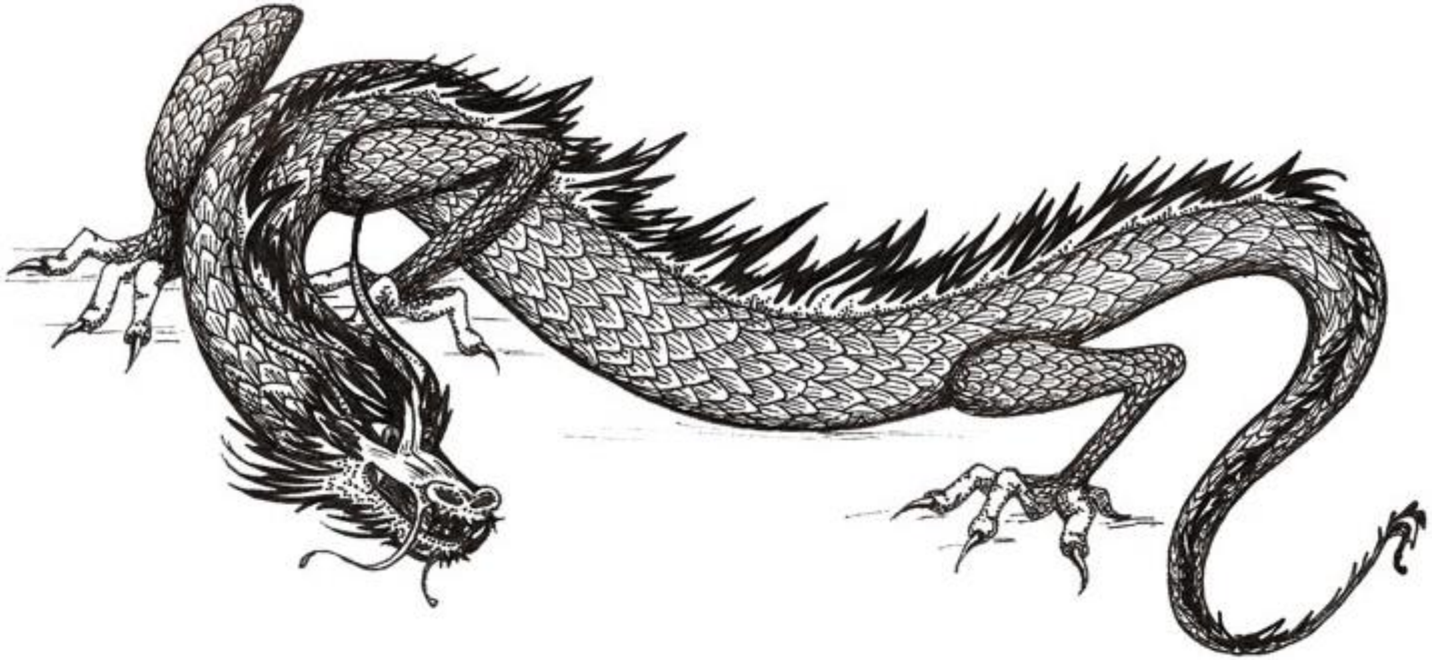
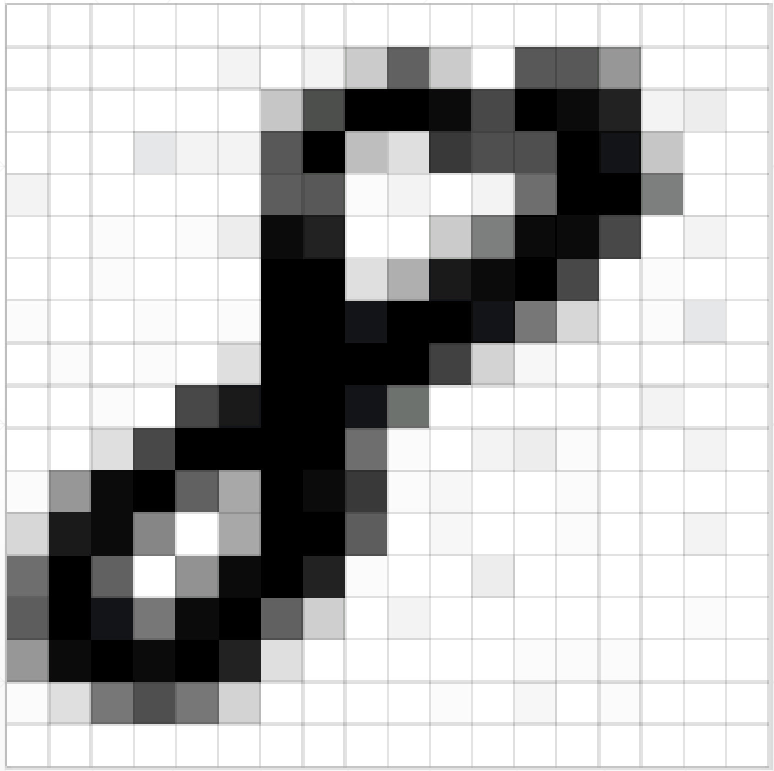


