Practice fitting, evaluating and making point estimates using multiple linear regression models (ch 6)

Justin Leinaweaver (Spring 2022)

Multiple Linear Regression: Point Estimates
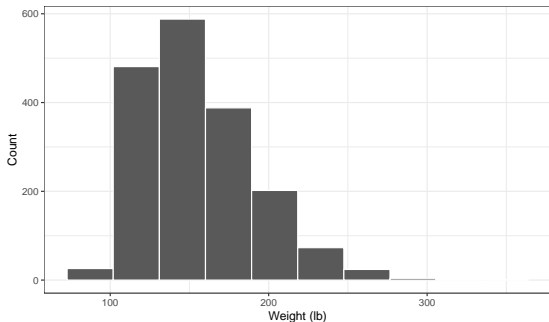
Simple linear regression model

$$Y = \alpha + \beta X$$

Multiple linear regression model

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k$$

Predictor 1	C
	(Sta
Predictor 2	C
	(Sta
Constant	C
	(Sta
Observations	# of
Adjusted R²	A
Residual Std Error	Model

What is the most "useful" model of weight in the Ross (1990) dataset?
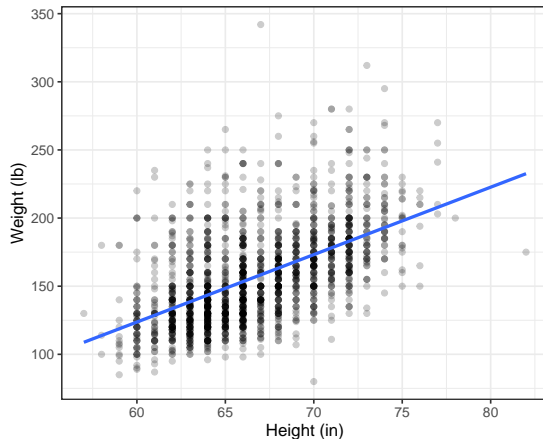

Source: Ross (1990)

Predictors to Explore
- Height
- Exercise
- Age

Model 1: Regress weight on height

	Weight (lb)
Height (in)	4.95*
	(0.18)
Constant	−173.26*
	(11.91)
Observations	1,788
Adjusted R^2	0.30
Residual Std. Error	28.96 (df = 1786)
F Statistic	767.70* (df = 1; 1786)
Note:	*p < 0.05

Visualize: Model 1

Source: Ross (1990)

Model 1: Regress weight on height

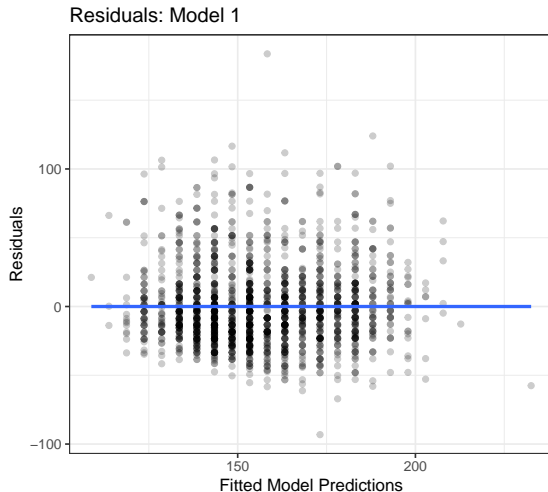|	Weight (lb)
Height (in)	4.95*
	(0.18)
Constant	−173.26*
	(11.91)
Observations	1,788
Adjusted R^2	0.30
Residual Std. Error	28.96 (df = 1786)
F Statistic	767.70* (df = 1; 1786)
Note:	*p < 0.05

Residuals: Model 1

	Weight (lb)
Height (in)	4.95*
	(0.18)
Constant	−173.26*
	(11.91)
Observations	1,788
Adjusted R^2	0.30
Residual Std. Error	28.96 (df = 1786)
F Statistic	767.70* (df = 1; 1786)
Note:	*$p < 0.05$

Visualize: Model 1

Source: Ross (1990)

Calculate a PE (w/ 95% PI) for a person of average height (5' 7")

