Welcome!

GM **#9** | HHS CS


CNN


Why do we even want CNNs?
option
command

(Each pixel in an image has # value)

28 pixels

28

784

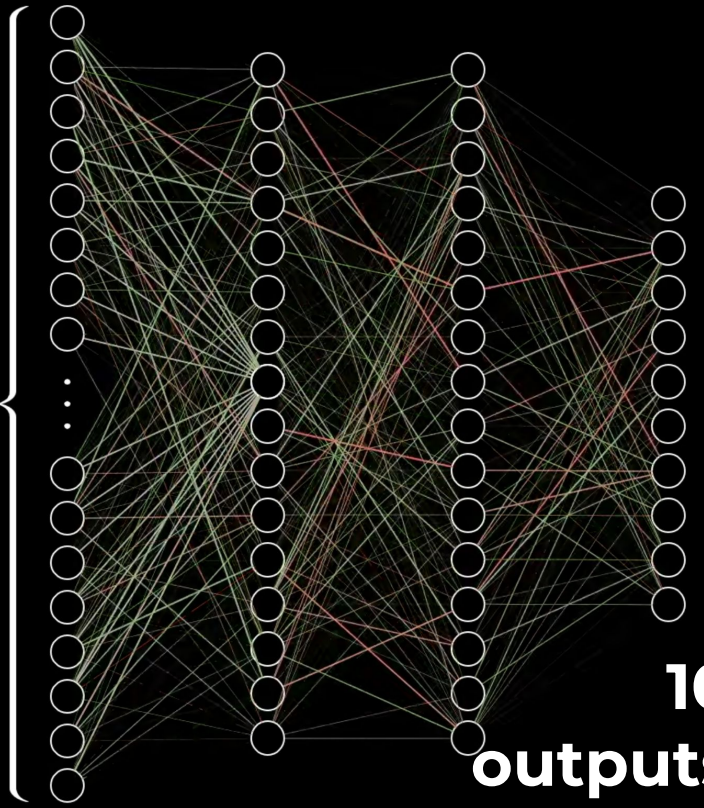
10 outputs

What if bigger images?

1000 pixels

1000

1 million



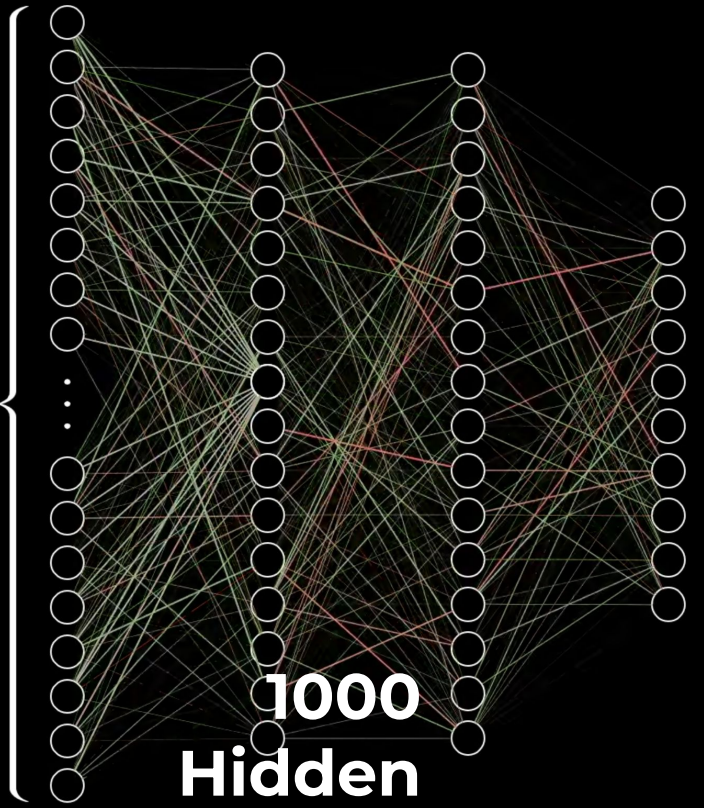
10 outputs

What if bigger images?

1000 pixels

1000

1 million



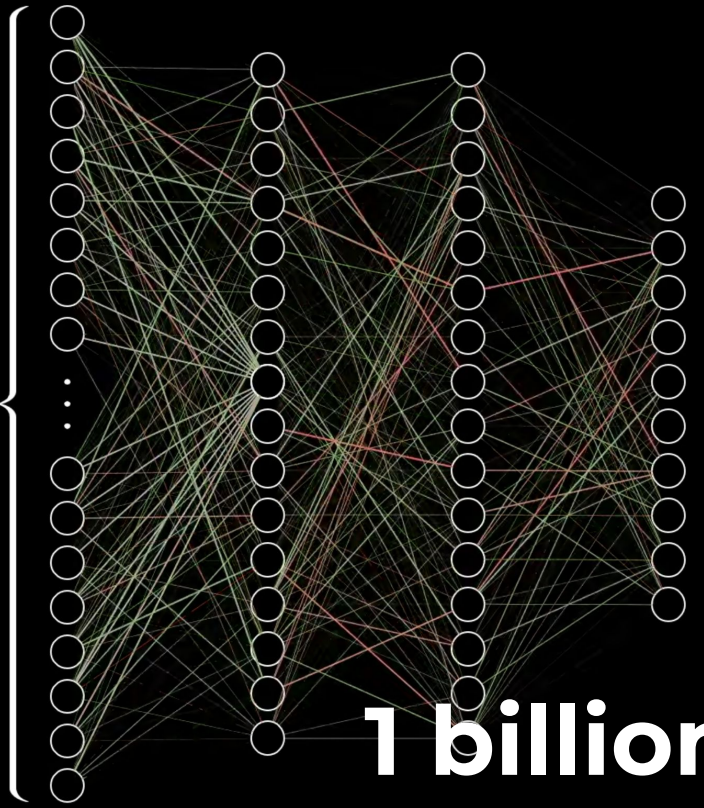
1000 Hidden Layers

What if bigger images?

