Pankajan T. 190428D

In [ ]:

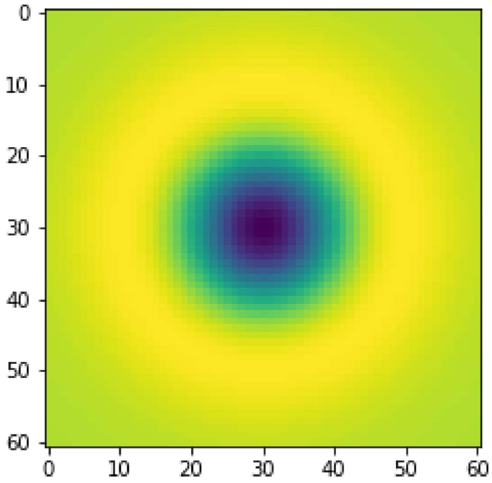
```
import numpy as np
import cv2 as cv
import matplotlib.pyplot as plt
```

In [ ]:

```
sigma = 10
hw = 3*sigma
X, Y = np.meshgrid(np.arange(-hw,hw+1,1),np.arange(-hw,hw+1,1))
log = 1/(2*np.pi*sigma**2)*(X**2/(sigma**2)+Y**2/(sigma**2)-2)*np.exp(-(X**2+Y**2)/(2*

plt.imshow(log)
```

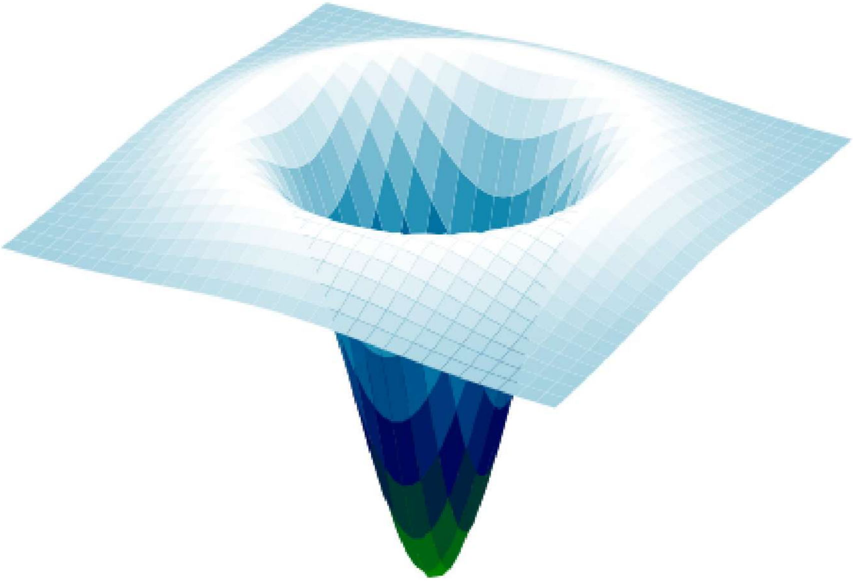
Out[ ]:

```
<matplotlib.image.AxesImage at 0x23c3df037c0>
```



In [ ]:

```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
from matplotlib import cm
from matplotlib.ticker import LinearLocator, FormatStrFormatter

fig = plt.figure(figsize=(10,10))
ax = fig.add_subplot(111, projection='3d')
surf = ax.plot_surface(X, Y, log, cmap=cm.ocean, linewidth = 0, antialiased=True)
ax.zaxis.set_major_locator(LinearLocator(10))
ax.zaxis.set_major_formatter(FormatStrFormatter('%.02f'))

plt.axis("off")
plt.show()
```

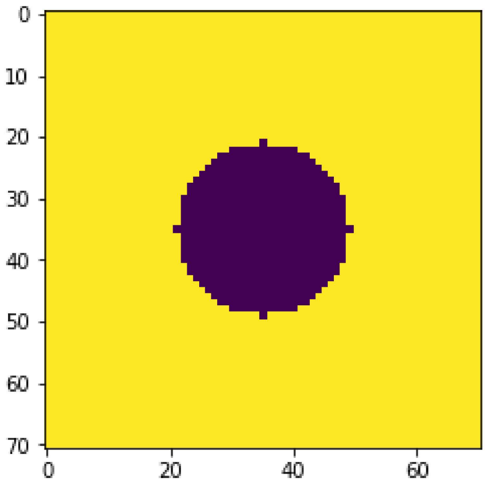


In [ ]:

```
#Q2
w, h = 71,71
hw = w//2
hh = h//2

f = np.ones((h,w),dtype=np.float32)*255
X, Y = np.meshgrid(np.arange(-hw,hw+1,1),np.arange(-hw,hw+1,1))

r = w//5 #14
f *=X**2 + Y**2 > r**2

plt.imshow(f)
```

Out[ ]:

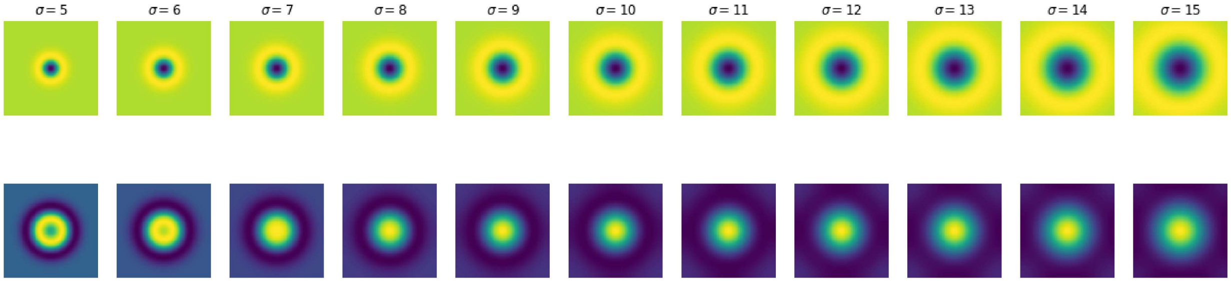
```
<matplotlib.image.AxesImage at 0x23c3de615b0>
```



In [ ]:

```
s = 11
fig , ax =plt.subplots(2,s,figsize = (20,5))

scale_space = np.empty((h,w,s),dtype = np.float32)
sigmas = np.arange(5,16,1)
for i ,sigma in enumerate(np.arange(5,16,1)):
    log_hw = 3*sigma
    X, Y = np.meshgrid(np.arange(-hw,hw+1,1),np.arange(-hw,hw+1,1))
    log = 1/(2*np.pi*sigma**2)*(X**2/(sigma**2)+Y**2/(sigma**2)-2)*np.exp(-(X**2+Y**2)
    f_log = cv.filter2D(f,-1,log)

    scale_space[:,:,i] = f_log
    ax[0,i].imshow(log)
    ax[0,i].set_title(r'$\sigma = {}$'.format(sigma))
    ax[0,i].axis('off')
    ax[1,i].imshow(f_log)
    ax[1,i].axis('off')

indices = np.unravel_index(np.argmax(scale_space, axis = None ),scale_space.shape)
print(indices)
print(sigmas[indices[2]])
```

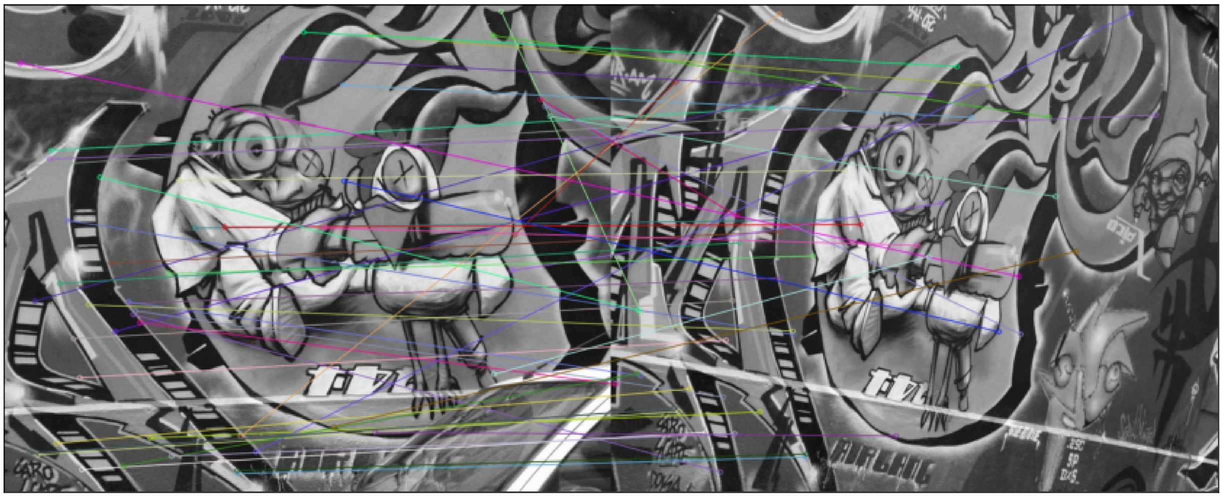
```
(35, 35, 5)
10
```



In [ ]:

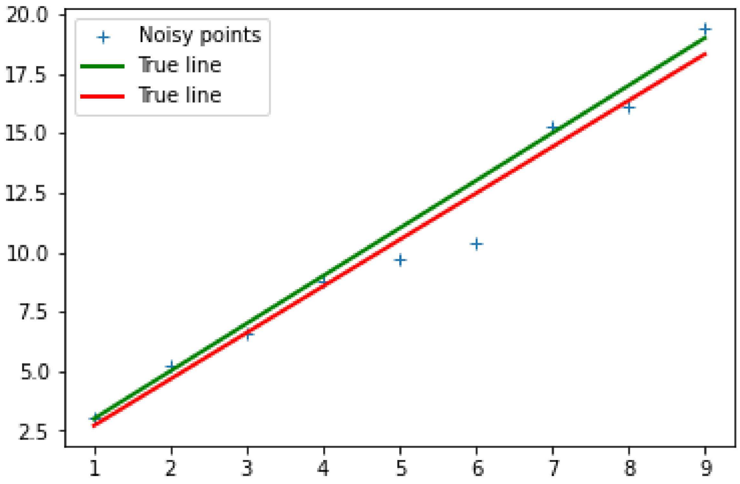
```
import cv2
import matplotlib.pyplot as plt

img1 = cv2.imread('img1.ppm')
img2 = cv2.imread('img3.ppm')

img1 = cv2.cvtColor(img1, cv2.COLOR_BGR2GRAY)
img2 = cv2.cvtColor(img2, cv2.COLOR_BGR2GRAY)
```

```
sift = cv2.SIFT_create()

keypoints_1, descriptors_1 = sift.detectAndCompute(img1,None)
keypoints_2, descriptors_2 = sift.detectAndCompute(img2,None)

bf = cv2.BFMatcher(cv2.NORM_L1, crossCheck=True)

matches = bf.match(descriptors_1,descriptors_2)
matches = sorted(matches, key = lambda x:x.distance)

img3 = cv2.drawMatches(img1, keypoints_1, img2, keypoints_2, matches[:50], img2, flags
plt.figure(figsize=(15,15))
plt.imshow(img3)
plt.xticks([]), plt.yticks([])
plt.show()
```



```
In [ ]: m = 2 # Line equation : y = m*x + c . m i s the s lope . c i s the int e r c ept .
        c = 1
        x = np.arange(1 ,10 , 1)
        np.random.seed(45)
        sigma=1
        noise=sigma*np.random.randn(len(x))
        n = 2.*np.random.randn( len( x ) )
        o= np.zeros(x.shape)
        # o[=1] = 20
        y = m*x + c + noise + o
        n=len(x)
        X=np.concatenate([x.reshape(n,1),np.ones((n,1))],axis=1)
        B=np.linalg.pinv(X.T @ X)@X.T@y
        mster=B[0]
        cstar=B[1]

        plt.plot(x,y,'+',label='Noisy points')
        plt.plot([x[0],x[-1]],[m*x[0]+c , m*x[-1]+c], color='g',linewidth=2, label=r'True line
        plt.plot([x[0],x[-1]],[mster*x[0]+cstar , mster*x[-1]+cstar], color='r',linewidth=2, l

        plt.legend()
```

```
Out[ ]: <matplotlib.legend.Legend at 0x23c3c8e8fd0>
```

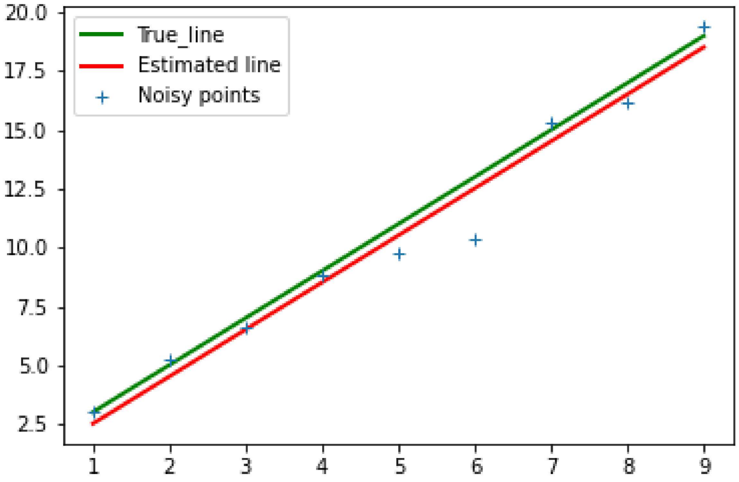


In [ ]:

```
m =2
c = 1
x = np.arange(1,10,1)
np.random.seed(45)
noise = np.random.randn(len(x))
o= np.zeros(x.shape)

y = m*x +c +o +noise
n = len(x)

u11 = np.sum((x -np.mean(x))**2)
u12 = np.sum((x-np.mean(x))*(y-np.mean(y)))
u21 = u12
u22 = np.sum((y-np.mean(y))**2)

W,V = np.linalg.eig(U)

U = np.array([[u11,u12],[u21,u22]])

ev_corresponding_to_smalest_ev = V[:,np.argmin(w)]

a = ev_corresponding_to_smalest_ev[0]
b = ev_corresponding_to_smalest_ev[1]
d = a*np.mean(x) +b*np.mean(y)


mstar = -a/b
cstar = d/b

plt.plot([x[0],x[-1]],[m*x[0]+c,m*x[-1]+c],color='g',linewidth=2,label=r'True_line')
plt.plot([x[0], x[-1]], [mstar*x[0] + cstar, mstar*x[-1] + cstar], color = 'r', linewi
plt.plot(x,y,'+',label='Noisy points')
plt.legend(loc='best')
```

Out[ ]:

```
<matplotlib.legend.Legend at 0x23c3c8cb580>
```


20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
1
2
3
4
5
6
7
8
9
True_line
Estimated line
Noisy points

```
In [ ]:
```