

Lecture October 15

Convolutional NN

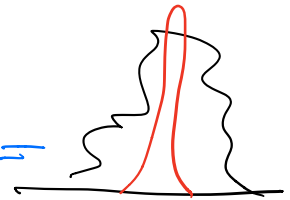
$$\begin{array}{ccccc} S(t) & = & \int & x(a) & w(t-a) da \\ \uparrow & & & \uparrow & \uparrow \\ \text{output} & & & \text{input} & \text{weight} \end{array}$$

Imaging and MC leads to multidim arrays: (m_h, m_w, m_c)

Each element is stored separately,

assume a 2D input I
and a 2D kernel (weight-function)
/ filter

$$S(i,j) = \underbrace{(I * K)}_{\text{convolution}}(i,j) =$$



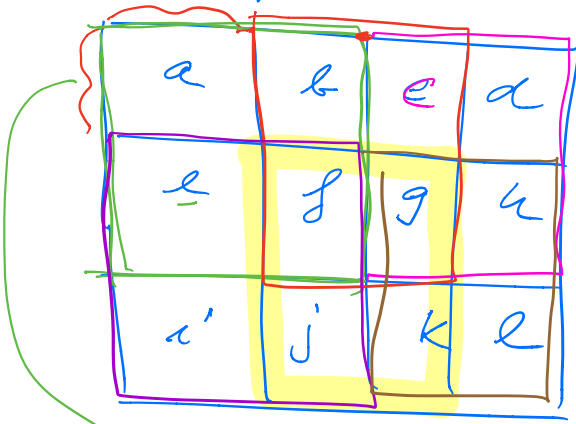
$$\sum_m \sum_n I(m,n) K(i-m, j-n)$$

Convolution is commutative

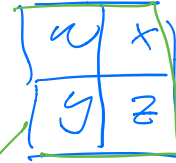
$$S(i,j) = \underbrace{(K * I)}_{\text{convolution}}(i,j) =$$

