The Binomial Theorem

- The binomial theorem gives an expression for \((a + b)^n\)

- For any real numbers \(a\) and \(b\) and non-negative integer \(n\)

\[
(a + b)^n = \sum_{k=0}^{n} \binom{n}{k} a^{n-k} b^k
\]
The Pigeonhole Principle

- \( k + 1 \) or more objects are distributed among \( k \) bins
- There is at least one bin that has two or more objects.

**Generalized Pigeonhole Principle:**

- \( n \) objects are placed into \( k \) bins
- There exists at least 1 bin containing at least \( \lceil \frac{n}{k} \rceil \) objects.