

Note: Solutions must be either typed or written neatly, and questions must be answered in order. Where SAS is used to answer a question, relevant SAS output must be copied as an image file and included with your answer to the question and not at the end of the assignment. Be sure to submit your assignment as a PDF and follow the instructions specified on the submission system.

1. Consider data collected by Brockman (1996) on female horseshoe crabs and the number of male “satellites” residing near them. We will look at a subset of $n = 41$ of these female horseshoe crabs with the best spine condition. For this subset, the numbers of female horseshoe crabs reporting particular numbers of satellites are as shown in the table below.

Satellites (r)	Frequency (f_r)
0	19
1	3
2	1
3	4
4	7
5	7

Source: Brockman, H.J. (1996). Satellite Male Groups in Horseshoe Crabs, *Limulus polyphemus*, *Ethology* 102(1):1-21.

- a. Assuming the number of satellites per female horseshoe crab follows a Poisson distribution, estimate the mean number of satellites per female horseshoe crab.
- b. Suppose we wish to test whether the distribution of the number of satellites per female horseshoe crab is consistent with a Poisson distribution. Can a chi-square goodness-of-fit test be applied to the data as presented in the table, or do certain numbers of satellites need to be grouped? If a grouping of numbers of satellites is necessary, determine an appropriate grouping, showing evidence that a chi-square goodness-of-fit test would indeed be appropriate for this grouping.
- c. Test whether the number of satellites per female horseshoe crab is consistent with a Poisson distribution. Be sure to clearly state the null and alternative hypotheses, present the test statistic and its distribution under the null hypothesis, and report the p -value and your conclusion at the $\alpha = 0.05$ significance level.

2. Recall the dataset produced from a study carried out by the European CanCer Organisation and analysed in Assignment 1. In that study, a non-invasive diagnostic test for stomach and esophageal cancers was carried out on 335 people, and cancer statuses and test results for these people were as shown in the table below.

Have stomach or esophageal cancer?	Tested positive for stomach or esophageal cancer?	
	No	Yes
No	140	32
Yes	32	131

- Using an odds ratio, describe and clearly interpret the association between cancer status and test result.
- Obtain a 95% confidence interval for the odds ratio θ calculated in part (a).
- Is it appropriate to carry out a chi-square test of independence for the data presented in the table? Briefly explain why or why not.
- Regardless of your answer to part (c), carry out both Pearson and likelihood ratio chi-square tests of independence to assess whether cancer status and test result are associated. Be sure to clearly state the null and alternative hypotheses, present the test statistic and its distribution under the null hypothesis, and report the p -value and your conclusion at the $\alpha = 0.05$ significance level.