Algorytmy zachlanne dla zagadnienia komiwojazera

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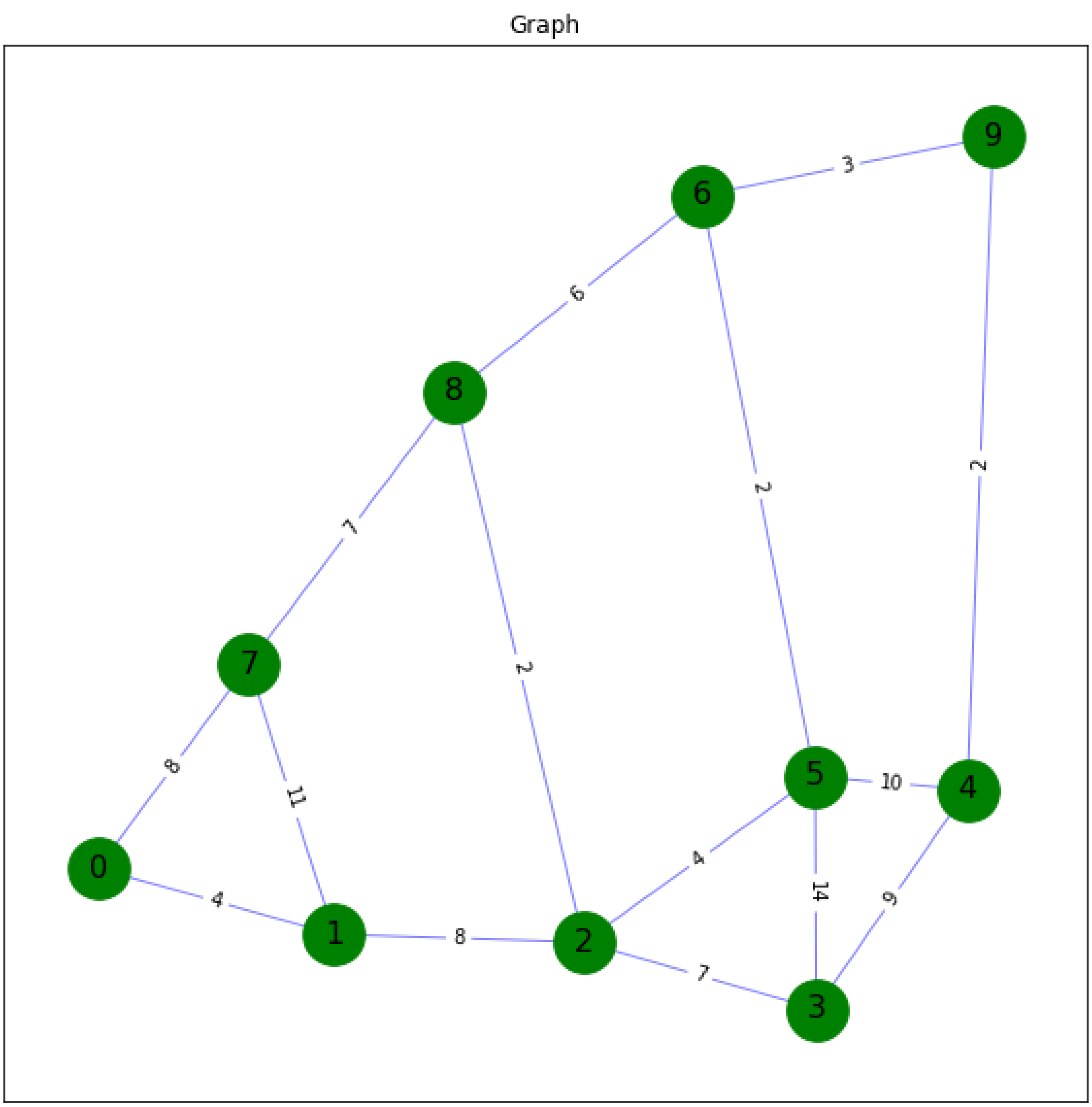
In [1]:
```
import networkx as nx
import numpy as np
import matplotlib.pyplot as plt
from typing import List, Dict
```

