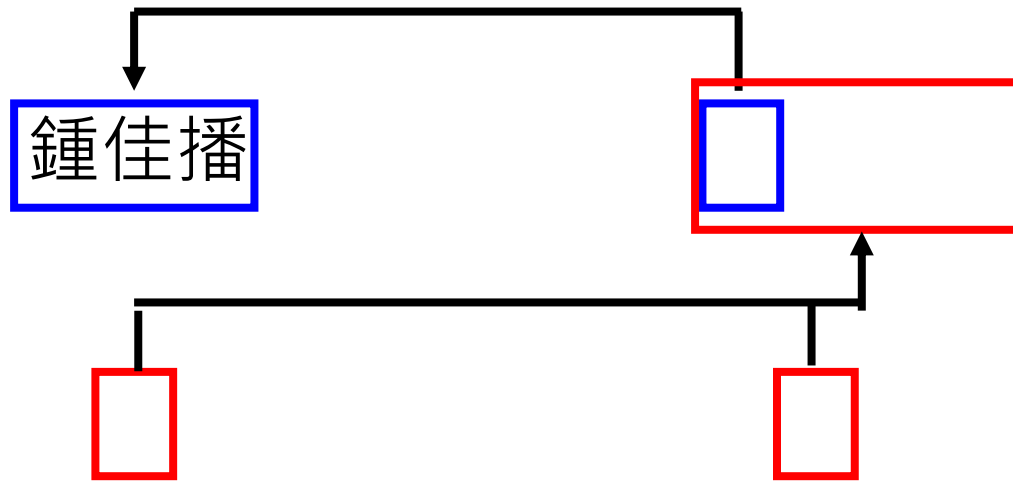


Coreference Resolution

Hung-yi Lee 李宏毅

Coreference Resolution



Coreference Resolution

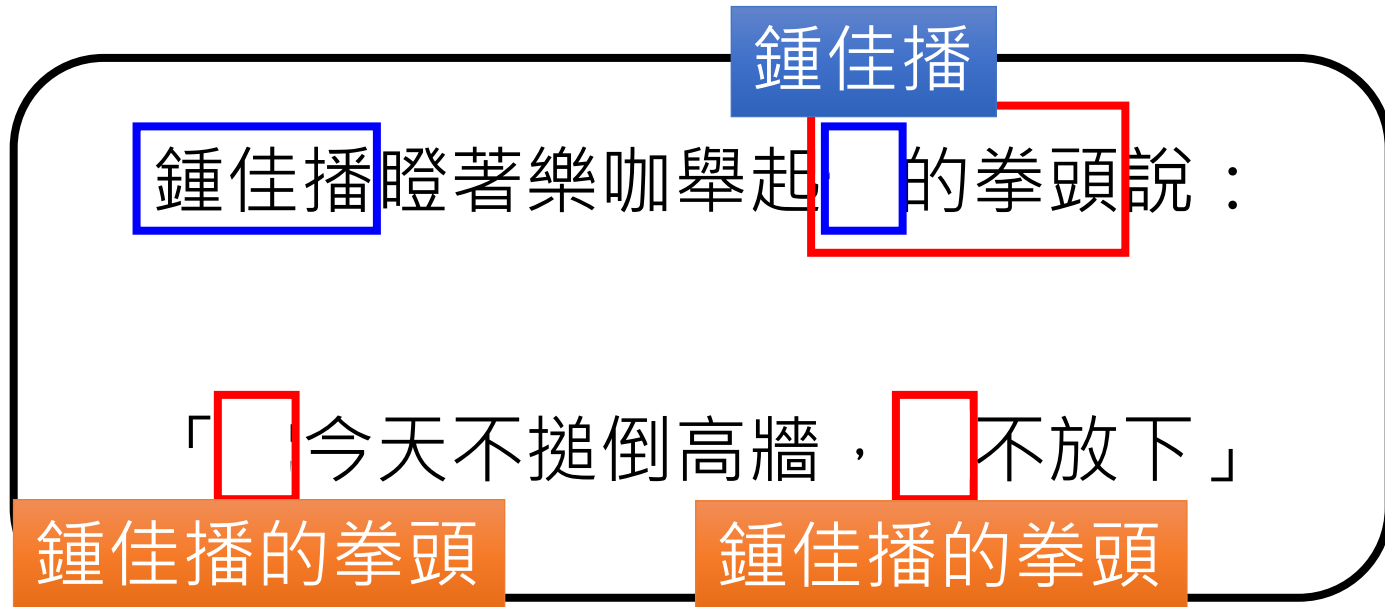
鍾佳播瞪著樂咖舉起他的拳頭說：

「它今天不搥倒高牆，它不放下」

Question: 甚麼東西會搥倒高牆？

Answer: 它

Coreference Resolution



Question: 甚麼東西會搥倒高牆？

Answer: 鍾佳播的拳頭

Coreference Resolution

- Winograd Schema Challenge



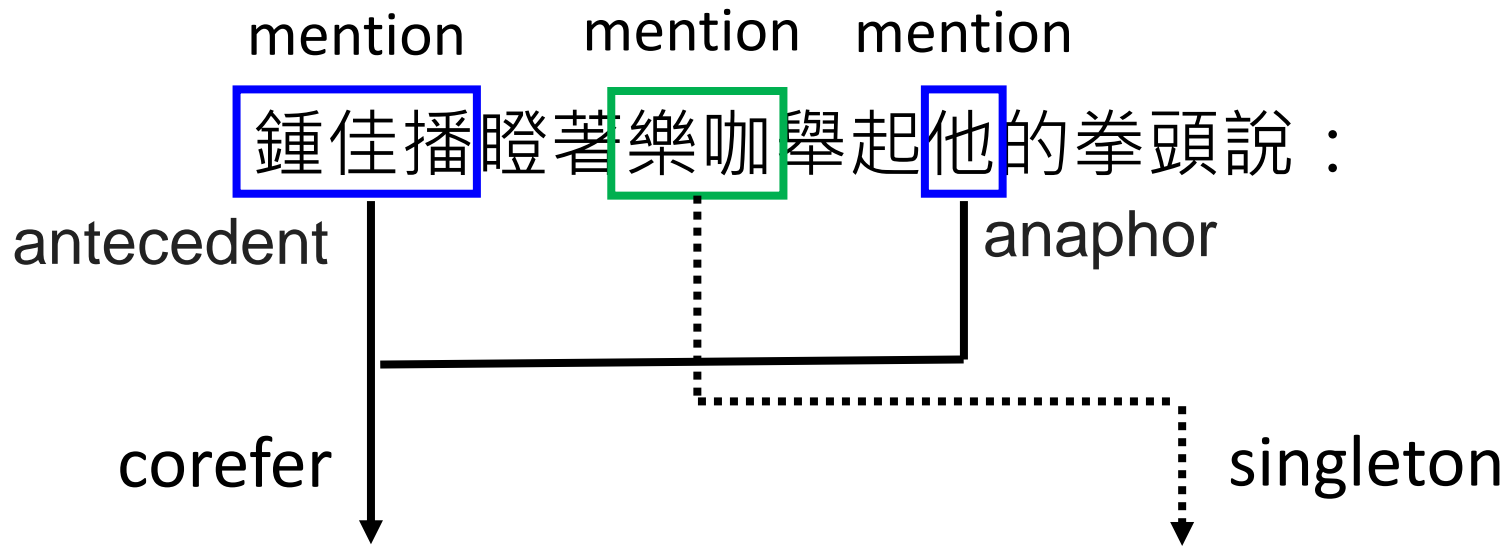
Terry Winograd



The **trophy** would not fit in the brown **suitcase** because **it** was too big. What was too big?

