Predicting with regression, multiple covariates

Jeffrey Leek
Johns Hopkins Bloomberg School of Public Health

Example: predicting wages

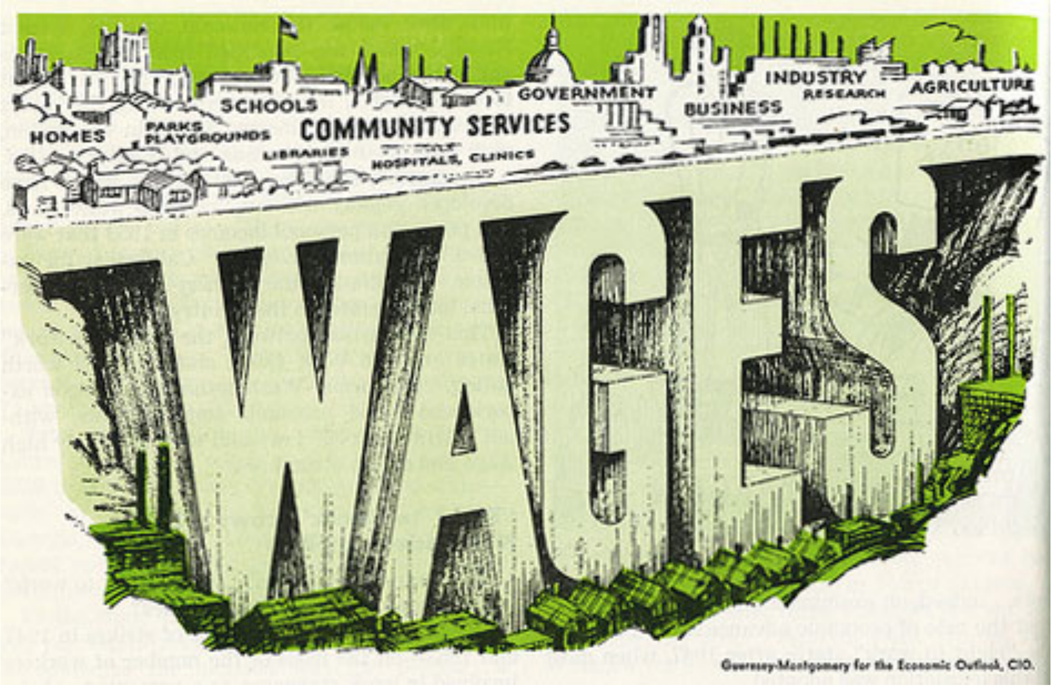


Image Credit http://www.cahs-media.org/the-high-cost-of-low-wages

Data from: ISLR package from the book: Introduction to statistical learning

Example: Wage data

```r
library(ISLR); library(ggplot2); library(caret);
data(Wage); Wage <- subset(Wage,select=-c(logwage))
summary(Wage)
```

```
      year           age               sex                    maritl           race
 Min.   :2003   Min.   :18.0   1. Male  :3000   1. Never Married: 648   1. White:2480
 1st Qu.:2004   1st Qu.:33.8   2. Female:   0   2. Married      :2074   2. Black: 293
 Median :2006   Median :42.0                    3. Widowed      :  19   3. Asian: 190
 Mean   :2006   Mean   :42.4                    4. Divorced     : 204   4. Other:  37
 3rd Qu.:2008   3rd Qu.:51.0                    5. Separated    :  55
 Max.   :2009   Max.   :80.0

              education                   region                      jobclass               health
 1. < HS Grad         :268   2. Middle Atlantic   :3000   1. Industrial  :1544   1. <=Good      : 858
 2. HS Grad           :971   1. New England       :    0   2. Information:1456   2. >=Very Good:2142
 3. Some College      :650   3. East North Central:    0
 4. College Grad      :685   4. West North Central:    0
 5. Advanced Degree:426   5. South Atlantic      :    0
                          6. East South Central:    0
```

