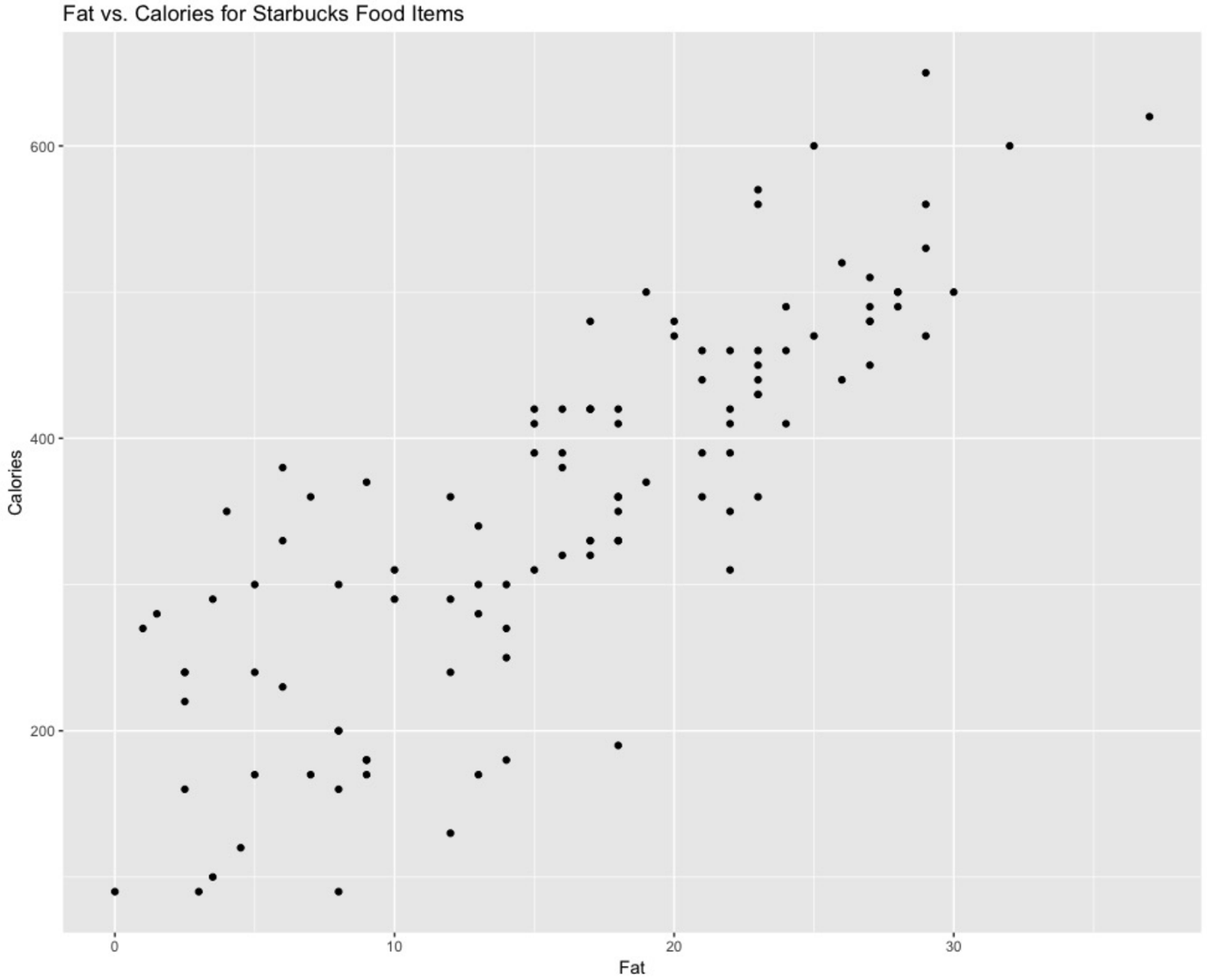
Welcome to the course!

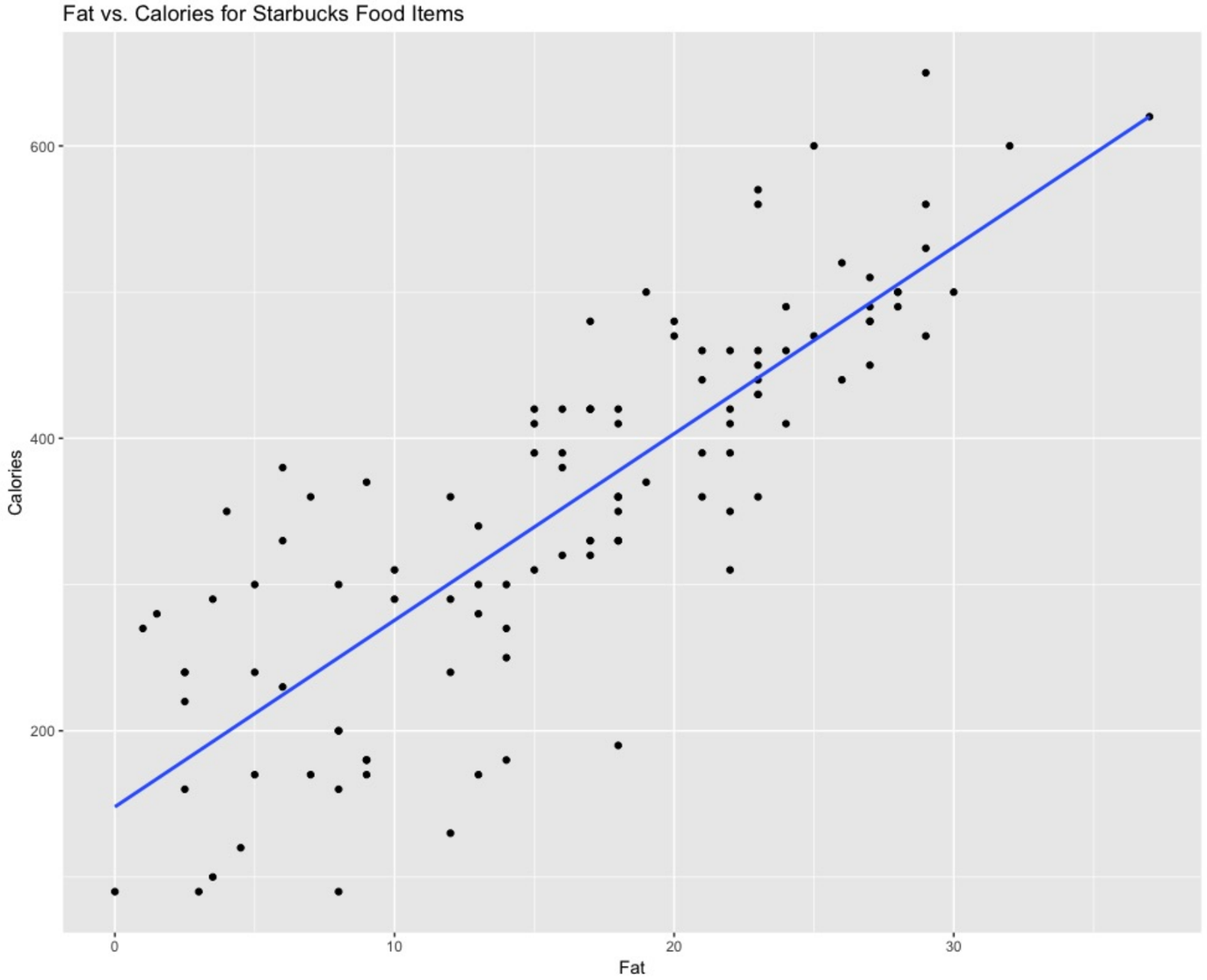
INFERENCE FOR LINEAR REGRESSION IN R

Jo Hardin
Professor, Pomona College

In this course you will

- Make inferential claims about models.
- Use least squares estimation.
- Create confidence intervals for the slope.


