CONVOLUTIONAL NEURAL NETWORKS

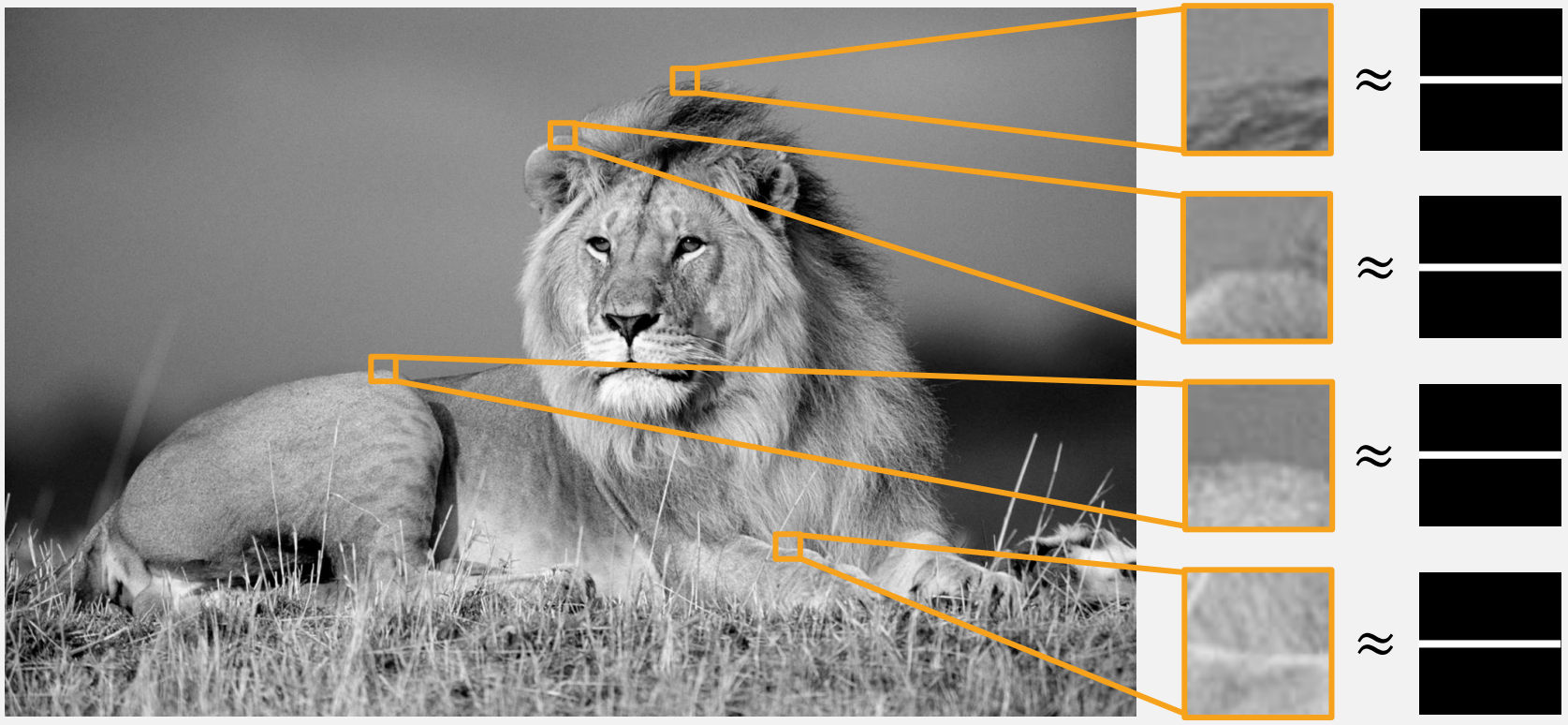
Lecture 3

MAL2, Spring 2025

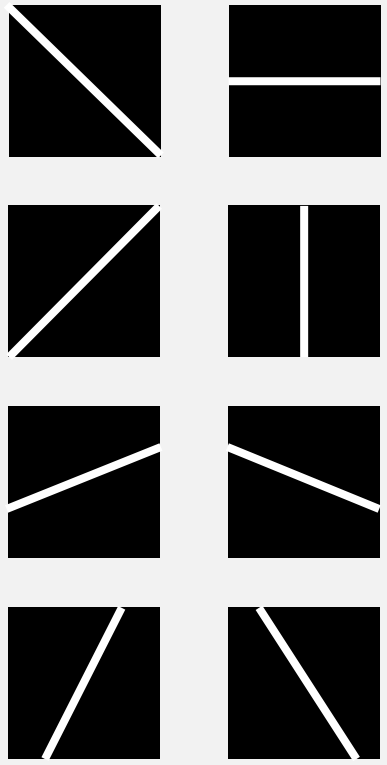
CONVOLUTIONAL NEURAL NETWORKS

- What is an image?
- Convolutional layers
- Pooling layers
- Implementing a CNN
- Pretrained CNNs
- Object localization

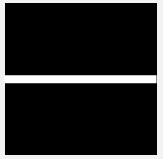
WHAT IS AN IMAGE?

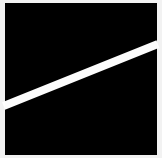


WHAT IS AN IMAGE?

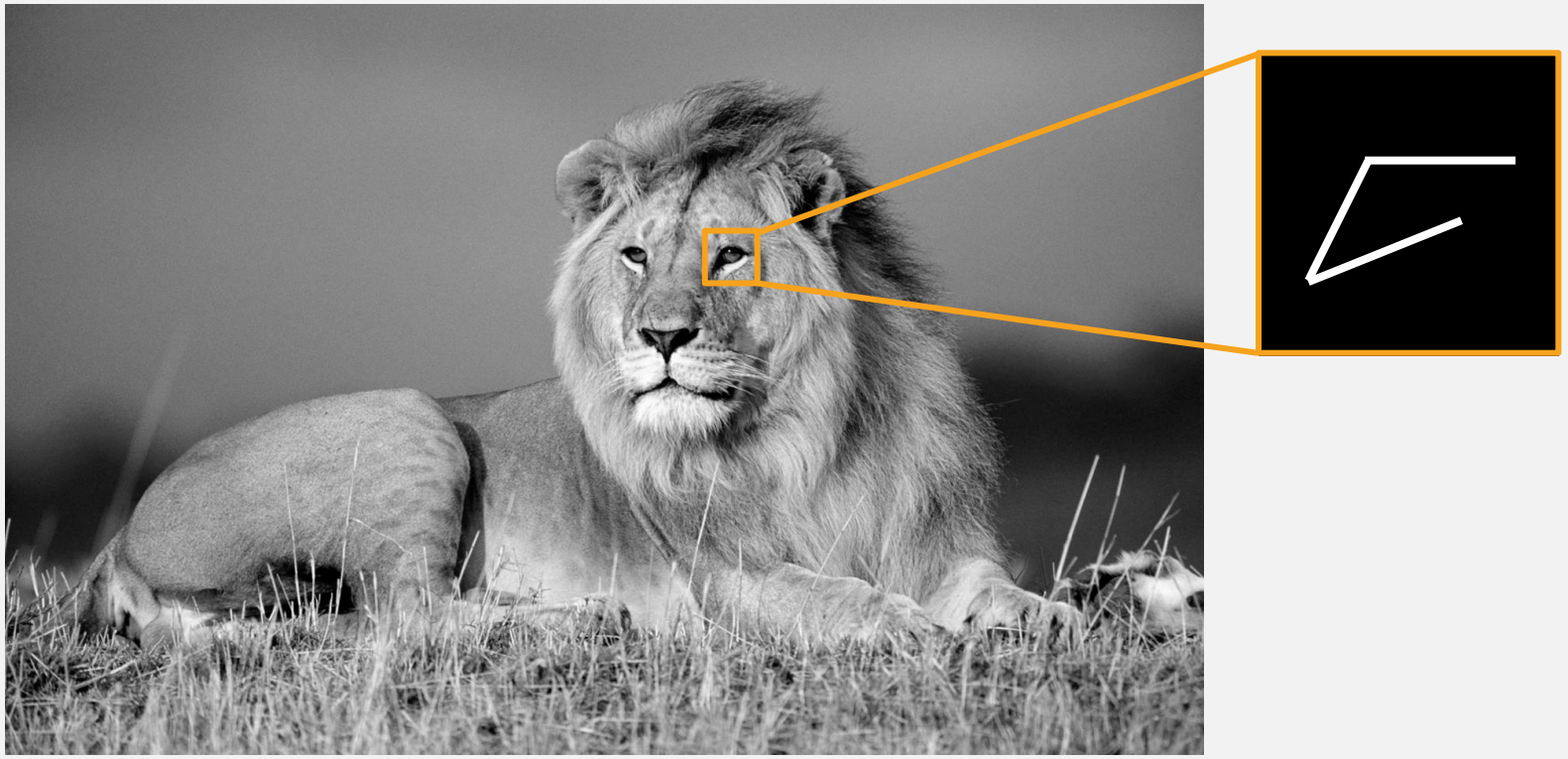


WHAT IS AN IMAGE?