The **trophy** would not fit in the brown **suitcase** because **it** was too small. What was too small?

Coreference Resolution



Task Introduction

鍾佳播瞪著樂咖舉起他的拳頭說：

「它今天不搥倒高牆，它不放下」

Cluster 1: { 鍾佳播, 他 }

Cluster 2: { 他的拳頭, 它, 它 }

- All the mentions are labeled (sometimes singletons are ignored).
- The mentions are grouped into clusters.

Framework

- Step 1: Mention Detection

N tokens in a token sequence

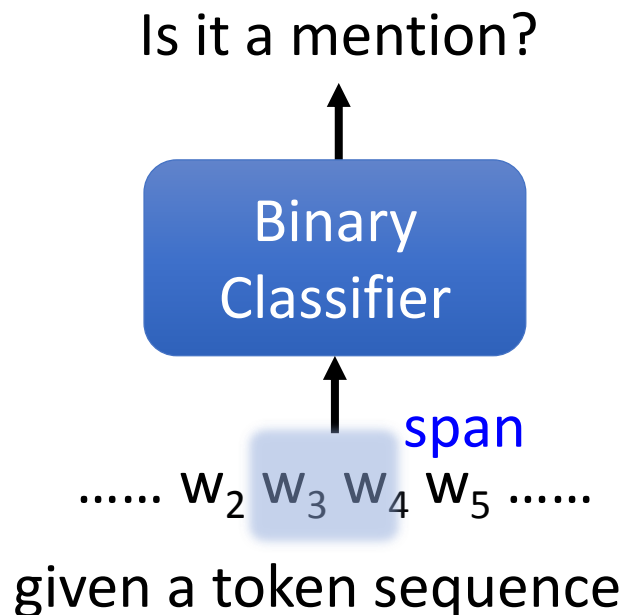
$N(N-1)/2$ possible spans

鍾佳播瞪著樂咖舉起他的拳頭

鍾佳播
樂咖
他
他的拳頭

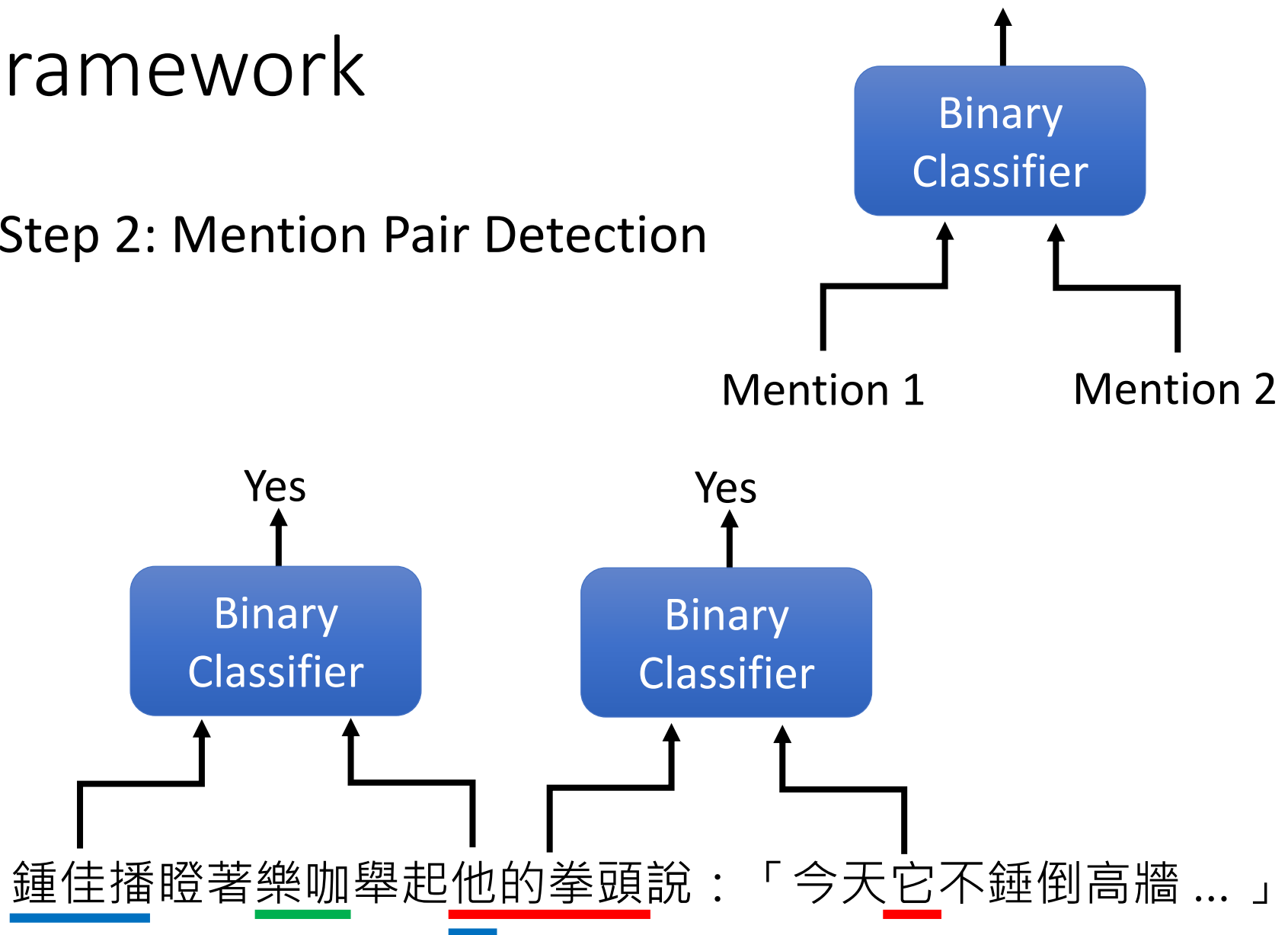
v.s.

