DEV DAY

Optimize your Machine Learning workloads

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Amazon SageMaker

Build

Pre-built notebooks for common problems

Built-in, high-performance algorithms

Train

One-click training

Hyperparameter optimization

P3DN, C5N
TensorFlow on 256 GPUs
Dynamic Training on MXNet
Automatic Model Tuning

Deploy

One-click deployment

Fully managed hosting with auto-scaling

Model compilation
Elastic inference
Inference pipelines

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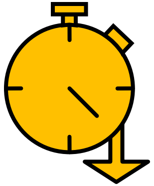
Optimizing infrastructure

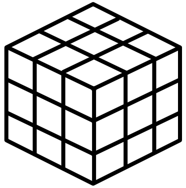
aws

Amazon EC2 P3dn

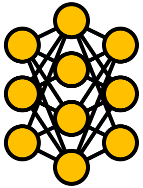
https://aws.amazon.com/blogs/aws/new-ec2-p3dn-gpu-instances-with-100-gbps-networking-local-nvme-storage-for-faster-machine-learning-p3-price-reduction/



Reduce machine learning training time



Better GPU utilization



Support larger, more complex models

KEY FEATURES

100Gbps of networking bandwidth

8 NVIDIA Tesla V100 GPUs

32GB of memory per GPU (2x more P3)

96 Intel Skylake vCPUs (50% more than P3) with AVX-512

Amazon EC2 C5n

https://aws.amazon.com/blogs/aws/new-c5n-instances-with-100-gbps-networking/

Intel Xeon Platinum 8000

Up to 3.5GHz single core speed

Up to 100Gbit networking

Based on Nitro hypervisor for bare metal-like performance

Instance Name	vCPUs	RAM	EBS Bandwidth	Network Bandwidth
c5n.large	2	5.25 GiB	Up to 3.5 Gbps	Up to 25 Gbps
c5n.xlarge	4	10.5 GiB	Up to 3.5 Gbps	Up to 25 Gbps
c5n.2xlarge	8	21 GiB	Up to 3.5 Gbps	Up to 25 Gbps
c5n.4xlarge	16	42 GiB	3.5 Gbps	Up to 25 Gbps
c5n.9xlarge	36	96 GiB	7 Gbps	50 Gbps
c5n.18xlarge	72	192 GiB	14 Gbps	100 Gbps

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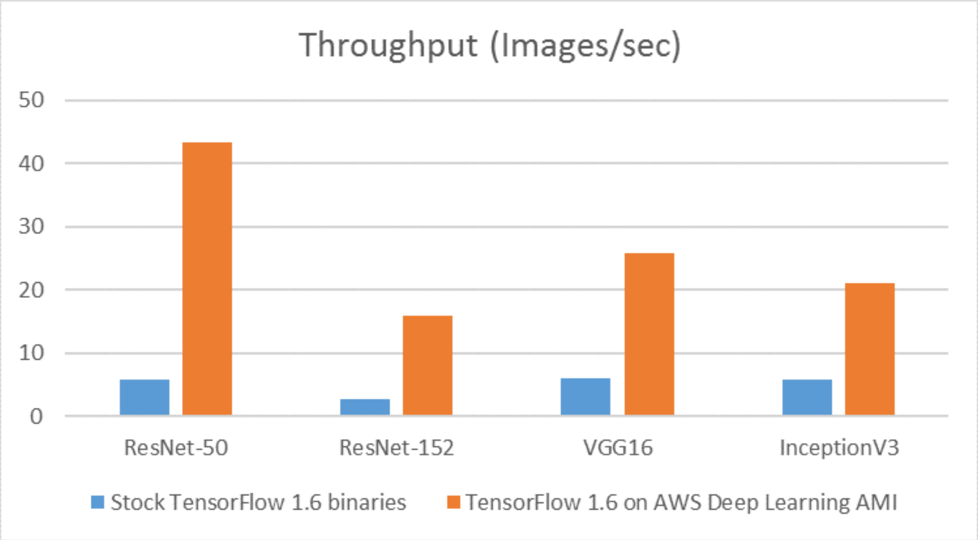
Optimizing frameworks

aws

Making TensorFlow faster



https://aws.amazon.com/blogs/machine-learning/faster-training-with-optimized-tensorflow-1-6-on-amazon-ec2-c5-and-p3-instances/ (March 2018)

