Documentation History
play-with-torch

1. Section 1
0. Tools
0.1. Hardware
+ **RasberryPi 4 Model B** Rev 1 (RPi), RAM: **4 GB** and Processor 4-core @ **1.5 GHz**
+ microSD Card **64 GB**
+ 5M USB Retractable Clip 120 Degrees WebCam Web Wide-angle Camera Laptop U7 Mini *or* Raspi Camera

0.2. Tested Software
+ Raspbian 10 (Buster) **[armv7l] 32 bit**, install on RPi
+ PyTorch **[armv7l]**: torch 1.6.0 and torchvision 0.7.0
+ Python min. ver. 3.6

1. Install the prerequisites
+ Test using above reference the result is:
In Raspbian, version python is 3.7.3

+ Source: https://github.com/ljk53/pytorch-rpi
torch 1.6.0 [armv7l]: https://github.com/ljk53/pytorch-rpi/blob/master/torch-1.6.0a0%2Bb31f58d-cp37-cp37m-linux_armv7l.whl

Move file to
$ scp torch-1.6.0a0+b31f58d-cp37-cp37m-linux_armv7l.whl pi@xxx:/home/xxx/Downloads
pi@raspberrypi:~/Downloads $ pip3 install torch-1.6.0a0+b31f58d-cp37-cp37m-linux_armv7l.whl

+ Install packages
$ sudo apt install build-essential make cmake git python3-pip libatlas-base-dev
$ sudo apt install libssl-dev
$ sudo apt install libopenblas-dev libblas-dev m4 cython python3-yaml

+ Update cmake to > 3.15
$ wget https://github.com/Kitware/CMake/releases/download/v3.18.0-rc1/cmake-3.18.0-rc1.tar.gz
$ sudo apt install libssl-dev
$ cd cmake-3.18.0
$ mkdir build && cd build
$ cmake ..
$ make
$ sudo make install

$ sudo apt remove cmake
$ sudo ln -s /usr/local/bin/cmake /usr/bin/cmake
$ sudo ldconfig

+ Make WASP to 2048 MB
$ nano /etc/dphys-swapfile

CONF_SWAPFILE=2048M

$ sudo dphys-swapfile setup

$ sudo dphys-swapfile swapon
$ free -h

```
pi@raspberrypi:~ $ free -h
              total        used        free      shared  buff/cache   available
Mem:          3.7Gi        65Mi       2.0Gi       8.0Mi       1.6Gi       3.5Gi
Swap:         2.0Gi          0B       2.0Gi
```

+ Test torch below:

```
pi@raspberrypi:~ $ python3
Python 3.7.3 (default, Jul 25 2020, 13:03:44)
[GCC 8.3.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import torch
>>> import numpy as np
>>> a = torch.from_numpy(np.random.randn(1, 100))
>>> print(a)
tensor([[-1.5612e+00, -1.1646e-01,  3.7521e-01, -9.3571e-01, -2.7875e-01,
         3.6622e-01,  1.2217e+00,  6.9403e-01, -5.2061e-01,  1.3009e+00,
```

it’s indicator that works.

```
pi@raspberrypi:~/DetectorPi/test $ python3 test_torch.py
tensor(2.)
tensor(1.)
tensor(1.)
w:  Parameter containing:
tensor([[-0.3264,  0.1669, -0.0741],
        [ 0.3053,  0.1813,  0.3761]], requires_grad=True)
b:  Parameter containing:
tensor([-0.4165,  0.0386], requires_grad=True)
loss:  1.3495376110076904
dL/dw:  tensor([[-0.3721,  0.0205, -1.1976],
        [ 0.3850,  0.3495,  1.0424]])
dL/db:  tensor([-0.7008, -0.0061])
loss after 1 step optimization:  1.315846562385559
pi@raspberrypi:~/DetectorPi/test $
```

2. Build PyTorch from the source (DO THIS INSTRUCTION ON Raspberry Pi 4)
Ref:
+ https://nmilosev.svbtle.com/compling-arm-stuff-without-an-arm-board-build-pytorch-for-the-raspberry-pi [**best complete explanation**]
+ https://github.com/nmilosev/pytorch-arm-builds [**complete explanation**]

+ https://gist.github.com/akaanirban/621e63237e63bb169126b537d7a1d979
+ https://github.com/Ben-Faessler/Python3-Wheels [**good**]
+ https://github.com/Kashu7100/pytorch-armv7l [finish]

Build PyTorch from the source to get **torchvision 0.7.0 [armv7l]** wheel.

