NVIDIA DIGITS

Tutorial

DU-08732-001_v5.0 | September 2021

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Chapter 1. Overview Of DIGITS

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. Writing A DIGITS Plugin

DIGITS supports ingesting data from a limited number of data sources (list of supported image file formats).

DIGITS data plug-ins 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 plug-ins make it possible to visualize the output of non-standard models.

This section walks you through the process of adding your own plugin.

2.1. 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* plugin, from the name of the corresponding dataset. The full code is available here.

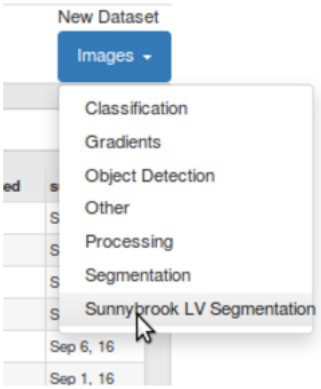
DIGITS may use a data plugin in the following situations:

- 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:

Figure 1. DIGITS main page



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.

2.1.1. 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.

2.1.1.1. `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.

2.1.1.2. 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
```

2.1.1.3. 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.

2.1.1.4. data.py

The `digitsDataPluginSunnybrook/data.py` file implements a `DataIngestion` class, which implements a DIGITS data extension database (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)
```

2.1.1.5. form.py

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

- the `DatasetForm` class to use to specify a dataset, and
- 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.

2.1.1.6. 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 }}
```

2.1.1.7. `inference_template.py`

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

2.1.2. 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.

2.2. 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 3. Troubleshooting

3.1. Support

For the latest Release Notes, see the DIGITS Release Notes Documentation website.

For more information about DIGITS, see:

- DIGITS website
- DIGITS 6.0 project
- GitHub documentation

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

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