Hope to Skills

Lecture# 24

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Agenda

- Limitations of simple Neural Network
- Convolutional Neural Networks (CNN)
- Basics for CNN
  - Images and features
  - Convolution
  - Pooling
- Quiz

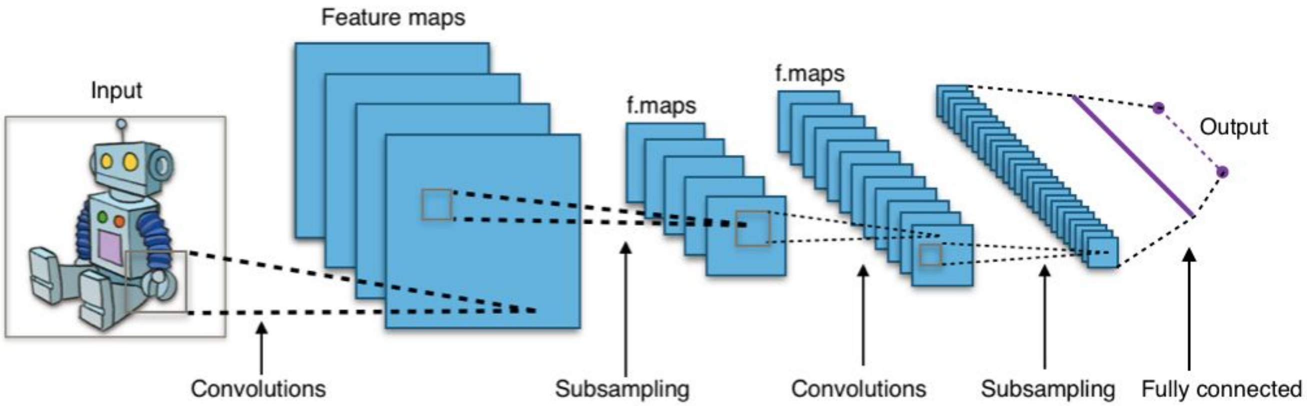
Limitations of Simple Neural Networks

1. **Pixel Equality:** Simple neural networks treat all pixels in an image equally, regardless of their spatial relationships or positions
2. **High Dimensionality:** Large sized Image have more pixels and model needs more weights to learn. **28x28=784, 256x256=65536**
3. **Limited Feature Extraction:** Simple networks lack specialized layers to automatically extract relevant features from images, making it harder to identify complex structures
4. **Large Computational Requirements:** Larger no of weights requires more computational resources to train.

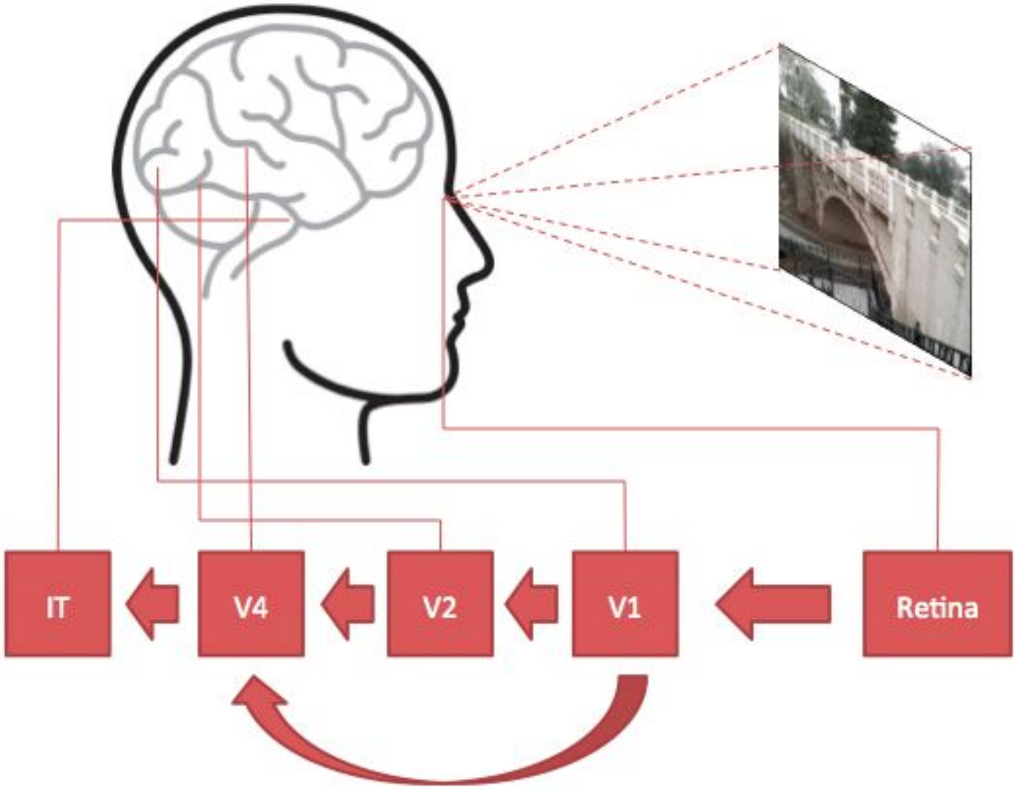
Convolutional Neural Networks (CNN)