+ Install package
$ sudo apt install libopenblas-dev libblas-dev m4 cmake cython python3-dev python3-yaml python3-setuptools

$ sudo apt install libavcodec-dev libavformat-dev
$ sudo apt python3-wheel python3-pillow python3-numpy

$ cd pytorch
pi@raspberrypi:~/pytorch $ git clone --recursive https://github.com/pytorch/vision --branch=release/0.7
pi@raspberrypi:~/pytorch $ cd vision

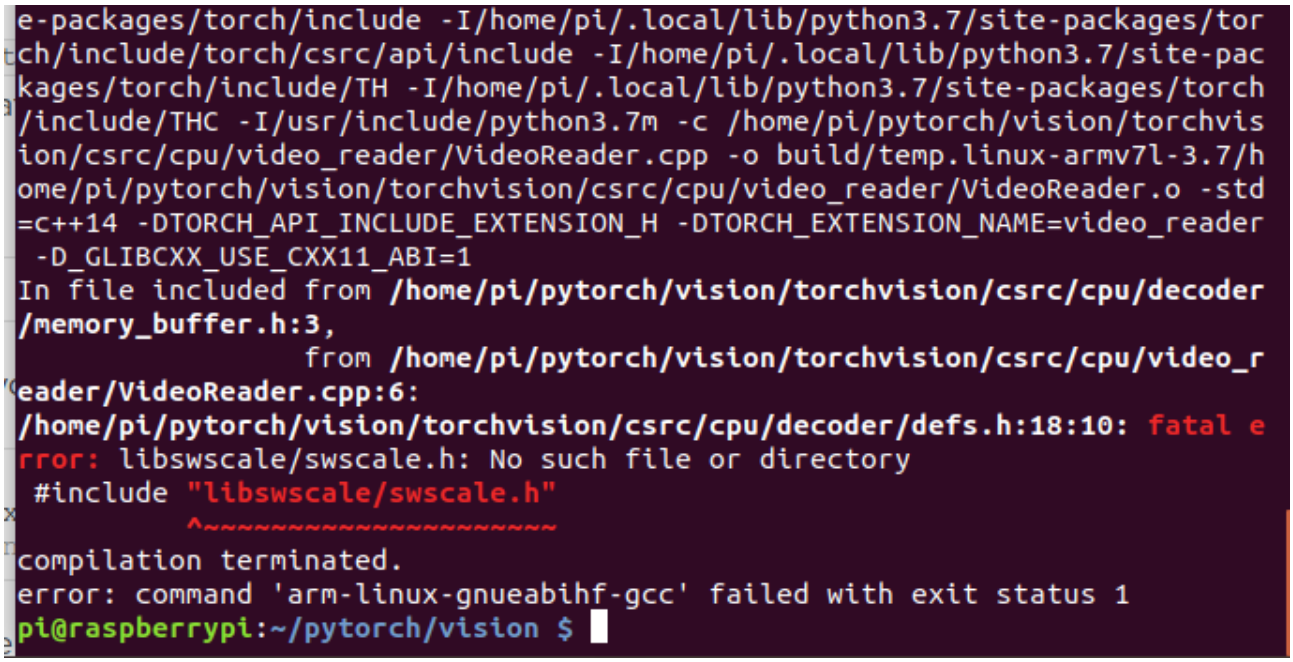
+ Run command below:

pi@raspberrypi:~/pytorch/vision $ export NO_CUDA=1
pi@raspberrypi:~/pytorch/vision $ export NO_DISTRIBUTED=1
pi@raspberrypi:~/pytorch/vision $ export NO_MKLDNN=1
pi@raspberrypi:~/pytorch/vision $ export BUILD_TEST=0 # for faster builds
pi@raspberrypi:~/pytorch/vision $ export MAX_JOBS=4 # I have 4 cores

pi@raspberrypi:~/pytorch/vision $ export NO_NNPACK=1 # update July 19, this is optional, can build with NNPACK
pi@raspberrypi:~/pytorch/vision $ export NO_QNNPACK=1 # same as above, can be omitted

+ Run command below and On Raspberry Pi 4 4GB with 2294MHz it take round **3 hours**
pi@raspberrypi:~/pytorch/vision $ python3 setup.py sdist bdist_wheel

Problem: **ERROR, need install one-by-one packages.**



Solution: use step 3. build pytorch from the source.