鍾
鍾佳
.....
播瞪著樂
.....
咖舉起他的



Framework

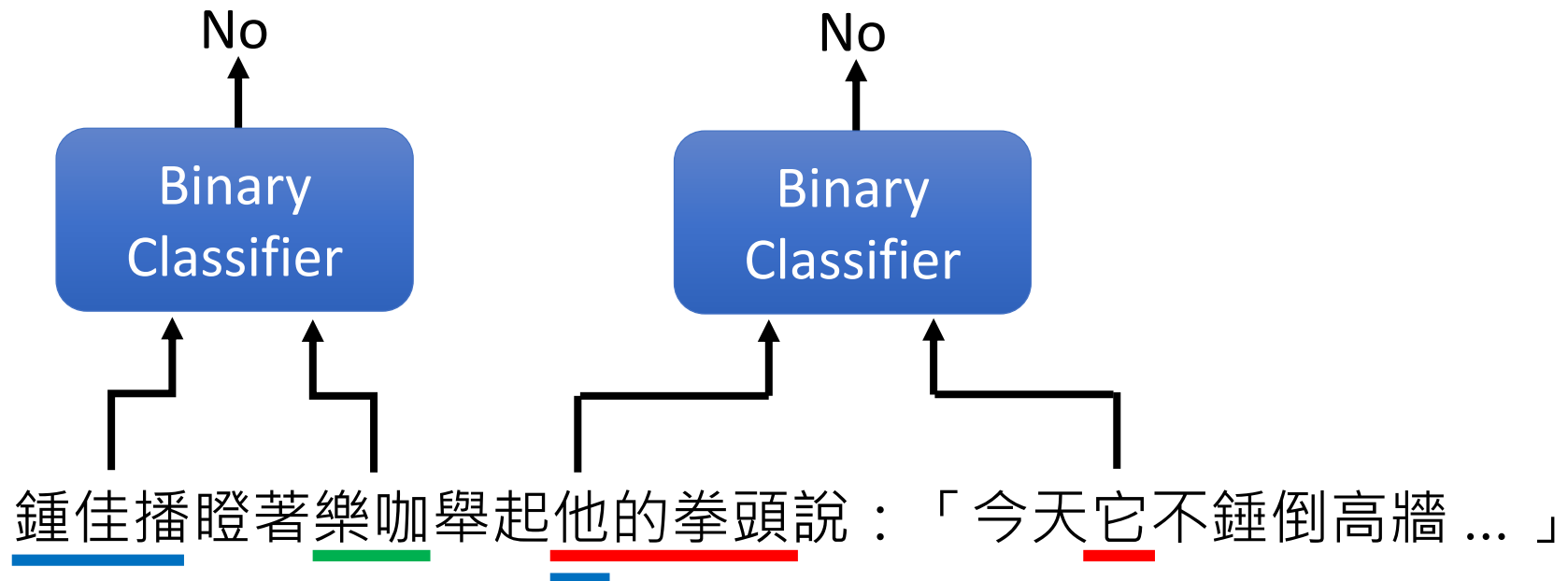
- Step 2: Mention Pair Detection



Framework

- Step 2: Mention Pair Detection

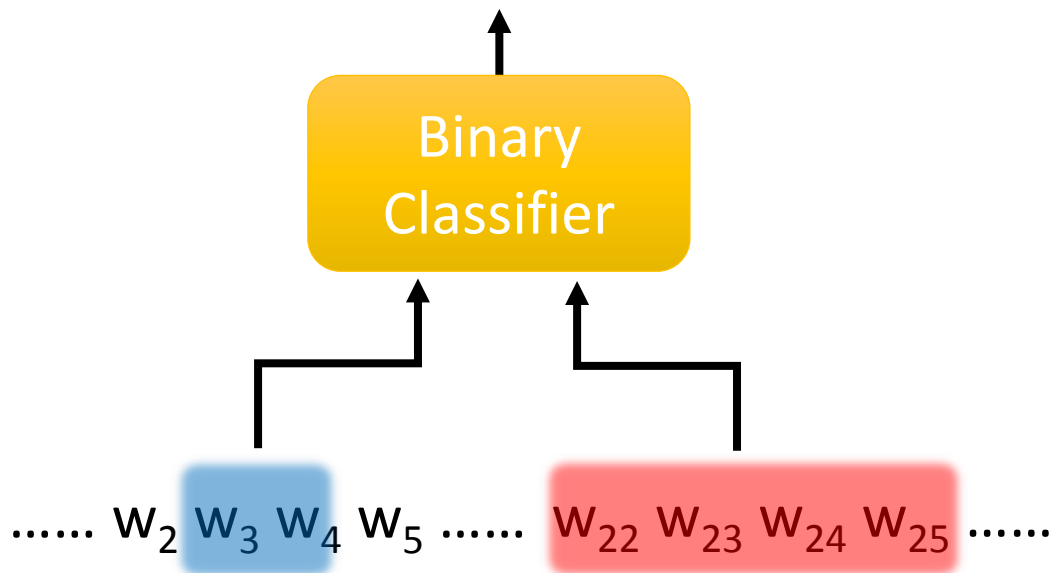
If there are K mentions, run the binary classifier $K(K-1)/2$ times.



