

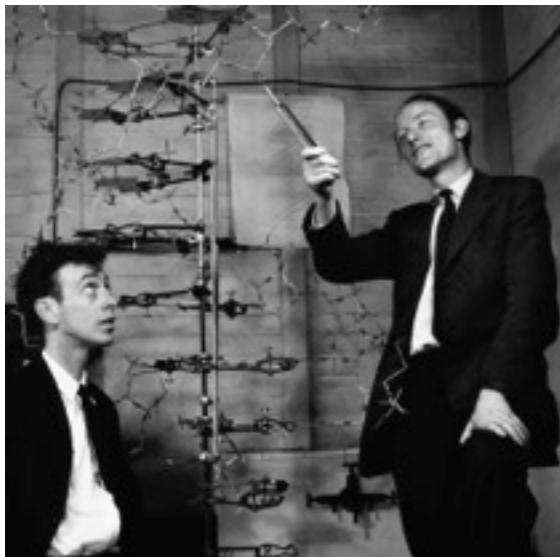
CS 109: Data Science

Visual Attributes, Color, Design Principles

Marc Streit

mstreit@seas.harvard.edu

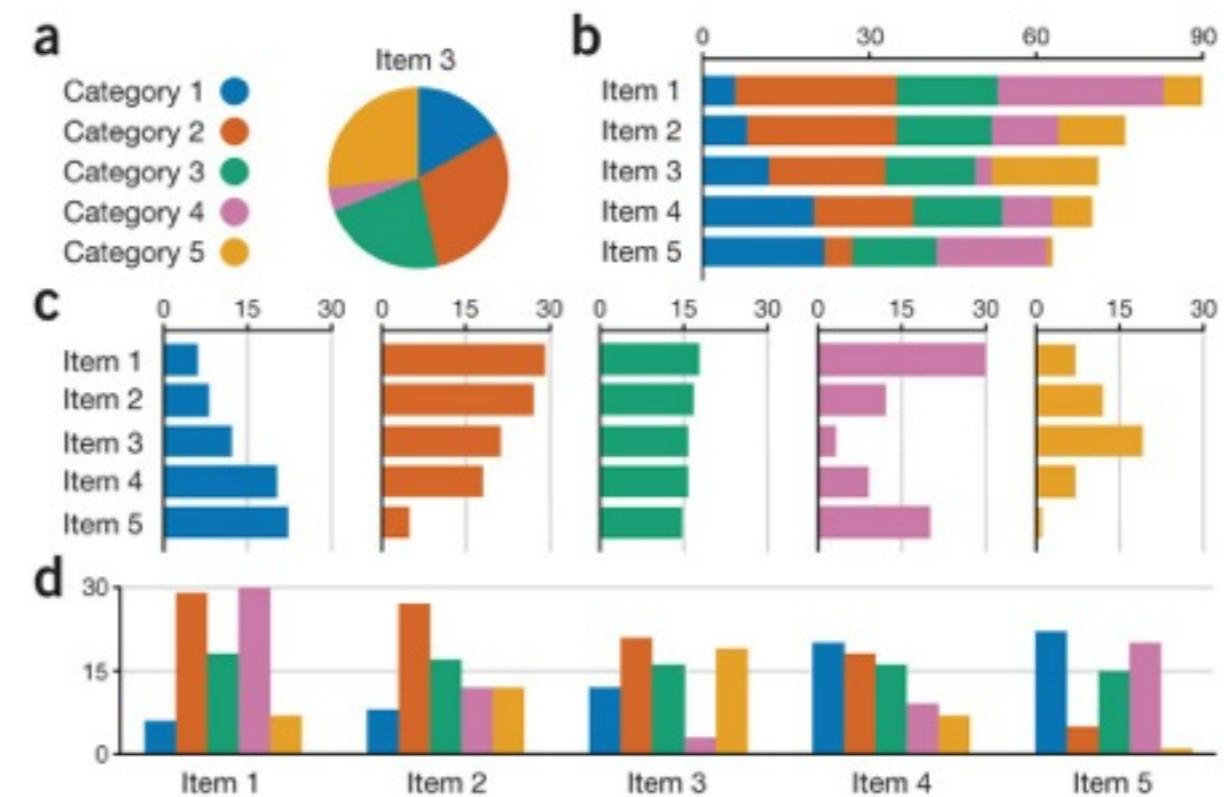
On Tuesday...



Vis Goals

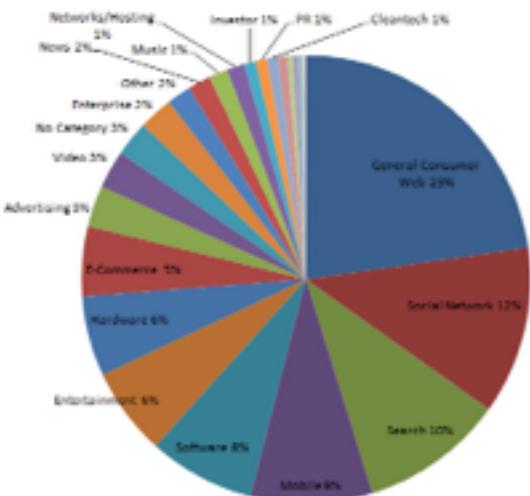
Data Types
Dimensionality

parch	fare	embarked	class	who
0	7.25	S	Third	man
0	71.2833	C	First	woman
0	7.925	S	Third	woman
0	53.1	S	First	woman
0	8.05	S	Third	man
0	8.4583	Q	Third	man
0	51.8625	S	First	man
1	21.075	S	Third	child
2	11.1333	S	Third	woman
0	30.0708	C	Second	child
1	16.7	S	Third	child
0	26.55	S	First	woman
0	8.05	S	Third	man
5	31.275	S	Third	man
0	7.8542	S	Third	child
0	16.0	S	Second	woman
1	29.125	Q	Third	child
0	13.0	S	Second	man
0	18.0	S	Third	woman
0	7.225	C	Third	woman
0	26.0	S	Second	man
0	13.0	S	Second	man
0	8.0292	Q	Third	child

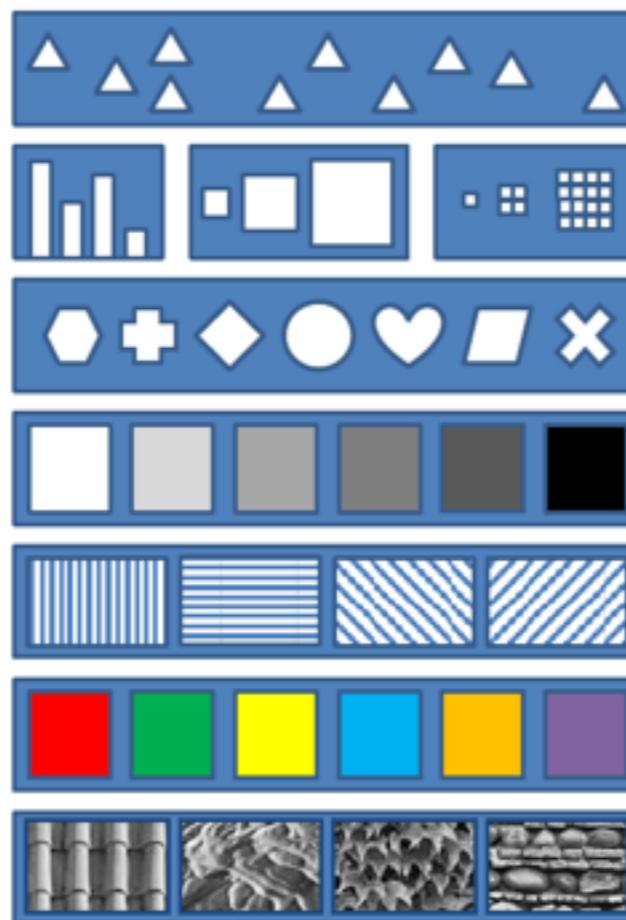
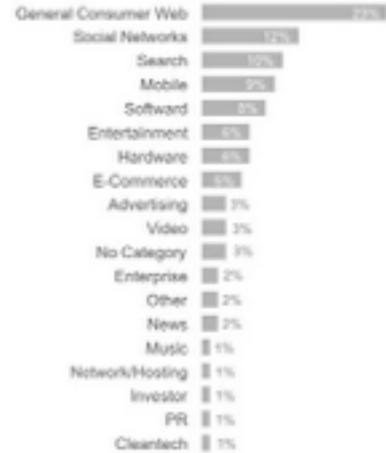


Graph Types

Outline



TechCrunch Coverage: 2005 - 2011
Bars are best!

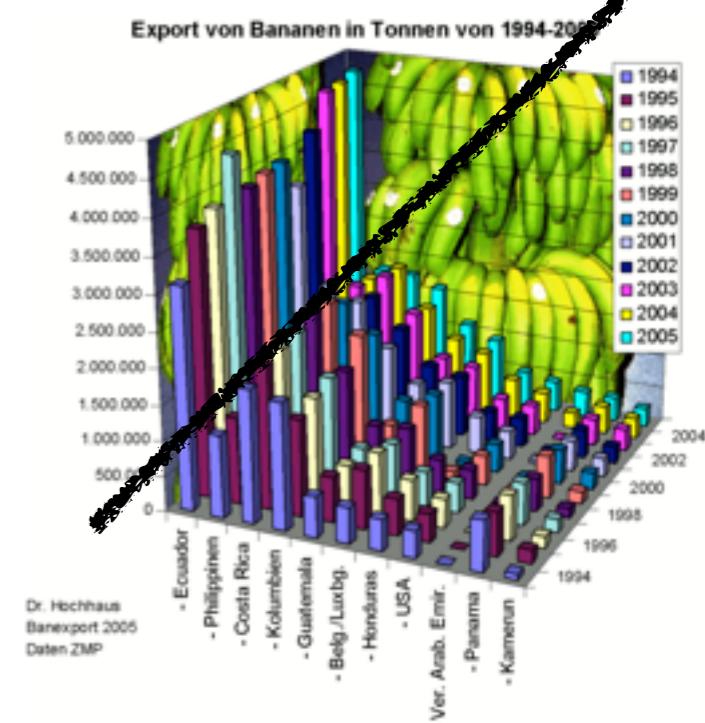
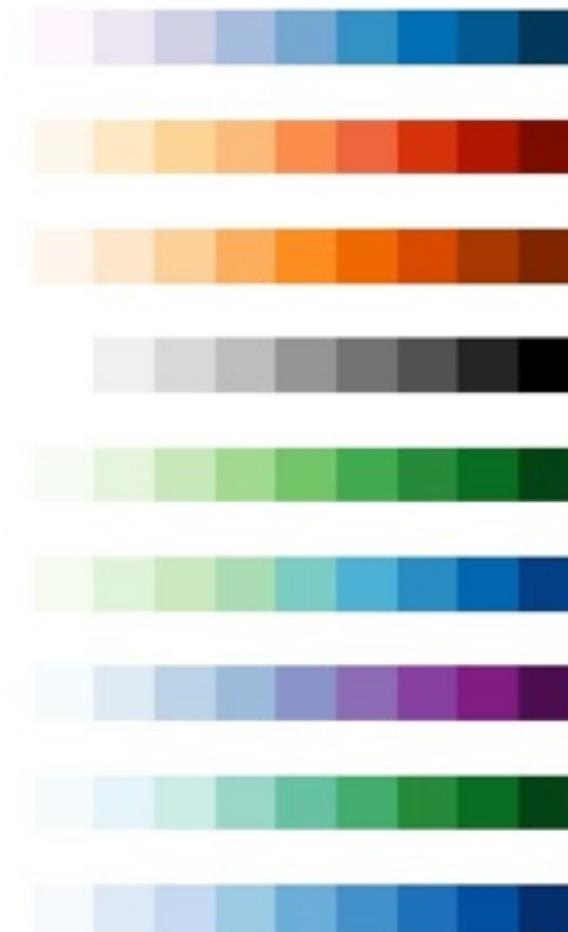


Effective vs.
Non Effective
Visualizations

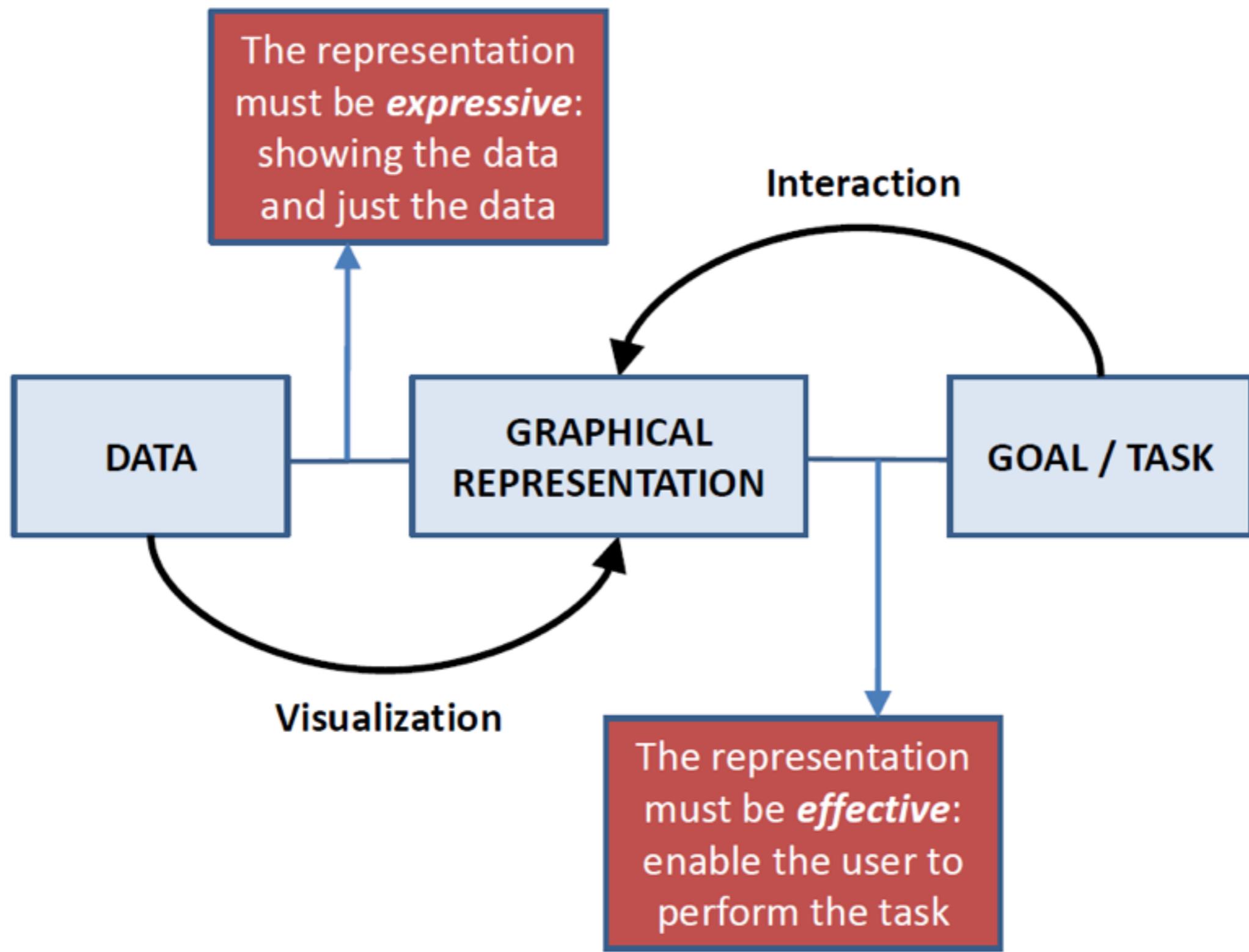
Visual
Attributes

Color

Design
Principles



Effective Visualizations



Not Effective...

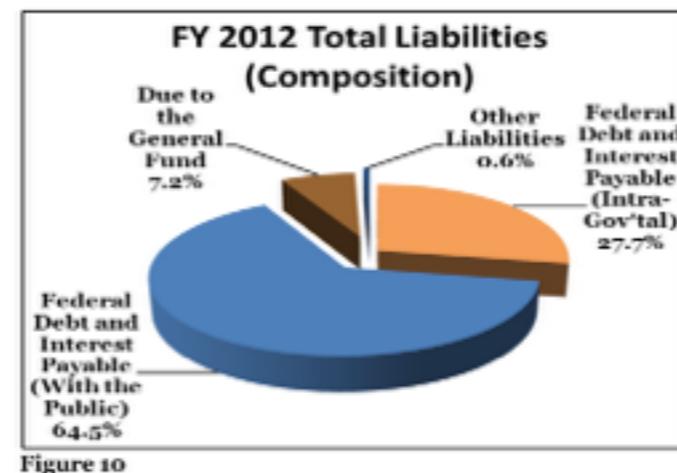
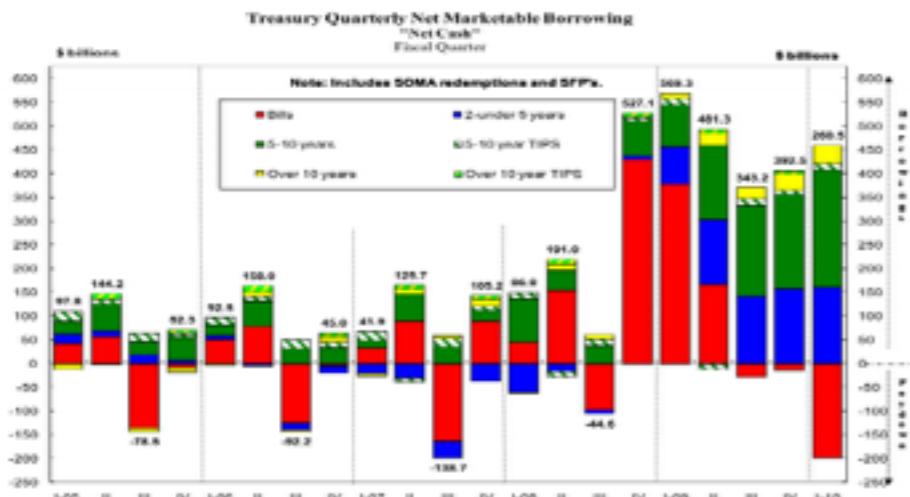
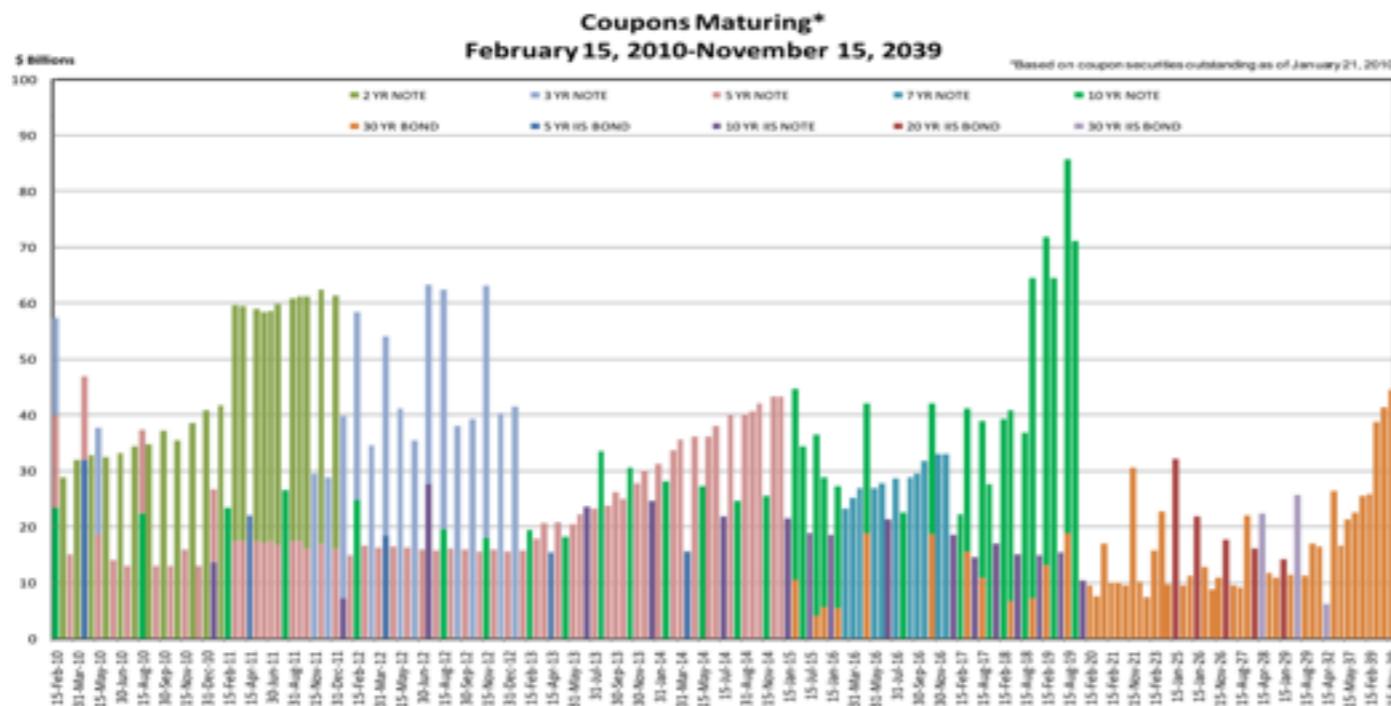
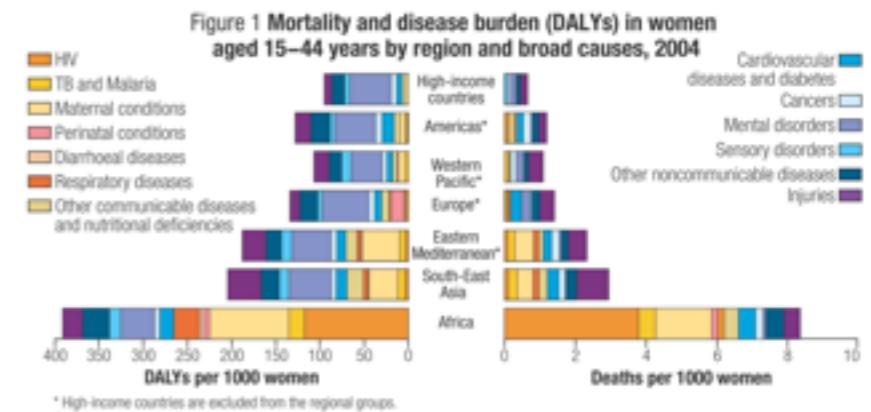
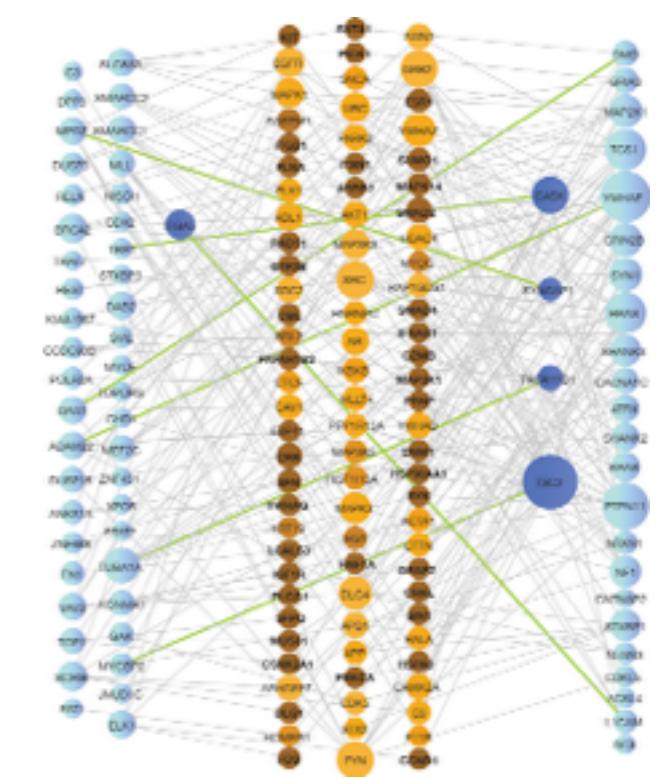
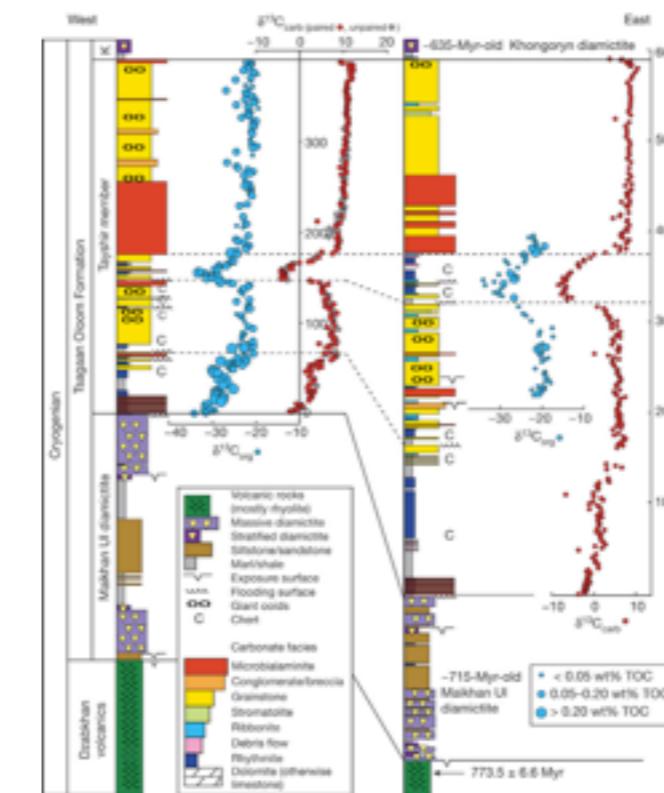
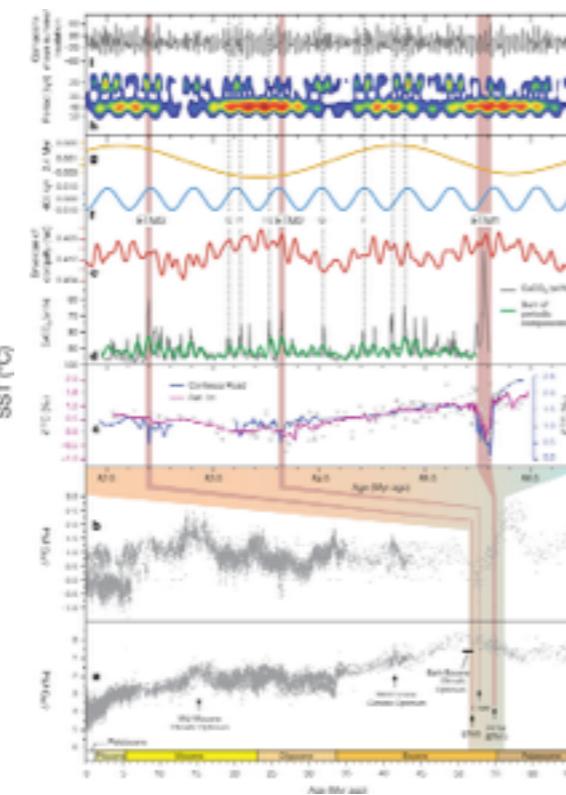
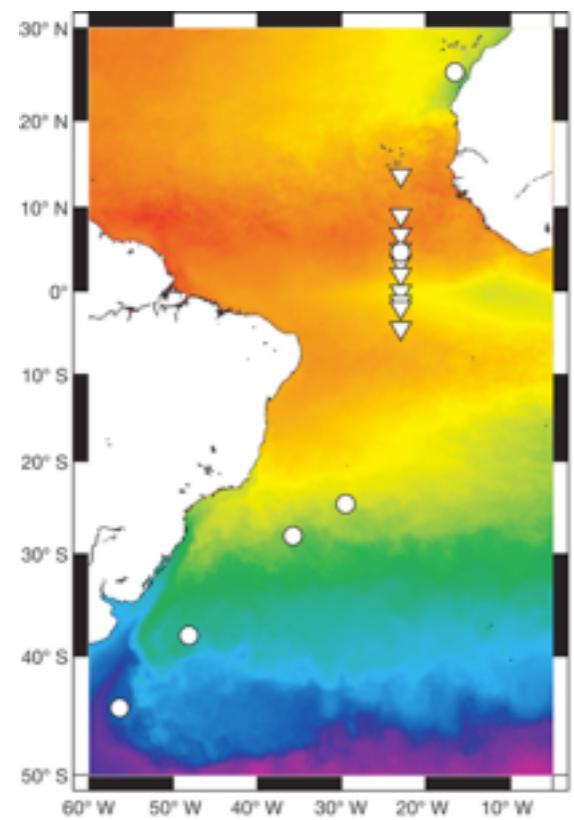
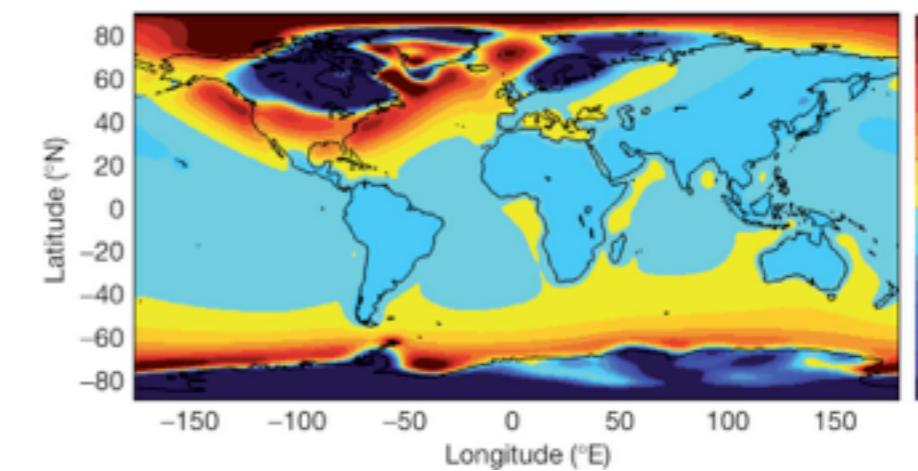
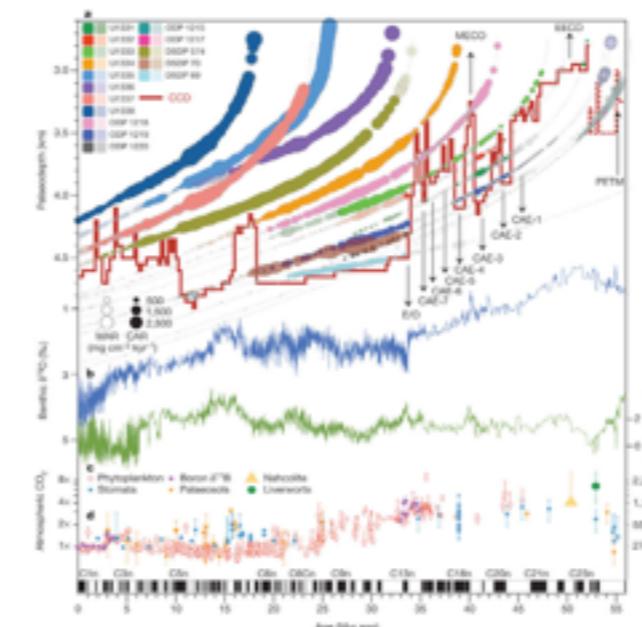
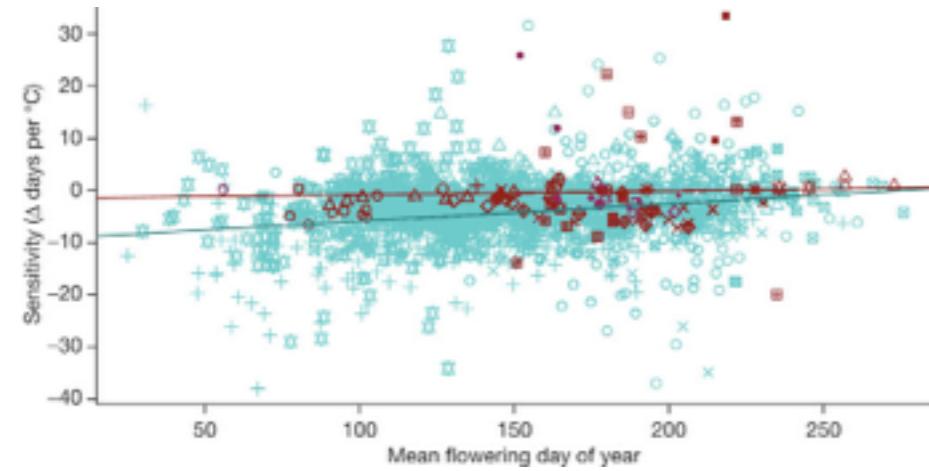


Figure 10

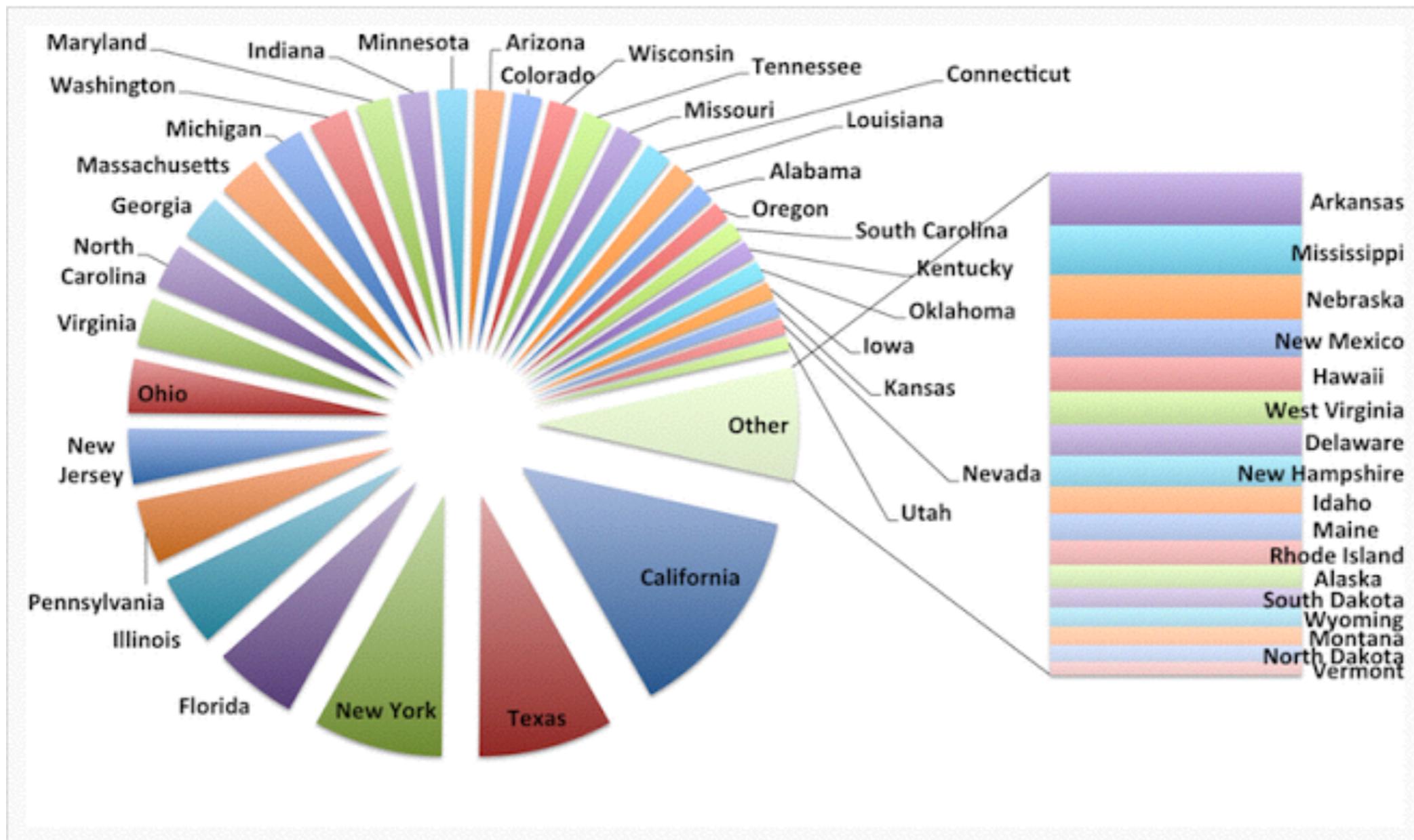


Also *not* effective...



WTF Visualizations

<http://wtfviz.net>



The United States GDP for individual states as a contribution to the total US GDP. Fraction of the total US GDP

per state was taken from [Wikipedia](#) and refers to 2010.

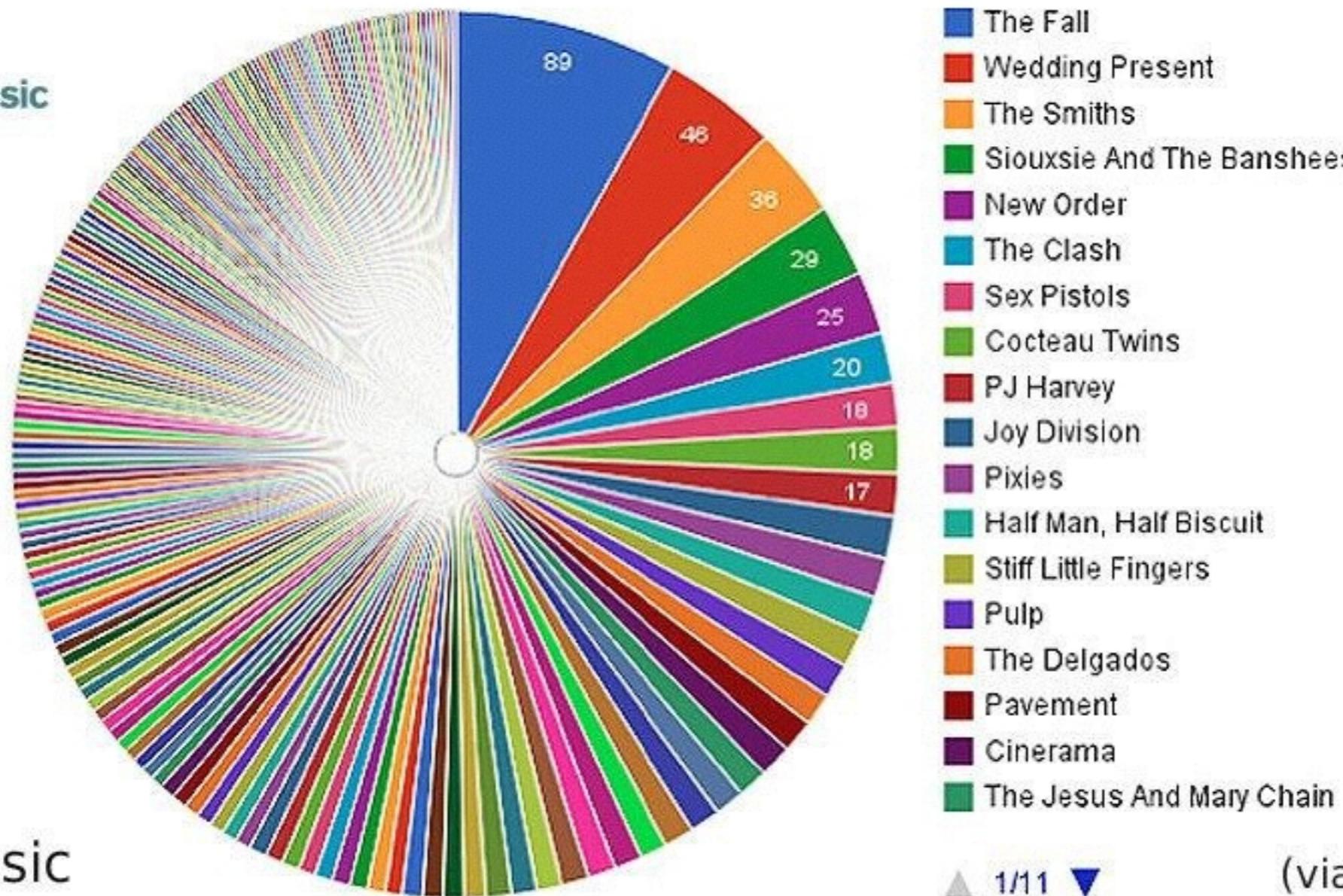
WTF Visualizations

<http://wtfviz.net>

John Peel's most played artists in his Festive 50s

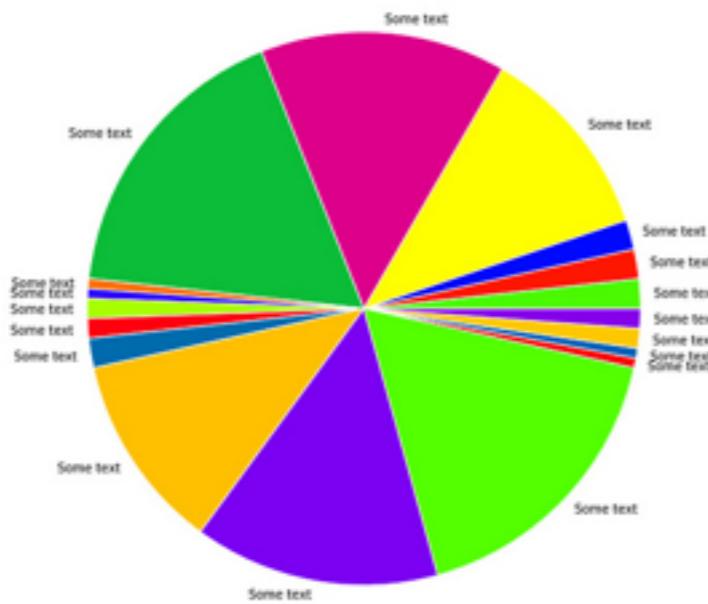
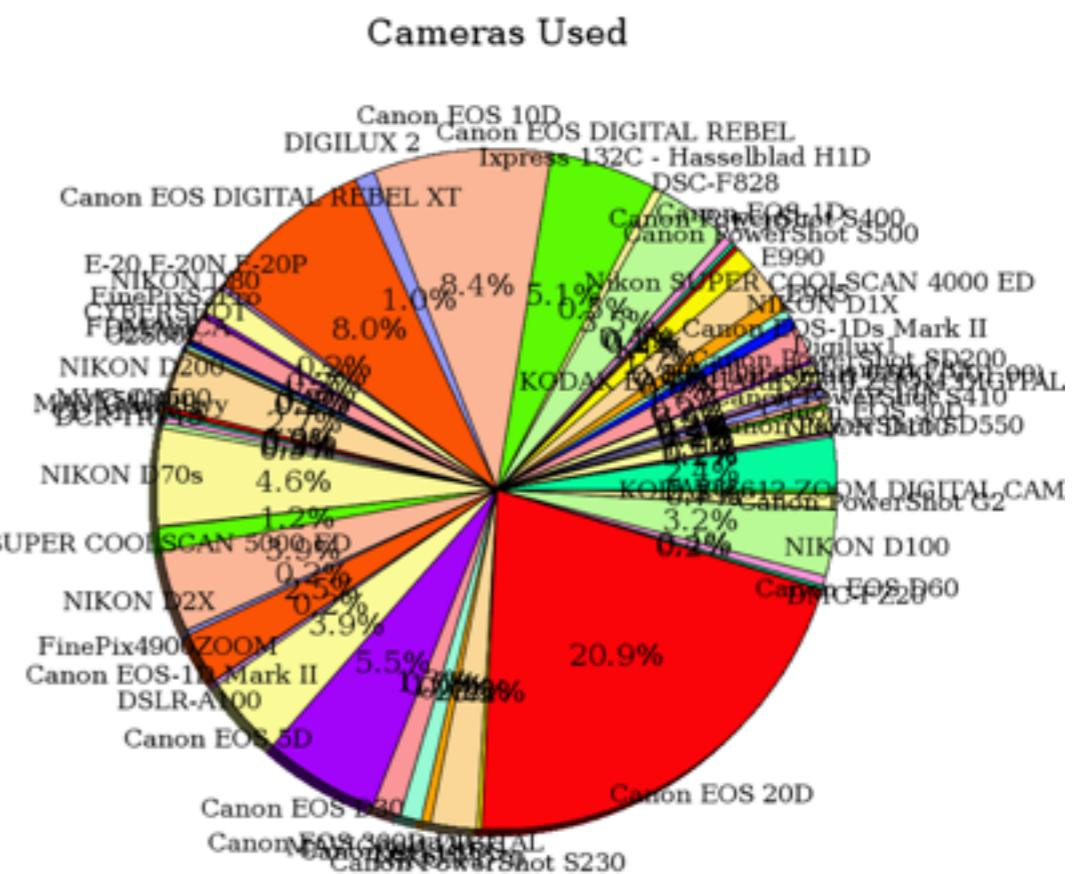
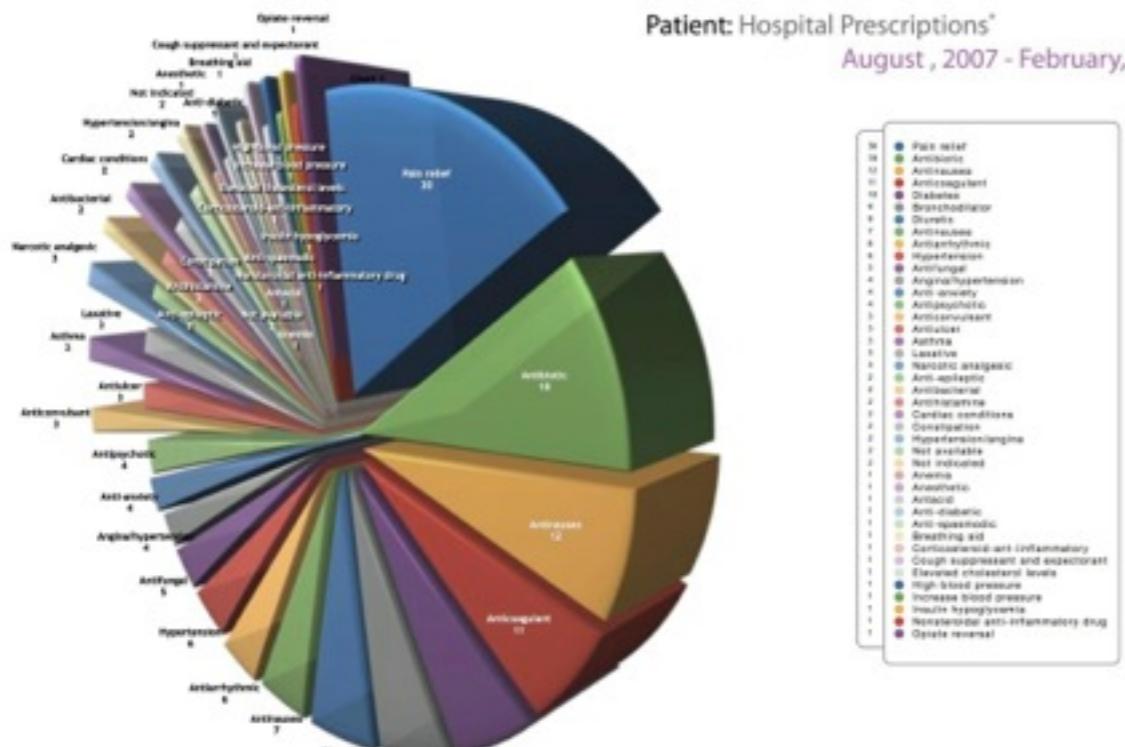
BBC

