Breast Cancer Detection with Convolutional Neural Network (CNN)

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Abstract

This paper is explaining the structure of the image classification work that done from CNN's for Signals And Systems Course.

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1 Artifical Neural Networks

Artificial Neural Networks (ANN) or connectionist systems are computing systems vaguely inspired by the biological neural networks that constitute animal brains.[1] The neural network itself is not an algorithm, but rather a framework for many different machine learning algorithms to work together and process complex data inputs.[2] Such systems "learn" to perform tasks by considering examples, generally without being programmed with any task-specific rules. For example, in image recognition, they might learn to identify images that contain cats by analyzing example images that have been manually labeled as "cat" or "no cat" and using the results to identify cats in other images. They do this without any prior knowledge about cats, for example, that they have fur, tails, whiskers and cat-like faces. Instead, they automatically generate identifying characteristics from the learning material that they process. An ANN is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a biological brain. Each connection, like the synapses in a biological brain, can transmit a signal from one artificial neuron to another. An artificial neuron that receives a signal can process it and then signal additional artificial neurons connected to it. In common ANN implementations, the signal at a connection between artificial neurons is a real number, and the output of each artificial neuron is computed by some non-linear function of the sum of its inputs. The connections between artificial neurons are called 'edges'. Artificial neurons and edges typically have a weight that adjusts as learning proceeds. The weight increases or decreases the strength of the signal at a connection. Typically, artificial neurons are aggregated into layers. Different layers may perform different kinds of transformations on their inputs. Signals travel from the first layer (the input layer), to the last layer (the output layer), possibly after traversing the layers multiple times.

The original goal of the ANN approach was to solve problems in the same way that a human brain would. However, over time, attention moved to performing specific tasks, leading to deviations from biology. Artificial neural networks have been used on a variety of tasks, including computer vision, speech recognition, machine translation, social network filtering, playing board and video games and medical diagnosis.

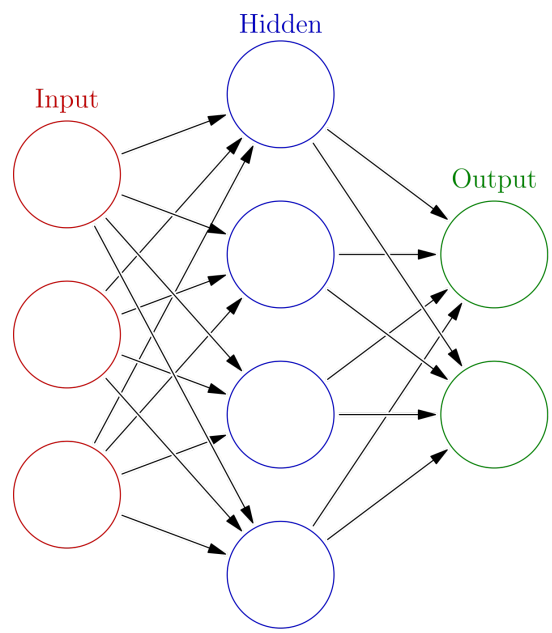

Figure 1: ANN Example

2 Convolutional Neural Networks (CNN)

Convolutional neural networks (CNN) is a special architecture of artificial neural networks, proposed by Yann LeCun in 1988. A convolutional neural network is a class of deep neural networks, most commonly applied to analyzing visual imagery. CNNs use a variation of multilayer perceptrons designed to require minimal preprocessing.[3] They are also known as shift invariant or space invariant artificial neural networks (SIANN), based on their shared-weights architecture and translation invariance characteristics.[4][5] Convolutional networks were inspired by biological processes[6] in that the connectivity pattern between neurons resembles the organization of the animal visual cortex. Individual cortical neurons respond to stimuli only in a restricted region of the visual field known as the receptive field. The receptive fields of different neurons partially overlap such that they cover the entire visual field. CNNs use relatively little pre-processing compared to other image classification algorithms. This means that the network learns the filters that in traditional algorithms were hand-engineered. This independence from prior knowledge and human effort in feature design is a major advantage. They have applications in image and video recognition, recommender systems,[7] image classification, medical image analysis, and natural language processing.[8]

3 Image Classification

CNN uses some features of the visual cortex. One of the most popular uses of this architecture is image classification. For example Facebook uses CNN for automatic tagging algorithms, Amazon for generating product recommendations and Google for search through among users' photos.

- The main task of image classification is acceptance of the input image and the following definition of its class. This is a skill that people learn from their birth and are able to easily determine that the image in the picture is an elephant. But the computer sees the pictures quite differently.

- Instead of the image, the computer sees an array of pixels. For example, if image size is 300 x 300. In this case, the size of the array will be

300x300x3. Where 300 is width, next 300 is height and 3 is RGB channel values.

- The image is passed through a series of convolutional, nonlinear, pooling layers and fully connected layers, and then generates the output.

The Convolution layer is always the first. he image (matrix with pixel values) is entered into it. Imagine that the reading of the input matrix begins at the top left of image. Next the software selects a smaller matrix there, which is called a filter (or neuron, or core). Then the filter produces convolution, i.e. moves along the input image. The filter's task is to multiply its values by the original pixel values. All these multiplications are summed up. One number is obtained in the end. Since the filter has read the image only in the upper left corner, it moves further and further right by 1 unit performing a similar operation. After passing the filter across all positions, a matrix is obtained, but smaller then a input matrix.

- This operation, from a human perspective, is analogous to identifying boundaries and simple colours on the image. But in order to recognize the properties of a higher level such as the trunk or large ears the whole network is needed.

