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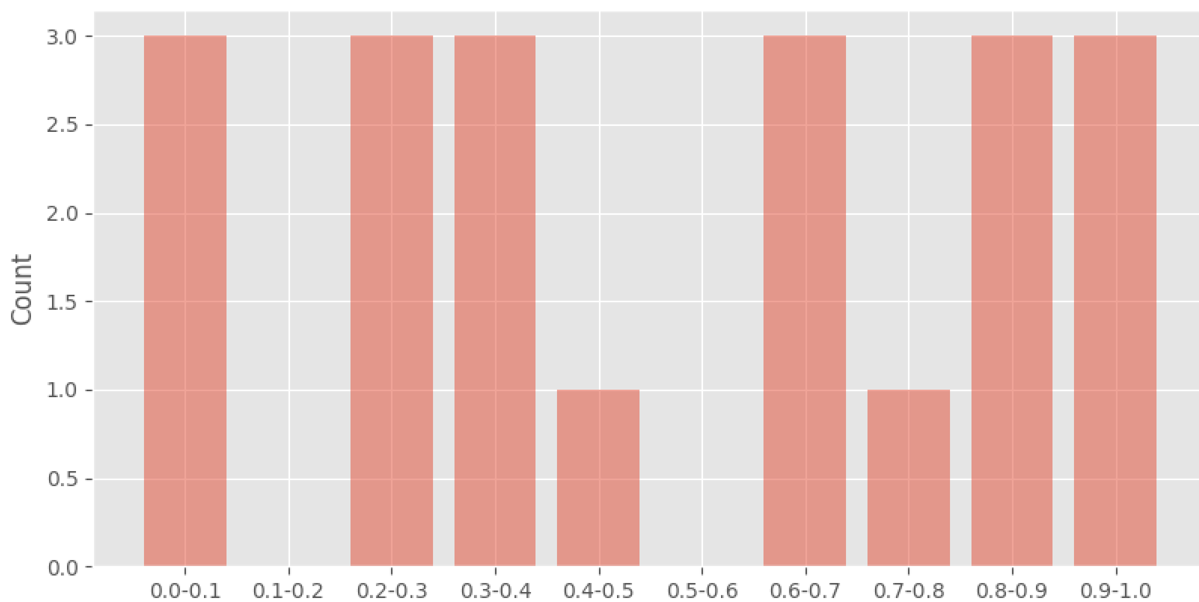
Homework 3

1. Chi-Squared Test
   a. For this problem, I created a program with the hard-coded numbers given and first used the matplotlib package to display the histogram. Next, I used sklearn package's chi-squared calculator to calculate the p values and compared them to the alpha. Since the p values are greater than the alpha, the null hypothesis holds true.

```
p values are [0.97643967 0.91161091 0.90380975]
```



   b. Using the same program from part a, I calculated the p values of the grade distribution and found that, while it was close to being statistically different, the set was also independent since the p values were above the alpha.

```
p values are [0.06788915 0.63941185 0.05157586 0.41421618 0.56370286]
```

2. For this section, I made a simple program in python that took the list of customers and serviced them based on their time. This first screenshot was done with only one server.

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```
Done. Time elapsed: 549
Customer 1 left at 51
Customer 2 left at 83
Customer 3 left at 138
Customer 4 left at 186
Customer 5 left at 204
Customer 6 left at 254
Customer 7 left at 301
Customer 8 left at 319
Customer 9 left at 347
Customer 10 left at 401
Customer 11 left at 450
Customer 12 left at 526
Customer 13 left at 548
Server usage: 92.896%
```

This screenshot was done with two servers.

