Einführung in *Mathematica*

Grundlegendes

Beenden von Befehlen

```
4 + 1
```
```
5
```
```
4 + 1;
```

Zugriff auf berechnete Ergebnisse

```
2 + 3
```
```
5
```
```
Sqrt[%]
```
$$\sqrt{5}$$
```
Sqrt[%%]
```
$$\sqrt{5}$$
```
N[%]
```
```
2.23607
```

Variable, Zuweisungen

```
a = 2 + 3
```
```
5
```
```
c = Sqrt[a]
```
$$\sqrt{5}$$
```
N[c]
```
```
2.23607
```
```
a = 10
```
```
10
```
```
c
```
$$\sqrt{5}$$
```
Clear[a, c]
```

Elementare Funktionen und Konstanten

```
Pi
```
$$\pi$$
```
N[Pi]
```
```
3.14159
```
```
E
```
$$e$$
```
N[E]
```
```
2.71828
```
```
I
```
$$i$$
```
I^2
```
```
-1
```
```
Cos[Pi]
```
```
-1
```
```
Sin[Pi]
```
```
0
```
```
Tan[Pi]
```
```
0
```
```
Cot[Pi]
```
```
ComplexInfinity
```



```
Exp[Pi] - E^Pi
```
```
0
```
```
Log[E^2]
```
```
2
```
```
Ln[E^2]
```
$$\text{Ln}[e^2]$$
```
Log[10, 100]
```
```
2
```

Ausdrücke, Regeln, und Funktionen

Ausdrücke

```
f = 1 + Sqrt[x]
```
$$1 + \sqrt{x}$$
```
f[1]
```
$$\left(1 + \sqrt{x}\right)[1]$$
```
f /. x → 5
```
$$1 + \sqrt{5}$$

Regeln, Substituieren von Werten

```
f /. x → y + 1
```
$$1 + \sqrt{1 + y}$$
```
f /. {x → y + 1, y → z + 1}
```
$$1 + \sqrt{1 + y}$$
```
f //. x → y + 1
```
$$1 + \sqrt{1 + y}$$
```
f //. {x → y + 1, y → z + 1}
```
$$1 + \sqrt{2 + z}$$

Funktionen

```
Clear[f]
f[x_] = 1 + Sqrt[x]
```
$$1 + \sqrt{x}$$
```
f[1]
```
```
2
```
```
f[5]
```
$$1 + \sqrt{5}$$
```
5 // f
```
$$1 + \sqrt{5}$$
```
Mittelwert[x_, y_] = (x + y) / 2
```
$$\frac{x + y}{2}$$
```
Mittelwert[3, 5]
```
```
4
```

Listen, Mengen

Liste

```
li = {a, b, c, d}
```
```
{a, b, c, d}
```
```
li[[1]]
```
```
a
```



```
li[[3]]
```
```
c
```
```
li[[-1]]
```
```
d
```
```
li[[{1, 3}]]
```
```
{a, c}
```
```
Map[g, li]
```
```
{g[a], g[b], g[c], g[d]}
```
```
?f
```
```
Global`f

f[x_] = 1 + √x
```
```
Map[f, li]
```
$$\left\{1 + \sqrt{a},\ 1 + \sqrt{b},\ 1 + \sqrt{c},\ 1 + \sqrt{d}\right\}$$
```
Length[li]
```
```
4
```
```
li2 = Table[i, {i, -2, 2}]
```
```
{-2, -1, 0, 1, 2}
```
```
Max[li2]
```
```
2
```
```
Table[i, {i, 1, 4}]
```
```
{1, 2, 3, 4}
```
```
Range[4]
```
```
{1, 2, 3, 4}
```
```
Range[-2, 2]
```
```
{-2, -1, 0, 1, 2}
```
```
Range[-3, 3, 2]
```
```
{-3, -1, 1, 3}
```

Mengen

```
g[x_] = x^2
```
$$x^2$$
```
li2
```
```
{-2, -1, 0, 1, 2}
```
```
Map[g, li2]
```
```
{4, 1, 0, 1, 4}
```
```
qu = Union[%]
```
```
{0, 1, 4}
```
```
Intersection[qu, li2]
```
```
{0, 1}
```
```
Union[qu, li2]
```
```
{-2, -1, 0, 1, 2, 4}
```
```
Complement[qu, li2]
```
```
{4}
```

Listen von Listen, Matrizen

```
A = {{1, 2, 3}, {4, 5, 6}, {7, 8, 9}}
```
```
{{1, 2, 3}, {4, 5, 6}, {7, 8, 9}}
```
```
TableForm[A]
```
```
1   2   3
4   5   6
7   8   9
```



```
MatrixForm[A]
```
$$\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$$
```
X = Table[x[i], {i, 3}]
```
```
{x[1], x[2], x[3]}
```
```
A.X // MatrixForm
```
$$\begin{pmatrix} x[1] + 2\,x[2] + 3\,x[3] \\ 4\,x[1] + 5\,x[2] + 6\,x[3] \\ 7\,x[1] + 8\,x[2] + 9\,x[3] \end{pmatrix}$$
```
A[[1, 2]]
```
```
2
```
```
A[[2, {2, 3}]]
```
```
{5, 6}
```
```
A[[2]]
```
```
{4, 5, 6}
```
```
A[[2, 3]] = 8
```
```
8
```
```
A
```
```
{{1, 2, 3}, {4, 5, 8}, {7, 8, 9}}
```

