



aCubelIT

Convolutional Neural Networks

L01 - Deep Learning for Life Sciences Course

Convolutional Neural Networks (CNNs)

Visual Recognition



Redmon et al., 2016. *You only look once: unified, real-time object detection.*

Convolutional Neural Networks (CNNs)

Visual Recognition

- Facial Identification
 - Medical Image Analysis
 - Drug Design
-

High-Level Feature Extraction

Can you identify key features in each image category ?



- Eyes
- Nose
- Lips

- Wheels
- Windshields
- Headlights

- Doors
- Windows
- Roofs

Manual Feature Extraction

Traditional Rule-Based Methods:



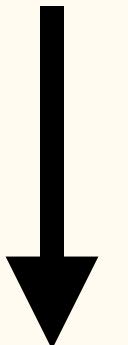
Problems ?

- Viewpoint variation
- Scale variation
- Occlusion
- Deformation
- Background clutter
- Illumination conditions
- Variation
- Etc

Convolutional Neural Networks (CNNs)

Solution

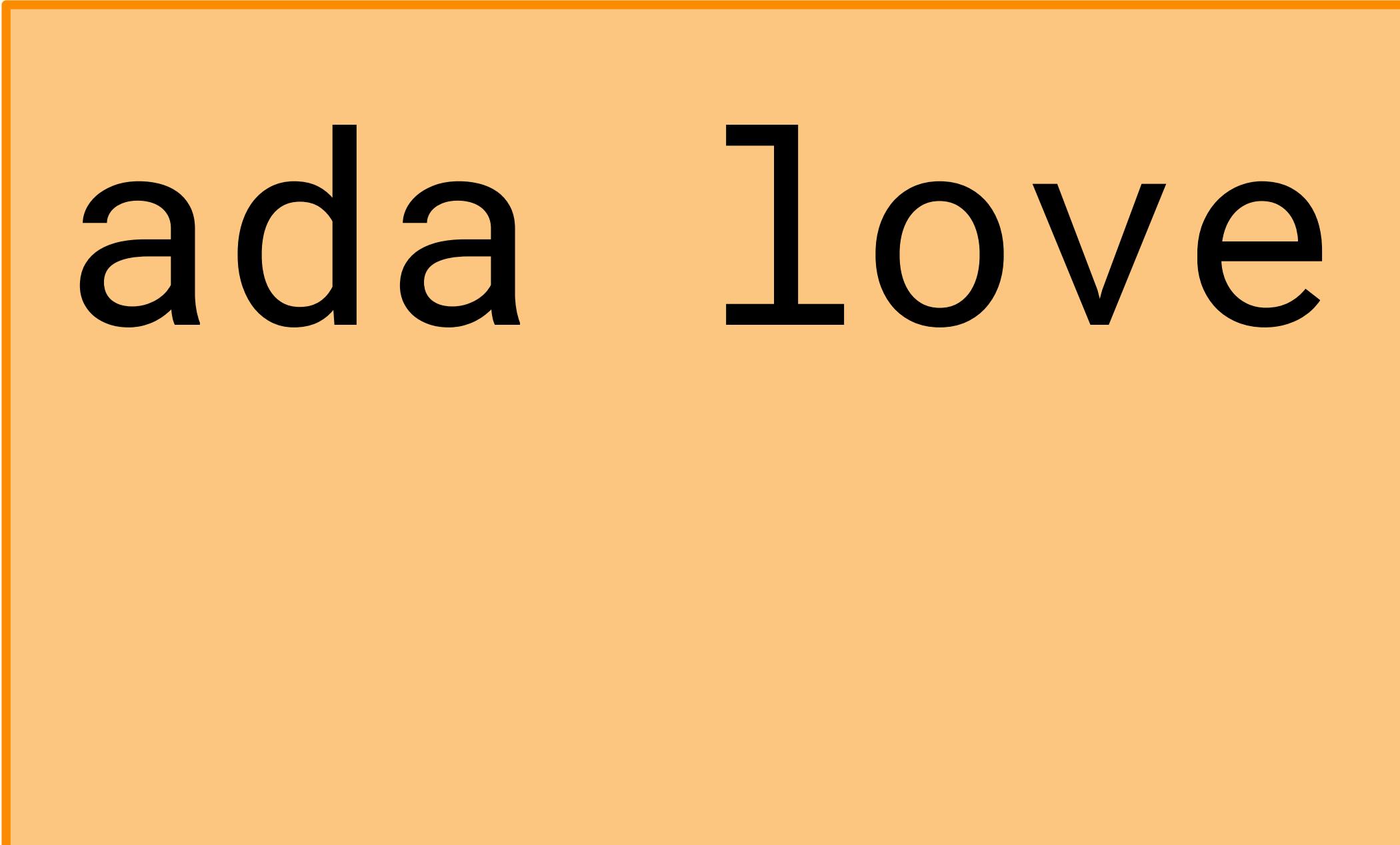
- Make the machine learn the features **by itself**
- Take into account the spatial proximity of features



