

TECHNICAL UNIVERSITY OF CRETE

DIPLOMA THESIS

---

# Design and Implementation of an FPGA-Based Convolutional Neural Network Accelerator

---

*Author:*

Christos SPYRIDAKIS

*Thesis Committee:*

Prof. Apostolos DOLLAS (Supervisor)

Asst. Prof. Eftychios KOUTROULIS

Asst. Prof. Panagiotis PARTSINEVELOS



*A thesis submitted in fulfillment of the requirements  
for the diploma of Electrical and Computer Engineer  
in the*

School of Electrical and Computer Engineering  
Microprocessor and Hardware Laboratory

October 28, 2020



TECHNICAL UNIVERSITY OF CRETE

# *Abstract*

School of Electrical and Computer Engineering

Electrical and Computer Engineer

## **Design and Implementation of an FPGA-Based Convolutional Neural Network Accelerator**

by Christos SPYRIDAKIS

The Thesis Abstract is written here (and usually kept to just this page). The page is kept centered vertically so can expand into the blank space above the title too...



## *Acknowledgements*

The acknowledgments and the people to thank go here, don't forget to include your project advisor. . .



# Contents

<b>Abstract</b>	<b>iii</b>
<b>Acknowledgements</b>	<b>v</b>
<b>Contents</b>	<b>vii</b>
<b>List of Figures</b>	<b>ix</b>
<b>List of Tables</b>	<b>xi</b>
<b>List of Algorithms</b>	<b>xiii</b>
<b>Physical Constants</b>	<b>xv</b>
<b>List of Symbols</b>	<b>xvii</b>
<b>List of Abbreviations</b>	<b>xix</b>
<b>1 Chapter Title Here</b>	<b>1</b>
1.1 Main Section 1 . . . . .	1
1.1.1 Subsection 1 . . . . .	1
1.1.2 Subsection 2 . . . . .	1
1.2 Main Section 2 . . . . .	2
<b>A Frequently Asked Questions</b>	<b>3</b>
A.1 How do I change the colors of links? . . . . .	3
<b>References</b>	<b>5</b>





# List of Figures



# List of Tables



# List of Algorithms



# Physical Constants

Speed of Light  $c_0 = 2.997\,924\,58 \times 10^8 \text{ m s}^{-1}$  (exact)  
Constant Name *Symbol = ConstantValue* with units





# List of Symbols

$a$	distance	m
$P$	power	W (J s <sup>-1</sup> )
Symbol	Name	Unit
$\omega$	angular frequency	rad



# List of Abbreviations

ALU    Arithmetic Logic Unit



*Dedicated to my family and friends. . .*



# Chapter 1

## Chapter Title Here

### 1.1 Main Section 1

"Let no one ignorant of  
geometry enter"

---

*Plato*

DoReFa-Net [1] fdg.

In this Chapter, we describe in detail the theoretical background of Machine Learning and especially for CNN.

[2]

#### 1.1.1 Subsection 1

Nunc posuere quam at lectus tristique eu ultrices augue venenatis. Vestibulum ante ipsum primis in faucibus orci luctus et ultrices posuere cubilia Curae; Aliquam erat volutpat. Vivamus sodales tortor eget quam adipiscing in vulputate ante ullamcorper. Sed eros ante, lacinia et sollicitudin et, aliquam sit amet augue. In hac habitasse platea dictumst. Hello

#### 1.1.2 Subsection 2

Morbi rutrum odio eget arcu adipiscing sodales. Aenean et purus a est pulvinar pellentesque. Cras in elit neque, quis varius elit. Phasellus fringilla, nibh eu tempus venenatis, dolor elit posuere quam, quis adipiscing urna leo nec orci. Sed nec nulla auctor odio aliquet consequat. Ut nec nulla in ante ullamcorper aliquam at sed dolor. Phasellus fermentum magna in augue gravida cursus. Cras sed

pretium lorem. Pellentesque eget ornare odio. Proin accumsan, massa viverra cursus pharetra, ipsum nisi lobortis velit, a malesuada dolor lorem eu neque.

## 1.2 Main Section 2

Sed ullamcorper quam eu nisl interdum at interdum enim egestas. Aliquam placerat justo sed lectus lobortis ut porta nisl porttitor. Vestibulum mi dolor, lacinia molestie gravida at, tempus vitae ligula. Donec eget quam sapien, in viverra eros. Donec pellentesque justo a massa fringilla non vestibulum metus vestibulum. Vestibulum in orci quis felis tempor lacinia. Vivamus ornare ultrices facilisis. Ut hendrerit volutpat vulputate. Morbi condimentum venenatis augue, id porta ipsum vulputate in. Curabitur luctus tempus justo. Vestibulum risus lectus, adipiscing nec condimentum quis, condimentum nec nisl. Aliquam dictum sagittis velit sed iaculis. Morbi tristique augue sit amet nulla pulvinar id facilisis ligula mollis. Nam elit libero, tincidunt ut aliquam at, molestie in quam. Aenean rhoncus vehicula hendrerit.



## Appendix A

# Frequently Asked Questions

### A.1 How do I change the colors of links?

The color of links can be changed to your liking using:

```
\hypersetup{urlcolor=red}, or
```

```
\hypersetup{citecolor=green}, or
```

```
\hypersetup{allcolor=blue}.
```

If you want to completely hide the links, you can use:

```
\hypersetup{allcolors=.}, or even better:
```

```
\hypersetup{hidelinks}.
```

If you want to have obvious links in the PDF but not the printed text, use:

```
\hypersetup{colorlinks=false}.
```



# References

- [1] Name. “Test”. In: *Jo* 72.1 (Jan. 111), pp. 11–11. URL: <http://google.com>.



## External Links

[2] *Wikipedia*. URL: <https://www.wikipedia.com/>.