# L04 Lab ITAI 2376

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ITAI 2376 Deep Learning in Artificial Intelligence

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## Introduction

This reflective Journal will showcase my experience implementing a convolutional Neural Network (CNN) for classifying the MNIST handwritten digits. This laboratory work reinforced earlier neural network concepts and offered a glimpse into CNNs' unique strengths.

While I had a foundational understanding of feedforward networks and the basic concepts of weight optimization, applying these ideas to image data highlighted the power of convolutional layers and pooling operations in extracting special features.

I will deep dive into the learning insights, challenges I encountered, and how this laboratory work shaped my future plans to deepen my knowledge.

## Body

One concept I remembered from my previous work was the specific mechanics of convolutional layers, especially how filters slide over the input image to detect local features like edges and corners. Although I knew that neural networks could learn patterns, CNNs demonstrated how filters capture increasingly abstract representations in deeper layers. While working on the lab assignment, I also gained practical understanding of MaxPooling2D, which helps reduce dimensionality and prevents overfitting by focusing on the most prominent features in each of the pooled regions. This lab work bridged the gap between the theory I was studying and the actual hands-

on experience of implementing it. Furthermore, I recalled the one-hot encoding and the choice of optimizers, such as Adam, from the computer vision class to support multi-class image classification tasks.

I was surprised how quickly the model was successful. By around the third epoch, validation accuracy already exceeded 0.98, reflecting both the relative simplicity of MNIST and the effectiveness of the CNN architecture. Watching the loss to minimize and rise of the accuracy in such a short time of training underscored how well suited the CNNs are for vision tasks, even when using small 3x3 kernels and relatively few filters (32 or 64 when experimenting).

**Challenges during the laboratory work**

One of the main challenges I faced was selecting the hyperparameters, including the number of filters, dropout rate, and the number of epochs. I was concerned about overfitting. If I used too many filters or trained for too long, the number of epochs would be high. Since I incorporated the dropout layer with a rate of 0.5, it helped mitigate that, and the model achieved an impressive 0.99 accuracy on the validation set. This success highlighted the importance of balancing complexity and regularization.

Another challenge I faced was with the data correctly reshaped with the additional channel dimension. Since I was experimenting with different setups and tried to tweak the code. I forgot to add that channel dimension, causing the dimension mismatch

error. I have quickly realized my error and fixed it in the code to align with Keras requirement for the Conv2D input. I have read online on geek for geek website and tried to learn more about the CNNS and their applications, which helped me significantly in my learning path as I wanted to ensure that I not only identify the problem but I am able to fix it. By changing the batch size, or trying different numbers of epochs, reinforced my knowledge and the concepts that I am aware of by showing me how each parameter is changing the behavior in real time.

**Personal development**

By completing this laboratory work, I have deepened my practical knowledge of CNNs and dramatically improved my ability to play with and perhaps build CNNs. I also recently purchased Sebastian Raschka's book Build a Large Language Model. Understanding the topic is very important to me, and since I really enjoy learning about Artificial intelligence, I am very passionate about it!

Looking ahead, I plan to dive deeper into more complex tasks, and I appreciate the opportunity to include the AWS course as part of my deep learning experience, where I can further engage in laboratory work. I need to concentrate on more advanced tasks such as object detection and segmentation. I will explore batch normalization and advanced optimizers to see if they can enhance performance or learning stability. Although I have some experience from my previous computer vision class, I am eager to

reinforce my knowledge and understanding of the principles. After all, that's how we, and artificial intelligence, learn—through reinforcement learning.

**Conclusion**

This Laboratory work was a deep dive into CNNs, reinforcing some of the foundational neural network concepts that I was already aware of. I faced some minor challenges during the laboratory work as I updated the code significantly. Ultimately, the laboratory work concluded with 99% accuracy on MNIST, illustrating the powerful balance between well-chosen layer regularization methods and the right optimizer.

My reinforcement of convolutional operations, pooling, and dropout has further strengthened my confidence in implementing CNNs for various applications. I look forward to extending this knowledge to more complex datasets and refining my deep learning skills.

**Resources:**

GeeksforGeeks. (2024, October 10). *Introduction to Convolution Neural Network*. GeeksforGeeks. https://www.geeksforgeeks.org/introduction-convolution-neural-network/

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GeeksforGeeks. (2025, February 4). *CNN | Introduction to pooling layer*. GeeksforGeeks. https://www.geeksforgeeks.org/cnn-introduction-to-pooling-layer/

GeeksforGeeks. (2024, October 22). *Activation functions*. GeeksforGeeks. https://www.geeksforgeeks.org/activation-functions/