1 Confidence Intervals for Comparing Population Parameters

So far we have constructed confidence intervals for determine a single population parameter. Of course, we are not restricted to looking at the estimated value of a single population parameter. We can also test to determine if population parameters are the same for different populations. Consider the following grade distributions from Fall 2016 in MATH 1107. Do women and men perform the same in MATH 1107 or are there differences in their performances? We could compare final course averages between men and women.

Analysis Variable : course_average course_average						
Gender	N Obs	Mean	Median	Minimum	Maximum	Std Dev
F	78	83.83	88.90	19.20	110.20	19.21
M	42	79.01	81.70	0.00	111.20	19.01

Or we could consider the percentage of letter grades earned by gender.

Table of Gender by Letter_Grade								
Gender(Gender)	Letter_Grade(Letter_Grade)							
Frequency	A	B	C	D	F	W	WF	Total
F	39	20	9	2	3	4	1	78
M	11	16	7	3	2	2	1	42
Total	50	36	16	5	5	6	2	120

In baseball, the roles of pitchers and batters (position players) are different. Pitchers aren't required to be good hitters. However, strong defense in the field will not make up for weak hitting. Does this lead to any differences in these two types of players? Historically this has led to a difference in the average age of batters and pitchers. Since average player age has changed over the years, we need to pair together the average ages by year (paired data).

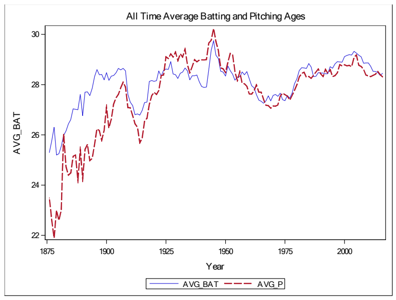

Figure 1: Average Batting and Pitching age by Year

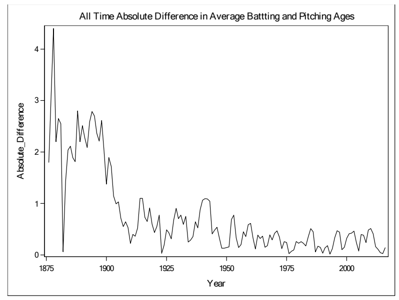

Figure 2: Difference of Batting and Pitching Age by year

2 5.4 Confidence Intervals for Comparing Independent Population Means

At 95% confidence, is there is a difference in the average score of men and women in MATH 1107. To perform the test, we must first translate our question of interest into a statement about the difference of the population parameters. For the performance in MATH 1107 question here, we wonder if the average score of women is the same as the average score of men. Notationally speaking, is $\mu_W = \mu_M$? We compute the confidence interval for $\mu_W - \mu_M$. If the confidence interval contains 0 then we conclude no statistically significant difference. If the confidence interval does not contain 0 then we conclude there is likely a difference in the population means. The form of our confidence interval for the difference of two means is $(x_1 - x_2) \pm z_{\frac{\alpha}{2}} * \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$. On the TI series of calculators, use the **2-SampZInterval** command for large samples and **2-SampTInterval** for small samples.

Exercise 1 *Using the sample means, sample standard deviations and sample sizes from populations 1 and 2 (men and women), we construct a 95% confidence interval for the difference of the sample means. This yields the confidence interval* $(-2.34, 11.98)$*. Since 0 falls into this confidence interval, we cannot conclude that there is a statistically significant difference.*

Exercise 2 *Elementary Statistics is a required course for admittance to KSU's highly competitive nursing program. In fact, earning an A in MATH 1107 is practically a requirement for entry into the program. Due to this, do nursing-interest students earn higher average scores than other majors in the course? In a class of 135 students, there were 41 nursing-interest students. The average final score for nursing-interest students was 86.7 with a standard deviation of 14.56. The remaining 94 students averaged 74.8 points with a standard deviation of 19.36. Test at 95% confidence.*

Exercise 3 *The Philadelphia Phillies have a long a storied history in Major League Baseball. Is the average attendance at their games different since the Free Agency era began in 1977 than in prior years? Test at 99% confidence.*

Analysis Variable : Attendance Attendance							
N	Mean	Std Dev	Minimum	Lower Quartile	Median	Upper Quartile	Maximum
40	2378399.18	653989.62	1490638.00	1846532.50	2114224.50	2738413.00	3777322.00

Attendance 1977 to 2016

Analysis Variable : Attendance Attendance							
N	Mean	Std Dev	Minimum	Lower Quartile	Median	Upper Quartile	Maximum
87	557087.24	459250.59	112066.00	240600.00	341216.00	819698.00	2480150.00

Attendance 1890 to 1976

Is the result necessarily due to Free Agency?

3 Homework

1. Navidi Section 5.4: 1, 3, 6-8, 14

4 5.5 Confidence Intervals for Comparing Independent Population Proportions (Traditional)

Let's return to the distribution of letter grades by gender from Fall 2016 and focus on the letter grade A.

Table of Gender by Letter_Grade								
Gender(Gender)	Letter_Grade(Letter_Grade)							
Frequency	A	B	C	D	F	W	WF	Total
F	39	20	9	2	3	4	1	78
M	11	16	7	3	2	2	1	42
Total	50	36	16	5	5	6	2	120

More women earned a grade of A than men. Is that due to more women taking the class? Or is a women more likely to earn an A than a man in MATH 1107? To put this in terms of a two-tailed confidence interval, is there a difference in the percentage of women who earn the letter grade A the same as the percentage of men?

Example 4 *Our confidence interval takes the form $\mu_{PW} - \mu_{PM}$. The general form for the difference of two proportions is*

$$(p_1 - p_2) \pm z_{\frac{\alpha}{2}} * \sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}.$$

Using the **2-PropZInterval** command yields the confidence interval $(.01, .47)$. At 99% confidence we have statistically significant evidence to suggest there is a difference in the percentage of women who earn the letter grade A vs. the percentage of men?

Example 5 *What if we wanted to conduct a one-tailed test at 99% confidence that the percentage of women who earn and A is larger than the percentage of men? We would then use the one-tailed $z_\alpha = 2.33$. Thus, $(\frac{39}{78} - \frac{11}{42}) - 2.33 * \sqrt{\frac{\frac{39}{78}*(1-\frac{39}{78})}{78} + \frac{\frac{11}{42}*(1-\frac{11}{42})}{42}} = 3.2213 \times 10^{-2} = 0.03$. So, our one-side confidence interval is $(0.03, \frac{39}{78} - \frac{11}{42}) = (0.03, .238)$. Once again, 0 does not fall into this confidence interval.*

Exercise 6 *The "DFW" rate is a measure of the percentage of students who have not sufficiently mastered the material of a course in order to proceed to the next course in sequence. Using the data above, is the "DFW" rate different for men and women in MATH 1107? Test at 99% confidence.*

5 Homework

1. Navidi Section 5.5: 1, 2, 4, 5, 7