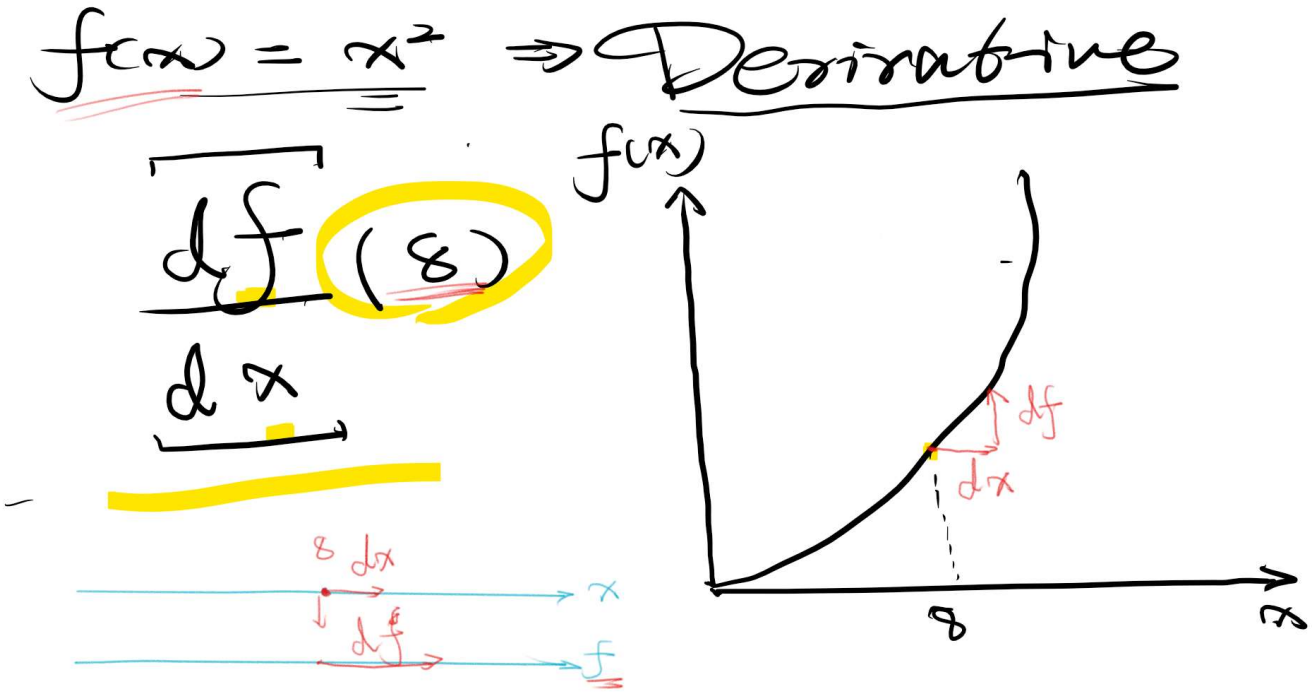
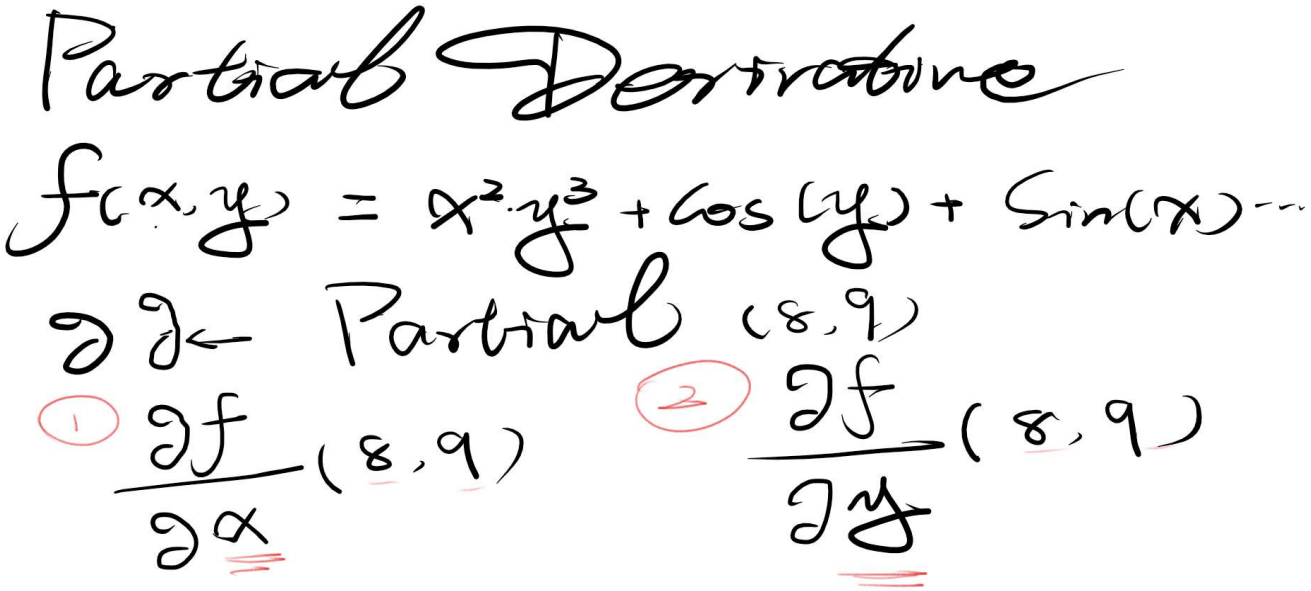
乐学偶得 版权所有 主讲人 ：William 由LX_LAB教研团队提供技术支持 乐学偶得版权所有 公众号：乐学Fintech 正版视频课程 网易云课堂：乐学偶得

