

Train network manager

Algorithms Project 22/23

Problem Description

This project aims to develop a program that can analyze data related to the national train network. The program will be able to identify various parameters such as the maximum number of trains that can reach a station, the maximum number of trains that can travel between two stations, and the maximization of revenue, to name a few

Implemented features

Reading the data

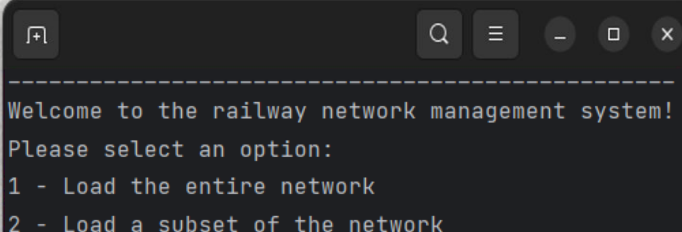
The methods `loadWithoutFilters` and `loadWithFilters` are used to read the provided data using two functions:

`readStations()` - reads the `stations.csv` file, creates objects of the `Station` class from the data, and adds a new node to the graph for each station. Auxiliary maps are also created.

`readNetwork()` - reads the `network.csv` file and adds to the graph the edges that represent connections between two stations. For each connection, an edge is added in each direction, with the capacity specified in the file.

Using the `loadWithFilters` method, it is possible to load only a portion of the network by specifying which lines or stations are desired.

As you can see on the right, we can load a subset of the network.

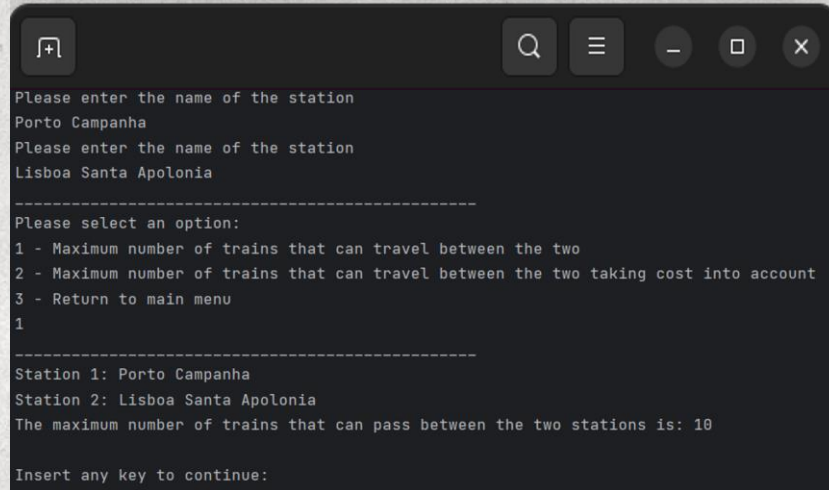


```
-----  
Welcome to the railway network management system!  
Please select an option:  
1 - Load the entire network  
2 - Load a subset of the network
```

Implemented features

Max number of trains between two stations

For this feature, we use the Edmonds-Karp algorithm to calculate the maximum flux between the two.



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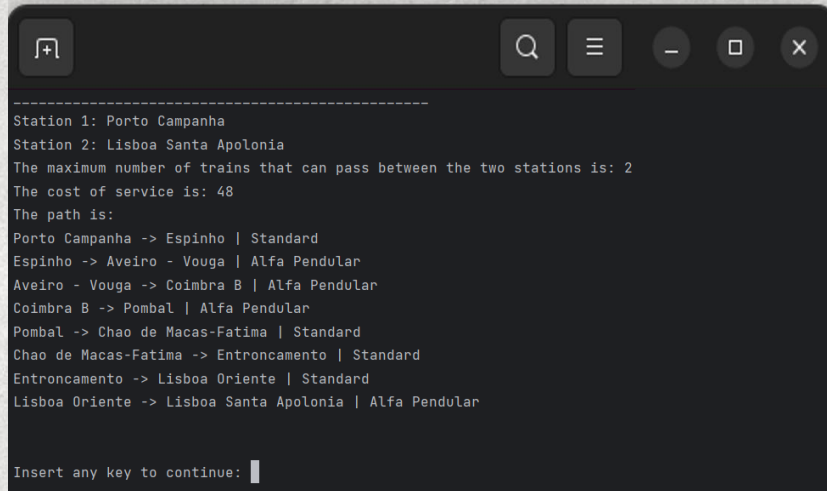
Please enter the name of the station
Porto Campanha
Please enter the name of the station
Lisboa Santa Apolonia
-----
Please select an option:
1 - Maximum number of trains that can travel between the two
2 - Maximum number of trains that can travel between the two taking cost into account
3 - Return to main menu
1
-----
Station 1: Porto Campanha
Station 2: Lisboa Santa Apolonia
The maximum number of trains that can pass between the two stations is: 10

