The key Innovation behind the use of CNN is Filters- learnable 2 dimensional matrices that slide over the input image to perform convolutions.
These filters are trained to detect specific patterns, such as edges, textures, or more complex features, by examining local patches of the image.

An essential capability of neural networks is their ability to extract features from data to then use them in achieving a certain goal, be it classification, regression, etc. In MLPs, this process is easy to conceptualize; data points, which are often attributes of a particular instance of data, are mapped to trained weights to combine or transform them in some form into essential features. On the other hand, feature extraction is not as clear-cut when it comes to CNNs, as they do not deal with a vector of attributes; rather, they deal with images, which are a 2-dimensional matrix of attributes (pixels).
Images onEdge
Edge perception is not just limited to human vision, some studies have argued that it is one of the reasons why Avians (birds) are so adept at dodging obstacles mid-flight at such high speeds as well as landing on small targets from so far away with pinpoint accuracy

Convolutional Neural Networks (CNNs) possess a remarkable capability: they can learn specialized edge detection filters tailored to the statistical patterns within a given dataset and the network's specific goals. While CNNs autonomously learn these filters, established, manually designed edge detection filters offer valuable insight into the concept of edge detection in computer vision. Examples of these traditional filters include Prewitt, Sobel, Laplacian, Robinson Compass, and Krisch Compass filters.
Follow along the code: https://www.digitalocean.com/community/tutorials/filters-in-convolutional-neural-networks

Good point to note: Convolution and filters
Convolution is a mathematical operation frequently used in signal processing, deCNNs. This tells you what kind of signal the function is trying to say. Filters are the ones that really tell how the shap of a function is influenced. Think of filters as stencils. Say your sencial says "THE" and you keep tracing it over a sentence, whenever you come across a "THE" through any word then u have maxm overlap and thereofre maximum scrore. Convolutional NN work that way.

Prewitt Filters

The Prewitt operator is comprised of two filters which help to detect vertical and horizontal edges. The horizontal (x-direction) filter helps to detect edges in the image which cut perpendicularly through the horizontal axis and vise versa for the vertical (y-direction) filter.