CNNs are a type of **Neural Networks** inspired by how our **brain** processes **visual information**.

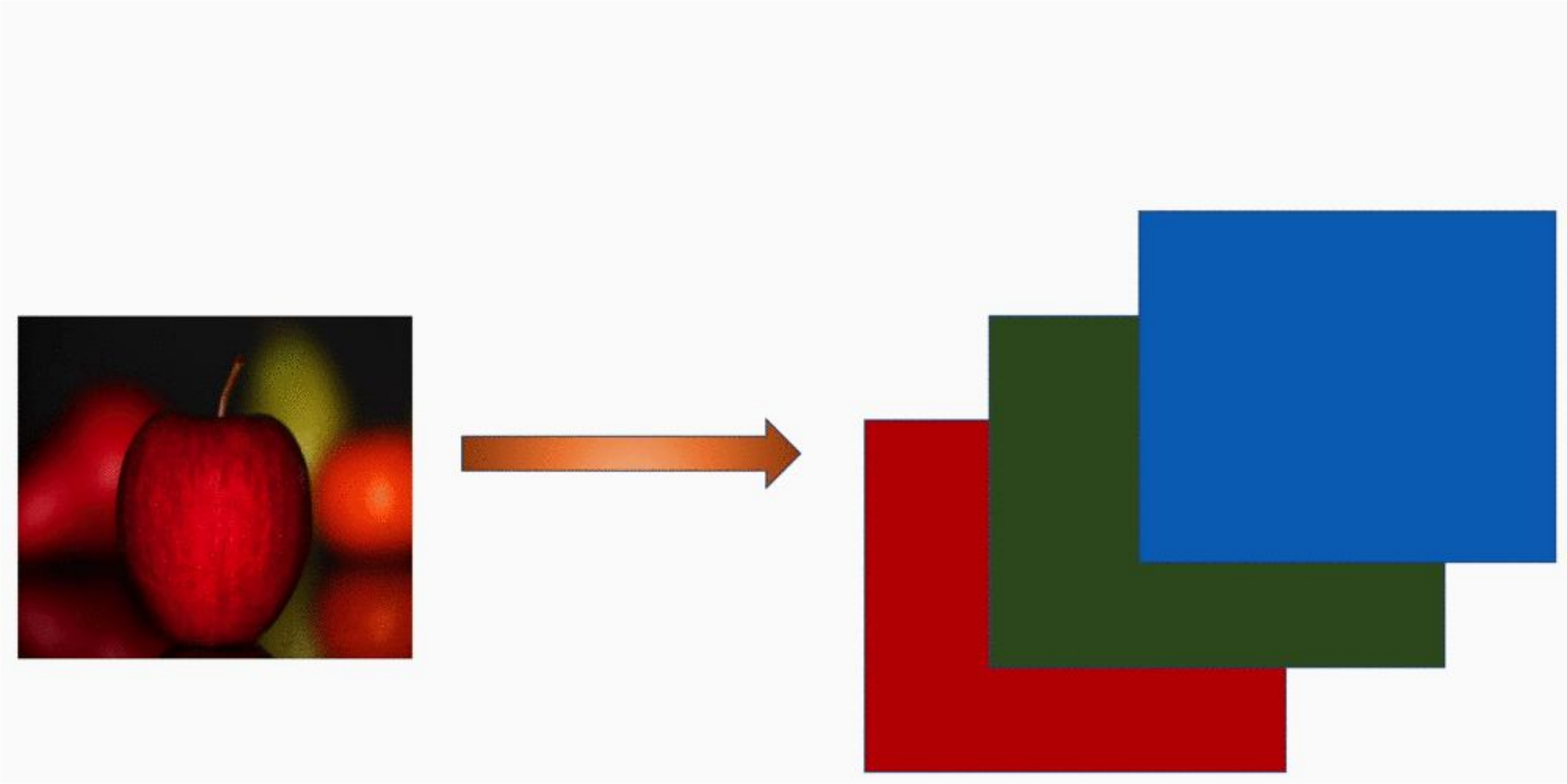
They're **specialized** for understanding **images**, making them powerful tools in image analysis, recognition, and more.



