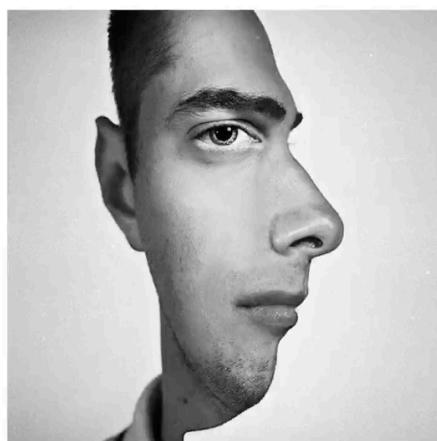


# Convolutional Neural Networks

## Convolutional Neural Networks

---



If you notice there is two perspectives in this image. If you look at right side of image you they guy looks at beyond, and if you look at the left side of image, you see a guy that looks at you.

This image shows that our brain looks at features, and depending on the features you see, you categorize things in a certain way. For example, if your central focus in left sight then you classify it in a different way.

# Convolutional Neural Networks

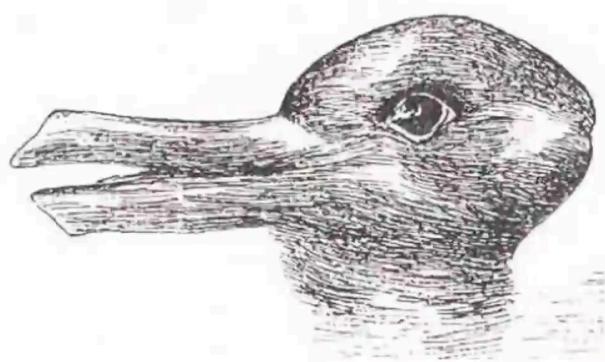


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Young and old lady.

# Convolutional Neural Networks

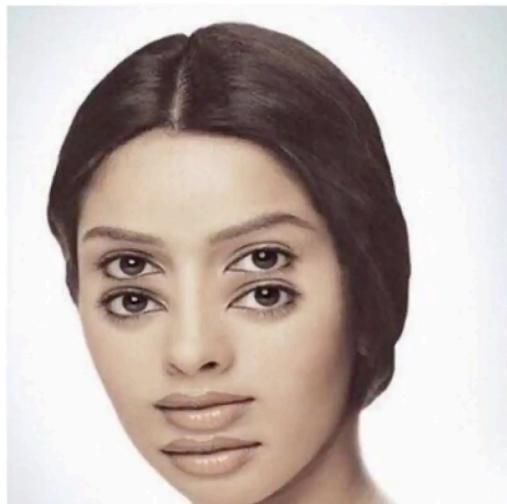


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Duck and rabbit

# Convolutional Neural Networks



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# Convolutional Neural Networks

Examples from the test set  
(with the network's guesses)



*Image Source: a talk by Geoffrey Hinton*

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# Convolutional Neural Networks

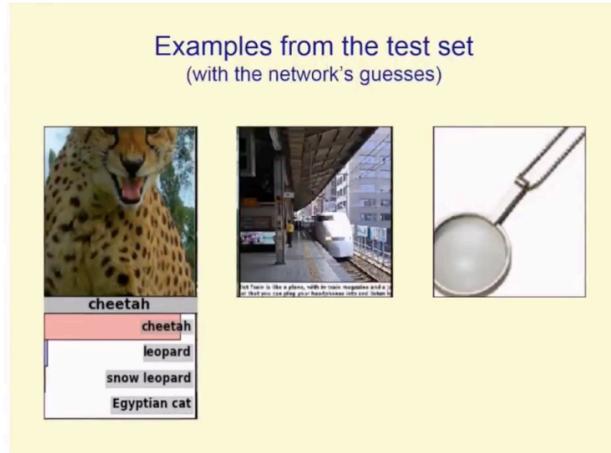


Image Source: a talk by Geoffrey Hinton

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# Convolutional Neural Networks