Insert any key to continue:
```


Implemented features

Max number of trains between two stations taking cost into account

For this feature, we first calculate the min-cost path using Dijkstra (this takes into account the cost of service and the number of trains). Then, we calculate the bottleneck capacity.



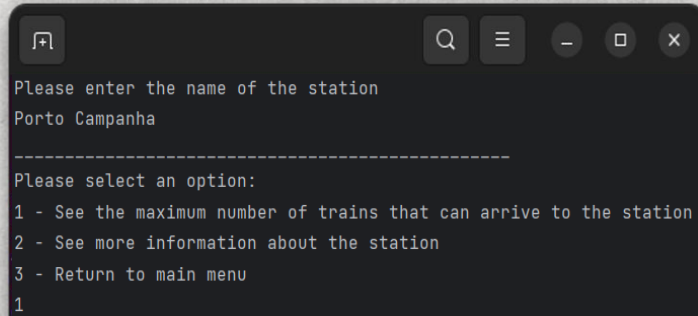
```
-----
Station 1: Porto Campanha
Station 2: Lisboa Santa Apolonia
The maximum number of trains that can pass between the two stations is: 2
The cost of service is: 48
The path is:
Porto Campanha -> Espinho | Standard
Espinho -> Aveiro - Vouga | Alfa Pendular
Aveiro - Vouga -> Coimbra B | Alfa Pendular
Coimbra B -> Pombal | Alfa Pendular
Pombal -> Chao de Macas-Fatima | Standard
Chao de Macas-Fatima -> Entroncamento | Standard
Entroncamento -> Lisboa Oriente | Standard
Lisboa Oriente -> Lisboa Santa Apolonia | Alfa Pendular

Insert any key to continue: |
```

Implemented features

Max number of trains reaching a station

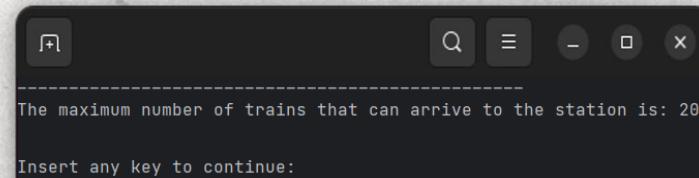
For this feature, a super source is created, connected to all stations that have only one connection to another station (which we interpreted as terminals). Then we use Edmonds-Karp to calculate the maximum flow from the super source to the station we are studying



```

Please enter the name of the station
Porto Campanha
-----
Please select an option:
1 - See the maximum number of trains that can arrive to the station
2 - See more information about the station
3 - Return to main menu
1

```



