

## HOW TO READ OUTLOUD SOME MATHEMATICAL EXPRESSIONS

---

### GREEK LETTERS

A B  $\Gamma$   $\Delta$  E Z H  $\Theta$  I K  $\Lambda$  M N  $\Xi$  O  $\Pi$  P  $\Sigma$  T Y  $\Phi$  X  $\Psi$   $\Omega$   
 $\alpha$   $\beta$   $\gamma$   $\delta$   $\epsilon$   $\zeta$   $\eta$   $\theta$   $\iota$   $\kappa$   $\lambda$   $\mu$   $\nu$   $\xi$   $\omicron$   $\pi$   $\rho$   $\sigma$   $\tau$   $\upsilon$   $\varphi$   $\chi$   $\psi$   $\omega$

---

alpha, beta, gamma, delta, epsilon, zeta, eta, theta, iota, kappa, lambda, mu, nu, xi, omicron, pi, rho, sigma, tau, upsilon, phi, chi, psi, omega

---

### FUNCTION

A function  $f$  that *takes an independent variable*  $x$ , written  $f(x)$  reads as  $f$  of  $x$ .

---

### ADDITION AND SUBTRACTION

$a + b$  reads as  $a$  *plus*  $b$ , and

$a - b$  reads as  $a$  *minus*  $b$ .

Commutative property:  $a + b = b + a$

Associative property:  $(a + b) + c = a + (b + c)$ .

---

### MULTIPLICATION

$(a \times b) = ab$  reads as  $a$  *times*  $b$

---

### FRACTIONS AND DIVISION

$a / b$  reads as  $a$  *divided by*  $b$  or  $a$  *over*  $b$ .

---

### EXPONENT

The exponentiation  $b^n$  can be read as:  **$b$**  *raised to the  $n$ --th power*,  **$b$**  *raised to the power of  $n$* , or  **$b$**  *raised by the exponent of  $n$* , most briefly as  **$b$**  *to the  $n$* .

$b^2$  is read as  **$b$**  *squared* and  $b^3$  as  **$b$**  *cubed*.

---

### SUBSCRIPTS

The expression of  $A[13]$  or  $A_{13}$  can be read as  $A$  *sub* 13.

---

### EXPONENTIATION

Superscripting is used to indicate exponentiation.

$x^y$  is read as:  $x$  *raised to the  $y$  power*.

The exponential function, usually denoted as  $e^x = \exp(x)$  is often read:  $e$  *to the  $x$  power*.

---

### ABSOLUTE VALUES

The notation  $|x|$  denotes the *absolute value* of  $x$ .

---

### RADICALS

A *square root* is always the positive square root unless the  $\pm$  (*plus or minus*) symbol precedes it.

For *higher order roots*,  $(\text{expression})^{1/n}$ , is read as: *the  $n$ th root of expression*.

For any real numbers  $a$  and  $b$ , and any positive integer  $n$ , if  $a^n = b$ , then  $a$  is the  $n$ th root of  $b$ .

---

### INEQUALITIES AND RELATIONAL SYMBOLS

$a > b$  means:  $a$  *greater than*  $b$ .

$a < b$  means:  $a$  *less than*  $b$ .

$a \geq b$  means:  $a$  *greater than or equal to*  $b$

$a \leq b$  means:  $a$  *less than or equal to*  $b$

$a \neq b$  means:  $a$  *not equal to*  $b$

---

### THE SIGMA SUMMATION SYMBOL

$$\sum_{j=1}^n A_j$$

The above reads as: *the summation from j equal 1 to n of A sub j*. It is the same as:

$$A_1 + A_2 + A_3 + \dots + A_n$$

---

### INFINITY

$\infty$ , indicates infinity. Note that in calculus we never use infinity as a number, but rather as a limit. If  $x$  can range from zero to  $\infty$ , then its *lower bound* is zero, but  $x$  has *no upper bound*.

---

### LIMITS

$$\lim_{x \rightarrow 0} f(x)$$

reads as: *the limit as x approaches zero of f(x)*.

---

### DERIVATIVES

The process of finding a derivative is called *differentiation*.

$$\frac{dy}{dx} = y'$$

where  $y$  is a function of  $x$  and reads as: *the derivative of y with respect to x*.

