NVIDIA DIGITS Container

User Guide

DU-09194-001 _v1.0 | September 2021

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Chapter 1. Overview

The Deep Learning GPU Training System™ (DIGITS) puts the power of deep learning into the hands of engineers and data scientists.

DIGITS is not a framework. DIGITS is a wrapper for TensorFlow™ ; which provides a graphical web interface to those frameworks rather than dealing with them directly on the command-line.

DIGITS can be used to rapidly train highly accurate deep neural network (DNNs) for image classification, segmentation, object detection tasks, and more. DIGITS simplifies common deep learning tasks such as managing data, designing and training neural networks on multi-GPU systems, monitoring performance in real time with advanced visualizations, and selecting the best performing model from the results browser for deployment. DIGITS is completely interactive so that data scientists can focus on designing and training networks rather than programming and debugging.

Chapter 2. Creating A Dataset Using Data From An S3 Endpoint

DIGITS can be trained on data that is stored on an S3 endpoint. This can be useful for cases in which data has been stored on a different node and you do not want to manually migrate the data over to the node running DIGITS.

1. Load the data into S3. As an example, we will use the following dataset:

   ```
   python -m digits.download_data mnist ~/mnist
   ```

   There is a python script called `upload_s3_data.py` which is provided and can be used to upload these files into a configured S3 endpoint. This script and its accompanying configuration file called `upload_config.cfg` is located in the `digits/digits/tools` directory.

   ```
   [S3 Config]
   endpoint = http://your-s3-endpoint.com:80
   accesskey = 0123456789abcde
   secretkey = PrIclctP80KrMi6+UPO9ZYNrkg6ByFeFRR6484qL
   bucket = digits
   prefix = mnist
   ```

   Where:

   - `endpoint` - Specifies the URL of the endpoint where the S3 data will be stored.
   - `accesskey` - The access key which will be used to authenticate your access to the endpoint.
   - `secretkey` - The secret key which will be used to authenticate your access to the endpoint.
   - `bucket` - The name of the bucket where this data should be stored. If it does not exist, it will be created by the script.
   - `prefix` - The prefix which will be prepended to all of the key names. This will be used later during the creation of the dataset.
2. After the file is configured, run it using:`python upload_s3_data.py ~/mnist`

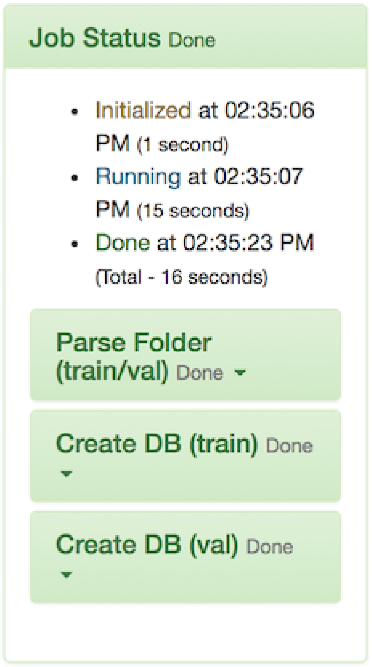
   Note: The time it takes to complete the upload process depends on your network speed and the computing resources of the S3 endpoint.

After the upload is complete, all of the keys from the dataset will be uploaded into S3 with the appropriate prefix structure to be used during dataset creation later. For example, in the above configuration, the files would be located in the bucket `digits` and prefixed with `mnist/train/<0-9>`.

3. Create a dataset within DIGITS.
   a). On the main screen, click **Images > Classification**.
   b). Click the **Use S3** tab to specify that you want the data to be accessed from an S3 endpoint.

   Note: The **Training Images** URL and **Bucket Name** fields may be filled out from the upload configuration fields **endpoint** and **bucket**, respectively. The **Training Images Path** consists of the prefix specified during the upload appended by `train/`. For our example, it would be `mnist/train/`. The access key and secret key are the credentials which will be used to access the data from the S3 endpoint.

