

第二部分：句子级的情感分析



基本框架



输出:



情感分类

句子表示

向量化

输入:

$w_1 w_2 \cdots w_n$

基本框架



输出: 

情感分类

句子表示

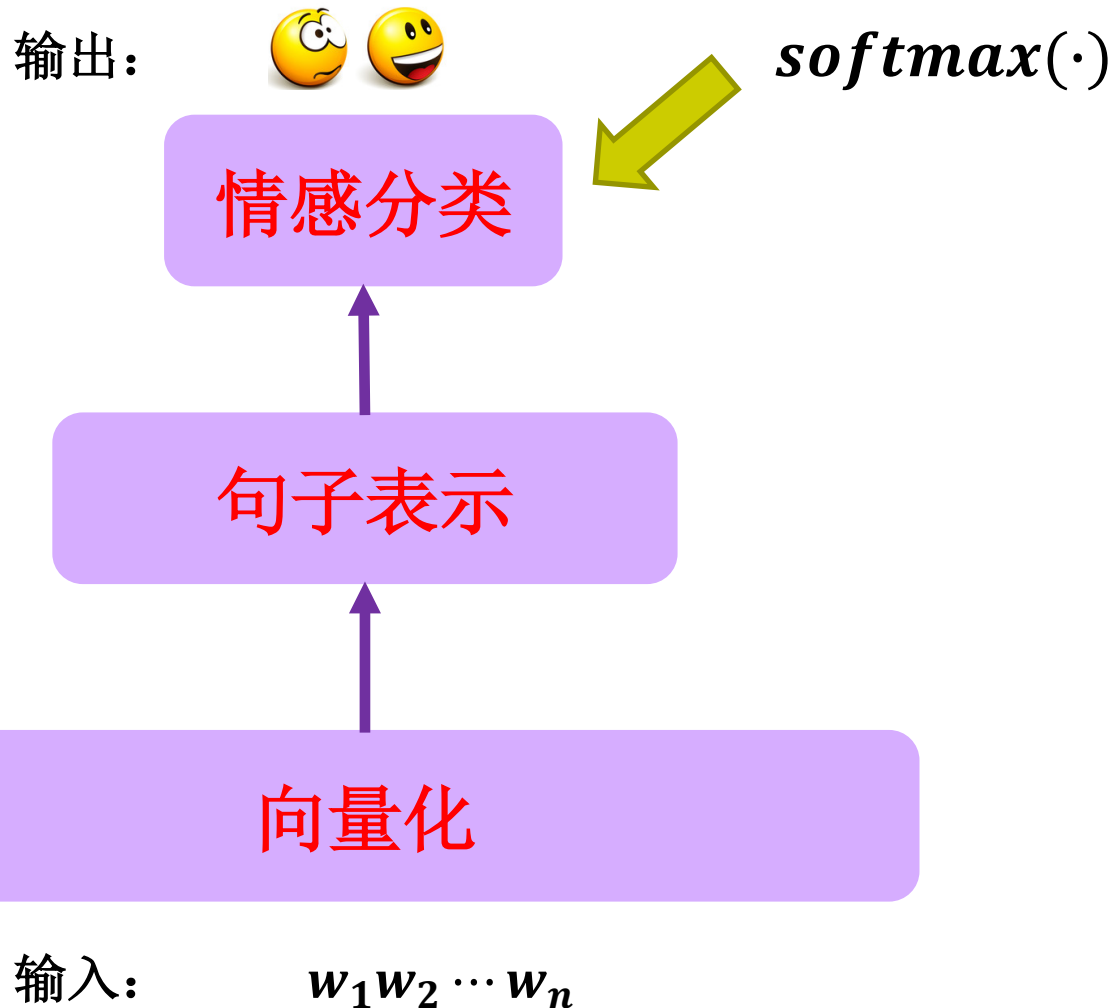
向量化

输入: $w_1 w_2 \cdots w_n$

第二部分内容



基本框架



基本框架



输出:



情感分类

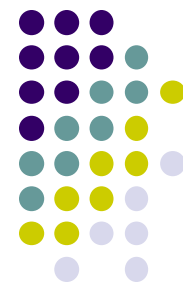
句子表示

向量化

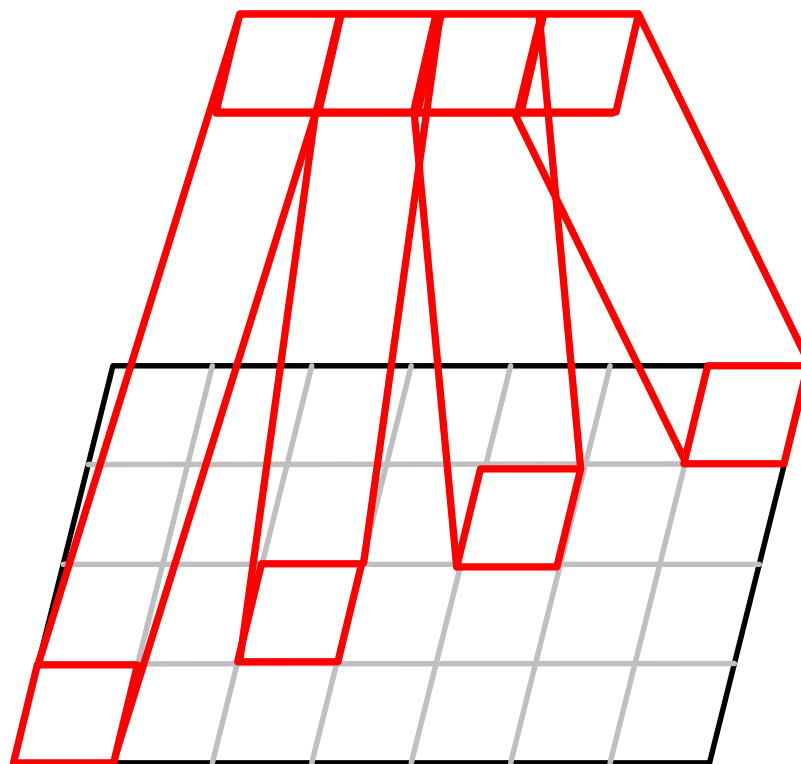
输入:

$w_1 w_2 \cdots w_n$

句子表示



最简单的方式

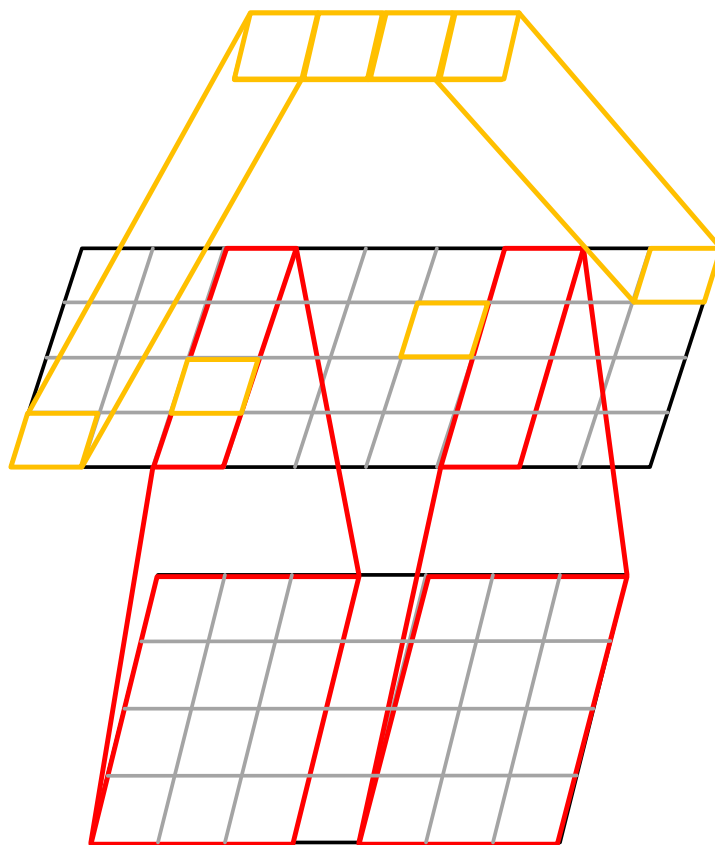


Duyu Tang, Furu Wei, Nan Yang, Ming Zhou, Ting Liu, and Bing Qin. Learning Sentiment-Specific Word Embedding for Twitter Sentiment Classification. In Proceedings of *ACL 2014*.

句子表示



最基本的卷积神经网络(CNN)

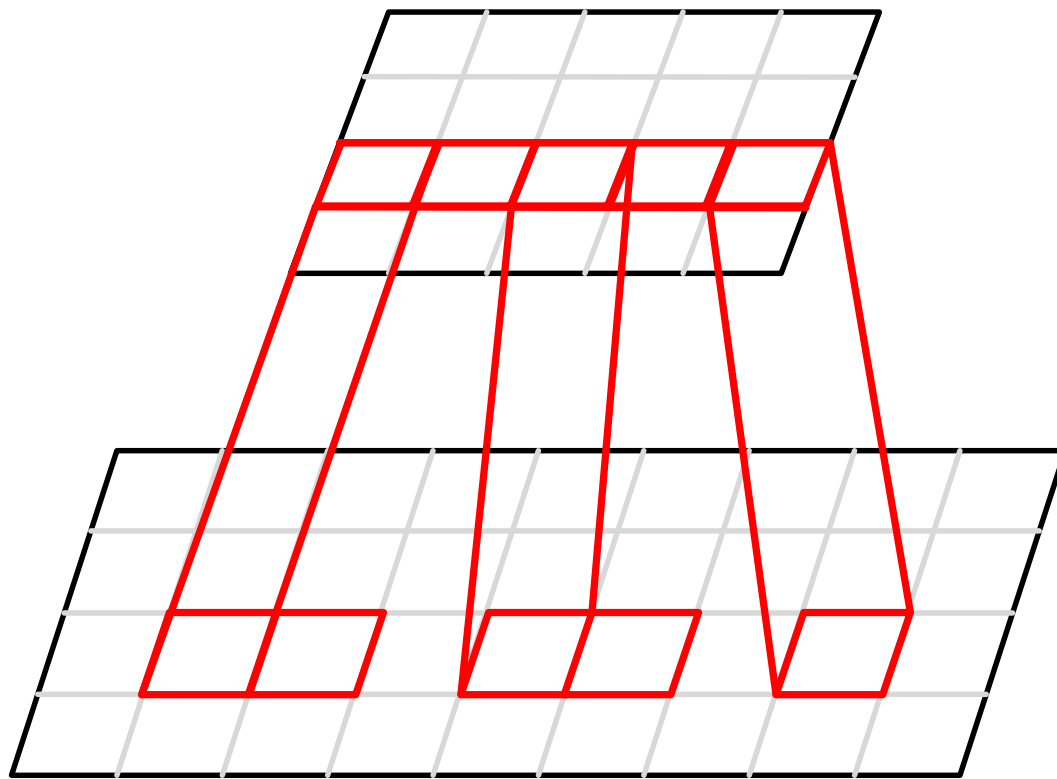


Ronan Collobert, Jason Weston, Leon Bottou, Michael Karlen, Koray Kavukcuoglu and Pavel Kuksa. Natural language processing (almost) from scratch. JMLR 2011.

句子表示



k-max pooling

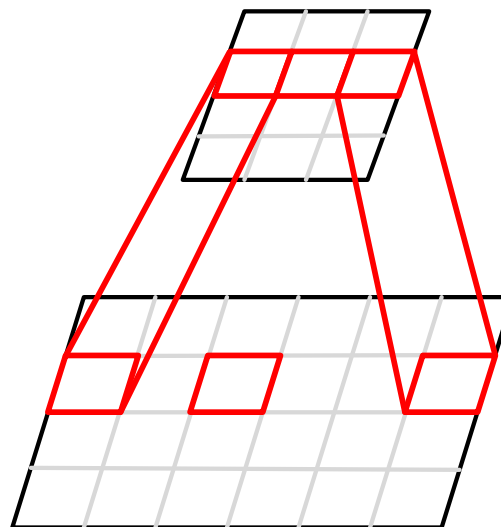
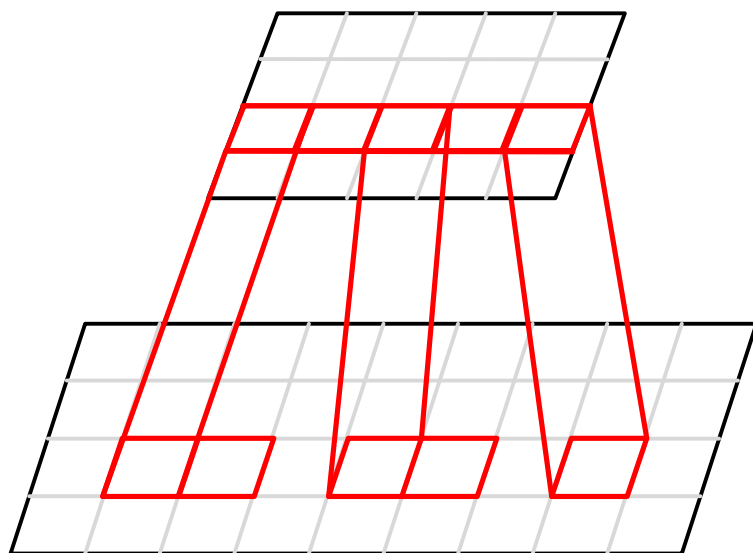


Nal Kalchbrenner, Edward Grefenstette, and Phil Blunsom. A convolutional neural network for modelling sentences. In Proceedings of ACL 2014.

