1. In a sample of scores, $s^2 = 0$. From this fact, it is necessarily true that (select one option):
   (a) all scores are equal to 0
   (b) all scores are equal to 1
   (c) each positive score has a corresponding negative score of the same absolute value
   (d) all scores are identical
   (e) two of the above

2. Consider a scatterplot that reveals a positive correlation, but when all subjects who score below the mean on $X$ are removed, the remaining data generate a negative correlation. Show what the original scatterplot might look like.

3. When $r = -1$, what will $SS_r$ be equal to?

4. A researcher obtains a random sample of 84 subjects and measures them on variables $X$ and $Y$. The correlation between $X$ and $Y$ is $-0.58$. The regression equation for predicting $Y$ from $X$ is $\hat{y} = 6.3 + (-0.10)(X - 24.7)$, and it is found that $s_Y = 1.2$.
   (a) What proportion of the variability in $Y$ is explained by the relationship between $X$ and $Y$?
   (b) What is the estimate of the mean $Y$ score for all the people in the population how have an $X$ score of 30?
   (c) What is the estimate of the standard deviation of the $Y$ scores for the group referred to in part (b)?

5. Consider a distribution of sample means based on samples with $N = 10$ drawn from a normally distributed population. Now consider two of these means. Mean A, based on sample A, comes from the extreme upper end of the distribution of sample means (i.e., it is one of the very largest sample means in the distribution), whereas Mean B, based on sample B, comes from near the middle of the distribution of sample means (i.e., its value is nearly equal to the mean of the population of raw scores). What can be said about the variance of the samples that produced these two means? Mark each claim that you deem to be correct (more than one might be a correct claim, or maybe none are correct, so be careful).

   (a) variance for sample A and variance for sample B are probably similar
   (b) variance for sample A is probably less than variance for sample B
   (c) variance for sample A is probably more than variance for sample B
   (d) variance for sample A and variance for sample B can take on about an equally wide range of possible values
   (e) variance for sample A can take on a much wider range of possible values than variance for sample B
   (f) variance for sample A can take on a much narrower range of possible values than variance for sample B
6. Consider a normal distribution of scores. We draw a random sample of 20 scores from this distribution (call this sample A). We compute the mean of sample A, then put these scores back. We then draw a random sample of 50 scores from the distribution (call this sample B) and compute the mean of this sample.

(a) Which of these two samples is more likely to contain the lowest score in the original distribution? A, B, or equally likely?

(b) Which of the two sample means is likely to be closer to the mean of the whole distribution? A, B, or equally likely?

7. A researcher tests the claim that the "whole-word" reading method is superior to the standard method for training children to read for comprehension. To conduct the test, a random sample of 28 grade 2 children is chosen and placed in a class for one school year. During that year, the children are taught using the whole-word reading method, and at the end of the year, they are given a standardized reading comprehension test. Historical data indicate that the mean on the standardized test for the population of grade 2 children taught with the normal method is 50, with a standard deviation of 10 (higher scores indicate better performance).

(a) What are the null and alternative hypotheses? State the hypotheses in symbolic form and in natural language. Use the directional form of the alternative hypothesis in this case, because the researcher expects this method to improve scores.

(b) Suppose the researcher's sample produces $M = 52.4$. Assuming that distribution of raw scores in the population of children taught with the whole-word method is normal, compute a $z$ test of the null hypothesis with a .05 significance level. This will be a directional test because the researcher specified the direction of the difference. Can the researcher reject the null hypothesis based on this result?

(c) What conclusion should the researcher make regarding the whole-word reading method in comparison to the standard method, given these results?

(d) Assuming that a directional test is conducted with $\alpha = .05$, what is the smallest sample mean that could be obtained and still allow the researcher to reject the null hypothesis?

8. Suppose that in question 7, we did not know the standard deviation of the population and instead the researcher has to rely on the sample standard deviation.

(a) Suppose the researcher's sample produces $M = 52.4$ and $s = 8.4$. Compute a $t$ test of the null hypothesis with $\alpha = .05$. Use a directional test. Should the researcher reject the null hypothesis based on this result?

(b) What conclusion should the researcher make regarding the whole-word reading method in comparison to the standard method, given these results?

9. Assume that in a normally distributed population of scores, $\sigma = 20$. If one were to test the null hypothesis that $\mu = 70$ using $\mu > 70$ as the alternative hypothesis with $\alpha = .05$, what is the minimum value of a sample mean that would be needed to reject the null hypothesis with a sample size of 25? With a sample size of 60? You should find that the minimum value of $M$ needed to reject the null hypothesis is larger (more different from the null hypothesis value of $\mu$) when a smaller sample size ($N = 25$) is used. Why does this happen? Explain with reference to the distribution of sample means.
10. Two researchers conduct a test of the same hypotheses about the mean of some population by drawing a random sample of the same size from the population. Each researcher draws a sample of 30 subjects. They obtain identical means for their samples, but researcher A obtains $s = 13.6$ and research B obtains $s = 21.0$. They each compute a $t$ test to decide whether or not to reject $H_0$. Will the $t$ ratios they obtain be equal to each other or will one be larger? If they are different, which researcher will obtain the larger $t$ ratio and why?

