THE UNIVERSITY OF TEXAS AT AUSTIN
McCOMBS SCHOOL OF BUSINESS

Interactions 2

Lecture 16

STA 371G

Project

- It's time to start thinking about our final project!
- You will work in groups of 4—sign up on Canvas by Sunday, March 25. You can create your own group or add to an existing group. Please fill partial groups before starting a new group.
- Your task will be to find or gather a regression data set, build an appropriate regression model, and write and present a report containing your findings.
- You must send me a proposal by Sunday, April 1 (details on handout available on Canvas)

Project

- Your data set must include
  - At least 100 data points.
  - At least 8 explanatory variables, at least one quantitative and one categorical.
- Your data set must not be:
  - A data set for which an existing analysis is published online.
  - A data set that is built in to R or from the R dataset package.
  - A data set that is more than 10 years old, or a data set for which more current data is readily available.

Project

Some examples from past years:

- Predicting **NBA player points-per-game**, with predictors including player height, position, and years in the NBA.
- Predicting **GPA**, with predictors including gender, number of classes, and hours of sleep.
- Predicting **grocery expenditure**, with predictors including age, gender, amount of exercise, and income.
- Predicting **high school graduation rates**, with predictors including presence of AP program, SAT/ACT scores, and spending per capita.
- Predicting **flight prices**, with predictors including mileage, days in advance, and weekday of flight.

NBA data

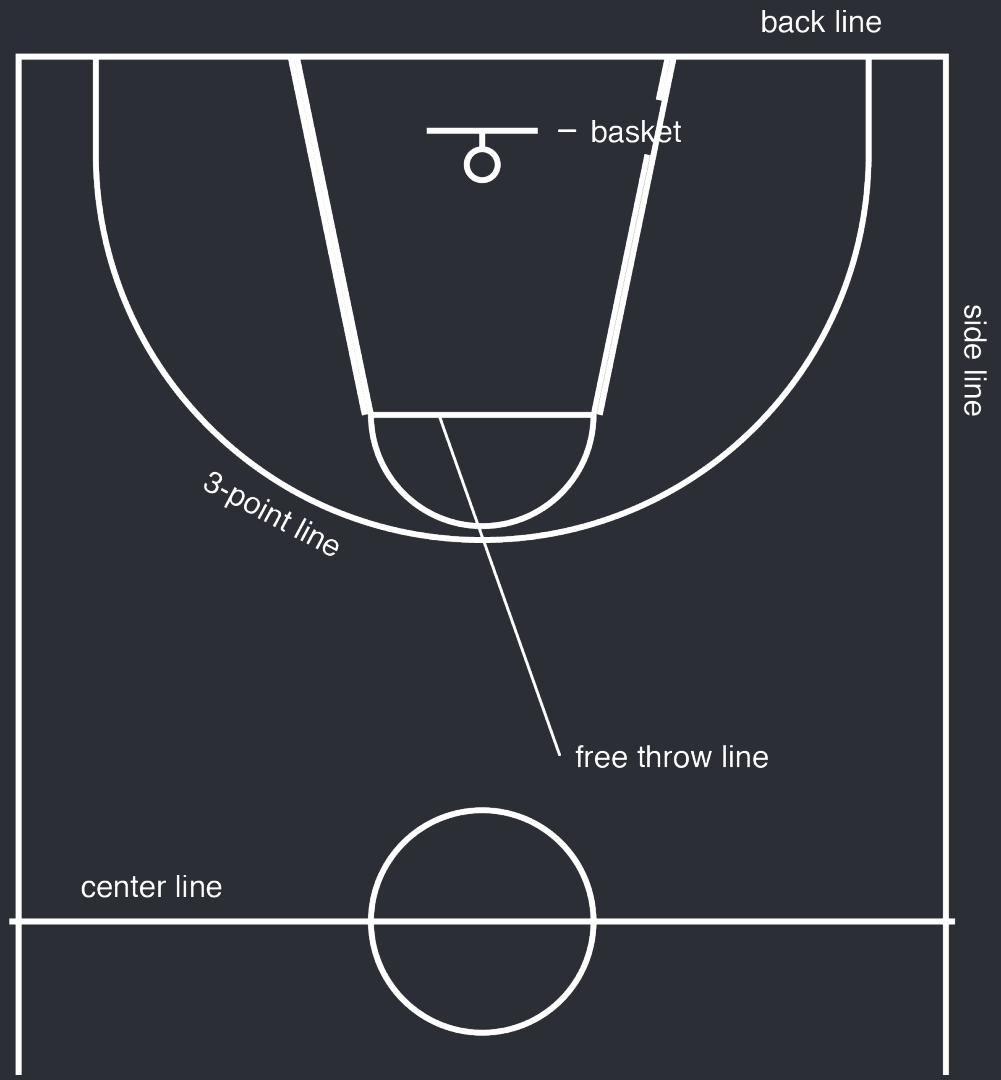
Basketball-Reference.com provides detailed data on NBA teams and players. We'll look at team data for 4 seasons ending in 2016; each of these metrics is the average across the season:

- **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.

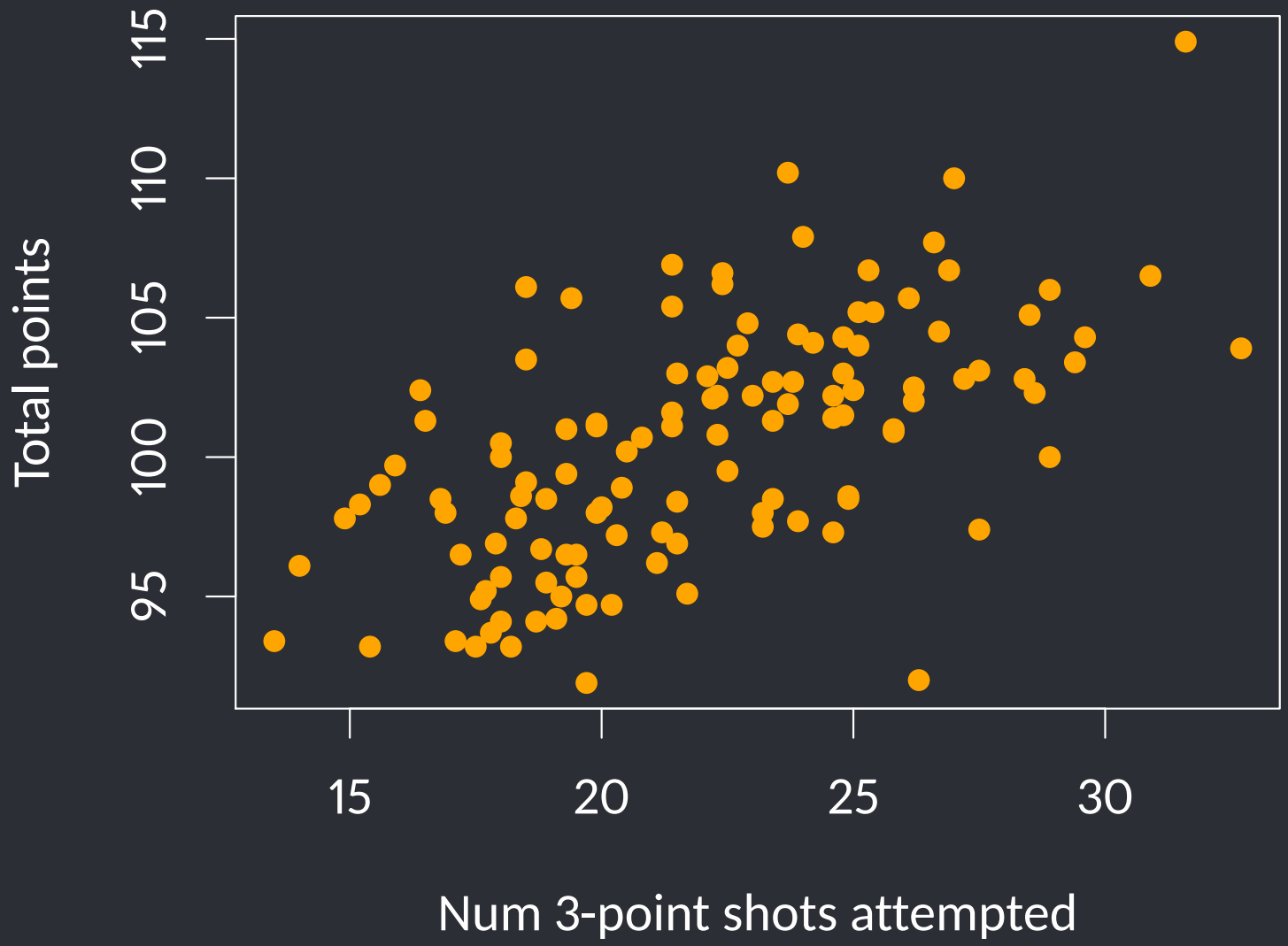
NBA data

In basketball, there are three ways to score:



- **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?

