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Chapter 1.
PYTORCH OVERVIEW

The NVIDIA Deep Learning SDK accelerates widely-used deep learning frameworks such as PyTorch.

PyTorch is a GPU accelerated tensor computational framework with a Python front end. Functionality can be easily extended with common Python libraries such as NumPy, SciPy and Cython. Automatic differentiation is done with a tape-based system at both a functional and neural network layer level. This functionality brings a high level of flexibility and speed as a deep learning framework and provides accelerated NumPy-like functionality.

PyTorch also includes standard defined neural network layers, deep learning optimizers, data loading utilities, and multi-gpu and multi-node support. Functions are executed immediately instead of enqueued in a static graph, improving ease of use and a sophisticated debugging experience.

This document describes the key features, software enhancements and improvements, any known issues, and how to run this container.
Before you can pull a container from the NGC container registry, you must have Docker
and nvidia-docker installed. For DGX users, this is explained in Preparing to use
NVIDIA Containers Getting Started Guide.

For users other than DGX, follow the NVIDIA® GPU Cloud™ (NGC) container registry
nvidia-docker installation documentation based on your platform.

You must also have access and be logged into the NGC container registry as explained in
the NGC Getting Started Guide.

There are four repositories where you can find the NGC docker containers.

nvcr.io/nvidia
   The deep learning framework containers are stored in the nvcr.io/nvidia
   repository.

nvcr.io/hpc
   The HPC containers are stored in the nvcr.io/hpc repository.

nvcr.io/nvidia-hpcvis
   The HPC visualization containers are stored in the nvcr.io/nvidia-hpcvis
   repository.

nvcr.io/partner
   The partner containers are stored in the nvcr.io/partner repository. Currently
   the partner containers are focused on Deep Learning or Machine Learning, but that
   doesn’t mean they are limited to those types of containers.
Before running the container, use the `docker pull` command to ensure an up-to-date image is installed. Once the pull is complete, you can run the container image. This is because nvidia-docker ensures that drivers that match the host are used and configured for the container. Without nvidia-docker, you are likely to get an error when trying to run the container.

1. Issue the command for the applicable release of the container that you want. The following command assumes you want to pull the latest container.

   ```bash
docker pull nvcr.io/nvidia/pytorch:19.01-py3
   ```

2. Open a command prompt and paste the pull command. The pulling of the container image begins. Ensure the pull completes successfully before proceeding to the next step.

3. Run the container image. To run the container, choose interactive mode or non-interactive mode.

   a) **Interactive mode:** Open a command prompt and issue:

   ```bash
   nvidia-docker run -it --rm -v local_dir:container_dir
   nvcr.io/nvidia/pytorch:<xx.xx>-py3
   ```

   b) **Non-interactive mode:** Open a command prompt and issue:

   ```bash
   nvidia-docker run --rm -v local_dir:container_dir
   nvcr.io/nvidia/pytorch:<xx.xx>-py3 <command>
   ```

   Where:
   - `-it` means interactive
   - `--rm` means delete the container when finished
   - `-v` means mount directory
   - `local_dir` is the directory or file from your host system (absolute path) that you want to access from inside your container. For example, the `local_dir` in the following path is `/home/jsmith/data/mnist`.

   ```bash
   -v /home/jsmith/data/mnist:/data/mnist
   ```
If you are inside the container, for example, `ls /data/mnist`, you will see the same files as if you issued the `ls /home/jsmith/data/mnist` command from outside the container.

- **container_dir** is the target directory when you are inside your container. For example, `/data/mnist` is the target directory in the example:

```
-v /home/jsmith/data/mnist:/data/mnist
```

- `<xx.xx>` is the container version. For example, `19.01`.
- `<command>` is the command you want to run in the image.

If you use multiprocessing for multi-threaded data loaders, the default shared memory segment size that the container runs with may not be enough. Therefore, you should increase the shared memory size by issuing either:

```
--ipc=host
```

or

```
--shm-size=<requested memory size>
```

in the command line to `nvidia-docker run`.

You might want to pull in data and model descriptions from locations outside the container for use by PyTorch or save results to locations outside the container. To accomplish this, the easiest method is to mount one or more host directories as Docker® data volumes.

You have pulled the latest files and run the container image.

4. See `/workspace/README.md` inside the container for information on customizing your PyTorch image.

For more information about PyTorch, including tutorials, documentation, and examples, see:

- PyTorch website
- PyTorch project
Chapter 4.
PYTORCH RELEASE 19.01

The NVIDIA container image for PyTorch, release 19.01, is available.

