Performance Analysis of GPU GTX 980 on Colon Histopathology Images Training Based on Convolutional Neural Network

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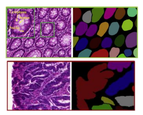
Abstract

Cancer diagnose based on the histopathology images still have some challenges recently. The variation of images, high resolution of images, different pattern of cell on the images have potential contribute to miss-classification. Convolutional neural network has widely used in image processing with its ability to extract and classify an object. Applying CNN on high resolution of images cause cost intensive in training process. For that, Graphics Processing Unit (GPU) has important role to speed-up the process. However, the problem in GPU is the limitation of memory size. This work focuses on the way to utilize the GPU memory in the training of CNN architecture. For training CNN architecture, NVIDIA GTX-980 are accelerated by customizing CUDA memory allocation from cnmem library. In the experiment, the parameter of cnmem are chosen from 0.6, 0.8, 1, 2 and and the best value will be used to the next training. To enrich the dataset, augmentation such as rotation, zoom, shear and flip are conducted. Some optimization technique are applied experimentally to determine the best model to classify two classes of cancer, benign or malignant.We use image variation from 32x32, 64x64, 128x128, 180x180 and 200x200 . In the training, a number of batch-size is selected experimentally from 10, 20, 50, 100 and 150. Our finding is that enabling cnmem with parameter 1 is selected as the best value. The 200x200 images show the most significant efficiency of GPU performance when training CNN. Speed-up are measure by comparing training time of GTX-980 with CPU core i7 machine from 16, 8, 4, 2 cores and the single core. The highest speed-up GTX-980 obtained with enabling cnmem are 4.49, 5.00, 7.58, 11,97 and 16.19 compare to 16, 8, 4, 2 and 1 core processor respectively

Conventional VS Automatic Detection

conventional method

Histopatology images



chen et.al 2016

gurcan et al 2009

expert pathologist

problem
- **human dependency**
- **tend of error**
- **time consuming**

automatic method

.: Convolutionan Neural Network ::.

- Automatic Feature Extraction
- General Feature Extraction
- Good Performance for Classification

Trade off : Training Time Expensive

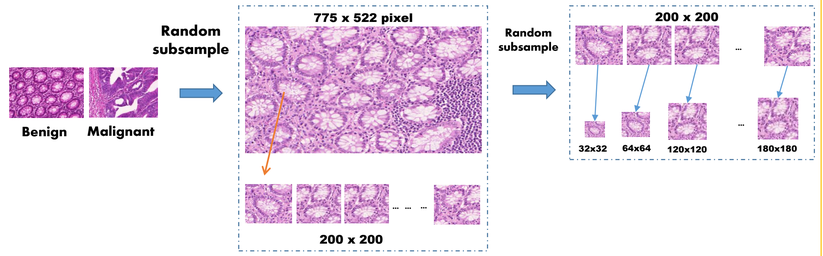
Objective

- Accelerate NVIDA GPU GTX-980 for training CNN
- Analysis of Performance

Methodology

Data set

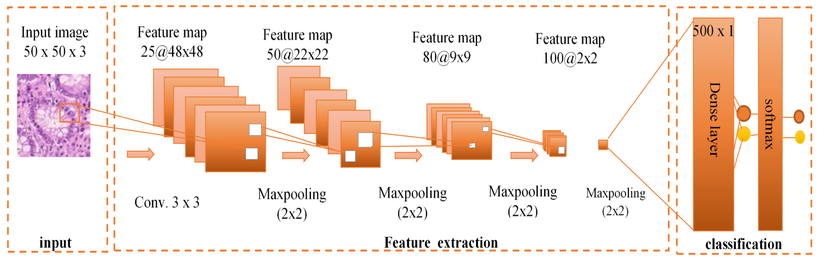
- Colon cancer data
- 32x32, 64x64, 128x128, 180x180, 200x200 pixel, 0.68 µm/pixel
- annotated
- 941 benign, 910 malignant



data pre-processing, data augmentation

- **Image augmentation**
- **normal, random rotation, flip (H/V) , zoom, shear**

CNN Architecture Design



CNN parameter

- **Mini batch-size : 10, 20, 50, 100, 150**
- **Optimizer : rmsprop, sgd, adam and adamx**

