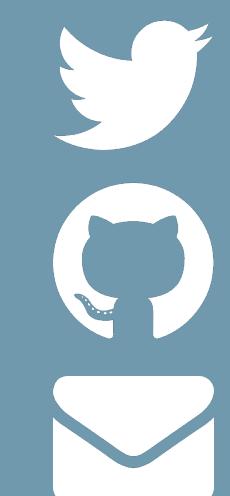


# a first-year undergraduate data science course

Slides at <http://bit.ly/first-ds>



@minebocek

mine-cetinkaya-rundel

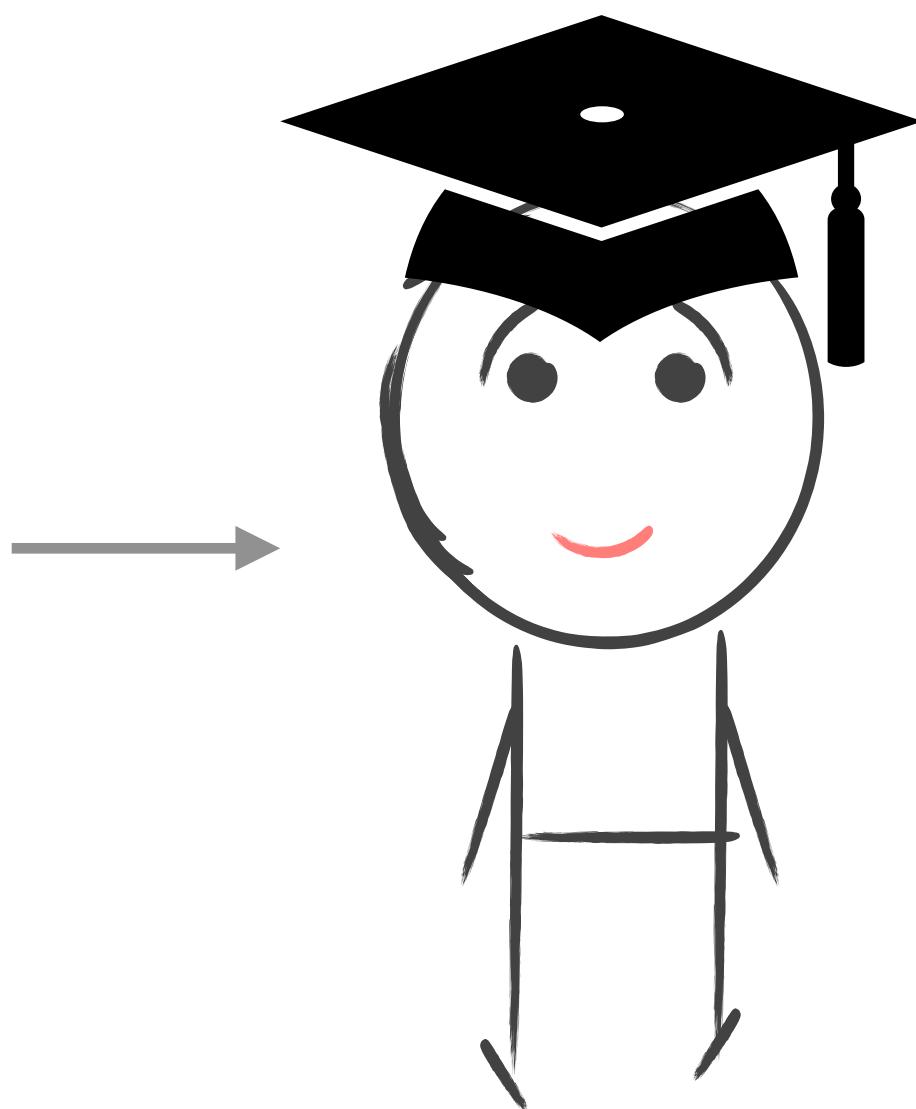
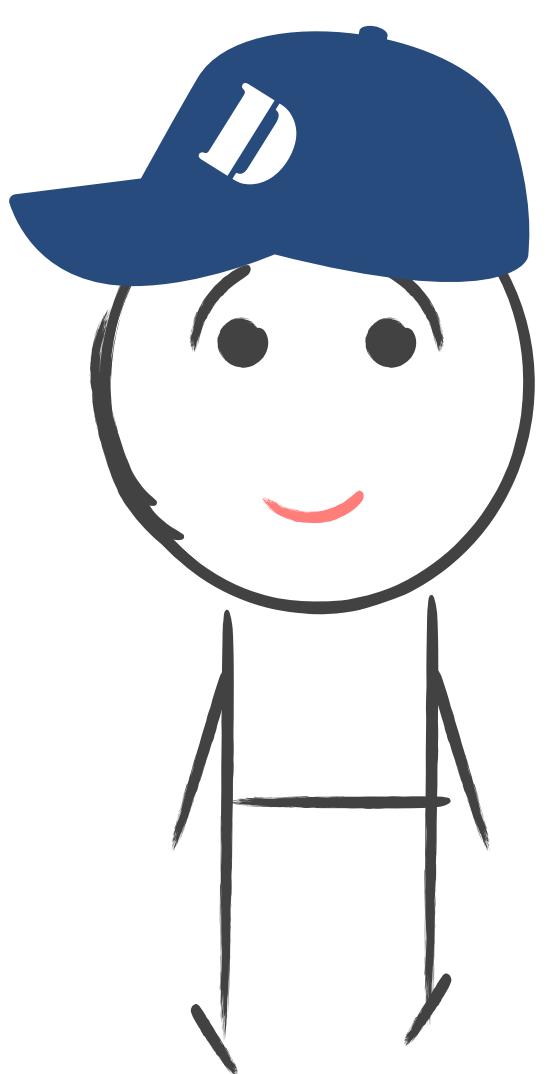
mine@stat.duke.edu

