Basics for 3D- visualization and why they are used?

In [9]:
```
# 1)fig = plt.figure(figsize=(10, 8)) - Initialize a new figure with a specific size.
# 2)ax = fig.add_subplot(111, projection='3d') - Add a 3D subplot to the figure.
# 3)x = np.linspace(0, 10, 100)- Create an array of 100 equally spaced points between 0 and 10.
# 4)z = np.sin(x) + np.cos(y)- Calculate the value of z using a mathematical function involving the x variable.
# 5)ax.plot_surface(x, y, z, cmap='viridis')- Plot a 3D surface using the x, y, and z data, with the 'viridis' colorm
# 6)ax.set_xlabel('X') - Set the label for the x-axis.
# 7)ax = fig.add_subplot(111, projection='3d') - Add another 3D subplot to the same figure.
# 8)x = np.arange(len(df['species'].unique()))- Create an array of numerical values representing unique categories fr
# 9)x, y = np.meshgrid(x, y) - Create 2D arrays representing x and y coordinates for a 3D plot.
# 10)ax.bar3d(x.ravel(), y.ravel(), np.zeros_like(z).ravel(), 1, 1, z.ravel()) - Plot a 3D bar chart with given x, y,
# 11)hist, xedges, yedges = np.histogram2d(df['sepal_length'], df['sepal_width'], bins=20)- Compute a 2D histogram of
# 12)xpos, ypos = np.meshgrid(xedges[:-1], yedges[:-1], indexing="ij")- Create meshgrid arrays for x and y coordinate
# 13)xpos = xpos.ravel()-Flatten the meshgrid arrays for x positions to create a 1D array.
```

Data Loading

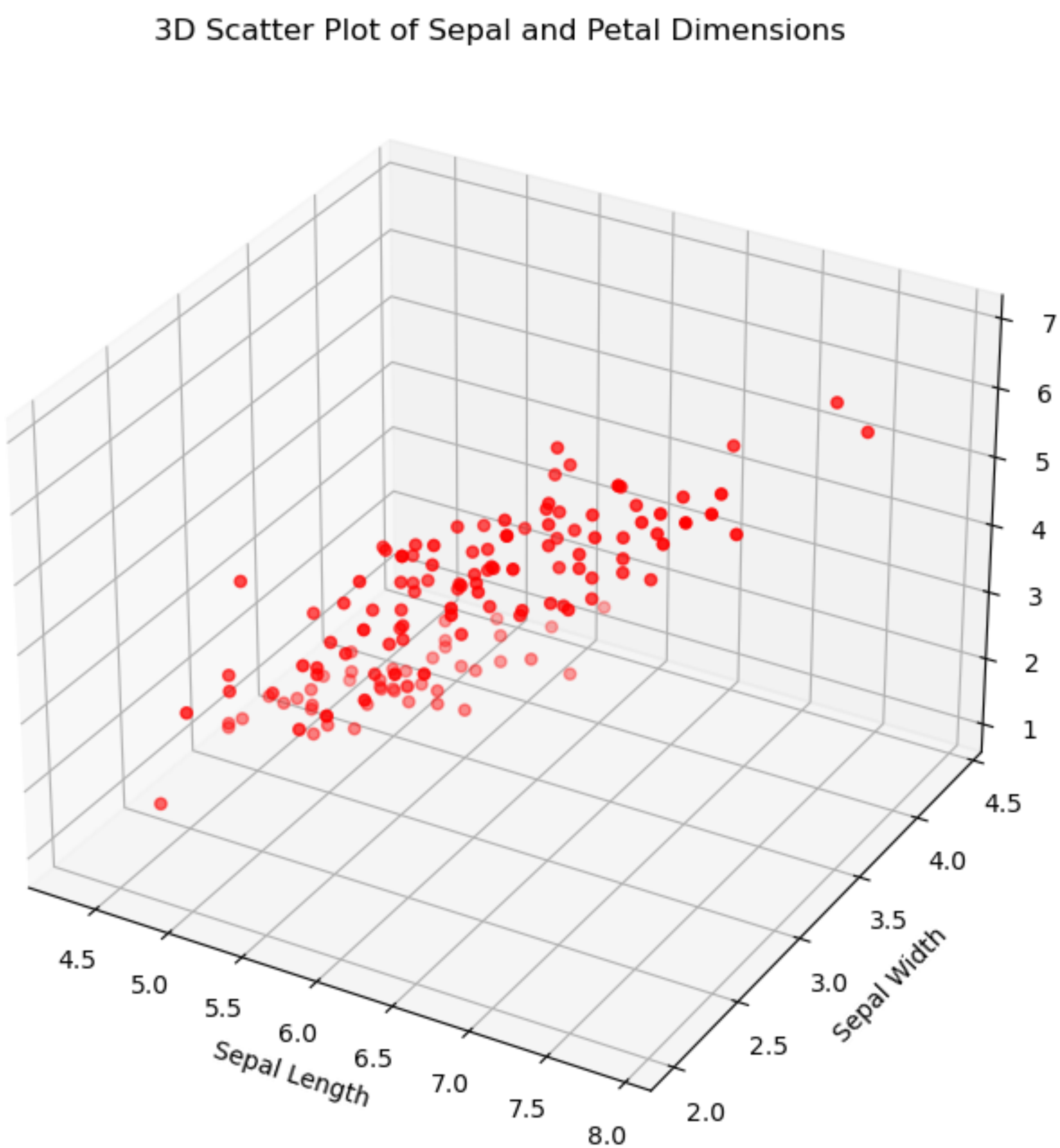
