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NEURAL NETS AND DEEP LEARNING

TOPIC OUTLINE

- Course book: DLBDSNNDL01_Neural Nets and Deep Learning, provided by IU, myStudies
- Reading list DLBDSNNDL01, provided by IU, myStudies
- This slide is a summarization of important contents in the course book.
- Additional teaching materials:

https://github.com/duongtrung/IU-DLBDSNNDL01_Neural_Nets_and_Deep_Learning

DISCLAIMER

- This is the modified version of the IU slides.
- I used it for my lectures at IU only.

UNIT 4

CONVOLUTIONAL NEURAL NETWORKS (Part 2)

STUDY GOALS

On completion of this session, you will be able to ...

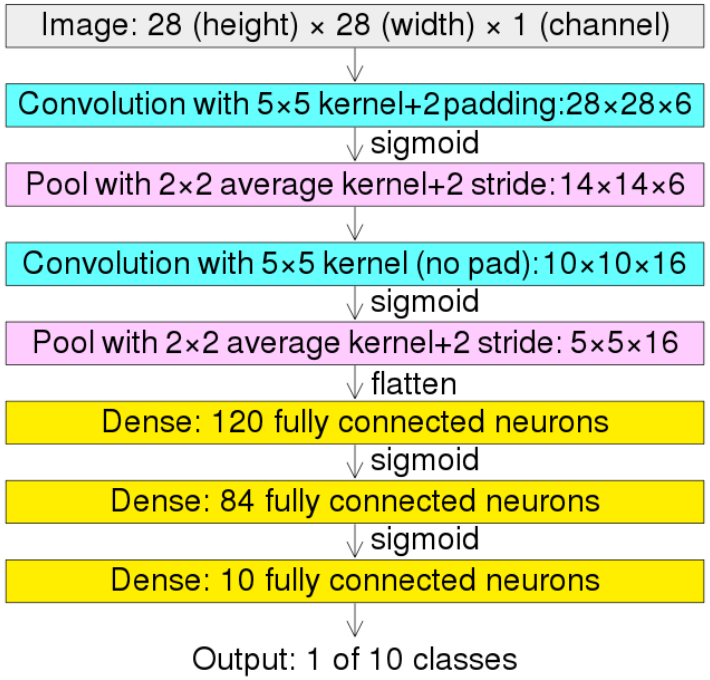
- analyze popular convolutional neural networks.
- learn the applications of convolutional neural network.
- implement convolutional neural network in Python.

EXPLAIN SIMPLY

- What are the popular convolutional neural networks?
- How are convolutional neural networks applied for real-world problems?
- How to implement a convolutional neural network in Python?

LeNet ...

- is **simple**, straightforward, and effective.
- is composed of convolutional layers, **average pooling** layers, and fully-connected layers

