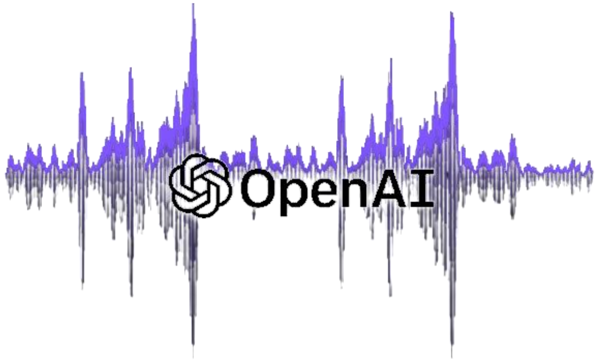
Outlines

Speach2Text
Whisper-OpenAI

NVIDIA NeMo
Framework

Quantization
TF32, FP16



NVIDIA NeMo

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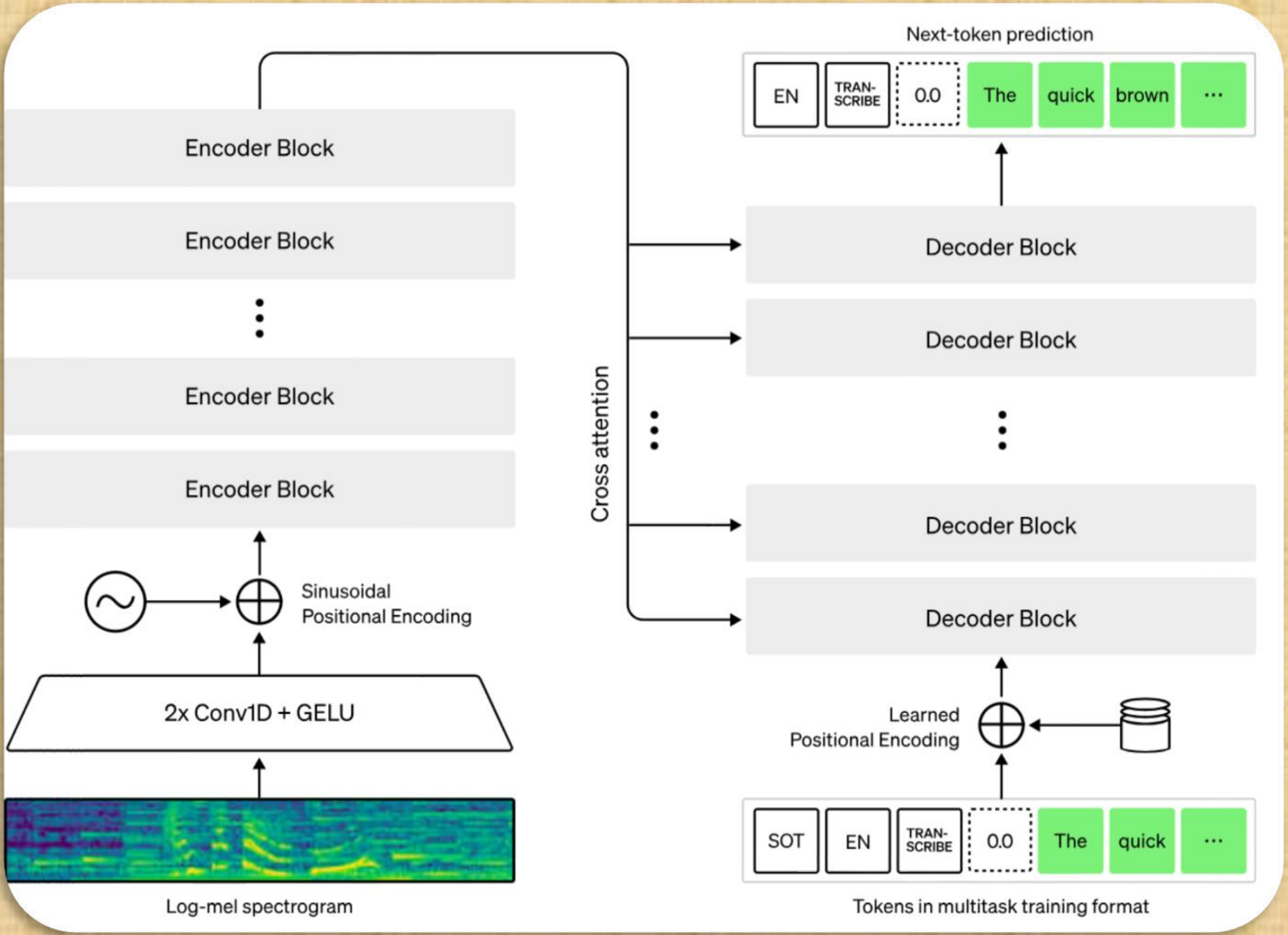
Encoder

