ME 1020 Engineering Programming with MATLAB

Handout 07

Homework 7 Assignment: 7.3, 7.6, 7.8, 7.10, 7.12, 7.14, 7.16, 7.23, 7.25

Section 7.1

1. The following list gives the measured gas mileage in miles per gallon for 22 cars of the same model. Plot the absolute frequency histogram and the relative frequency histogram.

23	25	26	25	27	25	24	22	23	25	26
26	24	24	22	25	26	24	24	24	27	23

2. Thirty pieces of structural timber of the same dimensions were subjected to an increasing lateral force until they broke. The measured force in pounds required to break them is given in the following list. Plot the absolute frequency histogram. Try bin widths of 50, 100, and 200 lb. Which gives the most meaningful histogram? Try to find a better value for the bin width.

243	236	389	628	143	417	205
404	464	605	137	123	372	439
497	500	535	577	441	231	675
132	196	217	660	569	865	725
457	347					

3. The following list gives the measured breaking force in newtons for a sample of 60 pieces of certain type of cord. Plot the absolute frequency histogram. Try bin widths of 10, 30, and 50 N. Which gives the most meaningful histogram? Try to find a better value for the bin width.

311	138	340	199	270	255	332	279	231	296	198	269
257	236	313	281	288	225	216	250	259	323	280	205
279	159	276	354	278	221	192	281	204	361	321	282
254	273	334	172	240	327	261	282	208	213	299	318
356	269	355	232	275	234	267	240	331	222	370	226

Section 7.2

4. For the data given in Problem 1:

a. Plot the scaled frequency histogram.

b. Compute the mean and standard deviation and use them to estimate the lower and upper limits of gas mileage corresponding to 68 percent of cars of this model. Compare these limits with those of the data.

5. For the data given in Problem 2:
   a. Plot the scaled frequency histogram.
   b. Compute the mean and standard deviation and use them to estimate the lower and upper limits of strength corresponding to 68 and 96 percent of such timber pieces. Compare these limits with those of the data.

6. For the data given in Problem 3:
   a. Plot the scaled frequency histogram.
   b. Compute the mean and standard deviation, and use them to estimate the lower and upper limits of breaking force corresponding to 68 and 96 percent of cord pieces of this type. Compare these limits with those of the data.

7.* Data analysis of the breaking strength of a certain fabric shows that it is normally distributed with a mean of 300 lb and a variance of 9.
   a. Estimate the percentage of fabric samples that will have a breaking strength no less than 294 lb.
   b. Estimate the percentage of fabric samples that will have a breaking strength no less than 297 lb and no greater than 303 lb.

8. Data from service records show that the time to repair a certain machine is normally distributed with a mean of 65 min and a standard deviation of 5 min. Estimate how often it will take more than 75 min to repair a machine.

9. Measurements of a number of fittings show that the pitch diameter of the thread is normally distributed with a mean of 8.007 mm and a standard deviation of 0.005 mm. The design specifications require that the pitch diameter be 8 ± 0.01 mm. Estimate the percentage of fittings that will be within tolerance.

10. A certain product requires that a shaft be inserted into a bearing. Measurements show that the diameter d_1 of the cylindrical hole in the bearing is normally distributed with a mean of 3 cm and a variance of 0.0064. The diameter d_2 of the shaft is normally distributed with a mean of 2.96 cm and a variance of 0.0036.
   a. Compute the mean and the variance of the clearance $c = d_1 - d_2$.
   b. Find the probability that a given shaft will not fit into the bearing. (*Hint:* Find the probability that the clearance is negative.)

11.* A shipping pallet holds 10 boxes. Each box holds 300 parts of different types. The part weight is normally distributed with a mean of 1 lb and a standard deviation of 0.2 lb.
   a. Compute the mean and standard deviation of the pallet weight.
   b. Compute the probability that the pallet weight will exceed 3015 lb.

12. A certain product is assembled by placing three components end to end. The components' lengths are L_1, L_2, and L_3. Each component is manufactured on a different machine, so the random variations in their lengths are independent of one another. The lengths are normally distributed with means of 1, 2, and 1.5 ft and variances of 0.00014, 0.0002, and 0.0003, respectively.

a. Compute the mean and variance of the length of the assembled product.

b. Estimate the percentage of assembled products that will be no less than 4.48 and no more than 4.52 ft in length.

Section 7.3

13. Use a random number generator to produce 1000 uniformly distributed numbers with a mean of 10, a minimum of 2, and a maximum of 18. Obtain the mean and the histogram of these numbers, and discuss whether they appear uniformly distributed with the desired mean.

14. Use a random number generator to produce 1000 normally distributed numbers with a mean of 20 and a variance of 4. Obtain the mean, variance, and histogram of these numbers, and discuss whether they appear normally distributed with the desired mean and variance.

15. The mean of the sum (or difference) of two independent random variables equals the sum (or difference) of their means, but the variance is always the sum of the two variances. Use random number generation to verify this statement for the case where $z = x + y$, where x and y are independent and normally distributed random variables. The mean and variance of x are $\mu_x = 8$ and $\sigma_x^2 = 2$. The mean and variance of y are $\mu_y = 15$ and $\sigma_y^2 = 4$. Find the mean and variance of z by simulation, and compare the results with the theoretical prediction. Do this for 100, 1000, and 5000 trials.

