Spectral Clustering Project Proposal for APPM 3310

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For our project, we plan to use techniques learned from *A Tutorial on Spectral Clustering* in order to explore spectral clustering and its applications to image processing. To these ends, we will create a program that will identify specific areas on a picture of a map. Our first objective will be to identify structures such as streets. Additionally, if we have time, we will attempt to create a system to track changes to the same map over time. Such a system could be used, for example, to study drying lakes, deforestation trends or undesired objects in private locations. We would like to use spectral clustering in new applications, so after learning the basics of this technique and applying it to reach our primary objective, we hope for the opportunity to explore this method in an open-ended fashion.

The program we are looking to write will construct a similarity graph whose nodes represent the picture's pixels. The values of these node will depend on the given pixel's individual RGB values. Then, using the Shi-Malik Algorithm of spectral clustering, (i.e. computing the unnormalized Laplacian, finding eigenvectors, carrying out the k-means algorithm, etc.), the program will find and separate clusters. Once the different clusters have been found, we will construct a new image highlighting the structures sought. In order to make this program, we are planning to use Python as well as several helper modules such as PyLab and SciKit-Learn.

We are eager to learn the method of spectral clustering and to explore the applications it has in the real world. We are hoping to realize several practical benefits. Firstly, in the case of our primary objective, streets detection is commonly used by mapping services, and learning how it is done is quite a valuable skill in the age of computer-aided analysis. Secondly, in the case of using spectral analysis to track changes across different iterations of the same map, such a tool could, excitingly, automate a great deal of work that researchers would otherwise have to undertake manually and scale to cases for which individual human labor would be infeasible. It would therefore constitute a novel technology that a diverse group of researchers stand to benefit from. Any additional applications we could take up would have further benefits. Beyond these concrete pay-offs, this project provides exposure to techniques in linear algebra, graph theory, machine learning and computer vision. With all of this in mind, we are looking forward to proceeding with this project.