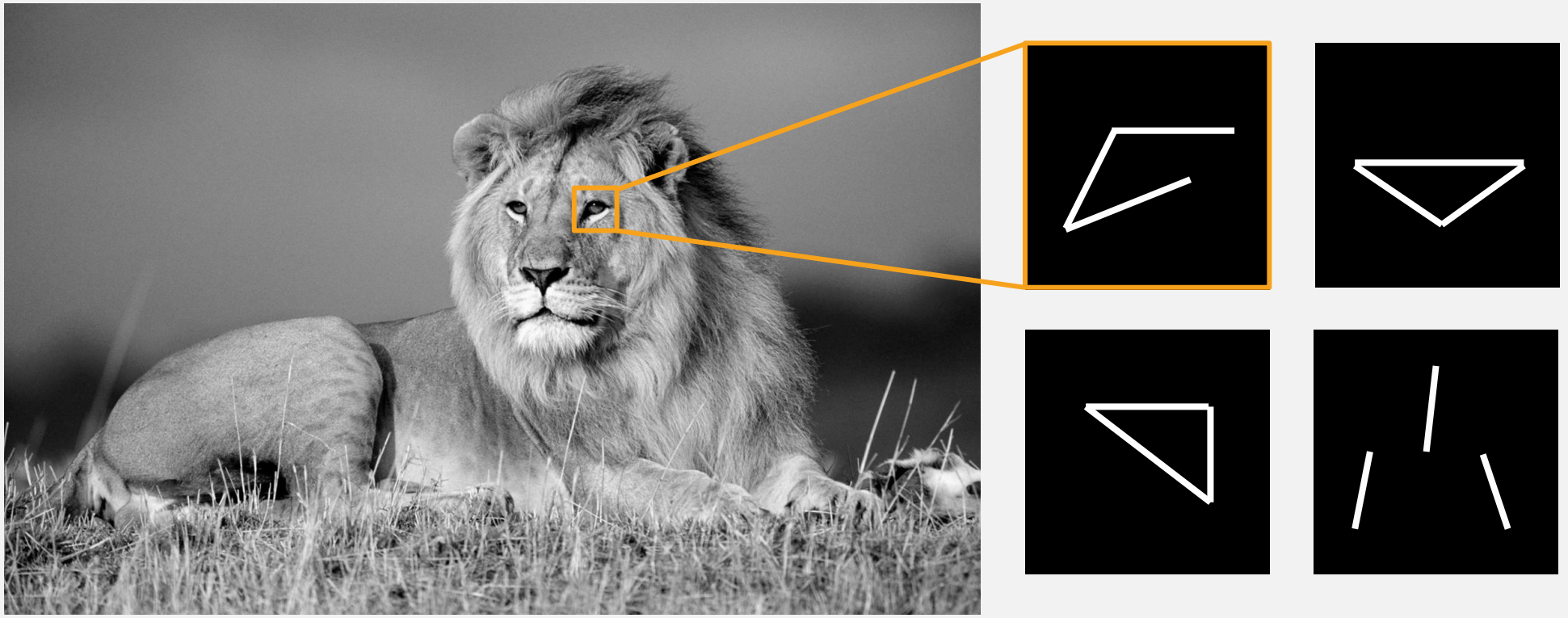




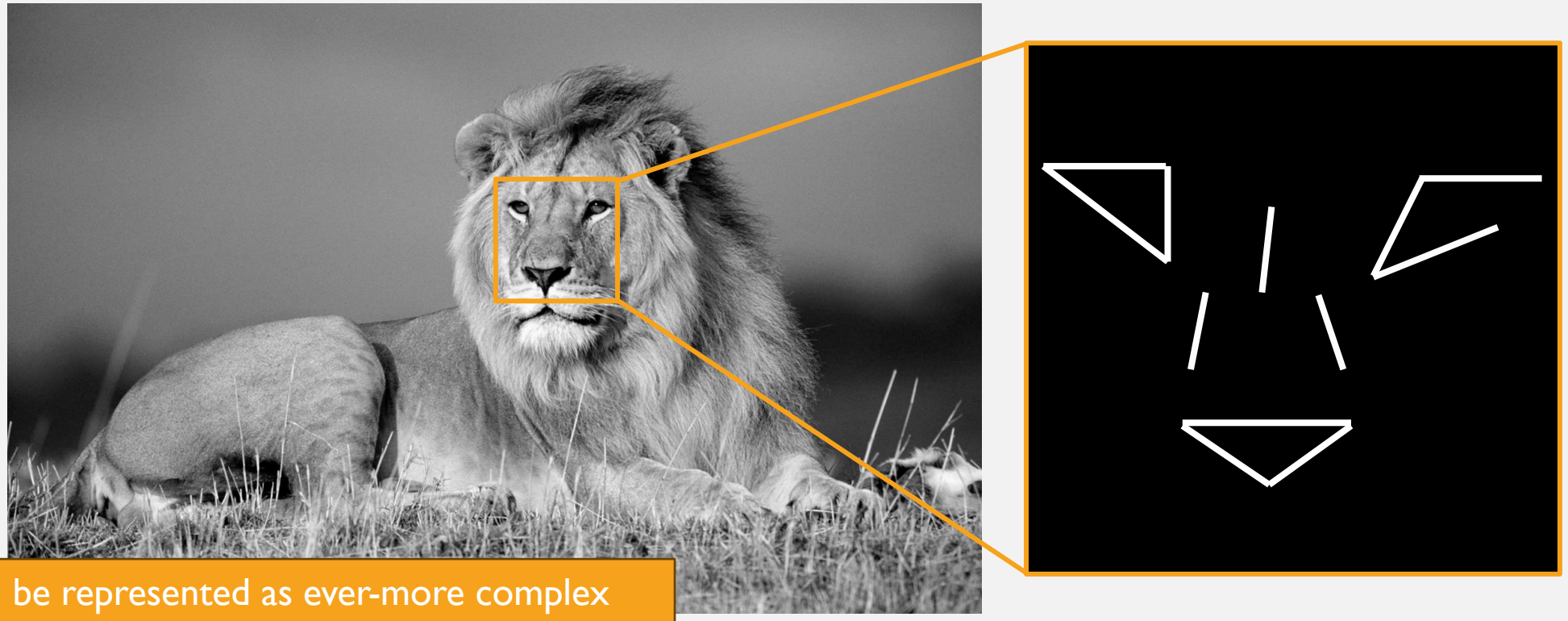
WHAT IS AN IMAGE?



WHAT IS AN IMAGE?



WHAT IS AN IMAGE?

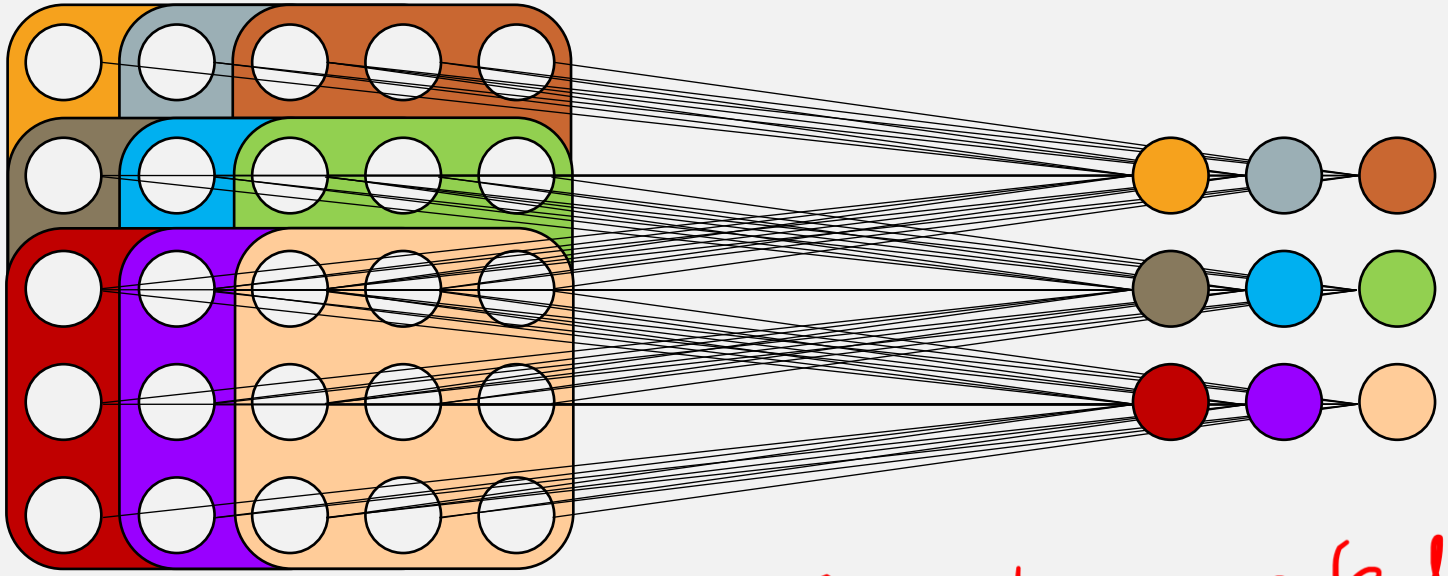


Any image can be represented as ever-more complex combinations of simple structures – we will use this to define a new architechture of neural networks.

