

Final Report

Convolutional Networks

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Convolutional processes are often used in deep learning within neuroscience. It is a class of deep neural networks and is most often used in visual analysis systems. In this lab we apply a convolutional process to analyze several different types of images. This involves defining a convolutional kernel, the number of input and output channels, as well as the depth of the convolutional filter of the input feature map.

The kernel within a convolutional processes is a filter that extracts features of the image inputs. The kernel does this by performing a dot product over each area of the input data, sub-region by sub-region, and then outputs a matrix of said dot products. This can be used to detect edges on a simple scale, but this can be expanded to detect categories of images.

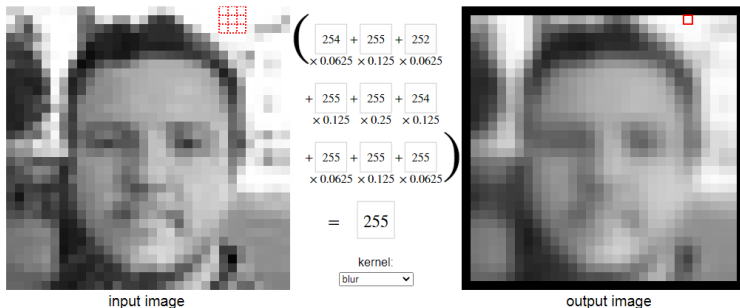
$$a = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

Kernels can also be changed to manipulate an image output. This is done by creating a matrix of pixels and manipulating each pixel within that matrix. This is done for each pixel within the image and the output changes the original image by a certain property.

Kernels Cont.

Kernels can be used to manipulate virtually any aspect of an image:

- color
- grayscale
- sharpness
- gain
- embossing the image
- blur



input image

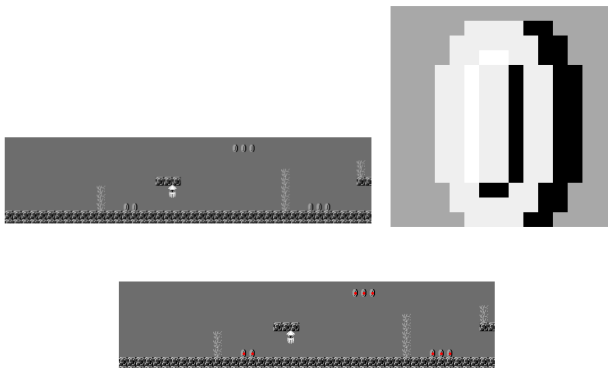
output image

kernel:
blur

$$\begin{pmatrix} \begin{matrix} 254 & 255 & 252 \\ \times 0.0625 & \times 0.125 & \times 0.0625 \end{matrix} \\ + \begin{matrix} 255 & 255 & 254 \\ \times 0.125 & \times 0.25 & \times 0.125 \end{matrix} \\ + \begin{matrix} 255 & 255 & 255 \\ \times 0.0625 & \times 0.125 & \times 0.0625 \end{matrix} \end{pmatrix} = 255$$

Identifying aspects with convolutions

This idea is expanded upon by assigning a name to a certain arrangement of pixels in the image. This is done with a "coin" in an image of the game Super Mario Bros. Using this coins are able to be identified by the algorithm and within the image.



Conclusions

Convolutional networks are complex tools used by many scientists, including computational neuroscientists, to model systems networks and study their progression. It's a useful tool because it allows one to study the iterative processes of natural systems without affecting environments or participants that would otherwise be involved.

A real life example of this that comes to mind is the Tuskegee Experiment that inhumanely withheld the treatment for syphilis from african americans in order to study the progression of the disease. It was a horrible experiment that resulted in pain and death for over 400 african americans. One can imagine that in the future, convolutional networks can be created to model the progression of different diseases and they could be studied without harming others in order to develop different treatment options.