Homework Problems

Homework # 1  
Chapter 2  
Due date Thursday 13-June-2019

Q1: A car rental agency has 19 compact cars and 12 intermediate-size cars. If four of the cars are randomly selected for a safety check, what is the probability of getting two of each kind?

Q2: The probabilities that a satellite launching rocket will explode during lift-off or have its guidance system fail in the flight are 0.0002 and 0.0005, respectively. Assuming independence find the probabilities that such a rocket will
a) not explode during lift-off;
b) explode during lift-off or have its guidance system fail in flight;
c) neither explode during lift-off nor have its guidance system fail in flight.

Q3: Suppose that of all individuals buying a certain personal computer, 60% include a word processing program in their purchase, 40% include a spreadsheet program, and 30% include both types of programs. We are interested in knowing the inclusion of the programs.
  a) Write out the sample space for the problem.
  b) Find the probability that a word processing program was included given that the selected individual was included a spreadsheet program.
  c) Are the vents “word processing program was included” and the event “selected individual was included a spreadsheet program” independent?

Q4: The following frequency table shows the classification of 90 students in their sophomore year of college according to their understanding of physics, chemistry and mathematics.

<table>
<thead>
<tr>
<th></th>
<th>Physics Average</th>
<th>Physics Extensive</th>
<th>Chemistry Average</th>
<th>Chemistry Extensive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average 8</td>
<td>Extensive 14</td>
<td>Average 12</td>
<td>Extensive 14</td>
</tr>
<tr>
<td>Math</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extensive 16</td>
<td>Average 12</td>
<td>Extensive 14</td>
<td>Average 4</td>
</tr>
</tbody>
</table>

If a student is selected at random, find the probability that the student has
a) an extensive understanding of chemistry;
b) an extensive understanding of physics and an average understanding of mathematics and chemistry;
c) an extensive understanding of any two subjects and an average understanding of the third;
d) an extensive understanding of any one subject and an average understanding of the other two.
Q5: Suppose that the probability that Ahmad and Mohammad will succeed in assembling the computer are 56% and 71% respectively and that the probability that both will succeed is 39%. Then compute the probability that Mohammad will not succeed in assembling the computer given that Ahmad has not succeeded in assembling the computer.

Q6: A large firm has 85% of its service calls made by a contractor, and a 10% of these calls result in customer complaints. The other 15% of the service calls are made by their own employees, and these calls have a 5% complaint rate. Find the
a) probability of receiving a complaint.
b) probability that the complaint was from a customer serviced by a contractor.

Homework #2
Chapter 3
Due date Thursday 20-June-2019

Q1: Upon reviewing recent use of conference rooms at an engineering consulting firm, an industrial engineer determined the following probability distribution for the number of requests for a conference room per half-day:

<table>
<thead>
<tr>
<th>X</th>
<th>P(X=x)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.07</td>
</tr>
<tr>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>2</td>
<td>0.45</td>
</tr>
<tr>
<td>3</td>
<td>0.25</td>
</tr>
<tr>
<td>4</td>
<td>0.08</td>
</tr>
</tbody>
</table>

a) Is this a legitimate probability distribution function?
b) Currently, the building has two conference rooms. What is the probability that the number of requests will exceed the number of rooms for a given half-day?
c) What is the probability that the two conference rooms will not be fully utilized on a given half-day?
d) Obtain the mean, the standard deviation for the number of requests for conference rooms.
e) Draw a probability histogram

Q2: In 16 experiments studying the electrical behavior of single cells, 12 use micro-electrodes made of metal and the other 4 use micro-electrodes made from glass tubing. If 2 of the experiments are to be terminated for financial reasons, and they are selected at random, what are the probabilities that
a) neither uses micro-electrodes made from glass tubing?
b) only one uses micro-electrodes made from glass tubing?
c) both use micro-electrodes made from glass tubing?

Q3: During an assembly process, parts arrive just as they are needed. However, at one station, the probability is 0.01 that a defective part will arrive in a one-hour period. Find the probability that
a) exactly 1 defective part arrives in a 4-hour span;
b) 1 or more defective parts arrive in a 4-hour span;
c) exactly 1 defective part arrives in a 4-hour span and exactly 1 defective part arrives in the next 4-hour span.

Q4: An automated weight monitor can detect under-filled cans of beverages with probability 0.98. What is the probability it fails to detect an under-filled can for the first time when it encounters the 10th under-filled can?

Q5: The probability that the noise level of a wide-band amplifier will exceed 2 dB is 0.05. Find the probabilities that among 12 such amplifiers the noise level of
a) one will exceed 2 dB;
b) at most two will exceed 2 dB;
c) two or more will exceed 2 dB.
Q1: Workers in silicon factories are prone to a lung disease called silicosis. In a recent survey in a factory, about 11% of the workers have been infected by it. Assume the same rate of infection holds everywhere. Use the normal distribution to approximate the probability that, out of a random sample of 425 workers, the numbers that are prone to infection at present will be

a) 30 or more;
b) 28 or less.