CONVOLUTIONAL NEURAL NETWORKS

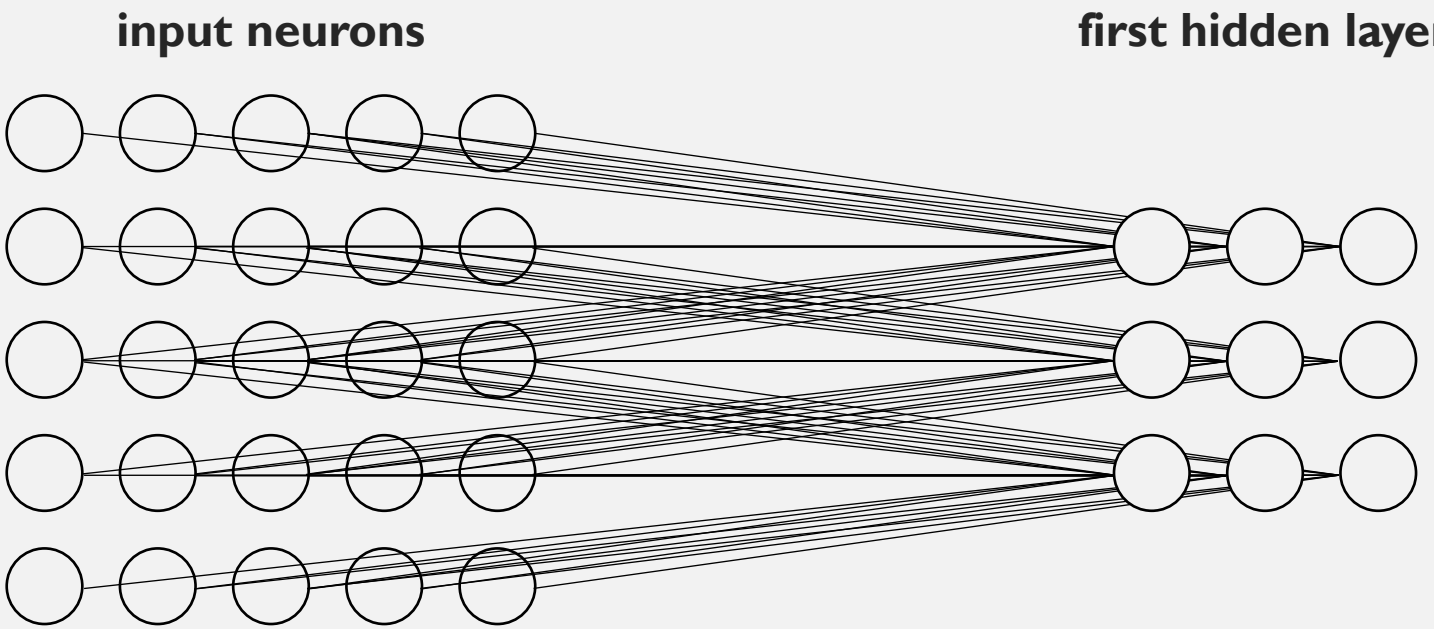
- What is an image?
- Convolutional layers
- Pooling layers
- Implementing a CNN
- Pretrained CNNs
- Object localization

CONVOLUTIONAL LAYERS

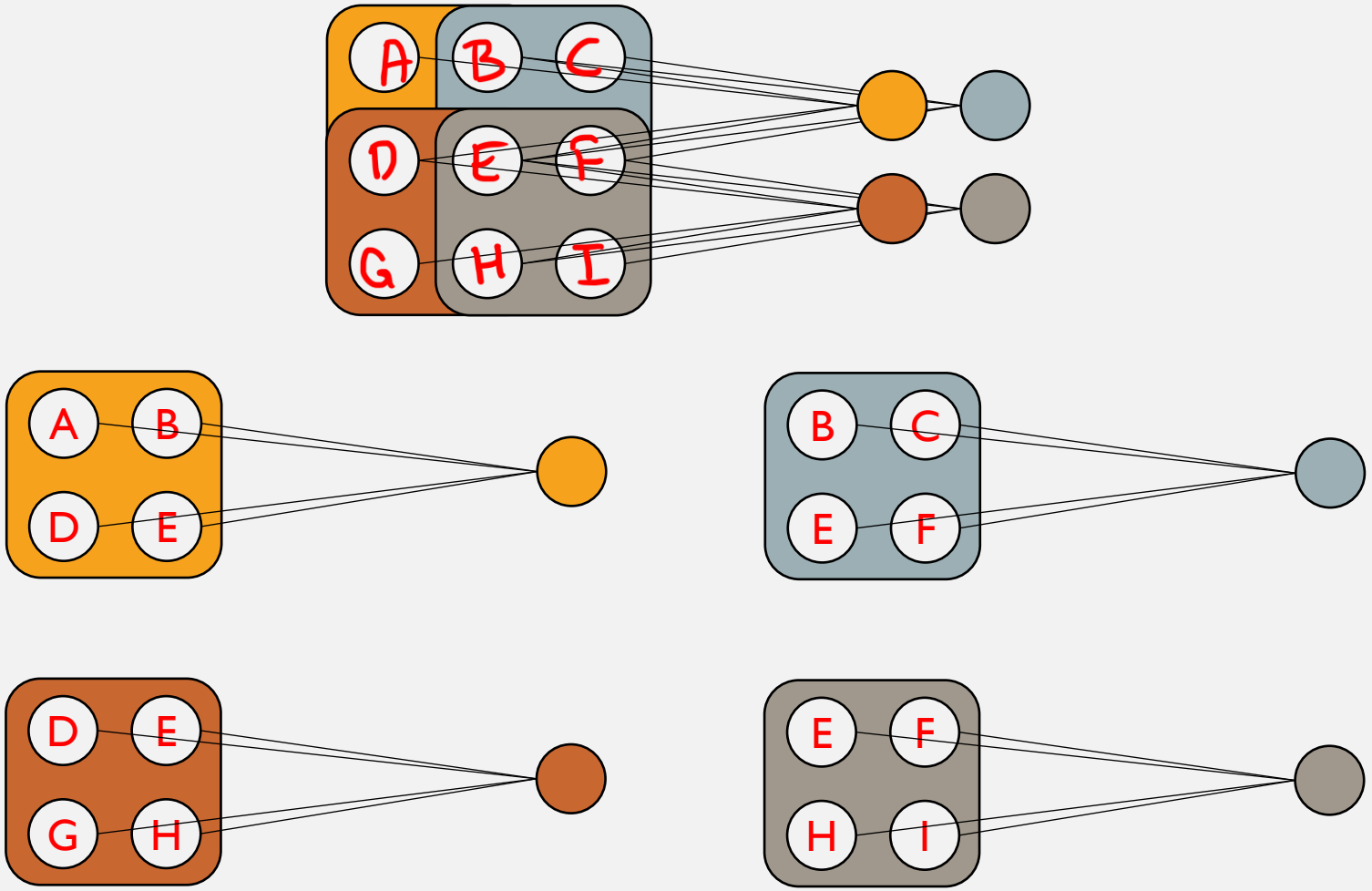


Each hidden neuron is only connected to a subset of the input neurons
↳ "local receptive field"