CPU Environment :

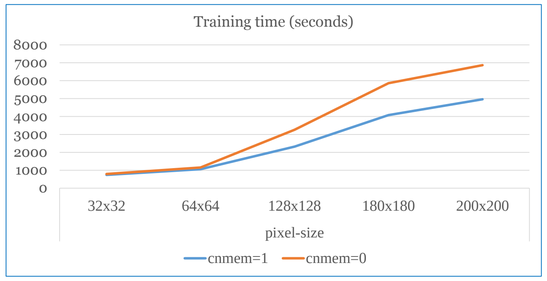
- **Intel ® Core™ i7-5960X**
- **Number of core : 16 cores @3GHz**
- **RAM size : 65GB**

GPU GTX-980 Environment :

- **Number of Cores : 2048**
- **Clock speed : 1126 Mhz**
- **GPU memory : 4GB**
- **Memory interface width : 256 bit**

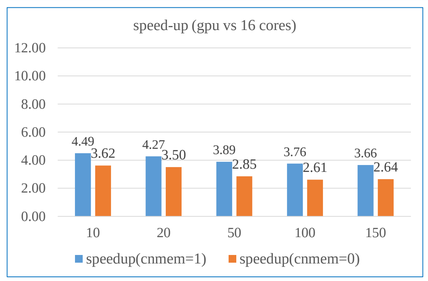
Result

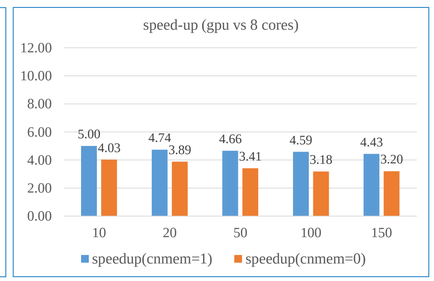
Significant image size to perform GPU efficiency

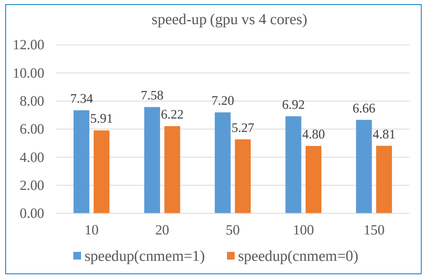


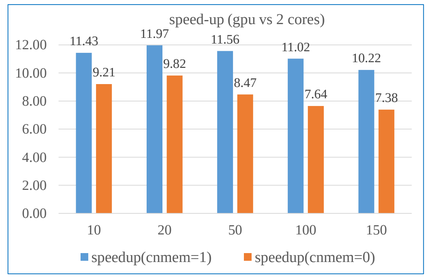
The figure describe training time (in seconds) for several image size for batch-size = 150. the figure also compare between enabling of cnmem. By enabling cnmem (cnmem=1), training time is faster.

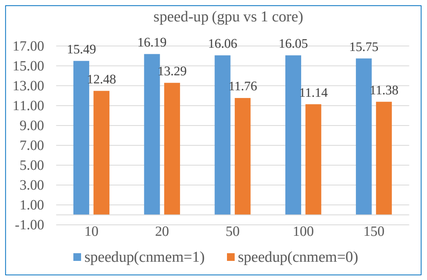
GTX-980 speed-up analysis: 10, 20, 50, 100 and 150 batch-size











The figures are speed-up analysis of training CNN using 200x200 pixel image. The speed-up measured by comparing between training time via CPU and GPU GTX-980 based on the formula :

$$speedup = \frac{t_{(s)}}{t_{(p)}}$$

Speed-up measured between GTX-980 and some scenario of multi-processors

Conclusion & Future directions

- **Performance of GPU GTX-980 for histopathology can be exploited by customizing and select optimal value of cnmem**
- **Mutiple GPU can be apply for next research**