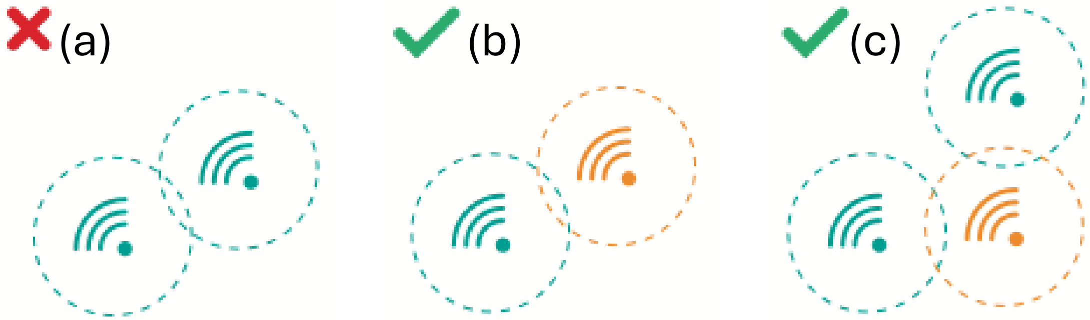
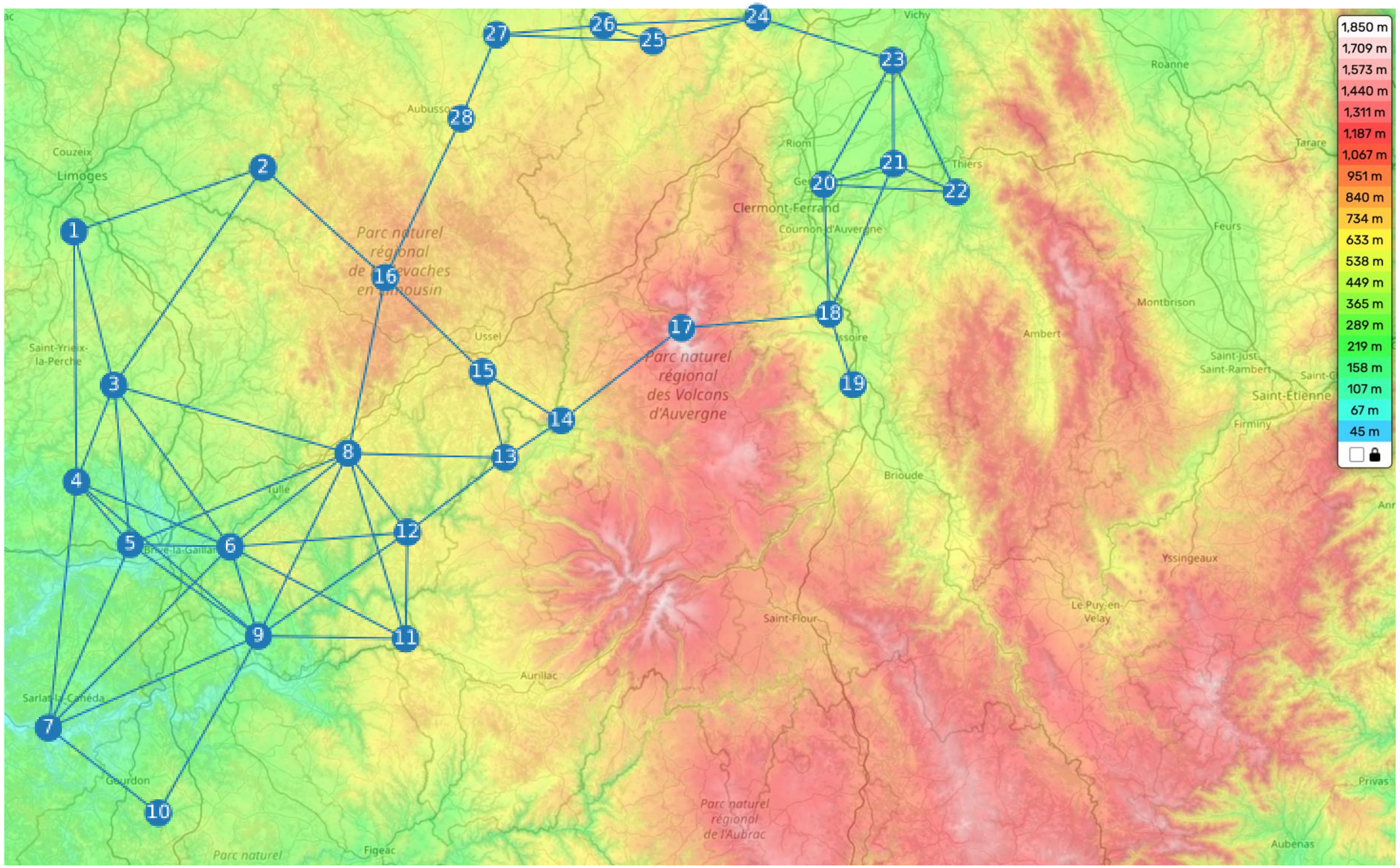
Neutral atom quantum computing in practice
EPITA Fall 2025
Final project assessment

