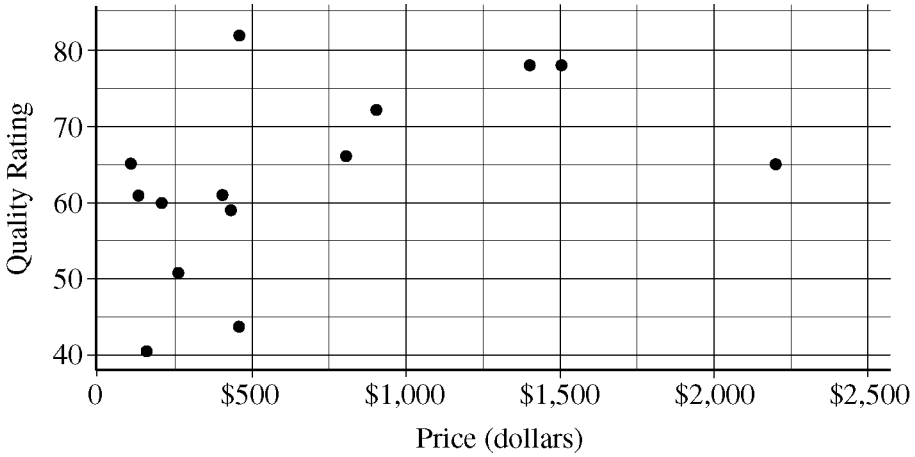
STATISTICS
SECTION II
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II score—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

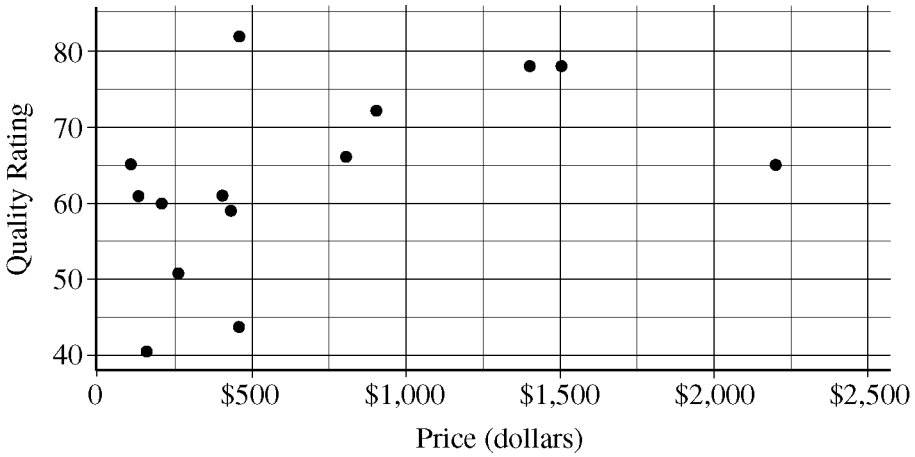
1. The scatterplot below displays the price in dollars and quality rating for 14 different sewing machines.



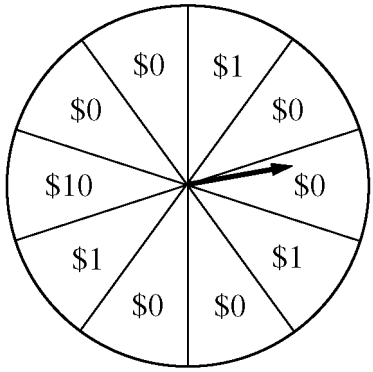
(a) Describe the nature of the association between price and quality rating for the sewing machines.

(b) One of the 14 sewing machines substantially affects the appropriateness of using a linear regression model to predict quality rating based on price. Report the approximate price and quality rating of that machine and explain your choice.

(c) Chris is interested in buying one of the 14 sewing machines. He will consider buying only those machines for which there is no other machine that has both higher quality and lower price. On the scatterplot reproduced below, circle all data points corresponding to machines that Chris will consider buying.



2. A charity fundraiser has a Spin the Pointer game that uses a spinner like the one illustrated in the figure below.



A donation of $2 is required to play the game. For each $2 donation, a player spins the pointer once and receives the amount of money indicated in the sector where the pointer lands on the wheel. The spinner has an equal probability of landing in each of the 10 sectors.

(a) Let X represent the net contribution to the charity when one person plays the game once. Complete the table for the probability distribution of X.

x	$2	$1	–$8
$P(x)$			

(b) What is the expected value of the net contribution to the charity for one play of the game?

(c) The charity would like to receive a net contribution of $500 from this game. What is the fewest number of times the game must be played for the expected value of the net contribution to be at least $500 ?

(d) Based on last year's event, the charity anticipates that the Spin the Pointer game will be played 1,000 times. The charity would like to know the probability of obtaining a net contribution of at least $500 in 1,000 plays of the game. The mean and standard deviation of the net contribution to the charity in 1,000 plays of the game are $700 and $92.79, respectively. Use the normal distribution to approximate the probability that the charity would obtain a net contribution of at least $500 in 1,000 plays of the game.

