FORMATTING INSTRUCTIONS FOR APS360 PROJECT BASED ON ICLR CONFERENCE FORMAT

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ABSTRACT

This template should be used for all your project related reports in APS360 course. – Write an abstract for your project here. Please review the **First Course Tutorial** for a quick start —-Total Pages: 6

1 PROJECT DOCUMENT SUBMISSION FOR APS360 COURSE

The format for the submissions is a variant of the ICLR 2022 format. Please read carefully the instructions below, and follow them faithfully. There is a **9 page** limit for the main text. References do not have any limitation. This is also ICLR's standard length for a paper submission. If your main text goes to page 10, a -20% penalty would be applied. If your main text goes to page 11, you will not receive any grade for your submission.

1.1 STYLE

Papers to be submitted to APS360 must be prepared according to the instructions presented here.

Authors are required to use the APS360 LaTeX style files obtainable at the APS360 website on Quercus. Tweaking the style is not permitted.

1.2 RETRIEVAL OF STYLE FILES

The file APS360_Project.pdf contains these instructions and illustrates the various formatting requirements your APS360 paper must satisfy. Submissions must be made using LaTeX and the style files iclr2022_conference.sty and iclr2022_conference.bst (to be used with LaTeX2e). The file APS360_Project.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 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 of 11 points. Times New Roman is the preferred typeface throughout. Paragraphs are separated by 1/2 line space, with no indentation.

Paper title is 17 point, in small caps and left-aligned. All pages should start at 1 inch (6 picas) from the top of the page.

Authors' names are set in boldface, and each name is placed above its corresponding address. The lead author's name is to be listed first, and the co-authors' names are set to follow. Authors sharing the same address can be on the same line.

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

There will be a strict upper limit of 9 pages for the main text of the initial submission, with unlimited additional pages for citations.

3   BACKGROUND AND RELATED WORKS

3.1   AUTONOMOUS RC CAR RELATED PROJECTS

Through the use of deep learning, many autonomous car projects have been developed and tested, showing the potential of this technology in real-world applications. The following is an overview of five works related to autonomous vehicles using deep learning.

3.1.1   DEEP CNN END-TO-END LEARNING FOR AUTONOMOUS RC CARS

In this study, end-to-end learning using deep convolutional neural networks (CNNs) was used to autonomously control an RC car around a race track. A front-facing camera is used to collect images of the car's view, which is fed to the model. The CNN extracts features through convolutional and poling layers, then applies the nonlinear ReLU activation function, which is then passed through 3 fully connected layers to generate the output of necessary steering angles and speed the car needs to travel [Cite].

3.1.2   AUTONOMOUS RC CAR USING NEURAL NETWORKS

This project explores autonomous driving through a small RC car using a Raspberry Pi and a CNN based end-to-end steering angle prediction system. To train the model, the team drove the car manually around a track and used the Raspberry Pi to track the analog inputs along with recording video frames taken at 10-20 fps. The project highlights limited computing resources from the Pi's on-board chips which may constrain CNN complexity along with data diversity being an issue where overfitting to a single environment leads to issues in other environments. Additionally, the project highlights the feasibility of deep learning for autonomous navigation and that it can be scaled up to larger robotic systems.

3.1.3   DEVELOPMENT OF SINGLE-BOARD COMPUTER-BASED SELF-DRIVING CAR MODEL

In this paper, an RC car based on the DonkeyCar project, powered by a Nvidia Jetson Nano and controlled by a CNN was used to drive autonomously around a track. The CNN uses live photos of the car's front view to predict the steering angle and speed required. The authors created varied training set sizes of 3000, 6000, 12000 and 24000 along with variations of network depth of between two and five layers of convolutional layers to find the best model [Cite]. Their results showed that the model with 24000 images with three convolution layers performed the best with an absolute error at 0.18257 [CITE]. Additionally, the results showed that having more data consistently reduced error, while adding layers above three had diminishing returns. The authors mention future improvements through image pre-processing, adding additional sensors such as LiDAR and maximizing performance by using more complex network architectures.

