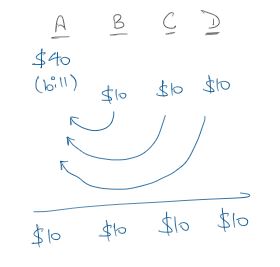
This file covers a few scenarios that we would like our web application to take care of.  
Some of the algorithms mentioned will be used for the demo on Wednesday, whereas the others are for future integration for other groups.

Various methods have been researched and the most appropriate ones have been included in this file. However, there may be other ways to achieve the following test cases in a more effective way. This document provides an initial read into how the application algorithms can be set up.

**Case 1:**

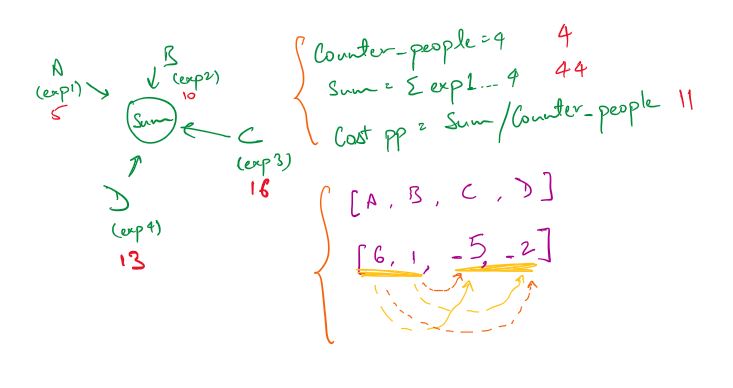
A single bill payment is made by an individual A on behalf of the group. The rest of the members now owe “A” a share of the bill. In our case, for simplicity, the shares will be equally divided.



Therefore, once the payments are made, everyone has had a net expenditure of $10 towards the bill (where 4 people had a total bill of $40).

**Case 2:**

Multiple transactions are made by various people in a group (for e.g. during a trip/vacation). Assuming all the bills must be settled evenly, we now have a scenario where a few people have paid more than they should have and a few people who haven’t paid enough. Therefore, we need to calculate the total amounts owed by the people who underpaid and who they need to pay to bring monetary equilibrium in the group.



**Case 3:**

Multiple transactions are made within a group but only between certain members. Therefore, we now don’t have an equal distribution of the expenditures as some people aren’t involved in certain activities. Below is an example describing this scenario.

Alice and Bill are going to lunch. Bill's card isn't working, so Alice pays $10 for his meal,.  
The next day, Bill and Charles meet each other on a railway station. Charles has no money for the ticket, so Bill buys him one for $5. Later that day, Alice borrows $5 from Charles and $1 from Bill to buy her friend a gift.

The transactions look like this:

Alice -> Bill $10

Bill -> Alice $1

Bill -> Charles $5

Charles -> Alice $5

To reach monetary equilibrium, Bill needs to give Alice $4 (he gave her $1 and Charlie indirectly paid his $5 to Alice already).

While this solution looks neat, it is complicated as the transactions can’t be predetermined and need to achieve the lowest number of payments to achieve equilibrium within the group. The following is a double entry accounting concept that could provide a basis for the solution to our problem.

The transactions could be structured as bookkeeping entries:

Alice Bill Charles Balance

Alice -> Bill $10 10 10- 0 0

Bill -> Alice $1 9 9- 0 0

Bill -> Charles $5 9 4- 5- 0

Charles -> Alice $5 4 4- 0 0

At each transaction, you credit one ledger account and debit another so that the balance is always zero. At the end, you simply work out the minimal number transactions to be applied to each account to return it to zero.

For this simple case, it's a simple $4 transfer from Bill to Alice. What you need to do is to reduce at least one account (but preferably two) to zero for every transaction added. Let's say you had the more complicated:

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Alice Bill Charles Balance

Alice -> Bill $10 10 10- 0 0

Bill -> Alice $1 9 9- 0 0

Bill -> Charles $5 9 4- 5- 0

Charles -> Alice $5 4 4- 0 0

Charles -> Bill $1 4 5- 1 0

Then the transactions needed would be:

Bill -> Alice $4 0 1- 1 0

Bill -> Charles $1 0 0 0 0

Unfortunately, there are some states where this simple greedy strategy does not generate the best solution. More information can be found in the links provided in the reference list.

REFERENCES:

*[Minimize Cash Flow among a given set of friends who have borrowed money from each other](https://www.citefast.com/?s=APA7" \o "Edit)*[. (2019, December 11). GeeksforGeeks. https://www.geeksforgeeks.org/minimize-cash-flow-among-given-set-friends-borrowed-money/](https://www.citefast.com/?s=APA7" \o "Edit)

*[Algorithm to share/settle expenses among a group](https://www.citefast.com/?s=APA7" \o "Edit)*[. (n.d.). Stack Overflow. https://stackoverflow.com/questions/974922/algorithm-to-share-settle-expenses-among-a-group](https://www.citefast.com/?s=APA7" \o "Edit)

*[What algorithm to use to determine minimum number of actions required to get the system to "Zero" state?](https://www.citefast.com/?s=APA7" \o "Edit)*[(n.d.). Stack Overflow. https://stackoverflow.com/questions/877728/what-algorithm-to-use-to-determine-minimum-number-of-actions-required-to-get-the/](https://www.citefast.com/?s=APA7" \o "Edit)