Chapter 15

Describing Relationships: Regression, Prediction, and Causation

The least-squares (regression) line, drawn on a scatterplot, is used for *prediction*. *Causation* (related to confounding effect in experiments) is also discussed.

Exercise 15.1 (Describing Relationships: Regression, Prediction, and Causation)

1. *Least–squares line: prediction and understanding.*

   (a) *Least-squares (regression) line: reading ability versus brightness.*

brightness, x	1	2	3	4	5	6	7	8	9	10
reading ability, y	70	70	75	88	91	94	100	92	90	85

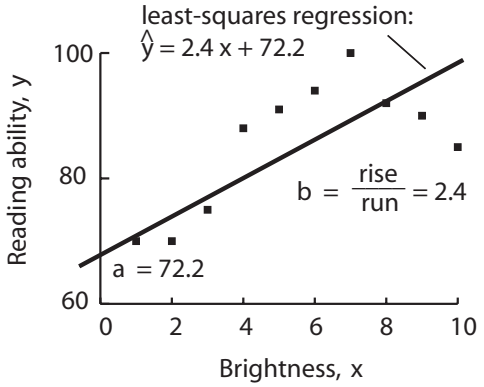

Figure 15.1 (Least–squares Line, reading ability versus brightness)

The least-squares regression line can be calculated using a complicated formula: you will not be responsible for knowing this formula in this course.

i. *Least-squares regression line.*

Least–squares line is (circle one)
$\boldsymbol{\hat{y} = 2.418x + 72.2}$
$\boldsymbol{\hat{y} = 2.418 + 72.2x}$
$\boldsymbol{\hat{y} = 2.944 + 47.04x}$

ii. *Slope and y-intercept of least-squares regression line.*

Slope is $b =$ (circle one) **72.2** / **2.418**.
Slope, $b = 2.418$, means, on average, reading ability increases 2.418 units for an increase of *one* unit of brightness.

The *y–intercept* is $a =$ (circle one) **72.2** / **2.418**.
The y–intercept, $a = 72.2$, means average reading ability is 72.2, if brightness is zero.

iii. *Prediction.*
At brightness $x = 6.5$, predicted reading ability is
$\hat{y} \approx 2.418x + 72.2 = 2.418(6.5) + 72.2 \approx$ **83.9** / **85.5** / **87.9**.

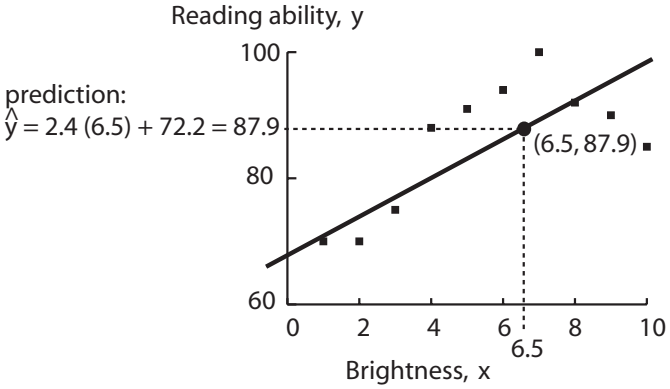

Figure 15.2 (Least–Squares Line: Prediction)

iv. *More Prediction.*
At brightness $x = 5.5$, $\hat{y} \approx 2.418(5.5) + 72.2 \approx$ **83.9** / **85.5** / **87.6**.
At brightness $x = 7.5$, $\hat{y} \approx 2.418(7.5) + 72.2 \approx$ **83.9** / **89.5** / **90.4**.

v. *Residual.*
At brightness $x = 7$, $\hat{y} \approx 2.418(7) + 72.2 \approx$ **87.9** / **89.1** / **120.6**.
Observed value, $y = 100$ compared to predicted $\hat{y} = 89.1$;
Observed value $y = 100$ is found in brightness versus reading ability table above at $x = 7$.
difference between two is *residual*:
$y - \hat{y} = 100 - 89.1 =$ (circle one) **9.2** / **10.9** / **12.6**.