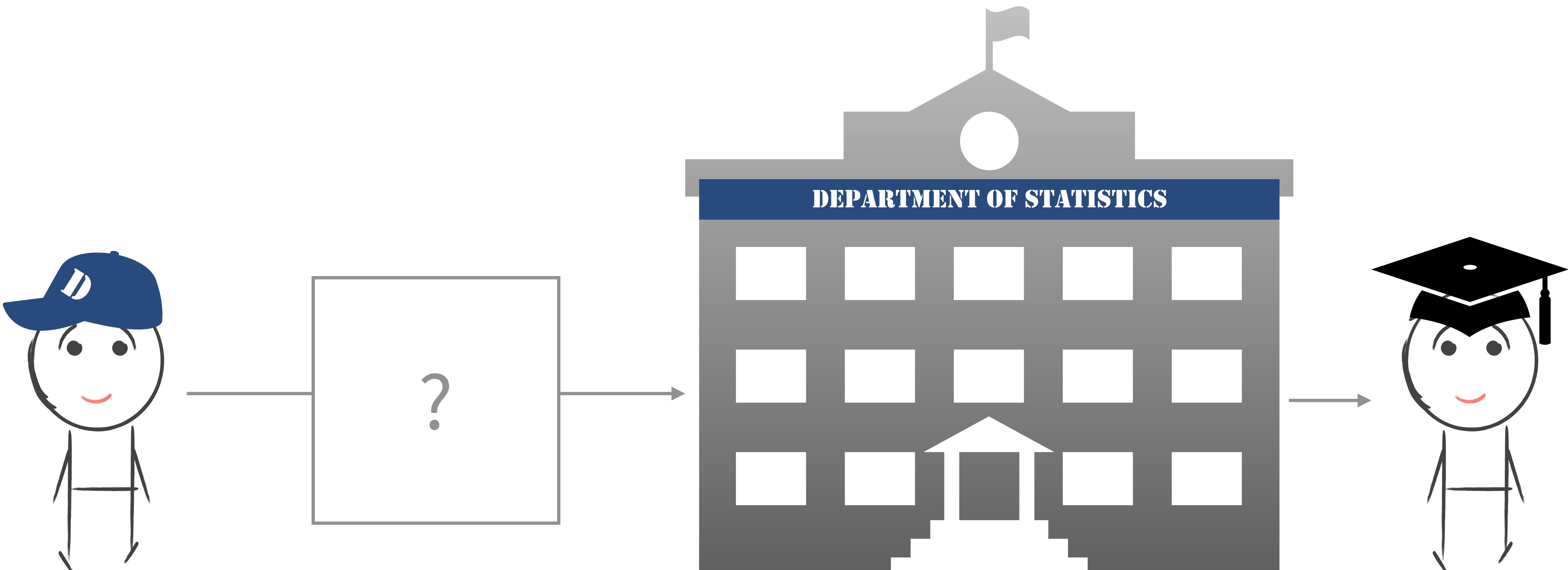
mine çetinkaya-rundel

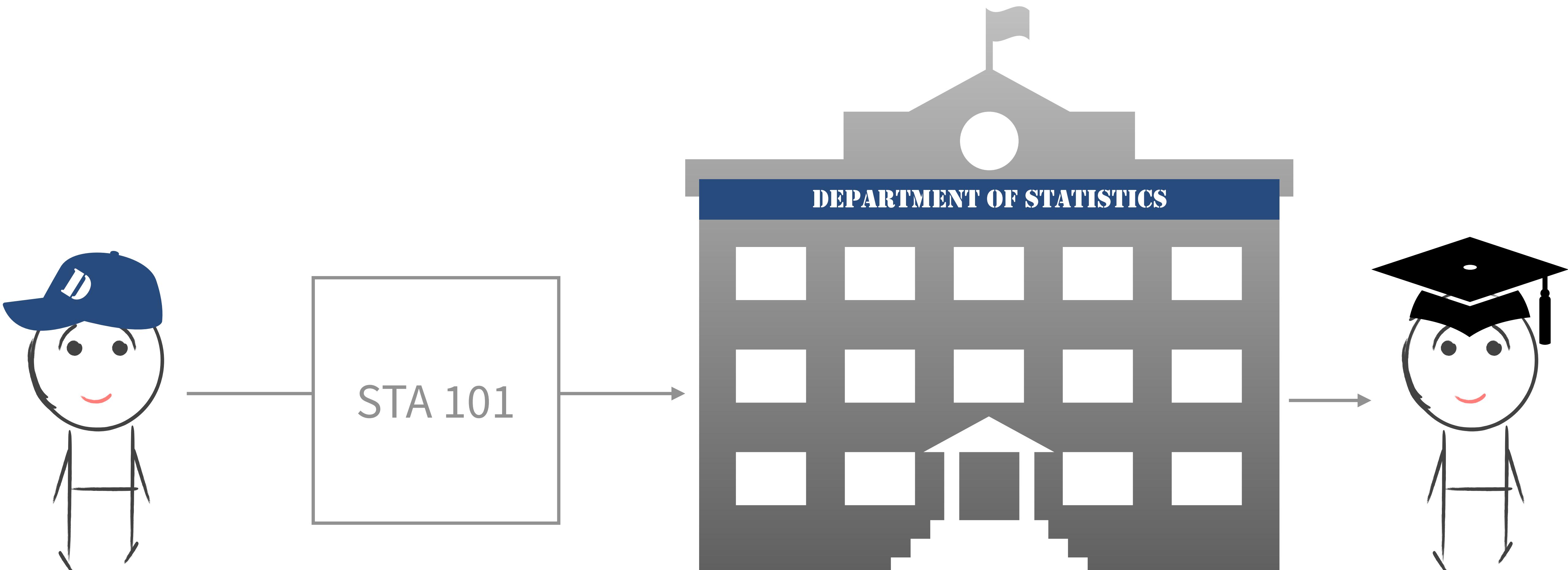
Duke  
UNIVERSITY

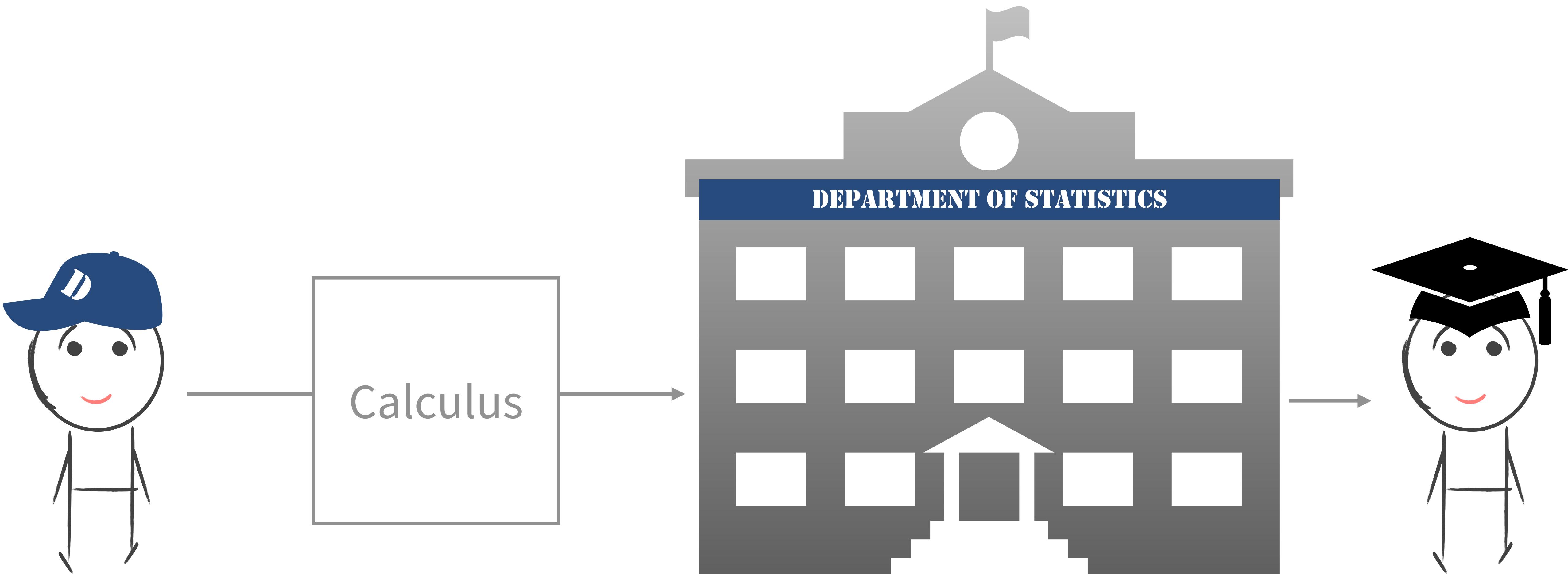
R Studio

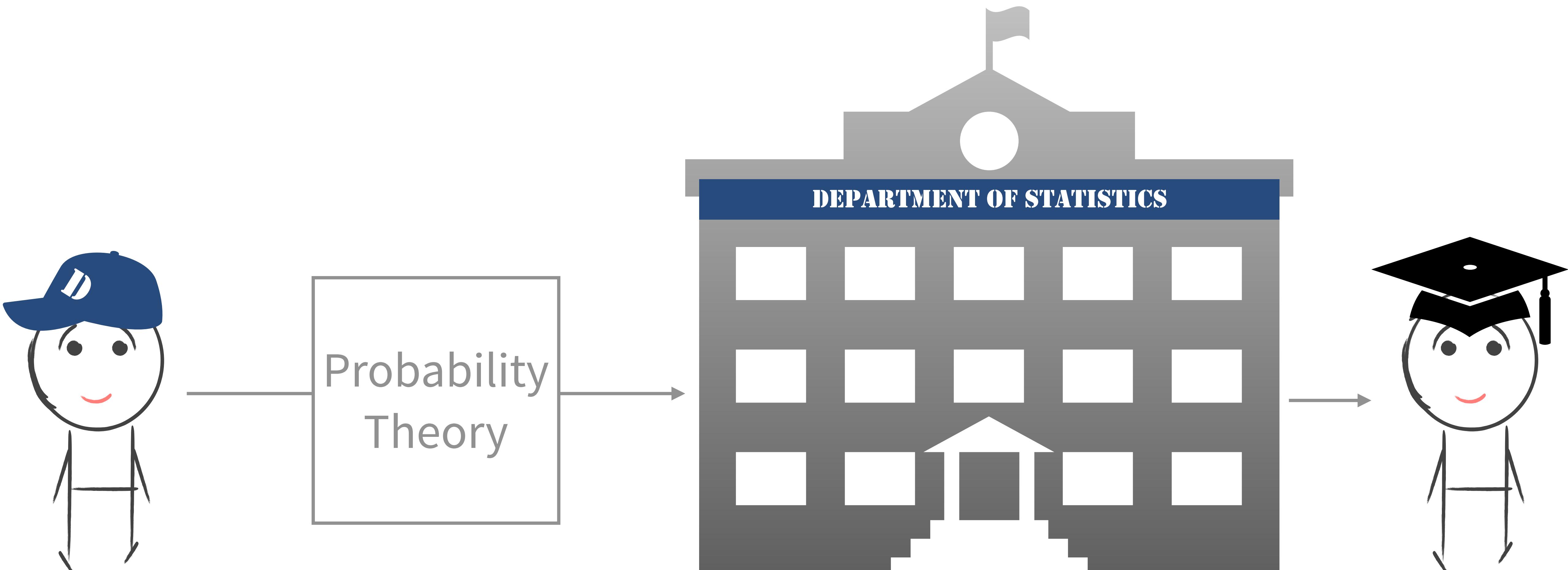


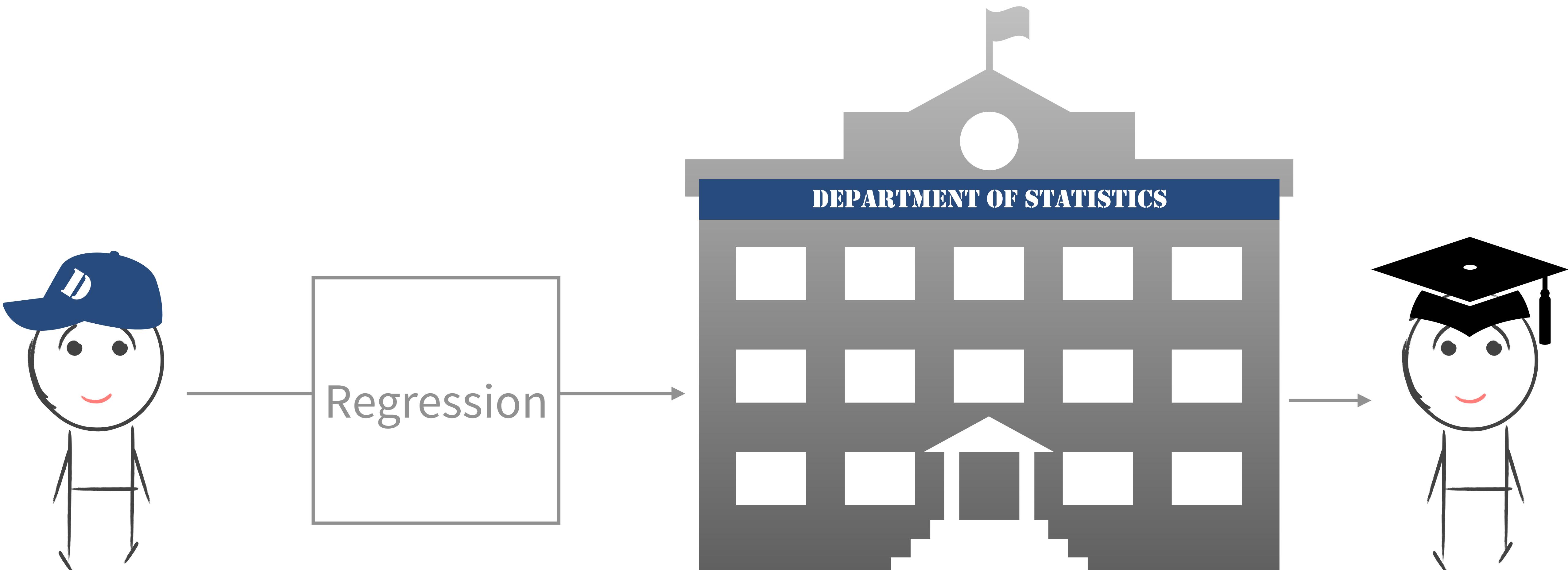


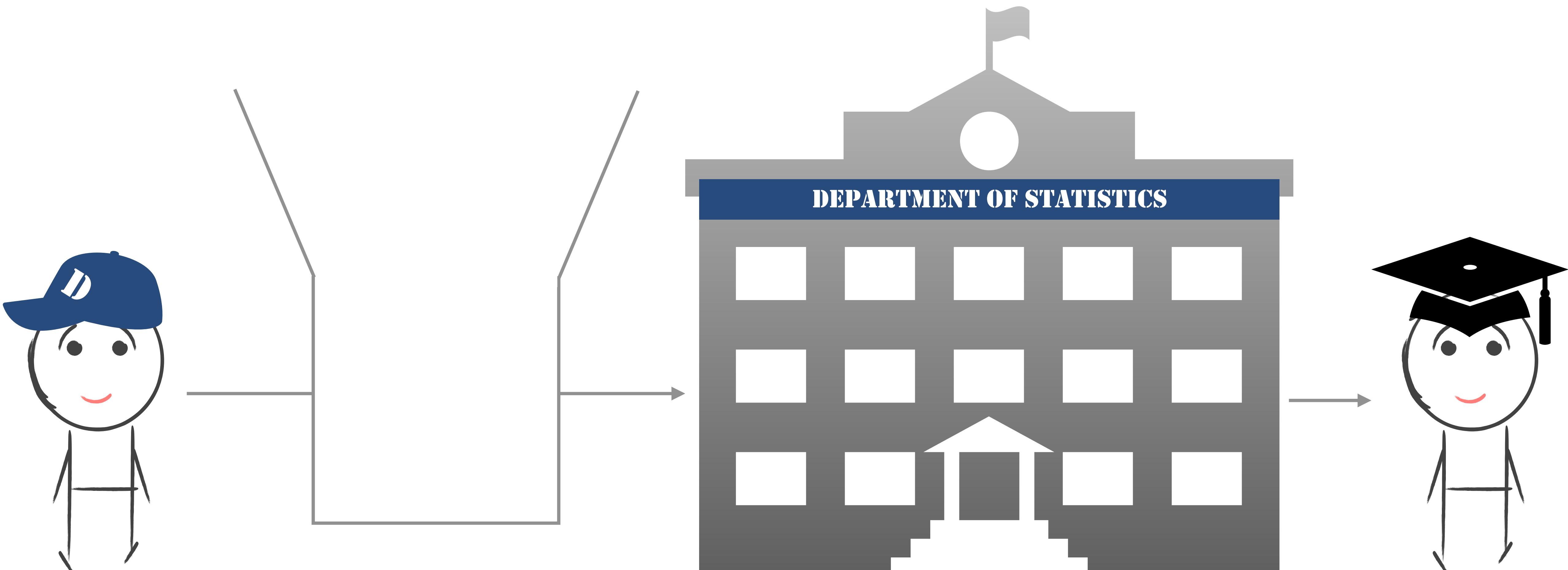


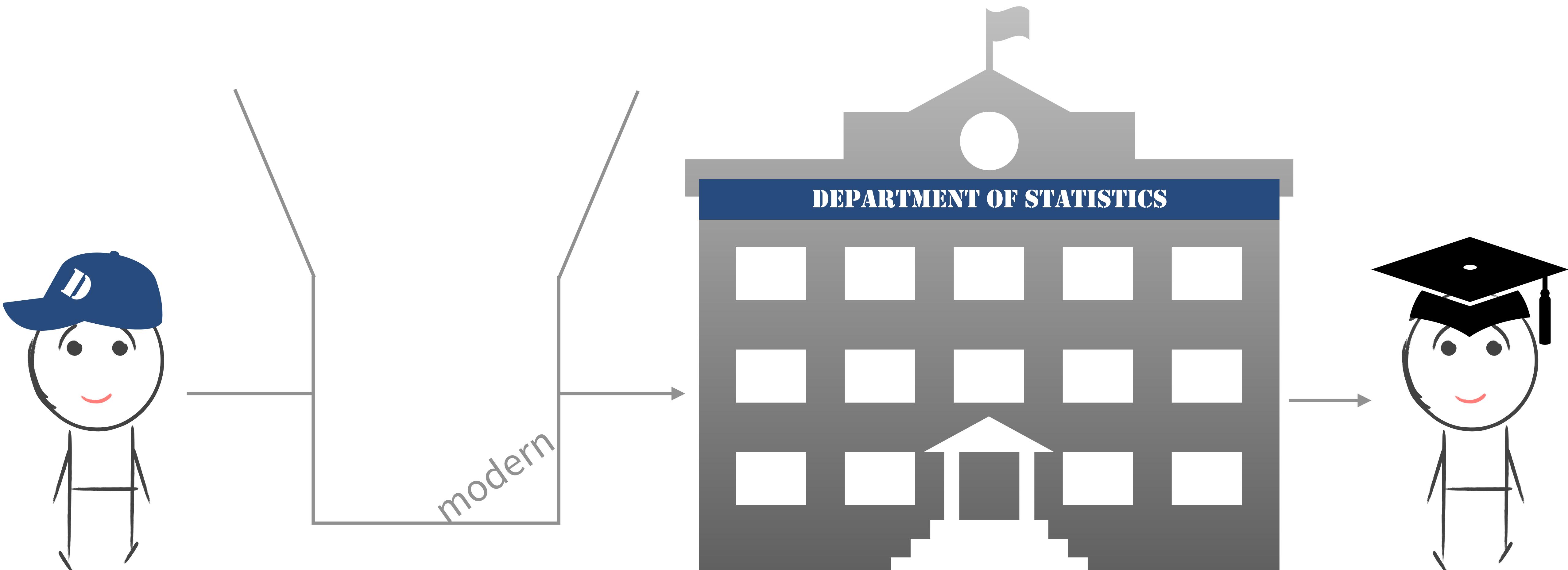


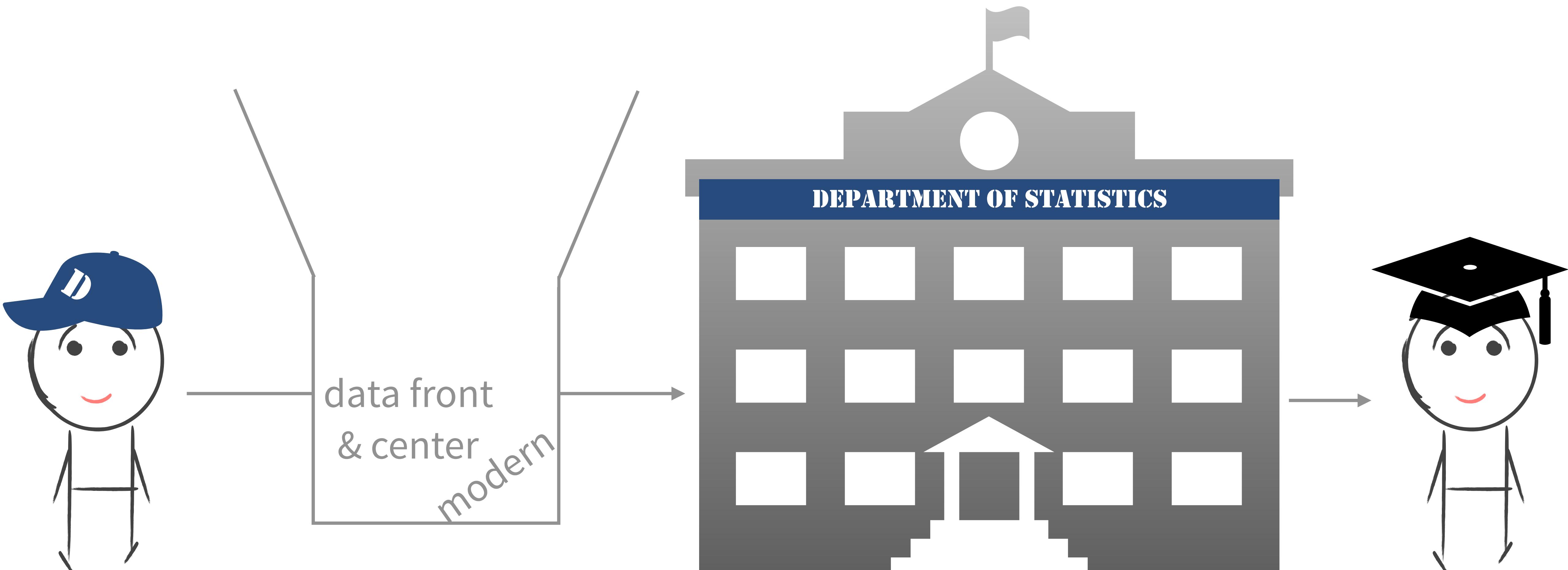


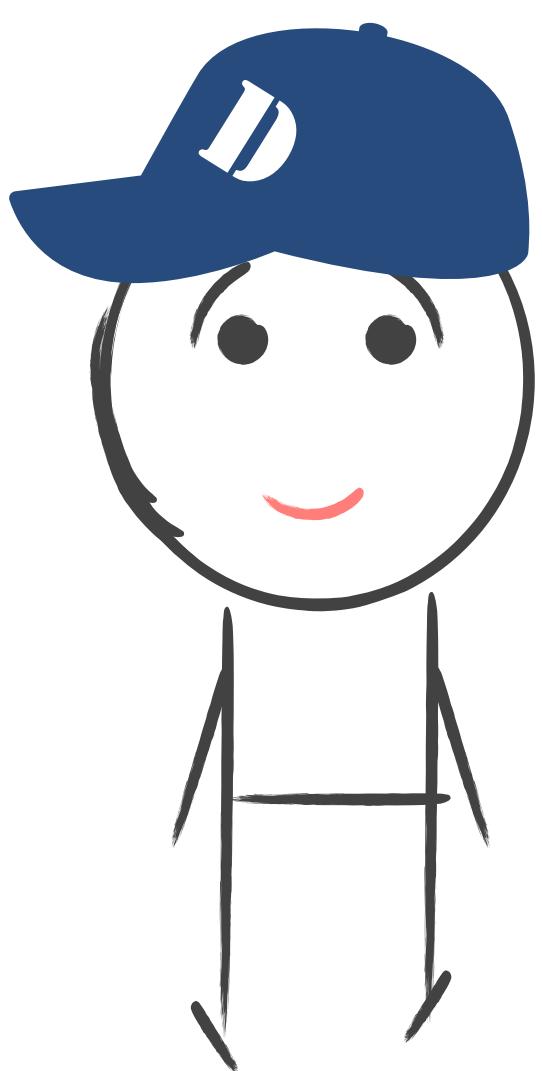








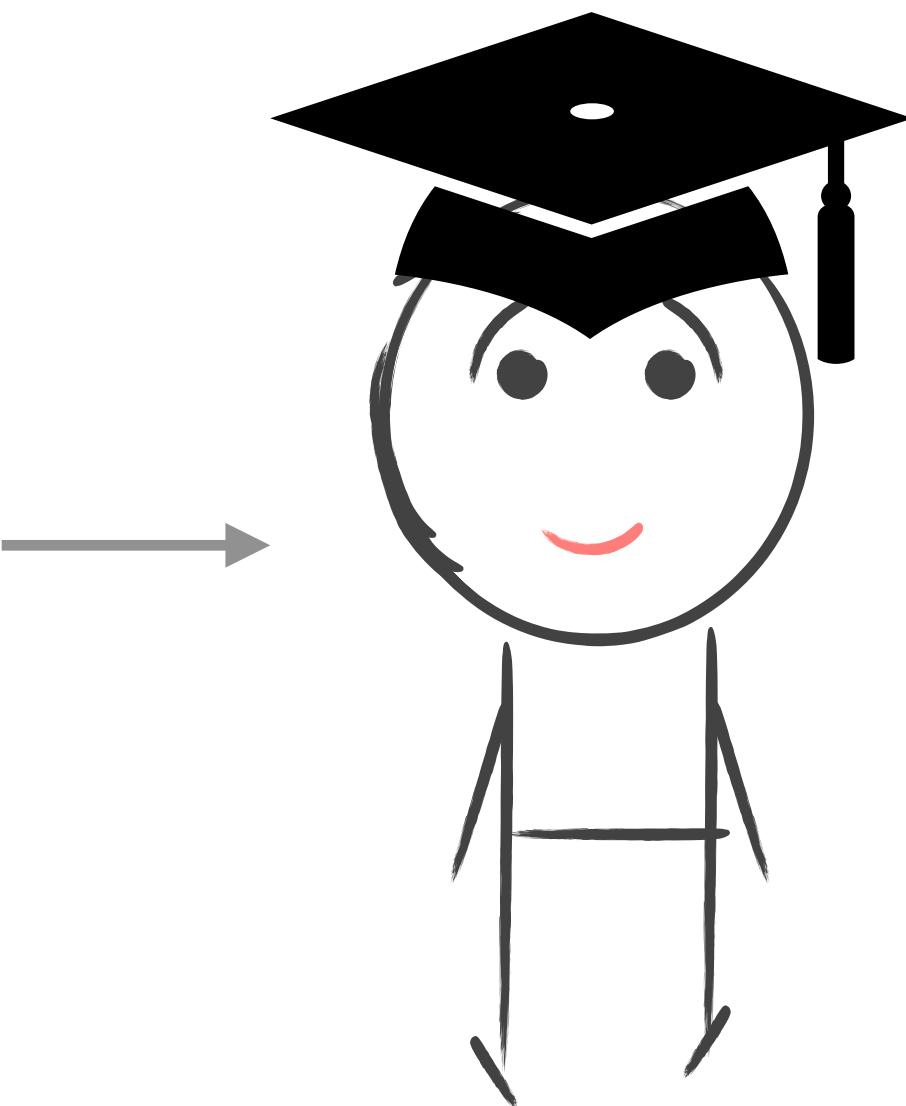


