PES University, Bangalore

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UE19CS203 – STATISTICS FOR DATA SCIENCE

Unit-4 - Hypothesis and Inference

QUESTION BANK

Large-sample tests for Difference between two means:

Exercises for section 6.5: [Text Book Exercise 6.5– Pg. No. [427 – 429]]

1. The article "Capillary Leak Syndrome in Children With C4A-Deficiency Undergoing Cardiac Surgery With Cardiopulmonary Bypass: A Double-Blind, Randomised Controlled Study" (S. Zhang, S. Wang, et al., *Lancet*, 2005:556–562) presents the results of a study of the effectiveness of giving blood plasma containing complement component C4A to pediatric cardiopulmonary bypass patients. Of 58 patients receiving C4A-rich plasma, the average length of hospital stay was 8.5 days and the standard deviation was 1.9 days. Of 58 patients receiving C4A-free plasma, the average length of hospital stay was 11.9 days and the standard deviation was 3.6 days. Can you conclude that the mean hospital stay is shorter for patients receiving C4A-rich plasma?

2. The article "Some Parameters of the Population Biology of Spotted Flounder (*Ciutharus linguatula* Linnaeus, 1758) in Edremit Bay (North Aegean Sea)," (D.T¨urker, B. Bayhan, et al., *Turkish Journal of Veterinary and Animal Science*, 2005:1013–1018) reports that a sample of 482 female spotted flounder had an average weight of 20.95 g with a standard deviation of 14.5 g, and a sample of 614 male spotted flounder had an average weight of 22.79 g with a standard deviation of 15.6 g. Can you conclude that the mean weight of male spotted flounder is greater than that of females?

3. The article "Measurement of Complex Permittivity of Asphalt Paving Materials" (J. Shang, J. Umana, et al., *Journal of Transportation Engineering*,

1999:347– 356) compared the dielectric constants between two types of asphalt, HL3 and HL8, commonly used in pavements. For 42 specimens of HL3 asphalt the average dielectric constant was 5.92 with a standard deviation of 0.15, and for 37 specimens of HL8 asphalt the average dielectric constant was 6.05 with a standard deviation of 0.16. Can you conclude that the mean dielectric constant differs between the two types of asphalt?

4. The article "Wired: Energy Drinks, Jock Identity, Masculine Norms, and Risk Taking" (K. Miller, *Journal of American College Health*, 2008:481–489) reports that in a sample of 413 male college students, the average number of energy drinks consumed per month was 2.49 with a standard deviation of 4.87, and in a sample of 382 female college students, the average was 1.22 with a standard deviation of 3.24. Can you conclude that the mean number of energy drinks is greater for male students than for female students?

5. In a test to compare the effectiveness of two drugs designed to lower cholesterol levels, 75 randomly selected patients were given drug A and 100 randomly selected patients were given drug B. Those given drug A reduced their cholesterol levels by an average of 40 with a standard deviation of 12, and those given drug B reduced their levels by an average of 42 with a standard deviation of 15. The units are milligrams of cholesterol per deciliter of blood serum. Can you conclude that the mean reduction using drug B is greater than that of drug A?

6. Two machines used to fill soft drink containers are being compared. The number of containers filled each minute is counted for 60 minutes for each machine. During the 60 minutes, machine 1 filled an average of 73.8 cans per minute with a standard deviation of 5.2 cans per minute, and machine 2 filled an average of 76.1 cans per minute with a standard deviation of 4.1 cans per minute.

a. If the counts are made each minute for 60 consecutive minutes, what assumption necessary to the validity of a hypothesis test may be violated?
b. Assuming that all necessary assumptions are met, perform a hypothesis test. Can you conclude that machine 2 is faster than machine 1?

7. A statistics instructor who teaches a lecture section of 160 students wants to determine whether students have more difficulty with one-tailed hypothesis tests or with two-tailed hypothesis tests. On the next exam, 80 of the students, chosen at random, get a version of the exam with a 10-point question that requires a one-tailed test. The other 80 students get a question that is identical except that it requires a two-tailed test. The one-tailed students average 7.79 points, and their standard deviation is 1.06 points. The two-tailed students average 7.64 points, and their standard deviation is 1.31 points.

a. Can you conclude that the mean score $\mu 1$ on one tailed hypothesis test questions is higher than the mean score $\mu 2$ on two-tailed hypothesis test questions? State the appropriate null and alternate hypotheses, and then compute the *P*-value.

b. Can you conclude that the mean score $\mu 1$ on one tailed hypothesis test questions differs from the mean score $\mu 2$ on two-tailed hypothesis test questions? State the appropriate null and alternate hypotheses, and then compute the *P*-value.

