# Math 5301 Homework 13

1. The number of emissions from a radioactive sample in a fixed time period is sometimes modeled using a poisson distribution. Suppose a researcher records the number of emissions in 200 one-minute time periods, and the data is summarized in the following table.

| Number of Emissions | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of Time Periods | 9 | 36 | 39 | 50 | 30 | 19 | 8 | 4 | 5 | 200 |

   Test the null hypothesis that the number of emissions follows a Poisson distribution.

   Hints: The p.m.f. for the poisson distribution with parameter $\lambda > 0$ is

$$P(X = x) = f(x) = \frac{e^{-\lambda}\lambda^x}{x!}, \text{ for } x = 0, 1, 2, \ldots.$$

   For this application, $\lambda$ represents the average number of particle emissions in a one-minute period, so a good estimate for $\lambda$ is

$$\hat{\lambda} = \frac{\text{Total Number of Emissions}}{200}.$$

   Because there are infinitely many possible values of $X$, the last cell in the table, corresponding to $X = 8$, should be replaced by $X \geq 8$, and the probability for that cell will be $P(X \geq 8)$. This guarantees that the $p_j^\star$'s will add up to 1.

   Then, to ensure $E_j \geq 5$, it would be best to combine $X = 7$ and $X \geq 8$ into one cell for $X \geq 7$.

2. The effectiveness of a number of different media for the growth of diphtheria bacilli was investigated by the Communicable Disease Centre, U.S. Public Health Service. Specimens were taken from the throats of sixty-nine suspected cases, and each specimen was grown on each of four media A, B, C, D. In the table below, 1 denotes that growth occurred with that medium.

| | Diphtheria Media | | | |
|---|---|---|---|---|
| Number of Cases | A | B | C | D |
| 4 | 1 | 1 | 1 | 1 |
| 2 | 1 | 1 | 0 | 1 |
| 3 | 0 | 1 | 1 | 1 |
| 1 | 0 | 1 | 0 | 1 |
| 59 | 0 | 0 | 0 | 0 |
| Column Totals | 6 | 10 | 7 | 10 |

   Test the null hypothesis that, for each specimen, the different media have the same growth probabilities.