

# Convolutional Neural Networks

# Image Classification

**Boy?**



**Girl?**

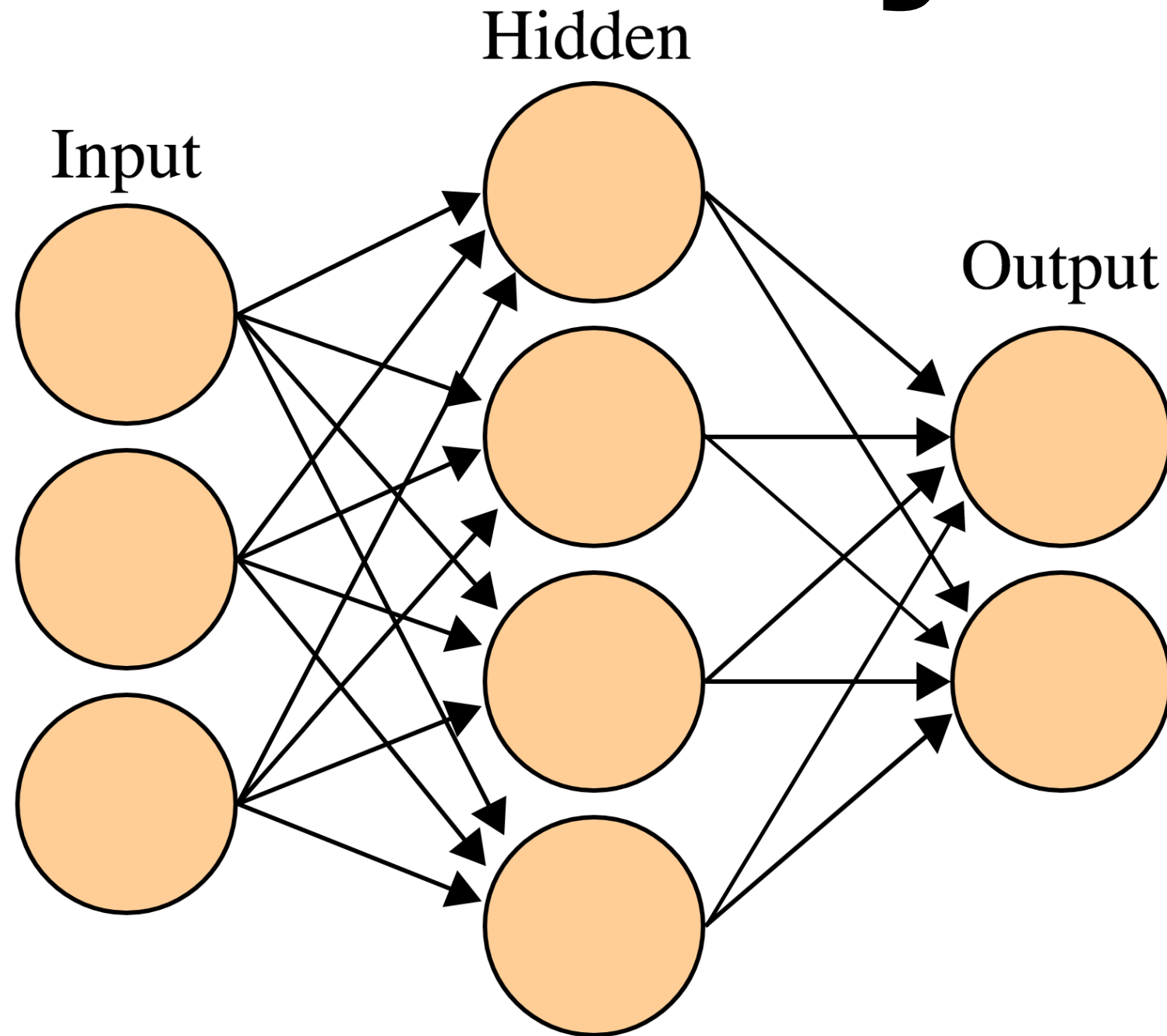


Image Credits:  
by pagarmidna  
[www.openclipart.org](http://www.openclipart.org)

$$f\left(\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \\ \vdots \\ x_{996} \\ x_{997} \\ x_{998} \\ x_{999} \\ x_{1000} \end{bmatrix}\right) \approx c$$

$$f\left(\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \\ \vdots \\ x_{996} \\ x_{997} \\ x_{998} \\ x_{999} \\ x_{1000} \end{bmatrix}\right) \approx \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \\ c_6 \\ c_7 \end{bmatrix}$$

