FUNDAMENTALS OF ENGINEERING STATISTICAL ANALYSIS

ISE/DSA 5013

Assignment 3

Show your work for calculation problems. You will receive no credit if you only provide the answer. Define any events which are necessary in solving probability problems. *As with all homework this semester, spend time to be neat and organized. Any disorganized submissions are subject to a zero grade.*

Problem 1

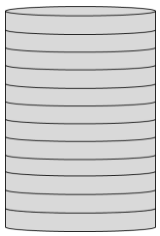
The University of Oklahoma has a renowned radar research program within the School of Electrical and Computer Engineering. Say that there are two radar prototypes under development, A1 and A2, and the effectiveness of each is determined by their ability to spatially detect a particular object. A1 has a probability of 0.5 of detecting the object, and A2 has probability 0.3 of detecting the object.

a. Find the probability that the object is detected.
b. Find the probability that the object is detected by exactly one of the radar prototypes.
c. Given that the object was detected by exactly one of the prototypes, find the probability that it was A1 that detected it.

Problem 2

A box of bolts contains eight thick bolts, five medium bolts, and three thin bolts. A box of nuts contains six that fit the thick bolts, four that fit the medium bolts, and two that fit the thin bolts. One bolt and one nut are chosen at random. What is the probability that the nut fits the bolt?

Problem 3



Say you're an electrical engineer designing an electromechanical subassembly for use in a larger aircraft system. Twelve components are to be stacked into a cylindrical casing in a manner that minimizes the impact of shocks.

a. If all components are different, how many different design configurations are possible?
b. If seven components are identical to one another, but the others are different, how many different design configurations are possible?
c. If three components are of one type and identical to each other, and four components are of another type and identical to each other, but the others are different, how many different design configurations are possible?

Problem 4

Study the special case of the "small world" problem called the "birthday problem" (http://en.wikipedia.org/wiki/Birthday_problem). Disregarding the possibility of a February 29 birthday, suppose a randomly selected individual is equally likely to have been born on any one of 365 days.

a. If eight people are randomly selected, what is the probability that all have different birthdays?
b. If eight people are randomly selected, what is the probability that at least two have the same birthday?
c. Create a table for *k* people being randomly selected, from *k* = 2 to *k* = the smallest value for which there is at least a 50-50 chance that at least two people will have the same birthday. (you should use Excel)

Problem 5

You are a production scheduling manager at Norman's fourth largest cracker factory, and you randomly assign operators to shifts. Of the 20 available operators, only eight have had a particular safety training course. If you randomly select six operators to fill a particular shift, what is the probability that nobody selected for the shift will have had the safety course?

Problem 6

You're a production engineering manager at a producer of pumpkin spice coffee. You're looking into failures of one of the coffee bagging machines, and historical data suggests that the machine fails on average 7.2 times per month and that failures per month follow a Poisson distribution.

a. What is the probability that the machine fails at least five times next month?
b. You're looking into replacing the bagging machine with one that fails on average 4.1 times per month. What is the probability that the machine fails at least five times next month?
c. The new machine costs $12,000. Assuming the machines are identical except for failure rate (i.e., no additional productivity), how long would it take to pay off on average through reduced failures when the average cost of a machine failure is $165.

Problem 7

You've designed a new radar system that you believe is an improvement over a previous system. You've placed four objects in a field, and you want to find the probability that "none of the objects" up to "all of the objects" are detected by your system. And you're not entirely sure the probability that any particular object is detected, so you assume that it ranges between 0.75 and 0.90. Fill out the table below, where the intersection of row and column represents the probability that the number of objects in the column is detected when the row probability of an individual object detection is assumed. (Excel would make this quite easy).

Individual object detection probability	Detected objects				
	0	1	2	3	4
0.75					
0.80					
0.85					
0.90					

Problem 8

The number of surface flaws in plastic panels used in the interior of automobiles has a Poisson distribution with a mean of 0.05 flaws per square foot of plastic panel. Assume an automobile interior contains ten square feet of plastic panel.

a. What is the probability that there are no surface flaws in one auto's interior?
b. If ten cars are sold to a rental company, what is the probability that nine or more of the cars have no surface flaws?

Problem 9

You're a healthcare engineering consultant and you're analyzing the emergency room design at Pawhuska Hospital, Inc. To understand the service rate of the ER, you must first analyze the arrival of patients, and you begin by studying the overnight arrivals. The probability distribution is shown in the table.

a. Plot the probability distribution function of hourly patients arriving to the ER.
b. Calculate the mean and standard deviation of the probability distribution of hourly ER arrivals.
c. What is the probability that fewer than three patients arrive in an hour?

Arrivals to the ER in an hour during the night shift	0	1	2	3	4	5	6	7
Probability	0.04	0.11	0.24	0.32	0.14	0.08	0.02	0.05

Problem 10

As a quality control engineer, you're examining the performance of two of the suppliers (A and B) of a key subassembly in a system that your factory produces. You purchased a total of 387 batches of parts from Supplier A and 283 batches from Supplier B. When batches arrive, you inspect them to determine if they meet quality standards: batches either "meet" or "fail to meet" standards. The past quality data that you've collected appears below.

a. From Supplier A, you pull a random sample of five subassemblies. What is the probability that fewer than two fail to meet standards?
b. From Supplier B, you pull a random sample of three subassemblies. What is the probability that all three meet standards?
c. From the collection of subassemblies that fail to meet standards, you pull a random sample of six subassemblies. What is the probability that only one comes from Supplier B?

	Meet standards	Fail to meet standards
Supplier A	346	41
Supplier B	245	38