Information Visualization 101

Chad Stolper, Georgia Tech

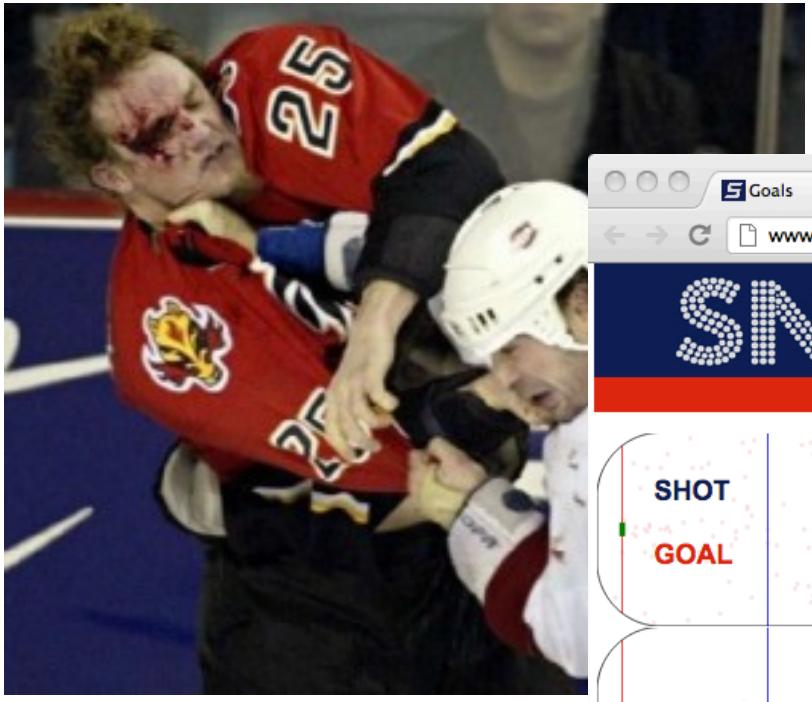
Information Visualization Crash Course

Chad Stolper, Georgia Tech

4th Year Computer Science PhD Student

John Stasko, Interactive Computing

Polo Chau, Computational Science and Engineering



Goals

www.cc.gatech.edu/~cstolper/d3Testing/locked/nhl/index.htm?page=all&colorby=sh...

SNAPSHOT

SELECT VIEW

SHOT
GOAL

SHOT
GOAL

Use the *Select View* dropdown above, the filters to the left, and the setting below to create a view or click on one of the views to the left to see its full-size, interactive version.

Color shots by: Shots/Goals
Heatmap Square Size: 3'x3'
Radial Heatmap Band Width: 3'
Apply

If you find a view that you would like to revist later, type a descriptive title into the dialogue box and click the *SnapShot This!* button to save it to a new tab.

Goals
SnapShot This!

Apply

All Teams @ All Rinks

Shots | Goals

Period 1 00:00 to Period 3 20:00

Even-Strength
Power-Play
Short-Handed

Defensemen
Left Wingers
Right Wingers
Centers

Reset to Regular Season
2010-10-07 to 2011-04-10

Show All Players

Apply

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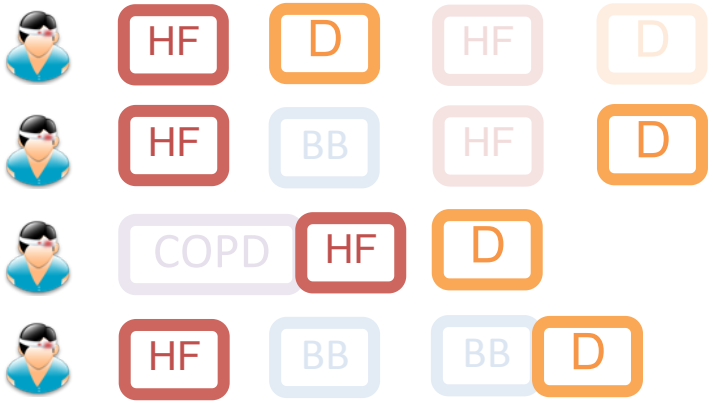
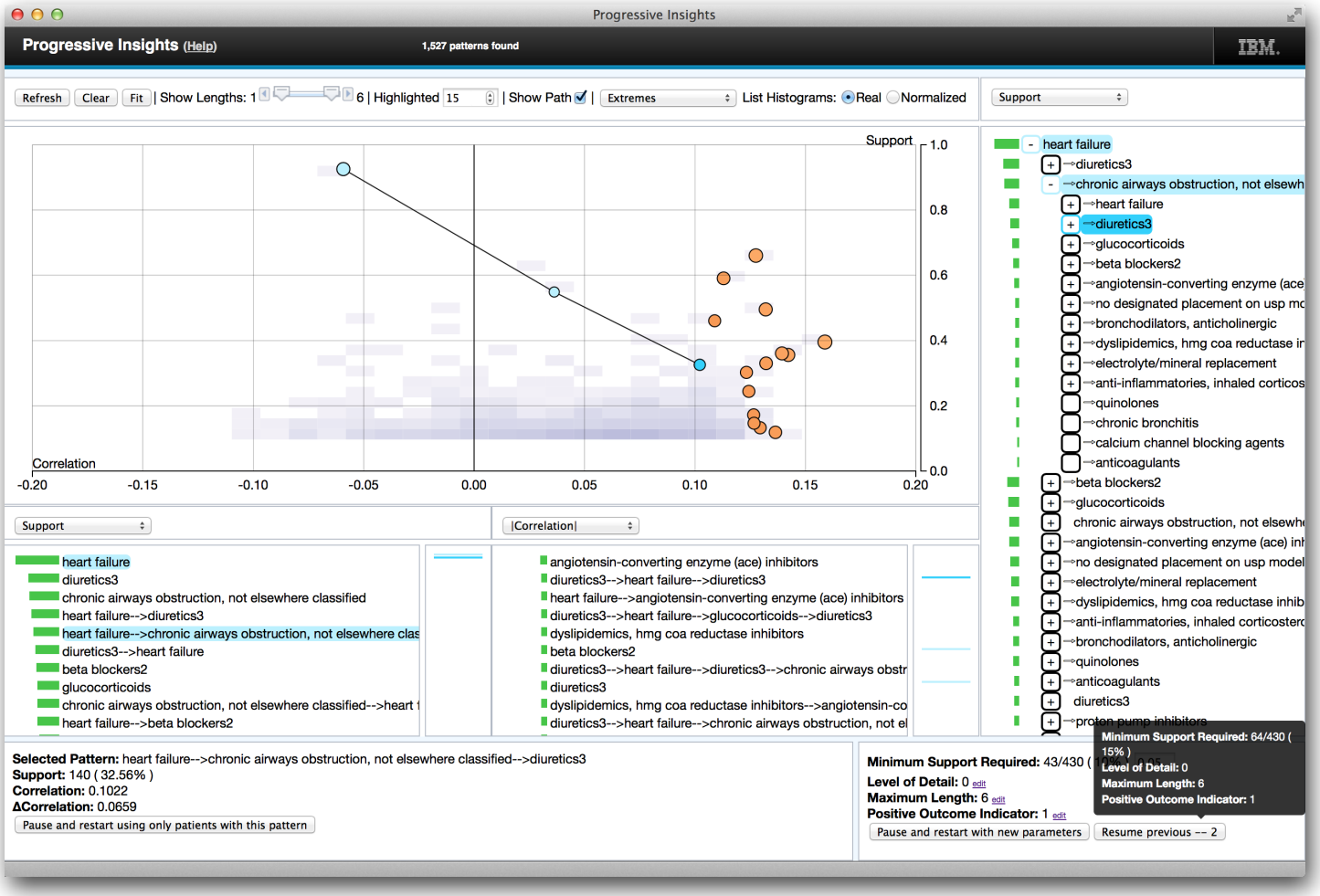
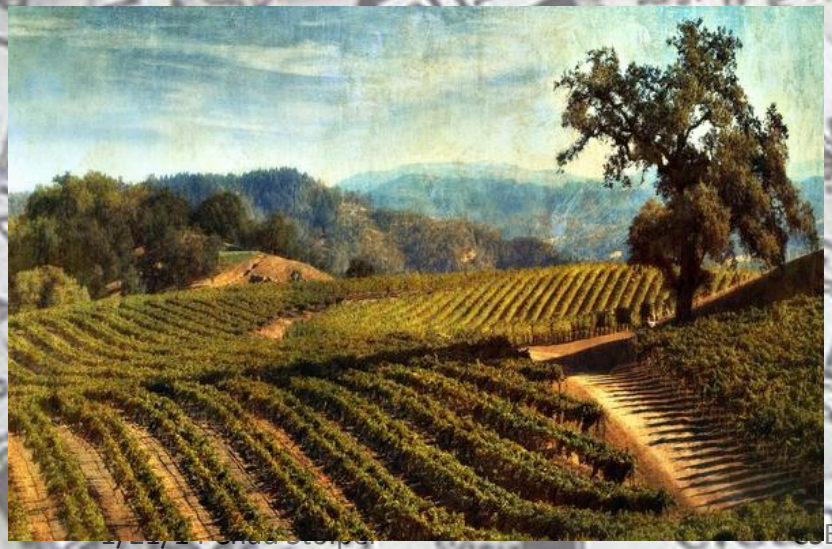
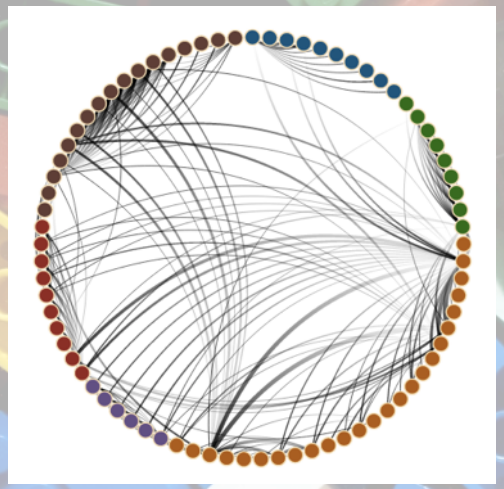
1/21/14 Chad Stolper

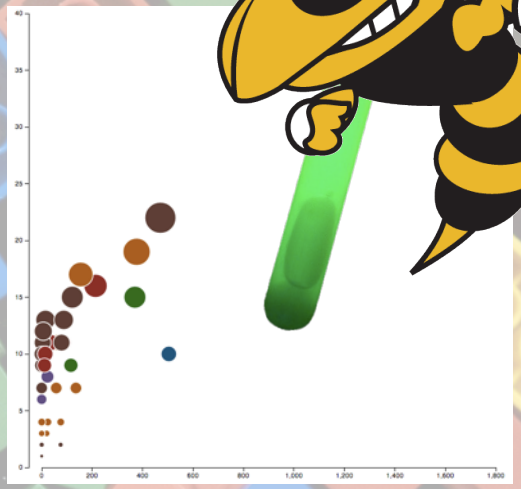


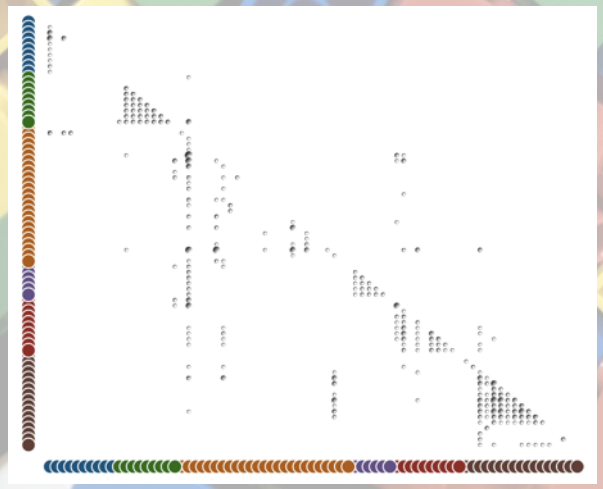


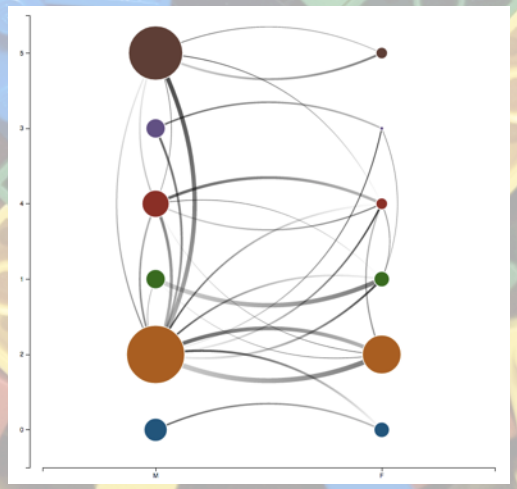
1/21/14 Chad Stolper

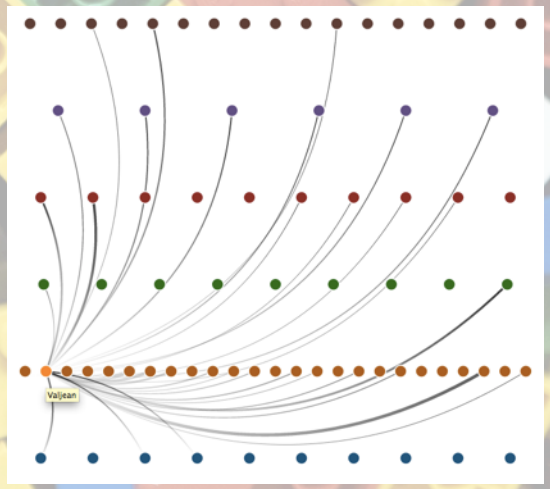











Valjean

Information Visualization 101

Chad Stolper, Georgia Tech

What is Infovis?

Why is it Important?

Human Perception

Chart Basics

(If Time, Some Color Theory)

The Shneiderman Mantra

Where to Learn More

Questions Encouraged!

What is Information Visualization?

Information Visualization

"The use of computer-supported, interactive, visual representations of abstract data to amplify cognition."

Card, Mackinlay, and Shneiderman 1999

Communication

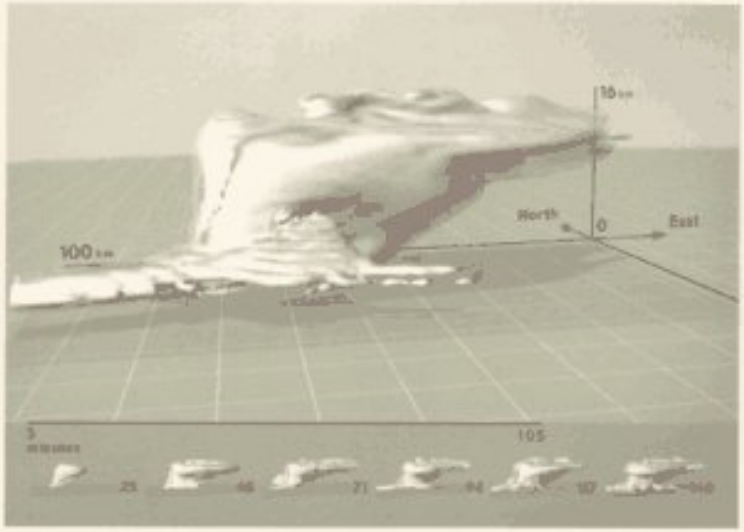
Exploratory Data Analysis

Communication

Communication Gone Wrong

EDWARD R. TUFTE

VISUAL EXPLANATIONS



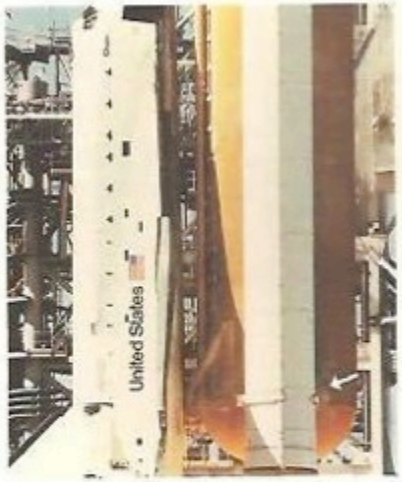
IMAGES AND QUANTITIES, EVIDENCE AND NARRATIVE

Space Shuttle Challenger

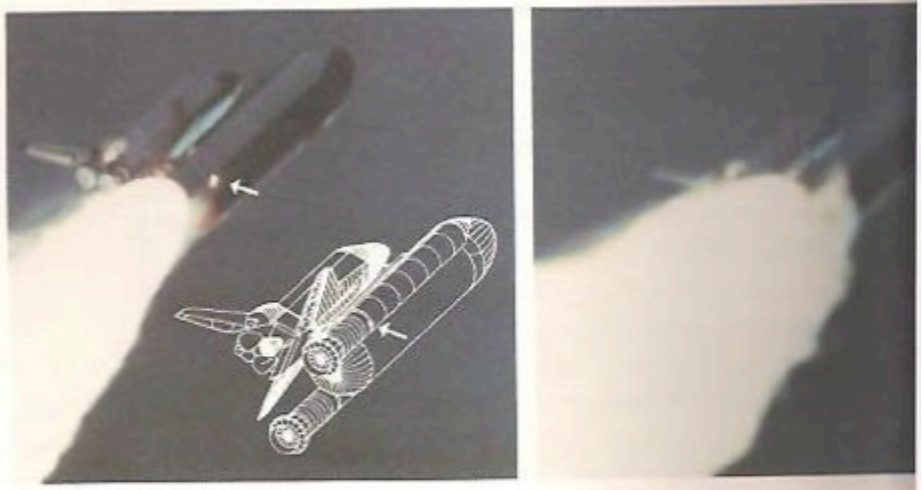
January 28, 1986

Morning Temperature: 31°F

What happened?



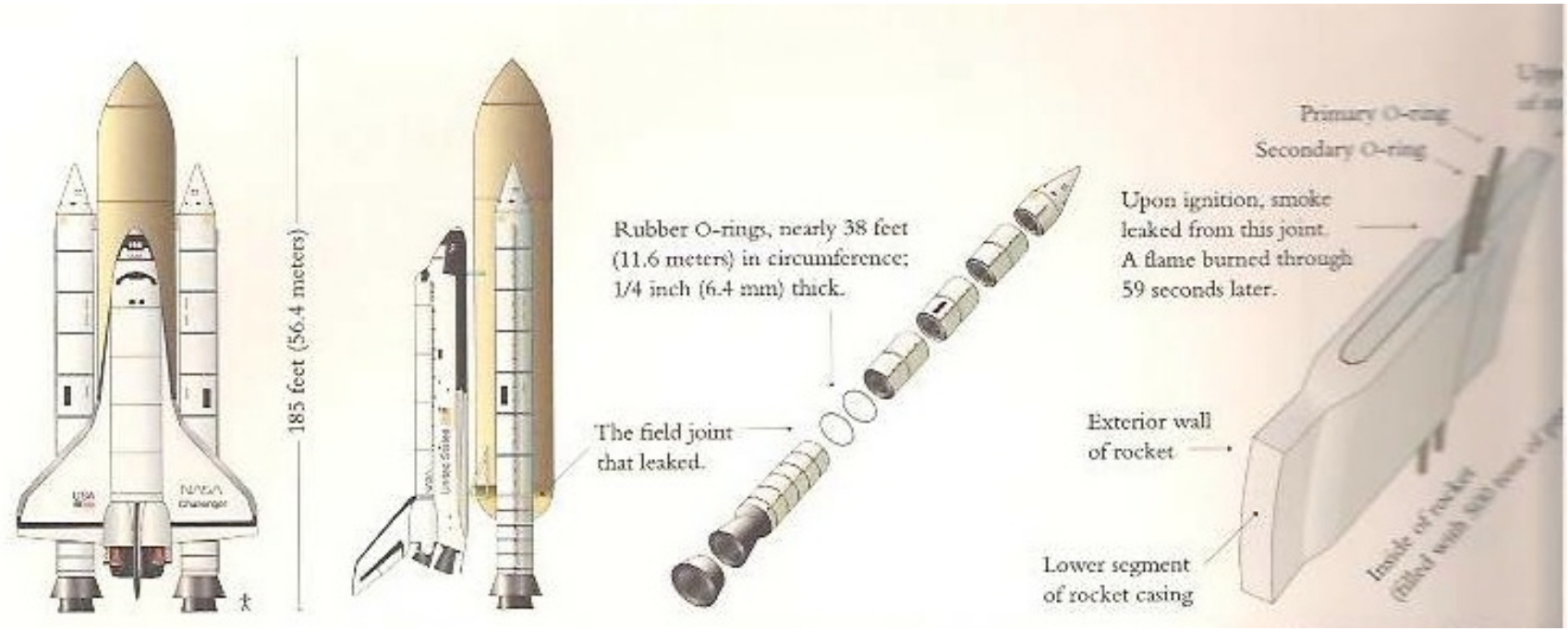
Less than 1 second after ignition, a puff of smoke appeared at the aft joint of the right booster, indicating that the O-rings burned through and failed to seal. At this point, all was lost.



On the launch pad, the leak lasted only about 2 seconds and then apparently was plugged by [illegible] and insulation as the shuttle rose, flying through rather strong cross-winds. Then 58.788 seconds [illegible] ignition, when the Challenger was 6 miles up, a flicker of flame emerged from the leaky joint. [illegible] seconds, the flame grew and engulfed the fuel tank (containing liquid hydrogen and liquid oxygen). That tank ruptured and exploded, destroying the shuttle.

As the shuttle exploded and broke up at approximately 73 seconds after launch, the two booster rockets crisscrossed and continued flying wildly. The right booster, identifiable by its failure plume, is now to the left of its non-defective counterpart.

The flight crew of Challenger 51-L. Front row, left to right: [illegible] Smith, pilot; Francis R. (Dick) Scobee, commander; Ronald [illegible] Back row: Ellison S. Onizuka, S. Christa McAuliffe, George [illegible] Judith A. Resnik.


185 feet (56.4 meters)
Rubber O-rings, nearly 38 feet (11.6 meters) in circumference; 1/4 inch (6.4 mm) thick.
The field joint that leaked.
Primary O-ring
Secondary O-ring
Upon ignition, smoke leaked from this joint. A flame burned through 59 seconds later.
Exterior wall of rocket
Lower segment of rocket casing

How did this happen?

Morton Thiokol's Presentation

TEMPERATURE CONCERN ON

SRM JOINTS

27 JAN 1986

HISTORY OF O-RING DAMAGE ON SRM FIELD JOINTS

	SRM No.	Cross Sectional View: Erosion Depth (in.)	Cross Sectional View: Perimeter Affected (deg)	Cross Sectional View: Nominal Dia. (in.)	Top View: Length Of Max Erosion (in.)	Top View: Total Heat Affected Length (in.)	Clocking Location (deg)
61A LH Center Field**	22A	None	None	0.280	None	None	36° -66°
61A LH CENTER FIELD**	22A	NONE	NONE	0.280	NONE	NONE	338°-18°
51C LH Forward Field**	15A	0.010	154.0	0.280	4.25	5.25	163
51C RH Center Field (prim)***	15B	0.038	130.0	0.280	12.50	58.75	354
51C RH Center Field (sec)***	15B	None	45.0	0.280	None	29.50	354
41D RH Forward Field	13B	0.028	110.0	0.280	3.00	None	275
41C LH Aft Field*	11A	None	None	0.280	None	None	--
41B LH Forward Field	10A	0.040	217.0	0.280	3.00	14.50	351
STS-2 RH Aft Field	2B	0.053	116.0	0.280	--	--	90

*Hot gas path detected in putty. Indication of heat on O-ring, but no damage.
**Soot behind primary O-ring.
***Soot behind primary O-ring, heat affected secondary O-ring.

Clocking location of leak check port - 0 deg.

OTHER SRM-15 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY AND NO SOOT NEAR OR BEYOND THE PRIMARY O-RING.

SRM-22 FORWARD FIELD JOINT HAD PUTTY PATH TO PRIMARY O-RING, BUT NO O-RING EROSION AND NO SOOT BLOWBY. OTHER SRM-22 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY.

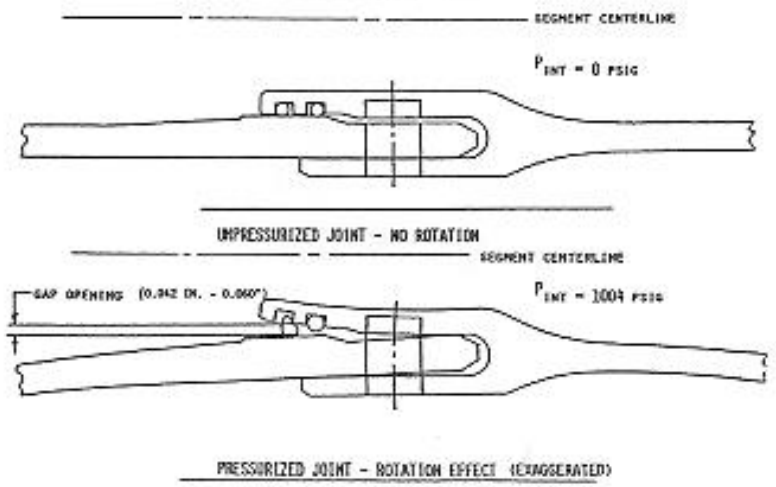
PRIMARY CONCERNS -

FIELD JOINT - HIGHEST CONCERN

- EROSION PENETRATION OF PRIMARY SEAL REQUIRES RELIABLE SECONDARY SEAL FOR PRESSURE INTEGRITY
  - IGNITION TRANSIENT - (0-600 MS)
    - (0-170 MS)HIGH PROBABILITY OF RELIABLE SECONDARY SEAL
    - (170-330 MS) REDUCED PROBABILITY OF RELIABLE SECONDARY SEAL
    - (330-600 MS) HIGH PROBABILITY OF NO SECONDARY SEAL CAPABILITY

- STEADY STATE - (600 MS - 2 MINUTES)
  - IF EROSION PENETRATES PRIMARY O-RING SEAL - HIGH PROBABILITY OF NO SECONDARY SEAL CAPABILITY
    - BENCH TESTING SHOWED O-RING NOT CAPABLE OF MAINTAINING CONTACT WITH METAL PARTS GAP OPENING RATE TO MEOP
    - BENCH TESTING SHOWED CAPABILITY TO MAINTAIN O-RING CONTACT DURING INITIAL PHASE (0-170 MS) OF TRANSIENT

PRIMARY CONCERNS - CONT



Blow By History

SRM-15 worst Blow-By

- 2 case joints (80°), (110°) arc
- much worse visually than SRM-22

SRM 22 Blow-By

- 2 case joints (30-40°)

SRM-13A, 15, 16A, 18, 23A 24A

- nozzle Blow-By

History of O-ring Temperatures (Degrees-F)

Motor	M&T	Amb	O-ring	Wind
DM-1	68	36	47	10 mph
DM-2	76	45	52	10 mph
QM-3	72.5	40	48	10 mph
QM-4	76	48	51	10 mph
SRM-15	52	64	53	10 mph
SRM-22	77	78	75	10 mph
SRM-25	55	26	29 27	10 mph 25 mph

CONCLUSIONS:

- TEMPERATURE OF O-RING IS NOT ONLY PARAMETER CONTROLLING BLOW-BY

  SRM 15 WITH BLOW-BY HAD AN O-RING TEMP AT 53°F
  SRM 22 WITH BLOW-BY HAD AN O-RING TEMP AT 75°F
  FOUR DEVELOPMENT MOTORS WITH NO BLOW-BY WERE TESTED AT O-RING TEMP OF 47° TO 52°F

  DEVELOPMENT MOTORS HAD PUTTY PACKING WHICH RESULTED IN BETTER PERFORMANCE

- AT ABOUT 50°F BLOW-BY COULD BE EXPERIENCED IN CASE JOINTS

- TEMP FOR SRM 25 ON 1-28-86 LAUNCH WILL BE 29°F 9 AM
  38°F 2 PM

- HAVE NO DATA THAT WOULD INDICATE SRM 25 IS DIFFERENT THAN SRM 15 OTHER THAN TEMP

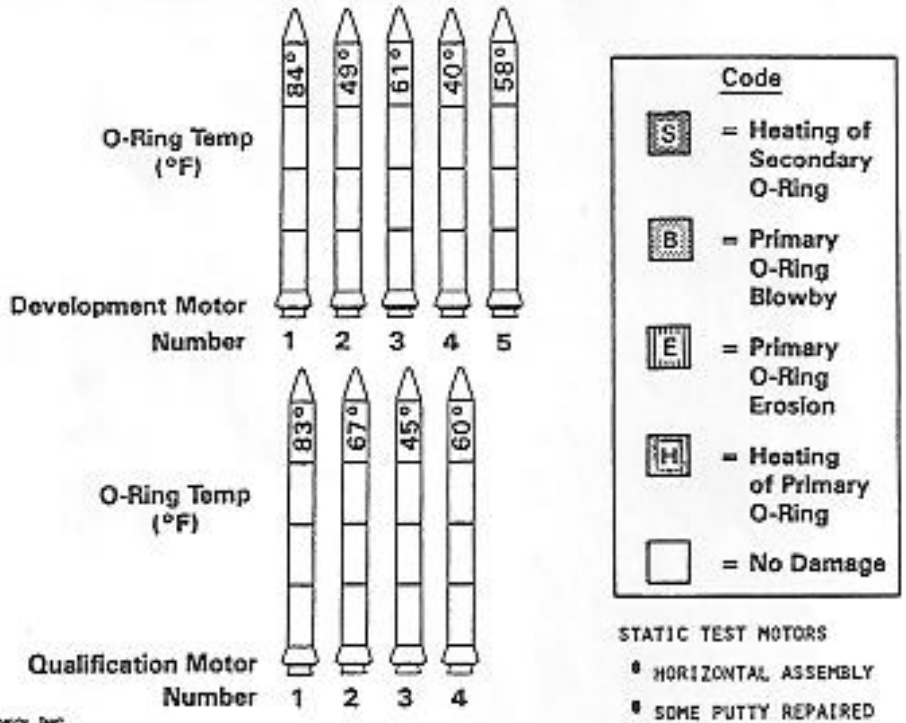
RECOMMENDATIONS:

- O-RING TEMP MUST BE $\geq$ 53°F AT LAUNCH

  DEVELOPMENT MOTORS AT 47° TO 52°F WITH PUTTY PACKING HAD NO BLOW-BY
  SRM 15 (THE BEST SIMULATION) WORKED AT 53°F

- PROJECT AMBIENT CONDITIONS (TEMP & WIND) TO DETERMINE LAUNCH TIME

History of O-Ring Damage in Field Joints



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Wasatch Operations

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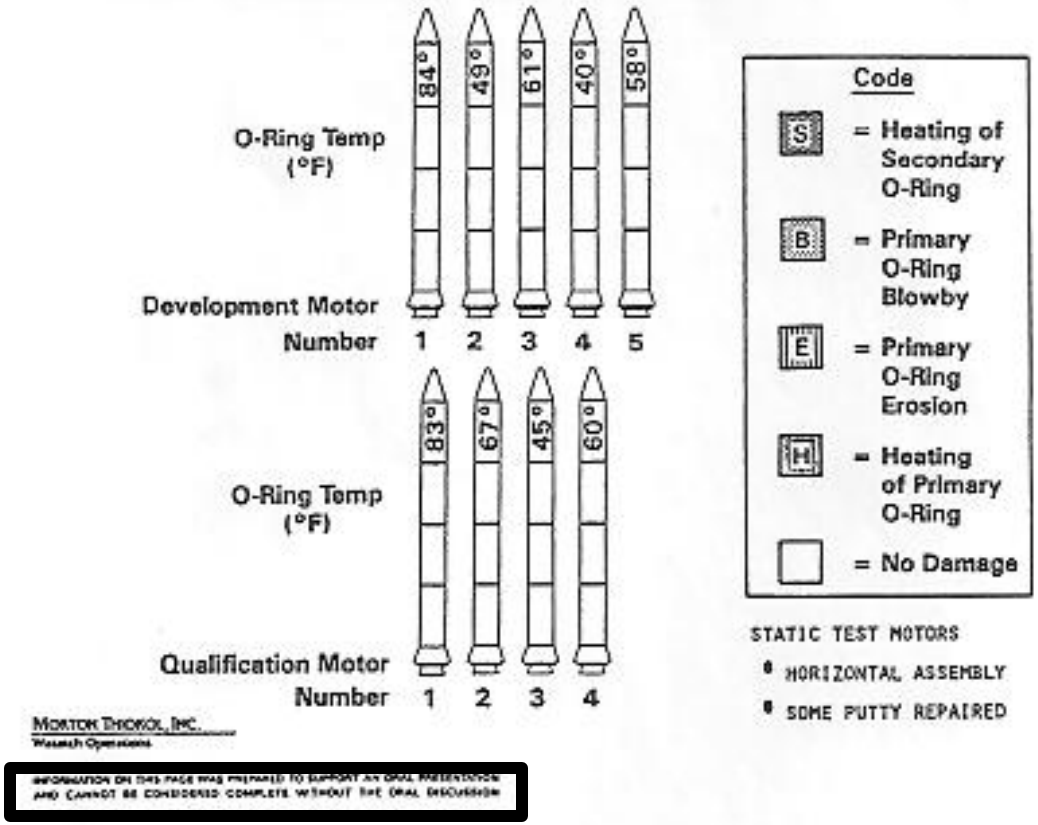
History of O-Ring Damage in Field Joints



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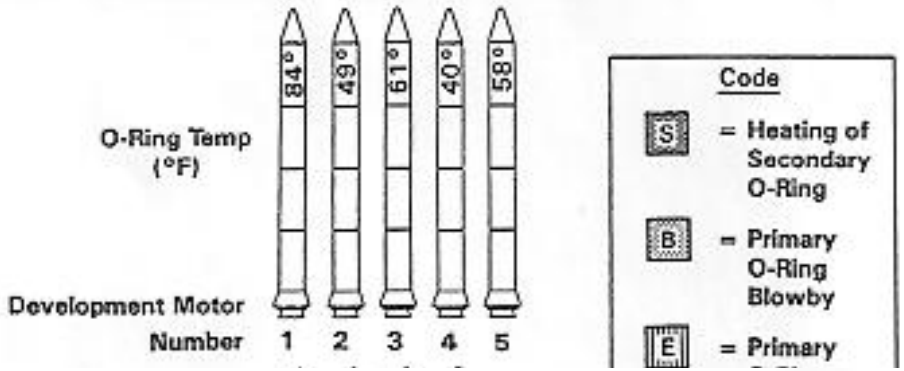
History of O-Ring Damage in Field Joints



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Number 1 2 3 4

* SOME PUTTY REPAIRED

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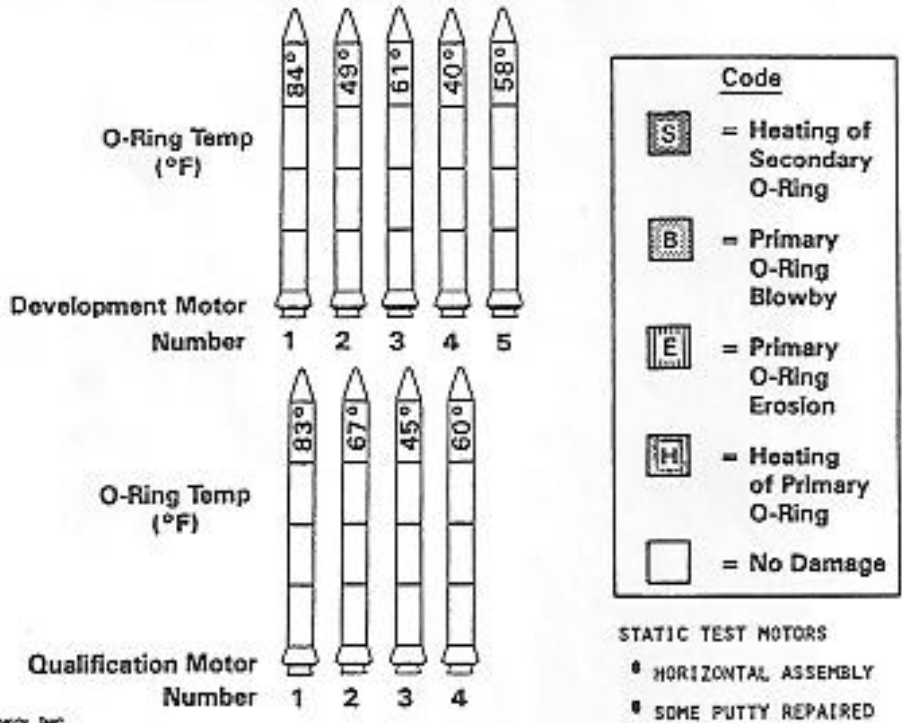
History of O-Ring Damage in Field Joints



