WPR 3

Lesson 36 (55 minutes) – In Lab

Version 1

SOLUTION

Login Name: .\secadet
Password: G0Systems2015!@
First Window: type EM384
Second Window: Section_LastName_FirstName
Open Excel Document

DOCUMENTATION. This WPR is an individual assignment – CLOSED BOOK and CLOSED NOTES. You may not use your computers or any digital media which is on your computer. No collaboration, e-mail, or internet use is authorized. You may ask questions of your instructor while doing the WPR. You may not depart the lab with these materials.

WPR Instructions

- Use this WPR Handout to formulate the problem and answer any questions. Fill-in your answer on this handout in the space provided and complete the digital work in Excel.
- This WPR consists of three separate problems.
- You are authorized to use a pencil, straight edge, issued calculator, and Excel.

Turn in requirements:

- Turn in the hard copy of your answer sheet prior to your departure. Make sure your name is on each page of the answer sheet.
- Submit your digital Excel file by saving the Excel file to the desktop and dragging the Excel file to the turn-in folder (on your lab computer desktop). **Confirm your instructor has received your Excel file before logging off of the computer.**

- Do not turn the page or begin work in Excel until told to do so by your instructor.
- Do not share any portion of this exam with another student.
- Save your Excel file early and often. Do not save this file to anywhere other than the Desktop of your workstation.
- You may not discuss any aspects of this WPR with anyone except an EM384 instructor until the Course Director has issued the 'all clear'.

I acknowledge that I have read and will comply with all instructions given above.

Cadet Signature: ____

Grading Summary

Problem / Part	**Points Available**	**Points Received**
Problem 1	65	
Problem 2	40	
Problem 3	45	
Total:	150	

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Excel Formula References for Block 4

Discrete General random variable:

use INDEX and RANDBETWEEN

Discrete Uniform random variable between a and b:

=RANDBETWEEN(a,b)

Bernoulli random variable with parameter p:

=IF(RAND()<p,1,0)

Binomial random variable with parameters n and p:

=BINOM.INV(n,p,RAND())

Poisson random variable with rate parameter λ and mean λ:

Use Data Analysis Tookpak

(Continuous) Uniform random variable with parameters a and b:

=RAND()*(b-a)+a

Normal random variable with parameters μ and σ:

=NORM.INV(RAND(),μ, σ)

Exponential random variable with rate parameter λ and mean $\frac{1}{\lambda}$.

= -1/ λ*LN(RAND())

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1. Monte Carlo problem (70 points)

You are the manager of Mr Cookie's new Cookie and Brownie Delights restaurant. The restaurant has seen a surge in demand for its freshly baked treats. Mr Cookie wants you to conduct a Monte Carlo Simulation to give a distribution of the profit that he can expect from each customer if he sells both cookies and brownies.

Mr Cookie will operate two locations where customers will come in a place an order cookies and brownies

- The number of cookies purchased by each customer is a **Binomial** random variable X where $X \sim (10, 0.3)$ (that is, $n = 10, p = 0.25$)
- The number of brownies purchased by each customer is a random variable Y where Y is a discrete **Uniform** random variable between 0 and 5 (that is, every customer orders an integer number of brownies between 0 and 5 included).
- Each customer tips an amount $Z \sim (1.5, 0.2)$. (that is, $\mu = 1.5, \sigma = 0.2$)
- Mr Cookie buys cookies and brownies for $0.50 each.
- Mr Cookie sells cookies for $1.00 and brownies for $2.00 each.

1.1 Create a Monte Carlo simulation in Excel to model the profit that a single customer brings in to the business. Create 200 iterations of your simulation, and name your Excel sheet *Cookie.* (**40pts**)

See Excel Solution

1.2 In the same sheet, using the profit result of your Monte Carlo simulation over 100 iterations, create a Histogram in Excel to show the distribution of profit that a single customer could bring in to the business. (**10pts**) See Excel Solution

1.3 In the same sheet, using the profit result of your Monte Carlo simulation of 200 iterations, find the average profit that a customer brings in. Write your answer below. (**5pts**)

$6.77 (your answer may vary within a certain range)

