Internship: Stochastic Methods for SVM and Linear Classification
Based on Sketching Inequalities

co-supervisors: Dr. Robert M. Gower and Dr. Francis Bach

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The workhorse of machine learning is linear classification. This project addresses the formulation of new stochastic sketching methods for linear classification based on the Perceptron method [4] and Support Vector Machines (SVMs). Determining a linear classifier using the Perceptron method or SVMs boils down to minimizing a simple quadratic function subject to linear inequality constraints:

**The Perceptron Model**

\[
\begin{align*}
\min_{x \in \mathbb{R}^d} & \quad \frac{1}{2} \|x\|^2 \\
\text{subject to} & \quad A^T x \geq 1,
\end{align*}
\]

**Support Vector Machine**

\[
\begin{align*}
\min_{x \in \mathbb{R}^d, \xi \in \mathbb{R}^n} & \quad \frac{\lambda}{2} \|x\|^2 + \frac{1}{n} \sum_{i=1}^n \xi_i \\
\text{subject to} & \quad A^T x + \xi \geq 1, \quad \xi \geq 0,
\end{align*}
\]

where \( A \in \mathbb{R}^{n \times d} \) is a given data matrix, \( \mathbf{1} = (1, \ldots, 1) \in \mathbb{R}^n \) and \( \lambda > 0 \) is a parameter. In this project you will develop new stochastic iterative methods for solving both of the above problems based on sketching and projecting onto the linear inequalities [2,1], thus developing new algorithms and analysis.

**Requisites:** The prospective student will have completed a course in optimization, linear algebra and preferably have some experience in programming.

**Timeline:** You will start by reading [2,3,1], after which you will analyse extensions of the Perceptron method and new methods for SVMs. The focus of this project will be on designing and analysing new algorithms. You will meet the co-supervisor Dr. Robert M. Gower on a weekly basis to discuss the project.

**Output:** The ideal output of the project would be a paper with either new insights/extensions of the Perceptron algorithm, and new methods for solving SVMs. Depending on the progress and your preference, there is an opportunity to implement and test the new methods.
References