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Wasatch Operations

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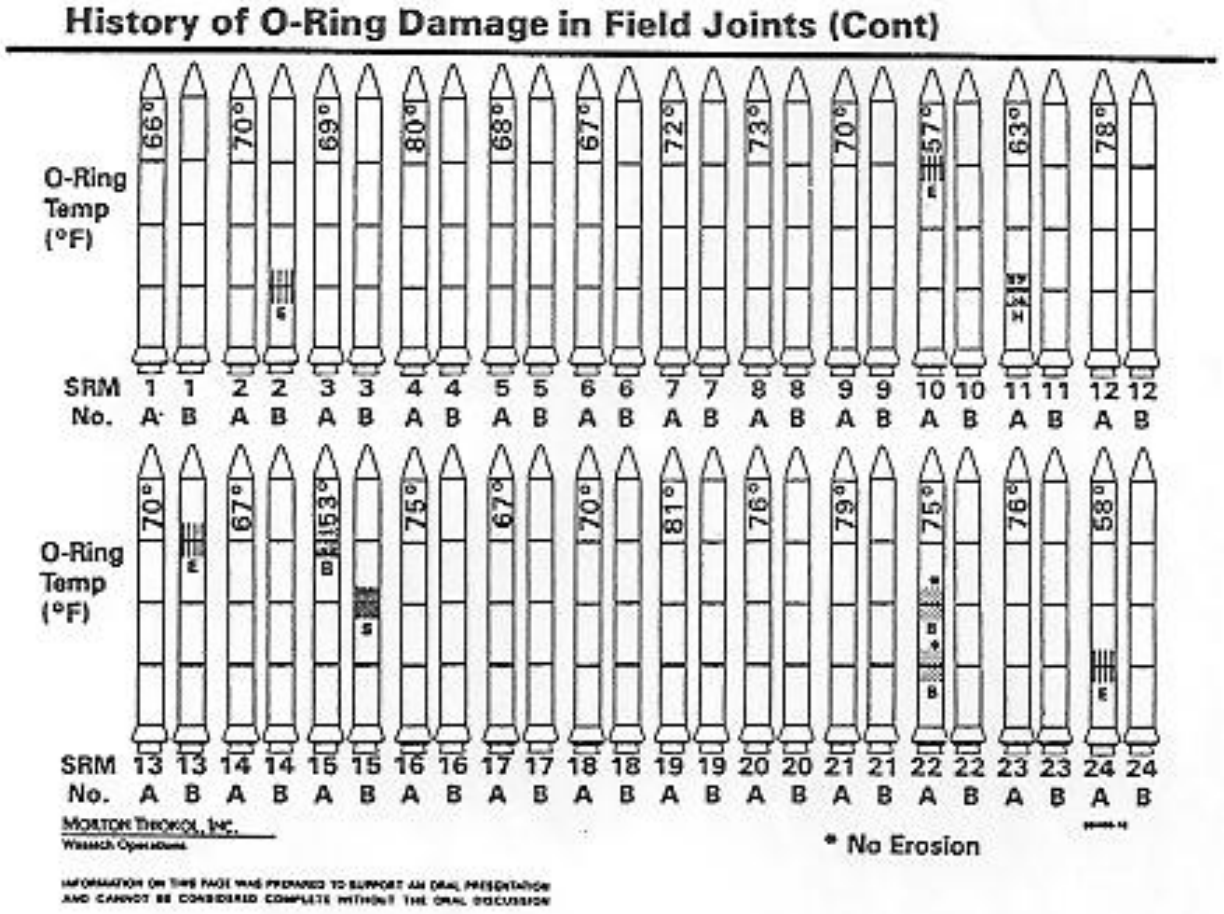
History of O-Ring Damage in Field Joints (Cont)
O-Ring Temp (°F)
66° 70° 69° 80° 68° 67° 72° 73° 70° 57° 63° 78°
SRM No. 1A 1B 2A 2B 3A 3B 4A 4B 5A 5B 6A 6B 7A 7B 8A 8B 9A 9B 10A 10B 11A 11B 12A 12B
O-Ring Temp (°F)
70° 67° 53° 75° 67° 70° 81° 76° 79° 75° 76° 58°
SRM No. 13A 13B 14A 14B 15A 15B 16A 16B 17A 17B 18A 18B 19A 19B 20A 20B 21A 21B 22A 22B 23A 23B 24A 24B
MORTON THIOKOL, INC.
Wasatch Operations
* No Erosion
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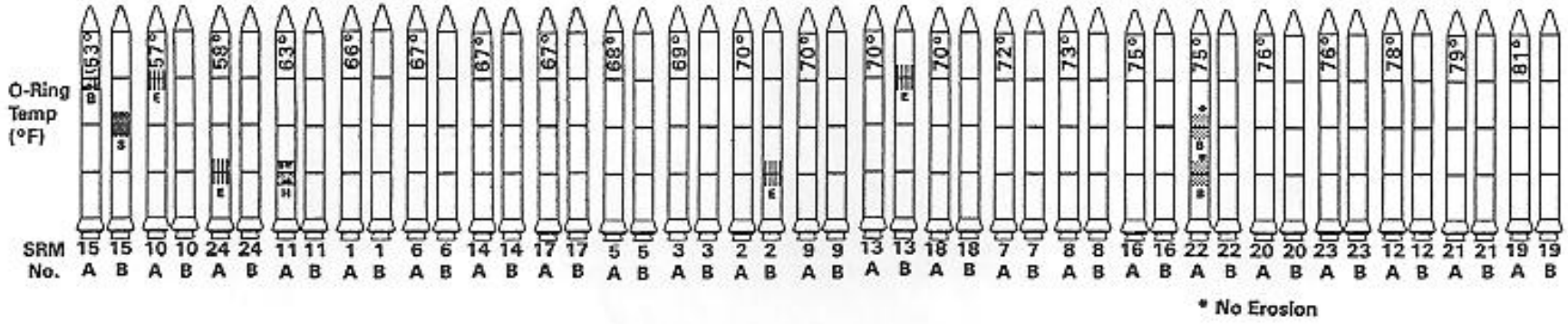
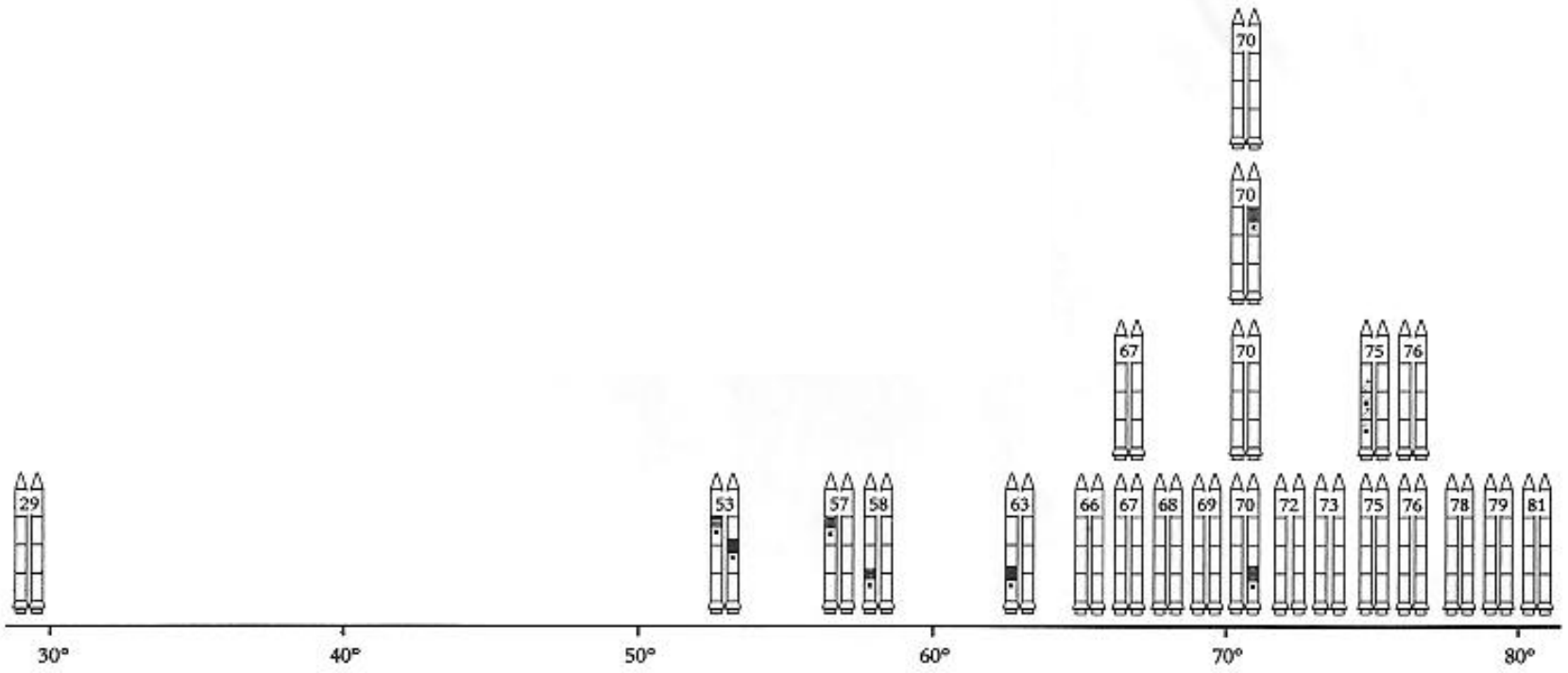
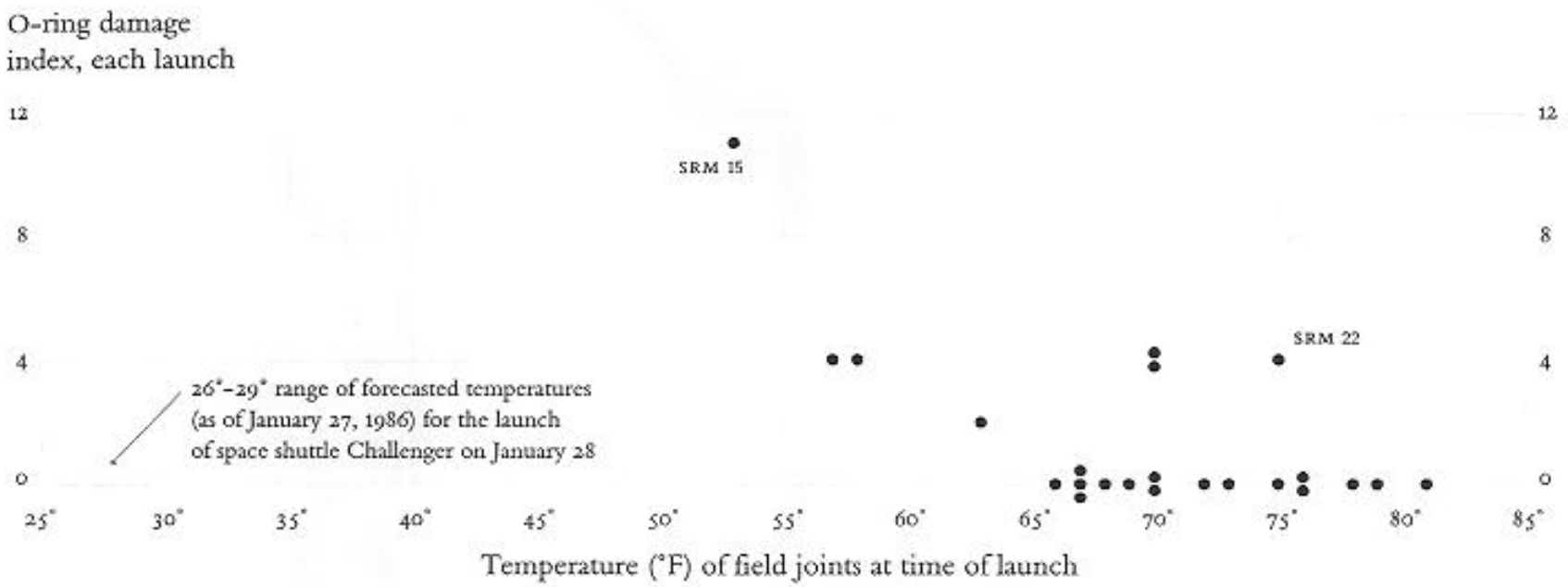

O-Ring Temp (°F)
53°
57°
58°
63°
66°
67°
67°
67°
68°
69°
70°
70°
70°
70°
72°
73°
75°
75°
76°
76°
78°
79°
81°
SRM No.
15 A
15 B
10 A
10 B
24 A
24 B
11 A
11 B
1 A
1 B
6 A
6 B
14 A
14 B
17 A
17 B
5 A
5 B
3 A
3 B
2 A
2 B
9 A
9 B
13 A
13 B
18 A
18 B
7 A
7 B
8 A
8 B
16 A
16 B
22 A
22 B
20 A
20 B
23 A
23 B
12 A
12 B
21 A
21 B
19 A
19 B
* No Erosion


70
70
67
70
75
76
29
53
57
58
63
66
67
68
69
70
72
73
75
76
78
79
81
30°
40°
50°
60°
70°
80°

Flight	Date	Temperature °F	Erosion incidents	Blow-by incidents	Damage index	Comments
51-C	01.24.85	53°	3	2	11	Most erosion any flight; blow-by; back-up rings heated.
41-B	02.03.84	57°	1		4	Deep, extensive erosion.
61-C	01.12.86	58°	1		4	O-ring erosion on launch two weeks before Challenger.
41-C	04.06.84	63°	1		2	O-rings showed signs of heating, but no damage.
1	04.12.81	66°			0	Coolest (66°) launch without O-ring problems.
6	04.04.83	67°			0	
51-A	11.08.84	67°			0	
51-D	04.12.85	67°			0	
5	11.11.82	68°			0	
3	03.22.82	69°			0	
2	11.12.81	70°	1		4	Extent of erosion not fully known.
9	11.28.83	70°			0	
41-D	08.30.84	70°	1		4	
51-G	06.17.85	70°			0	
7	06.18.83	72°			0	
8	08.30.83	73°			0	
51-B	04.29.85	75°			0	
61-A	10.30.85	75°		2	4	No erosion. Soot found behind two primary O-rings.
51-I	08.27.85	76°			0	
61-B	11.26.85	76°			0	
41-G	10.05.84	78°			0	
51-J	10.03.85	79°			0	
4	06.27.82	80°			?	O-ring condition unknown; rocket casing lost at sea.
51-F	07.29.85	81°			0	


O-ring damage
index, each launch
12
8
4
0
SRM 15
SRM 22
26°–29° range of forecasted temperatures
(as of January 27, 1986) for the launch
of space shuttle Challenger on January 28
25°
30°
35°
40°
45°
50°
55°
60°
65°
70°
75°
80°
85°
Temperature (°F) of field joints at time of launch

On the other hand…

Hans Rosling:

The best stats you've ever seen

TED2006 · 19:50 · **Filmed** Feb 2006

Subtitles available in 48 languages

http://www.ted.com/talks/hans_rosling_shows_the_best_stats_you_ve_ever_seen.html

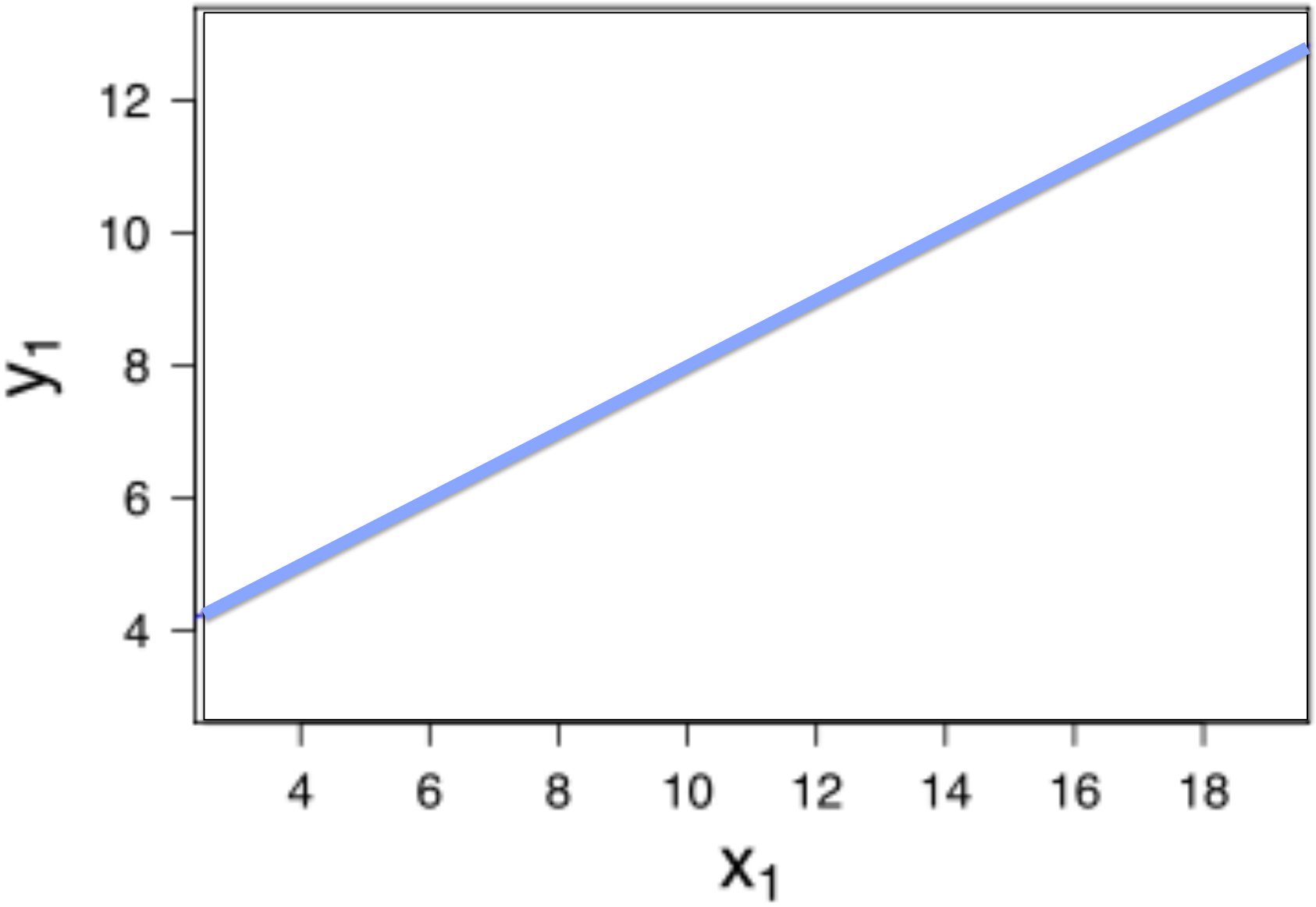
Exploratory Data Analysis

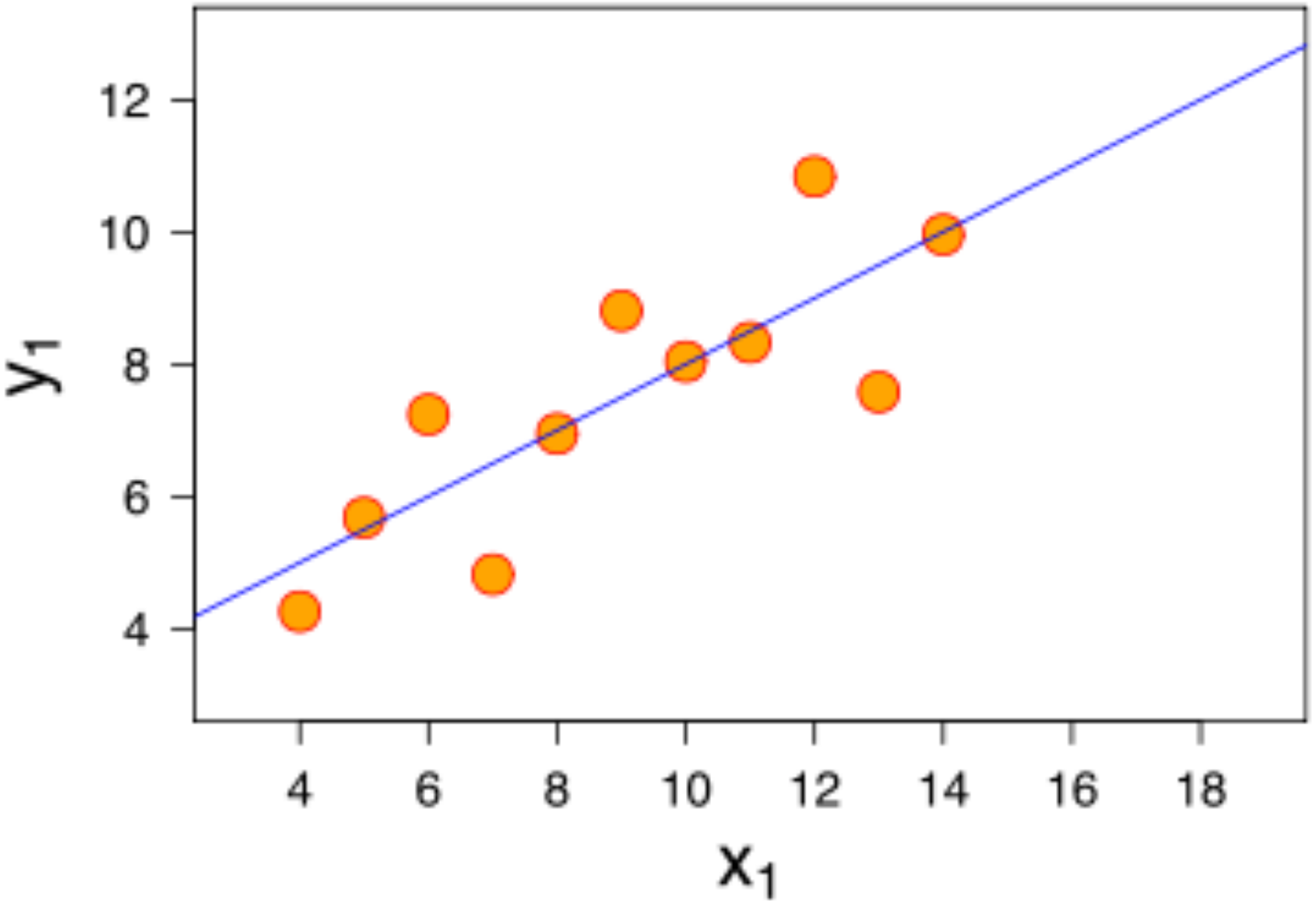
“There are three kinds of lies: lies, damned lies, and statistics.”

Mystery Data Set

Mystery Data Set

Property	Value
mean(x)	9
variance (x)	11
mean(y)	7.5
variance (y)	4.122
correlation (x,y)	0.816
Linear Regression Line	y = 3 + 0.5x


12
10
8
6
4
y_1
4
6
8
10
12
14
16
18
x_1


12
10
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y_1
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12
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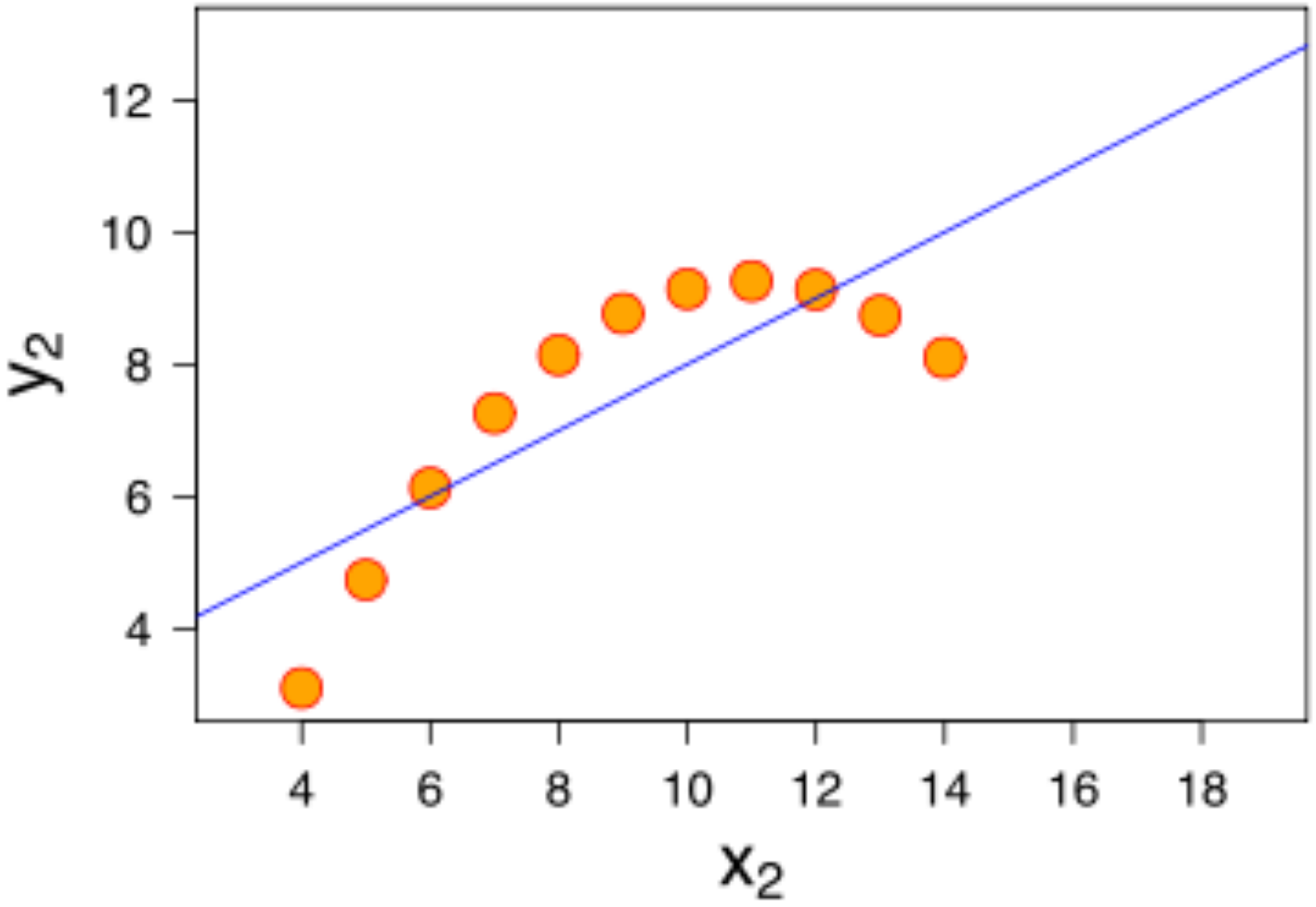
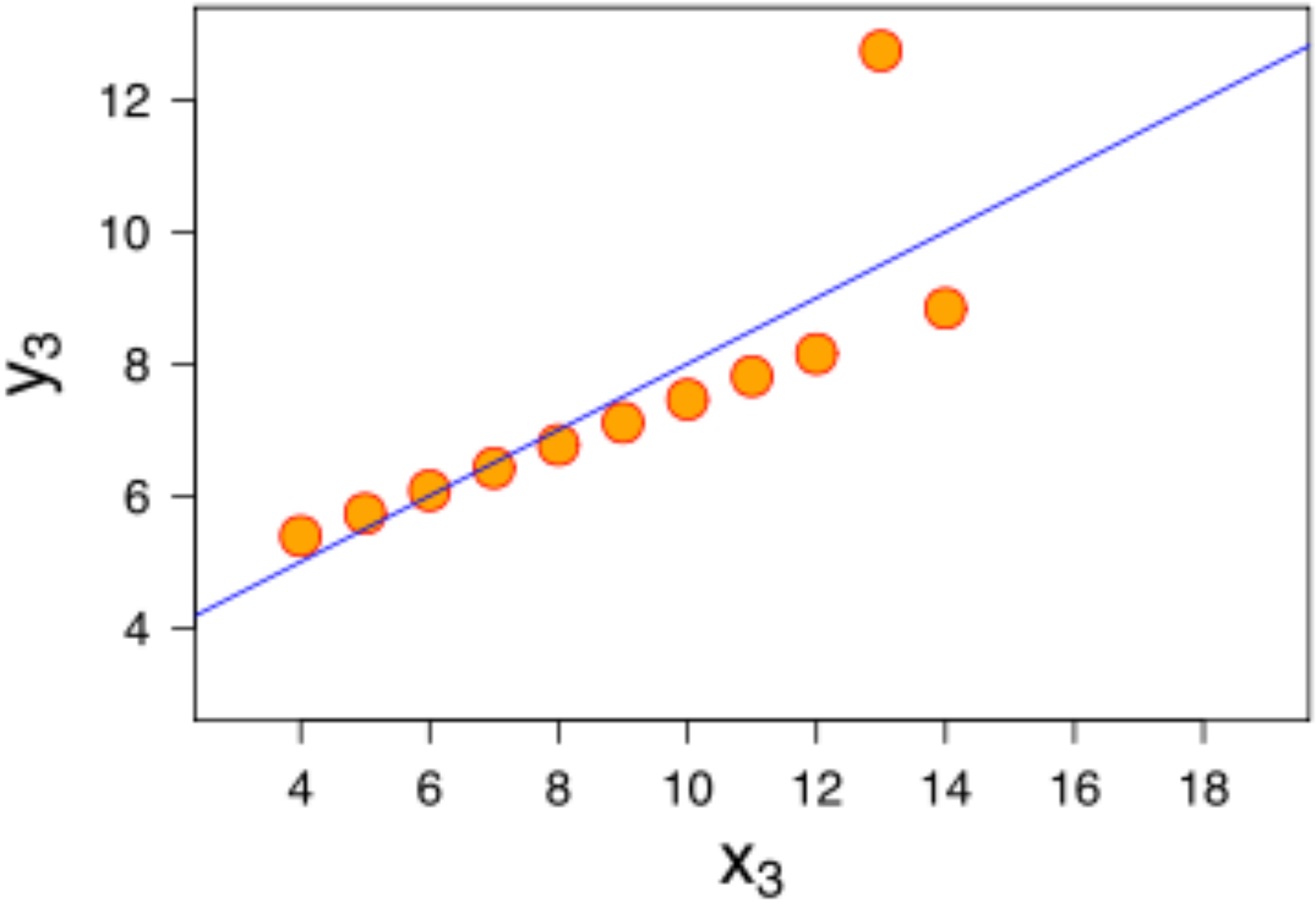
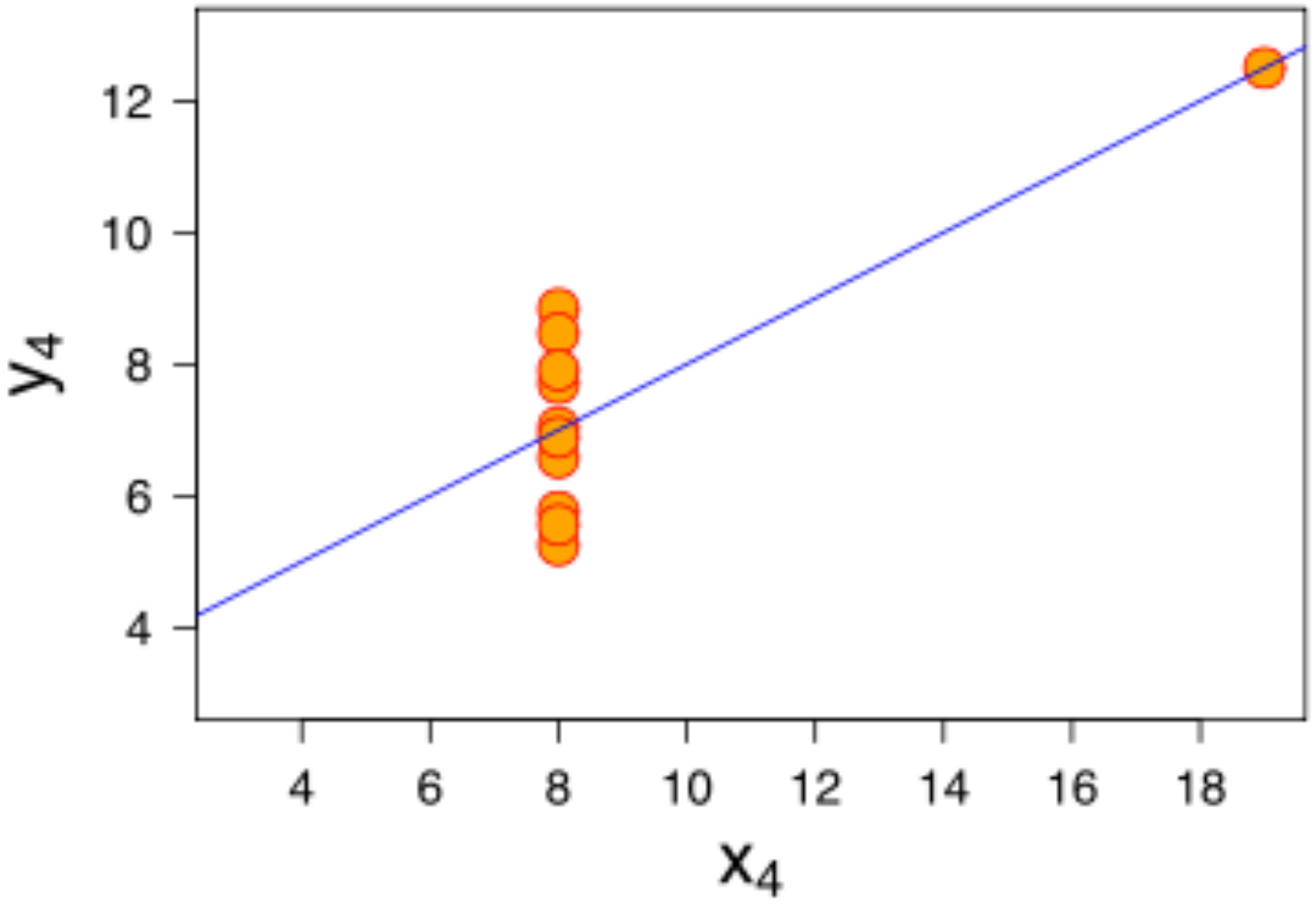
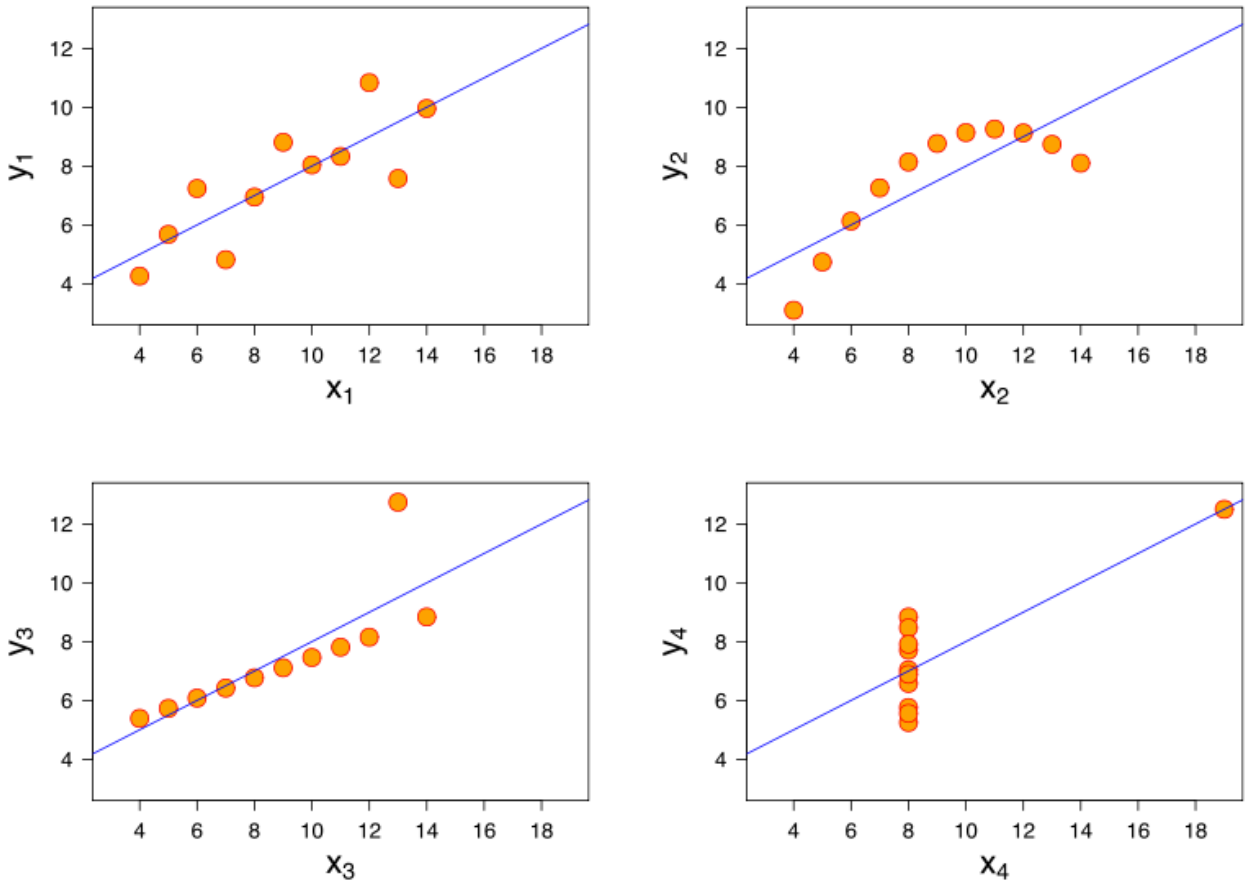
16
18
x_1