Prewitt Filters

$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

horizontal

$$\begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}$$

vertical

original

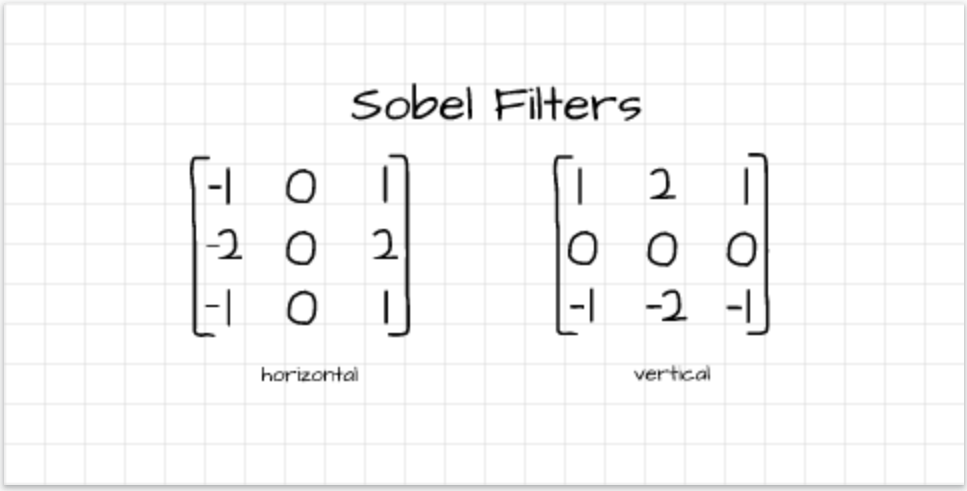
convolved

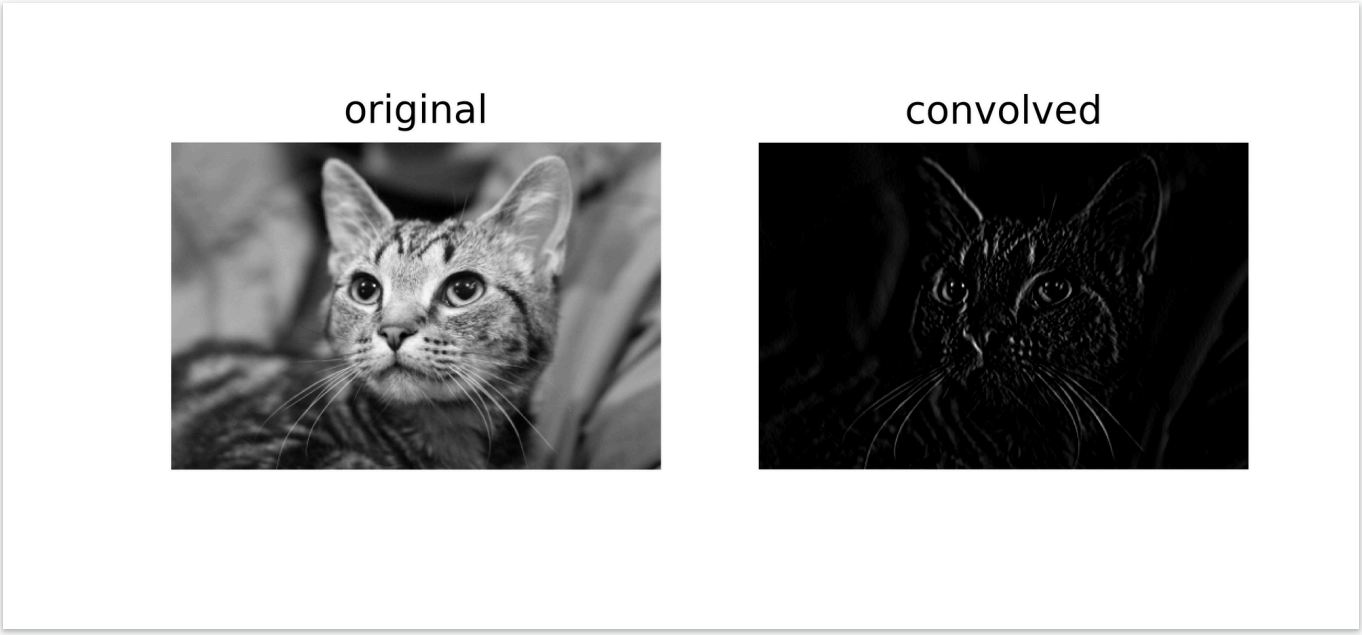
original

convolved

Sobel Filter

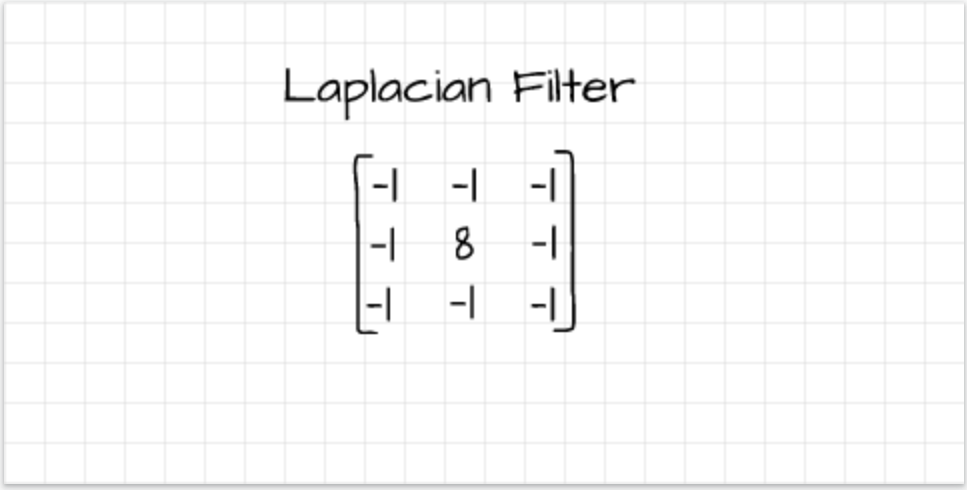
Just like the Prewitt operator, the Sobel operator is also made up of a vertical and horizontal edge detection filter. Detected edges are quite similar to results obtained using Prewitt filters, but with a distinction of higher edge pixel intensity. In other words, edges detected using the Sobel filters are sharper in comparison to Prewitt filters.





