


Candidate: Quan-Ha Le.

A. How to setup

- Python 3.7 for Windows implementation of Kiwiland Railroad. (I am using Windows 10)
- I am using the Python language version of JUnit by Kent Beck and Erich Gamma - that is the Python unit testing framework.

Please unzip / decompress the package kiwiland_railroad.zip (or kiwiland_railroad.rar) onto your hard drive. This is my screenshot (on Windows / DOS)



```
Command Prompt
c:\kiwiland_railroad>py -V
Python 3.7.0

c:\kiwiland_railroad>tree /f
Folder PATH listing for volume Windows
Volume serial number is 4C47-0BB2
C:.
|   QuanHaLe_documentation.docx
|   QuanHaLe_documentation.pdf
|
|_ src
|   |   dijkstras.py
|   |   railroad.py
|   |   __init__.py
|   |
|   |_ __pycache__
|   |   dijkstras.cpython-37.pyc
|   |   railroad.cpython-37.pyc
|   |   __init__.cpython-37.pyc
|
|_ tests
|   |   dijkstrasmodule.py
|   |   getdistancemodule.py
|   |   gettripsnumbermodule.py
|   |   test_insightglobal.py
|   |   __init__.py
|   |
|   |_ __pycache__
|   |   dijkstrasmodule.cpython-37.pyc
|   |   getdistancemodule.cpython-37.pyc
|   |   gettripsnumbermodule.cpython-37.pyc
|   |   test_insightglobal.cpython-37.pyc
|   |   __init__.cpython-37.pyc
|
c:\kiwiland_railroad>
```

B. How to execute

To run the 10 tests provided by Insight Global, please execute

- ``py -m unittest`` in the 'kiwiland_railroad' directory, or
- ``py -m unittest tests.test_insightglobal`` that will be the same

```
Command Prompt

c:\kiwiland_railroad>py -m unittest

The route A-B-C has the distance of 9.0
.
The route A-D has the distance of 5.0
.
The route A-D-C has the distance of 13.0
.
The route A-E-B-C-D has the distance of 22.0
.
A-E-D: NO SUCH ROUTE
.
The number of possible trips from C to C with maximum of 3 stops are: 2
.
The number of possible trips from A to C with exact 4 stops are: 3
.
The shortest route from A to C is: ABC with distance 9.0
.
The shortest route from B to B is: BCEB with distance 9.0
.
The number of possible trips from C to C with maximum distance of 30 are: 7
.
-----
Ran 10 tests in 0.020s

OK
```

The default test set's outputs above are the tests required by Insight Global company.

