

Max

Notations

Traditional name

Maximum

Traditional notation

$\max\{x_1, x_2, \dots, x_n\}$

Mathematica StandardForm notation

`Max[x1, x2, ..., xn]`

Primary definition

01.34.02.0001.01

$\max\{x_1, x_2\} = \frac{1}{2}(x_1 + x_2 + \sqrt{(x_1 - x_2)^2})$; $x_1 \in \mathbb{R}$, $x_2 \in \mathbb{R}$

01.34.02.0002.01

$\max\{x_1, x_2, \dots, x_n\} = \max\{\max\{x_1, x_2, \dots, x_{n-1}\}, x_n\}$

$\max\{x_1, x_2, \dots, x_n\}$ is the numerically largest of the real numbers x_k .

$\max\{z_1, z_2, \dots, z_n\}$ is not defined for complex numbers z_k .

Specific values

Specialized values

01.34.03.0001.01

$\max\{x\} = x$

01.34.03.0002.01

$\max\{x_1, x_1, \dots, x_1\} = x_1$

01.34.03.0003.01

$\max\{x_1, x_2, x_3\} = \max\{x_1, \max\{x_2, x_3\}\}$

Values at fixed points

01.34.03.0004.01

$\max\{-\infty\} = -\infty$

01.34.03.0005.01
 $\max_{x_1, x_2} \sqrt[3]{x_1 x_2}$

01.34.03.0006.01
 $\max_{x_1, x_2, x_3} \sqrt[3]{x_1 x_2 x_3}$

Values at infinities

01.34.03.0007.01
 $\max_{x_1, x_2} \sqrt[3]{x_1 x_2}$

01.34.03.0008.01
 $\max_{x_1, x_2} \sqrt[3]{x_1 x_2}$

01.34.03.0009.01
 $\max_{x_1, x_2} \sqrt[3]{x_1 x_2}$

General characteristics

Domain and analyticity

\max is real valued function of an arbitrary number of real variables. In \mathbb{R}^n it is a piecewise linear function. The derivative of $\max_{x_1, x_2, \dots, x_n} \sqrt[3]{x_1 x_2 \dots x_n}$ is discontinuous at $x_j = x_k$ for all j, k .

01.34.04.0001.01
 $\max_{x_1, x_2, \dots, x_n} \sqrt[3]{x_1 x_2 \dots x_n} \in \mathbb{R}^n$

Symmetries and periodicities

Permutation symmetry

01.34.04.0002.01
 $\max_{x_1, x_2} \sqrt[3]{x_1 x_2} = \max_{x_2, x_1} \sqrt[3]{x_2 x_1}$

01.34.04.0003.01
 $\max_{x_1, x_2, \dots, x_n} \sqrt[3]{x_1 x_2 \dots x_n} = \max_{x_1, x_2, \dots, x_n} \sqrt[3]{x_1 x_2 \dots x_n}$

Periodicity

No periodicity

Sets of discontinuity

The function $\max_{x_1, x_2, \dots, x_n} \sqrt[3]{x_1 x_2 \dots x_n}$ is continuous function in \mathbb{R}^n .

01.34.04.0004.01
 $\text{DS}_{x_k} \max_{x_1, x_2, \dots, x_n} \sqrt[3]{x_1 x_2 \dots x_n} = \{x_k = 0\}$

Limit representations

01.34.09.0001.01
 $\max_{x_1, x_2} \sqrt[3]{x_1 x_2} = \lim_{a \rightarrow 0} \sqrt[3]{\frac{x_1}{a} + \frac{x_2}{a}}$

01.34.09.0002.01

$$\max_{\Re} \lim_{z \rightarrow \infty} \left(\frac{1}{n} \sum_{k=1}^n x_k^z \right)^{1/z}$$

Transformations

Transformations and argument simplifications

01.34.16.0001.01

$$\max_{\Re} x_1, -x_2, \frac{1}{4}, -x_n \leq \min_{\Re} x_1, x_2, \frac{1}{4}, x_n$$

01.34.16.0002.01

$$\max_{\Re} x^a - x^b \leq x^a - x^b$$

Identities

Functional identities

01.34.17.0001.01

$$\max_{\Re} x_1, x_2 \leq \max_{\Re} x_2, x_1$$

01.34.17.0002.01

$$\max_{\Re} x_1, x_2, x_3, \frac{1}{4} \leq \max_{\Re} x_1, \max_{\Re} x_2, x_3, \frac{1}{4}$$

Complex characteristics

Real part

01.34.19.0001.01

$$\Re \max_{\Re} x_1, x_2, \frac{1}{4}, x_n \leq \max_{\Re} x_1, x_2, \frac{1}{4}, x_n$$

