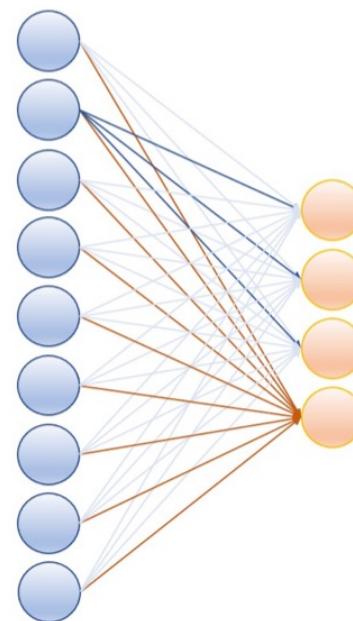


Convolutional NN

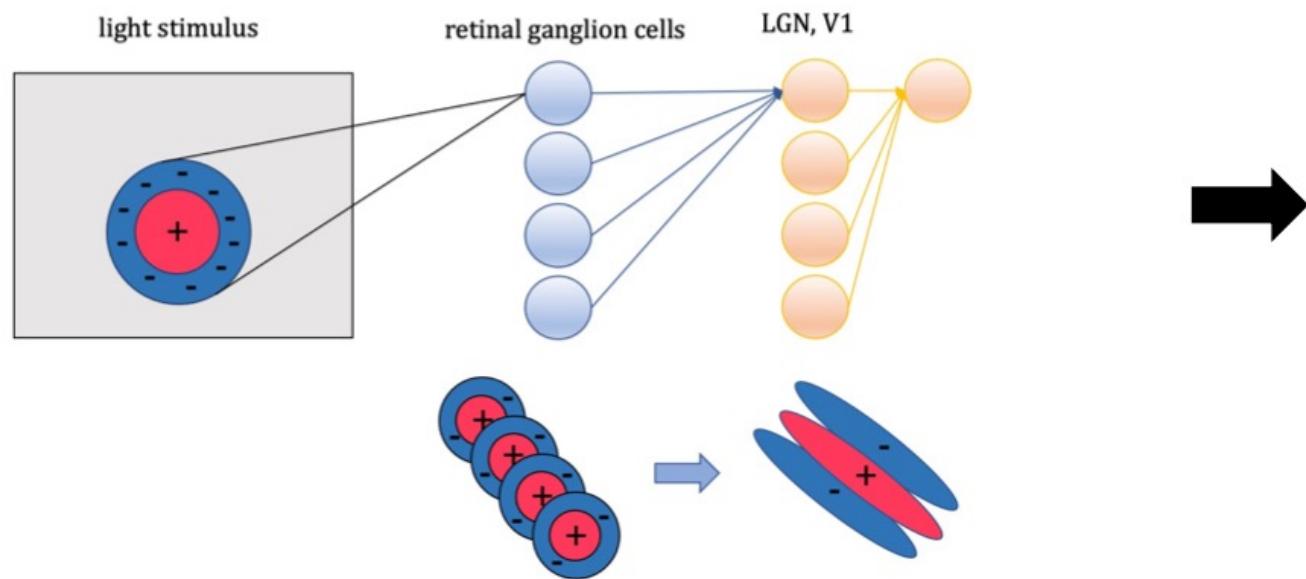
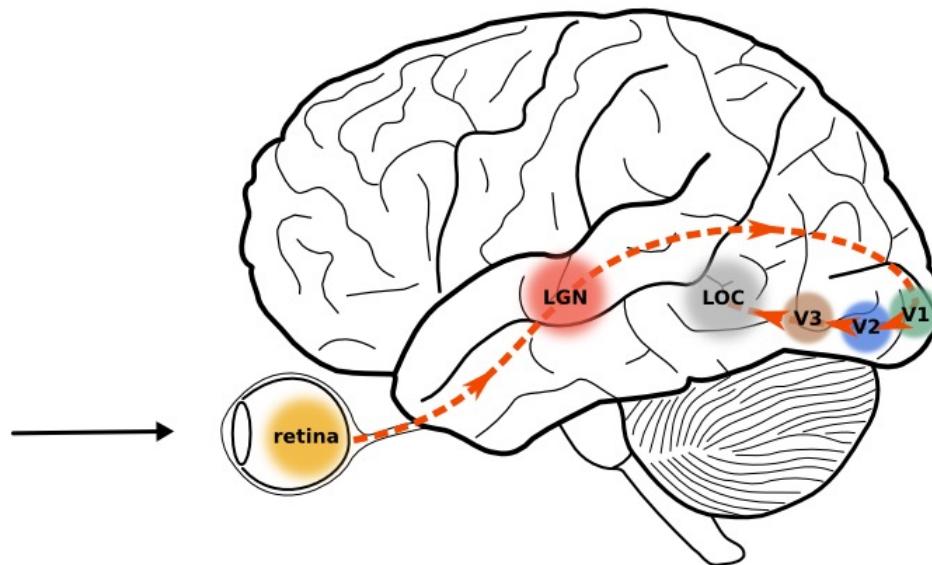
Fully (densely) connected layer



