Chapter 14

Inference on the Least-Squares Regression Model and Multiple Regression

14.1 Testing the Significance of the Least-Squares Regression Model

Test and CI for slope, β_1, of regression model $y_i = \beta_1 x_i + \beta_0 + \epsilon_i$, is

$$t_0 = \frac{b_1 - \beta_1}{\frac{s_e}{\sqrt{\sum(x_i - \bar{x})^2}}} = \frac{b_1 - \beta_1}{s_{b_1}}, \qquad b_1 \pm t_{\frac{\alpha}{2}} \left(\frac{s_e}{\sqrt{\sum(x_i - \bar{x})^2}} \right),$$

where $\mu_{y|x} = \beta_1 x + \beta_0$ and where standard error of estimate, s_e, is

$$s_e = \sqrt{\frac{\sum(y_i - \hat{y}_i)^2}{n-2}}$$

where $\hat{y}_i = b_1 x_i + b_0$ and where points are sampled at random and residuals, ϵ_i, are normal with constant variance and where $t_{\frac{\alpha}{2}}$ has $n-2$ degrees of freedom.

Exercise 14.1 (Testing Significance of Least-Squares Regression Model)

1. *Scatterplot, least-squares line, residuals review: height vs circumference of trees.*

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

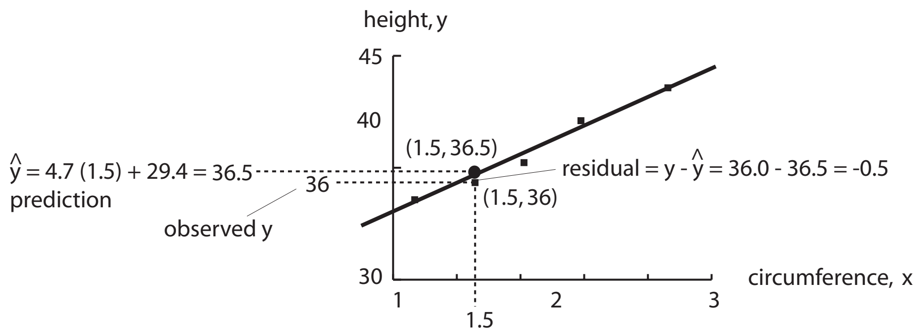

Figure 14.1 (Scatterplot, least-squares line, residuals)

(StatCrunch, My Data, choose 4.1 four scatter plots.)

(a) *Calculating least-squares regression line.*
$\boldsymbol{\hat{y} = 2.438x + 4.704}$
$\boldsymbol{\hat{y} = 4.704x + 29.438}$
$\boldsymbol{\hat{y} = 5.944x + 47.04}$.

(Stat, Regression, Simple Linear, X-Variable: circumference, Y-Variable: height, choose plot the fitted line, Calculate. Next (in Simple Linear Regression box) gives plotted regression.)

(b) *Slope and y-intercept of least-squares regression line,* $\hat{y} = 4.704x + 29.438$.

Slope is $b_1 =$ (circle one) **4.704** / **29.438**.

The *y–intercept* is $b_0 =$ (circle one) **4.704** / **29.438**.

If we sampled at random another five trees, (choose one) **same** / **different** *slope, y-intercept* would most likely occur. This implies b_0, b_1 are **statistics** / **parameters** used to estimate β_0, β_1.

Least–squares $\hat{y} = 4.704x + 29.438$ estimates model $\mu_{y|x} = \beta_1 x + \beta_0$.

(c) *Residuals, standard error of estimate,* s_e.

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	36.5	42.1	190
residual, $y - \hat{y}$	0.7	-0.4	0.4	-0.5	-0.1	0
residual^2, $(y - \hat{y})^2$	0.5	0.2	0.2	0.2	0.0	1.1

Total residuals^2, $\sum(y - \hat{y})^2 \approx 1.1$, measures how close points are to least-squares line. Standard error of estimate, s_e, measures "average" distance observed data is from least–squares line,

$$s_e = \sqrt{\frac{\sum(y_i - \hat{y}_i)^2}{n-2}} \approx \sqrt{\frac{1.1}{5-2}} \approx$$

(circle one) **0.40** / **0.60** / **0.80**.