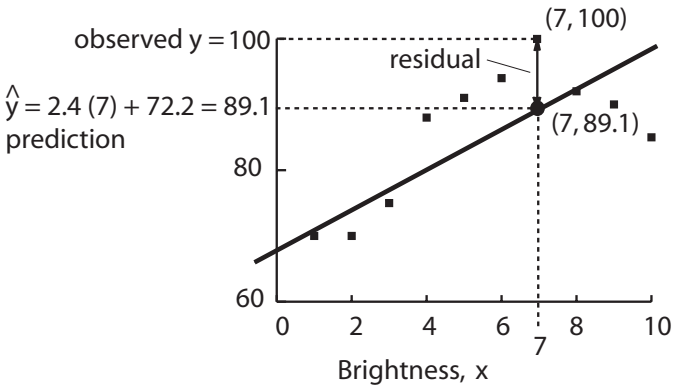

Figure 15.3 (Least–Squares Line: Residual)

Residual for $x = 7$ is *vertical* distance between observed (7,100) and predicted (7, 89.1) on least-squares regression line.

vi. *More Residuals.*
At brightness $x = 8$, $y - \hat{y} \approx 92 - 91.5 =$ **-0.5 / 0.5 / 1.5**.
Observed value $y = 92$ is found in table above where $x = 8$.
At brightness $x = 3$, $y - \hat{y} \approx 75 - 79.5 =$ **-4.5 / -3.5 / -1.5**.
There are (circle one) **1 / 5 / 10** residuals on scatterplot.

(b) *Grain yield (tons) versus distance from water (feet)*

dist, x	0	10	20	30	45	50	70	80	100	120	140	160	170	190
yield, y	500	590	410	470	450	480	510	450	360	400	300	410	280	350

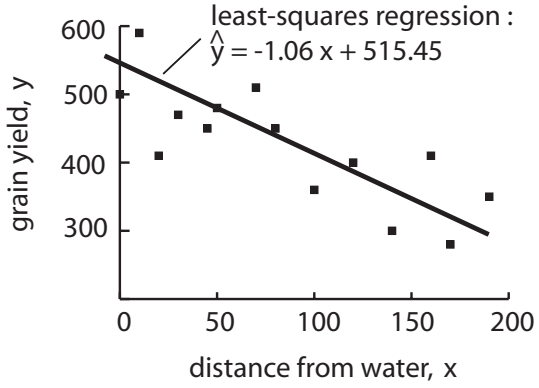

Figure 15.4 (Least–squares regression, grain yield versus distance)

i. The least–squares line is (circle one)
$\hat{y} = -1.56x + 515.45$
$\hat{y} = -2.56x + 535.45x$
$\hat{y} = -1.06x + 515.45$.

ii. *Slope and y-intercept.*
Slope is $b =$ (circle one) **515.45 / -1.06**.
Slope, $b = -1.06$, means, on average, grain yield decreases 1.06 tons

for an increase of one foot away from water.

The *y–intercept* is $a =$ (circle one) **515.45** / **−1.06**.
The y–intercept, $a = 515.45$, means average grain yield is 515.45 at water's edge.

iii. *Prediction.*
At distance $x = 100$,
$\hat{y} = -1.06x + 515.45 = -1.06(100) + 515.45 =$ **400** / **407.3** / **409.5**.
At distance $x = 165$,
$\hat{y} = -1.06x + 515.45 = -1.06(165) + 515.45 =$ **340.5** / **367.0** / **404.8**

iv. *Residual.*
At distance $x = 100$,
$y - \hat{y} \approx 360 - 409.5 =$ **−49.5** / **−36.5** / **−25.5**.
Observed value $y = 360$ is found in table above at $x = 100$.
At distance $x = 140$,
$y - \hat{y} \approx 300 - 367 =$ **−67** / **−55** / **−25**.

v. *Review.* Second random sample gives **same** / **different** scatterplot. Statistics calculated from second plot **same** / **different** from statistics calculated from first plot. So, slope, b, and y–intercept, a, and predicted values, $\hat{y} = bx + a$, all **statistics** / **parameters**.

(c) *Height versus circumference of trees.*

circumference, x	1.1	1.5	1.7	2.1	2.7
height, y	35	36	37	40	42

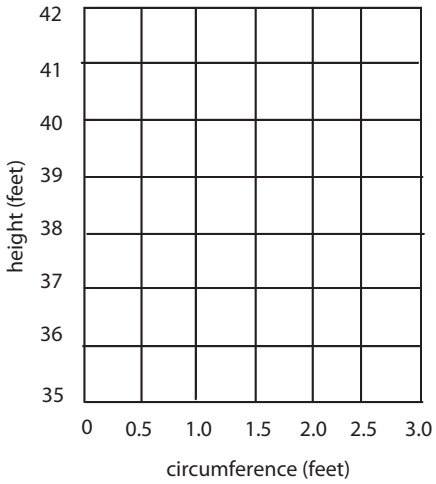

Figure 15.5 (Scatterplot, residual plot of height versus circumference)

i. *Scatterplot and least-squares line.* Use points in table to draw scatterplot. Draw least–squares line, $\hat{y} = 29.438 + 4.704x$, on scatterplot by calculating two points on regression and connecting these points

For example, at $x = 2$, $\hat{y} = 29.438 + 4.704(2) = 38.846$; so one point is $(2, 38.846)$.

