Deep Study of Deep Learning

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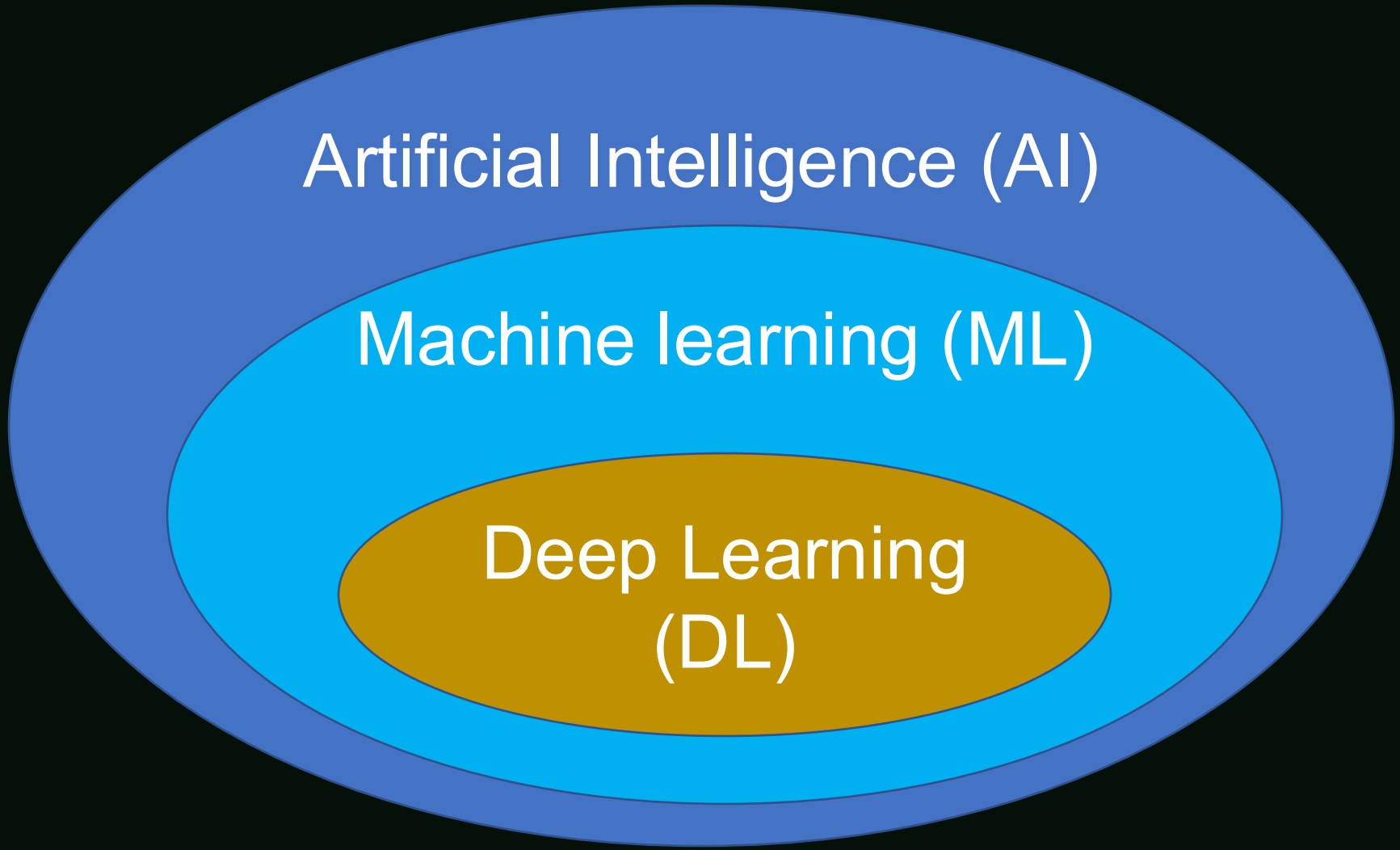
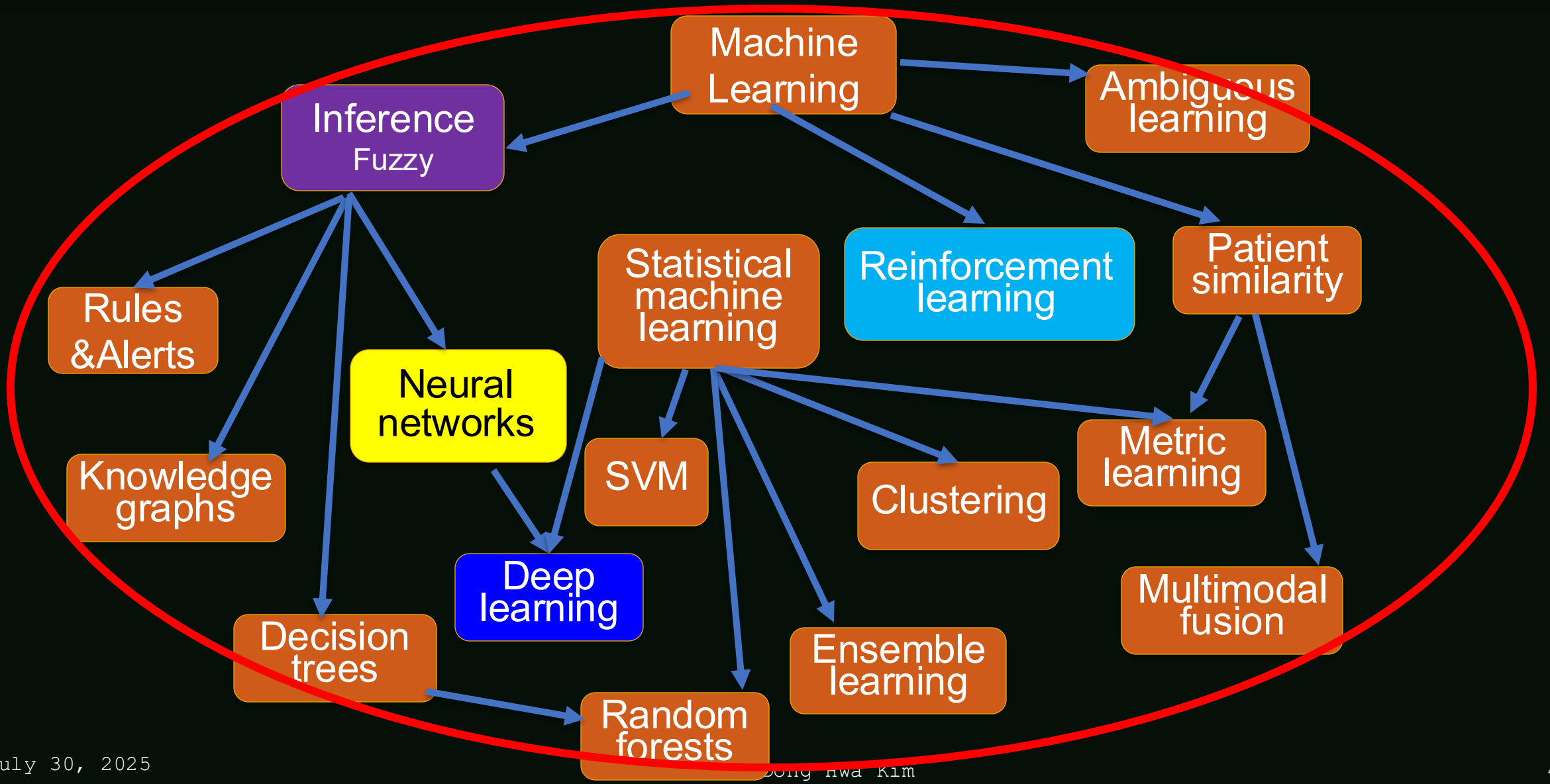
Content

- Status and Motivation for Study
- Machine learning and Deep learning
- Convolution Neural Network
- CNN and DL
- CNN Example
- Implementation in TensorFlow

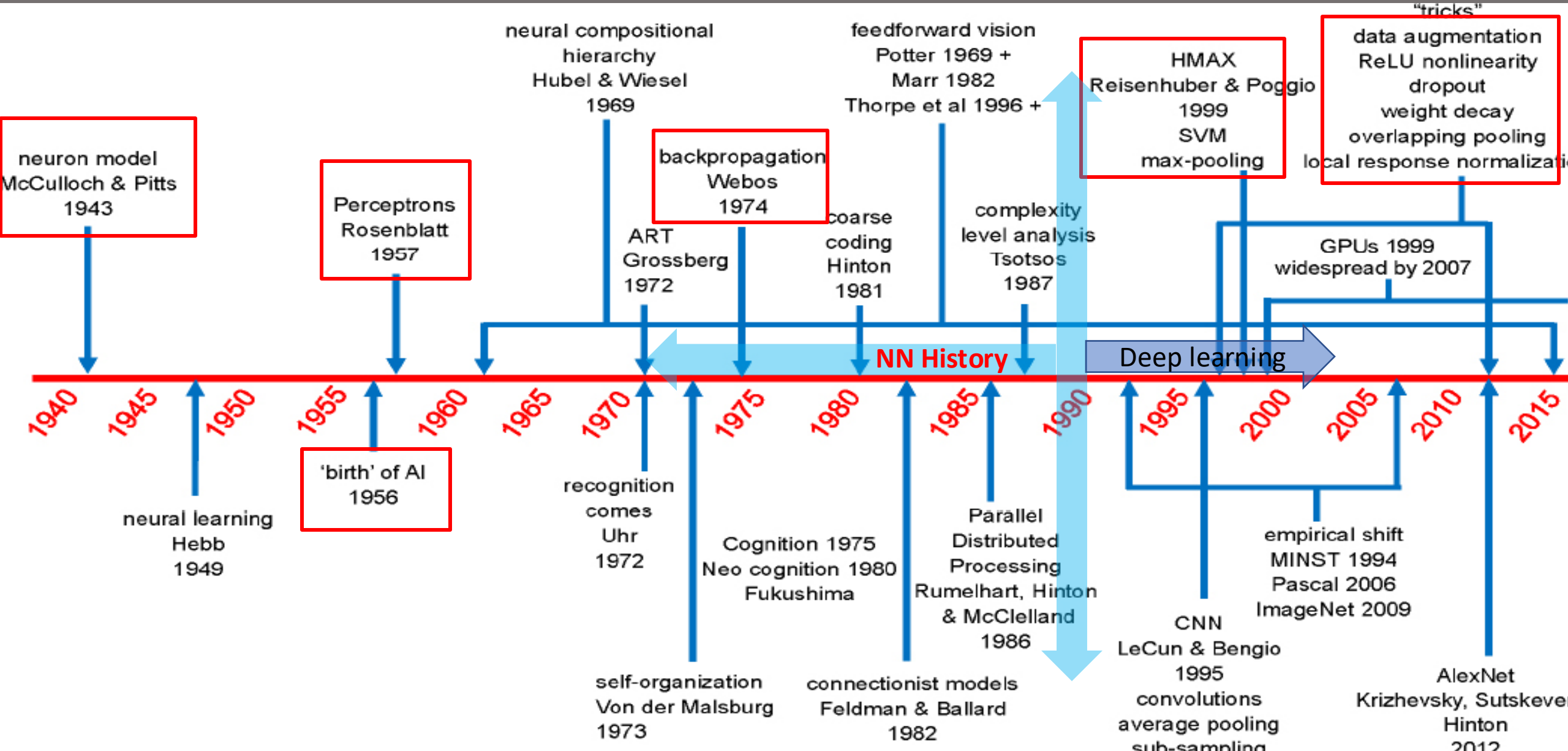
Areas of AI Fields



Where is the DL in AI areas



Deep Learning Timeline



How is DL Useful?

