RATIOMERA

Complete Solutions

Simple Linear Regression

Ratiomera Statistics

These complete solutions use the same identifiers and order as the Exercise Sheet. Intermediate values are retained until the stated rounding step, so small differences caused by earlier rounding are acceptable where noted. All settings, values, data, and software outputs are constructed teaching material; they are not empirical findings.

Part I: Theory

A08: Weak Evidence and Careful Interpretation

`T05-A08-V01`: Weekly practice and reasoning

Identify the issue

Because $p = 0.276 > 0.05$, we fail to reject $H_0 : \beta_1 = 0$.

The approximate interval is $0.16 \pm 2(0.14) = [-0.1200, 0.4400]$ and contains zero.

Reason through the evidence

The fit is $R^2 = (1.11)^2/[(1.11)^2 + 28 - 2] = 0.0452$, or 4.5% of sample variation.

The estimated slope is 0.16 points per hour, but the data remain compatible with zero and nearby slopes.

State the conclusion and its limits

The appropriate conclusion is weak or inconclusive linear evidence, not proof of no relationship.

Neither the sign nor a low p-value would establish causation without a suitable design.

`T05-A08-V02`: Archive experience and retrieval time

Identify the issue

Because $p = 0.288 > 0.05$, we fail to reject $H_0 : \beta_1 = 0$.

The approximate interval is $-0.12 \pm 2(0.11) = [-0.3400, 0.1000]$ and contains zero.

Reason through the evidence

The fit is $R^2 = (-1.08)^2/[(-1.08)^2 + 34 - 2] = 0.0352$, or 3.5% of sample variation.

The estimated slope is −0.12 minutes per month, but the data remain compatible with zero and nearby slopes.

State the conclusion and its limits

The appropriate conclusion is weak or inconclusive linear evidence, not proof of no relationship.

Neither the sign nor a low p-value would establish causation without a suitable design.

`T05-A08-V03`: Museum visits and knowledge

Identify the issue

Because $p = 0.283 > 0.05$, we fail to reject $H_0 : \beta_1 = 0$.

The approximate interval is $0.1 \pm 2(0.09) = [-0.0800, 0.2800]$ and contains zero.

Reason through the evidence

The fit is $R^2 = (1.09)^2/[(1.09)^2 + 40 - 2] = 0.0303$, or 3.0% of sample variation.

The estimated slope is 0.1 points per visit, but the data remain compatible with zero and nearby slopes.

State the conclusion and its limits

The appropriate conclusion is weak or inconclusive linear evidence, not proof of no relationship.

Neither the sign nor a low p-value would establish causation without a suitable design.

`T05-A08-V04`: Reading time and comprehension

Identify the issue

Because $p = 0.329 > 0.05$, we fail to reject $H_0 : \beta_1 = 0$.

The approximate interval is $0.08 \pm 2(0.08) = [-0.0800, 0.2400]$ and contains zero.

Reason through the evidence

The fit is $R^2 = (0.99)^2/[(0.99)^2 + 46 - 2] = 0.0218$, or 2.2% of sample variation.

The estimated slope is 0.08 points per hour, but the data remain compatible with zero and nearby slopes.

State the conclusion and its limits

The appropriate conclusion is weak or inconclusive linear evidence, not proof of no relationship.

Neither the sign nor a low p-value would establish causation without a suitable design.

`T05-A08-V05`: Route familiarity and navigation errors

Identify the issue

Because $p = 0.323 > 0.05$, we fail to reject $H_0 : \beta_1 = 0$.

The approximate interval is $-0.07 \pm 2(0.07) = [-0.2100, 0.0700]$ and contains zero.

Reason through the evidence

The fit is $R^2 = (-1.00)^2/[(-1.00)^2 + 52 - 2] = 0.0196$, or 2.0% of sample variation.

The estimated slope is −0.07 errors per point, but the data remain compatible with zero and nearby slopes.

State the conclusion and its limits

The appropriate conclusion is weak or inconclusive linear evidence, not proof of no relationship.

Neither the sign nor a low p-value would establish causation without a suitable design.

`T05-A08-V06`: Workshop attendance and confidence

Identify the issue

Because $p = 0.326 > 0.05$, we fail to reject $H_0 : \beta_1 = 0$.

The approximate interval is $0.06 \pm 2(0.06) = [-0.0600, 0.1800]$ and contains zero.

Reason through the evidence

The fit is $R^2 = (0.99)^2/[(0.99)^2 + 60 - 2] = 0.0166$, or 1.7% of sample variation.

The estimated slope is 0.06 points per session, but the data remain compatible with zero and nearby slopes.

State the conclusion and its limits

The appropriate conclusion is weak or inconclusive linear evidence, not proof of no relationship.

Neither the sign nor a low p-value would establish causation without a suitable design.

`T05-A08-V07`: Notification load and focus

Identify the issue

Because $p = 0.326 > 0.05$, we fail to reject $H_0 : \beta_1 = 0$.

The approximate interval is $-0.05 \pm 2(0.05) = [-0.1500, 0.0500]$ and contains zero.

Reason through the evidence

The fit is $R^2 = (-0.99)^2/[(-0.99)^2 + 70 - 2] = 0.0142$, or 1.4% of sample variation.

The estimated slope is −0.05 points per notification, but the data remain compatible with zero and nearby slopes.

State the conclusion and its limits

The appropriate conclusion is weak or inconclusive linear evidence, not proof of no relationship.

Neither the sign nor a low p-value would establish causation without a suitable design.

`T05-A08-V08`: Search practice and accuracy

Identify the issue

Because $p = 0.32 > 0.05$, we fail to reject $H_0 : \beta_1 = 0$.

The approximate interval is $0.05 \pm 2(0.05) = [-0.0500, 0.1500]$ and contains zero.

Reason through the evidence

The fit is $R^2 = (1.00)^2/[(1.00)^2 + 80 - 2] = 0.0127$, or 1.3% of sample variation.

The estimated slope is 0.05 points per set, but the data remain compatible with zero and nearby slopes.

State the conclusion and its limits

The appropriate conclusion is weak or inconclusive linear evidence, not proof of no relationship.

Neither the sign nor a low p-value would establish causation without a suitable design.

`T05-A08-V09`: Travel distance and visit duration

Identify the issue

Because $p = 0.325 > 0.05$, we fail to reject $H_0 : \beta_1 = 0$.

The approximate interval is $0.04 \pm 2(0.04) = [-0.0400, 0.1200]$ and contains zero.

Reason through the evidence

The fit is $R^2 = (0.99)^2/[(0.99)^2 + 90 - 2] = 0.0110$, or 1.1% of sample variation.

The estimated slope is 0.04 minutes per kilometer, but the data remain compatible with zero and nearby slopes.

State the conclusion and its limits

The appropriate conclusion is weak or inconclusive linear evidence, not proof of no relationship.

Neither the sign nor a low p-value would establish causation without a suitable design.

`T05-A08-V10`: Discussion participation and reasoning

Identify the issue

Because $p = 0.32 > 0.05$, we fail to reject $H_0 : \beta_1 = 0$.

The approximate interval is $-0.04 \pm 2(0.04) = [-0.1200, 0.0400]$ and contains zero.

Reason through the evidence

The fit is $R^2 = (-1.00)^2/[(-1.00)^2 + 100 - 2] = 0.0101$, or 1.0% of sample variation.

The estimated slope is −0.04 points per contribution, but the data remain compatible with zero and nearby slopes.

State the conclusion and its limits

The appropriate conclusion is weak or inconclusive linear evidence, not proof of no relationship.

Neither the sign nor a low p-value would establish causation without a suitable design.

A09: Residual Distribution Checks

`T05-A09-V01`: Weekly practice and reasoning

Identify the issue

A complete coordinate specification for the bars is (-3.0, 2), (-2.0, 7), (-1.0, 15), (0.0, 22), (1.0, 15), (2.0, 7), (3.0, 2); each second coordinate is the bar height at the first coordinate.

The resulting pattern is approximately normal.

Reason through the evidence

Approximate residual normality looks plausible from this coarse histogram.

This check matters chiefly for small-sample t and F reference distributions and their intervals and p-values.

State the conclusion and its limits

The fitted line can still be calculated without perfect normality.

A histogram ignores fitted values, so it cannot show whether the residual mean bends with the predictor or whether residual spread changes.

Those questions require a residual-versus-fitted plot.

`T05-A09-V02`: Archive experience and retrieval time

Identify the issue

A complete coordinate specification for the bars is (-3.0, 18), (-2.0, 20), (-1.0, 14), (0.0, 8), (1.0, 4), (2.0, 2), (3.0, 1); each second coordinate is the bar height at the first coordinate.

The resulting pattern is right-skewed.

Reason through the evidence

Approximate residual normality is questionable and should be investigated with the original residuals and a normal-quantile plot.

This check matters chiefly for small-sample t and F reference distributions and their intervals and p-values.

State the conclusion and its limits

The fitted line can still be calculated without perfect normality.

A histogram ignores fitted values, so it cannot show whether the residual mean bends with the predictor or whether residual spread changes.

Those questions require a residual-versus-fitted plot.

`T05-A09-V03`: Museum visits and knowledge

Identify the issue

A complete coordinate specification for the bars is (-3.0, 1), (-2.0, 6), (-1.0, 14), (0.0, 20), (1.0, 14), (2.0, 6), (3.0, 1); each second coordinate is the bar height at the first coordinate.

The resulting pattern is approximately normal.

Reason through the evidence

Approximate residual normality looks plausible from this coarse histogram.

This check matters chiefly for small-sample t and F reference distributions and their intervals and p-values.

State the conclusion and its limits

The fitted line can still be calculated without perfect normality.

A histogram ignores fitted values, so it cannot show whether the residual mean bends with the predictor or whether residual spread changes.

Those questions require a residual-versus-fitted plot.

`T05-A09-V04`: Reading time and comprehension

Identify the issue

A complete coordinate specification for the bars is (-4.0, 3), (-3.0, 8), (-2.0, 16), (-1.0, 22), (0.0, 15), (1.0, 5), (2.0, 1), (3.0, 0), (4.0, 1); each second coordinate is the bar height at the first coordinate.

The resulting pattern is an upper outlier or heavy right tail.

Reason through the evidence

Approximate residual normality is questionable and should be investigated with the original residuals and a normal-quantile plot.

This check matters chiefly for small-sample t and F reference distributions and their intervals and p-values.

State the conclusion and its limits

The fitted line can still be calculated without perfect normality.

A histogram ignores fitted values, so it cannot show whether the residual mean bends with the predictor or whether residual spread changes.

Those questions require a residual-versus-fitted plot.

`T05-A09-V05`: Route familiarity and navigation errors

Identify the issue

A complete coordinate specification for the bars is (-3.0, 5), (-2.0, 9), (-1.0, 12), (0.0, 13), (1.0, 12), (2.0, 9), (3.0, 5); each second coordinate is the bar height at the first coordinate.

