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Computationally Efficient Deep-Learning Algorithms for Computer Vision

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2018 RCEU Proposal
Computationally Efficient Deep-Learning Algorithms for Computer Vision

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<u>Women and minority students are strongly encouraged to apply for this project.</u>

<u>Project Summary</u>

Computer vision seeks to imitate the functionality of human eye and brain components responsible for the sense of sight, so that computers can gain high-level understanding from digital images and videos. Since its earliest research back in 1950s, computer vision has come a long way. Recently, applications of neural networks and deep learning have taken computer vision to a new level and made sophisticated things like self-driven cars possible in the near future. One of the most remarkable advancement is Convolution Neural Networks (CNNs). Deep CNNs form the crux of most sophisticated computer vision applications, such as self-driving cars, auto-tagging of friends in Facebook pictures, facial and gesture recognition, as well as automatic license plate recognition, etc. The power of artificial intelligence is beyond our imagination.

Recent research on deep convolutional neural networks (CNNs) has focused primarily on improving their accuracy. For a given accuracy level, it is typically possible to identify multiple CNN architectures that can achieve that accuracy level. However, with equivalent accuracy, smaller CNN architectures offer the following advantages: (i) They require less communication across servers during distributed training; (ii) They require less bandwidth to export a new model (e.g., from the cloud to an autonomous car); (iii) They are more feasible to deploy on mobile and embedded hardware platforms with limited memory and computation power. To this end, some reduced CNN architectures were proposed in the literature. For example, the so-called *SqueezeNet* (https://github.com/DeepScale/SqueezeNet) was able to compress the AlexNet (a popular deep CNN architecture) with 50x fewer parameters, while achieving the same level of accuracy on testing images in ImageNet (http://image-net.org/) , which is a large-scale image database widely used for computer vison research around the world.

In this project, the student will conduct research on training, testing, and evaluation of various deep learning algorithms, as well as implementations on computing platforms. The project will be conducted in the *Mobile Cloud Computing (MC^2) Lab* (ENG 241) directed by the faculty mentor. The lab is equipped with all the necessary software and hardware platforms (including mobile devices such as IOS and Android tablets, as well as embedded computing platforms such as Raspberry Pi's with cameras) to support the proposed research. The expected deliverables of the project include computer programs and/or mobile Apps with computer vision capability (e.g., automatic face recognition). We will compare the performances (in terms of number of parameters, computation times, power consumption, and classification accuracy) of various deep machine learning algorithms.

The student will not only learn state-of-the-art machine learning and computer vison algorithms, but will also gain hands-on experience with software development tools and libraries such as OpenCV and DeepBelief SDK (https://github.com/jetpacapp/DeepBeliefSDK).

Student Prerequisites

Coursework on computer programming languages (C/C++, or Java) is required; Experience with Matlab and/or Python is preferred.

Student Duties

- Training and testing of various deep-learning methods for object recognition. The following methods will be considered: SqueezeNet, LeNet-5, AlexNet, GoogLeNet, Microsoft ResNet, Generative Adversarial Networks, Deep Belief Network, VGGNet, and ZFNet.
- Implementing and evaluating the algorithms on various computing platforms, e.g., mobile devices and Raspberry Pi's (https://www.raspberrypi.org/).
- Writing weekly progress report and final report. Preparing slides for presentation in biweekly research-group meeting.

Mentor Supervision and Interaction

The faculty mentor will be available during the summer to provide timely guidance and feedbacks to the student. The faculty mentor's Ph.D. students will also be available to provide assistance with the project. There will be one meeting per week to ensure constant progress being made. There will be two formal reviews conducted, including a mid-term and a final review. We expect the research results to be of high-quality and publishable.