9.7: Chapter 9 Homework

9.3 The *F*-Distribution and the *F*-Ratio

1. There are five basic assumptions that must be fulfilled in order to perform a one-way ANOVA test. What are they?

Use the following information to answer the next eleven exercises. Groups of men from three different areas of the country are to be tested for mean weight. The entries in Table 9.7.1 are the weights for the different groups.

Group 1	Group 2	Group 3
216	202	170
198	213	165
240	284	182
187	228	197
176	210	201

Table 9.7.1

2. State the null and alternative hypotheses.

3. What is the Sum of Squares Factor?

4. What is the Sum of Squares Error?

5. What is the df for the numerator?

6. What is the df for the denominator?

7. What is the Mean Square Factor?

8. What is the Mean Square Error?

9. What is the F-observed value?

10. Create an ANOVA summary table.

11. What is the F-critical value for the 95% confidence level? Make a decision about the hypothesis.

12. What is the approximate p-value for F-observed here? Make a decision about the hypothesis using α = .05.

Use the following information to answer the next eleven exercises. Girls from four different soccer teams are to be tested for mean goals scored per game. The entries in Table 9.7.2 are the goals per game for the different teams.

Team 1	Team 2	Team 3	Team 4
1	2	0	3
2	3	1	4
0	2	1	4
3	4	0	3
2	4	0	2

Table 9.7.2

13. State the null and alternative hypotheses.

14. What is $SS_{Between}$?

15. What is the df for the numerator?

16. What is $MS_{Between}$?

17. What is SS_{Within}?

18. What is the df for the denominator?

19. What is MS_{Within}?

20. What is the F-observed value?

21. Create an ANOVA summary table.

22. What is the F-critical value for the 95% confidence level? Make a decision about the hypothesis.

23. What is the approximate p-value for F-observed here? Make a decision about the hypothesis using α = .05.

24. An F-statistic can have what values?

25. What happens to the curves as the degrees of freedom for the numerator and the denominator get larger?

Use the following information to answer the next ten exercises. Four basketball teams took a random sample of players regarding how high each player can jump (in inches). The results are shown in Table 9.7.3.

Team 1	Team 2	Team 3	Team 4	Team 5
36	32	48	38	41
42	35	50	44	39
51	38	39	46	40

Table 9.7.3

26. State the null and alternative hypotheses.

27. What is the df_{num}?

28. What is the df_{denom}?

29. What are the Sum of Squares and Mean Squares Factors?

30. What are the Sum of Squares and Mean Squares Errors?

31. What is the F-observed statistic?

32. Create an ANOVA summary table.

33. What is the F-critical value for the 95% confidence level?

34. What is the approximate p-value for F-observed here?

35. At the 5% significance level, is there a difference in the mean jump heights among the teams?

Use the following information to answer the next ten exercises. A video game developer is testing a new game on three different groups. Each group represents a different target market for the game. The developer collects scores from a random sample from each group. The results are shown in Table 9.7.4.

Group A	Group B	Group C
101	151	101
108	149	109
98	160	198
107	112	186
111	126	160

Table 9.7.4

36. State the null and alternative hypotheses.

37. What is the df_{num}?

38. What is the df_{denom}?

39. What are the $SS_{Between}$ and $MS_{Between}$?

40. What are the SS_{Within} and MS_{Within}?

41. What is the F-observed statistic?

42. Create an ANOVA summary table.

43. What is the F-critical value for the 99% confidence level? Make a decision about the hypothesis.

44. What is the approximate p-value for F-observed here? Make a decision about the hypothesis using α = .01.

45. At the 1% significance level, are the scores among the different groups different? Why or why not?

Use the following information to answer the next nine exercises. Suppose a group is interested in determining whether teenagers obtain their drivers licenses at approximately the same average age across the country. Suppose that the following data are randomly collected from four teenagers in each region of the country. The numbers represent the age at which teenagers obtained their drivers licenses.

