The Multiplication Principle

A tree diagram is a graph showing possibilities for an event having choices along the way. Suppose a rat in a maze starts at point A. There are five possible routes to get from point A to point B and 3 possible routes to get from point B to the final destination, point C. Represent the possible choices using a tree diagram.

Tree Diagrams for Rat Maze

Possible paths:
1a, 1b, 1c
2a, 2b, 2c
3a, 3b, 3c
4a, 4b, 4c
5a, 5b, 5c
Total possible paths = 15

What to wear?

Ever wonder just how many possible outfits you can create? Suppose that you have three shirts (red, white, gray), two pants (jeans and khakis), and two pair of shoes (tennis shoes and casual shoes) that can be mixed and matched. How many choices do you have?

The Answer?

- So, how many outfits would you be able to create?

The Multiplication Principle

Suppose that a task is composed of two consecutive operations. If operation 1 can be performed in \( m \) ways and, for each of these, operation 2 can be performed in \( n \) ways, then the complete task can be performed in \( m \cdot n \) ways.
Generalized Multiplication Principle

Suppose that a task is composed of \( t \) operations performed consecutively. Suppose operation 1 can be performed in \( m_1 \) ways; for each of these, operation 2 can be performed in \( m_2 \) ways; for each of these, operation 3 can be performed in \( m_3 \) ways; and so forth. Then the complete task can be performed in \( m_1m_2m_3\ldots m_t \) ways.

Decisions, Decisions!

Jake and Abby are planning a trip overseas and they have a lot of decisions to make in terms of transportation. First, they have to decide how to get to the airport: car, taxi, or bus. Once at the airport, five different airlines fly to their destination, so they must choose one. Once they land, they must get to hotel by means of shuttle, subway, taxi, or rented car.

How many possible travel options do Jake and Abby have?

Example 1

• How many different two-letter words (including nonsense words) can be formed such that the two letters are distinct?

• What if the letters can repeat?

Example 2

• How many license plates consisting of two letters followed by four digits are possible?

Example 3

• A sports writer is asked to rank eight teams. How many different orderings are possible?

Example 4

• How many three-digit odd numbers can be formed using the digits 1, 2, 3, 4, 5, 6, and 7?
Example 5
An automobile dealer is offering five models of a particular car. On each model the
customer may choose cloth or leather seats, each available in three colors, automatic or
manual transmission, and a CD player or a cassette player. The car can be ordered in
any one of eight exterior colors. How many
different cars can be ordered?

Example 6
A corporation has a board of directors consisting of 10 members. The board
must select from among its members a chairperson, vice chairperson, and
secretary. In how many ways can this be done?