(click Options in Simple Linear Regression box, choose Save residuals and predicted values, Compute!, then Data, Compute expression, sqrt(sum(Residuals∧2)/3), Compute.)

(d) Standard error of estimate is related to least–squares line in much same way standard deviation is related to (circle one) **average** / **variance**.

2. *Calculating standard error of estimate, s_e, using StatCrunch.*

(a) *Height versus circumference of trees.*

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

$s_e \approx$ (circle one) **0.40** / **0.60** / **0.80**.

(Notice Estimate of error standard deviation in Simple Linear Regression box is roughly 0.60.)

(b) *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

$s_e \approx$ (circle one) **6.45** / **7.03** / **7.83**.

(Stat, Regression, Simple Linear, X-Variable: brightness, Y-Variable: reading ability, Compute!)

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

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

$s_e \approx$ (circle one) **21.2** / **43.8** / **54.8**.

(Stat, Regression, Simple Linear, X-Variable: distance, Y-Variable: grain yield, Compute!)

3. *Inference for slope, β_1, of linear regression: reading ability.*

illumination, 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

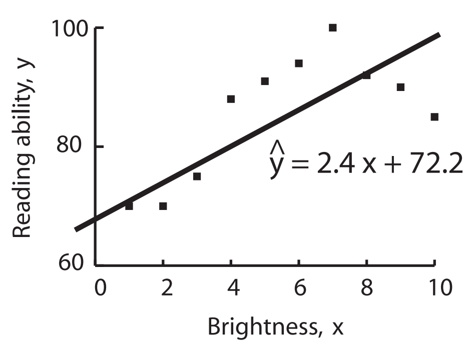

Figure 4.2 (Scatter diagram and least-squares, reading ability vs brightness)

Based on $n = 10$ data points, we find sample slope $b_1 \approx 2.418$. Test if population slope, β_1, is *positive* at a level of significance of 5%. Also, calculate a 95% CI.

(a) *Check assumptions.*

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

(Stat, Regression, Simple Linear, X-Variable: circumference, Y-Variable: height, choose plot the fitted line, QQ and Residual vs X-values plots, choose Save residuals and predicted values, Compute! Graphics, Boxplot, Residuals, Check Use fences to identify outliers, Create Graph!)

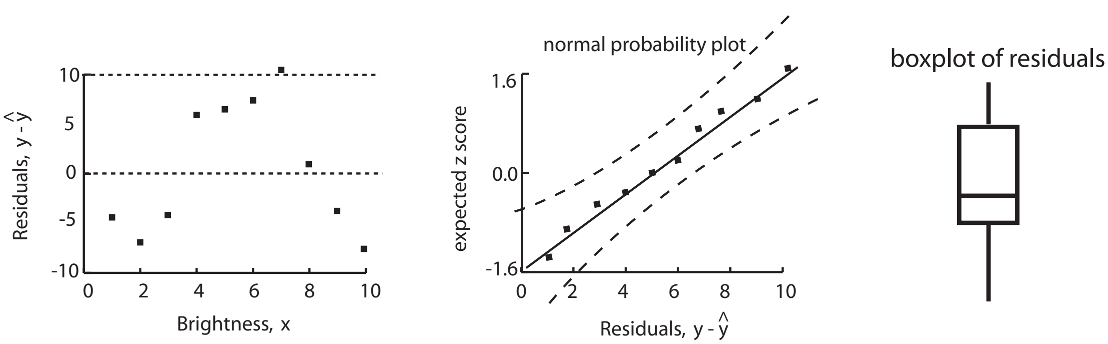

Figure 4.3 (Diagnostics of residuals, reading ability vs brightness)

i. *Pattern?*
According to either scatter diagram or residual plot, there **is a** / **is no** pattern: points are curved, not linear.

ii. *Constant variance?*
According to residual plot, residuals vary -10 and 10 over entire range of brightness; that is, data variance is **constant** / **variable**.

iii. *Residuals normal?*
Normal probability plot indicates residuals **normal** / **not normal** because data within dotted bounds.

iv. *Outliers?*
Boxplot indicates **outliers** / **no outliers**.

