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| This project will probably take longer than expected in order to work properly. **Start it Early!** Read this specification immediately, and please report any errors or inconsistency that you may find. |

# **Introduction**

Many people lose money in different types of economic bubbles or Ponzi schemes. Pyramid schemes[[1]](#footnote-0) are large scale scam operations that fool ordinary people with little (to no) experience in investment or marketing. Such organizations rely heavily on social media to attract new speculators by promising them that if they can convince other people to join, they will receive commissions or other bonuses. This idea benefits people who joined early (usually the directors of the organization) but leaves most members with great losses, simply because no new member will join after some time. There are also some variations that try to make it legitimate, such as advertising themselves as a marketing company that sells collectibles, which do not have any real value.

Recently2, PR police uncovered a pyramid scheme network in PR. The information came from *John Doe*, a recently arrested criminal who was the main bookkeeper of the network. While *Doe* was arrested on drug charges, police found evidence of a running pyramid network on his computer. He kept detailed logs of who joined the network, how and when, as well as how much assets they currently have.

PR police is now planning for *Operation Sahure*3 to crack down on this pyramid scheme. However, due to recent budget cuts in the island, there is only one unit to be sent to make arrests. So, they can only arrest one person at a time. After arresting a person, all their illegal assets will be seized. Considering that the news of arrest will spread publicly in a few hours after the first arrest, the police only have time to arrest at most a specific number of suspects. They want to maximize the amount of assets that they seize from suspects.

Furthermore, they do not have the location of members. The *Crown Attorney* prepared a deal for any arrested member to receive reduced charges when they reveal the location of another member to police. However, each member only knows a few other members in the network, a policy that was strictly enforced to protect the network from mass arrests. Every arrested member will accept the deal, if offered.

*Doe* also accepted a deal from the *Crown Attorney* to disclose the location of one member to the police in exchange for a reduced sentence. Now the police want to decide which group member they should select to arrest, to maximise the seized assets considering all limitations. So, they are asking you to help them find the answer. So, they are asking you to help them find the answer. Note that there may be multiple arrest scenarios that are the best.

# **Network Structure**

The pyramid network has a hierarchical structure, and uses special terms to refer to users. Consider the sample network topology shown in Figure 1. The number under each name is the illegal asset that the member has and can be seized if police arrested that member.







**Figure 1:** Sample Network Topology

There is one great boss (*Liam* in Figure 1) that has created and ruled the network. Other than him, each person who joined the network is sponsored by a network member. For example, *Emma* and *Jacob* are sponsored by *Liam*, to join the network. A new member is called a child of their sponsor in the network. For example, *Emma* and *Jacob* are *Liam’*s children in Figure 1.

When a new person joins the network, another member is appointed as their mentor and will teach the new member different techniques of recruiting more people. If the new member is the first child of their sponsor, the sponsor will also act as the mentor. As examples, *Alexander* is the first (and only) child of *James*, so *James* is both the sponsor and the mentor of *Alexander*; or, *Emma* is the first child of *Liam*, so *Liam* is both her sponsor and mentor.

If a member is not the first child of the sponsor, then the youngest child of the sponsor (the child who joined the network more recently) will be the mentor. For example, *Emma* is *Jacob*’s mentor as she has been the last person sponsored by *Liam* when *Jacob* joined the network. Similarly, *Mason* is *Sophia*’s mentor, and *Sophia* is *Olivia*’s mentor. (In Figure 1, the left-to-right order of children represents the order that they joined the network).

In this topology, each member knows the location of their sponsor, that of their mentor, and those of their children. When police arrest a member, that member—as part of the *Crown Attorney* deal—may be asked to reveal the location of either one of their children, their sponsor, or their mentor. Recall that the mentor of the first-child members is their sponsor.

# **Arrest Operation**

The police will ask *Doe* to reveal the location of a network member, called “target zero”. They will arrest target zero first, and ask him/her to reveal the location of another member (either their sponsor, mentor, or one of their children). Then, they will arrest that member, and continue the operation in the same manner until either they arrest the maximum members that they can arrest (due to time limit on overall operation), or the last arrested member cannot reveal the location of any other member that is not arrested already.

