

# 2D Visualizations for Support Vector Machine and Neural Network

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## Abstract

Aiming to organize and present machine learning concepts in a way that people can have a more intuitive understanding of what is happening, we introduce a visualization project. Our goal is to show both the real-time effects (i.e. change of decision boundaries generated by these algorithms) and how they work behind the scene (i.e. an explanation of the mathematical procedures for different models). It uses 2D canvases such that new data points can be added and the boundary of a particular algorithm is adjusted accordingly. Along with the visualization, we have also included the corresponding tutorial for each algorithm on our project page, which can be reached at <http://metoerite-j.github.io/Visual-Machine-Learning>.

## 1 Introduction

At the current stage, we present two different machine learning concepts, namely, Support Vector Machine (SVM) and Artificial Neural Network (ANN). For SVM, we focus on the Sequential Minimal Optimization (SMO) algorithm and the Primal Estimated Sub-Gradient Solver for SVMs. For ANN, we use the classic feed-forward back-propagation neural network as our model.

SVMs are effective and popular classification learning tool. The task of learning a support vector machine is cast as a constrained quadratic programming problem. stochastic sub-gradients descent algorithm for solving the optimization problem cast by SVMs.

## 2 SMO

### 2.1 Background

SMO is one of the most popular algorithm for training SVMs. It tackles the dual representation of the

SVM optimization problem, and employs an active set of constraints thus working on a subset of dual variables. Normally, training a Support Vector Machine (SVM) requires the solution of a very large quadratic programming (QP) optimization problem. SMO breaks this large QP problem into a series of smallest possible QP problems. These small QP problems are solved analytically, which avoids using a time-consuming numerical QP optimization as an inner loop. The amount of memory required for SMO is linear in the training set size, which allows SMO to handle very large training sets. Because large matrix computation is avoided, SMO scales somewhere between linear and quadratic in the training set size for various test problems, while a standard projected conjugate gradient (PCG) chunking algorithm scales somewhere between linear and cubic in the training set size. SMO's computation time is dominated by SVM evaluation, hence SMO is fastest for linear SVMs and sparse data sets.

### 2.2 The SMO Algorithm

For the production of the electronic manuscript you must use Adobe's Portable Document Format (PDF). This format can be generated from postscript files: on Unix systems, you can use `ps2pdf` for this purpose; under Microsoft Windows, you can use Adobe's Distiller, or if you have `cygwin` installed, you can use `dvipdf` or `ps2pdf`. Note that some word processing programs generate PDF which may not include all the necessary fonts (esp. tree diagrams, symbols). When you print or create the PDF file, there is usually an option in your printer setup to include none, all or just non-standard fonts. Please make sure that you select the option of including ALL the fonts. *Before sending it, test your PDF by printing it from a computer different from the one where it was created.* Moreover, some word processor may generate very large postscript/PDF files,

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For reasons of uniformity, Adobe’s **Times Roman** font should be used. In L<sup>A</sup>T<sub>E</sub>X2<sub>ε</sub> this is accomplished by putting

```
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Center the title, author’s name(s) and affiliation(s) across both columns. Do not use footnotes for affiliations. Do not include the paper ID number assigned during the submission process. Use the two-column format only when you begin the abstract.

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## 2.5 Sections

**Headings:** Type and label section and subsection headings in the style shown on the present document. Use numbered sections (Arabic numerals) in

order to facilitate cross references. Number subsections with the section number and the subsection number separated by a dot, in Arabic numerals.

**Citations:** Citations within the text appear in parentheses as (Gusfield, 1997) or, if the author’s name appears in the text itself, as Gusfield (1997). Append lowercase letters to the year in cases of ambiguities. Treat double authors as in (Aho and Ullman, 1972), but write as in (Chandra et al., 1981) when more than two authors are involved. Collapse multiple citations as in (Gusfield, 1997; Aho and Ullman, 1972).

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The L<sup>A</sup>T<sub>E</sub>X and BibT<sub>E</sub>X style files provided roughly fit the American Psychological Association format, allowing regular citations, short citations and multiple citations as described above.

**Appendices:** Appendices, if any, directly follow the text and the references (but see above). Letter them in sequence and provide an informative title: **Appendix A. Title of Appendix.**

**Acknowledgment** sections should go as a last (unnumbered) section immediately before the references.

## 2.6 Footnotes

**Footnotes:** Put footnotes at the bottom of the page. They may be numbered or referred to by asterisks or other symbols.<sup>1</sup> Footnotes should be separated from the text by a line.<sup>2</sup> Footnotes should be in 9 point font.

<sup>1</sup>This is how a footnote should appear.

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Table 1: Font guide.

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## 3 Length of Submission

The NAACL HLT 2010 main conference accepts submissions of long papers and short papers. The maximum length of a long paper manuscript is eight (8) pages of content and one (1) additional page of references *only* (appendices count against the eight pages, not the additional one page). The maximum length of a short paper manuscript is four (4) pages including references. For both long and short papers, all illustrations, references, and appendices must be accommodated within these page limits, observing the formatting instructions given in the present document. Papers that do not conform to the specified length and formatting requirements are subject to be rejected without review.

## Acknowledgments

Do not number the acknowledgment section.

## References

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