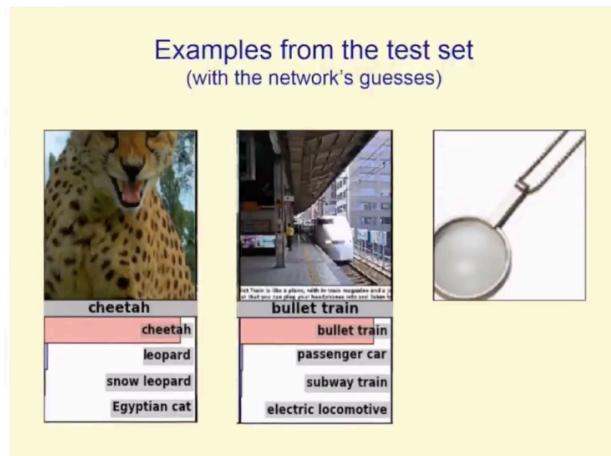


Image Source: a talk by Geoffrey Hinton

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# Convolutional Neural Networks

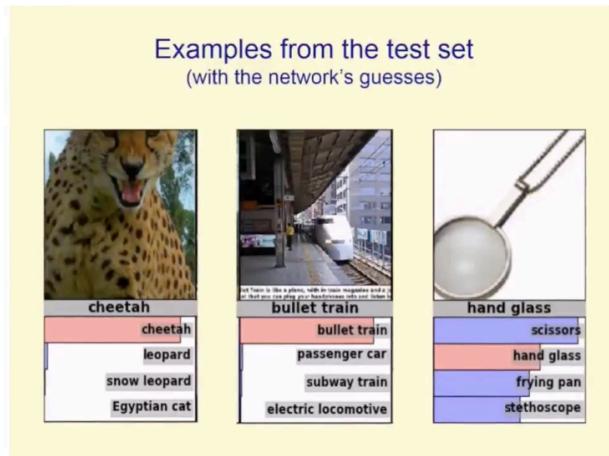


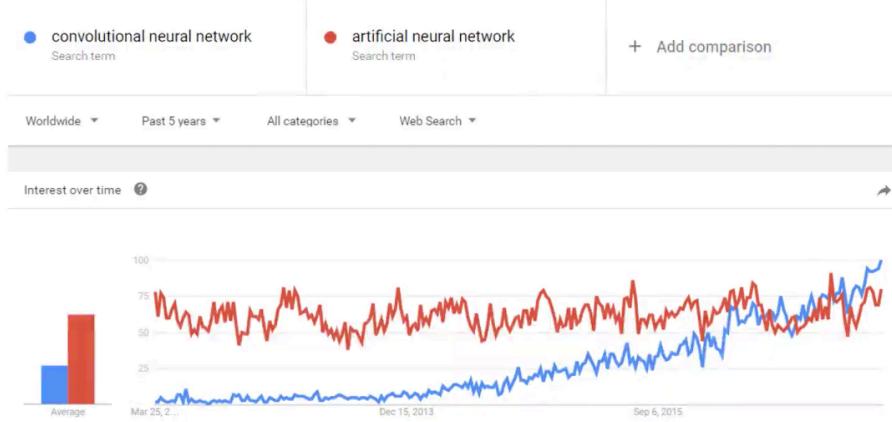
Image Source: a talk by Geoffrey Hinton

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Sometimes we can have an error, for example in the third picture, because it's not a good pic the prediction wasn't correct. The correct option was hand glass.

# Convolutional Neural Networks



Source: google trends

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CNN is taking over the ANN.

# Convolutional Neural Networks



Yann Lecun

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# Convolutional Neural Networks