In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

# Load the dataset into a DataFrame
url = "https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data"
df = pd.read_csv(url, header=None, names=['sepal_length', 'sepal_width', 'petal_length', 'petal_width', 'species'])
```

3D Scatter Plot:

Plotting three features against each other in a 3D space to visualize relationships among them.

In [2]:
```
# 3D Scatter Plot
fig = plt.figure(figsize=(10, 8))
ax = fig.add_subplot(111, projection='3d')
ax.scatter(df['sepal_length'], df['sepal_width'], df['petal_length'], c='r', marker='o')
ax.set_xlabel('Sepal Length')
ax.set_ylabel('Sepal Width')
ax.set_zlabel('Petal Length')
ax.set_title('3D Scatter Plot of Sepal and Petal Dimensions')
plt.show()
```


3D Scatter Plot of Sepal and Petal Dimensions
Sepal Length
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
Sepal Width
2.0
2.5
3.0
3.5
4.0
4.5
1
2
3
4
5
6
7

Imagine you have a bunch of flowers, and you want to compare their sizes. Scatter plots help us visualize how different measurements relate to each other.

Each axis has numbers showing the measurements in centimeters.

X-axis: Represents Sepal Length (how long the green leaf-like part of the flower is).

Y-axis: Represents Sepal Width (how wide that leaf-like part is).

Z-axis: Represents Petal Width (the width of the colorful petal part).

Those red dots are our data points. Each dot represents an individual iris flower.

