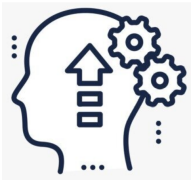
Wizualizacja danych

Wykład 6: Aspekty percepcyjne i kognitywne

Mariusz Tarnopolski

Instytut Astronomii UMK

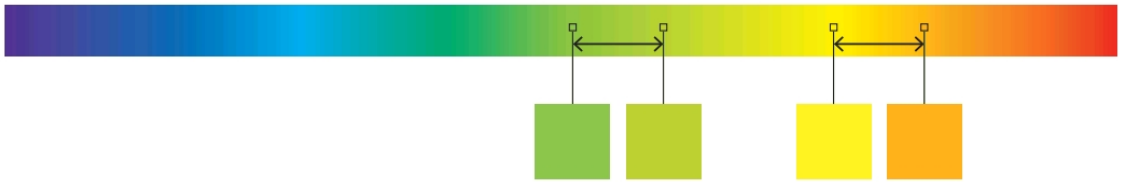
DataViz, 2024/2025



Rainbow:

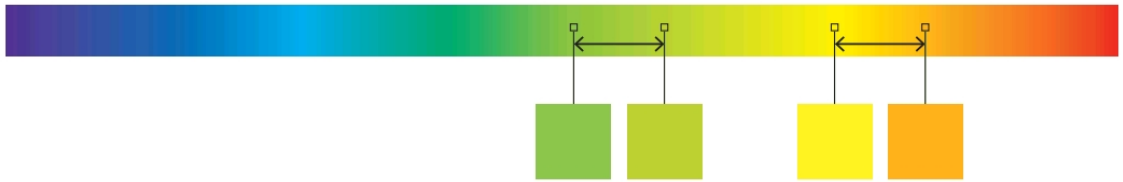
Rainbow:

Nie jest percepcyjnie jednorodny:



Rainbow:

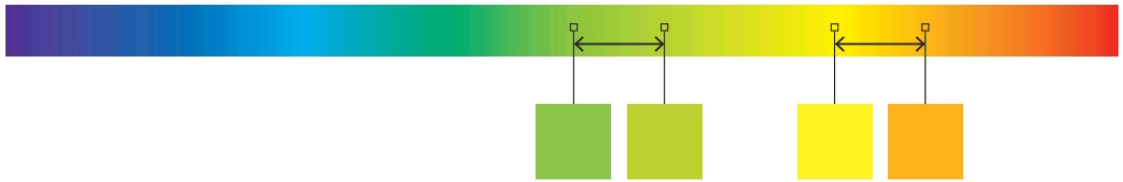
Nie jest percepcyjnie jednorodny:



W skali odcieni szarości:

Rainbow:

Nie jest percepcyjnie jednorodny:

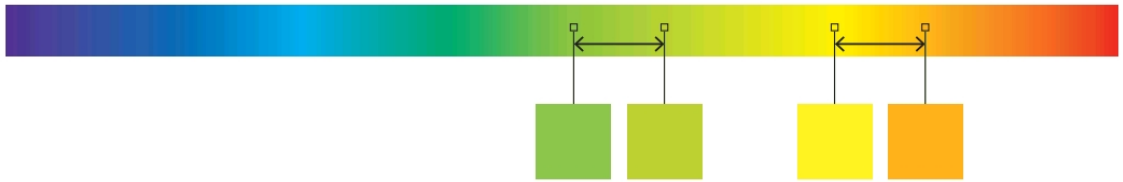


W skali odcieni szarości:

Skala sekwecyjna:

Rainbow:

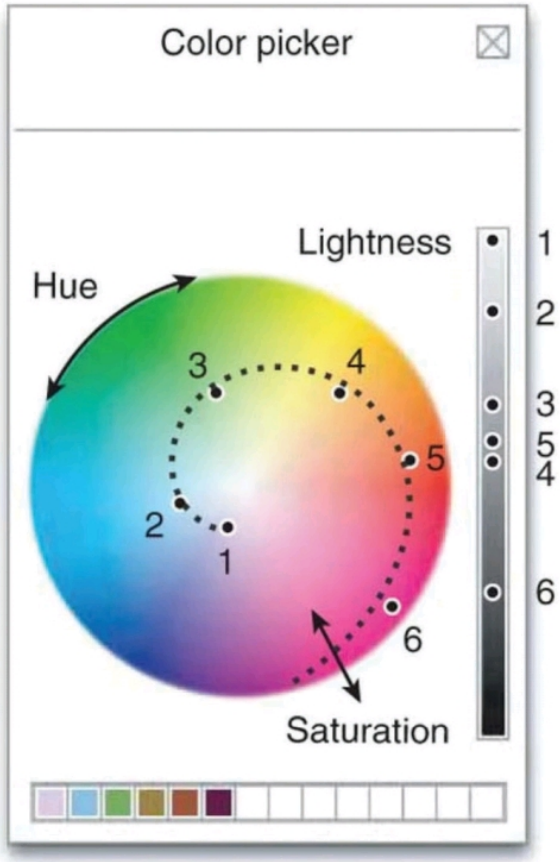
Nie jest percepcyjnie jednorodny:

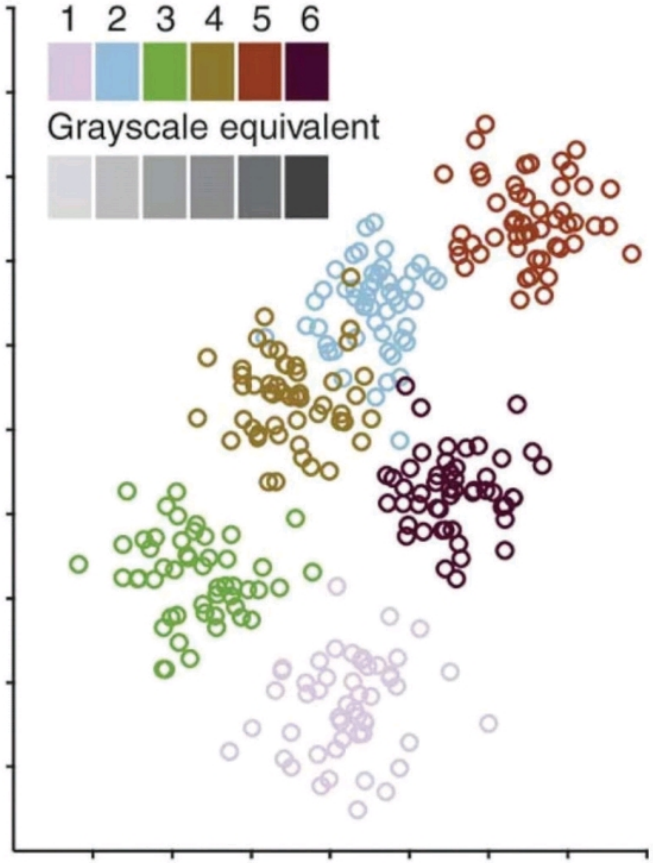


W skali odcieni szarości:

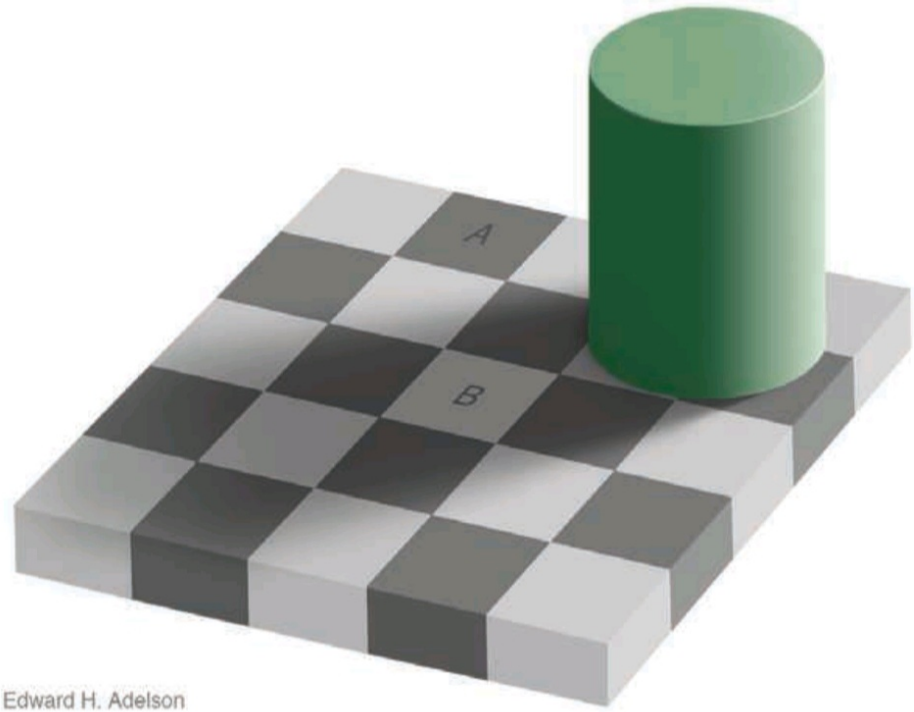
Skala sekwecyjna:

też wywołuje iluzje percepcyjne:

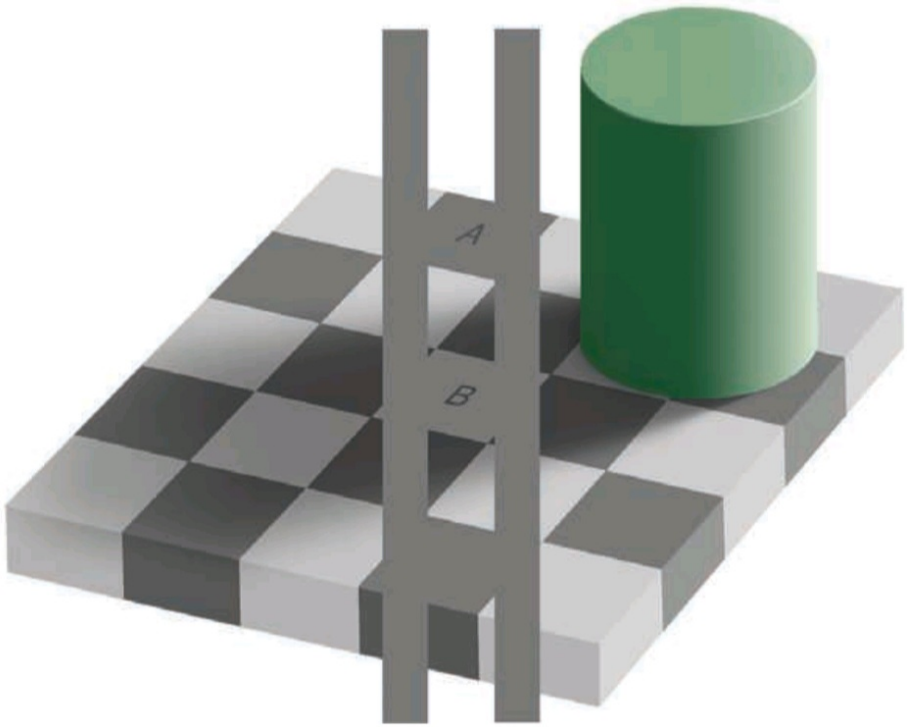

Color picker
Lightness
Hue
Saturation
1
2
3
4
5
6

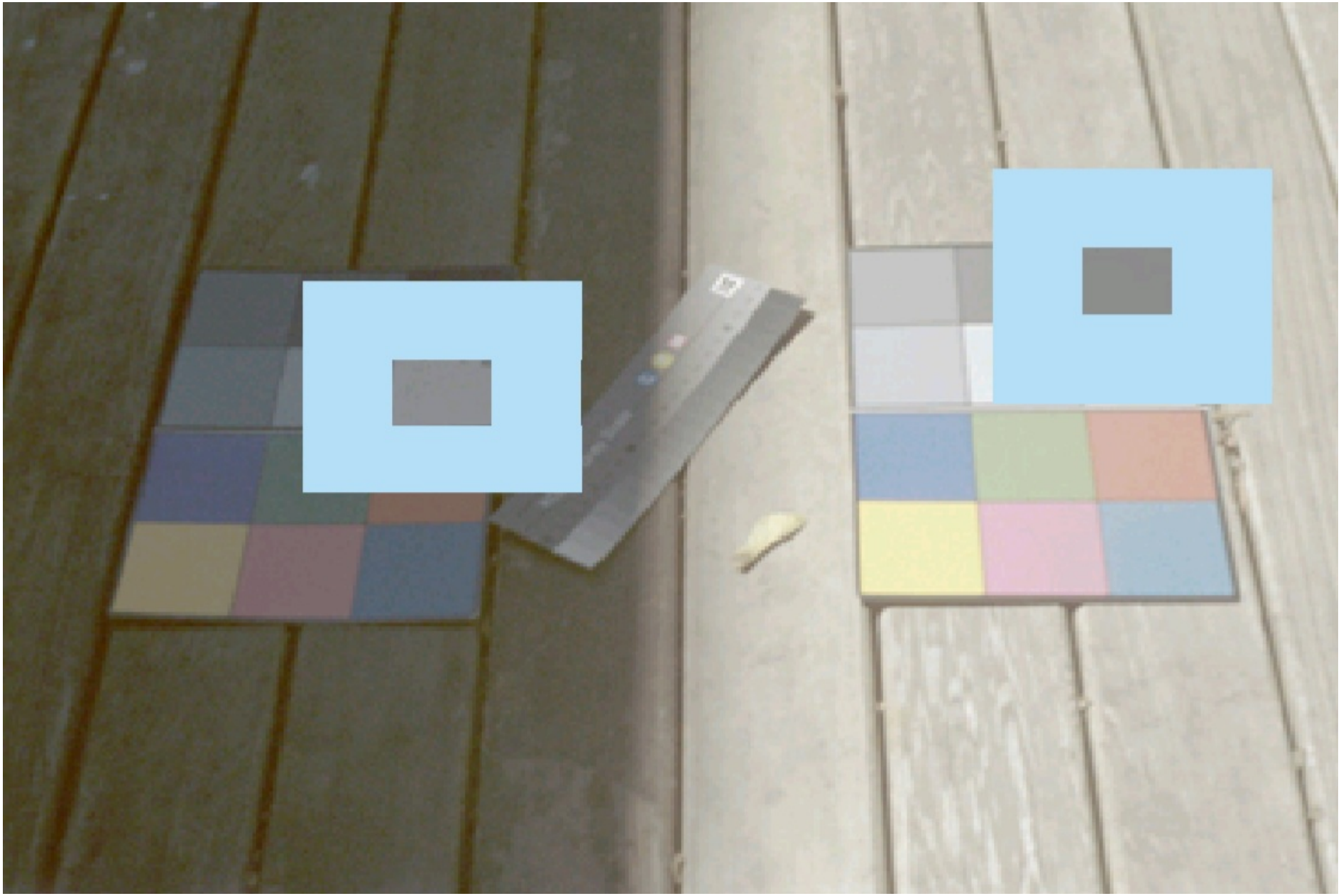

1 2 3 4 5 6
Grayscale equivalent

Efekt Adelsona

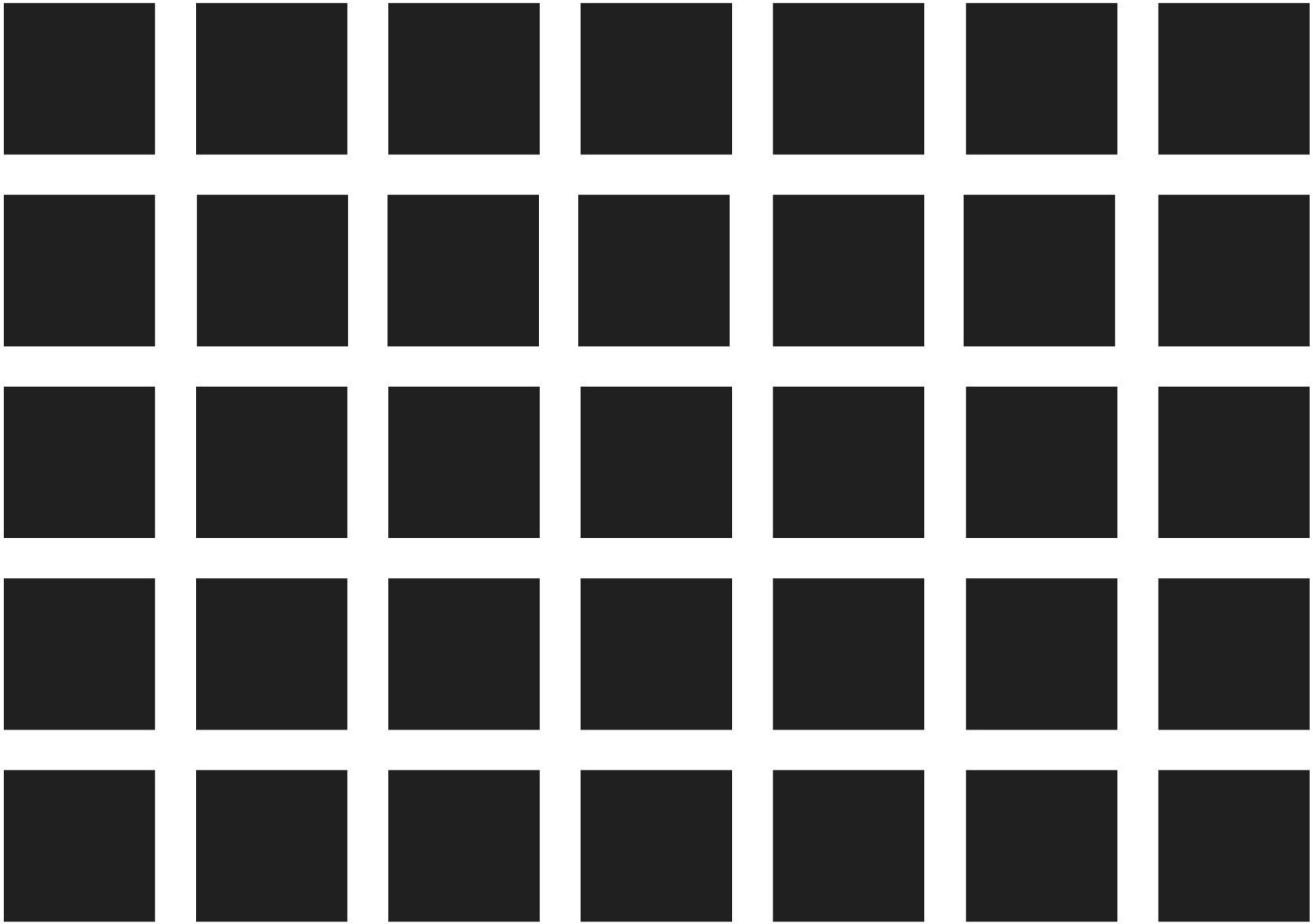


Edward H. Adelson



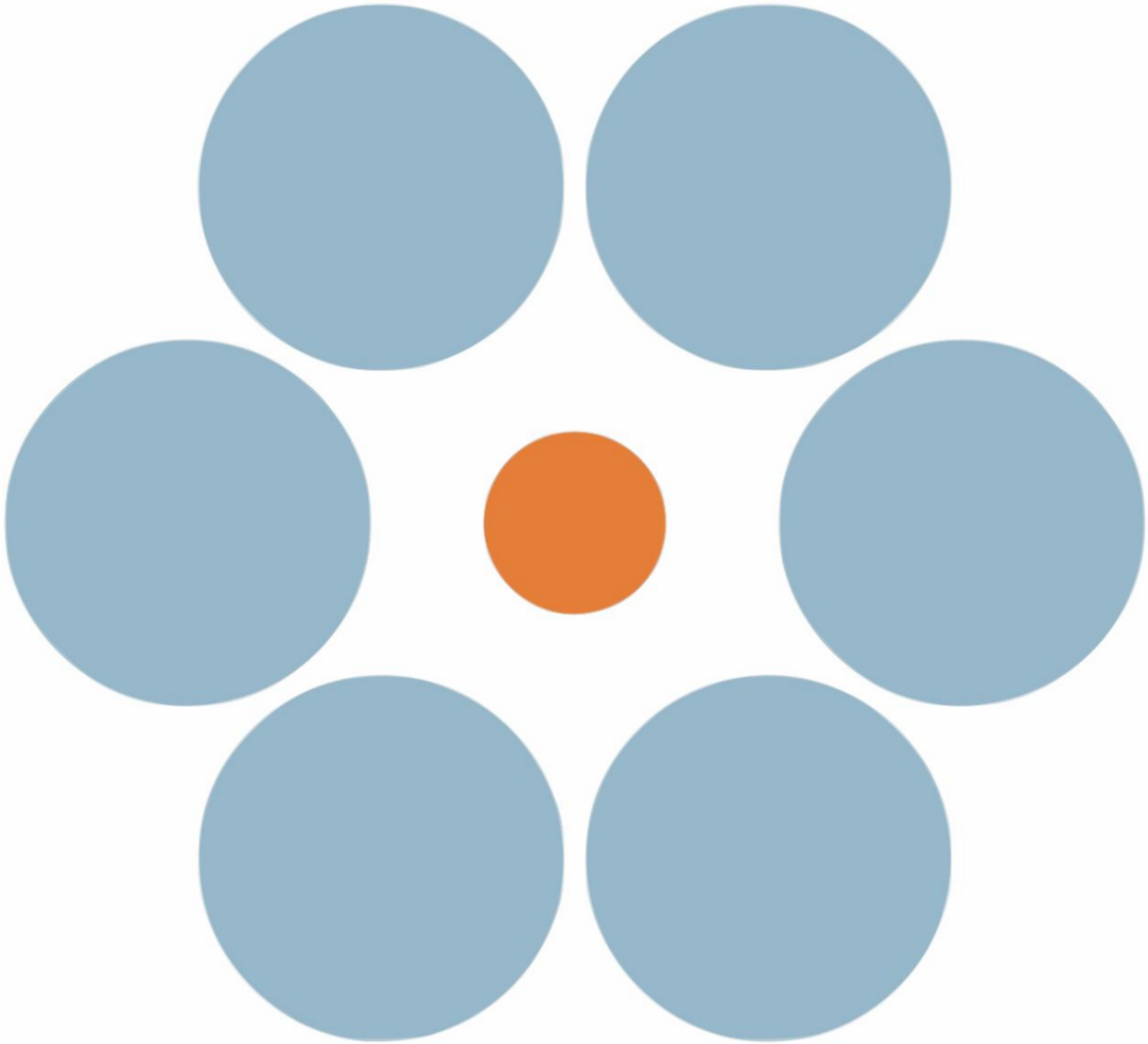


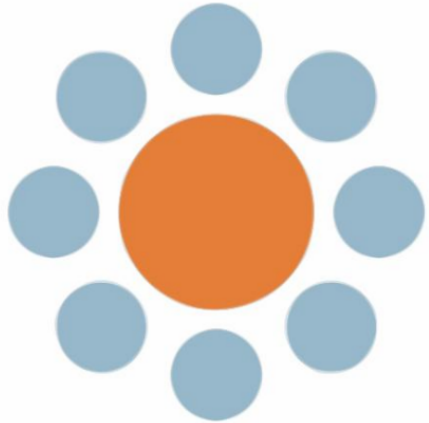
Iluzja siatki Hermanna



Pasmo Macha

Złudzenie Ebbingausa

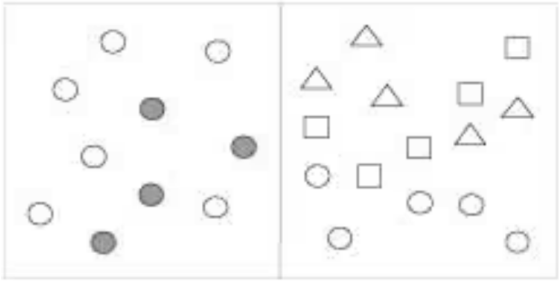




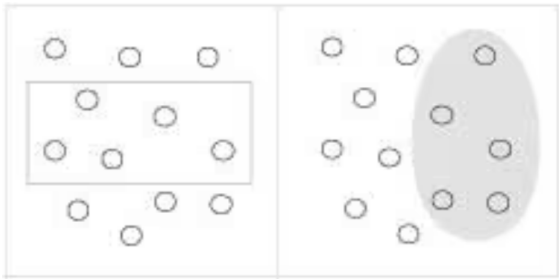
Psychologia percepcji Gestalt

Bliskość

Podobieństwo

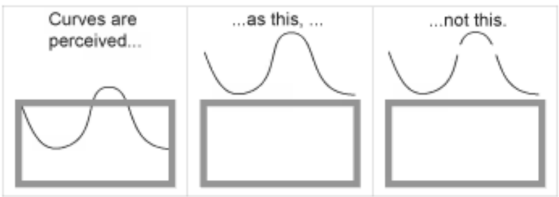


Zamknięcie

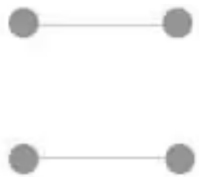