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Question 1

Intent of Question

The primary goals of this question were to assess students' ability to (1) describe a nonlinear association based on a scatterplot; (2) describe how an unusual observation may affect the appropriateness of using a linear model for bivariate numeric data; (3) implement a decision-making criterion on data presented in a scatterplot.

Solution

Part (a):

The data show a weak but positive association between price and quality rating for these sewing machines. The form of the association does not appear to be linear. Among machines that cost less than $500, there appears to be very little association between price and quality rating. But the machines that cost more than $500 do generally have better quality ratings than those that cost less than $500, which causes the overall association to be positive.

Part (b):

The sewing machine that most affects the appropriateness of using a linear regression model is the one that costs about $2,200 and has a quality rating of about 65. Although the other four sewing machines costing more than $500 generally have higher quality ratings than those costing under $500, their prices and quality ratings follow a trend that suggests that quality ratings may not continue to increase with higher prices, but instead may approach a maximum possible quality rating. The $2,200 sewing machine is the most expensive of all but has a relatively low quality rating, which is consistent with a nonlinear model that approaches a maximum possible quality rating and then perhaps decreases. If a linear model were fit to all of the data, this one machine would substantially pull the regression line toward it, resulting in a poor overall fit of the line to the data.

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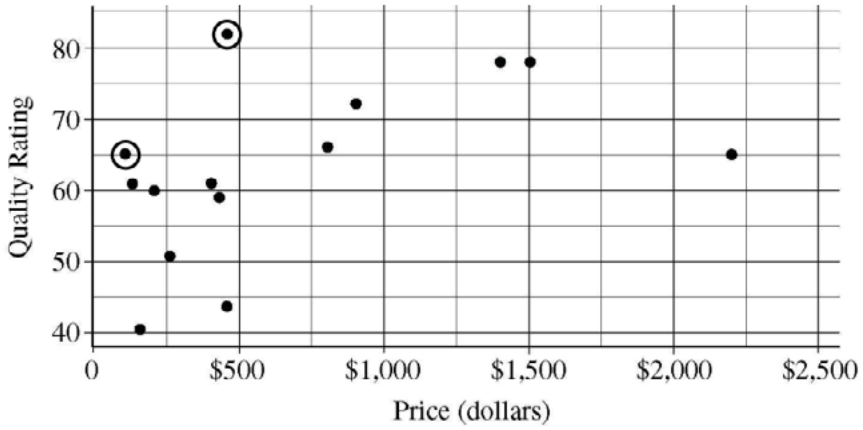
Question 1 (continued)

Part (c):

According to Chris's criterion, there are two sewing machine models that he will consider buying:

1. The model that costs a bit more than $100 and has a quality rating of 65.
2. The model that costs a bit below $500 and has a quality rating of 81 or 82.

The data points corresponding to these two machines have been circled on the scatterplot below.



Scoring

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

Part (a) is scored as follows:

Essentially correct (E) if the response correctly describes three aspects of association: direction (positive), strength (weak or moderate), and form (curved or nonlinear), *AND* describes the association in context.

Partially correct (P) if the response correctly describes two aspects of association in context
OR
if the response describes all three aspects of association without context.

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

Part (b) is scored as follows:

Essentially correct (E) if the response identifies the correct point with reasonable approximations to the price and quality values *AND* gives either of the following two explanations:

1. The point in conjunction with the entire collection of points appears to have a curved (or nonlinear) form.
2. A linear model that includes all the points would result in a poor overall fit to the data, largely owing to the presence and influence of the identified point.

Question 1 (continued)

Partially correct (P) if the response identifies the correct point with reasonable approximations to the price and quality values *AND* gives a weak explanation of why the point affects the reasonableness of a linear model. The following are examples of weak explanations.

1. The point is an outlier.
2. Removal of the point makes the pattern more linear.
3. The point does not follow the linear pattern of the others.
4. A sewing machine this expensive should have a higher quality rating.
5. There is a much cheaper sewing machine with the same quality rating as this one.
6. The point has considerable influence on the parameters of the least squares regression line.

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

Part (c) is scored as follows:

Essentially correct (E) if the correct two points are circled *AND* no other points are circled.

Partially correct (P) if the correct two points are circled *AND* one or two other points are circled.
OR
if only one of the two correct points is circled *AND* at most one other point is circled.

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

4 Complete Response

All three parts essentially correct

3 Substantial Response

Two parts essentially correct and one part partially correct

2 Developing Response

Two parts essentially correct and one part incorrect
OR
One part essentially correct and two parts partially correct
OR
One part essentially correct and one part partially correct
(*BUT* see the exception noted with an asterisk below)
OR
All three parts partially correct

1 Minimal Response

One part essentially correct and two parts incorrect
OR
*Part (c) essentially correct, part (b) partially correct, and part (a) incorrect
OR
Two parts partially correct and one part incorrect