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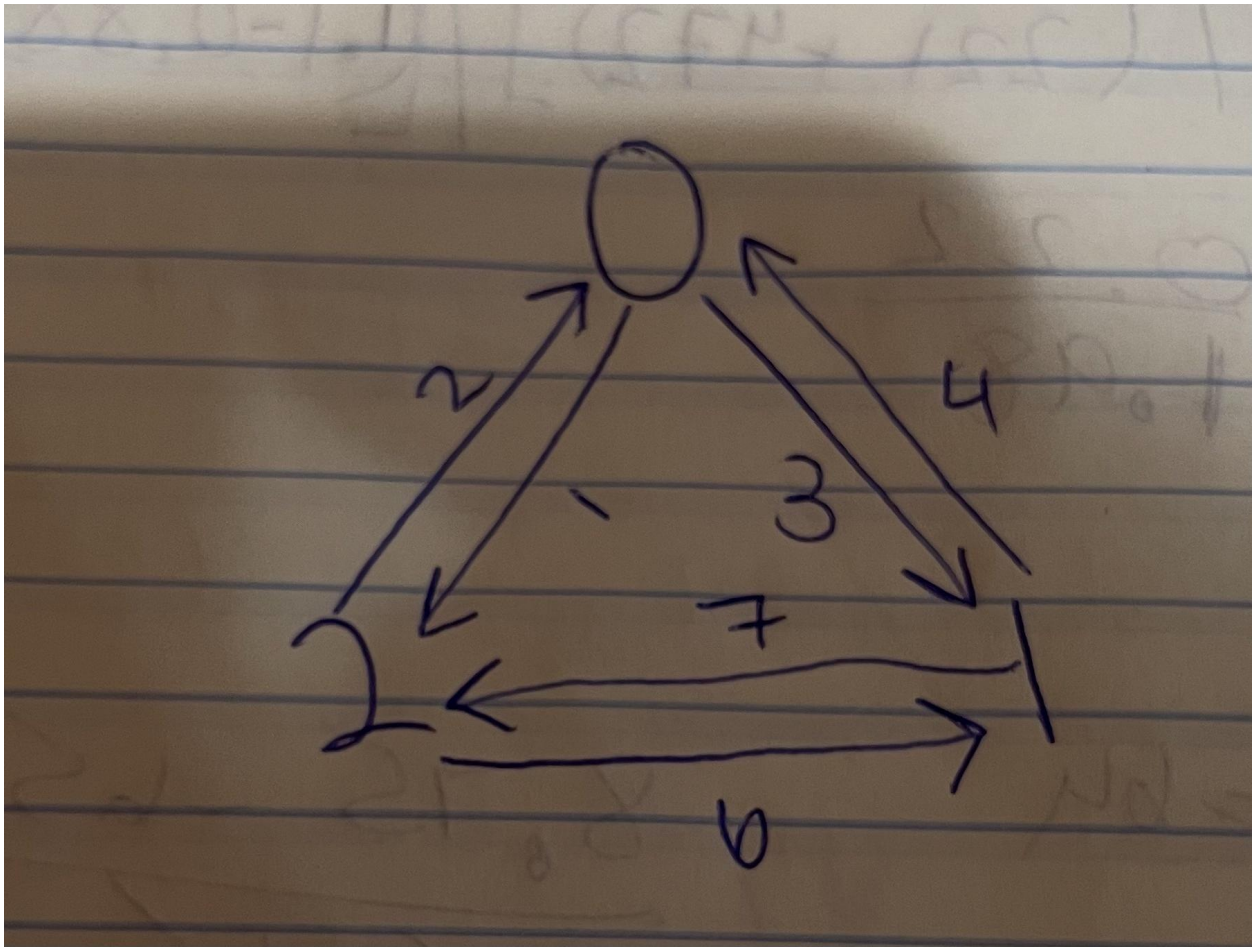
CSE 13S Spring 2021
Assignment 4: The Circumnavigations of Denver Long
Design Document

I. Description

This program uses depth-first search to find the shortest hamiltonian path with a given graph.



The image above is a visual representation of the graph. It shows that to go from 0 to 1 will have a weight of 3 but going from 1 to 0 will have a weight of 4. Given a starting point depth first search will find how to go to all the points and back to the first point in the shortest amount of time.