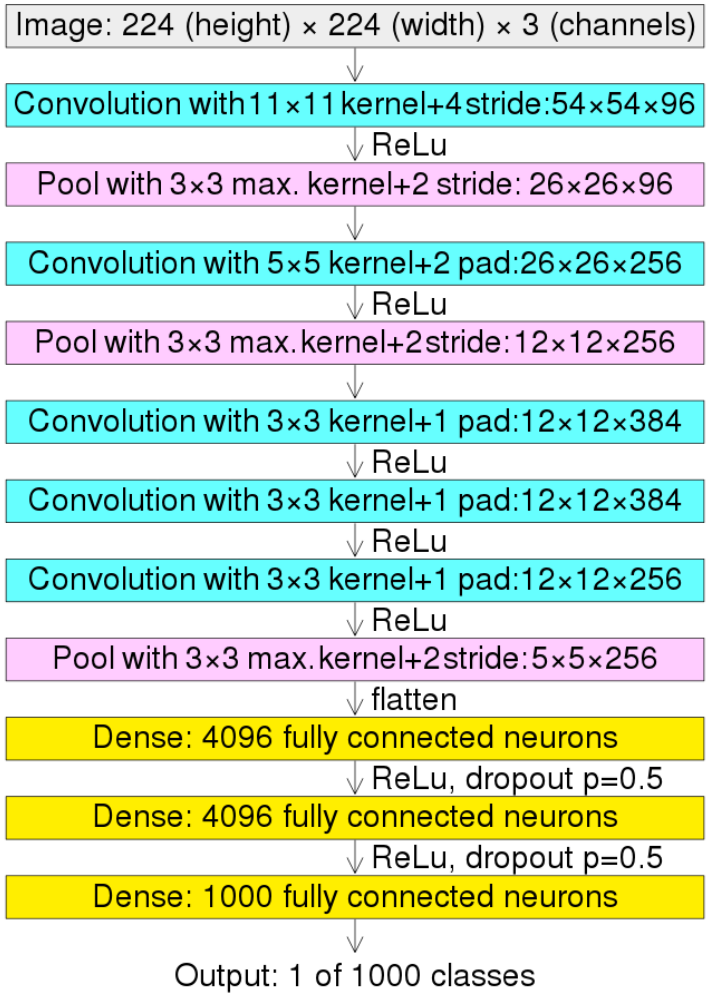


Architecture of LeNet

Source of the text and the image: Zöller (2023)

AlexNet ...

- is **similar** to LeNet in structure, but much larger and deeper.
- **stacks** convolution layers on top of each other.
- fights overfitting by using **dropout, data augmentation**, **normalization** techniques.