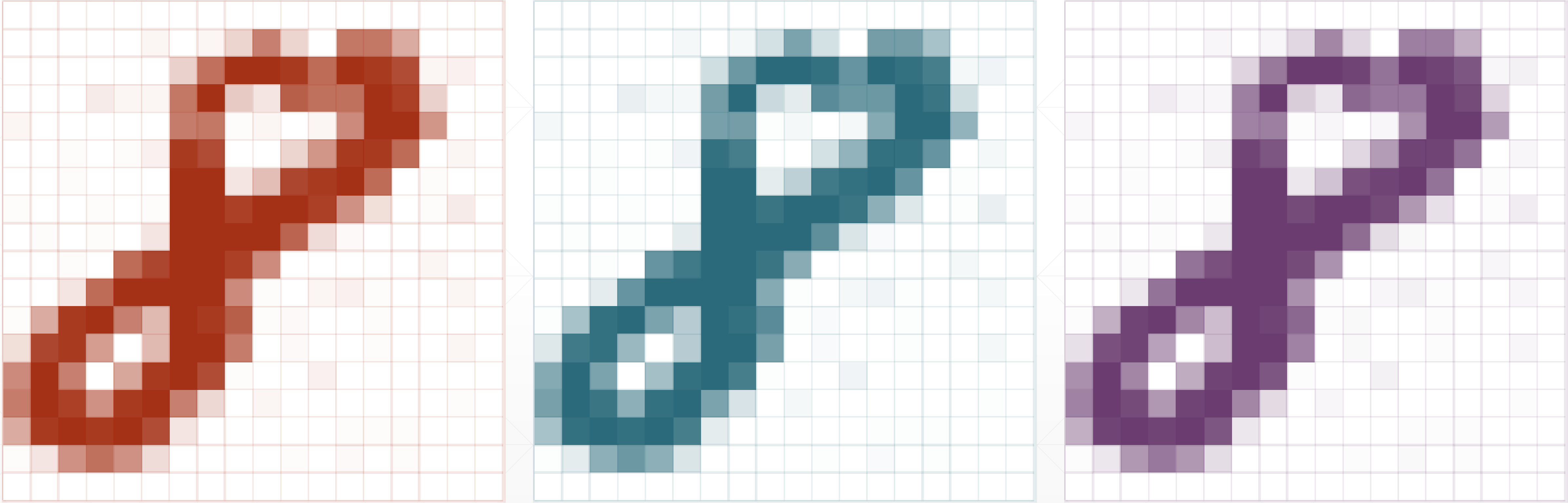
什么是卷积

主讲：龙良曲

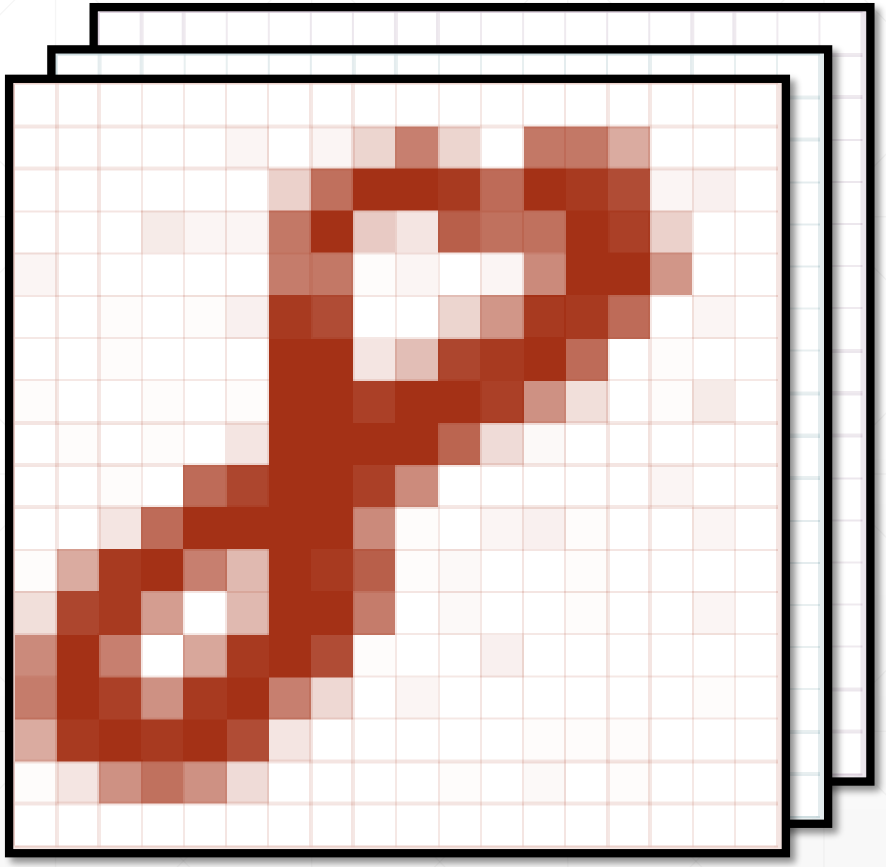
Feature maps



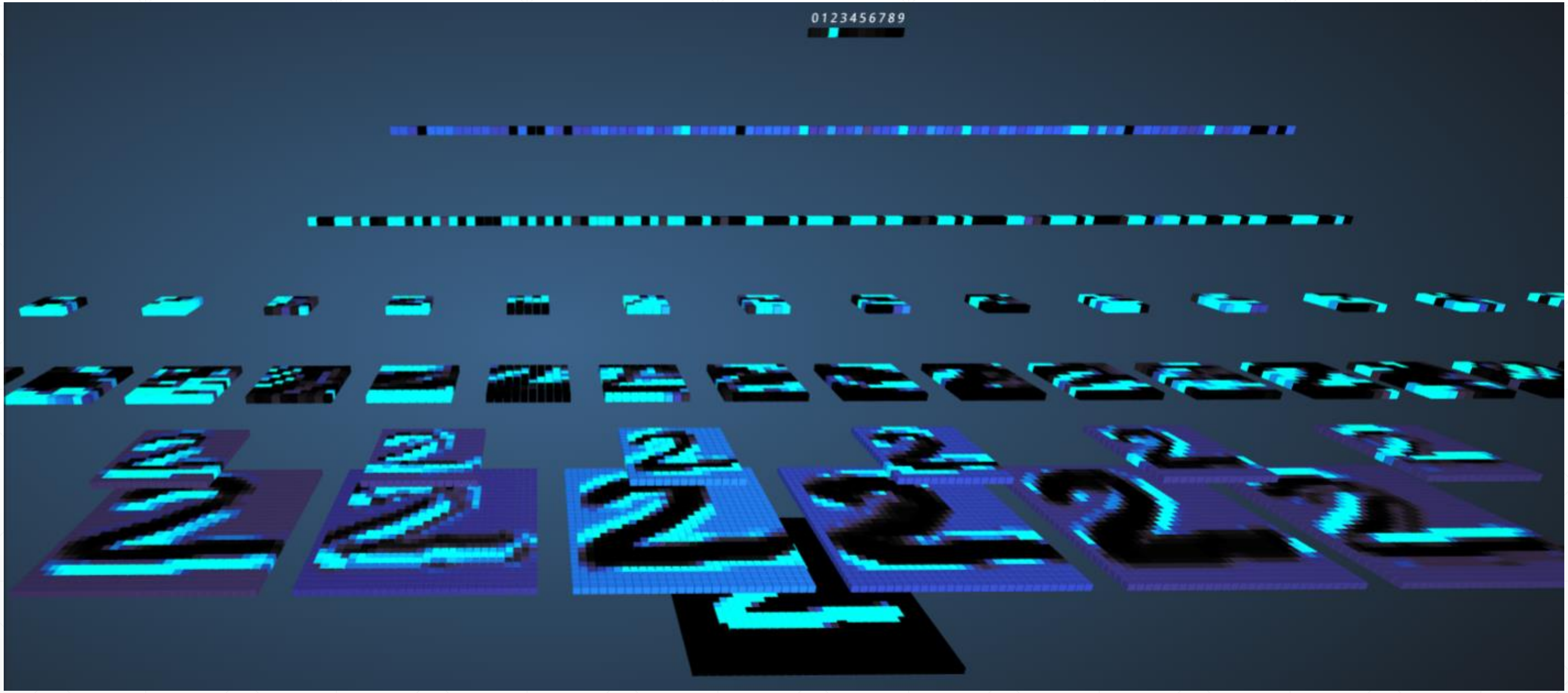
Feature maps



Feature maps



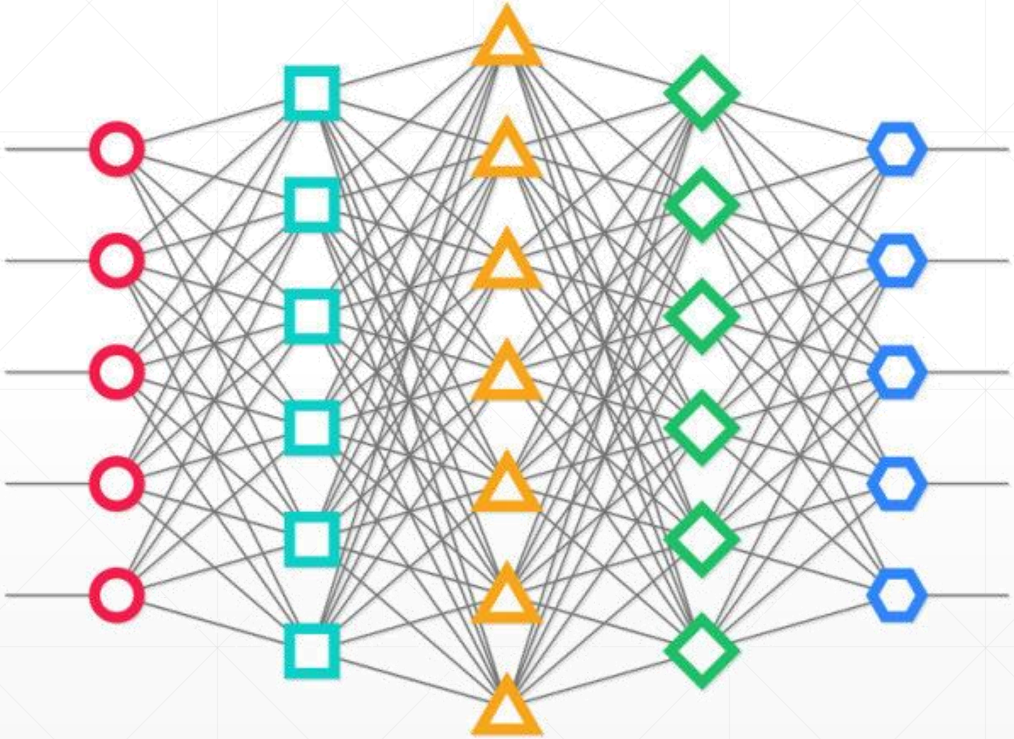
Feature maps



http://scs.ryerson.ca/~aharley/vis/conv/flat.html

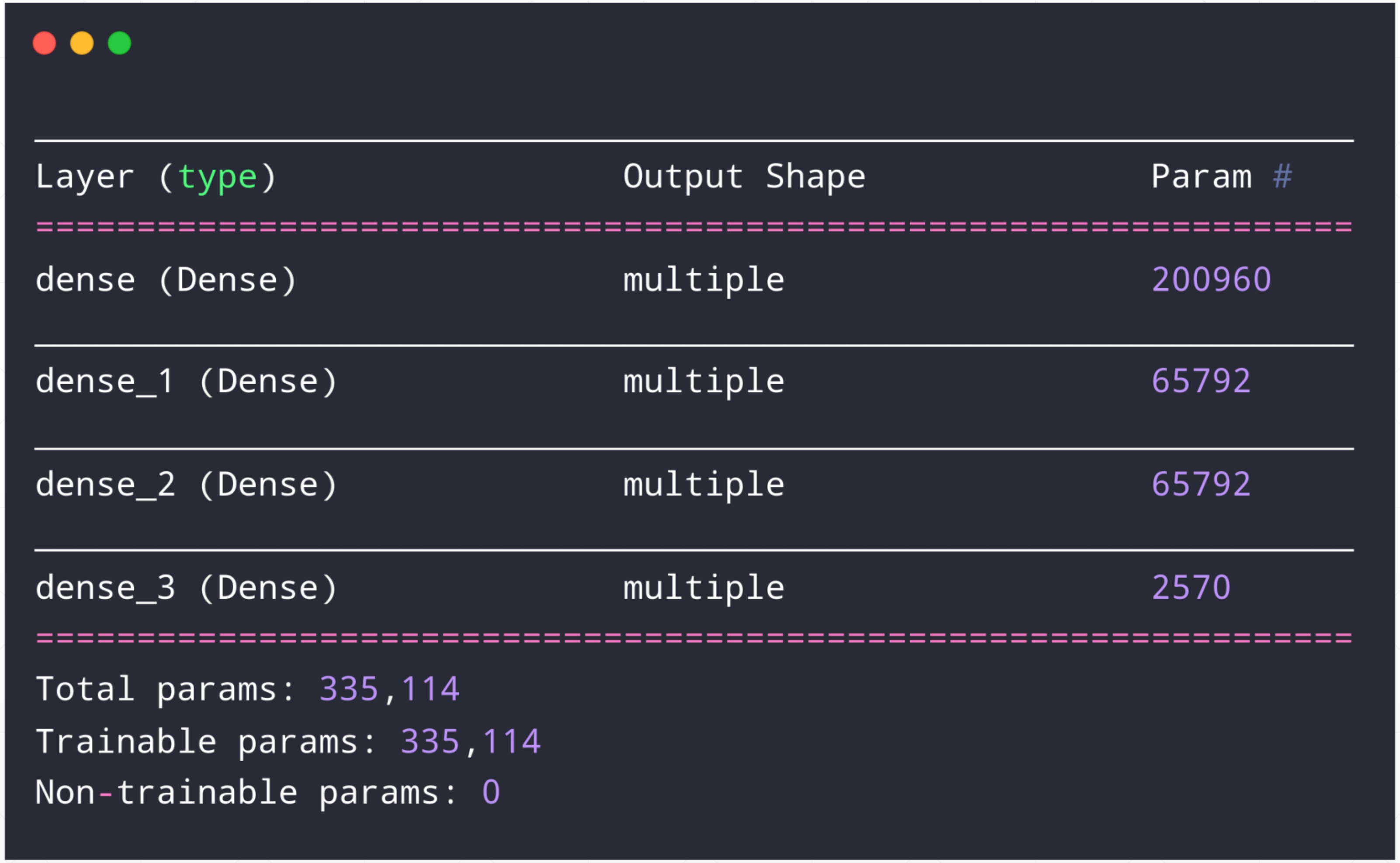
Why not Linear

- 4 Layers: [784, 256, 256, 256, 10]



http://slazebni.cs.illinois.edu/spring17/lec01_cnn_architectures.pdf

335K or 1.3MB



```
_________________________________________________________________
Layer (type)                 Output Shape                 Param #
=================================================================