Otoczenie

Ciągłość

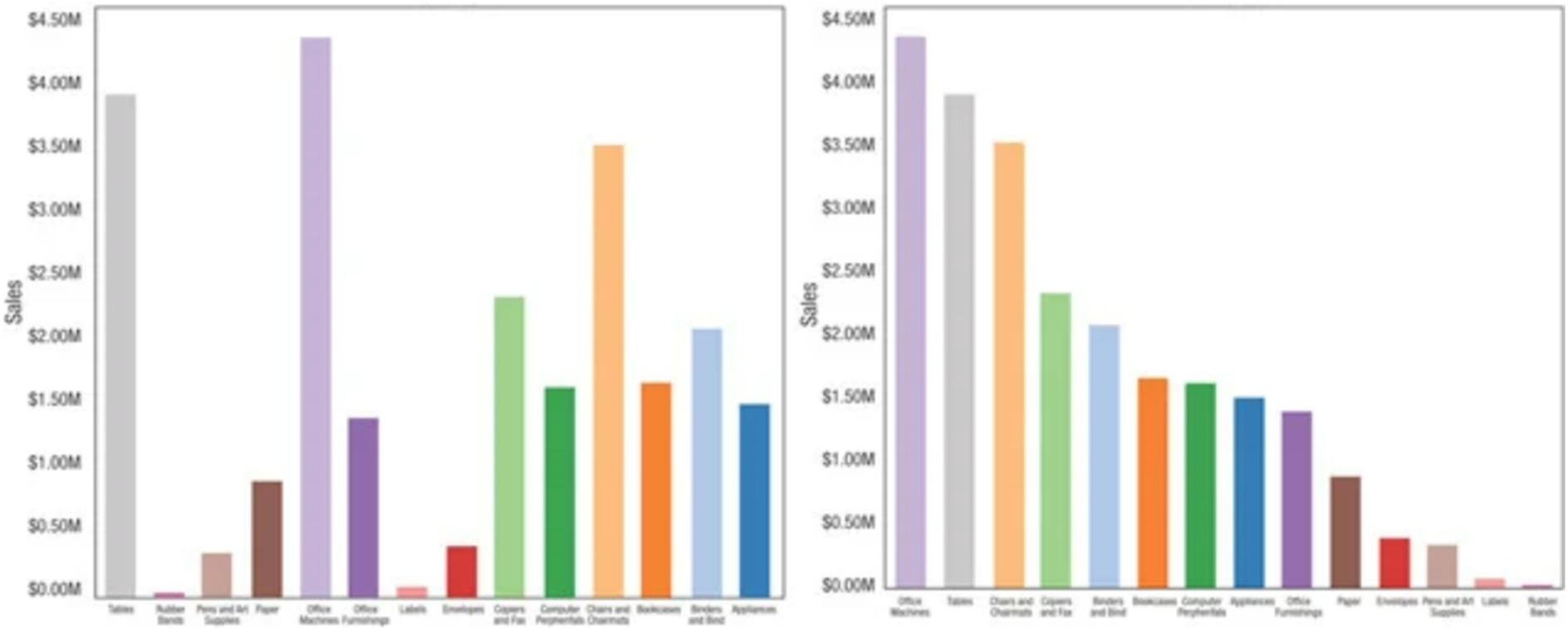


Połączenie



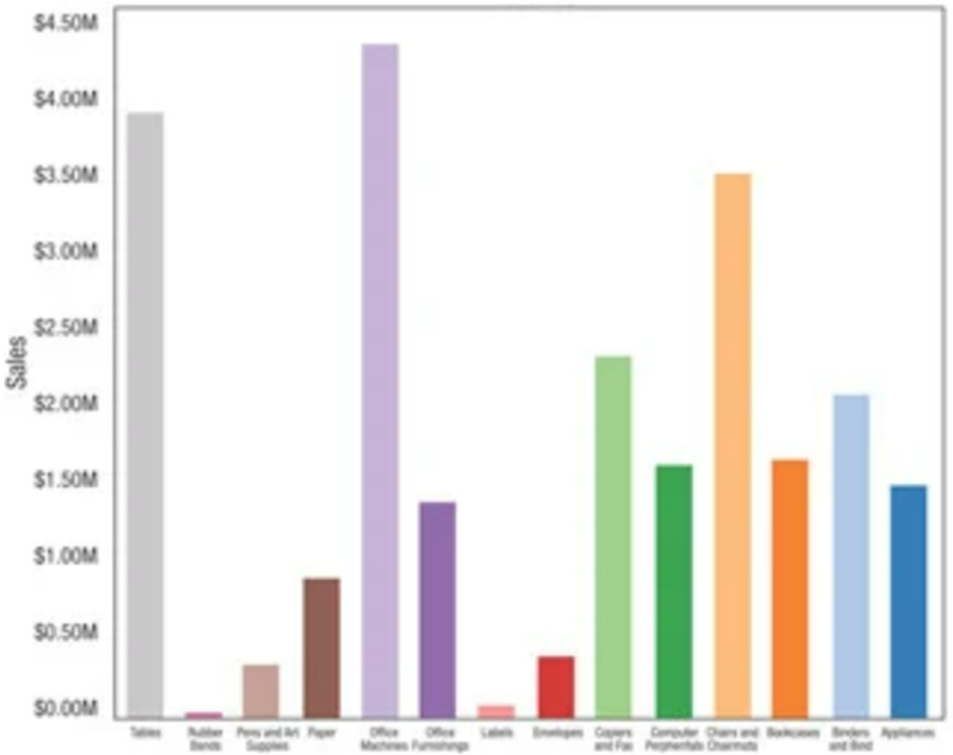
https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/data-visualization-for-human-perception

Prostota:



https://www.isaca.org/resources/isaca-journal/issues/2016/volume-2/the-art-of-data-visualization-a-gift-or-a-skill-part-2

Prostota:


$4.50M
$4.00M
$3.50M
$3.00M
$2.50M
$2.00M
$1.50M
$1.00M
$0.50M
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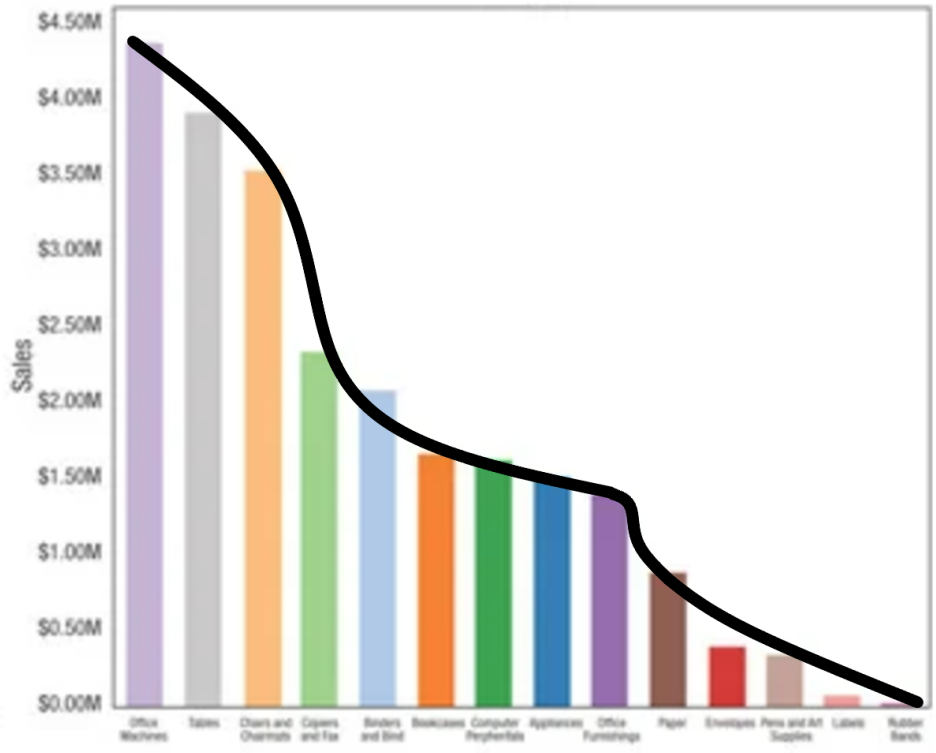
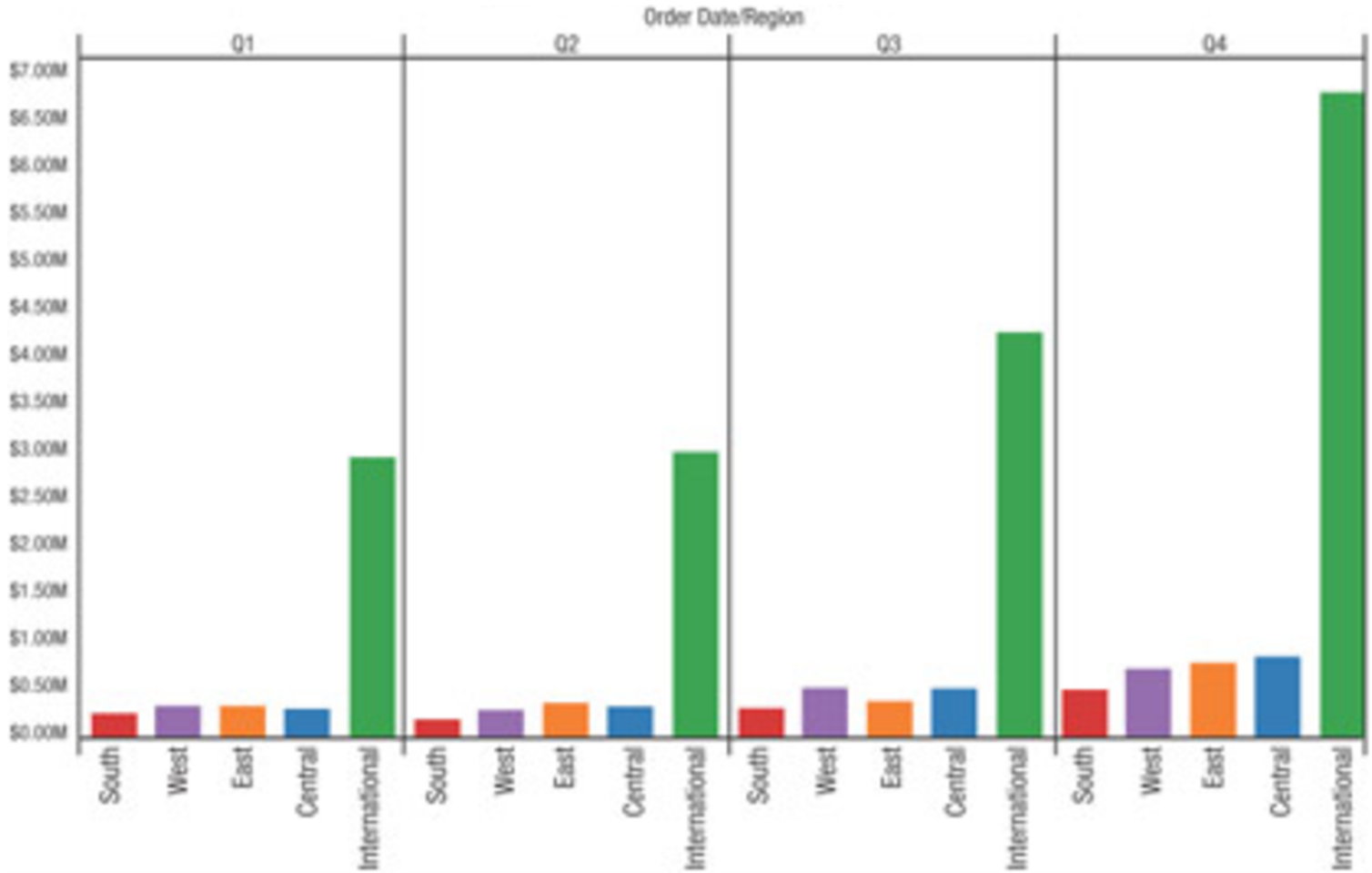
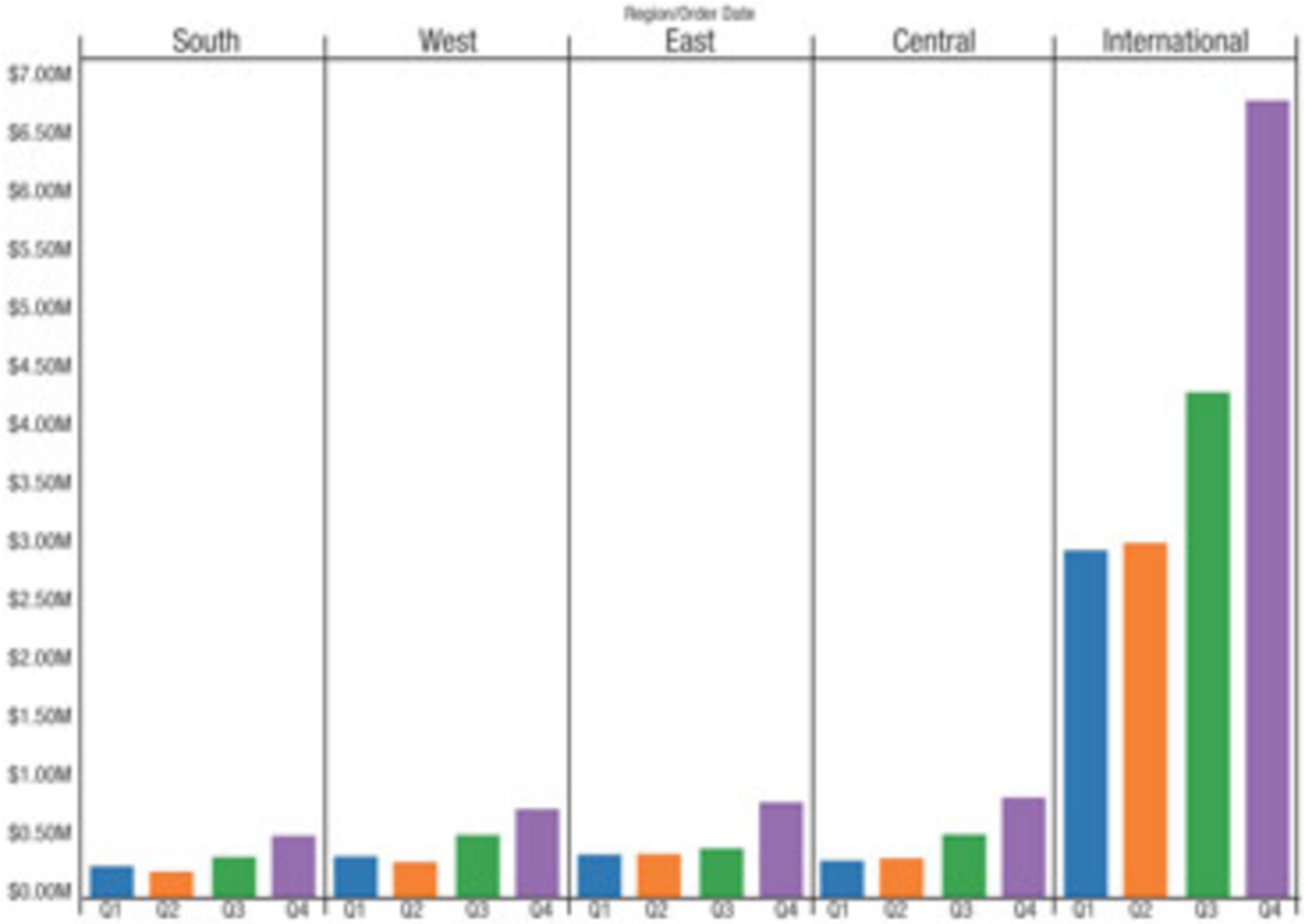
Sales