At $x = 2.5$, $\hat{y} = 29.438 + 4.704(2.5) = 41.198$; so another point is $(2.5, 41.198)$.

ii. Least–squares line is $\hat{y} = 29.438 + 4.704x$. This line can also be written as (choose one)
$\hat{y} = 29.438 + 4.704$
$\hat{y} = 4.704x + 29.438$
$\hat{y} = 2.944 + 47.04x$.

iii. *Residuals.* Fill in blanks.

circumference, x	2.1	1.7	1.1	1.5	2.7	total
observed height, y	40	37	35	36	42	190
predicted height, $\hat{y}$	39.3	37.4	34.6	_____	_____	190
residual, $y - \hat{y}$	0.7	-0.4	0.4	_____	_____	0
residual^2, $(y - \hat{y})^2$	0.5	0.2	0.2	_____	_____	1.1

So, at $x = 1.5$, $\hat{y} = 29.438 + 4.704x = 29.438 + 4.70(1.5) = 36.488$, so $y - \hat{y} = 36 - 36.488 = -0.488 \approx -0.5$ and $(y - \hat{y})^2 = (-0.5)^2 = 0.25 \approx 0.3$

at $x = 2.7$, $\hat{y} = 29.438 + 4.704x = 29.438 + 4.70(2.7) = 42.128$, so $y - \hat{y} = 42 - 42.128 = -0.128 \approx -0.1$ and $(y - \hat{y})^2 = (-0.1)^2 = 0.01 \approx 0$

Total residuals^2 measure how close points are to least-squares line.

2. *Diagnostic analyzes: reading ability versus brightness.*

brightness, x	1	2	3	4	5	6	7	8	9	10
ability to read, y	70	70	75	88	91	94	100	92	90	85
predicted, $\hat{y}$	74.6	77.0	79.5	81.9	84.3	86.7	89.1	91.5	94.0	96.4
residual, $y - \hat{y}$	-4.6	-7.0	-4.5	6.1	6.7	7.3	10.9	0.5	-4.0	-8.6

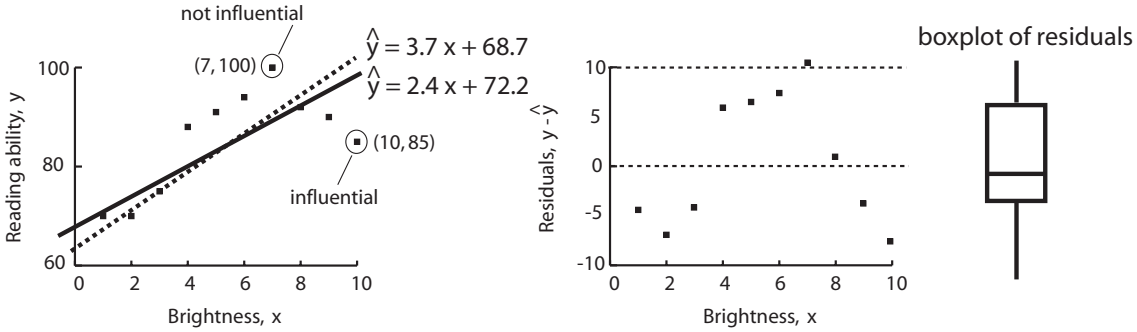

Figure 15.6 (Scatterplot, residual plot of reading ability vs brightness)

(a) *Pattern?*
According to either scatterplot or residual plot,
there (choose one) **is a** / **is no** pattern (around line): points are curved.

(b) *Outliers?*
According to boxplot of residuals, there **are** / **are no** outliers.
Outliers appear as "∗"s in boxplots. There are no "∗"s in given boxplot.

(c) *Influential points?*
least-squares line is $\hat{y} = 2.418x + 72.2$, $r = 0.704$

point $(x, y) = (7, 100)$ influential?
removing this point, $\hat{y} = 2.192x + 72.2$, $r = 0.721$
so $(7, 100)$ **is** / **is not** influential since a, b, r do not change much

point $(x, y) = (10, 85)$ influential?
removing this point, $\hat{y} = 3.367x + 68.7$, $r = 0.836$
so $(10, 85)$ **is** / **is not** influential since all three a, b, r change a lot

(d) *Square of correlation, r^2.*
Since $r^2 \approx 0.7^2 =$ (choose one) **0.49** / **0.52** / **0.53**, least-squares line explains 49% of variability in reading ability. Other 51% is unexplained, is random variability in reading ability for given levels of brightness.
Recall, previously, $r \approx 0.7$ for this brightness versus reading ability example.

