CS 6501 Natural Language Processing

Text Generation

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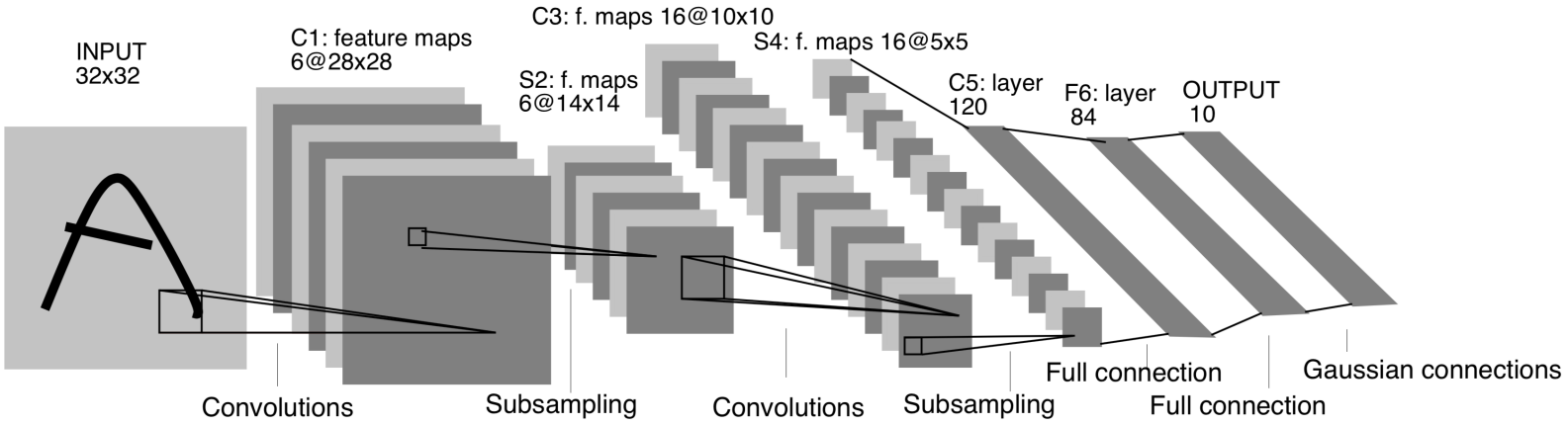
Overview

1. Basic Architecture of CNN

2. Applications in NLP

Basic Architecture of CNN

LeNet-5



[LeCun et al., 1998]

Two Basic Components

- Convolutional operations

$$s(t) = \int x(a)w(t-a)da \tag{1}$$

$$s(t) = \sum_{a=-\infty}^{\infty} x(a)w(t-a) \tag{2}$$

- Pooling

Convolutional Operations

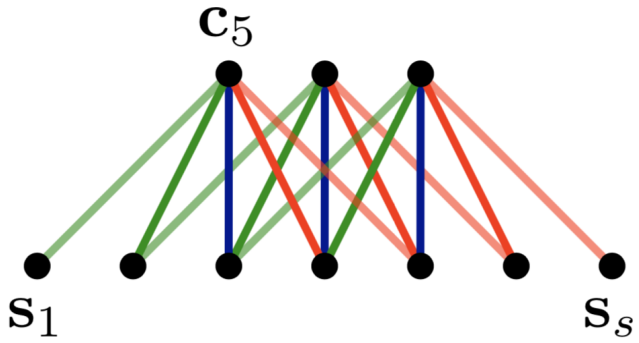
1-D convolutional operations

$$c_j = \boldsymbol{m}^\top \boldsymbol{s}_{j-m+1:j} \tag{3}$$

- $\boldsymbol{m} \in \mathbb{R}^n$: vector, filter
- $\boldsymbol{s} \in \mathbb{R}^T$: vector, input signal

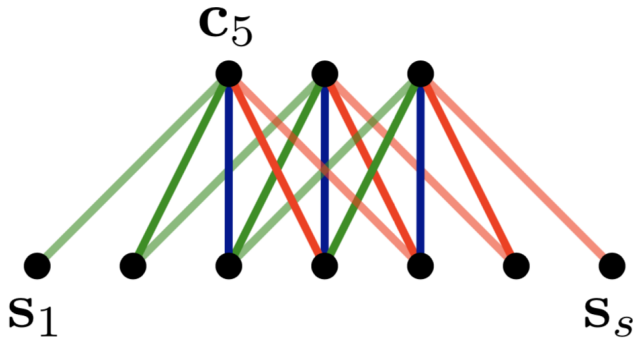
Convolutional Operations (II)