句子表示



动态k-max pooling

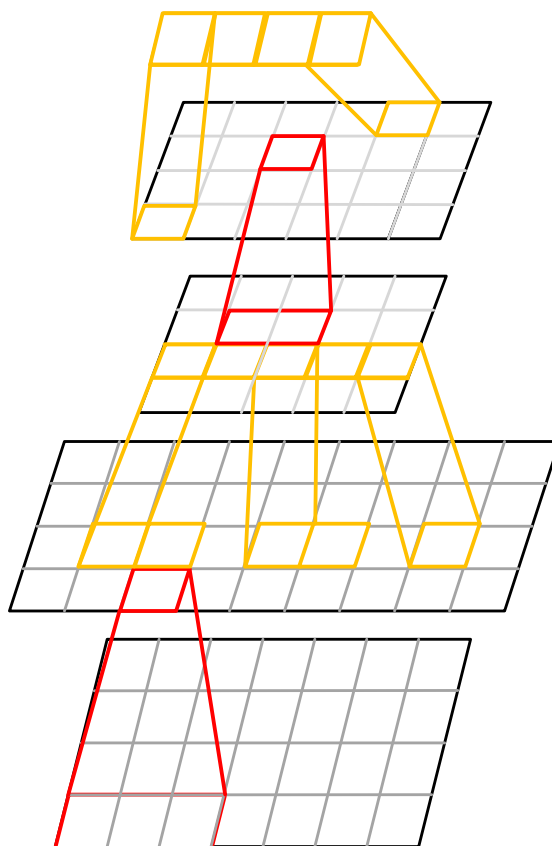


Nal Kalchbrenner, Edward Grefenstette, and Phil Blunsom. A convolutional neural network for modelling sentences. In Proceedings of ACL 2014.

句子表示



多层卷积神经网络(CNN)

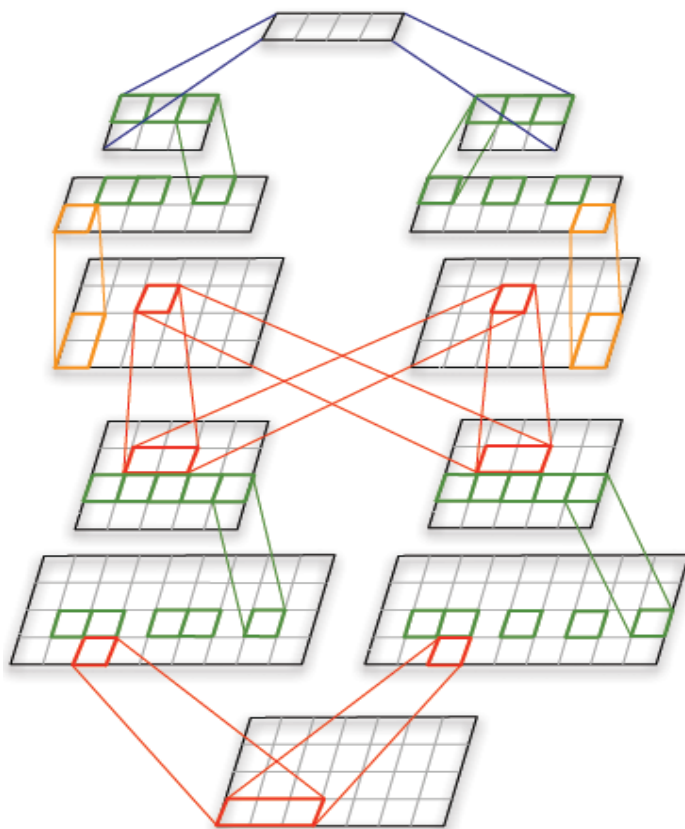


Nal Kalchbrenner, Edward Grefenstette, and Phil Blunsom. A convolutional neural network for modelling sentences. In Proceedings of ACL 2014.

句子表示



多个CNN神经网络结构

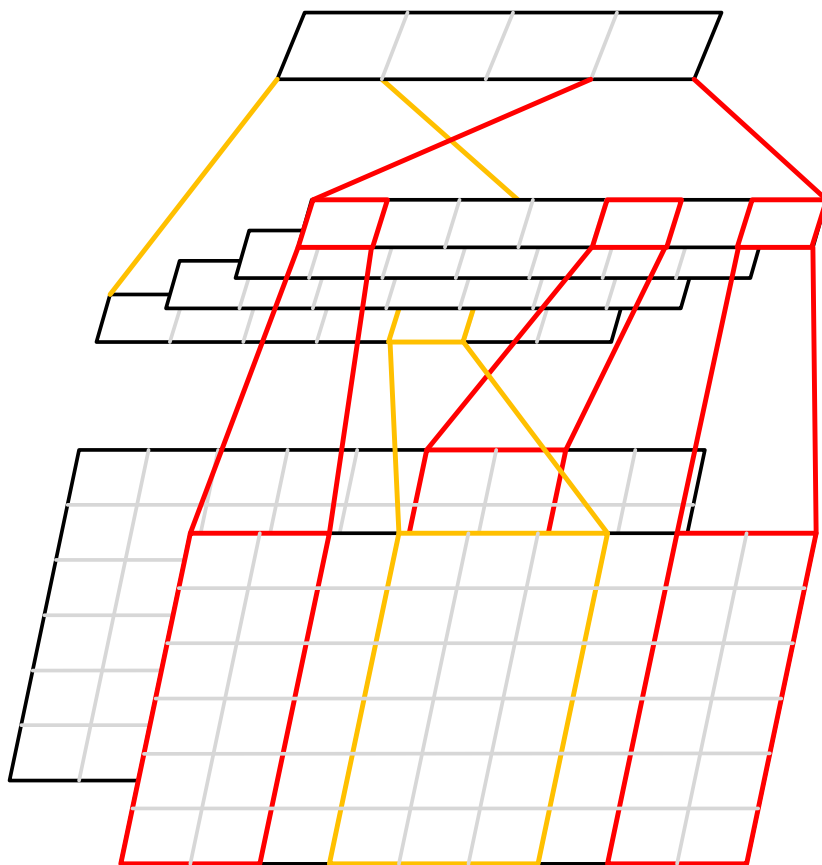


Nal Kalchbrenner, Edward Grefenstette, and Phil Blunsom. A convolutional neural network for modelling sentences. In Proceedings of ACL 2014.

句子表示



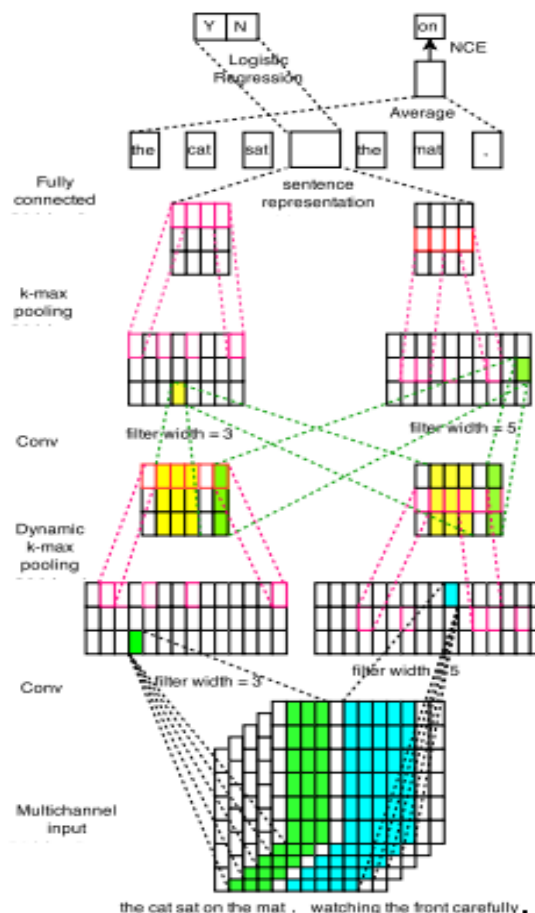
多个CNN神经网络结构



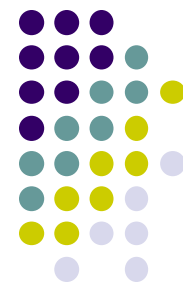
Yoon Kim. Convolutional neural networks for sentence classification. In Proceedings of EMNLP 2014.

