# Lego Piece Drawing Experiment

TUHH
Technische Universität Hamburg

**Group B | 18**: Youssef, Valentin, Asad Jamal

# Experimental Setup

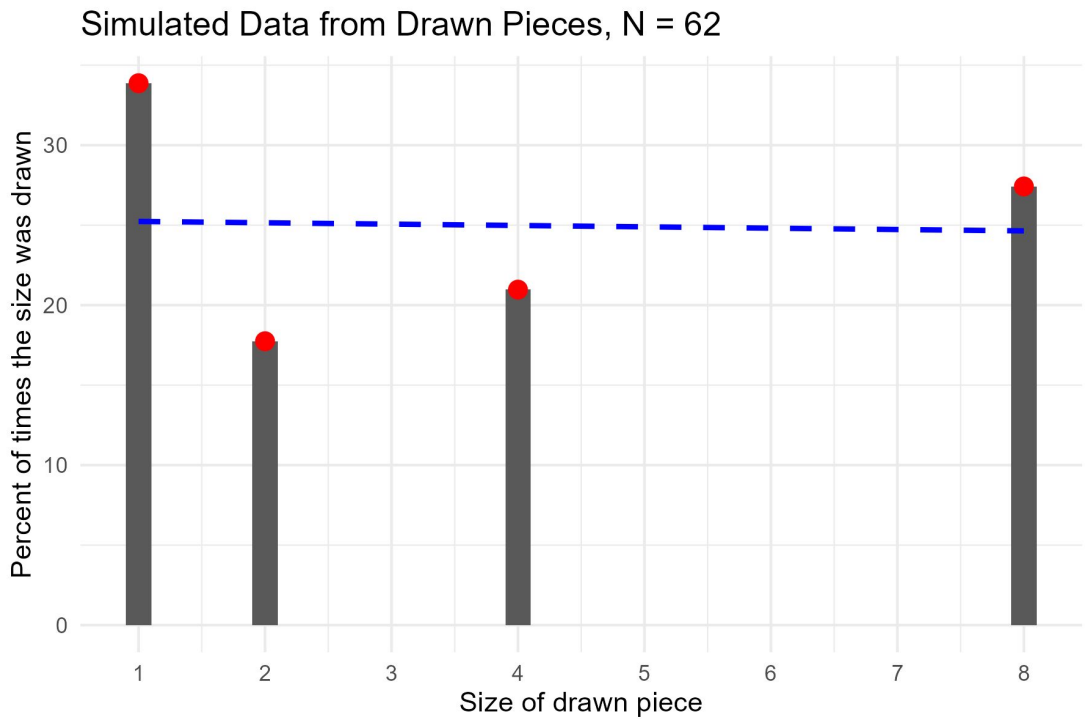
TUHH

**Task:** Draw a ***random*** object from the bag

- **Pieces in bag:**
  Ω = {1, 2, 4, 8}
- **Number of draws:**
  N = 62 -> Unique participants
- **Replacement:**
  After drawing, the piece was put back