$R^2 = 36\%$, so we can explain 36% of the variance in total points based only on knowing the number of 3-point attempts.

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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?

It would make sense that the **impact** of the number of 3-pointers taken on total points would **depend on** how well the team shoots the 3!

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It would make sense that the **impact** of the number of 3-pointers taken on total points would **depend on** how well the team shoots the 3!

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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- **PCT3P** ($-$0.98) is the predicted increase in total points for each additional percentage point of 3-point shooting accuracy, when N3PA $=$ 0.

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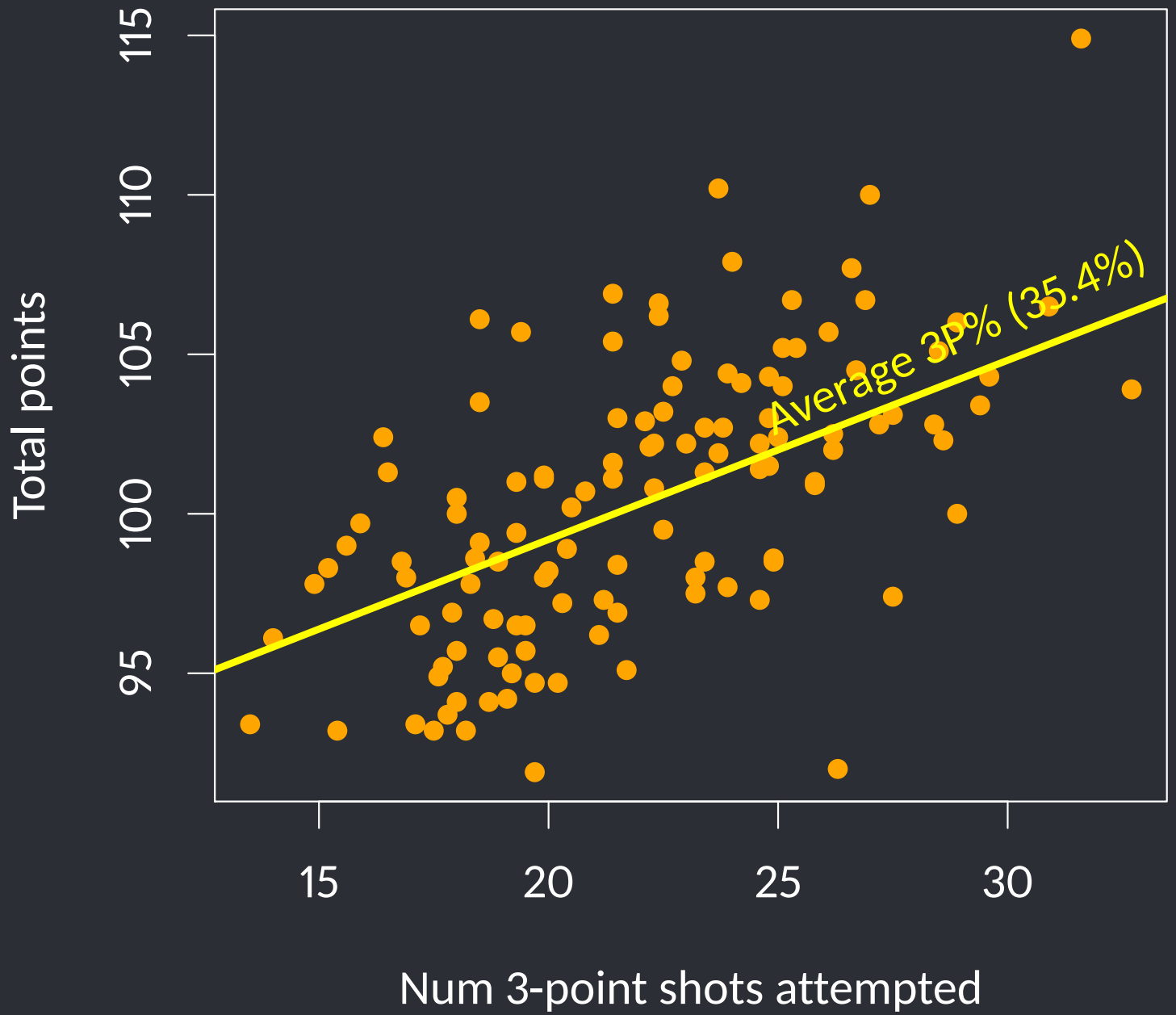
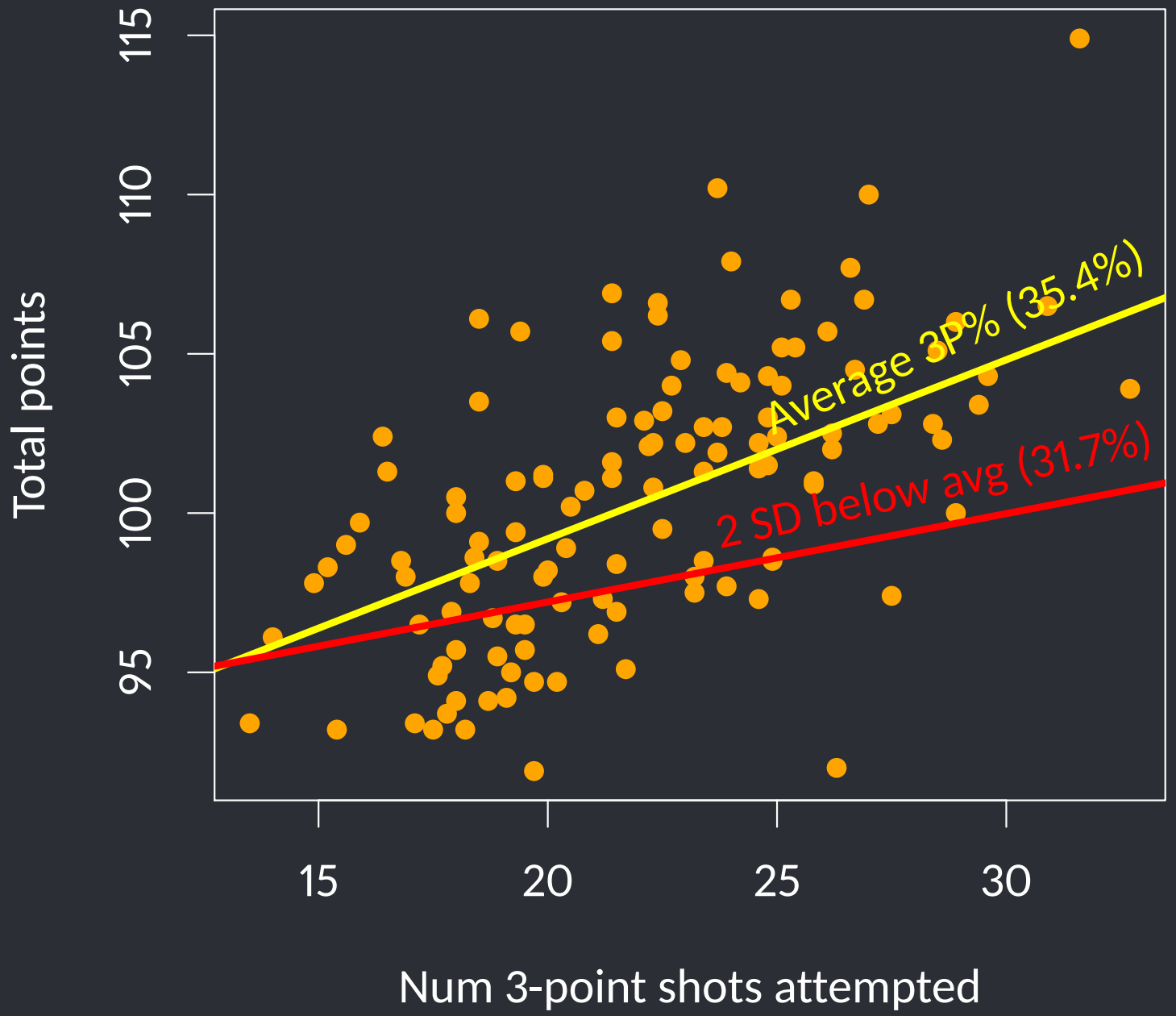

