THE UNIVERSITY OF TEXAS AT AUSTIN
McCOMBS SCHOOL OF BUSINESS

Interactions 2

Lecture 16

STA 371G

NBA data

Basketball-Reference.com provides detailed data on NBA teams and players. We'll look at team data for 4 seasons ending in 2016; each of these metrics is the average across the season:

- **PTS**: Total points
- **PCT3P**: Percentage of 3-point shots made
- **N3PA**: Number of 3-point shots attempted

There are 30 NBA teams $\times$ 4 seasons = 120 cases in this file.

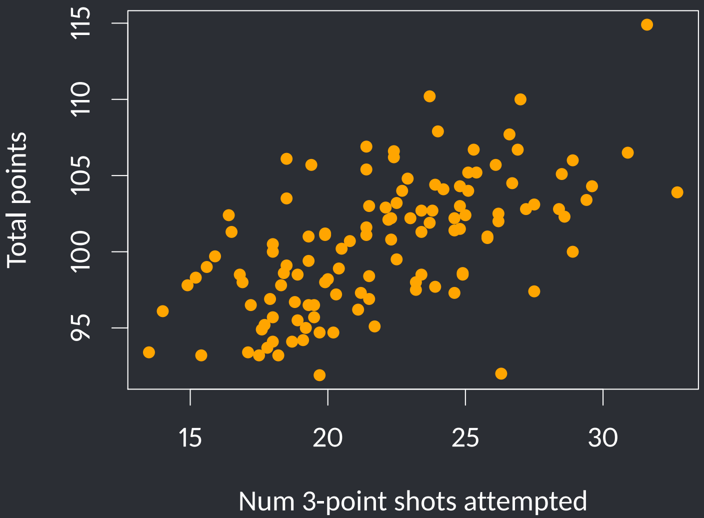
NBA data

In basketball, there are three ways to score:

basketball-court.png

- **1 point** for free throws made after a foul by the other team
- **2 points** for shots made inside the 3-point line
- **3 points** for shots made outside the 3-point line

```
plot(nba$N3PA, nba$PTS, pch=16, col='orange',
  xlab='Num 3-point shots attempted', ylab='Total points')
```



```r
model1 <- lm(PTS ~ N3PA, data=nba)
summary(model1)
```

```
Call:
lm(formula = PTS ~ N3PA, data = nba)

Residuals:
     Min       1Q   Median       3Q      Max 
-11.2454  -2.5114   0.0549   2.2252   8.6405 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) 86.19204    1.77464  48.569  < 2e-16 ***
N3PA         0.64842    0.07935   8.171 3.89e-13 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.496 on 118 degrees of freedom
Multiple R-squared:  0.3614,Adjusted R-squared:  0.356 
F-statistic: 66.77 on 1 and 118 DF,  p-value: 3.889e-13
```

Can we do better?

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This means that **most** of the variance (64%) in total points is **not** explained by the number of 3-point attempts.

Let's add another variable to our model — why might 3-point percentage be useful as another predictor?

Can we do better?

```
model2 <- lm(PTS ~ N3PA + PCT3P, data=nba)
summary(model2)



Call:
lm(formula = PTS ~ N3PA + PCT3P, data = nba)

Residuals:
    Min      1Q  Median      3Q     Max 
-8.3487 -2.1392 -0.0791  1.8691  9.1904 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) 62.00493    5.61396  11.045  < 2e-16 ***
N3PA         0.56467    0.07587   7.442 1.82e-11 ***
PCT3P        0.73415    0.16292   4.506 1.57e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.241 on 117 degrees of freedom
Multiple R-squared:  0.4558,Adjusted R-squared:  0.4465 
F-statistic:    49 on 2 and 117 DF,  p-value: 3.478e-16
```

Can we do even better?