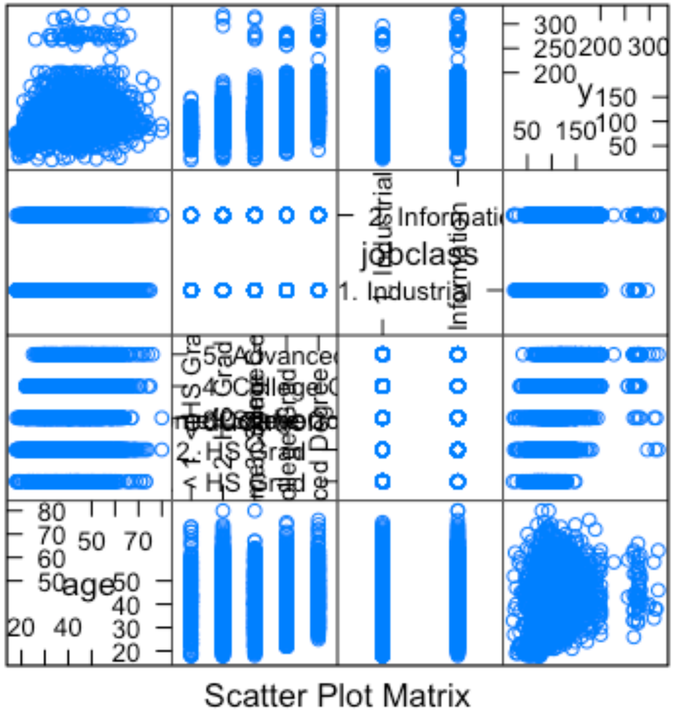
Get training/test sets

```
inTrain <- createDataPartition(y=Wage$wage,
                              p=0.7, list=FALSE)
training <- Wage[inTrain,]; testing <- Wage[-inTrain,]
dim(training); dim(testing)
```

```
[1] 898  12
```

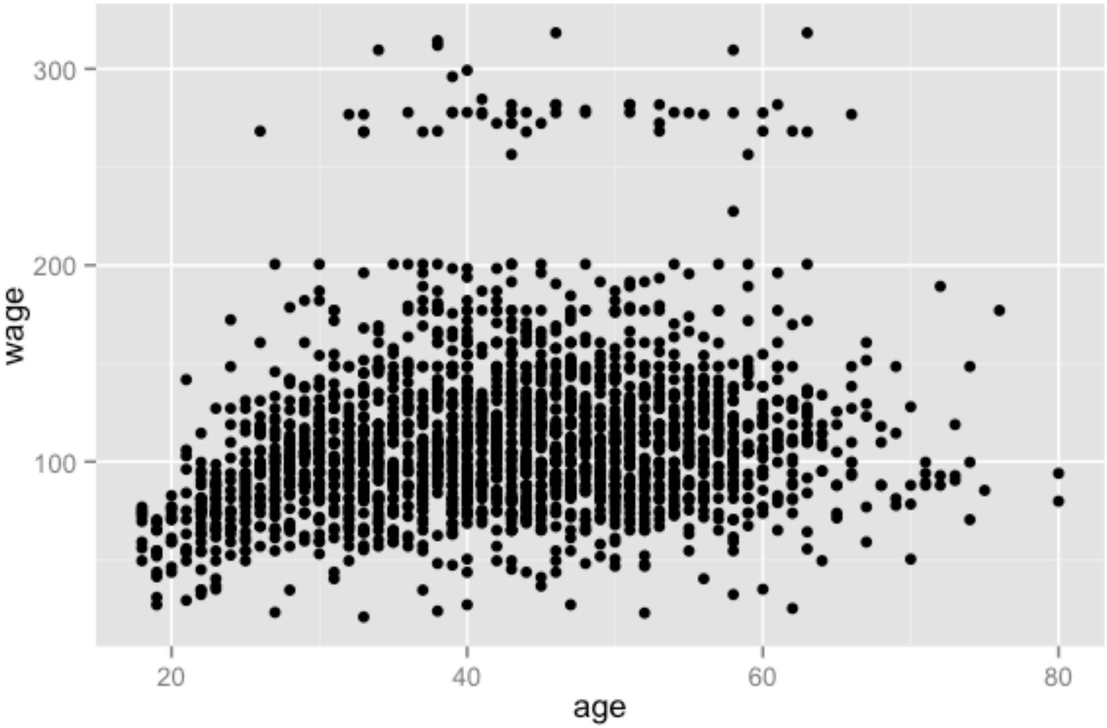
Feature plot

```
featurePlot(x=training[,c("age","education","jobclass")],
            y = training$wage,
            plot="pairs")
```