Converted into a log-Mel spectrogram

Input audio is split into 30-second chunks



Multilingual Speech Recognition
to-English Speech Translation
Language Identification
phrase-level timestamps
Voice Activity Detection

Python 3.9.9
PyTorch 1.10.1
OpenAI's tiktoken
Ex. Py 3.8-3.11

```
pip install -U openai-whisper
sudo apt update
sudo apt install ffmpeg
pip install setuptools-rust
```

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Speach2Text

Whisper

OpenAI

Whisper

https://openai.com/research/whisper

https://github.com/openai/whisper/tree/main

My Github with Dockerfile and example

https://github.com/HFarkhari/Whisper_OpenAI

Docker Image (Large-v2 model included)

https://hub.docker.com/r/hfarkhari/whisper_openai_speech2text

```
docker pull  hfarkhari/whisper_openai_speech2text:large-v2
docker run --gpus all -p 8888:8888 -it --rm  hfarkhari/whisper_openai_speech2text:large-v2
```

http://127.0.0.1:8888   password: 123

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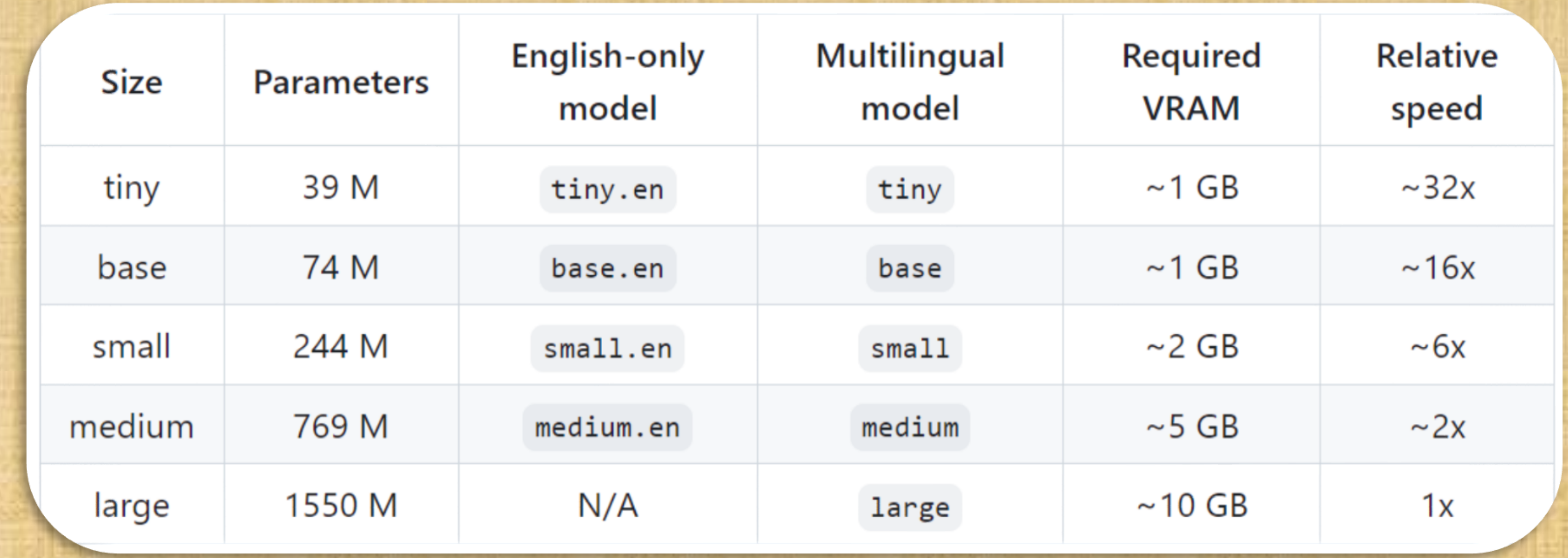
https://huggingface.co/openai/whisper-large-v2

HUGGING FACE



Size	Parameters	English-only model	Multilingual model	Required VRAM	Relative speed
tiny	39 M	`tiny.en`	`tiny`	~1 GB	~32x
base	74 M	`base.en`	`base`	~1 GB	~16x
small	244 M	`small.en`	`small`	~2 GB	~6x
medium	769 M	`medium.en`	`medium`	~5 GB	~2x
large	1550 M	N/A	`large`	~10 GB	1x

Large V2 ~10GB VRAM (GPU)

More Info

https://www.assemblyai.com/blog/how-to-run-openais-whisper-speech-recognition-model/