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This sounds like an interaction — let's make a model with an interaction between the two predictors!

```r
model3 <- lm(PTS ~ N3PA * PCT3P, data=nba)
summary(model3)
```

```
Call:
lm(formula = PTS ~ N3PA * PCT3P, data = nba)

Residuals:
    Min      1Q  Median      3Q     Max 
-7.2629 -2.2757  0.1148  1.9698  9.3756 

Coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept) 122.84903   30.58937   4.016 0.000105 ***
N3PA         -2.11904    1.32903  -1.594 0.113561    
PCT3P        -0.98410    0.86465  -1.138 0.257400    
N3PA:PCT3P    0.07561    0.03739   2.023 0.045423 *  
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.199 on 116 degrees of freedom
Multiple R-squared:  0.4743,Adjusted R-squared:  0.4608 
F-statistic: 34.89 on 3 and 116 DF,  p-value: 3.798e-16
```

Model 3 corresponds to the regression equation

$$\widehat{\text{PTS}} = 122.85 - 2.12 \cdot \text{N3PA} - 0.98 \cdot \text{PCT3P} + 0.08 \cdot \text{N3PA} \cdot \text{PCT3P}.$$

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- **Intercept** (122.85) is our prediction of total points when $\text{N3PA} = \text{PCT3P} = 0$. (Meaningless in this context!)

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- **N3PA** (-2.12) is the predicted increase in total points for each additional 3-pointer taken, when $\text{PCT3P} = 0$.

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  - the increase in the *slope coefficient* for N3PA for each 1-unit increase of PCT3P.

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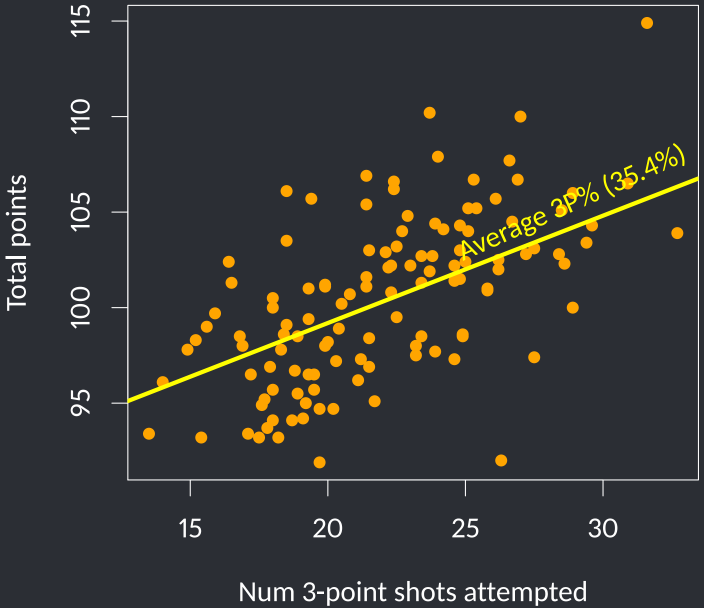
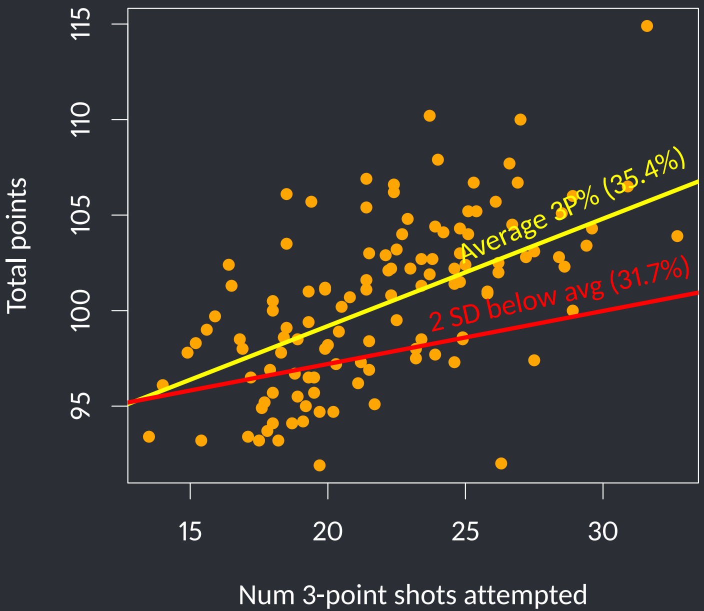

