WeightGrad: Geo-Distributed Data Analysis Using Quantization for Faster Convergence and Better Accuracy

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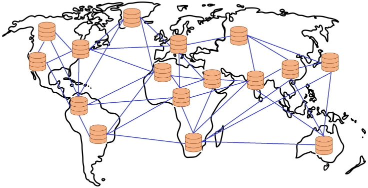
Problem Overview



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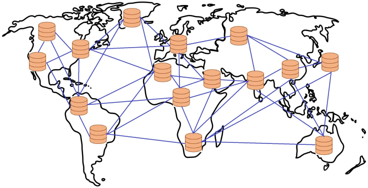

Problem

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- Huge amount of time.

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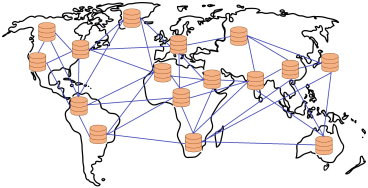

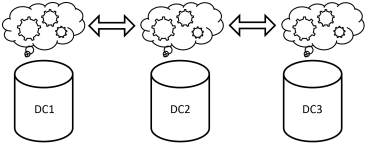

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Solution

- Distribute the DNN system across multiple data centers.

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- How to efficiently utilize limited WAN b/w
- How to ensure faster convergence without loss of accuracy

Methodology

We propose **WeightGrad** that

- adapts both weight and gradient quantization to provide best speedup possible on WAN
- proposes a synchronous structure to prevent the loss in accuracy due to quantization

WeightGrad System

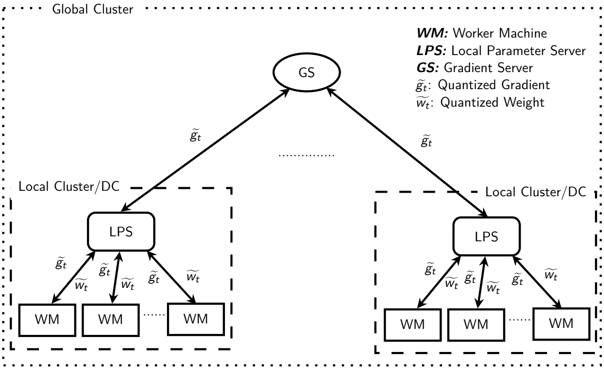
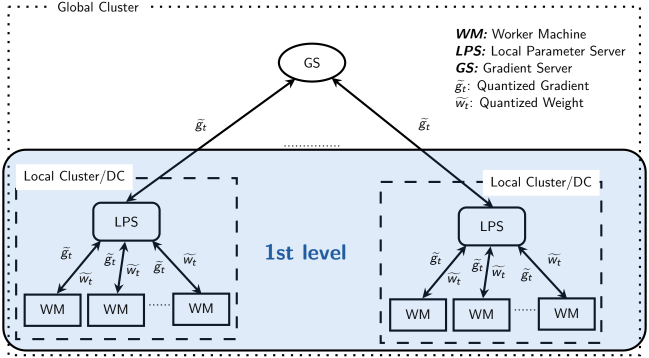


Figure: WeightGrad Tree Structure

Two Level Structure



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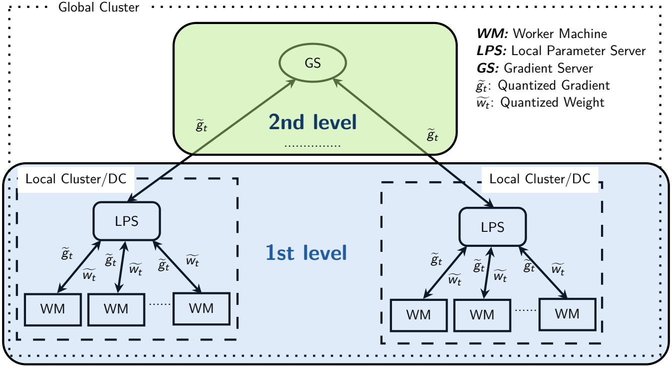

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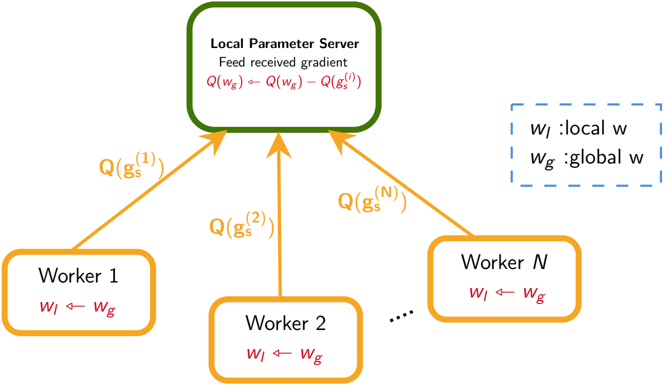
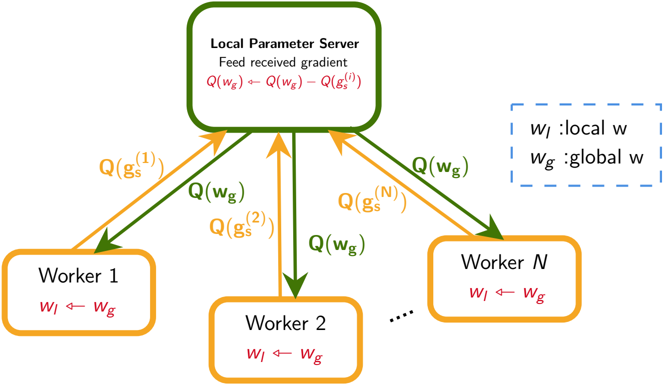