Fat vs. Calories for Starbucks Food Items
Calories
600
400
200
0
10
20
30
Fat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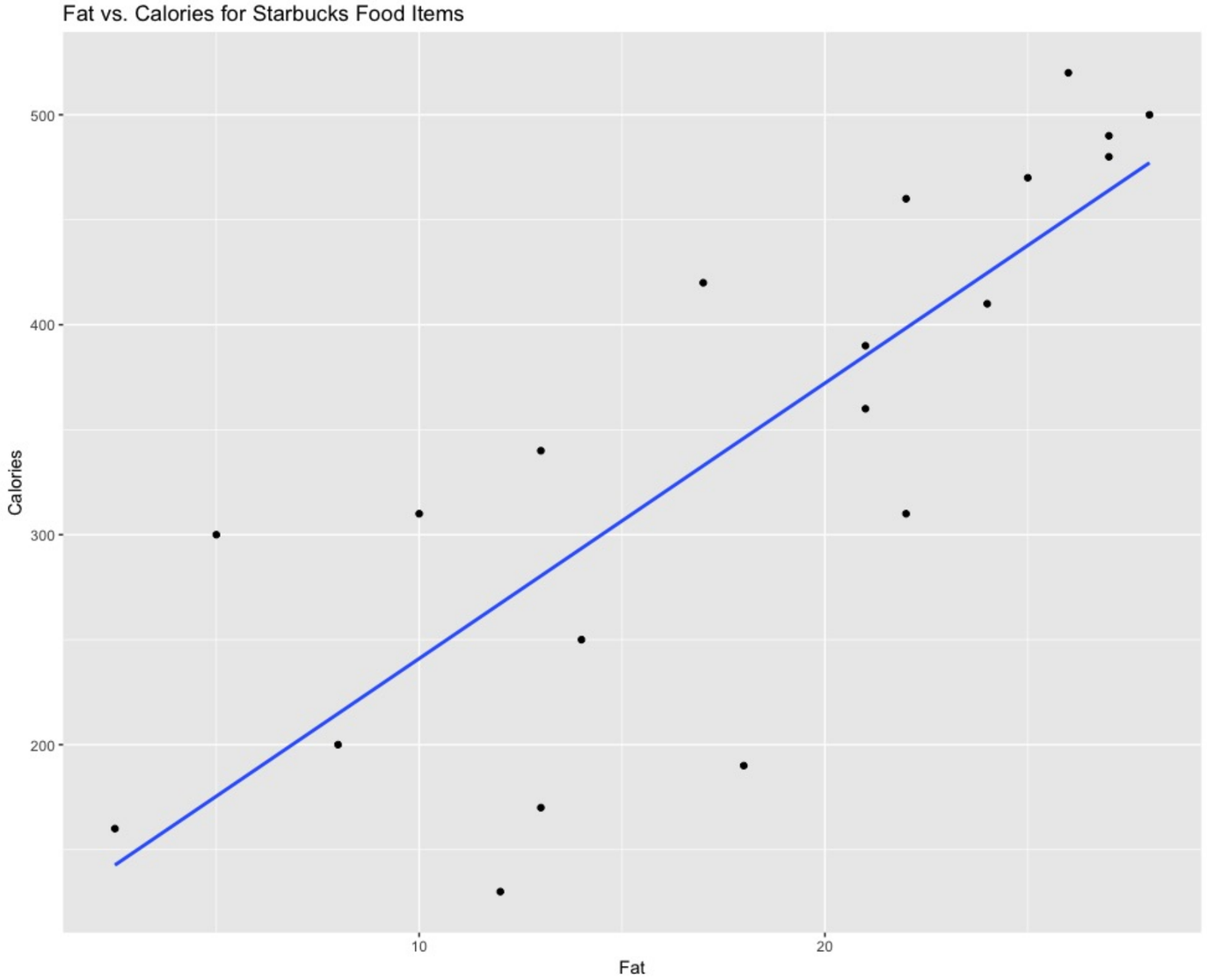
Fat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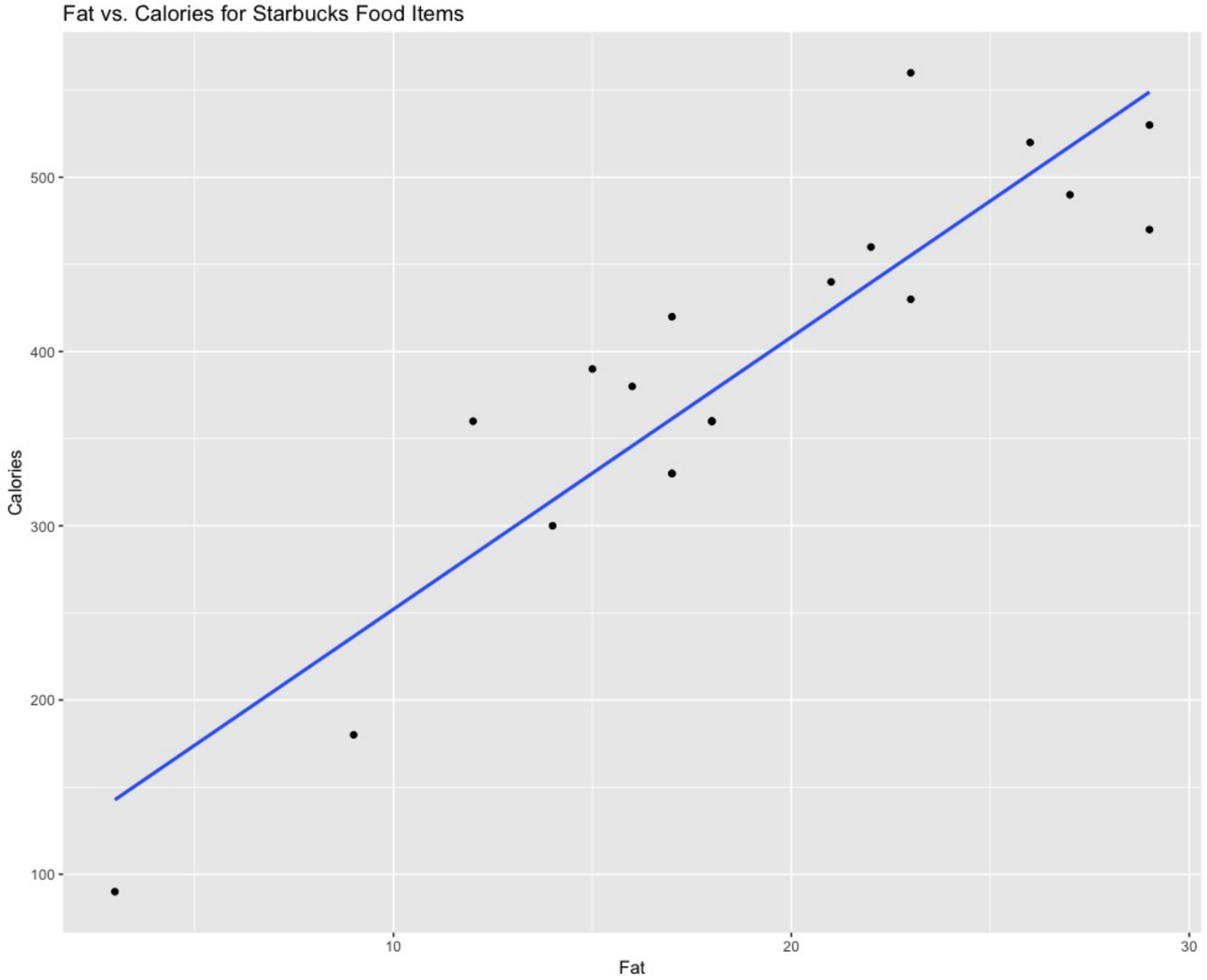