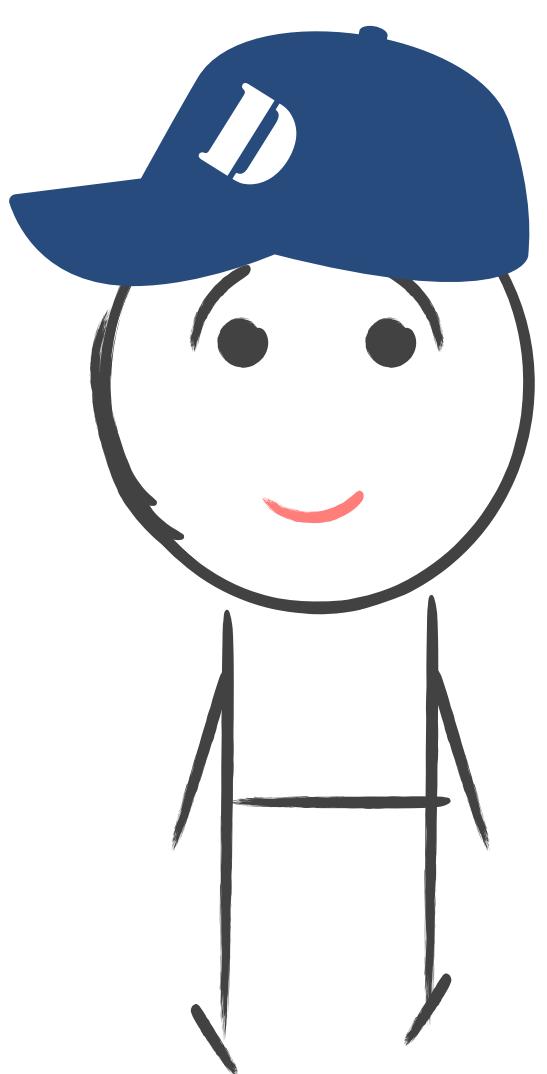


*quantitative  
(but not mathematical)*

data front  
& center

modern



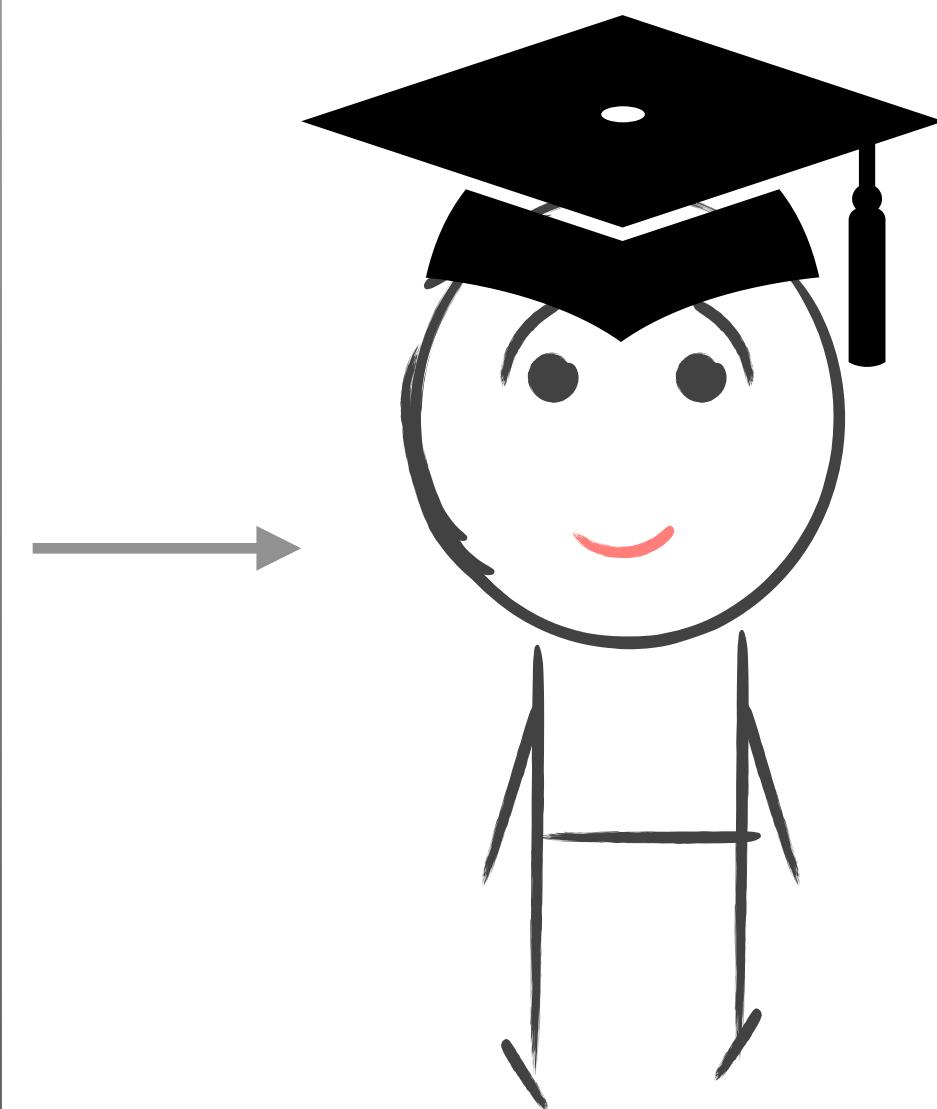


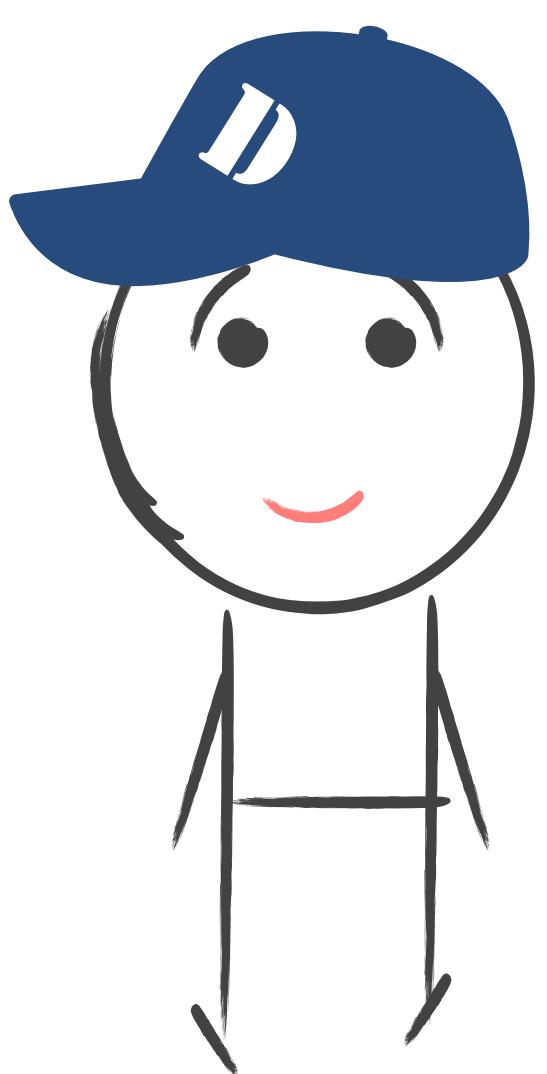
different than  
HS stats

quantitative  
(but not mathematical)

data front  
& center

modern





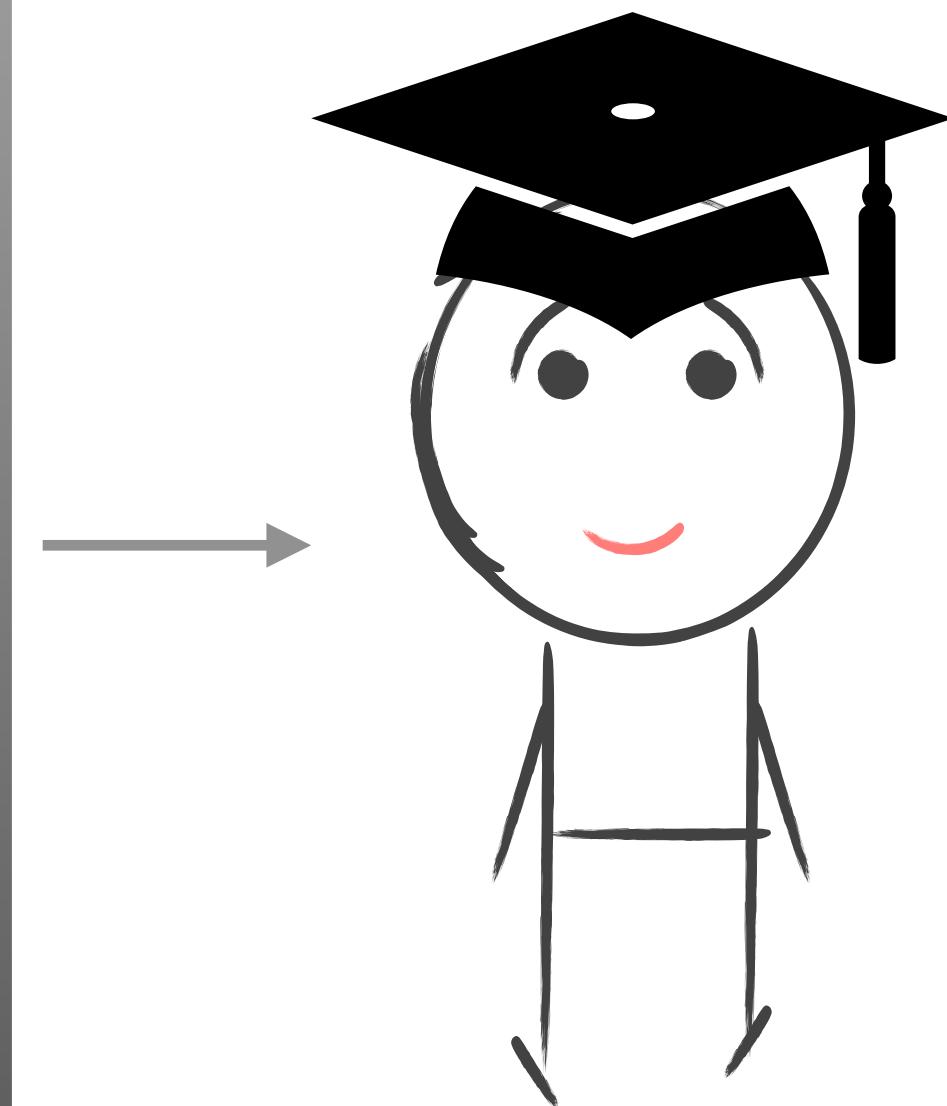
challenging  
(but not intimidating)

different than  
HS stats

quantitative  
(but not mathematical)

data front  
& center

modern



this course should...

