EBU4203 Introduction to AI – Week 3 Tutorial 2024

Q1: Explain static graph and dynamic graph used in deep learning frameworks.

Q2: Can you explain the fundamental steps involved in processing an image in Computer Vision?

Q3. Can you explain the concept of object recognition, and how is it used in Computer Vision applications?

Q4. In this question, you will be asked to calculate the dimensions of the outputs after an operation in a Convolution Neural Network (CNN).

a) Given an input image with dimensions 128x128 pixels, a 3x3 kernel, and a stride of 1, calculate the size of the output feature map.

b) If you have a 16x16 feature map and apply max-pooling with a 2x2 window and a stride of 2, what will be the dimensions of the resulting pooled feature map?

Q5. Consider a grayscale input image with dimensions of 6x6 pixels and a 3x3 convolutional kernel. The values of the input image are as follows:

Input Image:
[[2, 1, 2, 0, 3, 1],
 [1, 3, 2, 1, 2, 0],
 [3, 0, 1, 1, 2, 2],
 [0, 2, 3, 1, 1, 3],
 [2, 2, 0, 2, 1, 2],
 [1, 1, 3, 0, 2, 3]]

a) **2D Convolution:** Calculate the result of applying the 3x3 convolutional kernel with the following weights:

Kernel Weights:
[[1, 0, -1],
 [0, 1, 0],
 [-1, 0, 1]]

Use valid padding and a stride of 1. Show the resulting feature map.

b) **Average Pooling:** For the feature map obtained in Part A, perform average pooling with a 2x2 pooling window and a stride of 2. Calculate the resulting pooled feature map and show its values.

c) **Pooling/Stride Effect:** How does adjusting the stride in convolution or pooling operations impact the spatial dimensions of the output feature map?

d) **Padding Effect:** What is the purpose of adding zero-padding to an input image before convolution, and how does it affect the size of the output feature map?

Q6. Consider a 3D volume with dimensions of 3x3x3 and a 2x2x2 3D convolutional kernel. The values of the 3D volume are as follows:

3D Volume:

```
[
  [
    [2, 1, 2],
    [1, 3, 2],
    [3, 0, 1]
  ],
  [
    [0, 2, 3],
    [1, 1, 3],
    [2, 2, 0]
  ],
  [
    [1, 1, 2],
    [2, 0, 2],
    [1, 3, 0]
  ]
]
```

a) **3D Convolution**: Calculate the result of applying the 2x2x2 3D convolutional kernel with the following weights:

3D Kernel Weights:

```
[  [    [1, 0],
        [0, 1]
  ],
  [    [-1, 0],
       [0, -1]
  ]
]
```

Use valid padding and a stride of 1 in all three dimensions (x, y, z). Show the resulting 3D feature volume.

b) **3D Max Pooling**: For the 3D feature volume obtained in Part A, perform max pooling with a 2x2x2 pooling window and a stride of 2 in all three dimensions (x, y, z). Calculate the resulting 3D pooled feature volume and show its values.