Project 1 Questions

Instructions

- 5 questions.
- Include code, images, and equations where appropriate.
- Please make this document anonymous.
- When you are finished, compile this document to a PDF and submit it directly to Gradescope. On upload, **Gradescope will ask you to assign question numbers to your pages**. Making each question end with a page break after your answer is a good way to ease this process.

Questions

Q1: Image convolution, a type of image filtering, is a fundamental image processing tool that you will use repeatedly throughout the course.

(a) Explicitly describe the 3 main components of image convolution:
   (i) input
   (ii) transformation
   (iii) output

(b) Why is image convolution important in Computer Vision?

A1: Your answer here. Uncomment the stencil below and fill in your solution.

(a) (i) Inputs are an image–a matrix that we want to ”change” and a kernel that we apply math operations with weight to the pixels of image matrix

(ii) We use kernel as a filter to make the transformation to the image, in particular, we place the kernel over the image matrix, and multiple each elements correspondingly (or reversely because it is convolution) and sum it up to produce a new matrix. In another words, this is the process of adding each elements from its local neighbours with weight information from kernel. reference:https://en.wikipedia.org/wiki/ Kernel-(image-processing)Convolution

(iii) output is the new image after the matrix operation,the shape should remain as the same, the new image will be updated with the effects from the filter. Depends on the original image (grayscale or RGB), the output should keep the same dimension information with the original image.

(b) It is the basic technique of image processing, can run some nice effects like the blurring, sharpening, edge detection, noise reduction, etc. Just like those function on our phone. It also play a important role in communications, graphic arts, medical imaging, and remote sensing.

reference: https://pdfs.semanticscholar.org/391f/4dc0567f671b0718f80834fdc1e83a9fd54b.pdf

Q2: Correlation is another basic image operation. Correlation and convolution are, in some sense, the simplest operations we can perform to extract information from images.

(a) What is the difference between convolution and correlation?

(b) Construct a scenario which produces a different output between both operations. Include the kernel you used and your results.

Please use scipy.ndimage.convolve and scipy.ndimage.correlate to experiment!

A2: Your answer here. Uncomment the stencil below and fill in your solution.

(a)

$$Convolution := \sum_{s=-a}^{a} \sum_{s=-b}^{b} w(s,t) f(x-s, y-t)$$

$$Correlation := \sum_{s=-a}^{a} \sum_{s=-b}^{b} w(s,t) f(x+s, y+t)$$

Convolution is correlation with the filter rotated 180 degrees. If the filter has been rotated 180 degrees, the result makes no difference, for example the filter is symmetric, like a Gaussian. Note that symmetric filter in here is not the same sense as algebra symmetric matrix.If the filter is not symmetric, the result between convolution and correlation is different.

(b) Let's do an example—-
original image matrix

$$M = \begin{bmatrix} 1 & 0 & 0 \\ 4 & 1 & 1 \\ 1 & 2 & 2 \end{bmatrix}$$

Only focus at the center position (1,1) convolution kernel:

$$c1 = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 2 & 2 \\ 3 & 1 & 1 \end{bmatrix}$$

calculation=1*1+0*1+0*3+4*2+1*2+1*1+1*0+2*0+2*1=14

Actually, they are the same (c1=c2), but we are doing different operation.

correlation kernel:

$$c2 = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 2 & 2 \\ 3 & 1 & 1 \end{bmatrix}$$

calculation=1*1+0*0+0*0+4*1+1*2+1*2+1*3+2*1+2*1=16

14 is not equal to 16, in the center position, they are different.