Brain to AI: Visual Cortex



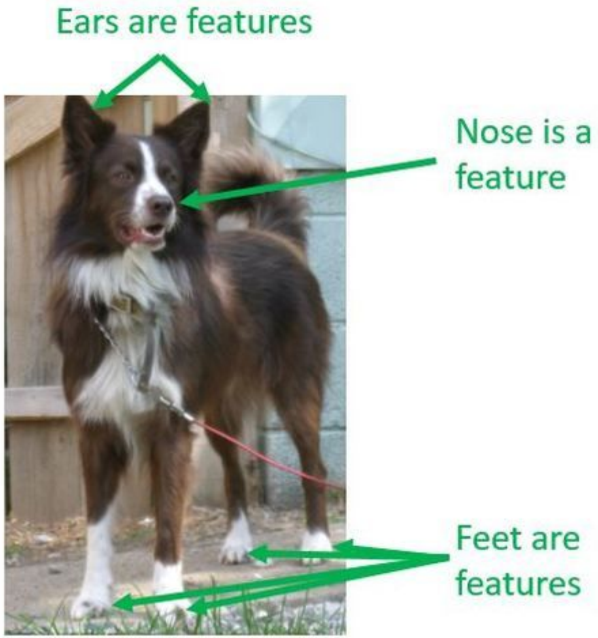
Images in Computer

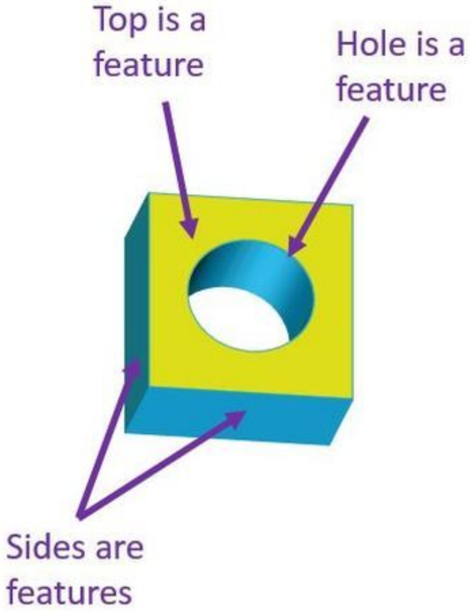


Features for Images

Images are full of important parts called **features.**

Features can be **edges**, **textures**, **shapes**, or even **faces**.

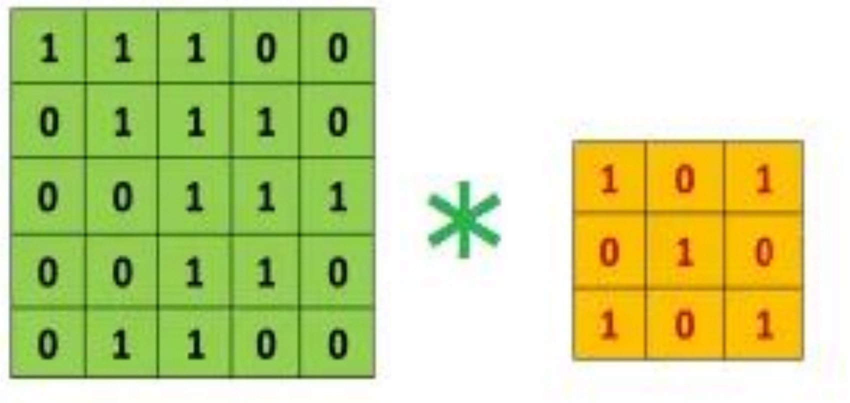




Convolution

Convolution is like a special way of looking at data. It's a **mathematical** operation that brings out **patterns**.

