Spiking Neural Networks

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April 8, 2022

Abstract

Use of Deep Neural Network, commonly referred to as *deep learning* spiked in recent years and has been used as a tool for impressive advancements in the field of *Artificial Intelligence (AI)* Spiking Neural Networks draw inspiration from the Purpose of this project is to demonstrate the capabilities of a Spiking Neural Network and compare it to a more conventional Object Recognition Deep Neural Network

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1 Architecture of the Spiking Neural Network

When it comes to building a neural network, one has to establish an architecture or an arrangement of layers and how they connect with each other. It is particularly important, when the network increases in complexity. Object classification + localization being a demanding task for a network to solve, we have adopted a published and well-tested architecture for the task – ResNet. The particular architecture we have tried to imitate titled *DECOLLE*, was first developed by Kaiser, Mostafa, and Neftci (2018) and later enhanced by Barchid, Mennesson, and Djéraba (2021). *DECOLLE* Neural Network adopts properties of classical ResNet model architecture as well as a pyramidal structure that was proposed by Lin et al. (2016).

1.1 ResNet

To begin with the cornerstone of our architecture – ResNet, it was named for its property, of convolutional layers of the network that are residually connected with each other using shortcut connections (He, Zhang, Ren, and Sun (2015)). According to the authors of the original paper on ResNets, addition of residual connections improves model's convergence, or ability for model's loss to move towards a minimum with a decreasing trend. Meanwhile, ResNets converge faster than their plain counterparts, the complexity of ResNets is much lower than complexity of well established Visual Geometry Group (VGG) Networks given the same depth (3.6 billion FLOPs (Float Point Operations) vs. 19.6 billion FLOPs) (He et al. (2015)).

1.2 Comparing Model Performance

To compare networks' performance one has to understand how it is measured and what constitutes an accurate model. For the task of object detection/localization accuracy of the model at predicting class of the object in the image is not enough. Thus, two additional performance metrics have been adapted : Mean Average Precision (mAP) and Intersection of Union (IoU). Firstly, Mean Average Precision for the pur-
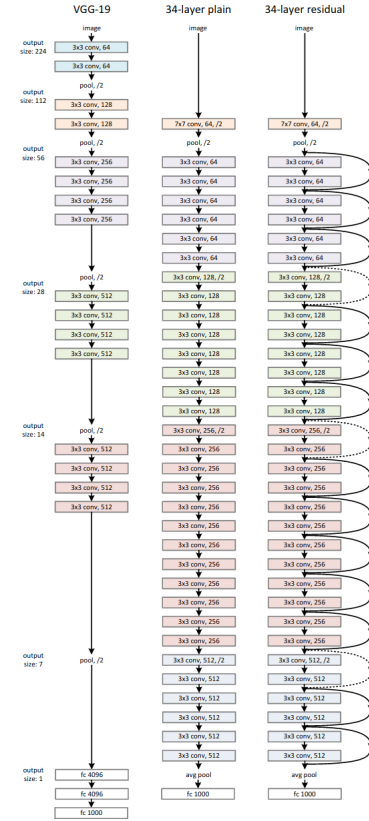

Figure 1: Examples of 16-layer VGG, Plain 34-layer, and 34-layer ResNet Network Architectures

poses of Object Detection is well-defined in the paper by Everingham, Gool, Williams, Winn, and Zisserman (2010). According to the authors, mAP is mean of Average Precision of the model for all the classes in the dataset.

$$\mathbf{mAP} = \frac{1}{N} * \sum_{i=1}^{N} \mathbf{AP}_i \tag{1}$$

$$AP = Average\ Precision,$$

$$N = number\ of\ classes.$$

Moreover, ResNets perform better than plain Deep Convolutional Networks in terms of accuracy. In order to compare

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