	Northeast	South	West	Central	East
	16.3	16.9	16.4	16.2	17.1
	16.1	16.5	16.5	16.6	17.2
	16.4	16.4	16.6	16.5	16.6
	16.5	16.2	16.1	16.4	16.8
$\bar{x}$=	_____	_____	_____	_____	_____
s^2=	_____	_____	_____	_____	_____

Table 9.7.5

46. State the hypotheses.

H_0: _____

H_a: _____

47. sum of squares – between groups: $SS_{Between}$ = _____

48. sum of squares – within groups: SS_{Within} = _____

49. degrees of freedom – numerator: df_{num} = _____

50. degrees of freedom – denominator: df_{denom} = _____

51. F-observed = _____

52. Approximate p-value = _____

State the decisions and conclusions (in complete sentences) for the following preconceived levels of α.

53. $\alpha = 0.05$

a. Decision: _____

b. Conclusion: _____

54. $\alpha = 0.01$

a. Decision: _____

b. Conclusion: _____

55. The American League and the National League of Major League Baseball are each divided into three divisions: East, Central, and West. Many years, fans talk about some divisions being stronger (having better teams) than other divisions. This may have consequences for the postseason. For instance, in 2012 Tampa Bay won 90 games and did not play in the postseason, while Detroit won only 88 and did play in the postseason. This may have been an oddity, but is there good evidence that in the 2012 season, the American League divisions were significantly different in overall records? Use the following data to complete the test statistic approach whether the mean number of wins per team in the three American League divisions were the same or not. Note that the data are not balanced, as two divisions had five teams, while one had only four. Use $\alpha = .05$.

Division	Team	Wins
East	NY Yankees	95
East	Baltimore	93
East	Tampa Bay	90
East	Toronto	73
East	Boston	69

Table 9.7.6

Division	Team	Wins
Central	Detroit	88
Central	Chicago Sox	85
Central	Kansas City	72
Central	Cleveland	68
Central	Minnesota	66

Table 9.7.7

Division	Team	Wins
West	Oakland	94
West	Texas	93
West	LA Angels	89
West	Seattle	75

Table 9.7.8

9.2 One-Way ANOVA

56. Three different traffic routes are tested for mean driving time. The entries in Table 9.7.9 are the driving times in minutes on the three different routes. Conduct a hypothesis test using the test statistic approach and 5% significance, and create an ANOVA summary table of the results.

Route 1	Route 2	Route 3
30	27	16
32	29	41
27	28	22
35	36	31

Table 9.7.9

9.3 The *F*-Distribution and the F-Ratio

57. Three students, Linda, Tuan, and Javier, are given five laboratory rats each for a nutritional experiment. Each rat's weight is recorded in grams. Linda feeds her rats Formula A, Tuan feeds his rats Formula B, and Javier feeds his rats Formula C. At the end of a specified time period, each rat is weighed again, and the net gain in grams is recorded. Using a significance level of 1% and the test statistic approach, test the hypothesis that the three formulas produce the same mean weight gain.

Linda's rats	Tuan's rats	Javier's rats
43.5	47.0	51.2
39.4	40.5	40.9
41.3	38.9	37.9
46.0	46.3	45.0
38.2	44.2	48.6

Table 9.7.10 Weights of Student Lab Rats

58. A grassroots group opposed to a proposed increase in the gas tax claimed that the increase would hurt working-class people the most, since they commute the farthest to work. Suppose that the group randomly surveyed 24 individuals and asked them their daily one-way commuting mileage. The results are in Table 9.7.11. Using a 5% significance level and the test statistic approach, test the hypothesis that the three mean commuting mileages are the same.

Working-class	Professional (middle incomes)	Professional (wealthy)
17.8	16.5	8.5
26.7	17.4	6.3
49.4	22.0	4.6
9.4	7.4	12.6
65.4	9.4	11.0
47.1	2.1	28.6
19.5	6.4	15.4
51.2	13.9	9.3

Table 9.7.11

Use the following information to answer the next two exercises. Table 9.7.12 lists the number of pages in four different types of magazines.

