Manual Convolutional Neural Network (CNN)

Team Mind Masters

Image Creation
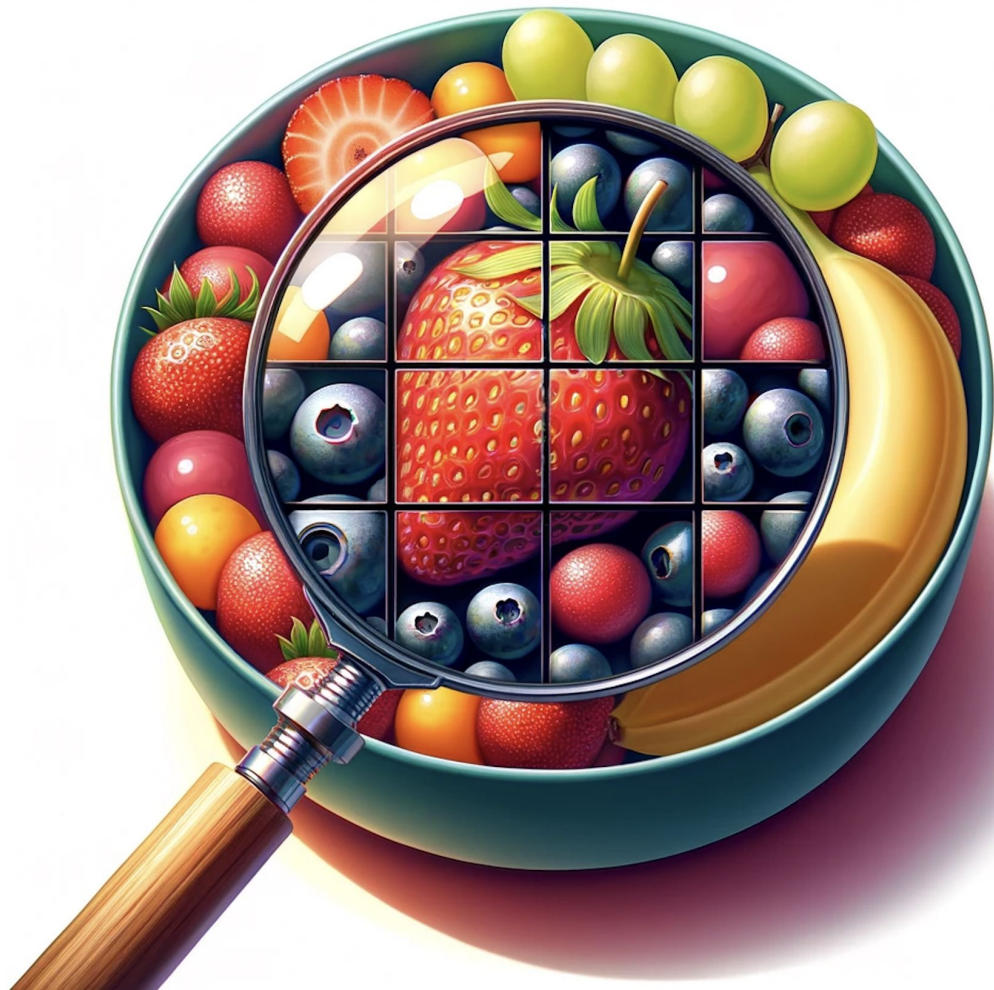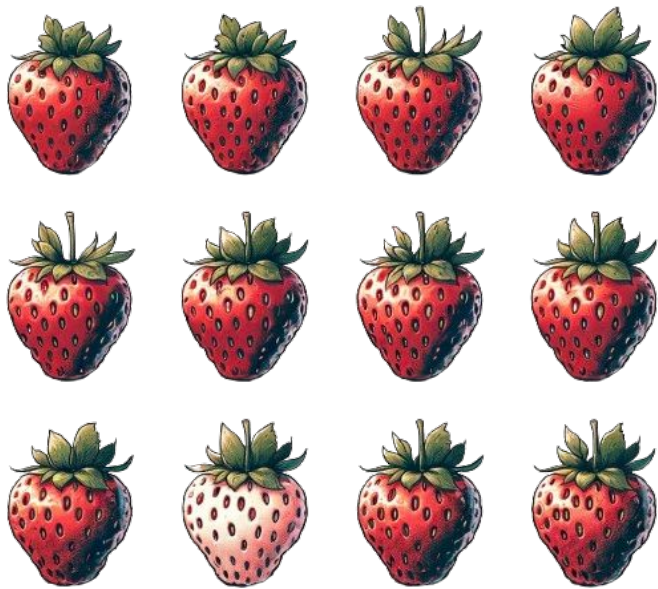
0	0	1	0	0
0	0	1	0	0
1	1	1	1	1
0	0	1	0	0
0	0	1	0	0

