Neural networks

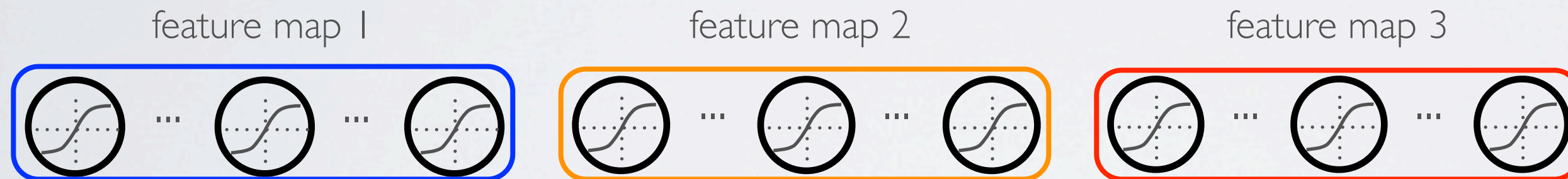Computer vision - parameter sharing

COMPUTER VISION

Topics: computer vision

- We can design neural networks that are specifically adapted for such problems

  ‣ must deal with very high-dimensional inputs

    - 150 x 150 pixels = 22500 inputs, or 3 x 22500 if RGB pixels

  ‣ can exploit the 2D topology of pixels (or 3D for video data)

  ‣ can build in invariance to certain variations we can expect

    - translations, illumination, etc.

