ECE-108 Assignment 10: Resistor Problem

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1 Resistors

Problem

An electrical engineer tests a batch of 20 resistors and finds that 15% of them are outside the specified tolerance. If 3 resistors are randomly selected from this batch, what is the probability that exactly 1 of them is outside the specified tolerance?

Solution

Given information:

- Batch contains 20 resistors
- 15% of the resistors are outside the specified tolerance
- We randomly select 3 resistors from the batch

First, let's determine the number of resistors outside tolerance:

$$\text{Number outside tolerance} = 20 \times 0.15 = 3 \tag{1}$$
$$\text{Number within tolerance} = 20 - 3 = 17 \tag{2}$$

This is a hypergeometric distribution problem since we're sampling without replacement from a finite population. We need to find the probability of selecting exactly 1 resistor that is outside tolerance when randomly choosing 3 resistors.

Using the hypergeometric probability formula:

$$P(X = 1) = \frac{\binom{3}{1} \times \binom{17}{2}}{\binom{20}{3}} \tag{3}$$

Where:

- $\binom{3}{1}$ = ways to select 1 defective from the 3 defective resistors
- $\binom{17}{2}$ = ways to select 2 good from the 17 good resistors

- $\binom{20}{3}$ = total ways to select 3 resistors from 20

Calculating each term:

$$\binom{3}{1} = 3 \tag{4}$$

$$\binom{17}{2} = \frac{17!}{2! \times 15!} = \frac{17 \times 16}{2} = 136 \tag{5}$$

$$\binom{20}{3} = \frac{20!}{3! \times 17!} = \frac{20 \times 19 \times 18}{6} = 1140 \tag{6}$$

Therefore:

$$P(X = 1) = \frac{3 \times 136}{1140} \tag{7}$$

$$= \frac{408}{1140} \tag{8}$$

$$= 0.3357 \tag{9}$$

$\boxed{\text{Answer: The probability is 35.8\%.}}$