12
10
8
6
4
y_2
4
6
8
10
12
14
16
18
x_2

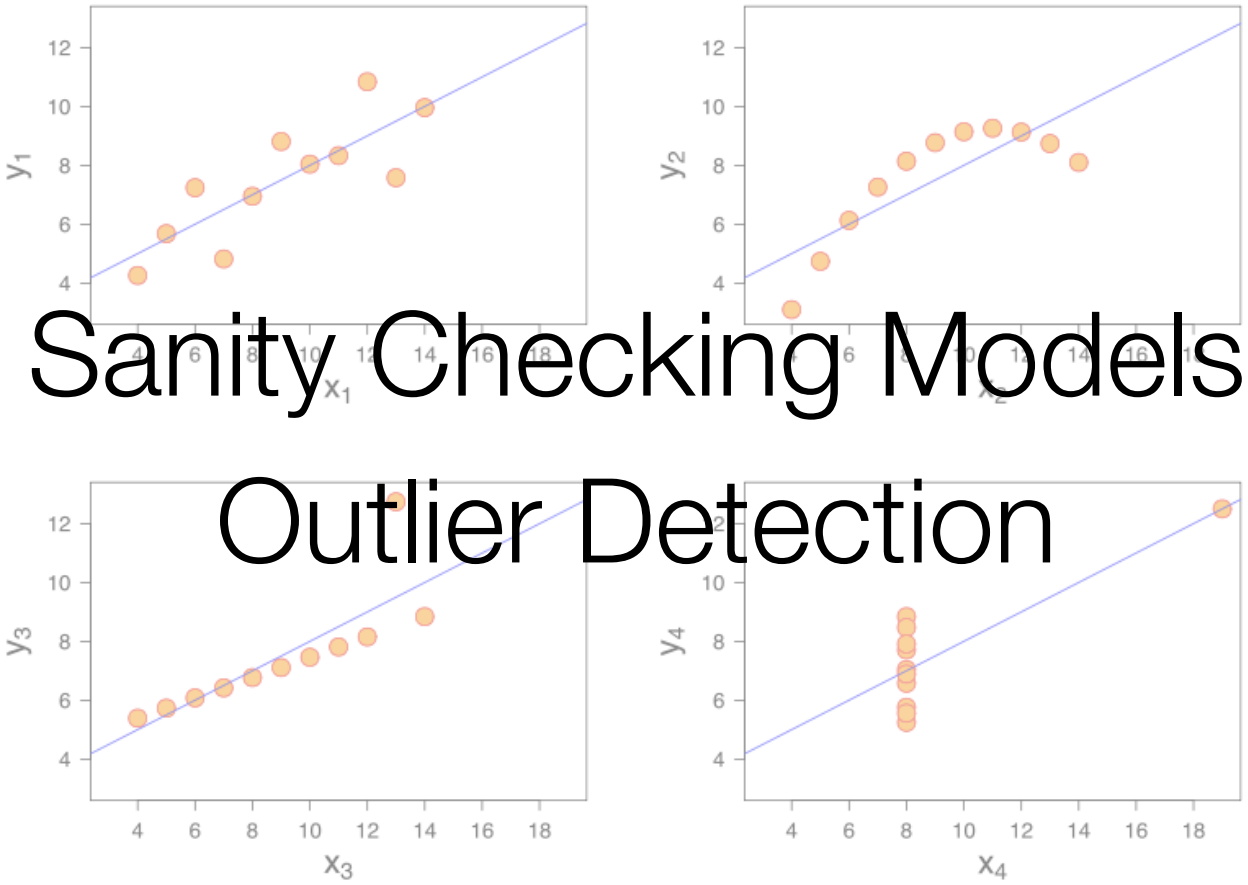

12
10
8
6
4
y_3
4
6
8
10
12
14
16
18
x_3


12
10
8
6
4
y4
4
6
8
10
12
14
16
18
x4

Anscombe's Quartet



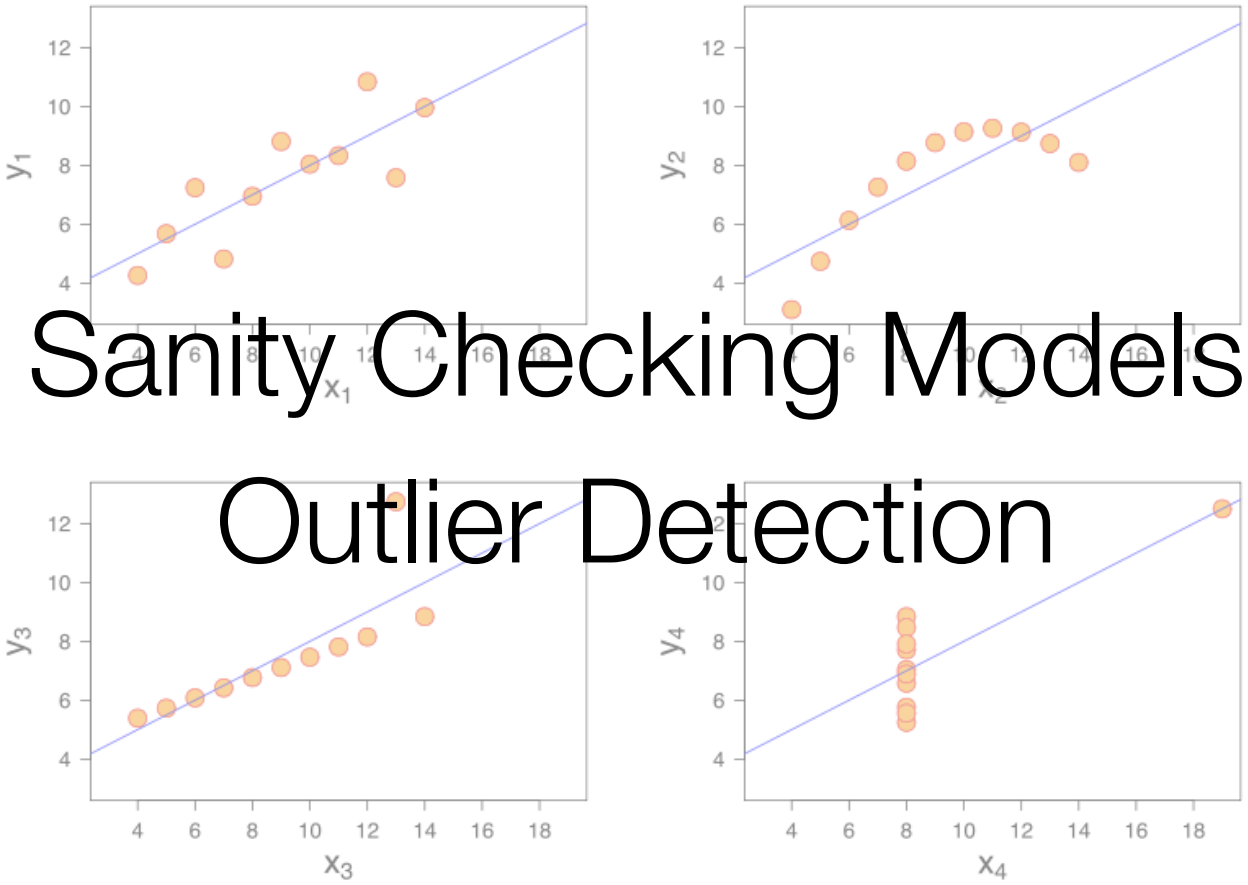
Anscombe's Quartet



Sanity Checking Models

Outlier Detection

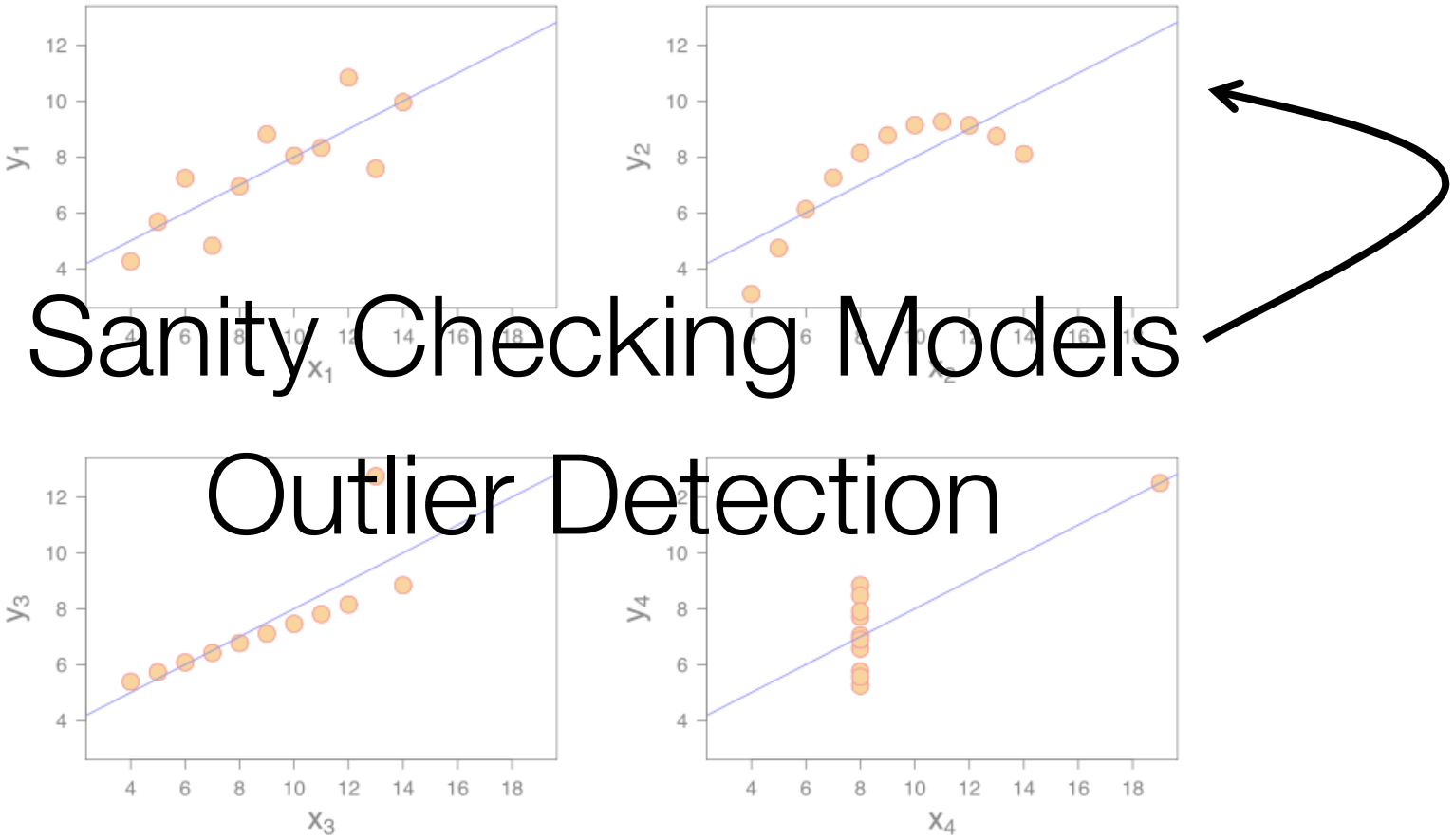
Anscombe's Quartet



Sanity Checking Models

Outlier Detection

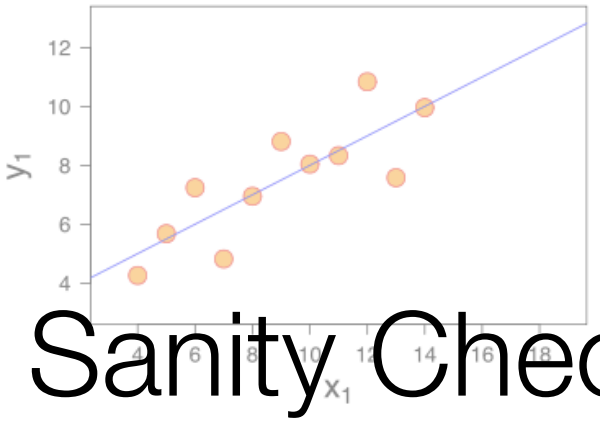
Anscombe's Quartet

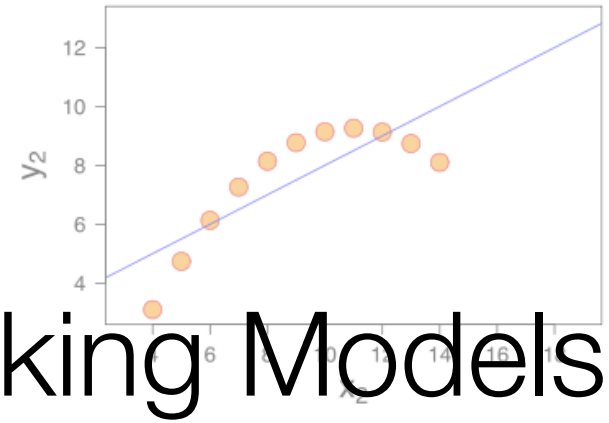


Sanity Checking Models

Outlier Detection

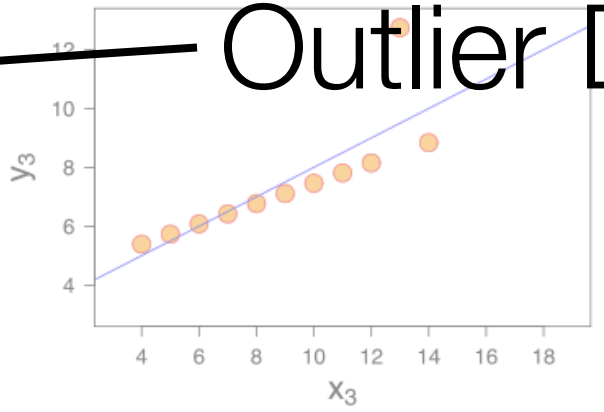
Anscombe's Quartet

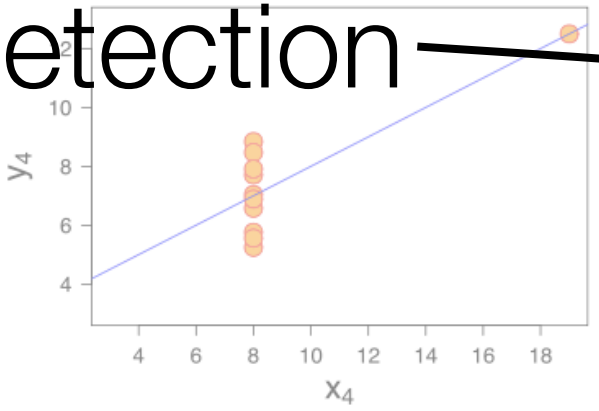




Sanity Checking Models

Outlier Detection





Anscombe's Quartet

I		II		III		IV	
x	y	x	y	x	y	x	y
10.00	8.04	10.00	9.14	10.00	7.46	8.00	6.58
8.00	6.95	8.00	8.14	8.00	6.77	8.00	5.76
13.00	7.58	13.00	8.74	13.00	12.74	8.00	7.71
9.00	8.81	9.00	8.77	9.00	7.11	8.00	8.84
11.00	8.33	11.00	9.26	11.00	7.81	8.00	8.47
14.00	9.96	14.00	8.10	14.00	8.84	8.00	7.04
6.00	7.24	6.00	6.13	6.00	6.08	8.00	5.25
4.00	4.26	4.00	3.10	4.00	5.39	19.00	12.50
12.00	10.84	12.00	9.13	12.00	8.15	8.00	5.56
7.00	4.82	7.00	7.26	7.00	6.42	8.00	7.91
5.00	5.68	5.00	4.74	5.00	5.73	8.00	6.89

Human Perception

Psychophysics
Cognitive Psychology

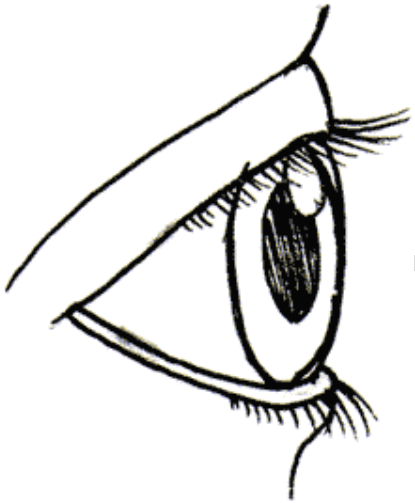
Name the five senses.

Sense	Bandwidth (bits/sec)
Sight	10,000,000
Touch	1,000,000
Hearing	100,000
Smell	100,000
Taste	1,000

http://www.britannica.com/EBchecked/topic/287907/information-theory/214958/Physiology

A (Simple) Model of Human Visual Perception

A (Simple) Model of Human Perception



Stage 1

Parallel detection of basic features into an iconic store

Stage 2

Serial processing of object identification and spatial layout

Stage 1: Pre-Attentive Processing

Rapid

Parallel

Automatic

(Fleeting)

Stage 2: Serial Processing

Relatively Slow

(Incorporates Memory)

Manual

Stage 1: Pre-Attentive Processing

The eye moves every 200ms

Stage 1: Pre-Attentive Processing

The eye moves every 200ms

(so this processing occurs every 200ms-250ms)

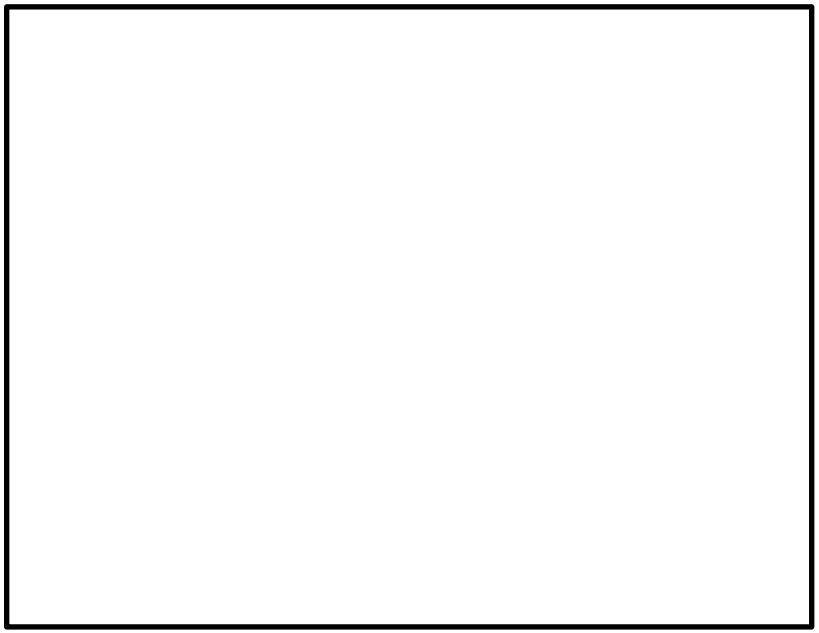
Example

128176875613897654698450698560498282676298098584582245098564589450984509809435859091030209905959595772564675050678904567884578980982167765487636490856091294968 6

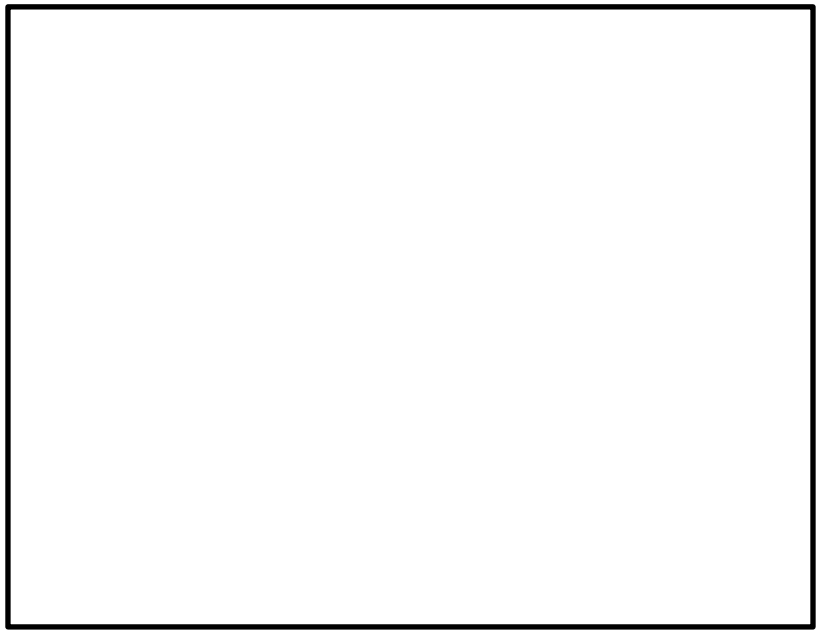
Example

1281768756138976546984506985604982826762
9809858458224509856458945098450980943585
9091030209905959595772564675050678904567
8845789809821677654876364908560912949686

A few more examples from Prof. Chris Healy at NC State

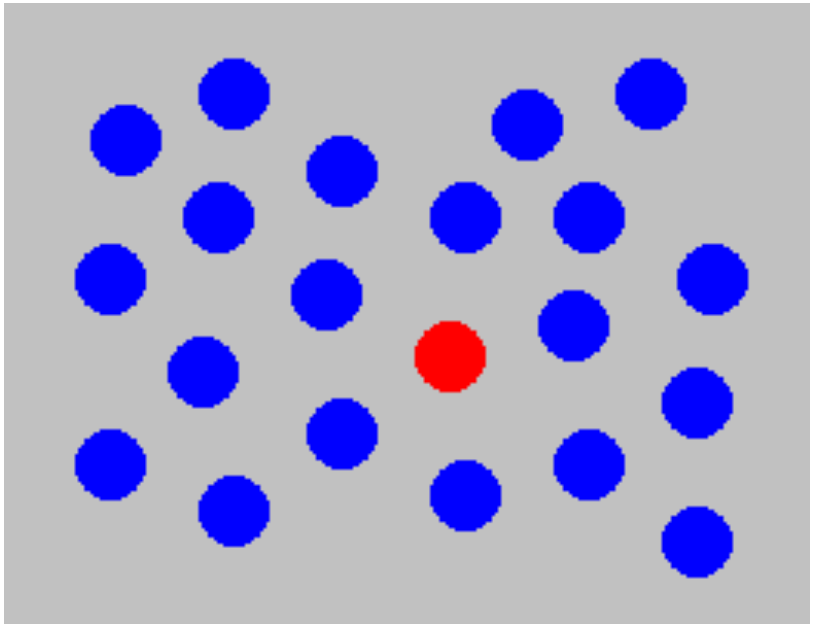


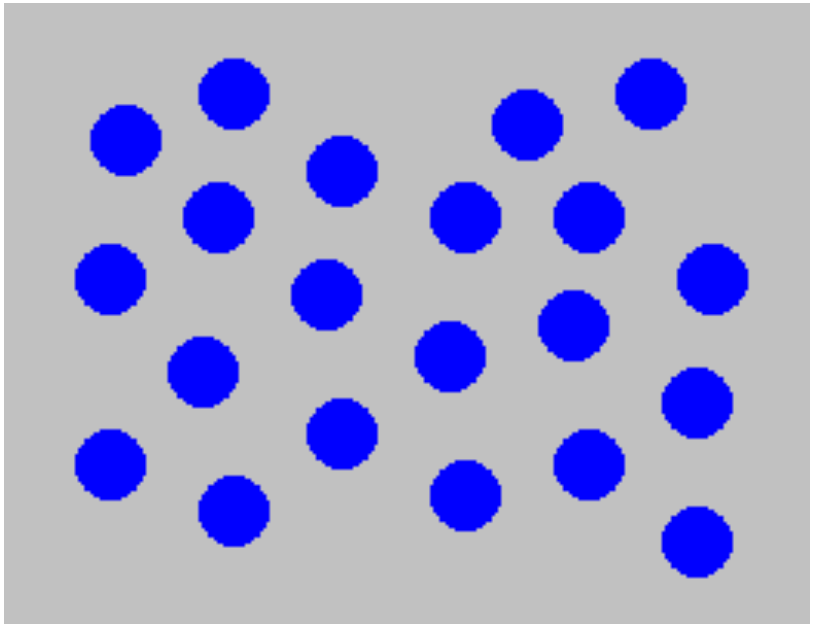
Left Side



Right Side

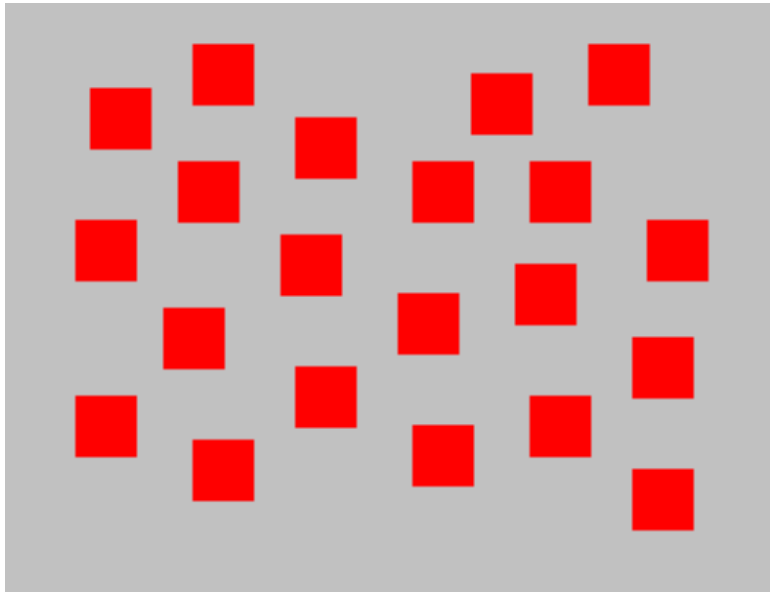
Determine if a RED DOT is present…

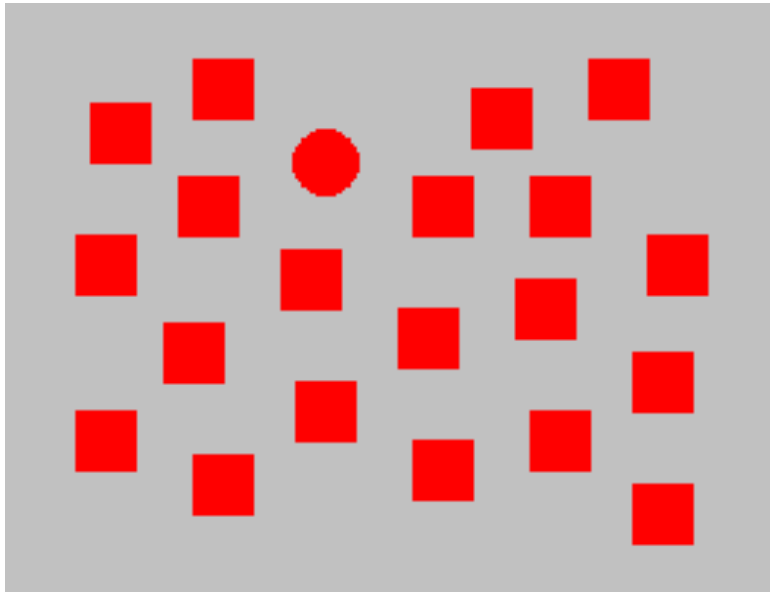




Color (hue) is pre-attentively processed.

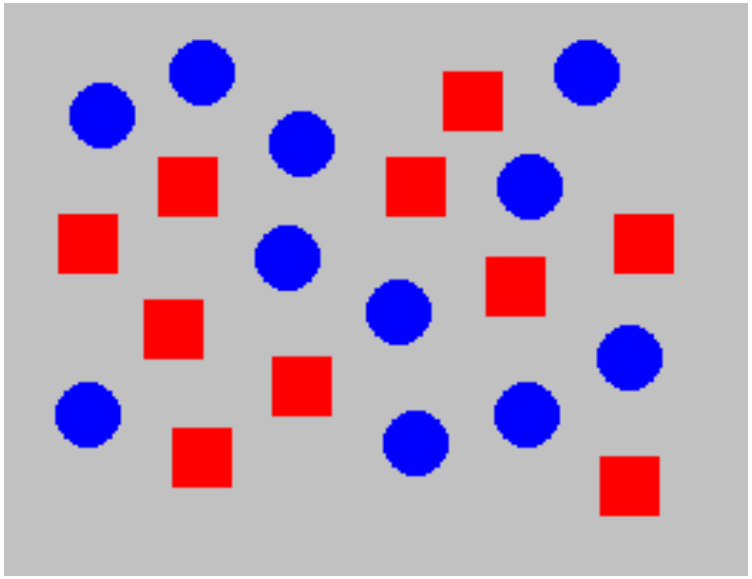
Determine if a RED DOT is present…

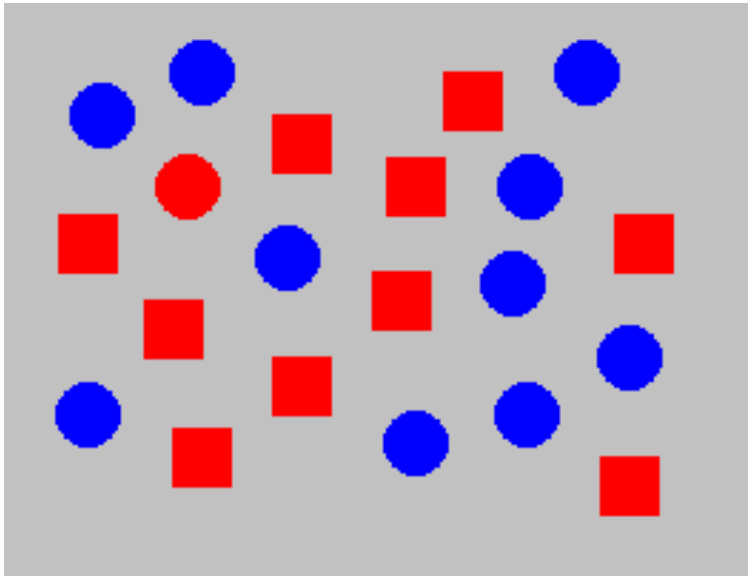




Shape is pre-attentively processed.

Determine if a RED DOT is present…

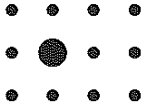
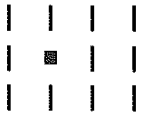
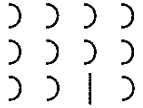
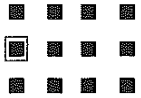
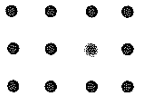
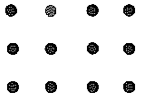
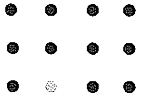




Hue and shape together are NOT pre-attentively processed.

