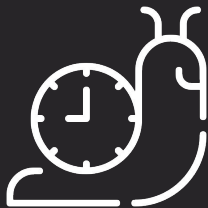# Module 1: A Beginner's Guide to Computer Vision

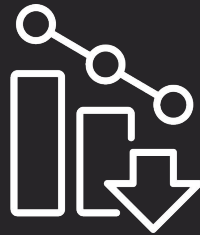**Video 6:** Building a CNN - Pooling Layer

Analytics Vidhya

Problems with Convolution

When working with massive data, convolutions may lead to the following problems:
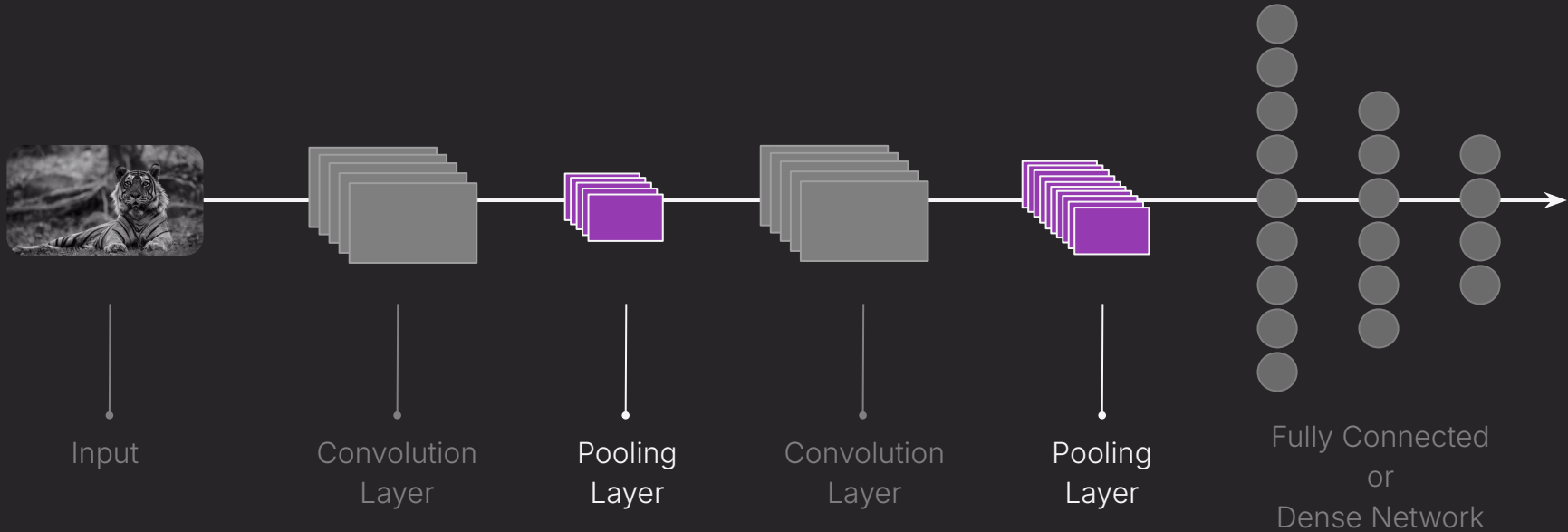
Slow Training

Analyzing every details from a massive database of images will result in long training times.

### Poor Performance

Model might learn irrelevant details during training leading to poor performance on unseen datasets.

The Pooling Layer

Input

Convolution Layer

Pooling Layer

Convolution Layer

Pooling Layer

Fully Connected or Dense Network

The Pooling Layer

- Reduces complexity of the image data by downsampling the feature maps.

- It focuses on essential details and maintains the overall pattern or structure.

