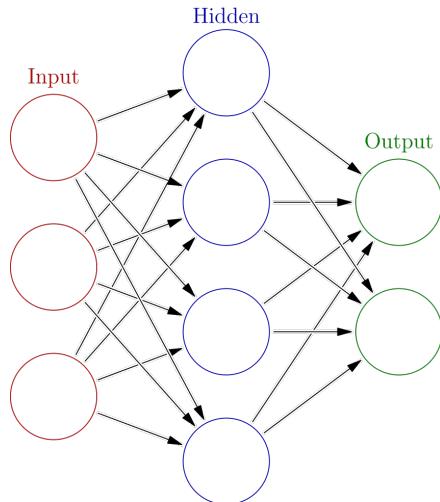




Computational Learning Theory Feature Extraction with Neural Networks

Karen Seidel, Martin Taraz
Hasso-Plattner-Institute
University of Potsdam

What is a Neural Network?

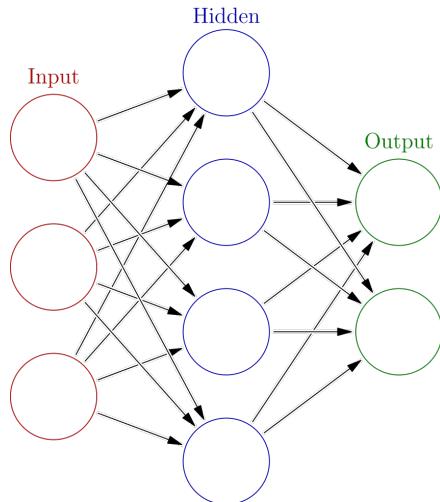


- Collection of connected artificial neurons

[https://en.wikipedia.org/wiki/File:
Colored_neural_network.svg](https://en.wikipedia.org/wiki/File:Colored_neural_network.svg)

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What is a Neural Network?

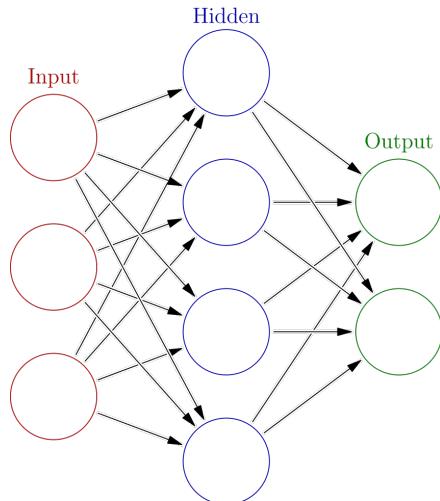


- Collection of connected artificial neurons
- Well defined Architecture indicating where connections exist

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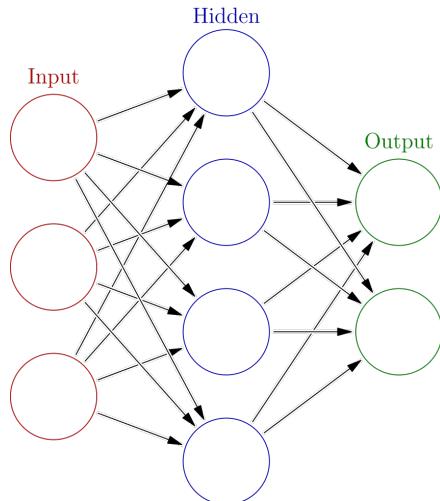


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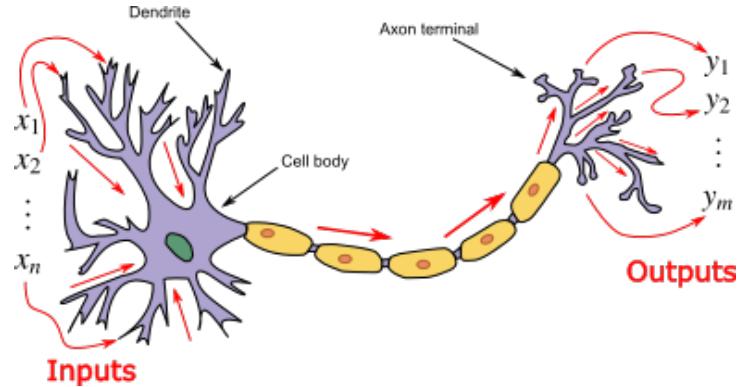