To run interactively, execute `py -i` in the 'kiwiland_railroad' directory. You can then enter below commands

```
import src.railroad as rr

my_routes = rr.Railroad("AB5, BC4, CD8, DC8, DE6, AD5, CE2, EB3, AE7")

my_routes.get_distance("A-B-C")
my_routes.get_distance("A-D")
my_routes.get_distance("A-D-C")
my_routes.get_distance("A-E-B-C-D")
my_routes.get_distance("A-E-D")

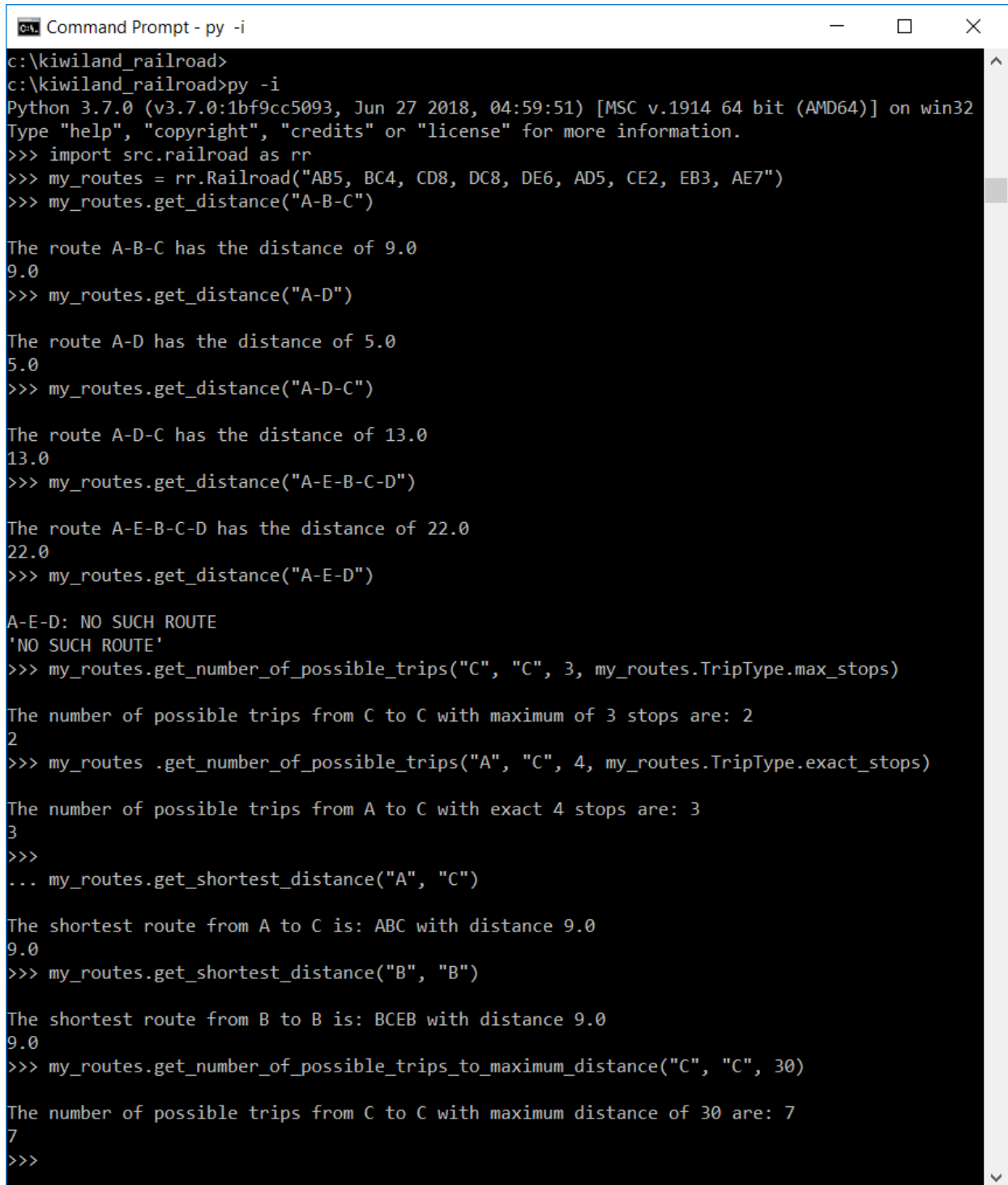
my_routes.get_number_of_possible_trips("C", "C", 3, my_routes.TripType.max_stops)
my_routes.get_number_of_possible_trips("A", "C", 4, my_routes.TripType.exact_stops)
```

```
my_routes.get_shortest_distance("A", "C")
```

```
my_routes.get_shortest_distance("B", "B")
```

```
my_routes.get_number_of_possible_trips_to_maximum_distance("C", "C", 30)
```

please look at this screenshot



```
Command Prompt - py -i
c:\kiwiland_railroad>
c:\kiwiland_railroad>py -i
Python 3.7.0 (v3.7.0:1bf9cc5093, Jun 27 2018, 04:59:51) [MSC v.1914 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> import src.railroad as rr
>>> my_routes = rr.Railroad("AB5, BC4, CD8, DC8, DE6, AD5, CE2, EB3, AE7")
>>> my_routes.get_distance("A-B-C")

The route A-B-C has the distance of 9.0
9.0
>>> my_routes.get_distance("A-D")

The route A-D has the distance of 5.0
5.0
>>> my_routes.get_distance("A-D-C")

The route A-D-C has the distance of 13.0
13.0
>>> my_routes.get_distance("A-E-B-C-D")

The route A-E-B-C-D has the distance of 22.0
22.0
>>> my_routes.get_distance("A-E-D")

A-E-D: NO SUCH ROUTE
'NO SUCH ROUTE'
>>> my_routes.get_number_of_possible_trips("C", "C", 3, my_routes.TripType.max_stops)

The number of possible trips from C to C with maximum of 3 stops are: 2
2
>>> my_routes.get_number_of_possible_trips("A", "C", 4, my_routes.TripType.exact_stops)

The number of possible trips from A to C with exact 4 stops are: 3
3
>>>
... my_routes.get_shortest_distance("A", "C")

The shortest route from A to C is: ABC with distance 9.0
9.0
>>> my_routes.get_shortest_distance("B", "B")

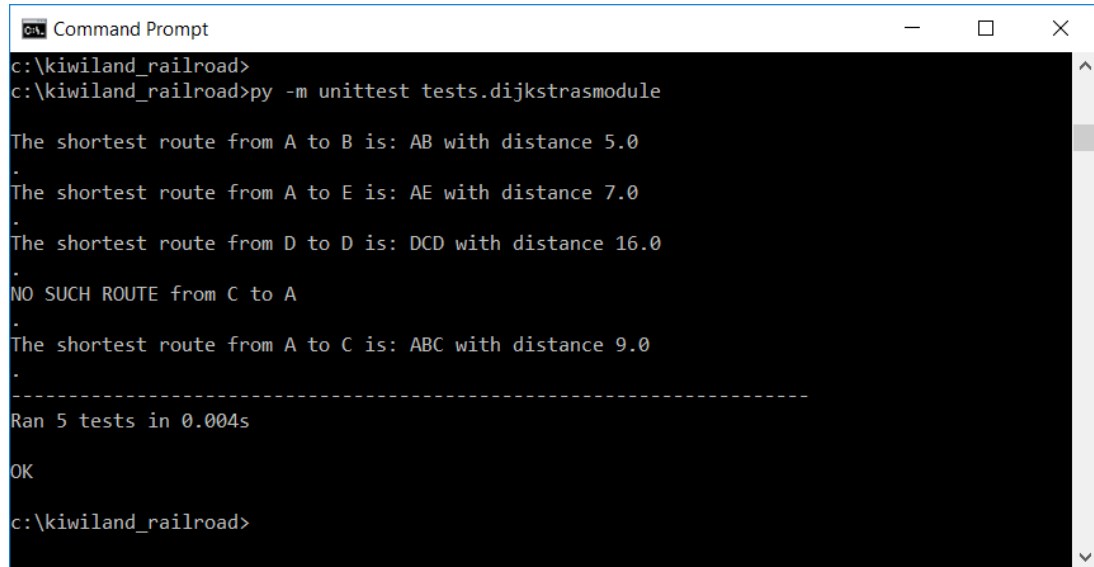
The shortest route from B to B is: BCEB with distance 9.0
9.0
>>> my_routes.get_number_of_possible_trips_to_maximum_distance("C", "C", 30)

The number of possible trips from C to C with maximum distance of 30 are: 7
7
>>>
```

