#### The title of my thesis

Any short subtitle

**Lucas Charpentier** 



Thesis submitted for the degree of Master in Computational Science (Imaging and Biomedical Computing) 60 credits

Departement of Informatics

Departement of Physics

Faculty of mathematics and natural sciences

**UNIVERSITY OF OSLO** 

Spring 2020

## The title of my thesis

Any short subtitle

Lucas Charpentier

© 2020 Lucas Charpentier

The title of my thesis

http://www.duo.uio.no/

Printed: Reprosentralen, University of Oslo

#### The title of my thesis

Lucas Charpentier

10th June 2020

#### **Abstract**

#### **Contents**

1	Intr	oduction	1				
	1.1	Background and Motivation	1				
	1.2	Problem Statement	1				
	1.3	Thesis Outline	1				
2	Plar	nning the project	3				
	2.1	Machine Learning	4				
		2.1.1 Supervised Learning	4				
		2.1.2 Unsupervised Learning	4				
	2.2	Artificial Neural Networks	4				
		2.2.1 Perceptron	4				
		2.2.2 Multilayer Perceptron	4				
		2.2.3 Training a Neural Network	4				
	2.3	Convolutional Neural Network	4				
		2.3.1 Convolutional Layers	4				
		2.3.2 Pooling Layers	4				
	2.4	Neural Network Training Optimization	4				
		2.4.1 Weight Initialization	4				
		2.4.2 Training Batch Size	4				
		2.4.3 Dropout	4				
	2.5	Network Pruning					
	2.6	8					
		2.6.1 MNIST	4				
		2.6.2 Fashion MNIST	4				
		2.6.3 CIFAR-10	4				
	2.7	Architectures	4				
		2.7.1 VGG-16	4				
3	Sin	gle Layer ANN	5				
	3.1	Pruning Nodes at Random	5				
	3.2	Estimating Node Importance based on Loss and Accuracy . 5					
	3.3	Pruning Nodes based on the Loss and Accuracy					
	3.4	Effects of Changing Training Batch Size on Node Importance 5					
	3.5	Effects of Using Droput	5				

4	Multi-Layer Perceptron		7	
	4.1	Pruning network with pre-calculated importance	7	
	4.2	Greedy approach to pruning instead of Exhaustive approach	7	
	4.3	Iterative weight initialization using Node importance	7	
5	Convolutional Neural Network		9	
	5.1	Looking at effects of per class accuracy after pruning	9	
	5.2	Pruning based on class accuracy	9	
6	Cas	e study: Reducing a VGG-16 model trained on X dataset	11	
7	Con	nclusion	13	
	7.1	Summary	13	
	7.2	Future Works	13	

# **List of Figures**

### **List of Tables**

#### **Preface**

### Introduction

- 1.1 Background and Motivation
- 1.2 Problem Statement
- 1.3 Thesis Outline

#### Planning the project

<b>^</b> 4	3 f 1 ·	T .
2.1	Machine	Learning
	11100011110	

- 2.1.1 Supervised Learning
- 2.1.2 Unsupervised Learning
- 2.2 Artificial Neural Networks
- 2.2.1 Perceptron
- 2.2.2 Multilayer Perceptron
- 2.2.3 Training a Neural Network
- 2.3 Convolutional Neural Network
- 2.3.1 Convolutional Layers
- 2.3.2 Pooling Layers
- 2.4 Neural Network Training Optimization
- 2.4.1 Weight Initialization
- 2.4.2 Training Batch Size
- 2.4.3 Dropout
- 2.5 Network Pruning
- 2.6 Datasets
- 2.6.1 MNIST
- 2.6.2 Fashion MNIST
- 2.6.3 CIFAR-10
- 2.7 Architectures
- 2.7.1 VGG-16

### Single Layer ANN

- 3.1 Pruning Nodes at Random
- 3.2 Estimating Node Importance based on Loss and Accuracy
- 3.3 Pruning Nodes based on the Loss and Accuracy
- 3.4 Effects of Changing Training Batch Size on Node Importance
- 3.5 Effects of Using Droput

## **Multi-Layer Perceptron**

- 4.1 Pruning network with pre-calculated importance
- 4.2 Greedy approach to pruning instead of Exhaustive approach
- 4.3 Iterative weight initialization using Node importance

#### **Convolutional Neural Network**

- 5.1 Looking at effects of per class accuracy after pruning
- 5.2 Pruning based on class accuracy

Case study: Reducing a VGG-16 model trained on X dataset

### Conclusion

- 7.1 Summary
- 7.2 Future Works