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- Collection of connected artificial neurons
- Well defined Architecture indicating where connections exist
- Each neuron has in- and outputs, that are numeric values
- Groups of neurons that serve similar tasks are called Blocks

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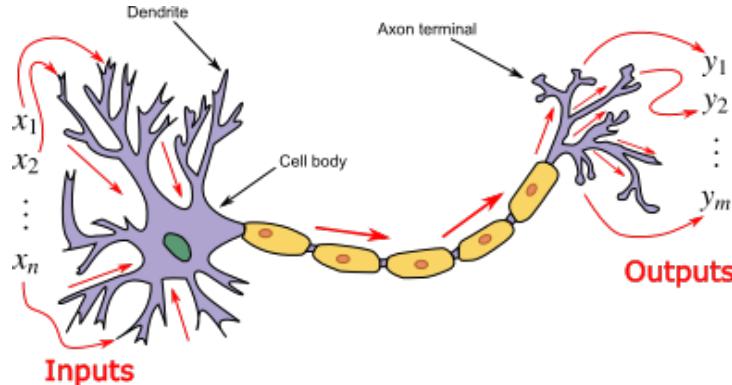
What is a Neuron?



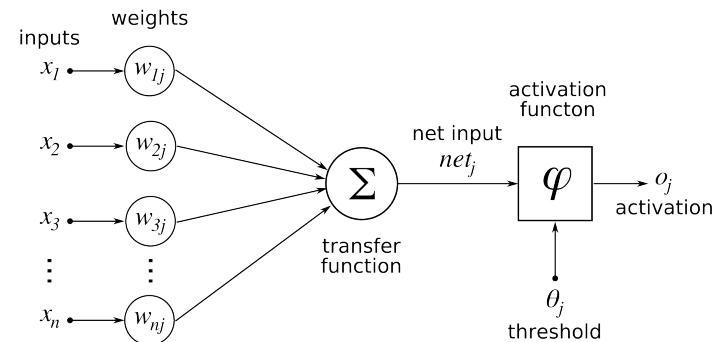
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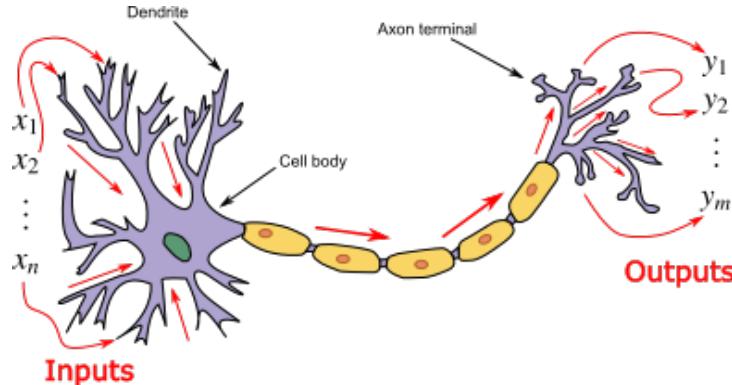
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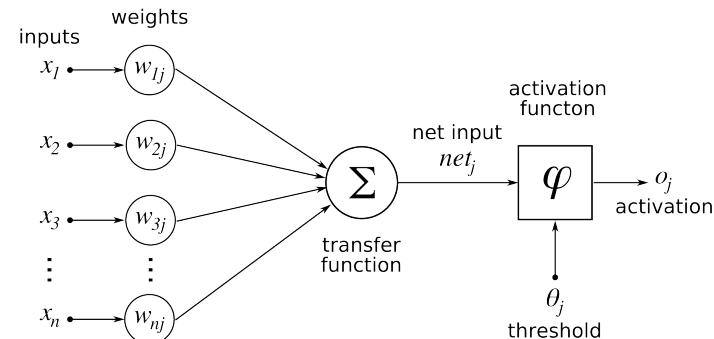
https://commons.wikimedia.org/wiki/File:ArtificialNeuronModel_english.png

