Jointly Learning to Label Sentences and Tokens

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Task 1: Sentence Classification

Error Detection

It was so long time to wait in the theatre .
I like to playing the guitar and sing very louder .
This is a great opportunity to learn more about whales .
Therefore, houses will be built on high supports .

Sentiment Analysis

The whole experience exceeded our expectations .
Tom Hanks gave a fantastic performance as the lead .
Sundance fans always try to find the Next Great Thing .
The movie takes some time to come to the conclusion .

Task 2: Sequence Labeling

Error Detection

```
- -    -  X       -   -       -   -    -    X       -
I like to playing the guitar and sing very louder .
```

Sentiment Analysis

```
-   -     -    - X          -             -  -   -    -
Tom Hanks gave a fantastic performance as the lead .
```

Main Idea

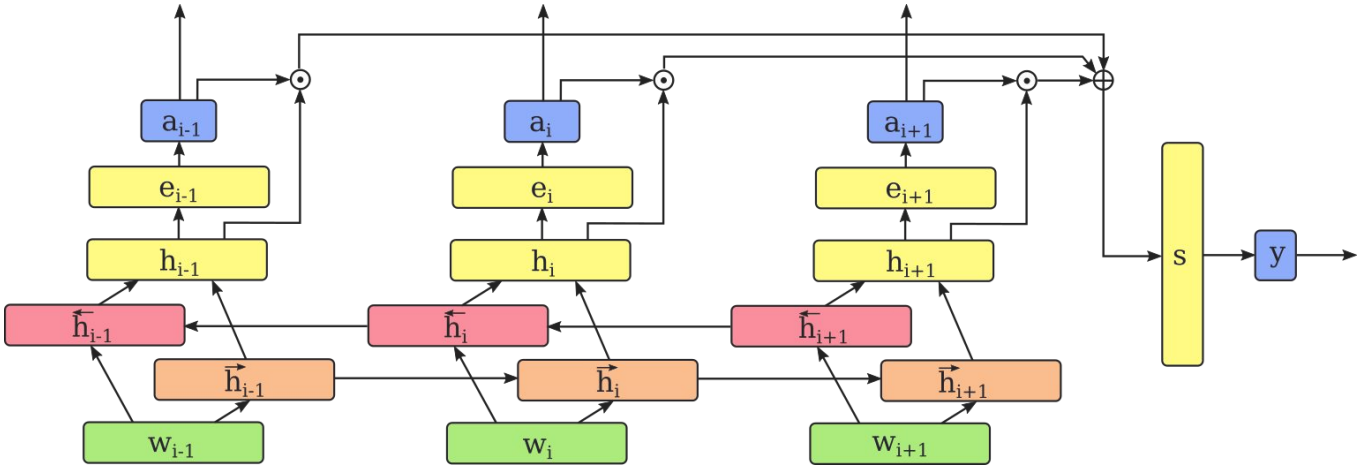
01 Join together predictions on both sentences and tokens

02 Token-level predictions act as self-attention weights

03 Teaching the model where it should be focusing in the sentence

Model Architecture

Make token-level prediction scores also function as sentence-level attention weights.



$$s = \sum_{i=1}^{N} a_i h_i \qquad L_{sent} = \sum_t (\hat{y}^{(t)} - y^{(t)})^2 \qquad L_{tok} = \sum_t \sum_i (\hat{a}_i^{(t)} - a_i^{(t)})^2$$

Soft Attention Weights

Based on sigmoid + normalisation:

$$\widetilde{a}_i = \frac{1}{1 + \exp(-\widetilde{e}_i)}$$

Token-level prediction

$$a_i = \frac{\widetilde{a}_i}{\sum_{k=1}^{N} \widetilde{a}_k}$$

Self-attention weight

We can constrain the attention values based on the sentence-level label.