flatten
→

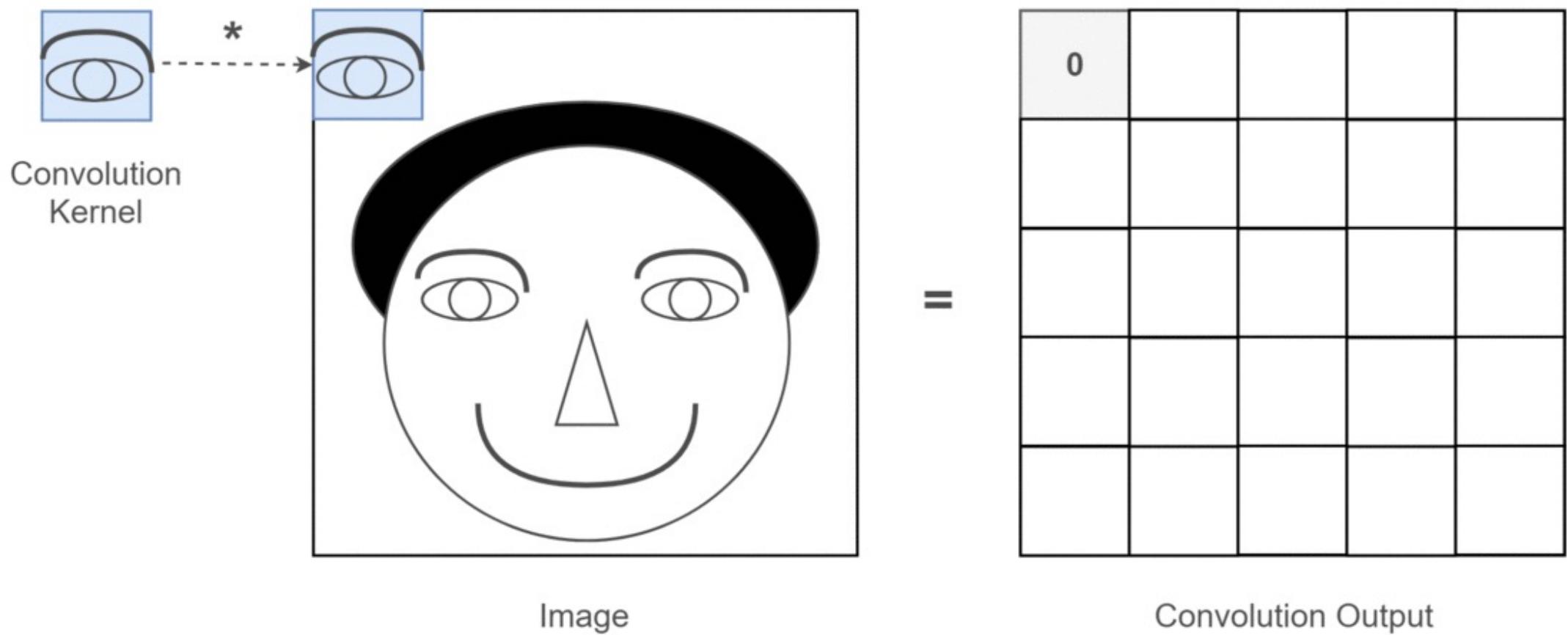


- 100 x 100 image
 - 100 neurons in hidden layer
- $\approx 1.000.000$ parameters

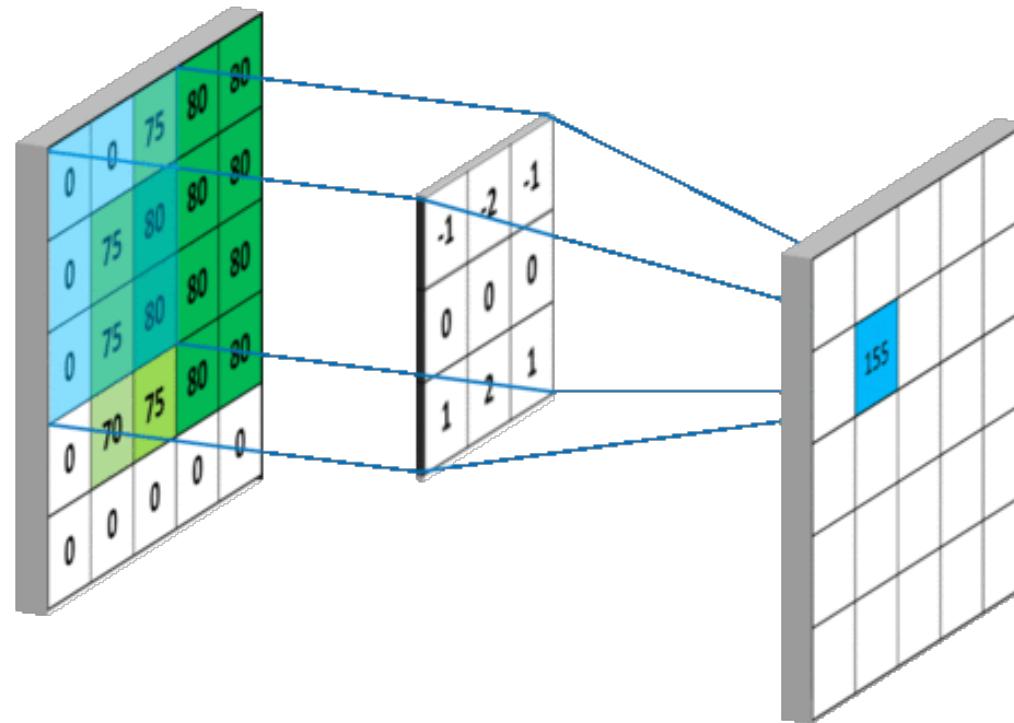


- idea of receptive field,
local connections
- idea of hierarchical structure,
from simple elements to complex
patterns

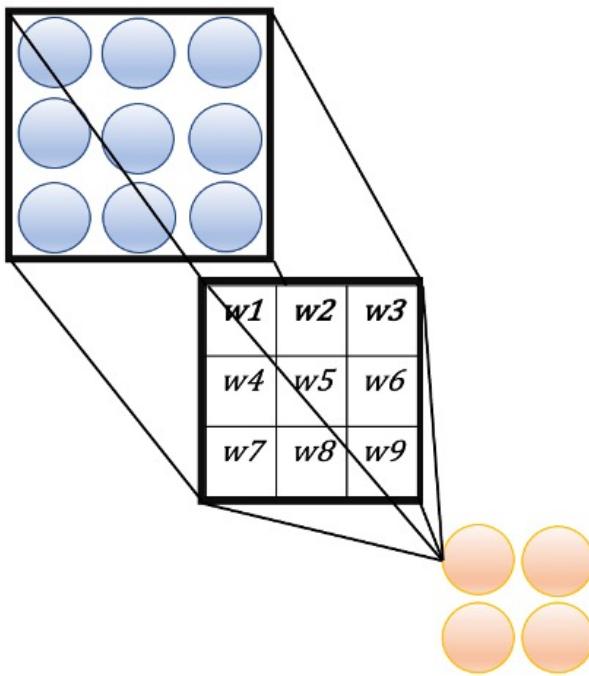
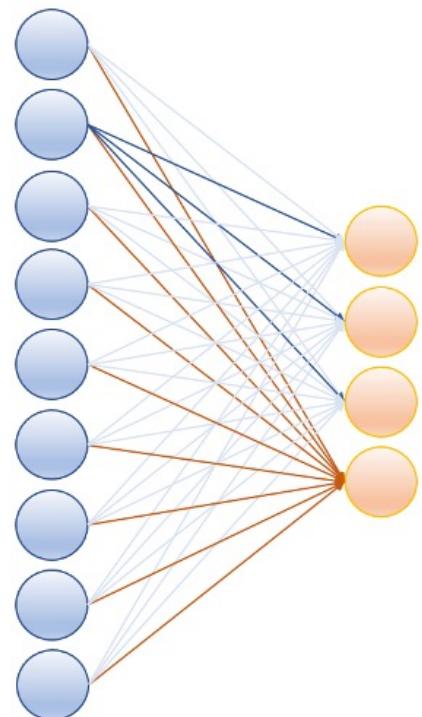
CNN - Biologically inspired ANN architecture



Convolution

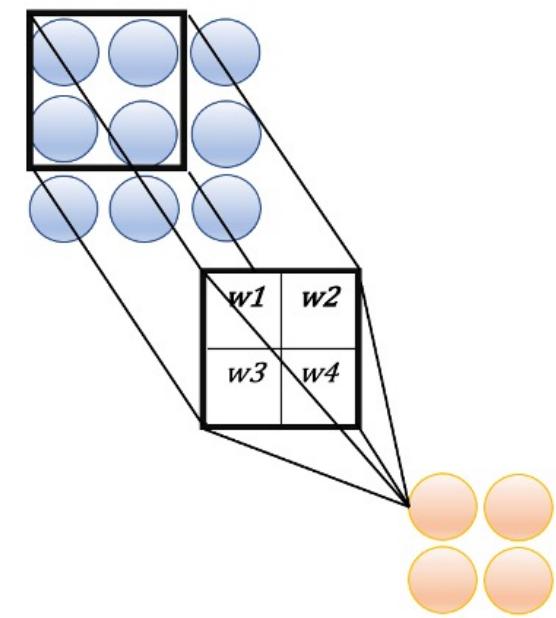
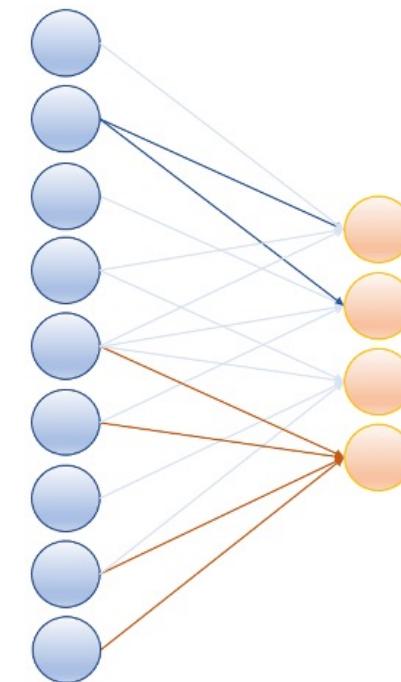