The resulting pattern is symmetric but flatter than a normal shape.

Reason through the evidence

Approximate residual normality is questionable and should be investigated with the original residuals and a normal-quantile plot.

This check matters chiefly for small-sample t and F reference distributions and their intervals and p-values.

State the conclusion and its limits

The fitted line can still be calculated without perfect normality.

A histogram ignores fitted values, so it cannot show whether the residual mean bends with the predictor or whether residual spread changes.

Those questions require a residual-versus-fitted plot.

`T05-A09-V06`: Workshop attendance and confidence

Identify the issue

A complete coordinate specification for the bars is (-3.0, 1), (-2.0, 2), (-1.0, 4), (0.0, 8), (1.0, 14), (2.0, 20), (3.0, 18); each second coordinate is the bar height at the first coordinate.

The resulting pattern is left-skewed.

Reason through the evidence

Approximate residual normality is questionable and should be investigated with the original residuals and a normal-quantile plot.

This check matters chiefly for small-sample t and F reference distributions and their intervals and p-values.

State the conclusion and its limits

The fitted line can still be calculated without perfect normality.

A histogram ignores fitted values, so it cannot show whether the residual mean bends with the predictor or whether residual spread changes.

Those questions require a residual-versus-fitted plot.

`T05-A09-V07`: Notification load and focus

Identify the issue

A complete coordinate specification for the bars is (-3.0, 2), (-2.0, 8), (-1.0, 17), (0.0, 24), (1.0, 17), (2.0, 8), (3.0, 2); each second coordinate is the bar height at the first coordinate.

The resulting pattern is approximately normal.

Reason through the evidence

Approximate residual normality looks plausible from this coarse histogram.

This check matters chiefly for small-sample t and F reference distributions and their intervals and p-values.

State the conclusion and its limits

The fitted line can still be calculated without perfect normality.

A histogram ignores fitted values, so it cannot show whether the residual mean bends with the predictor or whether residual spread changes.

Those questions require a residual-versus-fitted plot.

`T05-A09-V08`: Search practice and accuracy

Identify the issue

A complete coordinate specification for the bars is (-3.5, 3), (-2.5, 12), (-1.5, 18), (-0.5, 7), (0.5, 6), (1.5, 17), (2.5, 11), (3.5, 3); each second coordinate is the bar height at the first coordinate.

The resulting pattern is bimodal.

Reason through the evidence

Approximate residual normality is questionable and should be investigated with the original residuals and a normal-quantile plot.

This check matters chiefly for small-sample t and F reference distributions and their intervals and p-values.

State the conclusion and its limits

The fitted line can still be calculated without perfect normality.

A histogram ignores fitted values, so it cannot show whether the residual mean bends with the predictor or whether residual spread changes.

Those questions require a residual-versus-fitted plot.

`T05-A09-V09`: Travel distance and visit duration

Identify the issue

A complete coordinate specification for the bars is (-3.0, 5), (-2.0, 7), (-1.0, 12), (0.0, 20), (1.0, 12), (2.0, 7), (3.0, 5); each second coordinate is the bar height at the first coordinate.

The resulting pattern is symmetric with heavier tails.

Reason through the evidence

Approximate residual normality is questionable and should be investigated with the original residuals and a normal-quantile plot.

This check matters chiefly for small-sample t and F reference distributions and their intervals and p-values.

State the conclusion and its limits

The fitted line can still be calculated without perfect normality.

A histogram ignores fitted values, so it cannot show whether the residual mean bends with the predictor or whether residual spread changes.

Those questions require a residual-versus-fitted plot.

`T05-A09-V10`: Discussion participation and reasoning

Identify the issue

A complete coordinate specification for the bars is (-3.0, 1), (-2.0, 4), (-1.0, 10), (0.0, 30), (1.0, 10), (2.0, 4), (3.0, 1); each second coordinate is the bar height at the first coordinate.

The resulting pattern is symmetric but more sharply peaked.

Reason through the evidence

Approximate residual normality is questionable and should be investigated with the original residuals and a normal-quantile plot.

This check matters chiefly for small-sample t and F reference distributions and their intervals and p-values.

State the conclusion and its limits

The fitted line can still be calculated without perfect normality.

A histogram ignores fitted values, so it cannot show whether the residual mean bends with the predictor or whether residual spread changes.

Those questions require a residual-versus-fitted plot.

A10: Residual-versus-Fitted Patterns

`T05-A10-V01`: Weekly practice and reasoning

Identify the issue, part (a)

In the original-data panel, place weekly practice hours on the horizontal axis and reasoning score on the vertical axis. Draw an approximately straight center with a similar vertical spread from left to right, then add the fitted straight line as the reference the residuals evaluate.

Reason through the evidence, part (b)

The completed residual mean coordinates are $(1, -0.1)$, $(2, 0.2)$, $(3, -0.2)$, $(4, 0.1)$, $(5, 0.0)$. The five vertical bar endpoints are band 1: $[-2.2, 2.0]$, band 2: $[-1.8, 2.2]$, band 3: $[-2.4, 2.0]$, band 4: $[-2.0, 2.2]$, band 5: $[-2.0, 2.0]$.

Reason through the evidence, part (c)

Read the two panels together: distances above and below the fitted line in the original-data panel become positive and negative residuals in the second panel. The grouped residual display shows a random horizontal band. The residual means stay near zero and the spreads remain similar, which is the expected pattern. No obvious nonlinearity or unequal variance is visible in this grouped summary.

State the conclusion and its limits, part (d)

Inspect the case-level residual-versus-fitted plot rather than relying only on five bands. For curvature, consider whether a transformed predictor or explicitly justified nonlinear term matches the research question. For changing spread, inspect measurement, subgroups, outcome scale, and variance modeling. A clean pattern supports the diagnostic conditions but does not prove them or establish causation.

`T05-A10-V02`: Archive experience and retrieval time

Identify the issue, part (a)

In the original-data panel, place months of archive experience on the horizontal axis and retrieval time on the vertical axis. Draw a visibly curved center rather than one adequate straight line, then add the fitted straight line as the reference the residuals evaluate.

Reason through the evidence, part (b)

The completed residual mean coordinates are (1, 2.4), (2, 0.6), (3, −1.0), (4, 0.5), (5, 2.3). The five vertical bar endpoints are band 1: [0.9, 3.9], band 2: [−1.0, 2.2], band 3: [−2.7, 0.7], band 4: [−1.1, 2.1], band 5: [0.8, 3.8].

Reason through the evidence, part (c)

Read the two panels together: distances above and below the fitted line in the original-data panel become positive and negative residuals in the second panel. The grouped residual display shows curvature. The residual means change systematically from positive to negative and back, revealing curvature. The straight-line mean function is inadequate.

State the conclusion and its limits, part (d)

Inspect the case-level residual-versus-fitted plot rather than relying only on five bands. For curvature, consider whether a transformed predictor or explicitly justified nonlinear term matches the research question. For changing spread, inspect measurement, subgroups, outcome scale, and variance modeling. A clean pattern supports the diagnostic conditions but does not prove them or establish causation.

`T05-A10-V03`: Museum visits and knowledge

Identify the issue, part (a)

In the original-data panel, place museum visits this year on the horizontal axis and historical-knowledge score on the vertical axis. Draw an approximately straight center whose vertical spread shows increasing spread, then add the fitted straight line as the reference the residuals evaluate.

Reason through the evidence, part (b)

The completed residual mean coordinates are (1, 0.0), (2, 0.1), (3, −0.1), (4, 0.2), (5, 0.0). The five vertical bar endpoints are band 1: [−0.8, 0.8], band 2: [−1.1, 1.3], band 3: [−1.9, 1.7], band 4: [−2.4, 2.8], band 5: [−3.5, 3.5].

Reason through the evidence, part (c)

Read the two panels together: distances above and below the fitted line in the original-data panel become positive and negative residuals in the second panel. The grouped residual display shows increasing spread. The residual means stay near zero but the spread shows increasing spread. The constant-variance condition is questionable.

State the conclusion and its limits, part (d)

Inspect the case-level residual-versus-fitted plot rather than relying only on five bands. For curvature, consider whether a transformed predictor or explicitly justified nonlinear term matches the research question. For changing spread, inspect measurement, subgroups, outcome scale, and variance modeling. A clean pattern supports the diagnostic conditions but does not prove them or establish causation.

`T05-A10-V04`: Reading time and comprehension

Identify the issue, part (a)

In the original-data panel, place weekly reading time on the horizontal axis and comprehension score on the vertical axis. Draw a visibly curved center rather than one adequate straight line, then add the fitted straight line as the reference the residuals evaluate.

Reason through the evidence, part (b)

The completed residual mean coordinates are (1, −2.0), (2, −0.7), (3, 0.8), (4, 0.4), (5, −1.8). The five vertical bar endpoints are band 1: [−3.4, −0.6], band 2: [−2.2, 0.8], band 3: [−0.8, 2.4], band 4: [−1.1, 1.9], band 5: [−3.2, −0.4].

Reason through the evidence, part (c)

Read the two panels together: distances above and below the fitted line in the original-data panel become positive and negative residuals in the second panel. The grouped residual display shows curvature. The residual means change systematically from positive to negative and back, revealing curvature. The straight-line mean function is inadequate.

State the conclusion and its limits, part (d)

Inspect the case-level residual-versus-fitted plot rather than relying only on five bands. For curvature, consider whether a transformed predictor or explicitly justified nonlinear term matches the research question. For changing spread, inspect measurement, subgroups, outcome scale, and variance modeling. A clean pattern supports the diagnostic conditions but does not prove them or establish causation.

`T05-A10-V05`: Route familiarity and navigation errors

Identify the issue, part (a)

In the original-data panel, place route-familiarity score on the horizontal axis and navigation-error count on the vertical axis. Draw an approximately straight center whose vertical spread shows decreasing spread, then add the fitted straight line as the reference the residuals evaluate.

Reason through the evidence, part (b)

The completed residual mean coordinates are (1, 0.1), (2, −0.1), (3, 0.0), (4, 0.1), (5, −0.1). The five vertical bar endpoints are band 1: [−3.1, 3.3], band 2: [−2.7, 2.5], band 3: [−1.9, 1.9], band 4: [−1.2, 1.4], band 5: [−0.9, 0.7].

Reason through the evidence, part (c)

Read the two panels together: distances above and below the fitted line in the original-data panel become positive and negative residuals in the second panel. The grouped residual display shows decreasing spread. The residual means stay near zero but the spread shows decreasing spread. The constant-variance condition is questionable.

State the conclusion and its limits, part (d)

Inspect the case-level residual-versus-fitted plot rather than relying only on five bands. For curvature, consider whether a transformed predictor or explicitly justified nonlinear term matches the research question. For changing spread, inspect measurement, subgroups, outcome scale, and variance modeling. A clean pattern supports the diagnostic conditions but does not prove them or establish causation.