this course should...

emphasize modern  
and multivariate  
EDA + data  
visualization

# this course should...

emphasize modern  
and multivariate  
EDA + data  
visualization

teach  
(not just expect)  
reproducible  
computation

# this course should...:

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visualization

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

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from a model  
based perspective

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enforce working  
collaboratively  
(think, code, write,  
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teach  
(not just expect)  
reproducible  
computation

approach statistics  
from a model  
based perspective

underscore  
effective  
communication  
of findings

**and maybe more importantly...**

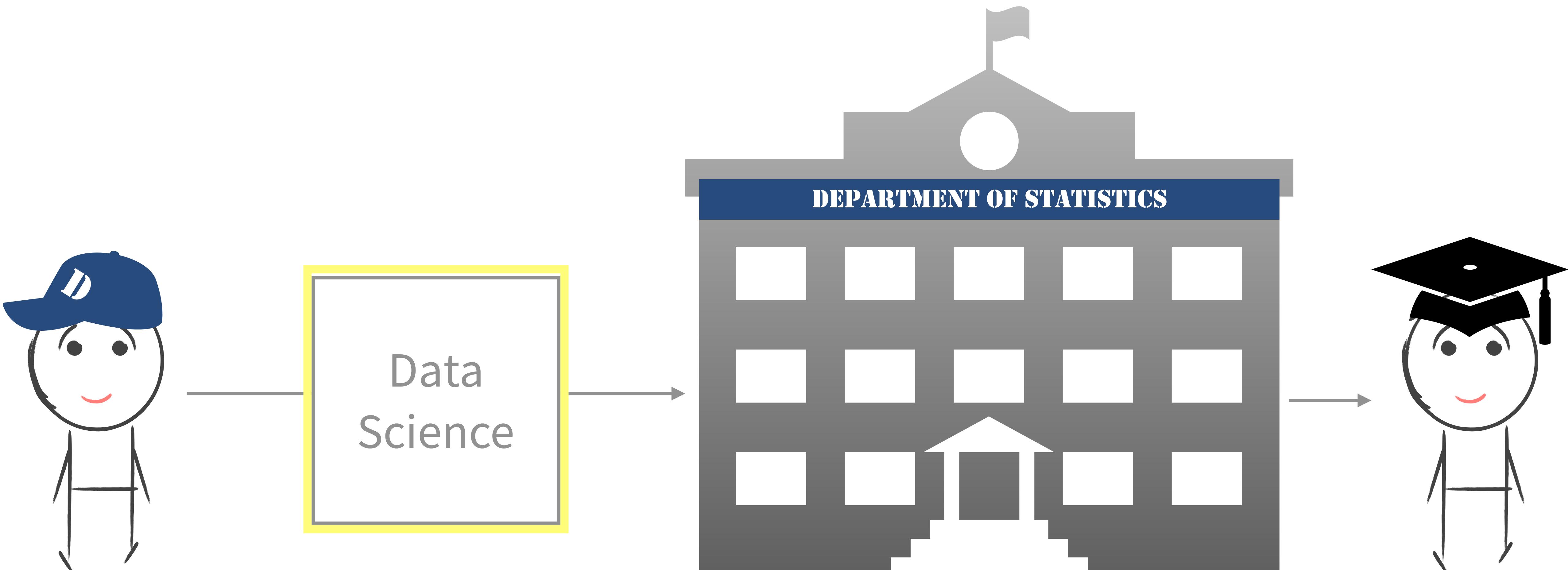
**and maybe more importantly...**

ask questions that  
students want to  
answer

**and maybe more importantly...**

ask questions that  
students want to  
answer

equip students  
with the tools to  
answer questions  
of their own  
choosing



outline

syllabus

computation

examples

interest

curriculum

syllabus

computation

examples

interest

curriculum

# course overview

## curriculum:

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

# course overview

## **curriculum:**

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

## **structure:**

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

# course overview

## curriculum:

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

## structure:

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

## assessment:

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

syllabus

computation

examples

interest

curriculum

core

**what:**

R + RStudio server

**what:**

R + RStudio server

**why:**  
minimize  
onboarding  
friction  
and time to 1st  
data viz

ex: start up instructions

# Local install

vs.

# RStudio Server

## # 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

## # Local install

- Install R: <https://cran.r-project.org/>
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  - knitr
  - tidyverse
  - ...
- Load these packages

vs.

## # RStudio Server

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

# data analysis toolkit

# data analysis toolkit

**what:**  
(mostly)  
tidyverse

# data analysis toolkit

**what:**  
(mostly)  
tidyverse

**why:**  
(closer to) human  
readable,  
consistent syntax,  
easy multivariate  
visualizations

## ex: recoding a binary variable

# base R

vs. # tidyverse

# base R

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

vs.

# tidyverse

# base R

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

vs.

# tidyverse

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

# base R

vs. # tidyverse

# base R

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

)
```

vs. # tidyverse

# 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"))
```

# ex: visualizing multiple variables

# base R

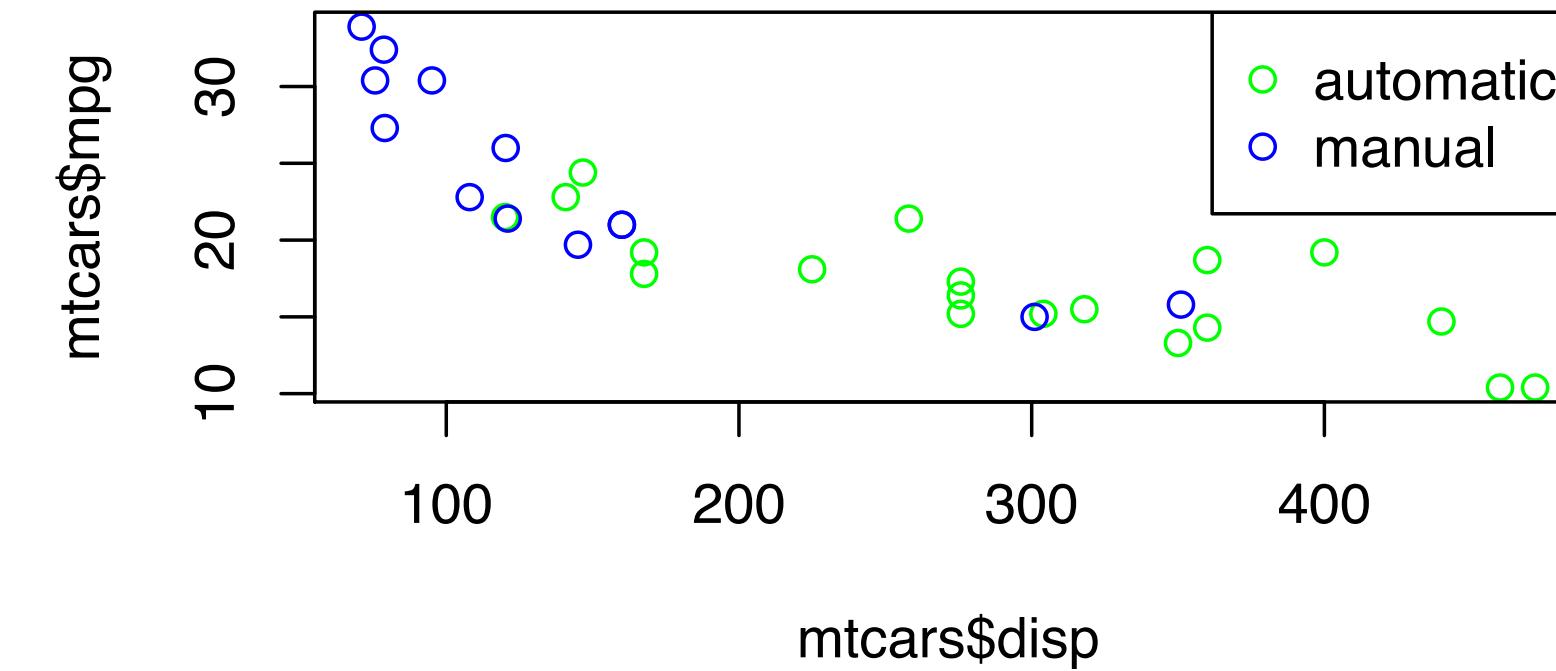
vs. # tidyverse

# ex: 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"))
```

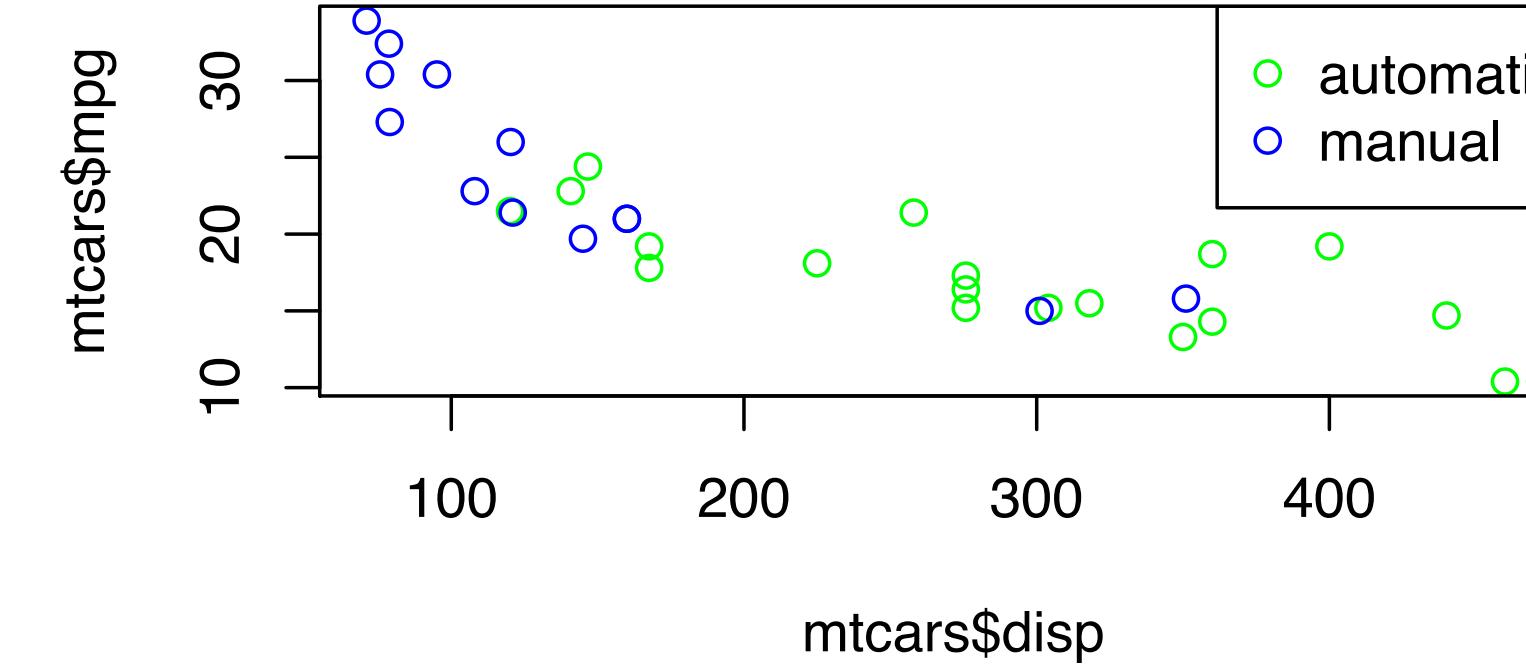
vs. # tidyverse



# ex: visualizing multiple variables

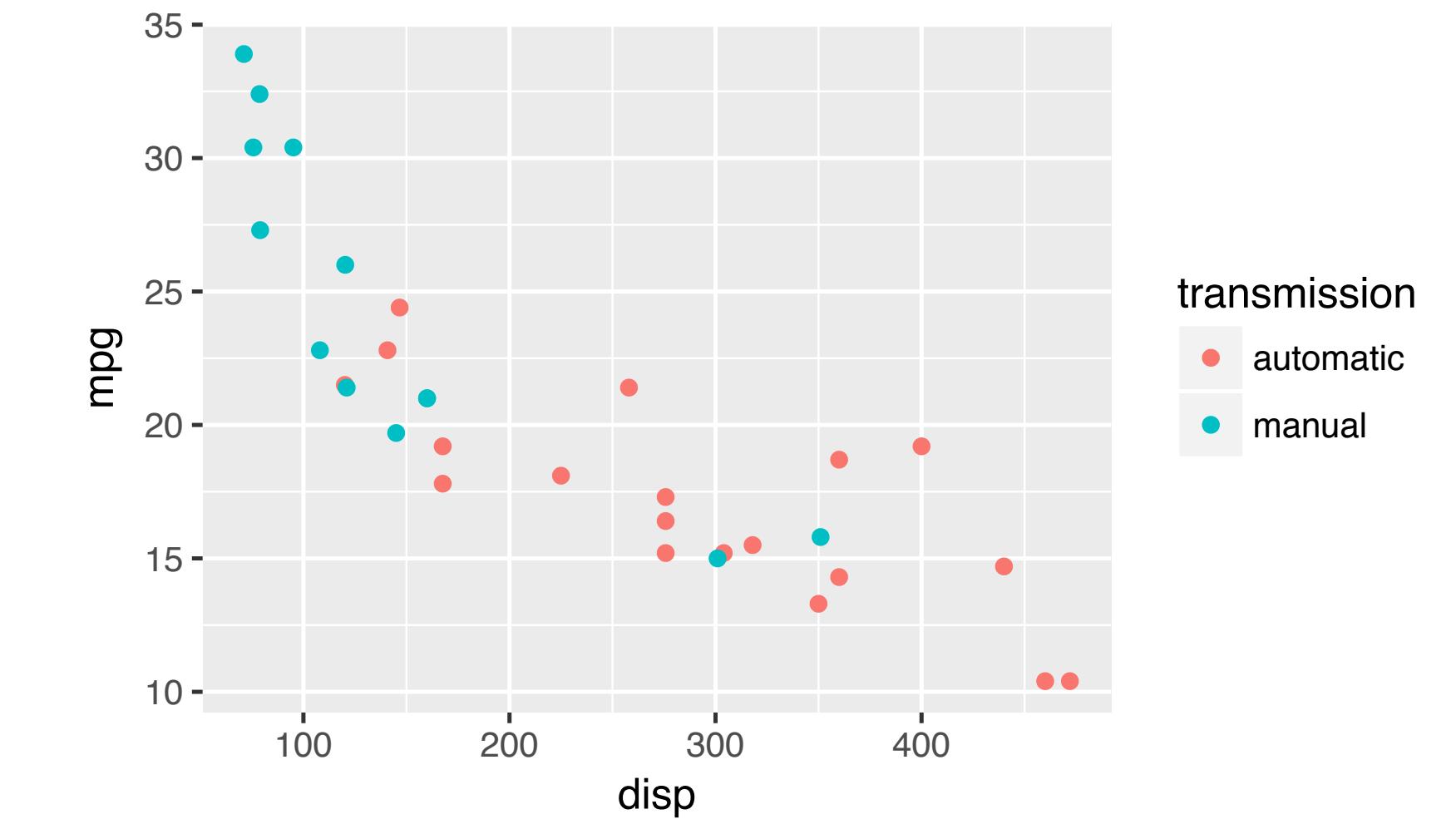
```
# base R
```

