

## CS 246—Assignment 5, Group Project (Fall 2025)

Due Date 1: Friday, November 21st, 5:00pm

Due Date 2: Friday, November 28th, 11:59pm

This project is intended to be doable by three people in two weeks. Because the breadth of students' abilities in this course is quite wide, exactly what constitutes two weeks' worth of work for three students is difficult to nail down. Some groups will finish quickly; others won't finish at all. We will attempt to grade this assignment in a way that addresses both ends of the spectrum. You should be able to pass the assignment with only a modest portion of your program working. Then, if you want a higher mark, it will take more than a proportionally higher effort to achieve, the higher you go. A perfect score will require a complete implementation. If you finish the entire program early, you can add extra features for a few extra marks.

Above all, **MAKE SURE YOUR SUBMITTED PROGRAM COMPILES AND RUNS.** The markers do not have time to examine source code and give partial correctness marks for non-working programs. So, no matter what, even if your program doesn't work properly, make sure it at least does something. After submitting, download your code from Marmoset and make sure it compiles and runs.

### Note on Graphics

If you have not already done so for Assignment 4, make sure you are able to use graphical applications from your Unix session. If you are using Linux you should be fine (if making an ssh connection to a campus machine, be sure to pass the `-Y` option). If you are using Windows and putty, you should download and run an X server such as Xming, and be sure that putty is configured to forward X connections. Alert course staff immediately if you are unable to set up your X connection (e.g. if you can't run `xeyes`).

Also (if working on your own machine) make sure you have the necessary libraries to compile graphics. Try executing the example provided in the `project/graphics_demo` directory (follow the `README.txt` to learn more).

**Note for Mac OS users:** On machines running Mac OS, you will need to install XQuartz <https://www.xquartz.org/>. Once installed, you must restart your machine. You will also need to explicitly tell `g++` where `X11` is located. If the example in `project/graphics_demo` does not work, browse through your Mac's file system, looking for a directory `X11` that contains directories `lib` and `include`. You must then specify the `lib` directory using the `-L` option and include directory using the `-I` (uppercase `i`) option. For most installations, the following linking step should work (last step from the `README.txt` from within the `project/graphics_demo` directory):

```
g++20 *.o -o demo -lX11 -L/usr/X11/lib -I/usr/X11/include
```

Where you should then be able to run the program

```
./demo
```

# The Game of RAIInet

In this project, your group will work together to produce the video game RAIInet, a game similar in style to Stratego. RAIInet is a game played between two opposing players, who take on the role of computer hackers. Each player controls eight pieces, called *links*. There are two different kinds of links: viruses and data. Each player has two goals:

1. Download four data
2. Make the opponent download four viruses

Upon achieving either goal, the player wins the game.

A game of RAIInet consists of an  $8 \times 8$  board on which players secretly place links face down. In this way, only the player who placed the link knows whether it is data or a virus.

The layout of a turn is as follows:

1. Optionally, use a single ability.
2. Move one of your links in any cardinal direction.

After a legal movement, the turn passes to your opponent, and the game continues.

There are two ways to achieve your goals. Moving a link off the *opponent's* edge of the board causes you to immediately download the moved link. There are two ways to force your opponent to download your links: either by moving them onto the opponent's server ports, or by losing to their link in a battle. By keeping which links are viruses and which links are data hidden, you can keep your opponent guessing as to what your game plan is!

## Links

There are two kinds of links: data, and viruses. If at any point a player has downloaded four data, they win the game. Conversely, if they have downloaded four viruses, they lose the game. In addition to being viruses or data, links have a *strength* between 1 and 4, with 1 being the weakest and 4 being the strongest. Initially, players are given viruses and data of each possible strength, for a total of 8 links.

## Movement and Capturing

Each turn you must move a single link you control one space in a cardinal direction. This movement is subject to a few conditions:

- You cannot move a link on top of another link you control (but can on top of an opponent's link; see below).
- You cannot move a link on top of your own server ports.
- You cannot move a link off the edge of the board, **except** off the edge upon which your opponents links started. When you move a link off the edge in this way, you download that link.
- If a link moves into the opponent server port, it is downloaded by the opponent.

- When a link is moved on top of a link controlled by an opposing player, both links are revealed to all players and they battle; the winner is the player whose link had higher strength. In the event of a tie, the initiating player wins the battle. After the battle, the winner downloads the link of the loser.

After moving one link, your turn ends. This is the only way a turn can be ended; there is no “pass” option.

