

Tensorflow Introduction

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Discussion Overview

- TensorFlow High Level
- TensorFlow Theory
- TensorFlow Example
- CGI Related Development Concerns

Tensorflow High Level

- Machine learning framework
- Heterogeneous Computing Model
 - Multicore
 - GPU
- Distributed
 - Coming soon to open source

TensorFlow Problem Domains

- Convolutional Neural Networks
- Recurrent Neural Networks
- Image Recognition
- NLP
- PDE

Compute Model

- Directed graph built on execution nodes
 - Similar to plan tree in RDBMS
- Operations
 - Combination of abstract operation and its input/outputs (i.e. add, multiply), along with attributes
- Edge Types
 - Data Flow
 - Input
 - Output
 - Tensors
 - Control Flow
 - Control Dependency
- Kernels
 - Implementation of an operation

Tensor Flow Usage

- C++ or Python API
- Sessions
 - Instantiates empty compute graph
 - Construct operations, forward precomputed tensors for inputs
 - Run the session by requesting certain outputs

Tensor Flow Execution

- Single Device
 - Compute nodes are completed in dependent specified order
 - All nodes with zero dependencies are added to a queue for processing
- Multi-Device
 - CPUs, GPUs, etc...
 - Scheduling algorithms use cost estimate model
 - Placement, Data Transfer, Compute Speed
 - Heuristic and Measured
 - Greedy
 - Communication
 - Send nodes for edges crossing device boundaries in subgraphs
- Distributed
 - Similar to Multi-Device with RPC

TensorFlow Model Extensions

- Partial Execution
 - Subgraphs can be executed
 - Tensors can be injected or requested from any edge
 - `Session.Run()` takes a set `{X_K}` of tensors for each input injected, or output requested
- Manual Constraints
 - Override or suggest optimizations to scheduler
- Control Flow Primitives
 - Switch, Merge
 - Conditional Tensor Eval
 - Enter, Leave, NextIterator
 - Loop Implementation in Dataflow Graph
 - Tagged to allow for Concurrent Execution
- Input Operations
 - File Load

TensorFlow Internal Optimizations

- Subexpression Elimination
- Scheduler
 - Attempts to Quickly Push Intermediate Computations out of Memory
 - ASLAP receive node scheduling
- Specialized kernel implementations
 - utilize BLAS, GPU libs, etc..
- Lossy Compression for Data Transfers
 - Floating Point

CGI and TensorFlow

- CPU Only
- GPU Upcoming
 - Challenges
 - Unstable TensorFlow features cause abort in GPU code
- Bazel Upcoming
 - Google Build Tool
 - Contributing to TensorFlow?
- Using TensorFlow in CGI
 - Upcoming in Example

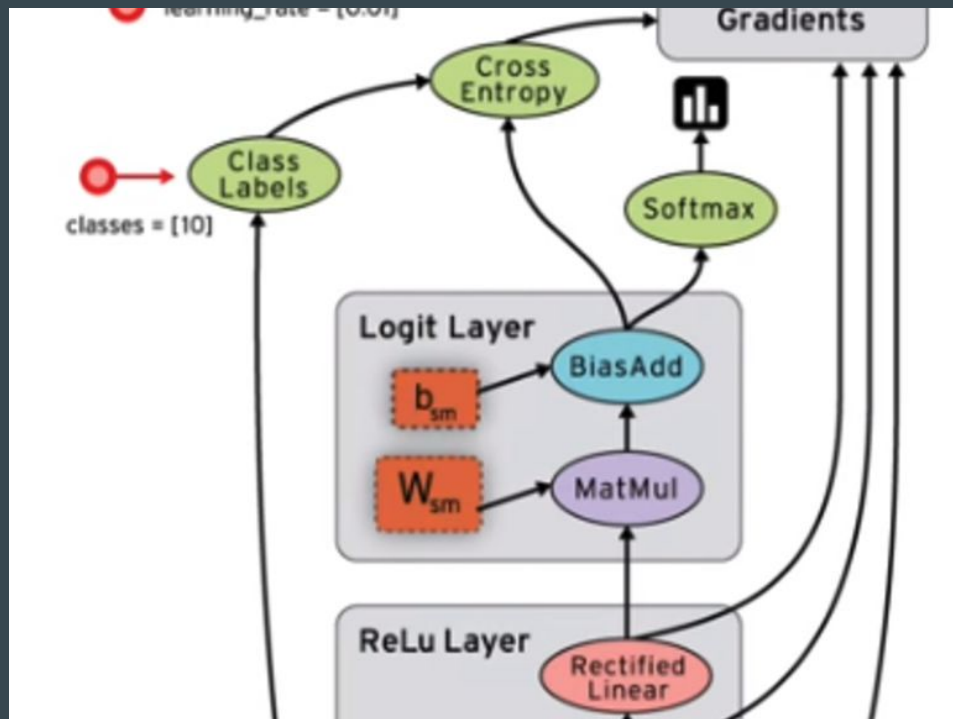
MINST Example

- Simple ML Program to demonstrate TensorFlow Usage
- Inputs are images of handwritten digits and labels identifying the images



Example Code Time!

Example:



Tour of Resources

- TensorFlow - TensorBoard
 - https://www.tensorflow.org/versions/0.6.0/how_tos/graph_viz/index.html
- TensorFlow Open Issues
 - <https://github.com/tensorflow/tensorflow/issues>

Questions?