Contents of PyTorch
This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed in the pytorch-py3.6 Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 10.0.130 including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 10.0.130
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.4.2
- NCCL 2.3.7 (optimized for NVLink™)
- Caffe2
- TensorRT 5.0.2
- DALI 0.6 Beta
- Tensor Core Optimized Examples:
  - Neural Collaborative Filtering (NCF)
  - Transformer
  - ResNet50 v1.5
  - GNMT v2

Driver Requirements
Release 19.01 is based on CUDA 10, which requires NVIDIA Driver release 410.xx. However, if you are running on Tesla (Tesla V100, Tesla P4, Tesla P40, or Tesla P100), you may use NVIDIA driver release 384. For more information, see CUDA Compatibility and Upgrades.
GPU Requirements

Release 19.01 supports CUDA compute capability 6.0 and higher. This corresponds to GPUs in the Pascal, Volta, and Turing families. Specifically, for a list of GPUs that this compute capability corresponds to, see CUDA GPUs. For additional support details, see Deep Learning Frameworks Support Matrix.

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

‣ PyTorch container image version 19.01 is based on PyTorch v1.0.0 with up-to-date features.
‣ Latest version of DALI 0.6 Beta
‣ Latest version of NVIDIA cuDNN 7.4.2
‣ Added the Neural Collaborative Filtering (NCF) and Transformer Tensor Core examples.
‣ Ubuntu 16.04 with December 2018 updates

Tensor Core Examples

These examples focus on achieving the best performance and convergence from NVIDIA Volta Tensor Cores by using the latest deep learning example networks for training. This container includes the following Tensor Core examples.

‣ An implementation of the Neural Collaborative Filtering (NCF) model. The NCF model focuses on providing recommendations, also known as collaborative filtering; with implicit feedback. The training data for this model should contain binary information about whether a user interacted with a specific item. NCF was first described by Xiangnan He, Lizi Liao, Hanwang Zhang, Liqiang Nie, Xia Hu and Tat-Seng Chua in the Neural Collaborative Filtering paper.

‣ An implementation of the Transformer model architecture. The Transformer model is based on the optimized implementation in Facebook’s Fairseq NLP Toolkit and is built on top of PyTorch. The original version in the Fairseq project was developed using Tensor Cores, which provides significant training speedup. Our implementation improves the performance and is tested on a DGX-1V 16GB.

‣ An implementation of the ResNet50 model. The ResNet50 v1.5 model is a modified version of the original ResNet50 v1 model.

‣ An implementation of the GNMT v2 model. The GNMT v2 model is similar to the one discussed in the Google’s Neural Machine Translation System: Bridging the Gap between Human and Machine Translation paper.
**Known Issues**
Persistent batch normalization kernels have been disabled due to a known bug during validation. Batch normalization provides correct results and work as expected from users, however, this may cause up to 10% regression in time to solution performance on networks using batch normalization.
Chapter 5.
PYTORCH RELEASE 18.12

The NVIDIA container image for PyTorch, release 18.12, is available.

**Contents of PyTorch**

This container image contains the complete source of the version of PyTorch in `/opt/pytorch`. It is pre-built and installed in the `pytorch-py3.6` Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 10.0.130 including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 10.0.130
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.4.1
- NCCL 2.3.7 (optimized for NVLink™)
- Caffe2
- TensorRT 5.0.2
- DALI 0.5.0 Beta
- Tensor Core Optimized Examples:
  - ResNet50 v1.5
  - GNMT v2

**Driver Requirements**

Release 18.12 is based on CUDA 10, which requires NVIDIA Driver release 410.xx. However, if you are running on Tesla (Tesla V100, Tesla P4, Tesla P40, or Tesla P100), you may use NVIDIA driver release 384. For more information, see CUDA Compatibility and Upgrades.
GPU Requirements

Release 18.12 supports CUDA compute capability 6.0 and higher. This corresponds to GPUs in the Pascal, Volta, and Turing families. Specifically, for a list of GPUs that this compute capability corresponds to, see CUDA GPUs. For additional support details, see Deep Learning Frameworks Support Matrix.

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

‣ PyTorch container image version 18.12 is based on PyTorch v0.4.1+ with up-to-date features from the PyTorch v1.0 preview (master branch up to PR 12303). PyTorch 0.4.1+ is released and included with this container.
‣ Performance improvement for PyTorch's native batch normalization.
‣ Mixed precision SoftMax enabling FP16 inputs, FP32 computations and FP32 outputs.
‣ Latest version of DALI 0.5.0 Beta.
‣ Ubuntu 16.04 with November 2018 updates

Tensor Core Examples

‣ An implementation of ResNet50. The ResNet50 v1.5 model is a modified version of the original ResNet50 v1 model.
‣ An implementation of GNMT v2. The GNMT v2 model is similar to the one discussed in the Google’s Neural Machine Translation System: Bridging the Gap between Human and Machine Translation paper.