Q2: The daily high temperature in a computer server room at the university can be modeled by a normal distribution with mean 68.7°F and standard deviation 1.2°F. Find the probability that, on a given day, the high temperature will be

a) between 68.3 and 70.3°F
b) greater than 71.5°F.
c) for which temperature is the probability 0.05 that it will be exceeded during one day?

Q4: If a random variable has the log-normal distribution with $\theta=-3$ and $\omega=3$,

a) find its mean and its standard deviation.
b) find the probabilities that the random variable will take on a value
   i) less than 8.0;
   ii) between 4.5 and 6.5.

Q5: The weekly demand for propane gas (in 1000’s of gallons) from a particular facility is a

$$f(x) = 2 \left(1 - \frac{1}{x^2}\right) \quad 1 < x < 2$$

a. Compute expected weekly demand by showing details and explain this quantity.
b. Find the median amount of weekly demand for propane gas.
Q6: A supplier of kerosene has a 200-gallon tank that is filled at the beginning of each week. His weekly demand shows a relative frequently behavior that increases steadily up to 100 gallons and then levels off between 100 and 200 gallons. The weekly demand in hundreds of gallons can be modelled with a random variable X with probability density function

\[ f(x) = \begin{cases} 
  x & 0 \leq x \leq 1 \\
  \frac{1}{2} & 1 < x \leq 2 \\
  0 & \text{elsewhere} 
\end{cases} \]

a. Find the probability that demand will be between 90 and 150 gallons on a given week.

b. If in a week, the demand is more than 100 gallons, what is the probability that the demand is more than 150 gallons during the same week?

c. Find the expected number of weekly demand?

Q7: At a certain bank, the amount of time that a customer spends being served by a teller is an exponential random variable with mean 5 minutes.

a. If there are no customers in service when you enter the bank, what is the probability that your serving time will not exceed 7 minutes?

b. If there is a customer in service when you enter the bank, what is the probability that he will still be with the teller after an additional 4 minutes?
Q8: You have the following data:

<table>
<thead>
<tr>
<th>8</th>
<th>6</th>
<th>11</th>
<th>14</th>
<th>10</th>
<th>11</th>
<th>9</th>
<th>7</th>
<th>2</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>12</td>
<td>7</td>
<td>8</td>
<td>4</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td>12</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>16</td>
<td>2</td>
<td>7</td>
<td>4</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>5</td>
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<tr>
<td>9</td>
<td>9</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>9</td>
<td>5</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>9</td>
<td>0</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>11</td>
<td>4</td>
</tr>
</tbody>
</table>

a) Construct a frequency distribution for these data. Use the distribution to approximate the mean and the standard derivation.

b) Develop a relative frequency distribution using the classes you constructed in part a.

c) Develop a cumulative frequency distribution and a cumulative relative frequency distribution using the classes you constructed in part a.

d) Develop a histogram and an ogive based on the frequency distribution constructed in part a.

e) Draw a stem and leaf plot for the above data.

f) Calculate the mean, the median, the mode, comment on the shape.

g) Calculate the range, the IQR, the standard deviation

h) Construct a box – plot, comment on the shape.

i) Do the data satisfy the empirical rule?

Homework # 4
Chapter 7 & Chapter 8
Due date Sunday 07-July-2019

Q1: A wire-bonding process is said to be in control if the mean pull strength is 10 pounds. It is known that the pull-strength measurements are normally distributed with a standard deviation of 1.5 pounds. Periodic random samples of size 4 are taken from this process and the process is said to be “out of control” if a sample mean is less than 7.75 pounds. For a random sample, what is the probability that the process is deemed out of control?

Q2: If the distribution of scores of all students in an examination has a mean of 296 and a standard deviation of 14, what is the probability that the combined gross score of 49 randomly selected students is less than 14,250?

Q3: In a study of automobile collision insurance costs, a random sample of 80 body repair costs for a particular kind of damage had a mean of $472.36 and a standard deviation of $62.35. If $X$=$472.36 is used as a point estimate of the true average repair cost of this kind of damage, with what confidence can one assert that the sampling error does not exceed $10?

Q4: The dean of a college wants to use the mean of a random sample to estimate the average amount of time students take to get from one class to the next, and she wants to be able to assert with 99% confidence that the error is at most 0.25 minute. If it can be presumed from experience that $\sigma$=1.40 minutes, how large a sample will she have to take?

Q5: A sample of 15 pneumatic thermostats intended for use in a centralized heating unit has an average output pressure of 9 psi and a standard deviation of 1.5 psi. Assuming the data may be treated as a random sample from a normal population, determine a 90% confidence interval for the actual mean pressure of the thermostat.
Q6: An industrial engineer concerned with service at a large medical clinic recorded the duration of time from the time a patient called until a doctor or nurse returned the call. A sample of size 180 calls had a mean of 1.65 hours and a standard deviation of 0.82.

a) Obtain a 95% confidence interval for the population mean of time to return a call.
b) Does \( \mu \) lie in your interval obtained in part (a)? Explain.

