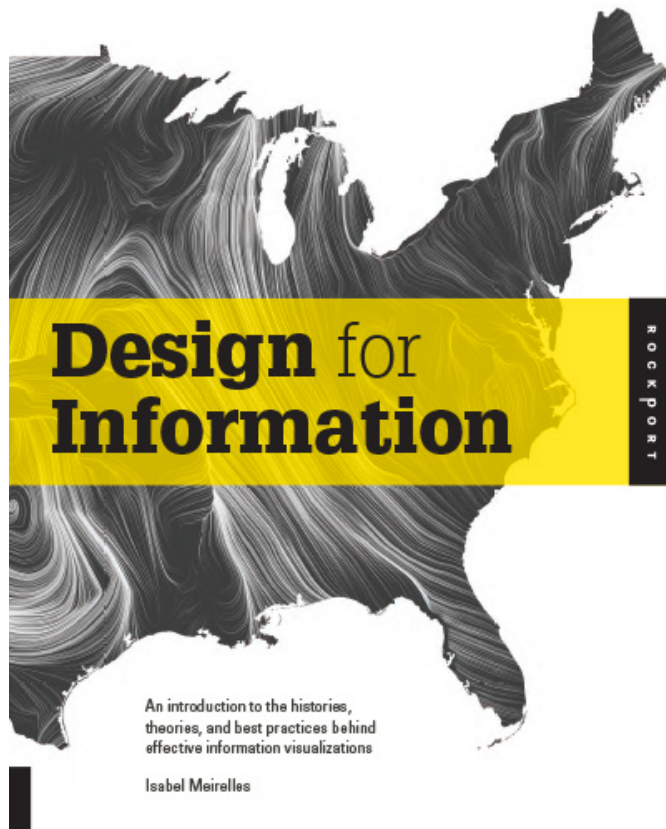


Importance of valid data

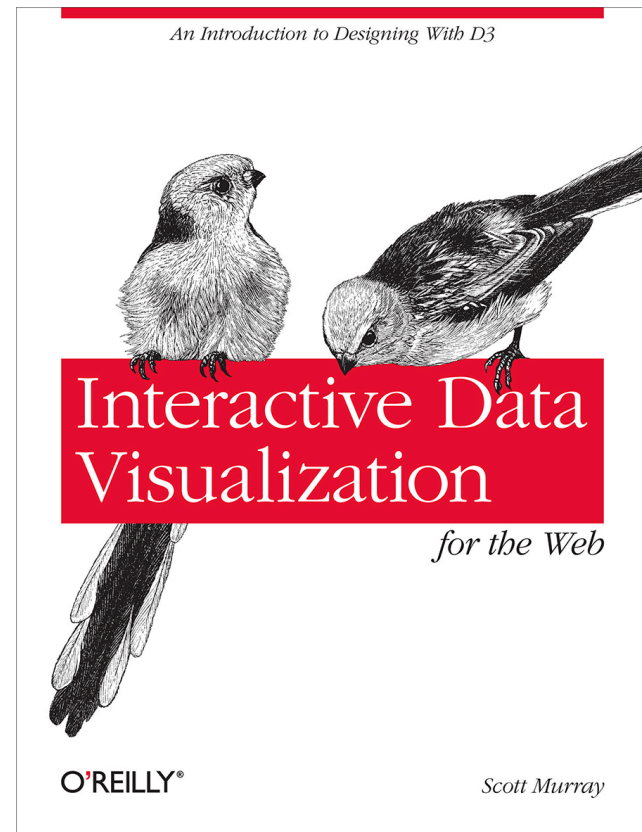


Textbooks

Design for Information Isabel Meirelles



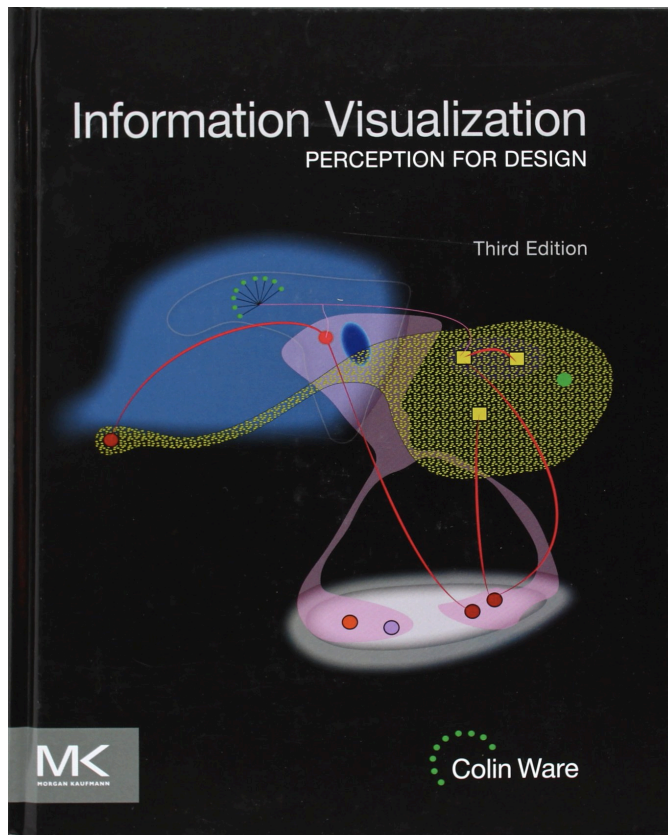
Interactive Data Visualization Scott Murray



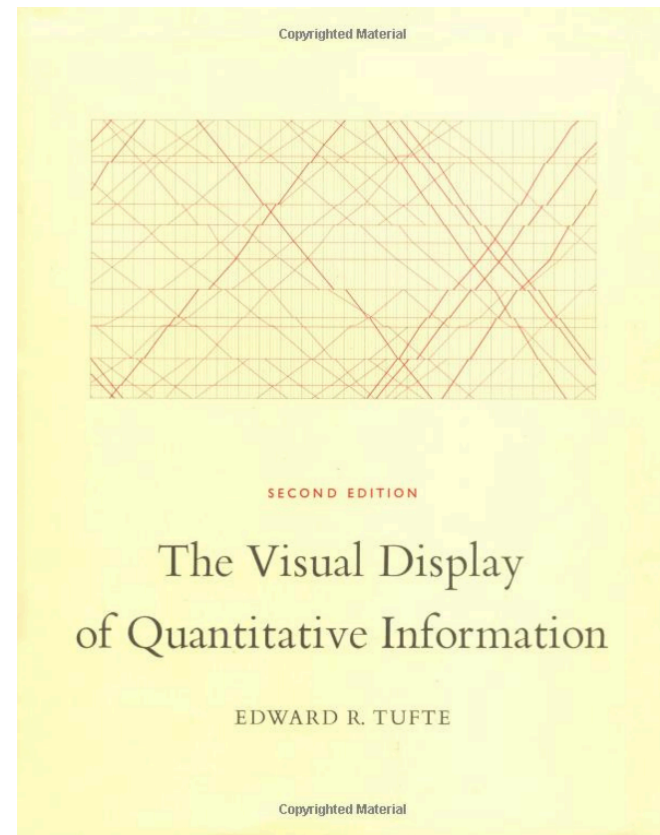
<http://alignedleft.com/tutorials>

Interesting Readings

Information Visualization Colin Ware



The Visual Display of Visual Information Edward R. Tufte



Other Resources

Observe how others resolved design problems

datavisualization.ch

informationisbeautiful.net

infosthetics.com



VISION AND PERCEPTION

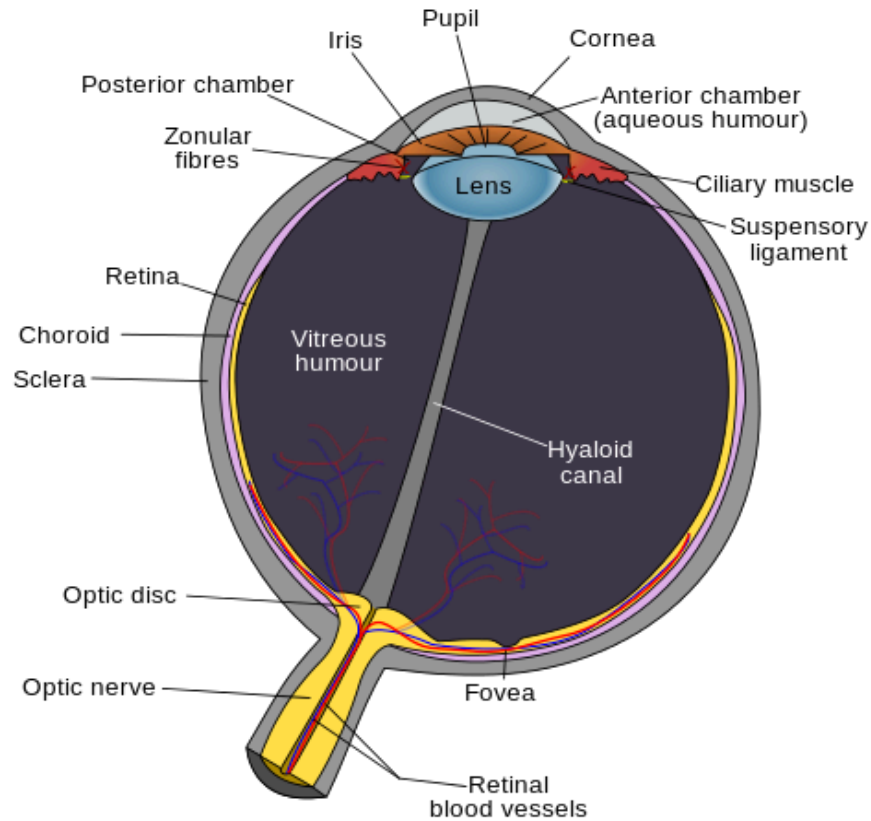
Perception and Cognition



VS

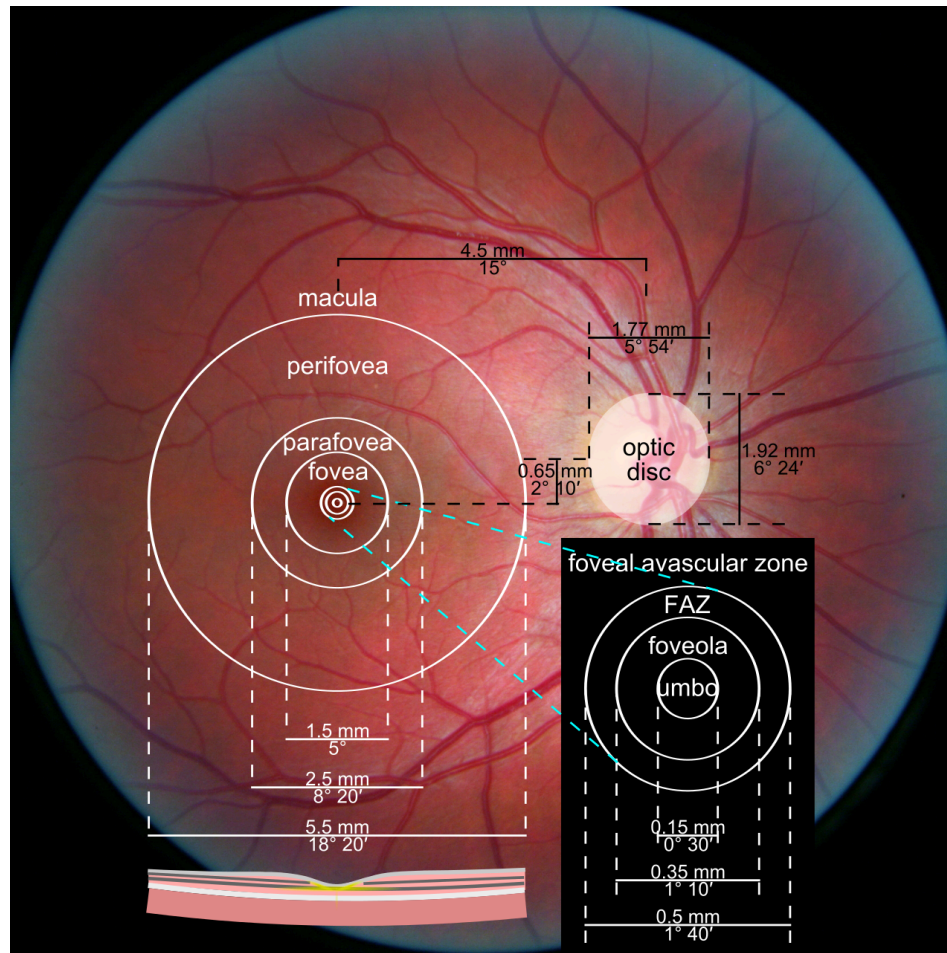


Human Eye



"Schematic diagram of the human eye en" by Rhcastilhos - Schematic_diagram_of_the_human_eye_with_English_annotations.svg. Licensed under Public Domain via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Schematic_diagram_of_the_human_eye_en.svg#mediaviewer/File:Schematic_diagram_of_the_human_eye_en.svg

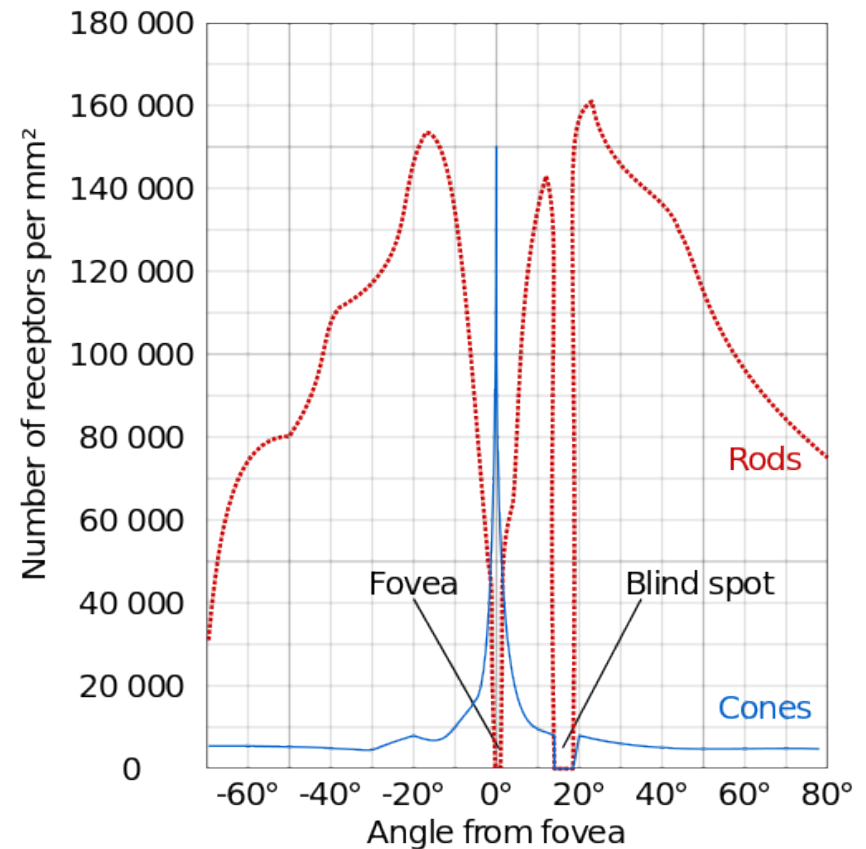
Macula and Fovea



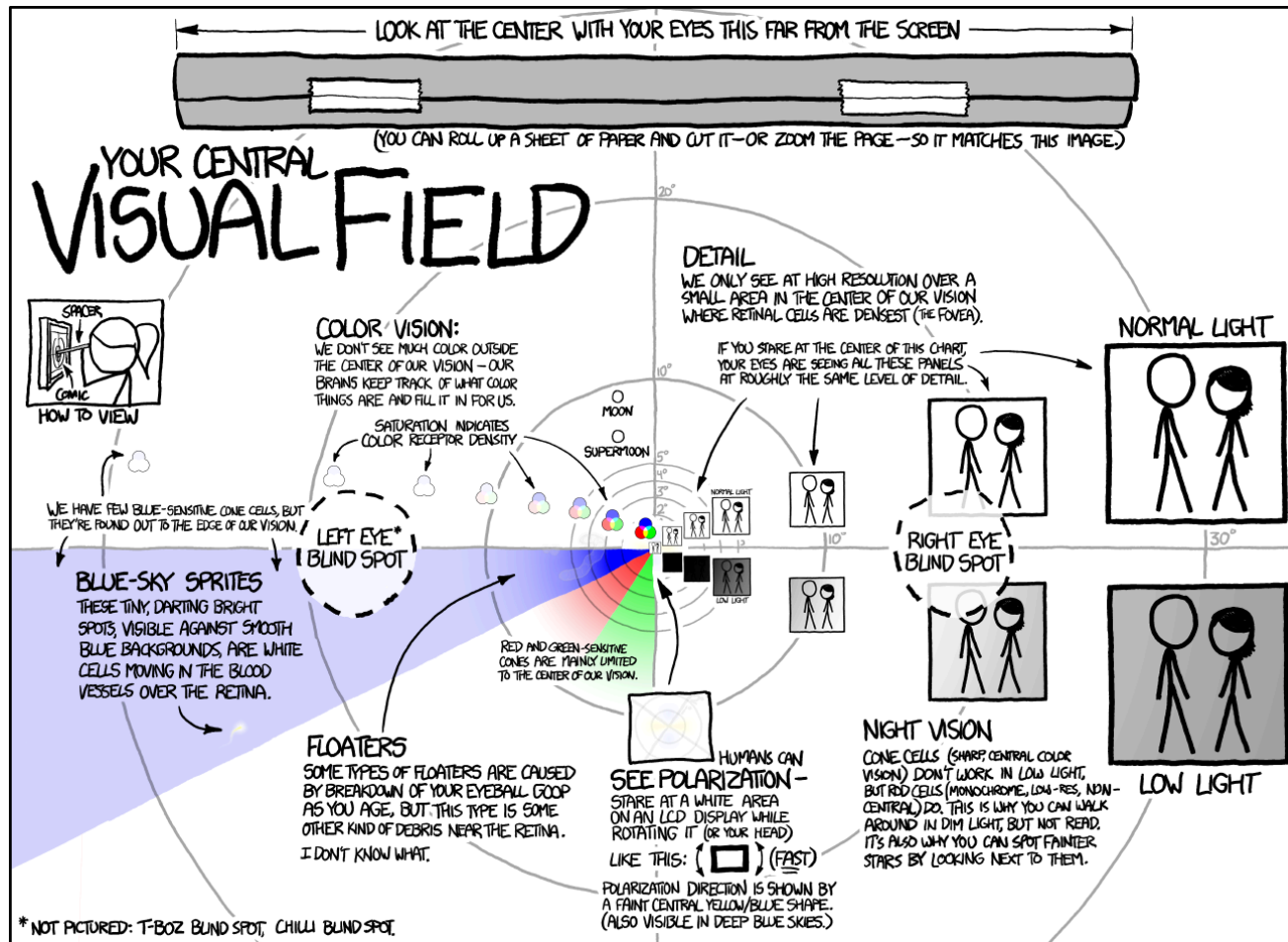
"Macula" by Photograph: Danny Hope from Brighton & Hove, UK -
File:Right_eye_retina.jpg (which come from My Right Eye). Licensed under CC BY
2.0 via Wikimedia Commons - [http://commons.wikimedia.org/wiki/
File:Macula.svg#mediaviewer/File:Macula.svg](http://commons.wikimedia.org/wiki/File:Macula.svg#mediaviewer/File:Macula.svg)

Photo Receptor Cells

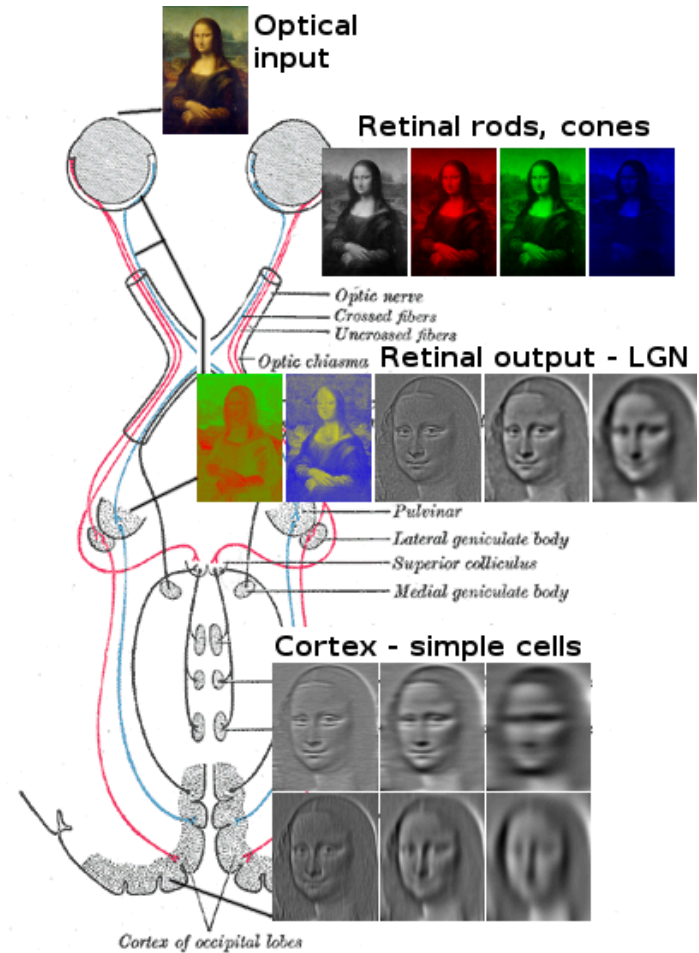
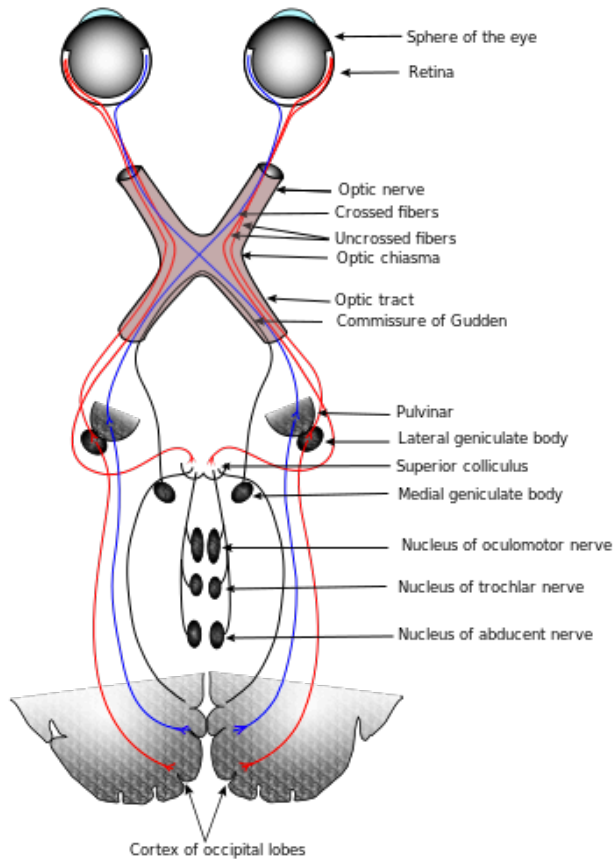
- Two types of light sensitive cells
 - **Rod Cells** (~120M)
 - Provide low-light vision
 - Peripheral vision
 - Almost no role in color vision
 - **Cone cells** (~6M)
 - Provide normal vision
 - Three sub-types of cells
 - Sensitivity to different light wavelengths
 - Used for colored vision



Vision Resolution



Visual System

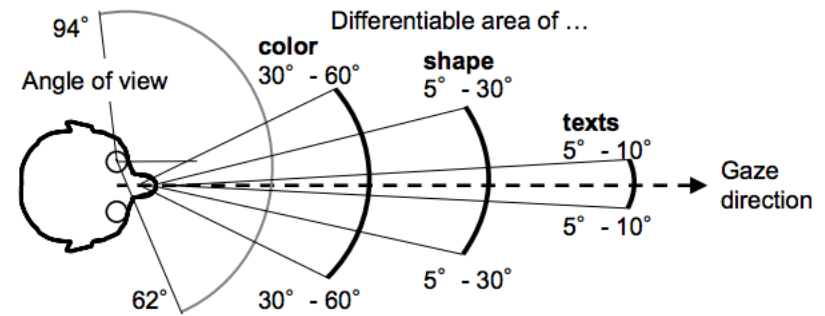


"Gray722-svg" by KDS444 - <https://commons.wikimedia.org/wiki/File:Gray722.png>. Licensed under Public Domain via Wikimedia Commons - <http://commons.wikimedia.org/wiki/File:Gray722-svg.svg#/media/File:Gray722-svg.svg>

