

Binomial coefficients:  $\binom{n}{j}$  read as "n choose j"  
 defined as  $\frac{n!}{j!(n-j)!}$

This is # of ways to pick exactly  $j$  out of  $n$  items in a row, without regard to the order of picking  
 i.e. without noting order of selection.

$\binom{5}{3}$



← 5 items, pick 3

with the order of selection noted, there are  $(5)(4)(3)$  ways to pick.



$$(5)(4)(3) = \frac{5!}{2!} = 60$$

also there are  $3!$  ways this triple could have been picked



2nd, 3rd, 5th items

so I overcounted by a factor of  $3!$  if I want to ignore the order of selection.

So there are really only  $\frac{5!}{3!2!} = 10$  ways if we ignore order of selection

- 10 ways:
- 1, 2, 3
  - 1, 2, 4
  - 1, 2, 5
  - 1, 3, 4
  - 1, 3, 5
  - 1, 4, 5
  - 2, 3, 4
  - 2, 3, 5
  - 2, 4, 5
  - 3, 4, 5

without regarding the order of selection  
 e.g. without coloring them as you pick them.

So if we have 5 trials, and we want exactly 3 successes, there are  $\binom{5}{3} = \frac{5!}{3!2!} = 10$  ways that this could happen.

binomial coefficients play a key role in defining Binomial random variables.