For example, consider Figure 1. Assume the maximum number of arrests is 4. Then, police may start by arresting *Mason*, then arrest *Emma*, *Liam*, and *Jacob*. However, if they arrest *Mason*, *Emma* and *Sophia*, they cannot arrest any fourth member, because *Sophia* cannot help them to arrest any new member: she does not have any child, and she only knows the location of *Emma* (her sponsor) and *Mason* (her mentor), both of whom are already arrested.

The police goal is to maximize the amount of seized money. So, if they follow the *Mason*, *Emma*, *Liam*, and *Jacob* scenario, they will seize a total of 126 = 14 + 42 + 20 + 50. But, by the *Mason*, *Emma*, and *Sophia* scenario, the seized asset will be 61 = 14 + 42 + 5. In this case, one best scenario is *Alexander*, *James*, *William*, and *Jacob* that will seize 162 = 60 + 10 + 42 + 50. Your goal in this project is to help the police find the best scenarios. Note that there may be multiple best scenarios.

# **Network Log Format**

Here, we describe the format of network log that police found on *Doe*’s computer. Each line of the file describes one member: i.e. the lines represent the order that members joined the network: the first line represents the first member, and the last line is the newest member of the network. Each line provides three pieces of information about the user: user name, their sponsor, and their illegal asset. The great boss does not have any sponsor, so that field is not present for him. These three parts are separated by a number sign ("#"). Here, assume saved in log1.txt file, it is the network log of the network shown in Figure 1:

Liam#20

Emma#42#Liam

Mason#14#Emma

Jacob#50#Liam

Sophia#5#Emma

William#42#Jacob

James#10#William

Ethan#5#Jacob

Olivia#8#Emma

Alexander#60#James

Note that children of a node are added from left to right.

# **Requirements**

# You are specifically required to comply with the following requirements for Design, Documentation, Team Declaration, etc., in addition to other details specified in this document.

**WORKING TEAMS**

In this project, you will be allowed to work individually or in teams of two persons **ONLY IF** you worked individually for Project 1. The team can be formed by students from different sections and professors as long as both team members worked individually in their project 1. Be aware that the grading process may include interviews to each team member or answering some questions in next exams, and you must show full understanding of the entire code that you submit. If you plan to work in team, the deadline to declare your team is **Friday January 5, 2018.** Email to **arun.sharma@upr.edu** and copy your teammate and your professor. Subject of the email: **P2 IC 4035/4020 Sem 17-1: Team Declaration**

**DESIGN**

You are required to design your project in accordance to Object Oriented Principles. You are also required to submit a PDF file, by **Tuesday January 9, 2018**, containing your UML diagram and brief description in accordance with notations and level of details used in the Big Java textbook. The UML diagram should show all dependencies among classes as well as methods’ signature. For java classes, you do not need to show method signatures though. Email to **arun.sharma@upr.edu** and copy your professor (and your teammate if any).

Subject of the email: **P2 IC 4035/4020 Sem 17-1: Design**

**USE OF JAVA CLASSES**

You are also allowed to use any Java classes that might be useful for the implementation of your project. However, any such class that you use must be fully understood by you, and you must be ready to answer questions that the grader may have about those classes verbally or in exams.

**DOCUMENTATION**

You are required to provide full documentation and comments for every part of your code.

**INPUT FORMAT**

Your project will be tested against different network log files and different maximum number of arrests, with the following specification. The network log file is a text file with the format explained above in Network Log Format Section. Your project should also read name of network log file from another file, let’s call it input.txt. Then, the input.txt may look like this:

4 log1.txt

2 log1.txt

13 bigLog.txt

The first line means that your project should find the maximum asset seized for the network specified in log1.txt where the maximum number of arrests are limited to 4. The second line means your project should find the maximum asset seized for the network specified in log1.txt where the maximum number of arrests are limited to 2. The third line means that your project should find the maximum asset seized for the network specified in bigLog.txt where the maximum number of arrests are limited to 13.