Other unit tests that I have also set up

- `py -m unittest tests.dijkstrasmodule`

This is to test Dijkstras' Algorithm



```
Command Prompt
c:\kiwiland_railroad>
c:\kiwiland_railroad>py -m unittest tests.dijkstrasmodule

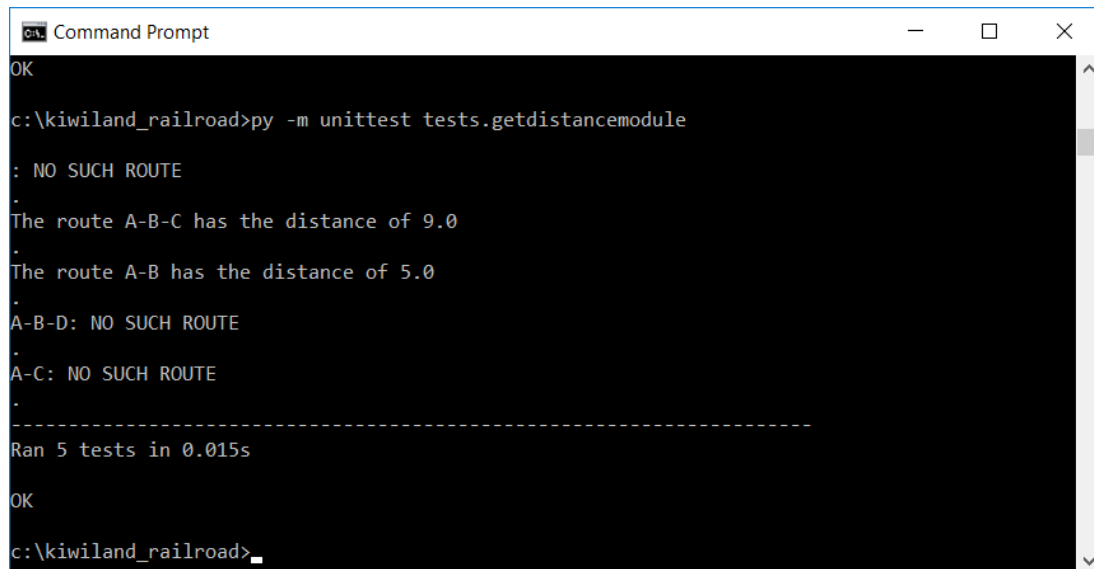
The shortest route from A to B is: AB with distance 5.0
.
The shortest route from A to E is: AE with distance 7.0
.
The shortest route from D to D is: DCD with distance 16.0
.
NO SUCH ROUTE from C to A
.
The shortest route from A to C is: ABC with distance 9.0
.
-----
Ran 5 tests in 0.004s

OK

c:\kiwiland_railroad>
```

