NetworkX is a powerful Python library for creating, analyzing, and visualizing complex networks (graphs). This guide covers installation, basic usage, and common operations.

---

1. Installation

Before importing NetworkX, ensure it's installed:

Using pip (Recommended)

bash Copy Download

```bash
pip install networkx
```

Using conda (for Anaconda users)

bash Copy Download

```bash
conda install -c conda-forge networkx
```

Verify Installation

python Copy Download

```python
import networkx as nx
print(nx.__version__)  # Should print the installed version
```

---

2. Importing NetworkX

The standard convention is to import it as `nx`:

python Copy Download

```python
import networkx as nx
```

Optional: Import Common Submodules

python Copy Download

```python
import matplotlib.pyplot as plt  # For graph visualization
```

---

3. Basic Graph Creation

Create an Empty Graph

python Copy Download

```python
G = nx.Graph()  # Undirected graph
DG = nx.DiGraph()  # Directed graph
MG = nx.MultiGraph()  # Undirected multigraph (multiple edges)
MDG = nx.MultiDiGraph()  # Directed multigraph
```

Add Nodes

python Copy Download

```python
G.add_node(1)  # Single node
G.add_nodes_from([2, 3, 4])  # Multiple nodes
G.add_node("A", weight=5)  # Node with attributes
```

Add Edges

python Copy Download

```python
G.add_edge(1, 2)  # Single edge
G.add_edges_from([(1, 3), (2, 4)])  # Multiple edges
G.add_edge("A", "B", weight=2.5)  # Edge with attributes
```

---

4. Graph Analysis

Basic Properties

python Copy Download

```python
print("Nodes:", G.nodes())
print("Edges:", G.edges())
print("Number of nodes:", G.number_of_nodes())
```

```python
print("Number of edges:", G.number_of_edges())
print("Degree of node 1:", G.degree(1))  # Number of connections
```

Shortest Path

python Copy Download

```python
path = nx.shortest_path(G, source=1, target=4)
print("Shortest path from 1 to 4:", path)
```

Centrality Measures

python Copy Download

```python
degree_centrality = nx.degree_centrality(G)
betweenness_centrality = nx.betweenness_centrality(G)
closeness_centrality = nx.closeness_centrality(G)
print("Degree centrality:", degree_centrality)
```

---

5. Visualization

Draw a Simple Graph

python Copy Download

```python
nx.draw(G, with_labels=True, node_color='lightblue', edge_color='gray')
plt.show()  # Requires matplotlib
```

Customized Plot

python Copy Download

```python
pos = nx.spring_layout(G)  # Layout algorithm
nx.draw(G, pos, with_labels=True, node_size=500, node_color='skyblue', font_weight='bold')
plt.title("NetworkX Graph Visualization")
plt.show()
```

---

6. Importing/Exporting Graphs

Save & Load (Adjacency List)

python Copy Download

```python
nx.write_adjlist(G, "graph.adjlist")  # Save
G = nx.read_adjlist("graph.adjlist")  # Load
```

Export to Pandas (for DataFrames)

python Copy Download

```python
import pandas as pd
df_edges = nx.to_pandas_edgelist(G)
df_nodes = pd.DataFrame.from_dict(dict(G.nodes(data=True)), orient='index')
```

---

7. Common Algorithms

Algorithm	Usage
BFS / DFS Traversal	`list(nx.bfs_tree(G, source=1))`
Connected Components	`list(nx.connected_components(G))`
PageRank	`nx.pagerank(G)`
Minimum Spanning Tree	`nx.minimum_spanning_tree(G)`
Community Detection	`nx.algorithms.community.greedy_modularity_communities(G)`

---

8. Advanced: Random Graphs

python Copy Download

```python
# Erdős-Rényi random graph
G_random = nx.erdos_renyi_graph(20, 0.1)  # 20 nodes, 10% edge probability
```

```python
# Barabási-Albert (scale-free) graph
G_ba = nx.barabasi_albert_graph(50, 2)  # 50 nodes, 2 edges per new node
```

---

9. Troubleshooting

- `ImportError: No module named 'networkx'` → Reinstall using `pip install networkx`.
- **Graph not displaying?** → Ensure `matplotlib` is installed (`pip install matplotlib`).
- **Slow performance?** → Use `nx.convert_node_labels_to_integers(G)` for large graphs.

Conclusion

NetworkX (`nx`) is a versatile library for graph analysis. This guide covers:

✅ Installation & import
✅ Graph creation & modification
✅ Basic analysis & visualization
✅ Common algorithms

For more details, check the official NetworkX documentation.