- Core technology for 4th wave
- To help business decisions
- Scientific analysis
- New development for material science
- Social pattern analysis
- New technology development

ML vs DL

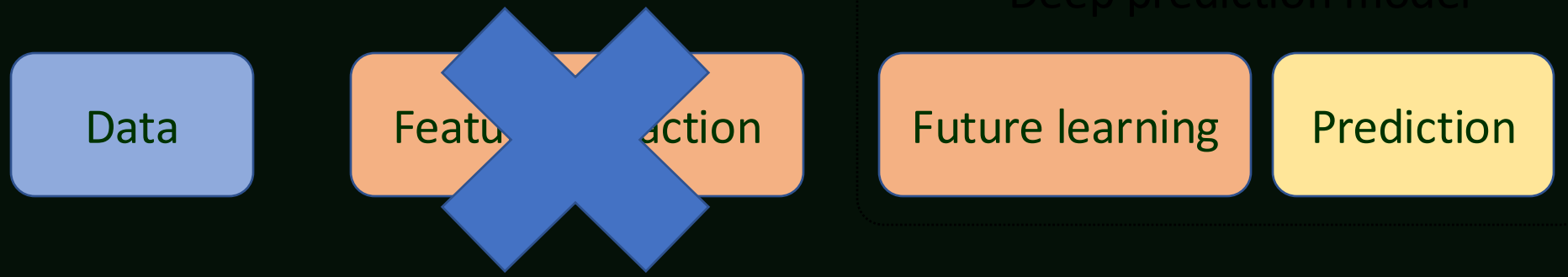
Why so Popular?

Item	ML	DL
Training data	Small	Large
Choose your own features	Yes	No
# of classifiers available	Many	Few
Training time	Short	Long

ML vs. DL

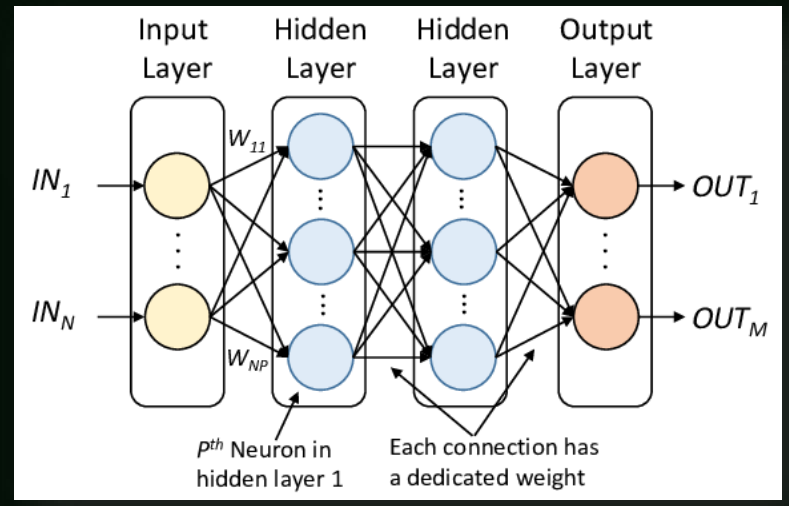
Conventional Machine Learning

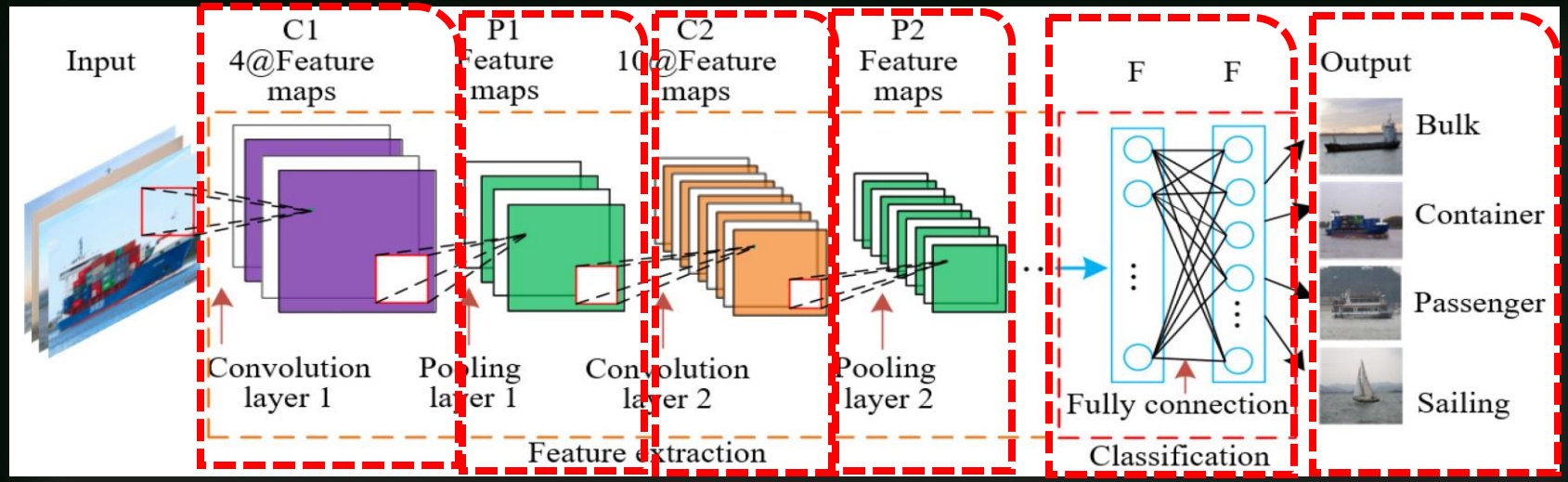
Deep Learning



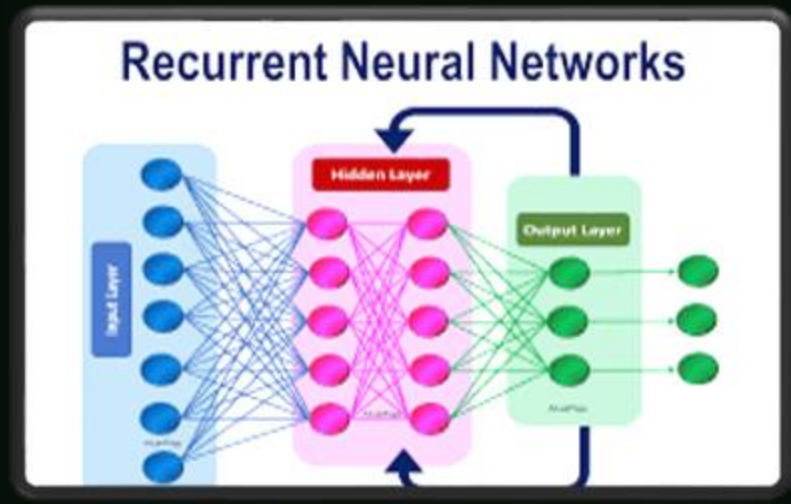
Structure of CNN to Use

- Fully connection





- Convolutional Neural Network

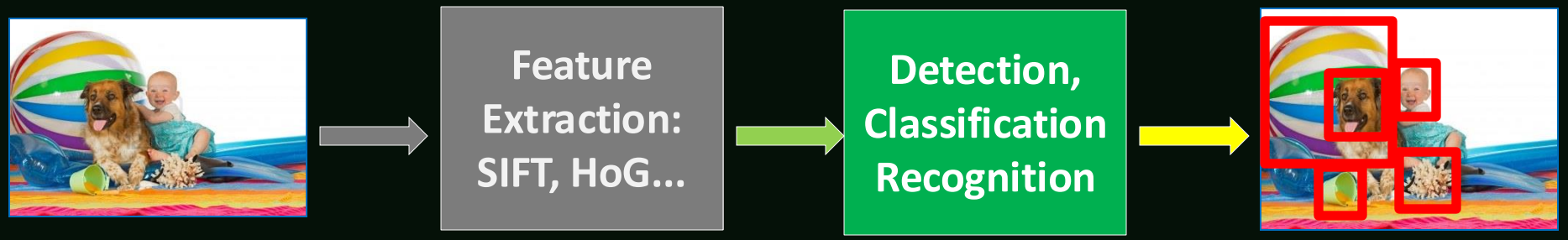


- Recurrent Neural Network

Classical Computer Vision (CV).

CV experts

1. Select / develop features: SURF, SIFT, RIFT, …
2. Add material and modify for multi-class future

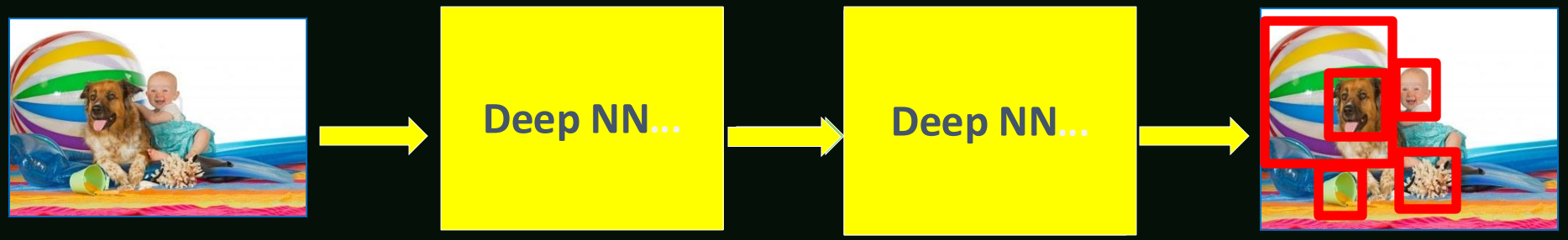


CV is time-consuming

Deep Learning –based Vision

Deep Learning:

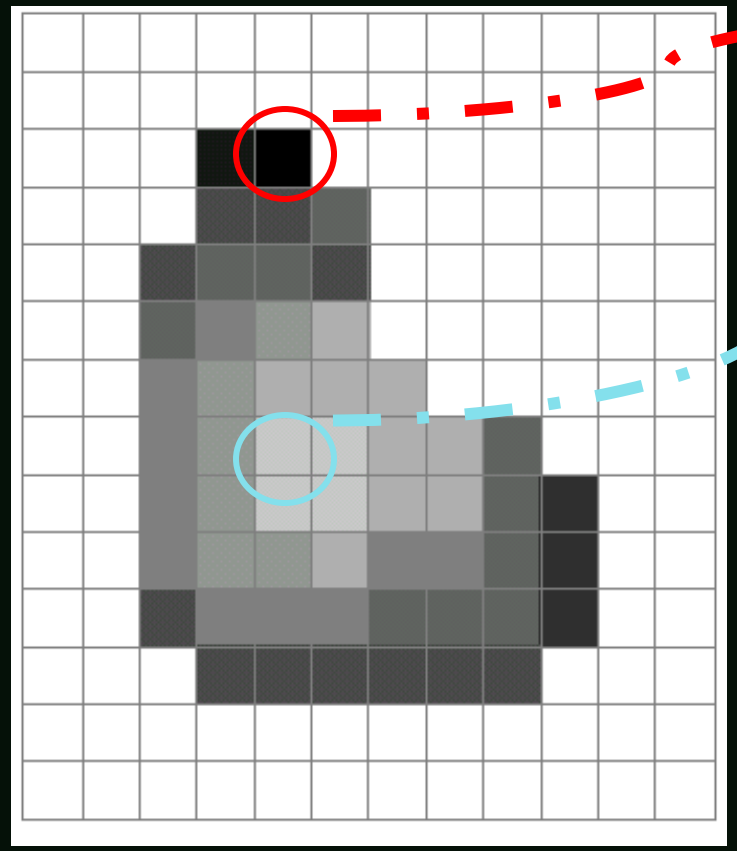
- Build features automatically based on training data
- Combine feature extraction and classification by DL



DL train good feature automatically within short time

What is an image?

