

Computational topology - group project

Šmarna gora

May 9, 2018

The goal of this project is to model the surroundings of Šmarna gora using discrete Morse theory.

Data: The file SMARNA.TXT contains elevation map of the surroundings of Šmarna gora. Each line contains three numbers in the following format.

latitude longitude altitude

The first two numbers represent the geographic coordinates (x_i, y_i) of a sample point, and the third is the altitude h_i at that point.

Project description: Construct the Delaunay triangulation on the points (x_i, y_i) . Use the function values h_i to construct a discrete gradient vector field on the triangulation. If the entire dataset is too large, take a subsample. Once you have computed the discrete gradient vector field do the following.

1. Write an algorithm for canceling pairs of critical simplices with values differing by less than some threshold p . Determine the value of the parameter p so that most of the unwanted critical simplices are canceled.

2. Determine the altitude of the top of Šmarna gora and of Grmada.

Hint: The tops are the local maxima, i.e. the critical simplices of dimension 2.

3. Find the saddle between Šmarna gora and Grmada.

Hint: The saddle should correspond to a critical edge.

4. Find the path down from each top to the saddle.

Hint: The path should correspond to a gradient path in the vector field from the boundary of the critical simplex representing the top to the critical edge representing the saddle.

5. Can you choose the value of the parameter p so that the critical simplex representing the top of Grmada is canceled? Does this ever happen?
6. Construct the Morse complex and compute the Betti numbers.