RADIO



#Peel6Music

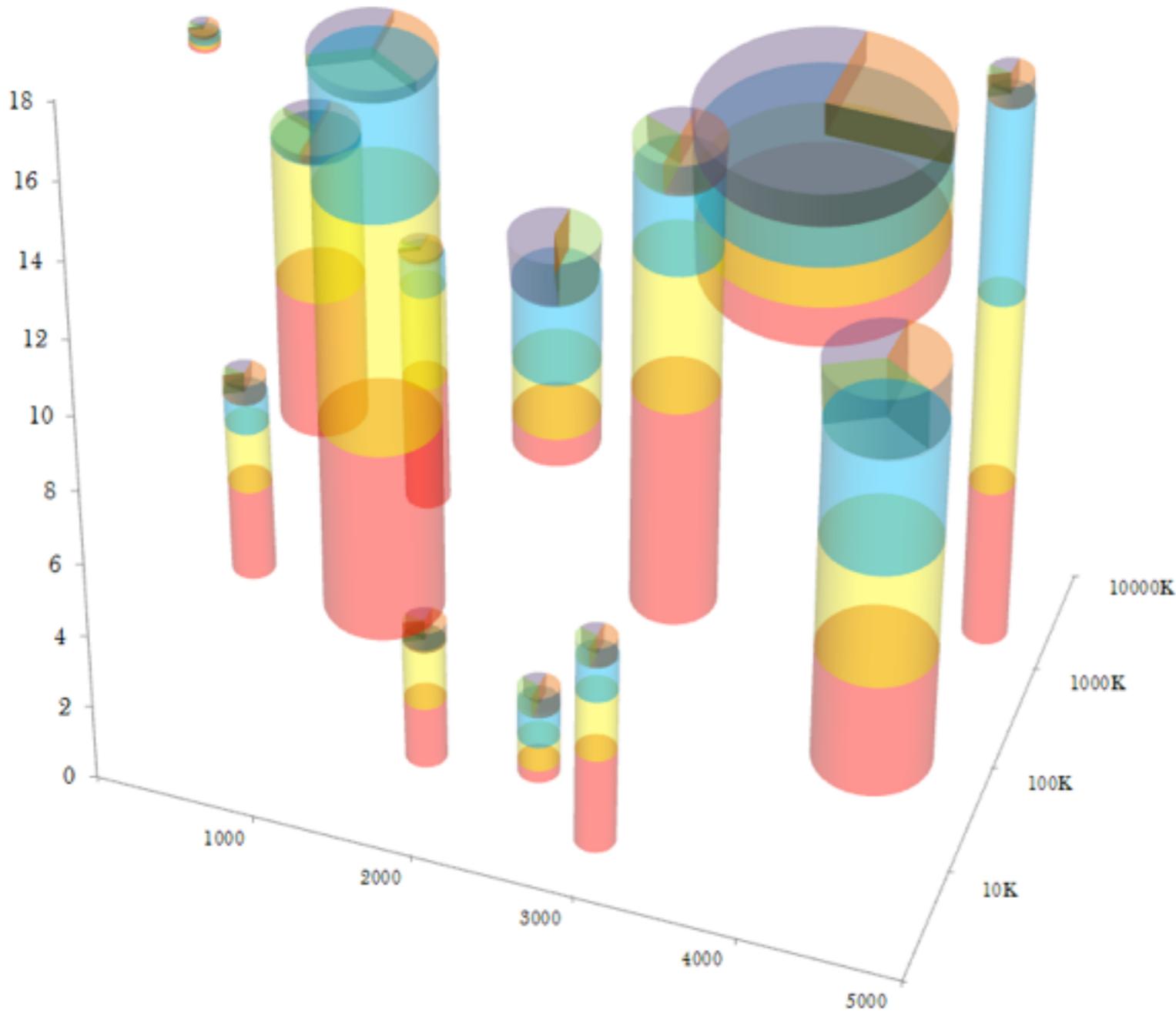
Don't



Job *

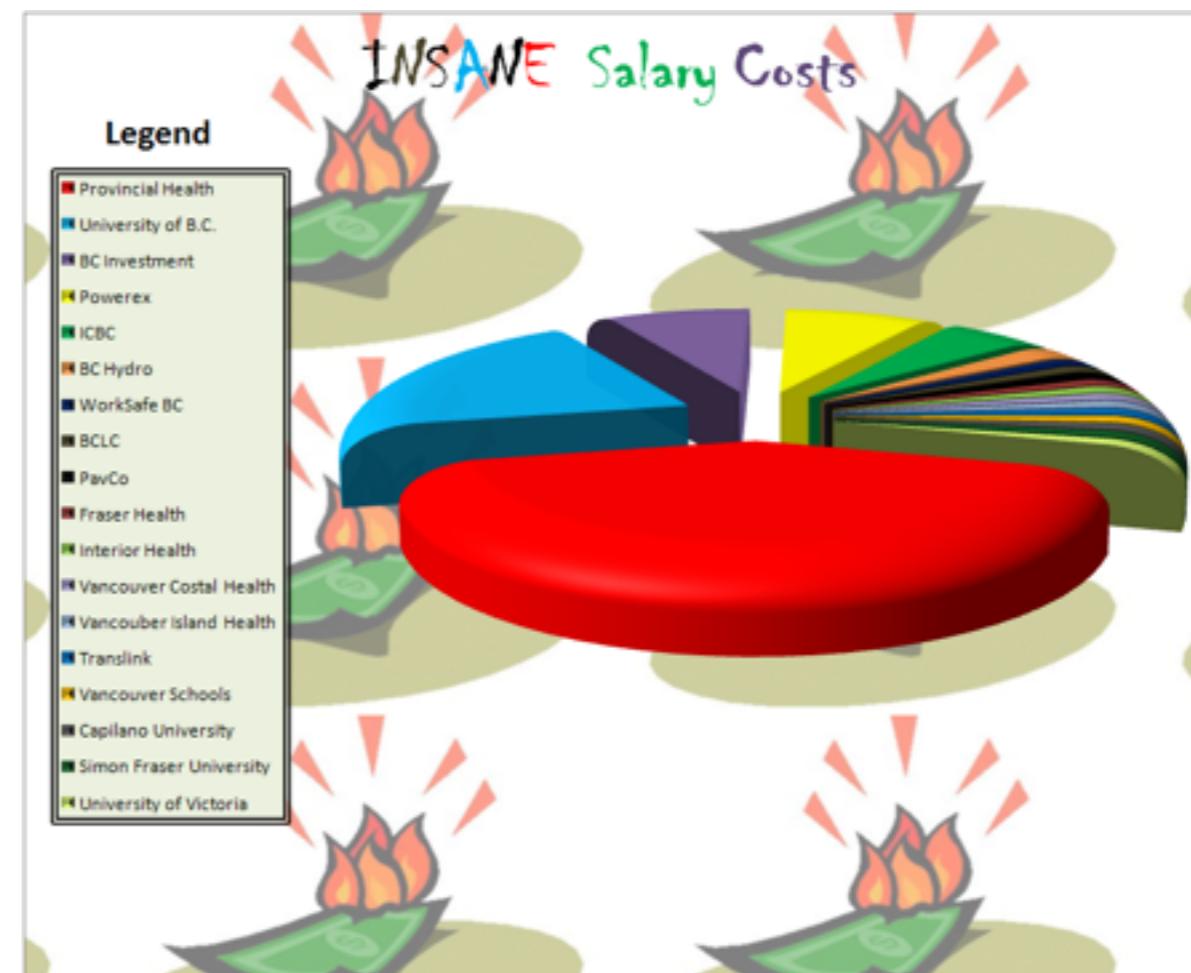
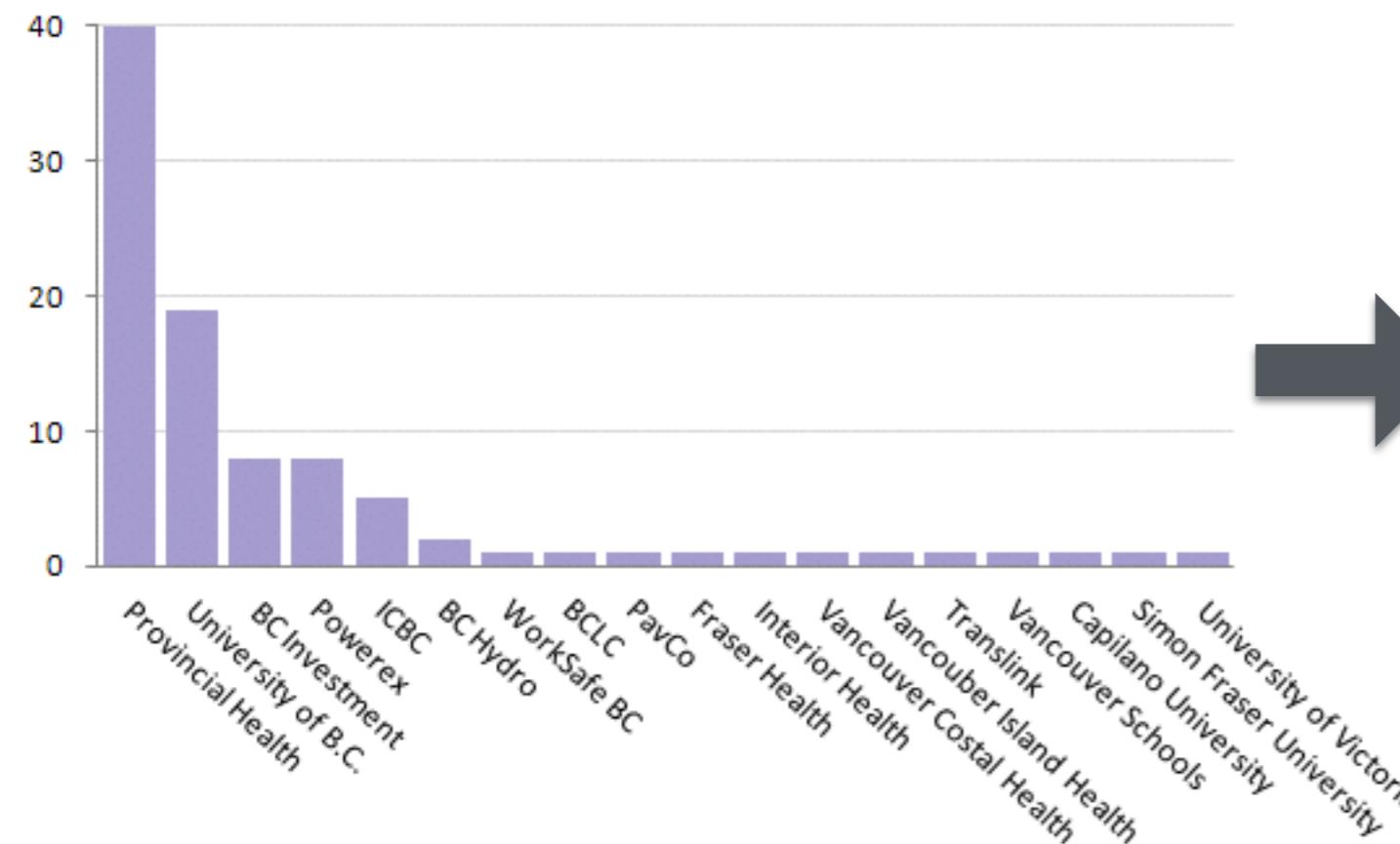
- 88% Broadcast reporter
 - 84% Camera Operator
 - 78% Columnist / Commentator
 - 78% Editor
 - 81% Photographer
 - 81% Internet reporter/writer
 - 81% Print reporter/writer
 - 78% Producer
 - 81% Publisher/Owner
 - 78% Technician

eagerpies.com



Close the Bars Down

<http://eagerpies.com/close-the-bars-down/>



The Periodic Table of the Elements

by Robert Creighton - version 1.4

18

4.002602
2372.3
He

Helium

[He]

20.1797
2080.7

Ne

Neon

[He] 2s² 2p⁶

39.948
1520.6

Ar

Argon

[He] 3s² 3p⁶

83.798
1350.8

Kr

Krypton

[He] 3d¹⁰ 4s² 4p⁶

132.9044
1170.4

Sr

Rubidium

[He] 4s¹

131.293
1170.4

Xe

Xenon

[He] 4d¹⁰ 5s¹ 5p⁶

126.9044
1008.4

Te

Tellurium

[He] 4d¹⁰ 5s² 5p⁴

127.60
869.3

I

Iodine

[He] 4d¹⁰ 5s² 5p⁵

132.9054
1008.4

Cs

Cesium

[He] 4s²

137.327
869.3

Ba

Boron

[He] 4s²

174.9668
869.3

Lu

Lutetium

[He] 4f¹⁴ 5d¹ 6s²

178.49
869.3

Hf

Hafnium

[He] 4f¹⁴ 5d² 6s²

180.9478
869.3

Ta

Tantalum

[He] 4f¹⁴ 5d³ 6s²

183.84
869.3

W

Tungsten

[He] 4f¹⁴ 5d⁴ 6s²

186.207
869.3

Re

Rhenium

[He] 4f¹⁴ 5d⁵ 6s²

190.23
869.3

Os

Osmium

[He] 4f¹⁴ 5d⁶ 6s²

192.217
869.3

Ir

Iridium

[He] 4f¹⁴ 5d⁷ 6s²

195.084
869.3

Pt

Platinum

[He] 4f¹⁴ 5d⁸ 6s²

196.9665
869.3

Au

Gold

[He] 4f¹⁴ 5d⁹ 6s¹

200.59
869.3

Hg

Mercury

[He] 4f¹⁴ 5d¹⁰ 6s¹

204.3833
869.3

Tl

Thallium

[He] 4f¹⁴ 5d¹⁰ 6s² 6p¹

207.2
869.3

Pb

Lead

[He] 4f¹⁴ 5d¹⁰ 6s² 6p²

208.9804
869.3

Bi

Bismuth

[He] 4f¹⁴ 5d¹⁰ 6s² 6p³

(210)
869.3

Po

Polonium

[He] 4f¹⁴ 5d¹⁰ 6s² 6p⁴

212.1
869.3

At

Astatine

[He] 4f¹⁴ 5d¹⁰ 6s² 6p⁵

212.1
869.3

Rn

Radon

[He] 4f¹⁴ 5d¹⁰ 6s² 6p⁶

212.1
869.3

Uus

Ununseptium

[He] 4f¹⁴ 5d¹⁰ 6s² 6p⁷

212.1
869.3

Uuo

Ununoctium

[He] 4f¹⁴ 5d¹⁰ 6s² 6p⁸

212.1
869.3

Fr

Francium

[He] 7s¹

226.0
869.3

Ra

Radium

[He] 5f¹⁴ 6d¹ 7s¹

226.0
869.3

Lr

Lawrencium

[He] 5f¹⁴ 6d¹ 7s¹

226.0
869.3

Rf

Rutherfordium

[He] 5f¹⁴ 6d² 7s¹

226.0
869.3

Db

Dubnium

[He] 5f¹⁴ 6d³ 7s¹

226.0
869.3

Sg

Seaborgium

[He] 5f¹⁴ 6d⁴ 7s¹

226.0
869.3

Bh

Bohrium

[He] 5f¹⁴ 6d⁵ 7s¹

226.0
869.3

Hs

Hassium

[He] 5f¹⁴ 6d⁶ 7s¹

226.0
869.3

Mt

Meltnerium

[He] 5f¹⁴ 6d⁷ 7s¹

226.0
869.3

Ds

Dominium

[He] 5f¹⁴ 6d⁸ 7s¹

226.0
869.3

Rg

Roentgenium

[He] 5f¹⁴ 6d⁹ 7s¹

226.0
869.3

Cn

Copernicium

[He] 5f¹⁴ 6d¹⁰ 7s¹

226.0
869.3

Uut

Ununtrium

[He] 5f¹⁴ 6d¹⁰ 7s²

226.0
869.3

Uuq

Ununquadium

[He] 5f¹⁴ 6d¹⁰ 7s³

226.0
869.3

Uup

Ununpentium

[He] 5f¹⁴ 6d¹⁰ 7s⁴

226.0
869.3

Uuh

Ununhexium

[He] 5f¹⁴ 6d¹⁰ 7s⁵

226.0
869.3

Uus

Ununseptium

<p

PERIODIC TABLE of WOOD

SITKA SPRUCE	27 lbs/ft³ • 425 kg/m³	NORTH AMERICA										EUROPE											
WESTERN RED CEDAR	22 lbs/ft³ • 370 kg/m³	DOUGLAS FIR	22 lbs/ft³ • 310 kg/m³									ENGLISH YEW	42 lbs/ft³ • 675 kg/m³	WYCH ELM	26 lbs/ft³ • 410 kg/m³	LONDON PINE	20 lbs/ft³ • 310 kg/m³	EUROPEAN BEACH	44 lbs/ft³ • 710 kg/m³	ENGLISH WALNUT	22 lbs/ft³ • 340 kg/m³	NORWAY SPRUCE	25 lbs/ft³ • 405 kg/m³
RED ALDER	28 lbs/ft³ • 450 kg/m³	BOX ELDER	30 lbs/ft³ • 480 kg/m³									BOXWOOD	41 lbs/ft³ • 675 kg/m³	OLIVE	32 lbs/ft³ • 520 kg/m³	CEDAR OF LEBANON	42 lbs/ft³ • 675 kg/m³	ENGLISH OAK	38 lbs/ft³ • 610 kg/m³	SYCAMORE MAPLE	42 lbs/ft³ • 680 kg/m³	MASUR BIRCH	42 lbs/ft³ • 680 kg/m³
REDWOOD	44 lbs/ft³ • 705 kg/m³	HARD MAPLE	35 lbs/ft³ • 540 kg/m³	BASSWOOD	36 lbs/ft³ • 575 kg/m³	RED ELM	42 lbs/ft³ • 675 kg/m³	WHITE ASH	43 lbs/ft³ • 680 kg/m³	YELLOW BIRCH	44 lbs/ft³ • 700 kg/m³	SASSAFRAS	31 lbs/ft³ • 485 kg/m³	BUTTERNUT	37 lbs/ft³ • 425 kg/m³	AMERICAN CHESTNUT	40 lbs/ft³ • 545 kg/m³	AFRORMOSIA	38 lbs/ft³ • 580 kg/m³	EAST INDIAN ROSEWOOD	42 lbs/ft³ • 675 kg/m³	BAMBOO	18 lbs/ft³ • 290 kg/m³
QUARO WALNUT	40 lbs/ft³ • 640 kg/m³	OSAGE ORANGE	54 lbs/ft³ • 835 kg/m³	BLACK LOCUST	58 lbs/ft³ • 800 kg/m³	SHAGBARK HICKORY	50 lbs/ft³ • 770 kg/m³	WHITE OAK	52 lbs/ft³ • 520 kg/m³	EASTERN RED CEDAR	47 lbs/ft³ • 735 kg/m³	SYCAMORE	34 lbs/ft³ • 545 kg/m³	BLACK WALNUT	29 lbs/ft³ • 455 kg/m³	SOUTHERN YELLOW POPLAR	36 lbs/ft³ • 410 kg/m³	BALD CYPRESS	32 lbs/ft³ • 515 kg/m³	ODANGKOL	31 lbs/ft³ • 515 kg/m³	TEAK	42 lbs/ft³ • 675 kg/m³
KATALOK	72 lbs/ft³ • 1150 kg/m³	BOCOTE	53 lbs/ft³ • 835 kg/m³	COCOBOLA	46 lbs/ft³ • 725 kg/m³	HONDURAN MAHOGANY	41 lbs/ft³ • 635 kg/m³	REDHEART	42 lbs/ft³ • 640 kg/m³	ZI-COTE	47 lbs/ft³ • 725 kg/m³	HONDURAN ROSEWOOD	75 lbs/ft³ • 1200 kg/m³	KINGWOOD	62 lbs/ft³ • 970 kg/m³	CHICHEN	43 lbs/ft³ • 680 kg/m³	CHAXTE VIGA	40 lbs/ft³ • 640 kg/m³	AFRICAN MAHOGANY	54 lbs/ft³ • 870 kg/m³	LIPIA	43 lbs/ft³ • 730 kg/m³
SPANISH CEDAR	29 lbs/ft³ • 470 kg/m³	ZATIBA	37 lbs/ft³ • 595 kg/m³	PURPLEHEART	38 lbs/ft³ • 595 kg/m³	OSMUNDIA UNTA	37 lbs/ft³ • 595 kg/m³	GONCALO ALVES	37 lbs/ft³ • 595 kg/m³	SANTOS MAHOGANY	36 lbs/ft³ • 595 kg/m³	LEOPARDWOOD	9 lbs/ft³ • 150 kg/m³	BALSA	29 lbs/ft³ • 445 kg/m³	PRIMAVERA	36 lbs/ft³ • 460 kg/m³	MONKEYPOD	40 lbs/ft³ • 955 kg/m³	GAROOON EBONY	42 lbs/ft³ • 685 kg/m³	MAKORE	45 lbs/ft³ • 725 kg/m³
CENTRAL AMERICA		SOUTH AMERICA										AFRICA											
AVERAGE DRIED WEIGHT (AT 12% MOISTURE CONTENT)	49 lbs/ft³ • 800 kg/m³	MACACUSA	48 lbs/ft³ • 760 kg/m³	CUMARU	27 lbs/ft³ • 430 kg/m³	PERUVIAN WALNUT	54 lbs/ft³ • 860 kg/m³	PAU FERRO	43 lbs/ft³ • 690 kg/m³	MASHERWOOD	42 lbs/ft³ • 690 kg/m³	TULIPWOOD	52 lbs/ft³ • 825 kg/m³	GREENHEART	50 lbs/ft³ • 825 kg/m³	BAZUMA	38 lbs/ft³ • 625 kg/m³	IROKO	41 lbs/ft³ • 660 kg/m³	SAPELE	42 lbs/ft³ • 670 kg/m³	AUSTRALIAN RED CEDAR	38 lbs/ft³ • 675 kg/m³
WOOD SAMPLE	52 lbs/ft³ • 830 kg/m³	CANARYWOOD	52 lbs/ft³ • 825 kg/m³	BLACK MESQUITE	23 lbs/ft³ • 350 kg/m³	LACEWOOD	76 lbs/ft³ • 1180 kg/m³	VERAWOOD	44 lbs/ft³ • 1025 kg/m³	CEBIL	52 lbs/ft³ • 825 kg/m³	IPÊ	48 lbs/ft³ • 1000 kg/m³	ANIGRE	34 lbs/ft³ • 550 kg/m³	PINK IVORY	79 lbs/ft³ • 1270 kg/m³	AFRICAN BLACKWOOD	52 lbs/ft³ • 825 kg/m³	JATOBÁ	24 lbs/ft³ • 540 kg/m³	SIKY OAK	42 lbs/ft³ • 680 kg/m³
COMMON NAME																						AUSTRALIAN BLACKWOOD	

A SPECIAL THANKS TO STEVE EARL, JUSTIN HOLDEN, AND KURT LOFGREN FOR PROVIDING SOME OF THE WOOD SAMPLES USED IN THIS POSTER.
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The Periodic Table of ACCOUNTING ELEMENTS

<http://www.opencolleges.edu.au/careers/periodic-table-of-accounting-elements>

CA	SDJ	FX	VA	PDJ	CRJ	MX	AE	DR	CR	AP	AR	PC	IN	COGS	LB	BS	RE	PIC	ADA	A	AM	L	OE	OC	RT	PO										
Chart of Accounts	Sales Distr. Journal	Fixed	Variable	Pur Distr. Journal	Cash Rec. Journal	Mixed	Accounting Equation	Debit	Credit	Accounts Payable	Accounts Receivable	Petty Cash	Inventory	Cost of Goods Sold	Ledger Balances	Balance Sheet	Retained Earnings	Paid In Capital	Allowance Doubtful Acc	Assets	Liability	Owners' Equity	Outstanding Cheques	Receiving Ticket	Purchase Order											
SDJ	VA	PDJ	CRJ	MX	AE	DR	CR	AP	AR	PC	IN	COGS	LB	BS	RE	DWM	PS	CNC	ABP	TD	TDIT	TD	TD	TD	TD											
Sales Distr. Journal	Variable	Pur Distr. Journal	Cash Rec. Journal	Mixed	Accounting Equation	Debit	Credit	Accounts Payable	Accounts Receivable	Petty Cash	Inventory	Cost of Goods Sold	Ledger Balances	Balance Sheet	Retained Earnings	Direct Write off Method	Percentage of Sales	Current & Non-Current	Adjusted Bal Book, Bank	Purchase Discount	Deposits In Transit	Trade Discount	Trade Discount	Trade Discount	Trade Discount	Trade Discount										
PDJ	CRJ	MX	AE	DR	CR	AP	AR	PC	IN	COGS	LB	BS	RE	DWM	PS	CNC	ABP	TD	TD	TD	TD	TD	TD	TD	TD											
Cash Rec. Journal	Cash Paym. Journal	General Margin	General Ledger	Trial Balance	Income Statement	Goods & Services Tax	GST Payable	GST Receivable	Perp Invent. Method	Perp Invent. Method	T Format	Columnar Format	Comprehen Income	Treasury Stock	Percentage of Acc Rec	Aging of Acc Rec	Demand Deposits	N30	CPJ	CM	GL	TB	IS	GST	GSTP	GSTR	PIM	PDCIM	TF	CF	CI	TS	PAR	AAR	DDEP	Net 30
Cash Paym. Journal	Cash Book	BEP	Capital	Depreciation	Gross Wages	Withholdings	Gain	Loss	Operating Income	Non-Oper Income	Cash Flow Statement	Cash Divident	Stock Dividend	Dividend Payable	Recovery of Bad Acc	Time Deposits	2/10	CB	General Margin	GL	TB	IS	GST	GSTP	GSTR	PIM	PDCIM	TF	CF	CI	TS	PAR	AAR	DDEP	Net 30	
Cash Book	BEP	Break Even Point	Capital	Depreciation	Gross Wages	Withholdings	Gain	Loss	Operating Income	Non-Oper Income	Cash Flow Statement	Cash Divident	Stock Dividend	Dividend Payable	Recovery of Bad Acc	Time Deposits	2/10	GJ	MS	DE	CA	SL	TA	CE	ACC	OA	IA	FA	CSDD	DD	RD	SS	FI	EOM	2/10, n30	
General Journal	Margin of Safety	Double Entry	Contra Account	Subsidiary Ledger	Temporary Accounts	Closing Entries	Accrual	Operating Activities	Investing Activities	Financial Activities	Common Stock Div Dis	Declaration Date	Record Date	Stock Split	Float	End of Month	2/10, n30	AEC	APC	GCC	MC	HCC	RLC	DCS	DD	DM	DCV	GAAP	IP	CP	RB	RV	IP	CP	RB	RV
General Journal	Margin of Safety	Double Entry	Contra Account	Subsidiary Ledger	Temporary Accounts	Closing Entries	Accrual	Operating Activities	Investing Activities	Financial Activities	Common Stock Div Dis	Declaration Date	Record Date	Stock Split	Float	End of Month	2/10, n30	Accounting Entity Conv	Accounting Period Conv	Going Concern Con	Monetary Convention	Historical Cost Conv	Recognition Law Conv	Doctrine of Consistency	Doctrine of Disclosure	Doctrine of Materiality	Doctrine of Conservatism	Doctrine of Conservatism	Industry Practices	Comparability	Reliability	Relevance	IP	CP	RB	RV
General Journal	Margin of Safety	Double Entry	Contra Account	Subsidiary Ledger	Temporary Accounts	Closing Entries	Accrual	Operating Activities	Investing Activities	Financial Activities	Common Stock Div Dis	Declaration Date	Record Date	Stock Split	Float	End of Month	2/10, n30	Working Capital	Current Ratio	Add-test Ratio	Quick Ratio	Receivables Turnover Ratio	Asset Turnover Rat	Inventory Turnover Rat	Average Coll Period	Days Sales Inventory	Free Cash Flow	Times Int Earned	Gross Margin	Gross Margin%	Return on Assets	Return on Equity	IP	CP	RB	RV
General Journal	Margin of Safety	Double Entry	Contra Account	Subsidiary Ledger	Temporary Accounts	Closing Entries	Accrual	Operating Activities	Investing Activities	Financial Activities	Common Stock Div Dis	Declaration Date	Record Date	Stock Split	Float	End of Month	2/10, n30	Working Capital	Current Ratio	Add-test Ratio	Quick Ratio	Receivables Turnover Ratio	Asset Turnover Rat	Inventory Turnover Rat	Average Coll Period	Days Sales Inventory	Free Cash Flow	Times Int Earned	Gross Margin	Gross Margin%	Return on Assets	Return on Equity	IP	CP	RB	RV

H	He
Li	Heineken
Be	Bing
Tin	Coca-Cola
Na	Nestle
Mg	Oogle
K	F
Ca	Ne
Sc	He
Ti	Heineken
V	Heineken
Cr	Heineken
Mn	Heineken
Fe	Heineken
Co	Heineken
Ni	Heineken
Cu	Heineken
Zn	Heineken
Ga	Heineken
Ge	Heineken
As	Heineken
Se	Heineken
Br	Heineken
Kr	Heineken
Rb	Canadian Club
Sr	Schweppes
Y	TIME
Zr	Dove Magazine
Nb	TIME
Mo	TIME
Tc	TIME
Ru	TIME
Pd	TIME
Ag	TIME
Cd	TIME
In	TIME
Sn	TIME
Sb	TIME
Te	TIME
I	TIME
Xe	TIME
Cs	British Airways
Ba	Hillshire Farm
Hf	Ta
Ta	W
Re	Os
Ir	Pt
Pt	Au
Hg	Tl
Tl	Pb
Bi	Po
Po	At
At	Rn
Fr	Ra
Ra	Rf
Db	Db
Sg	Bh
Bh	Hs
Mt	Ds
Rg	Rg
Cn	Uut
A	Uup
Lv	Uus
Uuo	Uuo
La	Ce
Ce	Pr
Pr	Nd
Pm	Pm
Sm	Eu
Gd	Gd
Tb	Tb
Dy	Dy
Ho	Ho
Er	Er
Tm	Yb
Lu	Lu
Ac	Th
Th	Pa
Pa	U
Np	Np
Pu	Am
Am	Cm
Bk	Bk
Cf	Cf
Es	Fm
Fm	Md
Md	No
No	Lr

Periodic Table of Famous Trademarks



Periodic Table of Marketing Elements

1 Cu
Curiosity

2 Da
Display Advertising

3 Ns
Natural Search (SEO)

4 Em
Email

6 Ps
Paid Search

7 Sm
Social Media

8 Dm
Direct Mail

9 Rt
Retargeting

13 Af
Affiliate Program

14 Bl
Blogging

15 Im
Images

16 We
Website Enhancements

17 Bc
Basecamp

18 Lc
Liveclicker

19 S7
Scene 7

20 Pw
PR Web

21 Ir
Internet Retailer

22 Bg
Bing Ads Editor

23 Et
Exact Target

24 Tw
Twitter

25 Wp
Wordpress

26 Sr
SEM Rush

27 Ce
CEO Letter

28 Cn
Contests

29 Ep
Empathy

30 Sf
SureFit Guarantees

31 Sh
Shopping Engines

32 Pr
Public Relations

33 Pm
Promotions

34 Fs
Free Samples

35 Gz
Gomez

36 Lv
Livperson

37 Ps
Photoshop

38 Ci
Cision

39 So
Shop.org

40 Pn
Pinterest

41 Bv
Bazaarvoice

42 Fb
Facebook

43 Sv
Survey Monkey

44 Ck
Cake

45 Ut
User Testing

46 Cg
Crazy Egg

47 Sp
Speed

48 Cs
Customer Service

49 Np
New Products

50 Ba
Brand Ambassadors

51 Ab
A/B Testing

52 Mc
Merchandising

53 Tt
Test & Target

54 Fw
Fireworks

55 Pp
Premiere Pro

56 Mb
Media Bistro

57 Ad
Google Adwords

58 Mn
Mantis

59 El
Excel

60 Yt
Youtube

61 Sk
Shortstack

62 Ex
Experimenting

63 Be
Brightedge

64 Ss
Site Surveys

65 Cl
Call Reviews

66 F2
Face2Face

67 Ra
Radio

68 Ap
Apps

69 Mv
Multivariate Testing

70 Bt
Behavioural Targeting

71 Om
Omniture

72 Dw
Dreamweaver

73 Ae
After Effects

74 Ai
Illustrator

75 Ss
Sprout Social

76 Hz
Houzz

77 Ga
Google Analytics

78 Go
Google Optimizer

79 Gt
Google Trends

80 Ev
eSearch Vision

81 Ja
Coffee

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Attract Prospects
Convert Prospects into Customers
Tools
Get Customer Feedback
Make it Surprisingly Easy and Exciting So They Tell Everyone!

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1st Time Right

10 Fs
Free Shipping

11 Vi
Videos

12 Rp
Referral Programs

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A PERIODIC TABLE OF VISUALIZATION METHODS

> < C continuum	Data Visualization Visual representations of quantitative data in schematic form (either with or without axes)	Strategy Visualization The systematic use of complementary visual representations in the analysis, development, formulation, communication, and implementation of strategies in organizations.	G graphic facilitation
> < Tb table	> < Ca cartesian coordinates	Information Visualization The use of interactive visual representations of data to amplify cognition. This means that the data is transformed into an image, it is mapped to screen space. The image can be changed by users as they proceed working with it	Metaphor Visualization Visual Metaphors position information graphically to organize and structure information. They also convey an insight about the represented information through the key characteristics of the metaphor that is employed
> < Pi pie chart	> < L line chart	Concept Visualization Methods to elaborate (mostly) qualitative concepts, ideas, plans, and analyses.	Compound Visualization The complementary use of different graphic representation formats in one single schema or frame
> < B bar chart	> < Ac area chart	> < R radar chart cobweb	> < Me meeting trace
> < Hi histogram	> < Sc scatterplot	> < Sa sankey diagram	> < Mm metro map
> < Hy hyperbolic tree	> < Pa parallel coordinates	> < Hy hyperbolic tree	> < Tm temple
> < Cy cycle diagram	> < Ey cycle diagram	> < T timeline	< > St story template
> < Ve venn diagram	> < Ve venn diagram	> < Mi mindmap	> < Tr tree
> < Li layer chart	< > Sq square of oppositions	> < Cc concentric circles	G graphic facilitation
> < Cl clustering	> < Ar argument slide	> < Sw swim lane diagram	> < Ct cartoon
> < Fl flow chart	> < Co communication diagram	> < Gc gantt chart	
> < Cl clustering	> < Fp flight plan	> < Pm perspectives diagram	
> < Py minto pyramid technique	> < Ds dilemma diagram	> < D dilemma diagram	
> < Ce cause-effect chains	> < Tl toulmin map	> < Pr parameter ruler	
> < Tl toulmin map	> < Dt decision tree	> < Kn knowledge map	
> < Cp cpm critical path method	> < Cf concept fan		
> < Cp concept map	> < Co concept map		
> < Dt decision tree	> < Ic iceberg		
> < Cp concept map	> < Lm learning map		
> < Ev evocative knowledge map	> < V Vee diagram		
> < Pe pert chart	< > Hh heaven 'n' hell chart		
> < Pr process event chains	> < I infomural		
> < Ed edgeworth box	> < Ed supply demand curve	> < Pc performance charting	> < St strategy map
> < Pf portfolio diagram	> < St strategy map	> < Oc organisation chart	< > Ho house of quality
> < Sg strategic game board	> < Oc organisation chart	> < Fd feedback diagram	> < Ft failure tree
> < Mz mintzberg's organigraph	< > Z zwicky's morphological box	< > Mq magic quadrant	> < Ld life-cycle diagram
> < Ad affinity diagram	< > De decision discovery diagram	> < Po porter's five forces	> < S s-cycle
> < Bm bcg matrix	> < Bm bcg matrix	< > Sm stakeholder map	< > Is ishikawa diagram
> < Stc strategy canvas	> < Stc strategy canvas	> < Tc technology roadmap	> < Ta taps
> < Hy hypercyclic	> < Vc value chain	< > Sr stakeholder rating map	< > Sd spray diagram

Cy Process Visualization

Hy Structure Visualization

○ Overview
□ Detail

○ Detail AND Overview

< > Divergent thinking

> < Convergent thinking

Note: Depending on your location and connection speed it can take some time to load a pop-up picture.

© Ralph Lengler & Martin J. Eppler, www.visual-literacy.org

version 1.5

> < Su supply demand curve	> < Pc performance charting	> < St strategy map	> < Oc organisation chart	< > Ho house of quality	> < Fd feedback diagram	□ Ft failure tree	> < Mq magic quadrant	> < Ld life-cycle diagram	> < Po porter's five forces	< > S s-cycle	> < Sm stakeholder map	○ Is ishikawa diagram	> < Tc technology roadmap
> < Ed edgeworth box	> < Pf portfolio diagram	> < Sg strategic game board	> < Mz mintzberg's organigraph	< > Z zwicky's morphological box	< > Ad affinity diagram	> < De decision discovery diagram	> < Bm bcg matrix	> < Stc strategy canvas	> < Vc value chain	< > Hy hypercyclic	> < Sr stakeholder rating map	> < Ta taps	< > Sd spray diagram

http://www.visual-literacy.org/periodic_table/periodic_table.html

Visualization is not Periodic, Period!

Robert Kosara, <http://eagereyes.org/blog/2009/visualization-is-not-periodic-html>

Much better...

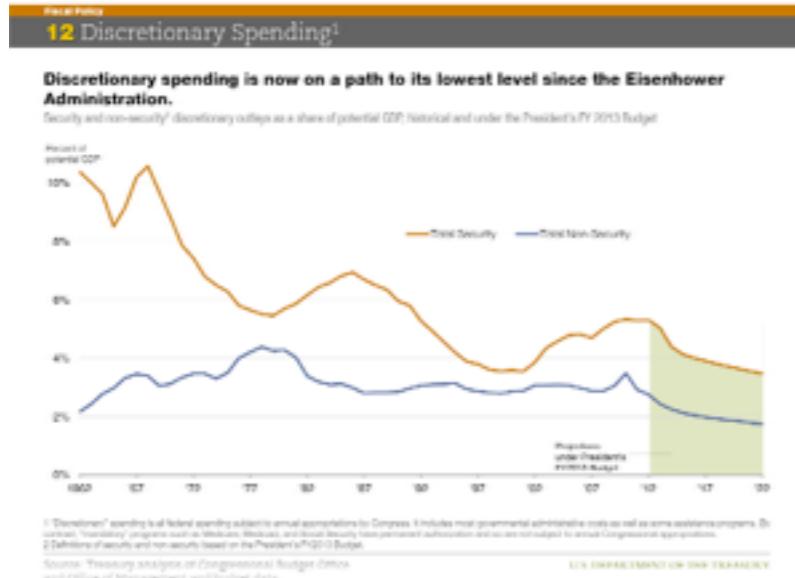
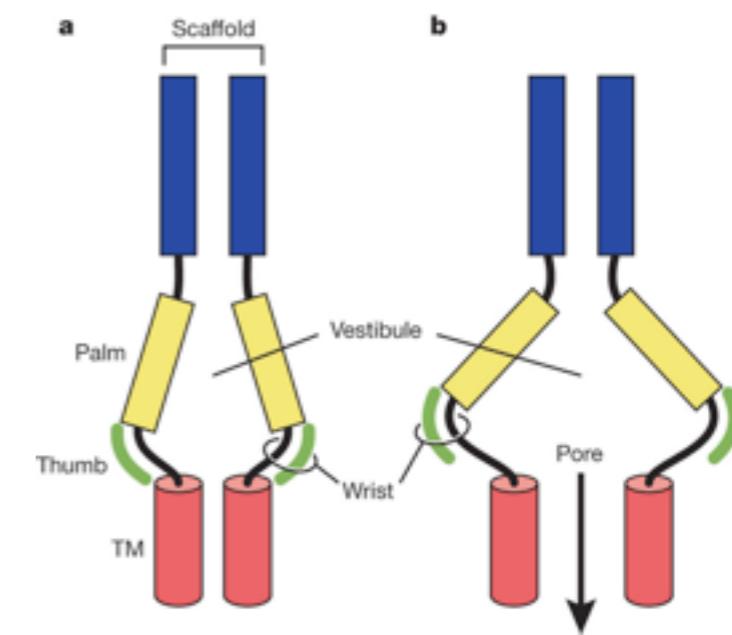
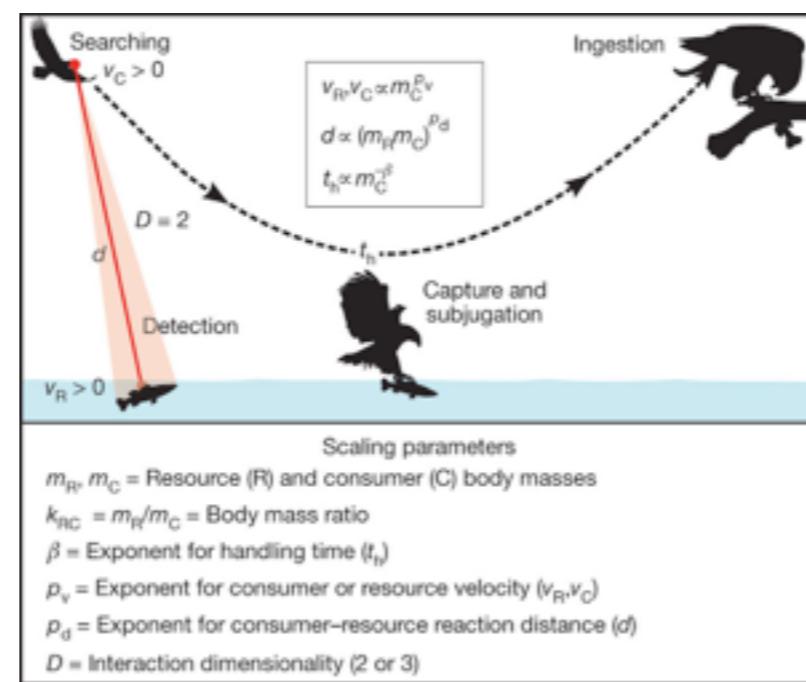
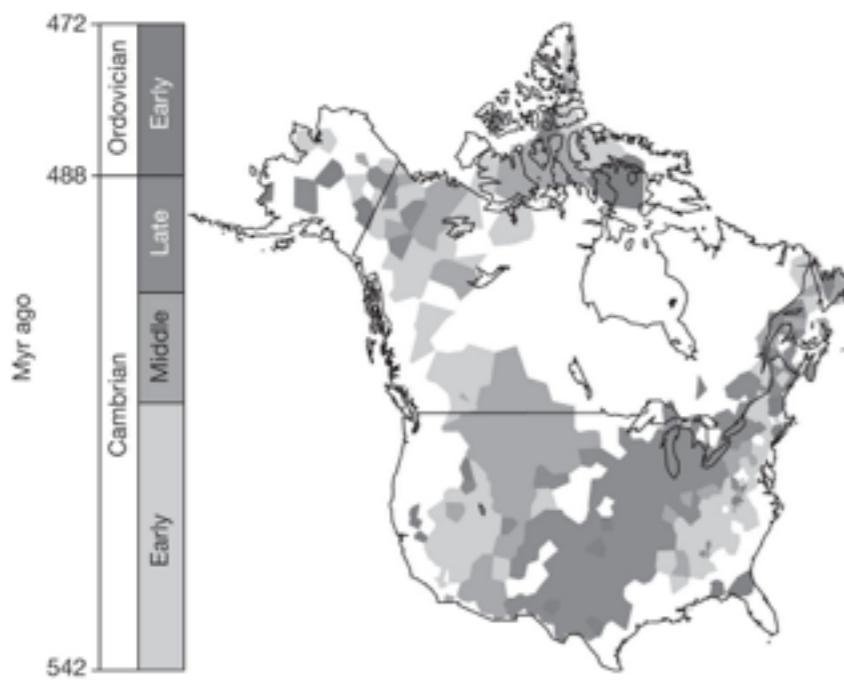
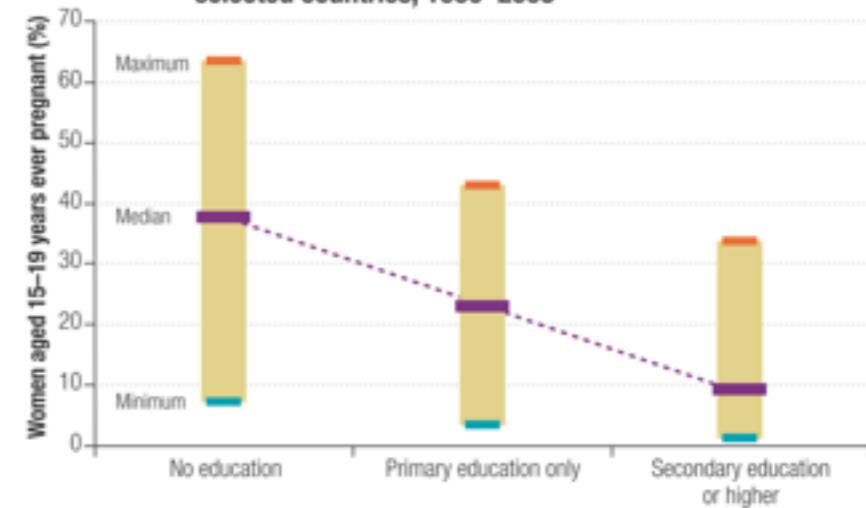
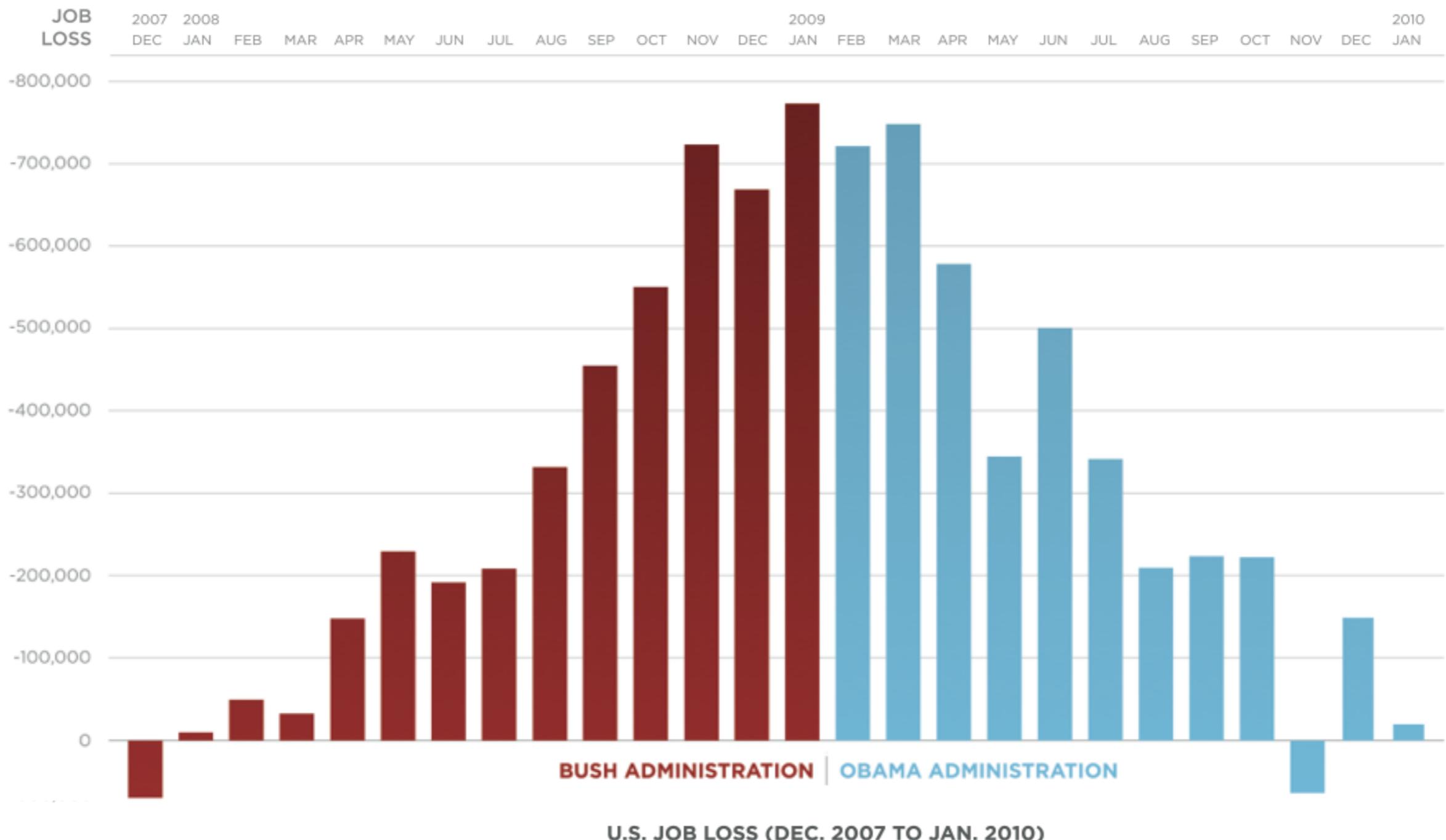


Figure 2 Adolescence pregnancy rates by educational level, selected countries, 1990–2005



Sources: US Treasury, WHO, Nature

Bikini Chart



SOURCE: BUREAU OF LABOR STATISTICS, 02/12/2010

What exactly makes a
visualization effective?

Visual Variables

Jacques Bertin

French cartographer
[1918-2010]

Book: Semiology of Graphics
[1967]

Theoretical principles for
visual encodings



Visual Marks

Basic geometric elements

→ Points



0D

→ Lines



1D

→ Areas



2D

Visual Variables (aka Channels)

④ Position

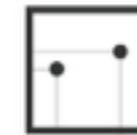
→ Horizontal



→ Vertical



→ Both



④ Color



④ Shape



④ Tilt



④ Size

→ Length



→ Area



→ Volume



Using Marks and Attributes



Length



Position



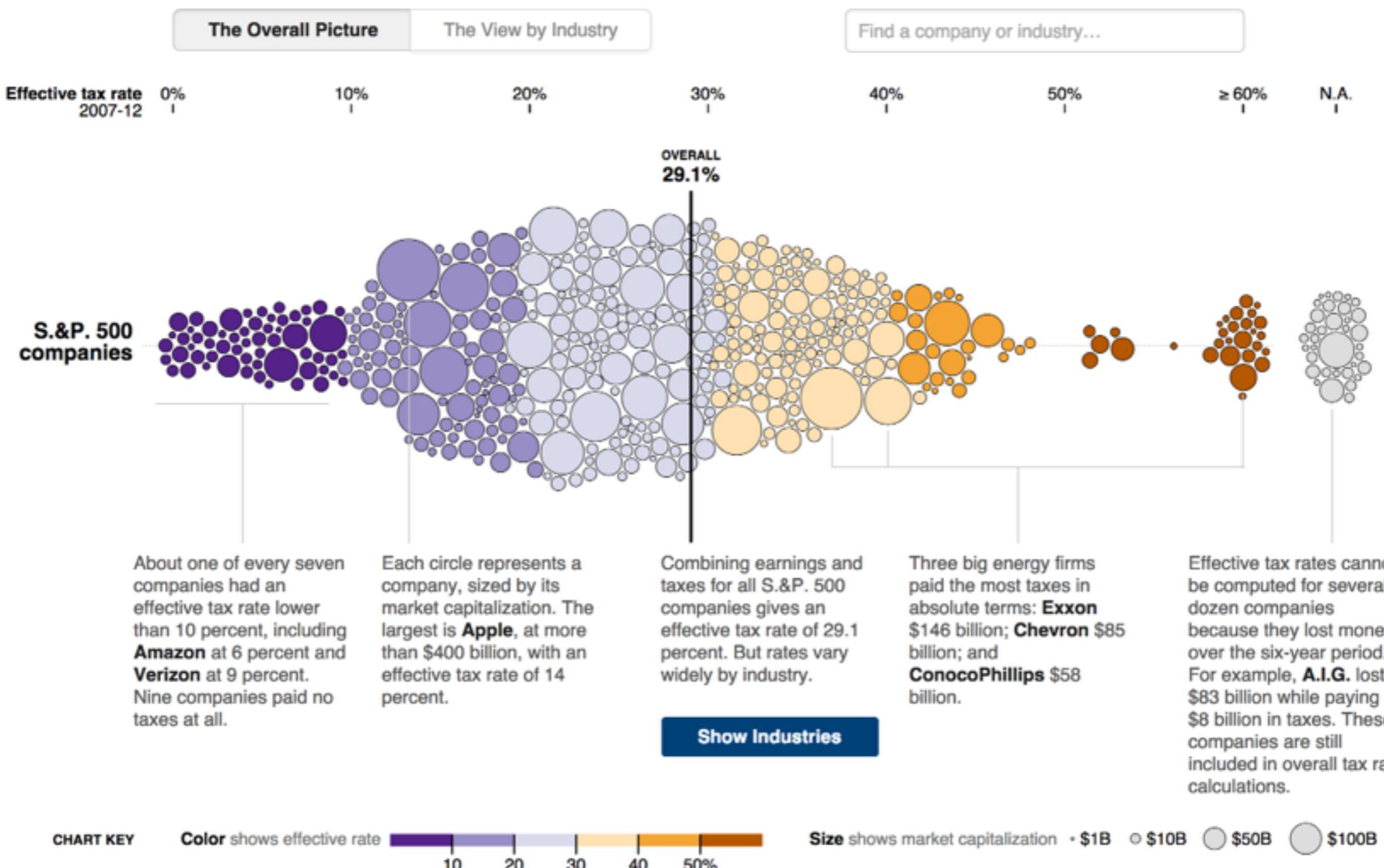
Color



Size

Across U.S. Companies, Tax Rates Vary Greatly

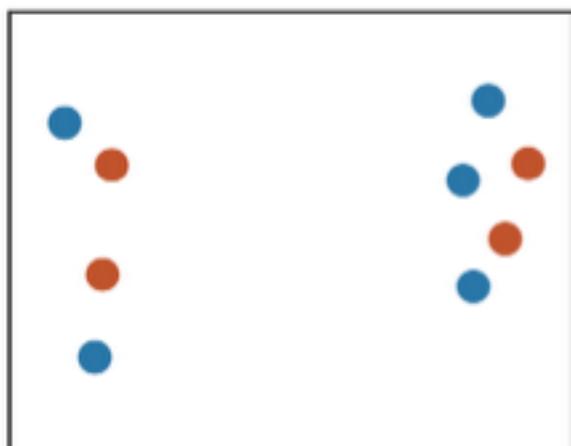
Last week, in a Congressional hearing, Apple got grilled for its low-tax strategy. But not every business can copy that approach. Here is a look at what S&P 500 companies paid in corporate income taxes — federal, state, local and foreign — from 2007 to 2012, according to S&P Capital IQ. [Related Article »](#)



What visual variables are used?

