

Mathematical Notation Reference

Pai Surya Darshan

December 2025

1 Geometry and Linear Algebra

Symbol	Meaning	Definition	Example
\perp <code>\perp</code>	Orthogonal	Two vectors or subspaces whose inner product is zero.	$\mathbf{u} \perp \mathbf{v}$
\parallel <code>\parallel</code>	Parallel	Objects with identical direction that never intersect.	$\ell_1 \parallel \ell_2$
$\langle \cdot, \cdot \rangle$ <code>\langle \cdot, \cdot \rangle</code>	Inner product	Bilinear form encoding angle and magnitude.	$\langle x, y \rangle$
$\ \cdot\ $ <code>\ \cdot\ </code>	Norm	Function measuring vector magnitude.	$\ x\ $
\times <code>\times</code>	Cross product	Vector product producing a perpendicular direction in \mathbb{R}^3 .	$a \times b$
\cdot <code>\cdot</code>	Dot product	Scalar product measuring alignment.	$a \cdot b$
$\text{span}(\cdot)$ <code>\text{span}(\cdot)</code>	Linear span	All linear combinations of given vectors.	$\text{span}\{v_1, v_2\}$
\oplus <code>\oplus</code>	Direct sum	Decomposition into independent subspaces.	$V = U \oplus W$

2 Sets and Logic

Symbol	Meaning	Definition	Example
\cup \cup	Union	Elements belonging to at least one set.	$A \cup B$
\cap \cap	Intersection	Elements common to both sets.	$A \cap B$
\emptyset \emptyset	Empty set	A set containing no elements.	$A = \emptyset$
\in \in	Element of	Denotes membership in a set.	$x \in A$
\notin \notin	Not an element of	Denotes non-membership.	$x \notin A$
\subseteq \subseteq	Subset	All elements of one set lie in another.	$A \subseteq B$
\subset \subset	Proper subset	Subset strictly smaller than the parent set.	$A \subset B$
\setminus \setminus	Set difference	Elements in one set but not another.	$A \setminus B$
Δ Δ	Symmetric difference	Elements belonging to exactly one of two sets.	$A \Delta B$
\mathbb{R} \mathbb{R}	Real numbers	Set of all real-valued numbers.	$x \in \mathbb{R}$

3 Probability and Statistics

Symbol	Meaning	Definition	Example
\sim $\backslash sim$	Distributed as	Specifies a probability distribution.	$X \sim \mathcal{N}(0, 1)$
\perp $\backslash perp$	Independence (informal)	Indicates absence of dependence.	$X \perp Y$
$\perp\!\!\!\perp$ $\backslash perp \backslash ! \backslash ! \backslash ! \backslash perp$	Independence (formal)	Formal symbol for probabilistic independence.	$X \perp\!\!\!\perp Y$
$\mathbb{E}[\cdot]$ $\backslash mathbb{E}[\cdot]$	Expectation	Mean value under a distribution.	$\mathbb{E}[X]$
$\text{Var}(\cdot)$ $\backslash mathrm{Var}(\cdot)$	Variance	Measure of dispersion around the mean.	$\text{Var}(X)$
$\text{Cov}(\cdot, \cdot)$ $\backslash mathrm{Cov}(\cdot, \cdot)$	Covariance	Joint variability of two variables.	$\text{Cov}(X, Y)$
\rightarrow $\backslash to$	Convergence	Limiting behaviour of a sequence.	$X_n \rightarrow X$
\Rightarrow $\backslash Rightarrow$	Implies	Logical implication.	$A \Rightarrow B$

