Multidimentional Scaling(MDS)

In [1]:

```
import pandas as pd
import numpy as np
from sklearn.manifold import MDS
import matplotlib.pyplot as plt
```

In [3]:

```
# Define the names of the politicians, which will be both row and column headers
politicians = [
    'Hitler', 'Mussolini', 'Churchill', 'Eisenhower', 'Stalin', 'Attlee',
    'Franco', 'De_Gaulle', 'Mao_Tse', 'Truman', 'Chamberlain', 'Tito'
]

# The distance data between the politicians, based on the previous image you provid
# This represents the full symmetric distance matrix.
data = {
    'Hitler': [0, 5, 11, 15, 8, 17, 5, 10, 16, 17, 12, 16],
    'Mussolini': [5, 0, 14, 16, 13, 18, 3, 11, 18, 18, 14, 17],
    'Churchill': [11, 14, 0, 7, 11, 11, 12, 5, 16, 8, 10, 8],
    'Eisenhower': [15, 16, 7, 0, 16, 16, 14, 8, 17, 6, 7, 12],
    'Stalin': [8, 13, 11, 16, 0, 15, 13, 11, 12, 14, 16, 12],
    'Attlee': [17, 18, 11, 16, 15, 0, 16, 12, 16, 12, 9, 13],
    'Franco': [5, 3, 12, 14, 13, 16, 0, 9, 17, 16, 10, 12],
    'De_Gaulle': [10, 11, 5, 8, 11, 12, 9, 0, 13, 9, 11, 7],
    'Mao_Tse': [16, 18, 16, 17, 12, 16, 17, 13, 0, 12, 17, 10],
    'Truman': [17, 18, 8, 6, 14, 12, 16, 9, 12, 0, 9, 11],
    'Chamberlain': [12, 14, 10, 7, 16, 9, 10, 11, 17, 9, 0, 15],
    'Tito': [16, 17, 8, 12, 12, 13, 12, 7, 10, 11, 15, 0]
}
data
```

Out[3]:

```
{'Hitler': [0, 5, 11, 15, 8, 17, 5, 10, 16, 17, 12, 16],
 'Mussolini': [5, 0, 14, 16, 13, 18, 3, 11, 18, 18, 14, 17],
 'Churchill': [11, 14, 0, 7, 11, 11, 12, 5, 16, 8, 10, 8],
 'Eisenhower': [15, 16, 7, 0, 16, 16, 14, 8, 17, 6, 7, 12],
 'Stalin': [8, 13, 11, 16, 0, 15, 13, 11, 12, 14, 16, 12],
 'Attlee': [17, 18, 11, 16, 15, 0, 16, 12, 16, 12, 9, 13],
 'Franco': [5, 3, 12, 14, 13, 16, 0, 9, 17, 16, 10, 12],
 'De_Gaulle': [10, 11, 5, 8, 11, 12, 9, 0, 13, 9, 11, 7],
 'Mao_Tse': [16, 18, 16, 17, 12, 16, 17, 13, 0, 12, 17, 10],
 'Truman': [17, 18, 8, 6, 14, 12, 16, 9, 12, 0, 9, 11],
 'Chamberlain': [12, 14, 10, 7, 16, 9, 10, 11, 17, 9, 0, 15],
 'Tito': [16, 17, 8, 12, 12, 13, 12, 7, 10, 11, 15, 0]}
```

In [4]:

```
# Create a DataFrame from the dictionary, setting the index and columns
# to be the politician names to form the distance matrix.
df_distance = pd.DataFrame(data, index=politicians, columns=politicians)

print("Distance Matrix (World War Politicians):")
print(df_distance)
print("-" * 50)
```

```
Distance Matrix (World War Politicians):
             Hitler  Mussolini  Churchill  Eisenhower  Stalin  Attlee  Franco  \
Hitler            0          5         11          15       8      17       5   
Mussolini         5          0         14          16      13      18       3   
Churchill        11         14          0           7      11      11      12   
Eisenhower       15         16          7           0      16      16      14   
Stalin            8         13         11          16       0      15      13   
Attlee           17         18         11          16      15       0      16   
Franco            5          3         12          14      13      16       0   
De_Gaulle        10         11          5           8      11      12       9   
Mao_Tse          16         18         16          17      12      16      17   
Truman           17         18          8           6      14      12      16   
Chamberlain      12         14         10           7      16       9      10   
Tito             16         17          8          12      12      13      12   

             De_Gaulle  Mao_Tse  Truman  Chamberlain  Tito  
Hitler              10       16      17           12    16  
Mussolini           11       18      18           14    17  
Churchill            5       16       8           10     8  
Eisenhower           8       17       6            7    12  
Stalin              11       12      14           16    12  
Attlee              12       16      12            9    13  
Franco               9       17      16           10    12  
De_Gaulle            0       13       9           11     7  
Mao_Tse             13        0      12           17    10  
Truman               9       12       0            9    11  
Chamberlain         11       17       9            0    15  
Tito                 7       10      11           15     0  
--------------------------------------------------
```

```
In [5]: df_distance
```