16. Suppose that $z = xy$, where x and y are independent and normally distributed random variables. The mean and variance of x are $\mu_x = 10$ and $\sigma_x^2 = 2$. The mean and variance of y are $\mu_y = 15$ and $\sigma_y^2 = 3$. Find the mean and variance of z by simulation. Does $\mu_z = \mu_x \mu_y$? Does $\sigma_z^2 = \sigma_x^2 \sigma_y^2$? Do this for 100, 1000, and 5000 trials.

17. Suppose that $y = x^2$, where x is a normally distributed random variable with a mean and variance of $\mu_x = 0$ and $\sigma_x^2 = 4$. Find the mean and variance of y by simulation. Does $\mu_y = \mu_x^2$? Does $\sigma_y = \sigma_x^2$? Do this for 100, 1000, and 5000 trials.

18.* Suppose you have analyzed the price behavior of a certain stock by plotting the scaled frequency histogram of the price over a number of months. Suppose that the histogram indicates that the price is normally distributed with a mean \$100 and a standard deviation of \$5. Write a

MATLAB program to simulate the effects of buying 50 shares of this stock whenever the price is below the $100 mean, and selling all your shares whenever the price is above $105. Analyze the outcome of this strategy over 250 days (the approximate number of business days in a year). Define the profit as the yearly income from selling stock plus the value of the stocks you own at year's end, minus the yearly cost of buying stock. Compute the mean yearly profit you would expect to make, the minimum expected yearly profit, the maximum expected yearly profit, and the standard deviation of the yearly profit. The broker charges 6 cents per share bought or sold with a minimum fee of $40 per transaction. Assume you make only one transaction per day.

19. Suppose that data show that a certain stock price is normally distributed with a mean of $150 and a variance of 100. Create a simulation to compare the results of the following two strategies over 250 days. You start the year with 1000 shares. With the first strategy, every day the price is below $140 you buy 100 shares, and every day the price is above $160 you sell all the shares you own. With the second strategy, every day the price is below $150 you buy 100 shares, and every day the price is above $160 you sell all the shares you own. The broker charges 5 cents per share traded with a minimum of $35 per transaction.

20. Write a script file to simulate 100 plays of a game in which you flip two coins. You win the game if you get two heads, lose if you get two tails, and flip again if you get one head and one tail. Create three user-defined functions to use in the script. Function `flip` simulates the flip of one coin, with the state `s` of the random number generator as the input argument, and the new state `s` and the result of the flip (0 for a tail and 1 for a head) as the outputs. Function `flips` simulates the flipping of two coins and calls `flip`. The input of `flips` is the state `s`, and the outputs are the new state `s` and the result (0 for two tails, 1 for a head and a tail, and 2 for two heads). Function `match` simulates a turn at the game. Its input is the state `s`, and its outputs are the result (1 for win, 0 for lose) and the new state `s`. The script should reset the random number generator to its initial state, compute the state `s`, and pass this state to the user-defined functions.

21. Write a script file to play a simple number guessing game as follows. The script should generate a random integer in the range 1, 2, 3, . . . , 14, 15. It should provide for the player to make repeated guesses of the number, and it should indicate if the player has won or give the player a hint after each wrong guess. The responses and hints are as follows:

- "You won" and then stop the game.
- "Very close" if the guess is within 1 of the correct number.
- "Getting close" if the guess is within 2 or 3 of the correct number.
- "Not close" if the guess is not within 3 of the correct number.

Section 7.4

22.* Interpolation is useful when one or more data points are missing. This situation often occurs with environmental measurements, such as temperature, because of the difficulty of making measurements around the clock. The following table of temperature versus time data is missing readings at 5 and 9 hours. Use linear interpolation with MATLAB to estimate the temperature at those times.

Time (hours, P.M.)	1	2	3	4	5	6	7	8	9	10	11	12
Temperature (°C)	10	9	18	24	?	21	20	18	?	15	13	11

23. The following table gives temperature data in °C as a function of time of day and day of the week at a specific location. Data are missing for the entries marked with a question mark (?). Use linear interpolation with MATLAB to estimate the temperature at the missing points.

	Day				
Hour	**Mon**	**Tues**	**Wed**	**Thurs**	**Fri**
1	17	15	12	16	16
2	13	?	8	11	12
3	14	14	9	?	15
4	17	15	14	15	19
5	23	18	17	20	24

24. Computer-controlled machines are used to cut and to form metal and other materials when manufacturing products. These machines often use cubic splines to specify the path to be cut or the contour of the part to be shaped. The following coodinates specify the shape of a certain car's front fender. Fit a series of cubic splines to the coordinates, and plot the splines along with the coordinate points.

x (ft)	0	0.25	0.75	1.25	1.5	1.75	1.875	2	2.125	2.25
y (ft)	1.2	1.18	1.1	1	0.92	0.8	0.7	0.55	0.35	0

25. The following data are the measured temperature T of water flowing from a hot water faucet after it is turned on at time $t = 0$.

t (sec)	T (°F)	t (sec)	T (°F)
0	72.5	6	109.3
1	78.1	7	110.2
2	86.4	8	110.5
3	92.3	9	109.9
4	110.6	10	110.2
5	111.5		

a. Plot the data with open circles, then plot the data by connecting them first with straight lines and then with a cubic spline.

b. Estimate the temperature values at the following times, using linear interpolation and then cubic spline interpolation: $t = 0.6, 2.5, 4.7, 8.9$.