(b) *Hypothesis test, right–sided.*

i. *Statement.* Choose one.

A. $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 < 0$

B. $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 > 0$

C. $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 \neq 0$

ii. *Test.*
Chance $b_1 = 2.418$ or more, *if* $\beta_1 = 0$, is

$$\text{p–value} = P(b_1 \geq 2.418) = P\left(\frac{b_1 - \beta_1}{\frac{s_e}{\sqrt{\sum(x_i-\bar{x})^2}}} \geq \frac{2.418 - 0}{\frac{7.827}{\sqrt{82.5}}}\right) \approx P(t \geq 2.81) \approx$$

0.002 / **0.012** / **0.058** (with $n - 2 = 10 - 2 = 8$ df)
(IF DETAILS of formula required in addition to p-value,
for b_1 and s_e: Stat, Regression, Simple Linear, X-Variable: brightness, Y-Variable: reading ability, Calculate, where b_1 is slope and s_e is Estimate of error standard deviation,
for $\sqrt{\sum(x_i - \bar{x})^2}$: Data, Compute expression, Expression sum((brightness-5.5)∧2), Compute.
then, for p-value: Stat, Calculators, T, DF: 8, Prob (X ≥ 2.81) = [?] Compute.

OR: Stat, Regression, Simple Linear, X-Variable: brightness, Y-Variable: reading ability, choose Null Slope = 0 Alternative: >, Compute! Notice P-Value for Slope is 0.0115.)
Level of significance $\alpha =$ (choose one) **0.01** / **0.05** / **0.10**.

iii. *Conclusion.*
Since p–value $= 0.012 < \alpha = 0.050$,
do not reject / **reject** null $H_0 : \beta_1 = 0$.
Data indicates population slope
smaller than / **equals** / **greater than** zero (0).
In other words, reading ability
is / **is not** positively associated with brightness.

(c) *Confidence interval for β_1.*
A 95% confidence interval for β_1 is

$$b_1 \pm t_{\frac{\alpha}{2}} \frac{s_e}{\sqrt{\sum(x_i - \bar{x})^2}} = b_1 \pm t_{\frac{\alpha}{2}} \times s_{b_1} = 2.42 \pm 2.306 \left(\frac{7.827}{\sqrt{82.5}}\right) \approx$$

(circle one) **2.42 ± 0.99** / **2.42 ± 1.99** / **2.42 ± 2.99** $\approx (0.43, 4.41)$
(DETAILS: For $t_{\frac{\alpha}{2}} = t_{\frac{0.05}{2}} = t_{0.025}$, Stat, Calculators, T, DF: 8, Prob (X ≥ [?]) = 0.025 Compute.;
for b_1 and s_e: Stat, Regression, Simple Linear, X-Variable: brightness, Y-Variable: reading ability, Calculate, where b_1 is slope and s_e is Estimate of error standard deviation,
for $\sqrt{\sum(x_i - \bar{x})^2}$, Data, Compute expression, Expression sum((brightness-5.5)∧2), Compute;
for s_{b_1}: Std. Err. of Slope in Simple Linear Regression box,

OR Stat, Regression, Simple Linear, X-Variable: brightness, Y-Variable: reading ability, choose Confidence Intervals Level: 0.95, Compute! Notice 95% L. Limit and 95% U. Limit for Slope.)

4. *Inference for slope, β_1, of linear regression: elastic band.*
As elastic band stretched, width of band decreases. Based on $n = 5$ data points, $b_1 \approx -4.704$. Test if population slope, β_1, is *less* than zero at level of significance of 5%. Also, calculate 95% CI for β_1.

band width, x	-2.1	-1.7	-1.1	-1.5	-2.7
stretch length, y	40	37	35	36	42

Relabel var9 band width, var10 stretch length. Type data into these two columns.

(a) *Hypothesis test, left–sided.*

i. *Statement.* Choose one.