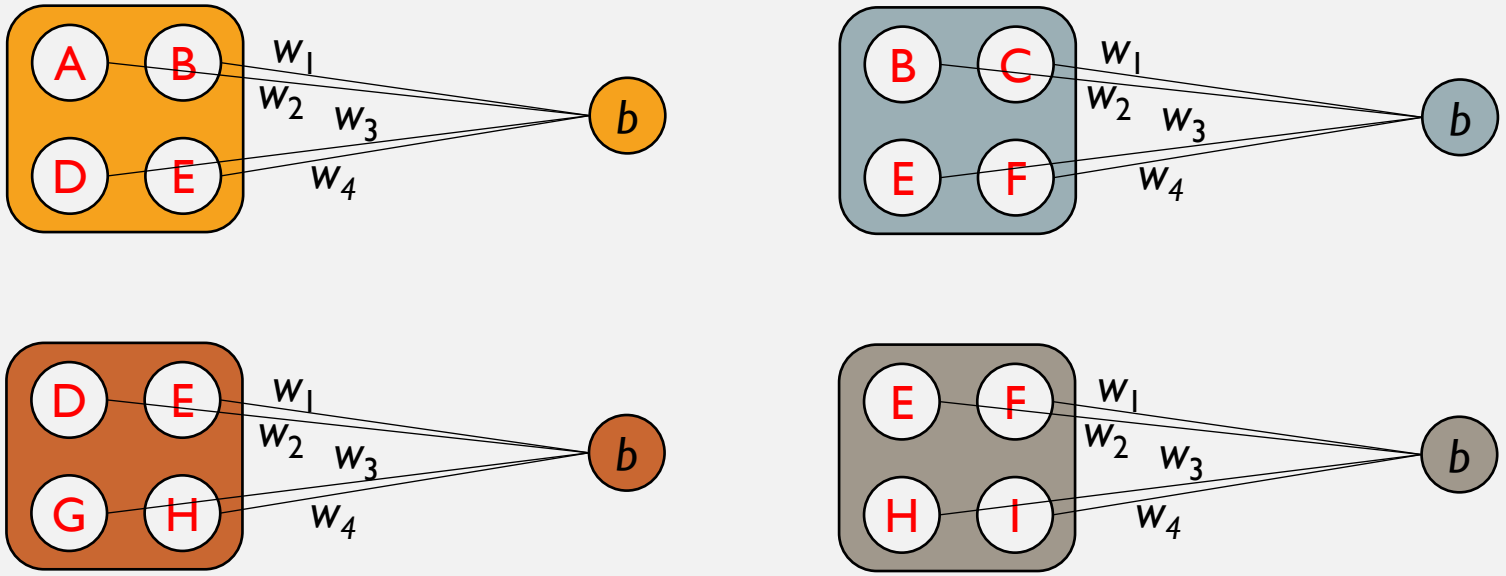
CONVOLUTIONAL LAYERS



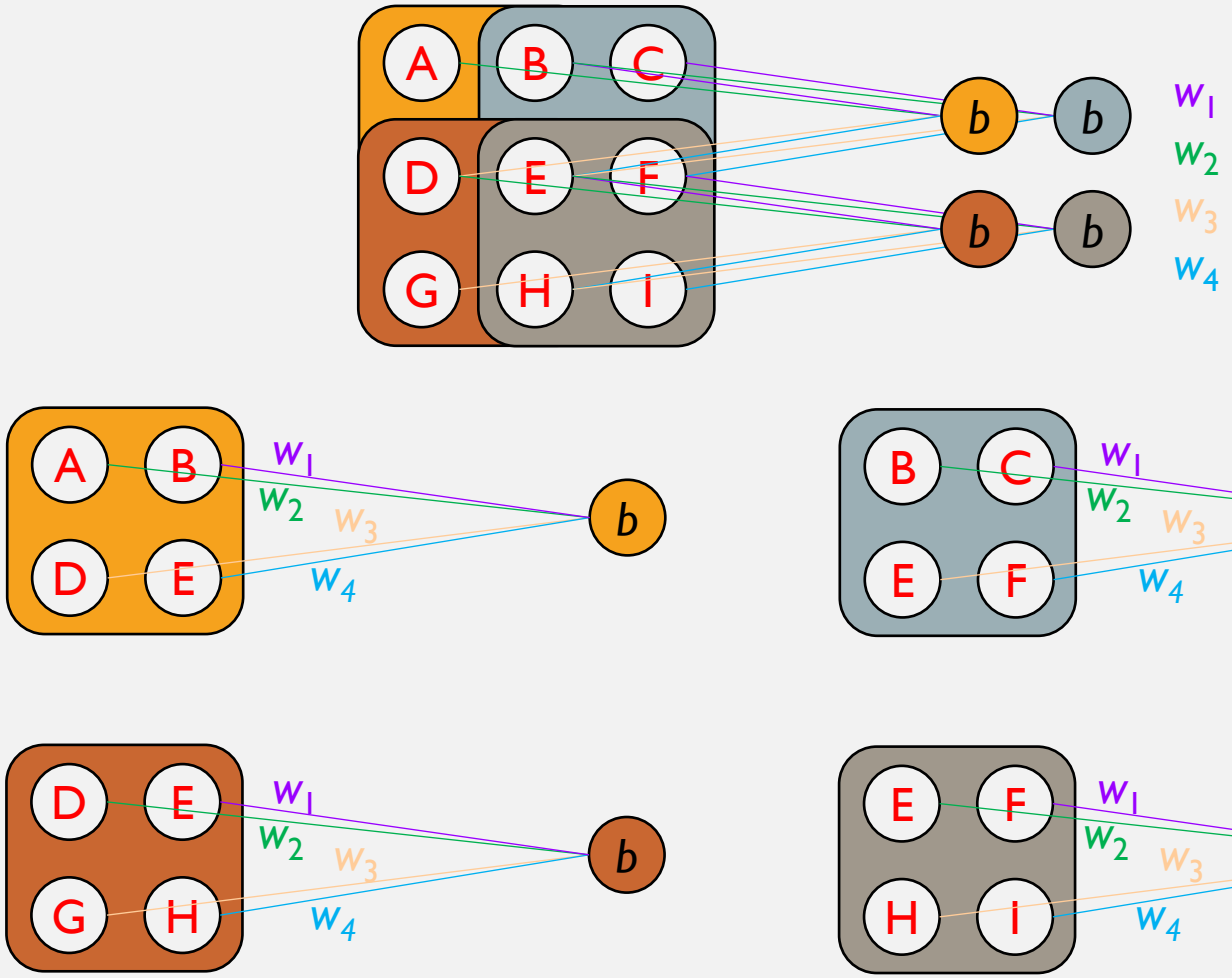
CONVOLUTIONAL LAYERS



CONVOLUTIONAL LAYERS

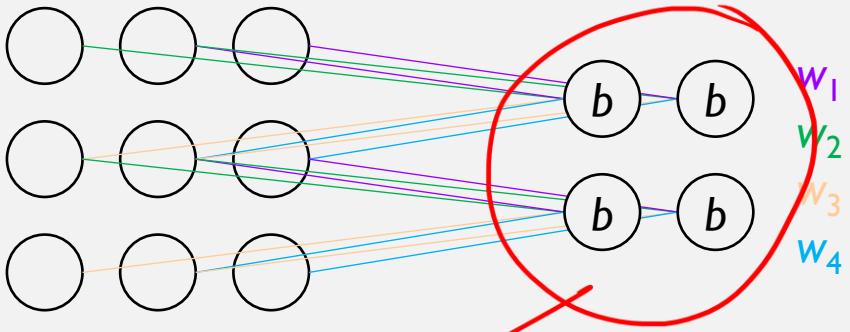


CONVOLUTIONAL LAYERS

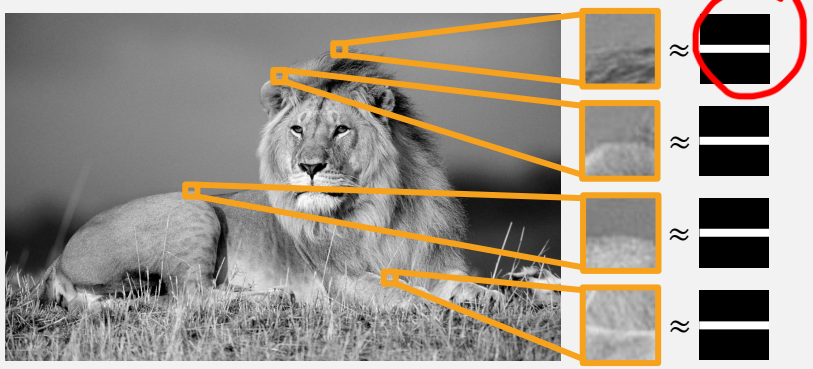


we aim to detect the same local patten at different places in the image