3. Build PyTorch from the source (WITHOUT Raspberry Pi 4)
Ref:
+ https://nmilosev.svbtle.com/compling-arm-stuff-without-an-arm-board-build-pytorch-for-the-raspberry-pi
+ Cross compiling for RaspberryPi: https://blog.kitware.com/cross-compiling-for-raspberry-pi/

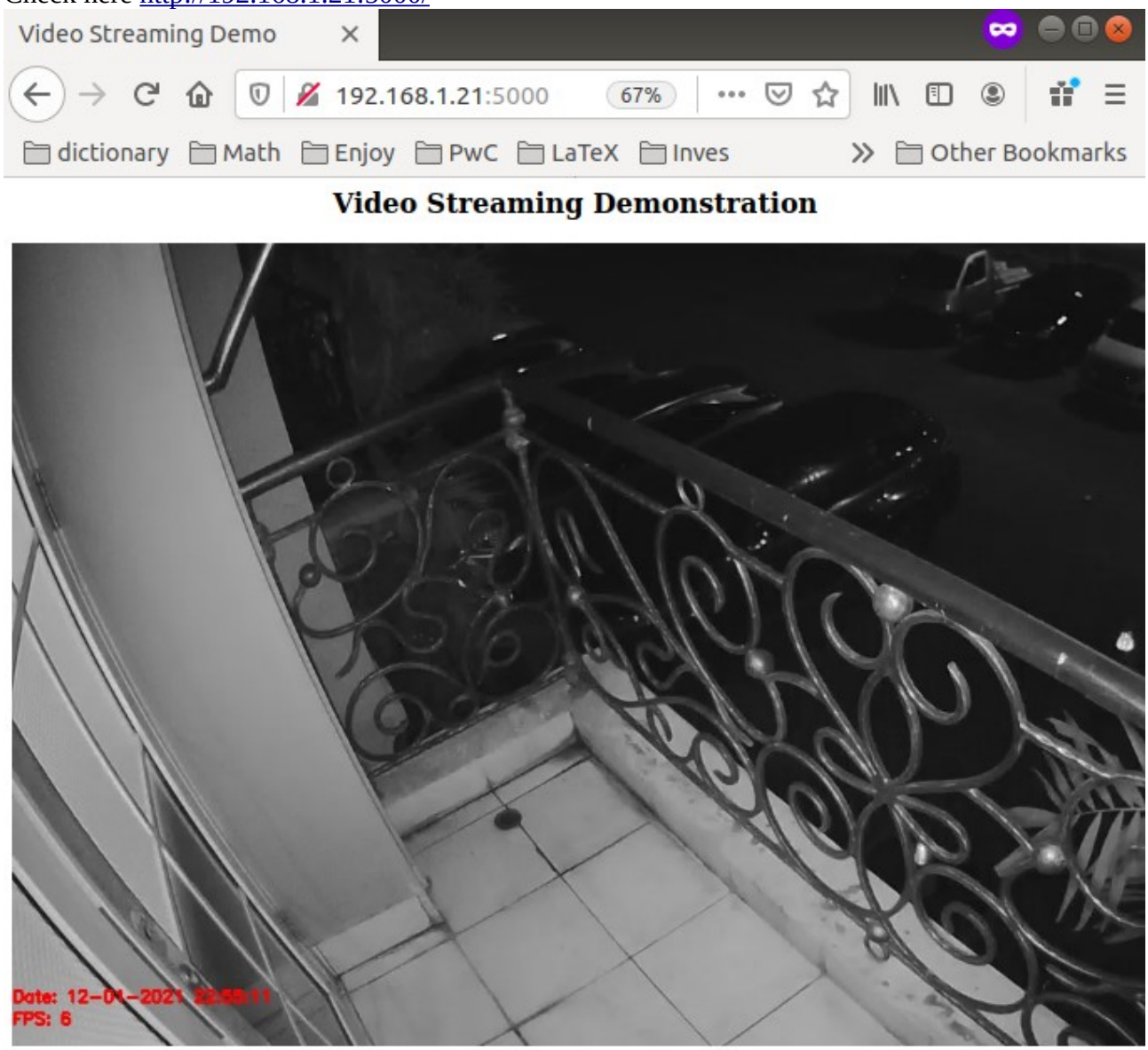
+ QEMU documentation: https://www.qemu.org/docs/master/user/main.html

4. Install opencv
$ pip3 install opencv-python

```
pi@raspberrypi:~/DetectorPi $ python3
Python 3.7.3 (default, Jul 25 2020, 13:03:44)
[GCC 8.3.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import cv2
>>> print(cv2.__version__)
4.5.1
>>>
```

Run in Pi using command below
pi@raspberrypi:~/VisionPi/test $ python3 test_opencv.py --source rtsp://Anonymous:Anonymous@192.168.1.11:554