Pre-Attentive Processing

- length
- width
- size
- curvature
- number
- terminators
- intersection
- closure
- hue
- lightness
- flicker
- direction of motion
- binocular lustre
- stereoscopic depth
- 3-D depth cues
- lighting direction

Group	Attribute		
Form	Length	Width	Orientation
	Size	Shape	Curvature
			
	Enclosure	Blur	
			
Color	Hue	Intensity	
			
Spatial Position	2-D Position	Spatial Grouping	
Motion	Direction		

Stephen Few
"Now You See It"
pg. 39

Pre-Attentive → Cognitive

Gestalt Psychology

Berlin, Early 1900s

Gestalt Psychology

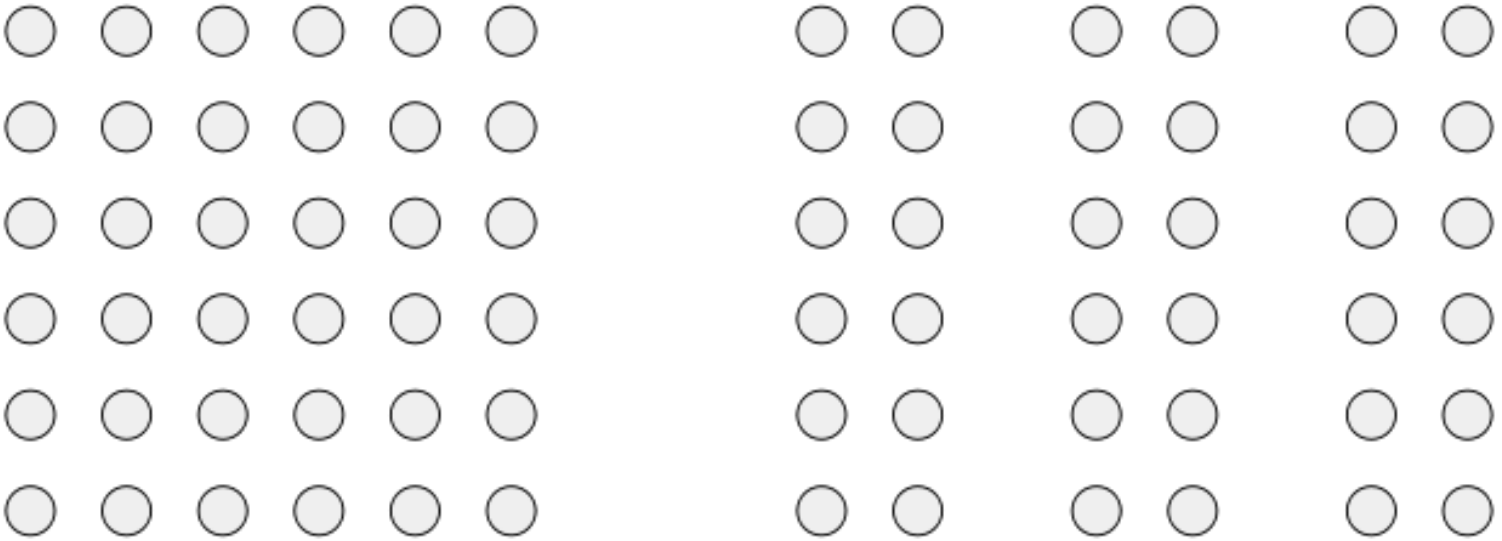
Goal was to understand pattern perception

Identified 8 “Laws of Grouping”

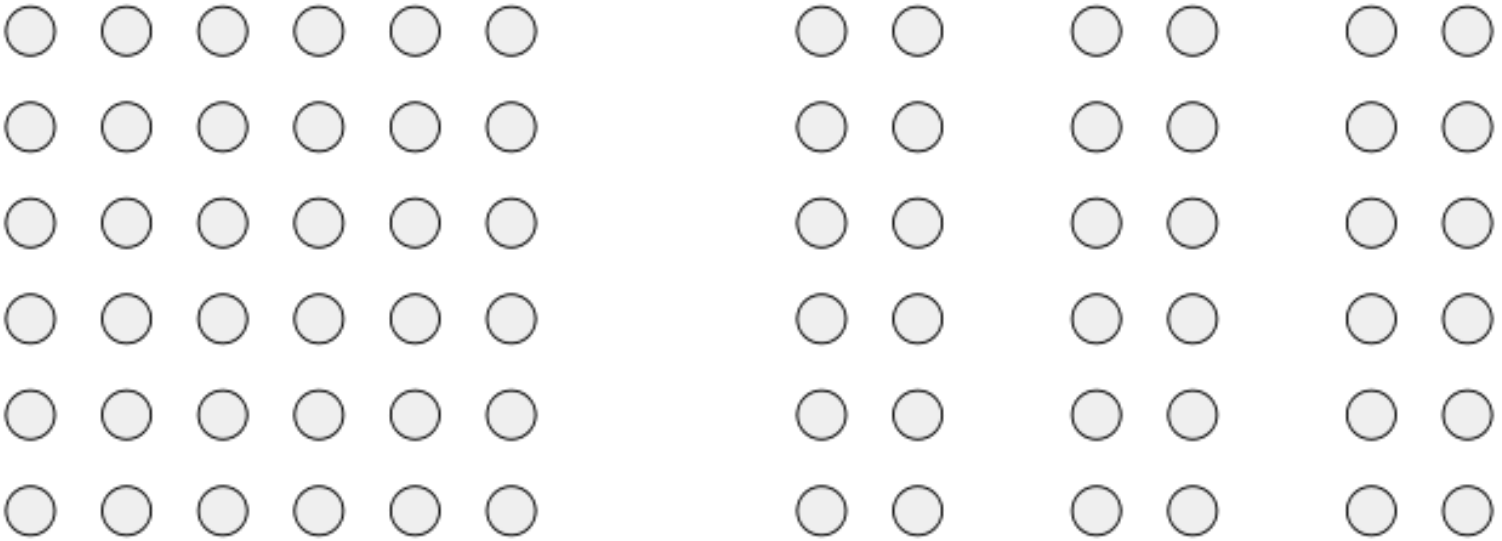
Gestalt Psychology

1. Proximity
2. Similarity
3. Closure
4. Symmetry
5. Common Fate
6. Continuity
7. Good Gestalt
8. Past Experience

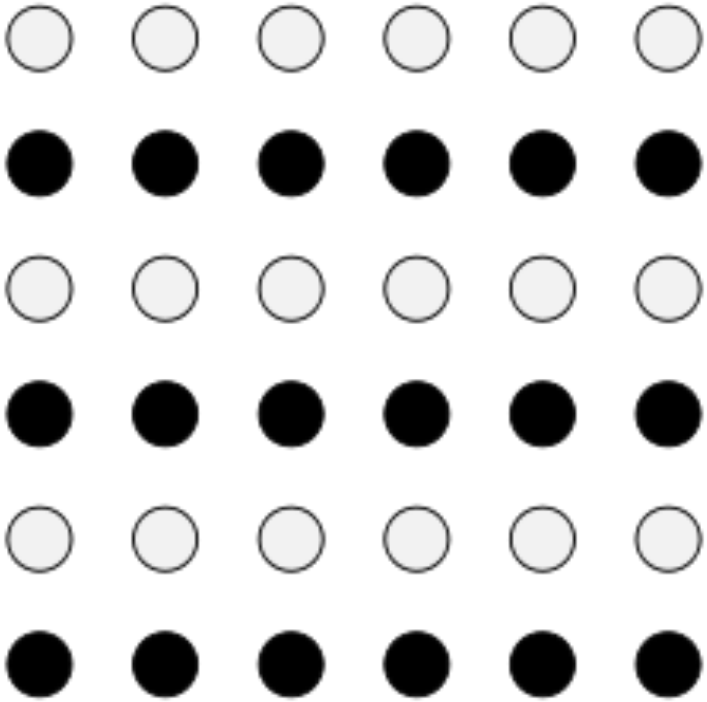
How many groups are there?



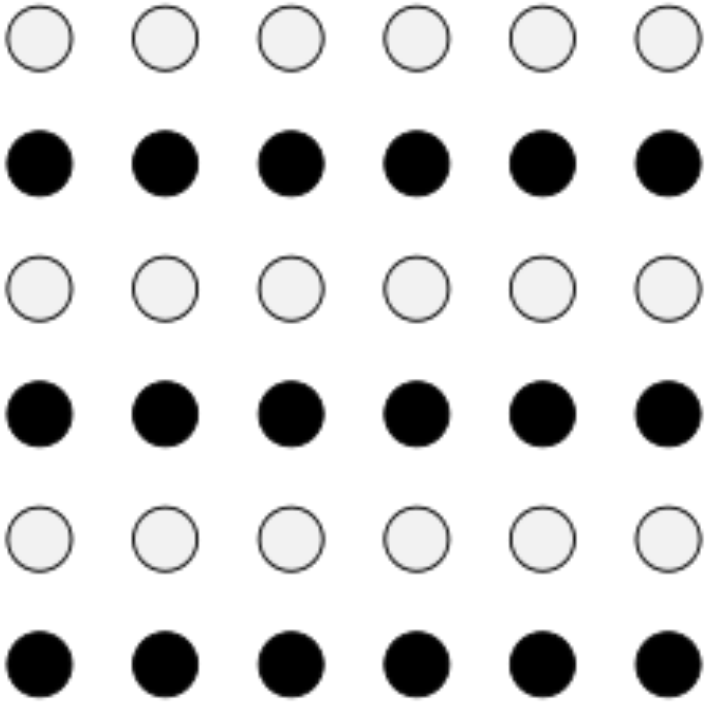
Proximity



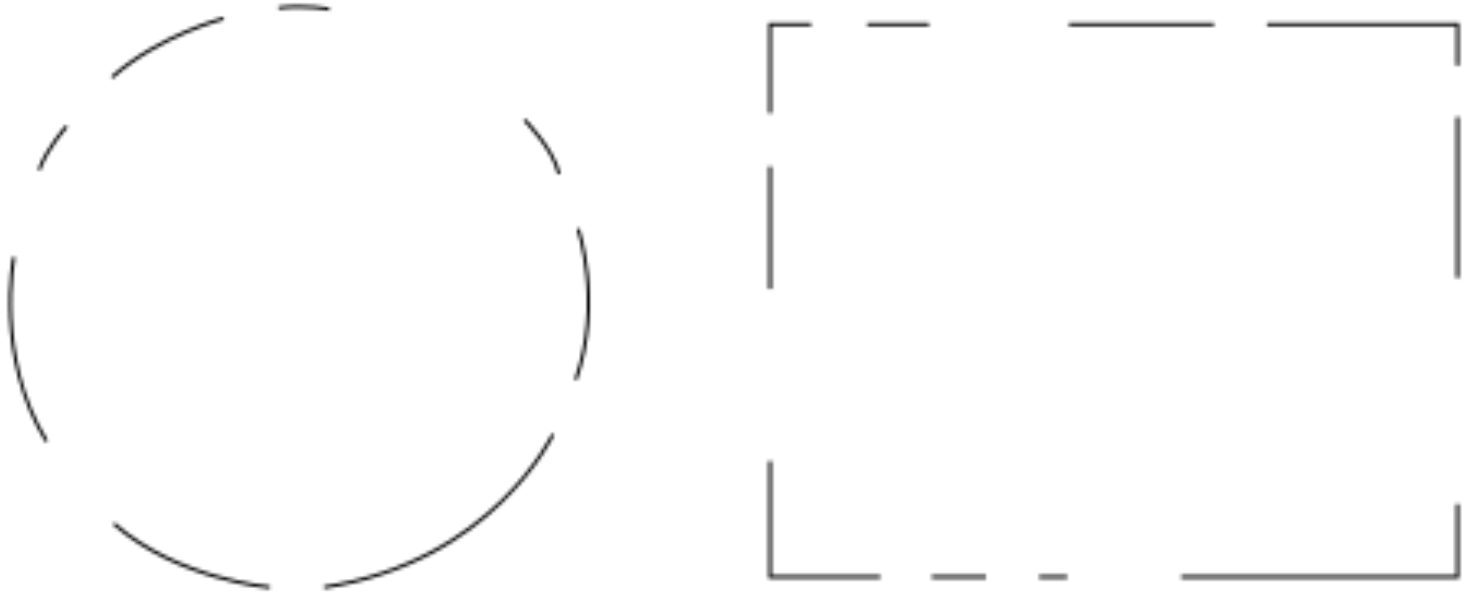
How many groups are there?



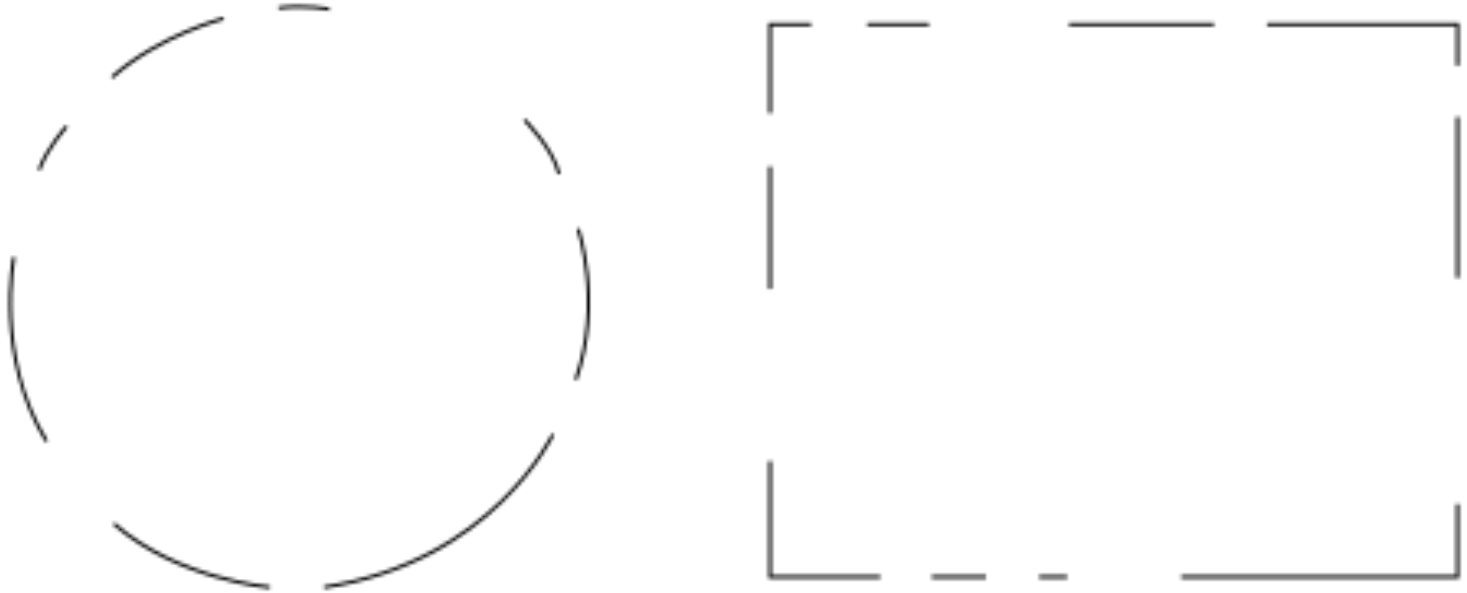
Similarity



How many shapes are there?



Closure



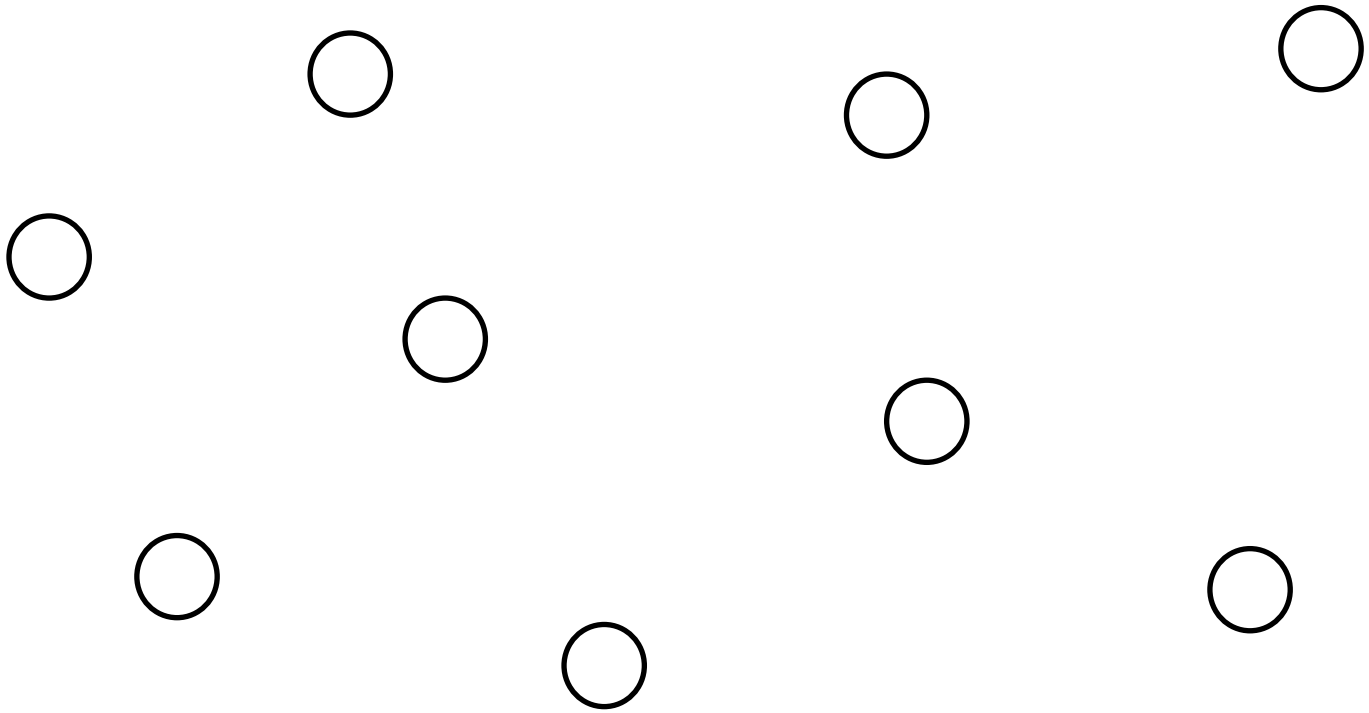
How many items are there?

[ ] { } [ ]

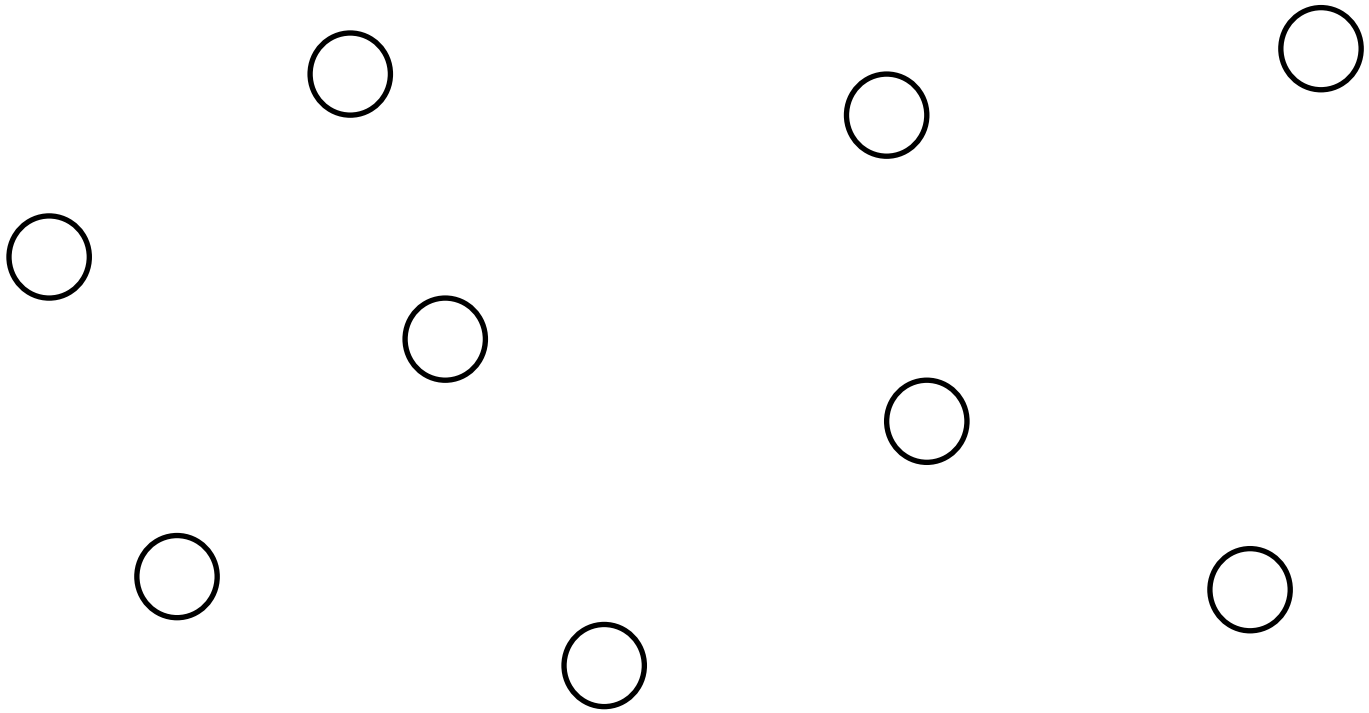
Symmetry

[ ] { } [ ]

How many sets are there?



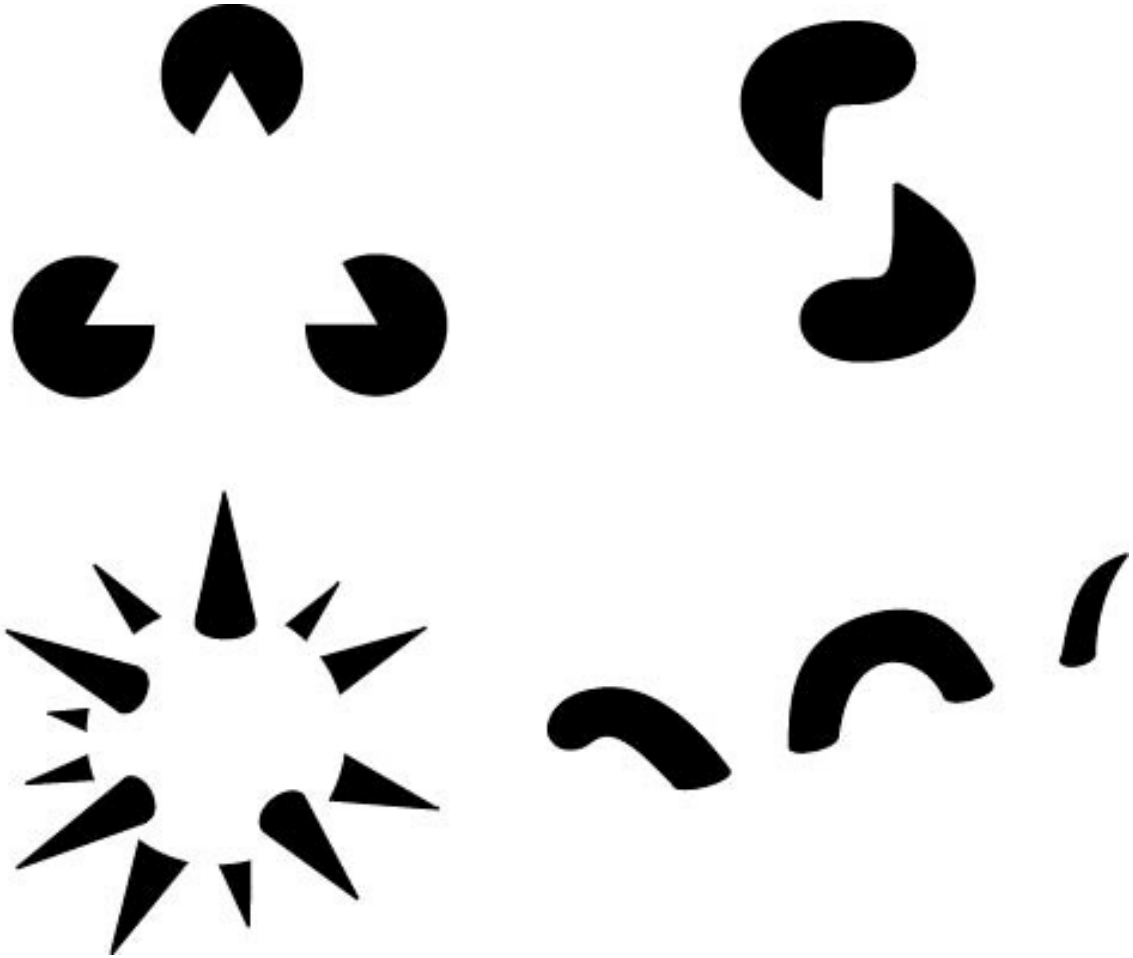
Common Fate



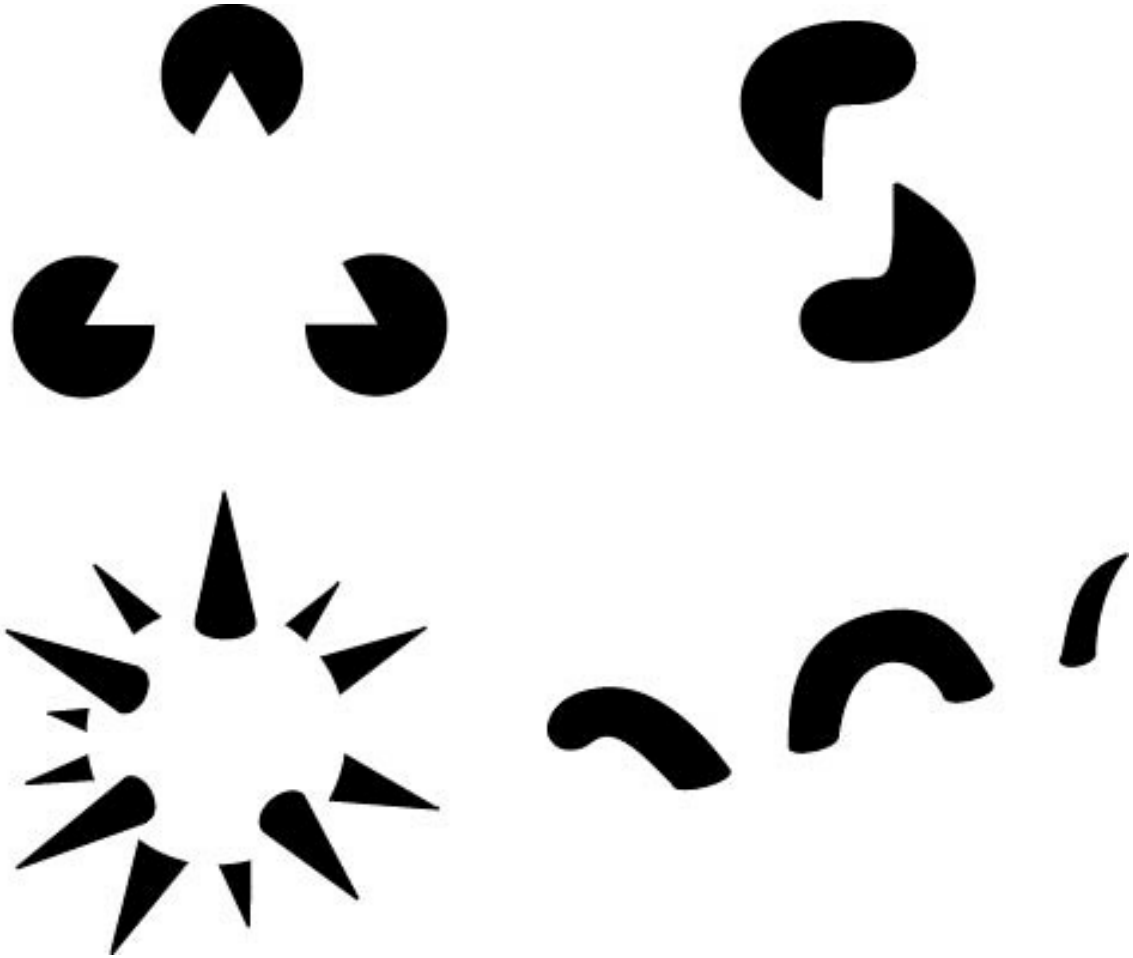
How many objects are there?

Continuity

How many objects are there?



Good Gestalt



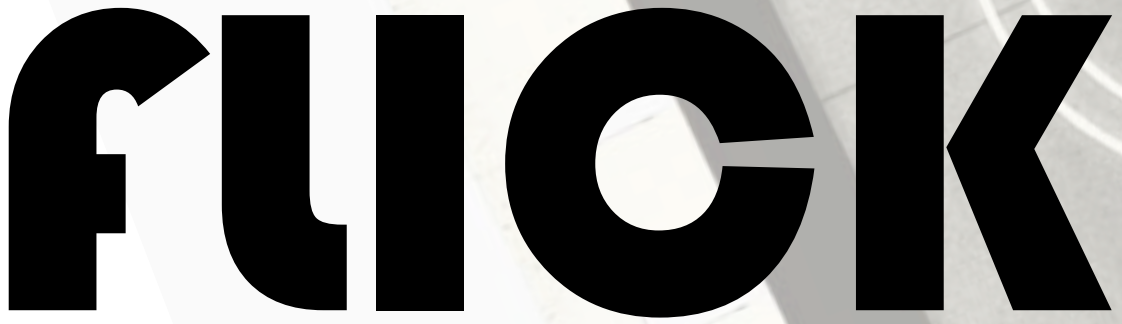
What is this word?
(Please Shout)

FLICK

Past Experience

FLICK

Past Experience



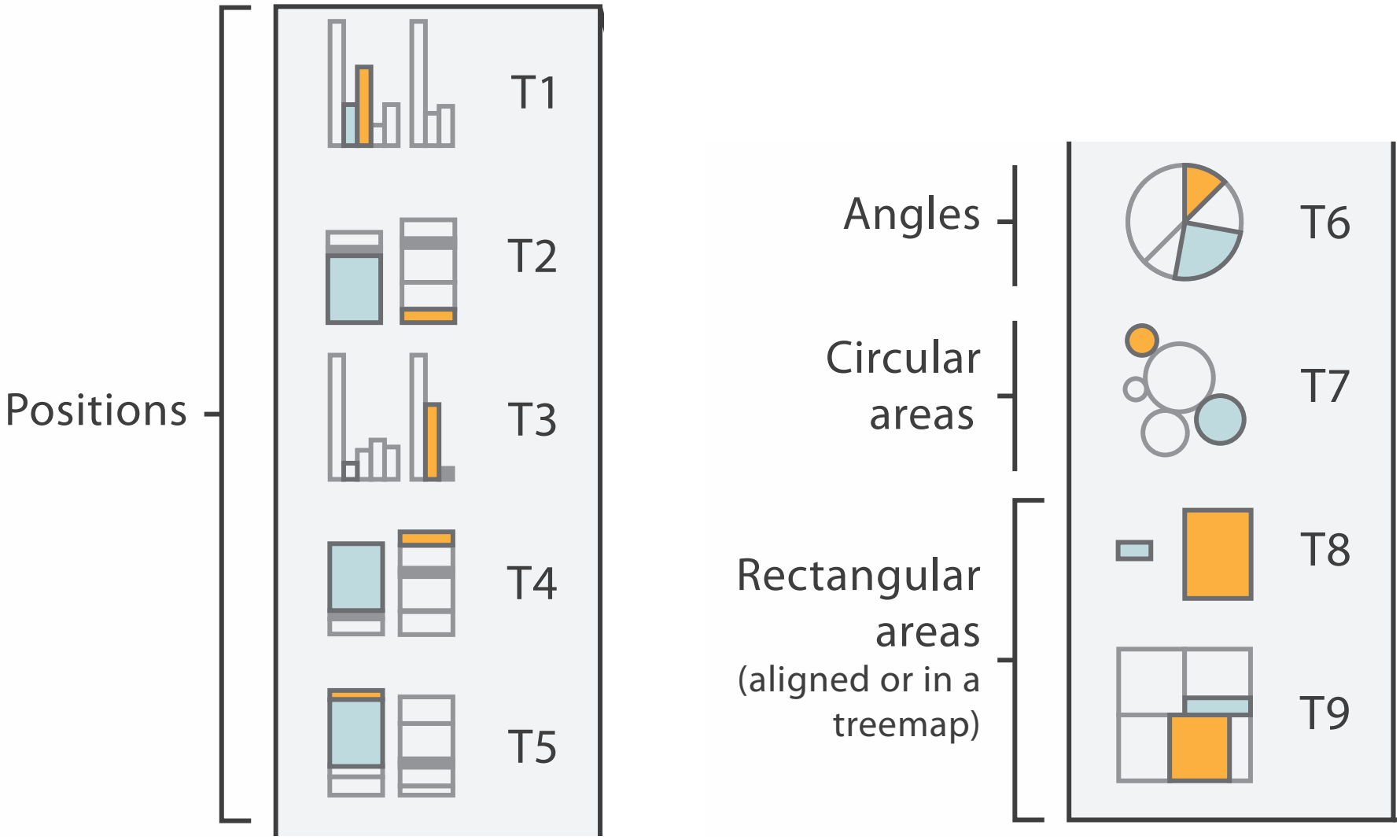
Pre-Attentive Processing

Gestalt Laws

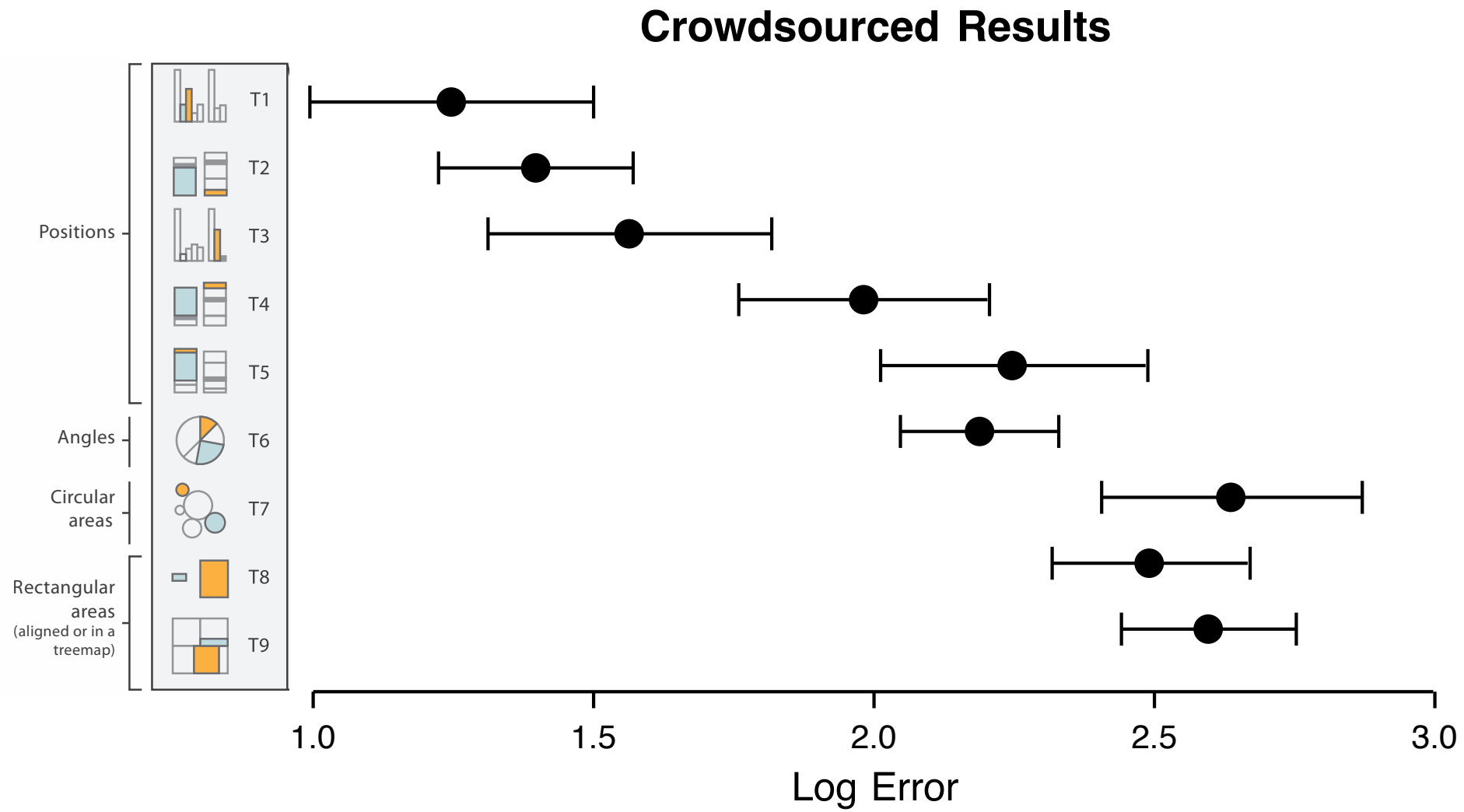
Detect Quickly

Detect Quickly

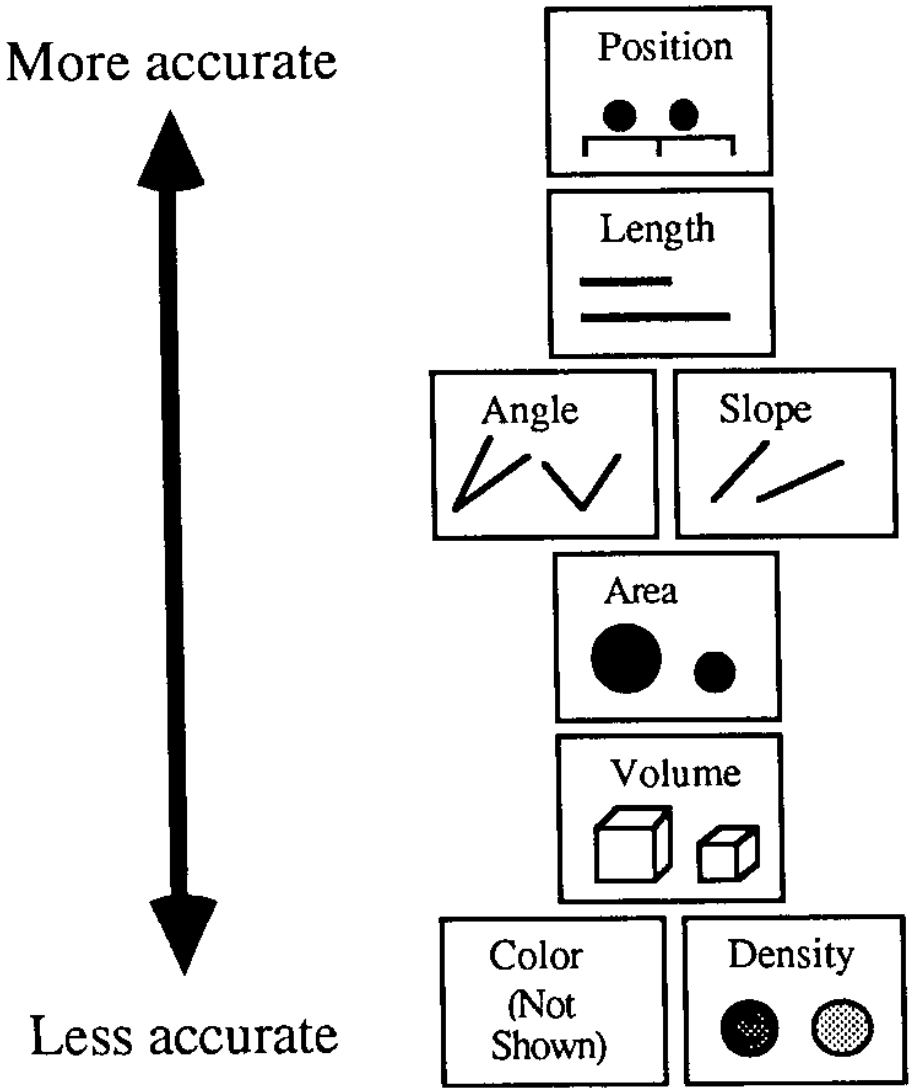
Detect Accurately



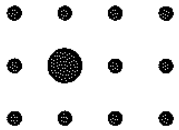
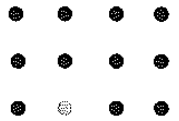
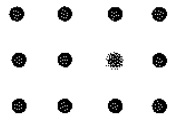
Crowdsourcing Graphical Perception: Using Mechanical Turk to Assess Visualization Design.Heer and Bostock. Proc ACM Conf. Human Factors in Computing Systems (CHI) 2010, p. 203–212.