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OpenAI

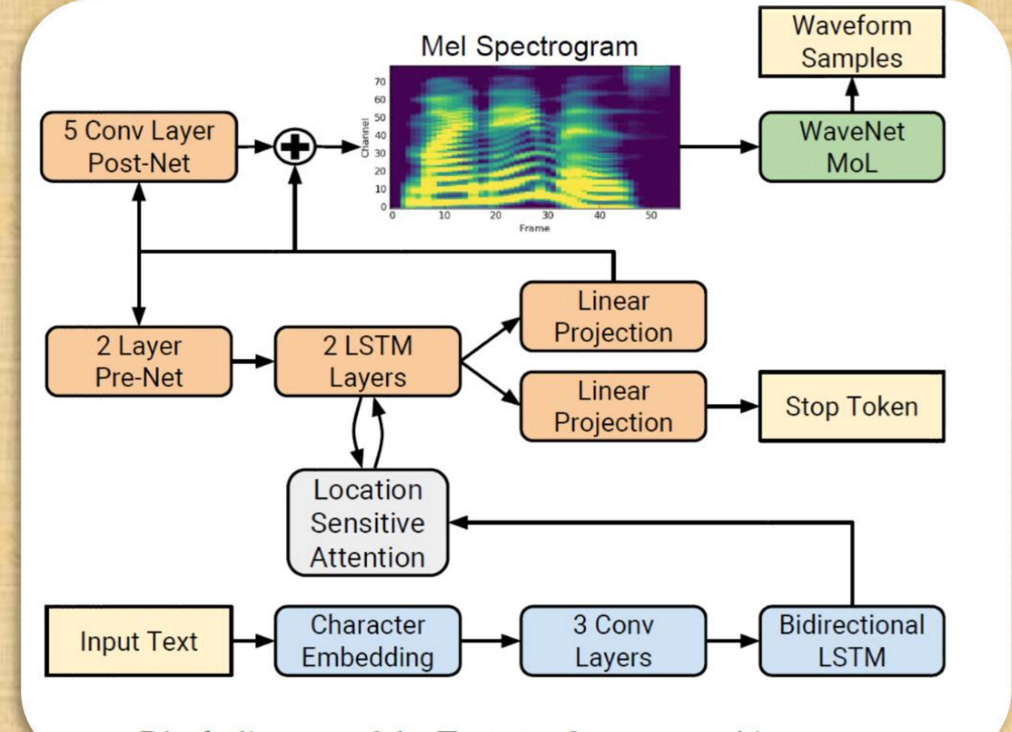
Tacotron2 - Text 2 Speech (TTS)

https://paperswithcode.com/task/text-to-speech-synthesis
https://github.com/NVIDIA/tacotron2
https://pytorch.org/hub/nvidia_deeplearningexamples_tacotron2/

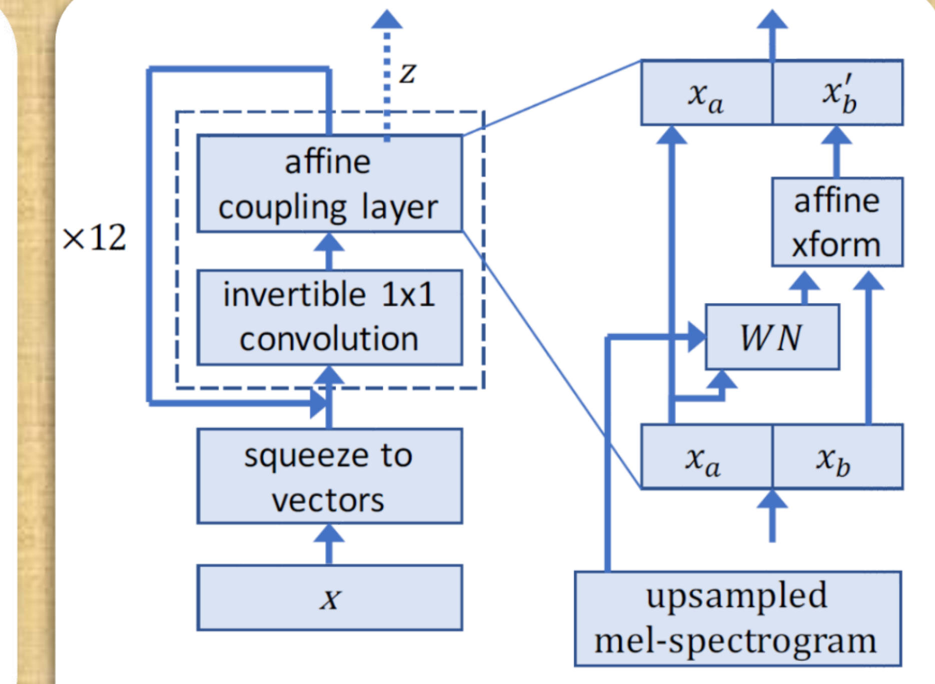
WaveGlow: a Flow-based Generative Network for Speech Synthesis

https://github.com/NVIDIA/waveglow
https://nv-adlr.github.io/WaveGlow

WAVEGLOW



Block diagram of the Tacotron 2 system architecture.