Dense layer



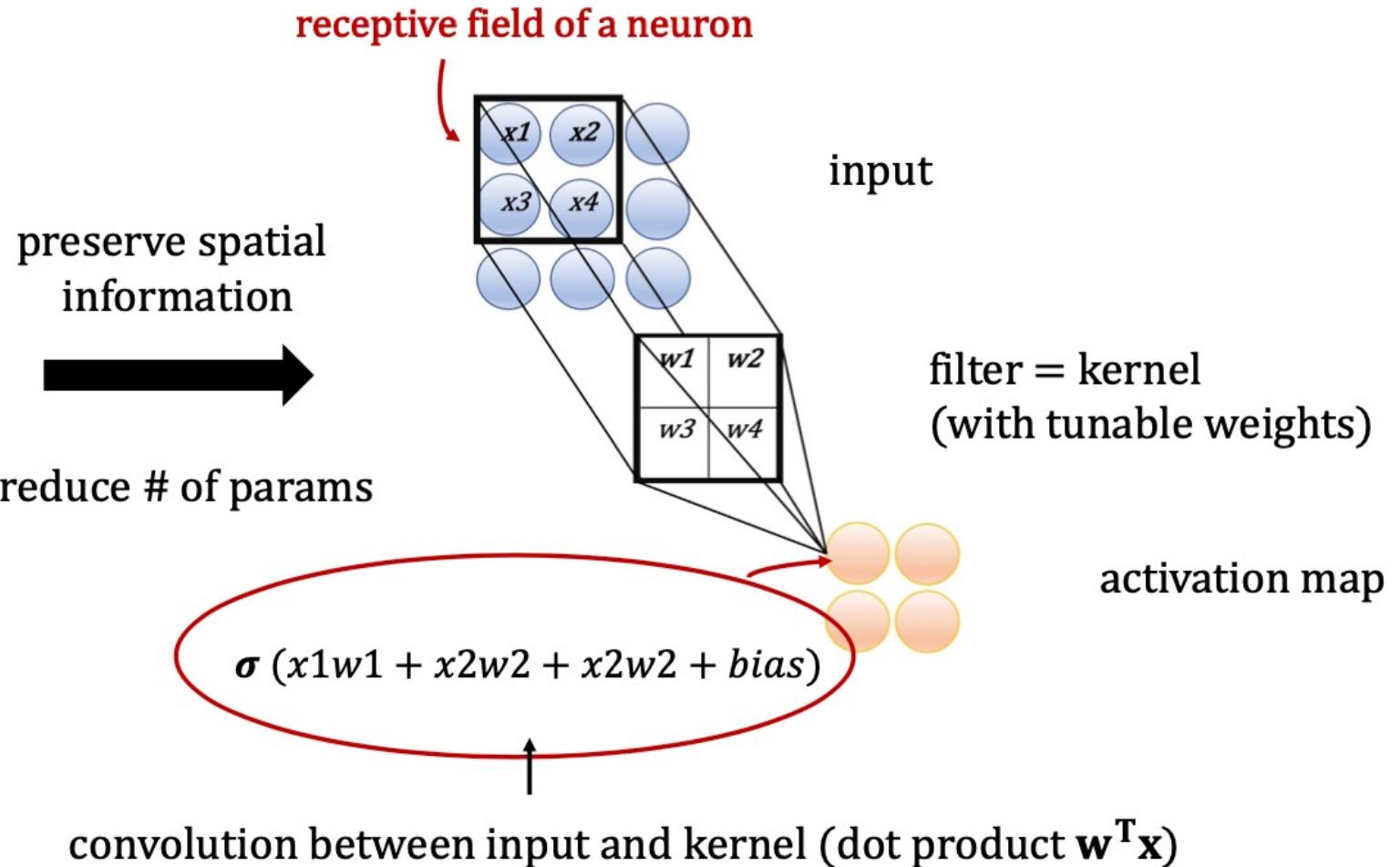
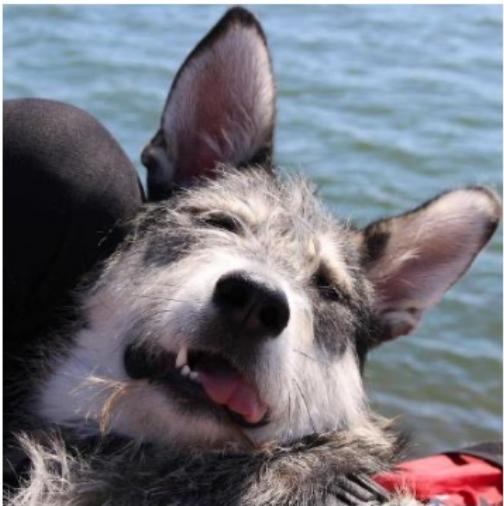
*Weights of the different neurons
are different!*

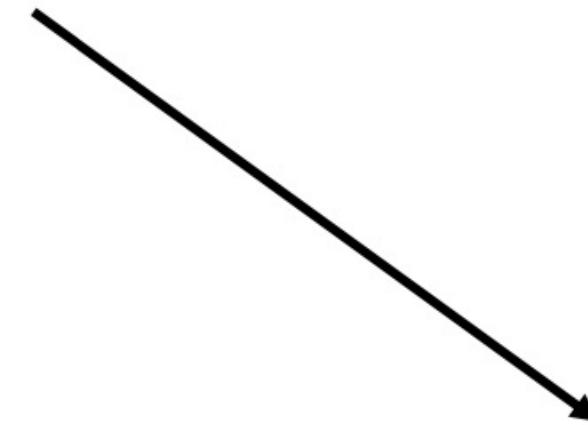
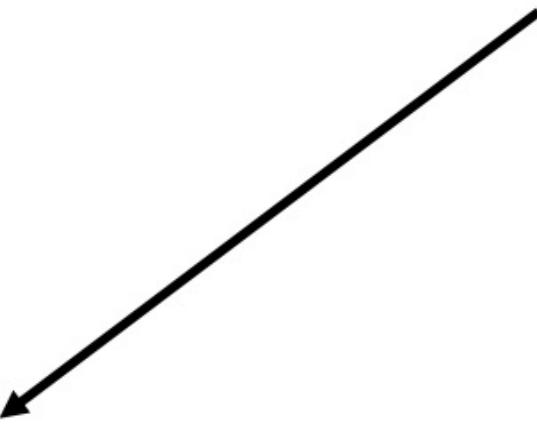
Convolutional layer