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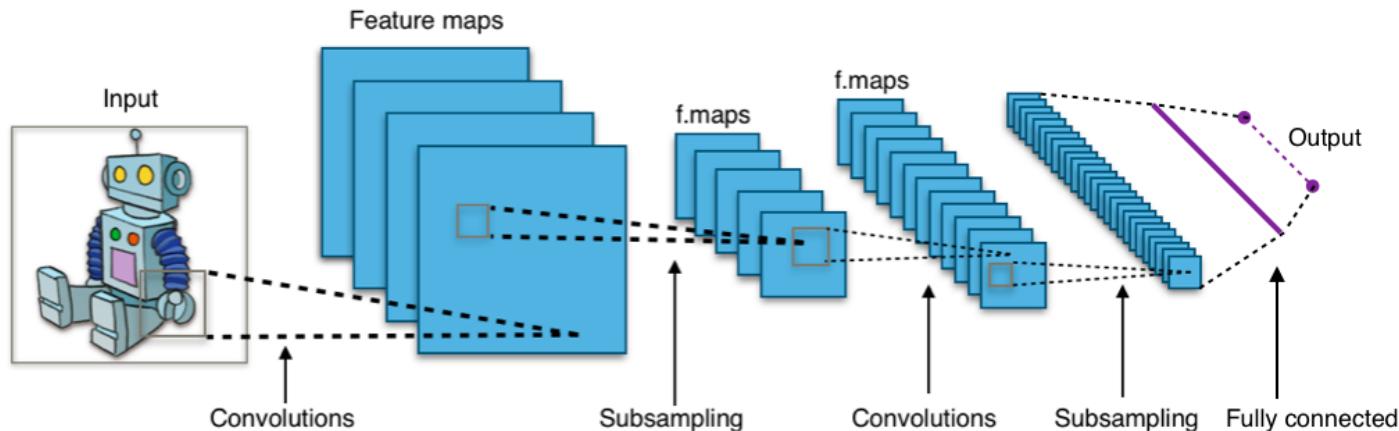


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A neuron takes weighted values and computes an aggregation value depending on its weights.

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What is a Convolutional Neural Network?

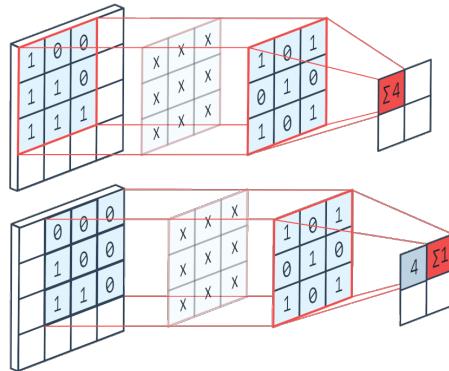


https://de.wikipedia.org/wiki/Convolutional_Neural_Network#/media/Datei:Typical_cnn.png

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How Do the Different Types of Blocks Work?

2D Convolution

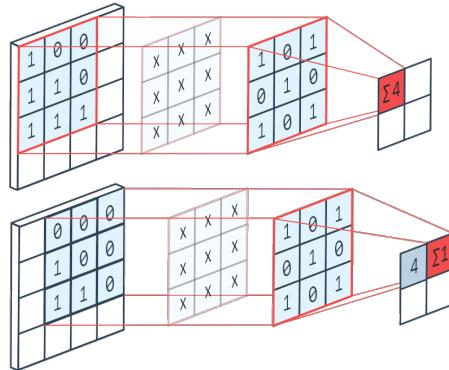


[https://peltarion.com/knowledge-center/
documentation/modeling-view/build-an-ai-model/
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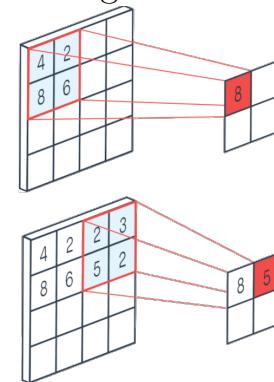
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Max Pooling 2D