Out[5]:

	Hitler	Mussolini	Churchill	Eisenhower	Stalin	Attlee	Franco	De_Gaulle	M
Hitler	0	5	11	15	8	17	5	10	
Mussolini	5	0	14	16	13	18	3	11	
Churchill	11	14	0	7	11	11	12	5	
Eisenhower	15	16	7	0	16	16	14	8	
Stalin	8	13	11	16	0	15	13	11	
Attlee	17	18	11	16	15	0	16	12	
Franco	5	3	12	14	13	16	0	9	
De_Gaulle	10	11	5	8	11	12	9	0	
Mao_Tse	16	18	16	17	12	16	17	13	
Truman	17	18	8	6	14	12	16	9	
Chamberlain	12	14	10	7	16	9	10	11	
Tito	16	17	8	12	12	13	12	7	

In [6]:

```
# Convert the DataFrame to a NumPy array, which is the format sklearn's MDS expects
distance_matrix = df_distance.values

# n_components=2: We want to reduce the data to 2 dimensions for visualization.
# dissimilarity='precomputed': We are providing a precomputed distance matrix.
# random_state: Set for reproducibility of results.
mds = MDS(n_components=2, dissimilarity='precomputed', random_state=42)
# Fit the model and transform the data
mds_result = mds.fit_transform(distance_matrix)

print("\nMDS Result (2-dimensional coordinates):")

# Create a DataFrame to store the MDS results for better readability
mds_df = pd.DataFrame(mds_result, index=politicians, columns=['Dimension 1', 'Dimen
print(mds_df)
print("-" * 50)
```

```
MDS Result (2-dimensional coordinates):
             Dimension 1  Dimension 2
Hitler          8.456274     2.278292
Mussolini      10.843789    -0.692751
Churchill      -2.085066    -1.962687
Eisenhower     -2.807598    -8.156923
Stalin          3.651738     8.128422
Attlee        -10.963555    -0.284193
Franco          8.032692    -1.705265
De_Gaulle       0.030121     0.137088
Mao_Tse        -4.689717    11.041273
Truman         -6.549266    -5.089881
Chamberlain     0.919077    -8.319612
Tito           -4.838490     4.626237
--------------------------------------------------
```

Interpretation:

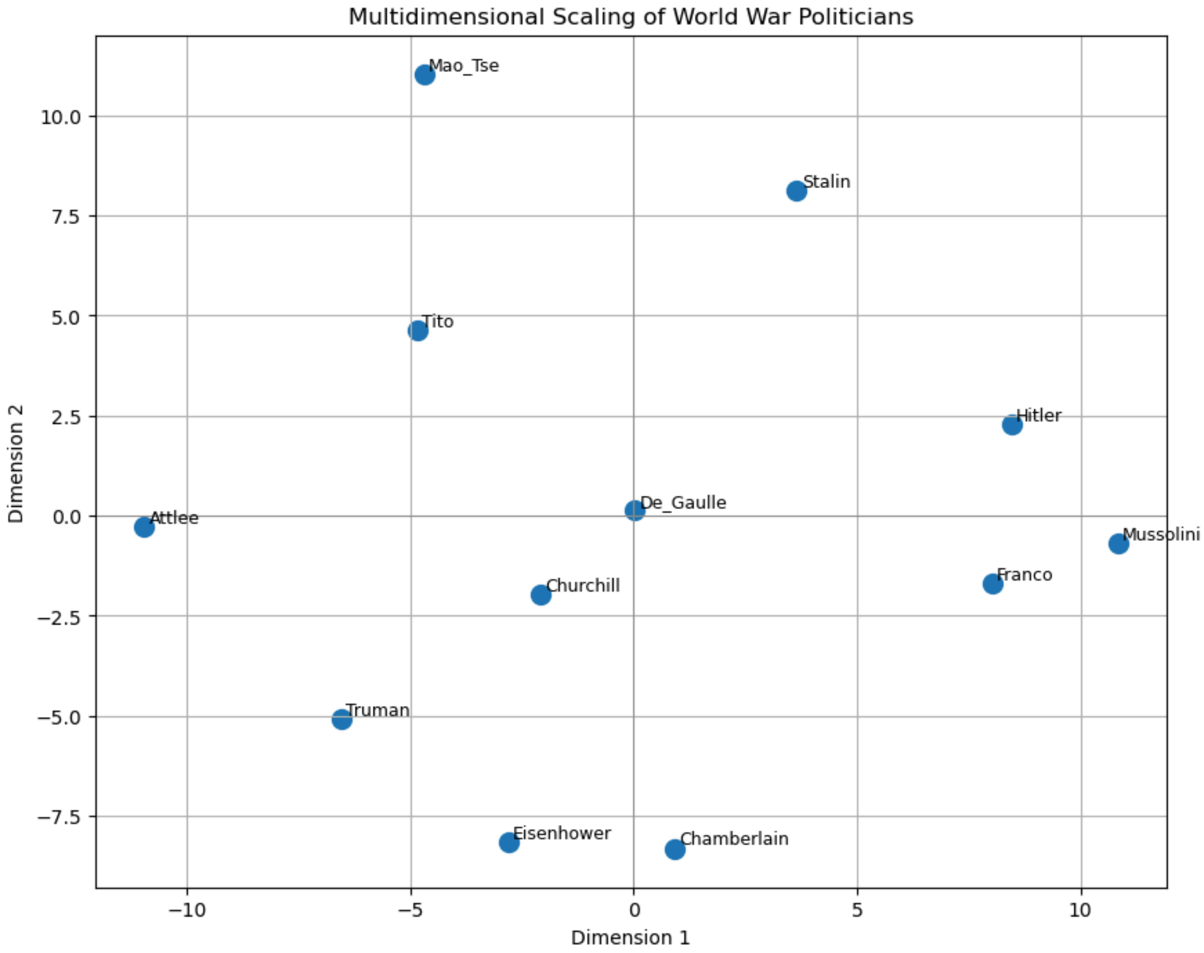
- Positive Dimension 1: Mussolini, Hitler, and Franco cluster together, indicating higher similarity in the underlying data.
- Negative Dimension 1: Attlee, Truman, Mao Tse, and Eisenhower lie on the opposite side, suggesting greater dissimilarity from the first group.
- Positive Dimension 2: Mao Tse and Stalin are distinctly separated upward in the 2D space.
- Negative Dimension 2: Eisenhower and Chamberlain are placed lower, forming a separate grouping.

Politicians close together in both dimensions indicate higher similarity.

In [7]:

```python
# Visualization
# Plotting the 2D representation of the politicians
plt.figure(figsize=(10, 8))
plt.scatter(mds_result[:, 0], mds_result[:, 1], s=100) # Plot points
# Annotate each point with the politician's name for clarity
for i, politician in enumerate(politicians):
    plt.annotate(politician, (mds_result[i, 0] + 0.1, mds_result[i, 1] + 0.1), font

plt.title('Multidimensional Scaling of World War Politicians')
plt.xlabel('Dimension 1')
plt.ylabel('Dimension 2')
plt.grid(True)
plt.axhline(0, color='grey', linewidth=0.5) # Add x-axis
plt.axvline(0, color='grey', linewidth=0.5) # Add y-axis
plt.show()
```



Interpretation:

- Axis Powers Cluster: Notice how Hitler, Mussolini, and Franco are all located in the top-right quadrant. Their proximity suggests they were perceived as highly similar in the dataset used for this analysis.
- Western Allied Leaders: Churchill and De Gaulle are relatively close to each other, separate from the Axis leaders, suggesting a shared similarity.
- Contrasting Figures: Mao Tse Tung is at the very top, far from most others, indicating he was perceived as very different from the European politicians. Eisenhower and Truman are in the bottom half of the graph, positioned far from the Axis leaders, highlighting their dissimilarity.
- Central Figures: Politicians like Stalin and De Gaulle are closer to the center of the graph, which might suggest they share characteristics with multiple groups or are less extreme on the dimensions represented.

In short, this MDS plot successfully translates a complex set of relationships into a simple 2D map. It visually confirms historical alliances and political ideologies by grouping similar leaders together and placing opposing figures far apart.