lektion2

October 17, 2019

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1 Lektion 2

[1]:
```
from sympy import *
init_printing()
```

1.1 Zahlen, Symbole

[2]:
```
1+1
```

[2]: 2

[3]:
```
2*3
```

[3]: 6

[4]:
```
1
```

[4]: 1

[5]:
```
type(1)
```

[5]: int

[6]:
```
1.0
```

[6]: 1.0

[7]:
```
type(1.0)
```

[7]: float

[8]:
```
1+1j
```

[8]: (1+1j)

[9]:
```
type(1+1j)
```

[9]: complex

[10]:
```
drittel = Rational(1,3)
```

[11]:
```
type(drittel)
```

[11]: sympy.core.numbers.Rational

1.1.1 Konstanten in Sympy

[12]:
```
N(pi,20) # Kreiszahl
```

[12]: 3.1415926535897932385

[13]:
```
N(EulerGamma,40) # Euler Gamma
```

[13]: 0.5772156649015328606065120900824024310422

[14]:
```
N(Catalan,30) # Catalans Konstante
```

[14]: 0.915965594177219015054603514932

[15]:
```
N(E,20) # Basis des nat. Logarithmus
```

[15]: 2.7182818284590452354

Zuordnung und Symbole

[16]:
```
s1 = 1
```

[18]:
```
type(s1)
```

[18]: int

[19]:
```
a = Symbol('a')
a
```

[19]: a

[20]:
```
x,y,z = symbols('x y z')
f = y*x**z+1
f
```

[20]: $x^z y + 1$

[21]:
```
a,b = symbols('b a') # nicht nachmachen
print('a ist :', a, 'und b ist', b)
```

```
a ist : b und b ist a
```

[22]:
```
xx, yy = symbols('xx yy',commutative=False)
xx*yy == yy*xx
```

[22]: False

[25]:
```
cos(m*pi)
```

[25]: $(-1)^m$

[ ]:

[26]:
```
m = symbols('m',integer=True)
m.assumptions0
```

[26]:
```
{'integer': True,
 'hermitian': True,
 'noninteger': False,
 'real': True,
 'complex': True,
 'commutative': True,
 'irrational': False,
 'algebraic': True,
 'rational': True,
 'transcendental': False,
 'imaginary': False}
```

[27]:
```
a = Symbol('a',positive=True)
sqrt(a**2), sqrt(b**2)
```

[27]: $\left(a,\ \sqrt{a^2}\right)$

[28]:
```
n = Symbol('n',positive=True,integer=True)
n.assumptions0
```

[28]:
```
{'positive': True,
 'hermitian': True,
 'negative': False,
 'real': True,
 'complex': True,
 'nonzero': True,
 'commutative': True,
 'nonpositive': False,
 'imaginary': False,
 'nonnegative': True,
 'zero': False,
 'integer': True,
 'noninteger': False,
 'irrational': False,
 'algebraic': True,
 'rational': True,
 'transcendental': False}
```

1.2 Tupel, Listen, Mengen, Dictionaries

[38]:
```
tupel = (1,2,'p',pi,2,cos(x),(3,4),3,1)
tupel
```

[38]:
```
(1, 2, 'p', pi, 2, cos(x), (3, 4), 3, 1)
```

[39]:
```
tupel[0]
```

[39]: 1

[42]:
```
tupel.count(1)
```

[42]: 2

[43]:
```
liste = [1,2,'p',pi,2,cos(x),(3,4)]
liste
```

[43]:
```
[1, 2, 'p', pi, 2, cos(x), (3, 4)]
```

[44]:
```
liste[3]
```

[44]: π

[46]:
```
liste[3] = E
liste
```

[46]:
```
[1, 2, 'p', E, 2, cos(x), (3, 4)]
```

[49]:
```
menge = {1,2,pi,sin(x),cos(x),cos(-x),1,2}
menge
```

[49]: $\{1, 2, \pi, \sin(x), \cos(x)\}$

[50]:
```
leereMenge = set() # nicht {}
leereMenge
```

[50]: $\{\}$

[51]:
```
pi in menge
```

[51]: True

[54]:
```
dictionary = {'Alice': 1234, 'Bob': 1224, 'Eve' : 2346}
dictionary['Alice']
```

[54]: 1234

[56]:
```
list(dictionary.keys())
```

[56]: ['Alice', 'Bob', 'Eve']