## Display

The game board is an 8x8 grid, similar to chess or checkers. The middle two squares on the first and last row are the *server ports*. To set up, players place their links on the first and last row respectively. The links that would be placed over the server ports are instead placed on the second and second last row. Here are two example board setups, one at the start of the game and one halfway through (as seen by player 1)

|                                  |                                  |
|----------------------------------|----------------------------------|
| Player 1:                        | Player 1:                        |
| Downloaded: 0D, 0V               | Downloaded: 1D, 2V               |
| Abilities: 5                     | Abilities: 3                     |
| a: V1    b: D4    c: V3    d: V2 | a: V1    b: D4    c: V3    d: V2 |
| e: D3    f: V4    g: D2    h: D1 | e: D3    f: V4    g: D2    h: D1 |
| =====                            | =====                            |
| abcSSfgh                         | a.cSSf.h                         |
| ...de...                         | ...E..g.                         |
| .....                            | .....                            |
| .....                            | .....                            |
| .....                            | .....                            |
| .....                            | A.....                           |
| ...DE...                         | ...D.F..                         |
| ABCSSFGH                         | ...SS.GH                         |
| =====                            | =====                            |
| Player 2:                        | Player 2:                        |
| Downloaded: 0D, 0V               | Downloaded: 1D, 1V               |
| Abilities: 5                     | Abilities: 3                     |
| A: ?    B: ?    C: ?    D: ?     | A: ?    B: V2    C: V3    D: ?   |
| E: ?    F: ?    G: ?    H: ?     | E: V4    F: ?    G: ?    H: ?    |

Notice that all of player two’s links appear as question marks; as the game progresses, player 1 may gain information as to what player two’s links are. Your display must update itself to reflect this new information as it becomes available. Player 2 would see something similar, but with question marks on the values of player 1’s links. Your display should always display all the information available to the active player. Both of the boards above would be how the display is printed on player 1’s turn. Note that additionally tracked on the display is each players number of unused abilities, and their download total—this information must also be reflected on your display. For more information on abilities, read the following section.

In addition to a text display, you are required to create a graphical display. This display must show the board like above, with all the same information. However, instead of having a line showing whether links are viruses or data, this should be reflected in the colour of the link in your display (e.g., green for data, red for virus).

**Question:** In this project, we ask you to implement a single display that flips between player 1 and player 2 as turns are switched. How would you change your code to instead have two displays, one of which is player 1's view, and the other of which is player 2's?

## Abilities

In addition to the basic movements, each player has a set of five ability cards available to them at the start of the game. Each card can only be used once per game—however players select which cards they wish to use, and can take up to 2 of each kind. For example, player 1 may decide to start the game with two copies of the card Firewall, two copies of the card Download, and one copy of the card Polarize. In this case, player 1 would be able to download two of player 2's links, by using both their download cards.

The five abilities your game must support are as follows:

- **Link boost** modifies a link you control by making it move one additional square in each direction when it moves. This allows the link to “jump over” obstacles. A link with a link boost equipped may be unable to reach the opponent server port. This effect remains active until the link is downloaded.
- **Firewall** is played targeting any empty square on the board. When passing through this square, opponent links are revealed and, if they are viruses, immediately downloaded by their owner. A square with a firewall with it must be printed somehow on the display (e.g. with a `m` for a firewall by player 1 and a `w` for a firewall by player 2) Links owned by the player who placed firewall are unaffected by this ability.
- **Download** immediately downloads an *opponent* link. It does not need to be revealed.
- **Polarize** changes a data to a virus of the same strength, or vice versa.
- **Scan** reveals the type and strength of any link on the field.

On every turn you may play one ability card you have not already used in the current game. After doing so, its effects resolve and you cannot play any other abilities on that turn. After moving, the turn will end.

**Question:** How can you design a general framework that makes adding abilities easy? To demonstrate your thought process for this question, you are required to add in three new abilities to your final game. One of these may be similar to one of the already present abilities, and the other two should introduce some novel, challenging mechanic.

## Winning and Losing

When you have downloaded four data, regardless of their strength or who they belonged to originally, you win the game. Conversely, if you ever have downloaded four viruses, you immediately lose the game.

Your program need not have a game over screen, but it must be clear that the program stopped because a player won the game, and it must indicate which player won.

**Question:** One could conceivably extend the game of RAIInet to be a four player game by making the board a plus shape (formed by the union of two 10x8 rectangles) and allowing links to escape

off the edge belonging to the opponent directly adjacent to them. Upon being eliminated by downloading four viruses, each links and firewall controlled by that player would be removed, and their server ports would become normal squares. What changes could you make in your code to handle this change to the game? Would it be possible to have this mode in addition to the two-player mode with minimal additional work?