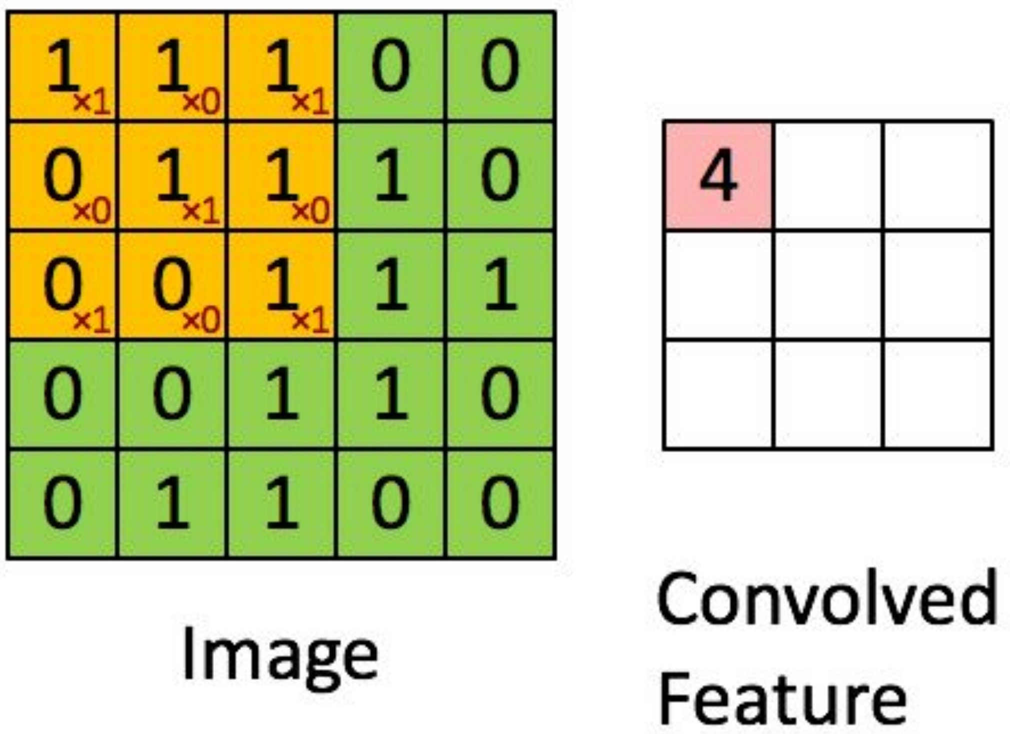
The filter slides over the image, one small piece at a time.



