Astronomy 350, Autumn 2002, Problem Set 2

Due Tuesday, October 15 in class

Problem 1:

Compute the mean, median, mode, and standard deviation of the following data:

11	12	6	7	8	8	10	9	5	9	8	5	8	10	8
6	5	6	3	9	7	5	6	8	9					

The data above are the result of an experiment in which two six-sided "fair" dice were thrown 25 times and the numbers that appeared on each throw added together. The probability distribution function for getting a "score" of *x* on a given throw, *P(x)*, is:

$$P(x) = \begin{cases} \dfrac{x-1}{36} \text{ for } 2 \le x \le 7 \\ \dfrac{13-x}{36} \text{ for } 7 \le x \le 12 \\ 0 \text{ for } x \le 1 \text{ and } x \ge 13 \end{cases}$$

Find the mean, mode, and standard deviation of this probability distribution, and compare your results from the data above to the predictions of this PDF.

Problem 2:

A quarter slot machine has 3 identical wheels each with 10 different pictures (bells, cherries, lemons, etc.). The machine is designed to pay off if 1, 2, or 3 cherries appear in the windows. The amount of payoff is inversely proportional to the probability of getting that number of cherries in the windows (i.e., the less likely the outcome, the higher the payoff). If getting 3 cherries results in a "jackpot" of \$1000, what should the payoffs be for getting 1 and 2 cherries, assuming that the machine is "fair" (i.e., probability of getting any of the pictures is equal), and that the casino does not take a cut of the winnings? Round your answer down to the nearest 25-cents (the payoff is in quarters).

Problem 3:

Collect 10 Nickels, all of recent mintage (they changed the formula about 20 yrs ago). Put the coins into a cup, shake the cup (with your hand over the top) and then toss them onto a sheet of paper. Count the number of heads that appear. Return the coins to the cup (use the paper as a scoop) and toss again, repeating the trials of the experiment until you have collected data for 100 separate tosses of the 10 nickels.

a) Make a table of your data, listing in the first column the number of heads that appeared (0 thru 10), the number of times this outcome occurred in column 2, and the fraction of the time out of 100 that this outcome occurred in colunn 3. This is your experimental data set.

b) Compute the sample mean ($\bar{x}$) and sample standard deviation (s) of your data using all 100 data points from your experiment. Call these $\bar{x}_{100}$ and s_{100}, respectively.

c) Re-compute the sample mean and standard deviation using only every 4th data point (N=25 total points). Call these $\bar{x}_{25}$ and s_{25}, respectively. How do these compare to what you got using the entire data set of 100 points?

d) Make a histogram plot of your data, using the data in the third column (fraction of occurence). Label the axes clearly, and indicate the sample mean and standard deviation on your plot. Make a second plot of the distribution of the 25 data points used in part c.

e) Evaluate the binomial distribution $P_B(x;n,p)$ for the case n=10 and p=0.5 for values $0 \le x \le 10$. Plot the theoretical distribution over each of your plots above. Also compute the parent mean and dispersion (μ and σ) of the parent distribution $P_B(x;n,p)$, and indicate these values on your plot. Compare the theoretical expectations with the results of your coin-toss experiment above. Please be quantitative in your comparison.