ТЕХНОСФЕРА

Лекция 12
Large scale machine learning

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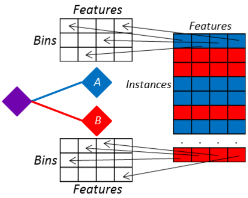
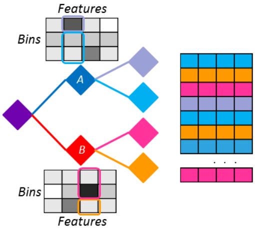
План лекции

Large scale decision trees ensembles

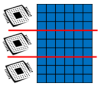
Large scale neural networks

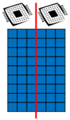
Distributed tree construction





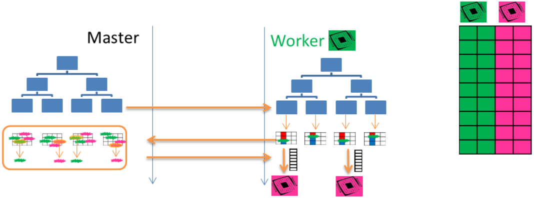
- Наблюдение 1: Одного прохода по данным достаточно на каждый уровень дерева
- Наблюдение 2: Итерироваться можно либо по точкам, либо по фичам





Distributed tree construction

Feature Distributed



Master

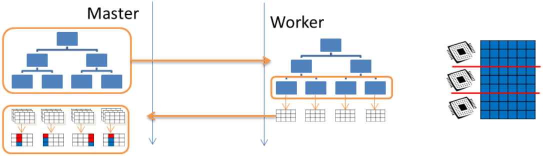
- Request workers to expand a set of nodes
- Wait to receive best per-feature splits from workers
- Select best feature-split for every node
- Request best splits' workers to broadcast per-instance assignments and residuals

Worker

- Pass through all instances for local features, aggregating split histograms for each node

Distributed tree construction

Data Distributed



Master

- Send workers current model and set of nodes to expand
- Wait to receive local split histograms from workers
- Aggregate local split histograms, select best split for every node

Worker

- Pass through local data, aggregating split histograms
- Send completed local historograms to master

Distributed tree construction

Data Distributed for sparse features

Algorithm 2 FindBestSplit

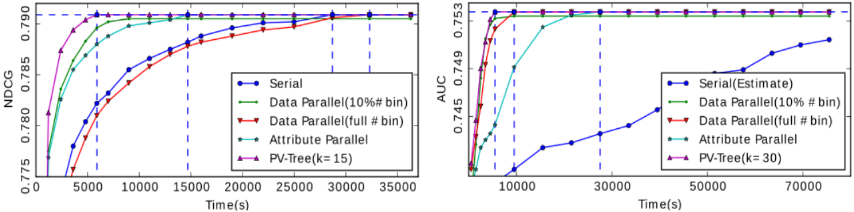
```
Input: DataSet D
for all X in D.Attribute do
  ▷ Construct Histogram
  H = new Histogram()
  for all x in X do
    H.binAt(x.bin).Put(x.label)
  end for
  ▷ Find Best Split
  leftSum = new HistogramSum()
  for all bin in H do
    leftSum = leftSum + H.binAt(bin)
    rightSum = H.AllSum - leftSum
    split.gain = CalSplitGain(leftSum, rightSum)
    bestSplit = ChoiceBetterOne(split,bestSplit)
  end for
end for
return bestSplit
```

Algorithm 3 PV-Tree_FindBestSplit

```
Input: Dataset D
localHistograms = ConstructHistograms(D)
▷ Local Voting
splits = []
for all H in localHistograms do
  splits.Push(H.FindBestSplit())
end for
localTop = splits.TopKByGain(K)
▷ Gather all candidates
allCandidates = AllGather(localTop)
▷ Global Voting
globalTop = allCandidates.TopKByMajority(2*K)
▷ Merge global histograms
globalHistograms = Gather(globalTop, localHis-
tograms)
bestSplit = globalHistograms.FindBestSplit()
return bestSplit
```

Distributed tree construction

Results



(a) LTR, 8 machines (b) CTR, 32 machines

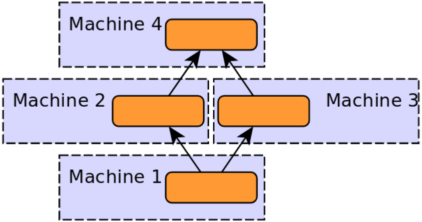
Figure 1: Performances of different algorithms