句子表示

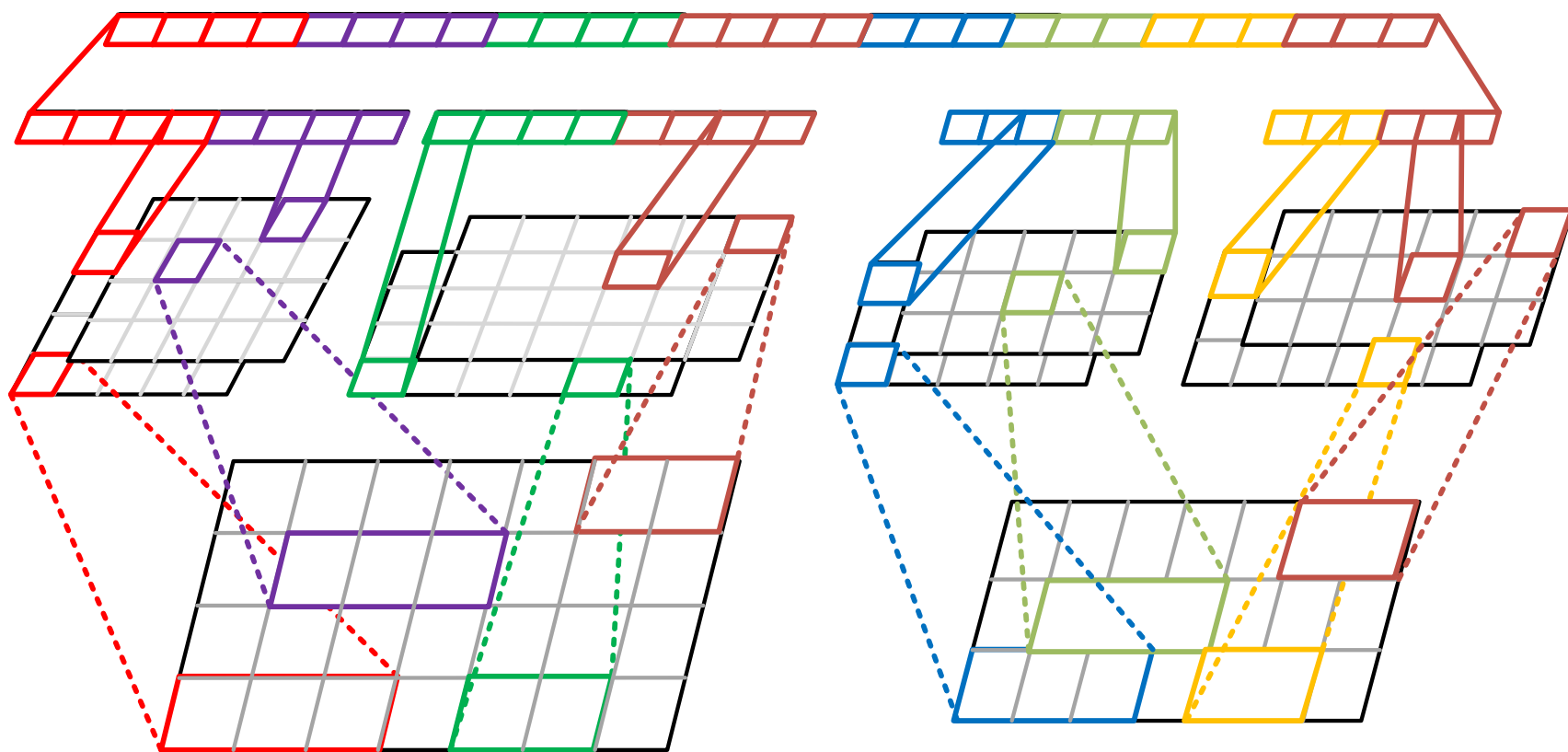
多种输入词向量



句子表示



多种输入词向量

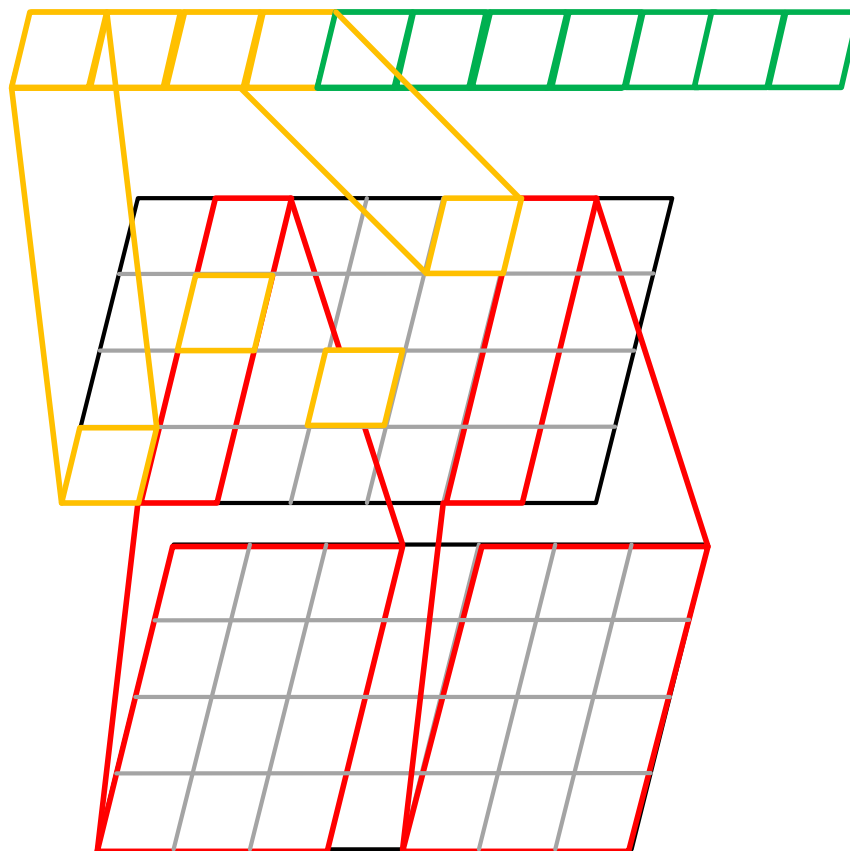


Ye Zhang, Stephen Roller, and Byron Wallace. Mgnc-cnn: A simple approach to exploiting multiple word embeddings for sentence classification. In Proceedings of NAACL 2016.

句子表示

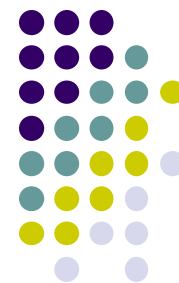


字/词向量组合

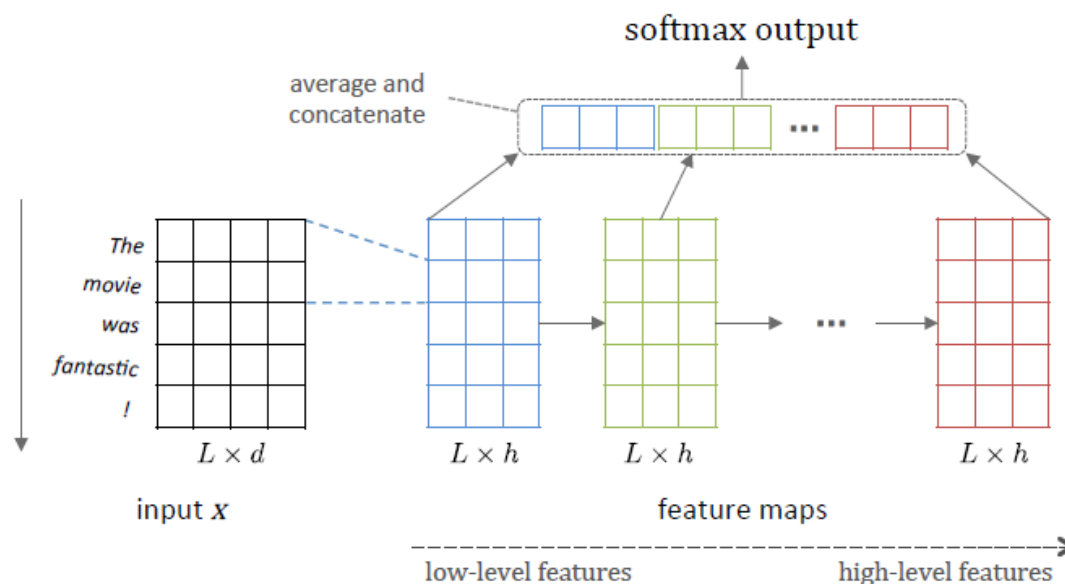


Cícero Nogueira dos Santos, and Maira Gatti. Deep Convolutional Neural Networks for Sentiment Analysis of Short Texts. In Proceedings of COLING 2014.

句子表示



非线性不连续的卷积方式



$$f_1[i] = \mathbf{P}\mathbf{x}_i$$

$$f_2[j] = \sum_{i < j} \lambda^{j-i-1} \cdot (\mathbf{P}\mathbf{x}_i \odot \mathbf{Q}\mathbf{x}_j)$$

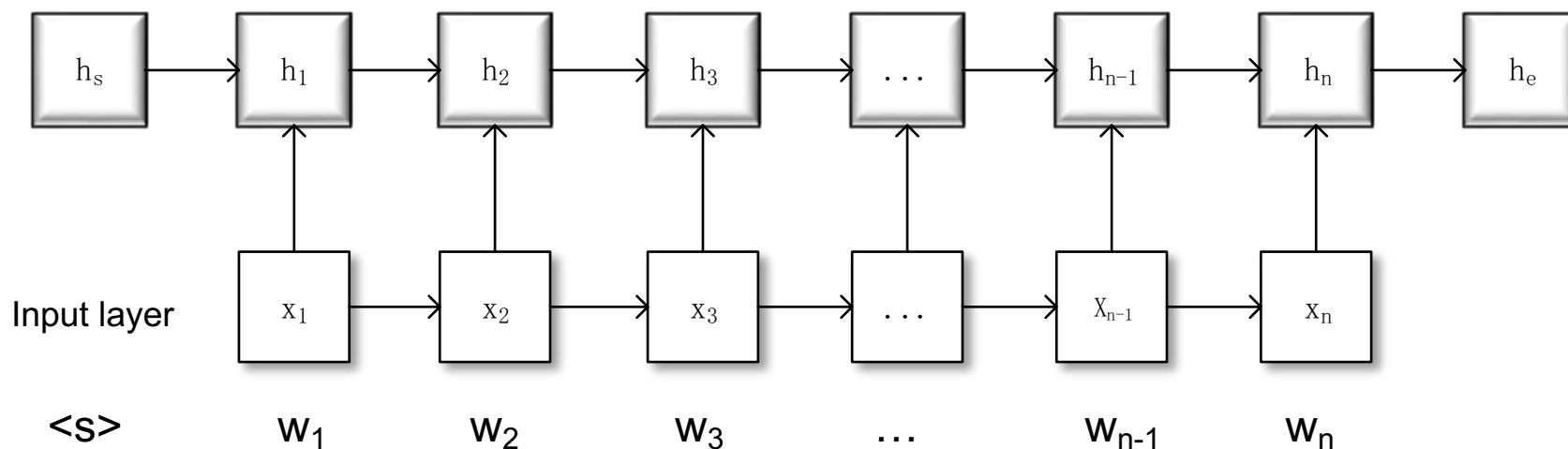
$$f_3[k] = \sum_{i < j < k} \lambda^{k-i-2} \cdot (\mathbf{P}\mathbf{x}_i \odot \mathbf{Q}\mathbf{x}_j \odot \mathbf{R}\mathbf{x}_k)$$

Tao Lei, Regina Barzilay, and Tommi Jaakkola. Molding CNNs for text: non-linear, non-consecutive convolutions. In Proceedings of EMNLP 2015.

句子表示



循环神经网络(RNN)



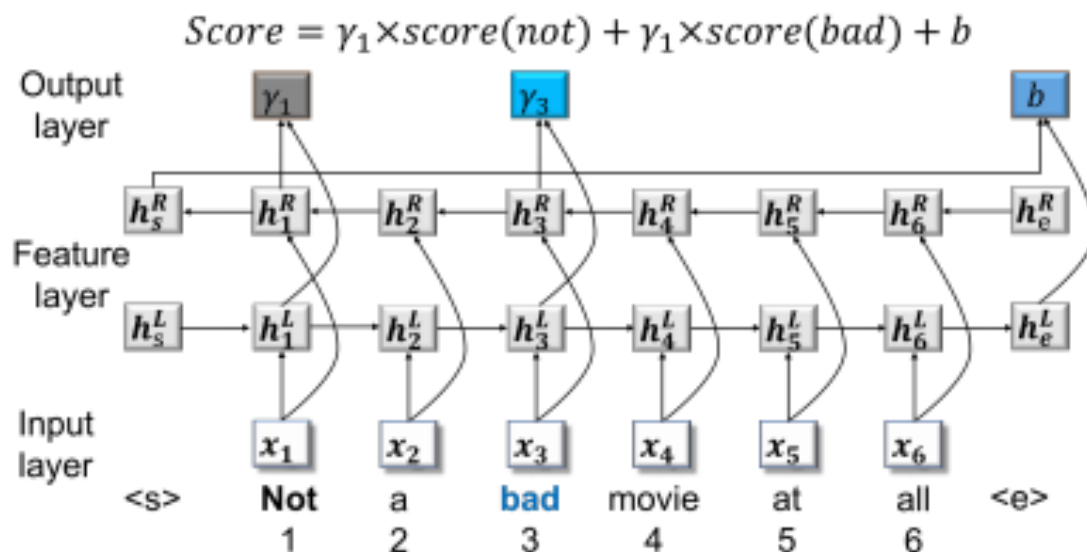
Xin Wang, Yuanchao Liu, Chengjie Sun, Baoxun Wang, and Xiaolong Wang. "Predicting polarities of tweets by composing word embeddings with long short-term memory. 2015. In Proceedings of ACL 2015

句子表示



循环神经网络(RNN)

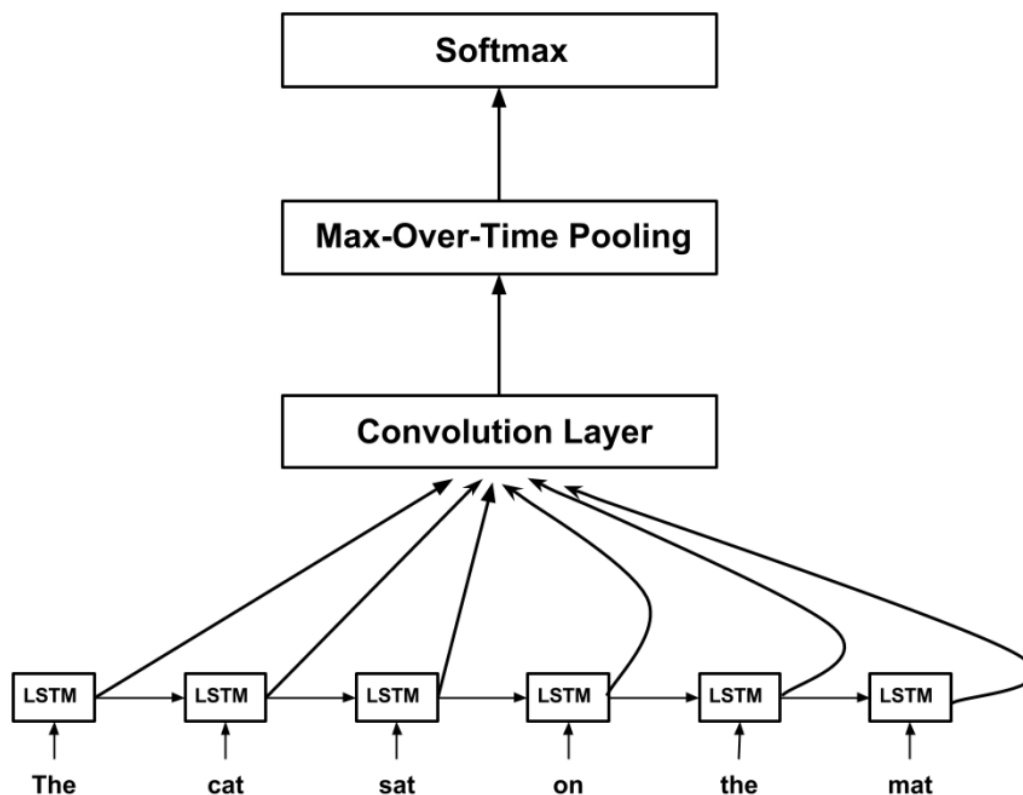
The performances were all really It's an insignificant [criticism] _{-1→-0.5} .
Nobody gives a [good] _{+3→-1} performance in this movie
She's not [terrific] _{+5→+1} but not [terrible] _{-5→-1} either.
It's not a very [good] _{+3→-0.25} movie song!
It removes my [doubts] _{-3→+1} .