1.3 Sympifizierung

[63]:
```
f = sympify("a**2*sin(x*pi)+.09*I*10")
f
```

[63]: $a^2 \sin(\pi x) + 0.9i$

[65]:
```
f = sympify("c**2*sin(x*pi)+.09*I*10")
f
```

[65]: $c^2 \sin(\pi x) + 0.9i$

[66]:
```
g = S('(x**2-3)/((x-2)*(x+1))')
g
```

[66]: $$\frac{x^2 - 3}{(x-2)(x+1)}$$

1.4 Zerlegen von Ausdrücken

[67]:
```
f.args
```

[67]: $\left(0.9i,\ c^2 \sin\left(\pi x\right)\right)$

[68]:
```
f.args[0] # Hilft nicht recht weiter
```

[68]: $0.9i$

[72]:
```
f
```

[72]: $c^2 \sin\left(\pi x\right) + 0.9i$

[73]:
```
f.atoms()
```

[73]: $\{0.9, 2, i, \pi, c, x\}$

[74]:
```
f.atoms(Symbol)
```

[74]: $\{c, x\}$

[75]:
```
f.atoms(Number)
```

[75]: $\{0.9, 2\}$

[76]:
```
f.atoms(NumberSymbol)
```

[76]: $\{\pi\}$

[77]:
```
f.atoms(I)
```

[77]: $\{i\}$

[78]:
```
f
```

[78]: $c^2 \sin\left(\pi x\right) + 0.9i$

[81]:
```
f.as_coeff_add()
```

[81]: $\left(0,\ \left(0.9i,\ c^2 \sin\left(\pi x\right)\right)\right)$

[80]:
```
g = f.as_coeff_add()[1][1]
g
```

[80]: $c^2 \sin\left(\pi x\right)$

[82]:
```
g.as_coeff_mul()
```

[82]: $\left(1,\ \left(c^2,\ \sin\left(\pi x\right)\right)\right)$

1.5 Auswertung von Ausdrücken

[86]:
```
g
```

[86]: $c^2 \sin(\pi x)$

[87]:
```
g.subs(x,1) # Ersetzung von x durch 1 in g
```

[87]: 0

[88]:
```
h = 2*x*y+x-y
h
```

[88]: $2xy + x - y$

[90]:
```
h.subs(y,2).subs(x,1) # mehrfache Ersetzung
```

[90]: 3

[91]:
```
h.subs({x:1,y:2}) # mehrfache Ersetzung mit Dictionary (Woerterbuch)
```

[91]: 3

[92]:
```
h.subs([(x,1),(y,2)]) # noch eine Alternative mit Liste von Tupeln
```

[92]: 3

[93]:
```
h.subs(x,1)
```

[93]: $y + 1$

[95]:
```
s = sqrt(8)
s
```

[95]: $2\sqrt{2}$

[96]:
```
s.evalf() # numerische Auswertung
```

[96]: 2.82842712474619

[104]:
```
N(s), s.n()
```

[104]: $(2.82842712474619,\ 2.82842712474619)$

[105]:
```
cosc = (cos(x)-1)/x
cosc
```

[105]: $\dfrac{\cos(x) - 1}{x}$

[109]:
```
cosc.evalf(subs={x:1})
```

[109]: -0.45969769413186

[107]:
```
cosc.subs(x,0) # Achtung Falle
```

[107]:
```
NaN
```

[108]:
```
cosc.evalf(subs={x:0})
```

[108]: 0

1.6 Grenzwerte

[110]:
```
cosc.limit(x,0)
```

[110]: 0

[111]:
```
limit(cosc,x,0)
```

[111]: 0

[116]:
```
Limit(cosc,x,0) # träger Operator
```

[116]: $\lim_{x \to 0^+} \left(\frac{\cos(x) - 1}{x} \right)$

[117]:
```
L = Limit(1/x,x,0,'+')
L
```

[117]: $\lim_{x \to 0^+} \frac{1}{x}$

[114]:
```
L.doit()
```

[114]: ∞

[115]:
```
limit(1/x,x,0,'-')
```

[115]: $-\infty$

[118]:
```
b = factorial(n)/sqrt(n)*(E/n)**n
b
```

[118]: $\frac{\left(\frac{e}{n}\right)^n n!}{\sqrt{n}}$

[119]:
```
L = Limit(b,n,oo)
L
```

[119]: $\lim_{n \to \infty} \left(\frac{\left(\frac{e}{n}\right)^n n!}{\sqrt{n}} \right)$

[120]:
```
L.doit() # das ist leider falsch
```

[120]:
$$0$$

[123]:
```
bb = b.subs(n,100000)
bb.evalf()
```

[123]:
$$2.50663036348877$$

[124]:
```
bb = b.subs(n,100000) - sqrt(2*pi)
bb.evalf()
```

[124]:
$$2.08885776587615 \cdot 10^{-6}$$

1.7 Summen

[125]:
```
s = Sum(m,(m,0,n))
s
```

[125]:
$$\sum_{m=0}^{n} m$$

[126]:
```
s.doit()
```

[126]:
$$\frac{n^2}{2} + \frac{n}{2}$$

[127]:
```
factor(s.doit())
```

[127]:
$$\frac{n\,(n+1)}{2}$$

[128]:
```
s = Sum(x**m,(m,0,n))
s
```

[128]:
$$\sum_{m=0}^{n} x^m$$

[129]:
```
s.doit()
```

[129]:
$$\begin{cases} n+1 & \text{for } x = 1 \\ \frac{1-x^{n+1}}{1-x} & \text{otherwise} \end{cases}$$