Calories
500
400
300
200
10
20
Fat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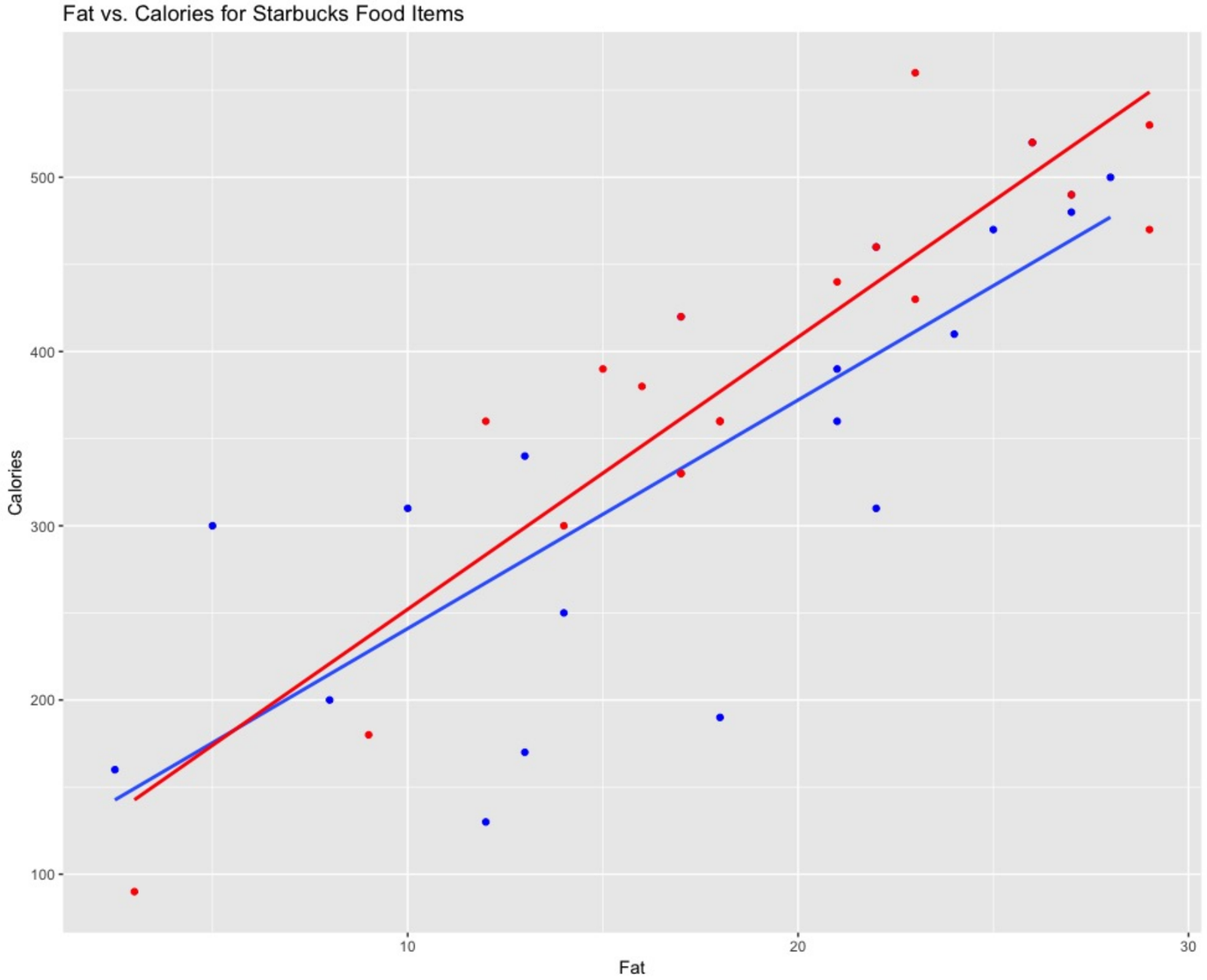
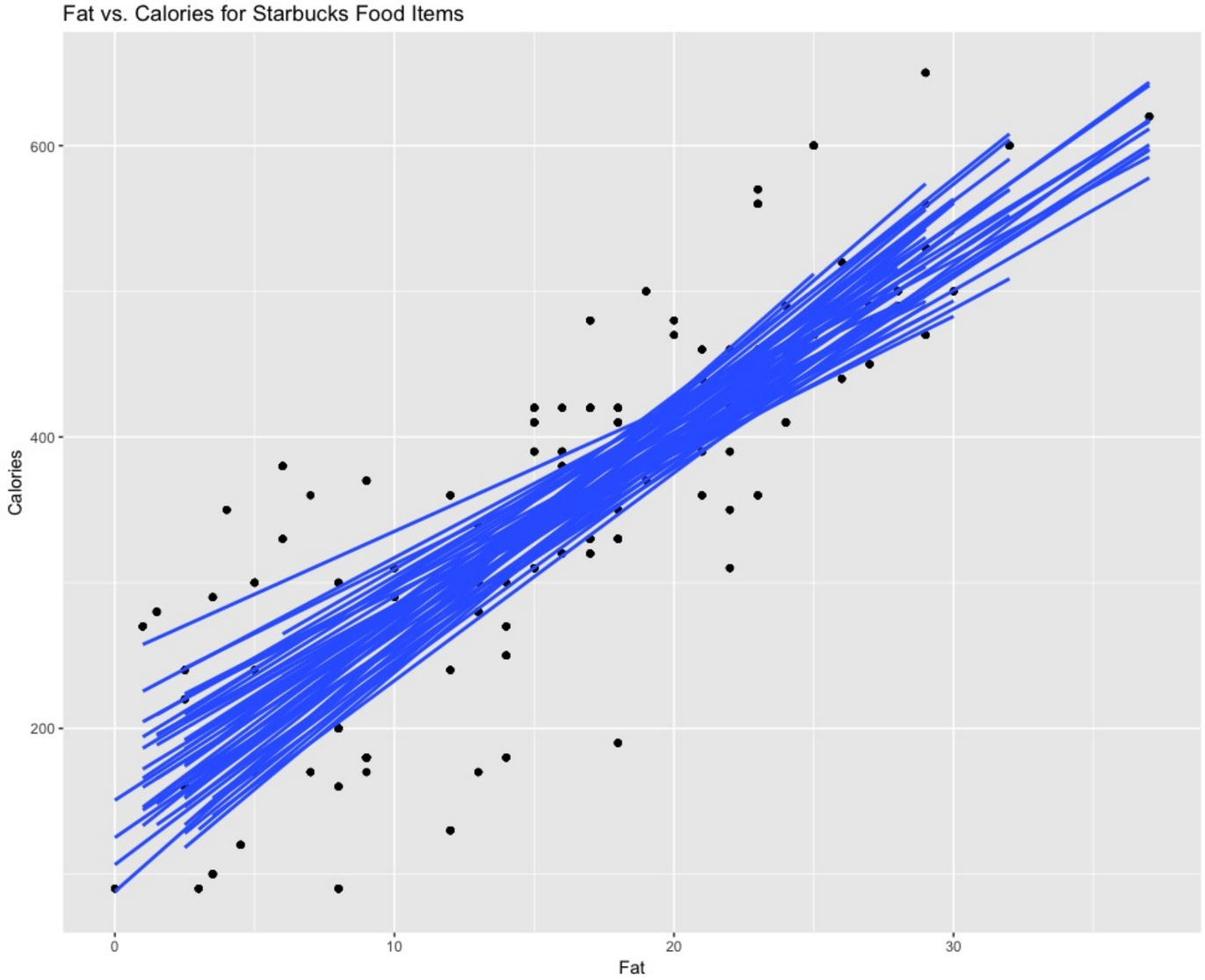
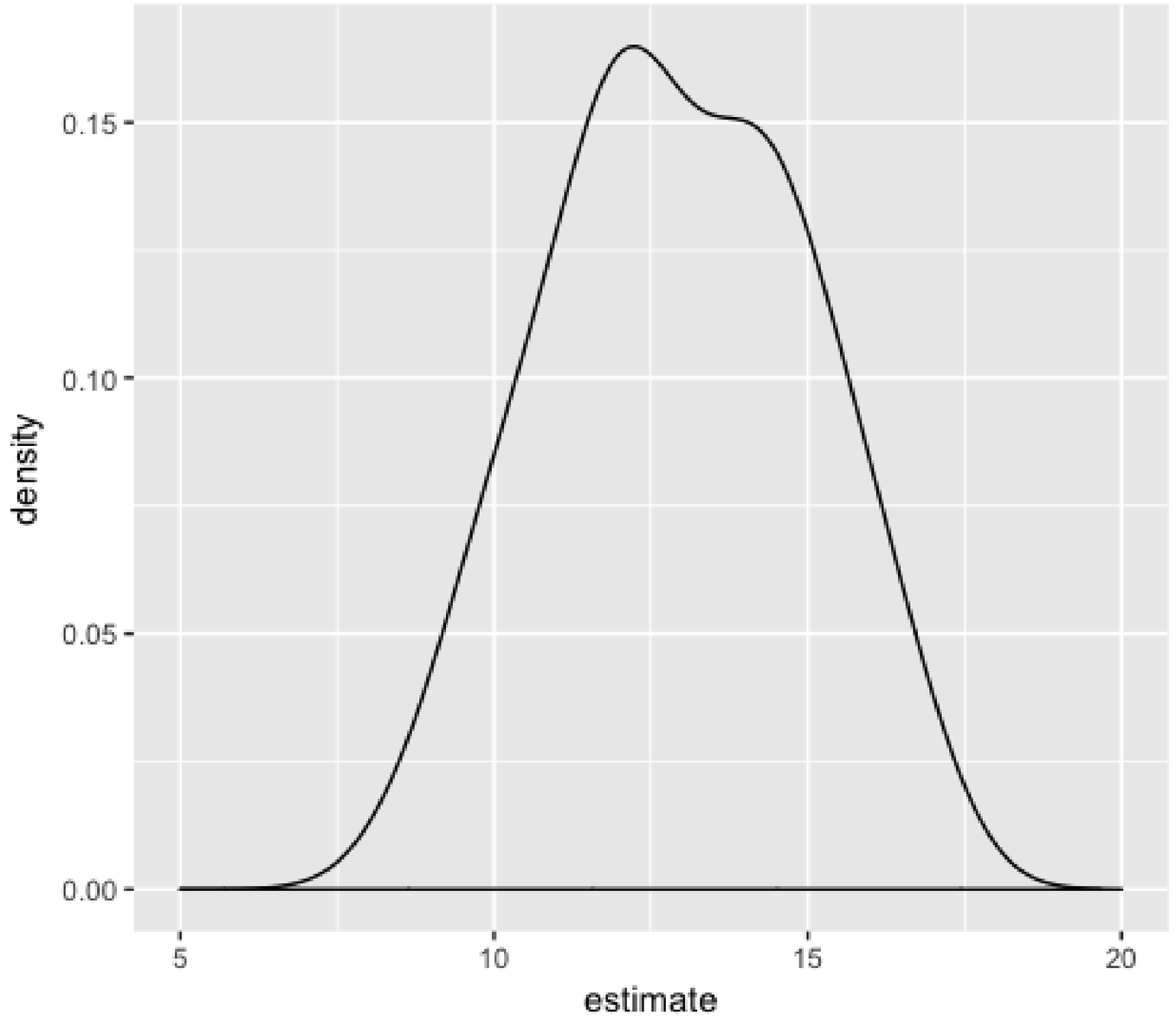
Calories
500
400
300
200
100
10
20
30
Fat


