Task11

2019 年 6 月 12 日

1 图像处理 +180776+ 胡欣毅 (Python 版)

2 13 周上课随堂任务

1. 不同方差、相关系数下二维高斯函数的图像
2. 不同方差、相关系数下二维高斯函数的平面投影特征 (等高线图)
3. 二维高斯函数值的 FFT 特征
4. 门函数的能量分布
5. 小波初步

```
In [1]: import matplotlib.pyplot as plt
        %matplotlib inline
        from mpl_toolkits.mplot3d import axes3d
        from mpl_toolkits.mplot3d import Axes3D
        from matplotlib import cm
        import matplotlib as mpl

        import cv2
        import numpy as np
```

画图

$$g_{\sigma_x,\sigma_y}(x,y) = \frac{1}{2\pi\left|\Sigma\right|^{\frac{1}{2}}}\exp\left(-\frac{\begin{pmatrix}x & y\end{pmatrix}\Sigma^{-1}\begin{pmatrix}x\\ y\end{pmatrix}}{2}\right)$$

$$g(x,y) = \frac{1}{\left(2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}\right)}\exp\left[-\frac{1}{2\left(1-\rho^2\right)}\left(\frac{(x-\mu_1)^2}{\sigma_1^2} - \frac{2\rho\left(x-\mu_1\right)\left(y-\mu_2\right)}{\sigma_1\sigma_2} + \frac{(y-\mu_2)^2}{\sigma_2^2}\right)\right]$$

$$g(x,y)=\frac{1}{\left(2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}\right)}\exp\left[-\frac{\left(\sigma_2^2(x-\mu_1)^2-2\sigma_1\sigma_2\rho(x-\mu_1)(y-\mu_2)+\sigma_1^2(y-\mu_2)^2\right)}{2(1-\rho^2)\sigma_1^2\sigma_2^2}\right]$$

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}^{-1}=\frac{1}{ad-bc}\begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$$

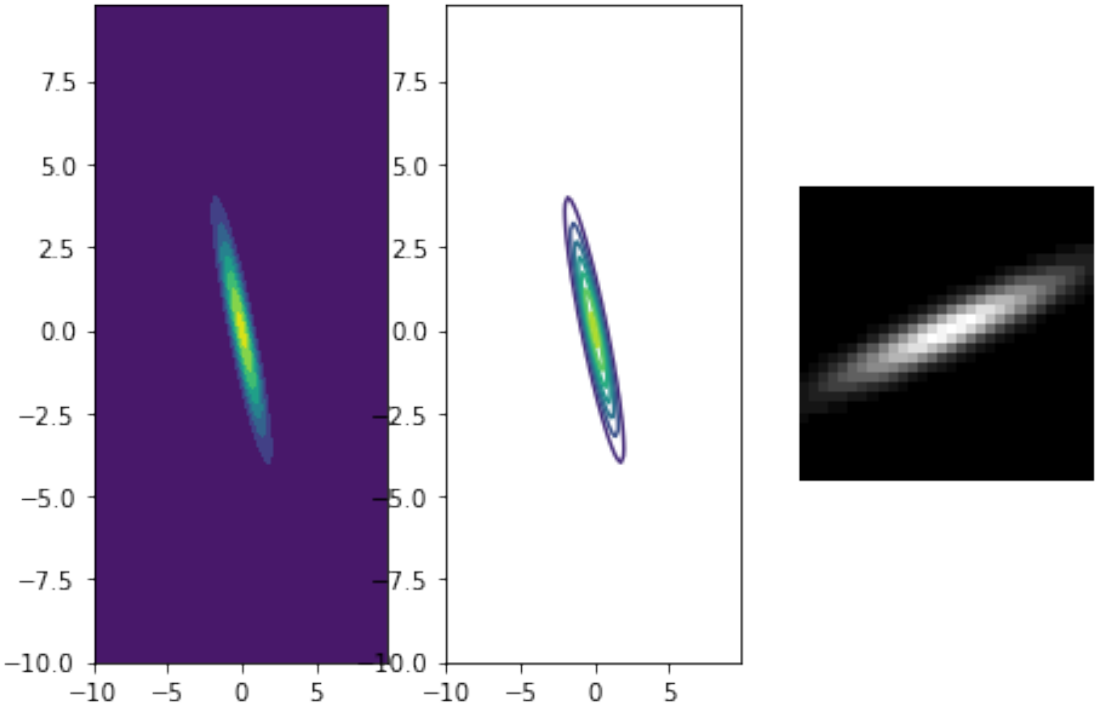
$$\begin{bmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 \\ \rho\sigma_1\sigma_2 & \sigma_2^2 \end{bmatrix}^{-1}=\frac{1}{\sigma_1^2\sigma_2^2-\rho^2\sigma_1^2\sigma_2^2}\begin{bmatrix} \sigma_2^2 & -\rho\sigma_1\sigma_2 \\ -\rho\sigma_1\sigma_2 & \sigma_1^2 \end{bmatrix}$$

