# **Efficient Distributed Stochastic Dual Coordinate Ascent**

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#### **Overview**

Problem Description and Related Work

Problem of Interest

Related Work

Practical GPU-version of SDCA

GPU-version of vanilla SDCA

**Problem Description and Related** 

Work

#### **Outline**

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#### **Problem of Interest**

Many machine learning problems can be formulated as the Regularized Finite Sum Minimization (RFSM) problem.

$$\min_{w \in \mathbb{R}^d} P(w), \text{ where } P(w) = \frac{1}{n} \sum_{i=1}^n \phi(w^\top x_i, y_i) + \lambda g(w), \tag{1}$$

where  $w\in\mathbb{R}^d$  denotes the weight vector,  $(x_i,y_i),x_i\in\mathbb{R}^d,y_i\in\mathbb{R},\,i=1,\ldots,n$  are training data,  $\lambda>0$  is a regularization parameter,  $\phi(z,y)$  is a convex function of z, and g(w) is a convex function of w.

## **Approaches to solve RFSM problem**

#### • The difficulty:

When the data size n is very large, it is difficult to use full gradient method or even fit all data on one single machine.

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#### The countermeasures:

- Stochastic Optimization
- Distributed Optimization

### **Outline**

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## **Stochastic Optimization**

- Stochastic Gradient Descent (SGD)
   [Bottou, 2010, Nemirovski et al., 2009]
- Stochastic Variance Reduced Gradient (SVRG)
   [Johnson and Zhang, 2013, Xiao and Zhang, 2014]
- Stochastic Dual Coordinate Ascent (SDCA)
   [Shalev-Shwartz and Zhang, 2013,
   Shalev-Shwartz and Zhang, 2014]
- . . .

## **Distributed Optimization**

- Distributed SGD [Lian et al., 2015]
- Distributed Stochastic ADMM [Boyd et al., 2011]
- Distributed SDCA [Yang, 2013, Yang et al., 2013]

#### **Our Contribution**

- The current SDCA and distributed SDCA are implemented by CPU
- Our contribution is to implement a practically more efficient GPU-based implementation, in both sequential setting and distributed setting.

## Practical GPU-version of SDCA

#### **Outline**

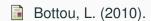
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## **GPU-version vanilla SDCA**



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