

CIVL 7012/8012
Probabilistic Methods for Engineers
Homework 1
Due February 6, 2019

(Note: You can do all questions by hand if you wish, or you can use any software to help you)

Question-1: You have been given a set of data consisting of monthly highway fatalities from 1954 through 1979. Determine the following:

- a) Mean, median, and mode
- b) Variance and standard deviation
- c) Coefficient of variation
- d) Create histogram with an appropriate number of “bins”.
- e) Create a stem-and-leaf diagram using stems corresponding to 20-24, 25-29, 30-34, and so on.
- f) Calculate the 1st, 2nd, and 3rd quartiles of the data and use the results to create a box plot.
- g) Is the data skewed to one side or the other?

Question-2: Corresponding annual vehicle miles travelled (VMT) data is also provided from 1954 to 1979. Determine the following:

- a) How the VMT trend has been during this period. Provide a descriptive statistics of the VMT data.
- b) Is there any trend between VMT and number of fatalities?

Question-3: A construction company has three branches A, B, and C. They are operating in different parts of the country. The chances that the branches will be profitable in any given year are 70%, 70%, and 60%, respectively. The operations of branches A and B are related such that if one makes a profit the probability of the other branch also making a profit increases to 90%, whereas branch C is independent of both A and B. At the end of each year, if at least two branches are profitable, the chance that employees will receive a bonus is 80%; otherwise the chance of a bonus will only be 20%.

- a) What is the probability that exactly two branches will make profits in a given year?
- b) Determine the probability that the company employees will receive a bonus this year.
- c) If it is known for sure that branch A will end this year in the red (i.e., not making any profit), how would this fact change the probability of part (b)?

Question-4: At a rock quarry, the time required to load crushed rocks onto a truck is equally likely to be either 2 or 3 minutes. Also, the number of trucks in a queue waiting to be loaded can vary considerably; data from 40 previous observations taken at random show the following:

No. of Trucks in Queue	No. of Observations	Relative Frequency
0	7	0.175
1	5	0.125
2	12	0.3
3	11	0.275
4	4	0.1
5	1	0.025
6	0	0
Total = 40		

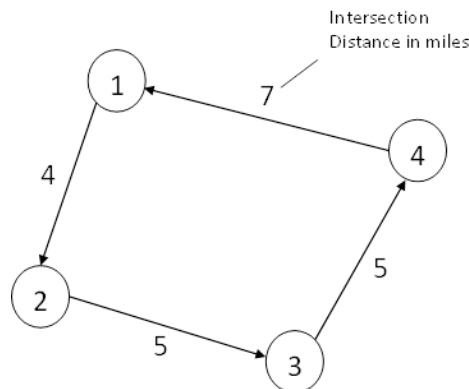
The time required to load a truck is statistically independent of the queue size.

- If there are two trucks in the queue when a truck arrives at the quarry, what is the probability that its “waiting time” will be less than 5 minutes?
- Before arriving at the quarry, and thus not knowing the size of the queue upon arrival, what is the probability that the waiting time of the truck will be less than 5 minutes?

Question-5: A transit system consists of one-way trains running between four stations as shown in the figure below. The distances between stations are shown in the figure below. The distances between stations are as indicated in the figure. The probabilities concerning origin and destination of passengers are summarized in the following matrix:

Origin	Destination			
	1	2	3	4
1	0	0.1	0.3	0.6
2	0.6	0	0.3	0.1
3	0.5	0.1	0	0.4
4	0.8	0.1	0.1	0

For example, a passenger originating from station 1 will get off at Station 2, 3 or 4 with probabilities 0.1, 0.3 and 0.6, respectively. Furthermore, the fraction of trips originating from Stations 1, 2, 3 and 4 are 0.25, 0.15, 0.35 and 0.25 respectively.



- What is the probability that a passenger will leave the train at Station 3?
- What is the expected trip length for a passenger boarding at Station 1? (Note: “Expected value of X ” = $\sum_{all} x_i p_i$ where p_i is probability of the outcome x_i).
- What proportion of passenger trips will exceed 10 miles?
- What fraction of the passengers departing the train at Station 3 originated from Station 1?

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Question-6: Use 2010 census population data for Shelby County, and present your findings.