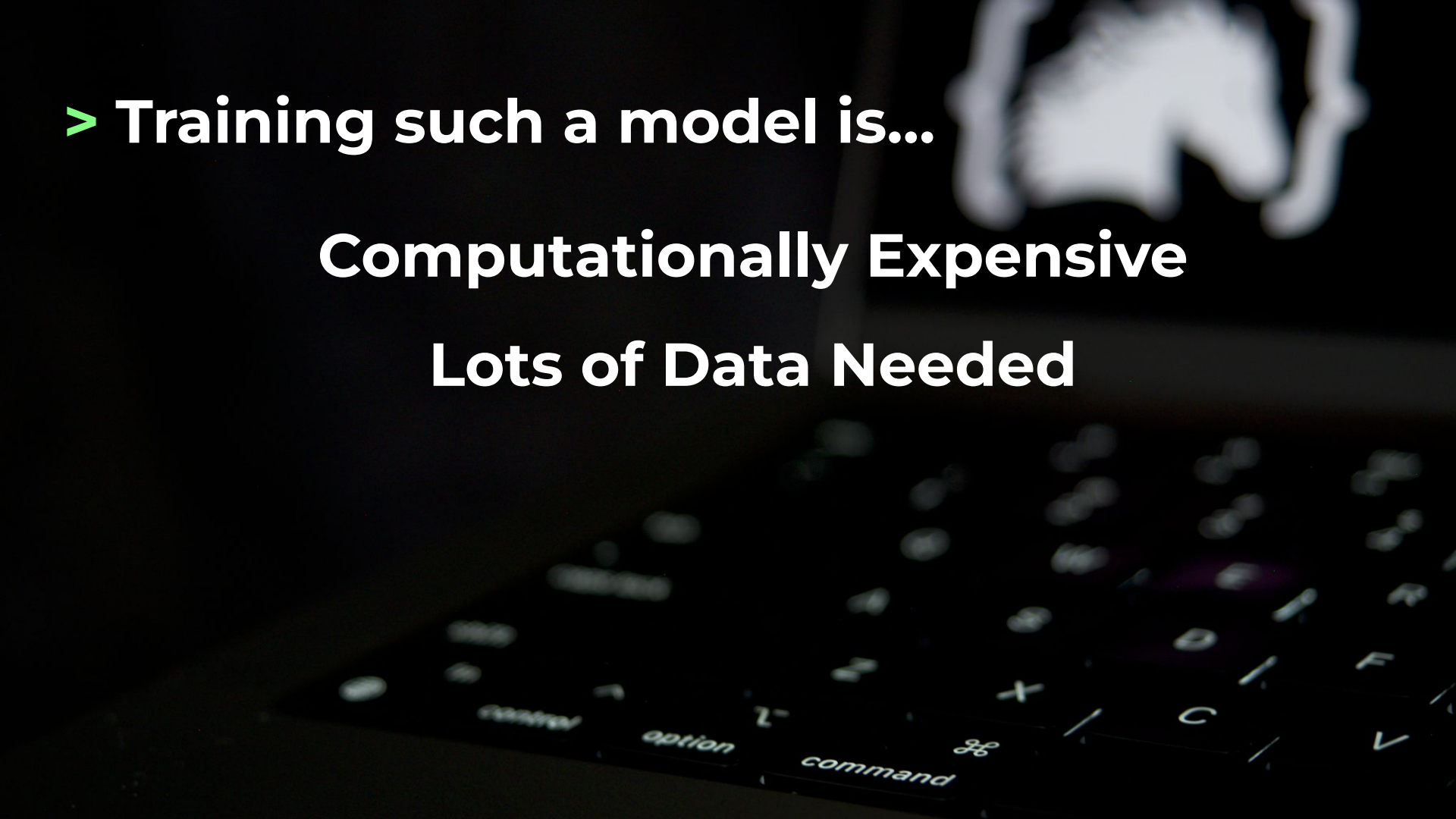
1000 pixels

1000

1 million



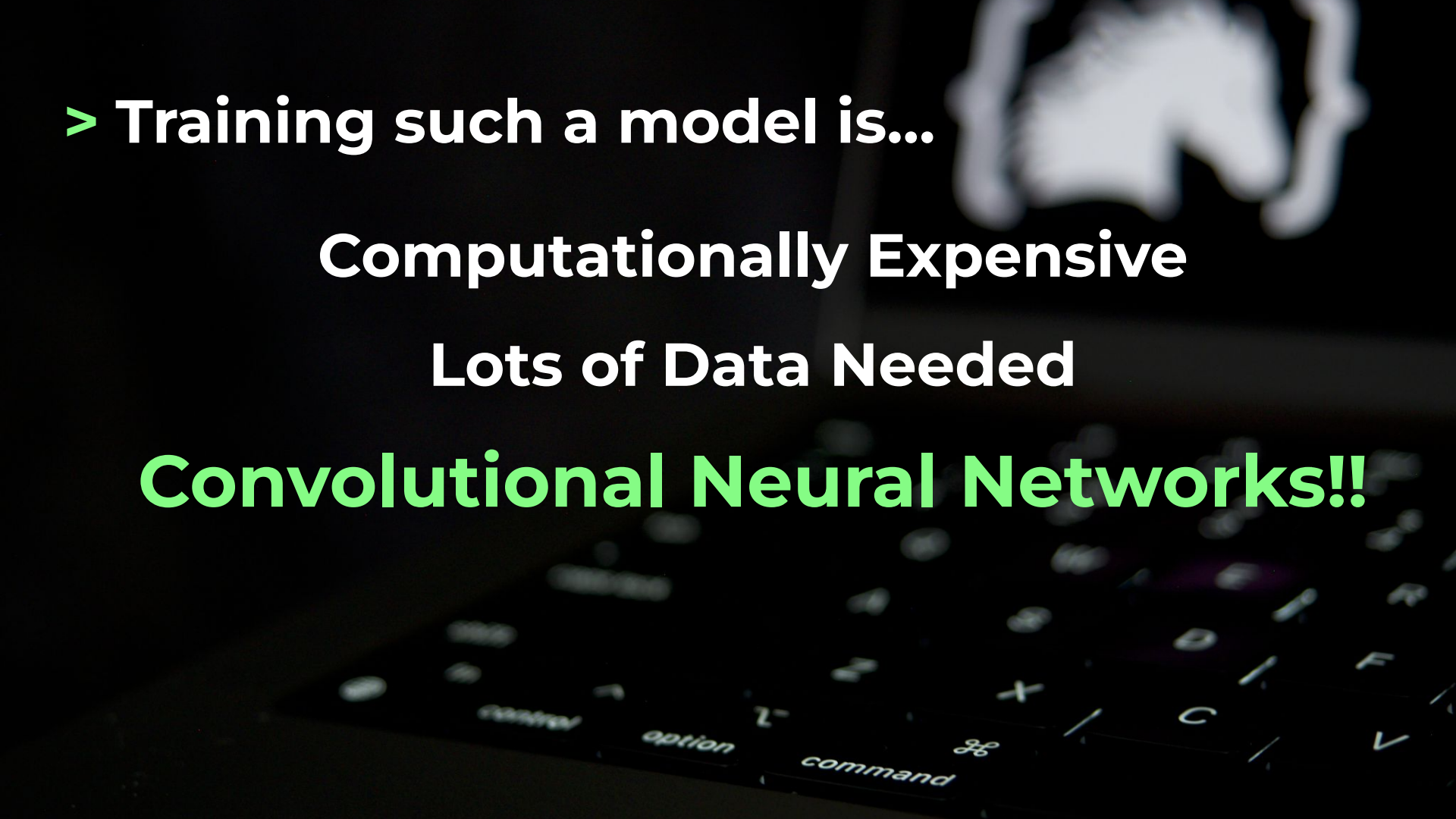
1 billion parameters!!



