Lab 2 (Week 3 - 4)

STAT 2601 - Business Statistics (2024 Fall)
School of Mathematics and Statistics, Carleton University

Schedule: September 30 - October 4, 2024

Q1: Binomial Distribution (Excel: Use of BINOM.DIST Function)

Use the binomial distribution Excel function to determine the following:

(a) $n = 6, p = .08$; find $P(X = 2)$

(b) $n = 9, p = .08$; determine $P(X < 4)$

(c) $n = 11, p = .65$; calculate $P(2 < X \leq 5)$

(d) $n = 14, p = .95$; find $P(X \geq 13)$

(e) $n = 20, p = .50$; compute $P(X > 3)$

(f) Create a Binomial Probability Distribution and Histogram.

Of all customers that enter Sweet Holes Donut Shop we know that 30% order donuts. Consider a random sample of 20 customers who enter this establishment. Let X represent the number of these 20 customers who order donuts. Here, $X \sim B(n = 20, p = 0.3)$.

(i) Step 1: Open a blank workbook in Excel. In cell A1, enter the label "x" In cell A2, type "0" In cell A3, type "1". Highlight cells A2 and A3 together, hover over the bottom-right corner of cell A3 until you see the + (called the fill handle), and then drag down until you reach row 22. We should now have the values 0 through 20 in the first column.

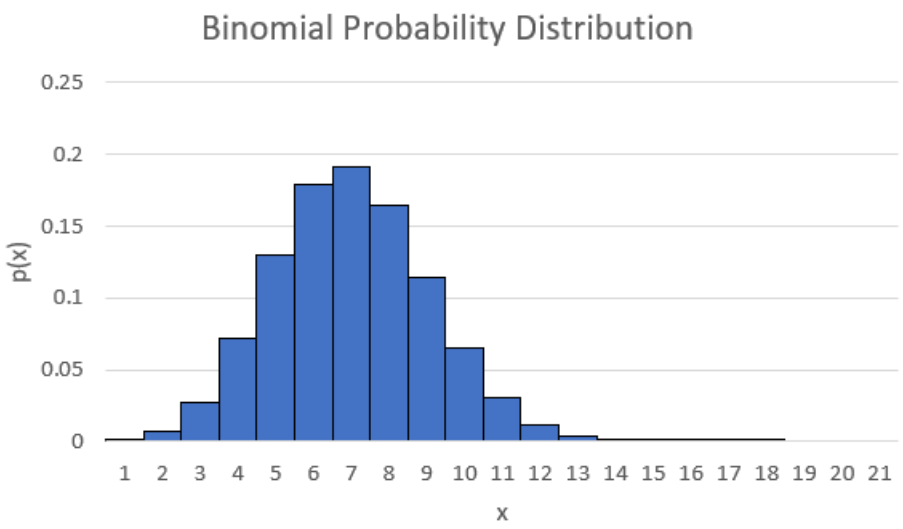
(ii) Step 2: In cell B1, enter the label "p(x)". In cell B2, enter the formula "=BINOM.DIST(A2, 20, 0.3, FALSE)". This will give us p(0) because A2 = 0. Highlight the cell B2, hover over the bottom-right corner the cell until you see the fill handle, and then drag down until you reach row 22. We should now have the values p(0) through p(20) in the first column. Select the cells from A1 to B22, right click, and select "All Borders" from the drop-down border menu.

x	p(x)
0	0.000797923
1	0.006839337
2	0.027845873
3	0.071603672
4	0.130420974
5	0.178863051
6	0.191638983
7	0.164261985
8	0.11439674
9	0.065369566
10	0.030817081
11	0.012006655
12	0.003859282
13	0.001017833
14	0.000218107
15	3.73898E-05
16	5.00756E-06
17	5.04964E-07
18	3.60688E-08
19	1.62717E-09
20	3.48678E-11

(iii) Step 3: Select the cells from A1 to B22. Under **Insert** > **Charts**, click on **Recommended Charts**, and then click the **All Charts** tab. Under **Column** > **Clustered Column**, select the chart that lists the probabilities along the vertical axis and the correct values of x from 0 to 20 on the horizontal axis. Click **OK**.

(iv) Step 4: Under **Chart Design**, click **Quick Layout**, and then click the option that removes the gap between all bars. (Layout 8) Label the vertical axis as"p(x)" and the horizontal axis as "x". Choose an appropriate title for your graph.

(v) Step 5: To differentiate between the bars, right-click over the bars, click outline, and select the colour black. You can add the horizontal gridlines back in by clicking the graph, clicking **Chart Elements** (the + sign in the top right corner), and selecting **Gridlines**.