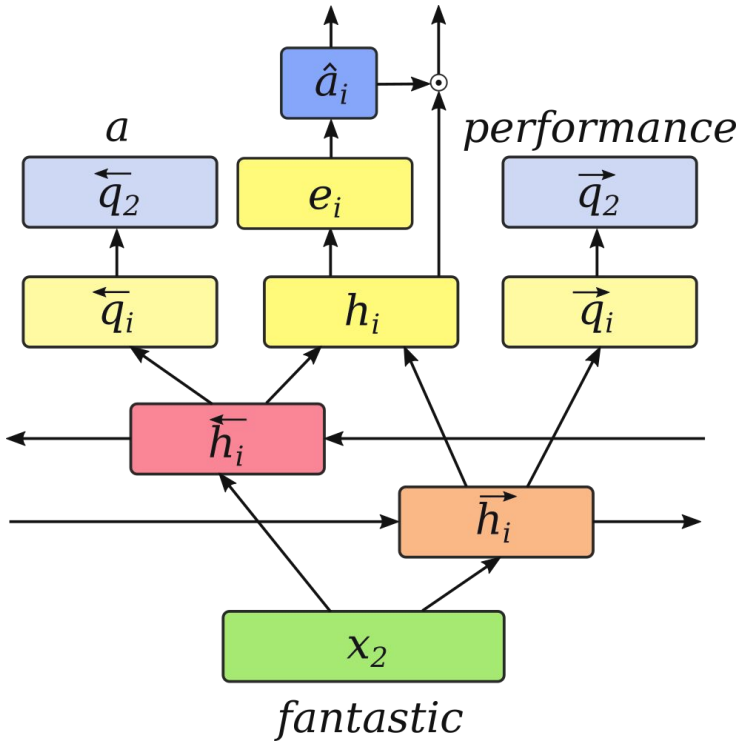
Language Modeling Objectives

1. Jointly training the network as a language model.

   Predicting the previous and the next word in the sequence.

2. Same principle extended to characters.

   Predicting the middle word based on characters of the surrounding words.



Evaluation

CoNLL 2010 (Farkas et al., 2010)

Detecting speculative (hedged) language.
Shared task dataset, containing sentences from biomedical papers.

FCE (Yannakoudakis et al., 2011)

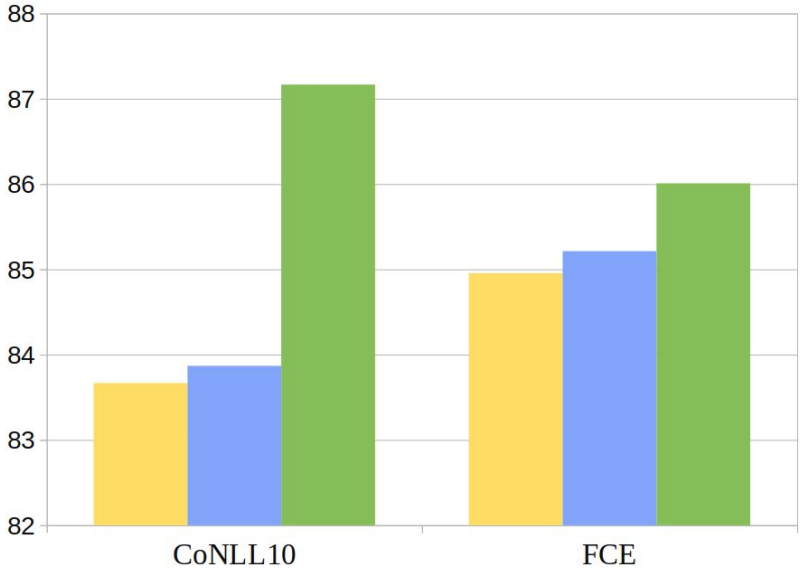
Detecting grammatically incorrect phrases and sentences.
Error-annotated essays written by language learners.

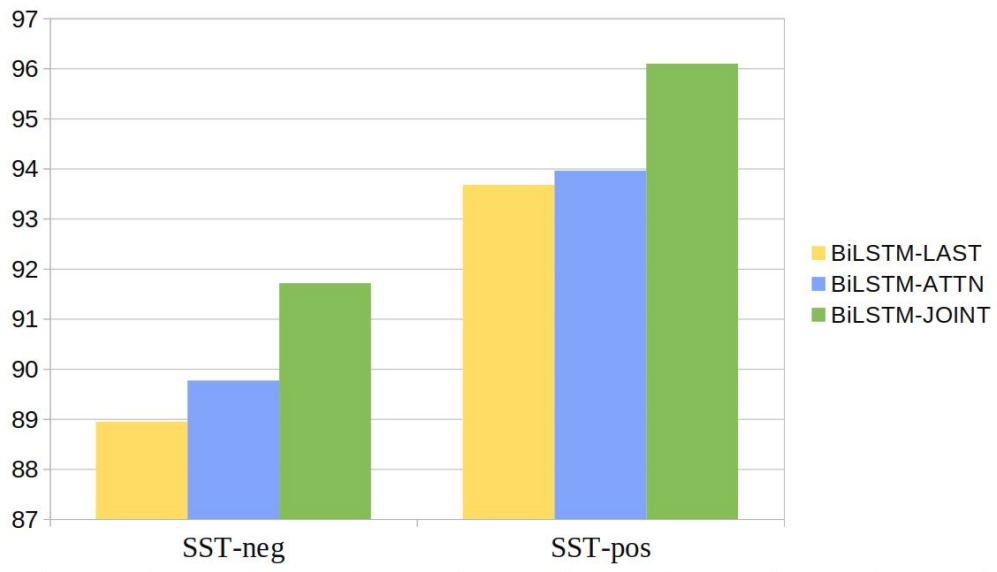
Stanford Sentiment Treebank (Socher et al., 2013)

Detecting sentiment in movie reviews.
Split into positive and negative sentiment detection.