*Weights of the different neurons
are the same!*

Convolutional layer





Hans-on: image classification with CNN

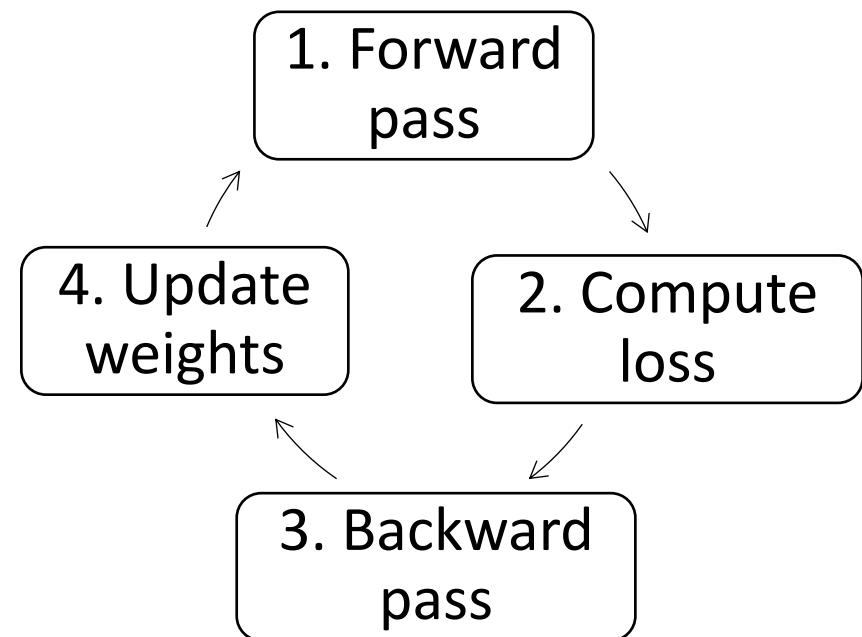
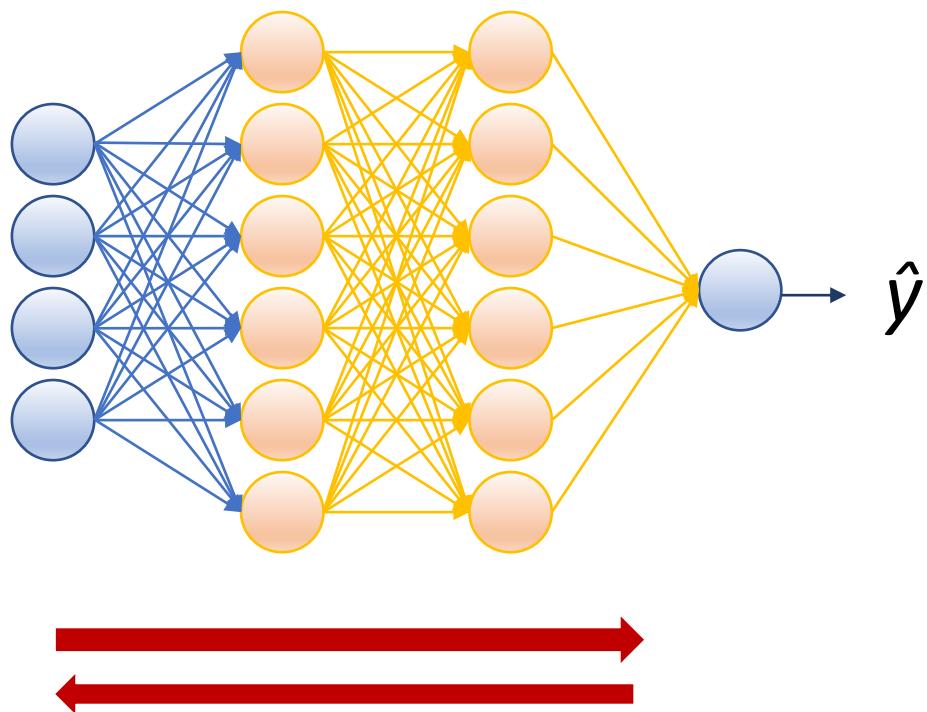
```
# Convolutional layer
tf.keras.layers.Conv2D(units=16,
                      kernel_size=3,
                      padding="same",
                      activation="relu")
```