3.1.4   CNN BASED END TO END LEARNING STEERING ANGLE PREDICTION FOR AUTONOMOUS ELECTRIC VEHICLES

This paper explores CNN based end-to-end learning for steering angle prediction in autonomous vehicles using images captured of the front view of the car which is passed through to the model in a Jetson TX1. The team trained 3 different models based on different CNN architectures with different numbers of layers and the results showed that the CNN model with 4 CNN layers and 4 connected layers performed the best with 0.0354 test loss [CITE]. These results highlight the viability of CNNs in learning steering behaviours compared to typical approaches in which systems

are broken into multiple stages (such as road and object detection, and path planning)as it has fewer potential failure points.

3.1.5 END TO END LEARNING FOR SELF-DRIVING CARS

In this paper, the team trained a CNN to map raw pixels from a front-facing camera directly to steering commands for a car. The network made up of nine layers, with one normalization layer, five convolutional layers and three fully connected layers was trained to minimize the mean squared error between steering commands and the human driver's inputs. Using only 72 hours of driving data, the team was able to successfully train the car to operate in diverse conditions showing how a CNN can perform the entire task without manual decomposition into smaller systems.

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 based on the `natbib` package and include the authors' last names and year (with the "et al." construct for more than two authors). When the authors or the publication are included in the sentence, the citation should not be in parenthesis using `\citet{}` (as in "See Hinton et al. (2006) for more information."). Otherwise, the citation should be in parenthesis using `\citep{}` (as in "Deep learning shows promise to make progress towards AI (Bengio & LeCun, 2007).").

The corresponding references are to be listed in alphabetical order of authors, in the REFERENCES section. As to the format of the references themselves, any style is acceptable as long as it is used consistently.

To cite a new paper, first, you need to add that paper's BibTeX information to `APS360_ref.bib` file and then you can use the `\citep{}` command to cite that in your main document.

4.2 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]

4.3 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.

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.

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[1]Sample of the first footnote
[2]Sample of the second footnote

Figure 1: Sample figure caption. Image: ZDNet

Table 1: Sample table title

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

5 Default Notation

In an attempt to encourage standardized notation, we have included the notation file from the textbook, *Deep Learning* Goodfellow et al. (2016) available at `https://github.com/goodfeli/dlbook_notation/`. Use of this style is not required and can be disabled by commenting out `math_commands.tex`.

Numbers and Arrays

a	A scalar (integer or real)
$\boldsymbol{a}$	A vector
$\boldsymbol{A}$	A matrix
$\mathbf{A}$	A tensor
$\boldsymbol{I}_n$	Identity matrix with n rows and n columns
$\boldsymbol{I}$	Identity matrix with dimensionality implied by context
$\boldsymbol{e}^{(i)}$	Standard basis vector $[0, \ldots, 0, 1, 0, \ldots, 0]$ with a 1 at position i
$\mathrm{diag}(\boldsymbol{a})$	A square, diagonal matrix with diagonal entries given by $\boldsymbol{a}$
a	A scalar random variable
$\mathbf{a}$	A vector-valued random variable
$\mathbf{A}$	A matrix-valued random variable

Sets and Graphs

$\mathbb{A}$	A set
$\mathbb{R}$	The set of real numbers
$\{0, 1\}$	The set containing 0 and 1
$\{0, 1, \dots, n\}$	The set of all integers between 0 and n
$[a, b]$	The real interval including a and b
$(a, b]$	The real interval excluding a but including b
$\mathbb{A} \backslash \mathbb{B}$	Set subtraction, i.e., the set containing the elements of $\mathbb{A}$ that are not in $\mathbb{B}$
$\mathcal{G}$	A graph
$Pa_{\mathcal{G}}(\mathrm{x}_i)$	The parents of x_i in $\mathcal{G}$

Indexing

a_i	Element i of vector $\boldsymbol{a}$, with indexing starting at 1
a_{-i}	All elements of vector $\boldsymbol{a}$ except for element i
$A_{i,j}$	Element i, j of matrix $\boldsymbol{A}$
$\boldsymbol{A}_{i,:}$	Row i of matrix $\boldsymbol{A}$
$\boldsymbol{A}_{:,i}$	Column i of matrix $\boldsymbol{A}$
$\mathsf{A}_{i,j,k}$	Element (i, j, k) of a 3-D tensor A
$\mathsf{A}_{:,:,i}$	2-D slice of a 3-D tensor
a_i	Element i of the random vector a