CONVOLUTIONAL LAYERS

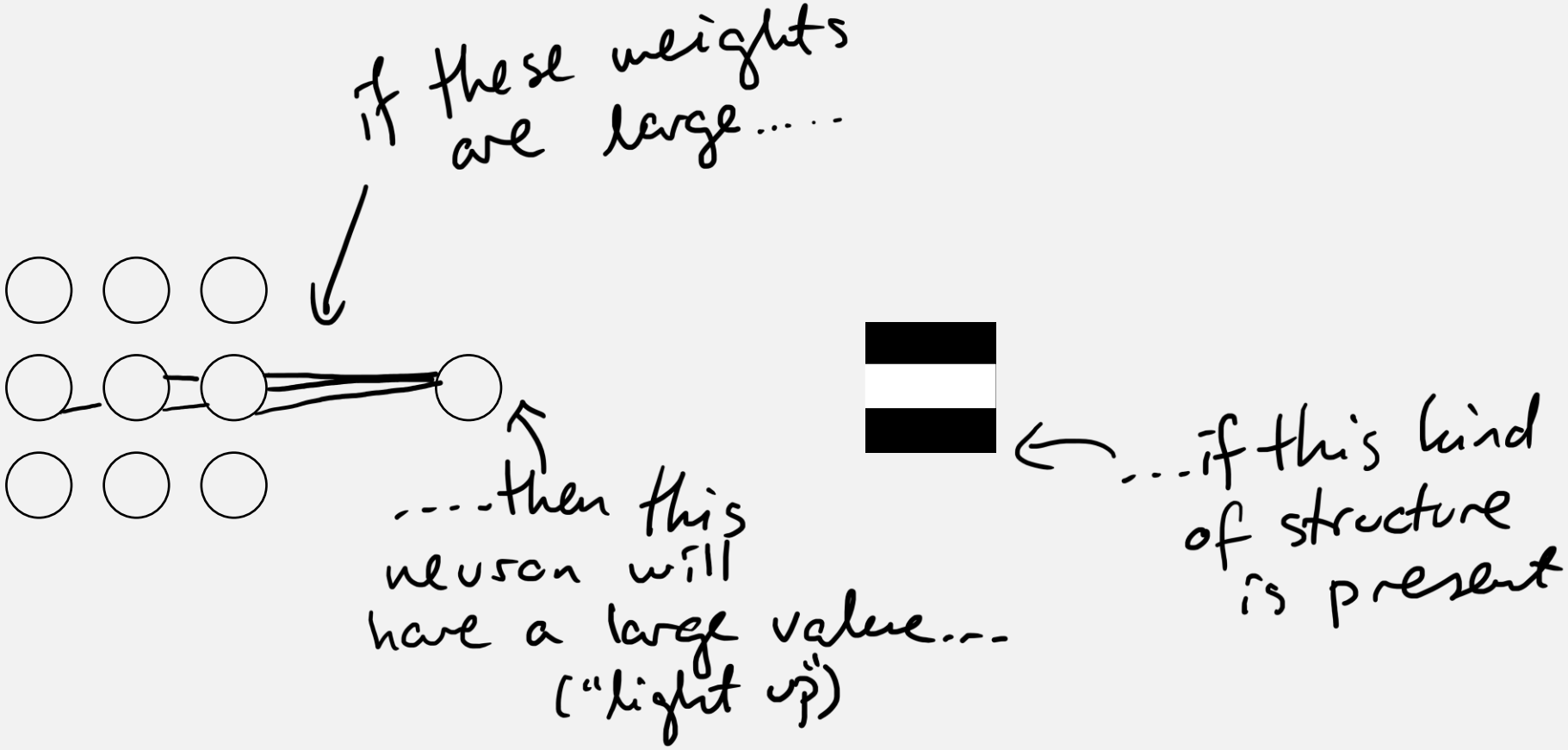


what's the connection?



Such a trained set of weights is called a **filter** or a **kernel**.

FILTERS AND FEATURE MAPS



FILTERS AND FEATURE MAPS

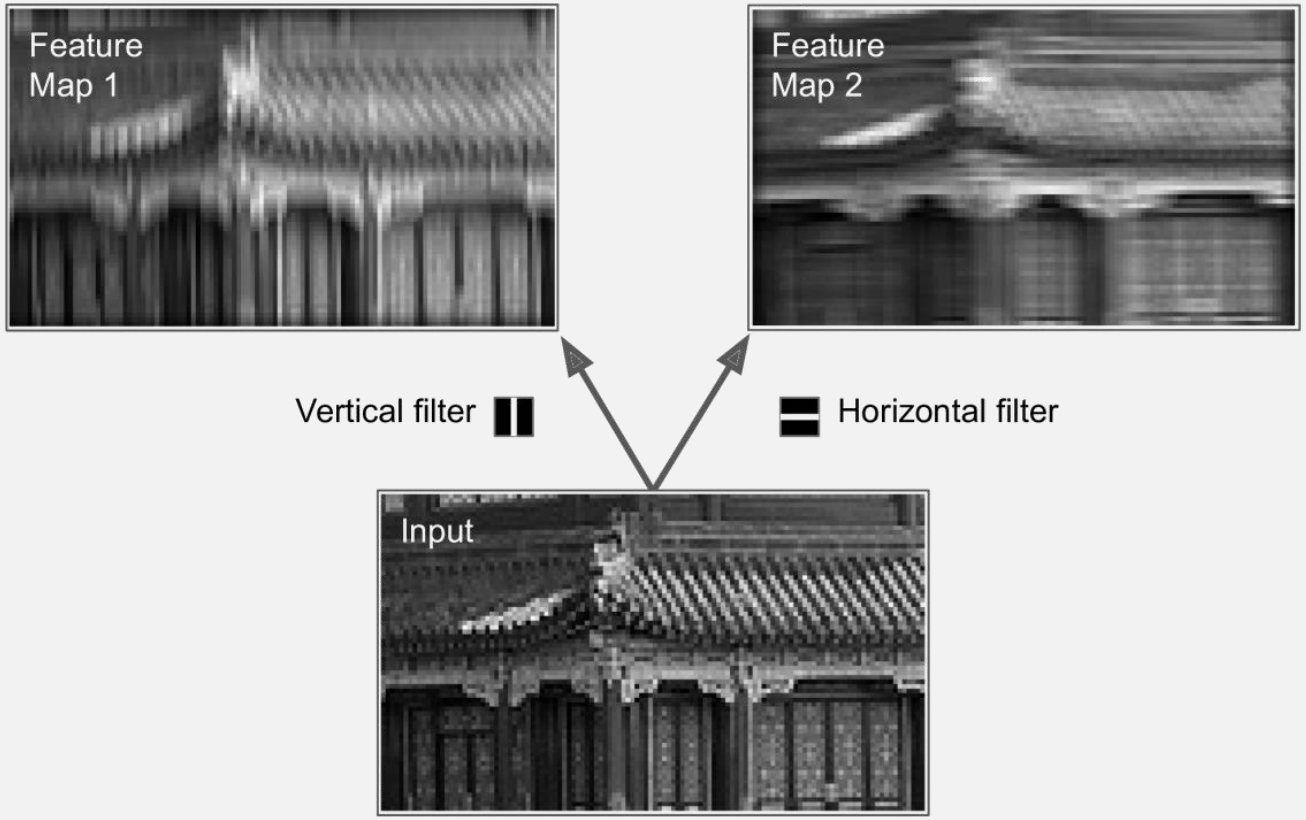
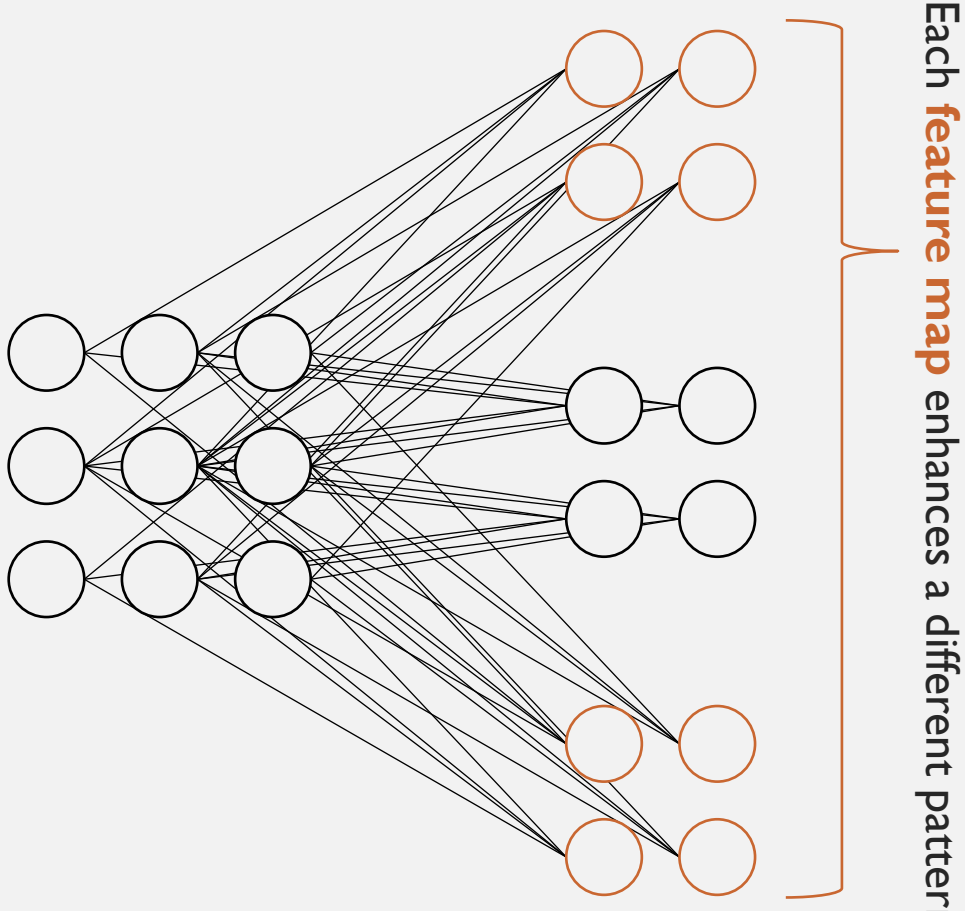


