CET-CNN: Modular Hierarchical Image Classification Using Conditional-Execution Tree CNNs

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Robust neural networks are crucial for image recognition. However, not all images are equally differentiable. It's easier to differentiate a cat from a tree than from a dog. Most image classifiers today are sequential, which treat all objects (classes) as equally differentiable, causing error. Hierarchical classifiers split predictions across multiple branches, allowing separate specialized classifiers to differentiate between similar classes. This study aimed to design a hierarchical neural network, named the Conditional Execution Tree Convolutional Neural Network (CET-CNN), composed of subunits that classify inputs and process inputs to be passed down to more units, named Multi-Task Processing Units (MPUs). Two MPU architectures were developed- MPU A's performed multi-class classification and MPU B's performed binary classification. CET-CNNs were compared to sequential networks with similar architectures. CET-CNNs were run with full, conditional, or single-path execution. They were trained, using TensorFlow in Python, with pretraining (nodes were added to the network and trained individually), full training (entire tree was trained at once), or both. MPU B-CET-CNNs were more accurate than MPU A-CET-CNNs by 10.43% (80.73% to 70.30%) for the CIFAR-10 dataset, and by 11.23% (47% to 35.77%) for the CIFAR-100 dataset. MPU B-CET-CNNs were also 4.18% more accurate than their corresponding sequential networks. MPU B-CET-CNNs had fewer parameters than MPU A-CET-CNNs and sequential networks, though MPU A's were 1.9-3.9x faster to compute. CET-CNNs were most accurate when trained with full training and run with full execution. CET-CNNs can improve classification accuracy and offer a new, scalable, and modular architecture for neural networks.

Awards Won:
Fourth Award of $500