Algebraische Umformungen

Polynome

```
Clear[X]
f = (X + Y)^10 - (X + Y^2)^5
```
$$(X + Y)^{10} - (X + Y^2)^5$$
```
Expand[f]
```
$$-X^5 + X^{10} + 10\,X^9\,Y - 5\,X^4\,Y^2 + 45\,X^8\,Y^2 + 120\,X^7\,Y^3 - 10\,X^3\,Y^4 + 210\,X^6\,Y^4 + 252\,X^5\,Y^5 - 10\,X^2\,Y^6 + 210\,X^4\,Y^6 + 120\,X^3\,Y^7 - 5\,X\,Y^8 + 45\,X^2\,Y^8 + 10\,X\,Y^9$$
```
Collect[f, X]
```
$$X^{10} + 10\,X^9\,Y + 45\,X^8\,Y^2 + 120\,X^7\,Y^3 + 210\,X^6\,Y^4 + X^5\,(-1 + 252\,Y^5) + X^4\,(-5\,Y^2 + 210\,Y^6) + X^3\,(-10\,Y^4 + 120\,Y^7) + X^2\,(-10\,Y^6 + 45\,Y^8) + X\,(-5\,Y^8 + 10\,Y^9)$$
```
Collect[f, X, Factor]
```
$$X^{10} + 10\,X^9\,Y + 45\,X^8\,Y^2 + 120\,X^7\,Y^3 + 210\,X^6\,Y^4 + 5\,X\,Y^8\,(-1 + 2\,Y) + 5\,X^2\,Y^6\,(-2 + 9\,Y^2) + 10\,X^3\,Y^4\,(-1 + 12\,Y^3) + 5\,X^4\,Y^2\,(-1 + 42\,Y^4) + X^5\,(-1 + 252\,Y^5)$$

```
Factor[f]
```

$$X\,(-1+X+2\,Y)\,(X^4+X^5+X^6+X^7+X^8+2\,X^4\,Y+4\,X^5\,Y+6\,X^6\,Y+8\,X^7\,Y+5\,X^3\,Y^2+9\,X^4\,Y^2+17\,X^5\,Y^2+29\,X^6\,Y^2+10\,X^3\,Y^3+28\,X^4\,Y^3+62\,X^5\,Y^3+10\,X^2\,Y^4+30\,X^3\,Y^4+86\,X^4\,Y^4+20\,X^2\,Y^5+80\,X^3\,Y^5+10\,X\,Y^6+50\,X^2\,Y^6+20\,X\,Y^7+5\,Y^8)$$

```
Coefficient[f, X, 5]
```

$$-1+252\,Y^5$$

```
Coefficient[f, X^5]
```

$$-1+252\,Y^5$$

```
Exponent[f, X]
```

$$10$$

```
Exponent[f, X, Min]
```

$$1$$

```
Exponent[f, X, h]
```

$$h[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]$$

Transzendente Funktionen

```
Sin[x]^2 + Cos[x]^2
```

$$\text{Cos}[x]^2+\text{Sin}[x]^2$$

```
Simplify[%]
```

$$1$$

```
Log[1 + Sqrt[2]] - ArcSinh[1]
```

$$-\text{ArcSinh}[1]+\text{Log}\left[1+\sqrt{2}\right]$$

```
Simplify[%]
```

$$-\text{ArcSinh}[1]+\text{Log}\left[1+\sqrt{2}\right]$$

```
FullSimplify[%]
```

$$0$$

```
Log[27 n]
```

$$\text{Log}[27\,n]$$

```
Expand[%]
```

$$\text{Log}[27\,n]$$

```
Simplify[%]
```

$$\text{Log}[27\,n]$$

```
FullSimplify[%]
```

$$\text{Log}[27\,n]$$

```
Expand[Log[27 n], Trig → True]
```

$$\text{Log}[27\,n]$$

```
PowerExpand[Log[27 n]]
```

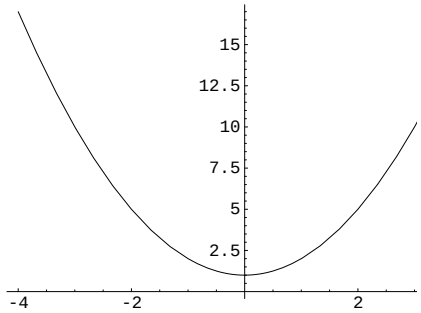
$$\text{Log}[27]+\text{Log}[n]$$

```
PowerExpand[Log[2 n - Sqrt[2] n]]
```