A telecommunication company contacts you with the following situation. They have a certain number of antennas distributed over a geographical area, and each antenna uses a certain frequency to communicate. If two antennas are geographically close to each other, then they will interfere with each other if they use the same frequency (see figure below). On the other hand, it's not possible to just assign a different frequency to each antenna, because the number of available frequencies is limited. Therefore, the client wants to assign a minimum number of different frequencies to their antennas, while minimizing interferences at the same time.



Schematic example of interference between antennas. (a) Bad frequency assignment. Two antennas are assigned the same frequency (represented by the color green) and they lie within the interference radius of each other (represented as a dashed circle around them). (b) The same antennas are assigned different frequencies (green and orange), so they will not interfere with each other even if they lie within the respective interference radius. (c) Two antennas can be assigned the same frequency (green) if they don't lie within each other's interference radius.

Certain geographical characteristics of the terrain cause the interference radius between two antennas to be larger or smaller. For example, if a mountain lies between two antennas, they will not interfere even if they are close to each other. On the other hand, if a group of antennas lie in a flat area, their radius or interference might be enhanced. The following figure depicts the position of the antennas (numbered nodes), the interference pattern (two antennas interfere if they are connected by an edge) overlayed over an elevation map of the area.



Observe for example how antenna 2 and 28 do not interfere with each other, because some hills between them block the signal.

Antennas on the bottom left corner instead have on average a larger interference radius because they lie in a flat area.

The graph (vertices, edges and coordinates) is given in json format in the course repository. Refer to the file “graph_data.json”.

Assignment

1. Find a suitable graph optimization problem to model the client’s problem
2. Design an analog quantum algorithm for neutral atoms that gives a solution to the problem. The algorithm <u>does NOT</u> need to be optimal. You are free to choose whichever solver you prefer (adiabatic evolution, QAOA, others).
3. Implement the algorithm in Pulser to find a solution to the client's problem.
4. Improve the implementation by including realistic error sources and hardware requirements in the algorithm.
5. Write a short report detailing the work, clearly explaining the problem modeling, the algorithm, and justifying your choices.

Practicalities

The report can be written with the document editor of your choice, although Latex is preferred over other options like Word. The code should be properly commented, and it has to be provided as a repository on GitHub or GitLab, with a README explaining how it works.
Clarity of exposition and readability of the code will be taken into account in the assessment. Optimality of the solution found by the algorithm is NOT necessarily the most important aspect. For example an algorithm that gives the correct solution for the given graph instance, but that is not based on correct and solid ideas, will be assessed negatively.

Complete the assignment in groups of your choice of maximum 3 people.
When you have completed the assignment, share your repository with my account:

GitHub username: darcangelomauro
GitHub email: darcangelo.mauro@gmail.com

GitLab username: mauro.darcangelo
GitLab email: mauro.darcangelo@pasqal.com

Deadline: 12 December 2025 (morning of 13 December at the very latest)