erf

Error function

Syntax

```
erf(x)
```

Description

`erf(x)` returns the Error Function evaluated for each element of x.   example

Examples

collapse all

▼   **Find Error Function**

Find the error function of a value.

```
erf(0.76)
```

ans = 0.7175

Find the error function of the elements of a vector.

```
V = [-0.5 0 1 0.72];
erf(V)
```

ans = *1×4*

    -0.5205   0   0.8427   0.6914

Find the error function of the elements of a matrix.

```
M = [0.29 -0.11; 3.1 -2.9];
erf(M)
```

ans = *2×2*

    0.3183   -0.1236
    1.0000   -1.0000

▼   **Find Cumulative Distribution Function of Normal Distribution**

The cumulative distribution function (CDF) of the normal, or Gaussian, distribution with standard deviation σ and mean μ is

$$\phi(x) = \frac{1}{2}\left(1 + \mathrm{erf}\left(\frac{x - \mu}{\sigma\sqrt{2}}\right)\right).$$

Note that for increased computational accuracy, you can rewrite the formula in terms of `erfc` . For details, see Tips.

Plot the CDF of the normal distribution with $\mu = 0$ and $\sigma = 1$.

```matlab
x = -3:0.1:3;
y = (1/2)*(1+erf(x/sqrt(2)));
plot(x,y)
grid on
title('CDF of normal distribution with \mu = 0 and \sigma = 1')
xlabel('x')
ylabel('CDF')
```
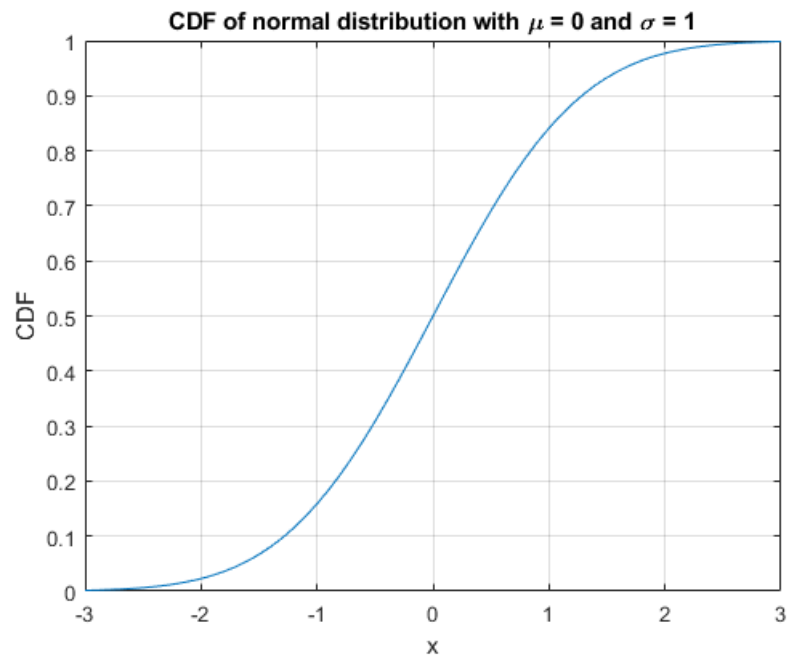

Calculate Solution of Heat Equation with Initial Condition

Where $u(x, t)$ represents the temperature at position x and time t, the heat equation is

$$\frac{\partial u}{\partial t} = c\frac{\partial^2 u}{\partial x^2},$$

where c is a constant.

For a material with heat coefficient k, and for the initial condition $u(x, 0) = a$ for $x > b$ and $u(x, 0) = 0$ elsewhere, the solution to the heat equation is

$$u(x, t) = \frac{a}{2}\left(\text{erf}\left(\frac{x - b}{\sqrt{4kt}}\right)\right).$$

For k = 2, a = 5, and b = 1, plot the solution of the heat equation at times t = 0.1, 5, and 100.

```
x = -4:0.01:6;
t = [0.1 5 100];
a = 5;
k = 2;
b = 1;
figure(1)
hold on
for i = 1:3
    u(i,:) = (a/2)*(erf((x-b)/sqrt(4*k*t(i))));
    plot(x,u(i,:))
end
grid on
xlabel('x')
ylabel('Temperature')
legend('t = 0.1','t = 5','t = 100','Location','best')
title('Temperatures across material at t = 0.1, t = 5, and t = 100')
```
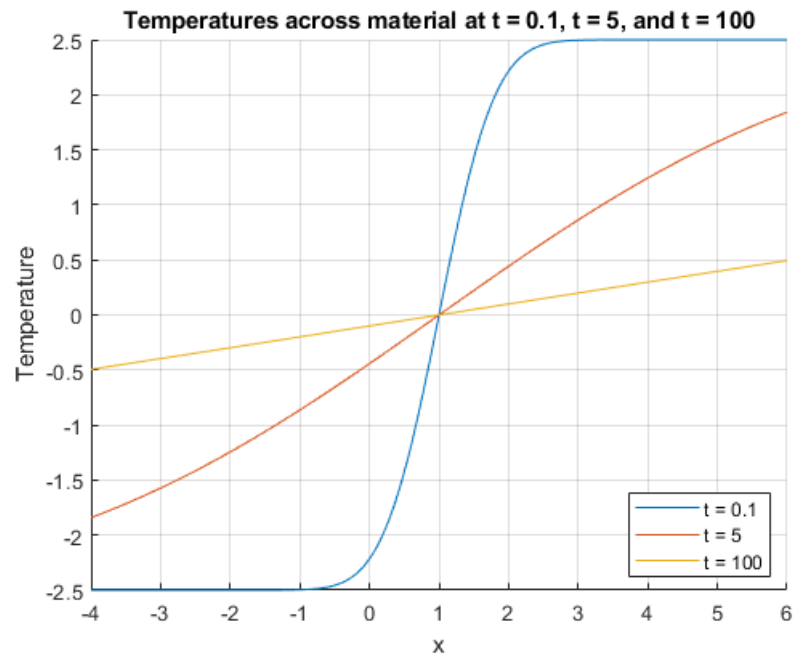
Input Arguments

⌄   **x — Input**
      real number | vector of real numbers | matrix of real numbers | multidimensional array of real numbers

Input, specified as a real number, or a vector, matrix, or multidimensional array of real numbers. x cannot be sparse.

Data Types: `single` | `double`

More About

⌄ Error Function

The error function erf of x is

$$\mathrm{erf}(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt.$$

Tips

- You can also find the standard normal probability distribution using the Statistics and Machine Learning Toolbox™ function `normcdf`. The relationship between the error function `erf` and `normcdf` is

$$\mathrm{normcdf}(x) = \frac{1}{2}\left(1 - \mathrm{erf}\left(\frac{-x}{\sqrt{2}}\right)\right).$$

- For expressions of the form `1 - erf(x)`, use the complementary error function `erfc` instead. This substitution maintains accuracy. When `erf(x)` is close to `1`, then `1 - erf(x)` is a small number and might be rounded down to `0`. Instead, replace `1 - erf(x)` with `erfc(x)`.

Extended Capabilities

> Tall Arrays
Calculate with arrays that have more rows than fit in memory.

> C/C++ Code Generation
Generate C and C++ code using MATLAB® Coder™.

> GPU Arrays
Accelerate code by running on a graphics processing unit (GPU) using Parallel Computing Toolbox™.

> Distributed Arrays
Partition large arrays across the combined memory of your cluster using Parallel Computing Toolbox™.

See Also

`erfc` | `erfcinv` | `erfcx` | `erfinv`

Introduced before R2006a