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Chapter 1.
OVERVIEW OF THE INFERENCE SERVER

The NVIDIA® Inference Server provides a cloud inferencing solution optimized for NVIDIA GPUs. The server provides an inference service via an HTTP endpoint, allowing remote clients to request inferencing for any model being managed by the server. The Inference Server provides the following features:

**Multiple model support**
- The server can manage any number and mix of models (limited by system disk and memory resources). Supports TensorRT and TensorFlow GraphDef model formats.
- Also supports TensorFlow and TensorRT integrated models.

**Multi-GPU support**
- The server can distribute inferencing across all system GPUs.

**Multi-tenancy support**
- Multiple models (or multiple instances of the same model) can run simultaneously on the same GPU.

**Batching support**

The Inference Server itself is provided as a pre-built container. External to the server, API schemas, C++ and Python client libraries, and related documentation are provided in source at: GitHub Inference Server.

### 1.1. Contents Of The Inference Server Container

This image contains the inference server in `/opt/inference_server`. The executable is `/opt/inference_server/bin/inference_server`. 
Chapter 2. PULLING THE INFERENCE SERVER CONTAINER

You can pull (download) an NVIDIA container that is already built, tested, tuned, and ready to run. Each NVIDIA deep learning container includes the code required to build the framework so that you can make changes to the internals. The containers do not contain sample data-sets or sample model definitions unless they are included with the source for the framework.

Currently, you can access NVIDIA GPU accelerated containers in one of two ways depending upon where you doing your training. If you own a DGX-1™ or a DGX Station™, then you should use the NVIDIA® DGX™ container registry located at https://compute.nvidia.com. You can pull the containers from there and you can also push containers there into your own account on the nvidia-docker repository, nvcr.io.

If you are accessing the NVIDIA containers from a Cloud Server Provider such as Amazon Web Services (AWS), then you should first create an account at the NGC located at https://ngc.nvidia.com. After you create an account, the commands to use containers are the same for the DGX-1 and the . However, currently, you cannot save any containers to the NVIDIA® GPU Cloud™ (NGC) container registry, nvcr.io if you are using NVIDIA® GPU Cloud™ (NGC). Instead you have to save the containers to your own Docker repository.

The containers are exactly the same, whether you pull them from the NVIDIA DGX container registry or the NGC container registry.

Before you can pull a container you must have Docker and nvidia-docker installed as explained in Preparing to use NVIDIA Containers Getting Started Guide. You must also have access and logged into the NGC container registry as explained in NGC Getting Started Guide.

For step-by-step instructions, see Container User Guide.
Chapter 3.
RUNNING THE INFECTION SERVER CONTAINER

Before running the Inference Server, you must first set up a model store containing the models that the server will make available for inferencing. The Model Store, describes how to create a model store. For this example, assume the model store is created on the host system directory /path/to/model/store. The following command will launch the inference server using that model store.

```
$ nvidia-docker run
--rm --shm-size=1g --ulimit memlock=-1 --ulimit
stack=67108864 -p8000:8000 --mount
type=bind,source=/path/to/model/store,target=/tmp/models <container>
/opt/inference_server/bin/inference_server
--model-store=/tmp/models
```

Where `<container>` is the name of the docker container that was pulled from the NVIDIA DGX or NGC container registry as described in Pulling The Inference Server Container.

The `nvidia-docker --mount` option maps /path/to/model/store on the host into the container at /tmp/models, and the `--model-store` option to the Inference Server is used to point to /tmp/models as the model store.

The Inference Server listens on port 8000 and the above command uses the `-p` flag to map container port 8000 to host port 8000. A different host port can be used by modifying the `-p` flag, for example `-p9000:8000` will cause the Inference Server to be available on host port 9000.

The `--shm-size` and `--ulimit` flags are recommended to improve Inference Server performance. For `--shm-size` the minimum recommended size if 1g but larger sizes may be necessary depending on the number and size of models being served.

