1.请详细考察上述梯度下降法中的任意1-2种，并利用它们寻找某二元、三元或多元函数(建 议自行构造)的极小值点，比较并记录你的运算结果

梯度下降法&Momentum

Momentum方法相对于最初的梯度下降法的最大区别就是用一个参数γ记录下了上一次的梯度带来的影响

```python
import numpy as np
def f(x,y):
    return np.power(x-1,2) + np.power(y-2,4) + 4
def fx(x,y):
    return 2*(x-1)
def fy(x,y):
    return 4*np.power(y-2,3)
```

```python
def GD(func, x0, y0):
    h = 0.05
    x,y = x0,y0
    for _ in range(1000):
        x -= h * fx(x,y)
        y -= h * fy(x,y)
    f = func(x,y)
    return x,y,f

def Momentum(func, x0, y0, gamma):
    eta = 0.05
    x,y = x0,y0
    vx = eta * fx(x,y)
    vy = eta * fy(x,y)
    for _ in range(1000):
        vx = gamma*vx + eta*fx(x,y)
        vy = gamma*vy + eta*fy(x,y)
        x -= vx
        y -= vy
    f = func(x,y)
    return x,y,f
```

```python
gdRESULT = GD(f,0.5,0.5)
print("GD预测结果为x={:.2f},y={:.2f},f=
{:.3f}".format(gdRESULT[0],gdRESULT[1],gdRESULT[2]))
momRESULT = Momentum(f,0.5,0.5,0.9)
print("Momentum预测结果为x={:.2f},y={:.2f},f=
{:.3f}".format(momRESULT[0],momRESULT[1],momRESULT[2]))
```

```
```

```
GD预测结果为x=1.00,y=1.95,f=4.000
Momentum预测结果为x=1.00,y=2.02,f=4.000
```

2.选用合适的梯度下降方案，用于计算文件ex1.dat (三列数据分别为欧氏空间的x,y,z坐标)中 所给散点数据的线性(z=a+bx+cy)最小二乘拟合。

```python
# 选择批梯度下降法
X = []
Y = []
Z = []
dim = 0
a,b,c = 1,1,1
with open("./ex1.dat") as file:
    for line in file:
        x,y,z = line.split(",")
        X.append(float(x))
        Y.append(float(y))
        Z.append(float(z))
    dim = len(X)
```

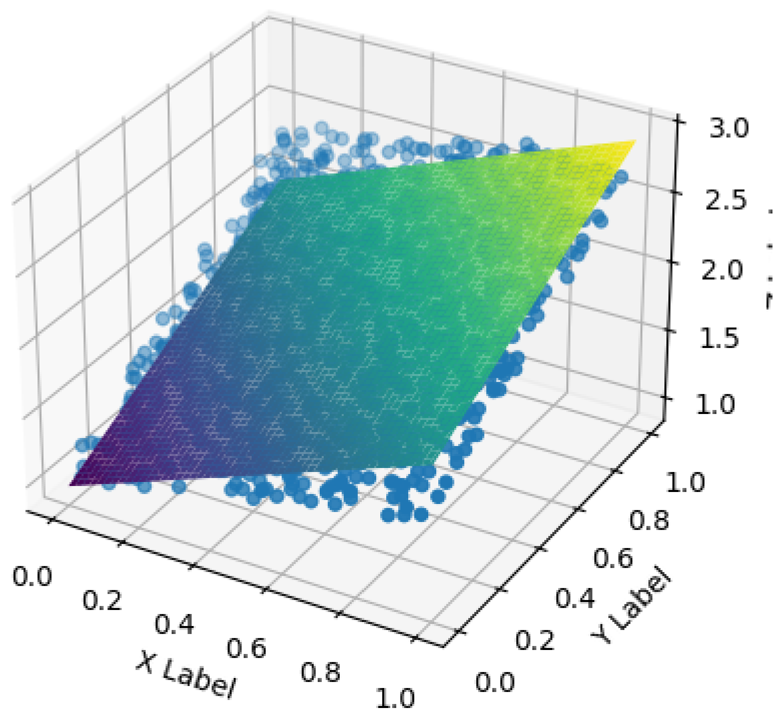
```python
def g(x,y,a,b,c):
    return a + b * x + c * y

# 损失函数
def E(X,Y,Z,a,b,c):
    S = 0
    for i in range(dim):
        S += (Z[i] - g(X[i],Y[i],a,b,c)) ** 2
    return S/dim
# 偏导数
def Ea(X,Y,Z,a,b,c):
    S = 0
    for i in range(dim):
        S += 2 * (g(X[i],Y[i],a,b,c) - Z[i])
    return S/dim
def Eb(X,Y,Z,a,b,c):
    S = 0
    for i in range(dim):
        S += 2 * b * (g(X[i],Y[i],a,b,c) - Z[i])
    return S/dim
def Ec(X,Y,Z,a,b,c):
    S = 0
    for i in range(dim):
        S += 2 * c * (g(X[i],Y[i],a,b,c) - Z[i])
    return S/dim
```

```
def BGD():
    a,b,c = 1,1,1
    alpha = 0.001
    e = [E(X,Y,Z,a,b,c)]

    for _ in range(1000):
        a -= alpha * Ea(X,Y,Z,a,b,c)
        b -= alpha * Eb(X,Y,Z,a,b,c)
        c -= alpha * Ec(X,Y,Z,a,b,c)
        e.append(E(X,Y,Z,a,b,c))
    return a,b,c,e[-1]
```

```
a,b,c,e = BGD()
print("拟合结果:  a = {:.3f},b = {:.3f}, c = {:.3f}, 方差 var =
{:.3f}".format(a,b,c,e))
```

```
拟合结果:  a = 0.967,b = 0.968, c = 0.968, 方差 var = 0.024
```

```
import matplotlib.pyplot as plt

x = np.linspace(0, 1, 100)
y = np.linspace(0, 1, 100)
x, y = np.meshgrid(x, y)
z = g(x, y, a, b, c)

fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')  # 使用一个子图

# 绘制曲面
ax.plot_surface(x, y, z, cmap='viridis')

# 绘制散点图
x, y, z = np.array(X), np.array(Y), np.array(Z)
ax.scatter(x, y, z)
ax.set_xlabel('X Label')
ax.set_ylabel('Y Label')
ax.set_zlabel('Z Label')

plt.show()
```



X Label
Y Label
0.0
0.2
0.4
0.6
0.8
1.0
1.0
1.5
2.0
2.5
3.0