句子表示



RNN+CNN

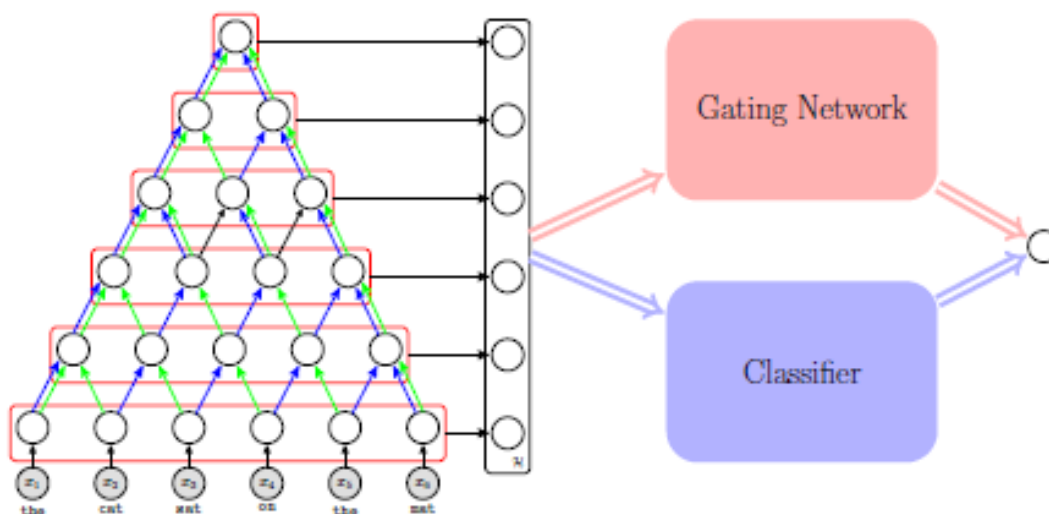


Zhang, Rui and Lee, Honglak and Radev, Dragomir R. Dependency Sensitive Convolutional Neural Networks for Modeling Sentences and Documents. In Proceedings of NAACL2016

句子表示



递归神经网络(Recursive NN)



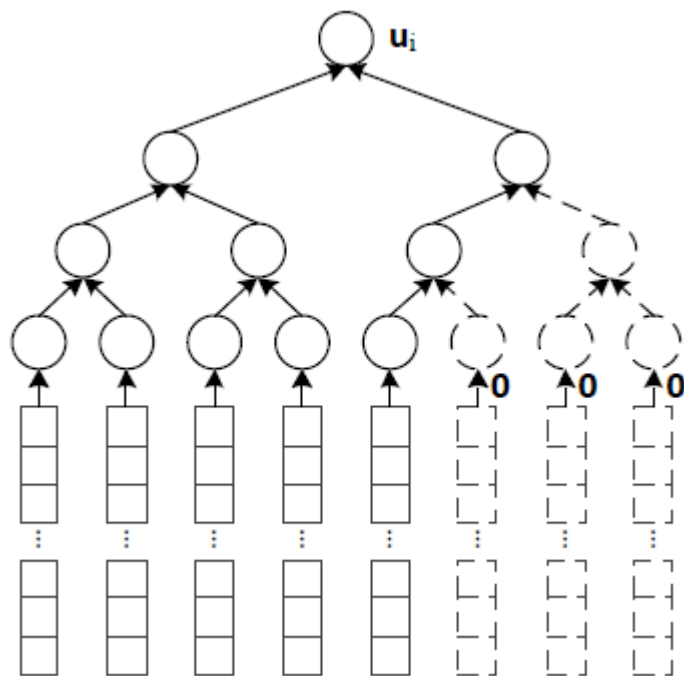
$$p(C = c | \mathbf{x}_{1:T}) = \sum_{t=1}^T p(C = c | \mathcal{H}_{\mathbf{x}} = t) \cdot p(\mathcal{H}_{\mathbf{x}} = t | \mathbf{x}_{1:T}) = \sum_{t=1}^T g(\bar{h}^t) \cdot w(\bar{h}^t)$$

Han Zhao, Zhengdong Lu, and Pascal Poupart. Self-adaptive hierarchical sentence model. In Proceedings of IJCAI2015.

句子表示



递归神经网络(Recursive NN)

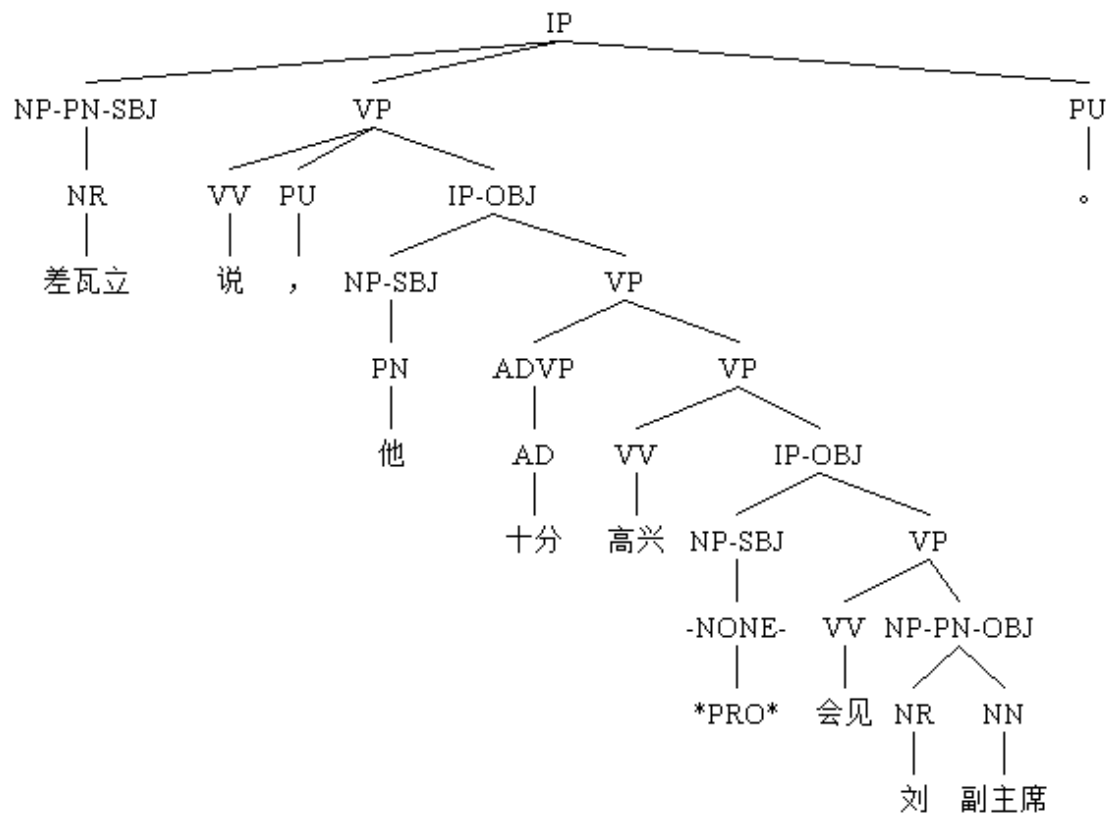


Xinchi Chen, Xipeng Qiu, Chenxi Zhu, Shiyu Wu, and Xuanjing Huang. Sentence modeling with gated recursive neural network. In Proceedings of EMNLP2015.

句子表示



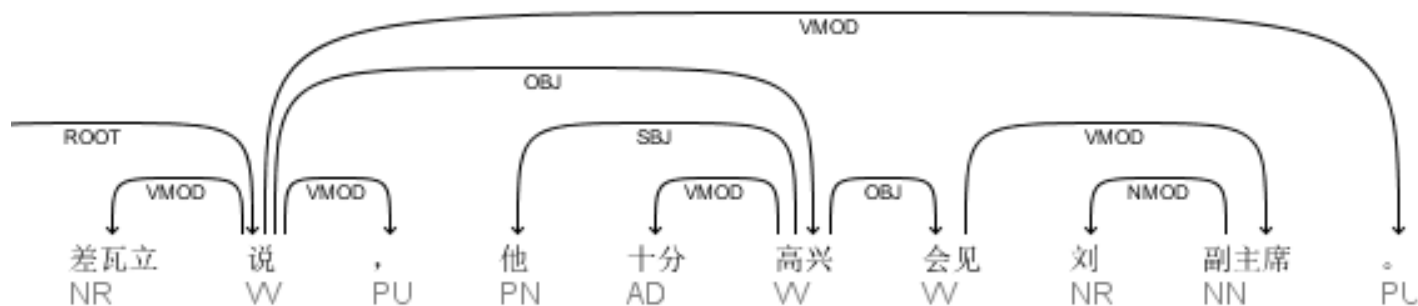
树结构信息?



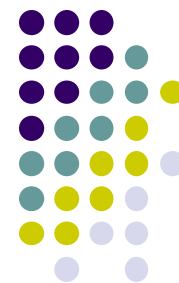
句子表示



树结构信息?

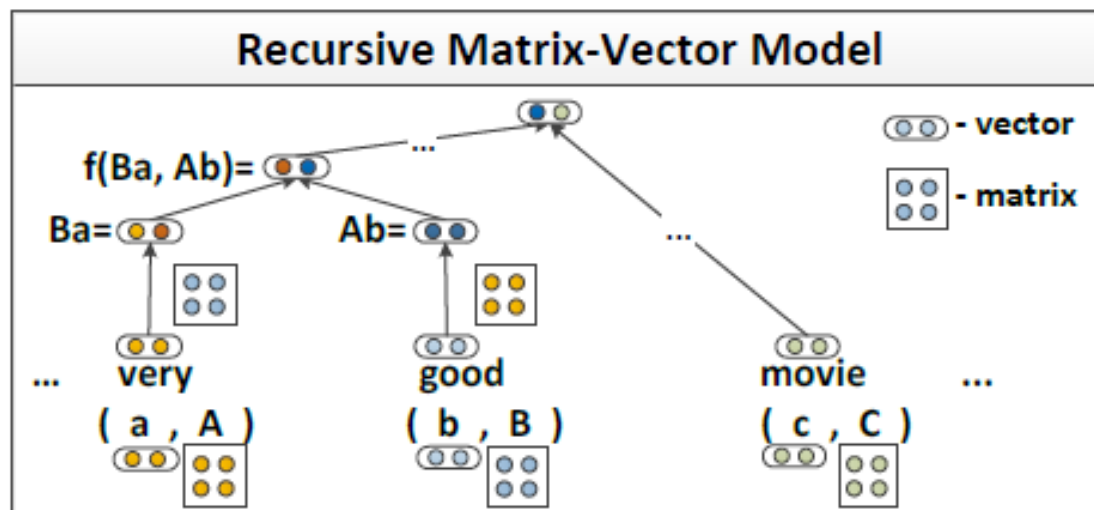


句子表示

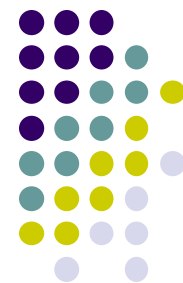


递归神经网络(Recursive NN)

