JSS MAHAVIDYAPEETHA

JSS SCIENCE AND TECHNOLOGY UNIVERSITY

SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING

MYSURU – 570006

"NUTRITION ANALYSIS USING PROBABLITY THEORY"

Problem solving approach in

ENGINEERING MATHEMATICS IV

04/03/2019

Under the Guidance of

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Problem Statement

The owner of the cafe and restaurant wants to analyse his customer's orders based on nutrition. The cafe and restaurant have 50 items of 100g each in its menu.

If a customer orders *n* items from the menu and if X denotes the number of

1. Calorie – rich items (≥ 300cal)
2. Protein – rich items (≥ 8%)
3. Fat – rich items (≥ 15%), and
4. Carbs– rich items (≥ 30%)

in the customer's orders.

Find the probability distribution of X (for individual nutrients), Mean, Variance and Standard Deviation of the distribution and plot the cumulative graph.

CONTENTS

ABSTRACT

Probability theory is concerned with the analysis of random phenomena. Today it has applications far beyond games of chance. It has contributed to the solution of problems in biology, physics, chemistry, other natural sciences, and in social sciences as well.

Here, we analyze food items of a restaurant on the grounds of its nutrition scale (using probability distribution function), and determining the average number of a type of items that the owner of the restaurant can expect from his customers.

The outcome cannot be determined unless a customer places an order, but it may be any one of several possible outcomes. The actual outcome is considered to be determined by chance

INTRODUCTION

Good nutrition is an important part of leading a healthy lifestyle. Combined with physical activity, a good diet can help you to reach and maintain a healthy weight, reducing the risk of chronic diseases, and promoting your overall health.

In today’s busy world, people are eating and drinking about one-third of their calories away from home. Although consumers can find calories and other nutrition information on the Nutrition Facts label on packaged foods and beverages they buy in stores, this type of labeling is generally not available in restaurants or visible on food from vending machines.

Calorie labeling on restaurant menus and vending machines can help you make healthy and informed decisions about meals and snacks.

Many restaurants fear the thought that they would lose customers if the customers knew how unhealthy their food was, and they are also socially responsible when they provide food its customers.

Customers are more likely to visit restaurants that provide both healthy foods and nutrition information. Therefore, it is necessary for restaurants to keep track of their orders, and analyze them based on nutrition

Data Set:

***************************** MENU ********************************

Sl No.	Food Product(100g)	Calories	Protein(%)	Fat(%)	Carbs(%)
1	Cheese Sandwich	298	10	13.6	34.3
2	Fried Rice	110	2.2	3.6	17.4
3	Plain Dosa	189	5.2	4.8	31.5
4	Wheat Chapati	244	8.7	1.2	49.6
5	Rava Upma	131	3.4	4.8	18.7
6	Wheat Poori	288	8	10.6	43.6
7	Palak Paneer	118	4	9.5	4.1
8	Rasam	43	2.4	1.1	6.2
9	White Rice	115	2.5	0.3	25.6
10	Rice Idli	139	4.9	0.3	29
11	Uddina Vada	348	10.5	22.4	26
12	Vegetable Pulao	97	2.3	2.5	16.4
13	Akki Rotti	208	2.7	8.1	30.4
14	Curd Rice	118	3.7	3.1	18.7
15	Maggi Noodles	423	9.2	15.8	61.1
16	Wheat Bread	270	5	29	66
17	Brown Bread	244	8.8	1.4	49
18	Coco Cola(100ml)	42	0	0	10.6
19	Fanta(100ml)	51	0	0	13
20	Sprite(100ml)	48	0	0	12
21	Maaza Drink(100ml)	55	0	0	13.3
22	Cow's Milk(100ml)	69	3.3	4.2	4.5
23	Powdered Milk(100ml)	434	17.4	18.2	50.3
24	Curd	60	3.1	4	3
25	Tea with Sugar & Milk	41	1.7	1.8	4.6

26	Coffee with Sugar	54	1.5	2.9	5.1
27	Peanut Butter	594	21.9	50	25
28	Paneer	265	18.3	20.8	1.2
29	Butter	729	0	81	0
30	Ice Cream	262	2	19.2	21.7
31	Cake	392	6	21.8	44.2
32	Chocolate Pastry	377	7.3	18.4	45.8
33	French Fries	314	3.8	16.1	38.4
34	Samosa	268	3.9	15.3	28.5
35	Vegetable Pizza	127	5.9	2.4	20.8
36	Lays Maxx Potato Chips	520	8	31	52
37	Kurkure	564	6.3	35.7	54.3
38	Banana Chips	519	2.3	33.6	58.4
39	Pani Puri	231	3.3	12.2	26.9
40	Masala Puri	129	5.2	2.8	23.2
41	Bhel Puri	119	2.5	2.7	21.4
42	Kachori	375	8	21.8	36.8
43	Pav Bhaji	151	3.3	2.4	29.3
44	Vegetable Puff	255	3.9	16.7	22.5
45	Aloo Bun	287	6.2	8.9	45.4
46	Mysore Pak	366	3	22.4	39
47	Jelebi	236	4.5	8.9	34.2
48	Gulab Jamun	375	4.2	23.9	36.8
49	Champakali	127	3.3	3.3	21.7
50	Carrot Halwa	241	4.9	11.3	30.3

Solution:

Let the customer order 3 items from the menu i.e., $n = 3$.

Sample space S = { (a,b,c) | $a, b, c \in$ Food products in Menu. }

Total number of possible outcomes $= |S|$

$= {}^{50}C_3$

$= \mathbf{19600}$

Let X be the number of calorie-rich items in the customer's order.

