ALGOSOC

UOB

DATA SCIENCE & MACHINE LEARNING WORKSHOP

Week 7 - Architecture and Project Showcase

AGENDA

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Week 7 topic:

- Convolutions
- Convolution Neural Network
- UNets
- RNNs and Memory Models

Repository:
https://github.com/AlgoSoc/Data-Science

CONVOLUTION

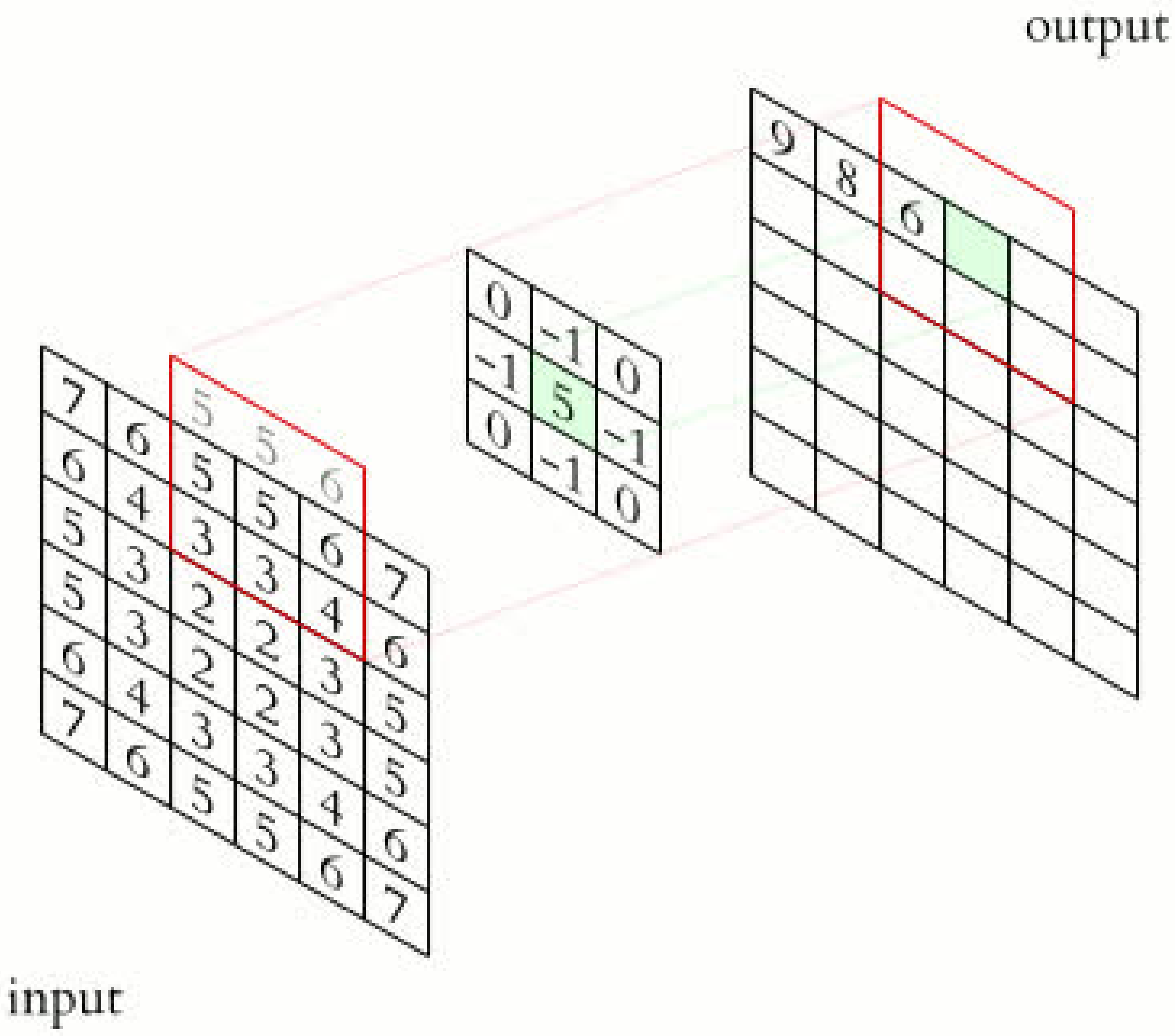


Image Source: https://commons.wikimedia.org/wiki/File:2D_Convolution_Animation.gif