Training a ResNet-50 benchmark with the synthetic ImageNet dataset using our optimized build of TensorFlow 1.11 on a c5.18xlarge instance type is **11x faster** than training on the stock binaries.

https://aws.amazon.com/about-aws/whats-new/2018/10/chainer4-4_theano_1-0-2_launch_deep_learning_ami/ (October 2018)

Scaling TensorFlow near-linearly to 256 GPUs

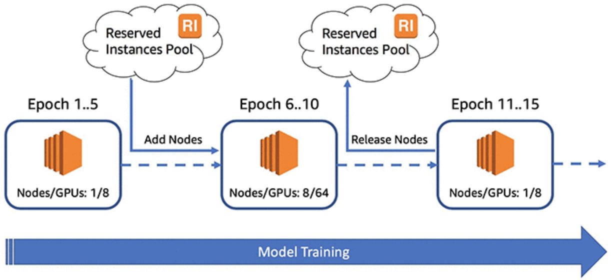
https://aws.amazon.com/about-aws/whats-new/2018/11/tensorflow-scalability-to-256-gpus/

Stock TensorFlow		AWS-Optimized TensorFlow	
65% scaling efficiency with 256 GPUs	→	90% scaling efficiency with 256 GPUs	Available with Amazon SageMaker and the AWS Deep Learning AMIs
30m training time	→	14m training time	

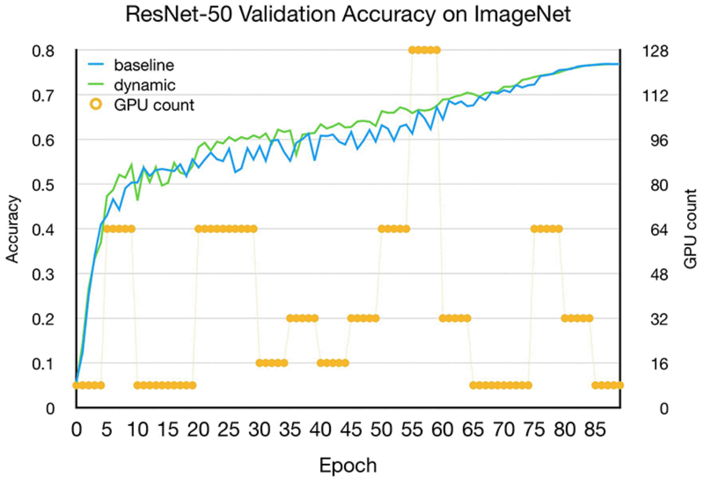
Dynamic training with Apache MXNet and RIs

https://aws.amazon.com/blogs/machine-learning/introducing-dynamic-training-for-deep-learning-with-amazon-ec2/

Use a variable number of instances for distributed training



No loss of accuracy



Coming soon
spot instances,
additional frameworks

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Optimizing models

Examples of hyperparameters

XGBoost

Tree depth
Max leaf nodes
Gamma
Eta
Lambda
Alpha
…

Neural Networks

Number of layers
Hidden layer width
Learning rate
Embedding dimensions
Dropout
…

Automatic Model Tuning

Finding the optimal set of hyper parameters

1. Manual Search ("I know what I'm doing")
2. Grid Search ("X marks the spot")
   - Typically training hundreds of models
   - Slow and expensive
3. Random Search ("Spray and pray")
   - Works better and faster than Grid Search
   - But… but… but… it's random!
4. HPO: use Machine Learning
   - Training fewer models
   - Gaussian Process Regression and Bayesian Optimization
   - You can now resume from a previous tuning job

Demo: HPO with Apache MXNet

https://github.com/awslabs/amazon-sagemaker-examples/tree/master/hyperparameter_tuning/hpo_mxnet_mnist.ipynb