GBM ON HADOOP

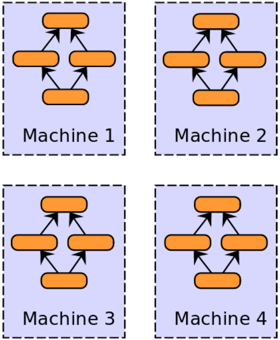
Large scale neural networks

Paradigms

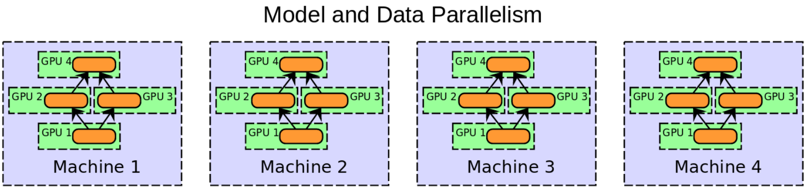
Model Parallelism



Data Parallelism



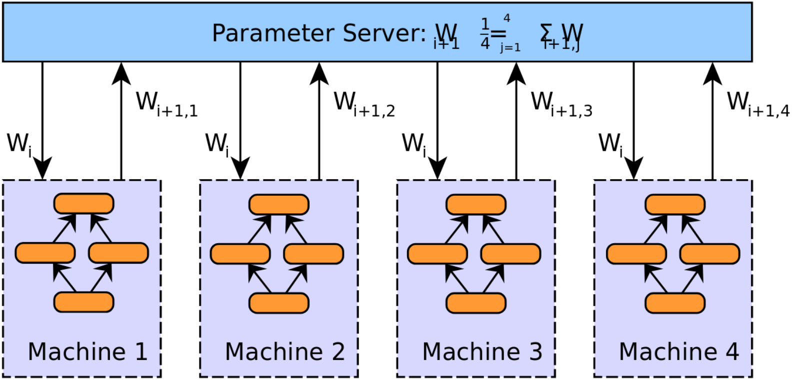
Model and data parallelism



Parameter averaging

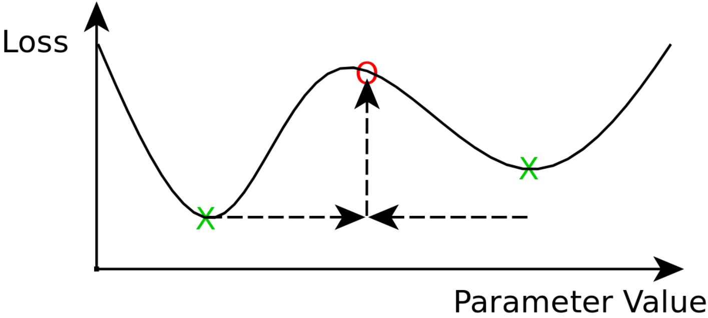
1. Initialize the network parameters randomly based on the model configuration
2. Distribute a copy of the current parameters to each worker
3. Train each worker on a subset of the data
4. Set the global parameters to the average the parameters from each worker
5. While there is more data to process, go to step 2

Parameter averaging

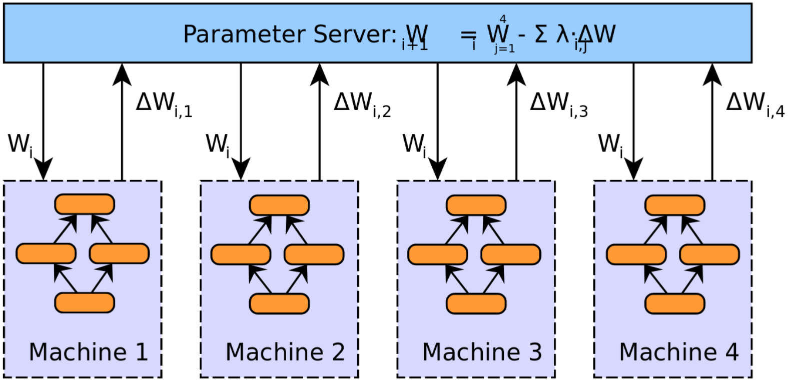


Parameter averaging problem

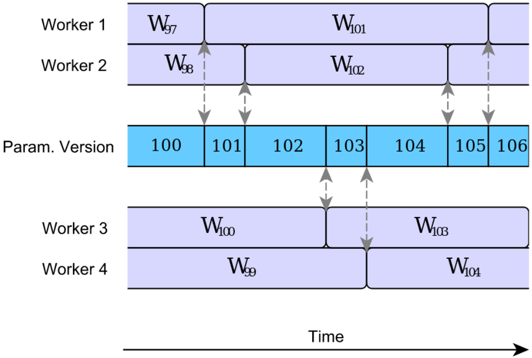
Сумма N локальных минимумов не является глобальным минимумом



Asynchronous Stochastic Gradient Descent



Stale Gradient Problem



$$\vdots$$

$$W_{101} = W_{100} - \lambda \Delta W_{97}$$

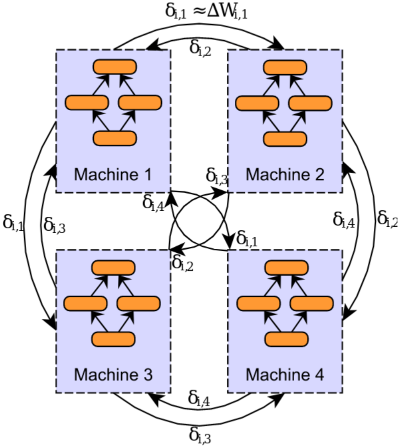
$$W_{102} = W_{101} - \lambda \Delta W_{98}$$

$$W_{103} = W_{102} - \lambda \Delta W_{100}$$

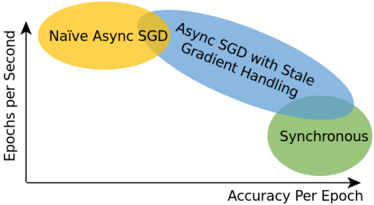
$$W_{104} = W_{103} - \lambda \Delta W_{99}$$

$$\vdots$$

Decentralized Asychronous Stochastic Gradient Descent



Which Approach is Best?



Вопросы