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# Formatting Instructions For NeurIPS 2022

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## Abstract

The abstract paragraph should be indented  $\frac{1}{2}$  inch (3 picas) on both the left- and right-hand margins. Use 10 point type, with a vertical spacing (leading) 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

Reinforcement learning is a subset of artificial intelligence that concerns itself with developing agents that can learn to take actions in a stochastic environment with the goal to maximize a reward function. In recent years, reinforcement learning has gained considerable attention as it is a powerful approach that can be used in a wide range of applications, from robotics and gaming to finance and healthcare. Among the many algorithms in reinforcement learning, Q Learning has been one of the most popular and most used. However, Q Learning also has its limitations when it comes to handling large state spaces and continuous action spaces. One of the proposed solution is Deep Q Learning (DQL), which combines Q Learning with deep neural networks to learn policies that can handle complex state-action spaces.

In this project, we will compare the performance of Q Learning and Deep Q Learning algorithms on two games from the OpenAI Gym environment: CartPole and Lunar Lander. CartPole is a game that involves balancing a pole on a cart by moving the cart left or right. On the other hand, Lunar Lander is a game that involves landing a spacecraft on a landing pad by controlling its thrusters. Both games have discrete action spaces, which make them suitable for testing the performance of Q Learning and DQL.

Q Learning is a model free reinforcement learning algorithm that uses a table to store the Q values for each state-action pair. The Q value represents the expected return that the agent can obtain by taking a specific action in a given state. To learn, Q Learning updates the Q values based on the Bellman equation. To be more specific, the algorithm learns by updating the expected return in terms of the immediate reward and the expected return in the next state. In simple environments, Q Learning is very effective. However, the model struggles in more complex environments, usually due to the high dimensionality. This generally comes from the exponential increase in the number of states as the number of dimensions increase, making it impractical to store and update the Q values for all the state-action pairs.

To overcome the limitations of Q Learning, Deep Q Learning was introduced. DQL combines Q Learning with deep neural networks to learn policies that can handle state-action spaces. The deep neural network approximates the Q values, which enables the agent to learn a function that maps the states to the Q values. Using neural networks as our function approximator, we can handle large state spaces as well as continuous action spaces.

However, no algorithm is perfect, as DQL faces its own challenge of instability. In fact, DQL can be quite unstable during the learning process and also requires careful hyperparameter tuning. The

instability arises mainly from the non-stationarity of the learning process, where the Q values change as the agent learns, which then affects the target values used in the update rule. The need of careful tuning of hyperparameters arises from the complexity of the DQL algorithm, which involves the use of multiple layers of neural networks, different learning rates and replay buffers.

In this project, the aim is to compare the performance of Q Learning and Deep Q Learning in two games and observe the advantages and limitations of each algorithm. By comparing the results, we hope to gain insights into the strengths and weaknesses of each algorithm and provide a better understanding of their performance in different environments. The motivation for this comparison comes from the need to understand the trade-offs between the two algorithms and their applicability in different scenarios.

## **2 Background**

## **3 Algorithm**

## **4 Methodology**

## **5 Results**

## **6 Conclusion**

## 7 Submission of papers to NeurIPS 2022

Please read the instructions below carefully and follow them faithfully.

### 7.1 Style

Papers to be submitted to NeurIPS 2022 must be prepared according to the instructions presented here. Papers may only be up to **nine** pages long, including figures. 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 at the conference.

The margins in 2022 are the same as those in 2007, which allow for  $\sim 15\%$  more words in the paper compared to earlier years.

Authors are required to use the NeurIPS L<sup>A</sup>T<sub>E</sub>X 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.

### 7.2 Retrieval of style files

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

<http://www.neurips.cc/>

The file `neurips_2022.pdf` contains these instructions and illustrates the various formatting requirements your NeurIPS paper must satisfy.