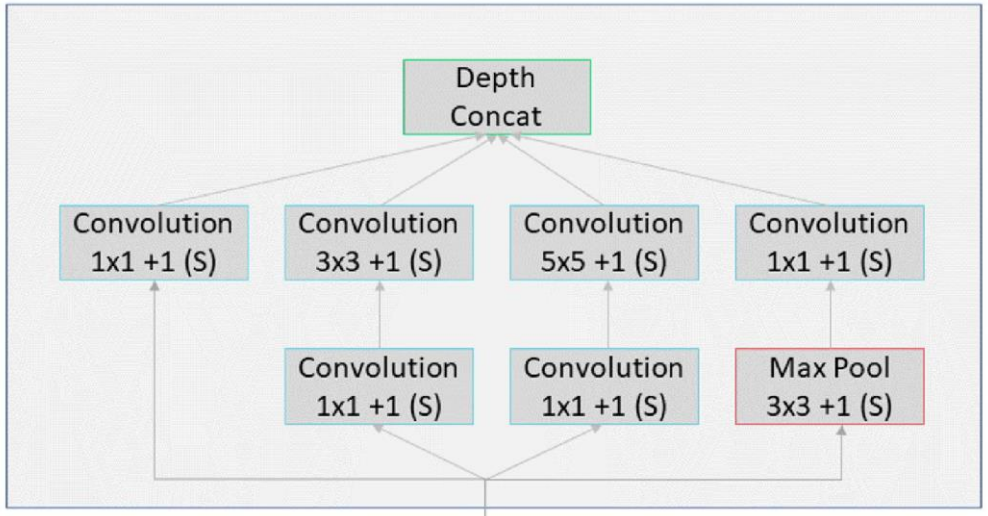


Architecture of AlexNet

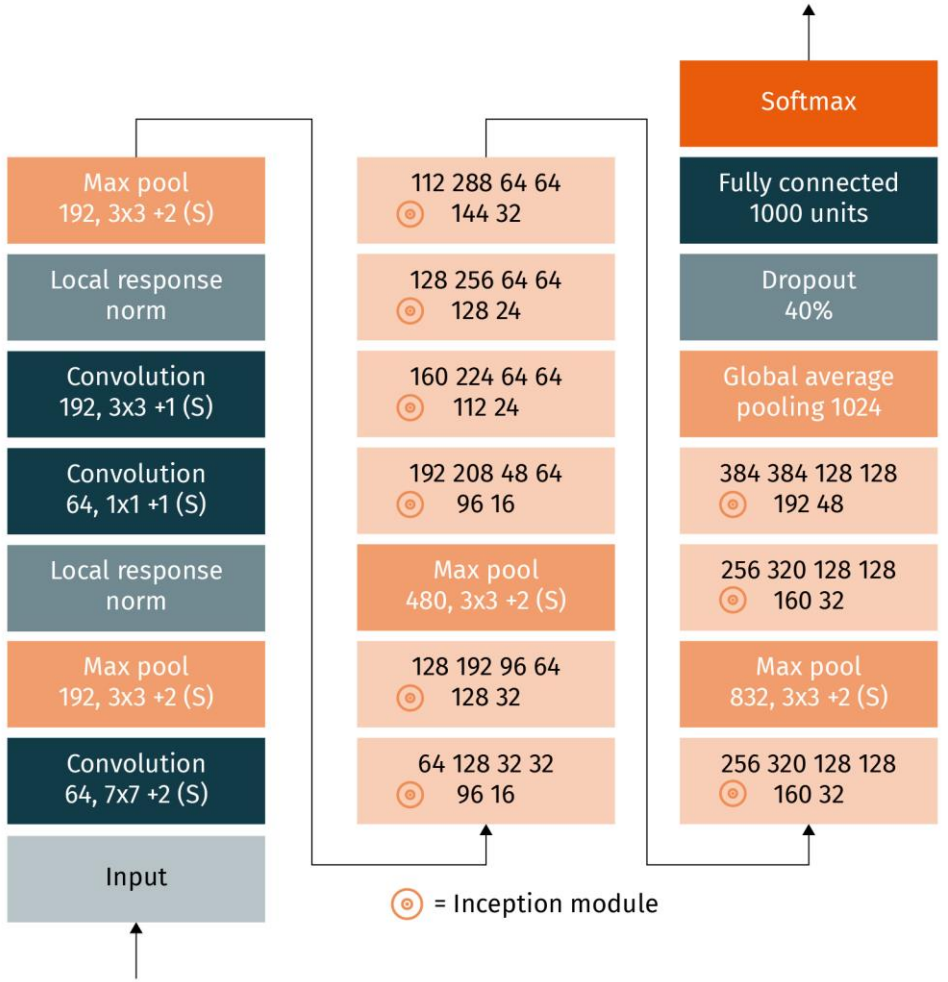
Source of the text and the image: Zöller (2023)

GoogLeNet

- introduces **inception modules**.
- significantly reduces **dimensionality** and speed up **computations.**
- is a highly **effective** and well-researched model.