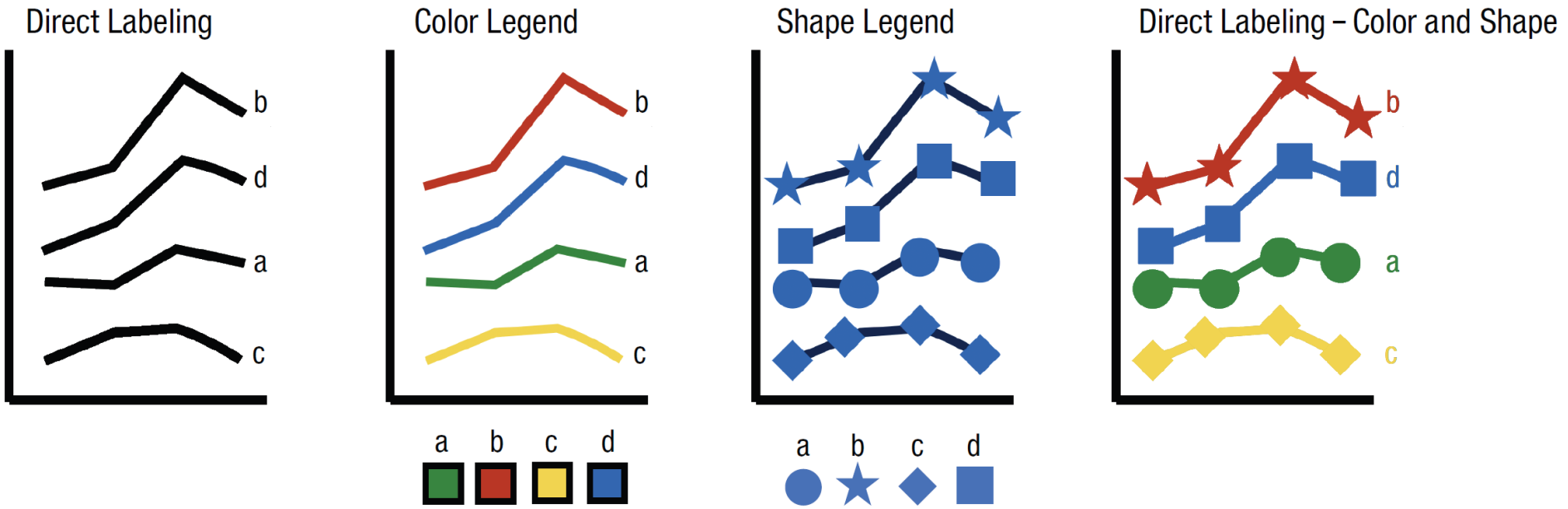

$4.50M
$4.00M
$3.50M
$3.00M
$2.50M
$2.00M
$1.50M
$1.00M
$0.50M
$0.00M
Sales

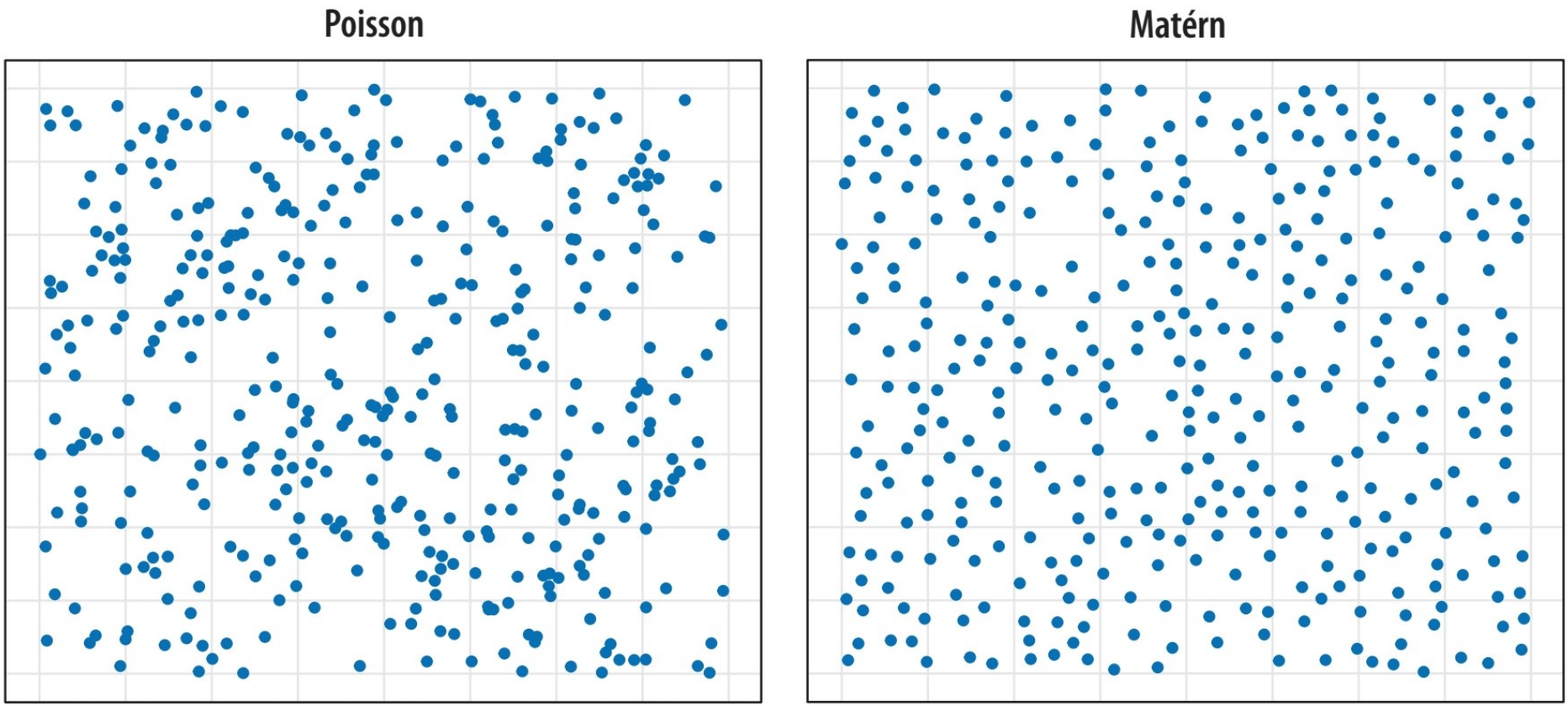
Bliskość/zamknięcie/połączenie:

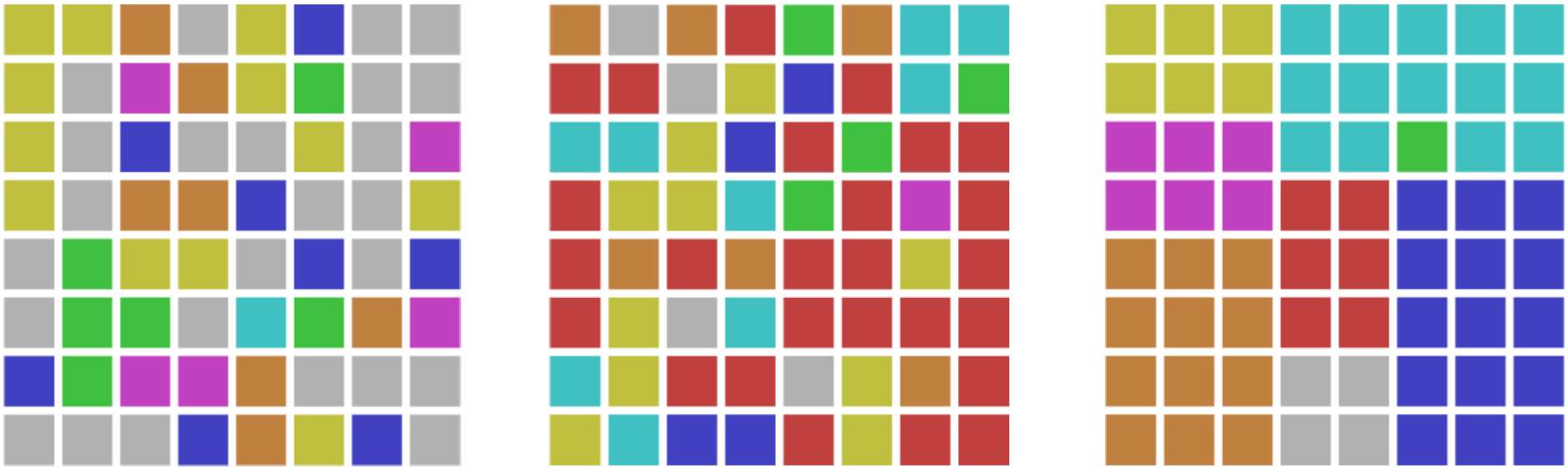


Bliskość/zamknięcie/połączenie:




Direct Labeling
b
d
a
c
Color Legend
b
d
a
c
a b c d
Shape Legend
a b c d
Direct Labeling – Color and Shape
b
d
a
c