`T05-A10-V06`: Workshop attendance and confidence

Identify the issue, part (a)

In the original-data panel, place workshop sessions attended on the horizontal axis and confidence score on the vertical axis. Draw an approximately straight center with a similar vertical spread from left to right, then add the fitted straight line as the reference the residuals evaluate.

Reason through the evidence, part (b)

The completed residual mean coordinates are (1, 0.2), (2, −0.2), (3, 0.1), (4, −0.1), (5, 0.0). The five vertical bar endpoints are band 1: [−1.6, 2.0], band 2: [−2.1, 1.7], band 3: [−1.6, 1.8], band 4: [−1.9, 1.7], band 5: [−1.9, 1.9].

Reason through the evidence, part (c)

Read the two panels together: distances above and below the fitted line in the original-data panel become positive and negative residuals in the second panel. The grouped residual display shows a random horizontal band. The residual means stay near zero and the spreads remain similar, which is the expected pattern. No obvious nonlinearity or unequal variance is visible in this grouped summary.

State the conclusion and its limits, part (d)

Inspect the case-level residual-versus-fitted plot rather than relying only on five bands. For curvature, consider whether a transformed predictor or explicitly justified nonlinear term matches the research question. For changing spread, inspect measurement, subgroups, outcome scale, and variance modeling. A clean pattern supports the diagnostic conditions but does not prove them or establish causation.

`T05-A10-V07`: Notification load and focus

Identify the issue, part (a)

In the original-data panel, place daily notification count on the horizontal axis and focus score on the vertical axis. Draw a visibly curved center rather than one adequate straight line, then add the fitted straight line as the reference the residuals evaluate.

Reason through the evidence, part (b)

The completed residual mean coordinates are (1, −1.5), (2, −0.4), (3, 0.6), (4, 0.3), (5, −1.4). The five vertical bar endpoints are band 1: [−2.7, −0.3], band 2: [−1.7, 0.9], band 3: [−0.8, 2.0], band 4: [−1.0, 1.6], band 5: [−2.6, −0.2].

Reason through the evidence, part (c)

Read the two panels together: distances above and below the fitted line in the original-data panel become positive and negative residuals in the second panel. The grouped residual display shows curvature. The residual means change systematically from positive to negative and back, revealing curvature. The straight-line mean function is inadequate.

State the conclusion and its limits, part (d)

Inspect the case-level residual-versus-fitted plot rather than relying only on five bands. For curvature, consider whether a transformed predictor or explicitly justified nonlinear term matches the research question. For changing spread, inspect measurement, subgroups, outcome scale, and variance modeling. A clean pattern supports the diagnostic conditions but does not prove them or establish causation.

`T05-A10-V08`: Search practice and accuracy

Identify the issue, part (a)

In the original-data panel, place completed search-practice sets on the horizontal axis and search-accuracy score on the vertical axis. Draw an approximately straight center whose vertical spread shows increasing spread, then add the fitted straight line as the reference the residuals evaluate.

Reason through the evidence, part (b)

The completed residual mean coordinates are (1, 0.0), (2, 0.1), (3, 0.0), (4, −0.1), (5, 0.1). The five vertical bar endpoints are band 1: [−0.7, 0.7], band 2: [−1.0, 1.2], band 3: [−1.7, 1.7], band 4: [−2.5, 2.3], band 5: [−3.1, 3.3].

Reason through the evidence, part (c)

Read the two panels together: distances above and below the fitted line in the original-data panel become positive and negative residuals in the second panel. The grouped residual display shows increasing spread.

The residual means stay near zero but the spread shows increasing spread. The constant-variance condition is questionable.

State the conclusion and its limits, part (d)

Inspect the case-level residual-versus-fitted plot rather than relying only on five bands. For curvature, consider whether a transformed predictor or explicitly justified nonlinear term matches the research question. For changing spread, inspect measurement, subgroups, outcome scale, and variance modeling. A clean pattern supports the diagnostic conditions but does not prove them or establish causation.

`T05-A10-V09`: Travel distance and visit duration

Identify the issue, part (a)

In the original-data panel, place travel distance on the horizontal axis and visit duration on the vertical axis. Draw an approximately straight center with a similar vertical spread from left to right, then add the fitted straight line as the reference the residuals evaluate.

Reason through the evidence, part (b)

The completed residual mean coordinates are (1, 0.1), (2, 0.0), (3, −0.1), (4, 0.0), (5, 0.1). The five vertical bar endpoints are band 1: [−1.9, 2.1], band 2: [−2.1, 2.1], band 3: [−2.0, 1.8], band 4: [−2.0, 2.0], band 5: [−2.0, 2.2].

Reason through the evidence, part (c)

Read the two panels together: distances above and below the fitted line in the original-data panel become positive and negative residuals in the second panel. The grouped residual display shows a random horizontal band. The residual means stay near zero and the spreads remain similar, which is the expected pattern. No obvious nonlinearity or unequal variance is visible in this grouped summary.

State the conclusion and its limits, part (d)

Inspect the case-level residual-versus-fitted plot rather than relying only on five bands. For curvature, consider whether a transformed predictor or explicitly justified nonlinear term matches the research question. For changing spread, inspect measurement, subgroups, outcome scale, and variance modeling. A clean pattern supports the diagnostic conditions but does not prove them or establish causation.

`T05-A10-V10`: Discussion participation and reasoning

Identify the issue, part (a)

In the original-data panel, place discussion contributions on the horizontal axis and reasoning score on the vertical axis. Draw a visibly curved center rather than one adequate straight line, then add the fitted straight line as the reference the residuals evaluate.

Reason through the evidence, part (b)

The completed residual mean coordinates are (1, 1.8), (2, 0.5), (3, −0.9), (4, 0.4), (5, 1.7). The five vertical bar endpoints are band 1: [0.5, 3.1], band 2: [−0.9, 1.9], band 3: [−2.4, 0.6], band 4: [−1.0, 1.8], band 5: [0.4, 3.0].

Reason through the evidence, part (c)

Read the two panels together: distances above and below the fitted line in the original-data panel become positive and negative residuals in the second panel. The grouped residual display shows curvature. The residual means change systematically from positive to negative and back, revealing curvature. The straight-line mean function is inadequate.

State the conclusion and its limits, part (d)

Inspect the case-level residual-versus-fitted plot rather than relying only on five bands. For curvature, consider whether a transformed predictor or explicitly justified nonlinear term matches the research question. For changing spread, inspect measurement, subgroups, outcome scale, and variance modeling. A clean pattern supports the diagnostic conditions but does not prove them or establish causation.

Part II: Calculator Practice

A01: Least-Squares Coefficients from Raw Sums

`T05-A01-V01`: Weekly practice and reasoning

Set up the calculation

The completed scatterplot uses the coordinates (2, 58), (3, 60), (4, 65), (5, 67), (6, 71), (7, 73), (8, 78), (9, 80), with horizontal range [2, 9].

Reading the ordered points from left to right shows an approximately straight upward pattern and no single coordinate separated sharply from all neighboring points.

The means are $\bar{x} = 44/8 = 5.5000$ hours and $\bar{y} = 552/8 = 69.0000$ points.

The corrected sums are $S_{xx} = 284 - 44^2/8 = 42.0000$ and $S_{xy} = 3172 - 44(552)/8 = 136.0000$.

Work through the calculation

Thus $b_1 = 136.0000/42.0000 = 3.2381$ points per hour, and $b_0 = 69.0000 - (3.2381)(5.5000) = 51.1905$ points.

The slope is the fitted outcome difference of 3.2381 points for a one-hour increase in weekly practice hours.

The intercept is the fitted outcome at $X = 0$.

Zero is outside the observed range [2, 9], so the intercept is mathematically needed but should not be treated as a supported observed baseline.

Interpret and check the result

The fitted equation is $\hat{Y} = 51.1905 + (3.2381)X$.

Because $2 \leq 6 \leq 9$, the request is interpolation.

At $X = 6$, $\hat{Y} = 51.1905 + (3.2381)(6) = 70.6190$ points.

This is an estimated conditional mean, not a guaranteed outcome for one case.

`T05-A01-V02`: Archive experience and retrieval time

Set up the calculation

The completed scatterplot uses the coordinates (2, 68), (4, 64), (6, 61), (8, 57), (10, 55), (12, 50), (14, 48), (16, 45), with horizontal range [2, 16].

Reading the ordered points from left to right shows an approximately straight downward pattern and no single coordinate separated sharply from all neighboring points.

The means are $\bar{x} = 72/8 = 9.0000$ months and $\bar{y} = 448/8 = 56.0000$ minutes.

The corrected sums are $S_{xx} = 816 - 72^2/8 = 168.0000$ and $S_{xy} = 3756 - 72(448)/8 = -276.0000$.

Work through the calculation

Thus $b_1 = -276.0000/168.0000 = -1.6429$ minutes per month, and $b_0 = 56.0000 - (-1.6429)(9.0000) = 70.7857$ minutes.

The slope is the fitted outcome difference of −1.6429 minutes for a one-month increase in months of archive experience.

The intercept is the fitted outcome at $X = 0$.

Zero is outside the observed range [2, 16], so the intercept is mathematically needed but should not be treated as a supported observed baseline.

Interpret and check the result

The fitted equation is $\hat{Y} = 70.7857 + (-1.6429)X$.

Because $2 \leq 9 \leq 16$, the request is interpolation.

At $X = 9$, $\hat{Y} = 70.7857 + (-1.6429)(9) = 56.0000$ minutes.

This is an estimated conditional mean, not a guaranteed outcome for one case.

`T05-A01-V03`: Museum visits and knowledge

Set up the calculation

The completed scatterplot uses the coordinates (0, 45), (1, 48), (2, 52), (3, 56), (4, 61), (5, 65), (6, 68), (7, 74), with horizontal range [0, 7].

Reading the ordered points from left to right shows an approximately straight upward pattern and no single coordinate separated sharply from all neighboring points.

The means are $\bar{x} = 28/8 = 3.5000$ visits and $\bar{y} = 469/8 = 58.6250$ points.

The corrected sums are $S_{xx} = 140 - 28^2/8 = 42.0000$ and $S_{xy} = 1815 - 28(469)/8 = 173.5000$.

Work through the calculation

Thus $b_1 = 173.5000/42.0000 = 4.1310$ points per visit, and $b_0 = 58.6250 - (4.1310)(3.5000) = 44.1667$ points.

The slope is the fitted outcome difference of 4.1310 points for a one-visit increase in museum visits this year.

The intercept is the fitted outcome at $X = 0$.

Zero is inside the observed range [0, 7], so the intercept describes a fitted baseline represented by these data.

Interpret and check the result

The fitted equation is $\hat{Y} = 44.1667 + (4.1310)X$.

Because $0 \leq 4 \leq 7$, the request is interpolation.

At $X = 4$, $\hat{Y} = 44.1667 + (4.1310)(4) = 60.6905$ points.