Known Issues

Persistent batch normalization kernels have been disabled due to a known bug during validation. Batch normalization provides correct results and work as expected from users, however, this may cause up to 10% regression in time to solution performance on networks using batch normalization.
The NVIDIA container image for PyTorch, release 18.12, is available.

**Contents of PyTorch**

This container image contains the complete source of the version of PyTorch in `/opt/pytorch`. It is pre-built and installed in the `pytorch-py3.6` Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 10.0.130 including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 10.0.130
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.4.1
- NCCL 2.3.7 (optimized for NVLink™)
- Caffe2
- TensorRT 5.0.2
- DALI 0.5.0 Beta
- Tensor Core Optimized Examples:
  - ResNet50 v1.5
  - GNMT v2

**Driver Requirements**

Release 18.12 is based on CUDA 10, which requires NVIDIA Driver release 410.xx. However, if you are running on Tesla (Tesla V100, Tesla P4, Tesla P40, or Tesla P100), you may use NVIDIA driver release 384. For more information, see CUDA Compatibility and Upgrades.
GPU Requirements
Release 18.12 supports CUDA compute capability 6.0 and higher. This corresponds to GPUs in the Pascal, Volta, and Turing families. Specifically, for a list of GPUs that this compute capability corresponds to, see CUDA GPUs. For additional support details, see Deep Learning Frameworks Support Matrix.

Key Features and Enhancements
This PyTorch release includes the following key features and enhancements.

‣ PyTorch container image version 18.12 is based on PyTorch v0.4.1+ with up-to-date features from the PyTorch v1.0 preview (master branch up to PR 12303). PyTorch 0.4.1+ is released and included with this container.
‣ Performance improvement for PyTorch’s native batch normalization.
‣ Mixed precision SoftMax enabling FP16 inputs, FP32 computations and FP32 outputs.
‣ Latest version of DALI 0.5.0 Beta.
‣ Ubuntu 16.04 with November 2018 updates

Tensor Core Examples
‣ An implementation of ResNet50. The ResNet50 v1.5 model is a modified version of the original ResNet50 v1 model.
‣ An implementation of GNMT v2. The GNMT v2 model is similar to the one discussed in the Google’s Neural Machine Translation System: Bridging the Gap between Human and Machine Translation paper.

Known Issues
Persistent batch normalization kernels have been disabled due to a known bug during validation. Batch normalization provides correct results and work as expected from users, however, this may cause up to 10% regression in time to solution performance on networks using batch normalization.
Chapter 7.
PYTORCH RELEASE 18.11

The NVIDIA container image for PyTorch, release 18.11, is available.

**Contents of PyTorch**

This container image contains the complete source of the version of PyTorch in `/opt/pytorch`. It is pre-built and installed in the `pytorch-py3.6` Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 10.0.130 including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 10.0.130
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.4.1
- NCCL 2.3.7 (optimized for NVLink™)
- Caffe2
- TensorRT 5.0.2
- DALI 0.4.1 Beta
- Tensor Core Optimized Examples:
  - ResNet50 v1.5
  - GNMT v2

**Driver Requirements**

Release 18.11 is based on CUDA 10, which requires NVIDIA Driver release 410.xx. However, if you are running on Tesla (Tesla V100, Tesla P4, Tesla P40, or Tesla P100), you may use NVIDIA driver release 384. For more information, see CUDA Compatibility and Upgrades.
Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

‣ PyTorch container image version 18.11 is based on PyTorch v0.4.1+ with up-to-date features from the PyTorch v1.0 preview (master branch up to PR \(11834\)). PyTorch 0.4.1+ is released and included with this container.

‣ Latest version of NCCL 2.3.7.

‣ Latest version of NVIDIA cuDNN 7.4.1.

‣ Latest version of TensorRT 5.0.2

‣ Latest version of DALI 0.4.1 Beta.

‣ Ubuntu 16.04 with October 2018 updates

Tensor Core Examples

‣ An implementation of ResNet50. The \texttt{ResNet50 v1.5 model} is a modified version of the \texttt{original ResNet50 v1 model}.

‣ An implementation of GNMT v2. The \texttt{GNMT v2 model} is similar to the one discussed in the \texttt{Google's Neural Machine Translation System: Bridging the Gap between Human and Machine Translation paper}.