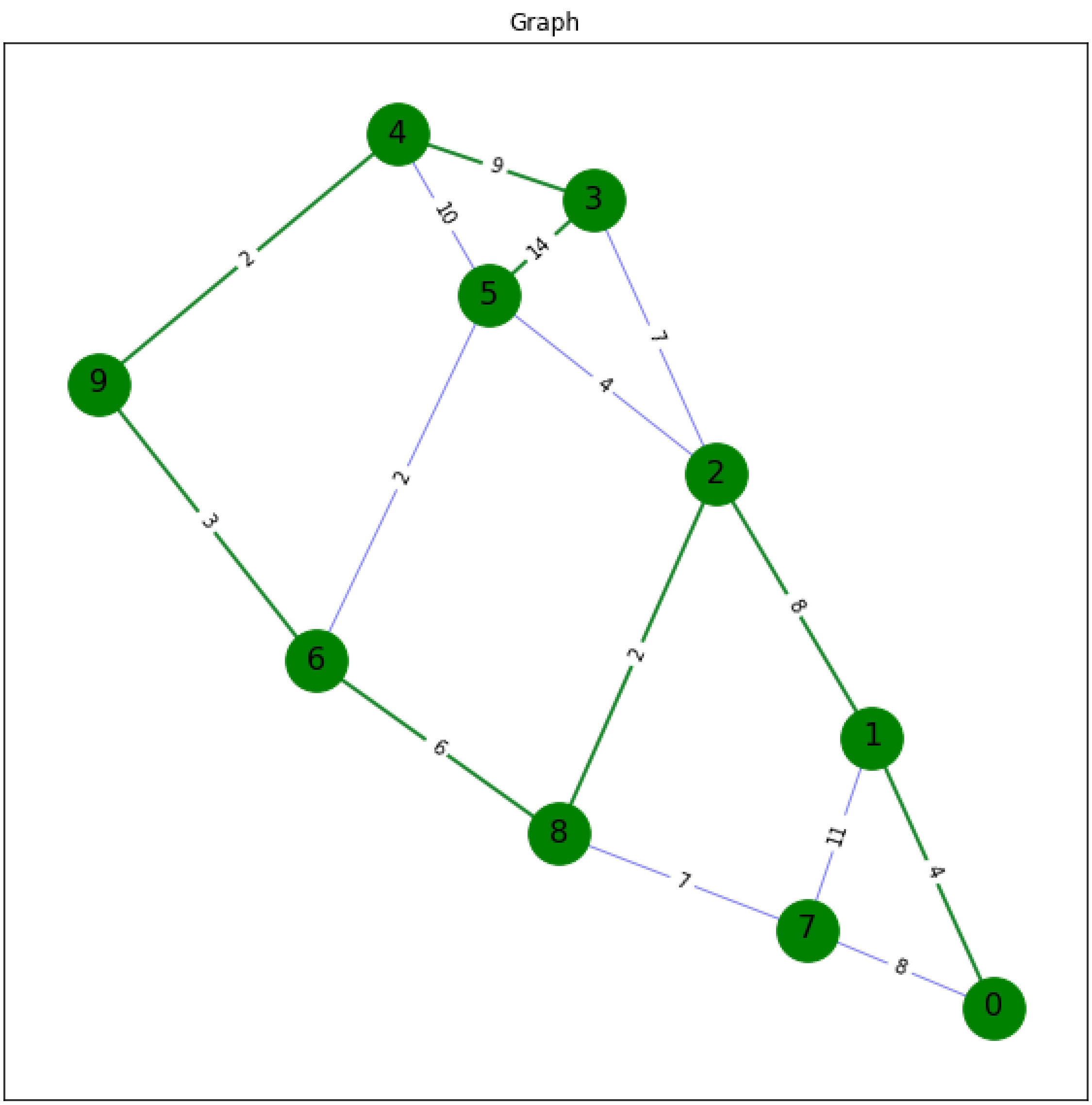
In [2]:
```
weights = [
    (0, 1, 4),
    (0, 7, 8),
    (1, 7, 11),
    (2, 1, 8),
    (2, 8, 2),
    (2, 5, 4),
    (2, 3, 7),
    (3, 4, 9),
    (3, 5, 14),
    (4, 5, 10),
    (5, 6, 2),
    (6, 8, 6),
    (7, 8, 7),
    (6, 9, 3),
    (9, 4, 2)
]

G = nx.Graph()

G.add_weighted_edges_from(weights)

fig = plt.figure(figsize=(10, 10))

pos = nx.spring_layout(G)

nx.draw_networkx_nodes(G, pos, nodelist=[i for i in range(10)], node_color='g', node_siz
nx.draw_networkx_edges(G, pos, width=1,alpha=0.5,edge_color='b')

nx.draw_networkx_edge_labels(G, pos, font_size=10, edge_labels = nx.get_edge_attributes(
nx.draw_networkx_labels(G, pos, font_size=16)

plt.title("Graph")
plt.show()
```