```
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()
```



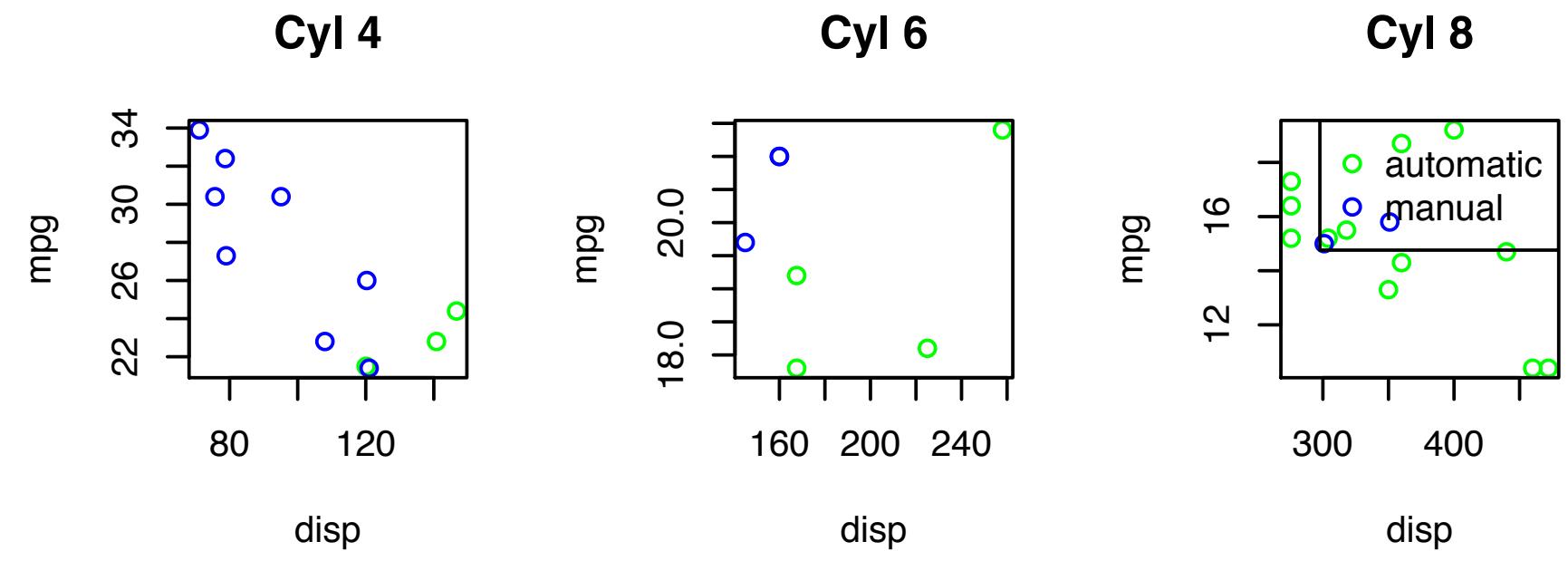
# base R

vs. # tidyverse

# 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"))
```



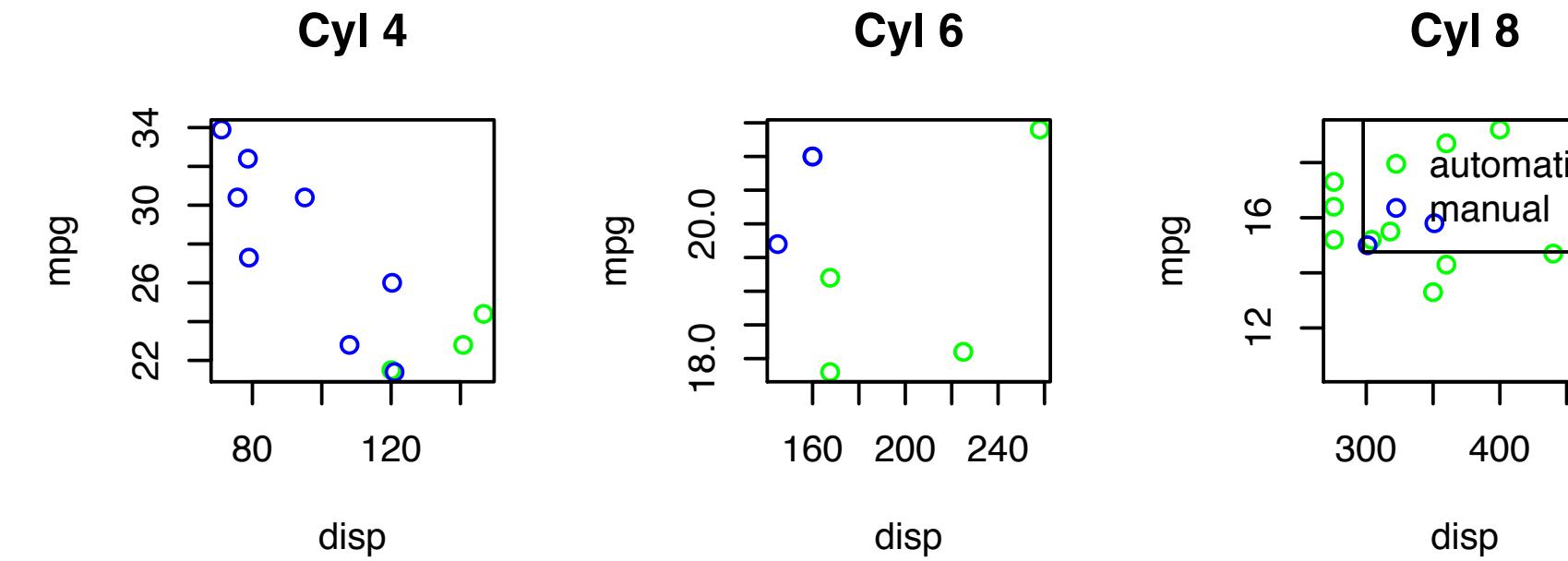
vs. # tidyverse

# ex: visualizing even more variables

# base R

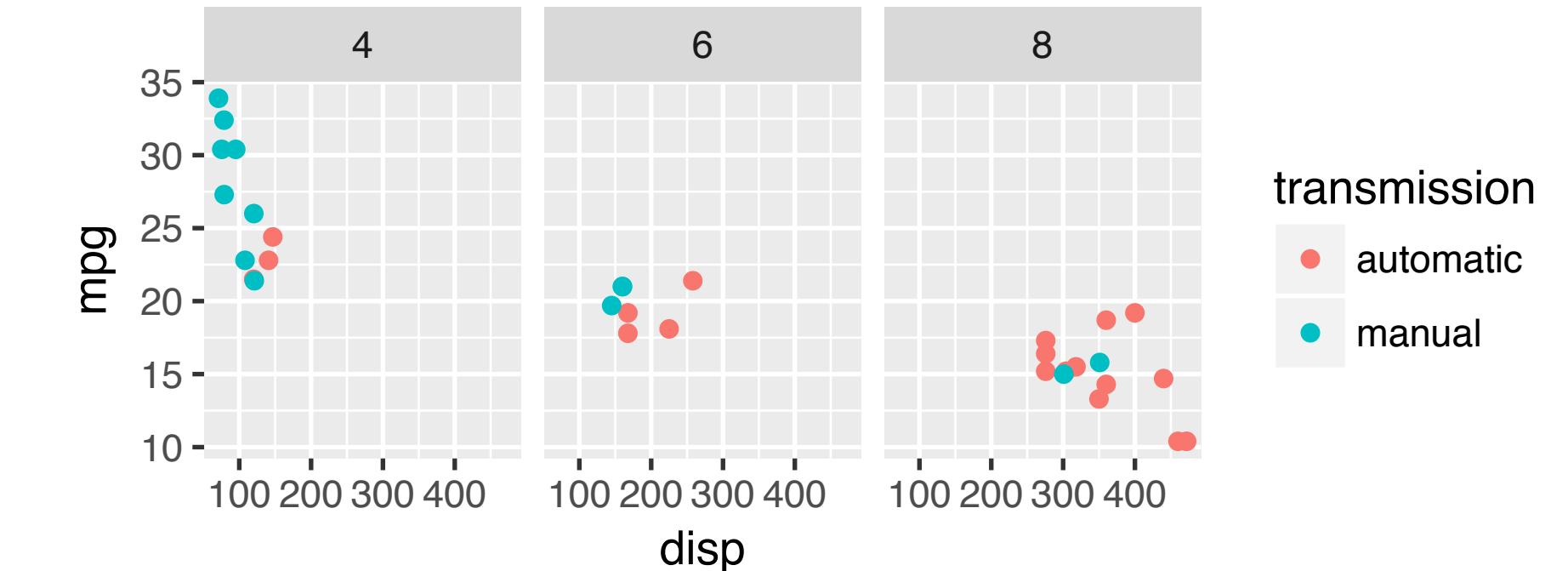
```
mtcars_cyl4 = mtcars[mtcars$cyl == 4, ]
mtcars_cyl6 = mtcars[mtcars$cyl == 6, ]
mtcars_cyl8 = mtcars[mtcars$cyl == 8, ]

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)
```