Known Issues

There is a known bug when using persistent batch normalization kernels. If you are experiencing a drop in predictive power during testing and validation, the recommended workaround is to not add the \texttt{.eval()} flag on your model when doing testing or validation.
Chapter 8.
PYTORCH RELEASE 18.10

The NVIDIA container image of PyTorch, release 18.10, is available.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in `/opt/pytorch`. It is pre-built and installed in the `pytorch-py3.6 Conda`™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 10.0.130 including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 10.0.130
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.4.0
- NCCL 2.3.6 (optimized for NVLink™)
- Caffe2
- TensorRT 5.0.0 RC
- DALI 0.4 Beta
- Tensor Core Optimized Examples:
  - ResNet50 v1.5
  - GNMT v2

Driver Requirements

Release 18.10 is based on CUDA 10, which requires NVIDIA Driver release 410.xx. However, if you are running on Tesla (Tesla V100, Tesla P4, Tesla P40, or Tesla P100), you may use NVIDIA driver release 384. For more information, see CUDA Compatibility and Upgrades.
Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- **PyTorch** container image version 18.10 is based on PyTorch v0.4.1+ with up-to-date features from the PyTorch v1.0 preview (master branch up to PR 11834). PyTorch 0.4.1+ is released and included with this container.
- When possible PyTorch will now automatically use cuDNN persistent RNN’s providing improved speed for smaller RNN’s.
- Improved multi-GPU performance in both PyTorch c10d and Apex’s DDP.
- Faster weight norm with improved mixed-precision accuracy used through `torch.nn.utils.weight_norm`.
- Improved functionality of the `torch.jit.script` and `torch.jit.trace` preview features including better support for pointwise operations in fusion.
- Added support for a C++ only API (new PyTorch 1.0 preview feature).
- Dataloader may still throw a benign error when stopping iterations early, however, it is no longer preventing the process from ending.
- Latest version of DALI 0.4 Beta.
- Latest version of NCCL 2.3.6.
- Ubuntu 16.04 with September 2018 updates

Tensor Core Examples

- An implementation of ResNet50. The ResNet50 v1.5 model is a modified version of the original ResNet50 v1 model.
- An implementation of GNMT v2. The GNMT v2 model is similar to the one discussed in the Google’s Neural Machine Translation System: Bridging the Gap between Human and Machine Translation paper.

Known Issues

There are no new issues in this release.
Chapter 9.
PYTORCH RELEASE 18.09

The NVIDIA container image of PyTorch, release 18.09, is available.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed in the pytorch-py3.6 Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 10.0.130 including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 10.0.130
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.3.0
- NCCL 2.3.4 (optimized for NVLink™)
- Caffe2
- TensorRT 5.0.0 RC
- DALI 0.2 Beta
- Tensor Core Optimized Examples:
  - ResNet50 v1.5
  - GNMT v2

Driver Requirements

Release 18.09 is based on CUDA 10, which requires NVIDIA Driver release 410.xx. However, if you are running on Tesla (Tesla V100, Tesla P4, Tesla P40, or Tesla P100), you may use NVIDIA driver release 384. For more information, see CUDA Compatibility and Upgrades.
Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- PyTorch container image version 18.09 is based on PyTorch 0.4.1+. PyTorch 0.4.1 is released and included with this container.
- Latest version of cuDNN 7.3.0.
- Latest version of CUDA 10.0.130 which includes support for DGX-2, Turing, and Jetson Xavier.
- Latest version of cuBLAS 10.0.130.
- Latest version of NCCL 2.3.4.
- Latest version of TensorRT 5.0.0 RC.

All 18.09 containers inherit TensorRT 5.0.0 RC from the base container, however, some containers may not use TensorRT if there is no support for TensorRT in the given framework.

- An implementation of ResNet50. The ResNet50 v1.5 model is a modified version of the original ResNet50 v1 model.
- Stream pool: PyTorch now uses per GPU stream pools behind the scenes. This means that CUDA streams are created when first used on a GPU and destroyed on exit. As a result, networks that use multiple streams may see the same stream used repeatedly in their profiles, and networks that retain streams for long periods may accidentally schedule parallelizable work to the same stream. It’s recommended that streams be acquired, used, and released as needed.
- Reliability: Some cases where a dataloader could hang if shutdown during its iteration has been fixed.
- Fusion: Tensor and constant scalar operations, like \( \text{add}(t, 1) \), and chunk operations are now fusible.
- Performance improvements: dropout, 1x1 convolutions for NCHW, and weightnorm should be faster in a majority of scenarios.
- Latest version of DALI 0.2 Beta
- Ubuntu 16.04 with August 2018 updates

Tensor Core Examples

- An implementation of ResNet50. The ResNet50 v1.5 model is a modified version of the original ResNet50 v1 model.
- An implementation of GNMT v2. The GNMT v2 model is similar to the one discussed in the Google’s Neural Machine Translation System: Bridging the Gap between Human and Machine Translation paper.
Known Issues

- The DALI integrated ResNet-50 samples in the 18.09 NGC TensorFlow and PyTorch containers may result in lower than expected performance results. We are working to address the issue in the next release.

