

Accepted Manuscript

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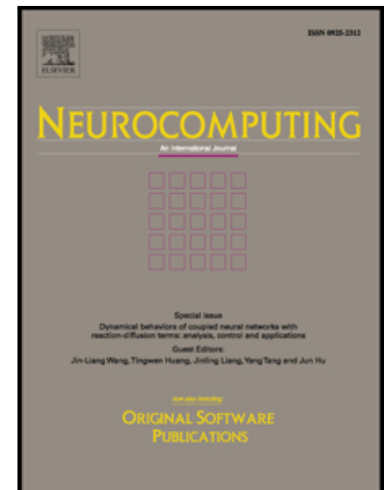
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PII: S0925-2312(17)31843-X
DOI: [10.1016/j.neucom.2017.11.069](https://doi.org/10.1016/j.neucom.2017.11.069)
Reference: NEUCOM 19149

To appear in: *Neurocomputing*

Received date: 7 July 2017
Revised date: 10 November 2017
Accepted date: 20 November 2017

Please cite this article as: Fabien Lauer, MLweb: A toolkit for machine learning on the web, *Neurocomputing* (2017), doi: [10.1016/j.neucom.2017.11.069](https://doi.org/10.1016/j.neucom.2017.11.069)



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MLweb: A toolkit for machine learning on the web

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Abstract

This paper describes MLweb, an open source software toolkit for machine learning on the web. The specificity of MLweb is that all computations are performed on the client side without the need to send data to a third-party server. MLweb includes three main components: a JavaScript API for scientific computing (LALOLib), an extension of this library with machine learning tools (ML.js) and an online development environment (LALOLab) with many examples.

Keywords: machine learning, classification, regression, JavaScript

1. Introduction

MLweb is an open source software toolkit for machine learning on the web. A number of web-based commercial solutions exist to enable web applications with machine learning capabilities. These are often server-based: both training and predictions are performed by the server with data and results traveling across the Internet to the client upon request. This model is particularly suitable for the “big data” challenge, where heavy computing resources are needed. However, this also raises issues regarding for instance the privacy of data or the offline use of the prediction models. In addition, such a computing model relies on expensive computing infrastructures and leaves a number of individuals or nonprofit organizations without an easy and free access to machine learning capabilities. On the opposite, MLweb focuses on these issues (privacy, offline use, accessibility to non-experts and affordability at the individual level).

With these goals in mind, MLweb develops machine learning tools for the web in which all computations are performed on the client side, i.e., in the browser. Such a client-side approach has the direct combined benefits of privacy and offline use, since no data, models or predictions need to travel across the network. However, there is currently a lack of machine learning software following that approach, except for a few libraries dedicated to some specific algorithm (see, e.g., [1] for deep learning). Other open-source alternatives with a broader scope like scikit-learn [2] that might satisfy privacy and accessibility constraints do not work on the web and do not offer the possibility to develop applications easily distributed on the Internet without requiring users to go through a complex installation procedure. On the opposite, MLweb just works on many platforms without requiring any installation step. For teaching or communication purposes, this can be used to easily set up an interactive demonstration of a (possibly novel) learning algorithm while ensuring that it is accessible from anywhere (even tablets and smartphones). Other potential uses include applications for which privacy might be more valuable than efficiency,

or where the network or server constitutes the efficiency bottleneck.

2. Software Framework

MLweb includes three main components described below: a client-side web API in JavaScript for scientific computing (LALOLib), an extension of this library with machine learning tools (ML.js) and an online development environment (LALOLab). It also comes with an online help including many examples and an extended documentation in the form of a webbook.

MLweb uses only two third-party libraries, glpk.js for linear programming and JSZip for easy data compression. They are both automatically downloaded when installing from the source code and fetched when necessary when using the online executables.

2.1. LALOLib: a Linear Algebra Online Library

LALOLib is a *Linear Algebra Online Library* written in JavaScript to enable scientific computing in web pages. JavaScript is the standard language for web applications, which is both very versatile and platform-independent. However, as a non-compiled language, it was not made for computation-intensive tasks and few numerical libraries exist. LALOLib attempts to fill this gap with both ease of use and efficiency in mind. With LALOLib, many common linear algebra, statistics and optimization operations are made available to the web page. A script within the page can for instance compute the singular values of a random matrix with

```
X = rand(200,300);
singularvalues = svd(X);
```

This example directly calls LALOLib functions, providing an easy access to their results. However, such a synchronous approach blocks the page (and freezes the browser) until the functions return. To maintain the responsiveness of the web application, LALOLib also provides an asynchronous mode based on callbacks.

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