This is an estimated conditional mean, not a guaranteed outcome for one case.

`T05-A01-V04`: Reading time and comprehension

Set up the calculation

The completed scatterplot uses the coordinates (1, 52), (2, 56), (3, 60), (4, 63), (5, 69), (6, 72), (7, 76), (8, 81), with horizontal range [1, 8].

Reading the ordered points from left to right shows an approximately straight upward pattern and no single coordinate separated sharply from all neighboring points.

The means are $\bar{x} = 36/8 = 4.5000$ hours and $\bar{y} = 529/8 = 66.1250$ points.

The corrected sums are $S_{xx} = 204 - 36^2/8 = 42.0000$ and $S_{xy} = 2553 - 36(529)/8 = 172.5000$.

Work through the calculation

Thus $b_1 = 172.5000/42.0000 = 4.1071$ points per hour, and $b_0 = 66.1250 - (4.1071)(4.5000) = 47.6429$ points.

The slope is the fitted outcome difference of 4.1071 points for a one-hour increase in weekly reading time.

The intercept is the fitted outcome at $X = 0$.

Zero is outside the observed range [1, 8], so the intercept is mathematically needed but should not be treated as a supported observed baseline.

Interpret and check the result

The fitted equation is $\hat{Y} = 47.6429 + (4.1071)X$.

Because $1 \leq 5 \leq 8$, the request is interpolation.

At $X = 5$, $\hat{Y} = 47.6429 + (4.1071)(5) = 68.1786$ points.

This is an estimated conditional mean, not a guaranteed outcome for one case.

`T05-A01-V05`: Route familiarity and navigation errors

Set up the calculation

The completed scatterplot uses the coordinates (2, 14), (3, 12), (4, 11), (5, 9), (6, 8), (7, 6), (8, 5), (9, 4), with horizontal range [2, 9].

Reading the ordered points from left to right shows an approximately straight downward pattern and no single coordinate separated sharply from all neighboring points.

The means are $\bar{x} = 44/8 = 5.5000$ points and $\bar{y} = 69/8 = 8.6250$ errors.

The corrected sums are $S_{xx} = 284 - 44^2/8 = 42.0000$ and $S_{xy} = 319 - 44(69)/8 = -60.5000$.

Work through the calculation

Thus $b_1 = -60.5000/42.0000 = -1.4405$ errors per point, and $b_0 = 8.6250 - (-1.4405)(5.5000) = 16.5476$ errors.

The slope is the fitted outcome difference of −1.4405 errors for a one-point increase in route-familiarity score.

The intercept is the fitted outcome at $X = 0$.

Zero is outside the observed range [2, 9], so the intercept is mathematically needed but should not be treated as a supported observed baseline.

Interpret and check the result

The fitted equation is $\hat{Y} = 16.5476 + (-1.4405)X$.

Because $2 \leq 6 \leq 9$, the request is interpolation.

At $X = 6$, $\hat{Y} = 16.5476 + (-1.4405)(6) = 7.9048$ errors.

This is an estimated conditional mean, not a guaranteed outcome for one case.

`T05-A01-V06`: Workshop attendance and confidence

Set up the calculation

The completed scatterplot uses the coordinates (0, 38), (1, 43), (2, 47), (3, 53), (4, 56), (5, 62), (6, 65), (7, 70), with horizontal range [0, 7].

Reading the ordered points from left to right shows an approximately straight upward pattern and no single coordinate separated sharply from all neighboring points.

The means are $\bar{x} = 28/8 = 3.5000$ sessions and $\bar{y} = 434/8 = 54.2500$ points.

The corrected sums are $S_{xx} = 140 - 28^2/8 = 42.0000$ and $S_{xy} = 1710 - 28(434)/8 = 191.0000$.

Work through the calculation

Thus $b_1 = 191.0000/42.0000 = 4.5476$ points per session, and $b_0 = 54.2500 - (4.5476)(3.5000) = 38.3333$ points.

The slope is the fitted outcome difference of 4.5476 points for a one-session increase in workshop sessions attended.

The intercept is the fitted outcome at $X = 0$.

Zero is inside the observed range [0, 7], so the intercept describes a fitted baseline represented by these data.

Interpret and check the result

The fitted equation is $\hat{Y} = 38.3333 + (4.5476)X$.

Because $0 \leq 4 \leq 7$, the request is interpolation.

At $X = 4$, $\hat{Y} = 38.3333 + (4.5476)(4) = 56.5238$ points.

This is an estimated conditional mean, not a guaranteed outcome for one case.

`T05-A01-V07`: Notification load and focus

Set up the calculation

The completed scatterplot uses the coordinates (10, 88), (20, 84), (30, 79), (40, 73), (50, 69), (60, 64), (70, 58), (80, 54), with horizontal range [10, 80].

Reading the ordered points from left to right shows an approximately straight downward pattern and no single coordinate separated sharply from all neighboring points.

The means are $\bar{x} = 360/8 = 45.0000$ notifications and $\bar{y} = 569/8 = 71.1250$ points.

The corrected sums are $S_{xx} = 20400 - 360^2/8 = 4200.0000$ and $S_{xy} = 23520 - 360(569)/8 = -2085.0000$.

Work through the calculation

Thus $b_1 = -2085.0000/4200.0000 = -0.4964$ points per notification, and $b_0 = 71.1250 - (-0.4964)(45.0000) = 93.4643$ points.

The slope is the fitted outcome difference of −0.4964 points for a one-notification increase in daily notification count.

The intercept is the fitted outcome at $X = 0$.

Zero is outside the observed range [10, 80], so the intercept is mathematically needed but should not be treated as a supported observed baseline.

Interpret and check the result

The fitted equation is $\hat{Y} = 93.4643 + (-0.4964)X$.

Because $10 \leq 45 \leq 80$, the request is interpolation.

At $X = 45$, $\hat{Y} = 93.4643 + (-0.4964)(45) = 71.1250$ points.

This is an estimated conditional mean, not a guaranteed outcome for one case.

`T05-A01-V08`: Search practice and accuracy

Set up the calculation

The completed scatterplot uses the coordinates (1, 55), (2, 59), (3, 63), (4, 68), (5, 72), (6, 77), (7, 81), (8, 86), with horizontal range [1, 8].

Reading the ordered points from left to right shows an approximately straight upward pattern and no single coordinate separated sharply from all neighboring points.

The means are $\bar{x} = 36/8 = 4.5000$ sets and $\bar{y} = 561/8 = 70.1250$ points.

The corrected sums are $S_{xx} = 204 - 36^2/8 = 42.0000$ and $S_{xy} = 2711 - 36(561)/8 = 186.5000$.

Work through the calculation

Thus $b_1 = 186.5000/42.0000 = 4.4405$ points per set, and $b_0 = 70.1250 - (4.4405)(4.5000) = 50.1429$ points.

The slope is the fitted outcome difference of 4.4405 points for a one-set increase in completed search-practice sets.

The intercept is the fitted outcome at $X = 0$.

Zero is outside the observed range [1, 8], so the intercept is mathematically needed but should not be treated as a supported observed baseline.

Interpret and check the result

The fitted equation is $\hat{Y} = 50.1429 + (4.4405)X$.

Because $1 \leq 5 \leq 8$, the request is interpolation.

At $X = 5$, $\hat{Y} = 50.1429 + (4.4405)(5) = 72.3452$ points.

This is an estimated conditional mean, not a guaranteed outcome for one case.

`T05-A01-V09`: Travel distance and visit duration

Set up the calculation

The completed scatterplot uses the coordinates (2, 65), (4, 70), (6, 75), (8, 82), (10, 88), (12, 94), (14, 101), (16, 107), with horizontal range [2, 16].

Reading the ordered points from left to right shows an approximately straight upward pattern and no single coordinate separated sharply from all neighboring points.

The means are $\bar{x} = 72/8 = 9.0000$ kilometers and $\bar{y} = 682/8 = 85.2500$ minutes.

The corrected sums are $S_{xx} = 816 - 72^2/8 = 168.0000$ and $S_{xy} = 6650 - 72(682)/8 = 512.0000$.

Work through the calculation

Thus $b_1 = 512.0000/168.0000 = 3.0476$ minutes per kilometer, and $b_0 = 85.2500 - (3.0476)(9.0000) = 57.8214$ minutes.

The slope is the fitted outcome difference of 3.0476 minutes for a one-kilometer increase in travel distance.

The intercept is the fitted outcome at $X = 0$.

Zero is outside the observed range [2, 16], so the intercept is mathematically needed but should not be treated as a supported observed baseline.

Interpret and check the result

The fitted equation is $\hat{Y} = 57.8214 + (3.0476)X$.

Because $2 \leq 9 \leq 16$, the request is interpolation.

At $X = 9$, $\hat{Y} = 57.8214 + (3.0476)(9) = 85.2500$ minutes.

This is an estimated conditional mean, not a guaranteed outcome for one case.

`T05-A01-V10`: Discussion participation and reasoning

Set up the calculation

The completed scatterplot uses the coordinates (0, 50), (1, 54), (2, 58), (3, 61), (4, 66), (5, 69), (6, 73), (7, 78), with horizontal range [0, 7].

Reading the ordered points from left to right shows an approximately straight upward pattern and no single coordinate separated sharply from all neighboring points.

The means are $\bar{x} = 28/8 = 3.5000$ contributions and $\bar{y} = 509/8 = 63.6250$ points.

The corrected sums are $S_{xx} = 140 - 28^2/8 = 42.0000$ and $S_{xy} = 1946 - 28(509)/8 = 164.5000$.

Work through the calculation

Thus $b_1 = 164.5000/42.0000 = 3.9167$ points per contribution, and $b_0 = 63.6250 - (3.9167)(3.5000) = 49.9167$ points.

The slope is the fitted outcome difference of 3.9167 points for a one-contribution increase in discussion contributions.

The intercept is the fitted outcome at $X = 0$.

Zero is inside the observed range [0, 7], so the intercept describes a fitted baseline represented by these data.

Interpret and check the result

The fitted equation is $\hat{Y} = 49.9167 + (3.9167)X$.

Because $0 \leq 4 \leq 7$, the request is interpolation.

At $X = 4$, $\hat{Y} = 49.9167 + (3.9167)(4) = 65.5833$ points.

This is an estimated conditional mean, not a guaranteed outcome for one case.

A02: From Means, Standard Deviations, and Covariance to a Line

`T05-A02-V01`: Weekly practice and reasoning
Reason before calculating

The correlation is $r = 11.0/(2.2 \times 8.0) = 0.6250$.

The slope is $b_1 = 11.0/2.2^2 = 2.2727$ points per one unit of X, and $b_0 = 68 - (2.2727)(5.5) = 55.5000$ points.

Work through the calculation

At $X = 7.0$, $\hat{Y} = 55.5000 + (2.2727)(7.0) = 71.4091$ points.