WaveGlow network

Quantization
TF32, FP16

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NVIDIA NeMo Framework

https://github.com/NVIDIA/NeMo/tree/main/examples

- Automatic Speech Recognition (ASR)
- NLP (Language Modeling, Information Retrieval, Machine Translation, Question Answering, Text Classification, …)
- Speech Intent Classification and Slot Filling on SLURP Dataset
- TTS (FastPitch, Tacotron2, WaveGlow, Spectrogram Enhancer, …)

https://catalog.ngc.nvidia.com/orgs/nvidia/containers/nemo

```
docker pull nvcr.io/nvidia/nemo:23.04
docker run  --gpus all  -it  --rm  -p 8888:8888   nvcr.io/nvidia/nemo:23.04
```

```
docker run --gpus all -it --rm --shm-size=8g -p 8888:8888 -p 6006:6006 --ulimit memlock=-1
--ulimit stack=67108864 nvcr.io/nvidia/pytorch:23.04-py3
```

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Tutorials
https://docs.nvidia.com/deeplearning/nemo/user-guide/docs/en/stable/starthere/tutorials.html

- Automatic Speech Recognition (ASR)
- NLP (Language Modeling, Information Retrieval, Machine Translation, Question Answering, Text Classification, …)
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https://catalog.ngc.nvidia.com/orgs/nvidia/containers/nemo

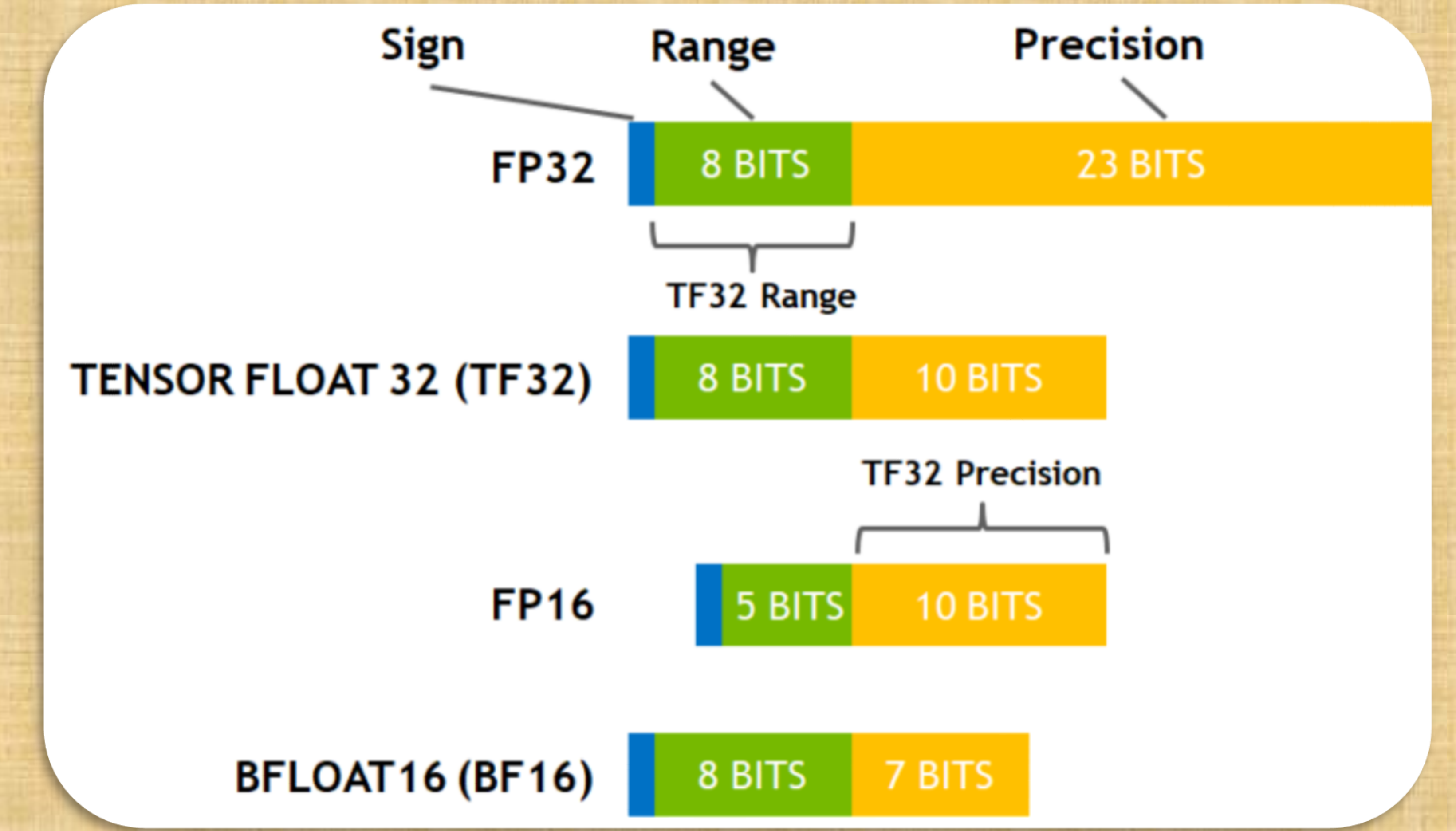
```
docker pull nvcr.io/nvidia/nemo:23.04
docker run  --gpus all  -it  --rm  -p 8888:8888   nvcr.io/nvidia/nemo:23.04

docker  run  --runtime=nvidia  -it  --rm  -v   --shm-size=16g   -p 8888:8888   -p 6006:6006
--ulimit memlock=-1  --ulimit stack=67108864   nvcr.io/nvidia/nemo:23.04
```