Fat vs. Calories for Starbucks Food Items
Calories
500
400
300
200
100
10
20
30
Fat

Sampling variability

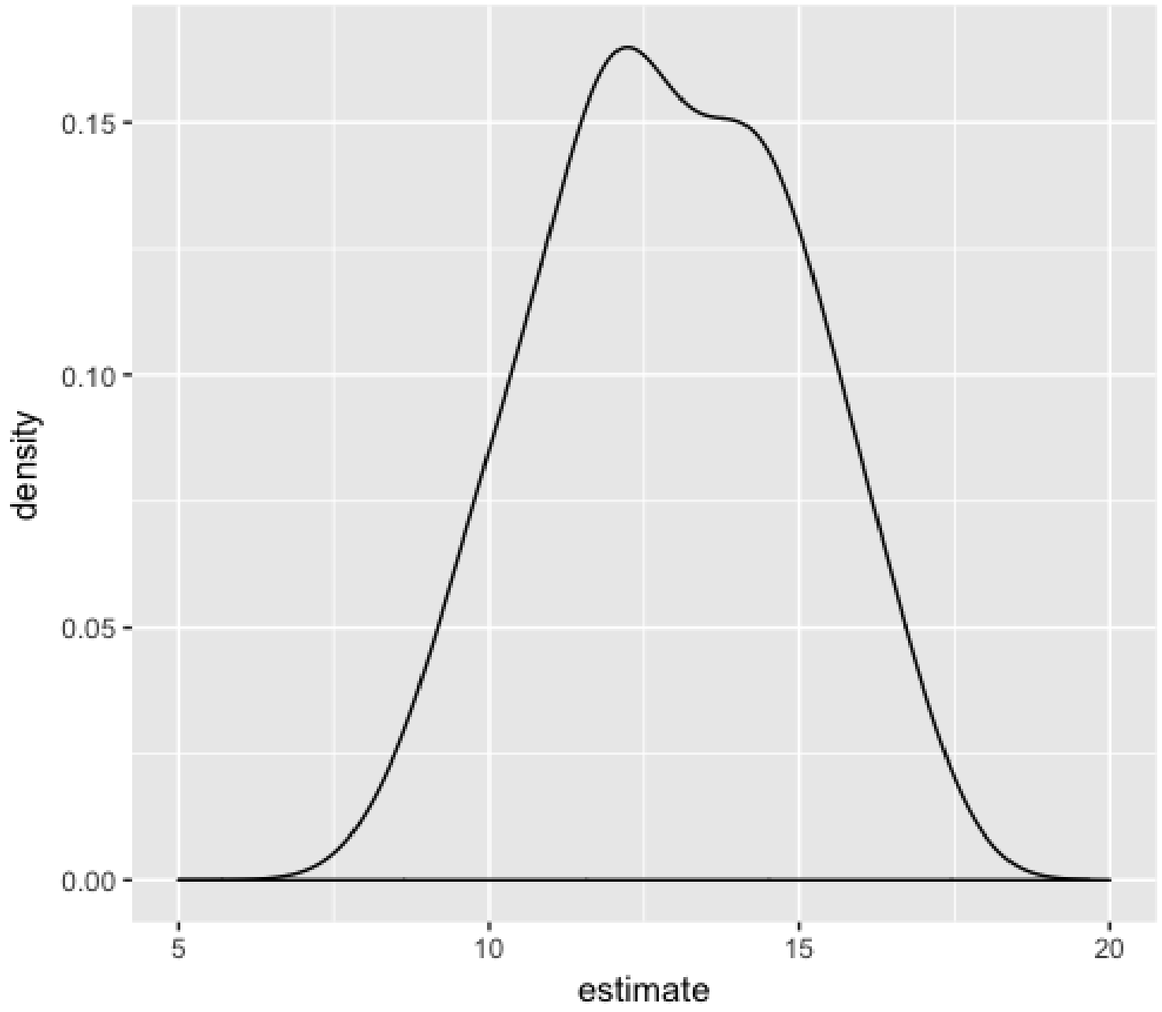
- Variability in the regression line

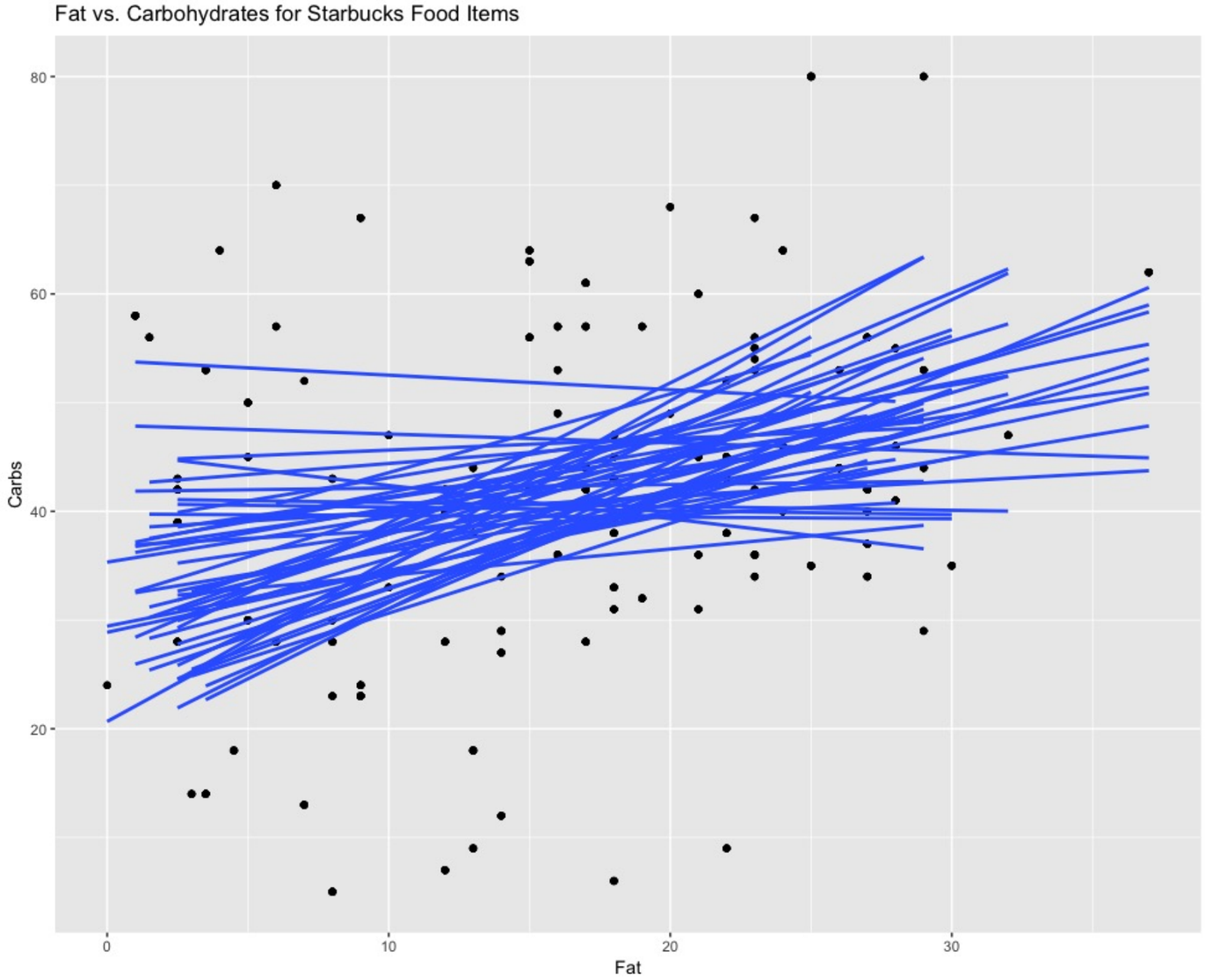

Fat vs. Calories for Starbucks Food Items