CONVOLUTION

Effects of Convolution

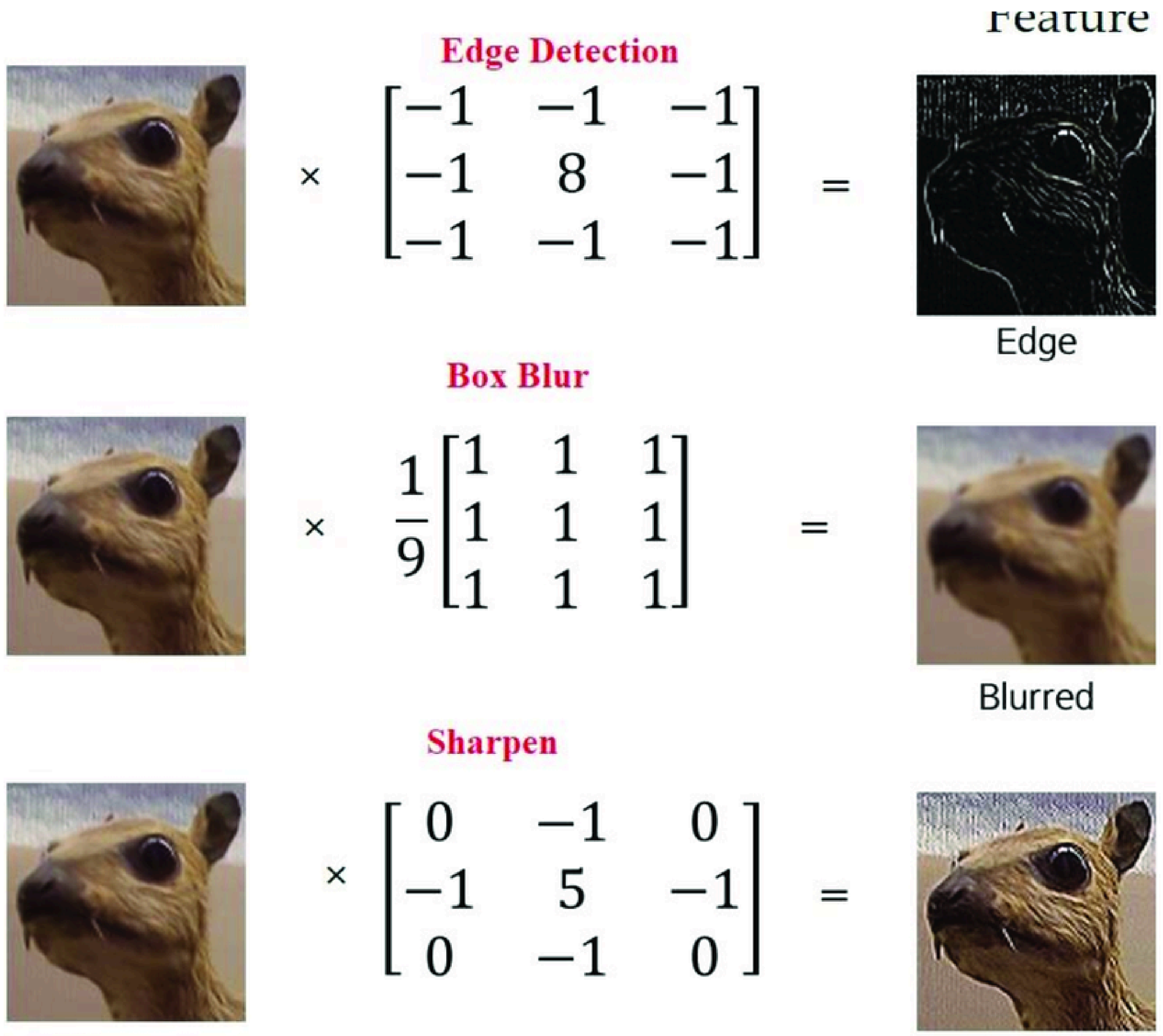
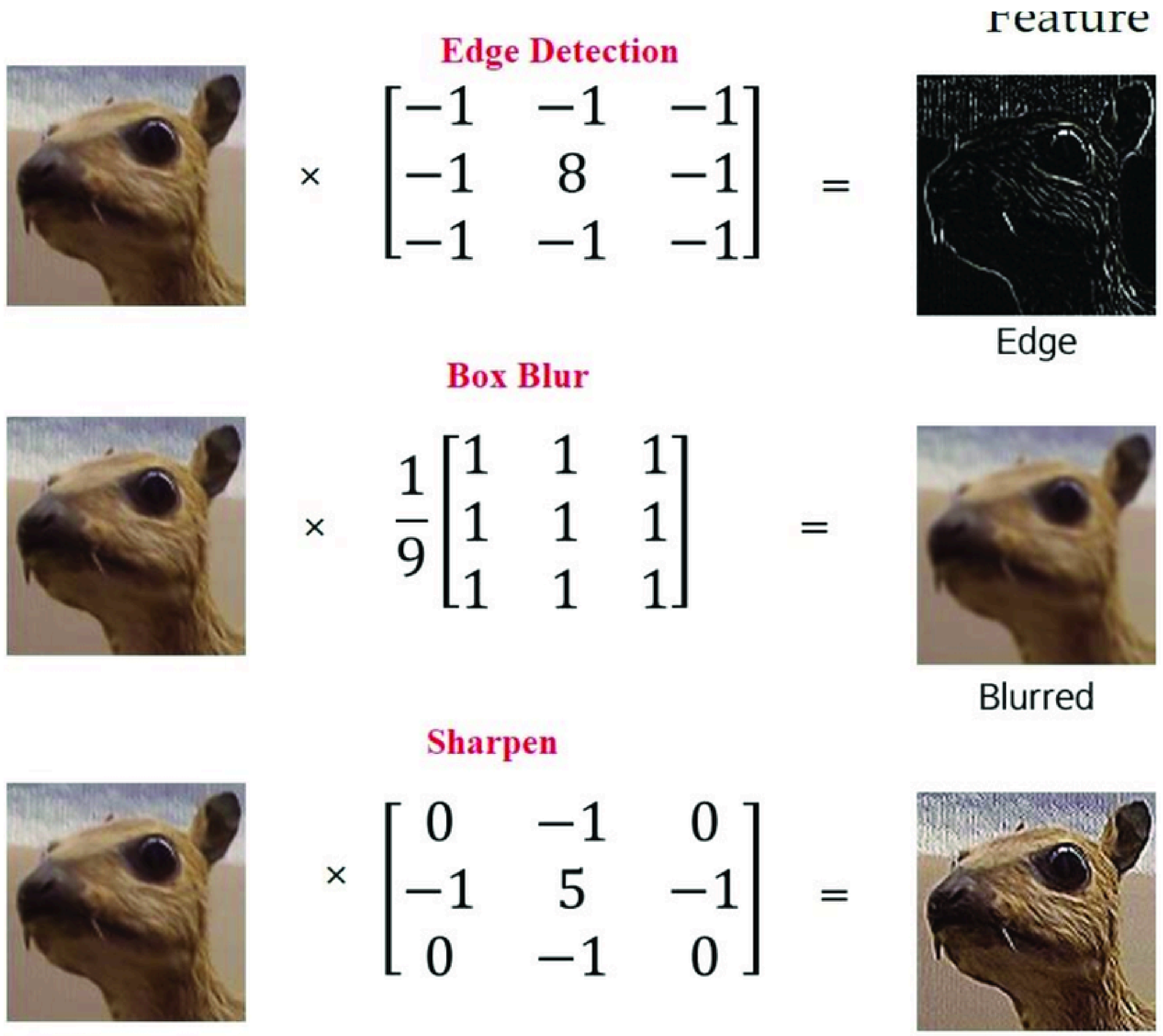


Image Source: https://www.researchgate.net/figure/Effects-of-different-convolution-matrices-21_fig1_369059212

in convolutional neural network, we let the network to learn the kernel automatically, hence we don’t really control what type of feature is being extracted

