FPGA Paper Title*

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***Abstract*—This document is a model and instructions for LaTeX. This and the IEEEtran.cls file define the components of your paper [title, text, heads, etc.]. *CRITICAL: Do Not Use Symbols, Special Characters, Footnotes, or Math in Paper Title or Abstract.**

***Index Terms*—Deep Learning, Artificial Neural Network**

I. Introduction

This paper is an introduction into deep learning. First, an overview is presented with a comparison between machine learning and deep learning. This allows readers with less background to follow the reasons why deep learning often is associated with artificial networks in particular artificial neural networks.

Deep learning is used in a wide range of applications but especially show improved performance in pattern recognition. Where as image recognition and speech recognition are often used as examples or for testing to show performance improvements if a field programmable gate array (FPGA) is used over a conventional central processing unit (CPU). Furthermore, most often a dedicated FPGA seems to have a better energy performance in comparison to a FPGA.

Second, deep learning (DL) will be the focus point and especially the different methods that are commonly used as neural networks (NN).

II. Background

A. General Concepts

Learning is a commonly used word and means according to Merriam Webster the following [1]:

1 : the act or experience of one that learns
\\ a computer program that makes learning fun
2 : knowledge or skill acquired by instruction or study
\\ people of good education and considerable learning
3 : modification of a behavioral tendency by experience (such as exposure to conditioning)

This means that a machine that learns receives either instructions or experiences something. This leads to the not unreasonable assumption that if a machine learns, somebody teaches the machine in form of instructions or exploits the machine to experience. To give a machine instructions is most likely the essence of the todays computing. While a machine is capable of receiving instructions in many different forms the most common at the time is still the users instruction, according to the authors opinion. By applying this concept to a machine that learns a instruction in terms of machine learning not a single instruction is given a algorithm is implemented that similar to adaptive filtering in signal processing wights an input x and will provide an output z. The a function W is used to define the weight according to different methods as example linear regression or a second order polynomial. The issue for such an algorithm is the weighting function W needs to be defined by a human that invests a lot of time studying cases and tries to figure out what might be the best function to weight the input for a certain situation. By introducing this thought of weight which is implemented as a simple multiplication of an input value x. This allows to use a vector to describe inputs hence the weights would be a vector of the same length. Now if as example an image of 128x128 pixels would be wighted a vector of length 16384 would have to be used, assuming it is a chromatic picture with a single integer that defines each pixel. This is a real simple example as you start thinking about it but nobody in the world would try to do that with no strategy on hand. To make a point, a machine would have to learn how to interpret a picture depending on the state of the wight of each pixel or most likely groups of pixels. A machine could improve the resolution of his weighting function by learning known pictures where the result is known which is known as **supervised learning**. Due to the fact that a machine can learn such sets and define a wight for each situation very fast a machine is capable of learning more situations in days than a human is capable of in years.

At this point lets create a hypothetical scenario to understand learning furthermore. Assume that a human with all cognitive abilities that we have just start to exist on a plane with a river and a sun. As a human needs a lot of water most likely this human would experience a sense of thirstiness at some point. The human has no teacher and no previous knowledge so how can the human know that he can drink from the river if not learned from a teacher.

Assume there is an animal too on this plane that drinks from the water. If there is no teacher and a similar situation and obviously no other option than to explore the river the

Identify applicable funding agency here. If none, delete this.

human might be try to do the same even not knowing that it will help to still the sense of thirstiness. The human **learned unsupervised** by experience of a situation as a witness.

This rises the question would make a human brain the decision that it could try to drink from the river with having a single reference. The authors best guess is that most likely a decision would be either drinking, not drinking or something else not expected like trying to communicate with the animal and ask it why it drinks. This shows that a solution can have more possibilities then just yes or no which can be **classified** as a vector.

In summary, there are three important terms to know highlighted in the previous sub Section II-A which are input, output, supervised learning, unsupervised learning, classification. Notice, this is not meant to be a full list of concepts there is more to explore and to know. Due to the fact that the paper shall not exceed a certain length not every concept is discussed rather than a subset is chosen that seems in the authors opinion the most important to understand the background of the matter.

The next sub section II-B is dedicated to machine learning.

B. Machine Learning

Where as general concepts has been discussed in the previous section II-A in this section machine learning will be discussed. In machine learning all the previous discussed concepts can be applied. As the previous discussed example of an 128x 128 picture introduced the goal is to find functions that wights the input there for in machine learning which involves usually no more then one non linear logic layer that is applied to each input vector. The goal is to optimize the weight function W in case of using the concept of supervised learning it would be a predefined set of pictures with known result that is instructed to machine. A commonly known and widely used set is Caltech 101 [2].

C. Artificial Neural Network

D. Deep Learning

E. Machine vs. deep

III. Computational challenges

IV. Computational approaches

V. Conclusion

1. Abstract

2. Background Machine Learning, Deep Learning ANN 3. Computational challenges 4. Computational approaches 5. Conclusion

VI. Ease of Use

A. Maintaining the Integrity of the Specifications

The IEEEtran class file is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

VII. Prepare Your Paper Before Styling

Before you begin to format your paper, first write and save the content as a separate text file. Complete all content and organizational editing before formatting. Please note sections VII-A–VII-E below for more information on proofreading, spelling and grammar.

Keep your text and graphic files separate until after the text has been formatted and styled. Do not number text heads—LaTeX will do that for you.

A. Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

B. Units

- Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as “3.5-inch disk drive”.
- Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.
- Do not mix complete spellings and abbreviations of units: “Wb/m^2” or “webers per square meter”, not “webers/m^2”. Spell out units when they appear in text: “. . . a few henries”, not “. . . a few H”.
- Use a zero before decimal points: “0.25”, not “.25”. Use “cm^3”, not “cc”.)

C. Equations

Number equations consecutively. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

$$a + b = \gamma \tag{1}$$

Be sure that the symbols in your equation have been defined before or immediately following the equation. Use “(1)”, not “Eq. (1)” or “equation (1)”, except at the beginning of a sentence: “Equation (1) is . . .”

D. LaTeX-Specific Advice

Please use "soft" (e.g., `\eqref{Eq}`) cross references instead of "hard" references (e.g., `(1)`). That will make it possible to combine sections, add equations, or change the order of figures or citations without having to go through the file line by line.

Please don't use the `{eqnarray}` equation environment. Use `{align}` or `{IEEEeqnarray}` instead. The `{eqnarray}` environment leaves unsightly spaces around relation symbols.

Please note that the `{subequations}` environment in LaTeX will increment the main equation counter even when there are no equation numbers displayed. If you forget that, you might write an article in which the equation numbers skip from (17) to (20), causing the copy editors to wonder if you've discovered a new method of counting.

BibTeX does not work by magic. It doesn't get the bibliographic data from thin air but from .bib files. If you use BibTeX to produce a bibliography you must send the .bib files.

LaTeX can't read your mind. If you assign the same label to a subsubsection and a table, you might find that Table I has been cross referenced as Table IV-B3.

LaTeX does not have precognitive abilities. If you put a `\label` command before the command that updates the counter it's supposed to be using, the label will pick up the last counter to be cross referenced instead. In particular, a `\label` command should not go before the caption of a figure or a table.

Do not use `\nonumber` inside the `{array}` environment. It will not stop equation numbers inside `{array}` (there won't be any anyway) and it might stop a wanted equation number in the surrounding equation.

E. Some Common Mistakes

- The word "data" is plural, not singular.
- The subscript for the permeability of vacuum μ_0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter "o".
- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
- A graph within a graph is an "inset", not an "insert". The word alternatively is preferred to the word "alternately" (unless you really mean something that alternates).
- Do not use the word "essentially" to mean "approximately" or "effectively".
- In your paper title, if the words "that uses" can accurately replace the word "using", capitalize the "u"; if not, keep using lower-cased.
- Be aware of the different meanings of the homophones "affect" and "effect", "complement" and "compliment", "discreet" and "discrete", "principal" and "principle".
- Do not confuse "imply" and "infer".
- The prefix "non" is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the "et" in the Latin abbreviation "et al.".
- The abbreviation "i.e." means "that is", and the abbreviation "e.g." means "for example".

An excellent style manual for science writers is [**?**].

F. Authors and Affiliations

The class file is designed for, but not limited to, six authors. A minimum of one author is required for all conference articles. Author names should be listed starting from left to right and then moving down to the next line. This is the author sequence that will be used in future citations and by indexing services. Names should not be listed in columns nor group by affiliation. Please keep your affiliations as succinct as possible (for example, do not differentiate among departments of the same organization).

G. Identify the Headings

Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

Component heads identify the different components of your paper and are not topically subordinate to each other. Examples include Acknowledgments and References and, for these, the correct style to use is "Heading 5". Use "figure caption" for your Figure captions, and "table head" for your table title. Run-in heads, such as "Abstract", will require you to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the head from the text.

Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced.

H. Figures and Tables

a) Positioning Figures and Tables: Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table heads should appear above the tables. Insert figures and tables after they are cited in the text. Use the abbreviation "Fig. **??**", even at the beginning of a sentence.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an

TABLE I
TABLE TYPE STYLES

Table Head	Table Column Head		
	Table column subhead	*Subhead*	*Subhead*
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[a]Sample of a Table footnote.

example, write the quantity "Magnetization", or "Magnetization, M", not just "M". If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write "Magnetization (A/m)" or "Magnetization {A[m(1)]}", not just "A/m". Do not label axes with a ratio of quantities and units. For example, write "Temperature (K)", not "Temperature/K".

ACKNOWLEDGMENT

The preferred spelling of the word "acknowledgment" in America is without an "e" after the "g". Avoid the stilted expression "one of us (R. B. G.) thanks ...". Instead, try "R. B. G. thanks...". Put sponsor acknowledgments in the unnumbered footnote on the first page.

REFERENCES

Please number citations consecutively within brackets [**?**]. The sentence punctuation follows the bracket [**?**]. Refer simply to the reference number, as in [**?**]—do not use "Ref. [**?**]" or "reference [**?**]" except at the beginning of a sentence: "Reference [**?**] was the first ..."

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors' names; do not use "et al.". Papers that have not been published, even if they have been submitted for publication, should be cited as "unpublished" [**?**]. Papers that have been accepted for publication should be cited as "in press" [**?**]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [**?**].

REFERENCES

[1] [1] "Learning — Definition of Learning by Merriam-Webster." [Online]. Available: https://www.merriam-webster.com/dictionary/learning. [Accessed: 26-Sep-2018].

[2] [2] "Caltech101." [Online]. Available: http://www.vision.caltech.edu/Image_Datasets/Caltech101/. [Accessed: 26-Sep-2018].