A. $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 < 0$

B. $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 > 0$

C. $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 \neq 0$

ii. *Test.*

Chance $b_1 = -4.704$ or less, if $\beta_1 = 0$, is

$$\text{p–value} = P(b_1 \leq -4.704) = P\left(\frac{b_1 - \beta_1}{\frac{s_e}{\sqrt{\sum(x_i-\bar{x})^2}}} \leq \frac{-4.704 - 0}{\frac{0.59718}{\sqrt{1.488}}}\right) \approx P\left(t \leq -9.61\right) \approx$$

0.0012 / **0.0023** / **0.0058**

(Stat, Regression, Simple Linear, X-Variable: band width, Y-Variable: stretch length, Next Null Slope = 0 Alternative: <, Compute!)

Level of significance $\alpha =$ (choose one) **0.01** / **0.05** / **0.10**.

iii. *Conclusion.*

Since p–value $= 0.0012 < \alpha = 0.0500$,
do not reject / **reject** null $H_0 : \beta_1 = 0$.
Data indicates population slope
smaller than / **equals** / **greater than** zero (0).
In other words, stretch length is
negatively / **positively** associated with band width.

(b) *Confidence Interval For β_1.*

A 95% confidence interval for β_1 is

$$b_1 \pm t_{\frac{\alpha}{2}} \frac{s_e}{\sqrt{\sum(x_i - \bar{x})^2}} = -4.704 \pm 3.18 \left(\frac{0.59718}{\sqrt{1.488}}\right) \approx$$

$\mathbf{-4.704 \pm 0.743}$ / $\mathbf{-4.704 \pm 0.843}$ / $\mathbf{-4.704 \pm 1.557}$ $\approx (-6.26, -3.15)$

(Stat, Regression, Simple Linear, X-Variable: band width, Y-Variable: stretch length, choose Confidence Intervals Level: 0.95, Compute! Notice 95% L. Limit and 95% U. Limit for Slope.)

5. *Inference for slope, β_1, of linear regression: pizza.*

Consider data on sales (y, in \$1000s) of pizzas versus student population (x, in 1000s). Based on $n = 10$ data points, $b_1 = 5$. Test if population slope, β_1, is *different* than zero at a level of significance of 5%. Also, calculate 95% CI.

number students, x	2	6	8	8	12	16	20	20	22	26
pizza sales, y	58	105	88	118	117	137	157	169	149	202

(a) *Hypothesis test, two–sided.*

i. *Statement.* Choose one.

A. $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 < 0$

B. $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 > 0$

C. $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 \neq 0$

ii. *Test.*

$$\text{p–value} = 2\times P(b_1 \geq 5) = 2\times P\left(\frac{b_1 - \beta_1}{\frac{s_e}{\sqrt{\sum(x_i-\bar{x})^2}}} \geq \frac{5-0}{\frac{13.83}{\sqrt{568}}}\right) \approx 2\times P\left(t \geq 8.62\right) \approx$$

0.00 / **0.01** / **0.06** (with $n - 2 = 10 - 2 = 8$ df)

(Stat, Regression, Simple Linear, X-Variable: number, Y-Variable: pizza sales, choose Null Slope = 0 Alternative: $\neq$, Compute!)

Level of significance $\alpha =$ (choose one) **0.01** / **0.05** / **0.10**.

iii. *Conclusion.*

Since p–value $= 0.00 < \alpha = 0.05$,
do not reject / **reject** null $H_0 : \beta_1 = 0$.
Data indicates population slope
smaller than / **equals** / **does not equal** zero (0).
In other words, sales
is / **is not** associated with student number.

(b) *Confidence interval for β_1.*

A 95% confidence interval for β_1 is

$$b_1 \pm t_{\frac{\alpha}{2}} \frac{s_e}{\sqrt{\sum(x_i - \bar{x})^2}} = 5 \pm 2.31\left(\frac{13.829}{\sqrt{568}}\right) =$$

(circle one) $\mathbf{5 \pm 0.74}$ / $\mathbf{5 \pm 1.3}$ / $\mathbf{5 \pm 2.2}$ $\approx (3.7, 6.3)$

(Stat, Regression, Simple Linear, X-Variable: number, Y-Variable: pizza sales, choose Confidence Intervals Level: 0.95, Compute! Notice 95% L. Limit and 95% U. Limit for Slope.)