Crowdsourcing Graphical Perception: Using Mechanical Turk to Assess Visualization Design.Heer and Bostock. Proc ACM Conf. Human Factors in Computing Systems (CHI) 2010, p. 203–212.



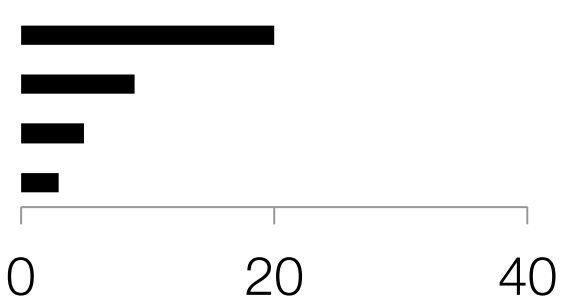
Mackinlay, 1986

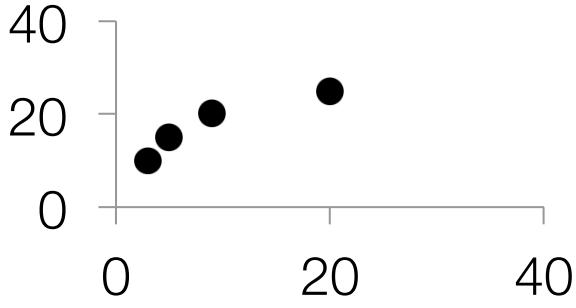
Precision of Quantitative Perception	Attribute	Example	Description
Very precise	Length		Longer = greater
	2-D Position		Higher or farther to the right = greater
Not very precise	Width		Wider = greater
	Size		Bigger = greater
	Intensity		Darker = greater
	Blur		Clearer = greater

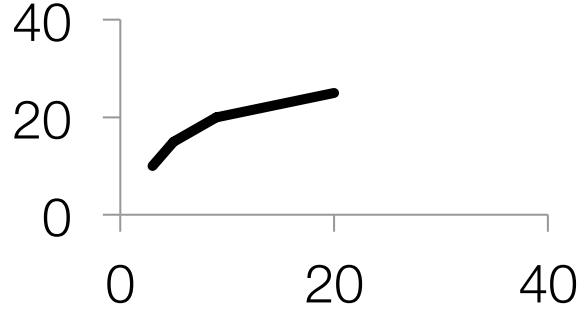
Stephen Few
"Now You See It"
pg. 41

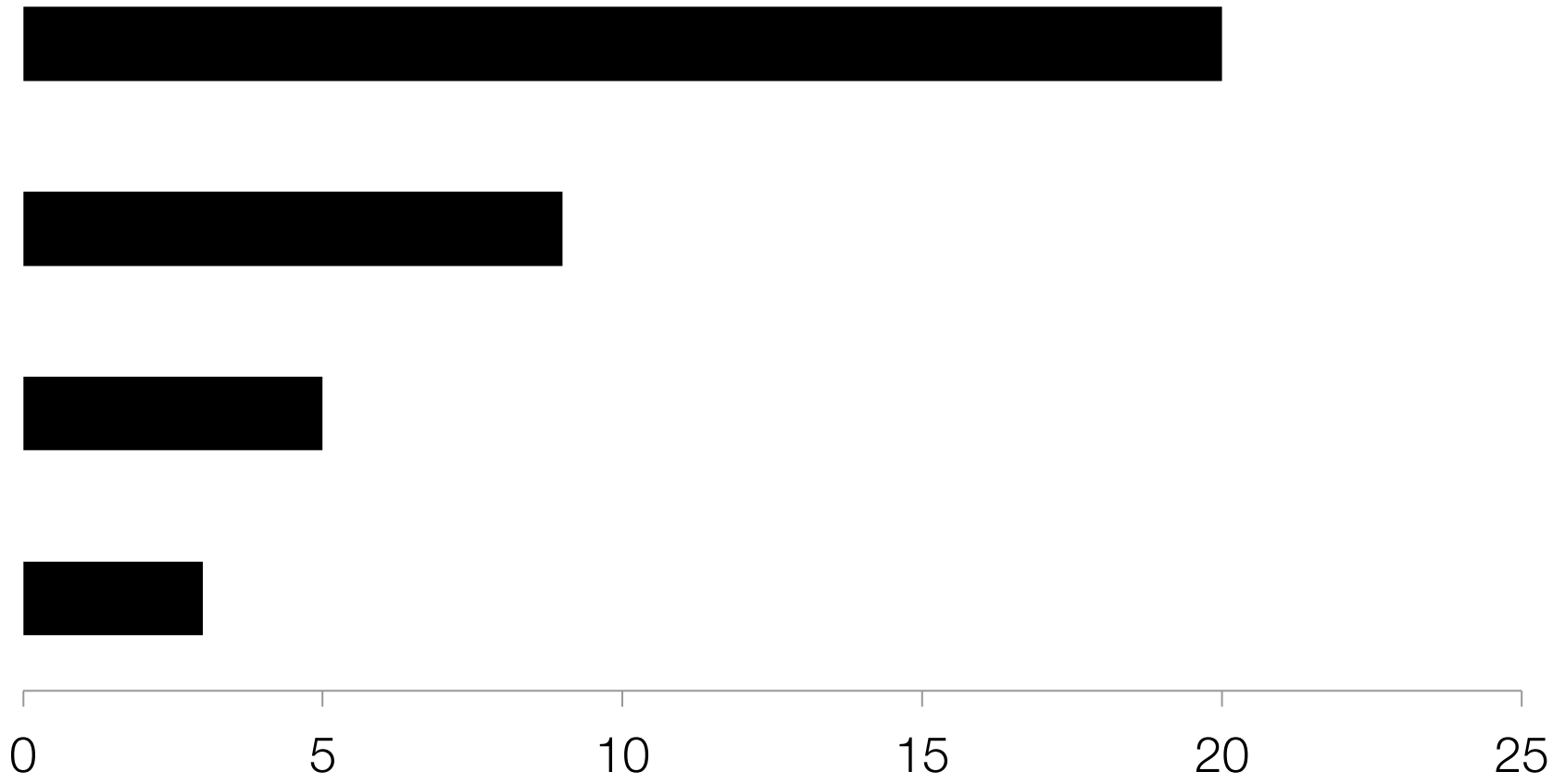
What does this tell us?

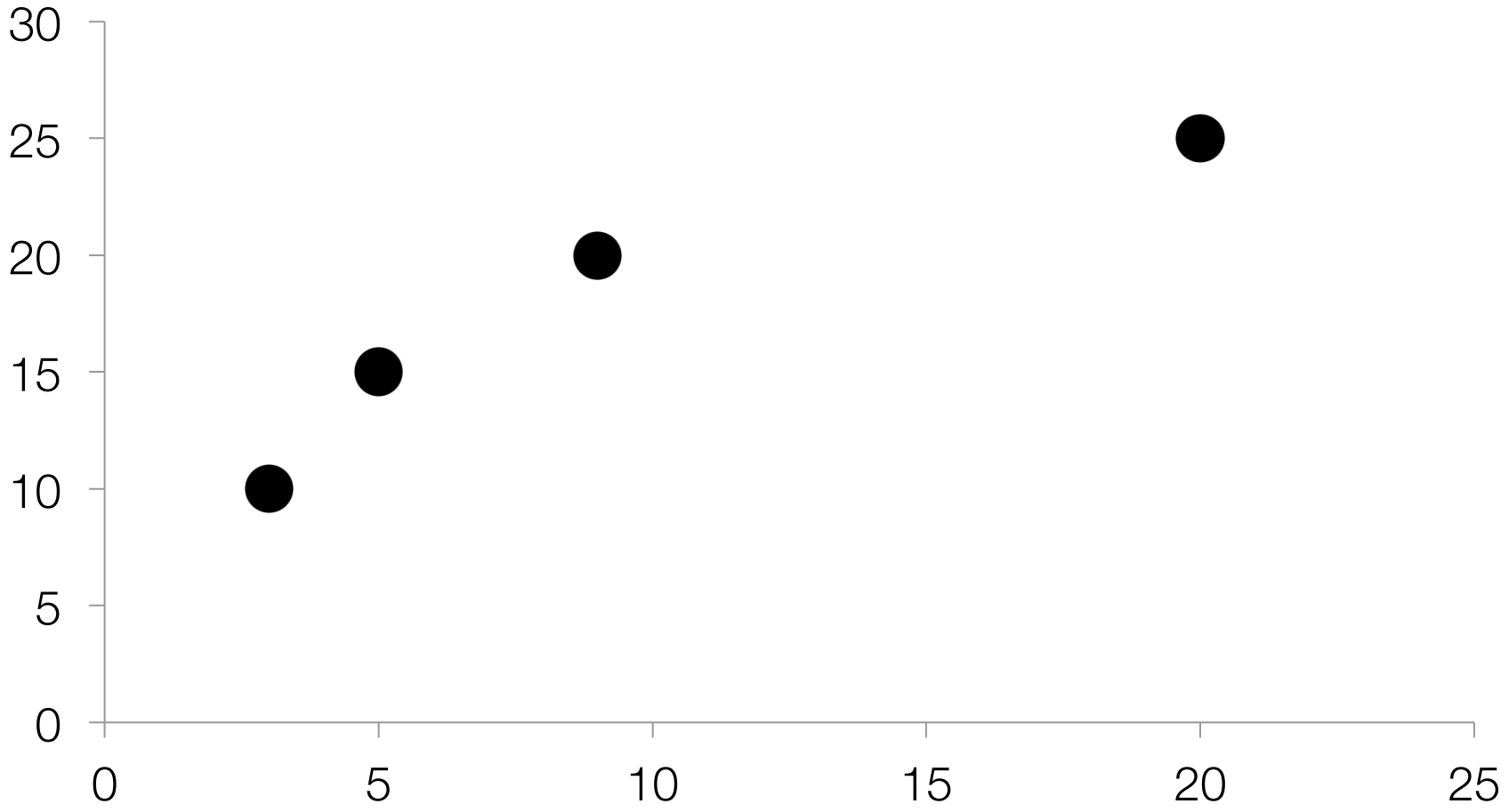
Barcharts, scatterplots, and line charts are *really* effective for quantitative data








0
5
10
15
20
25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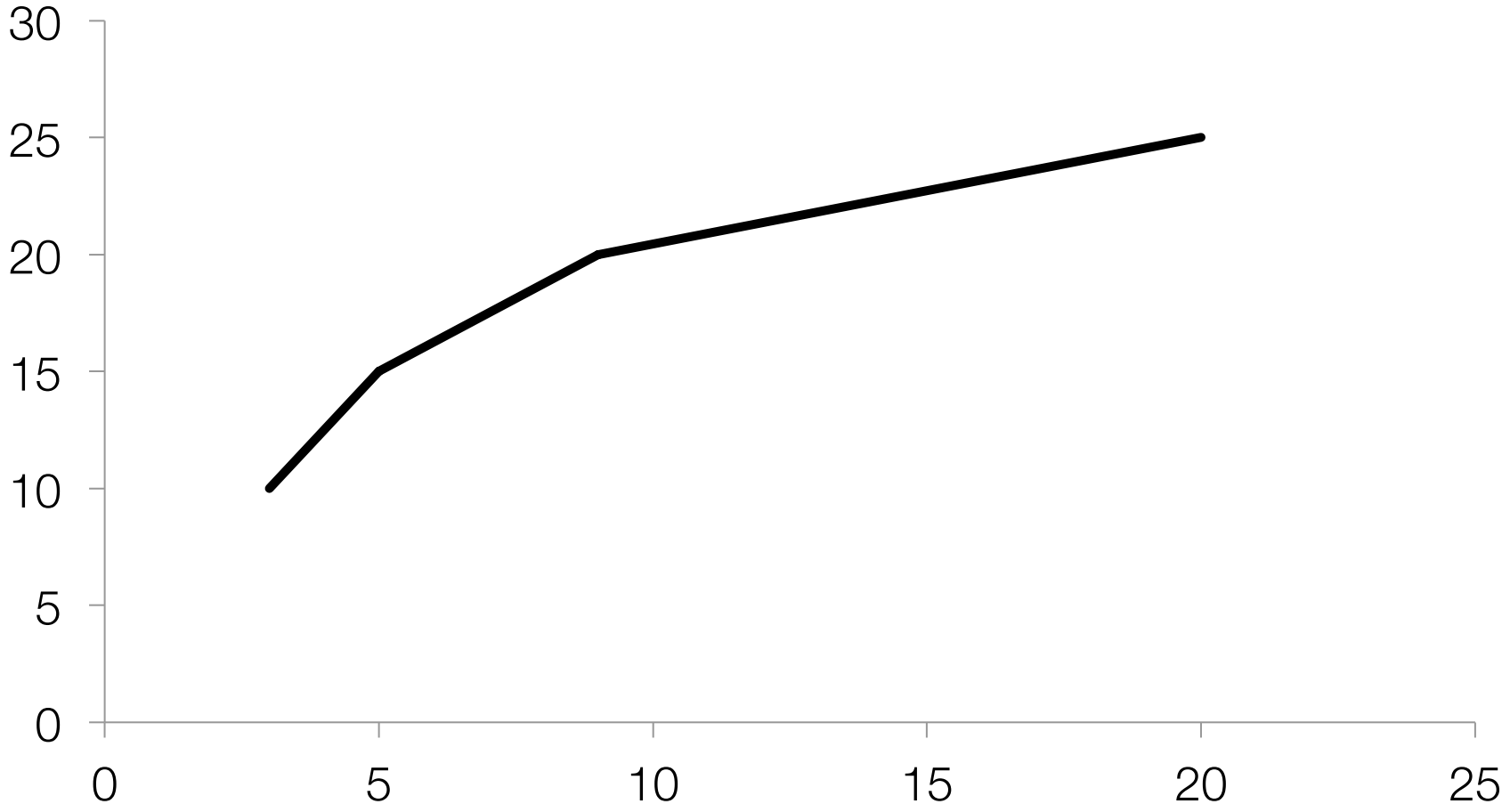
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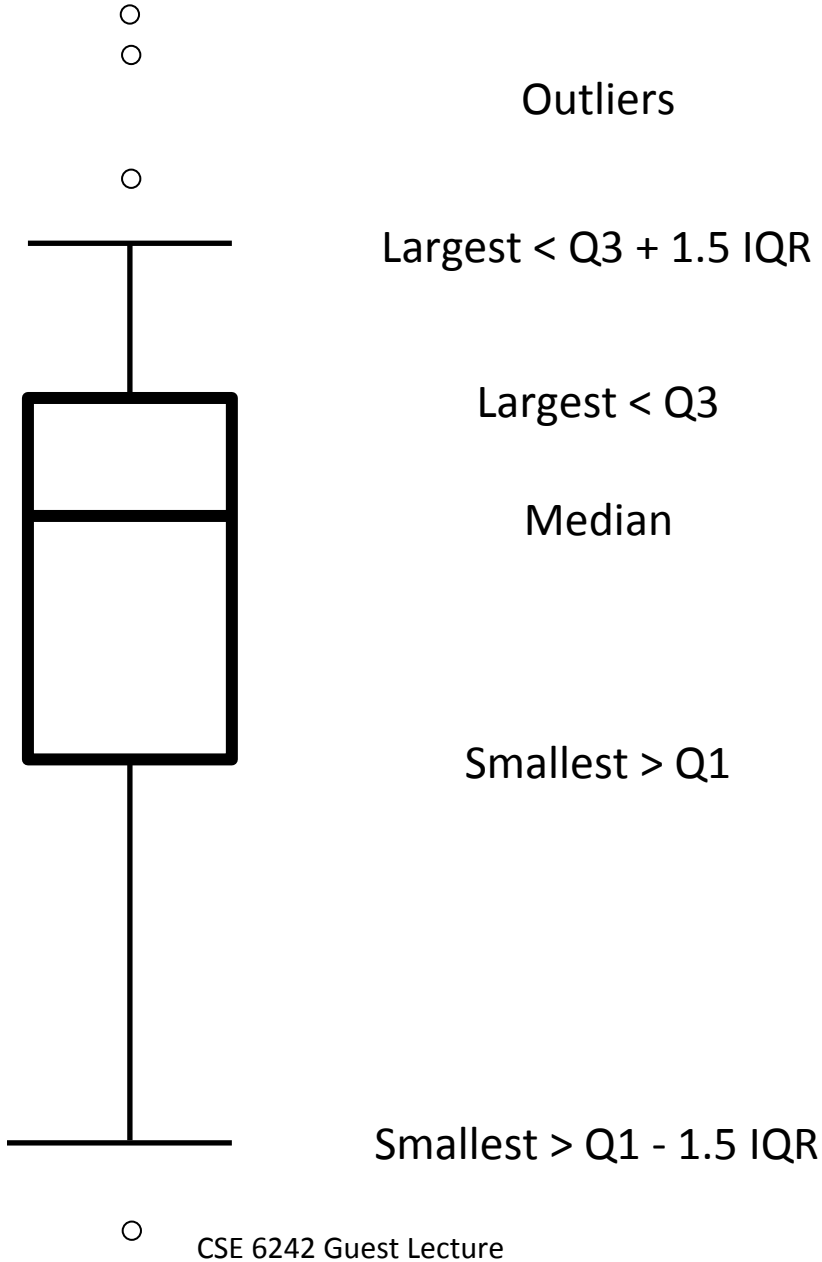
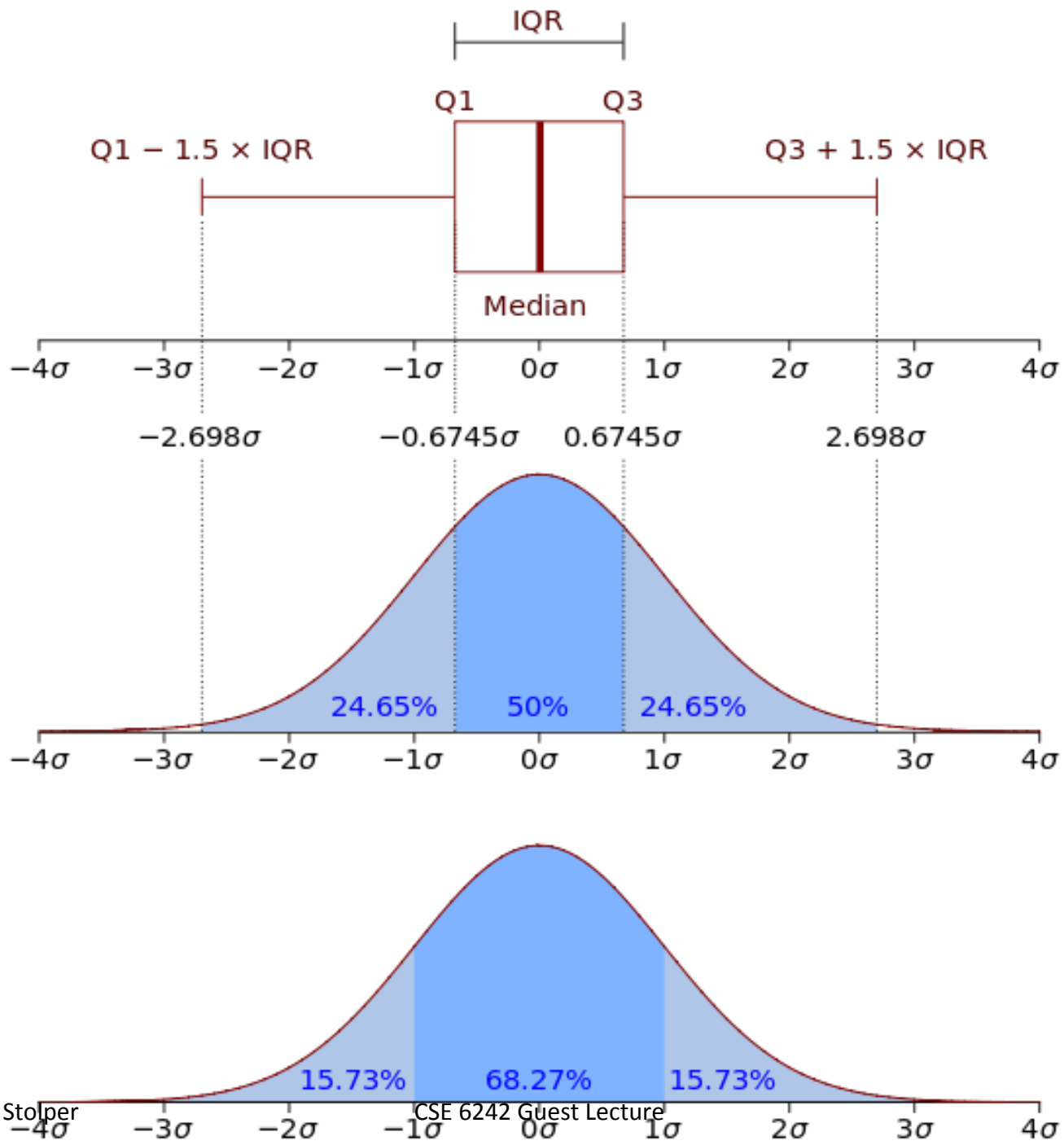
25

(and for statistical distributions) Tukey Box Plots


Outliers
Largest < Q3 + 1.5 IQR
Largest < Q3
Median
Smallest > Q1
Smallest > Q1 - 1.5 IQR


IQR
Q1
Q3
Q1 − 1.5 × IQR
Q3 + 1.5 × IQR
Median
−4σ
−3σ
−2σ
−1σ
0σ
1σ
2σ
3σ
4σ
−2.698σ
−0.6745σ
0.6745σ
2.698σ
24.65%
50%
24.65%
15.73%
68.27%
15.73%

Tufte's Chart Principles

Tufte's Chart Principles

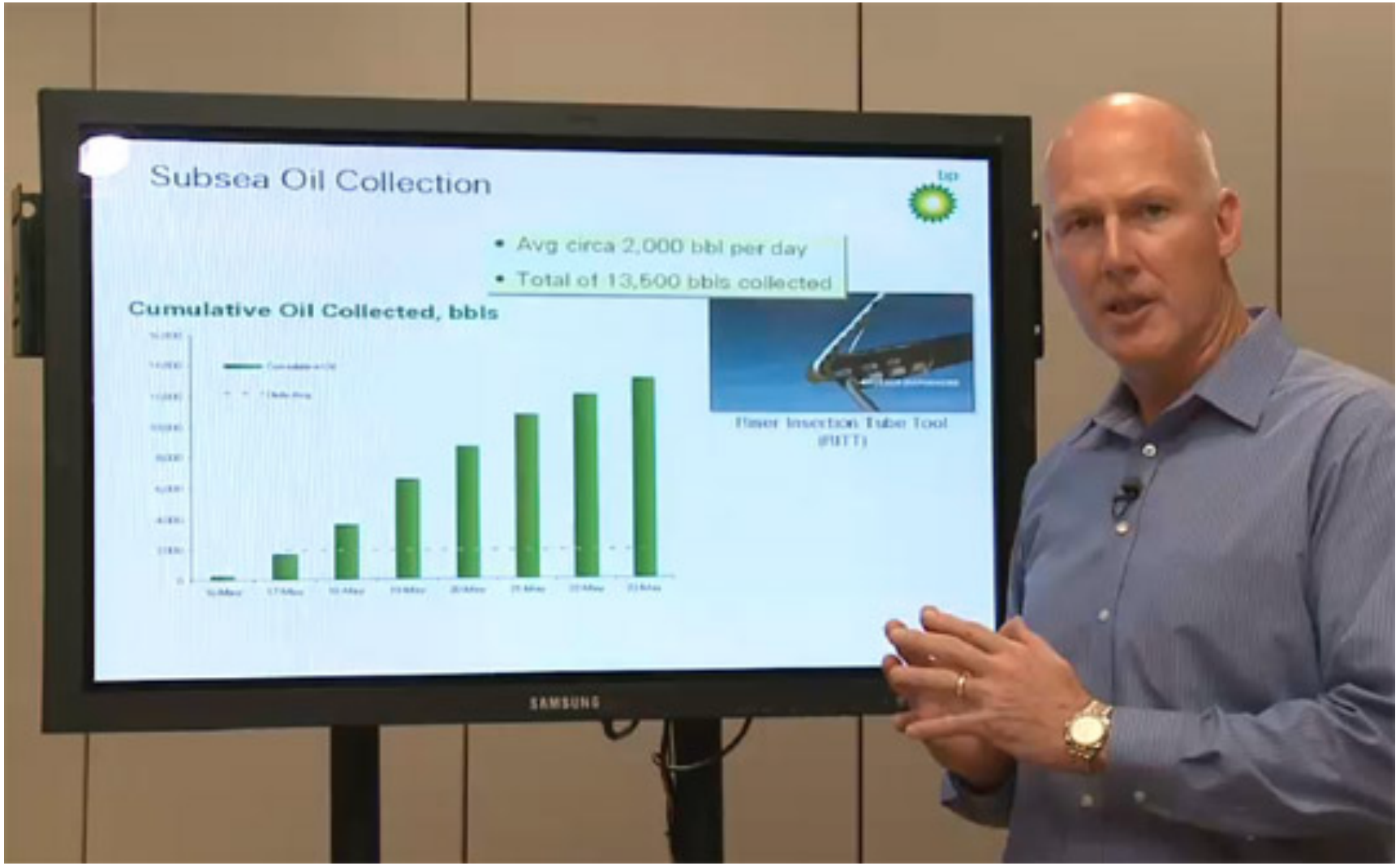
DO NOT LIE!

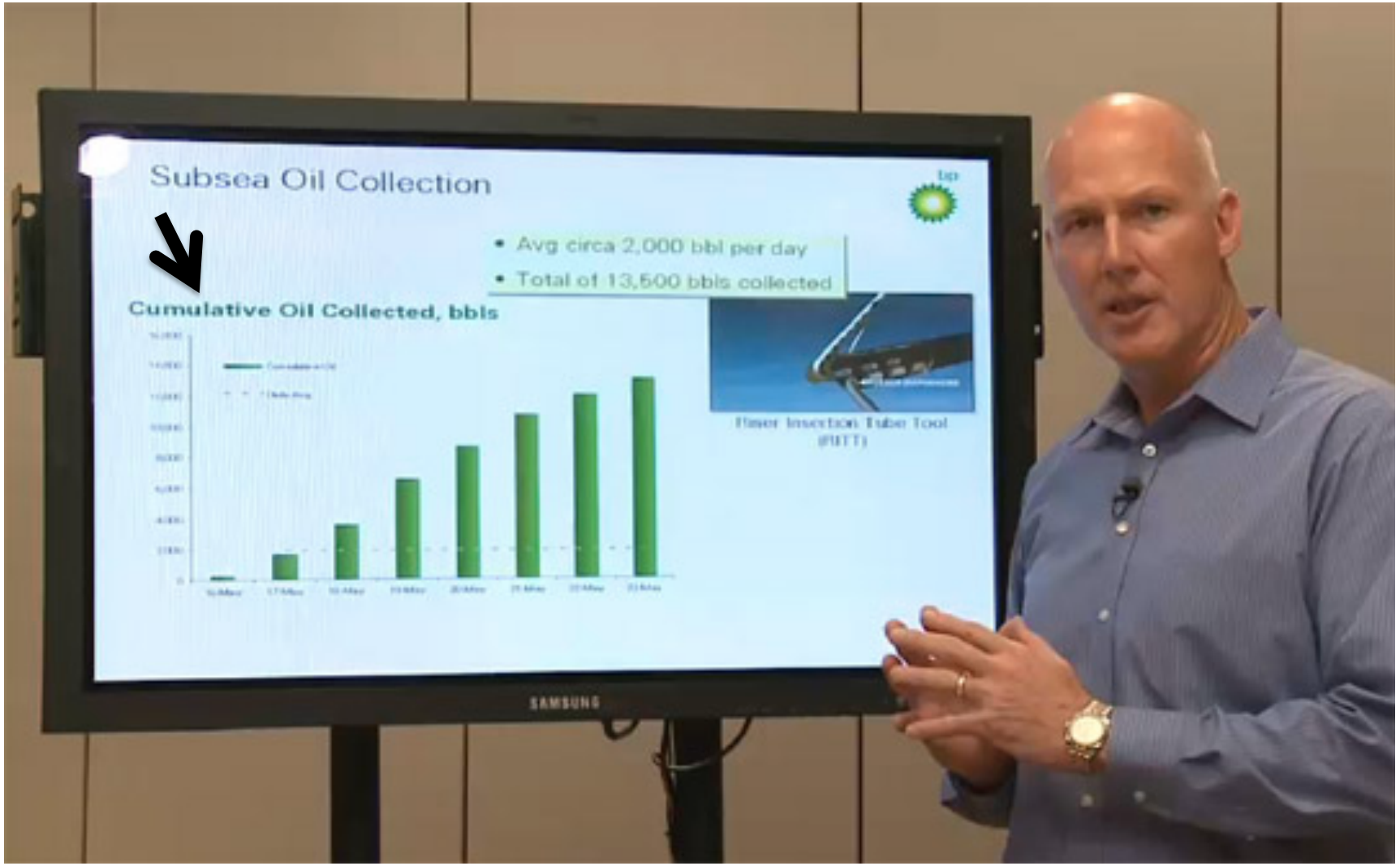
Tufte's Chart Principles

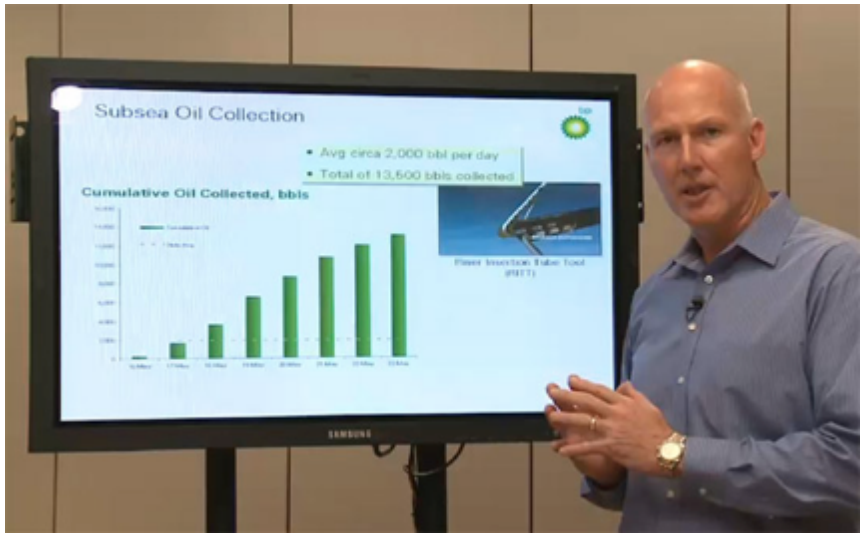
DO NOT LIE!