"Lisa analysis" by Clock - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Lisa_analysis.png#/media/File:Lisa_analysis.png

Vision Resolution

- Fovea yields the highest resolution (normal light)
- Fovea occupies around 15° of visual field
- Highest resolution is provided by *fovea centralis* (around 1°)



Komatsubara, A. Human error, Maruzen co. Ltd. 2008. (In japanese)

Photo Receptor Cells

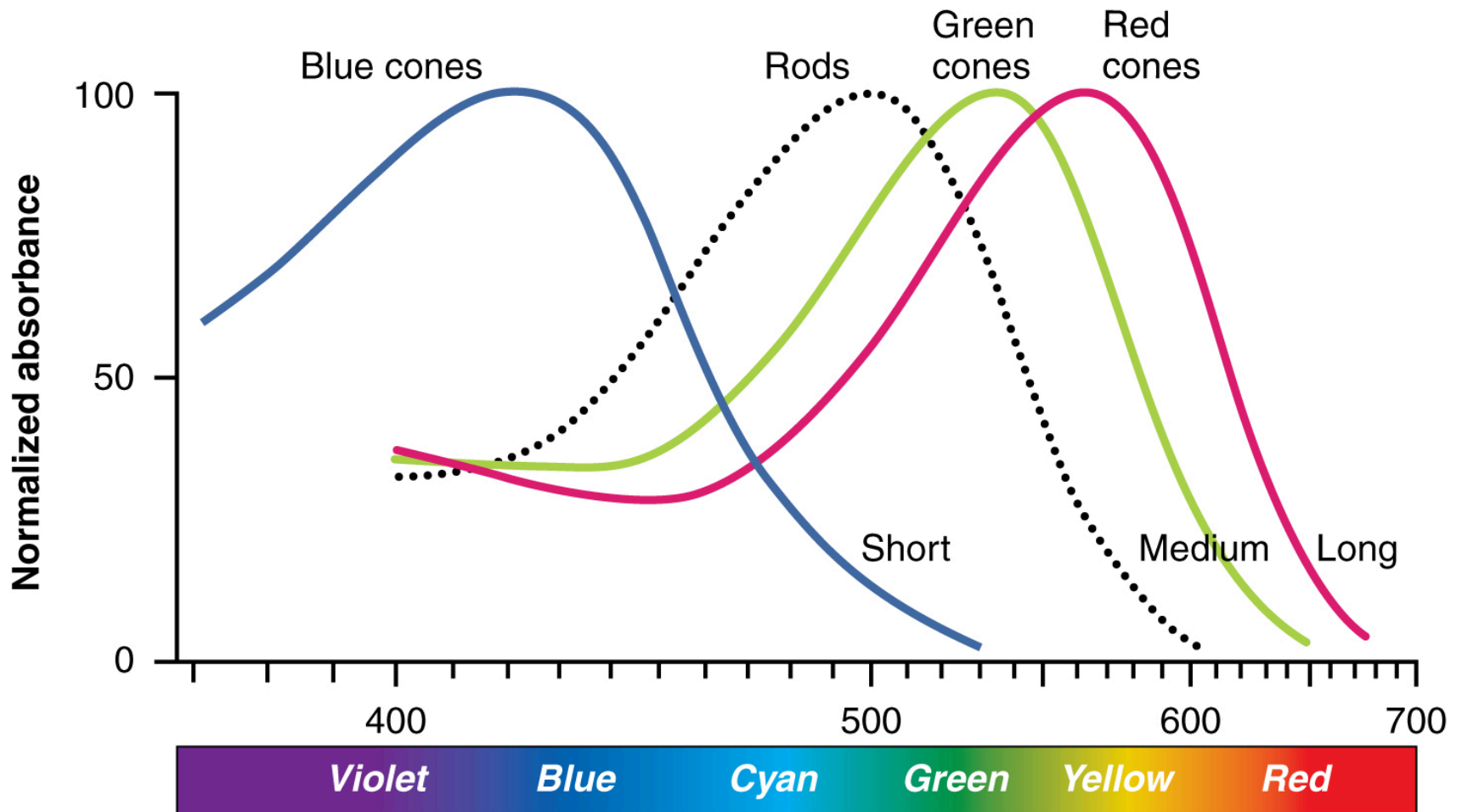
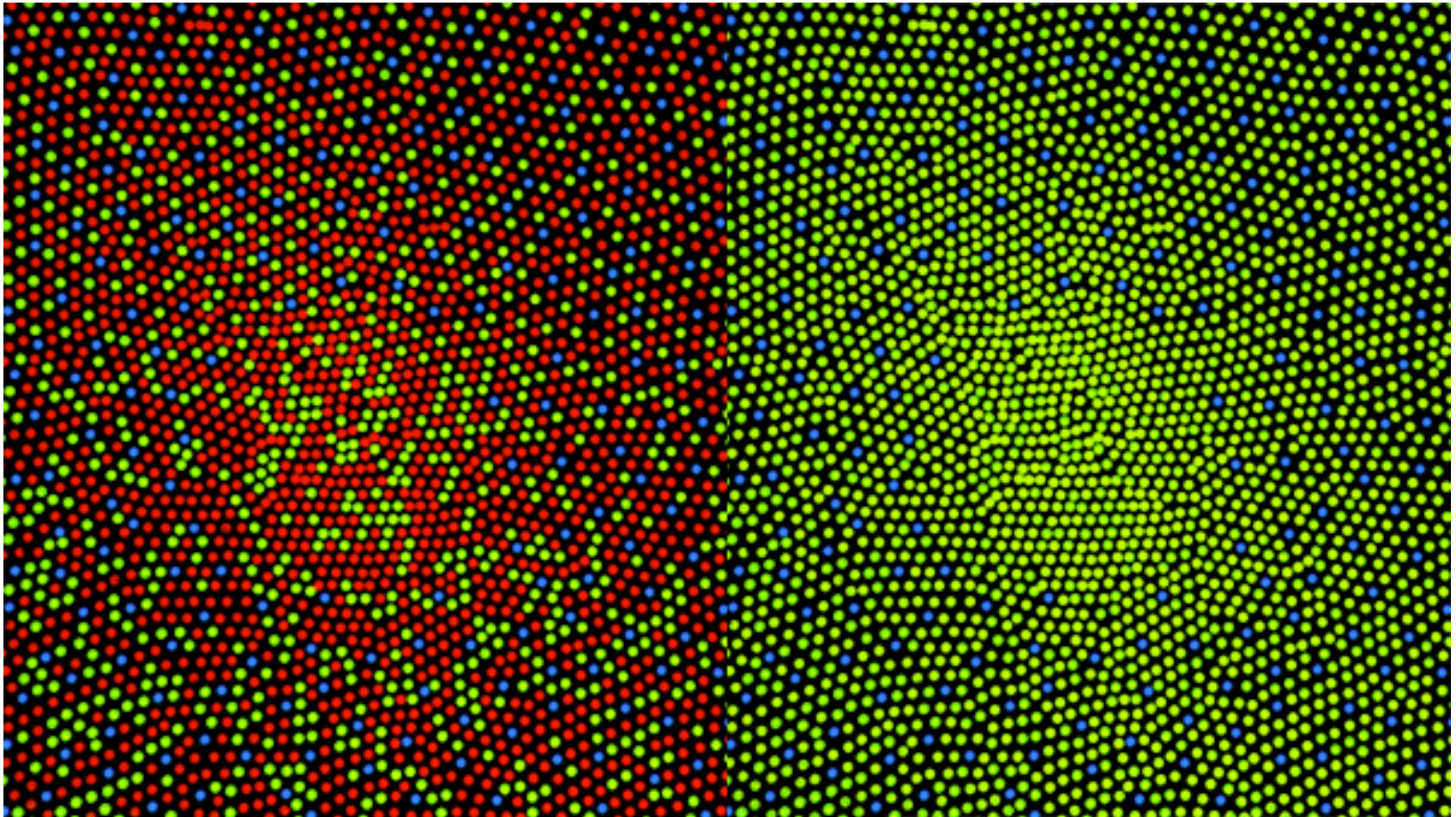


Photo Receptor Cells

Distribution of cone cells in the fovea of an individual with normal color vision (left), and a color blind retina.



"ConeMosaics" by Mark Fairchild. Licensed under CC BY-SA 3.0 via Wikimedia Commons - <http://commons.wikimedia.org/wiki/File:ConeMosaics.jpg#mediaviewer/File:ConeMosaics.jpg>

Where is Waldo? – Game #2

THE GOBBLING GLUTTONS

ONCE UPON A TIME, WALDO EMBARKED UPON A FANTASTIC JOURNEY. FIRST, AMONG A THRONG OF GOBBLING GLUTTONS, HE MET WIZARD WHITEBEARD, WHO COMMANDED HIM TO FIND A SCROLL AND THEN TO FIND ANOTHER AT EVERY STAGE OF HIS JOURNEY. FOR WHEN HE HAD FOUND 12 SCROLLS, HE WOULD UNDERSTAND THE TRUTH ABOUT HIMSELF.

IN EVERY PICTURE FIND WALDO, WOOF (BUT ALL YOU CAN SEE IS HIS TAIL), WENDA, WIZARD WHITEBEARD, ODLAW, AND THE SCROLL. THEN FIND WALDO'S KEY, WOOF'S BONE (IN THIS SCENE IT'S THE BONE THAT'S NEAREST TO HIS TAIL), WENDA'S CAMERA, AND ODLAW'S BINOCULARS.



THERE ARE ALSO 25 WALDO-WATCHERS, EACH OF WHOM APPEARS ONLY ONCE SOMEWHERE IN THE FOLLOWING 12 PICTURES. AND ONE MORE THING! CAN YOU FIND ANOTHER CHARACTER, NOT SHOWN BELOW, WHO APPEARS ONCE IN EVERY PICTURE EXCEPT THE LAST?



High Resolution Vision

- HiRes vision is limited to a narrow angle of field vision
- Eyes move to scan an object in order to expose the image on the fovea
- The movement of eyes is not regular or linear

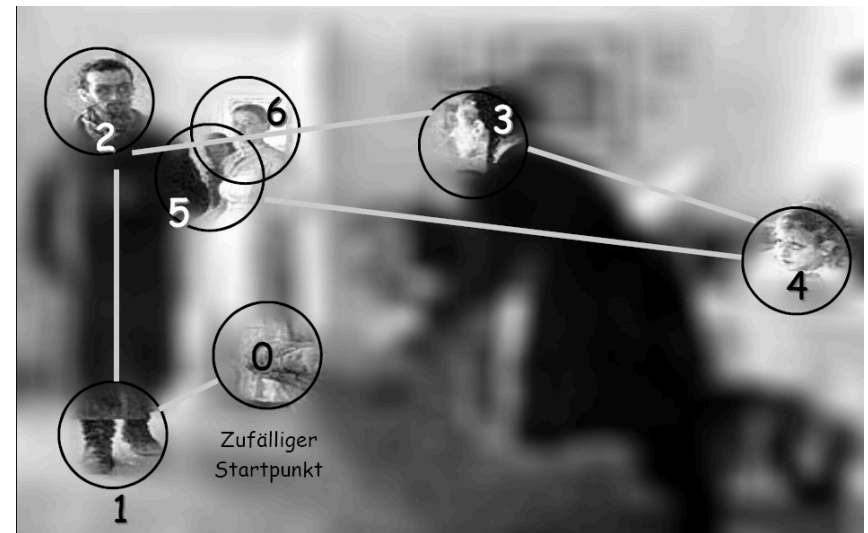


Bild 11: Foveale Ergänzung durch die ersten 6 Fixationen (nach Daten von Yarbus, 1967)

"Vision 2 secondes" by Hans-Werner Hunziker. Licensed under CC BY 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Vision_2_secondes.jpg#/media/File:Vision_2_secondes.jpg

Eye Tracking for Design



Top-Down Attention



<http://channel.nationalgeographic.com/brain-games/videos/brain-games-pay-attention/>

Game #4 – How many 3s?

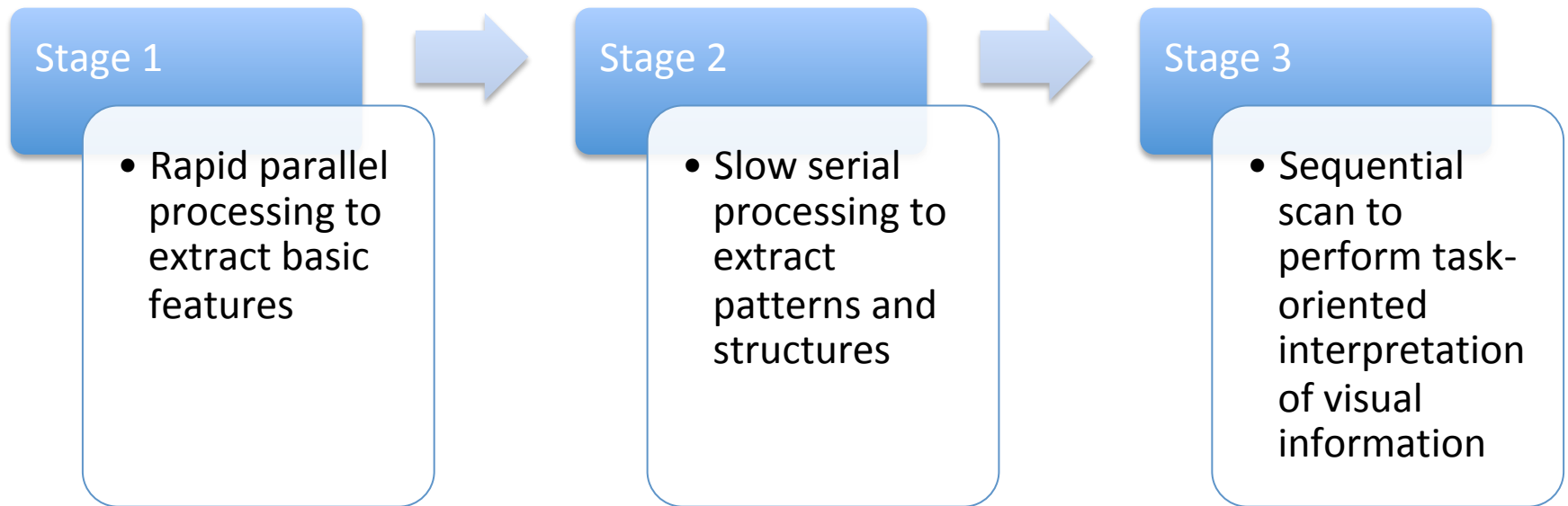
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5463479654321320354968413
2068798417184529529287149
2174953178195293926546831
3546516509898554684982984

1258965168765132168943213
5463479654321320354968413
2068798417184529529287149
2174953178195293926546831
3546516509898554684982984

1258965168765132168943213
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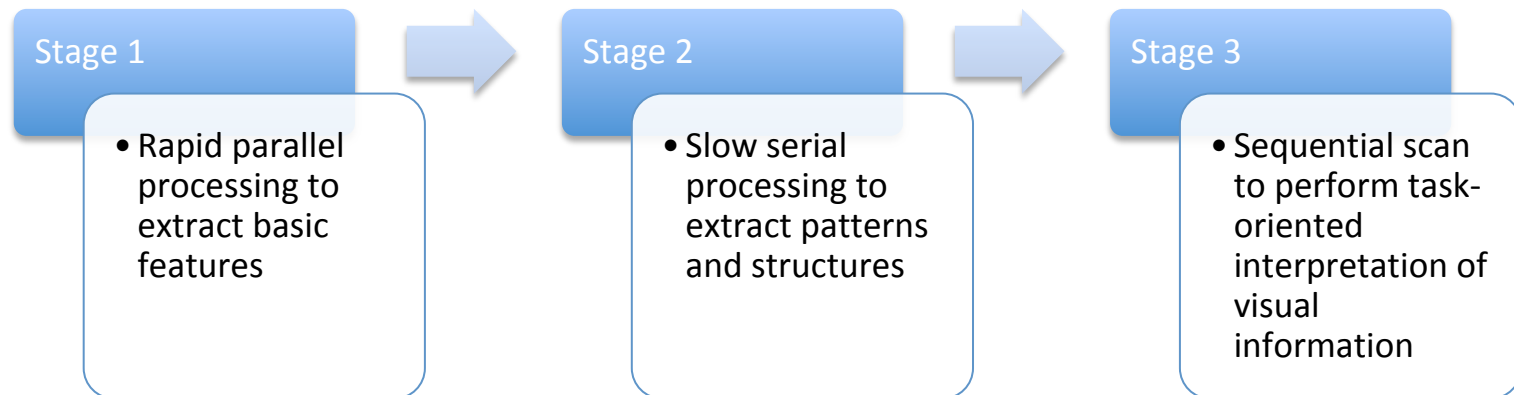
How many “3”?

Perception and Cognition



Visual Perception

- Early visual processing takes place without our conscious intervention
- Graphs that convey information at this level allow the observer to be more efficient in decoding



Visual Cognition

- At second stage, the observer is required to consciously analyze the image/scene
- At this level, the observer can perform higher level reasoning
 - This object is larger than the other one
 - This street slope is lower than the previous

Timer

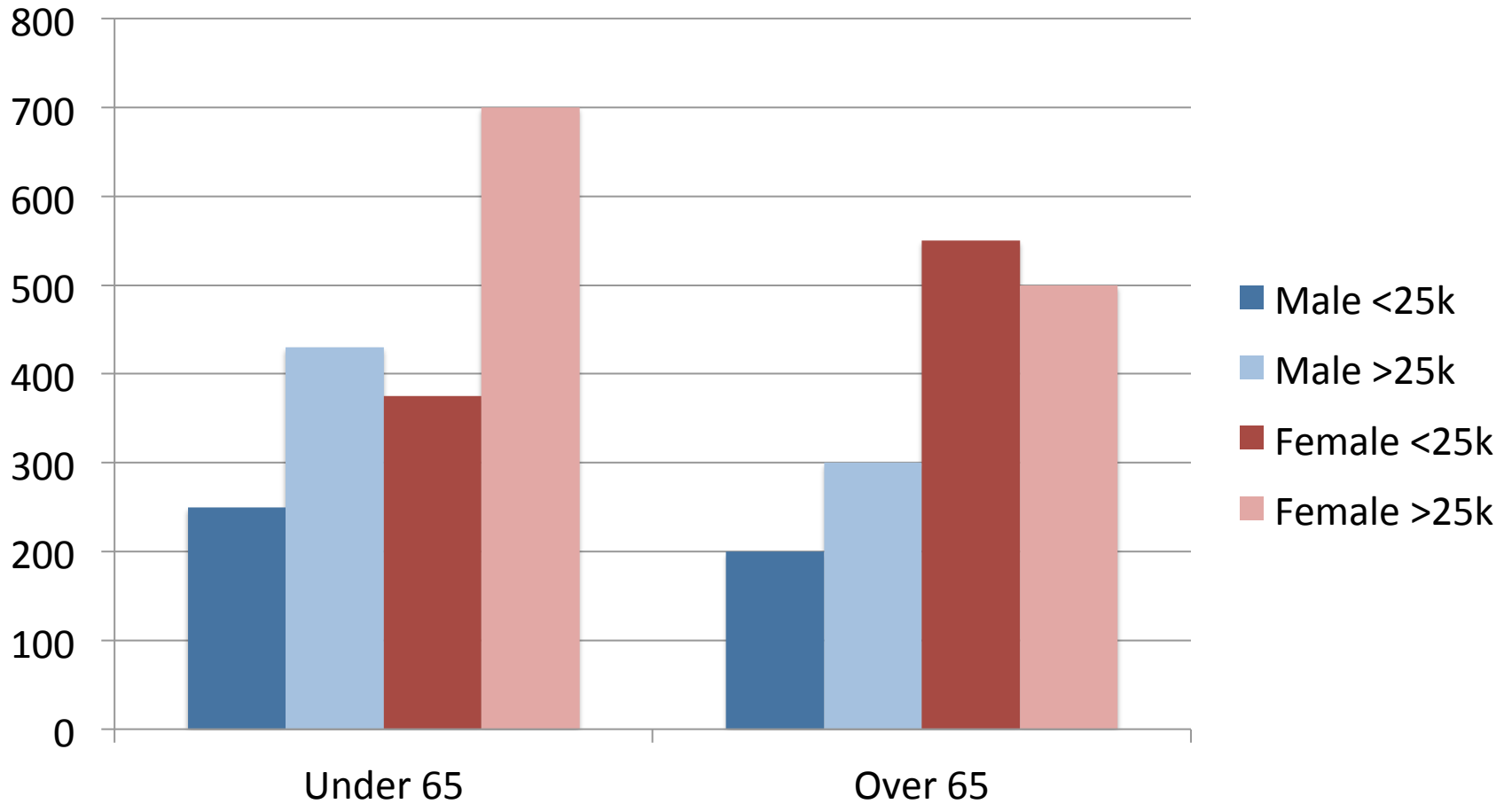
TEST CASE – CHOLESTEROL, AGE, AND GENDER

Game #5 – Cholesterol, Age, and Gender

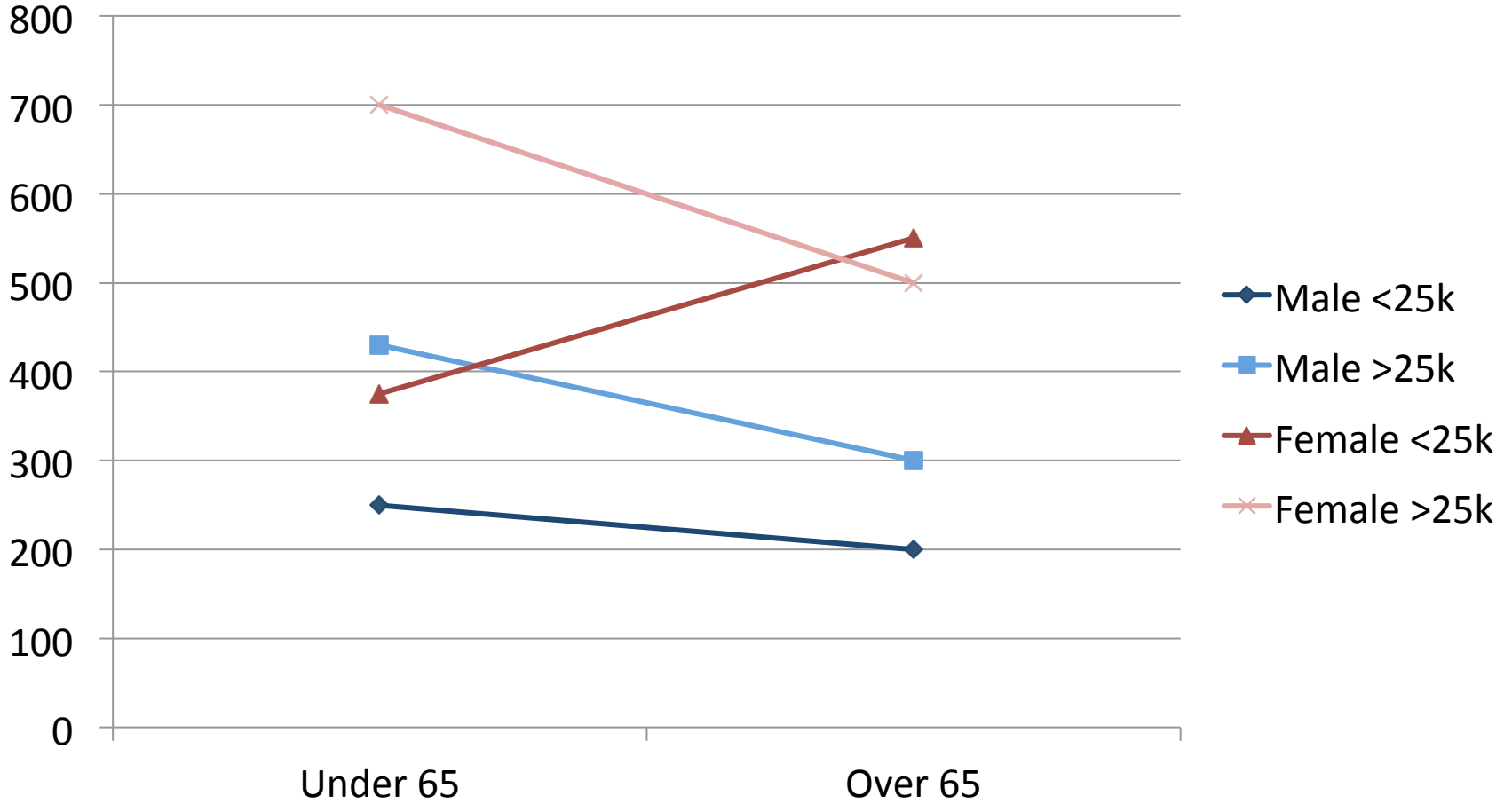
Which relation between gender or income level groups?