The position of each dot tells us about the flower's sepal length, sepal width, and petal width.

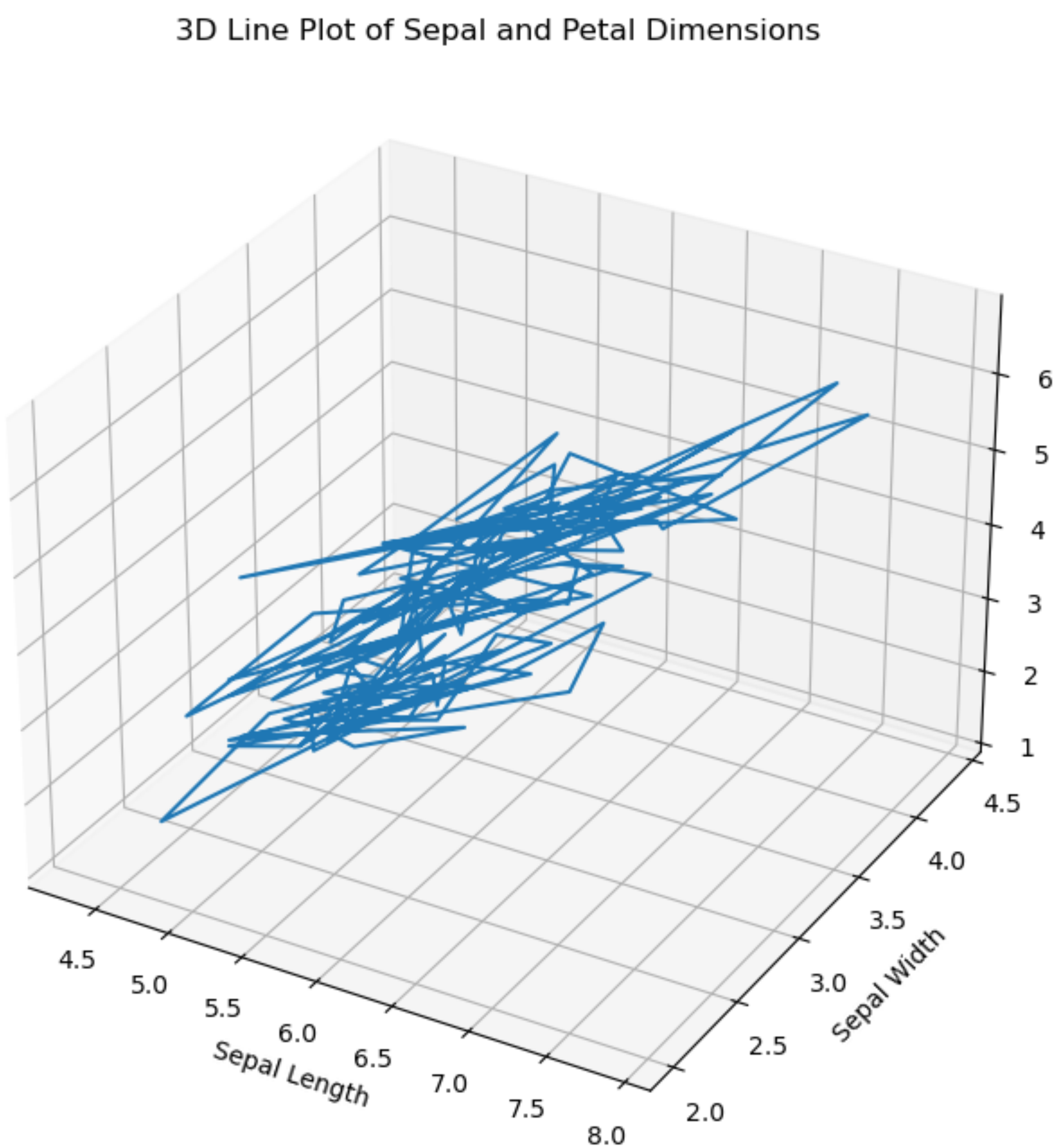
For example, if a dot is higher up on the Z-axis, it means that flower has a wider petal.

petal width seems to increase as sepal length increases.

3D Line Plot:

Plotting a line in 3D space, useful for visualizing trends or trajectories.

In [3]:
```
# 3D Line Plot
fig = plt.figure(figsize=(10, 8))
ax = fig.add_subplot(111, projection='3d')
ax.plot(df['sepal_length'], df['sepal_width'], df['petal_length'])
ax.set_xlabel('Sepal Length')
ax.set_ylabel('Sepal Width')
ax.set_zlabel('Petal Length')
ax.set_title('3D Line Plot of Sepal and Petal Dimensions')
plt.show()
```


3D Line Plot of Sepal and Petal Dimensions
Sepal Length
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
Sepal Width
2.0
2.5
3.0
3.5
4.0
4.5
1
2
3
4
5
6

to understand their sizes and shapes 3D line plot is like a special graph that helps us see how different measurements relate to each other in three dimensions.

X-axis: Represents Sepal Length (how long the green leaf-like part of the flower is).

Y-axis: Represents Sepal Width (how wide that leaf-like part is).

Z-axis: Represents Petal Length (the length of the colorful petal part).

Each axis has numbers showing the measurements in centimeters.

Those blue lines crisscrossing within the space represent individual flowers.Each line connects the measurements of one specific flower.