- A grid (matrix) of intensity values



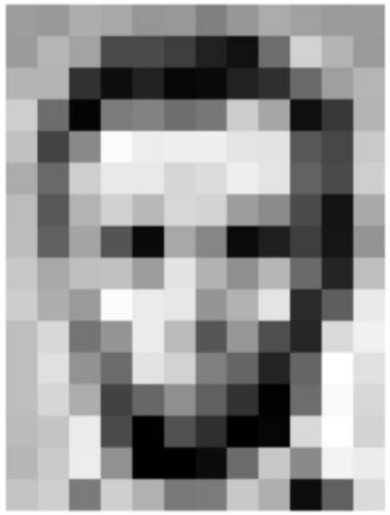
=

255	255	255	255	255	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255	255	255	255	255
255	255	255	20	0	255	255	255	255	255	255	255
255	255	255	75	75	75	255	255	255	255	255	255
255	255	75	95	95	75	255	255	255	255	255	255
255	255	96	127	145	175	255	255	255	255	255	255
255	255	127	145	175	175	175	255	255	255	255	255
255	255	127	145	200	200	175	175	95	255	255	255
255	255	127	145	200	200	175	175	95	47	255	255
255	255	127	145	145	175	127	127	95	47	255	255
255	255	74	127	127	127	95	95	95	47	255	255
255	255	255	74	74	74	74	74	74	255	255	255
255	255	255	255	255	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255	255	255	255	255

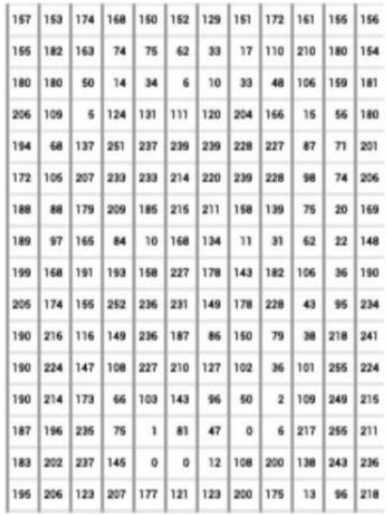
(common to use one byte per value: 0 = black, 255 = white)

Classification Function of DL

Tasks in Computer Vision



Input Image



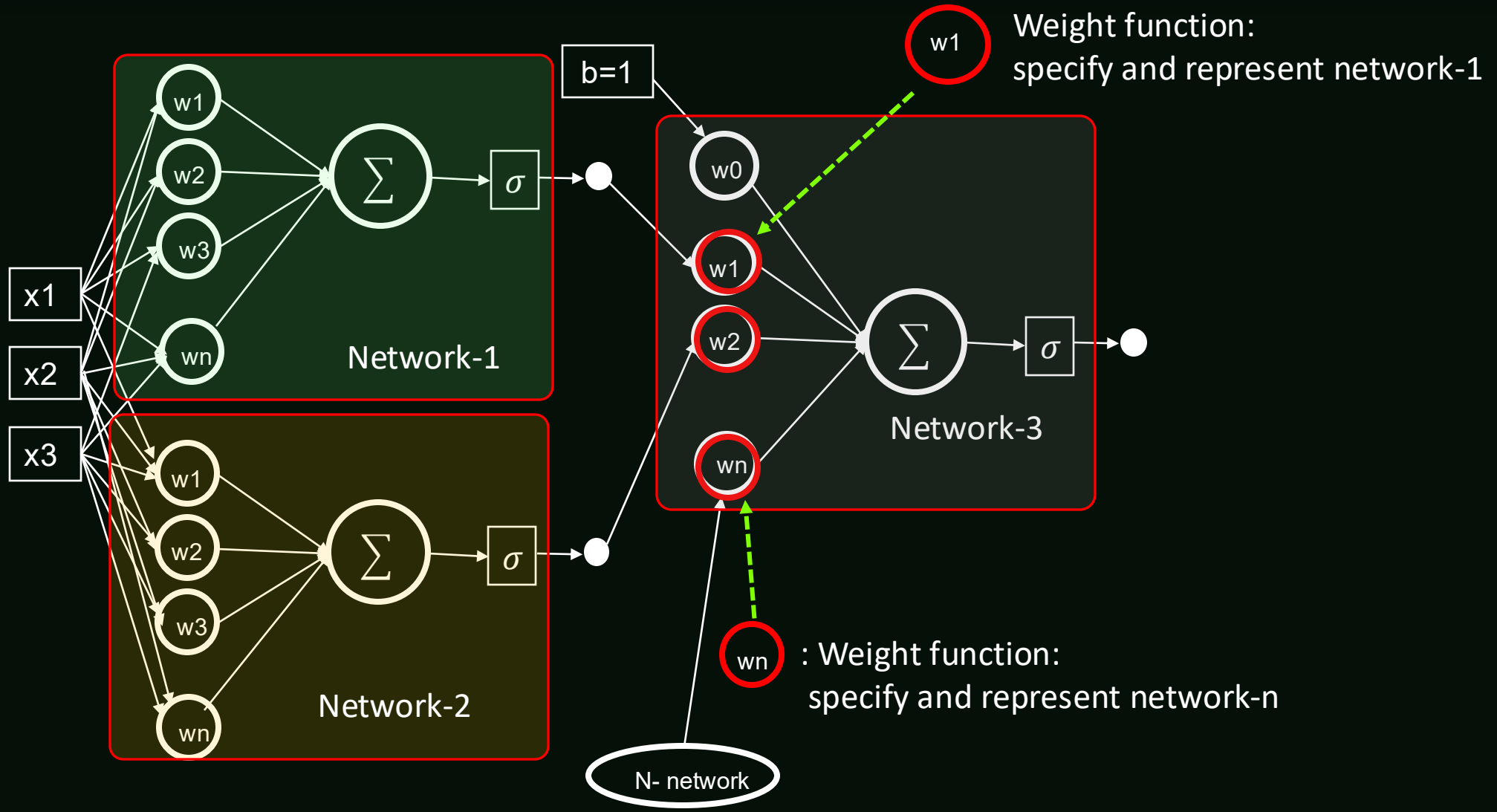
Pixel Representation

classification

Lincoln	0.8
Washington	0.1
Jefferson	0.05
Obama	0.05

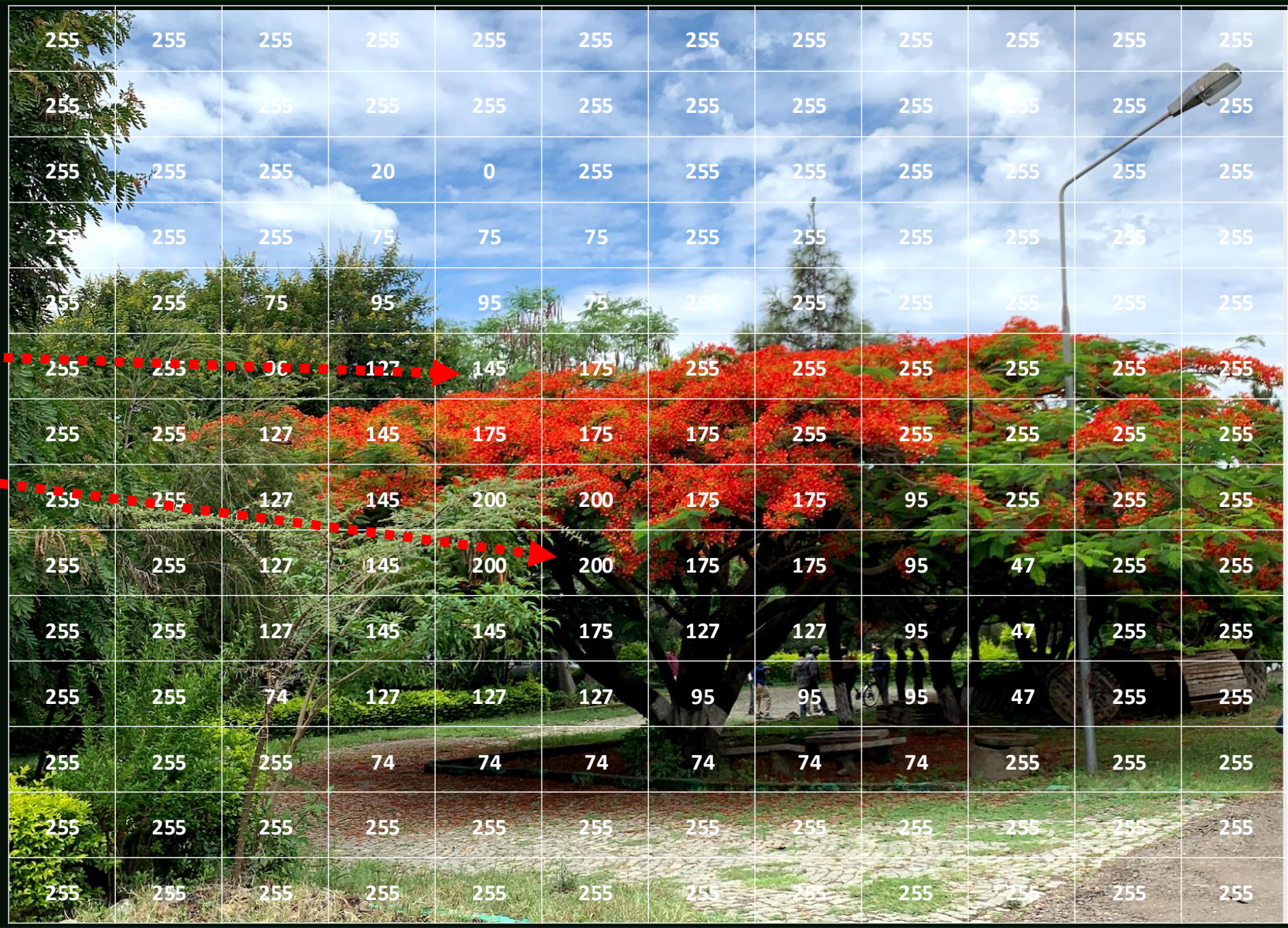
- **Regression**: output variable takes continuous value
- **Classification**: output variable takes class label. Can produce probability of belonging to a particular class

