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Primal estimated sub-gradient solver for SVM

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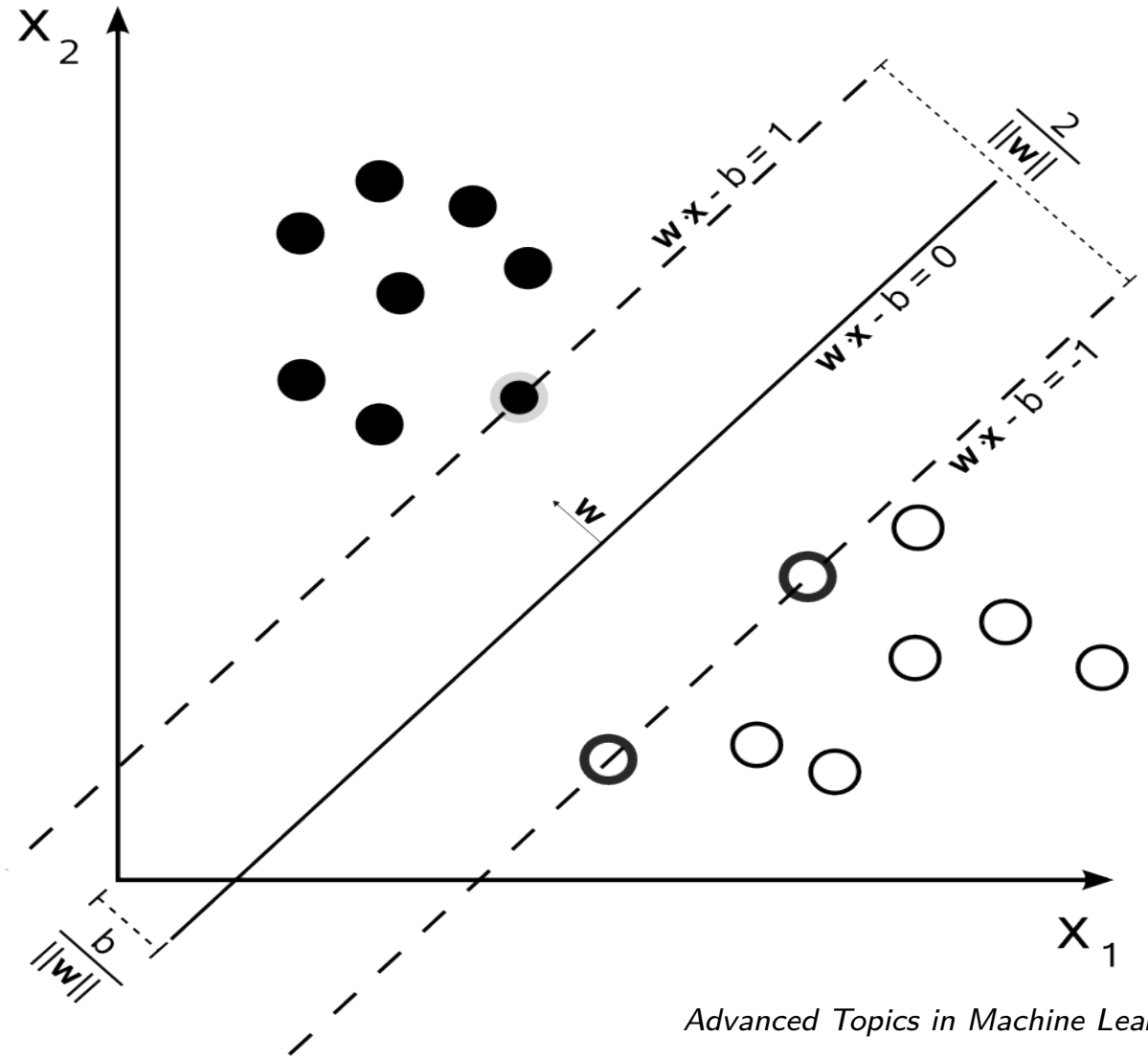
Motivating example



Support Vector Machine

Definition

In machine learning many models to do classification and regression analysis are of the following form. Given a training set $(\boldsymbol{x}_i, y_i)_{i=1}^n$ with $\boldsymbol{x}_i \in \mathbb{R}^d$, $y_i \in \{-1, +1\}$, learning is formulated as the task of minimizing the following objective function:

$$f(\boldsymbol{w}) := \frac{1}{n} \sum_{i=1}^{n} L_i(\boldsymbol{w}) + \frac{\lambda}{2} \|\boldsymbol{w}\|^2$$

Loss Function and Subgradient

Definition

- Loss: $L_i := \ell(\langle \boldsymbol{x}_i, \boldsymbol{w} \rangle, y_i)$
- Subgradient: $l'(\langle \boldsymbol{x}_i, \boldsymbol{w} \rangle, y_i)$

Use the notation $z = \langle \boldsymbol{w}, \boldsymbol{x}_i \rangle$, sample loss functions:

Loss function	Subgradient
$l(z, y_i) = \max\{0, 1 - y_i z\}$	ss
$l(z, y_i) = \log(1 + e^{-y_i z})$	1
$l(z, y_i) = \max\{0, \lvert y_i - z \rvert - \epsilon\}$	1

Stochastic Gradient Descent

Description

Following the basic Pegasos algorithm, $\boldsymbol{w}$ is set to be 0 initially. In each round, we pick a random training example $(\boldsymbol{x}_i, y_i)$ in which i is picked with probability p_i, $\mathrm{s.t.}$ $p_i \geq 0$ and $\sum_{i=1}^{n} p_i = 1$.

G

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- Technically
- xx
- Methodologically
- xx

Thank You!

Q&A

Acknowledgement:

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Reference

[1] Shalev-Shwartz, Shai, et al. "Pegasos: Primal estimated sub-gradient solver for svm." Mathematical programming 127.1 (2011): 3-30.

[2] Lacoste-Julien, Simon, Mark Schmidt, and Francis Bach. "A simpler approach to obtaining an o (1/t) convergence rate for the projected stochastic subgradient method." arXiv preprint arXiv:1212.2002 (2012).

[3] Takáč Martin, et al. "Mini-batch primal and dual methods for SVMs." arXiv preprint arXiv:1303.2314 (2013).

[4] Zhao, Peilin, and Tong Zhang. "Stochastic optimization with importance sampling." arXiv preprint arXiv:1401.2753 (2014).