Teaching Data Science to new useRs

bit.ly/user2017

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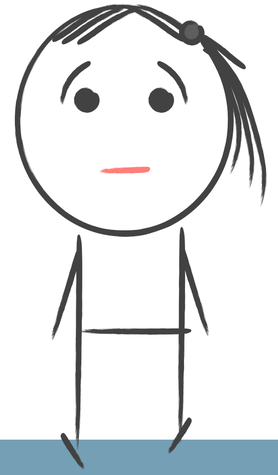
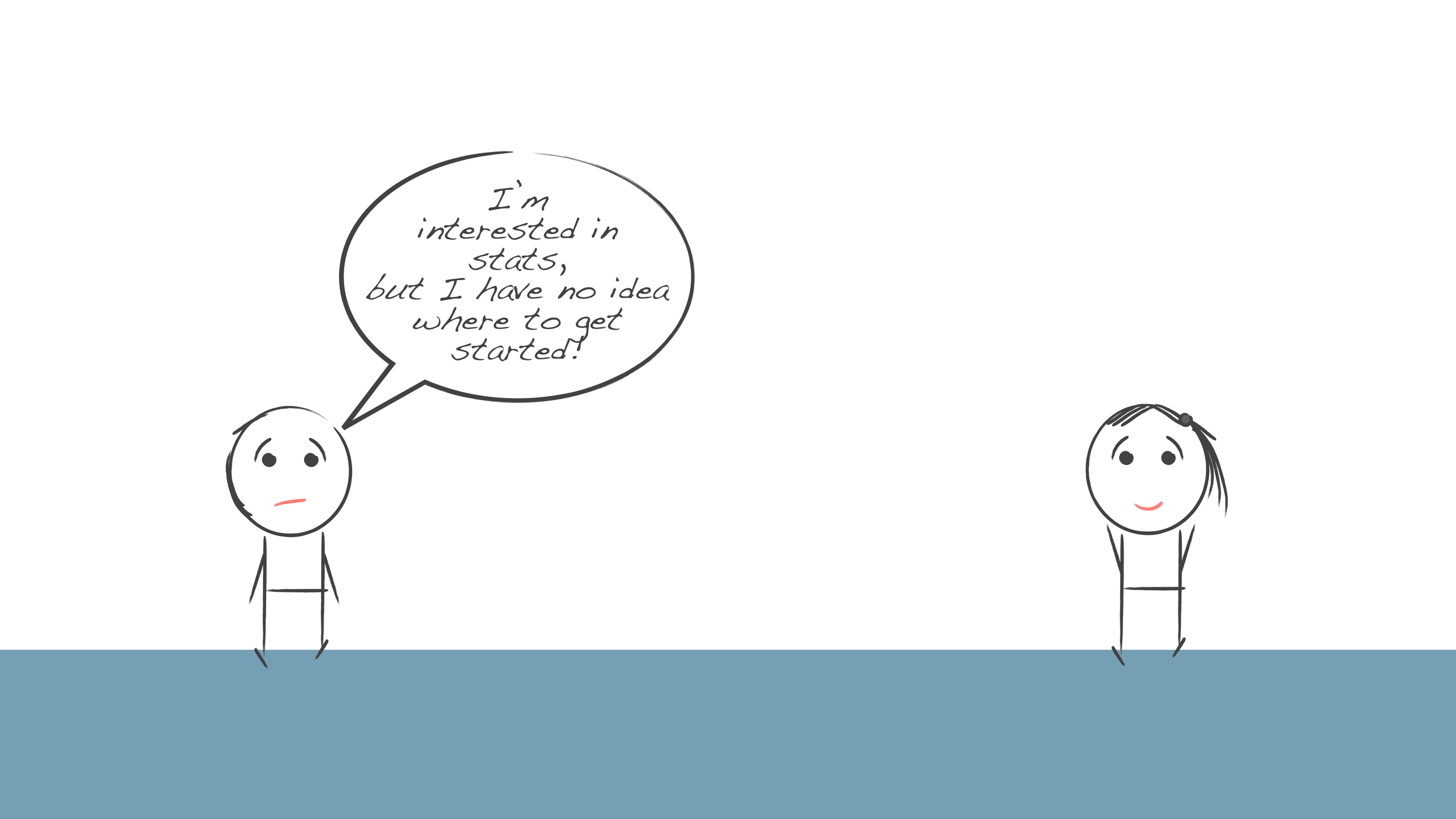
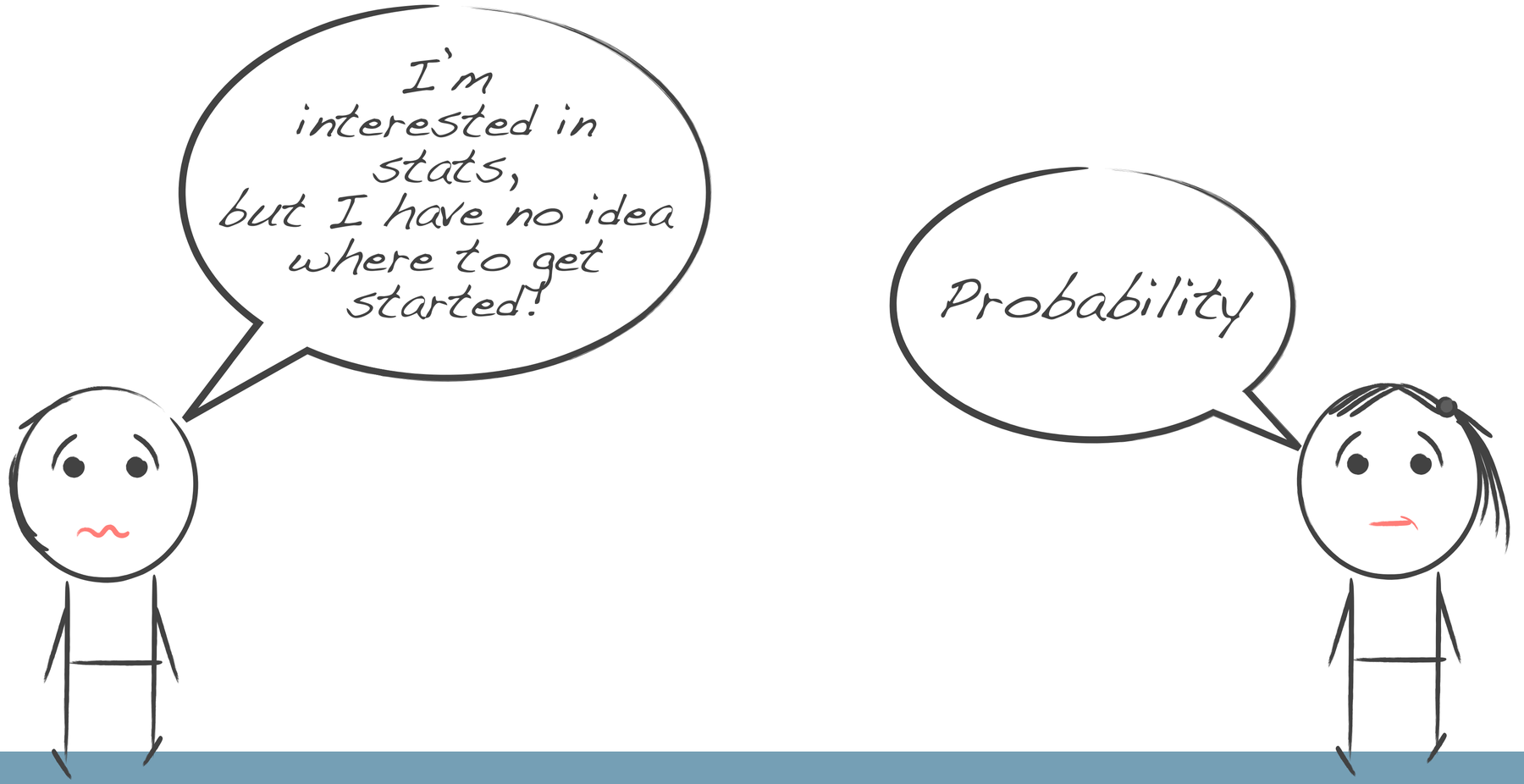



I'm interested in stats, but I have no idea where to get started!

