ECE 341 - Homework #14

Chi-Squared Tests. Summer 2024

Loaded Dice

1) The following Matlab code generates 240 random numbers from 1..6 (sixty 6-sided dice)

```
RESULT = zeros(1,6);
for i=1:240
   d6 = ceil(rand*6);
   RESULT(d6) = RESULT(d6) + 1;
end
```

Use a chi-squared test to determine if this is a fair die.

2) The following Matlab code generates 240 random die rolls with 8% loading (8% of the time you roll a 6)

```
RESULT = zeros(1,6);
for i=1:240
   if(rand < 0.08) d6 = 6;
   else d6 = ceil(rand*6);
   end
   RESULT(d6) = RESULT(d6) + 1;
end
```

Use a chi-squared test to determine if this is a fair die.

3) Repeat problem #2 with 1000 die rolls

Am I psychic?

4) Shuffle a deck of 52 playing cards. Without looking at the top card, predict the suit (clubs, diamonds, hearts, and spades). Repeat for all 52 cards, keeping track of how many you got right and how many you got wrong.

- From the results, use a chi-squared test to determine if you are just guessing (25% chance of getting the suit correct.)

Central Limit Theorem:

5) The following code sums four uniform distributions

```
Y = sum(rand(4,1));
```

The Central Limit Theorem states that this will converge to a normal distribution with

- mean = 2.0
- variance = 4/12

Use a chi-squared test to determine if Y does / does not have a normal distribution.

Poisson approximation for a binomial distribution.

7) Let X be the number of 1's you get when you roll 60 dice. The Poisson approximation for the pdf is

$$\binom{60}{x}\left(\frac{1}{6}\right)^{x}\left(\frac{5}{6}\right)^{90-x} \approx \left(\frac{1}{x!}\right) 10^{x}\, e^{-10}$$

- Use Matlab to count the number of 1's you get when you roll 90 dice
- Repeat 200 times
- Check whether the result is consistent with a Poisson distribution with $\lambda = Np = 10$ using a Chi-squred test

Code:

```
Result = zeros(60,1);
for i=1:200
    Dice = ceil(6*rand(60,1));
    N = sum(Dice == 1);
    Result(N) = Result(N) + 1;
end

k = [1:30]';
Result = Result(k);

Poisson = 1./ factorial(k) .* (10.^k) * exp(-10) * 200;

plot(k,Result,'*',k,Poisson)
```