Problem Statement

The goal of this program is to read cell tower data from a file and allocate frequencies to the cell towers, ensuring that towers that are close to each other do not share the same frequency. Towers that are furthest apart should have the same frequency wherever possible.

Key Constraints

- Towers that are close together cannot share the same frequency.
- Towers that are identified as being the furthest apart should be assigned the same frequency if it does not yet have any frequency assigned to it.
- Once a frequency is assigned based on distance, it must respect the existing allocations.

Example Scenario

Consider the following setup:

- Cell Tower X is close to Cell Towers Y and Z, and furthest from Cell Tower A.
- Cell Tower Y is close to Cell Towers X and B, and also furthest from Cell Tower A.

In this case:

- Cell Tower X cannot have the same frequency as Cell Tower Y or Cell Tower Z.
- Cell Tower Y cannot have the same frequency as Cell Tower X or Cell Tower B.

However:

- Cell Tower X and Cell Tower A must have the same frequency, because X is furthest from A as long as Cell Tower Y and A do not have the same frequency.
- Similarly, Cell Tower Y and Cell Tower A must have the same frequency, for the same reason.

Important to note the following:

- If the program first allocates a frequency to Cell Tower X and Cell Tower A, then Cell Tower Y cannot reuse that frequency (because it is close to Cell Tower X). Thus, Cell Tower Y will require a different frequency, even though it is also furthest from Cell Tower A.
- In this approach, the program ensures that the furthest-away tower maintains the frequency of the first tower identified as furthest from it, while maintaining conflict avoidance between neighboring towers.

Choosing Between Easting/Northing and Longitude/Latitude

In this project, Longitude and Latitude were chosen over Easting and Northing.

The primary reason for this choice is that the Haversine formula [1], which calculates the shortest distance between two points on the Earth's surface, works directly with Longitude and Latitude. This is due to the formula taking into account the radius of the Earth, which ensures more accurate distance calculations compared to a Cartesian system like Easting and Northing, which doesn't consider Earth's curvature.

Therefore, using Longitude and Latitude ensures the program calculates more accurate distances between the towers, improving the frequency allocation process.

Solution

Note that during development I noticed no threshold was given to compare distances and declare towers as "too close". Therefore, I calculated all distances between the towers and saw most distances revolve around 0.5 kilometers and chose "0.5" as the threshold value. Additionally, "-1" was used as a default frequency value for towers that cannot be allocated one of the other frequencies.

The following table illustrates the allocation of the frequencies based on the data provided:

Frequencies	Cell Tower IDs
110	A, D, I, J, P
111	B, E, N
112	C, G, M, O
113	F, Q
114	H, R
115	K, S
-1	L

References

[1] Kettle, S. (2017). *Distance on a sphere: The Haversine Formula*. [online] Esri Community. Available at:https://community.esri.com/t5/coordinate-reference-systems-blog/distance-on-a-sphere-the-haversine-formula/ba-p/902128.