Project Options for Math 149

January 27, 2014

First, note that you may have your own ideas about what a good project would be. That would be excellent, and you should go ahead with it. I am offering some suggestions, which I will discuss in class. You may work individually or in groups. Ideally the groups should not be too large, i.e. pairs would be great, but groups of three would need to tackle a very substantial project. You should try to settle on a project by Tuesday, February 4.

1. There is a family of spaces defined by algebraic equations called *elliptic curves*. Study how persistent homology works on these spaces by sampling from them, and computing persistent homology.

2. Study how persistent homology works on images (of alphabetic characters, or other drawn objects) to determine the topological type of the figure. Ideally, develop a small pipeline for recognizing a small family of drawn figures using persistence barcodes.

3. Consider a particular object in three dimensional space, and consider the space of images obtained by taking pictures from a fixed vantage point as the object runs through all three dimensional rotations. Can you detect the homology of the rotation group this way?

4. Produce an exposition of the methods of excision, long exact sequences, and Mayer-Vietoris sequences as convenient ways of studying homology by hand.

5. Study how persistent homology with functional parameter (to be defined) can be used to get further distinctions between figures, i.e. letters.

6. Analyze a data set of your own choosing homologically.