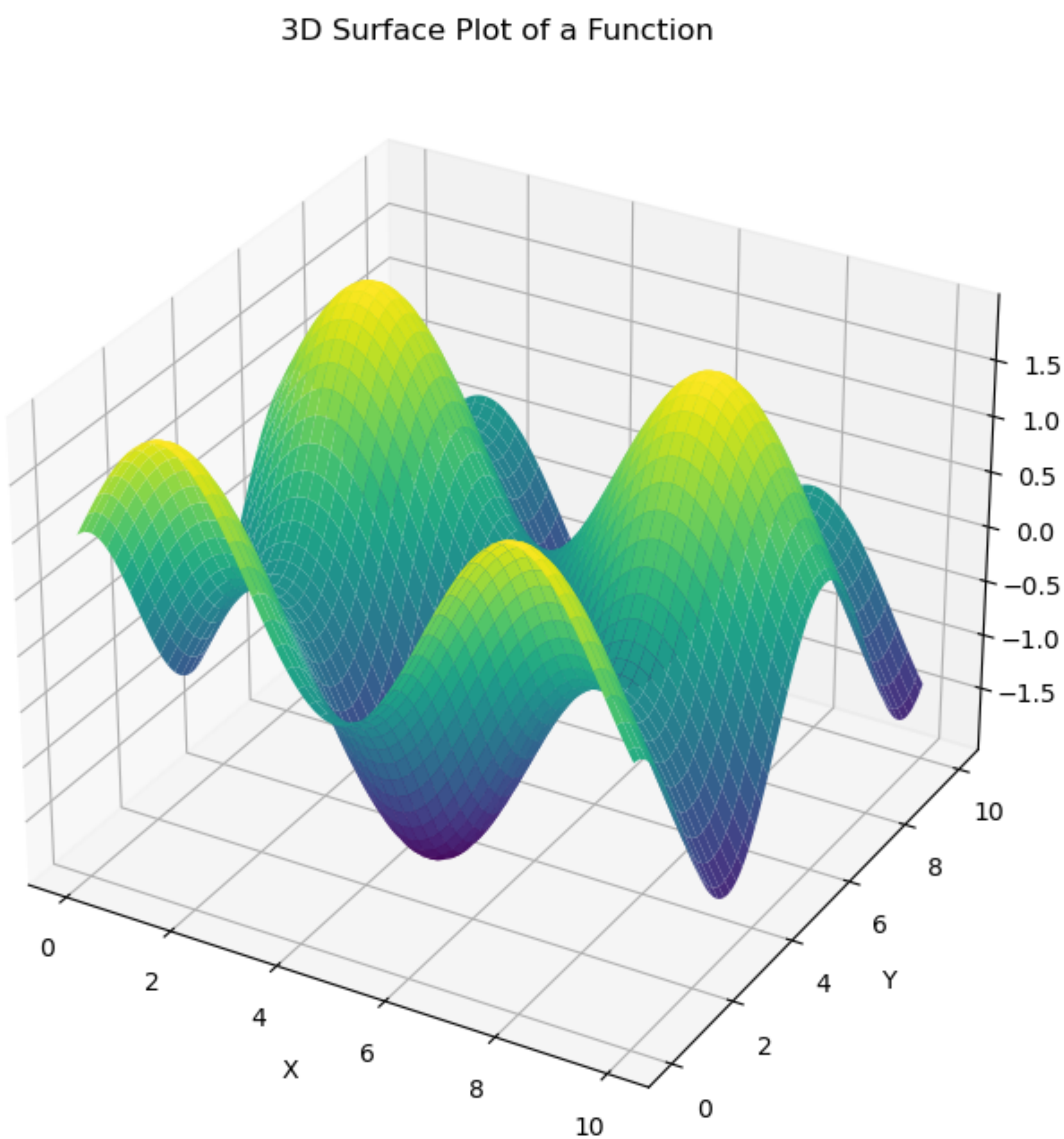
For example, if you follow a line, you'll see how that flower's sepal length, sepal width, and petal length are related.

3D Surface Plot:

Plotting a surface in 3D space, helpful for visualizing functions of two variables.

In [4]:

```
# 3D Surface Plot (Example of a function of two variables)
import numpy as np
fig = plt.figure(figsize=(10, 8))
ax = fig.add_subplot(111, projection='3d')
x = np.linspace(0, 10, 100)
y = np.linspace(0, 10, 100)
x, y = np.meshgrid(x, y)
z = np.sin(x) + np.cos(y)
ax.plot_surface(x, y, z, cmap='viridis')
ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
ax.set_title('3D Surface Plot of a Function')
plt.show()
```


3D Surface Plot of a Function
X
Y
0
2
4
6
8
10
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5

The plot is set within a three-dimensional Cartesian coordinate system.

The axes are labeled as follows:

X-axis: Ranges from 0 to 10.

Y-axis: Ranges from 0 to 8.

Z-axis: Ranges from -1.5 to 1.5.

Surface Shape:

The surface is wavy, indicating variations in the output values (Z-axis) corresponding to different combinations of input values (X and Y axes).

Peaks and troughs on the surface represent local maxima and minima of the function.

Blue: Represents lower Z-values.

Green: Indicates intermediate values.

Yellow: Corresponds to higher Z-values.