CONVOLUTION

Effects of Convolution



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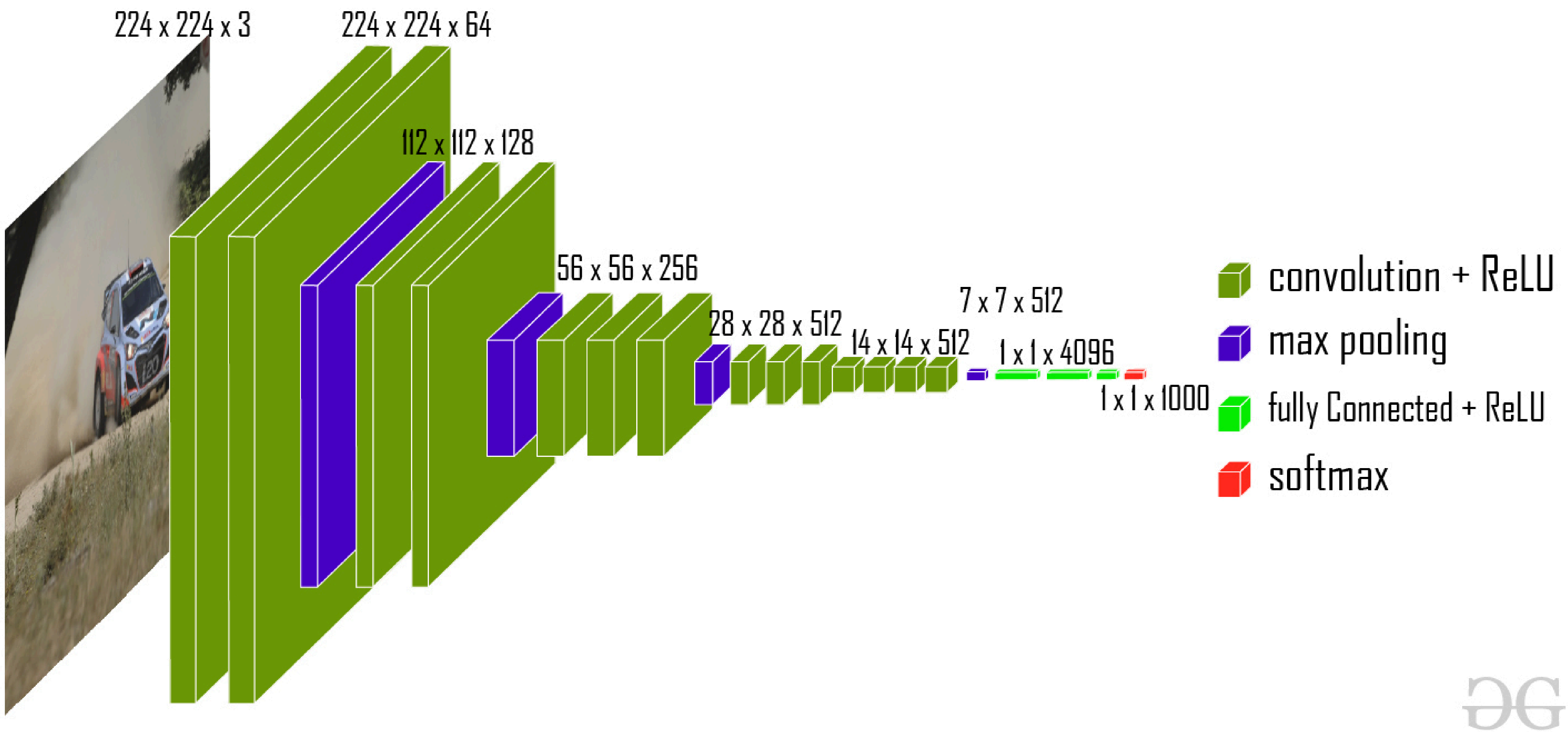
VGG 16



This architecture allows for image classification.

The pooling layers reduce the dimensions of the image and the fully connected layers are the MLP with a final **softmax activation function** for classification

Image Source: https://www.geeksforgeeks.org/computer-vision/vgg-16-cnn-model/

Image Detection (Bounding Box)

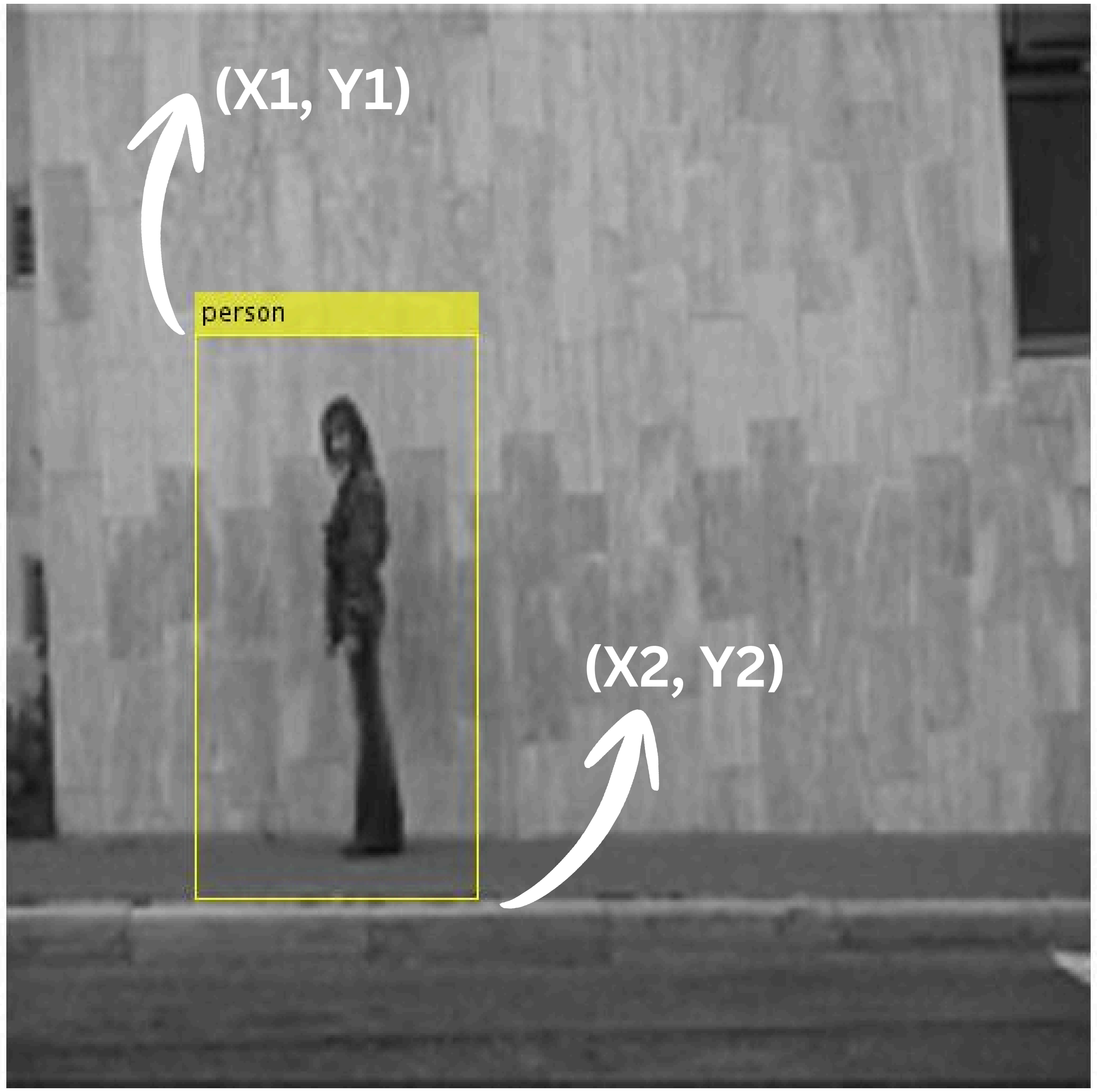


Image Source: https://stackoverflow.com/questions/27478102/draw-a-rectangular-bounding-box-around-a-person-in-an-image

For tasks such as image detection, we would need bounding boxes

What would be the minimum of coordinates do we need to infer bounding box?