→ Assume a linear distribution over Ω

# Simulated Uniform Model

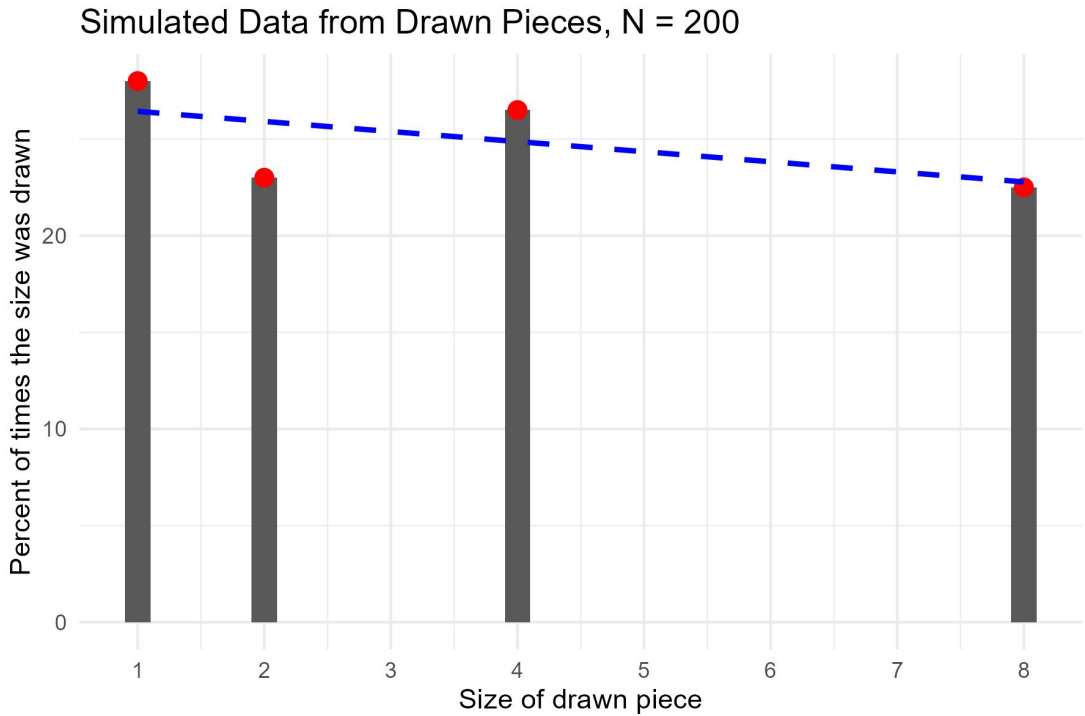



We assume a uniform distribution over the solution space Ω

$$\mathbb{P}(X = 1) = 0.25,$$
$$\mathbb{P}(X = 2) = 0.25,$$
$$\mathbb{P}(X = 4) = 0.25,$$
$$\mathbb{P}(X = 8) = 0.25.$$

# Simulated Uniform Model

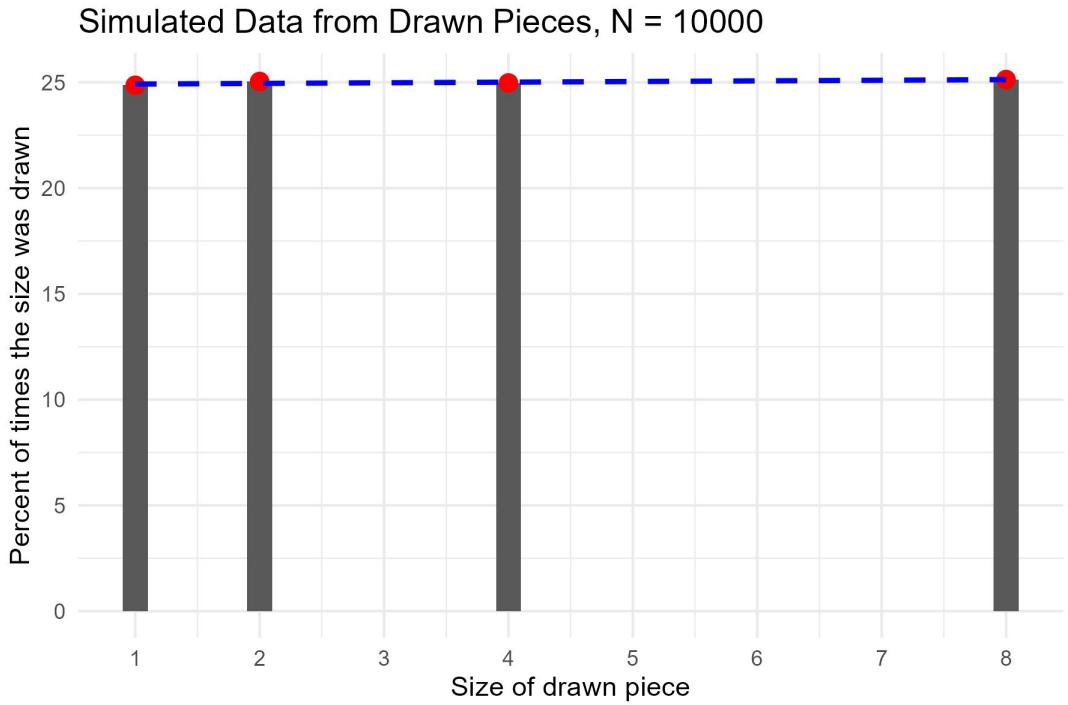





We assume a uniform distribution over the solution space Ω

$$\mathbb{P}(X = 1) = 0.25,$$
$$\mathbb{P}(X = 2) = 0.25,$$
$$\mathbb{P}(X = 4) = 0.25,$$
$$\mathbb{P}(X = 8) = 0.25.$$