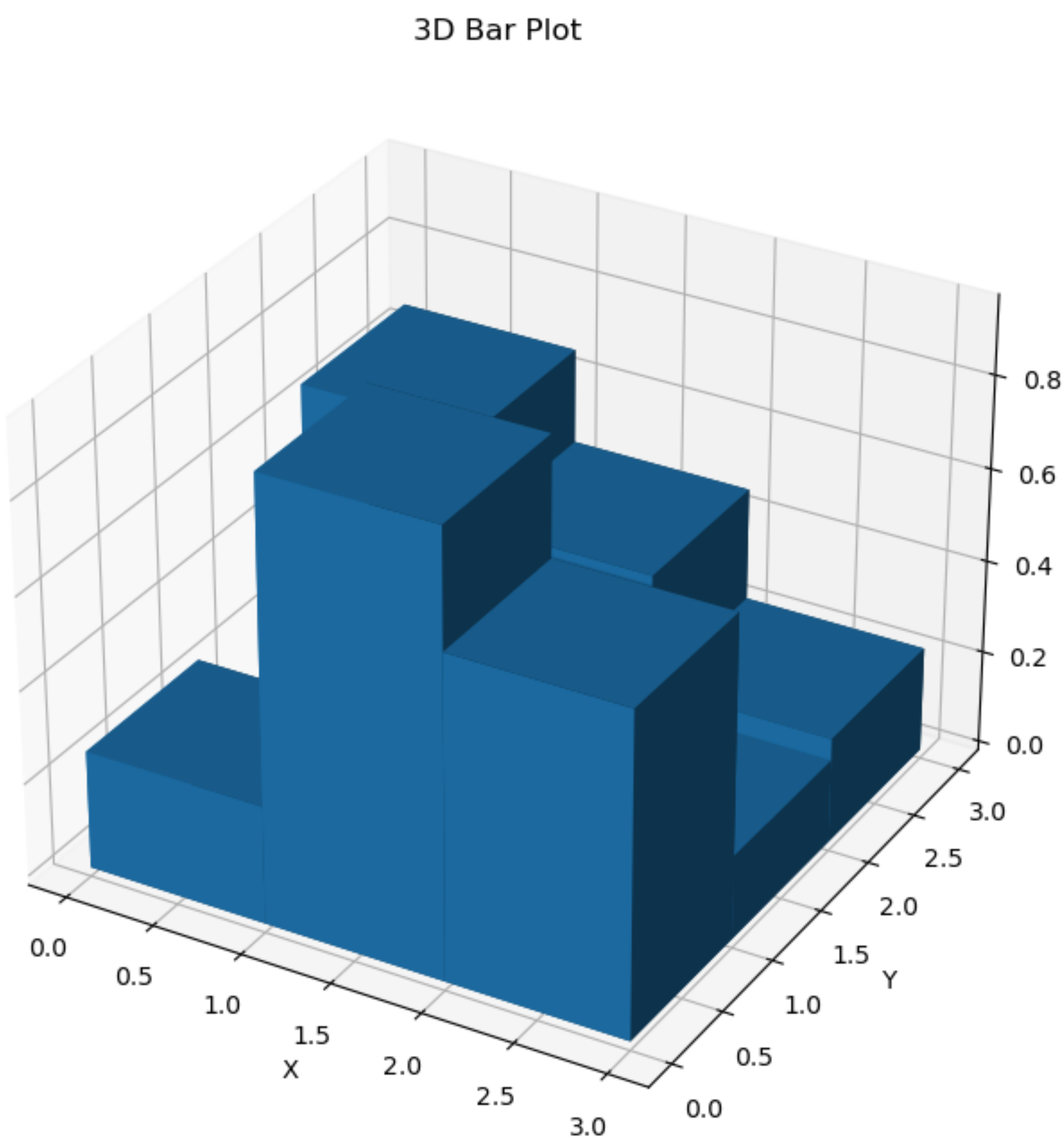
Grid lines are visible on all faces of the plotting space.

They aid in estimating function values at various points on the surface.

3D Bar Plot:

Plotting bars in 3D space, useful for comparing quantities across multiple categories. Note:- we need to assign numerical values to the x-axis categories which are in string format.

