Neural networks

Computer vision - object recognition
Topics: convolutional network

• This architecture works well for handwritten character recognition

• It performs poorly on object recognition in general
  ‣ we need to introduce other operations between
**Topics:** rectification layer

- **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

- Local contrast normalization:

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

\[ y_{ijk} = \frac{v_{ijk}}{\max(c, \sigma_{jk})} \]

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

\[ \sum_{pq} w_{pq} = 1 \]

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
**Topics:** local contrast normalization layer

- Local contrast normalization:

\[
\begin{align*}
    v_{ijk} &= x_{ijk} - \sum_{ipq} w_{pq} x_{i,j+p,k+q} \\
    y_{ijk} &= \frac{v_{ijk}}{\max(c, \sigma_{jk})} \\
    \sigma_{jk} &= \left( \sum_{ipq} w_{pq} v_{i,j+p,k+q}^2 \right)^{1/2} \\
    \sum_{pq} w_{pq} &= 1
\end{align*}
\]

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

- Local contrast normalization:

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

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

\[ \sigma_{jk} = (\sum_{ipq} w_{pq} v_{i,j+p,k+q}^2)^{1/2} \]

\[ \sum_{pq} w_{pq} = 1 \]

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: convolutional network

• 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