Total points
95
100
105
110
115
15
20
25
30
Num 3-point shots attempted
Average 3P% (35.4%)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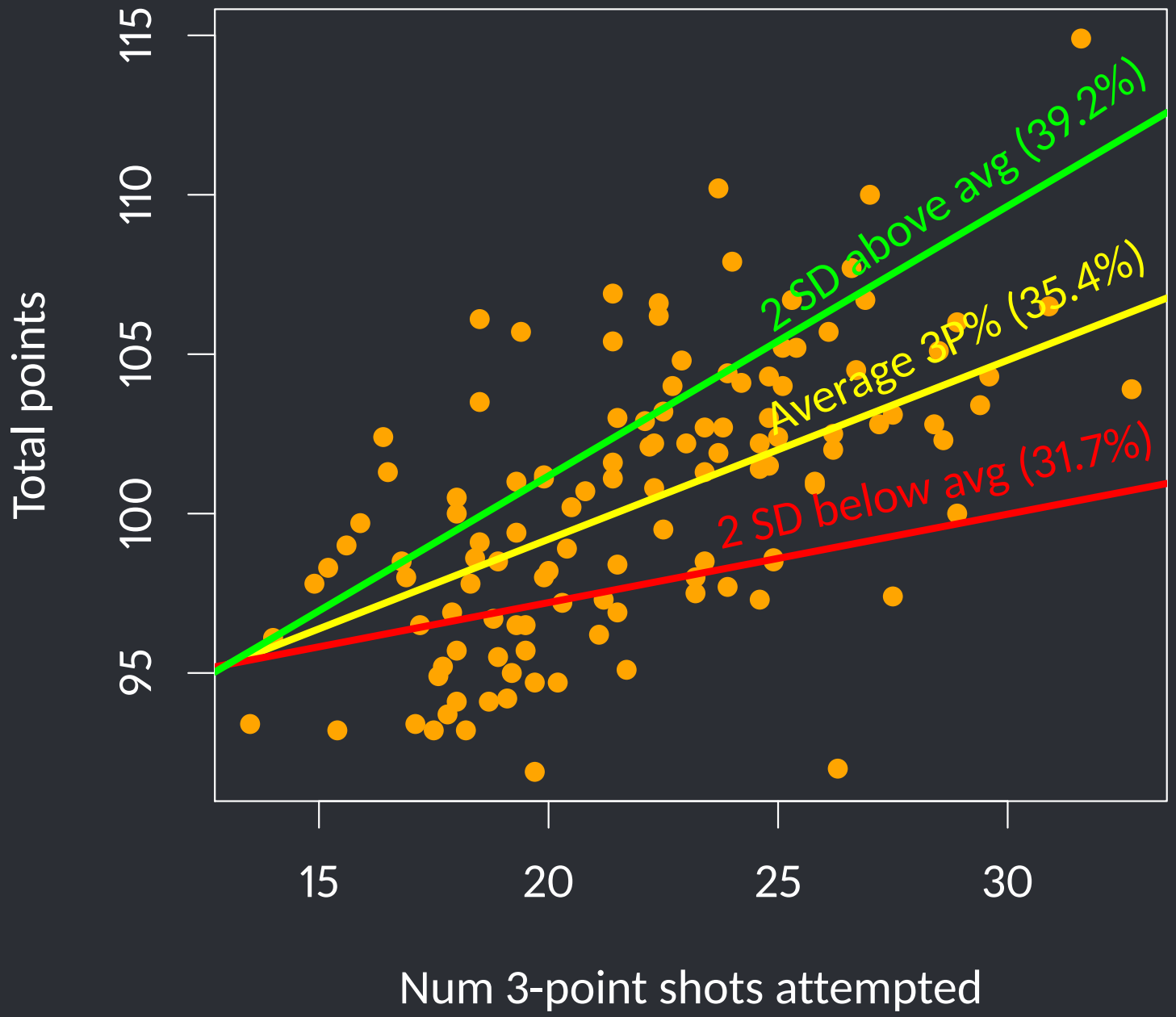
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2 SD above avg (39.2%)
Average 3P% (35.4%)
2 SD below avg (31.7%)

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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?

