COMNET: CORTICAL MODULES ARE POWERFUL SUPPLEMENTARY MATERIAL

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We always have envisaged to come up with simpler architectures while having multi-dimensional efficiency. However, in the past, trade-off exists. For example, if we increase representation power, we lose real-time accessibility or latency and vice versa (1), (4). In addition, we go for network footprint efficiencies, network becomes extremely complex (5). Hence, in this work, based on several network designs, and considering biological evidences, we come up with CoMNet which can target multiple dimensions such as latency, parameters, representation power, memory access cost, hardware friendliness, minimal branching etc altogether. The driving force has been the fact that CNNs are widespread in autonomous machines.

Although there exists transformer architectures, they are still far from deployment for real-time applications and on edge devices. On the other hand, we believe that the fully explored appearing CNNs are still unexplored.

1 BIOLOGICAL REFERENCE TO THE CORTICAL MODULES

Here we put light on the cortical modules by borrowing texts and figures from the original works to make the reader understand the concept better. As mentioned in the paper, that in a biological cortex, there can be many cortical columns which may receive input from a common part of the cortex. This structure is shown is Figure 1. In the figure, a rough pictorial representation of the columnar organization can be seen where multiple columns are projecting to many columns (from bottom to top). The concept of signal sharing in the paper or cortical module feeder is inspired from this organization. More details can be found in the paper (2).

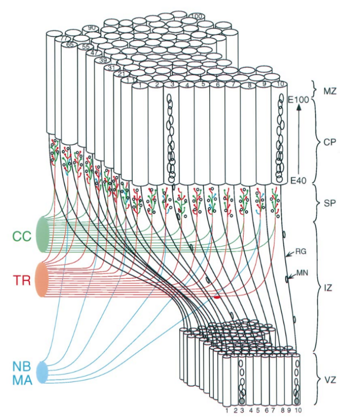

Figure 1: Single column to multi-column projection. Siganl travels from bottom to top. Source: (2).

Next, we put light on the organization of cortical modules in the inferotemporal cortex. Figure 3 depicts a human understandable representation of the cortical modules. It can be seen that in the representation, a particular area of the cortex is dedicated to different variations of a particular stimuli such as monkey face, start or other shapes. The modules are organized as columnar structure and may consist of layers.

In this supplementary material, we have covered the most elementary details. For more detailed understanding of the cortical modules, reader is referred to the original works.

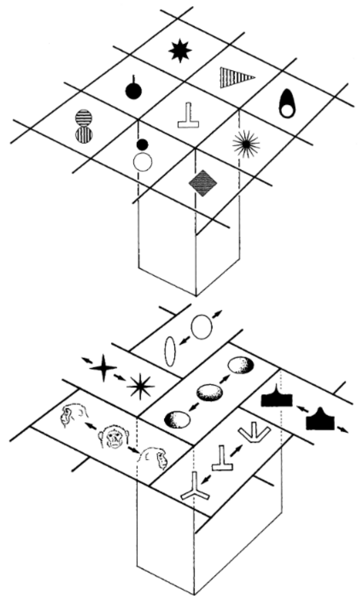

Figure 2: Cortical module concept picture. Source: (6).

1.1 CoMNet Unit With BatchNorm and ReLU

1.2 Codes and Implementation

All codes shall be opensourced post the review process in PyTorch (3). We have provided GPU implementation of `CM_Feeder` in supplementary material. The corresponding file is named as `cm_feeder_layer.cu`. Other files `cm_feeder_layer.cpp`, `cm_feeder_layer.py` are also provided which holds pytorch class implementation of `CM_Feeder`. The remaining network training and inference code which will be shared post the review process.

References

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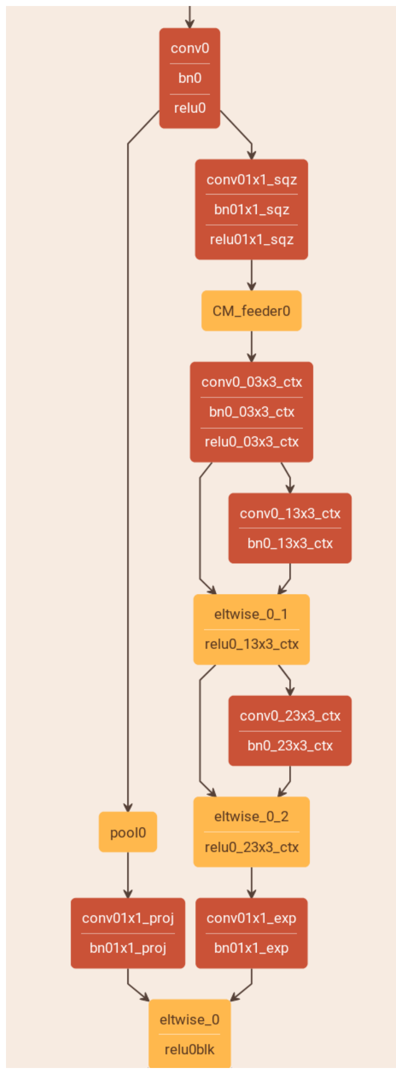

Figure 3: Fully functional CoMNet unit.