Poisson
Matérn



https://libgen.is/scimag/?q=10.1109%2FTVCG.2012.233

Percepcyjne kanały prezentacji danych

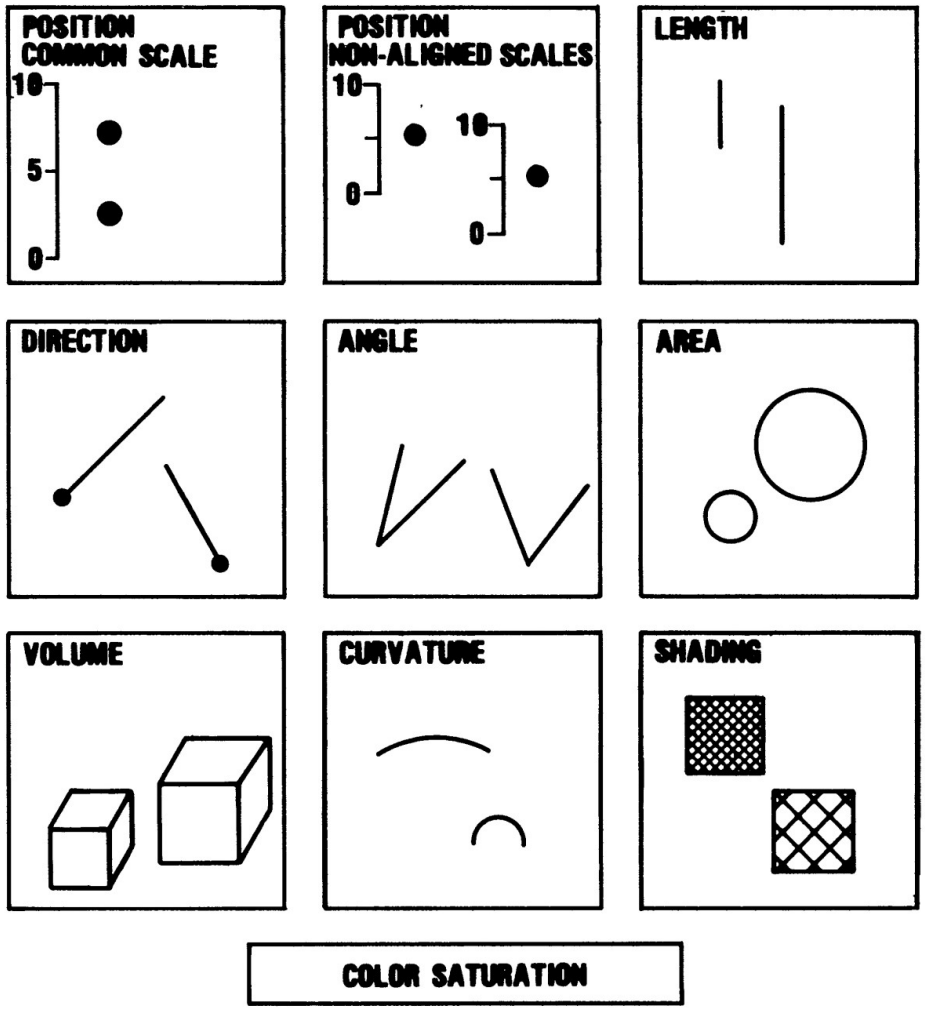
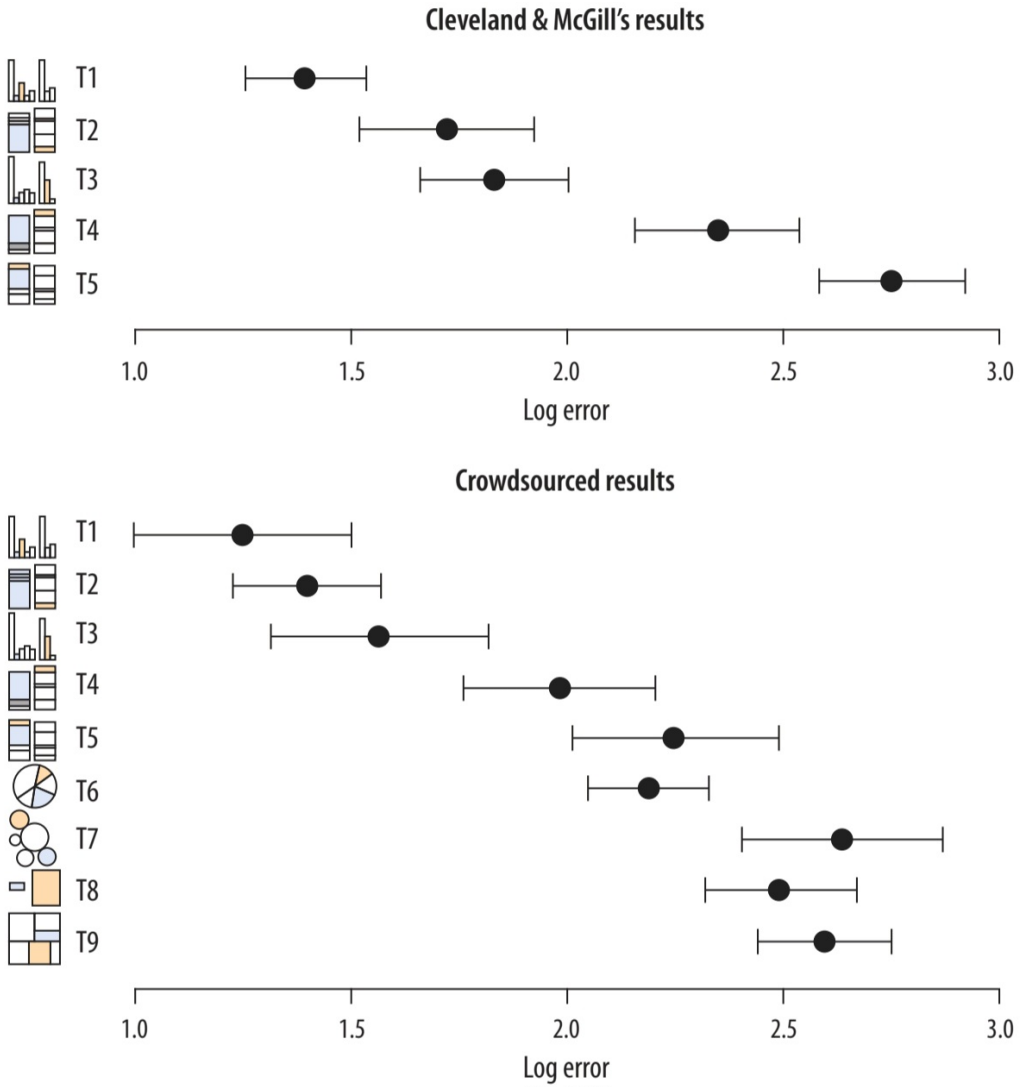


Figure 1. Elementary perceptual tasks.

http://euclid.psych.yorku.ca/www/psy6135/papers/ClevelandMcGill1984.pdf

Percepcyjne kanały prezentacji danych



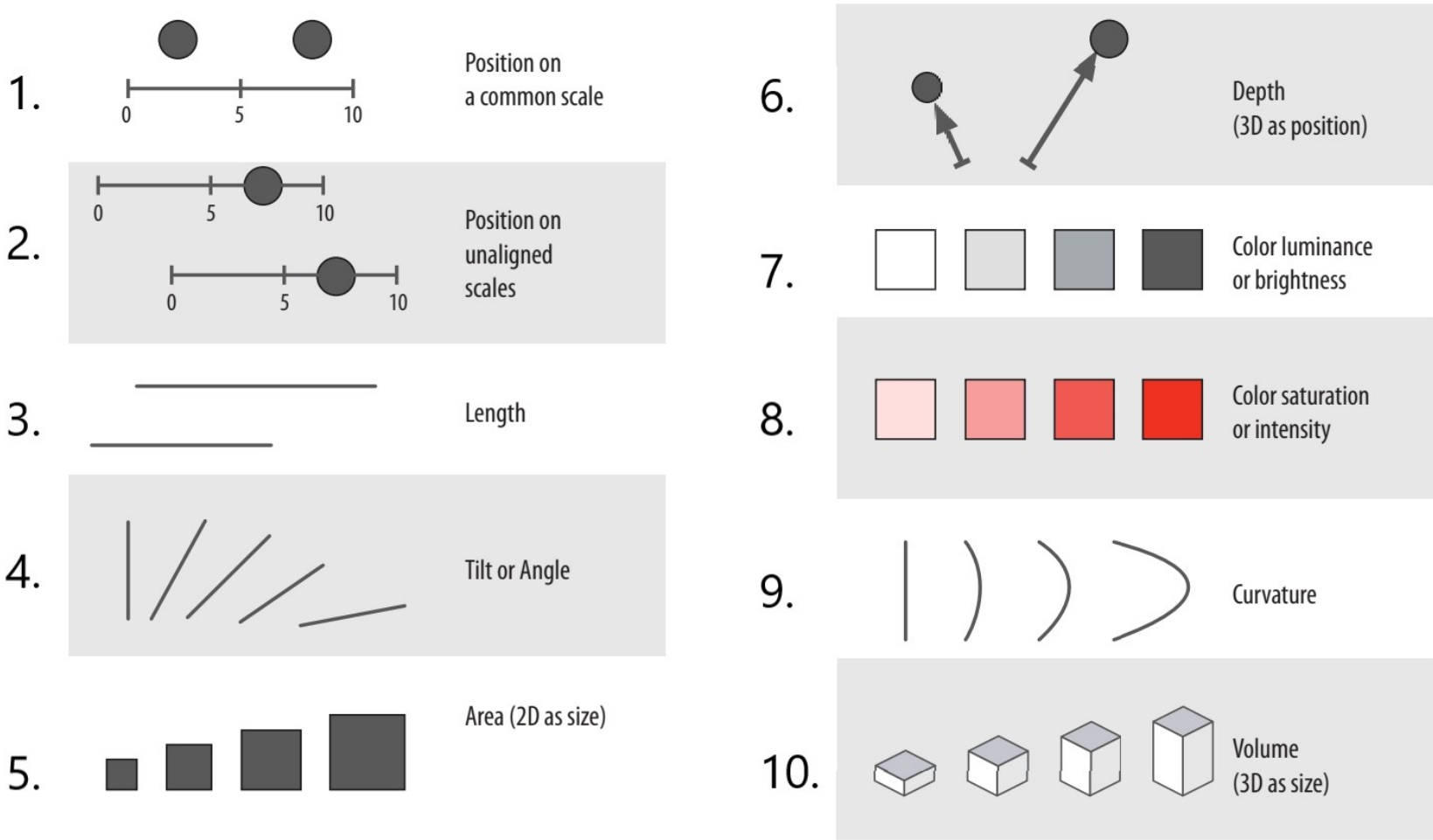
Kieran Healy. Data Vizualization. A practical introduction

Percepcyjne kanały prezentacji danych

$$\text{error} = \log_2 \left(\left| \text{judged percent} - \text{true percent} \right| + \frac{1}{8} \right)$$

Percepcyjne kanały prezentacji danych

$$\text{error} = \log_2\left(\left|\text{judged percent} - \text{true percent}\right| + \frac{1}{8}\right)$$

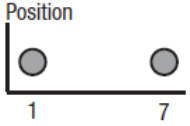


Absolute Precision Ranking for Seeing a Single Ratio

Visual estimation of the 1:7 ratio is noisier toward bottom

Highest

Position



Length

Area

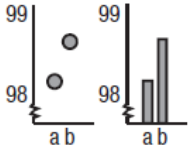
Angle

Intensity

Lowest

Common Illusions That Distort Data

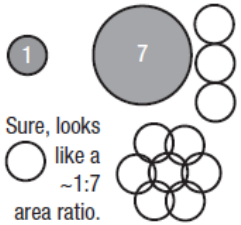
Caveats for the visual encoding in each row



Use caution with nonzero axes: Viewers tend to overestimate differences… even when the nonzero base is marked, as in the examples at left.

Stacked bar: Bars on baseline are position-coded = more precise perception.

The black & dark gray bars have the same value differences among them, but the differences are only visible across the black bars.



But beware: if the number is actually mapped to *Length*, the gray circles depict ~1:2.5 ratio.

The difference is larger for the lighter segments compared with the darker ones, right?
That is an illusion—the differences are identical.

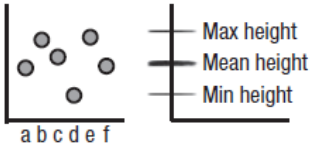
Intensity values can look different depending their backgrounds.

Do not plot intensities on intensities.

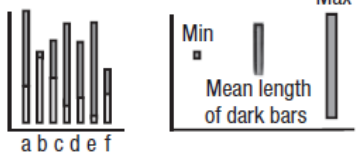
Vision Is Powerful for Global Statistics

For each visualization, statistics are available quickly

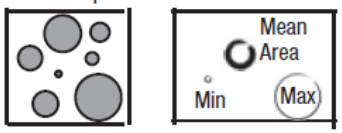
Dot Plot



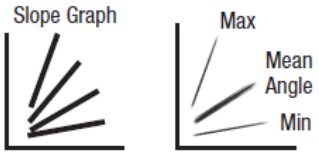
Stacked Bar



Bubble Map



Slope Graph

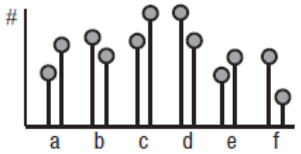


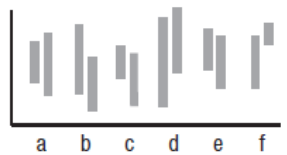
Heat Map

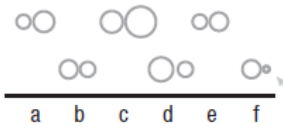
Mean Intensity

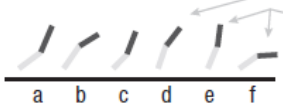
Vision Is Sluggish for Comparisons

Isolating pairs with "larger second values" is tough…



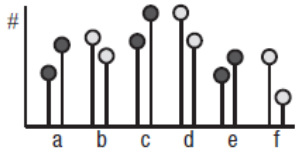






So guide viewers to the right comparisons

Tool: Shortcut comparisons by adding direct depictions of the deltas, as below



"a, c, & e have increased"

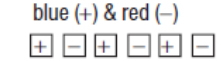
Tool: Highlight and annotate the right comparisons for your viewers, as above.