$$\sum_m \sum_n I(i-m, j-n) K(m, n)$$

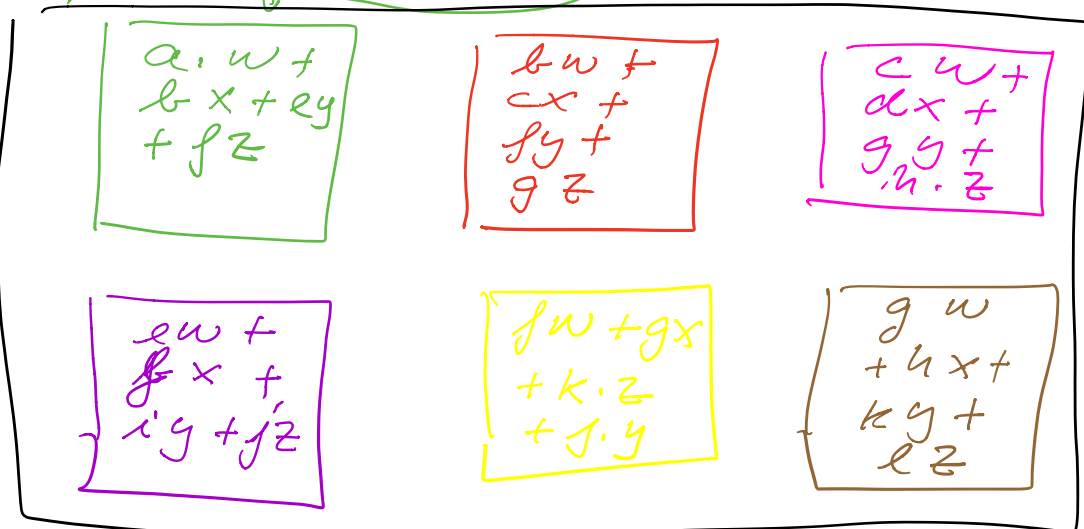
input



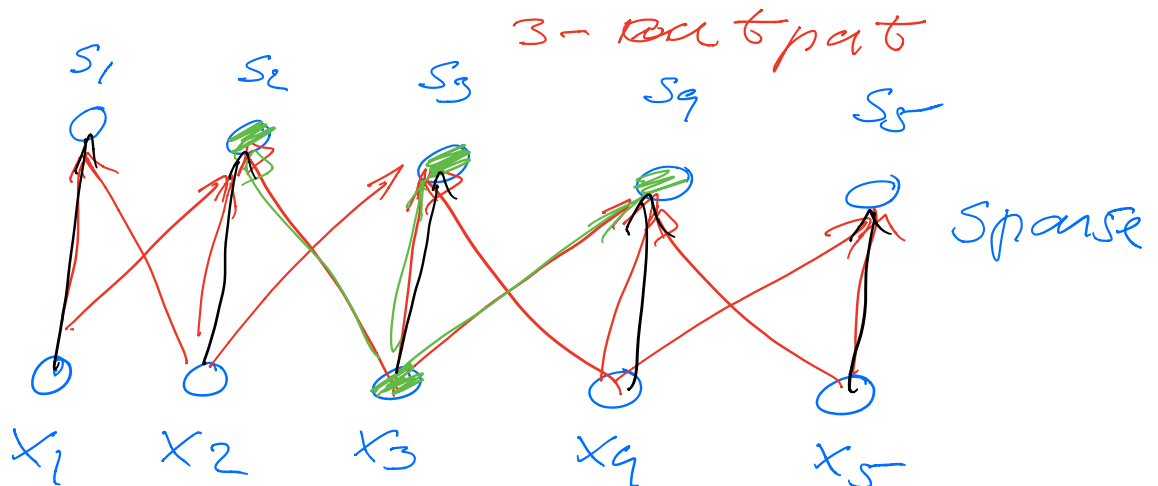
kernel/filter



stride = 1

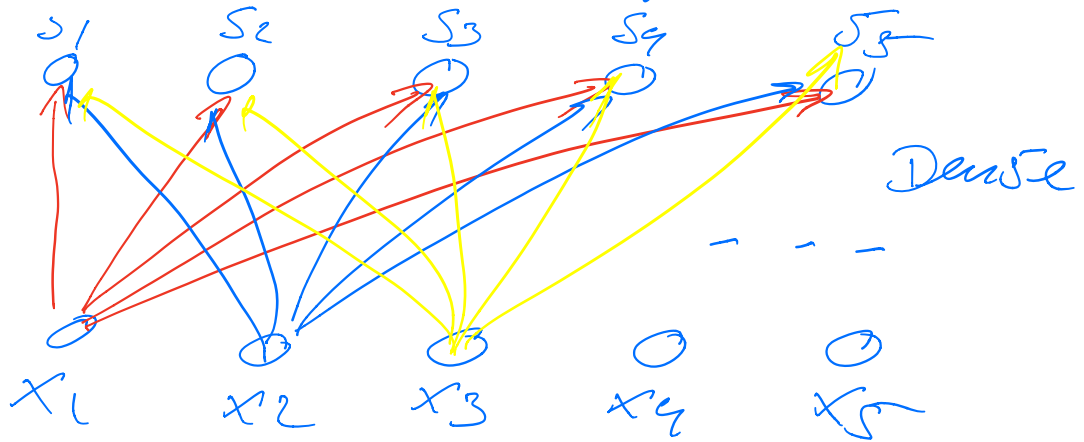


kernel < input



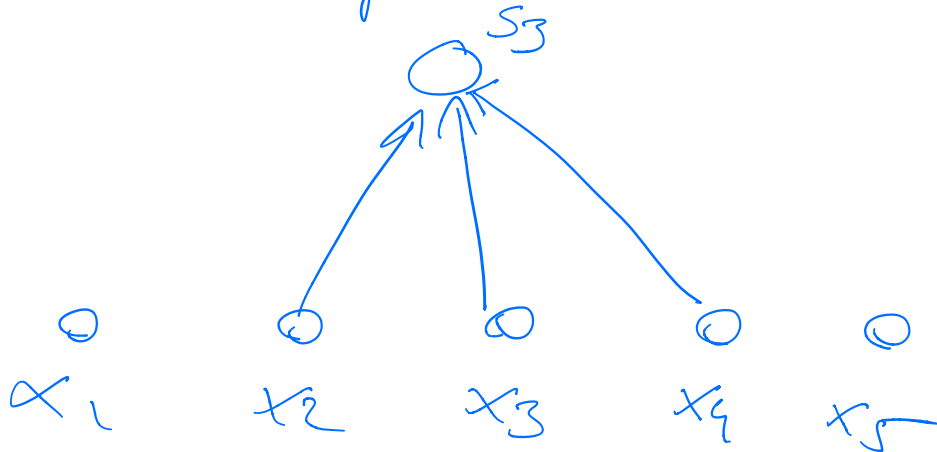
S -input

Neural net (affine)