# Simulated Uniform Model

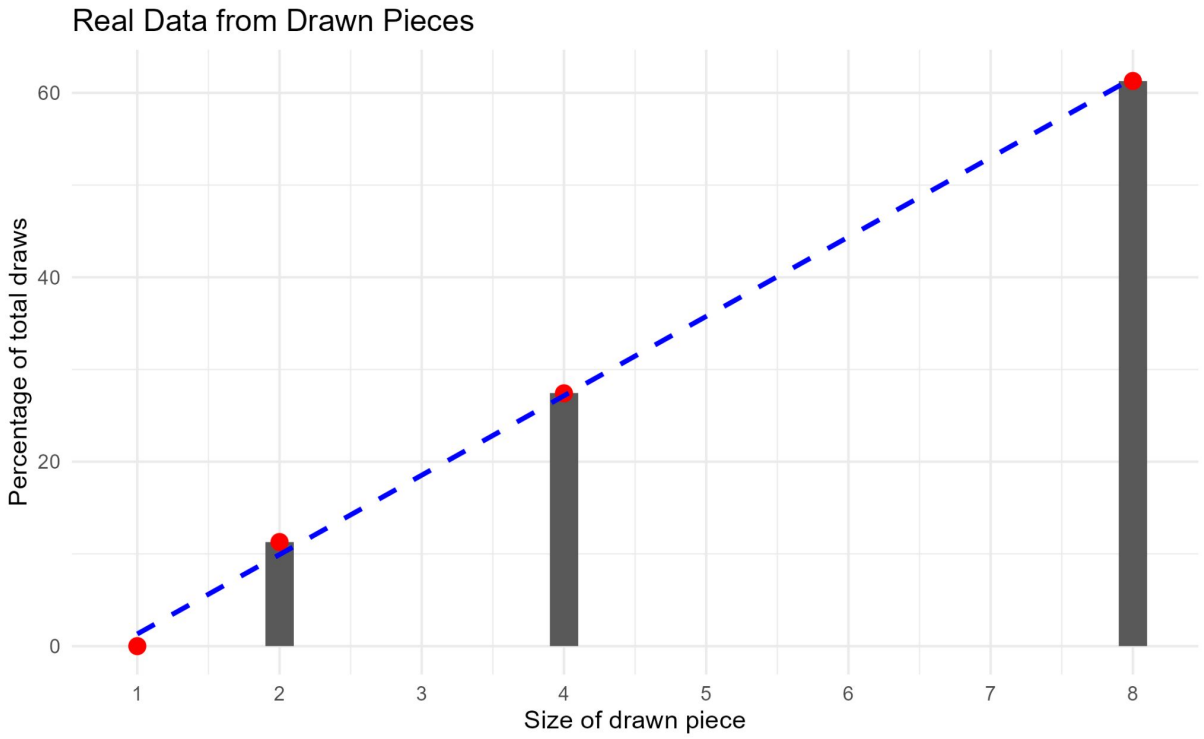



We assume a uniform distribution over the solution space Ω

$$\mathbb{P}(X = 1) = 0.25,$$
$$\mathbb{P}(X = 2) = 0.25,$$
$$\mathbb{P}(X = 4) = 0.25,$$
$$\mathbb{P}(X = 8) = 0.25.$$

# Real Experiment Results

TUHH




- N1 = 0 → 0.00%
- N2 = 7 → 11.3%
- N4 = 17 → 27.4%
- N8 = 38 → 61.3%

Reasons for N1 = 0:

- Difficult to grab it
- Stuck in the corners of the bag?
- People might think it's too small to be considered random