End-to-end

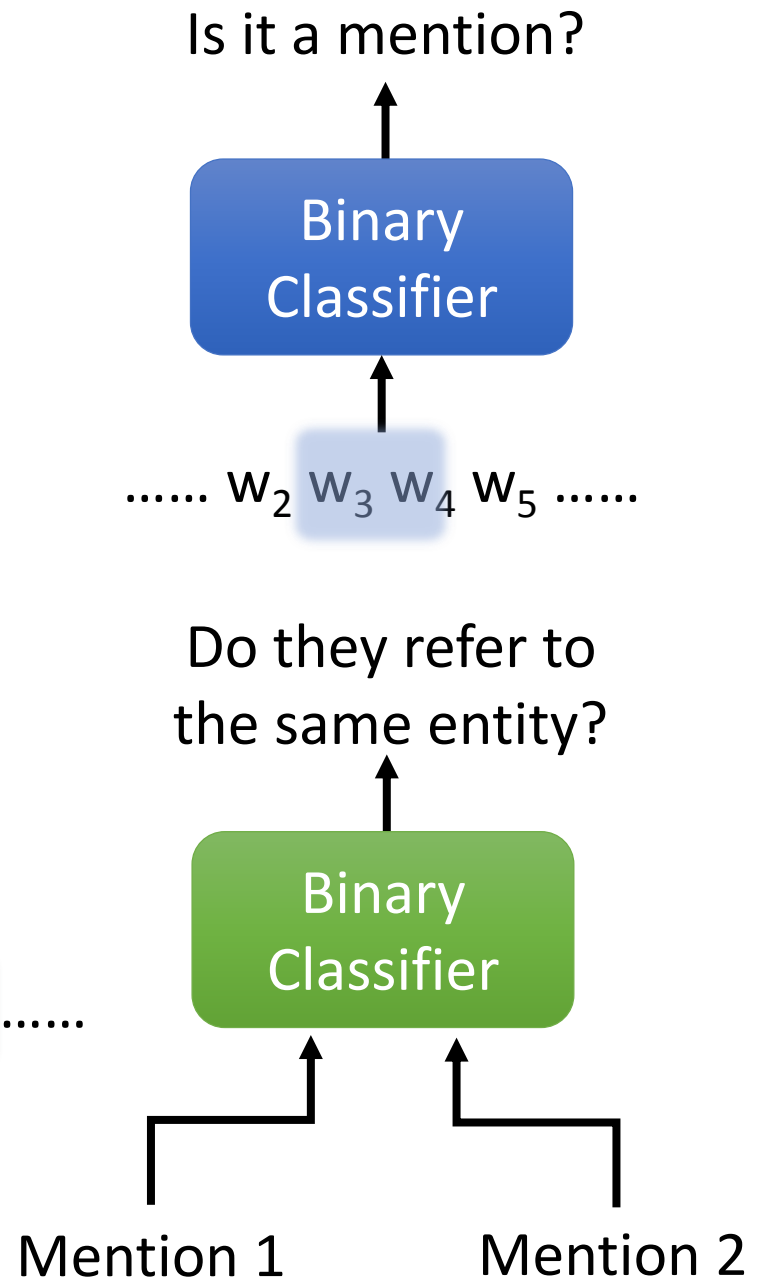
Output “yes” if ...

“Both inputs are mentions” and
“They refer to the same entity”