Home decorating	News	Health	Computer
172	87	82	104
286	94	153	136
163	123	87	98
205	106	103	207
197	101	96	146

Table 9.7.12

59. Using a significance level of 5%, use test statistics test whether the four magazine types have the same mean length. Create an ANOVA summary table of the results.

60. Eliminate one magazine type that you now feel has a mean length different from the others. Redo the hypothesis test, testing that the remaining three means are statistically the same. Create a new ANOVA summary table. Based on this test, are the mean lengths for the remaining three magazines statistically the same?

61. A researcher wants to know if the mean times (in minutes) that people watch their favorite news station are the same. Suppose that Table 9.7.13 shows the results of a study. Assume that all distributions are normal, the four population standard deviations are approximately the same, and the data were collected independently and randomly. Use $\alpha = 0.05$ and the test statistic approach.

CNN	FOX	Local
45	15	72
12	43	37
18	68	56
38	50	60
23	31	51
35	22	

Table 9.7.13

62. Are the means for the final exams the same for all statistics class delivery types? Table 9.7.14 shows the scores on final exams from several randomly selected classes that used the different delivery types. Assume that all distributions are normal, the four population standard deviations are approximately the same, and the data were collected independently and randomly. Use a level of significance of 0.05 to test this with test statistics.

Online	Hybrid	Face-to-Face
72	83	80
84	73	78
77	84	84
80	81	81
81		86
		79
		82

Table 9.7.14

63. Are the mean number of times a month a person eats out the same for Whites, Blacks, Hispanics and Asians? Suppose that Table 9.7.15 shows the results of a study. Assume that all distributions are normal, the four population standard deviations are approximately the same, and the data were collected independently and randomly. Use a level of significance of 0.01 and the test statistic approach. Create an ANOVA summary table.

White	Black	Hispanic	Asian
6	4	7	8
8	1	3	3
2	5	5	5
4	2	4	1

White	Black	Hispanic	Asian
6		6	7

Table 9.7.15

64. Are the mean numbers of daily visitors to a ski resort the same for the three types of snow conditions? Suppose that Table 9.7.16 shows the results of a study. Assume that all distributions are normal, the four population standard deviations are approximately the same, and the data were collected independently and randomly. Use a level of significance of 0.05 and the test statistic approach.

Powder	Machine Made	Hard Packed
1,210	2,107	2,846
1,080	1,149	1,638
1,537	862	2,019
941	1,870	1,178
	1,528	2,233
	1,382	

Table 9.7.16

65. Sanjay made identical paper airplanes out of three different weights of paper, light, medium and heavy. He made four airplanes from each of the weights, and launched them himself across the room. Here are the distances (in meters) that his planes flew.

Paper type/Trial	Trial 1	Trial 2	Trial 3	Trial 4
Heavy	5.1 meters	3.1 meters	4.7 meters	5.3 meters
Medium	4 meters	3.5 meters	4.5 meters	6.1 meters
Light	3.1 meters	3.3 meters	2.1 meters	1.9 meters

Table 9.7.17

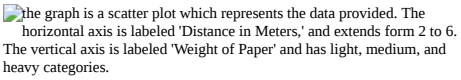

Figure 9.7.1

1. Take a look at the data in the graph. Look at the spread of data for each group (light, medium, heavy). Does it seem reasonable to assume a normal distribution with the same variance for each group? Yes or No.
2. Why is this a balanced design?
3. Calculate the sample mean and sample standard deviation for each group.
4. Does the weight of the paper have an effect on how far the plane will travel? Use a 1% level of significance.
   - g = _____
   - n = _____
   - $SS_{Between}$ = _____
   - $MS_{Between}$ = _____
   - SS_{Within} = _____
   - MS_{Within} = _____
   - df_{num} = _____, df_{denom} = _____
   - F statistic = _____
   - F-critical = _____
   - Graph the F-observed and F-critical values.

