
Smart Model Elimination for Efficient Automated Machine Learning

Eric Su Zhang*
St. Mark's School of Texas
10600 Preston Rd, Dallas, TX 75230
ericspring08@gmail.com

Benjamin Standefer
St. Mark's School of Texas
10600 Preston Rd, Dallas, TX 75230
bjmstandefer@gmail.com

Abstract

Automated Machine Learning or AutoML has emerged as a popular field of research. Many of these frameworks optimize a form of model selection, however, they all require every model to be run and evaluated. We propose a novel framework that automatically eliminates models that are unlikely to be performant by training a Boosting Model on hundreds of kaggle datasets. Out of the 30 model options, our framework can predict a top five model within its top eight 80% of the time.

1 Introduction

Machine learning (ML) is a type of artificial intelligence (AI) that uses a variety of algorithms to interpret data and extrapolate from it, making predictions based on observed trends. Individual models are trained on datasets to become smarter so as to make predictions based on new data. The development and optimization of these models is a time-consuming process involving statistical nuances and complex learning strategies. This has led to the emergence of Automated Machine Learning (AutoML) frameworks and research.

One sector of the global industry that has the most potential for beneficial integration of AutoML frameworks is healthcare, particularly in developing countries. These countries have severe shortages of healthcare workers and limited tools for diagnosis. For example, Africa has 2.3 healthcare workers per 1000 individuals, while the Americas have 24.8 healthcare workers per 1000. The World Health Organization (WHO) emphasized that this deficit is growing every year and will likely reach 18 million personnel by 2030. The use of AI in healthcare has been varied. Medical AI's typically automate repetitive tasks, making time consumption a primary concern. This coupled with a lack of adequate resources makes designing faster diagnostic systems for developing countries' medical sectors a pivotal issue.

Most AutoML frameworks implement some form of model selection where a pool of models are filtered until a final model is selected. However, these frameworks require that every model to be run to filter out. In theory, this means that much energy is spent training models that are unlikely to be selected. We propose SMEML, a novel model selection algorithm that automatically eliminates models that it believes will not be performant.

1.1 Style

Papers to be submitted to NeurIPS 2024 must be prepared according to the instructions presented here. Papers may only be up to **four** pages long, including figures. In these four content pages, authors may link to supplementary artifacts including videos, working demonstrations, digital posters, websites,

*Use footnote for providing further information about author (webpage, alternative address)—*not* for acknowledging funding agencies.

or source code. Please do not link to additional text. All such supplementary material should be wholly created by the authors and should directly support the submission content. Additional pages *containing only acknowledgments and references* are allowed. Papers that exceed the page limit will not be reviewed or in any other way considered for presentation.

The margins in 2024 are the same as those in previous years of the NeurIPS conference.

Authors are required to use the NeurIPS L^AT_EX style files obtainable at the NeurIPS website as indicated below. Please make sure you use the current files and not previous versions. Tweaking the style files may be grounds for rejection.

1.2 Style files

The file `neurips_hs_2024.pdf` contains these instructions and illustrates the various formatting requirements your NeurIPS paper must satisfy.

The only supported style file for NeurIPS 2024 is `neurips_2024.sty`, rewritten for L^AT_EX 2_ε. **Previous style files for L^AT_EX 2.09, Microsoft Word, and RTF are no longer supported!**

The L^AT_EX style file contains three optional arguments: `final`, which creates a camera-ready copy, `preprint`, which creates a preprint for submission to, e.g., arXiv, and `nonatbib`, which will not load the `natbib` package for you in case of package clash.

Preprint option As the high school project submissions are not anonymous, please use the preprint option. This will create a nonanonymized version of your work with the text “Preprint. Work in progress.” in the footer. Please **do not** use the `final` option, which should **only** be used for papers accepted at NeurIPS.

The file `neurips_hs_2024.tex` may be used as a “shell” for writing your paper. All you have to do is replace the author, title, abstract, and text of the paper with your own.