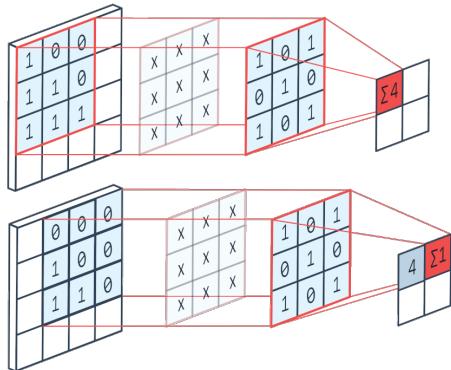
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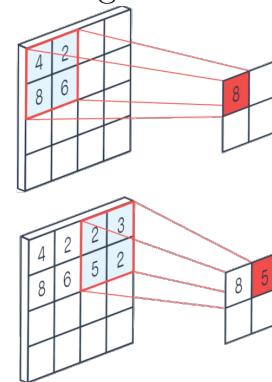
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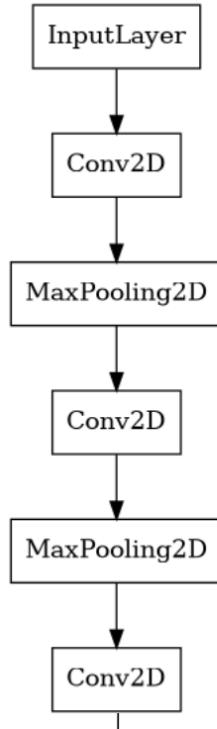
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Both Conv2D and MaxPooling Blocks work on segments of the input array and aggregate nearby data points together.

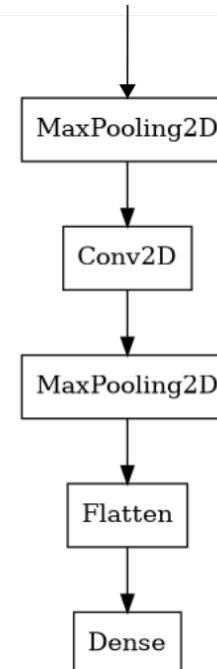
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Building our CNN Architecture With Python



```

model = Sequential()
model.add(Conv2D(16, (3, 3), padding="same",
                activation="relu",
                input_shape = (128,128,3)))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(32, (3, 3),
                padding="same",
                activation="relu"))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(64, (3, 3),
                padding="same",
                activation="relu"))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(128, (3, 3),
                padding="same",
                activation="relu"))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Flatten())
model.add(Dense(1, activation='sigmoid'))
  