Quantization
TF32, FP16

NVIDIA NeMo Framework

FP32, TF32, FP16, BF16

https://developer.nvidia.com/blog/accelerating-ai-training-with-tf32-tensor-cores/



Quantization
TF32, FP16

NVIDIA NeMo Framework

FP32, TF32, FP16, BF16

https://developer.nvidia.com/blog/accelerating-ai-training-with-tf32-tensor-cores/

TensorFloat32 (TF32) support

- Accelerating FP32 Only convolutions and matrix multiplications.
- All storage in memory and other operations remain completely in FP32, only convolutions and matrix-multiplications convert their inputs to TF32 right before multiplication.
- TF32 mode is the default option for AI training with 32-bit variables on Ampere GPU architecture (A100).
- Rounds FP32 inputs to TF32, computes the products without loss of precision, then accumulates those products into an FP32 output.
- TF32 is only exposed as a Tensor Core operation mode, not a type.
- achieves the same accuracy as FP32 training, requires no changes to hyperparameters for training scripts

FP32, TF32, FP16, BF16

https://developer.nvidia.com/blog/accelerating-ai-training-with-tf32-tensor-cores/

Quantization
TF32, FP16

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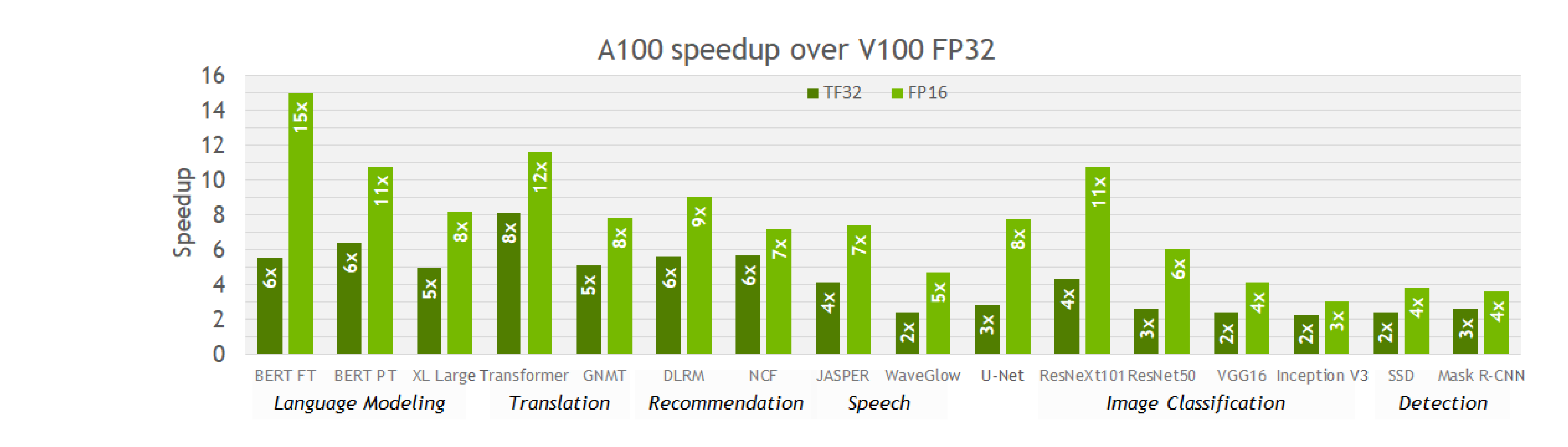
TensorFloat32 (TF32) support

