Project 1 - Intelligence
CmpE 250, Data Structures and Algorithms, Fall 2023

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Due: 09/11/2023, 23:55 Strict

1 Introduction

You are working for the Lounge Intelligence Services. The Service is closely monitoring the Tattaglia Crime Family and needs your help. Your duty is to keep track of the organization's structure using the tips from the informants and provide a detailed analysis of this structure.

2 Organization

Tattaglia Family believes in the golden mean, so they came up with the golden mean score (GMS) devised from attributes such as criminal record, risk-taking, and reputation. They are organized in a way that members that are closer to the golden mean are higher up in the hierarchy:
Note: All GMS values in I/O files must be represented with 3 figures after the floating point. For example: 5.000, 0.450, 0.123

2.1 Basics

- There is always a current boss of the family who resides at the top of the hierarchy. The boss has a rank of 0 which is the highest rank.
- Every member has non-zero a rank, which indicates their importance to the family. Rank is determined by their distance to the boss. For example, if a member's superior is the direct inferior of the boss, that member has a rank of 2.
- Every family member except the boss has a direct higher ranking member that gives orders to them.
- Every family member has at most two direct lower-ranking members to give orders.
- If there are two lower-ranking members under the command of a higher-ranking member, one must have a higher GMS than the commander's GMS, and one must have a lower GMS than the commander's GMS.

- Every new member initially joins the family at the bottom of the hierarchy.
- There are no two members that have the same GMS.

2.2 Keeping the Balance

- Tattaglia Family also believes that lower levels of the hierarchy are better. So, the family ensures that among the members that have no members to command, the highest ranking and the lowest ranking should not have more than 1 rank difference.
- This 1 rank difference is ensured by a reorganization process. After a new member is welcomed into the family, all of the new member's commanding superiors, starting with the lowest ranking one to the highest ranking one, initializes the reorganization process. Similarly, after a member leaves the family, commanding superiors of the replacing member (or the leaving member if there are no replacements) initialize the reorganization process.

2.2.1 Reorganization Process

1. If the height of the substructure that is commanded by reorganizing member's inferior with the lower GMS and the height of the substructure commanded by the inferior's inferior with the lower GMS is larger than the height of the substructure commanded by the inferior's inferior with the higher GMS, the inferior takes the place of the reorganizing member.
2. If the height of the substructure that is commanded by reorganizing member's inferior with the higher GMS and the height of the substructure commanded by the inferior's inferior with the higher GMS is larger than the height of the substructure commanded by the inferior's inferior with the lower GMS, the inferior takes the place of the reorganizing member.
3. If the height of the substructure that is commanded by reorganizing member's inferior with the lower GMS and the height of the substructure commanded by the inferior's inferior with the higher GMS is larger than the height of the substructure commanded by the inferior's inferior with the lower GMS, the inferior's inferior takes the place of the reorganizing member.
4. If the height of the substructure that is commanded by reorganizing member's inferior with the higher GMS and the height of the substructure commanded by the inferior's inferior with the lower GMS is larger than the height of the substructure commanded by the inferior's inferior with the higher GMS, the inferior's inferior takes the place of the reorganizing member.

2.3 Leaving the Family

- If a member with no authority over another member leaves the family, nothing happens.
- If a member with only one direct member under their command leaves, that member takes their place.
- If a member has two direct members under their command leaves, a member under the leaving member's command replaces them. The chosen member has the lowest GMS among the candidates that has more GMS than the leaving member.

3 I/O Files

The input file consists of tips from informants and analysis requests by the service. All of the commands in the input file will require you to log something to the output file, either a tip log or an analysis result, which are explained in detail in the 4 - Functionality part. The first line of the input file will be the name and the GMS of the boss, for which you don't have to output anything.

Example:
CORLEONE_VITO 0.500
MEMBER_IN CORLEONE_SONNY 0.700
MEMBER_IN CLEMENZA_PETER 0.300
INTEL_TARGET CORLEONE_SONNY 0.700 CLEMENZA_PETER 0.300
MEMBER_OUT CORLEONE_SONNY 0.700
INTEL_DIVIDE

For more information, you can refer to the additional input-output files.