Tool: You and your viewers will (generally) compare values that

(a) are close together or connected and
(b) have similar colors,

in that priority order.

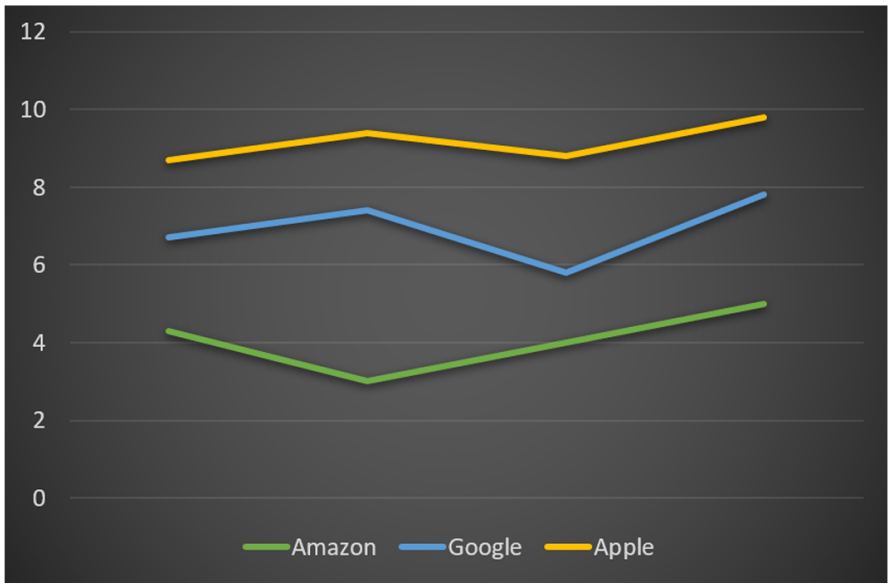
For color heat maps, depict deltas as blue (+) & red (–)

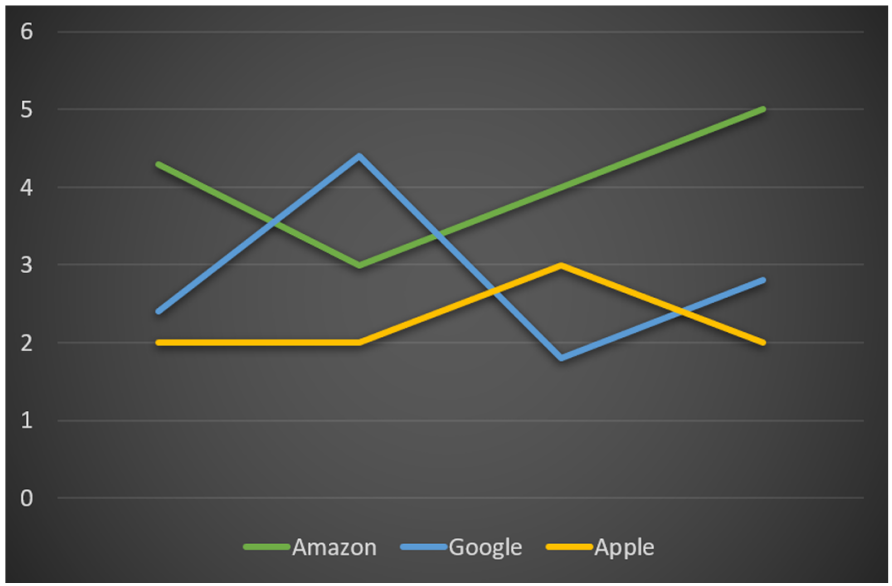


[green/red is unsafe for colorblindness]

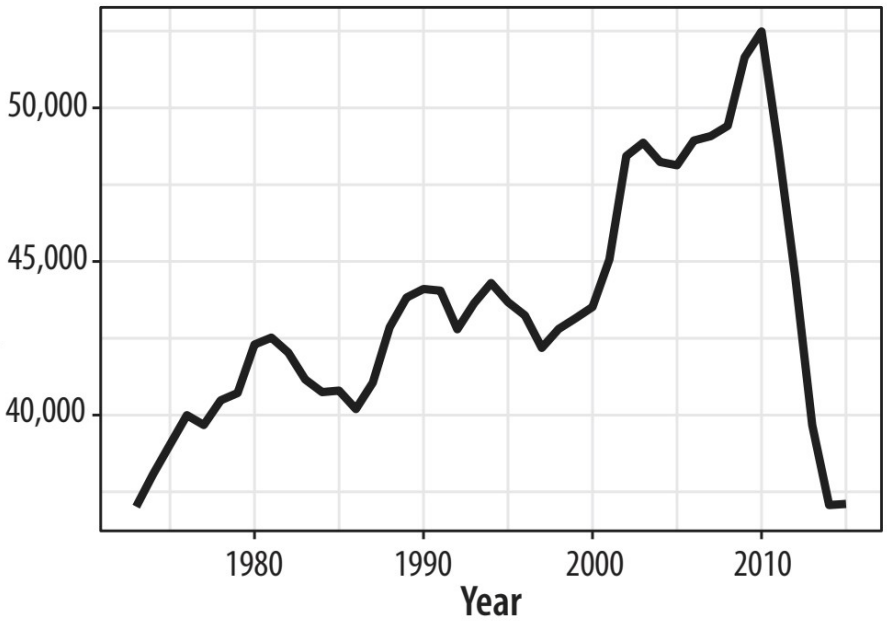
Sposoby (nie)celowego wprowadzania w błąd

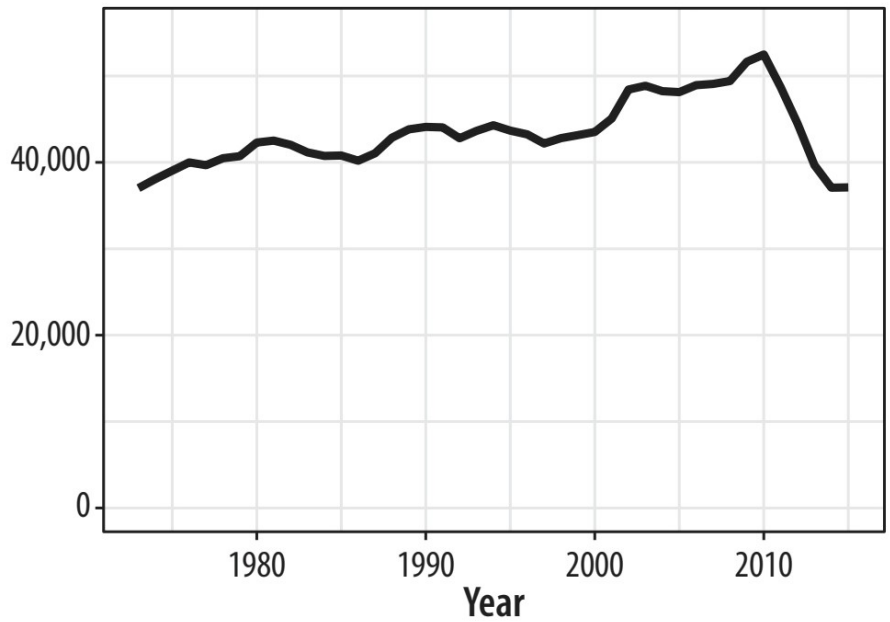
- 3D gdy nie jest to konieczne (zob. wykład 2, slajd 27)
- Wprowadzanie zbędnych informacji (np. 3D), których percepcyjnie nie da się ignorować
- Ukrywanie danych w większej ilości danych (stacked plot/graph/chart):





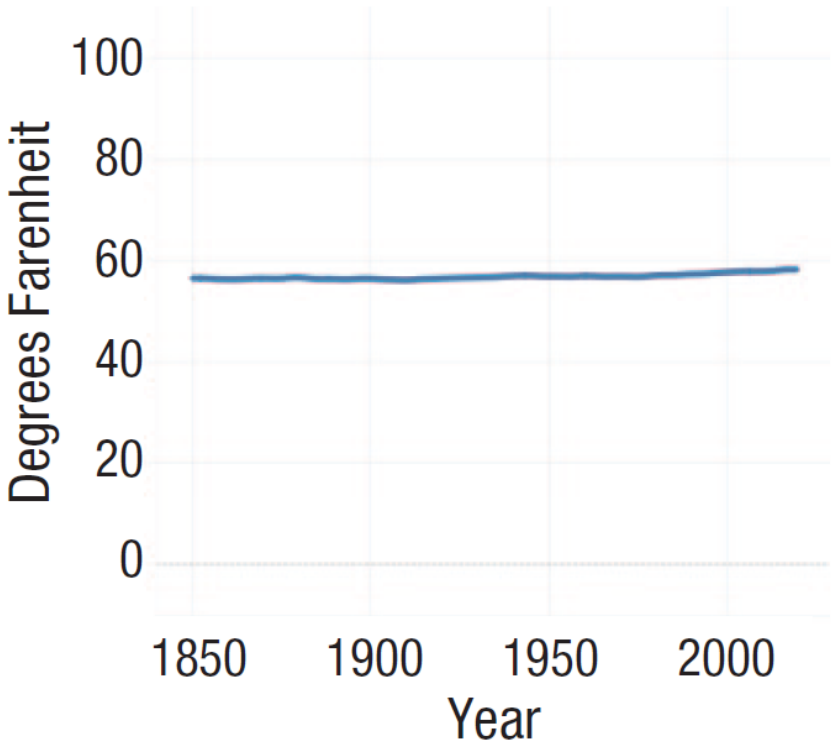
- (Nie)dobranie zakresu osi:

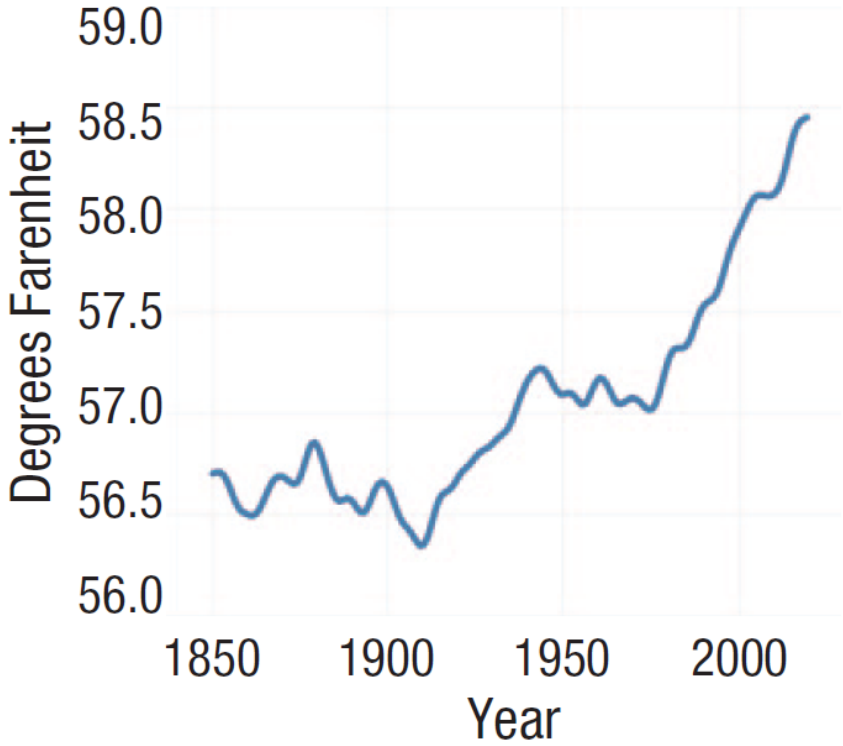

50,000
45,000
40,000
1980
1990
2000
2010
Year


40,000
20,000
0
1980
1990
2000
2010
Year

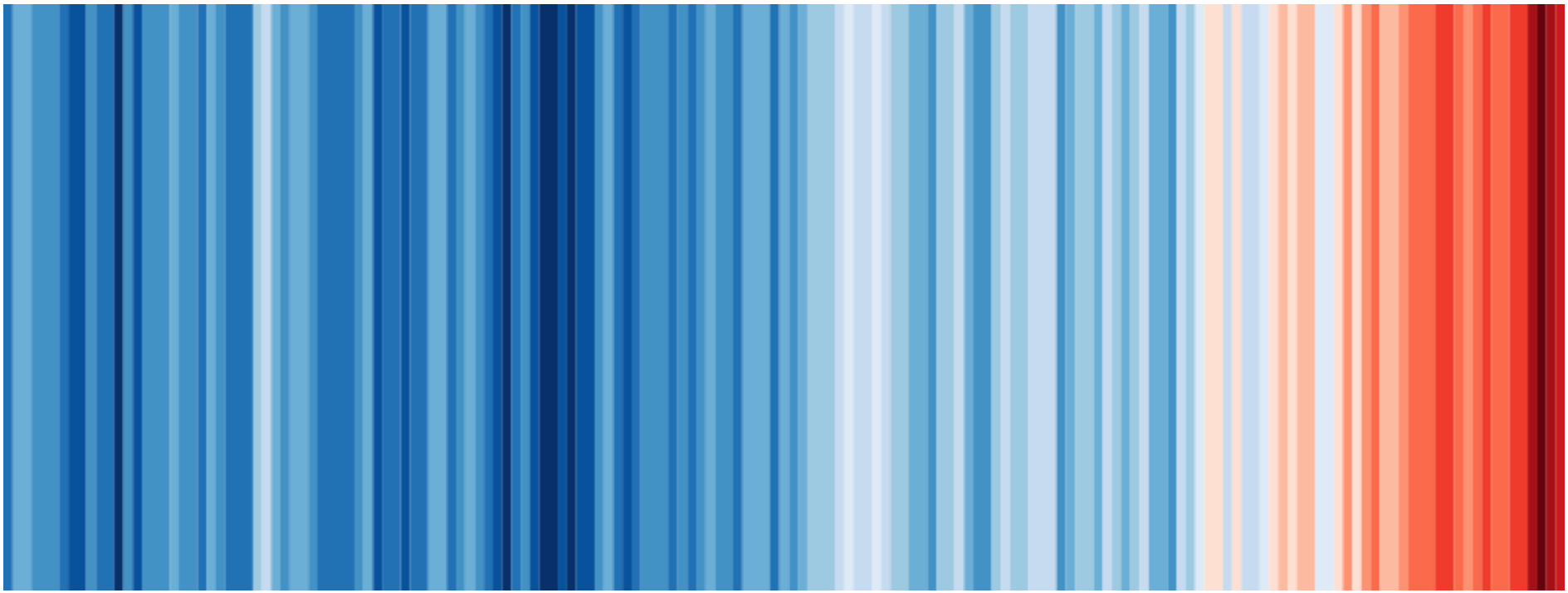

Oceania
Europe
Americas
Asia
Africa
60
70
80
Life expectancy in years, 2007


Oceania
Europe
Americas
Asia
Africa
0
20
40
60
80
Life expectancy in years, 2007

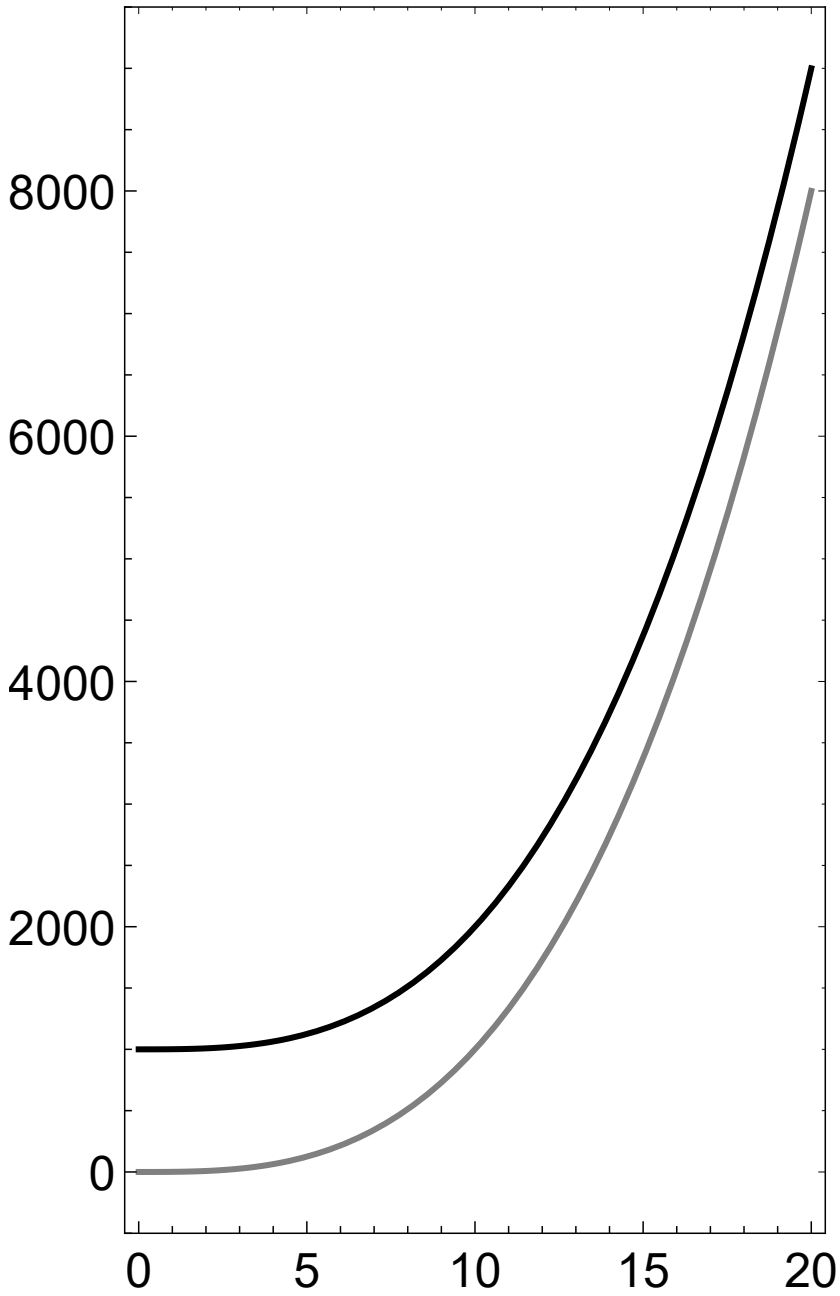


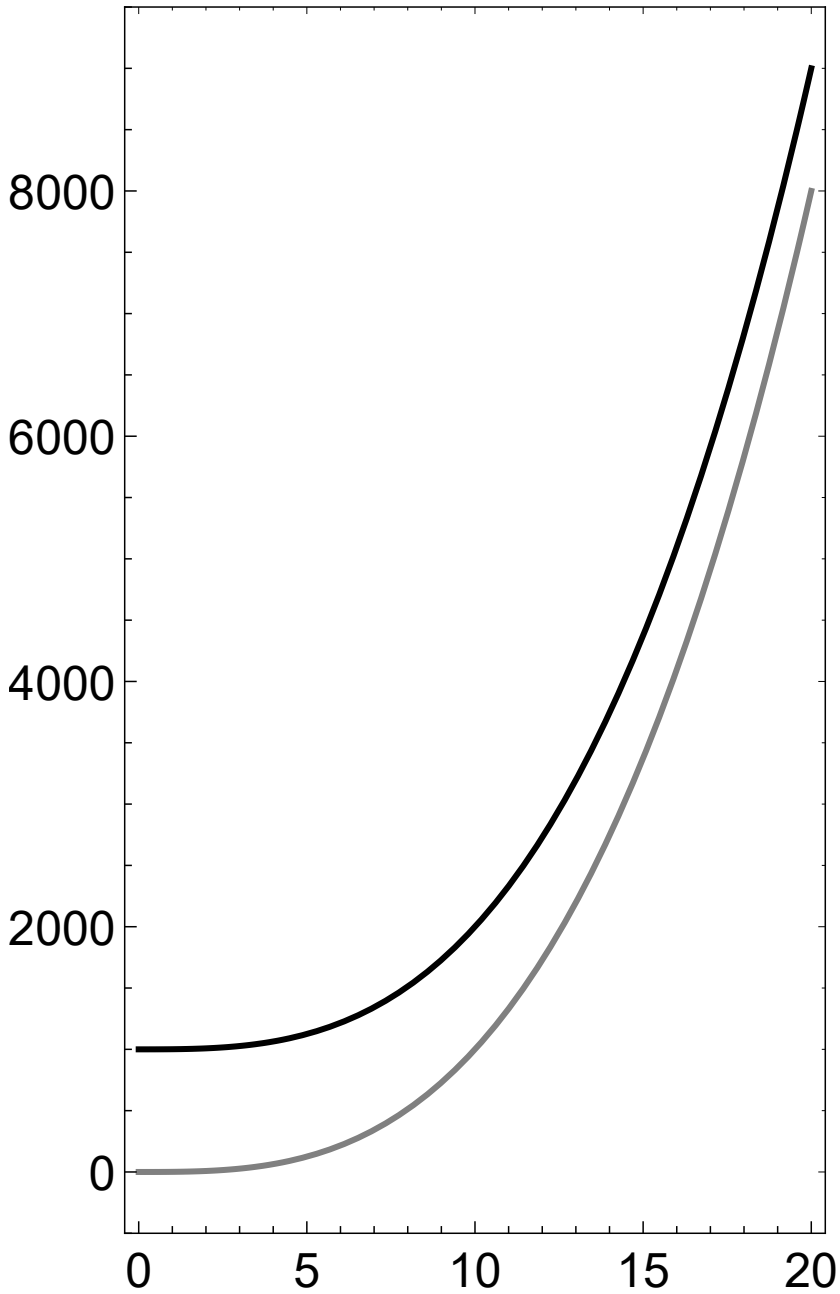


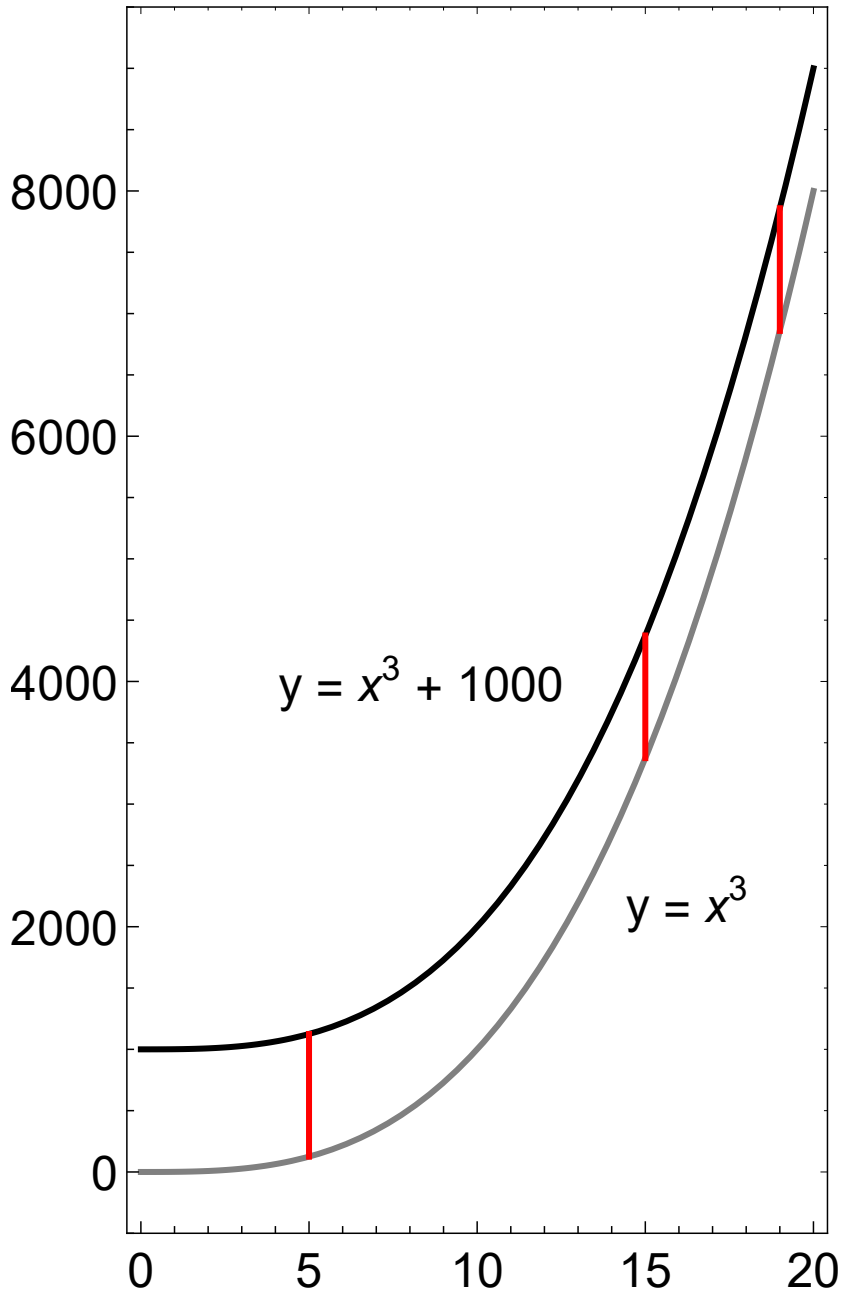
https://doi.org/10.1177/15291006211051956