Separability of Attributes

Position
+ Hue (Color)



Fully separable

Size
+ Hue (Color)



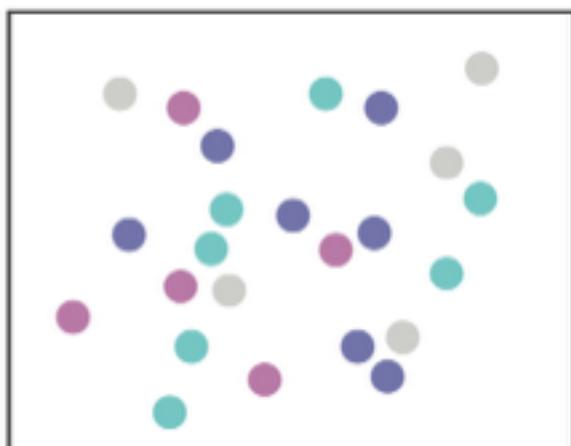
Some interference

Width
+ Height



Some/significant
interference

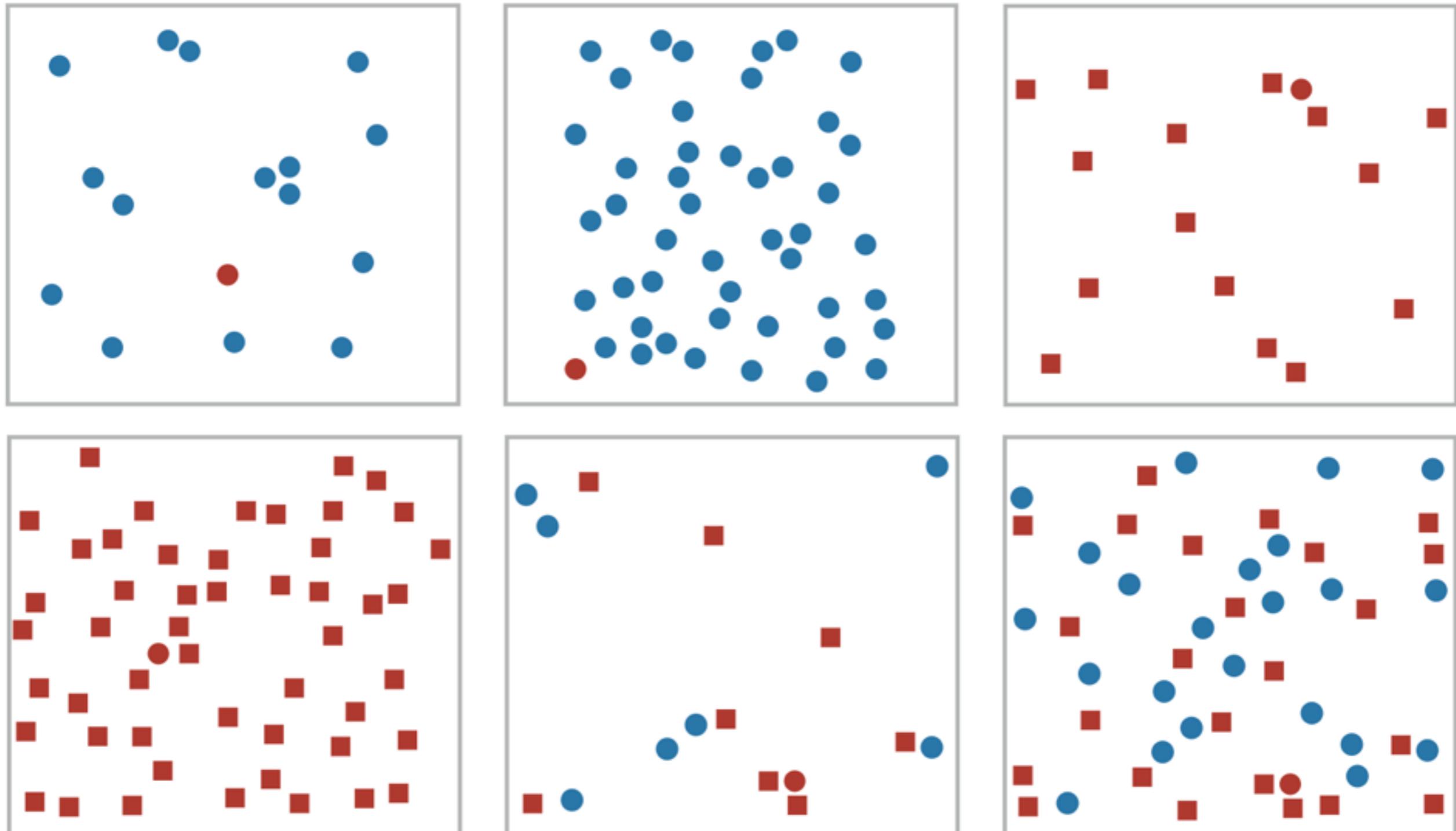
Red
+ Green



Major interference

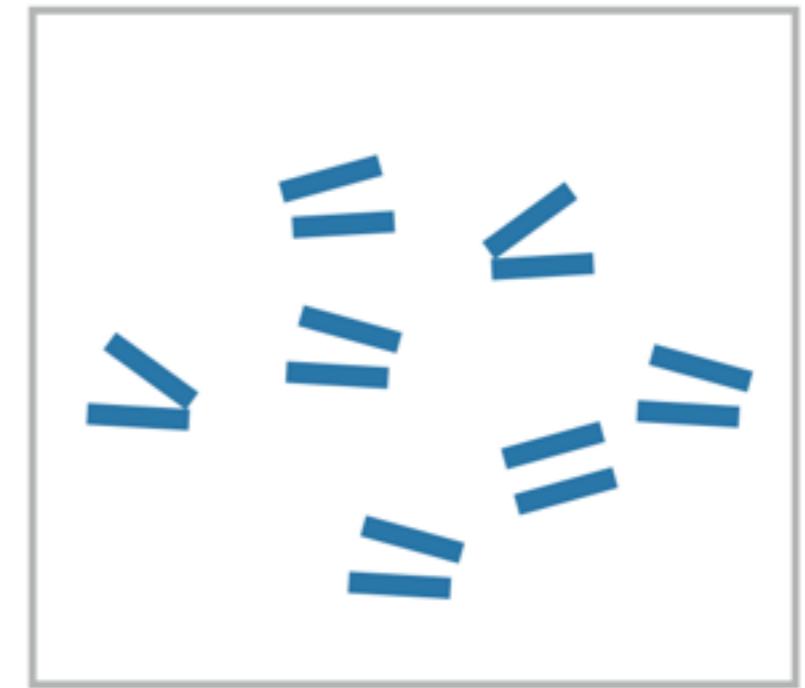
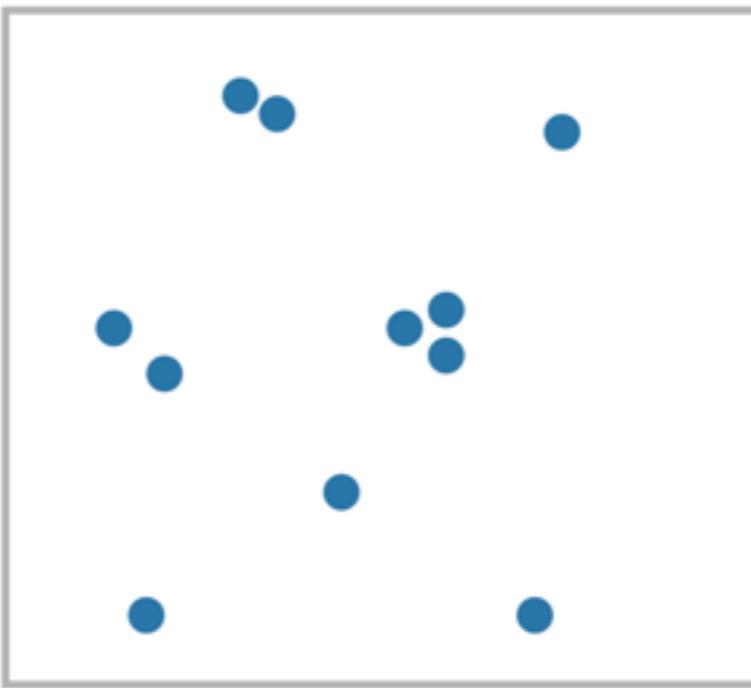
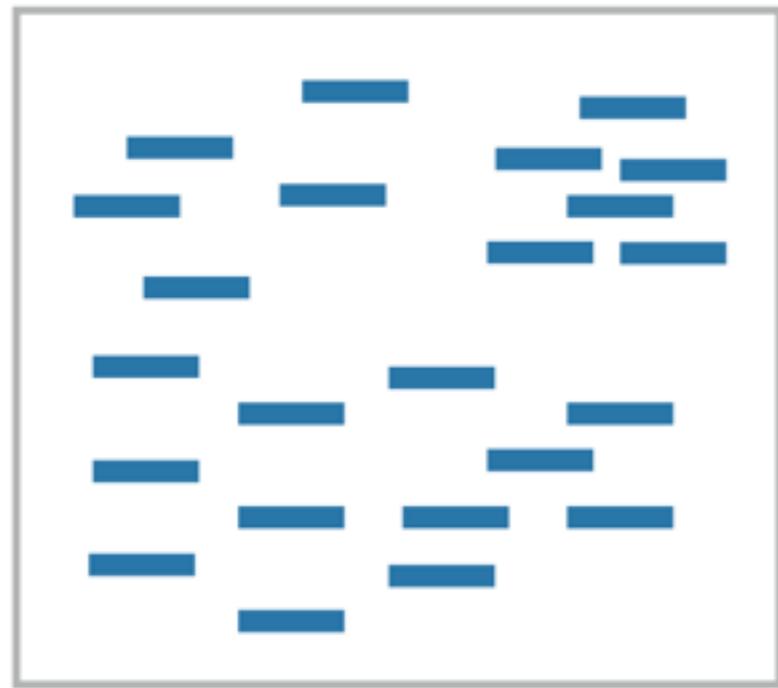
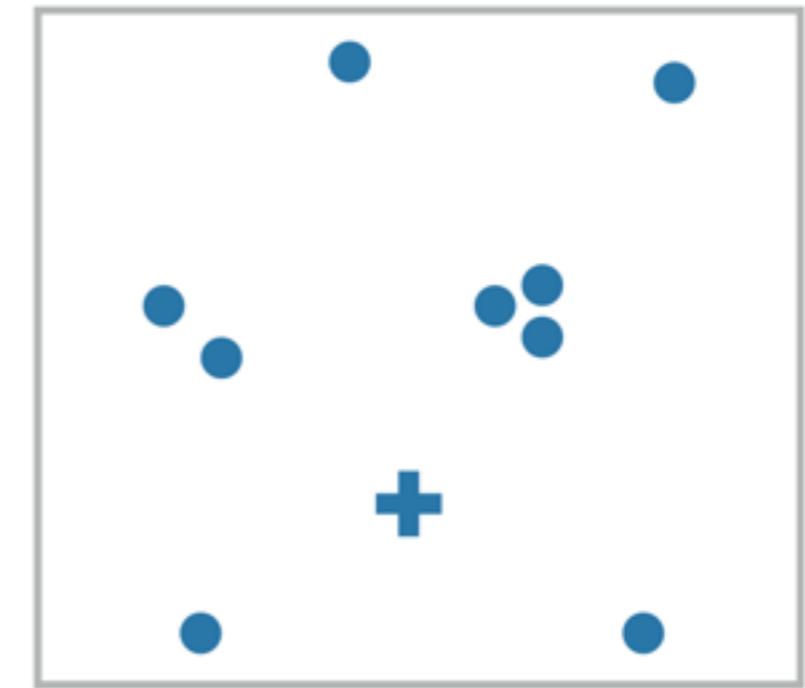
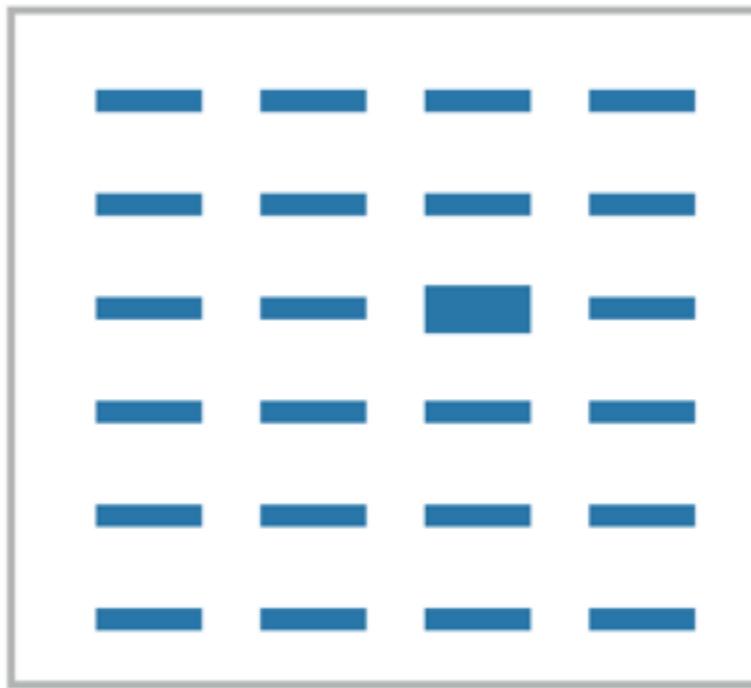
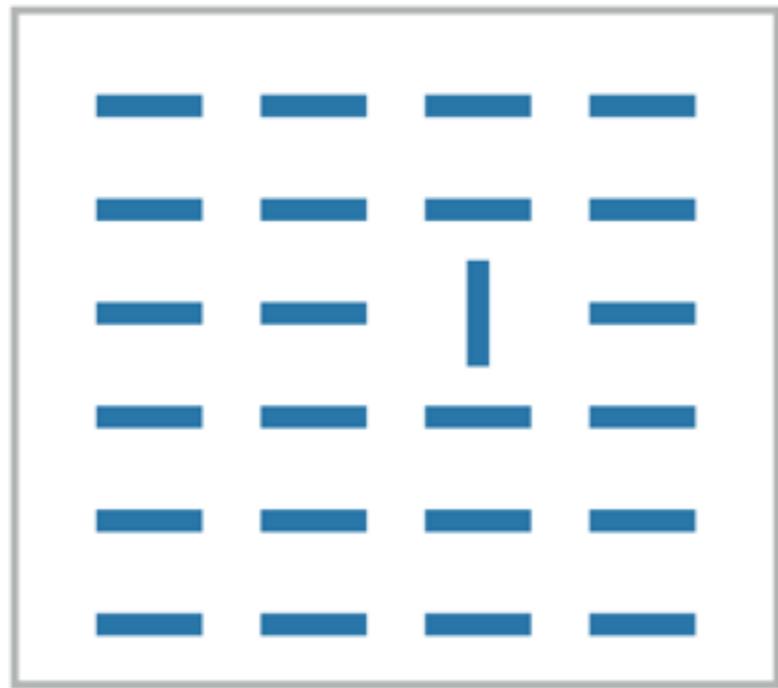
Visual Popout

Preattentive Features

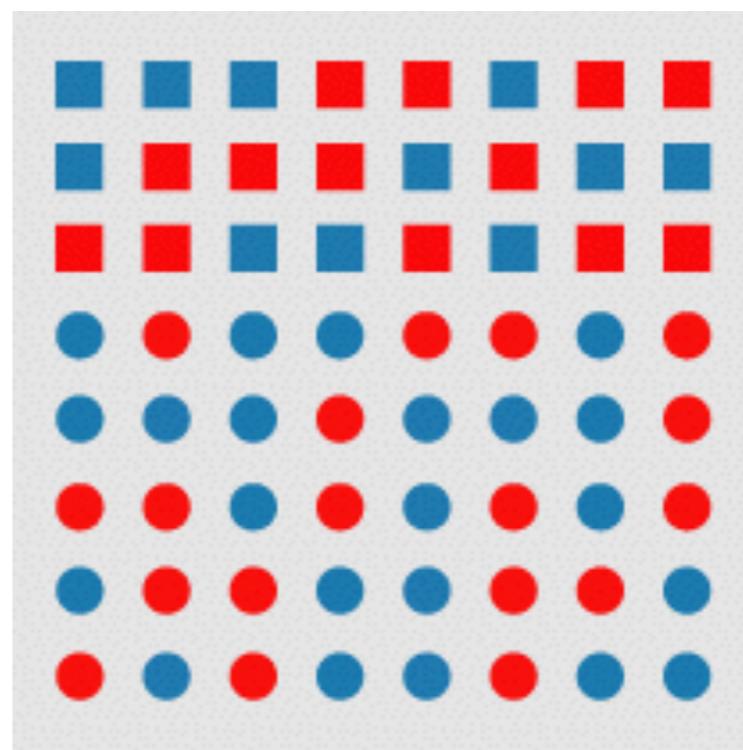
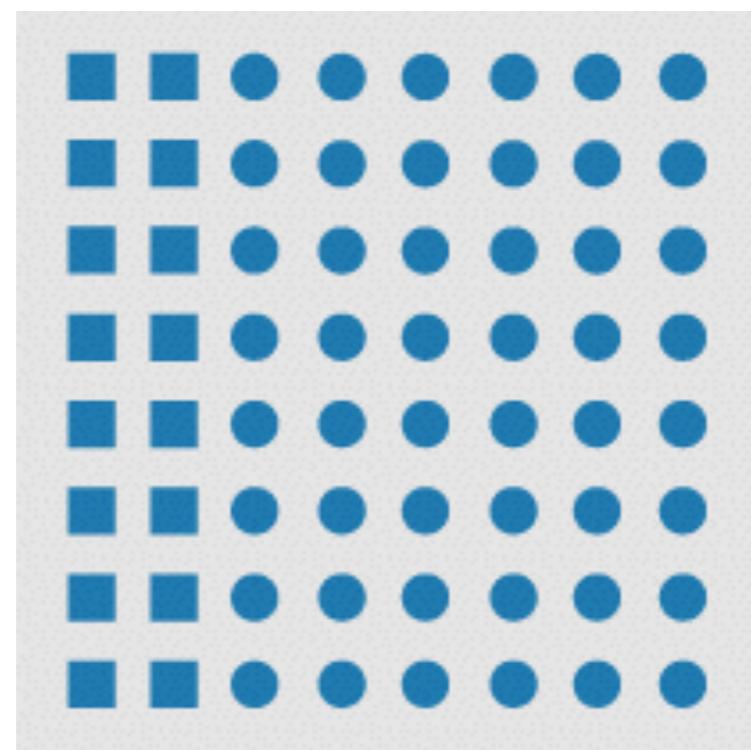
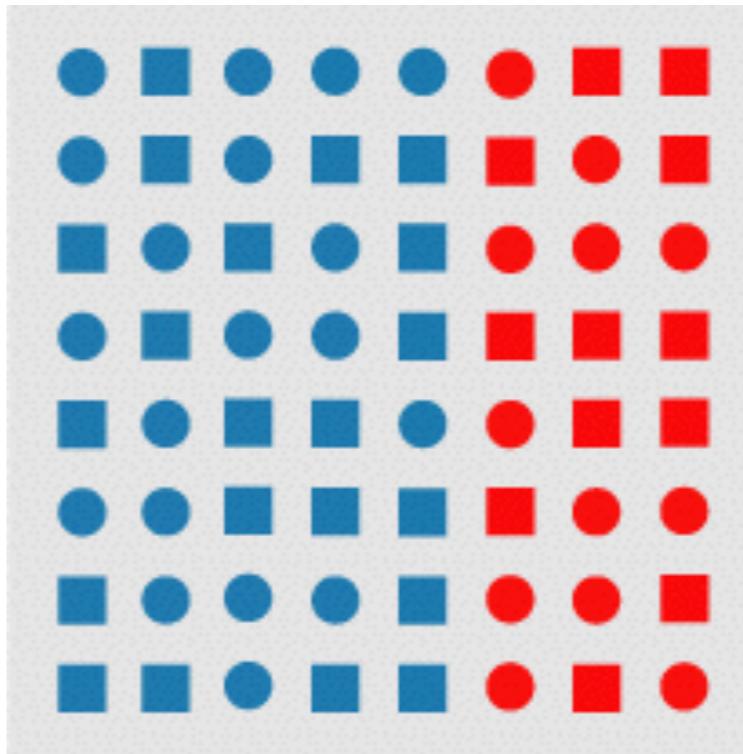
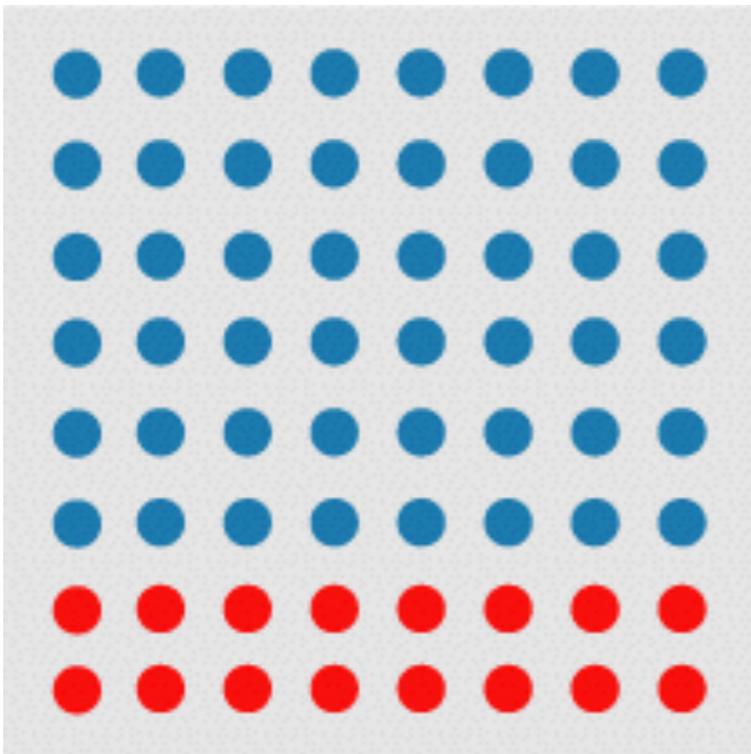


Visual Popout

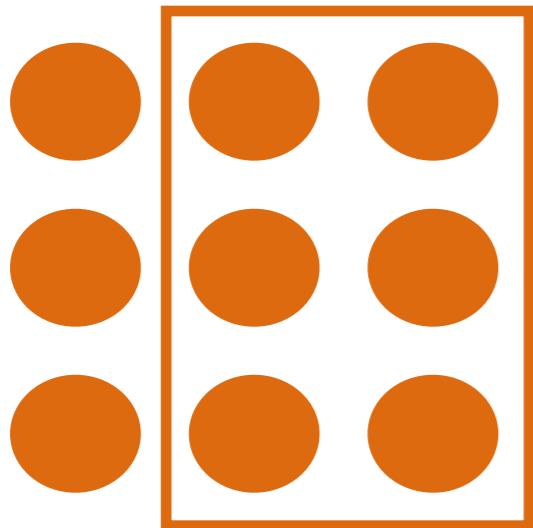
Preattentive Features



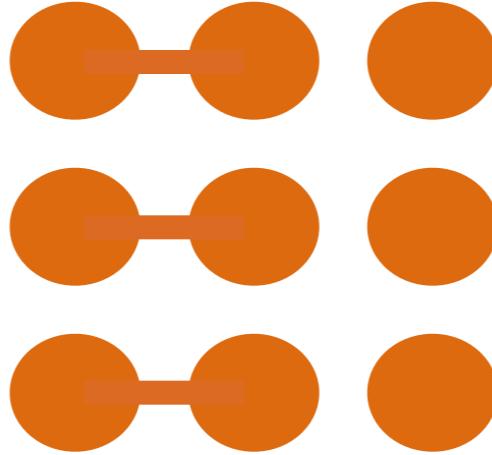
Feature Hierarchy



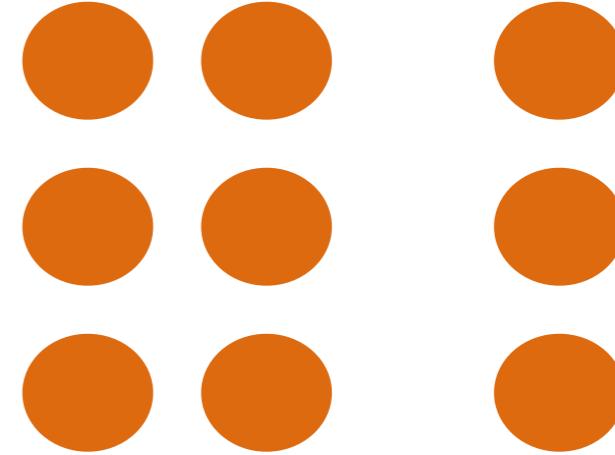
Grouping Principles



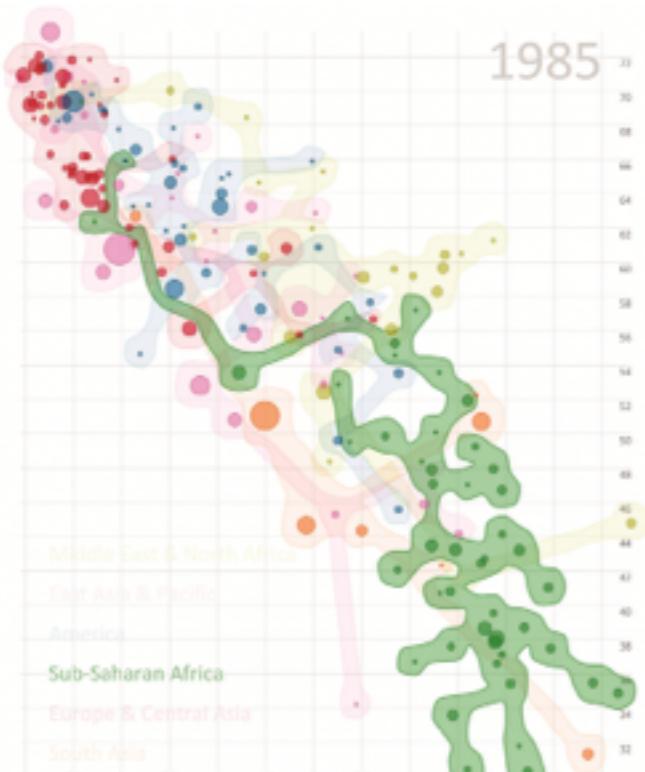
Containment



Connection



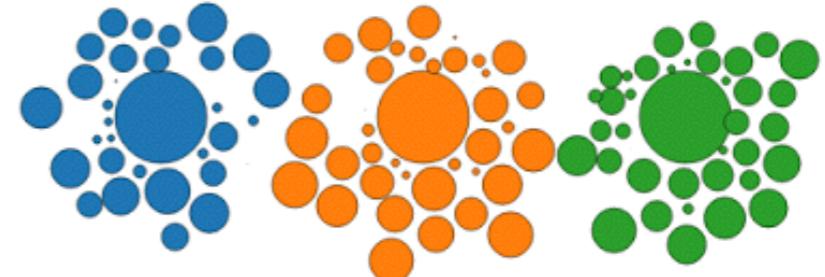
Proximity



Collins et al. 2009

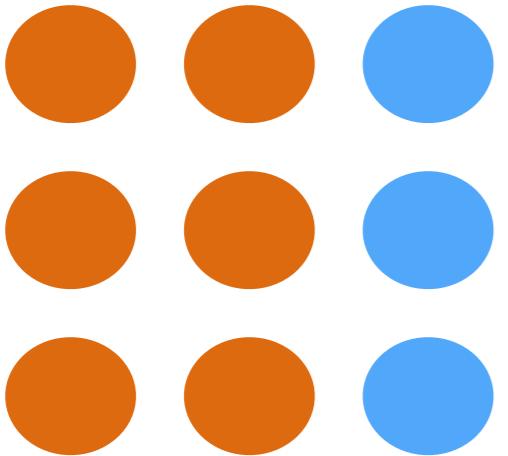


D3.js Example

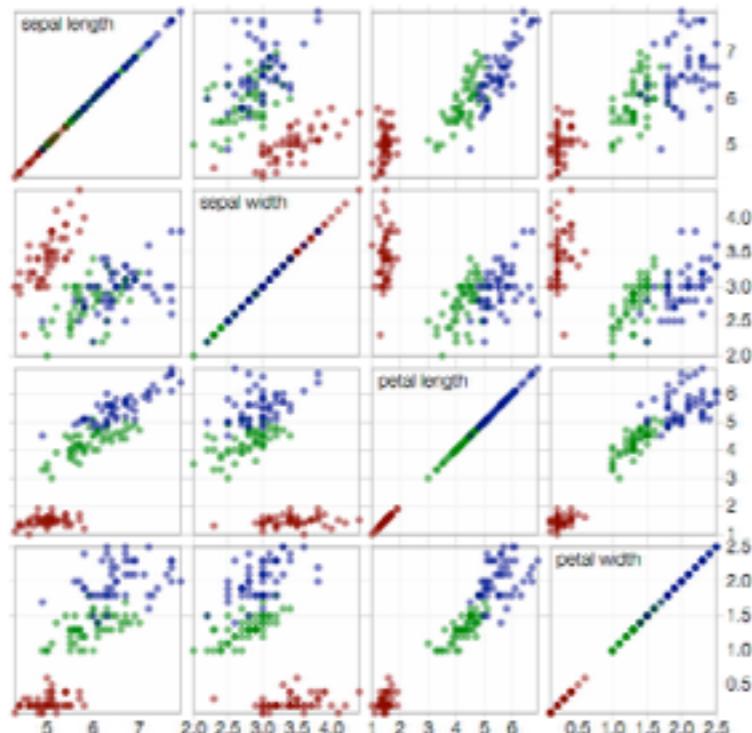


D3.js Example

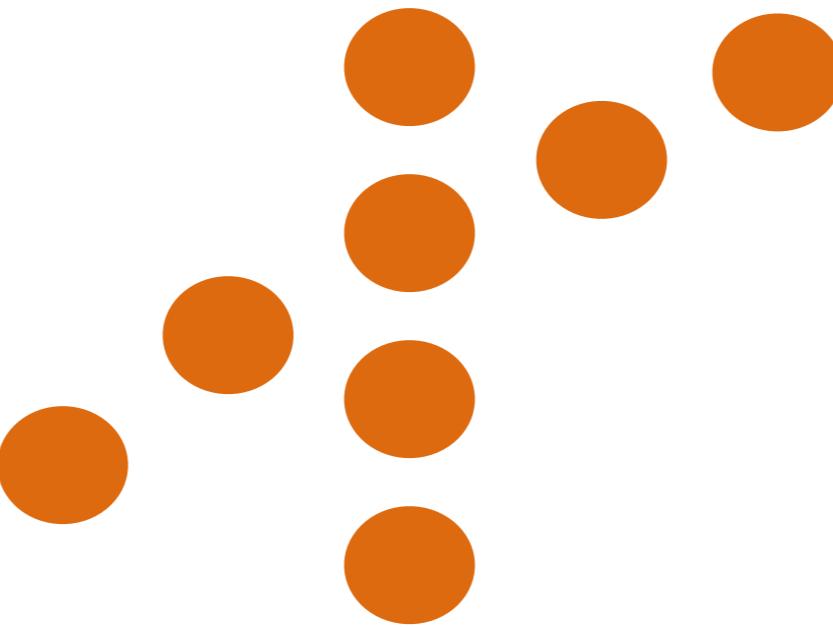
Grouping Principles



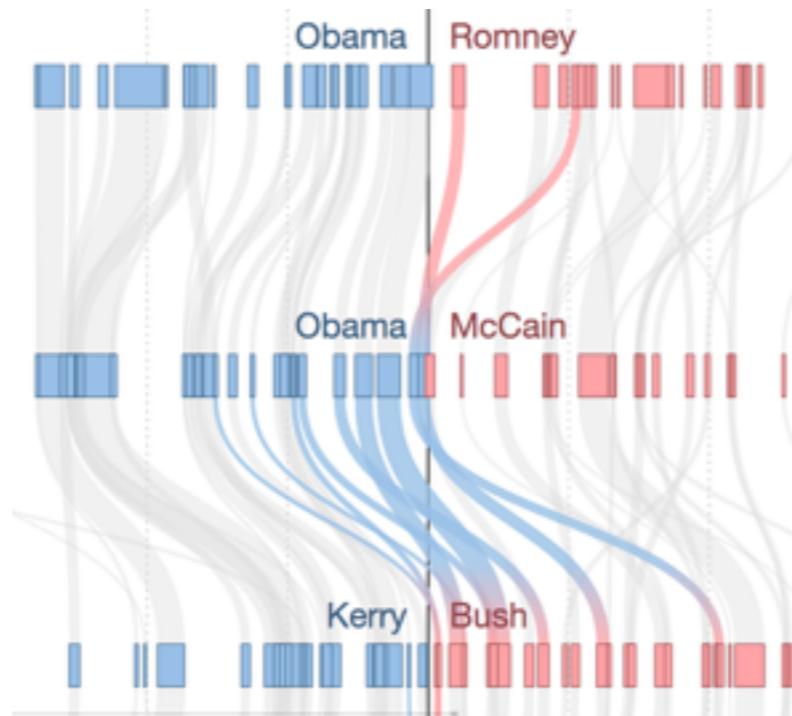
Similarity



D3.js Example



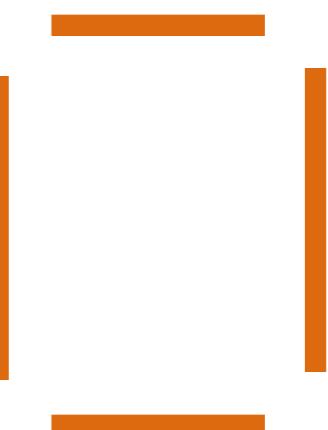
Continuity



NYT Swing States



Common Fate



Closure

Visual Attributes by Data Type

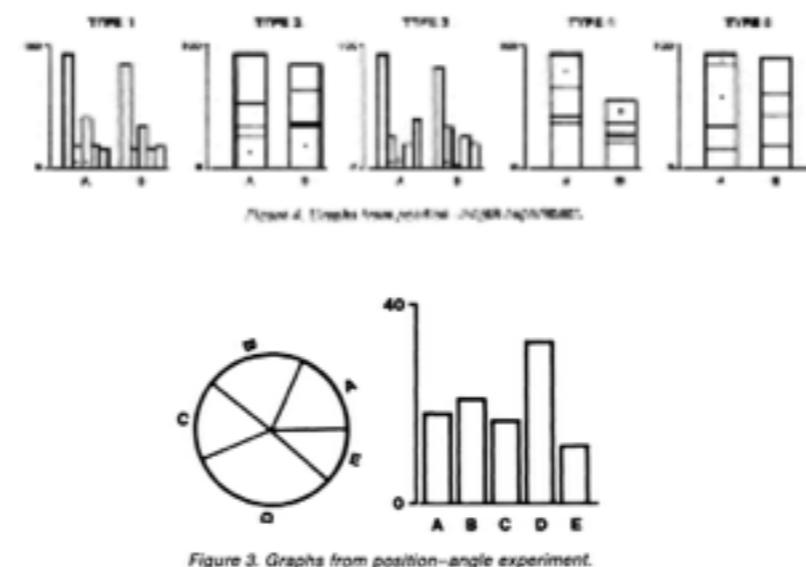
Bertin, 1967

	Categories	Ordinal	Quantitative
Position	✓	✓	✓
Length	✓	✓	✓
Brightness	✓	✓	~
Texture	✓	~	✗
Color	✓	~	✗
Angle	✓	✗	✗
Shape	✓	✗	✗

✓ = Good
 ~ = OK
 ✗ = Bad

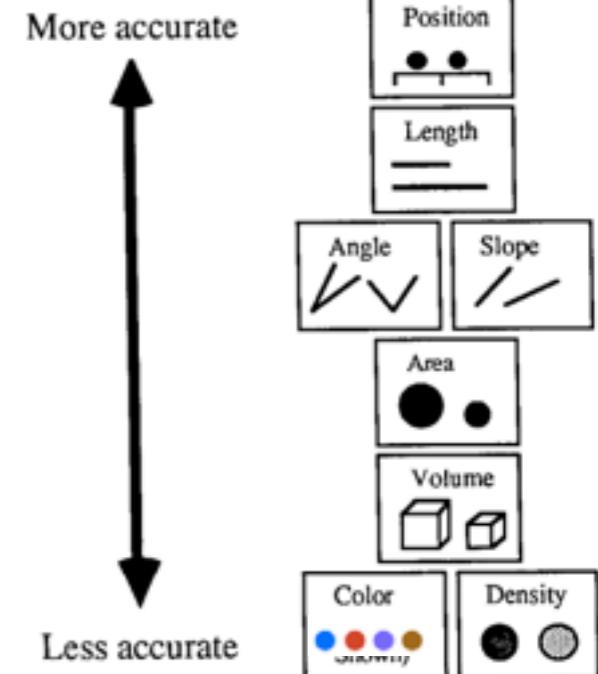
Bertin, Semiology of Graphics, 1967

Cleveland / McGill, 1984



William S. Cleveland; Robert McGill , “Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods.” 1984

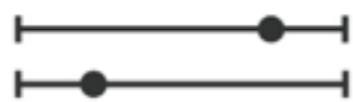
Mackinlay, 1986



Jock Mackinlay “Automating The Design of Graphical Presentations.” 1986

→ Magnitude Channels: Ordered Attributes

Position on common scale



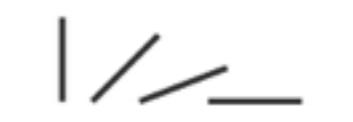
Position on unaligned scale



Length (1D size)



Tilt/angle



Area (2D size)



Depth (3D position)



Color luminance



Color saturation



Curvature



Volume (3D size)



→ Identity Channels: Categorical Attributes

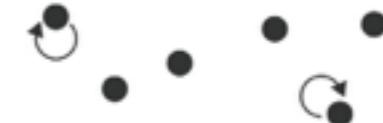
Spatial region



Color hue



Motion



Shape



Most ▲

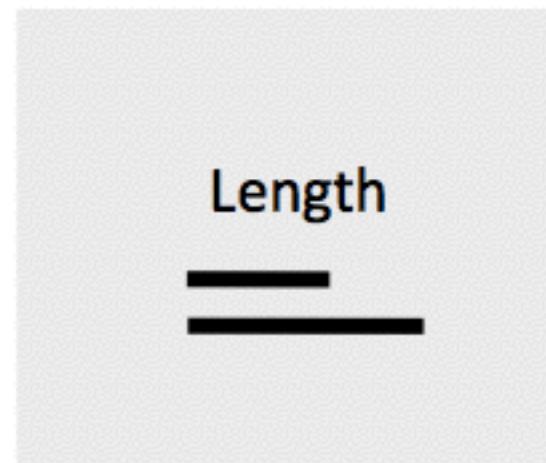
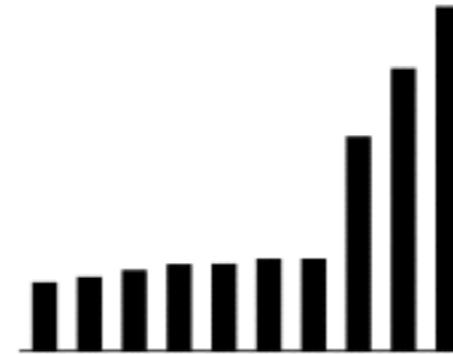
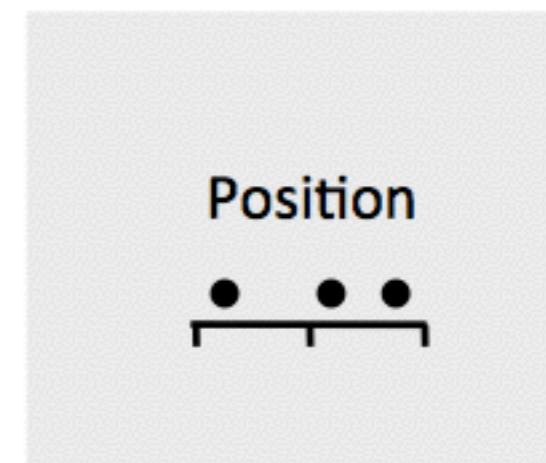
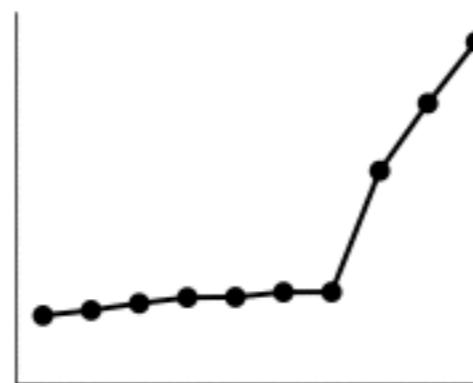
Effectiveness

Least ▼

Same] [Same]

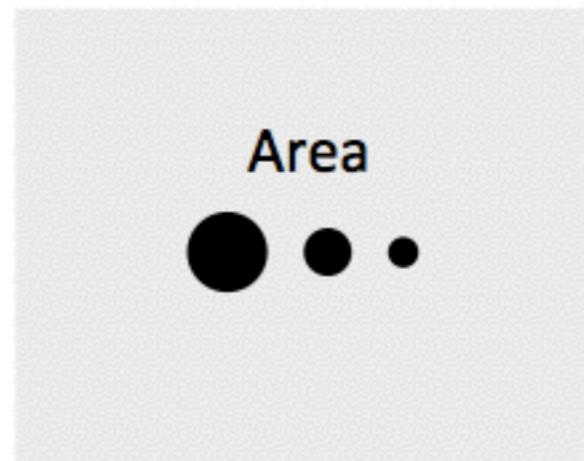
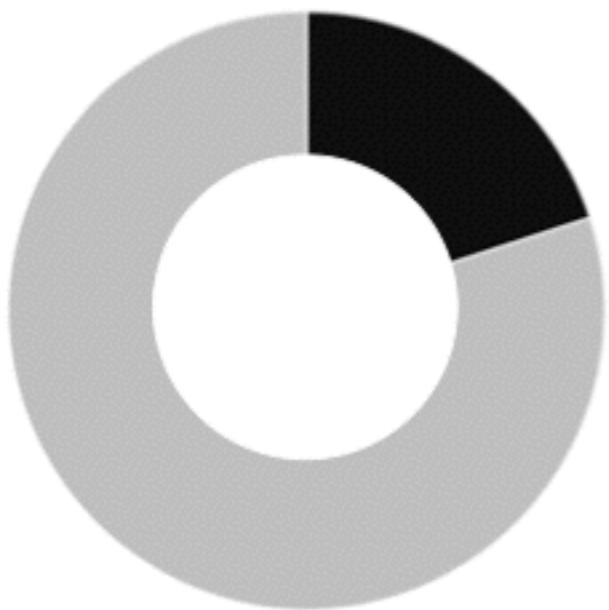
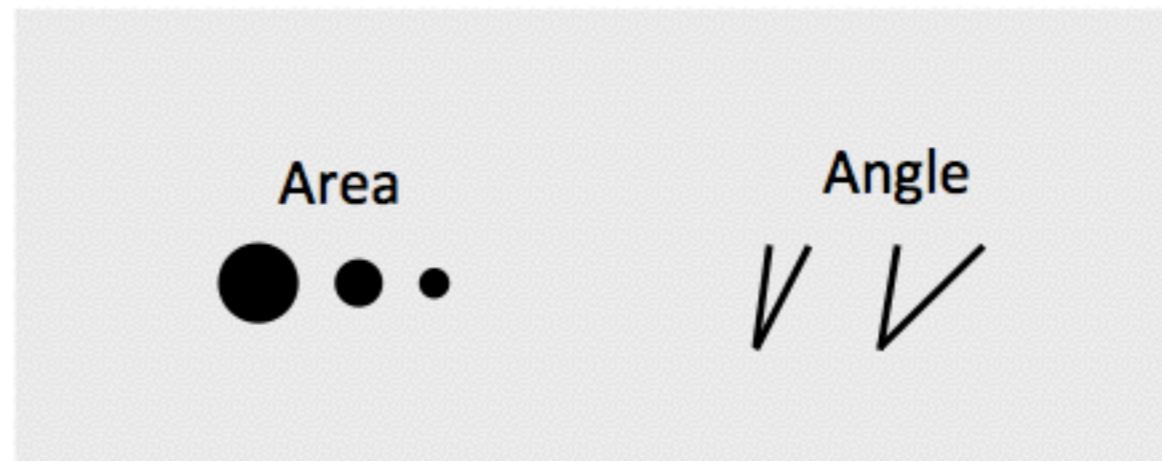
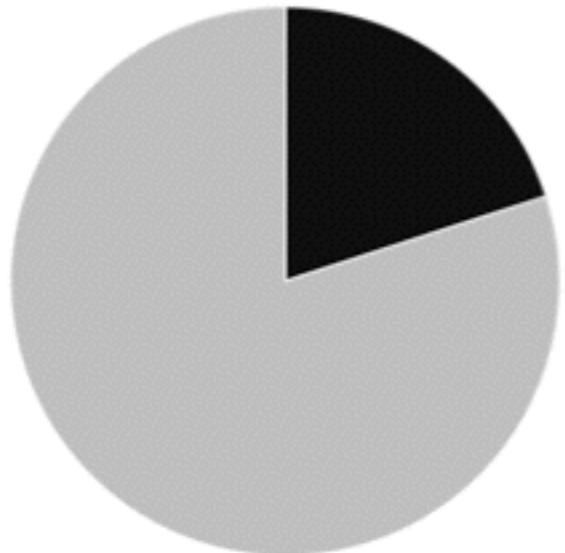
Most Effective

For Quantitative/Ordinal Data



Less Effective

For Quantitative/Ordinal Data



Least Effective: Color For Quantitative/Ordinal Data

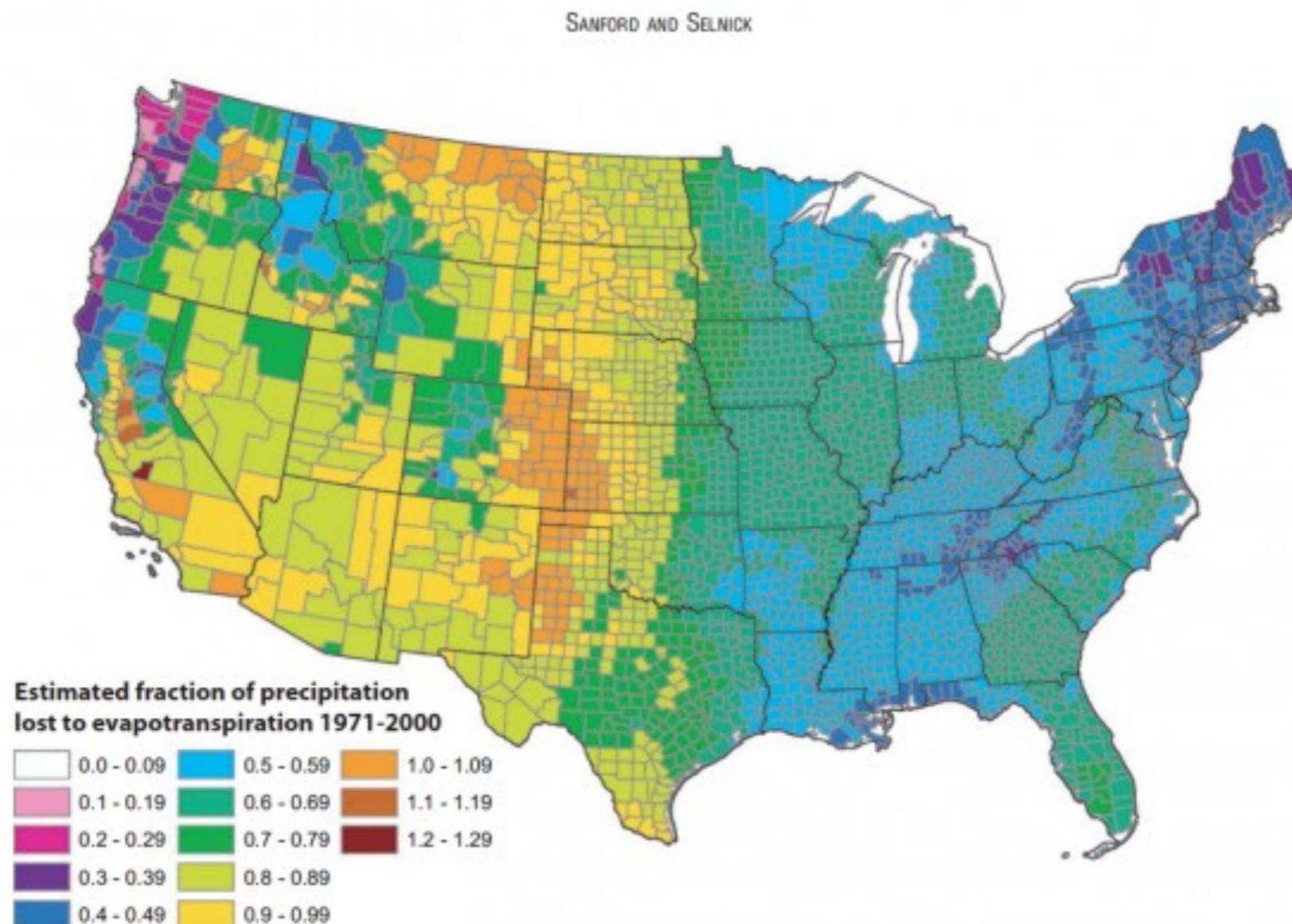
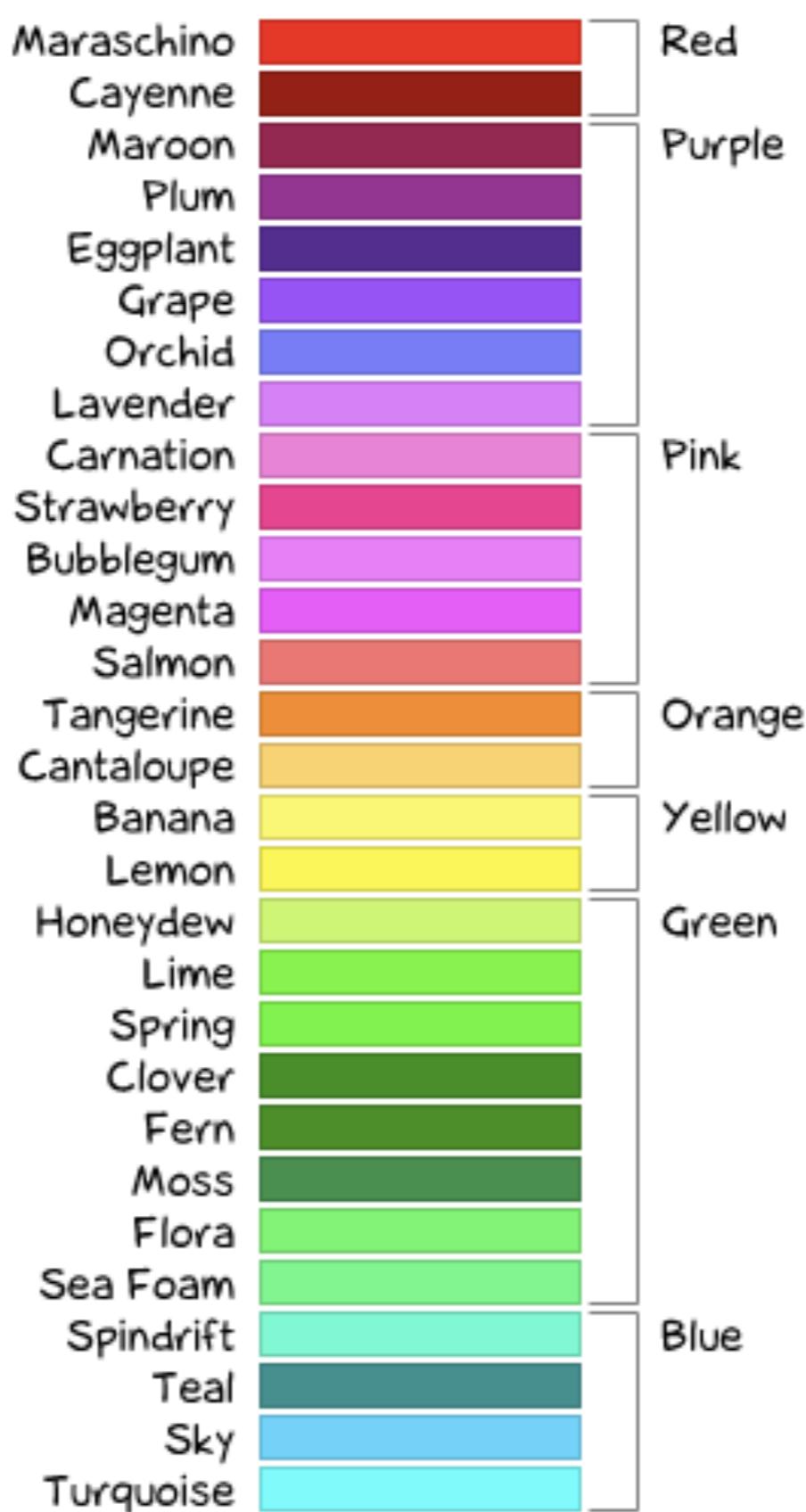


FIGURE 13. Estimated Mean Annual Ratio of Actual Evapotranspiration (ET) to Precipitation (P) for the Conterminous U.S. for the Period 1971-2000. Estimates are based on the regression equation in Table 1 that includes land cover. Calculations of ET/P were made first at the 800-m resolution of the PRISM climate data. The mean values for the counties (shown) were then calculated by averaging the 800-m values within each county. Areas with fractions >1 are agricultural counties that either import surface water or mine deep groundwater.