3. *Diagnostic analyzes: grain yield versus distance from water.*

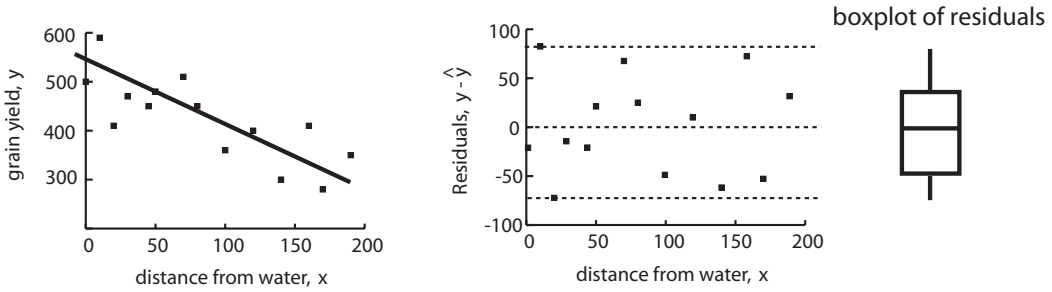

Figure 15.7 (Scatterplot, residual plot of reading ability versus brightness)

(a) *Pattern?*
According to either scatterplot or residual plot,
there (choose one) **is a** / **is no** pattern (around line).

(b) *Outliers?*
According to boxplot of residuals, there **are** / **are no** outliers.

(c) *Influential points?*
least-squares line is $\hat{y} = -1.06x + 515.45$, $r = -0.785$

point $(x, y) = (20, 410)$ influential?
removing this point, $\hat{y} = -1.18x + 533.10$, $r = -0.839$
so $(20, 410)$ **is** / **is not** influential since a, b, r do not change much

point $(x, y) = (190, 350)$ influential?
removing this point, $\hat{y} = -1.16x + 520.58$, $r = -0.781$
so $(190, 350)$ **is / is not** influential since a, b, r do not change much

(d) *Square of correlation, r^2.*
Since $r^2 = 0.78^2 \approx$ (choose one) **0.49 / −0.61 / 0.61**, least-squares line explains 61.0% of variability in grain yield. Other 39.0% is unexplained, is random variability in grain yield for given distances from the water.

Assume $r \approx 0.78$ for this grain yield versus distance from water example.

4. *Association or causation: reading ability versus brightness.*

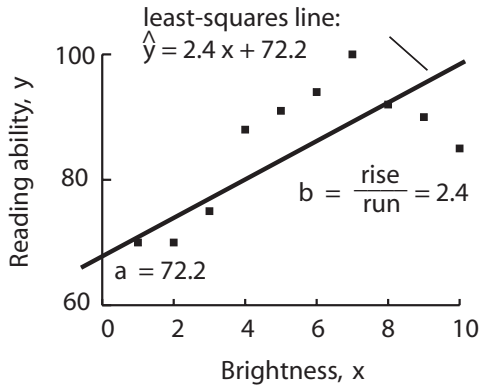

Figure 15.8 (Reading ability versus brightness)

Participants were asked to read a text aloud as brightness levels were increased. Reading ability score was based on how well the participants were able to read the text. Experiments noticed, in particular, reading ability changed after brightness levels changed. Recall, linear correlation between reading ability and brightness is $r \approx 0.7$. Assume this correlation has been confirmed many times in a number of studies conducted by a number of different people.

(a) *Is association strong?*
Since linear correlation $r \approx 0.7 < 0.8$, association is **strong / not strong**

Since association (measured by correlation, $r < 0.8$) is *moderate*, this indicates there is just an association, *not* causation relationship between brightness and reading ability.

(b) *Is association consistent?*
Since *many* studies done by *different* people have shown $r \approx 0.7$, association is **consistent / not consistent**

Since association is consistent, this indicates that brightness is not merely associated with reading ability, but that a change in brightness *causes* a change in reading ability.

(c) *Is higher dose associated with stronger response?*
Brighter is associated with **lower / higher** reading ability

Since (within reason, for brightness levels between 0 and 8) brighter is associated with higher reading ability, this indicates brightness is not merely associated with reading ability, but that a change in brightness *causes* a change in reading ability.

(d) *Does (alleged) cause precede response in time?*
Change in brightness **precedes** / **unrelated** to change in reading ability
Yes, reading ability changed *after* brightness changed.

(e) *Is (alleged) cause plausible?*
Brightness change **plausibly** / **implausibly** causes reading ability change
Yes, it seems plausible that changes in brightness would cause changes in reading ability, but not vis-versa.

(f) Relationship between reading ability and brightness is (choose one)
association / **causation**
It is most likely causation because four of the five criterion indicate this.