Hans-on: image classification with CNN

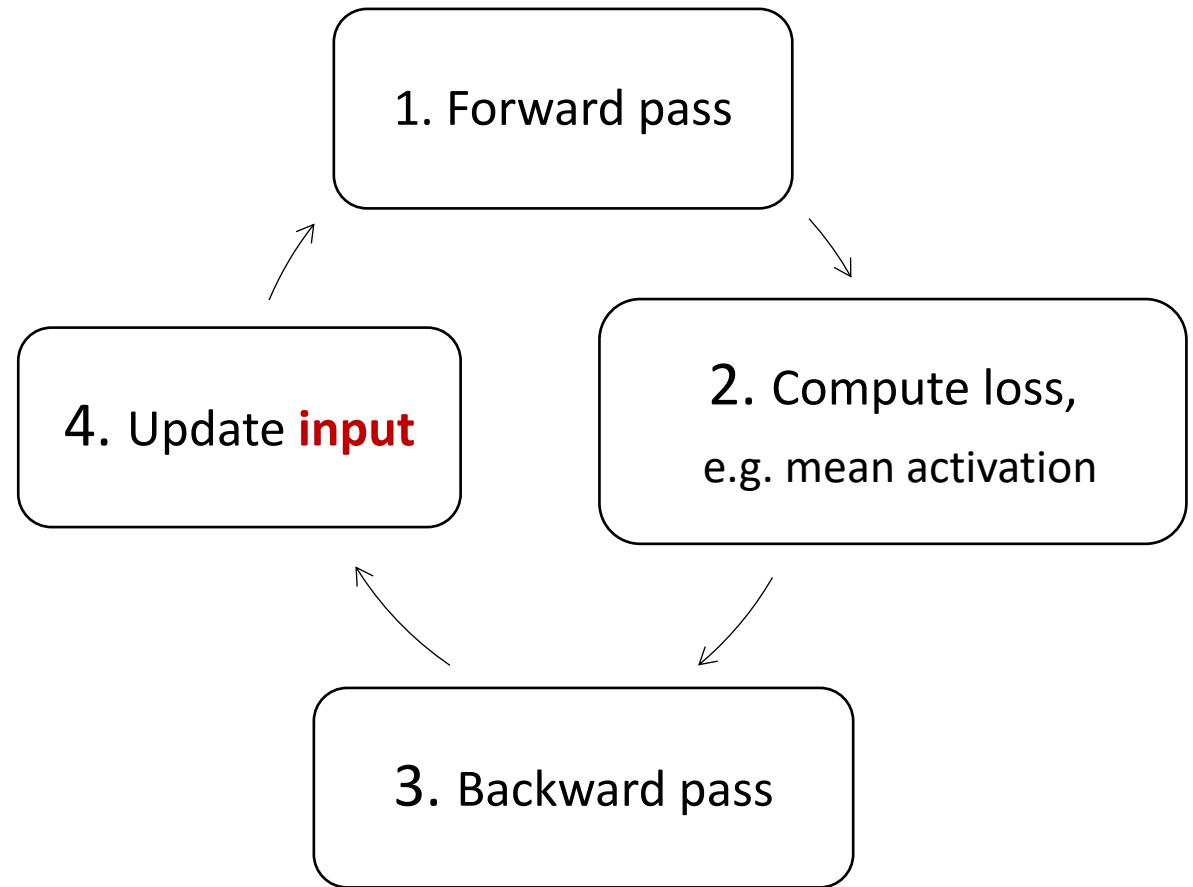
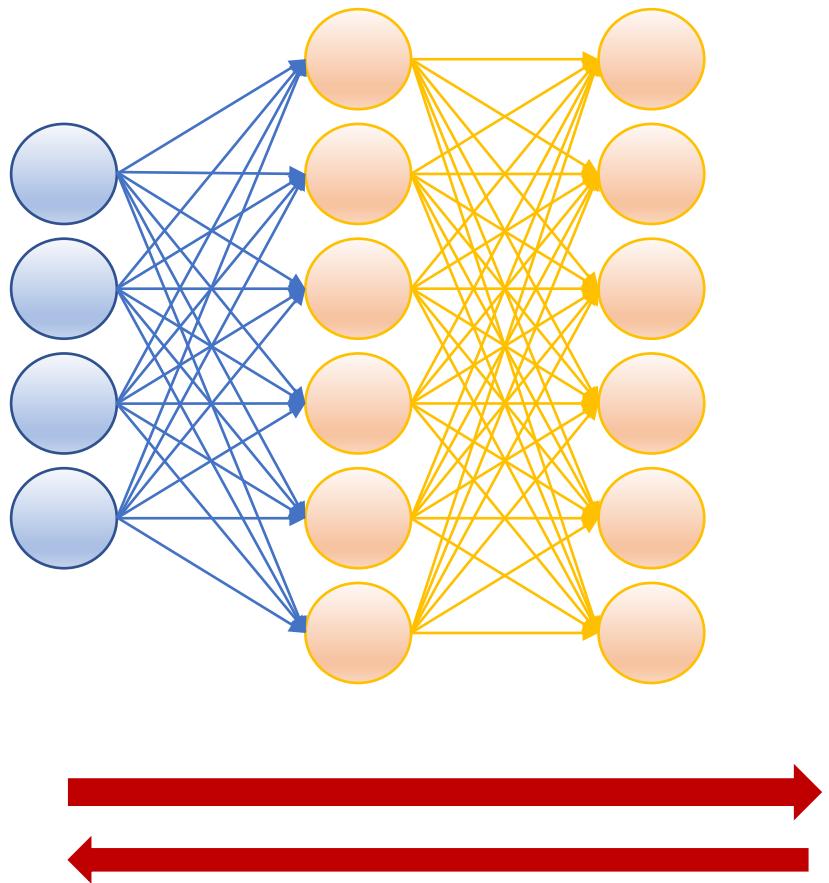
```
model = tf.keras.models.Sequential([
# input + (Conv → Conv → Pool) block
tf.keras.layers.Conv2D(16, 3, padding="same", activation="relu",
input_shape=[28,28,1]),
tf.keras.layers.Conv2D(16, 3, padding="same", activation="relu"),
tf.keras.layers.MaxPool2D(pool_size=2)

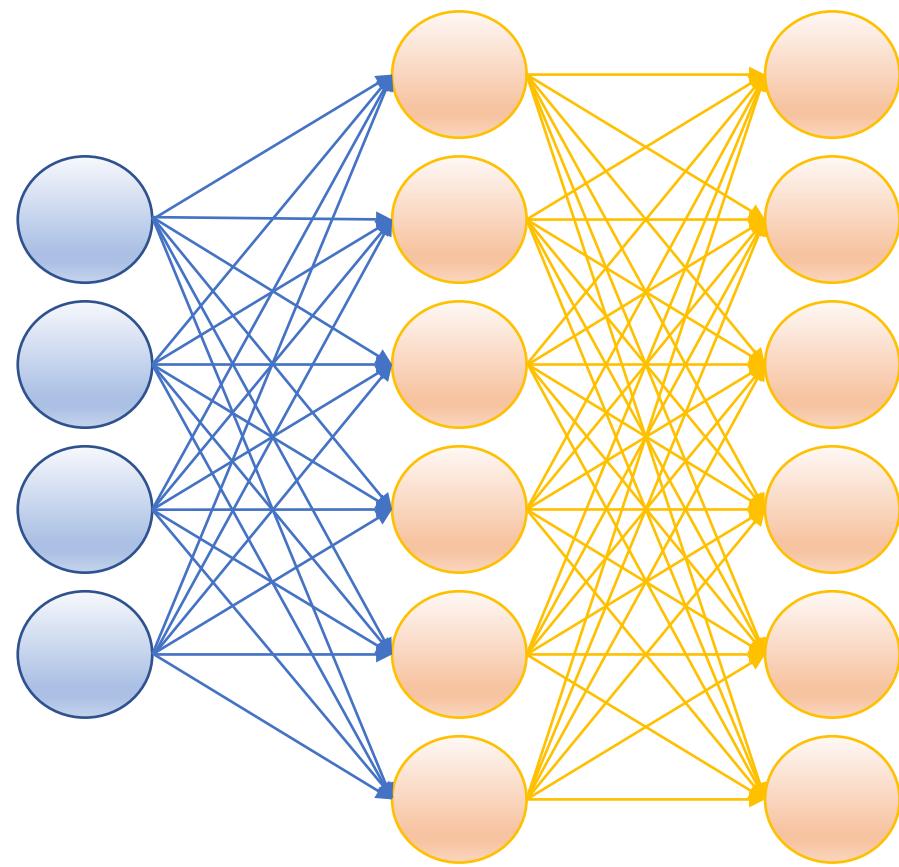
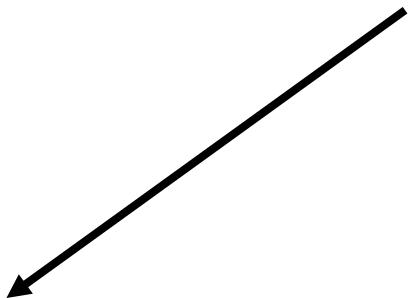
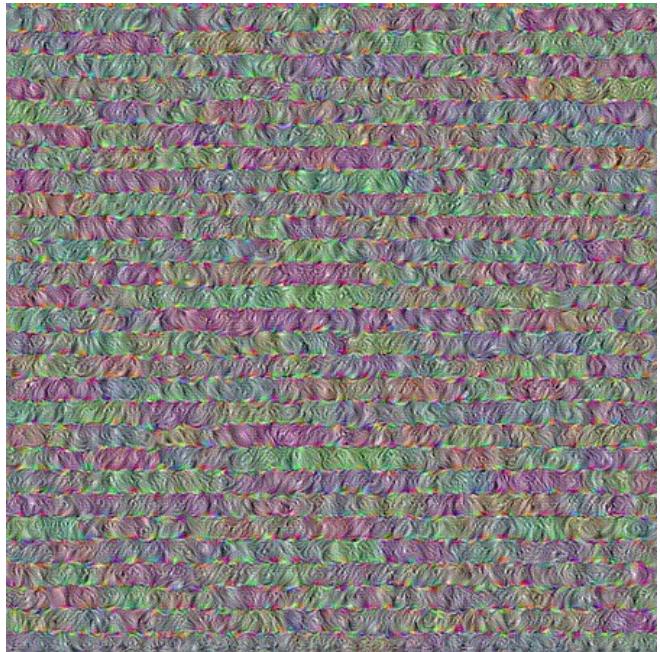
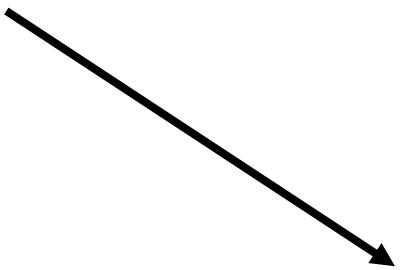
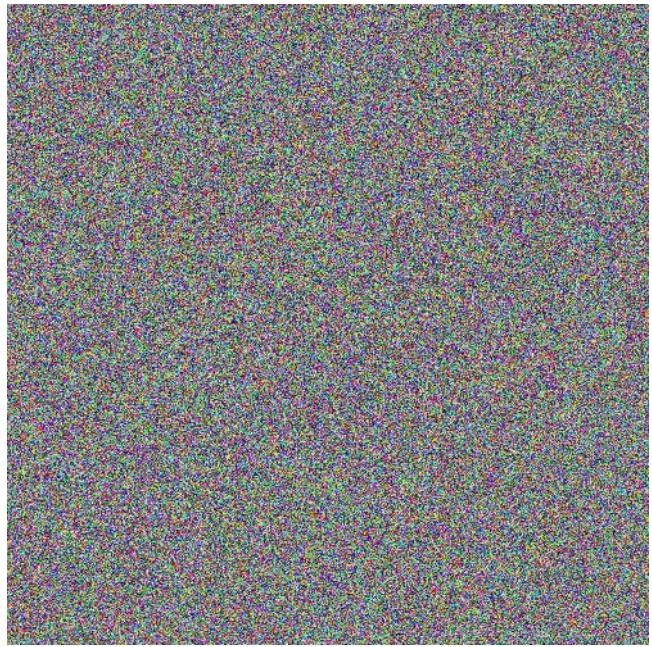
# Flatten
tf.keras.layers.Flatten(),
# 1st Dense layer
tf.keras.layers.Dense(64, "relu")
# 2nd Dense (output) layer
tf.keras.layers.Dense(10, activation="softmax")
])
```