In [8]:
```
import numpy as np
# 3D Bar Plot (Example with randomly generated data)
fig = plt.figure(figsize=(10, 8))
ax = fig.add_subplot(111, projection='3d')
x = np.arange(len(df['species'].unique()))  # Numeric values for x-axis categories
y = np.arange(len(df['species'].unique()))  # Numeric values for y-axis categories
x, y = np.meshgrid(x, y)
z = np.random.rand(len(df['species'].unique()), len(df['species'].unique()))
ax.bar3d(x.ravel(), y.ravel(), np.zeros_like(z).ravel(), 1, 1, z.ravel())
ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
ax.set_title('3D Bar Plot')
plt.show()
```


3D Bar Plot
0.0
0.2
0.4
0.6
0.8
0.0
0.5
1.0
1.5
2.0
2.5
3.0
X
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Y

The plot is set within a three-dimensional grid space.

X-axis: Ranges from 0 to 3.

Y-axis: Ranges from 0 to 2.5.

Z-axis: Ranges from 0 to 1.

There are five blue bars, each representing different values.

The tallest bar is located at approximately (X=0.5, Y=1), extending up to about Z=0.8.

Two medium-height bars are adjacent to the tallest one; one extends up to approximately Z=0.6, and the other up to about Z=0.4.

Two shorter bars are located further along the X-axis; both extend up just above Z=0.2.

The X and Y axes likely represent different categories or variables.

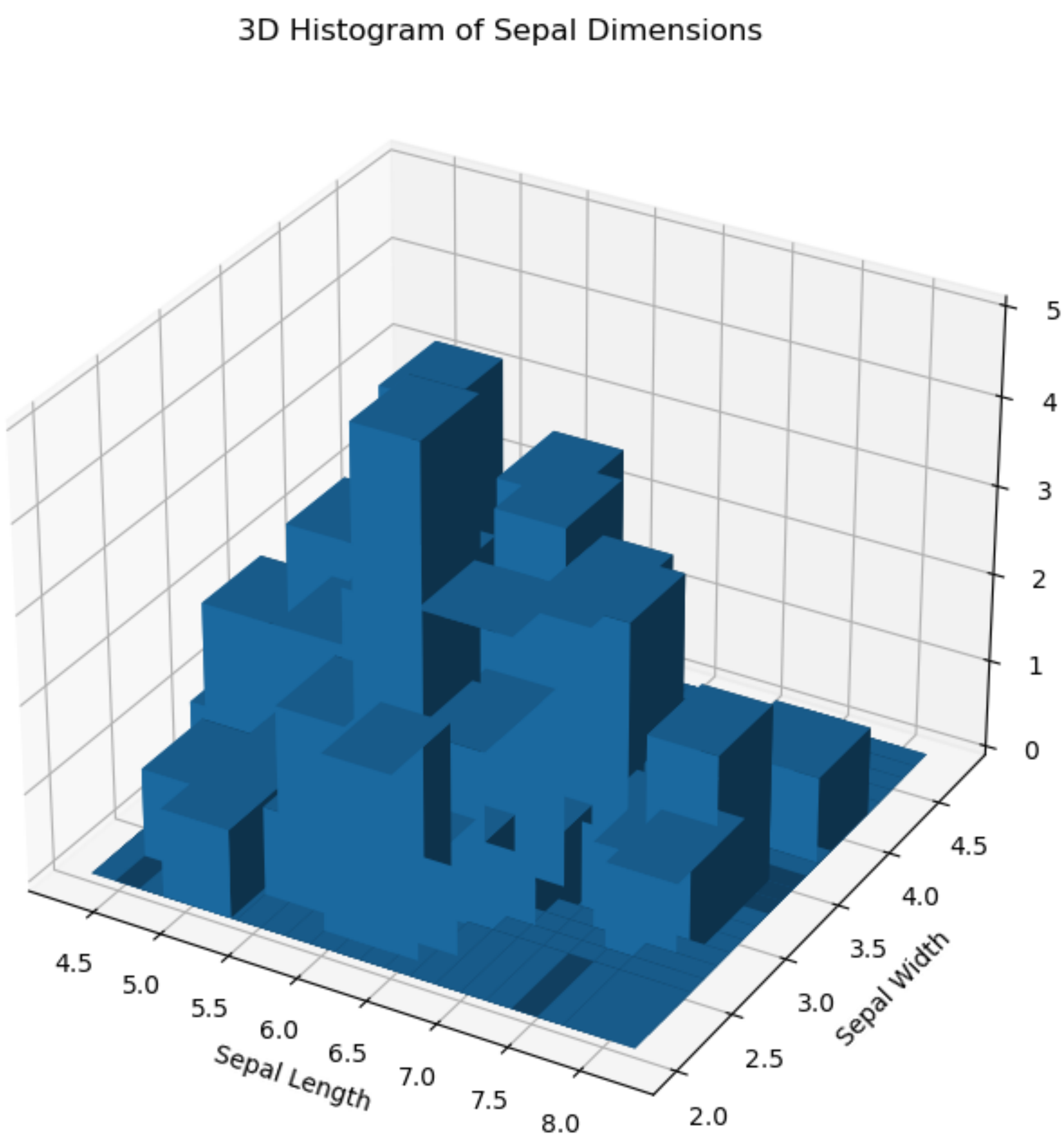
The Z axis (height of the bars) represents the values or counts associated with combinations of X and Y categories.