```

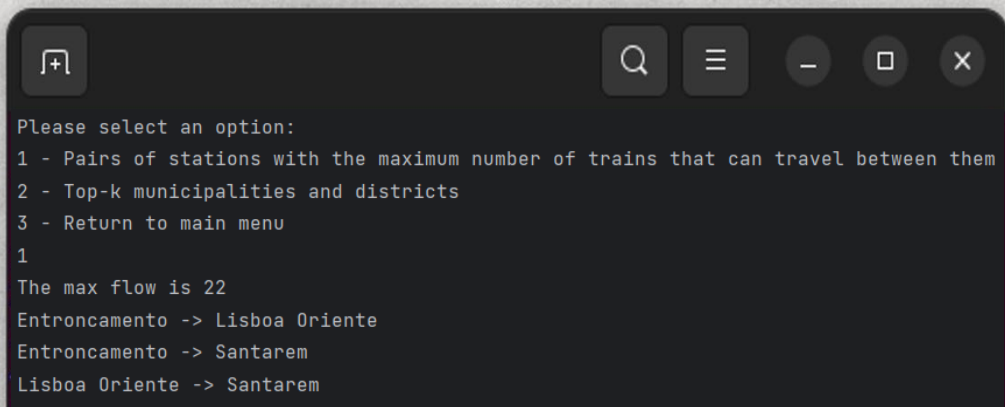
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The maximum number of trains that can arrive to the station is: 20
Insert any key to continue:

```

Implemented features

Which stations require more trains

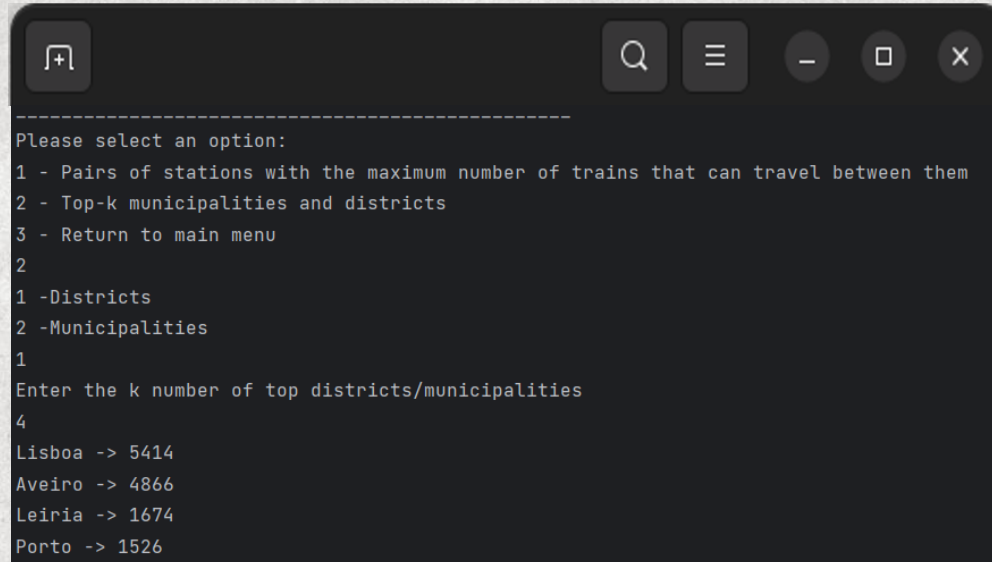
For this feature, we iterate over every pair of stations and calculate the flow. Then we display the stations with the max flow as you can see below.



Implemented features

Top-k districts and municipalities

This feature ranks districts/municipalities based on the total flow of all pairs of stations within each district/municipality. The user can select the number 'k' of districts/municipalities they want to view as you can see below.



```
-----
Please select an option:
1 - Pairs of stations with the maximum number of trains that can travel between them
2 - Top-k municipalities and districts
3 - Return to main menu
2
1 -Districts
2 -Municipalities
1
Enter the k number of top districts/municipalities
4
Lisboa -> 5414
Aveiro -> 4866
Leiria -> 1674
Porto -> 1526
```


Implemented features

Network with reduced connectivity

We start by asking the user if he wants to receive a report. If he does, we calculate the max number of trains that can enter the station before the change and after. We then show the stations where the change was greater.

```
-----
Please select an option:
1 - See information about a single station
2 - See information about two stations
3 - See information about the entire network
4 - Make a change to the capacity of a connection
5 - Exit
4
-----
Do you wish to receive a report of the changes made? (y/n)
y
How many changes do you wish to make : 1
```

```
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Change 1:
Please enter the name of the station
Caide
Please enter the name of the station
Meinedo
Please enter the new capacity. It must be equal or less than 4
0
-----
The capacity was changed
```

```
-----
Please enter the number of stations you wish to see
4
-----
The 4 stations with the less trains are:
Pinhao with 2 less trains
Cabeda with 2 less trains
Vargelas with 2 less trains
Paredes with 2 less trains
If you wish to undo your changes you must restart the program.
Insert any key to continue:
```

Group Members

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