- Convolutional networks leverage these ideas

  ‣ local connectivity

  ‣ **parameter sharing**

  ‣ pooling / subsampling hidden units

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Topics: parameter sharing

• Second idea: share matrix of parameters across certain units

‣ units organized into the same "feature map" share parameters

‣ hidden units within a feature map cover different positions in the image

feature map 1   feature map 2   feature map 3

same color
=
same matrix
of connections

6

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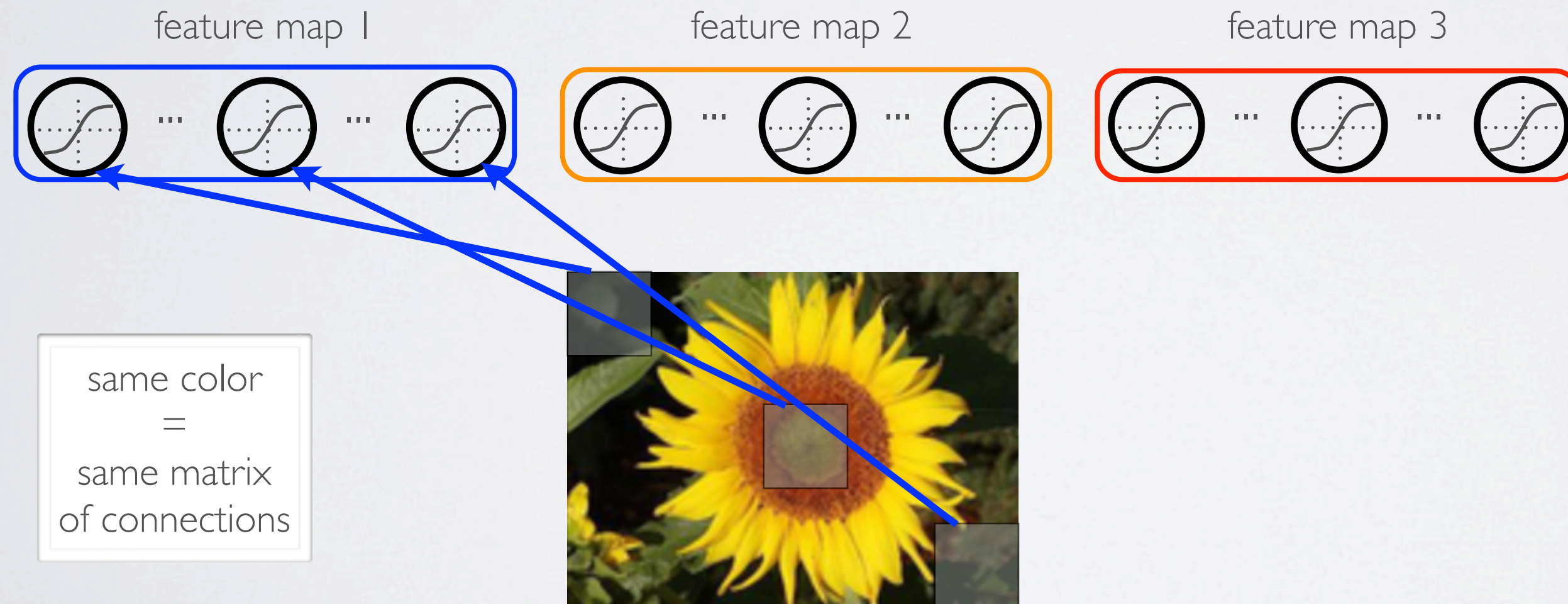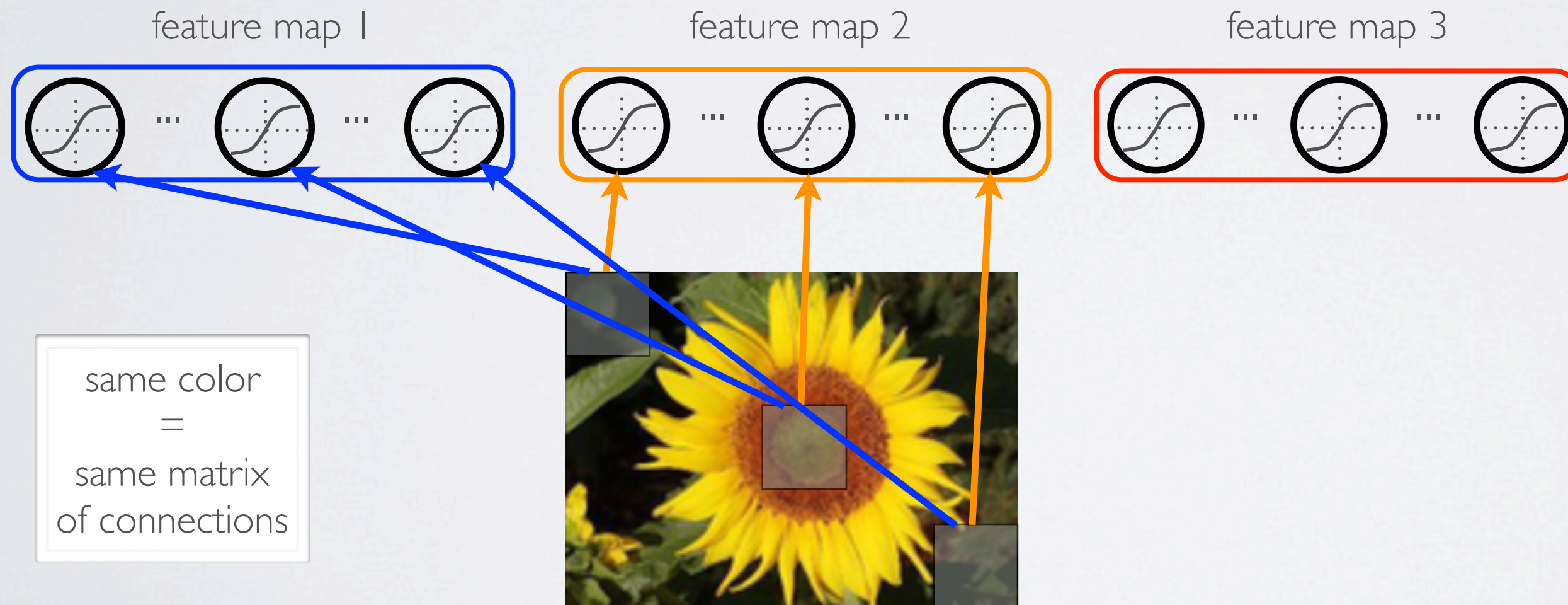 - ‣ hidden units within a feature map cover different positions in the image