	Males		Females	
Income Group	Under 65	65 and Over	Under 65	65 and Over
0 – 24,999\$	250	200	375	550
25,000\$ +	430	300	700	500

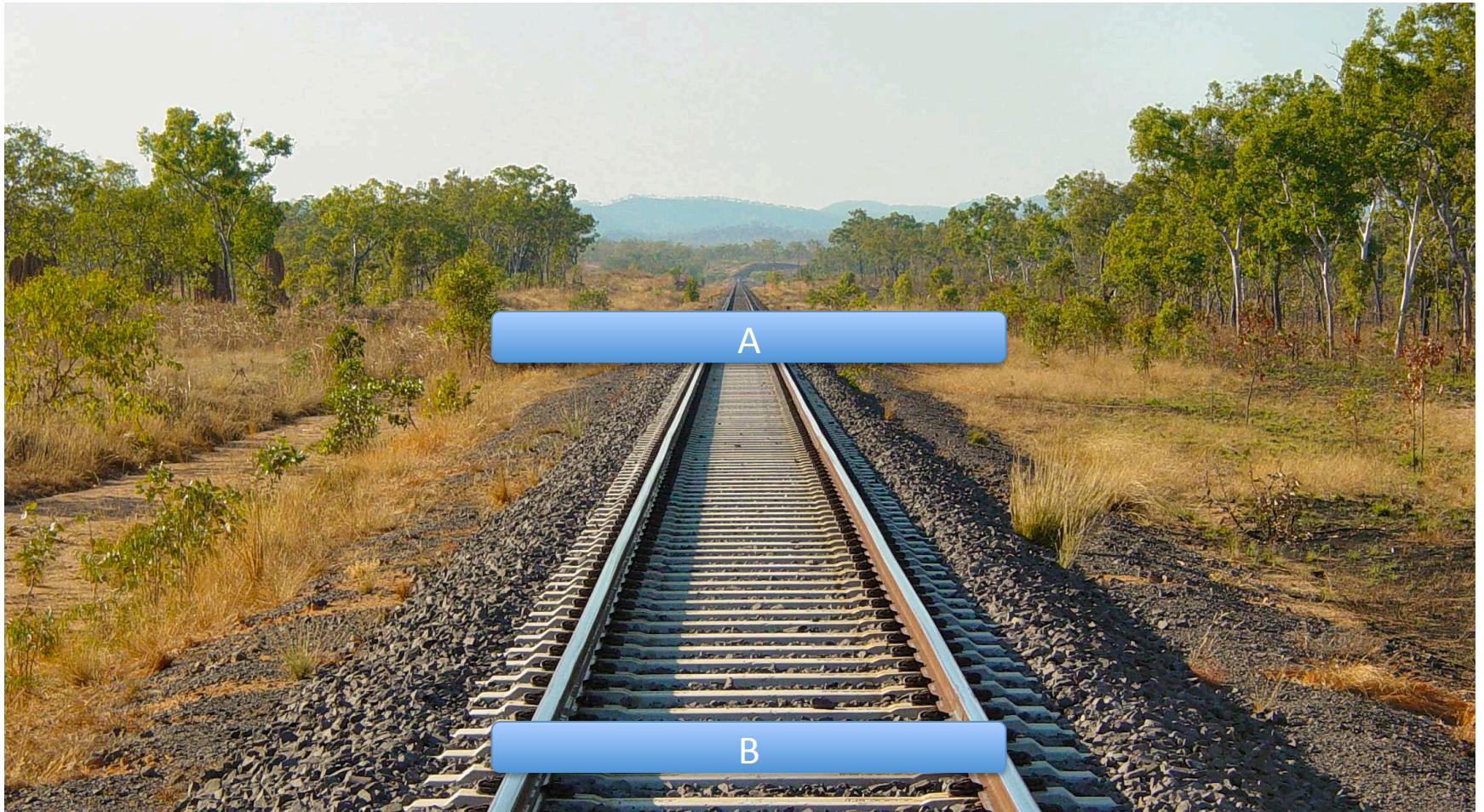
Game #5 – Visual Solution



Game #5 – Visual Solution (2)



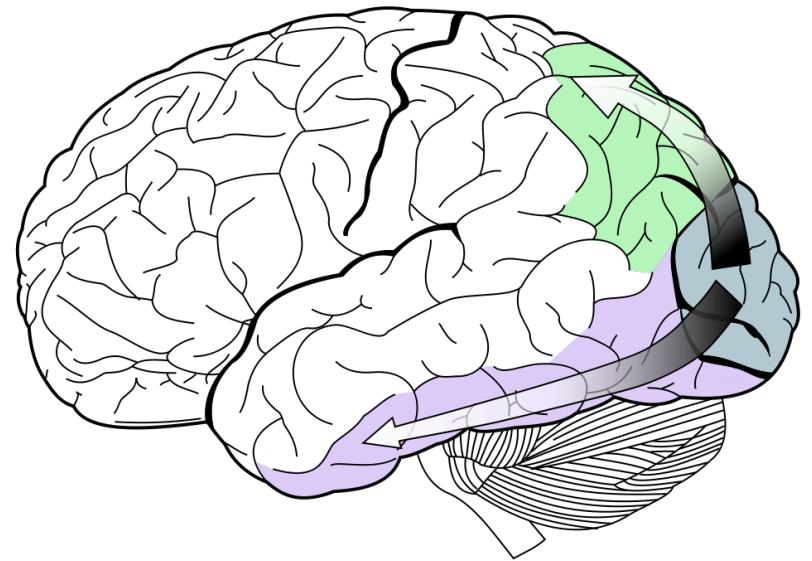
Game #6 – Length comparison



Perception

- Perception: the way in which something is regarded, understood, or interpreted (Oxford Dictionary)
- Electrical signals from vision system are interpreted and organized by the brain
- Two-stream hypothesis:
 - Ventral Stream
 - Dorsal Stream

The dorsal stream (green) and ventral stream (purple) are shown. They originate from a common source in the visual cortex

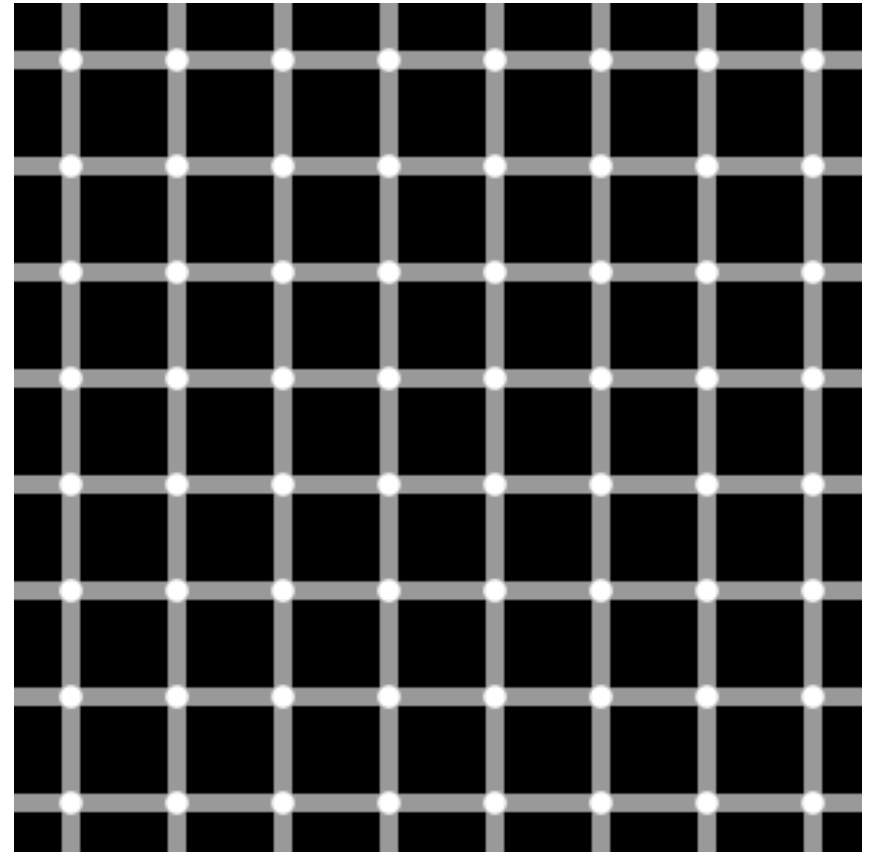
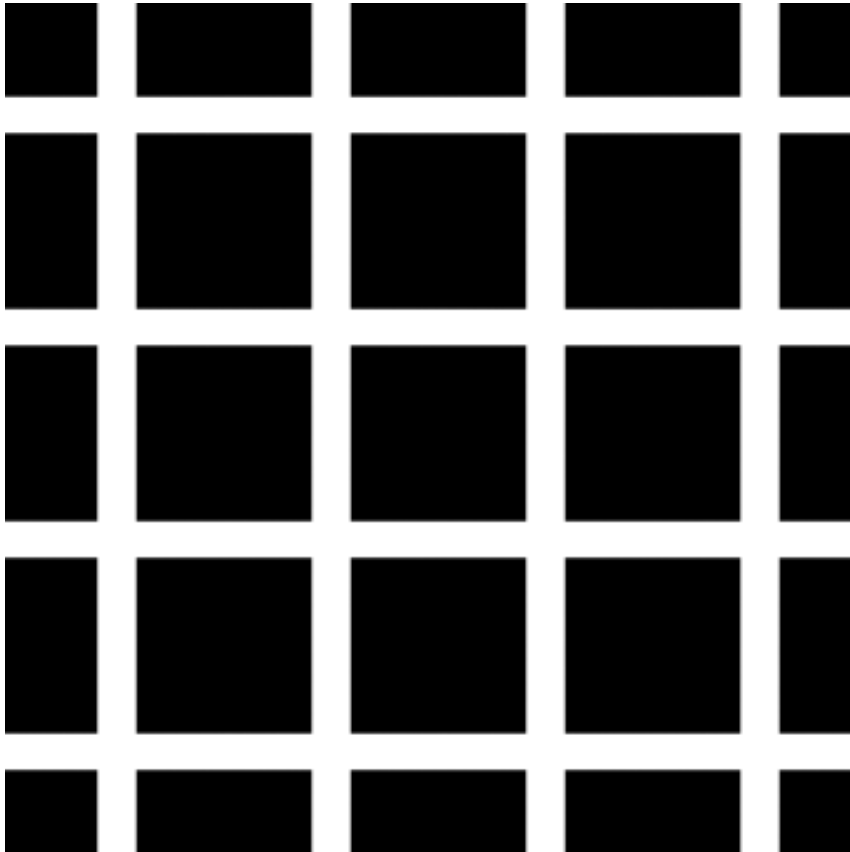


"Ventral-dorsal streams" by Selket - I (Selket) made this from Image:Gray728.svg. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Ventral-dorsal_streams.svg#/media/File:Ventral-dorsal_streams.svg

Visual Illusions

- Perceived images differ from measurable reality
 - Optical Illusions
 - Physiological illusions (Mach Bands)
 - Cognitive illusions
 - Arise by unconscious inferences based on assumptions about real world

Physiological Grid Illusion

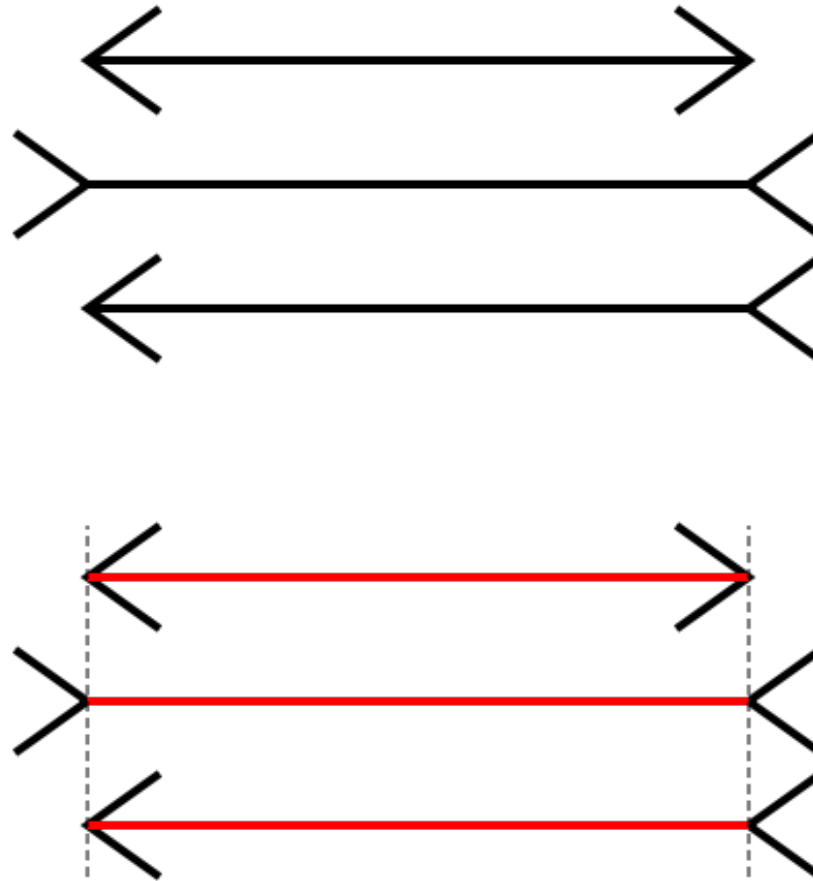


"HermannGrid" by en>User:Famousdog - <http://en.wikipedia.org/wiki/File:HermannGrid.gif>. Licensed under Public Domain via Wikimedia Commons - <http://commons.wikimedia.org/wiki/File:HermannGrid.gif#/media/File:HermannGrid.gif>

"Grid illusion" by User:Tó campos1 - Own work. Licensed under Public Domain via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Grid_illusion.svg#/media/File:Grid_illusion.svg

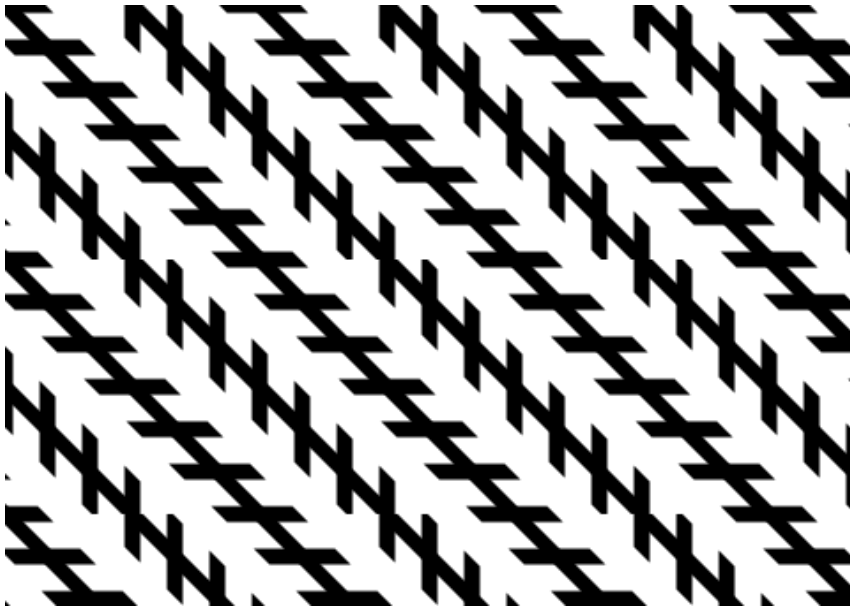
Lengths Distortion

Müller-Lyer illusion

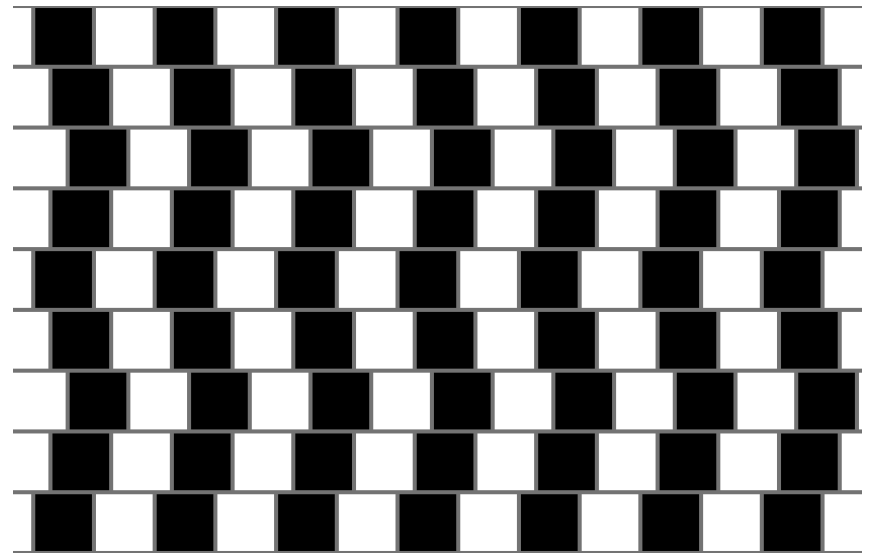


Orientation Illusion

Zöllner illusion

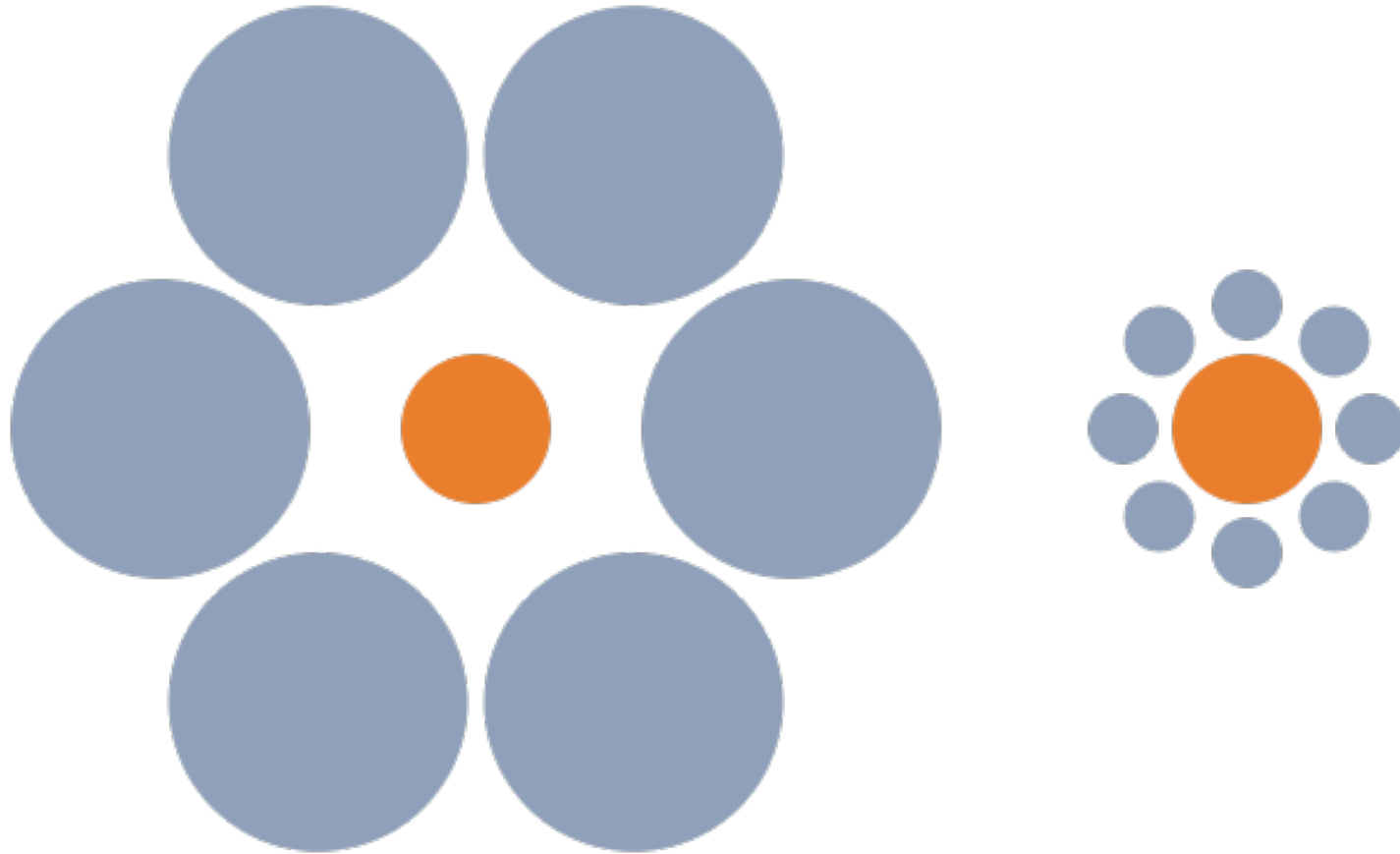


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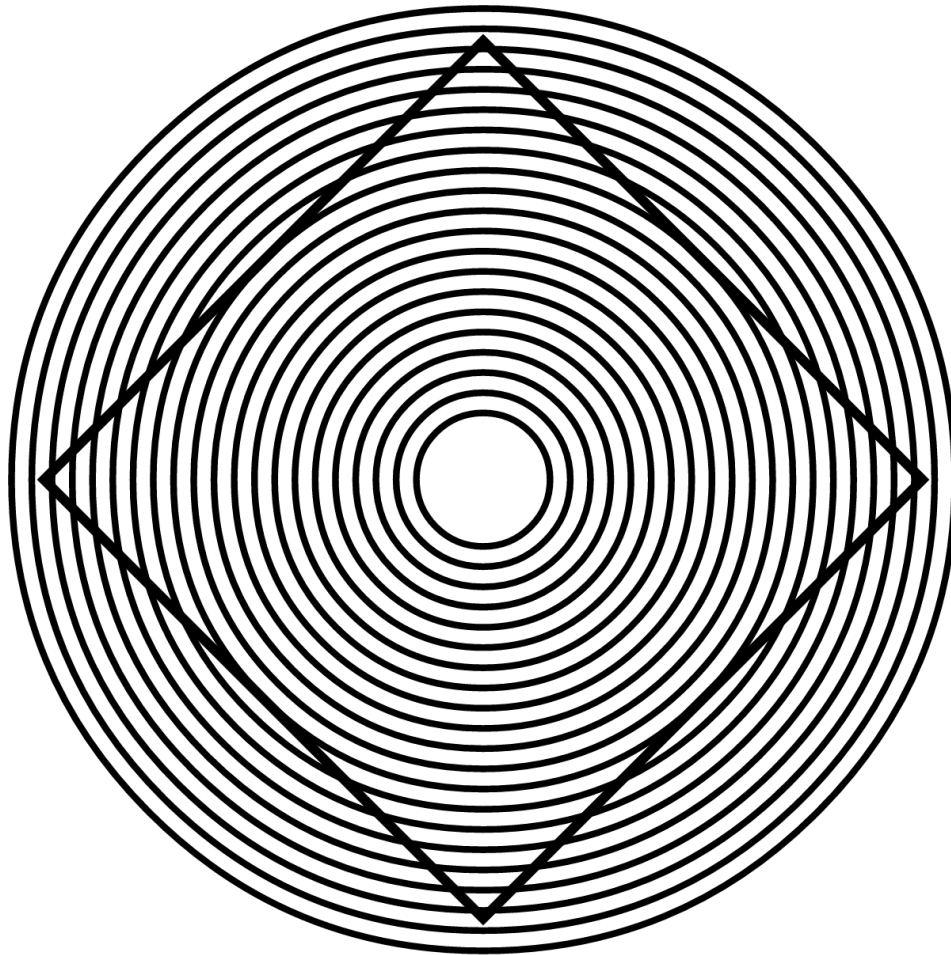
"Café wall" by Fibonacci - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Caf%C3%A9_wall.svg#/media/File:Caf%C3%A9_wall.svg