Color

Color names if
you're a girl...



Color names if
you're a guy...

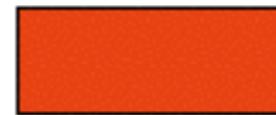
Doghouse Diaries
"We take no as an answer."

*Actual color names
if you're a girl ...*

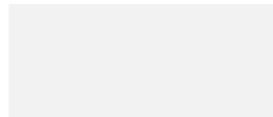


*Actual color names
if you're a guy ...*

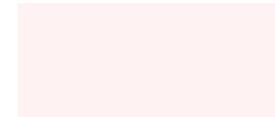
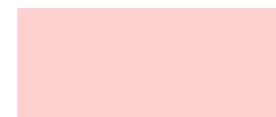
Order These Colors



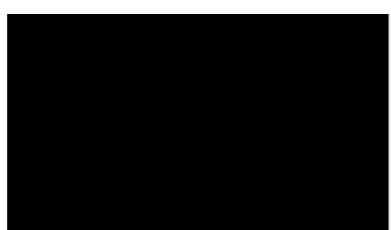
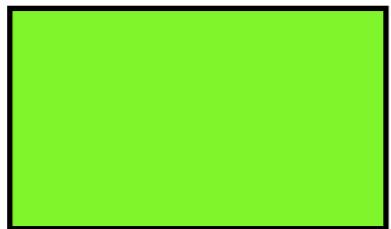
Order These Colors



Order These Colors



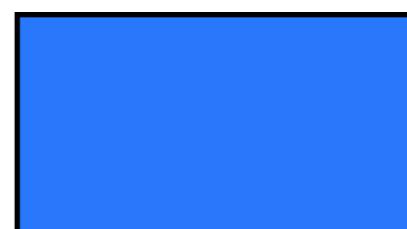
Brightness



Saturation



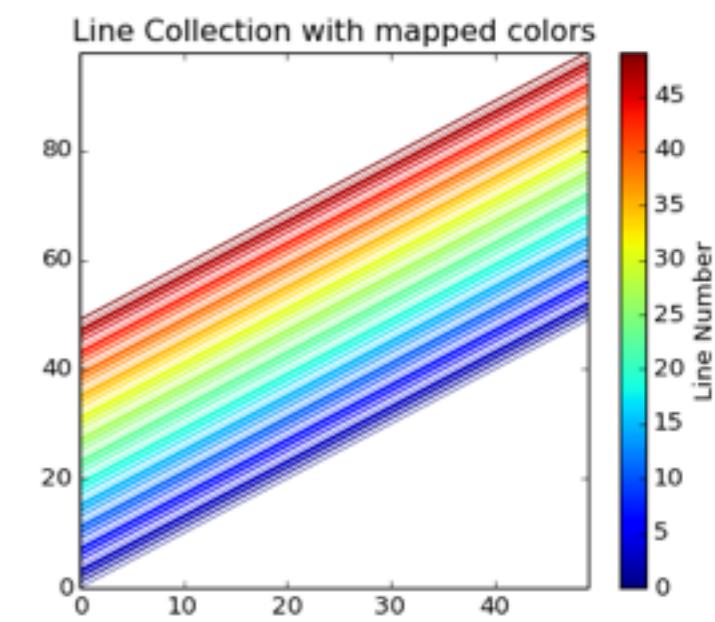
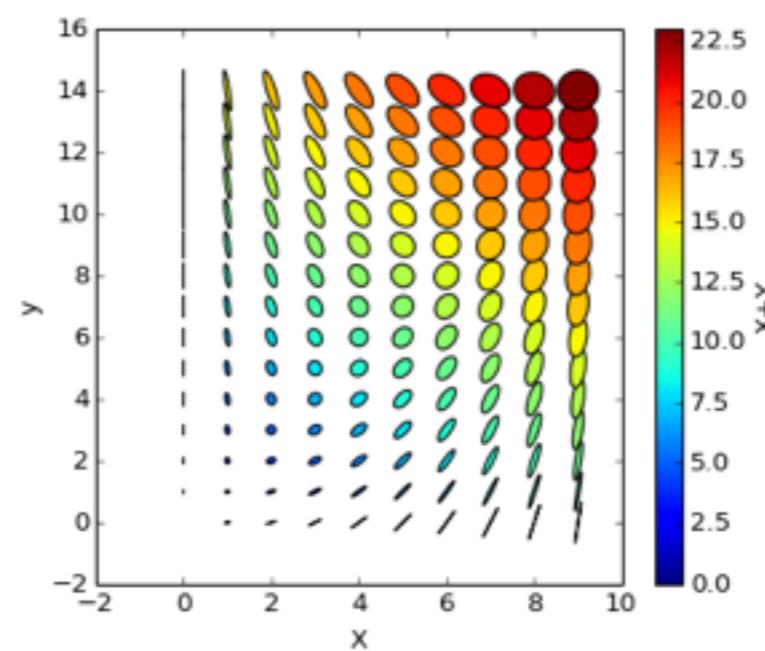
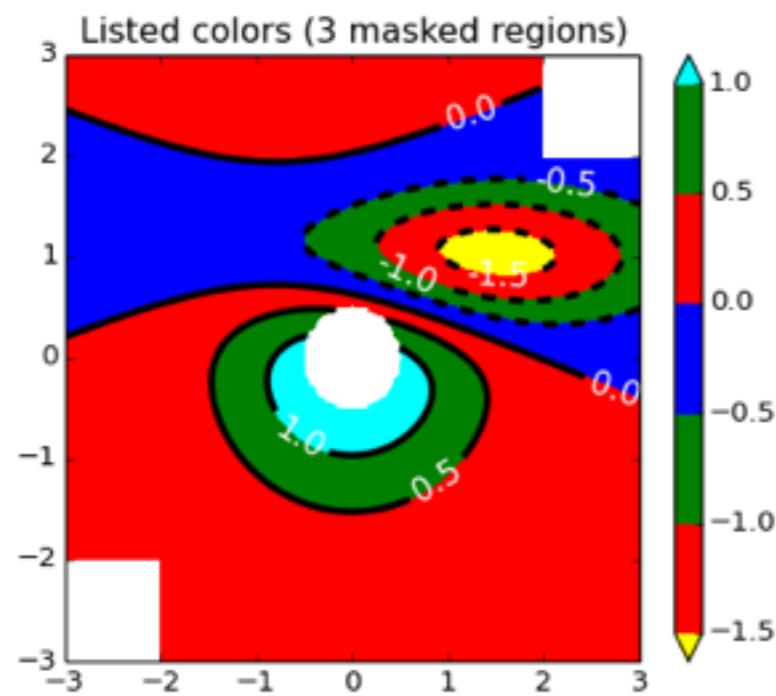
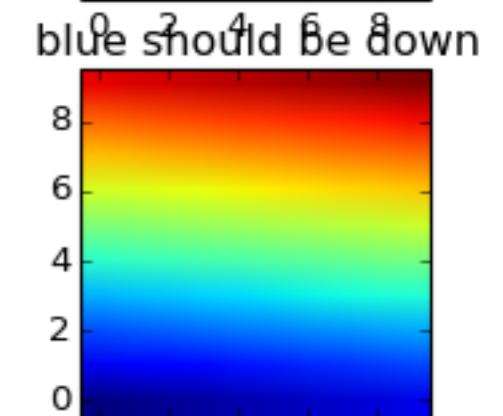
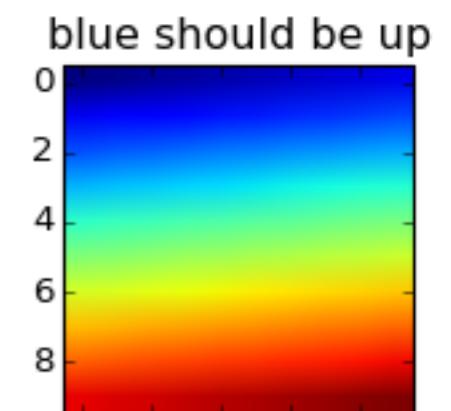
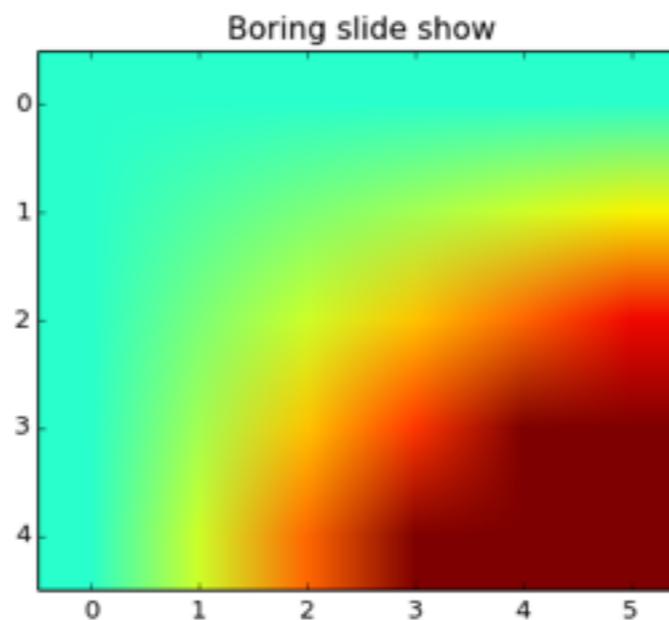
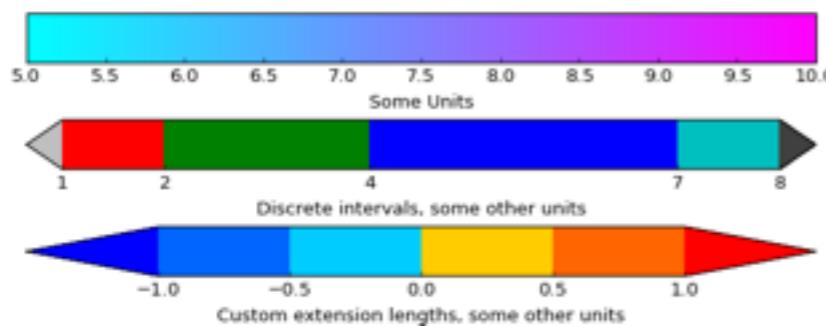
Hue



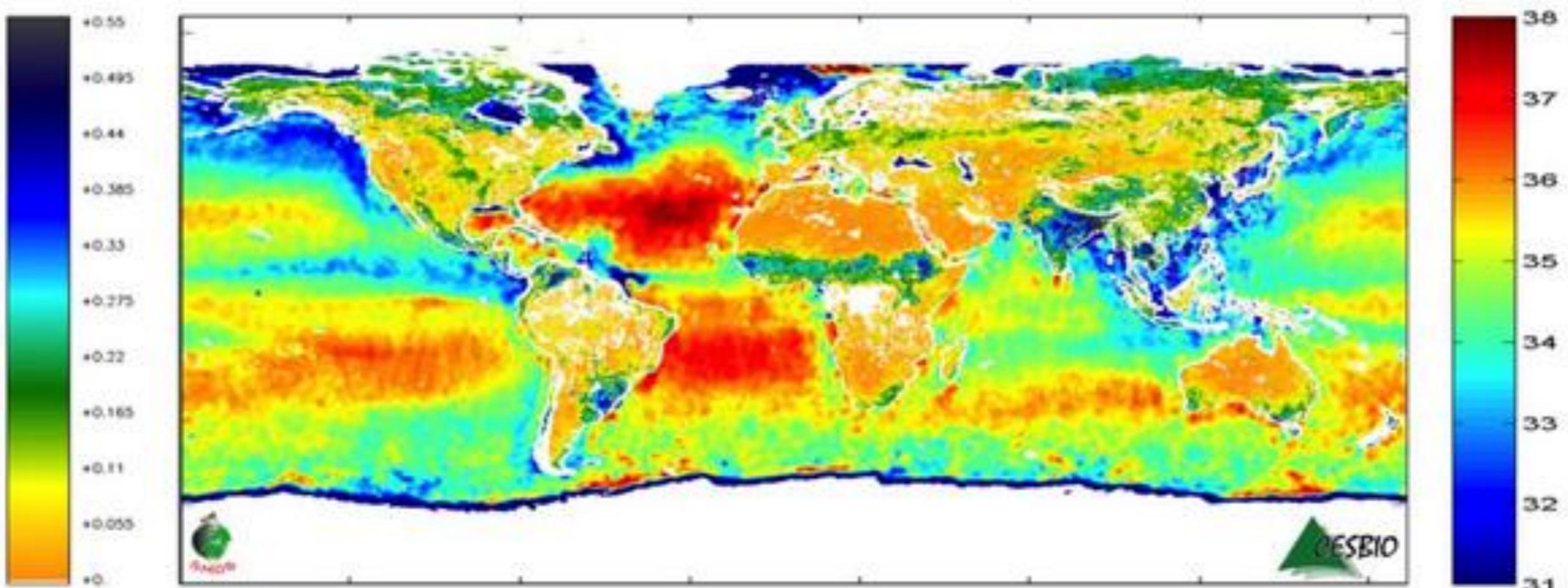
Perceived as Ordered

Not as much

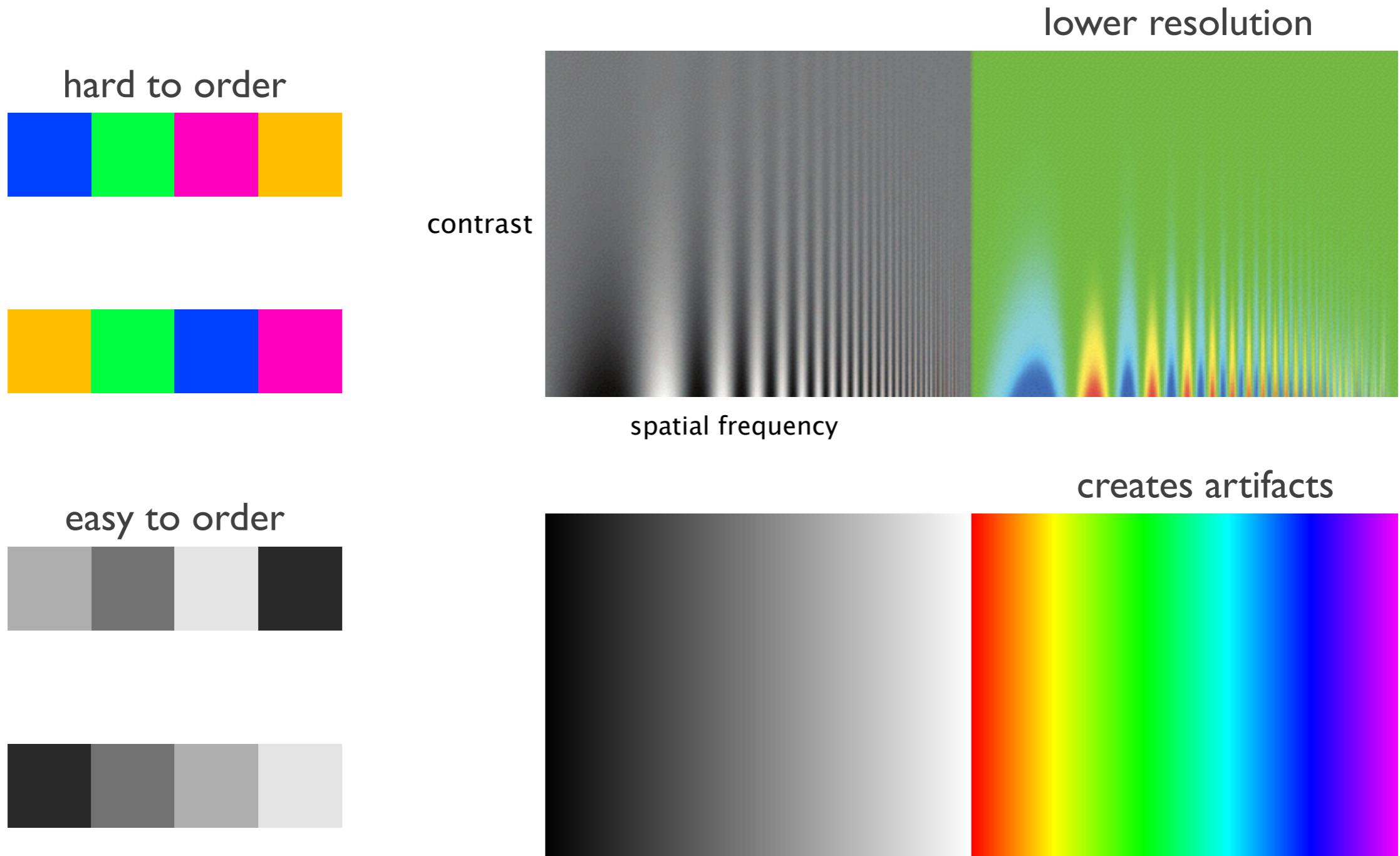
Rainbow Colors



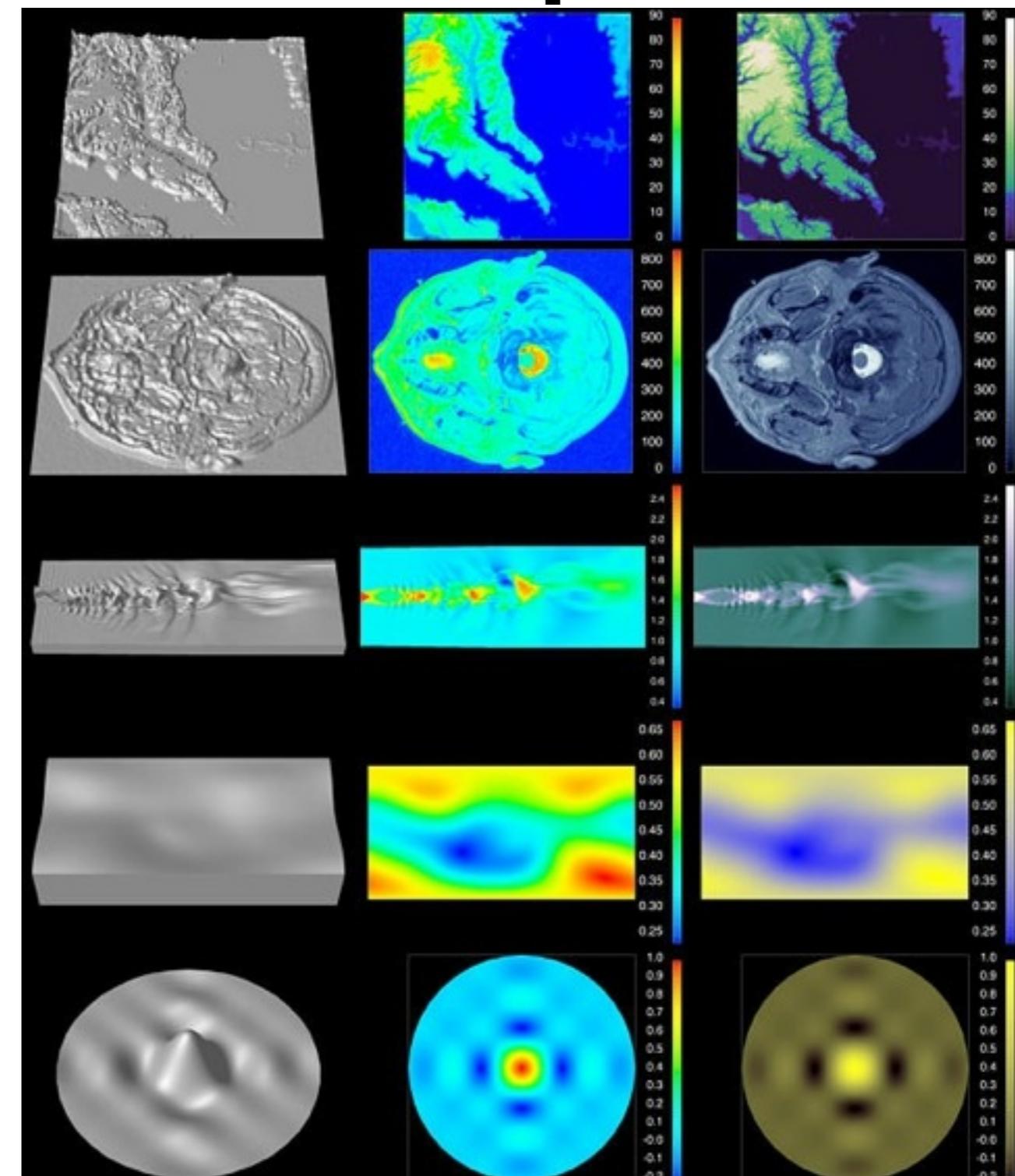
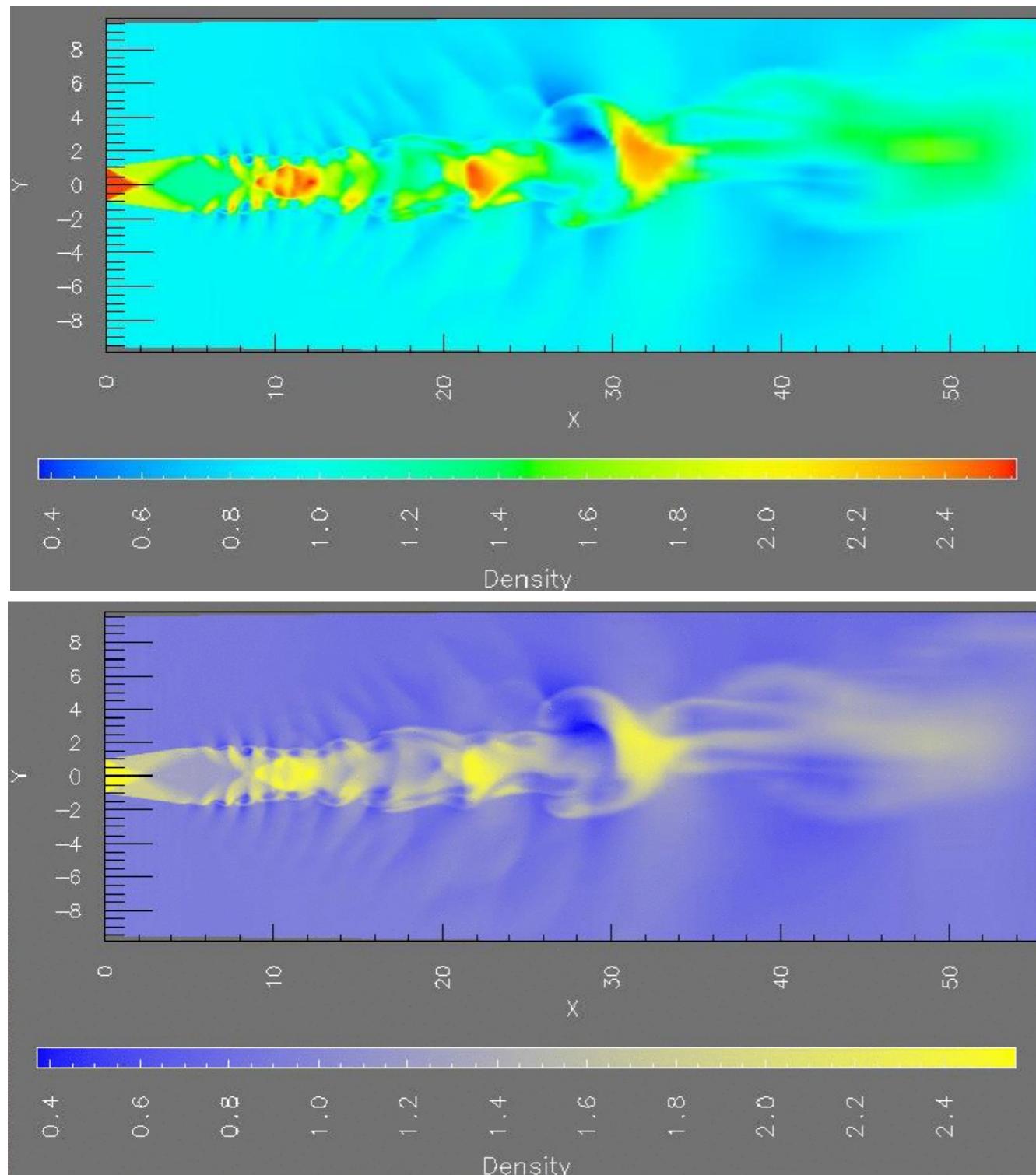
Rainbow Colormap



Rainbow Colormap

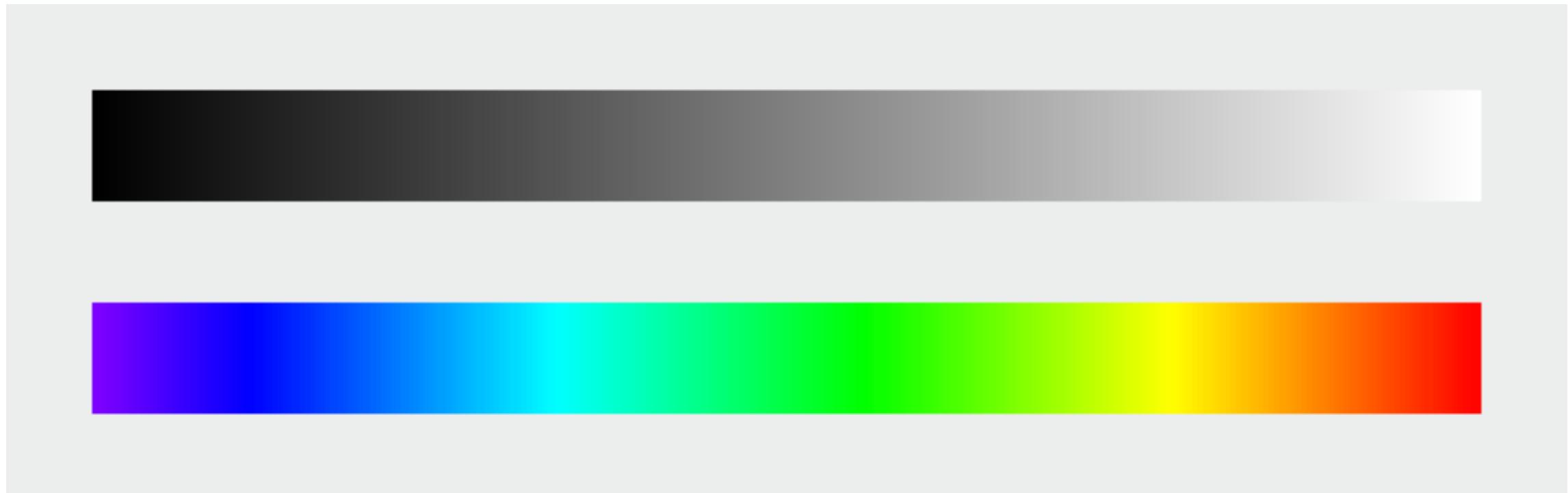


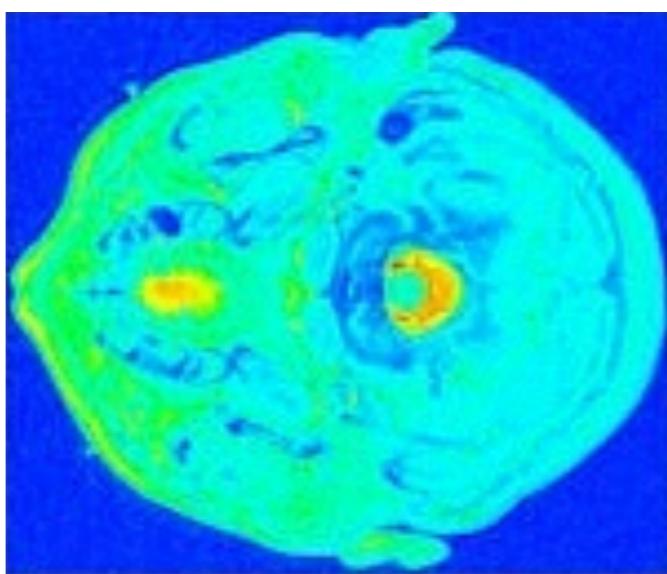
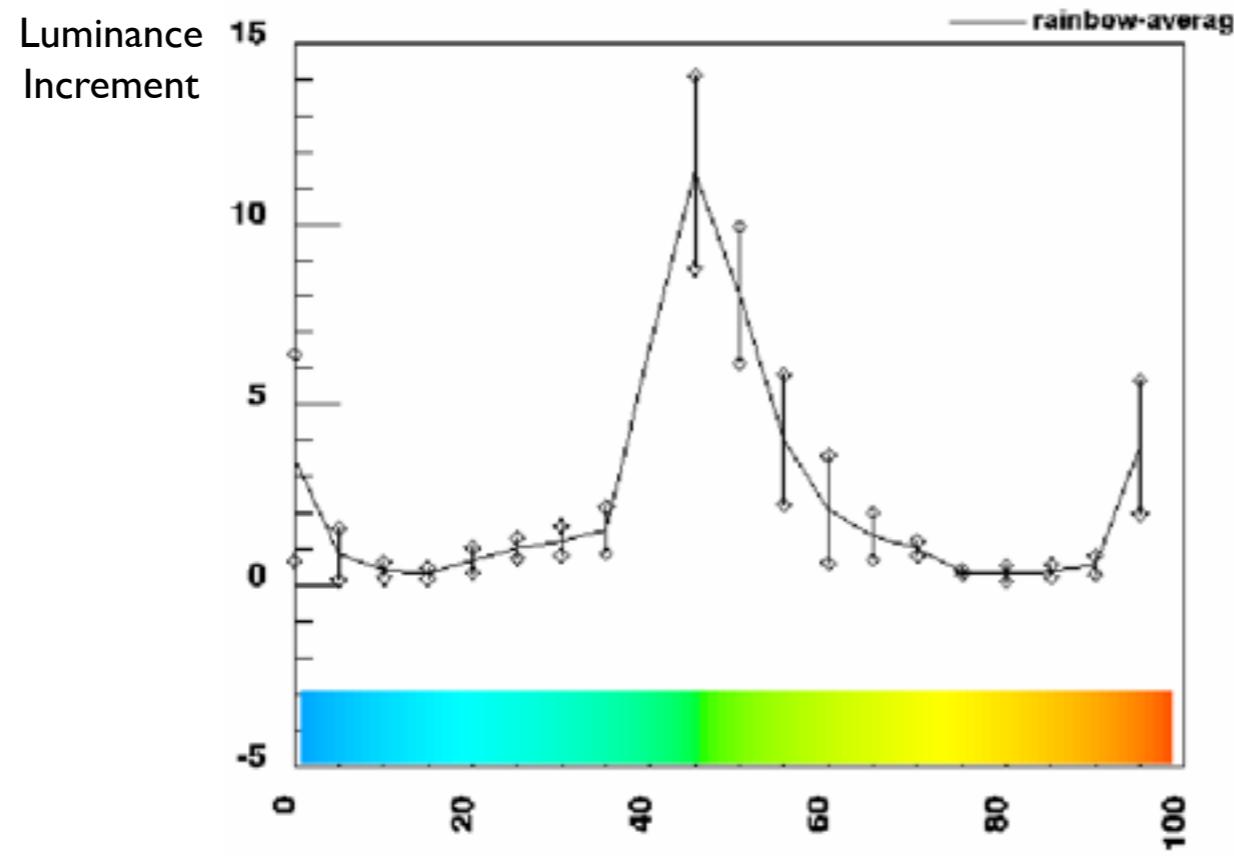
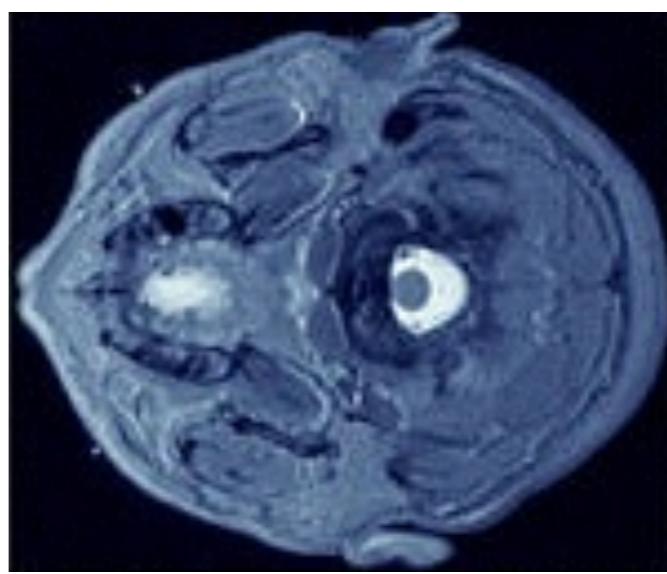
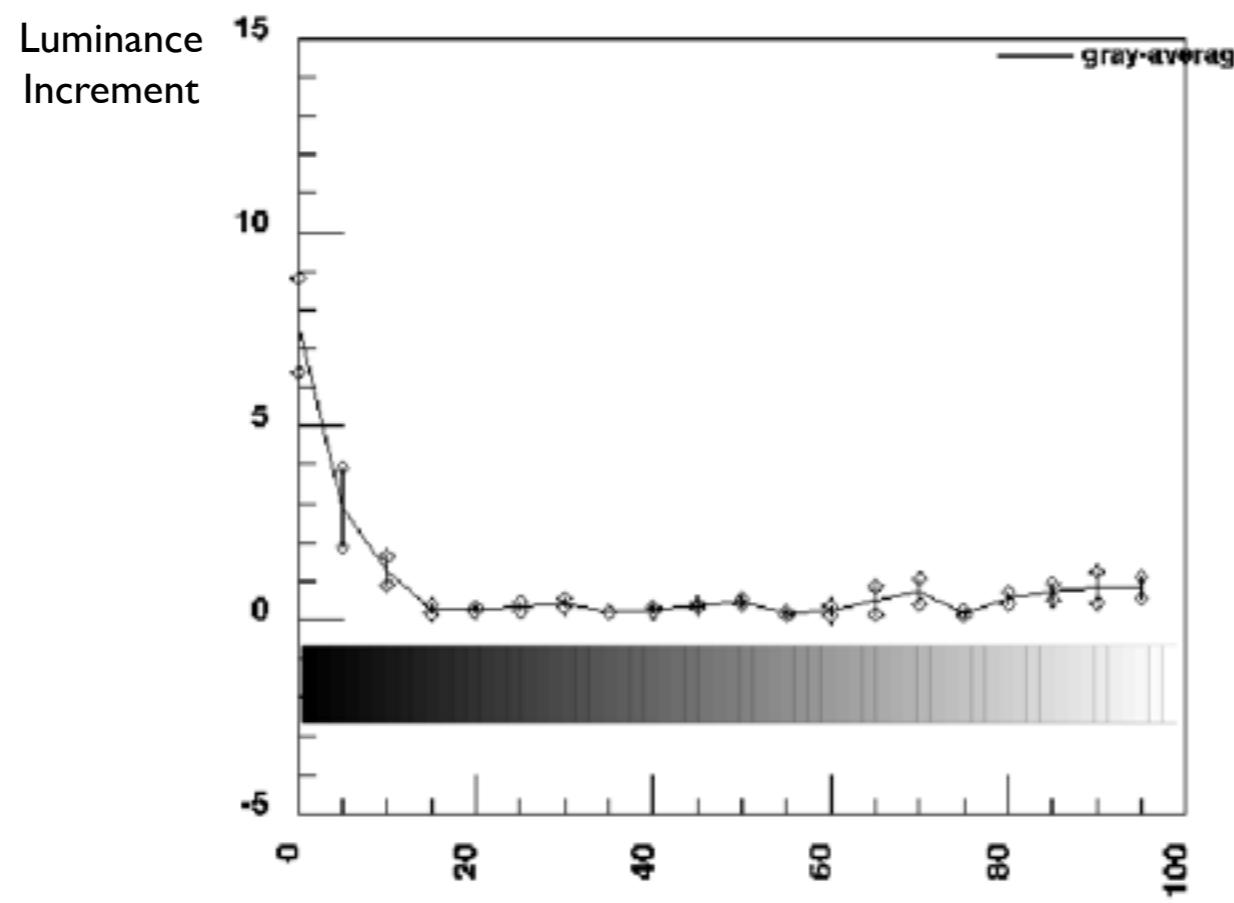
Rainbow Colormap



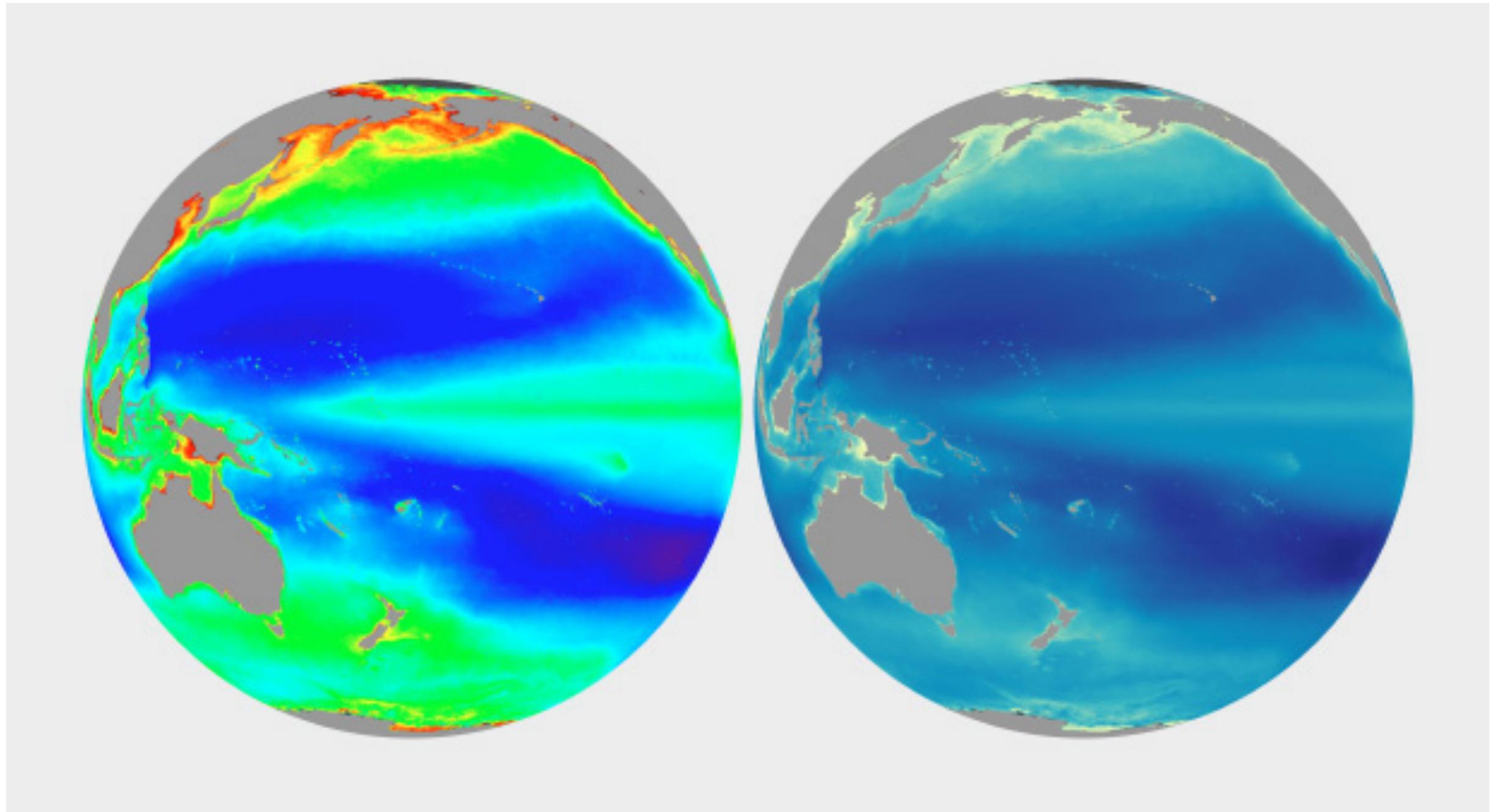
Rainbow Colormap

Rainbow colormap is perceptually nonlinear





Rainbow Colormap



Map Example Revisited

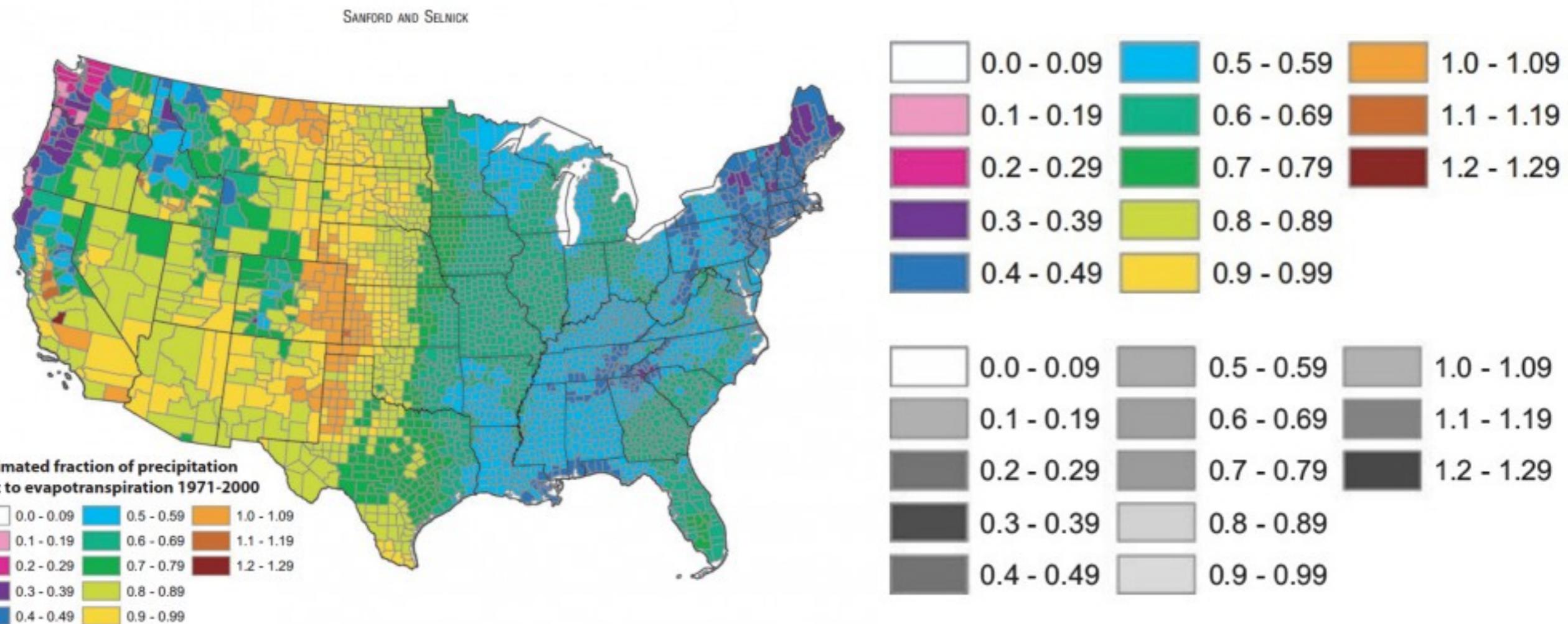
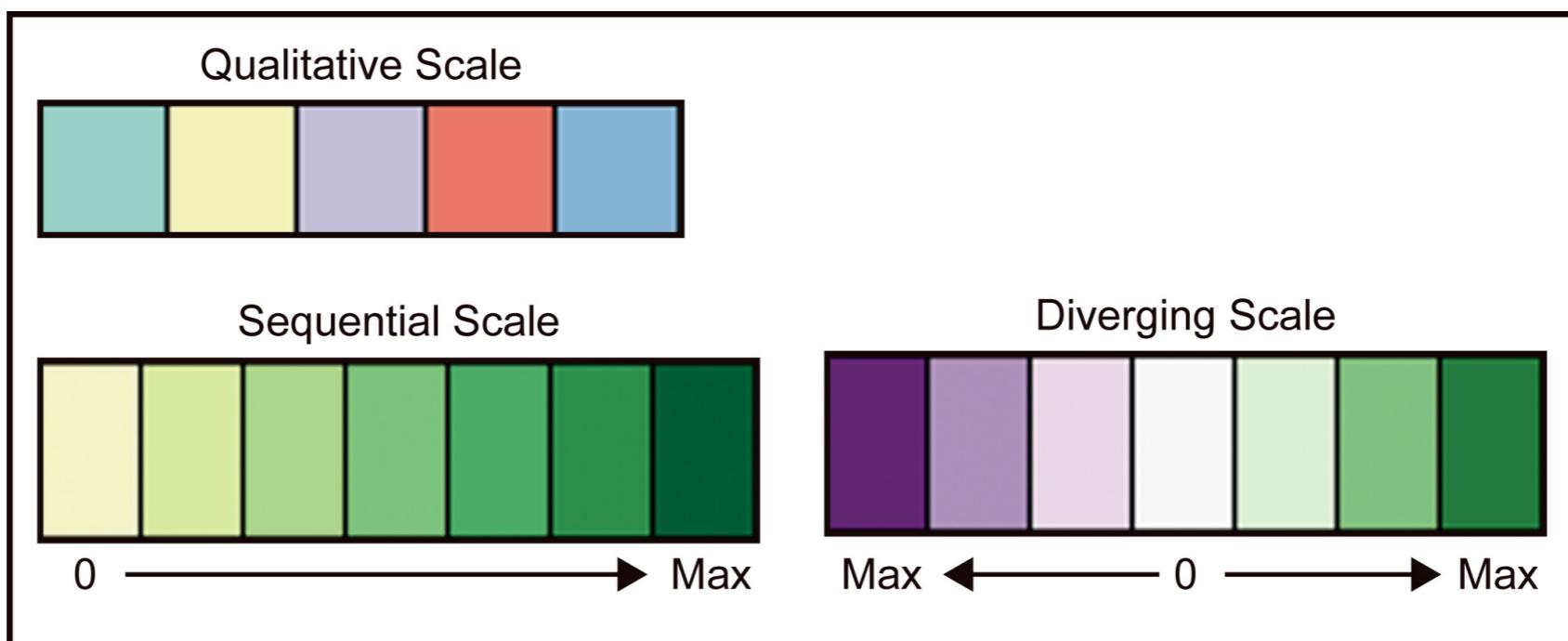


FIGURE 13. Estimated Mean Annual Ratio of Actual Evapotranspiration (ET) to Precipitation (P) for the Conterminous U.S. for the Period 1971-2000. Estimates are based on the regression equation in Table 1 that includes land cover. Calculations of ET/P were made first at the 800-m resolution of the PRISM climate data. The mean values for the counties (shown) were then calculated by averaging the 800-m values within each county. Areas with fractions >1 are agricultural counties that either import surface water or mine deep groundwater.

