Assignment 1

Tutors: (list all your tutors)
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Abstract

In abstract, you should briefly introduce the topic of this assignment and describe the organization of your report.

The abstract paragraph should be indented 1/2 inch (3 picas) on both left and right-hand margins. Use 10 point type, with a vertical spacing of 11 points. The word **Abstract** must be centered, bold, and in point size 12. Two line spaces precede the abstract. The abstract must be limited to one paragraph.

1 Introduction

In introduction, you should firstly introduce the main idea of NMF as well as its applications. You should then give an overview of the methods you want to use.

2 Related Work

In related work, you are expected to review the main idea of related NMF algorithms (including their advantages and disadvantages).

3 Methods

In methods, you should describe the details of your method (including the definition of objective functions as well as optimization steps). You should also describe your choices of noise and you are encouraged to explain the robustness of each algorithm from theoretical view.

3.1 Traditional NMF

The traditional NMF algorithm seeks to find, given a non-negative matrix X, two non-negative matrices D and R such that $X \approx DR$. To give a precise meaning to the approximate sign, the factorisation is expressed as a minimisation problem:

$$D, R = \underset{D \geq 0, R \geq 0}{\arg\min} ||X - DR||_F^2 \tag{1}$$

where $||\cdot||$ is the Frobenius norm of a matrix. For a matrix A with elements a_{ij}, the (square) of the Frobenius norm is defined as:

$$||A||_F^2 = \sum_{ij} a_{ij}^2 \tag{2}$$

The minimisation problem is convex in D (keeping R fixed) and it is convex in R (keeping D fixed) but not simultaneously in D and in R. So it cannot be hoped to find with certainty the global minimum (the optimal D and R) but only a local minimum. Gradient descent methods could be applied but convergence can be slow. So, multiplicative methods have been developed. These methods usually start from random guesses for D and R and iteratively update D and R using update formulae. For the traditional NMF, these update equations can be written as:

$$\begin{aligned} D_{ij} &\leftarrow\!\!\rightarrow D_{ij} \frac{(XR^\top)_{ij}}{(DRR^\top)_{ij}} \\ R_{ij} &\leftarrow\!\!\rightarrow R_{ij} \frac{(D^\top X)_{ij}}{(D^\top DR)_{ij}} \end{aligned} \tag{3}$$

3.2

4 Experiments

In experiment, firstly, you should introduce the experimental setup (e.g. datasets, algorithms, and noise used in your experiment for comparison). Second, you should show the experimental results and give some comments.

5 Conclusion

In conclusion, you should summarize your results and discuss your insights for future work.

References

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.

[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.

6 General formatting instructions

Please pay special attention to the instructions in section 8 regarding figures, tables, acknowledgments, and references.

7 Headings: first level

First level headings are lower case (except for first word and proper nouns), flush left, bold and in point size 12. One line space before the first level heading and 1/2 line space after the first level heading.

7.1 Headings: second level

Second level headings are lower case (except for first word and proper nouns), flush left, bold and in point size 10. One line space before the second level heading and 1/2 line space after the second level heading.

7.1.1 Headings: third level

Third level headings are lower case (except for first word and proper nouns), flush left, bold and in point size 10. One line space before the third level heading and 1/2 line space after the third level heading.

8 Citations, figures, tables, references

8.1 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 style is acceptable as long as it is used consistently.

8.2 Footnotes

Indicate footnotes with a number[1] 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).[2]

8.3 Figures

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

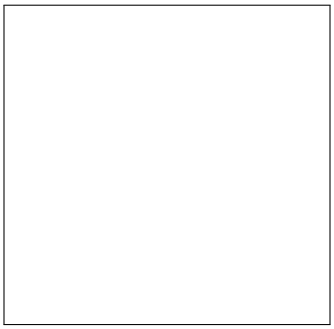

Figure 1: Sample figure caption.

8.4 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.

8.5 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 using .eps graphics

[1] Sample of the first footnote

[2] Sample of the second footnote

Table 1: Sample table title

PART	DESCRIPTION
Dendrite	Input terminal
Axon	Output terminal
Soma	Cell body (contains cell nucleus)

```
\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/tex-archive/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.

References

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.

[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.

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