[130]:
```
s = Sum(x**m,(m,0,oo))
s
```

[130]:
$$\sum_{m=0}^{\infty} x^m$$

[131]:
```
s.doit()
```

[131]:
$$\begin{cases} \frac{1}{1-x} & \text{for } |x| < 1 \\ \sum_{m=0}^{\infty} x^m & \text{otherwise} \end{cases}$$

[132]:
```
s.doit().args
```

[132]:
$$\left(\left(\frac{1}{1-x}, \ |x| < 1\right), \ \left(\sum_{m=0}^{\infty} x^m, \ \text{True}\right)\right)$$

[133]:
```
s.doit().args[0]
```

[133]:
$$\left(\frac{1}{1-x}, \ |x| < 1\right)$$

[134]:
```
s.doit().args[0][0]
```

[134]:
$$\frac{1}{1-x}$$

[135]:
```
s = Sum((-1)**(m+1)/m,(m,1,oo))
s
```

[135]:
$$\sum_{m=1}^{\infty} \frac{(-1)^{m+1}}{m}$$

[136]:
```
s.doit()
```

[136]:
$$\log(2)$$

[137]:
```
s = Sum(1/m**2,(m,1,oo))
s
```

[137]:
$$\sum_{m=1}^{\infty} \frac{1}{m^2}$$

[138]:
```
s.doit()
```

[138]:
$$\frac{\pi^2}{6}$$

1.8 Integrale

[139]:
```
f = x**2/sqrt(4-x**2)
f
```

[139]:
$$\frac{x^2}{\sqrt{4-x^2}}$$

[140]:
```
F = Integral(f,(x,0,2))
F
```

[140]:
$$\int_0^2 \frac{x^2}{\sqrt{4-x^2}}\,dx$$

[141]:
```
F.doit()
```

[141]:
$$\pi$$

[142]:
```
f.integrate((x,0,2))
```

[142]:
$$\pi$$

[143]:
```
F = Integral(f,x)
F
```

[143]:
$$\int \frac{x^2}{\sqrt{4-x^2}}\,dx$$

[144]:
```
FF = F.doit()
FF
```

[144]:
$$-\frac{x\sqrt{4-x^2}}{2} + 2\operatorname{asin}\left(\frac{x}{2}\right)$$

[145]:
```
limit(FF,x,0), limit(FF,x,2)
```

[145]:
$$(0,\ \pi)$$

[146]:
```
ff = diff(FF,x)
ff
```

[146]:
$$\frac{x^2}{2\sqrt{4-x^2}} - \frac{\sqrt{4-x^2}}{2} + \frac{1}{\sqrt{1-\frac{x^2}{4}}}$$

[147]:
```
simplify(ff)
```

[147]:
$$\frac{x^2}{\sqrt{4-x^2}}$$

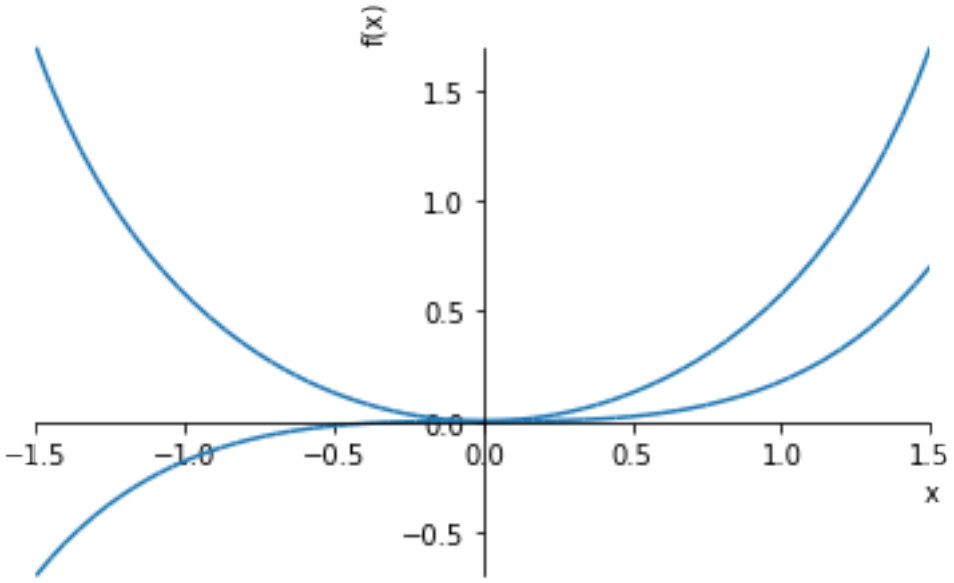
[148]:
```
integrate(exp(-x**2),x)
```

[148]:
$$\frac{\sqrt{\pi}\operatorname{erf}(x)}{2}$$

[149]:
```
integrate(exp(-x**2),(x,-oo,oo))
```

[149]:
$$\sqrt{\pi}$$

[151]:
```
plot(f,FF,(x,-1.5,1.5))
```



[151]:
```
<sympy.plotting.plot.Plot at 0x7fd79568da10>
```

[152]:
```
?plot
```

[ ]:
```

```