Calories
600
400
200
0
10
20
30
Fat

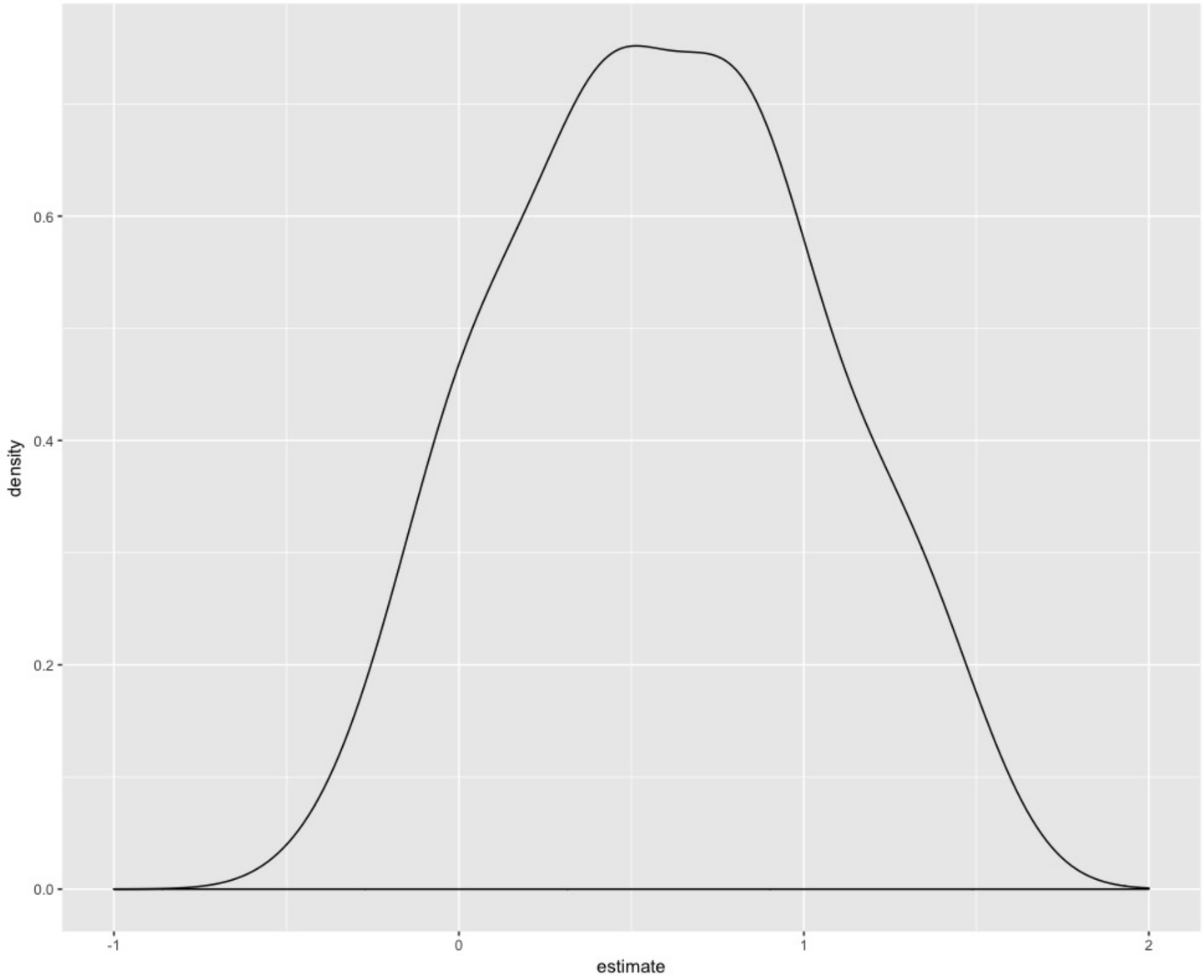

0.15
0.10
0.05
0.00
density
5
10
15
20
estimate

Interpret the density plot

- Slopes between 8 and 17
- None close to zero
- Strong evidence the association is positive