2 coordinate, of corners in different sides (top left - bottom right || top right - bottom right)

Therefore, for image detection, we can try to predict three things:

- Coordinate 1
- Coordiante 2
- Class of object

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Bounding Box Detection

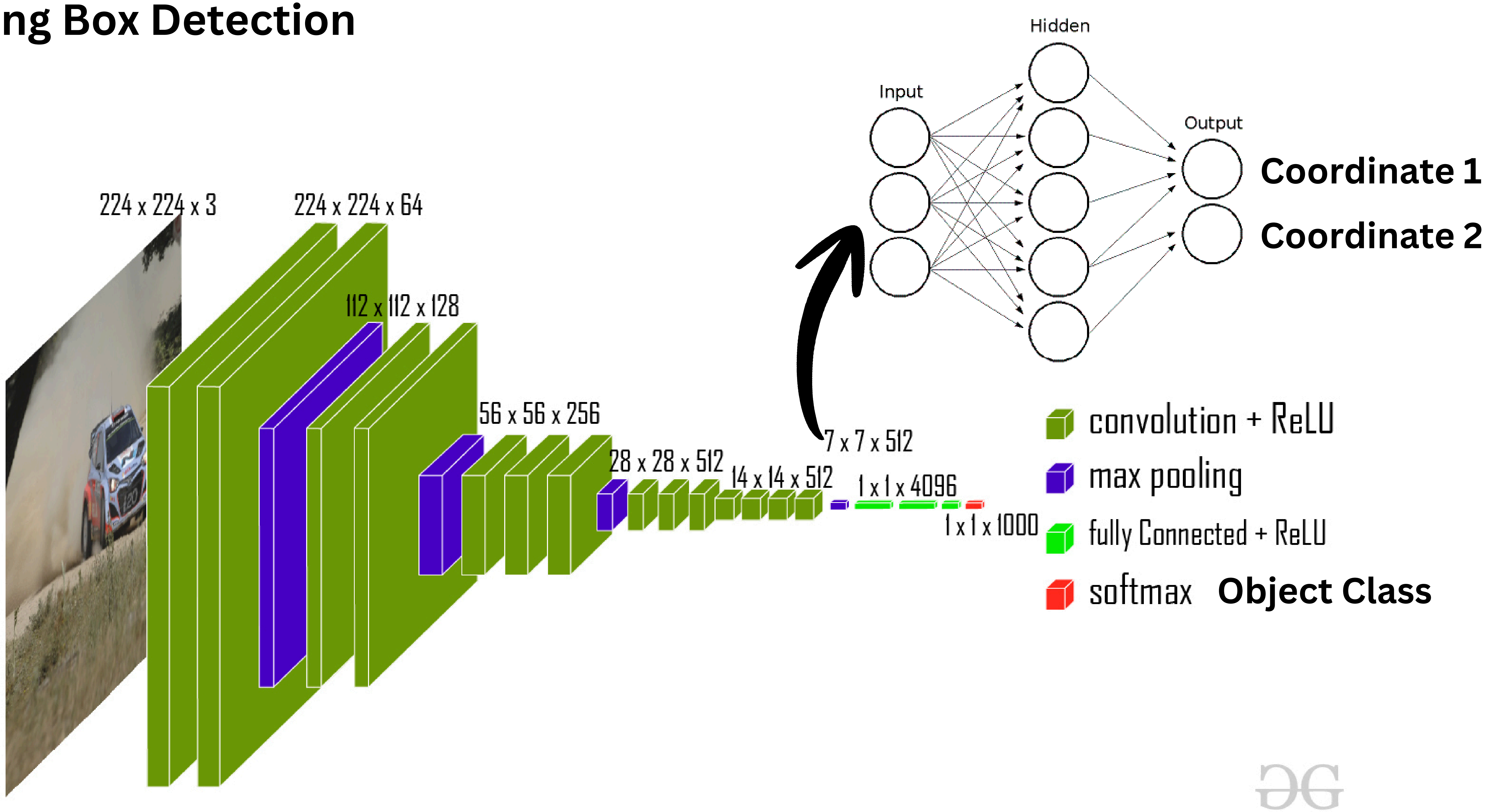


Image Source: https://www.geeksforgeeks.org/computer-vision/vgg-16-cnn-model/

What about binary or semantic segmentation?