- Narrow type of convolution

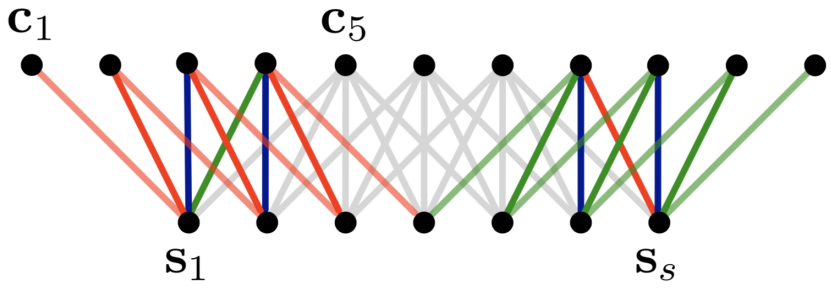


Convolutional Operations (II)

- Narrow type of convolution

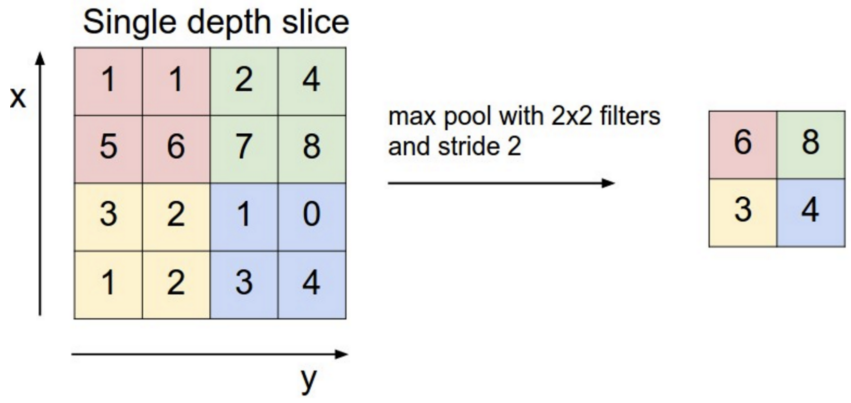


- Wide type of convolution



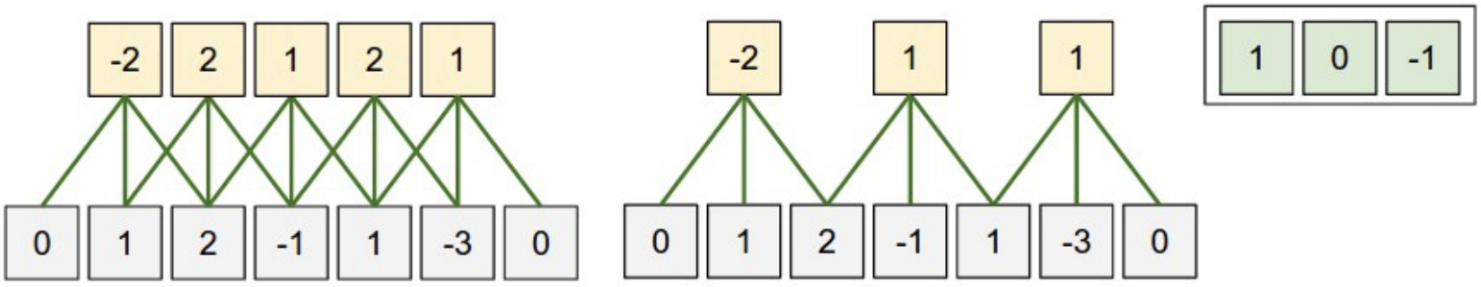
Pooling

- Max pooling



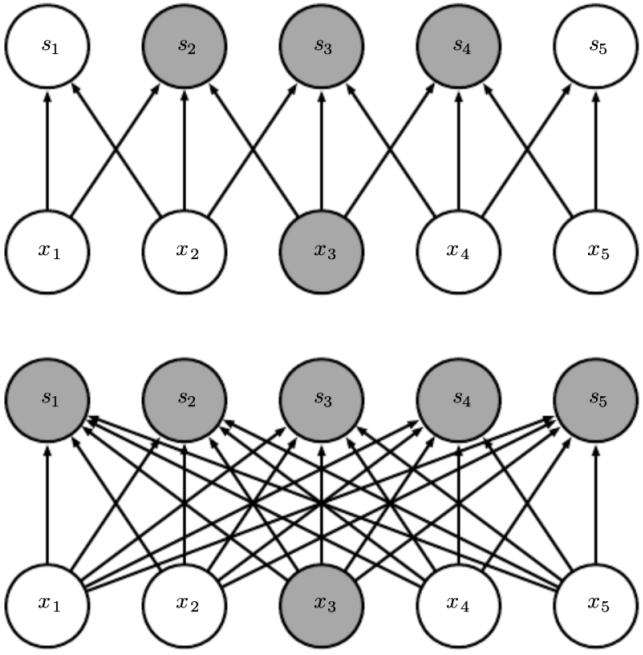
- Average pooling [LeCun et al., 1998]
- Min pooling