6. *Inference for slope, β_1, of linear regression: recidivism time.*
Consider data on recidivism time (y, in days) of juvenile delinquents versus juvenile age (x, in years). Based on $n = 11$ data points, $b_1 = -1.64$. Test if population slope, β_1, is *less* than zero at a level of significance of 5%. Also, calculate 90% CI.

juvenile age, x	8	8	9	9	9	10	10	11	11	11	12
recidivism time, y	48	46	7	26	20	37	2	17	50	10	40

(a) *Hypothesis test, left–sided.*

i. *Statement.* Choose one.

A. $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 < 0$

B. $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 > 0$

C. $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 \neq 0$

ii. *Test.*

$$\text{p–value} = P(b_1 \leq -1.64) = P\left(\frac{b_1 - \beta_1}{\frac{s_e}{\sqrt{\sum(x_i-\bar{x})^2}}} \leq \frac{-1.64 - 0}{\frac{18.30}{\sqrt{17.64}}}\right) \approx P\left(t \leq -0.38\right) \approx$$

0.23 / **0.36** / **0.56** (with $n - 2 = 11 - 2 = 9$ df)

(Stat, Regression, Simple Linear, X-Variable: juvenile age, Y-Variable: recidivism time, choose Null Slope = 0 Alternative: ≤, Compute!)

Level of significance $\alpha =$ (choose one) **0.01** / **0.05** / **0.10**.

iii. *Conclusion.*

Since p–value $= 0.36 > \alpha = 0.05$,
do not reject / **reject** null $H_0 : \beta_1 = 0$.
Data indicates population slope
smaller than / **equals** / **does not equal** zero (0).
In other words, recidivism time
is / **is not** associated with juvenile age.

(b) *Confidence interval for β_1.*

A 90% confidence interval for β_1 is

$$b_1 \pm t_{\frac{\alpha}{2}} \frac{s_e}{\sqrt{\sum(x_i - \bar{x})^2}} = -1.64 \pm 1.80 \left(\frac{18.30}{\sqrt{17.64}}\right) \approx$$

(circle one) $\mathbf{-1.6 \pm 6}$ / $\mathbf{-1.6 \pm 7}$ / $\mathbf{-1.6 \pm 8}$ $\approx (-9.6, 6.4)$

(Stat, Regression, Simple Linear, X-Variable: number, Y-Variable: pizza sales, choose Confidence Intervals Level: 0.90, Compute! Notice 90% L. Limit and 90% U. Limit for Slope.)

(c) *Estimate for recidivism time, y.*

An appropriate estimate for recidivism time, y, is
$\bar{y} \approx$ **27.5** / **27.7** / **27.8** Why? Hint: Recidivism, y, is *not* associated with juvenile age, x
(Stat, Summary Stats, Columns, recidivism time, Compute!)

14.2 Confidence and Prediction Intervals

Confidence interval (CI) for *mean* response and prediction interval (PI) for *individual* response of regression model $y_i = \beta_1 x_i + \beta_0 + \epsilon_i$ are given, respectively, as

$$\hat{y} \pm t_{\frac{\alpha}{2}} \cdot s_e \sqrt{\frac{1}{n} + \frac{(x^* - \bar{x})^2}{\sum(x_i - \bar{x})^2}} \qquad \hat{y} \pm t_{\frac{\alpha}{2}} \cdot s_e \sqrt{1 + \frac{1}{n} + \frac{(x^* - \bar{x})^2}{\sum(x_i - \bar{x})^2}},$$

for given (fixed) x^* where points are sampled at random and residuals, ϵ_i, are normal with constant variance and where $t_{\frac{\alpha}{2}}$ has $n-2$ degrees of freedom.

Exercise 14.2 (Confidence and Prediction Intervals)

1. *CI and PI: reading versus illumination.*

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

Calculate 95% CI and 95% PI for $\hat{y}$ at $x^* = 3.5$ and at $x^* = 6.5$.