Convolutions

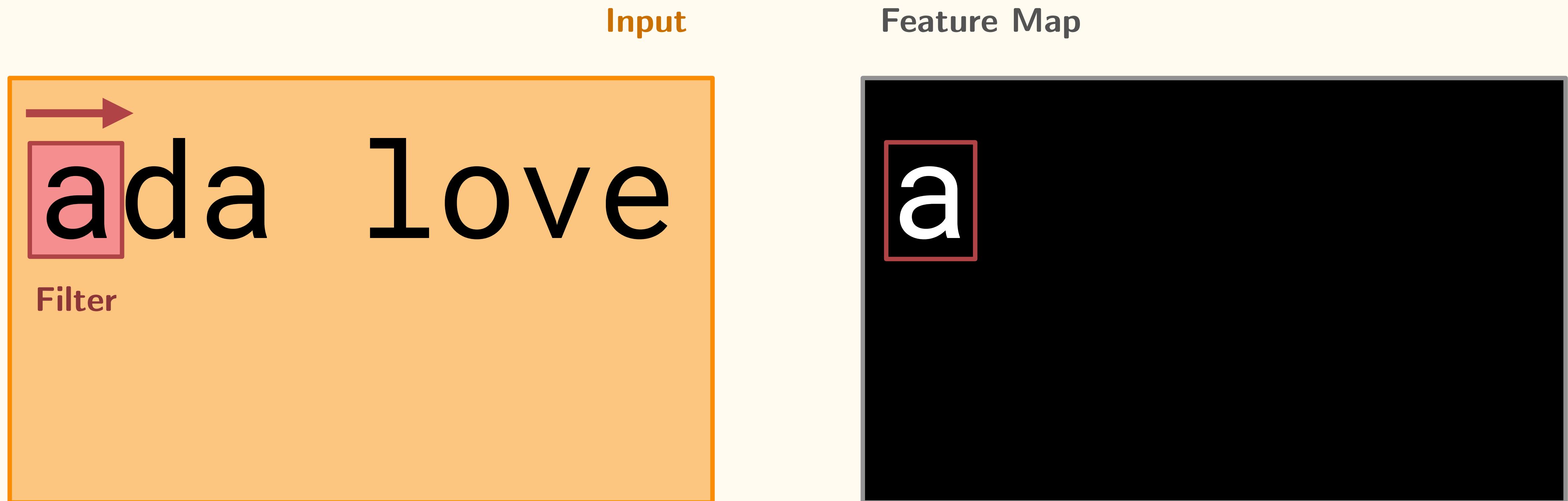
Sliding Window

Input

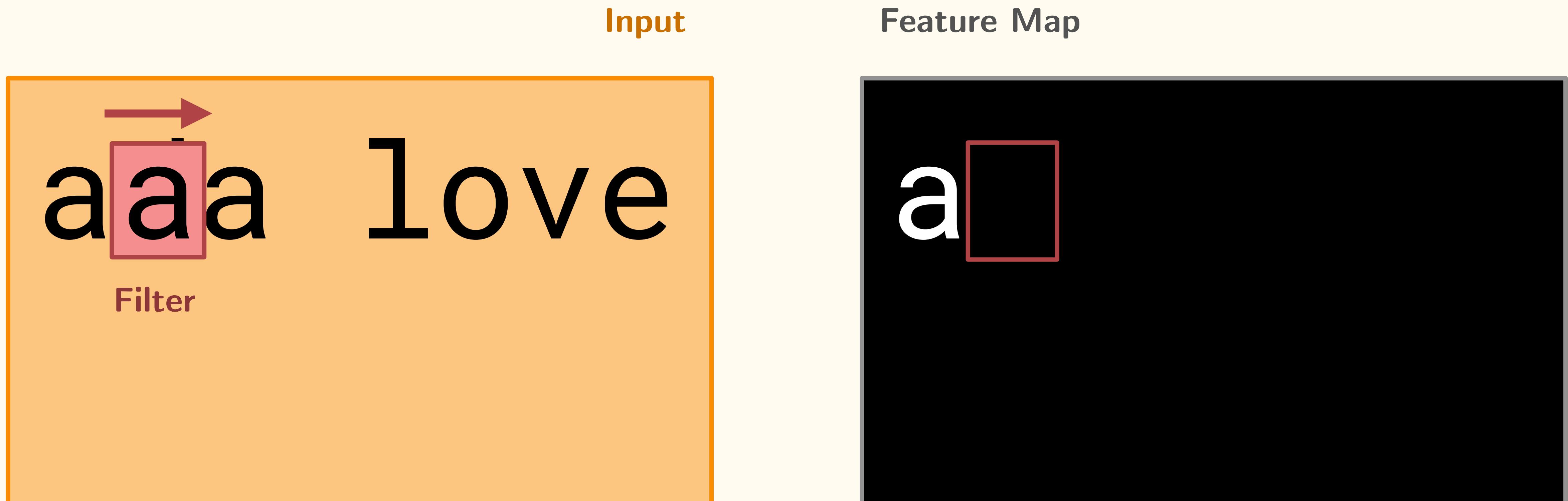


ada love

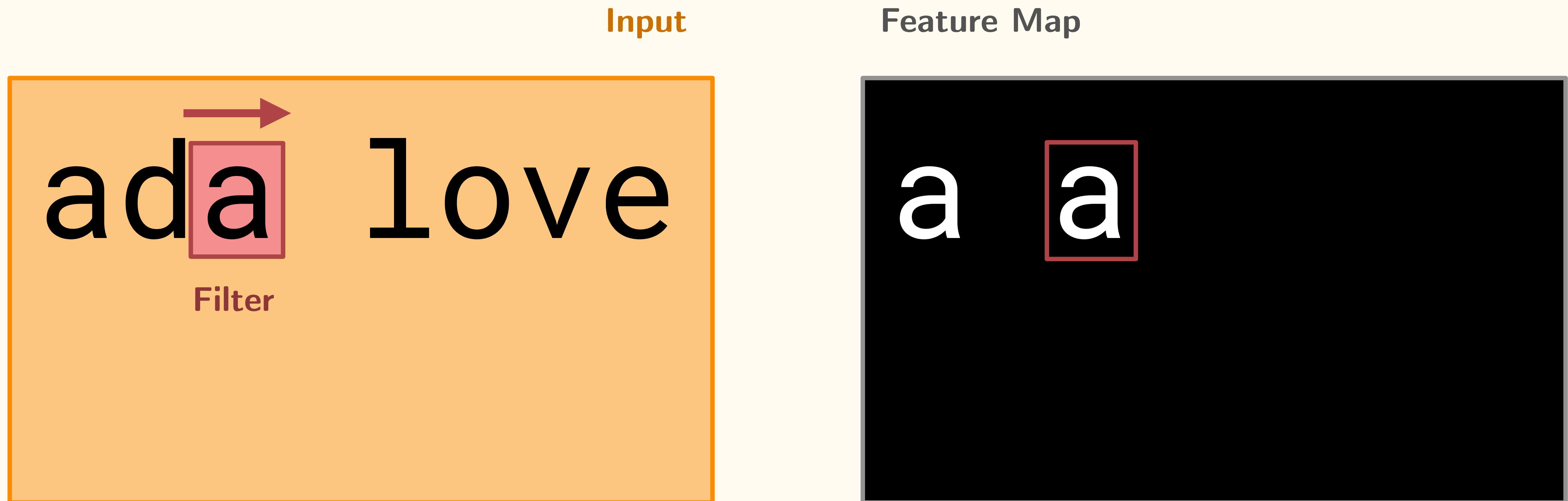
Sliding Window



Sliding Window



Sliding Window



First-Layer Convolution

We use filters to extract local features.

ada lovelace was a mathematician and writer who lived in the 19th century. lovelace holds the honor of having published the very first algorithm intended to be used by a machine to perform calculations, which make lovelace the first-ever computer programmer.

