Distributed Deep Learning (DDL) with HopsML

RISE Machine Learning Study Group

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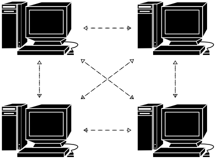
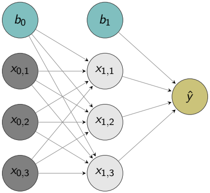
Outline

1. Distributed Deep Learning (DDL) Theory
2. HopsML: Distributed Deep Learning in Practice
3. Use-Case of DDL: Anti-Money-Laundering

Distributed Computing



Deep Learning



Why Combine the two?

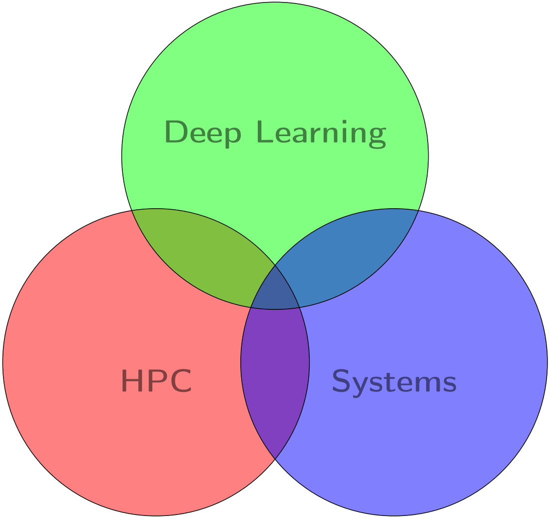
- More productive Data Science[1]
- Unreasonable effectiveness of data[2]
- To achieve state-of-the-art results[3]

[1] Alex Sergeev and title = Meet Horovod: Uber's Open Source Distributed Deep Learning Framework for TensorFlow howpublished = https://eng.uber.com/horovod/ note = Accessed: 2018-11-24 Mike Del Balso year=2017.

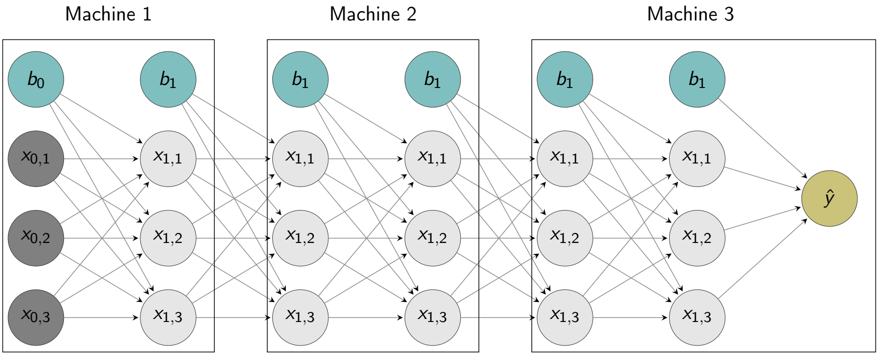
[2] Chen Sun et al. "Revisiting Unreasonable Effectiveness of Data in Deep Learning Era". In: *CoRR* abs/1707.02968 (2017). arXiv: 1707.02968. URL: http://arxiv.org/abs/1707.02968.

[3] Jeffrey Dean et al. "Large Scale Distributed Deep Networks". In: *Advances in Neural Information Processing Systems 25*. Ed. by F. Pereira et al. Curran Associates, Inc., 2012, pp. 1223–1231. URL: http://papers.nips.cc/paper/4687-large-scale-distributed-deep-networks.pdf.

What is Distributed Deep Learning?