5 x 5 – Image Matrix

3 x 3 – Filter Matrix

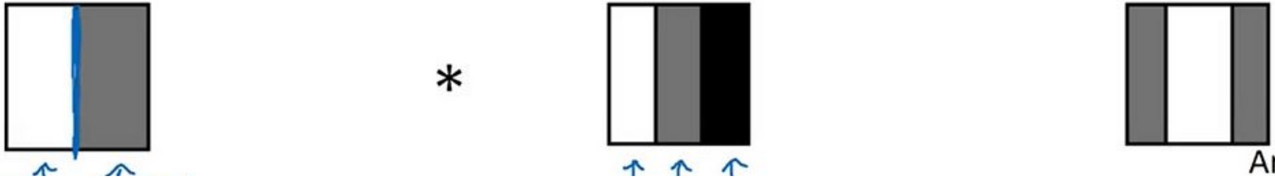
Convolution



Filter as Magnifier

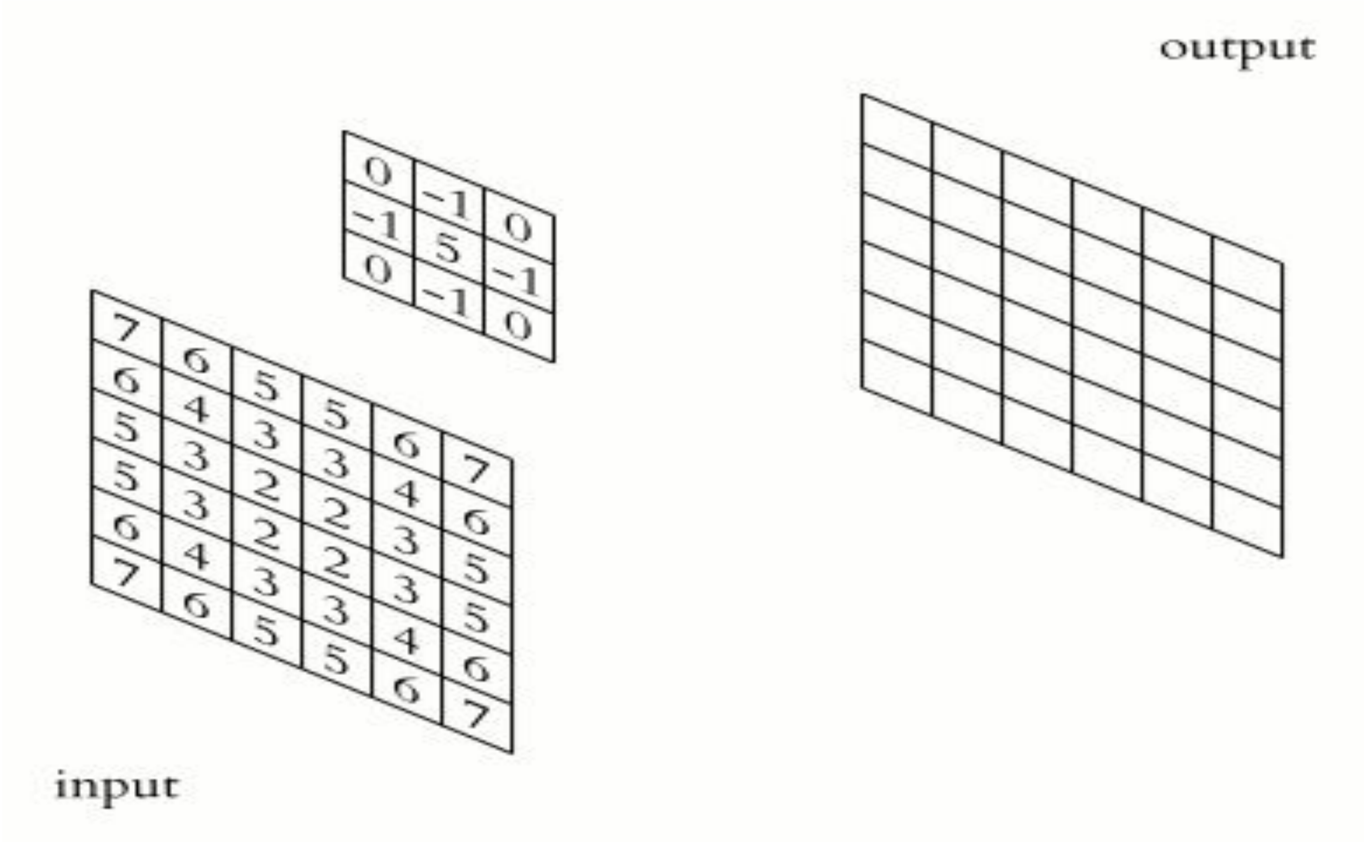
Vertical edge detection

$$\underbrace{\begin{array}{|c|c|c|c|c|c|}\hline 10 & 10 & 10 & 0 & 0 & 0 \\ \hline 10 & 10 & 10 & 0 & 0 & 0 \\ \hline 10 & 10 & 10 & 0 & 0 & 0 \\ \hline 10 & 10 & 10 & 0 & 0 & 0 \\ \hline 10 & 10 & 10 & 0 & 0 & 0 \\ \hline 10 & 10 & 10 & 0 & 0 & 0 \\ \hline \end{array}}_{6\times 6} * \underbrace{\begin{array}{|c|c|c|}\hline 1 & 0 & -1 \\ \hline 1 & 0 & -1 \\ \hline 1 & 0 & -1 \\ \hline \end{array}}_{3\times 3} = \begin{array}{|c|c|c|c|}\hline 0 & 30 & 30 & 0 \\ \hline 0 & 30 & 30 & 0 \\ \hline 0 & 30 & 30 & 0 \\ \hline 0 & 30 & 30 & 0 \\ \hline \end{array}$$