- The network will consist of several convolutional networks mixed with nonlinear and pooling layers. When the image passes through one convolution layer, the output of the first layer becomes the input for the second layer. And this happens with every further convolutional layer.

The nonlinear layer is added after each convolution operation. It has an activation function, which brings nonlinear property. Without this property a network would not be sufficiently intense and will not be able to model the response variable (as a class label). The pooling layer follows the nonlinear layer. It works with width and height of the image and performs a downsampling operation on them. As a result the image volume is reduced. This means that if some features (as for example boundaries) have already been identified in the previous convolution operation, than a detailed image is no longer needed for further processing, and it is compressed to less detailed pictures. After completion of series of convolutional, nonlinear and pooling layers, it is necessary to attach a fully connected layer. This layer takes the output information from convolutional networks. Attaching a fully connected layer to the end of the network results in an N dimensional vector, where N is the amount of classes from which the model selects the desired class.

4 Experiments

4.1 Breast Histology Images And Architecture Of Network

About this Dataset : This dataset consists of 5547 breast histology images of size 50 x 50 x 3, curated from Andrew Janowczyk website and used for a data science tutorial at Epidemium. The goal is to classify cancerous images (IDC : invasive ductal carcinoma) vs non-IDC images.

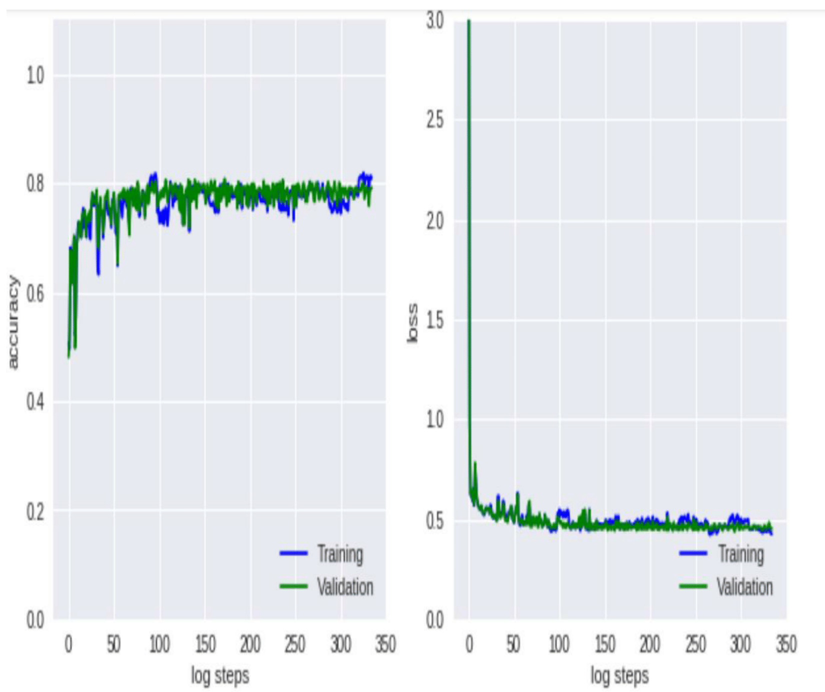

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Figure 2: Tests

Table 1: Architecture Of Network

Input layer	[., 50, 50, 3]			
Hidden layer	Conv1	ReLu	MaxPool	[., 25, 25, 36]
Hidden layer	Conv2	ReLu	MaxPool	[., 13, 13, 36]
Hidden layer	Conv3	ReLu	MaxPool	[., 7, 7, 36]
Hidden layer	FC	ReLu	[., 576]	
Output layer	FC	ReLu	[., 2]	

4.2 Results

Train and validate the neural network (Accuracy,Loss)

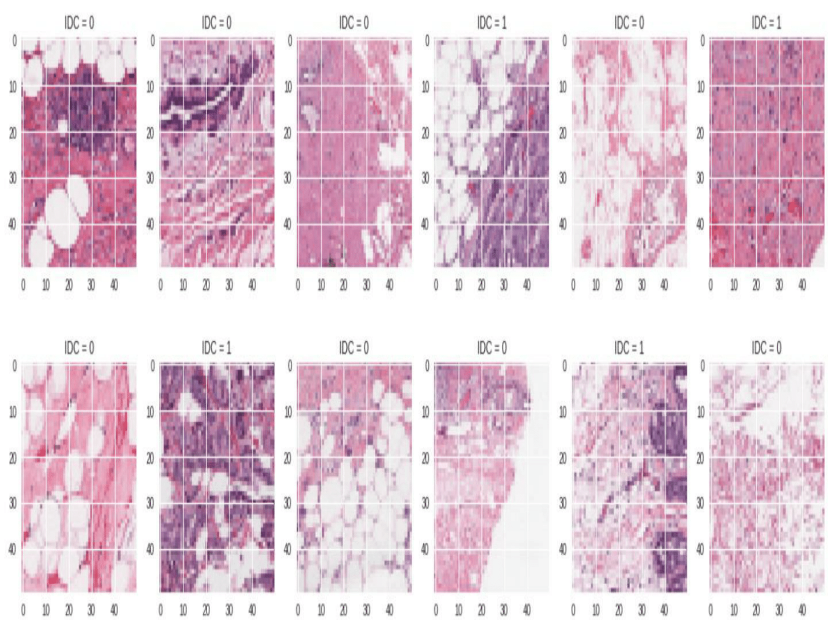

Figure 3. is giving results of experiments.

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