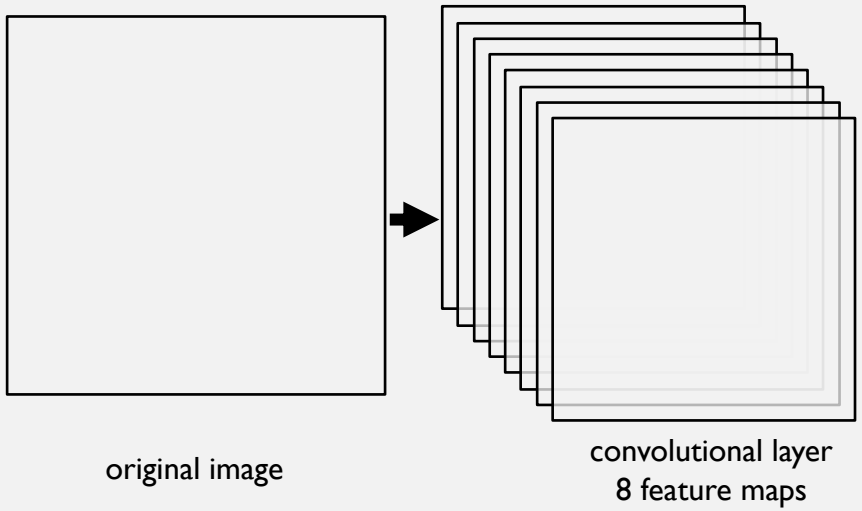
Fig. 14-5 from the book

STACKING FEATURE MAPS



Each **feature map** enhances a different pattern

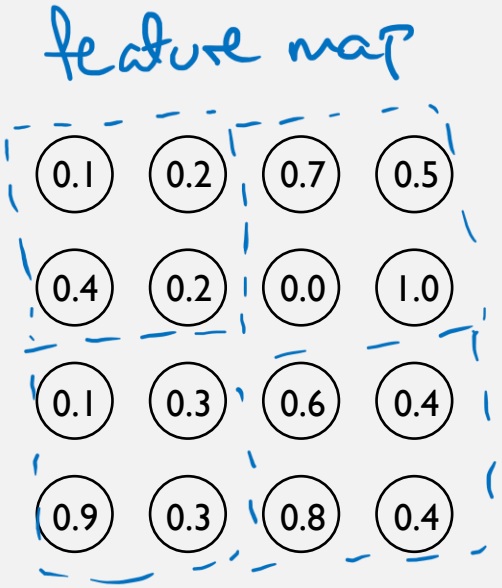
CONVOLUTIONAL LAYERS



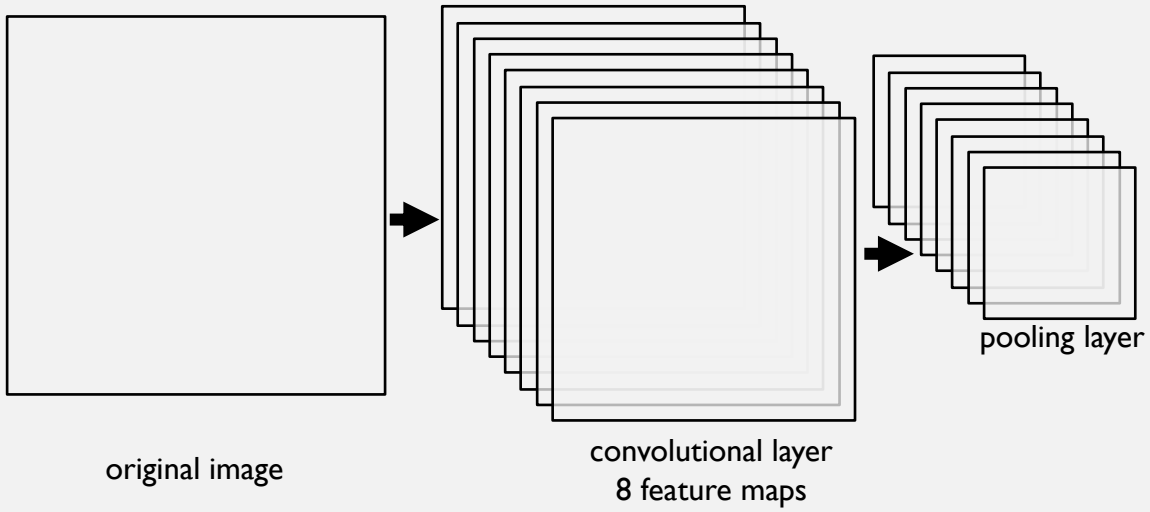
CONVOLUTIONAL NEURAL NETWORKS

- What is an image?
- Convolutional layers
- Pooling layers
- Implementing a CNN
- Pretrained CNNs
- Object localization

POOLING LAYERS



POOLING LAYERS

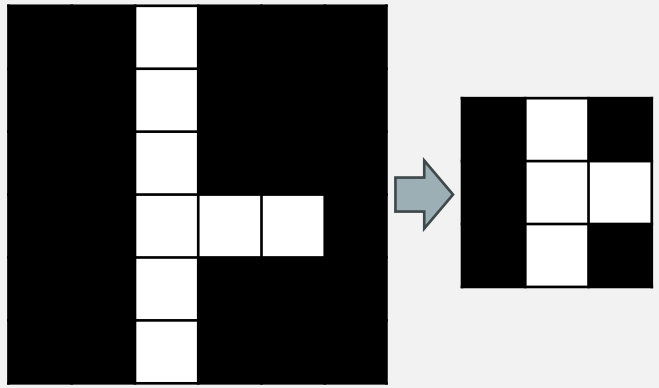


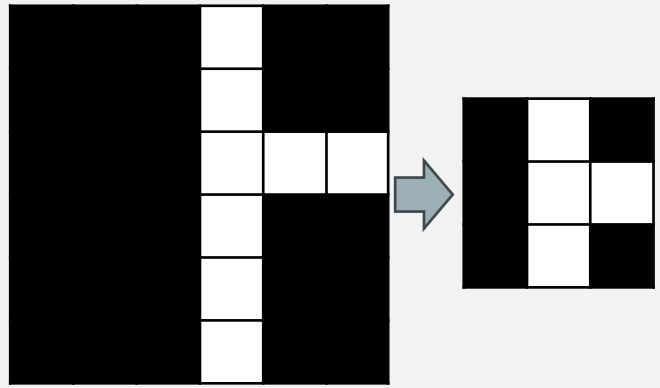
BUT WHY?