> Training such a model is...

Computationally Expensive

Lots of Data Needed



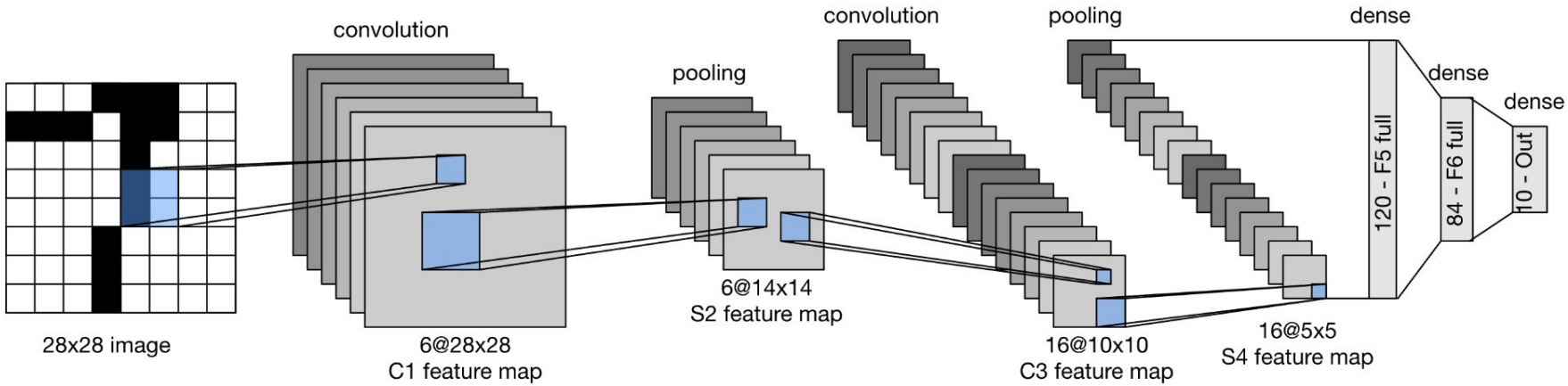
> Training such a model is...

