

Image Processing  
Ungraded Assign 1 Deadline: 14<sup>th</sup> Aug, 4PM  
Matlab/Python can be used.

Q1.a. Determine the nearest neighbor interpolation of the following 2x2 input image

Co-ordinates: (1,1) (2,1)  
                  (1,2) (2,2)

Pixel values at the corresponding locations are:

1	2
4	5

The interpolation or scaling factor is 2 on X direction and 1 for Y, ie the output image should have 4x2 dimension.

You should show this theoretically as well write a code for obtaining the output image.

Steps:

- You should create an input grid, as given in question.
- Create an output grid from (1,1) to (4,4)
- Use the interpolation factor and divide the output grid by this factor. For example take (3,3). Divide by 2, will give (1.5, 1.5).
- You shall obtain all the coordinate values and then determine which is nearest neighbor to these coordinates in the input grid. Closest point to (1.5, 1.5) can be either (1,1) or (2,2). You can choose either, but whichever you choose you shall follow same rule for all the points.
- Go to the output grid and place the pixel values obtained in previous step. For example, you choose the nearest neighbor as (2,2), the pixel value there is 5. You can put this value at output grid at (3,3).

Ans.

1	1	2	2
4	4	5	6

Q1.b. Now use the image 'cameraman.tif' and write a code to interpolate it by a factor of 2x2. You can create an output grid of double the image size on both X and Y dimensions. Initialize the output matrix with zeros. Then run a loop to compute the nearest neighbor and plug in the values. A pseudo code is given below.

Here I1 is the input and I2 is the output image. A better

way would be to use meshgrid and avoid for loop (look for lecture notes/ <https://scipython.com/book/chapter-8-scipy/additional-examples/interpolation-of-an-image/>).

```
for x=1:N2      % rows in output
for y=1:M2      % columns in output
% Calculate position of output grid coordinates in input grid
v = x/cx;
w = y/cy;

% We'll just pick the nearest neighbor to (v,w)
v = round(v);
w = round(w);

I2(x,y) = I1(v,w);
end
end
```

Q2. For a signal  $f(x, y) = \sin(2\pi x + 4\pi y) + 1$ , perform sampling using the sampling theorem. Comment on what happens when sampling theorem is violated.

Use lecture slide code

Choose points  $dx < 1/(2 \text{ times frequency in X})$  ie  $dx < 1/1$   
 $dy < 1/2$

Q3. For an arbitrary image, pixels depend linearly on  $x$  and quadratically on  $y$ . Write an equation to model the dependence of pixel values on spatial co-ordinates.

Assuming that coordinates and respective pixel values are known, derive an equation for computing the unknown parameters.

$$v(x, y) = ax + by^2 + c$$