Powyzszy algorytm ma zlozonosc obliczeniowa $O(|V|)$. Jego duza wada jest natomiast to ze jest to algorytm zachlanny zatem nie zawsze laczy on wszystkie wierzcholki. Pokazane jest to ponizej.

In [3]:
```python
M = nx.to_numpy_array(G, nodelist=sorted(G.nodes()))

def nearestNeighbour(G: List[List[int]], start: int) -> List[int]:
    current = start
    visited = []
    n = len(G)

    while len(visited) < n:
        visited.append(current)
        minimal = np.inf
        for i in range(n):
            if minimal > G[current][i] and G[current][i] > 0 and i not in visited:
                minimal = i

        if minimal == np.inf:
            return visited
        current = minimal

    return visited


def nodesToPath(nodes: List[int]):
    path = []
    for i in range(len(nodes) - 1):
        path.append((nodes[i], nodes[i+1]))
```

```
    return path


nodes = nearestNeighbour(M, 0)
path = nodesToPath(nodes)

fig = plt.figure(figsize=(10, 10))

pos = nx.spring_layout(G)

nx.draw_networkx_nodes(G, pos, nodelist=[i for i in range(10)], node_color='g', node_siz
nx.draw_networkx_edges(G, pos, width=1,alpha=0.5,edge_color='b')
nx.draw_networkx_edges(G, pos, edgelist=path, width=2,alpha=0.8,edge_color='g')

nx.draw_networkx_edge_labels(G, pos, font_size=10, edge_labels = nx.get_edge_attributes(
nx.draw_networkx_labels(G, pos, font_size=16)

plt.title("Graph")
plt.show()
```