P(X=0) = Probability of not ordering any calorie rich food item from the Menu.

$$= \frac{{}^{14}C_0 \times {}^{36}C_3}{{}^{50}C_3} = \frac{7140}{19600} = \frac{51}{140} = \mathbf{0.3643}$$

P(X=1) = Probability of ordering 1calorie rich food item from the Menu.

$$= \frac{{}^{14}C_1 \times {}^{36}C_2}{{}^{50}C_3} = \frac{8820}{19600} = \frac{9}{20} = \mathbf{0.4500}$$

P(X=2) = Probability of ordering 2 calorie rich food items from the Menu.

$$= \frac{{}^{14}C_2 \times {}^{36}C_1}{{}^{50}C_3} = \frac{3276}{19600} = \frac{117}{700} = \mathbf{0.1671}$$

P(X=3) = Probability of ordering 3 calorie rich food items from the Menu.

$$= \frac{{}^{14}C_3 \times {}^{36}C_0}{{}^{50}C_3} = \frac{364}{19600} = \frac{13}{700} = \mathbf{0.0185}$$

Probability Distribution Table:

X	0	1	2	3
P(x)	0.3643	0.4500	0.1671	0.0185

Mean $\mu = \sum x_i P(x_i)$

$= 0\times0.3643 + 1\times0.4500 + 2\times0.1671 + 3\times0.0185$

$\therefore \quad \boldsymbol{\mu = 0.8400}$

is the expected average of the number of items with high calories in the customer's order.

Variance $\sigma^2 = E[\ (x - \mu)^2\ ]$

$$= \sum_{i=1}^{n} (x - \mu)^2\ P(x_i)$$

$$= \sum_{i=1}^{n} (x - 0.8400)^2\ P(x_i)$$

$$= (0 - 0.84)^2 \times 0.3643\ +\ (1 - 0.84)^2 \times 0.4500\ +\ (2 - 0.84)^2 \times 0.1671\ +\ (3 - 0.84)^2 \times 0.0185$$

$\therefore$ $\boldsymbol{\sigma^2 = 0.5801}$

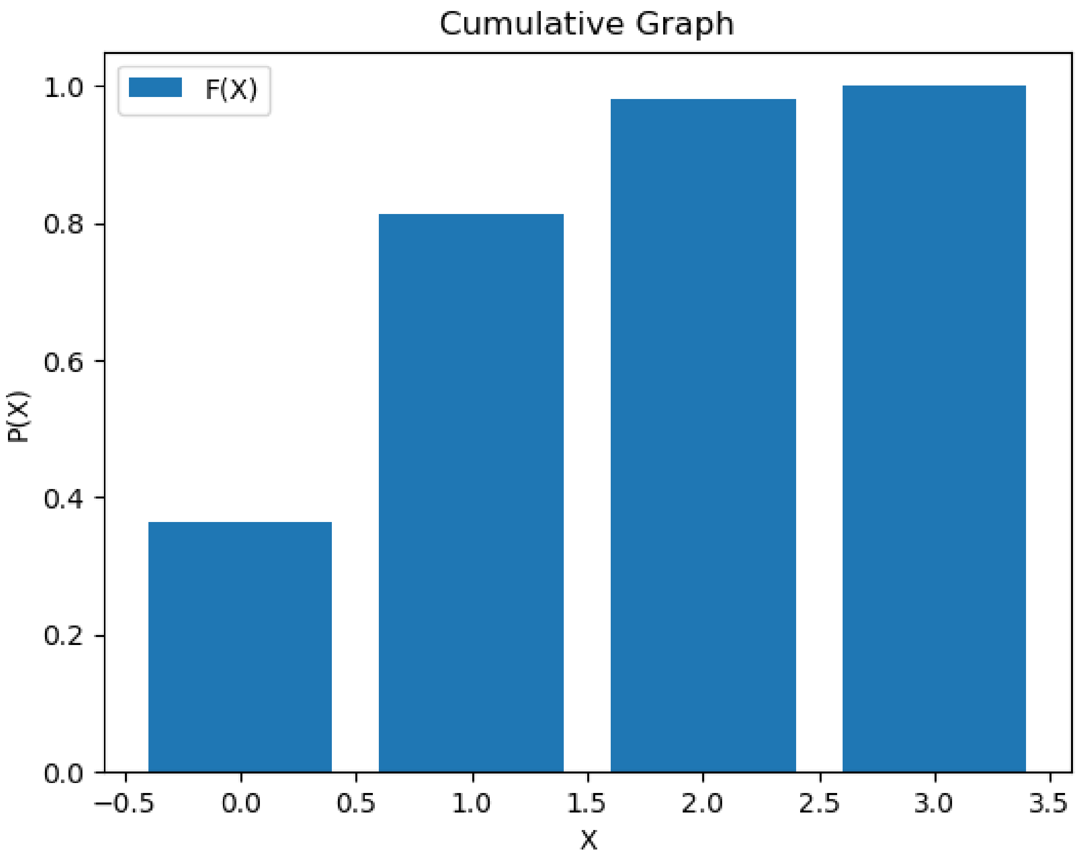
Standard Deviation $\sigma = \sqrt{\text{Variance}}$

$$= \sqrt{\sigma^2}$$

$$= \sqrt{0.5801}$$

$\therefore$ $\boldsymbol{\sigma = 0.7417}$

Cumulative Graph:



Let X be the number of protein-rich items in the custo

mer's order.