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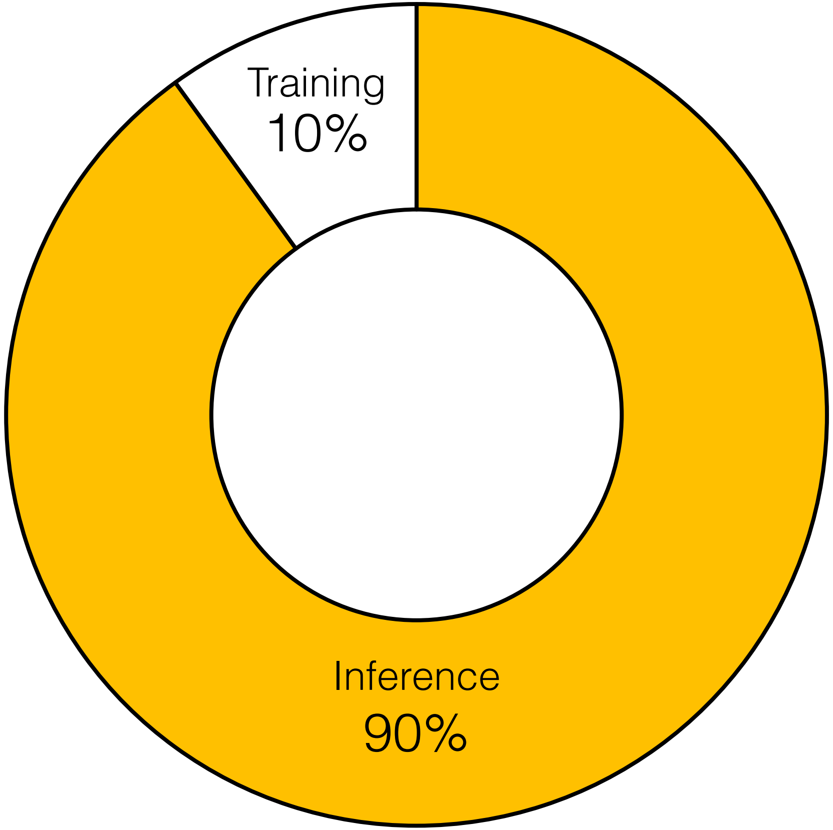
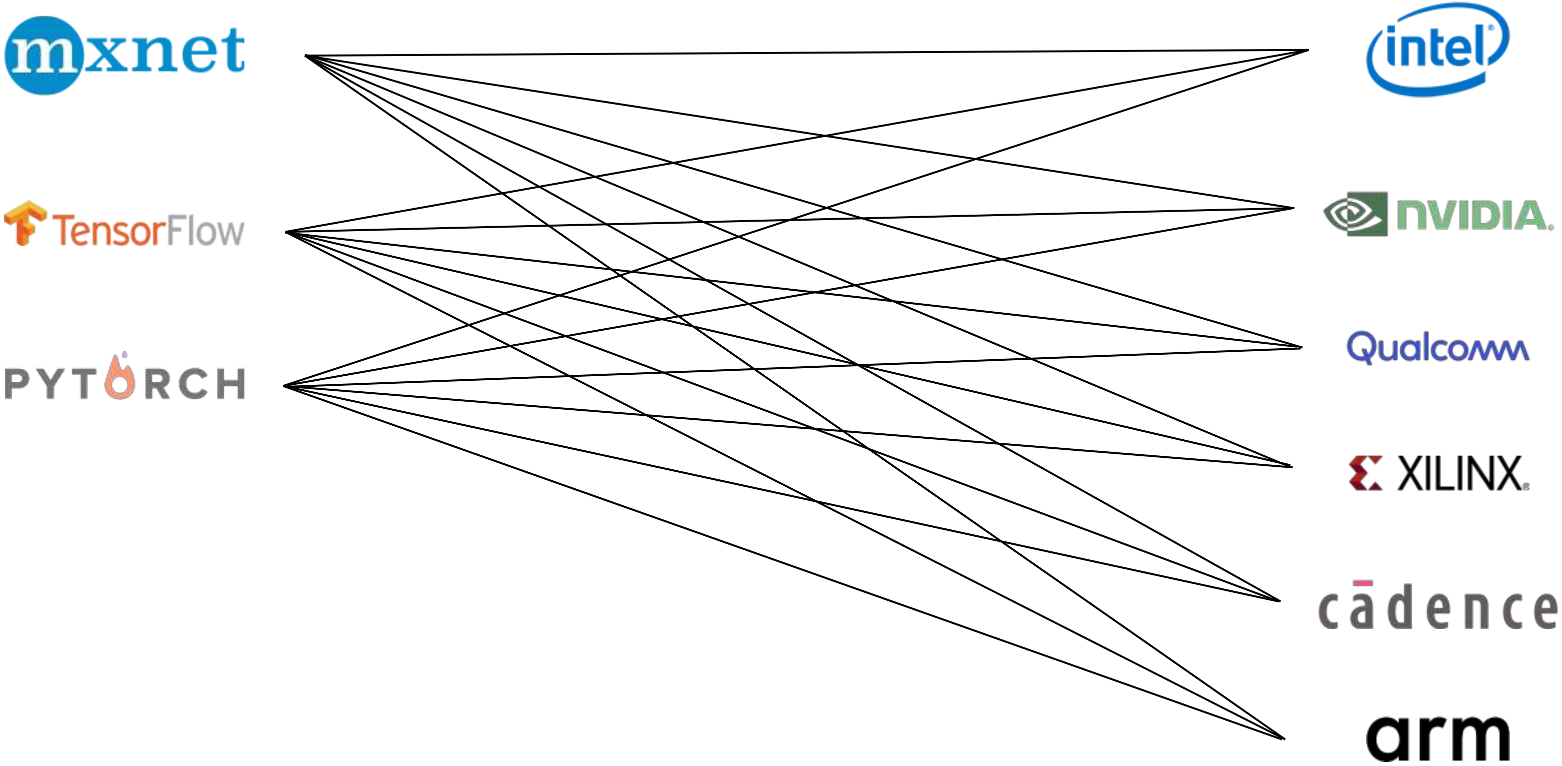
Optimizing inference