1.Derivative(求导)，精髓在于“变化率” 2.Partial Derivative(偏导数) multivariable function





In [1]:

```
import sympy as sym
```

In [2]:

```
sym.init_printing()
```

In [3]:

```
x,y = sym.symbols("x y")
```

In [4]:

```
f = x**2*y**3+sym.cos(y)+sym.sin(x)
```

In [5]:

```
sym.Derivative(f,x)
```

Out[5]:

$$\frac{\partial}{\partial x}\left(x^{2} y^{3} + \sin\left(x\right) + \cos\left(y\right)\right)$$

In [6]:

```
sym.diff(f,x)
```

Out[6]:

$$2 x y^{3} + \cos\left(x\right)$$

In [7]:

```
sym.diff(f,y)
```

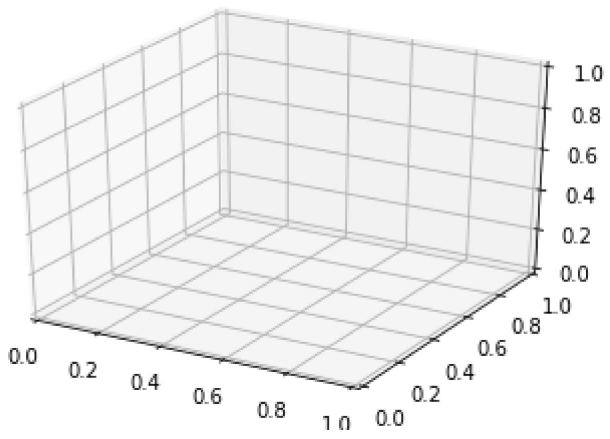
Out[7]:

$$3 x^{2} y^{2} - \sin\left(y\right)$$

In [8]:

```
%matplotlib inline

from mpl_toolkits import mplot3d
import numpy as np
import matplotlib.pyplot as plt
fig = plt.figure()
ax = plt.axes(projection = "3d")
```



In [25]:

```
%matplotlib notebook
def func(x,y):
    return x**2*y+np.cos(y)+np.sin(x)

x = np.linspace(-888,888,8)
y = np.linspace(-888,888,8)
```

In [26]:

```
x
```

Out[26]:

```
array([-888.        , -634.28571429, -380.57142857, -126.85714286,
        126.85714286,  380.57142857,  634.28571429,  888.        ])
```

In [27]:

```
y
```

Out[27]:

```
array([-888.        , -634.28571429, -380.57142857, -126.85714286,
        126.85714286,  380.57142857,  634.28571429,  888.        ])
```

In [28]:

```
X, Y =  np.meshgrid(x,y)
X
```

Out[28]:

```
array([[-888.        , -634.28571429, -380.57142857, -126.85714286,
         126.85714286,  380.57142857,  634.28571429,  888.        ],
       [-888.        , -634.28571429, -380.57142857, -126.85714286,
         126.85714286,  380.57142857,  634.28571429,  888.        ],
       [-888.        , -634.28571429, -380.57142857, -126.85714286,
         126.85714286,  380.57142857,  634.28571429,  888.        ],
       [-888.        , -634.28571429, -380.57142857, -126.85714286,
         126.85714286,  380.57142857,  634.28571429,  888.        ],
       [-888.        , -634.28571429, -380.57142857, -126.85714286,
         126.85714286,  380.57142857,  634.28571429,  888.        ],
       [-888.        , -634.28571429, -380.57142857, -126.85714286,
         126.85714286,  380.57142857,  634.28571429,  888.        ],
       [-888.        , -634.28571429, -380.57142857, -126.85714286,
         126.85714286,  380.57142857,  634.28571429,  888.        ],
       [-888.        , -634.28571429, -380.57142857, -126.85714286,
         126.85714286,  380.57142857,  634.28571429,  888.        ]])
```

