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%% Exercise 19 - Working with images

%% 1. Digitization from screen
% One of the common tasks in working with data is digitization of data from
% images. Here is an example of doing this task in Matlab. Digitize the
% temperature profile as a function of depth in Lake Kivu (East Africa).
% First, download the image KivuT.jpg and load it into workspace. Replace
% the image path below by the directory to which you downloaded the image.
I=imread('../../Users/sergeikatsev/Documents/KivuT.jpg');
imshow(I)
% The command 'imread' reads the .jpg format and parses it into a 3D array
% where the first two dimensions are width and height, and the third one is
% the color depth.
%%
% Now you need to relate the pixel coordinates to the data coordinates. You
% can use the 'ginput' command to get the pixel coordinates of the corner
% with the minimum x- and y- values (upper left in this example) and the corner
% with the maximum values (lower right here).
a=size(I,2); b=size(I,1);
disp('Click on the corner of the graph with (xmin,ymin) then (xmax, ymax), then
<return>')
[xcr ycr]=ginput;
%%
% Define the limits for the axes in the image. These are the data
% coordinates of the points that you just clicked on.
xmin=22;xmax=27;
ymin=0; ymax=480;
%%
% Now you can digitize the data. Click on the data points that you would
% like to read the coordinates from. The data values will be in  pixel
% coordinates.
[xdata ydata]=ginput;
%%
% Show the dataset that you have created along with the image.
imshow(I)
hold on
plot(xdata,ydata,'o--')
hold off

%%
% Convert the points to the real coordinates and verify the graph.
figure
XDATA = xmin + (xmax-xmin)/(xcr(2)-xcr(1))*(xdata-xcr(1));
YDATA = ymin + (ymax-ymin)/(ycr(2)-ycr(1))*(ydata-ycr(1));
plot(XDATA,YDATA,'o-');axis ij
axis([xmin xmax ymin ymax])
% If you find that you would like to add more points to your profile, how
% would you do that?


%% 2. Digitization of color levels in images
% In many areas, one needs the ability to process images such as maps or
% microscopy pictures. Here is the image of the sediment core from the
% Western arm of Lake Superior. Download the file CoreImage.jpg and load it
% into the workspace.
CoreImage=imread('../../Users/sergeikatsev/Documents/CoreImage.jpg');
imshow(CoreImage)
%%
% In cases where the information is contained mainly in the brightness of
% the color, it may be beneficial to work with grayscale images. Let's make
% a grayscale copy:
CoreImageGray=rgb2gray(CoreImage);
imshow(CoreImageGray)
%%
% If you worked with digital photos, you may be familiar with the concept
% of an image histogram. This is the distribution of grayscale levels in
% the image.
imhist(CoreImageGray)
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%%
% Many common image enhancement techniques are based on modifying the
% histogram. Here is the result of histogram equilization. Note that the
% contrast is enhanced.
CoreImageEq=histeq(CoreImageGray);

subplot(3,1,1)
imshow(CoreImage)
subplot(3,1,2)
imshow(CoreImageGray)
subplot(3,1,3)
imshow(CoreImageEq)
%%
% imhist(CoreImageEq)
%%
% You may also convert the original image from true color to indexed color
% (fewer colors), although this is not particularly useful in this
% exercise.
[x map]=rgb2ind(CoreImage, 16);
imshow(x,map)

%% Color intensity transect
% Let's digitize the color levels.
imshow(CoreImageEq)
axis on   % shows the image dimensions in pixels
%%
% Use the ginput command to convert the scaling from pixels to cm.
% Click on the scale in the image two times, at a 10 cm interval, and hit
% Enter.
[x,y]=ginput
% Now the scaling factor should be 10/(x(2)-x(1))
%%
%Show the image with the new scaling factor. Compare your scale against the
%ruler in the image. What can be done to improve the accuracy?
ix=10/(x(2)-x(1)) * size(CoreImageEq,2)
iy=10/(x(2)-x(1)) * size(CoreImageEq,1)
imshow(CoreImageEq,'Xdata',[0 ix],'Ydata',[0 iy]), axis on
%%
% Now determine the color internsity along a transect.
% The function 'improfile' determines the RGB pixel values C along line
% segments defined by coordinates [CX, CY].
[CX,CY,C]=improfile;
% Click on the image to define the transect and hit Enter;
%%
% Show the transect and the color values
% First, on the grayscale image
%subplot(2,1,1)
imshow(CoreImageEq,'Xdata',[0 ix],'Ydata',[0 iy]), hold on
plot(CX,CY),
axis on

plot(CX,C/30,'k','LineWidth',2);
xlim([0 71])
hold off
% The grayscale levels have been scaled to fit within the image.

%% Second, on the colored image (the R G B values)
%C=improfile(CoreImage,[CX(1) CX(size(CX,1))],[CY(1) CY(size(CY,1))]);
imshow(CoreImage,'Xdata',[0 ix],'Ydata',[0 iy]), axis on
[CX,CY,C]=improfile;
%%
subplot(2,1,2)
imshow(CoreImage,'Xdata',[0 ix],'Ydata',[0 iy]), hold on
%plot(CX,CY),
axis on
plot(CX,C(:,1)/10,'r',CX,C(:,2)/10,'g',CX,C(:,3)/10,'b')
hold off
```