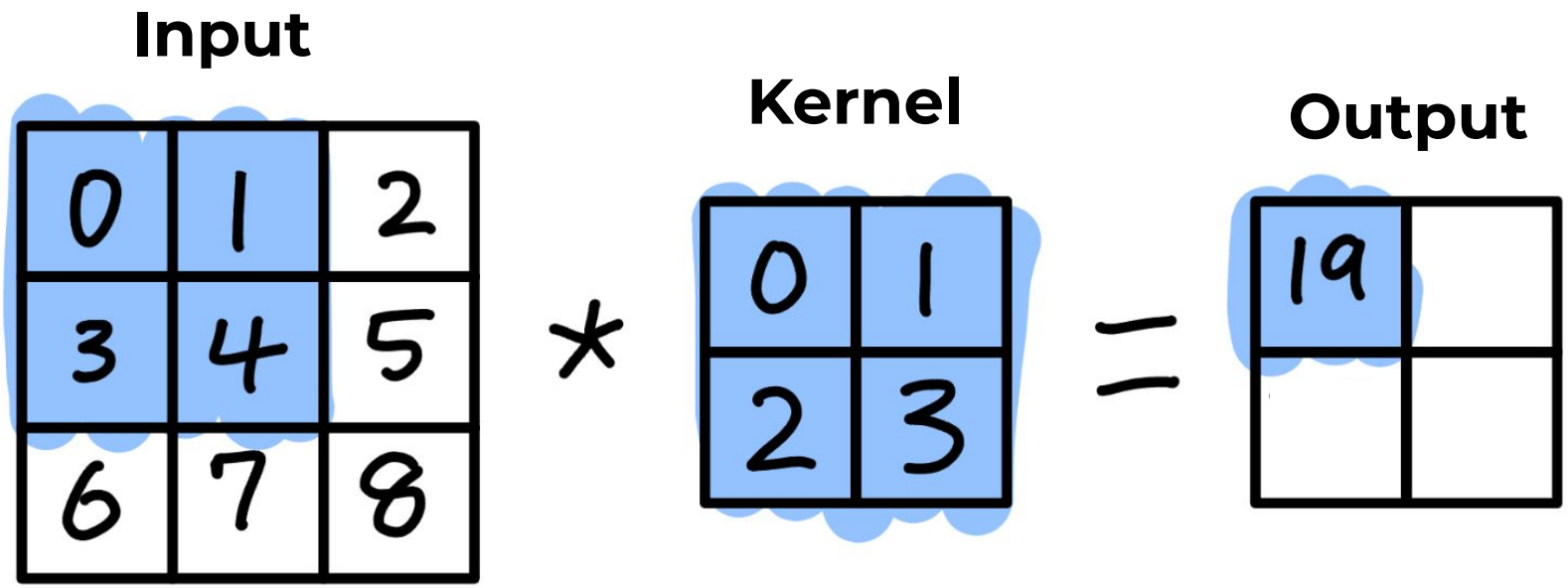
Computationally Expensive

Lots of Data Needed

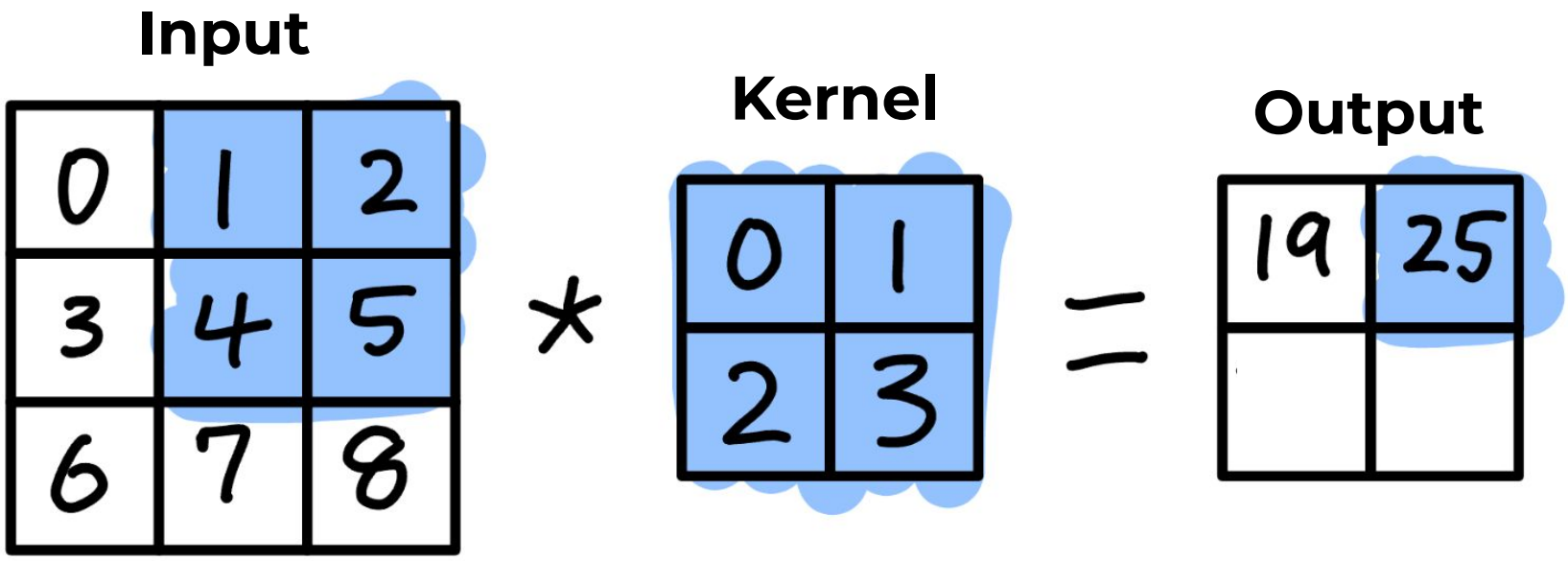
Convolutional Neural Networks!!