aws

Predictions drive complexity and cost in production



Model optimization is extremely complex



Amazon Neo: compiling models

https://aws.amazon.com/blogs/aws/amazon-sagemaker-neo-train-your-machine-learning-models-once-run-them-anywhere/

- Train once, run anywhere
- Frameworks and algorithms
    - TensorFlow, Apache MXNet, PyTorch, ONNX, and XGBoost
- Hardware architectures
    - ARM, Intel, and NVIDIA starting today
    - Cadence, Qualcomm, and Xilinx hardware coming soon
- Amazon SageMaker Neo is open source, enabling hardware vendors to customize it for their processors and devices: https://github.com/neo-ai/

Compiling ResNet-50 for the Raspberry Pi

Configure the compilation job

```
{
  "RoleArn":$ROLE_ARN,
  "InputConfig": {
   "S3Uri":"s3://jsimon-neo/model.tar.gz",
   "DataInputConfig": "{\"data\": [1, 3, 224, 224]}",
   "Framework": "MXNET"
  },
 "OutputConfig": {
  "S3OutputLocation": "s3://jsimon-neo/",
  "TargetDevice": "rasp3b"
 },
 "StoppingCondition": {
 "MaxRuntimeInSeconds": 300
 }
}
```

Compile the model

```
$ aws sagemaker create-compilation-job
--cli-input-json file://config.json
--compilation-job-name resnet50-mxnet-pi

$ aws s3 cp s3://jsimon-neo/model-
rasp3b.tar.gz .

$ gtar tfz model-rasp3b.tar.gz
compiled.params
compiled_model.json
compiled.so
```

Predict with the compiled model

```
from dlr import DLRModel
model = DLRModel('resnet50', input_shape,
output_shape, device)
out = model.run(input_data)
```

Demo: compiling a pre-trained PyTorch model with Neo

https://github.com/awslabs/amazon-sagemaker-examples/blob/master/advanced_functionality/pytorch_torchvision_neo/pytorch_torchvision_neo.ipynb

Amazon Elastic Inference

https://aws.amazon.com/blogs/aws/amazon-elastic-inference-gpu-powered-deep-learning-inference-acceleration/

Lower inference costs up to 75%

Match capacity to demand

Available between 1 to 32 TFLOPS

KEY FEATURES

Integrated with Amazon EC2, Amazon SageMaker, and Amazon DL AMIs

Support for TensorFlow, Apache MXNet, and ONNX with PyTorch coming soon

Single and mixed-precision operations

Demo:
Elastic Inference with TensorFlow

https://github.com/awslabs/amazon-sagemaker-examples/blob/master/sagemaker-python-sdk/tensorflow_iris_dnn_classifier_using_estimators/

Train & predict faster

Save time

Save money

Save your sanity (no plumbing!)

Getting started

https://ml.aws

https://aws.amazon.com/sagemaker

https://github.com/awslabs/amazon-sagemaker-examples

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Thank you!

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