Image Source: https://ieeexplore.ieee.org/abstract/document/10605400

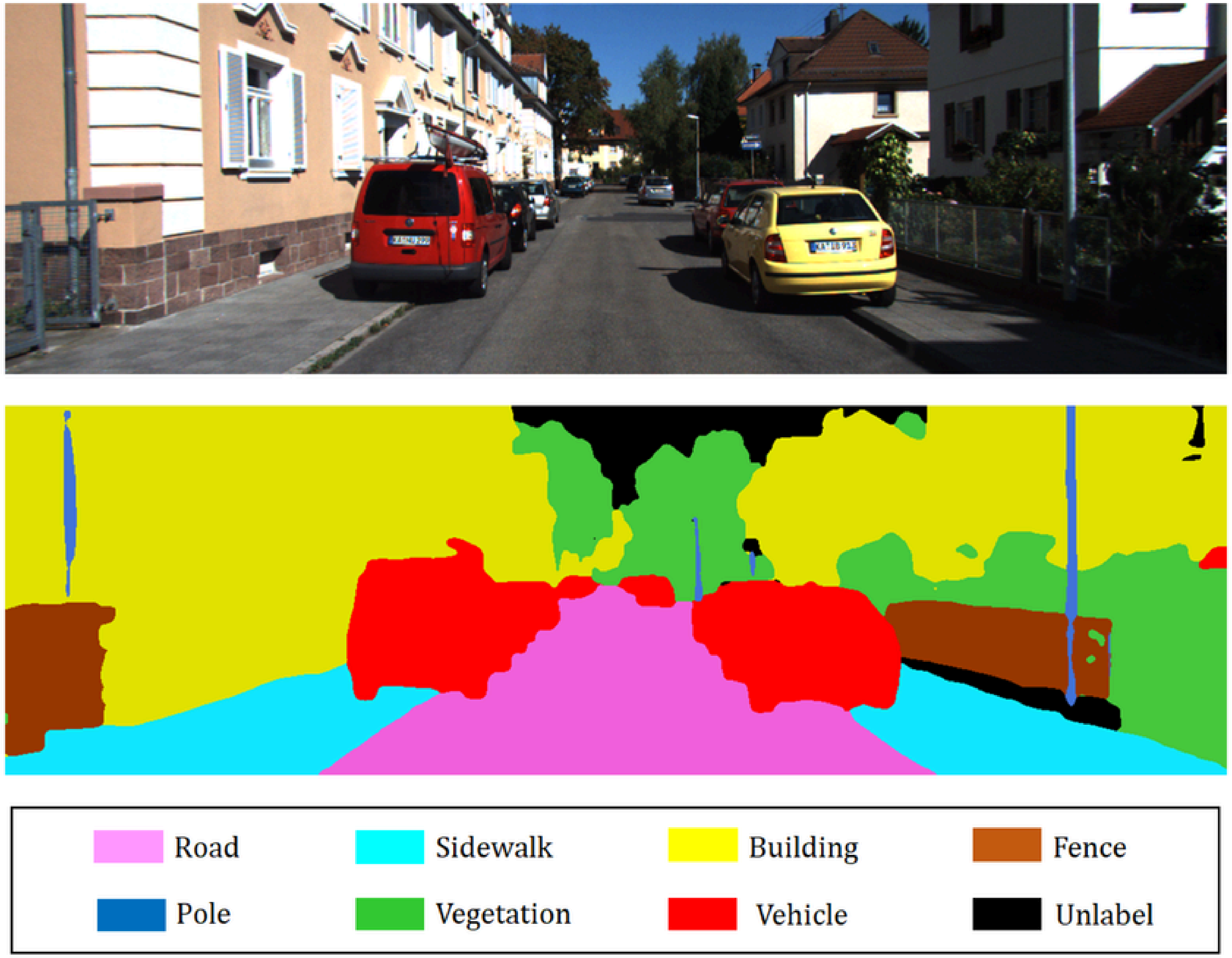
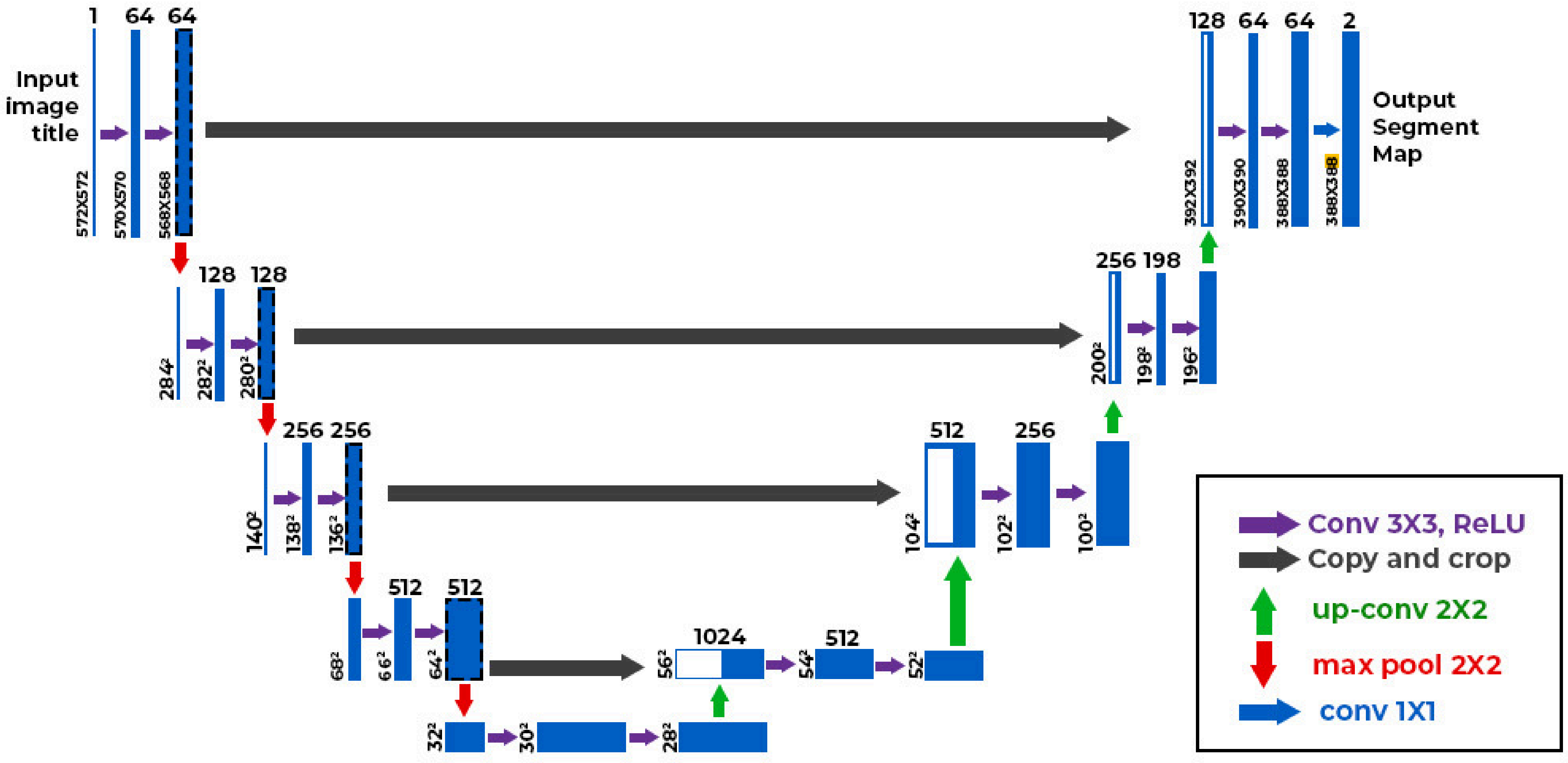


Image Source: https://www.researchgate.net/figure/Example-of-2D-semantic-segmentation-Top-input-image-Bottom-prediction_fig3_326875064

UNETS

We can use the U-shaped network (UNet)



UNet uses convolutions, pooling, and upsampling (or up-conv) to extract and process information.

Image Source: https://www.geeksforgeeks.org/machine-learning/u-net-architecture-explained/

UNETS

Unets can also be used in diffusion models

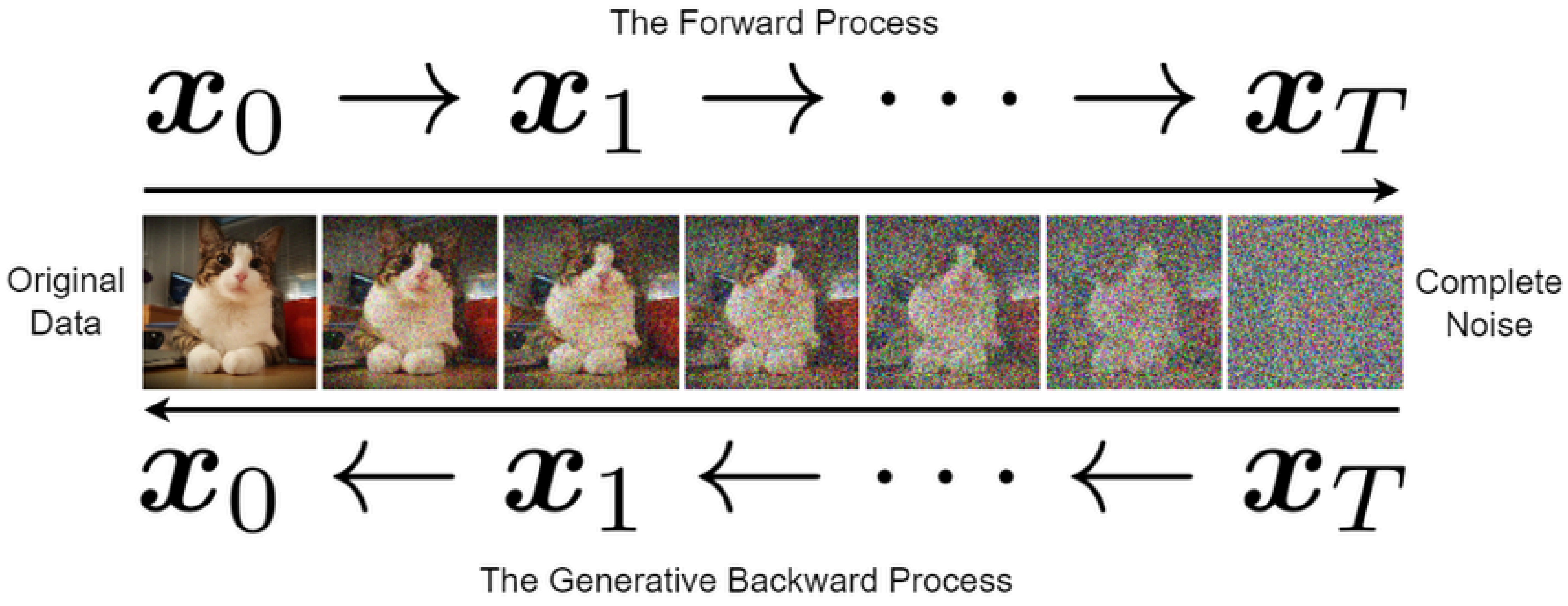


Image Source: https://www.researchgate.net/figure/The-forward-and-backward-processes-of-the-diffusion-model-The-credit-of-the-used-images_fig1_382128283

