
Learning Representations for Multiple Time Series via Supervised and Unsupervised Learning

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Abstract

1 Place abstract here after paper is written.

2 1 Introduction

3 Often, supervised learning on time series is performed on a single schema. When multiple time series,
4 each with their own schema, are needed to inform the same supervised task, the representation of this
5 data is usually constructed via an arbitrary choice in representation. Consider multiple time series
6 stored in relational database so that different tables contain different time series and each row contains
7 a single event in time. We wish to produce a single schema for one table that contains events from all
8 tables, so that we can learn supervised tasks driven by this data. There are some obvious options for
9 making a single schema that captures multiple time series. One option is creating a single schema
10 through joining where the rows represent event combinations. Another option is using the same
11 schema as a join, where the rows by inserting rows from each schema. The first option is unfeasible
12 with entities that originate in large datasets, for example, datasets having more than a billion rows.
13 The second option is feasible and will yield less sparsity than the first option. In this paper, we would
14 like to explore two new methods for representing multiple time series per entity. One representation is
15 learned via an auto-encoder and another representation learned as part of a supervised learning task.
16 We wish to compare the performance of each representation on a supervised learning task.

17 1.1 Style

18 Papers to be submitted to NIPS 2017 must be prepared according to the instructions presented here.
19 Papers may only be up to eight pages long, including figures. This does not include acknowledgments
20 and cited references which are allowed on subsequent pages. Papers that exceed these limits will not
21 be reviewed, or in any other way considered for presentation at the conference.

22 The margins in 2017 are the same as since 2007, which allow for ~15% more words in the paper
23 compared to earlier years.

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

27 1.2 Retrieval of style files

28 The style files for NIPS and other conference information are available on the World Wide Web at

29 <http://www.nips.cc/>

30 The file `nips_2017.pdf` contains these instructions and illustrates the various formatting require-
31 ments your NIPS paper must satisfy.

32 The only supported style file for NIPS 2017 is `nips_2017.sty`, rewritten for L^AT_EX 2_ε. **Previous**
33 **style files for L^AT_EX 2.09, Microsoft Word, and RTF are no longer supported!**

34 The new L^AT_EX style file contains two optional arguments: `final`, which creates a camera-ready copy,
35 and `nonatbib`, which will not load the `natbib` package for you in case of package clash.

36 At submission time, please omit the `final` option. This will anonymize your submission and add
37 line numbers to aid review. Please do *not* refer to these line numbers in your paper as they will be
38 removed during generation of camera-ready copies.

39 The file `nips_2017.tex` may be used as a “shell” for writing your paper. All you have to do is
40 replace the author, title, abstract, and text of the paper with your own.

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

43 **2 General formatting instructions**

44 The text must be confined within a rectangle 5.5 inches (33 picas) wide and 9 inches (54 picas) long.
45 The left margin is 1.5 inch (9 picas). Use 10 point type with a vertical spacing (leading) of 11 points.
46 Times New Roman is the preferred typeface throughout, and will be selected for you by default.
47 Paragraphs are separated by 1/2 line space (5.5 points), with no indentation.

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

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

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

58 **3 Headings: first level**

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

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

61 **3.1 Headings: second level**

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

63 **3.1.1 Headings: third level**

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

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

67 **4 Citations, figures, tables, references**

68 These instructions apply to everyone.

69 **4.1 Citations within the text**

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

73 The documentation for natbib may be found at

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

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

76 example,

77 `\citet{hasselmo}` investigated\dotso

78 produces

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

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

81 nips_2017 package:

82 `\PassOptionsToPackage{options}{natbib}`

83 If natbib clashes with another package you load, you can add the optional argument `nonatbib`

84 when loading the style file:

85 `\usepackage[nonatbib]{nips_2017}`

86 As submission is double blind, refer to your own published work in the third person. That is, use “In

87 the previous work of Jones et al. [4],” not “In our previous work [4].” If you cite your other papers

88 that are not widely available (e.g., a journal paper under review), use anonymous author names in the

89 citation, e.g., an author of the form “A. Anonymous.”

90 **4.2 Footnotes**

91 Footnotes should be used sparingly. If you do require a footnote, indicate footnotes with a number¹

92 in the text. Place the footnotes at the bottom of the page on which they appear. Precede the footnote

93 with a horizontal rule of 2 inches (12 picas).

94 Note that footnotes are properly typeset *after* punctuation marks.²

95 **4.3 Figures**

96 All artwork must be neat, clean, and legible. Lines should be dark enough for purposes of reproduction.

97 The figure number and caption always appear after the figure. Place one line space before the figure

98 caption and one line space after the figure. The figure caption should be lower case (except for first

99 word and proper nouns); figures are numbered consecutively.

100 You may use color figures. However, it is best for the figure captions and the paper body to be legible

101 if the paper is printed in either black/white or in color.

102 **4.4 Tables**

103 All tables must be centered, neat, clean and legible. The table number and title always appear before

104 the table. See Table 1.

105 Place one line space before the table title, one line space after the table title, and one line space after

106 the table. The table title must be lower case (except for first word and proper nouns); tables are

107 numbered consecutively.

108 Note that publication-quality tables *do not contain vertical rules*. We strongly suggest the use of the

109 booktabs package, which allows for typesetting high-quality, professional tables:

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

111 This package was used to typeset Table 1.

¹Sample of the first footnote.

²As 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

5 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.

6 Preparing PDF files

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

Fonts were the main cause of problems in the past years. 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 file uses. In Acrobat Reader, select the menu Files>Document Properties>Fonts and select Show All Fonts. You can also use the program `pdf fonts` which comes with `xpdf` and is available out-of-the-box on most Linux machines.
- The IEEE has recommendations for generating PDF files whose fonts are also acceptable for NIPS. Please see <http://www.emfield.org/icuwb2010/downloads/IEEE-PDF-SpecV32.pdf>
- `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.

138 6.1 Margins in L^AT_EX

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

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

144 See Section 4.4 in the graphics bundle documentation ([http://mirrors.ctan.org/macros/](http://mirrors.ctan.org/macros/latex/required/graphics/grfguide.pdf)
145 [latex/required/graphics/grfguide.pdf](http://mirrors.ctan.org/macros/latex/required/graphics/grfguide.pdf))

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

148 Acknowledgments

149 Omitted until final paper

150 References

151 References follow the acknowledgments. Use unnumbered first-level heading for the references. Any
152 choice of citation style is acceptable as long as you are consistent. It is permissible to reduce the font
153 size to `small` (9 point) when listing the references. **Remember that you can go over 8 pages as**
154 **long as the subsequent ones contain *only* cited references.**

155 [1] Alexander, J.A. & Mozer, M.C. (1995) Template-based algorithms for connectionist rule extraction. In
156 G. Tesauro, D.S. Touretzky and T.K. Leen (eds.), *Advances in Neural Information Processing Systems 7*, pp.
157 609–616. Cambridge, MA: MIT Press.

158 [2] Bower, J.M. & Beeman, D. (1995) *The Book of GENESIS: Exploring Realistic Neural Models with the*
159 *GENeral NEural Simulation System*. New York: TELOS/Springer–Verlag.

160 [3] Hasselmo, M.E., Schnell, E. & Barkai, E. (1995) Dynamics of learning and recall at excitatory recurrent
161 synapses and cholinergic modulation in rat hippocampal region CA3. *Journal of Neuroscience* **15**(7):5249-5262.