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COMP 15 Homework 6-Degrees

1. Prelude

You're a COMP 105 student. You notice that you were your current TA's COMP 15 TA back in the day. You wonder, "How many 'TA-ing degrees of separation' are there between me and my friends?" You think back on your data structures training from COMP 15 and notice that this project is a graph problem.

After begging the department administrators to give you rosters and TAs of every class for the past seven years, you sit down to write your program...

2. Overview

Note: This was added for clarification.

You will read in files containing TA lists and course rosters going many semesters back and store this information in some data structure(s). You will store information about which students have TAed which other students: Student A has TAed student B if student A was a TA for a given course during the same semester that student B took that course.) **Then, your program will loop reading commands from standard input (cin) until it reaches the end of file.** You must support the following commands, which will help your debugging:

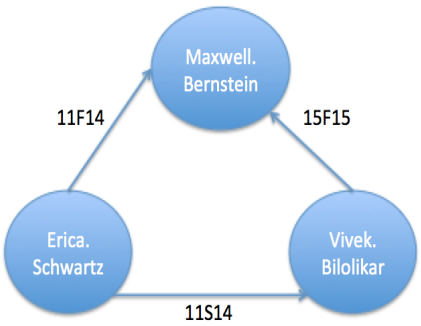
1. `ls`
   Lists the students found in both of the input files. Student names should be printed followed by newlines.
2. `lc`
   Lists the courses found in both of the input files, one per line.
3. `taed <student_name>`
   Lists the courses that *<student_name>* has TAed, again, one per line.
4. `roster <course name>`
   Lists the roster of the class *<course_name>*, one name per line.
5. `paths <student_a> <student_b>`
   Print all paths between *<student_a>* and *<student_b>*. One path should be printed per line (see the output format below). A path cannot contain the same student more than once. You could use a breadth-first search to find these paths.
6. `shortestpath <student_a> <student_b>`
   Find the shortest path between *<student_a>* and *<student_b>*. If multiple paths have the shortest length, output any one. Paths should be output in the following format:

```
Brad.Pitt +- 15S13 -> George.Clooney +- 11F14 -> Tom.Cruise
```

3. Examples

Example A

Say Erica.Schwartz TAed Vivek.Bilolikar in comp11 in spring 2014 and Maxwell.Bernstein in comp11 in fall 2014, and then Vivek.Bilolikar TAed Maxwell.Bernstein in comp15 in fall 2015. The following graph depicts this situation:



Your input will come in the form of two input files whose names are specified on the command line. In this case, the first file, which specifies who took what course, looks like this (Fig. 1):

```
Maxwell.Bernstein:11:F14
Maxwell.Bernstein:15:F15
Vivek.Bilolikar:11:S14
```

And the second file, which specifies who TAed what course, looks like this (Fig. 2):

```
Erica.Schwartz:11:F14
Erica.Schwartz:11:S14
Vivek.Bilolikar:15:F15
```

You will read in and store this information, and then wait for input from `cin`.

When the user enters `ls` they are asking for a list of students. In this example you print:

```
Erica.Schwartz
Maxwell.Bernstein
Vivek.Bilolikar
```

When the user enters `lc` they are asking for a list of courses, and you should print:

```
11F14
11S14
15F15
```

When the user enters

```
taed Vivek.Bilolikar
```

they are asking for a list of courses Vivek.Bilolikar TAed, and you should print:

```
15F15
```

When the user enters:

```
roster 11F14
```

they are asking for the roster of comp11 in fall 2014 and you should print:

```
Maxwell.Bernstein
```

When a user enters:

```
paths Erica.Schwartz Maxwell.Bernstein
```

they are asking for paths from Erica.Schwartz to Maxwell.Bernstein, and you should print:

```
Erica.Schwartz +- 11F14 -> Maxwell.Bernstein
Erica.Schwartz +- 11S14 -> Vivek.Bilolikar +- 15F15 -> Maxwell.Bernstein
```

When the user enters:

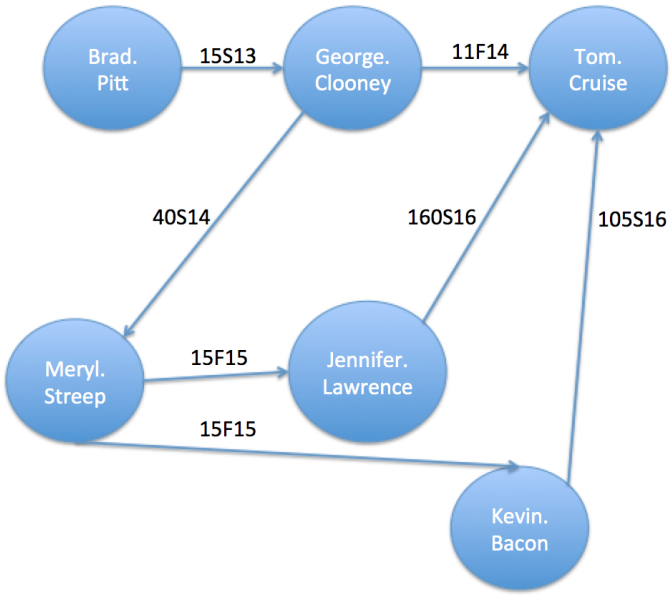
```
shortestpath Vivek.Bilolikar Maxwell.Bernstein
```

they are asking for the shortest path from Vivek.Bilolikar to Maxwell.Bernstein, and you print:

```
Vivek.Bilolikar +- 15F15 -> Maxwell.Bernstein
```