Matrix-Vector

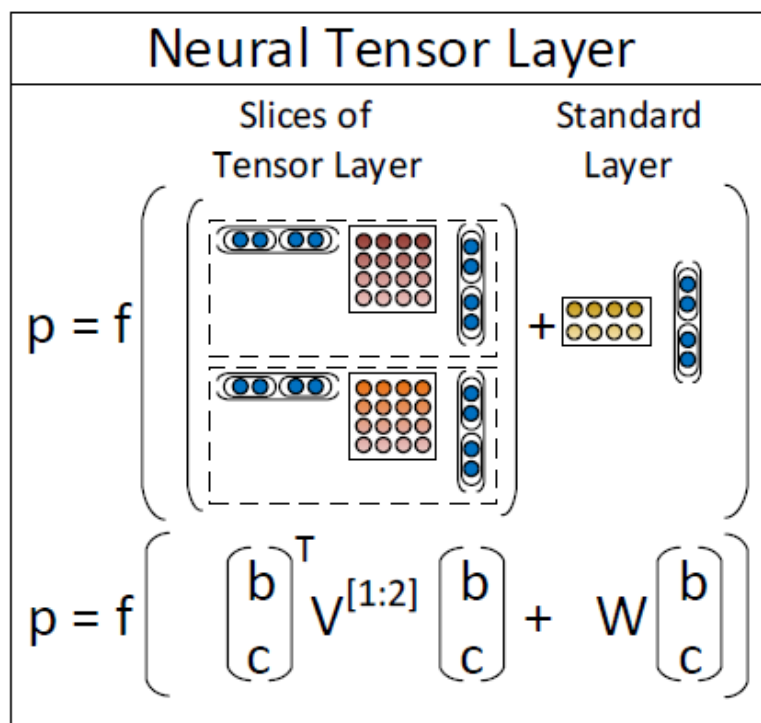


句子表示



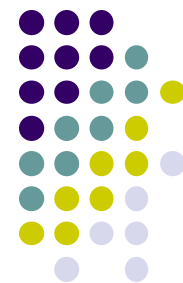
递归神经网络(Recursive NN)

Tensor NN



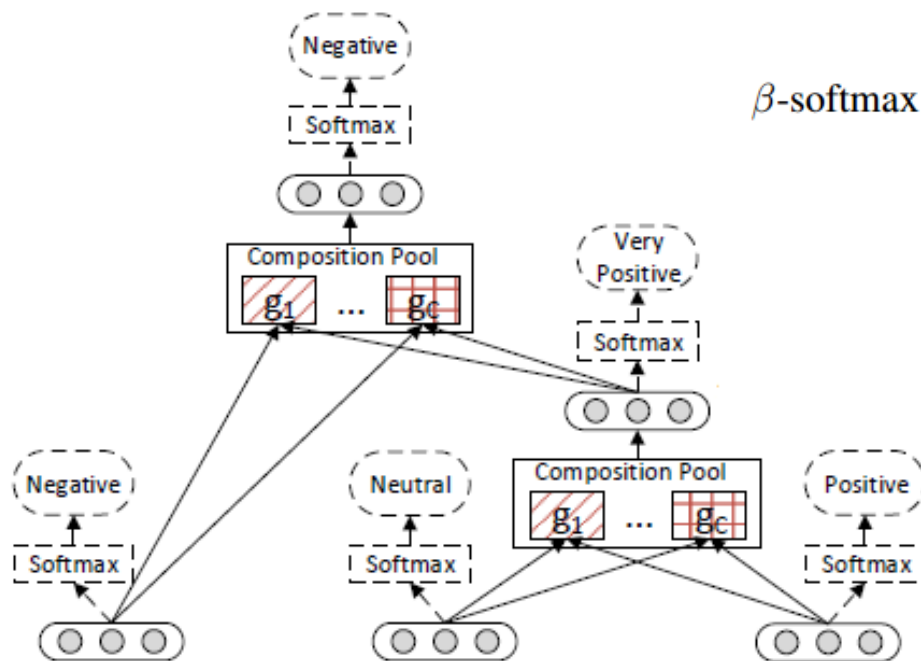
Richard Socher, Alex Perelygin, Jean Y. Wu, Jason Chuang, Christopher D. Manning, Andrew Y. Ng, and Christopher Potts. Recursive deep models for semantic compositionality over a sentiment treebank. In Proceedings of EMNLP2013.

句子表示



递归神经网络(Recursive NN)

Adaptive Multi-Compositionality



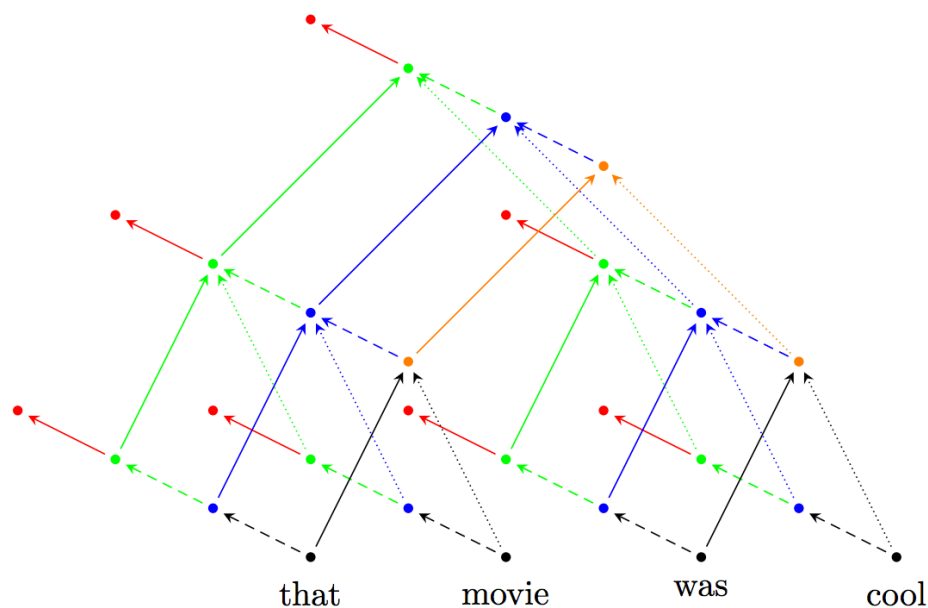
$$\beta\text{-softmax}(\mathbf{z}) = \frac{1}{\sum_i \exp\{\beta \mathbf{z}_i\}} \begin{bmatrix} \exp\{\beta \mathbf{z}_1\} \\ \vdots \\ \exp\{\beta \mathbf{z}_K\} \end{bmatrix}$$

句子表示



递归神经网络(Recursive NN)

多个Recursive NN结构



Ozan Irsoy, and Claire Cardie. Deep recursive neural networks for compositionality in language. In Proceedings of NIPS2014.

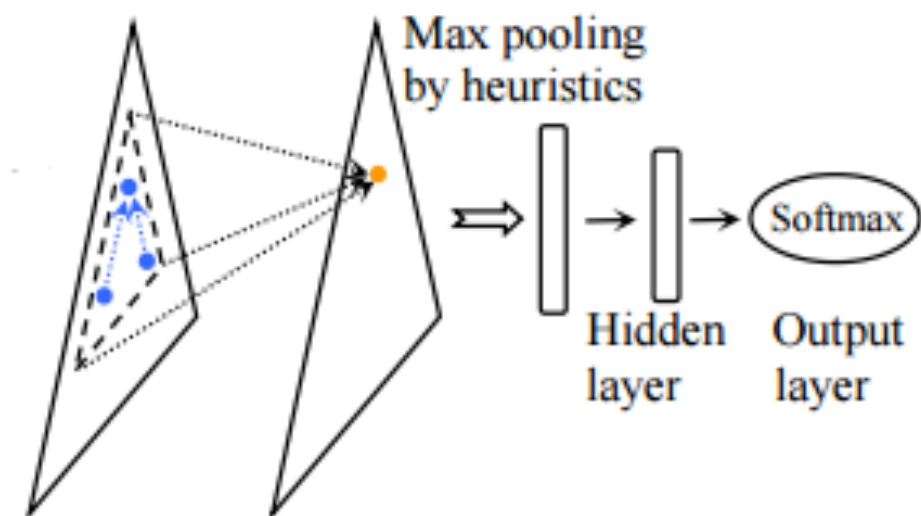


Xiaodan Zhu, Parinaz Sobhani, and Hongyu Guo. Long short-term memory over recursive structures. In Proceedings of ICML2015.

句子表示



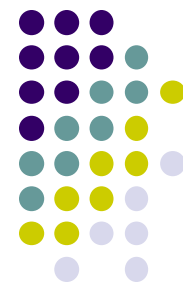
基于树的卷积(Tree- Convolution)



Lili Mou, Hao Peng, Ge Li, Yan Xu, Lu Zhang and Zhi Jin. Discriminative Neural Sentence Modeling by Tree-Based Convolution. In Proceedings of EMNLP2015.

Mingbo Ma, Liang Huang, Bowen Zhou and Bing Xiang. Dependency-based convolutional neural networks for sentence embedding[C] In Proceedings of ACL2015.

句子表示



利用额外数据

句子表示



利用无标注数据

- **Sequential (Denoising) Autoencoders**

- Encoder-decoder框架
- 噪声
 - 以一定概率删除一个词
 - 以一定概率交换相邻的两个词

- **FastSent**

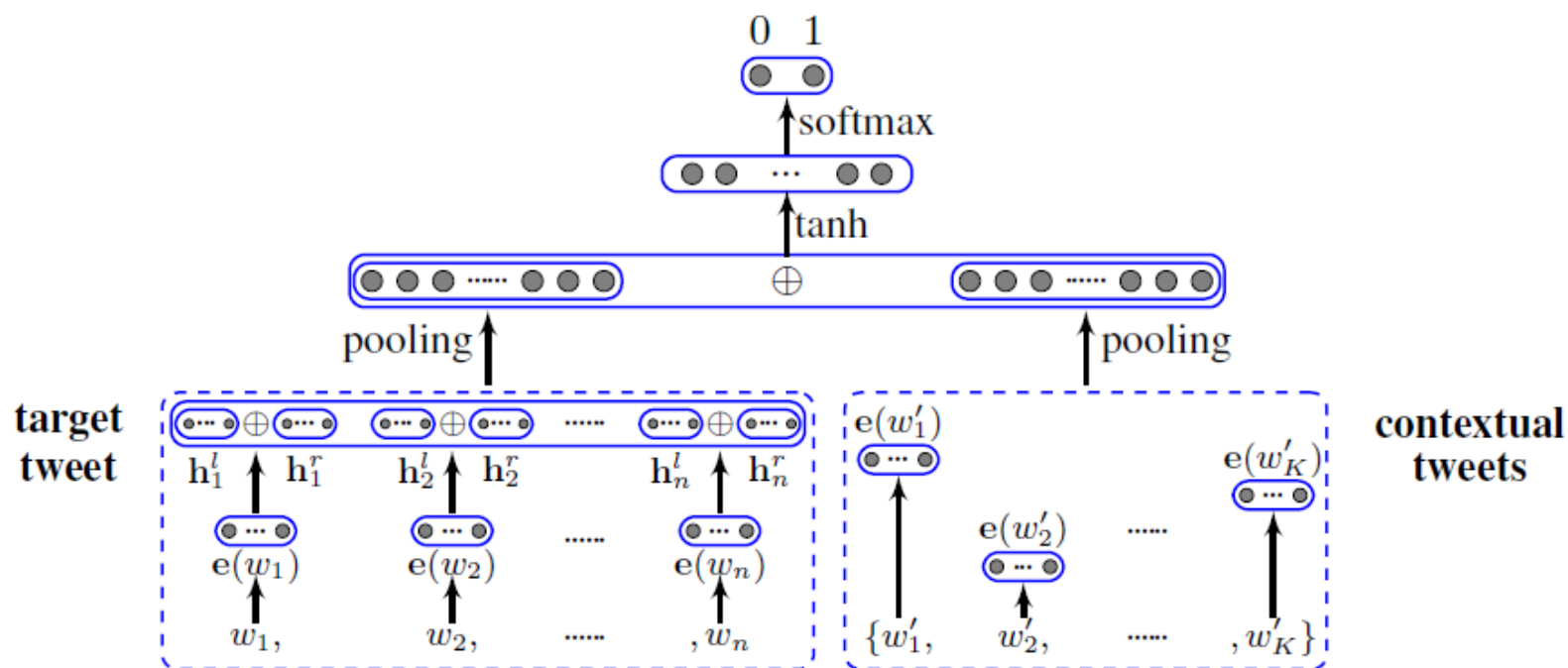
- 根据当前句子预测周围句子的词
- 也可以将autoencoder融入进去

$$\mathbf{s}_i = \sum_{w \in S_i} u_w$$
$$\sum_{w \in S_{i-1} \cup S_{i+1}} \phi(\mathbf{s}_i, v_w)$$

$$\sum_{w \in S_{i-1} \cup S_i \cup S_{i+1}} \phi(\mathbf{s}_i, v_w)$$

句子表示

利用上下文信息



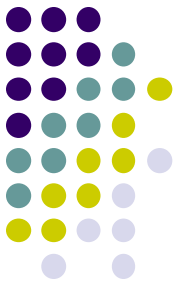
Meishan Zhang, Yue Zhang, Guohong Fu. Tweet Sarcasm Detection Using Deep Neural Network. In Proceedings of COLING2016.