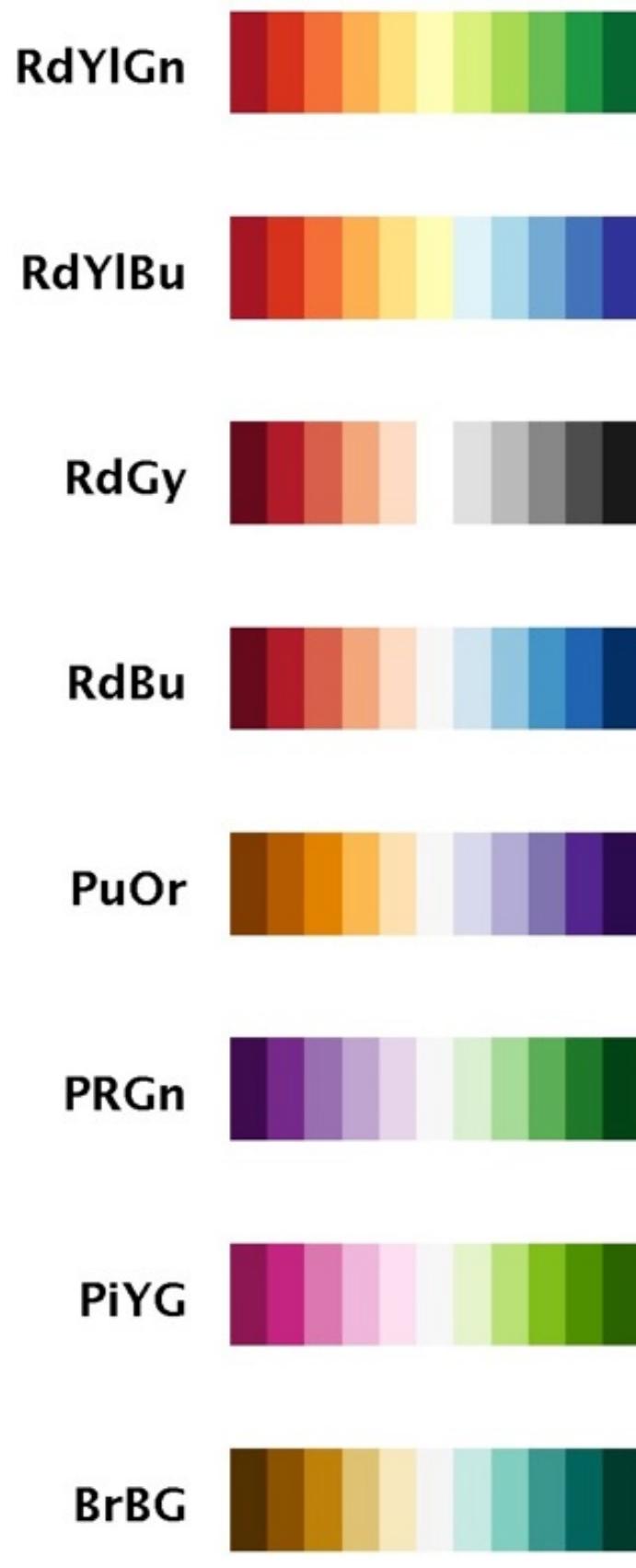
Brewer Scales

Nominal



Ordinal

Diverging



Sequential



Qualitative



number of data classes on your map

3 | [learn more >](#)

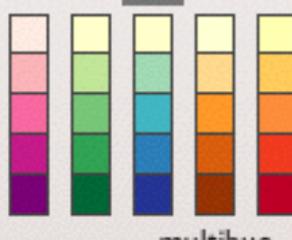
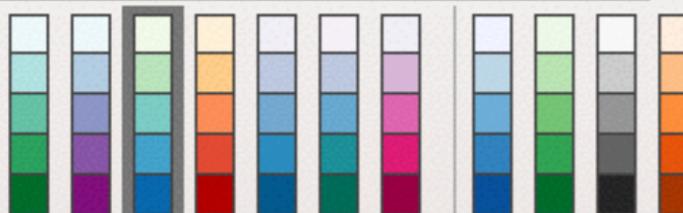
how to use | updates | credits

COLORBREWER 2.0
color advice for cartography

the nature of your data

sequential | [learn more >](#)

pick a color scheme: GnBu



single hue

(optional) only show schemes that are:

colorblind safe print friendly

photocopy-able [learn more >](#)

pick a color system

224, 243, 219 RGB CMYK HEX

168, 221, 181

67, 162, 202

RGB CMYK HEX

adjust map context

roads

cities

borders

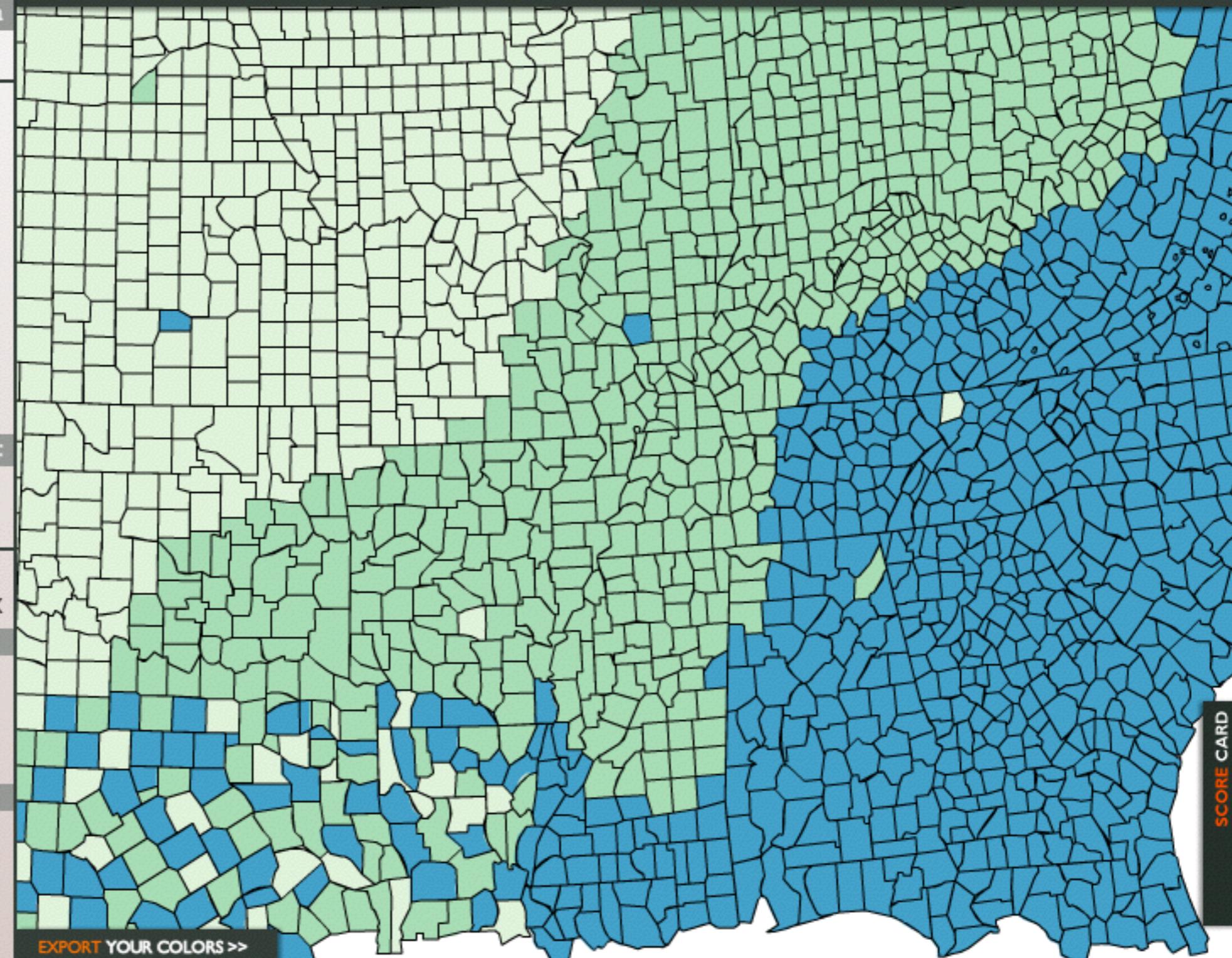
select a background

solid color

terrain

color transparency

[learn more >](#)



SCORE CARD

© Cynthia Brewer, Mark Harrower and The Pennsylvania State University

[Support](#)

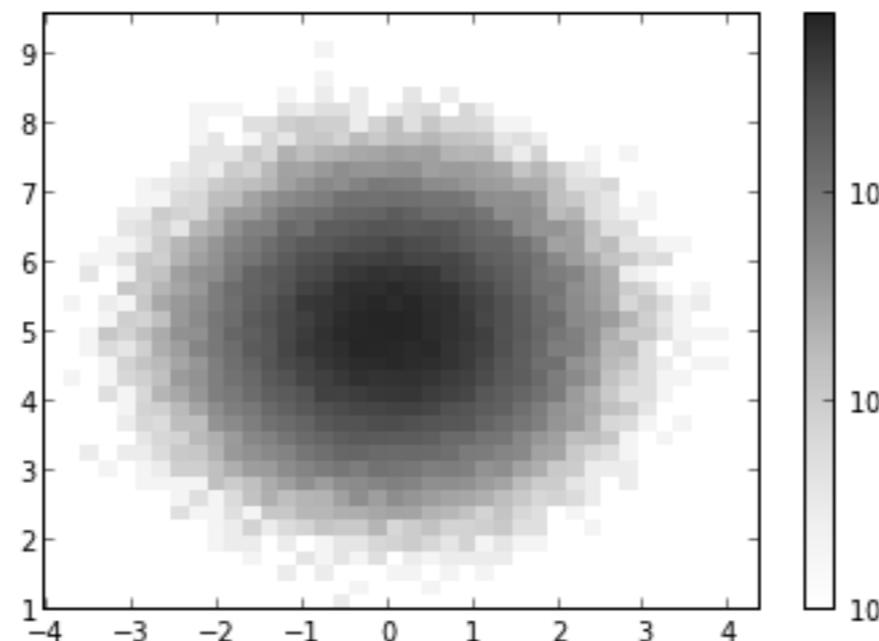
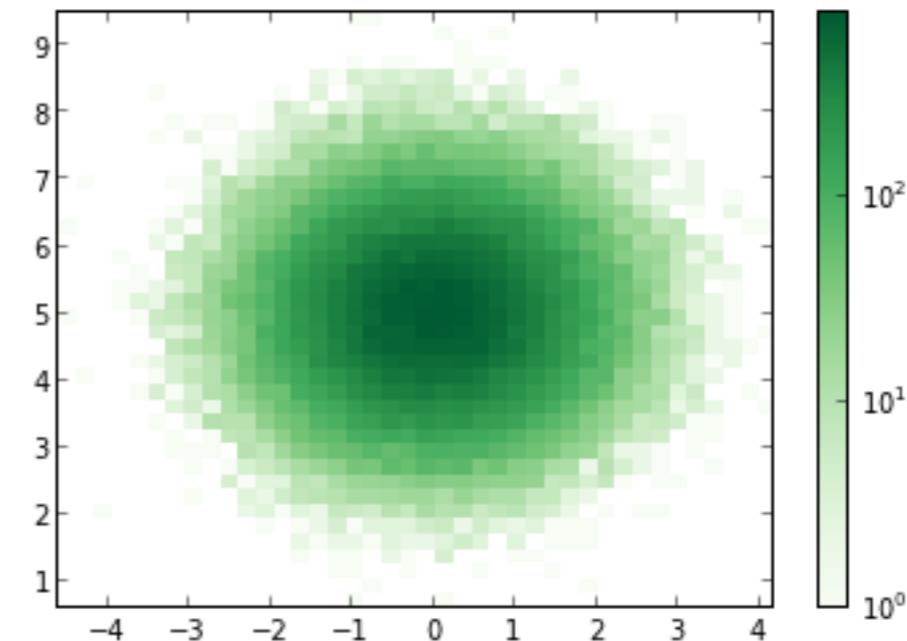
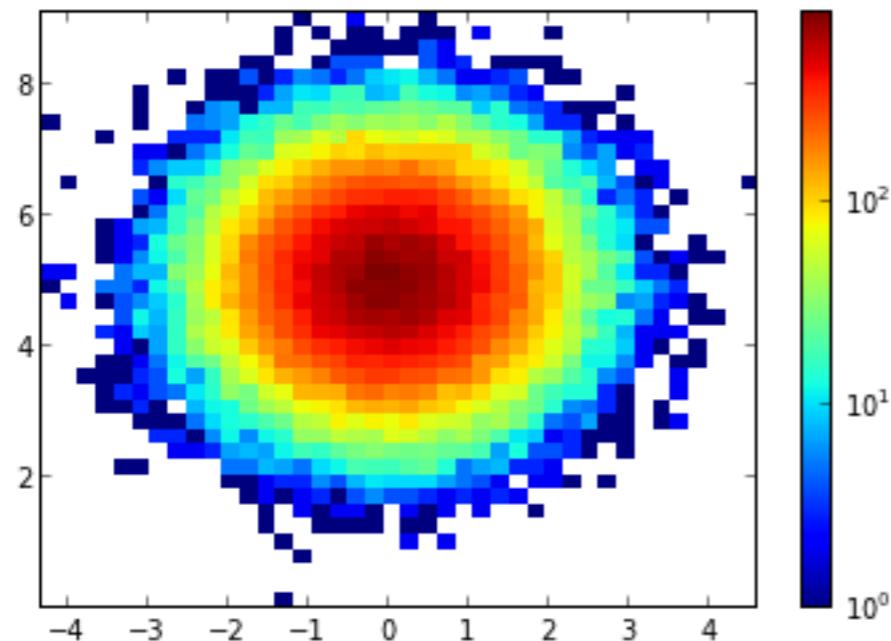
[Back to ColorBrewer 1.0](#)

axm

<http://colorbrewer2.org>

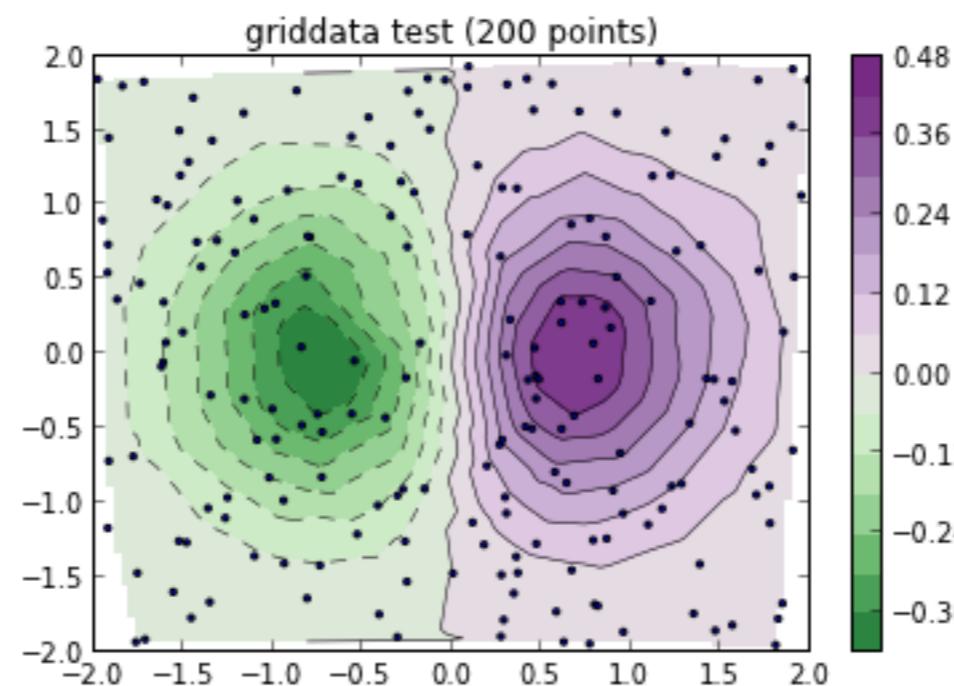
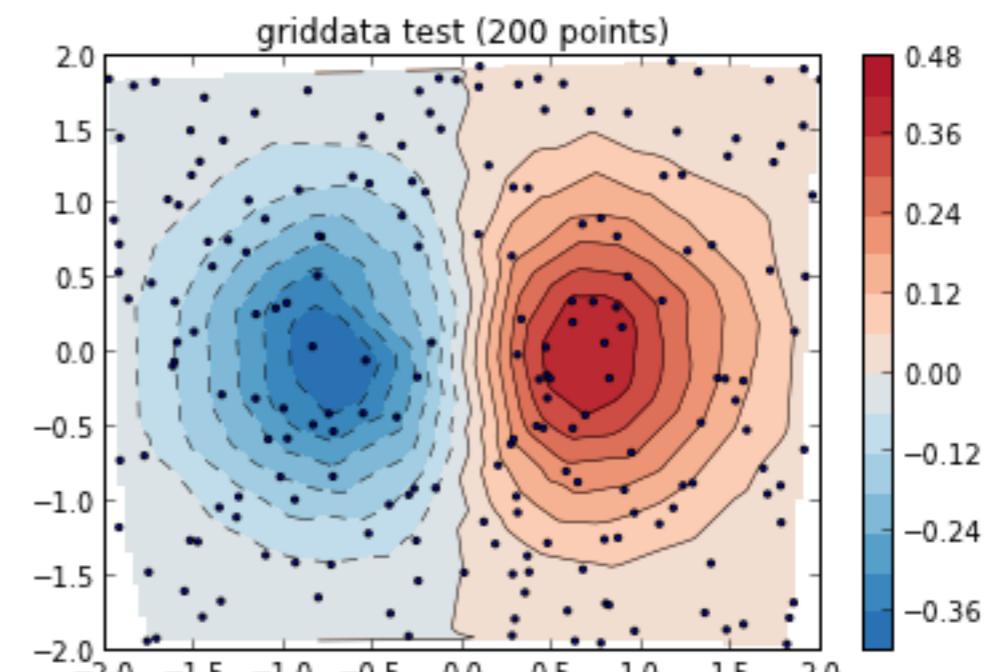
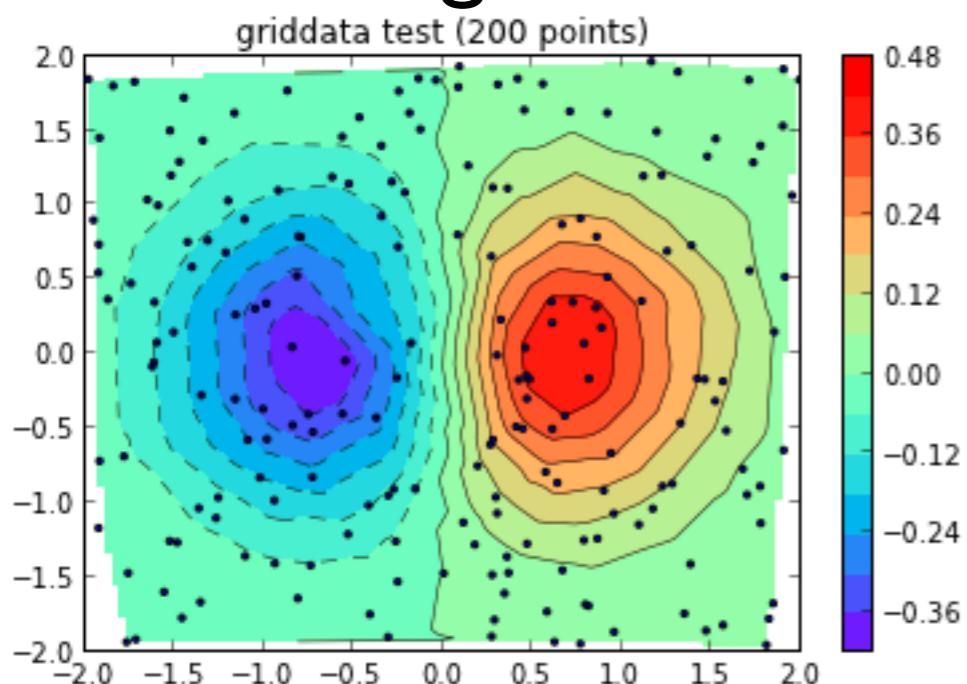
Sequential Brewer Scales

No!

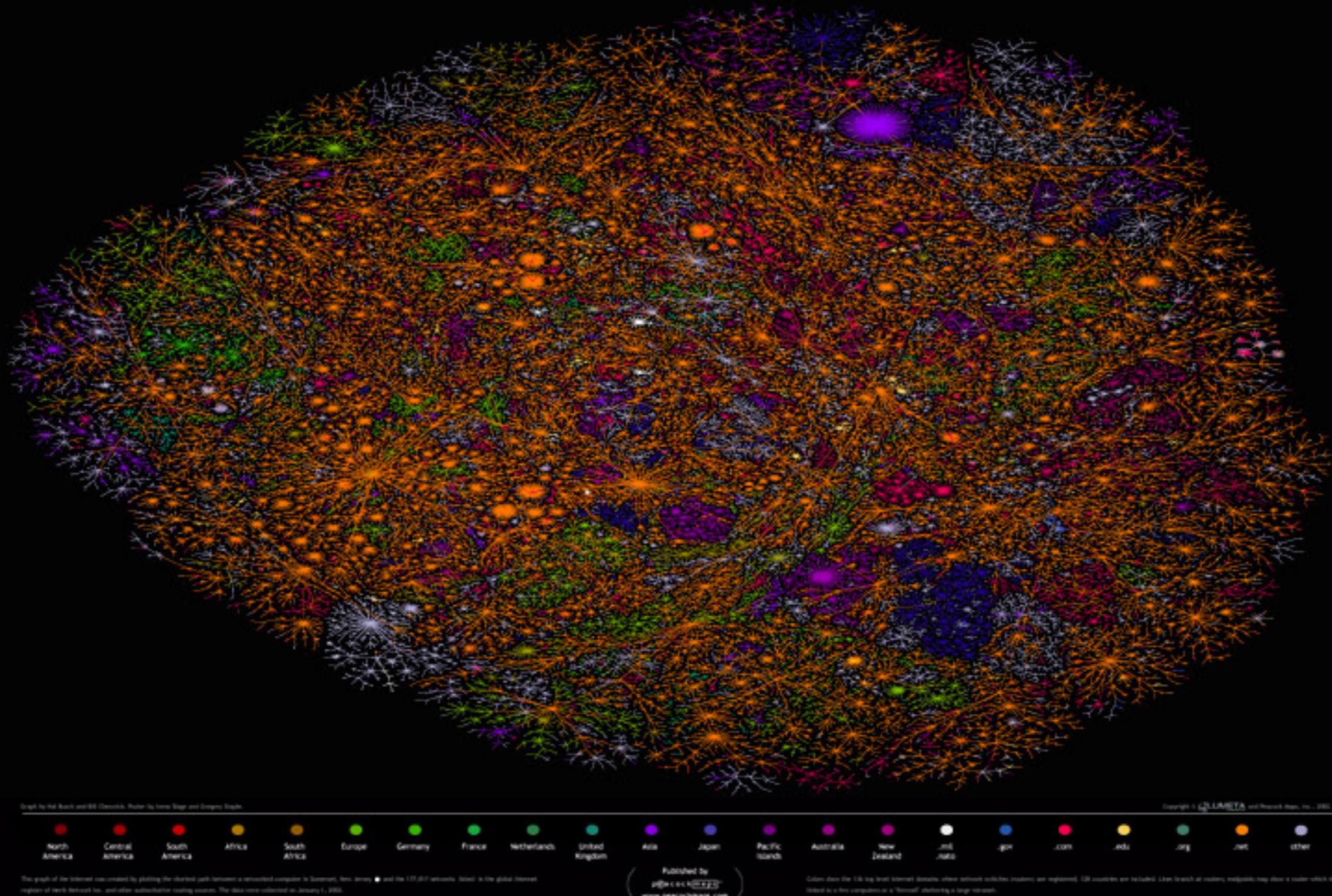


Divergent Brewer Scales

Not great

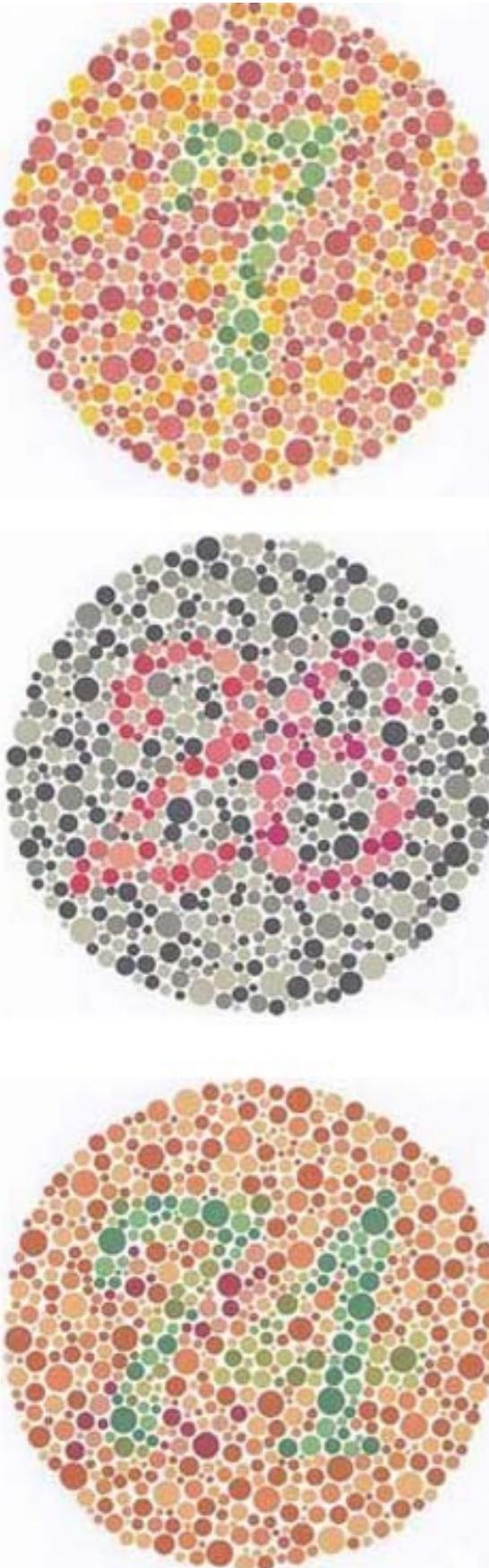


The Internet: 2002



Peacock Maps, 2002

Nominal Data: Do not use more than 6-10 colors!



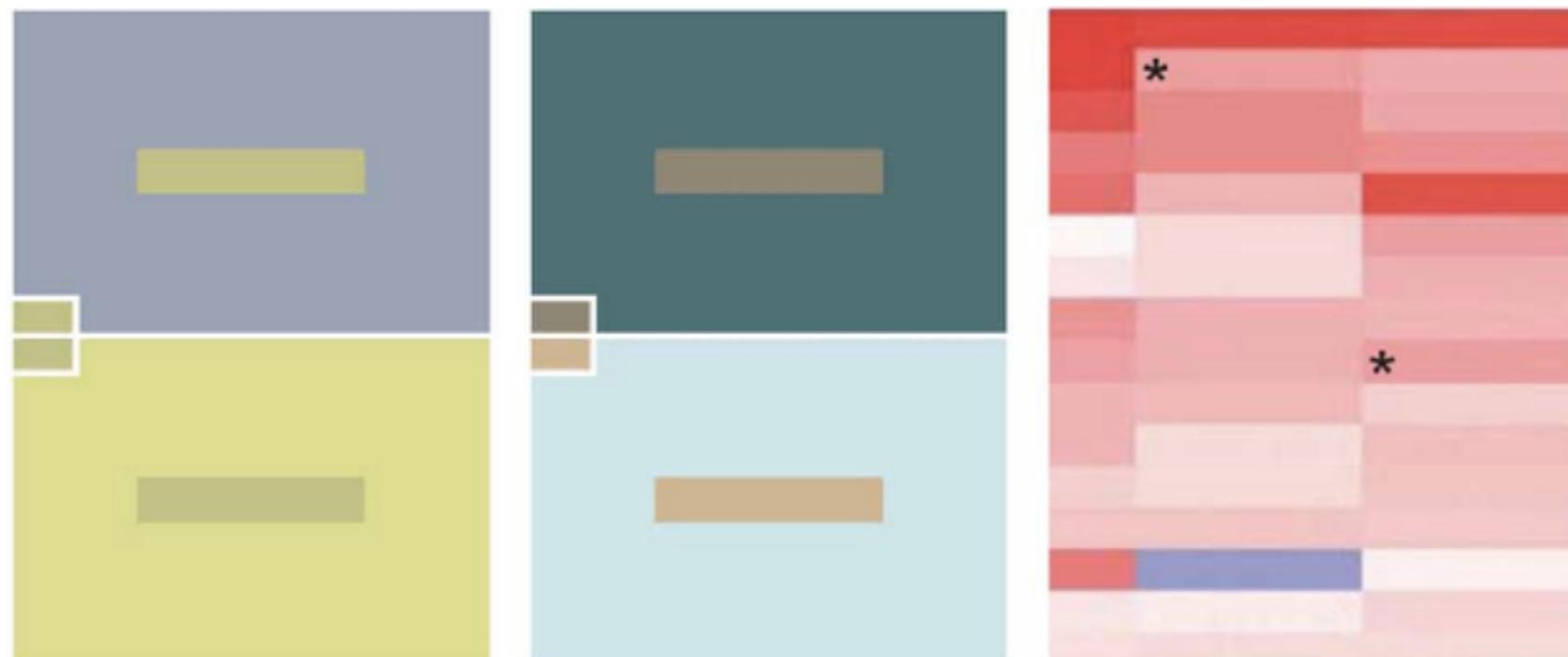
Color Blindness

8% of males, 1% of females

Most common is red-green weakness / blindness

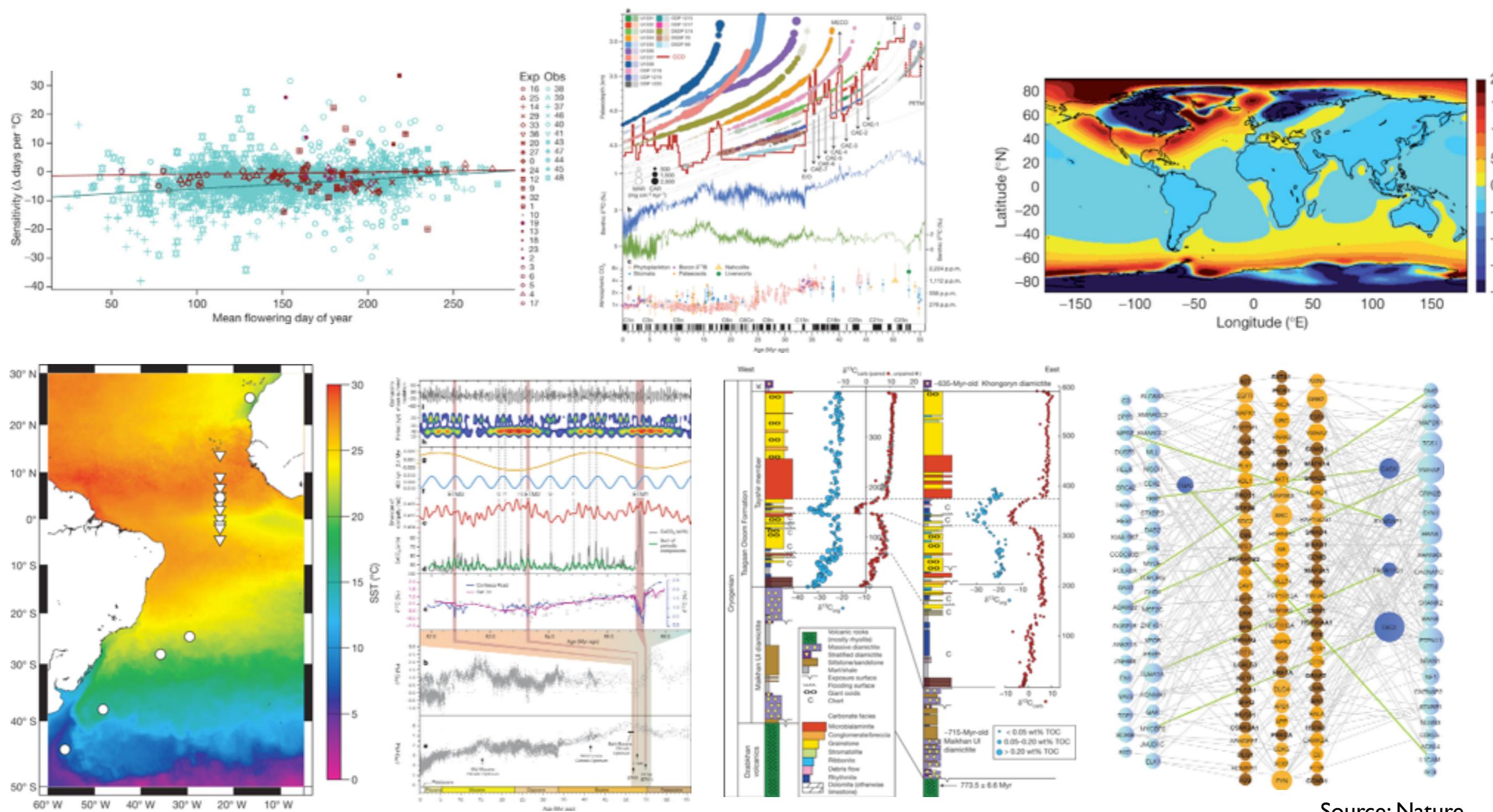
Color	Color name	RGB (1–255)	CMYK (%)	P	D
	Black	0, 0, 0	0, 0, 0, 100		
	Orange	230, 159, 0	0, 50, 100, 0		
	Sky blue	86, 180, 233	80, 0, 0, 0		
	Bluish green	0, 158, 115	97, 0, 75, 0		
	Yellow	240, 228, 66	10, 5, 90, 0		
	Blue	0, 114, 178	100, 50, 0, 0		
	Vermillion	213, 94, 0	0, 80, 100, 0		
	Reddish purple	204, 121, 167	10, 70, 0, 0		

Color is Relative



Design Principles

Non Effective Examples Revisited...



Source: Nature

« [Job openings at American University](#)

[False memories and statistical analysis](#) »

What we need here is some peer review for statistical graphics

Posted by [Andrew](#) on 8 September 2013, 9:49 am

Under the heading, "Bad graph candidate," Kevin Wright points to [this article](#) [link fixed], writing:

Some of the figures use the same line type for two different series.

More egregious are the confidence intervals that are constant width instead of increasing in width into the future.

Indeed. What's even more embarrassing is that these graphs appeared in an article in the magazine *Significance*, sponsored by the American Statistical Association and the Royal Statistical Society.

Perhaps every scientific journal could have a graphics editor whose job is to point out really horrible problems and require authors to make improvements.

The difficulty, as always, is that scientists write these articles for free and as a public service (publishing in *Significance* doesn't pay, nor does it count as a publication in an academic record), so it might be difficult to get authors to fix their graphs. On the other hand, if an article is worth writing at all, it's worth trying to convey conclusions clearly.

I'm not angry at the authors for publishing bad graphs—scientists typically don't get training in how to construct or evaluate graphical displays, indeed I've seen stuff just as bad in JASA and other top statistics journals—but it would be good to catch this stuff before it gets out for public consumption.



Filed under [Sociology](#), [Statistical graphics](#)

[Comment \(RSS\)](#) | [Trackback](#) | [Permalink](#)

Points of View (PoV)



Bang
Wong



Nils
Gehlenborg

Points of Significance (PoS)



Martin
Krzywinski

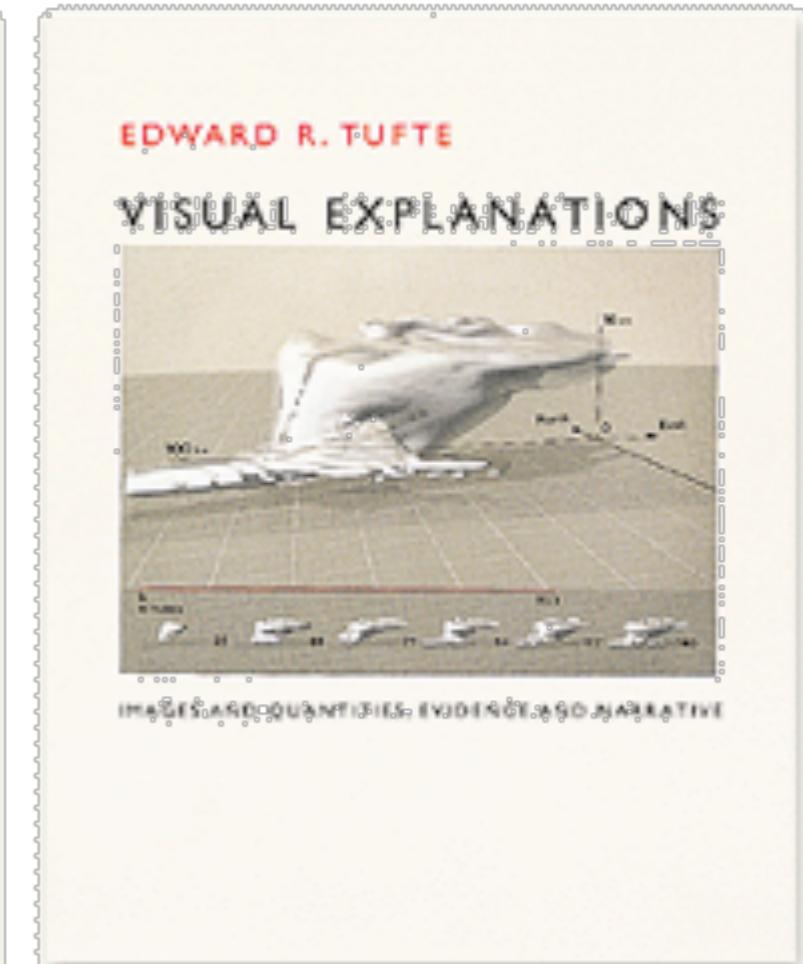
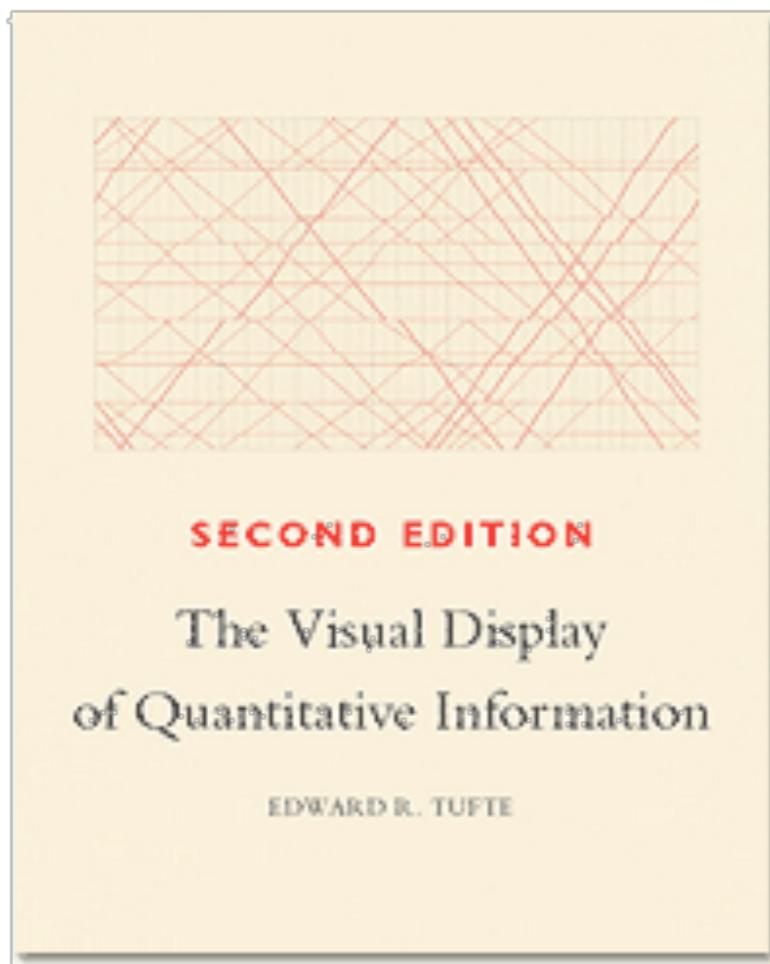


Naomi
Altman

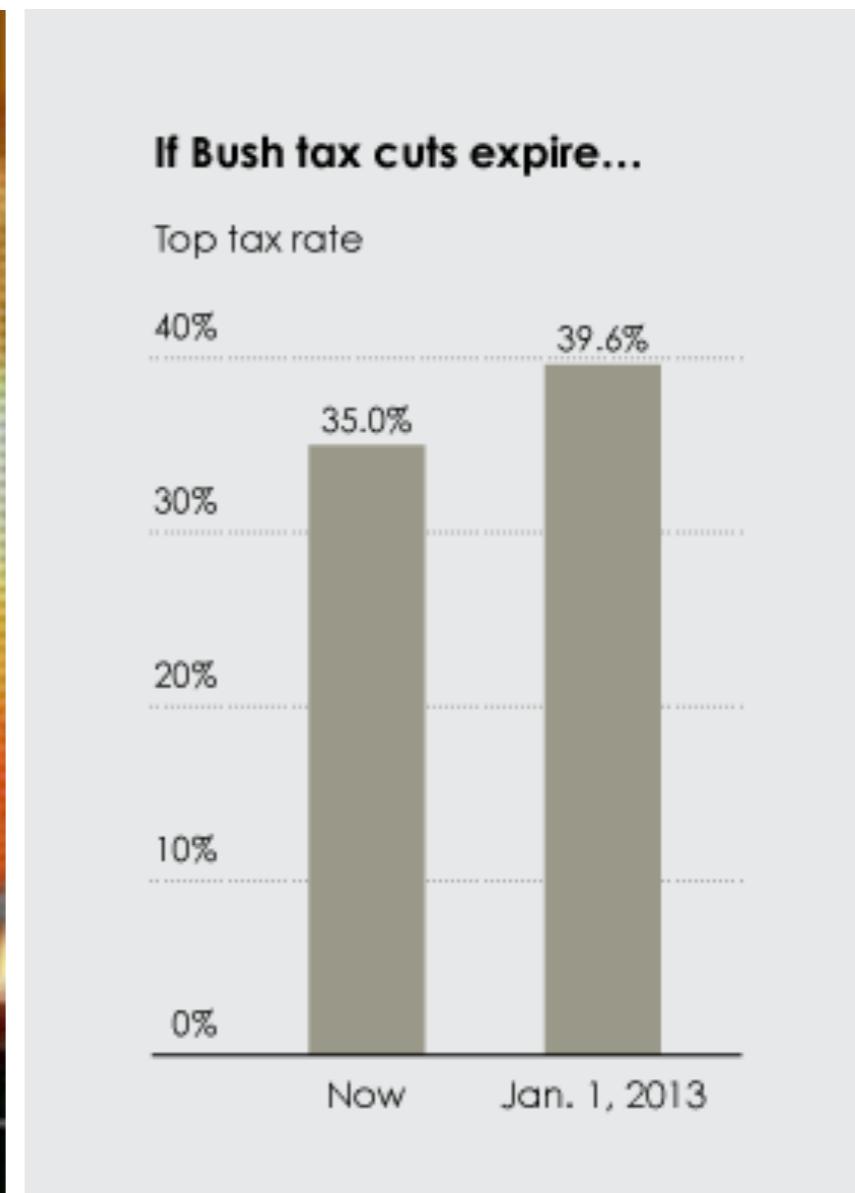
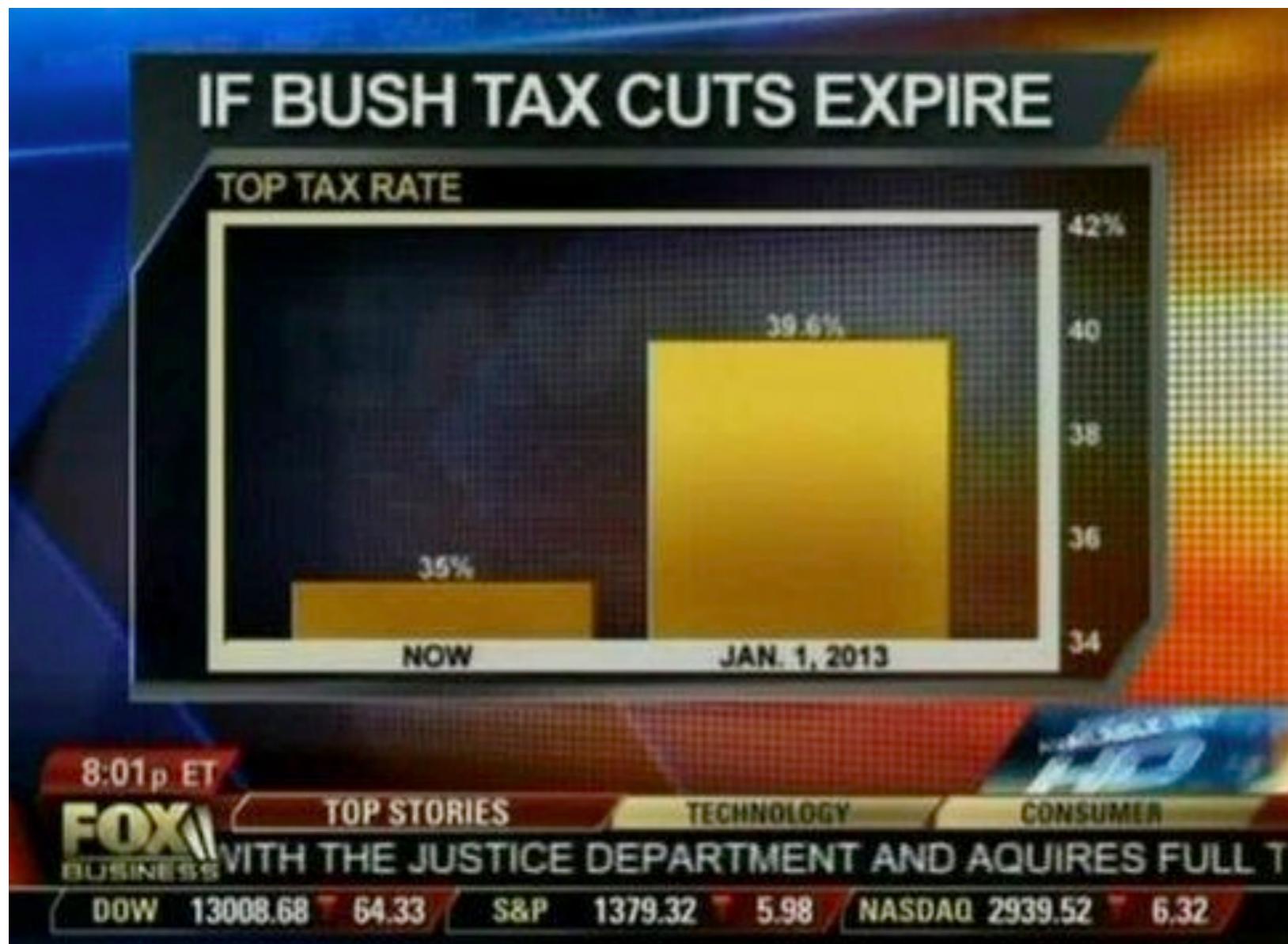
Summary of PoV and PoS articles

<http://blogs.nature.com/methagora/2013/07/data-visualization-points-of-view.html>

Edward Tufte



Scale Distortions



Scale Distortions

How 2012 STACKS UP

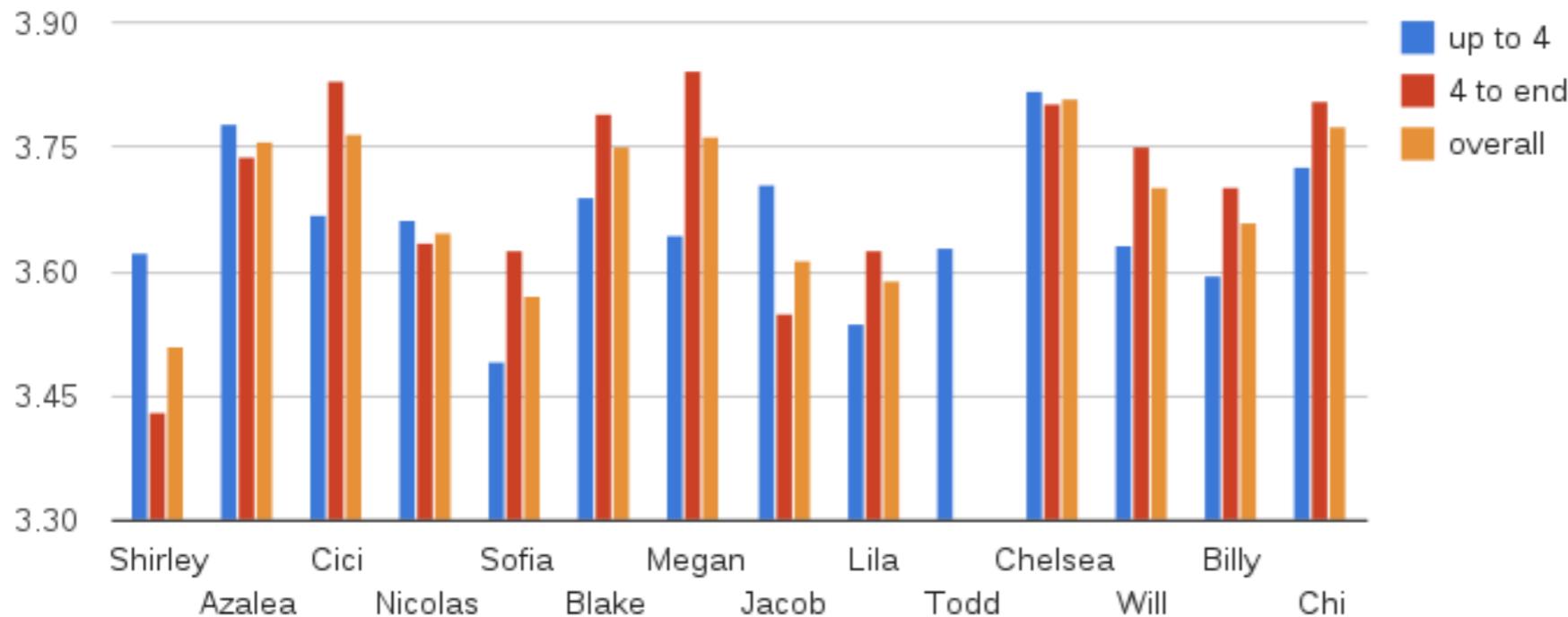
THE WARMEST YEARS ON RECORD
CONTIGUOUS U.S.