You can also say: "d y by d x", or "d y over d x". "d y d x" is often used but may lead to confusion.

*Second derivatives* are read as *the second derivative of y with respect to x*.

$$\frac{d^2y}{dx^2} = y''$$

Higher DERIVATIVES are read as *the nth derivative of y with respect to x.*

$$\frac{d^n y}{dx^n} = y^{(n)}$$

---

### PARTIAL DERIVATIVES

$$\frac{\partial y}{\partial x}$$

The above is read *the partial derivative of y with respect to x.*

To distinguish it from the letter *d*,  $\partial$  is sometimes pronounced "del" or "partial" instead of "dee".

---

### INTEGRALS

The reverse process of differentiation is called *antidifferentiation*.

The *integral over x of a real-valued function f(x)*, is written as

$$\int f(x) dx.$$

The *integral sign*  $\int$  represents integration. The *dx* indicates that we are *integrating over x*; *dx* is called the variable of *integration*.

The expression to be integrated is called the *integrand*.

Because there is no domain specified, the integral is called an *indefinite integral*.

When integrating over a specified domain, we speak of a *definite integral*.

$$\int_D f(x) dx, \text{ or } \int_a^b f(x) dx$$

Here we are integrating over a domain *D* where the domain is an interval  $[a, b]$  of *x*;

The domain *D* or the interval  $[a, b]$  is called the *domain of integration*.

This is said as *the integral from a to b of f(x) dx*

---

### LOGICAL IMPLICATION SYMBOLS

The symbols for logical implication will always be shown in **bold** type to distinguish them from similar-looking relational symbols (like less than or equal to).

statement 1  $\Rightarrow$  statement 2

means that statement 1 logically implies statement 2. In other words, if statement 1 is true, then statement 2 must also be true, but not necessarily vice versa. In still other words, statement 1 is a *sufficient* condition for statement 2.

statement 1  $\Leftarrow$  statement 2

means that statement 1 is implied by statement 2. In other words, if statement 2 is true, then statement 1 must also be true, but not necessarily vice versa. Or statement 2 is true

*only if* statement 1 is true. In still other words, statement 1 is a *necessary* condition for statement 2.

statement 1  $\Leftrightarrow$  statement 2

means that each statement implies the other. If either of them are true, then both must be true. This relationship is called *logical equivalence*. It can also be worded as: statement 1 is a *necessary and sufficient* condition for statement 2, or statement 1 *if and only if* statement 2.

The phrase *if and only if* is often abbreviated as *iff*.

---

## VECTORS

### Norm

The *norm* of a vector is represented with double bars on both sides of the vector. The norm of a vector  $\mathbf{v}$  can be represented as:

$$\|\mathbf{v}\|$$

### Inner product

The *inner product* is also known as the *scalar product*, of two vectors is represented as an ordered pair enclosed in angle brackets. The *inner product of two vectors*  $\mathbf{u}$  and  $\mathbf{v}$  can be represented as:

$$\langle \mathbf{u}, \mathbf{v} \rangle$$

### Dot product

In  $\mathbb{R}^n$ , the inner product is also known as the *dot product*. The dot product of two vectors  $\mathbf{u}$  and  $\mathbf{v}$  can be represented as:

$$\mathbf{u} \cdot \mathbf{v}$$

### Cross product

The *cross product* of two vectors  $\mathbf{u}$  and  $\mathbf{v}$  can be represented as:

$$\mathbf{u} \times \mathbf{v}$$

In some older literature, the following notation is used for the cross product between  $\mathbf{u}$  and  $\mathbf{v}$ :

$$[\mathbf{u}, \mathbf{v}]$$

---

## SETS

An object that belongs to a *set* is called an *element* (or a *member*) of that set.

- $a \in A$   $a$  is an element of set membership  $A$
- $x \notin A$  element of no set membership
- The intersection of two sets,  $X$  and  $Y$ , is the set of elements that are common to both  $X$  and  $Y$ . It is denoted by  $X \cap Y$ , and is read " $X$  intersect  $Y$ ".
- The union of two sets  $A$  and  $B$ , is the set of elements which are in  $A$  or in  $B$  or in both. It is denoted by  $A \cup B$ , and is read " $A$  union  $B$ ".
- The complement of set  $A$  is denoted by  $A'$ , You can also say "*complement of  $A$  in  $U$* ", or " $A$ --prime".