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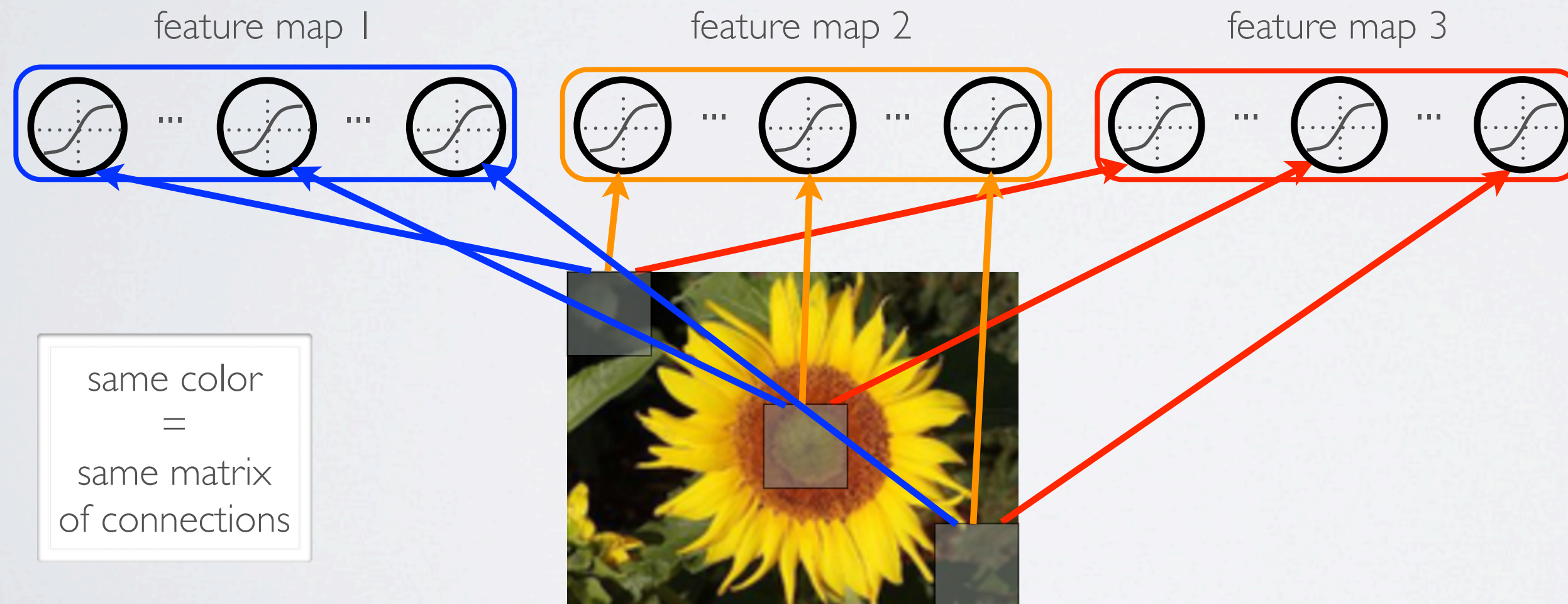
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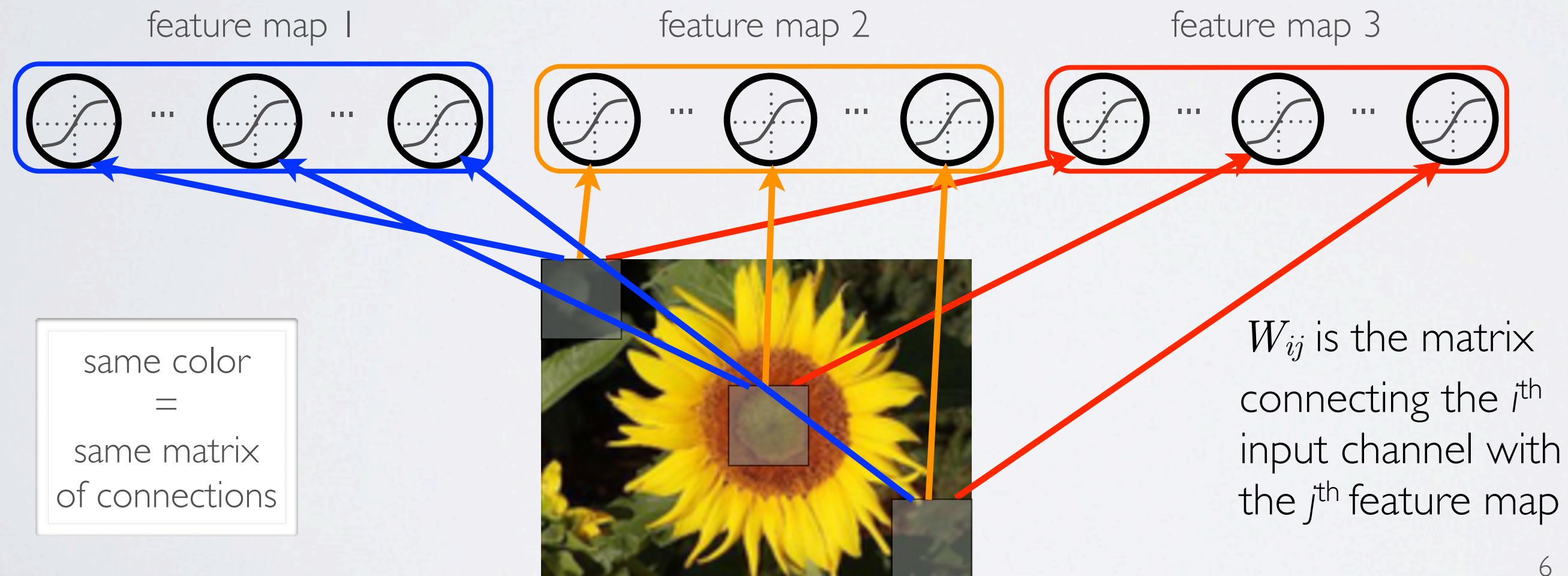