Deep Neural Network



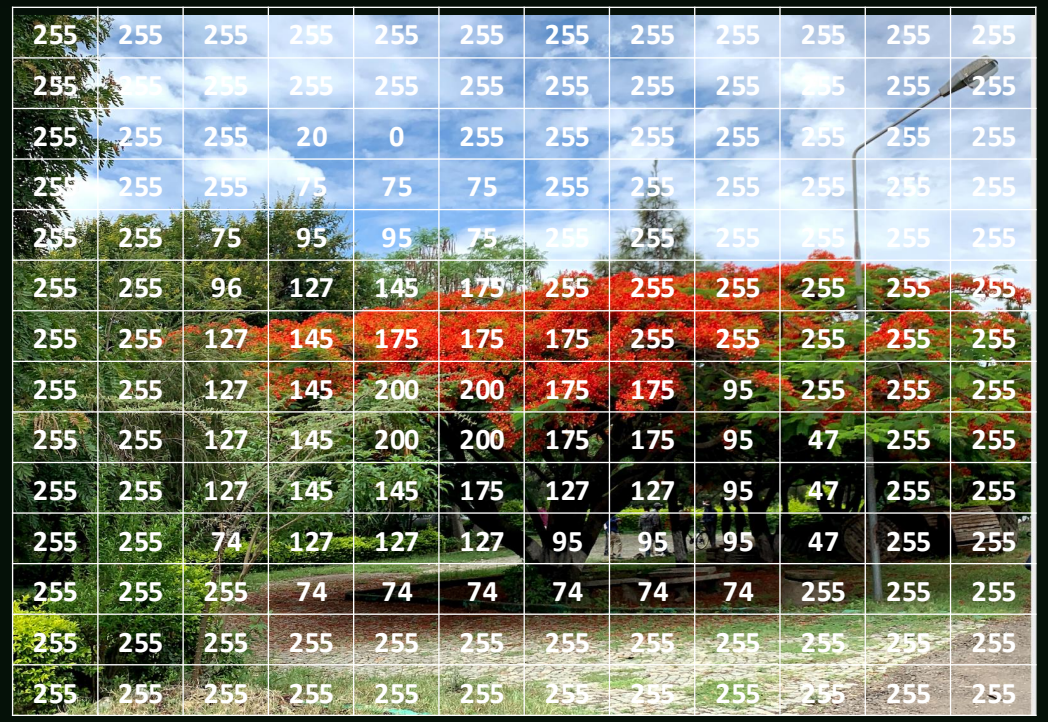
Filter Principle in CNN

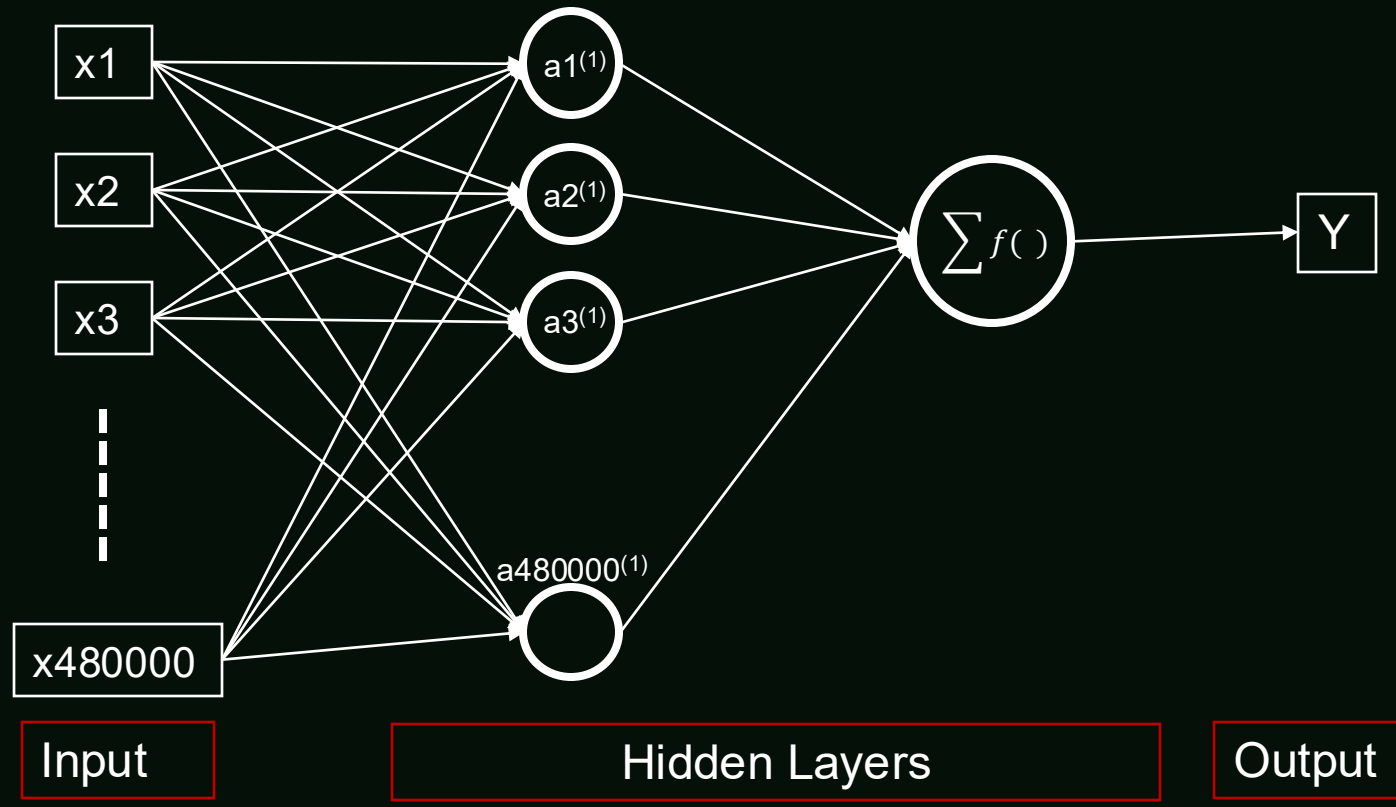
- Neural network recognize near area and compare (145, 175).
- It does not recognize a long distance (200, 127).
- With this principle, CNN can detector specified point.



Why Convolution?

Ref: Param Vir Singh



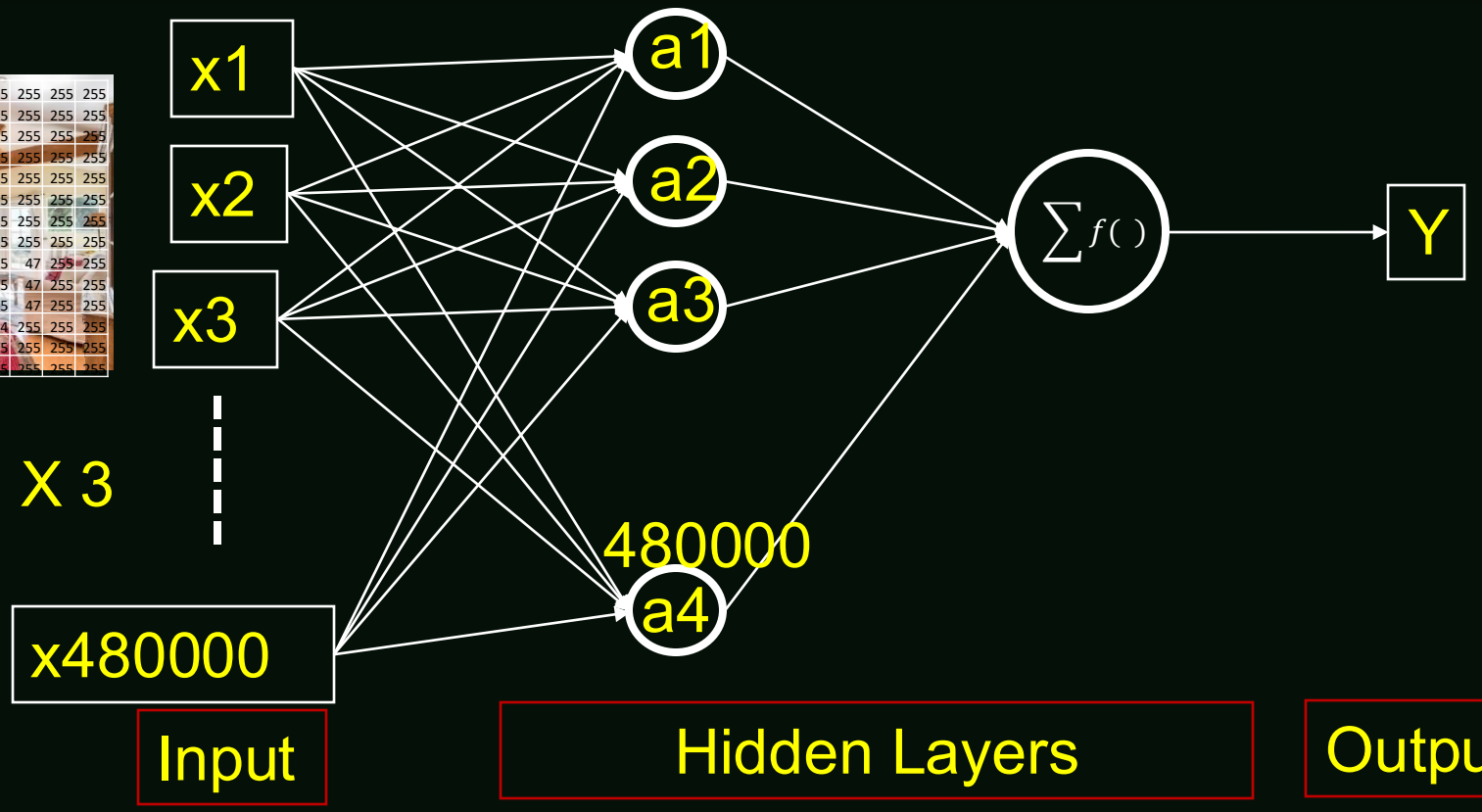


- Number of Parameters: 400 X 400 X 3
- 480000*480000 + 480000 +1 = approximately 230 Billion !!!
- 480000*1000 + 1000 +1 = approximately 480 million !!!

Why Convolution?

Ref: Param Vir Singh

400 X 400 X 3



Number of Parameters

480000*480000 + 480000 +1 = approximately 230 Billion !!!

480000*1000 + 1000 +1 = approximately 480 million !!!