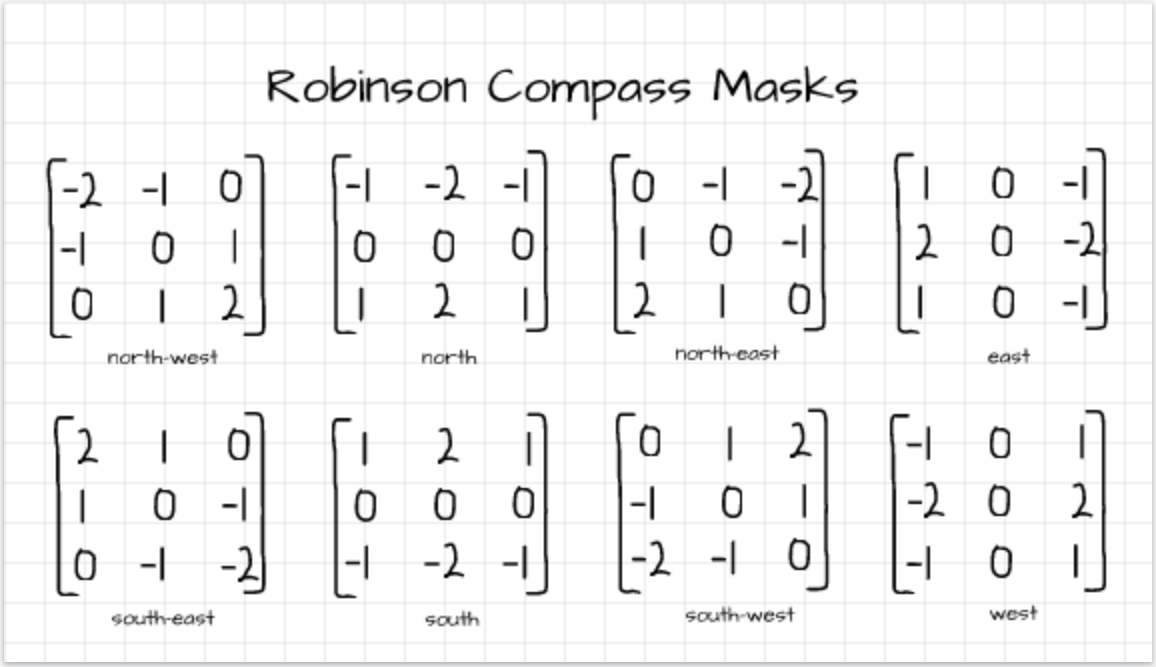
Laplacian Filter

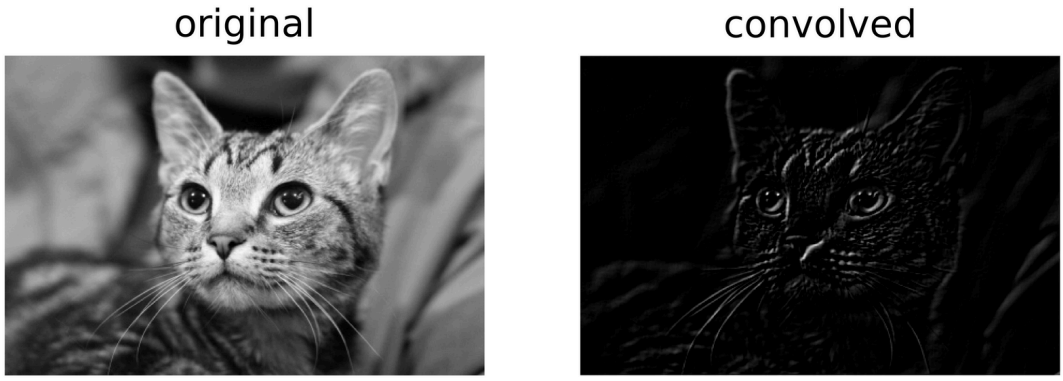
Unlike the Prewitt and Sobel filters, the Laplacian filter is a single filter which detects edges of different orientation. From a mathematical standpoint, it computes second order derivatives of pixel values unlike the Prewitt and Sobel filters which compute first order derivatives.