```



Performance Depends on the Training Setting

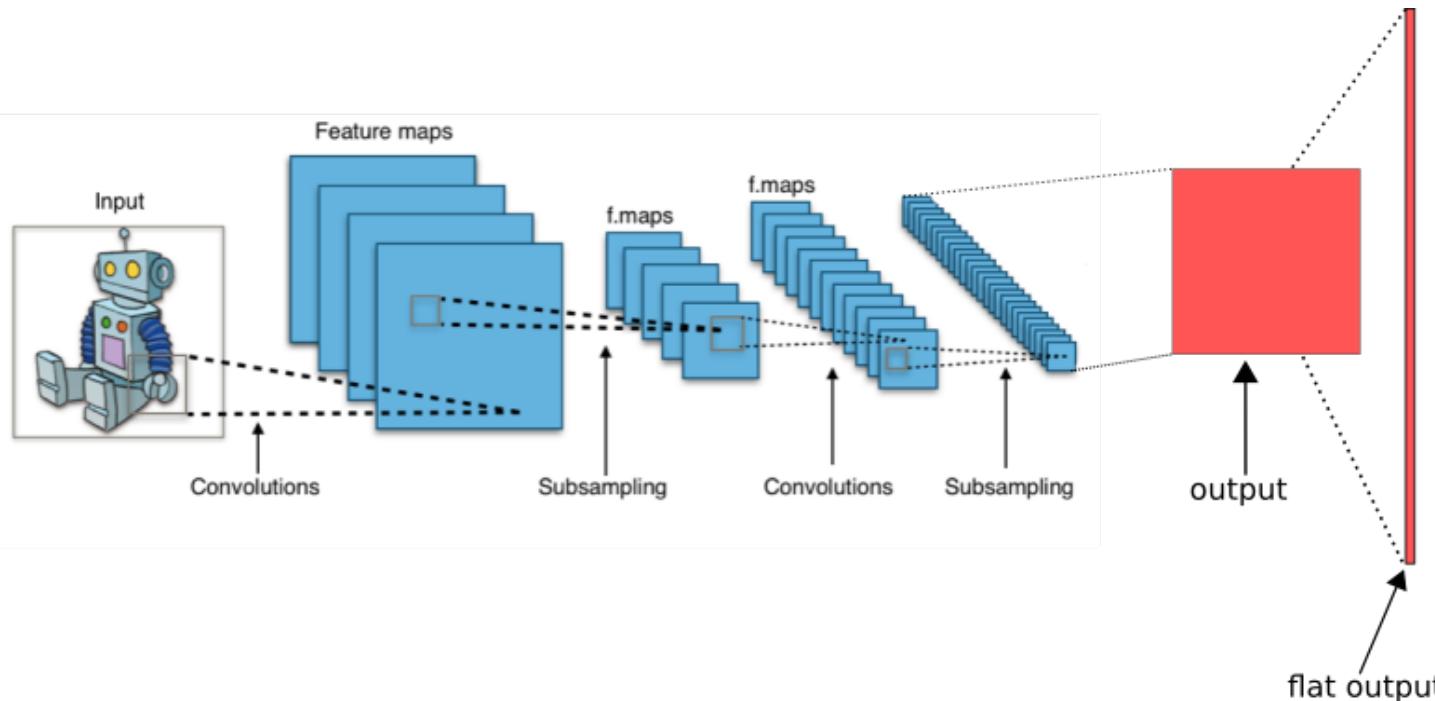
Training Mode	1st Epoch		2nd Epoch		3rd Epoch	
	Accuracy	Loss	Accuracy	Loss	Accuracy	Loss
Online (Batch Size=1)	0.80	0.44	0.79	0.44	0.82	0.40
Mini Batch (Batch Size = 64)	0.83	0.38	0.83	0.39	0.83	0.37
Mini Batch (Batch Size = 128)	0.84	0.38	0.83	0.38	0.83	0.38
Full Batch (Batch Size = 6500)	0.69	0.48	0.69	0.47	0.69	0.48

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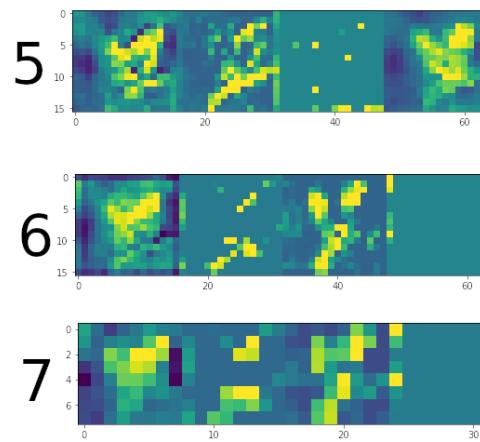
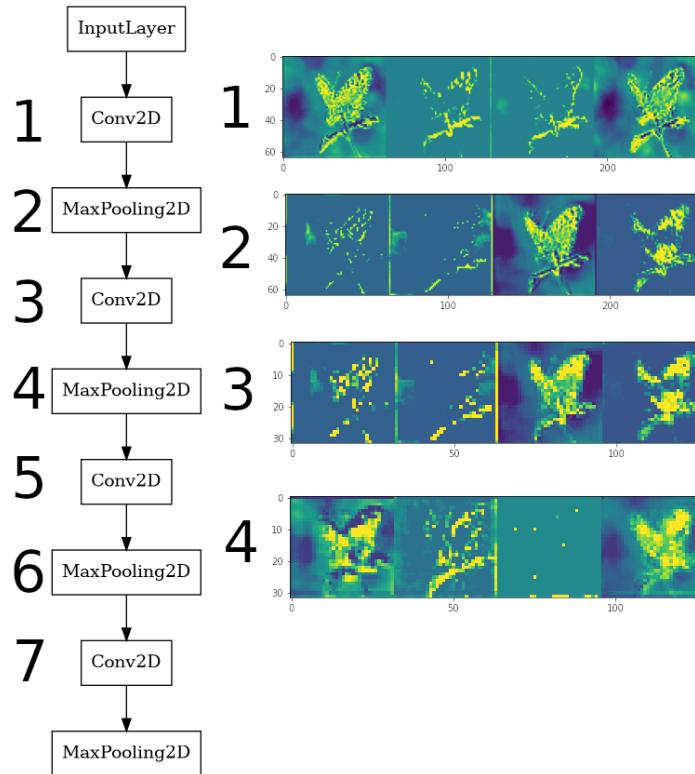
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Using a Convolutional Neural Network for Feature Extraction