5. *Association or causation: grain yield versus distance from water.*

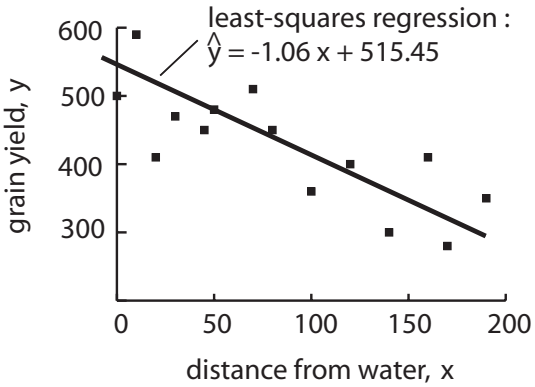

Figure 15.9 (Grain yield and distance from water)

Recall, linear correlation between grain yield and distance from water is $r \approx -0.8$. Assume this correlation appears in only one study.

(a) *Is association strong?*
strong / **not strong**
Since association (measured by correlation, $r \approx -0.8$) is (negatively) *strong*, this indicates there is a causation relationship.

(b) *Is association consistent?*
consistent / **not consistent**
Only one study has been done.

(c) *Is higher dose associated with stronger response?*
Further from water associated with **lower** / **higher** yield
Grain yield clearly lower far away from water.

(d) *Does (alleged) cause precede response in time?*
Change in distance **precedes** / **unrelated** grain yield
Not clear from study, so correct answer is "unknown".

(e) *Is (alleged) cause plausible?*
Distance change **plausibly** / **implausibly** causes grain yield change
Yes, it seems plausible that change in distance from water would cause change in grain yield.

(f) Relationship between grain yield and distance is (choose one)
association / **causation**
Hard to say if causation because only three of the five criterion indicate causation, although it seems reasonable to think there is causation here, but, really, more study is required.

6. *Response often influenced by more than one variable.*

(a) *Reading ability versus brightness.*

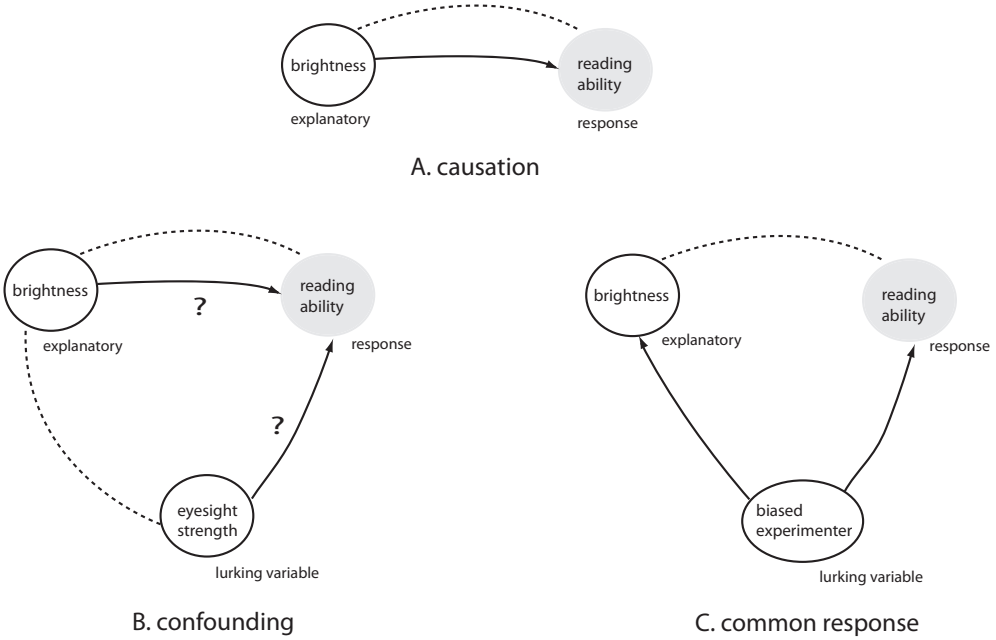

Figure 15.10 (Types of observed association: reading ability versus brightness)

Different types of observed association are given in figure where, notice, response is often influenced by more than one variable. Dotted lines are observed *association*; solid arrows are possible *cause-and-effect* links.

A. brightness change **causes** / **does not cause** reading ability change
previous analysis seems to indicate causation relationship between (explanatory variable) brightness and (response variable) reading ability

B. eyesight strength **confounded** / **not confounded** with brightness

(explanatory variable) brightness and (lurking variable) eyesight are confounded because they are positively associated with one another and with (response) reading ability and it is not clear what contributions each has to (response) reading ability.

C. change in both brightness and reading ability
in (common) response / **not in (common) response**
to a biased experimenter

a (lurking variable) biased experimenter might be manipulating both (explanatory variable) brightness and (response variable) reading ability to make it look like change in brightness causes change in reading ability.