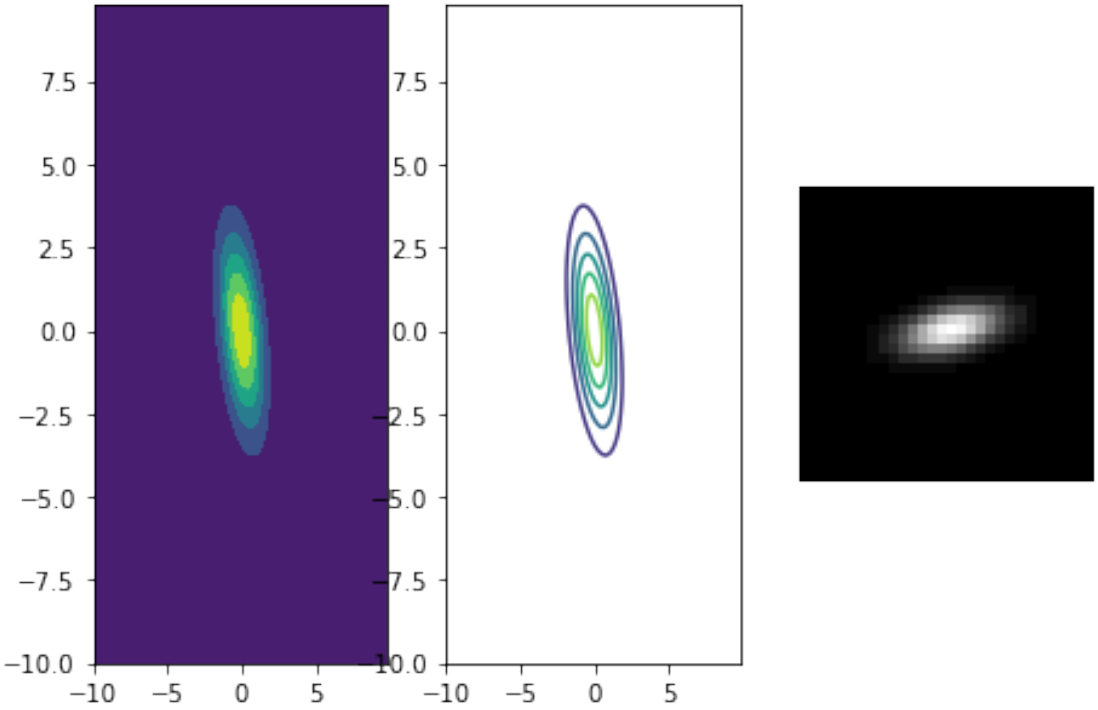
In [2]:
```
sigma1 = 1
sigma2 = 2
ro = [-0.9 ,-0.4 , 0 , 0.4 , 0.9]

X = np.arange(-10, 10, 0.2)
Y = np.arange(-10, 10, 0.2)
X, Y = np.meshgrid(X, Y)
X_len,Y_len = len(X)//2 ,len(Y)//2
```