P(X=0) = Probability of not ordering any protein rich food item from the Menu.

$$= \frac{{}^{11}C_0 \times {}^{39}C_3}{{}^{50}C_3} = \frac{9139}{19600} = \mathbf{0.4663}$$

P(X=1) = Probability of ordering 1 protein rich food item from the Menu.

$$= \frac{{}^{11}C_1 \times {}^{39}C_2}{{}^{50}C_3} = \frac{8151}{19600} = \mathbf{0.4159}$$

P(X=2) = Probability of ordering 2 protein rich food items from the Menu.

$$= \frac{{}^{11}C_2 \times {}^{39}C_1}{{}^{50}C_3} = \frac{2145}{19600} = \frac{429}{3920} = \mathbf{0.1094}$$

P(X=3) = Probability of ordering 3 protein rich food items from the Menu.

$$= \frac{{}^{11}C_3 \times {}^{39}C_0}{{}^{50}C_3} = \frac{165}{19600} = \frac{33}{3920} = \mathbf{0.0084}$$

Probability Distribution Table:

X	0	1	2	3
P(x)	0.4663	0.4159	0.1094	0.0084

Mean $\mu = \sum x_i P(x_i)$

$$= 0 \times 0.4663 + 1 \times 0.4159 + 2 \times 0.1094 + 3 \times 0.0084$$

$\therefore$ $\boldsymbol{\mu = 0.6600}$

is the expected average of the number of items with high protein in the customer's order.

Variance $\sigma^2 = E[(x - \mu)^2]$

$$= \sum_{i=1}^{n} (x - \mu)^2 P(x_i)$$

$$= \sum_{i=1}^{n} (x - 0.6600)^2 P(x_i)$$

$$= (0 - 0.6600)^2 \times 0.4663 + (0 - 0.6600)^2 \times 0.4159 + (0 - 0.6600)^2 \times 0.1094 + (0 - 0.6600)^2 \times 0.0084$$

$\therefore$ $\boldsymbol{\sigma^2 = 0.4938}$

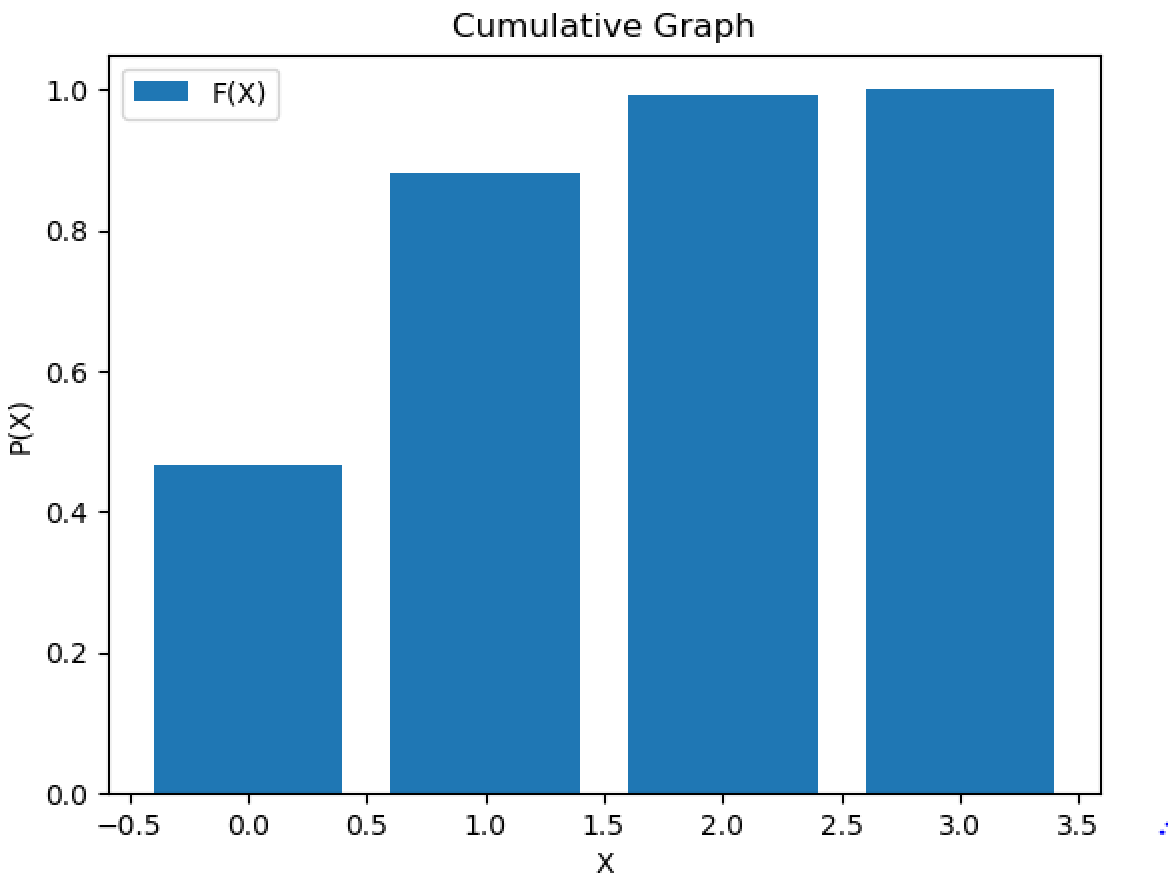
Standard Deviation $\sigma = \sqrt{\text{Variance}}$

$$= \sqrt{\sigma^2}$$

$$= \sqrt{0.3863}$$

$$\therefore \quad \boldsymbol{\sigma = 0.7027}$$

Cumulative Graph:



Let X be the number of Fat-rich items in the customer's order.

P(X=0) = Probability of not ordering any fat rich food item from the menu.

$$= \frac{{}^{19}C_0 \times {}^{31}C_3}{{}^{50}C_3} = \frac{4495}{19600} = \frac{899}{3920} = \mathbf{0.2293}$$

P(X=1) = Probability of ordering 1 fat rich food item from the menu.

$$= \frac{{}^{19}C_1 \times {}^{31}C_2}{{}^{50}C_3} = \frac{8835}{19600} = \frac{1767}{3920} = \mathbf{0.4508}$$

P(X=2) = Probability of ordering 2 fat rich food items from the menu.

$$= \frac{{}^{19}C_2 \times {}^{31}C_1}{{}^{50}C_3} = \frac{5301}{19600} = \mathbf{0.2705}$$

P(X=3) = Probability of ordering 3 fat rich food items from the menu.

$$= \frac{{}^{19}C_3 \times {}^{31}C_0}{{}^{50}C_3} = \frac{969}{19600} = \mathbf{0.0494}$$

Probability Distribution Table:

X	0	1	2	3
P(x)	0.2293	0.4508	0.2705	0.0494

Mean $\mu = \sum x_i P(x_i)$

$$= 0 \times 0.2293 + 1 \times 0.4508 + 2 \times 0.2705 + 3 \times 0.0494$$

$\therefore$ $\boldsymbol{\mu = 1.1400}$
is the expected average of the number of the items with high in the customer's order.