II. Pseudocode

A. Stack

```
class Stack:
    def __init__(self, capacity):
```

```
        self.capacity = capacity
        self.top = 0
        self.items = []

    def stack_empty(self):
        return self.top == 0

    def stack_print(self):
        print(self.items)

    def stack_full(self):
        return self.top == self.capacity

    def stack_size(self):
        return self.top

    def stack_push(self, x):
        if (self.stack_full()):
            return False
        self.items.append(x)
        self.top += 1
        return True

    def stack_pop(self, x):
        if (self.stack_empty()):
            return False
        self.top -= 1
        x = self.items.pop()
        return True

    def stack_peek(self, x):
        return self.items[len(self.items)]
```

```
        def stack_copy(self, x, y):
            y = copy.deepcopy(x)
```

B. Graph

```
class Graph:
    def __init__(self, vertices, undirected):
        self.vertices = vertices
        self.undirected = undirected
        self.visited = []
        self.matrix = [[0 for x in range(vertices)] for
y in range(vertices)]

    def graph_vertices(self):
        return self.vertices

    def graph_add_edge(self, i, j, k):
        self.matrix[i][j] = k
        if self.undirected:
            self.matrix[j][i] = k

    def graph_has_edge(self, i, j):
        return self.matrix[i][j] > 0

    def graph_edge_weight(self, i, j):
        return self.matrix[i][j]

    def graph_visited(self, v):
        return self.visited[v] == True

    def graph_mark_visited(self, v):
        self.visited[v] = True
```

```
        return True

    def graph_mark_unvisited(self, v):
        self.visited[v] = False
        return True

    def graph_print(self, v):
        print(self.matrix)
```

C. Path

```
class Path:
    def __init__(self):
        vertices = 26
        self.vertices = []
        self.length = 0

    def path_push_vertex(self, v, G):
        t = self.vertices[-1]
        self.vertices.append(t)
        if (t != v):
            self.length += G.graph_edge_weight(t, v)
            return True

    def path_pop_vertex(self, v, G):
        v = self.vertices.pop()
        t = self.vertices[-1]
        if (t != v):
            self.length += G.graph_edge_weight(t, v)
            return True

    def path_vertices(self):
        return len(self.vertices)
```

```
    def path_length(self):
        return self.length

    def path_copy(self, dst):
        return copy.deepcopy(self)

    def path_print(self):
        print(self.vertices)
```

D. Main

```
import getopt
import sys
from pseudocode import Graph, Path
verbose = False
undirected = False
recursive_calls = 0
in_fp = sys.stdin
out_fp = sys.stdout
cities = []
curr = None
shortest = None
graph = None


def dfs(v):
    recursive_calls += 1
    graph.mark_visited(v)
    curr.path_push_vertex(v, graph)
    nottoolong = (shortest.path_length() == 0 or (
        curr.path_length() < shortest.path_length()))
```

```
    if nottoolong == False:
        return
    for w in range(graph.graph_vertices):
        if graph.graph_has_edge(v, w):
            if (graph.visited == False):
                dfs(w)
            elif(w == 0):
                if (curr.path_vertices ==
graph.graph_vertices):
                    if (shortest.path_length() == 0 or
(
                            curr.path_length() <
shortest.path_length())):
                        curr.path_push_vertex(v, graph)
                        curr.path_copy(shortest)
                        if verbose:
                            curr.path_print()
                        curr.path_pop_vertex(v)
    curr.path_pop_vertex(v,graph)
    graph.graph_mark_unvisited(v)
    return


def main():
    global in_fp, verbose, undirected, recursive_calls,
out_fp, cities, curr, shortest, graph
    s = set()
    try:
        opts, args = getopt.getopt(sys.argv[1:],
"vui:o:", ["help"])
    except getopt.GetoptError:
        sys.exit(2)
```

```
    for o, a in opts:
        if o == "-h":
            # print_help()
            sys.exit(2)
        elif o == '-v':
            verbose = True
        elif o == '-u':
            undirected = True
        elif o == '-i':
            in_fp = open(a, 'r')
        elif o == '-o':
            out_fp = open(a, 'w')
        else:
            # print_help()
            sys.exit(2)
    first = int(in_fp.readline())
    print(first)
    graph = Graph(first, undirected)
    cities = [in_fp.readline().strip() for i in
range(first)]
    for line in in_fp:
        line = line.strip().split()
        line = [int(x) for x in line]

        graph.graph_add_edge(line[0], line[1], line[2])
    shortest = Path()
    curr = Path()
    dfs(0)


if __name__ == '__main__':
    main()
```