



B5 - Computer Numerical Analysis

B-CNA-500

Game of Graphs

A song of Graphs and Matrices

Game of Graphs

binary name: `game_of_graphs`

language: everything working on "the dump"

compilation: when necessary, via Makefile, including `re`, `clean` and `fclean` rules



- The totality of your source files, except all useless files (binary, temp files, obj files,...), must be included in your delivery.
- All the bonus files (including a potential specific Makefile) should be in a directory named *bonus*.
- Error messages have to be written on the error output, and the program should then exit with the 84 error code (0 if there is no error).

INTRODUCTION

You are the Grand Maester of the Iron Throne and the Red Keep, currently occupied by Cersei Lannister, Queen of the Andals, the Rhoynar, and the First Men, and Protector of the Seven Kingdoms. However, her throne is threatened by numerous enemies that conspire against her.

Fortunately, you have access to the best spies in Westeros. They made a report with two parchments stating their observations about the state of the relationships between the major political figures of Westeros and Essos.

Your best weapon being cunning and not force, you need to decide either to plot with some political figures so that they assassinate threats to the Crown, therefore protecting it, or to betray the Crown if you see that you cannot protect it.

As Grand Maester, you have access to the latest technological advances, such as the very secret "computer", a machine able to do a lot of computations very quickly, and decide to use this to your advantage to analyze all these data using graph theory.

THE PROJECT

Your program will take various arguments, among them a friendships report (**FR**) and a conspiracy report (**CR**)

You will create a program that works in two modes:

- “Links” mode: it will take one file (**FR**) and two people as input, and displays the degree of separation of these people (or -1 if they are not connected).
- “Plots” mode: it will take two files (**FR** and **CR**) and a number n as input, and displays:
 - the list of people in alphabetical order (the order that will be used to build the matrices),
 - the matrix of the shortest paths, with lengths less than or equal to n .
 - a report of your actions (see “*Conspiracies*”)



All the people are described in the “friendships report” file. If a person is in the “conspiracies report” but not in the “friendships report”, this is an error



Friendships are reciprocal: if A is friends with B, B is also friends with A. This is not the case for conspiracies



Two “friends” can conspire against one another

CONSPIRACIES

You need to build a graph representing the conspiracies between each political figures (who plots against whom). Using this graph, you will need to stop people plotting against the Queen (called direct enemies), by plotting against them.

To do so, you need to contact every “close” friend to the Crown that is plotting against these enemies. If an enemy has only non-close friends plotting against them, you can still convince these non-close friends by plotting against their enemies.

You will need to check who’s plotting against them. These people are “indirect enemies”, and just like your direct enemies, you can plot with their enemies if the latters are “close” friends. If you can plot against at least one of their enemies, then this “non-close friend” will help you, just like a “close friend”.

You must continue until finding a way to plot (directly or indirectly) against all your direct enemies.



A person is considered a “close friend” if their friendship level relative to the Queen is less than or equal to n .

You must display the chain of treason that results on saving the Queen, sorted from the shortest to the longest chains. For each chain of same length, you must display them in alphabetical order.

If you can conspire with multiple allies, choose in priority the ones that are closest to the Queen, then those who are the less threatening towards you (i.e.: less flagged as direct or indirect enemies) and finally take the first one in alphabetical order.

If you can successfully plot against all the direct enemies, you must print “The Crown is safe !”, otherwise you need to betray the Crown and must display “There is only one way out: treason !”.



The Queen will always be named “Cersei Lannister”



Don't take assumption about alliances ! You can plot with someone against a common enemy, even though this person is also directly plotting against you



External functions and libraries handling graphs and matrices don't exist in Westeros, and are obviously unauthorized regardless of the language.

USAGE

```
Terminal
~/B-CNA-500> ./game_of_graphs --help
USAGE
  ./game_of_graphs [--links fr p1 p2 | --plots fr cr n]

DESCRIPTION
  fr    file containing friendship relations between people
  pi    name of someone in the friendships file
  cr    file containing conspiracies intentions
  n     maximum length of friendship paths
```



SUGGESTED BONUSES

- Display the link connecting the people
- Graphical visualization of the connections between people