Figure: WeightGrad: Local Cluster

WeightGrad System



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LPS with Gradient Synchronizer

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Dynamic Threshold

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Fixed Interval

- Maintains a fixed interval T, within which LPS receives aggregated gradient values from the GS.

Amazon EC-2

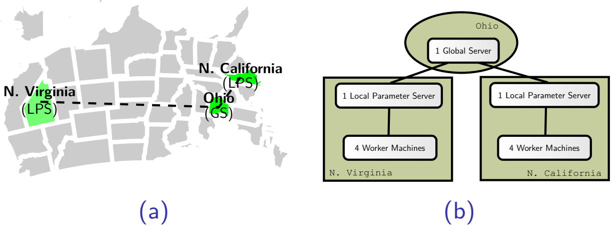
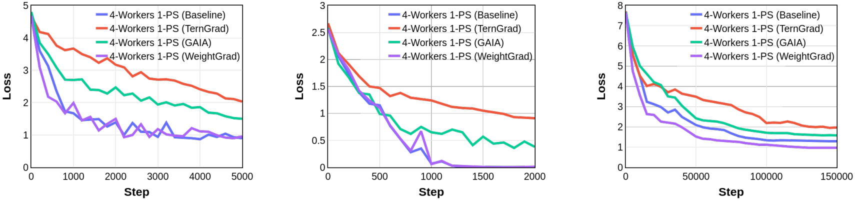


Figure: (a)Deployment Regions in AWS(b)Instance Hierarchy

Instances	Instance Type	RAM	vCPU	GPU	B/W
11	g3s.xlarge, 64-bit Ubuntu Server 16.04 LTS	30.5 GiB	4	NVIDIA Tesla M60 GPU	10 Gbps

Training Loss Analysis



(a) Training Loss for CifarNet

(b) Training Loss for VGGNet

(c) Training Loss for ImageNet

Figure: (a) Training loss for CifarNet model on CIFAR-10 dataset (b) Training loss for VGGNet model on CIFAR-10 dataset (c) Training loss for AlexNet on ImageNet dataset

SpeedUp Analysis

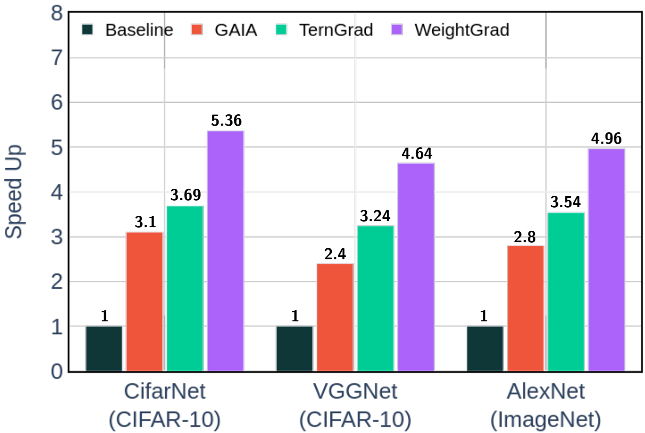


Figure: Training Speed Comparison

Accuracy Comparison

Model	SGD	Base LR	Total mini-batch size	Steps	Gradients	Workers	Accuracy
CifarNet	GD	0.1	128	50k	Baseline	4	84.56%
					Gaia	4	83.48%(-1.08%)
					TernGrad	4	82.41%(-2.15%)
					WeightGrad	**4**	**84.56%(-0.00%)**
	GD	0.1	512	50k	Baseline	8	83.19%
					Gaia	8	83.04%(-0.13%)
					TernGrad	8	81.40%(-1.79%)
					WeightGrad	**8**	**83.21%(+0.03%)**
VGG-Net	GD	0.1	512	50k	Baseline	8	88.14%
					Gaia	8	87.19%(-0.95%)
					TernGrad	8	86.3%(-1.84%)
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(a)

Table: Comparison of training methods on (a) Cifar-10 data and (b) ImageNet

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(a)

Model	Steps	Training Method	Top-1 Accuracy	Top-5 Accuracy
AlexNet	185k	Baseline	58.17%	80.19%
		Gaia	58.02%(-0.15%)	80.20%(+0.01%)
		TernGrad	57.32%(-0.85%)	80.18%(-0.01%)
		Deep Gradient Compression	58.20%(+0.03%)	80.20%(+0.01%)
		WeightGrad	**59.28%(+1.06%)**	**80.25%(+0.06)**

(b)

Table: Comparison of training methods on (a) Cifar-10 data and (b) ImageNet

THANK YOU!