Results: Sentence Classification

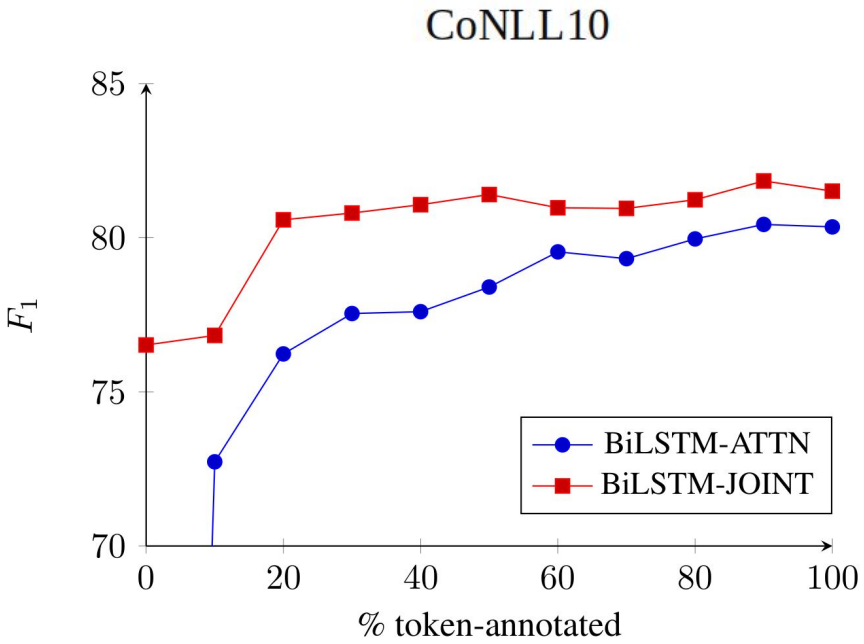
Supervision on the token level explicitly teaches the model where to focus for sentence classification.

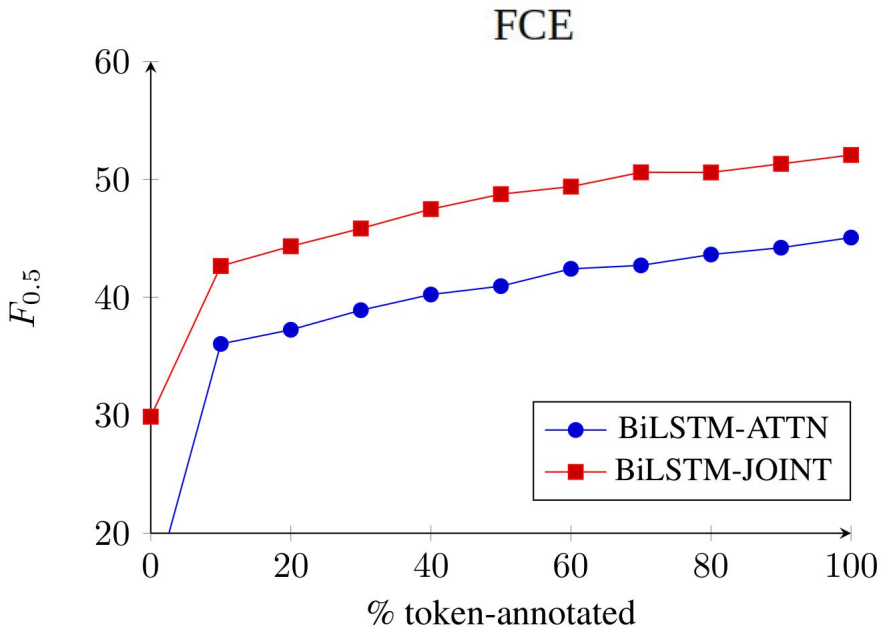




Results: Sequence Labeling

Supervision on the sentence level regularizes the sequence labeler and encourages it to predict jointly consistent labels.





Conclusion

01 Token-level labels can be used to supervise the attention module for sentence-level composition

02 Sentence-level labels can be used to regularize the token-level predictions

03 Language modeling objectives on tokens and characters help the model learn better composition functions

04 The result is a robust sentence classifier that is able to point to individual tokens to explain its decisions

Thank you!
Any questions?