Let's use python to run some code.

```
im=np.array([[1,0,0],[4,1,1],[1,2,2]])
k=np.array([[1,0,0],[1,2,2],[3,1,1]])
print(ndimage.convolve(im, k, mode='constant', cval=0.0))
print(ndimage.correlate(im, k, mode='constant', cval=0.0))
```

Result:

$$convolutionresult = \begin{bmatrix} 3 & 3 & 0 \\ 12 & 14 & 4 \\ 11 & 16 & 10 \end{bmatrix}$$

$$correlationresult = \begin{bmatrix} 7 & 15 & 4 \\ 13 & 16 & 11 \\ 6 & 13 & 7 \end{bmatrix}$$

Q3: A hybrid image is created by applying a high pass filter on one image, a low pass filter on another image, and then summing the two images together. For questions (a) through (c), fill in the box for whether the kernel corresponds to a high pass filter, a low pass filter, or neither. For questions (d) and (e), the images are outputs of a filtering operation with high pass or low pass filters. Fill in the box indicating what kernel was used for the result.

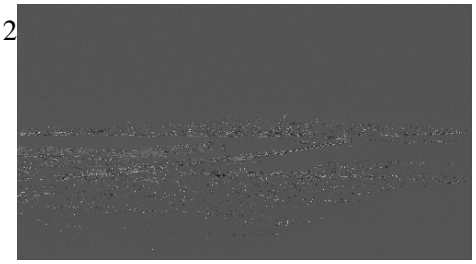
LaTeX: To fill in boxes, replace '\square' with '\blacksquare' for your answer.

(a) $\begin{bmatrix} 1 & 0 & -1 \\ 1 & 0 & -1 \\ 1 & 0 & -1 \end{bmatrix}$ ☐ High pass ☐ Low pass ■ Neither

(b) $\begin{bmatrix} \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \\ \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \\ \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \end{bmatrix}$ ☐ High pass ■ Low pass ☐ Neither

(c) $\begin{bmatrix} -\frac{1}{9} & -\frac{1}{9} & -\frac{1}{9} \\ -\frac{1}{9} & \frac{8}{9} & -\frac{1}{9} \\ -\frac{1}{9} & -\frac{1}{9} & -\frac{1}{9} \end{bmatrix}$ ■ High pass ☐ Low pass ☐ Neither

(d)  ☐ High pass ■ Low pass

(e) 2  ■ High pass ☐ Low pass

(f) Which of the following statements are true? (Check all that apply).

- ■ High pass filter kernels will always contain at least one negative number
- ■ A Gaussian filter is an example of a low pass filter
- ☐ A high pass filter is the basis for most smoothing methods
- ■ In a high pass filter, the center of the kernel must have the highest value

article python

Q4:

(a) How does computation time vary with filter sizes from 3×3 to 15×15 (test odd and square sizes, i.e. 3×3, 5×5, 7×7, etc.), and with image sizes from 0.25 MPix to 8 MPix? Choose your own intervals.

Measure both using *scipy.ndimage.convolve* or *scipy.ndimage.correlate* to produce a matrix of values. Use the *skimage.transform* module to vary the size of an image. Use an appropriate charting function to plot your matrix of results, such as *Axes3D.scatter* or *Axes3D.plot_surface*.

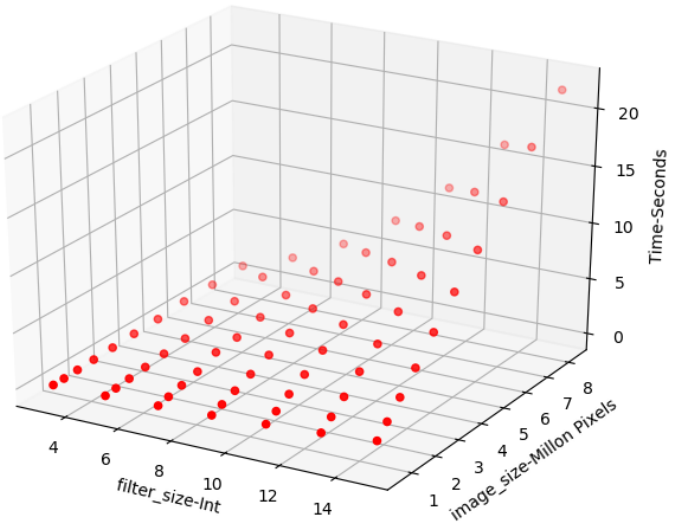
Image: RISDance.jpg (in the .tex directory).

(b) Do the results match your expectation given the number of multiply and add operations in convolution?

