Hypothesis testing - Introduction

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- We are in sections 9.1, 9.4 of the textbook
- This chapter is about *hypothesis testing*. This is the other side of estimation.
- Remember a statistic is a number computed from a data set.
- In hypothesis testing, we compute the same statistic for two populations, or from a population and a subpopulation. Or, we compare a statistic to a predetermined value. In each case, we will be comparing two numbers that are not exactly the same. We want to know if the difference is *significant*.
- The *null hypothesis* is that the difference in the numbers is due to chance. This could relate to sampling error or to other random factors. The null hypothesis is abbreviated as H_0.
- The *alternate hypothesis* is that the difference between the numbers is significant. The alternate hypothesis is written as H_1.

1. We want to test the emissions of Volkswagen cars to see if the manufacturer's claims are correct. The cars are supposed to have an NOX emissions level of 40 mg/kg, but we think the emissions level may be higher.

   (a) Write the null hypothesis, H_0, with a sentence. It should have an equals sign.

   (b) Write the alternate hypothesis, H_1, with a sentence. It should have an greater than sign.

2. Dogs of a certain breed have an average heart rate of 115. Each time the rate is measured, it may be slightly higher or lower. The overall distribution is normal with a standard deviation of 12. A particular dog has its heart rate measured six times, and the measurements are

   93   109   110   89   112   117

   We want to decide if this dog's average heart rate R (which we don't know) is lower than the average for the breed.

   (a) What is the average of the six measurements? Using this sample average and looking at the data, explain why we might expect that this dog's average heart rate is lower than the average for the breed.

   (b) What is the null hypothesis? Write it with an equals sign. Let R stand for the heart rate.

   (c) What is the alternative hypothesis?

   (d) If the dog's heart rate actually did average 115, there is still a chance we could get low measurements. Use the sampling normal distribution to tell how often we would get an average less than or equal to 105. In other words, we want to compute $P(x \leq 105)$ in the sampling distribution.

   (e) What conclusion can we make about this dog's heart rate?

3. Adult males have an average height of 70 inches with a standard deviation of four inches. I suspect that a certain group is taller than the average. I measure 10 people in the group, and get these heights:

69	72	73	71	75	73	71	72	75	71

(a) What is the sample average?

(b) Is the sample average higher or lower than the population average?

(c) What are the null and alternative hypotheses for my test? The null hypothesis should have an equals sign.

(d) What is the probability that a random sample would have an average greater than or equal to the average I obtained? You can use the formula

$$z = (\bar{x} - \mu) / \left(\frac{\sigma}{\sqrt{n}} \right)$$

to find the z-value, and a normal table to find the probability.

(e) What does this mean about my hypothesis?

4. Adult males have an average height of 70 inches with a standard deviation of four inches. I suspect that a certain group is taller than the average. I measure 20 people in the group, and get these heights:

69	72	73	71	75	73	71	72	75	71
74	78	73	68	75	73	74	69	76	73

   (a) What is the sample average?

   (b) Is the sample average higher or lower than the population average?

   (c) What are the null and alternative hypotheses for my test? The null hypothesis should have an equals sign.

   (d) What is the probability that a random sample would have an average greater than or equal to the average I obtained? You can use the formula

$$z = (\bar{x} - \mu) / \left(\frac{\sigma}{\sqrt{n}} \right)$$

   to find the z-value, and a normal table to find the probability.

   (e) What does this mean about my hypothesis?