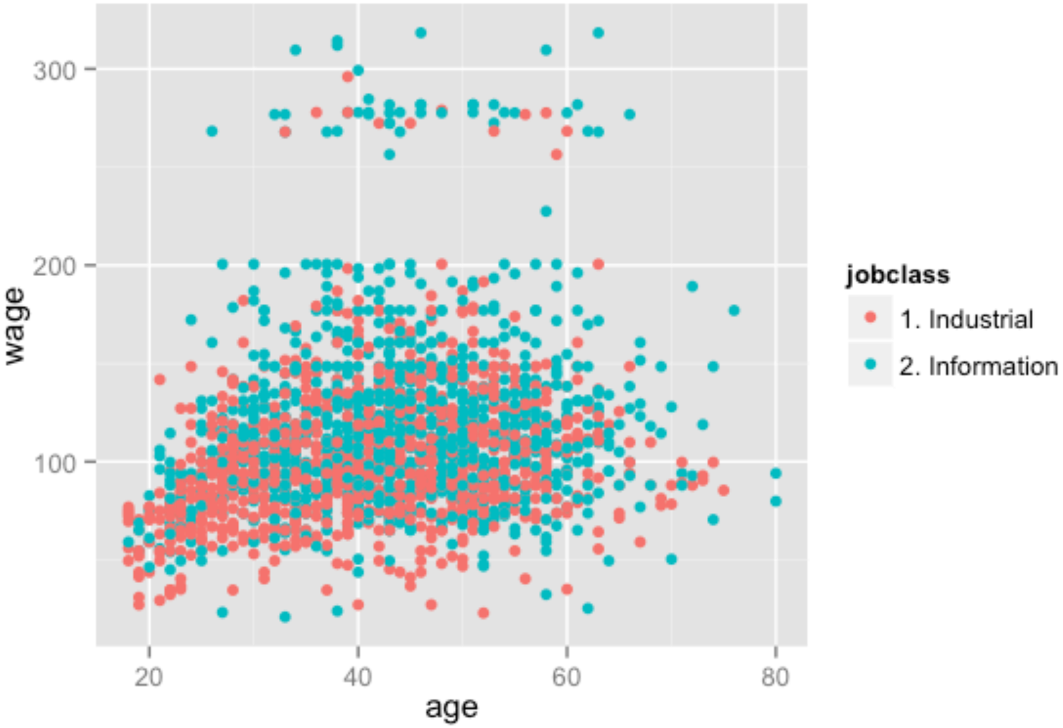
Plot age versus wage

```
qplot(age,wage,data=training)
```



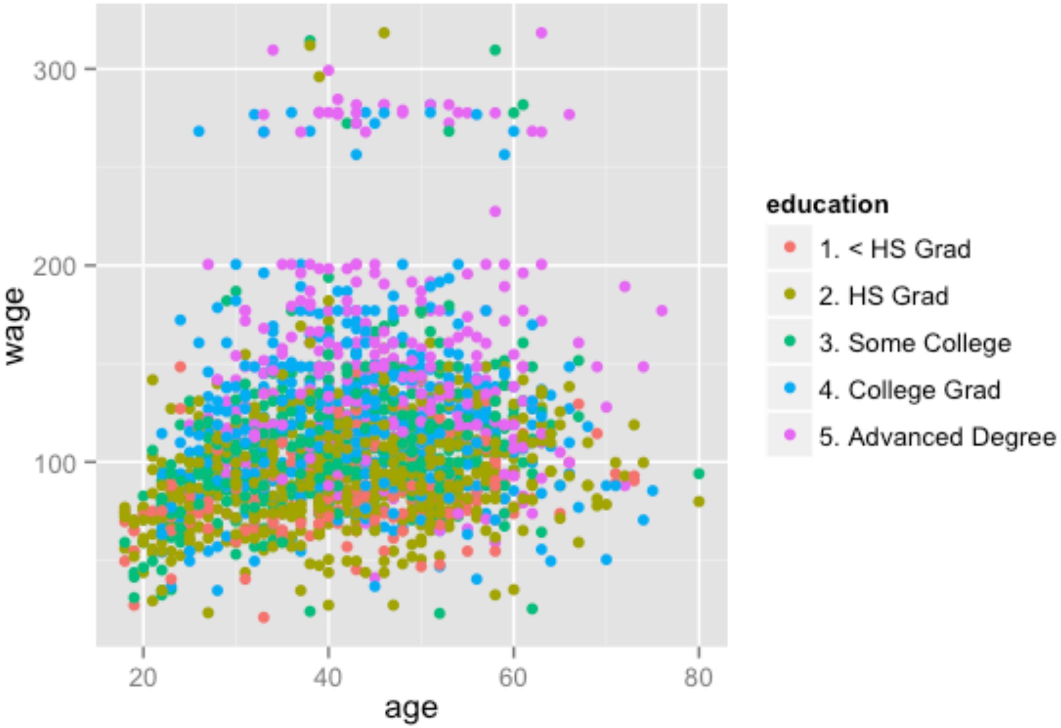
Plot age versus wage colour by jobclass

```
qplot(age,wage,colour=jobclass,data=training)
```



