

## AP Stat FR Review Hypotheses Testing

For each question below, determine what test we are running, why we are running that test, calculate the test statistic, calculate the p-value, and state whether you will reject, or fail to reject the null hypotheses.

- 1) A study of chromosome abnormalities and criminality examined data from 4124 males born in Copenhagen. Each man was classified as having a criminal record or not, using the registers maintained in the local police offices. Each was also classified as having the normal male XY chromosome pair or one of the abnormalities XYY or XXY. Of the 4096 men with normal chromosomes, 381 had criminal records, while 8 of the 28 men with abnormal chromosomes had criminal records. Some experts believe chromosome abnormalities are associated with increased criminality.

Test: 2 prop Z-test Why: 2 proportions

Test Statistic: -3.48 p-value: .000254 Reject/Fail to Reject: Reject

- 2) Statistics can help decide the authorship of literary works. Sonnets by an Elizabethan poet are known to contain an average of  $\mu = 6.9$  new words (words not used in the poet's other works). The distribution of new words in this poet's sonnets is Normal with standard deviation  $\sigma = 2.7$ . Now a manuscript with five new sonnets has come to light, and scholars are debating whether it is the poet's work. The new sonnets contain an average of  $\bar{x} = 9.2$  words not used in the poet's known works. We expect poems by another author to contain more new words than found in the Elizabethan poet's poems.

Test: Z-test Why: 1 mean,  $\sigma$  known

Test Statistic: 1.905 p-value: .0284 Reject/Fail to Reject: Reject

- 3) In a study of heart surgery, one issue was the effect of drugs called beta-blockers on the pulse rate of patients during surgery. The available subjects were divided at random into two groups of 30 patients each. One group received a beta-blocker; the other group received a placebo. The pulse rate of each patient at a critical point during the operation was recorded. The treatment group had mean 65.2 and standard deviation 7.8. For the control group, the mean was 70.3 and the standard deviation was 8.3. Perform an appropriate significance test to see if beta-blockers reduce the pulse rate.

Test: 2-samp T-test Why: 2 means,  $\sigma$  unknown

Test Statistic: -2.45 p-value: .0086 Reject/Fail to Reject: Reject

- 4) Emissions of sulfur dioxide by industry set off chemical changes in the atmosphere that result in "acid rain." The acidity of liquids is measured by pH on a scale of 0 to 14. Distilled water has pH 7.0, and lower pH values indicate acidity. "Normal" rain is somewhat acidic, so acid rain is sometimes defined as rainfall with a pH below 5.0. Suppose that pH measurements of rainfall on different days in a Canadian forest follow a Normal distribution with standard deviation  $\sigma = 0.5$ . A sample of <sup>15</sup> days finds that the mean pH is  $\bar{x} = 4.8$ . Is this good evidence that the mean pH  $\mu$  for all rainy days is less than 5.0?

Test: Z-test Why: 1 mean,  $\sigma$  known

Test Statistic: -1.55 p-value: .06067 Reject/Fail to Reject: Fail to Reject

- 5) LeRoy, a starting player for a major college basketball team, made only 40% of his free throws last season. During the summer, he worked on developing a softer shot in hopes of improving his free throw accuracy. In the first eight games of this season, LeRoy made 25 free throws in 40 attempts. You want to investigate whether LeRoy's work over the summer will result in a higher proportion of free-throw successes this season. What conclusion would you draw at the  $\alpha = 0.01$  level about LeRoy's free throw shooting?

Test: 1 prop Z-test Why: 1 proportion

Test Statistic: 2.9 p-value: .001838 Reject/Fail to Reject: Reject

- 6) The amount of lead in a certain type of soil, when released by a standard extraction method, averages 86 parts per million (ppm). A new extraction method is tried on 40 specimens of the soil, yielding a mean of 83 ppm lead and a standard deviation of 10 ppm. Is there significant evidence at the 5% level that the new method frees less lead from the soil?

Test: T-test Why: 1 mean,  $\sigma$  unknown

Test Statistic: -1.897 p-value: .0326 Reject/Fail to Reject: Reject

- 7) More than 200,000 people worldwide take the GMAT examination each year as they apply for MBA programs. Their scores vary Normally with mean about  $\mu = 525$  and standard deviation about  $\sigma = 100$ . One hundred students go through a rigorous training program designed to raise their GMAT scores. If the students' average score is  $\bar{x} = 541.4$ , perform a significance test to determine whether the training program improves students' GMAT scores. Assume that  $\sigma = 100$  for students who participate in the training program.

Test: Z-test Why: 1 mean,  $\sigma$  known

Test Statistic: 1.64 p-value: .0505 Reject/Fail to Reject: Fail to Reject

- 8) A study of "adverse symptoms" in users of over-the-counter pain relief medications assigned subjects at random to one of two common pain relievers: acetaminophen and ibuprofen. In all, 650 subjects took acetaminophen, and 44 experienced some adverse symptom. Of the 347 subjects who took ibuprofen, 49 had an adverse symptom. We want to assess the evidence that the two pain relievers differ in the proportion of people who experience an adverse symptom.

Test: 2 prop Z-test Why: 2 proportions

Test Statistic: -3.8 p-value: .00014345 Reject/Fail to Reject: Reject