After starting, the Inference Server will log initialization information to the console. Initialization is complete and the server is ready to accept requests after the console shows the following:
Starting server listening on :8000
Chapter 4.
VERIFYING THE INFRINGEMENT SERVER

The simplest way to verify that the Inference Server is running correctly is to use the Server Status API to query the server’s status. For more information about the Inference Server API, see Inference Server API. From the host system use curl to request server status. The response is protobuf text showing the status for the server and for each model being served, for example:

```bash
$ curl localhost:8000/api/status
version: "18.04"
model_status {
  key: "resnet50"
  value {
    config {
      name: "resnet50"
      model_platform: "tensorflow_graphdef"
      max_batch_size: 128
      input {
        name: "input"
        data_type: TYPE_FP32
        format: FORMAT_NHWC
        dims: 224
        dims: 224
        dims: 3
      }
      output {
        name: "output"
        data_type: TYPE_FP32
        dims: 1000
        label_filename: "resnet50_labels.txt"
      }
    }
  }
}...
```
The Inference Server accesses models from a locally accessible file path. This path is specified when the server is started using the `--model-store` option. The model store must be organized as follows:

```
<model-store path>/
   model_0/
      config.pbtxt
      output0_labels.txt
      1/
         model.plan
      2/
         model.plan
   model_1/
      config.pbtxt
      output0_labels.txt
      output1_labels.txt
      0/
         model.graphdef
      7/
         model.graphdef
   model_2/
   model_n/
```

Any number of models may be specified, however, after the Inference Server is started, models cannot be added to or removed from the model store. To add or remove a model:

1. The Inference Server must be stopped.
2. The model store is updated as desired.
3. The Inference Server is restarted.

The name of the model directory (for example, `model_0`, `model_1`) must match the name of the model specified in the required configuration file, `config.pbtxt`. This model name is used in the client and server APIs to identify the model. Each model directory must have at least one numeric subdirectory (for example, `model_0/1`). Each of these subdirectories holds a version of the model with the version number corresponding to the directory name. Version subdirectories can be added and removed from the model store while the Inference Server is running.
For more information about how the model versions are handled by the server, see Model Versions. Within each version subdirectory, there is one or more model definition files. For more information about the model definition files contained in each version subdirectory, see Model Definition Files.

The configuration file, config.pbtxt, for each model must be protobuf text adhering to the ModelConfig schema defined and explained below. The *_labels.txt files are optional and are used to provide labels for outputs that represent classifications.

5.1. Model Versions

Each model can have one or more versions available in the model store. Each version is stored in its own, numerically named, subdirectory where the name of the subdirectory corresponds to the version number of the model. Version subdirectories can be added and removed while the Inference Server is running to add and remove the corresponding model versions. Each model specifies a version policy that controls which of the versions in the model store are made available by the Inference Server at any given time. The ModelVersionPolicy portion, as described in Model Configuration Schema specifies one of the following policies.

All  
All versions of the model that are specified in the model store are available for inferencing.

Latest  
Only the latest n versions of the model specified in the model store are available for inferencing. The latest versions of the model are the numerically greatest version numbers.

Specific  
The specifically listed versions of the model are available for inferencing.

If no version policy is specified, then Latest-1 is used as the default, indicating that only the most recent version of the model is made available by the Inference Server. In all cases, the addition or removal of version subdirectories from the model store can change which model version is used on subsequent inference requests.

5.2. Model Definition Files

Each model version subdirectory must contain at least one model definition file. By default, the name of this file must be model.plan for TensorRT models, and model.graphdef for TensorFlow GraphDef models, but the default can be overridden using the default_model_filename property in Model Configuration Schema.

Optionally, a model can provide multiple model definition files, each targeted at a GPU with a different Compute Capability. Most commonly, this feature is needed for TensorRT and TensorFlow to TensorRT integrated models where the model definition is valid for only a single compute capability. See the trt_mnist configuration in Model Configuration Schema for an example.
5.3. Model Configuration Schema

Each model in the model store must include a file called `config.pbtxt` that contains the configuration information for the model. The model configuration must be specified as protobuff text using the ModelConfig schema described at GitHub: Inference Server model_config.proto.

The following example configuration file is for a TensorRT MNIST model that accepts a single “data” input tensor of shape [1,28,28] and produces a single “prob” output vector. The output vector is a classification and the labels associated with each class are in `mnist_labels.txt`. The Inference Server will run two instances of this model on GPU 0 so that two `trt_mnist` inference requests can be handled simultaneously. Batch sizes up to 8 will be accepted by the server. Two model definition files are provided for each version of this model, one for compute capability 6.1 called `model6_1.plan` and another for compute capability 7.0 called `model7_0.plan`.

```protobuf
define 
name: "trt_mnist"
platform: "tensorrt_plan"
max_batch_size: 8
input [ 
  name: "data"
data_type: TYPE_FP32
format: FORMAT_NCHW
dims: [ 1, 28, 28 ]
] 
output [ 
  name: "prob"
data_type: TYPE_FP32
dims: [ 10, 1, 1 ]
label_filename: "mnist_labels.txt"
] 
cc_model_filenames [ 
  key: "6.1"
  value: "model6_1.plan"
],
  key: "7.0"
  value: "model7_0.plan"
] 
instance_group [ 
  count: 2
gpus: [ 0 ]
]]
```