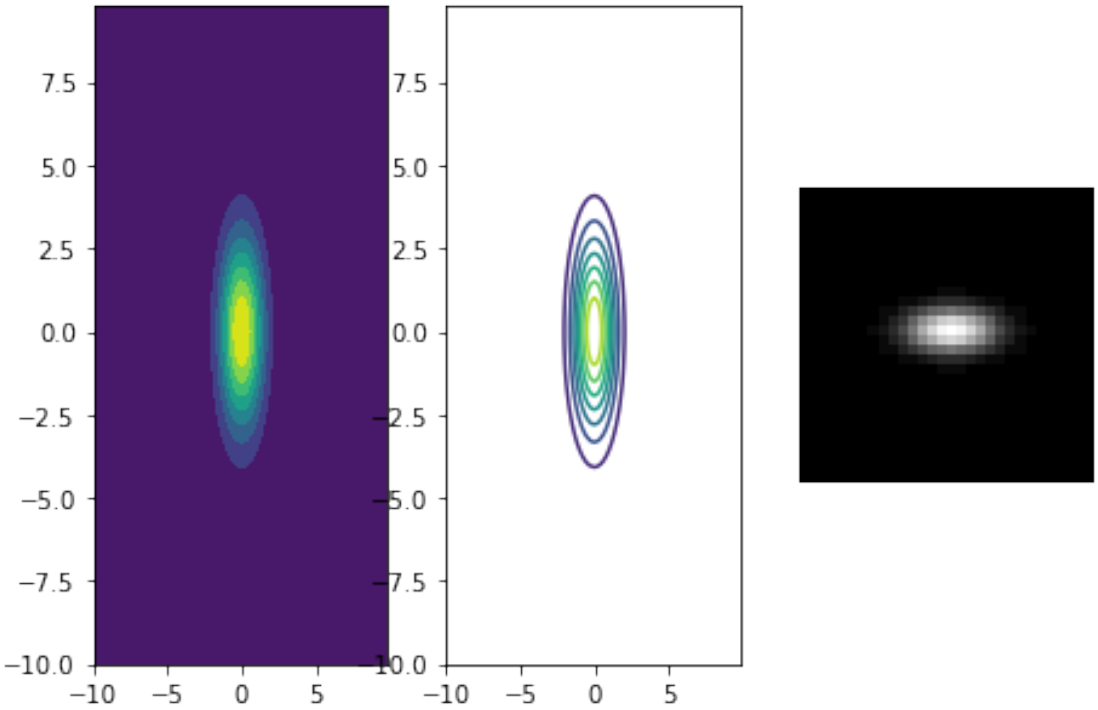
$$\widehat{G}(\xi,\eta)=\exp\left(-2\pi^2(\sigma_1^2\xi^2+\sigma_2^2\eta^2+2\rho\sigma_1\sigma_2\xi\eta)\right)$$

