**Counting**

**Product rule:** (printer example) an operation consists of k steps where:

* 1st step can be performed in n1 ways;
* 2nd step can be performed in n2 ways regardless of how 1st step was performed;
* ...
* Nth can be performed in nk ways regardless of how preceding steps were performed;

Then the whole operation can be performed in: n1 × n2 × ... × nk

**Permutation:** a permutation of a set of objects is an order of the objects in sequence e.g.

S = {a, b, c}

= abc, acb, bac, bca, cab, cba

**Counting permutation:** A set A of n objects has n! = n × (n − 1) × (n − 2) × · · · × 1 permutations

Why?... Because:

* n choices from A for the 1st element p 1 of the permutation
* n − 1 choices from A − {p1} for the 2nd element p2 of the permutation (1 removed)
* n − 2 choices from A − {p1, p2} for the 3rd element p3 of the permutation(2 removed)
* · · ·
* 1 choice for the last

Therefore it follows product rule.

**r-permutations:** an r-permutation of a set of n elements is an ordered selection of r elements taken from the set without repetition

Suppose we have squad of 14 cricketers. How many batting line ups of 11 players are there?

E.g. suppose we insist users choose a password of exactly 4 characters with at least one number followed by at least one letter (only letters &numbers allowed). How many possible passwords are there?

Let S be the set of allowed passwords

S1 = Passwords with 1 number 3 letters

S2 = passwords with 2 numbers 2 letters

S3 = passwords with 3 numbers 1 letter

**r-combination:** an r-combination of a set of size n is a subset of size r .Let denote the number of r-combinations of a set of size n.

Then:

**Combinatorial equivalence:** Some counting problems can be made easier by recognising when there is a one-to-one correspondence to another problem

**1)** How many ways are there of choosing 2 elements from the set:

{1, 2, . . . , 9}?

**2)** How many ways are there of choosing 7 elements from the set:

{1, 2, . . . , 9}?