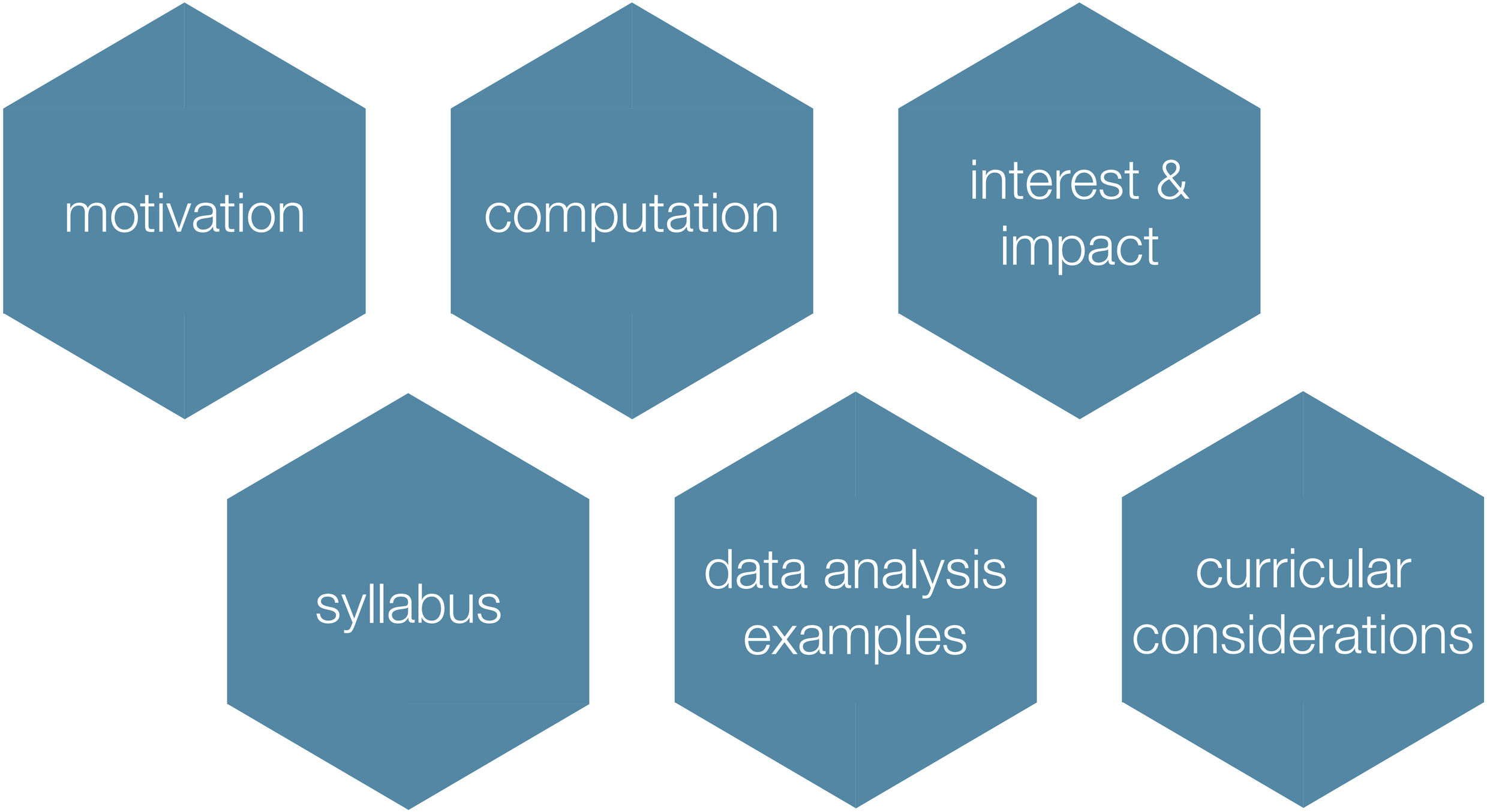

I'm interested in stats, but I have no idea where to get started!
Sta 101


I'm interested in stats, but I have no idea where to get started!
Calculus


I'm interested in stats, but I have no idea where to get started!
Probability


I'm interested in stats, but I have no idea where to get started!
Regression


I'm interested in stats, but I have no idea where to get started!
Intro to data science and statistics


motivation
computation
interest & impact
syllabus
data analysis examples
curricular considerations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goal

a course that provides
a common (gateway) experience
to students wanting to get started with stats,
and that is

- modern
- places data front and center
- quantitative (but not mathematical)
- different than HS stats
- challenging (but not intimidating)

this course should…

emphasize modern and multivariate EDA + data visualization

start at the beginning of data analysis cycle with data collection and cleaning

encourage + enforce working collaboratively (think, code, write, present)

teach (not just expect) reproducible computation

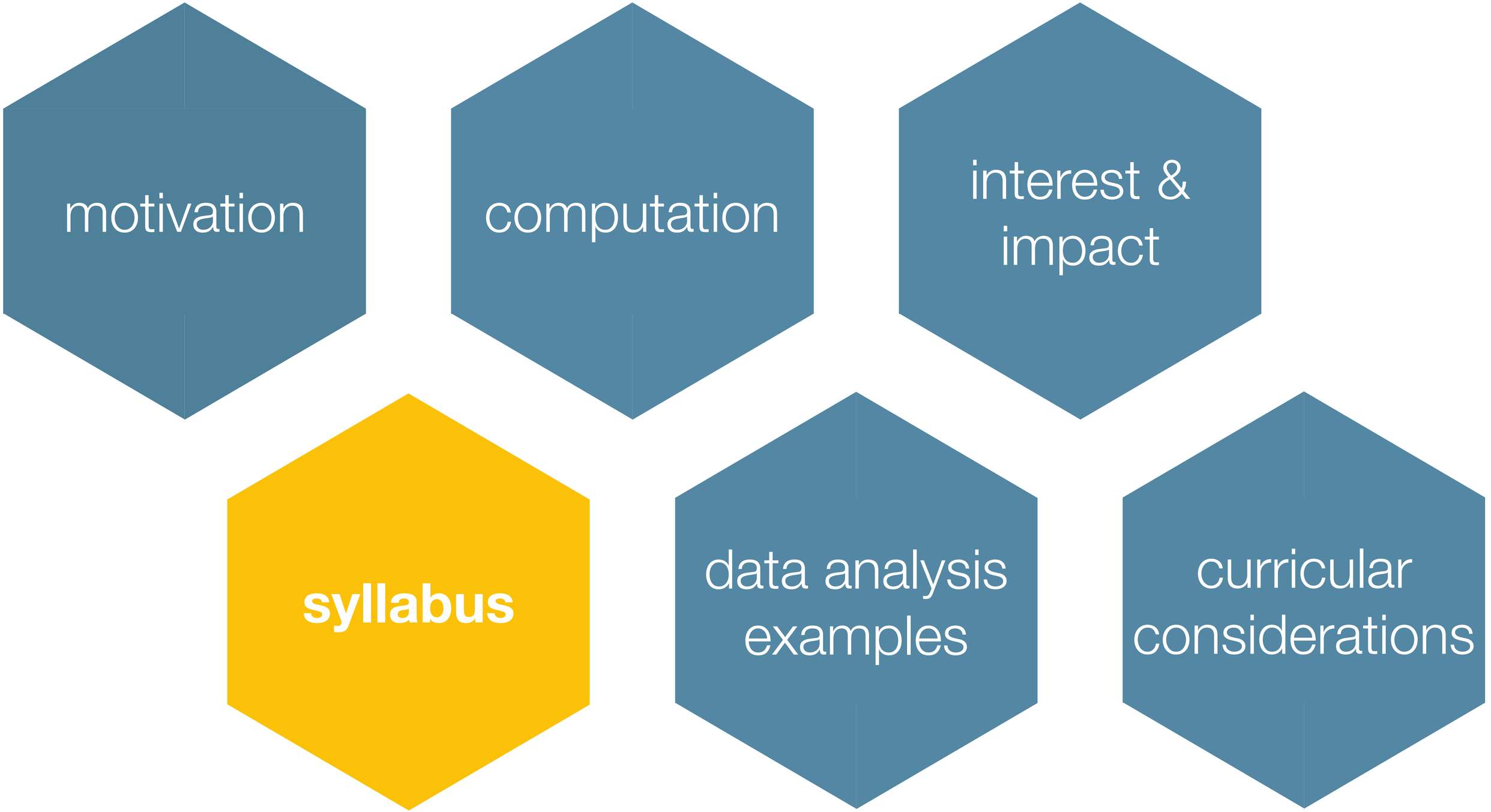
approach statistics from a model based perspective

underscore effective communication of findings

and maybe more importantly…

ask questions that students want to answer

equip students with the tools to answer questions of their own choosing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this course doesn't yet exist, but…

Better Living Through Data Science:

Exploring / Modeling / Predicting / Understanding

Combines techniques from statistics, math, computer science, and social sciences, to learn how to use data to understand natural phenomena, explore patterns, model outcomes, and make predictions. Case studies include examples from election forecasts, movie reviews, and online dating match algorithms. Discussions around reproducibility, data sharing, data privacy will accompany these case studies. Gain experience in data wrangling and munging, exploratory data analysis, predictive modeling, and data visualization, and effective communication of results. Course will focus on R statistical computing language. No computing background necessary. For students in the FOCUS Program.

Part of the What If? Explaining the Past/Predicting the Future cluster.

first-year seminar for undergrads interested in quantitative fields

course overview

curriculum:

data gathering + wrangling, EDA + viz, multivariate modeling, basic inference, communication

structure:

teams: in class exercises + projects
indivudual: HW + take home midterm and final

assessment:

not just final work but also the process, peer evaluations and contribution diagnostics

assignments

culminating:

final open ended project on data of own choosing, team based

periodic:

semi open ended homework, individual

in (every) class:

semi open ended application exercises, team based

fast feedback:

Sakai (LMS) quizzes

individual

assignments

culminating:

final open ended project on data of own choosing, team based

periodic:

semi open ended homework, individual

in (every) class:

semi open ended application exercises, team based

fast feedback:

tryr / DataCamp / etc.

individual

assignments

culminating:

final open ended project on data of own choosing, team based

periodic:

semi open ended homework, individual

in (every) class:

semi open ended application exercises, team based

fast feedback:

`learnr` modules, individual

Interactive Tutorials for R

Mine

Secure https://rstudio.github.io/learnr/

learnr | Home | Exercises | Questions | Publishing | Formats | Examples

- Overview
- Getting Started
- Tutorial Types
- Exercises
- Questions
- Videos
- Shiny Components
- External Resources
- Preserving Work
- Publishing

Interactive Tutorials for R

Overview

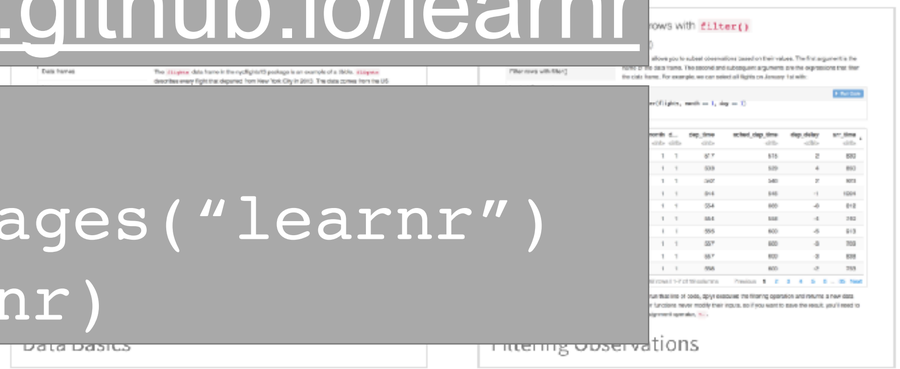
The **learnr** package makes it easy to turn any R Markdown document into an interactive tutorial. Tutorials consist of content along with interactive components for checking and reinforcing understanding. Tutorials can include any or all of the following:

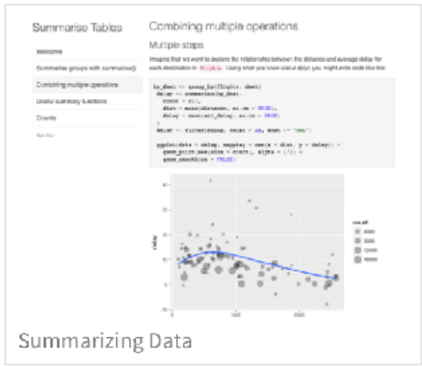
1. Narrative, figures, illustrations, and equations.
2. Code exercises (R code chunks that users can edit and execute directly).
3. Quiz questions.
4. Videos (supported services include YouTube and Vimeo).
5. Interactive Shiny components.

