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# Multi-way block localization vis sparse tensor clustering

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**Yuchen Zeng**

University of Wisconsin – Madison  
yzeng58@wisc.edu

**Miaoyan Wang**

University of Wisconsin – Madison  
miaoyan.wang@wisc.edu

## Abstract

We consider the task of simultaneously clustering each mode of a large noisy tensor. We assume that the tensor elements are distributed with a block-specific mean and propose a least-square estimation for multi-way clustering. An  $\ell_1$  penalty is applied to the block-means in order to select and identify important blocks. We show that our method is applicable to large tensors with a wide range of multi-way cluster structure, including a single block, multiple blocks, checkerboard clusters, 1-way or lower-way blocks. Our proposal amounts to a sparse, multi-way version of  $k$ -mean clustering, and a relaxation of our proposal yields the tensor Tucker decomposition. The performance of our proposals are demonstrated in simulations and on...

## 1 Introduction

In recent years, much interest has centered around the unsupervised analysis of high-dimensional high-order tensor data. ....

### 1.1 Notation

We use  $\mathcal{T}$ ,  $\mathcal{X}$ , and  $\mathcal{E}$  to represent input, signal, and noise tensors, respectively. For any set  $J$ ,  $|J|$  denotes its cardinality.  $[n]$  represents the set  $\{1, 2, \dots, n\}$ .  $\mathbf{x} \otimes \mathbf{y}$  is the Kronecker product of two vectors. Papers to be submitted to NeurIPS 2018 must be prepared according to the instructions presented here. Papers may only be up to eight pages long, including figures. Additional pages *containing only acknowledgments and/or cited references* are allowed. Papers that exceed eight pages of content (ignoring references) will not be reviewed, or in any other way considered for presentation at the conference.

The margins in 2018 are the same as since 2007, which allow for  $\sim 15\%$  more words in the paper compared to earlier years.

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### 1.2 Problem formulation

In

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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  $\frac{1}{2}$  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  $\frac{1}{4}$  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\dotso
```

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_2018` 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_2018}
```

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

Footnotes should be used sparingly. If you do require a footnote, indicate footnotes with a number<sup>1</sup> 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.<sup>2</sup>

### 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.

### 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.

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<sup>1</sup>Sample of the first footnote.

<sup>2</sup>As in this example.



Figure 1: Sample figure caption.

Table 1: Sample table title

| Part     |                 |                        |
|----------|-----------------|------------------------|
| Name     | Description     | Size ( $\mu\text{m}$ ) |
| Dendrite | Input terminal  | $\sim 100$             |
| Axon     | Output terminal | $\sim 10$              |
| Soma     | Cell body       | up to $10^6$           |

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.

## 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 Simulation and Evaluation

We do simulations here and evaluate the result of clustering in different settings.

[scale=0.5]../mycode/figures/figure1/truth.png  
[scale=0.5]../mycode/figures/figure1/*kmeans.png*[scale =  
0.5]../mycode/figures/figure1/output.png

Figure 2:

## 6.1 Simulation 1: Choose the number of clusters in each mode

## 6.2 Simulation 2:

### 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. **Remember that you can use more than eight pages as long as the additional pages contain *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 hippocampal region CA3. *Journal of Neuroscience* **15**(7):5249-5262.