Input **Filter** **Feature Map**

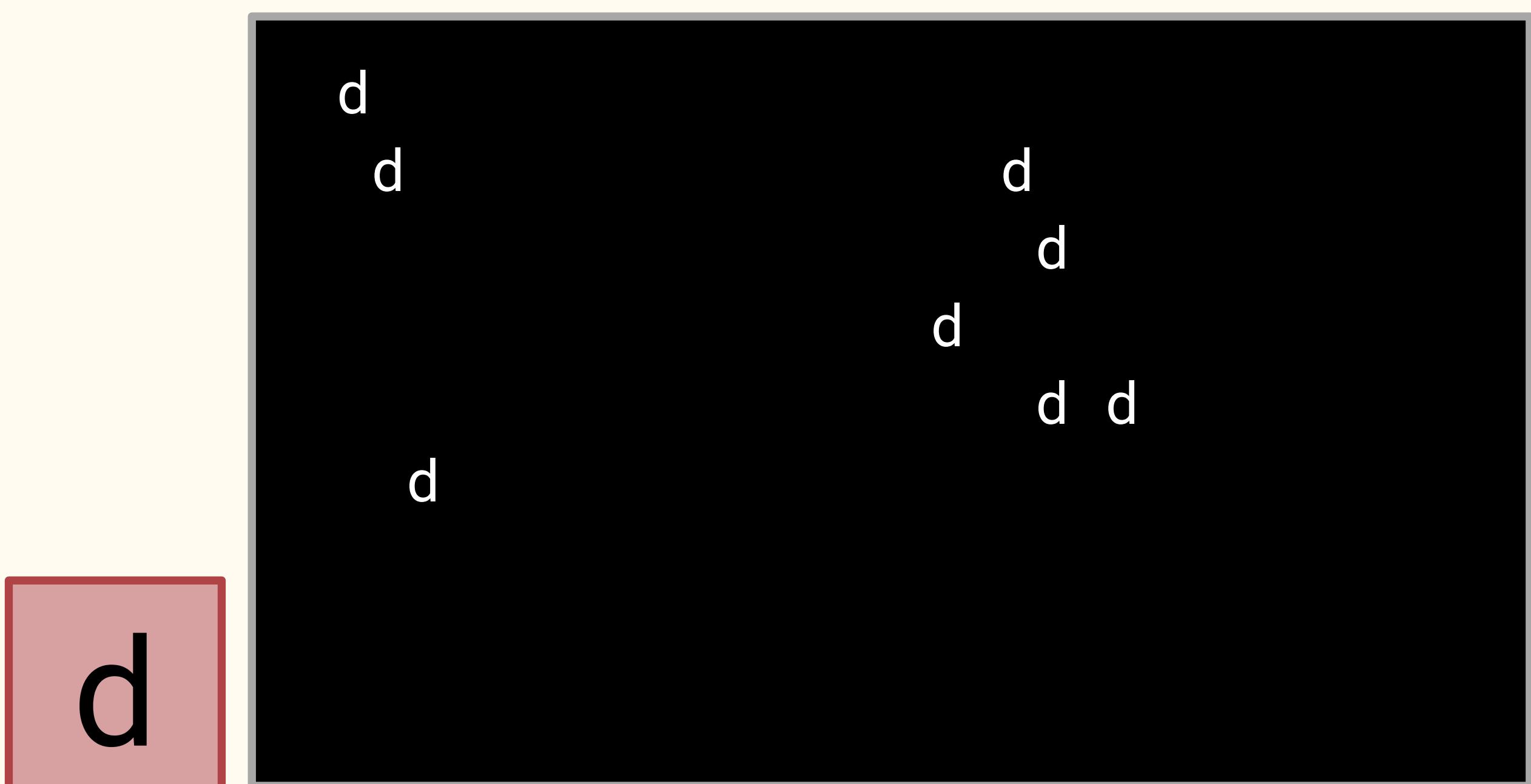
a	a	a	a	a	a	a	a	a
a								
	a							
	a							
		a	a	a				
		a	a				a	a
			a					

First-Layer Convolution

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Input **Filter** **Feature Map**



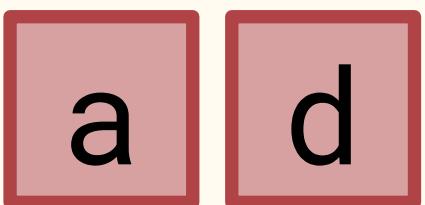
Second-Layer Convolution

We use **multiple** filters to extract different features.

Stacked First-Layer Feature Maps

ada lovelace was a mathematician and writer who lived in the 19th century. lovelace holds the honor of having published the very first algorithm intended to be used by a machine to perform calculations, which make lovelace the first-ever computer programmer.

First-Layer Filters:

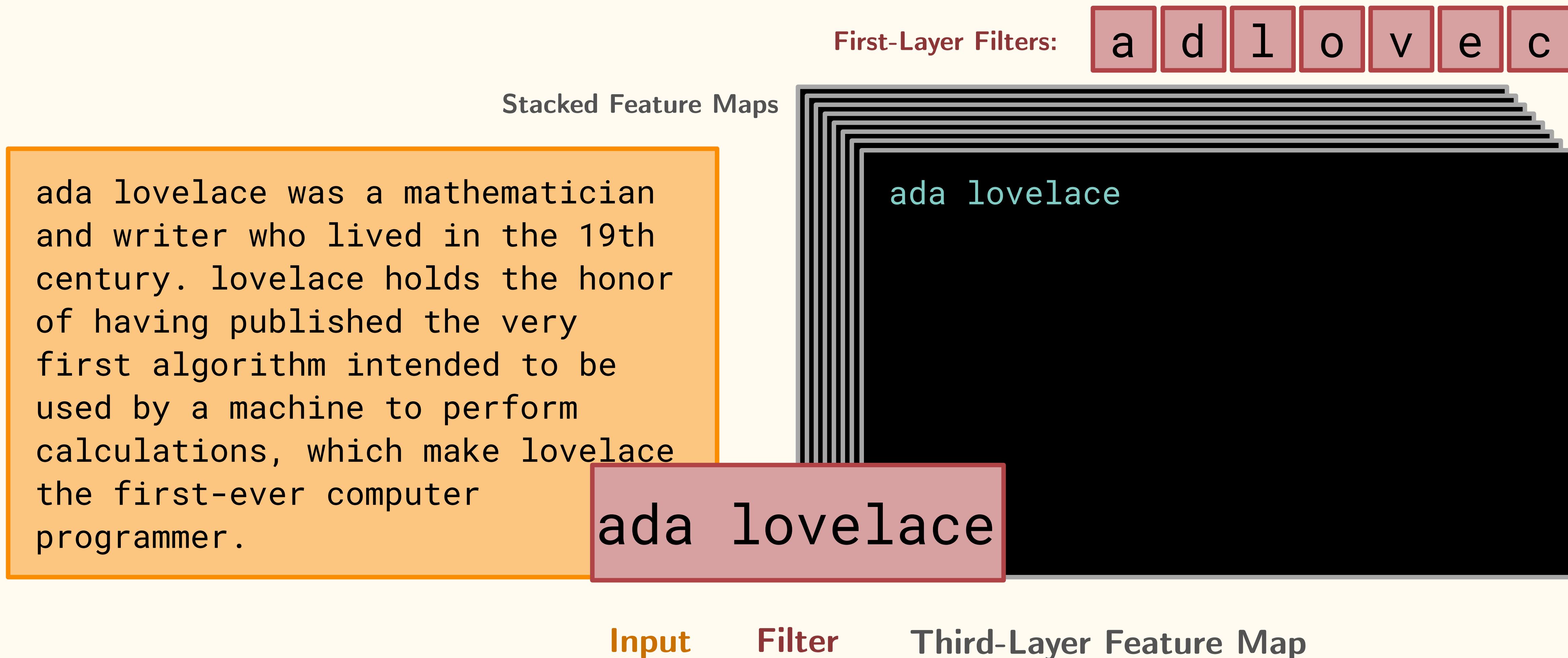


Input

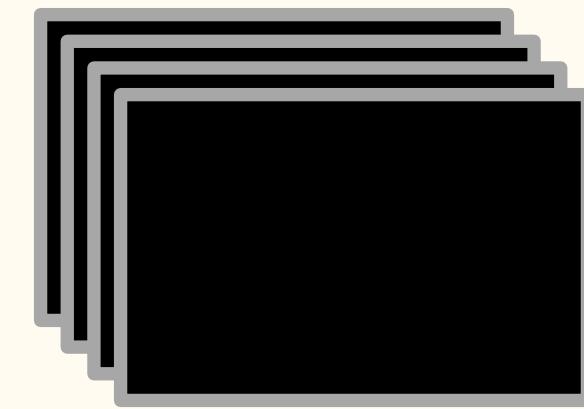
Filter

Second-Layer Feature Map

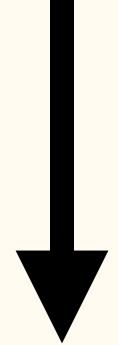
Third-Layer Convolution



Convolutional Neural Networks (CNNs)