Tutorials automatically preserve work done within them, so if a user works on a few exercises or questions and returns to the tutorial later they can pick up right where they left off.

Examples

earnr package:





Summarizing Data

https://rstudio.github.io/learnr

```
# on CRAN
> install.packages("learnr")
> library(learnr)
```

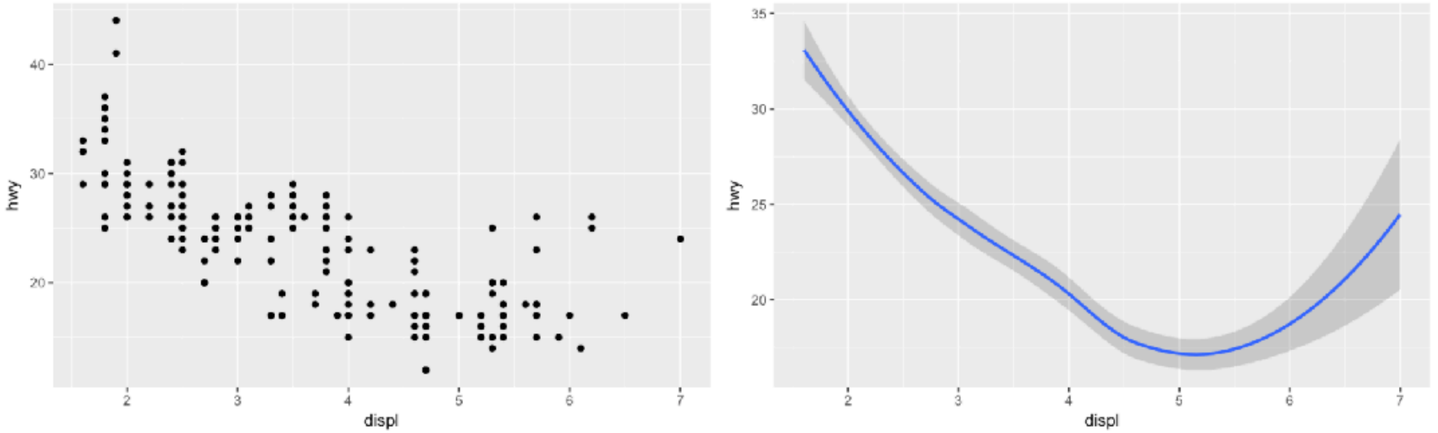
Data Visualization Basics

Start Over

Geometric objects

Geoms

How are these two plots similar?



Both plots contain the same x variable, the same y variable, and both describe the same data. But the plots are not identical. Each plot uses a different visual object to represent the data. In ggplot2 syntax, we say that they use different **geoms**.

A **geom** is the geometrical object that a plot uses to represent observations. People often describe plots by the type of geom that the plot uses. For example, bar charts use bar geoms, line charts use line geoms, boxplots use boxplot geoms, and so on. Scatterplots break the trend; they use the point geom.

As we see above, you can use different geoms to plot the same data. The plot on the left uses the point geom, and the plot on the right uses the smooth geom, a smooth line fitted to the data.

Continue

Data Visualization Basics

Start Over

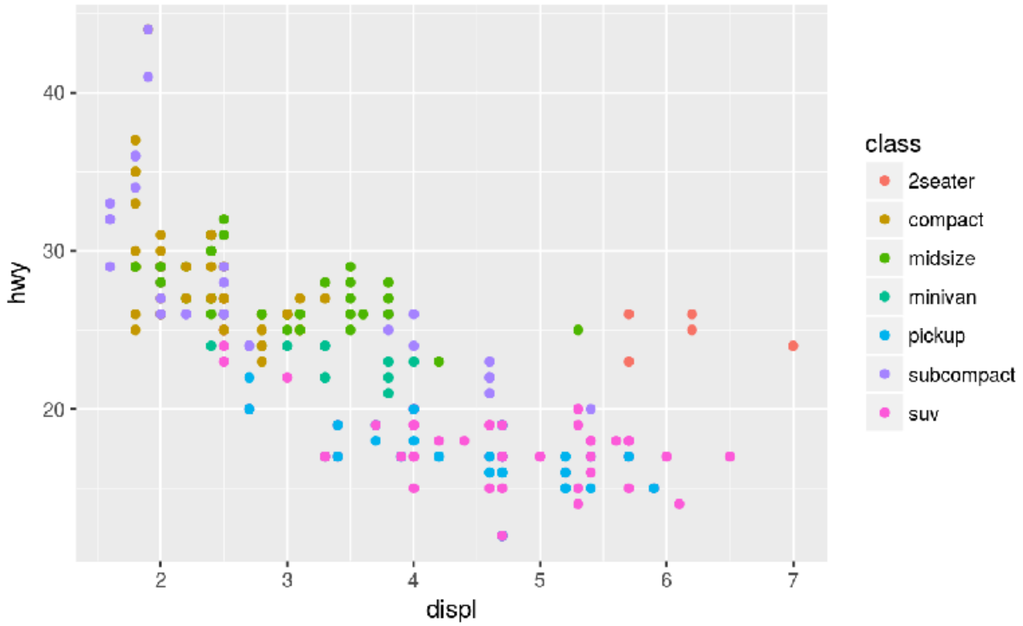
✓ A strategy

We can add the `class` variable to the plot by mapping the levels of an aesthetic (like color) to the values of `class`. For example, we can color a point green if it belongs to the compact class, blue if it belongs to the midsize class, and so on.

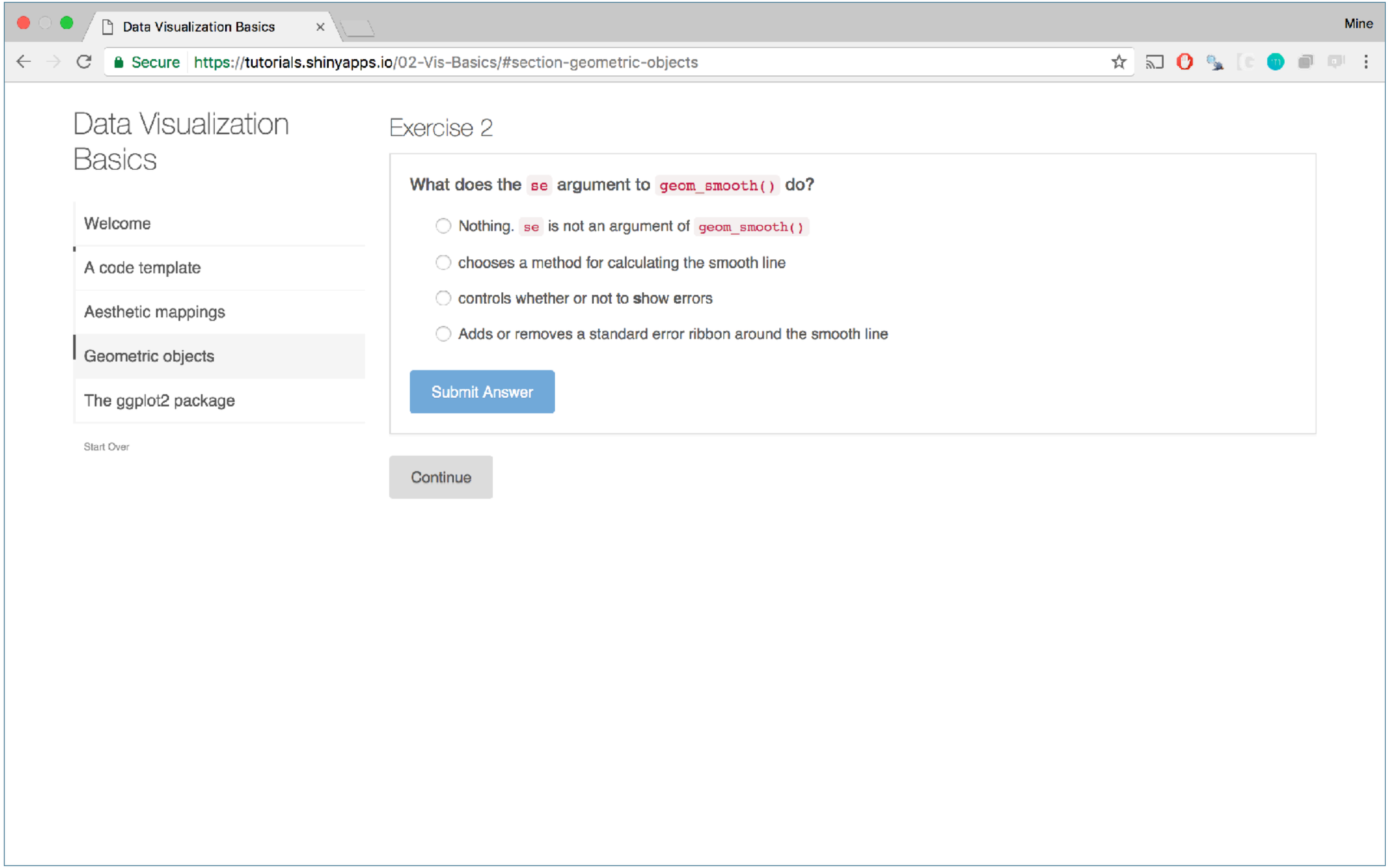
Let's give this a try. Fill in the blank piece of code below with `color = class`. What happens? Delete the commenting symbols (`#`) before running your code. (If you prefer British English, you can use `colour` instead of `color`.)

