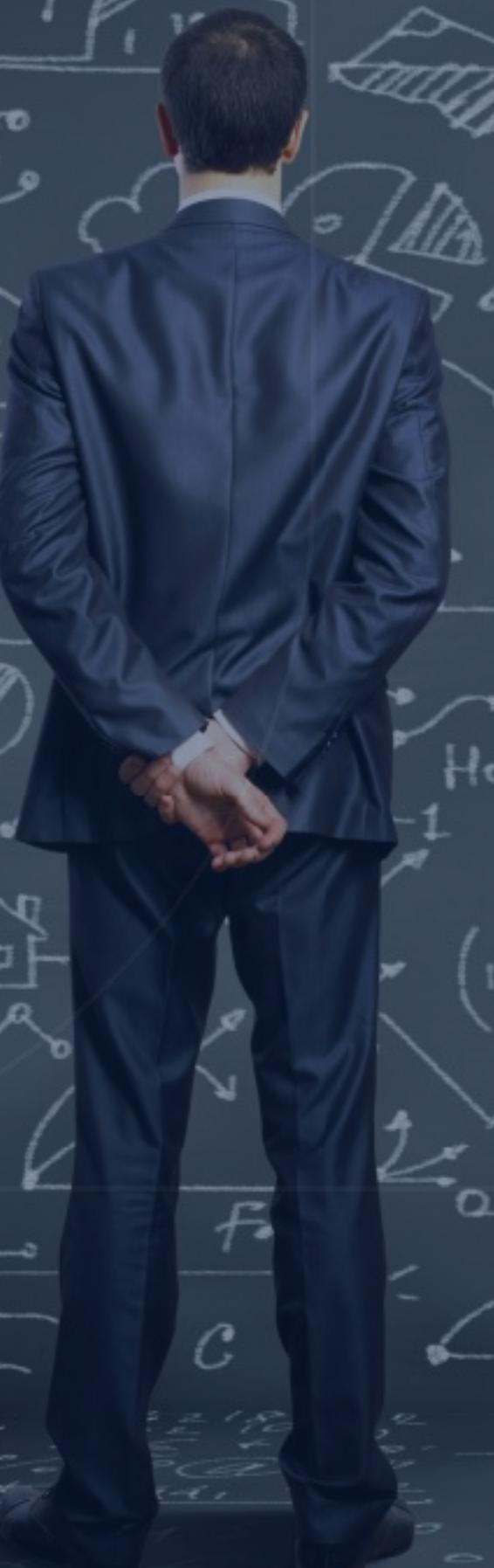


Presenting Data



(c) 2018 Gates Matthew Stoner

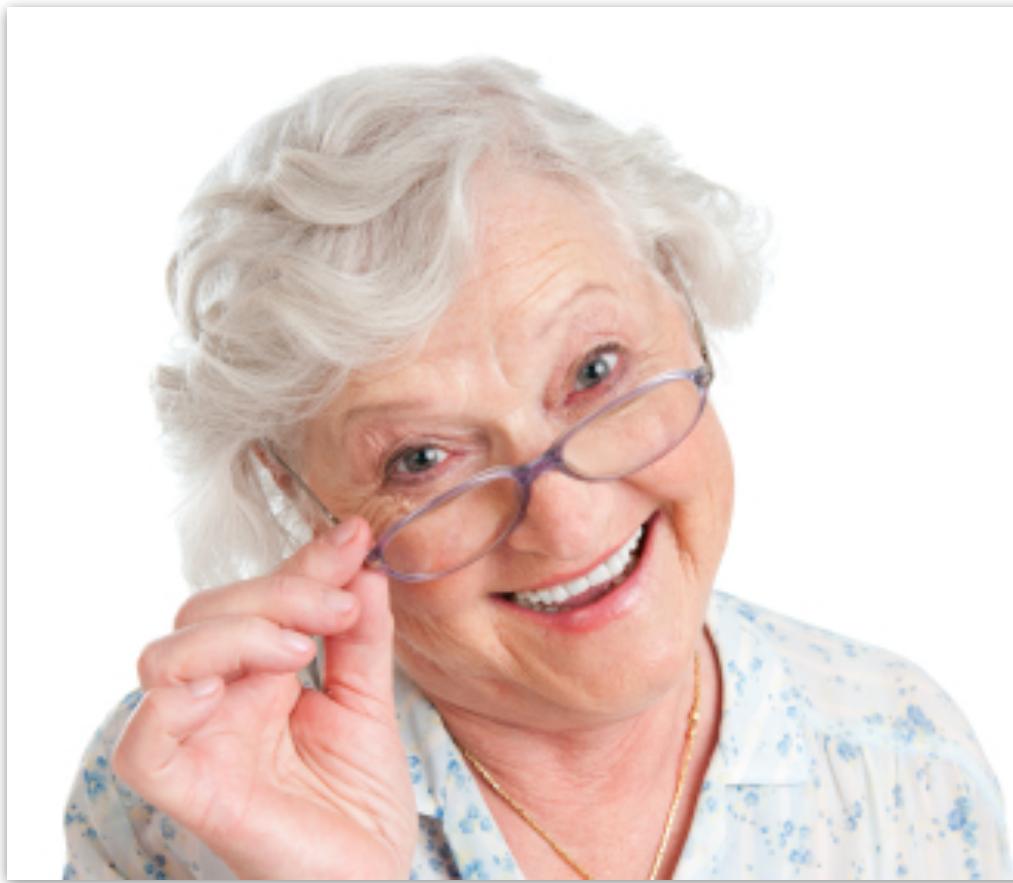


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Agenda

- Audience & Purpose
- Best Practices
- Picking the Right Tool
- Statistical & Mathematical Data

Who's your audience?



Public



Engineers



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Engineering & Mechanics**

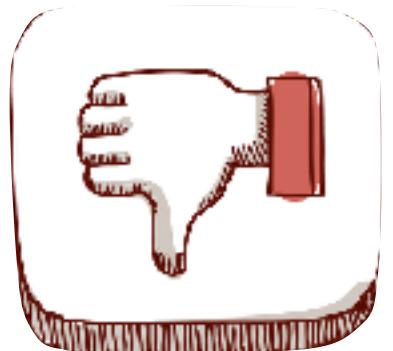
Who's your audience?

- Your audience will dictate the type of data you choose to present and the level of engineering details
- Even a mixed audience of engineering specialities can alter your approach
- The same presentation is likely **not appropriate** for different audiences

A photograph of three senior women laughing together outdoors. The woman on the left is wearing a large straw hat and a white shirt, the woman in the middle is wearing a light blue polo shirt, and the woman on the right is wearing a pink top. They are all smiling broadly.

What does grandma
care about?

What does grandma care about?

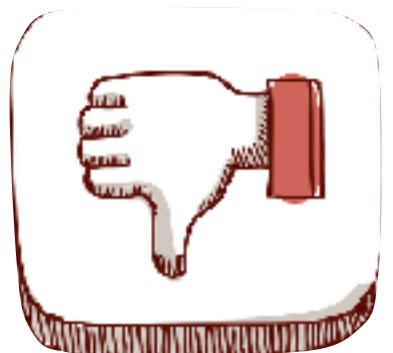


- Concret PSI
- LOS
- Continuous truss bridge
- Is the bridge sturdy?
- Strong enough to not fail
- Will I get to the library without delay?



What do your fellow
engineers care about?

What do your fellow engineers



- Hidden key data points
- No details on how tests performed
- Lack of citations
- Construction material
- Important deadlines
- Special loading
- Type of soils on site

What is your purpose?



Inform



Persuade



Instruct



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Purpose

- When your goal is to inform the audience, be careful to not **overwhelm** them
- Highlight the most important pieces of data for the audience
- Contextualize the data and explain its relevance



Purpose

- The best defense is a good offense
- Don't hide data that is contrary
- Explain **why** your other data is more persuasive
- Data alone is not persuasive
- **Losing strategy** is sharing as much data as you can



Purpose

- **Never assume** your audience knows as much about the data as you do
- Training others to understand expected data outcomes
 - ranges, calibrations, etc
- Often instructing others with data requires defining



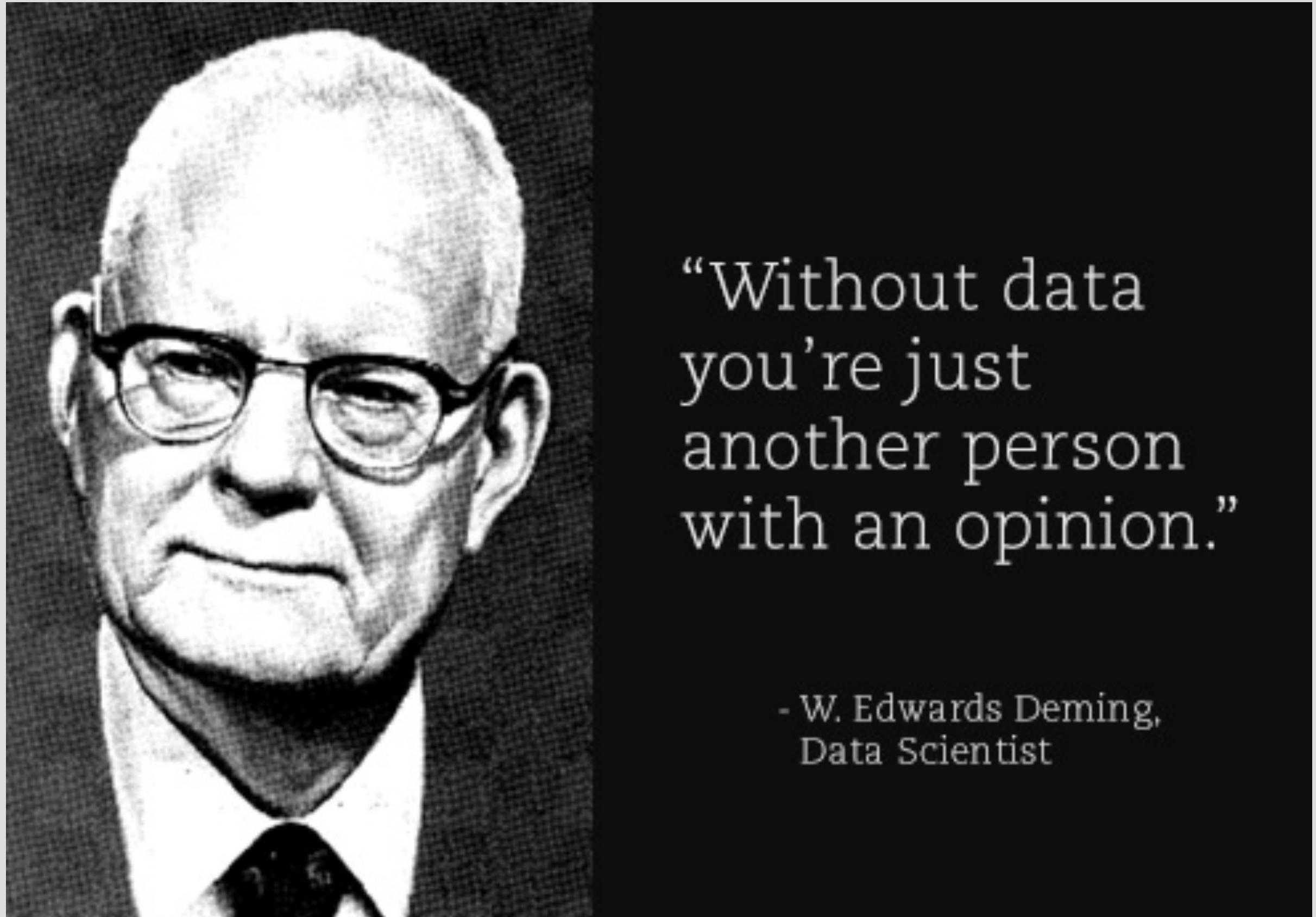
What is your thesis?

- What are the key takeaways the audience need to know for you to achieve your purpose?

THESIS



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“Without data
you’re just
another person
with an opinion.”

- W. Edwards Deming,
Data Scientist



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What is your thesis?

- Once you have determined your audience, purpose and thesis
THEN you can start the process of **choosing** the data to present
- **Caution:** What is interesting and relevant to you
 - may or may not support your thesis
 - be relevant to your audience

**“Not everything
that can be
counted counts,
and not
everything that
counts can be
counted”**

Albert Einstein



When presenting data

- **How** and **When** was it collected?
- **What** is the data
 - population or sample data?
 - precision or estimation?
- **Why** is it important?