Variance $\sigma^2 = E[(x - \mu)^2]$

$$= \sum_{i=1}^{n}(x - \mu)^2 P(x_i)$$

$$= \sum_{i=1}^{n}(x - 1.1400)^2 P(x_i)$$

$$= (0 - 1.1400^2 \times 0.2293 + (0 - 1.1400)^2 \times 0.4508 + (0 - 1.1400)^2 \times 0.2705 + (0 - 1.1400)^2 \times 0.0494$$

$\therefore$ $\boldsymbol{\sigma^2 = 0.6780}$

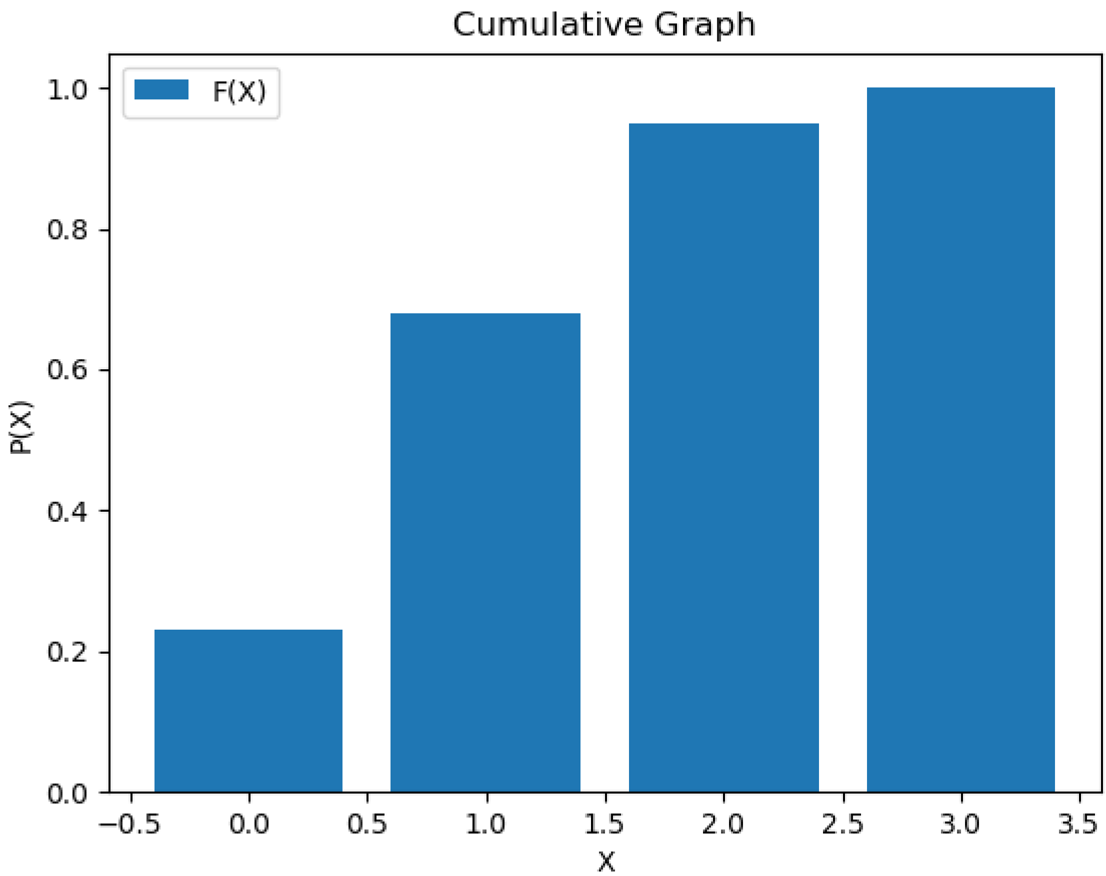
Standard Deviation $\sigma = \sqrt{\text{Variance}}$

$= \sqrt{\sigma^2}$

$= \sqrt{0.780}$

$\therefore \quad \boldsymbol{\sigma} = \mathbf{0.8234}$

Cumulative Graph:



Let X be the number of Carbs-rich items in the customer's order.

P(X=0) = Probability of not ordering any carbs rich food item from the menu.

$$= \frac{{}^{21}C_0 \times {}^{29}C_3}{{}^{50}C_3} = \frac{3654}{19600} = \frac{261}{1400} = \mathbf{0.1864}$$

P(X=1) = Probability of ordering 1 carbs rich food item from the menu.

$$= \frac{{}^{21}C_1 \times {}^{29}C_2}{{}^{50}C_3} = \frac{8526}{19600} = \frac{87}{200} = \mathbf{0.4350}$$

P(X=2) = Probability of ordering 2 carbs rich food items from the menu.

$$= \frac{{}^{20}C_2 \times {}^{30}C_1}{{}^{50}C_3} = \frac{6090}{19600} = \frac{87}{280} = \mathbf{0.3107}$$

P(X=3) = Probability of ordering 3 Carbs rich food items from the Menu.

$$= \frac{{}^{20}C_3 \times {}^{30}C_0}{{}^{50}C_3} = \frac{1330}{19600} = \frac{19}{280} = \mathbf{0.0679}$$

Probability Distribution Table:

X	0	1	2	3
P(x)	0.1864	0.4350	0.3107	0.0679

Mean μ = $\sum x_i P(x_i)$

$$= 0 \times 0.1864 + 1 \times 0.4350 + 2 \times 0.3107 + 3 \times 0.0679$$

∴ $\boldsymbol{\mu = 1.2600}$

is the expected average of the number of items with high carbohydrates in the customer's order.