(a) *Confidence interval (CI) and prediction interval (PI) at* $x^* = 3.5$
95% CI for $\hat{y}$ at $x^* = 3.5$ is

$$\hat{y} \pm t_{\frac{\alpha}{2}} s_e \sqrt{\frac{1}{n} + \frac{(x^* - \bar{x})^2}{\sum(x_i - \bar{x})^2}} \approx$$

(circle one) **(54.23, 102.32)** / **(61.32, 100.01)** / **(73.71, 87.62)**.
(Stat, Regression, Simple Linear, X-Variable: brightness, Y-Variable: reading ability, choose Predict Y for X = 3.5, Level 0.95, Compute! Notice 95% C.I. for mean.)

95% PI for $\hat{y}$ at $x^* = 3.5$ is

$$\hat{y} \pm t_{\frac{\alpha}{2}} s_e \sqrt{1 + \frac{1}{n} + \frac{(x^* - \bar{x})^2}{\sum(x_i - \bar{x})^2}} \approx$$

(circle one) **(54.23, 102.32)** / **(61.32, 100.01)** / **(73.71, 87.62)**.
(Notice 95% P.I. for mean.)
CI is **longer** / **shorter** than PI.

(b) *Confidence interval (CI) and prediction interval (PI) at* $x^* = 6.5$
95% CI for $\hat{y}$ at $x^* = 6.5$ is

$$\hat{y} \pm t_{\frac{\alpha}{2}} s_e \sqrt{\frac{1}{n} + \frac{(x^* - \bar{x})^2}{\sum(x_i - \bar{x})^2}} \approx$$

(circle one) **(81.88, 93.96)** / **(68.88, 106.95)** / **(66.54, 108.11)**.
(Options, choose Predict Y for X = 6.5, Level 0.95, Compute!)

95% PI for $\hat{y}$ at $x^* = 6.5$ is

$$\hat{y} \pm t_{\frac{\alpha}{2}} s_e \sqrt{1 + \frac{1}{n} + \frac{(x^* - \bar{x})^2}{\sum(x_i - \bar{x})^2}} \approx$$

(circle one) **(81.88, 93.96)** / **(68.88, 106.95)** / **(66.54, 108.11)**.
CI is **longer** / **shorter** than PI.

(c) *Confidence (prediction) band, from confidence (prediction) intervals.*
True / **False** CIs (PIs) change for different x^* and, together, create a confidence (prediction) *band* of intervals.

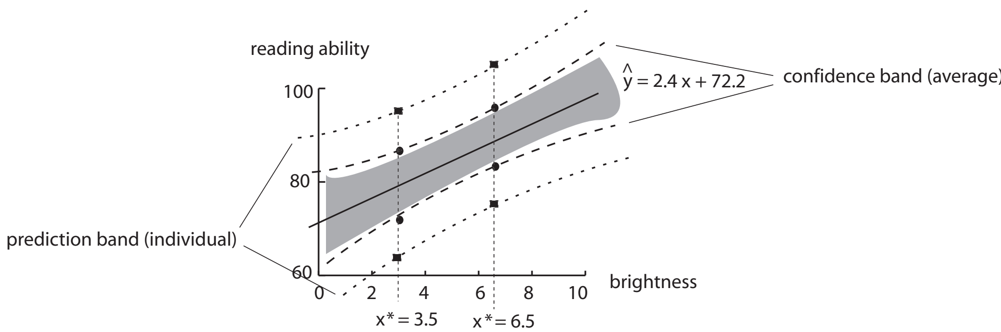

Figure 4.4 (CI, PI, confidence and prediction bands)

Confidence (prediction) *band* narrowest at point of averages $(\bar{x}, \bar{y})$.

2. *CI and PI: elastic band.*

band width, x	-2.1	-1.7	-1.1	-1.5	-2.7
stretch length, y	40	37	35	36	42

Calculate a 92% CI and 92% PI for $\hat{y}$ at $x^* = -1.8$.

(a) *Confidence interval (CI) and prediction interval (PI) at* $x^* = -1.8$
92% CI for $\hat{y}$ at $x^* = -1.8$ is

$$\hat{y} \pm t_{\frac{\alpha}{2}} s_e \sqrt{\frac{1}{n} + \frac{(x^* - \bar{x})^2}{\sum(x_i - \bar{x})^2}} \approx$$

(circle one) **(38.23, 39.32)** / **(37.21, 38.60)** / **(36.20, 39.61)**.
(Stat, Regression, Simple Linear, X-Variable: band width, Y-Variable: stretch length, choose Predict Y for X = -1.8, Level 0.92, Compute! Notice 92% C.I. for mean.)