KISS Principle

- Don't overwhelm the audience
- Simplicity is golden
- Aid audience retention

When presenting data

Avoid the temptation to

- present all data available
- rapidly present charts and tables
- reduce font size to fit data onto screen/page
- share data inappropriate for the audience



What type of data?



Plans



Lab Results



Field Tests



Budget



Timelines



Surveys

What type of data?



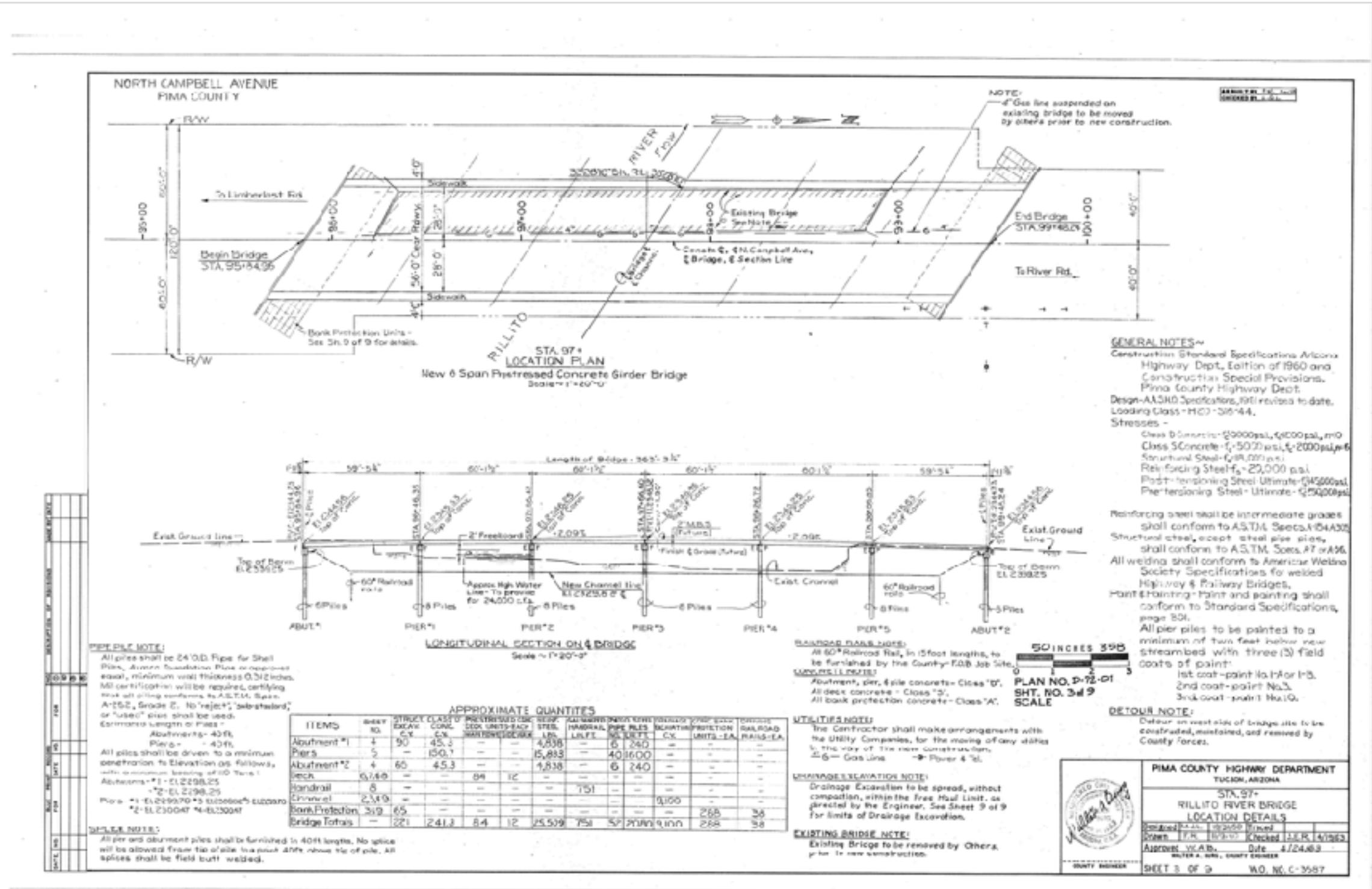
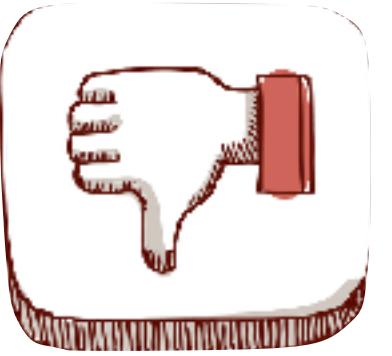
- Most plans are too complex to project as a slide
- Highlight **portions** of plans to make points supporting your thesis
- Only display a visual for the part of the plan you are **currently** discussing, not the whole plan or never changing the visual throughout the presentation

What type of data?

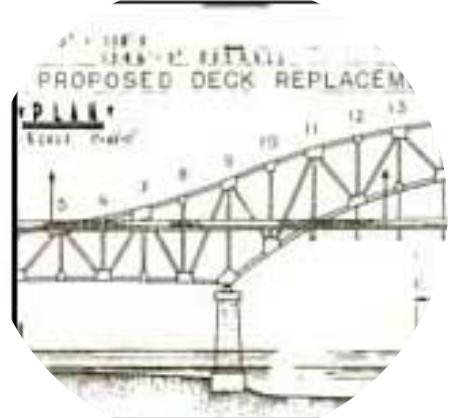


- Use a visual of the plan to support your thesis/main points
- Handouts can compliment a presentation
- Be sure scale, measurements, and other engineering details can
clearly be read

What type of data?



What type of data?



What type of data?

- What equipment was used?
- What tests were conducted?
- How were the tests performed?
- What is the accuracy/reliability of the equipment and test procedure?
- When were the tests conducted?



What type of data?



Written Reports v Presentation

- Highlight key data to support conclusions in presentations
- Written reports can contain complete analysis to support conclusions

What type of data?



- Where were the samples collected?
- What procedures were used to collect the samples?
- Where were the tests performed?
 - In the field or samples brought back to lab
- What is the reliability of the testing procedures?

What type of data?



- Project budgets are important for new project proposals and project status updates
- Financial data can easily overwhelm an audience
- Determine what budget data is most important to the audience

What type of data?



Types of budget data

- Planned expenditures
- Incurred expenses
- Distribution of expenses (materials, labor, services)
- Over/Under on budget items

What type of data?



Who is the audience

- Public
- Client
- Project Managers
- Management

What type of data?



Who prepared the data

- Project Team
- Accountants
- External Vendors

What type of data?



Cost Analysis



I-17 to SR 51

- Total Project Cost: \$103,821,200
- Engineering (\$6,712,000, 9%)
- Contingencies (\$3,729,000, 5%)

SR 51 to Princess Drive

- Total Project Cost: \$51,404,100
- Engineering (\$3,364,000, 9%)
- Contingencies (\$1,869,000, 5%)

AECOM

7720 N. 16th Street, Suite 100
Phoenix, Arizona 85020



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What type of data?



Criterion	Yellow Corridor	Orange Corridor	No Build
Annual operating cost for commuter rail portion of service (2013 dollars)	\$67.0 Million	\$86.0 Million	\$0
Capital Cost (2013 dollars)	\$4.5 Billion	\$7.6 Billion	\$0
Right-of-Way cost (2013 dollars)	\$144.9 Million	\$62.1 Milllion	\$0



What type of data?



- Macro- v Micro-level detail
- Need to know v Good to know
- Milestones v Tasks
- Blockers
- Dependencies

What type of data?



Collection methods data

- Random sampling
- Convenience sampling
- Representativeness

What type of data?

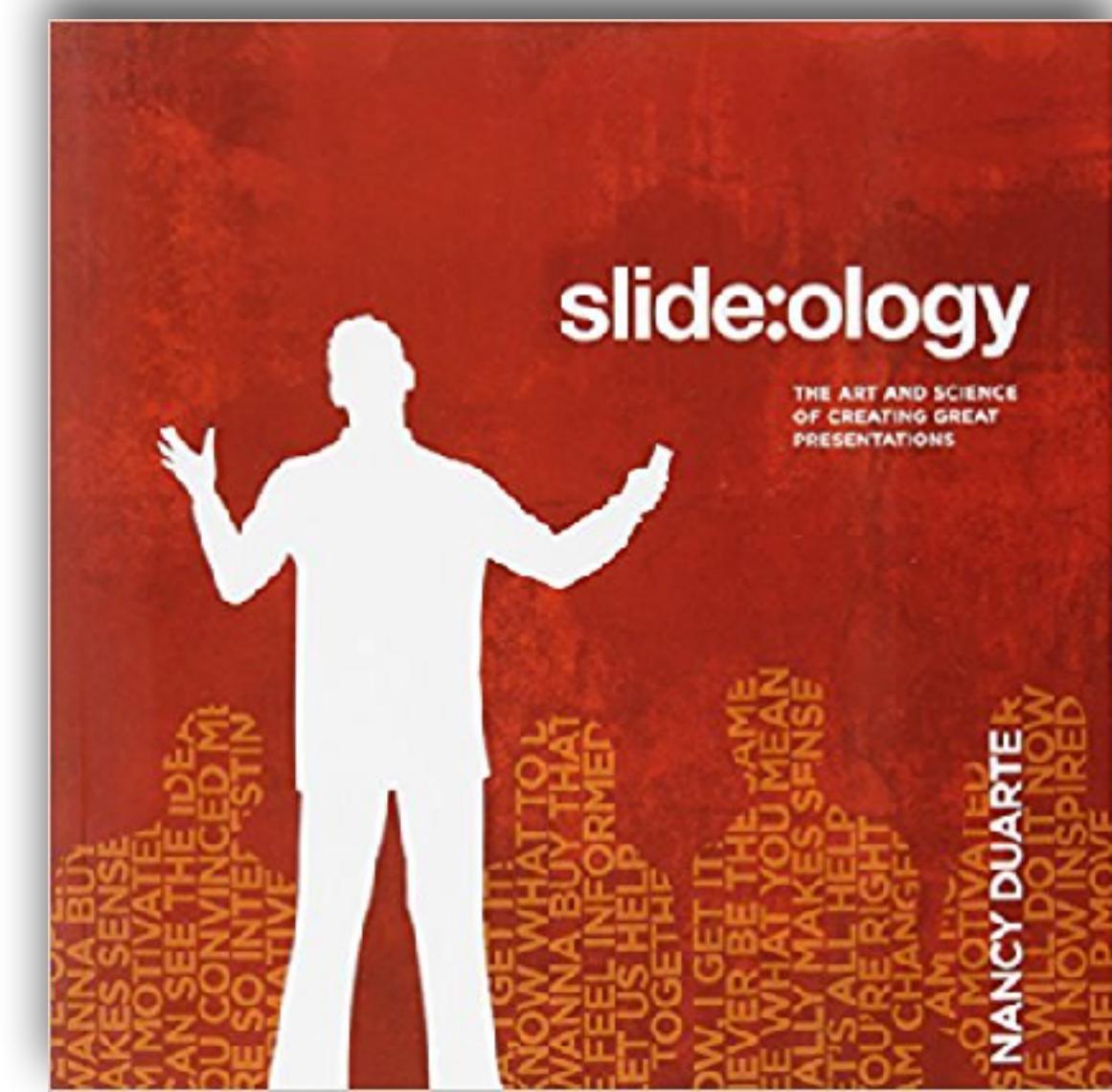
- Statistical power
- Question quality
- Single item versus aggregated measure
- Administration methods



Presenting Data

5 tips from Nancy Duarte

- Pick the right tool for the job
- Highlight what is important
- Keep it Simple
- Tell the truth
- Get to the point

