Practice of programming (NF06A)
— Project 2021-2022 **—**

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"Le Marcel" manager: bike rental service management

Instructions

- Work in monome or in binome.
- Report (PDF format) + code + executable files are to be uploaded in the project folder of the TD group in which you will make your presentation. If you are a pair of students, think about indicating both names.
- The presentation (power point + execution) will take place during the last tutorial session.
- The code will have to be commented in full. To do this, you must use the Doxygen tool [1] to manage the documentation.
- Recommendations: The C language is very informative on the internet, do a search before contacting a friend or professor.
- It is not allowed to take a code from someone otherwise you could be sanctioned.
- It is crucial to cite your references.

Report

The report must include:

1. An introduction that clearly states the topic, as well as the plan of the document.
2. A part that describes the algorithms used (the operation and not the code).
3. The encountered problems and the solutions you have found.
4. An instruction manual for the program
5. A conclusion and perspectives to optimize your program.
6. An appendix that includes the commented code.

It is also requested to estimate the time required to complete the different parts of the code.

[1] www.doxygen.org

Required Work

"Among all its mobility services, Troyes Champagne Métropole offers Le Marcel, a self-service electric bicycle rental service, available 7 days a week, 24 hours a day."[2] The city of Troyes introduced a new electrical bikes rental service called "Le marcel", with docking stations all over the city. People can rent a bike and return it to any of these stations. Allowing such flexibility comes at a cost, the city needs to manage these stations and bikes to ensure a good user experience. This includes: bike maintenance, station maintenance, stations' load balancing... The city is asking you to build a management system to help them improve their service. We propose to model the database of bikes and stations as follow:

1. Bikes:
    - UID: unique ID that characterizes the bike.
    - Battery: charging level of the bike (percentage).
    - Nb_days: number of days the bike is in use.
    - Nb_rents: number of times the bike is rented.
2. Stations
    - UID: unique ID that characterizes the station.
    - Name: name of the station.
    - Location: to simplify this, we represent it as 2D point (x,y) coordinates of the station.
    - List of bikes in the station.
    - Nb_rents: Number of times a bike is rented from this station.
    - Nb_returns: Number of times a bike is returned to the station.

This system uses a clear menu to ensure the following features:

The following features must be implemented in Python:

1. Import/export the database of stations and bikes from/to a file.
2. Dock a bike: read a bike's information and place it in one of the stations to be chosen by the user.

[2] https://www.troyesparcauto.com/en/le-marcel-velo-en-libre-service

3. Display stations and bikes: display each station with the docked bikes in a descending order according to their battery level.
4. Rent bike: the user will specify:
   - Bike from one of the stations to rent.
   - Station where to return the bike.
   - Number of minutes (for each minute reduce the battery with 2%).
5. Returns a summary of the whole system, this includes:
   (a) Bikes: Number of all bikes. List of bikes sorted according to:number of days in use, number of times rented.
   (b) Stations: Average battery level for each station and overall, List of stations sorted according to: number of rents, number of returns.
6. Maintenance:

   At the end of each day, the user enters a list of defective bikes, provide this list to the C algorithm to find the best path to bring the bikes to the warehouse (see question below). Display the returned path using the library networkx [3] by representing the stations as a graph and specifying the rank (order) of each visited edge.

The following feature must be implemented in C:

Maintenance: In order to ensure the bikes are always in good condition, the city needs to pass by the end of each day by some of the stations in order to get the defective bikes. The goal is to propose the best route that we should take to get all the defective bikes traveling the least distance possible.

This is known as the traveling salesman problem, there are different algorithms to solve it (greedy, heuristics like 2-opt or nearest neighbor...). The Python part will provide the list of stations we need to visit each day:

- Implement an algorithm in C that returns the order in which the city should visit the stations to minimize the traveled distance, suppose that we start from the main warehouse located at coordinates (x=0, y=0) and return to it at the end.

Bonus

By the end of each day, some stations have more bikes than others. Implement an algorithm (in C or in Python) to determine the necessary bike movements that need to be done in order to balance the number of bikes in each station.

[3] https://networkx.org/

Tips and recommendations

1. The appropriate data structures for each part (C and Python) must be created.
2. The code should be well formatted (Indentation, good variable naming convention), commented and features split into functions and procedures.
3. Using libraries in Python is encouraged e.g. json, xml for files ...
4. Graphical interfaces in Python are a plus.
5. Interactions between the C and Python must be done using existing libraries for the purpose (Ctypes preferably but other libraries are also accepted)