dense (Dense)                multiple                     200960

_________________________________________________________________
dense_1 (Dense)              multiple                     65792

_________________________________________________________________
dense_2 (Dense)              multiple                     65792

_________________________________________________________________
dense_3 (Dense)              multiple                     2570
=================================================================
Total params: 335,114
Trainable params: 335,114
Non-trainable params: 0
```

em...

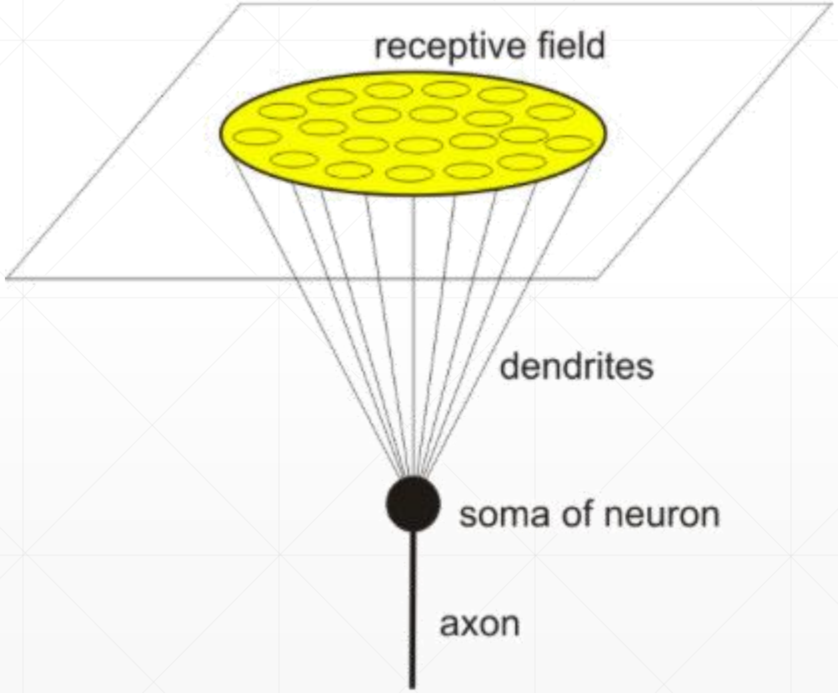
- 486 PC + AT&T DSP32C
  - 256KB
  - 66Mhz

