SLICING FOR BIOLOGY

Computer imaging technology can be of great assistance to students doing projects in which finding density is important. For example, students studying invertebrate anatomy could make a quantitative comparison of the mass, length, and width of several shells. However, to gather more information, students could photograph the shells with a scale and make an area analysis with a piece of easy-to-use computer software, which is also freeware. Software of this type includes *Scion Image* for PCs, *NIH Image* for Macintosh, and *ImageJ*, which is an Internet-based application. Using any of these applications, it is possible to measure quickly the area of the shells as well as confirm measurements of the length and width. In addition to enhancing the shell analysis, students also have a "photograph" that can be incorporated into a presentation.

This type of analysis is called density slicing. Density slicing allows objects to be selected on the basis of their range of gray levels. The levels of gray denoting the shells are selected and highlighted in red, and the essentially white background is ignored.

Figure 1 is an image of two shells and a ruler opened up under one of the freeware applications.

Fig. 1 Fig. 2 Fig. 3

Because the shells are on a highly contrasting background, density slicing allows students to find their area and perimeter. The image is converted to gray scale, and the density slicing tool is used to select that part of the gray scale the student wants to analyze. In this case it is the gray scale range being occupied by the shells. (Figure 2). The rectangle tool is then used to select one of the shells for analysis of area and perimeter (Figure 3).

Students examining insects could do a similar analysis. In my class, students perform a density slicing analysis of different insects. In additon to comparing the different insect sizes they can also compare insect appendages and segments as to length and width .

There are any number of biology exercises that use yeast cells as an experimental organism. These cells can be subjected to different pH's, temperatures, nutrients, and other factors to examine their influence on the rate of yeast growth. One way to evaluate the growth in response to one of these factors is to count the yeast cells under the microscope. One difficulty with this that the yeast cells reproduce by budding. A question arises: how to take this into account when comparing several different cultures.