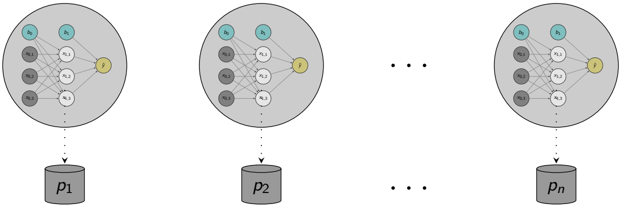
Model Parallelism



Data Parallelism

Data Parallel Workers $\mathcal{W}$

Data Partitions $\mathcal{P}$

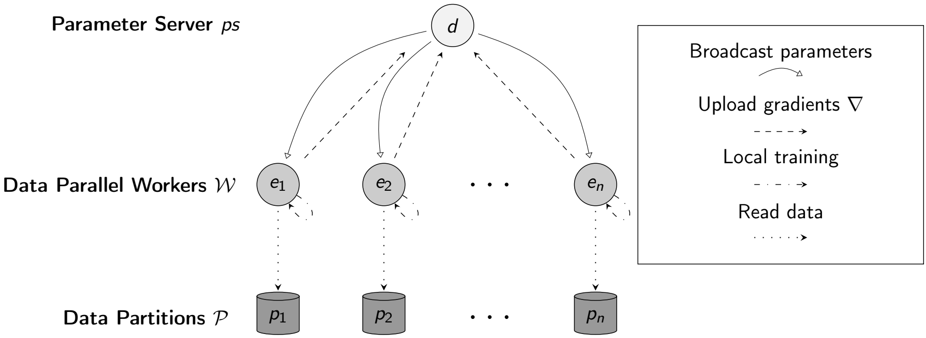


When to use Model Parallel and Data Parallel?

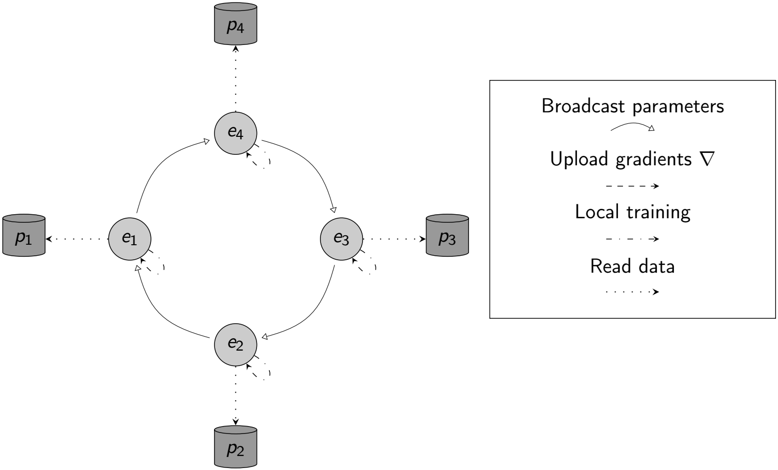
- How big is your model parameters θ vs GPU memory? If $size(\theta) > size(gpu)$ you have to use model parallelism

- If your model fits on a single GPU $\implies$ in 99.999% you want to use data parallelism to reduce training time

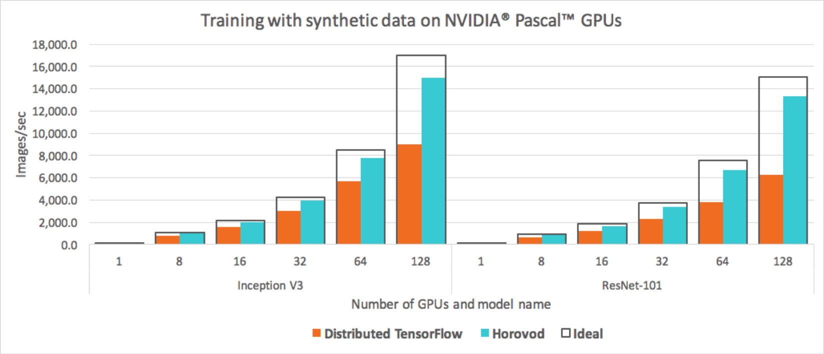
Parameter Server Architecture



Ring-All-Reduce Architecture



When to use Parameter-Server and when to use Ring-All-Reduce?



Ring-all-reduce scales better $\implies$ generally prefer ring-all-reduce[4]

[4] Alex Sergeev and title = Meet Horovod: Uber's Open Source Distributed Deep Learning Framework for TensorFlow howpublished = https://eng.uber.com/horovod/ note = Accessed: 2018-11-24 Mike Del Balso year=2017.

How to get started?

