**Week 1 – Notes**

**Convolutional Neural Networks**

**Computer Vision**

There are multiple compute vision problems like image classification, object detection and neural style transfer

CNNs appeared because you cannot use classical fully connected NN to learn from images because the input size and the number of weights would be of the order of millions or even billions

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Description automatically generated

**Edge Detection Example**

CNNs work based on finding features like edges (vertical, horizontal, and so on)

To detect them we are using filters / kernels that are applied on images through the process of convolution which means that you multiply each pixel with the corresponding filter value and in the end you just add the values

A screenshot of a whiteboard

Description automatically generated with low confidence

Higher values denote shades of white

A screenshot of a math game

Description automatically generated with low confidence

We can see that a vertical edge detector finds regions where there’s a transition from higher to lower values

**More Edge Detection**

If the transition is inverse, from lower values to higher ones, then, in our case, the result of the convolution would be a matrix composed on 0 and -30

In the same fashion we can detect horizontal edges

There are many types of filters (the first one is called Prewitt), for example the Sobel variant is more robust because it weighs more the central value of each side

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Essentially, we would want to let the CNN learn the values of these filter so that it can extract the best features for the data set at hand and in addition to find edges of all kinds of inclinations

To do this, we treat each value of a filter as a weight that is learned through backprop

**Padding**

After applying the convolution, we end up with a matrix of the size n – f + 1 x n – f + 1, where n represents the size of the input image and f the size of the filter

Thus, there are some flaws:by applying many convolutions, we end up with a smaller and smaller output and we do not take into consideration values that are on the edge of the image

To solve these problems, we can use a padding with zero values around the image, then the output after the convolution will have a size of n + 2p – f + 1 x n + 2p – f + 1

There are 2 types of convolutions:

Valid – they have not padding

Same – pad so that the output size is the same as the input size (p = (f – 1) / 2)

The filter size is usually odd (by convention) because in this way we have a central value when we apply it and because we can pad symmetrically on the left and right of the image

Common filters are 1x1, 3x3, 5x5 and 7x7