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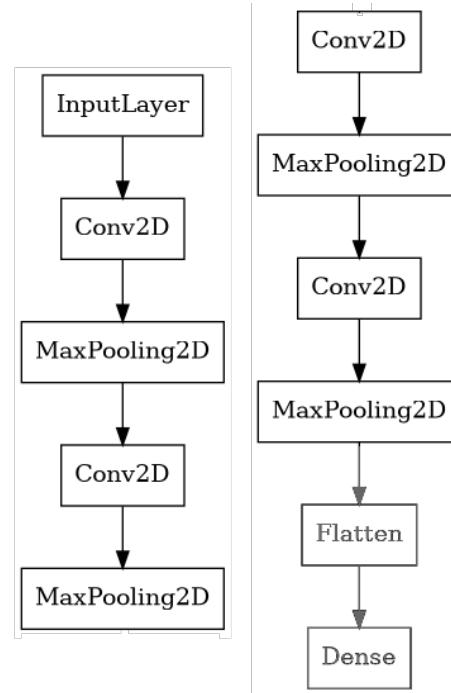
What Does Our Convolutional Neural Network See?



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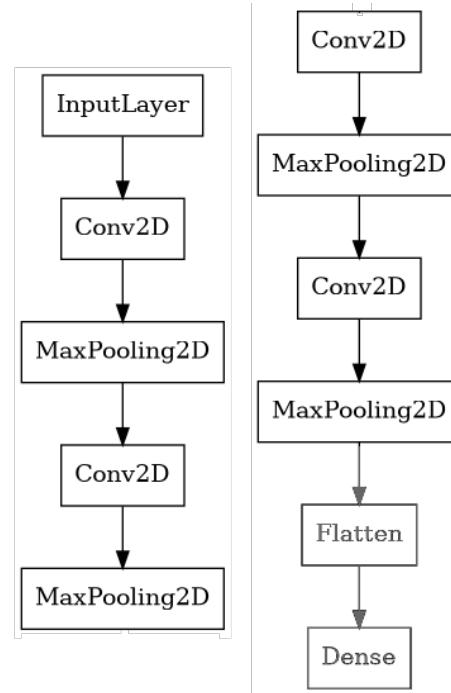
Our Modified CNN

- We drop the Flatten and Dense Layer



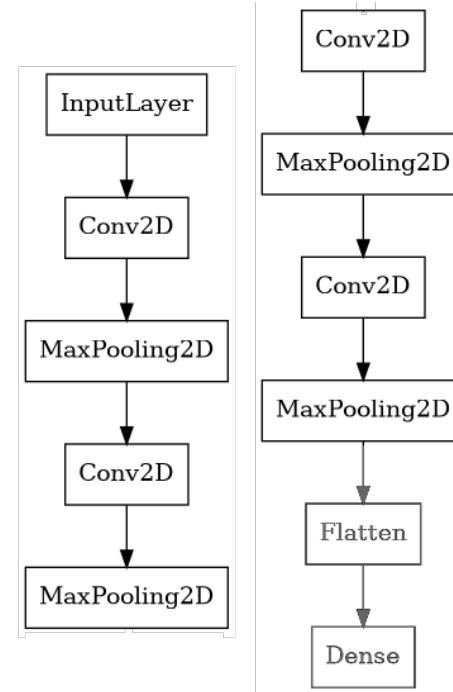
Our Modified CNN

- We drop the Flatten and Dense Layer
- The output from the Last Max Pooling 2D Layer is used for further classification