Plot age versus wage colour by education

```
qplot(age,wage,colour=education,data=training)
```



Fit a linear model

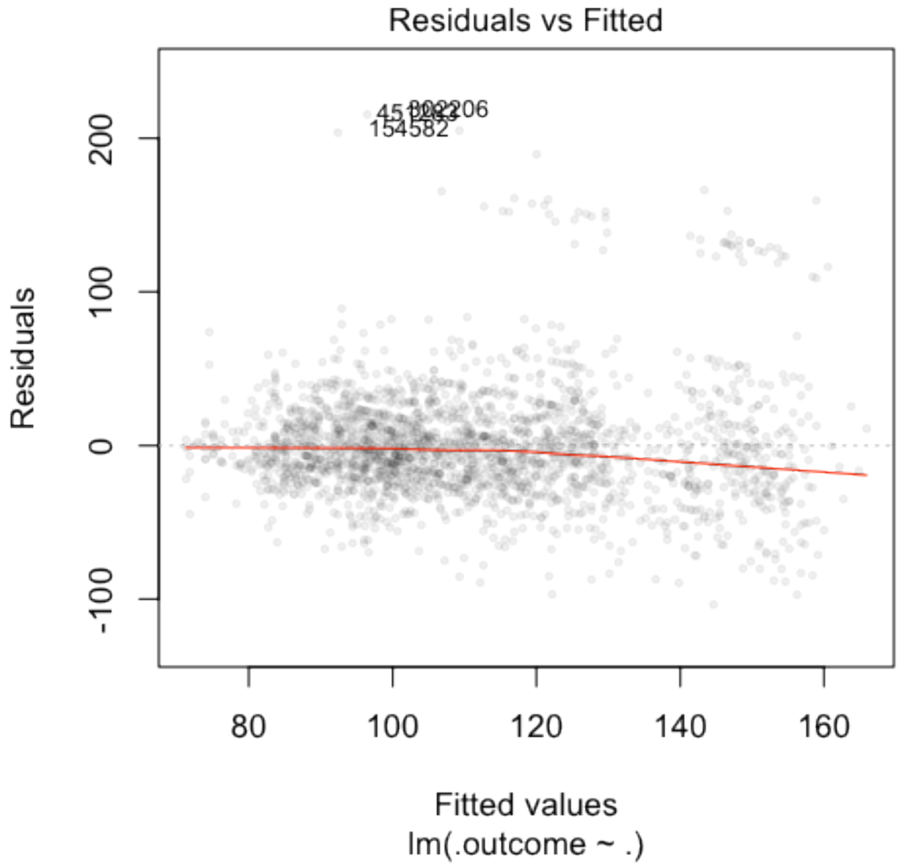
$$ED_i = b_0 + b_1 age + b_2 I(Jobclass_i ="\ Information\ ") + \sum_{k=1}^{4} \gamma_k I(education_i = levelk)$$

```
modFit<- train(wage ~ age + jobclass + education,
               method = "lm",data=training)
finMod <- modFit$finalModel
print(modFit)
```

```
Linear Regression

2102 samples
  11 predictors

No pre-processing
Resampling: Bootstrapped (25 reps)

Summary of sample sizes: 2102, 2102, 2102, 2102, 2102, 2102, ...

Resampling results
```