Ebbinghaus Illusion



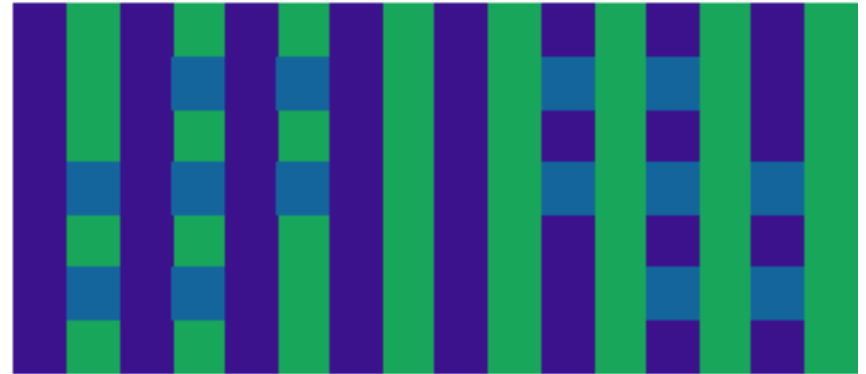
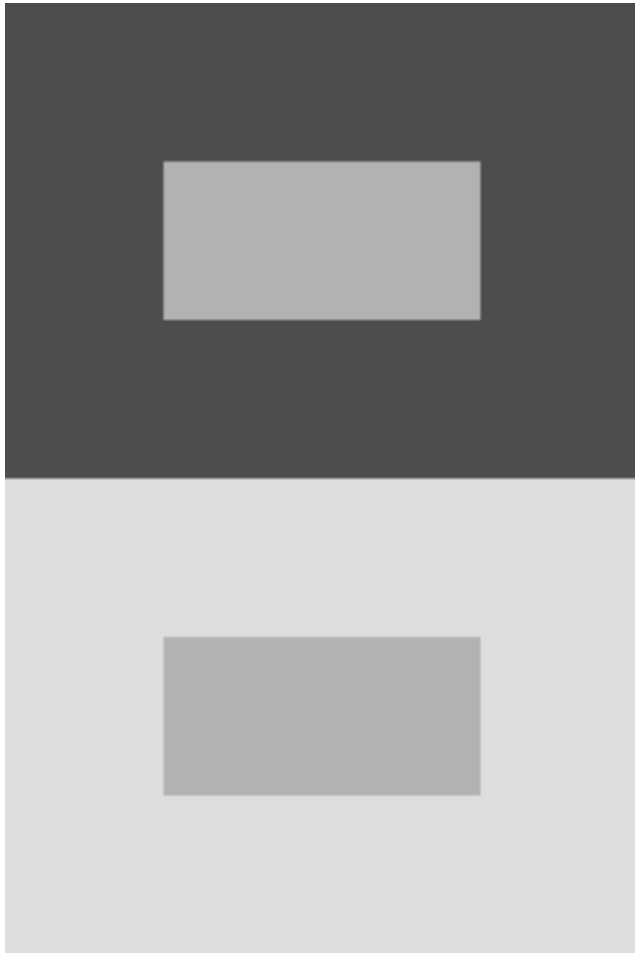
"Mond-vergleich". Licensed under Public Domain via Wikimedia Commons - <http://commons.wikimedia.org/wiki/File:Mond-vergleich.svg#/media/File:Mond-vergleich.svg>

Ehrenstein Illusion



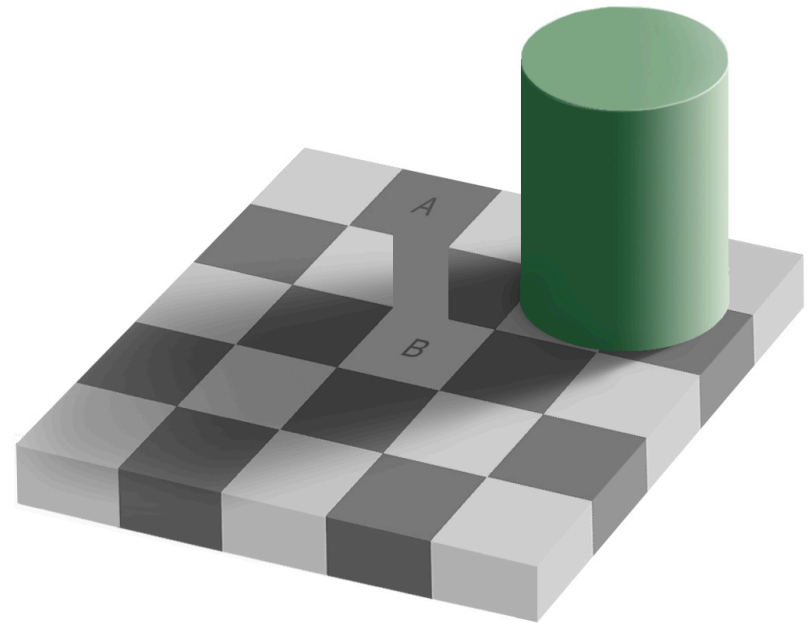
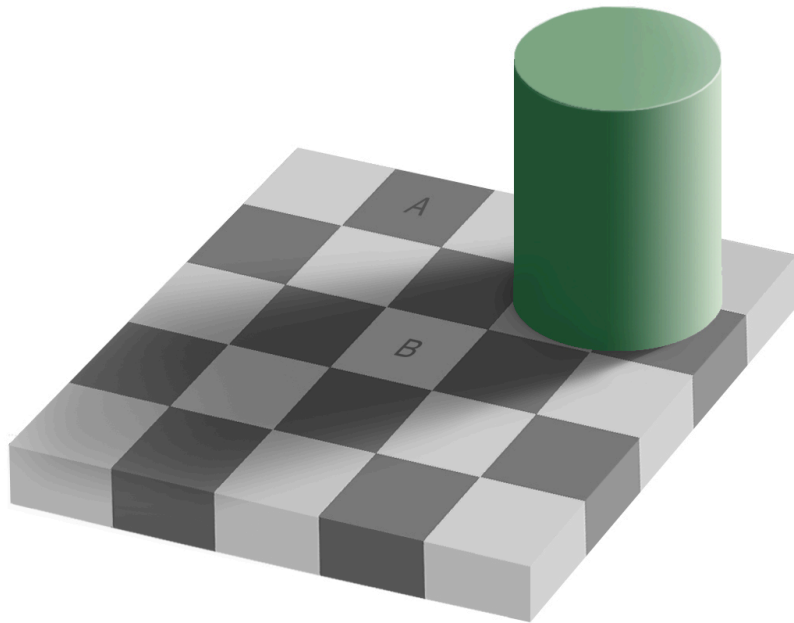
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Simultaneous Contrast



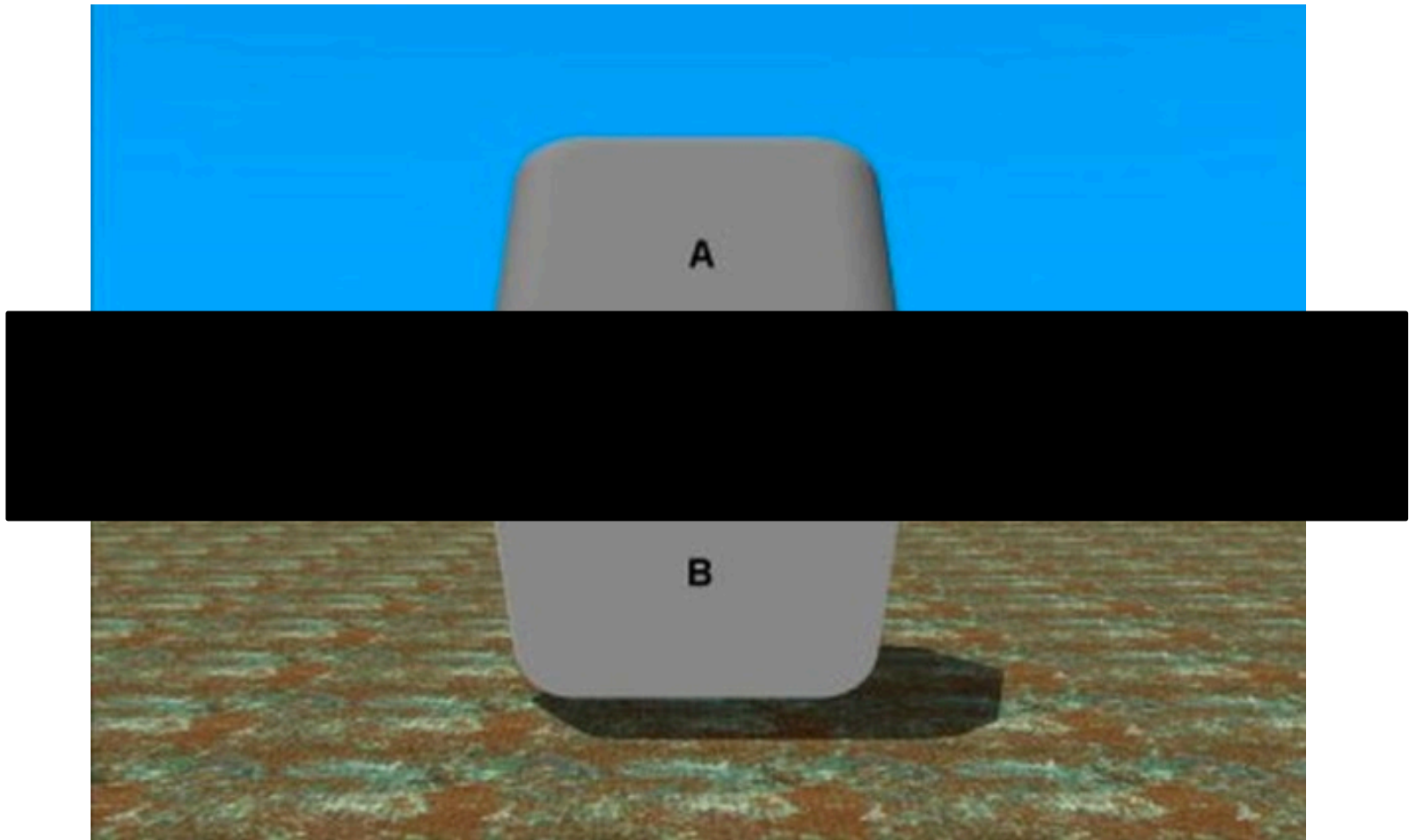
"Simultaneous Contrast" by K. P. Miyapuram - Licensed under Public Domain via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Simultaneous_Contrast.svg#/media/File:Simultaneous_Contrast.svg

Adelson's Illusion

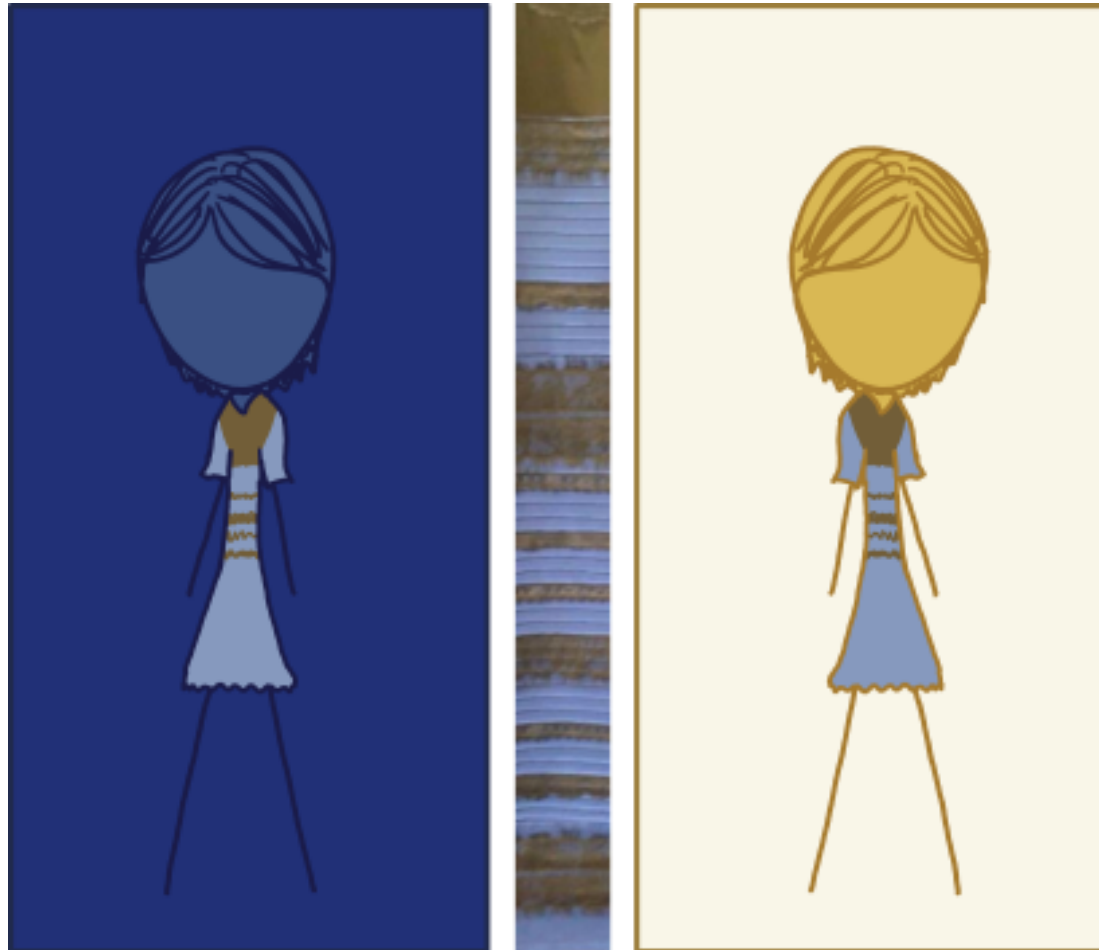


"Grey square optical illusion" by Original by Edward H. Adelson, this file by Gustavb - File created by Adrian Pingstone, based on the original created by Edward H. Adelson. Licensed under Copyrighted free use via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Grey_square_optical_illusion.PNG#/media/File:Grey_square_optical_illusion.PNG

Context




Dress Color



Takeaway Messages

- Limitations of human vision system
- Exploits message broadcast at early stage of perception: preattemptive perception
- Avoid possible causes of biases

a A a A



APE
ape

b B b B



BICICLETTA
bicicletta

ca Ca ca Ca



CAVALLO
cavallo

co Co co Co



CONIGLIO
coniglio

cu Cu cu Cu



CUBO
cubo

ce Ce ce Ce



CESTO
cesto

gu Gu gu Gu



GUFO
gufo

ge Ge ge Ge



GELATO
gelato

gi Gi gi Gi



GIRASOLE
girasole

h H h H




HOTEL
hotel

i I i I



INDIANO
indiano

j J j J



JUDO
judo

VISUAL LIBRARIES

SCIENCE

Vol. 103, No. 2684

Friday, June 7, 1946

On the Theory of Scales of Measurement

S. S. Stevens

Director, Psycho-Acoustic Laboratory, Harvard University

FOR SEVEN YEARS A COMMITTEE of the British Association for the Advancement of Science debated the problem of measurement. Appointed in 1932 to represent Section A (Mathematical and Physical Sciences) and Section J (Psychology), the committee was instructed to consider and report upon the possibility of "quantitative estimates of sensory events"—meaning simply: Is it possible to measure human sensation? Deliberation led only to disagreement, mainly about what is meant by the term measurement. An interim report in 1938 found one member complaining that his colleagues

by the formal (mathematical) properties of the scales. Furthermore—and this is of great concern to several of the sciences—the statistical manipulations that can legitimately be applied to empirical data depend upon the type of scale against which the data are ordered.

A CLASSIFICATION OF SCALES OF MEASUREMENT

Paraphrasing N. R. Campbell (Final Report, p. 340), we may say that measurement, in the broadest sense, is defined as the assignment of numerals to objects or events according to rules. The fact that numerals can be assigned under different rules leads

Data Types

- Nominal (N)
 - Equality relation
 - Apples, bananas, pears,...
- Ordinal (O)
 - Ordering relation
 - Small, medium, large, darker, dark, light,...
- Quantitative (Q)
 - Arithmetic relations
 - 10m, 32 degree, 2 bars,...
- Q-Interval (no reference point)
 - Dates, Location
 - Not directly comparable
 - Distances: A is 3 degree hotter than B
- Q-Ratio (reference point)
 - Length, mass
 - Proportions: A is twice as large as B

Data Types Operators

- Nominal
 - $\neq, =$
- Ordinal
 - $\neq, =, >, <$
- Quantitative Interval
 - $\neq, =, >, <, +, -$
- Quantitative Ratio
 - $\neq, =, >, <, +, -, \times, \div$

From Data to Conceptual Model

- Data Model: low-level representation of data and operations
- Conceptual Model: mental and semantic construction

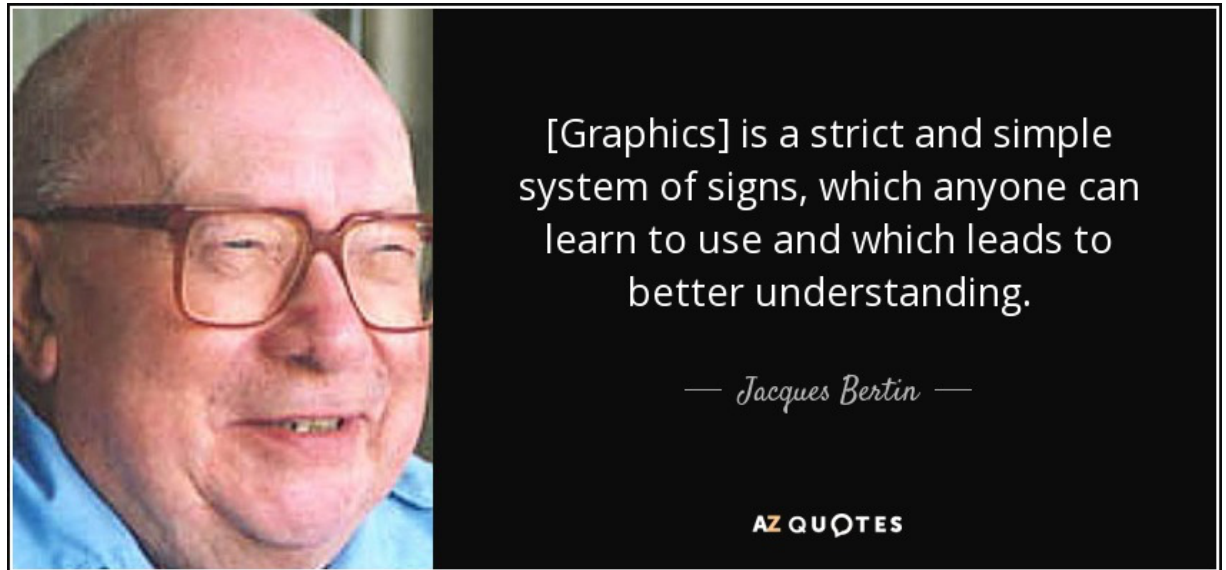
Data	Concept
1D number	Temperature
2D numbers	Geographic Coordinate
3D numbers	Spatio-temporal position

From Data to Conceptual Model

- From **data model**...
 - 70.8, 27.2, -10.2,...
- ... using **conceptual model** ...
 - Temperature
- ... to **data type**
 - Continuous variation
 - Warm, hot, cold
 - Burned vs not burned

Visual Variables

- Jacques Bertin (1918-2010), cartographer
- Theoretical principles of visual encodings
- Semiology of Graphics (1967)



Bertin's Visual Variables

Variables of a Visual Image

X Y
2 Dimensions
of A Chart

Z

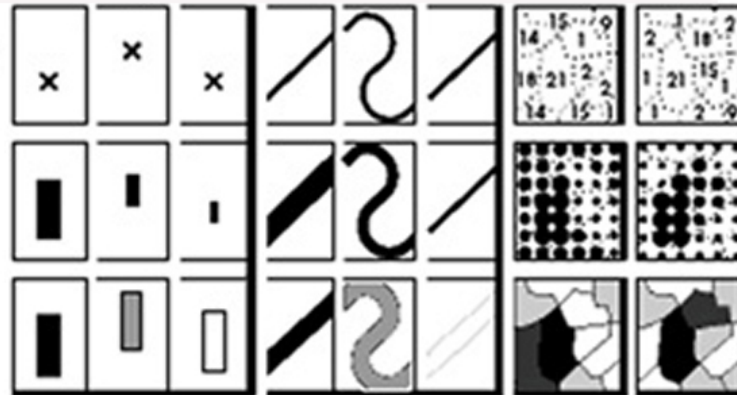
Size

Value

Points

Lines

Areas



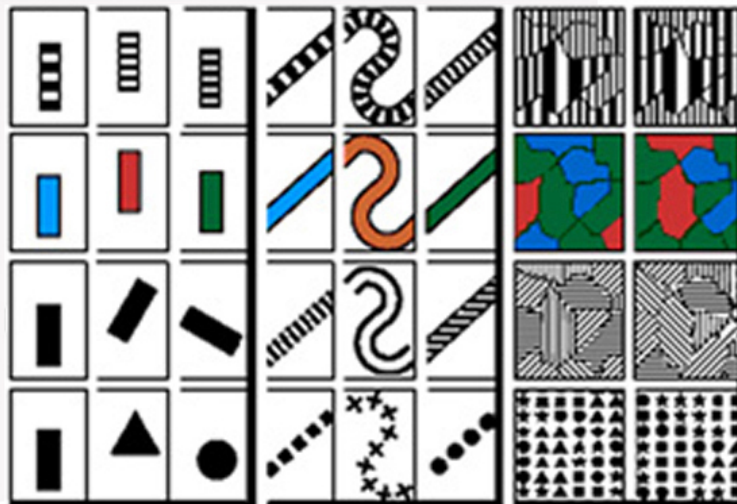
Variables to Separate Images

Texture

Colour

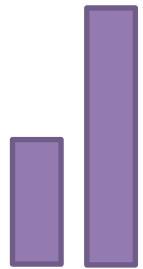
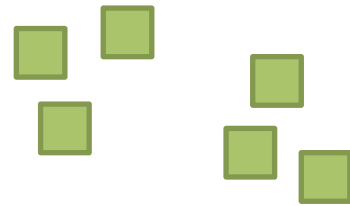
Orientation

Shape



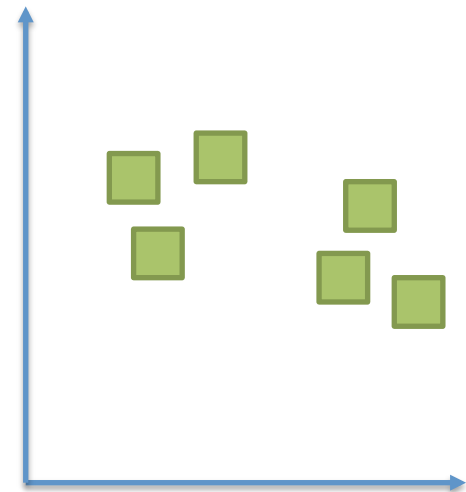
Characteristics of Visual Variables

- Selective
 - May I distinguish a symbol from the others
- Associative
 - May I identify groups?
- Quantitative
 - May I quantify the difference of two values?
- Order
 - May I identify an ordering?
- Length
 - How many values?



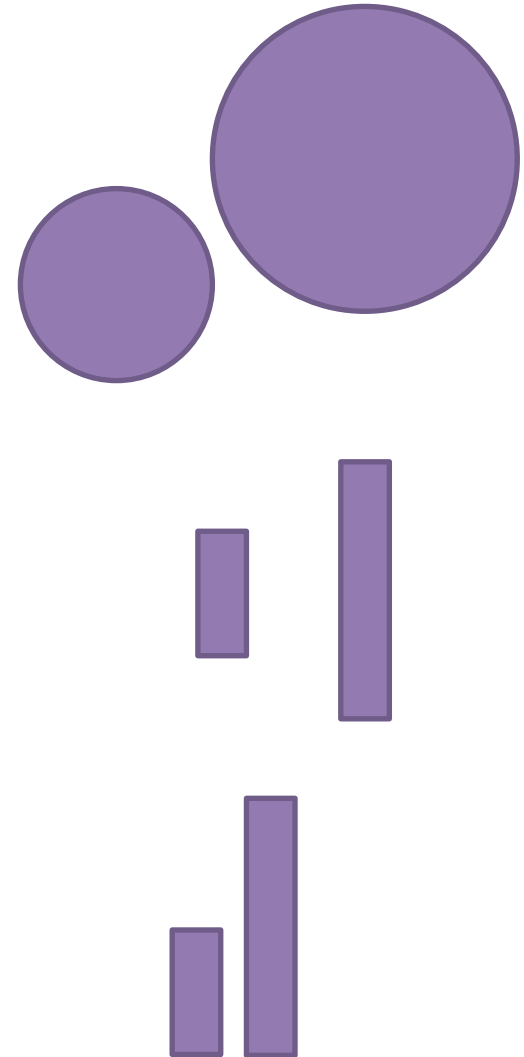
VV: Position

- Strongest visual variable
- Compatible for all data types
- Cons:
 - Not always applicable (e.g. nD data)
 - Cluttering



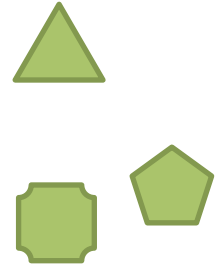
VV: Size and Length

- Easy to compare dimensions
- Grouping
- Estimate differences
 - Quantitative encoding
 - Changes in lengths
 - Worse for change in area



VV: Shapes

- Strong for nominal encoding
- No ordering
- No grouping



VV: Value (intensity)

- Quantitative representation (when size and length are used)
- Limited number of shades
- Support grouping



VV: Color (Tint)

- Good for qualitative data
- Limited number of classes (!!!)
- Not good for quantitative data
- Be careful!!

