R Coding Assignment 3: Binomial Probability Distributions

San Diego State University - STAT550

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Overview

This assignment applies binomial probability distributions to solve real-world probability problems. The binomial distribution models the number of successes in a fixed number of independent trials, each with the same probability of success.

Key R Functions Used: - `dbinom(x, n, p)`: Probability of exactly x successes - `pbinom(x, n, p)`: Cumulative probability of x or fewer successes

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Question 1: Drug Side Effects Analysis

Scenario: If 10% of people who are given a certain drug experience dizziness, find these probabilities for a sample of 25 people who take the drug.

Question 1.A) Exactly 3 people will become dizzy

```r
# dbinom calculates P(X = 3) where X ~ Binomial(n=25, p=0.10)
# Parameters: x=3 successes, n=25 trials, p=0.10 probability
dbinom(3, 25, 0.10)
```

```
## [1] 0.2264973
```

Interpretation: There is approximately a 22.6% probability that exactly 3 out of 25 people will experience dizziness.

Question 1.B) At least 9 people will become dizzy

```r
# P(X >= 9) = 1 - P(X <= 8)
# pbinom gives cumulative probability, so we subtract from 1
1 - pbinom(8, 25, 0.10)
```

```
## [1] 0.0004575493
```

Interpretation: There is approximately a 0.046% probability that 9 or more people will experience dizziness. This is a very rare event.

Question 1.C) Less than 7 people will become dizzy

```r
# P(X < 7) = P(X <= 6)
# pbinom directly gives cumulative probability
pbinom(6, 25, 0.10)
```

```
## [1] 0.9905236
```

Interpretation: There is approximately a 99.1% probability that fewer than 7 people will experience dizziness.

Question 2: Green Bottles Probability

Scenario: There were ten green bottles sitting on the wall. The probability of a green bottle accidentally falling is 0.95. What is the probability that fewer than 8 of the green bottles accidentally fall?

```r
# P(X < 8) = P(X <= 7) where X ~ Binomial(n=10, p=0.95)
# With such a high probability of falling (0.95), we expect most bottles to fall
pbinom(7, 10, 0.95)
```

```
## [1] 0.01150356
```

Interpretation: There is approximately a 1.2% probability that fewer than 8 bottles will fall. Given the high probability (95%) of each bottle falling, it's very likely that 8 or more will fall.

Question 3: Defective Tires Quality Control

Scenario: The LMB Company manufactures tires. They claim that only 0.007 (0.7%) of LMB tires are defective. What is the probability of finding 2 defective tires in a random sample of 50 LMB tires?

```r
# P(X = 2) where X ~ Binomial(n=50, p=0.007)
# This models quality control with a very low defect rate
dbinom(2, 50, 0.007)
```

```
## [1] 0.0428446
```

Interpretation: There is approximately a 4.3% probability of finding exactly 2 defective tires in a sample of 50. This suggests the defect rate claim is reasonable if we observe 2 defects.

Key Takeaways

1. **Binomial Distribution** is appropriate when:
   - Fixed number of independent trials (n)
   - Each trial has two outcomes (success/failure)
   - Constant probability of success (p)
2. **Function Selection:**
   - Use `dbinom()` for "exactly x" probabilities
   - Use `pbinom()` for "at most x" or cumulative probabilities
   - Use `1 - pbinom()` for "at least x" probabilities
3. **Real-World Applications:**
   - Drug efficacy and side effects analysis
   - Quality control and defect detection
   - Risk assessment and decision-making