

# Statistics 452: Statistical Learning and Prediction

## Chapter 1: Introduction

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# What is Statistical Learning?

- ▶ Tools for learning from data.
- ▶ Multiple regression is an example of such a tool:
  - ▶ We propose a linear model  $Y = \beta_0 + X_1\beta_1 + \dots + X_p\beta_p + \epsilon$ , and fit the model.
  - ▶ We may interpret fitted coefficients, or use them to obtain predictions.
  - ▶ Such a problem is said to be “supervised” because of the response variable  $Y$ , viewed as an “output” that is influenced by the “inputs”  $X_1, \dots, X_p$ .

## Example: The Wage data

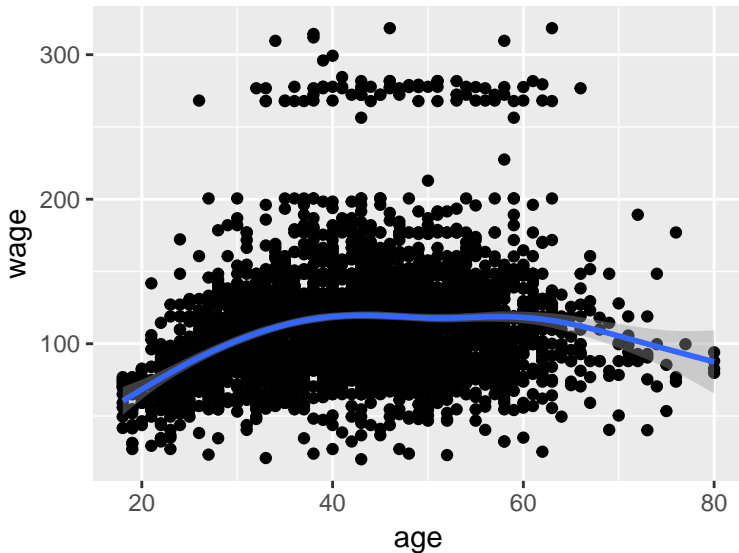
```
library(ISLR)
```

```
data(Wage)
```

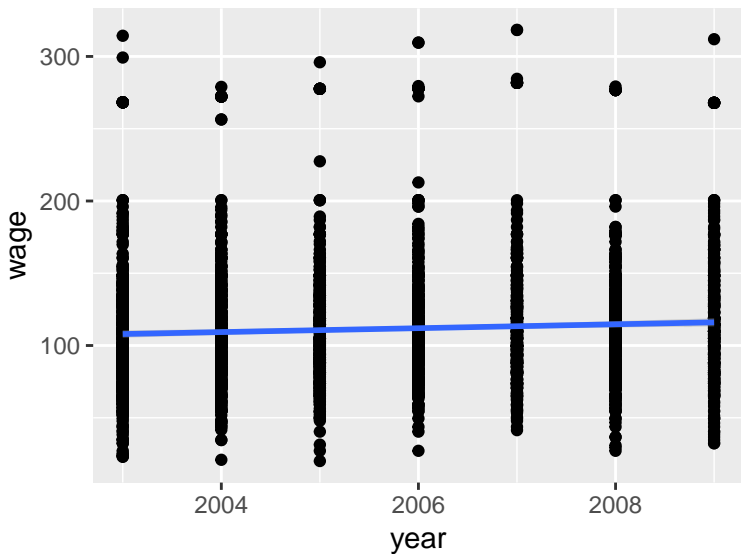
```
head(Wage)
```

```
##          year age          maritl          race          education
## 231655 2006   18 1. Never Married 1. White      1. < HS Grad
## 86582 2004   24 1. Never Married 1. White      4. College Grad
## 161300 2003   45          2. Married 1. White      3. Some College
## 155159 2003   43          2. Married 3. Asian      4. College Grad
## 11443 2005   50          4. Divorced 1. White      2. HS Grad
## 376662 2008   54          2. Married 1. White      4. College Grad
##
##          region          jobclass          health health_ins
## 231655 2. Middle Atlantic 1. Industrial      1. <=Good      2. No
## 86582 2. Middle Atlantic 2. Information 2. >=Very Good      2. No
## 161300 2. Middle Atlantic 1. Industrial      1. <=Good      1. Yes
## 155159 2. Middle Atlantic 2. Information 2. >=Very Good      1. Yes
## 11443 2. Middle Atlantic 2. Information      1. <=Good      1. Yes
## 376662 2. Middle Atlantic 2. Information 2. >=Very Good      1. Yes
##
##          logwage          wage
## 231655 4.318063 75.04315
## 86582 4.255273 70.47602
## 161300 4.875061 130.98218
## 155159 5.041393 154.68529
## 11443 4.318063 75.04315
## 376662 4.845098 127.11574
```

