COMPUTER VISION FOR WETLAND IDENTIFICATION

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Department of Innovation and Technology

CITY OF BOSTON

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MOTIVATION

Wetlands are capable of mitigating three major types of climate risks that Boston is facing: extreme heat, stormwater flooding, and coastal and riverine flooding.

The Environment Department wants to use predictive analytics to identify wetlands in Boston.

Predictions will complement the Department's efforts to prioritize their resources by identifying likely wetland locations to validate through in-person, expert inspection.

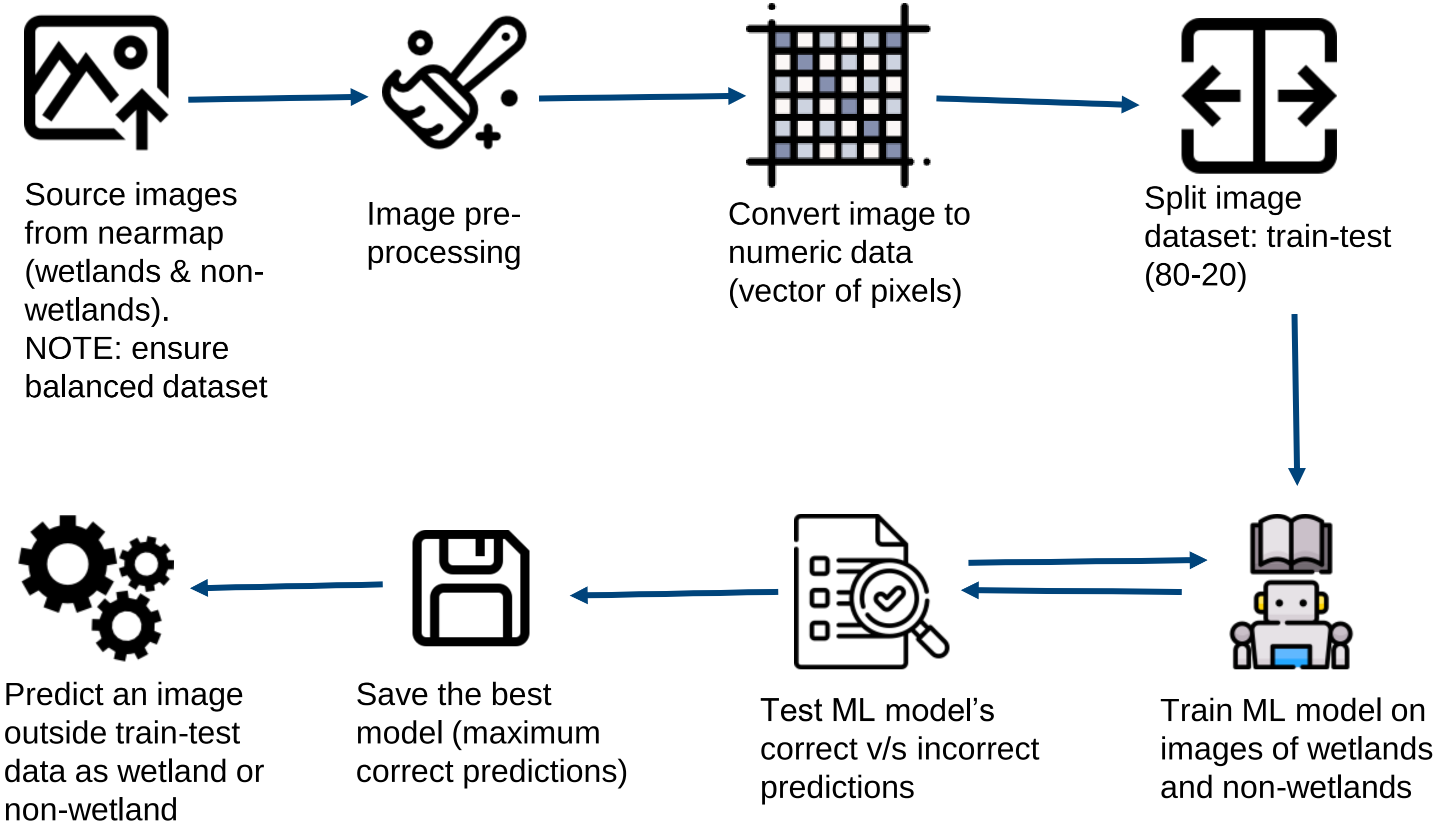
PROBLEM STATEMENT

- **Use satellite images to identify the presence of wetlands**
  - Nearmap
- **Application of Computer Vision**
  - Train a machine learning model to predict whether an image contains a wetland or not
  - (a.k.a binary image classification)
  - 2 class labels: “Wetland” or “Nonwetland”

DEFINE WETLANDS

- Any natural water bodies
- Like lakes, ponds, river
- Excluding swimming pools (human-made water bodies)