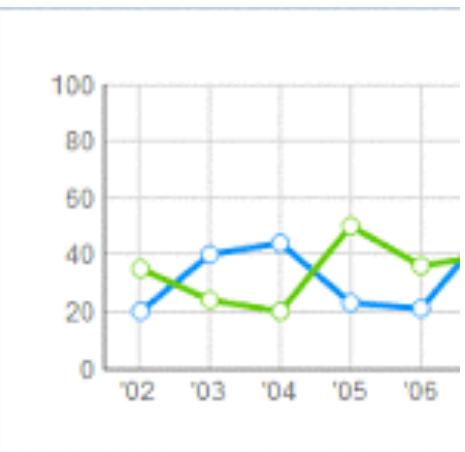
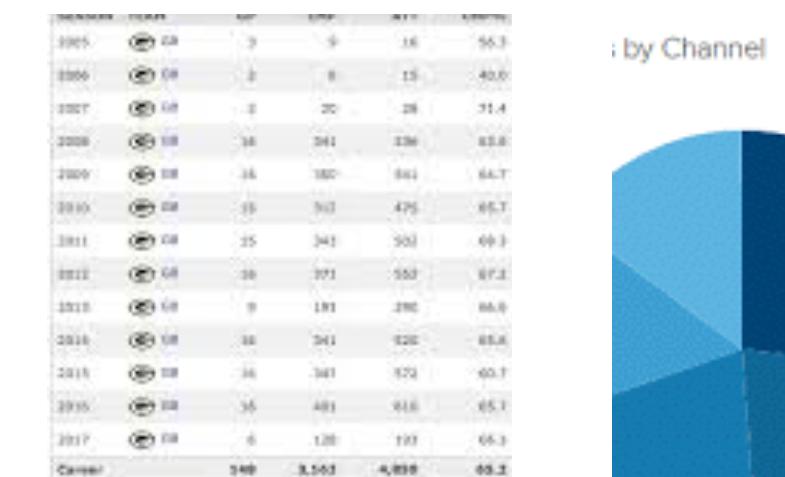
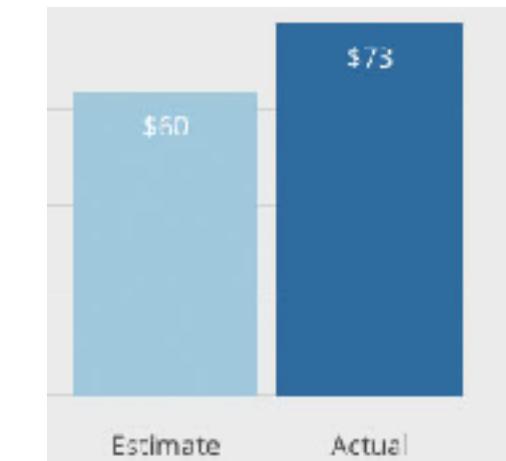


Picking the right tool

Show

- comparisons
- relationships
- differences

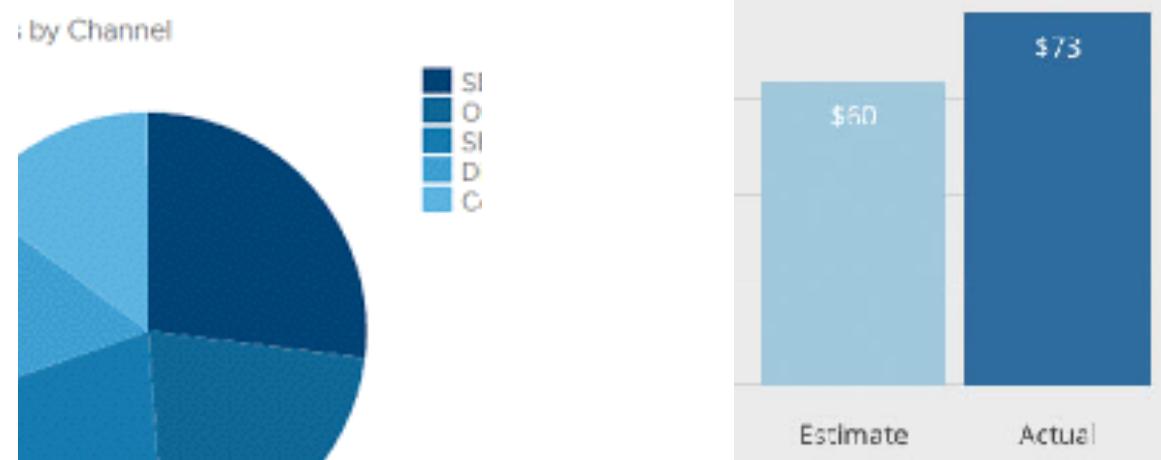
Year	Category	Actual	Estimate	Diff.	% Diff.
2005	SI	3	5	-2	-50.0
2006	O	2	3	-1	-33.3
2007	SI	2	20	-18	-90.0
2008	O	18	241	223	123.8
2009	SI	16	187	171	64.7
2010	O	15	303	288	65.7
2011	SI	25	241	50	99.2
2012	O	38	271	233	87.5
2013	SI	9	181	172	66.0
2014	O	11	241	230	63.6
2015	SI	16	241	175	60.7
2016	O	15	403	258	63.8
2017	SI	6	128	122	66.7
Grand		249	3,543	4,800	49.2



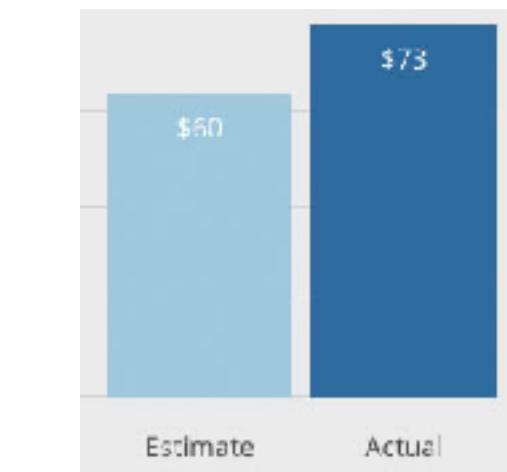
Picking the right tool

Year	Category	Value	Label	Unit
2005	SI	3	9	16
2006	O	2	8	15
2007	SI	2	20	28
2008	O	18	241	236
2009	O	18	182	181
2010	O	19	303	475
2011	O	25	342	353
2012	O	28	272	352
2013	O	9	181	286
2014	O	18	241	926
2015	O	18	342	373
2016	O	36	403	416
2017	O	6	120	123
Total		348	3,563	4,839
				65.3

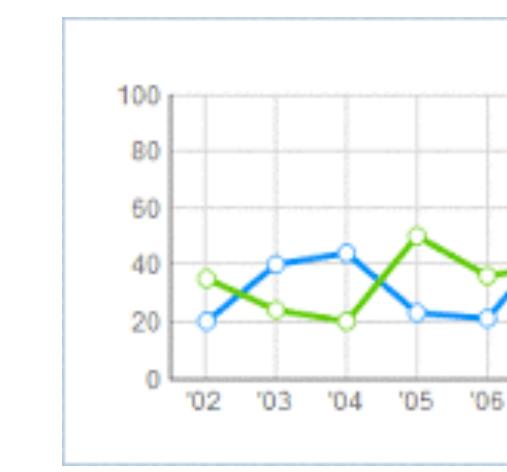
Tables



Pie



Bar



Line



Picking the right tool

- Without formatting, tables provide lots of data without highlighting key data points
- Full tables on a slide might make data **unreadable**
- Reduce noise by displaying only key data critical to your thesis

Year	Team	W	L	%	AVG(G)
2005	GB	2	9	.16	55.3
2006	GB	2	9	.15	49.0
2007	GB	2	9	.16	51.4
2008	GB	18	341	.33	63.6
2009	GB	16	360	.44	64.7
2010	GB	15	361	.42	65.7
2011	GB	25	342	.50	69.3
2012	GB	18	371	.53	67.2
2013	GB	9	381	.23	66.0
2014	GB	10	341	.23	63.6
2015	GB	16	341	.47	60.7
2016	GB	16	401	.41	65.1
2017	GB	6	120	.13	65.3
Career		348	3,563	4.88	63.2

Picking the right tool

Highlight outlier

	2015	2016	2017	2018
Q1	123	130	152	148
Q2	125	135	157	166
Q3	122	138	181	152
Q4	108	130	153	153

Year	Category	Value	Min	Max	Avg
2005	Q1	9	5	16	10.2
2006	Q1	2	0	15	40.0
2007	Q1	2	0	28	31.4
2008	Q1	18	14	341	138.8
2009	Q1	16	10	380	161.7
2010	Q1	15	10	476	167.7
2011	Q1	25	14	501	169.3
2012	Q1	18	11	533	172.2
2013	Q1	9	1	280	66.8
2014	Q1	10	5	341	123.6
2015	Q1	16	14	341	127.2
2016	Q1	16	14	481	165.7
2017	Q1	6	1	120	65.3
Career		348	3,563	4,898	109.2



Picking the right tool

Highlight trend

	2015	2016	2017	2018
Q1	123	130	152	148
Q2	125	135	157	166
Q3	122	138	181	152
Q4	108	130	153	153

Year	Category	Value	Min	Max	Avg
2005	Q1	9	5	16	10.2
2006	Q1	2	0	15	40.0
2007	Q1	2	0	28	31.4
2008	Q1	18	14	34	23.8
2009	Q1	16	10	30	24.2
2010	Q1	15	10	47	25.7
2011	Q1	25	14	50	39.3
2012	Q1	18	11	53	37.2
2013	Q1	9	1	29	16.8
2014	Q1	10	5	34	18.6
2015	Q1	16	14	32	20.7
2016	Q1	16	14	48	25.1
2017	Q1	6	1	10	16.3
Career		348	3,563	4,898	69.2

Picking the right tool

Highlight comparison

	2015	2016	2017	2018
Q1	123	130	152	148
Q2	125	135	157	166
Q3	122	138	181	152
Q4	108	130	153	153

Year	Category	Value	Label
1975	Q1	2	5
1986	Q1	2	8
1987	Q1	2	20
1988	Q1	18	341
1989	Q1	16	380
1990	Q1	15	363
1991	Q1	25	342
1992	Q1	18	371
1993	Q1	9	181
1994	Q1	10	341
1995	Q1	16	372
1996	Q1	16	481
1997	Q1	6	128
Career		348	4,998



Picking the right tool

Highlight differences

	2015	2016	2017	2018
Q1	123	130	152	148
Q2	125	135	157	166
Q3	122	138	181	152
Q4	108	130	153	153

Year	Q1	Q2	Q3	Q4	Total
1975	28	2	5	16	55.2
1986	28	2	8	15	49.0
1987	28	2	20	28	51.4
1988	28	18	341	136	53.8
1989	28	16	380	641	64.7
1990	28	15	363	426	65.7
1991	28	25	342	503	69.3
1992	28	18	371	533	67.2
1993	28	9	181	286	66.8
1994	28	10	341	626	63.6
1995	28	16	341	572	60.7
1996	28	16	481	916	65.1
1997	28	6	128	193	65.3
Career	348	3,563	4,938	69.2	



Picking the right tool

Don't

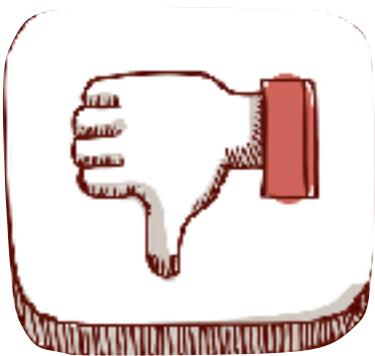
- Copy tables as pixelated images from reports. If data is critical, recreate
- Display tables with numbers that can't be read from the back of the room due to small font size
- Display data without context for the audience

Year	Team	W	L	%	Margin
2005	GB	2	9	.16	55.3
2006	GB	2	9	.15	40.0
2007	GB	2	9	.20	31.4
2008	GB	18	341	.39	83.8
2009	GB	16	380	.41	64.7
2010	GB	15	393	.42	65.7
2011	GB	25	342	.50	69.3
2012	GB	18	371	.53	67.2
2013	GB	9	181	.26	66.0
2014	GB	10	341	.26	63.6
2015	GB	16	341	.47	60.7
2016	GB	16	401	.41	65.1
2017	GB	6	120	.13	65.3
Career		348	3,563	4.88	63.2