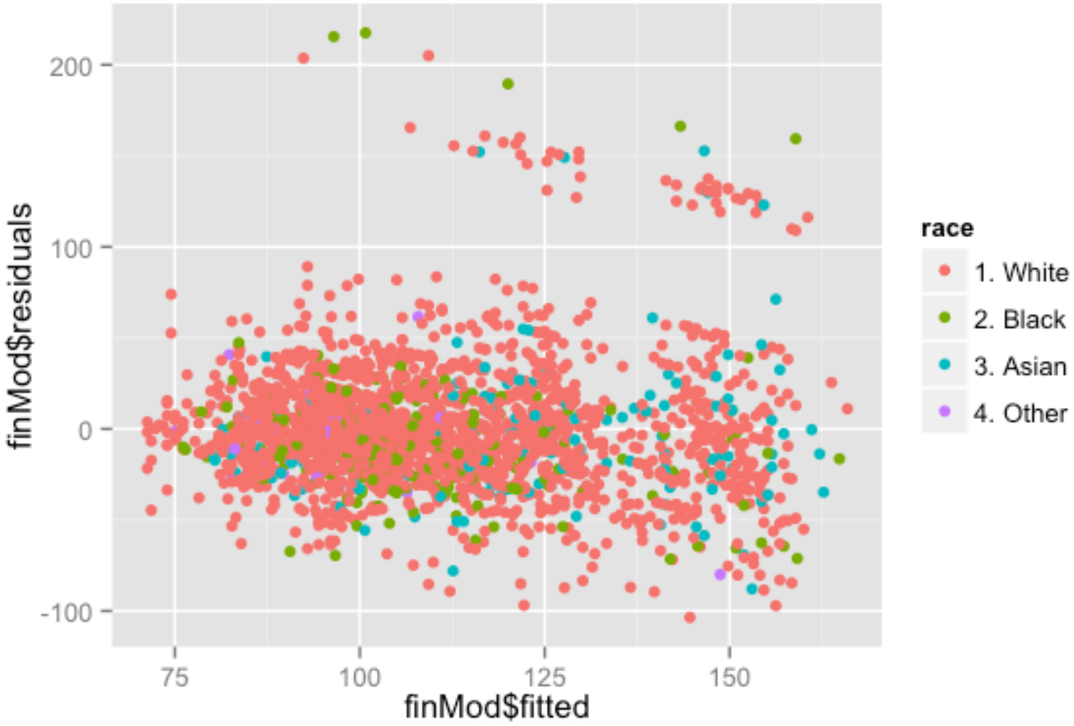
Diagnostics

```
plot(finMod,1,pch=19,cex=0.5,col="#00000010")
```



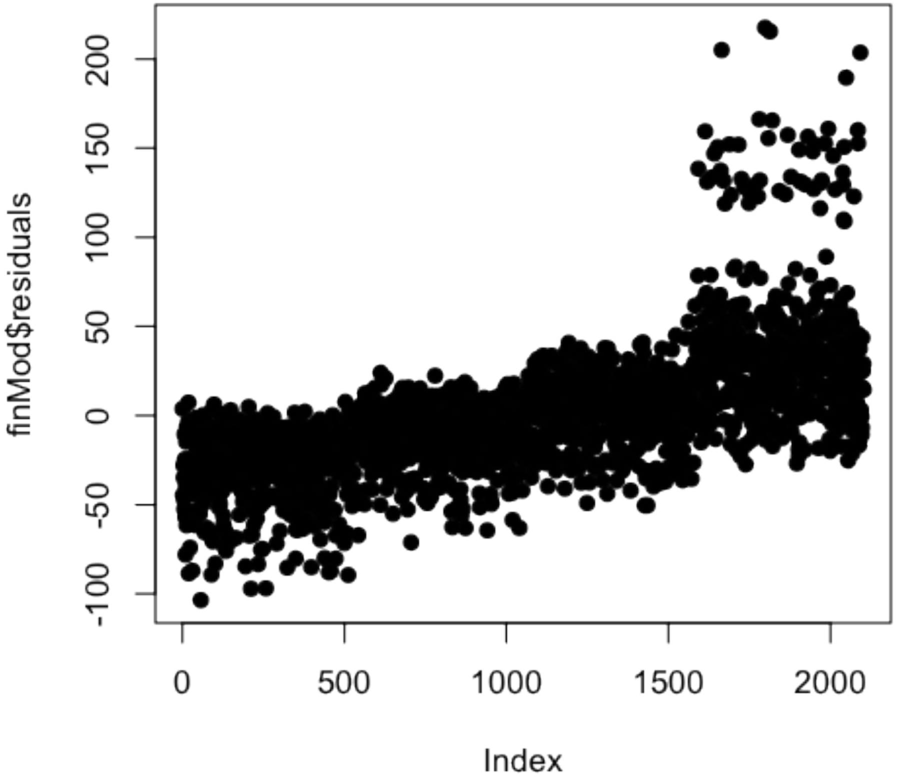
Color by variables not used in the model

```
qplot(finMod$fitted,finMod$residuals,colour=race,data=training)
```