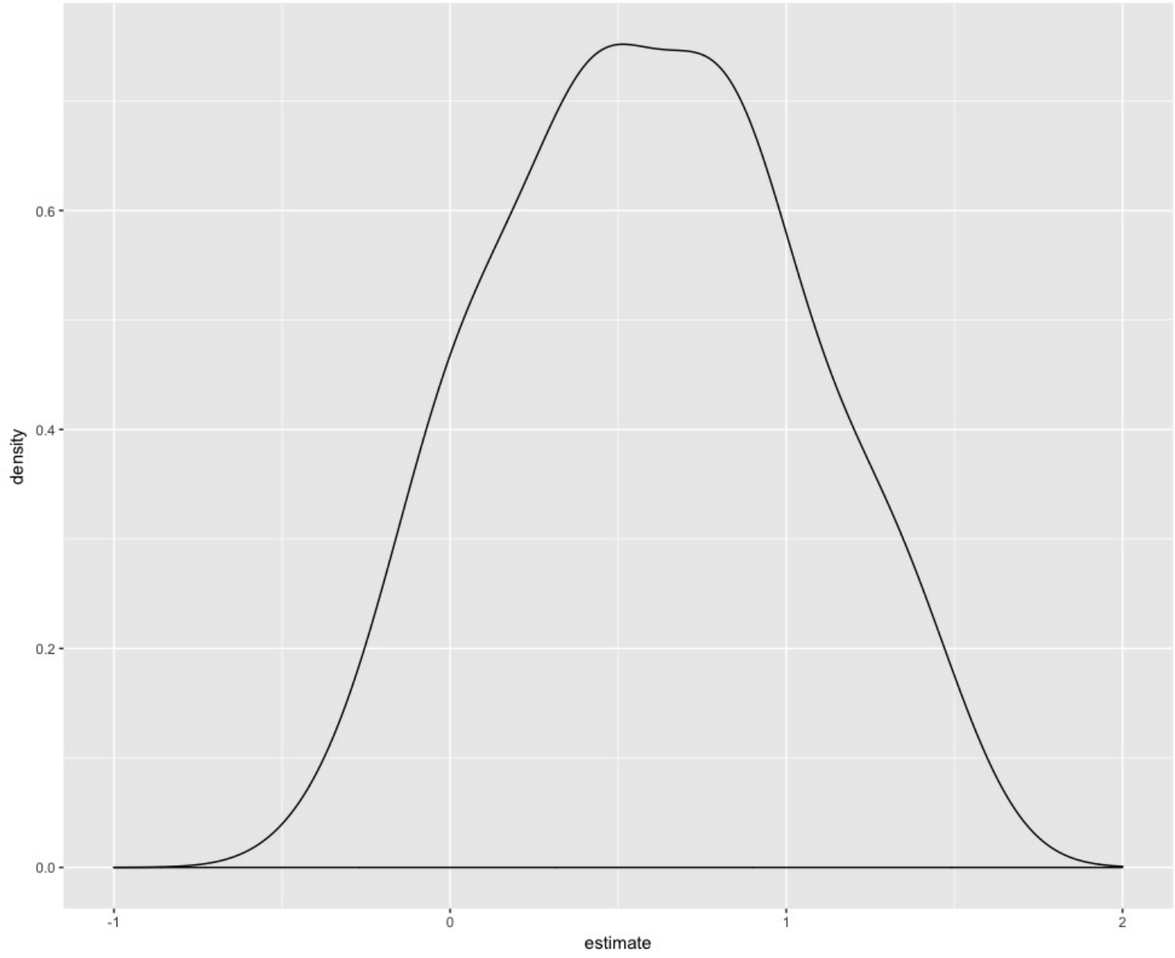



Fat vs. Carbohydrates for Starbucks Food Items
Carbs
80
60
40
20
0
10
20
30
Fat


density
0.6
0.4
0.2
0.0
-1
0
1
2
estimate

Interpreting the density plot

- Some slopes close to zero
- High variability
- We can't make any conclusions



Let's practice!

INFERENCE FOR LINEAR REGRESSION IN R

Research question

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Consider possible research questions for the Starbucks data

- Are protein and carbohydrates linearly associated in the population? (two-sided research question)
- Are protein and carbohydrates linearly associated in a **positive** direction in the population? (one-sided research question)

```
head(starbucks)
```

```
A tibble: 6 x 6
                                 Item Calories   Fat Carbs
                                <chr>    <int> <dbl> <int>
1                        Chonga Bagel      300     5    50
2                        8-Grain Roll      380     6    70
3                      Almond Croissant      410    22    45
4                         Apple Fritter      460    23    56
5                      Banana Nut Bread      420    22    52
6 Blueberry Muffin with Yogurt and Honey      380    16    53
# ... with 2 more variables: Fiber <int>, Protein <int>
```

```
summary(lm(Carbs ~ Protein, data = starbucks))
```

```
Call:
lm(formula = Carbs ~ Protein, data = starbucks)
Residuals:
    Min      1Q  Median      3Q     Max
-35.360 -11.019   0.125   9.970  35.640
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  37.1116     2.4680   15.04   <2e-16 ***
Protein       0.3815     0.1734    2.20   0.0299 *
 ---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
...
```

```
lm(Carbs ~ Protein, data = starbucks) %>% tidy()
```

```
         term   estimate std.error statistic      p.value
1 (Intercept) 37.1116401 2.4680349 15.036919 1.539345e-28
2     Protein  0.3814696 0.1734226  2.199654 2.990434e-02
```

```
Call:
lm(formula = Carbs ~ Protein,
   data = starbucks)

Residuals:
    Min      1Q  Median      3Q     Max
-35.360 -11.019   0.125   9.970  35.640

Coefficients:
```

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summary(lm(Carbs ~ Protein,
        data = starbucks))
```

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            Estimate Std. Error
(Intercept)  37.1116     2.4680
Protein       0.3815     0.1734
            t value Pr(>|t|)
(Intercept)   15.04   <2e-16 ***
Protein        2.20   0.0299 *
--
Signif. codes:
  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Std. Error
2.4680
0.1734
```

```
lm(Carbs ~ Protein,
   data = starbucks) %>%
  tidy()
```

```
std.error
2.4680349
0.1734226
```

```
Call:
lm(formula = Carbs ~ Protein,
   data = starbucks)

Residuals:
    Min      1Q  Median      3Q     Max
-35.360 -11.019   0.125   9.970  35.640

Coefficients:
```

```
summary(lm(Carbs ~ Protein,
           data = starbucks))
```

```
t value
15.04
2.20
```

```
            Estimate Std. Error
(Intercept)  37.1116     2.4680
Protein       0.3815     0.1734
            t value Pr(>|t|)
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Protein        2.20   0.0299 *
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Signif. codes:
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```

```
lm(Carbs ~ Protein,
   data = starbucks) %>%
  tidy()
```

```
statistic
15.036919
 2.199654
```

```
Call:
lm(formula = Carbs ~ Protein,
   data = starbucks)

Residuals:
    Min      1Q  Median      3Q     Max
-35.360 -11.019   0.125   9.970  35.640

Coefficients:
```

```
summary(lm(Carbs ~ Protein,
        data = starbucks))
```

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            Estimate Std. Error
(Intercept)  37.1116     2.4680
Protein       0.3815     0.1734
            t value Pr(>|t|)
(Intercept)   15.04   <2e-16 ***
Protein        2.20   0.0299 *
--
Signif. codes:
  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Pr(>|t|)
<2e-16 ***
0.0299 *
```

```
lm(Carbs ~ Protein,
   data = starbucks) %>%
  tidy()
```

```
p.value
1.539345e-28
2.990434e-02
```

Let's practice!