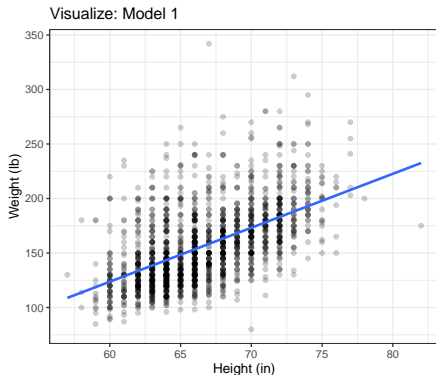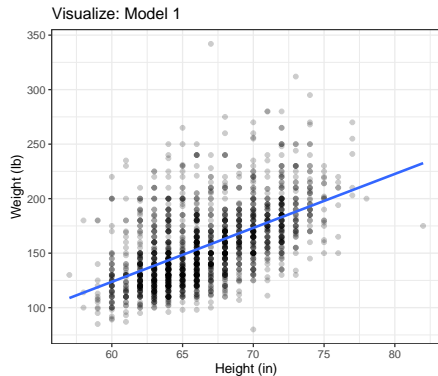|	Weight (lb)
Height (in)	4.95*
	(0.18)
Constant	−173.26*
	(11.91)
Observations	1,788
Adjusted R^2	0.30
Residual Std. Error	28.96 (df = 1786)
F Statistic	767.70* (df = 1; 1786)
Note:	*p < 0.05

Visualize: Model 1

Source: Ross (1990)

$$\text{Weight} = -173.26 + 4.95 \times (67\text{in}) = 158.39\text{lb}$$

	Weight (lb)
Height (in)	4.95*
	(0.18)
Constant	−173.26*
	(11.91)
Observations	1,788
Adjusted R^2	0.30
Residual Std. Error	28.96 (df = 1786)
F Statistic	767.70* (df = 1; 1786)
Note:	*p < 0.05

Visualize: Model 1
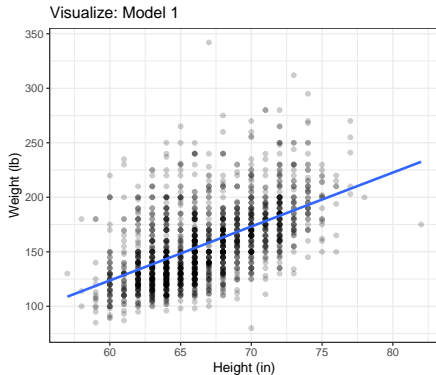
Source: Ross (1990)

$$158.39 \pm 2 \text{ x } 28.96 \approx 100.47 \text{ to } 216.31 \text{ lb}$$

M2: Regress weight on height and exercise

1. Put the results into a regression table

2. Evaluate the regression with all five steps

   - Logical
   - Statistical Significance
   - Explanatory Power: R2 and F Statistic
   - Check the Residuals
   - Check for Multicollinearity

	Weight (lb)
Height (in)	5.21*
	(0.18)
Exercise	−2.05*
	(0.30)
Constant	−184.54*
	(11.88)
Observations	1,788
Adjusted R^2	0.32
Residual Std. Error	28.59 (df = 1785)
F Statistic	417.44* (df = 2; 1785)
Note:	*p < 0.05

1. Does the model make sense?

	Weight (lb)
Height (in)	5.21*
	(0.18)
Exercise	−2.05*
	(0.30)
Constant	−184.54*
	(11.88)
Observations	1,788
Adjusted R^2	0.32
Residual Std. Error	28.59 (df = 1785)
F Statistic	417.44* (df = 2; 1785)

Note: $*p < 0.05$

2. Check for statistical significance

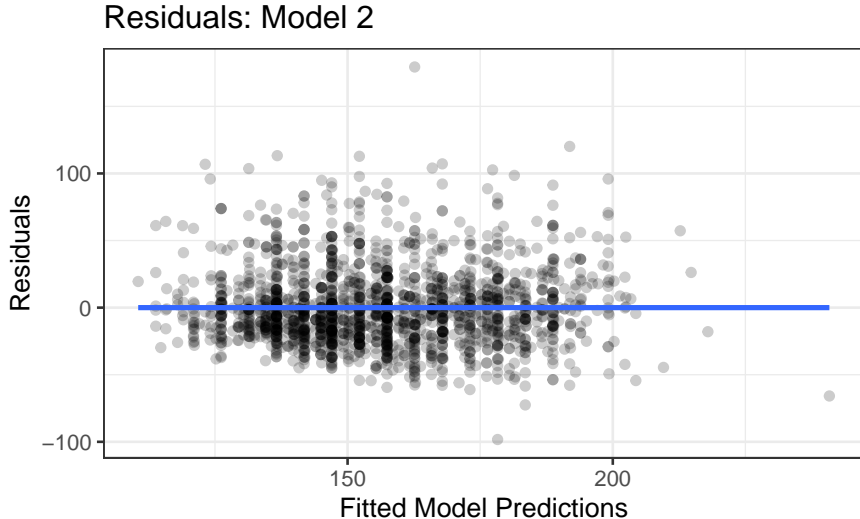|	Weight (lb)
Height (in)	5.21^*
	(0.18)
Exercise	-2.05^*
	(0.30)
Constant	-184.54^*
	(11.88)
Observations	1,788
Adjusted R^2	0.32
Residual Std. Error	28.59 (df = 1785)
F Statistic	417.44^* (df = 2; 1785)
Note:	$^*p < 0.05$