C? change in both brightness and reading ability
in (common) response / **not in (common) response**
to a eyesight strength

a (lurking variable) eyesight strength might be a cause of (response variable) reading ability, but it clearly is not also a cause of (explanatory variable) brightness

(b) *Grain yield versus distance from water.*

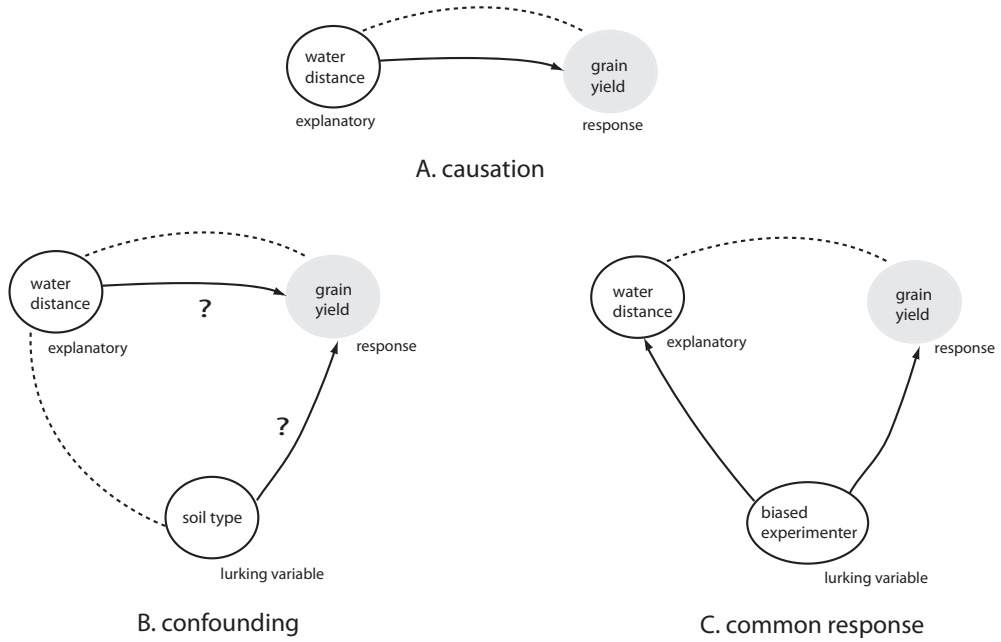

Figure 15.11 (Types of observed association: grain yield versus distance from water)

A. distance from water change **causes** / **does not cause** yield change

not clear, but previous analysis indicates possibility of causation relationship between (explanatory

variable) distance from water and (response variable) grain yield

B. soil type **confounded** / **not confounded** with water distance

(explanatory variable) distance from water and (lurking variable) soil type are confounded because they are positively associated with one another and with (response) grain yield and it is not clear what contributions each has to (response) grain yield.

B? humidity **confounded** / **not confounded** with water distance

(explanatory variable) distance from water and (lurking variable) humidity are confounded because they are positively associated with one another and with (response) grain yield and it is not clear what contributions each has to (response) grain yield.

C. change in both water distance and grain yield
in (common) response / **not in (common) response**
to a biased experimenter

a (lurking variable) biased experimenter might be manipulating both (explanatory variable) distance from water and (response variable) grain yield to make it look like change in distance from water causes change in grain yield.

C? change in both water distance and grain yield
in (common) response / **not in (common) response**
to soil type

a (lurking variable) soil type might be a cause of (response variable) grain yield, but it is not also a cause of (explanatory variable) distance from water (although the reverse might be true: distance from water might cause different types of soil)

7. *Big data, prediction and correlation: Reading ability versus brightness.*

brightness, x	1	2	3	4	5	6	7	8	9	10
reading ability, y	70	70	75	88	91	94	100	92	90	85

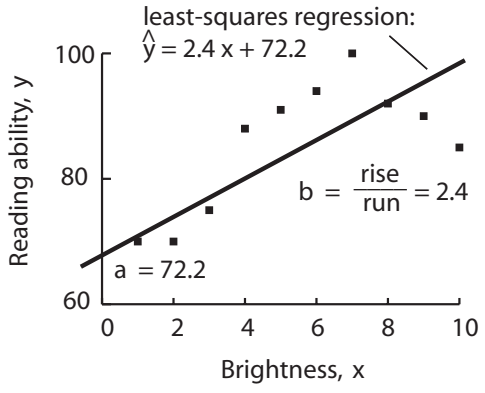

Figure 15.12 (Least–squares Line, reading ability versus brightness)

Recall, least–squares line is $\hat{y} = 2.418 + 72.2x$ where the slope, $b = 2.418$, means, on average, reading ability increases 2.418 units for an increase of *one* unit of brightness and at brightness $x = 6.5$, predicted reading ability is
$\hat{y} \approx 2.418x + 72.2 = 2.418(6.5) + 72.2 \approx 87.9$.