$$\text{Log}\left[2\,n-\sqrt{2}\,n\right]$$

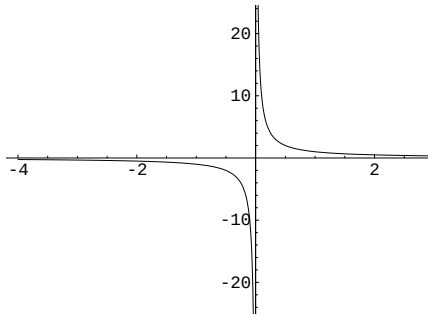
Plots

```
Plot[1 + x^2, {x, -4, 4}]
```




```
- Graphics -
```

```
Plot[1 / x, {x, -4, 4}]
```




```
- Graphics -
```



```
?? Plot
```

```
Plot[f, {x, xmin, xmax}] generates
   a plot of f as a function of
   x from xmin to xmax. Plot[{f1,
   f2, ... }, {x, xmin, xmax}]
   plots several functions fi. More...

Attributes[Plot] = {HoldAll, Protected}


Options[Plot] = {AspectRatio → 1/GoldenRatio,
  Axes → Automatic, AxesLabel → None,
  AxesOrigin → Automatic,
  AxesStyle → Automatic,
  Background → Automatic,
  ColorOutput → Automatic,
  Compiled → True,
  DefaultColor → Automatic, Epilog → {},
  Frame → False, FrameLabel → None,
  FrameStyle → Automatic,
  FrameTicks → Automatic,
  GridLines → None,
  ImageSize → Automatic, MaxBend → 10.,
  PlotDivision → 30., PlotLabel → None,
  PlotPoints → 25, PlotRange → Automatic,
  PlotRegion → Automatic,
  PlotStyle → Automatic, Prolog → {},
  RotateLabel → True, Ticks → Automatic,
  DefaultFont :→ $DefaultFont,
  DisplayFunction :→ $DisplayFunction,
  FormatType :→ $FormatType,
  TextStyle :→ $TextStyle}
```

Mathematisches

Ableitungen

```
D[1 + x^2, x]
```

$$2\,x$$

```
f[x_] = 1 + x^2
```

```
Set::write : Tag Plus in
   ((X + Y)^10 - (X + Y^2)^5)[x_] is Protected.
```

$$1+x^2$$

```
Clear[f]
f[x_] = 1 + x^2
```

$$1+x^2$$

```
D[f, x]
```

$$0$$

```
D[f[x], x]
```

$$2\,x$$

```
f'[x]
```

$$2\,x$$

```
Clear[f]
f[x_, y_] = x^2 + 3 x y + y^2
```

$$x^2+3\,x\,y+y^2$$

```
f'[x, y]
```

$$f'[x, y]$$

```
Derivative[1, 0][f][x, y]
```

$$2\,x+3\,y$$

```
Derivative[0, 1][f][x, y]
```

$$3\,x+2\,y$$

```
Derivative[1, 1][f][x, y]
```

$$3$$


```
Derivative[2, 0][f][x, y]
```

$$2$$

Reihen

```
e1 = Series[Sin[x], {x, 0, 5}]
```

$$x-\frac{x^3}{6}+\frac{x^5}{120}+O[x]^6$$

```
Coefficient[e1, x, 5]
```

$$\frac{1}{120}$$

```
f = x - x^3 / 6 + x^5 / 120 + x^6
```

$$x-\frac{x^3}{6}+\frac{x^5}{120}+x^6$$

```
e2 = Series[f, {x, 0, 5}]
```

$$x-\frac{x^3}{6}+\frac{x^5}{120}+O[x]^6$$

```
e1 - e2
```

$$O[x]^6$$

```
Series[Sin[x] - f, {x, 0, 5}]
```

$$O[x]^6$$

```
e3 = Series[Sqrt[x^2 + 1],
  {x, Infinity, 5}]
```

$$\frac{1}{\frac{1}{x}}+\frac{1}{2\,x}-\frac{1}{8}\left(\frac{1}{x}\right)^3+O\left[\frac{1}{x}\right]^5$$

```
e3 * Log[x]
```

$$-\frac{\text{Log}\left[\frac{1}{x}\right]}{\frac{1}{x}}-\frac{\text{Log}\left[\frac{1}{x}\right]}{2\,x}+\frac{1}{8}\,\text{Log}\left[\frac{1}{x}\right]\left(\frac{1}{x}\right)^3+O\left[\frac{1}{x}\right]^5$$

```
Series[Gamma[x], {x, Infinity, 5}]
```

$$e^{-x}\,x^x\left(\sqrt{2\,\pi}\,\sqrt{\frac{1}{x}}+\frac{1}{6}\,\sqrt{\frac{\pi}{2}}\left(\frac{1}{x}\right)^{3/2}+\frac{1}{144}\,\sqrt{\frac{\pi}{2}}\left(\frac{1}{x}\right)^{5/2}-\frac{139\,\sqrt{\frac{\pi}{2}}\left(\frac{1}{x}\right)^{7/2}}{25920}-\frac{571\,\sqrt{\frac{\pi}{2}}\left(\frac{1}{x}\right)^{9/2}}{1244160}+O\left[\frac{1}{x}\right]^{11/2}\right)$$