- `py -m unittest tests.getdistancemodule`

This is to test the `get_distance` method



```
Command Prompt
OK
c:\kiwiland_railroad>py -m unittest tests.getdistancemodule

: NO SUCH ROUTE
.
The route A-B-C has the distance of 9.0
.
The route A-B has the distance of 5.0
.
A-B-D: NO SUCH ROUTE
.
A-C: NO SUCH ROUTE
.
-----
Ran 5 tests in 0.015s

OK

c:\kiwiland_railroad>
```

- `py -m unittest tests.gettripsnumbermodule`

This is to test the `get_number_of_possible_trips` method and the `get_number_of_possible_trips_to_maximum_distance` method

```
Select Command Prompt

c:\kiwiland_railroad>py -m unittest tests.gettripsnumbermodule

The number of possible trips from A to C with maximum distance of 19 are: 5
.
The number of possible trips from E to B with maximum distance of 0 are: 0
.
The number of possible trips from E to A with maximum distance of 100 are: 0
.
The number of possible trips from A to A with exact 3 stops are: 0
.
The number of possible trips from E to D with exact 4 stops are: 0
.
The number of possible trips from A to C with exact 2 stops are: 2
.
The number of possible trips from A to A with maximum of 3 stops are: 0
.
The number of possible trips from E to D with maximum of 2 stops are: 0
.
The number of possible trips from E to D with maximum of 5 stops are: 2
.
-----
Ran 9 tests in 0.014s

OK

c:\kiwiland_railroad>
```

C. Technical implementation

1. I implement on Python the Dijkstra's Algorithm

Dijkstra's Algorithm is an algorithm for finding the shortest paths between nodes in a graph, which may represent, for example, railroad networks. It was conceived by computer scientist Edsger W. Dijkstra in 1956 and published three years later.

The algorithm exists in many variants; Dijkstra's original variant found the shortest path between two nodes, but I would like to apply the most common variant fixes each single node as the "start" node and finds shortest paths from the start node to all other reachable nodes in the graph, producing a shortest-path dictionary.

The source code for Dijkstra's Algorithm is `\kiwiland_railroad\src\dijkstras.py`

Let the node at which we are starting be called the start node. Let the distance of node Y be the distance from the initial node to Y. Dijkstra's algorithm will assign some initial distance values and will try to improve them step by step.

- Step 1. Create a set named `visit_nodes` and loop through all the nodes, initialize the `visit_nodes` with the start node only.
- Step 2. Loop through the unvisited nodes inside the `visit_nodes` set
- Step 3. Take a `next_node`
- Step 4. Append all neighbour nodes of the above `next_node` into the `visit_nodes` set and calculate or re- update the distances from the start node to each neighbour node.

- Step 5. Store the minimum route inside the previous_nodes list
- Step 6. Store the minimum distance inside the shortest_routes list
- Step 7. End Loop when you already visited all the visit_nodes set and you have no more reachable nodes to add into the visit_nodes set.

2. The Railroad Graph

The source code is \kiwiland_railroad\src\railroad.py

3. The Insight Global Test.

The source code is \kiwiland_railroad\tests\test_insightglobal.py

I apply TestSuite and this is the default 10 tests required by Insight Global company as belows

1. The distance of the route A-B-C.
2. The distance of the route A-D.
3. The distance of the route A-D-C.
4. The distance of the route A-E-B-C-D.
5. The distance of the route A-E-D.
6. The number of trips starting at C and ending at C with a maximum of 3 stops.
7. The number of trips starting at A and ending at C with exactly 4 stops.
8. The length of the shortest route (in terms of distance to travel) from A to C.
9. The length of the shortest route (in terms of distance to travel) from B to B.
10. The number of different routes from C to C with a distance of less than 30.

Test Input: Graph: AB5, BC4, CD8, DC8, DE6, AD5, CE2, EB3, AE7

This input is stored inside this file \kiwiland_railroad\tests__init__.py, if you want to change the graph input of all tests, please change this line inside \kiwiland_railroad\tests__init__.py

```
Kiwiland = Railroad("AB5, BC4, CD8, DC8, DE6, AD5, CE2, EB3, AE7")
```

4. The Dijkstra's Algorithm Test

The source code is \kiwiland_railroad\tests\dijkstrasmodule.py

I apply TestSuite and there are 5 tests to find the shortest routes by Dijkstra's Algorithm.

5. The Get Distance Test

The source code is \kiwiland_railroad\tests\getdistancemodule.py

I apply TestSuite and there are 5 tests to find the distance of specific routes.

6. The Get Number of Possible Trip Test

The source code is \kiwiland_railroad\tests\gettripsnumbermodule.py

I apply TestSuite and there are 9 tests to find the number of possible trips from a departure_city to a destination_city.