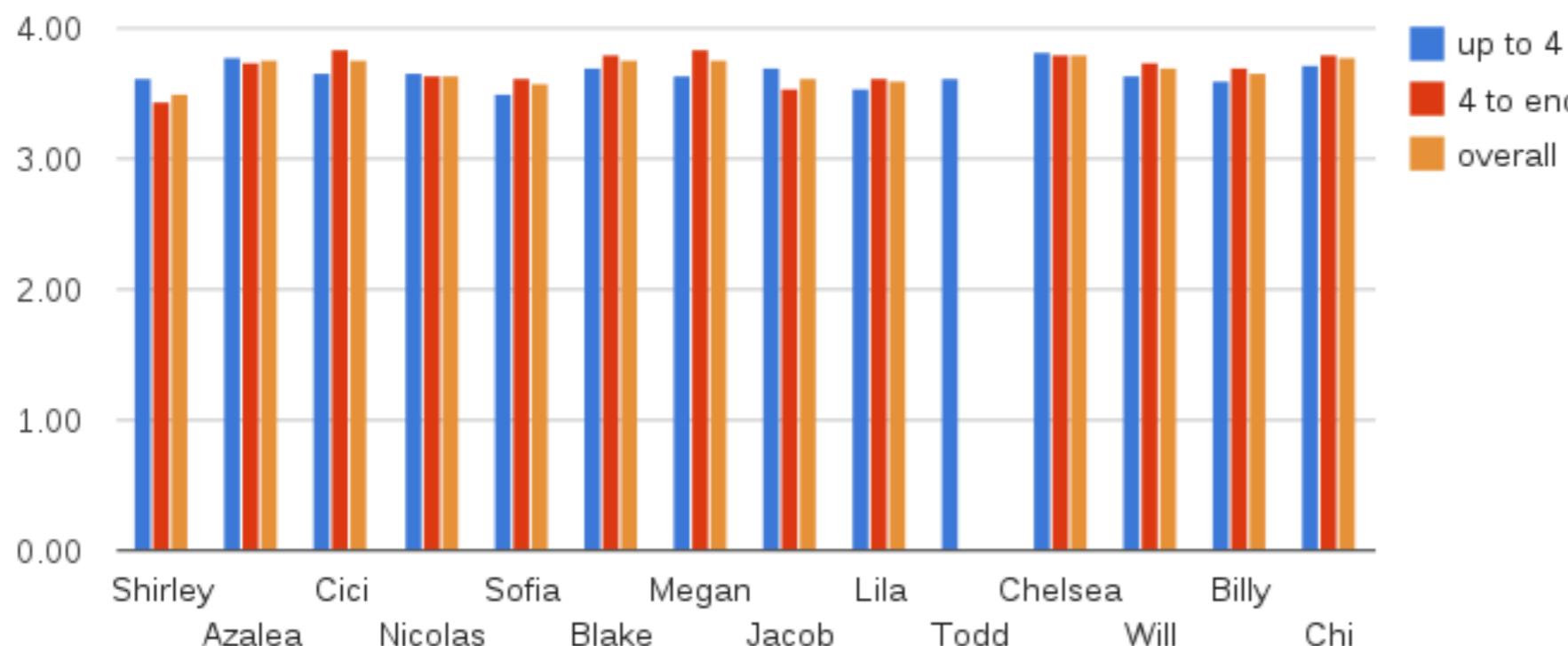
Source: NOAA's National Climatic Data Center - State of the Climate National Overview

CLIMATE  CENTRAL

Scale Distortions

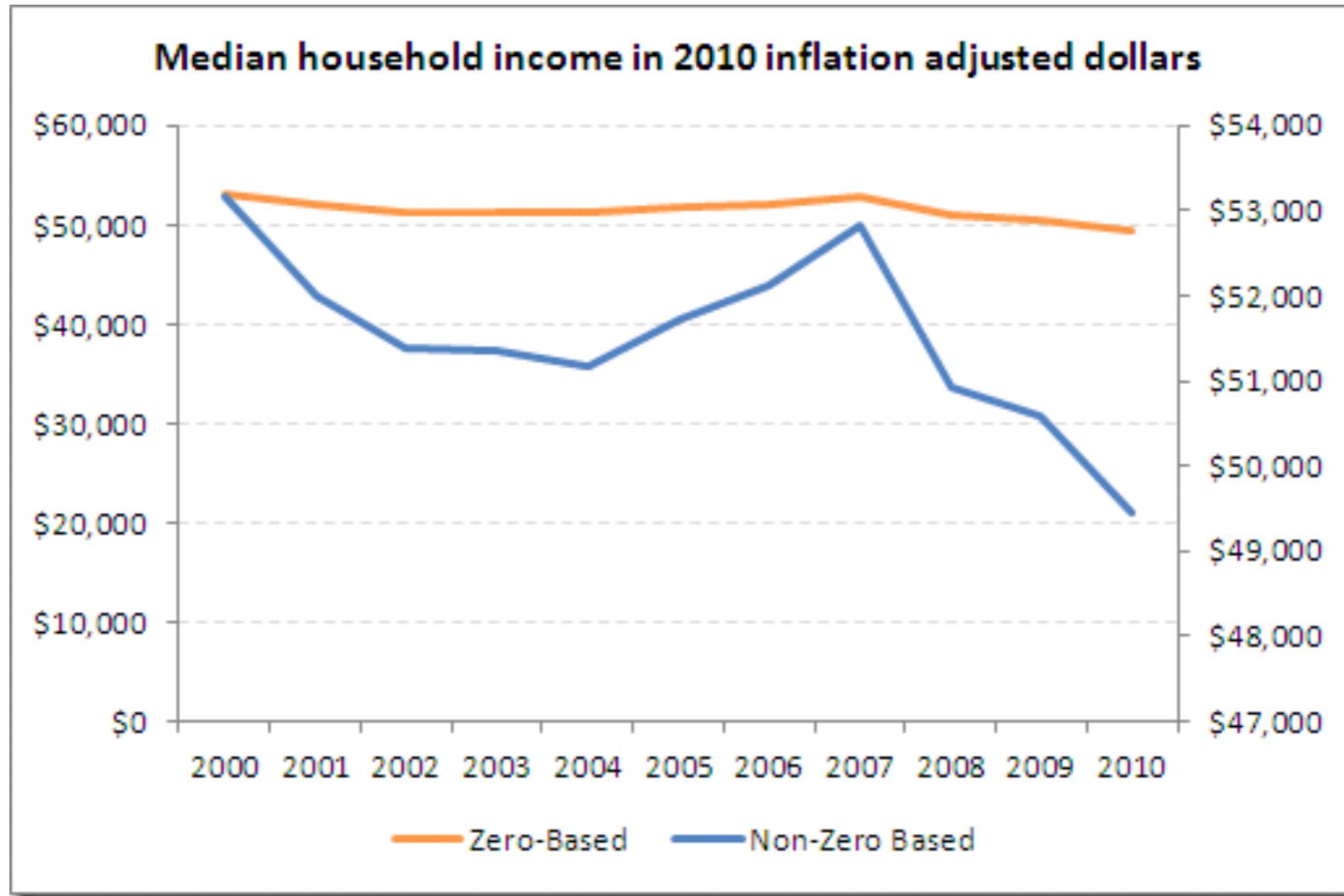


Grade Fluctuation

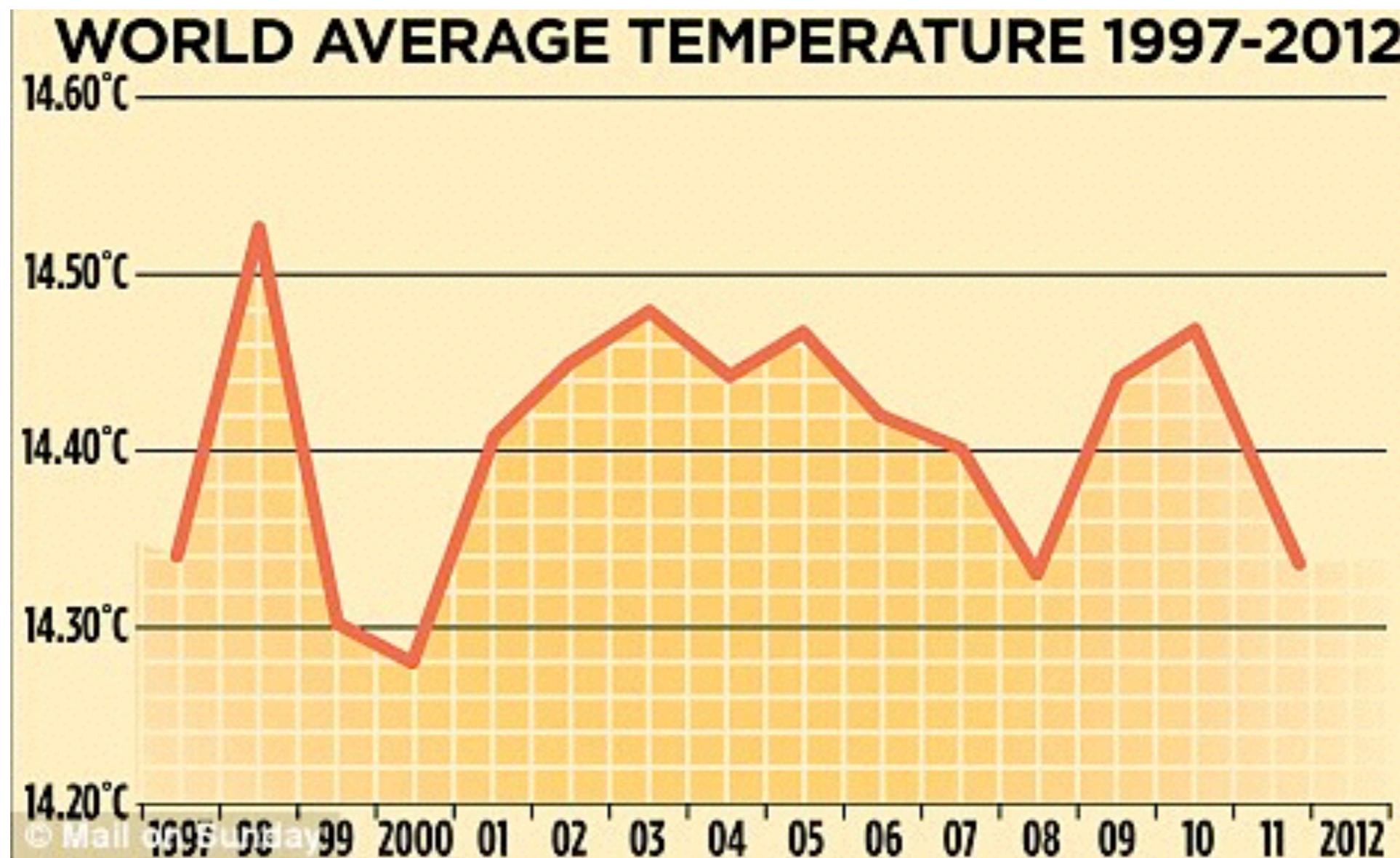


*Always start your
bar graphs at zero!*

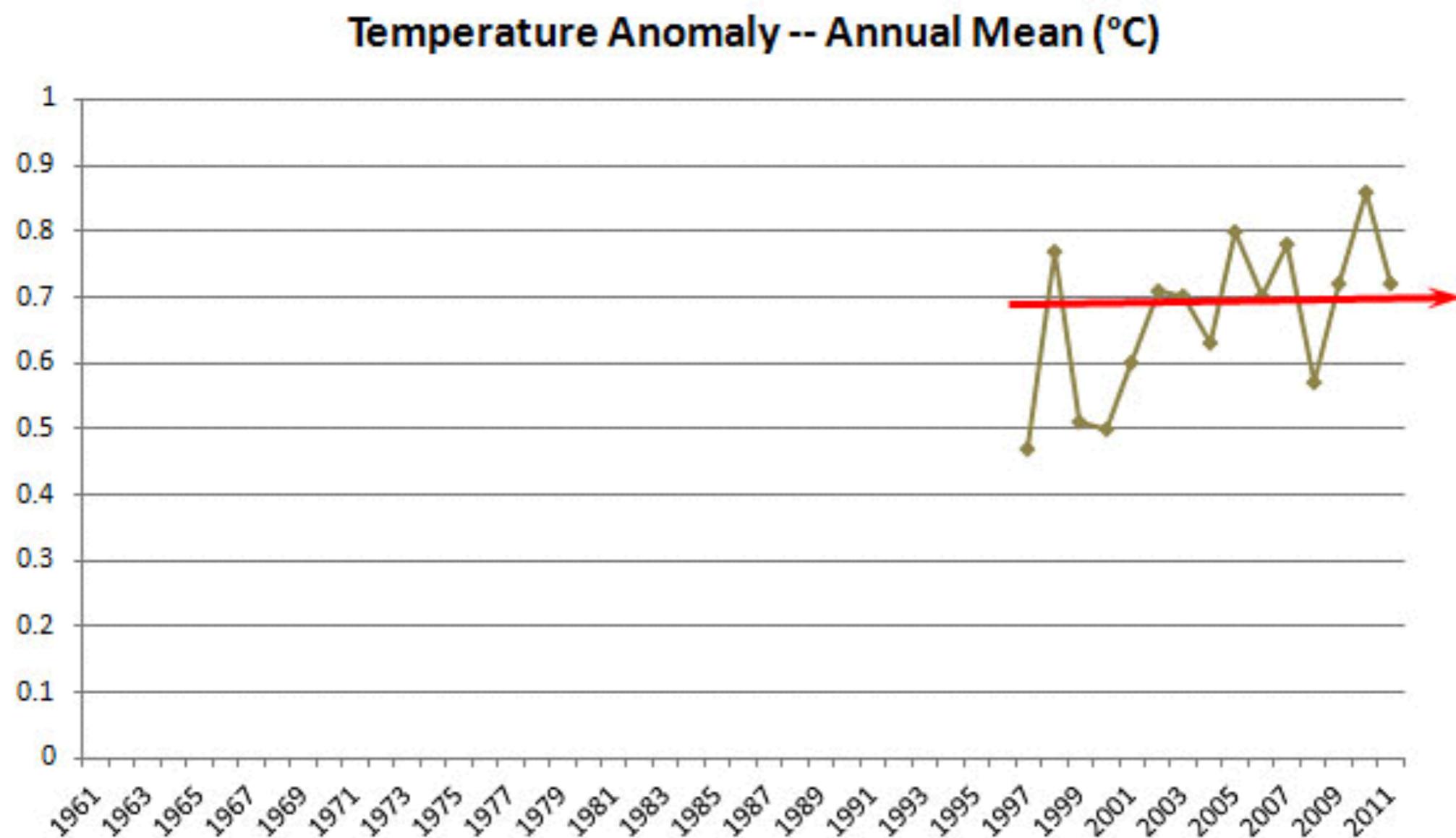
Scale Distortions



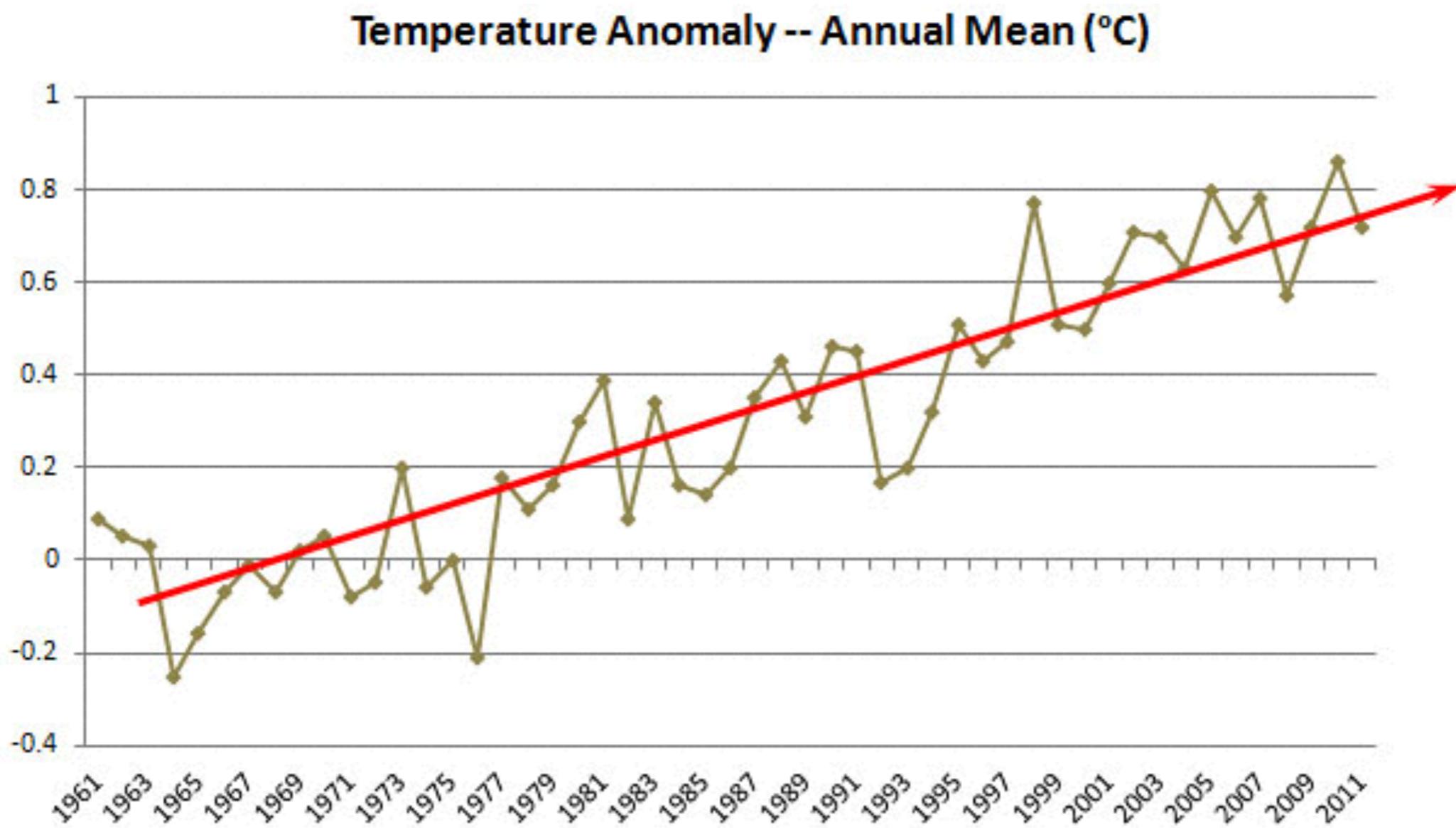
Global Warming?



Global Warming?

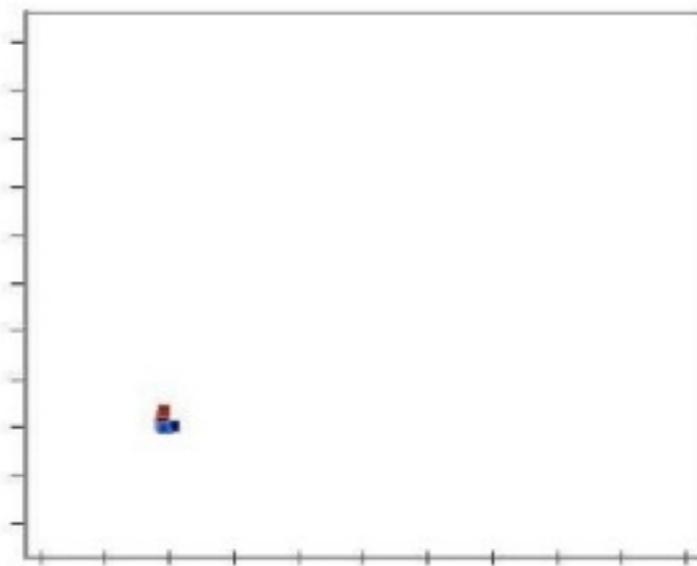


Global Warming!

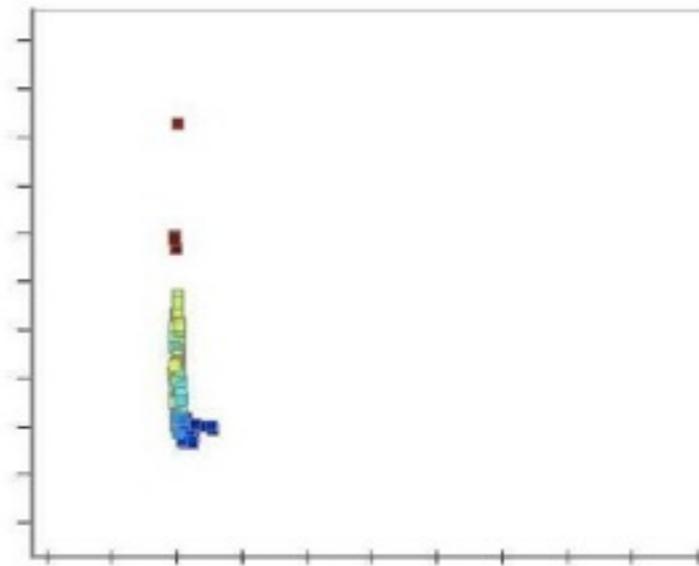


Lying with Scales

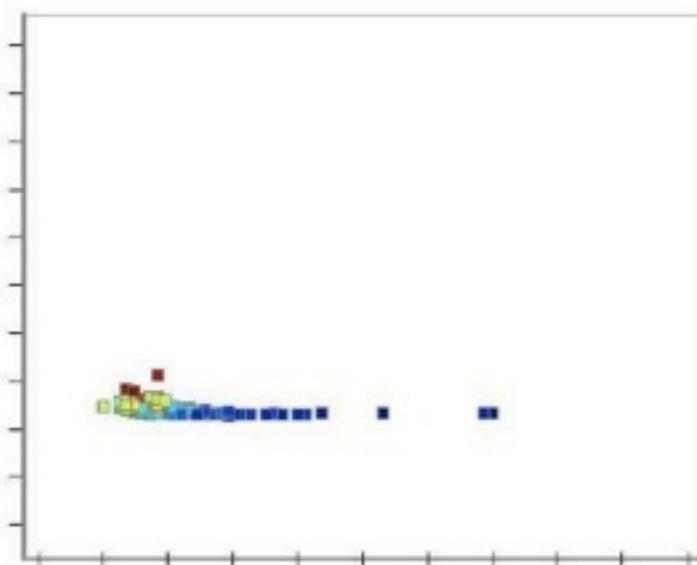
Same data - different scales



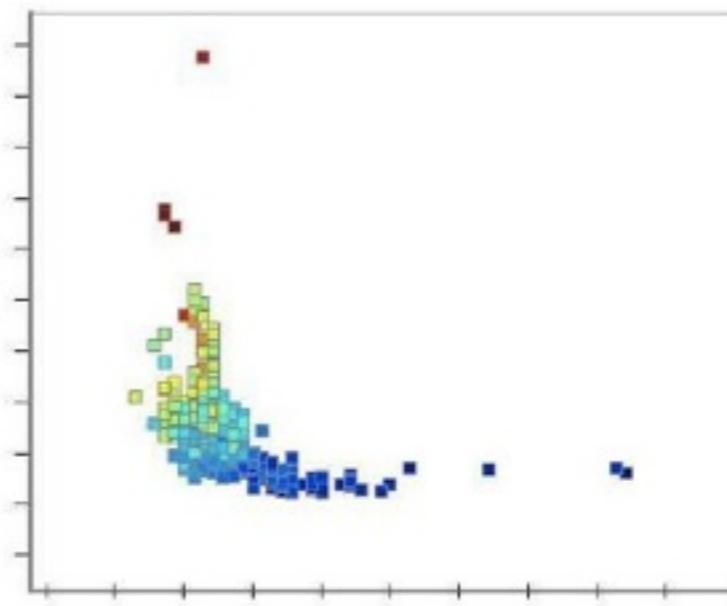
Uniform scale in both x and y



Larger scale in y



Larger scale in x



Larger scale in x and y

Scales are critical!

What are your bounds – upper and lower?

What scale works?

Linear? Log? Clipping? Breaks?

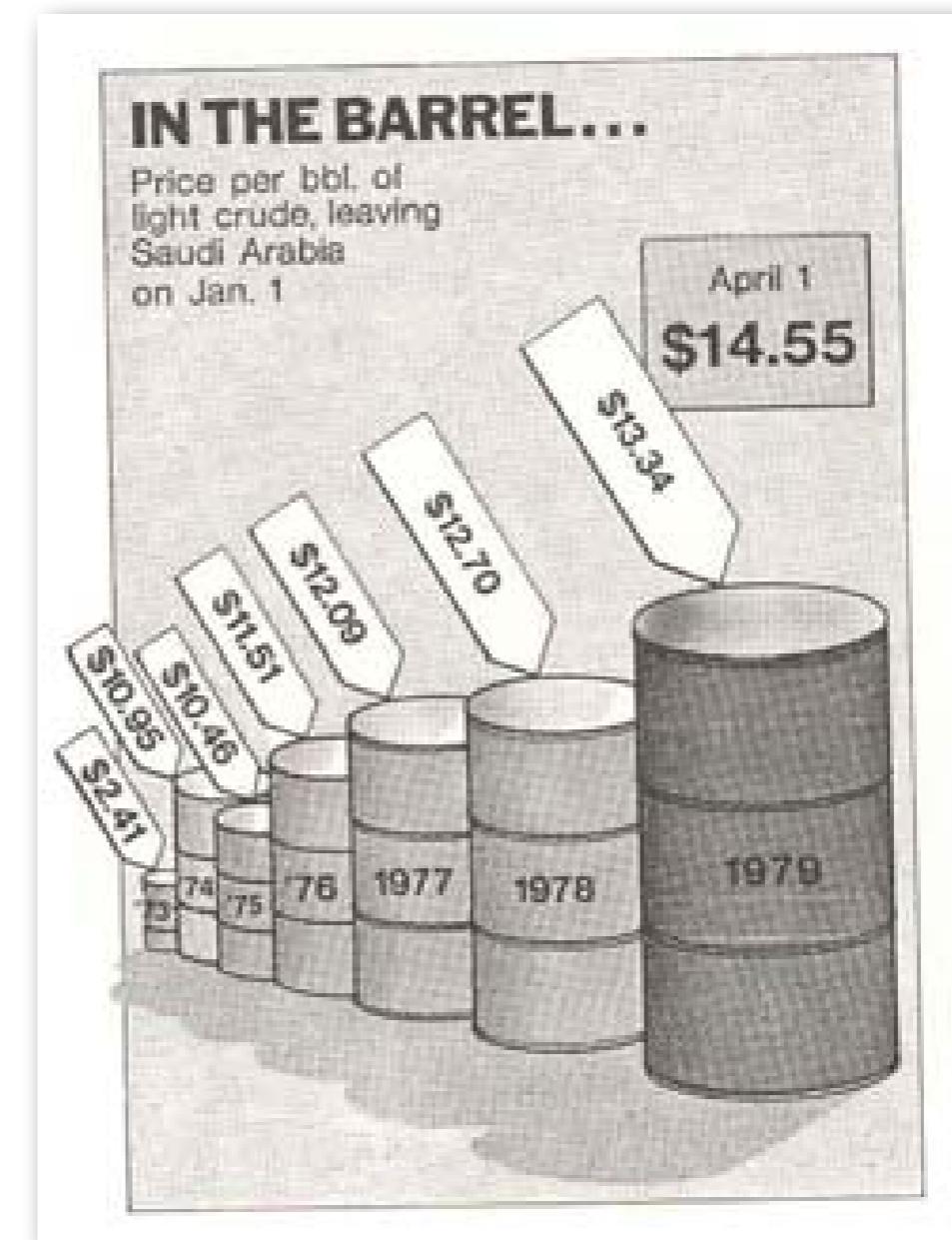
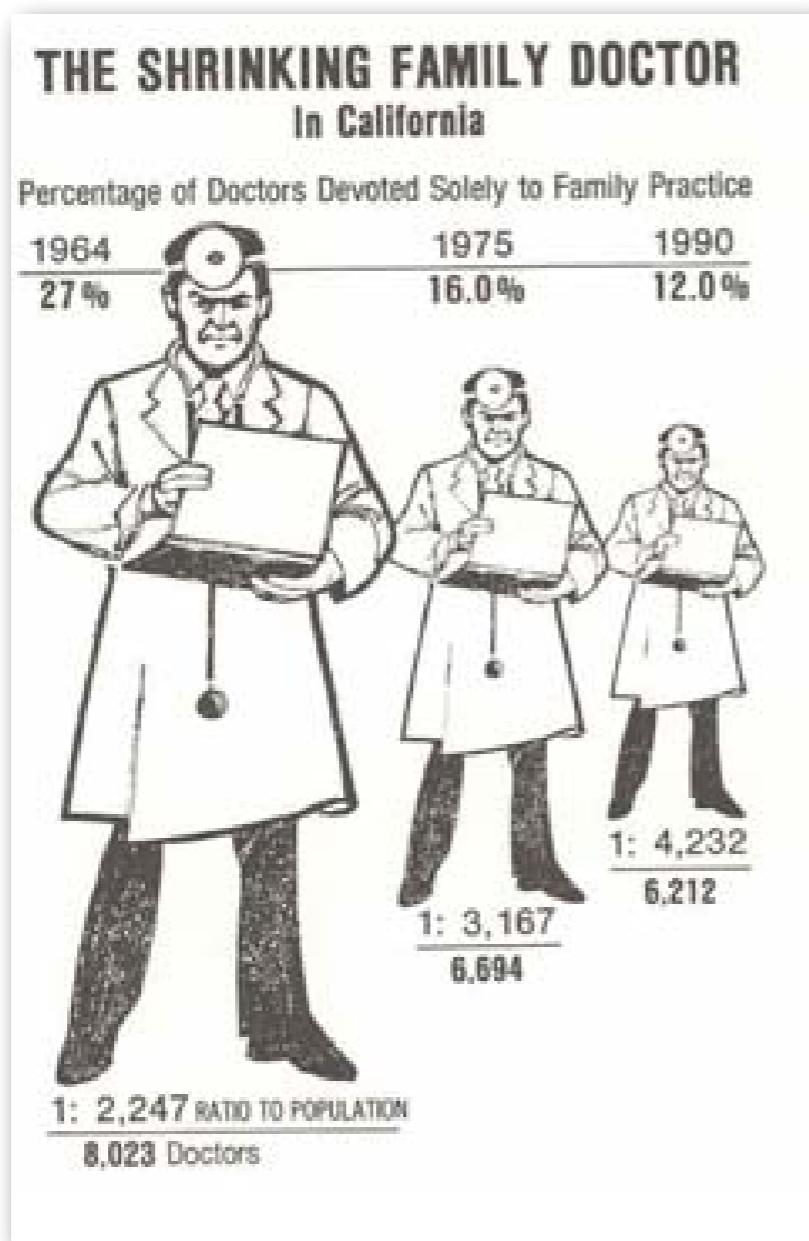
Relative or absolute values?

How can you make things comparable?

The Lie Factor

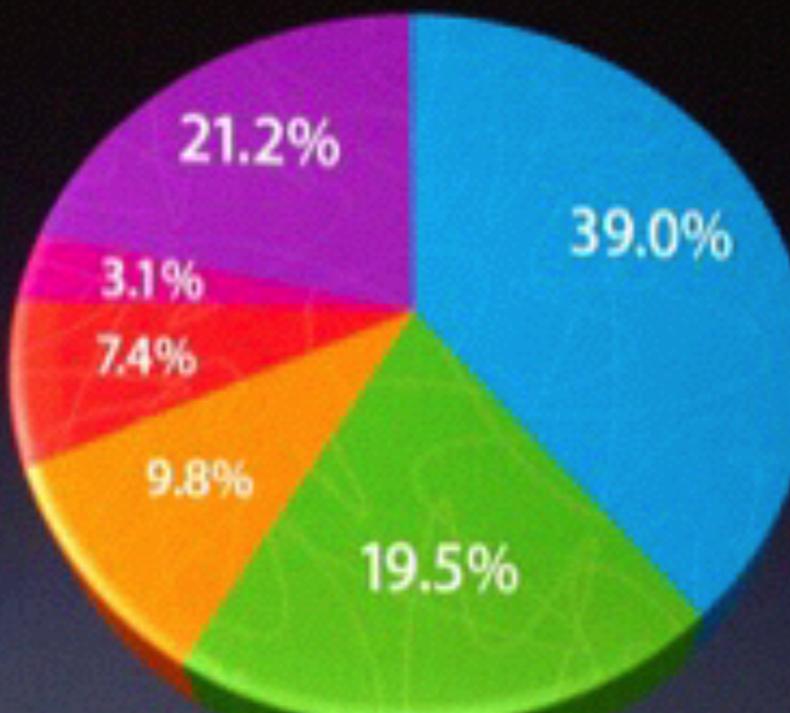
Size of effect shown in graphic

Size of effect in data



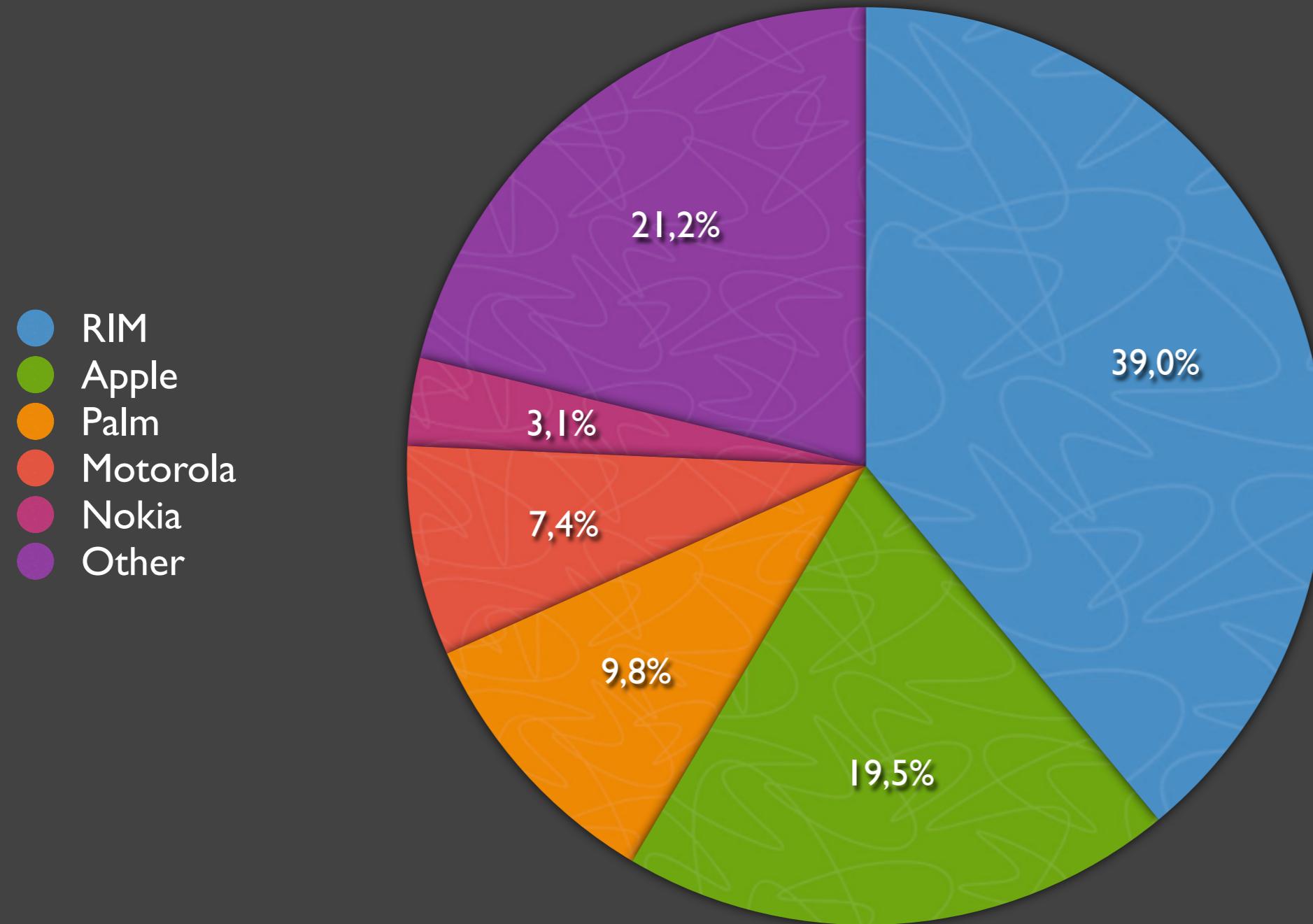
U.S. SmartPhone Marketshare

- RIM
- Apple
- Palm
- Motorola
- Nokia
- Other

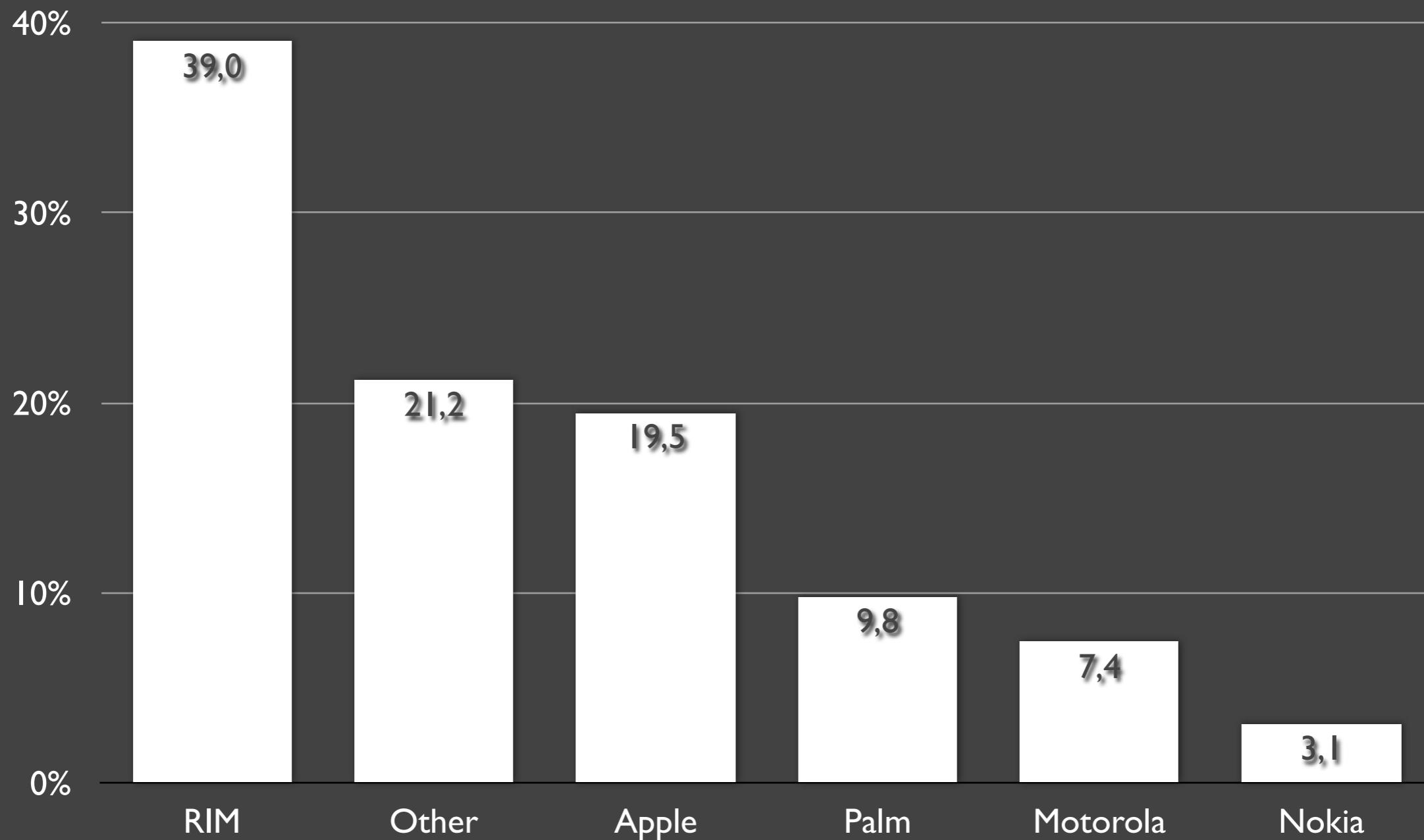


Engage Gartner for

U.S. SmartPhone Marketshare



U.S. SmartPhone Marketshare



*Same Veritas. More Lux.*

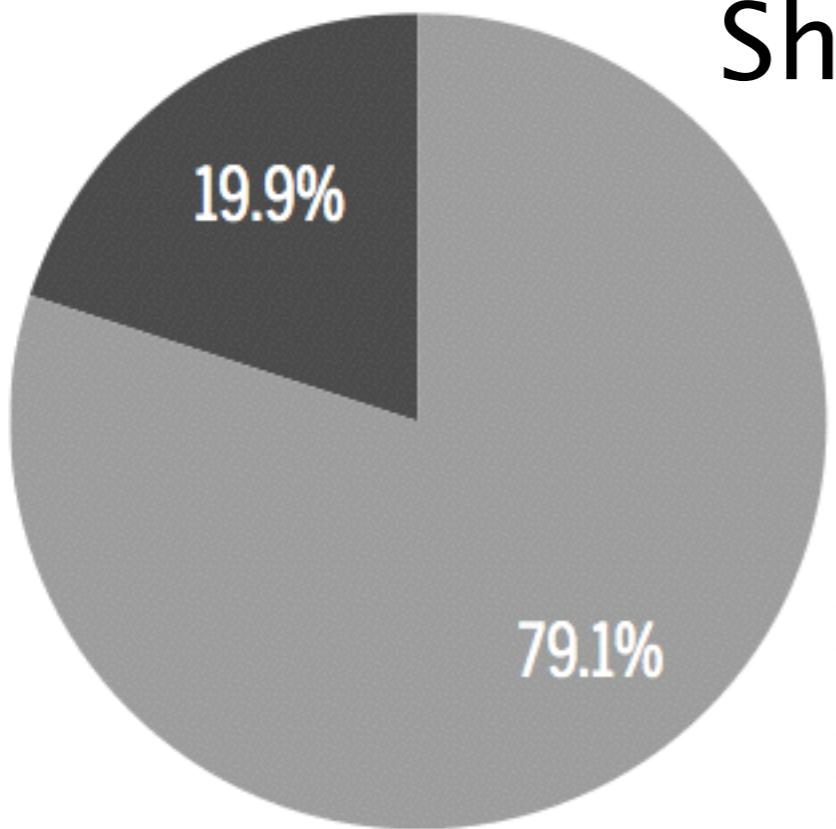
Yale Summer Session

Over 200 full-credit courses.

June 4 – July 6 , July 9 – Aug 10

2012 *experience Yale*

CHART YALE GRADUATES' MAJORS, CLASS OF 2011



Should always add up to 100

Facebook Recommendations



[Shake Shack to open in New Haven](#)
277 people recommend this.



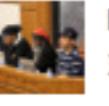
[Popular anti-religion creates false dichotomy](#)
15 people recommend this.



[Friends remember Foucher LAW '14](#)
10 people recommend this.



[AIDS activist speaks about documentary film](#)
8 people recommend this.



[Panel outlines changes in hip-hop](#)
30 people recommend this.

