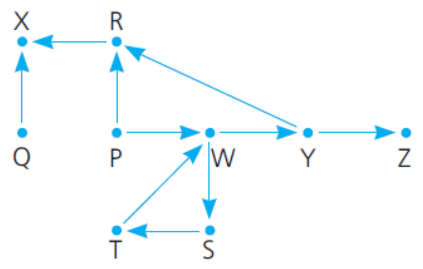
Project 5: Find Route in Map (Backtracking using a Stack)



For this project you will **design** and **implement** two classes (`City` and `RouteMap`) to find a route, if one exists, from origin to destination city, given a particular map.

This project will build on ideas we have worked with already (reading input from a csv file, working with abstractions - i.e. a City and a RouteMap).

However this time you will be responsible for the design!

The idea: In a map, as the one pictured above, we say that R is ***adjacent*** to P because there is an arrow going from P to R (*you can go from P to R, so R*). However, P is NOT adjacent to R because you cannot go from R to P following a single arrow. A ***route*** from an origin city to a destination city is a sequence of cities s.t. each city in the sequence is adjacent to the previous one. As we discussed in lecture, it is possible to find out if there is a route from an origin city to a destination city by implementing **backtracking using a stack**

- Starting from the origin, push adjacent cities that have not yet been visited onto the stack, and mark them as having been visited.
- If you reach a dead end (no more unvisited adjacent cities available from the city at the top of the stack), **pop the stack to backtrack.**
- Stop when you either **have the destination at the top of the stack** (**found route!)** or the stack is empty (there is no route)

The input: The input will be in the following format:

- The first line will be a comma-separated list of city names in alphabetical order. For example, for the RouteMap pictured above, **the first line** in the corresponding input file will be:

```
P,Q,R,S,T,W,X,Y,Z
```

- The remainder of the file will be a comma separated list of city pairs separated by `'-'`, where the second city in the pair is adjacent to the first. For example, for the RouteMap pictured above, the remainder of the file will be:

```
P-R,P-W,Q-X,R-X,S-T,T-W,W-Y,W-S,Y-R,Y-Z
```

You may assume that the city names are unique (no two cities have the same name) but not necessarily single letters, and that the input file is in the correct format.

Design and Implementation:

You will design and implement the two classes: `City` (`City.hpp` and `City.cpp`) and `RouteMap` (`RouteMap.hpp` and `RouteMap.cpp`)

Design Requirements - to successfully implement backtracking using a stack you need to:

- Be able to mark a city as having been visited
- Find out what cities are adjacent to any given city

Furthermore

- The **`RouteMap`** class **must have** the following **3 public methods** (you may and <u>should</u> add any public and private members that you deem necessary to implement and support the following)

```
/**
@param input_file_name of a csv file representing a route map where the first
       line is a comma-separated list of city names, and the remainder is a
       comma-separated list of city-pairs of the form A-B, indicating that B
       is adjacent to A (i.e. there is an arrow in the map going from A to B)
@post this depends on your design, the input data representing the map must
       have been stored. Adjacent cities must be stored and explored in the
       same order in which they are read from the input file
**/
bool readMap(std::string input_file_name);



/**
@return a pointer to the city found at position, where
        0 <= position <= n-1, and n is the number of cities,
        and cities are stored in the same order in which they appear
        in the input file
**/
City* getCity(size_t position);


/**
@return true if there is a route from origin to destination, false otherwise
@post if a route is found from origin to destination, it will print it to
      standard output in the form "ORIGIN -> ... -> DESTINATION\n"
**/
bool isRoute(City* origin, City* destination);
```

For example, with the map in the above example,
`isRoute(T_ptr, Z_ptr);` will return **`true`** and print

new line

```
T -> W -> Y -> Z
```

NOTE: `isRoute` MUST explore adjacent cities in the same order in which they were read from the input file.
Should you submit a program that mimics the output instead of solving the problem as per this specification, I reserve the right to take away points even if Gradescope gives you full credit.

Project Notes: For this project I suggest that you use the STL stack for backtracking (`#include <stack>`) as well as STL vectors or any other container you may deem appropriate to represent and store your data.
https://en.cppreference.com/w/cpp/container/stack

Extra Credit: Add exception handling for reading an empty file and calling `getCity` with position greater than the number of cities. When catching the exception your program should output "Catching" (for grading purposes output to `cout` not `cerr`). In such cases, a call to `isRoute` should still return **`false`.**

Testing: You should design and test incrementally. Write a main function to test your `City` class. Instantiate `City` objects and test every member function.
Next implement and test your `RouteMap` class, also incrementally. You should produce different input files and test that your RouteMap methods are correct on different test cases (there is a route, there is no route, there is a cycle, etc.)

Grading Rubric:

- **Correctness 80%** (distributed across unit testing of your submission)
- **Documentation 10%**
- **Style and Design 10%** (proper naming, modularity and organization)

Notes:

- I reserve the right to detract points given by Gradescope if your submission does not comply in some way with this specification.
- A submission that implements all required classes and functions but does not compile will receive 40 points total (including documentation and design).

Submission:

You must **submit `City.hpp`, `City.cpp`, `RouteMap.hpp`** and **`RouteMap.cpp`** (**4 files**)

Your project must be submitted on Gradescope.
Although Gradescope allows multiple submissions, it is not a platform for testing and/or debugging and it should not be used for that. You MUST test and debug your program locally.

Before submitting to Gradescope you MUST ensure that your program compiles (with g++) and runs correctly on the Linux machines in the labs at Hunter (see detailed instructions on how to upload, compile and run your files in the "Programming Rules" document). That is your baseline, if it runs correctly there it will run correctly on Gradescope and if it does not, you will have the necessary feedback (compiler error messages, debugger or program output) to guide you in debugging, which you don't have through Gradescope.
"But it ran on my machine" is not a valid excuse to get credit.
Once you have done all the above you submit it to Gradescope.

The due date is Monday July 8 by 9pm. No late submissions will be accepted.

Have Fun!!!!!