Module 8 - Bonus Challenges

§M8: Neural Networks II

- Below are open-ended bonus challenges; solving them is not required but can help you better understand ML/AI in the context of engineering, and how to use them in practical cases.
- Bonus points earned in all homework assignments will be averaged (6 bonus points for each assignment) and then directly added to your final score to calculate your final letter grade.

Challenge 1.1. For this bonus question, you will apply a neural network to predict the altitude of various locations in Pittsburgh and use the trained model to identify the highest peak. Specifically, as shown in Figure 1, Pittsburgh (where CMU is located) has a hilly landscape with varying altitudes. We extracted the contour map in Figure 1to represent the altitudes across different locations (see Figure 2)

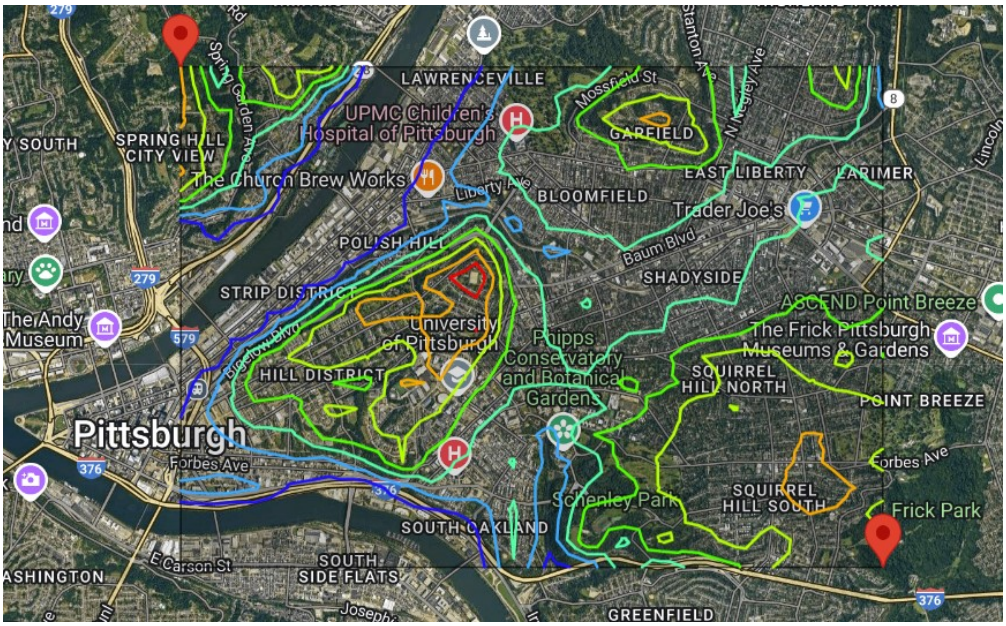

Figure 1: Map of Pittsburgh

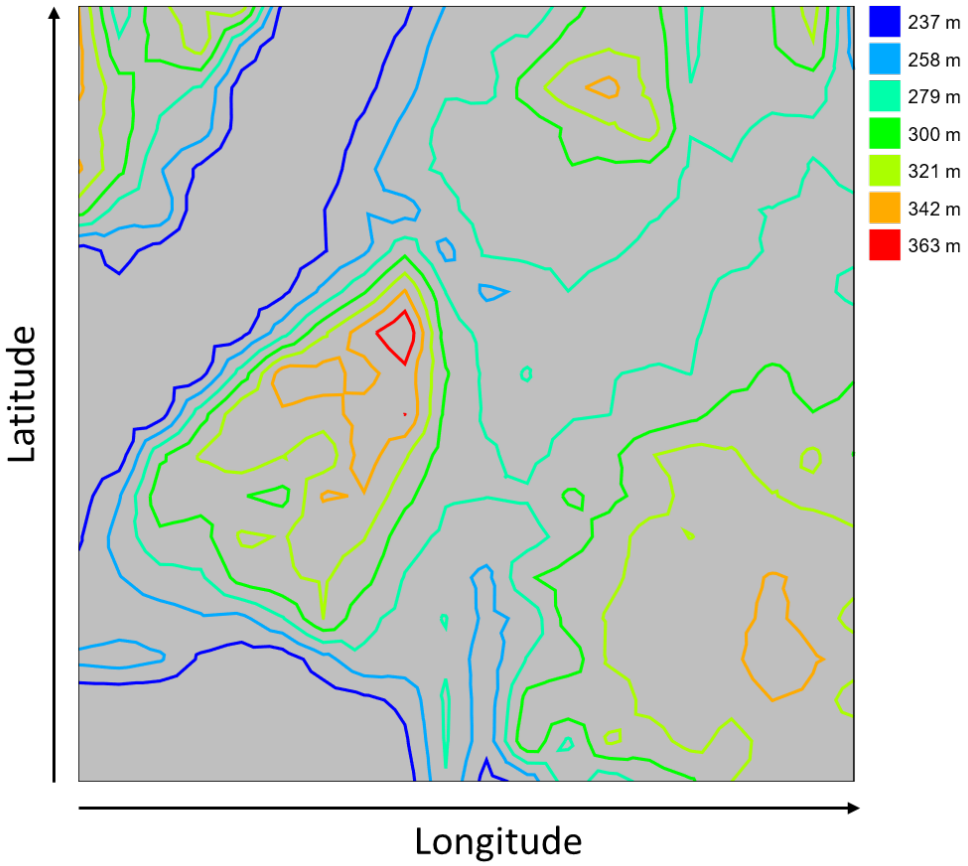

Figure 2: Extracted contour map

The data from the extracted contour map is provided in the file `PittsburghMap.xls`‘. The first two columns, labeled `'Longitude'` and `'Latitude'` represent the sampling locations. Longitude corresponds to the northern longitude, and the negative latitude values represent western latitudes. The third column, labeled `'altitude'` , provides the height or altitude of each location.