- There is a chance that PyTorch will hang on exit when running multi-gpu training. This hang does not affect any results of the run; however, the process will have to be terminated manually.
Chapter 10. 
PYTORCH RELEASE 18.08

The NVIDIA container image of PyTorch, release 18.08, is available.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed in the pytorch-py3.6 Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 9.0.176 (see Errata section and 2.1) including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 9.0.425
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.2.1
- NCCL 2.2.13 (optimized for NVLink™)
- Caffe2 0.8.1
- DALI 0.1.2 Beta
- Tensor Core Optimized Examples:
  - GNMT v2

Driver Requirements

Release 18.08 is based on CUDA 9, which requires NVIDIA Driver release 384.xx.

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- PyTorch container image version 18.08 is based on PyTorch 0.4.1. PyTorch 0.4.1 is released and included with this container. See the release notes at https://github.com/pytorch/pytorch/releases for significant changes from PyTorch 0.4.
Apex is now entirely Python for improved compatibility. Previous versions of Apex will not work with PyTorch 0.4.1 or newer versions.

New ops in 18.08: `torch.pinverse`, `torch.unique`, `torch.erfc`, `torch.isinf`, `torch.isfinite`, `torch.reshape_as`.

Support for cross-device gradient clipping.

torch.svd and torch.eig in CUDA have been fixed, previously they could return incorrect results.

An implementation of GNMT v2. The GNMT v2 model is similar to the one discussed in the Google's Neural Machine Translation System: Bridging the Gap between Human and Machine Translation paper.

Latest version of cuDNN 7.2.1.

Latest version of DALI 0.1.2 Beta.

Added support for the Tensor Core Optimized Example: PyTorch GNMT model

Ubuntu 16.04 with July 2018 updates

Usage
The PYTHONPATH environment variable in this container version has been updated to include all packages installed in the Conda environment and all PyTorch related packages. Users that rely on PYTHONPATH to point to local modules are advised to carefully check and set their PYTHONPATH variable in this container and moving forward.

Tensor Core Examples
An implementation of GNMT v2. The GNMT v2 model is similar to the one discussed in the Google's Neural Machine Translation System: Bridging the Gap between Human and Machine Translation paper.

Known Issues
The DALI integrated ResNet-50 samples in the 18.08 NGC TensorFlow and PyTorch containers may result in lower than expected performance results. We are working to address the issue in the next release.
The NVIDIA container image of PyTorch, release 18.07, is available.

**Contents of PyTorch**

This container image contains the complete source of the version of PyTorch in `/opt/pytorch`. It is pre-built and installed in the `pytorch-py3.6` Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 9.0.176 (see Errata section and 2.1) including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 9.0.425
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.1.4
- NCCL 2.2.13 (optimized for NVLink™)
- Caffe2 0.8.1
- DALI 0.1 Beta

**Driver Requirements**

Release 18.07 is based on CUDA 9, which requires NVIDIA Driver release 384.xx.

**Key Features and Enhancements**

This PyTorch release includes the following key features and enhancements.

- PyTorch container image version 18.07 is based on PyTorch 0.4.0 upstream master branch post commit cca2476.
- Clip grads can be used on a single tensor directly.
- The precision of MSELoss with half inputs has been improved.
- PyTorch's JIT (still in Alpha) now supports FP16 inputs and outputs, comparisons, the exp operator, and ReLU gates.
- Added support for DALI 0.1 Beta.
- Latest version of CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 9.0.425.
- Ubuntu 16.04 with June 2018 updates

**Known Issues**

When importing Caffe2 after importing Torch, there is an issue which causes GPU support for Caffe2 to be disabled. For users affected by this bug, it is recommended to either use the PyTorch 18.06 or 18.08 container.
Chapter 12.
PYTORCH RELEASE 18.06

The NVIDIA container image of PyTorch, release 18.06, is available.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed in the pytorch-py3.6 Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 9.0.176 (see Errata section and 2.1) including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 9.0.333 (see section 2.3.1)
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.1.4
- NCCL 2.2.13 (optimized for NVLink™)
- Caffe2 0.8.1

Driver Requirements

Release 18.06 is based on CUDA 9, which requires NVIDIA Driver release 384.xx.