Check here http://192.168.1.21:5000/

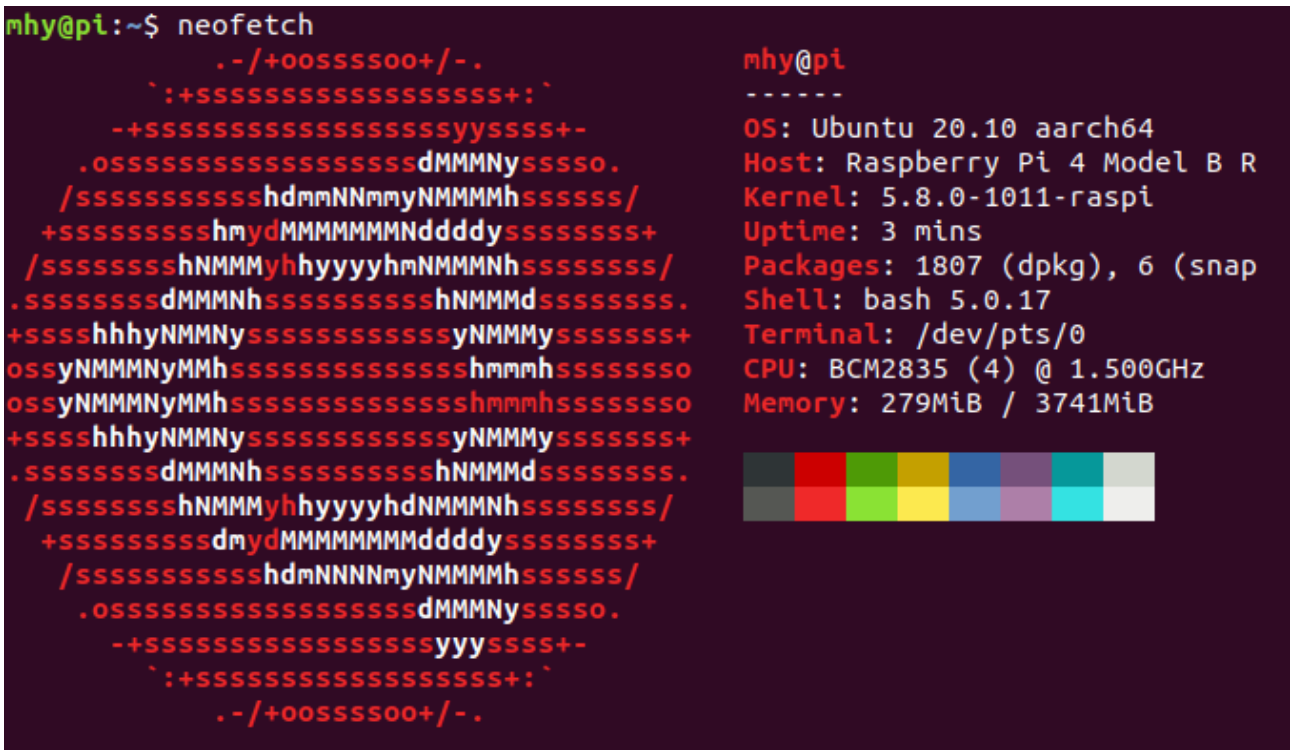


Problem: **During my testing, JIT tracing didn't work for 32 bit. As JITing your model is something that comes to mind with ARM, I thought it was better to work with the (working) 64 bit version.**
Ref: http://mathinf.com/pytorch/arm64/ and https://github.com/pytorch/pytorch/issues/27040

2. Section 2

0. Tools
0.1. Hardware
+ **RasberryPi 4 Model B** Rev 1 (RPi), RAM: **4 GB** and Processor 4-core @ **1.5 GHz**
+ microSD Card **64 GB**
+ 5M USB Retractable Clip 120 Degrees WebCam Web Wide-angle Camera Laptop U7 Mini *or* Raspi Camera

0.2. Tested Software
+ Ubuntu 20.10 **[aarch64] 64 bit**, install on RPi
+ PyTorch **[aarch64]**: torch 1.6.0 and torchvision 0.7.0
+ Python min. ver. 3.6



$ sudo apt install python3-numpy python3-wheel python3-setuptools python3-future python3-yaml python3-six python3-requests python3-pip python3-pillow

+ Download file that build with a 8GB Raspberry Pi 4 (and without needing swap) starting from the minimal Raspberry Pi OS (Buster), python 3.7.
torch-1.6.0a0+b31f58d-cp37-cp37m-linux_aarch64.whl: http://mathinf.com/pytorch/arm64/torch-1.6.0a0+b31f58d-cp37-cp37m-linux_aarch64.whl
torchvision-0.7.0a0+78ed10c-cp37-cp37m-linux_aarch64.whl:
http://mathinf.com/pytorch/arm64/torchvision-0.7.0a0+78ed10c-cp37-cp37m-linux_aarch64.whl