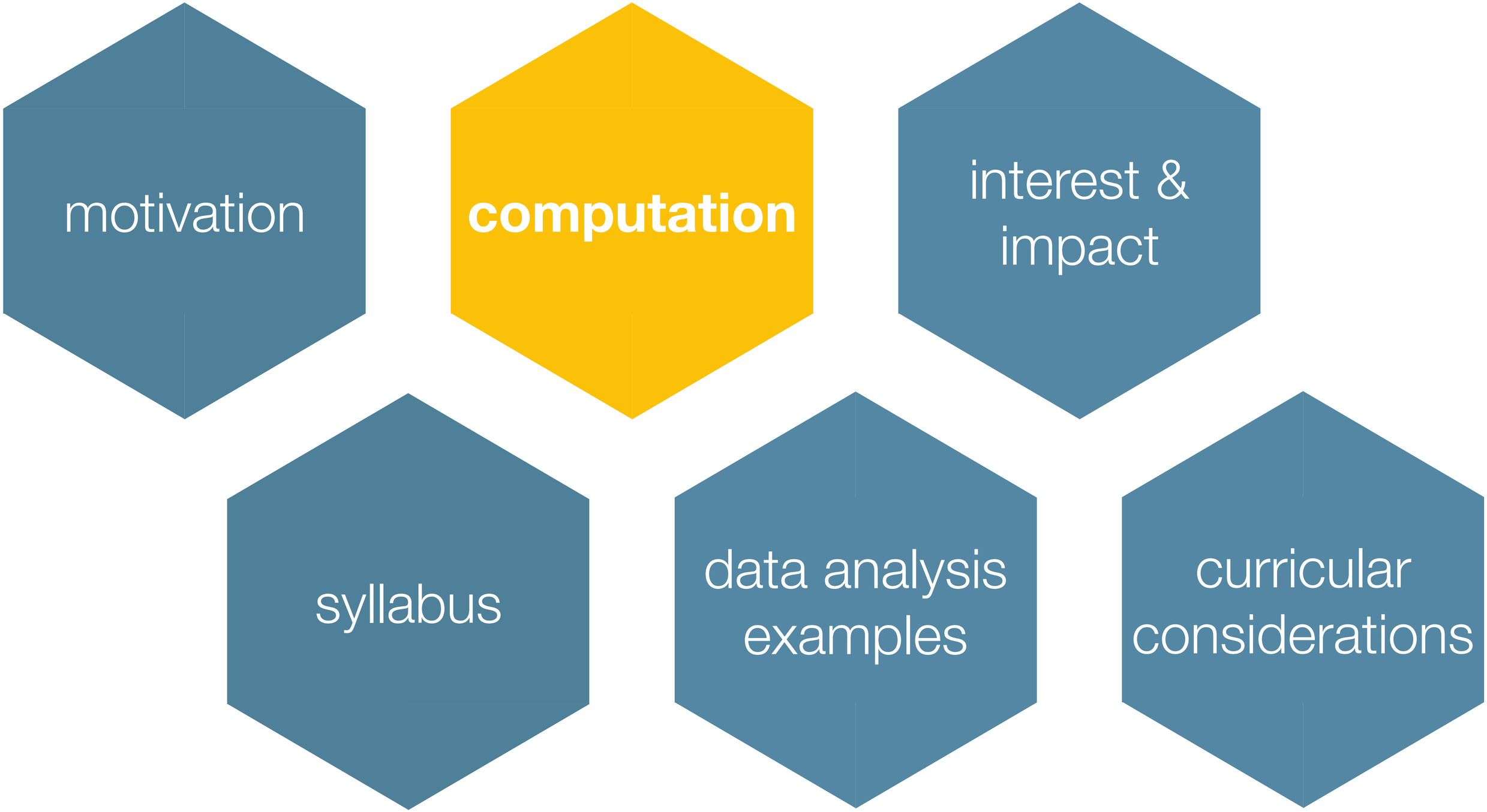
Code | Start Over | Hint | Run Code | Submit Answer

```
1 ggplot(data = mpg) +
2   geom_point(mapping = aes(x = displ, y = hwy, color = class))
3
```



"Great Job! You can now tell which class of car each point represents by examining the color of the point."


Data Visualization Basics
Mine
Secure https://tutorials.shinyapps.io/02-Vis-Basics/#section-geometric-objects
Data Visualization Basics
Welcome
A code template
Aesthetic mappings
Geometric objects
The ggplot2 package
Start Over
Exercise 2
What does the se argument to geom_smooth() do?
Nothing. se is not an argument of geom_smooth()
chooses a method for calculating the smooth line
controls whether or not to show errors
Adds or removes a standard error ribbon around the smooth line
Submit Answer
Continue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computation

core:

R + RStudio server

toolkit:[a]

(mostly)

`tidyverse`

reproducibility:

R Markdown +

Git / GitHub

core:

R + RStudio server

why?

start up instructions

Local install

- Install R: https://cran.r-project.org/
- Install RStudio: https://www.rstudio.com/products/rstudio/
- Install the following packages:
  - rmarkdown
  - knitr
  - tidyverse
  - ...
- Load these packages

vs.

RStudio Server

- Go to smith.stat.duke.edu:8787
- Log in with your Net ID & pass

core: R + RStudio Server

goal:
minimize onboarding friction and time to 1st data viz

how:
avoid local installation with RStudio Server (Pro)

at the end:
provide instructions for + help with local install

toolkit:

(mostly)
`tidyverse`

why?

recoding a binary variable

base R

```
mtcars$transmission <-
  ifelse(mtcars$am == 0,
         "automatic",
         "manual")
```

vs.

tidyverse

```
mtcars <- mtcars %>%
  mutate(
    transmission =
      case_when(
        am == 0 ~ "automatic",
        am == 1 ~ "manual"
      )
  )
```

recoding a multi-level variable

base R

```
mtcars$gear_char <-
  ifelse(mtcars$gear == 3,
         "three",
         ifelse(mtcars$gear == 4,
                "four",
                "five")
  )
```

vs.

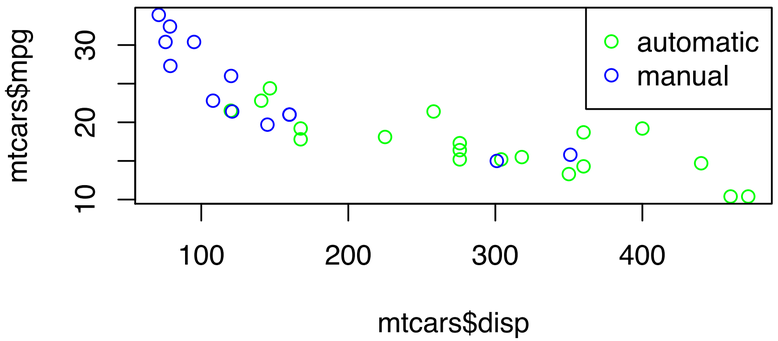
tidyverse

```
mtcars <- mtcars %>%
  mutate(
    gear_char =
      case_when(
        gear == 3 ~ "three",
        gear == 4 ~ "four",
        gear == 5 ~ "five"
      )
  )
```

visualizing multiple variables

base R

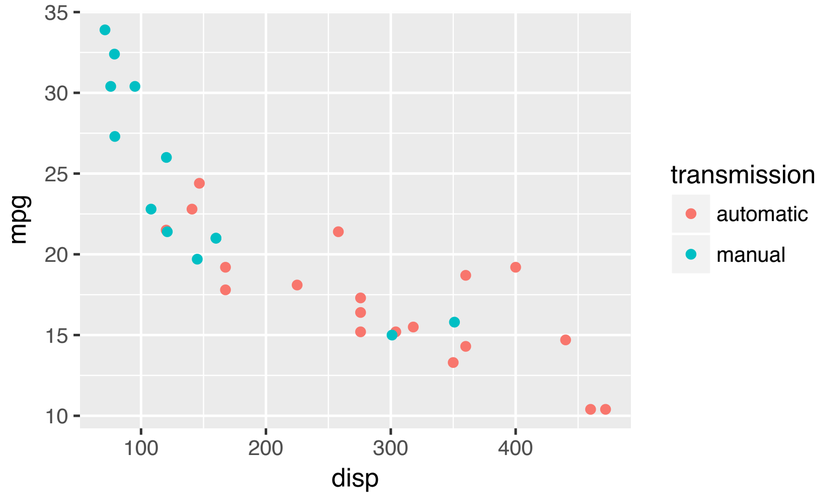
```
mtcars$trans_color <-
  ifelse(mtcars$transmission == "automatic",
         "green",
         "blue")

plot(mtcars$mpg ~ mtcars$disp,
     col = mtcars$trans_color)
legend("topright",
       legend = c("automatic", "manual"),
       pch = 1, col = c("green", "blue"))
```



vs.

tidyverse

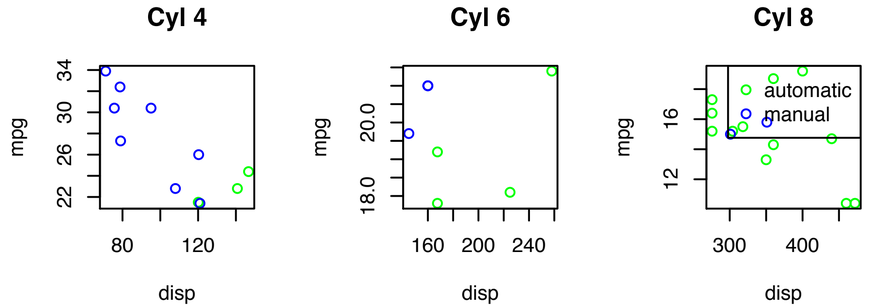
```
ggplot(mtcars,
       aes(x = disp, y = mpg,
           color = transmission)) +
  geom_point()
```



visualizing even more variables

base R

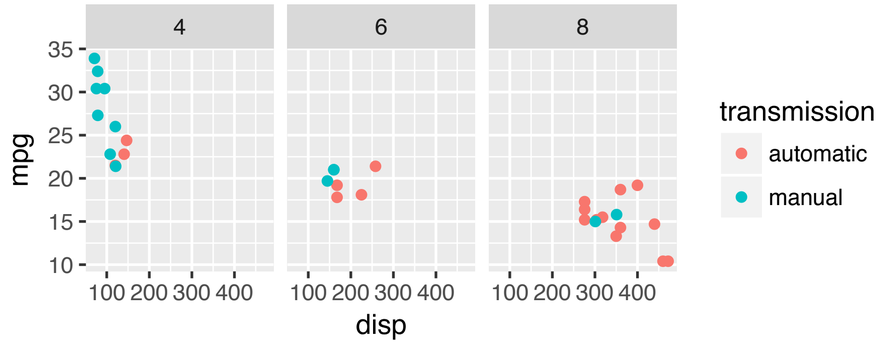
```
mtcars_cyl4 = mtcars[mtcars$cyl == 4, ]
mtcars_cyl6 = mtcars[mtcars$cyl == 6, ]
mtcars_cyl8 = mtcars[mtcars$cyl == 8, ]

par(mfrow = c(1, 3))
plot(mpg ~ disp, data = mtcars_cyl4,
     col = trans_color, main = "Cyl 4")
plot(mpg ~ disp, data = mtcars_cyl6,
     col = trans_color, main = "Cyl 6")
plot(mpg ~ disp, data = mtcars_cyl8,
     col = trans_color, main = "Cyl 8")
legend("topright",
       legend = c("automatic", "manual"),
       pch = 1, col = c("green", "blue"))
```



vs.