> Convolutions

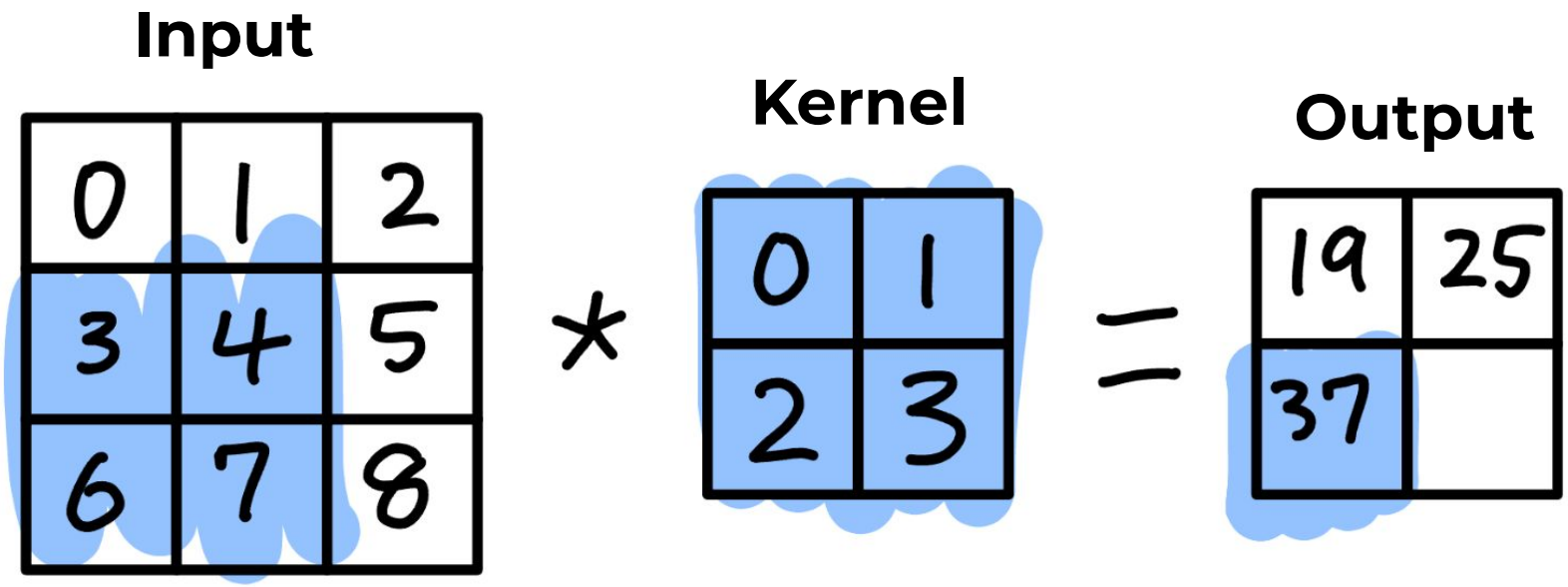


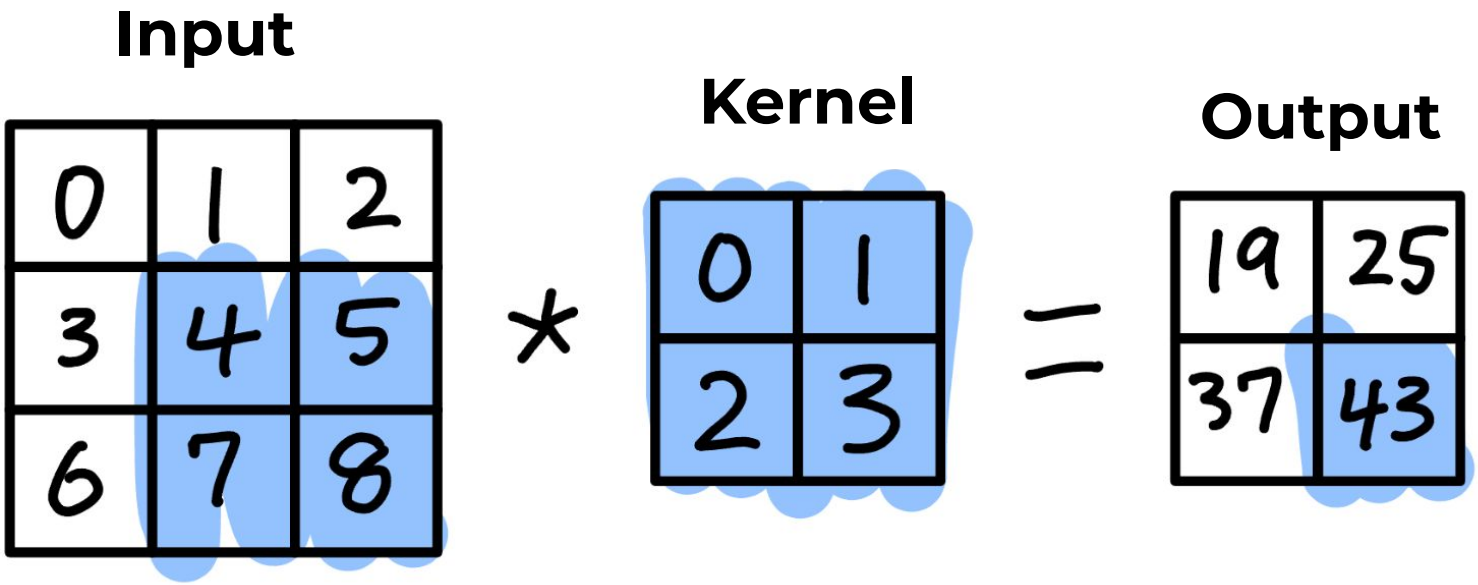


$$0 \times 0 + 1 \times 1 + 3 \times 2 + 4 \times 3 = 19$$

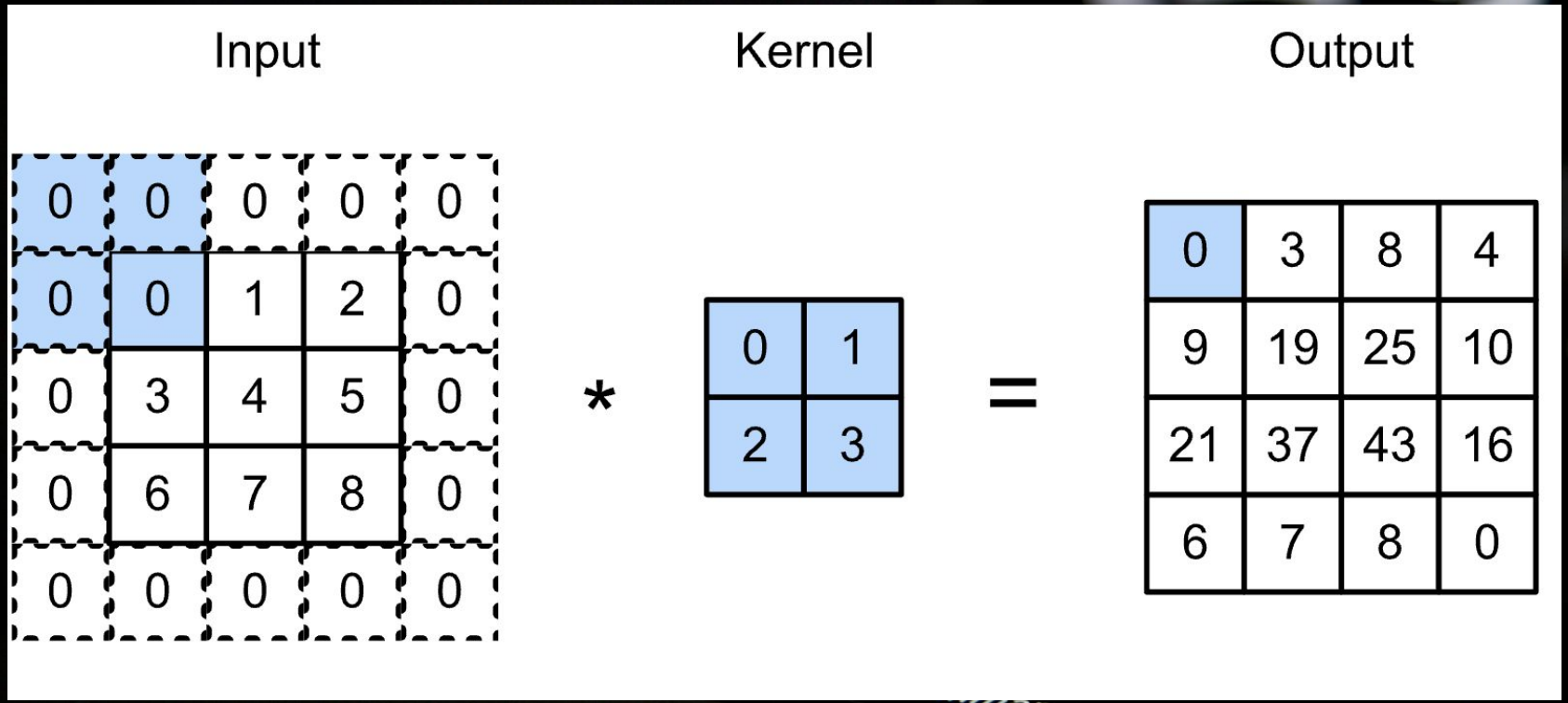


$$1 \times 0 + 2 \times 1 + 4 \times 2 + 5 \times 3 = 25$$

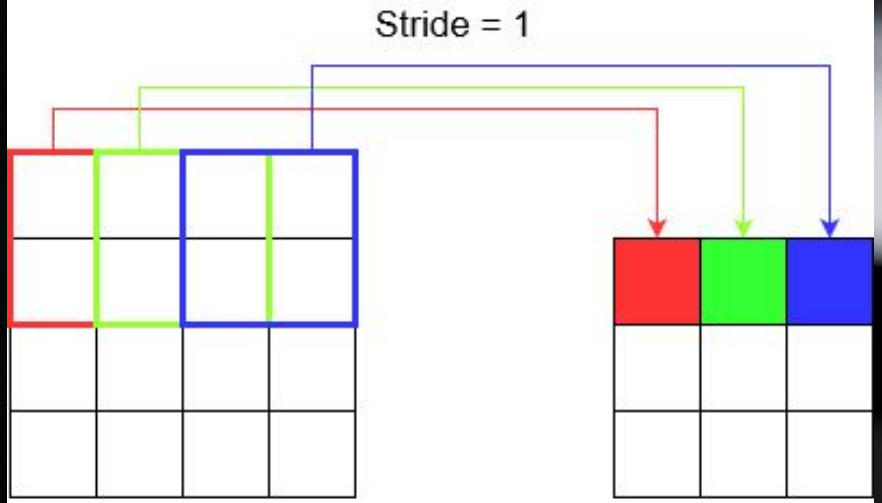

Input
0 1 2
3 4 5
6 7 8
*
Kernel
0 1
2 3
=
Output
19 25
37

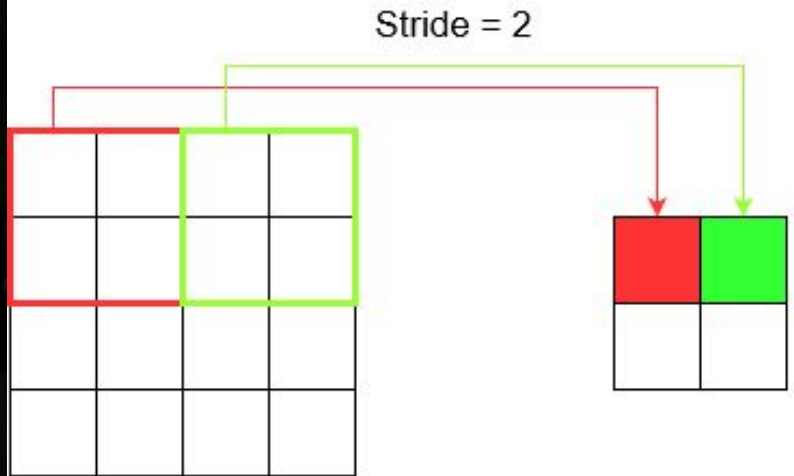

Input
Kernel
Output
0 1 2
3 4 5
6 7 8
*
0 1
2 3
=
19 25
37 43

> Padding

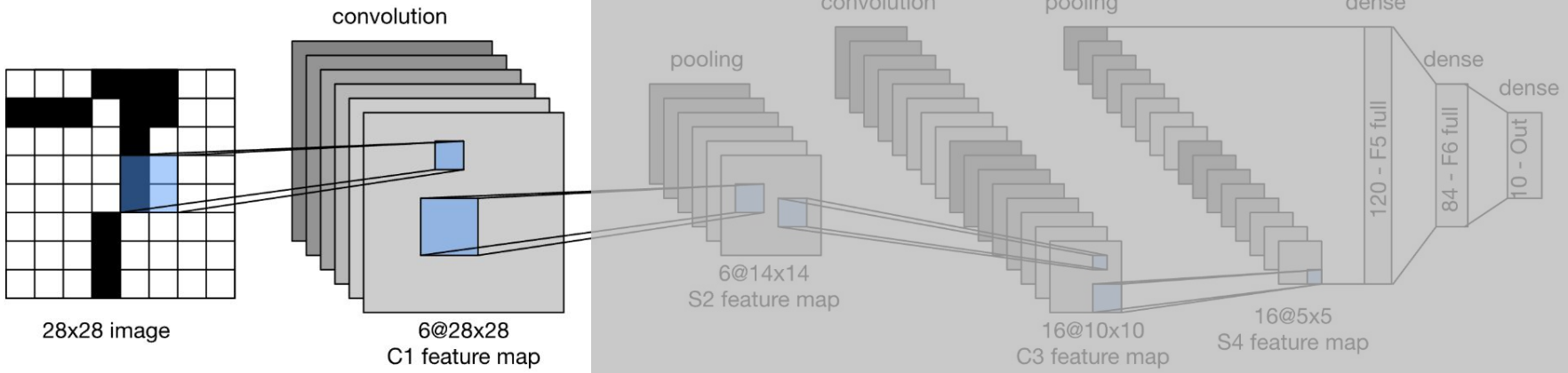

Input
Kernel
Output
0 0 0 0 0