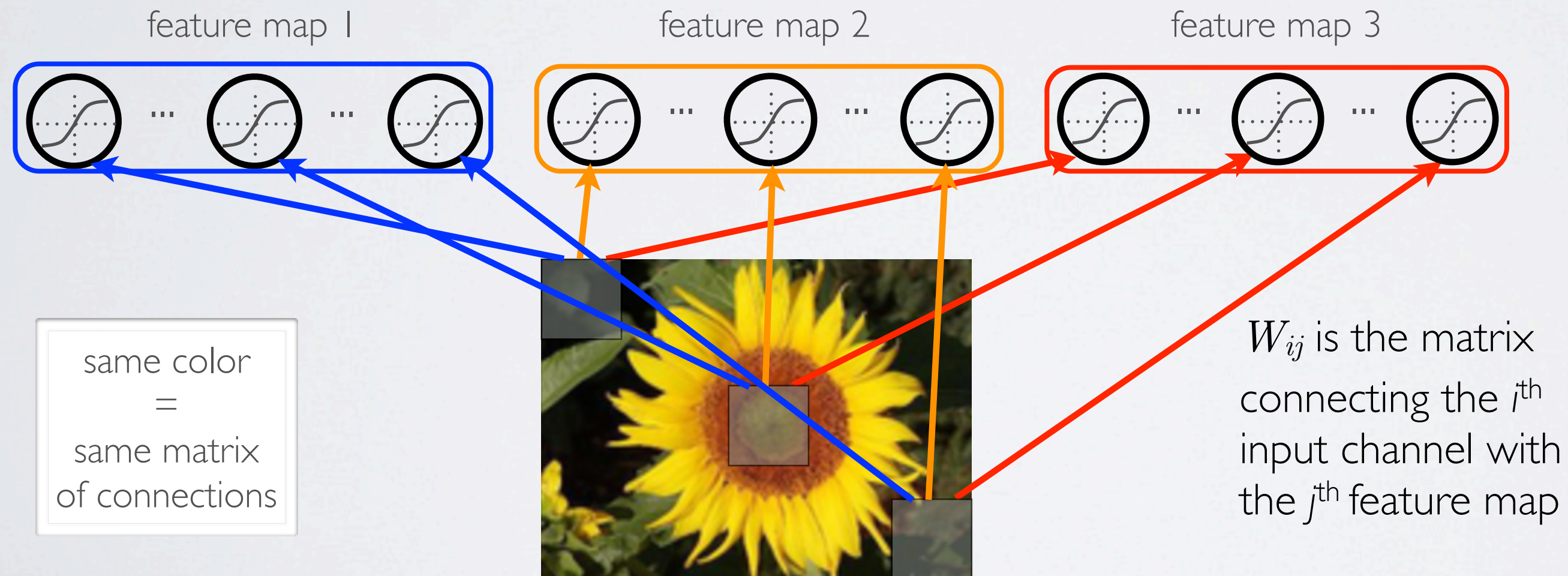
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W_{ij} is the matrix connecting the ith input channel with the jth feature map