Picking the right tool

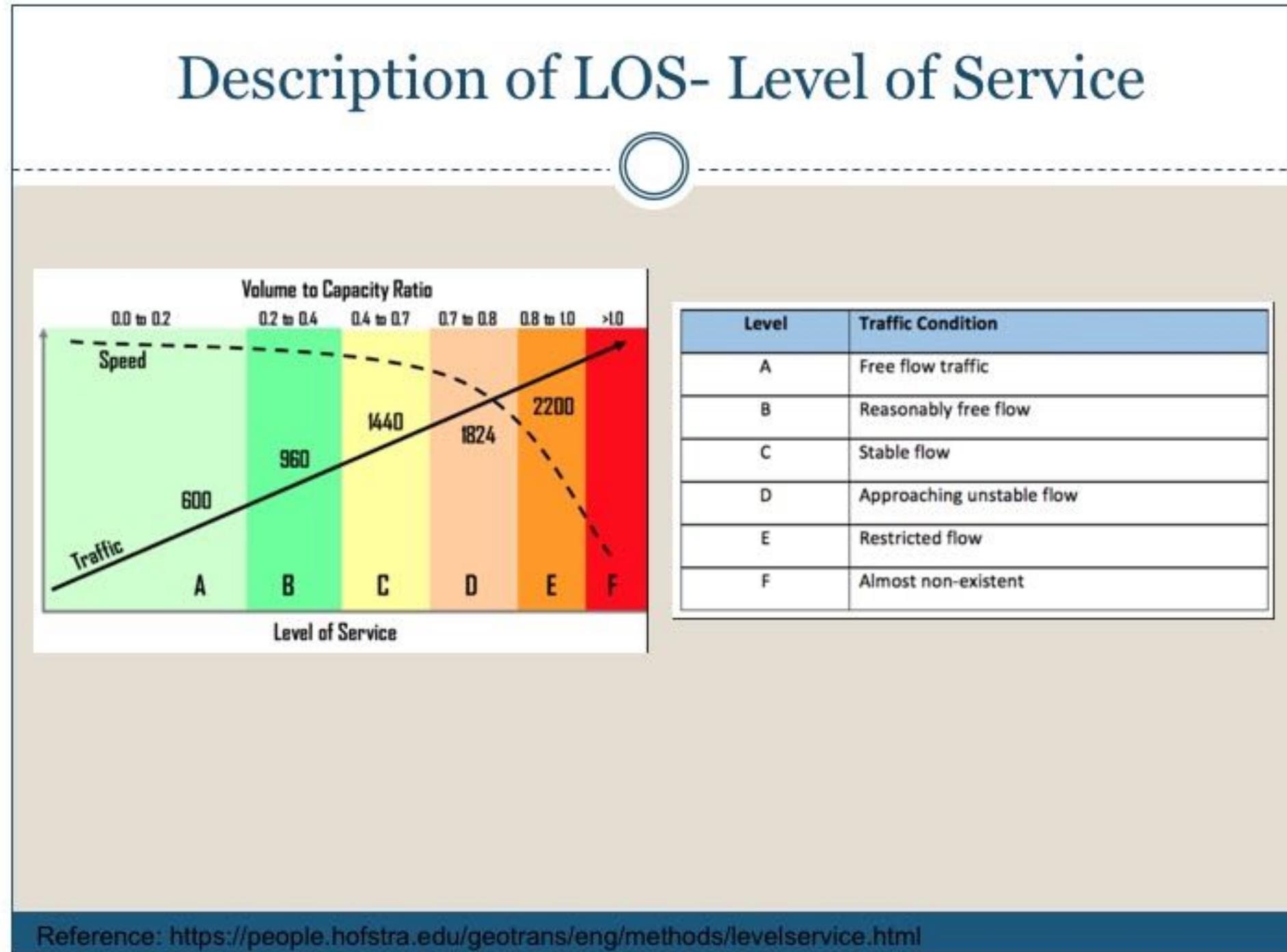
Year	Category	Value	Min	Max	Avg	Std Dev
2005	② 08	3	3	18	56.3	
2006	② 08	2	3	15	40.0	
2007	② 08	2	20	28	31.4	
2008	② 08	18	341	336	113.8	
2009	② 08	16	380	381	64.7	
2010	② 08	15	362	475	65.7	
2011	② 08	15	341	561	69.3	
2012	② 08	10	371	553	87.1	
2013	② 08	9	181	290	66.0	
2014	② 08	11	241	528	113.8	
2015	② 08	16	341	572	60.7	
2016	② 08	16	481	918	65.1	
2017	② 08	6	120	193	66.3	
Coeff.		249	3,163	4,898	69.3	

Table 5-1: Candidate Alternatives 2040 Peak Hour Level-of-Service Summary



INTERSECTION	ALTERNATIVE E		ALTERNATIVE F2		ALTERNATIVE H	
	LOS	DELAY	LOS	DELAY	LOS	DELAY
2 - SR 347 and HONEYCUTT AVE	D	44	D	44	D	44
5 - SR 347 and HONEYCUTT RD	F	118.6	F	99.6	C	21.4
9 - MARICOPA-CASA GRANDE HWY and HONEYCUTT RD	C	25	C	25	B	15.9

Picking the right tool



PERIOD	ROUTE	WT	SPD	AVG SPD
2005	08	2	5	55.3
2006	08	2	8	40.0
2007	08	2	20	31.4
2008	08	18	341	136.8
2009	08	16	380	141.7
2010	08	15	302	125.7
2011	08	25	342	103.3
2012	08	10	371	97.2
2013	08	9	181	66.0
2014	08	10	341	63.6
2015	08	16	341	60.7
2016	08	16	481	65.1
2017	08	6	120	65.3
Career		348	3,563	69.2



Picking the right tool

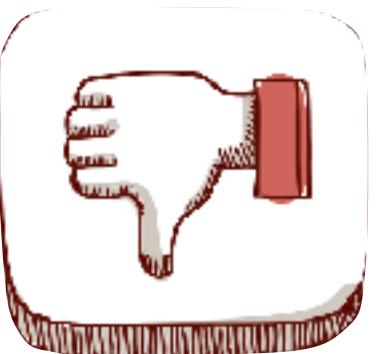


Table 15 – Mainline Crash Summary

Freeway Segment	No. of Crashes (March 2006 – March 2011)	Crash Rate (2006 – 2011) (Crash/Million Vehicle Miles)
Eastbound SR 101L		
I-17 to 19th Avenue	64	0.68
19th Avenue to 7th Avenue	204	1.71
7th Avenue to 7th Street	145	1.24
7th Street to 16th Street	154	1.30
16th Street to Cave Creek Road	245	1.80
Cave Creek Road to 32nd Street	145	1.00
32nd Street to SR 51	101	0.77
SR 51 to Tatum Boulevard	93	0.57
Tatum Boulevard to 56th Street	87	0.51
56th Street to Scottsdale Road	151	0.57
Scottsdale Road to Hayden Road	42	0.29
Hayden Road to Princess Drive	41	0.29
Westbound SR 101L		
Princess Drive to Hayden Road	49	0.34
Hayden Road to Scottsdale Road	123	0.86
Scottsdale Road to 56th Street	235	0.89
56th Street to Tatum Boulevard	126	0.74
Tatum Boulevard to SR 51	156	0.96
SR 51 to 32nd Street	187	1.43
32nd Street to Cave Creek Road	75	0.52
Cave Creek Road to 16th Street	148	1.09
16th Street to 7th Street	143	1.21
7th Street to 7th Avenue	205	1.75
7th Avenue to 19th Avenue	195	1.63
19th Avenue to I-17	78	0.82

Year	Segment	No.	MPD	MVMS
2005	SR 51	2	5	55.3
2006	SR 51	2	8	40.0
2007	SR 51	2	20	31.4
2008	SR 51	18	341	43.8
2009	SR 51	16	380	64.7
2010	SR 51	15	302	47.7
2011	SR 51	25	342	69.3
2012	SR 51	10	371	67.2
2013	SR 51	9	181	66.0
2014	SR 51	10	341	63.6
2015	SR 51	16	341	60.7
2016	SR 51	16	481	65.1
2017	SR 51	6	120	65.3
Career		348	3,563	63.2



Picking the right tool



Criterion	Yellow Corridor	Orange Corridor	No Build
Annual operating cost for commuter rail portion of service (2013 dollars)	\$67.0 Million	\$86.0 Million	\$0
Capital Cost (2013 dollars)	\$4.5 Billion	\$7.6 Billion	\$0
Right-of-Way cost (2013 dollars)	\$144.9 Million	\$62.1 Milllion	\$0

Picking the right tool



Capital Cost estimates:

- \$4.5 billion for the Yellow Corridor
- \$7.6 billion for the Orange Corridor



ADOT Intercity Corridor Alternative: YELLOW		119.8 Route Miles			
FTA Major Standard Cost Categories	Base Year Cost w/o Contingency (x000)	Base Year Allocated Contingency (x000)	Base Year Dollars Total (x000)	Base Year \$ Percentage of Construction Cost	Base Year \$ Percentage of Total Cost
10 Guideway & Track Elements	\$1,466,063	\$111,935	\$1,577,997	55%	35%
20 Stations, Stops, Terminals, Intermodal	\$38,333	\$63,963	\$102,296	4%	2%
30 Support Facilities: Yards, Shops, Admin. Buildings	\$148,000	\$63,963	\$211,963	7%	5%
40 Sitework & Special Conditions	\$449,471	\$95,944	\$545,415	19%	12%
50 Systems	\$356,060	\$79,953	\$436,013	15%	10%
Construction Subtotal (10 - 50)	\$2,457,927	\$415,758	\$2,873,685	100%	
60 ROW, Land, Existing Improvements	\$120,760	\$127,926	\$248,686		6%
70 Vehicles	\$368,000	\$95,944	\$463,944		10%
80 Professional Services	\$251,450		\$251,450		6%
Subtotal (10 - 80)	\$3,198,138	\$639,628	\$3,837,765		
90 Unallocated Contingency			\$639,628		14%
Total (10 - 90)			\$4,477,393		100%

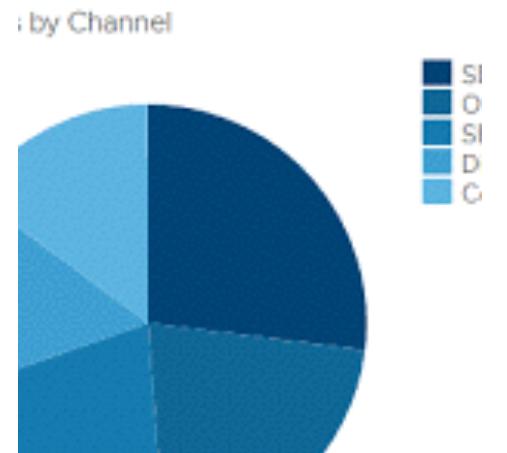


Year	Route	W	L	RTF	MTD
2005	28	2	5	16	55.3
2006	28	2	8	15	40.0
2007	28	2	20	28	31.4
2008	28	18	341	136	43.8
2009	28	16	380	641	64.7
2010	28	15	302	475	45.7
2011	28	25	342	502	69.3
2012	28	18	371	533	67.2
2013	28	9	181	286	66.0
2014	28	10	341	626	63.6
2015	28	16	341	572	60.7
2016	28	16	481	916	65.1
2017	28	6	128	103	65.3
Career	28	3,563	4,898	69.2	