MACHINE LEARNING FOR IMAGE CLASSIFICATION PIPELINE



WETLAND IDENTIFICATION DEMO

CITY OF BOSTON

Identify Wetlands in Boston

img

Clear

Submit

output

Nonwetland

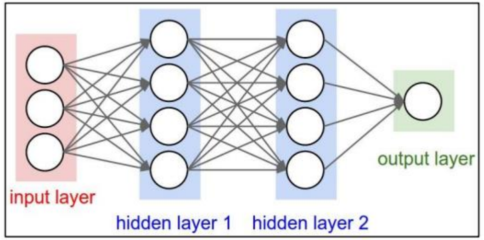
Nonwetland	65%
Wetland	35%

Flag

view api • built with gradio

CONVOLUTIONAL NEURAL NETWORK (CNN) - I

- **CNNs are a type of deep learning model that are used for computer vision applications**
- **Common applications of CNN:**
  - Image Classification
  - Image Recognition
  - Object Detection
- **What is Deep Learning?**

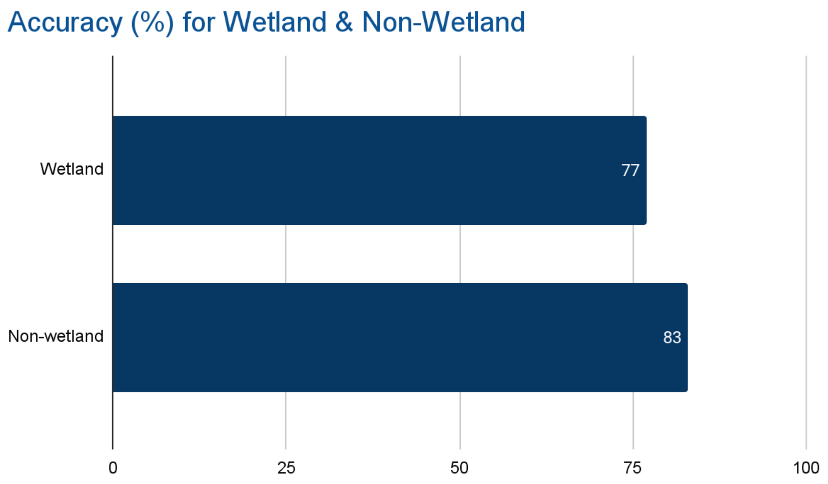


Sample a batch of images → Initialise weights & biases for each neuron ⇄ Pass images in network & predict. Find prediction error. ⇄ Based on error/residual, update parameters to min. error

× Loop for each "batch" of images

MODEL PERFORMANCE

- **Model performance is evaluated by using a common metric called Accuracy for each class label**
  - Wetlands Identification model has 2 class labels: 1) Wetland, 2) Non-wetland
- **Prediction Accuracy for “Wetland” class**
  - 100 x (Number of correct predictions for Wetland / Total Wetland images)