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Variability of coefficients

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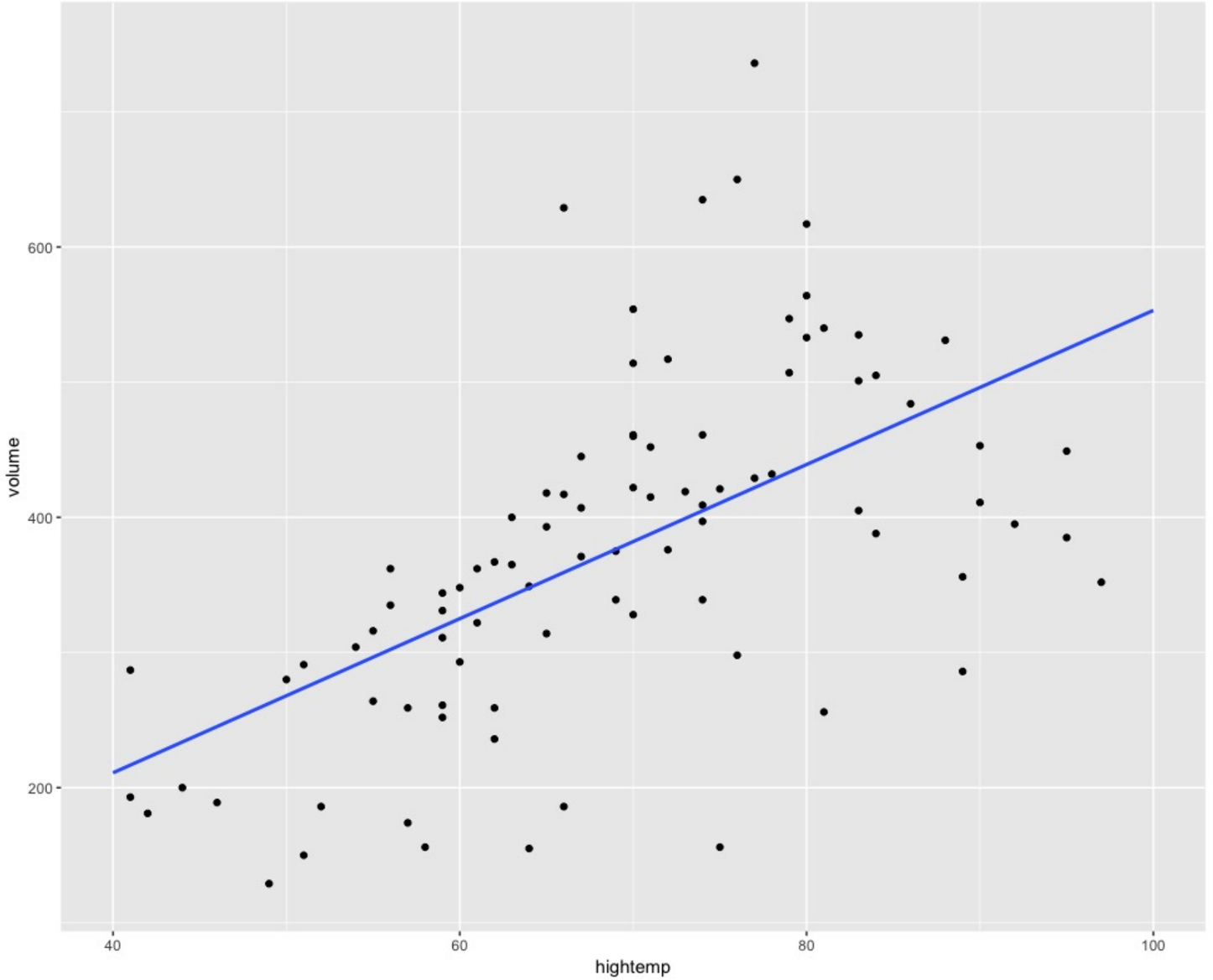
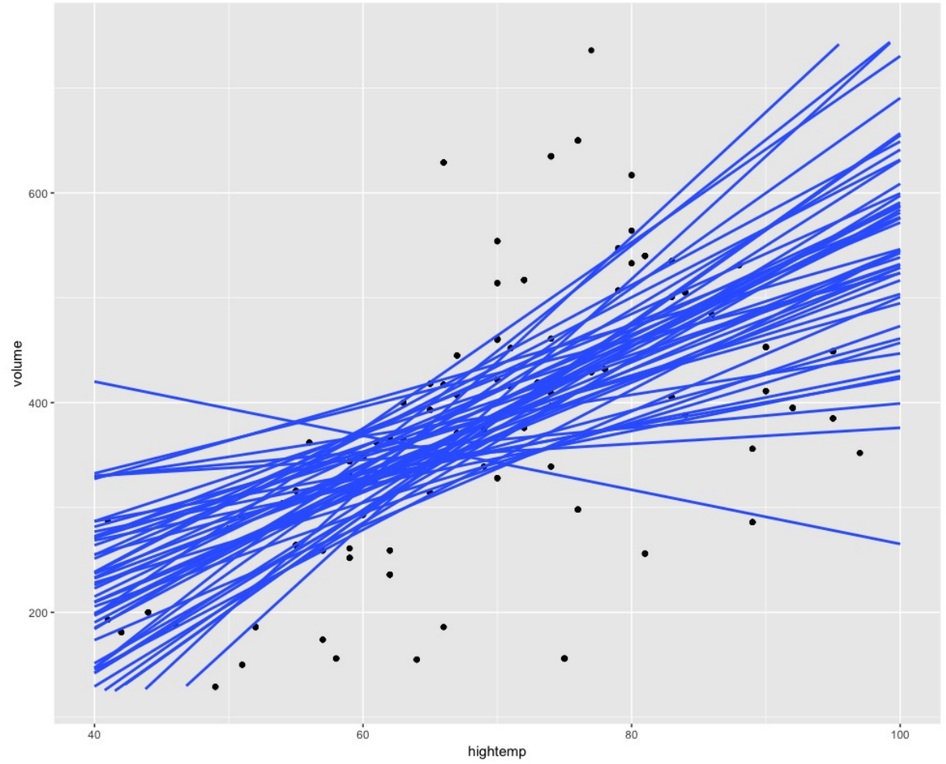
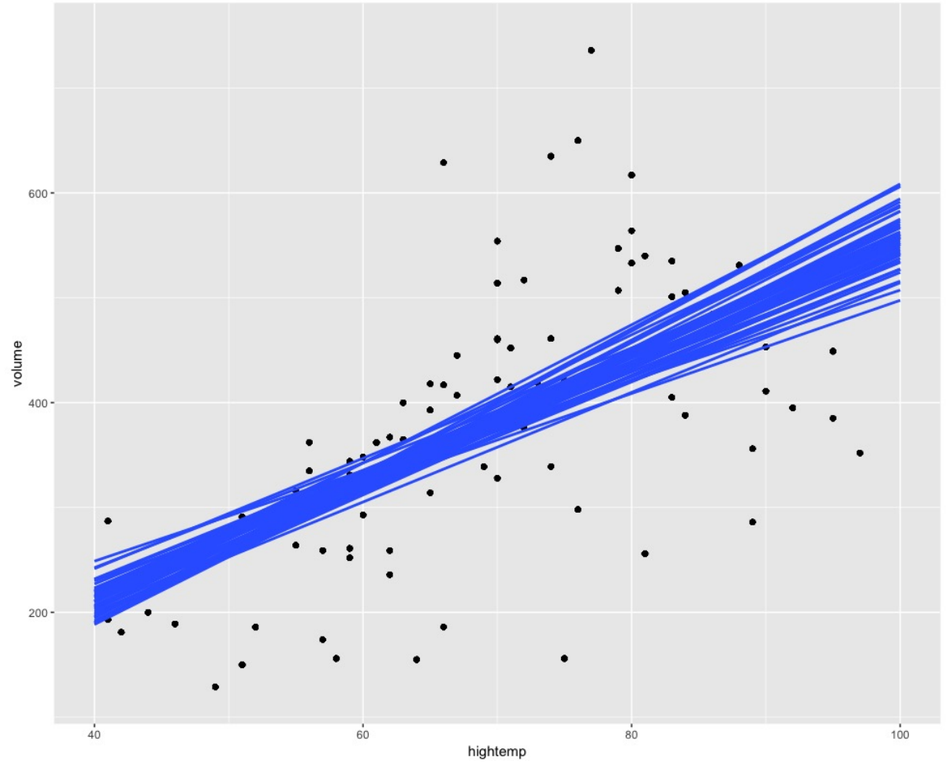

