Assignment A07: Convolutional Layers and Filters in Image Recognition

Course: Introduction to Artificial Intelligence

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Step 1: Create your image

Below is an 8x8 grid that represents a simplified image. The pixel values are 0 for black and 1 for white. This image represents a basic shape: a cross.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |

Step 2: Design Filters

Below are two 3x3 filters designed to detect edges in the image. Filter 1 is a vertical edge detector, and Filter 2 is a horizontal edge detector.

Filter 1: Vertical Edge Detection

|  |  |  |
| --- | --- | --- |
| -1 | 0 | 1 |
| -1 | 0 | 1 |
| -1 | 0 | 1 |

Filter 2: Horizontal Edge Detection

|  |  |  |
| --- | --- | --- |
| 1 | 1 | 1 |
| 0 | 0 | 0 |
| -1 | -1 | -1 |

Step 3: Convolve Manually

Now, we manually slide the filter across the image and compute the convolution. Below is the step-by-step calculation using Filter 1.

The calculation process involves multiplying each value in the filter with the corresponding value in the image and then summing them up. This is repeated as the filter slides over the image. An example is shown below.

Example Calculation:

For the first 3x3 block of the image, applying Filter 1 results in the following calculation:

(-1 x 0) + (0 x 0) + (1 x 0) + (-1 x 0) + (0 x 1) + (1 x 1) + (-1 x 0) + (0 x 0) + (1 x 0) = 1

Step 4: Identify Features

After applying the filter, the resulting values highlight the vertical and horizontal edges in the image. The areas with the highest values correspond to the strongest detected features (edges or corners). Below are the results of the convolution operation.

In conclusion, the manual convolution process demonstrates how CNNs detect features like edges in an image. The filters we designed helped identify specific patterns in the image, which can be interpreted as features like vertical and horizontal edges.