tidyverse

```
ggplot(mtcars,
       aes(x = disp, y = mpg,
           color = transmission)) +
  geom_point() +
  facet_wrap(~ cyl)
```



toolkit: (mostly) tidyverse

(closer to)
human readable

consistent syntax

ease of
multivariate
visualizations

why?

reproducibility:

R Markdown +
Git / GitHub

R Markdown

reproducibility:

train new analysts whose only workflow is a reproducible one

efficiency:

consistent formatting + built in "show your work" = easier grading

pedagogy:

code + output + prose together

syntax highlighting + notebooks FTW!

key to success:

iterative development: knit early, and often

Git + GitHub

version control:

lots of mistakes along the way, need ability keep track of history (revert)

accountability:

transparent commit history

collaboration:

platform and interface designed to enable collaboration

early intro:

mastery takes time, start early (day 1)

marketability + discoverability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#1 paris paintings

data expeditions

pairs of grad students, work with course instructor to formulate question & pathway

element of an undergrad course that introduces students to exploratory data analysis

graduate student participants receive a travel grant

Source: http://bigdata.duke.edu/data-expeditions

meet the experts

Sandra Van Ginhoven
PhD, Art History

Hilary Coe Cronheim
PhD, Art History

data source: auction catalogs

89 Deux tableaux très riches de com- *1666*
position, d'une belle exécution, & dont le mérite eſt très remarquable, chacun de 17 pouces 3 lignes de haut, ſur 23 pouces de large; le premier, peint ſur bois, vient du Cabinet de Madame la Comteſſe de Verrue; il repréſente un départ pour la chaſſe : on y voit ſur le devant un

enrichi...
Le ſecond tableau, qui eſt ſur toile, fait voir un terrein d'une grande étendue, près la mer qui eſt à gauche, & ſur laquelle ſont des vaiſſeaux : on y voit auſſi des bagages que l'on décharge d'un charriot, des hommes, des femmes, des enfants, deux chevaux qui mangent, & des mulets chargés de bagages.

Two paintings very rich in composition, of a beautiful execution, and whose merit is very remarkable, each 17 inches 3 lines high, 23 inches wide; the first, painted on wood, comes from the Cabinet of Madame la Comtesse de Verrue; it represents a departure for the hunt: it shows in the front a child on a white horse, a man who gives the horn to gather the dogs, a falconer and other figures nicely distributed across the width of the painting; two horses drinking from a fountain; on the right in the corner a lovely country house topped by a terrace, on which people are at the table, others who play instruments; trees and fabriques pleasantly enrich the background.

data transcription

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	name	sale	lot	dealer	year	origin_ author	origin_ cat	school_ pntg	diff_origin	price	count	subject	authorstandard	artistliving	authorstyle	author	winner
2517	R1777-86	R1777	86	R	1777	D/FL	D/FL	D/FL	0	620.0	1	2 femmes, enfants, paysage vu à travers une arcade	Bega, Cornelis Pieterszoon	0	n/a	Corneille Bega	Lebrun
2518	R1777-87	R1777	87	R	1777	D/FL	D/FL	D/FL	0	12,000.0	1	Course du hareng	Wouwerman, Philips	0	n/a	Philippe Wouwerman	Donjeux
2519	R1777-88	R1777	88	R	1777	D/FL	D/FL	D/FL	0	8,000.0	1	Paysage sablonneux	Wouwerman, Philips	0	n/a	Philippe Wouwerman	Lambert
2520	R1777-89a	R1777	89	R	1777	D/FL	D/FL	D/FL	0	5,300.0	1	Départ pour la chasse	Wouwerman, Philips	0	n/a	Philippe Wouwerman	Langlier

	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	winningbidder	winningbiddertype	endbuyer	interm	type_interm ed	Height_in	Width_in	Surface_Rect	Diam_in	Surface_Rnd	Shape	Surface	material	mat	quantity	nfigures	engraved
2516	Feuillet	D	D	0		16	20	320			squ_rect	320	toile	t	1	0	0
2517	Lebrun, Jean-Baptiste-Pierre	D	D	0		13.25	11	145.75			squ_rect	145.75	bois	b	1	0	0
2518	Donjeux, Vincent	D	D	0		23	29.25	672.75			squ_rect	672.75	toile	t	1	50	0
2519	Lambert, John (Chevalier Lambert)	C	C	0		23	30	690			squ_rect	690	toile	t	1	0	1
2520	Langlier, Jacques for Poullain, Antoine	DC	C	1	D	17.25	23	396.75			squ_rect	396.75	bois	b	1	0	0

	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF
1	nfigures	engraved	original	prevcoll	othartist	paired	figures	finished	lrgfont	relig	landsALL	lands_ sc	lands_ figs	lands_ment	arch	mytho	peasant	othgenre	singlefig	portrait	still_life	discauth	history	allegory	pastorale	other
2516	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
2517	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
2518	50	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
2519	0	1	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2520	0	0	0	1	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

paris paintings

data:

painting
auction data
1764 - 1780
[3,393 x 57]

visualize:

data visualization to explore patterns and possible interactions

clean:

data cleaning and wrangling

model:

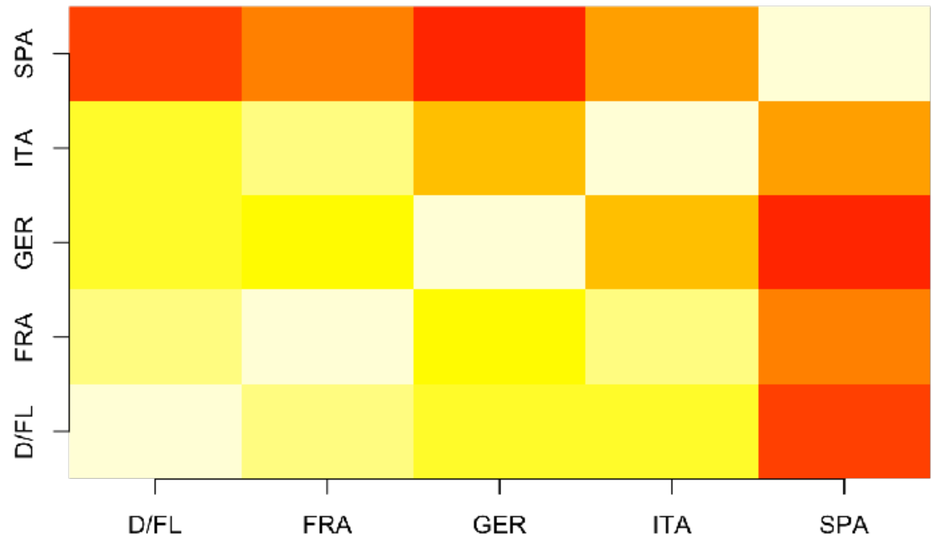
model log(price) and perform procedural and expert opinion based model selection

sample exploration #1 — similarity of schools

Calculate a similarity score between different classes of art - score between 0 and 1, higher scores reflect a greater degree of similarity among features; i.e. a score of 1 would indicate identical vectors while a score of 0 would indicate vectors with no features in common.

```
similarity = function (vec1, vec2) {
  mag1 = sqrt(vec1 %*% vec1)
  mag2 = sqrt(vec2 %*% vec2)
  return(vec1 %*% vec2 / mag1 / mag2)
}
```

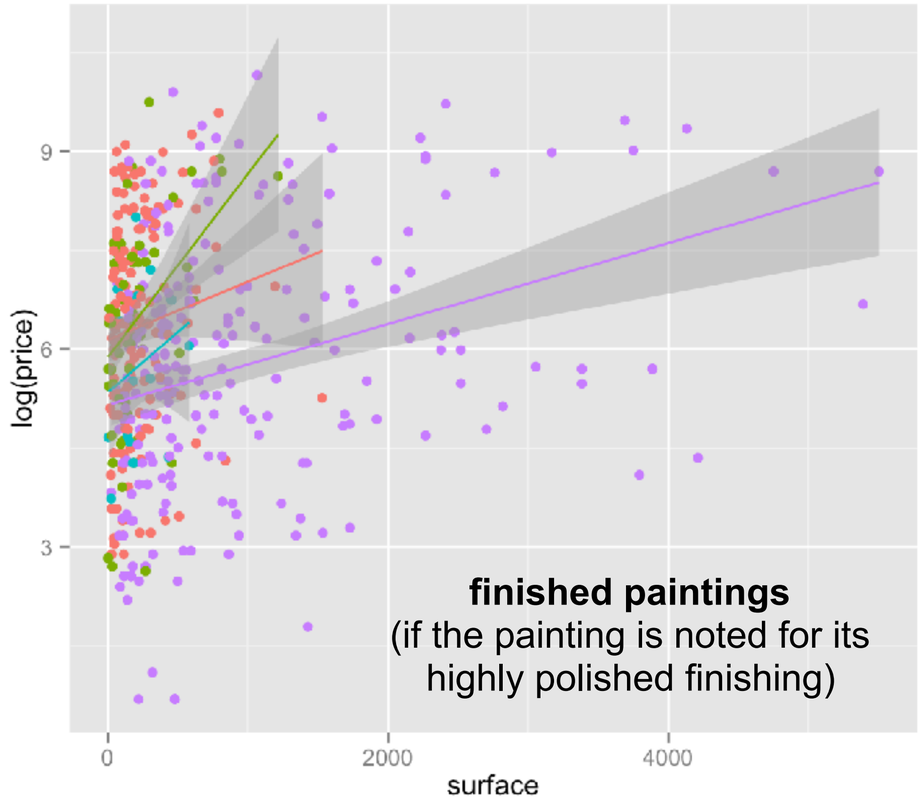
Spanish art is most notably different from the other schools (Lighter colors indicate similarities, while deep red indicates large differences).