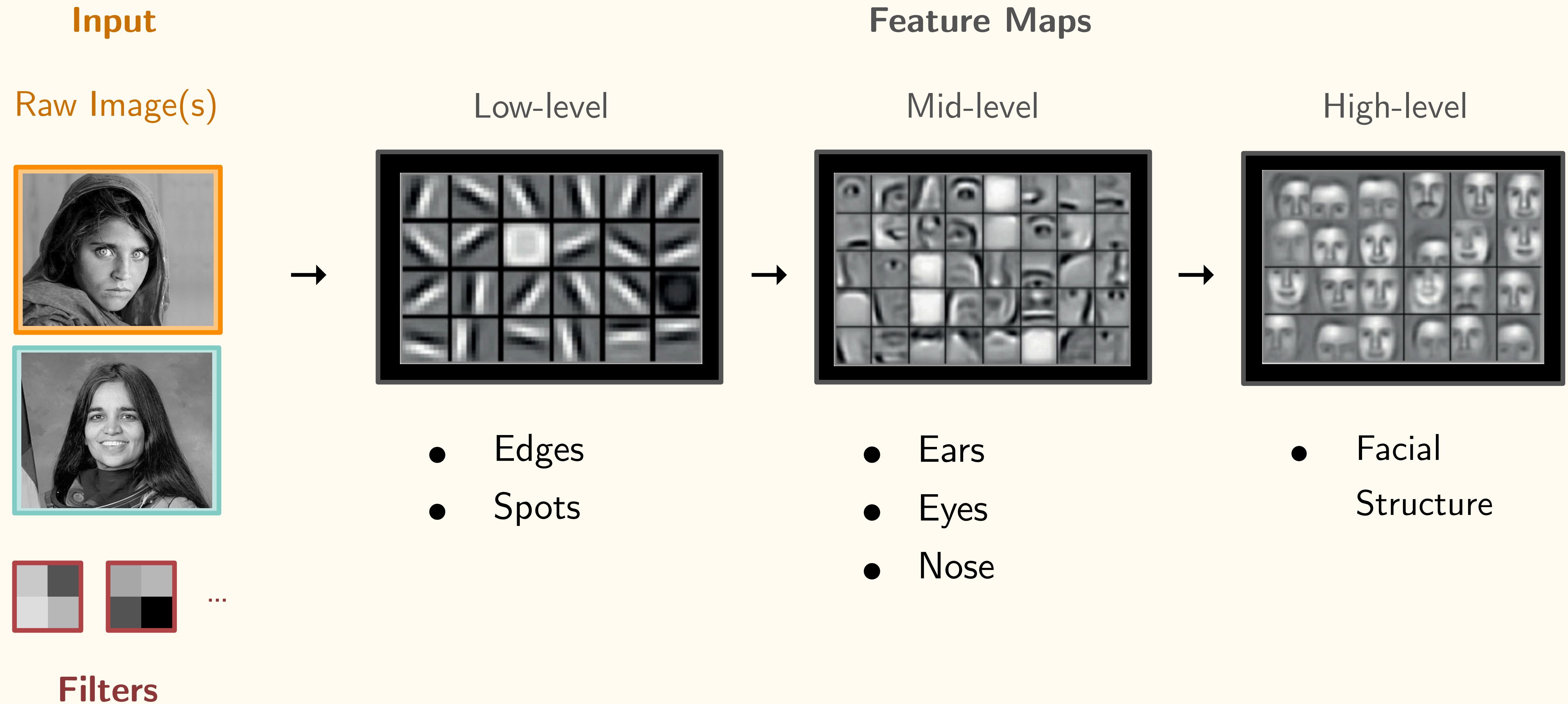


CNNs deal with greater *complexity* by having more **layers**.



Deep Learning

Convolutional Neural Networks (CNNs)

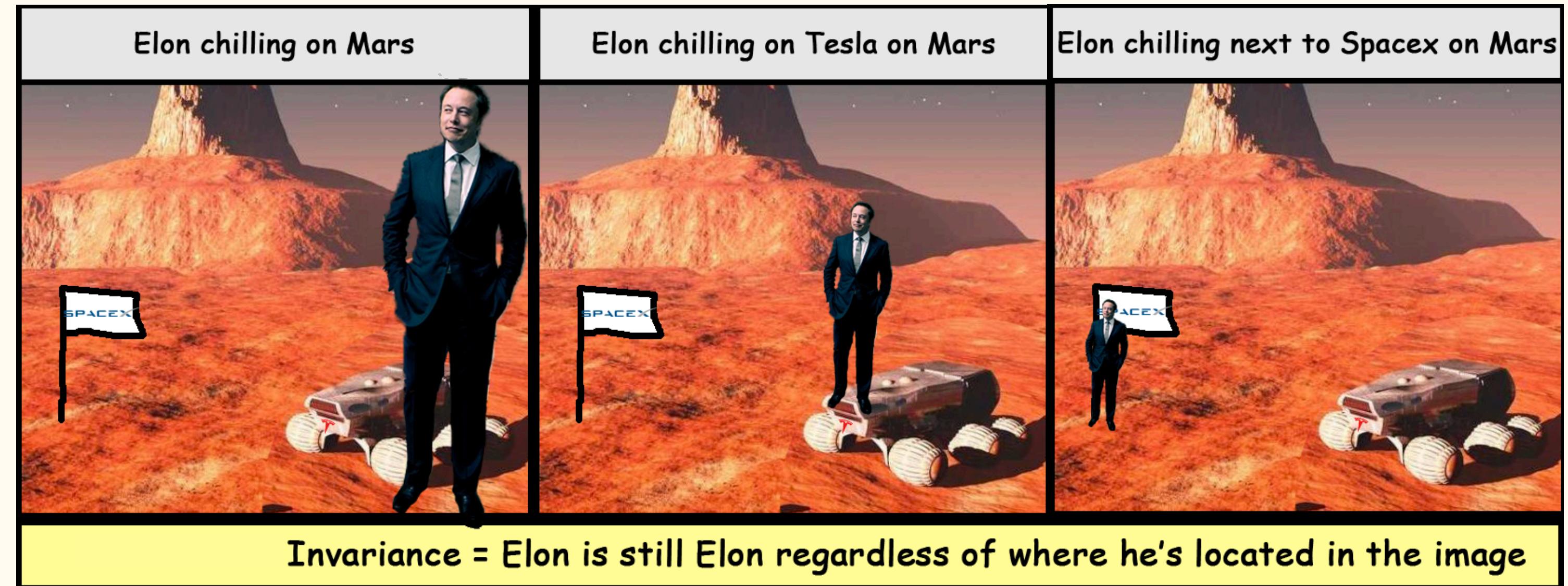


Convolutional Neural Networks (CNNs)