**OUTPUT FORMAT:**

For every line of the input.txt file, your project must generate an output text file, named outputN.txt where N starts form 1 and increments by each line. For instance, for the input.txt file above, three output files should be produced: output1.txt, outpu2.txt, and output3.txt. Further, each output file must have the following content and format.

Maximum seized assets: M

List 1: ARRESTED-LIST1

List 2: ARRESTED-LIST2

…

List x: ARRESTED-LISTX

where M is the maximum seized assets and ARRESTED-LISTX is the list of arrested people for each scenario X. For instance, if Figure 1 is saved in log1.txt in accordance with the format specified in the Network Log Format section (above), and we run your project for input.txt above, then your output1.txt should look like the following

Maximum seized assets: 162

List 1: Alexander, James, William, Jacob

List 2: Jacob, William, James, Alexander

Similarly, your outpu2.txt should look like the following:

Maximum seized assets: 92

List 1: William, Jacob

List 2: Jacob, William

List 3: Jacob, Emma

Note that the order of arrested lists does not have to be necessarily as above. Also, note that we are not going to give you other sample inputs/outputs. Make sure though you test your project against different scenarios.

1. **Deadline and Submission Guidelines**

The final deadline for this project is set to **Sunday, January 14.**

It is expected that you submit the following:

1. Zip file containing a directory inside which your project is located when extracted and saved. That zip file shall be named as: **P2\_4035\_nnnnnnnnn\_171.zip**. (Where nnnnnnnnn are the 9 digits of the student id number of one of the members of the team - ONLY ONE.)
   1. It should contain your project directory, whose name shall be: P2\_nnnnnnnnn. (... the number as before)
   2. Inside this last directory is where your project folder is located
2. Your project directory will also contain the pdf file with important information about your project. At the beginning of that document you should include clear instructions describing how your program can be executed from the command prompt. You should verify that those instructions work correctly. Also, your program should be able to read the input files (as specified) as long as those input files are located at the same directory from where the program is executed (from where the command to execute is typed).

Your code should include at least the proper documentation for its classes and methods, which must follow the standards required for the Javadoc tool. You don’t need to submit html files that are produced by the Javadoc tool; just make sure that your comments follow that standard. Make sure to properly include your names (both members of the team, if you work in a team) as comments at the beginning of each source file.

Once your zip file is ready, please, send it (as an attachment) by email to arun.sharma@upr.edu and copy your professor, as well as your teammate, if any. You must send such email from your student account in upr.edu. Emails from other sources may not be considered. Use the following subject on your email: **P2 IC 4035/4020 Sem 17-1 Implementation**.

Failing to comply with instructions for submission may cause deduction of points in your final grade or for the project to be considered as not submitted. Projects submitted after the specified deadline (day and time) will be considered as not submitted and therefore shall not be graded.

1. **Special Office Hours**

The TA Arun Sharma is going to hold special office hours to help you step by step if you have any doubts in this project or stuck with some concepts. He will be available in Stefani Lobby from 10:00AM to 12:00 NOON in the following days.

Tue (Jan 2), Wed (Jan3), Thu(Jan 4), Tue (Jan 9), Wed(Jan 10) and Thu(Jan 11)

His help will be provided on one-by-one and FIFO bases. Make sure you start the project early and ask for help early!

1. **End**

1. For more information, take a look at [https://en.wikipedia.org/wiki/Pyramid](https://en.wikipedia.org/wiki/Pyramid_scheme) [scheme](https://en.wikipedia.org/wiki/Pyramid_scheme)

   2 Note that this is a fictional scenario, and all names and events are not real.

   3 Sahure is an ancient pharaoh, which built a great pyramid for himself. You can read more about him on https://en.wikipedia.org/wiki/Sahure [↑](#footnote-ref-0)