# Hidden Layers



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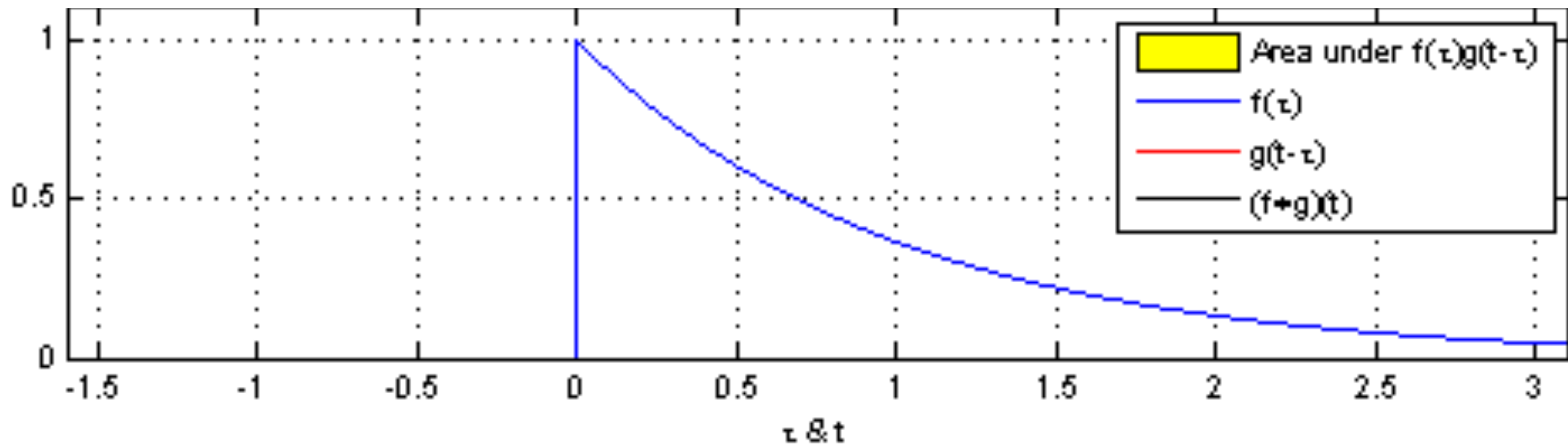
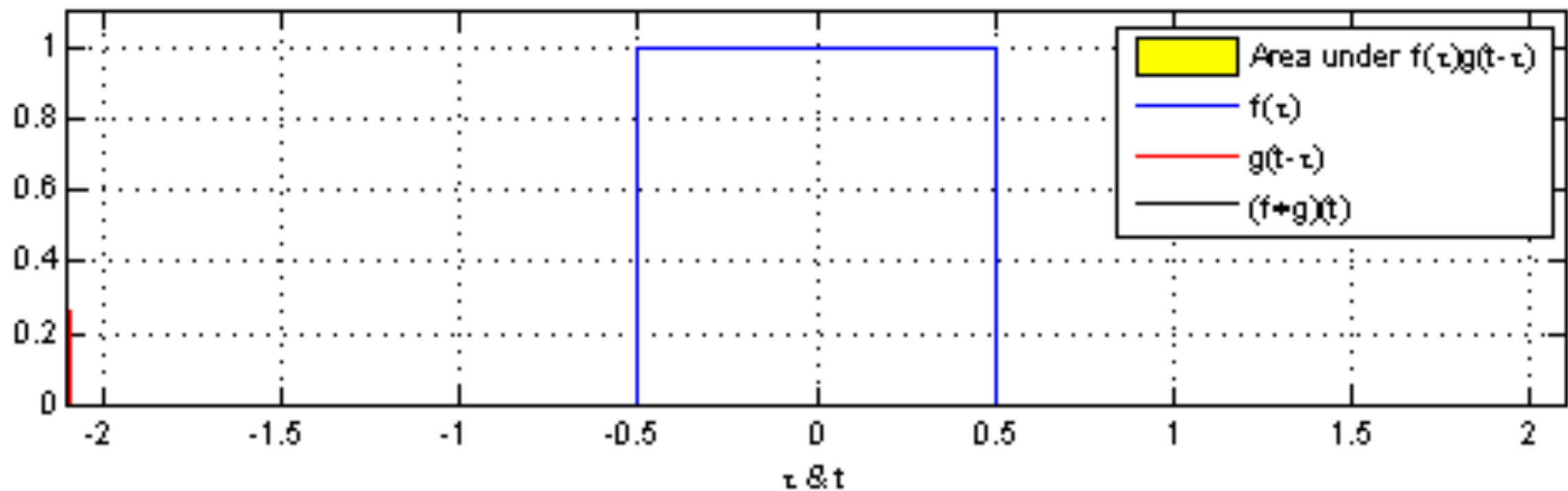


