AP® STATISTICS
2011 SCORING GUIDELINES

Question 5

Intent of Question

The primary goals of this question were to assess students' ability to (1) determine the equation of the least squares regression line from a computer output; (2) use the slope of the least squares line to compare expected values of the response variable for different values of the explanatory variable; (3) recognize how to determine the proportion of variability in the response variable explained by the least squares line; (4) use computer output to determine whether the linear relationship between two quantitative variables is statistically significant.

Solution

Part (a):

The equation of the least squares regression line is

predicted electricity production = 0.137 + 0.240 × wind velocity.

Part (b):

The slope coefficient of 0.240 indicates that for each additional mph of wind speed, the expected electricity production increases by 0.240 amperes. Thus, the expected electricity production is $10 \times 0.240 = 2.40$ amperes higher on a day with 25 mph wind velocity as compared to a day with 15 mph wind velocity.

Part (c):

The proportion of variation in electricity production that is explained by the linear relationship with wind speed is R^2, which the regression output reports to be 0.873.

Part (d):

Yes, there is very strong statistical evidence that the population slope differs from zero, so electricity production is linearly related to wind speed. For testing the hypotheses $H_0 : \beta = 0$ versus $H_a : \beta \neq 0$, where β represents the population slope, the output reveals that the test statistic is $t = 12.63$ and the *p*-value (to three decimal places) is 0.000. Because the *p*-value is so small (much less than both 0.05 and 0.01), the sample data provide very strong statistical evidence that electricity production is linearly related to wind speed.

Scoring

Parts (a), (b), (c) and (d) are scored as essentially correct (E), partially correct (P) or incorrect (I).

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Question 5 (continued)

Part (a) is scored as follows:

Essentially correct (E) if the response gives the correct equation *AND* includes the following two components:

1. Provides correct variable names (with context).
2. Uses a modifier such as "expected" or "predicted" or "estimated" (or a "hat" symbol) with the response variable, electricity production.

Partially correct (P) if the response gives the correct equation *AND* includes exactly one of the two components listed above.

Incorrect (I) if the response does not meet the criteria for E or P.

Part (b) is scored as follows:

Essentially correct (E) if the response identifies and uses the correct slope value (0.240) *OR* the slope value identified in part (a) of the response

AND

the response includes the following three components:

1. Shows work (correct multiplication or correct substitution into an appropriate expression).
2. Arrives at an answer.
3. Provides correct measurement units (amperes).

Note: Calculating predicted values for both wind speeds and taking their difference is sufficient, as long as measurement units are provided.

Partially correct (P) if the response identifies and uses the correct slope value (0.240) or the slope value identified in part (a) of the response *AND* includes exactly two of the three components listed above.

Incorrect (I) if the response does not meet the criteria for E or P.

Part (c) is scored as follows:

Essentially correct (E) if response is 0.873.

Note: No work needs to be shown to earn an E, because the answer is read from the computer output.

Partially correct (P) if the response gives the value of adjusted R^2, rather than R^2, *OR* the response approximates (or rounds) the value of R^2.

Incorrect (I) if the response gives neither R^2 nor adjusted R^2, or if the response reports the square root of R^2.

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Question 5 (continued)

Part (d) is scored as follows:

Essentially correct (E) if the response includes the following three components:
1. Gives the correct conclusion based on a test for the population slope.
2. Reports the correct *p*-value and/or *t*-statistic.
3. Provides linkage/justification between the *p*-value (or *t*-statistic) and the conclusion.

Partially correct (P) if the response provides exactly two of the three components listed above.

Note: If the wrong *p*-value is chosen, but the conclusion is consistent with that *p*-value and linkage or justification is provided, the response earns a P.

Incorrect (I) if the response fails to meet the criteria for E or P.

Each essentially correct (E) part counts as 1 point. Each partially correct (P) part counts as ½ point.

4 **Complete Response**

3 **Substantial Response**

2 **Developing Response**

1 **Minimal Response**

If a response is between two scores (for example, 2½ points), use a holistic approach to determine whether to score up or down, depending on the overall strength of the response and communication.