The background grid helps visualize the dimensions and provides scale for interpreting bar heights.

3D Histogram:

Plotting a 3D histogram to visualize the distribution of three variables simultaneously.

In [6]:
```
# 3D Histogram
fig = plt.figure(figsize=(10, 8))
ax = fig.add_subplot(111, projection='3d')
hist, xedges, yedges = np.histogram2d(df['sepal_length'], df['sepal_width'], bins=20)
xpos, ypos = np.meshgrid(xedges[:-1], yedges[:-1], indexing="ij")
xpos = xpos.ravel()
ypos = ypos.ravel()
zpos = 0
dx = dy = 0.5 * np.ones_like(zpos)
dz = hist.ravel()
ax.bar3d(xpos, ypos, zpos, dx, dy, dz, zsort='average')
ax.set_xlabel('Sepal Length')
ax.set_ylabel('Sepal Width')
ax.set_zlabel('Frequency')
ax.set_title('3D Histogram of Sepal Dimensions')
plt.show()
```


3D Histogram of Sepal Dimensions
Sepal Length
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
Sepal Width
2.0
2.5
3.0
3.5
4.0
4.5
0
1
2
3
4
5

It represents data related to sepal dimensions.

X-axis: Represents Sepal Length, ranging from 4.5 to 8 units.

Y-axis: Represents Sepal Width, with values between 2 and 4.5 units.

Z-axis: Depicts frequency counts, with bars reaching up to a height of 5. Each bar represents the occurrence of a specific combination of sepal length and width.

There are five blue bars, each representing different values.

observations: 1)The tallest bar is located at approximately (X=0.5, Y=1), extending up to about Z=0.8.

2)Two medium-height bars are adjacent to the tallest one:

2a)One extends up to approximately Z=0.6.

2b)The other reaches about Z=0.4.

3)Two shorter bars are located further along the X-axis:

Both extend up just above Z=0.2.

The X and Y axes likely represent different categories or variables related to sepal dimensions.

The Z axis (bar heights) represents the frequency counts associated with specific combinations of sepal length and width.

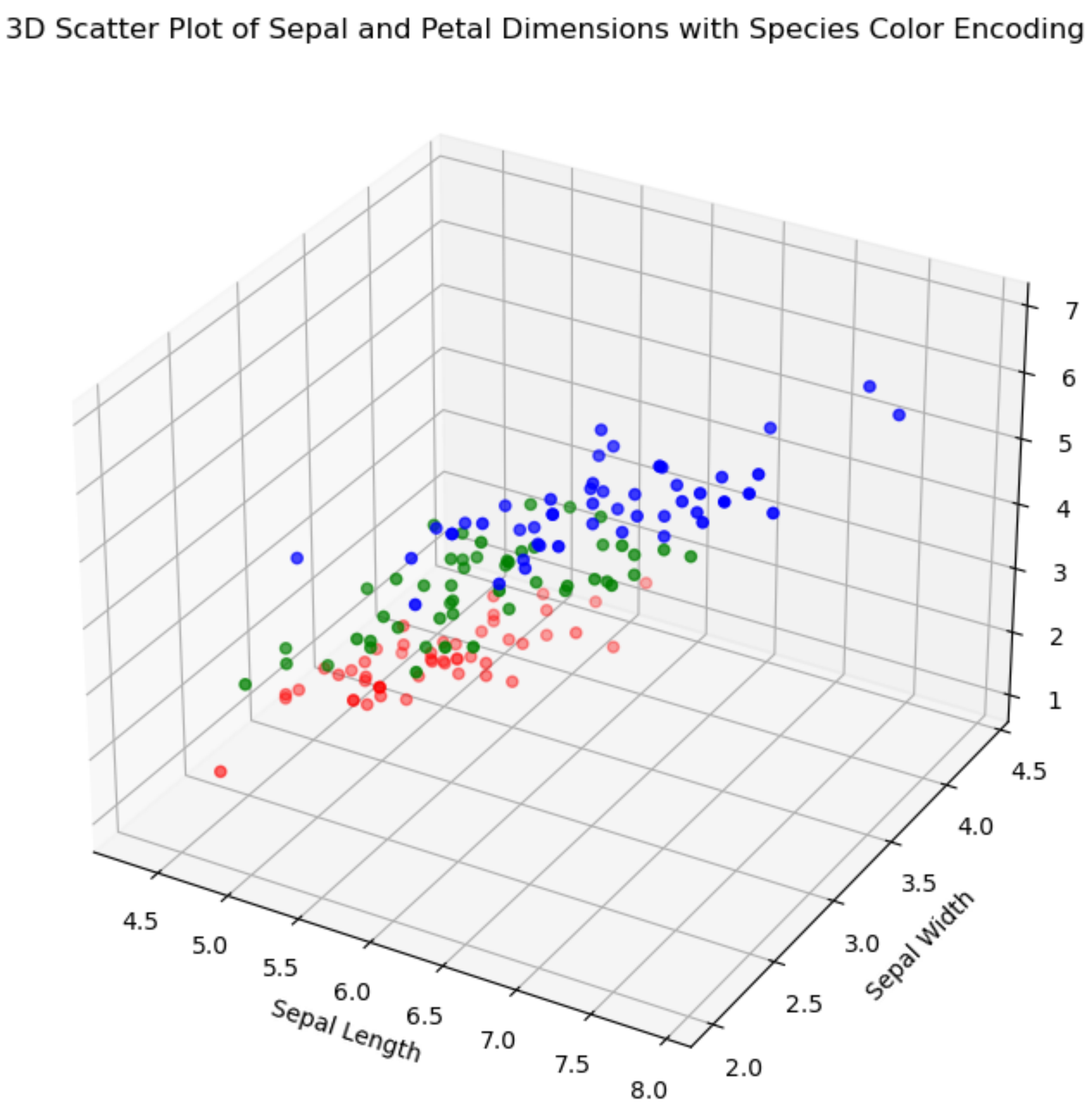
The background grid helps visualize the dimensions and provides scale for interpreting bar heights.

