Voronoi project

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1 Goals

Understand Newton's method and its use in accelerating numerical methods. Study the concept of centroidal Voronoi tessellations (CVTs) and its use in physical and engineering applications, such as data compression and segmentation. Develop the set of routines for accelerating data analysis by coupling Lloyd algorithm with Newton, explore possible shortcomings and alternatives.

2 Long-term plan

5 weeks time frame

1. Get familiar with the software
2. Learn basic numerical analysis techniques using Newton's iteration as an example
3. Experiment with data analysis, image rasterization and compression
4. Study the principles of CVT-based compression
5. Implement CVT-based compression algorithm, test it for several images, get accuracy estimates
6. Accelerate basic CVT routine developed at the previous stage using Newton iteration, compare performance
7. Explore analytical and numerical properties of both algorithms and possible modifications

3 Short-term plan

3.1 Introduction to software - week 1

- Get familiar with Matlab environment: look at the Matlab tutorial here: `http://www.amath.washington.edu/~calhoun/464/handouts/matlab_intro.pdf`
- learn how to create m-files, plot and manipulate data

- Refresh the Newton's method idea by looking at `http://archives.math.utk.edu/visual.calculus/3/newton.5/`
- test your skills on the following example: implement Newton's method for functions $f(x) = (x-2)^2$, $g(x) = 3x^3 + x^2 - 15x + 3$ with $x_0 = 1$
- graph the results in the form $(x_n, f(x_n))$, where x_n is the value of x after n iterations, together with the graph of the function $(x, f(x))$.
- make a short movie of the above process, save in AVI format.

3.2 Image and data analysis

This will be your next step.