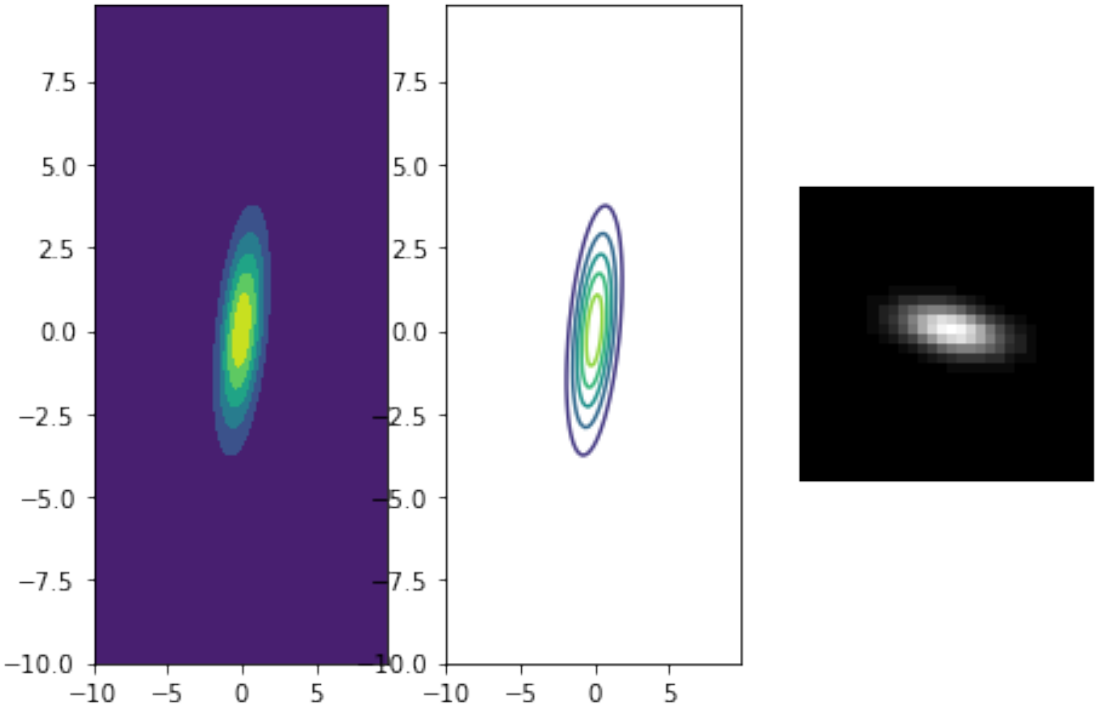
In [3]:
```
for i in range(len(ro)):
    rho = ro[i]
    Z = np.exp((-0.5)*((X*X)/(sigma1**2) + \
                       (Y*Y)/(sigma2**2) - \
                   2*rho*(X*Y)/(sigma1*sigma2))/(1-rho**2) )\
                   /(2*np.pi*sigma1*sigma2*np.sqrt(1-rho**2))

    G = np.exp(-2*(np.pi**2)*( (sigma1**2)*(X**2)  + \
                (sigma2**2)*(Y**2)  + 2*rho*(sigma1*sigma2)*(X*Y)  ))

    '''
    fig = plt.figure()
    ax = Axes3D(fig)
    ax.plot_surface(X, Y, Z, rstride=1, cstride=1, alpha=0.5, cmap=cm.coolwarm)
    #plt.savefig("../"+str(i)+".pdf")
    plt.show()
```

```
'''

plt.figure(figsize=(10,5))
plt.subplot(141)
plt.contourf(X,Y,Z)

plt.subplot(142)
plt.contour(X,Y,Z)

z = np.fft.fft2(Z)
z = np.fft.fftshift(z)

plt.subplot(143)
plt.imshow(np.abs(z).astype(int)[X_len-15:X_len+15,\
    Y_len-15:Y_len+15],cmap="gray",origin='lower')
plt.axis('off')

plt.show()
```




7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
−10
−5
0
5


7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
−10
−5
0
5


7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
−10
−5
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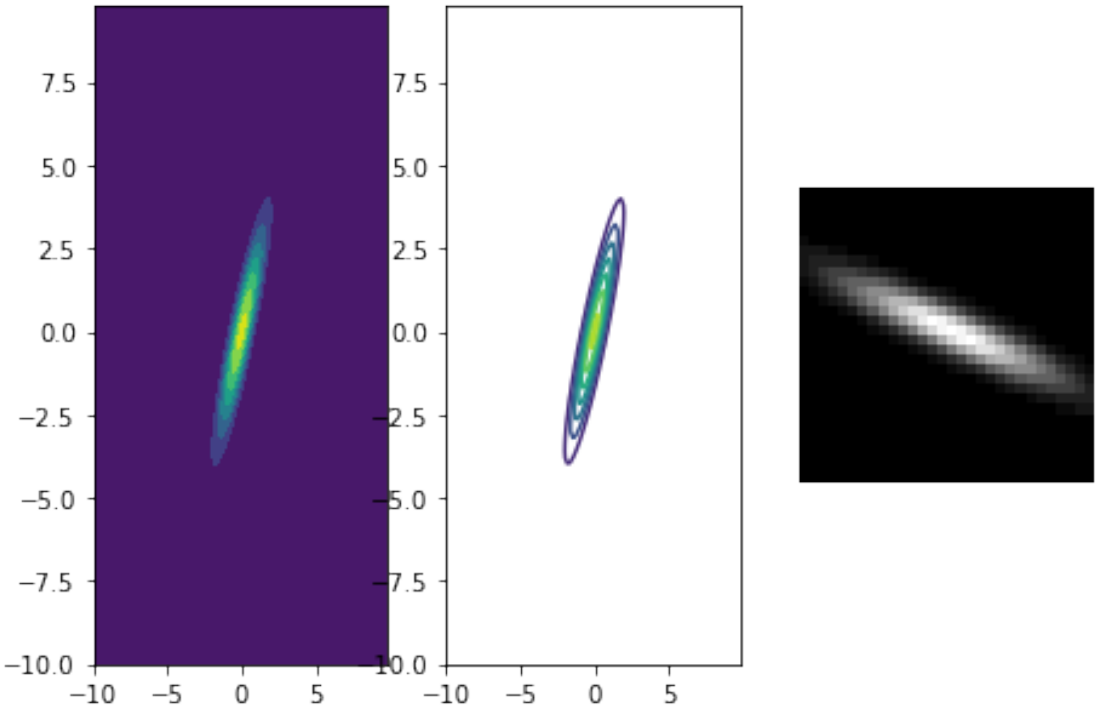
5