Average 3P% (35.4%)
Total points
115
110
105
100
95
15
20
25
30
Num 3-point shots attempted


Total points
Num 3-point shots attempted
95
100
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110
115
15
20
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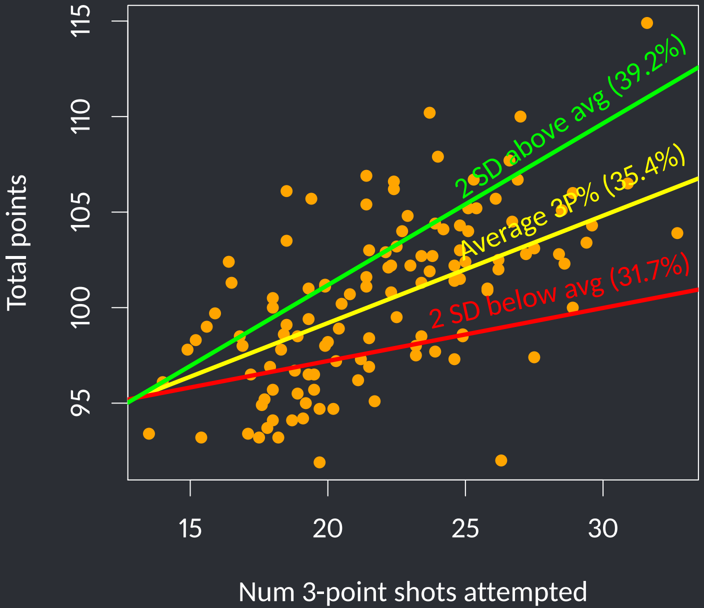
Average 3P% (35.4%)
2 SD below avg (31.7%)



2 SD above avg (39.2%)
Average 3P% (35.4%)
2 SD below avg (31.7%)
Total points
95
100
105
110
115
15
20
25
30
Num 3-point shots attempted

$$\widehat{\text{PTS}} = 122.85 - 2.12 \cdot \text{N3PA} - 0.98 \cdot \text{PCT3P} + 0.08 \cdot \text{N3PA} \cdot \text{PCT3P}.$$

- How many points per game do you predict for a team that shoots 3-pointers at the NBA average rate (35.4) and that takes 30 3-pointers per game?

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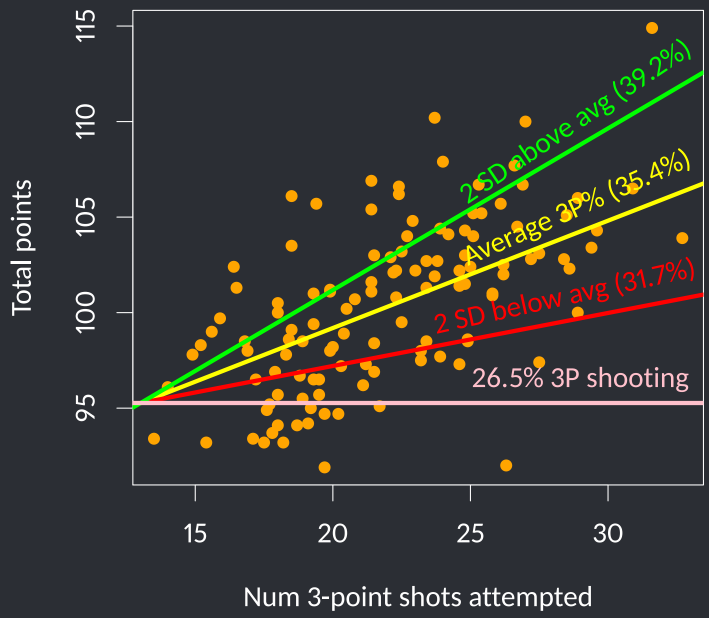
- How many points per game do you predict for a team that shoots 3-pointers at the NBA average rate (35.4) and that takes 30 3-pointers per game?
- How bad would a team have to shoot the 3 before taking 3-point shots start to have a negative impact on total points?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Average 3P% (35.4%)
2 SD below avg (31.7%)
26.5% 3P shooting