Variance $\sigma^2 = E[(x - \mu)^2]$

$$= \sum_{i=1}^{n} (x - \mu)^2 \; P(x_i)$$

$$= \sum_{i=1}^{n} (x - 1.2600)^2 \; P(x_i)$$

$$= (0 - 1.2600)^2 \times 0.1864 + (0 - 1.2600)^2 \times 0.4350 + (0 - 1.2600)^2 \times 0.3107 + (0 - 1.2600)^2 \times 0.0679$$

∴ $\boldsymbol{\sigma^2 = 0.7010}$

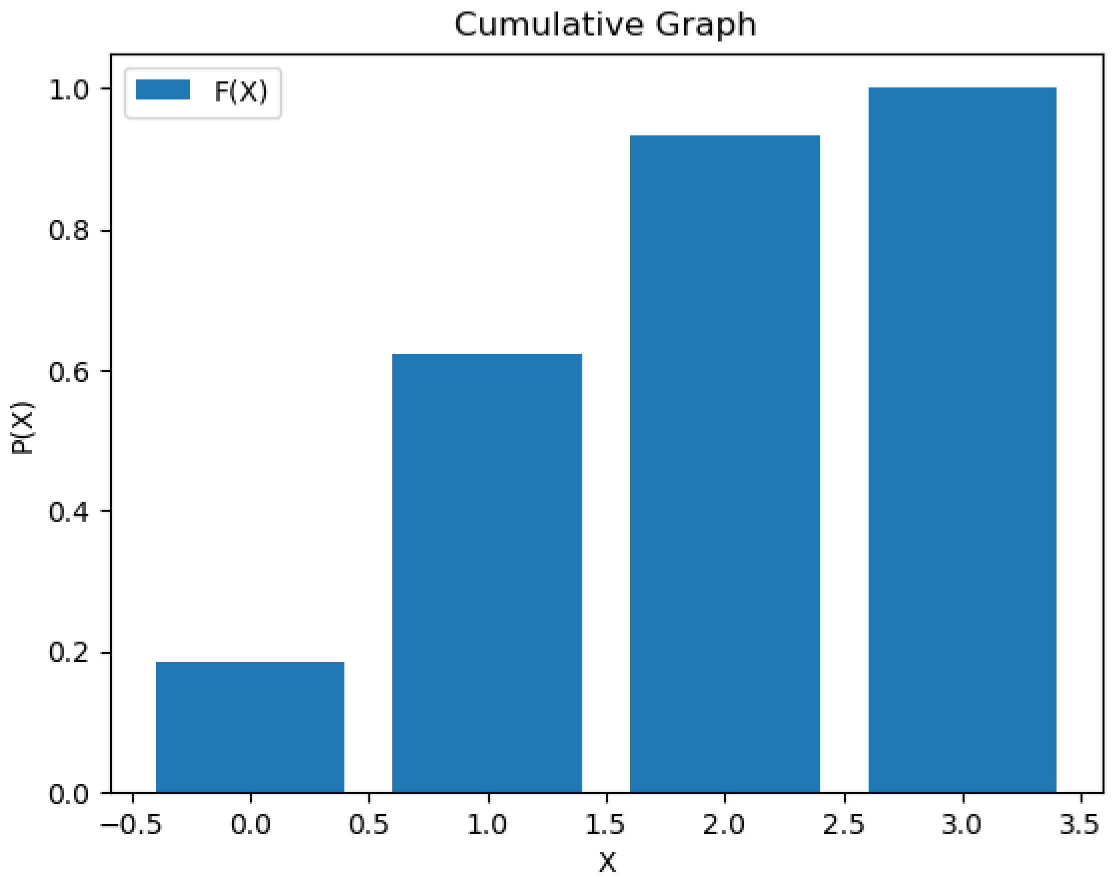
Standard Deviation $\sigma = \sqrt{\text{Variance}}$

$= \sqrt{\sigma^2}$

$= \sqrt{0.7010}$

$\therefore \quad \boldsymbol{\sigma = 0.8372}$

Cumulative Graph:



Source Code (in Python):

```
import math
import matplotlib.pyplot as plt

def dispProbMenu(file):
	print("MENU (in detail)".center(94,"-")+"\n"+file.read()+"-"*94)
	print("The restaurant has 50 items (100g each) in its menu.")
	n=int(input("How many items did the customer order? "))
	ch=int(input("\nProbability Distribution of\n1: Calorie-rich(>300cal) items\n2: Protein-rich(>8%) items\n3: Fat-rich(>15%) items\n4: Carbs-rich(>30%) items\nSelect the probability distribution you require: "))
	while ch not in [1,2,3,4]: ch=int(input("Invalid selection!\nRe-enter valid choice: "))
	file.close()
	return [n,ch]

def findDistribution(file,n,ch):
	items=[]; val=[]; richItems=[]; richVal=[]; px=[]; threshold=[300,8,15,30]; firstLine=True
	while 1:
		line=file.readline()
		if firstLine:
			firstLine=False; continue
		if not line: break
		words=list(filter(lambda x: x!=",line.split("\t")))
		items.append(words[1])
		val.append(words[ch+1])
		if float(words[ch+1])>=threshold[ch-1]:
			richItems.append(words[1])
			richVal.append(words[ch+1])
	items.pop(0); val.pop(0)
	s=C(50,n) #|sample space|
	nrich=len(richVal)
	for i in range(0,n+1):
		px.append(C(nrich,i)*C(50-nrich,n-i)/s)
	print("\nFood items with high "+(["Calories","Proteins","Fat","Carbs"][ch-1])+":")
	for i in range(0,nrich):
		print(str(i+1)+".",richItems[i],"("+richVal[i],end=")
		if ch==1: print("cal)")
		else: print("%)")
	print("\nLet X be the number of "+(["Calorie","Protein","Fat","Carbs"][ch-1])+"-rich items in the customer's order.\n"+"Probabilty Distribution Table:")
	print("-"*(9*n+19),"\n|"+"X".center(8)+"|",end=")
```

```
	for i in range(0,n+1): print(str(i).center(8)+"|",end='')
	print("\n"+"-"*(9*n+19),"\n|"+"P(X)".center(8)+"|",end='')
	for i in px: print("{0:0.4f}".format(i).center(8)+"|",end='')
	print("\n"+"-"*(9*n+19))
	file.close()
	return px

def findSD(n,px,ch):
	mean,var,sd=0,0,0
	for x in range(0,n+1): mean=mean+x*px[x]
	for x in range(0,n+1): var=var+pow(x-mean,2)*px[x]
	sd=math.sqrt(var)
	print("Mean = {:0.4f}, is the expected average of the number of items with
high ".format(mean)+(["Calorie","Protein","Fat","Carbs"][ch-1])+" in the customer's
order.\n"+"Variance = {:0.4f}\nStandard Deviation = {:0.4f}".format(var,sd))

def C(n,r):
	f = math.factorial
	return f(n) / (f(r)*f(n-r))

def plot(n,px):
	f=[];
	for i in range(n+1):
		sum=0
		for j in range(i+1):
			sum+=px[j]
		f.append(sum)
	plt.bar([i for i in range(n+1)],f,label="F(X)")
	plt.legend()
	plt.xlabel('X')
	plt.ylabel('P(X)')
	plt.title('Cumulative Graph')
	plt.show()
# Driver Code
l=dispProbMenu(open("data.txt"))
px=findDistribution(open("data.txt"),l[0],l[1])
findSD(l[0],px,l[1])
plot(l[0],px)
```

Output:

1.

```
---------------------------------------MENU (in detail)---------------------------------------
Sl no.  Food Product(100g)     Calories        Protein(%)        Fat(%)      Carbohydrates(%)
01      Cheese Sandwich          298             10.0            13.6            34.3
02      Fried Rice               110             2.2             3.6             17.4
03      Plain Dosa               189             5.2             4.8             31.5
04      Wheat Chapati            244             8.7             1.2             49.6
05      Rava Upma                131             3.4             4.8             18.7
06      Wheat Poori              288             8.0             10.6            43.6
07      Palak Paneer             118             4.0             9.5             4.1
08      Rasam                    43              2.4             1.1             6.2
09      White Rice               115             2.5             0.3             25.6