How to works in Convolutional Layers

Ref: Param Vir Singh

- What is Convolution?

$$h1 = f(a * w1 + b * w2 + e * w3 + f * w4)$$

w1	w2
w3	w4

h1	h2	

Input Image

Filter

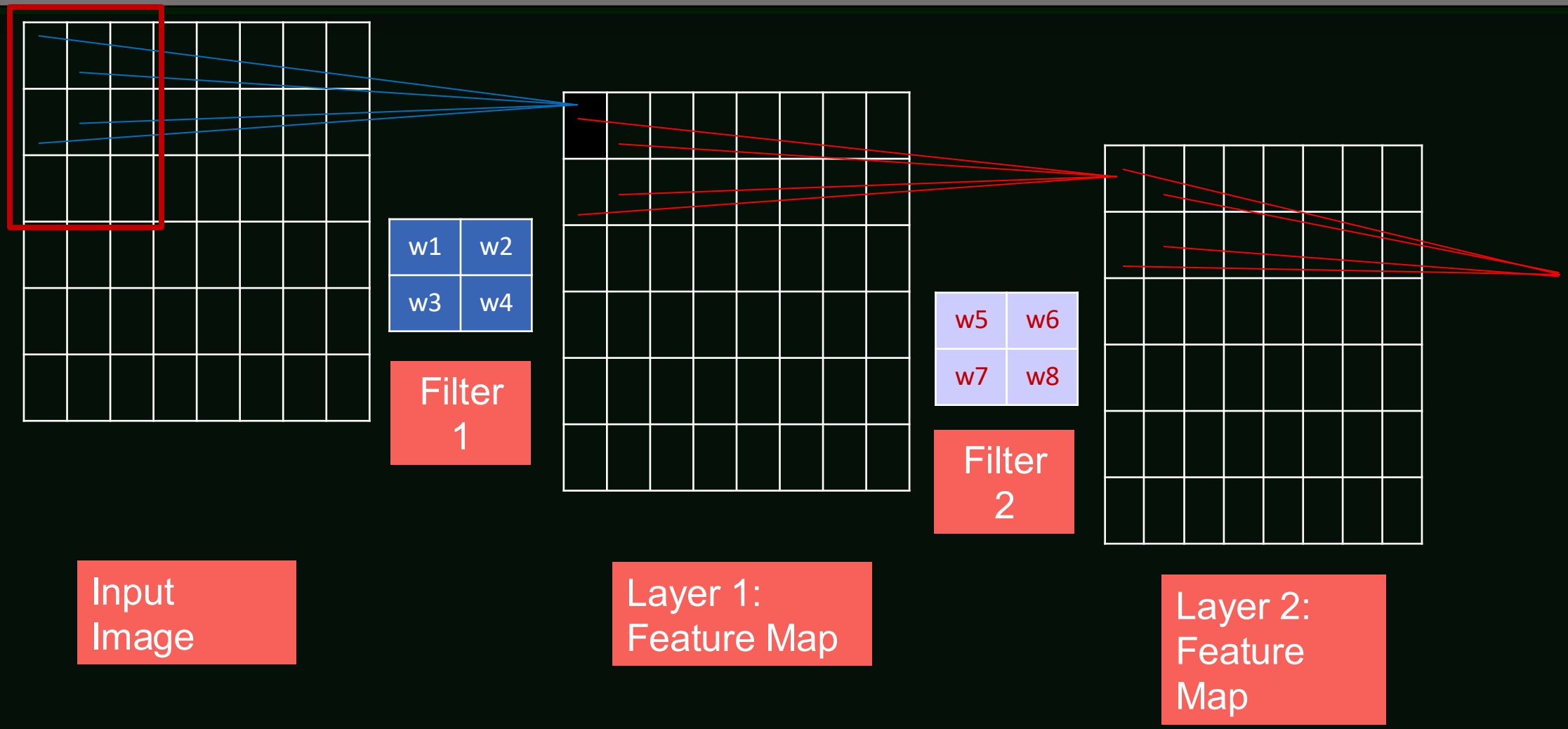
Convolved Image (Feature Map)

$$h2 = f(b * w1 + c * w2 + f * w3 + g * w4)$$

Number of Parameters for one feature map = 4

Number of Parameters for 100 feature map = 4*100

Lower Level to More Complex Features

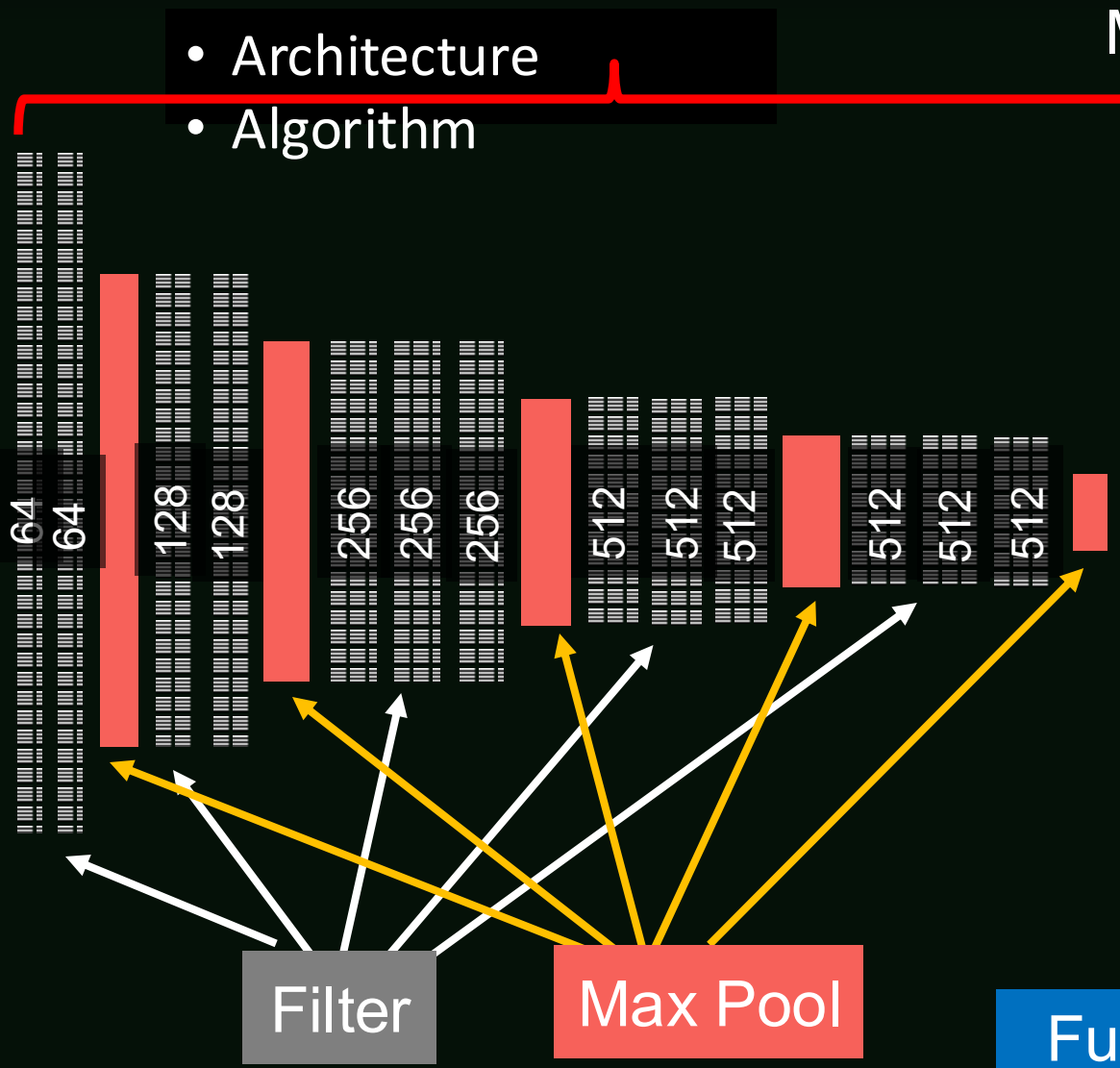


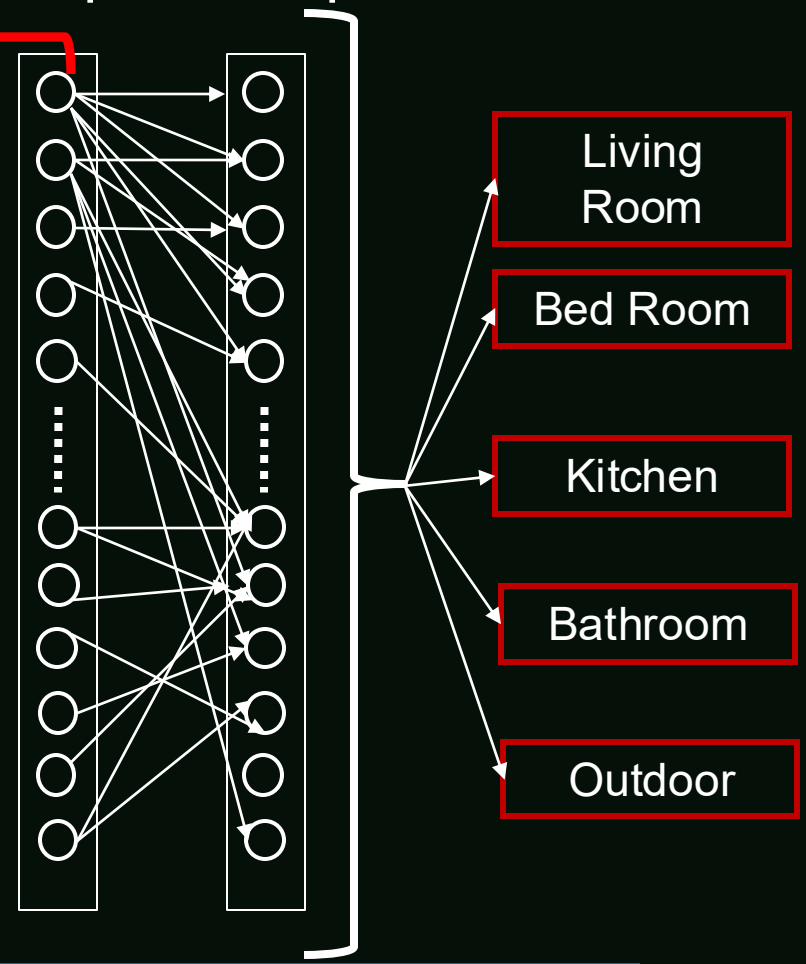
- In CNN, hidden units are only connected to local receptive field.