+ Source: https://github.com/ljk53/pytorch-rpi

torch-1.6.0a0+b31f58d-cp38-cp38-linux_aarch64.whl https://github.com/ljk53/pytorch-rpi/blob/master/torch-1.6.0a0%2Bb31f58d-cp38-cp38-linux_aarch64.whl
torchvision 0.7.0:

$ scp torch-1.6.0a0+b31f58d-cp38-cp38-linux_aarch64.whl mhy@192.168.1.21:/home/mhy/Downloads

mhy@pi:~/Downloads$ pip3 install torch-1.6.0a0+b31f58d-cp38-cp38-linux_aarch64.whl

+ Install packages
$ sudo apt install build-essential make cmake git python3-pip libatlas-base-dev
$ sudo apt install libssl-dev
$ sudo apt install libopenblas-dev libblas-dev m4 python3-yaml
$ sudo apt install libomp-dev

+ Make WASP to 2048 MB
$ free -h

```
mhy@pi:~$ free -h
              total        used        free      shared  buff/cache   available
Mem:          3,7Gi       273Mi       2,3Gi       4,0Mi       1,1Gi       3,3Gi
Swap:         1,0Gi          0B       1,0Gi
```

$ sudo swapoff -a
$ sudo dd if=/dev/zero of=/swapfile bs=1M count=2048

```
mhy@pi:~$ sudo dd if=/dev/zero of=/swapfile bs=1M count=2048
2048+0 records in
2048+0 records out
2147483648 bytes (2,1 GB, 2,0 GiB) copied, 126,679 s, 17,0 MB/s
```

$ sudo mkswap /swapfile
$ sudo swapon /swapfile
$ free -h

```
mhy@pi:~$ free -h
              total        used        free      shared  buff/cache   available
Mem:          3,7Gi       275Mi       216Mi       4,0Mi       3,2Gi       3,3Gi
Swap:         2,0Gi          0B       2,0Gi
```

+ Test PyTorch:

```
mhy@pi:~$ python3
Python 3.8.6 (default, Sep 25 2020, 09:36:53)
[GCC 10.2.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import torch
>>> exit()
```

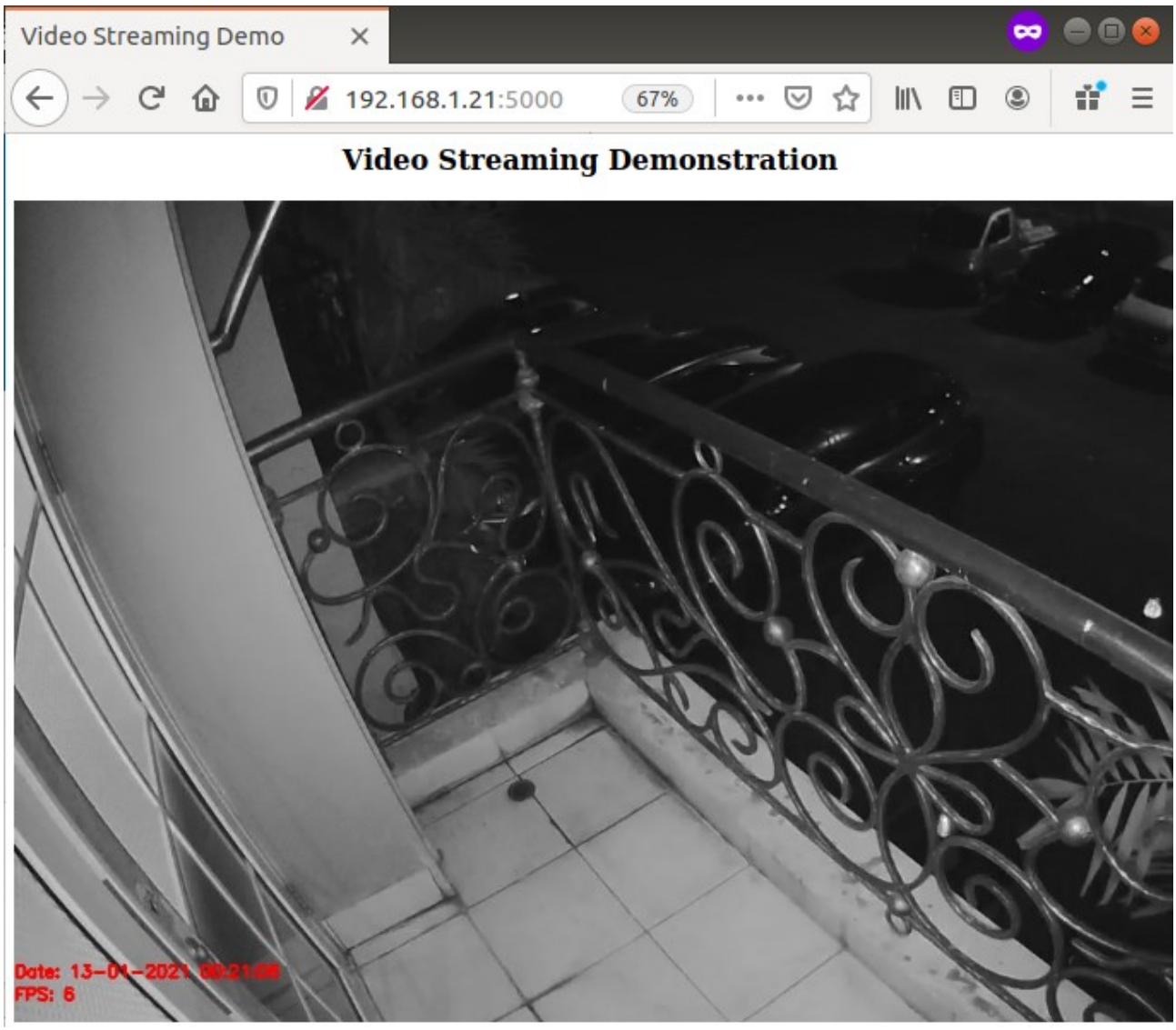
```
mhy@pi:~/DetectorPi/test$ python3 test_torch.py
tensor(2.)
tensor(1.)
tensor(1.)
w:  Parameter containing:
tensor([[ 0.1052,  0.4078, -0.4026],
        [ 0.4273,  0.3837, -0.0545]], requires_grad=True)
b:  Parameter containing:
tensor([ 0.5224, -0.3139], requires_grad=True)
loss:  0.8868435025215149
dL/dw:  tensor([[-0.3426,  0.1850, -0.0676],
        [-0.1126,  0.5372,  0.1734]])
dL/db:  tensor([0.6858, 0.1581])
loss after 1 step optimization:  0.8770723342895508
mhy@pi:~/DetectorPi/test$
```