Yafeng Ren, Yue Zhang, Meishan Zhang, Donghong Ji. Context-Sensitive Twitter Sentiment Classification Using Neural Network. In Proceedings of the AAAI2016.

第四部分：细粒度的情感分析



细粒度的情感分析



主要内容:

- 实体级别
- 属性级别
- 短语识别
- 立场检测

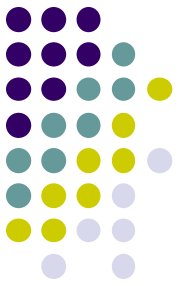
细粒度的情感分析



主要内容:

- 实体级别
- 属性级别
- 短语识别
- 立场检测

实体级别情感分析

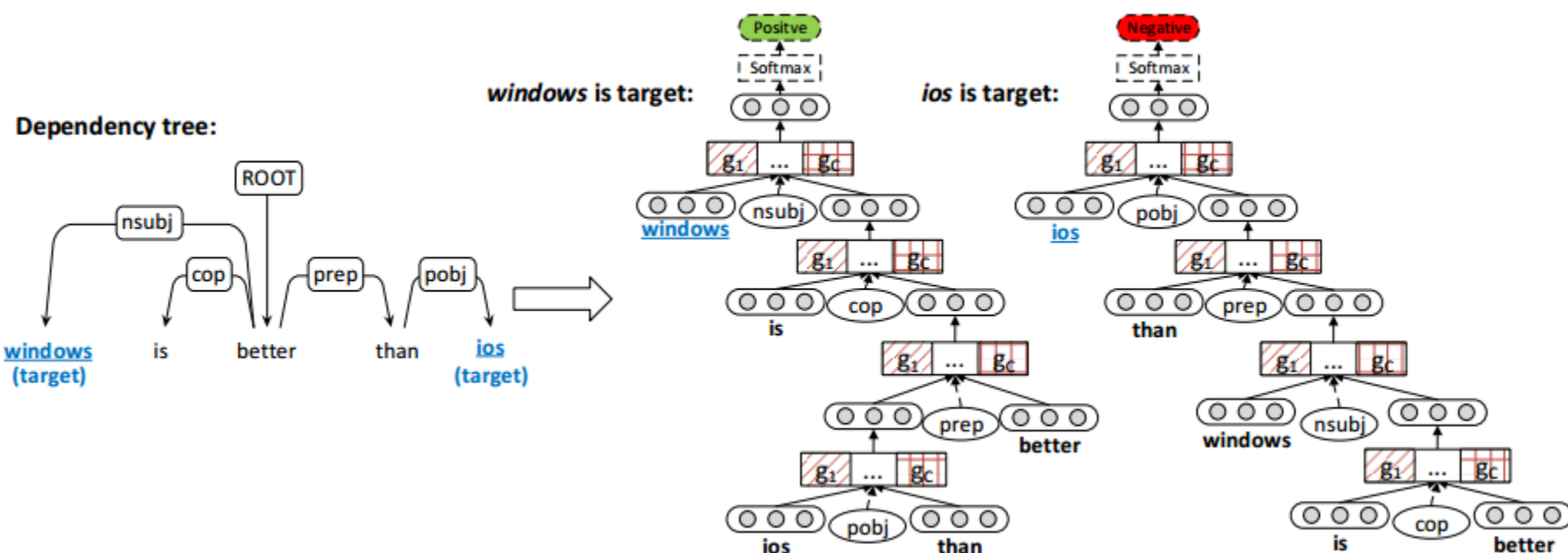


- + 我非常喜欢 **这款手环**，功能很强大。
- **食堂的饭菜**真是难以下咽。
- 0 我明天出发去 **武汉** 旅游。

实体级别情感分析



句法树结合Recursive NN



Li Dong, Furu Wei, Chuanqi Tan, Duyu Tang, Ming Zhou, and Ke Xu. Adaptive Recursive Neural Network for Target-dependent Twitter Sentiment Classification. In Proceedings of ACL2014.

实体级别情感分析



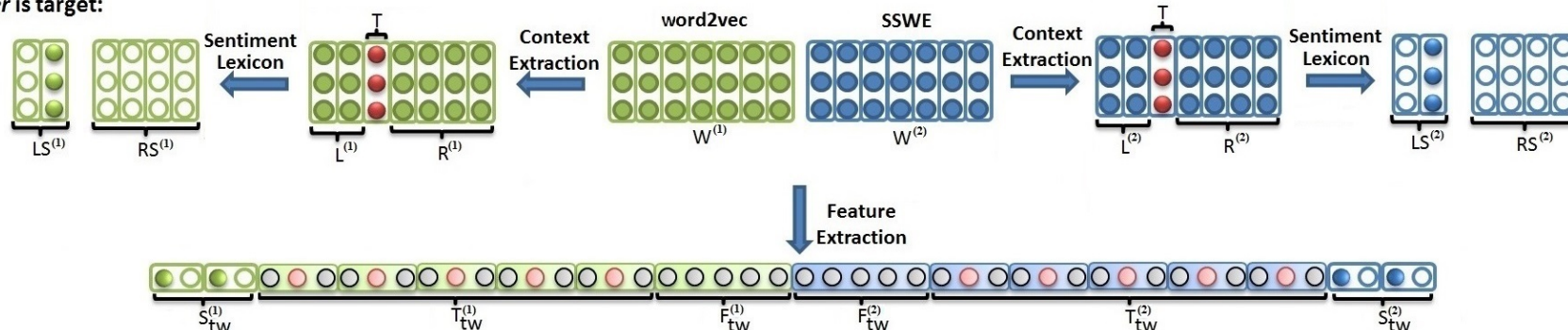
分段式的Pooling

Input:

I love **Twitter** more than **Facebook**!

Vector
Representations

Twitter is target:



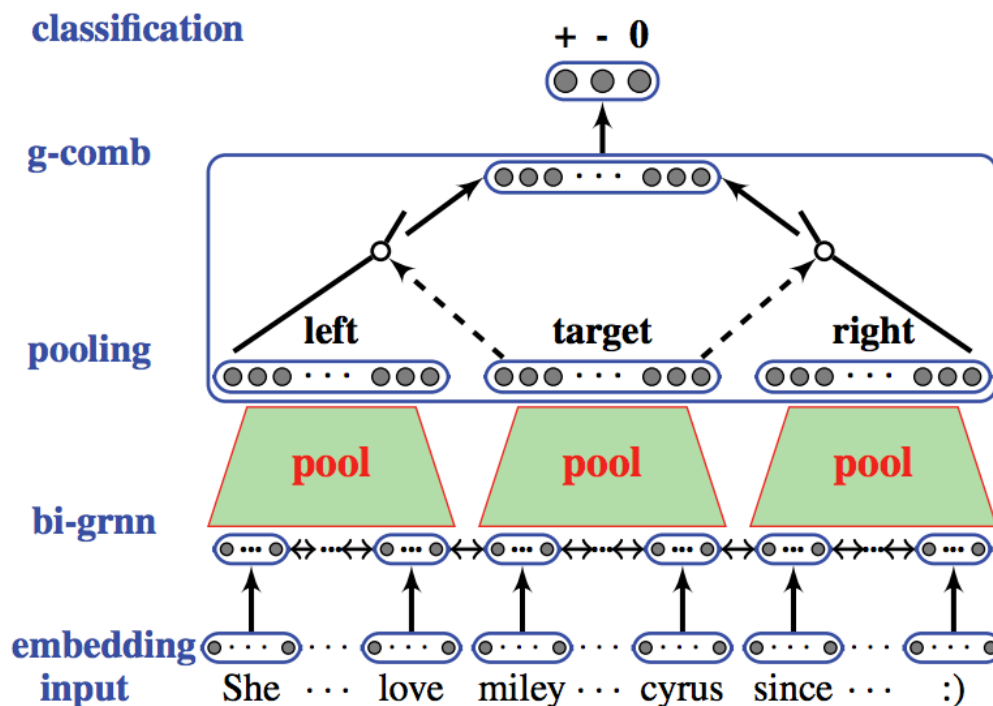
$$\overline{x_i} = \left(\sum_{k=1}^n x_{i,k}^p \right)^{\frac{1}{p}}$$

Duy-Tin Vo, and Yue Zhang. Target-dependent twitter sentiment classification with rich automatic features. In Proceedings of IJCAI2015.

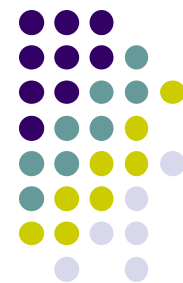
实体级别情感分析



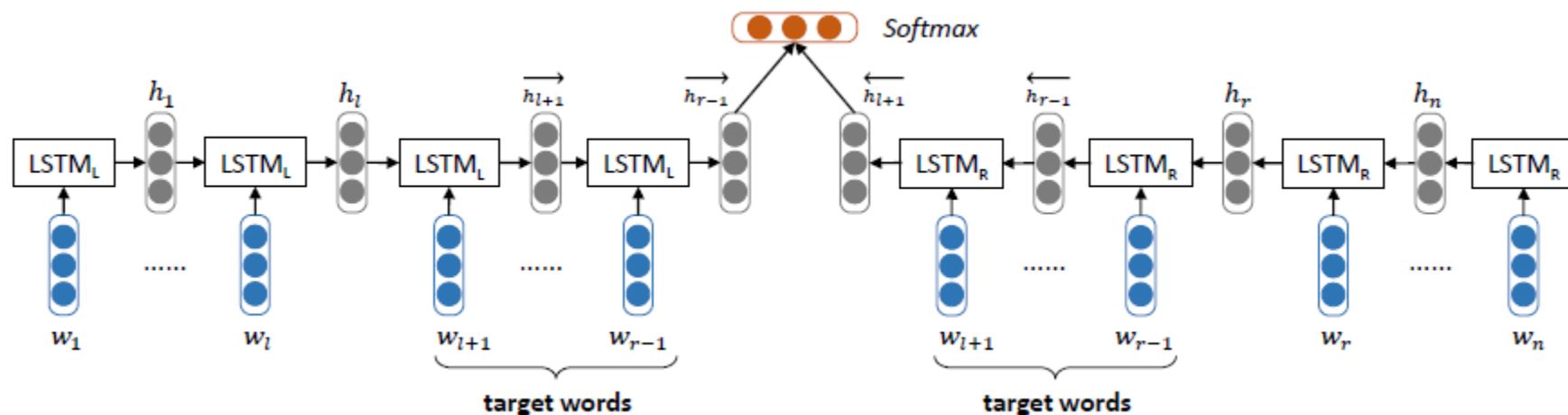
分段式的深度神经网络



实体级别情感分析



分段式的深度神经网络

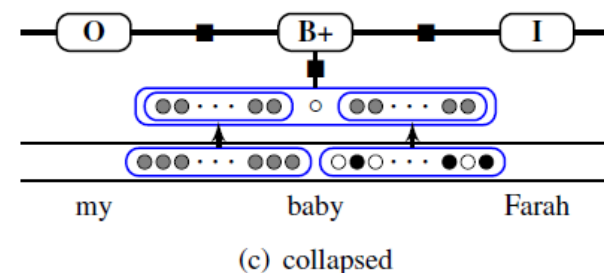
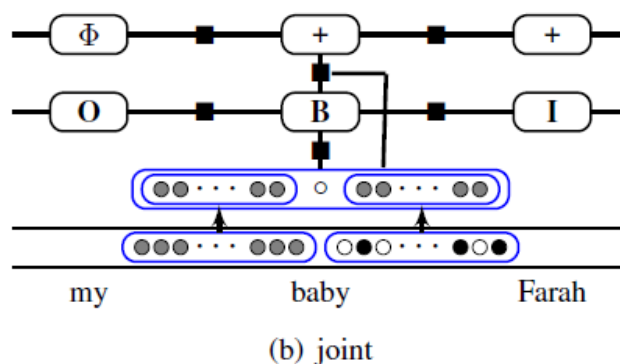
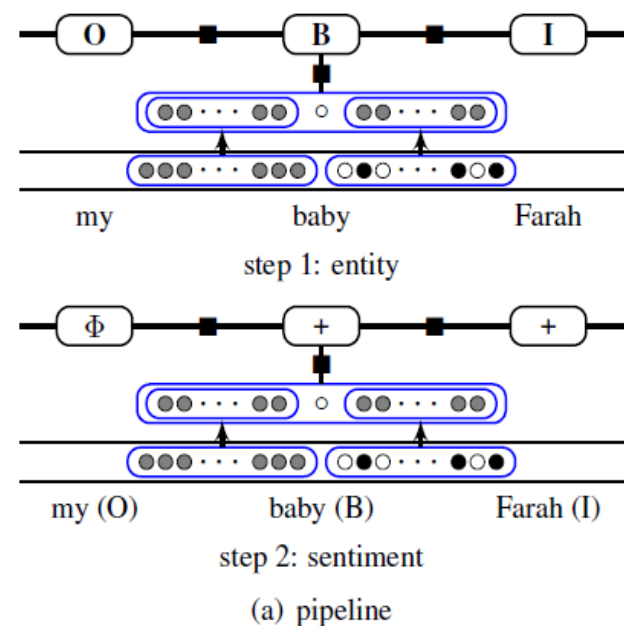