92% PI for $\hat{y}$ at $x^* = -1.8$ is

$$\hat{y} \pm t_{\frac{\alpha}{2}} s_e \sqrt{1 + \frac{1}{n} + \frac{(x^* - \bar{x})^2}{\sum(x_i - \bar{x})^2}} \approx$$

(circle one) **(38.23, 39.32)** / **(37.21, 38.60)** / **(36.20, 39.61)**.

(b) *Detail calculations 92% CI and 92% PI for* $\hat{y}$ *at* $x^* = -1.8$.

i. *Calculate least–squares line,* $\hat{y} = b_1 x + b_0$.
$\boldsymbol{\hat{y} = 29.44 - 4.70x}$ / $\boldsymbol{\hat{y} = 29.44 - 4.98x}$ / $\boldsymbol{\hat{y} = 29.44 - 5.89x}$.
(Given in Simple Linear Regression box.)

ii. *Predicted value, $\hat{y}$.*
Since least–squares line is $\hat{y} = -4.70x + 29.44$, at $x = -1.8$,
$\hat{y} = -4.70(-1.8) + 29.44 =$ (circle one) **26.9** / **37.9** / **48.9**.
(Given in Simple Linear Regression box.)

iii. *Critical value, $t_{\frac{\alpha}{2}}$.*
$92\% = (1 - \alpha) \cdot 100\% = (1 - 0.08) \cdot 100\%$, $n - 2 = 5 - 2 = 3$ df
$t_{\frac{\alpha}{2}} = t_{\frac{0.08}{2}} = t_{0.04} =$ (circle one) (circle one) **2.61** / **2.88** / **2.98**.
(Stat, Calculators, T, DF: 3, Prob (X $\geq$ [?]) = 0.04)

iv. *Standard error of estimate, s_e.*
Standard error of estimate, $s_e =$ (circle one) **0.50** / **0.60** / **0.70**.
(Given in Simple Linear Regression box.)

v. *Sum of squares of x.*
$\sum(x_i - \bar{x})^2 =$ (circle one) **0.567** / **0.978** / **1.488**.
(Data, Compute, Expression sum(("band width" - mean("band width"))∧2), Compute.
OR $\sum(x_i - \bar{x})^2 = \left(\frac{s_e}{s_{b_1}}\right)^2 \approx \left(\frac{0.59718575}{0.48956231}\right)^2 \approx 1.488$ where s_{b_1} is Std. Err. of Slope.)

vi. *CI of mean stretch length at $x^* = -1.8$.*
Also, $n = 5$, $\bar{x} = -1.82$, and so

$$\hat{y} \pm t_{\frac{\alpha}{2}} s_e \sqrt{\frac{1}{n} + \frac{(x^* - \bar{x})^2}{\sum(x_i - \bar{x})^2}} = 37.9 \pm (2.61)(0.60)\sqrt{\frac{1}{5} + \frac{(-1.8 - (-1.82))^2}{1.488}} =$$

(circle one) **37.9 ± 0.3** / **37.9 ± 0.5** / **37.9 ± 0.7**.

vii. *PI of individual stretch length at $x^* = -1.82$.*
Also, $n = 5$, $\bar{x} = -1.82$, and so

$$\hat{y} \pm t_{\frac{\alpha}{2}} s_e \sqrt{1 + \frac{1}{n} + \frac{(x^* - \bar{x})^2}{\sum(x_i - \bar{x})^2}} = 37.9 \pm (2.61)(0.60)\sqrt{1 + \frac{1}{5} + \frac{(-1.8 - (-1.82))^2}{1.488}} =$$

(circle one) **37.9 ± 1.72** / **37.9 ± 2.34** / **37.9 ± 3.49**.

14.3 Introduction to Multiple Regression

Not covered.

14.4 Interaction and Dummy Variables

Not covered.

14.5 Polynomial Regression

Not covered.

14.6 Building a Regression Model

Not covered.