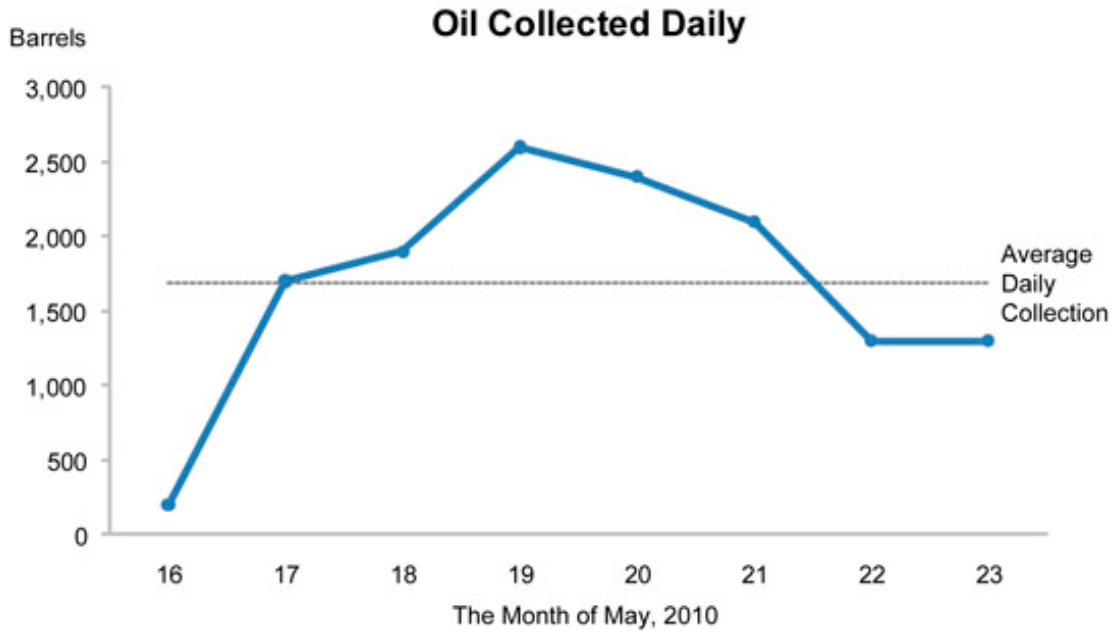
Maximize Data-Ink Ratio

Minimize Chart Junk

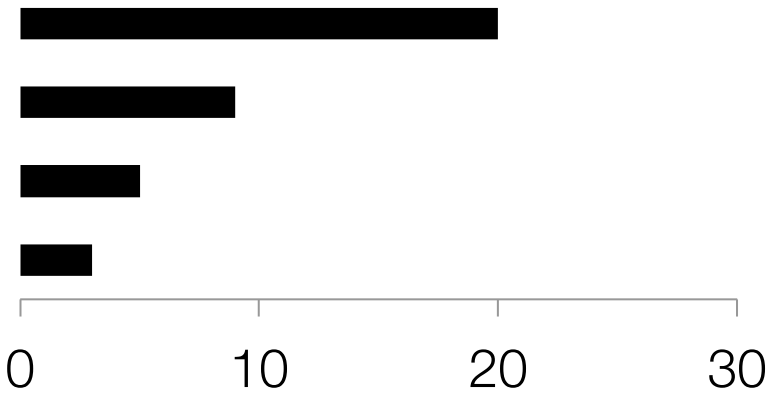

Subsea Oil Collection
• Avg circa 2,000 bbl per day
• Total of 13,500 bbls collected
Cumulative Oil Collected, bbls
SAMSUNG


Subsea Oil Collection
• Avg circa 2,000 bbl per day
• Total of 13,600 bbls collected
Cumulative Oil Collected, bbls
SAMSUNG





http://www.perceptualedge.com/blog/?p=790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20
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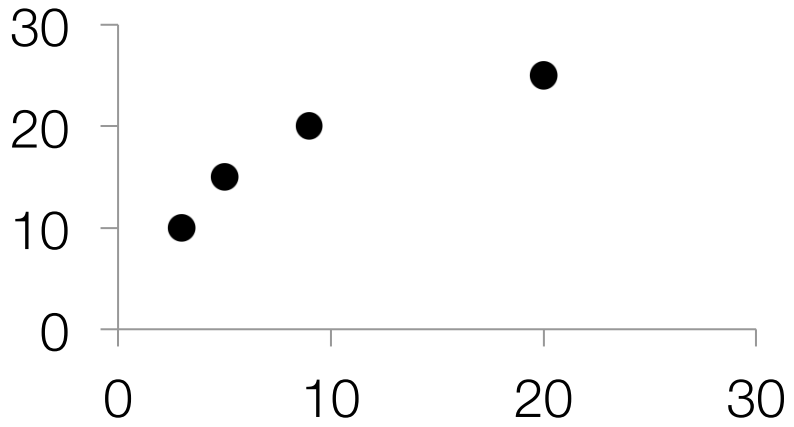
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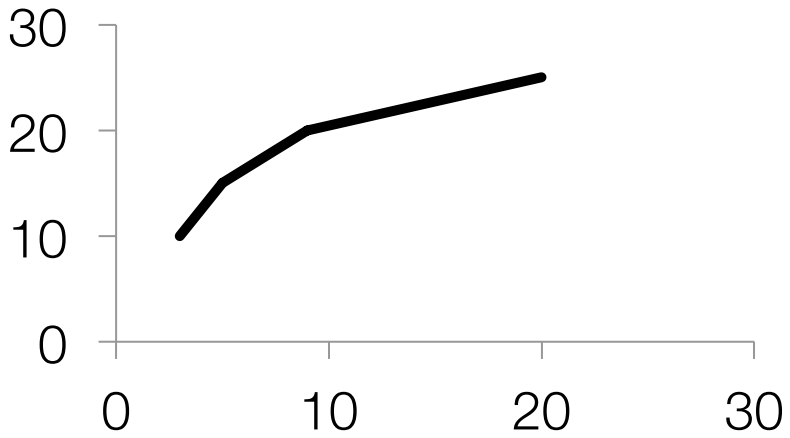
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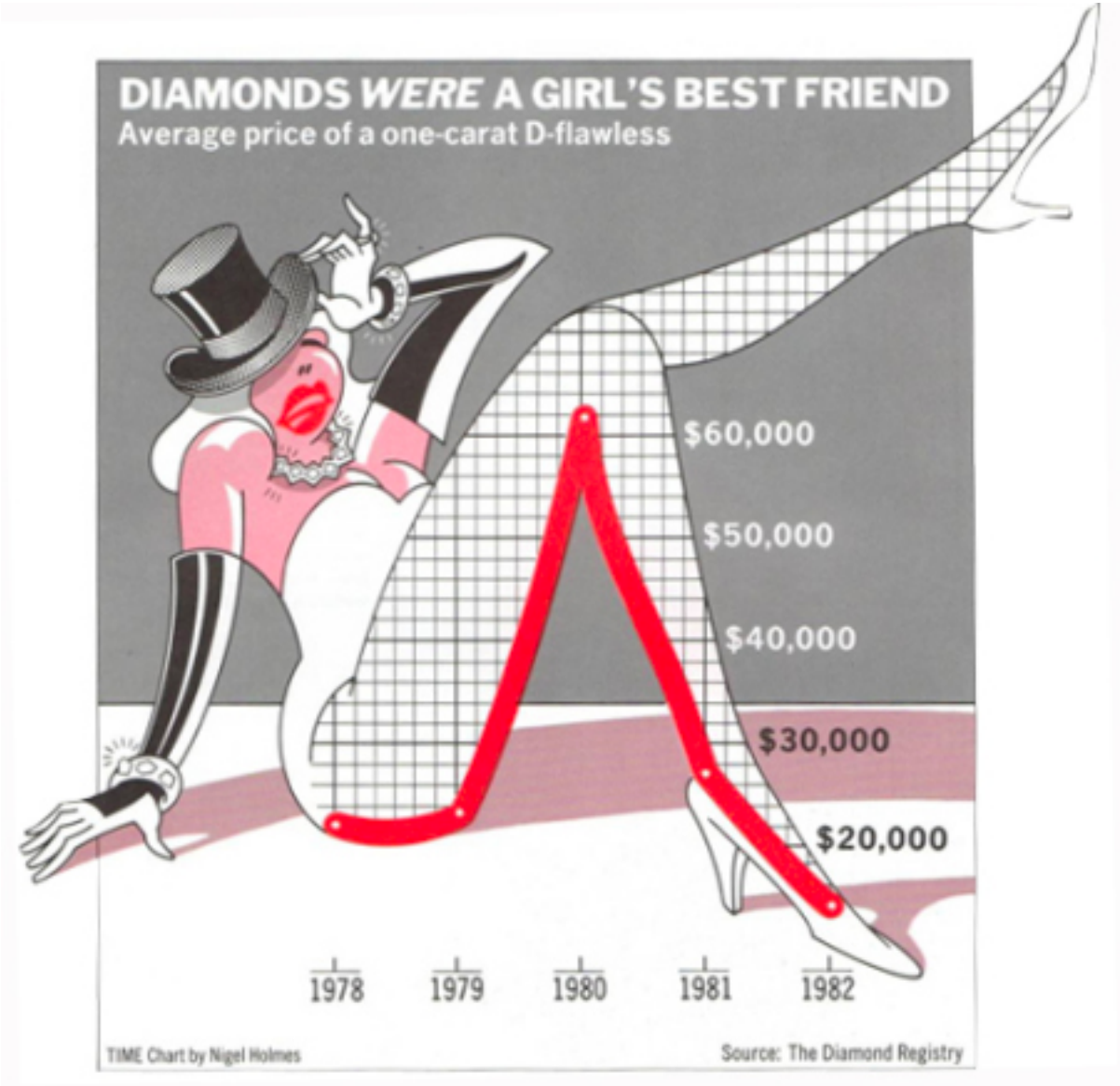
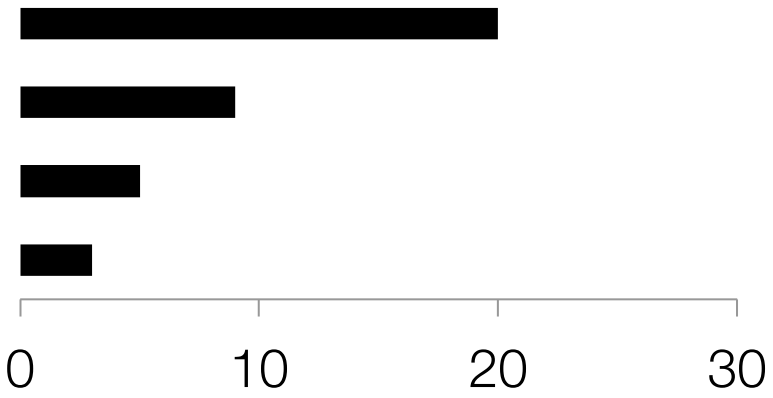


http://skilfulminds.com/2011/04/05/exploring-the-usefulness-of-chartjunk-at-stl-ux-2011/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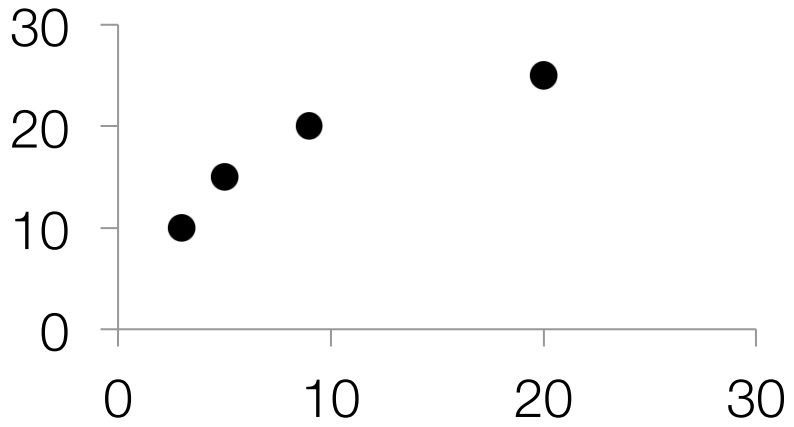
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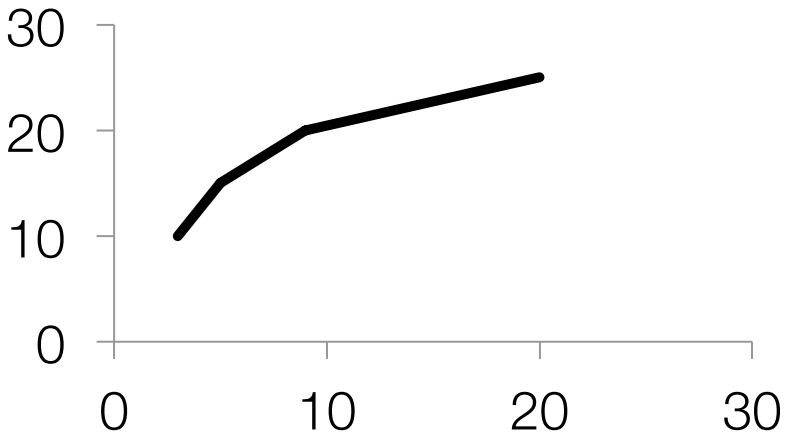
30
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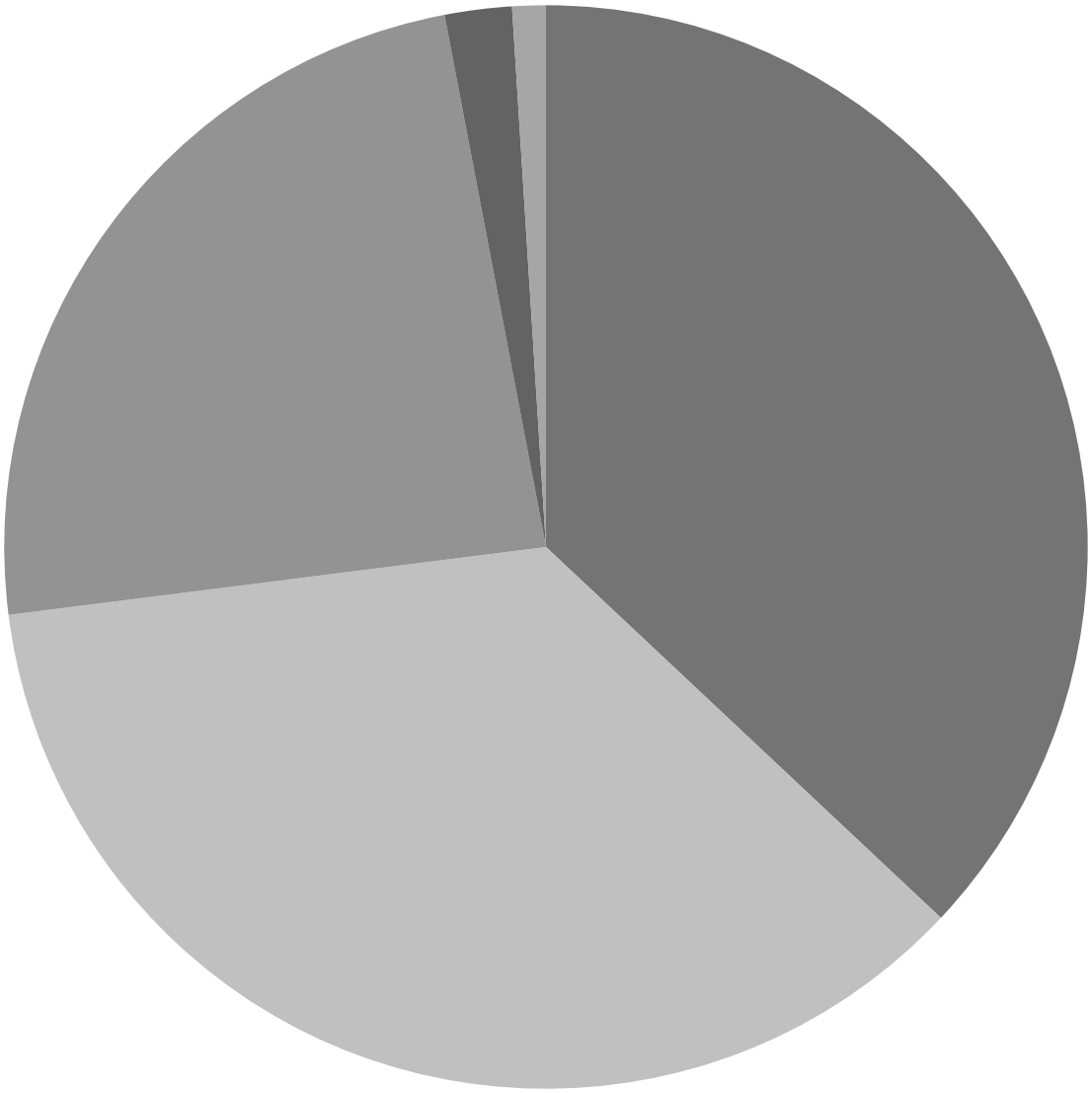
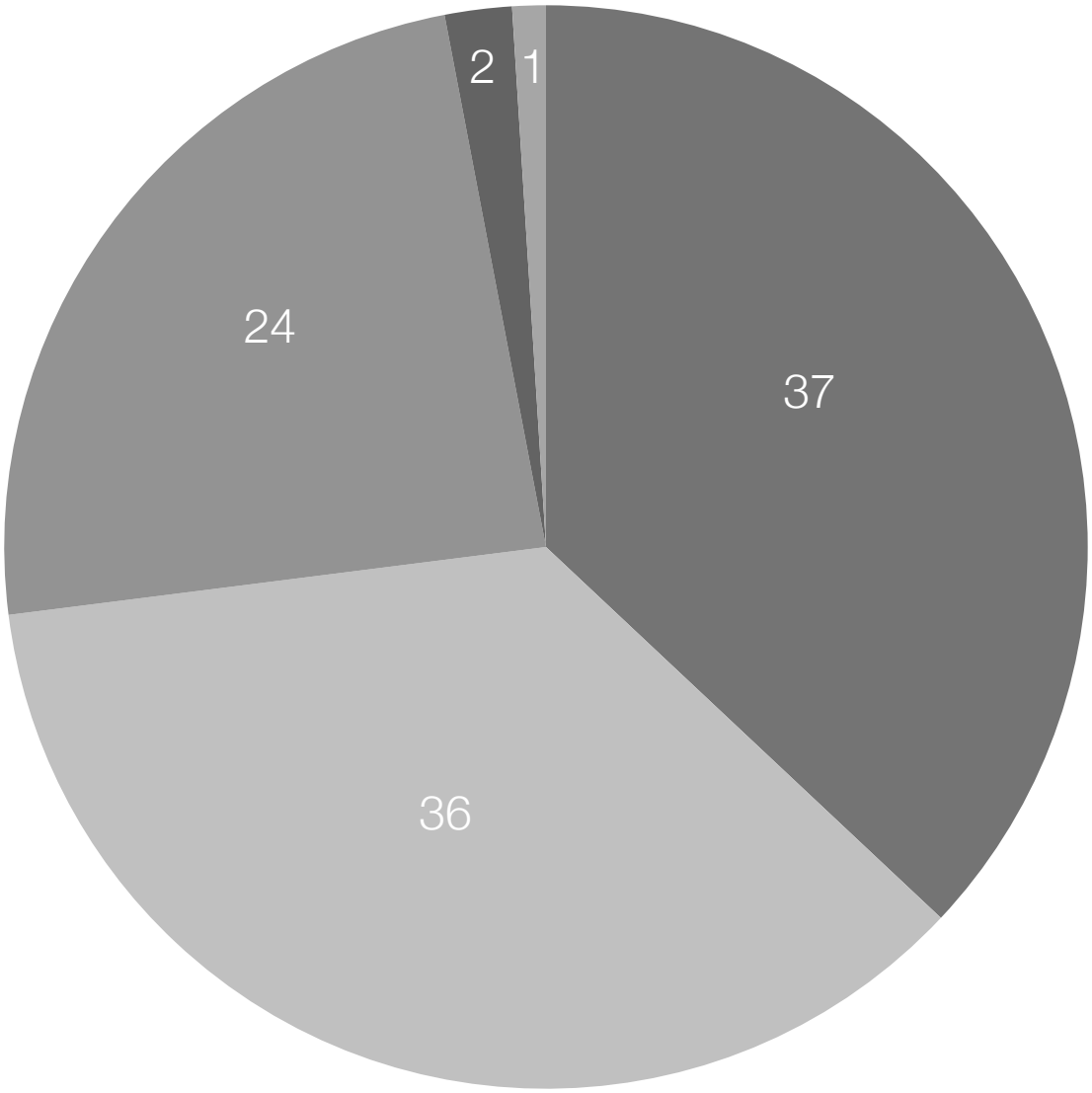
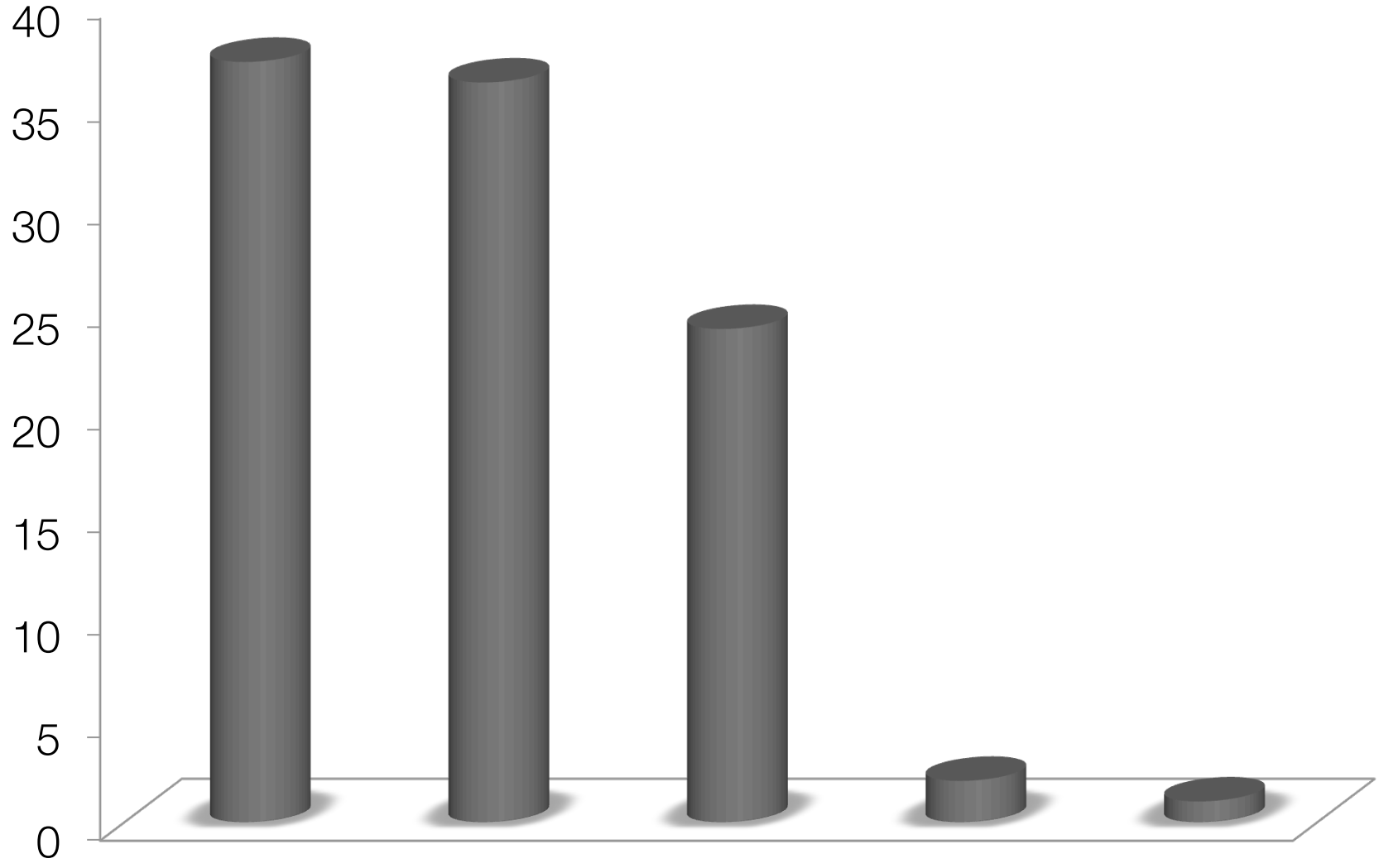
Please…

No pie charts.
No 2.5D charts.




2
1
24
37
36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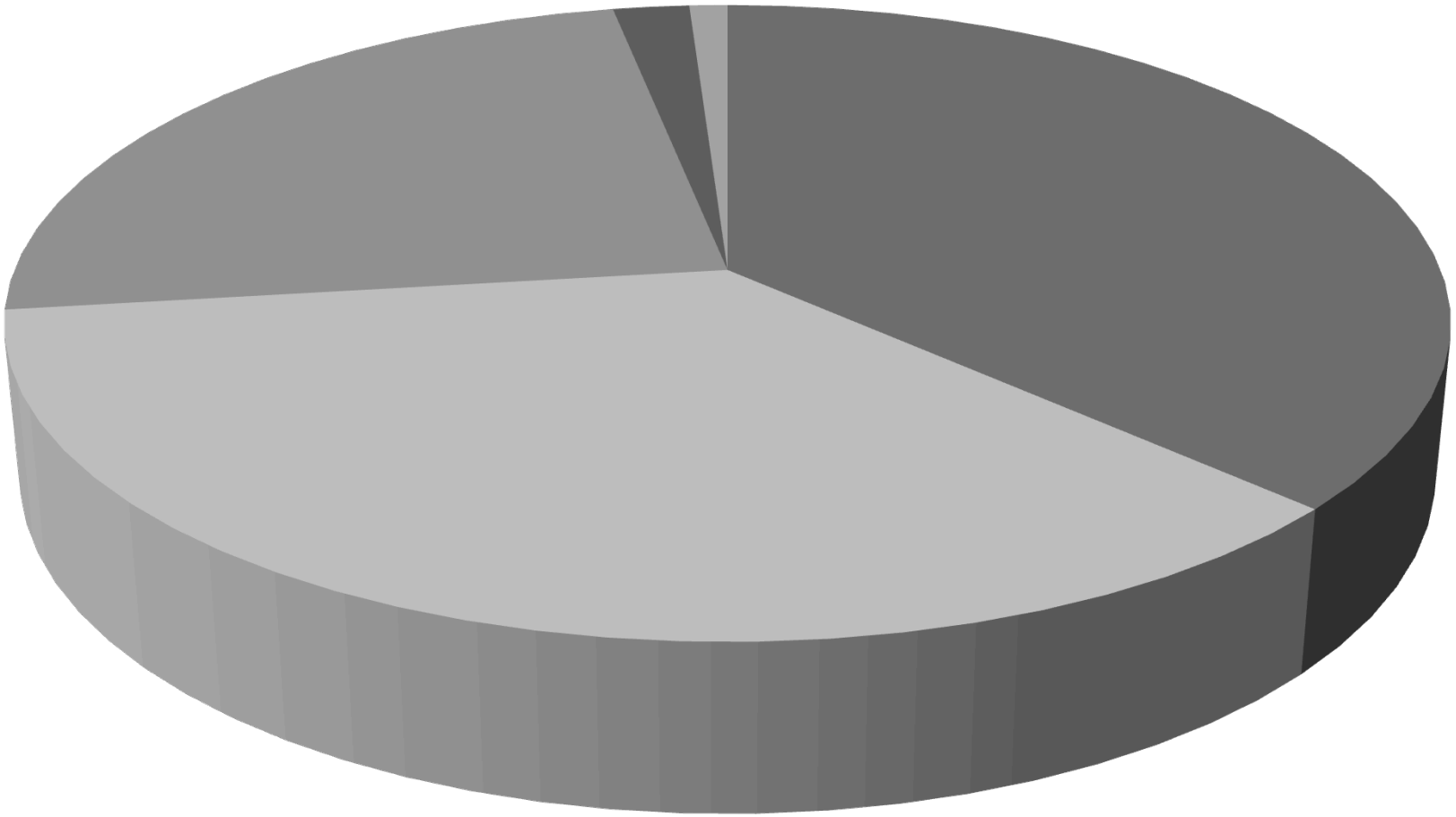
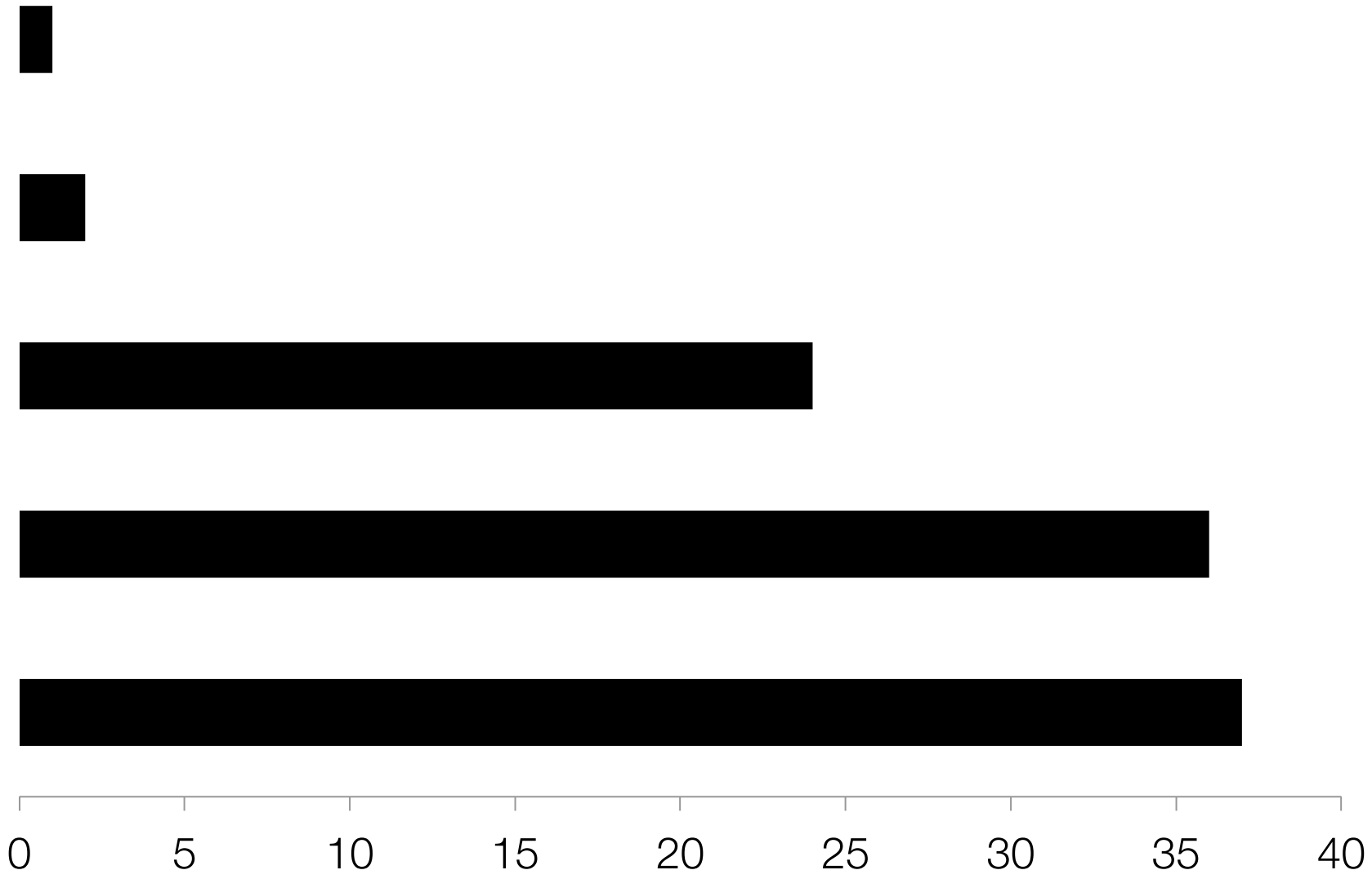


PLEASE DON'T
EVER DO THIS!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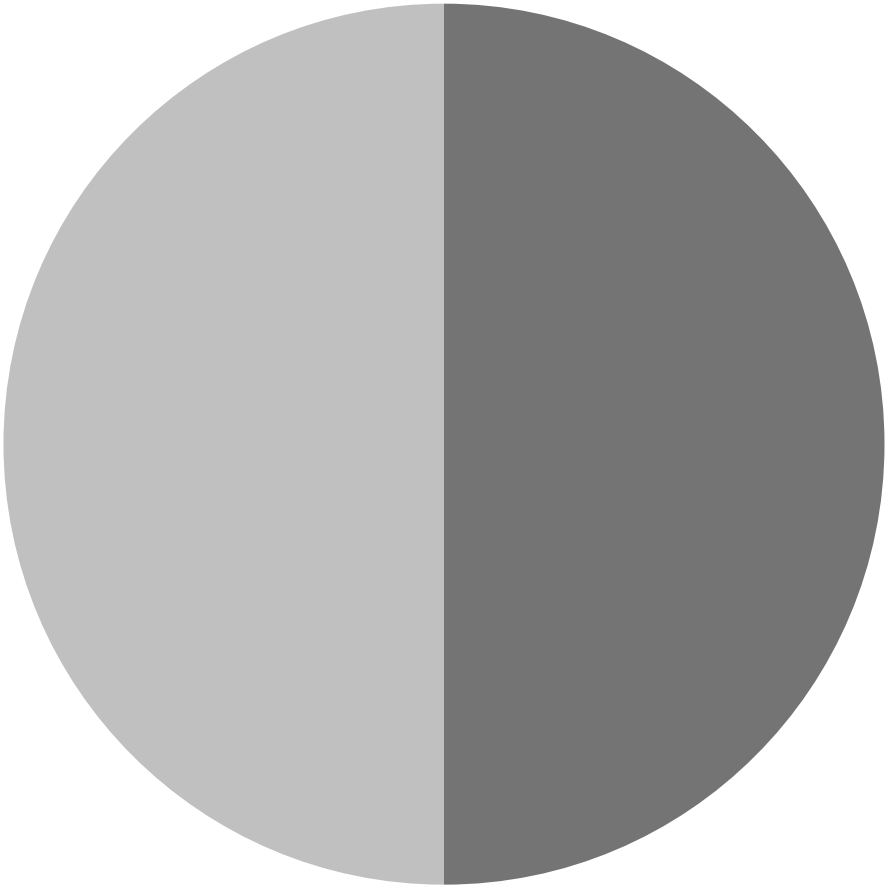
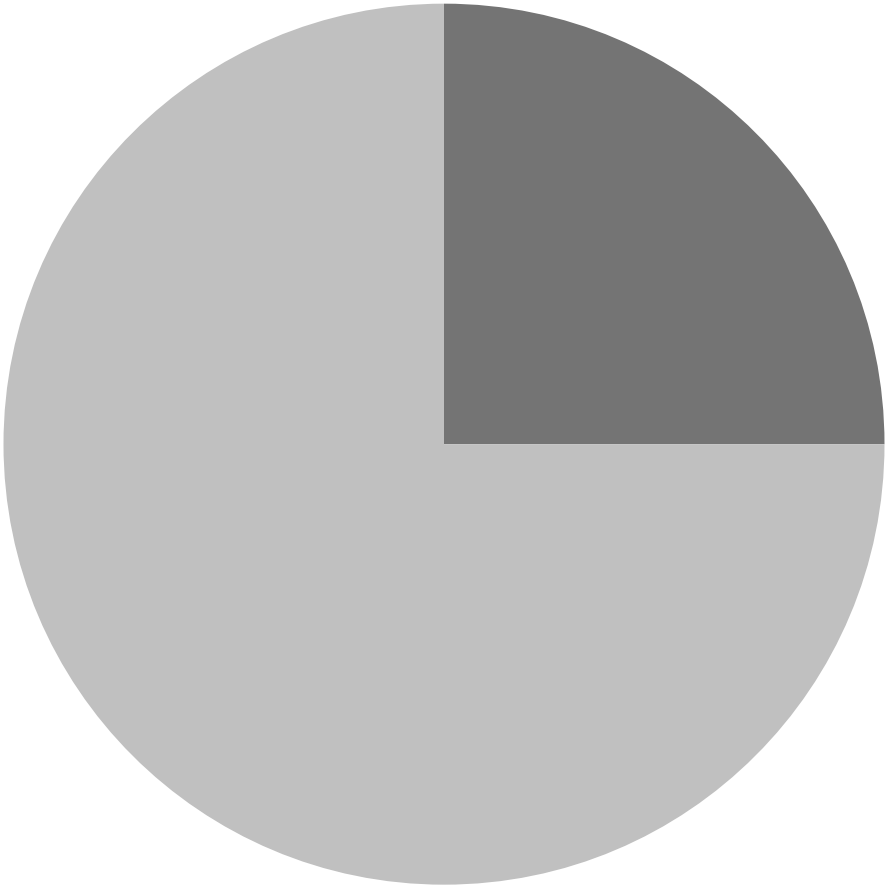
40

Two times to use a pie chart…

50-50

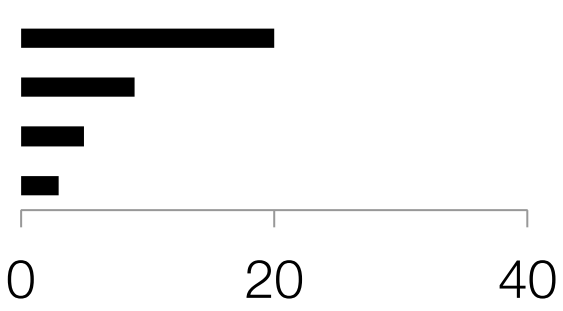


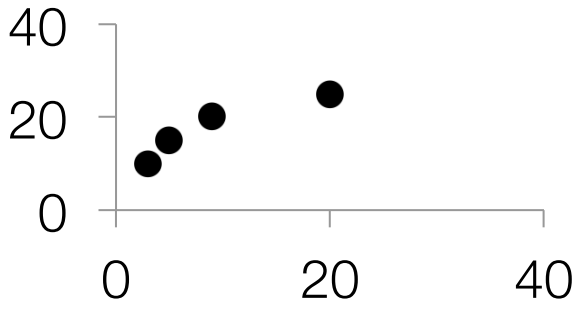
75-25

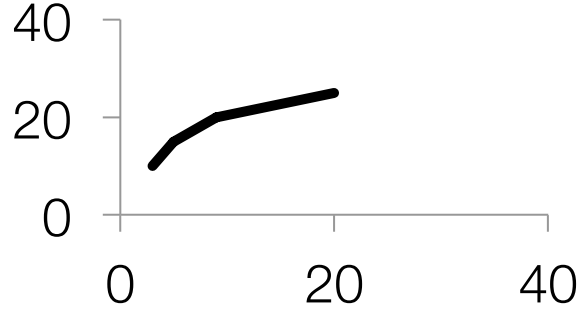


But otherwise…

Barcharts, scatterplots, and line charts are ***really effective*** for quantitative data







Anyone else bored
by my color choices?