Drop 75% of neurons in a layer

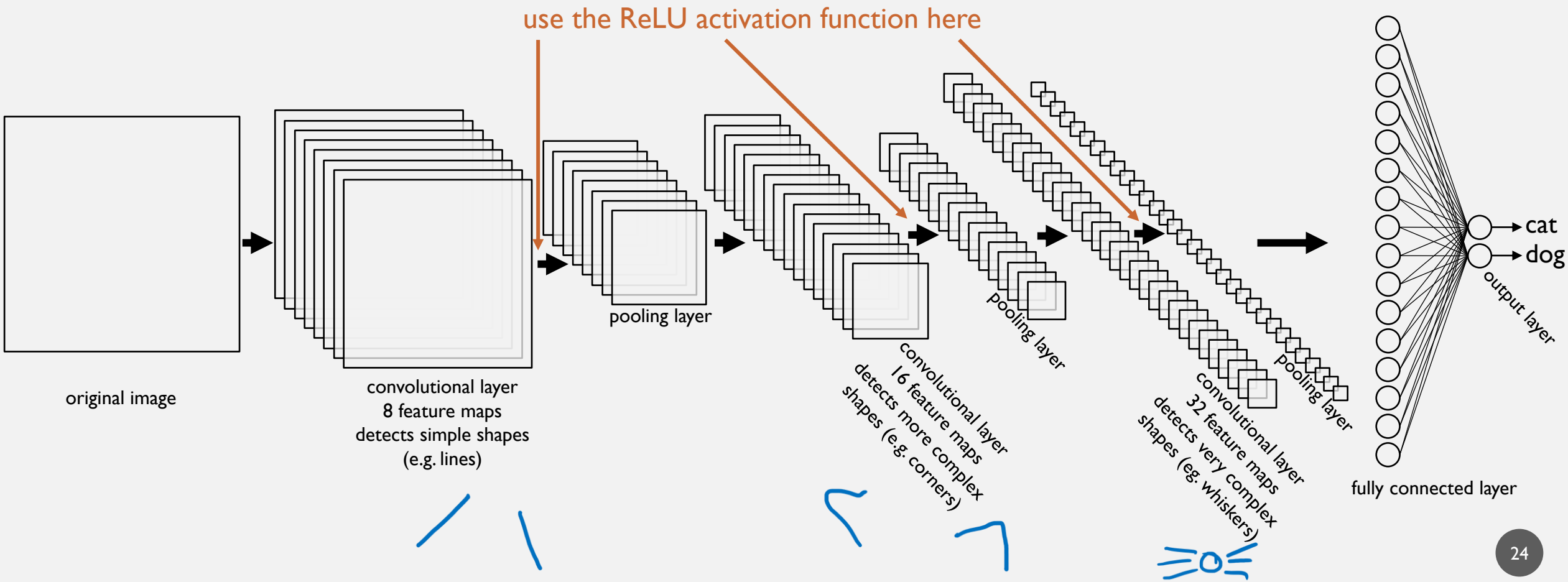
- Reduces comp. time, memory load, #parameters

- Translational invariance — acts as a regularizer





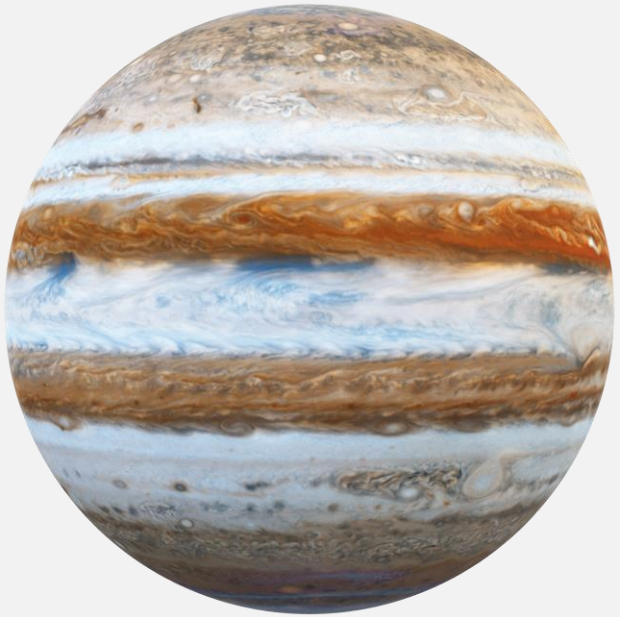
A TYPICAL CNN STRUCTURE



CONVOLUTIONAL NEURAL NETWORKS

- What is an image?
- Convolutional layers
- Pooling layers
- Implementing a CNN
- Pretrained CNNs
- Object localization

IMPLEMENTING A CNN



IMPLEMENTING A CNN

Take the CNN we just made

and see if you can improve it

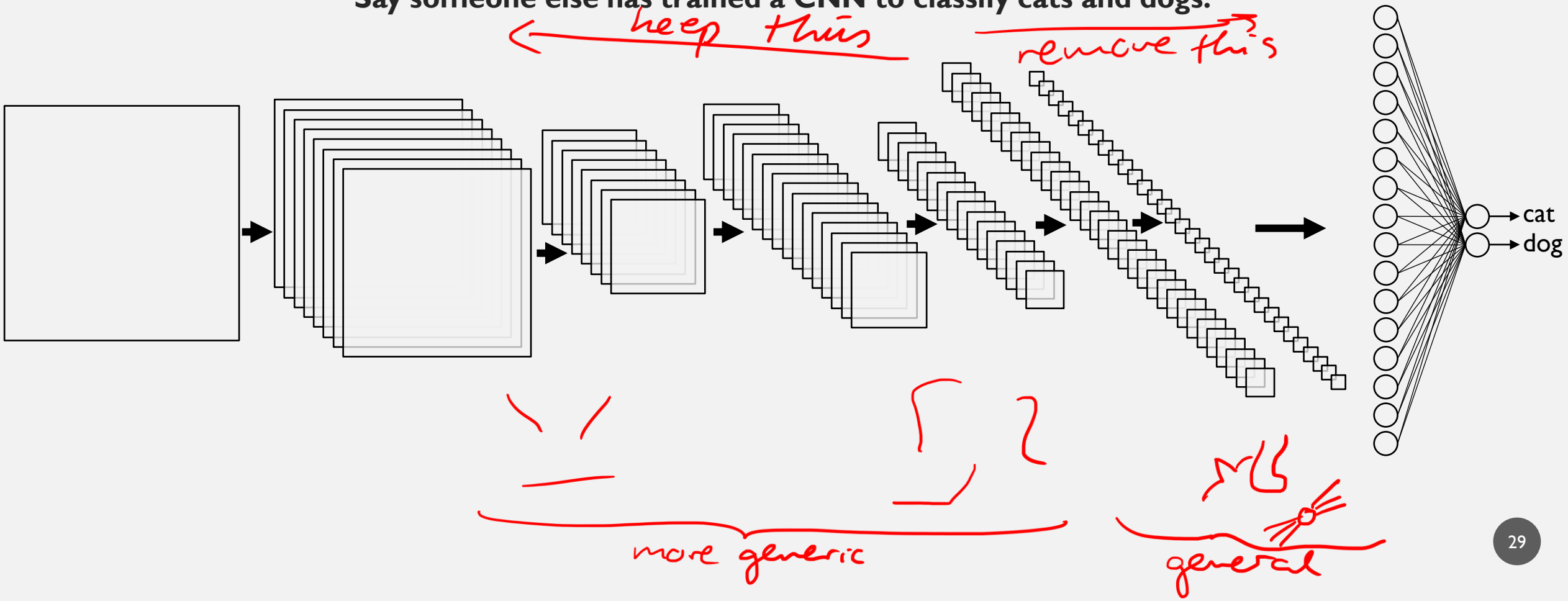
You have 15 minutes

CONVOLUTIONAL NEURAL NETWORKS

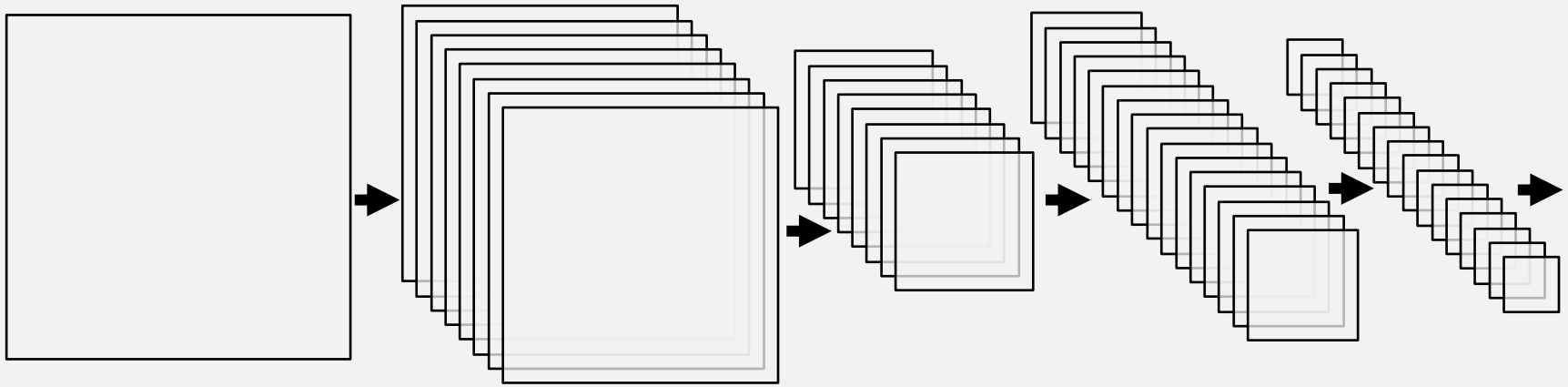
- What is an image?
- Convolutional layers
- Pooling layers
- Implementing a CNN
- Pretrained CNNs
- Object localization