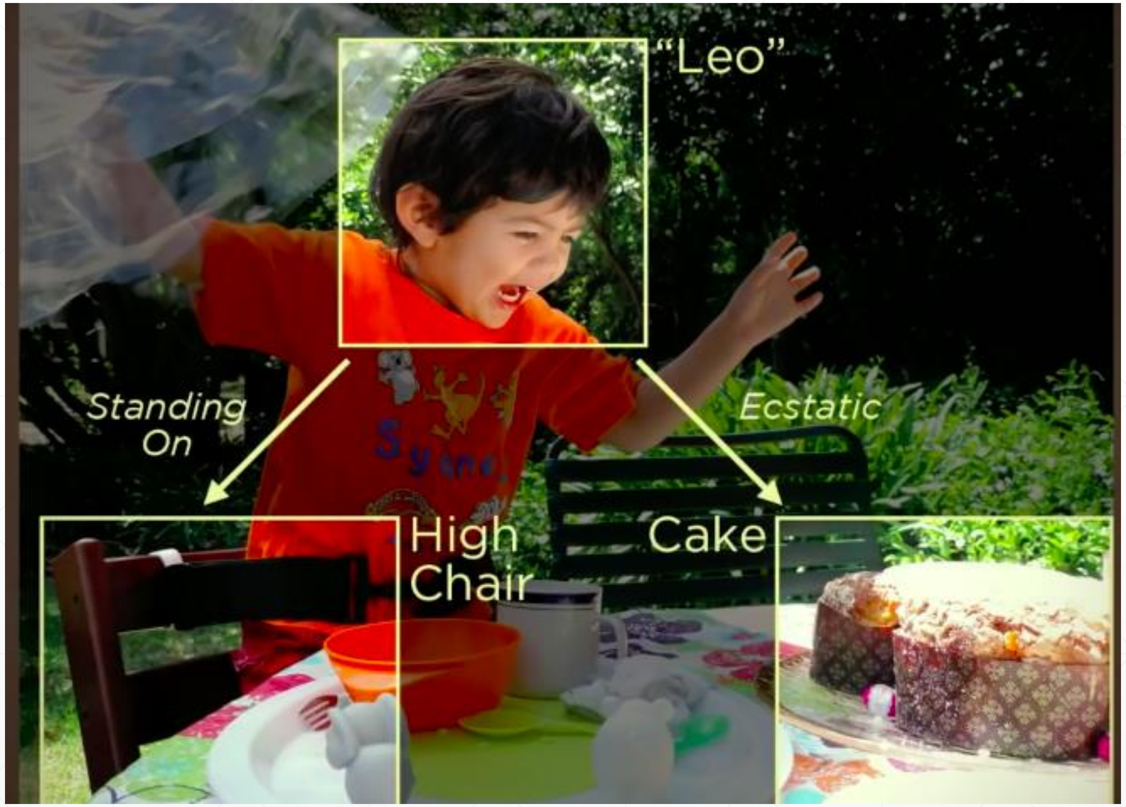
- Batch X
- Gradient Cache
- etc.

https://www.ebay.com/itm/8pc-NOS-DSP32C-Digital-Signal-Processor-AT-T-/173357711735

How?