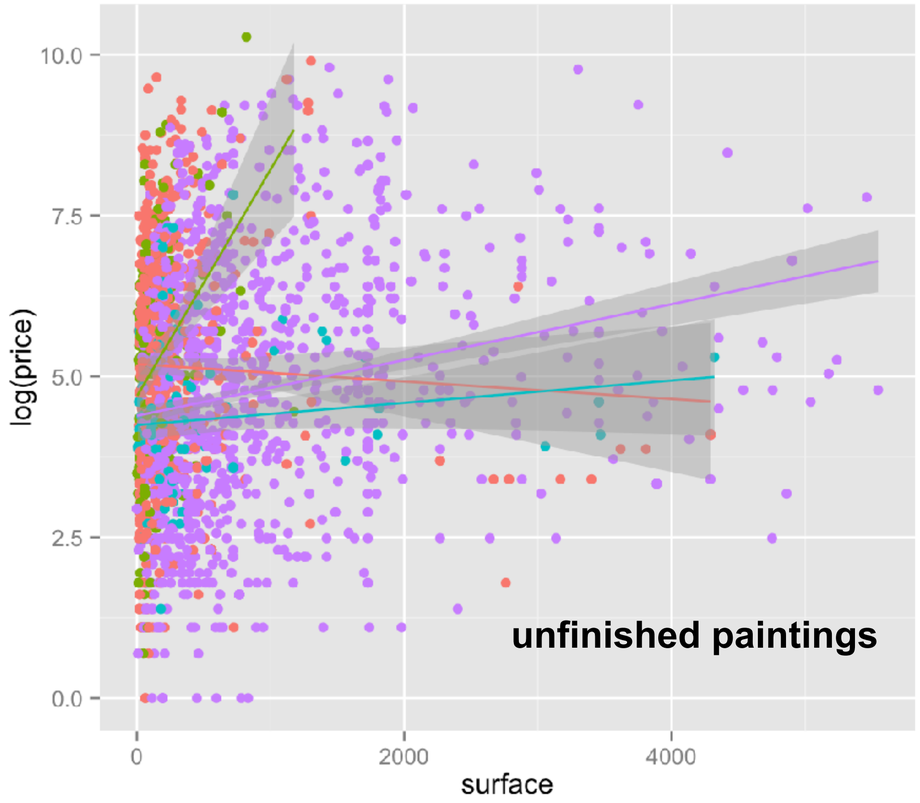


sample exploration #2

material and price

Copper paintings, though typically small, have a notably strong interation with surface area





student experience

non-standard application piqued student interest

“massive” data overwhelming but expert input refreshing

unfamiliar variables made narrative challenging

novel application pushed creativity

#2 basketball

data

goduke.statsgeek.com/basketball-m/seasons/schedule.php?season=2014-15

2014-15 Schedule & Results

Date		[Rk] Opponent	Duke Rank	Location (Venue)	Score (OT)	Att.	Tip Time	TV
11/14	~	**Presbyterian**	4	Durham, N.C. (Cameron Indoor Stadium)	W 113-44	9,314	6 p.m.	ESPNU
11/15	~	**Fairfield**	4	Durham, N.C. (Cameron Indoor Stadium)	W 109-59	9,314	8 p.m.	ESPN3
11/18	¶¶	vs. [19] Michigan State	4	Indianapolis, Ind. (Bankers Life Fieldhouse)	W 81-71	19,306	7 p.m.	ESPN
11/21	~	vs. Temple	4	Brooklyn, N.Y. (Barclays Center)	W 74-54	10,135	9:30 p.m.	TruTV
11/22	~	vs. Stanford	4	Brooklyn, N.Y. (Barclays Center)	W 70-59	10,046	9:30 p.m.	TruTV
11/26		**Furman**	4	Durham, N.C. (Cameron Indoor Stadium)	W 93-54	9,314	5 p.m.	ESPNU
11/30		**Army**	4	Durham, N.C. (Cameron Indoor Stadium)	W 93-73	9,314	12 p.m.	ESPNU
12/3	#	at [2] Wisconsin	4	Madison, Wisc. (Kohl Center)	W 80-70	17,279	9:30 p.m.	ESPN
12/15		**Elon**	2	Durham, N.C. (Cameron Indoor Stadium)	W 75-62	9,314	7 p.m.	ESPNU
12/18		vs. Connecticut	2	East Rutherford, N.J. (Izod Center)	W 66-56	16,541	8 p.m.	ESPN
12/29		**Toledo**	2	Durham, N.C. (Cameron Indoor Stadium)	W 86-69	9,314	7 p.m.	ESPN2
12/31		**Wofford**	2	Durham, N.C. (Cameron Indoor Stadium)	W 84-55	9,314	3 p.m.	RSN
1/3	*	**Boston College**	2	Durham, N.C. (Cameron Indoor Stadium)	W 85-62	9,314	4 p.m.	RSN
1/7	*	at Wake Forest	2	Winston-Salem, N.C. (Joel Coliseum)	W 73-65	12,651	9 p.m.	ACCN
1/11	*	at N.C. State	2	Raleigh, N.C. (PNC Arena)	L 75-87	19,500	1:30 p.m.	CBS
1/13	*	**Miami**	4	Durham, N.C. (Cameron Indoor Stadium)	L 74-90	9,314	9 p.m.	ESPNU
1/17	*	at [6] Louisville	4	Louisville, Ky. (KFC Yum! Center)	W 63-52	22,791	12 p.m.	ESPN
1/19	*	**Pittsburgh**	5	Durham, N.C. (Cameron Indoor Stadium)	W 79-65	9,314	7 p.m.	ESPN
1/25		at St. Johns	5	New York, N.Y. (Madison Square Garden)	W 77-68	19,812	2 p.m.	FOX
1/28	*	at [8] Notre Dame	4	Notre Dame, Ind. (Joyce Center)	L 73-77	9,149	7:30 p.m.	ESPN2
1/31	*	at [2] Virginia	4	Charlottesville, Va. (John Paul Jones Arena)	W 69-63	14,593	7 p.m.	ESPN
2/4	*	**Georgia Tech**	4	Durham, N.C. (Cameron Indoor Stadium)	W 72-66	9,314	7 p.m.	ESPN2
2/7	*	[10] **Notre Dame**	4	Durham, N.C. (Cameron Indoor Stadium)	W 90-60	9,314	1 p.m.	CBS
2/9	*	at Florida State	4	Tallahassee, Fla. (Donald L. Tucker Center)	W 73-70	11,498	7 p.m.	ESPN
2/14	*	at Syracuse	4	Syracuse, N.Y. (Carrier Dome)	W 80-72	35,446	6 p.m.	ESPN
2/18	*	[15] **North Carolina**	4	Durham, N.C. (Cameron Indoor Stadium)	W 92-90 •	9,314	9 p.m.	ESPN/ACCN
2/21	*	**Clemson**	4	Durham, N.C. (Cameron Indoor Stadium)	W 78-56	9,314	4 p.m.	ESPN
2/25	*	at Virginia Tech	4	Blacksburg, Va. (Cassell Coliseum)	W 91-86 •	9,847	9 p.m.	ESPN2
2/28	*	**Syracuse**	4	Durham, N.C. (Cameron Indoor Stadium)	W 73-54	9,314	7 p.m.	ESPN
3/4	*	**Wake Forest**	3	Durham, N.C. (Cameron Indoor Stadium)	W 94-51	9,314	8 p.m.	ACCN
3/7	*	at [19] North Carolina	3	Chapel Hill, N.C. (Dean Dome)	W 84-77	21,750	9 p.m.	ESPN
3/12	$$$	vs. N.C. State	2	Greensboro, N.C. (Greensboro Coliseum)	W 77-53	22,026	7 p.m.	ESPN
3/13	$$$$	vs. [11] Notre Dame	2	Greensboro, N.C. (Greensboro Coliseum)	L 64-74	22,026	9 p.m.	ESPN
3/20	!!	vs. Robert Morris	4	Charlotte, N.C. (Time Warner Cable Arena)	W 85-56	16,945	7 p.m.	CBS
3/22	!!!	vs. San Diego State	4	Charlotte, N.C. (Time Warner Cable Arena)	W 68-49	18,482	2 p.m.	CBS
3/27	!!!!	vs. [19] Utah	4	Houston, Texas (NRG Stadium)	W 63-57	21,168	7:45 p.m.	CBS
3/29	!!!!!	vs. [7] Gonzaga	4	Houston, Texas (NRG Stadium)	W 66-52	20,744	4 p.m.	CBS
4/4	!!!!!!	vs. [23] Michigan State	4	Indianapolis, Ind. (Lucas Oil Stadium)	W 81-61	72,238	6 p.m.	TBS/TNT
4/6	!!!!!!!	vs. [3] Wisconsin	4	Indianapolis, Ind. (Lucas Oil Stadium)	W 68-63	71,149	9:15 p.m.	CBS