   Similar to any other dataset, the properties including database backend, image encoding, group name, and dataset name may be specified towards the bottom of the screen. When the dataset has been configured the way you want, click **Create**.
   c). If the job processes correctly, then you have successfully created a dataset from data stored in an S3 endpoint. You will see an image similar to the following:


Job Status Done

- Initialized at 02:35:06 PM (1 second)
- Running at 02:35:07 PM (15 seconds)
- Done at 02:35:23 PM (Total - 16 seconds)

Parse Folder (train/val) Done

Create DB (train) Done

Create DB (val) Done

You can now proceed to use this dataset to train your model.

Chapter 3. Writing a DIGITS Plugin

This is a tutorial for writing a DIGITS plugin. This section walks you through the process of adding your own plugin. DIGITS supports ingesting data from a limited number of data sources (list of supported image file formats).

DIGITS data plugins enable a mechanism by which you can extend DIGITS to ingest data from custom sources.

Likewise, DIGITS offers a number of model output visualization types such as Image Classification, Object Detection or Image Segmentation. DIGITS visualization plugins make it possible to visualize the output of non-standard models.

3.1. Reading Data from DICOM Files

In this example, we will implement a data plugin for image segmentation that reads images from DICOM files and their ground-truth from text files. This plugin has already been featured in the medical imaging example. This plugin is referred to as the *Sunnybrook* plug-in, from the name of the corresponding dataset. The full code is available here.

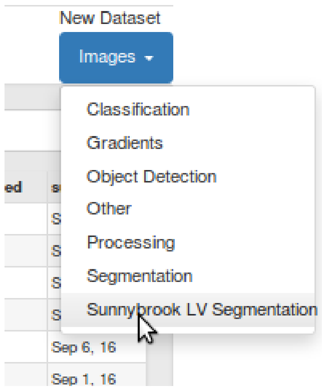
DIGITS may use a data plugin in the following situations:

- when creating a new dataset, in order to create a database
- when performing inference, in order to feed data to a model

Note:

Most of the concepts we need to understand to create a data plugin also apply to writing visualization plugins.

Upon installation of the plugin, DIGITS begins to show a corresponding menu on the main page. For example:



Optionally, if your data module has indicated that it can also ingest data during inference, you will see a **Visualization Options** menu on the model page.

3.1.1. Data plugin file tree

Below is an example file tree for a data plugin:

```
sunnybook/
├── digitsDataPluginSunnybrook/
│   ├── templates
│   │   ├── dataset_template.html
│   │   └── inference_template.html
│   ├── __init__.py
│   ├── data.py
│   └── forms.py
├── MANIFEST.in
└── setup.py
```

In the following sections, each of the important files are defined which need to be created in order to write a plugin.

3.1.1.1. setup.py

The `setup.py` file specifies how to install the plugin. The main section of interest here is the invocation of the `setup` command from `setuptools` package:

```
setup(
    name="digits_sunnybrook_data_plugin",
    version="0.0.1",
    author="Greg Heinrich",
    description=("A data ingestion plugin for the Sunnybrook cardiac dataset"),
    long_description=read('README'),
    license="Apache",
    packages=find_packages(),
    entry_points={
        DIGITS_PLUGIN_GROUP: [
        'class=digitsDataPluginSunnybrook:DataIngestion',
        ]},
    include_package_data=True,
    install_requires=['pydicom'],
)
```

Upon installation, the Python package will export entry points (`entry_points`). The sample code is assigning the `DataIngestionclass` from the `digitsDataPluginSunnybrook` package to the `DIGITS_PLUGIN_GROUP` entry point group. This will make it possible for DIGITS to discover installed plugins on startup.

In the `install_requires` argument we specify the list of Python package dependencies for this plugin. In this case, the plugin requires the `pydicom` package.

3.1.1.2. MANIFEST.in

The `MANIFEST.in` file specifies the resource files to include in the plugin package. In this sample, we are recursively including all `.html` files within the `digitsDataPluginSunnybrook` folder. If you are writing your own plugin, ensure these files are located inside the package folder.

```
recursive-include digitsDataPluginSunnybrook *.html
```

3.1.1.3. init.py

The `digitsDataPluginSunnybrook/init.py` file indicates that the `digitsDataPluginSunnybrook` folder is a Python package. In most cases, the digitsDataPluginSunnybrook folder can be left empty. In our case, because we are creating a shortcut to the `DataIngestion` member of `data.py` file, we can refer to it as `digitsDataPluginSunnybrook:DataIngestion` in the `setup.py` file.

