



13

Convolutional Neural Networks

CNNs! No not that CNN.

13.1

What are **CNNs**?

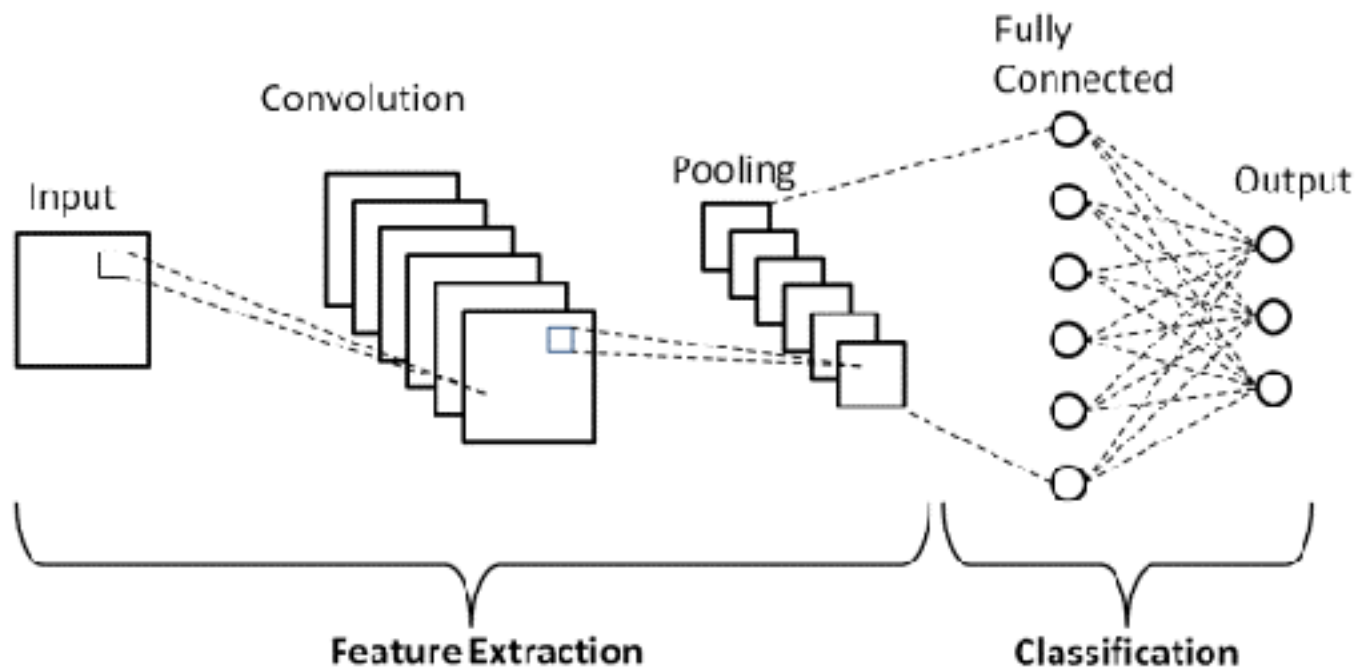
Convolutional Neural Network (CNN)

- A CNN is a type of deep learning neural network model primarily used in processing data with grid-like topology (e.g., images)
- Really effective in image recognition and classification tasks
- **Structure:** Composed of layers that automatically and adaptively learn spatial hierarchies of features from input images

Applications of CNN

- Image and Video Recognition
- Image Analysis & Classification
- Medical Image Analysis
- Self-Driving Cars

Understanding CNN Architecture



CNN Architecture Step-by-step

- Input Layer
 - Receives the raw pixel values of the image. Typically, images are converted into a 3D array format (height x width x color channels).
- Convolutional Layer
 - Applies a number of filters to the input to create feature maps. Identifies features like edges, textures, etc

CNN Architecture Step-by-step

- Activation Layer (Rectified Linear Activation)
 - Introduces non-linearity to the system. Helps the network learn complex patterns.
- Pooling Layer
 - Reduces the spatial size of the input volume for the next convolutional layer

CNN Architecture Step-by-step

- Fully Connected Layer
 - After several convolutional and pooling layers, the high-level reasoning is done via fully connected layers.
- Output Layer
 - Produces the final output, e.g. softmax for multi-class classification

Key Characteristics of CNNs

- **Parameter Sharing:** Reduces the number of parameters, enabling the network to be deeper with fewer parameters
- **Local Connectivity:** Focusing on local regions helps in capturing spatial hierarchies
- **Depth:** Deeper layers capturing more complex features

13.2

Working with **Image Data.**

Common Image Preprocessing tools

- Often when working with image datasets, the data will require to be preprocessed, similar to previously shown .csv files or text corpora
- To preprocess images there are certain common tools people often use

Common Image Preprocessing tools

- **Resizing:** Adjusting the dimensions of the image to match the input size required by the CNN.
- **Rescaling:** Adjusting the pixel values (e.g., dividing by 255) to bring them into a similar scale, typically 0 to
- **Cropping:** Removing parts of the image that are less relevant or to focus on a specific region

Common Image Preprocessing tools

- **Padding:** Adding extra pixels around the image, often used to maintain aspect ratio after resizing
- **Color Space Conversion:** Adjusting the color format (e.g., from RGB to grayscale) to reduce complexity or meet model requirements

Modifying Dataset for Broader Representation

- If a model learns the representation of a pineapple only from its side view, it won't be able to detect one when its upside down
- To prevent such scenarios, we modify existing image datasets so our model can detect them no matter which orientation they are in

Modifying Dataset for Broader Representation

- Data Augmentation:
 - Includes rotation, translation, zooming, flipping, etc.
 - Creates a more diverse set of training images, helping the model generalize better.
- Synthetic Data Generation
 - Creating new, artificial images using various algorithms

Modifying Dataset for Broader Representation

- Class Balancing:
 - Augmenting underrepresented classes or undersampling overrepresented ones.
- Incorporating Diverse Scenarios
 - Ensuring the dataset includes a wide range of scenarios and conditions (e.g., different lighting, backgrounds)

END.