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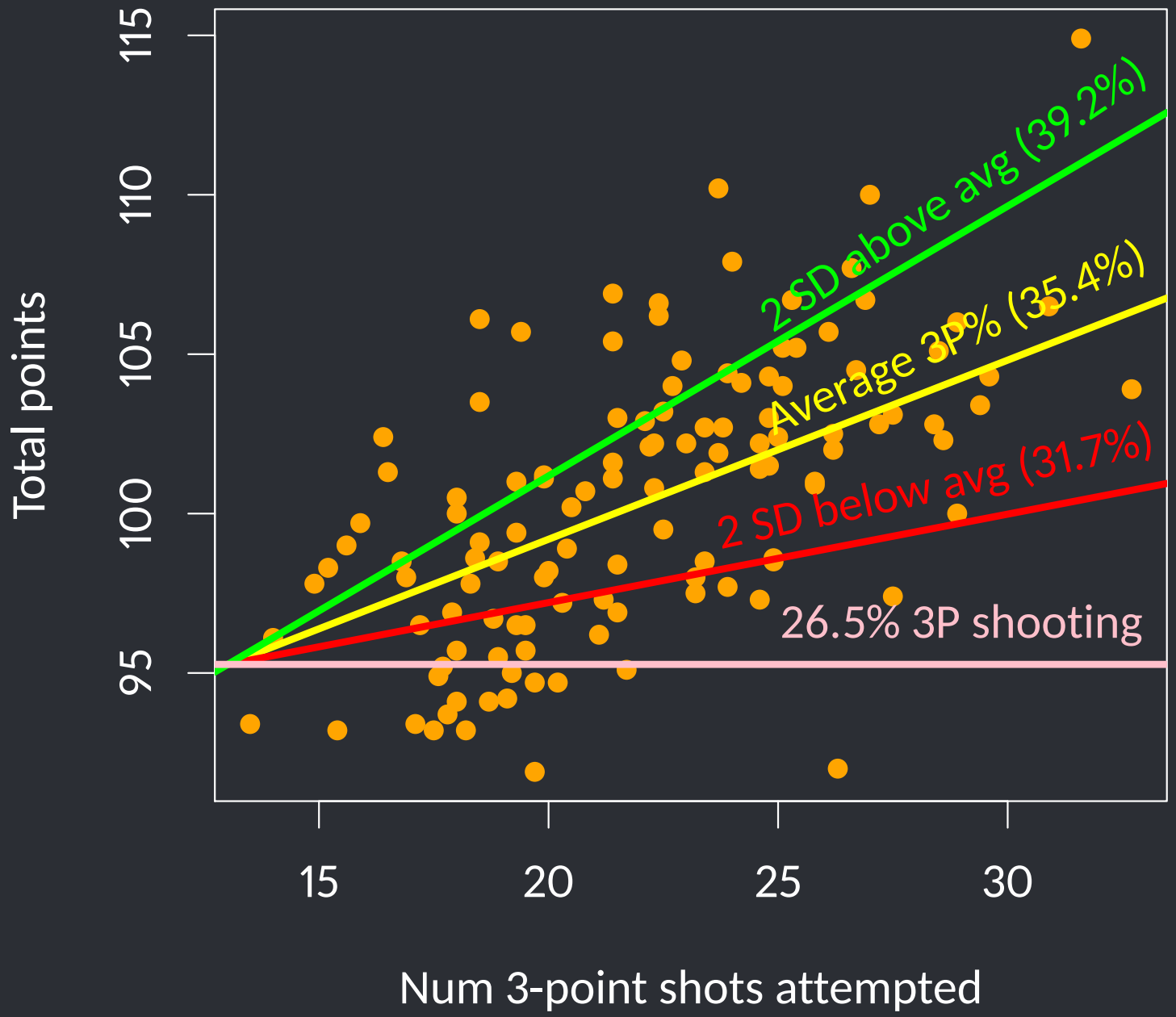
- How many points per game do you predict for a team that shoots 3-pointers at the NBA average rate (35.4) and that takes 30 3-pointers per game?
- How bad would a team have to shoot the 3 before taking 3-point shots start to have a negative impact on total points?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26.5%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