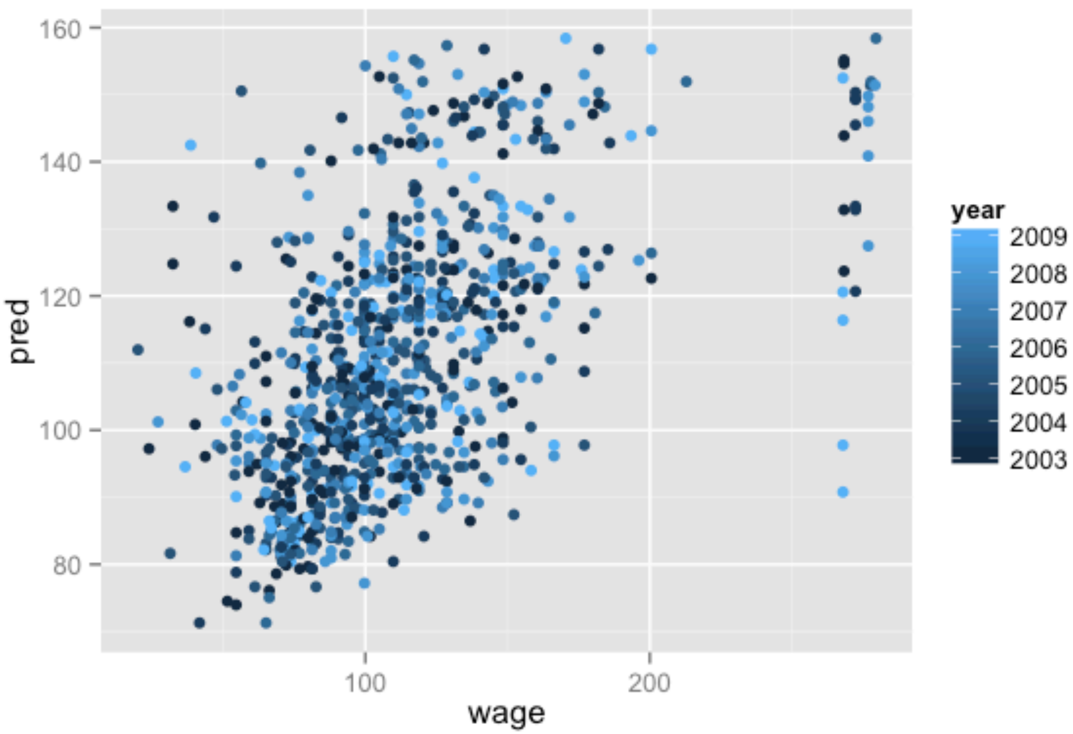
Plot by index

```
plot(finMod$residuals,pch=19)
```



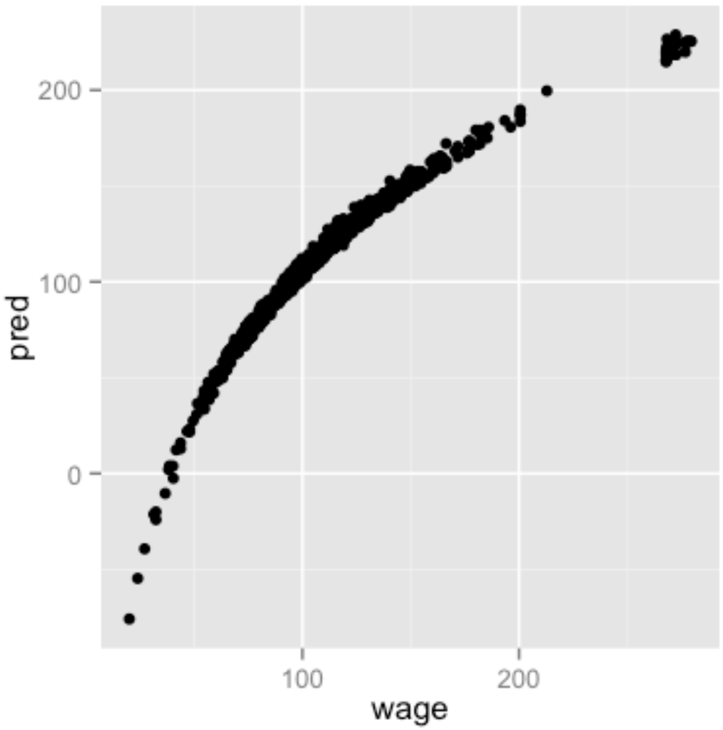
Predicted versus truth in test set

```
pred <- predict(modFit, testing)
qplot(wage,pred,colour=year,data=testing)
```



If you want to use all covariates

```r
modFitAll<- train(wage ~ .,data=training,method="lm")
pred <- predict(modFitAll, testing)
qplot(wage,pred,data=testing)
```



Notes and further reading

- Often useful in combination with other models
- Elements of statistical learning
- Modern applied statistics with S
- Introduction to statistical learning