Applied Calculus for IT

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1 Limits and Continuity

Find $\lim_{x \to 0} f(x) = \frac{cos(x)}{x}$

```
from sympy import *

x = symbols('x')
f = cos(x)/x
lm = limit(f, x, 0)
print('The limit of f(x) at x =
   0: {}'.format(lm))
```

Find $\lim_{x \to 0^-} f(x) = \frac{cos(x)}{x}$

```
from sympy import *

x = symbols('x')
f = cos(x)/x
lml = limit(f, x, 0 ,'-')
print('The left limit of f(x) at
    x = 0: {}'.format(lml))
```

Find $\lim_{x \to 0^+} f(x) = \frac{cos(x)}{x}$

```
from sympy import *

x = symbols('x')
f = cos(x)/x
lmr = limit(f, x, 0 ,'+')
print('The right limit of f(x)
   at x = 0: {}'.format(lmr))
```

2 Derivatives

Find the first order of derivative of $f(x) = 5x - 3x^2$

```
from sympy import *

x = symbols('x')
f = 5*x - 3*x**2
df = diff(f,x, 1)
print('The first order of
   derivative of f(x) = {}'.
   format(df))
```

Find the second order of derivative of $f(x) = 5x - 3x^2$

```
from sympy import *

x = symbols('x')
f = 5*x - 3*x**2
df = diff(f,x, 2)
print('The second order of
   derivative of f(x) = {}'.
   format(df))
```

Find the first order of derivative of $f(x) = 5x - 3x^2$ at $x = 2$

```
from sympy import *

x = symbols('x')
f = 5*x - 3*x**2
dfa = diff(f,x, 1).subs(x, 2)
print(' df(2) : {}'.format(dfa))
```

3 Sequences and Series

Find the Taylor polynomial generated by $f(x) = sin(x)$ at $x = 1$ and order 3

```
from sympy import *

x = symbols('x')
expr = sin(x)
taylor_poly = expr.series(x, 1,
   3)
print('Taylor polynomial {}'.
   format(taylor_poly))
```

Find the Maclaurin polynomial generated by $f(x) = sin(x)$ at $x = 0$ and order 3

```
from sympy import *

x = symbols('x')
expr = cos(x)
maclaurin_poly = expr.series(x,
   0, 3)
print('Maclaurin polynomial {}'.
   format(maclaurin_poly))
```

4 Partial Derivatives

$f(x,y) = x^2 + 3xy + y - 1$ find the first-order derivative $\frac{\partial f}{\partial x}$ and $\frac{\partial f}{\partial y}$

```
from sympy import *

x, y = symbols('x, y')
f = x**2 + 3*x*y + y - 1
dfx = diff(f, x, 1)
dfy = diff(f, y, 1)
print('The first order of
   partial derivative of f(x, y)
    w.r.t x = {}'.format(dfx))

print('The first order of
   partial derivative of f(x, y)
    w.r.t y = {}'.format(dfy))
```

5 Extreme Values and Saddle Points

Find the critical value of $f(x) = x^3 - 2x + 1$

```
from sympy import *

x = symbols('x')
f = x**3 - 2*x + 1
df = diff(f, x)
cvals = solveset(df, x)
print('Critical values:',[i for
   i in cvals.evalf()])
```

Find the absolute maximum and minimim values of $f(x) = x^2$ on $[-2, 1]$

```
from sympy import *

x = symbols('x')
f = x**2
x_c = solve(diff(f),x)
candidates = [-2, 1] + x_c
yvals = [f.subs(x, v).evalf()
   for v in candidates]
print('The absoluate maximum is
   ', max(yvals))
print('The absoluate minimum is
   ', min(yvals))
```

6 Integrals

Find the integrate of $f(x) = \int x^2 + x + 1$

```
from sympy import *
from sympy import oo

x = symbols('x')
f = x**2 + x + 1
fin = integrate(f, x)
print('The integrate of f(x) =
   {}'.format(fin))
```

Find the integrate of $f(x,c) = \int_0^2 \frac{1}{x^3 - 2x - c}$

```
from sympy import *
from sympy import oo

x = symbols('x')
f = lambda x, c:1/(x**3 - 2*x -
   c)
fin = integrate(f(x,5), (x, 0,
   2))
print('The integrate of f(x) =
   {}'.format(fin.evalf()))
```