Biological inspired neural networks

Youmna Salah| Dr. Aysha | German University In Cairo

Introduction

The image perception journey starts from the eye, but it truly takes place in the brain.

Hypothesis

- “The visual hierarchy of biological brains is a form a deep and complex recurrent neural network, Though the computational models of the brain that have been dominating the computational neuroscience, in vision and beyond are rather largely shallow architectures performing simple computations “

Overview

Vision starts when light is reflected from an object passing through several layers in the eye and transferred from light energy to nerve impulses and send to the brain. The brain have a specialized area for vison known as the visual cortex. The visual cortex is a hierarchy of visual areas that are specialized in learning different features similarly to what happens in convolution neural networks an example of feed forward NN. There were several trials to understand what each layer and weight channel in CNN learns.

Networks evolution passes through several stages starting from perceptron model passing through multi-layer perceptrons to recurrent networks and LSTM networks as well as others, Each type of network have a limitations that results into developing another type of network or other paradigm for learning.

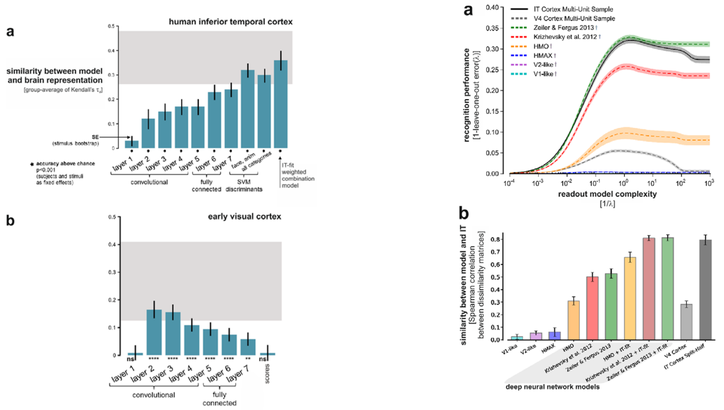
Experiments

A sample experiment was developed to test the similarities between the brain representation and level of recognition.

Procedures

- Expose a deep NN (Alex net) and a human being to the same motif
- Measure the brain activity and the activations at each vision area and that at each layer
- Compare the activations as well as the overall performance in object recognition

Results



What layers learn in CNN?

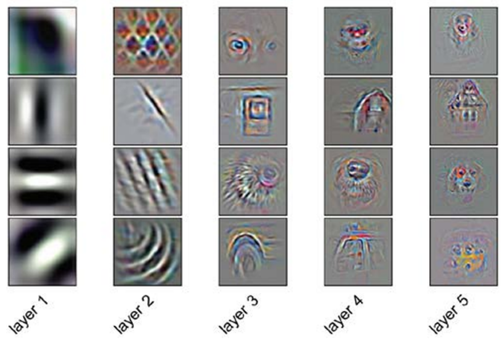
A network developed by Zeiler and Fergus on the hope of understanding what does each layer in CNN learn.

Procedures

- For each layer in CNN build a layer that performs the opposite functionality is developed
- Measure the brain activity and the activations at each vision area and that at each layer
- Compare the activations as well as the overall performance in object recognition

Observations

- Shallow layers learns simple features while shallow ones learn more complex features
- Problem : Might be the exceptions rather the rule!



FNN drawbacks and solutions

Since backpropagation does not account for any previous data and that it lacks sense of time, recurrent neural networks were developed. One example of RNN is echo-state networks. Most of RNN use backpropagation through time for learning, which is different from back propagation in that it takes values from previous time steps into consideration but still that is not sufficient for remembering everything that happened in the past, so long short term memory networks were developed to solve such a problem.

Alternatives to supervision

Because Biological organisms do not presumably learn in only supervised manner, and because scientist seek perfectionism, unsupervised learning was developed to allow a system to learn without the need of labeled input data. one example of such systems is auto encoders developed by Hinton and his fellows in 2006. Auto encoders are similar to feedforward NN with only two special traits, first the number of units in the input layer is the same as that in the output layer another point is that there is a bottle neck layer a.k.a. the code layer (dividing the network to 2 parts namely an encoder (layers form the input to the code layer) and a decoder (layers form the code to the output layer) that is a layer with less number of neurons than the layer before and after. The network learns to produce the input image at the output layer. This type of networks use backpropagation for learning. Such a network technique is useful for data compression and training FNN when insufficient labeled training data are available by training each layer in an auto encoder framework using large set of unlabeled images.

Conclusion

- vision in man and machine ,vision process in human beings ,evolution process of vision in machines, similarities between artificial and biological neural networks ,FFN e.g. CNN ,RNN e.g. echo state , unsupervised e.g. auto encoders, papers written by pioneers but Nikolaus Kriegeskorte, "ANN that are now dominating the computer vision field are rather shallow and perform simple computations, what about ALex net, it needs to evolve but certainly not shallow also, methods used to compare similarities between CNN and biological were vague and did not mention if difference in neuron and unit models were taken into consideration .

References

- http://www.nature.com/neuro/journal/v19/n3/full/nn.4244.html
- http://www.nature.com/nature/journal/v521/n7553/full/nature14539.html
- http://www.annualreviews.org/doi/abs/10.1146/annurev-vision-082114-035447