3. Determine the explanatory power of the model

	Weight (lb)
Height (in)	5.21*
	(0.18)
Exercise	−2.05*
	(0.30)
Constant	−184.54*
	(11.88)
Observations	1,788
Adjusted R^2	0.32
Residual Std. Error	28.59 (df = 1785)
F Statistic	417.44* (df = 2; 1785)
Note:	*$p < 0.05$

4. Check for problems in the residuals

Residuals: Model 2

5. Check for multicollinearity

	height	exercise
height	1	0.215
exercise	0.215	1

Calculate a point estimate (w/ 95% PI) for a person of average height (5'7") and average exercise (3).

M2: Regress weight on height and exercise

Calculate a point estimate (w/ 95% PI) for a person of average height (5'7") and average exercise (3).

- Weight ≈ -184.54 + 5.21 x (Height) + -2.05 x (Exercise)

M2: Regress weight on height and exercise

Calculate a point estimate (w/ 95% PI) for a person of average height (5'7") and average exercise (3).

- Weight $\approx$ -184.54 + 5.21 x (Height) + -2.05 x (Exercise)
- Weight $\approx$ -184.54 + 5.21 x (67) + -2.05 x (3)

M2: Regress weight on height and exercise

Calculate a point estimate (w/ 95% PI) for a person of average height (5'7") and average exercise (3).

- Weight $\approx$ -184.54 + 5.21 x (Height) + -2.05 x (Exercise)
- Weight $\approx$ -184.54 + 5.21 x (67) + -2.05 x (3)
- Weight $\approx$ 158.38 lb

Estimate the Prediction Interval (95%)

Residual Standard Error $= 28.59$

Weight ≈ 158.4 lb

- 95% PI (Low): $158.38 - 2 \times 28.59 = 101.2$ lb
- 95% PI (High): $158.38 + 2 \times 28.59 = 215.56$ lb

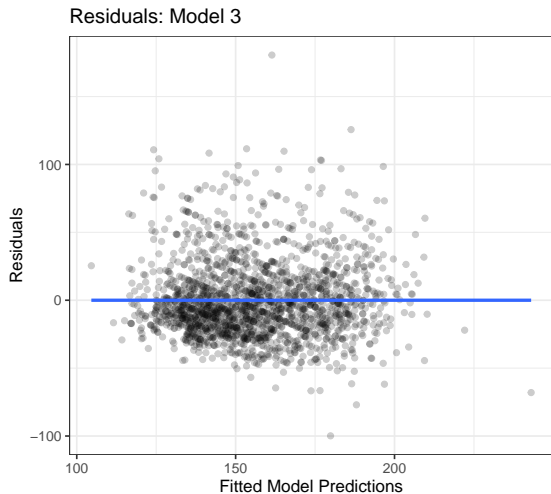|	Weight (lb)	
	(1)	(2)
Height (in)	4.95*	5.21*
	(0.18)	(0.18)
Exercise		−2.05*
		(0.30)
Constant	−173.26*	−184.54*
	(11.91)	(11.88)
Observations	1,788	1,788
Adjusted R^2	0.30	0.32
Residual Std. Error	28.96 (df = 1786)	28.59 (df = 1785)
F Statistic	767.70* (df = 1; 1786)	417.44* (df = 2; 1785)

Note: *$p < 0.05$

M3: Regress weight on height and age

1. Put the results into a regression table

2. Evaluate the regression with all five steps

3. Calculate a point estimate (w/ 95% PI) for a person of average height (5'7") and average age (43).

	Weight (lb)
Height (in)	5.15*
	(0.18)
Age	0.33*
	(0.04)
Constant	−200.94*
	(12.14)
Observations	1,788
Adjusted R^2	0.33
Residual Std. Error	28.41 (df = 1785)
F Statistic	434.54* (df = 2; 1785)
Note:	*p < 0.05

Residuals: Model 3

M3: Regress weight on height and age

Calculate a point estimate (w/ 95% PI) for a person of average height (5'7") and average age (43).