Out put of CNN

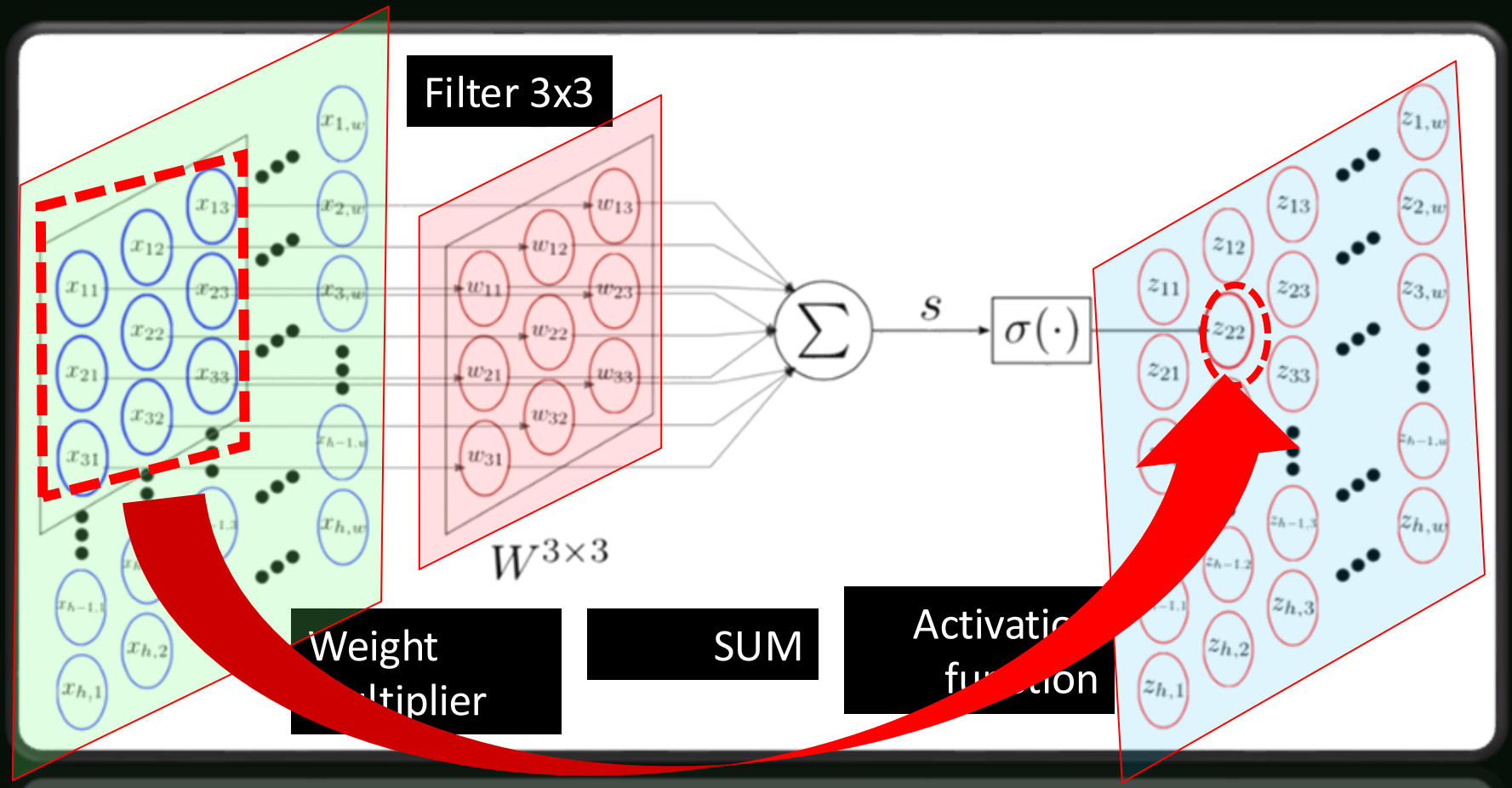
Ref: Param Vir Sing

- Architecture
- Algorithm



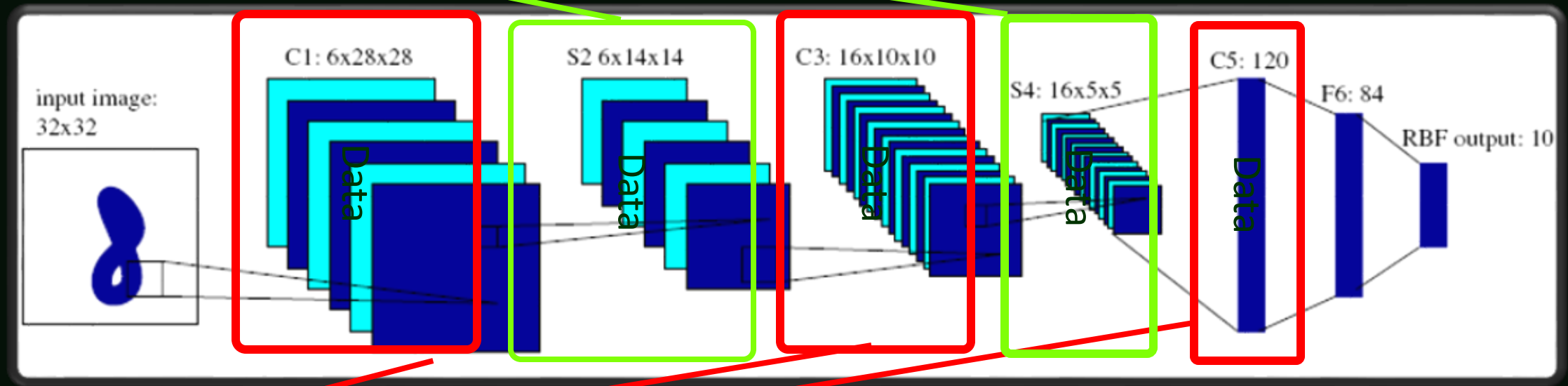


Filter Conception in CNN



Structure of CNN

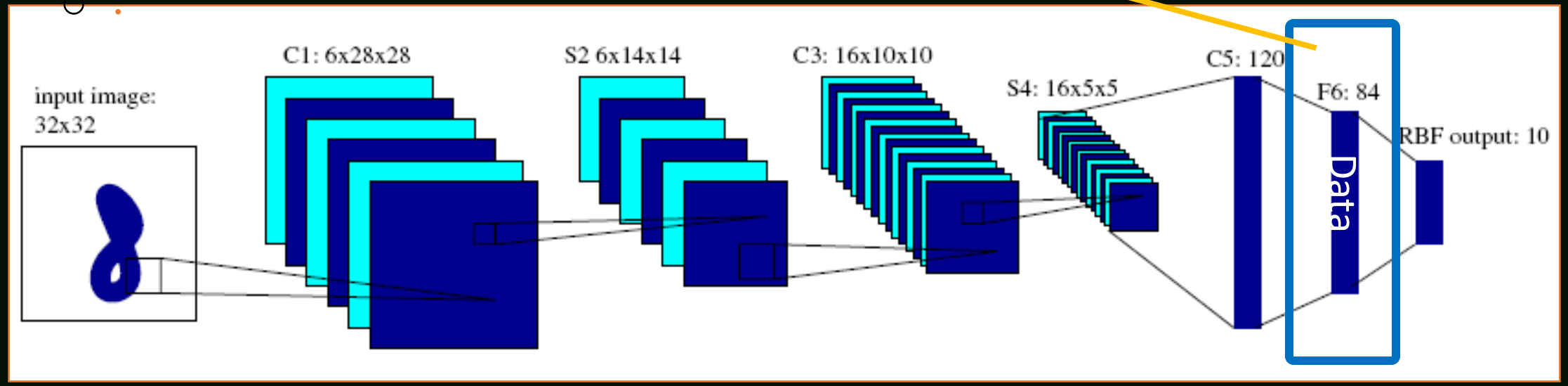
- S2, S4: Pooling layer: It provides a down-sampling of the convolutional output
- F6: Fully layer



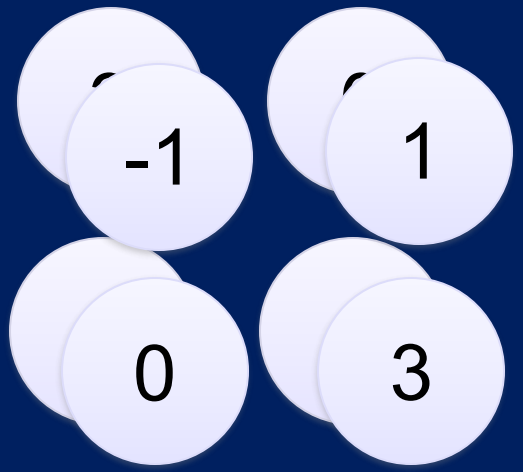
- C1,C3,C5 : Convolutional layer: Filters work on every part of the image. They are searching for the same feature everywhere in the image.

Structure of CNN

- F6: Fully layer: each node is fully connected to all input nodes, each node computes weighted sum of all input nodes. It has one- dimensional structure. It helps to classify input pattern with high-level features extracted by previous layers.
-
-