(a) Sample size is **10** / **100** / **1000**. It is important this sample is **random** / **non-random**, otherwise it may not represent the population, it may have bias. It is also important brightness **(linearly) causes** / **is associated with** reading ability to believe prediction.

(b) Slope $b = 2.418$ is a **statistic** / **parameter** based on 10 observations. The slope b **changes** / **remains the same** if another random sample is taken. The slope b **estimates** / **is exactly the same as** the true slope. Variability in slope estimate b **decreases** / **increases** with increasing sample size.

(c) Best estimate of slope $b = 2.1418$ is based on

(i) SRS of size 10.

(ii) non-SRS of size 10.

(iii) SRS of size 1000.

(iv) non-SRS of size 1000.

(v) non-SRS of size 1,000,000,000 (1 billion).

(d) Best estimate of prediction $\hat{y} \approx 87.9$ is based on least-squares line where

(i) brightness change is a known linear cause of reading ability change

(ii) brightness change is weakly correlated with reading ability change

(iii) brightness change is negatively correlated reading ability change

(iv) brightness change is strongly correlated with reading ability change

because causation implies a better understanding of the relationship, a stronger more reliable connection, than just association between reading ability and brightness which may depend on other possibly changing lurking variables.

(e) *Big Data.*
True / **False** No matter how big the data, from Google or Facebook say, we must always we very careful of how the data was collected, whether it is biased or whether variables are merely correlated with one another or one causes the other.

Chapter 16

The Consumer Price Index and Government Statistics

Generally, inflation of money occurs over time. This means the dollar loses buying power over time; that is, the dollar buys less in the future than now. Consumer Price Index (CPI) measures the buying power of the dollar. Formulas considered include

$$\text{index number} = \frac{\text{value}}{\text{base value}} \times 100$$

and

$$\% \text{ increase} = \frac{\text{value - base value}}{\text{base value}} \times 100$$

which are both closely related to the *fixed market basket price index* and also the consumer price index (CPI), which leads to the following conversion

$$\text{dollars in time B} = \text{dollars in time A} \times \frac{\text{CPI at time B}}{\text{CPI at time A}}.$$

Exercise 16.1 (The Consumer Price Index and Government Statistics)

1. *Index number.* Index number is

$$\text{index number} = \frac{\text{value}}{\text{base value}} \times 100$$

   (a) Bread cost \$0.40 a loaf in 1952; in 2009 it costs \$2.50. Bread index number

$$\text{index number} = \frac{\text{value}}{\text{base value}} \times 100 = \frac{2.50}{0.40} \times 100 =$$

   6.25 / **525** / **625**. This means 2009 bread is 625% of 1952 base value, or

$$\% \text{ increase} = \frac{\text{value - base value}}{\text{base value}} \times 100 = \frac{2.50 - 0.40}{0.40} \times 100 = \frac{2.10}{0.40} \times 100 =$$

   6.25% / **525%** / **625%**.

(b) Portable music devices (iPod Touch) cost \$200 in 2008; in 2009 they cost \$150.

$$\text{index number} = \frac{\text{value}}{\text{base value}} \times 100 = \frac{150}{200} \times 100 \approx$$

0.75 / **1.25** / **75**. 2009 portable music device 75% of 2008 base value, or

$$\%\text{ decrease} = \frac{\text{value - base value}}{\text{base value}} \times 100 = \frac{150 - 200}{200} \times 100 = -\frac{50}{200} \times 100 =$$

25% / **33%** / **75%**.

(c) Portable music devices (Sony Walkmans) cost \$95 in 1983; in 2008 iPod Touch cost \$200. Portable music device index number

$$\text{index number} = \frac{\text{value}}{\text{base value}} \times 100 = \frac{200}{95} \times 100 \approx$$

2.105 / **210.5** / **110.5**.

iPod Touches closest thing in 2008 to what Sony Walkmans were in 1983.

so portable music device in 2008 is 210.5% of 1983 base value, or

$$\%\text{ increase} = \frac{\text{value - base value}}{\text{base value}} \times 100 = \frac{200 - 95}{95} \times 100 = \frac{105}{95} \times 100 =$$

2.105% / **210.5%** / **110.5%**.

(d) Statistics text cost \$30 in 1985; in 2005 similar text cost \$100.

$$\text{index number} = \frac{\text{value}}{\text{base value}} \times 100 = \frac{100}{30} \times 100 \approx$$

3.33 / **333** / **233**. This text in 2005 is 333% of 1985 base value, or

$$\%\text{ increase} = \frac{\text{value - base value}}{\text{base value}} \times 100 = \frac{100 - 30}{30} \times 100 = \frac{70}{30} \times 100 =$$

3.33% / **333%** / **233%**.