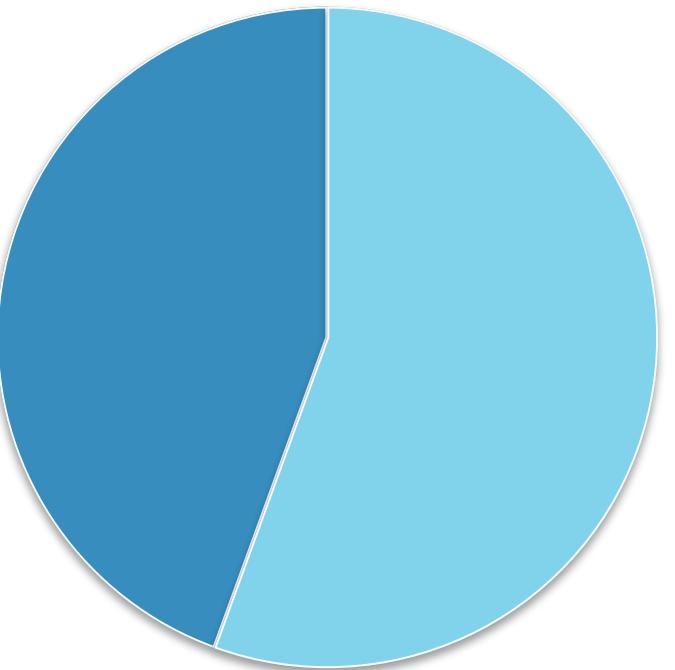
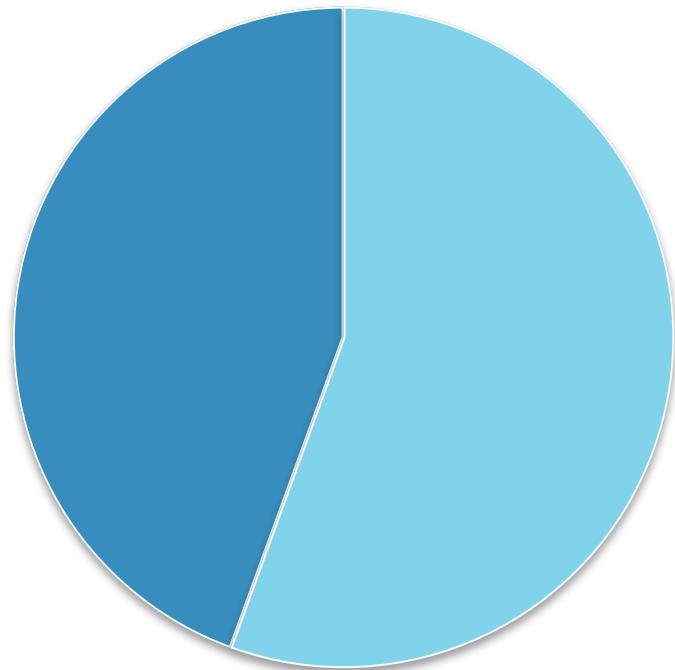
Highlight what is important

- Communicate conclusions & insight
- Focus audience attention on key data
- Use handouts/reports for more complex data

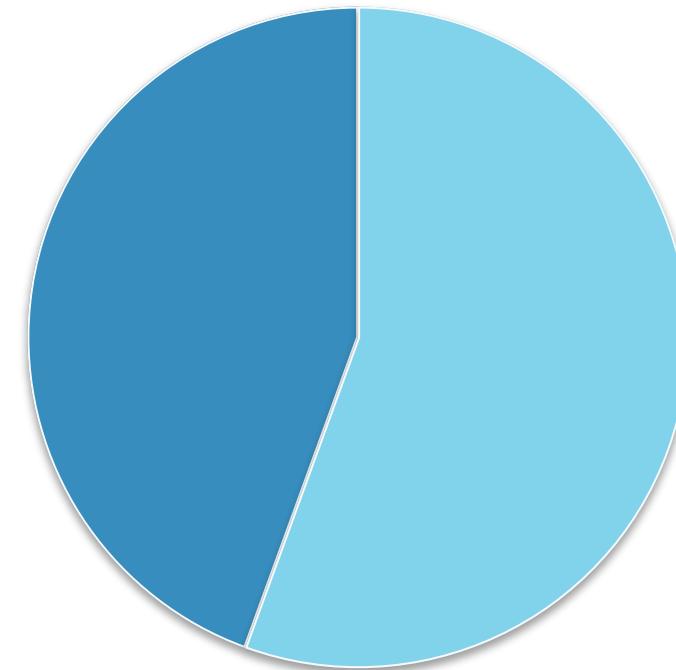
Picking the right tool



- Proportions without sample size are meaningless



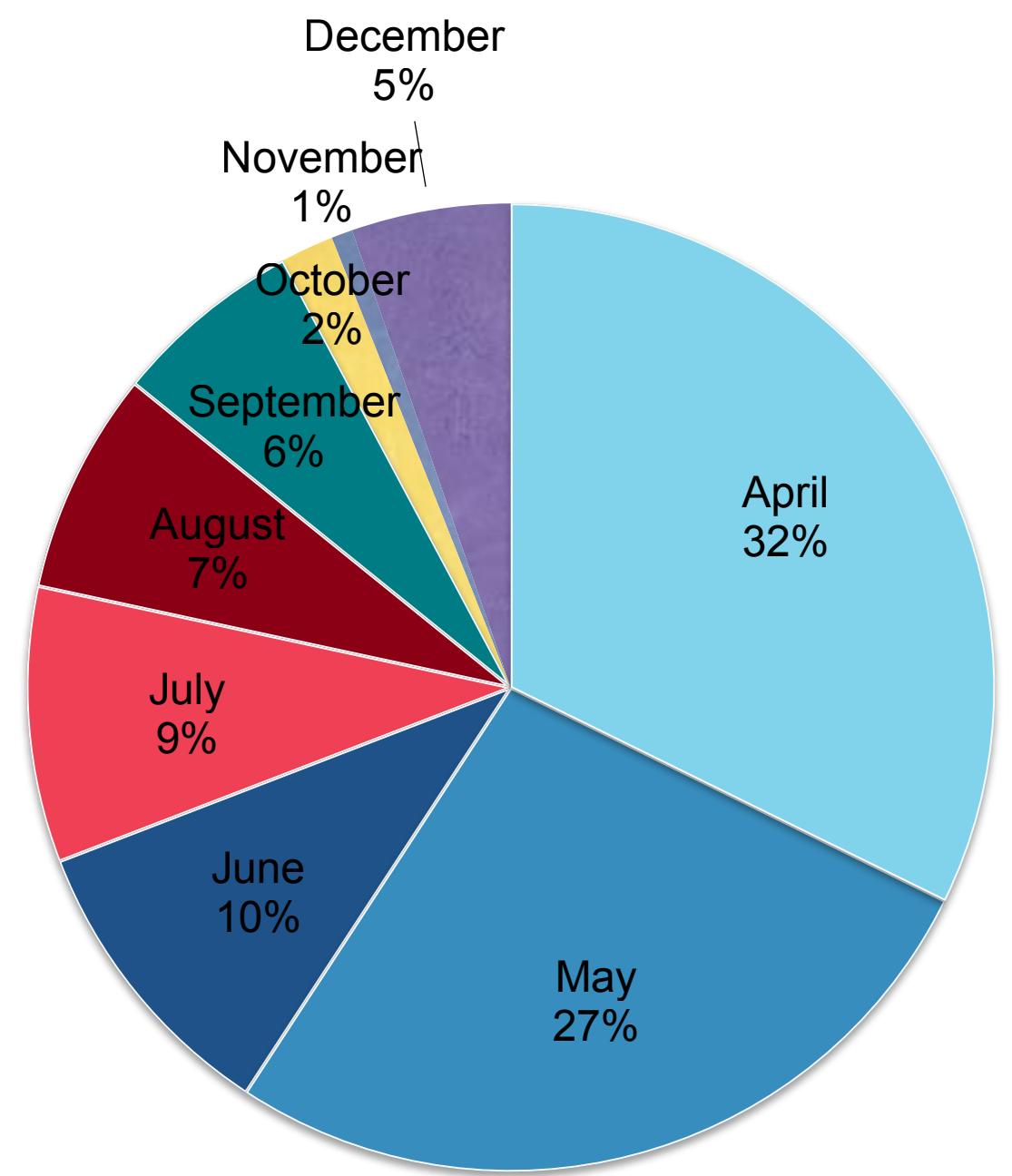
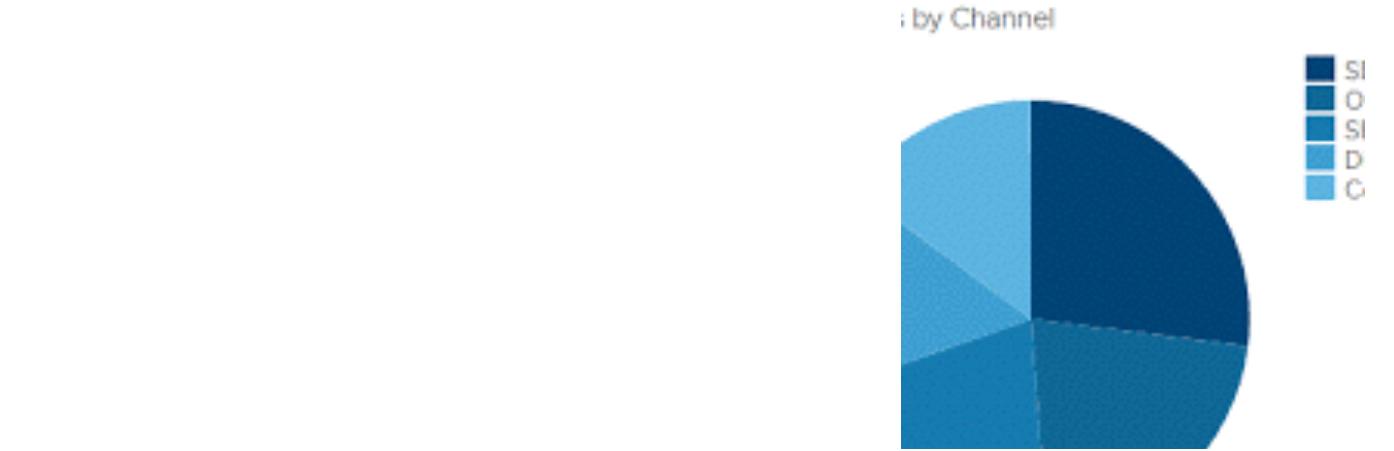
$n=6$



$n=600$

Picking the right tool

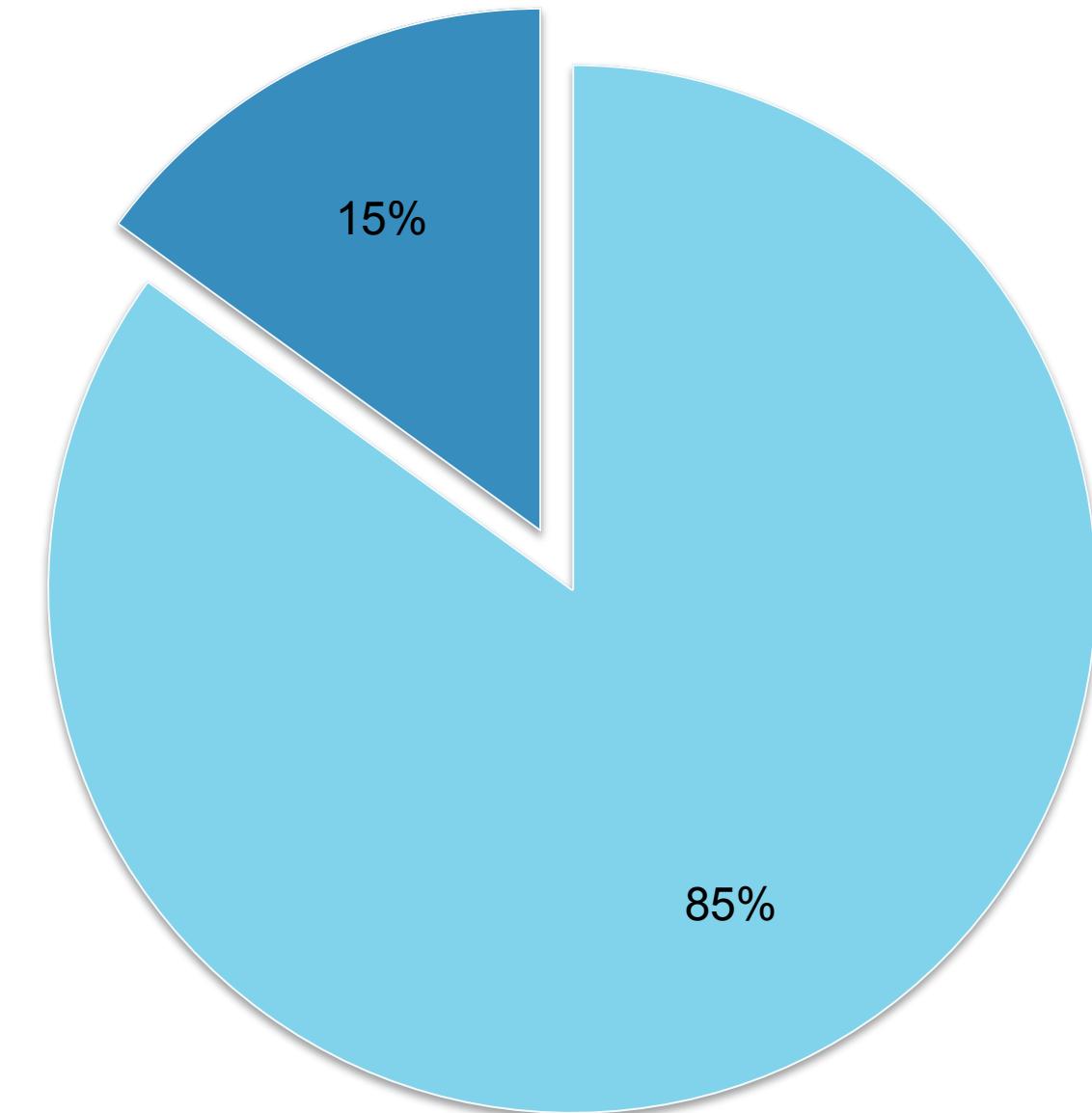
- Beware of too many wedges, label placement
- Does the chart best present the data for your thesis?