Correlation is unit-free and symmetric between X and Y.

Interpret and check the result

The regression slope names Y as the outcome, retains measurement units, and describes fitted outcome change per predictor unit.

Both begin with the same signed co-variation.

`T05-A02-V02`: Archive experience and retrieval time
Reason before calculating

The correlation is $r = -36.0/(6.0 \times 9.0) = -0.6667$.

The slope is $b_1 = -36.0/6.0^2 = -1.0000$ minutes per one unit of X, and $b_0 = 42 - (-1.0000)(18) = 60.0000$ minutes.

Work through the calculation

At $X = 24$, $\hat{Y} = 60.0000 + (-1.0000)(24) = 36.0000$ minutes.

Correlation is unit-free and symmetric between X and Y.

Interpret and check the result

The regression slope names Y as the outcome, retains measurement units, and describes fitted outcome change per predictor unit.

Both begin with the same signed co-variation.

`T05-A02-V03`: Museum visits and knowledge
Reason before calculating

The correlation is $r = 13.5/(1.8 \times 10.0) = 0.7500$.

The slope is $b_1 = 13.5/1.8^2 = 4.1667$ points per one unit of X, and $b_0 = 62 - (4.1667)(4.5) = 43.2500$ points.

Work through the calculation

At $X = 6$, $\hat{Y} = 43.2500 + (4.1667)(6) = 68.2500$ points.

Correlation is unit-free and symmetric between X and Y.

Interpret and check the result

The regression slope names Y as the outcome, retains measurement units, and describes fitted outcome change per predictor unit.

Both begin with the same signed co-variation.

`T05-A02-V04`: Reading time and comprehension
Reason before calculating

The correlation is $r = 15.75/(2.5 \times 9.0) = 0.7000$.

The slope is $b_1 = 15.75/2.5^2 = 2.5200$ points per one unit of X, and $b_0 = 74 - (2.5200)(7) = 56.3600$ points.

Work through the calculation

At $X = 9$, $\hat{Y} = 56.3600 + (2.5200)(9) = 79.0400$ points.

Correlation is unit-free and symmetric between X and Y.

Interpret and check the result

The regression slope names Y as the outcome, retains measurement units, and describes fitted outcome change per predictor unit.

Both begin with the same signed co-variation.

`T05-A02-V05`: Route familiarity and navigation errors
Reason before calculating

The correlation is $r = -25.2/(12.0 \times 3.0) = -0.7000$.

The slope is $b_1 = -25.2/12.0^2 = -0.1750$ errors per one unit of X, and $b_0 = 8 - (-0.1750)(55) = 17.6250$ errors.

Work through the calculation

At $X = 65$, $\hat{Y} = 17.6250 + (-0.1750)(65) = 6.2500$ errors.

Correlation is unit-free and symmetric between X and Y.

Interpret and check the result

The regression slope names Y as the outcome, retains measurement units, and describes fitted outcome change per predictor unit.

Both begin with the same signed co-variation.

`T05-A02-V06`: Workshop attendance and confidence
Reason before calculating

The correlation is $r = 7.35/(1.5 \times 7.0) = 0.7000$.

The slope is $b_1 = 7.35/1.5^2 = 3.2667$ points per one unit of X, and $b_0 = 51 - (3.2667)(3.5) = 39.5667$ points.

Work through the calculation

At $X = 5$, $\hat{Y} = 39.5667 + (3.2667)(5) = 55.9000$ points.

Correlation is unit-free and symmetric between X and Y.

Interpret and check the result

The regression slope names Y as the outcome, retains measurement units, and describes fitted outcome change per predictor unit.

Both begin with the same signed co-variation.

`T05-A02-V07`: Notification load and focus
Reason before calculating

The correlation is $r = -82.5/(15.0 \times 11.0) = -0.5000$.

The slope is $b_1 = -82.5/15.0^2 = -0.3667$ points per one unit of X, and $b_0 = 70 - (-0.3667)(48) = 87.6000$ points.

Work through the calculation

At $X = 35$, $\hat{Y} = 87.6000 + (-0.3667)(35) = 74.7667$ points.

Correlation is unit-free and symmetric between X and Y.

Interpret and check the result

The regression slope names Y as the outcome, retains measurement units, and describes fitted outcome change per predictor unit.

Both begin with the same signed co-variation.

`T05-A02-V08`: Search practice and accuracy
Reason before calculating

The correlation is $r = 11.2/(2.0 \times 8.0) = 0.7000$.

The slope is $b_1 = 11.2/2.0^2 = 2.8000$ points per one unit of X, and $b_0 = 76 - (2.8000)(6) = 59.2000$ points.

Work through the calculation

At $X = 9$, $\hat{Y} = 59.2000 + (2.8000)(9) = 84.4000$ points.

Correlation is unit-free and symmetric between X and Y.

Interpret and check the result

The regression slope names Y as the outcome, retains measurement units, and describes fitted outcome change per predictor unit.

Both begin with the same signed co-variation.

`T05-A02-V09`: Travel distance and visit duration
Reason before calculating

The correlation is $r = 54.0/(5.0 \times 18.0) = 0.6000$.

The slope is $b_1 = 54.0/5.0^2 = 2.1600$ minutes per one unit of X, and $b_0 = 95 - (2.1600)(14) = 64.7600$ minutes.

Work through the calculation

At $X = 18$, $\hat{Y} = 64.7600 + (2.1600)(18) = 103.6400$ minutes.

Correlation is unit-free and symmetric between X and Y.

Interpret and check the result

The regression slope names Y as the outcome, retains measurement units, and describes fitted outcome change per predictor unit.

Both begin with the same signed co-variation.

`T05-A02-V10`: Discussion participation and reasoning

Reason before calculating

The correlation is $r = 18.0/(3.0 \times 10.0) = 0.6000$.

The slope is $b_1 = 18.0/3.0^2 = 2.0000$ points per one unit of X, and $b_0 = 67 - (2.0000)(8) = 51.0000$ points.

Work through the calculation

At $X = 11$, $\hat{Y} = 51.0000 + (2.0000)(11) = 73.0000$ points.

Correlation is unit-free and symmetric between X and Y.

Interpret and check the result

The regression slope names Y as the outcome, retains measurement units, and describes fitted outcome change per predictor unit.

Both begin with the same signed co-variation.

A03: Unstandardized and Standardized Slopes

`T05-A03-V01`: Weekly practice and reasoning

Set up the calculation

The unstandardized slope 3.2 means that a one-unit difference in weekly practice hours accompanies a fitted difference of 3.2 points in reasoning score.

Work through the calculation

The prediction is $\hat{Y} = 42 + (3.2)(2) = 48.4000$ points.

The standardized slope is $\beta^* = (3.2)(1.5)/8.0 = 0.6000$.

Interpret and check the result

Thus a one-standard-deviation difference in the predictor, equal to 1.5 hours, accompanies a fitted difference of 0.6000 outcome standard deviations.

The unstandardized number answers an original-unit question; the standardized number answers a standard-deviation question.

`T05-A03-V02`: Archive experience and retrieval time

Set up the calculation

The unstandardized slope −1.2 means that a one-unit difference in months of archive experience accompanies a fitted difference of −1.2 minutes in retrieval time.

Work through the calculation

The prediction is $\hat{Y} = 75 + (-1.2)(20) = 51.0000$ minutes.

The standardized slope is $\beta^* = (-1.2)(6.0)/9.0 = -0.8000$.

Interpret and check the result

Thus a one-standard-deviation difference in the predictor, equal to 6.0 months, accompanies a fitted difference of −0.8000 outcome standard deviations.

The unstandardized number answers an original-unit question; the standardized number answers a standard-deviation question.

`T05-A03-V03`: Museum visits and knowledge
Set up the calculation

The unstandardized slope 4.5 means that a one-unit difference in museum visits this year accompanies a fitted difference of 4.5 points in historical-knowledge score.

Work through the calculation

The prediction is $\hat{Y} = 48 + (4.5)(3) = 61.5000$ points.

The standardized slope is $\beta^* = (4.5)(1.8)/10.0 = 0.8100$.

Interpret and check the result

Thus a one-standard-deviation difference in the predictor, equal to 1.8 visits, accompanies a fitted difference of 0.8100 outcome standard deviations.

The unstandardized number answers an original-unit question; the standardized number answers a standard-deviation question.

`T05-A03-V04`: Reading time and comprehension
Set up the calculation

The unstandardized slope 2.8 means that a one-unit difference in weekly reading time accompanies a fitted difference of 2.8 points in comprehension score.

Work through the calculation

The prediction is $\hat{Y} = 55 + (2.8)(8) = 77.4000$ points.

The standardized slope is $\beta^* = (2.8)(2.5)/9.0 = 0.7778$.

Interpret and check the result

Thus a one-standard-deviation difference in the predictor, equal to 2.5 hours, accompanies a fitted difference of 0.7778 outcome standard deviations.

The unstandardized number answers an original-unit question; the standardized number answers a standard-deviation question.

`T05-A03-V05`: Route familiarity and navigation errors
Set up the calculation

The unstandardized slope −0.12 means that a one-unit difference in route-familiarity score accompanies a fitted difference of −0.12 errors in navigation-error count.

Work through the calculation

The prediction is $\hat{Y} = 18 + (-0.12)(60) = 10.8000$ errors.

The standardized slope is $\beta^* = (-0.12)(12.0)/3.0 = -0.4800$.

Interpret and check the result

Thus a one-standard-deviation difference in the predictor, equal to 12.0 points, accompanies a fitted difference of −0.4800 outcome standard deviations.

The unstandardized number answers an original-unit question; the standardized number answers a standard-deviation question.

`T05-A03-V06`: Workshop attendance and confidence

Set up the calculation

The unstandardized slope 3.5 means that a one-unit difference in workshop sessions attended accompanies a fitted difference of 3.5 points in confidence score.

Work through the calculation

The prediction is $\hat{Y} = 35 + (3.5)(4) = 49.0000$ points.

The standardized slope is $\beta^* = (3.5)(1.5)/7.0 = 0.7500$.

Interpret and check the result

Thus a one-standard-deviation difference in the predictor, equal to 1.5 sessions, accompanies a fitted difference of 0.7500 outcome standard deviations.

The unstandardized number answers an original-unit question; the standardized number answers a standard-deviation question.

`T05-A03-V07`: Notification load and focus

Set up the calculation

The unstandardized slope −0.3 means that a one-unit difference in daily notification count accompanies a fitted difference of −0.3 points in focus score.

Work through the calculation

The prediction is $\hat{Y} = 82 + (-0.3)(50) = 67.0000$ points.

The standardized slope is $\beta^* = (-0.3)(15.0)/11.0 = -0.4091$.

Interpret and check the result

Thus a one-standard-deviation difference in the predictor, equal to 15.0 notifications, accompanies a fitted difference of −0.4091 outcome standard deviations.

