

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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*Version 1***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 Toolpak

(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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Version 1**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 $X \sim \text{Binomial}(10, 0.3)$ (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 $Z \sim \text{Normal}(1.5, 0.2)$. (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.
- Assume that there are no fixed costs and that Mr Cookie purchases for his supply the same number of cookies and brownies demanded by customers.

- 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)**

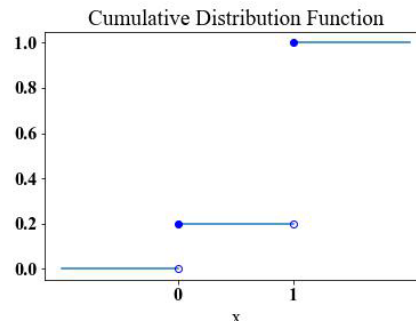
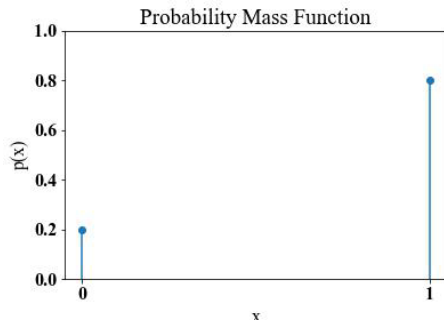
0.13 (your answer may vary within a certain range)

- 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

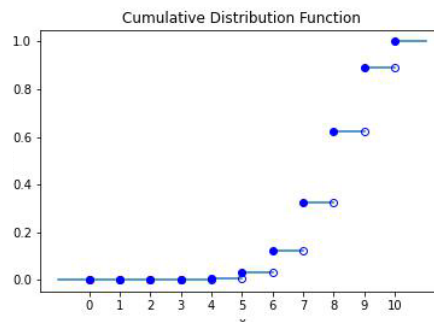
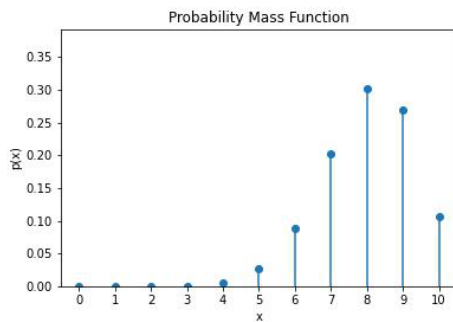
WPR 3**Lesson 36 (55 minutes) – In Lab****Version 1****2. Probability Distributions (40 points)**

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**

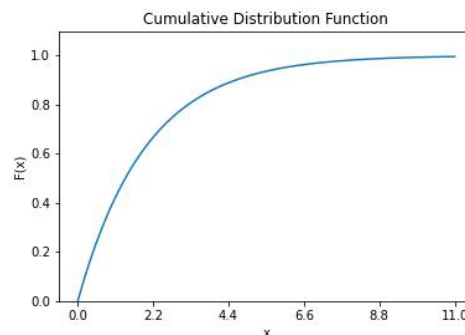
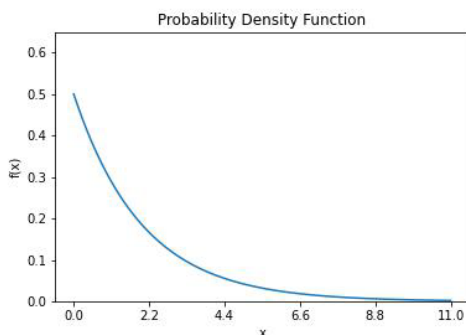
Continuous

Name of the distribution:

Bernoulli**2.2 Distribution 2: $S = \{0,1, \dots, 10\}$ (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)**

$F(4) = 1$ 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)**

$$P(X = 4) = 1 - 0.25 = 0.75$$

- 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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Version 1**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 function 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.