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| **Formatting Instructions for NIPS 2013** |
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**Abstract**

Ubiquitous decision support systems require more intelligent mechanism in which more timely and accurate decision support is available. This paper develops several machine learning algorithms to model the waiting time at offices of the Department of Motor Vehicles(DMV) and extract significant patterns in the dataset giving a time series sensor data of a user. Then it will use the inferred model to predict the future behavior of the time series while considering various internal and external factors that can be sensed through various sensors. The application of this paper will be predicting the waiting time at DMV based on models trained from historical data. Questions to be answered include: 1) What is the best time in the week to go to DMV? 2) Given a location of the user and the current time, which DMV should the user go to.

**1 INTRODUCTION**

In this paper, we present a fusion of machine learning algorithms to model the waiting time series at DMV offices. The fusion of machine learning algorithms are geared for predicting next waiting time at a certain DMV. We use Waiting Time dataset for this research.

**1.1 Style**

Papers to be submitted to NIPS 2013 must be prepared according to the instructions presented here. Papers may be only up to 8 pages long, including figures and references. Since 2009, an additional ninth page *containing only cited references* is allowed. Papers that exceed nine pages will not be reviewed, or in any other way considered for presentation at the conference.

Please note that this year we have introduced automatic line number generation into the style file (for LaTeX 2e and MS Word versions). This is to help reviewers refer to specific lines of the paper when they make their comments. Please do NOT refer to these line numbers in your paper as they will be removed from the style file for the final version of accepted papers.

The margins in 2013 are the same as since 2007, which allow for ~ 15% more words in the paper compared to earlier years. We are also again using double-blind reviewing. Both of these require the use of new style files.

Authors are required to use the NIPS LaTeX or RTF (MS Word) style files obtainable at the NIPS 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 Retrieval of style files**

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

http://www.nips.cc/

The file **nips2013.pdf** contains these instructions and illustrates the various formatting requirements that your NIPS paper must satisfy. LaTeX users can choose between two style files: **nips11submit\_09.sty** (to be used with LaTeX version 2.09) and **nips11submit\_e.sty** (to be used with LaTeX2e). The file **nips2013.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 file **nips2013.rtf** is provided as a shell for MS Word users.

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

**2 PREDICTION MODELS**

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 inches (9 picas). Use 10 point type with a vertical spacing of 11 points. Times New Roman is the preferred typeface throughout. Paragraphs are separated by ½ line space, with no indentation.

Paper title is 17 point, initial caps/lower case, bold, centered between 2 horizontal rules. Top rule is 4 points thick and bottom rule is 1 point thick. Allow ¼ inch space above and below title to rules. All pages should start 1 inch (6 picas) from the top of the page.

The version of the paper submitted for review should have "Anonymous Author(s)" as the author of the paper. 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 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, acknowledgements, and references.

**3 PREDICTION MODELS**

We split the whole dataset into two parts, one for training and the other for testing.

**3.1 Time-Based Waiting Time Prediction**

The first model used in our work is the time-based waiting time model. This model uses only the time feature to predict waiting time at a certain time. We use time in a day as the time information, and fit a Gaussian distribution for P(wt|ht), and use the mean value of the Gaussian distribution to predict the future waiting time at ht in a day. The prediction for each ht is as follows:

And then we use the prediction to calculate the average error in testing data. The result is 0.5 hour.

**3.2 Hidden Markov Model**

The next model we try is Hidden Markov Model (HMM). Each time we observe the current time, and the hidden state is the corresponding waiting time. In order to make hidden state meaningful, we discretize the continuous waiting time. The method is to draw an equal-height histogram for waiting time which means that in each bucket of the histogram, we have equal number of counts, and we use the median value of this bucket to denote the discretized value of the waiting time which belongs to this bucket. So the possible state value is as follows:

And we use Viterbi algorithm to do inference on a sequence of waiting time given a time sequence. The prediction is as follows and the average accuracy is

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

These instructions apply to everyone, regardless of the formatter being used.

**4.1 Citations within the text**

Citations within the text should be numbered consecutively. The corresponding number is to appear enclosed in square brackets, such as [1] or [2]-[5]. The corresponding references are to be listed in the same order at the end of the paper, in the **References** section. (Note: the standard BibTeX style unsrt produces this.) As to the format of the references themselves, any standard reference style is acceptable, as long as it is used consistently.

As submission is double blind, refer to your own published work in the third person. That is, use "In the previous work of Jones et al. [4]", not "In our previous work [4]". If you cite your other papers that are not widely available (e.g. a journal paper under review), use anonymous author names in the citation, e.g. an author of the form "A.Anonymous".