1.4 In the same sheet, using the profit result of your Monte Carlo simulation of 200 iterations, find the probability that a customer brings in less than $5.00 in profit. Write your answer below. (**5pts**)

0.29 (your answer may vary within a certain range)

1.5 In the same sheet, using the profit result of your Monte Carlo simulation of 200 iterations, find the probability that a customer brings in more than $10.00 in profit. Write your answer below. (**5pts**)

0.13 (your answer may vary within a certain range)

1.6 In the same sheet, using the profit result of your Monte Carlo simulation of 200 iterations, find the probability that a customer brings in between $5.00 (included) and $10.00 (included) in profit. Write your answer below. (**5pts**)

1 - 0.29 - 0.13 = 0.54

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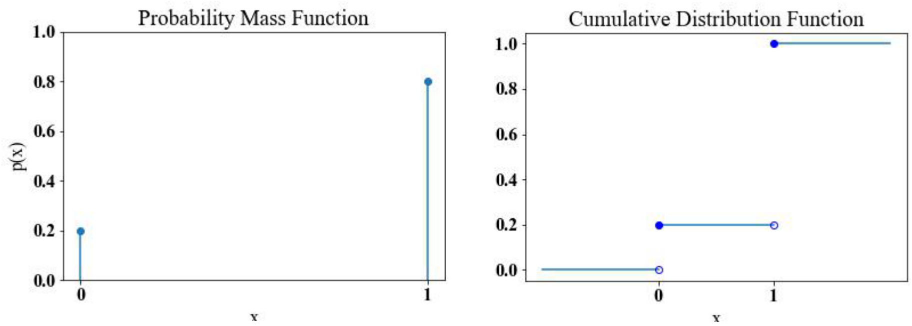
2. Probability Distributions (40 points)

For each of the following graphs, **CIRCLE** whether the probability distribution is discrete or continuous, and what the name of the distribution is. For each one, you are given the sample space S. You may use Excel to assist you in answering these questions:

2.1 Distribution 1: $S = \{0,1\}$ (**5pts**)

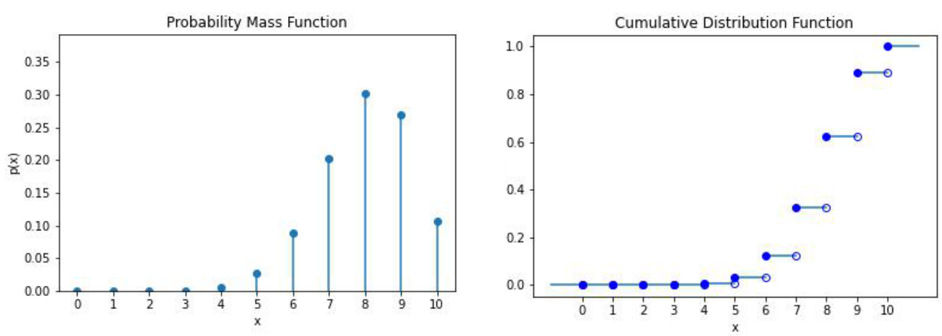


Discrete Continuous

Name of the distribution:

Bernoulli

2.2 Distribution 2: $S = \{0,1,\ldots,10\}$ (**5pts**)

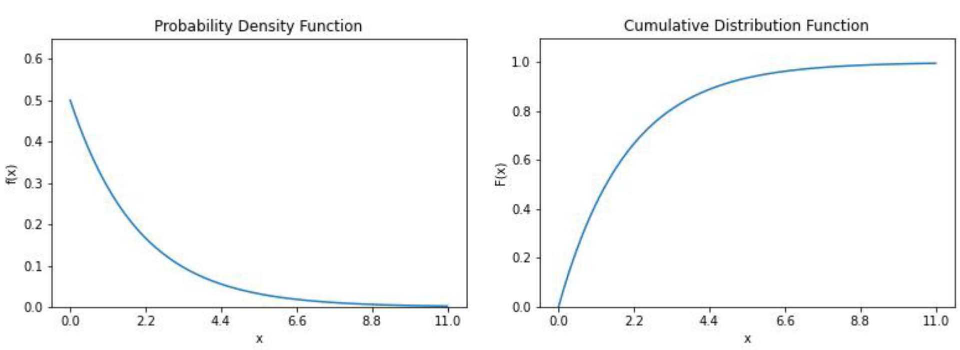


Discrete Continuous

Name of the distribution:

Binomial

2.3 Distribution 3: $S = [0,\infty)$ (**5pts**)



Discrete Continuous

Name of the distribution:

Exponential

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2.6 You conduct a Monte Carlo simulation for Mr Butterfinger. The input is the stochastic demand x_1 and stochastic production amount x_2 (for his new factory). The output of your simulation is the profit y (in \$). You then found the ECDF function $G(y)$ using Python. Explain in a few words what $G(300)$ gives you: (**5pts**)

G(300) gives the probability that profit is less than or equal to \$300, based on the output of our simulation.

2.7 Your friend tells you that $f(x)$ is the probability density function of a continuous random variable X. He knows that the probability $P(X = a)$ is equal to zero for any continuous random variable x and constant a (since on a continuous sample space there are infinite values, so the probability of getting any single one is zero). However, he is confused because when he calculates $f(3)$, he gets 4. Explain why he does not get zero. (**5pts**)

He does not get zero because f(3) measures a density, and not a probability. To measure a probability, you would need to measure the area under the density curve over an interval.

2.8 Let $F(x)$ be the cumulative distribution function of a continuous random variable X. If $F(1) = 0.1$ and $F\ \ (3) = 1$, what is $F\ \ (4)$? (**5pts**)

$\mathrm{F}(4) = 1$ since the CDF is an increasing function from 0 to 1, and $4 > 3$.

2.9 Let $p(x)$ be the probability mass function of a random variable X defined on sample space $\{1,2,3,4\}$. If $P(X \leq 3) = 0.25$, what is $P(X = 4)$? (**5pts**)

$\mathrm{P}(\mathrm{X} = 4) = 1 - 0.25 = 0.75$

2.10 Given the following discrete general distribution of random variable X, calculate the expected value. (**5pts**)

x	1	4	5	6
p(x)	0.25	0.5	0.125	0.125

E(X) = 1(0.25) + 4(0.5) + 5(0.125) + 6(0.125) = 3.625

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3. Monte Carlo Simulation in Python (45 points)

For each question below, we give one or more lines of Python code that are being executed in the Spyder IDE. Assume that all necessary libraries have been imported.

3.1 Consider the following Python Code (There are two examples that result in the same value of y). After running this code, what value y is printed in the console? (**5pts**)

```
x = np.array([1,2,3,4,5])
y = x[3] + x[1]
print(y)
```

```
x = [1,2,3,4,5]
y = x[3] + x[1]
print(y)
```

y = 4 + 2 = 6

3.2 Consider the following Python Code. After running this code, what value $count$ is printed in the console? To work this problem and receive partial credit, you may fill out the table of values below for each iteration. (**10pts**)

```
count = 0
for i in range(1,5):
    count = count + i
print(count)
```

10

After Iteration	***Value of i***	***Value of count***
1	1	1
2	2	3
3	3	6
4	4	10

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3.3 Consider the following Python Code. After running this code, what value x is printed in the console? (**5pts**)

```
x = 1
y = 2
if x == 1:
    x = y + x
elif y == 2:
    x = x + 1
print(x)
```

3

3.4 Consider the following Python Code. What is the **value of counter** saved in the **variable explorer** when this code is done running? (**5pts**)

```
counter = 0
while counter <= 10 :
    print('the counter is at',counter)
    counter = counter + 1
```

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3.5 Consider the following Python code. After running this code, what line(s) are printed in the console? (**5pts**)

```
course_list = [3,6,4,7]
for i in course_list:
    print(i)
```

3
6
4
7

3.6 Consider the following Python code. Is $output$ a variable or a function? Support your answer by explaining its purpose in the context of this code. (**10pts**)

```
from statsmodels.distributions.empirical_distribution import ECDF
vals = np.random.exponential(scale = 1/5, size = 1000)
output = ECDF(vals)
x = np.linspace(0,2,1000)
y = output(x)
```

output is a <u>function</u> because ECDF returns a function based on the data in ***vals***. Furthermore, we use ***output*** in line 5 as a function to get a list of ECDF ***y*** values from our list of ***x*** values.