PRETRAINED CNNS

Say someone else has trained a CNN to classify cats and dogs:



PRETRAINED CNNS

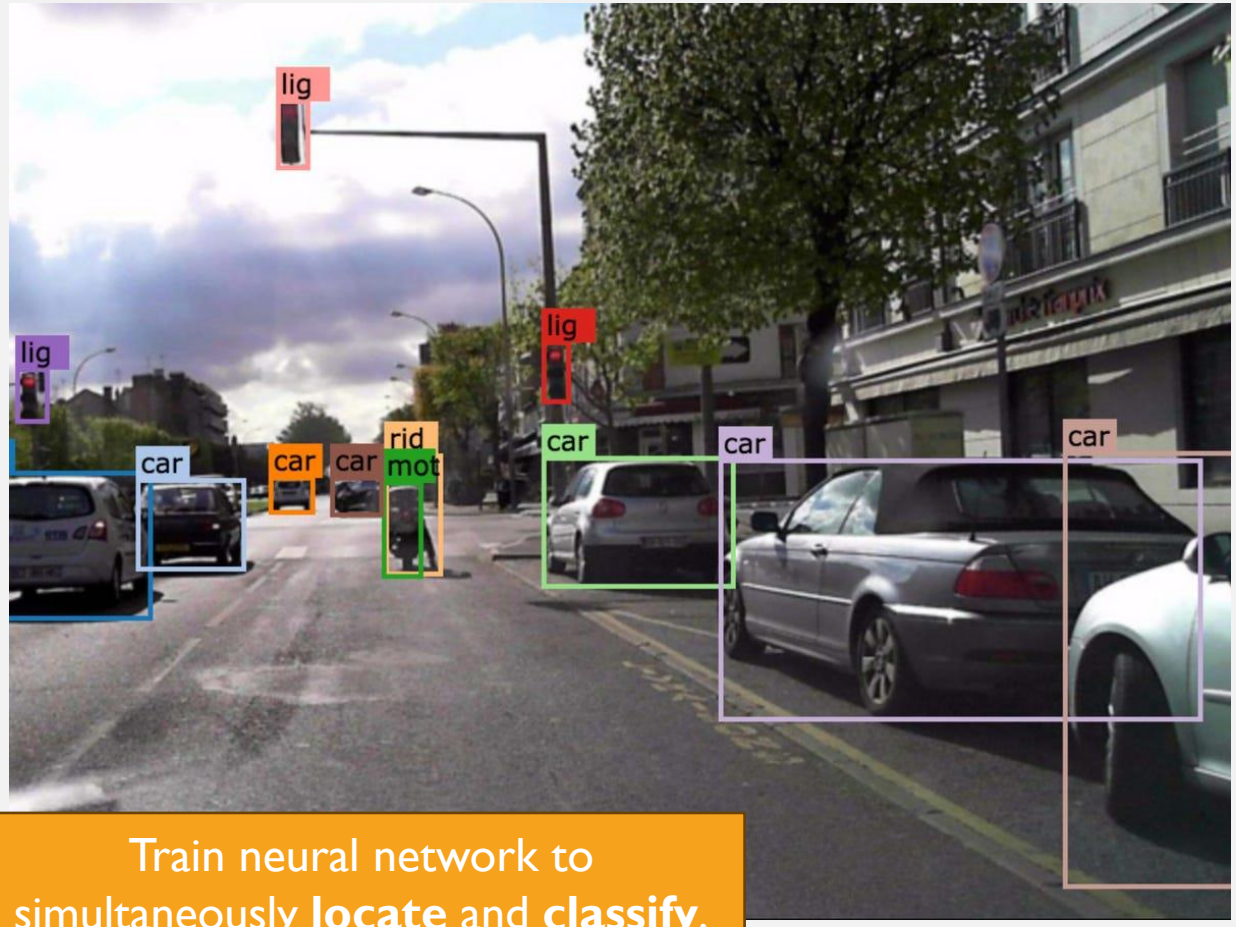


build our own classifier on top of this

CONVOLUTIONAL NEURAL NETWORKS

- What is an image?
- Convolutional layers
- Pooling layers
- Implementing a CNN
- Pretrained CNNs
- Object localization

OBJECT LOCALIZATION

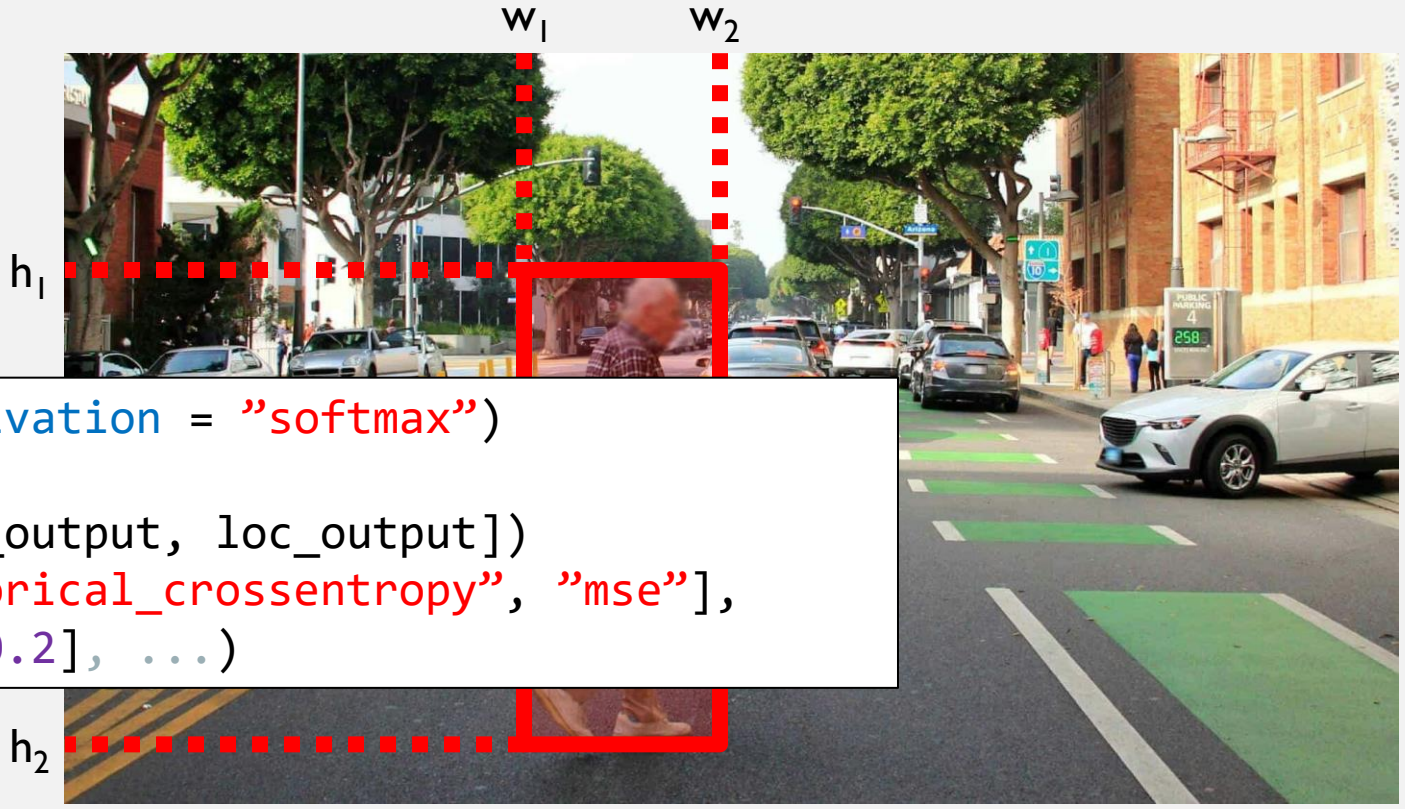


Train neural network to simultaneously **locate** and **classify**.

Great idea for a final project!

OBJECT LOCALIZATION

- Classification is a classification task (duh).
- Localization is a regression task!




```
class_output = Dense(n_classes, activation = ”softmax”)
loc_output = Dense(4)
model = Model(..., outputs = [class_output, loc_output])
model.compile(loss = [”sparse_categorical_crossentropy”, ”mse”],
              loss_weights = [0.8, 0.2], ...)
```

YOUR TICKET OUT THE DOOR

Scan this QR code

and tell me about something
you are still unsure about