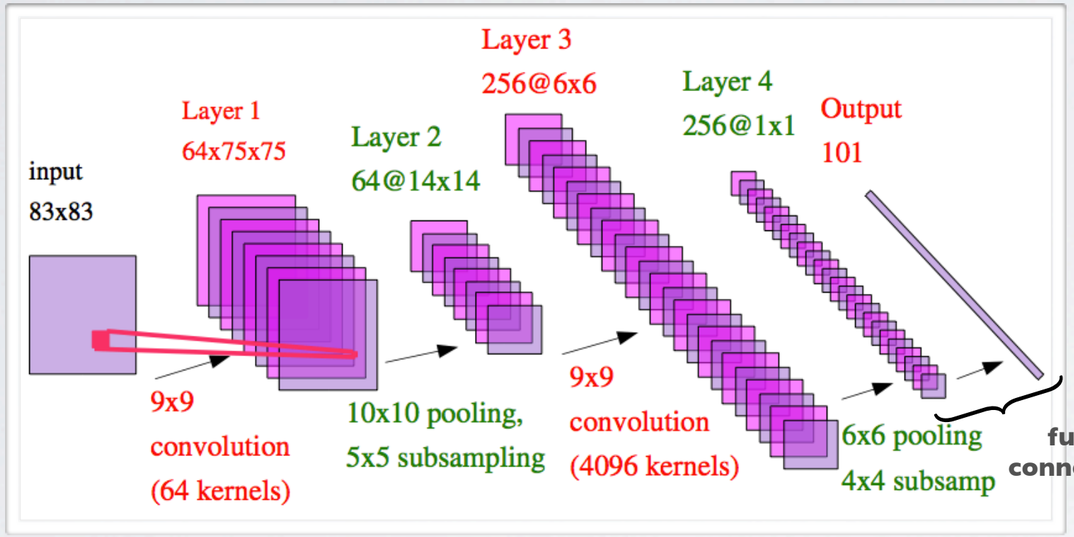
Neural networks

Computer vision - object recognition

CONVOLUTIONAL NETWORK

Topics: convolutional network

- This architecture works well for handwritten character recognition



(from Yann Lecun)

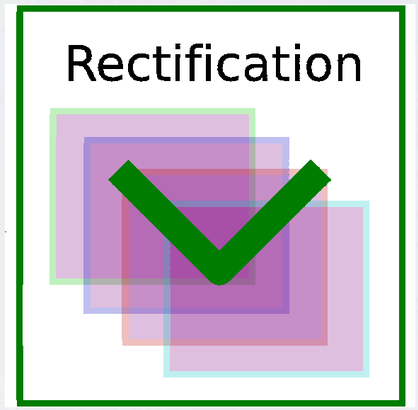
- It performs poorly on object recognition in general
  - we need to introduce other operations between

CONVOLUTIONAL NETWORK

Topics: rectification layer

Jarret et al. 2009

- Rectification layer: $y_{ijk} = |x_{ijk}|$
  - introduces invariance to the sign of the unit in the previous layer
    - for instance, lose information of whether an edge is black-to-white or white-to-black



CONVOLUTIONAL NETWORK

Topics: local contrast normalization layer

Jarret et al. 2009

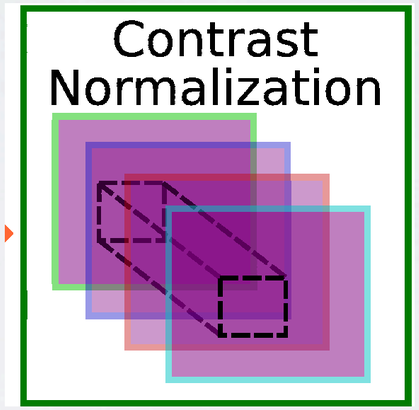
- Local contrast normalization:

$$v_{ijk} = x_{ijk} - \sum_{ipq} w_{pq} x_{i,j+p,k+q}$$

$$y_{ijk} = v_{ijk} / \max(c, \sigma_{jk})$$

$$\sigma_{jk} = (\sum_{ipq} w_{pq} v^2_{i,j+p,k+q})^{1/2}$$

$$\sum_{pq} w_{pq} = 1$$



where c is a small constant to prevent division by 0

- reduces unit's activation if neighbors are also active
- creates competition between feature maps