Google      Facebook

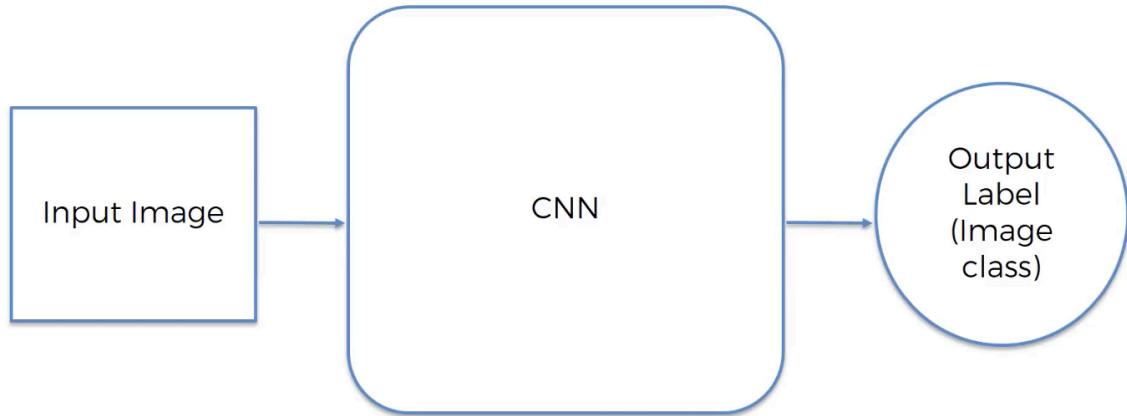


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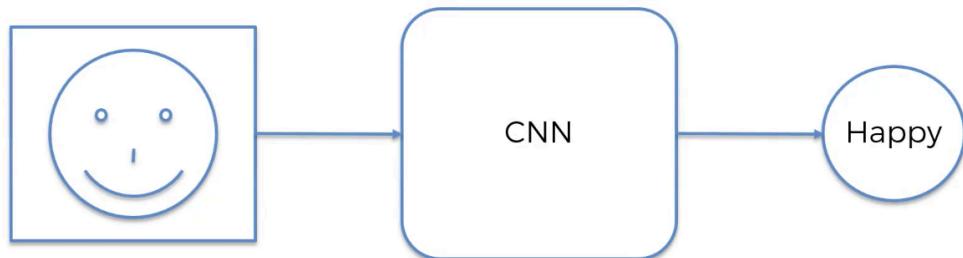
© SuperDataScience

Jeffrey Hinton is the god father of ANN and Deep learning and Yann Lecun is the grant father of CNN. His method is using in self tagging image in Facebook.

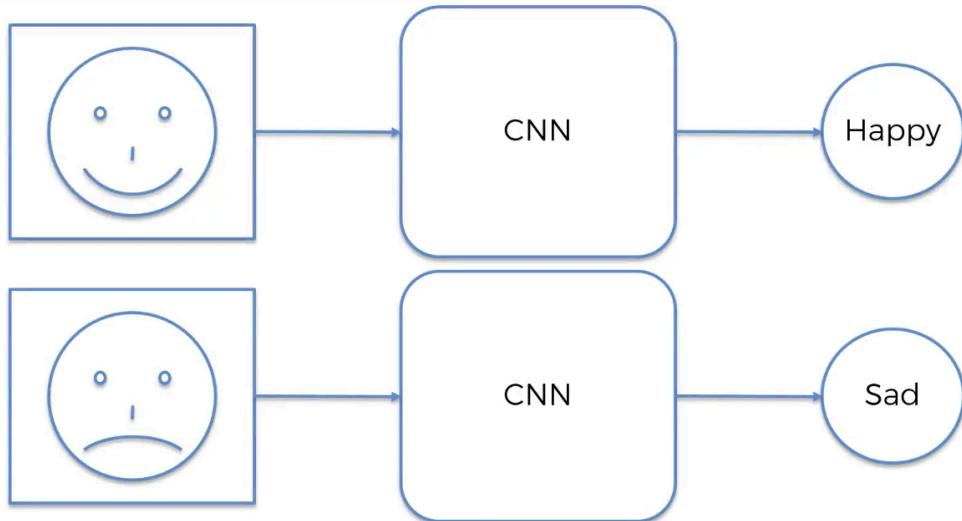
# Convolutional Neural Networks



# Convolutional Neural Networks



# Convolutional Neural Networks



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Remember sometimes there might be some errors because we haven't seen enough features

# Convolutional Neural Networks

B / W Image 2x2px

Pixel 1	Pixel 2
Pixel 3	Pixel 4

Colored Image 2x2px

Pixel 1	Pixel 2
Pixel 3	Pixel 4

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# Convolutional Neural Networks

B / W Image 2x2px

Pixel 1	Pixel 2
Pixel 3	Pixel 4

2d array



Colored Image 2x2px

Pixel 1	Pixel 2
Pixel 3	Pixel 4

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# Convolutional Neural Networks

B / W Image 2x2px

Pixel 1	Pixel 2
Pixel 3	Pixel 4

2d array



Pixel 1 0 ≤ pixel value ≤ 255	Pixel 2 0 ≤ pixel value ≤ 255
Pixel 3 0 ≤ pixel value ≤ 255	Pixel 4 0 ≤ pixel value ≤ 255

Colored Image 2x2px

Pixel 1	Pixel 2
Pixel 3	Pixel 4

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# Convolutional Neural Networks

B / W Image 2x2px

Pixel 1	Pixel 2
Pixel 3	Pixel 4

2d array

Pixel 1	Pixel 2
0 ≤ pixel value ≤ 255	0 ≤ pixel value ≤ 255
Pixel 3	Pixel 4
0 ≤ pixel value ≤ 255	0 ≤ pixel value ≤ 255

