

The SHOGUN Machine Learning Toolbox

(and its python interface)

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Outline

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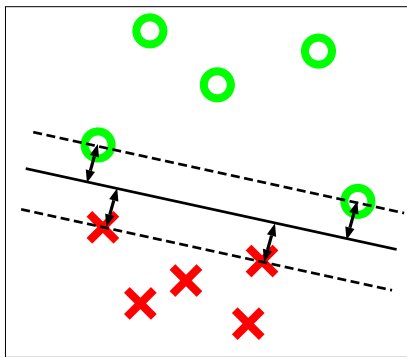
Introduction

What can you do with the SHOGUN Machine Learning Toolbox [6]?

- Types of problems:
 - Clustering (no labels)
 - **Classification** (binary labels)
 - Regression (real valued labels)
 - Structured Output Learning (structured labels)
- Main focus is on **Support Vector Machines** (SVMs)
- Also implements a number of other ML methods like
 - Hidden Markov Models (HMMs)
 - Linear Discriminant Analysis (LDA)
 - Kernel Perceptrons

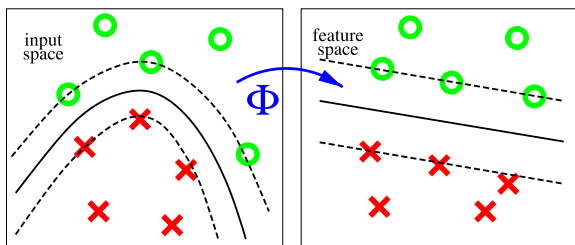
Support Vector Machine

- Given: Points $\mathbf{x}_i \in \mathcal{X}$ ($i = 1, \dots, N$) with labels $y_i \in \{-1, +1\}$
- Task: Find hyperplane that maximizes **margin**



Decision function $f(\mathbf{x}) = \mathbf{w} \cdot \mathbf{x} + b$

SVM with Kernels



- SVM decision function in kernel feature space:

$$f(\mathbf{x}) = \sum_{i=1}^N y_i \alpha_i \underbrace{\Phi(\mathbf{x}) \cdot \Phi(\mathbf{x}_i)}_{=k(\mathbf{x}, \mathbf{x}_i)} + b \quad (1)$$

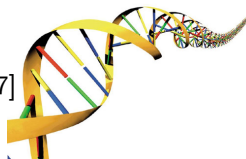
- Training: Find parameters α
- Corresponds to solving quadratic optimization problem (QP)

Large-Scale SVM Implementations

- Different SVM solvers employ different strategies
 - Provides generic interface to 11 SVM solvers
 - Established implementations for solving SVMs with kernels
 - LibSVM
 - SVM^{light}
 - More recent developments: Fast linear SVM solvers
 - LibLinear
 - SvmOCAS [1]
 - Support of Multi-Threading
- ⇒ We have trained SVMs with up to 50 million training examples

Various Kernel Functions

- Real-valued Data (will be in demo)
 - Linear Kernel, Polynomial Kernel, Gaussian Kernel
- String Kernels
 - Applications in Bioinformatics [3, 5, 7]
 - Intrusion Detection
- Heterogeneous Data Sources
 - CombinedKernel class to construct kernel from weighted linear combination of subkernels $K(x, z) = \sum_{i=1}^M \beta_i \cdot K_i(x, z)$
 - β_i can be learned using Multiple Kernel Learning [4, 2]



Interoperability

- Supports many programming languages
 - Core written in C++ (> 130,000 lines of code)
 - Glue code mostly written in Python 🐍
 - Additional bindings: Matlab, Octave, R
 - More to come, e.g. Java
- Supports many data formats
 - SVM^{light}, LibSVM, CSV
 - HDF5
- Community Integration
 - Documentation available, many many examples (> 600)
 - Source code is freely available
 - There is a Debian Package, MacOSX
 - Mailing-List, public SVN repository (read-only)
 - Part of MLOSS.org

Demo:

- Support Vector Classification
 - Task: separate 2 clouds of points in 2D

Simple code example: SVM Training

```
lab = Labels(labels)
train = RealFeatures(features)
gk = GaussianKernel(train, train, width)
svm = LibSVM(10.0, gk, lab)
svm.train()
```

When is SHOGUN for you?

- You want to work with SVMs (11 solvers to choose from)
- You want to work with Kernels (35 different kernels)
⇒ Esp.: String Kernels / combinations of Kernels
- You have large scale computations to do (up to 50 million)
- You use one of the following languages:
Python, R, octave/MATLAB, C++
- Community matters: mloss.org, mldata.org

Thank you!

Thank you for your attention!!

For more information, visit:

- Implementation <http://www.shogun-toolbox.org>
- More machine learning software <http://mloss.org>
- Machine Learning Data <http://mldata.org>

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