# ECE 341 - Test #3

Markov Chains and Data Analysis

Open-Book, Open Notes.  Calculators, Matlab, Tarot cards, Internet allowed.  Just not other people.

Please sign if possible (i.e. you did not get help from someone else).

*No aid given, received, or observed:* _____

Due Monday, June 15th, 8am

**1) Markov Chains:**  Two people, A and B, are playing a game.

- A has a 60% chance of winning    A gains +1 point on a win
- There is a 15% chance of a tie      A loses one point on a tie
- A has a 25% chance of losing       A loses two points on a loss

If A reaches +3 points, A wins the match

If A reaces -3 points, B wins the match

1a)  What is the state transition matrix (going from k games to k+1 games)

1b)  What is the chance that A will win the match assuming they start out at even (A has zero points)?

1c)  What is the z-transform for the probability of A winning after k games?

1d)  From the z-transforms, determine the probability of A winning the match
- i.e. the partial fraction expansion over the (z-1) term

2) t-Test (One data set).  A Monte-Carlo simulation was run 10 times.  Each simulation dealt 10,000 hands for 5-card draw and counted the number of times you got a 3-of-a-kind.

      # hands = {  788  752  755  800  748  787  777  758  828  796 }

2a)  If I run this experiment an 11th time, what number will I get with a confidence level of 90%? (5% tails)

2b)  What is the 90% confidence interval for the actual probability of getting 3-of-a-kind with 5-card draw based upon this data?

3) t-Test (Two data sets):  The average temperatures in March and November from 1942 - 2019 in Fargo, ND are:

March = [  33.8  17.6  20.2  35.1  34.7  24.7  17.7  22.1  20.7   15.7  20.4  28.0  25.5  16.8  19.5  27.5
30.9  30.9   15.5  34.5  22.7  29.0  20.8  13.7  29.7  26.8  34.0   15.2  18.6  27.6  23.9  36.0  22.9  18.4
 22.9  32.0   23.5  20.4  20.7  33.5  22.9  29.8  23.4  32.8  31.6   31.4  29.5  20.0  31.4  30.3  32.6  25.6
 30.5  28.3   17.3  20.1  26.5  31.1  35.2  22.9  20.0  24.7  30.3   28.0  27.4  31.6  22.8  24.0  35.4  20.5
 41.6  17.3   22.3  33.5  38.3  29.5  26.2  19.8 ]

November = [   27.5  29.6  32.9  26.0  27.1  22.2  29.1  34.1  22.3  21.0  30.8  35.1  34.5  18.8  30.5
28.9  29.7  20.5  29.9  30.1  35.0  34.7  29.2  26.0  23.1  29.0  31.0  30.5  27.8  29.6  28.5  25.1  29.2
31.1  23.2  25.6  22.7  24.5  33.0  35.4  24.1  31.2  29.7  15.4  23.1  33.4  27.5  24.0  32.1  22.0  27.3
26.6  34.0  21.2  17.7  23.2  29.3  37.1  25.9  39.7  27.9  24.9  34.2  31.2  31.9  31.1  31.7  38.4  29.2
33.8  30.3  28.2  22.8  36.2  41.8  28.3  22.4  22.0 ]


3a)  What is the probability that March 2021 will be warmer than November 2021?


3b)  What is the probability that March is warmer than November?

4) Chi-Squared Test:  The following Matlab code generated 100 random values for X:

```
X = [];
for i=1:100
    X(i) = sum(-5*log(1 - rand(3,1)));
    end
```

It is conjectured that X has an exponential distribution with a mean of 15

$$f(x) = \left(\frac{1}{15}\right) e^{-t/15} \, u(t)$$

4a)  Generate 100 values for X and give the sorted results ( Matlab command *sort(X)* )

4b) Determine if X does or does not have this exponential pdf using a Chi-squared test.

5) F-Test (Three data sets): The average temerature in Fargo since 1942 in the months of June and July are:

June = [62.6 63.7 65.5 60.3 64.7 61.4 63.8 65.6 65.5 60.7 67.3 64.9 65.3 65.4 70.7 62.7 59.7 68.1 63.3 68.6 66.2 68.8 67.2 63.9 66.1 62.6 64.1 57.3 67.8 67.4 66.9 64.7 64.4 65.2 68.5 66.5 64.7 65.4 65.7 62.8 59.1 66.0 65.7 60.0 67.5 69.1 73.8 64.1 66.9 70.1 61.9 63.1 68.2 71.4 67.0 68.9 63.4 66.3 62.7 65.9 69.0 65.4 62.5 68.2 68.5 69.8 63.6 63.6 66.5 66.8 69.9 67.5 67.2 67.1 68.8 67.8 70.3 67.1 ]

July = [68.8 73.0 69.3 68.6 71.2 71.5 71.2 71.3 67.9 68.5 69.7 69.9 71.8 74.5 68.0 75.3 67.3 72.2 71.4 70.4 68.8 73.6 74.0 68.5 73.8 67.9 69.6 68.3 71.8 65.0 68.3 68.2 73.6 74.2 71.7 72.2 69.5 71.9 71.8 71.1 70.9 73.5 70.6 68.9 71.5 74.0 75.8 75.8 70.0 70.2 64.3 67.0 67.6 70.0 67.8 69.2 71.7 71.5 70.6 72.5 73.0 70.4 68.2 71.3 74.9 74.0 70.3 66.5 72.0 74.5 76.6 71.7 69.4 72.5 71.9 72.1 70.9 72.2 ]


5a) What is the probability that the variance of June is different than the variance of July?




5b) What is the probability that
- June 1942 - 1967  (first 26 data points)
- June 1968 - 1993  (next 26 data points)
- June 1994 - 2019  (last 26 data points)

all have the same average temeprature using an ANOVA test?