The formatting instructions contained in these style files are summarized in Sections 2, 3, and 4 below.

2 General formatting instructions

The text must be confined within a rectangle 5.5 inches (33 picas) wide and 9 inches (54 picas) long. The left margin is 1.5 inch (9 picas). Use 10 point type with a vertical spacing (leading) of 11 points. Times New Roman is the preferred typeface throughout, and will be selected for you by default. Paragraphs are separated by ½ line space (5.5 points), with no indentation.

The paper title should be 17 point, initial caps/lower case, bold, centered between two horizontal rules. The top rule should be 4 points thick and the bottom rule should be 1 point thick. Allow ¼ inch space above and below the title to rules. All pages should start at 1 inch (6 picas) from the top of the page.

For the final version, authors’ names are set in boldface, and each name is centered above the corresponding address. The lead author’s name is to be listed first (left-most), and the co-authors’ names (if different address) are set to follow. If there is only one co-author, list both author and co-author side by side.

Please pay special attention to the instructions in Section 4 regarding figures, tables, acknowledgments, and references.

3 Headings: first level

All headings should be lower case (except for first word and proper nouns), flush left, and bold.

First-level headings should be in 12-point type.

3.1 Headings: second level

Second-level headings should be in 10-point type.

3.1.1 Headings: third level

Third-level headings should be in 10-point type.

Paragraphs There is also a `\paragraph` command available, which sets the heading in bold, flush left, and inline with the text, with the heading followed by 1 em of space.

4 Citations, figures, tables, references

These instructions apply to everyone.

4.1 Citations within the text

The `natbib` package will be loaded for you by default. Citations may be author/year or numeric, as long as you maintain internal consistency. As to the format of the references themselves, any style is acceptable as long as it is used consistently.

The documentation for `natbib` may be found at

<http://mirrors.ctan.org/macros/latex/contrib/natbib/natnotes.pdf>

Of note is the command `\citet`, which produces citations appropriate for use in inline text. For example,

```
\citet{hasselmo} investigated\dots
```

produces

Hasselmo, et al. (1995) investigated...

If you wish to load the `natbib` package with options, you may add the following before loading the `neurips_2024` package:

```
\PassOptionsToPackage{options}{natbib}
```

If `natbib` clashes with another package you load, you can add the optional argument `nonatbib` when loading the style file:

```
\usepackage[nonatbib]{neurips_2024}
```

4.2 Footnotes

Footnotes should be used sparingly. If you do require a footnote, indicate footnotes with a number² in the text. Place the footnotes at the bottom of the page on which they appear. Precede the footnote with a horizontal rule of 2 inches (12 picas).

Note that footnotes are properly typeset *after* punctuation marks.³

4.3 Figures

All artwork must be neat, clean, and legible. Lines should be dark enough for purposes of reproduction. The figure number and caption always appear after the figure. Place one line space before the figure caption and one line space after the figure. The figure caption should be lower case (except for first word and proper nouns); figures are numbered consecutively.

You may use color figures. However, it is best for the figure captions and the paper body to be legible if the paper is printed in either black/white or in color.

²Sample of the first footnote.

³As in this example.



Figure 1: Sample figure caption.

Table 1: Sample table title

| Part | | |
|----------|-----------------|------------------------|
| Name | Description | Size (μm) |
| Dendrite | Input terminal | ~ 100 |
| Axon | Output terminal | ~ 10 |
| Soma | Cell body | up to 10^6 |

4.4 Tables

All tables must be centered, neat, clean and legible. The table number and title always appear before the table. See Table 1.

Place one line space before the table title, one line space after the table title, and one line space after the table. The table title must be lower case (except for first word and proper nouns); tables are numbered consecutively.

Note that publication-quality tables *do not contain vertical rules*. We strongly suggest the use of the booktabs package, which allows for typesetting high-quality, professional tables:

<https://www.ctan.org/pkg/booktabs>

This package was used to typeset Table 1.