**4.2 Footnotes**

Indicate footnotes with a number 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).

**4.3 Figures**

All artwork must be neat, clean, and legible. Lines should be dark enough for purposes of reproduction; artwork should not be hand drawn. 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 is lower case (except for first word and proper nouns); figures are numbered consecutively.

Make sure the figure caption does not get separated from the figure. Leave sufficient space to avoid splitting the figure and figure caption.

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

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Figure 1: Sample Figure Caption

**4.4 Tables**

All tables must be centered, neat, clean and legible. Do not use hand drawn tables. 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.

Table 1: Sample table title

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| **Part**  **Description** |  |
| Dendrite | Input terminal |
| Axon | Output terminal |
| Soma | Cell Body (contains cell nucleus) |

**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 that 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 PostScript or PDF files**

Please prepare PostScript or PDF files with paper size “US Letter,” and not, for example, “A4.” The -t letter option on dvips will produce US Letter files.

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 can check which fonts a PDF files uses. In Acrobat Reader, select 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.
* 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
* LaTeX users:
  + Consider directly generating PDF files using pdflatex (especially if you are a MiKTeX user). PDF figures must be substituted for EPS figures, however.
  + Otherwise, please generate your PostScript and PDF files with the following commands:
  + dvips mypaper.dvi -t letter -Ppdf -G0 -o mypaper.ps
  + ps2pdf mypaper.ps mypaper.pdf
  + Check that the PDF files only contains Type 1 fonts.
* xfig “patterned” shapes are implemented with bitmap fonts. Use “solid” shapes instead.
* The \bbold package almost always uses bitmap fonts. You can try the equivalent AMS Fonts with command
  + \usepackage[psamsfonts]{amssymb}
  + or use the following workaround for reals, natural and complex:
  + \newcommand{\RR}{I\!\!R} %real numbers
  + \newcommand{\Nat}{I\!\!N} %natural numbers
  + \newcommand{\CC}{I\!\!\!\!C} %complex numbers
* Sometimes the problematic fonts are used in figures included in LaTeX files. The ghostscript program eps2eps is the simplest way to clean such figures. For black and white figures, slightly better results can be achieved with program potrace.
* MSWord 2007 and Windows users (via PDF file):
  + Install the Microsoft Save as PDF Office 2007 Add-in from
  + http://www.microsoft.com/downloads/details.aspx?displaylang=en&familyid=4d951911-3e7e-4ae6-b059-a2e79ed87041
  + Select "Save or Publish to PDF" from the Office or File menu
* MSWord and Mac OS X users (via PDF file):
  + From the print menu, click the PDF drop-down box, and select "Save as PDF…"
* MSWord and Windows users (via PS file):
  + To create a new printer on your computer, install the AdobePS printer driver and the Adobe PostScript Printer Description (PPD) file from
  + <http://www.adobe.com/support/downloads/detail.jsp?ftpID=204>
  + *Note:* You must reboot your PC after installing the AdobePS driver for it to take effect.
  + To produce the ps file, select "Print" from the MS app, choose the installed AdobePS printer, click on "Properties", click on "Advanced."
  + Set “TrueType Font” to be “Download as Softfont”
  + Open the “PostScript Options” folder
  + Select “PostScript Output Option” to be “Optimize for Portability”
  + Select “TrueType Font Download Option” to be “Outline”
  + Select “Send PostScript Error Handler” to be “No”
  + Click “OK” three times, print your file.
  + Now, use Adobe Acrobat Distiller or ps2pdf to create a PDF file from the PS file. In Acrobat, check the option “Embed all fonts” if applicable.

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

**6.1 Margins in LaTeX**

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[dvips]{graphicx} ...

\includegraphics[width=0.8\linewidth]{myfile.eps}

or

\usepackage[pdftex]{graphicx} ...

\includegraphics[width=0.8\linewidth]{myfile.pdf}

for .pdf graphics. See section 4.4 in the graphics bundle documentation (http://www.ctan.org/texarchive/macros/latex/required/graphics/grfguide.ps)

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

**Acknowledgments**

Use unnumbered third level headings for the acknowledgments. All acknowledgements go at the end of the paper. Do not include acknowledgements in the anonymized submission, only in the final paper.

**References**

References follow the acknowledgments. Use unnumbered third 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. **Remember that this year you can use a ninth page as long as it contains *only* cited references.**

[1] Alexander, J.A. & Mozer, M.C. (1995) Template-based algorithms for connectionist rule extraction. In G. Tesauro, 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 hiippocampal region CA3. *Journal of Neuroscience* **15**(7):5249-5262.