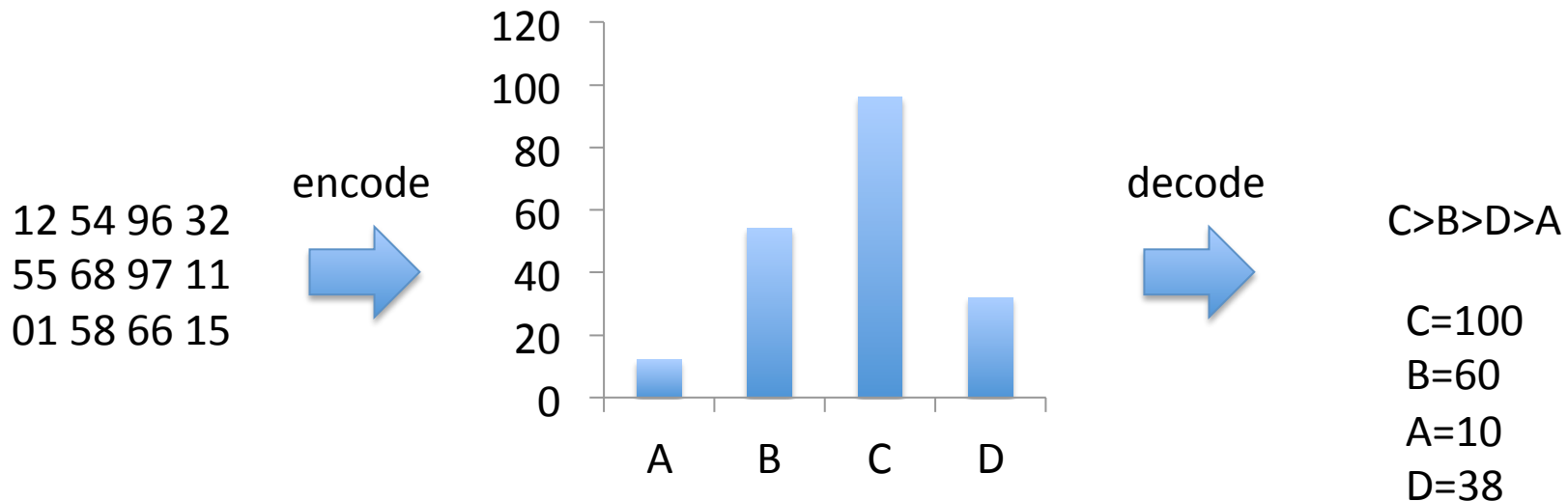


Bertin Visual Variables

	Nominal	Ordinal	Quantitative
Position	✓	✓	✓
Size	✓	✓	~
Value (intensity)	✓	✓	~
Texture	✓	~	✗
Color	✓	✗	✗
Orientation	✓	✗	✗
Shape	✓	✗	✗

Visual Encoding/Decoding

- A graph **encode** a set of information as a set of graphical attributes
- The observer have to **decode** the graphical attributes to extract the original information





TAXONOMY OF VISUAL VARIABLES

Cleveland McGill [1984]

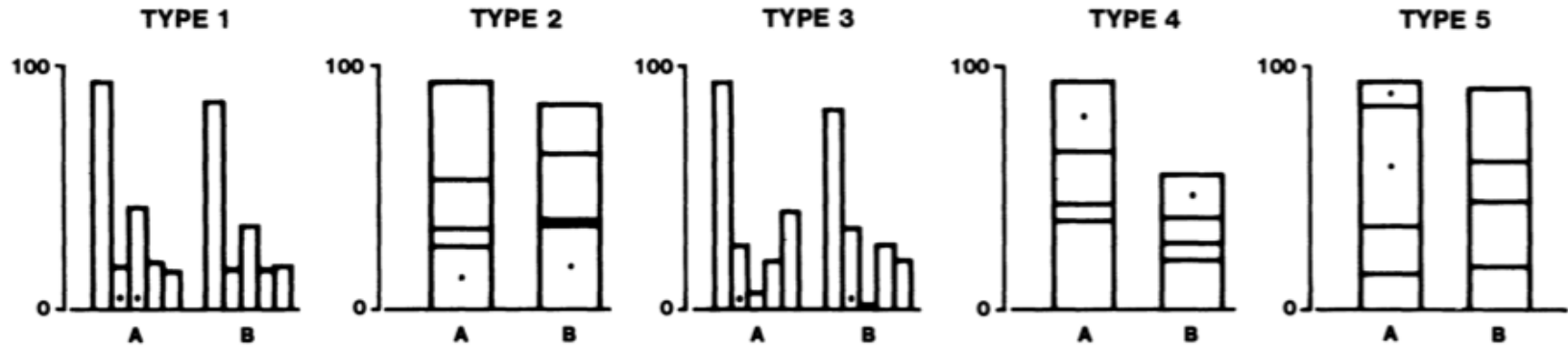


Figure 4. Graphs from position-length experiment.

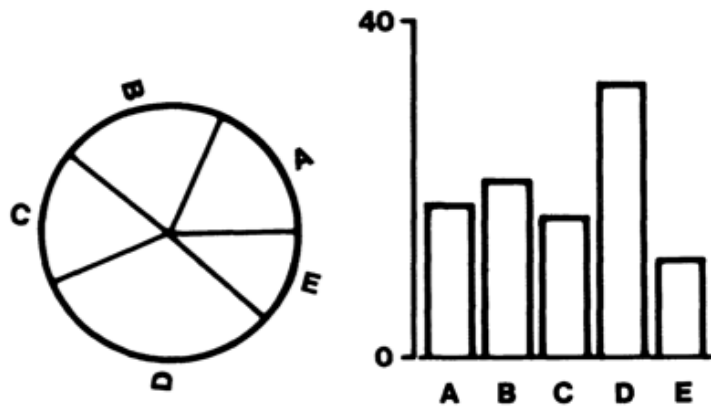


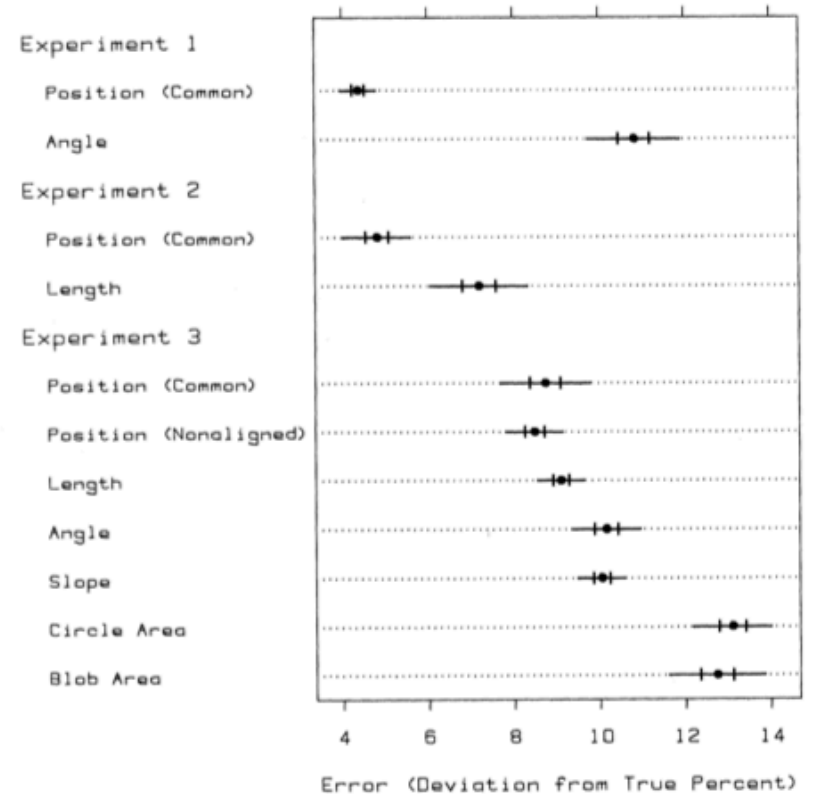
Figure 3. Graphs from position-angle experiment.

Cleveland & McGill: graphical encodings

- Angle
- Area
- Color Hue
- Color Saturation
- Density
- Length
- Position on a common scale
- Position on non aligned scale
- Slope
- Volume

Designing Effective Visualizations

- If possible, use graphical encoding that are easily decoded
- Graphical Attributes ordered (Cleveland & McGill):
 - Position along a common scale
 - Position on non aligned scales
 - Length
 - Angle and Slope
 - Area
 - Volume, density, color saturation
 - Color Hue





Most Efficient

t



Least Efficient

t

Position



Length



Slope



Angle



Area



Intensity



Color



Shape



Quantitative

Ordinal

Nominal

Takeaway messages

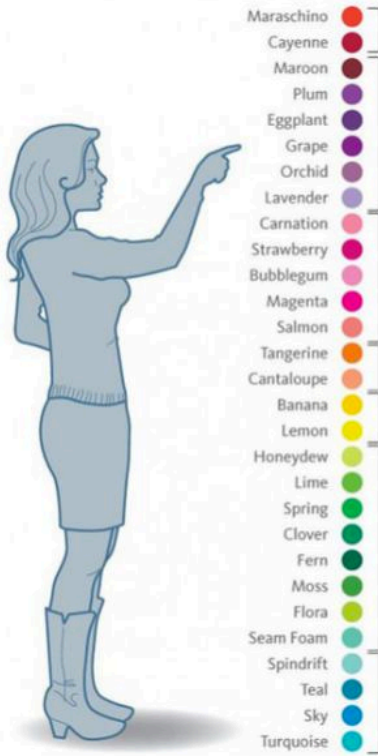
- Data type for entities and relationships
- Visual variables for representation
- Mapping of types to VVs
- Some VVs are more appropriate for specific data types



COLORS

How many color?

Female



Male

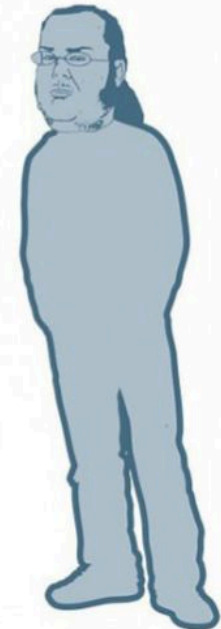


Dog



Programmer

- Gray #f94433
- Gray #ac203b
- Gray #85343d
- Gray #874994
- Gray #663c84
- Gray #8c2590
- Gray #a16799
- Gray #af99c7
- Gray #f38da3
- Gray #d2157b
- Gray #ec90b7
- Gray #e90086
- Gray #f57d7e
- Gray #f27727
- Gray #fc9b7b
- Gray #f7d305
- Gray #f1e311
- Gray #ccdf62
- Gray #68bd46
- Gray #0aae4f
- Gray #069665
- Gray #057054
- Gray #3ba246
- Gray #abc37
- Gray #68c3b2
- Gray #8bccd0
- Gray #0687a7
- Gray #078dca
- Gray #0fb8b5



Game #6

The image features two large, stylized parentheses, one on the left and one on the right, which serve as brackets for the central text. Each parenthesis is composed of multiple overlapping, semi-transparent curved bands. The left parenthesis has a rainbow gradient from yellow at the top to blue at the bottom. The right parenthesis has a rainbow gradient from yellow at the top to purple at the bottom. In the center, the word "color" is written in a large, bold, black, lowercase sans-serif font.

color

click to get started

<http://color.method.ac>

Color of the Year: 2016

COLOR FORMULA & GUIDES

PANTONE Color of the Year 2016 can be found in the following color systems:

ROSE QUARTZ

FASHION + HOME PANTONE 13-1520TCX

RGB for TCX

sR	sG	sB
247	202	201

CMYK for TCX

C	M	Y	K
0	24	15	0

HTML Values for TCX: F7CAC9

PANTONE Pastel 9281 C (Closest Match)

9281 C RGB

sR	sG	sB
242	221	222

CMYK for 9281 C

C	M	Y	K
0	14	9	0

HTML Values for 9281 C: F2DDDE

↓ Get Rose Quartz & Serenity and color pairings in [ASE file format](#) for Adobe® Applications.

Plastic

PQ-13-1520TCX

SERENITY

FASHION + HOME PANTONE 15-3919TCX

RGB for TCX

sR	sG	sB
146	168	209

CMYK for TCX

C	M	Y	K
42	24	3	0

HTML Values for TCX: 92A8D1

PLUS Series 7451 C (Closest Match)

Plus Series RGB

sR	sG	sB
137	171	227

Plus Series CMYK

C	M	Y	K
46	23	0	0

HTML Values for Plus Series: 89ABE3

↓ Download Rose Quartz and Serenity wallpaper for your mobile device or desktop.

Plastic

PQ-15-3919TCX

Color of the Year: 2017

COLOR FORMULAS, GUIDES & STANDARDS



COLOR FORMULA & GUIDES

PANTONE Color of the Year 2017 can be found in the following color systems:

GREENERY

FASHION + HOME PANTONE 15-0343 TCX

RGB for TCX

sR	sG	sB
136	176	75

CMYK for TCX

C	M	Y	K
51	9	88	0

HTML Values for TCX: 88B04B

PANTONE 376 C (Closest Match)


PLUS Series RGB

sR	sG	sB
132	189	0

PLUS Series CMYK

C	M	Y	K
54	0	100	0

HTML Values for PLUS Series: 84BD00

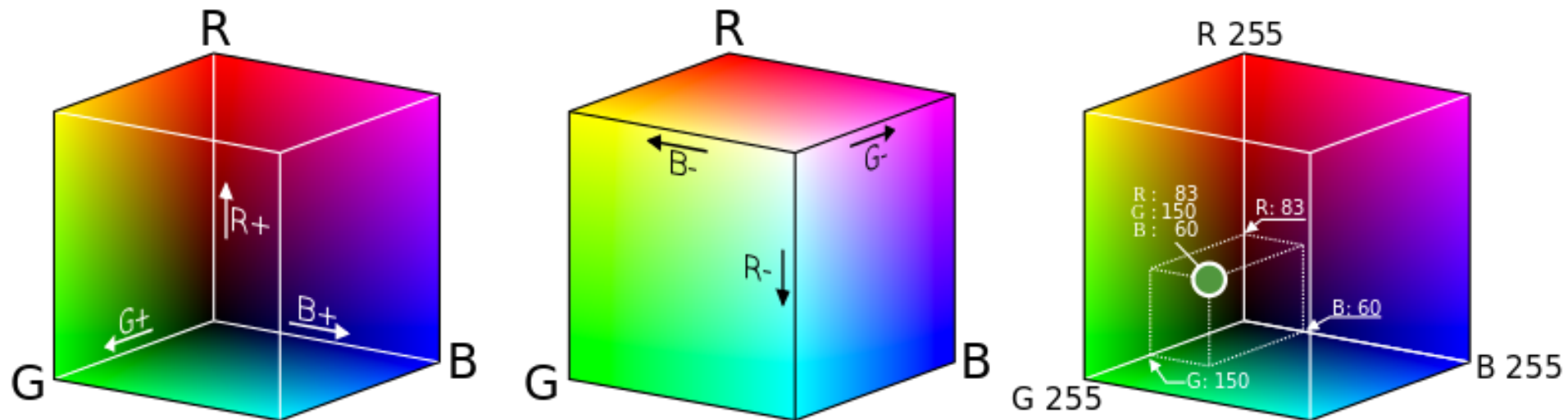
 Get Greenery in [ASE file format for Adobe® Applications.](#)

Plastic

PQ-15-0343 TCX

RGB Color Model

- Based on direct specification of three primary colors
- Additive model, each component is summed with the others

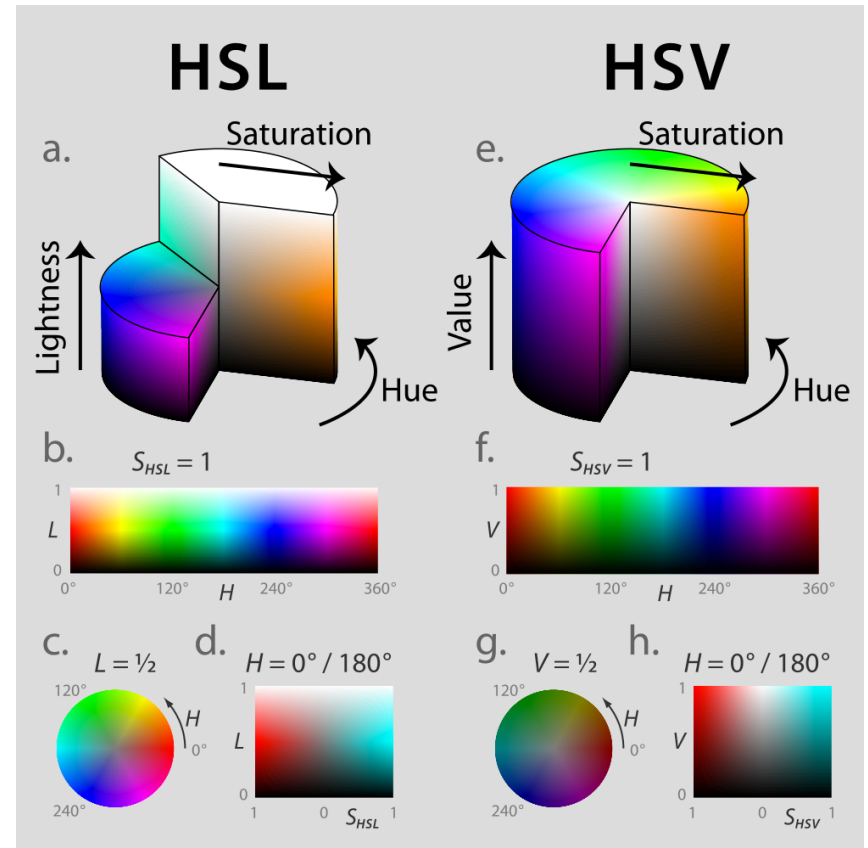


RGB Color Model

- R,G,B values may be expressed in range [0,1]
- Some applications use the range[0,255]
- Usually a hexadecimal notation is used for range [0,ff]
- Not really intuitive: how to define brown?

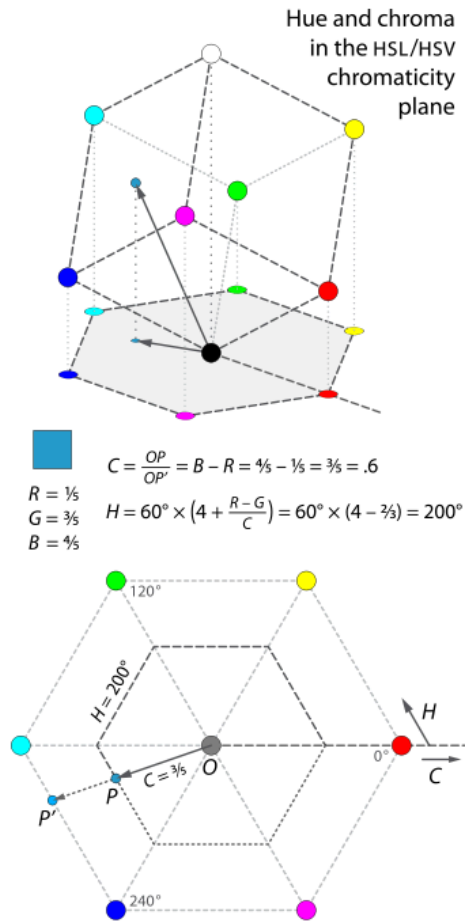
HSV Color Model

- Based on the intuitive concepts of
 - Hue
 - Saturation
 - Value
- Component values are expressed in ranges $[0,1]$ or $[0,255]$

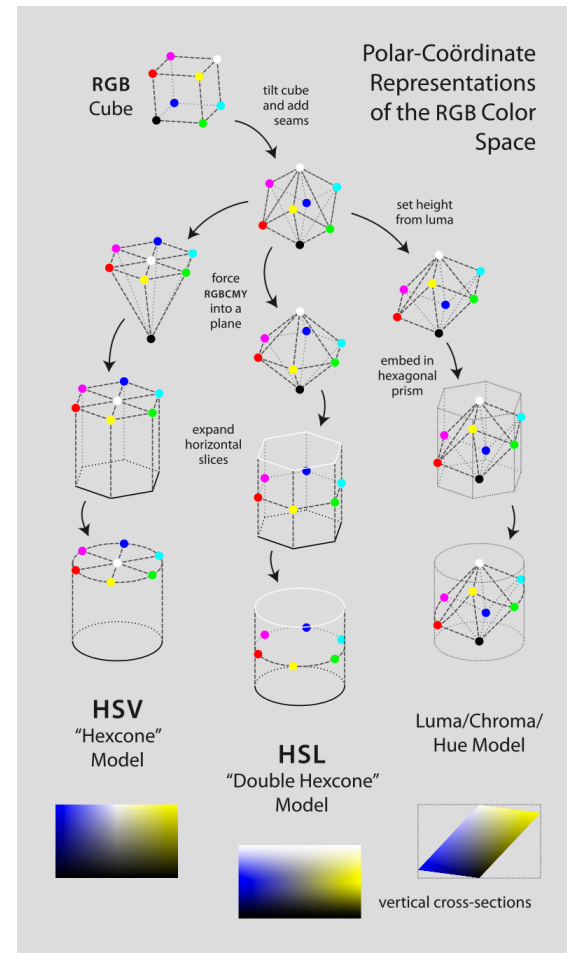


"Hsl-hsv models" by Jacob Rus - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Hsl-hsv_models.svg#/media/File:Hsl-hsv_models.svg

RGB and HSV



"HSL-HSV hue and chroma" by Jacob Rus - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:HSL-HSV_hue_and_chroma.svg#/media/File:HSL-HSV_hue_and_chroma.svg



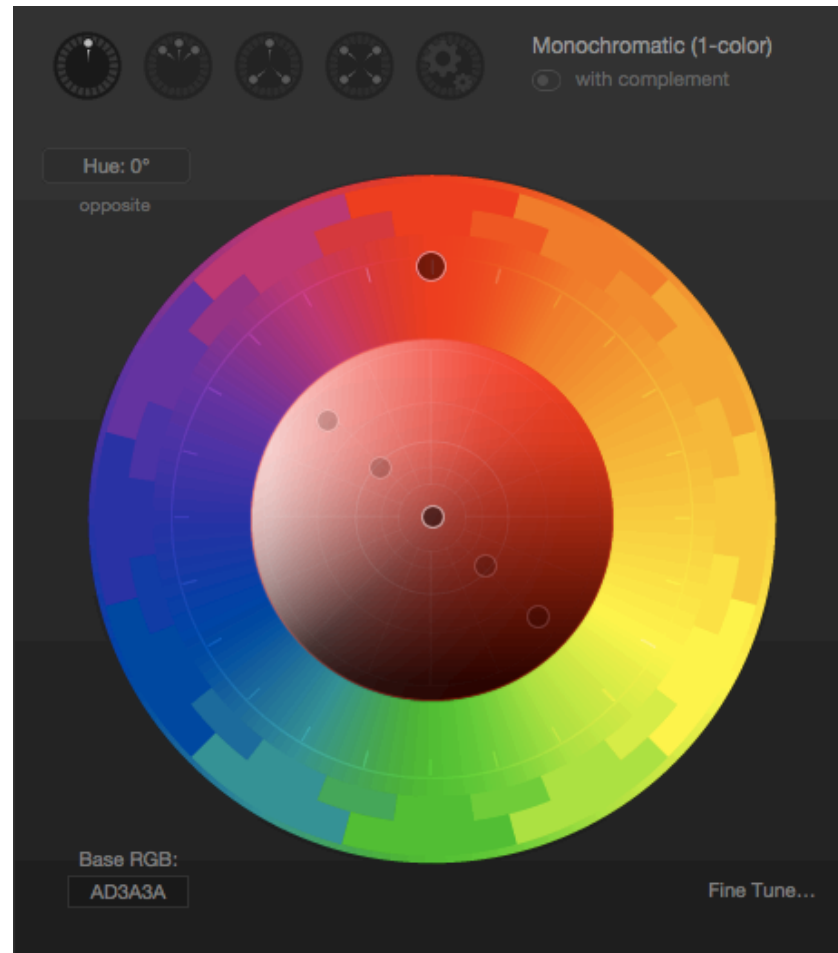
"Hsl-and-hsv" by Jacob Rus - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - <http://commons.wikimedia.org/wiki/File:Hsl-and-hsv.svg#/media/File:Hsl-and-hsv.svg>



PALETTE

Color Schemes

Cold colors



Warm colors

<http://paletton.com/>

Color Schemes for Cartography

The screenshot displays the ColorBrewer 2.0 web application interface. At the top right, the text "COLORBREWER 2.0" is prominently displayed in white and orange, with the tagline "color advice for cartography" below it. Navigation links for "how to use", "updates", "downloads", and "credits" are visible in the top left of the main area.