10      Rice Idli                139             4.9             0.3             29.0
11      Uddina Vada              348             10.5            22.4            26.0
12      Vegetable Pulao          97              2.3             2.5             16.4
13      Akki Rotti               208             2.7             8.1             30.4
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15      Maggi Noodles            423             9.2             15.8            61.1
16      Wheat Bread              270             5.0             29.0            66.0
17      Brown Bread              244             8.8             1.4             49.0
18      Coco Cola(100ml)         42              0.0             0.0             10.6
19      Fanta(100ml)             51              0.0             0.0             13.0
20      Sprite(100ml)            48              0.0             0.0             12.0
21      Maaza Drink(100ml)       55              0.0             0.0             13.3
22      Cow's Milk(100ml)        69              3.3             4.2             4.5
23      Powdered Milk(100ml)     434             17.4            18.2            50.3
24      Curd                     60              3.1             4.0             3.0
25      Tea with Sugar & Milk    41              1.7             1.8             4.6
26      Coffee with Sugar        54              1.5             2.9             5.1
27      Peanut Butter            594             21.9            50.0            25.0
28      Paneer                   265             18.3            20.8            1.2
29      Butter                   729             0.0             81.0            0.0
30      Ice Cream               262             2.0             19.2            21.7
31      Cake                    392             6.0             21.8            44.2
32      Chocolate Pastry        377             7.3             18.4            45.8
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35      Vegetable Pizza         127             5.9             2.4             20.8
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42      Kachori                 375             8.0             21.8            36.8
43      Pav Bhaji               151             3.3             2.4             29.3
44      Vegetable Puff          255             3.9             16.7            22.5
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---------------------------------------------------------------------------------------------
The restaurant has 50 items (100g each) in its menu.
How many items did the customer order? 3

Probability Distribution of
1: Calorie-rich(>300cal) items
2: Protein-rich(>8%) items
3: Fat-rich(>15%) items
4: Carbs-rich(>30%) items
Select the probability distribution you require: 2
```
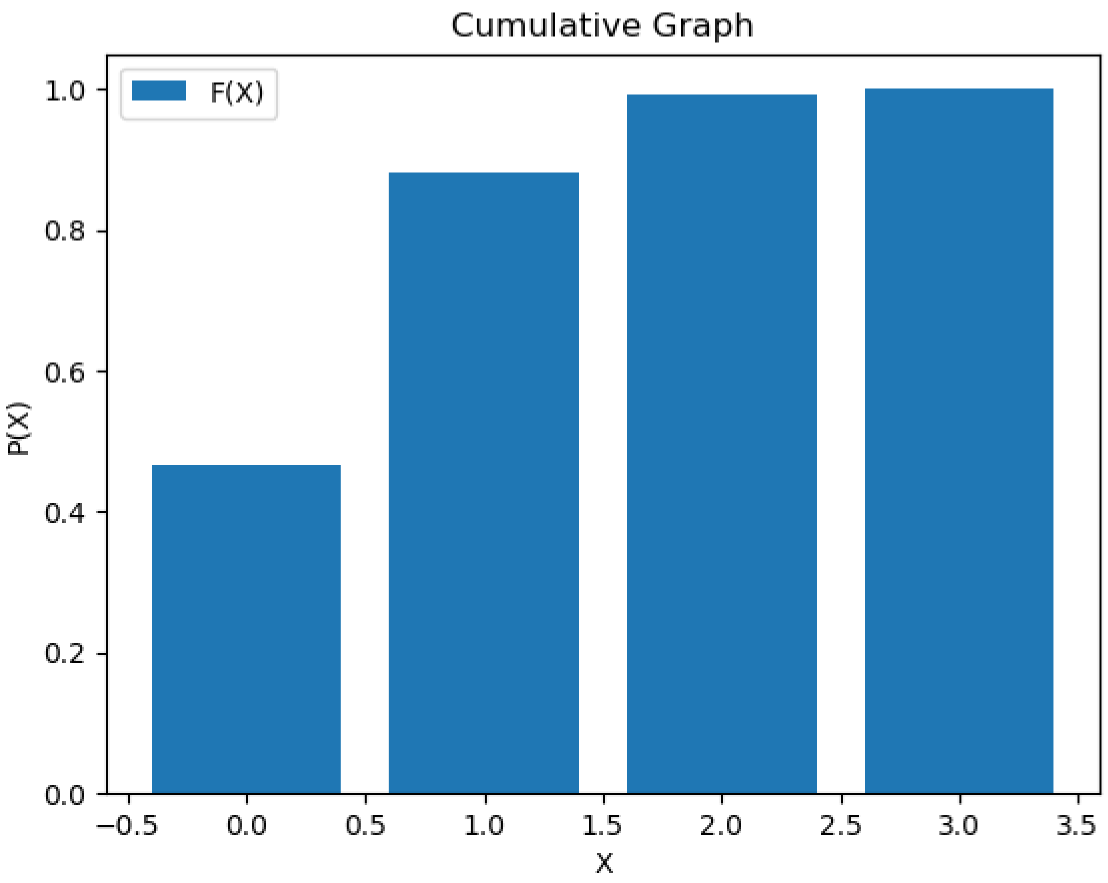

```
Food items with high Proteins:
1. Cheese Sandwich (10.0%)
2. Wheat Chapati (8.7%)
3. Wheat Poori (8.0%)
4. Uddina Vada (10.5%)
5. Maggi Noodles (9.2%)
6. Brown Bread (8.8%)
7. Powdered Milk(100ml) (17.4%)
8. Peanut Butter (21.9%)
9. Paneer (18.3%)
10. Lays Maxx Potato Chips (8.0%)
11. Kachori (8.0%)

Let X be the number of Protein-rich items in the customer's order.
Probabilty Distribution Table:
----------------------------------------------
|   X    |   0    |   1    |   2    |   3    |
----------------------------------------------
|  P(X)  | 0.4663 | 0.4159 | 0.1094 | 0.0084 |
----------------------------------------------
Mean = 0.6600, is the expected average of the number of items with high Protein in the customer's order.
Variance = 0.4938
Standard Deviation = 0.7027
```