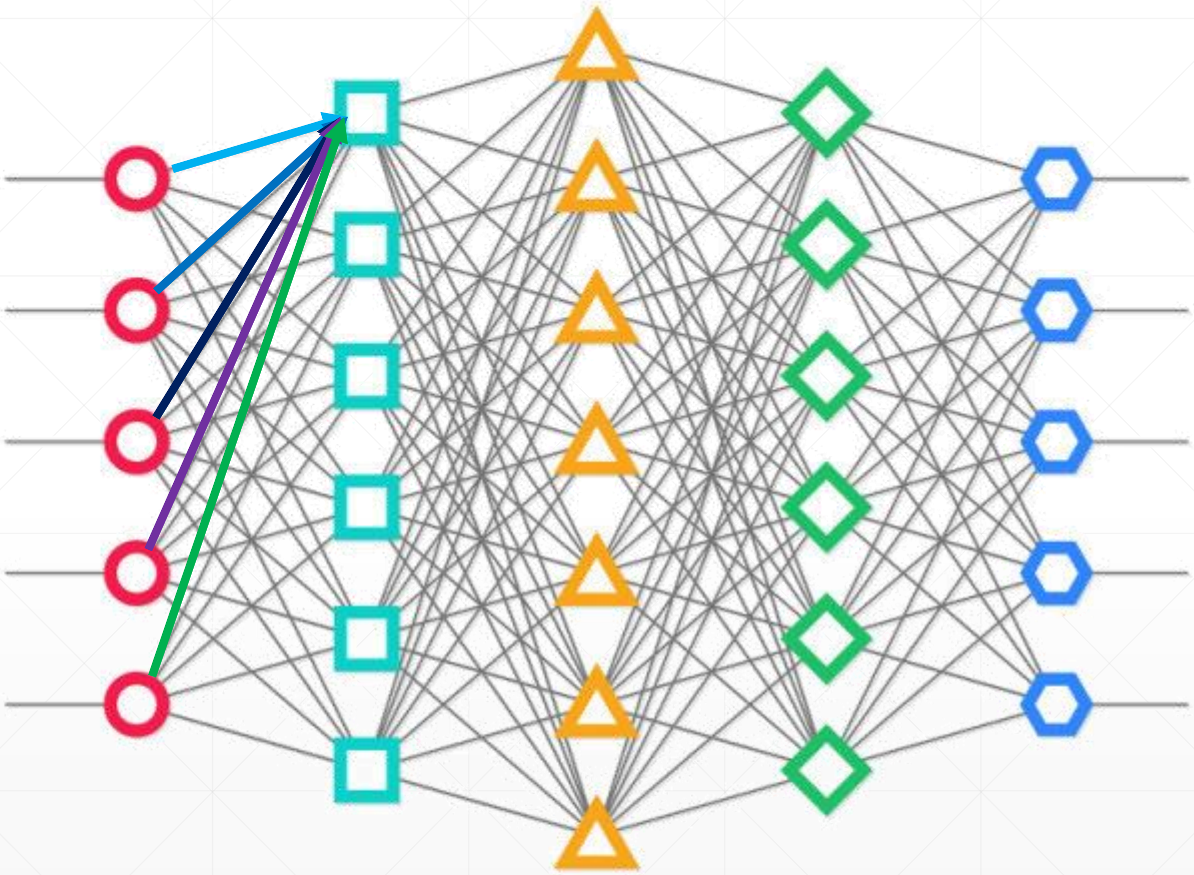
Receptive Field



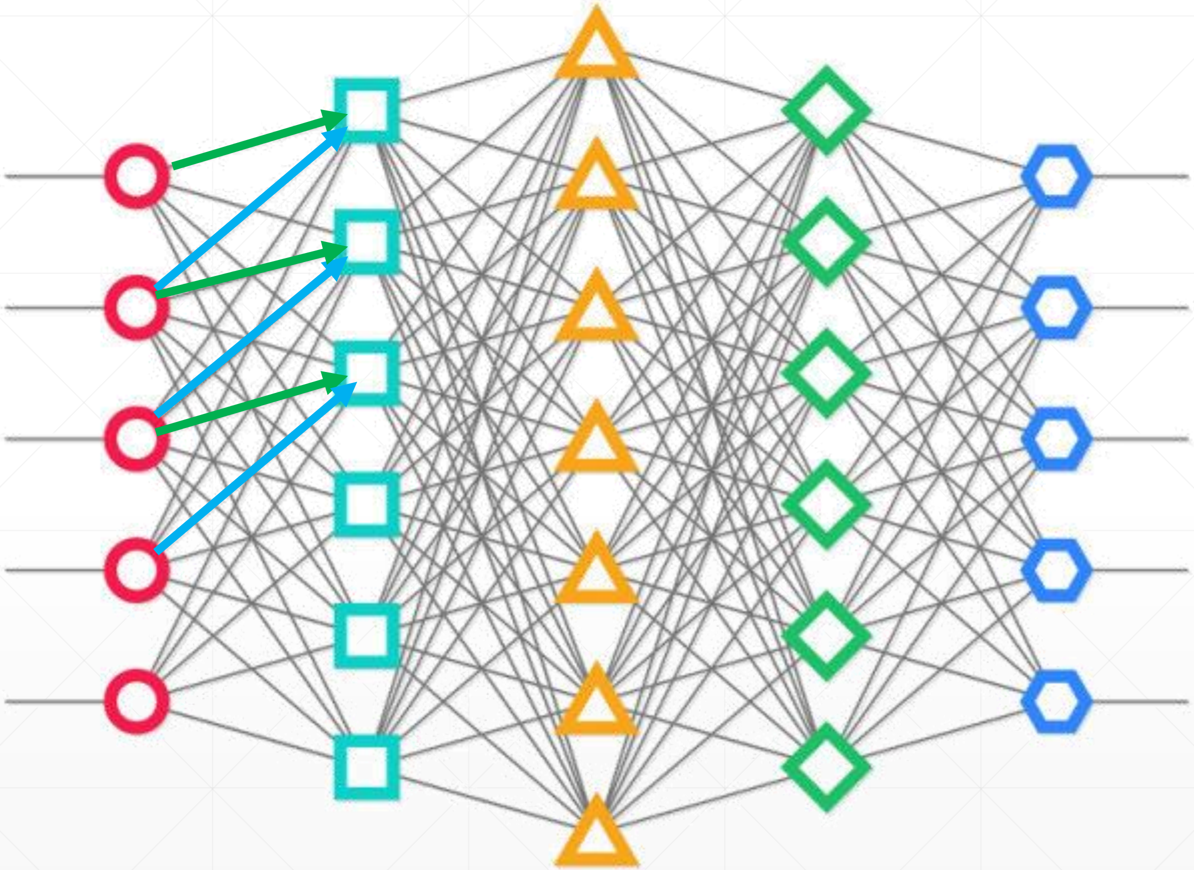


https://medium.freecodecamp.org/an-intuitive-guide-to-convolutional-neural-networks-260c2de0a050