In [29]:

```
Y
```

Out[29]:

```
array([[-888.        , -888.        , -888.        , -888.        ,
        -888.        , -888.        , -888.        , -888.        ],
       [-634.28571429, -634.28571429, -634.28571429, -634.28571429,
        -634.28571429, -634.28571429, -634.28571429, -634.28571429],
       [-380.57142857, -380.57142857, -380.57142857, -380.57142857,
        -380.57142857, -380.57142857, -380.57142857, -380.57142857],
       [-126.85714286, -126.85714286, -126.85714286, -126.85714286,
        -126.85714286, -126.85714286, -126.85714286, -126.85714286],
       [ 126.85714286,  126.85714286,  126.85714286,  126.85714286,
         126.85714286,  126.85714286,  126.85714286,  126.85714286],
       [ 380.57142857,  380.57142857,  380.57142857,  380.57142857,
         380.57142857,  380.57142857,  380.57142857,  380.57142857],
       [ 634.28571429,  634.28571429,  634.28571429,  634.28571429,
         634.28571429,  634.28571429,  634.28571429,  634.28571429],
       [ 888.        ,  888.        ,  888.        ,  888.        ,
         888.        ,  888.        ,  888.        ,  888.        ]])
```

In [30]:

```
Z = func(X,Y)
```

In [31]:

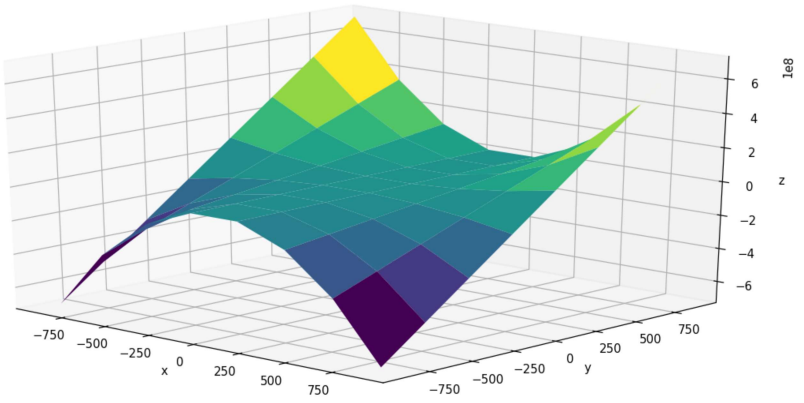
```
Z
```

Out[31]:

```
array([[-7.00227073e+08, -3.57258710e+08, -1.28613136e+08,
        -1.42903498e+07, -1.42903480e+07, -1.28613137e+08,
        -3.57258711e+08, -7.00227072e+08],
       [-5.00162194e+08, -2.55184792e+08, -9.18665241e+07,
        -1.02073917e+07, -1.02073898e+07, -9.18665250e+07,
        -2.55184792e+08, -5.00162192e+08],
       [-3.00097318e+08, -1.53110876e+08, -5.51199158e+07,
        -6.12443687e+06, -6.12443501e+06, -5.51199166e+07,
        -1.53110877e+08, -3.00097317e+08],
       [-1.00032439e+08, -5.10369579e+07, -1.83733043e+07,
        -2.04147891e+06, -2.04147705e+06, -1.83733052e+07,
        -5.10369585e+07, -1.00032438e+08],
       [ 1.00032438e+08,  5.10369593e+07,  1.83733059e+07,
         2.04147778e+06,  2.04147964e+06,  1.83733050e+07,
         5.10369587e+07,  1.00032440e+08],
       [ 3.00097315e+08,  1.53110875e+08,  5.51199148e+07,
         6.12443320e+06,  6.12443506e+06,  5.51199140e+07,
         1.53110875e+08,  3.00097317e+08],
       [ 5.00162194e+08,  2.55184794e+08,  9.18665269e+07,
         1.02073917e+07,  1.02073936e+07,  9.18665260e+07,
         2.55184794e+08,  5.00162196e+08],
       [ 7.00227071e+08,  3.57258710e+08,  1.28613136e+08,
         1.42903470e+07,  1.42903489e+07,  1.28613135e+08,
         3.57258709e+08,  7.00227072e+08]])
```

In [38]:

```
fig =plt.figure()
ax= plt.axes(projection = "3d")
ax.contour3D(X,Y,Z,50,cmap="binary")
```



Out[38]:

```
<matplotlib.contour.QuadContourSet at 0x2696c7c0550>
```

In [46]:

```
ax=plt.axes(projection="3d")
ax.plot_surface(X,Y,Z,rstride=1,cstride=1,cmap="viridis",edgecolor="none")
ax.set_xlabel("x")
ax.set_ylabel("y")
ax.set_zlabel("z")
```

Out[46]:

```
Text(0.5, 0, 'z')
```

$$function: f(x,y)$$

$$GradientVector: \nabla f(x,y) = \begin{bmatrix} \frac{\partial f(x,y)}{\partial x} \\ \frac{\partial f(x,y)}{\partial y} \end{bmatrix} = \begin{bmatrix} f_x \\ f_y \end{bmatrix}$$

$$Grandientmagnitude = |\nabla f(x,y)| = \sqrt{f_x^2 + f_y^2}$$

$$GrawdientDirection = \theta = tan^{-}1\frac{f_x}{f_y}$$

In [ ]:

```

```