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2014-15 Schedule & Results

Date		[Rk] Opponent	Duke Rank	Location (Venue)	Score (OT)	Att.	Tip Time	TV
11/14	~	**Presbyterian**	4	Durham, N.C. (Cameron Indoor Stadium)	W 113-44	9,314	6 p.m.	ESPNU
11/15	~	**Fairfield**	4	Durham, N.C. (Cameron Indoor Stadium)	W 109-59	9,314	8 p.m.	ESPN3
11/18	¶¶	vs. [19] Michigan State	4	Indianapolis, Ind. (Bankers Life Fieldhouse)	W 81-71	19,306	7 p.m.	ESPN
11/21	~	vs. Temple	4	Brooklyn, N.Y. (Barclays Center)	W 74-54	10,135	9:30 p.m.	TruTV
11/22	~	vs. Stanford	1	Brooklyn, N.Y. (Barclays Center)	W 70-59	10,046	9:30 p.m.	TruTV
11/26		**Furman**	1	Durham, N.C. (Cameron Indoor Stadium)	W 93-54	9,314	5 p.m.	ESPNU
11/30		**Army**	4	Durham, N.C. (Cameron Indoor Stadium)	W 93-73	9,314	12 p.m.	ESPNU
12/3	#	at [2] Wisconsin	4	Madison, Wisc. (Kohl Center)	W 80-70	17,279	9:30 p.m.	ESPN
12/15		**Elon**	2	Durham, N.C. (Cameron Indoor Stadium)	W 75-62	9,314	7 p.m.	ESPNU
12/18		vs. Connecticut	2	East Rutherford, N.J. (Izod Center)	W 66-56	16,541	8 p.m.	ESPN
12/29		**Toledo**	2	Durham, N.C. (Cameron Indoor Stadium)	W 86-69	9,314	7 p.m.	ESPN2
12/31		**Wofford**	2	Durham, N.C. (Cameron Indoor Stadium)	W 84-55	9,314	3 p.m.	RSN
1/3	*	**Boston College**	2	Durham, N.C. (Cameron Indoor Stadium)	W 85-62	9,314	4 p.m.	RSN
1/7	*	at Wake Forest	2	Winston-Salem, N.C. (Joel Coliseum)	W 73-65	12,651	9 p.m.	ACCN
1/11	*	at N.C. State	2	Raleigh, N.C. (PNC Arena)	L 75-87	19,500	1:30 p.m.	CBS
1/13	*	**Miami**	4	Durham, N.C. (Cameron Indoor Stadium)	L 74-90	9,314	9 p.m.	ESPNU
1/17	*	at [6] Louisville	4	Louisville, Ky. (KFC Yum! Center)	W 63-52	22,791	12 p.m.	ESPN
1/19	*	**Pittsburgh**	5	Durham, N.C. (Cameron Indoor Stadium)	W 79-65	9,314	7 p.m.	ESPN
1/25		at St. Johns	5	New York, N.Y. (Madison Square Garden)	W 77-68	19,812	2 p.m.	FOX
1/28	*	at [8] Notre Dame	4	Notre Dame, Ind. (Joyce Center)	L 73-77	9,149	7:30 p.m.	ESPN2
1/31	*	at [2] Virginia	4	Charlottesville, Va. (John Paul Jones Arena)	W 69-63	14,593	7 p.m.	ESPN
2/4	*	**Georgia Tech**	4	Durham, N.C. (Cameron Indoor Stadium)	W 72-66	9,314	7 p.m.	ESPN2
2/7	*	[10] **Notre Dame**	4	Durham, N.C. (Cameron Indoor Stadium)	W 90-60	9,314	1 p.m.	CBS
2/9	*	at Florida State	4	Tallahassee, Fla. (Donald L. Tucker Center)	W 73-70	11,498	7 p.m.	ESPN
2/14	*	at Syracuse	1	Syracuse, N.Y. (Carrier Dome)	W 80-72	35,446	6 p.m.	ESPN
2/18	*	[15] **North Carolina**	1	Durham, N.C. (Cameron Indoor Stadium)	W 92-90 •	9,314	9 p.m.	ESPN/ACCN
2/21	*	**Clemson**	4	Durham, N.C. (Cameron Indoor Stadium)	W 78-56	9,314	4 p.m.	ESPN
2/25	*	at Virginia Tech	4	Blacksburg, Va. (Cassell Coliseum)	W 91-86 •	9,847	9 p.m.	ESPN2
2/28	*	**Syracuse**	4	Durham, N.C. (Cameron Indoor Stadium)	W 73-54	9,314	7 p.m.	ESPN
3/4	*	**Wake Forest**	3	Durham, N.C. (Cameron Indoor Stadium)	W 94-51	9,314	8 p.m.	ACCN
3/7	*	at [19] North Carolina	3	Chapel Hill, N.C. (Dean Dome)	W 84-77	21,750	9 p.m.	ESPN
3/12	$$$	vs. N.C. State	2	Greensboro, N.C. (Greensboro Coliseum)	W 77-53	22,026	7 p.m.	ESPN
3/13	$$$$	vs. [11] Notre Dame	2	Greensboro, N.C. (Greensboro Coliseum)	L 64-74	22,026	9 p.m.	ESPN
3/20	!!	vs. Robert Morris	4	Charlotte, N.C. (Time Warner Cable Arena)	W 85-56	16,945	7 p.m.	CBS
3/22	!!!	vs. San Diego State	4	Charlotte, N.C. (Time Warner Cable Arena)	W 68-49	18,482	2 p.m.	CBS
3/27	!!!!	vs. [19] Utah	4	Houston, Texas (NRG Stadium)	W 63-57	21,168	7:45 p.m.	CBS
3/29	!!!!!	vs. [7] Gonzaga	4	Houston, Texas (NRG Stadium)	W 66-52	20,744	4 p.m.	CBS
4/4	!!!!!!	vs. [23] Michigan State	1	Indianapolis, Ind. (Lucas Oil Stadium)	W 81-61	72,238	6 p.m.	TBS/TNT
4/6	!!!!!!!	vs. [3] Wisconsin	1	Indianapolis, Ind. (Lucas Oil Stadium)	W 68-63	71,149	9:15 p.m.	CBS

paste

	A	B	C	D	E	F	G	H	I	J
3	Date		[16] Opponent	Rank	Location (Qty.)	Result (OT)	Pts.	Att.	TV	
4	14-Nov	-	**Presbyterian**	4	Durham, N.C. (C	W	113-44	9,314	6 p.m.	ESPNU
5	15-Nov	~	**Fairfield**	4	Durham, N.C. (C	W	109-59	9,314	8 p.m.	ESPN3
6	18-Nov	¶¶	vs. [19] Michiga	4	Indianapolis, In	W	81-71	19,306	7 p.m.	ESPN
7	21-Nov	~	vs. Temple	4	Brooklyn, N.Y.	W	74-54	10,135	9:30 p.m.	TruTV
8	22-Nov	~	vs. Stanford	4	Brooklyn, N.Y.	W	70-59	10,046	9:30 p.m.	TruTV
9	26-Nov		**Furman**	4	Durham, N.C. (C	W	93-54	9,314	5 p.m.	ESPNU
10	30-Nov		**Army**				93-72	9,314	12 p.m.	ESPNU
11	3-Dec	#	at [2] Wisconsin					17,279	9:30 p.m.	ESPN
12	15-Dec		**Elon**					9,314	7 p.m.	ESPNU
13	18-Dec		vs. Connecticu					16,541	8 p.m.	ESPN
14	29-Dec		**Toledo**					,314	7 p.m.	ESPN2
15	31-Dec		**Wofford**					14	3 p.m.	RSN
16	3-Jan	*	**Boston**					4	4 p.m.	RSN
17	7-Jan	*	at Wal					1	9 p.m.	ACCN
18	11-Jan	*	at N.C						1:30 p.m.	CBS
19	13 Jan	*	**Mian**						9 p.m.	ESPNU
20	17-Jan	*	at [6]						12 p.m.	ESPN
21	19-Jan	*	**Pittsbu**						7 p.m.	ESPN
22	25-Jan		at St. Jo					12	2 p.m.	FOX
23	28-Jan	*	at [8] Notr					149	7:30 p.m.	ESPN2
24	31 Jan	*	at [2] Virgi					4,593	7 p.m.	ESPN
25	4-Feb	*	**Georgia Tec**					9,314	7 p.m.	ESPN2
26	7-Feb	*	[10] **Notre D**					9,314	1 p.m.	CBS
27	9-Feb	*	at Florida Sta					11,498	7 p.m.	ESPN
28	14-Feb	*	at Syracuse					35,446	6 p.m.	ESPN
29	18 Feb	*	[15] **North**		Du			9,314	9 p.m.	ESPN/ACCN
30	21-Feb	*	**Clemson**		Durham, N.C. (C	W		9,314	4 p.m.	ESPN
31	25-Feb	*	at Virginia Tech	4	Blacksburg, Va.	W	91-56 •	9,847	9 p.m.	ESPN2
32	28-Feb	*	**Syracuse**	4	Durham, N.C. (C	W	73-54	9,314	7 p.m.	ESPN
33	4-Mar	*	**Wake Forest**	3	Durham, N.C. (C	W	94-51	9,314	8 p.m.	ACCN
34	7-Mar	*	at [19] North Ca	3	Chapel Hill, N.C	W	84-77	21,750	9 p.m.	ESPN
35	12-Mar	$$$	vs. N.C. State	2	Greensboro, N.C	W	77-53	22,026	7 p.m.	ESPN
36	13-Mar	$$$$	vs. [11] Notre D	2	Greensboro, N.C	L	64-74	22,026	9 p.m.	ESPN
37	20-Mar	!!	vs. Robert Morr	4	Charlotte, N.C. (	W	85-56	15,945	7 p.m.	CBS
38	22-Mar	!!!	vs. San Diego St	4	Charlotte, N.C. (	W	68-49	18,482	2 p.m.	CBS
39	27-Mar	!!!!	vs. [19] Utah	4	Houston, Texas	W	63-57	21,168	7:45 p.m.	CBS
40	29-Mar	!!!!!	vs. [7] Gonzaga	4	Houston, Texas	W	66-52	20,744	4 p.m.	CBS
41	4-Apr	!!!!!!	vs. [23] Michiga	4	Indianapolis, In	W	81-61	72,238	6 p.m.	TBS/TNT
42	6-Apr	!!!!!!	vs. [3] Wisconsi	4	Indianapolis, In	W	68-63	71,149	9:15 p.m.	CBS

scrape

```
# Load packages ------------------------------------------------
library(rvest)
library(stringr)
library(dplyr)

# Read page with season data -----------------------------------
page <- read_html("http://goduke.statsgeek.com/basketball-m/seasons/schedule.php?season=2014-15")

# Harvest fields -----------------------------------------------
date <- page %>%
  html_nodes(".stattextline b") %>%
  html_text()

opponent <- page %>%
  html_nodes(".stattextltgray2:nth-child(3)") %>%
  html_text() %>%
  str_trim()

venue <- page %>%
  html_nodes(".stattextltgray2:nth-child(5)") %>%
  html_text() %>%
  str_trim()

# Put fields into a tibble -------------------------------------
blue_devils_1415 <- data_frame(date, opponent, venue)
```

voila!

blue_devils_1415

Filter

	date	opponent	venue
1	11/14	Presbyterian	Durham, N.C. (Cameron Indoor Stadium)
2	11/15	Fairfield	Durham, N.C. (Cameron Indoor Stadium)
3	11/18	vs. [19] Michigan State	Indianapolis, Ind. (Bankers Life Fieldhouse)
4	11/21	vs. Temple	Brooklyn, N.Y. (Barclays Center)
5	11/22	vs. Stanford	Brooklyn, N.Y. (Barclays Center)
6	11/26	Furman	Durham, N.C. (Cameron Indoor Stadium)
7	11/30	Army	Durham, N.C. (Cameron Indoor Stadium)
8	12/3	at [2] Wisconsin	Madison, Wisc. (Kohl Center)
9	12/15	Elon	Durham, N.C. (Cameron Indoor Stadium)
10	12/18	vs. Connecticut	East Rutherford, N.J. (Izod Center)
11	12/29	Toledo	Durham, N.C. (Cameron Indoor Stadium)
12	12/31	Wofford	Durham, N.C. (Cameron Indoor Stadium)

Showing 1 to 13 of 39 entries

best laid plans…

Mine CetinkayaRundel
@minebocek

Students upset b/c website they need to scrape data from for hw assignment is down. Bad assignment or good lesson in working w/ real data?