4 Functionality

4.1 Tips

4.1.1 New Member Joins

Whenever a new member joins the family, you will be informed by the informants:

Structure: MEMBER_IN <SURNAME_NAME> <GMS>
Example: MEMBER_IN COSTIGAN_WILLIAM 0.400

To join the family, every member must meet and gain approval from their commanding superiors. You are responsible for keeping the logs of these meetings, so you should log every meeting, starting from the boss to the direct superior of the new member:

Structure: <SUPERIOR_SURNAME_NAME> welcomed <NEW_MEMBER_SURNAME_NAME>
Example: COSTELLO_FRANK welcomed COSTIGAN_WILLIAM

4.1.2 A Member Leaves

Whenever an existing member leaves the family, you will be informed by the informants:

Structure: MEMBER_OUT <SURNAME_NAME> <GMS>
Example: MEMBER_OUT COSTIGAN_WILLIAM 0.400

If a member left and was replaced by nobody, you should log:

Structure: <SURNAME_NAME> left the family, replaced by nobody
Example: COSTELLO_FRANK left the family, replaced by nobody

If a member left and was replaced by another member, you should log:

Structure: <LEAVING_MEMBER_SURNAME_NAME> left the family, replaced by <REPLACING_MEMBER_SURNAME_NAME>
Example: COSTELLO_FRANK left the family, replaced by COSTIGAN_WILLIAM

4.2 Analysis

The Service will request an analysis of the state of the family before certain operations:

4.2.1 Targeting the Family

If The Service is planning simultaneous arrests of two family members, they will need to sabotage their communication with the boss. To do this, they will want from you the lowest ranking member that is the superior of both of these members.
Note: The Service will always make a request with two members.

Request:

Structure: INTEL_TARGET <SURNAME_NAME_1> <GMS_1> <SURNAME_NAME_2> <GMS_2>
Example: INTEL_TARGET CORLEONE_SONNY 0.700 CLEMENZA_PETER 0.300

Analysis:

Structure: Target Analysis Result: <SURNAME_NAME> <GMS>
Example: Target Analysis Result: CORLEONE_VITO 0.500

4.2.2 Dividing the Family

If an operation tries to divide the whole family, The Service will request the maximum number of independent members that can be targeted. No two members in the target list should be the direct superior or inferior of the other.

Request:

Structure: INTEL_DIVIDE

Analysis:

Structure: Division Analysis Result: <TARGET_LIST_SIZE>
Example: Division Analysis Result: 2

4.2.3 Monitoring Ranks in the Family

The Service also wants to investigate the ranks in the family to understand the missions assigned to them to predict future actions that the family will take. For this purpose, they will provide you with a member they have been recently monitoring and will want you to give them the members with the same rank, including the member they provided.
Note: You should output the members sorted with increasing GMS.

Request:

Structure: INTEL_RANK <SURNAME_NAME> <GMS>
Example: INTEL_RANK CORLEONE_SONNY 0.700

Analysis:

Structure: Rank Analysis Result: <SURNAME_NAME_1> <GMS_1> <SURNAME_NAME_2> <GMS_2> ...
Example: Rank Analysis Result: CLEMENZA_PETER 0.300 CORLEONE_SONNY 0.700

Figure 1: Cat looking angrily

5 Submission

You will be submitting a zip file containing your code via Moodle. Your code must be able to run correctly with these commands:

```
javac *.java
java Main <input_file> <output_file>
```

Your code will be tested with large input cases. Your execution time will be considered for grading in those cases. Your execution time will be determined with this command:

```
time java Main <input_file> <output_file>
```

If you want to test your code in Windows machine, you should run this script before testing:

```
function time { $Command = "$args"; Measure-Command { Invoke-Expression $Command 2>&1 | out- default} }
```

You will be provided the execution times of the large cases in our machine. If your program runs a couple of times slower than the given time, it is OK. For example, if given time is 5 seconds and your time is 15 seconds, you will get fully graded if all other parts are correct. But if your program runs very poorly, you will get partially graded. For example, if given time is 5 seconds and your time is over 1 minute, you will get partially graded.

6 Warnings

- All source codes are checked automatically for similarity with other submissions and exercises from previous years. Make sure you write and submit your own code. Any sign of cheating will be penalized by at least -100 points at the first attempt and disciplinary action in case of recurrence.
- You cannot include any external libraries to your project. Java Standard libraries such as java.util, java.io are allowed. You should implement your own classes for further needs.
- Make sure you document your code with necessary inline comments and use meaningful variable names. Do not over-comment or make your variable names unnecessarily long. This is very important for partial grading.
- Make sure that the white spaces in your output are correct. You can disregard the ones at the end of the line.
- Please use the discussion forum at Moodle for your questions and check if it has already been answered before.