7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
−10
−5
0
5

***rho* 从*-1* 到 *1*, 等高线椭圆顺时针转**

2.1 小波初步

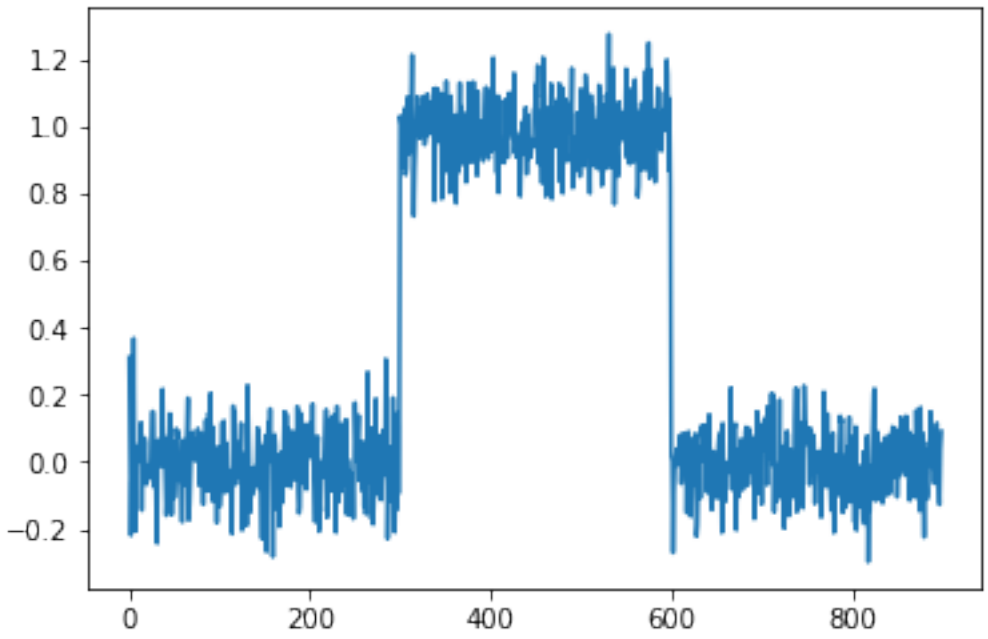
$$\iint f(x,y)h(x-a,y-b)\exp\left(-2\pi i(x\xi+y\eta)\right)dxdy$$

Gabor 小波

$$h(x-a,y-b)\exp\left(-2\pi i(x\xi+y\eta)\right)$$

2.2 门函数的能量分布

```
In [4]: one = np.ones((1,300))
        zero = np.zeros((1,300))
        tmp = np.hstack((zero,one))
        f = np.hstack((tmp,zero))[0]
        fx = f + 0.1* np.random.normal(0, 1, len(f))
        plt.figure()
        plt.plot(fx)
        plt.show()
```



In [5]:
```
xfft = np.fft.fft2(fx.reshape(-1,1))
xfft = np.fft.fftshift(xfft)
plt.figure()
plt.plot(np.abs(xfft)[400:500])
plt.show()
```