期末考试 2

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1 第一题

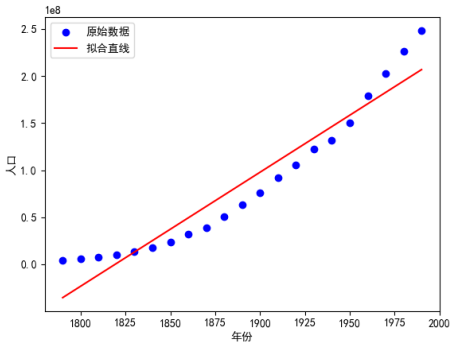
1.1

```
import numpy as np

data = np.loadtxt('uspop.txt')

x = data[:, 0] # 年份
y = data[:, 1] # 人口数
```

1.2

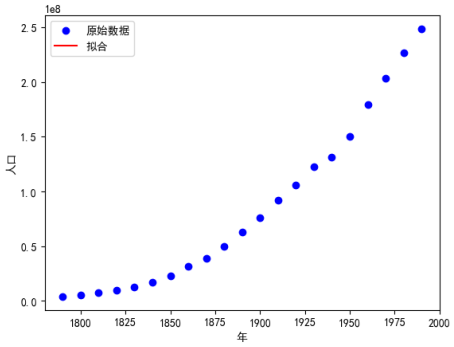
```
import matplotlib.pyplot as plt
from scipy.stats import linregress

plt.rcParams['font.sans-serif'] = ['SimHei']
plt.rcParams['axes.unicode_minus'] = False

slope, intercept, r_value, p_value, std_err = linregress(x, y)

plt.plot(x, y, 'bo', label='原始数据')

plt.plot(x, slope*x + intercept, 'r', label='拟合直线')
```

```
plt.xlabel('年份')
plt.ylabel('人口')
plt.legend()
plt.show()
```



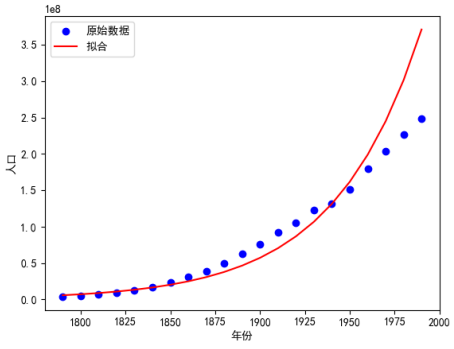
1.3

```
from scipy.optimize import curve_fit

def exponential_func(x, a, c):
  return a * np.exp(c * x)

popt, pcov = curve_fit(exponential_func, x, y)

plt.plot(x, y, 'bo', label='原始数据')

plt.plot(x, exponential_func(x,*popt), 'r', label='拟合')

plt.xlabel('年')
plt.ylabel('人口')
plt.legend()
plt.show()
```



1.4

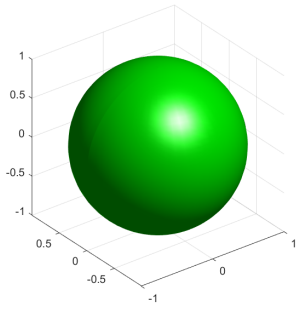
```
y_transformed = np.log(y)

slope, intercept, r_value, p_value, std_err = linregress(x, y_transformed)

plt.plot(x, y, 'bo', label='原始数据')

plt.plot(x, np.exp(intercept) * np.exp(slope * x), 'r', label='拟合')

plt.xlabel('年份')
plt.ylabel('人口')
plt.legend()
plt.show()
```



2 第二题

2.1

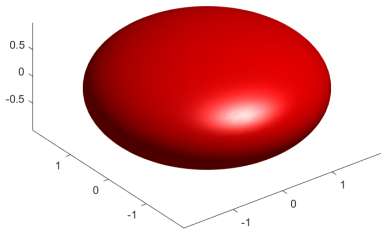
```
[x, y, z] = sphere(50);
r = 1;
x = r * x;
y = r * y;
z = r * z;

figure;
surf(x, y, z, 'FaceColor', 'g', 'EdgeColor', 'none');
axis equal;
camlight;
lighting gouraud;
```



2.2

```
a = 2;
b = 1;
[x, y, z] = meshgrid(linspace(-a, a, 50), linspace(-a, a, 50), linspace(-a,
f = x.^2/a^2 + y.^2/a^2 + z.^2/b^2 - 1;


figure;
```

```
p = patch(isosurface(x, y, z, f, 0));
isonormals(x, y, z, f, p);
set(p, 'FaceColor', 'red', 'EdgeColor', 'none');
daspect([1 1 1]);
view(3);
axis equal;
camlight;
lighting gouraud;
```



3 第三题

Integrate[(Sin[x] - Sin[3 x] + Sin[5 x])/(Cos[x] + Cos[3 x] + Cos[5 x])

4 第四题

Lorenz Attractor

The Lorenz attractor is an attractor that arises in a simplified system of equations describing the two-dimensional flow of fluid. In the early 1960s, Lorenz accidentally discovered the chaotic behavior of this system when he found that, for a simplified system, periodic solutions of the form

$$\psi = \psi_0 sin(\frac{\pi ax}{H}) sin(\frac{\pi z}{H})$$
$$\theta = \theta_0 cos(\frac{\pi ax}{H}) cos(\frac{\pi z}{H})$$

grew for Rayleigh numbers larger than the critical value, $Ra > Ra_c$. Furthermore, vastly different results were obtained for very small changes in the initial values, representing one of the earliest discoveries of the so-called butterfly effect.

Lorenz obtained the simplified equations.

$$\begin{aligned} \dot{X} &= \sigma(Y - X) \\ \dot{Y} &= X(\rho - Z) - Y \\ \dot{Z} &= XY - \beta Z \end{aligned}$$

now known as the Lorenz equations.