## Command Interpreter

You interact with the system by issuing text-based commands. The following commands are to be supported:

- `move <A> <dir>` moves the link `A` (where this can be any link you control) in the direction `dir`, which can be any of up, down, left, right.
- `abilities` displays the ability cards you have, together with an ID (from 1-5) and some indication if the ability card has been used or not.
- `ability <N>` uses the ability card with ID `N`. Some ability cards will require additional information, such as a target for Link Boost, or a square of the board for Firewall. Your program must support giving links as targets using the alphabetical code shown in the display section; so if ability 1 is Link Boost, `ability 1 b` attaches a Link Boost to the link `b`. Squares, such as for Firewall, must be specified by row and then column, where the top left corner is (0,0). For example, to place a firewall directly below one of player 1's server ports, one would use `ability 1 1 3` or `ability 1 1 4`, assuming that ability 1 is Firewall.
- `board` displays the board in the format shown in the Display section.
- `sequence <file>` Executes the sequence of commands found in `file`. This is to facilitate the construction of test cases.
- `quit` quits the game.

End-of-file (EOF) terminates the game.

**Although it is not required that your program respond to invalid input, we highly recommend that you arrange that invalid input (e.g., misspelled commands) not cause your program to crash. It will cost you precious time during your demo otherwise.**

## Command-line Interface

Your program should support the following options on the command line:

- `-ability1 <order>` specifies the abilities for player 1 (this is a list of the 5 abilities player 1 will use). If not specified, use the default set of abilities (Link boost, Firewall, Download, Scan, Polarize **in that order**). The abilities are given by a string consisting of the first letter of each ability. For example, the default order is `-ability1 LFDSP`. Ensure that when you add new abilities, they start with different letters.
- `-ability2 <order>` is as above but for the second player.

- `-link1 <order>` specifies the order of links player 1 receives. The string `<order>` should list what each link `a`, `b`, ..., `h` should be. For example, the example board in the display section can be made with `-p1order V1D4V3V2D3V4D2D1`. If this argument is not specified, your program should use the ordering `V1V2V3V4D1D2D3D4`.
- `-link2 <order>` is as above but for the second player.
- `-graphics` should enable your graphical interface.

**For testing purposes it is very important that all of the above (except perhaps graphics) as well as the sequence command are working; without these we may be unable to run a substantial portion of our tests.**

The contents of a test file passed to sequence are a list of commands, with each on a new line. For example, the following might be a test file:

```
ability 4 E
move a up
ability 5 E
move E down
```

In this example, with no arguments passed to the program, player 1 uses the ability `Scan` to reveal player 2's link `E`, which is data of strength 1. To prevent player 1 from downloading it, player 2 responds by playing `Polarize` on `E`, to change it to a virus of strength 1.

## Grading

Your project will be graded as described in the project guidelines document.

Even if your program doesn't work at all, you can still earn a lot of marks through good documentation and design, (in the latter case, there needs to be enough code present to make a reasonable assessment).

**Above all, make sure your submitted program runs, and does something!** You don't get correctness marks for something you can't show, but if your program at least does something that looks like the beginnings of the game, there may be some marks available for that.

## If Things Go Wrong

If you run into trouble and find yourself unable to complete the entire assignment, please do your best to submit something that works, even if it doesn't solve the entire assignment. For example:

- don't have abilities
- program only produces text output; no graphics
- server ports don't work
- no battles

You will get a higher mark for fully implementing some of the requirements than for a program that attempts all of the requirements, but doesn't run.

**Every time you add a new feature to your program, make sure it runs, before adding anything else. That way, you always have a working program to submit. The**

**worst thing you could do would be to write the whole program, and then compile and test it at the end, hoping it works.**

A well-documented, well-designed program that has all of the deficiencies listed above, but still runs, can still potentially earn a passing grade.

## **Plan for the Worst**

Even the best programmers have bad days, and the simplest pointer error can take hours to track down. So be sure to have a plan of attack in place that maximizes your chances of always at least having a working program to submit. Prioritize your goals to maximize what you can demonstrate at any given time. We suggest: save any graphics for last, and first do the game in pure text. One of the first things you should probably do is write code to draw the display (probably a class with an overloaded friend `operator<<`). It can start out blank, and become more sophisticated as you add features. You should also do the command interpreter early, so that you can interact with your program. You can then add commands one-by-one, and separately work on supporting the full command syntax. Take the time to work on a test suite at the same time as you are writing your project. Although we are not asking you to submit a test suite, having one on hand will speed up the process of verifying your implementation.

You will be asked to submit a plan, with projected completion dates and divided responsibilities, as part of your documentation for Due Date 1.

## **If Things Go Well**

If you complete the entire project, you can earn up to 10% extra credit for implementing extra features. See **guidelines.pdf** for more details.

## **Submission Instructions**

See **guidelines.pdf** for **important** instructions about what should be included in your Due Date 1 and Due Date 2 submissions. Read it now!