The unstandardized number answers an original-unit question; the standardized number answers a standard-deviation question.

`T05-A03-V08`: Search practice and accuracy

Set up the calculation

The unstandardized slope 4.0 means that a one-unit difference in completed search-practice sets accompanies a fitted difference of 4.0 points in search-accuracy score.

Work through the calculation

The prediction is $\hat{Y} = 60 + (4.0)(7) = 88.0000$ points.

The standardized slope is $\beta^* = (4.0)(2.0)/8.0 = 1.0000$.

Interpret and check the result

Thus a one-standard-deviation difference in the predictor, equal to 2.0 sets, accompanies a fitted difference of 1.0000 outcome standard deviations.

The unstandardized number answers an original-unit question; the standardized number answers a standard-deviation question.

`T05-A03-V09`: Travel distance and visit duration

Set up the calculation

The unstandardized slope 2.4 means that a one-unit difference in travel distance accompanies a fitted difference of 2.4 minutes in visit duration.

Work through the calculation

The prediction is $\hat{Y} = 50 + (2.4)(16) = 88.4000$ minutes.

The standardized slope is $\beta^* = (2.4)(5.0)/18.0 = 0.6667$.

Interpret and check the result

Thus a one-standard-deviation difference in the predictor, equal to 5.0 kilometers, accompanies a fitted difference of 0.6667 outcome standard deviations.

The unstandardized number answers an original-unit question; the standardized number answers a standard-deviation question.

`T05-A03-V10`: Discussion participation and reasoning

Set up the calculation

The unstandardized slope 3.0 means that a one-unit difference in discussion contributions accompanies a fitted difference of 3.0 points in reasoning score.

Work through the calculation

The prediction is $\hat{Y} = 40 + (3.0)(10) = 70.0000$ points.

The standardized slope is $\beta^* = (3.0)(3.0)/10.0 = 0.9000$.

Interpret and check the result

Thus a one-standard-deviation difference in the predictor, equal to 3.0 contributions, accompanies a fitted difference of 0.9000 outcome standard deviations.

The unstandardized number answers an original-unit question; the standardized number answers a standard-deviation question.

A04: Comparing Two Simple-Regression Outputs

`T05-A04-V01`: Weekly practice and reasoning

Reason before calculating

The predictor estimates are 2.6 in Output A and 3.1 in Output B; 38 and 45 are intercepts.

In Output A, a one-hour increase in weekly practice hours accompanies a fitted increase of 2.60 points in reasoning score.

Work through the calculation

In Output B, a one-session increase in guided-study sessions accompanies a fitted increase of 3.10 points.

The standardized slopes are 0.49 and 0.58.

They express fitted changes in outcome standard deviations per one predictor standard deviation, so their absolute values can be compared: guided-study sessions has the larger absolute standardized association in these two separate models.

Interpret and check the result

In a simple regression with an intercept, each standardized slope also equals that predictor's Pearson correlation with the outcome.

The raw slopes cannot be ranked as strengths because a one-hour change in weekly practice hours is not the same scale as a one-session change in guided-study sessions.

These are two bivariate associations; they neither hold the other predictor constant nor establish a causal effect.

`T05-A04-V02`: Archive experience and retrieval time

Reason before calculating

The predictor estimates are −1.5 in Output A and −2.2 in Output B; 80 and 70 are intercepts.

In Output A, a one-month increase in months of archive experience accompanies a fitted decrease of 1.50 minutes in retrieval time.

Work through the calculation

In Output B, a one-session increase in retrieval-practice sessions accompanies a fitted decrease of 2.20 minutes.

The standardized slopes are −0.46 and −0.35.

They express fitted changes in outcome standard deviations per one predictor standard deviation, so their absolute values can be compared: months of archive experience has the larger absolute standardized association in these two separate models.

Interpret and check the result

In a simple regression with an intercept, each standardized slope also equals that predictor's Pearson correlation with the outcome.

The raw slopes cannot be ranked as strengths because a one-month change in months of archive experience is not the same scale as a one-session change in retrieval-practice sessions.

These are two bivariate associations; they neither hold the other predictor constant nor establish a causal effect.

`T05-A04-V03`: Museum visits and knowledge

Reason before calculating

The predictor estimates are 4.2 in Output A and 3.6 in Output B; 45 and 50 are intercepts.

In Output A, a one-visit increase in museum visits this year accompanies a fitted increase of 4.20 points in historical-knowledge score.

Work through the calculation

In Output B, a one-session increase in history-reading sessions accompanies a fitted increase of 3.60 points.

The standardized slopes are 0.58 and 0.44.

They express fitted changes in outcome standard deviations per one predictor standard deviation, so their absolute values can be compared: museum visits this year has the larger absolute standardized association in these two separate models.

Interpret and check the result

In a simple regression with an intercept, each standardized slope also equals that predictor's Pearson correlation with the outcome.

The raw slopes cannot be ranked as strengths because a one-visit change in museum visits this year is not the same scale as a one-session change in history-reading sessions.

These are two bivariate associations; they neither hold the other predictor constant nor establish a causal effect.

T05-A04-V04: Reading time and comprehension
Reason before calculating

The predictor estimates are 3.0 in Output A and 0.9 in Output B; 52 and 48 are intercepts.

In Output A, a one-hour increase in weekly reading time accompanies a fitted increase of 3.00 points in comprehension score.

Work through the calculation

In Output B, a one-page increase in annotated pages per week accompanies a fitted increase of 0.90 points.

The standardized slopes are 0.4 and 0.55.

They express fitted changes in outcome standard deviations per one predictor standard deviation, so their absolute values can be compared: annotated pages per week has the larger absolute standardized association in these two separate models.

Interpret and check the result

In a simple regression with an intercept, each standardized slope also equals that predictor's Pearson correlation with the outcome.

The raw slopes cannot be ranked as strengths because a one-hour change in weekly reading time is not the same scale as a one-page change in annotated pages per week.

These are two bivariate associations; they neither hold the other predictor constant nor establish a causal effect.

T05-A04-V05: Route familiarity and navigation errors
Reason before calculating

The predictor estimates are −0.1 in Output A and −0.55 in Output B; 15 and 13 are intercepts.

In Output A, a one-point increase in route-familiarity score accompanies a fitted decrease of 0.10 errors in navigation-error count.

Work through the calculation

In Output B, a one-attempt increase in prior route attempts accompanies a fitted decrease of 0.55 errors.

The standardized slopes are −0.35 and −0.62.

They express fitted changes in outcome standard deviations per one predictor standard deviation, so their absolute values can be compared: prior route attempts has the larger absolute standardized association in these two separate models.

Interpret and check the result

In a simple regression with an intercept, each standardized slope also equals that predictor's Pearson correlation with the outcome.

The raw slopes cannot be ranked as strengths because a one-point change in route-familiarity score is not the same scale as a one-attempt change in prior route attempts.

These are two bivariate associations; they neither hold the other predictor constant nor establish a causal effect.

T05-A04-V06: Workshop attendance and confidence
Reason before calculating

The predictor estimates are 3.8 in Output A and 2.7 in Output B; 33 and 40 are intercepts.

In Output A, a one-session increase in workshop sessions attended accompanies a fitted increase of 3.80 points in confidence score.

Work through the calculation

In Output B, a one-session increase in peer-feedback sessions accompanies a fitted increase of 2.70 points.

The standardized slopes are 0.55 and 0.47.

They express fitted changes in outcome standard deviations per one predictor standard deviation, so their absolute values can be compared: workshop sessions attended has the larger absolute standardized association in these two separate models.

Interpret and check the result

In a simple regression with an intercept, each standardized slope also equals that predictor's Pearson correlation with the outcome.

The raw slopes cannot be ranked as strengths because a one-session change in workshop sessions attended is not the same scale as a one-session change in peer-feedback sessions.

These are two bivariate associations; they neither hold the other predictor constant nor establish a causal effect.

`T05-A04-V07`: Notification load and focus

Reason before calculating

The predictor estimates are −0.28 in Output A and 2.4 in Output B; 85 and 78 are intercepts.

In Output A, a one-notification increase in daily notification count accompanies a fitted decrease of 0.28 points in focus score.

Work through the calculation

In Output B, a one-block increase in scheduled focus blocks accompanies a fitted increase of 2.40 points.

The standardized slopes are −0.42 and 0.51.

They express fitted changes in outcome standard deviations per one predictor standard deviation, so their absolute values can be compared: scheduled focus blocks has the larger absolute standardized association in these two separate models.

Interpret and check the result

In a simple regression with an intercept, each standardized slope also equals that predictor's Pearson correlation with the outcome.

The raw slopes cannot be ranked as strengths because a one-notification change in daily notification count is not the same scale as a one-block change in scheduled focus blocks.

These are two bivariate associations; they neither hold the other predictor constant nor establish a causal effect.

`T05-A04-V08`: Search practice and accuracy

Reason before calculating

The predictor estimates are 4.4 in Output A and 1.5 in Output B; 58 and 62 are intercepts.

In Output A, a one-set increase in completed search-practice sets accompanies a fitted increase of 4.40 points in search-accuracy score.

Work through the calculation

In Output B, a one-month increase in months of archive experience accompanies a fitted increase of 1.50 points.

The standardized slopes are 0.63 and 0.39.

They express fitted changes in outcome standard deviations per one predictor standard deviation, so their absolute values can be compared: completed search-practice sets has the larger absolute standardized association in these two separate models.

Interpret and check the result

In a simple regression with an intercept, each standardized slope also equals that predictor's Pearson correlation with the outcome.

The raw slopes cannot be ranked as strengths because a one-set change in completed search-practice sets is not the same scale as a one-month change in months of archive experience.

These are two bivariate associations; they neither hold the other predictor constant nor establish a causal effect.

`T05-A04-V09`: Travel distance and visit duration

Reason before calculating

The predictor estimates are 2.1 in Output A and 4.5 in Output B; 47 and 55 are intercepts.

In Output A, a one-kilometer increase in travel distance accompanies a fitted increase of 2.10 minutes in visit duration.

Work through the calculation

In Output B, a one-stop increase in planned stops accompanies a fitted increase of 4.50 minutes.

The standardized slopes are 0.38 and 0.66.

They express fitted changes in outcome standard deviations per one predictor standard deviation, so their absolute values can be compared: planned stops has the larger absolute standardized association in these two separate models.

Interpret and check the result

In a simple regression with an intercept, each standardized slope also equals that predictor's Pearson correlation with the outcome.

The raw slopes cannot be ranked as strengths because a one-kilometer change in travel distance is not the same scale as a one-stop change in planned stops.

These are two bivariate associations; they neither hold the other predictor constant nor establish a causal effect.

`T05-A04-V10`: Discussion participation and reasoning

Reason before calculating

The predictor estimates are 2.7 in Output A and 3.4 in Output B; 43 and 49 are intercepts.

In Output A, a one-contribution increase in discussion contributions accompanies a fitted increase of 2.70 points in reasoning score.