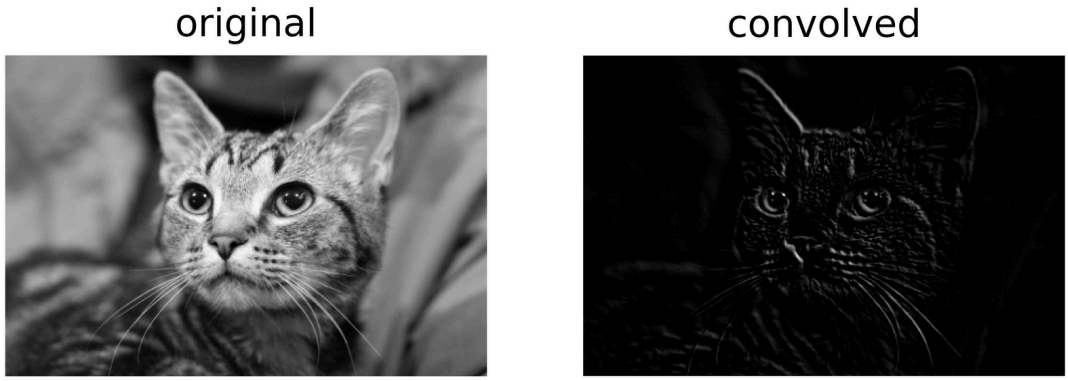


Robinson Compass Masks

The Robinson Compass masks are edge detection filters which are made up of 8 different filters accounting for the 8 geographical compass directions as shown in the image above. These filters help to detect edges oriented in those compass directions. For brevity, just two of the filters are used for illustration purposes.







Krisch Compass Masks

Similar to the Robinson Compass masks, the Krisch Compass mask is also comprised of 8 filters which help to detect edges in geographical compass directions. two of the filters are used below.

Krisch Compass Masks

$$\begin{bmatrix} -3 & 5 & 5 \\ -3 & 0 & 5 \\ -3 & -3 & -3 \end{bmatrix}$$ north-west

$$\begin{bmatrix} -3 & -3 & 5 \\ -3 & 0 & 5 \\ -3 & -3 & 5 \end{bmatrix}$$ north

$$\begin{bmatrix} -3 & -3 & -3 \\ -3 & 0 & 5 \\ -3 & 5 & 5 \end{bmatrix}$$ north-east

$$\begin{bmatrix} -3 & -3 & -3 \\ -3 & 0 & -3 \\ 5 & 5 & 5 \end{bmatrix}$$ east

$$\begin{bmatrix} -3 & -3 & -3 \\ 5 & 0 & -3 \\ 5 & 5 & -3 \end{bmatrix}$$ south-east

$$\begin{bmatrix} 5 & -3 & -3 \\ 5 & 0 & -3 \\ 5 & -3 & -3 \end{bmatrix}$$ south

$$\begin{bmatrix} 5 & 5 & -3 \\ 5 & 0 & -3 \\ -3 & -3 & -3 \end{bmatrix}$$ south-west

$$\begin{bmatrix} 5 & 5 & 5 \\ -3 & 0 & -3 \\ -3 & -3 & -3 \end{bmatrix}$$ west

original

convolved

original

convolved