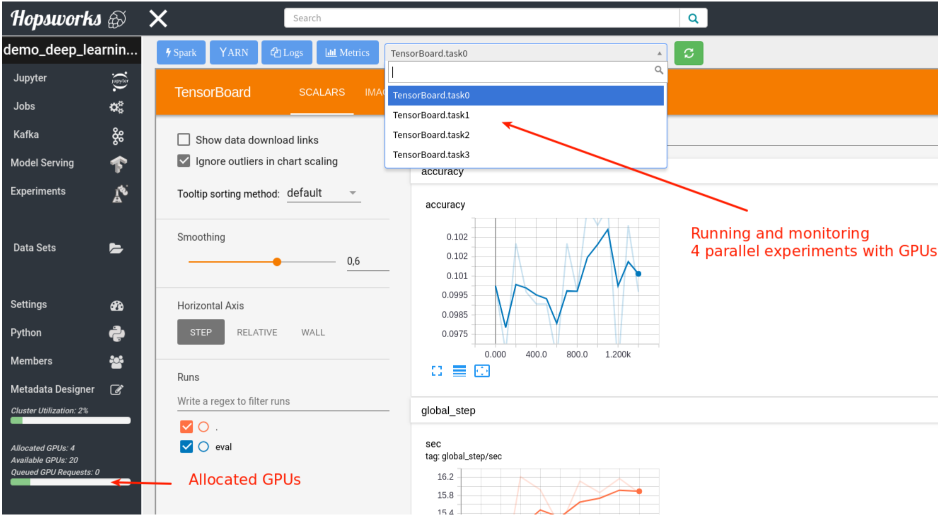
ICE (RISE SICS NORTH) provides the hardware that you need

- GPU Machines for training ✔
- CPU Machines for data prep ✔
- Disks for storing large datasets ✔

HopsML provides the ML infrastructure that you need

- Fast Distributed File System ✔
- Spark-jobs and notebooks for data prep ✔
- Framework for reproducible and versioned parallel experiments ✔
- Framework for distributed training ✔
- Framework for monitoring training ✔
- Support for auto-scaling model serving ✔
- Feature store ✗(Soon!)

Hopsworks: UI-driven front-end to the ML infrastructure



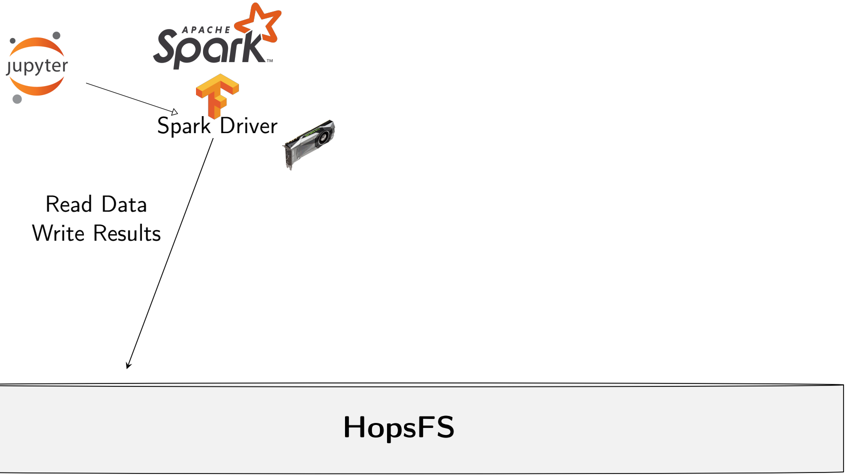
Python-First API-powered workflow

Write your regular tensorflow/python/pytorch/keras code and put it in a function, for example called `collective_all_reduce_mnist`, then you can create a reproducible experiment using many GPUs and collective-all-reduce as follows:

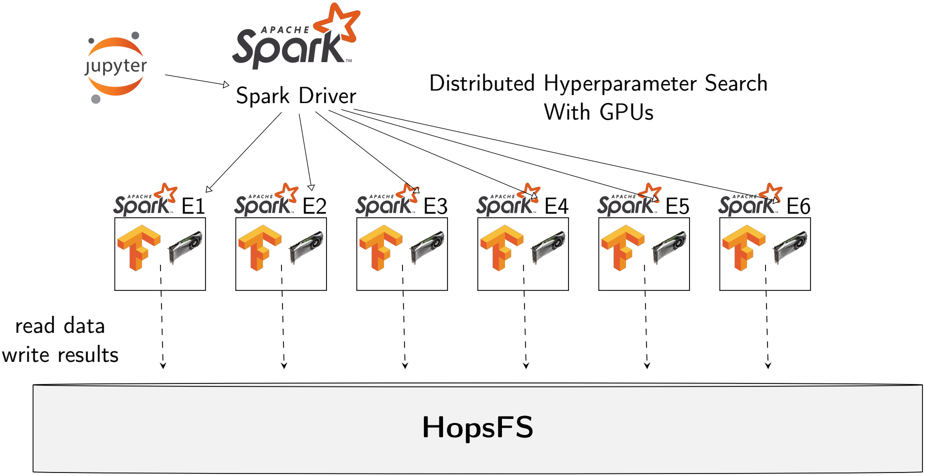
```python
from hops import experiment
from hops import hdfs


notebook = hdfs.project_path() +
"Jupyter/Distributed_Training/collective_allreduce_strategy/mnist.ipynb"
experiment.collective_all_reduce(collective_all_reduce_mnist,
                    name='mnist estimator',
                    description='A minimal mnist example with two hidden layers',
                    versioned_resources=[notebook], local_logdir=True)
```