# reproducibility

# reproducibility

**what:**

R Markdown +  
Git / GitHub

# reproducibility

**what:**

R Markdown +  
Git / GitHub

**why:**

train new analysts  
whose only  
workflow is a  
reproducible one

syllabus

computation

examples

interest

curriculum

# #1 paris paintings

(1) paris paintings

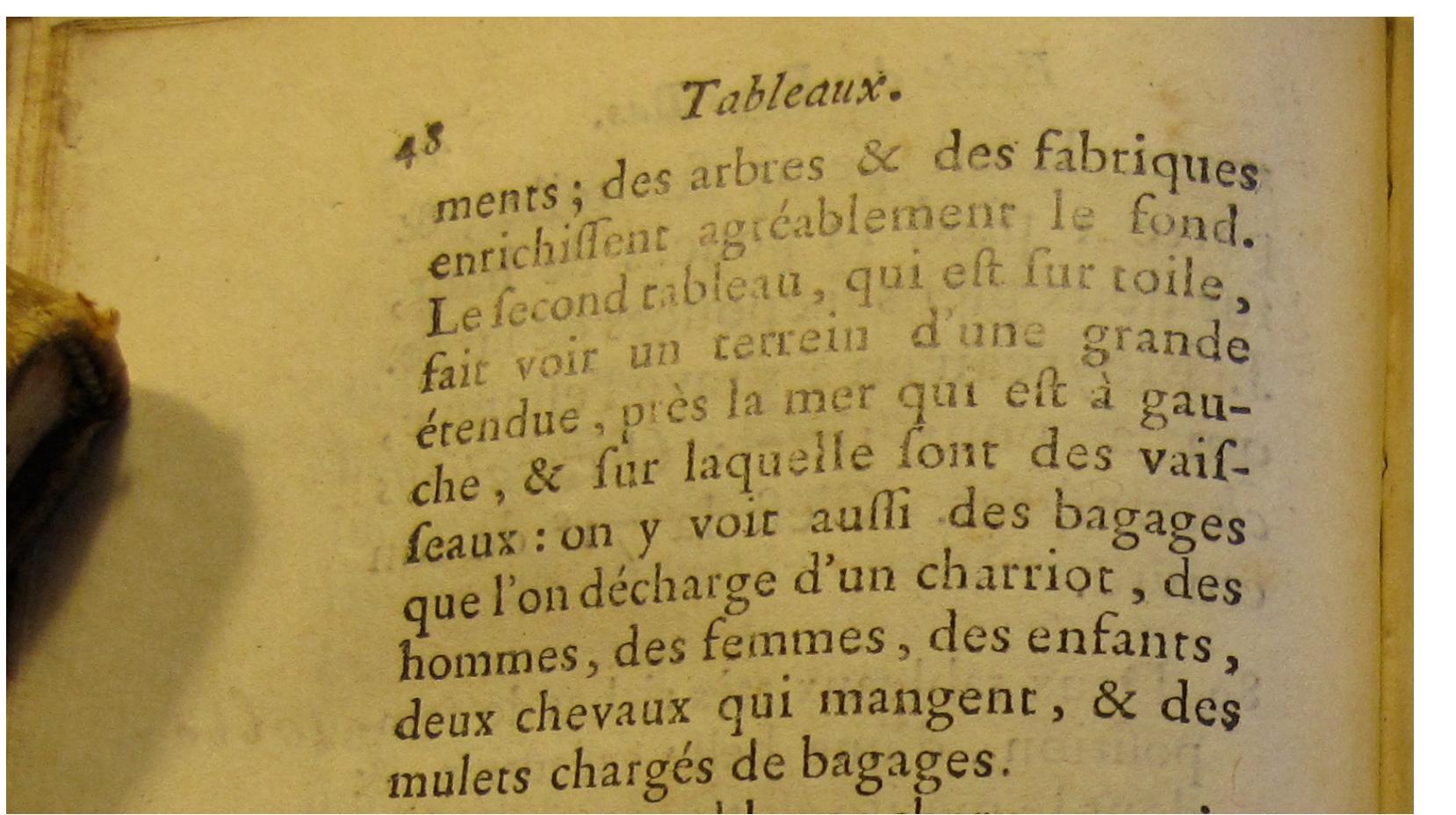
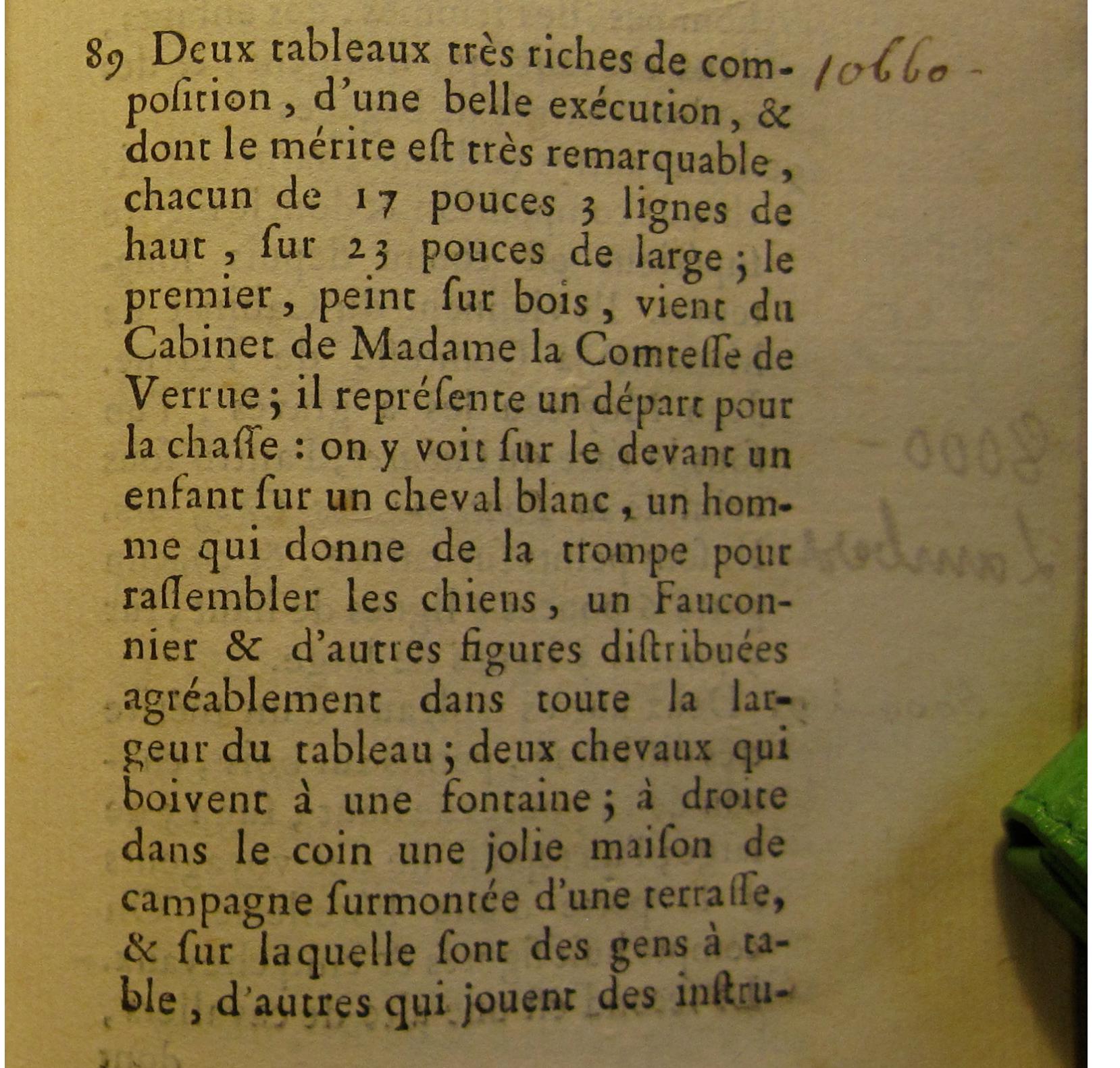




Hilary Coe Cronheim  
PhD, Art History

Sandra Van Ginhoven  
PhD, Art History







*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.*



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# data transcription

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	
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	Donjeu
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	Langlie

	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	winningbidder	winningbiddertype	endbuyer	Interm	type_intermed	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
2517	Lebrun, Jean-Baptiste-Pierre	D	D	0		13.25	11	145.75			squ_rect		145.75	bois	b	1	0
2518	Donjeux, Vincent	D	D	0		23	29.25	672.75			squ_rect		672.75	toile	t	1	50
2519	Lambert, John (Chevalier Lambert)	C	C	0		23	30	690			squ_rect		690	toile	t	1	0
2520	Langlier, Jacques for Poullain, Antoine	DC	C	1	D	17.25	23	396.75			squ_rect		396.75	bois	b	1	0

# data transcription

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	
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
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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
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	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	winningbidder	winningbiddertype	endbuyer	Interm	type_intermed	Height_in	Width_in	Surface_Rect	Diam_in	Surface_Rnd	d 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

# paris paintings

# paris paintings

**data:**

painting

auction data

1764 - 1780

[3,393 x 57]

# paris paintings

**data:**

painting

auction data

1764 - 1780

[3,393 x 57]

**clean:**

data cleaning and  
wrangling

# 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

# 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:**

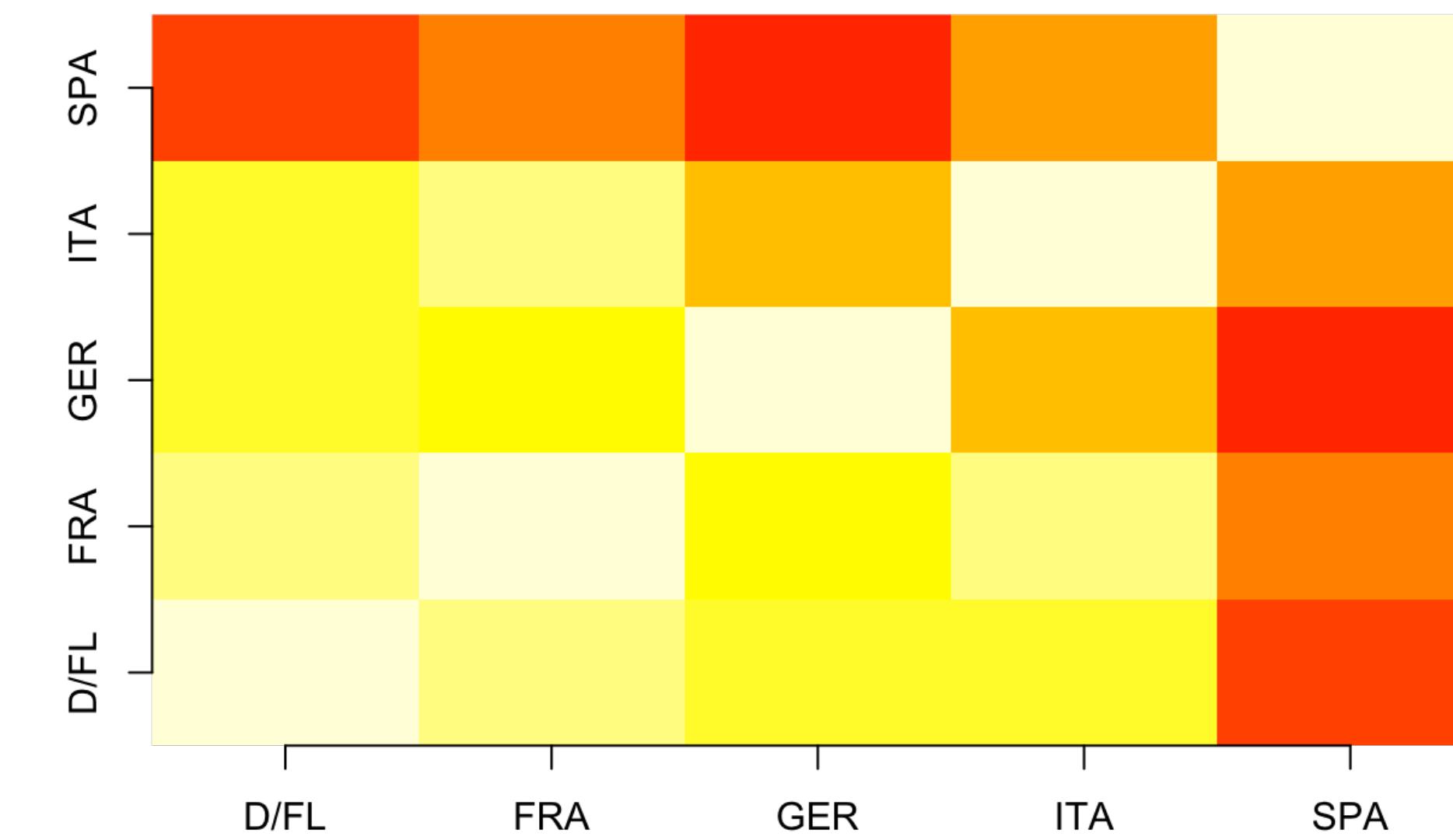
model  $\log(\text{price})$  and  
perform procedural  
and expert opinion  
based model  
selection