Input   Convolution Layer   **Pooling Layer**   Convolution Layer   **Pooling Layer**   Fully Connected or Dense Network
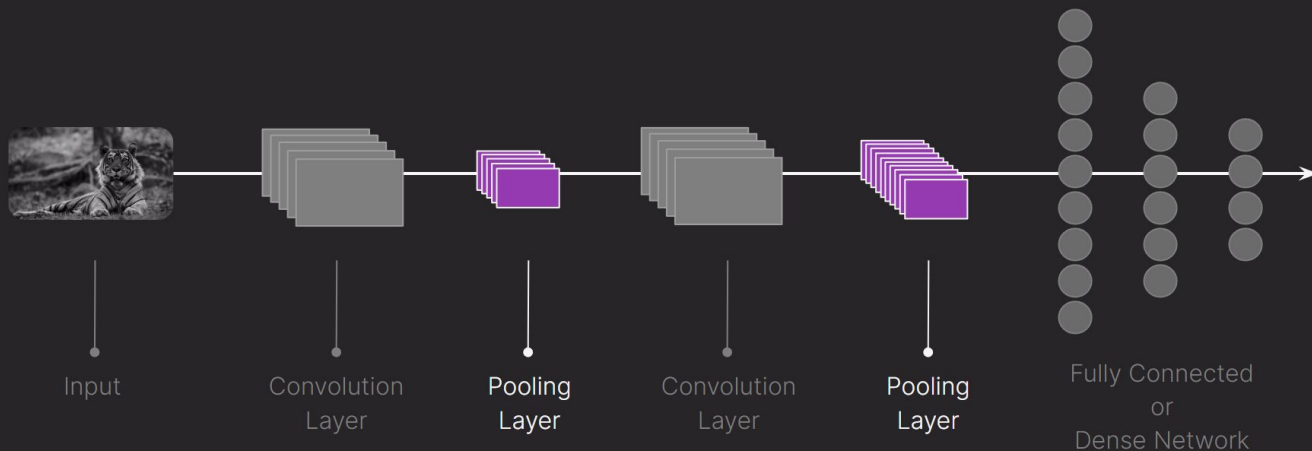
Types of Pooling

The two main types of pooling are:

● Max Pooling

● Average Pooling
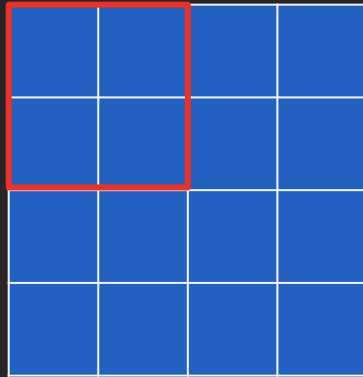
Original 4×4 Feature Map

Applying 2×2 Pooling

Output 2×2 Feature Map

Types of Pooling: Max Pooling

Max pooling takes the maximum value from each path of the feature map.

1	3	2	4
5	**6**	7	8
9	2	10	1
4	3	2	0

Applying 2×2 Max Pooling

6	

Input 4×4 Feature Map

Output 2×2 Feature Map

Types of Pooling: Max Pooling

Max pooling takes the maximum value from each path of the feature map.

1	3	2	4
5	6	7	**8**
9	2	10	1
4	3	2	0

Input 4×4 Feature Map

Applying 2×2 Max Pooling

| 6 | **8** |
| | |

Output 2×2 Feature Map

Types of Pooling: Max Pooling

Max pooling takes the maximum value from each path of the feature map.

1	3	2	4
5	6	7	8
9	2	10	1
4	3	2	0

Applying 2×2 Max Pooling

6	8
9	

Input 4×4 Feature Map

Output 2×2 Feature Map

Types of Pooling: Max Pooling

Max pooling takes the maximum value from each path of the feature map.

1	3	2	4
5	6	7	8
9	2	**10**	1
4	3	2	0

Applying 2×2 Max Pooling

6	8
9	**10**

Input 4×4 Feature Map

Output 2×2 Feature Map

Types of Pooling: Max Pooling

Input Image

Max Pooled Image

Types of Pooling: Average Pooling

Average pooling takes the average value from each path of the feature map.

1	3	2	4
5	6	7	8
9	2	10	1
4	3	2	0

Input 4×4 Feature Map

= (1+3+5+6)/4 =3.75

Rounded down to 3

3	

Output 2×2 Feature Map

Types of Pooling: Average Pooling

Average pooling takes the average value from each path of the feature map.

1	3	2	4
5	6	7	8
9	2	10	1
4	3	2	0

= (2+4+7+8)/4=5.25

Rounded down to 5

3	5

Input 4×4 Feature Map

Output 2×2 Feature Map

Types of Pooling: Average Pooling

Average pooling takes the average value from each path of the feature map.

1	3	2	4
5	6	7	8
9	2	10	1
4	3	2	0

= (10+1+2+0)/4=3.25

Rounded down to 3

3	5
4	**3**

Input 4×4 Feature Map

Output 2×2 Feature Map

Types of Pooling: Average Pooling

Input Image

Average Pooled Image

Pooling Formula

1	3	2	4
5	6	7	8
9	2	10	1
4	3	2	0

Input 4×4 Feature Map

3	5
4	3

Output 2×2 Feature Map

$$\text{Output size} = \frac{W - P_s}{S} + 1$$

- W = Width of the input

- P_s = Pooling Size

- S = Stride used

Pooling Formula

Input 4×4 Feature Map

Output 2×2 Feature Map

$$\text{Output size} = \frac{W - P_s}{S} + 1$$

$$\text{Output size} = \frac{4 - 2}{2} + 1$$

$$= 2$$

The Pooling Layer

Recognize objects regardless of their position or orientation.

Contributes to the model's generalization ability.

Max Pooled Image

Up Next : Module 2: Building Blocks for Image Recognition