Inception Module

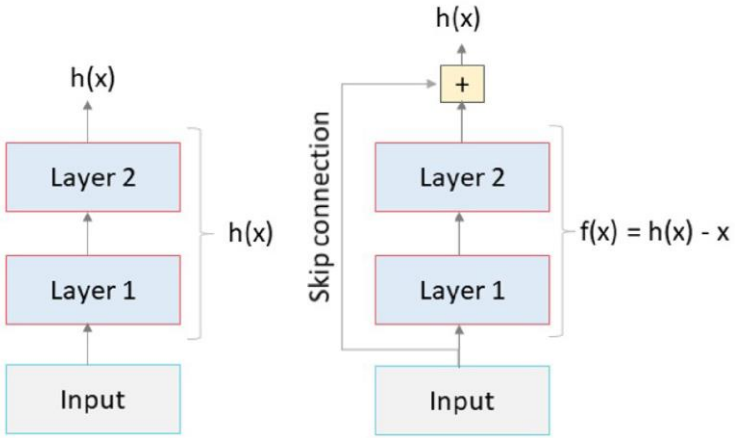


Architecture of GoogLeNet

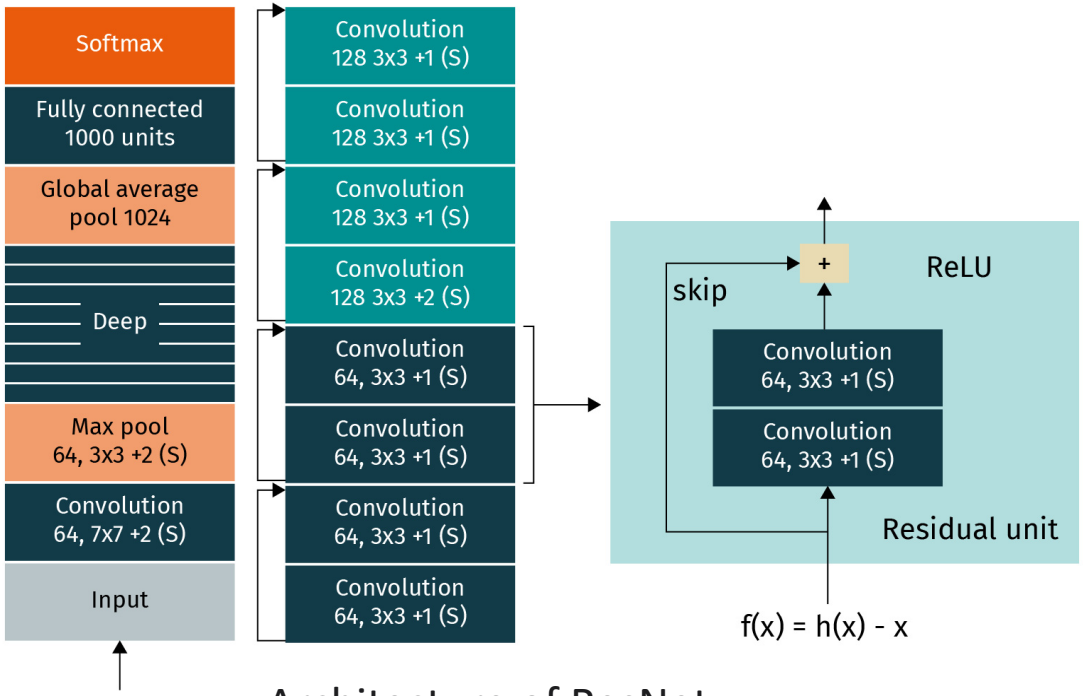
Source of the text and the image: Zöller (2023)

ResNet

- introduces **residual blocks** to allow "**skip connections**" at some layers of the model.
- allows to train deep networks more **effectively**.
- does not require any extra **parameters**, nor computational **time**.



Residual Learning

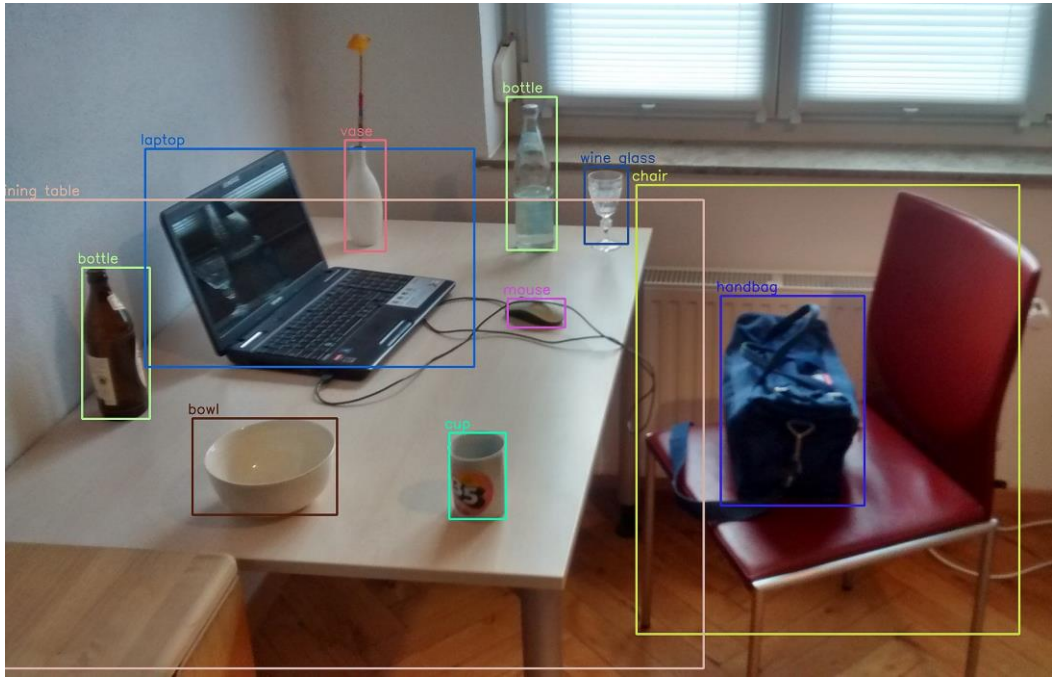


Architecture of ResNet

Source of the text and the image: Zöller (2023)

Object detection

- CNNs are successfully used to identify objects in images by analyzing **key features** and **patterns**.
- Object detection with CNNs encompasses a **diverse range** of items, animals, and objects.