The next example configuration file is for a TensorFlow ResNet-50 GraphDef model that accepts a single input tensor named “input” in HWC format with shape [224,224,3] and produces a single output vector named “output”. The Inference Server will run two instances of this model, one on GPU 0 and one on GPU 1. Batch sizes up to 128 will be accepted by the server.
name: "resnet50"
platform: "tensorflow_graphdef"
max_batch_size: 128
input [
  
  name: "input"
  data_type: TYPE_FP32
  format: FORMAT_NHWC
  dims: [ 224, 224, 3 ]
]

output [

  name: "output"
  data_type: TYPE_FP32
  dims: [ 1000 ]
]

instance_group [

  
  gpus: [ 0 ]
],

  
  gpus: [ 1 ]
]
Chapter 6.
INFERENCEx SERVER API

The Inference Server can be accessed directly using two exposed HTTP endpoints:

/api/status
The server status API for getting information about the server and about the models being served.

/api/infer
The inference API that accepts model inputs, runs inference and returns the requested outputs.

The HTTP endpoints can be used directly as described in this section, but for most use-cases, the preferred way to access the Inference Server is via the C++ and Python client API libraries. The libraries are available at GitHub: Inference Server.

6.1. Server Status API

Performing an HTTP GET to /api/status returns status information about the server and all the models being served. Performing an HTTP GET to /api/status/<model name> returns information about the server and the single model specified by <model name>. An example is shown in Verifying The Inference Server.

The server status is returned in the HTTP response body in either text format (the default) or in binary format if query parameter format=binary is specified (for example, /api/status?format=binary). The status schema is defined by the protobuf schema given in server_status.proto defined at GitHub: Inference Server server_status.proto.

The success or failure of the server status request is indicated in the HTTP response code and the NV-Status response header. The NV-Status response header returns a text protobuf formatted status following the status.proto schema defined at GitHub: Inference Server status.proto. If the request is successful the HTTP status is 200 and the NV-Status response header will indicate no failure:

NV-Status: code: SUCCESS

If the server status request fails, the response body will be empty, a non-200 HTTP status will be returned and the NV-Status header will indicate the failure reason, for example:
6.2. Infer

Performing an HTTP POST to /api/infer/<model name> performs inference using the latest available version of <model name> model. The latest available version is the numerically greatest version number. Performing an HTTP POST to /api/infer/<model name>/<model version> performs inference using a specific version of the model.

In either case, the request uses the NV-InferRequest header to communicate an InferRequestHeader protobuf message that describes the input tensors and the requested output tensors as defined at GitHub: Inference Server api.proto. For example, for the ResNet-50 example shown in Model Configuration Schema the following NV-InferRequest header indicates that a batch-size 1 request is being made with input size of 602112 bytes (3 * 224 * 224 * sizeof(FP32)), and that the result of the "output" tensor should be returned as the top-3 classification values.

NV-InferRequest: batch_size: 1 input { name: "input" byte_size: 602112 } output { name: "output" byte_size: 4000 cls { count: 3 } }

The input tensor values are communicated in the body of the HTTP POST request as raw binary in the order as the inputs are listed in the request header.

The inference results are returned in the body of the HTTP response to the POST request. For outputs where full result tensors were requested, the result values are communicated in the body of the response in the order as the outputs are listed in the request header. After those, an InferResponseHeader message is appended to the response body. The InferResponseHeader message is returned in either text format (the default) or in binary format if query parameter format=binary is specified (for example, /api/infer/foo?format=binary).

For example, assuming outputs specified in the InferRequestHeader in order are output0, output1, …, outputn, the response body would contain:

<raw binary tensor values for output0, if raw output was requested for output0>
<raw binary tensor values for output1, if raw output was requested for output1>
<text or binary encoded InferResponseHeader proto>

The success or failure of the inference request is indicated in the HTTP response code and the NV-Status response header. The NV-Status response header returns a text protobuf formatted status following the status.proto schema. If the request is successful the HTTP status is 200 and the NV-Status response header will indicate no failure:

NV-Status: code: SUCCESS

If the inference request fails, a non-200 HTTP status will be returned and the NV-Status header will indicate the failure reason, for example:
NV-Status: code: NOT_FOUND msg: "no status available for unknown model \'x\'"
Chapter 7.
SUPPORT

For questions, view bug reports and ask for feature requests for the Inference Server, create your ask in the Inference Server issue tracker at GitHub: Inference Server Issues.
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