The only supported style file for NeurIPS 2022 is `neurips_2022.sty`, rewritten for L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub>. **Previous style files for L<sup>A</sup>T<sub>E</sub>X 2.09, Microsoft Word, and RTF are no longer supported!**

The L<sup>A</sup>T<sub>E</sub>X 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** If you wish to post a preprint of your work online, e.g., on arXiv, using the NeurIPS style, please use the `preprint` option. This will create a nonanonymized version of your work with the text “Preprint. Work in progress.” in the footer. This version may be distributed as you see fit. Please **do not** use the `final` option, which should **only** be used for papers accepted to NeurIPS.

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

The file `neurips_2022.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 ??, ??, and ?? below.

## 8 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 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 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 ?? regarding figures, tables, acknowledgments, and references.

## 9 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.

### 9.1 Headings: second level

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

#### 9.1.1 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.

## 10 Citations, figures, tables, references

These instructions apply to everyone.

### 10.1 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_2022` 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_2022}
```

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."



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 $10^6$

## 10.2 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>

## 10.3 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.

## 10.4 Tables

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

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 ??.

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

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

## 11 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.

## 12 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 NeurIPS. 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.

### 12.1 Margins in L<sup>A</sup>T<sub>E</sub>X

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<sup>A</sup>T<sub>E</sub>X 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/2022/PaperInformation/FundingDisclosure>.

Do **not** include this section in the anonymized submission, only in the final paper. You can use the ack environment provided in the style file to automatically hide this section in the anonymized submission.

## Checklist

The checklist follows the references. Please read the checklist guidelines carefully for information on how to answer these questions. For each question, change the default **[TODO]** to **[Yes]**, **[No]**, or **[N/A]**. You are strongly encouraged to include a **justification to your answer**, either by referencing the appropriate section of your paper or providing a brief inline description. For example:

- Did you include the license to the code and datasets? **[Yes]** See Section ??.
- Did you include the license to the code and datasets? **[No]** The code and the data are proprietary.
- Did you include the license to the code and datasets? **[N/A]**

Please do not modify the questions and only use the provided macros for your answers. Note that the Checklist section does not count towards the page limit. In your paper, please delete this instructions block and only keep the Checklist section heading above along with the questions/answers below.

1. For all authors...
  - (a) Do the main claims made in the abstract and introduction accurately reflect the paper's contributions and scope? **[TODO]**
  - (b) Did you describe the limitations of your work? **[TODO]**
  - (c) Did you discuss any potential negative societal impacts of your work? **[TODO]**
  - (d) Have you read the ethics review guidelines and ensured that your paper conforms to them? **[TODO]**
2. If you are including theoretical results...
  - (a) Did you state the full set of assumptions of all theoretical results? **[TODO]**
  - (b) Did you include complete proofs of all theoretical results? **[TODO]**
3. If you ran experiments...
  - (a) Did you include the code, data, and instructions needed to reproduce the main experimental results (either in the supplemental material or as a URL)? **[TODO]**
  - (b) Did you specify all the training details (e.g., data splits, hyperparameters, how they were chosen)? **[TODO]**
  - (c) Did you report error bars (e.g., with respect to the random seed after running experiments multiple times)? **[TODO]**
  - (d) Did you include the total amount of compute and the type of resources used (e.g., type of GPUs, internal cluster, or cloud provider)? **[TODO]**
4. If you are using existing assets (e.g., code, data, models) or curating/releasing new assets...
  - (a) If your work uses existing assets, did you cite the creators? **[TODO]**
  - (b) Did you mention the license of the assets? **[TODO]**
  - (c) Did you include any new assets either in the supplemental material or as a URL? **[TODO]**
  - (d) Did you discuss whether and how consent was obtained from people whose data you're using/curating? **[TODO]**
  - (e) Did you discuss whether the data you are using/curating contains personally identifiable information or offensive content? **[TODO]**
5. If you used crowdsourcing or conducted research with human subjects...
  - (a) Did you include the full text of instructions given to participants and screenshots, if applicable? **[TODO]**
  - (b) Did you describe any potential participant risks, with links to Institutional Review Board (IRB) approvals, if applicable? **[TODO]**
  - (c) Did you include the estimated hourly wage paid to participants and the total amount spent on participant compensation? **[TODO]**

## A Appendix

Optionally include extra information (complete proofs, additional experiments and plots) in the appendix. [?] This section will often be part of the supplemental material.

### 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. 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.