from scipy.integrate import odeint  
import numpy as np  
import matplotlib.pyplot as plt  
import pandas as pd  
  
# 为了显示中文  
from pylab import mpl  
mpl.rcParams['font.sans-serif'] = [u'SimHei']  
mpl.rcParams['axes.unicode\_minus'] = False  
  
#x为人口数，t为年份，r为每年增长率  
data = pd.DataFrame({  
 "x": [3.9, 5.3, 7.2, 9.6, 12.9, 17.1, 23.2, 31.4, 38.6, 50.2, 62.9, 76, 92, 105.7,  
 122.8, 131.7, 150.7, 179.3, 203.2, 226.5, 248.7, 281.4],  
 "t": range(22),  
 "r": [0.2949, 0.3113, 0.2986, 0.2969, 0.2907, 0.3012, 0.3082, 0.2452, 0.2435, 0.242,  
 0.2051, 0.1914, 0.1614, 0.1457, 0.1059, 0.1059, 0.1579, 0.1464, 0.1161, 0.1004,  
 0.1104, 0.1349]  
})  
  
from scipy.optimize import curve\_fit  
  
  
def func(x, R, xm):  
 return R \* (1 - x / xm)  
  
x = data['x']  
r = data['r']  
  
params = curve\_fit(func, x, r)  
#print(params)  
r0 = params[0][0]  
xm = params[0][1]  
print('最优增长率r:',r0)  
print('最大人口数X\_max:',xm)  
  
  
def logistics(x, t):  
 return np.array(r0 \* x \* (1 - x / xm) + 0 \* t)  
  
  
T = np.arange(0, 30, 1)  
x = odeint(logistics, x[0], T)  
plt.scatter(data['t'], data['x'], c='r')  
plt.ylabel('人口数/万人')  
plt.xlabel('年份')  
plt.plot(x)  
plt.show()