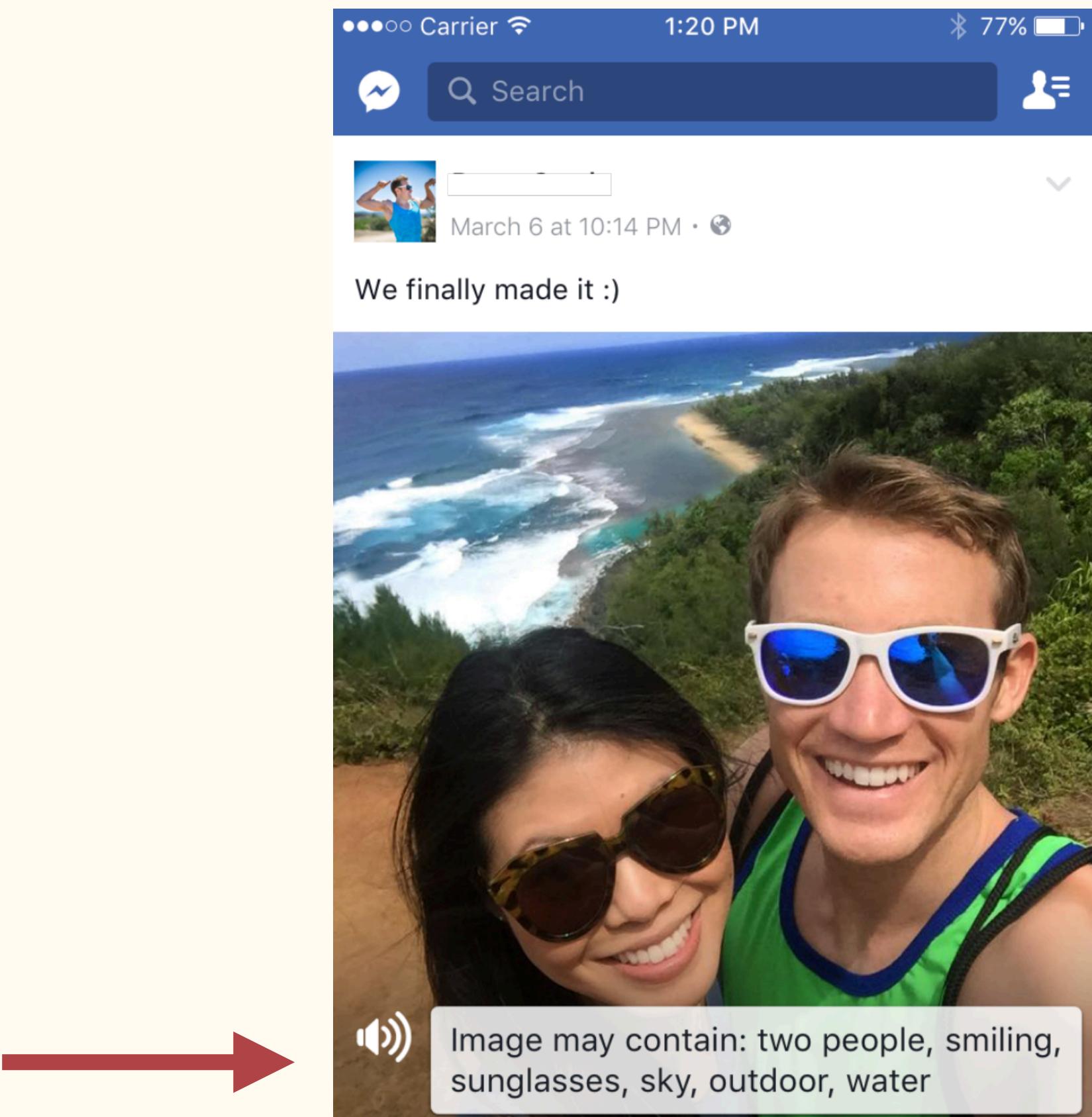
Convolutional Neural Networks (CNNs)

- Works well on data with spatial relationship
- Translation invariant
- Scale invariant