Work through the calculation

In Output B, a one-hour increase in preparation time accompanies a fitted increase of 3.40 points.

The standardized slopes are 0.45 and 0.52.

They express fitted changes in outcome standard deviations per one predictor standard deviation, so their absolute values can be compared: preparation time has the larger absolute standardized association in these two separate models.

Interpret and check the result

In a simple regression with an intercept, each standardized slope also equals that predictor's Pearson correlation with the outcome.

The raw slopes cannot be ranked as strengths because a one-contribution change in discussion contributions is not the same scale as a one-hour change in preparation time.

These are two bivariate associations; they neither hold the other predictor constant nor establish a causal effect.

A05: Coefficients and Explained Variation

`T05-A05-V01`: Weekly practice and reasoning

Set up the calculation

The slope is $b_1 = S_{xy}/S_{xx} = 120/180 = 0.6667$.

Explained variation is $SSR = 720 - 640.0000 = 80.0000$, which also equals $b_1 S_{xy} = 0.6667(120) = 80.0000$.

Work through the calculation

Therefore $R^2 = 80.0000/720 = 0.1111$.

The fitted value is $\hat{Y} = 40 + (0.6667)(8) = 45.3333$.

Interpret and check the result

The model accounts for 11.1% of the sample's total squared variation around $\bar{y}$; the remaining 88.9% is represented by squared residual variation.

This is a variation decomposition for the fitted sample, not a success rate and not causal evidence.

`T05-A05-V02`: Archive experience and retrieval time

Set up the calculation

The slope is $b_1 = S_{xy}/S_{xx} = -84/210 = -0.4000$.

Explained variation is $SSR = 630 - 596.4000 = 33.6000$, which also equals $b_1 S_{xy} = -0.4000(-84) = 33.6000$.

Work through the calculation

Therefore $R^2 = 33.6000/630 = 0.0533$.

The fitted value is $\hat{Y} = 42 + (-0.4000)(20) = 34.0000$.

Interpret and check the result

The model accounts for 5.3% of the sample's total squared variation around $\bar{y}$; the remaining 94.7% is represented by squared residual variation.

This is a variation decomposition for the fitted sample, not a success rate and not causal evidence.

`T05-A05-V03`: Museum visits and knowledge

Set up the calculation

The slope is $b_1 = S_{xy}/S_{xx} = 144/240 = 0.6000$.

Explained variation is $SSR = 840 - 753.6000 = 86.4000$, which also equals $b_1 S_{xy} = 0.6000(144) = 86.4000$.

Work through the calculation

Therefore $R^2 = 86.4000/840 = 0.1029$.

The fitted value is $\hat{Y} = 36 + (0.6000)(6) = 39.6000$.

Interpret and check the result

The model accounts for 10.3% of the sample's total squared variation around $\bar{y}$; the remaining 89.7% is represented by squared residual variation.

This is a variation decomposition for the fitted sample, not a success rate and not causal evidence.

`T05-A05-V04`: Reading time and comprehension

Set up the calculation

The slope is $b_1 = S_{xy}/S_{xx} = 135/225 = 0.6000$.

Explained variation is $SSR = 900 - 819.0000 = 81.0000$, which also equals $b_1 S_{xy} = 0.6000(135) = 81.0000$.

Work through the calculation

Therefore $R^2 = 81.0000/900 = 0.0900$.

The fitted value is $\hat{Y} = 50 + (0.6000)(9) = 55.4000$.

Interpret and check the result

The model accounts for 9.0% of the sample's total squared variation around $\bar{y}$; the remaining 91.0% is represented by squared residual variation.

This is a variation decomposition for the fitted sample, not a success rate and not causal evidence.

`T05-A05-V05`: Route familiarity and navigation errors

Set up the calculation

The slope is $b_1 = S_{xy}/S_{xx} = -66/132 = -0.5000$.

Explained variation is $SSR = 528 - 495.0000 = 33.0000$, which also equals $b_1 S_{xy} = -0.5000(-66) = 33.0000$.

Work through the calculation

Therefore $R^2 = 33.0000/528 = 0.0625$.

The fitted value is $\hat{Y} = 44 + (-0.5000)(60) = 14.0000$.

Interpret and check the result

The model accounts for 6.2% of the sample's total squared variation around $\bar{y}$; the remaining 93.8% is represented by squared residual variation.

This is a variation decomposition for the fitted sample, not a success rate and not causal evidence.

`T05-A05-V06`: Workshop attendance and confidence

Set up the calculation

The slope is $b_1 = S_{xy}/S_{xx} = 114/190 = 0.6000$.

Explained variation is $SSR = 760 - 691.6000 = 68.4000$, which also equals $b_1 S_{xy} = 0.6000(114) = 68.4000$.

Work through the calculation

Therefore $R^2 = 68.4000/760 = 0.0900$.

The fitted value is $\hat{Y} = 38 + (0.6000)(5) = 41.0000$.

Interpret and check the result

The model accounts for 9.0% of the sample's total squared variation around $\bar{y}$; the remaining 91.0% is represented by squared residual variation.

This is a variation decomposition for the fitted sample, not a success rate and not causal evidence.

`T05-A05-V07`: Notification load and focus

Set up the calculation

The slope is $b_1 = S_{xy}/S_{xx} = -96/240 = -0.4000$.

Explained variation is $SSR = 960 - 921.6000 = 38.4000$, which also equals $b_1 S_{xy} = -0.4000(-96) = 38.4000$.

Work through the calculation

Therefore $R^2 = 38.4000/960 = 0.0400$.

The fitted value is $\hat{Y} = 48 + (-0.4000)(45) = 30.0000$.

Interpret and check the result

The model accounts for 4.0% of the sample's total squared variation around $\bar{y}$; the remaining 96.0% is represented by squared residual variation.

This is a variation decomposition for the fitted sample, not a success rate and not causal evidence.

`T05-A05-V08`: Search practice and accuracy

Set up the calculation

The slope is $b_1 = S_{xy}/S_{xx} = 138/230 = 0.6000$.

Explained variation is $SSR = 920 - 837.2000 = 82.8000$, which also equals $b_1 S_{xy} = 0.6000(138) = 82.8000$.

Work through the calculation

Therefore $R^2 = 82.8000/920 = 0.0900$.

The fitted value is $\hat{Y} = 46 + (0.6000)(8) = 50.8000$.

Interpret and check the result

The model accounts for 9.0% of the sample's total squared variation around $\bar{y}$; the remaining 91.0% is represented by squared residual variation.

This is a variation decomposition for the fitted sample, not a success rate and not causal evidence.

`T05-A05-V09`: Travel distance and visit duration

Set up the calculation

The slope is $b_1 = S_{xy}/S_{xx} = 104/208 = 0.5000$.

Explained variation is $SSR = 832 - 780.0000 = 52.0000$, which also equals $b_1 S_{xy} = 0.5000(104) = 52.0000$.

Work through the calculation

Therefore $R^2 = 52.0000/832 = 0.0625$.

The fitted value is $\hat{Y} = 52 + (0.5000)(18) = 61.0000$.

Interpret and check the result

The model accounts for 6.2% of the sample's total squared variation around $\bar{y}$; the remaining 93.8% is represented by squared residual variation.

This is a variation decomposition for the fitted sample, not a success rate and not causal evidence.

`T05-A05-V10`: Discussion participation and reasoning

Set up the calculation

The slope is $b_1 = S_{xy}/S_{xx} = 100/200 = 0.5000$.

Explained variation is $SSR = 800 - 750.0000 = 50.0000$, which also equals $b_1 S_{xy} = 0.5000(100) = 50.0000$.

Work through the calculation

Therefore $R^2 = 50.0000/800 = 0.0625$.

The fitted value is $\hat{Y} = 40 + (0.5000)(10) = 45.0000$.

Interpret and check the result

The model accounts for 6.2% of the sample's total squared variation around $\bar{y}$; the remaining 93.8% is represented by squared residual variation.

This is a variation decomposition for the fitted sample, not a success rate and not causal evidence.

A06: Slope Tests and Confidence Intervals

`T05-A06-V01`: Weekly practice and reasoning

Reason before calculating

The statistic is $t = 2.4/0.75 = 3.2000$ with $df = 22$.

The exact two-sided t-distribution p-value is $p = 2P(T_{22} \geq |3.2000|) = 0.0041$.

Work through the calculation

The 95% critical value is $t_{0.975}(22) = 2.0739$, so the interval is $2.4 \pm 2.0739(0.75) = [0.8446, 3.9554]$.

Zero is outside the interval, so the matching two-sided test rejects H_0.

Interpret and check the result

The estimated fitted change is 2.4 points for a one-hour increase in weekly practice hours.

The interval shows the range of population slopes compatible with this procedure and sample under the linear-model assumptions.

The p-value and interval use the same t reference distribution, so their decisions agree.

`T05-A06-V02`: Archive experience and retrieval time

Reason before calculating

The statistic is $t = -1.6/0.6 = -2.6667$ with $df = 28$.

The exact two-sided t-distribution p-value is $p = 2P(T_{28} \geq |-2.6667|) = 0.0126$.

Work through the calculation

The 95% critical value is $t_{0.975}(28) = 2.0484$, so the interval is $-1.6 \pm 2.0484(0.6) = [-2.8290, -0.3710]$.

Zero is outside the interval, so the matching two-sided test rejects H_0.

Interpret and check the result

The estimated fitted change is −1.6 minutes for a one-month increase in months of archive experience.

The interval shows the range of population slopes compatible with this procedure and sample under the linear-model assumptions.

The p-value and interval use the same t reference distribution, so their decisions agree.

`T05-A06-V03`: Museum visits and knowledge

Reason before calculating

The statistic is $t = 3.1/1.05 = 2.9524$ with $df = 34$.

The exact two-sided t-distribution p-value is $p = 2P(T_{34} \geq |2.9524|) = 0.0057$.

Work through the calculation

The 95% critical value is $t_{0.975}(34) = 2.0322$, so the interval is $3.1 \pm 2.0322(1.05) = [0.9661, 5.2339]$.

Zero is outside the interval, so the matching two-sided test rejects H_0.

Interpret and check the result

The estimated fitted change is 3.1 points for a one-visit increase in museum visits this year.

The interval shows the range of population slopes compatible with this procedure and sample under the linear-model assumptions.

The p-value and interval use the same t reference distribution, so their decisions agree.

`T05-A06-V04`: Reading time and comprehension

Reason before calculating

The statistic is $t = 2.0/0.68 = 2.9412$ with $df = 40$.

The exact two-sided t-distribution p-value is $p = 2P(T_{40} \geq |2.9412|) = 0.0054$.

Work through the calculation

The 95% critical value is $t_{0.975}(40) = 2.0211$, so the interval is $2.0 \pm 2.0211(0.68) = [0.6257, 3.3743]$.

Zero is outside the interval, so the matching two-sided test rejects H_0.