Greedy G-TSP

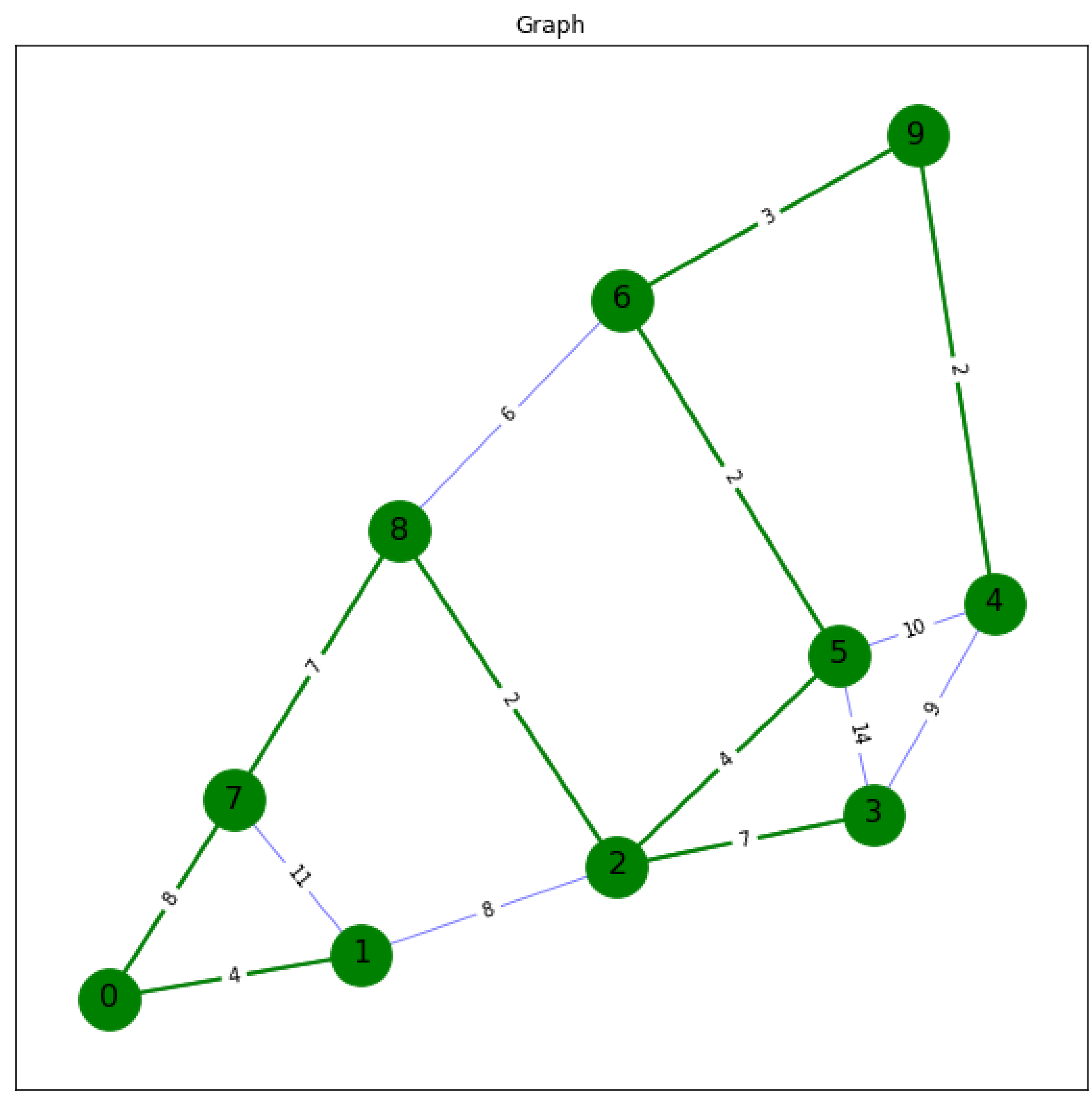
In [4]:
```
from collections import deque

def notCycle(path, newEdge):
```

```python
    start, end, weight = newEdge
    queue = deque([start])
    visited = []

    while len(queue) > 0:
        current = queue.popleft()
        visited.append(current)

        if current == end:
            return False

        if path.get(current) is not None:
            for node in path[current]:
                if node not in visited:
                    queue.append(node)

    return True


def addEdgeToPath(path, newEdge):
    start, end, weight = newEdge
    if path.get(start) is None:
        path[start] = [end]
    elif end not in path[start]:
        path[start].append(end)

    if path.get(end) is None:
        path[end] = [start]

    elif start not in path[end]:
        path[end].append(start)



def greedyTSP(G):
    edges = []
    n = len(G)
    for i in range(n):
        for j in range(n):
            if G[i][j] > 0:
                edges.append((i, j, G[i][j]))
    # Pobieramy krawedzie i sortujemy
    edges.sort(key=lambda x: x[2])

    path = dict()

    edgesCount = 0
    while edgesCount < n and len(edges) > 0:
        newEdge = edges.pop(0)
        # Sprawdzamy czy dodanie krawedzi nie utworzy cyklu
        if notCycle(path, newEdge):
            edgesCount += 1
            # Dodajemy krawedz do sciezki
            addEdgeToPath(path, newEdge)

    return path
```

