2. A manufacturer of boots plans to conduct an experiment to compare a new method of waterproofing to the current method. The appearance of the boots is not changed by either method. The company recruits 100 volunteers in Seattle, where it rains frequently, to wear the boots as they normally would for 6 months. At the end of the 6 months, the boots will be returned to the company to be evaluated for water damage.

   (a) Describe a design for this experiment that uses the 100 volunteers. Include a few sentences on how it would be implemented.

   (b) Could your design be double blind? Explain.

3. There are 4 runners on the New High School team. The team is planning to participate in a race in which each runner runs a mile. The team time is the sum of the individual times for the 4 runners. Assume that the individual times of the 4 runners are all independent of each other. The individual times, in minutes, of the runners in similar races are approximately normally distributed with the following means and standard deviations.

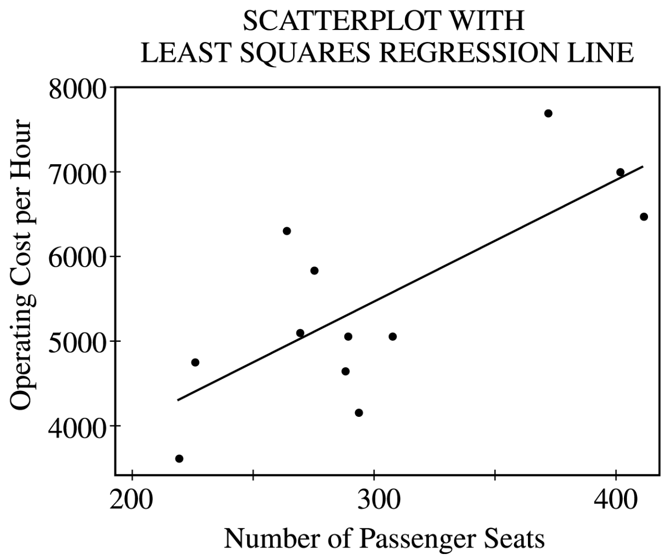
	Mean	Standard Deviation
Runner 1	4.9	0.15
Runner 2	4.7	0.16
Runner 3	4.5	0.14
Runner 4	4.8	0.15

   (a) Runner 3 thinks that he can run a mile in less than 4.2 minutes in the next race. Is this likely to happen? Explain.

   (b) The distribution of possible team times is approximately normal. What are the mean and standard deviation of this distribution?

   (c) Suppose the team's best time to date is 18.4 minutes. What is the probability that the team will beat its own best time in the next race?

4. Commercial airlines need to know the operating cost per hour of flight for each plane in their fleet. In a study of the relationship between operating cost per hour and number of passenger seats, investigators computed the regression of operating cost per hour on the number of passenger seats. The 12 sample aircraft used in the study included planes with as few as 216 passenger seats and planes with as many as 410 passenger seats. Operating cost per hour ranged between \$3,600 and \$7,800. Some computer output from a regression analysis of these data is shown below.



Predictor	Coef	StDev	T	P
Constant	1136	1226	0.93	0.376
Seats	14.673	4.027	3.64	0.005
S = 845.3	R-Sq = 57.0%		R-Sq (adj) = 52.7%	

(a) What is the equation of the least squares regression line that describes the relationship between operating cost per hour and number of passenger seats in the plane? Define any variables used in this equation.

(b) What is the value of the correlation coefficient for operating cost per hour and number of passenger seats in the plane? Interpret this correlation.

(c) Suppose that you want to describe the relationship between operating cost per hour and number of passenger seats in the plane for planes only in the range of 250 to 350 seats. Does the line shown in the scatterplot still provide the best description of the relationship for data in this range? Why or why not?

Question 3

Solution

Part (a):

For runner 3

$$P(time < 4.2) = P\left(z < \frac{4.2 - 4.5}{.14}\right) = P(z < -2.14) = 0.0162 \quad (\textit{from table})$$

OR

$$P(time < 4.2) = 0.0160622279 \quad (\textit{from}\ \text{Calculator})$$

It is possible but unlikely that runner 3 will run a mile in less than 4.2 minutes on the next race. Based on his running time distribution, we would expect that he would have times less than 4.2 minutes less than 2 times in 100 races in the long run.

OR

It is possible but unlikely that runner 3 will run a mile in less than 4.2 minutes on the next race because 4.2 is more than 2 standard deviations below the mean. Since the running time has a normal distribution, it is unlikely to be more than 2 standard deviations below the mean.

Part (b):

$$\mu_T = \mu_1 + \mu_2 + \mu_3 + \mu_4 = 4.9 + 4.7 + 4.5 + 4.8 = 18.9$$

The runners' times are independently distributed, therefore

$$\sigma_T^2 = \sigma_1^2 + \sigma_2^2 + \sigma_3^2 + \sigma_4^2 = (.15)^2 + (.16)^2 + (.14)^2 + (.15)^2 = 0.0902$$

$$\sigma_T = \sqrt{.0902} = 0.3003$$

Part (c):

$$P(team\ time < 18.4) = P\left(z < \frac{18.4 - 18.9}{.3003}\right) = P(z < -1.67) = 0.0475 \quad (\textit{from table})$$

OR

$$P(team\ time < 18.4) = 0.0479561904 \quad (\textit{from}\ \text{Calculator})$$

Question 3 (cont'd.)

Scoring

Each part is scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is *essentially correct* if:

the probability is calculated correctly, it is correctly assessed as unlikely, and the justification is acceptable
OR
the student does not compute the probability, but appeals to the fact that a time of 4.2 minutes is more than 2 standard deviations below the mean of a normal distribution and then uses this information to reach a conclusion with appropriate communication.

Part (a) is *partially correct* if:

the probability computed is not correct (for example, $P(z > -2.14)$ or $P(z < +2.14)$ might be computed), but the given probability is correctly assessed
OR
an argument is based on the number of standard deviations from the mean without invoking normality.

Part (b) is *essentially correct* if both the mean and the standard deviation of the team time distribution are correctly computed (except for purely arithmetic mistakes).

Part (b) is *partially correct* if only one of these is correctly computed (except for purely arithmetic mistakes).

CAUTION: A standard deviation of .3 (numerically correct) can arise from this incorrect calculation: $\frac{(.15+.16+.14+.15)}{\sqrt{4}} = 0.3$

Part (c) is *essentially correct* if the probability is correctly calculated using a mean which is either correct or carried from (b) as well as a standard deviation which is either correct or carried from (b).

Part (c) is *partially correct* if:

both the mean and standard deviation are correct or carried from (b), but the computed probability is incorrect
OR
the mean or standard deviation is incorrectly derived from (b) but the subsequent probability calculation is correct.

Question 3 (cont'd.)

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 no parts partially correct.
OR
One part essentially correct and two parts partially correct.
OR
One part essentially correct and one part partially correct.
OR
Three parts partially correct.

1 Minimal Response
One part essentially correct and zero parts partially correct.
OR
No parts essentially correct and two parts partially correct.