A4: Your answer here.

Here is the result 3d object and my code in python:

(a)




```
from matplotlib import pyplot
from mpl_toolkits.mplot3d import Axes3D
fig = pyplot.figure()
ax = Axes3D(fig)
timelist=[]
imagesize=[]
```

```
filter_list=[3,5,7,9,11,13,15]
image_o = load_image('../junch/cv/RISDance.jpg')
image = image_o
for m in filter_list:

    for x in range(10):
```

```
        k=np.ones((m,m,3))
        imagesize.append(image.shape[0]*image.shape[1]*0.000001)
        start=time.time()
        ndimage.convolve(image, k, mode='constant', cval=0.0)
        end=time.time()
        timelist.append(end-start)
        image=resize(image,(int(image.shape[0]-177.5),int(image.
                                                shape[1]-315.5),3))
    ax.scatter([m,m,m,m,m,m,m,m,m,m], imagesize, timelist, c='r',
                                            marker='o')
    imagesize=[]
    timelist=[]
    image= image_o


ax.set_xlabel('filter_size-Int ')
ax.set_ylabel('image_size-Millon Pixels')
ax.set_zlabel('Time-Seconds')

pyplot.show()
```

(b) Yes, the result match my expectations when the filter size getting bigger, the execution time will just be longer than smaller filter. And if the image size is getting higher (more pixels), then the execution time will also be longer.

Q5: In 1990, *New York Times* photography critic Andy Grundberg stated that:
"In the future, readers of newspapers and magazines will probably view news pictures more as illustrations than as reportage, since they can no longer distinguish between a genuine image and one that has been manipulated."

(a) When is Grundberg's 'future' ? Why? (2–4 sentences)

(b) When is a news picture no longer genuine? Are any manipulations permissible, and if so, which ones? (2–4 sentences)

(c) If you worked for the *New York Times* and were tasked with maintaining readers' trust in news pictures in Grundberg's future, what would you do? Consider everything that happens in the publication of a news picture. Describe your approach, and why it would work. (3–5 sentences)

  (i) As per c), but instead you worked for the *College Hill Independent*? (2–4 sentences)

(d) Include an example of a manipulated news picture, and identify the manipulation. What was the intent and impact of the manipulation? (2–4 sentences)

Note: There are open questions. We will grade for thought and justification.

A5: Your answer here.

(a) I think the future is now. I am not sure how other people think, but for me I seldom trust those newspaper companies since they only speak for their own benefits. Undoubtedly, we do have some newspaper corporation that send out genuine information but nowadays we need to be careful about those news pictures.

(b) If those companies intentionally made some changes to the pictures then it should not be permissible. There is no manipulation exist that can be permissible, including any method to make the picture looks nicer. Even a real picture can be faked intentionally by only taking certain angles of recording or shooting.

(c) If that is the case, the best thing to maintain reader's trust is to provide source for the picture, I will just let these New York Times fans to find out themselves what is the truth behind. Also I can provide pictures from multiple angles to make sure nothing is hidden on purpose. Or, in the worst situation, I can decide not to put any image in the newspaper, but only words and source to find pictures.

  (i) College Hill Independent is a relatively small information source so I won't really care too much. If you are a real fan of our newspaper you should believe us otherwise please unsubscribe! No no no, it is just a joke.But I think it shouldn't be hard to maintain trust in news pictures because what is the purpose to fake the news pictures?

(d) Back to 2018 NBA finals, after Warriors win the championship and celebration is ongoing. And then a few hours later, people saw this image in the Twitter. LBJ

betrayed his Cavs team and all Cav fans are outraged, start burning LBJ's jersey. This picture is faked intentionally to make people image it would be amazing if LBJ,KD and curry on the same team.

picture source: https://www.google.com/url?sa=isource=imagescd=ved=2ahUKEwin69KM8annAhUej3IEH

A5: Continued; extra space as needed.

Feedback? (Optional)

Please help us make the course better. If you have any feedback for this assignment, we'd love to hear it!

I love this assignment! The only thing is the TA office are always full occupied :(