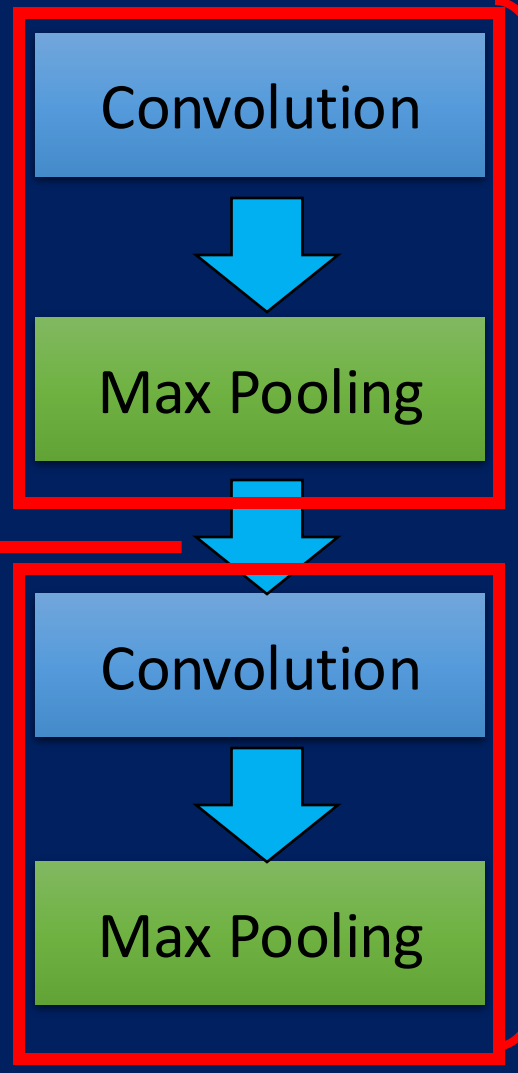
The whole CNN



A new image

Smaller than the original image

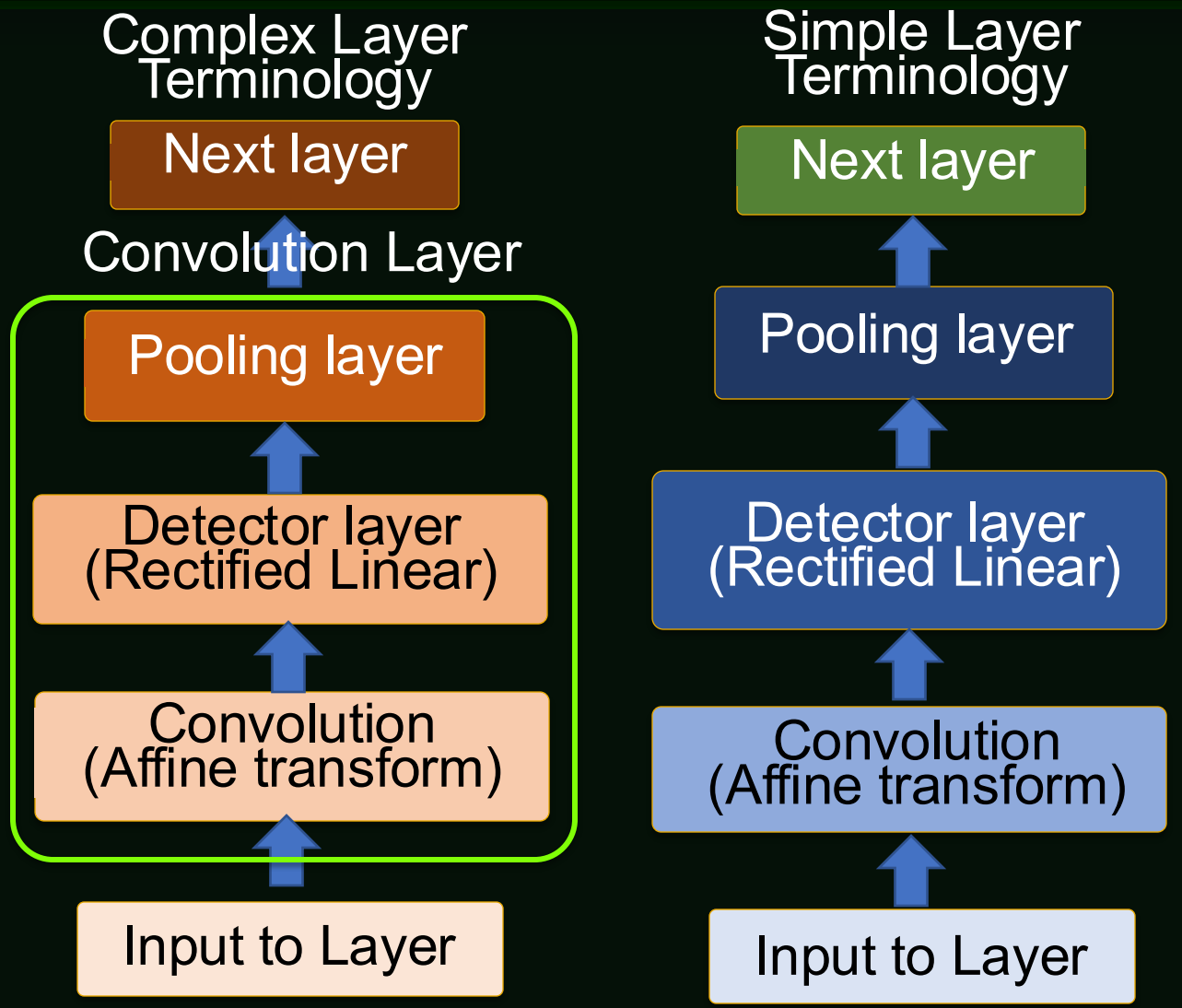
The number of channels is the number of filters



Can repeat many times

Process of Convolution Layer

- 3. Pooling stage: max pooling, average pooling
- 2. Nonlinearity stage: a nonlinear transform by rectified linear or $tanh$
- 1. Convolution stage

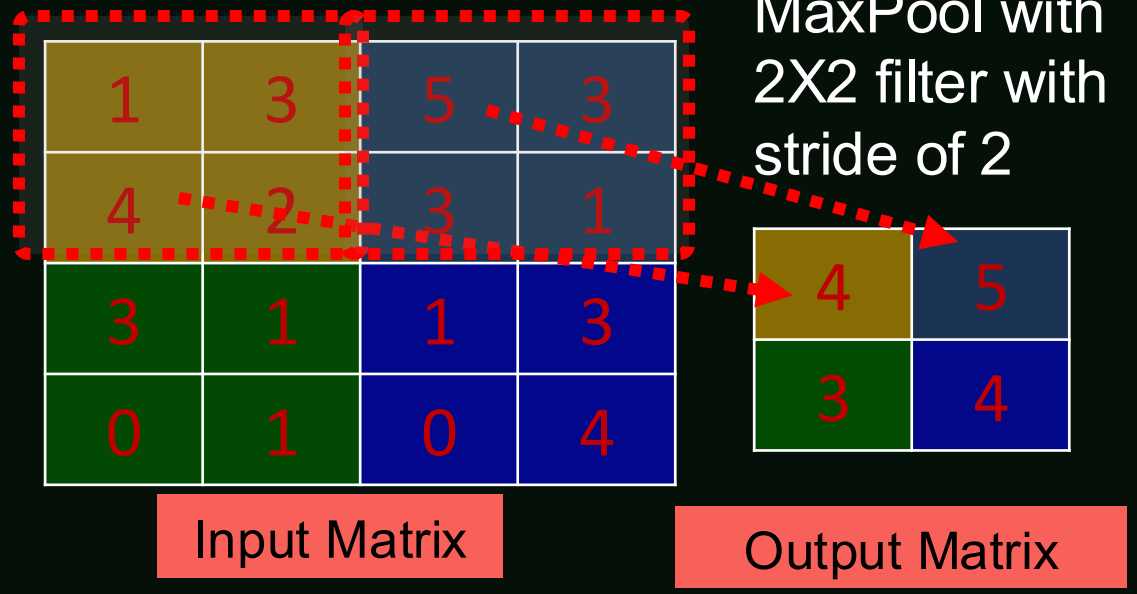


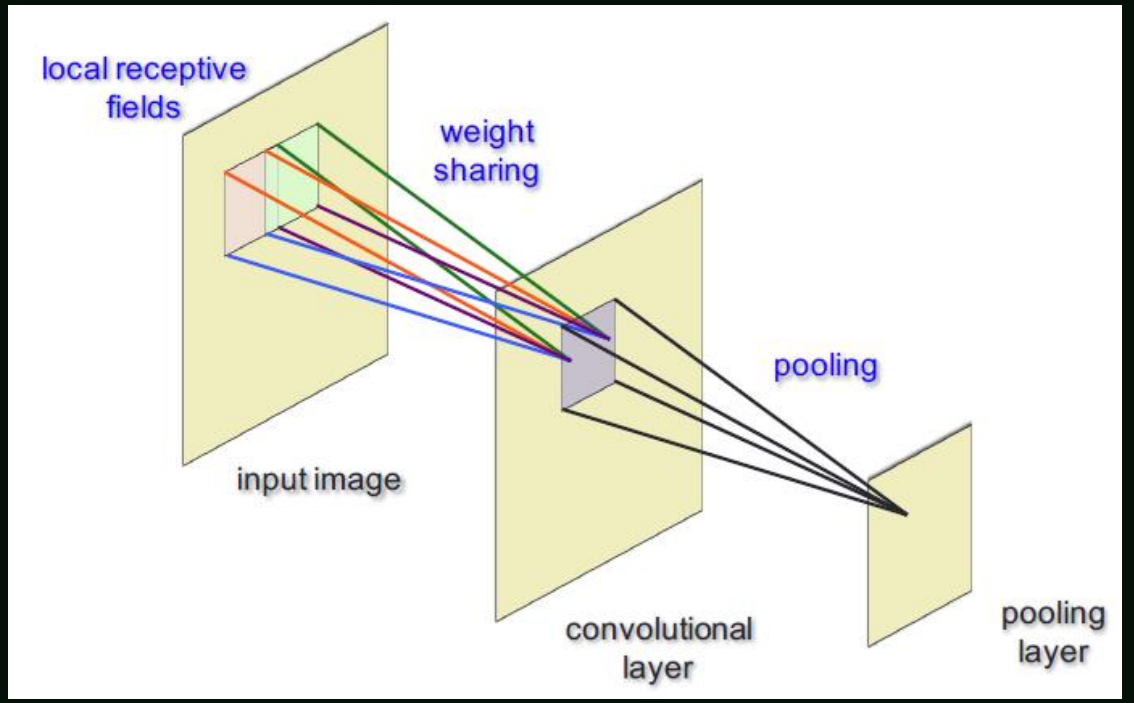
Why Pooling?

- Reducing number of connections
- Shared weights on the edges
- Max pooling further reduces the complexity

Pooling

- Max pooling: reports the maximum output within a rectangular neighborhood.
- Average pooling: reports the average output of a rectangular neighborhood.





CNN Example

Figure from Gradient-based learning applied to document recognition, *by Y. LeCun, L. Bottou, Y. Bengio and P. Haffne*