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- PyTorch container image version 18.06 is based on PyTorch 0.4.0 upstream master branch post commit 0e9613c.
- Improved data loader pipeline in the ImageNet example, see /opt/pytorch/examples/imagenet within the container.
- Data loader pipeline now uses pillow-simd and jpeg-turbo.
- Improved FP16 support, specifically, reductions like sum() are now more accurate when using FP16.
- Improved distributed performance, specifically, gradient communication can now overlap with gradient computation in `backwards()`.
- Compatibility changes, specifically, Magma 1 is no longer supported.
- Ubuntu 16.04 with May 2018 updates

**Known Issues**

There are no known issues in this release.
The NVIDIA container image of PyTorch, release 18.05, is available.

**Contents of PyTorch**

This container image contains the complete source of the version of PyTorch in `/opt/pytorch`. It is pre-built and installed in the `pytorch-py3.6` Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 9.0.176 (see Errata section and 2.1) including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 9.0.333 (see section 2.3.1)
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.1.2
- NCCL 2.1.15 (optimized for NVLink™)
- Caffe2 0.8.1

**Driver Requirements**

Release 18.05 is based on CUDA 9, which requires NVIDIA Driver release 384.xx.

**Key Features and Enhancements**

This PyTorch release includes the following key features and enhancements.

- PyTorch container image version 18.05 is based on PyTorch 0.4.0.
- Includes Caffe2 0.8.1. For more information, see PyTorch and Caffe2 repos getting closer together.
- APEX, an extension providing utilities for FP16 and multi-gpu training. For more information, see APEX: A PyTorch Extension and APEX.
- Ubuntu 16.04 with April 2018 updates
Known Issues

- Some mixed-precision models might encounter a crash due to a new FP16 overflow check added in PyTorch. We have an upstream fix submitted with PR 7382 and should be resolved in a future container.

- There is a minor performance regression with the imagenet sample in `/opt/pytorch/examples/imagenet` for some network architectures on multi-gpu cases. This regression will be fixed in the next release.
Chapter 14.
PYTORCH RELEASE 18.04

The NVIDIA container image of PyTorch, release 18.04, is available.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in `/opt/pytorch`. It is pre-built and installed in the `pytorch-py3.6` Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 9.0.176 (see Errata section and 2.1) including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 9.0.333 (see section 2.3.1)
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.1.1
- NCCL 2.1.15 (optimized for NVLink™)

Driver Requirements

Release 18.04 is based on CUDA 9, which requires NVIDIA Driver release 384.xx.

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- PyTorch container image version 18.04 is based on PyTorch 0.3.1.
- Incorporated all upstream changes from the PyTorch master branch, specifically up to and including commit 2f27c1b5.
- Latest version of NCCL 2.1.15
- Ubuntu 16.04 with March 2018 updates
Known Issues

Some mixed-precision models might encounter a crash due to a new FP16 overflow check added in PyTorch. We have an upstream fix submitted with PR 7382 and should be resolved in a future container.
Chapter 15.
PYTORCH RELEASE 18.03

The NVIDIA container image of PyTorch, release 18.03, is available.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed in the pytorch-py3.6 Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 9.0.176 (see Errata section and 2.1) including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 9.0.333 (see section 2.3.1)
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.1.1
- NCCL 2.1.2 (optimized for NVLink™)

Driver Requirements

Release 18.03 is based on CUDA 9, which requires NVIDIA Driver release 384.xx.

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- PyTorch container image version 18.03 is based on PyTorch 0.3.0.
- Incorporated all upstream changes from the PyTorch master branch, specifically, PR 5327.
- Latest version of cuBLAS 9.0.333
- Latest version of cuDNN 7.1.1
- Ubuntu 16.04 with February 2018 updates
Known Issues

There are no known issues in this release.
Chapter 16.
PYTORCH RELEASE 18.02

The NVIDIA container image of PyTorch, release 18.02, is available. PyTorch container image version 18.02 is based on PyTorch 0.3.0.

Contents of PyTorch
This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed in the pytorch-py3.6 Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 9.0.176 including:
  - CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 9.0.282 Patch 2 which is installed by default
  - cuBLAS 9.0.234 Patch 1 as a debian file. Installing Patch 1 by issuing the dpkg -i /opt/cuda-cublas-9-0_9.0.234-1_amd64.deb command is the workaround for the known issue described below.
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.0.5
- NCCL 2.1.2 (optimized for NVLink™)

Driver Requirements
Release 18.02 is based on CUDA 9, which requires NVIDIA Driver release 384.xx.