```
Done. Time elapsed: 549
Customer 1 left at 51
Customer 2 left at 62
Customer 3 left at 117
Customer 5 left at 135
Customer 4 left at 142
Customer 6 left at 203
Customer 8 left at 238
Customer 7 left at 244
Customer 9 left at 331
Customer 10 left at 399
Customer 11 left at 450
Customer 12 left at 526
Customer 13 left at 548
Server 1 usage: 68.852%
Server 2 usage: 22.587%
```

For these two servers, server 2 acted as a back up for server 1. If server 1 had a client, they would go to server 2. Otherwise, the go to server was 1.

3. A.

$$\int_0^2 f(x)dx \; = \; \int_0^2 c_1 dx = c_1 x_0^2 = 2c_1$$

Since c1 has to be equal to 1/3, **c1 = 1/6**.

$$\int_2^3 c_2 dx = c_2 x_2^3 = c_1$$

Since c2 has to be equal to 1/3, **c2 = 1/3**.

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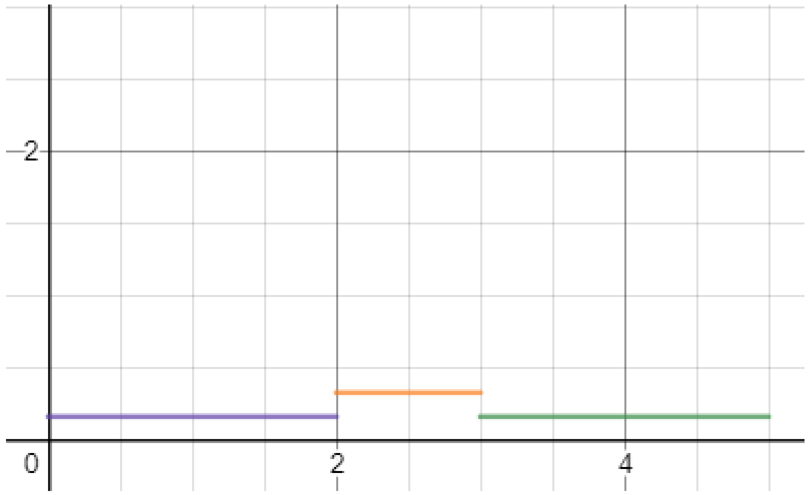
$$f(x) = \begin{cases} \frac{1}{6}, & 0 \le x < 2 \\ \frac{1}{3}, & 2 \le x < 3 \\ \frac{1}{6}, & 3 \le x < 5 \end{cases}$$



b. E(X) = $\int_0^2 \frac{1}{6}xdx + \int_2^3 \frac{1}{3}xdx + \int_3^5 \frac{1}{6}xdx = \frac{1}{12}x^2\Big|_0^2 + \frac{1}{6}x^2\Big|_2^3 + \frac{1}{12}x^2\Big|_3^5 =$
$\left[\frac{4}{12} - 0\right] + \left[\frac{9}{6} - \frac{4}{6}\right] + \left[\frac{25}{12} - \frac{9}{12}\right] = \frac{2}{6} + \frac{5}{6} + \frac{8}{6} = \frac{5}{2}$

E(x^2) = $\int_0^2 \frac{1}{6}x^2dx + \int_2^3 \frac{1}{3}x^2dx + \int_3^5 \frac{1}{6}x^2dx = \frac{1}{18}x^3\Big|_0^2 + \frac{1}{9}x^3\Big|_2^3 + \frac{1}{18}x^3\Big|_3^5 =$
$\left[\frac{8}{18} - 0\right] + \left[\frac{27}{9} - \frac{8}{9}\right] + \left[\frac{125}{18} - \frac{27}{18}\right] = \frac{4}{9} + \frac{19}{9} + \frac{49}{9} = \frac{72}{9} = 8$

V(x) = E(x^2) – E$(x)^2$

V(x) = 8 – $(5/2)^2$ = 8-(25/4) = 32-25/4 = **7/4**

c. P{1<x<3}

$$\int_1^2 \frac{1}{6}dx + \int_2^3 \frac{1}{3}dx = \frac{x}{6}\Big|_1^2 + \frac{x}{3}\Big|_2^3 = \frac{1}{6}(2-1) + \frac{1}{3}(3-2) = \frac{1}{6} + \frac{1}{3} = \mathbf{\frac{1}{2}}$$

d. P{X>3|X>1}

$$P(x > 3) = \int_3^5 \frac{1}{6}dx = \frac{x}{6}\Big|_3^5 = \frac{5-3}{6} = \frac{1}{3}$$

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$$P(x > 1) = \int_1^2 \frac{1}{6}dx + \int_2^3 \frac{1}{3}dx + \int_3^5 \frac{1}{6}dx = \frac{x}{6}\,{}_{1}^{2} + \frac{x}{3}\,{}_{2}^{3} + \frac{x}{6}\,{}_{3}^{5} = \frac{2-1}{6} + \frac{3-2}{3} + \frac{5-3}{6} = \frac{1}{6} + \frac{1}{3} + \frac{1}{3} = \frac{5}{6}$$

Since P{X>3|X>1} = P(x>3)/P(x>1) = (1/3)/(5/6) = **2/5**