Colored Image 2x2px

Pixel 1	Pixel 2
Pixel 3	Pixel 4

3d array

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# Convolutional Neural Networks

B / W Image 2x2px

Pixel 1	Pixel 2
Pixel 3	Pixel 4

2d array

Pixel 1	Pixel 2
0 ≤ pixel value ≤ 255	0 ≤ pixel value ≤ 255
Pixel 3	Pixel 4
0 ≤ pixel value ≤ 255	0 ≤ pixel value ≤ 255

Colored Image 2x2px

Pixel 1	Pixel 2
Pixel 3	Pixel 4

3d array

Pixel 1	Pixel 2
0 ≤ pixel value ≤ 255	0 ≤ pixel value ≤ 255
Pixel 3	Pixel 4
0 ≤ pixel value ≤ 255	0 ≤ pixel value ≤ 255

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# Convolutional Neural Networks

B / W Image 2x2px

Pixel 1	Pixel 2
Pixel 3	Pixel 4

2d array

Pixel 1	Pixel 2
0 ≤ pixel value ≤ 255	0 ≤ pixel value ≤ 255
Pixel 3	Pixel 4
0 ≤ pixel value ≤ 255	0 ≤ pixel value ≤ 255

Colored Image 2x2px

Pixel 1	Pixel 2
Pixel 3	Pixel 4

3d array

Red channel

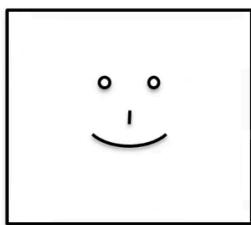
Green channel

Blue channel

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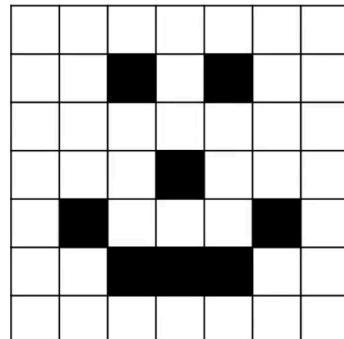
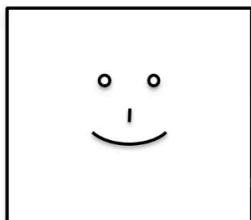
# Convolutional Neural Networks



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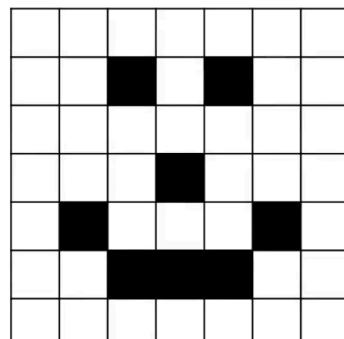
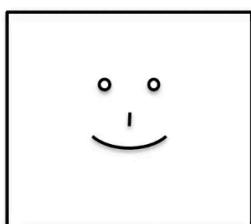
# Convolutional Neural Networks



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# Convolutional Neural Networks



0	0	0	0	0	0	0	0
0	1	0	0	0	1	0	0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0
0	1	0	0	0	1	0	0
0	0	1	1	1	0	0	0
0	0	0	0	0	0	0	0

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# Convolutional Neural Networks

**STEP 1:** Convolution

# Convolutional Neural Networks

**STEP 1:** Convolution



**STEP 2:** Max Pooling

# Convolutional Neural Networks

**STEP 1:** Convolution



**STEP 2:** Max Pooling



**STEP 3:** Flattening

# Convolutional Neural Networks

**STEP 1:** Convolution



**STEP 2:** Max Pooling



**STEP 3:** Flattening



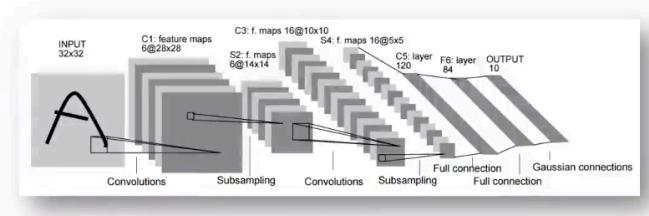
**STEP 4:** Full Connection

# Convolutional Neural Networks

Additional Reading:

*Gradient-Based Learning  
Applied to Document  
Recognition*

By Yann LeCun et al. (1998)



Link:

<http://yann.lecun.com/exdb/publis/pdf/lecun-01a.pdf>