PREDICTING WETLANDS ROADMAP: NEXT STEPS

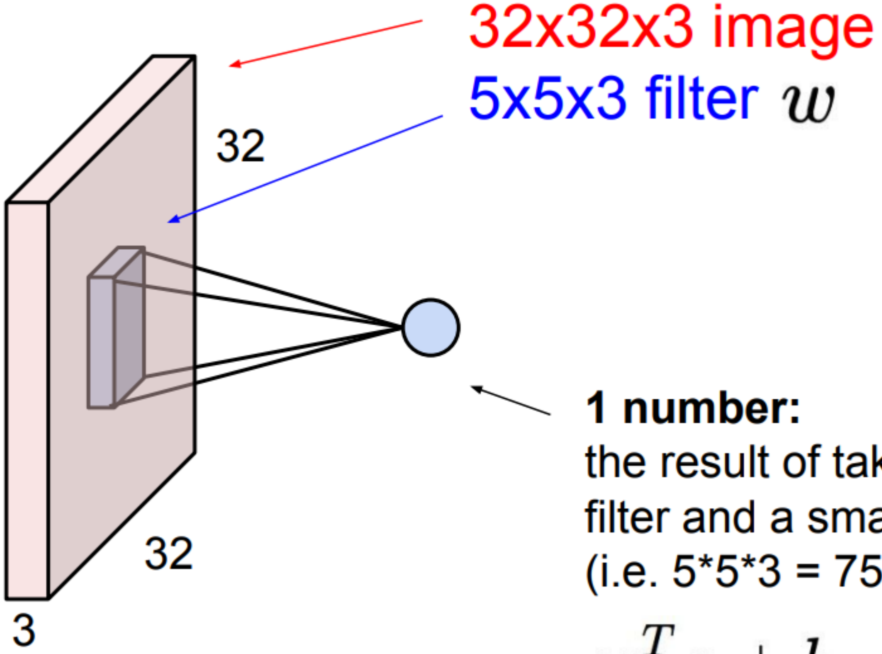
- **Integrate model's predictions with the Environment Department's work for resource allocation on identifying wetlands**
- **Tune hyper-parameters (eg. number of layers, dimensions of each layer, epochs) to improve current model's prediction accuracy**
- **K-fold cross-validation to reduce over-fitting (improve model's ability to generalise its learnings on new images)**
  - Code provided, need to just run it!

THANK YOU!

