Dreaming Deep into Neural Networks

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Abstract

Artificial neural networks have been in use for image classification and face recognition among many other applications. In 2015, Mordvintsev and Tyka [2015] introduced their work on Deep dream for the first time. Deep Dream adjusts the original image that was given for image classification, to get neurons with higher confidence scores. This can be used for visualizations to understand the hidden layers of the neural network better. Our paper proposes to use this concept of Deep Dream and apply it to our dataset of images using TensorFlow. We wish to explore the different effects that our testing yields by enabling certain layers at a time.

1 Introduction

DeepDream, created by Google engineer Alexander Mordvintsev, is a computer vision program. It uses a Convolutional Neural Network to find then enhance patterns in images, by applying algorithmic pareidolia.This results into deliberately over-processed images having a hallucinogenic appearance. To achieve this, Artificial neural networks are used, that are nothing but statistical model inspired by biological neural network. As deep neural networks, have made a remarkable progress in area of image classification, image recognition etc., it is very important to understand why these models work in certain way, how do these models adjust their weights.
The main core working of these deep neural networks is based on how effectively they adjust their weights with respect to problem statement .Therefore , the main theme of this project is to explore how these adjustment of weights takes at various level , what exactly goes on at each layer by using deep dream technique. With this exploration, we would have an understanding and visualization of how neural network are able to carry out such difficult classification tasks, improve neural networks has learned during training .We train neural models based on various training examples so that it learns from those examples what are important features and ignore those which don't matter .But how do we check whether our neural network is learning in right direction . With this approach , we would get a general idea of what is the network model thinking at each layer. Deep dream as a concept is relatively new in the field of Computer Vision, hence not much has been done with it. We did not not have any different approaches to choose from, hence we. are sticking to the basics.

2 Past related work

1. Previously, we found in the paper He [2016], the author has tried to compare many methods of achieving what Deep Dream does. Some of these papers had approaches regarding Neural Doodling,etc.Then cropping its input images into 300x300px images. He has explained the setup of installing softwares required for going ahead with the inceptionism program and has explored the algorithm's results by modifying its parameters and tweaking its setting. The author then discussed its application in the field of art.

2. JOAQUIM SILVESTRE [2016] presents experiments with Convoluted Neural Networks that explores the layers of ConvNet for architecture image generation purpose. This paper focuses on 2D perspective representation of architecture. This is mainly due to the input data format: pictures of architecture buildings.

3. Christian Szegedy [2016] , the author mentions *GoogleNet*,22 layers of deep network used for classification and detection of objects and apply this network to proposed deep dream algorithm , *Inception* , with the help of which developing an analyzed on the imageNet dataset.

4. Leon A. Gatys [2015] , the author has similar work to the Christian's paper.This works focuses on developing artistic images of high perceptually quality.This model uses the neural representation to separating and combine the content and style of arbitrary images . Thus , developing new artistic images.

5. Champandard [2016], another approach similar to the above paper focuses on semantically transferring style to image using the deep dream concept of analyzing each layer, and enhance those layers to generate the more artistically image.

3 Proposed approach

Our approach in this project to analyze various levels of Convoluted Neural Networks by using Tensorflow and Google's Deep Dream base to test our resultant images on a Face detector algorithm.Hence , our first step is to build a version of Google's deep dream algorithm using tensor flow, used for the purpose of conducting machine learning and deep neural networks research.

Numpy:Math calculation | Tensor Flow : For building Deep Dreamed images | Predefined CNN based face recognition

We will use Python's Numpy, Tensorflow among many others to implement our project.
Basic Programming steps :

1. Incorporate the pre-train CNN into our model
2. Create tensor flow session
3. Pick one layer and understand what this layer has learned
4. Apply the gradient ascent property this layer
5. Output the deep dream image

4 Dataset

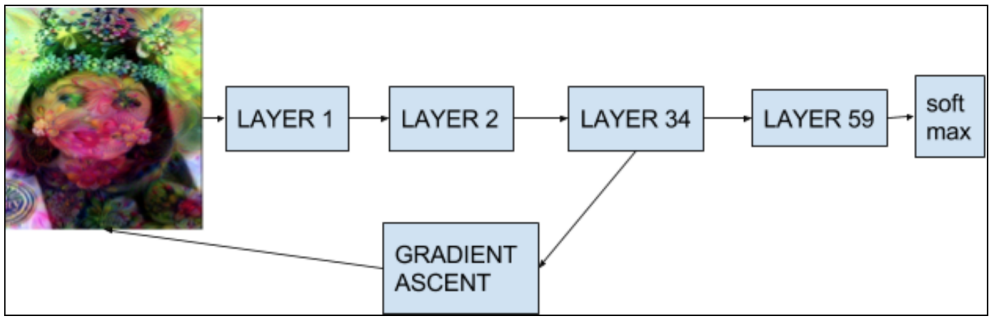
Our dataset was provided by Mr.Geeta Madhav Gali, as we are extending his work on face detection. We aim on using our dataset of 17000 images of Indian actors and actresses. These images will be our input to the system.