Homework # 5
Chapter 9
Due date Thursday 18-July-2019

Q1: In a study of automobile collision insurance costs, a random sample of 80 body repair costs for a particular kind of damage had a mean of $472.36 and a standard deviation of $62.35. If \( X = $472.36 \) is used as a point estimate of the true average repair cost of this kind of damage, with what confidence can one assert that the sampling error does not exceed $10?

Q2: The dean of a college wants to use the mean of a random sample to estimate the average amount of time students take to get from one class to the next, and she wants to be able to assert with 99% confidence that the error is at most 0.25 minute. If it can be presumed from experience that \( \sigma = 1.40 \) minutes, how large a sample will she have to take?

Q3: A sample of 15 pneumatic thermostats intended for use in a centralized heating unit has an average output pressure of 9 psi and a standard deviation of 1.5 psi. Assuming the data may be treated as a random sample from a normal population, determine a 90% confidence interval for the actual mean pressure of the thermostat.

Q4: An industrial engineer concerned with service at a large medical clinic recorded the duration of time from the time a patient called until a doctor or nurse returned the call. A sample of size 180 calls had a mean of 1.65 hours and a standard deviation of 0.82.

a) Obtain a 95% confidence interval for the population mean of time to return a call.
b) Does \( \mu \) lie in your interval obtained in part (a)? Explain.
c) Perform a test (using critical value approach) with the intention of establishing that the mean time to return a call is greater than 1.5 hours. Use \( \alpha = 0.05 \). Also confirm your decision using p-value approach.
d) In light of your conclusion in part (a), what error could you have made? Explain in the context of this problem.
e) In a long series of repeated experiments, with new random samples collected for each experiment, what proportion of the resulting tests would reject the null hypothesis if it prevailed? Explain your reasoning.
Q6: An industrial engineer collected data on the labor time required to produce an order of automobile mufflers using a heavy stamping machine. The data on times (hours) for \( n = 52 \) orders of different parts:

<table>
<thead>
<tr>
<th>Time (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.15, 2.27, 0.99, 0.63, 2.45, 1.3, 2.63, 2.2, 0.99, 1, 1.05</td>
</tr>
<tr>
<td>3.44, 0.49, 0.93, 2.52, 1.05, 1.39, 1.22, 3.17, 0.85, 1.18, 2.27</td>
</tr>
<tr>
<td>1.52, 0.48, 1.33, 4.2, 1.37, 2.7, 0.63, 1.13, 3.81, 0.2, 1.08</td>
</tr>
<tr>
<td>2.92, 2.87, 2.62, 1.03, 2.76, 0.97, 0.78, 4.68, 5.2, 1.9, 0.55</td>
</tr>
<tr>
<td>1, 2.95, 0.45, 0.7, 2.43, 3.65, 4.55, 0.33</td>
</tr>
</tbody>
</table>

has mean 1.8646 hours and variance 1.5623 hours\(^2\).

Using the 90% confidence interval, based on the t distribution, for the mean labor time:

<table>
<thead>
<tr>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
<th>SE Mean</th>
<th>90% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>1.8646</td>
<td>1.2499</td>
<td>0.1733</td>
<td>(1.57423, 2.15500)</td>
</tr>
</tbody>
</table>

a) decide whether or not to reject \( H_0 : \mu = 1.6 \) in favor of \( H_1 : \mu \neq 1.6 \) at \( \alpha = 0.10 \);
b) decide whether or not to reject \( H_0 : \mu = 2.2 \) in favor of \( H_1 : \mu \neq 2.2 \) at \( \alpha = 0.10 \);
c) What is your decision in part (a) if \( \alpha = 0.05 \)? Explain.

Q7: An engineering firm responsible for maintaining and improving the performance of thousands of wind turbines is asked to check on the sound levels. The purpose is to determine the proportion that currently would not meet proposed new sound level restrictions. How large a sample of wind turbines is needed to ensure that, with at least 95% confidence, the error in our estimate of the sample proportion is at most 0.06 if

a) nothing is known about the population proportion?
b) the population proportion is known not to exceed 0.20?

Q8: A supplier of imported Vernier calipers claims that 90% of their instruments have a precision of 0.999. Testing the null hypothesis \( p = 0.90 \) against the alternative hypothesis \( p \neq 0.90 \), what can we conclude at the level of significance \( \alpha =0.10 \), if there were 665 calipers out of 700 with a precision of 0.999? Use critical value approach.

Practice Problems from Book (Optional)

Ch. 2: 8, 25, 37, 42, 55, 63, 77, 88, 102, 108, 125, 141, 149, 153 and 172.

Ch. 3: 3, 5, 12, 17, 23, 37, 42, 58, 65, 85, 109, 122, and 137.

Ch. 4: 4, 10, 14, 23, 35, 43, 49, 51, 53, 61, 68, 70, 83, 87, 99, 105, 131 and 141.

Ch. 7: 3, 7, 10 and 12.
Ch. 8: 4, 7, 11, 27, 35, 40 and 58.

Ch. 9: 5, 9, 26(a), 40, 66, 67, 90 and 93.
Ch. 11: 2, 8, 24, 44 and 70.