Key Features and Enhancements
This PyTorch release includes the following key features and enhancements.

- Improved multi-GPU performance on image networks shown in /opt/pytorch/examples/imagenet. You can run this example for multi-GPU by issuing the python -m multiproc main.py command.
Latest version of cuBLAS
- Ubuntu 16.04 with January 2018 updates

Known Issues

cuBLAS 9.0.282 regresses RNN seq2seq FP16 performance for a small subset of input sizes. This issue should be fixed in the next update. As a workaround, install cuBLAS 9.0.234 Patch 1 by issuing the `dpkg -i /opt/cuda-cublas-9-0_9.0.234-1_amd64.deb` command.
Chapter 17.
PYTORCH RELEASE 18.01

The NVIDIA container image of PyTorch, release 18.01, is available.
PyTorch container image version 18.01 is based on PyTorch 0.3.0.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed in the `pytorch-py3.6` Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04 including Python 3.6 environment
- NVIDIA CUDA 9.0.176 including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 9.0.282
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.0.5
- NCCL 2.1.2 (optimized for NVLink™)

Driver Requirements

Release 18.01 is based on CUDA 9, which requires NVIDIA Driver release 384.xx.

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- Latest version of cuBLAS
- Latest version of cuDNN
- Latest version of NCCL
- Ubuntu 16.04 with December 2017 updates
Known Issues

cuBLAS 9.0.282 regresses RNN seq2seq FP16 performance for a small subset of input sizes. As a workaround, revert back to the 11.12 container.
Chapter 18.
PYTORCH RELEASE 17.12

The NVIDIA container image of PyTorch, release 17.12, is available. PyTorch container image version 17.12 is based on PyTorch 0.2.0.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed in the pytorch-py35 Conda™ environment in the container image. The container also includes the following:

- Ubuntu 16.04
- NVIDIA CUDA 9.0.176 including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 9.0.234
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.0.5
- NCCL 2.1.2 (optimized for NVLink™)

Driver Requirements

Release 17.12 is based on CUDA 9, which requires NVIDIA Driver release 384.xx.

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- Latest version of CUDA
- Latest version of cuDNN
- Latest version of NCCL
- Ubuntu 16.04 with November 2017 updates

Known Issues

There are no known issues in this release.
Chapter 19.
PYTORCH RELEASE 17.11

The NVIDIA container image of PyTorch, release 17.11, is available.

PyTorch container image version 17.11 is based on PyTorch 0.2.0.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed in the pytorch-py35 Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04
- NVIDIA CUDA 9.0.176 including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) 9.0.234
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.0.4
- NCCL 2.1.2 (optimized for NVLink™)

Driver Requirements

Release 17.11 is based on CUDA 9, which requires NVIDIA Driver release 384.xx.

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- Tensor Op accelerated RNNs for Volta architecture
- Improved depthwise separable convolution performance
- Improved automatic differentiation engine latency
- Latest version of CUDA
- Latest version of cuDNN
- Latest version of NCCL
- Ubuntu 16.04 with October 2017 updates
Known Issues

There are no known issues in this release.
Chapter 20.  
PYTORCH RELEASE 17.10

The NVIDIA container image of PyTorch, release 17.10, is available. PyTorch container image version 17.10 is based on PyTorch 0.2.0.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed in the `pytorch-py35` Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04
- NVIDIA CUDA® 9.0
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.0.3
- NVIDIA® Collective Communications Library™ (NCCL) 2.0.5 (optimized for NVLink™)

Driver Requirements

Release 17.10 is based on CUDA 9, which requires NVIDIA Driver release 384.xx.

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- Latest version of CUDA
- Latest version of cuDNN
- Latest version of NCCL
- Ubuntu 16.04 with September 2017 updates

Known Issues

There are no known issues in this release.
Chapter 21.
PYTORCH RELEASE 17.09

The NVIDIA container image of PyTorch, release 17.09, is available. PyTorch container image version 17.09 is based on PyTorch 0.2.0.

**Contents of PyTorch**

This container image contains the complete source of the version of PyTorch in `/opt/pytorch`. It is pre-built and installed in the `pytorch-py35` Conda™ environment in the container image.

The container also includes the following:

- Ubuntu 16.04
- NVIDIA CUDA® 9.0
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 7.0.2
- NVIDIA® Collective Communications Library™ (NCCL) 2.0.5 (optimized for NVLink™)

**Driver Requirements**

Release 17.09 is based on CUDA 9, which requires NVIDIA Driver release 384.xx.