8. Fifty specimens of a new computer chip were tested for speed in a certain application, along with 50 specimens of chips with the old design. The average speed, in MHz, for the new chips was 495.6, and the standard deviation was 19.4. The average speed for the old chips was 481.2, and the standard deviation was 14.3.

a. Can you conclude that the mean speed for the new chips is greater than that of the old chips? State the appropriate null and alternate hypotheses, and then find the *P*-value.

b. A sample of 60 even older chips had an average speed of 391.2 MHz with a standard deviation of 17.2 MHz. Someone claims that the new chips average more than 100MHzfaster than these very old ones. Do the data provide convincing evidence for this claim? State the appropriate null and alternate hypotheses, and then find the *P*-value.

9. Are low-fat diets or low-carb diets more effective for weight loss? This question was addressed in the article “Comparison of the Atkins, Zone, Ornish, and LEARN Diets for Change inWeight and Related Risk Factors Among Overweight Premenopausal Women: TheATOZWeight Loss Study:ARandomized Trial” (C. Gardner, A. Kiazand, et al., *Journal of the*

American Medical Association 2007:969–977). A sample of 77 subjects went on a low-carbohydrate diet for six months. At the end of that time the sample mean weight loss was 4.7 kg with a sample standard deviation of 7.2 kg. A second sample of 79 subjects went on a low-fat diet. Their sample mean weight loss was 2.6 kg with a standard deviation of 5.9 kg.

a. Can you conclude that the mean weight loss is greater for those on the low-carbohydrate diet?
b. Can you conclude that the mean weight loss on the low-carbohydrate diet is more than 1 kg greater than that of the low-fat diet?

10. In a certain supermarket, a sample of 60 customers who used a self-service checkout lane averaged 5.2 minutes of checkout time, with a standard deviation of 3.1 minutes. A sample of 72 customers who used a cashier averaged 6.1 minutes with a standard deviation of 2.8 minutes.

a. Can you conclude that the mean checkout time is less for people who use the self-service lane?
b. Can you conclude that if everyone used the self-service lane, that the mean checkout time would decrease? Consider the number of items checked out when formulating your answer.

11. The National Opinion Research Center polled a sample of 92 people aged 18–22 in the year 2002, asking them how many hours per week they spent on the internet. The sample mean was 7.38, with a sample standard deviation of 12.83. A second sample of 123 people aged 18–22 was taken in the year 2004. For this sample, the mean was 8.20 with a standard deviation of 9.84. Can you conclude that the mean number of hours per week increased between 2002 and 2004?

12. The following MINITAB output presents the results of a hypothesis test for the difference $\mu_X - \mu_Y$ between two population means:

```
Two-sample T for X vs Y

        N     Mean     StDev     SE Mean
X     135     3.94      2.65        0.23
Y     180     4.43      2.38        0.18

Difference = mu (X) – mu (Y)
Estimate for difference: –0.484442
95% upper bound for difference: –0.007380
T-Test of difference = 0 (vs <): T-Value = –1.68  P-Value = 0.047  DF = 270
```

a. Is this a one-tailed or two-tailed test?

b. What is the null hypothesis?

c. Can H_0 be rejected at the 5% level? How can you tell?

d. The output presents a Student's t test. Compute the P-value using a z test. Are the two results similar?

e. Use the output and an appropriate table to compute a 99% confidence interval for $\mu_X - \mu_Y$ based on the z statistic.

13. The following MINITAB output presents the results of a hypothesis test for the difference $\mu_X - \mu_Y$ between two population means. Some of the numbers are missing.

```
Two-sample T for X vs Y

      N     Mean     StDev     SE Mean
X    78     23.3       (i)        1.26
Y    63    20.63      3.02        (ii)

Difference = mu (X) – mu (Y)
Estimate for difference: 2.670
95% CI for difference: (0.05472, 5.2853)
T-Test of difference = 0 (vs not =): T-Value = 2.03 P-Value = 0.045 DF = 90
```

a. Fill in the missing numbers for (i) and (ii).

b. The output presents a Student's t test. Compute the P-value using a z test. Are the two results similar?

c. Use the output and an appropriate table to compute a 98% confidence interval for $\mu_X - \mu_Y$ based on the z statistic.