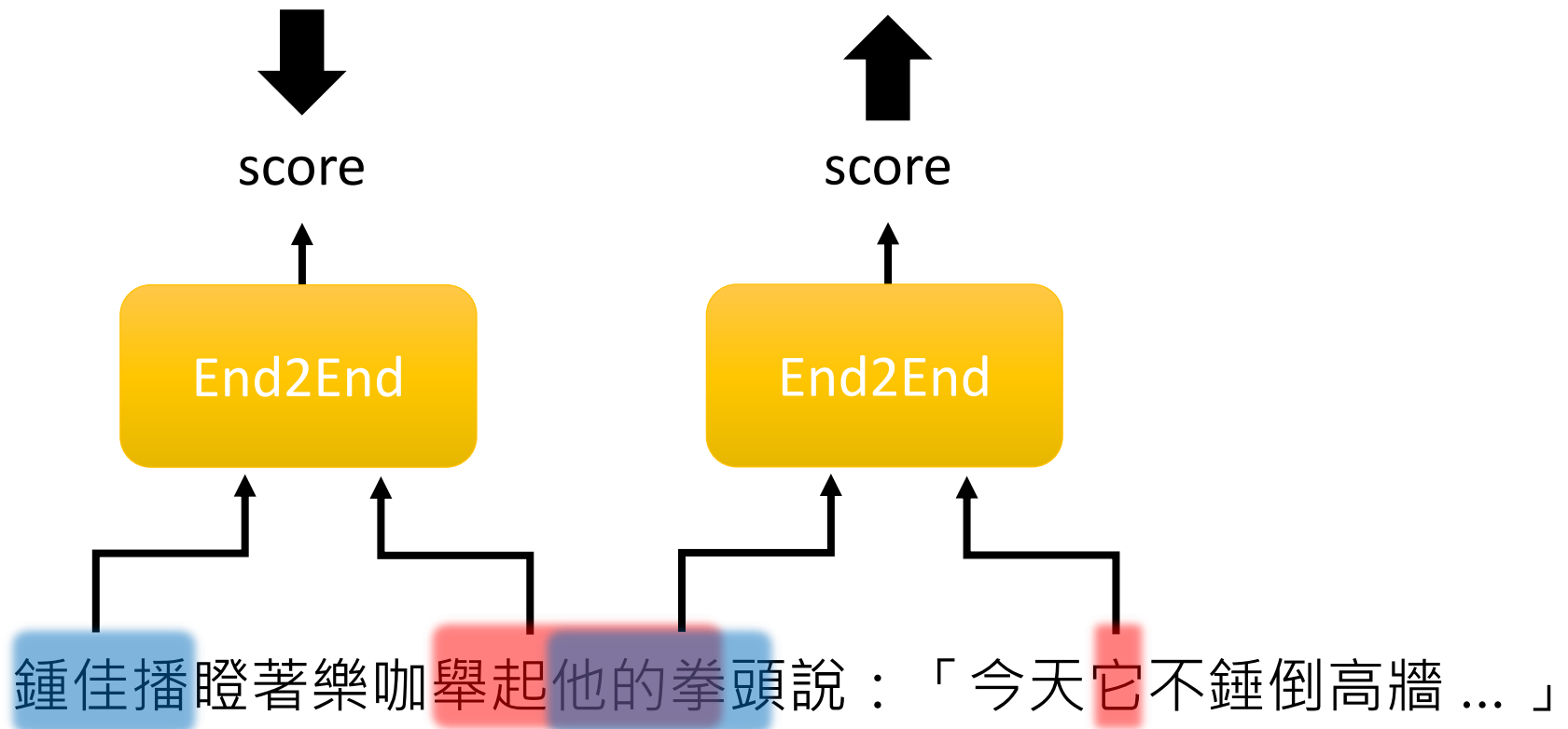


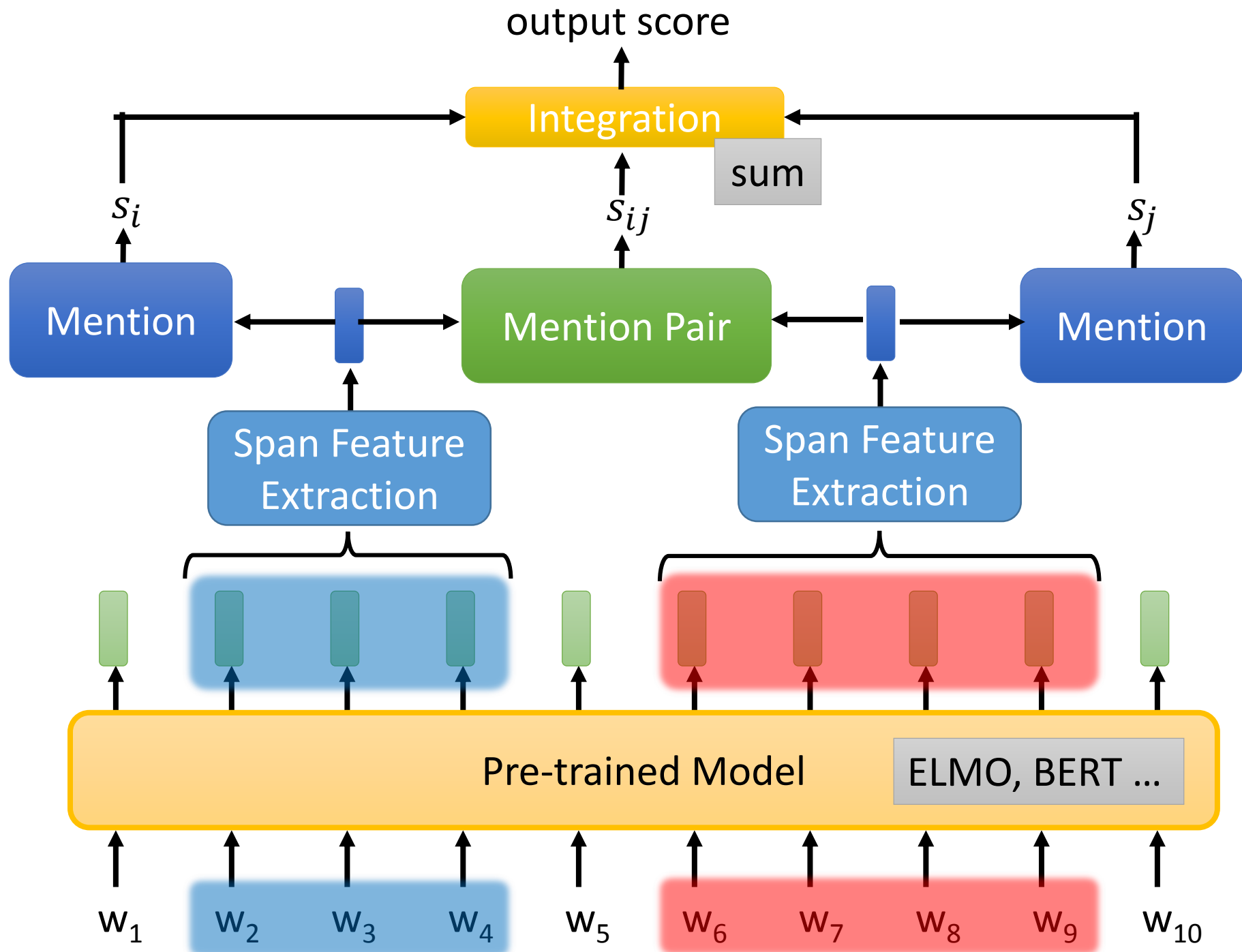
N tokens $N(N-1)/2$ spans = K

Run $K(K-1)/2$ times

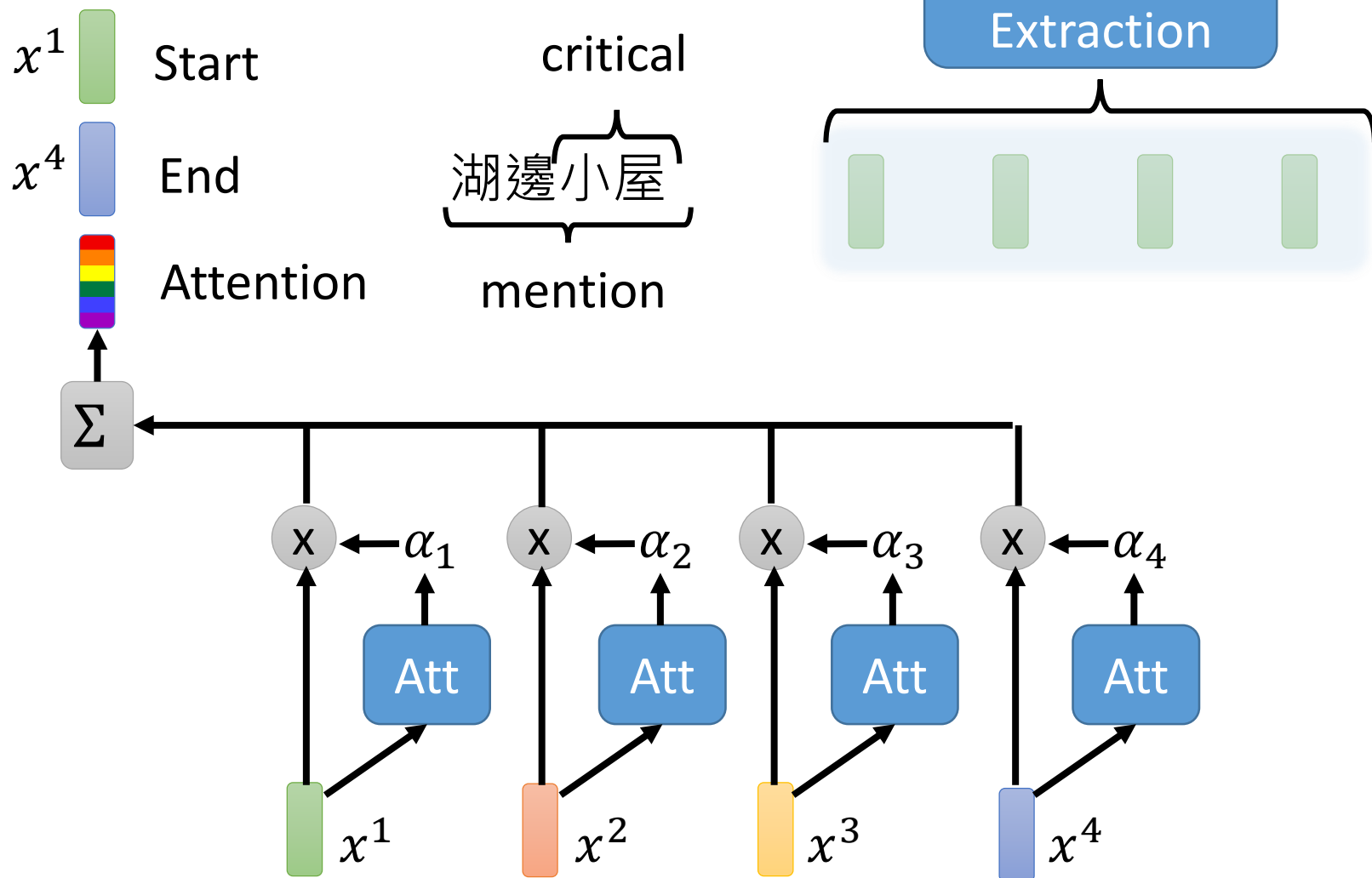


Training – Binary Classification





Span Representation



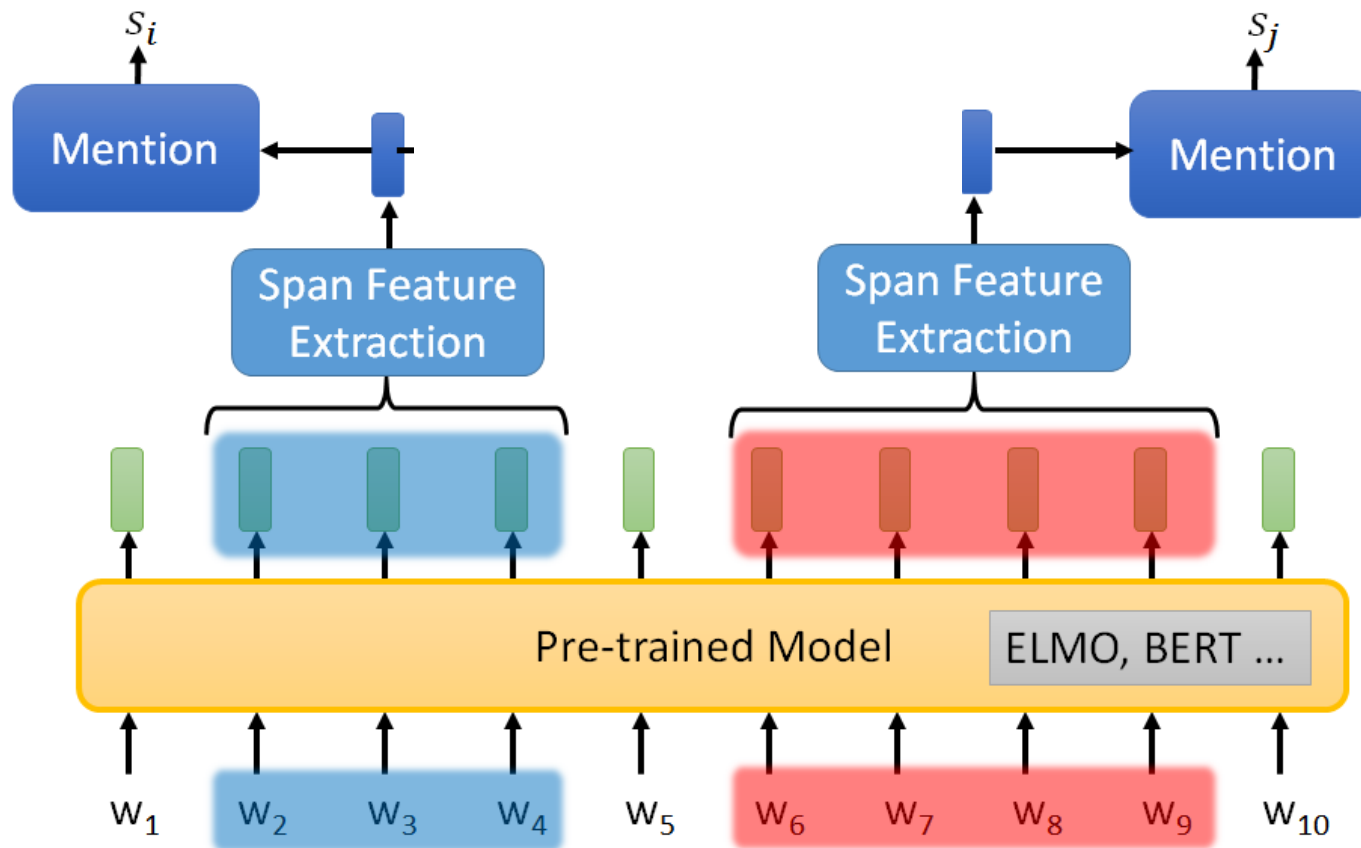
Practical Implementation

Can be reduced by
length constraint

$K \ll N$

Run mention detector $N(N-1)/2$ times to score each span

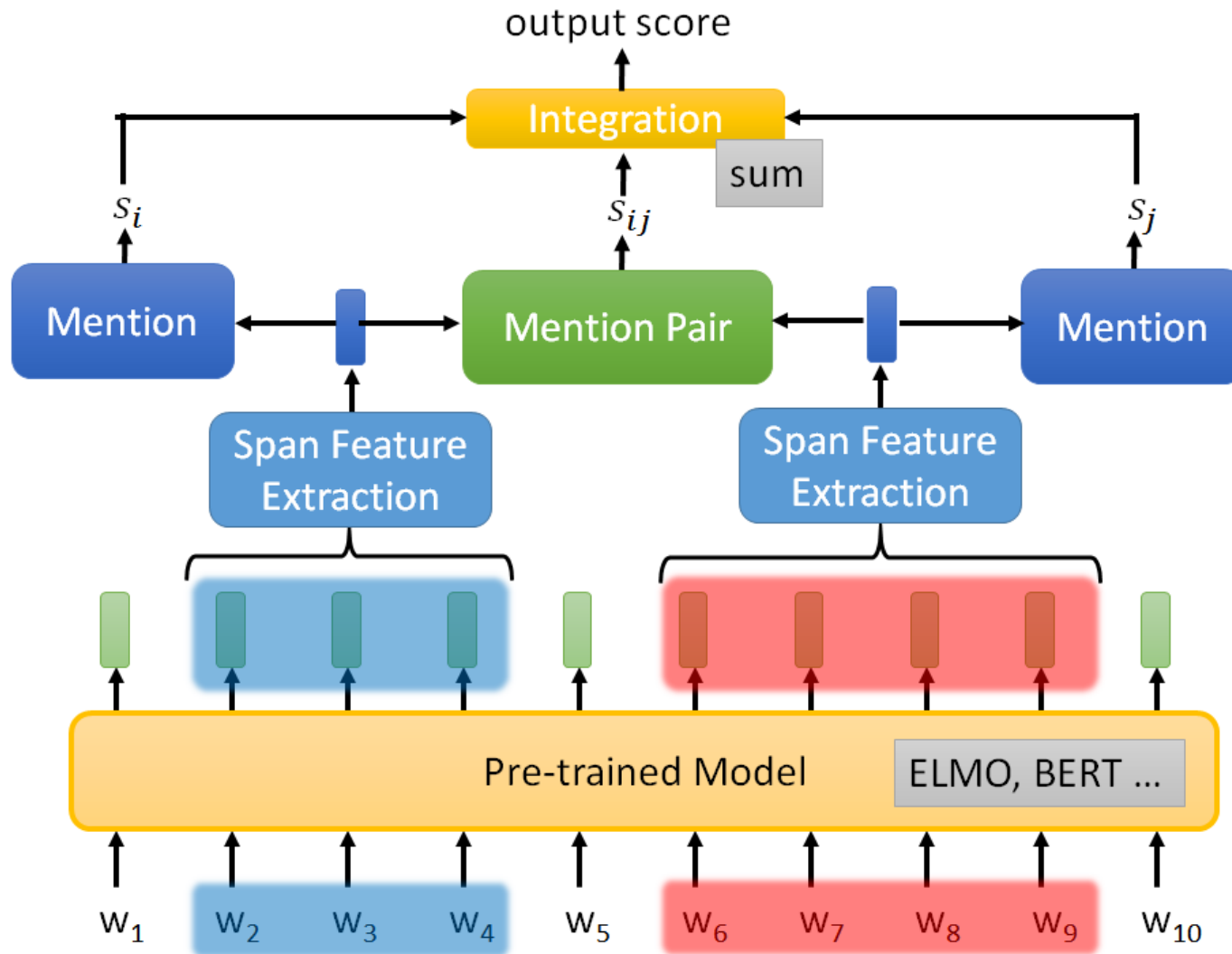
Only select the K mentions with the highest scores



Practical Implementation

$K \ll N$

The whole model is run only $K(K-1)/2$ times.



GLoVe+LSTM [Lee, et al., EMNLP'17]

ELMo [Lee, et al., NAACL'18]

BERT [Joshi, et al., EMNLP'19]

Results