COMPUTER VISION

Topics: parameter sharing

• Solves the following problems:

‣ reduces even more the number of parameters

‣ will extract the same features at every position (features are "equivariant")

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COMPUTER VISION

Topics: parameter sharing

Jarret et al. 2009

• Each feature map forms a 2D grid of features

‣ can be computed with a discrete convolution ($*$) of a kernel matrix k_{ij} which is the hidden weights matrix W_{ij} with its rows and columns flipped
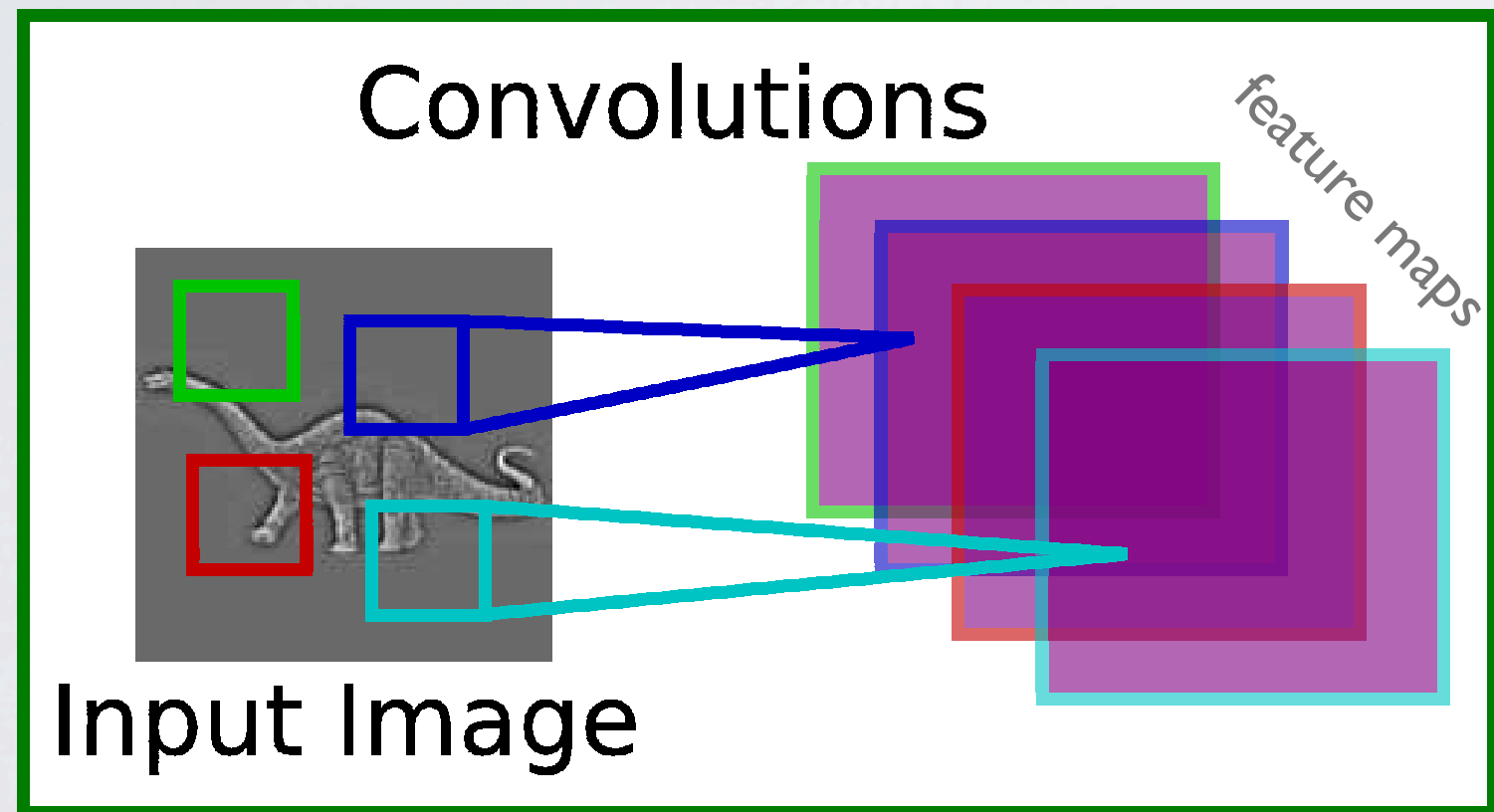
‣ x_i is the ith channel of input

‣ k_{ij} is the convolution kernel

‣ g_j is a learned scaling factor

‣ y_j is the hidden layer

(could have added a bias)

$$y_j = g_j \tanh(\sum_i k_{ij} * x_i)$$