

Lab Assignment – IA5 Vector Visualizations

Note on Software used for following Visualizations: (Python)

Python is a High-Level Programming Language, commonly used for data analysis, AI and Machine Learning related fields.

It includes:

- Python is a **high-level programming language** that has English-like syntax. This makes it easier to read and understand the code.
- Python is really easy to **pick up and learn**, that is why a lot of people recommend Python to beginners. You need less lines of code to perform the same task as compared to other major languages like **C/C++** and **Java**.

Q) Create a vector dataset and using an appropriate tool, create its visualization

Answer: Some Key points to note before visualization process:

1. Dataset Used:

The dataset is self-made, depicts the elevation of various points on a surface. Describes the nature of the surface, as well as the cities present within the topography. Total of 49 Rows for 5 Columns. Description given below (within Image).

Contour Data (Vector Visualization).xlsx - Excel

JONATHAN RUFUS SAMUEL

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	x	y	fx	fy	Cities																		
2	-3	-3.5	21	8	(-1,1)																		
3	-2.875	-3.34375	19.22656	7.265625	(0,1.8)																		
4	-2.75	-3.1875	17.53125	6.5625	(-2.5,3)																		
5	-2.625	-3.03125	15.91406	5.890625																			
6	-2.5	-2.875	14.375	5.25																			
7	-2.375	-2.71875	12.91406	4.640625																			
8	-2.25	-2.5625	11.53125	4.0625																			
9	-2.125	-2.40625	10.22656	3.515625																			
10	-2	-2.25	9	3																			
11	-1.875	-2.09375	7.851563	2.515625																			
12	-1.75	-1.9375	6.78125	2.0625																			
13	-1.625	-1.78125	5.789063	1.640625																			
14	-1.5	-1.625	4.875	1.25																			
15	-1.375	-1.46875	4.039063	0.890625																			
16	-1.25	-1.3125	3.28125	0.5625																			
17	-1.125	-1.15625	2.601563	0.265625																			
18	-1	-1	2	0																			
19	-0.875	-0.84375	1.476563	-0.23438																			
20	-0.75	-0.6875	1.03125	-0.4375																			
21	-0.625	-0.53125	0.664063	-0.60938																			
22	-0.5	-0.375	0.375	-0.75																			
23	-0.375	-0.21875	0.164063	-0.85938																			
24	-0.25	-0.0625	0.03125	-0.9375																			
25	-0.125	0.09375	-0.02344	-0.98438																			
26	0	0.25	0	-1																			
27	0.125	0.40625	0.101563	-0.98438																			
28	0.25	0.60938	0.265625	-0.9375																			

fx = 2 * x * y
fy = x^2 - 1

Self-Made Dataset for Vector Visualization, denotes the data points of a contour map for a group of cities. Vector Visualization that is shown is that of variance in Height.

2. Visualization:

a. Visualization using Colour Mapping for Given Vector Visualization

Generalization based on the 2 following Numerical Data: x-coordinate and y-coordinate. Surface Equation given by $Z(x,y) = 2*x*y, x^2-1$. Final Vector Map of Elevation to be displayed.

Code:

```
from turtle import color
import matplotlib.pyplot as plt
from matplotlib import cm
import numpy as np
from mpl_toolkits.mplot3d import axes3d
import pandas as pd

data = pd.read_csv('D:/CompSci - Learn/Python/Data
Visualization/IA5/final.csv')
print(data.head(5))

x = data['x'].values
y = data['y'].values
X,Y = np.meshgrid(x,y)
Z = X**2*Y - Y
fx = 2*X*Y
fy = X**2 - 1
```

```

fig = plt.figure(figsize=(20, 8))
ax1 = fig.add_subplot(121, projection='3d')
ax1.title.set_text('Z = f(x, y) = $x^2 y - y$')
ax1.plot_surface(X, Y, Z)

color = (((fx-y)/2)*2 + ((fy-x)/2)*2)

ax2 = fig.add_subplot(122)
ax2.grid()
ax2.plot([-1, 1], 'bo', label = 'City Group 1', color='red')
ax2.plot([0, 1.8], 'bo', label = 'City Group 2', color='blue')
ax2.plot([-2.5, 3], 'bo', label = 'City Group 3', color='green')
ax2.quiver(X, Y, fx, fy, color, alpha = 1)
ax2.title.set_text('Gradient of Terrain f(x, y) = (2xy, x^2 - 1)')
ax2.legend()
plt.show()

```

Output:

Windows PowerShell

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Try the new cross-platform PowerShell <https://aka.ms/pscore6>

```
PS D:\CompSci - Learn\Python\Data Visualization> python -u "d:\CompSci -
Learn\Python\Data Visualization\IA5\q1.py"
```

	x	y	fx	fy	Cities
0	-3.000	-3.50000	21.000000	8.000000	[-1,1]
1	-2.875	-3.34375	19.226562	7.265625	[0,1.8]
2	-2.750	-3.18750	17.531250	6.562500	[-2.5,3]
3	-2.625	-3.03125	15.914062	5.890625	NaN
4	-2.500	-2.87500	14.375000	5.250000	NaN

```
d:\CompSci - Learn\Python\Data Visualization\IA5\q1.py:21: UserWarning: Z contains NaN
values. This may result in rendering artifacts.
```

```
ax1.plot_surface(X, Y, Z)
```

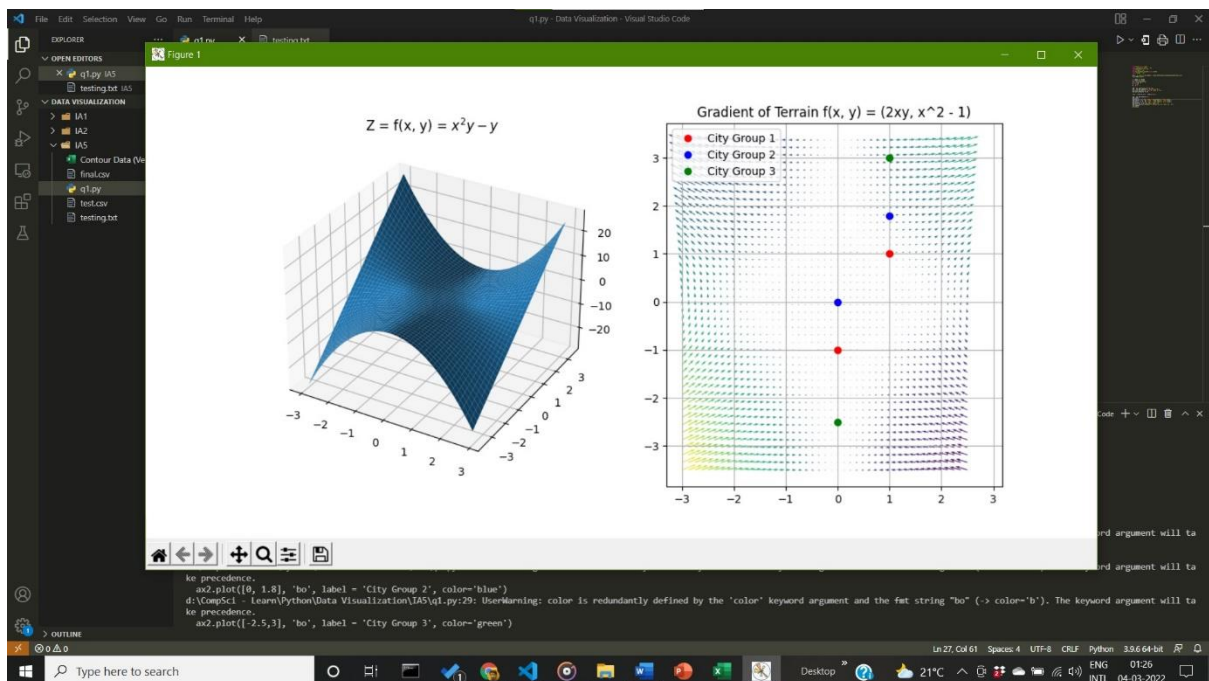
```
d:\CompSci - Learn\Python\Data Visualization\IA5\q1.py:27: UserWarning: color is
redundantly defined by the 'color' keyword argument and the fmt string "bo" (-> color='b').
The keyword argument will take precedence.
```

```
ax2.plot([-1, 1], 'bo', label = 'City Group 1', color='red')
```

```
d:\CompSci - Learn\Python\Data Visualization\IA5\q1.py:28: UserWarning: color is
redundantly defined by the 'color' keyword argument and the fmt string "bo" (-> color='b').
The keyword argument will take precedence.
```

```
ax2.plot([0, 1.8], 'bo', label = 'City Group 2', color='blue')
d:\CompSci - Learn\Python\Data Visualization\IA5\q1.py:29: UserWarning: color is
redundantly defined by the 'color' keyword argument and the fmt string "bo" (-> color='b').
The keyword argument will take precedence.
ax2.plot([-2.5,3], 'bo', label = 'City Group 3', color='green')
PS D:\CompSci - Learn\Python\Data Visualization>
```

```
1 from turtle import color
2 import matplotlib.pyplot as plt
3 from matplotlib import cm
4 import numpy as np
5 from mpl_toolkits.mplot3d import axes3d
6 import pandas as pd
7
8 data = pd.read_csv('D:\CompSci - Learn\Python\Data Visualization\IA5\final.csv')
9 print(data.head(5))
10
11 x = data['x'].values
12 y = data['y'].values
13 X,Y = np.meshgrid(x,y)
14 Z = X**2*Y - Y
15 fx = 2*X*Y
16 fy = X**2 - 1
17
18 fig = plt.figure(figsize=(20, 8))
19 ax1 = fig.add_subplot(121, projection='3d')
20 ax1.title.set text('Z = f(x, y) = $x^2 y - y$')
21 ax1.plot_surface(X, Y, Z)
22
23 color = (((fx y)/2)**2 + ((fy x)/2)**2)
24
25 ax2 = fig.add_subplot(122)
26 ax2.grid()
27 ax2.plot([ 1, 1], 'bo', label = 'City Group 1', color='red')
28 ax2.plot([0, 1.8], 'bo', label = 'City Group 2', color='blue')
29 ax2.plot([-2.5,3], 'bo', label = 'City Group 3', color='green')
30 ax2.quiver(X, Y, fx, fy, color, alpha = 1)
31 ax2.title.set text('Gradient of Terrain f(x, y) = (2xy, x^2 - 1)')
32 ax2.legend()
33 plt.show()
```