**Key Features and Enhancements**

This PyTorch release includes the following key features and enhancements.

- Supports Tensor Core operations for convolutions and GEMMs on Volta hardware
- The `examples` directory contains examples of ImageNet and LSTM training scripts that use FP16 data, as well as show how to train with FP16
- Matrix multiplication on FP16 inputs uses Tensor Core math when available
- A custom batch normalization layer is implemented to use cuDNN for batch normalization with FP16 inputs
- Latest version of CUDA
- Latest version of cuDNN with support for Tensor Core math when available
- Latest version of NCCL
- Ubuntu 16.04 with August 2017 updates

**Known Issues**

There are no known issues in this release.
Chapter 22.
PYTORCH RELEASE 17.07

The NVIDIA container image of PyTorch, release 17.07, is available.
PyTorch container image version 17.07 is based on PyTorch 0.1.12.

Contents of PyTorch
This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed into the /usr/local/[bin,share,lib] directories in the container image.
The container also includes the following:

- Ubuntu 16.04
- NVIDIA CUDA® 8.0.61.2 including CUDA® Basic Linear Algebra Subroutines library™ (cuBLAS) Patch 2
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 6.0.21
- NVIDIA® Collective Communications Library™ (NCCL) 2.0.3 (optimized for NVLink™)

Key Features and Enhancements
This PyTorch release includes the following key features and enhancements.

- Support for advanced tensor indexing
- Support multi-node or multi-process mode on the same node
- Support for double backward for most functions, including convolution
- Ubuntu 16.04 with June 2017 updates

Known Issues
There are no known issues in this release.
Chapter 23. PYTORCH RELEASE 17.06

The NVIDIA container image of PyTorch, release 17.06, is available. PyTorch container image version 17.06 is based on PyTorch 0.1.12.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed into the /usr/local/[bin,share,lib] directories in the container image.

The container also includes the following:

- Ubuntu 16.04
- NVIDIA CUDA® 8.0.61
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 6.0.21
- NVIDIA® Collective Communications Library™ (NCCL) 1.6.1 (optimized for NVLink™)

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- Ubuntu 16.04 with May 2017 updates

Known Issues

The NCCL library version 1.6.1 included in this image, modifies the output buffers on all GPUs during in-place ncclReduce() operations, whereas normally only the "root" (target) device's output buffer should be modified. This is fixed in later versions of NCCL, as will be packaged in later versions of this image. As a workaround, either use ncclAllReduce(), which correctly modifies output buffers of all GPUs to the same values, or use out-of-place ncclReduce(), wherein the output buffer is distinct from the input buffer.
Chapter 24.
PYTORCH RELEASE 17.05

The NVIDIA container image of PyTorch, release 17.05, is available. PyTorch container image version 17.05 is based on PyTorch 0.1.12.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed into the /usr/local/[bin,share,lib] directories in the container image.

The container also includes the following:

- Ubuntu 16.04
- NVIDIA CUDA® 8.0.61
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 6.0.21
- NVIDIA® Collective Communications Library™ (NCCL) 1.6.1 (optimized for NVLink™)

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- Latest cuDNN release
- Ubuntu 16.04 with April 2017 updates

Known Issues

The NCCL library version 1.6.1 included in this image, modifies the output buffers on all GPUs during in-place ncclReduce() operations, whereas normally only the "root" (target) device's output buffer should be modified. This is fixed in later versions of NCCL, as will be packaged in later versions of this image. As a workaround, either use ncclAllReduce(), which correctly modifies output buffers of all GPUs to the same
values, or use out-of-place `ncclReduce()`, wherein the output buffer is distinct from the input buffer.
Chapter 25.
PYTORCH RELEASE 17.04

The NVIDIA container image of PyTorch, release 17.04, is available.
PyTorch container image version 17.04 is based on PyTorch 0.1.10.

Contents of PyTorch

This container image contains the complete source of the version of PyTorch in /opt/pytorch. It is pre-built and installed into the /usr/local/[bin,share,lib] directories in the container image.

The container also includes the following:

- Ubuntu 16.04
- NVIDIA CUDA® 8.0.61
- NVIDIA CUDA® Deep Neural Network library™ (cuDNN) 6.0.20
- NVIDIA® Collective Communications Library™ (NCCL) 1.6.1 (optimized for NVLink™)

Key Features and Enhancements

This PyTorch release includes the following key features and enhancements.

- Reduce DataParallel overhead on more than 4 GPUs
- cuDNN v6 integration
- Synced to upstream PyTorch version as of March 2017
- Ubuntu 16.04 with March 2017 updates

Known Issues

There are no known issues in this release.
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