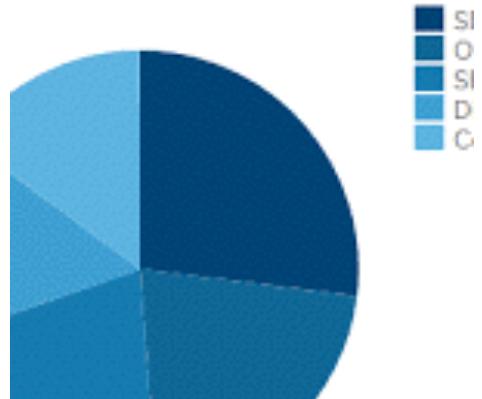
Get to the point

- Highlight the trend or key take away
- Articulate the conclusions to be drawn from the data

Audience Perceptions of Data Presentations



● Boring ● Interesting

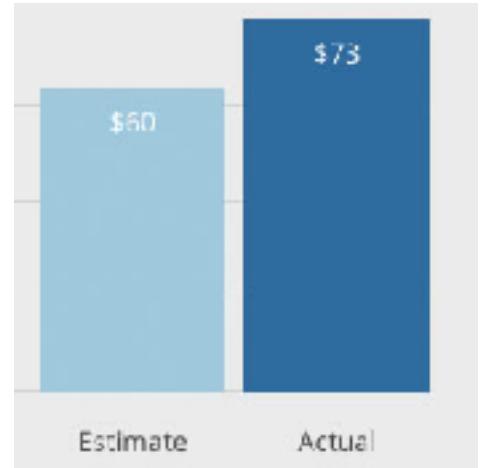


Picking the right tool

- Whenever there is similarity in the information available, a pie chart is not the right chart to use
- Whenever there are multiple (3 or more) different points of data, a pie chart is not the right chart to use
- Pie charts are very easy to abuse
- A pie chart is not the right chart to use if you need to label each percent

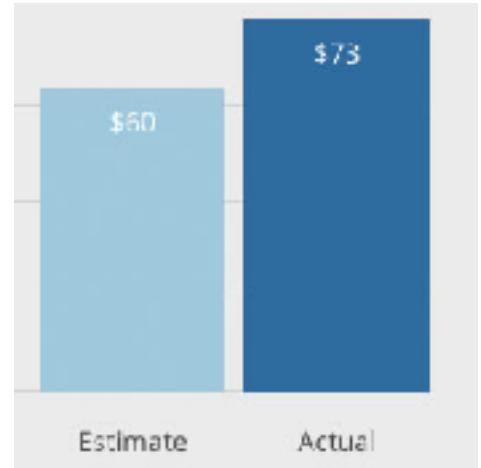
<http://www.businessinsider.com/pie-charts-are-the-worst-2013-6>

Picking the right tool



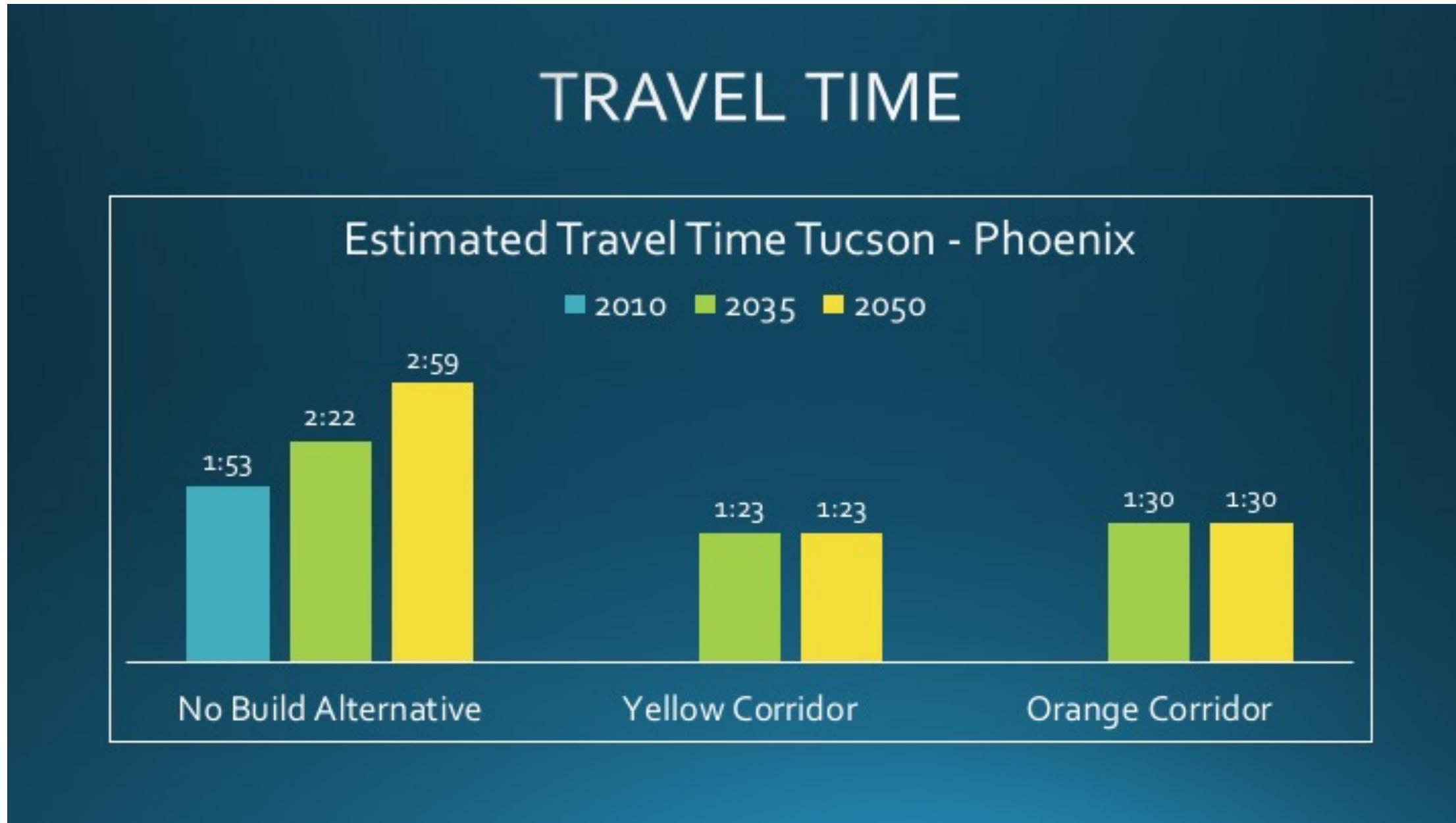
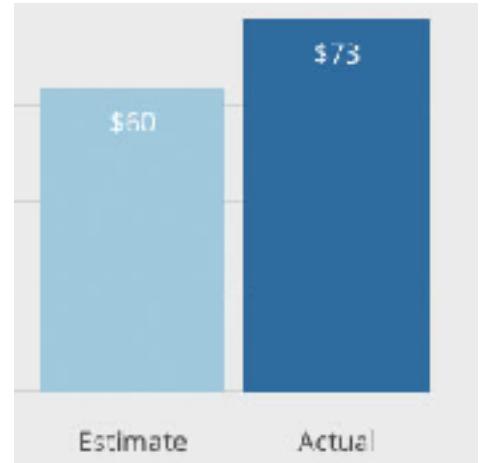
- Bar charts are used to show comparisons between categories of data
 - Time – months, quarters, years
 - Frequencies – traffic flow, incidents, sales
 - Estimates versus Actuals

Picking the right tool

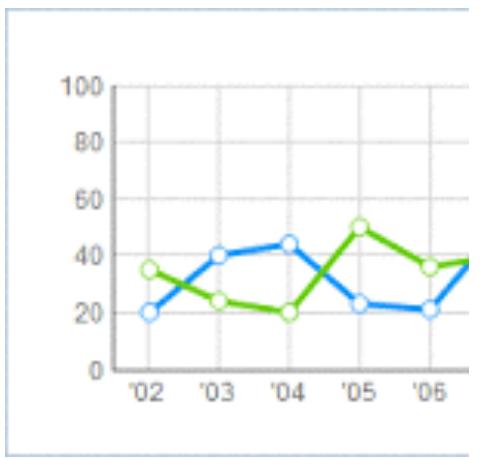


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Picking the right tool



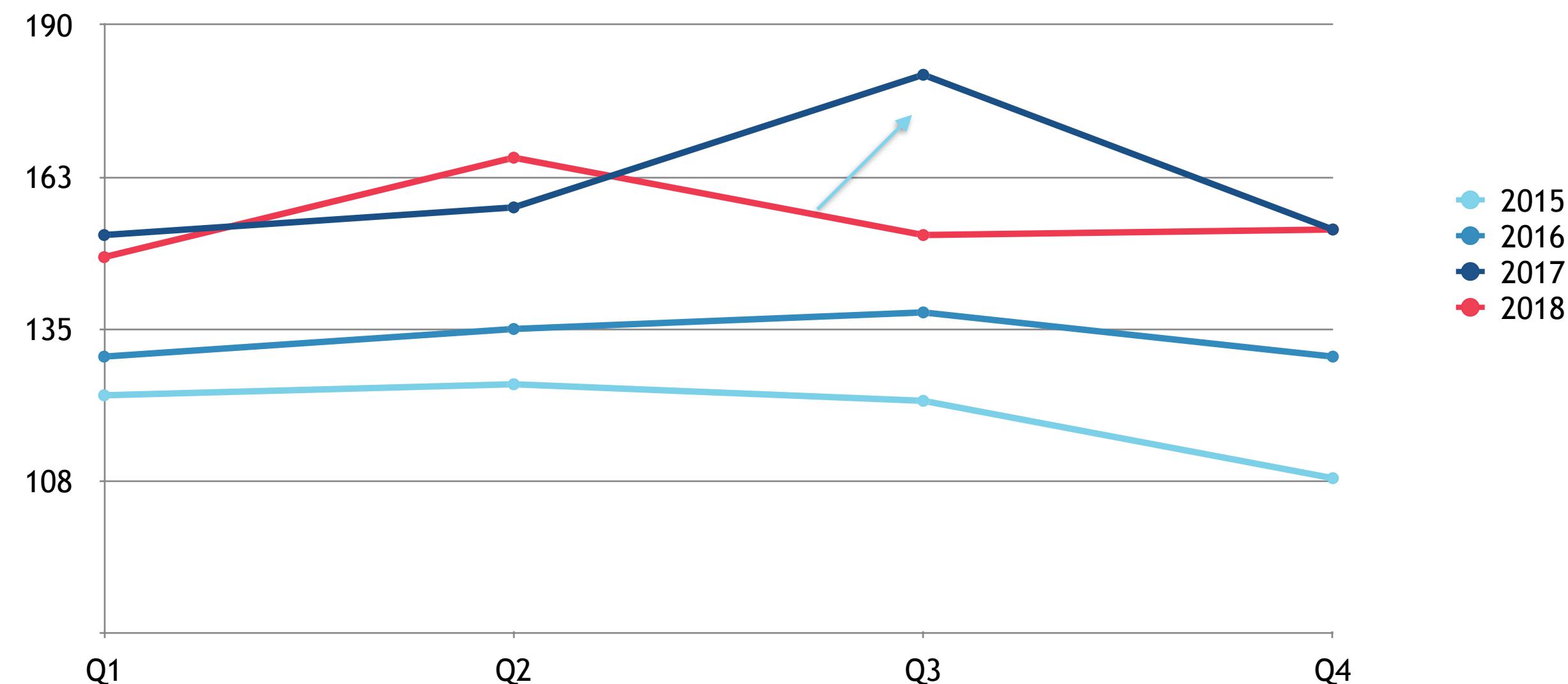
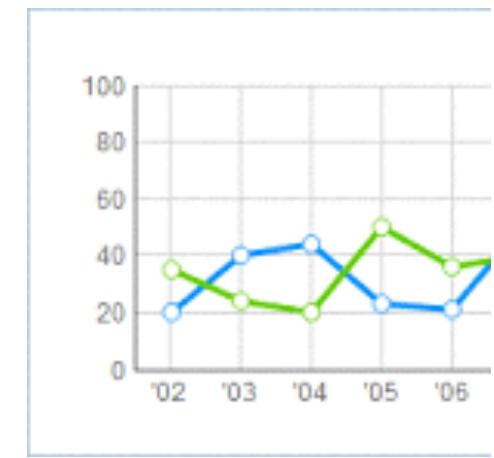
Picking the right tool