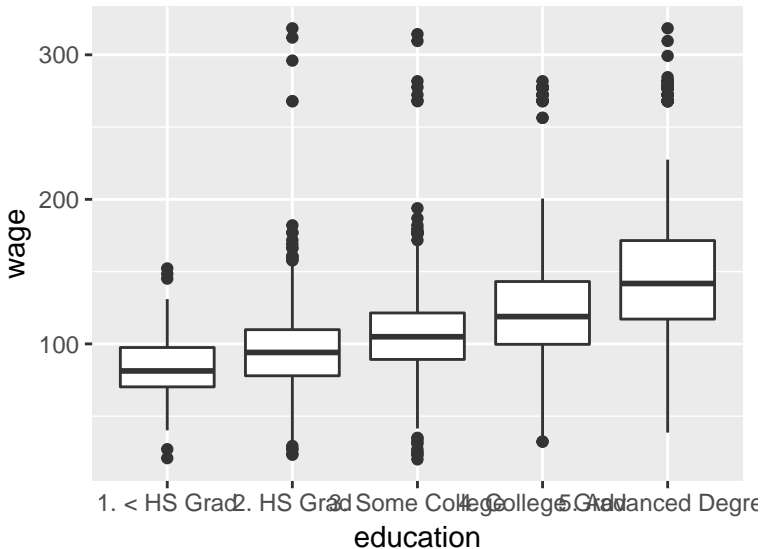
```
library(ggplot2)
ggplot(Wage, aes(x=age, y=wage)) +
  geom_point() + geom_smooth()
```



```
ggplot(Wage, aes(x=year, y=wage)) + geom_point() + geom_smooth(method="lm")
```



```
library(ggplot2)
ggplot(Wage, aes(x=education, y=wage)) +
  geom_boxplot()
```



```
wfit <- lm(wage ~ age + I(age^2) + year + education, data=Wage)
summary(wfit)$coefficients
```

##	Estimate	Std. Error	t value
## (Intercept)	-2307.7808304	6.375417e+02	-3.619811
## age	4.2360813	3.443460e-01	12.301818
## I(age^2)	-0.0424098	3.921848e-03	-10.813726
## year	1.1445212	3.177882e-01	3.601522
## education2. HS Grad	10.7519901	2.430424e+00	4.423916
## education3. Some College	23.2956075	2.558074e+00	9.106698
## education4. College Grad	37.9663708	2.542784e+00	14.931023
## education5. Advanced Degree	62.6013504	2.759253e+00	22.687786
##	Pr(> t )		
## (Intercept)	2.997042e-04		
## age	5.780734e-34		
## I(age^2)	9.200003e-27		
## year	3.215041e-04		
## education2. HS Grad	1.003869e-05		
## education3. Some College	1.513602e-19		
## education4. College Grad	1.122880e-48		
## education5. Advanced Degree	2.775558e-105		

## Other tools

- ▶ We will study non-linear methods for supervised learning, and methods appropriate to “unsupervised” problems, where there is no response variable.



# Notation

- ▶ There are  $n$  distinct observations.
- ▶ The random response for the  $i$ th individual is  $Y_i$  and observed value is  $y_i$ ;  $i = 1 \dots, n$ .
- ▶ There are  $p$  explanatory variables  $X = (X_1, \dots, X_p)$ .
- ▶ The measured value of the  $j$ th explanatory variable on the  $i$ th observation is denoted  $x_{ij}$

# More Notation and Simple Matrix Algebra

- ▶ TA will discuss in tutorial (tutorials start in week 2) for those who need a refresher or quick intro.

# R and RStudio

- ▶ You will need to install both R and the RStudio interface, **and** you will need to create an RStudio “project” based on the class GitHub repository.
  - ▶ See the computer software “getting started” page on canvas.
  - ▶ TA to discuss in tutorial (tutorials start week 2).
- ▶ Also be sure to install the tidyverse and ISLR packages using the RStudio Tools menu, or from the command line

```
install.packages(c("tidyverse", "ISLR"))
```