11. A data file called `memory.txt` contains a hypothetical sample of 40 scores from a test of short-term memory ability. Assume that these scores were obtained from a random sample of subjects who have sustained a concussion in the past six months. The scores are from a standardized short-term memory test in which some large population of people obtained a mean score of 35. Use the `t.test` function in R to test the null hypothesis that people who have recently sustained a concussion have the same mean short-term memory performance as the general population. Use $\alpha = .05$ and a nondirectional (two-tailed) test. Based on the outcome of this test, what can you conclude about the mean short-term memory performance of people who recently incurred a concussion, relative to the general population? The `t.test` function in this case requires you to specify (a) the name of the data variable (i.e., the variable into which you will read the `memory.txt` file), (b) the type of alternative hypothesis being used, and (c) the null hypothesis value of the population mean. In the present case, the `t.test` function would be something like this:

```r
> t.test(data, alternative = "two.sided", mu = 35)
```

If this had been a directional (one-tailed) test, what would the obtained $p$ value have been? Figure this out on your own, then check your answer by running the `t.test` function but this time with `alternative = "one.sided"`. 

12. A researcher tests the hypothesis that people are better able to recall events that relate to survival than events that are meaningful in other ways. The researcher selects a sample of words denoting common objects (e.g., knife, shoe, basket, etc.) and presents them in a random order to a sample of eight subjects. Just before presenting each word, the researcher presents one of two cues, telling the subject how to think about the word. The cue $S$ was used to tell the subject to think about how the object denoted by the word might be used to aid survival in the wilderness. The cue $P$ was used to tell the subject to think about how pleasant the word is. For each subject, one half of the words are cued with $S$ and the other half are cued with $P$. The words assigned to the $S$ and $P$ conditions are randomly determined for each subject. After presentation of the word list, each subject works on a cross-word puzzle for 30 minutes, then is asked to recall as many words as possible. The number of words recalled in each condition is shown for each subject:
Subject | S | P
---|---|---
1 | 12 | 6
2 | 4 | 2
3 | 6 | 8
4 | 9 | 9
5 | 10 | 4
6 | 7 | 5
7 | 3 | 1
8 | 13 | 9

Compute a related-samples *t* test of the null hypothesis which claims that words that are processed under a survival instruction or under a pleasantness instruction should be recalled equally well. Use a nondirectional alternative hypothesis with $\alpha = .05$. What conclusion do these results allow you to draw regarding how memorable survival oriented processing of words is compared to processing the pleasantness of words?

13. A researcher tests the influence of alcohol on judgments of facial attractiveness by drawing a random sample of 30 female subjects. Each subject is tested twice, once after consuming the equivalent of two alcoholic drinks and once after consuming an equivalent amount of a nonalcoholic beverage. The order of presenting these two conditions to a given subject is randomly determined and two days intervene between each of the two conditions. In each of the two tests, a subject rates the attractiveness of 10 faces on a seven-point scale. Each subject ends up with an average rating score in each of the two conditions (one for the alcohol condition, and one for the control condition). These scores are provided in a file called *attract1.txt*. One column is labeled A for alcohol and the other is labeled C for control. Read this file into a data variable in *R*, then compute the mean for each condition.

```r
> library(psych)
> describe(data)
```

Next, use the `t.test` function to compute a related-samples *t* test for these data. The command would be:

```r
> t.test(data$A, data$C, paired = T)
```

Does this *t* test allow rejection of the null hypothesis with $\alpha = .05$? What conclusion should the researcher make?

14. Working with the data set in question 13, compute the correlation between the two sets of scores (alcohol and control condition). Use the `cor` function for this purpose.

```r
> cor(data)
```

Now read in the data file called *attract2.txt*. This is another hypothetical set of data from 30 subjects that fits the experiment described in question 13. Use the `describe` function to
obtain the descriptive statistics as in question 13, and compute a $t$ test on the data using the `t.test` function. Notice the similarities in the descriptive statistics for this case and for what was found in question 13 (particularly, the means and standard deviations are the same as in question 13). Notice how the outcome of the $t$ test is quite different. Compute the correlation between the two sets of scores, as in question 13. Notice the size of the correlation for this data set. How does it compare to the correlation obtained for the original data set? You can also compare the variability of the difference scores in the two data sets. Use the following command to put the difference scores for a data set into a new variable, then compute the standard deviation of that set of difference scores.

```r
> diff = data$A - data$C
> sd(diff)
```

Do this for both data sets and compare the values of the resulting standard deviations.

Now suppose that the researcher working with the `attract2.txt` data had used a directional rather than a nondirectional test, with the alternative hypothesis specifying that ratings would be higher in the alcohol condition. Based on the $p$ value you obtained in the nondirectional test of these data, would the data in the `attract2.txt` file allow rejection of the null hypothesis with $\alpha = .05$? If the directional alternative hypothesis had instead claimed that ratings would be higher in the control condition, would those data allow rejection of the null hypothesis?