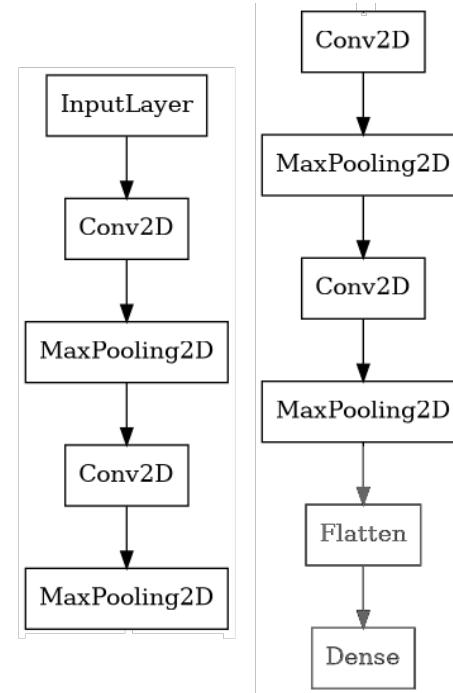
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- Vector with 8192 values can now be extracted from each image

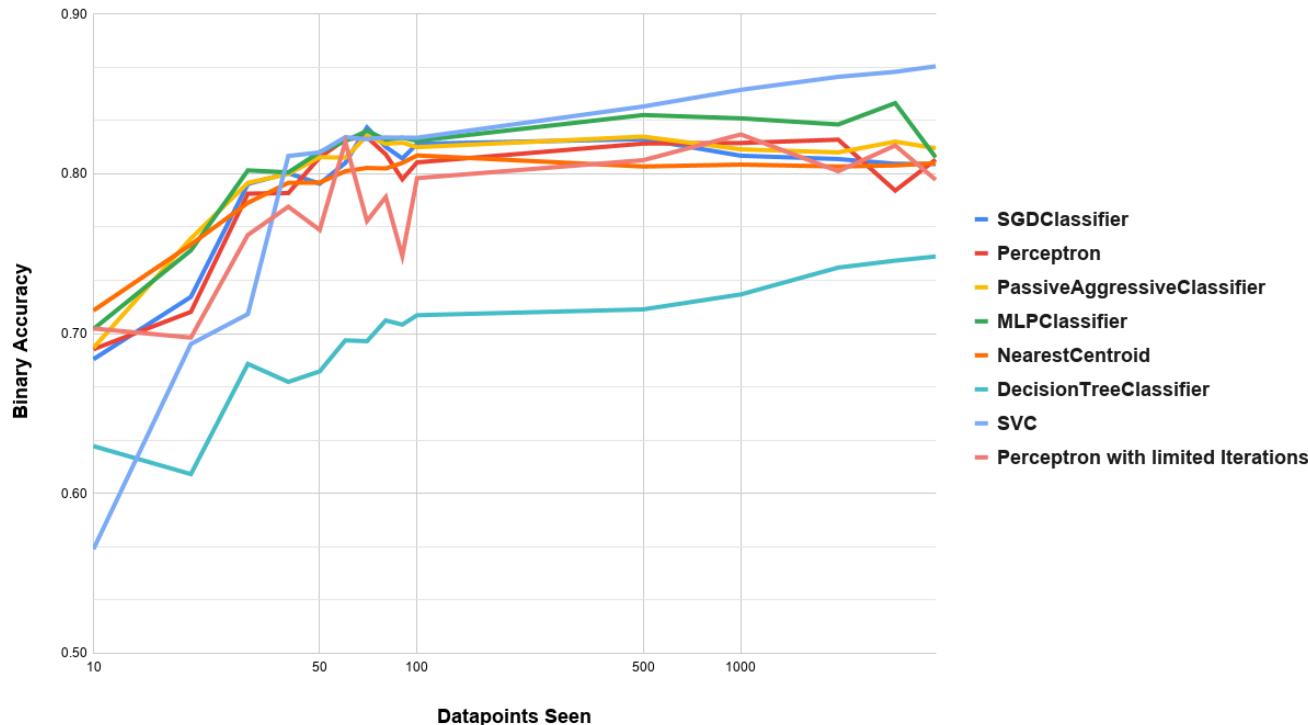


Our Modified CNN

- We drop the Flatten and Dense Layer
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- Vector with 8192 values can now be extracted from each image
- 6416 data points for further classification



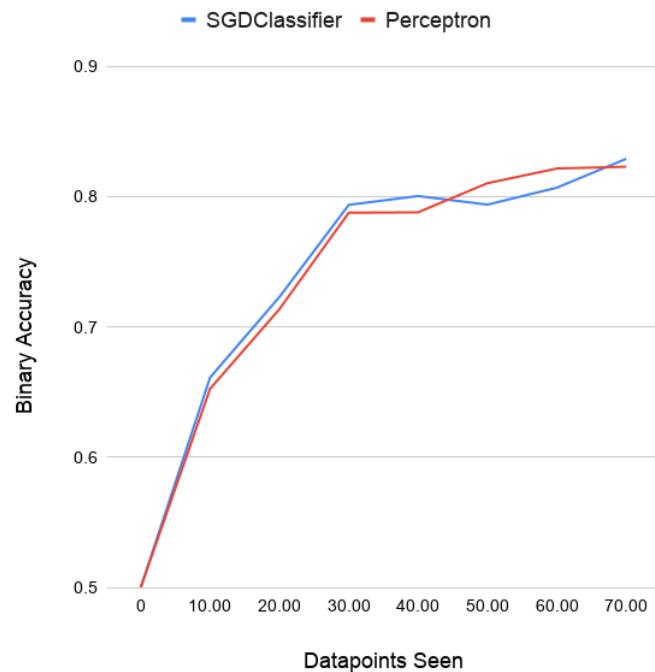
Performance of Full Batch Learning Those Features



