PRACTICAL DEEP LEARNING EXAMPLES

Image Classification, Object Detection, Localization, Action Recognition, Scene Understanding

Speech Recognition, Speech Translation, Natural Language Processing

Pedestrian Detection, Traffic Sign Recognition

Breast Cancer Cell Mitosis Detection, Volumetric Brain Image Segmentation
WHAT IS DEEP LEARNING?

IMAGE CLASSIFICATION WITH DNN

Deep Learning Framework

Forward Propagation

Compute weight update to nudge from “turtle” towards “dog”

Backward Propagation

Repeat Training

Classification

Tree

Cat

Dog

Trained Model

Classification

Training
IMAGE CLASSIFICATION WITH DNNS

Typical training run

- Pick a DNN design
- Input thousands to millions training images spanning 1,000 or more categories
- *Day to a week* of computation

Test accuracy

- If bad: modify DNN, fix training set or update training parameters
**GPUs and Deep Learning**

<table>
<thead>
<tr>
<th></th>
<th>Neural Networks</th>
<th>GPUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inherently Parallel</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Matrix Operations</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>FLOPS</td>
<td>✓</td>
<td>✓</td>
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</tbody>
</table>

**GPUs deliver** --
- same or better prediction accuracy
- faster results
- smaller footprint
- lower power
NVIDIA DEEP LEARNING PLATFORM

DEVELOPMENT

- Software
  - cuDNN
- Systems
  - DIGITS DevBox
- Hardware
  - Titan X

DEPLOYMENT

- Applications
- DIGITS Tools
- Deep Learning Frameworks

- Software
- Systems
  - HP, DELL
- Hardware
  - Tesla
cuDNN

- Accelerates key routines to improve performance of neural net training
  - Routines for convolution and cross-correlation as well as activation functions
  - Up to 1.8x faster on AlexNet than a baseline GPU implementation
- Integrated into all major Deep Learning frameworks: Caffe, Theano, Torch
## GPU-ACCELERATED DEEP LEARNING FRAMEWORKS

<table>
<thead>
<tr>
<th>Domain</th>
<th>CAFFE</th>
<th>TORCH</th>
<th>THEANO</th>
<th>CUDA-CONVNET2</th>
<th>KALDI</th>
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</thead>
<tbody>
<tr>
<td>cuDNN</td>
<td>R2</td>
<td>R2</td>
<td>R2</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Multi-GPU</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓ (nnet2)</td>
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<tr>
<td>Multi-CPU</td>
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<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓ (nnet2)</td>
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<tr>
<td>License</td>
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<td>GPL</td>
<td>BSD</td>
<td>Apache 2.0</td>
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<tr>
<td>Interface(s)</td>
<td>Text-based definition files, Python, MATLAB</td>
<td>Python, Lua, MATLAB</td>
<td>Python</td>
<td>C++</td>
<td>C++, Shell scripts</td>
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<tr>
<td>Embedded (TK1)</td>
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<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

NVIDIA® DIGITS™
Interactive Deep Learning GPU Training System

Dashboard
Real time monitoring
Network Visualization
Data Scientists & Researchers:

- Quickly design the best deep neural network (DNN) for your data
- Visually monitor DNN training quality in real-time
- Manage training of many DNNs in parallel on multi-GPU systems
- Open source!
- https://developer.nvidia.com/digits
DIGITS WORKFLOW

CREATE YOUR DATABASE
CONFIGURE YOUR MODEL
Creating the Database

DIGITS can automatically create your training and validation set

OR use a URL list

OR insert the path to your training and validation set

Create your dataset

Image parameter options
CREATE THE DATABASE

DIGITS creates your training and validation set for you.

Image directory on host machine

New Image Classification Dataset

Insert the path to your images here
CREATE THE DATABASE

Create Training and Validation Set

Training
- truck
- cars
- person
- house
- planes
- dogs
- cats
- bikes

Validation
CREATE THE DATABASE

Apply rotation, color distortion, noise to training set
CREATING THE DATABASE

Training and validation data set information

Category data information is posted

Job status information displays here – progress, completion, and errors
NETWORK CONFIGURATION

- Load one of your pretrained networks
- Create a your own network
- Customize a network
- Load a pretrained network and fine tune it
Select a standard network and start training

OR

Customize a Standard Network
Select training dataset

Make network changes here

NETWORK CONFIGURATION

Select a standard network and start training

OR

Customize a Standard Network

Visualize your network
Select training dataset

Make network changes here

Start training

Select a standard network and start training

OR

Customize a Standard Network

Visualize your network

Start training
TRAINING

Visualize DNN performance in real time
Compare networks

Classification on the with the network snapshots

Download network files

Training status
Accuracy and loss values during training

Learning rate

Classification
COMPARE RESULTS
PRESENTATION LINEUP

- **Monday**
  - 4 - Introduction to Graph Analytics
- **Tuesday**
  - 2 - Performance Testing in Virtual Environments
  - 3 - Leverage GPUs for Image Processing with ENVI
- **Wednesday**
  - 1 - Accelerating FMV PED Workflows with Real-Time Image Processing
  - 3 - Legion: A CUDA-based Engine for Geospatial Analytics
  - 4 DL Open House
- **Thursday**
  - 1:30 - Accelerating Visualization and Analytics in Socet GXP with GPUs