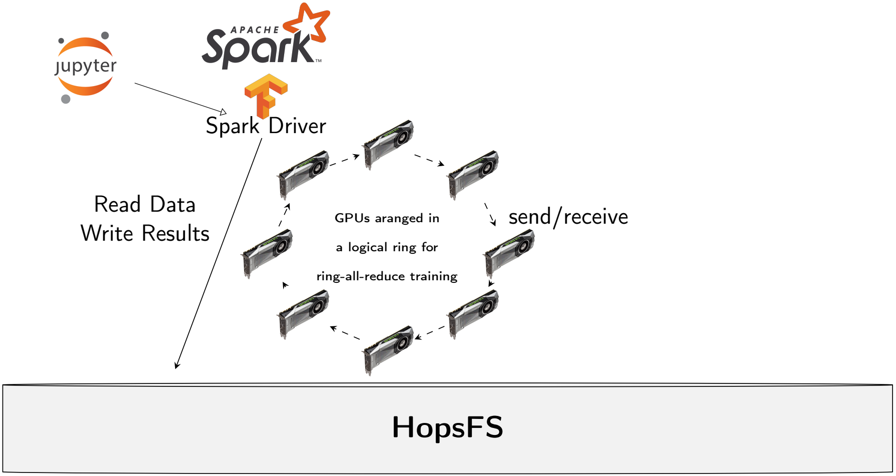
Single-GPU Training on Hops



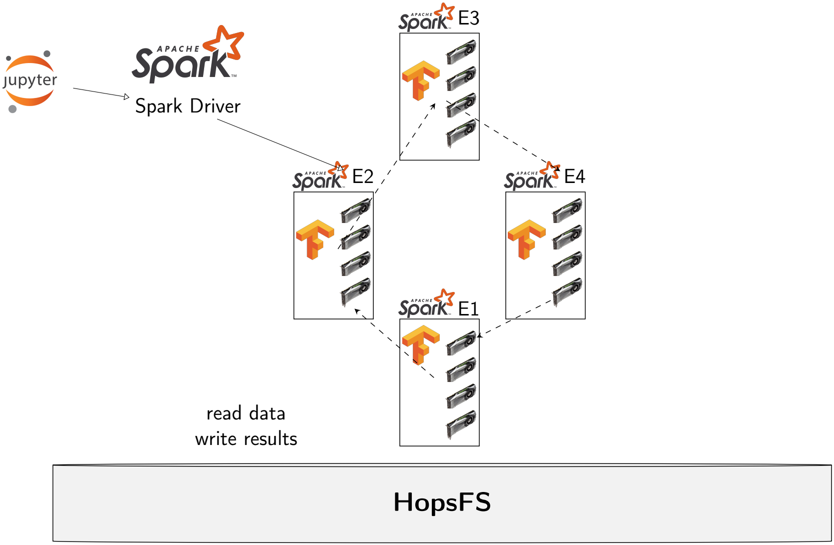
Parallel Experiments on Hops



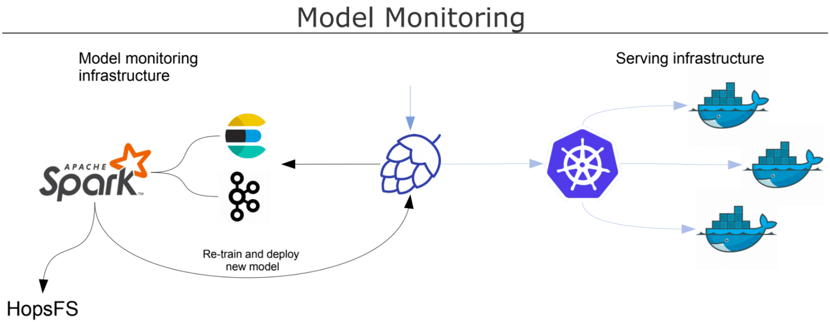
Multi-GPU Training on Hops



Distributed GPU Training on Hops



Model Serving on Hops



- Register at `hops.site`, email: kim@logicalclocks.com if your registration is not approved
- Try out the deep learning tour on hopsworks
- Example code: `https://github.com/logicalclocks/hops-examples`
- Look at the docs: `https://www.hops.io/`
- If you get stuck, write on gitter: `https://gitter.im/hopshadoop/hopsworks`

DEMO