Tensorcom

Tensorcom

- decompression, preprocessing, and loading often create bottlenecks
  - e.g., PyTorch `DataLoader` with workers is limited to a single machine
- `Tensorcom` permits distributed preprocessing
- also permits RDMA, PUB/SUB
- uses a GPU-friendly, simple binary encoding
- makes preprocessing independent of DL framework

N × Storage Server → M × Tensorcom Process → G × GPU machines

N, M, and G can be independently scaled

In [1]:

```
%pylab inline
!date; hostname; whoami; pwd; curl https://ipinfo.io/hostname; nvidia-smi -L
from imp import reload
from torch import nn, optim
from torch.nn import functional as F
from torchmore import layers, flex
import torch
from torchvision import datasets, transforms
from torchvision.datasets import imagenet
import os.path
from torch.utils import data as torchdata
import helpers
import tensorcom as tc
```

```
Populating the interactive namespace from numpy and matplotlib
Sun Dec  8 04:03:45 UTC 2019
tmbcomp
tmb
/home/tmb/exp/bigdata19
158.153.83.34.bc.googleusercontent.com
GPU 0: Tesla V100-SXM2-16GB (UUID: GPU-ffa2b7fc-dde2-eb1c-7481-861ea0f181a3)
GPU 1: Tesla V100-SXM2-16GB (UUID: GPU-80d5ad59-f785-94da-ec20-cb43f2114bd1)
GPU 2: Tesla V100-SXM2-16GB (UUID: GPU-e1896053-8373-94a6-c0d3-febdfe9312ca)
GPU 3: Tesla V100-SXM2-16GB (UUID: GPU-ba5fd29a-104c-ac84-b13d-f04ff2f6f9bc)

/opt/conda/lib/python3.6/site-packages/torchvision/io/_video_opt.py:17: UserWarning: video reader ba
sed on ffmpeg c++ ops not available
  warnings.warn("video reader based on ffmpeg c++ ops not available")
```

Tensorcom Server

- reads ImageNet samples out of a storage bucket
- batches them up in batches of size 128
- publishes them over a ZMQ PUB socket
- this command starts multiple parallel servers at multiple addresses

(The `tmux` command just puts this in the background inside a notebook.)

In [2]:

```
!tmux new -d 'serve-imagenet-shards -b 128 "zpub://127.0.0.1:788{0..3}"'
```

Tensorcom Monitor

The `tensormon` client connects to a Tensorcom server and outputs statistics about the rate at which samples are sent out.

In [3]:

```
!bash -c 'tensormon -c 50 zsub://127.0.0.1:788{0..3}'
```

```
input: ['zsub://127.0.0.1:7880', 'zsub://127.0.0.1:7881', 'zsub://127.0.0.1:7882', 'zsub://127.0.0.1
:7883']
zsub://127.0.0.1:7880
zsub://127.0.0.1:7881
zsub://127.0.0.1:7882
zsub://127.0.0.1:7883
connected
                  10   19.961 batches/s 2555.036 samples/s (batchsize: 128)
                  20   21.803 batches/s 2790.764 samples/s (batchsize: 128)
                  30   13.762 batches/s 1761.558 samples/s (batchsize: 128)
                  40   20.709 batches/s 2650.714 samples/s (batchsize: 128)
                  50   13.977 batches/s 1789.093 samples/s (batchsize: 128)
```

Statistics and Display

- `tensortstat` computes statistics over tensors sent from a server
- `tensorshow` shows images being served

In [4]:

```
!bash -c 'tensorstat -c 50 zsub://127.0.0.1:788{0..3}'
```

```
reading batches...

Source:
rate 0.000000 msg/s throughput 0.00e+00 bytes/s

=== Input 0 ===

50 [0 255] mean=114 std=69.4 n=963379200
{('uint8', 128, 224, 224, 3)}

=== Input 1 ===

50 [1 1e+03] mean=497 std=288 n=6400
{('int32', 128)}
```

Loading

- data augmentation and normalization have already happened in the server
- data is sent as `uint8` for bandwidth, need to convert to float
- also change from 1-based to 0-based class labels

In [6]:

```
def normalize(x): return x/255.0
def normalize_cls(x): return x-1

training_dl = tc.Connection("zsub://127.0.0.1:788{0..3}", epoch=1000000,
                            batch_transforms=[normalize, normalize_cls],
                            converters="torch")
```

Loading

`tensorcom.Connection` works like a `DataLoader`

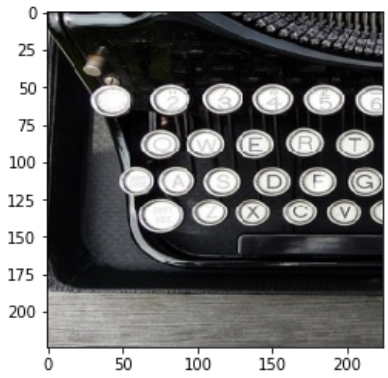
In [7]:

```
image_batch, cls_batch = next(iter(training_dl))
print(image_batch.shape, image_batch.dtype, image_batch.min(), image_batch.max(), cls_batch.min(), cls_batch.max(
))
imshow(image_batch[0].permute(1, 2, 0).numpy())
```

```
torch.Size([128, 3, 224, 224]) torch.float32 tensor(0.) tensor(1.) tensor(0) tensor(990)
```

Out[7]:

```
<matplotlib.image.AxesImage at 0x7f494826eba8>
```



Creating the Model

Note that we use `layers.Input` to check the size and magnitude of tensors; this is optional.

In [ ]:

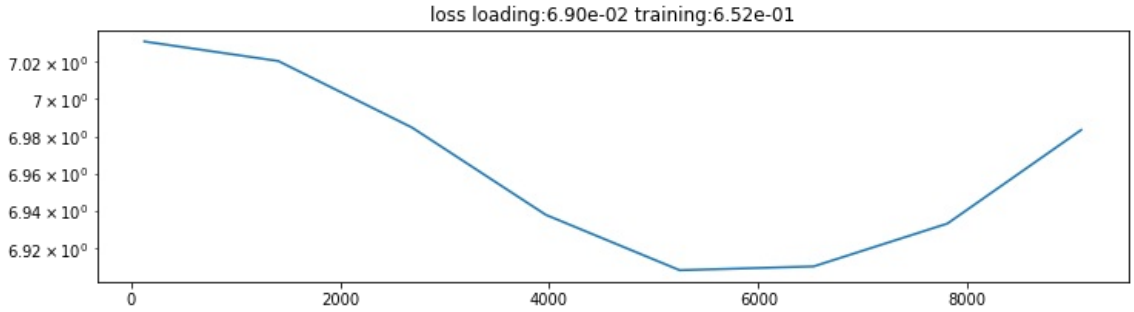
```
from torchvision import models
def make_model():
    return nn.Sequential(
        layers.Input("BDHW", range=(0, 1), sizes=[(2, 9999), 3, 224, 224]),
        models.resnet50()
    )
model = make_model()
model.cuda();
```

Training

Note that loading is now very fast (1/10th the time of learning).

In [9]:

```
reload(helpers)
trainer = helpers.Trainer(model)
trainer.set_lr(1e-3)
trainer.train_for(10000, training_dl)
clf()
```




```
<Figure size 864x216 with 0 Axes>
```