4.5 Math

Note that display math in bare TeX commands will not create correct line numbers for submission. Please use LaTeX (or AMSTeX) commands for unnumbered display math. (You really shouldn't be using \$\$ anyway; see <https://tex.stackexchange.com/questions/503/why-is-preferable-to> and <https://tex.stackexchange.com/questions/40492/what-are-the-differences-between-align-equation-and-displaymath> for more information.)

4.6 Final instructions

Do not change any aspects of the formatting parameters in the style files. In particular, do not modify the width or length of the rectangle the text should fit into, and do not change font sizes (except perhaps in the **References** section; see below). Please note that pages should be numbered.

5 Preparing PDF files

Please prepare submission files with paper size “US Letter,” and not, for example, “A4.”

Your PDF file must only contain Type 1 or Embedded TrueType fonts. Here are a few instructions to achieve this.

- You should directly generate PDF files using `pdflatex`.
- You can check which fonts a PDF files uses. In Acrobat Reader, select the menu Files>Document Properties>Fonts and select Show All Fonts. You can also use the program `pdffonts` which comes with `xpdf` and is available out-of-the-box on most Linux machines.
- `xfig` "patterned" shapes are implemented with bitmap fonts. Use "solid" shapes instead.
- The `\bbold` package almost always uses bitmap fonts. You should use the equivalent AMS Fonts:

```
\usepackage{amsfonts}
```

followed by, e.g., `\mathbb{R}`, `\mathbb{N}`, or `\mathbb{C}` for \mathbb{R} , \mathbb{N} or \mathbb{C} . You can also use the following workaround for reals, natural and complex:

```
\newcommand{\RR}{\mathbb{R}} %real numbers
\newcommand{\Nat}{\mathbb{N}} %natural numbers
\newcommand{\CC}{\mathbb{C}} %complex numbers
```

Note that `amsfonts` is automatically loaded by the `amssymb` package.

If your file contains type 3 fonts or non embedded TrueType fonts, we will ask you to fix it.

5.1 Margins in L^AT_EX

Most of the margin problems come from figures positioned by hand using `\special` or other commands. We suggest using the command `\includegraphics` from the `graphicx` package. Always specify the figure width as a multiple of the line width as in the example below:

```
\usepackage[pdftex]{graphicx} ...
\includegraphics[width=0.8\linewidth]{myfile.pdf}
```

See Section 4.4 in the `graphics` bundle documentation (<http://mirrors.ctan.org/macros/latex/required/graphics/grfguide.pdf>)

A number of width problems arise when L^AT_EX cannot properly hyphenate a line. Please give LaTeX hyphenation hints using the `\-` command when necessary.

Acknowledgments and Disclosure of Funding

Use unnumbered first level headings for the acknowledgments. All acknowledgments go at the end of the paper before the list of references. Moreover, you are required to declare funding (financial activities supporting the submitted work) and competing interests (related financial activities outside the submitted work). More information about this disclosure can be found at: <https://neurips.cc/Conferences/2024/PaperInformation/FundingDisclosure>.

References

References follow the acknowledgments. Use unnumbered first-level heading for the references. Any choice of citation style is acceptable as long as you are consistent. It is permissible to reduce the font size to `small` (9 point) when listing the references. Note that the Reference section does not count towards the page limit.

[1] Alexander, J.A. & Mozer, M.C. (1995) Template-based algorithms for connectionist rule extraction. In G. Tesauero, D.S. Touretzky and T.K. Leen (eds.), *Advances in Neural Information Processing Systems* 7, pp. 609–616. Cambridge, MA: MIT Press.

[2] Bower, J.M. & Beeman, D. (1995) *The Book of GENESIS: Exploring Realistic Neural Models with the GENeral NEural Simulation System*. New York: TELOS/Springer–Verlag.

[3] Hasselmo, M.E., Schnell, E. & Barkai, E. (1995) Dynamics of learning and recall at excitatory recurrent synapses and cholinergic modulation in rat hippocampal region CA3. *Journal of Neuroscience* **15**(7):5249–5262.