2.

```
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09      White Rice              115             2.5               0.3             25.6
10      Rice Idli               139             4.9               0.3             29.0
11      Uddina Vada             348             10.5              22.4            26.0
12      Vegetable Pulao         97              2.3               2.5             16.4
13      Akki Rotti              208             2.7               8.1             30.4
14      Curd Rice               118             3.7               3.1             18.7
15      Maggi Noodles           423             9.2               15.8            61.1
16      Wheat Bread             270             5.0               29.0            66.0
17      Brown Bread             244             8.8               1.4             49.0
18      Coco Cola(100ml)        42              0.0               0.0             10.6
19      Fanta(100ml)            51              0.0               0.0             13.0
20      Sprite(100ml)           48              0.0               0.0             12.0
21      Maaza Drink(100ml)      55              0.0               0.0             13.3
22      Cow's Milk(100ml)       69              3.3               4.2             4.5
23      Powdered Milk(100ml)    434             17.4              18.2            50.3
24      Curd                    60              3.1               4.0             3.0
25      Tea with Sugar & Milk   41              1.7               1.8             4.6
26      Coffee with Sugar       54              1.5               2.9             5.1
27      Peanut Butter           594             21.9              50.0            25.0
28      Paneer                  265             18.3              20.8            1.2
29      Butter                  729             0.0               81.0            0.0
30      Ice Cream              262             2.0               19.2            21.7
31      Cake                   392             6.0               21.8            44.2
32      Chocolate Pastry       377             7.3               18.4            45.8
33      French Fries           314             3.8               16.1            38.4
34      Samosa                 268             3.9               15.3            28.5
35      Vegetable Pizza        127             5.9               2.4             20.8
36      Lays Maxx Potato Chips 520             8.0               31.0            52.0
37      Kurkure                564             6.3               35.7            54.3
38      Banana Chips           519             2.3               33.6            58.4
39      Pani Puri              231             3.3               12.2            26.9
40      Masala Puri            129             5.2               2.8             23.2
41      Bhel Puri              119             2.5               2.7             21.4
42      Kachori                375             8.0               21.8            36.8
43      Pav Bhaji              151             3.3               2.4             29.3
44      Vegetable Puff         255             3.9               16.7            22.5
45      Aloo Bun               287             6.2               8.9             45.4
46      Mysore Pak             366             3.0               22.4            39.0
47      Jelebi                 236             4.5               8.9             34.2
48      Gulab Jamun            375             4.2               23.9            36.8
49      Champakali             127             3.3               3.3             21.7
50      Carrot Halwa           241             4.9               11.3            30.3
---------------------------------------------------------------------------------------------
The restaurant has 50 items (100g each) in its menu.
How many items did the customer order? 8

Probability Distribution of
1: Calorie-rich(>300cal) items
2: Protein-rich(>8%) items
3: Fat-rich(>15%) items
4: Carbs-rich(>30%) items
Select the probability distribution you require: 3
```
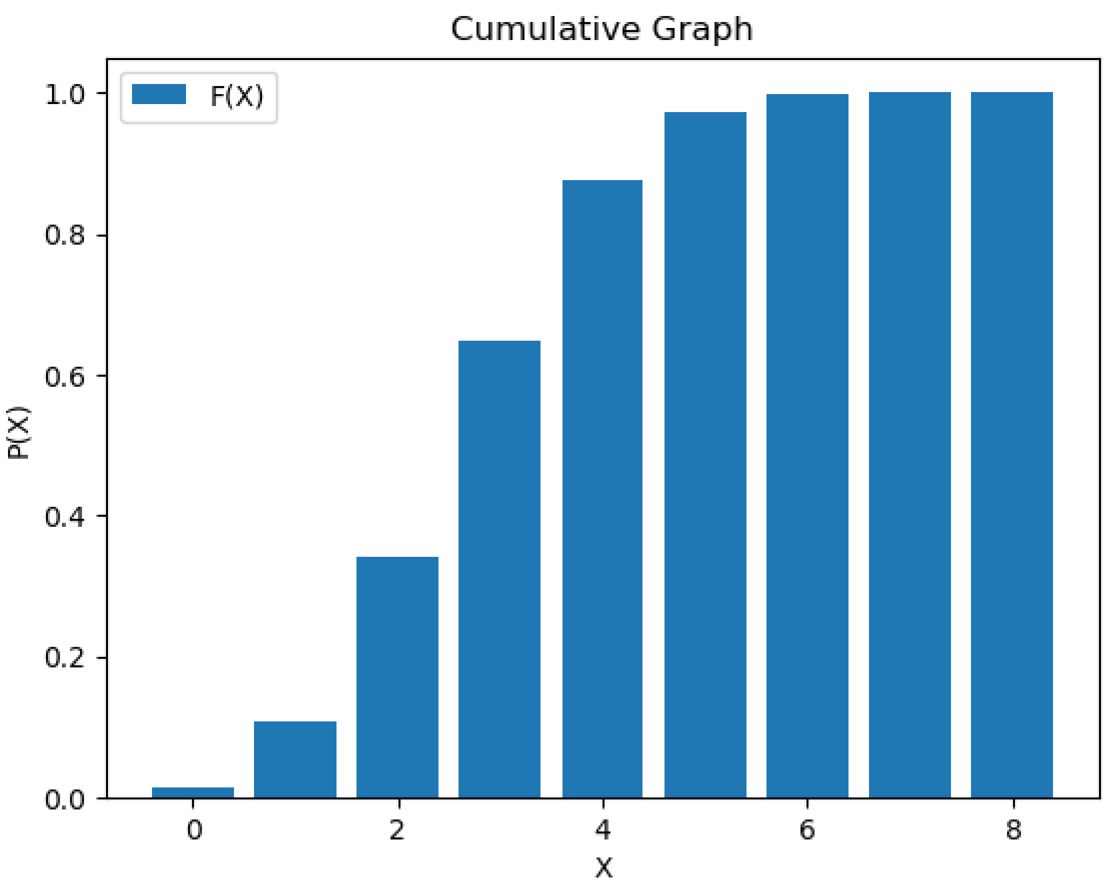

```
Food items with high Fat:
1. Uddina Vada (22.4%)
2. Maggi Noodles (15.8%)
3. Wheat Bread (29.0%)
4. Powdered Milk(100ml) (18.2%)
5. Peanut Butter (50.0%)
6. Paneer (20.8%)
7. Butter (81.0%)
8. Ice Cream (19.2%)
9. Cake (21.8%)
10. Chocolate Pastry (18.4%)
11. French Fries (16.1%)
12. Samosa (15.3%)
13. Lays Maxx Potato Chips (31.0%)
14. Kurkure (35.7%)
15. Banana Chips (33.6%)
16. Kachori (21.8%)
17. Vegetable Puff (16.7%)
18. Mysore Pak (22.4%)
19. Gulab Jamun (23.9%)

Let X be the number of Fat-rich items in the customer's order.
Probabilty Distribution Table:
-------------------------------------------------------------------------------------------
|   X    |   0    |   1    |   2    |   3    |   4    |   5    |   6    |   7    |   8    |
-------------------------------------------------------------------------------------------
|  P(X)  | 0.0147 | 0.0931 | 0.2345 | 0.3067 | 0.2272 | 0.0974 | 0.0235 | 0.0029 | 0.0001 |
-------------------------------------------------------------------------------------------
Mean = 3.0400, is the expected average of the number of items with high Fat in the customer's order.
Variance = 1.6155
Standard Deviation = 1.2710
```



Applications of probability theory:

Probability theory today has applications far beyond games of chance. It has contributed to the solution of problems in Biology, Physics, Chemistry, other natural sciences and in the Social Sciences as well. It is also used to make important business decisions such as where to locate a supermarket and to analyze the needs of customers.

The telephone network, call centers, and airline companies with their randomly fluctuating loads could not have been economically designed without probability theory.

The Defense Forces also use probability theory to estimate whether a missile will hit its target or not. Various sampling techniques which are used in the quality control of mass produced items, are based on the theory of probability.

CONCLUSION

The use of probability theory in this analysis helps the owner of the restaurant to expect an average number of a type of items that his customer is likely to order.

Providing healthy food and nutrition information can improve a restaurant's image. Often, managers must choose between profitability and social responsibility when making decisions. However, providing nutrition information and healthy food items yields benefits from both perspectives.

Based on results of this study, the owner of a restaurant may make an easy decision to increase more healthy items on their menu while simultaneously increasing the image of their business.

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