



Assessment 2: METAL Vertex Search

Due: 9:00 AM, Wednesday, September 24, 2025

In this assessment, you will be developing a C program that reads in data representing points on the surface of the Earth, and finds and reports the points among that set which are at the four directional extremes.

You may work alone or in groups of size 2 or 3 on this assessment. However, in order to make sure you learn the material and are well-prepared for the exams, those who work in a group must collaborate closely while completing the assignment (that is, be in the same place at the same time with all group members focused on the task at hand). In particular, the “you do these and I’ll do these” approach is sure to leave you unprepared for upcoming tasks and the exams and is prohibited.

This assessment will be graded as a programming assignment. Please review the syllabus description of the expectations for a programming assignment as opposed to a practice program.

AI assistance is not permitted on this assignment, as the purpose of this assignment is to practice and to gain a deeper understanding of C programming.

Learning goals:

1. To gain experience working with a larger C program.
2. To practice with file I/O, pointers, and `structs` in C.

Getting Set Up

In Canvas, you will find a link to follow to set up your GitHub repository, which will be named `vsearch-assessmentt-yourgitname`, for this assessment. Only one member of the group should follow the link to set up the repository on GitHub, then others should request a link to be granted write access.

All GitHub repositories must be created with all group members having write access and all group member names specified in the `README.md` file by 11:59 PM, Friday, September 19, 2025. This applies to those who choose to work alone as well!

Development Process Expectations and Reporting

Important: in order to encourage a step-by-step problem-solving approach and good software development practices, you must have no fewer than 5 commits of partially-working versions of this

program, with good commit messages (e.g., “reading input file correctly”, “first working version of the waypoint structure”, etc.). You will likely have more than 5 total commits.

Please add the 5 commits you wish to have considered for this requirement to the table that you will find in your repository’s `README.md` file. To find the information to include in this table, go to your repository on GitHub. Then go to its commits page. At the end of each commit listed there, you will see an icon that looks like this: `<>`. This is a link to the GitHub repository as it existed after that commit. Copy that link and the corresponding commit message into the table in the `README.md` file.

A penalty up to 50% will be applied if these commits are not listed in the `README.md` and/or do not demonstrate an appropriate development process.

Implementing a Vertex Extremes Search

As many of you have done in the past, we’ll be working with some data from the METAL project. In fact, you might have already written code to solve the “problem” we’re looking at in Java for an earlier class.

METAL provides a collection of graph data files that represent various highway systems. Each of the “.tmg” files is in the format described on METAL’s “Graph File Formats” page. You’ll want to download a few smaller and a few larger data files, and should choose “collapsed” or “simple” format graphs. The “traveled” format graphs have additional information not needed for this task. You can use METAL’s Highway Data Examiner to run the Vertex Extremes algorithm visualization to see how the algorithm works, and to check your answers, if you’d like.

Write a program with its `main` function in `extremes.c` that reads the “waypoints” portion of a graph file whose file name is specified as a command-line parameter, and then finds the easternmost, westernmost, northernmost, and southernmost waypoints in the file. For each “winner”, print out all of that waypoint’s information: its label, its latitude and its longitude. Handle ties by keeping only the first waypoint at a given extreme latitude or longitude that you encounter. Include a `Makefile` that builds your program.

Notes:

- You do not need to read or store the “road segments” portion of the input file, only the waypoints.
- You may assume that no waypoint label is longer than 256 characters.
- By including the `\n` in your `fscanf` format string, you can automatically move the input to the next line. You might alternately use a function that reads characters from the input until a new line is encountered to skip over things you don’t need to read. The latter has the advantage that you would not need a place to store things you don’t care about.
- If reading into a `double` variable with `scanf` or `fscanf`, you will need the `%lf` format specifier (a “long float”) so it knows you have the larger memory chunk available to write as a `double` rather than a `float` (which would use a `%f` format specifier). The compiler

should warn you if you about any such mismatch between format specifier and variable type when you specify `-Wall`.

- You can copy one C string to another using the `strcpy` function, defined in `string.h`. If you have strings declared as

```
char str1[256];  
char str2[256];
```

the following would copy the contents of `str1` to `str2`:

```
strcpy(str2, str1);
```

- Valid values for latitudes range from -90 (southernmost) to 90 (northernmost) and for longitudes range from -180 (westernmost) to 180 (easternmost).
- If you were doing this in an object-oriented language like Java or C++, you might create an object to represent each waypoint and provide methods to compare them, print them, *etc.*. But here, you should use a `struct` that has fields for a string (array of `char`) and two doubles to represent the current waypoint you are considering. Follow the model of the `struct ratio` from earlier, and have functions to operate on your waypoints, place them in their own C source file `waypoint.c`, and have a header file `waypoint.h` with appropriate information (`struct` definitions and function prototypes) that you can include in `extremes.c`.
- This will allow you to store a pointer to a waypoint structure to keep track of the “most extreme” leader in each direction you’ve encountered so far. Do this rather than keeping track of leaders by remembering indices into an array, so you will gain some extra experience with pointers in C.
- You don’t actually need to store all of the waypoints. But, for a little extra practice with arrays and pointers, and in recognition that they might be useful if we were to expand this program to have some additional functionality, let’s do this extra step. Store pointers to all of the waypoints in an array as they’re being read in, then traverse that array to find the answers. You are given the number of waypoints at the top of the file, so you can dynamically allocate enough space for it before you start reading and creating waypoints. At the end, also perform a search for each “winner” waypoint in the array to print out its index along with the other information about the waypoint. This could alternately be accomplished by storing the waypoint number of each waypoint as an additional field in the structure, but you should not do that.

Submission

Commit and push! And list your commits to be considered for the development process evaluation in the table in your repository’s `README.md`.

Grading

This assignment will be graded out of 60 points.

Feature	Value	Score
Command-line parameter	2	
Read input file	2	
waypoint structure and functionality	15	
Array of <code>waypoint</code> pointers created and filled	5	
Correctly find extreme waypoints	10	
Print all waypoint information for extreme winners	4	
Search for and print indices of winners	4	
All cleanup done properly (closing files, freeing memory)	4	
Documentation	10	
Design/style/efficiency	3	
Makefile	1	
Total	60	