2. *Fixed market basket price index.* Fixed market basket price index is index number of total cost of fixed collection of goods and services.

(a) *Student supplies basket price index.*

	quantity	1985	quantity	2005
binders	5	\$2.50 per binder	5	\$10 per binder
books	10	\$30 per book	10	\$80 per book
computer	1	\$300 per computer	1	\$500 per computer
Total		\$612.50		\$1350

student supplies basket price index $= \dfrac{\text{value}}{\text{base value}} \times 100 = \dfrac{1350}{612.50} \times 100 \approx$

2.20 / **120** / **220**.

Computer in 1985 is desktop with 32 K memory; in 2005, is laptop with 1 G memory.

(b) *Pet dog owner basket price index.*

	quantity	1981	quantity	2009
dog food	50 pounds	\$5 per pound	75 pounds	\$10 per pound
toys	10	\$7 per toy	8	\$10 per toy
veterinarian	2 visits	\$75 per visit	3 visits	\$100 per visit

Since pet dog owner 1981 total cost is

$$50 \times \$5 + 10 \times \$7 + 2 \times \$75 =$$

300 / **420** / **470** and *fixed (same basket)* pet dog owner 2009 total cost is

$$50 \times \$10 + 10 \times \$10 + 2 \times \$100 =$$

700 / **800** / **900** then

$$\text{basket price index} = \frac{\text{value}}{\text{base value}} \times 100 = \frac{800}{470} \times 100 \approx$$

1.70 / **170** / **220**.

(c) *Pet dog owner basket price index again.*

	quantity	1981	2000	2009
dog food	50 pounds	\$5 per pound	\$8 per pound	\$10 per pound
toys	10	\$7 per toy	\$9 per toy	\$10 per toy
veterinarian	2 visits	\$75 per visit	\$80 per visit	\$100 per visit
Total		\$470	\$650	\$800

If 1981 is base value, pet dog owner basket price index values for 1981, 2000 and 2009 are $\frac{470}{470} \times 100$, $\frac{650}{470} \times 100$, $\frac{800}{470} \times 100$ respectively; that is,

i. 90, 138.3, 170.2 respectively.

ii. 100, 148.3, 170.2 respectively.

iii. 100, 138.3, 170.2 respectively.

(d) *Pet dog owner basket price index revised.*
If 2000 (not 1981!) is base value, pet dog owner basket price index values for 1981, 2000 and 2009 are $\frac{470}{650} \times 100$, $\frac{650}{650} \times 100$, $\frac{800}{650} \times 100$; that is,

i. 72.3, 100, 123.1 respectively.
ii. 100, 148.3, 170.2 respectively.
iii. 100, 138.3, 170.2 respectively.

So different base values give different basket price index values.

3. *Consumer Price Index (CPI).* Consumer price index is index number of (approximate) total cost of *everything* American consumers buy. Part of Table 16.1 Annual average Consumer Price Index, 1982-84 = 100, is given below.

Year	1915	1982	1984	2007
CPI	10.1	96.5	103.9	207.3

CPI allows conversion of dollars in time A to dollars in time B using

$$\text{dollars in time B} = \text{dollars in time A} \times \frac{\text{CPI at time B}}{\text{CPI at time A}}.$$

(a) How much is \$100 in 1915 worth in 2007?

$$\text{dollars in 2007} = \$100 \text{ in 1915} \times \frac{\text{CPI in 2007}}{\text{CPI in 1915}} = \$100 \times \frac{207.3}{10.1} \approx$$

\$1002.60 / **\$2052.48** / **\$2770.84**.

(b) How much is \$135 in 1915 worth in 2007?

$$\text{dollars in 2007} = \$135 \text{ in 1915} \times \frac{\text{CPI in 2007}}{\text{CPI in 1915}} = \$135 \times \frac{207.3}{10.1} \approx$$

\$1002.60 / **\$2052.48** / **\$2770.84**.

(c) How much is \$100 in 1984 worth in 2007?

$$\text{dollars in 2007} = \$100 \text{ in 1984} \times \frac{\text{CPI in 2007}}{\text{CPI in 1984}} = \$100 \times \frac{207.3}{103.9} \approx$$

\$102.60 / **\$127.58** / **\$199.52**.

(d) Using Table 16.1, how much is \$60 in 1991 worth in 2003?

$$\text{dollars in 2003} = \$60 \text{ in 1991} \times \frac{\text{CPI in 2003}}{\text{CPI in 1991}} = \$60 \times \frac{184.0}{136.2} \approx$$

\$81.06 / **\$127.58** / **\$200.33**.