- decision: _____
- conclusion: _____

66. DDT is a pesticide that has been banned from use in the United States and most other areas of the world. It is quite effective, but persisted in the environment and over time became seen as harmful to higher-level organisms. Famously, egg shells of eagles and other raptors were believed to be thinner and prone to breakage in the nest because of ingestion of DDT in the food chain of the birds.

An experiment was conducted on the number of eggs (fecundity) laid by female fruit flies. There are three groups of flies. One group was bred to be resistant to DDT (the RS group). Another was bred to be especially susceptible to DDT (SS). Finally there was a control line of non-selected or typical fruitflies (NS). Here are the data:

RS	SS	NS	RS	SS	NS
12.8	38.4	35.4	22.4	23.1	22.6
21.6	32.9	27.4	27.5	29.4	40.4
14.8	48.5	19.3	20.3	16	34.4
23.1	20.9	41.8	38.7	20.1	30.4
34.6	11.6	20.3	26.4	23.3	14.9
19.7	22.3	37.6	23.7	22.9	51.8
22.6	30.2	36.9	26.1	22.5	33.8
29.6	33.4	37.3	29.5	15.1	37.9
16.4	26.7	28.2	38.6	31	29.5
20.3	39	23.4	44.4	16.9	42.4
29.3	12.8	33.7	23.2	16.1	36.6
14.9	14.6	29.2	23.6	10.8	47.4
27.3	12.2	41.7			

Table 9.7.18

The values are the average number of eggs laid daily for each of 75 flies (25 in each group) over the first 14 days of their lives. Using a 1% level of significance and the *p*-value approach, are the mean rates of egg selection for the three strains of fruitfly different? If so, in what way? Specifically, the researchers were interested in whether or not the selectively bred strains were different from the non-selected line, and whether the two selected lines were different from each other.

Here is a chart of the three groups:

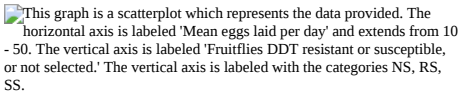

Figure 9.7.2

67. The data shown is the recorded body temperatures of 130 subjects as estimated from available histograms.

Traditionally we are taught that the normal human body temperature is 98.6 F. This is not quite correct for everyone. Are the mean temperatures among the four groups different? Conduct both the test statistic and *p*-value approach using 99% confidence.

FL	FH	ML	MH	FL	FH	ML	MH
96.4	96.8	96.3	96.9	98.4	98.6	98.1	98.6
96.7	97.7	96.7	97	98.7	98.6	98.1	98.6

FL	FH	ML	MH	FL	FH	ML	MH
97.2	97.8	97.1	97.1	98.7	98.6	98.2	98.7
97.2	97.9	97.2	97.1	98.7	98.7	98.2	98.8
97.4	98	97.3	97.4	98.7	98.7	98.2	98.8
97.6	98	97.4	97.5	98.8	98.8	98.2	98.8
97.7	98	97.4	97.6	98.8	98.8	98.3	98.9
97.8	98	97.4	97.7	98.8	98.8	98.4	99
97.8	98.1	97.5	97.8	98.8	98.9	98.4	99
97.9	98.3	97.6	97.9	99.2	99	98.5	99
97.9	98.3	97.6	98	99.3	99	98.5	99.2
98	98.3	97.8	98		99.1	98.6	99.5
98.2	98.4	97.8	98		99.1	98.6	
98.2	98.4	97.8	98.3		99.2	98.7	
98.2	98.4	97.9	98.4		99.4	99.1	
98.2	98.4	98	98.4		99.9	99.3	
98.2	98.5	98	98.6		100	99.4	
98.2	98.6	98	98.6		100.8		

Table 9.7.19