In this example, we have created the shape of a cross for our image

Filter Designs

Here, we define filters for various features that may be found in our image

0	1	0
0	1	0
0	1	0

0	0	0
1	1	1
0	0	0

0	1	0
1	1	1
0	1	0

Vertical Line   Horizontal Line   Intersection

Manual Convolution Example

	0	0	1	0	0
	0	0	1	0	0
	1	1	1	1	1
	0	0	1	0	0
	0	0	1	0	0

0	1	0
0	1	0
0	1	0

0				

Vertical Line Feature Map

Convolution involves applying the filters to the image. It typically starts in the upper left of the image. Since there are no pixels outside the image, we use a technique called padding where imaginary pixels are given a value of 0 around the border of the image.

Manual Convolution Example

0x0	0x1	1x0	0	0
0x1	0x1	1x0	0	0
1	1	1	1	1
0	0	1	0	0
0	0	1	0	0

0	1	0
0	1	0
0	1	0

0	0			

Vertical Line Feature Map

We move the filter progressively across and down the image as we apply it to each pixel/section. The values are calculated by multiplying the pixel values times the filter values and adding them together.

Manual Convolution Example

0	0x0	1x1	0x0	0
0	0x0	1x1	0x0	0
1	1	1	1	1
0	0	1	0	0
0	0	1	0	0

0	1	0
0	1	0
0	1	0

0	0	1+1 = 2		

Vertical Line Feature Map

Here, we have 2 pixels that match our filter. We add them together and record the value in the feature map.

Manual Convolution Example

0	0	1	0	0
0	0	1	0	0
1	1	1	1	1
0	0	1	0	0
0	0	1	0	0

0	0	0
1	1	1
0	0	0

		1		

Horizontal Line Feature Map

We start fresh for each new feature map using a different filter and repeat the process. Typically, it starts in the upper left corner again but we are starting in the top middle for this example.

Manual Convolution Example

0	0	1	0	0
0	0	1	0	0
1	1	1	1	1
0	0	1	0	0
0	0	1	0	0

0	0	0
1	1	1
0	0	0

		1		
		1		

Horizontal Line Feature Map

Manual Convolution Example

0	0	1	0	0
0	0	1	0	0
1	1	1	1	1
0	0	1	0	0
0	0	1	0	0

0	0	0
1	1	1
0	0	0

		1		
		1		
		3		

Horizontal Line Feature Map

Manual Convolution Example

0	0	1	0	0
0	0	1	0	0
1	1	1	1	1
0	0	1	0	0
0	0	1	0	0

0	1	0
1	1	1
0	1	0

		5		

Intersection Feature Map

Pixels that correspond to high values on the feature map are likely to be examples of the features that the filters represent.

Features Identified

0	0	2	0	0
1	1	3	1	1
1	1	3	1	1
1	1	3	1	1
0	0	2	0	0

Vertical Line Feature Map

Filling out the feature maps, we can see that the higher values with greener colors match up with sections on the original image that resemble the feature in question. The higher the value, the more it is likely to resemble the representative feature or be near to a feature.

Features Identified

0	1	1	1	0
0	1	1	1	0
2	3	3	3	2
0	1	1	1	0
0	1	1	1	0

Horizontal Line Feature Map

Features Identified

Intersection Feature Map

References

https://towardsdatascience.com/applied-deep-learning-part-4-convolutional-neural-networks-584bc134c1e2

https://www.freecodecamp.org/news/an-intuitive-guide-to-convolutional-neural-networks-260c2de0a050/