Figure 4

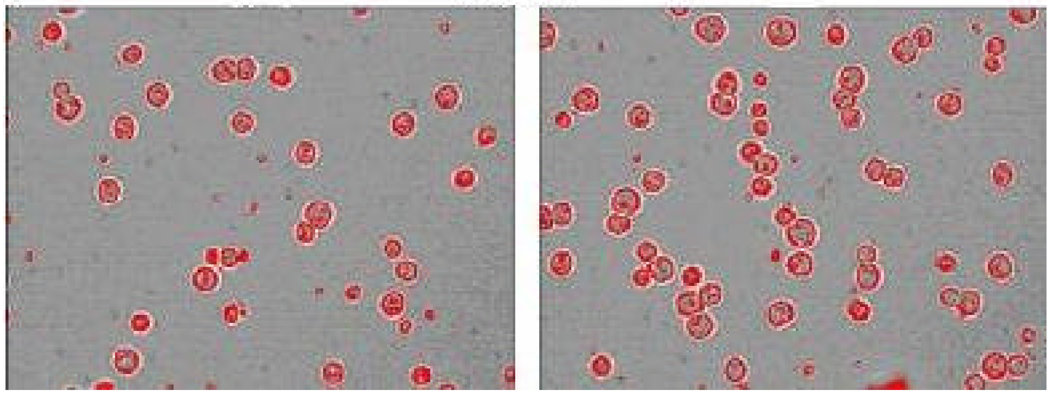


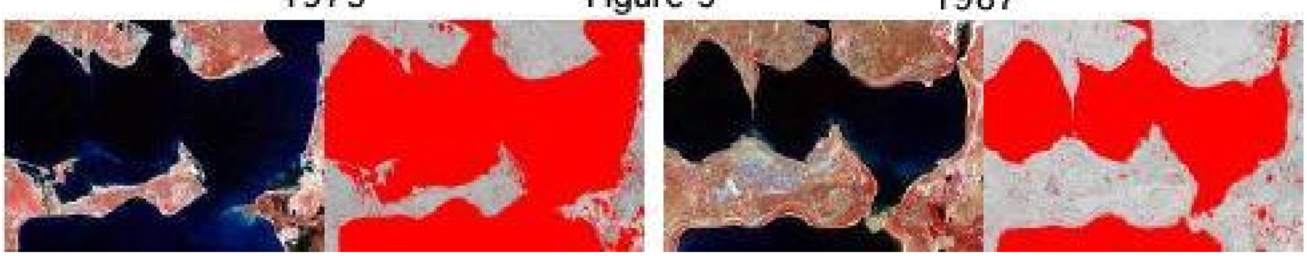
Figure 4 shows two different yeast cultures before and after density slicing. Density slicing partially addresses the budding problem by giving the area of everything in red of the two contrasting cultures. Now, you are truly comparing the relevant yeast densities in the two cultures by counting everything.

While the previous examples described activities that might have taken place in a biology class, this software could also be used in an Earth science class. For instance, when studying pollution control, students might obtain an aerial photo of a waste lagoon that requires filling.

If the aerial photograph of the lagoon also included an object of known length, such as a car, then the image can be calibrated and density sliced. This gives the perimeter and area of the lagoon. If the teacher chooses, for instance, a Landsat image that shows good contrast between areas of land and water as well as vegetative and non-vegetative areas, and the teacher tells students that this lagoon has an average depth of 2 meters, then students can calculate the amount of fill required.

In a similar type of Earth science activity, teachers could obtain an aerial photo of the Aral Sea at two points in time, 14 years apart. Figure 5 shows part of the highly polluted Aral Sea

1973 Figure 5 1987



The changes during that time period are readily apparent. The diminishing areas of red range of gray level denoting the sea) show the rapid filling-in of this part of the Aral Sea.   Included with this fill is a wide range of pesticides that have washed in from the farms upstream.

It is these toxins which have such a severe effect on the plant and animal life in the sea. The students are given WEB sites where the problem as well as possible solutions are discussed.

A teacher in the middle school might be interested in using the following imaging example as a means of introducing or reinforcing some techniiques of mathematical analysis. It is relatively easy to look at fabric samples under a light microscope and photograph them. If this is done with a two samples; one loosely woven and one more tightly woven, students can then density slice to select the thread or the holes and calculate the percentage of open area in the weave.

As a final example of an activity in which density slicing is useful, students examine two X-rays of the lumbar vertebrae of two subjects. In Figure 6, patient one has a normal X-ray and lumbar vertebra.

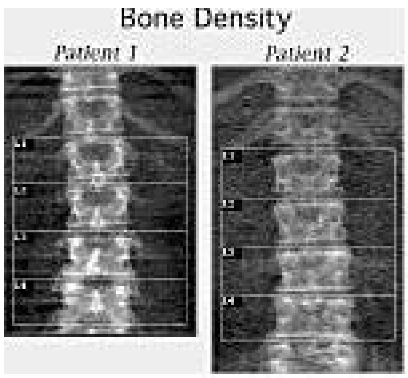
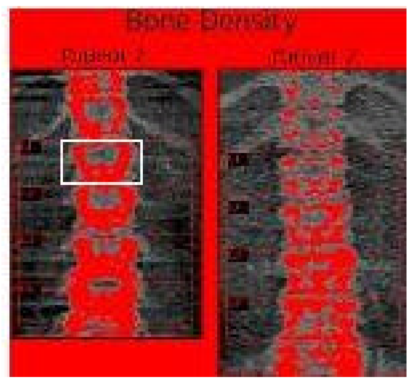


Figure 6



L1 has been selected on the density slice by the rectangle selection tool. The mean density is quickly ascertained, and then the rectangle is moved down to L2, L3, and L4 to make similar mean density measurements.
Patient two has osteoporosis. That patient’s density slice is on the right. If students repeat the four measurements they did for patient one, they can then plot the two sets of measurements with L1, L4 representing the x-axis and density measurement on the y-axis.

Analysis by density slicing can be an important analytical tool that allows students to do project work in a highly quantitative manner. For more information about density slicing I refer you to my website where you can look up Internet Imaging.

http://science.exeter.edu/jekstrom/default.html

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