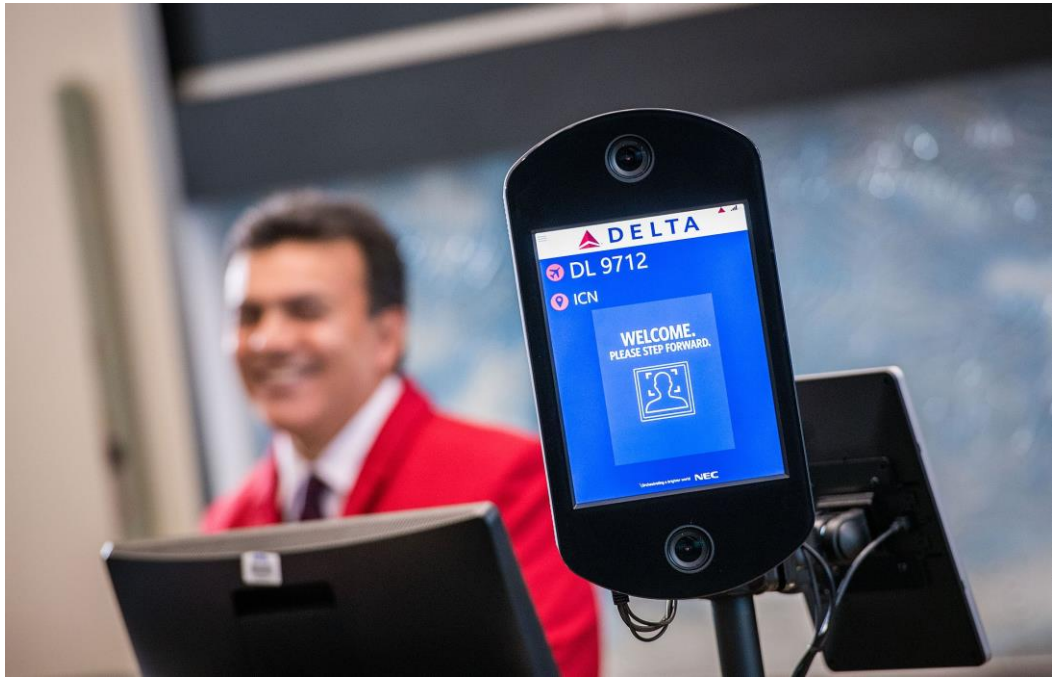


Object detection

Source of the text : Zöller (2023)
Source of the image: File: Detected-with-YOLO--Schreibtisch-mit-Objekten.jpg

Face and emotion recognition

- CNN frameworks can **accurately** detect faces in images by identifying features like eyes, nose, and mouth.
- CNNs are **effective** in reducing distortion in facial images.
- CNNs can also **correctly** distinguish between different facial expressions representing emotions (e.g., happy or anger).



Face recognition

Source of the text : Zöller (2023)
Source of the image: File: Facial_recognition_technology_at_gate.jpg.

Self-driving

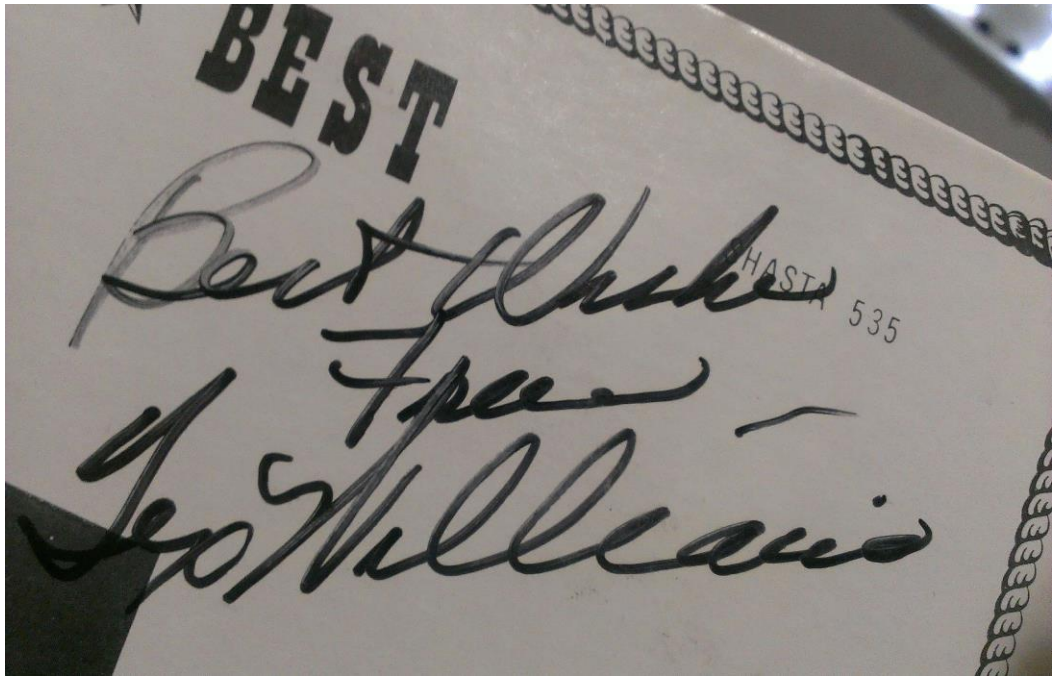
- CNNs help to solve **difficult tasks** in self-driving cars (e.g., detecting traffic signs and obstacles on the road).
- CNNs are **combined** with other techniques (e.g., reinforcement learning) to respond **appropriately** to visual information.