Stride Size



Advantages of CNNs

Comparing to Feed-forward NNs: Parameter sharing, sparse connections



[Goodfellow et al., 2016]

Applications in NLP

Example: Time-Delay Neural Networks

- Input

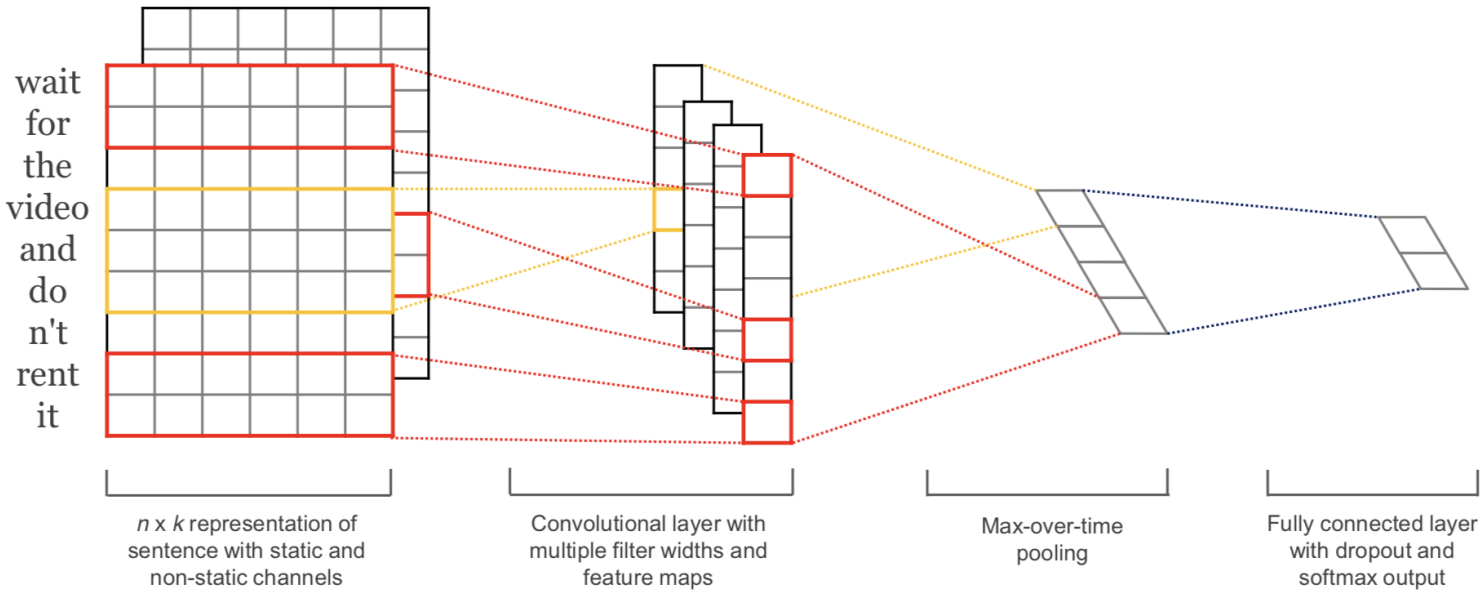
$$\mathbf{s} = \begin{bmatrix} | & | & | \\ \mathbf{w}_1 & \dots & \mathbf{w}_s \\ | & | & | \end{bmatrix}$$

- 1-D convolutional operations
- Max-pooling

$$\mathbf{c}_{max} = \begin{bmatrix} \max(\mathbf{c}_{1,:}) \\ \vdots \\ \max(\mathbf{c}_{d,:}) \end{bmatrix}$$

[Kalchbrenner et al., 2014]

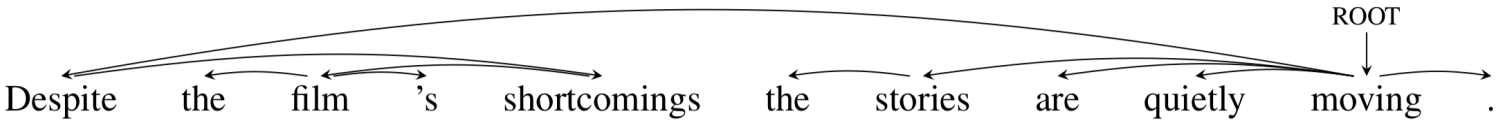
Example: 2-D Convolutional Operations



$$c_i = f(\boldsymbol{w}\boldsymbol{x}_{i:i+h-1} + b) \qquad (4)$$

[Kim, 2014]