CNNs in Technology

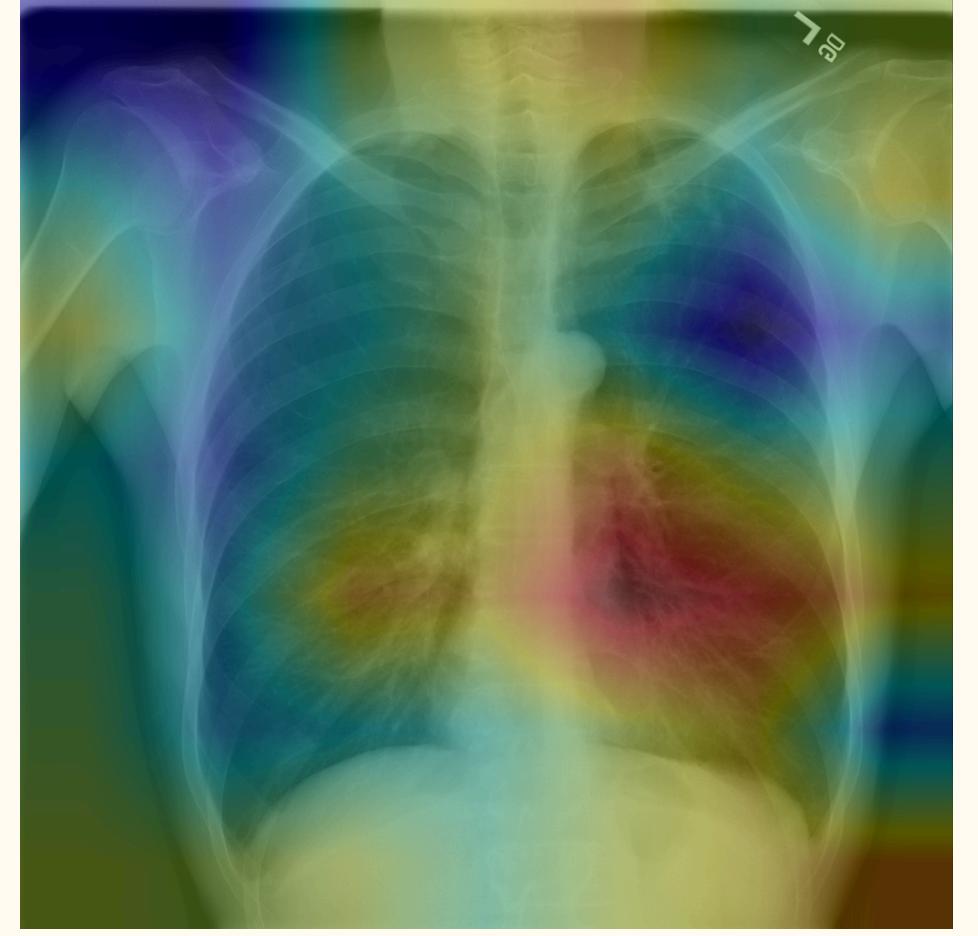
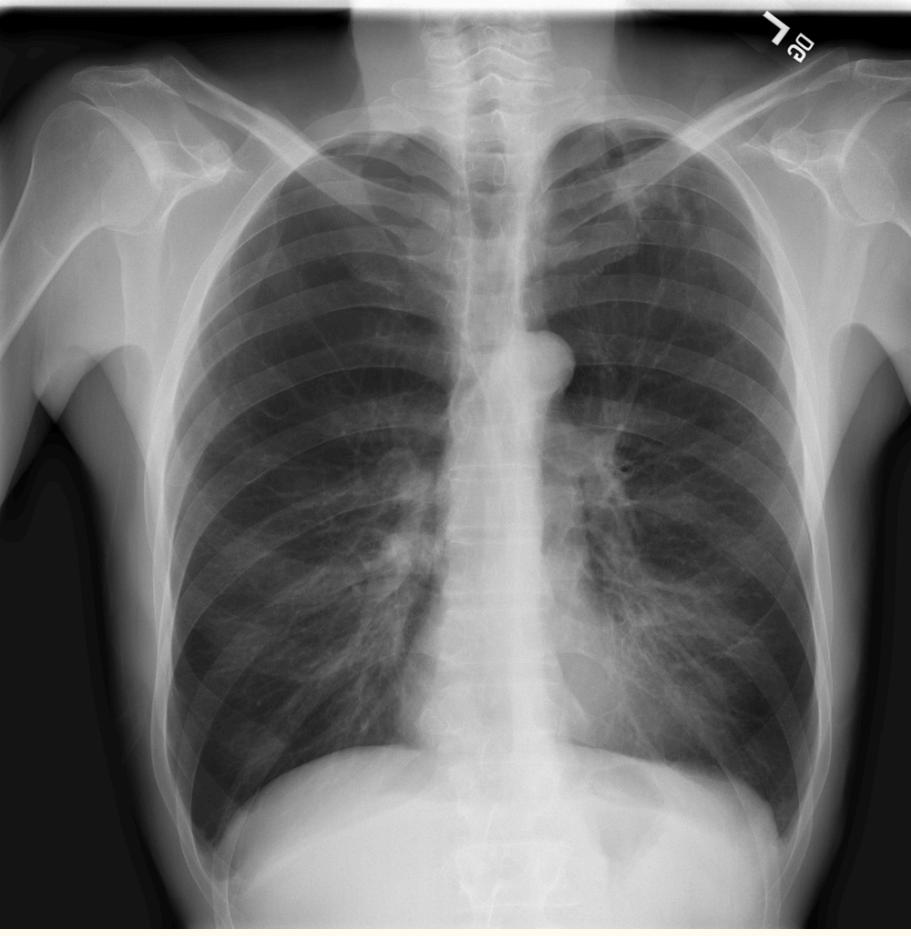
- Automatic image recognition and captioning
- Used for visually impaired people



CNNs in Life Sciences

Medical Diagnosis

- CheXNet:
 - 21-layer CNN
 - Input: chest X-ray image
 - Outputs: probability of a pathology



Summary

- Visual recognition
- Convolutions
 - Filters
 - Feature Maps
 - Architectures
 - Strides
 - Layers
- Handling complexity