实体级别情感分析

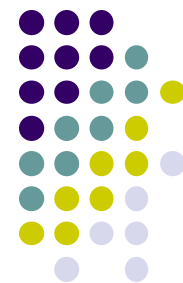


开放领域实体分析

- 实体未指定



细粒度的情感分析



主要内容:

- 实体级别
- 属性级别
- 短语识别
- 立场检测



属性级别情感分析

aspect-level (和target-level基本相似)

这台笔记本 **屏幕** 非常 不错。

(屏幕, +)

东北饭馆的 **服务态度** 一直让人诟病。

(态度, -)

每个领域属性提前给定

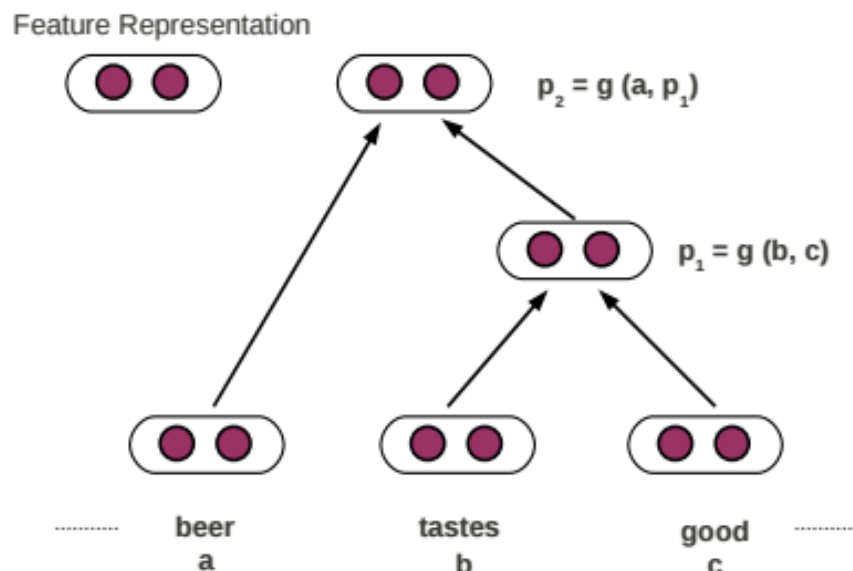
- n 个属性, 则 $2n$ 分类问题

属性级别情感分析

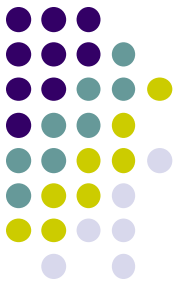


递归神经网络

- Matrix-Vector RNN (MV-RNN)



属性级别情感分析



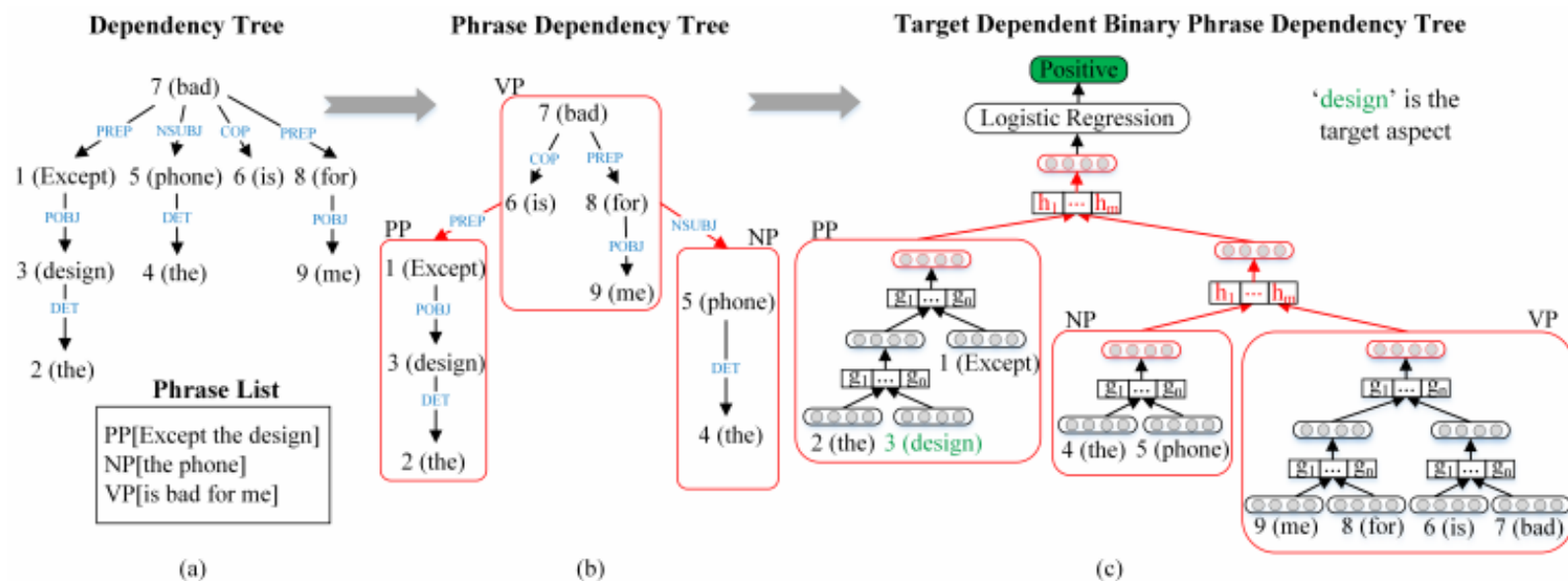
循环神经网络和递归神经网络

- RNN, GRU, LSTM
- Recursive NN
- 比较和分析

属性级别情感分析

递归神经网络

- 假定Aspect在句子中的位置已经给定
- 短语结构句法树

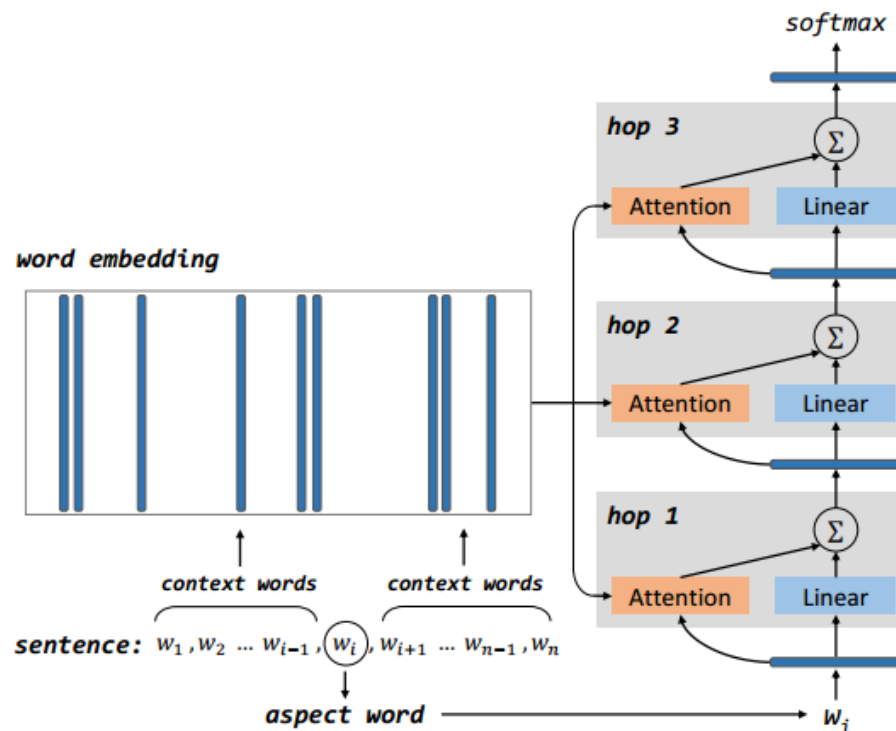


属性级别情感分析

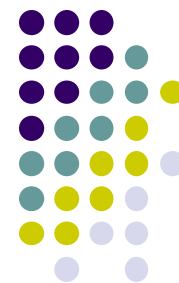


循环神经网络

- Aspect词已经给定

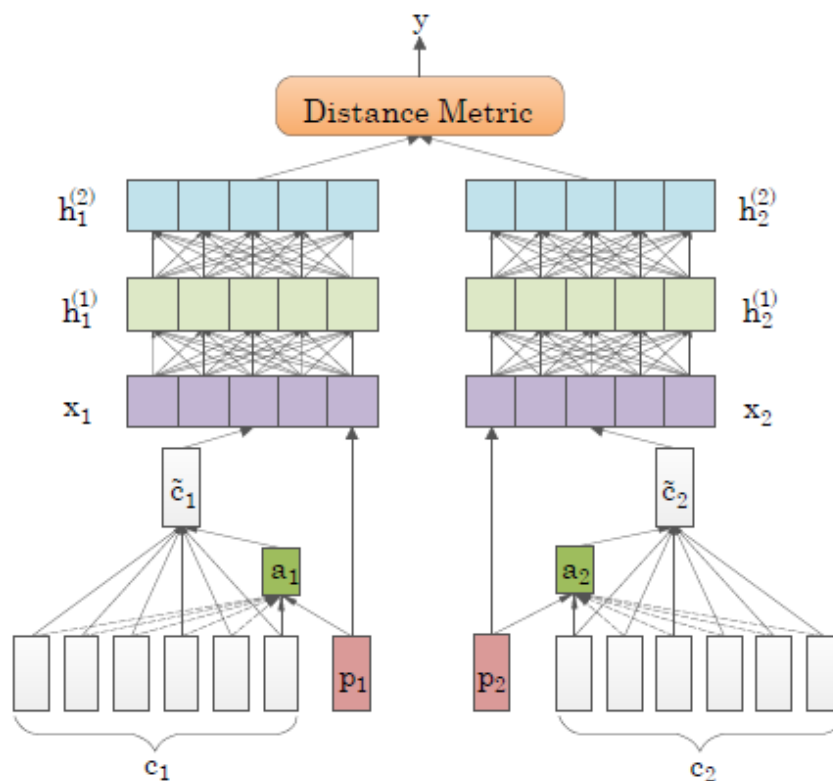


属性级别情感分析

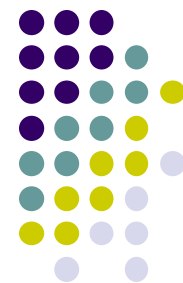


Aspect未知，如何自动发现

- 聚类问题



细粒度的情感分析



主要内容:

- 实体级别
- 属性级别
- 短语识别
- 立场检测

短语识别



情感表达式

他和那些人的态度一样，不喜欢这里这么嘈杂的氛围。

情感持有者

他和那些人的态度一样，不喜欢这里这么嘈杂的氛围。

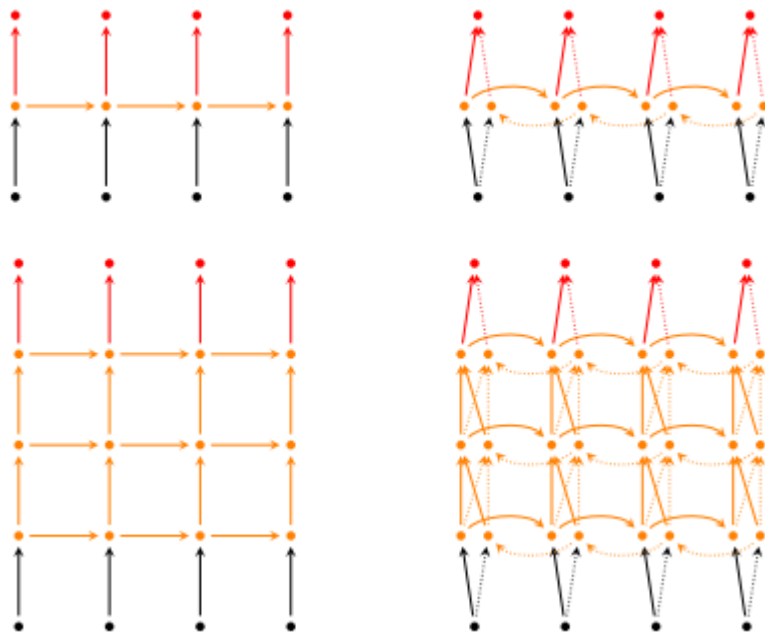
情感对象

他和那些人的态度一样，不喜欢这里这么嘈杂的氛围。

短语识别



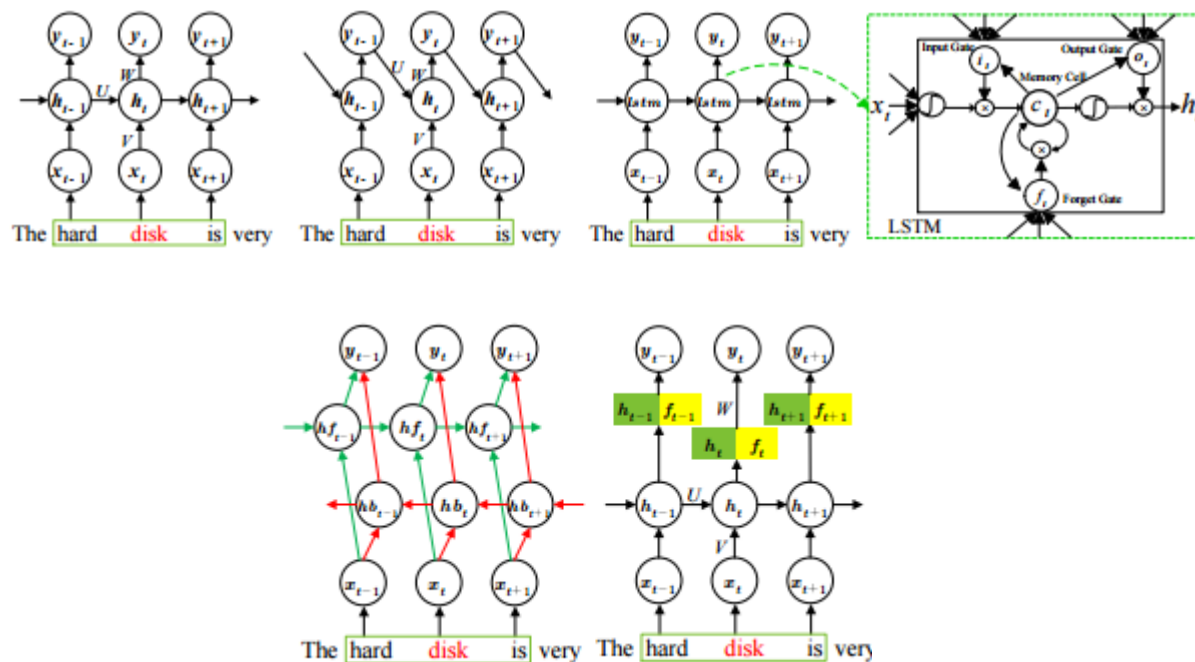
序列标注模型



Ozan Irsoy, and Claire Cardie. Opinion Mining with Deep Recurrent Neural Networks. In Proceedings of EMNLP2014.

短语识别

序列标注模型



SENNA Embeddings
Google embeddings
Amazon Embeddings

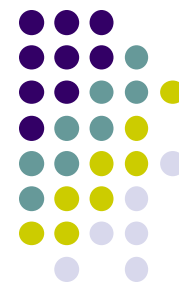
细粒度的情感分析



主要内容:

- 实体级别
- 属性级别
- 短语识别
- 立场检测

立场检测



主题：俄罗斯在叙利亚的反恐行动

俄罗斯总是被美国战略欺骗。

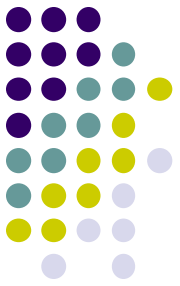
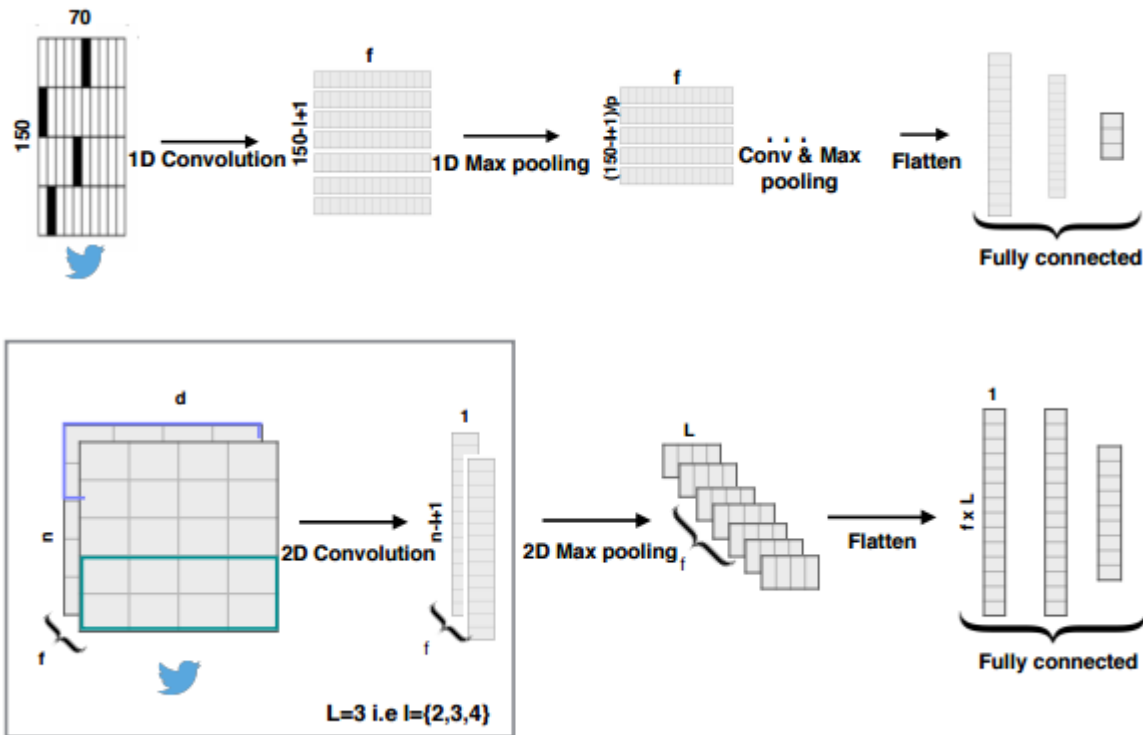
反对

俄罗斯将反恐进行到底！

支持

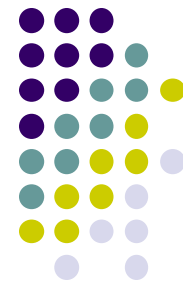
立场检测

卷积神经网络

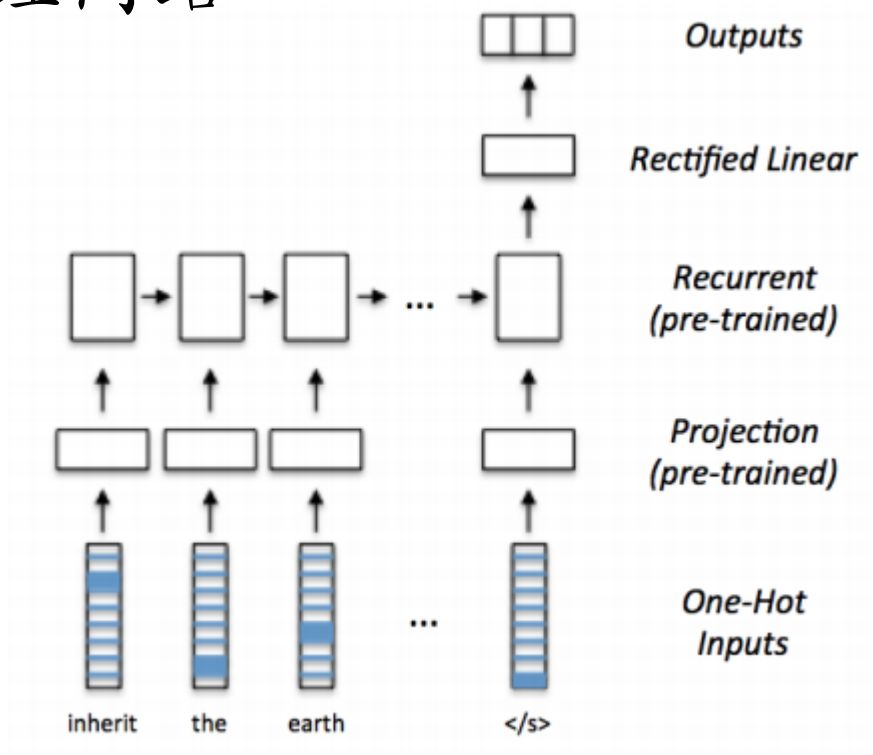


Prashanth Vijayaraghavan, Ivan Sysoev, Soroush Vosoughi, and Deb Roy. DeepStance at SemEval-2016 Task 6: Detecting Stance in Tweets Using Character and Word-Level CNNs. In Proceedings of SemEval2016.

立场检测



循环神经网络

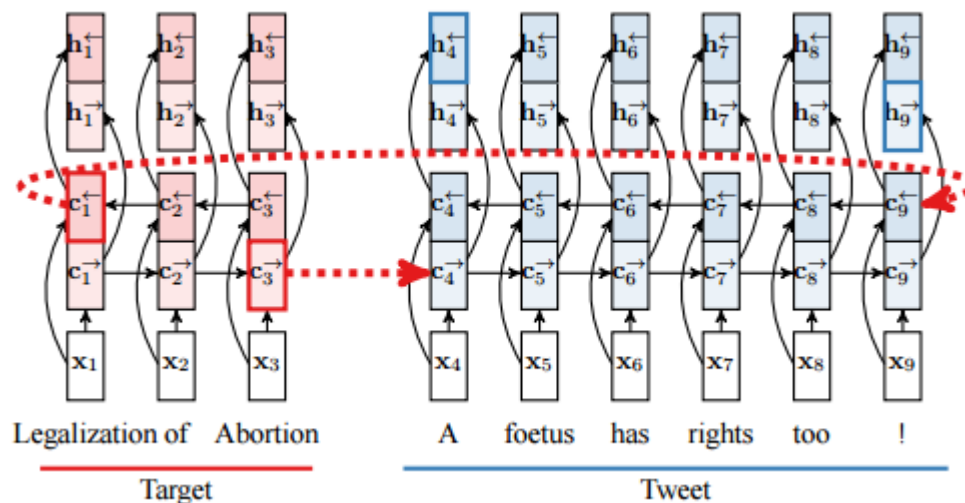


主题分类的方式

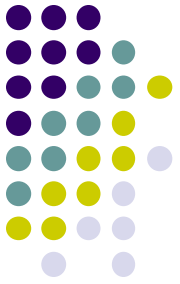
word2vec;
word2phrase

立场检测

双向LSTM



Augenstein I, Rocktäschel T, Vlachos A, and Bontcheva K. Stance Detection with Bidirectional Conditional Encoding. In Proceedings of EMNLP2016.



Q/A?
Thanks!