Dependency-based CNNs

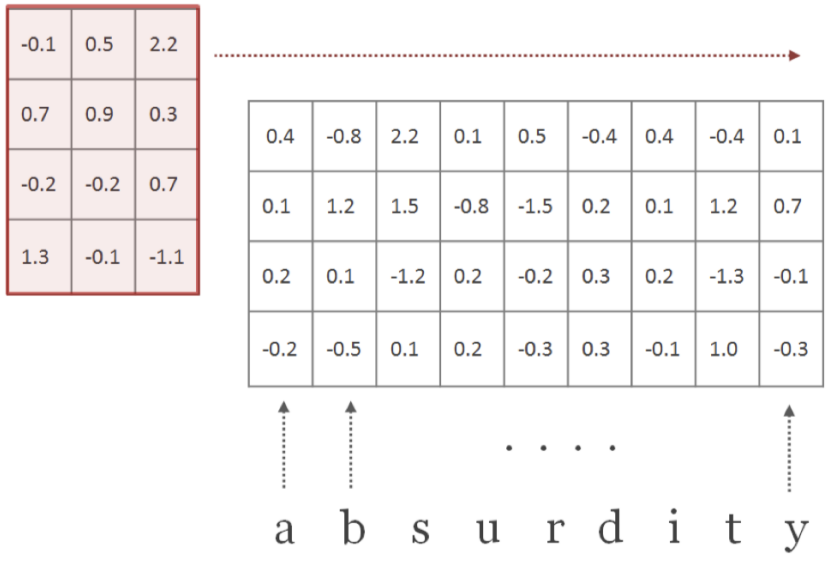


$$\boldsymbol{x}_i^{(k)} = [\boldsymbol{x}, \boldsymbol{x}_{p(i)}, \ldots, \boldsymbol{x}_{p^{k-1}(i)} \quad (5)$$

$$c = f(\boldsymbol{w}\boldsymbol{x}_{i,k} + b) \quad (6)$$

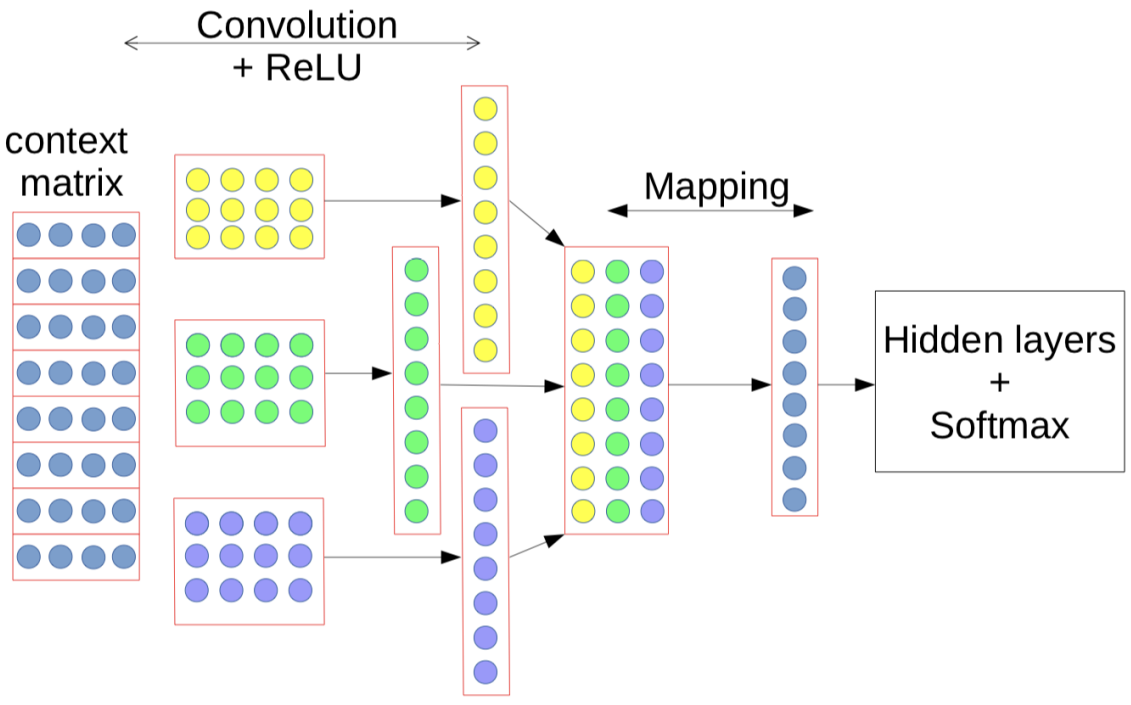
[Ma et al., 2015]

CharCNN



[Kim et al., 2016]

CNN for Language Modeling



[Gehring et al., 2016]

Summary

1. Basic Architecture of CNN

2. Applications in NLP

Reference

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