The interface is divided into several control panels on the left side of a large map preview:

- Number of data classes:** A dropdown menu is set to "3".
- Nature of your data:** Three radio buttons are present: "sequential" (unselected), "diverging" (unselected), and "qualitative" (selected).
- Pick a color scheme:** A grid of 12 different color scheme thumbnails is shown.
- Only show:** Three checkboxes are present: "colorblind safe" (unchecked), "print friendly" (unchecked), and "photocopy safe" (unchecked).
- Context:** Three checkboxes are present: "roads" (unchecked), "cities" (unchecked), and "borders" (checked).
- Background:** Two radio buttons are present: "solid color" (selected) and "terrain" (unselected). Below this is a "color transparency" slider.
- 3-class Set1:** A legend for the selected scheme shows three color swatches: red (#e41a1c), blue (#377eb8), and green (#4daf4a).
- EXPORT:** A vertical button is located next to the legend.

The main map area shows a geographical region divided into numerous small polygons, each colored according to the selected 3-class qualitative scheme. The colors are red, blue, and green, distributed across the map area.

<http://colorbrewer2.org/>

Takeaway Messages

- Different color models and encodings
- Color palettes to represent scales of values



Visual Analytics

Dos and Don'ts for visual charts

Crash course on effective Charting

THE WALL STREET JOURNAL.
**GUIDE TO
INFORMATION
GRAPHICS**
THE DOS & DON'TS
OF PRESENTING
DATA, FACTS,
AND FIGURES
DONA M. WONG

"INVALUABLE." —HOW DESIGN



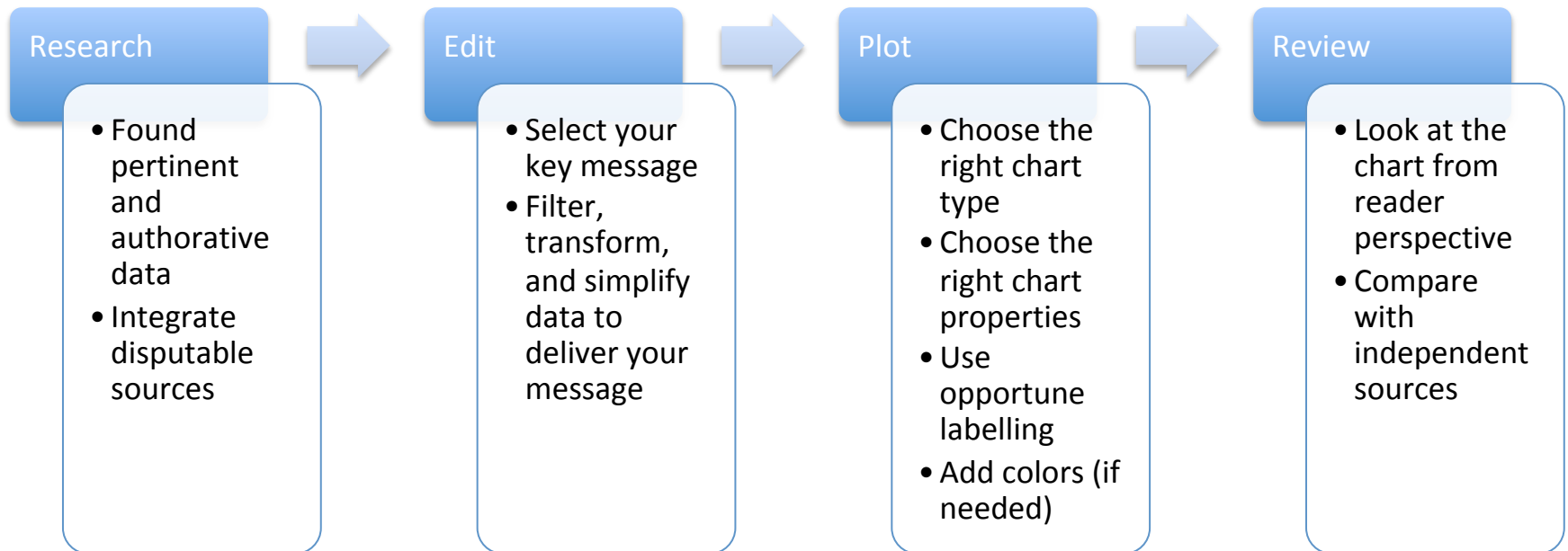
Dona M. Wong

Guide to Information Graphics

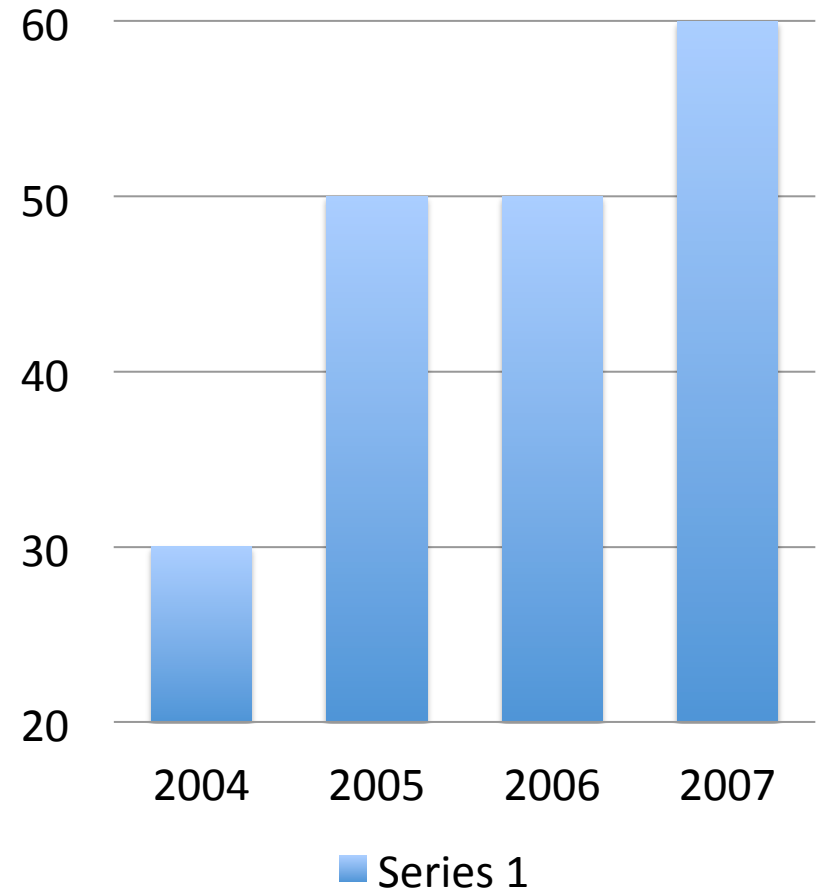
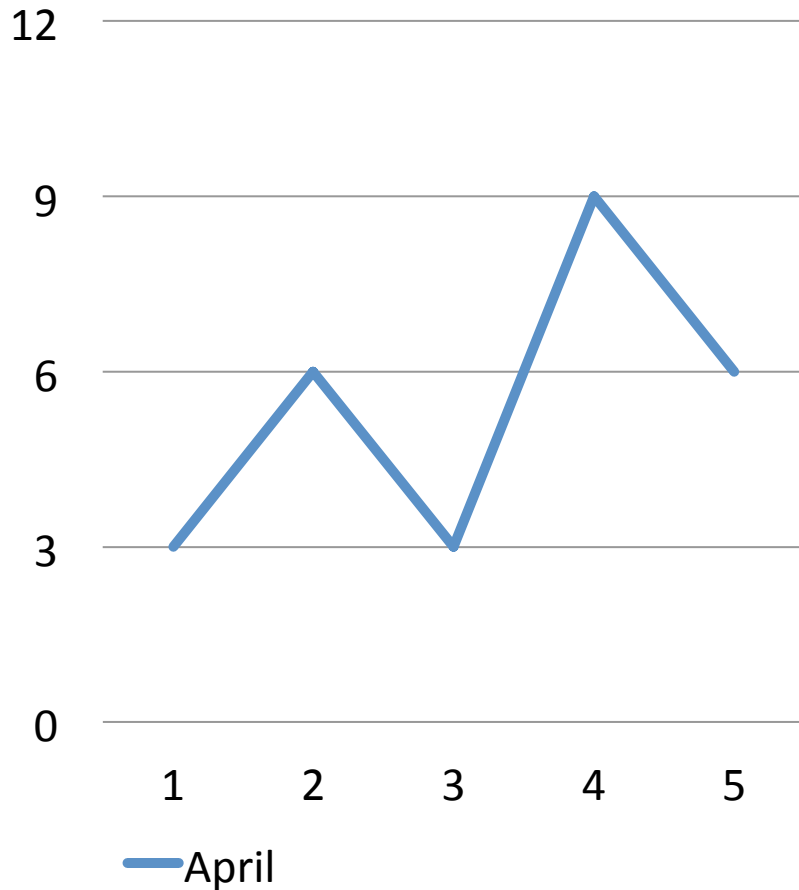
The Dos and Don'ts of Presenting Data,
Facts, and Figures

W. W. Norton & Company

Charting Pipeline



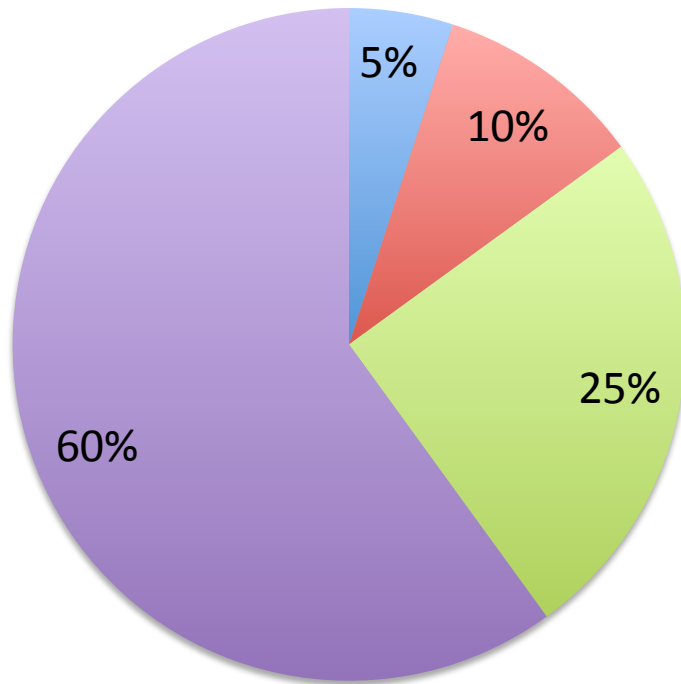
Charting Examples



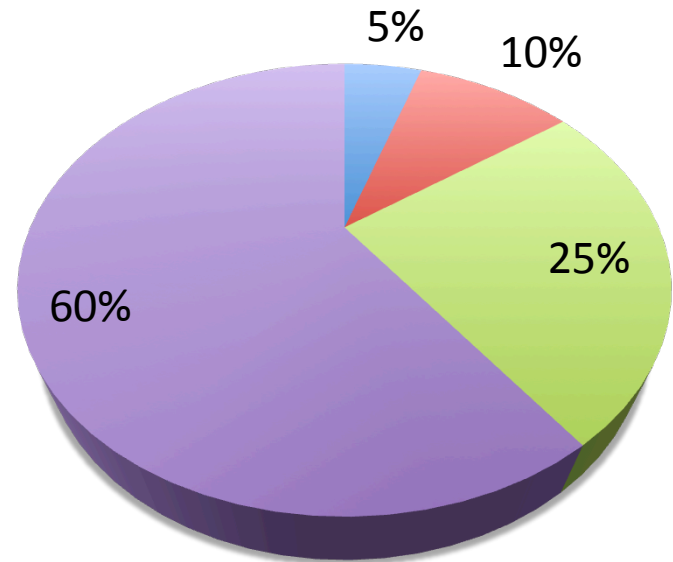
May these charts be improved? Why? How?

Charting Examples

Sales



Sales

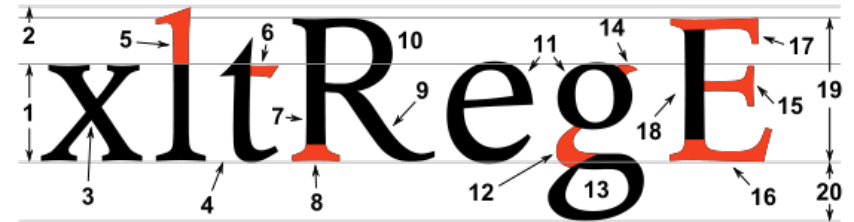
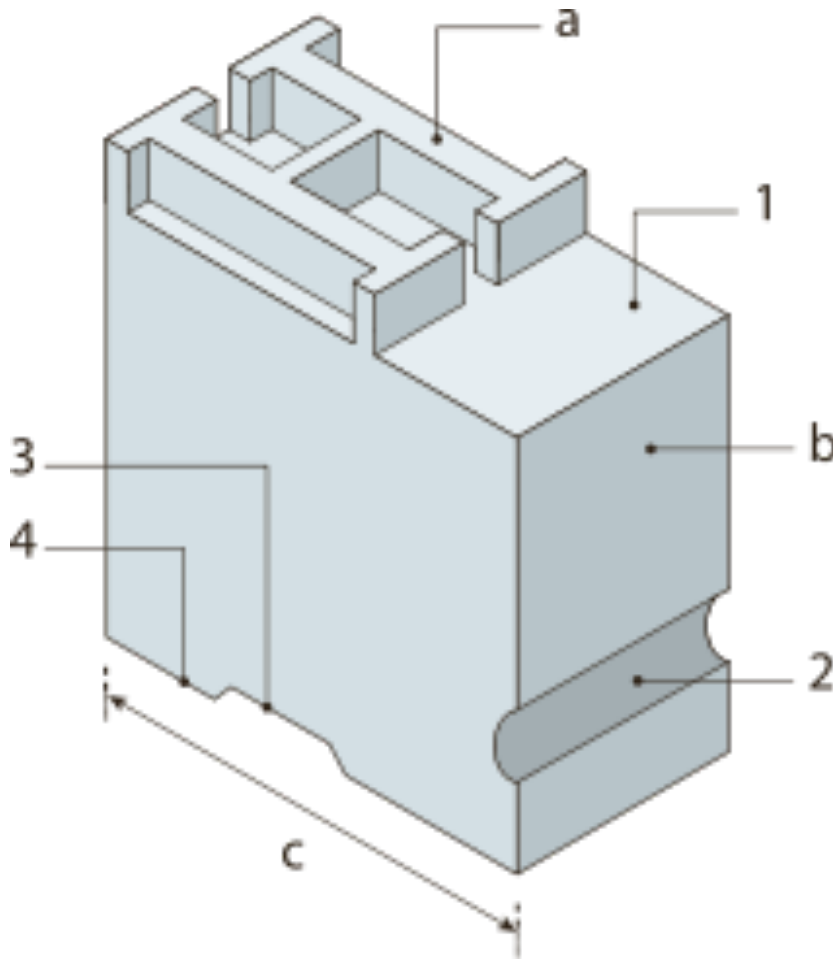


May these charts be improved? Why? How?



FONTS

Fonts



Typographic parts of a glyph:

1) x-height; 2) **ascender line**; 3) apex; 4) **baseline**; 5) ascender; 6) crossbar; 7) stem; 8) **serif**; 9) leg; 10) bowl; 11) counter; 12) collar; 13) loop; 14) ear; 15) tie; 16) horizontal bar; 17) arm; 18) vertical bar; 19) cap height; 20) **descender line**.

$$\begin{aligned}\text{Font size} &= (1) + (2) + (20) \\ &= (19) + (20)\end{aligned}$$

"Metal type". Licensed under Public Domain via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Metal_type.svg#mediaviewer/File:Metal_type.svg

"Typoghaphia" by F l a n k e r (typographic font designed by myself, named Emperor). Licensed under Public Domain via Wikimedia Commons - <http://commons.wikimedia.org/wiki/File:Typoghaphia.svg#mediaviewer/File:Typoghaphia.svg>

Fonts: general rules

- Leading should be 2 points larger than type size
- Avoid too small or condensed type faces
- Keep style simple: use **bold** or *italic* to emphasize a word (better not ***both***)
- Avoid ALL CAPS
- Avoid *styled fonts*
- Avoid C***C Sans Serif
- Reduce type at an angle
- Avoid t r a c k i n g

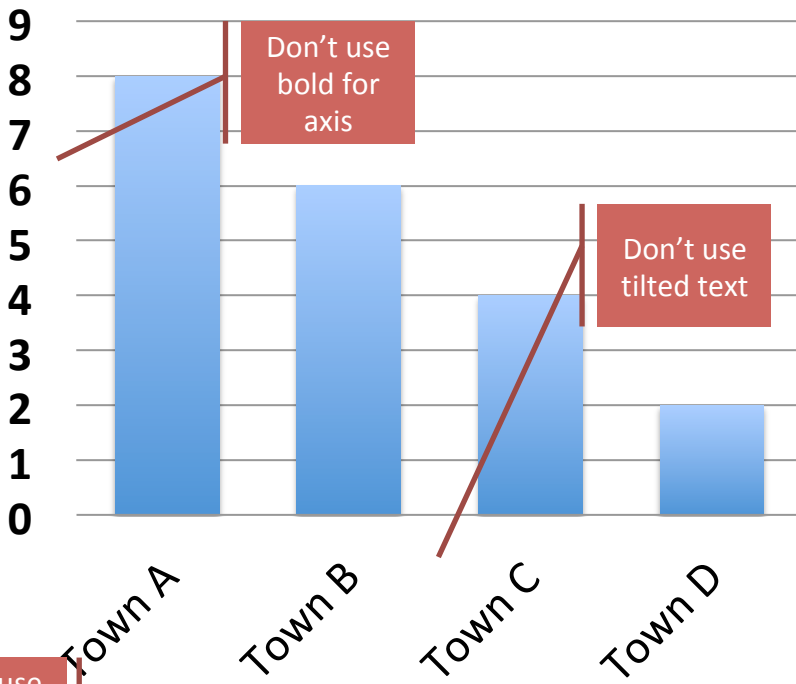
Fonts are meant to describe, not to adorn

Typography in Charts

Don't

Don't use all caps or high contrast white type out of black

HEADLINE OF THE CHART



Don't use bold for axis

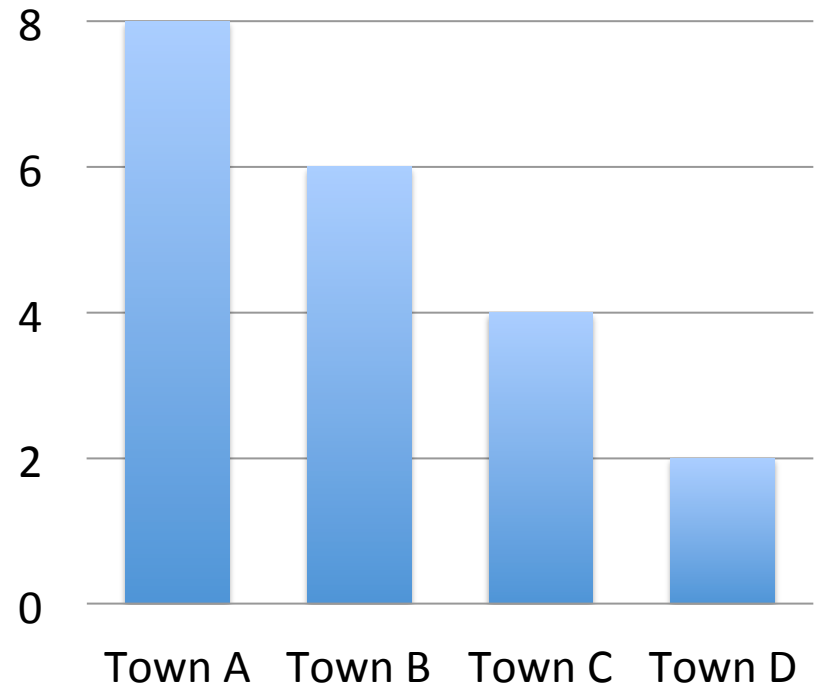
Don't use tilted text

Don't use bold and italic

A brief description that outlines what the data shows

Do

Headline of the chart

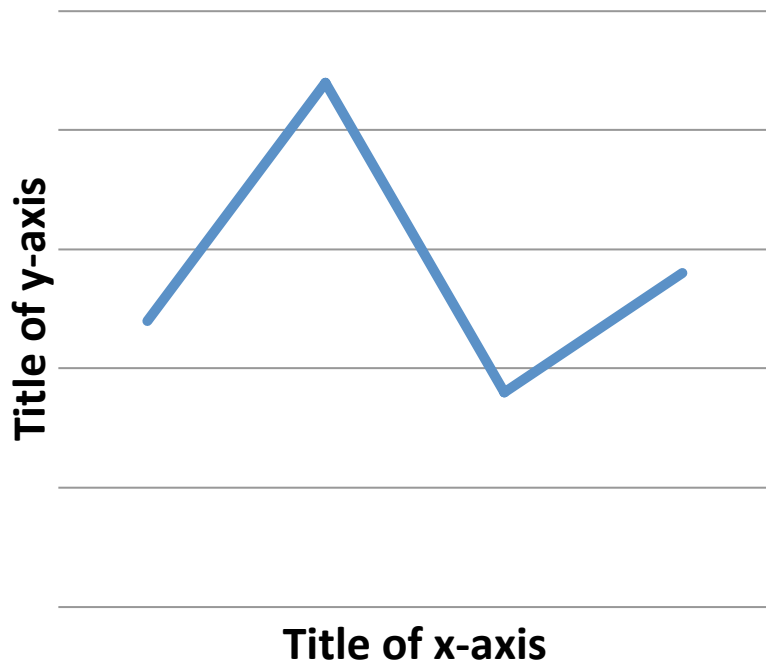


A brief description that outlines what the data shows

Typography in Charts

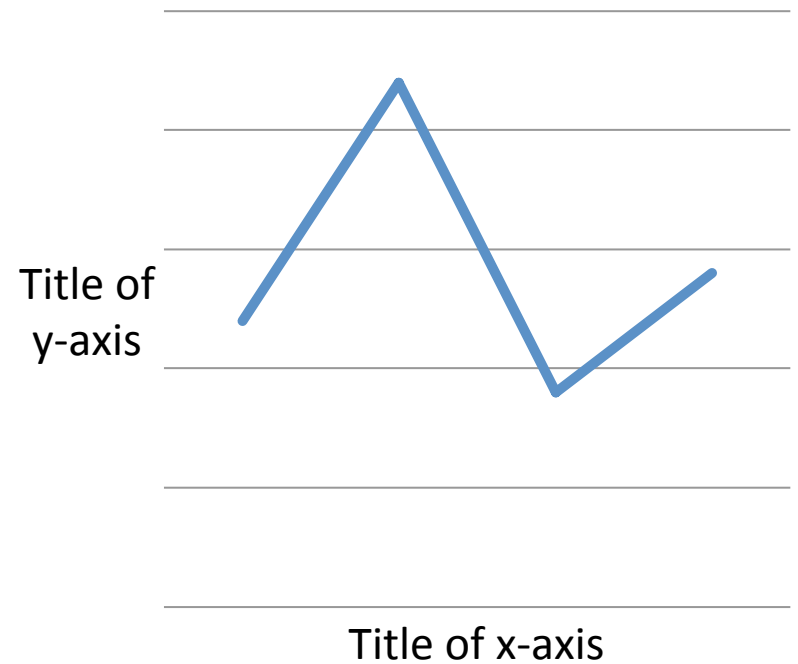
Don't

Headline of the chart



Do

Headline of the chart




Typography in Charts

Name	Data	Data	Data
Company A	0.0	0.0	0.0
Company B	0.0	0.0	0.0
Company C	0.0	0.0	0.0
Company D	0.0	0.0	0.0

Many elements in bold. Which part is highlighted?