Fully connected

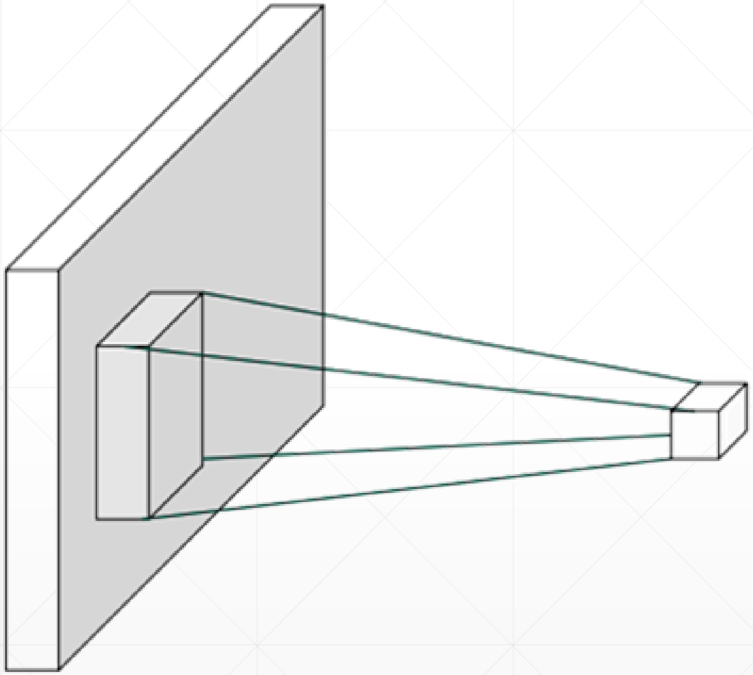


Partial connected

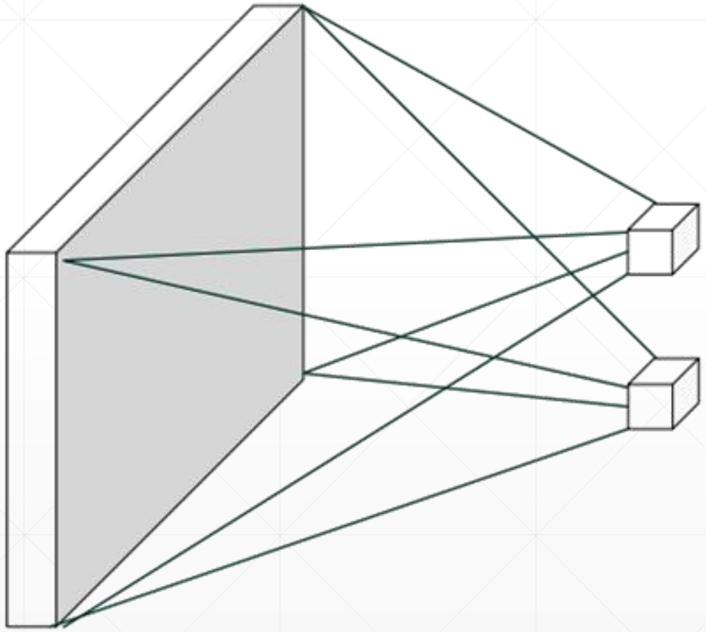


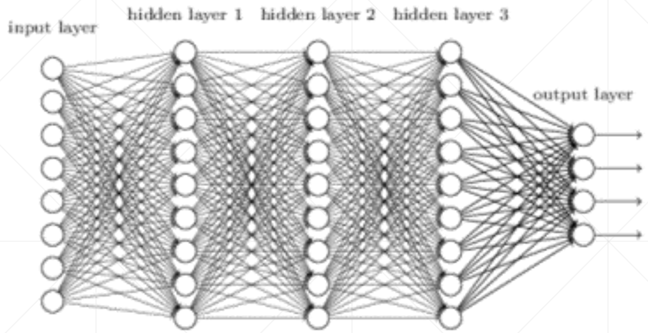
sharing

→Locally connected



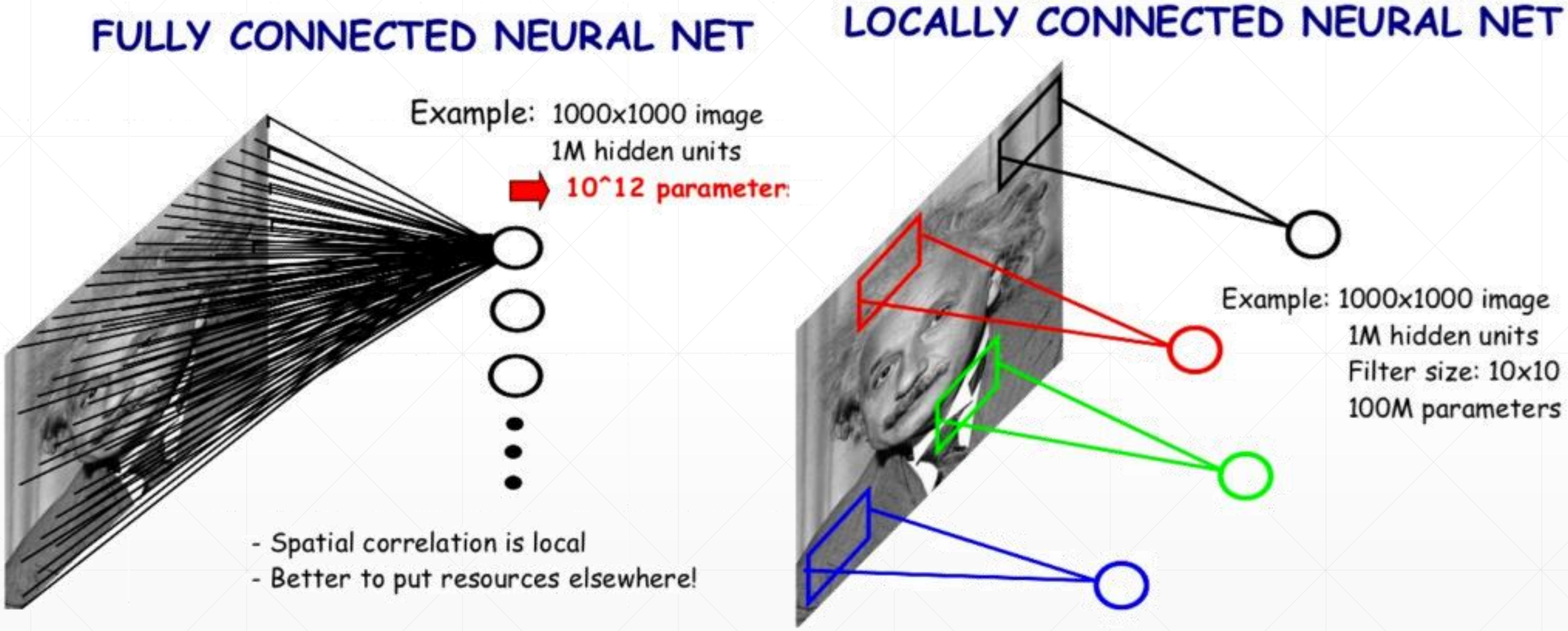
Rethink Linear layer





http://slazebni.cs.illinois.edu/spring17/lec01_cnn_architectures.pdf

Fully VS Locally



FULLY CONNECTED NEURAL NET

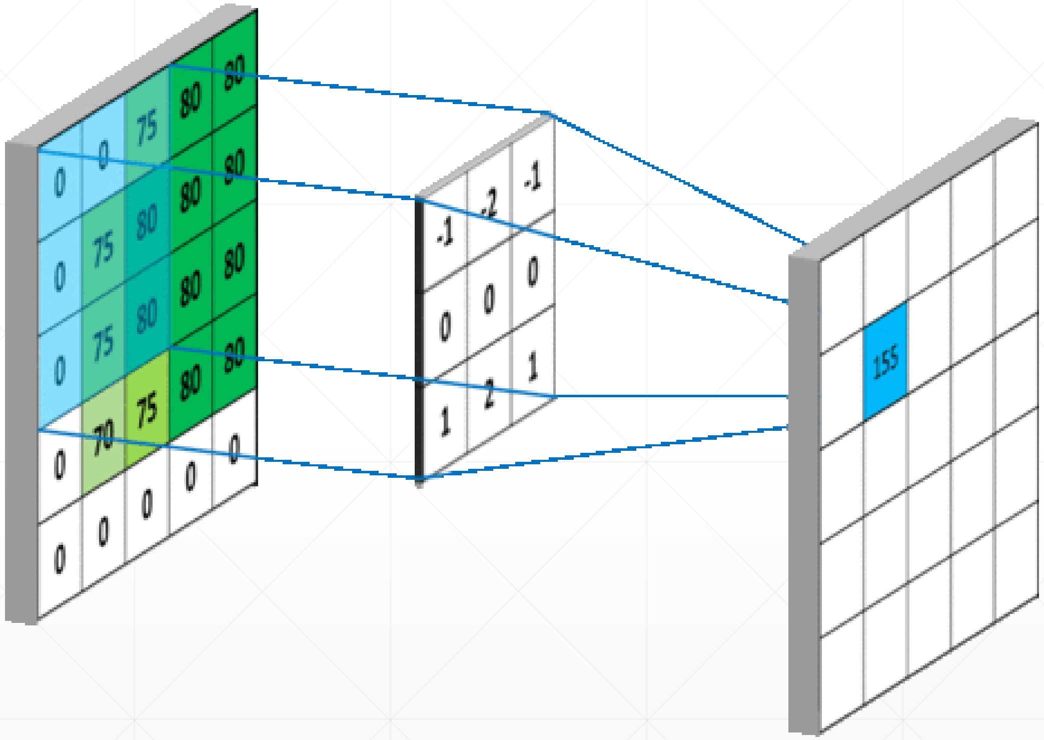
Example: 1000x1000 image
1M hidden units
➡ 10^12 parameter

- Spatial correlation is local
- Better to put resources elsewhere!