- FP16 gives a further speedup of up to ~2x, as 16-bit Tensor Cores are 2x faster than TF32 mode



Quantization TF32, FP16

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TensorFloat32 (TF32) Tips

- TF32 is the default mode for AI on A100 when using the NVIDIA optimized deep learning framework containers for TensorFlow, PyTorch, and MX Net, starting with the 20.06.
- PyTorch 1.7, TensorFlow 2.4, nightly builds for MXNet 1.8 (minimum version).
- cuDNN version 8.0 and greater.
- cuBLAS version 11.0 and greater.
- cuSOLVER
- cuTENSOR version 1.1.0 and greater.
- BF16 is introduced as Tensor Core math mode in cuBLAS 11.0 and as a numerical type in CUDA 11.0.
- Deep learning frameworks and AMP will support BF16 soon.

Quantization
TF32, FP16

NVIDIA NeMo Framework

TensorFloat32 (TF32) Tips

- TF32 mode accelerates convolution and matrix-multiply layers, including linear and fully connected layers, recurrent cells, and attention blocks.
- TF32 does not accelerate layers that operate on non-FP32 tensors, such as 16-bits, FP64, or integer precisions.
- TF32 also does not apply to layers that are not convolution or matrix-multiply operations (for example, batch normalization), as well as optimizer or solver operations.
- Tensor storage is not changed when training with TF32. Everything remains in FP32, or whichever format is specified in the script.

Quantization
TF32, FP16

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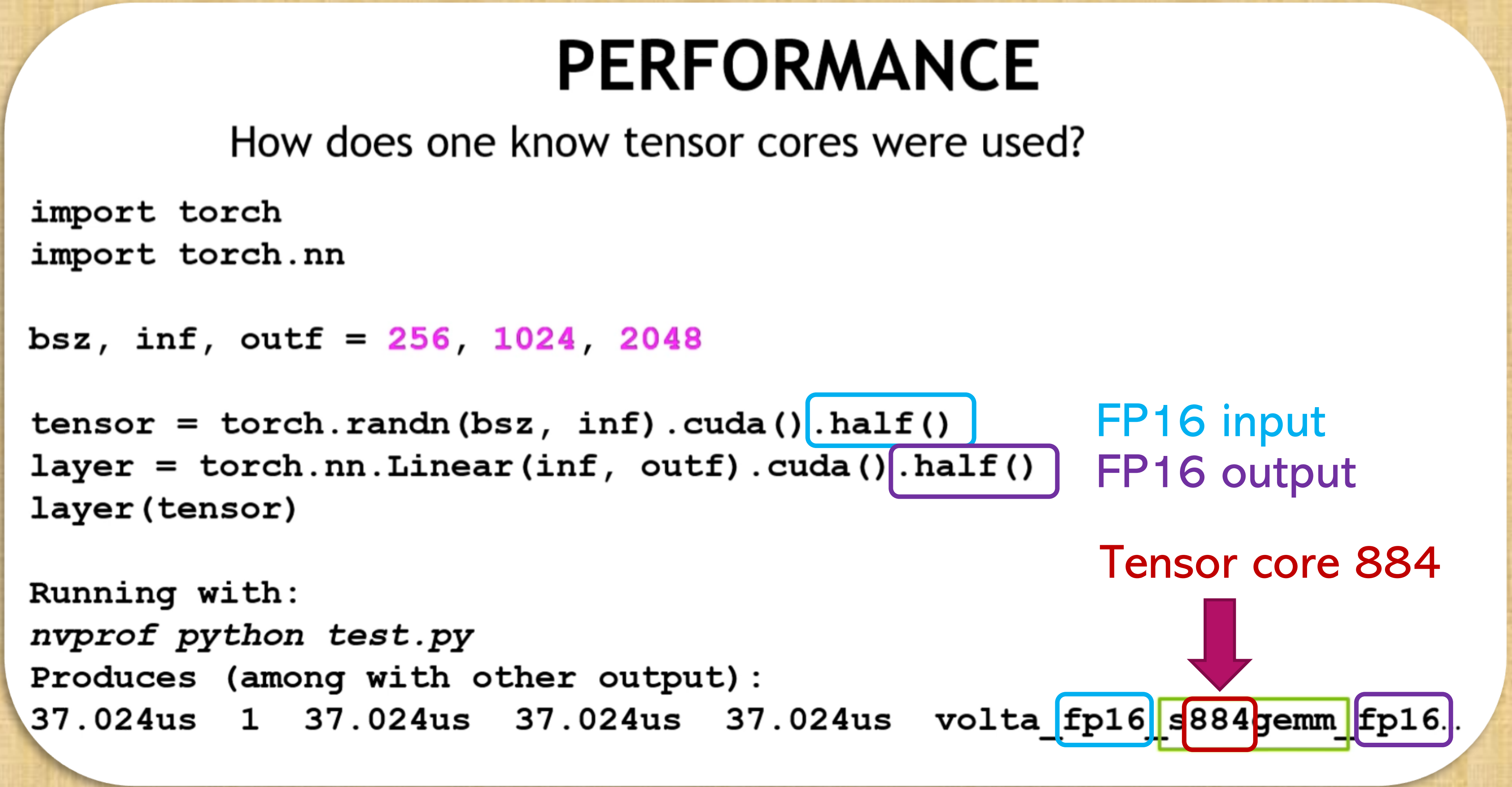
TensorFloat32 (TF32) Tips