Image Credits:

[https://en.wikipedia.org/wiki/Convolution#/media/File:Convolution\\_of\\_box\\_signal\\_with\\_itself2.gif](https://en.wikipedia.org/wiki/Convolution#/media/File:Convolution_of_box_signal_with_itself2.gif)  
[https://en.wikipedia.org/wiki/File:Convolution\\_of\\_box\\_signal\\_with\\_itself2.gif](https://en.wikipedia.org/wiki/File:Convolution_of_box_signal_with_itself2.gif)

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

Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>

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

1	0	1
0	1	0
1	0	1

Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>



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

\*

1	0	1
0	1	0
1	0	1

=

Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>

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

\*

1	0	1
0	1	0
1	0	1

=

1	0	1
0	1	0
0	0	1

Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>

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

\*

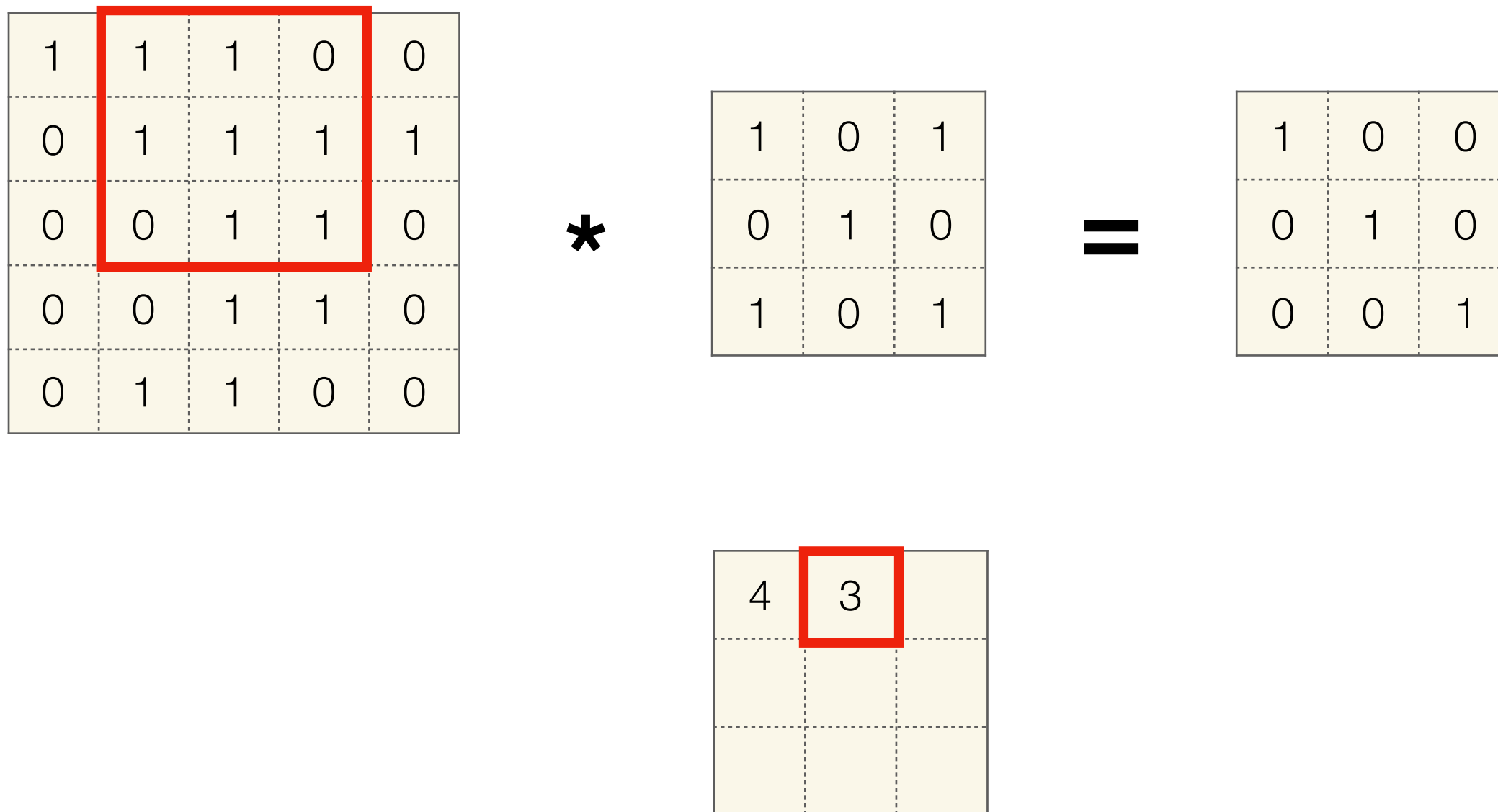
1	0	1
0	1	0
1	0	1

=

1	0	1
0	1	0
0	0	1

4		

Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>



Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>

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