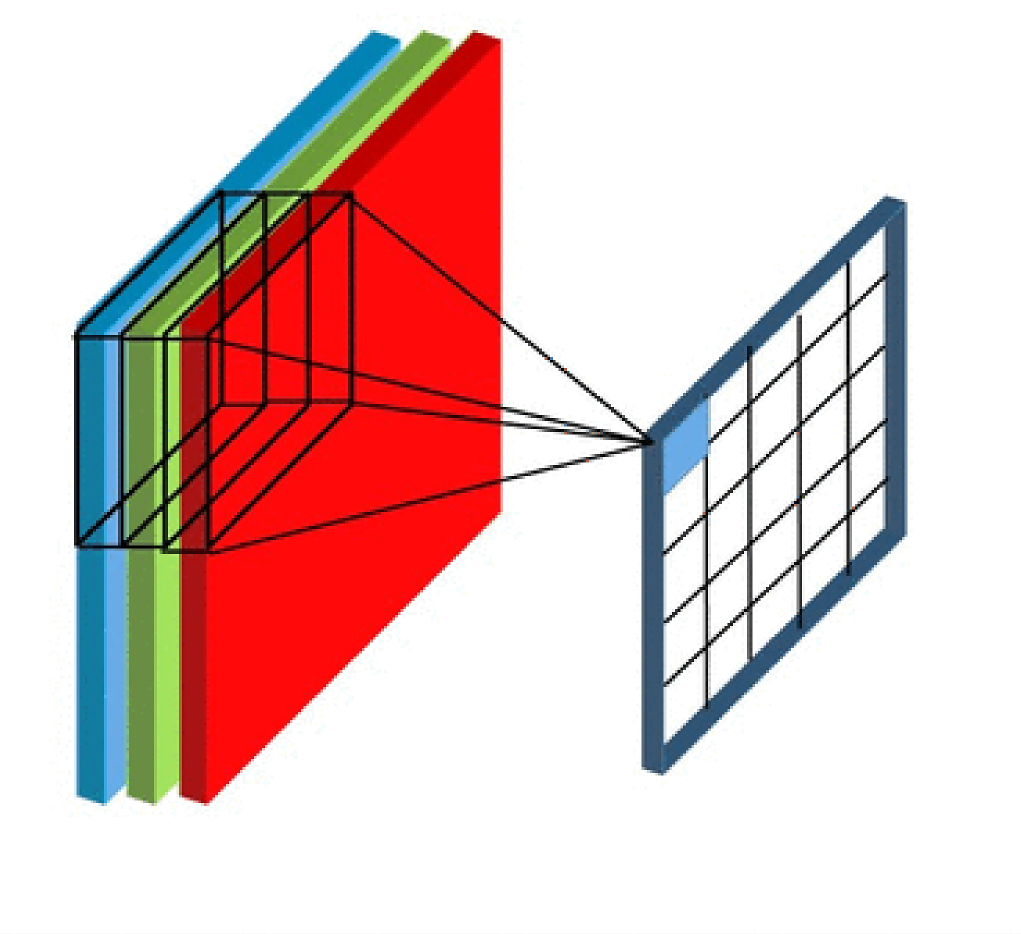
LOCALLY CONNECTED NEURAL NET

Example: 1000x1000 image
1M hidden units
Filter size: 10x10
100M parameters

Weight Sharing

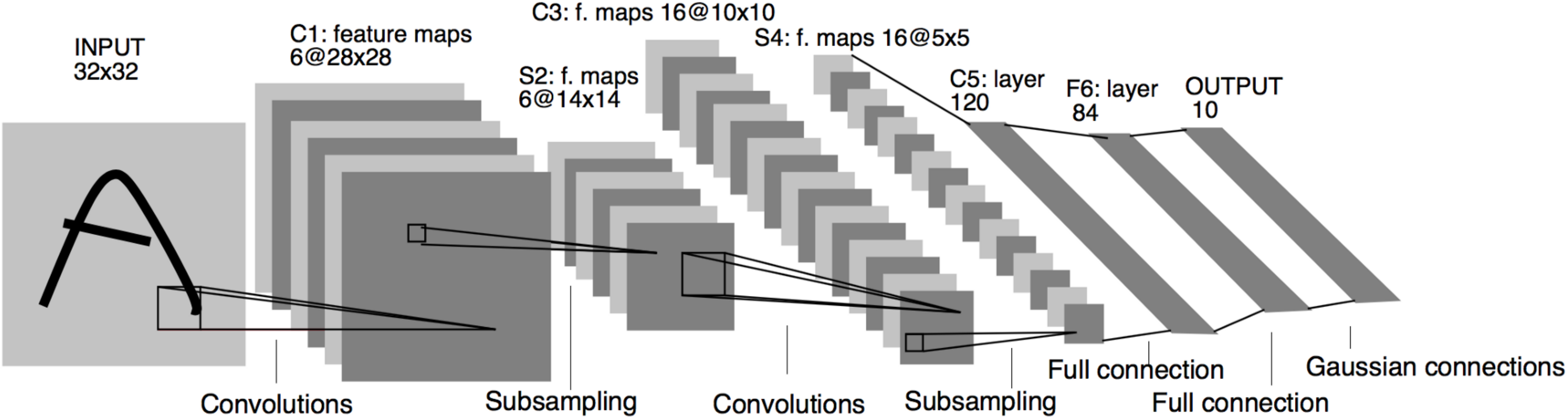


Weight Sharing



Weight sharing

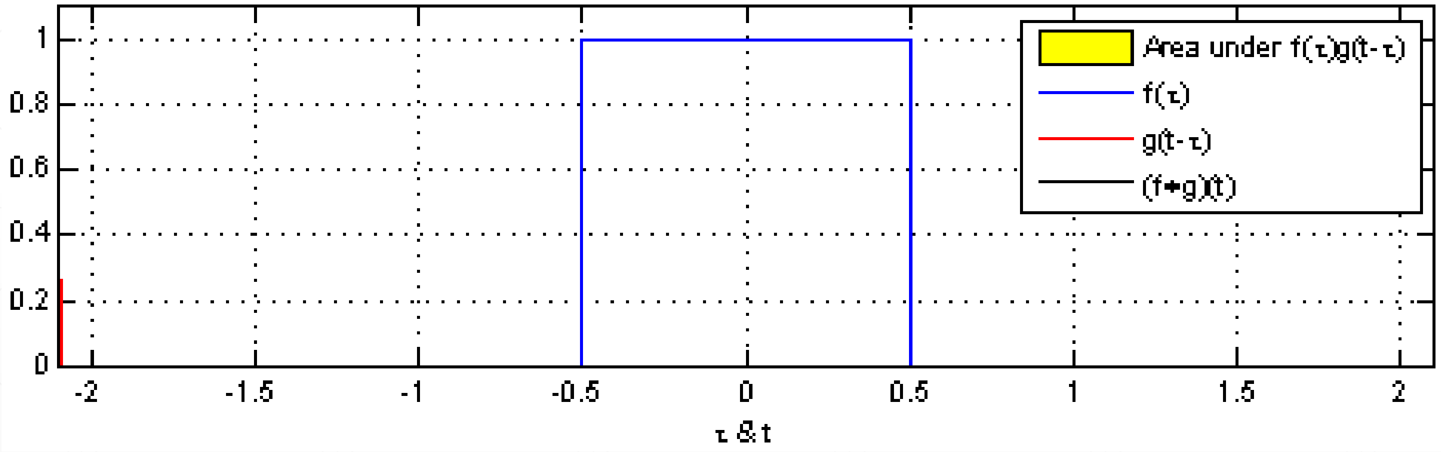
- 6 Layers
  - ~60k parameters
- 4 layers, 335K



http://yann.lecun.com/exdb/publis/pdf/lecun-89e.pdf

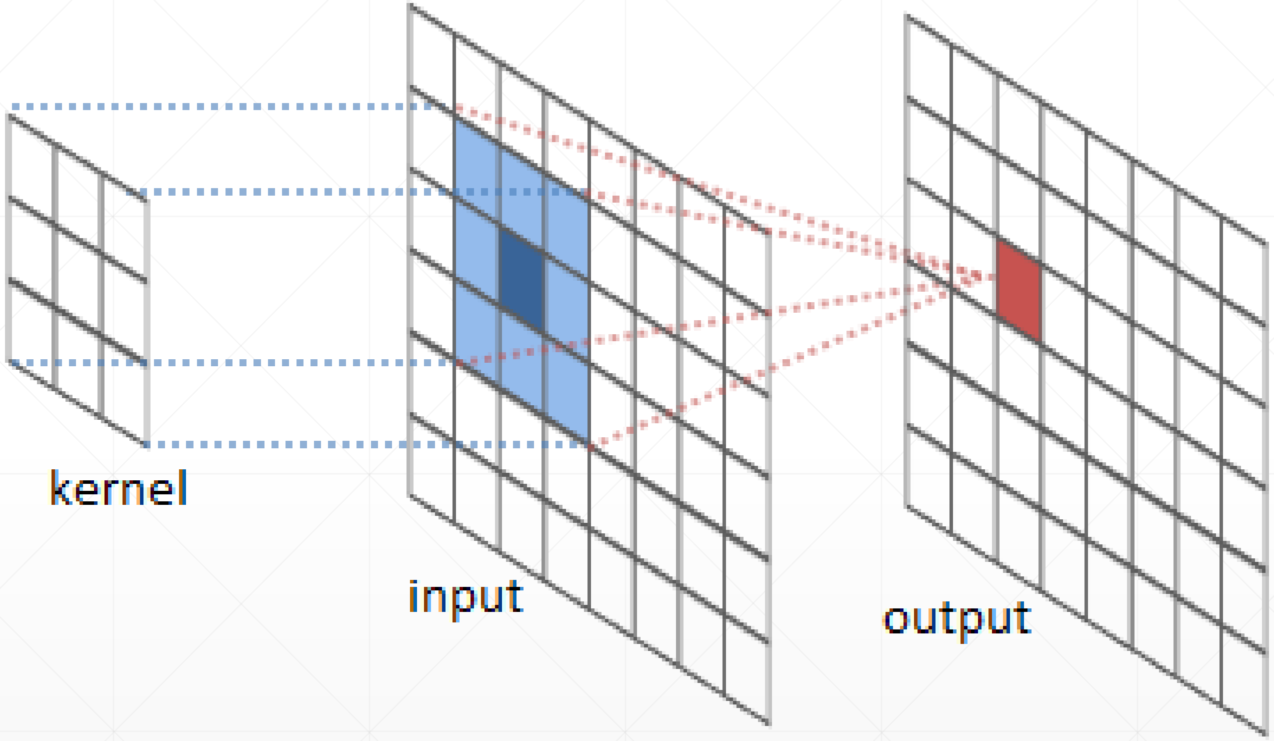
Why call Convolution?

$$y(t) = x(t) * h(t) = \int_{-\infty}^{\infty} x(\tau)h(t-\tau)d\tau$$



2D Convolution

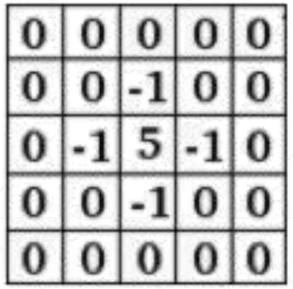
$$y(t) = x(t) * h(t) = \int_{-\infty}^{\infty} x(\tau)h(t-\tau)d\tau$$