volume
600
400
200
40
60
80
100
hightemp

RailTrails - a change in sample size

n=10

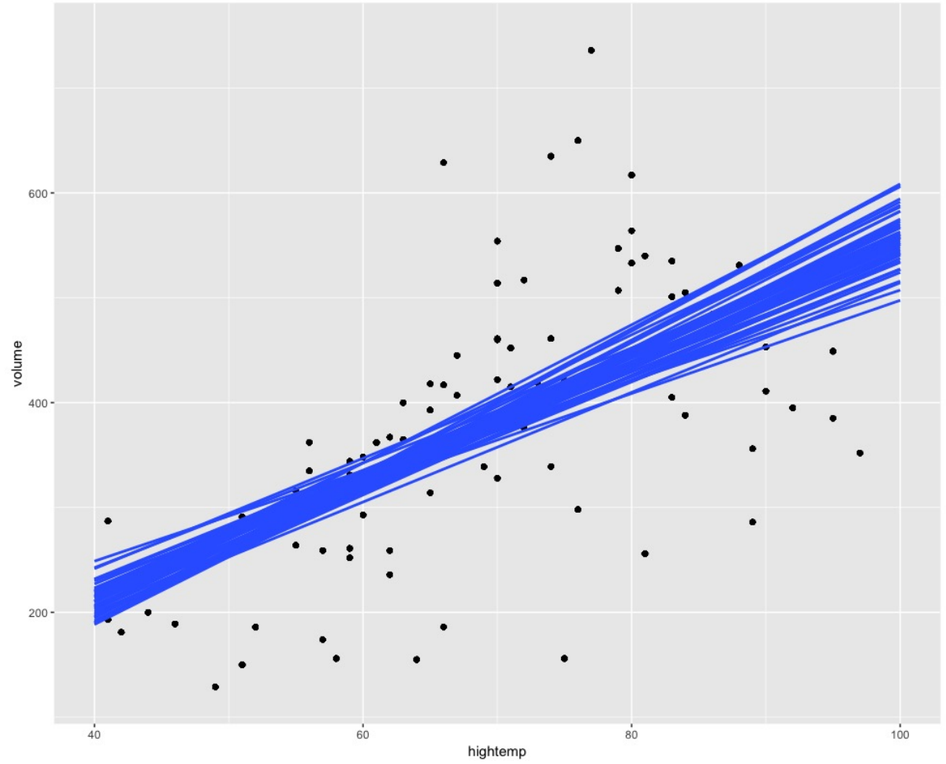


n=50

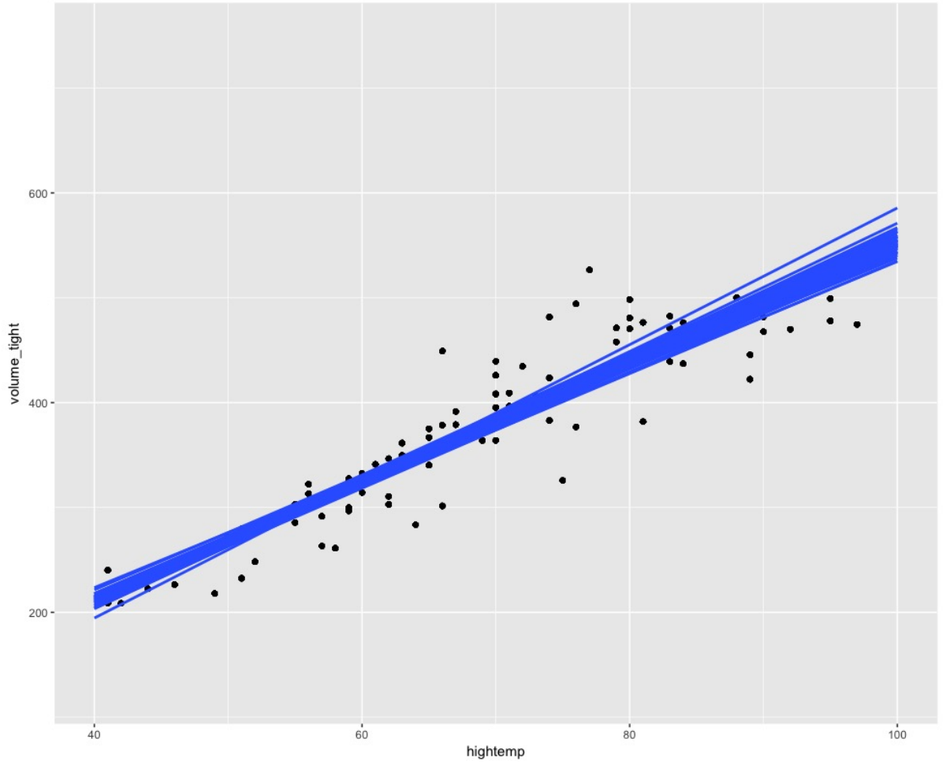


RailTrails - less variability around the line

n=50, original data

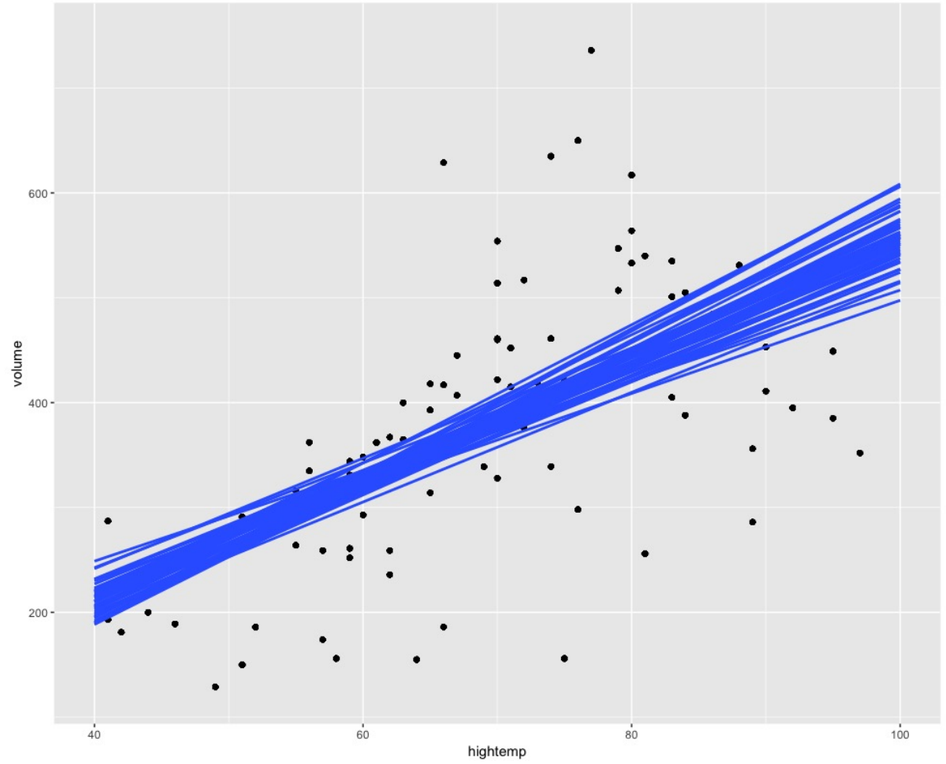


n=50, tighter data

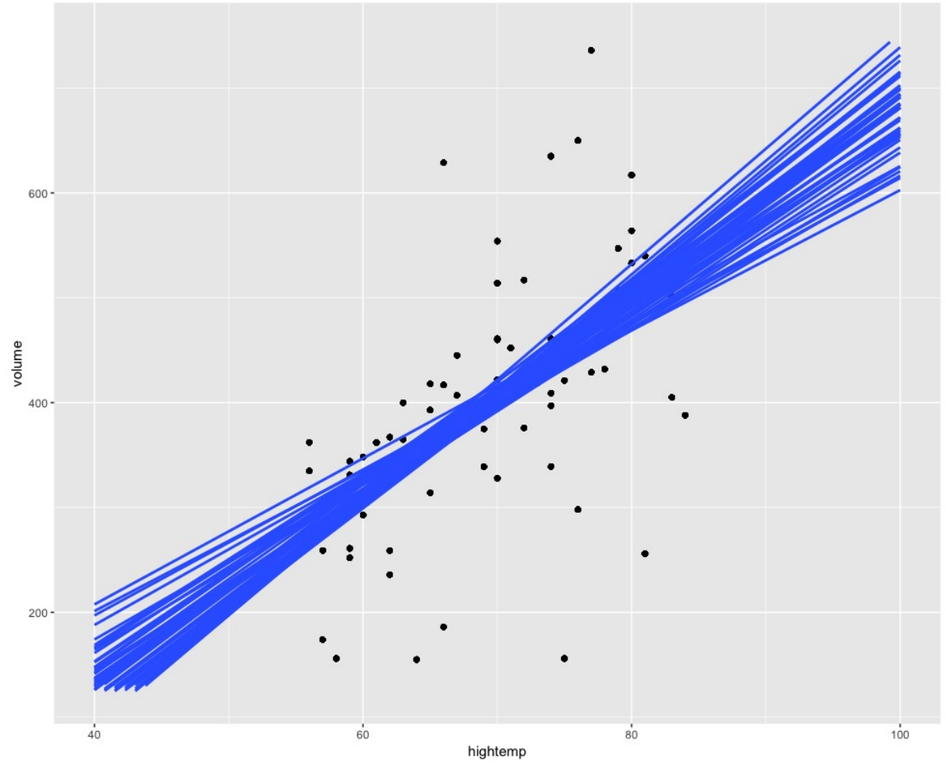


RailTrails - less variability in the x direction

n=50, original data



n=50, less data in x-direction



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