\*

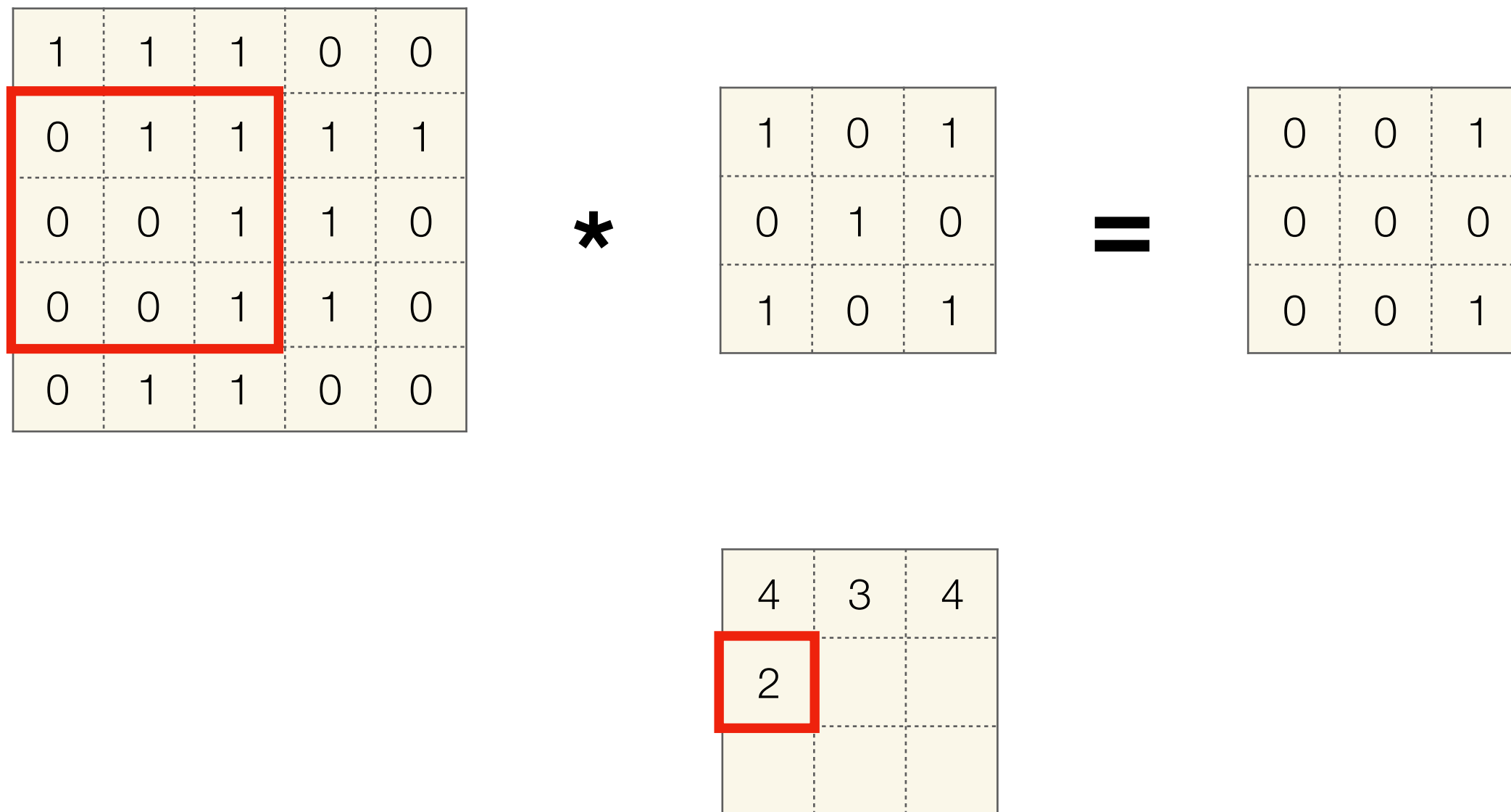
1	0	1
0	1	0
1	0	1

=

1	0	0
0	1	0
1	0	0

4	3	4

Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>



Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>

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

\*

1	0	1
0	1	0
1	0	1

4	3	4
2	4	3
2	3	4

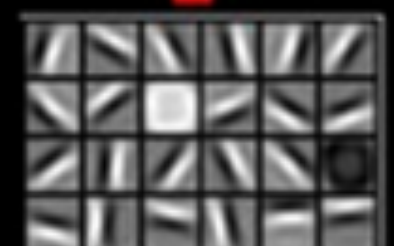
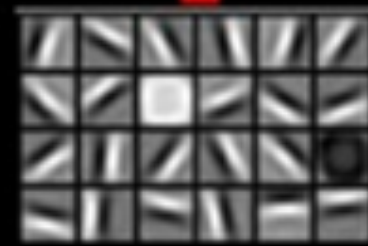
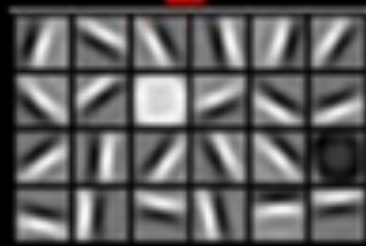
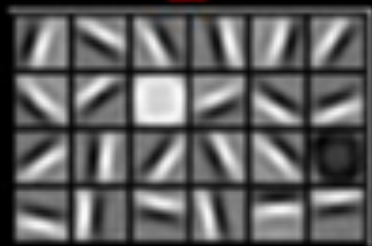
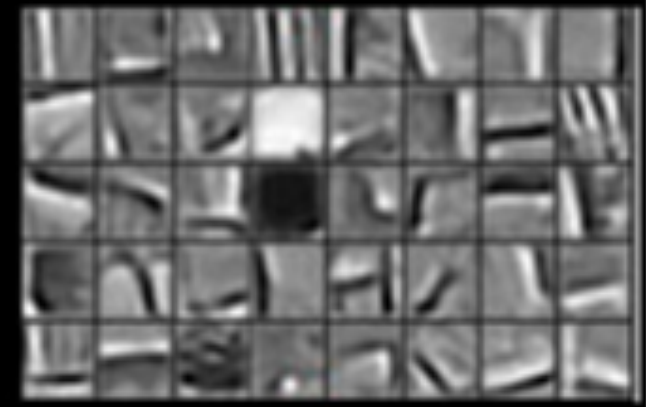
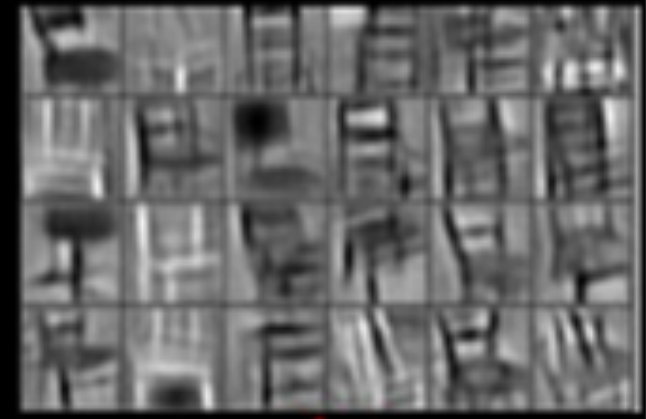
Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>

