For $0 \le r \le n$,

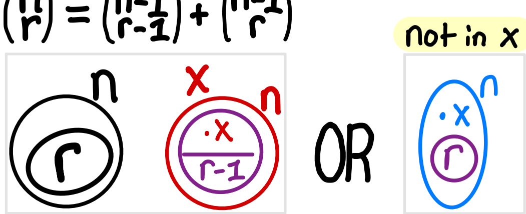
$$C_r^n = \binom{n}{r} = \frac{n!}{r!(n-r)!}$$

is the number of r-combinations of an n-element set.

For $r>0$ or $r \le 0$.
define $\binom{n}{r} = 0$
The numbers $\binom{n}{r}$ are called Binomial Coefficients

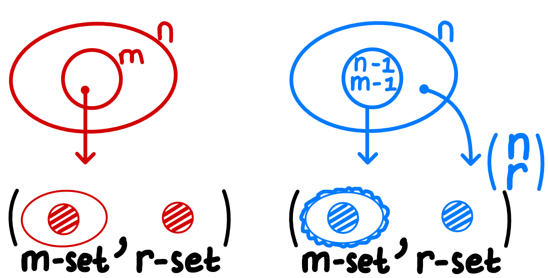
Relations satisfied by $\binom{n}{r}$:

- $\binom{n}{r} = \binom{n}{n-r}$
- $\binom{n}{r} = \binom{n-1}{r-1} + \binom{n-1}{r}$



- $\binom{n}{r} = \frac{n}{r}\binom{n-1}{r-1}$
- $\binom{n}{r} = \frac{n-r+1}{r}\binom{n}{r-1}$
- $\binom{n}{m}\binom{m}{r} = \binom{n}{r}\binom{n-1}{m-1}$

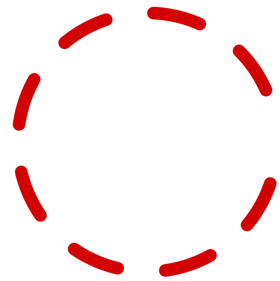
$$\binom{n}{m}\binom{m}{r} = \binom{n}{r}\binom{n-1}{m-1}$$



Line-up items

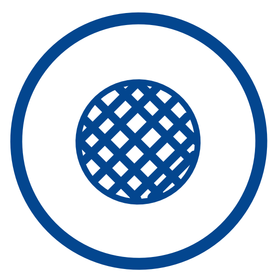
___ , ___ , ___ , ___

$$P_r^n = n(n-1)\ldots(n-r+1)$$



Circle

$$Q_r^n = \frac{1}{r} P_r^n$$



Line-up & divide up with symmetry

$$C_r^n = \frac{P_r^n}{r!}$$