MA477: Data Science

Lesson 26-27 Board Sheet — 19 / 24 March 2026

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1 CNN Lesson Objectives

- Calendar review
- Student review
- CNN Discussion
- Coding Exercise

2 CNN Lesson Objectives

- Understand the architecture of a typical convolutional neural network to include convolution and pooling layers.
- Understand how data augmentation improves model performance in image classification.
- Use functions in Python's keras module to fit convolutional neural networks for image classification.

Discussion Questions

- Why are CNNs preferred over fully connected / networks in some settings? What settings are CNNs preferred?
- Describe what the following parameters are from Geron:
  - f
  - b
  - s
  - p
- What is meant by weight sharing and feature maps?
- Name or describe some additional operations filters execute?

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Class Exercise

Given:

$$X = \begin{bmatrix} 2 & 1 & 0 \\ 1 & 3 & 2 \\ 0 & 1 & 2 \end{bmatrix} \quad K = \begin{bmatrix} 1 & -1 \\ 0 & 1 \end{bmatrix} \quad b = 0$$

Parameters:

- Kernel size: $f = 2$
- Stride: $s = 1$
- Padding: $p = 0$

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Tasks:

1. Compute the output dimension
2. Compute all values:

$$Z_{1,1},\ Z_{1,2},\ Z_{2,1},\ Z_{2,2}$$

3. Show each step:
    - Extracted patch
    - Elementwise multiplication
    - Final sum

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