Faces

Cars

Elephants

Chairs



Source

<https://stats.stackexchange.com/questions/146413/why-convolutional-neural-networks-belong-to-deep-learning/146476>

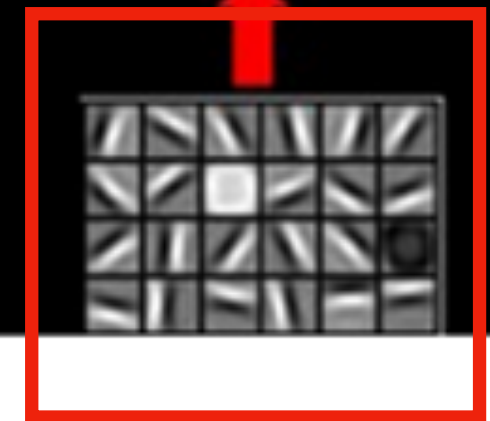
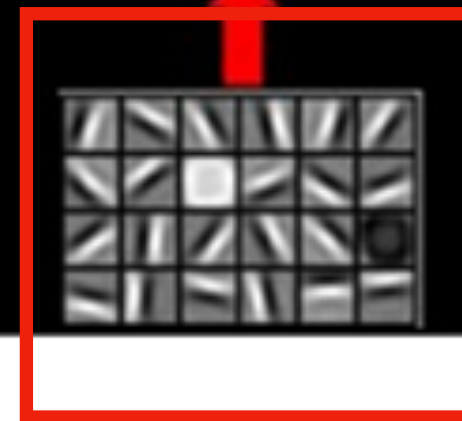
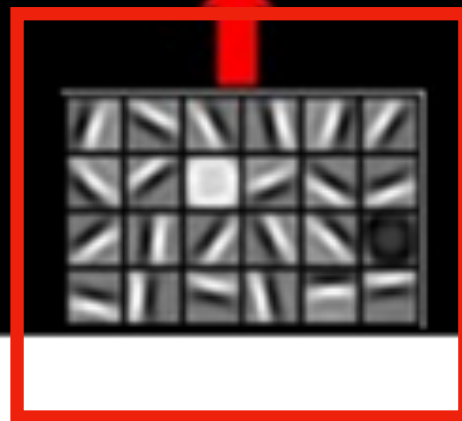
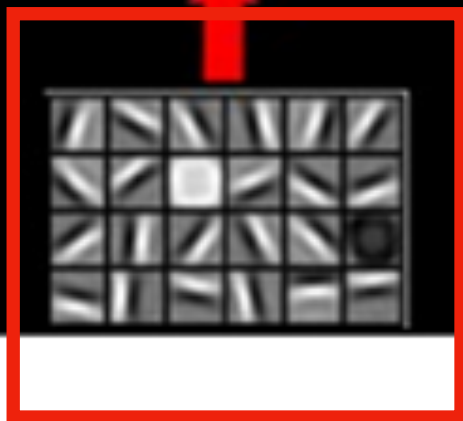
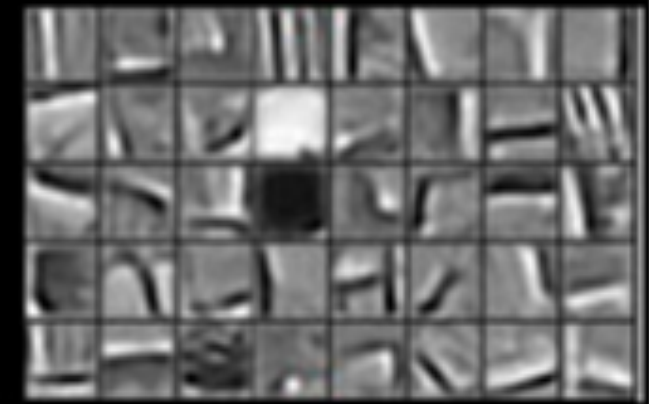
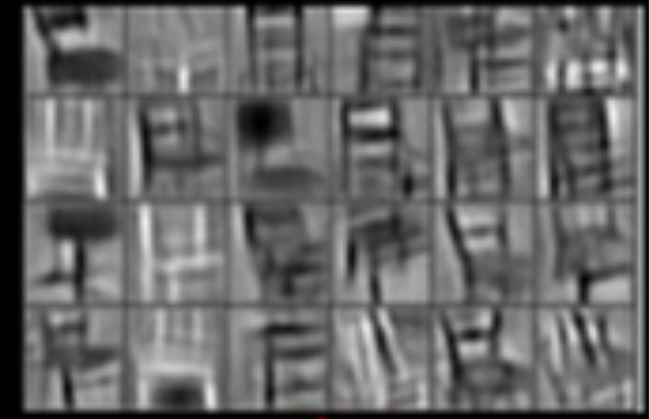


