

# Customize 3D Surface Plots using Matplotlib

Let's create a lab exercise to demonstrate how to create and customize 3D surface plots using Matplotlib. This exercise will help you understand how to visualize data in three dimensions and customize the appearance of the plots.

## Lab Exercise: 3D Surface Plots in Matplotlib

### Objective

Learn how to create and customize 3D surface plots using Matplotlib.

### Requirements

- Python 3.x
- Matplotlib library
- Numpy library

### Steps

Install Required Libraries (if not already installed):

```
pip install matplotlib numpy
```

## 1. Generate Sample Data:

Generate some sample data to be used in the 3D surface plot.

```
import numpy as np

# Generate sample data
x = np.linspace(-5, 5, 100)
y = np.linspace(-5, 5, 100)
x, y = np.meshgrid(x, y)
z = np.sin(np.sqrt(x**2 + y**2))
```

## 2. Create a Basic 3D Surface Plot:

Create a 3D surface plot using the sample data.

```
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

fig = plt.figure(figsize=(10, 7))
ax = fig.add_subplot(111, projection='3d')

# Create surface plot
surf = ax.plot_surface(x, y, z, cmap='viridis')
```

```
# Add a color bar
fig.colorbar(surf, ax=ax, shrink=0.5, aspect=5)

# Display the plot
plt.show()
```

### 3. Task: Customizing 3D Surface Plots

Explanation: Customize the 3D surface plot to improve its readability and visual appeal.

#### a) Task 1: Adding Titles and Labels:

Add a title, and x, y, and z labels to the plot.

```
fig = plt.figure(figsize=(10, 7))
ax = fig.add_subplot(111, projection='3d')

# Create surface plot
surf = ax.plot_surface(x, y, z, cmap='viridis')

# Add a color bar
fig.colorbar(surf, ax=ax, shrink=0.5, aspect=5)

# Add titles and labels
ax.set_title('3D Surface Plot')
```

```
ax.set_xlabel('X-axis')
ax.set_ylabel('Y-axis')
ax.set_zlabel('Z-axis')

# Display the plot
plt.show()
```

## **b) Task 2: Customizing the Color Map and Adding a Wireframe:**

Change the color map and add a wireframe overlay.

```
fig = plt.figure(figsize=(10, 7))
ax = fig.add_subplot(111, projection='3d')

# Create surface plot
surf = ax.plot_surface(x, y, z, cmap='coolwarm')

# Add wireframe
ax.plot_wireframe(x, y, z, color='black', linewidth=0.5)

# Add a color bar
fig.colorbar(surf, ax=ax, shrink=0.5, aspect=5)

# Add titles and labels
ax.set_title('3D Surface Plot with Wireframe')
```

```
ax.set_xlabel('X-axis')
ax.set_ylabel('Y-axis')
ax.set_zlabel('Z-axis')

# Display the plot
plt.show()
```

### c) Task 3: Adjusting the View Angle:

Adjust the view angle to get a better perspective of the 3D plot.

```
fig = plt.figure(figsize=(10, 7))
ax = fig.add_subplot(111, projection='3d')

# Create surface plot
surf = ax.plot_surface(x, y, z, cmap='viridis')

# Add a color bar
fig.colorbar(surf, ax=ax, shrink=0.5, aspect=5)

# Add titles and labels
ax.set_title('3D Surface Plot with Adjusted View Angle')
ax.set_xlabel('X-axis')
ax.set_ylabel('Y-axis')
ax.set_zlabel('Z-axis')
```

```
# Adjust the view angle
ax.view_init(elev=30, azim=45)

# Display the plot
plt.show()
```

#### **d) Task 4: Adding Contour Projections:**

Add contour projections on the bottom plane.

```
fig = plt.figure(figsize=(10, 7))
ax = fig.add_subplot(111, projection='3d')

# Create surface plot
surf = ax.plot_surface(x, y, z, cmap='viridis', edgecolor='none')

# Add contour projections
ax.contourf(x, y, z, zdir='z', offset=-2, cmap='viridis')

# Add a color bar
fig.colorbar(surf, ax=ax, shrink=0.5, aspect=5)

# Add titles and labels
ax.set_title('3D Surface Plot with Contour Projections')
```

```
ax.set_xlabel('X-axis')
ax.set_ylabel('Y-axis')
ax.set_zlabel('Z-axis')

# Adjust the z limit to include the contour projection
ax.set_zlim(-2, 1)

# Display the plot
plt.show()
```

## Explanation

### Generating Sample Data:

- **numpy.linspace** creates evenly spaced values over a specified range.
- **numpy.meshgrid** creates coordinate matrices from coordinate vectors.
- **numpy.sin** computes the trigonometric sine of an array element-wise.

### Creating a Basic 3D Surface Plot:

- `fig.add_subplot(111, projection='3d')` creates a 3D subplot.
- `plot_surface` creates the 3D surface plot.
- `fig.colorbar` adds a color bar to the plot for reference.

### Customizing the Plot:

- `set_title`, `set_xlabel`, `set_ylabel`, and `set_zlabel` add titles and labels.
- `plot_wireframe` adds a wireframe overlay to the surface plot.
- `ax.view_init` adjusts the elevation and azimuthal angles for a better view.
- `contourf` adds contour projections on the specified plane.

By completing these tasks, you will learn how to create and customize 3D surface plots using Matplotlib, making your data visualizations more informative and visually appealing.