

sin() — Trigonometric and hyperbolic functions
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Description

`sin(Z)`, `cos(Z)`, and `tan(Z)` return the appropriate trigonometric functions. Angles are measured in radians. All return real if the argument is real and complex if the argument is complex.

`sin(x)`, x real, returns the sine of x . `sin()` returns a value between -1 and 1 .

`sin(z)`, z complex, returns the complex sine of z , mathematically defined as $\{\exp(i * z) - \exp(-i * z)\}/2i$.

`cos(x)`, x real, returns the cosine of x . `cos()` returns a value between -1 and 1 .

`cos(z)`, z complex, returns the complex cosine of z , mathematically defined as $\{\exp(i * z) + \exp(-i * z)\}/2$.

`tan(x)`, x real, returns the tangent of x .

`tan(z)`, z complex, returns the complex tangent of z , mathematically defined as $\sin(z)/\cos(z)$.

`asin(Z)`, `acos(Z)`, and `atan(Z)` return the appropriate inverse trigonometric functions. Returned results are in radians. All return real if the argument is real and complex if the argument is complex.

`asin(x)`, x real, returns arcsine in the range $[-\pi/2, \pi/2]$. If $x < -1$ or $x > 1$, missing (.) is returned.

`asin(z)`, z complex, returns the complex arcsine, mathematically defined as $-i * \ln\{i * z + \sqrt{1 - z * z}\}$. $\text{Re}(\text{asin}())$ is chosen to be in the interval $[-\pi/2, \pi/2]$.

`acos(x)`, x real, returns arccosine in the range $[0, \pi]$. If $x < -1$ or $x > 1$, missing (.) is returned.

`acos(z)`, z complex, returns the complex arccosine, mathematically defined as $-i * \ln\{z + \sqrt{z * z - 1}\}$. $\text{Re}(\text{acos}())$ is chosen to be in the interval $[0, \pi]$.

`atan(x)`, x real, returns arctangent in the range $(-\pi/2, \pi/2)$.

`atan(z)`, z complex, returns the complex arctangent, mathematically defined as $\ln\{(1 + iz)/(1 - iz)\}/(2i)$. $\text{Re}(\text{atan}())$ is chosen to be in the interval $[0, \pi]$.

`atan2(X, Y)` returns the radian value in the range $(-\pi, \pi]$ of the angle of the vector determined by (X, Y) , the result being in the range $[0, \pi]$ for quadrants 1 and 2 and $[0, -\pi]$ for quadrants 4 and 3. X and Y must be real. `atan2(X, Y)` is equivalent to `arg(C(X, Y))`.

`arg(Z)` returns the arctangent of $\text{Im}(Z)/\text{Re}(Z)$ in the correct quadrant, the result being in the range $(-\pi, \pi]$; $[0, \pi]$ in quadrants 1 and 2 and $[0, -\pi]$ in quadrants 4 and 3. `arg(Z)` is equivalent to `atan2(Re(Z), Im(Z))`.

`sinh(Z)`, `cosh(Z)`, and `tanh(Z)` return the hyperbolic sine, cosine, and tangent, respectively. The returned value is real if the argument is real and complex if the argument is complex.

`sinh(x)`, x real, returns the inverse hyperbolic sine of x , mathematically defined as $\{\exp(x) - \exp(-x)\}/2$.

`sinh(z)`, z complex, returns the complex hyperbolic sine of z , mathematically defined as $\{\exp(z) - \exp(-z)\}/2$.

`cosh(x)`, x real, returns the inverse hyperbolic cosine of x , mathematically defined as $\{\exp(x) + \exp(-x)\}/2$.

`cosh(z)`, z complex, returns the complex hyperbolic cosine of z , mathematically defined as $\{\exp(z) + \exp(-z)\}/2$.

`tanh(x)`, x real, returns the inverse hyperbolic tangent of x , mathematically defined as $\sinh(x)/\cosh(x)$.

`tanh(z)`, z complex, returns the complex hyperbolic tangent of z , mathematically defined as $\sinh(z)/\cosh(z)$.

`asinh(Z)`, `acosh(Z)`, and `atanh(Z)` return the inverse hyperbolic sine, cosine, and tangent, respectively. The returned value is real if the argument is real and complex if the argument is complex.

`asinh(x)`, x real, returns the inverse hyperbolic sine.

`asinh(z)`, z complex, returns the complex inverse hyperbolic sine, mathematically defined as $\ln\{z + \sqrt{z * z + 1}\}$. $\text{Im}(\text{asinh}())$ is chosen to be in the interval $[-\pi/2, \pi/2]$.

`acosh(x)`, x real, returns the inverse hyperbolic cosine. If $x < 1$, missing (.) is returned.

`acosh(z)`, z complex, returns the complex inverse hyperbolic cosine, mathematically defined as $\ln\{z + \sqrt{z * z - 1}\}$. $\text{Im}(\text{acosh}())$ is chosen to be in the interval $[-\pi, \pi]$; $\text{Re}(\text{acosh}())$ is chosen to be nonnegative.

`atanh(x)`, x real, returns the inverse hyperbolic tangent. If $|x| > 1$, missing (.) is returned.

`atanh(z)`, z complex, returns the complex inverse hyperbolic tangent, mathematically defined as $\ln\{(1 + z)/(1 - z)\}/2$. $\text{Im}(\text{atanh}())$ is chosen to be in the interval $[-\pi/2, \pi/2]$.

`pi()` returns the value of π .

Syntax

numeric matrix `sin(numeric matrix Z)`

numeric matrix `cos(numeric matrix Z)`

numeric matrix `tan(numeric matrix Z)`

numeric matrix `asin(numeric matrix Z)`

numeric matrix `acos(numeric matrix Z)`

numeric matrix `atan(numeric matrix Z)`

real matrix `atan2(real matrix X, real matrix Y)`

real matrix `arg(complex matrix Z)`

numeric matrix `sinh(numeric matrix Z)`

numeric matrix `cosh(numeric matrix Z)`

numeric matrix `tanh(numeric matrix Z)`

numeric matrix `asinh(numeric matrix Z)`

numeric matrix `acosh(numeric matrix Z)`

numeric matrix `atanh(numeric matrix Z)`

real scalar `pi()`

Conformability

`atan2(X, Y)`:

X: $r_1 \times c_1$

Y: $r_2 \times c_2$, *X* and *Y* r-conformable

result: $\max(r_1, r_2) \times \max(c_1, c_2)$

`pi()` returns a 1×1 scalar.

All other functions return a matrix of the same dimension as input containing element-by-element calculated results.

Diagnostics

All functions return missing for real arguments when the result would be complex. For instance, `acos(2) = .`, whereas `acos(2+0i) = -1.317i`.

Also see

[M-4] **Scalar** — Scalar mathematical functions

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