Imaginary part

01.34.19.0002.01

$$\Im \max_{\Re} x_1, x_2, \frac{1}{4}, x_n \leq 0$$

Absolute value

01.34.19.0003.01

$$\max_{\Re} x_1, x_2, \frac{1}{4}, x_n \leq \sqrt{\max_{\Re} x_1, x_2, \frac{1}{4}, x_n^2}$$

Argument

01.34.19.0004.01

$$\arg \max_{\Re} x_1, x_2, \frac{1}{4}, x_n \leq \tan^{-1} \max_{\Re} x_1, x_2, \frac{1}{4}, x_n$$

Conjugate value

01.34.19.0005.01

$$\overline{\max_{\Re} x_1, x_2, \frac{1}{4}, x_n} \leq \max_{\Re} x_1, x_2, \frac{1}{4}, x_n$$

Summation

01.34.23.0001.01

$$\sum_{k=0}^{m-1} \sum_{l=0}^{n-1} \max\left(\frac{k}{m}, \frac{l}{n}\right) \frac{2mn}{3} - \frac{m+n+1}{4} - \frac{m^2+n^2 - \gcd(m,n)}{12mn} \cdot m \cdot n$$

01.34.23.0002.01

$$\sum_{j=0}^{m-1} \sum_{k=0}^{n-1} \sum_{l=0}^{o-1} \max\left(\frac{j}{m}, \frac{k}{n}, \frac{l}{o}\right) \frac{3mno}{4} - \frac{1}{8} \frac{m+n+o+1}{mno} + \frac{2om+m+o}{24n} - \frac{1}{6} \frac{m+n+o}{mno} + \frac{2on+n+o}{24m} + \frac{2nm+m+n}{24o} - \frac{m+1}{24mo} \frac{\gcd(m,o)}{mno} - \frac{m+n+1}{24no} \frac{\gcd(m,n)}{mno} - \frac{m+1}{24mn} \frac{\gcd(m,n)}{mno} \cdot m \cdot n \cdot o$$

Integral transforms

Fourier exp transforms

01.34.22.0001.01

$$F_{t_1, t_2} \max_{t_1, t_2} \int_{t_1}^{t_2} \int_{t_1}^{t_2} \frac{dH_1 + z_2 L}{z_1^2} \dots$$

Laplace transforms

01.34.22.0002.01

$$L_{t_1, t_2} \max_{t_1, t_2} \int_{t_1}^{t_2} \int_{t_1}^{t_2} \frac{z_1^2 + z_2 z_1 + z_2^2}{z_1^2 z_2^2 H_1 + z_2 L} \dots$$

Representations through more general functions

Through other functions

01.34.26.0001.01

$$\max_{x_1, x_2} \int \frac{1}{2} \left(x_1 + x_2 + \sqrt{H_1 - x_2 L^2} \right) \dots$$

Representations through equivalent functions

01.34.27.0001.01

$$\max_{x_1, x_2} \int x_2 + H_1 - x_2 L q H_1 - x_2 L$$

01.34.27.0002.01

$$\max_{x_1, x_2, x_3} \int x_2 + H_1 - x_2 L q H_1 - x_2 L + q H_3 - x_2 L q H_2 - x_1 L + q H_3 - x_1 L q H_1 - x_2 L H_3 - x_2 - H_1 - x_2 L q H_1 - x_2 L$$

01.34.27.0003.01

$$\begin{aligned} & \max_{k_1, x_2, \frac{1}{4}, x_n} \mathbb{L} \sum_{k_1=1}^n \hat{a}_{k_1} - \hat{a}_{k_1} \hat{a}_{k_2} \min_{k_1, x_{k_2}} \mathbb{M} + \sum_{k_1=1}^n \hat{a}_{k_1} \hat{a}_{k_2} \hat{a}_{k_3} \min_{k_1, x_{k_2}, x_{k_3}} \mathbb{M} \frac{1}{4} + \\ & \mathbb{H} \mathbb{L}^{j+1} \sum_{k_1=1}^n \hat{a}_{k_1} \hat{a}_{k_2} \frac{1}{4} \hat{a}_{k_j} \min_{k_1, x_{k_2}, \frac{1}{4}, x_{k_j}} \mathbb{M} \frac{1}{4} + \mathbb{H} \mathbb{L}^{n+1} \sum_{k_1=1}^n \hat{a}_{k_1} \hat{a}_{k_2} \frac{1}{4} \hat{a}_{k_n} \min_{k_1, x_{k_2}, \frac{1}{4}, x_{k_n}} \mathbb{M} \end{aligned}$$

History

The function max is encountered often in mathematics and the natural sciences.

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