Please complete the task according to the following instructions: (*6pts*)

1. Randomly split the dataset into 80% for training and 20% for testing, using `train_test_split` in `sklearn`.

2. Fit a neural network model to the training dataset using PyTorch, where longitude and latitude serve as the inputs, and altitude is the output.

3. Predict the altitudes for points on a uniform 100x100 grid within the original range of the input space. Plot the corresponding contour map, similar to Figure 3

4. Based on the trained neural network, apply stochastic gradient ascent to find the location in Pittsburgh with the highest altitude. Unlike training, where you optimize model parameters, here you'll optimize the inputs to maximize the altitude output.

Adjust your step size and initial solution to ensure convergence to a point within the training input range.

5. Report the longitude, latitude, and altitude of the peak you identified. Mark this peak on the contour plot with a white triangle, as shown in Figure 3.

6. Use an external source (such as Google) to identify and report the name of the place corresponding to the peak location.

7. Submit your Jupyter notebook file with necessary comments.

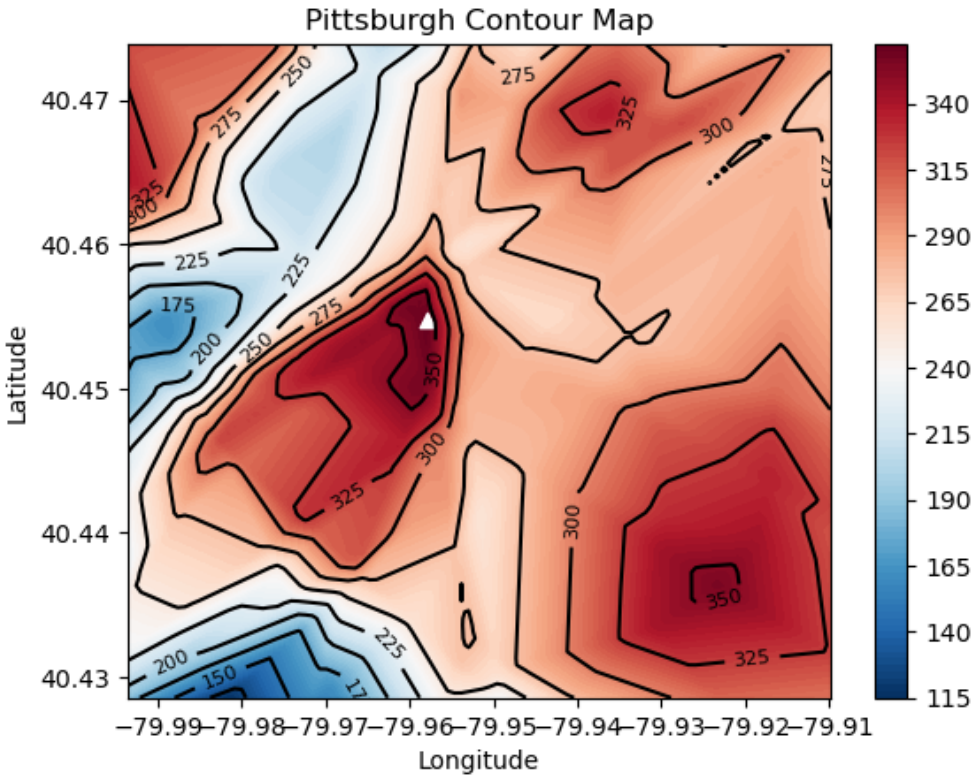

Figure 3: Predicted contour map