EXAMPLES

```
Terminal
~/B-CNA-500> cat friends_example
Jon Snow is friends with Sansa Stark
Missandei is friends with Daenerys Targaryen
Tywin Lannister is friends with Cersei Lannister
Sansa Stark is friends with Cersei Lannister
Lynce Hightower is friends with Jorah Mormont
Daenerys Targaryen is friends with Jorah Mormont
Jeor Mormont is friends with Jorah Mormont
Samwell Tarly is friends with Maester Aemon
Samwell Tarly is friends with Sansa Stark
Maester Aemon is friends with Tywin Lannister
Vere is friends with Samwell Tarly
Theon Greyjoy is friends with Jon Snow
Tyrion Lannister is friends with Cersei Lannister
Samwell Tarly is friends with Jon Snow
The Mountain is friends with Cersei Lannister
Jorah Mormont is friends with Cersei Lannister
```

```
Terminal
~/B-CNA-500> cat plots_example
Daenerys Targaryen is plotting against Cersei Lannister
Tywin Lannister is plotting against Cersei Lannister
Sansa Stark is plotting against Theon Greyjoy
The Mountain is plotting against Jon Snow
Jon Snow is plotting against Tywin Lannister
Theon Greyjoy is plotting against Sansa Stark
Jon Snow is plotting against Theon Greyjoy
Tywin Lannister is plotting against Daenerys Targaryen
Sansa Stark is plotting against Cersei Lannister
```

```
Terminal
~/B-CNA-500> ./game_of_graphs --links friends_example "Vere" "Cersei Lannister"
Degree of separation between Vere and Cersei Lannister: 3
```



```
Terminal
~/B-CNA-500> ./game_of_graphs --links friends_example "Jon Snow" "Jon Snow"
Degree of separation between Jon Snow and Jon Snow: 0
```

```
Terminal
~/B-CNA-500> ./game_of_graphs --links friends_example "Jon Snow" "Harry Potter"
Degree of separation between Jon Snow and Harry Potter: -1
```



```
Terminal
~/B-CNA-500> ./game_of_graphs --plots friends_example plots_example 3
Names:
Cersei Lannister
Daenerys Targaryen
Jeor Mormont
Jon Snow
Jorah Mormont
Lynce Hightower
Maester Aemon
Missandei
Samwell Tarly
Sansa Stark
The Mountain
Theon Greyjoy
Tyrion Lannister
Tywin Lannister
Vere

Relationships:
0 2 2 2 1 2 2 3 2 1 1 3 1 1 3
2 0 2 0 1 2 0 1 0 3 3 0 3 3 0
2 2 0 0 1 2 0 3 0 3 3 0 3 3 0
2 0 0 0 3 0 2 0 1 1 3 1 3 3 2
1 1 1 3 0 1 3 2 3 2 2 0 2 2 0
2 2 2 0 1 0 0 3 0 3 3 0 3 3 0
2 0 0 2 3 0 0 0 1 2 3 3 3 1 2
3 1 3 0 2 3 0 0 0 0 0 0 0 0 0
2 0 0 1 3 0 1 0 0 1 3 2 3 2 1
1 3 3 1 2 3 2 0 1 0 2 2 2 2 2
1 3 3 3 2 3 3 0 3 2 0 0 2 2 0
3 0 0 1 0 0 3 0 2 2 0 0 0 0 3
1 3 3 3 2 3 3 0 3 2 2 0 0 2 0
1 3 3 3 2 3 1 0 2 2 2 0 2 0 3
3 0 0 2 0 0 2 0 1 2 0 3 0 3 0

Conspiracies:
Jon Snow -> Tywin Lannister
Theon Greyjoy -> Sansa Stark
Tywin Lannister -> Daenerys Targaryen

Result:
The Crown is safe !
```



```
Terminal
~/B-CNA-500> ./game_of_graphs --plots friends_example plots_example 2
Names:
Cersei Lannister
Daenerys Targaryen
Jeor Mormont
Jon Snow
Jorah Mormont
Lynce Hightower
Maester Aemon
Missandei
Samwell Tarly
Sansa Stark
The Mountain
Theon Greyjoy
Tyrion Lannister
Tywin Lannister
Vere

Relationships:
0 2 2 2 1 2 2 0 2 1 1 0 1 1 0
2 0 2 0 1 2 0 1 0 0 0 0 0 0 0
2 2 0 0 1 2 0 0 0 0 0 0 0 0 0
2 0 0 0 0 0 2 0 1 1 0 1 0 0 2
1 1 1 0 0 1 0 2 0 2 2 0 2 2 0
2 2 2 0 1 0 0 0 0 0 0 0 0 0 0
2 0 0 2 0 0 0 0 1 2 0 0 0 1 2
0 1 0 0 2 0 0 0 0 0 0 0 0 0 0
2 0 0 1 0 0 1 0 0 1 0 2 0 2 1
1 0 0 1 2 0 2 0 1 0 2 2 2 2 2
1 0 0 0 2 0 0 0 0 2 0 0 2 2 0
0 0 0 1 0 0 0 0 2 2 0 0 0 0 0
1 0 0 0 2 0 0 0 0 2 2 0 0 2 0
1 0 0 0 2 0 1 0 2 2 2 0 2 0 0
0 0 0 2 0 0 2 0 1 2 0 0 0 0 0

Conspiracies:
Jon Snow -> Tywin Lannister
Tywin Lannister -> Daenerys Targaryen
The Mountain -> Jon Snow -> Theon Greyjoy -> Sansa Stark

Result:
The Crown is safe !
```




```
Terminal
~/B-CNA-500> ./game_of_graphs --plots friends_example plots_example 1
Names:
Cersei Lannister
Daenerys Targaryen
Jeor Mormont
Jon Snow
Jorah Mormont
Lynce Hightower
Maester Aemon
Missandei
Samwell Tarly
Sansa Stark
The Mountain
Theon Greyjoy
Tyrion Lannister
Tywin Lannister
Vere

Relationships:
0 0 0 0 1 0 0 0 0 1 1 0 1 1 0
0 0 0 0 1 0 0 1 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 1 0 1 0 0
1 1 1 0 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 0 0 0 1
0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 1 0 0 1 0 0 0 0 1
1 0 0 1 0 0 0 0 0 1 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 0 0 0 0

Conspiracies:
Tywin Lannister -> Daenerys Targaryen
The Mountain -> Jon Snow -> Theon Greyjoy -> Sansa Stark
No conspiracy possible against Tywin Lannister

Result:
There is only one way out: treason !
```