- While bar charts do not need time based categories, line charts are often used to show trends over time

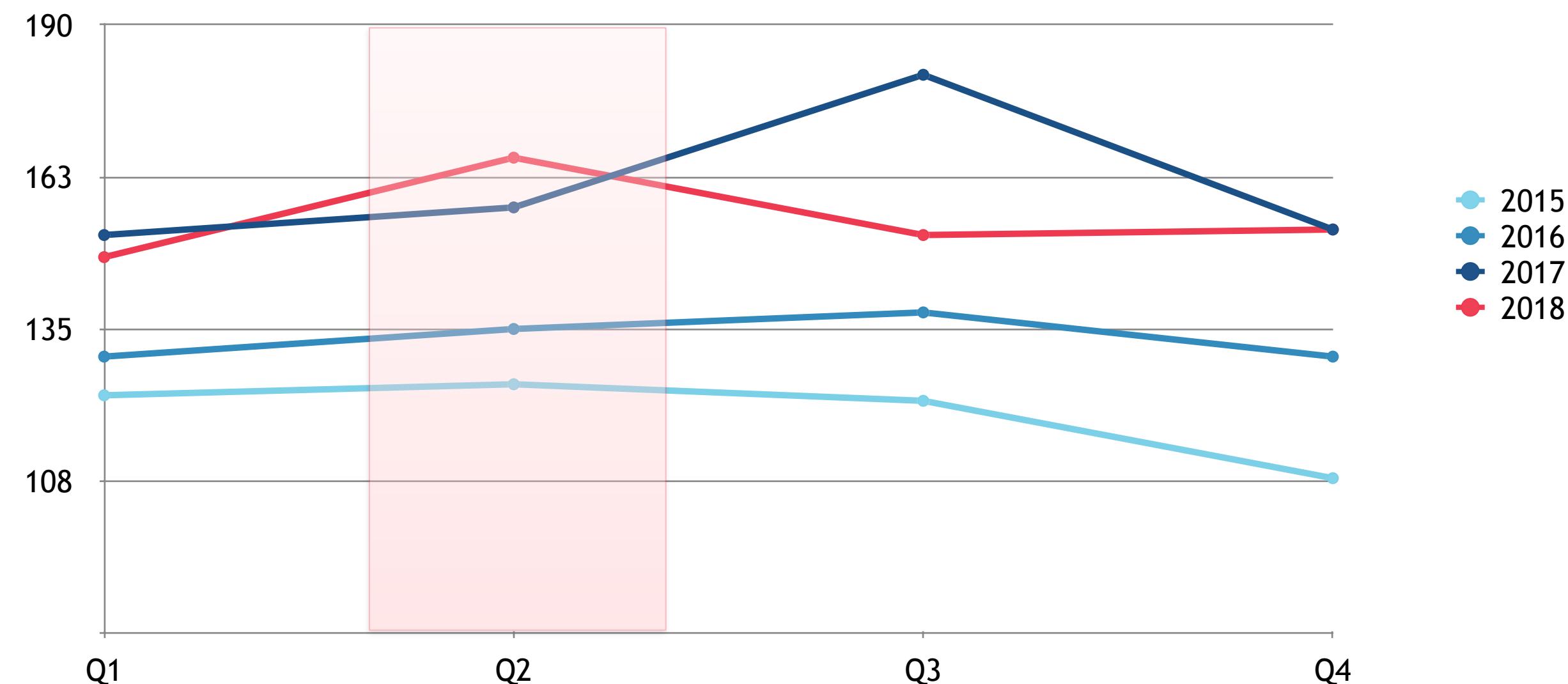
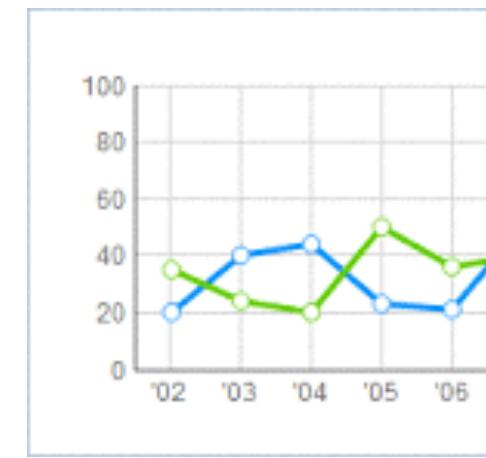
Picking the right tool

Highlight outlier



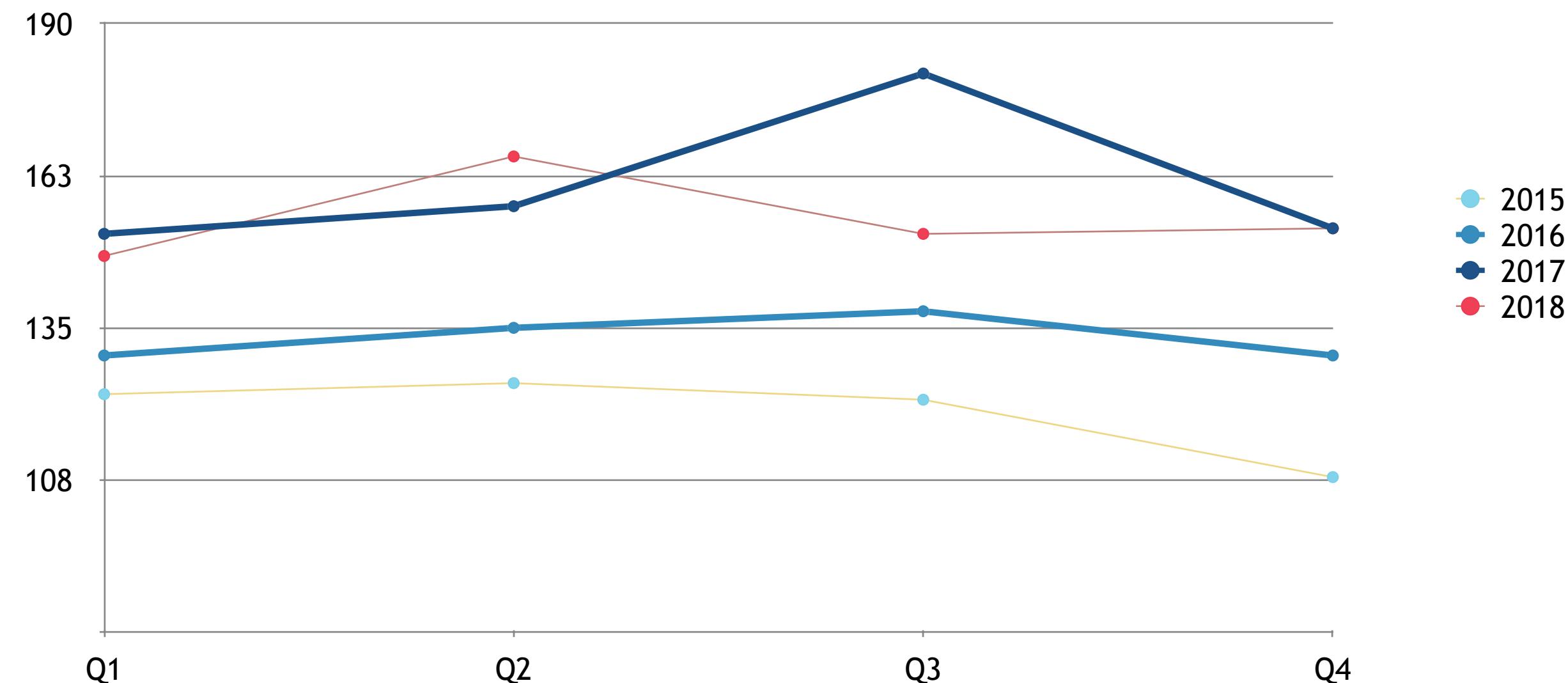
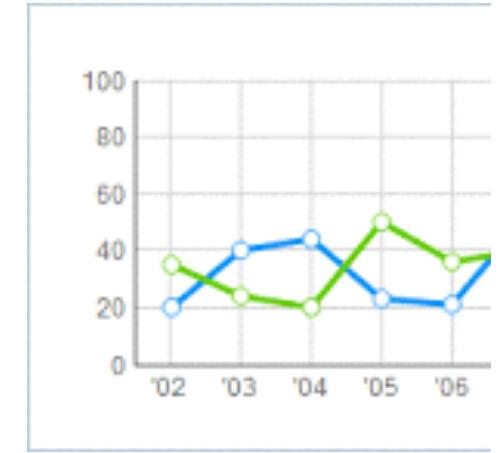
Picking the right tool