$g(x,y)$ $f(x,y)$ $o(\Delta x, \Delta y)$

Convolution in Computer Vision

Sharpen:

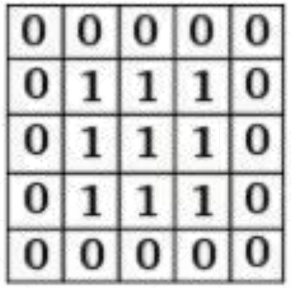


0	0	0	0	0
0	0	-1	0	0
0	-1	5	-1	0
0	0	-1	0	0
0	0	0	0	0

https://www.superdatascience.com/convolutional-neural-networks-cnn-step-1-convolution-operation/

Convolution in Computer Vision

Blur:

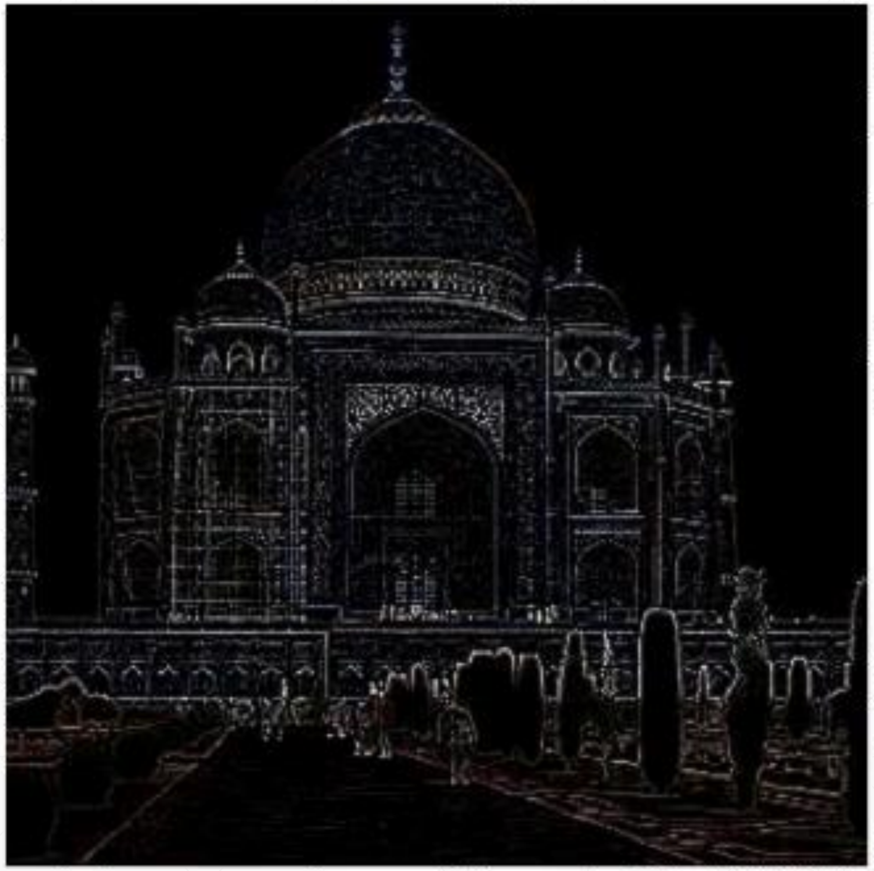


0	0	0	0	0
0	1	1	1	0
0	1	1	1	0
0	1	1	1	0
0	0	0	0	0

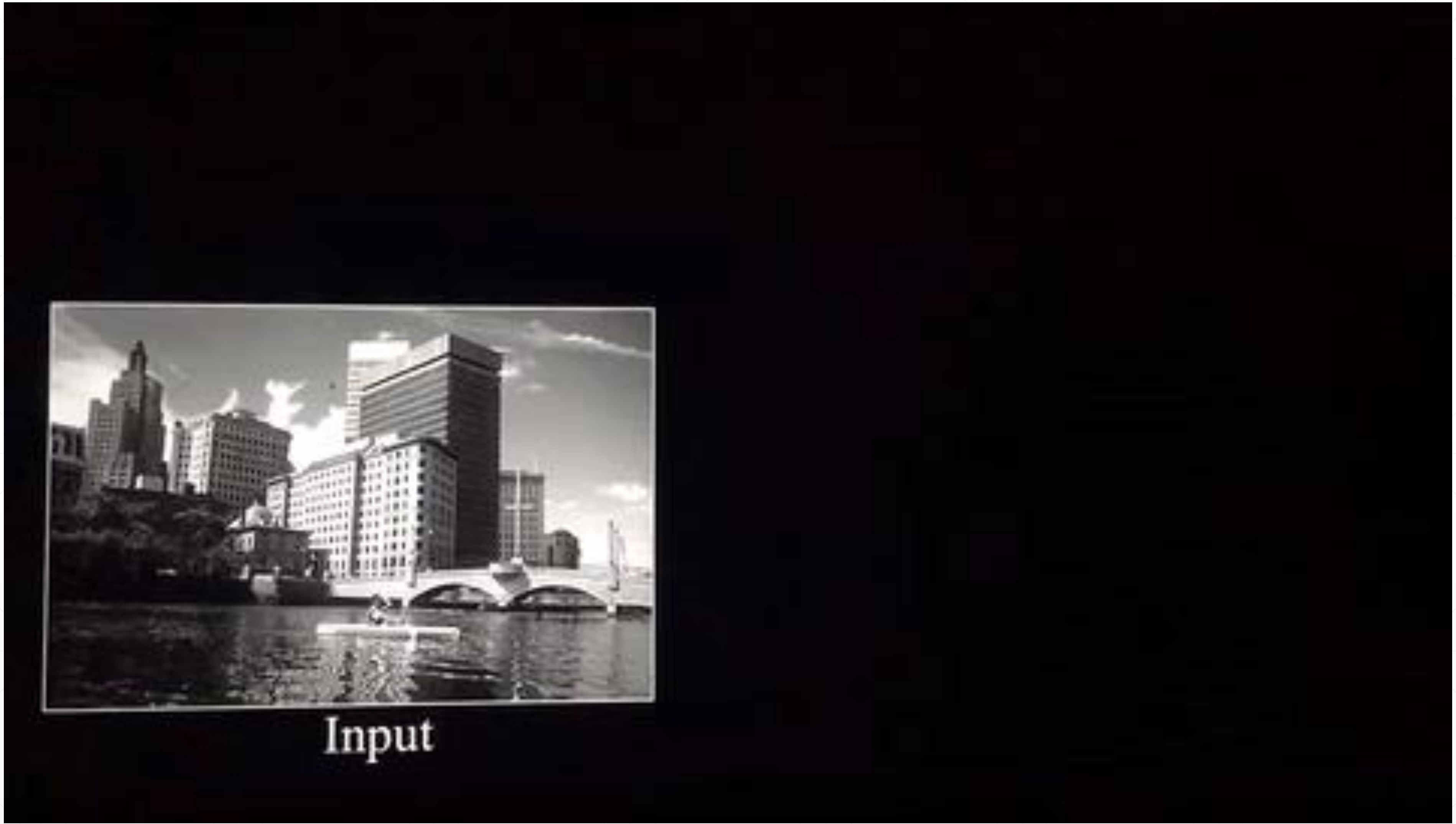
Convolution in Computer Vision

Edge Detect:

	0	1	0	
	1	-4	1	
	0	1	0	



CNN on feature maps



https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/

下一课时

卷积神经网络

Thank You.