# sample: 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.

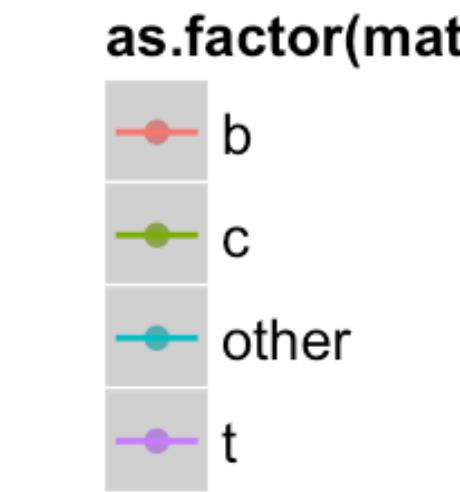
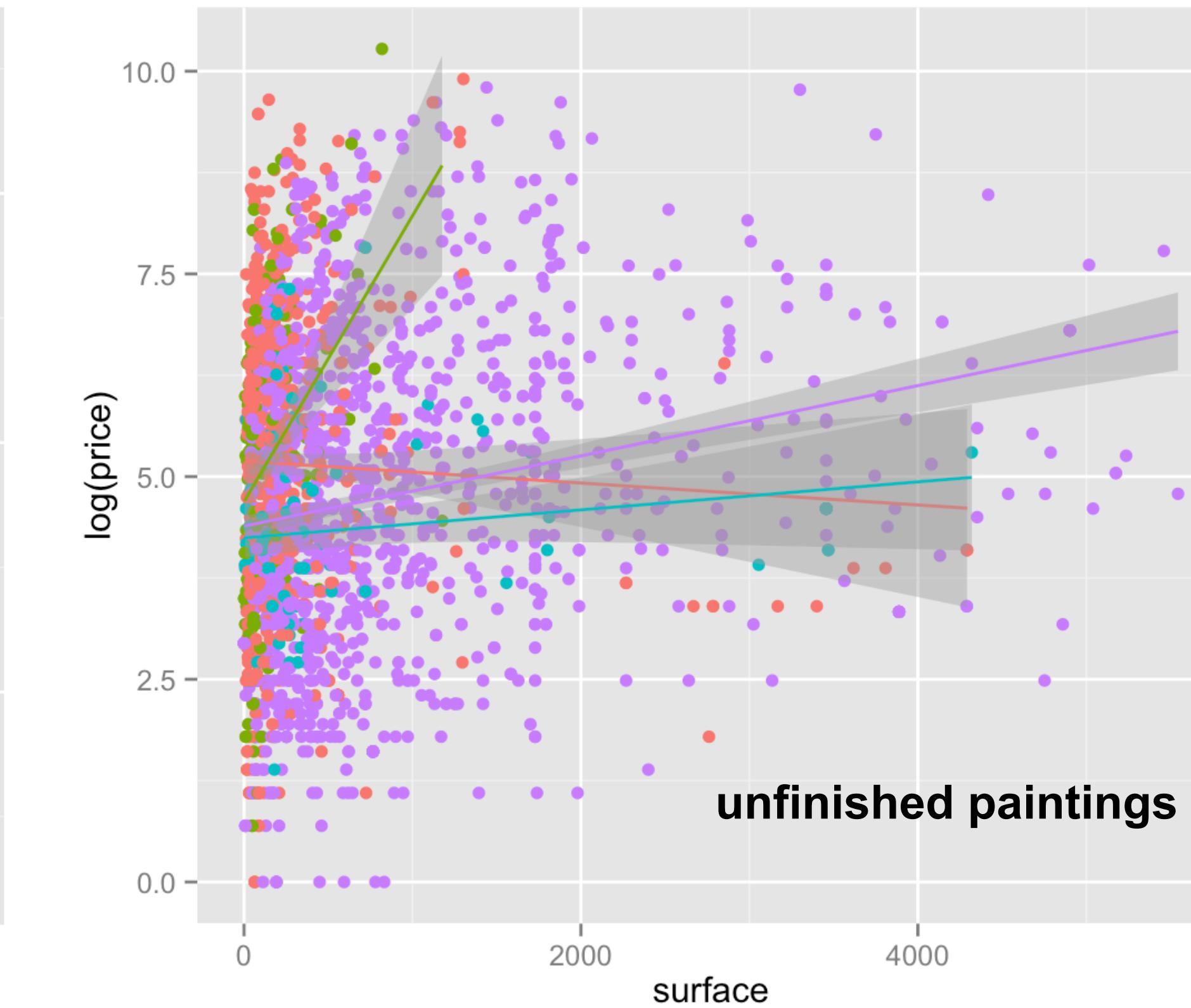
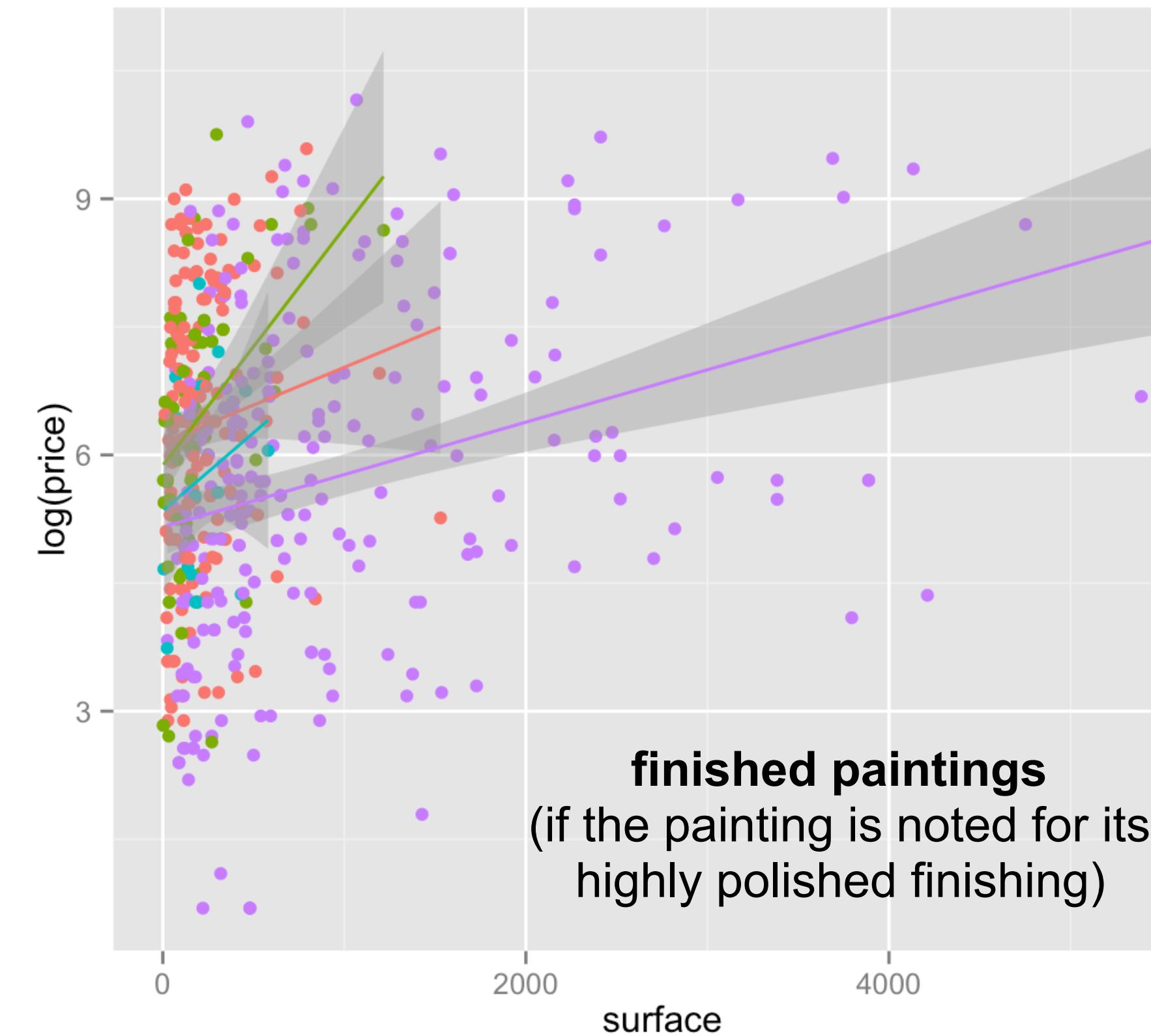
```
similarity = function (vec1, vec2) {  
  mag1 = sqrt(vec1 %*% vec1)  
  mag2 = sqrt(vec2 %*% vec2)  
  return(vec1 %*% vec2 / mag1 / mag2)  
}
```

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



# sample: material and price

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



## (2) basketball



2014-15 Schedule & Results							
Date	[Rk] Opponent	Duke Rank	Location (Venue)	Score (OT)	Att.	Tip Time	TV
<b>11/14</b>	~ <b>Presbyterian</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 113-44	9,314	6 p.m.	ESPNU
<b>11/15</b>	~ <b>Fairfield</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 109-59	9,314	8 p.m.	ESPN3
<b>11/18</b>	¶ vs. [19] Michigan State	4	Indianapolis, Ind. (Bankers Life Fieldhouse)	W 81-71	19,306	7 p.m.	ESPN
<b>11/21</b>	~ vs. Temple	4	Brooklyn, N.Y. (Barclays Center)	W 74-54	10,135	9:30 p.m.	TruTV
<b>11/22</b>	~ vs. Stanford	4	Brooklyn, N.Y. (Barclays Center)	W 70-59	10,046	9:30 p.m.	TruTV
<b>11/26</b>	<b>Furman</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 93-54	9,314	5 p.m.	ESPNU
<b>11/30</b>	<b>Army</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 93-73	9,314	12 p.m.	ESPNU
<b>12/3</b>	# at [2] Wisconsin	4	Madison, Wisc. (Kohl Center)	W 80-70	17,279	9:30 p.m.	ESPN
<b>12/15</b>	<b>Elon</b>	2	Durham, N.C. (Cameron Indoor Stadium)	W 75-62	9,314	7 p.m.	ESPNU
<b>12/18</b>	vs. Connecticut	2	East Rutherford, N.J. (Izod Center)	W 66-56	16,541	8 p.m.	ESPN
<b>12/29</b>	<b>Toledo</b>	2	Durham, N.C. (Cameron Indoor Stadium)	W 86-69	9,314	7 p.m.	ESPN2
<b>12/31</b>	<b>Wofford</b>	2	Durham, N.C. (Cameron Indoor Stadium)	W 84-55	9,314	3 p.m.	RSN
<b>1/3</b>	* <b>Boston College</b>	2	Durham, N.C. (Cameron Indoor Stadium)	W 85-62	9,314	4 p.m.	RSN
<b>1/7</b>	* at Wake Forest	2	Winston-Salem, N.C. (Joel Coliseum)	W 73-65	12,651	9 p.m.	ACCN
<b>1/11</b>	* at N.C. State	2	Raleigh, N.C. (PNC Arena)	L 75-87	19,500	1:30 p.m.	CBS
<b>1/13</b>	* <b>Miami</b>	4	Durham, N.C. (Cameron Indoor Stadium)	L 74-90	9,314	9 p.m.	ESPNU
<b>1/17</b>	* at [6] Louisville	4	Louisville, Ky. (KFC Yum! Center)	W 63-52	22,791	12 p.m.	ESPN
<b>1/19</b>	* <b>Pittsburgh</b>	5	Durham, N.C. (Cameron Indoor Stadium)	W 79-65	9,314	7 p.m.	ESPN
<b>1/25</b>	at St. Johns	5	New York, N.Y. (Madison Square Garden)	W 77-68	19,812	2 p.m.	FOX
<b>1/28</b>	* at [8] Notre Dame	4	Notre Dame, Ind. (Joyce Center)	L 73-77	9,149	7:30 p.m.	ESPN2
<b>1/31</b>	* at [2] Virginia	4	Charlottesville, Va. (John Paul Jones Arena)	W 69-63	14,593	7 p.m.	ESPN
<b>2/4</b>	* <b>Georgia Tech</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 72-66	9,314	7 p.m.	ESPN2
<b>2/7</b>	* [10] <b>Notre Dame</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 90-60	9,314	1 p.m.	CBS
<b>2/9</b>	* at Florida State	4	Tallahassee, Fla. (Donald L. Tucker Center)	W 73-70	11,498	7 p.m.	ESPN
<b>2/14</b>	* at Syracuse	4	Syracuse, N.Y. (Carrier Dome)	W 80-72	35,446	6 p.m.	ESPN
<b>2/18</b>	* [15] <b>North Carolina</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 92-90 •	9,314	9 p.m.	ESPN/ACCN
<b>2/21</b>	* <b>Clemson</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 78-56	9,314	4 p.m.	ESPN
<b>2/25</b>	* at Virginia Tech	4	Blacksburg, Va. (Cassell Coliseum)	W 91-86 •	9,847	9 p.m.	ESPN2
<b>2/28</b>	* <b>Syracuse</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 73-54	9,314	7 p.m.	ESPN
<b>3/4</b>	* <b>Wake Forest</b>	3	Durham, N.C. (Cameron Indoor Stadium)	W 94-51	9,314	8 p.m.	ACCN
<b>3/7</b>	* at [19] North Carolina	3	Chapel Hill, N.C. (Dean Dome)	W 84-77	21,750	9 p.m.	ESPN
<b>3/12</b>	\$\$\$ vs. N.C. State	2	Greensboro, N.C. (Greensboro Coliseum)	W 77-53	22,026	7 p.m.	ESPN
<b>3/13</b>	\$\$\$\$ vs. [11] Notre Dame	2	Greensboro, N.C. (Greensboro Coliseum)	L 64-74	22,026	9 p.m.	ESPN
<b>3/20</b>	!! vs. Robert Morris	4	Charlotte, N.C. (Time Warner Cable Arena)	W 85-56	16,945	7 p.m.	CBS
<b>3/22</b>	!!! vs. San Diego State	4	Charlotte, N.C. (Time Warner Cable Arena)	W 68-49	18,482	2 p.m.	CBS
<b>3/27</b>	!!!! vs. [19] Utah	4	Houston, Texas (NRG Stadium)	W 63-57	21,168	7:45 p.m.	CBS
<b>3/29</b>	!!!!!! vs. [7] Gonzaga	4	Houston, Texas (NRG Stadium)	W 66-52	20,744	4 p.m.	CBS
<b>4/4</b>	!!!!!! vs. [23] Michigan State	4	Indianapolis, Ind. (Lucas Oil Stadium)	W 81-61	72,238	6 p.m.	TBS/TNT
<b>4/6</b>	!!!!!!! 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
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11/15	~ <b>Fairfield</b>	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	<b>Furman</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 93-54	9,314	5 p.m.	ESPNU
11/30	<b>Army</b>	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	<b>Elon</b>	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	<b>Toledo</b>	2	Durham, N.C. (Cameron Indoor Stadium)	W 86-69	9,314	7 p.m.	ESPN2
12/31	<b>Wofford</b>	2	Durham, N.C. (Cameron Indoor Stadium)	W 84-55	9,314	3 p.m.	RSN
1/3	* <b>Boston College</b>	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	* <b>Miami</b>	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	* <b>Pittsburgh</b>	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	* <b>Georgia Tech</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 72-66	9,314	7 p.m.	ESPN2
2/7	* [10] <b>Notre Dame</b>	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] <b>North Carolina</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 92-90 •	9,314	9 p.m.	ESPN/ACCN
2/21	* <b>Clemson</b>	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	* <b>Syracuse</b>	4	Durham, N.C. (Cameron Indoor Stadium)	W 73-54	9,314	7 p.m.	ESPN
3/4	* <b>Wake Forest</b>	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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A	B	C	D	E	F	G	H	I	J
3	14-Nov	~	Presbyterian	4	Durham, N.C. (W	113-44	9,314	6 p.m.	ESPNU
4	15-Nov	~	Fairfield	4	Durham, N.C. (W	109-59	9,314	8 p.m.	ESPN3
5	18-Nov	¶¶	vs. [19] Michigan	4	Indianapolis, Ind 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. (W	93-54	9,314	5 p.m.	ESPNU
10	30-Nov		Army	4	Durham, N.C. (W	93-73	9,314	12 p.m.	ESPNU
11	3-Dec	#	at [2] Wisconsin	4	Madison, Wisc. W	80-70	17,279	9:30 p.m.	ESPN
12	15-Dec		Elon	2	Durham, N.C. (W	75-62	9,314	7 p.m.	ESPNU
13	18-Dec		vs. Connecticut	2	East Rutherford, N.J. W	66-56	16,541	8 p.m.	ESPN
14	29-Dec		Toledo	2	Durham, N.C. (W	86-69	9,314	7 p.m.	ESPN2
15	31-Dec		Wofford	2	Durham, N.C. (W	84-55	9,314	3 p.m.	RSN
16	3-Jan	*	Boston College	2	Durham, N.C. (W	85-62	9,314	4 p.m.	RSN
17	7-Jan	*	at Wake Forest	2	Winston-Salem, N.C. W	73-65	12,651	9 p.m.	ACCN
18	11-Jan	*	at N.C. State	2	Raleigh, N.C. (F L	75-87	19,500	1:30 p.m.	CBS
19	13-Jan	*	Miami	4	Durham, N.C. (L	74-90	9,314	9 p.m.	ESPNU
20	17-Jan	*	at [6] Louisville	4	Louisville, Ky. W	63-52	22,791	12 p.m.	ESPN
21	19-Jan	*	Pittsburgh	5	Durham, N.C. (W	79-65	9,314	7 p.m.	ESPN
22	25-Jan		at St. Johns	5	New York, N.Y. W	77-68	19,812	2 p.m.	FOX
23	28-Jan	*	at [8] Notre Dame	4	Notre Dame, Ind L	73-77	9,149	7:30 p.m.	ESPN2
24	31-Jan	*	at [2] Virginia	4	Charlottesville, Va. W	69-63	14,593	7 p.m.	ESPN
25	4-Feb	*	Georgia Tech	4	Durham, N.C. (W	72-66	9,314	7 p.m.	ESPN2
26	7-Feb	*	[10] Notre Dame	4	Durham, N.C. (W	90-60	9,314	1 p.m.	CBS
27	9-Feb	*	at Florida State	4	Tallahassee, Fla. W	73-70	11,498	7 p.m.	ESPN
28	14-Feb	*	at Syracuse	4	Syracuse, N.Y. W	80-72	35,446	6 p.m.	ESPN
29	18-Feb	*	[15] North Carolina	4	Durham, N.C. (W	92-90 •	9,314	9 p.m.	ESPN/ACCN
30	21-Feb	*	Clemson	4	Durham, N.C. (W	78-56	9,314	4 p.m.	ESPN
31	25-Feb	*	at Virginia Tech	4	Blacksburg, Va. W	91-86 •	9,847	9 p.m.	ESPN2
32	28-Feb	*	Syracuse	4	Durham, N.C. (W	73-54	9,314	7 p.m.	ESPN
33	4-Mar	*	Wake Forest	3	Durham, N.C. (W	94-51	9,314	8 p.m.	ACCN
34	7-Mar	*	at [19] North Carolina	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 Dame	2	Greensboro, N.C. L	64-74	22,026	9 p.m.	ESPN
37	20-Mar	!!	vs. Robert Morris	4	Charlotte, N.C. W	85-56	16,945	7 p.m.	CBS
38	22-Mar	!!!	vs. San Diego State	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] Michigan	4	Indianapolis, Ind W	81-61	72,238	6 p.m.	TBS/TNT
42	6-Apr	!!!!!!	vs. [3] Wisconsin	4	Indianapolis, Ind W	68-63	71,149	9:15 p.m.	CBS