0 0 1 2 0
0 3 4 5 0
0 6 7 8 0
0 0 0 0 0
*
0 1
2 3
=
0 3 8 4
9 19 25 10
21 37 43 16
6 7 8 0

> Stride





> CNNs


convolution
pooling
convolution
pooling
dense
dense
dense
120 - F5 full
84 - F6 full
10 - Out
28x28 image
6@28x28
C1 feature map
6@14x14
S2 feature map
16@10x10
C3 feature map
16@5x5
S4 feature map

Input

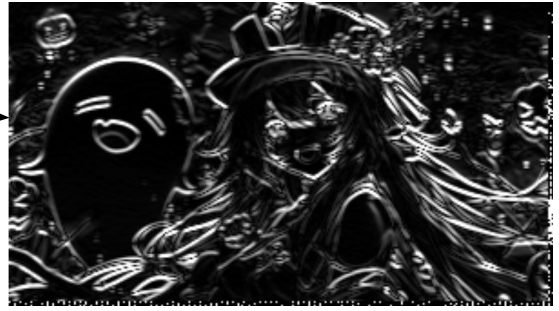
Kernels

```
[[-1, 0, 1],
 [-1, 0, 1],
 [-1, 0, 1]]
```

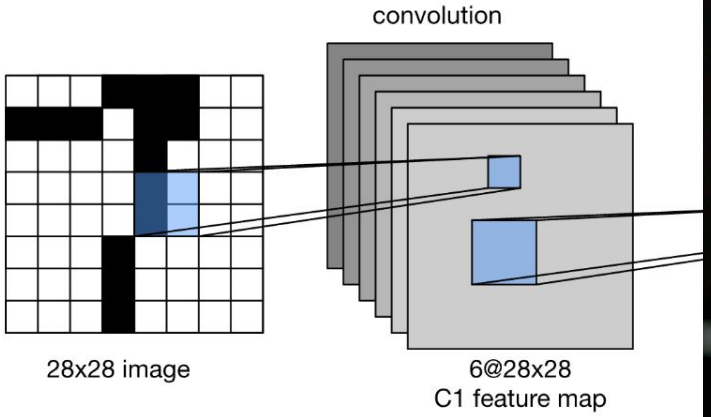
```
[[ 1,  1,  1],
 [ 0,  0,  0],
 [-1, -1, -1]]
```

```
[[1, 1, 1],
 [1, 0, 1],
 [1, 1, 1]]
```