Andrew Ng

Convolution

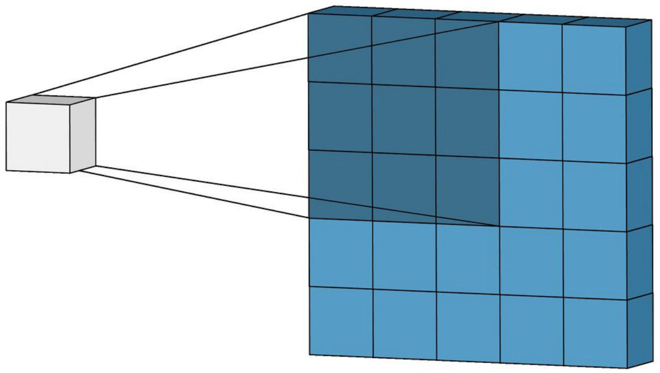


Pooling

Pooling is like **summarizing information**, keeping what's **important**.

It helps **reduce** the **dimensionality** while retaining **important information.**

Pooling = Downsizing + Information Summary.



Types of Pooling

Feature Map

6	6	6	6
4	5	5	4
2	4	4	2
2	4	4	2

Max Pooling

Average Pooling

Sum Pooling

Types of Pooling

Feature Map

6	6	6	6
4	5	5	4
2	4	4	2
2	4	4	2

Max Pooling

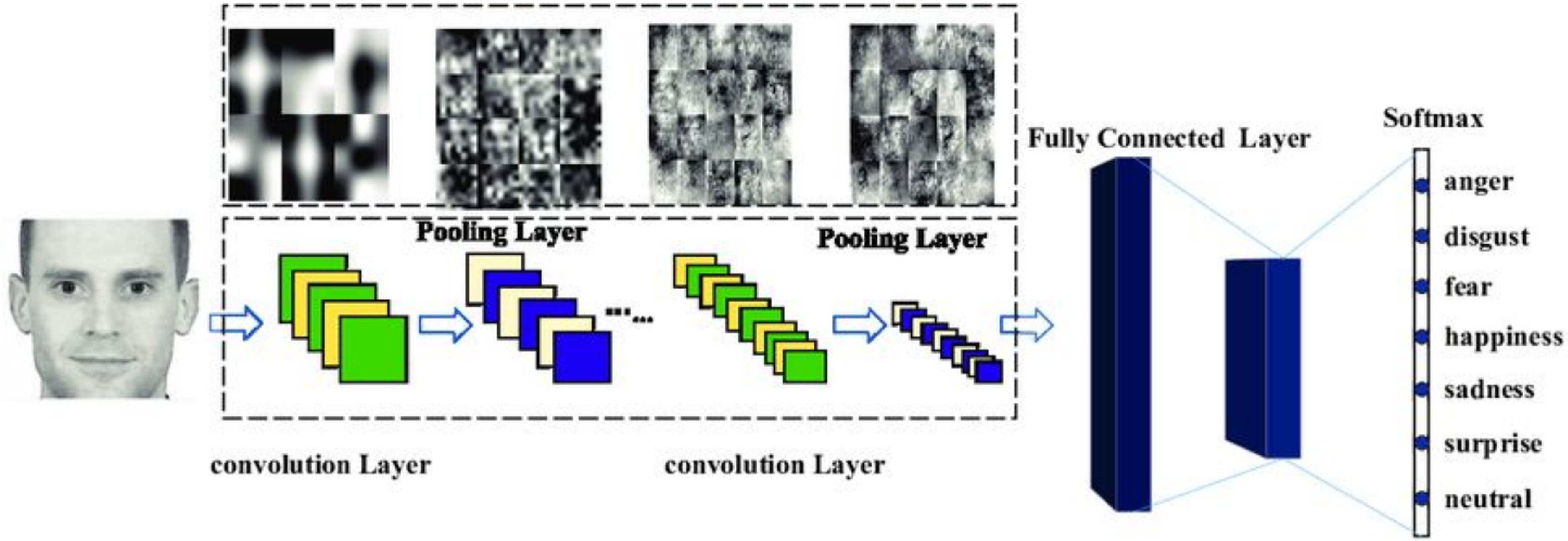
Advantages of Max Pooling:

Feature Retention: Keeps dominant features intact.

Translation Invariance: Recognizes features regardless of exact location.

Dimension Reduction: Reduces data size, providing efficiency.

CNN Architecture



CNN Architecture