Binomial Probability Distribution
0.25
0.2
0.15
0.1
0.05
0
p(x)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
x

EXCEL Instructions

- Open blank worksheet.
- In any cell, type "=" and click on f_x (Insert function wizard).
- Select **Statistical Category**.
- Select the **BINOM.DIST** function.
- Fill in the information in the template and click OK.
  - (i) **Number_s**: Number of success (x)
  - (ii) **Trials**: Number of trials (n)
  - (iii) **Probability_s**: Probability of success (p)
  - (iv) **Cumulative**: TRUE (if cumulative), FALSE (if exact)
- EXCEL functions:
  - (a) $P(X = 2) = \textbf{BINOM.DIST}(2, 6, 0.08, \text{FALSE}) = 0.068774$
  - (b)

$$\begin{aligned} P(X < 4) &= P(0) + P(1) + P(2) + P(3) \\ &= \textbf{BINOM.DIST}(3, 9, 0.08, \text{TRUE}) \\ &= 0.996285 \end{aligned}$$

  - (c)

$$\begin{aligned} P(2 < X \leq 5) &= P(3) + P(4) + P(5) \\ &= \textbf{BINOM.DIST}(5, 11, 0.65, \text{TRUE}) \\ &\quad - \textbf{BINOM.DIST}(2, 11, 0.65, \text{TRUE}) \\ &= 0.146645 \end{aligned}$$

  - (d)

$$\begin{aligned} P(X \geq 13) &= P(X = 13) + P(X = 14) \\ &= \textbf{BINOM.DIST}(13, 14, 0.95, \text{FALSE}) \\ &\quad + \textbf{BINOM.DIST}(14, 14, 0.95, \text{FALSE}) \\ &= 0.847014 \end{aligned}$$

  - (e)

$$\begin{aligned} P(X > 3) &= 1 - P(X \leq 3) \\ &= 1 - [P(0) + P(1) + P(2) + P(3)] \\ &= 1 - \textbf{BINOM.DIST}(3, 20, 0.50, \text{TRUE}) \\ &= 0.998712_4 \end{aligned}$$

Q2: Poisson Distribution (Excel: Use of POISSON.DIST Function)

Arrivals to a bank automated teller machine (ATM) are distributed according to a Poisson distribution with a mean equal to 3 per 15 minutes.

(a) Determine the probability that in a given 15-minute segment, no customers will arrive at the ATM.

(b) What is the probability that fewer than four customers will arrive in a 30-minute segment?

(c) What is the probability that more than 5 customers will arrive in a 45 minute segment?

(d) What is the probability that at least 2 customers will arrive in a 10-minute segment?

EXCEL Instructions

- Open blank worksheet.
- In any cell, type "=" and click on f_x (Insert function wizard).
- Select **Statistical Category**.
- Select the **POISSON.DIST** function.
- Fill in the information in the template and click OK.
  - (i) **X**: Number of Success
  - (ii) **Mean**: Mean of Poisson Distribution
  - (iii) **Cumulative**: TRUE/FALSE (depending on the problem)
- Excel Functions:
  - (a) $P(X = 0) = \textbf{POISSON.DIST}(0, 3, \text{FALSE}) = 0.049787$
  - (b) (μ scaled to $6 = \dfrac{3 \times 30}{15}$ as time segment changes to 30-minute)

$$\begin{aligned} P(X < 4) &= P(X \leq 3) \\ &= P(0) + P(1) + P(2) + P(3) \\ &= \textbf{POISSON.DIST}(3, 6, \text{TRUE}) \\ &= 0.151204 \end{aligned}$$

  - (c) (μ scaled to $9 = \dfrac{3 \times 45}{15}$ as time segment changes to 45-minute)

$$\begin{aligned} P(X > 5) &= 1 - P(X \leq 5) \\ &= 1 - [P(0) + P(1) + P(2) + P(3) + P(4) + P(5)] \\ &= 1 - \textbf{POISSON.DIST}(5, 9, \text{TRUE}) \\ &= 0.884309 \end{aligned}$$

  - (d) (μ scaled to $2 = \dfrac{3 \times 10}{15}$ as time segment changes to 10-minute)

$$\begin{aligned} P(X \geq 2) &= 1 - P(X < 2) \\ &= 1 - [P(0) + P(1)] \\ &= 1 - \textbf{POISSON.DIST}(1, 2, \text{TRUE}) \\ &= 0.59399 \end{aligned}$$