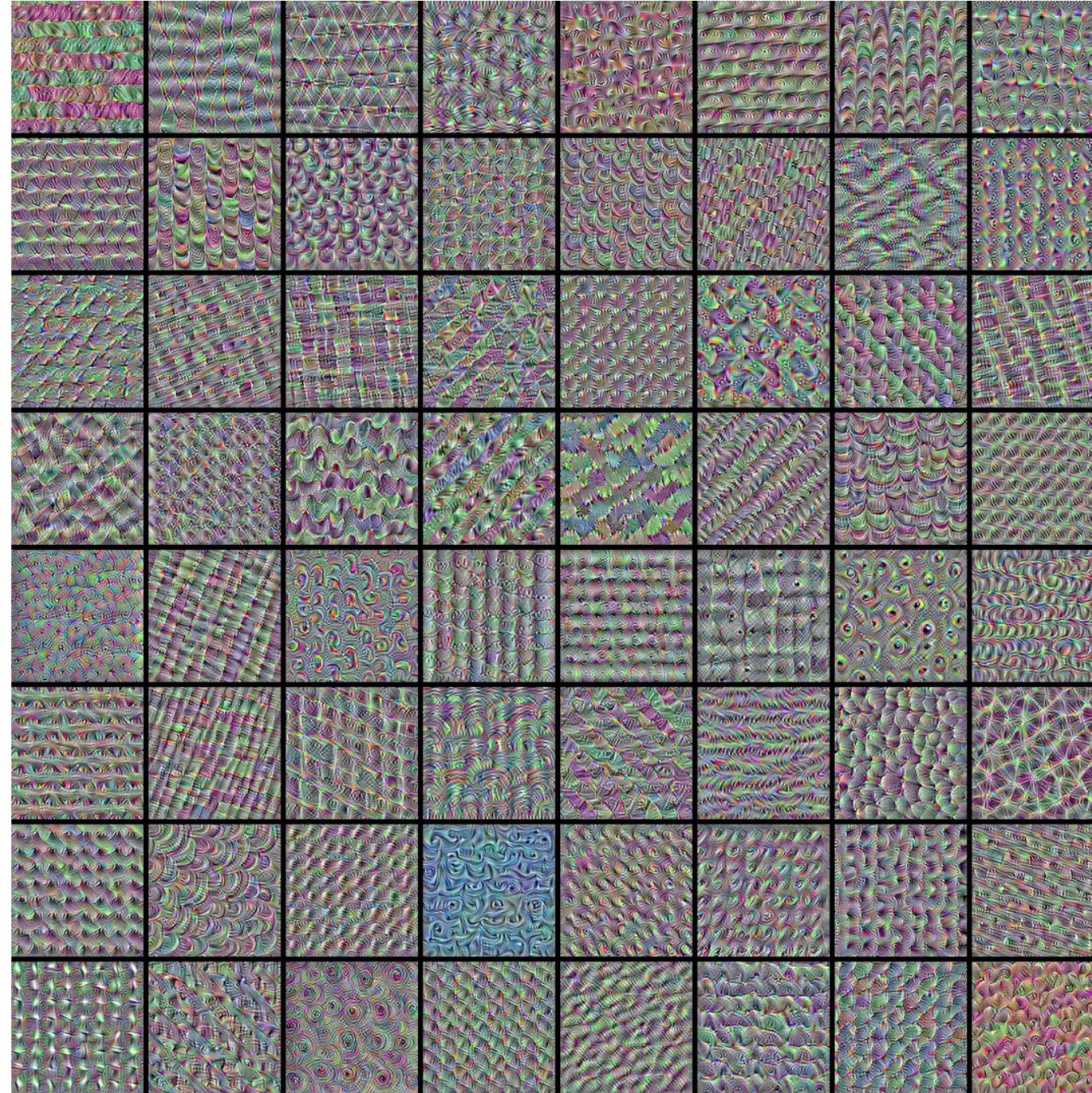
Gradient Descent Algorithm



Gradient Ascent Algorithm







How convolutional neural networks see the world

"... what do they really "understand"?

