ProgrammingSolution_Sheet2_NayanManSinghPradhan

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## Done By: Nayan Man Singh Pradhan
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## Importing
import numpy as np
import matplotlib.pyplot as plt
from matplotlib import cm
from mpl_toolkits.mplot3d import Axes3D
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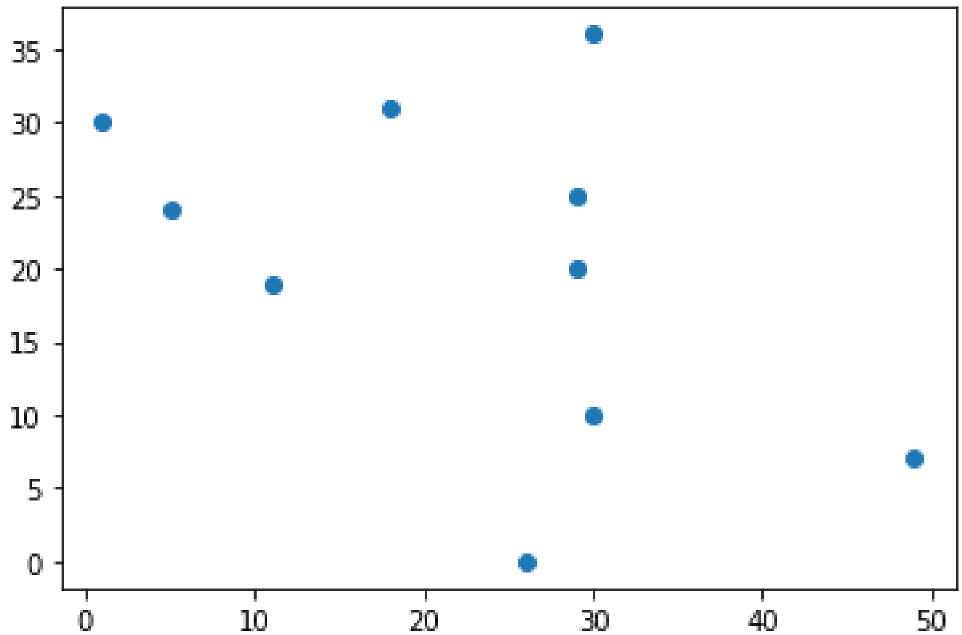
## a)

n = 10 ## number of random points
x = np.random.randint(0, 50, n) ## generates n random integers between 0 and 50
# print(x) ## test
y = np.random.randint(0, 50, n) ## generates n ranodm integers between 0 and 50
# print(y) ## test
coordinates = tuple(zip(x,y))
# print(coordinates) ## test
plt.scatter(x, y) ## create scatter
plt.show() ## plot scatter
```



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## b)

## define 2d distribution over X and Y
N = 100 ## smoothning
X = np.linspace(-4, 4, N)
Y = np.linspace(-2, 4, N)
X, Y = np.meshgrid(X, Y)

## mean matrix and sigma matrix
mean_matrix = np.array([0,1]) ## making mean matrix
sigma_matrix = np.array([[1, 0.25], [0.5, 1]]) ## making sigma matrix

## pack X and Y into single 3d array
pos = np.empty(X.shape + (2,))
pos[:, :, 0] = X
pos[:, :, 1] = Y

## define function that calculates the gaussian function
def twoD_Gaussian(pos, mean_matrix, sigma_matrix):
    shape = mean_matrix.shape[0]
    sigma_inv = np.linalg.inv(sigma_matrix) ## inverse of sigma matrix
    sigma_det = np.linalg.det(sigma_matrix) ## determinant of sigma matrix
    temp_denominator = np.sqrt((2*np.pi)**shape * sigma_det) ## temporary␣
↪denominator used later
    fac = np.einsum('...k,kl,...l->...', pos - mean_matrix, sigma_inv, pos -␣
↪mean_matrix)
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    ## einsum calculates (x-mu)T.sigma-1.(x-mu) in a vectorized way across all␣
↪the input variables
    return (np.exp(-fac/2)/temp_denominator)

Z = twoD_Gaussian(pos, mean_matrix, sigma_matrix)

# Plot
fig = plt.figure()
ax = fig.gca(projection='3d')
ax.plot_surface(X, Y, Z, rstride=3, cstride=3, linewidth=1, antialiased=True,
                cmap=cm.viridis)

cset = ax.contourf(X, Y, Z, zdir='z', offset=-0.15, cmap=cm.viridis)

# Adjust the limits, ticks and view angle
ax.set_zlim(-0.2,0.2)
ax.set_zticks(np.linspace(0,0.2,5))
ax.view_init(27, -21)

plt.show()
```

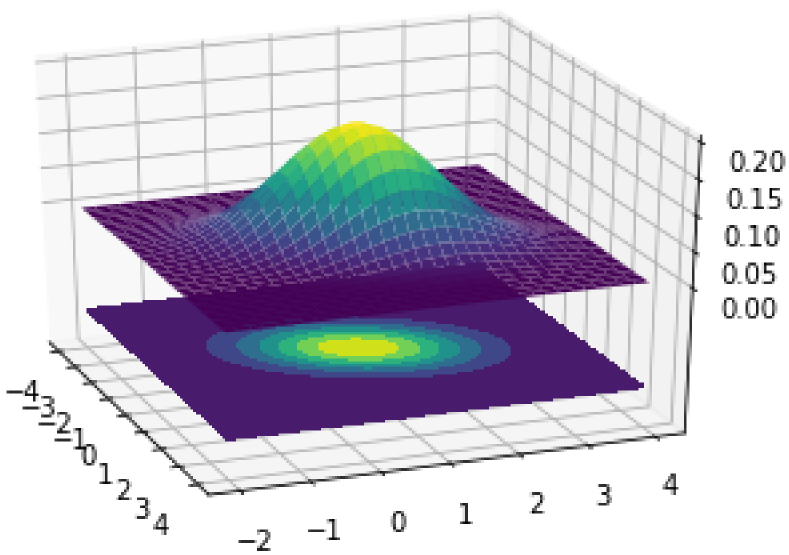


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