- Weight ≈ -200.94 + 5.15 x (Height) + 0.33 x (Age)

- Weight ≈ -200.94 + 5.15 x (67) + 0.33 x (43)

- Weight ≈ 158.3 lb

M3: Regress weight on height and age

Residual Standard Error = 28.41

Weight ≈ 158.3 lb

- 95% PI (Low): 158.3 - 2 x 28.41 = 101.48 lb
- 95% PI (High): 158.3 + 2 x 28.41 = 215.12 lb

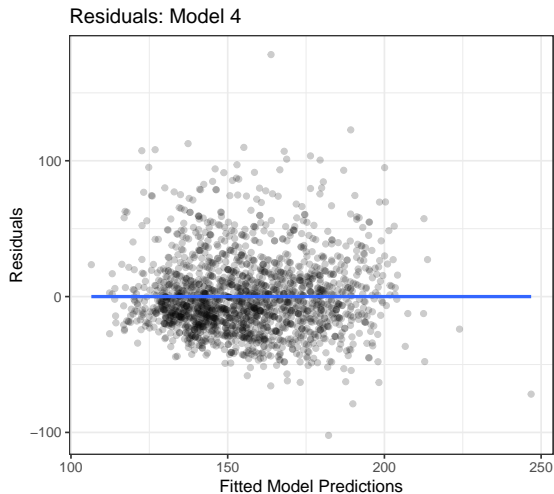|	Weight (lb)		
	(1)	(2)	(3)
Height (in)	4.95*	5.21*	5.15*
	(0.18)	(0.18)	(0.18)
Exercise		−2.05*	
		(0.30)	
Age			0.33*
			(0.04)
Constant	−173.26*	−184.54*	−200.94*
	(11.91)	(11.88)	(12.14)
Observations	1,788	1,788	1,788
Adjusted R^2	0.30	0.32	0.33
Residual Std. Error	28.96 (df = 1786)	28.59 (df = 1785)	28.41 (df = 1785)
F Statistic	767.70* (df = 1; 1786)	417.44* (df = 2; 1785)	434.54* (df = 2; 1785)

Note: $^*p < 0.05$

M4: Regress weight on height, excercise & age

1. Put the results into a regression table

2. Evaluate the regression with all five steps

3. Calculate a point estimate (w/ 95% PI) for a person of average height (5'7"), exercise (3) and average age (43).

	Weight (lb)
Height (in)	5.29*
	(0.18)
Exercise	−1.40*
	(0.31)
Age	0.27*
	(0.04)
Constant	−203.76*
	(12.09)
Observations	1,788
Adjusted R^2	0.33
Residual Std. Error	28.25 (df = 1784)
F Statistic	299.65* (df = 3; 1784)
Note:	*p < 0.05

Residuals: Model 4

Model 4

Calculate a point estimate (w/ 95% PI) for a person of average height (5'7"), exercise (3) and average age (43).

- Weight $\approx$ -203.76 + 5.29 x (Height) + -1.4 x (Exercise) + 0.27 x (Age)
- Weight $\approx$ -203.76 + 5.29 x (67) + -1.4 x (3) + 0.27 x (43)
- Weight $\approx$ 158.08 lb

Model 4

$$\text{Residual Standard Error} = 28.25$$

Weight $\approx$ 158.08 lb

- 95% PI (Low): 158.08 - 2 x 28.25 = 101.58 lb
- 95% PI (High): 158.08 + 2 x 28.25 = 214.58 lb

	(1)	(2)	(3)	(4)
		Weight (lb)		
height	4.95*	5.21*	5.15*	5.29*
	(0.18)	(0.18)	(0.18)	(0.18)
exercise		−2.05*		−1.40*
		(0.30)		(0.31)
age			0.33*	0.27*
			(0.04)	(0.04)
Constant	−173.26*	−184.54*	−200.94*	−203.76*
	(11.91)	(11.88)	(12.14)	(12.09)
Observations	1,788	1,788	1,788	1,788
Adjusted R^2	0.30	0.32	0.33	0.33
Residual Std. Error	28.96 (df = 1786)	28.59 (df = 1785)	28.41 (df = 1785)	28.25 (df = 1784)
F Statistic	767.70* (df = 1; 1786)	417.44* (df = 2; 1785)	434.54* (df = 2; 1785)	299.65* (df = 3; 1784)

Note: *$p < 0.05$

For Thursday

Evaluate our four models using Wheelan ch 12

- Model 1: Height
- Model 2: Height and Exercise
- Model 3: Height and Age
- Model 4: Height, Exercise and Age