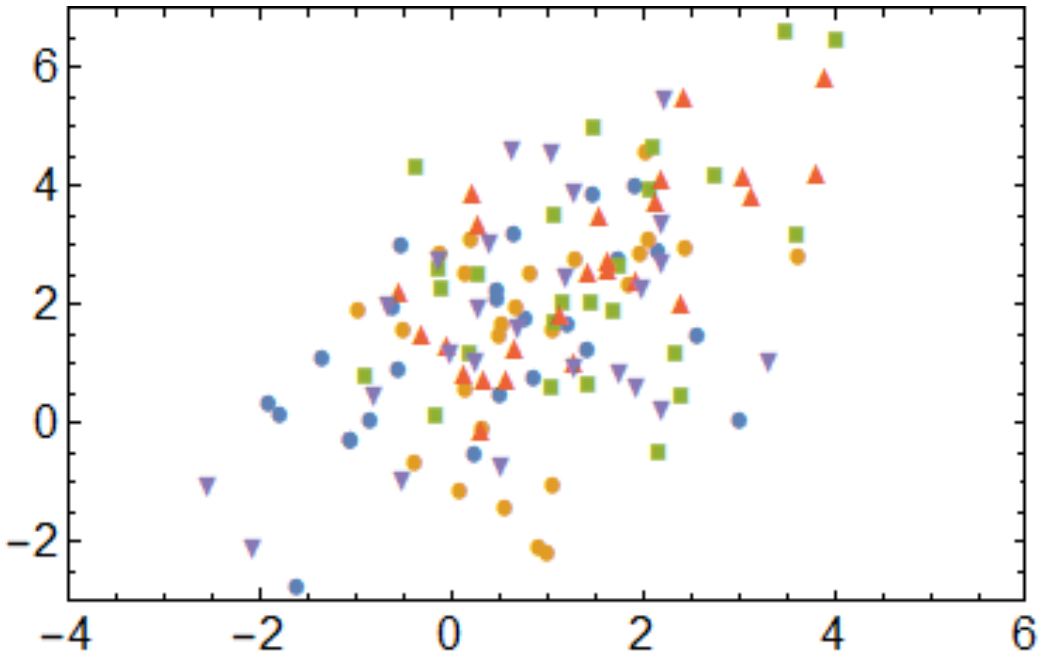
https://en.wikipedia.org/wiki/Warming_stripes


8000
6000
4000
2000
0
0
5
10
15
20

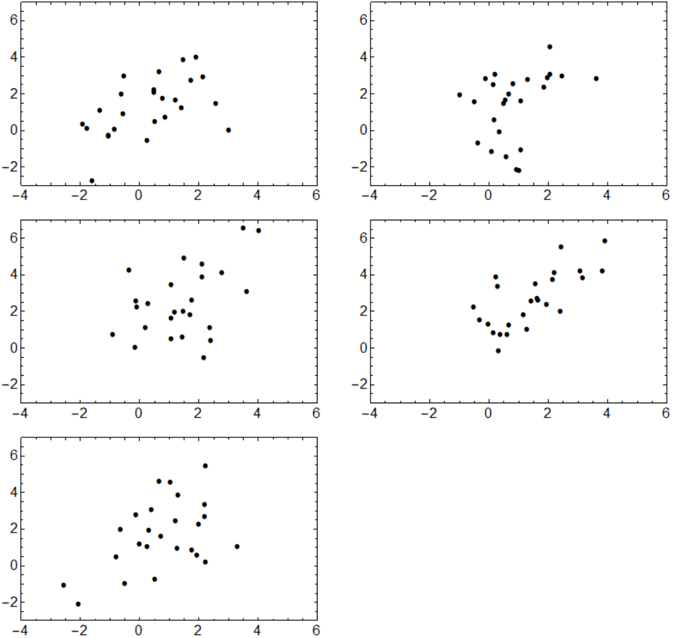

8000
6000
4000
2000
0
0
5
10
15
20

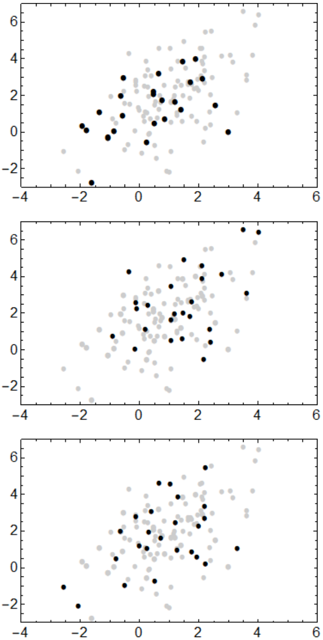

8000
6000
4000
2000
0
y = x^3 + 1000
y = x^3
0
5
10
15
20

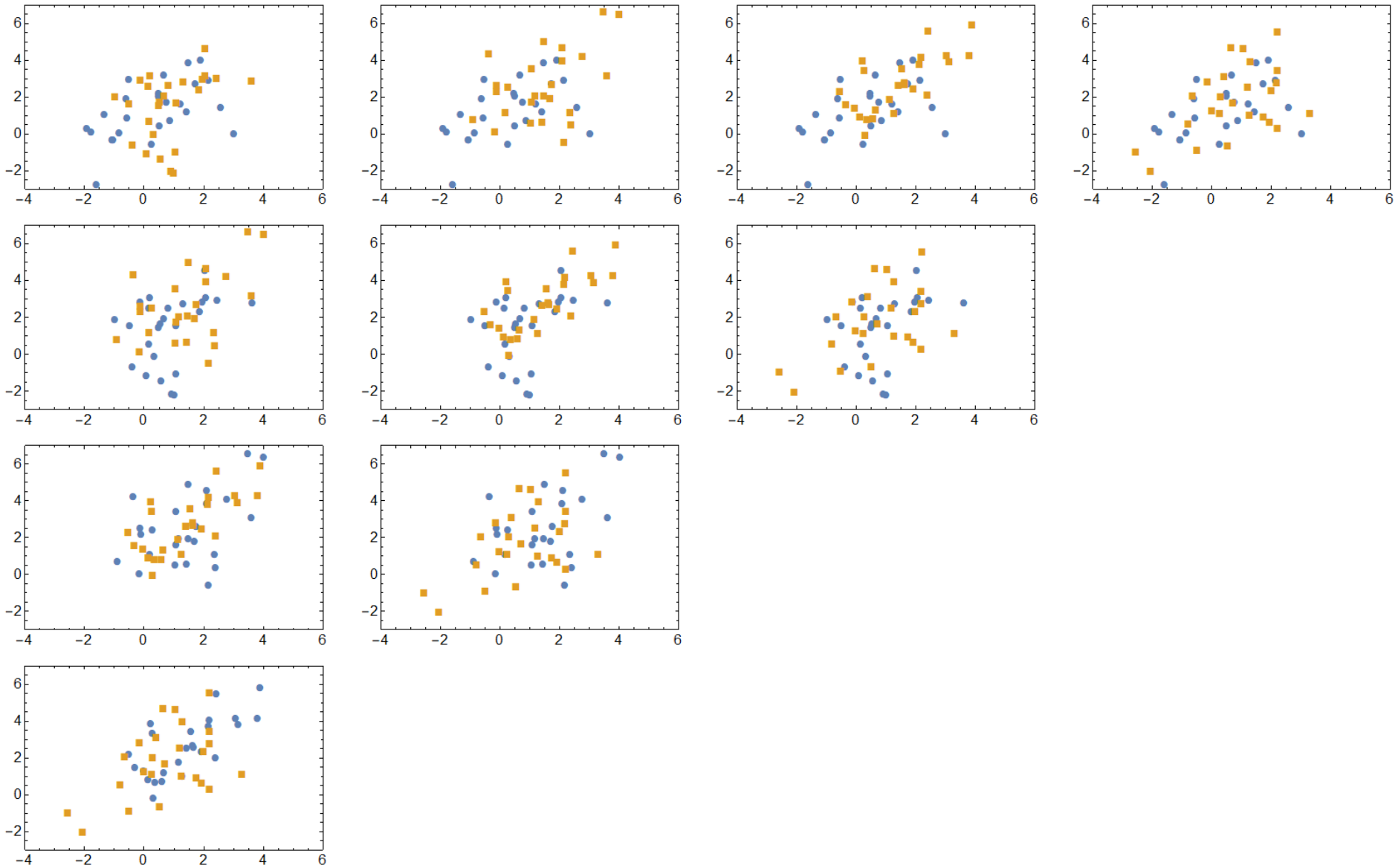
Nawet niewielka ilość danych (5 $\times$ 25 punktów; kodowanie i kolorem, i kształtem) może być trudna do rozróżnienia*:



*Ale zob. wykład 5, slajd 43.

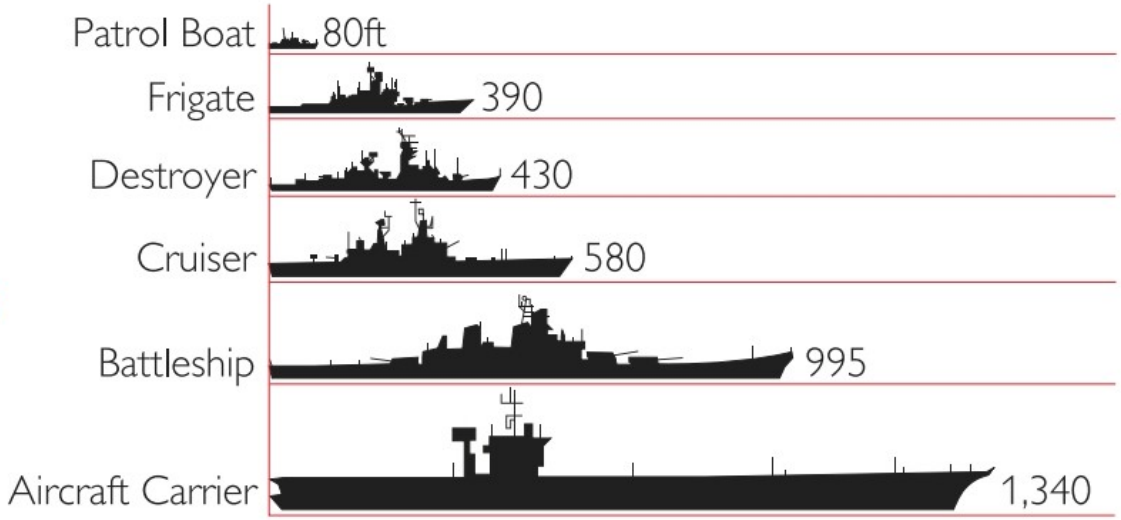

6
4
2
0
−2
−4
−2
0
2
4
6


6
4
2
0
−2
−4
−2
0
2
4
6

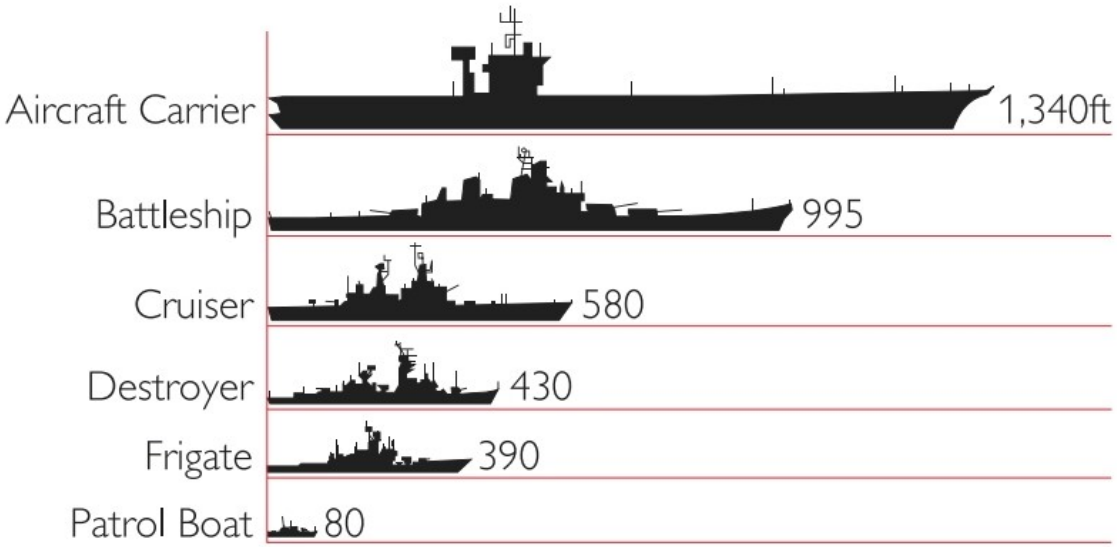

6
4
2
0
−2
−4
−2
0
2
4
6

Is this picture OK?

NO, because what you see here looks like a scene of docked boats, naturally receding into the distance.



Simple answer: reverse the order of the ships. This flattens the chart, and removes the perspective effect.



Nigel Holmes, Joyful infographics. A friendly, human approach to data