

Consider the problem

How many ways can we buy 20 cupcakes if there are 4 variations?



Combinatorics

This is the topic called combinatorics, the number of ways we can select objects given certain restrictions.

The formulas

- The number of **PERMUTATIONS** of k objects out of a group of n is given by $P(n,k)$
- The number of **COMBINATIONS** of k objects out of a group of n is given by $C(n,k)$

The plan

	Repetition allowed	Repetition NOT allowed
Order matters	Use multiplication principle	Use $P(n,k)$
Order does NOT matter	Use $C(n+k-1, k)$	Use $C(n, k)$

So given the original problem of buying 20 cupcakes given that there are 4 variations which formula do we choose?

The plan

	Repetition allowed	Repetition NOT allowed
Order matters	Use multiplication principle	Use $P(n,k)$
Order does NOT matter	Use $C(n+k-1, k)$	Use $C(n, k)$

We have 4 variations and we need to buy 20,
so we use the formula

$$C(4+20-1, 20) = C(23,20)$$

The plan

	Repetition allowed	Repetition NOT allowed
Order matters	Use multiplication principle	Use $P(n,k)$
Order does NOT matter	Use $C(n+k-1, k)$	Use $C(n, k)$

Suppose we need to ensure at least 2 of each variation are bought, how many ways of buying 20 cupcakes are there now?

The plan

- Deal with **restrictions** first: we must have 2 of each variation, so buy 2 of each.
- Deal with what's left: we have already bought 8 cupcakes so we only need 12 more.
- The answer is $C(15,12)$.

Combinatorics

Revise and Read

- Truss, J : Discrete Mathematics for Computer Scientists, Chapter 5.
- Slomson, A : An Introduction to Combinatorics.
- Johnsonbaugh, R : Discrete Mathematics.