Weighting matrix: 400x120

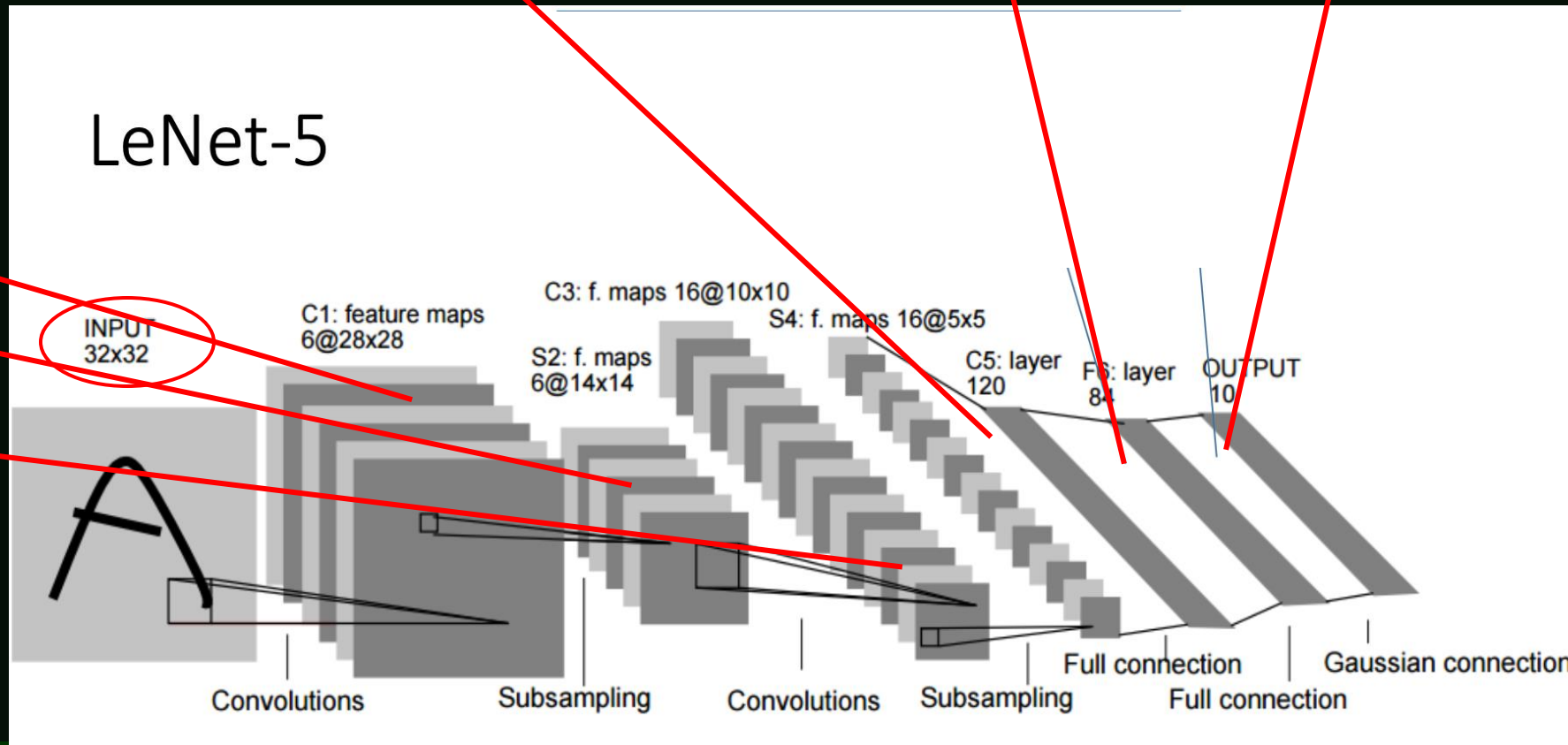
Weighting matrix: 120x84

Weighting matrix: 84x10

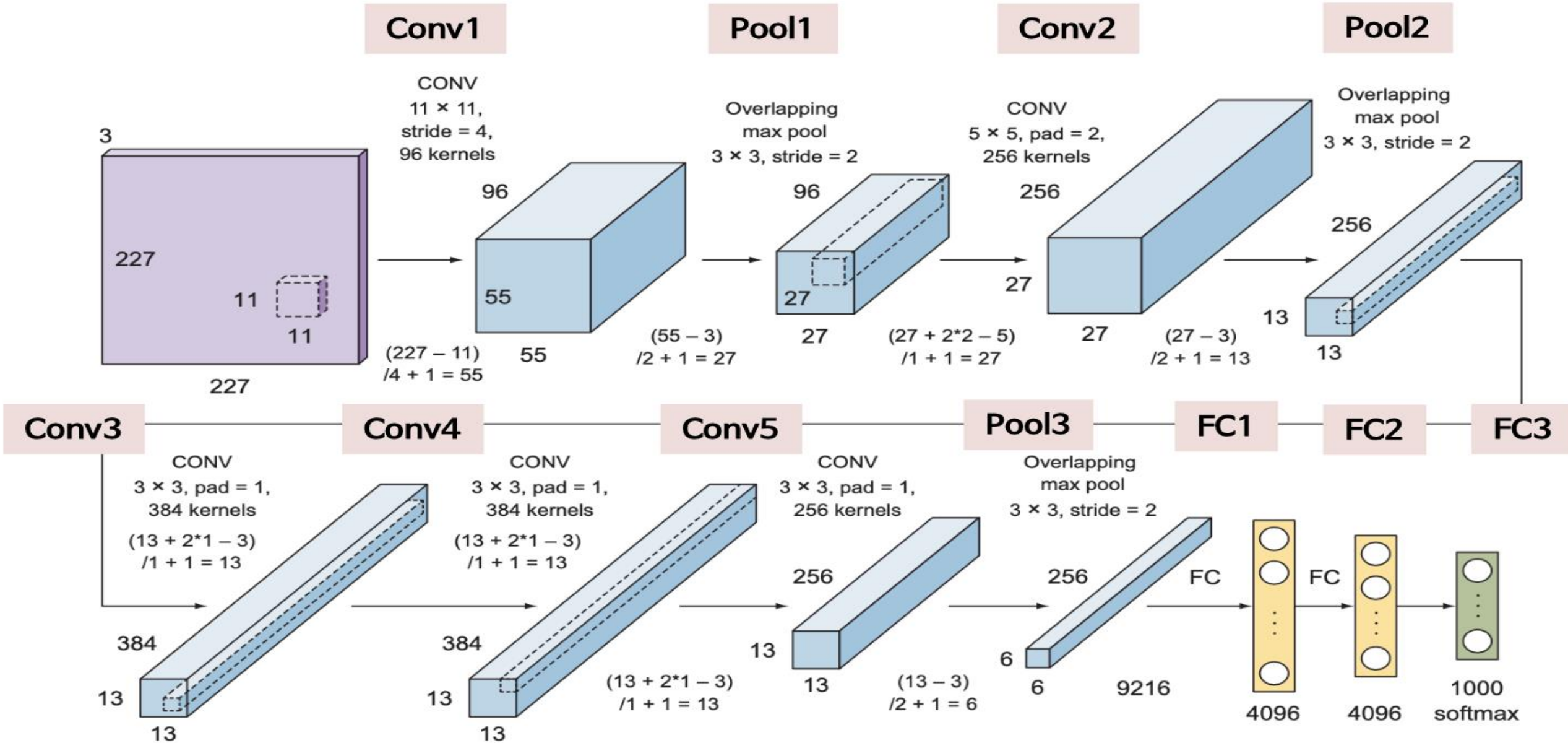
Filter: 5x5, stride: 1x1,
# of filter: 6

Pooling: 2x2, Stride: 2

Filter: 5x5x6, stride: 1x1,
# of filter: 16

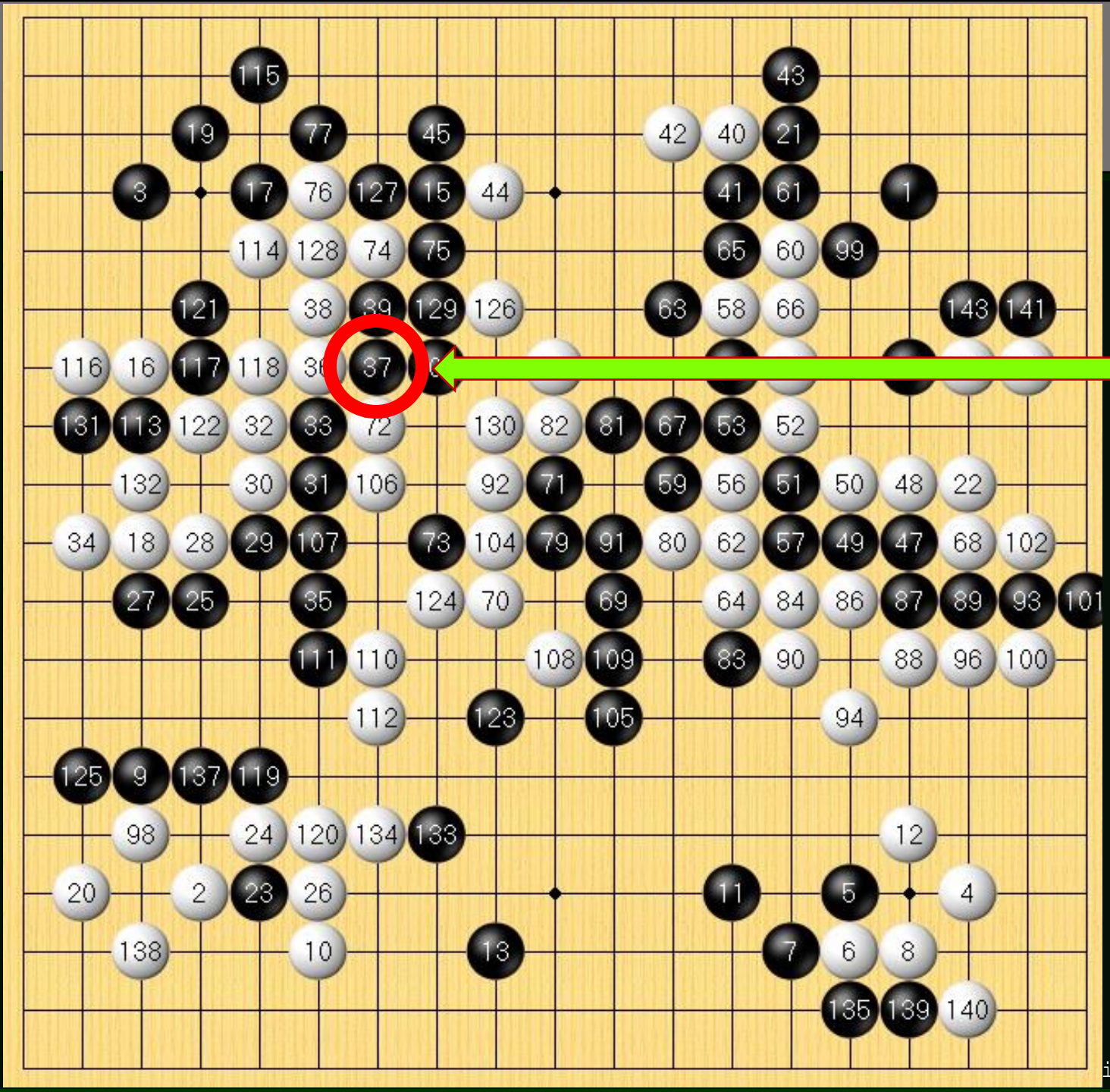


AlexNet full structure




Google DeepMind
Challenge Match
8 - 15 March 2016
AlphaGo
• S. Korea
• March 8-15, 2016.
Machine
(4)
Se Dol Lee
(1)
ALPHAGO
02:00:00
LEE SEDOL
01:59:42
AlphaGo
Lee Sedol

AI is better than Human



play go

37th Stone

- 3000 History

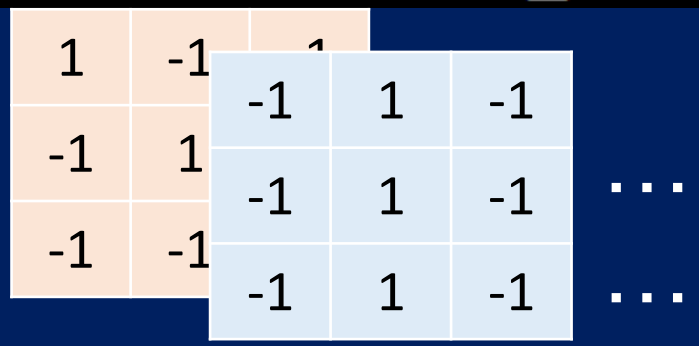
AI Prediction

Black stone: Never put place in the past during human history 3,000years

CNN in Keras

Only modified the network structure and input format
(vector -> 3-D tensor)

```
model2.add( Convolution2D( 25,3,3,
                input_shape=(28,28,1)) )
```



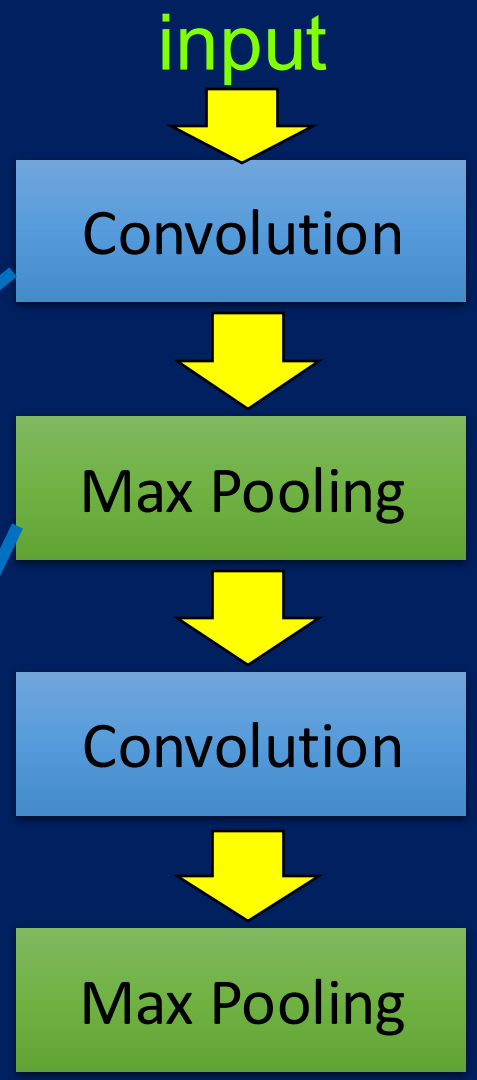
There are 25 3x3 filters.

Input_shape = (28 , 28 , 1)

28 x 28 pixels

1: black/white, 3: RGB

```
model2.add(MaxPooling2D((2,2)))
```



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Thank You!

Questions?