CSCI 124 - Discrete Structures II - Fall 2010
George Washington University

MATLAB Exercises for Spans

Typing "matlab" at a command prompt gets you into the matlab environment.

You can see your variables at any time by typing "who".

Use "save" to save your work to a file matlab.mat which you can load the next time using "load".

Typing "help function" provides matlab documentation on the function. So, for example, "help save" and "help load" will tell you more about how to save and load matlab data.

Matlab manuals may also be found online.

You can see the images and sounds using matlab viewers only if you are located at a hobbes machine, not if, for example, you have logged in remotely. In that case, you would need to write the images and audio clips onto files and view them through your installed viewers directly, and not through matlab.

1 Images in Matlab

Grey scale images are read into two dimensional arrays in matlab.

Step 1: Read Image

Image1 = imread('cameraman.tif');

Do not forget the semi-colon, else matlab will write the entire large matrix on the screen.

You can also try images: coin.png, peppers.png, pout.tif, saturn.png, rice.png, circles.png

Step 2A: See size of image

size(Image1)

without a semi-colon will show you the size of the image. If there is a third dimension, it should be "3", and indicates a color image.

Step 2 B: Crop image if size too large

Image1Crop = Image1(xlow:xhigh, ylow:yhigh);

Step 3: View Image

imtool(Image1Crop)

2 Create some images to combine

Recall that the span of a set of vectors is, loosely speaking, the smallest vector space containing the two vectors. Thus, for example, the span of a single vector (the smallest vector space containing that single

vector) is simply the set of all multiples of that vector.

Now consider the span of two vectors. As it is the smallest vector space containing the two vectors, it must certainly contain all multiples of each of the two vectors. Additionally, a vector space is closed with respect to vector addition, so it must contain all sums of all multiples of the two vectors. So, if the vectors are $\mathbf{a}_1$ and $\mathbf{a}_2$, the span is $\{c_1\mathbf{a}_1 + c_2\mathbf{a}_2 \mid c_1, c_2 \in \mathbb{R}\}$. Similarly, the span of k vectors: $\mathbf{a}_1, \mathbf{a}_2, ..., \mathbf{a}_k$ is

$$Span(\{\mathbf{a}_i\}_{i=1}^{k}) = \{\sum_{i=1}^{n} c_i\mathbf{a}_i \mid c_1, c_2, ..., c_k \in \mathbb{R}\}$$

You will generate three images, each of size 256×256 and see what else you can generate by combining these images. That is, by adding multiples of these images, you will see what the vectors in the span look like. The images you will generate are: (i) a constant image with a common value for all pixels (ii) an image with zeroes in the bottom half and a common value for all pixels in the top half and (iii) an image with zeroes in the left half and a common value for all pixels in the right half.

Step 4: Create constant background image and view it

```
Background=ones(256, 'uint8');
imwrite(Background, 'Background', 'gif');
imtool('Background.gif')
```

You should see an entirely black image (though it is grey-scale, with a very small value). If you cannot use imtool, simply find the saved file in your directory and view it on a browser.

Step 5: Create top-half-brighter image and view it

```
TopHalf = Background;
for i=129:256
for j=1:256
TopHalf(i,j)=0;
end
end
imwrite(TopHalf, 'TopHalf', 'gif');
imtool('TopHalf.gif')
```

You should see an image which is lighter in the top half than in the bottom half.

3 Add multiples of the images

To combine the two images, try:

Step 6: Combine constant-background and top-half-brighter images

First initialize the image:

```
Image2=Background;
for i=1:256
for j=1:256
Image2(i,j) = 2*TopHalf(i,j) + 3*Background(i,j);
end
end
imwrite(Image2, 'Image2', 'gif');
```

You can try different combinations. Make sure the total value stays below 255, in case matlab scales images to 255 before saving, in which case your exact image will not be saved if any of your pixel values go above 255.

Step 7: Combine constant-background and top-half-brighter images

How will you combine these two images to get an image which has value 50 in the bottom half and value 200 in the top half?

Step 8: Create right-half-brighter images

Now you may create the third image:

```
RightHalf = Background;
for i=1:256
for j=1:129
RightHalf(i,j)=0;
end
end
imwrite(RightHalf, 'RightHalf', 'gif');
imtool('RightHalf.gif')
```

You should see an image which is lighter in the left half than in the right half.

Step 9: Combine all three images

How will you combine the three images you have generated (Background, RightHalf and TopHalf) into one in which the left bottom quadrant is of value 100, the right bottom of value 150, the left top of value 200 and the right top of value 250?

Step 10: There are some images that cannot be obtained by combining these three

You cannot obtain an image in which all quadrants are as above, except the top right quadrant is of value 200. Why not?

Step 11: What images can you obtain?

Try various combinations of the three images to see what types of images you can get.

Step 12: Can you define exactly all the images that can be obtained by combining the three?