+ Install packages
$ pip3 install Flask
$ pip3 install waitress

+ Install opencv
$ pip3 install opencv-python

```
mhy@pi:~$ python3
Python 3.8.6 (default, Sep 25 2020, 09:36:53)
[GCC 10.2.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import cv2
>>> print(cv2.__version__)
4.5.1
>>>
```

mhy@pi:~/VisionPi/test$ python3 test_opencv.py --source rtsp://Anonymous:Anonymous@192.168.1.11:554

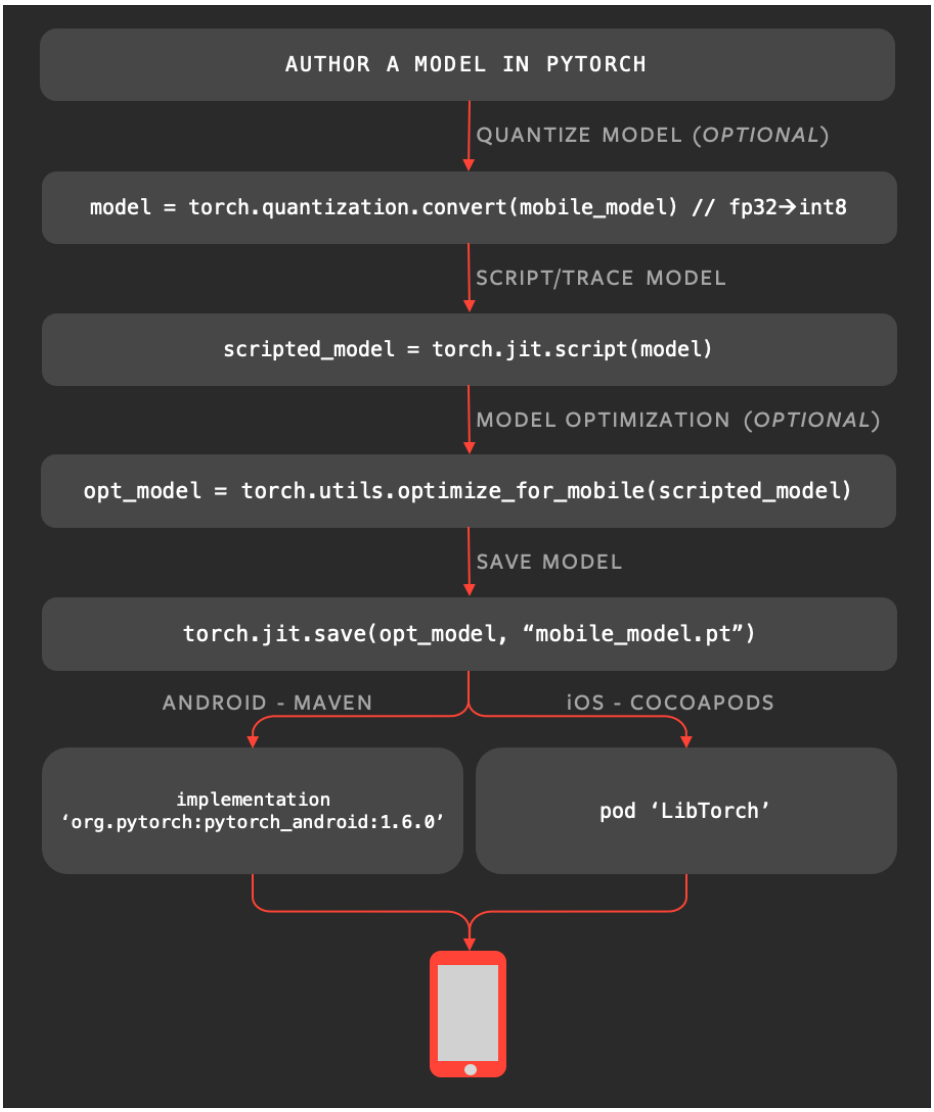

Video Streaming Demo
192.168.1.21:5000
67%
Video Streaming Demonstration
FPS: 6

PyTorch Mobile

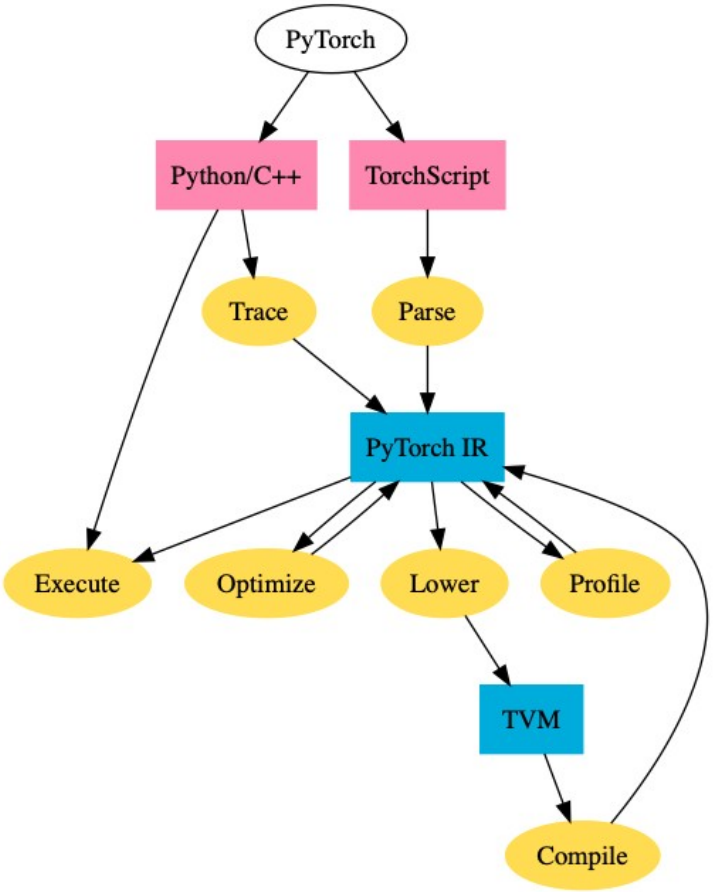
0. Referensi

+ Official website: https://pytorch.org/mobile/home/

Masih versi beta tetapi juga sudah digunakan untuk tahap produksi secara luas.



URL: https://github.com/pytorch/tvm



+ https://github.com/pytorch/android-demo-app
+ https://github.com/cedrickchee/pytorch-mobile-kit

PyTorch Embedded System

0. Referensi
+ FedML: A Research Library and Benchmark for Federated Machine Learning: https://github.com/FedML-AI
+ FedML-IoT: Federated Learning on IoT Devices (supported by FedML framework) : https://github.com/FedML-AI/FedML-IoT

+ FastDepth: Fast Monocular Depth Estimation on Embedded Systems: https://github.com/tau-adl/FastDepth

1. Compiling PyTorch
+ https://nmilosev.svbtle.com/compling-arm-stuff-without-an-arm-board-build-pytorch-for-the-raspberry-pi

NanoDet

Last update: Sep 5, 2021
Ref: https://github.com/RangiLyu/nanodet

>> Train Custom Dataset
Ref: https://github.com/RangiLyu/nanodet#how-to-train
+.1. Prepare dataset
If your dataset annotations are pascal voc xml format, refer to **config/nanodet_custom_xml_dataset.yml**.