5 Methodology

We have used Google's pre-trained CNN network known as inception5h.Once we have loaded this pre-trained network , we create a tensor-flow session and enhance the layer by using gradient ascent. We can test this system by exploring the deep dream algorithm by tweaking various components of this model and then analyzing what the layers had already learned and what was the effect on the image by enhancing or weakening its certain features. Our basic goal here is to apply this image set to various layers of our model and develop basic understanding of how this network's develops an abstraction of what it has learned at various levels : low level which involves around low level details like edges, corners etc. to higher level which involves progressively -larger high features that help network recognize what it's trying to recognize.
Pre-train CNN network : We have used Google's pre-train CNN network called Inception5h. Number of layers : 59
Experimental steps for analyzing the developed model :

1. Loading model with images:
2. Generate dream images with different iterations : We use gradient ascent process to maximize our loss function of a particular layer .Each iteration of the algorithm makes some change to the input image. More iterations adds changes and "recognizes " the image with higher confidence.
3. Generate dream images with different layers : Since the model has various abstraction levels, we can specify the layer we want to enhance. Higher levels are focused on the more complicated features while the lower level layers are focused on small details of the images such as texture,edges etc.

FLOWCHART :



DEEP DREAM APPROACH

6 Results and discussions

6.1 RESULTS

We have uploaded our input/ test image dataset in the Google Drive link Gali [2017] shared below. The dataset was, as mentioned earlier, shared by Mr.Geeta Madhav Gali. Any of the images from the

dataset can be used as an input to our code. We input the image from this dataset to our deep dream model. By selecting various layers and also, by increasing the iteration we generate a deep dream images generated by the model.

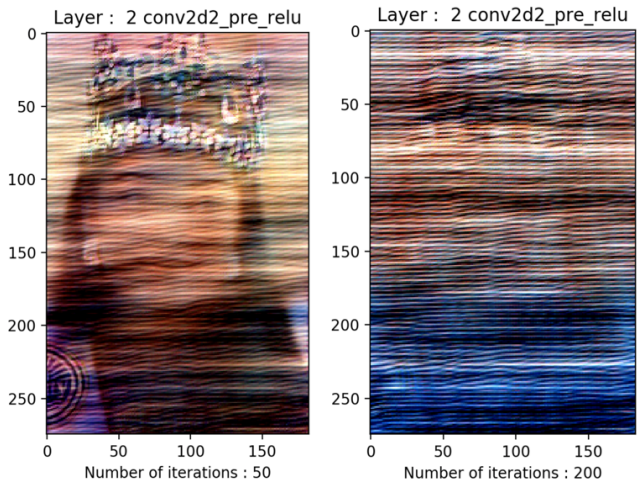


Figure 1: Layer 2 (PNG).

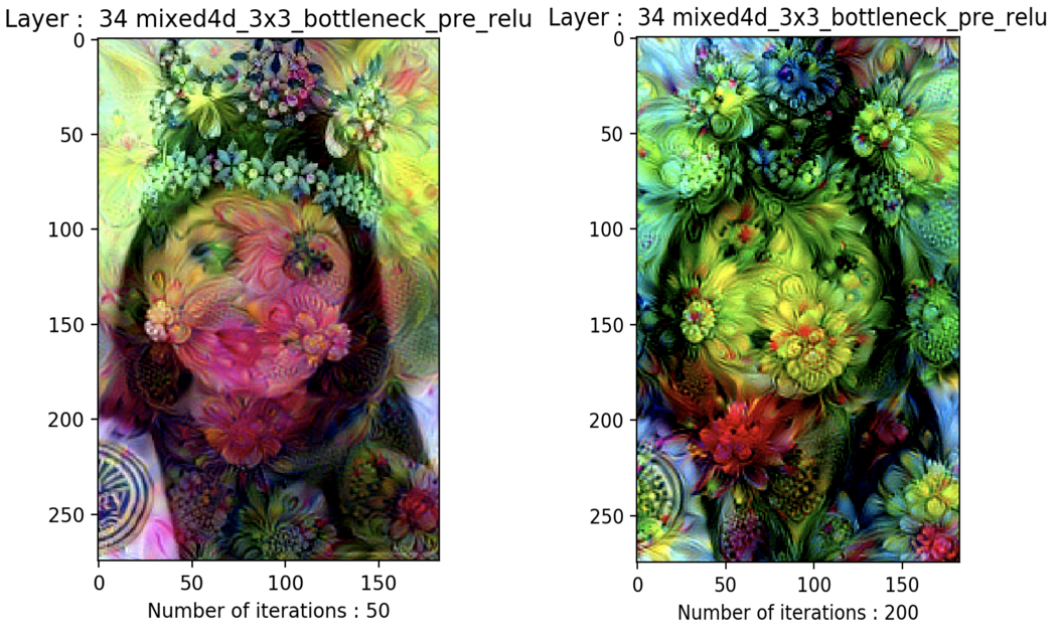


Figure 2: Layer 39 (PNG).