In fact, grayscale can be risky…

In fact, grayscale can be risky…

Color is Powerful

Color

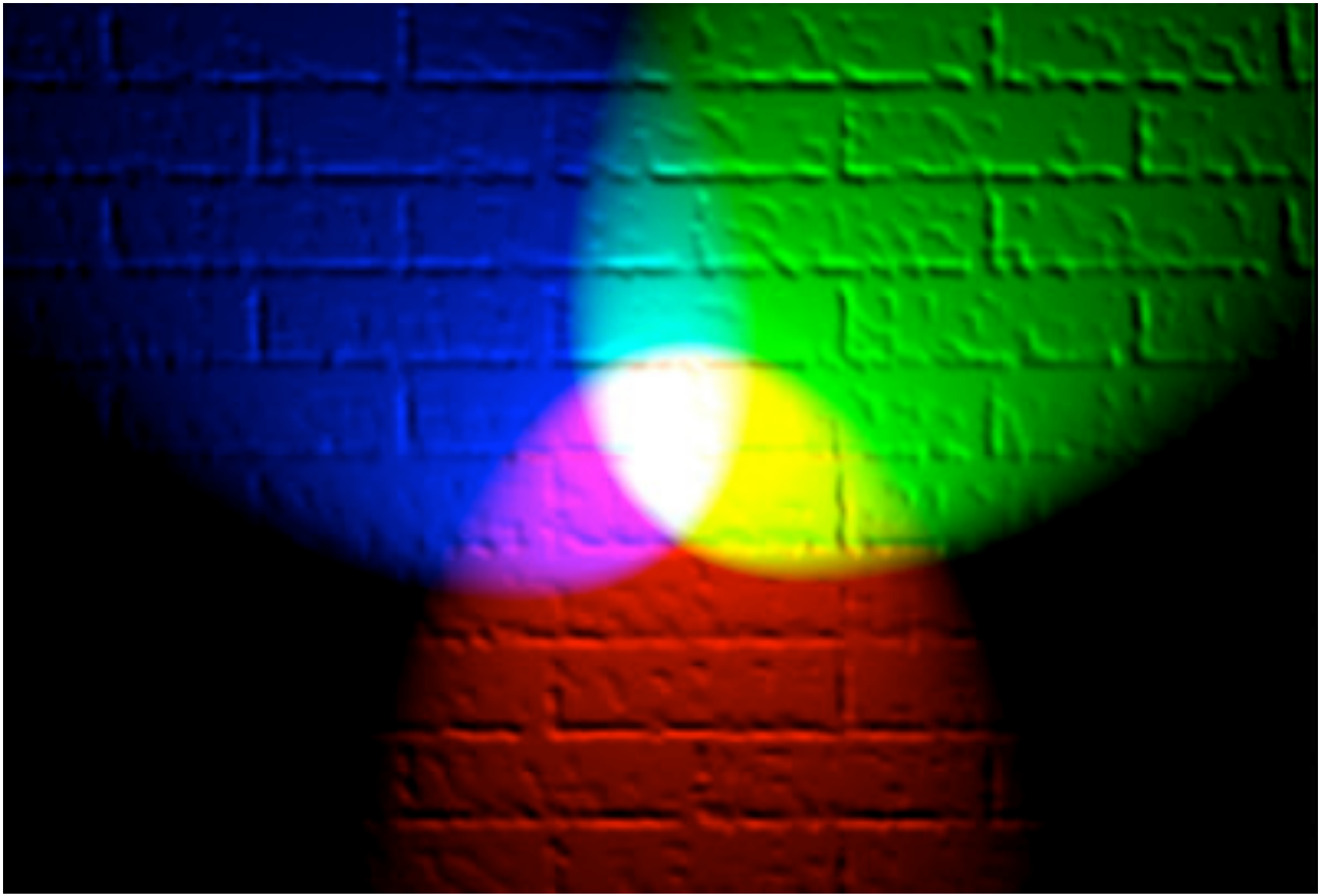
Call attention to information

Increase appeal

Increase memorability

Another dimension to work with

How many of you have heard of RGB?



We see in RGB,
but we don't interpret in RGB…

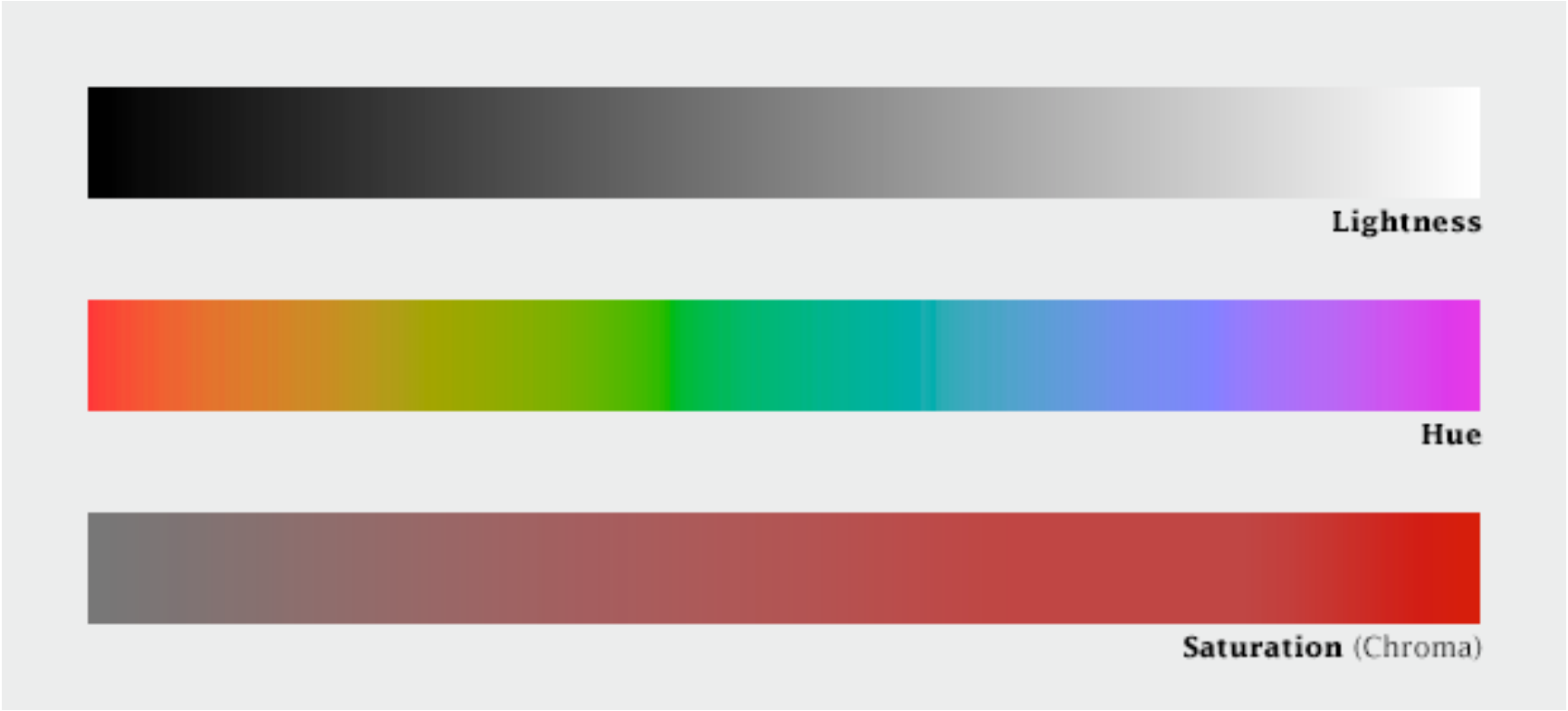
How many have heard of HSV?

HSV Color Model

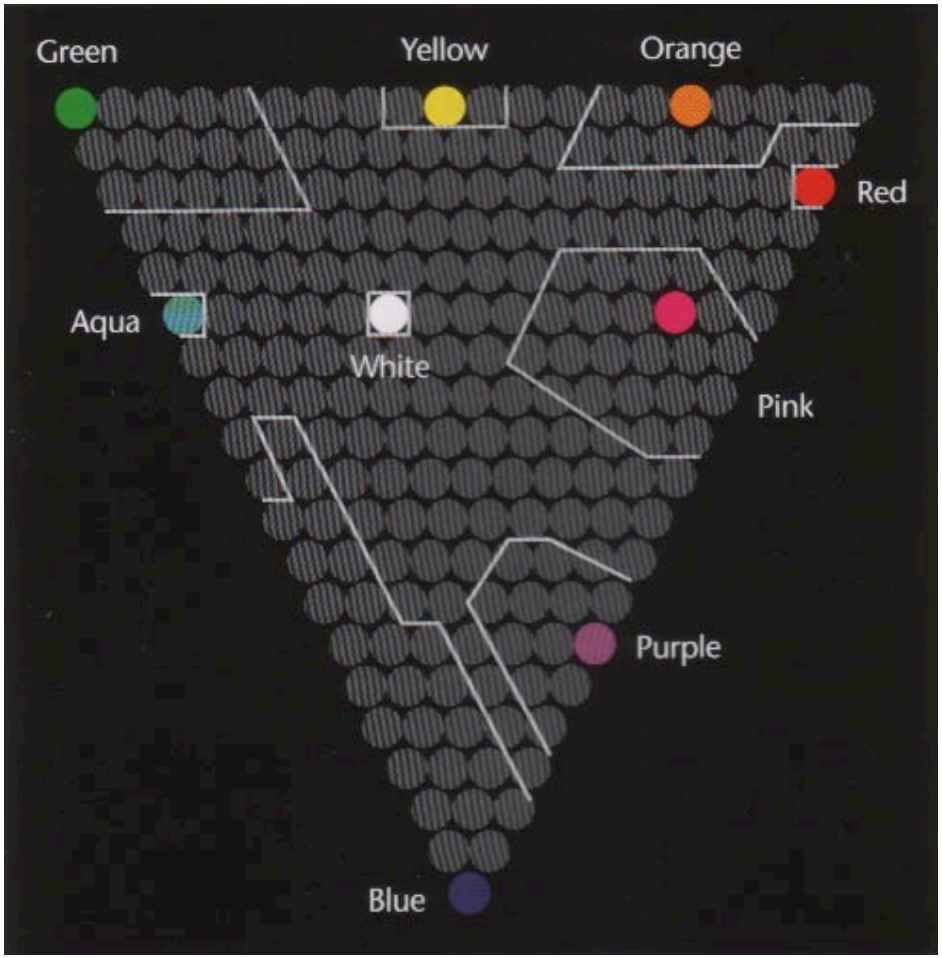
Hue/“Color”

Saturation/Chroma

Value/Lightness

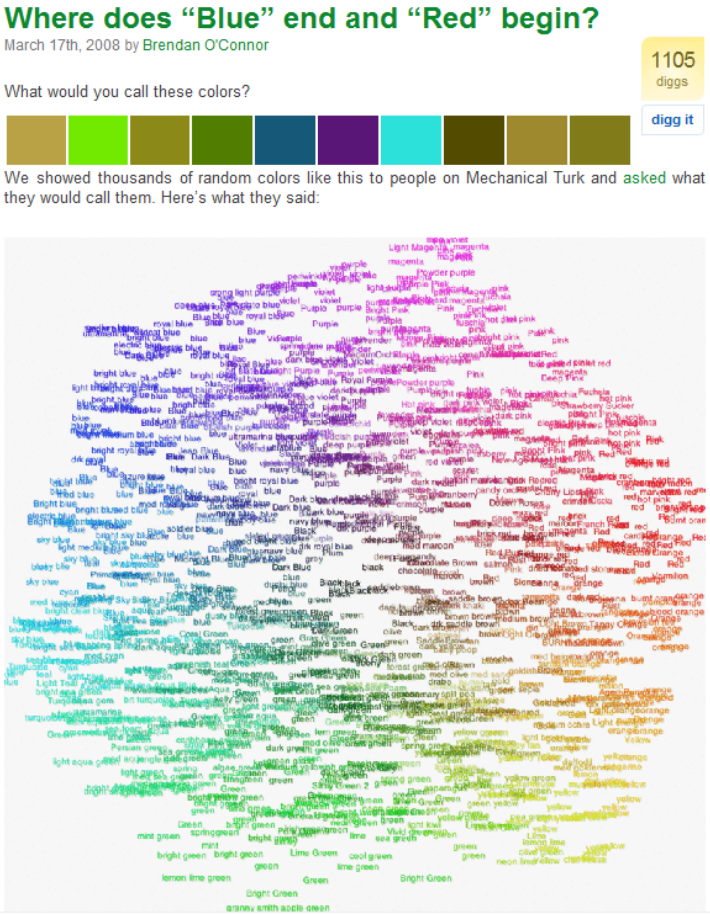

Lightness
Hue
Saturation (Chroma)

Hue



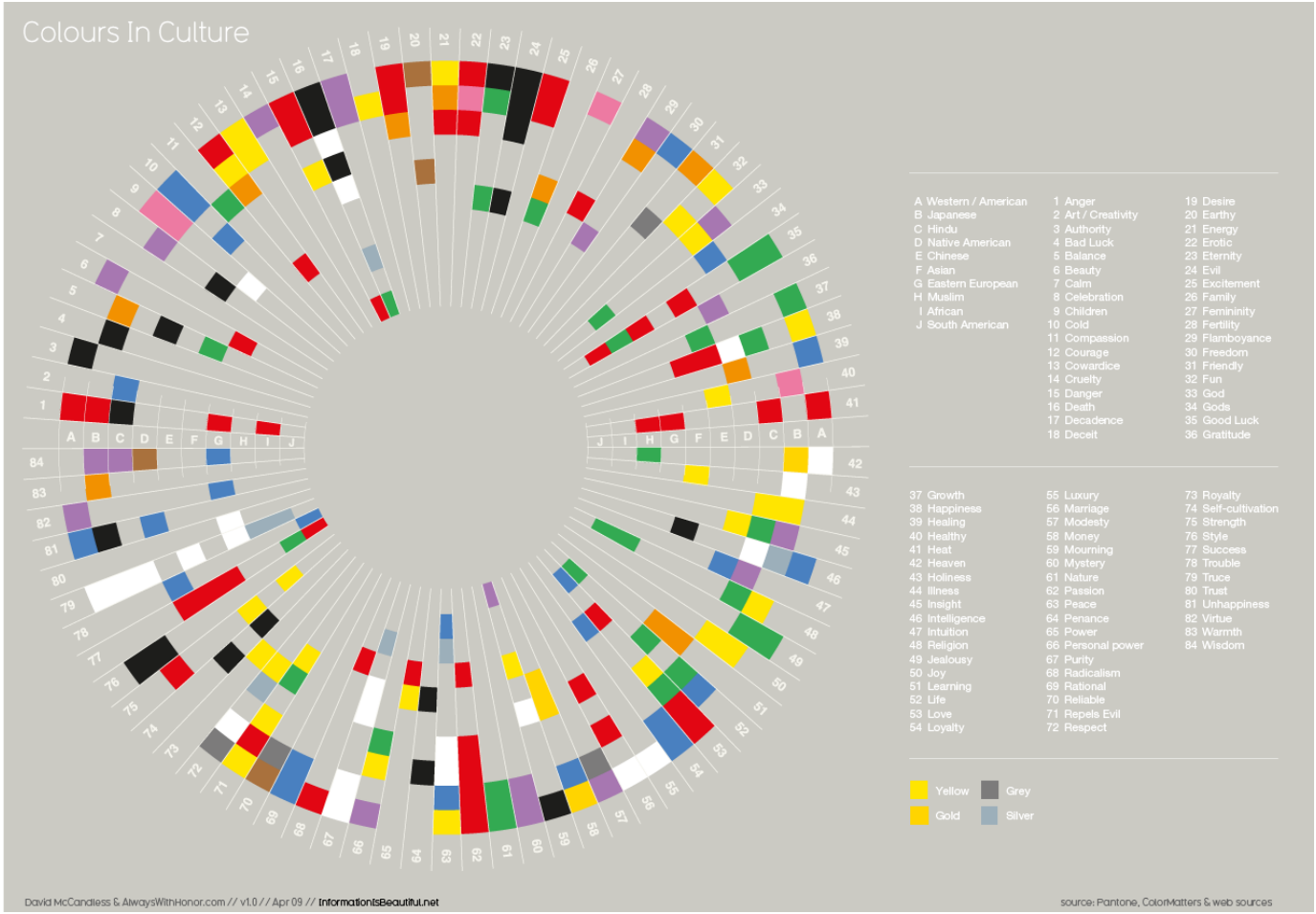
Post & Greene, 1986

Hue



http://blog.doloreslabs.com/2008/03/where-does-blue-end-and-red-begin/
[Currently down]

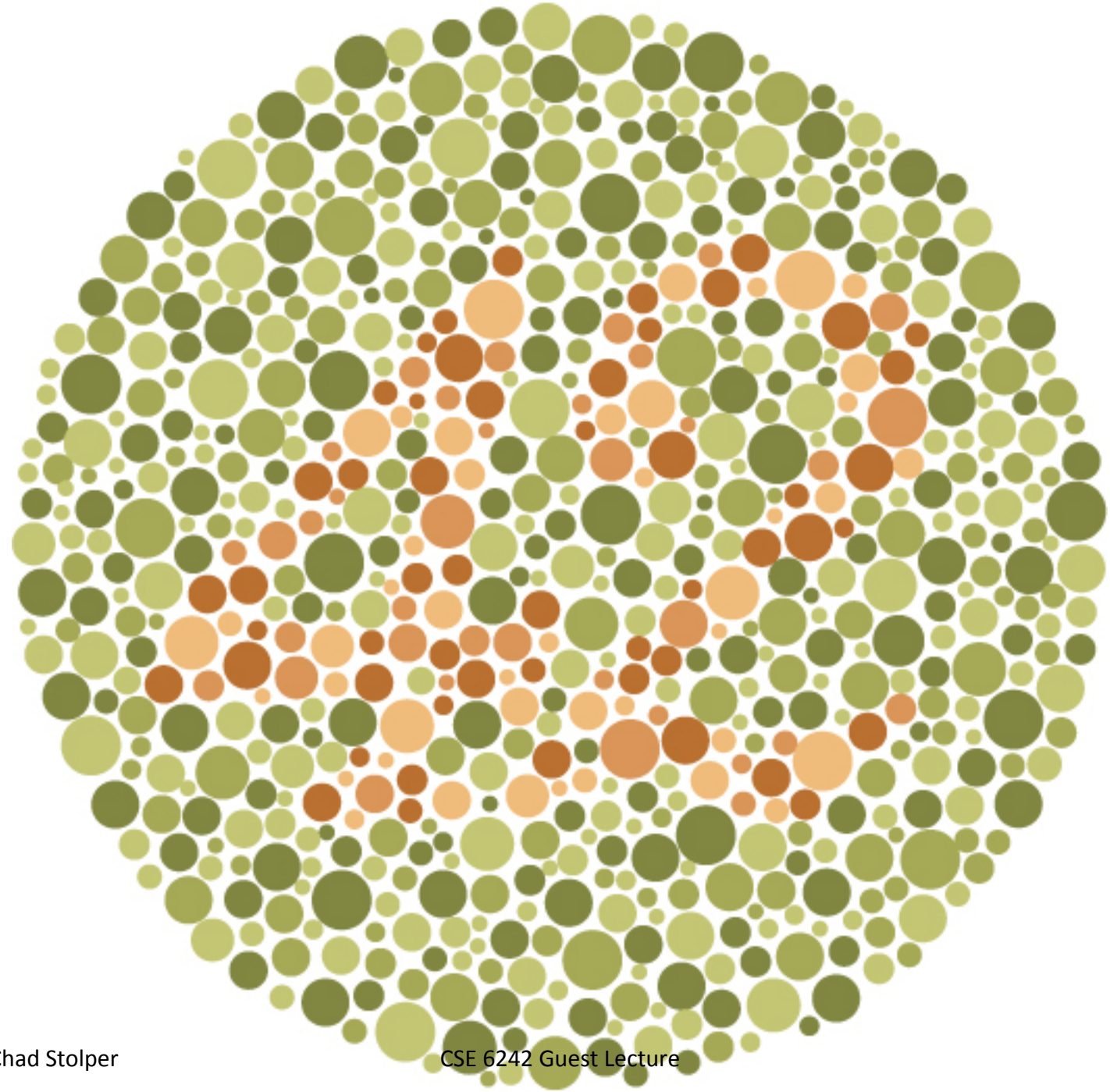
Hue and Culture



http://www.informationisbeautiful.net/visualizations/colours-in-cultures/

Hue and Colorblindness

10% of males and 1% of females are Red-Green Colorblind



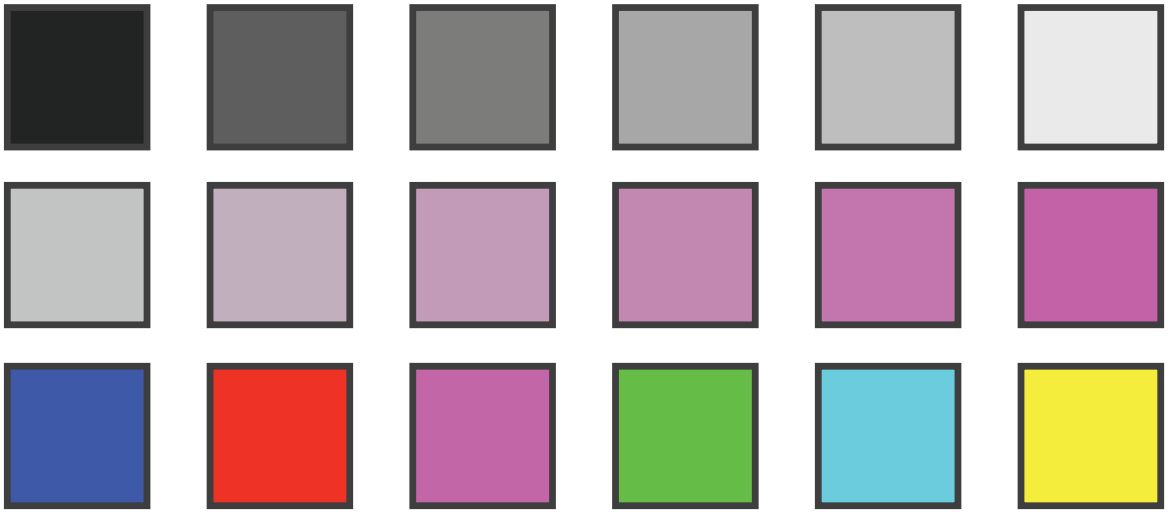
May be better to consider a third model:

Hue – Saturation - LUMINANCE

Luminance

Saturation

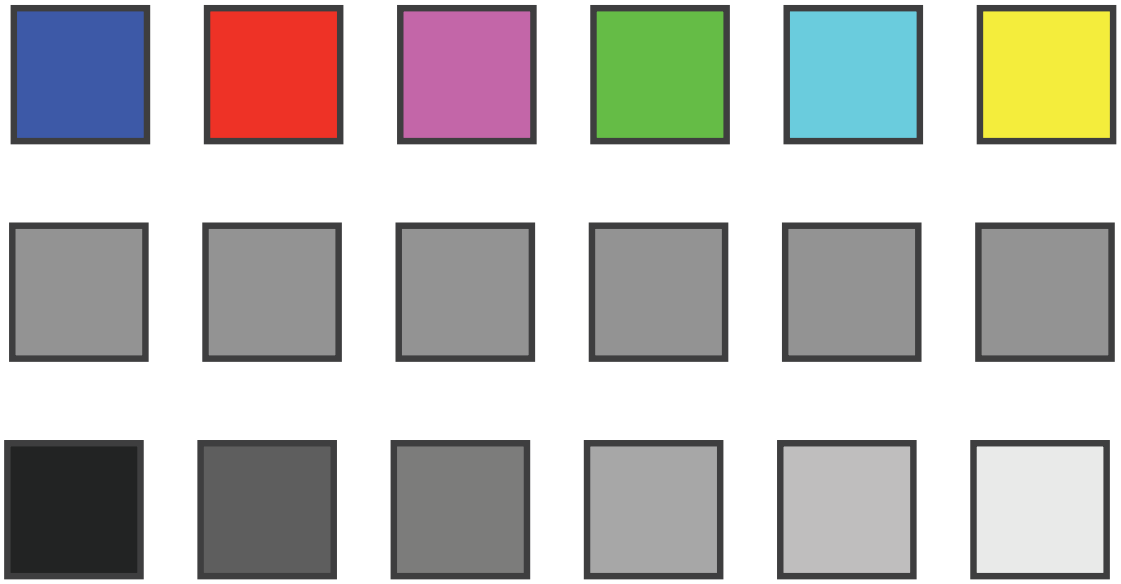
Hue



Corners of the RGB color cube

L from HLS
All the same

Luminance values



Luminance

Hello, here is some text. Can you read what it says?

Hello, here is some text. Can you read what it says?

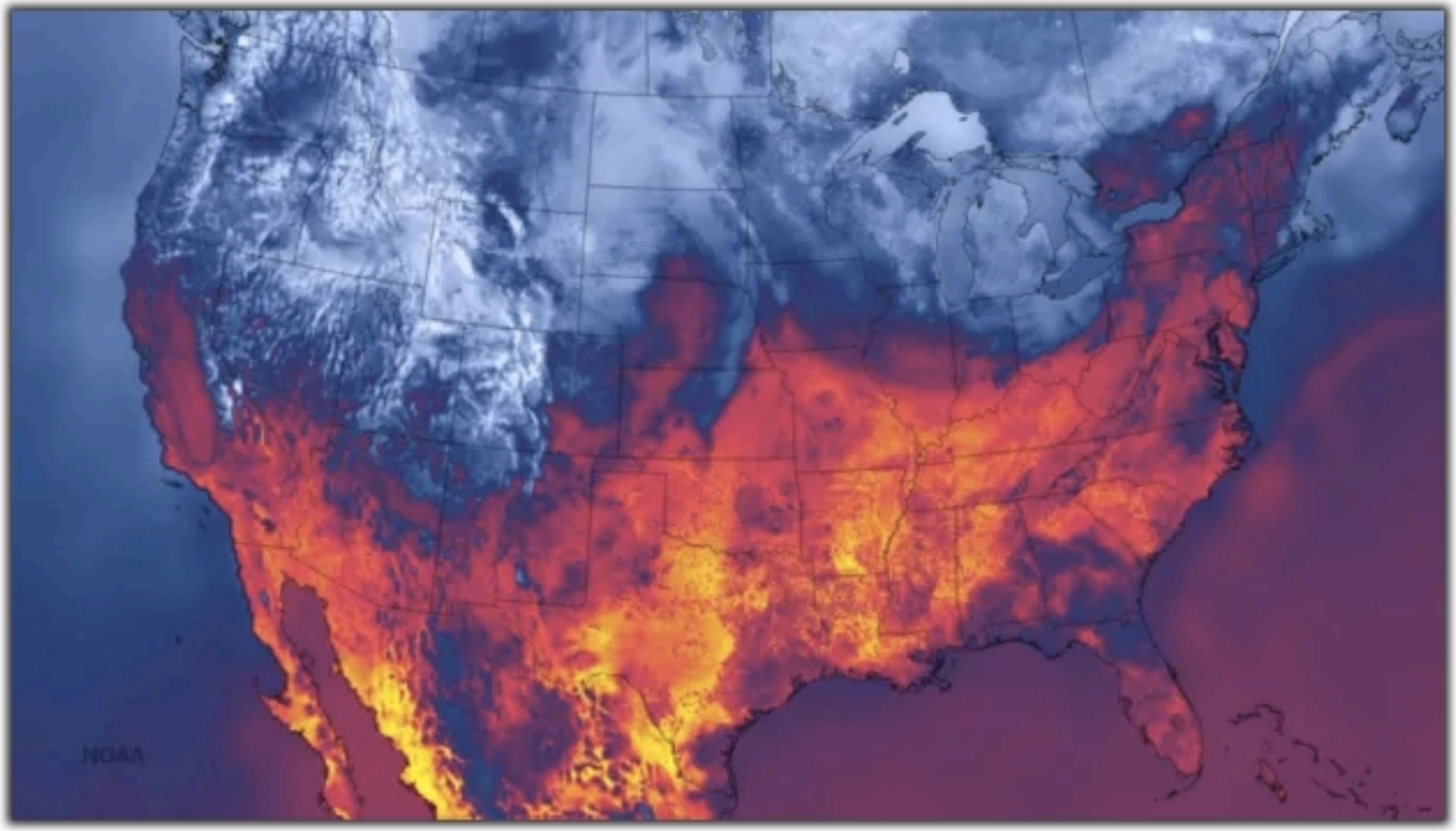
Hello, here is some text. Can you read what it says?

Hello, here is some text. Can you read what it says?

Hello, here is some text. Can you read what it says?

Hello, here is some text. Can you read what it says?

Hello, here is some text. Can you read what it says?



Surface temperature (°C)

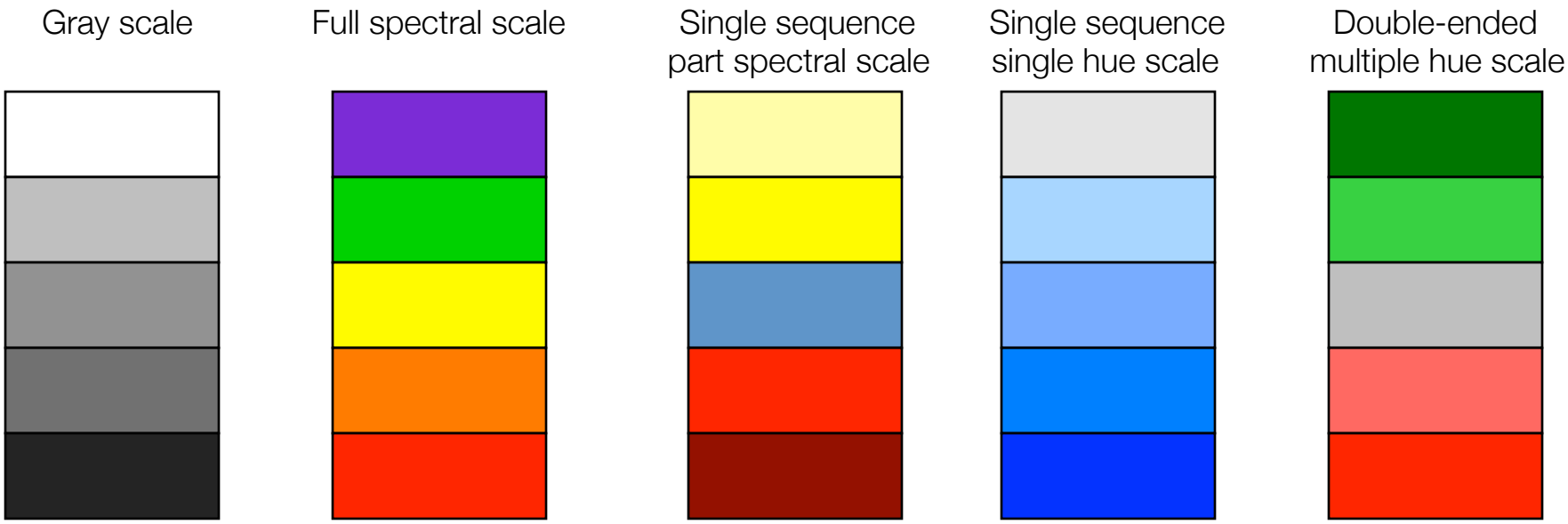
0 45

Sep 30, 2014

NOAA's Latest High Resolution Weather Model is Released

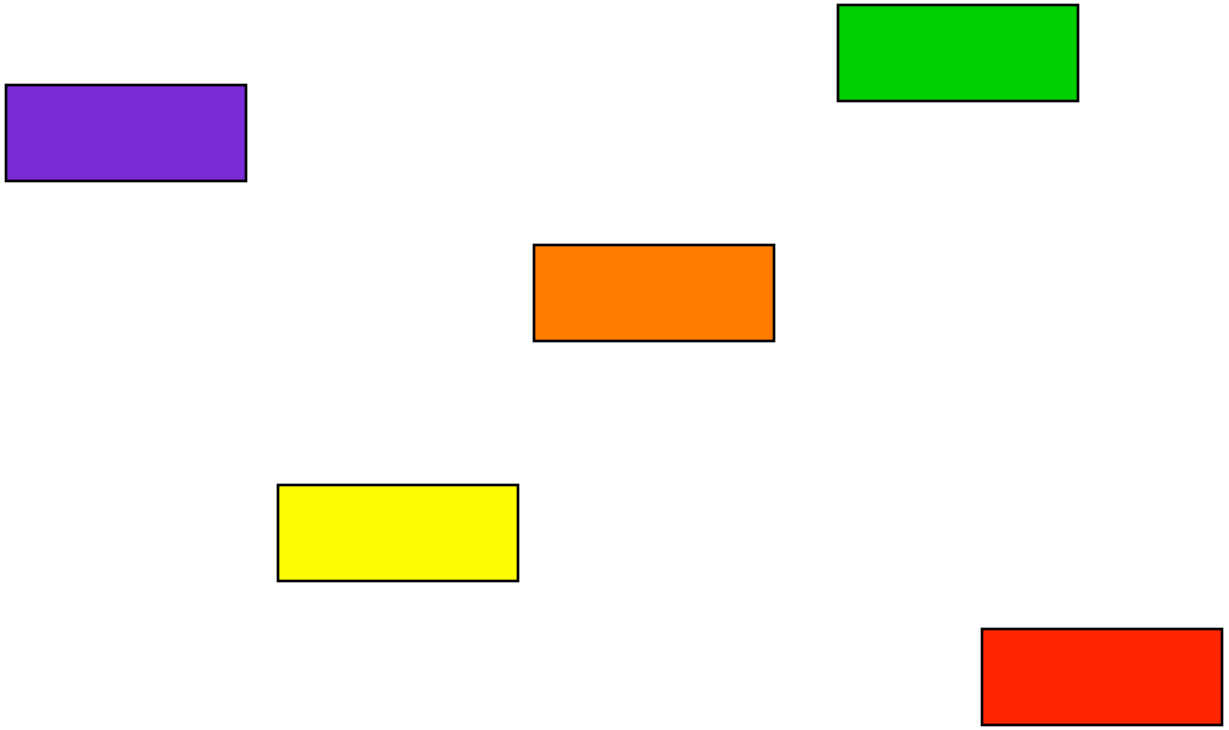
http://viz.wtf/post/98981561686/ht-matthewbgilmore-noaas-new-weather-modelling