Lane centering

Source of the text : Zöller (2023)
Source of the image: File:Tesla_Autopilot_Engaged_in_Model_X.jpg

Words recognition, prediction and translation

- CNNs are used for recognizing and distinguishing **handwritten characters** in **different languages** and contexts.
- CNNs can **predict** the next word in a sentence with increasing accuracy.
- CNNs are also utilized for accurate automatic **translation** between languages.

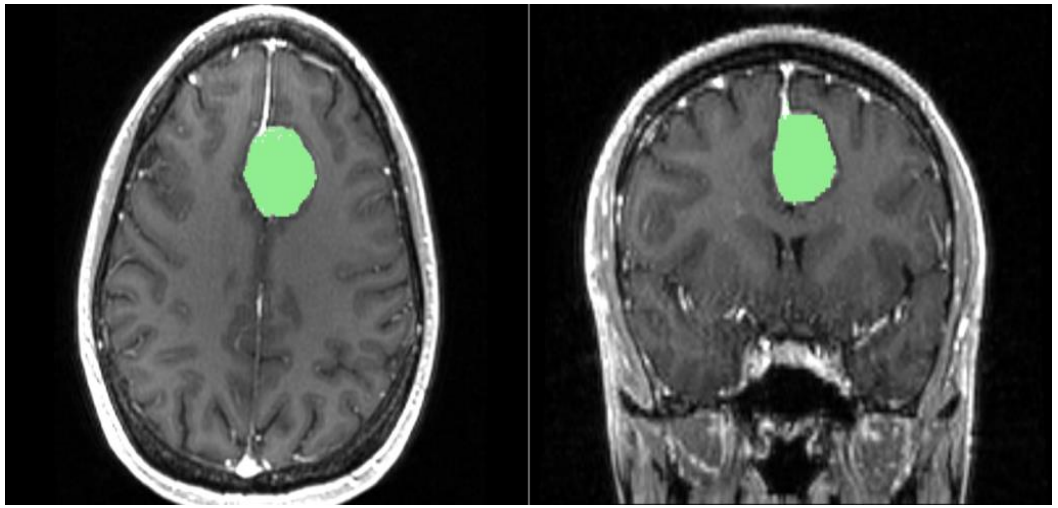


Handwriting recognition

Source of the text : Zöller (2023)
Source of the image: File:Signiture_of_country_stat,_Tex_Williams.jpg

Medical analysis

- CNNs are commonly used to detect **abnormalities** in medical images.
- Trained CNNs on large medical image datasets have high **accuracy**.
- In certain cases, CNNs can **outperform** human doctors.