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<https://stats.stackexchange.com/questions/146413/why-convolutional-neural-networks-belong-to-deep-learning/146476>

Lee et al., Convolutional Deep Belief Networks for Scalable Unsupervised Learning of Hierarchical Representations

1	1	2	4
5	6	7	8
3	2	1	0
1	2	3	4

Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>

1	1	2	4
5	6	7	8
3	2	1	0
1	2	3	4

Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>

1	1	2	4
5	6	7	8
3	2	1	0
1	2	3	4

6	

Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>

1	1	2	4
5	6	7	8
3	2	1	0
1	2	3	4

6	8
3	4

Example inspired by:  
<https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/>

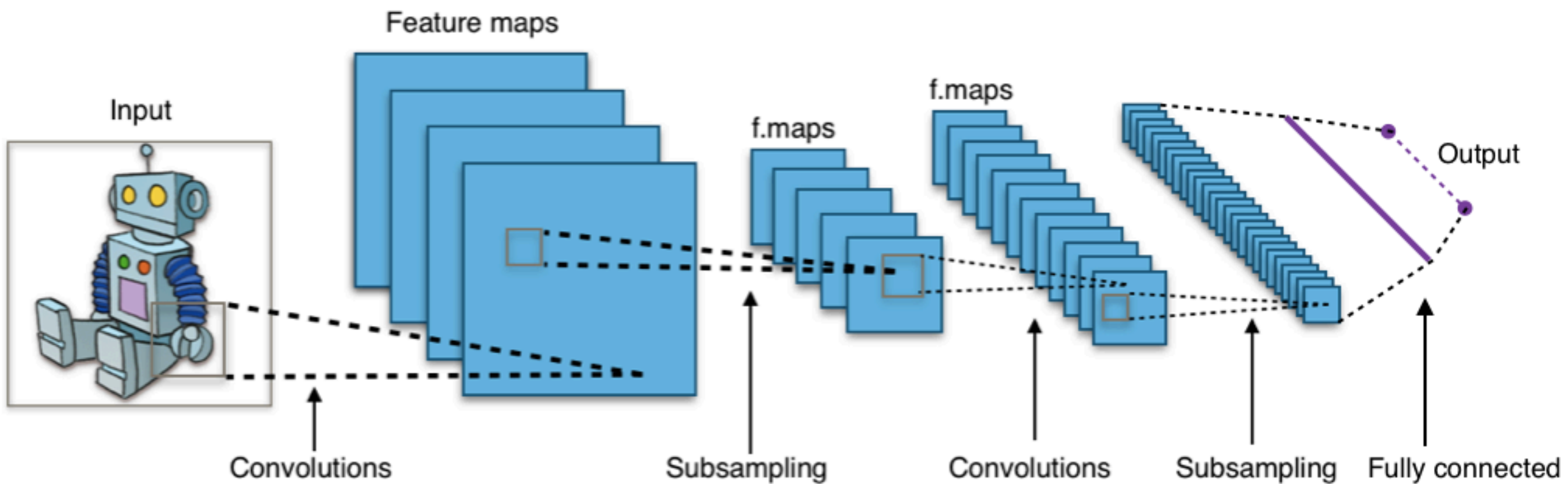


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# Recurrent Neural Networks