4 Probability and Statistics (Core Additions)

Symbol	Meaning	Definition	Example
$\mathbb{P}(\cdot)$	Probability	Probability measure assigning a value in $[0, 1]$ to an event. $\mathbb{P}(P)(\cdot)$	$\mathbb{P}(A)$
$ $	Conditioning bar \mid	Used to denote conditional probability or conditional distributions. $\mathbb{P}(A B)$	$\mathbb{P}(A B)$
$\mathbb{P}(A B)$	Conditional probability $\mathbb{P}(A \mid B)$	Probability of event A given that event B occurred. $\mathbb{P}(A B) = \frac{\mathbb{P}(A \cap B)}{\mathbb{P}(B)}$	
$p(x)$ $p(x)$	PMF (discrete)	Probability mass function: $p(x) = \mathbb{P}(X = x)$ for discrete X .	$X \in \{0, 1\}$, $p(1) = 0.3$
$f(x)$ $f(x)$	PDF (continuous)	Probability density function such that $\mathbb{P}(a \leq X \leq b) = \int_a^b f(x) dx.$	$\mathbb{P}(0 \leq X \leq 1) = \int_0^1 f(x) dx$
$F(x)$ $F(x)$	CDF	Cumulative distribution function: $F(x) = \mathbb{P}(X \leq x).$	$F(0) = \mathbb{P}(X \leq 0)$
$\mathbf{1}_A$ $\mathbf{1}_A$	Indicator function	Equals 1 if the condition/event A holds, otherwise 0.	$\mathbf{1}_{\{X > 0\}}$

5 Analysis and Asymptotics

Symbol	Meaning	Definition	Example
\rightarrow $\backslash to$	Tends to	Approaches a limit.	$x \rightarrow \infty$
\approx $\backslash approx$	Approximately	Numerical closeness.	$\pi \approx 3.14$
\sim $\backslash sim$	Asymptotically equal	Same growth rate asymptotically.	$f(n) \sim g(n)$
$\mathcal{O}(\cdot)$ $\backslash mathcal{O}(\cdot)$	Big-O	Upper bound on growth rate.	$n^2 + 3n = \mathcal{O}(n^2)$
$o(\cdot)$ $\backslash o(\cdot)$	Little-o	Strictly smaller growth rate.	$n = o(n^2)$
$\Theta(\cdot)$ $\backslash Theta(\cdot)$	Tight bound	Exact asymptotic order.	$n^2 + 3n = \Theta(n^2)$
∞ $\backslash infinity$	Infinity	Unbounded growth.	$x \rightarrow \infty$

6 Linear Maps and Operators

Symbol	Meaning	Definition	Example
\mapsto $\backslash mapsto$	Mapping	Defines input-output relation.	$x \mapsto x^2$
\circ $\backslash circ$	Composition	Function application chaining.	$(f \circ g)(x)$
∇ $\backslash nabla$	Gradient	Vector of partial derivatives.	∇f
∂ $\backslash partial$	Partial derivative	Derivative with respect to one variable.	$\partial_x f$
Δ $\backslash Delta$	Laplacian	Sum of second derivatives.	Δf
\dagger $\backslash dagger$	Adjoint	Generalised transpose operator.	A^\dagger
T $\backslash T$	Transpose	Row–column swap of a matrix.	A^T

7 Advanced and Commonly Seen Symbols

Symbol	Meaning	Definition	Example
\otimes <code>\otimes</code>	Tensor product	Constructs product spaces.	$A \otimes B$
\odot <code>\odot</code>	Hadamard product	Elementwise multiplication.	$(A \odot B)_{ij}$
\mathcal{H} <code>\mathcal{H}</code>	Hilbert space	Complete inner-product space.	$\mathcal{H} = L^2([0, 1])$
\mathcal{L} <code>\mathcal{L}</code>	Operator / loss	Linear operator or loss function.	$\mathcal{L}(\theta)$
\mathcal{O} <code>\mathcal{O}</code>	Operator / set	Generic operator notation.	$\mathcal{O}(n^2)$
\rightleftharpoons <code>\rightleftharpoons</code>	Reversible	Bidirectional dynamics.	$A \rightleftharpoons B$
\rightharpoonup <code>\rightharpoonup</code>	Weak convergence	Weak limit notion.	$x_n \rightharpoonup x$
$\langle\!\langle \cdot \rangle\!\rangle$ <code>\langle\!\langle \cdot \rangle\!\rangle</code>	Ensemble average	Average over realizations.	$\langle\!\langle X \rangle\!\rangle$
$\lceil \cdot \rceil$ <code>\lceil \cdot \rceil</code>	Ceiling	Smallest integer above.	$\lceil 3.2 \rceil = 4$
$\lfloor \cdot \rfloor$ <code>\lfloor \cdot \rfloor</code>	Floor	Largest integer below.	$\lfloor 3.2 \rfloor = 3$