(A **fire** in a Bangladeshi garment factory) has left at least 37 people dead and 100 hospitalized. Most of the deceased were killed in the crush as workers tried to flee (**the blaze**) in the four-story building.

1

A fire in (a **Bangladeshi garment factory**) has left at least 37 people dead and 100 hospitalized. Most of the deceased were killed in the crush as workers tried to flee the blaze in (**the four-story building**).

2

We are looking for (a **region of central Italy bordering the Adriatic Sea**). (**The area**) is mostly mountainous and includes Mt. Corno, the highest peak of the Apennines. (**It**) also includes a lot of sheep, good clean-living, healthy sheep, and an Italian entrepreneur has an idea about how to make a little money of them.

3

(**The flight attendants**) have until 6:00 today to ratify labor concessions. (**The pilots'**) union and ground crew did so yesterday.

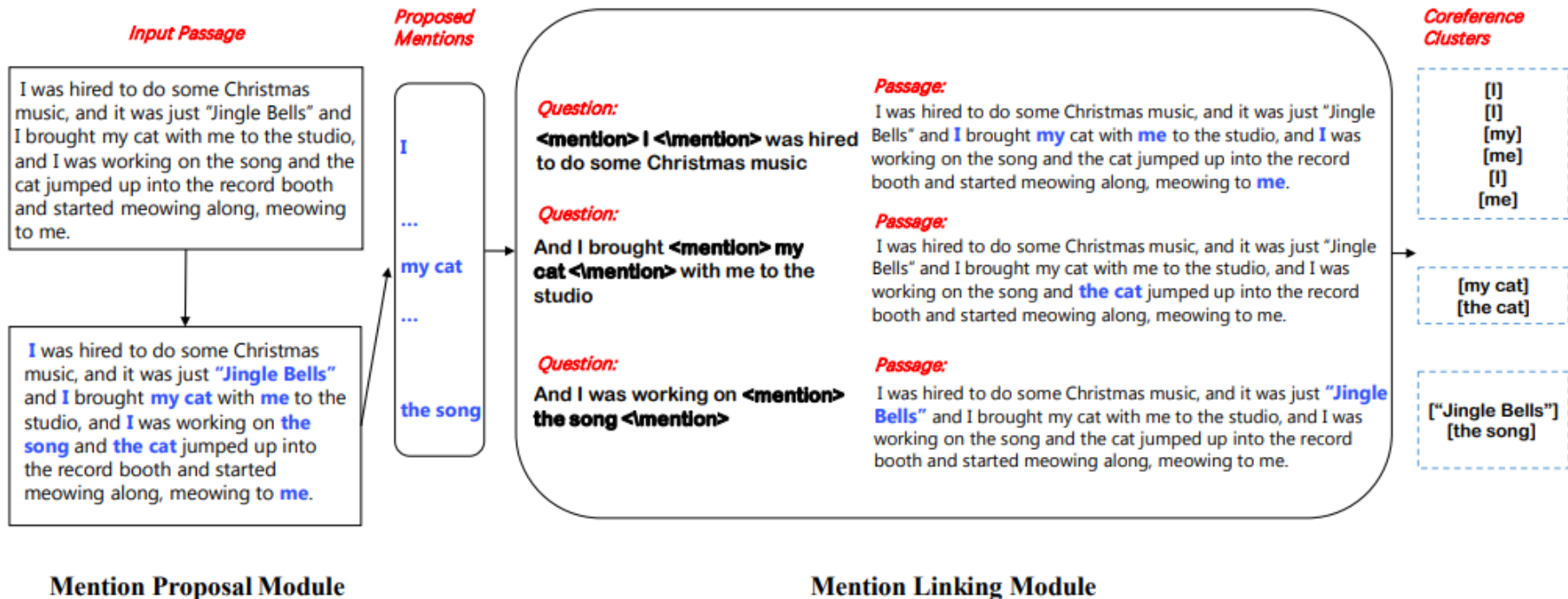
4

(**Prince Charles and his new wife Camilla**) have jumped across the pond and are touring the United States making (**their**) first stop today in New York. It's Charles' first opportunity to showcase his new wife, but few Americans seem to care. Here's Jeanie Mowth. What a difference two decades make. (**Charles and Diana**) visited a JC Penney's on the prince's last official US tour. Twenty years later here's the prince with his new wife.

source of image: <https://arxiv.org/pdf/1707.07045.pdf>

Coref as QA?