+.2. Prepare config file
Detail explanation: https://github.com/RangiLyu/nanodet/blob/main/docs/config_file_detail.md
- Copy and modify an **example yml config file** in config/ folder.
- Change **save_path** to where you want to save model.
- Change **num_classes** in models->arch->head.
- Change **image path** and **annotation path** in both data->train and data->val.
- Set **gpu ids**, **num workers** and **batch size** in device to fit your device.
gpu_ids: CUDA device id. For multi-gpu training, set [0, 1, 2...].
workers_per_gpu: how many dataloader processes for each gpu.
batchsize_per_gpu: amount of images in one batch for each gpu.

Issue1: https://stackoverflow.com/questions/53998282/how-does-the-number-of-workers-parameter-in-pytorch-dataloader-actually-work
So when **num_workers=2** you have at most 2 workers simultaneously putting data into **RAM**.
So setting **workers to number of CPU cores** is a good rule of thumb, nothing more.

- Set **total_epochs**, **lr** and **lr_schedule** according to your dataset and batchsize.

-PASCAL VOCO dataset structure:
Ref0: http://host.robots.ox.ac.uk/pascal/VOC/voc2012/

Ref1: https://detectron2.readthedocs.io/en/latest/tutorials/builtin_datasets.html#expected-dataset-structure-for-pascal-voc

Expected dataset structure for Pascal VOC:

```
VOC20{07,12}/
  Annotations/
  ImageSets/
    Main/
      trainval.txt
      test.txt
      # train.txt or val.txt, if you use these splits
  JPEGImages/
```

Ref2: https://pytorch.org/vision/stable/datasets.html#torchvision.datasets.VOCDetection

CLASS `torchvision.datasets.VOCDetection(root: str, year: str = '2012', image_set: str = 'train', download: bool = False, transform: Optional[Callable] = None, target_transform: Optional[Callable] = None, transforms: Optional[Callable] = None)` [SOURCE]

Pascal VOC Detection Dataset.

Parameters

- **root** (*string*) – Root directory of the VOC Dataset.
- **year** (*string, optional*) – The dataset year, supports years `"2007"` to `"2012"`.
- **image_set** (*string, optional*) – Select the image_set to use, `"train"`, `"trainval"` or `"val"`. If `year=="2007"`, can also be `"test"`.
- **download** (*bool, optional*) – If true, downloads the dataset from the internet and puts it in root directory. If dataset is already downloaded, it is not downloaded again. (default: alphabetic indexing of VOC's 20 classes).
- **transform** (*callable, optional*) – A function/transform that takes in an PIL image and returns a transformed version. E.g, `transforms.RandomCrop`
- **target_transform** (*callable, required*) – A function/transform that takes in the target and transforms it.
- **transforms** (*callable, optional*) – A function/transform that takes input sample and its target as entry and returns a transformed version.

Ref3: https://github.com/open-mmlab/mmsegmentation/blob/master/docs/dataset_prepare.md

```
mmsegmentation
├── mmseg
├── tools
├── configs
├── data
│   ├── cityscapes
│   │   ├── leftImg8bit
│   │   │   ├── train
│   │   │   ├── val
│   │   ├── gtFine
│   │   │   ├── train
│   │   │   ├── val
│   ├── VOCdevkit
│   │   ├── VOC2012
│   │   │   ├── JPEGImages
│   │   │   ├── SegmentationClass
│   │   │   ├── ImageSets
│   │   │   │   ├── Segmentation
│   │   ├── VOC2010
│   │   │   ├── JPEGImages
│   │   │   ├── SegmentationClassContext
│   │   │   ├── ImageSets
│   │   │   │   ├── SegmentationContext
│   │   │   │   │   ├── train.txt
│   │   │   │   │   ├── val.txt
│   │   │   ├── trainval_merged.json
│   │   ├── VOCaug
│   │   │   ├── dataset
│   │   │   │   ├── cls
```

Ref4:

- Set training, validation, and testing dataset:
Ref1: How to split data into three sets (train, validation, and test) And why?
https://towardsdatascience.com/how-to-split-data-into-three-sets-train-validation-and-test-and-why-e50d22d3e54c

+.3. Start training
NanoDet is now using **pytorch lightning** for training.

>> Architecture