CONVOLUTIONAL NETWORK

Topics: local contrast normalization layer

Jarret et al. 2009

- Local contrast normalization:

local average

$$v_{ijk} = x_{ijk} - \sum_{ipq} w_{pq} x_{i,j+p,k+q}$$

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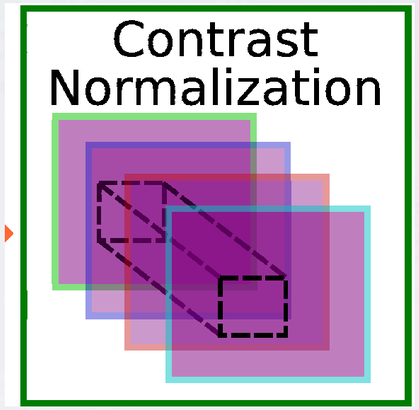

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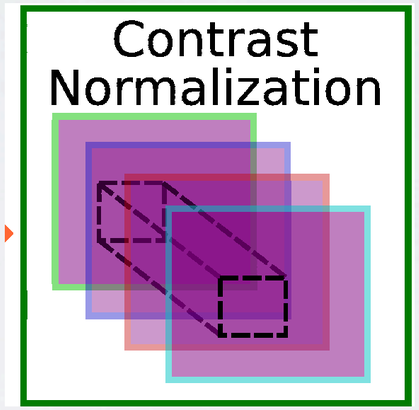
$$y_{ijk} = v_{ijk} / \max(c, \sigma_{jk})$$

local std dev.

$$\sigma_{jk} = \left(\sum_{ipq} w_{pq} v^2_{i,j+p,k+q}\right)^{1/2}$$

$$\sum_{pq} w_{pq} = 1$$



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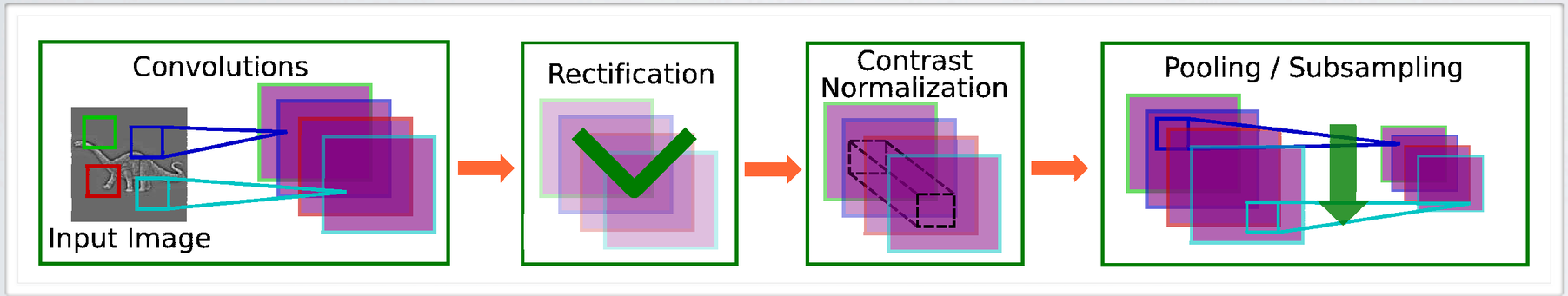
Jarret et al. 2009

- These operations are inserted after the convolutions and before the pooling



- Images should also be preprocessed by
  - converting to grayscale (if appropriate)
  - resizing images to 150 x 150 pixels (use zero padding for non-square images)
  - removing (intra image) mean and dividing by standard deviation of the image
  - applying local contrast normalization