In [5]:

```python
path = greedyTSP(M)
# print(path)
edgeList = set()

for key, values in path.items():
    for val in values:
        edgeList.add((key, val))
```

```
fig = plt.figure(figsize=(10, 10))

pos = nx.spring_layout(G)

nx.draw_networkx_nodes(G, pos, nodelist=[i for i in range(10)], node_color='g', node_siz
nx.draw_networkx_edges(G, pos, width=1,alpha=0.5,edge_color='b')
nx.draw_networkx_edges(G, pos, edgelist=list(edgeList), width=2,alpha=0.8,edge_color='g'

nx.draw_networkx_edge_labels(G, pos, font_size=10, edge_labels = nx.get_edge_attributes(
nx.draw_networkx_labels(G, pos, font_size=16)

plt.title("Graph")
plt.show()
```



Christofides Algorithm

In [6]:
```
class PriorityQueue:
    def __init__(self, queue=[]):
        self.queue = queue

    def __len__(self):
        return len(self.queue)

    def enqueue(self, value, priority):
        self.queue.append((value, priority))
```

```python
        self.queue.sort(key=lambda item: item[1])

    def dequeue(self):
        return self.queue.pop(0)[0]

    def isEmpty(self):
        return len(self.queue) == 0



def dijkstraPrimAlgorithm(G, start):
    queue = PriorityQueue([(start, 0)])
    visited = []

    while len(queue) > 0:
        current = queue.dequeue()
        if G.get(current) is not None:
            for node, weight in G[current]:
                if node not in visited:
                    queue.enqueue(node, weight)
                    visited.append(node)
    return visited


def christofides(G, start):
    edges = dijkstraPrimAlgorithm(G, start)
    print(edges)
```

In [7]:

```python
# dictOfLists = nx.to_dict_of_lists(G)
# M = nx.to_numpy_array(G)

# for key, values in dictOfLists.items():
#     for index, value in enumerate(values):
#         dictOfLists[key][index] = (value, M[key][value])
```

Zadanie 2

W przypadku rozwiazania algorytmem G-TSP nie wybieramy wierzcholka poczatkowego dlatego niema on znaczenia. W algorytmie wystepuje zalozenie ze dodawanie kolejnych wierzcholkow spowoduje utworzenie sciezki. W niektorych przypadkach jest ono poprawne, lecz w powyzszym przykladzie widzimy ze nie musi byc prawdziwe. W algorytmie znaczenie ma to gdzie znajduja sie najkrotsze krawedzie.

Zadanie 3

Zlozonosc obliczeniowa algorytmu wynosi $O(|E| \cdot \log |E| + |E|)$, poniewaz nalezy posortowac liste z krawedziami a nastepnie przeiterowac po niej.

Roznica algorytmow

W przypadku algorytmu G-TSP mamy gwarancje ze do utworzenia podgrafu uzyjemy krawedzi o najmniejszych wagach, natomiast nie mamy gwarancji ze bedzie to cykl. W przypadku algorytmu najblizszego sasiada nie mamy gwarancji ze uzyjemy najmnijeszych wag, natomiast mamy gwarancje ze utworzymy sciezke.

Algorytmy zachlanne nie rozwiazuja problemu komiwojazera, natomiast sa jakims uproszczeniem problemu. Znajduja one poprawne rozwiazania dla lokalnego wybranego problemu.