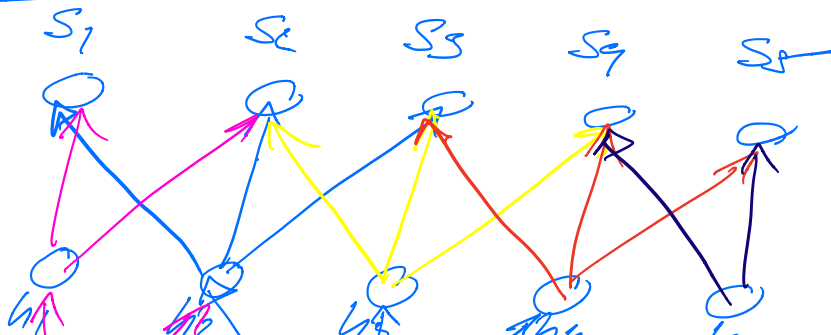


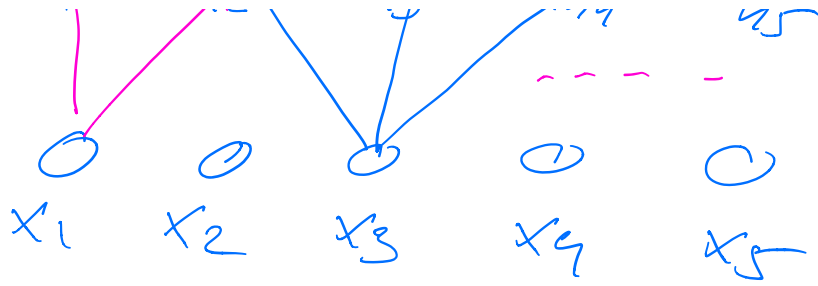
all connected

viewed from above



Deeper network





A CNN has three basic stages

1st stage: several convolutions stage (in parallel). weights and biases. with a set of linear activations

2nd stage: each linear activation is run through an activation function (ReLU, ...)

3rd stage: pooling stage function to modify output of the layer further

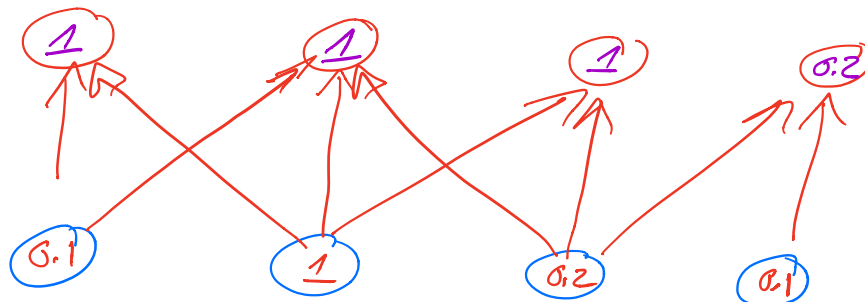


[]

pooling: new downsampling of image features

max pooling: reports the max output within a rectangular neighborhood;

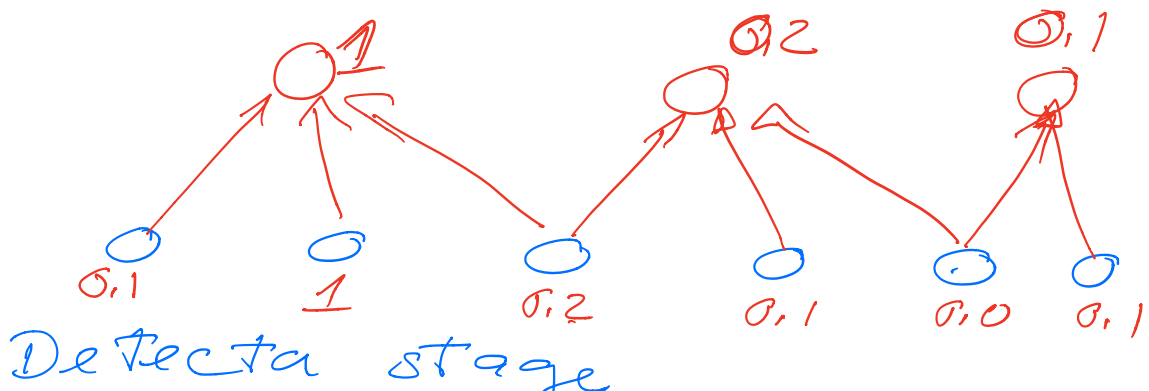
pooling stage



Detector stage

pooling has no parameters

Normal to have less pooling than detector units-



Detector stage

one layer in a CNN

- Convolutional stage
- pooling layer
- Feed into next layer.
(Fully connected layer)