[Wu, et al., ACL'20]

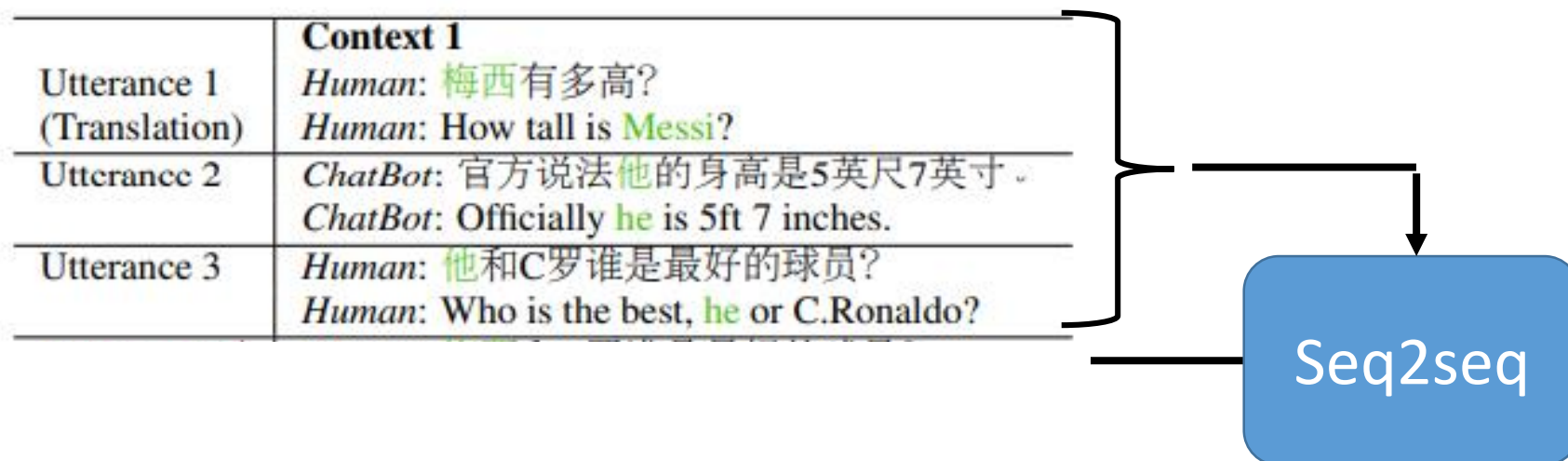


Source of image: <https://arxiv.org/pdf/1911.01746.pdf>

Seq2Seq?

Source of image:

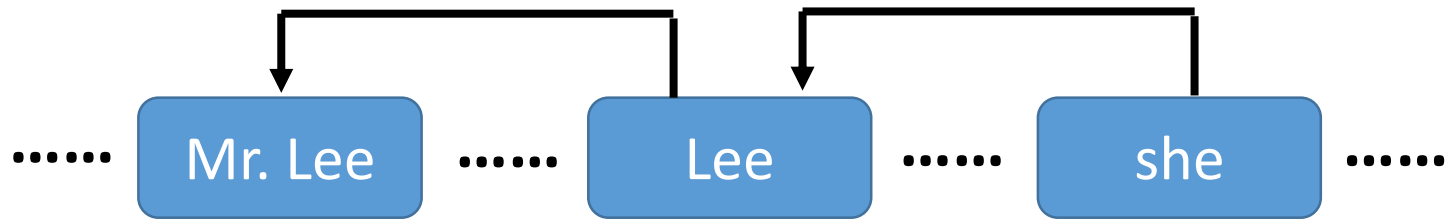
<https://www.aclweb.org/anthology/P19-1003.pdf>



[Su, et al., ACL'19]

Advanced Topics

Global Information



Cluster: {Mr. Lee, Lee, she} Contradiction!

[Lee, et al., NAACL'18] [Kantor, et al., ACL'19]

Unsupervised

Gina arrives and she is furious with Denise for not protecting Jody from Kingsley, as **MASK** was meant to be the parent.

Using pre-train model to fill-in the blank.

Reference

- [Lee, et al., EMNLP'17] Kenton Lee, Luheng He, Mike Lewis, Luke Zettlemoyer, End-to-end Neural Coreference Resolution, EMNLP, 2017
- [Su, et al., ACL'19] Hui Su, Xiaoyu Shen, Rongzhi Zhang, Fei Sun, Pengwei Hu, Cheng Niu, Jie Zhou, Improving Multi-turn Dialogue Modelling with Utterance ReWriter, ACL, 2019
- [Wu, et al., ACL'20] Wei Wu, Fei Wang, Arianna Yuan, Fei Wu, Jiwei Li, Coreference Resolution as Query-based Span Prediction, ACL, 2020
- [Lee, et al., NAACL'18] Kenton Lee, Luheng He, and Luke Zettlemoyer, Higher-order coreference resolution with coarse-to-fine inference, NAACL, 2018
- [Joshi, et al., EMNLP'19] Mandar Joshi, Omer Levy, Luke Zettlemoyer, Daniel Weld, BERT for Coreference Resolution: Baselines and Analysis, EMNLP, 2019
- [Kantor, et al., ACL'19] Ben Kantor, Amir Globerson, Coreference Resolution with Entity Equalization, ACL, 2019
- Vid Kocijan, Oana-Maria Camburu, Ana-Maria Cretu, Yordan Yordanov, Phil Blunsom, Thomas Lukasiewicz, WikiCREM: A Large Unsupervised Corpus for Coreference Resolution, EMNLP, 2019