A diffusion model would try to generate “realistic” images from random noise

It will step-by-step try to generate less-noised image until it reached a realistic image

To generate a “less-noised” image, we can use UNet

Reference for Diffusion Model: https://www.youtube.com/watch?v=x2GRE-RzmD8

RNNS AND MEMORY MODELS

What if we need to model conditional probabilities

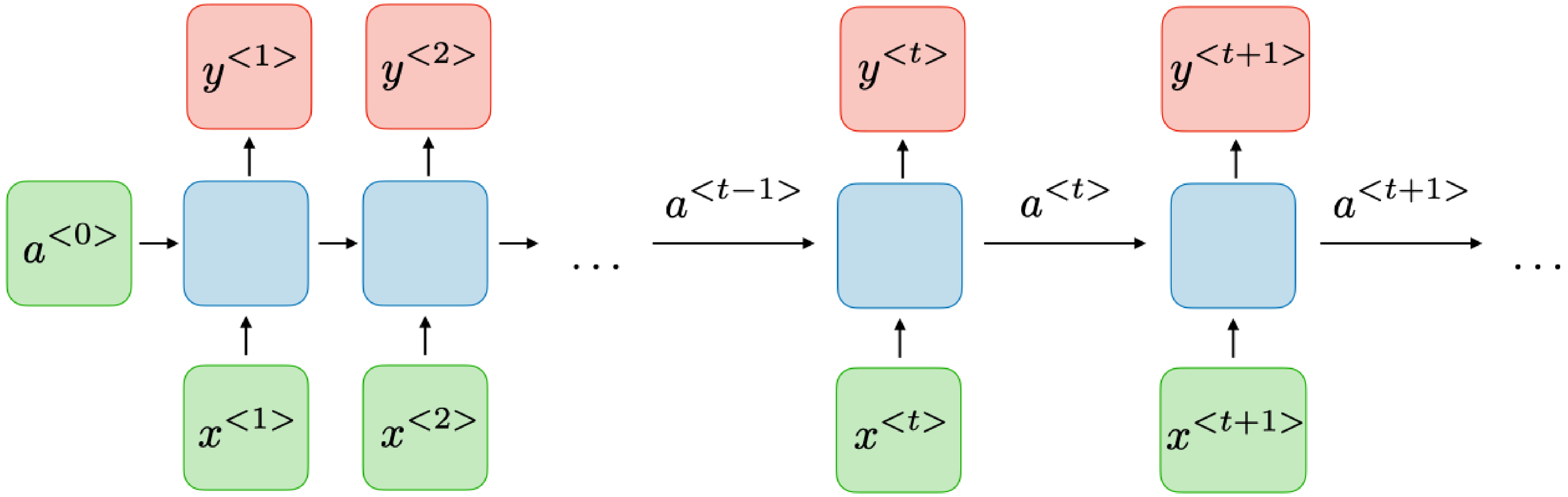


Image Source: https://stanford.edu/~shervine/teaching/cs-230/cheatsheet-recurrent-neural-networks

in tasks such as language modelling, we would want to predict the probability of a sentence:

$$P(w_1 w_2 \dots w_n) = \prod_i P(w_i | w_1 w_2 \dots w_{i-1})$$

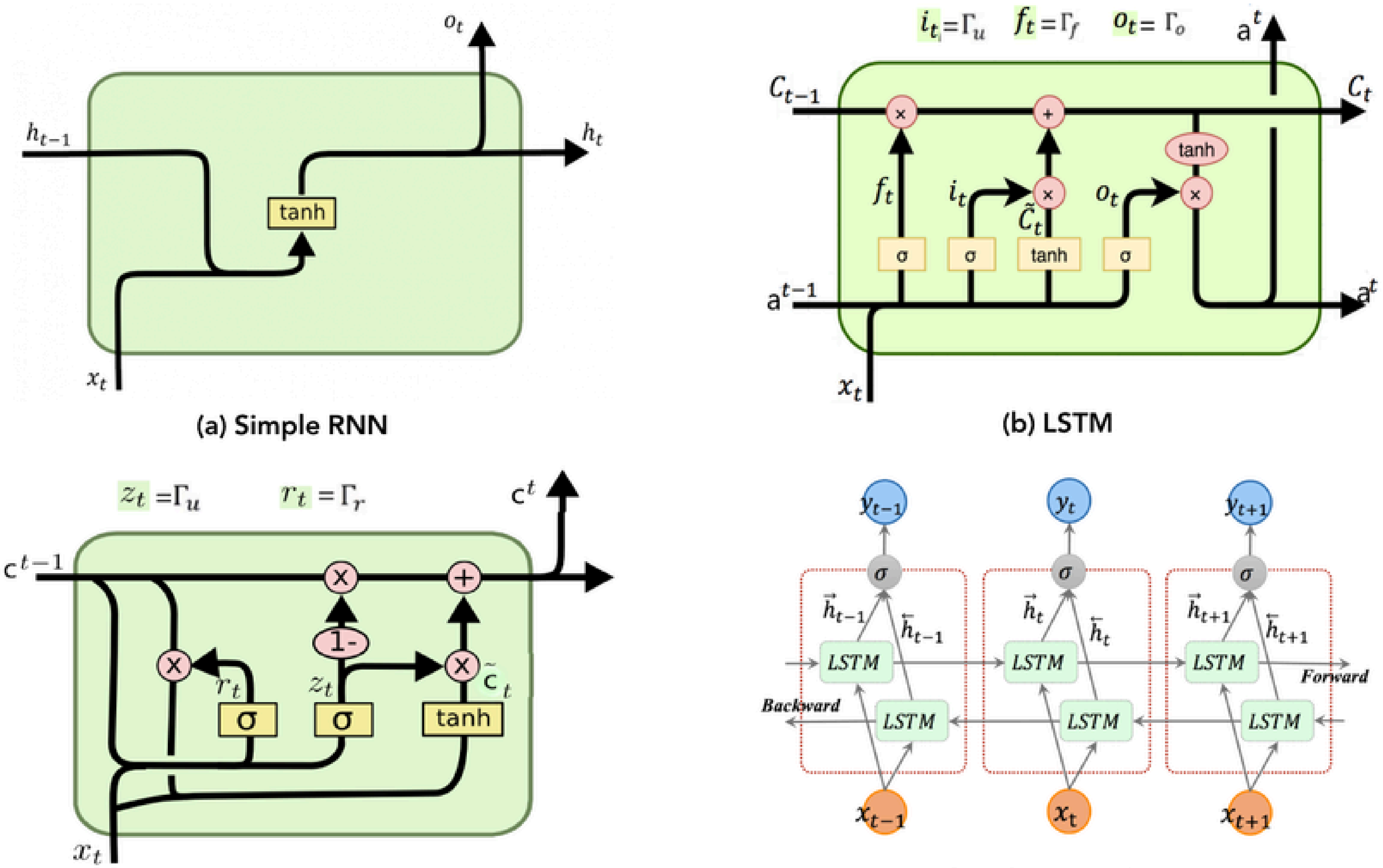
To model the probability, we can use neural network as denoted: P(X; θ) where X is our input and θ is our model parameters