# Proportional Model

TUHH

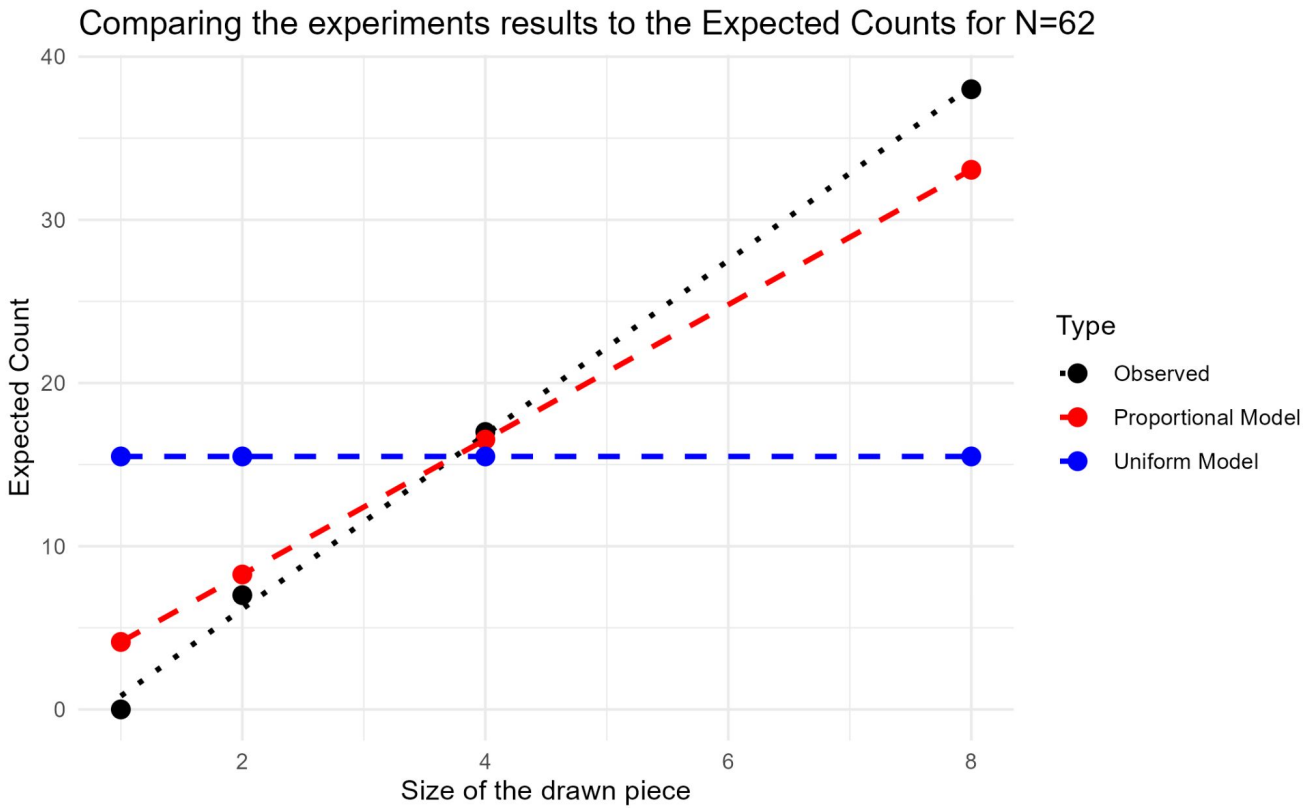
The probability *P_i* of a piece being drawn is assumed to be proportional to its size *s* We have four pieces with sizes s_i ∈ {1, 2, 4, 8}

$$s_{\text{total}} = \sum_{i \in \{1,2,4,8\}} s_i = 1 + 2 + 4 + 8 = 15$$

$$P_i = \frac{s_i}{s_{\text{total}}}$$

$$P_1 = \frac{1}{15}, \quad P_2 = \frac{2}{15}, \quad P_4 = \frac{4}{15}, \quad P_8 = \frac{8}{15}$$

# Observed vs Models



# Chi Squared Test

TUHH

We compare the observed frequencies with two models:

$$\text{Uniform model: } P = (0.25,\ 0.25,\ 0.25,\ 0.25), \qquad \text{Proportional model: } P = (1/15,\ 2/15,\ 4/15,\ 8/15).$$

For the uniform model the chi-squared test yields:

$$\chi^2 = 52.968, \qquad \mathrm{df} = 3, \qquad p = 1.863 \times 10^{-11}.$$

Since the test statistic is way too large in combination with the p-value being extremely small, we reject the null hypothesis. Thus, the **uniform model does not provide a good fit** to the observed data.

For the proportional model, the test gives:

$$\chi^2 = 5.0766, \qquad \mathrm{df} = 3, \qquad p = 0.1663.$$

The test statistic is well below the critical value

$$\chi^2_{0.05,\,3} = 7.815,$$

and the p-value is sufficiently large.
Therefore, we fail to reject the proportional model.

The proportional model is a plausible and good fit for the data.