Calculus

$\dfrac{dy}{dx}$	Derivative of y with respect to x
$\dfrac{\partial y}{\partial x}$	Partial derivative of y with respect to x
$\nabla_{\boldsymbol{x}} y$	Gradient of y with respect to $\boldsymbol{x}$
$\nabla_{\boldsymbol{X}} y$	Matrix derivatives of y with respect to $\boldsymbol{X}$
$\nabla_{\mathsf{X}} y$	Tensor containing derivatives of y with respect to X
$\dfrac{\partial f}{\partial \boldsymbol{x}}$	Jacobian matrix $\boldsymbol{J} \in \mathbb{R}^{m \times n}$ of $f : \mathbb{R}^n \to \mathbb{R}^m$
$\nabla_{\boldsymbol{x}}^2 f(\boldsymbol{x})$ or $\boldsymbol{H}(f)(\boldsymbol{x})$	The Hessian matrix of f at input point $\boldsymbol{x}$
$\displaystyle \int f(\boldsymbol{x}) d\boldsymbol{x}$	Definite integral over the entire domain of $\boldsymbol{x}$
$\displaystyle \int_{\mathbb{S}} f(\boldsymbol{x}) d\boldsymbol{x}$	Definite integral with respect to $\boldsymbol{x}$ over the set $\mathbb{S}$

Probability and Information Theory

$P(\mathrm{a})$	A probability distribution over a discrete variable
$p(\mathrm{a})$	A probability distribution over a continuous variable, or over a variable whose type has not been specified
$\mathrm{a} \sim P$	Random variable a has distribution P
$\mathbb{E}_{\mathrm{x} \sim P}[f(x)]$ or $\mathbb{E}f(x)$	Expectation of $f(x)$ with respect to $P(\mathrm{x})$
$\mathrm{Var}(f(x))$	Variance of $f(x)$ under $P(\mathrm{x})$
$\mathrm{Cov}(f(x), g(x))$	Covariance of $f(x)$ and $g(x)$ under $P(\mathrm{x})$
$H(\mathrm{x})$	Shannon entropy of the random variable x
$D_{\mathrm{KL}}(P\|Q)$	Kullback-Leibler divergence of P and Q
$\mathcal{N}(\boldsymbol{x}; \boldsymbol{\mu}, \boldsymbol{\Sigma})$	Gaussian distribution over $\boldsymbol{x}$ with mean $\boldsymbol{\mu}$ and covariance $\boldsymbol{\Sigma}$

Functions

$f : \mathbb{A} \to \mathbb{B}$	The function f with domain $\mathbb{A}$ and range $\mathbb{B}$
$f \circ g$	Composition of the functions f and g
$f(\boldsymbol{x}; \boldsymbol{\theta})$	A function of $\boldsymbol{x}$ parametrized by $\boldsymbol{\theta}$. (Sometimes we write $f(\boldsymbol{x})$ and omit the argument $\boldsymbol{\theta}$ to lighten notation)
$\log x$	Natural logarithm of x
$\sigma(x)$	Logistic sigmoid, $\dfrac{1}{1 + \exp(-x)}$
$\zeta(x)$	Softplus, $\log(1 + \exp(x))$
$\|\boldsymbol{x}\|_p$	L^p norm of $\boldsymbol{x}$
$\|\boldsymbol{x}\|$	L^2 norm of $\boldsymbol{x}$
x^+	Positive part of x, i.e., $\max(0, x)$
$\mathbf{1}_{\mathrm{condition}}$	is 1 if the condition is true, 0 otherwise

6 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.

AUTHOR CONTRIBUTIONS

If you'd like to, you may include a section for author contributions as is done in many journals. This is optional and at the discretion of the authors.

ACKNOWLEDGMENTS

Use unnumbered third level headings for the acknowledgments. All acknowledgments, including those to funding agencies, go at the end of the paper.

REFERENCES

Yoshua Bengio and Yann LeCun. Scaling learning algorithms towards AI. In *Large Scale Kernel Machines*. MIT Press, 2007.

Ian Goodfellow, Yoshua Bengio, Aaron Courville, and Yoshua Bengio. *Deep learning*, volume 1. MIT Press, 2016.

Geoffrey E. Hinton, Simon Osindero, and Yee Whye Teh. A fast learning algorithm for deep belief nets. *Neural Computation*, 18:1527–1554, 2006.