Name	Data	Data	Data
Company A	0.0	0.0	0.0
Company B	0.0	0.0	0.0
Company C	0.0	0.0	0.0
Company D	0.0	0.0	0.0

Give emphasis to relevant results

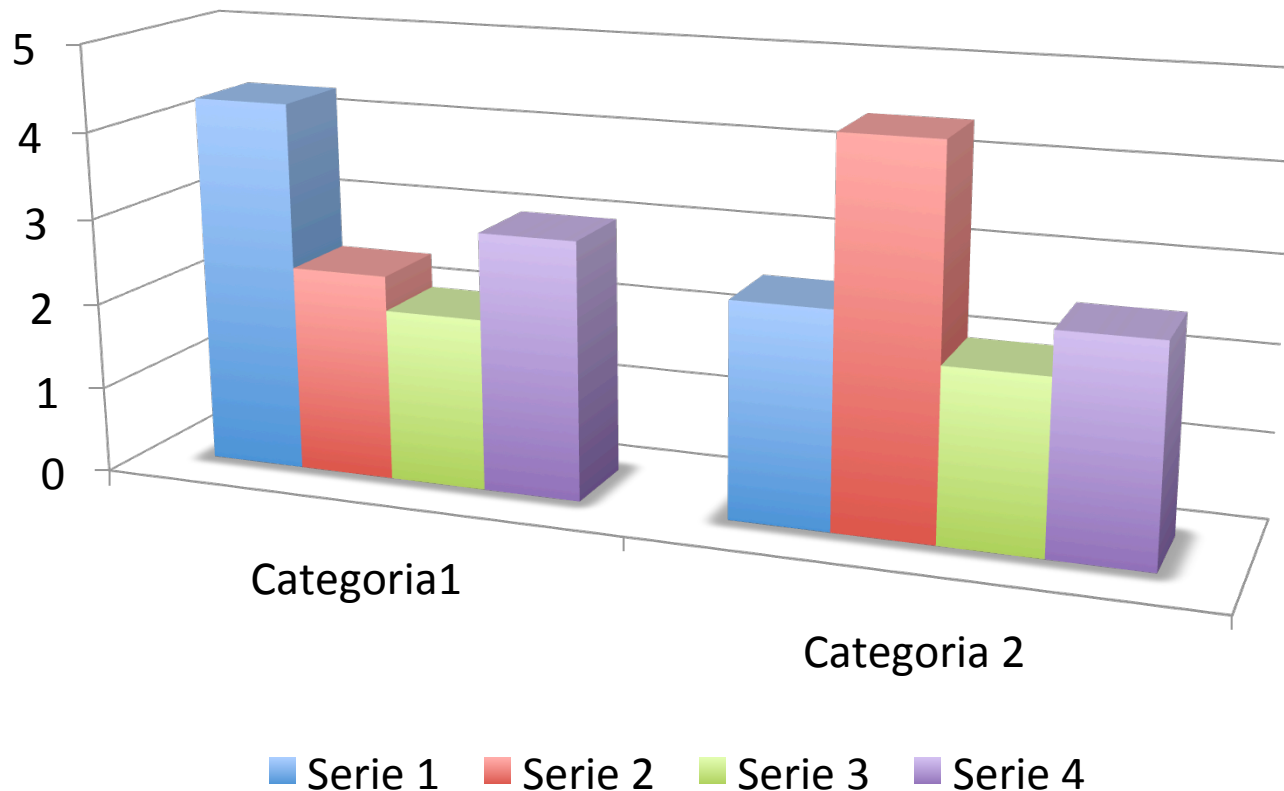


Visual Display of Quantitative Data
Edward Tufte, 1983

DATA-INK RATIO

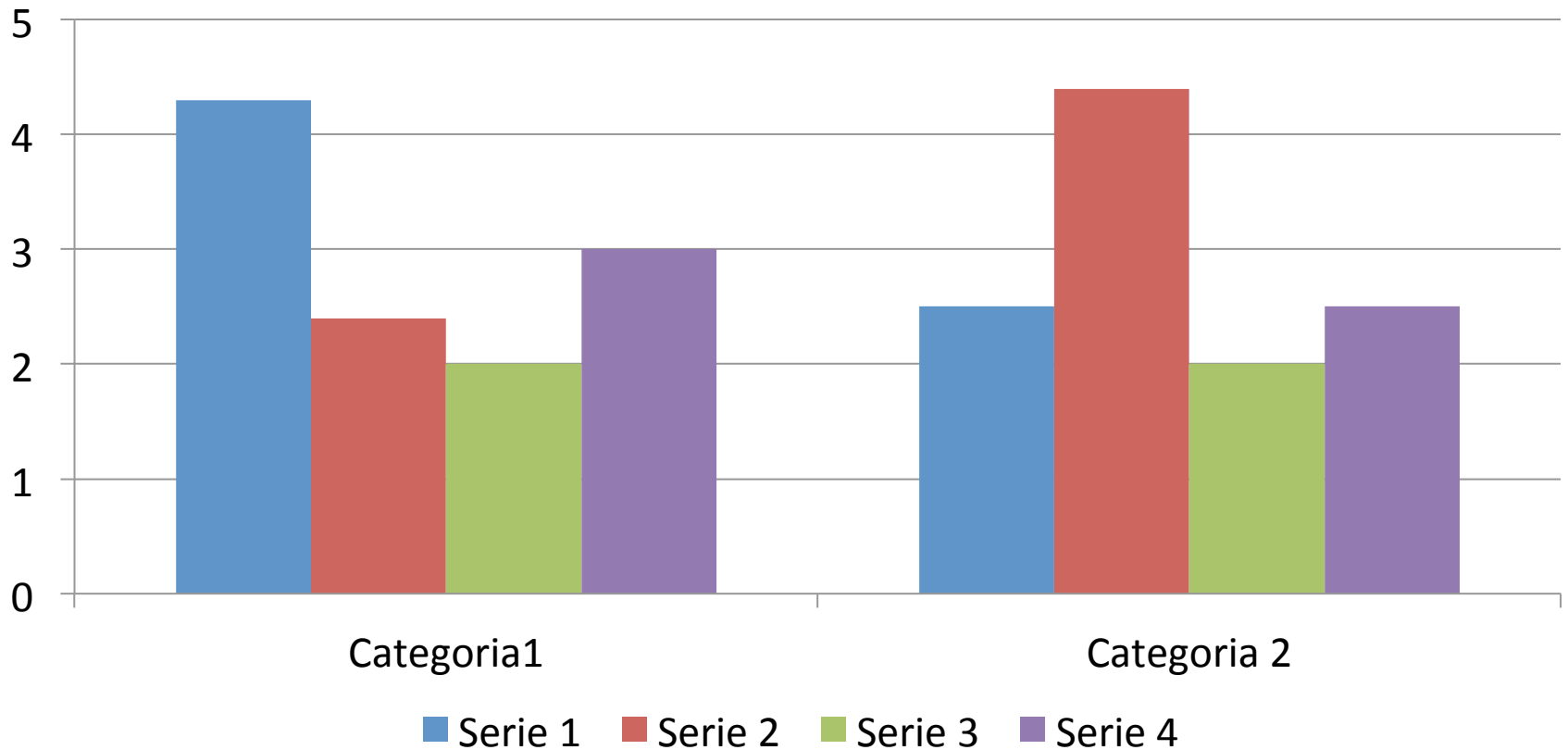
Data-ink Ratio

$$\text{Data-Ink Ratio} = \frac{\text{Data ink}}{\text{Total ink used in graphic}}$$



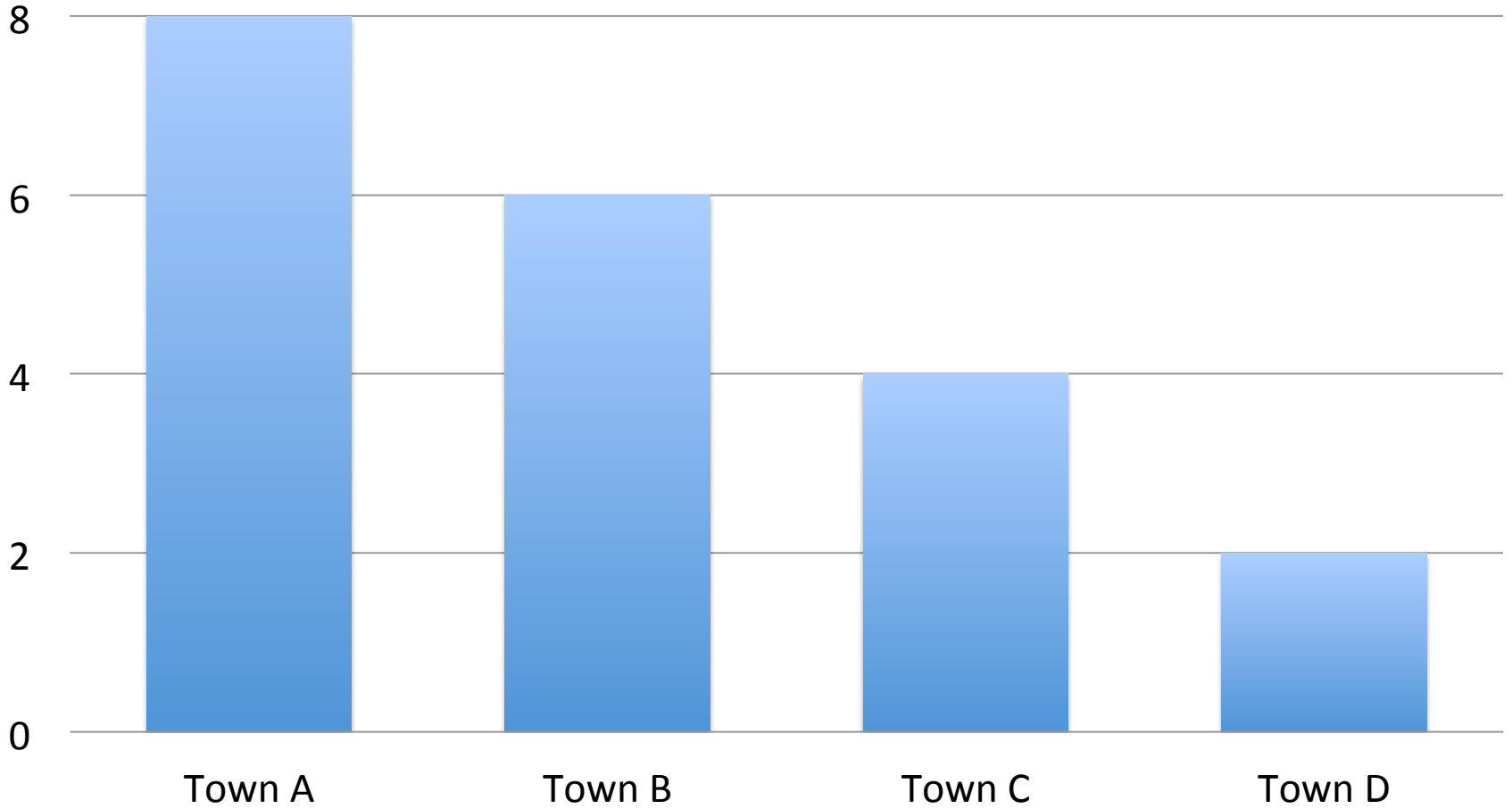
Data-ink Ratio

$$\text{Data-Ink Ratio} = \frac{\text{Data ink}}{\text{Total ink used in graphic}}$$



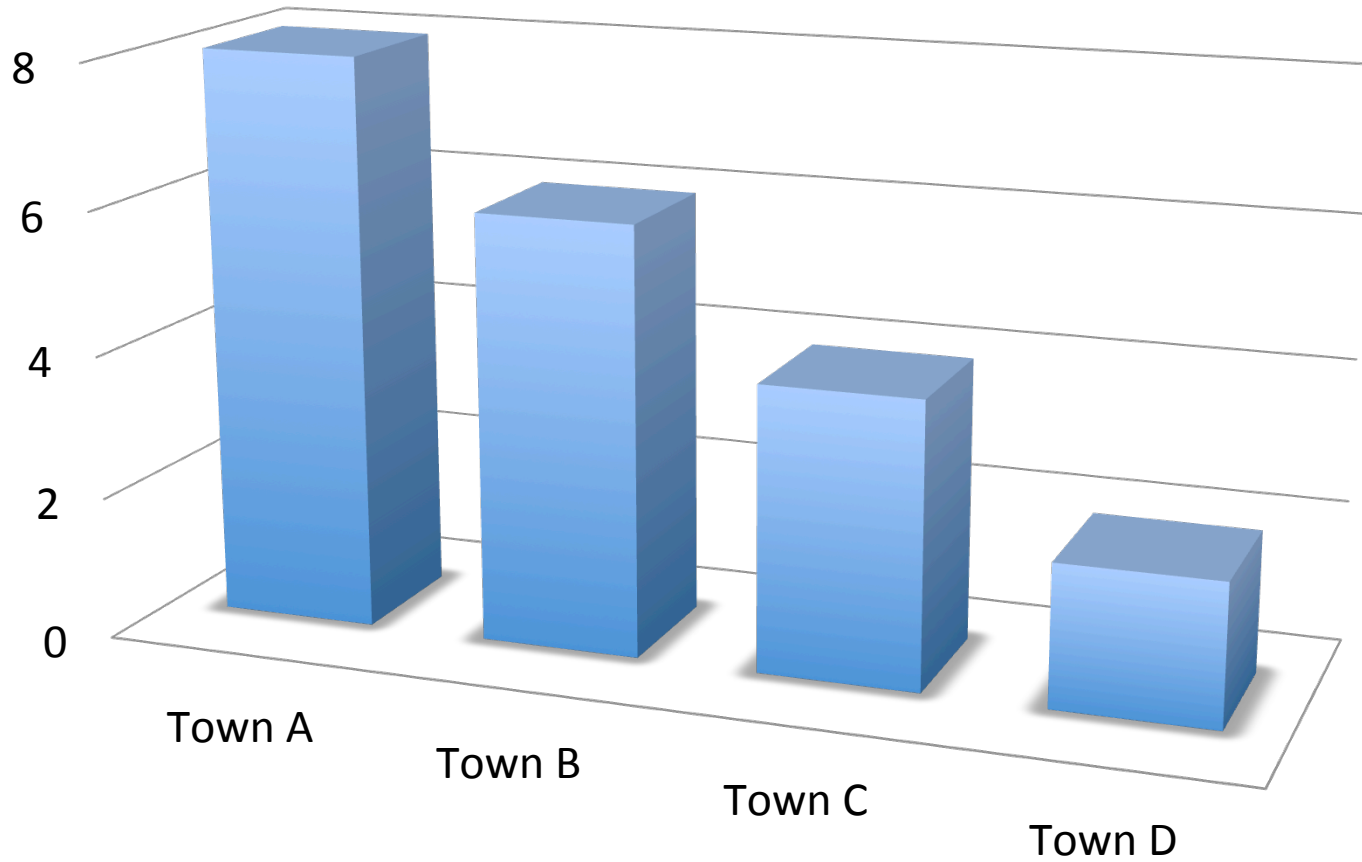
Bar Charts

Represent discrete quantities



Bar Charts

Avoid non-functional adornment



Bar Charts: baseline

Chart Title

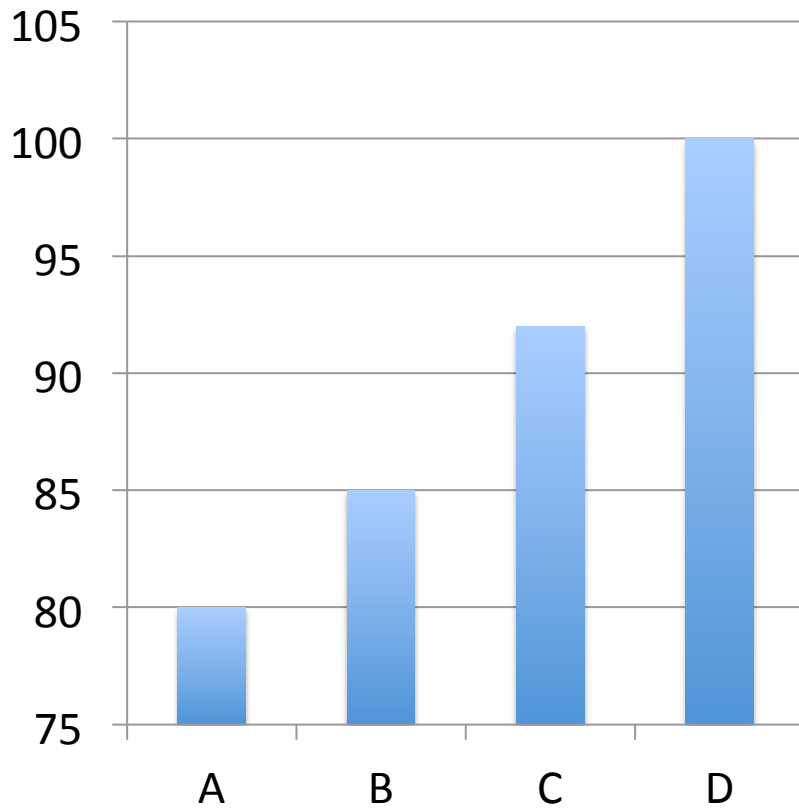
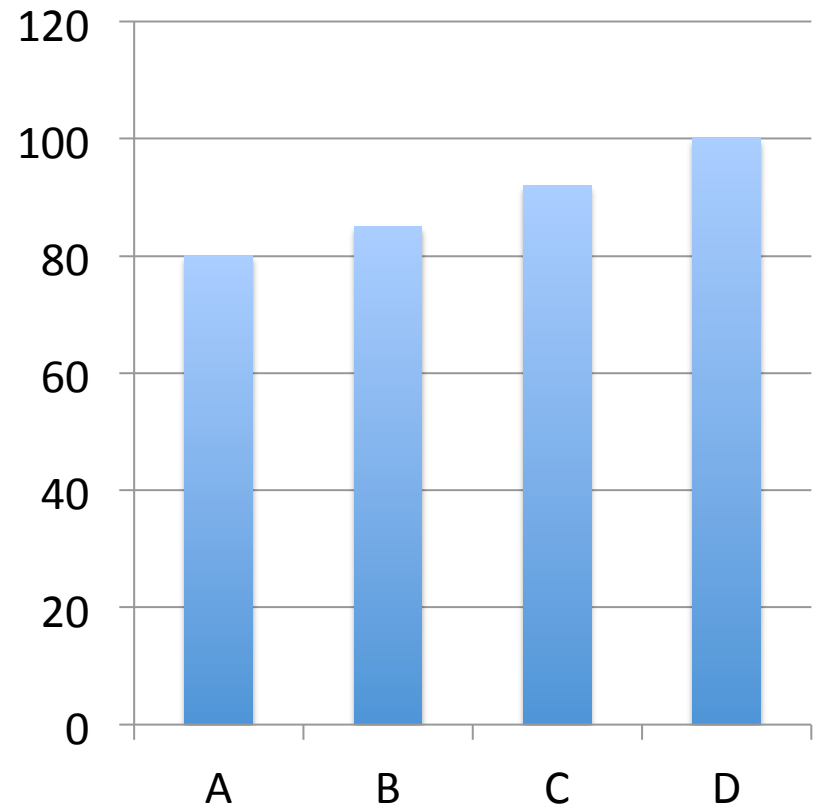
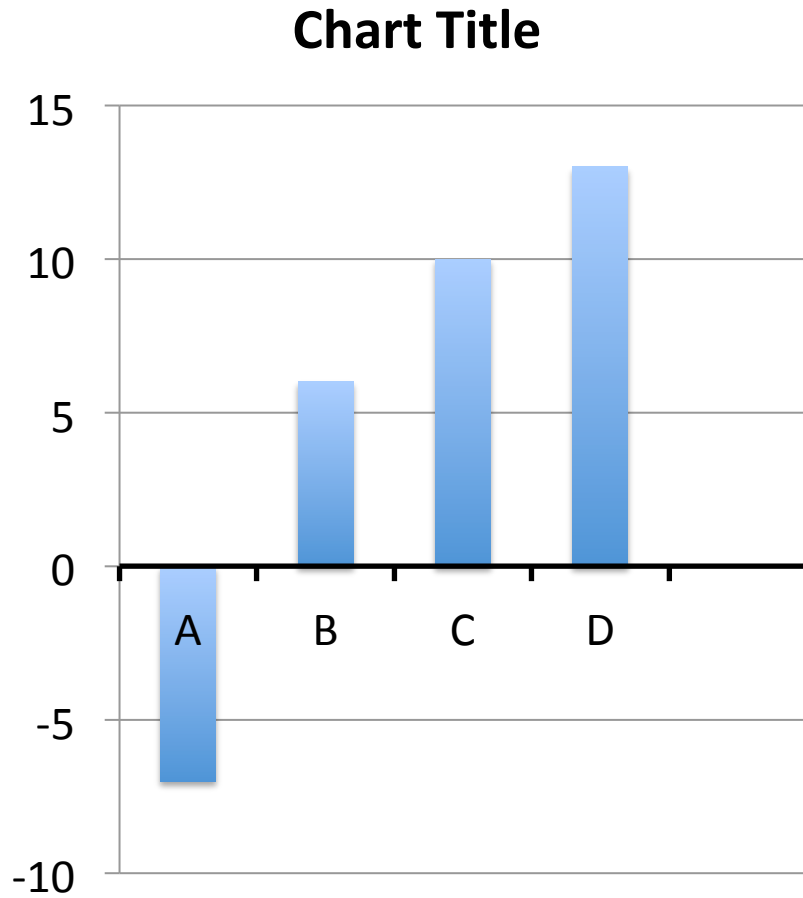


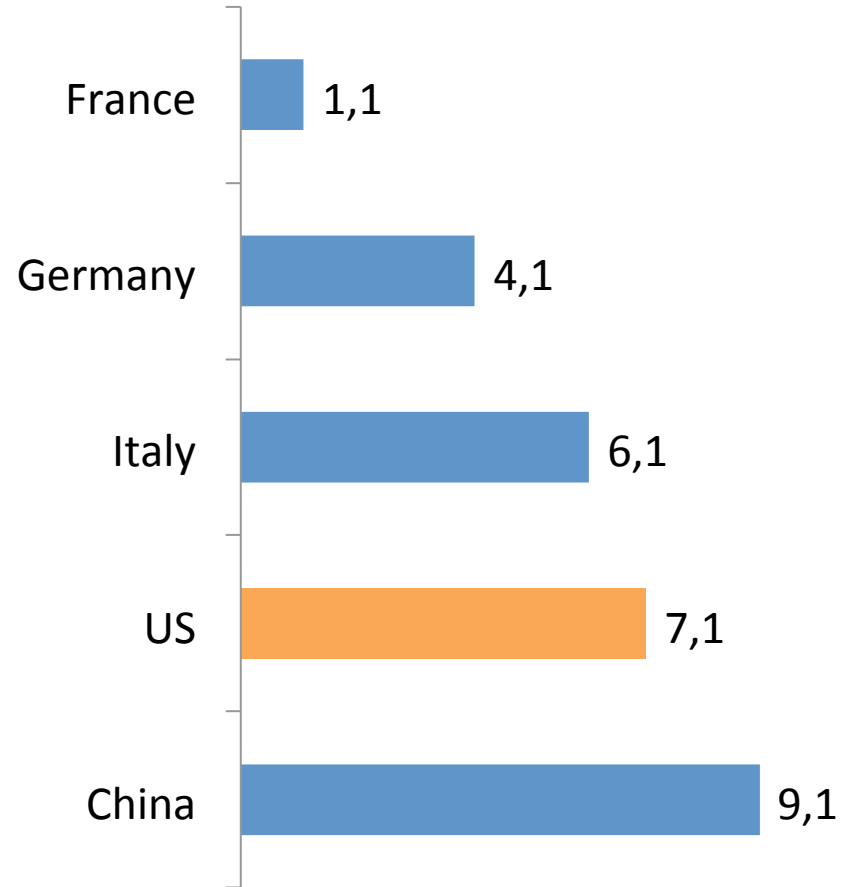
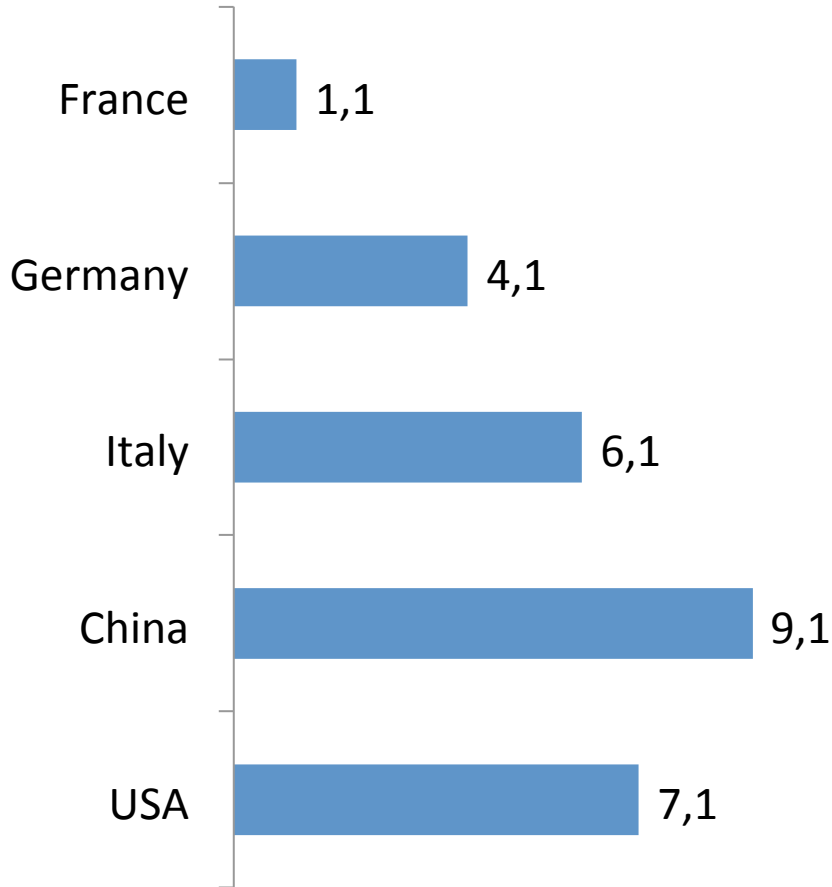
Chart Title