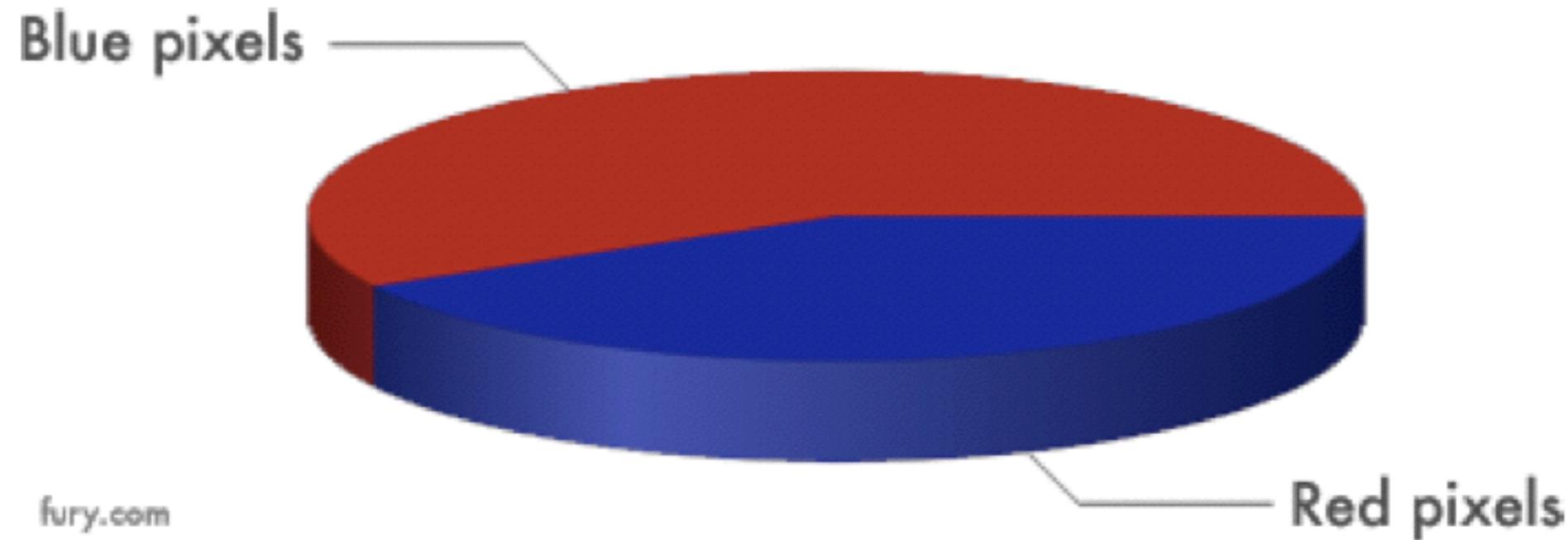
 Facebook social plugin

Advertisement

Featured

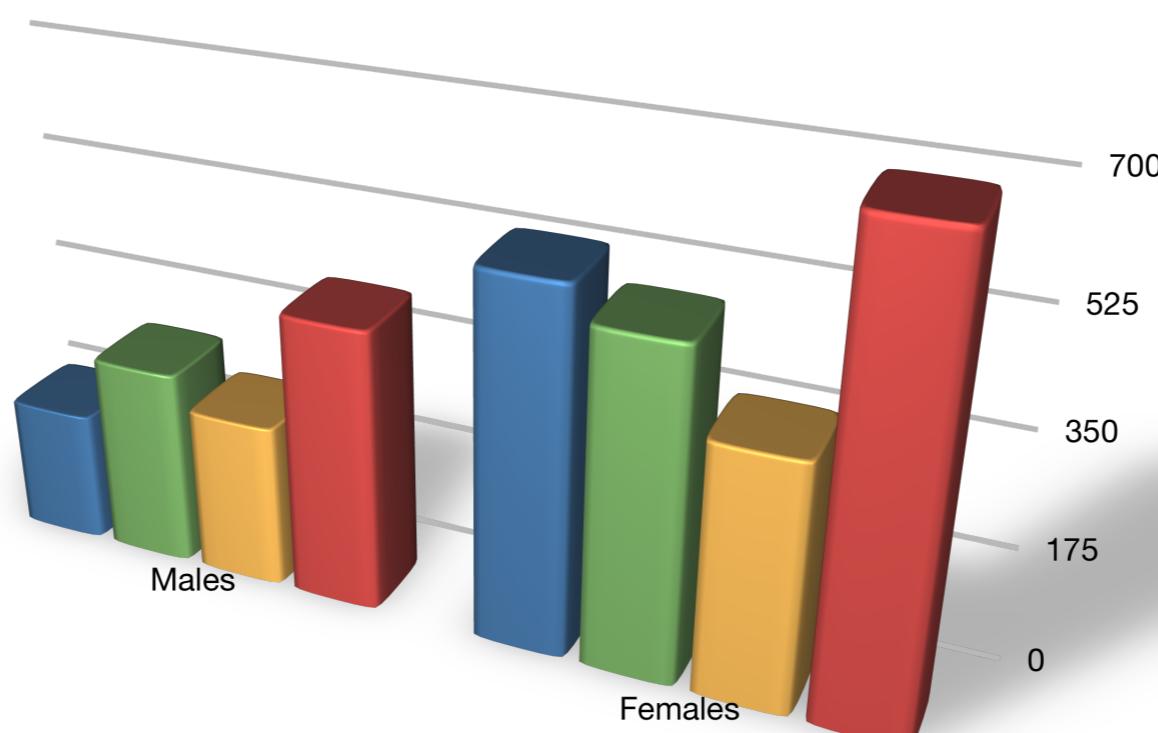
Jobs

Why 3D Pie Charts are Bad



Maximize Data-Ink Ratio

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



■ 0-\$24,999

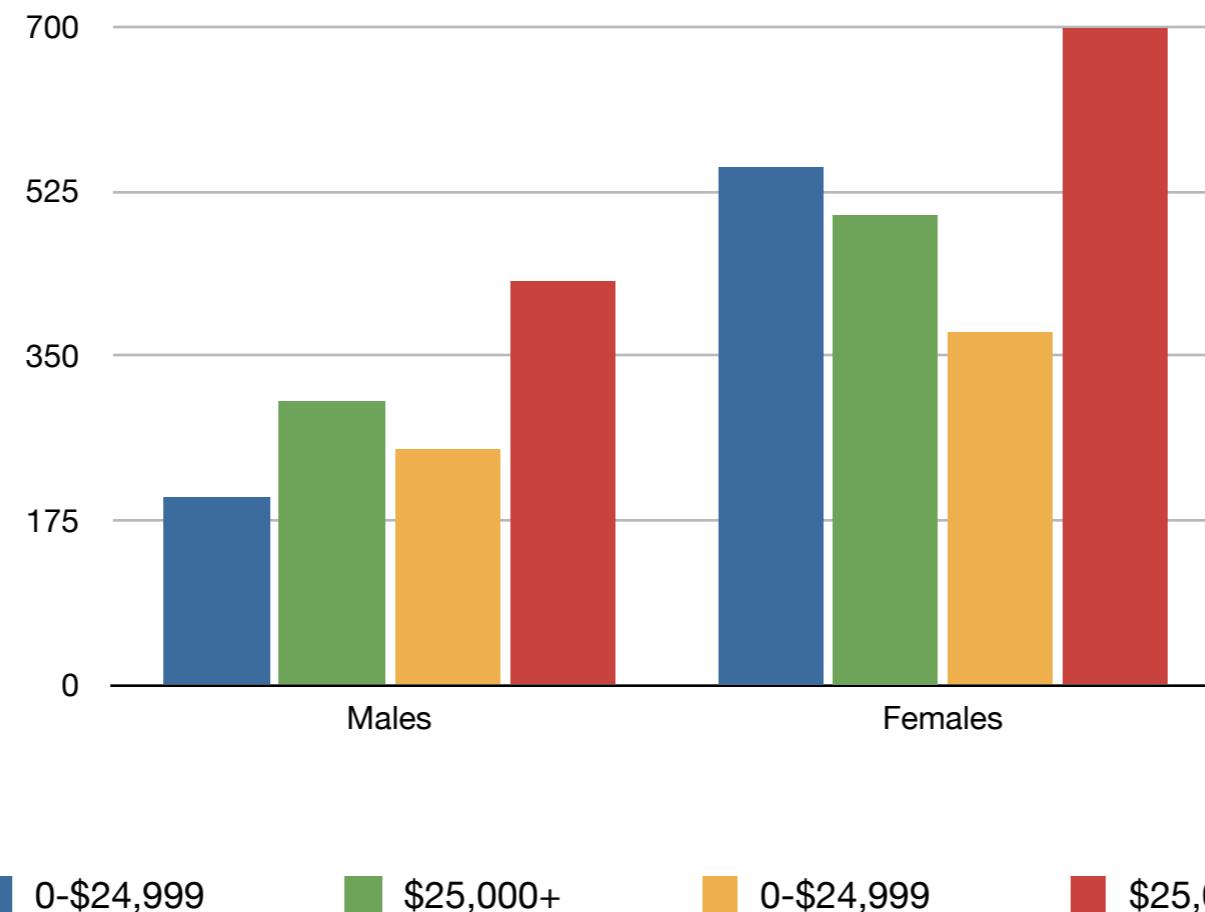
■ \$25,000+

■ 0-\$24,999

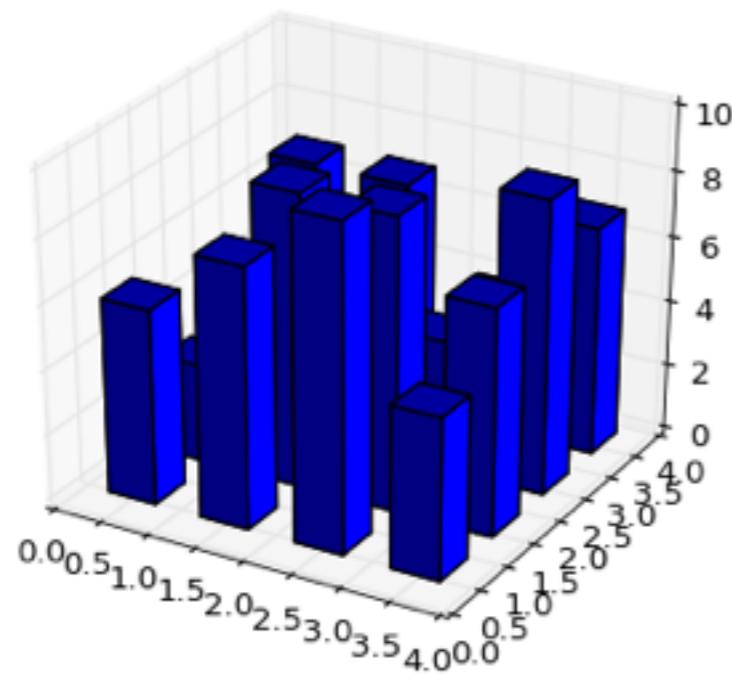
■ \$25,000+

Maximize Data-Ink Ratio

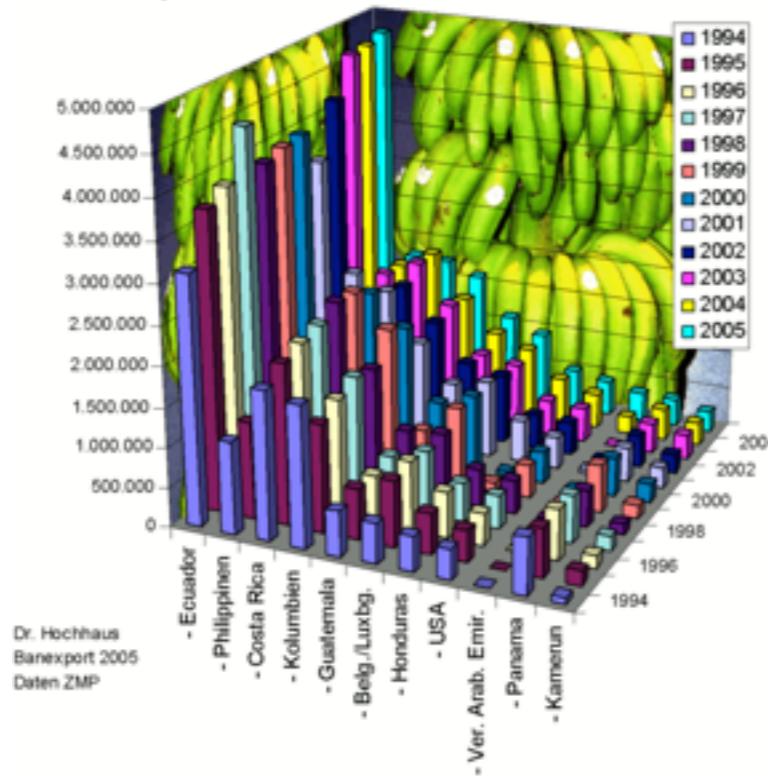
Data-Ink Ratio = $\frac{\text{Data ink}}{\text{Total ink used in graphic}}$



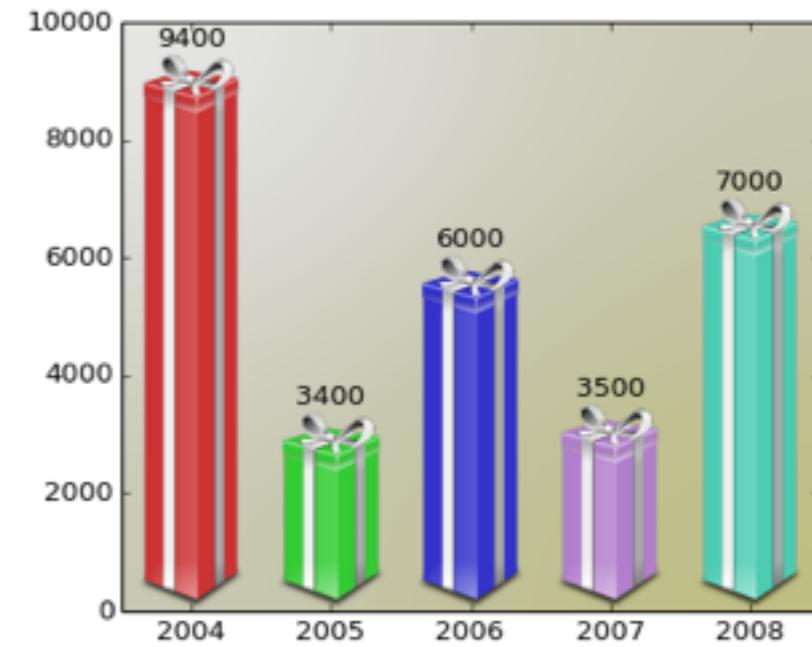
Don't Use 3D



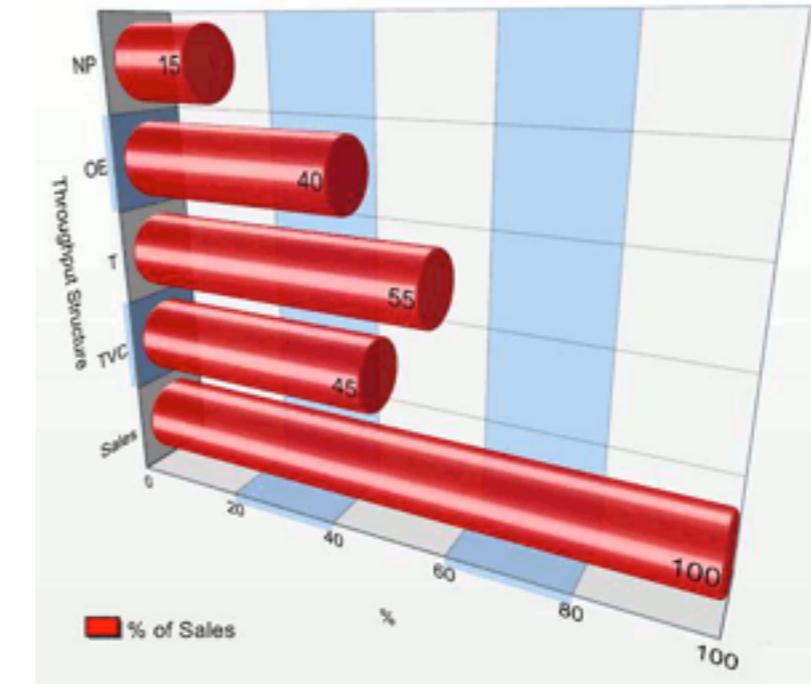
Export von Bananen in Tonnen von 1994-2005



Dr. Hochhaus
Banlexport 2005
Daten ZMP



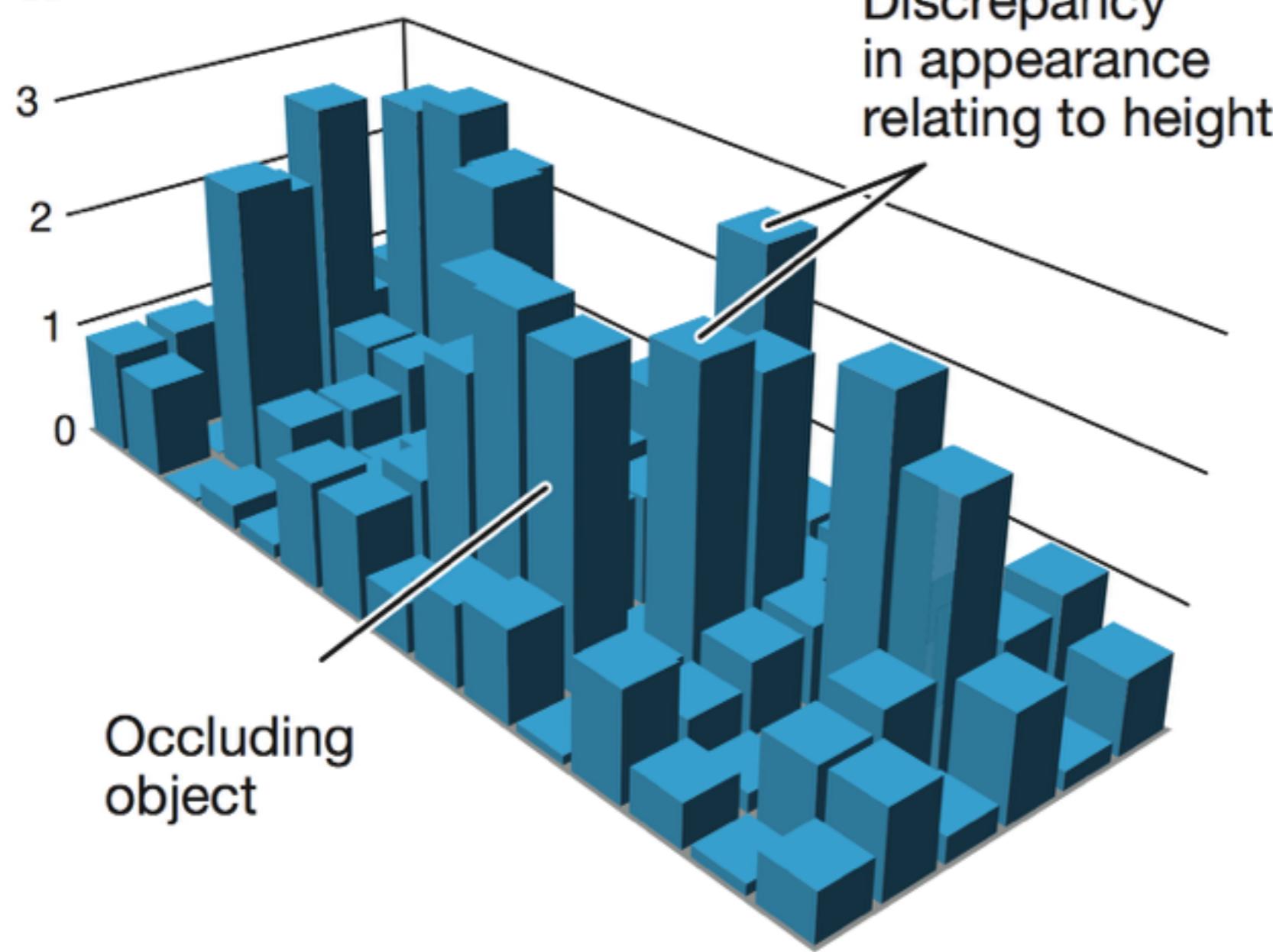
matplotlib gallery



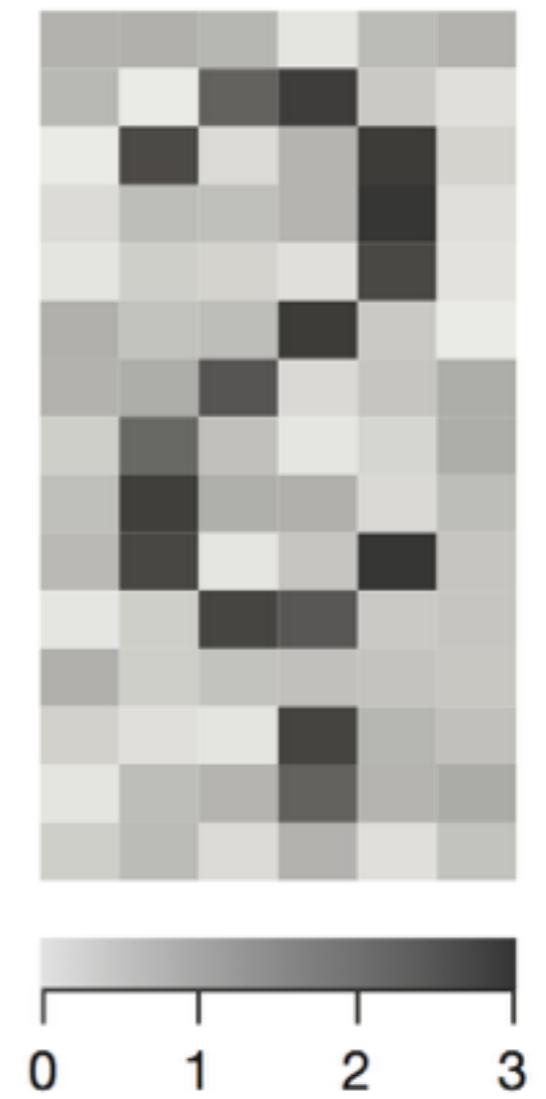
Excel Charts Blog

3D Bar Plot

a



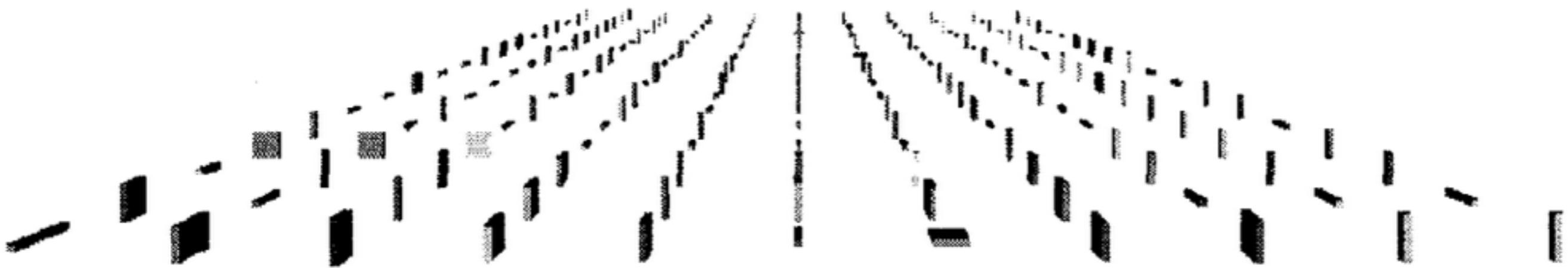
b



Which one is the tallest bar?
What is the pattern in the data?

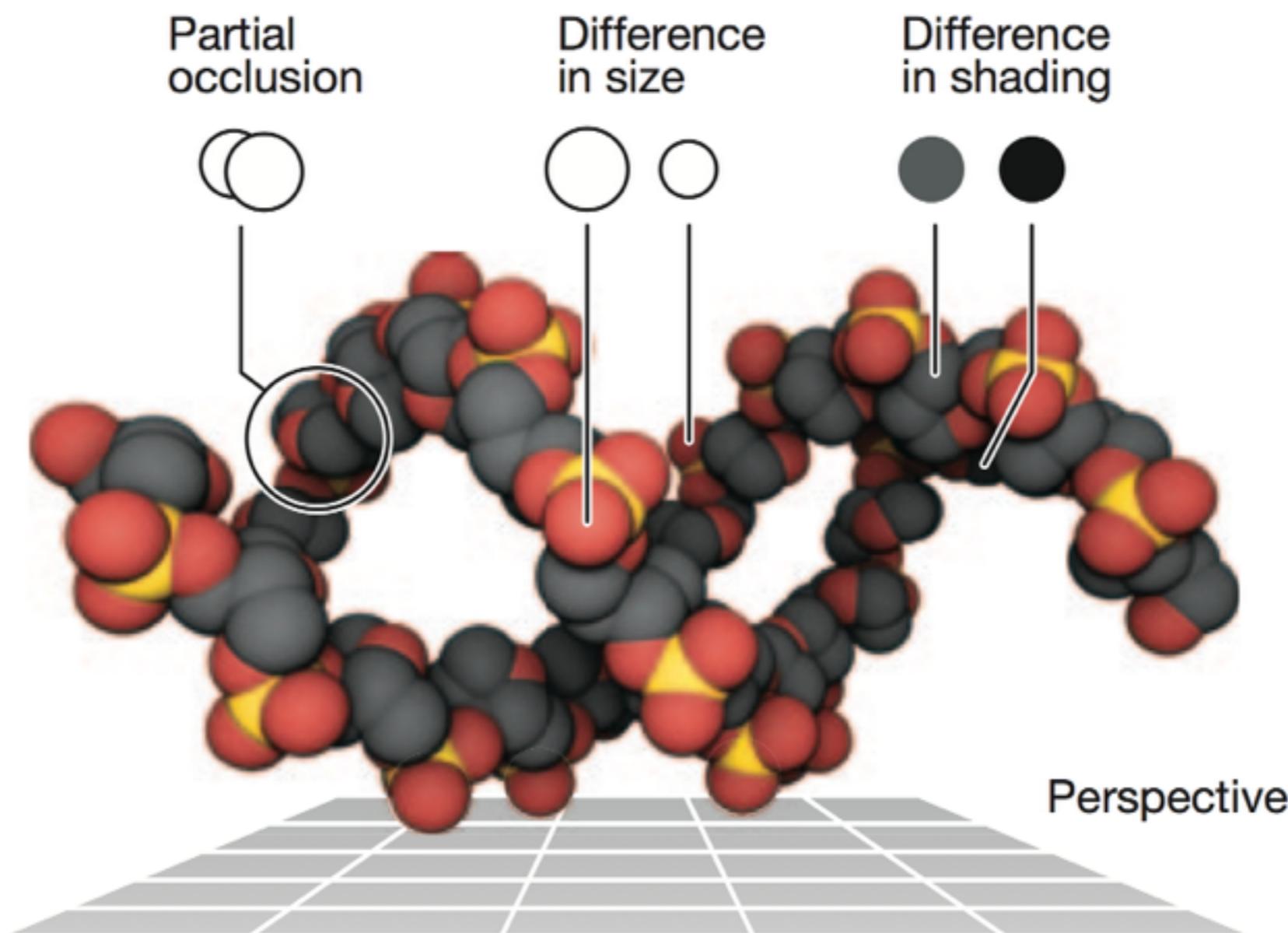
Gehlenborg & Wong, PoV, Nature Methods, 2012

Perspective Distortion in 3D



Position and size channel are negatively affected

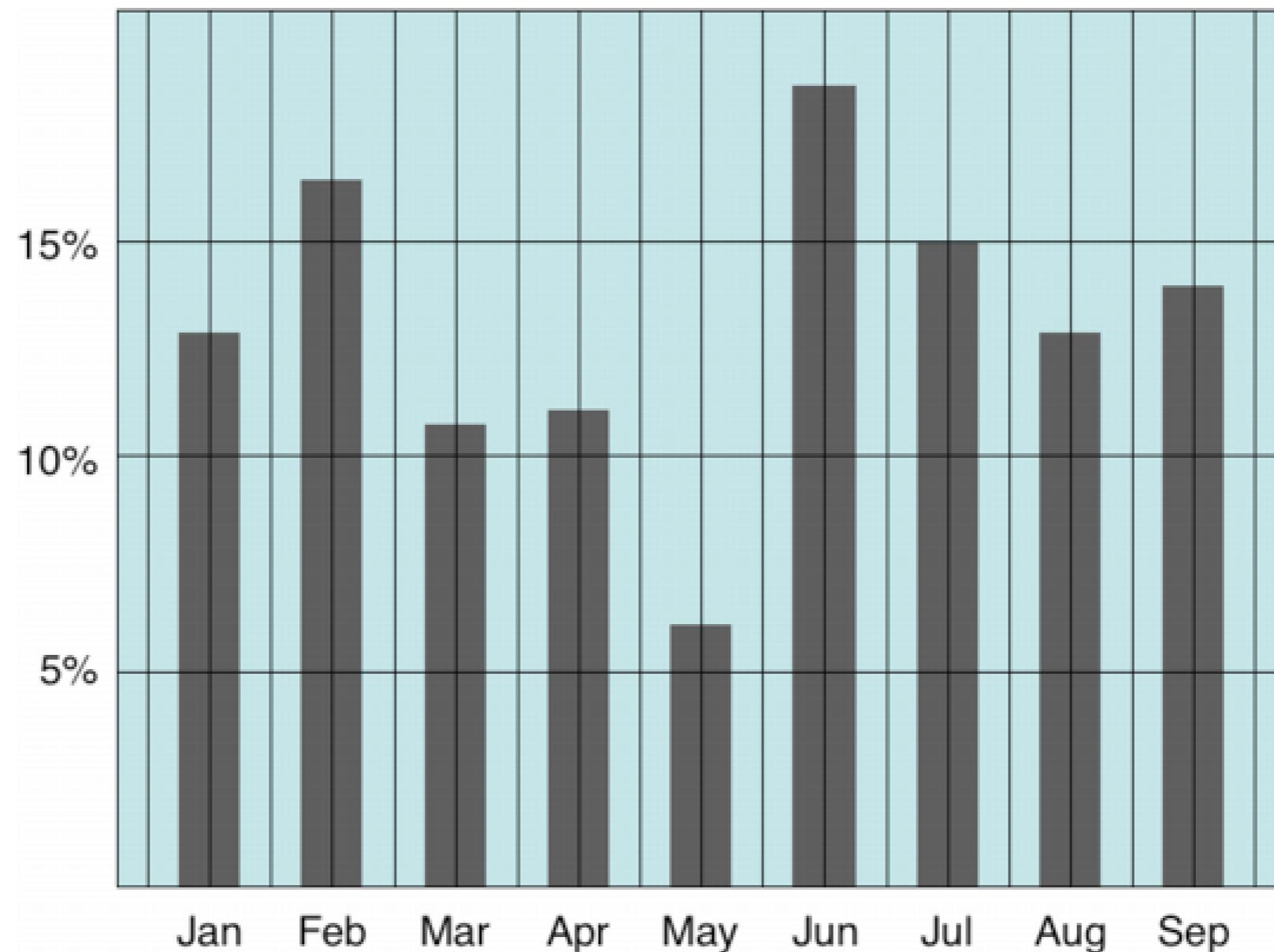
Exception: 3D Phenomena



Depth cues enable us to perceive 2D images as 3D objects

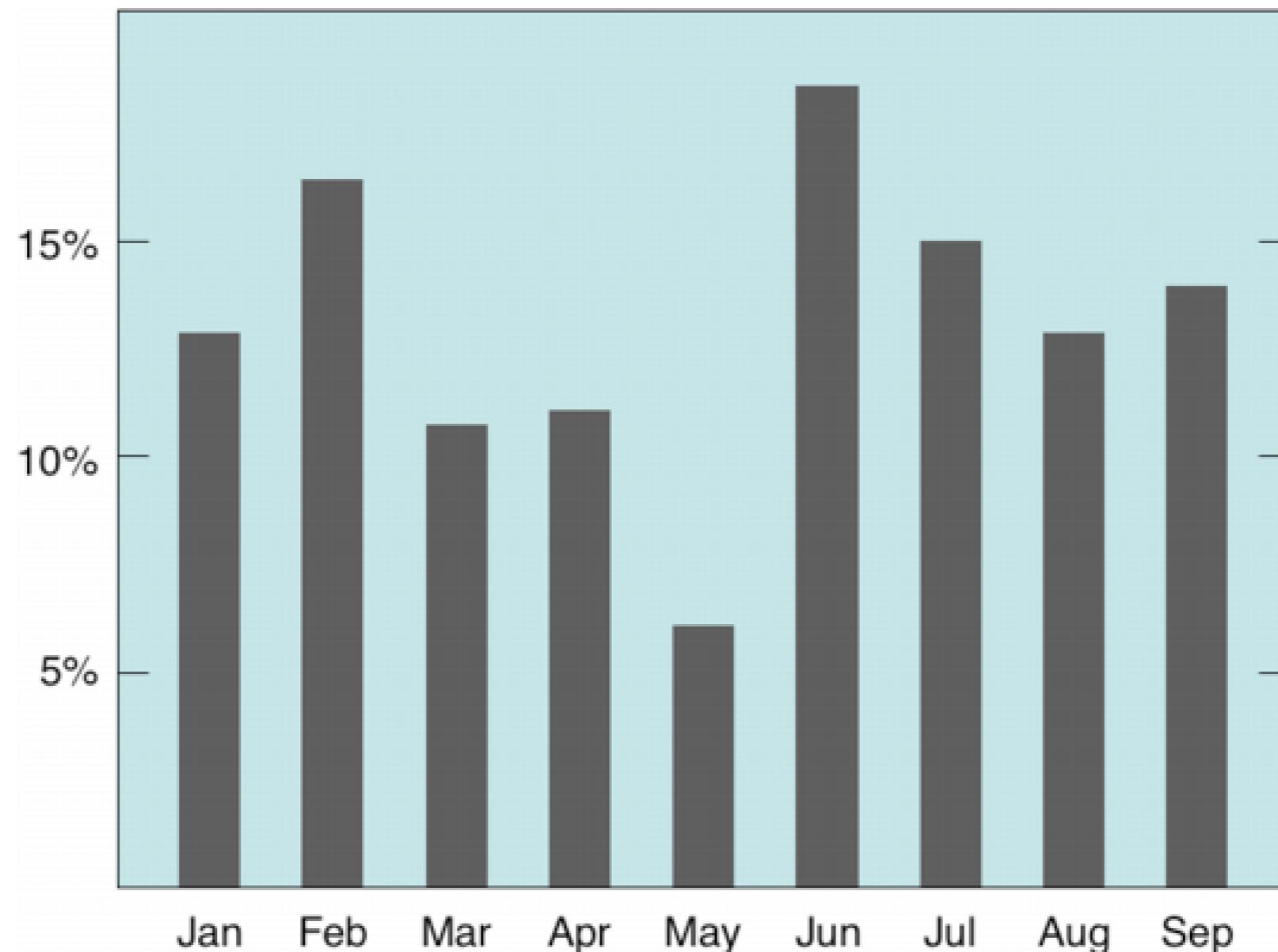
Avoid Chart Junk

Extraneous visual elements that distract from the message



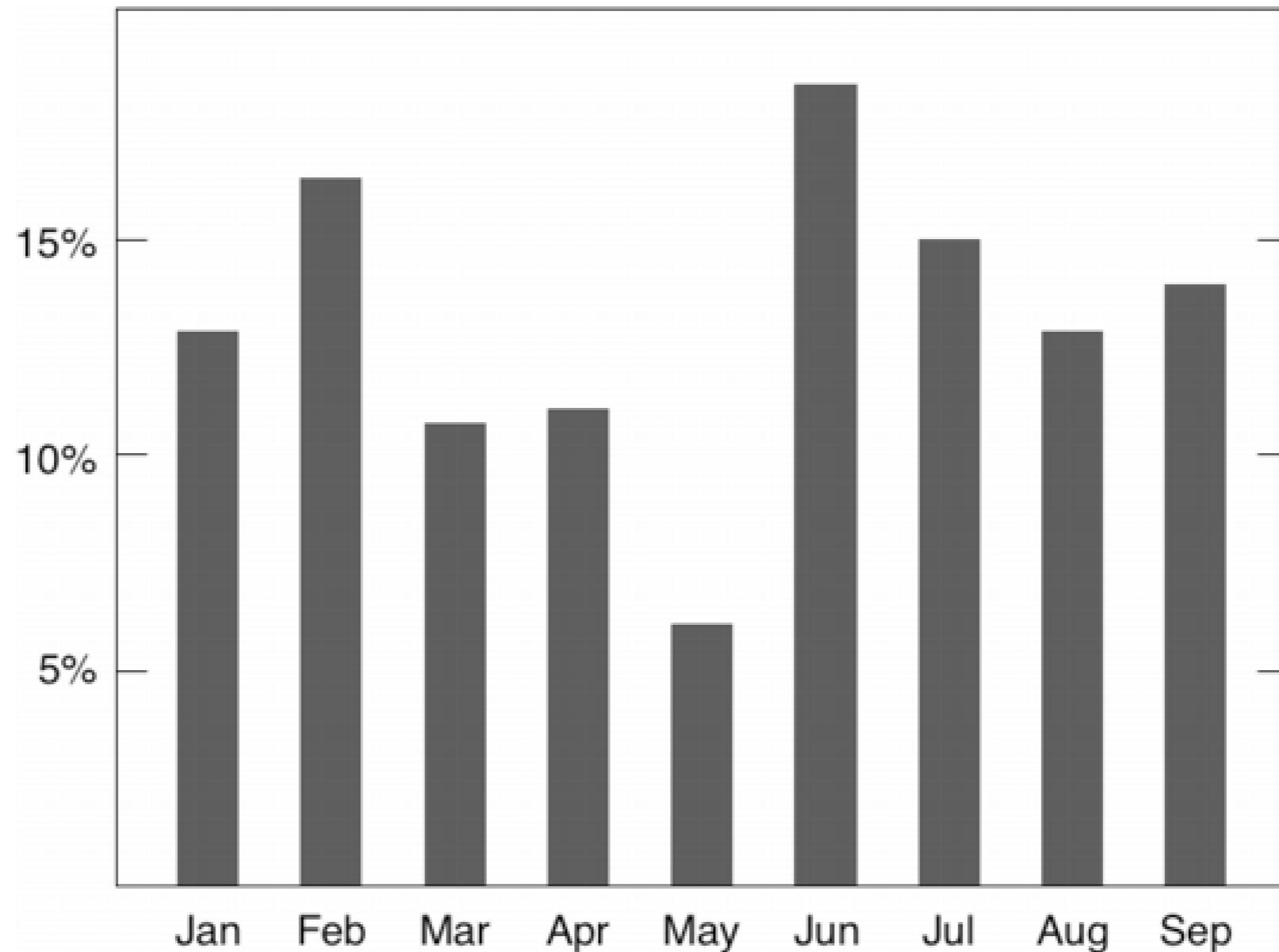
Avoid Chart Junk

Extraneous visual elements that distract from the message



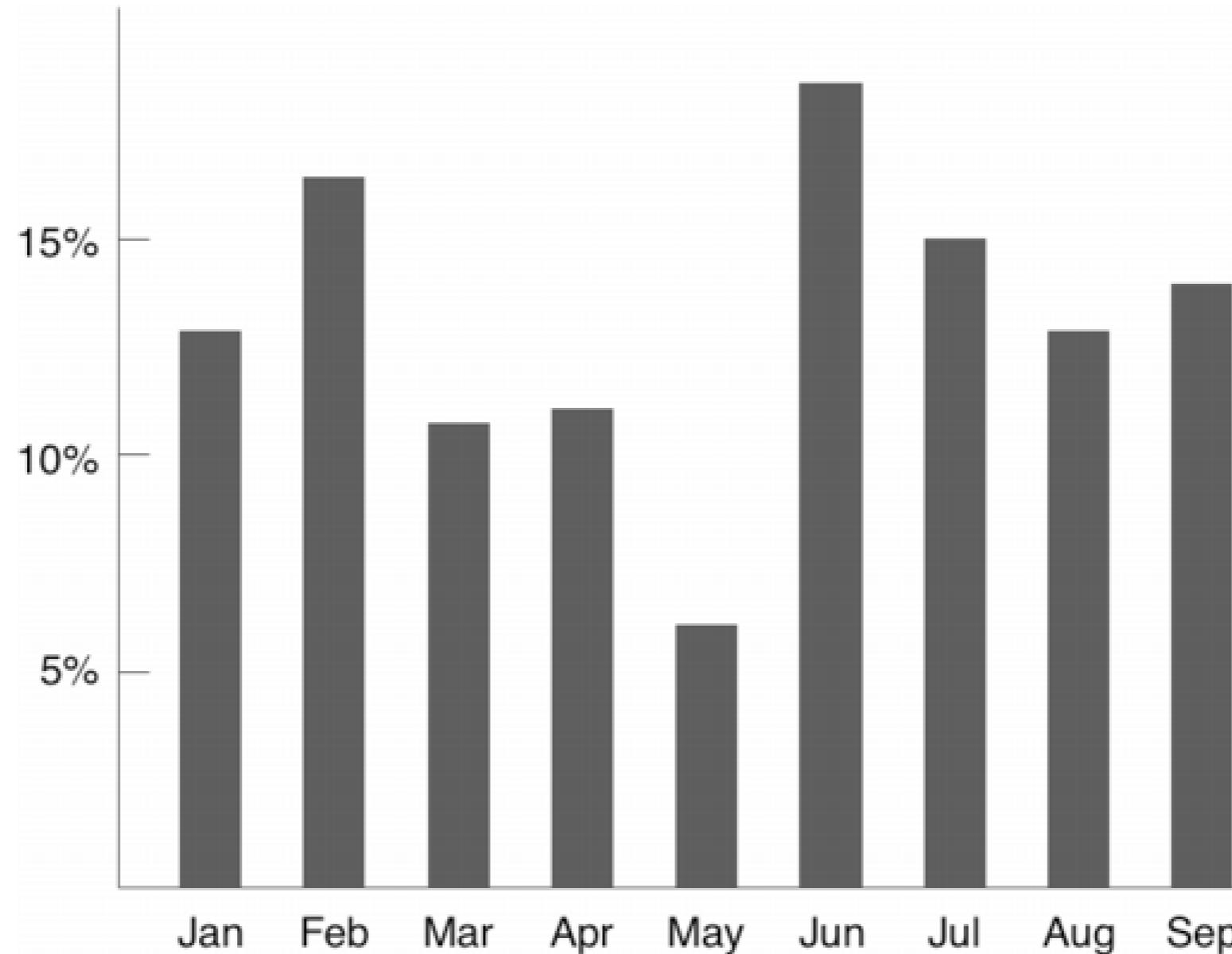
Avoid Chart Junk

Extraneous visual elements that distract from the message



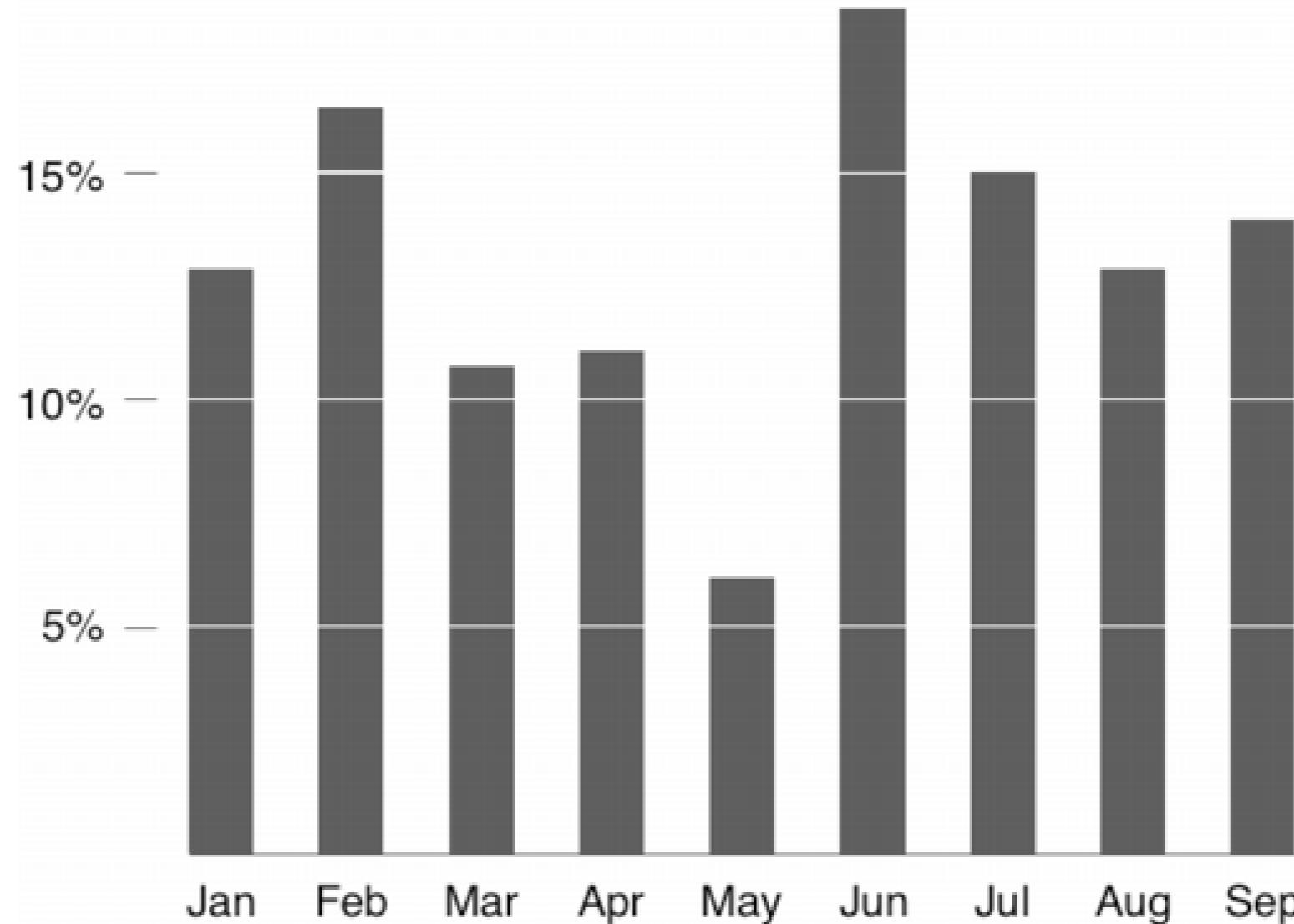
Avoid Chart Junk

Extraneous visual elements that distract from the message



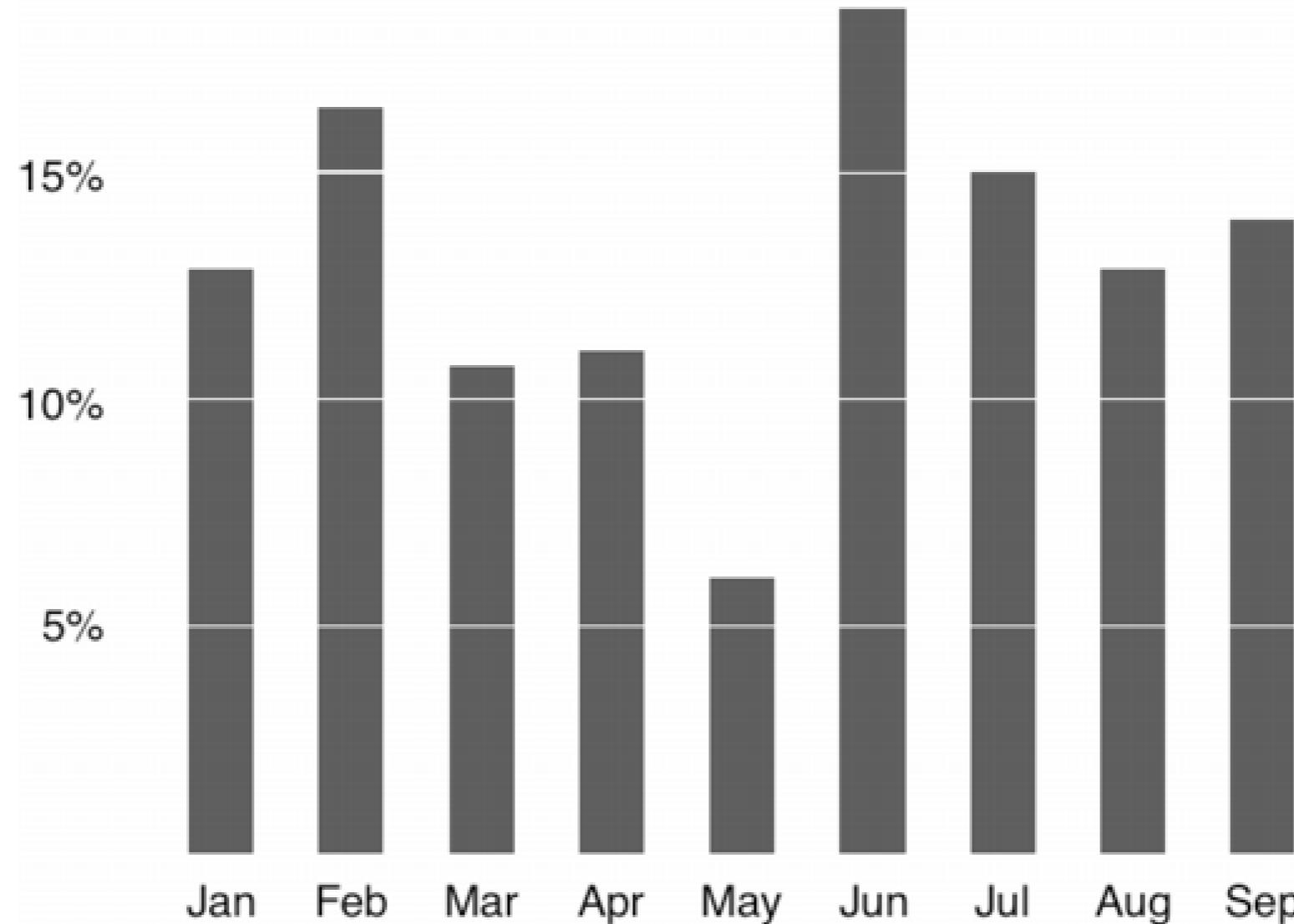
Avoid Chart Junk

Extraneous visual elements that distract from the message

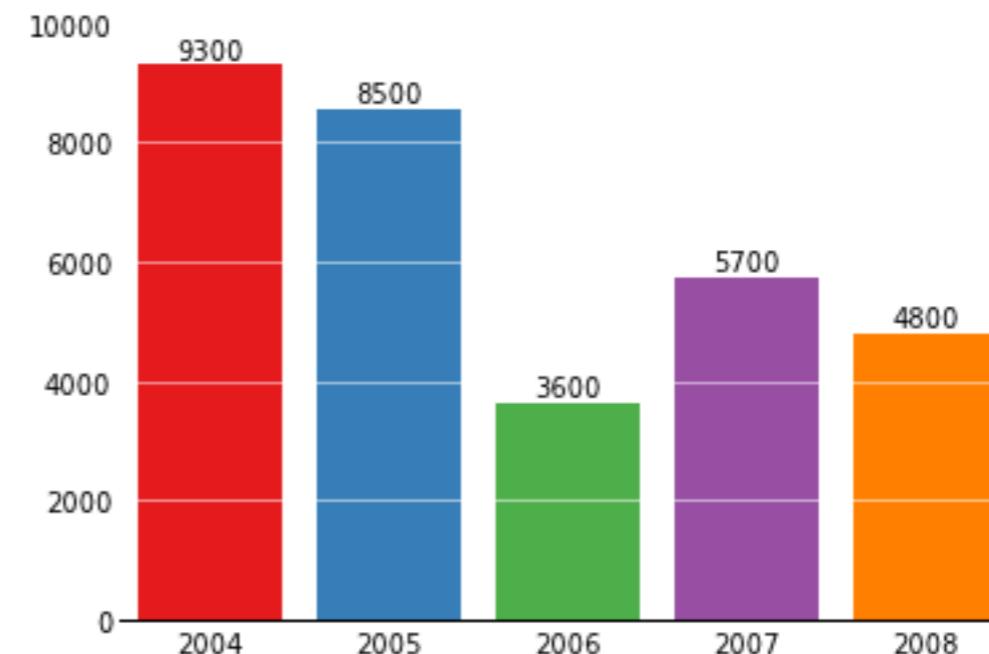
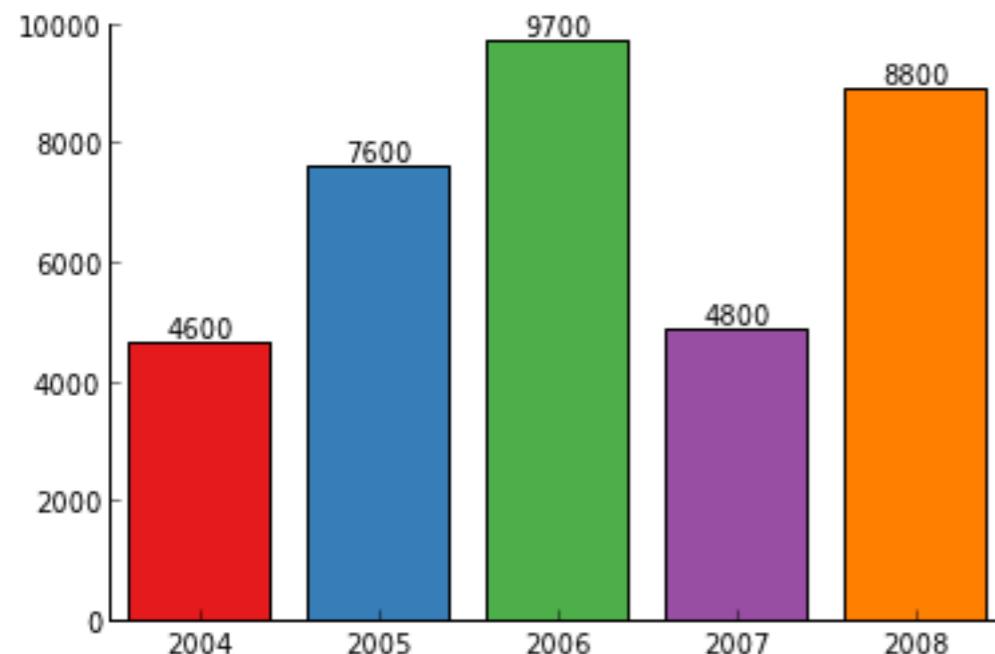
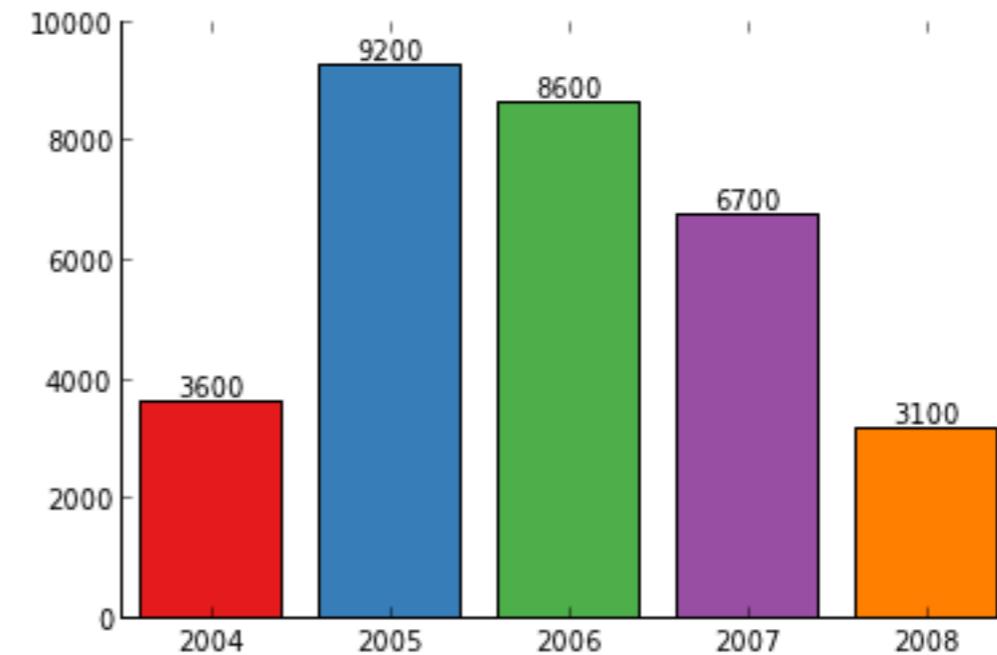
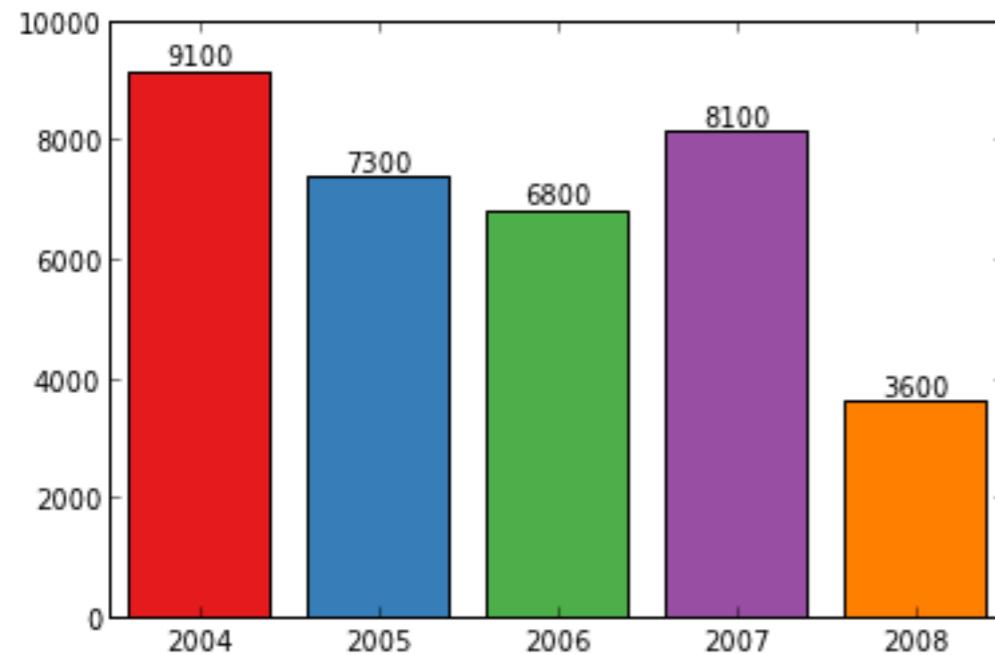