Example B

Now, consider the following graph:
In this case, the first file would look like this:




```
George.Clooney:15:S13
Jennifer.Lawrence:15:F15
Kevin.Bacon:15:F15
Meryl.Streep:40:S14
Tom.Cruise:11:F14
Tom.Cruise:160:S16
Tom.Cruise:105:S16
```

And the second file would look like this:

```
Brad.Pitt:15:S13
George.Clooney:11:F14
George.Clooney:40:S14
Jennifer.Lawrence:160:S16
Kevin.Bacon:105:S16
Meryl.Streep:15:F15
```

When the user enters:

```
paths Brad.Pitt Tom.Cruise
```

You should print:

```
Brad.Pitt +- 15S13 -> George.Clooney +- 11F14 -> Tom.Cruise
Brad.Pitt +- 15S13 -> George.Clooney +- 40S14 -> Meryl.Streep +- 15F15
          -> Jennifer.Lawrence +- 160S16 -> Tom.Cruise
Brad.Pitt +- 15S13 -> George.Clooney +- 40S14 -> Meryl.Streep +- 15F15
          -> Kevin.Bacon +- 105S16 -> Tom.Cruise
```

(Note: The second two paths should each be on one line, but they're too long to be on one line in this document.)

When the user enters:

```
paths George.Clooney Kevin.Bacon
```

You should print:

```
George.Clooney +- 40S14 -> Meryl.Streep +- 15F15 -> Kevin.Bacon
```

When the user enters:

```
paths Tom.Cruise Brad.Pitt
```

your program should not produce any output, because there is no path in this example between these people.

When the user enters:

```
paths Oprah.Winfrey Tom.Cruise
```

or

```
paths George.Clooney Jimmy.Fallon
```

or

```
paths Oprah.Winfrey Jimmy.Fallon
```

you should print:

```
Student not found
```

4. Implementation Specifics

Your program should be runnable by typing:

```
make
./hw6degrees students.txt tas.txt
```

into the terminal, where `students.txt` is a file in the directory that contains input as formatted in Fig. 1 and `tas.txt` is a file in the directory that contains input as formatted in Fig. 2.

You will store students and courses in data structure(s) of your choice. You are welcome to use the C++ Standard Template Library for queues, stacks, vectors, and/or sets, but you must implement all other data structures yourself.

We provide you with a hash function (in `hashfunc.cpp` and `hashfunc.h`), should you choose to implement a hash table. We also provide you with a `Makefile` that you will need to edit when you add `.h` and `.cpp` files of your own. You will have **make your own ReadMe** this time. Copy the files we're providing using the following command:

```
mkdir hw6; cd hw6
cp /comp/15/files/hw6/* ./
```

5. Implementation Plan

As in HW5, this project will be split into steps. You should be continually testing and debugging your code along the way. Be careful to keep any possible edge cases in mind. The stages are:

Stage zero

Think. Don't open an editor right away. What is being asked of you? Review the pictures and examples above. Do you understand what information is being represented? Can you find paths by hand? Once you're there, make a list: what information do you need to store, i. e., what is the data? Just brainstorm at first. You can do this with others (you can't share code, but you help each other understand the problem). For different kinds of data, what will you need to do with it? You may start thinking of some classes if some data elements have lots of state or operations. Make a list of such things. We started this in class already. Use paper. But you can also start putting things in your ReadMe file, which you can update as you go.

Stage one

Design your solution — choose your data structures, and outline your classes, your .h files, and your call tree. Aim to be finished with this stage by Monday, April 11th.

Stage two

Now you can start to implement your data structures, *and* you can work on the program skeleton. You can do this in different orders. If you have classes, then you can implement them and test them with specialized main functions/files.

For the assigned main program, you need to get some basic things going: Read in Student and TA files. Start by just reading each file in and printing it. Then, when you have some of your data structures working and you have the basic input working, read in the files and store them in your data structures. Now you can implement the user interaction commands ls and lc. At this point, you can be pretty sure you are correctly reading in, storing, and retrieving the data. If you can't do these things, you can't debug the rest of the project!

Aim to be finished with this stage by Friday, April 15th.

Stage three

Implement `taed`, `roster`, `paths` and `shortestpath` commands, as well as all other unfinished aspects of the project.

HW6 is due by the end of ~~Thursday, April 21st~~ Saturday 23 April

Stage four

Turn it in. Do not forget to update the `ReadMe.md` and `Makefile`.

Congratulations!