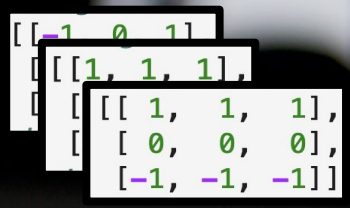
Output



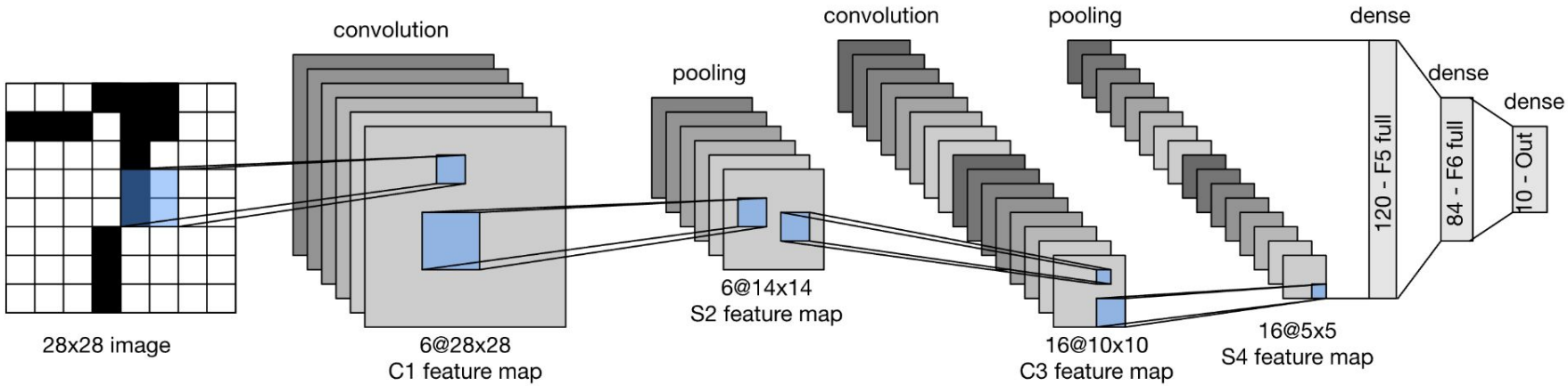
> Channels



Convolutions



> CNNs


convolution
pooling
convolution
pooling
dense
dense
dense
120 - F5 full
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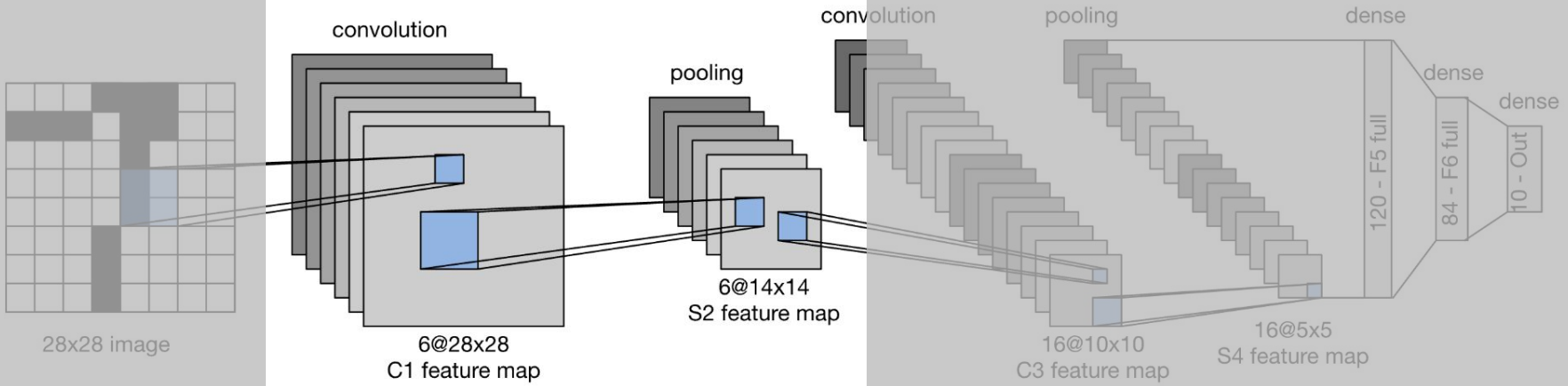
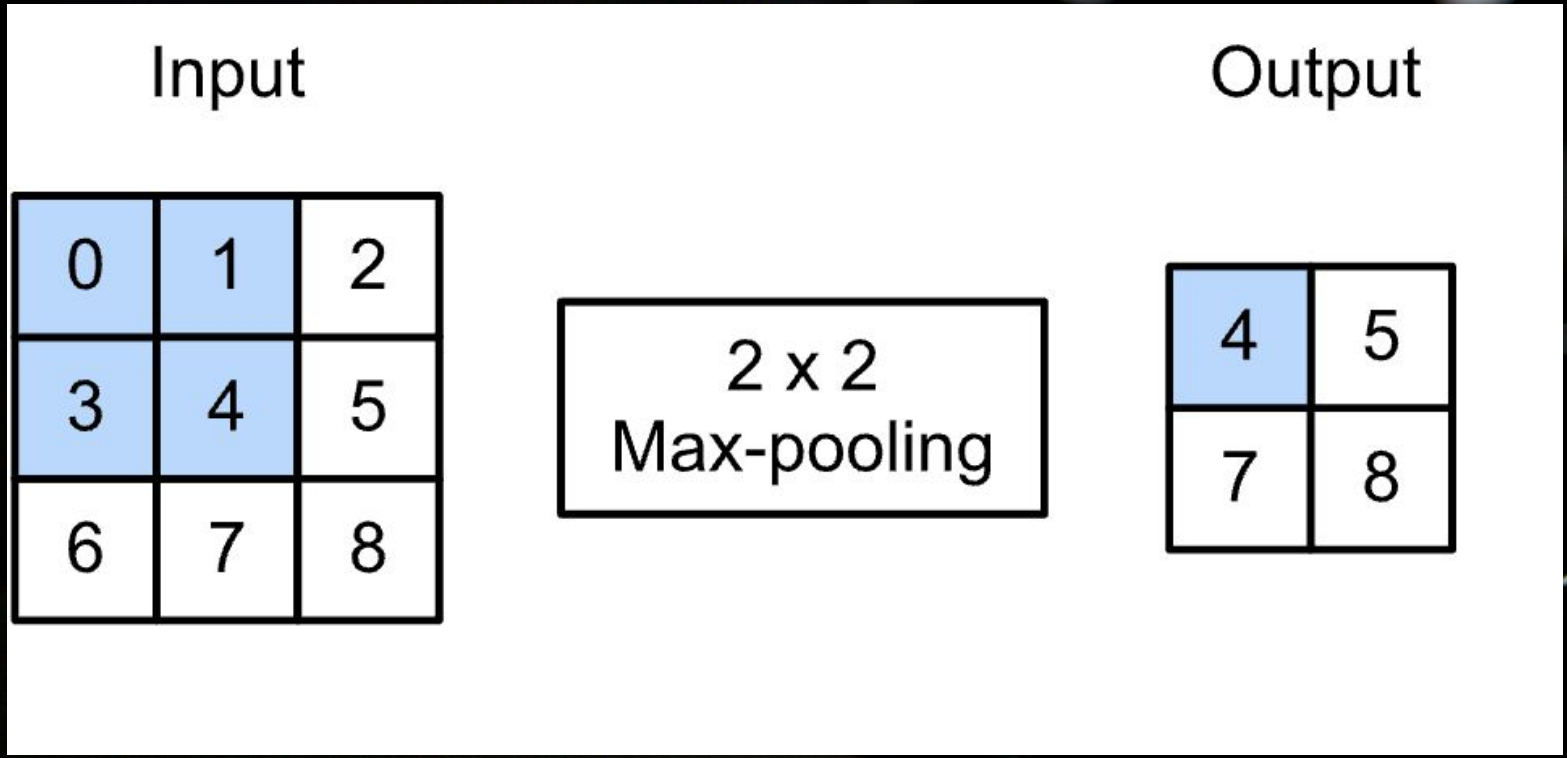
10 - Out
28x28 image
6@28x28
C1 feature map
6@14x14
S2 feature map
16@10x10
C3 feature map
16@5x5
S4 feature map

> Locality Principle

> CNNs


convolution
pooling
convolution
pooling
dense
dense
dense
28x28 image
6@28x28
C1 feature map
6@14x14
S2 feature map
16@10x10
C3 feature map
16@5x5
S4 feature map
120 - F5 full
84 - F6 full
10 - Out