6.2 Analysis

We used our dataset to test the system with various images and get the resultant modified images. From layer 1 to a possible of 59 total layers, we tested the below given layers choosing from each interval of the given range of layers.

1. Lower level : Layer 2
2. Middle level : Layer 34

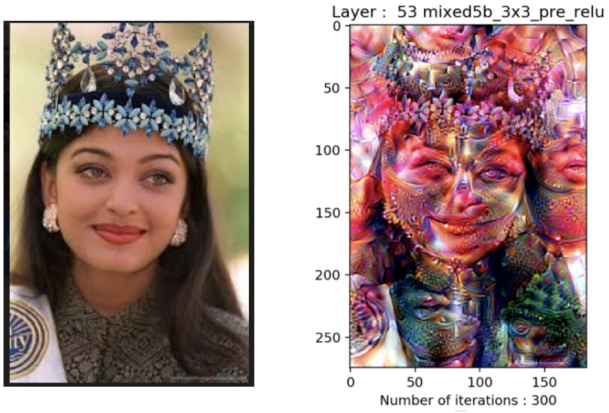


Figure 3: Original and Layer 53(PNG).

3. Middle level : Layer 39
4. Higher level : Layer 53

On checking various layers out of the possible 59 Layers, each layer presented a unique image. Furthermore, our results varied on fine tuning the number of Iterations or Epochs. The higher the Epoch number, the more convoluted the resultant image was.

Using lower layers gave images that were

interpreted with minimal expected image's features. This implies the network tries to identify basic edges, corners, gradients, and blobs to identify what the input image consists of. This can be observed in the figure Next, on testing the middle level layers like layer 34 named "$mixed4d\_3x3\_bottleneck\_pre\_relu$", we got images where we saw in an increase in the repeated presence of a certain alien feature to out input image. For instance, in the example feeding of Aishwarya Rai Bachchan's facial image to layer 39 of the Deep Dream network, as the iteration kept increasing so did the count of abstract flowers appearing out of nowhere. This implies that the network recognized some features of the image that matched a feature of some flower that it had trained on. Hence, to increase its confidence value, that is, its probability of classifying the image correctly, it started manipulating the original image to make it more like its expected flower image.

Additionally, on probing further,we saw in the layer 53 named $mixed5b\_3x3\_pre\_relu$", it is generates triggers the maximum level capacity of the network trying to immerse the features it expected in the original image.

As seen in result section , for lower layer 2 the network analysis the edges in the input image and for higher number of iterations is enhances this particular feature for the input image.Further , for more higher level 34 , it analysis more higher features such as flowers and when enhanced by applying gradient ascent , we get a more clear flowery picture.

7 Conclusion and future work

We studied the mystical working of neural Networks. It is a fact that humans on using Psychedelic drugs start hallucinating. Psychedelics help manifest certain parts of our minds that are untouched otherwise. Neural Networks albeit based on the neurological system of us humans, were not expected to be so similar human brains. When Google engineer Alexander MordvintsevMordvintsev and Tyka [2015], created a Constitutional Neural Network that via algorithmic pareidolia, produces enhanced trippy images, the world went in a surprising frenzy. As per the experiments conducted in this project, original unadulterated images are given input to the network of pre-trained layers, and this network then back-propagates to adjust not the weights but the original image itself. Thus resulting in a visually dream-like image that has been plucked out straight from the thinking layer of this network before it reaches its final classifier. Deep Dream creates deliberately over-processed results that help

us understand how neural networks work towards achieving a better confidence score for its ultimate goal of image classification. The layer as they increase generate more abstract and more detailed results that are totally unexpected.

Contributions: We combined our workload to complete this project, following is the contribution by the members of this team project:

1. Trisha P Malhotra : Decided the Project topic, documented phase 1 report including citations and references. Wrote Abstract, Introduction, and researched and added content to Past Related Work section. Wrote complete detailed analysis and conclusion, thus finishing up the documentation segment and research of this project.Contributed for selection of project topic , documented phase 1 report proposed approach , dataset , methodology.Developed diagrams for proposed approach and flow chart for deep dream approach.Researched and developed the main running code of the project.

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