3.1.1.4. data.py

The `digitsDataPluginSunnybrook/data.py` file implements a `DataIngestion` class, which implements a DIGITS data extension database (https://github.com/NVIDIA/DIGITS/blob/digits-5.0/digits/extensions/data/interface.py). Ensure you review the interface API and its docstrings.

The `DataIngestion` class is the only interface between DIGITS and the Sunnybrook plugin. Familiarize yourself with the interface for details about the required methods to implement in this class. The most important ones are:

- `get_dataset_form` – This is a static method that returns a form (a child of `flask.ext.wtf.Form`) which contains all the fields required to create a dataset. For example, a form may include text fields to allow users to specify file names or various dataset options.
- `get_dataset_template` – This is a static method that returns a Jinja template for the form to display in the DIGITS web user interface; this method also returns a dictionary of context variables that should include all the variables that are referenced in the Jinja template. For example, the Sunnybrook plugin provides the form as context because the Jinja template references this variable to render the form into the web user interface.

- `get_inference_form` – This is similar to `get_dataset_form` but this is used when showing data ingestion options during inference.

  Note: This method may return `None` to indicate that your data plugin cannot be operated during inference. In this case, it is expected that the regular image inference option in DIGITS will work for the model you are training.

- `get_inference_template` – This is similar to `get_dataset_template` but this is used during inference.
- `__init__` – This is the initialization routine used to create an instance of the class. During initialization this is provided with two parameters. The first parameter is named `is_inference_db` and indicates whether this instance is going to be used during inference. The second parameter is a dictionary that contains all the form fields that were specified by the user either during the dataset creation or when specifying data options for inference.
- `itemize_entries` – This method parses form fields in order to generate a list of data sample identifiers. For example, if your data plugin needs to encode all the files in a directory, then the itemized entries could be a list of all the filenames.
- `encode_entry` – This method is the core of the data plugin. It reads data associated with one of the identifiers returned in `itemize_entries` and converts the data into a 3-dimensional NumPy array. This function also returns a label, which may be either a scalar or another 3-dimensional NumPy array. Note: The process of reading an image in a DICOM file is relatively straightforward:

```
f = dicom.read_file(full_path)
img = f.pixel_array.astype(np.int)
```

3.1.1.5. form.py

The `digitsDataPluginSunnybrook/form.py` file is where we define:

- the `DatasetForm` class to use to specify a dataset
- optionally, the `InferenceForm` class to specify inference data

In the Sunnybrook example, instances of these classes are created and returned in `DataIngestion:get_dataset_form` and `DataIngestion:get_inference_form`, respectively. These classes are children of `flask.ext.wtf.Form`. For more information, see WTForms doc .

3.1.1.6. dataset_template.py

The `digitsDataPluginSunnybrook/templates/dataset_template.py` file is a Jinja template that defines what you will see in the Web user interface. For more information, see Jinja doc .

Note: The Sunnybrook template references the form variable which was given as context in `DataIngestion:get_dataset_template`. For example:

```
{{ form.image_folder.label }}
```

3.1.1.7. inference_template.py

The `digitsDataPluginSunnybrook/templates/inference_template.py` file is the Jinja template to show inference data options.

3.1.2. Installing the Plugin

In order to install the plugin, you need to run the following command from the directory that includes your data plugin `setup.py` file.

```
$ pip install
```

Next, restart DIGITS for the changes to take effect.

Your plugin is installed.

3.2. Visualization Plugin

Visualization plugins work in a similar way as data plugins. The main difference is that visualization plugins implement the view interface. Refer to the inline docstrings in this file for more information on usage.

Chapter 4. Support

For the latest Release Notes, see the DIGITS Release Notes Documentation website: (http://docs.nvidia.com/deeplearning/digits/digits-release-notes/index.html).

For more information about DIGITS, see:

- DIGITS website (https://developer.nvidia.com/digits)
- DIGITS project (https://github.com/NVIDIA/DIGITS/blob/digits-5.0/README.md)
- GitHub documentation (https://github.com/NVIDIA/nvidia-docker/wiki/DIGITS)

Note: There may be slight variations between the NVIDIA-docker images and this image.

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