PERFORMANCE

How does one know tensor cores were used?

```
import torch
import torch.nn

bsz, inf, outf = 256, 1024, 2048

tensor = torch.randn(bsz, inf).cuda().half()
layer = torch.nn.Linear(inf, outf).cuda().half()
layer(tensor)

Running with:
nvprof python test.py
Produces (among with other output):
37.024us   1   37.024us   37.024us   37.024us   volta_fp16_s884gemm_fp16..
```

FP16 input

FP16 output

Tensor core 884

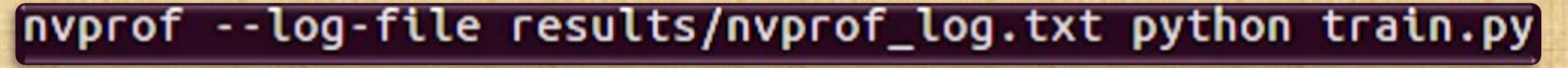
https://youtu.be/tAIakfEt-tI

Quantization

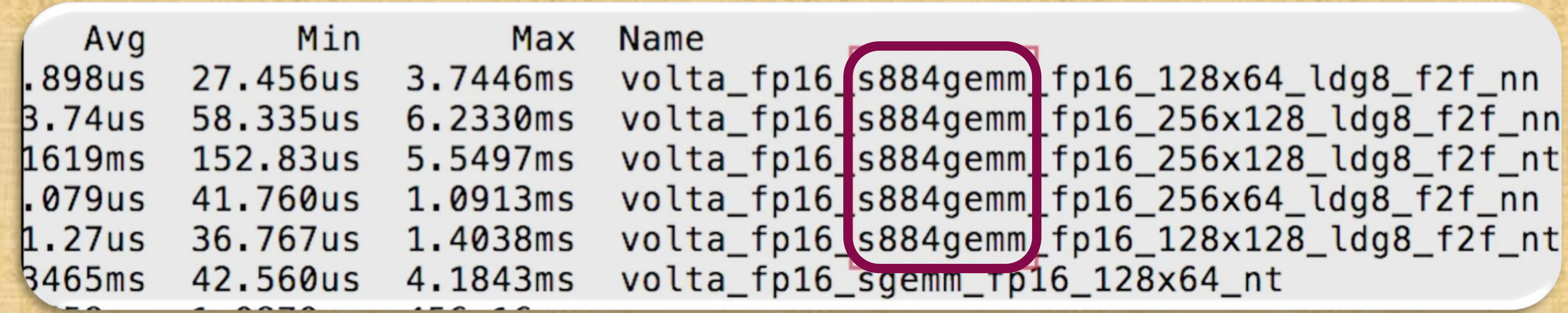
TF32, FP16

NVIDIA NeMo Framework

TensorFloat32 (TF32) Tips



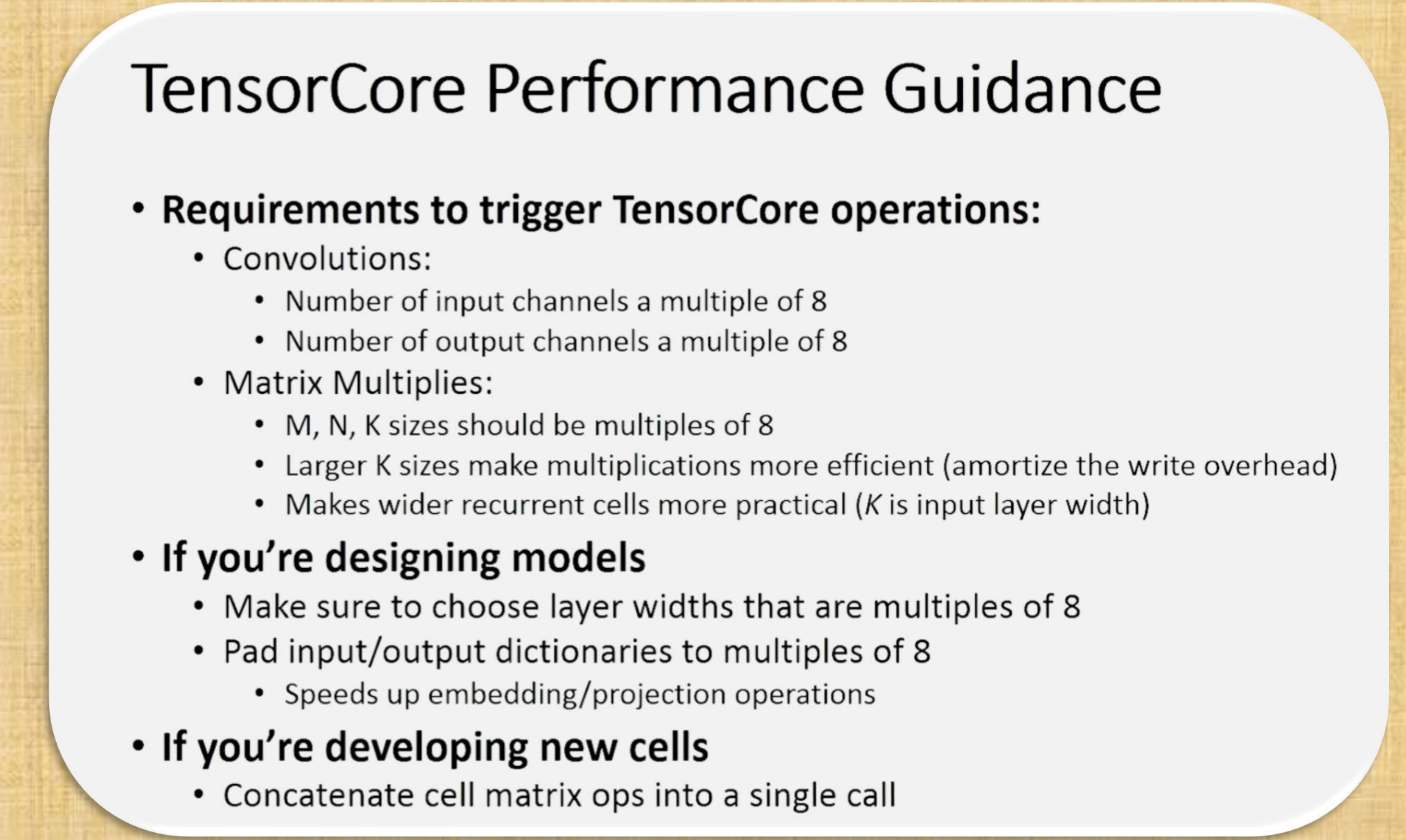
```
nvprof --log-file results/nvprof_log.txt python train.py
```



```
    Avg          Min          Max    Name
.898us    27.456us    3.7446ms    volta_fp16_s884gemm_fp16_128x64_ldg8_f2f_nn
3.74us    58.335us    6.2330ms    volta_fp16_s884gemm_fp16_256x128_ldg8_f2f_nn
1619ms    152.83us    5.5497ms    volta_fp16_s884gemm_fp16_256x128_ldg8_f2f_nt
.079us    41.760us    1.0913ms    volta_fp16_s884gemm_fp16_256x64_ldg8_f2f_nn
1.27us    36.767us    1.4038ms    volta_fp16_s884gemm_fp16_128x128_ldg8_f2f_nt
3465ms    42.560us    4.1843ms    volta_fp16_sgemm_fp16_128x64_nt
```

Quantization
TF32, FP16

NVIDIA NeMo Framework



TensorCore Performance Guidance

- **Requirements to trigger TensorCore operations:**
  - Convolutions:
    - Number of input channels a multiple of 8
    - Number of output channels a multiple of 8
  - Matrix Multiplies:
    - M, N, K sizes should be multiples of 8
    - Larger K sizes make multiplications more efficient (amortize the write overhead)
    - Makes wider recurrent cells more practical (*K* is input layer width)
- **If you're designing models**
  - Make sure to choose layer widths that are multiples of 8
  - Pad input/output dictionaries to multiples of 8
    - Speeds up embedding/projection operations
- **If you're developing new cells**
  - Concatenate cell matrix ops into a single call

https://youtu.be/i8-Jw48Cp8w

Quantization
TF32, FP16

NVIDIA NeMo
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Download Docker Containers Framework compatible with TF32

Download Latest TensorFlow

https://catalog.ngc.nvidia.com/orgs/nvidia/containers/tensorflow

Download Latest PyTorch

https://catalog.ngc.nvidia.com/orgs/nvidia/containers/pytorch

Thanks

Any Question ?