Avoid Chart Junk

Extraneous visual elements that distract from the message



Matplotlib Example



Tufte's Design Principles

Clear, detailed, and thorough labeling and appropriate scales

Size of the graphic effect should be directly proportional to the numerical quantities (“lie factor”)

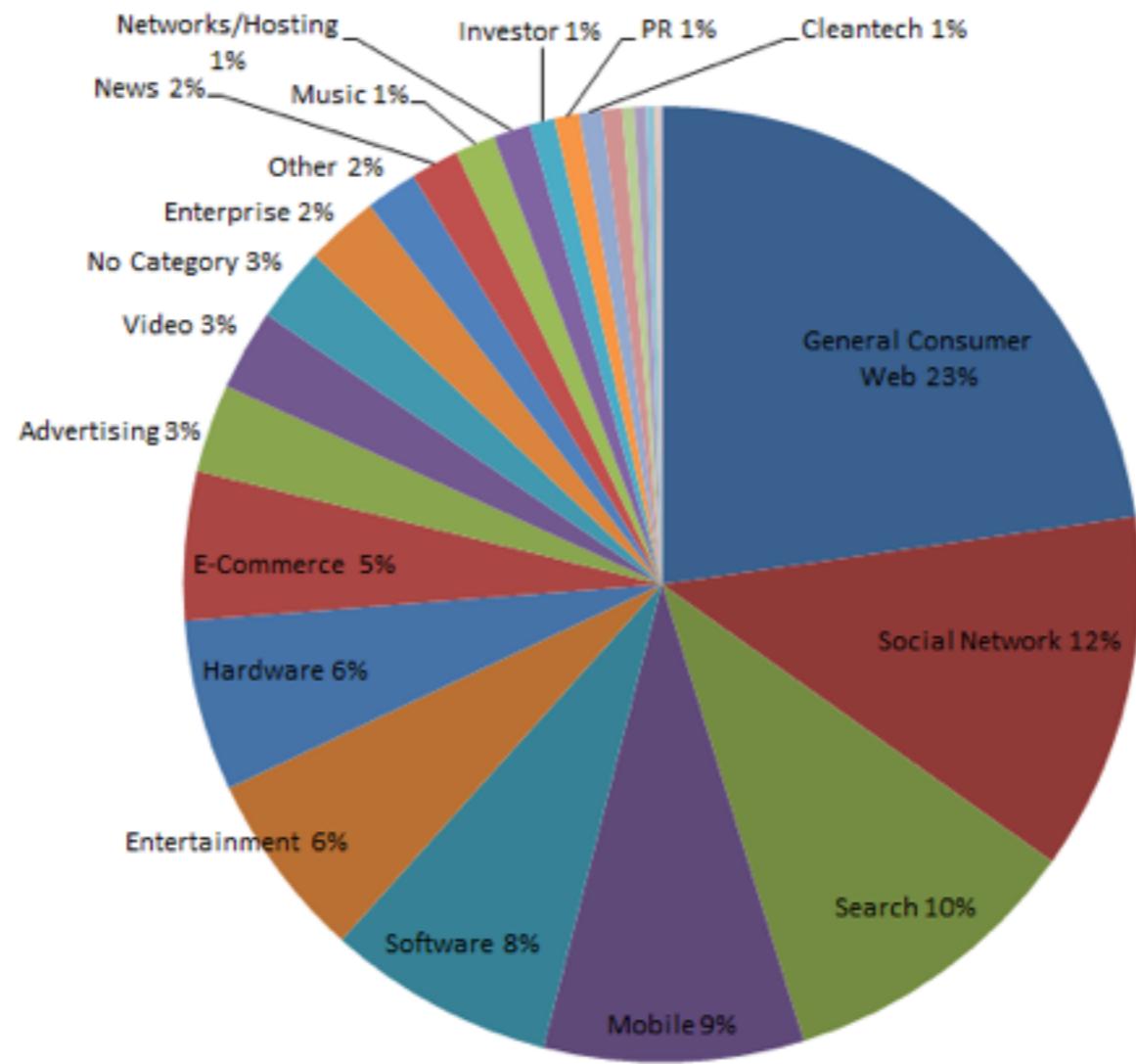
Maximize data-ink ratio

Avoid chart junk



Visualization Critique

Death to Pie Charts

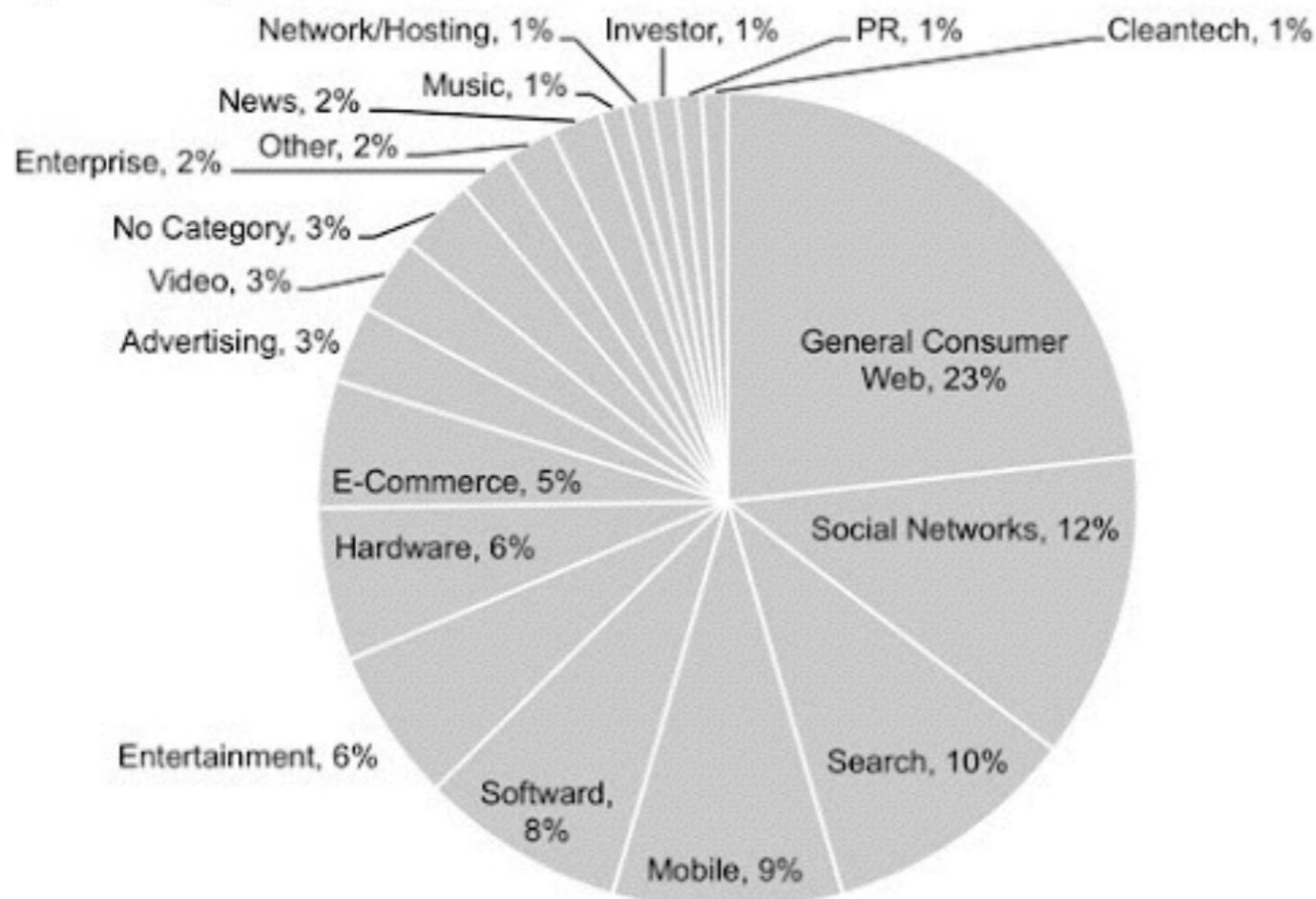


“I hate pie charts.
I mean, really hate them.”

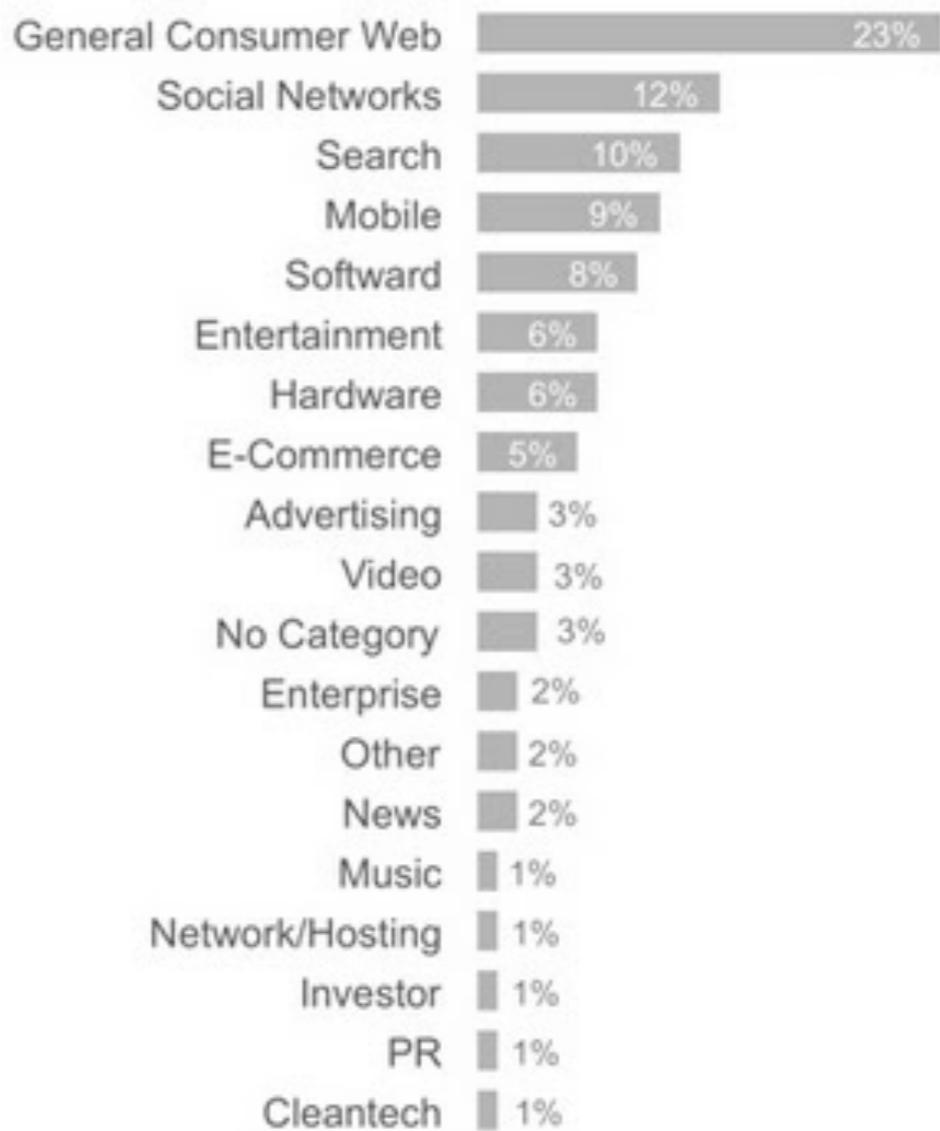
Redesign

TechCrunch Coverage: 2005 - 2011

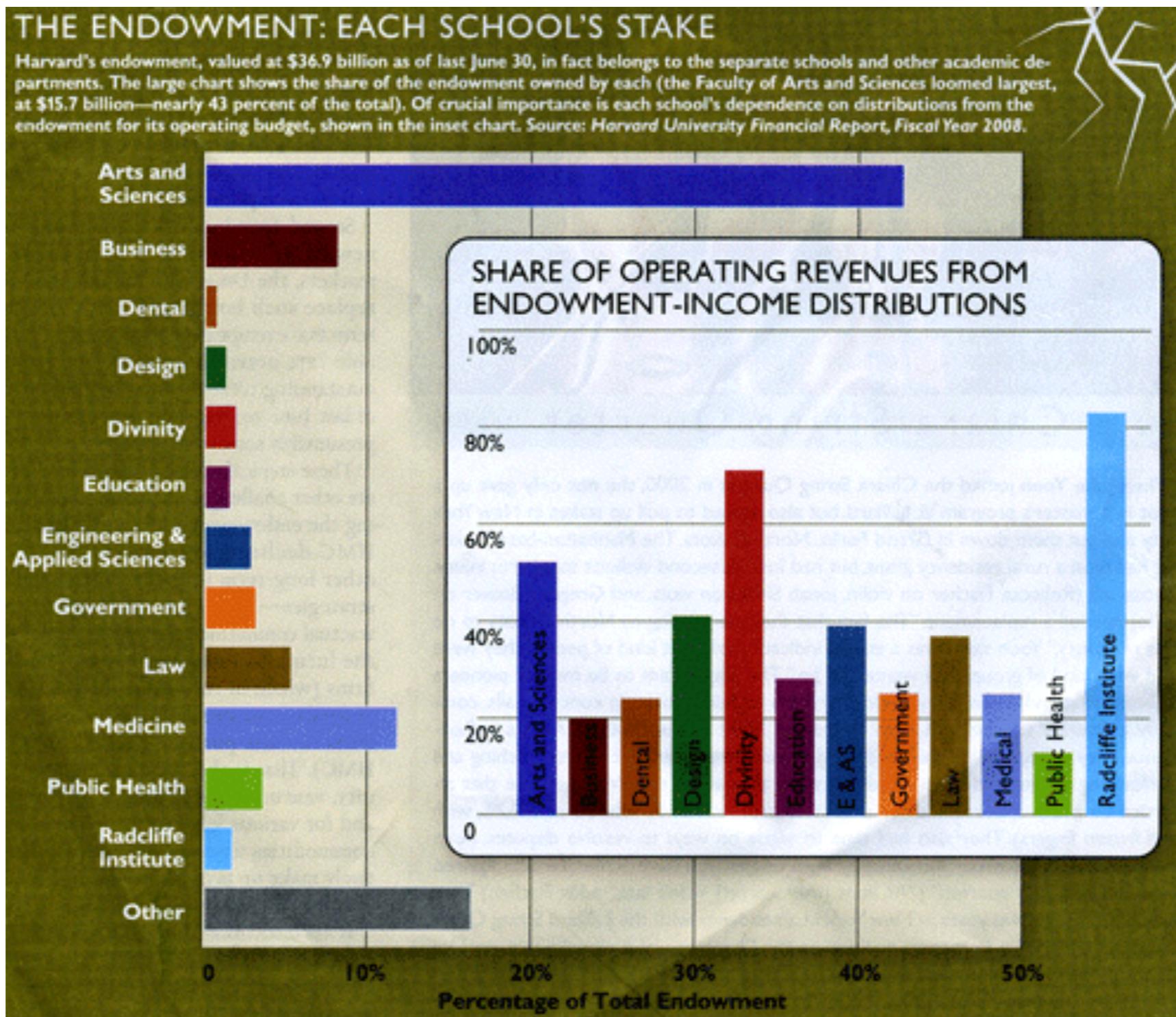
A slightly better pie?



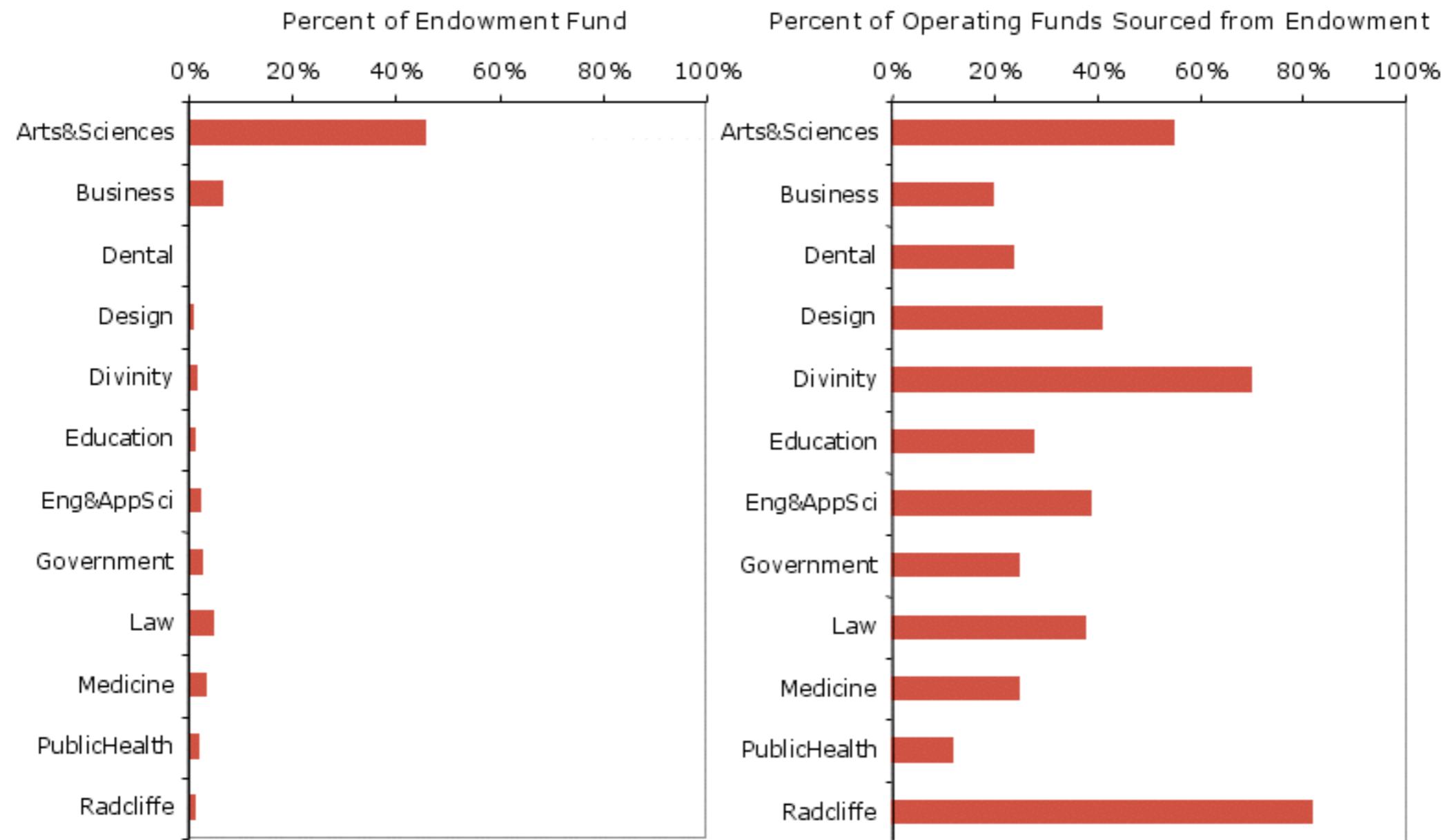
TechCrunch Coverage: 2005 - 2011 Bars are best!



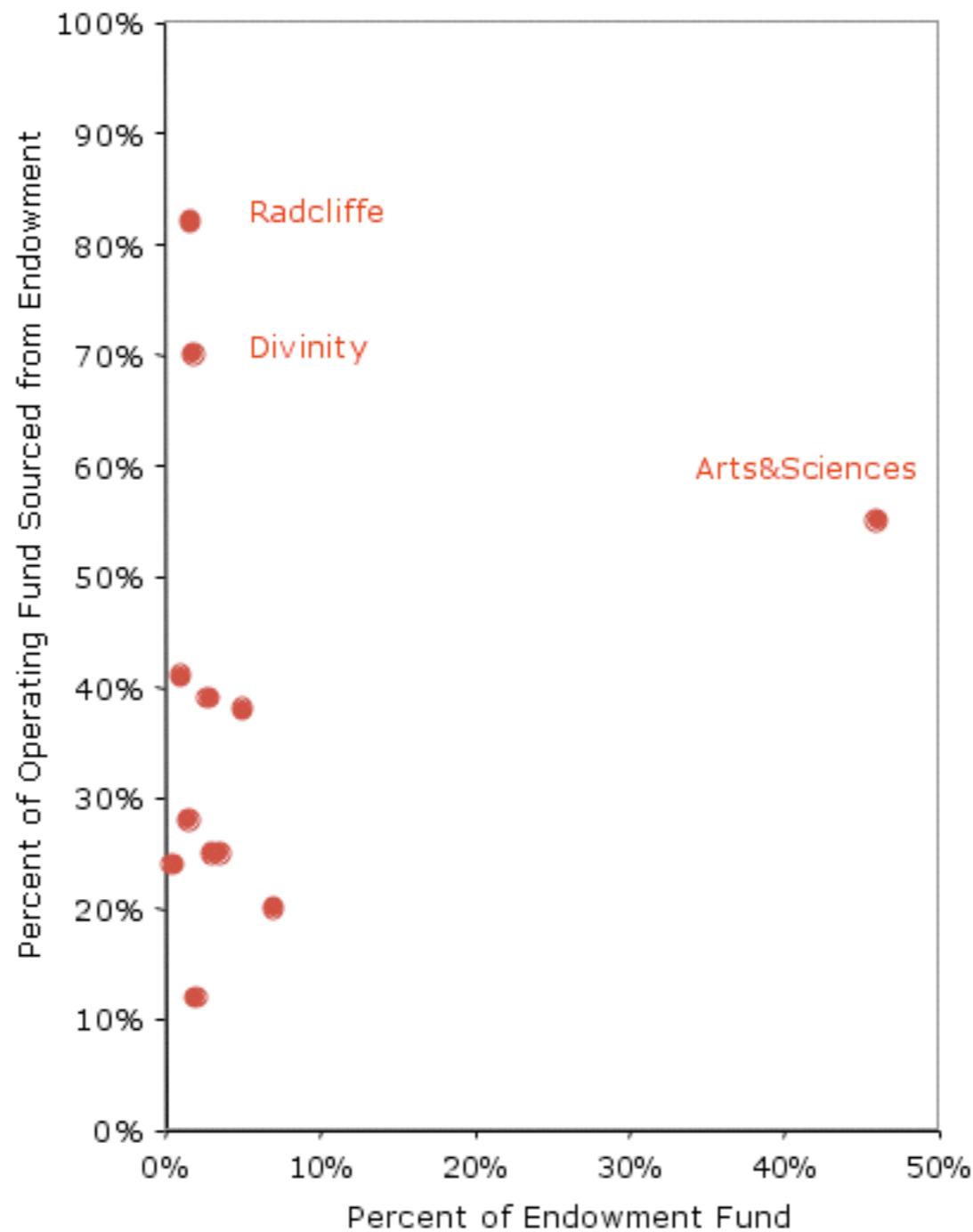
Harvard's Troubles



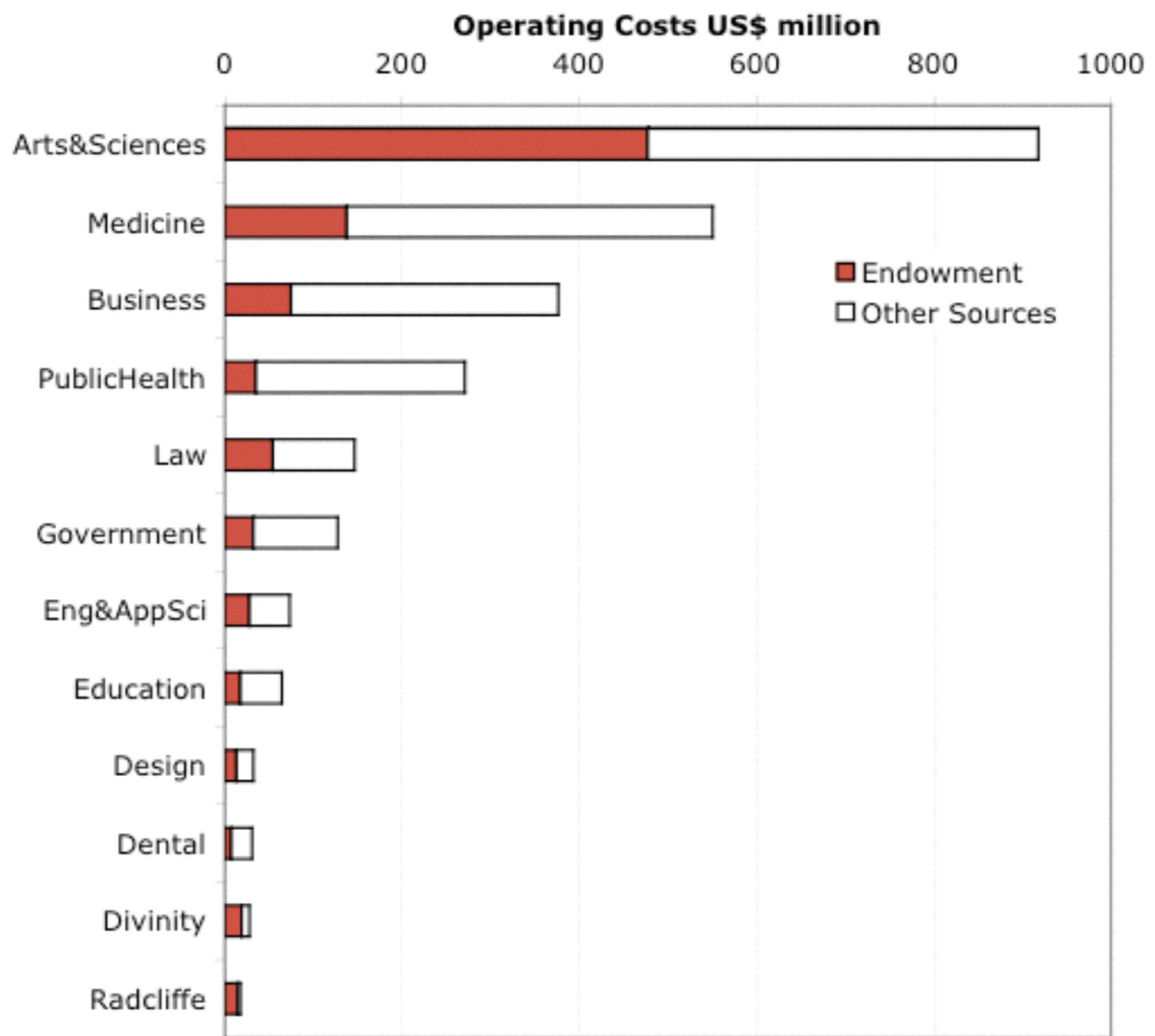
Redesign I



Redesign II

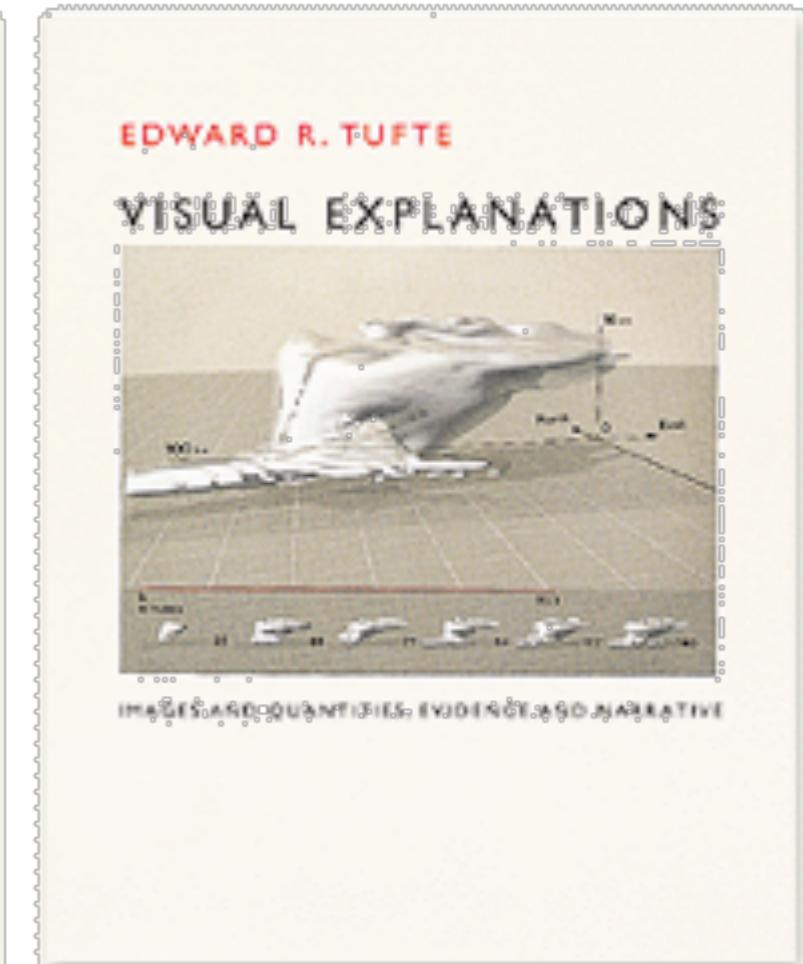
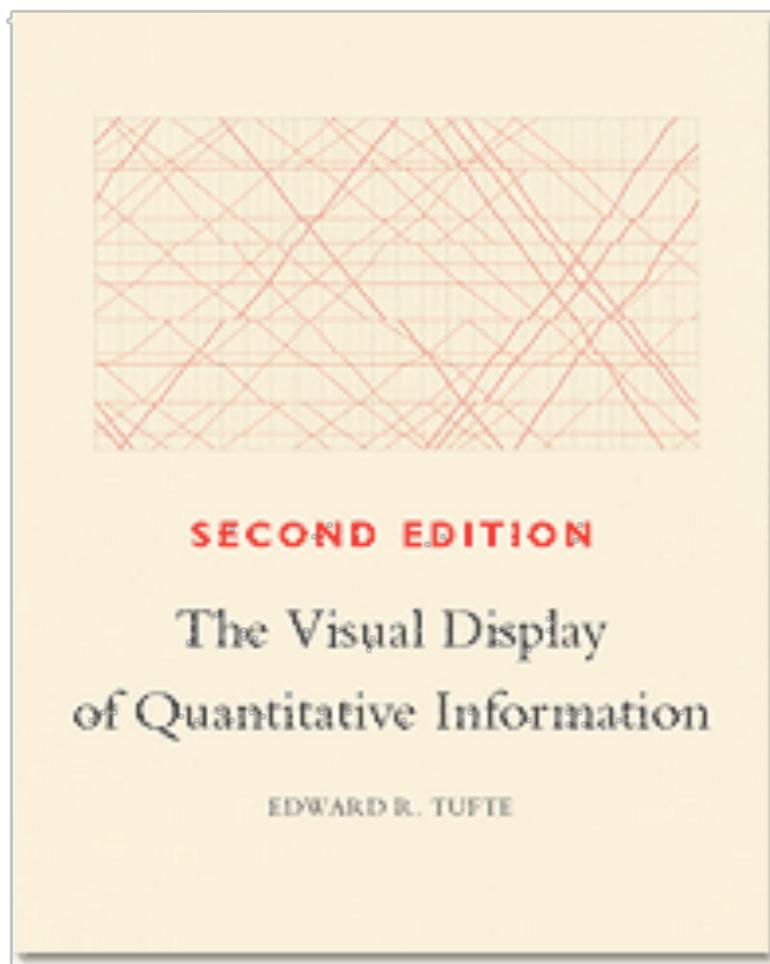


Redesign III

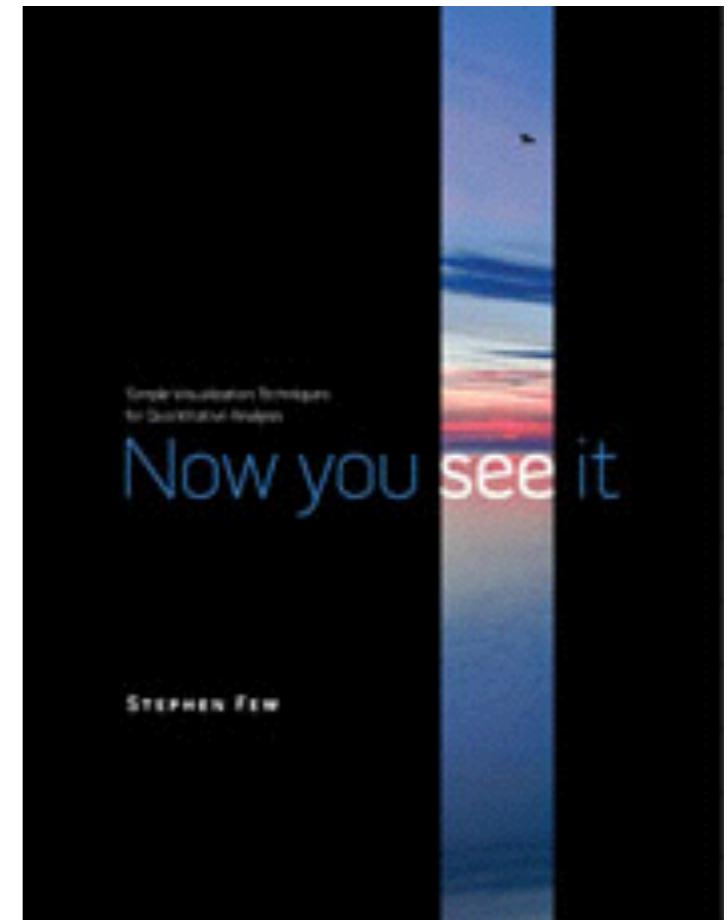
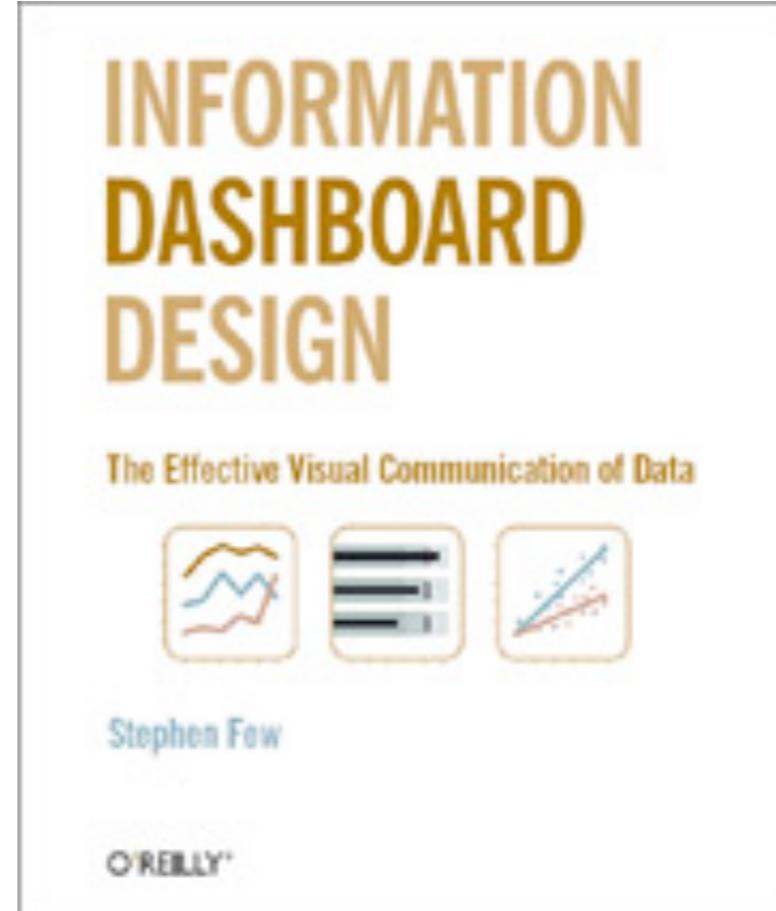
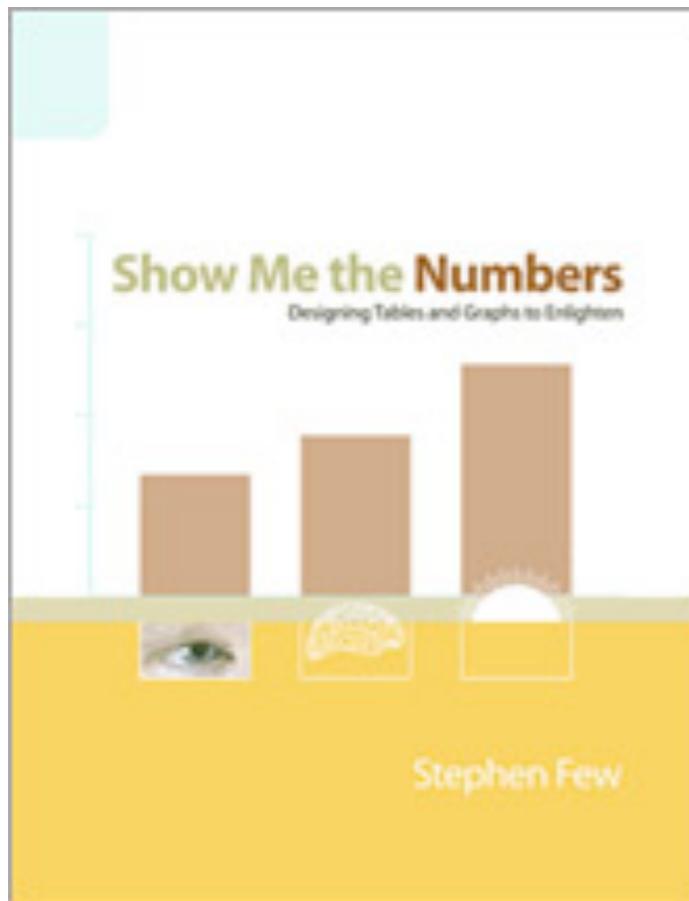
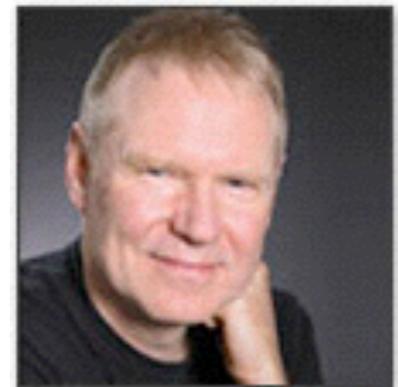


Further Reading

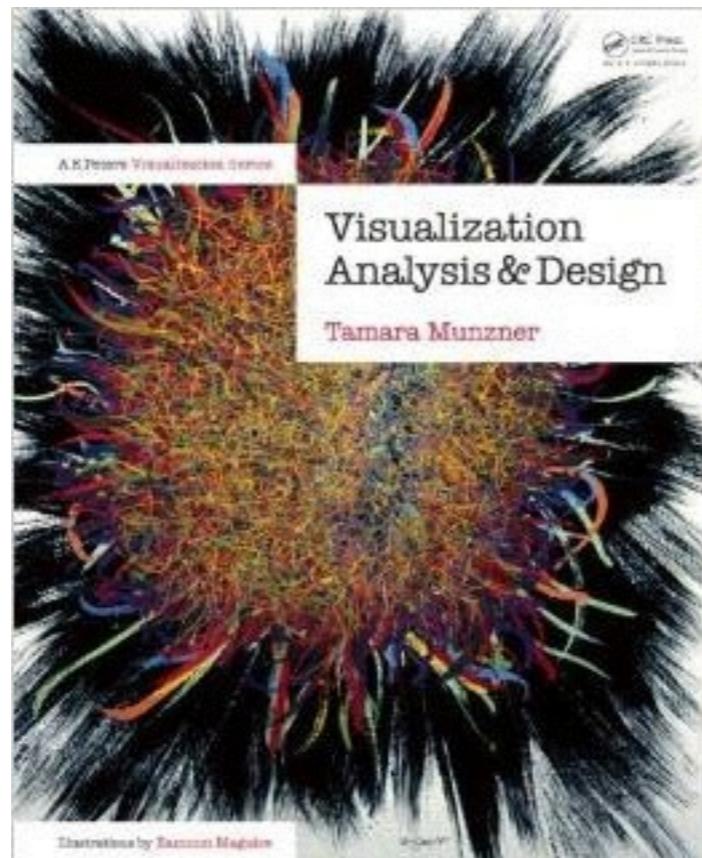
Edward Tufte



Stephen Few

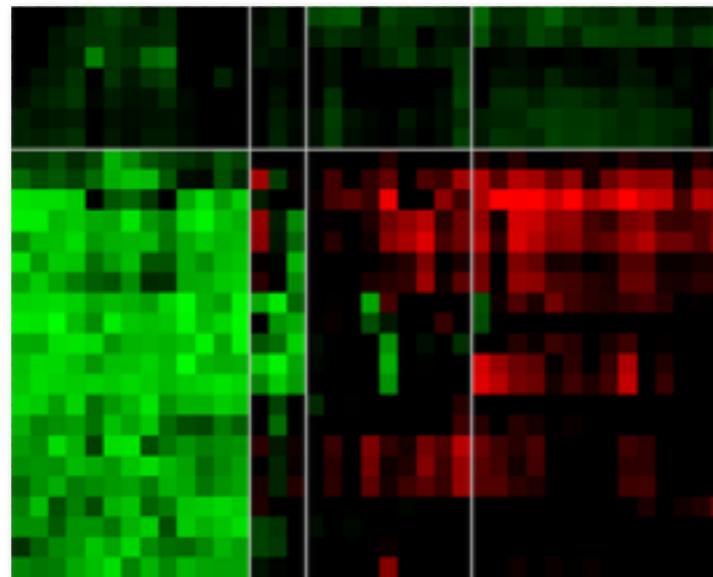
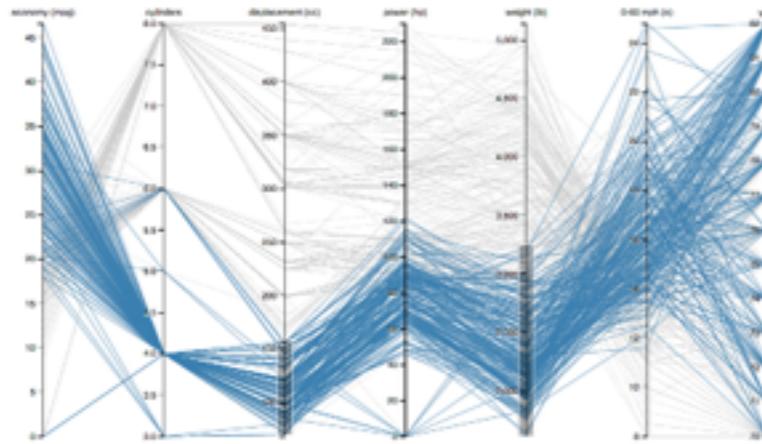


Tamara Munzner

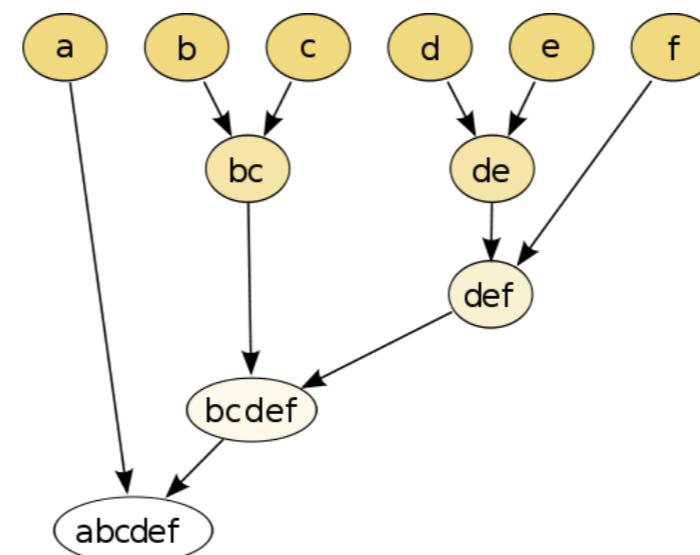


Visualization Analysis and Design

Next Tuesday

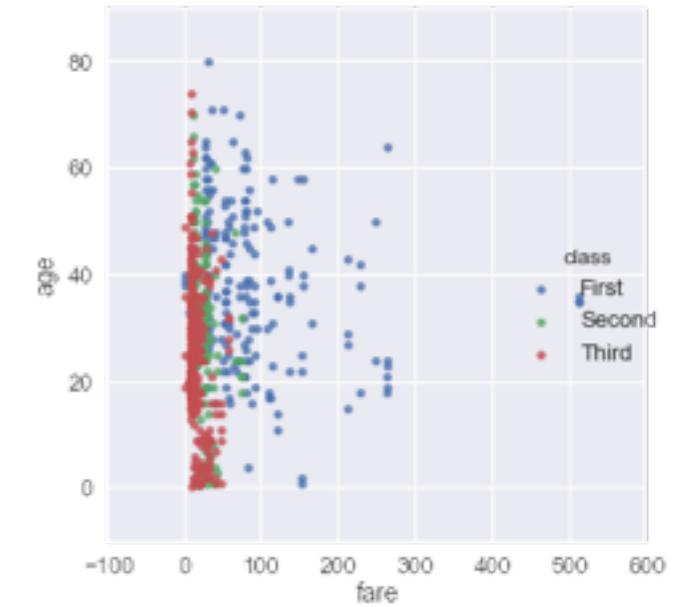


Multi-Dimensional
Data Visualization



Distance,
Clustering

survived	pclass	sex	age	sibsp	parch	fare	embarked	class	who	adult_male	deck	embark_town	alive	alone
0	3	male	22.0	1	0	7.25	S	Third	man	True		Southampton	no	False
1	1	female	38.0	1	0	71.2833	C	First	woman	False	C	Cherbourg	yes	False
1	3	female	26.0	0	0	7.925	S	Third	woman	False		Southampton	yes	True
1	1	female	35.0	1	0	53.1	S	First	woman	False	C	Southampton	yes	False
0	3	male	35.0	0	0	8.05	S	Third	man	True		Southampton	no	True
0	3	male	0	0	0	8.4583	Q	Third	man	True		Queenstown	no	True
0	1	male	54.0	0	0	51.8625	S	First	man	True	E	Southampton	no	True
0	3	male	2.0	3	1	21.075	S	Third	child	False		Southampton	no	False
1	3	female	27.0	0	2	11.1333	S	Third	woman	False		Southampton	yes	False
1	2	female	14.0	1	0	30.0708	C	Second	child	False		Cherbourg	yes	False
1	3	female	4.0	1	1	16.7	S	Third	child	False	G	Southampton	yes	False
1	1	female	58.0	0	0	26.55	S	First	woman	False	C	Southampton	yes	True
0	3	male	20.0	0	0	8.05	S	Third	man	True		Southampton	no	True
0	3	male	39.0	1	5	31.275	S	Third	man	True		Southampton	no	False
0	3	female	14.0	0	0	7.8542	S	Third	child	False		Southampton	no	True
1	2	female	55.0	0	0	16.0	S	Second	woman	False		Southampton	yes	True
0	3	male	2.0	4	1	29.125	Q	Third	child	False		Queenstown	no	False
1	2	male	0	0	0	13.0	S	Second	man	True		Southampton	yes	True
0	3	female	31.0	1	0	18.0	S	Third	woman	False		Southampton	no	False
1	3	female	0	0	0	7.225	C	Third	woman	False		Cherbourg	yes	True
0	2	male	35.0	0	0	26.0	S	Second	man	True		Southampton	no	True
1	2	male	34.0	0	0	13.0	S	Second	man	True	D	Southampton	yes	True
1	3	female	15.0	0	0	8.0292	Q	Third	child	False		Queenstown	yes	True



Dimensionality
Reduction

Questions