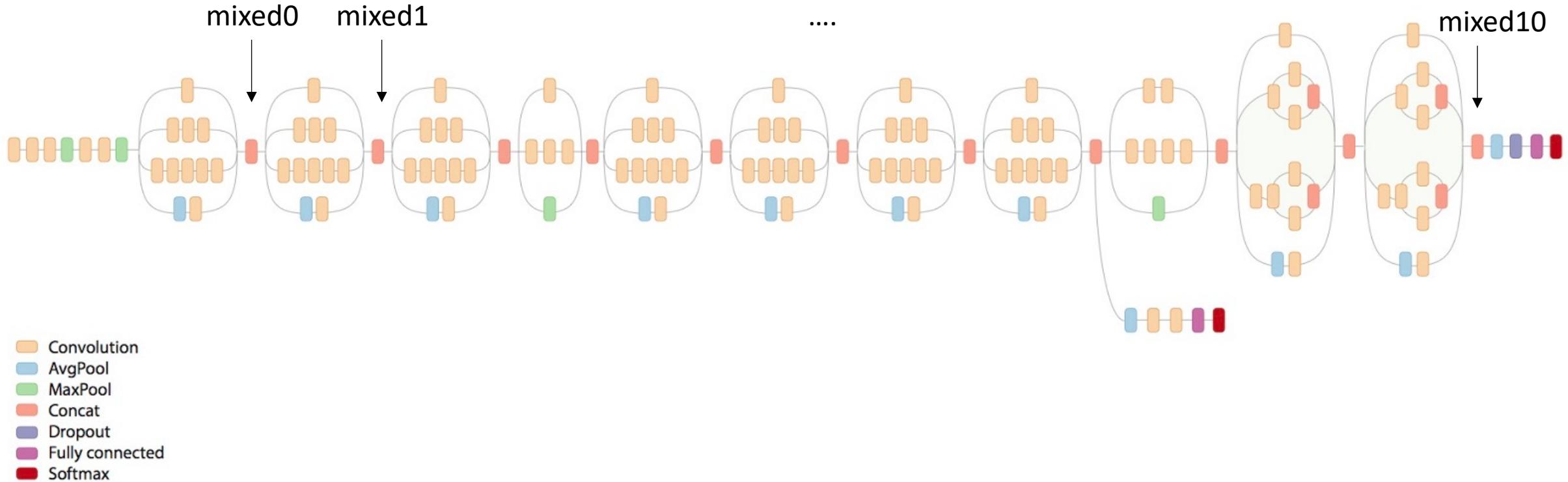
Two things: first, they understand a decomposition of their visual input space as a hierarchical-modular network of convolution filters, and second, they understand a probabilistic mapping between certain combinations of these filters and a set of arbitrary labels.

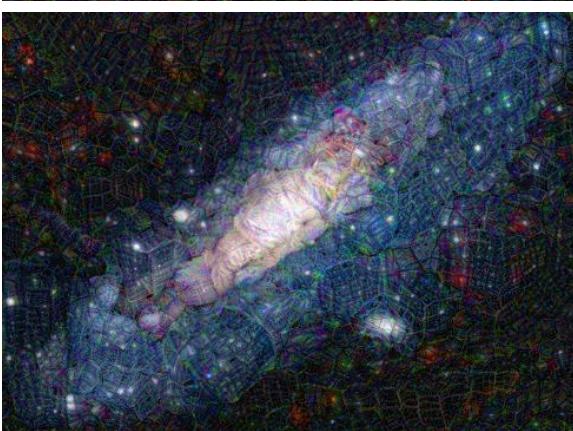
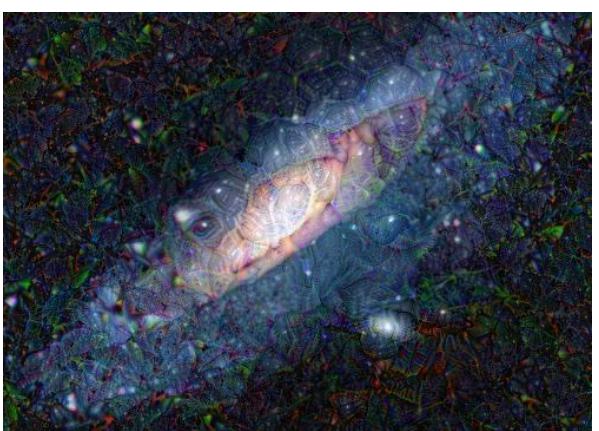
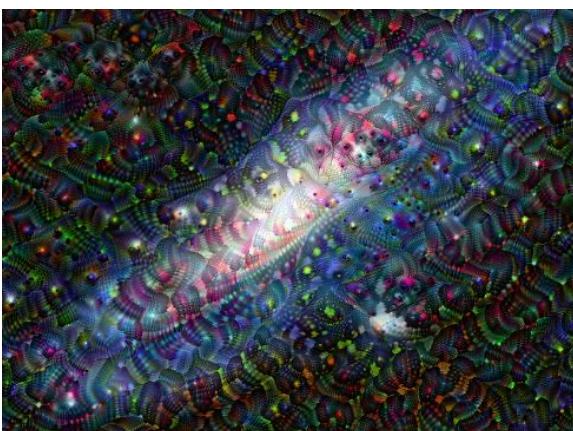
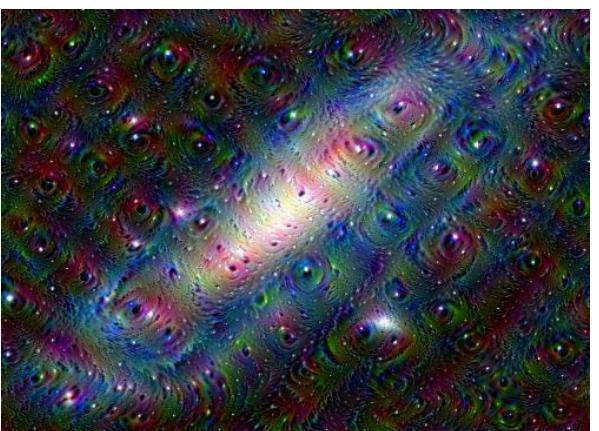
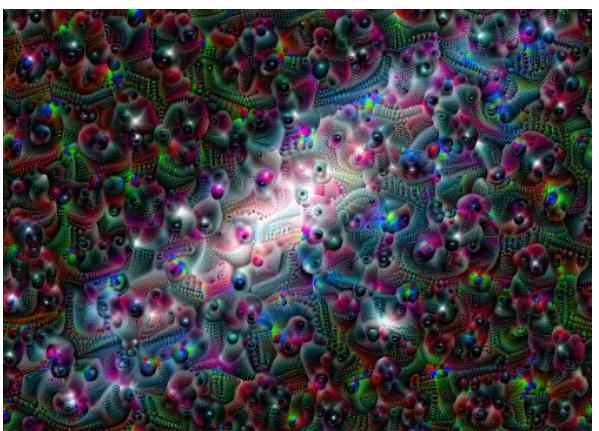
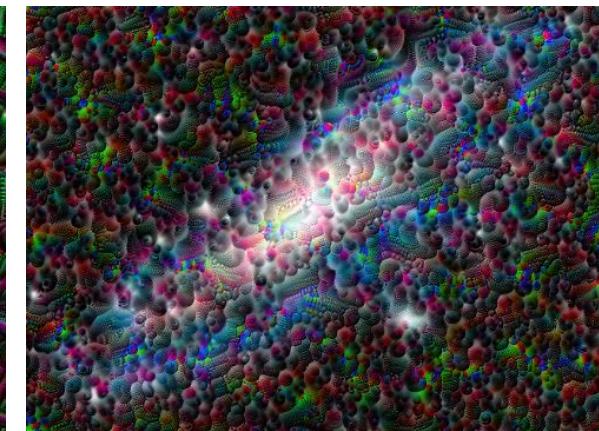
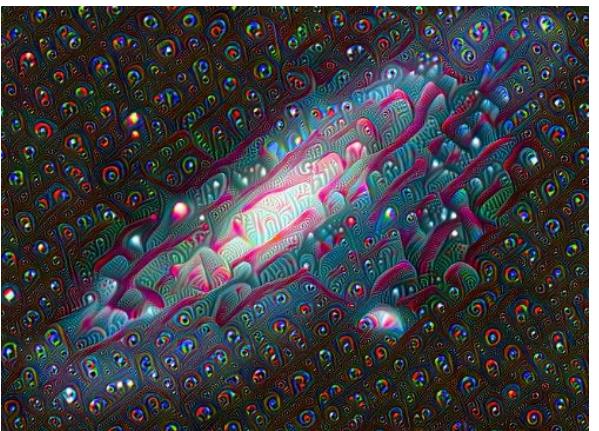
Naturally, this does not qualify as "seeing" in any human sense, and from a scientific perspective it certainly doesn't mean that we somehow solved computer vision at this point.