Medical image processing

Source of the text : Zöller (2023)
Source of the image: File:MeningiomaMRISegmentation.png

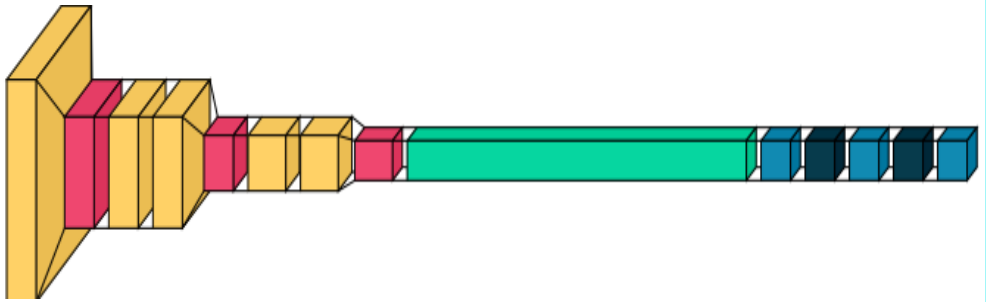
CNN-Implementation in Python

```
# import & install libraries
import keras
!pip install visualkeras
import visualkeras
from functools import partial

# build CNN model
DefaultConv2D = partial(keras.layers.Conv2D,
        kernel_size=3,
        activation='relu’,
        padding="SAME")
model = keras.models.Sequential([
        DefaultConv2D(filters=64, kernel_size=7,
        input_shape=[28, 28, 1]),
        keras.layers.MaxPooling2D(pool_size=2),
        DefaultConv2D(filters=128),
        DefaultConv2D(filters=128),
        keras.layers.MaxPooling2D(pool_size=2),
        DefaultConv2D(filters=256),
        DefaultConv2D(filters=256),
        keras.layers.MaxPooling2D(pool_size=2),
        keras.layers.Flatten(),
        keras.layers.Dense(units=128,
        activation='relu’),
        keras.layers.Dropout(0.5),
        keras.layers.Dense(units=64,
        activation='relu’),
        keras.layers.Dropout(0.5),
        keras.layers.Dense(units=10,
        activation='softmax'),
])

# visualize the model
visualkeras.layered_view(model)

# result
```



Source of the text: Zöller (2023)

REVIEW STUDY GOALS

- analyze popular convolutional neural networks.
- learn the applications of convolutional neural network.
- Implement convolutional neural network in Python.

SESSION 5

CONVOLUTIONAL NEURAL NETWORKS (Part 2)

TRANSFER TASK
PRESENTATION OF THE RESULTS

Please present your results.

The results will be discussed in plenary.

Task:

Propose you want to apply CNNs to Self-driving vehicles. Name and explain 3 possible applications.

Sample solution:

1. Lane Detection: CNNs could be used to detect and track lane boundaries, helping autonomous vehicles stay in their designated lanes and navigate safely on the road.

2. Object Detection and Recognition: CNNs are effective in identifying and classifying objects on the road such as pedestrians, bicycles, and other vehicles, which is crucial for self-driving cars to make informed decisions.

3. Traffic Sign Recognition: By training CNNs on large datasets of traffic signs, they can accurately recognize and interpret various traffic signs, including speed limits, stop signs, and road warnings, enabling autonomous vehicles to navigate roads effectively..

1. Which of the following statements is true about LeNet? Select one.
   a) LeNet stacks convolution layers on top of each other.
   b) LeNet introduces inception modules.
   c) LeNet introduces residual blocks.
   d) LeNet is simple, straight forward and effective.

2. Which of the following statements is correct regarding CNNs? Select one
   a) CNNs are primarily used to identify objects in images by analyzing key features and patterns.
   b) CNNs are commonly used to analyze and classify text data.
   c) CNNs are designed to solve optimization problems such as linear programming.
   d) CNNs are capable of generating realistic 3D visualizations from 2D images.

3. Which of the following statements is **incorrect** regarding the use of CNNs in medical imaging? Select one.

a) CNNs are commonly used to detect abnormalities in medical images.
b) CNNs can outperform human doctors in certain cases.
c) Trained CNNs on large medical image datasets have low accuracy.
d) Trained CNNs on large medical image datasets have high accuracy.

Answers

1. d)
2. a)
3. c)

LIST OF SOURCES

Text

Zöller, T. (2023). Neural Nets and Deep Learning Course Book. IU International University of Applied Sciences.

Images

Zöller (2023).
File: Detected-with-YOLO--Schreibtisch-mit-Objekten.jpg. Object detection (2023, October). *Wikipedia Commons*. *https://en.wikipedia.org/wiki/Object_detection*
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