

Visualization of Convolutional Neural Networks

MEI

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1 Resume

It seems like everywhere you look you see the words machine learning, deep learning and neural networks. The ubiquity of these terms in the technological world is a reality. Although these words are often mentioned, few understand the intricacies of this technology.

Despite the many frameworks and user friendly libraries that allow the creation and generation of convolution neural networks(CNNs), for many the operation of the algorithm is a mystery, often mention as a black box that outputs like magic the correct answer. The unfamiliarity behind the operation of the algorithm or the base concept is an obstacle to take full advantage of these algorithms.

The goal of this work is the development of an API with visualization tools that allow to understand how a convolution neural networks works, and analyze their behavior during training and recall.

2 Context

The artificial intelligence and computer vision industry has experienced great growth in recent years thanks to the development of hardware and developments in machine learning / deep learning . Technologies like object detection, music generation, patterns recognition are all present in our everyday. Although this technologies are commonly used, there are still "obscure" phenomena on neural networks[3], as in the detection of images the layers of the networks that retains features that are impossible to see without tools of visualization [1]. Classification algorithms have this problem too, the good performance of some algorithms are still clocked in mystery, the development of visual tools are of vital importance to understand, study and develop more and better technology.

In the last years have been developed new techniques of visualization of CNNs that allow to unravel how large network models have demonstrated impressive classification performance on the ImageNet benchmark and how they might be improved upon[6]. In visual recognition some techniques have been developed to analyze what CNN's learned[8] like visualizing the activation and first-layer weights, the retrieving of images that maximally activate a neuron, embedding the codes with t-SNE [5].

New tools have been developed that assist in the study of CNNs [2], that enable visualize the evolution of the networks, with the goal to give a new perspective and understanding of the effect of learning rate during the training process. Others tools have been developed focused in enable interactive visualization of neural networks given user-provided inputs[4].

In the context of adversarial examples, visualization tool could also provide some insight to this reported weakness on CNNs[9][7].

3 Objectives

There are several types of neural networks for the most varied purposes, but for this work we will focus on convolutional neural networks. These types of networks are the among the most commonly used and most commonly known which is a good starting point to begin the study and understanding of neural network in general.

The main goal is the development of an API to support a wide range of visualization techniques of the inner workings of a CNN. The visualization will be available for both trained networks, as well as for the learning process itself.

4 Research Methodology

Initially the focus of this work will be research and understand the fundamentals of the generics CNN and how they work, analyze their behavior and the tuning techniques.

Next, several existing tool kits will be tested and analyzed. The most used features of these toolkits will be implemented in the API.

This will be complemented with visualization techniques described in the literature.

5 Scheduling

This project will have the following work agenda:

- research and understand the fundamentals of the generics CNN;
- research and testing existing CNN's visualization tools;
- Development visualization tools API;
- Writing of dissertation;

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References

- [1] Andrea Vedaldi Aravindh Mahendran. Visualizing deep convolutional neural networks using natural pre-images. 2016.
- [2] Xinyu Chen, Qiang Guan, Xin Liang, Li-Ta Lo, Simon Su, Trilce Estrada, and James Ahrens. Tensorview: visualizing the training of convolutional neural network using paraview. 2017.
- [3] Aaron Courville Dumitru Erhan, Yoshua Bengio and Pascal Vincent. Visualizing higher-layer features of a deep network. *Dept. IRO, Universite de Montreal*, 2009.
- [4] Adam W. Harley. An interactive node-link visualization of convolutional neural networks. *Department of Computer Science, Ryerson University*, 2015.
- [5] Geoffrey Hinton Laurens van der Maaten. Visualizing data using t-sne. *Journal of Machine Learning Research*, 2008.
- [6] Rob Fergus Matthew D. Zeiler. Visualizing and understanding convolutional networks. *Dept. of Computer Science, New York University*, 2013.
- [7] David Wagner Nicholas Carlini. Adversarial examples are not easily detected: Bypassing ten detection methods. *arXiv:1705.07263v2 [cs.LG] 1 Nov 2017*, 2017.
- [8] Stanford University. Cs231n: Convolutional neural networks for visual recognition.

- [9] Fuxin Li Xin Li. Adversarial examples detection in deep networks with convolutional filter statistics. *arXiv preprint arXiv:1612.07767 (2016)*, 2016.

Signatures

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