APPENDIX

Source: Stanford Lecture Slides, Towards Data Science

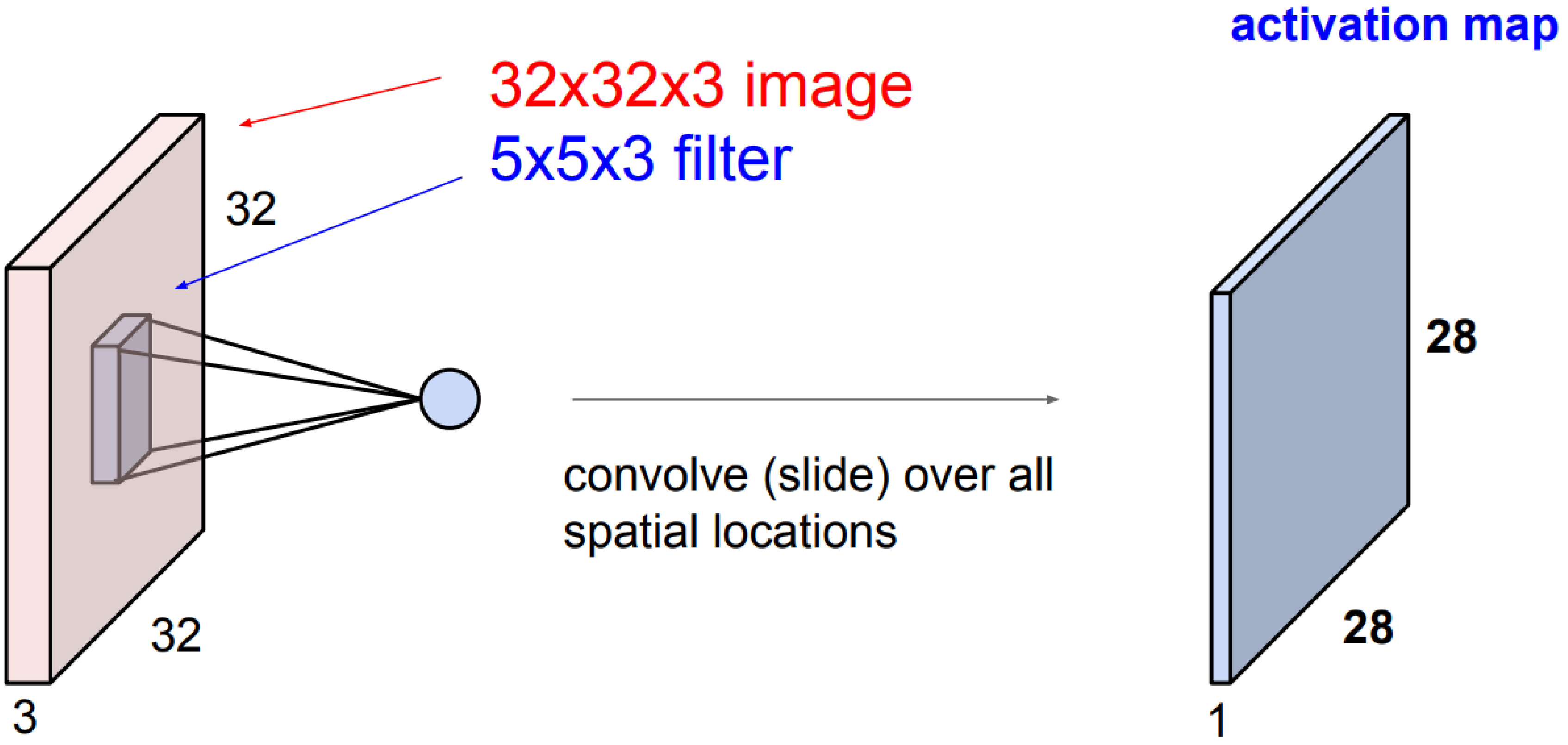
Convolution Layer



1 number:
the result of taking a dot product between the filter and a small 5x5x3 chunk of the image
(i.e. 5*5*3 = 75-dimensional dot product + bias)