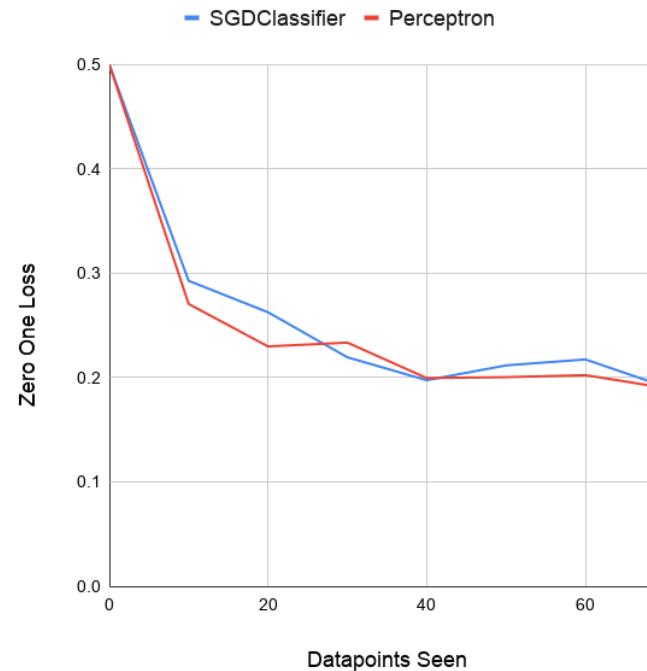
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Comparing SVM and Perceptron Learners

Accuracy



Loss



Summary

- CNN architectures are widely used for classification tasks.

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- CNN architectures are widely used for classification tasks.
- We built a CNN for classifying images with butterflies and trained it.
- We dropped the last layers and extracted features for our images.
- We trained other classifiers on those extracted features.