That means our estimate of probability P using neural networks would need to take into consideration previous inputs

RNNs can do this

RNNS AND MEMORY MODELS

There are also other memory models



(a) Simple RNN

(b) LSTM

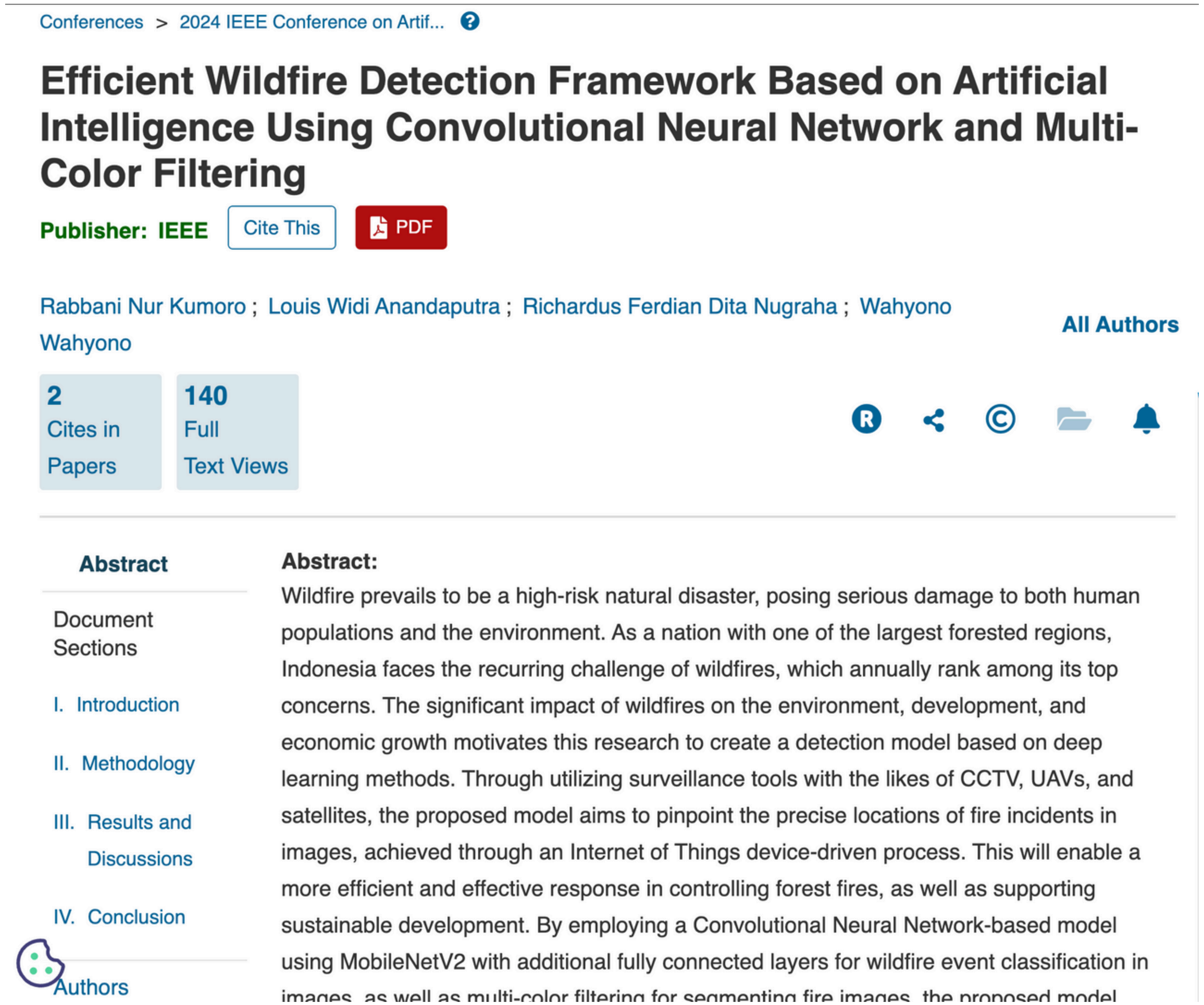
(c) GRU

(d) Bidirectional LSTM

Image Source: https://www.researchgate.net/figure/The-general-structure-of-recurrent-neural-network-models-a-Simple-RNN-b-LSTM-c_fig2_364893200

PROJECT SHOWCASE

Wildfire Detection


Conferences > 2024 IEEE Conference on Artif...

Efficient Wildfire Detection Framework Based on Artificial Intelligence Using Convolutional Neural Network and Multi-Color Filtering

Publisher: IEEE Cite This PDF

Rabbani Nur Kumoro ; Louis Widi Anandaputra ; Richardus Ferdian Dita Nugraha ; Wahyono Wahyono

All Authors

Abstract:
Wildfire prevails to be a high-risk natural disaster, posing serious damage to both human populations and the environment. As a nation with one of the largest forested regions, Indonesia faces the recurring challenge of wildfires, which annually rank among its top concerns. The significant impact of wildfires on the environment, development, and economic growth motivates this research to create a detection model based on deep learning methods. Through utilizing surveillance tools with the likes of CCTV, UAVs, and satellites, the proposed model aims to pinpoint the precise locations of fire incidents in images, achieved through an Internet of Things device-driven process. This will enable a more efficient and effective response in controlling forest fires, as well as supporting sustainable development. By employing a Convolutional Neural Network-based model using MobileNetV2 with additional fully connected layers for wildfire event classification in images, as well as multi-color filtering for segmenting fire images, the proposed model

Source: https://ieeexplore.ieee.org/abstract/document/10605400

Data Type: Image

Basic Idea:

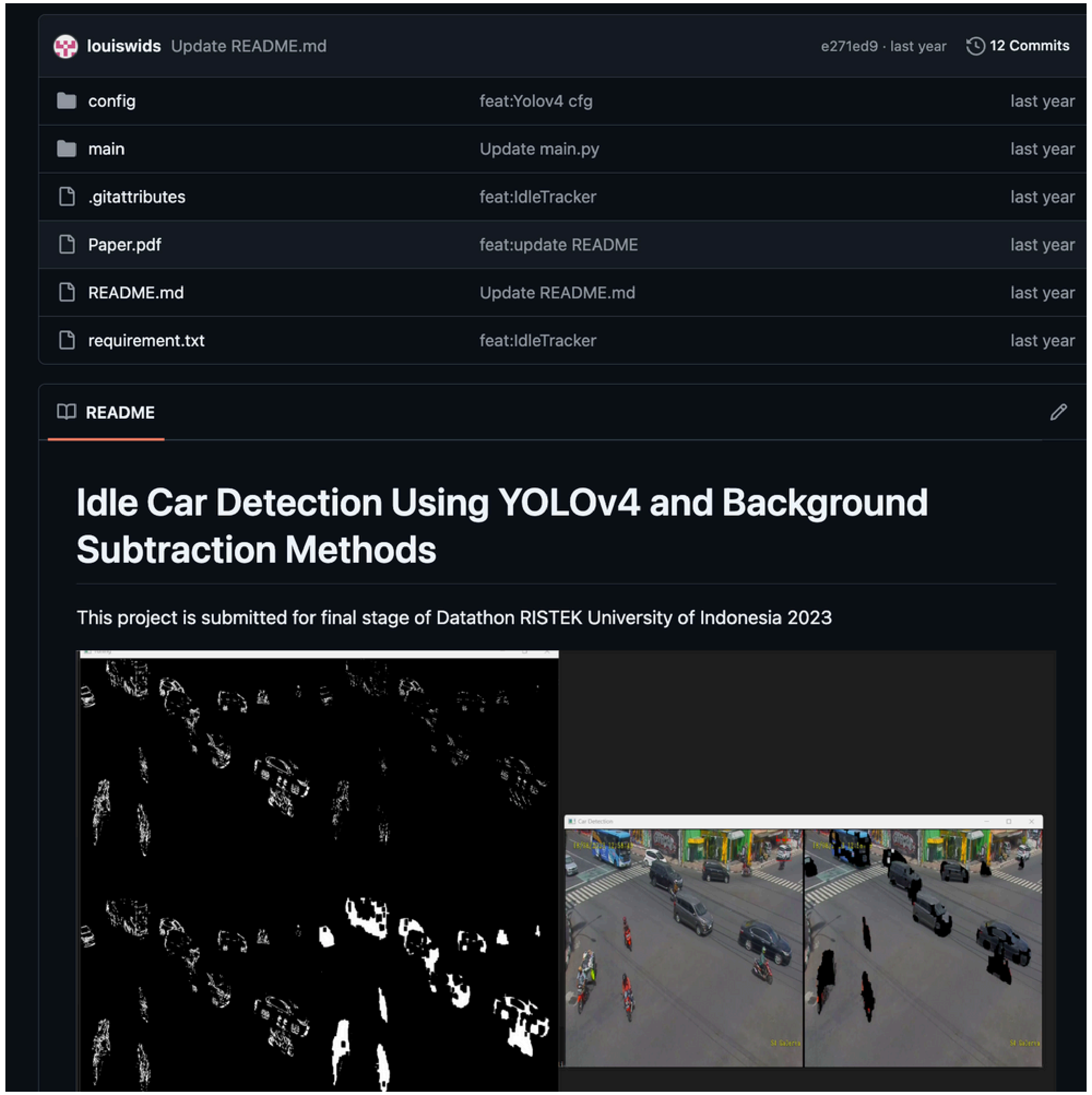
1. Use a pretrained model (MobileNetV2) as a feature extractor and add fully connected layers to classify images
2. If images are considered fire images, segment for detecting fire
3. In image segmentation, use rule-based segmentation and morphological operations (details in the paper)

Benefits:

- Reduced computational cost for image segmentation while keeping the context of fire available using the image classification

PROJECT SHOWCASE

Idle Object Tracking



Source: https://github.com/yosefnuragaw/IdleTracker

Data Type: Video

Basic Idea:

1. Treat video as sequence of images (X1,..Xn)
2. Use long term and short term average to detect moving objects and create a segment mask
3. Enhance the mask using morphological operations
4. Separate moving objects from the stationary objects using the mask
5. Use YOLO-like models to detect illegally parked cars
6. Use tracker to track how long the car has parked there

Benefits:

- More powerful detection methods using a YOLO-like detector

PROJECT SHOWCASE

Fraud Detection

Kuliah Di Depok V2 - Optimizing Information Theory: Fraud User Detection with Social Network Banking Data

The financial industry has been highly digitalized over the past several years. The addition of digital platforms in banking eases various operational processes. One of the most mainstream utilizations is the logging of loan applications by bank customers. Digital software can be used on the client side to apply for a loan and the bank can easily log all the details. Such details may include the information between the bank's customers.

In terms of loans, this issue is crucial as a study found that social networks play an important role in lending inside the banking industry [1]. Machine learning methods as heuristic solutions can optimize the detection process of fraud customers, trying to acquire lending by creating fake profiles. In terms of applying social networks, a dataset has been created as a benchmark for machine learning models in D-Graph [2]. This data set is useful for creating benchmarks between machine learning models, especially graphical neural network models. However, training a graph neural network requires a hefty amount of computing resources as on the feed-forward algorithm a graph of a social network is passed onto. Therefore, a lighter representation of the social network may need to be acquired and if possible, be implemented in a standard lighter machine learning algorithm compared to a graphical neural network.

Given a bank with a dataset of its customers with their respective information alongside their loan activities, we were given the task of identifying whether a certain customer is a fraud. There are several sets of data, The first set is the Non-Borrowing, meaning the bank customers who did not apply for loans. Next is the Training and Testing set, which are the borrowing customers with the training set having labels indicating whether a customer with a certain unique ID is a fraud customer and the testing set serves the same purpose but with no label. **The label in the test set will be predicted in this work**. Lastly, we have the loan activities, a data set that provides information about relations between customers. A borrowing user would need to put in a reference contact (another customer of the bank) before applying, in which the loan type can vary and the user can apply for the loan at any time.

In Figure 1, the exampled user from the train set is a fraud user. It is on the borrowing group and the loan activities set would enable a relationship between the borrowing user and the referenced user of the bank. On the other hand, the test set we are presented with still has unknown conditions for the user, therefore we will try to predict it.

However, after performing an analysis of the given data set, the loan activities are in the form of an undirected graph. The stated USER_ID and REFERENCE_ID may not directly show which one is the borrower or the reference as some referenced users are in the train or test sets.

DEPEDENCIES

In [ ]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from scipy.stats import f_oneway
```

Source: https://github.com/louiswids/Datathon-2024-Preliminary

Data Type:

- Tabular, but
- Each banking customer has a relation to other customers (resembling a graph)

Basic Idea:

1. Ditch graph neural network, do standard ML
2. Extract graph-based features:
   a. Page rank
   b. centrality
   c. HITS, and many more
3. Represent those feature in a standard vector format
4. Perform supervised learning with XGB

Benefits:

- Better interpretability of features determining if someone is a fraudulent customer (although this is not end-to-end learning)

Projects Source:

1. Wildfire Detection: https://ieeexplore.ieee.org/abstract/document/10605400
2. Idle Object Tracker: https://github.com/yosefnuragaw/IdleTracker
3. Graph-based fraudulent customer classification:

https://github.com/louiswids/Datathon-2024-Preliminary/