RETWEET 1 LIKES 10

9:48 AM - 26 Nov 2015

#3 interactivity

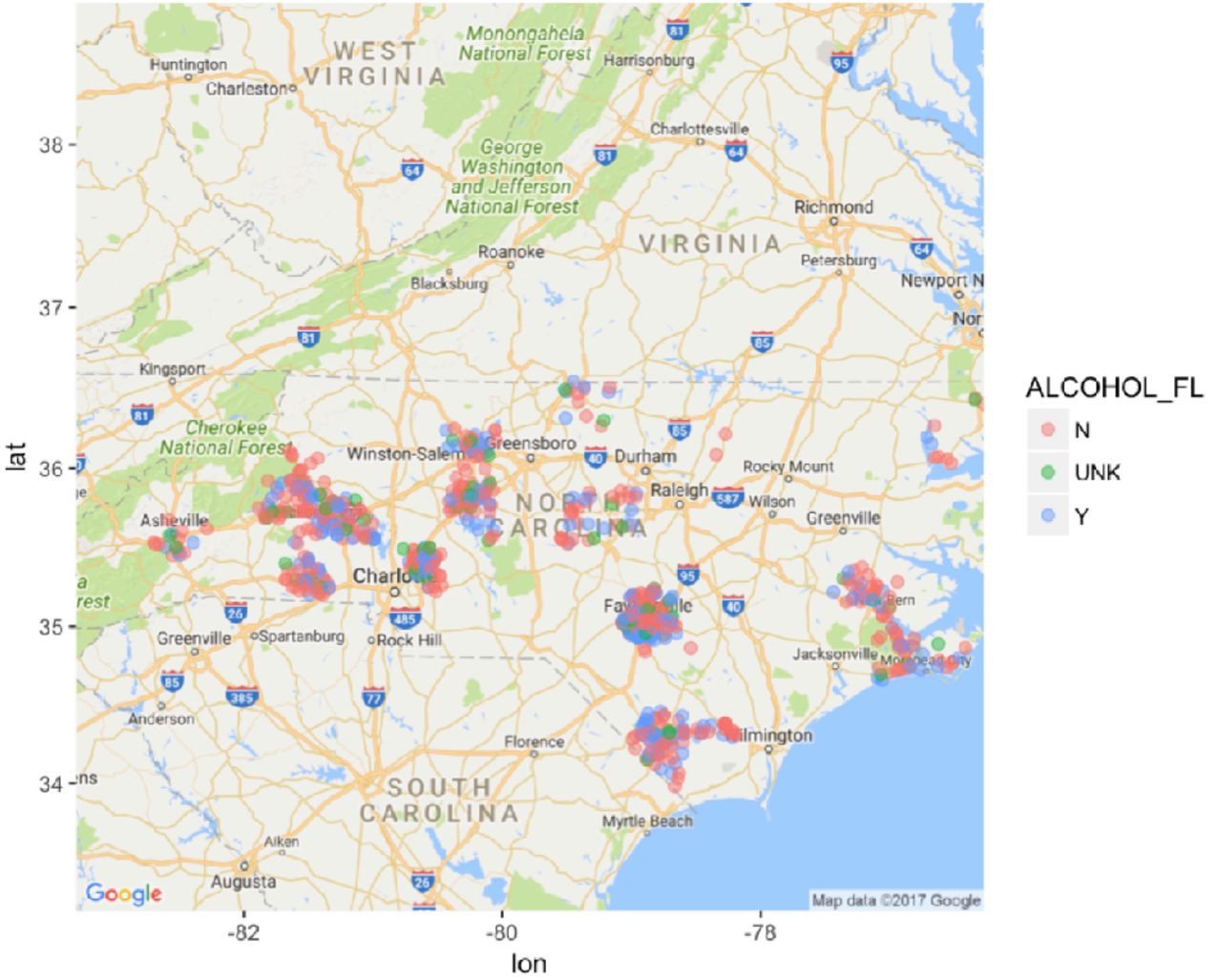
```
> library(shiny)
```

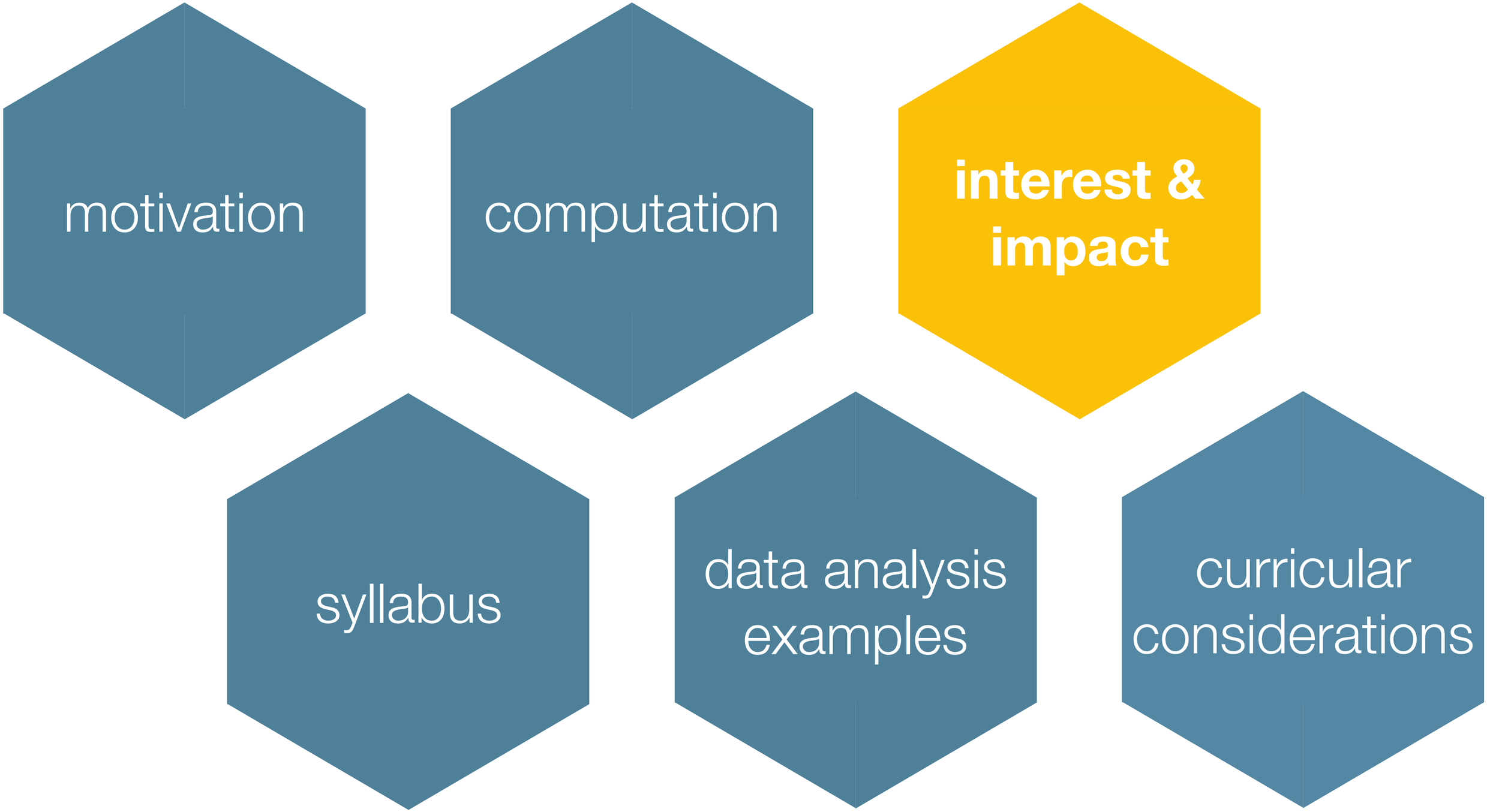
Modeling the Distributions of Fatal Car Crashes

Select categorical variable

alcohol involved

- crash type
- alcohol involved
- teen driver
- older driver
- direction




motivation
computation
interest & impact
syllabus
data analysis examples
curricular considerations

interest

duke focus:

first-year undergrads modeling cluster: “What if? Explaining the Past, Predicting the Future”

interest in What If:

no hard data, but “definitely significant increase in applications the last two years than previous years”

interest in DS:

% of
What If applicants interested in DS
2015: 76%
2016: 83%

impact

pipeline for stats:

2014: 19% declared
2015: 31% declared
2016: ~40%
expressed interest

diversity:

% female
2014: 44%
2015: 50%
2016: 35%

~25% in Probability

curricular:

basis for
gateway to stats
major course
to be offered in
Spring 2018!


motivation
computation
interest & impact
syllabus
data analysis examples
curricular considerations

curricular considerations

move away from ad-hoc computing education and/or expecting students to pick it up along the way

uniformity of tools is important: choose a toolkit that works for you and stick to it throughout the curriculum

teach computing early (without any prereqs) and often!

@minebocek
mine-cetinkaya-rundel
mine@stat.duke.edu

bit.ly/user2017