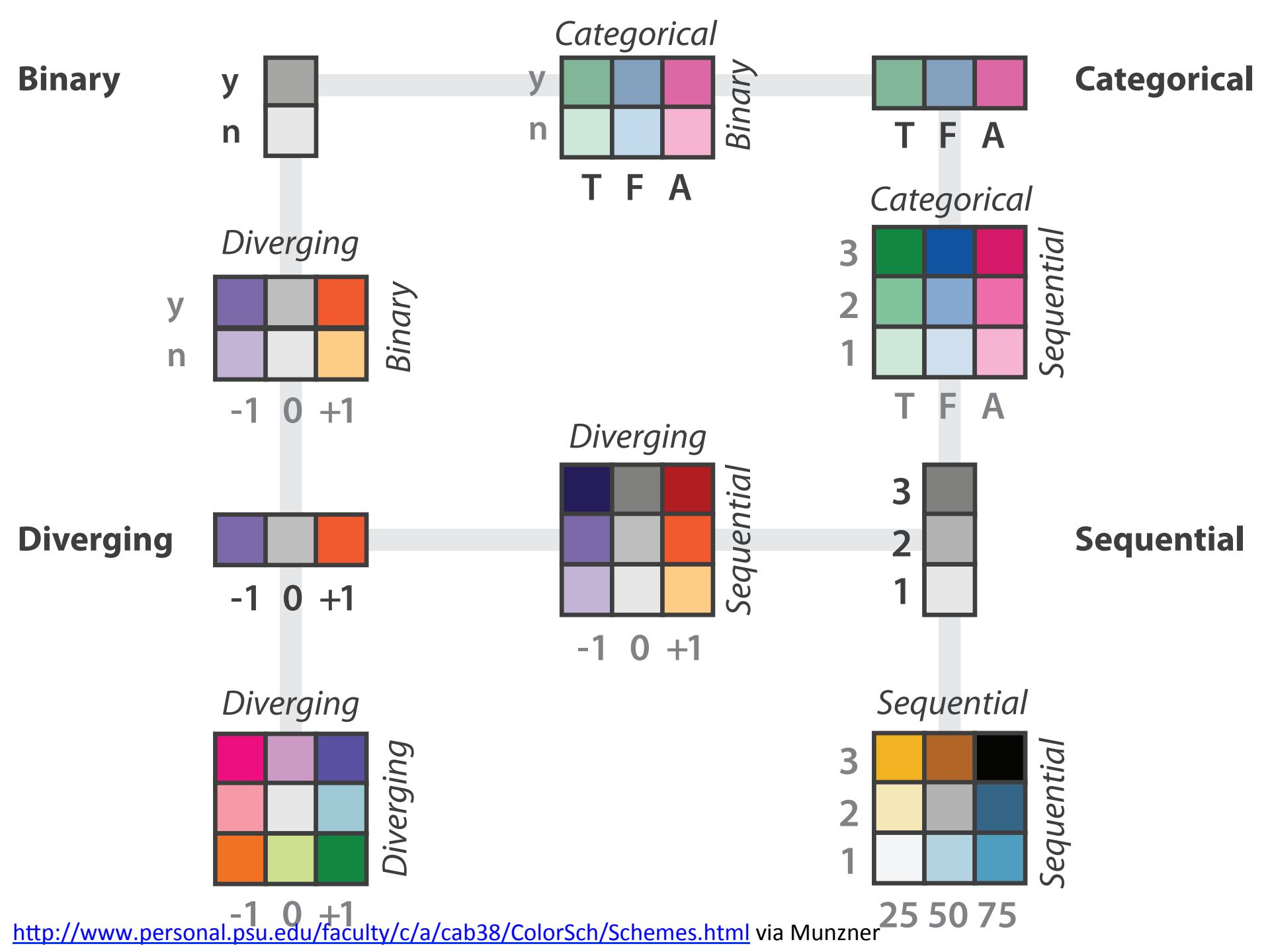
Color and Quantitative Data



Color and Quantitative Data

Can you order these (low→hi)?





http://www.personal.psu.edu/faculty/c/a/cab38/ColorSch/Schemes.html via Munzner

Color Scales

Color Brewer

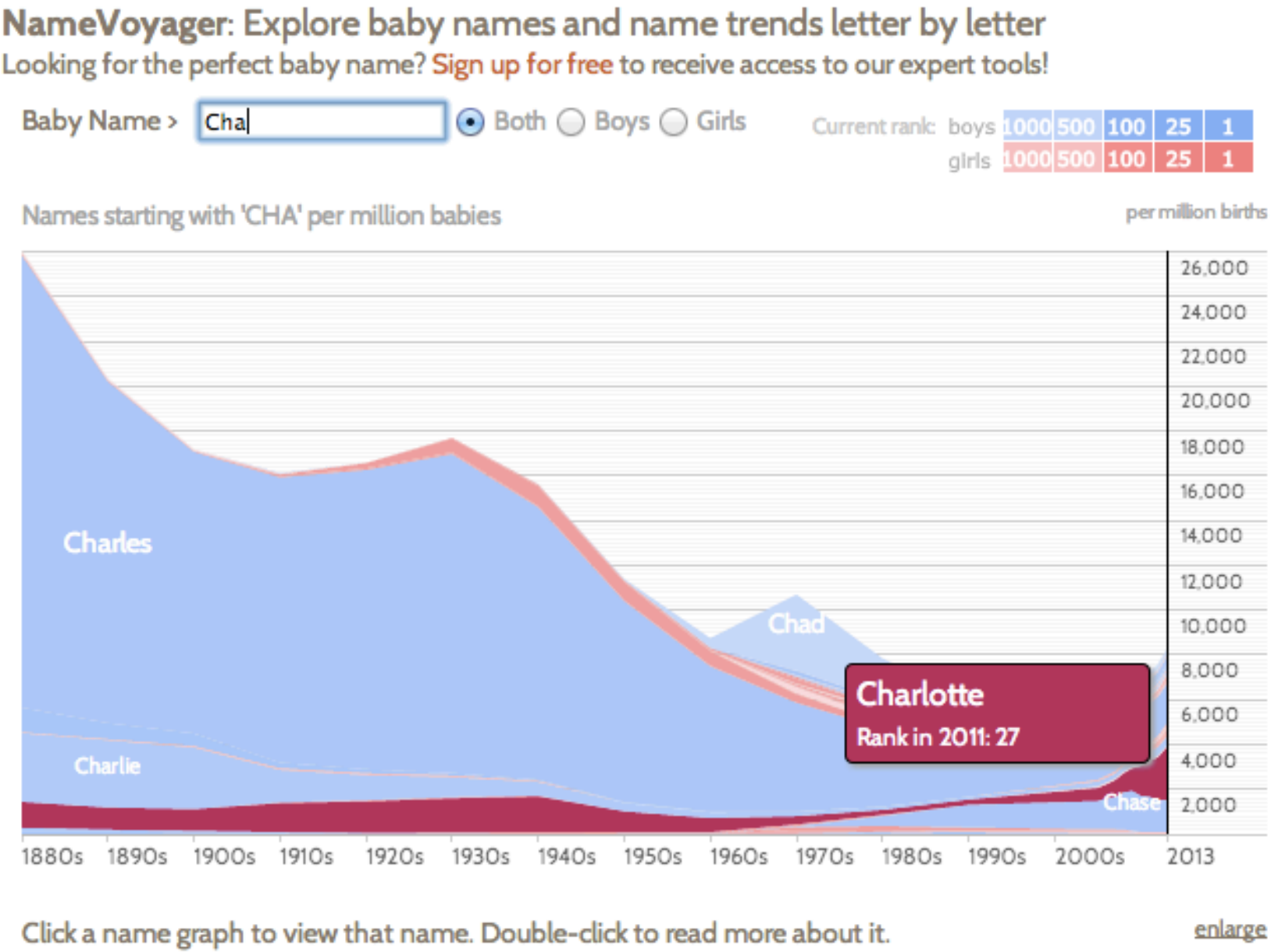
http://colorbrewer2.org/

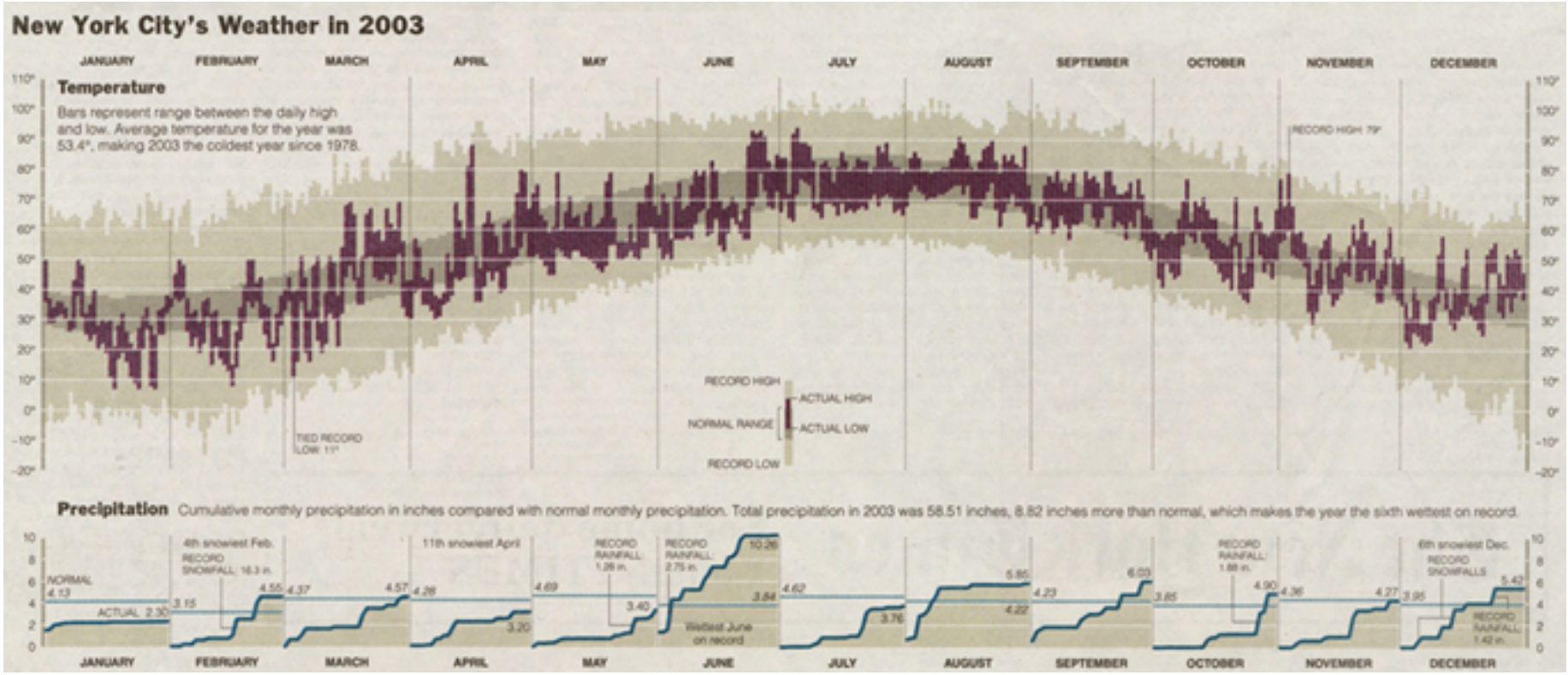
Overview
Zoom+Filter
Details on Demand

Shneiderman Mantra

GEORGE R.R. MARTIN
A GAME OF THRONES
GEORGE R.R. MARTIN
A CLASH OF KINGS
GEORGE R.R. MARTIN
A STORM OF SWORDS
GEORGE R.R. MARTIN
A FEAST FOR CROWS
GEORGE R.R. MARTIN
A DANCE WITH DRAGONS

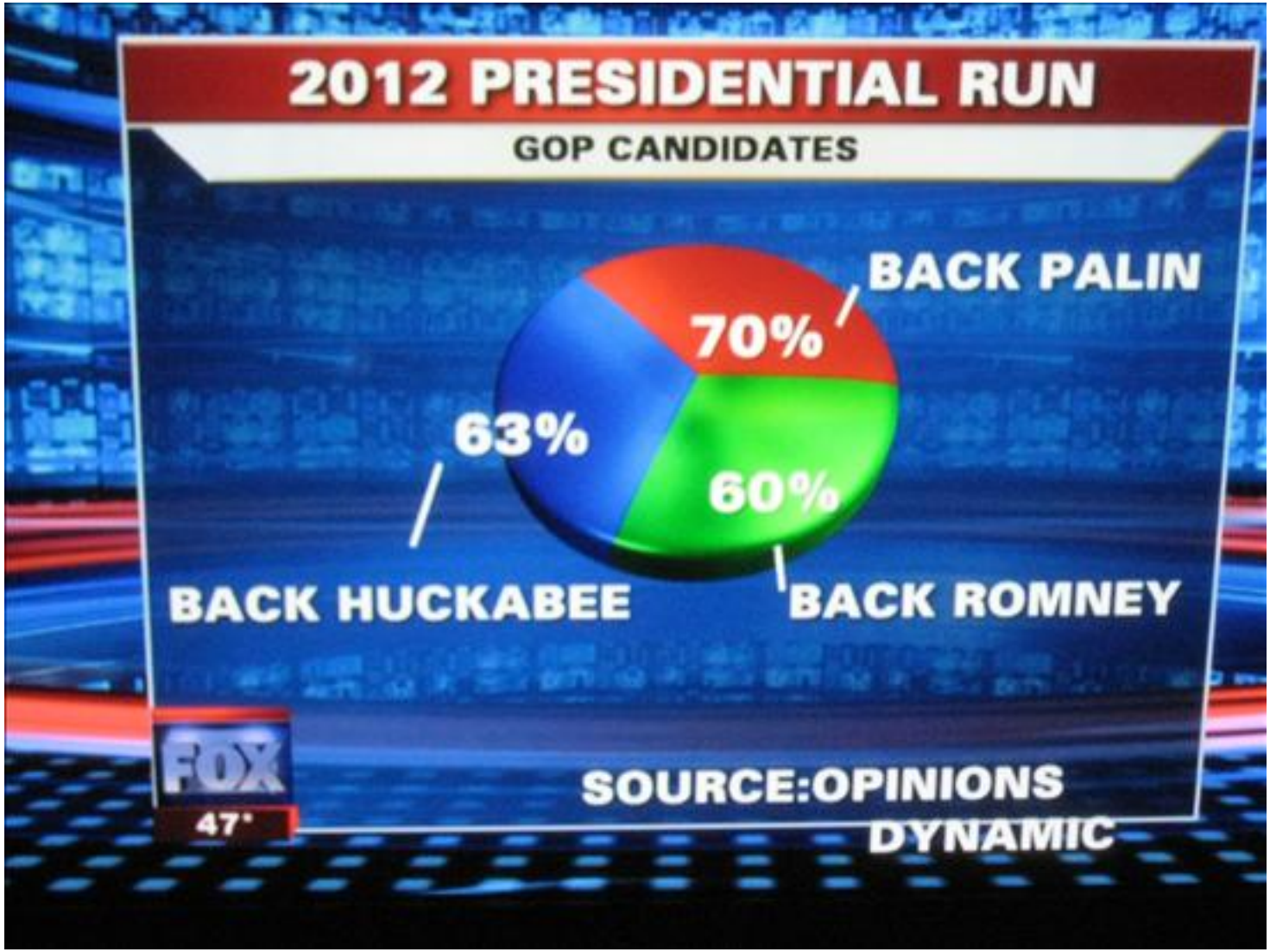
http://visual.ly/every-single-death-game-thrones-series


NameVoyager: Explore baby names and name trends letter by letter
Looking for the perfect baby name? Sign up for free to receive access to our expert tools!
Baby Name > Cha
Both
Boys
Girls
Current rank: boys 1000 500 100 25 1
girls 1000 500 100 25 1
Names starting with 'CHA' per million babies
per million births
26,000
24,000
22,000
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
Charles
Chad
Charlie
Chase
Charlotte
Rank in 2011: 27
1880s
1890s
1900s
1910s
1920s
1930s
1940s
1950s
1960s
1970s
1980s
1990s
2000s
2013
Click a name graph to view that name. Double-click to read more about it.
enlarge

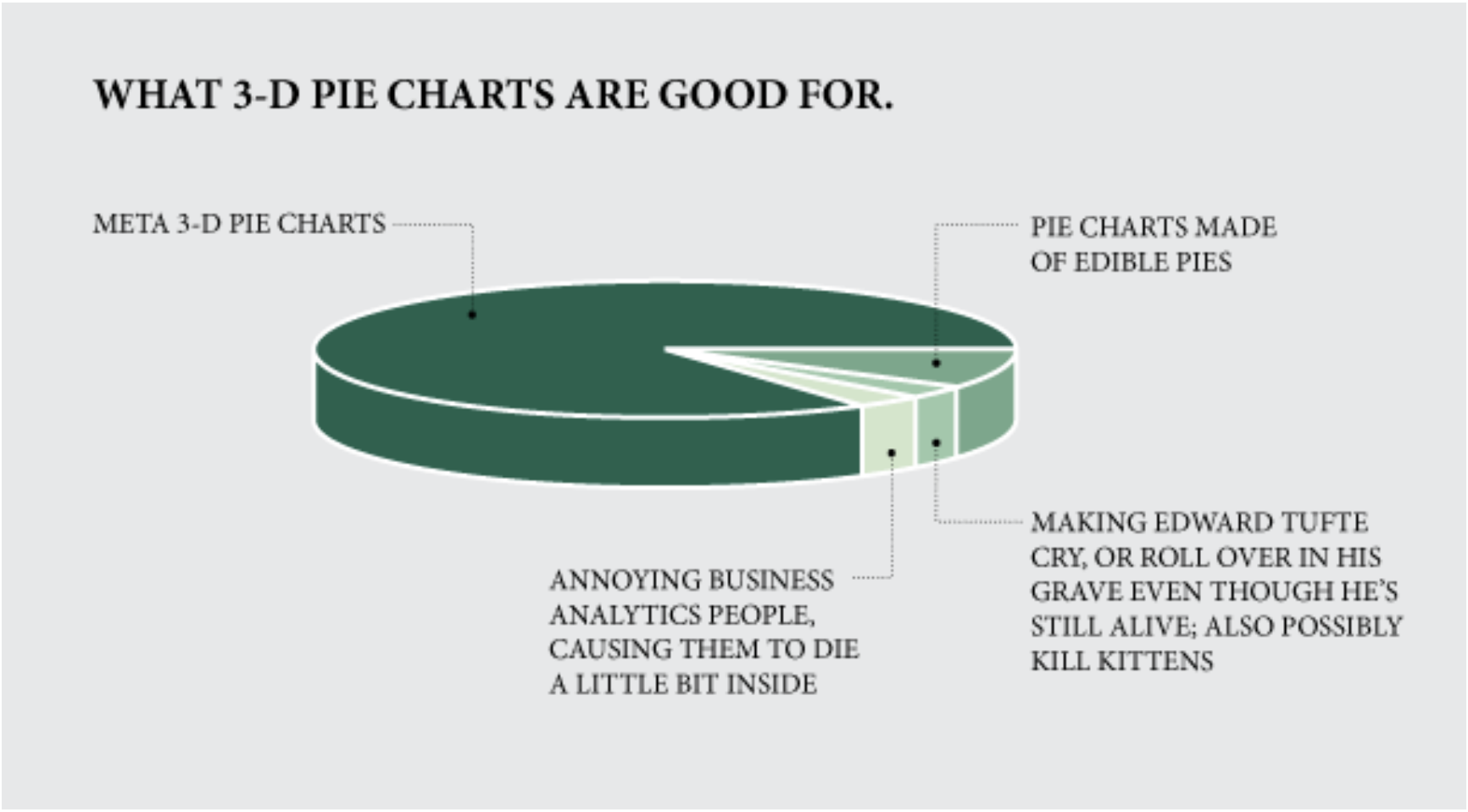


http://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=00014g

Special fares apply
Chesham
Amersham
Chalfont & Latimer
Watford
Croxley
Chorleywood
Rickmansworth
Moor Park
Northwood
Northwood Hills
Pinner
North Harrow
West Ruislip
Hillingdon
Uxbridge
Ruislip
Ruislip Manor
Ickenham
Eastcote
Ruislip Gardens
Rayners Lane
West Harrow
South Ruislip
South Harrow
Sudbury Hill
Northolt
Sudbury Town
Alperton
Greenford
Perivale
Hanger Lane
Park Royal
North Ealing
Ealing Broadway
Ealing Common
Acton Central
South Acton
Acton Town
South Ealing
Northfields
Boston Manor
Osterley
Hounslow East
Hounslow Central
Hounslow West
Hatton Cross
Heathrow Terminals 1, 2, 3
Heathrow Terminal 4
Heathrow Terminal 5
West Acton
North Acton
East Acton
White City
Wood Lane
Shepherd's Bush
Shepherd's Bush Market
Goldhawk Road
Hammersmith
Chiswick Park
Turnham Green
Stamford Brook
Ravenscourt Park
Barons Court
West Kensington
Earl's Court
Kensington (Olympia)
Gunnersbury
Kew Gardens
Richmond
Watford Junction
Watford High Street
Bushey
Carpenders Park
Hatch End
Headstone Lane
Harrow & Wealdstone
Kenton
Preston Road
Northwick Park
South Kenton
North Wembley
Wembley Central
Stonebridge Park
Harlesden
Willesden Junction
Wembley Park
Stanmore
Canons Park
Queensbury
Kingsbury
Neasden
Dollis Hill
Willesden Green
Kilburn
West Hampstead
Kensal Rise
Brondesbury Park
Brondesbury
Kensal Green
Queen's Park
Kilburn High Road
South Hampstead
Finchley Road
Swiss Cottage
St. John's Wood
Kilburn Park
Maida Vale
Warwick Avenue
Paddington
Edgware Road
Marylebone
Royal Oak
Westbourne Park
Ladbroke Grove
Latimer Road
Bayswater
Notting Hill Gate
Lancaster Gate
Queensway
Bond Street
Marble Arch
Holland Park
High Street Kensington
Hyde Park Corner
Knightsbridge
Gloucester Road
South Kensington
Sloane Square
Victoria
St. James's Park
Westminster
Green Park
Piccadilly Circus
Charing Cross
Embankment
Waterloo
Pimlico
Vauxhall
Clapham Junction
Fulham Broadway
Parsons Green
Putney Bridge
East Putney
Southfields
Wimbledon Park
Wimbledon
Imperial Wharf
Edgware
Burnt Oak
Colindale
Hendon Central
Brent Cross
Golders Green
Hampstead
Finchley Road & Frognal
Belsize Park
Chalk Farm
Camden Town
Mornington Crescent
Euston
Great Portland Street
Warren Street
Baker Street
Regent's Park
Oxford Circus
Tottenham Court Road
Leicester Square
Covent Garden
Holborn
Temple
Mansion House
Blackfriars
Cannon Street
Monument
Tower Hill
Aldgate
Aldgate East
Liverpool Street
Bank
St. Paul's
Chancery Lane
Russell Square
Euston Square
King's Cross St. Pancras
Angel
Farringdon
Barbican
Moorgate
Old Street
Shoreditch High Street
Whitechapel
Stepney Green
Mile End
Bethnal Green
Bow Road
Bow Church
Devons Road
Langdon Park
All Saints
Westferry
Blackwall
Limehouse
Poplar
East India
Canning Town
Royal Victoria
Custom House for ExCeL
Prince Regent
Royal Albert
Beckton Park
Cyprus
Gallions Reach
Beckton
West Silvertown
Pontoon Dock
London City Airport
King George V
Woolwich Arsenal
North Greenwich
Canary Wharf
Heron Quays
South Quay
Crossharbour
Mudchute
Island Gardens
Cutty Sark for Maritime Greenwich
Greenwich
Deptford Bridge
Elverson Road
Lewisham
Wapping
Rotherhithe
Bermondsey
Canada Water
Surrey Quays
New Cross
New Cross Gate
Brockley
Honor Oak Park
Forest Hill
Sydenham
Penge West
Anerley
Norwood Junction
West Croydon
Crystal Palace
London Bridge
Tower Gateway
River Thames
Southwark
Lambeth North
Borough
Elephant & Castle
Oval
Kennington
Stockwell
Clapham North
Clapham Common
Clapham South
Balham
Tooting Bec
Tooting Broadway
Colliers Wood
South Wimbledon
Morden
Brixton
High Barnet
Totteridge & Whetstone
Woodside Park
West Finchley
Finchley Central
East Finchley
Highgate
Archway
Tufnell Park
Kentish Town
Kentish Town West
Gospel Oak
Hampstead Heath
Mill Hill East
Camden Road
Caledonian Road
Holloway Road
Arsenal
Upper Holloway
Crouch Hill
Finsbury Park
Manor House
Caledonian Road & Barnsbury
Highbury & Islington
Canonbury
Dalston Kingsland
Dalston Junction
Hackney Central
Hackney Wick
Haggerston
Hoxton
Homerton
Stratford
Pudding Mill Lane
Upton Park
East Ham
Barking
Upney
Becontree
Dagenham Heathway
Dagenham East
Elm Park
Hornchurch
Upminster Bridge
Upminster
Leyton
Leyton Midland Road
Leytonstone
Leytonstone High Road
Wanstead Park
Woodgrange Park
West Ham
Bromley-by-Bow
Cockfosters
Oakwood
Southgate
Arnos Grove
Bounds Green
Wood Green
Turnpike Lane
Harringay Green Lanes
Seven Sisters
South Tottenham
Tottenham Hale
Blackhorse Road
Walthamstow Central
Walthamstow Queen's Road
Epping
Theydon Bois
Debden
Loughton
Buckhurst Hill
Roding Valley
Grange Hill
Chigwell
Hainault
Woodford
South Woodford
Snaresbrook
Fairlop
Barkingside
Newbury Park
Redbridge
Wanstead
Gants Hill



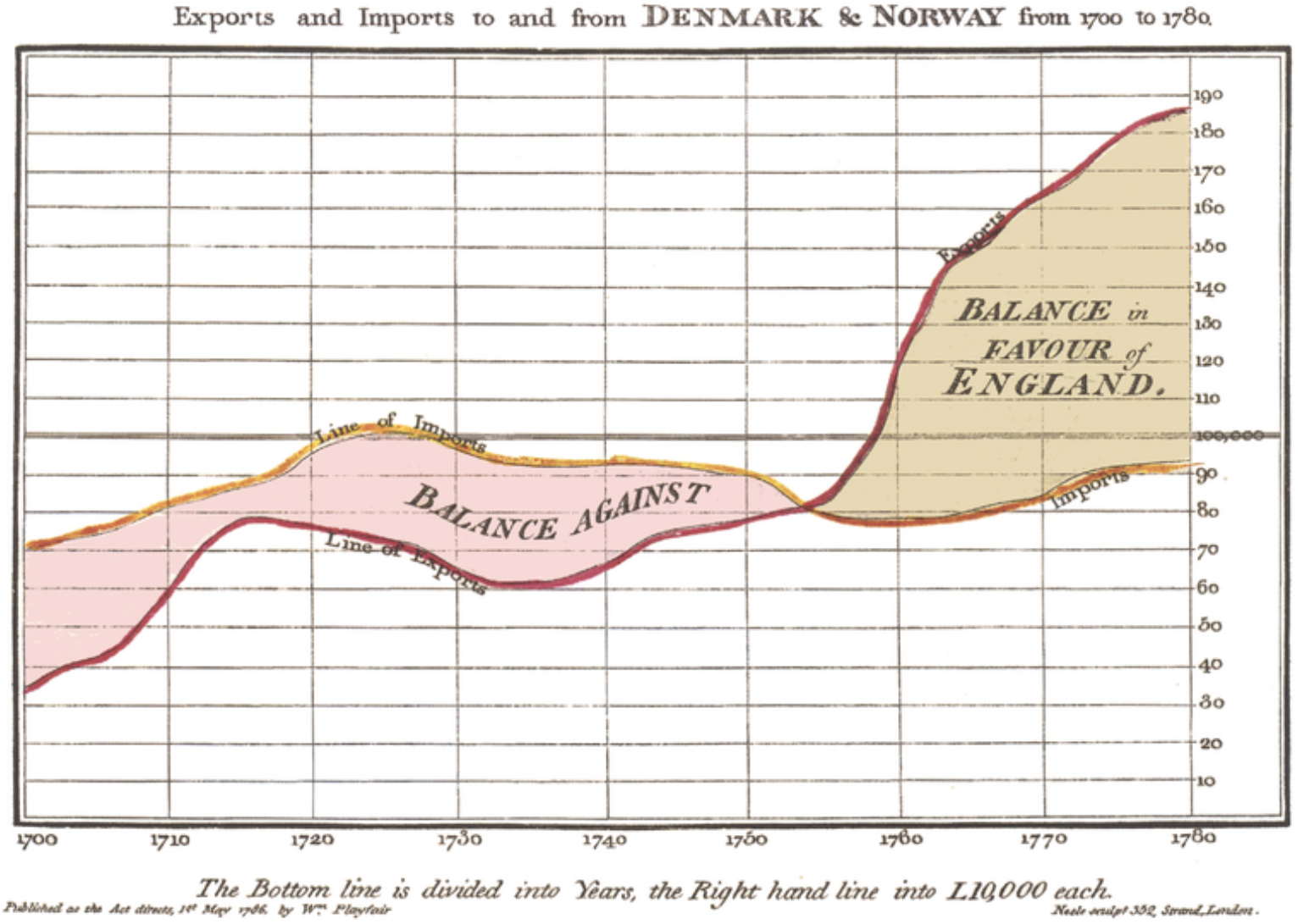
http://wonkette.com/412361/all-193-of-republicans-support-palin-romney-and-huckabee



http://flowingdata.com/2012/06/15/what-3-d-pie-charts-are-good-for/

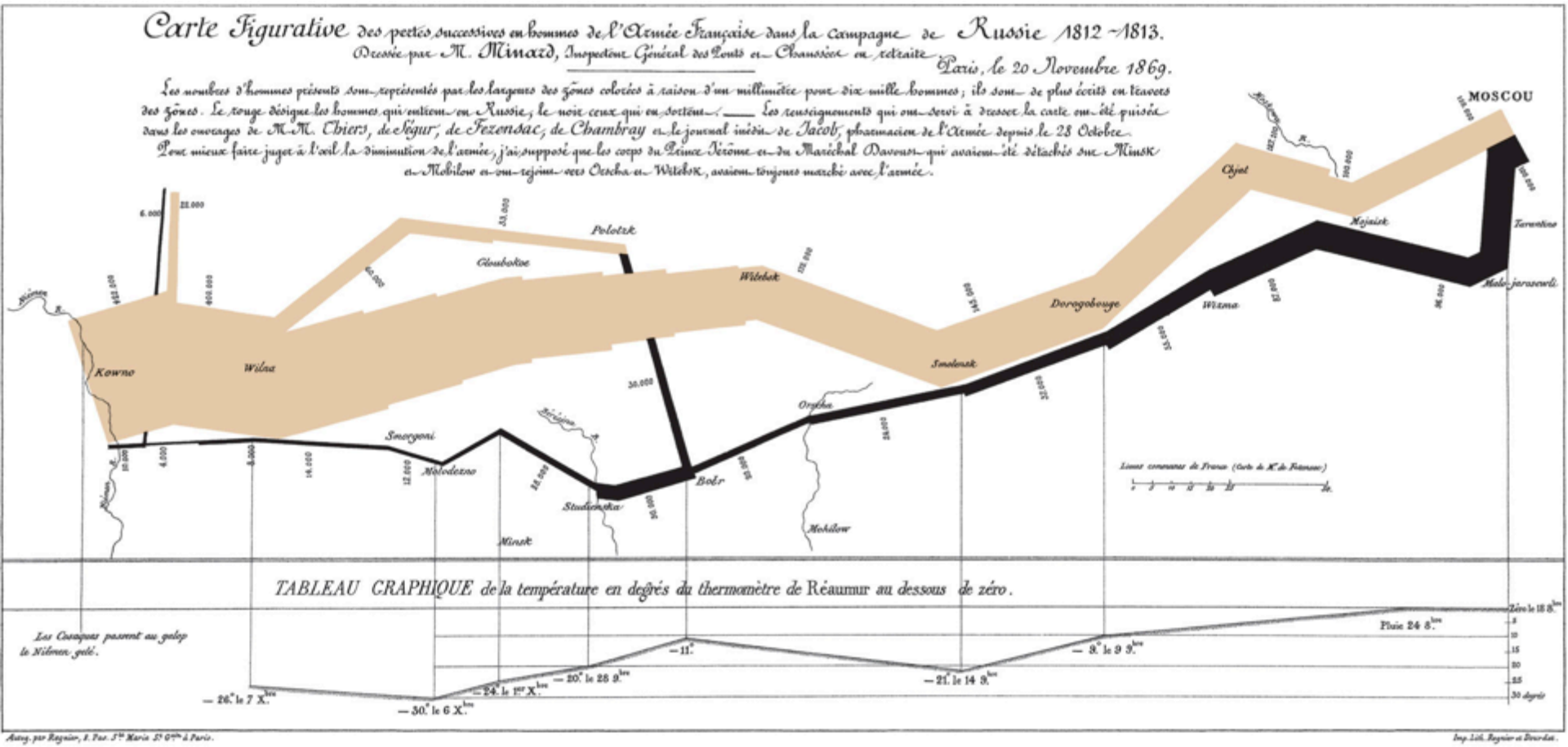
http://infosthetics.com/archives/2008/09/funniest_pie_chart_ever.html

and finally…



William Playfair, 1786

John Snow, 1854



Charles Minard, 1869

Where to learn more?

CS 7450
Information Visualization
Every Fall

How to Make Good Charts

- Edward Tufte's One-Day Workshop
  - http://www.edwardtufte.com/tufte/courses
- Edward Tufte, *Visual Display of Quantitative Information*
  - http://www.edwardtufte.com/tufte/books_vdqi
- Stephen Few, *Show Me the Numbers: Designing Tables and Graphs to Enlighten*
  - http://www.amazon.com/Show-Me-Numbers-Designing-Enlighten/dp/0970601972/ref=la_B001H6IQ5M_1_2?s=books&ie=UTF8&qid=1385050724&sr=1-2

Visualization Theory "Books"

- Tamara Munzner VIS Tutorial
  - http://www.cs.ubc.ca/~tmm/talks.html
- Colin Ware, *Information Visualization: Perception for Design*
  - http://www.amazon.com/Information-Visualization-Perception-Interactive-Technologies/dp/1558605118
- Stephen Few, *Now You See It*
  - http://www.amazon.com/Now-You-See-Visualization-Quantitative/dp/0970601980/ref=pd_bxgy_b_img_z
- Edward Tufte, *Envisioning Information*
  - http://www.edwardtufte.com/tufte/books_ei
- Edward Tufte, *Visual Explanations*
  - http://www.edwardtufte.com/tufte/books_visex
- Edward Tufte, *Beautiful Evidence*
  - http://www.edwardtufte.com/tufte/books_be
- Tamara Munzner, Visualization Analysis & Design
  - http://www.amazon.com/Visualization-Analysis-Design-AK-Peters/dp/1466508914

Perception and Color Websites

- Chris Healy, NC State
  - http://www.csc.ncsu.edu/faculty/healey/PP/index.html
- Color Brewer
  - http://colorbrewer2.org/
- Maureen C. Stone (Color Links, Blog, Workshops)
  - http://www.stonesc.com/color/index.htm
- Subtleties of Color by Robert Simmon of NASA
  - http://blog.visual.ly/subtleties-of-color/

Visualization Blogs

- Flowing Data by Nathan Yau
  - http://flowingdata.com/
- Information Aesthetics by Andrew Vande Moere
  - http://infosthetics.com/
- Information is Beautiful by David McCandless
  - http://www.informationisbeautiful.net/
- Visual.ly Blog
  - http://blog.visual.ly/
- Indexed Comic by Jessica Hagy
  - http://thisisindexed.com/

Infographics

Visual.ly/view

(wtfviz.net)

Information Interfaces Group

http://www.cc.gatech.edu/gvu/ii/index.html

Visualization @GeorgiaTech

vis.gatech.edu

Thanks!

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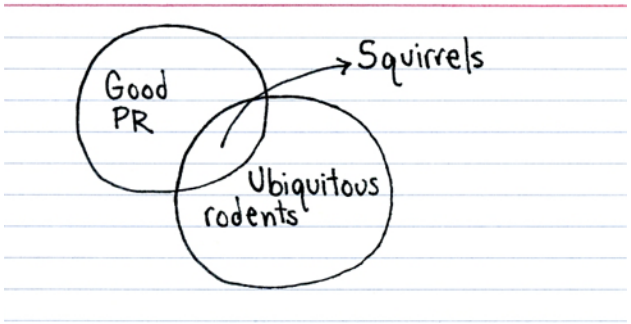
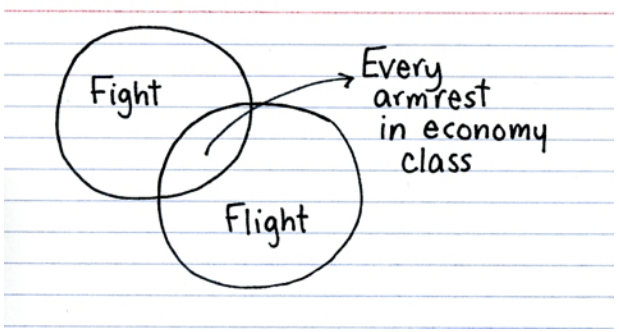
Jessica Hagy thisisindexed.com





Questions?

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