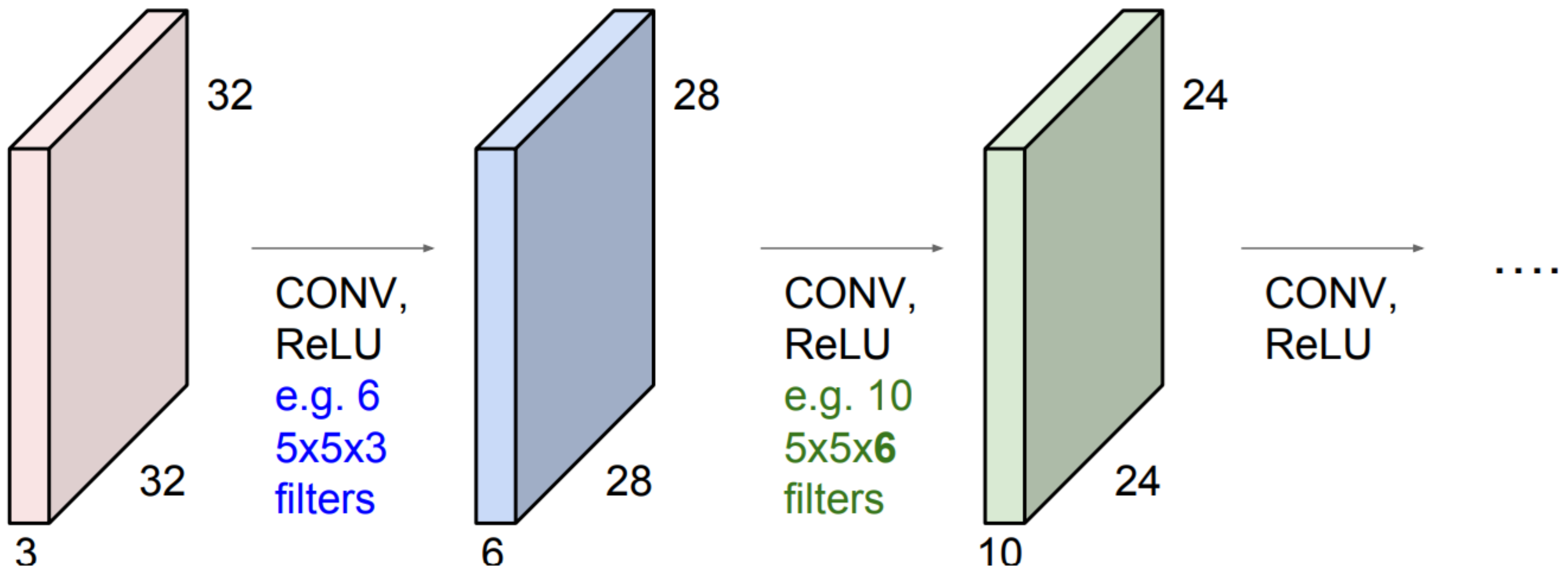
$$w^T x + b$$

CONVOLUTIONAL NEURAL NETWORK (CNN) - II



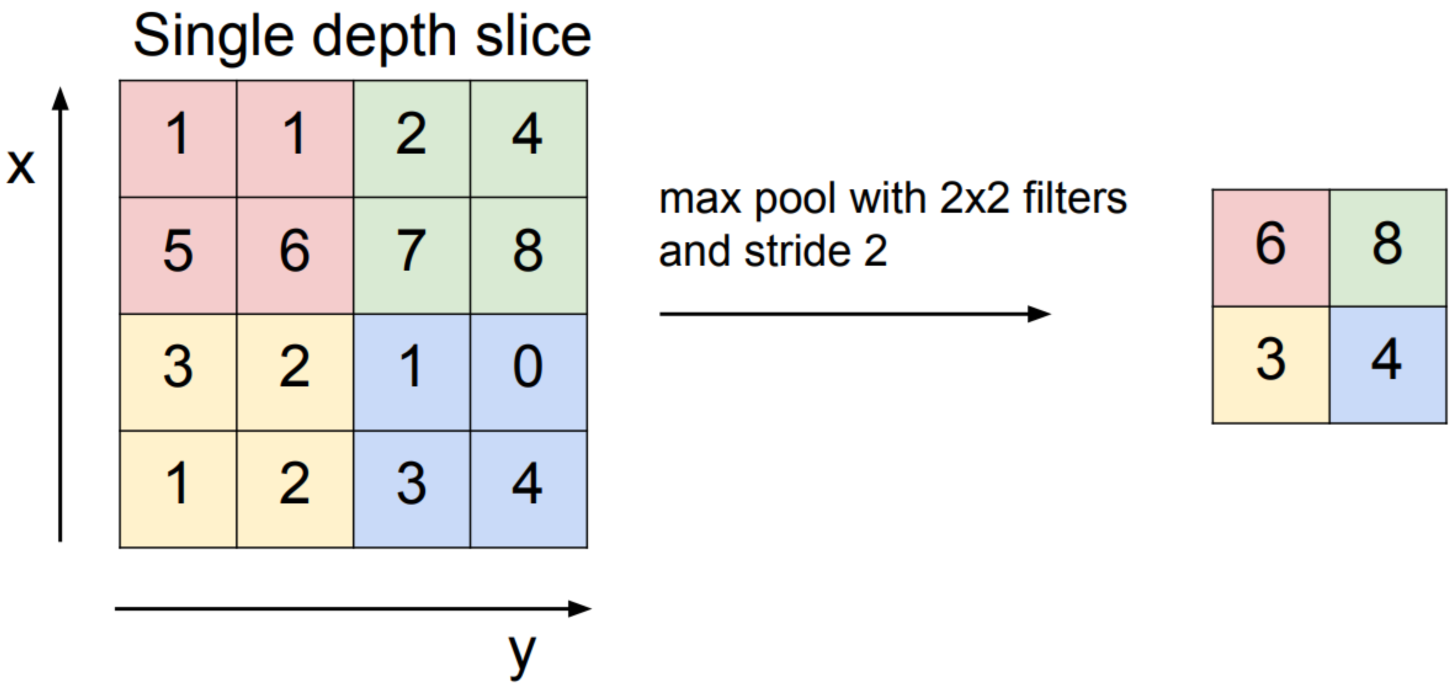
CONVOLUTIONAL NEURAL NETWORK (CNN) - III

E.g. 32x32 input convolved repeatedly with 5x5 filters shrinks volumes spatially! (32 -> 28 -> 24 ...). Shrinking too fast is not good, doesn't work well.