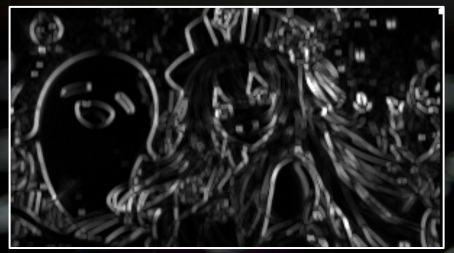
> Pooling



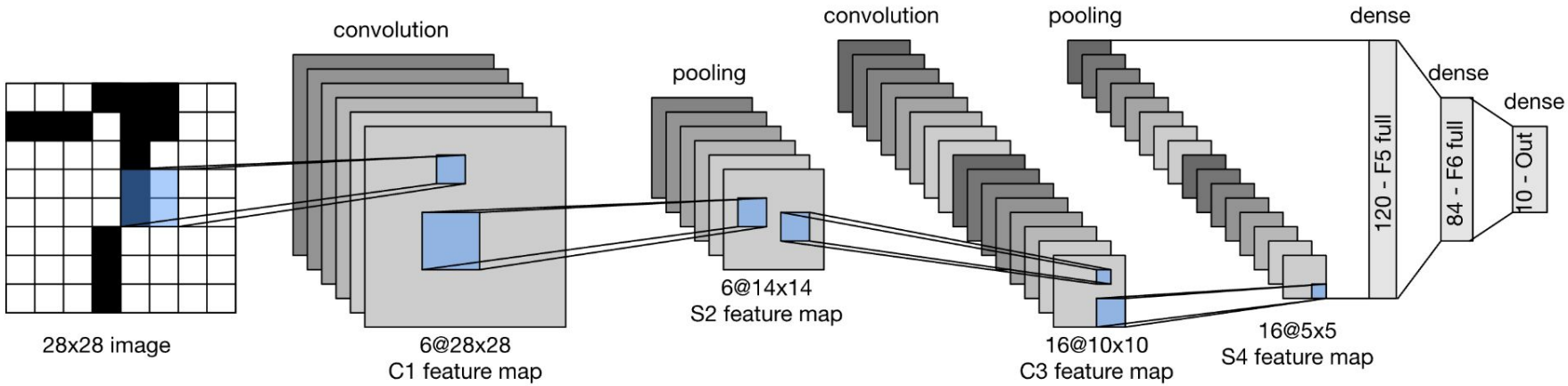
> Pooling

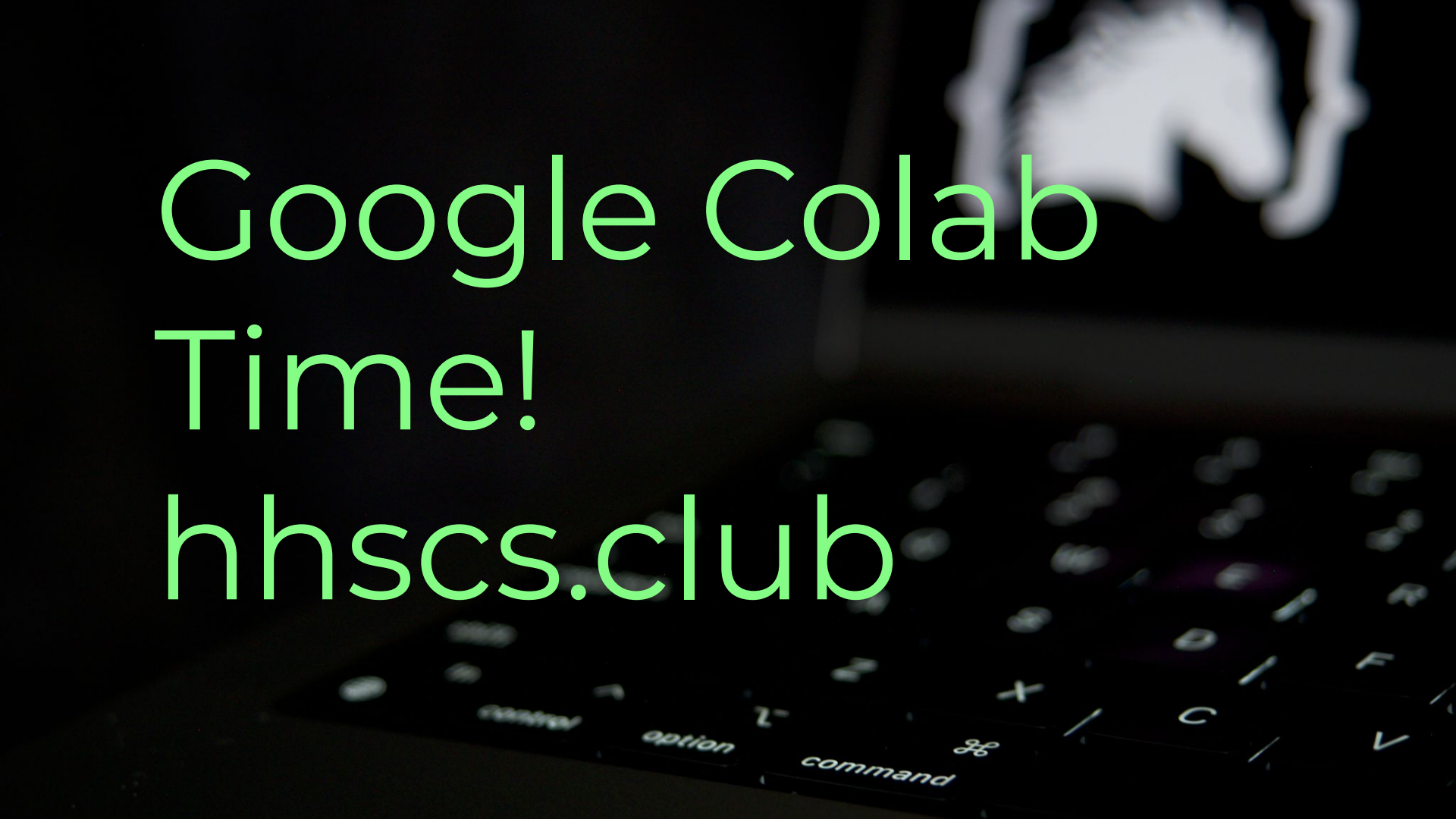
Translation Invariance

Pooling



> LeNet


convolution
pooling
convolution
pooling
dense
dense
dense
120 - F5 full
84 - F6 full
10 - Out
28x28 image
6@28x28
C1 feature map
6@14x14
S2 feature map
16@10x10
C3 feature map
16@5x5
S4 feature map



Google Colab Time!

hhscs.club

> Socials

Website: hhscs.club

Email List:

Insta:

@hhscomputerscience

Discord:

Next Meeting:

Tuesday (11/7) Lunch