paste

A	B	C	D	E	F	G	H	I	J
3	Day	Opponent	Location	Attendance	Scoring	Time	TV		
4	<a href="#">14-Nov</a>	~	<b>Presbyterian</b>	4 Durham, N.C. (W)	113-44	9,314	6 p.m.	ESPNU	
5	<a href="#">15-Nov</a>	~	<b>Fairfield</b>	4 Durham, N.C. (W)	109-59	9,314	8 p.m.	ESPN3	
6	<a href="#">18-Nov</a>	¶¶	vs. [19] Michigan	4 Indianapolis, Ind (W)	81-71	19,306	7 p.m.	ESPN	
7	<a href="#">21-Nov</a>	~	vs. Temple	4 Brooklyn, N.Y. (W)	74-54	10,135	9:30 p.m.	TruTV	
8	<a href="#">22-Nov</a>	~	vs. Stanford	4 Brooklyn, N.Y. (W)	70-59	10,046	9:30 p.m.	TruTV	
9	<a href="#">26-Nov</a>		<b>Furman</b>	4 Durham, N.C. (W)	93-54	9,314	5 p.m.	ESPNU	
10	<a href="#">30-Nov</a>		<b>Army</b>	4	93-73	9,314	12 p.m.	ESPNU	
11	<a href="#">3-Dec</a>	#	at [2] Wisconsin			17,279	9:30 p.m.	ESPN	
12	<a href="#">15-Dec</a>		<b>Elon</b>			9,314	7 p.m.	ESPNU	
13	<a href="#">18-Dec</a>		vs. Connecticut			16,541	8 p.m.	ESPN	
14	<a href="#">29-Dec</a>		<b>Toledo</b>			9,314	7 p.m.	ESPN2	
15	<a href="#">31-Dec</a>		<b>Wofford</b>			14	3 p.m.	RSN	
16	<a href="#">3-Jan</a>	*	<b>Boston</b>			4	4 p.m.	RSN	
17	<a href="#">7-Jan</a>	*	at Wake Forest			1	9 p.m.	ACCN	
18	<a href="#">11-Jan</a>	*	at N.C. State				1:30 p.m.	CBS	
19	<a href="#">13-Jan</a>	*	<b>Miami</b>				9 p.m.	ESPNU	
20	<a href="#">17-Jan</a>	*	at [6] Louisville				12 p.m.	ESPN	
21	<a href="#">19-Jan</a>	*	<b>Pittsburgh</b>				7 p.m.	ESPN	
22	<a href="#">25-Jan</a>		at St. John's			12	2 p.m.	FOX	
23	<a href="#">28-Jan</a>	*	at [8] Notre Dame			149	7:30 p.m.	ESPN2	
24	<a href="#">31-Jan</a>	*	at [2] Virginia Tech			4,593	7 p.m.	ESPN	
25	<a href="#">4-Feb</a>	*	<b>Georgia Tech</b>			9,314	7 p.m.	ESPN2	
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28	<a href="#">14-Feb</a>	*	at Syracuse			35,446	6 p.m.	ESPN	
29	<a href="#">18-Feb</a>	*	[15] North Carolina			9,314	9 p.m.	ESPN/ACCN	
30	<a href="#">21-Feb</a>	*	<b>Clemson</b>	4 Durham, N.C. (W)		9,314	4 p.m.	ESPN	
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42	<a href="#">6-Apr</a>	!!!!!!	vs. [3] Wisconsin	4 Indianapolis, Ind (W)	68-63	71,149	9:15 p.m.	CBS	

# scraper

```
# 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)
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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

### (3) interactivity

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```
> library(shiny)
```

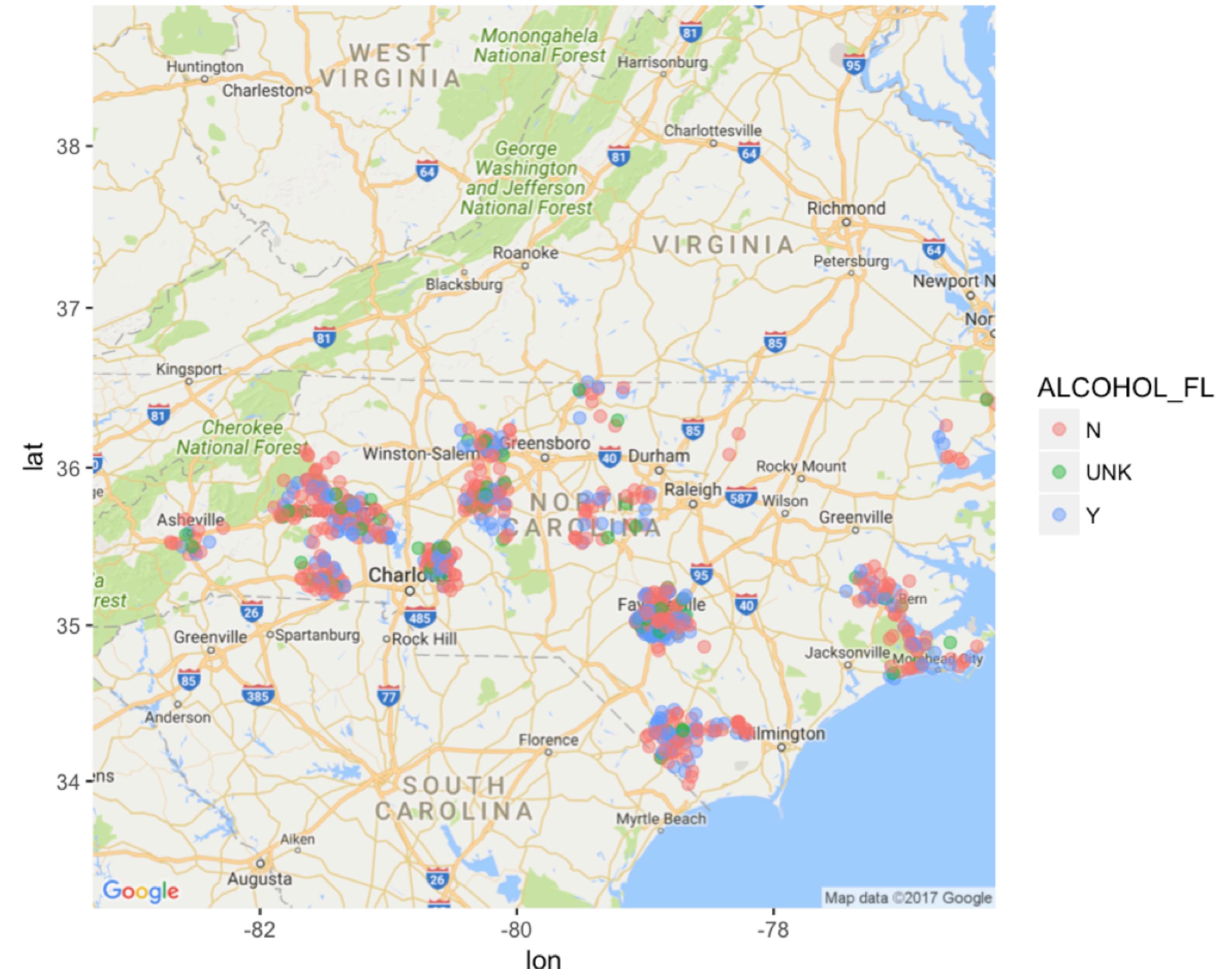
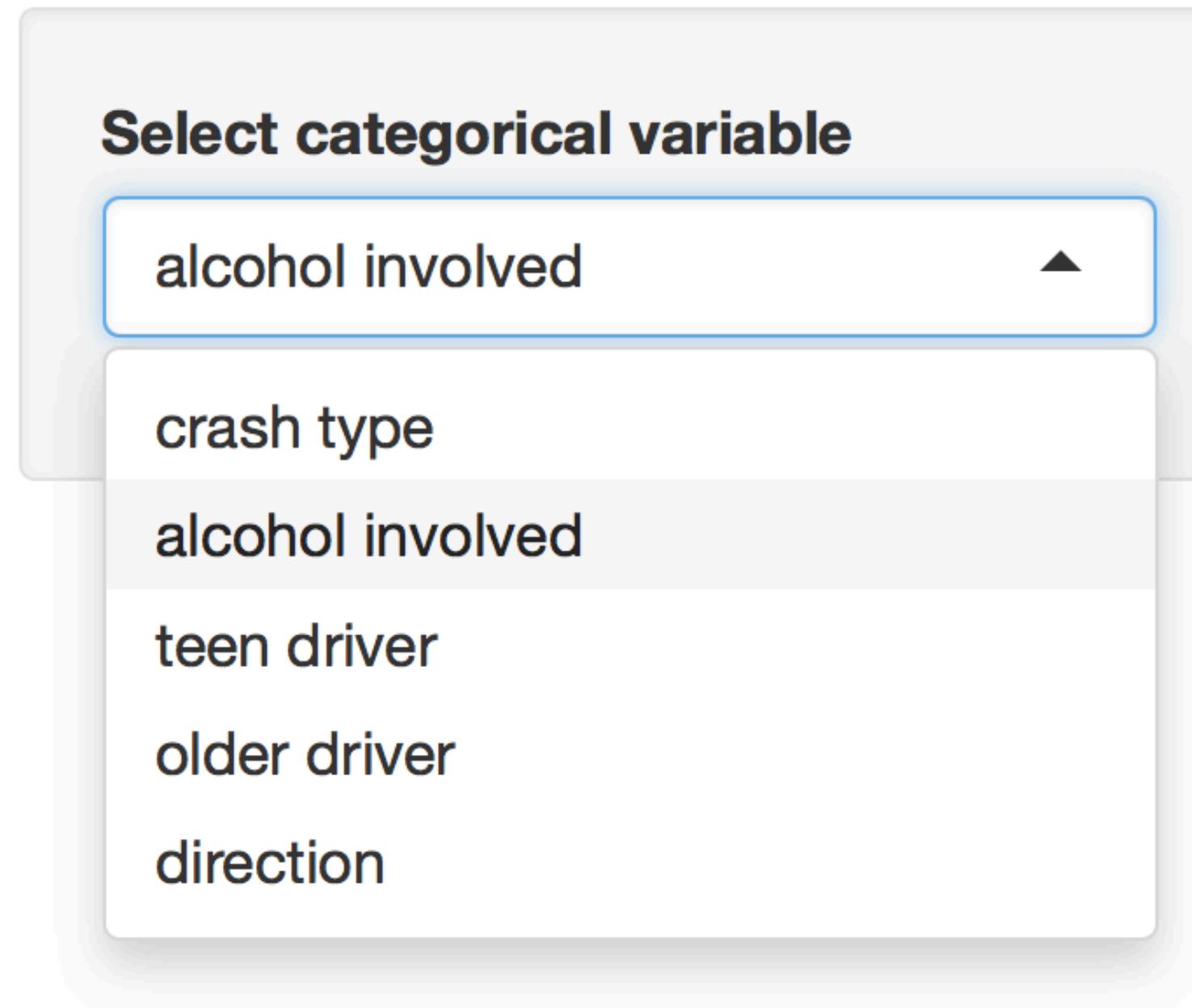
### (3) interactivity



```
> library(shiny)
```



# Modeling the Distributions of Fatal Car Crashes



syllabus

computation

examples

interest

curriculum

interest

**duke focus:**

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

# interest

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## **interest in What If:**

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

# interest

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modeling cluster:  
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the Future”

## interest in What If:

no hard data, but  
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significant increase  
in applications the  
last two years than

## 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

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2016: ~40%  
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**diversity:**  
% female  
2014: 44%  
2015: 50%  
2016: 35%  
~25% in Probability

**pipeline for stats:**  
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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!

syllabus

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## **curricular considerations**

# curricular considerations

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

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you and stick to it  
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# curricular considerations

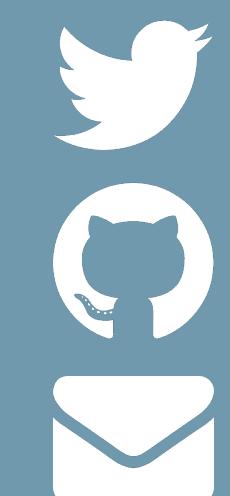
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teach computing  
early (without any  
prereqs) and often!

# a first-year undergraduate data science course

Slides at <http://bit.ly/first-ds>



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