Bar Charts: baseline

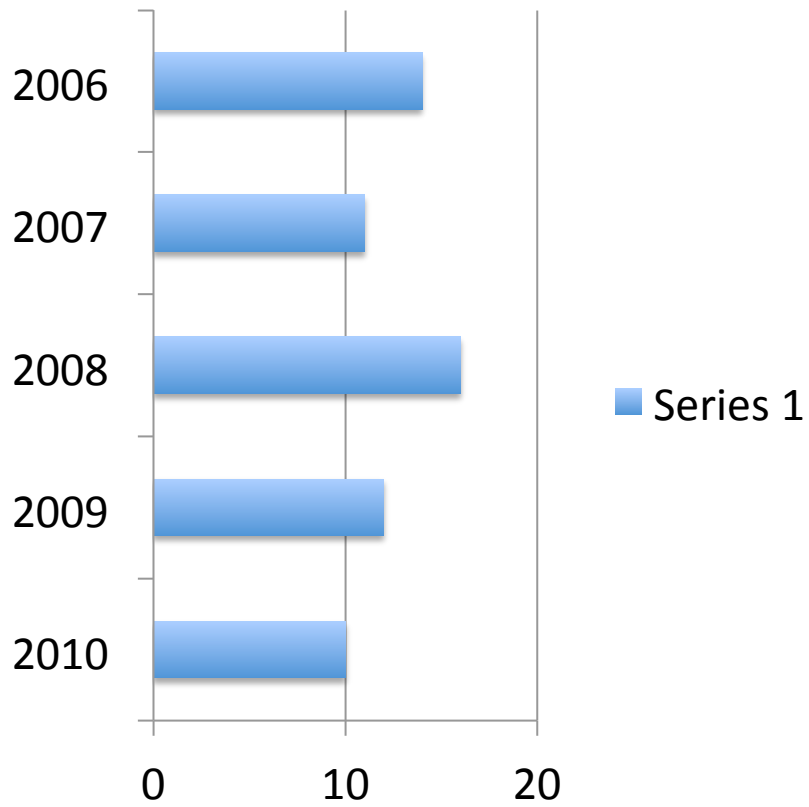


Bar Charts: ordering

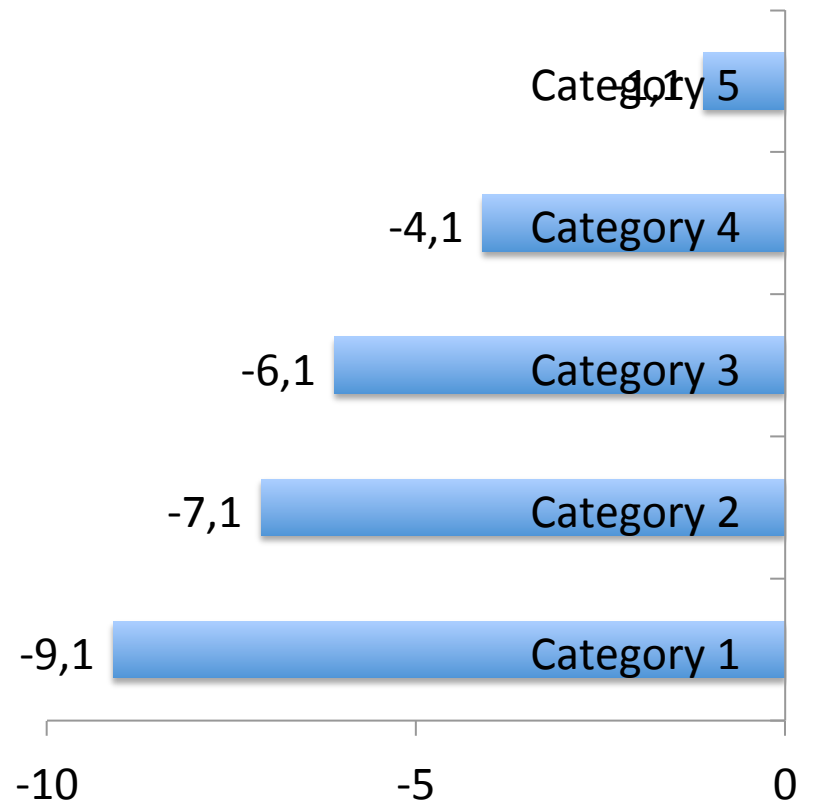




Series 1

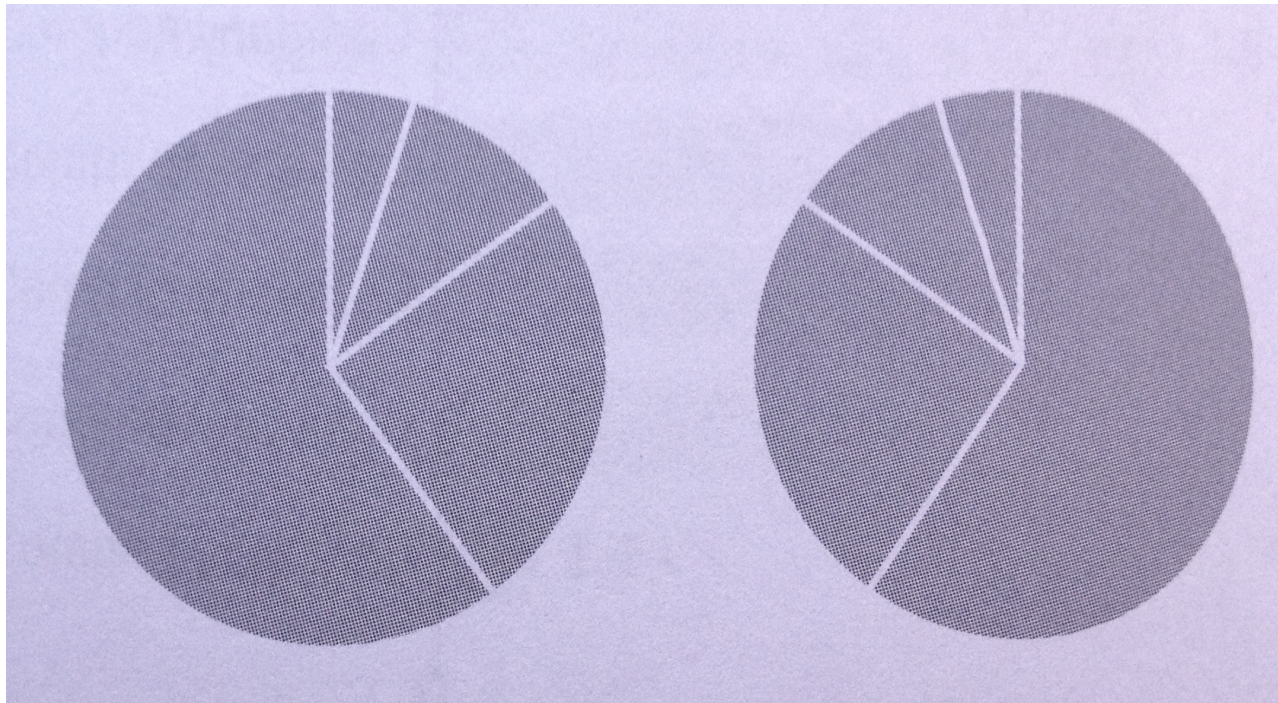


Series 1

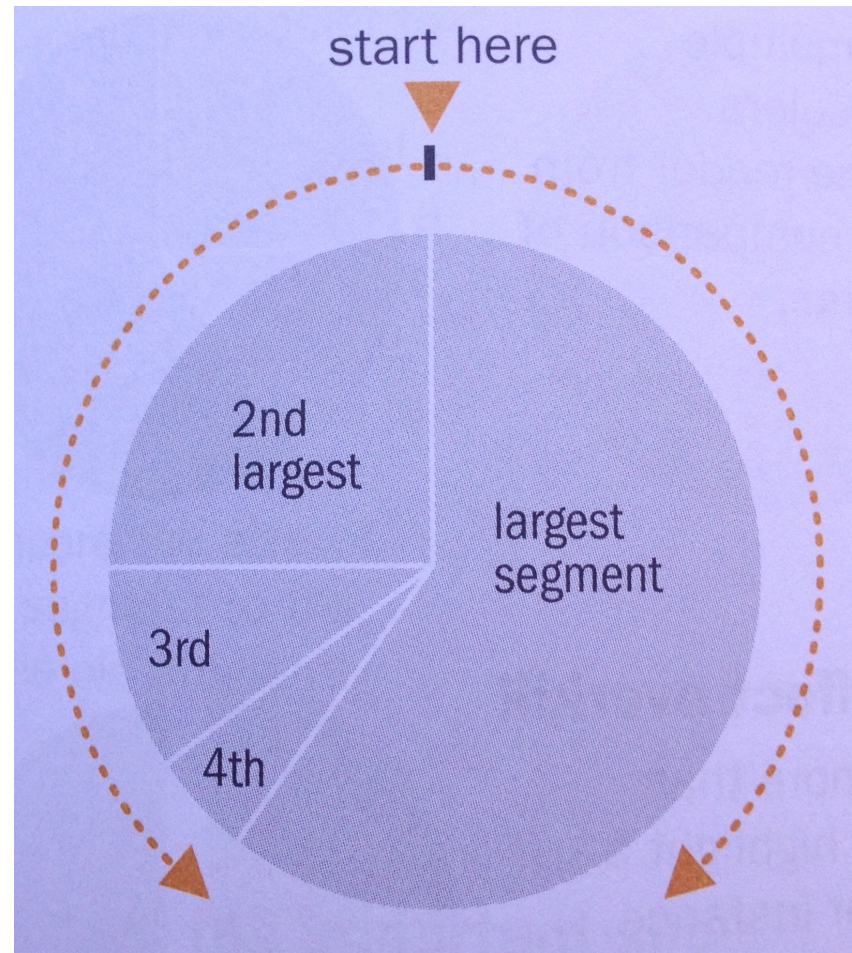


Pie Charts

- Pie Charts compares relative sizes and contributions

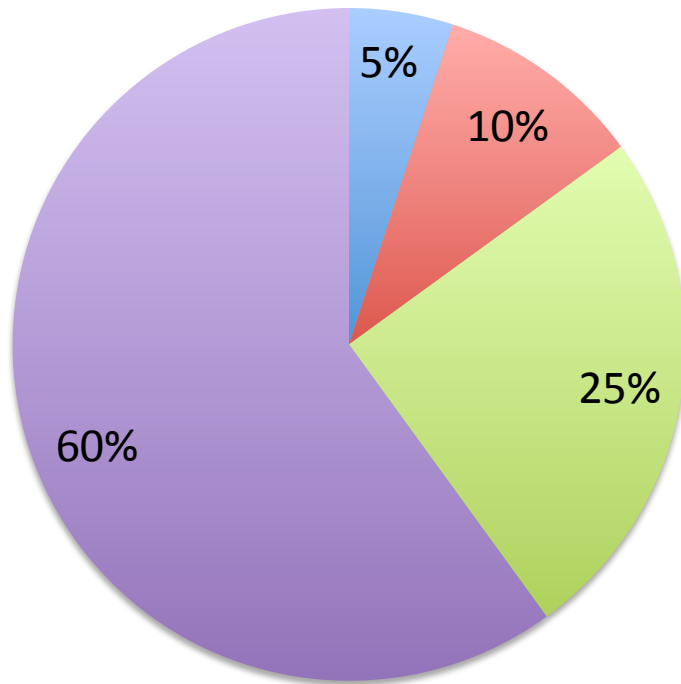


Pie Charts: ordering slices

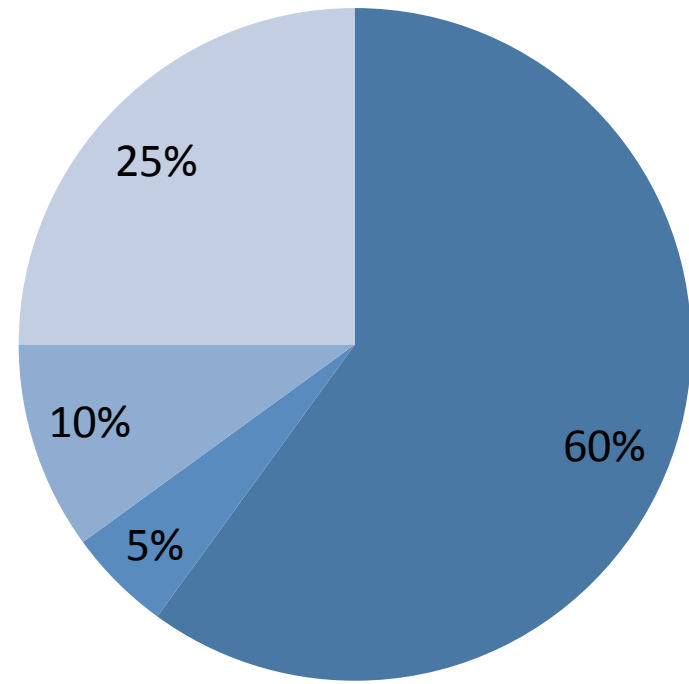


Charting Examples

Sales



Sales



May these charts be improved? Why? How?

Takeaway Messages

- Charts exploit position on scale VV
- Best practice to reduce biases and misinterpretation of charts

Visual Taxonomy

The Data Visualisation Catalogue

About · Suggest · Shop · Resources

Search by Function

View by List



Arc Diagram



Area Graph



Bar Chart



Box & Whisker Plot



Brainstorm



Bubble Chart



Bubble Map



Calendar



Chord Diagram



Choropleth Map



Circle Packing



Connection Map

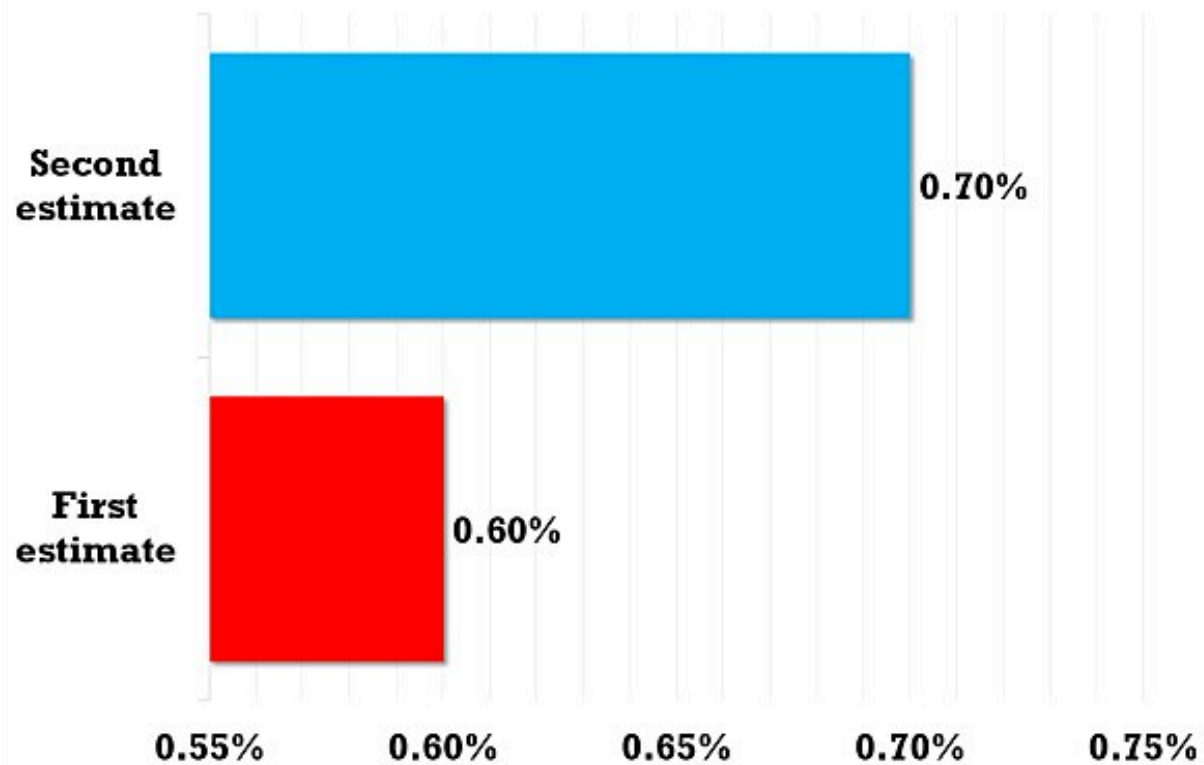


<http://www.datavizcatalogue.com/>



A FEW EXAMPLES AND CASE STUDIES

2016 Q4 GROWTH UPGRADED



Source: ONS

The Office for National Statistics (ONS) said gross domestic product (GDP) expanded by 0.7 per cent in the fourth quarter - an increase from the 0.6 per cent calculated on the watchdog's first look at the economy

Source: <http://www.dailymail.co.uk/news/article-4248690/Economy-grew-0-7-final-three-months-2016.html>

Awareness

Engagement

Tickets

Audience



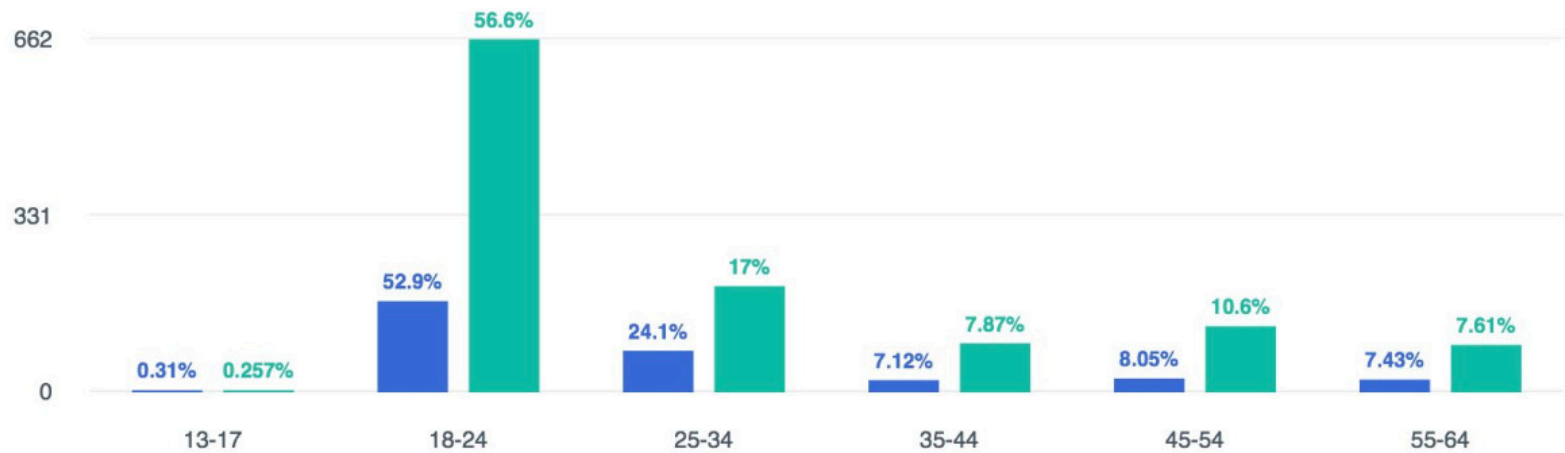
Include events that your Page is co-hosting

Last 7 days ▾

Demographics

Men

Women



Source: Facebook Analytics

Procent użytków rolnych w gospodarstwach > niż 50 ha:

1989

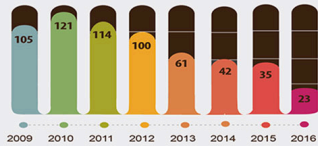
25%





CAMERA INDUSTRY FACTS 2009-2016

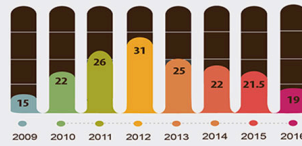
Amount of Total Cameras Manufactured by Year*



*in millions

35% DROP IN SHIPPED CAMERAS IN 2016

Amount of Interchangeable Lenses Manufactured by Year*



*in millions

12% DROP IN SHIPPED LENSES IN 2016

DSLR vs. Mirrorless 2013-2016

*in millions



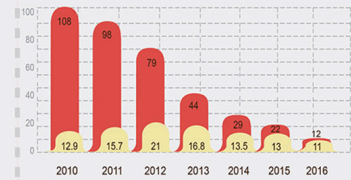
4% DECREASE IN MIRRORLESS PRODUCED

17% DROP IN DSLR PRODUCED IN 2016



Based on CIPA (Camera & Imaging Products Association), Shipment of Digital Still Cameras & Lenses Data

Cameras Manufactured Between 2010-2016 interchangeable vs. Non interchangeable

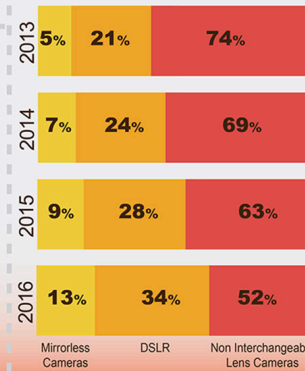


Legend: DSLR/Mirrorless (Yellow), Non interchangeable Lens Cameras (Red)

THE ENTIRE CAMERA MARKET IN 2016 SAW 81% DROP COMPARED TO 2010

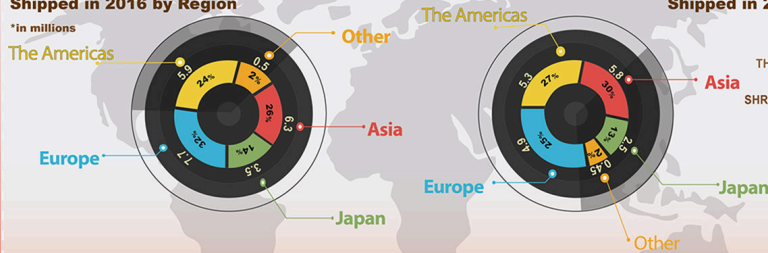


Camera Market Overview 2013-2016



Number of Cameras Shipped in 2016 by Region

*in millions



THE ASIAN CAMERA MARKET SHARE GREW BY 2% IN 2016, WHILE THE MARKET SHARE OF EUROPE WENT DOWN BY 2%

Number of Lenses Shipped in 2016 by Region

*in millions

THE EUROPEAN LENS MARKET SHARE SHRANK BY 2% IN 2016

Takeaway Messages

- Appropriate chart type for specific data type and visualization task