Highlight trend



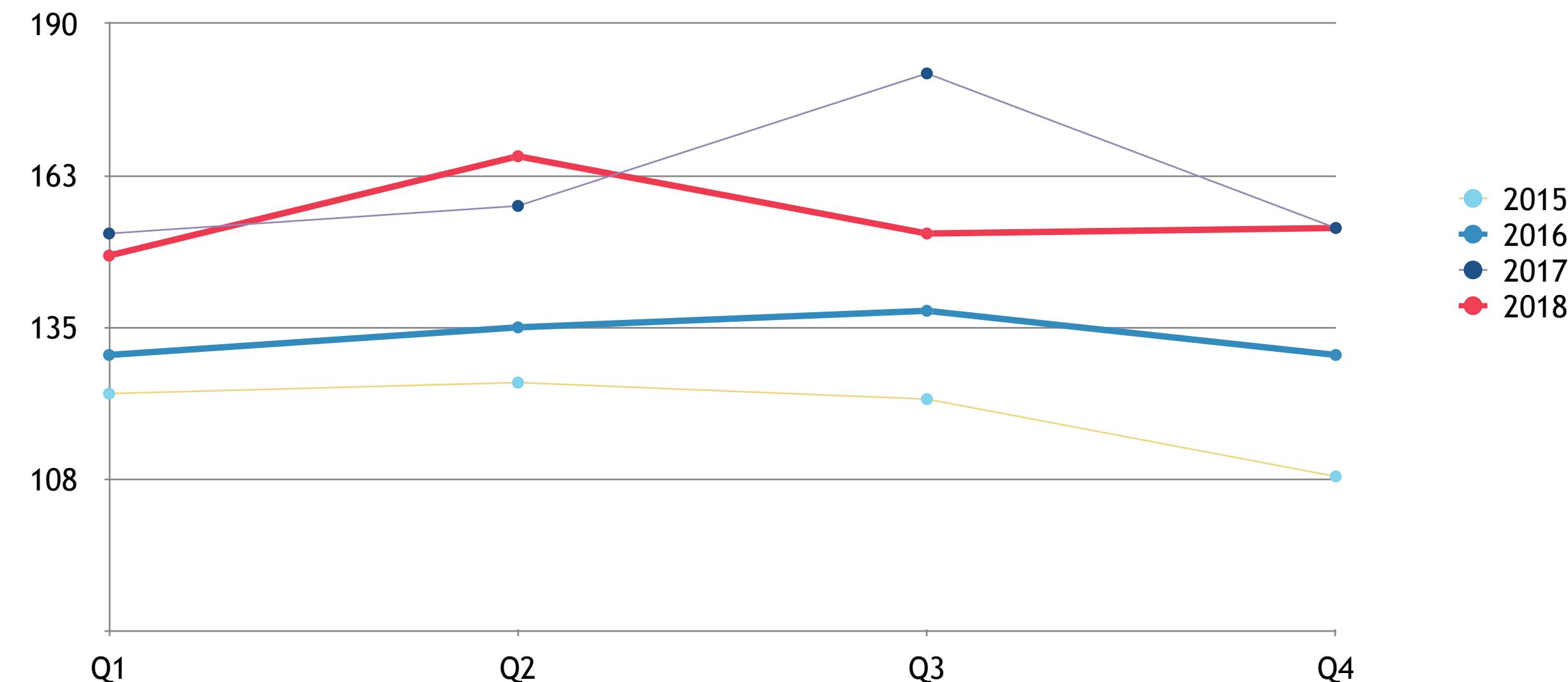
Picking the right tool

Highlight differences

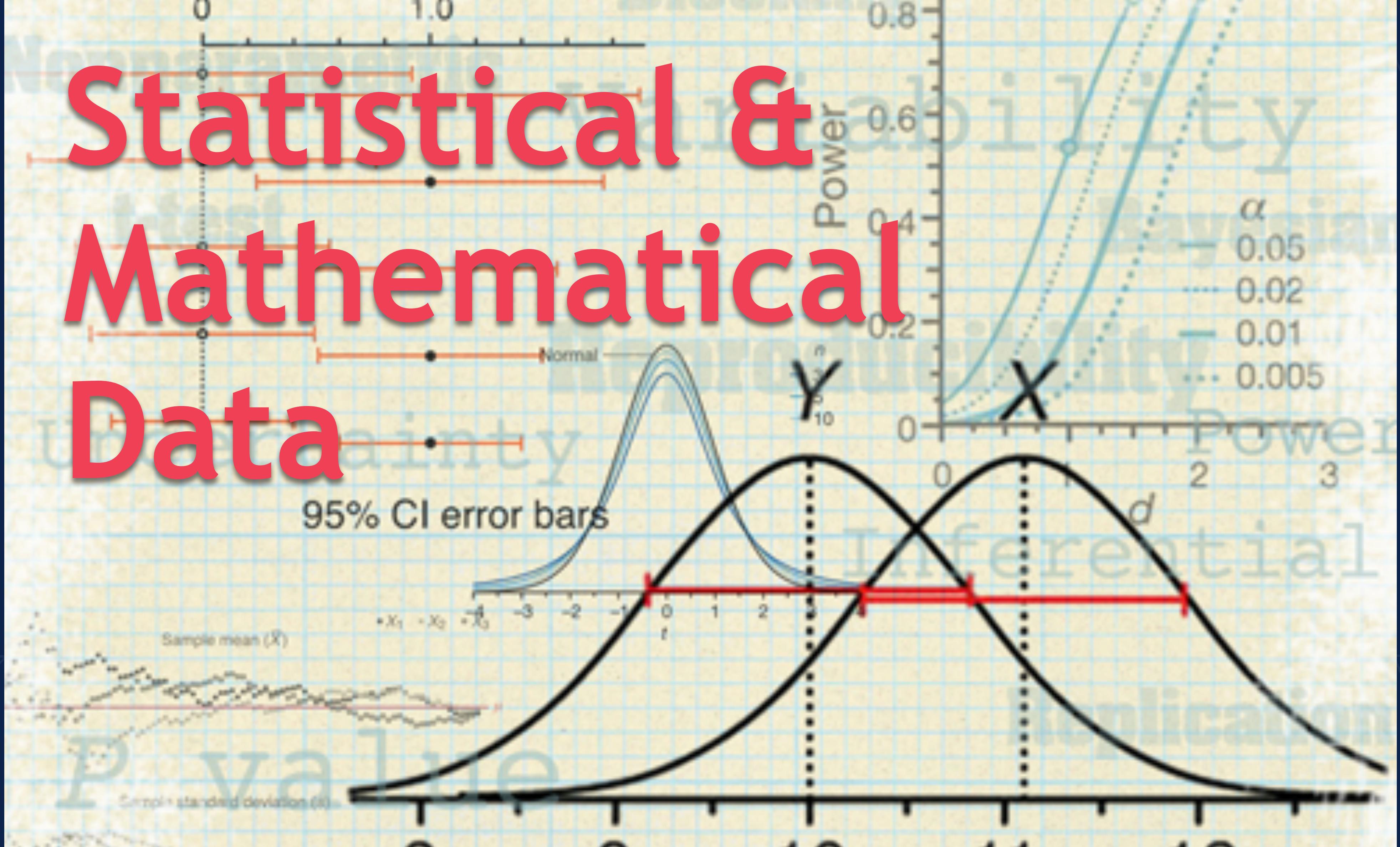


Picking the right tool

Highlight comparisons

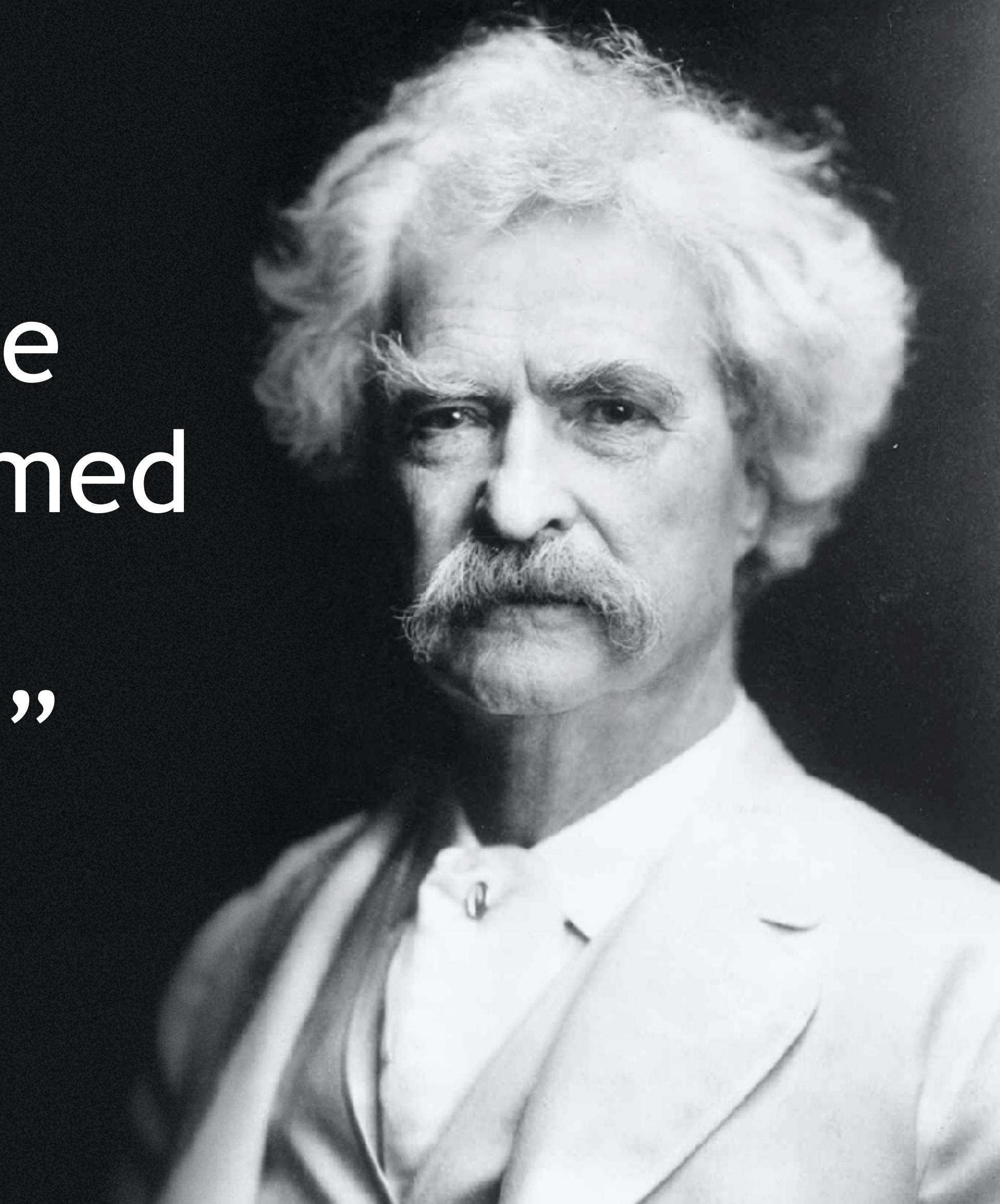


Statistical & Mathematical Data



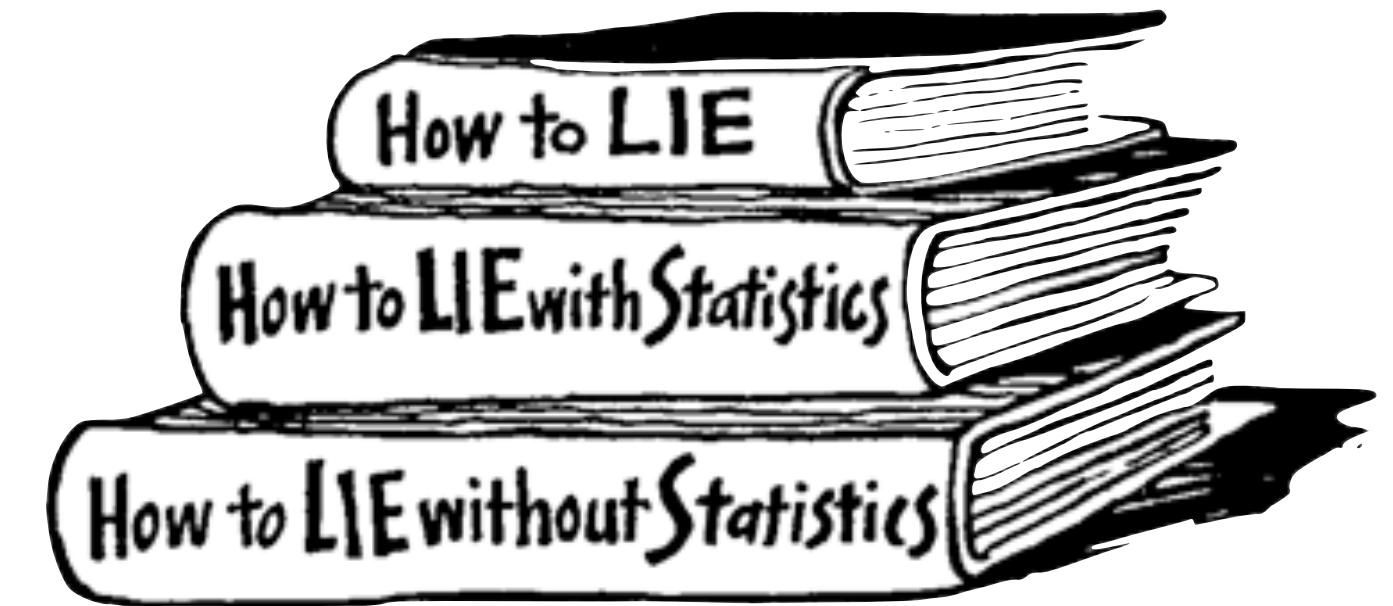
“There are
lies, dammed
lies, and
statistics.”

Mark Twain



Tell the truth

- Avoid misleading charts or claims
- Credibility of all content at risk for **one misleading** claim
- Don't hide bad news
- Don't use decoration to obscure the data



Context

- A number without context and related statistical values is **useless**

Sample
Size

Confidence
Interval

Expected
Ranges

Statistical
Test



Constants

- Elastics
- Young's modulus
- Poisson's Ratio
- Hooke's Law

Equations

- Variable notation (+)
- Units (-)

Fluid Mechanics

$$P = \frac{F}{A}$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad (\text{Charles' Law})$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad (\text{Guy-Lussac's Law})$$

$$P_1 V_1 = P_2 V_2 \quad (\text{Boyle's Law})$$

$$Q = Av$$

$$A_1 v_1 = A_2 v_2$$

$$\text{Horsepower} = \frac{QP}{1714}$$

absolute pressure = gauge pressure
+ atmospheric pressure

P = absolute pressure

F = Force

A = Area

V = volume

T = absolute temperature

Q = flow rate

v = flow velocity