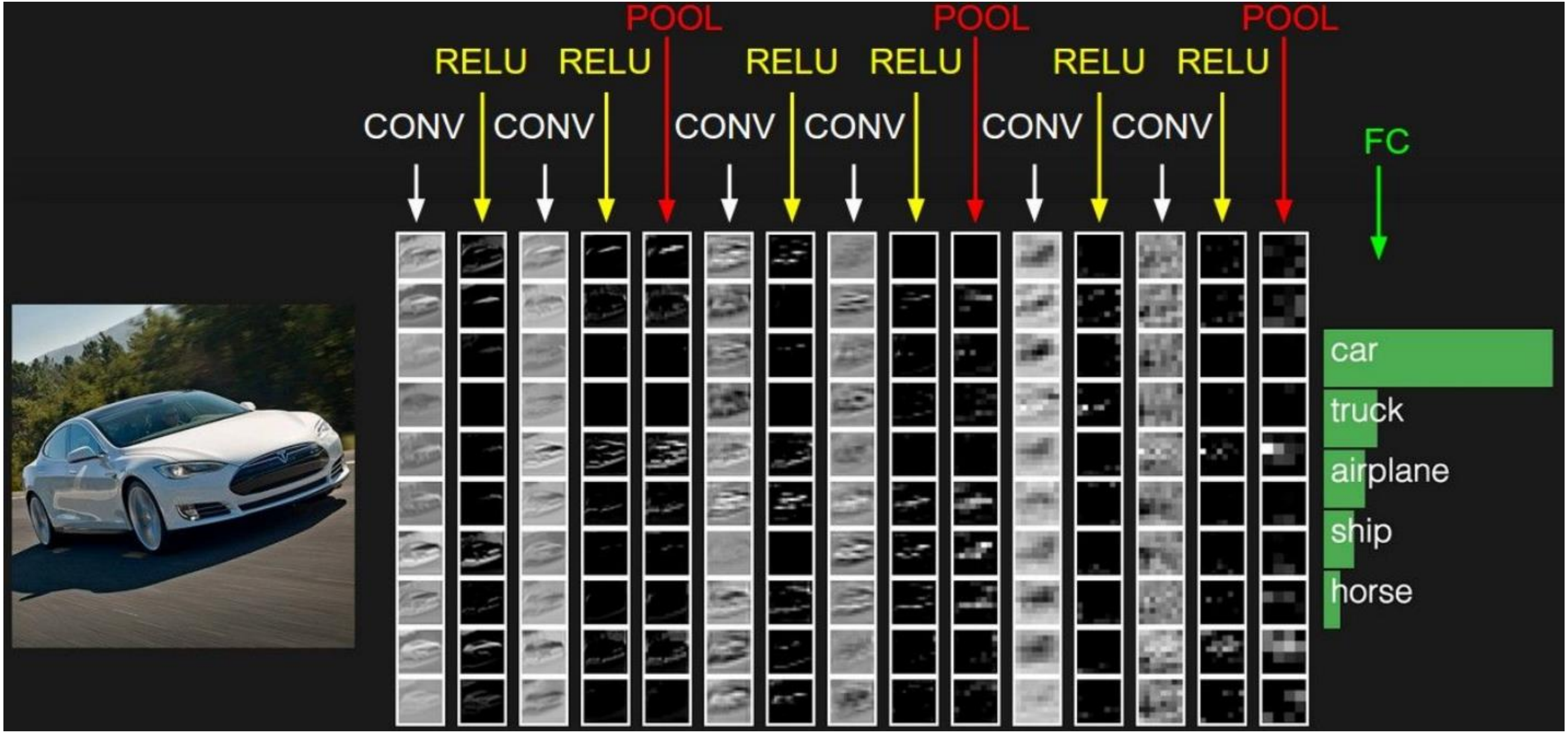


CONVOLUTIONAL NEURAL NETWORK (CNN) - IV

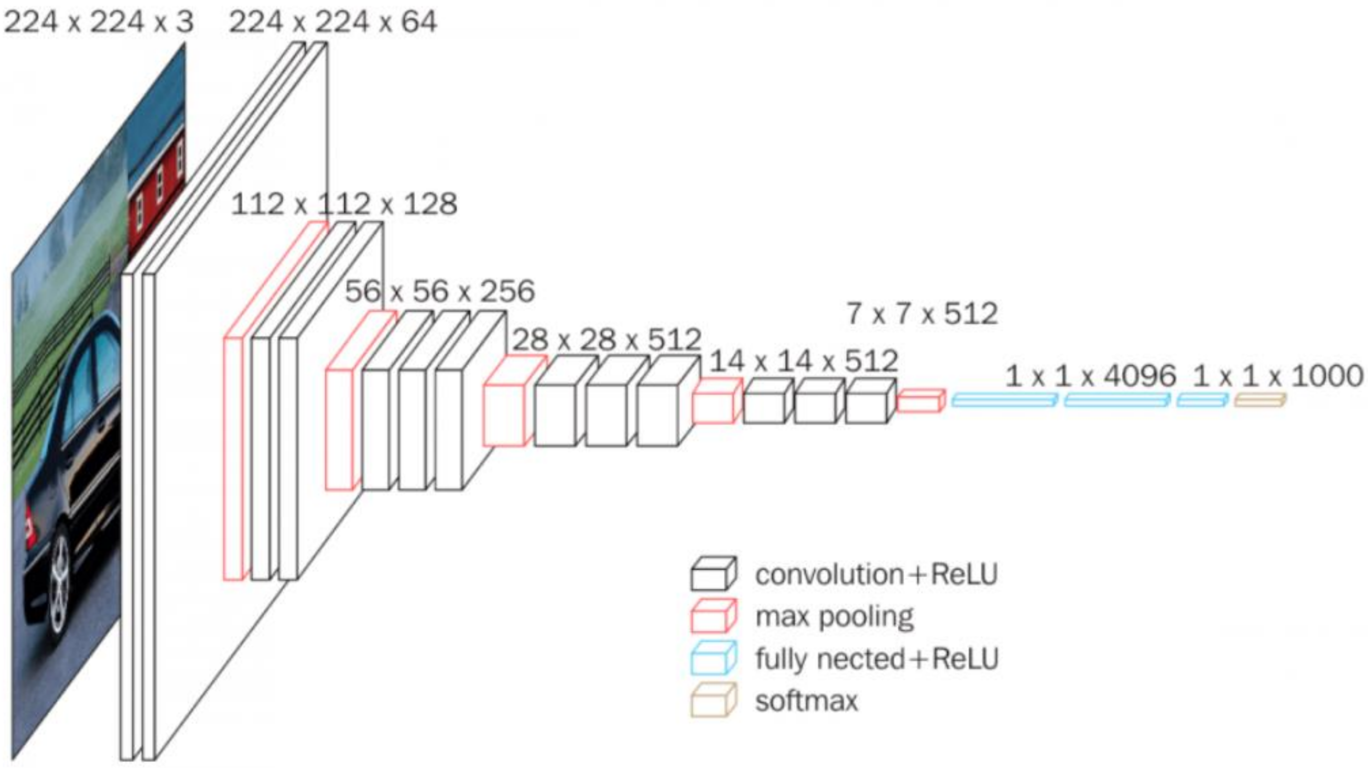
MAX POOLING



CONVOLUTIONAL NEURAL NETWORK (CNN) - V



CONVOLUTIONAL NEURAL NETWORK (CNN) - VI



VGG-16 Network Architecture. Source: https://neurohive.io/wp-content/uploads/2018/11/vgg16-1-