Assignment 2 out!

Bid on topics, submit group (1 sentences) – Oct 5
Project Proposal (2 pages) – Oct 16

Introduction
Related Work
Timeline (with eval plan)
EMPIRICAL RISK MINIMIZATION

\[
\min_{w \in \mathbb{R}^d} \sum_{i=1}^{N} f(w, z_i) + P(w)
\]
DEEP LEARNING

ResNet18

Convolution
ReLU
MaxPool
Fully Connected
SoftMax
STOCHASTIC GRADIENT DESCENT

\[ w^{(k+1)} = w^{(k)} - \alpha_k \nabla f(w^{(k)}) \]

Initialize \( w \)
For many iterations:
   - Loss = Forward pass
   - Gradient = backward
   - Update model
End
DATA PARALLEL MODEL TRAINING
COLLECTIVE COMMUNICATION

Broadcast, Scatter

MPI_Bcast

Gather, Reduce

MPI_Gather

MPI_Scatter

MPI_Reduce

From https://mpitutorial.com/tutorials/
ALL REDUCE

MPI_Allreduce

From https://mpitutorial.com/tutorials/
DISTRIBUTED DATA PARALLEL API

# setup model and optimizer
net = nn.Linear(10, 10)
net = par.DistributedDataParallel(net)
opt = optim.SGD(net.parameters(), lr=0.01)

# run forward pass
inp = torch.randn(20, 10)
exp = torch.randn(20, 10)
out = net(inp)

# run backward pass
nn.MSELoss()(out, exp).backward()

# update parameters
opt.step()
GRADIENT BUCKETING

Why do we need gradient bucketing?
GRADIENT BUCKETING + ALL REDUCE
```python
1  ddp = DistributedDataParallel(net)
2  with ddp.no_sync():
3      for inp, exp in zip(inputs, expected_outputs):
4          # no synchronization, accumulate grads
5          loss_fn(ddp(inp), exp).backward()
6      # synchronize grads
7  loss_fn(ddp(another_inp), another_exp).backward()
8  opt.step()
```
IMPLEMENTATION

Bucket_cap_mb

Parameter-to-bucket mapping

Round-robin ProcessGroups
Figure 6: Per Iteration Latency Breakdown
Pytorch: Framework for deep learning
DistributedDataParallel API
Gradient bucketing, AllReduce
Overlap computation and communication
DISCUSSION

https://forms.gle/6xhVBNBhdzsJ6gBE6
Figure 7: Per Iteration Latency vs Bucket Size on 16 GPUs

Figure 8: Per Iteration Latency vs Bucket Size on 32 GPUs
What could be some challenges in implementing similar optimizations for AllReduce in Apache Spark?
NEXT STEPS

Next class: PipeDream
Assignment 2 is due soon!

Project Proposal
  Groups by Oct 5
  2 pager by Oct 16