- $A \subseteq B$      A is a subset of B
  - $A \subset B$      A is a proper subset / strict subset of B
  - $A \not\subseteq B$     A is not a subset of B
  - $A \supseteq B$     A is a superset of B--
  - $A \supset B$     A is a proper superset / strict superset of b
  - $\emptyset$         empty set
  - $U$          universal set
  
  - $\mathbb{N}_0$         natural numbers / whole numbers set (with zero)
  - $\mathbb{Z}$          integer numbers
  - $\mathbb{Q}$          rational numbers
  - $\mathbb{R}$          real numbers
  - $\mathbb{C}$          complex numbers
- 

## STATISTICS

### 1) Basic Terminology

*Data* (plural): measurements or observations (aka scores)

*Variable*: A characteristic or condition that has different values for different individuals (ex. height, test scores, gender)

*Independent Variable*(IV): The variable that is controlled by an experimenter.

*Quasi-Independent Variable* (Q-IV): A variable that can't be manipulated but is used to determine groups.(height, hair color, age, gender, etc...)

*Dependent Variable* (DV): A variable that is allowed to vary and is observed in relation to the IV.(dependent on the independent variable).

*Statistics*: A set of calculations used to organize, summarize and interpret information

*Descriptive Statistics*: Used to organize, simplify and summarize data.

*Inferential Statistics*: Using Sample statistics to make generalizations about their population.

*Population*: ALL of the individual you wish to study (ex. all students in the US)

*Parameter*: A value used to describe a population.

*Sample*: ONLY SOME of the individuals/objects you wish to study from a population (ex. 1000 students from New York)

*Statistic*: A value used to describe a sample.

*Sampling Error*: A discrepancy which occurs between a sample and its population.

*Control Condition*: Individuals in this type of experimentation are given no experimental treatment or are given a type of placebo. (This condition is used to have a base of reference for the experimental group.)

*Experimental Condition*: Individuals in this type of experimentation do receive the treatment being tested.

## 2) Basic Symbols

$\Sigma$  = Sum

$x$  = each variable score

SS = Sum of squared deviations

sqrt = Square root

df = degrees of freedom

Symbols used to describe a Population

$\mu$  = mean

$\sigma$  = standard Deviation

$\sigma^2$  = variance

$N$  = Total number of population scores

Symbols used to describe a Sample

$M$  = mean

$s$  = Standard Deviation

$s^2$  = variance

$n$  = Total number of sample scores

## 3) Distribution: Tables and Graphs

*Frequency Distribution*: This is a list of the scores for a certain experiment and a measure of the frequency of each score. This information can be used to construct tables and graphs

*Variability*: A quantitative measurement of the degree to which the scores in a distribution are spread out or clustered together.

*Normal Distribution*

This type of distribution is seen when the variables are clustered together with gradual decrease on either side of the distribution.

It is also called a *Gaussian Curve* or *Bell Curve*.

*Negative Skew*

When the variables in a distribution are clustered together with a few outliers which change the distribution. (The tail of the graph points to the negative end)

*outliers*: These are variables that fall outside the normal trends for the distribution.

*Postive Skew*

When the variables in a distribution are clustered together with a few outliers that change the distribution positively. (The tail of the graph points to the positive end)

#### 4) Central Tendency: The Mean, Median and Mode

*Central Tendency:* A measurement that uses only one score to describe a distribution of scores.

*Mean* ( $\mu$  or  $M$ ): The average (sum of scores/# of scores)

Ex. (5,4,3)  $5+4+3=12$ ,  $12/3=4$ , Mean = 4

*Median:* The score which divides all scores in half when put into ascending order.

Ex. (10,4,3,2,1) Median = 3

*Mode:* The score or scores that occur most often in a set.

Ex. (5,4,3,3,2) Mode = 3

#### 5) More on Variables and Scales

*Discrete:* No values can exist between pre-determined categories.

*Continuous Variables:* Variables that have an infinite number of possibilities usually numerical.

N O I R Scales for Variables

*N = Nominal:* A discrete set of categories with different names

*O = Ordinal:* A set of categories ordered by sequence.

*I = Interval:* Ordered Categories with exact distances between categories. NO Real Zero.

*R = Ratio:* This is a numerical scale with a true zero.