3D Scatter Plot with Color Encoding:

Similar to a regular 3D scatter plot but with points colored according to a fourth variable, adding another dimension of information.

In [7]:

```
# 3D Scatter Plot with Color Encoding
fig = plt.figure(figsize=(10, 8))
ax = fig.add_subplot(111, projection='3d')
species_colors = {'Iris-setosa': 'r', 'Iris-versicolor': 'g', 'Iris-virginica': 'b'}
ax.scatter(df['sepal_length'], df['sepal_width'], df['petal_length'], c=df['species'].map(species_colors), marker='o
ax.set_xlabel('Sepal Length')
ax.set_ylabel('Sepal Width')
ax.set_zlabel('Petal Length')
ax.set_title('3D Scatter Plot of Sepal and Petal Dimensions with Species Color Encoding')
plt.show()
```


3D Scatter Plot of Sepal and Petal Dimensions with Species Color Encoding
Sepal Length
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
Sepal Width
2.0
2.5
3.0
3.5
4.0
4.5
1
2
3
4
5
6
7

“3D Scatter Plot of Sepal and Petal Dimensions with Species Color Encoding.”

It represents data related to sepal and petal dimensions of different flower species.

The plot is set within a three-dimensional grid space.

The axes are labeled as follows:

X-axis: Represents Sepal Length, ranging from 4.5 to 8 units.

Y-axis: Represents Sepal Width, with values between 2 and 4 units.

Z-axis: Represents Petal Length, ranging from 1 to 7 units.

Red Points: Represent flowers with smaller sepals and petals. They cluster towards the lower values of all three axes.

Green Points: Indicate flowers with medium-sized sepals and petals. They are spread across the middle range values.

Blue Points: Represent flowers with larger sepals and petals, scattered towards higher values on all axes.

Flowers with smaller sepals and petals (red points) tend to have lower values across all dimensions.

Medium-sized sepals and petals (green points) occupy mid-range values.

Flowers with larger sepals and petals (blue points) are scattered at higher axis values.

This information can be instrumental in classifying unknown flowers based on their sepal and petal dimensions.