Interpret and check the result

The estimated fitted change is 2.0 points for a one-hour increase in weekly reading time.

The interval shows the range of population slopes compatible with this procedure and sample under the linear-model assumptions.

The p-value and interval use the same t reference distribution, so their decisions agree.

`T05-A06-V05`: Route familiarity and navigation errors

Reason before calculating

The statistic is $t = -0.11/0.05 = -2.2000$ with $df = 48$.

The exact two-sided t-distribution p-value is $p = 2P(T_{48} \geq |-2.2000|) = 0.0327$.

Work through the calculation

The 95% critical value is $t_{0.975}(48) = 2.0106$, so the interval is $-0.11 \pm 2.0106(0.05) = [-0.2105, -0.0095]$.

Zero is outside the interval, so the matching two-sided test rejects H_0.

Interpret and check the result

The estimated fitted change is −0.11 errors for a one-point increase in route-familiarity score.

The interval shows the range of population slopes compatible with this procedure and sample under the linear-model assumptions.

The p-value and interval use the same t reference distribution, so their decisions agree.

`T05-A06-V06`: Workshop attendance and confidence

Reason before calculating

The statistic is $t = 2.8/0.9 = 3.1111$ with $df = 58$.

The exact two-sided t-distribution p-value is $p = 2P(T_{58} \geq |3.1111|) = 0.0029$.

Work through the calculation

The 95% critical value is $t_{0.975}(58) = 2.0017$, so the interval is $2.8 \pm 2.0017(0.9) = [0.9985, 4.6015]$.

Zero is outside the interval, so the matching two-sided test rejects H_0.

Interpret and check the result

The estimated fitted change is 2.8 points for a one-session increase in workshop sessions attended.

The interval shows the range of population slopes compatible with this procedure and sample under the linear-model assumptions.

The p-value and interval use the same t reference distribution, so their decisions agree.

`T05-A06-V07`: Notification load and focus

Reason before calculating

The statistic is $t = -0.24/0.1 = -2.4000$ with $df = 68$.

The exact two-sided t-distribution p-value is $p = 2P(T_{68} \geq |-2.4000|) = 0.0191$.

Work through the calculation

The 95% critical value is $t_{0.975}(68) = 1.9955$, so the interval is $-0.24 \pm 1.9955(0.1) = [-0.4395, -0.0405]$.

Zero is outside the interval, so the matching two-sided test rejects H_0.

Interpret and check the result

The estimated fitted change is −0.24 points for a one-notification increase in daily notification count.

The interval shows the range of population slopes compatible with this procedure and sample under the linear-model assumptions.

The p-value and interval use the same t reference distribution, so their decisions agree.

`T05-A06-V08`: Search practice and accuracy

Reason before calculating

The statistic is $t = 3.6/1.1 = 3.2727$ with $df = 78$.

The exact two-sided t-distribution p-value is $p = 2P(T_{78} \geq |3.2727|) = 0.0016$.

Work through the calculation

The 95% critical value is $t_{0.975}(78) = 1.9908$, so the interval is $3.6 \pm 1.9908(1.1) = [1.4101, 5.7899]$.

Zero is outside the interval, so the matching two-sided test rejects H_0.

Interpret and check the result

The estimated fitted change is 3.6 points for a one-set increase in completed search-practice sets.

The interval shows the range of population slopes compatible with this procedure and sample under the linear-model assumptions.

The p-value and interval use the same t reference distribution, so their decisions agree.

`T05-A06-V09`: Travel distance and visit duration

Reason before calculating

The statistic is $t = 1.5/0.72 = 2.0833$ with $df = 88$.

The exact two-sided t-distribution p-value is $p = 2P(T_{88} \geq |2.0833|) = 0.0401$.

Work through the calculation

The 95% critical value is $t_{0.975}(88) = 1.9873$, so the interval is $1.5 \pm 1.9873(0.72) = [0.0692, 2.9308]$.

Zero is outside the interval, so the matching two-sided test rejects H_0.

Interpret and check the result

The estimated fitted change is 1.5 minutes for a one-kilometer increase in travel distance.

The interval shows the range of population slopes compatible with this procedure and sample under the linear-model assumptions.

The p-value and interval use the same t reference distribution, so their decisions agree.

`T05-A06-V10`: Discussion participation and reasoning
Reason before calculating

The statistic is $t = 1.2/0.62 = 1.9355$ with $df = 98$.

The exact two-sided t-distribution p-value is $p = 2P(T_{98} \geq |1.9355|) = 0.0558$.

Work through the calculation

The 95% critical value is $t_{0.975}(98) = 1.9845$, so the interval is $1.2 \pm 1.9845(0.62) = [-0.0304, 2.4304]$.

Zero is inside the interval, so the matching two-sided test fails to reject H_0.

Interpret and check the result

The estimated fitted change is 1.2 points for a one-contribution increase in discussion contributions.

The interval shows the range of population slopes compatible with this procedure and sample under the linear-model assumptions.

The p-value and interval use the same t reference distribution, so their decisions agree.

A07: The Simple-Regression Model Test through R-Squared

`T05-A07-V01`: Weekly practice and reasoning
Set up the calculation

The null is $H_0 : \beta_1 = 0$, equivalently $H_0 : R^2_{population} = 0$ for this one-predictor linear model.

Work through the calculation

$F = [0.28/1]/[(1 - 0.28)/(20 - 2)] = 7.0000.$

Because 7.0000 exceeds 4.414, we reject the null at 5%.

Interpret and check the result

The sample provides evidence of a nonzero linear population slope.

With one predictor, $F = t^2$ for the slope test, so the global model and two-sided coefficient tests ask the same question and produce the same decision.

`T05-A07-V02`: Archive experience and retrieval time
Set up the calculation

The null is $H_0 : \beta_1 = 0$, equivalently $H_0 : R^2_{population} = 0$ for this one-predictor linear model.

Work through the calculation

$F = [0.22/1]/[(1 - 0.22)/(25 - 2)] = 6.4872.$

Because 6.4872 exceeds 4.279, we reject the null at 5%.

Interpret and check the result

The sample provides evidence of a nonzero linear population slope.

With one predictor, $F = t^2$ for the slope test, so the global model and two-sided coefficient tests ask the same question and produce the same decision.

`T05-A07-V03`: Museum visits and knowledge

Set up the calculation

The null is $H_0 : \beta_1 = 0$, equivalently $H_0 : R^2_{population} = 0$ for this one-predictor linear model.

Work through the calculation

$F = [0.18/1]/[(1 - 0.18)/(30 - 2)] = 6.1463.$

Because 6.1463 exceeds 4.196, we reject the null at 5%.

Interpret and check the result

The sample provides evidence of a nonzero linear population slope.

With one predictor, $F = t^2$ for the slope test, so the global model and two-sided coefficient tests ask the same question and produce the same decision.

`T05-A07-V04`: Reading time and comprehension

Set up the calculation

The null is $H_0 : \beta_1 = 0$, equivalently $H_0 : R^2_{population} = 0$ for this one-predictor linear model.

Work through the calculation

$F = [0.15/1]/[(1 - 0.15)/(35 - 2)] = 5.8235.$

Because 5.8235 exceeds 4.139, we reject the null at 5%.

Interpret and check the result

The sample provides evidence of a nonzero linear population slope.

With one predictor, $F = t^2$ for the slope test, so the global model and two-sided coefficient tests ask the same question and produce the same decision.

`T05-A07-V05`: Route familiarity and navigation errors

Set up the calculation

The null is $H_0 : \beta_1 = 0$, equivalently $H_0 : R^2_{population} = 0$ for this one-predictor linear model.

Work through the calculation

$F = [0.12/1]/[(1 - 0.12)/(40 - 2)] = 5.1818.$

Because 5.1818 exceeds 4.098, we reject the null at 5%.

Interpret and check the result

The sample provides evidence of a nonzero linear population slope.

With one predictor, $F = t^2$ for the slope test, so the global model and two-sided coefficient tests ask the same question and produce the same decision.

`T05-A07-V06`: Workshop attendance and confidence

Set up the calculation

The null is $H_0 : \beta_1 = 0$, equivalently $H_0 : R^2_{population} = 0$ for this one-predictor linear model.

Work through the calculation

$F = [0.1/1]/[(1 - 0.1)/(50 - 2)] = 5.3333.$

Because 5.3333 exceeds 4.043, we reject the null at 5%.

Interpret and check the result

The sample provides evidence of a nonzero linear population slope.

With one predictor, $F = t^2$ for the slope test, so the global model and two-sided coefficient tests ask the same question and produce the same decision.

`T05-A07-V07`: Notification load and focus

Set up the calculation

The null is $H_0 : \beta_1 = 0$, equivalently $H_0 : R^2_{population} = 0$ for this one-predictor linear model.

Work through the calculation

$F = [0.08/1]/[(1 - 0.08)/(60 - 2)] = 5.0435$.

Because 5.0435 exceeds 4.007, we reject the null at 5%.

Interpret and check the result

The sample provides evidence of a nonzero linear population slope.

With one predictor, $F = t^2$ for the slope test, so the global model and two-sided coefficient tests ask the same question and produce the same decision.

`T05-A07-V08`: Search practice and accuracy

Set up the calculation

The null is $H_0 : \beta_1 = 0$, equivalently $H_0 : R^2_{population} = 0$ for this one-predictor linear model.

Work through the calculation

$F = [0.07/1]/[(1 - 0.07)/(75 - 2)] = 5.4946$.

Because 5.4946 exceeds 3.972, we reject the null at 5%.

Interpret and check the result

The sample provides evidence of a nonzero linear population slope.

With one predictor, $F = t^2$ for the slope test, so the global model and two-sided coefficient tests ask the same question and produce the same decision.

`T05-A07-V09`: Travel distance and visit duration

Set up the calculation

The null is $H_0 : \beta_1 = 0$, equivalently $H_0 : R^2_{population} = 0$ for this one-predictor linear model.

Work through the calculation

$F = [0.06/1]/[(1 - 0.06)/(90 - 2)] = 5.6170$.

Because 5.6170 exceeds 3.949, we reject the null at 5%.

Interpret and check the result

The sample provides evidence of a nonzero linear population slope.

With one predictor, $F = t^2$ for the slope test, so the global model and two-sided coefficient tests ask the same question and produce the same decision.

`T05-A07-V10`: Discussion participation and reasoning

Set up the calculation

The null is $H_0 : \beta_1 = 0$, equivalently $H_0 : R^2_{population} = 0$ for this one-predictor linear model.

Work through the calculation

$F = [0.05/1]/[(1 - 0.05)/(120 - 2)] = 6.2105.$

Because 6.2105 exceeds 3.921, we reject the null at 5%.

Interpret and check the result

The sample provides evidence of a nonzero linear population slope.

With one predictor, $F = t^2$ for the slope test, so the global model and two-sided coefficient tests ask the same question and produce the same decision.