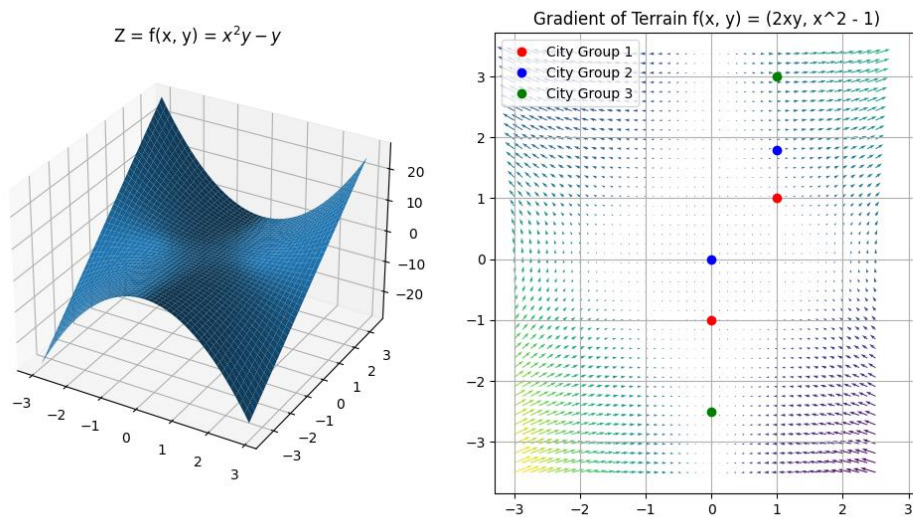
```

q1.py - Data Visualization - Visual Studio Code
File Edit Selection View Go Run Terminal Help
EXPLORER
  OPEN EDITORS
    x1.py IAS
    testing.txt IAS
  DATA VISUALIZATION
    IAS1
    IAS2
    IAS5
    Contour Data (Vector...)
    final.csv
    q1.py
    test.csv
    testing.txt
  OUTLINE
    Type here to search
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL
Windows PowerShell
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Try the new cross-platform PowerShell https://aka.ms/powershell

PS D:\CompSci - Learn\Python\Data Visualization> python -u "d:\CompSci - Learn\Python\Data Visualization\IAS\q1.py"
x      y      fx      fy      Cities
0 -3.0000 -3.500000 21.000000 8.000000 [-1,1]
1 -2.8750 -3.34375 19.226562 7.265625 [0,1.8]
2 -2.7500 -3.18750 17.531250 6.562500 [-2.5,3]
3 -2.6250 -3.03125 15.914062 5.890625 NaN
4 -2.5000 -2.87500 14.375000 5.250000 NaN
d:\CompSci - Learn\Python\Data Visualization\IAS\q1.py:21: UserWarning: Z contains NaN values. This may result in rendering artifacts.
  ax1.plot_surface(X, Y, Z)
d:\CompSci - Learn\Python\Data Visualization\IAS\q1.py:27: UserWarning: color is redundantly defined by the 'color' keyword argument and the fmt string 'bo' (-> color='b'). The keyword argument will take precedence.
  ax2.plot([-1, 1], 'bo', label = 'City Group 1', color='red')
d:\CompSci - Learn\Python\Data Visualization\IAS\q1.py:28: UserWarning: color is redundantly defined by the 'color' keyword argument and the fmt string 'bo' (-> color='b'). The keyword argument will take precedence.
  ax2.plot([0, 1.8], 'bo', label = 'City Group 2', color='blue')
d:\CompSci - Learn\Python\Data Visualization\IAS\q1.py:29: UserWarning: color is redundantly defined by the 'color' keyword argument and the fmt string 'bo' (-> color='b'). The keyword argument will take precedence.
  ax2.plot([-2.5, 3], 'bo', label = 'City Group 3', color='green')
PS D:\CompSci - Learn\Python\Data Visualization>

```



Inference:

Almost all the cities have little to negligible amounts of elevation within them.