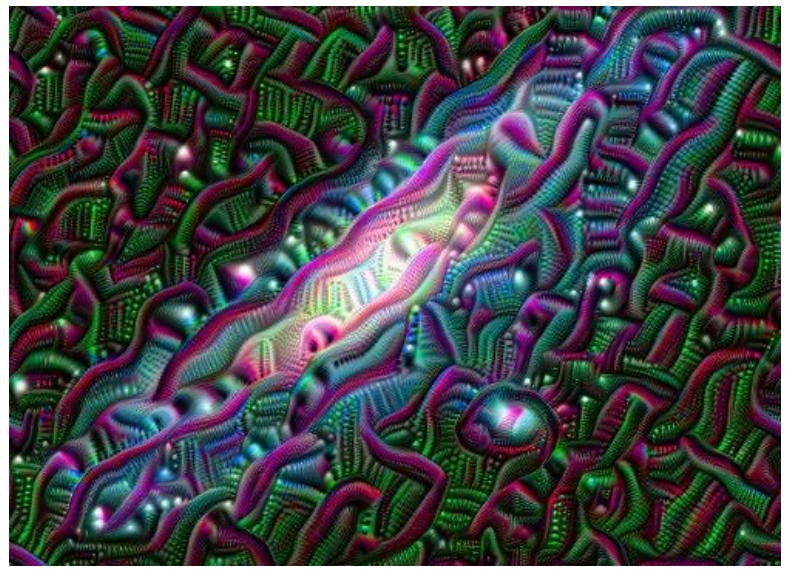
Don't believe the hype; we are merely standing on the first step of a very tall ladder."

Hands-on: Deep Dream

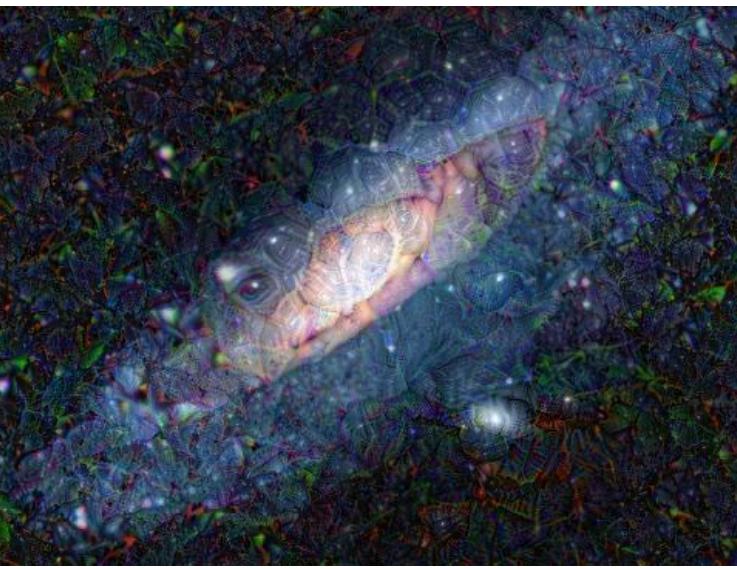
Inception v-3



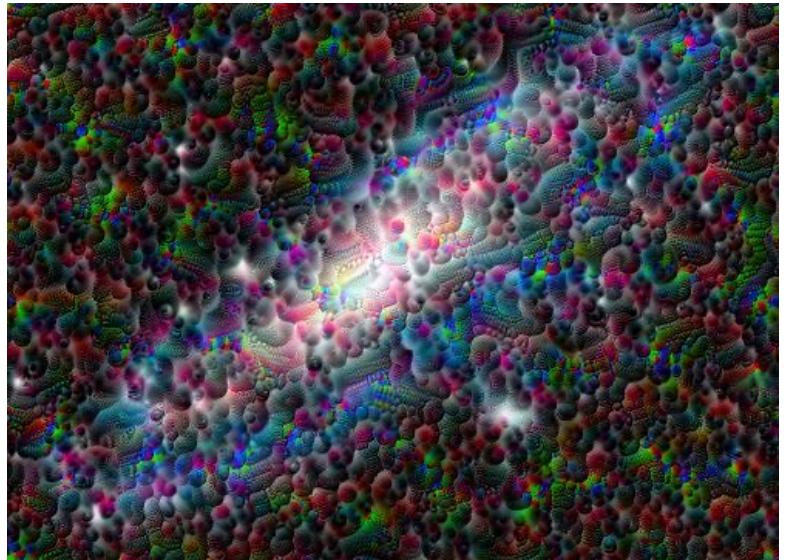
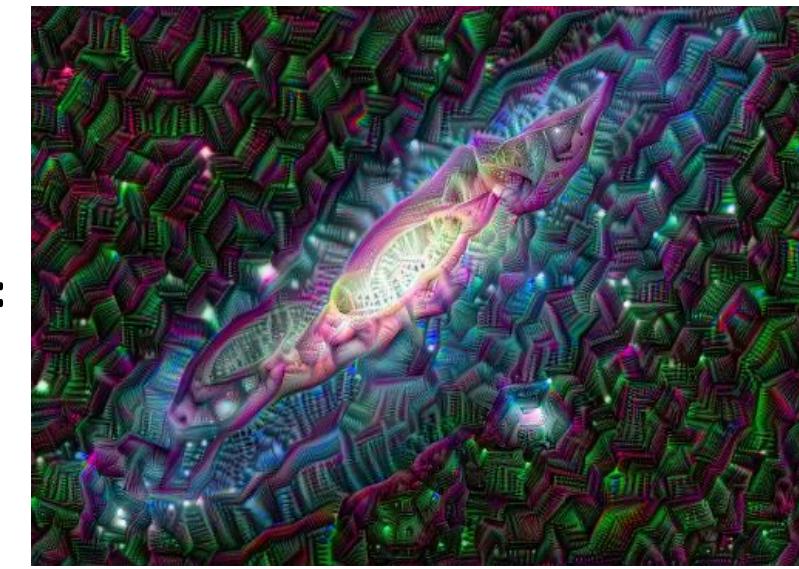




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@teenybiscuit

Advanced techniques with Deep Dream

- Zooming in at each step → infinite animation
- Painting ping-pong with Deep Dream:
 - Use your painting as input
 - Get Deep Dream output
 - Zoom-in until good pattern appears
 - Paint based on observed pattern
 - Repeat n-times
 - Compile video

["Neverending Story" music video](#)