Implicit Argument Prediction with Event Knowledge

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Introduction

Text: More than 2,600 people have been infected by ***Ebola*** in Liberia, Guinea, Sierra Leone and Nigeria since the ***outbreak*** began in December, according to the World Health Organization. Nearly 1,500 have ***died***.
Question: The X ***outbreak*** has ***killed*** nearly 1,500.

- ***Ebola*** is an implicit argument of both ***outbreak*** and ***die***, which is key to answering this question.
- Implicit arguments are NOT syntactically connected to their predicates, thus hard to extract.
- Previous work focused on very small datasets [1].

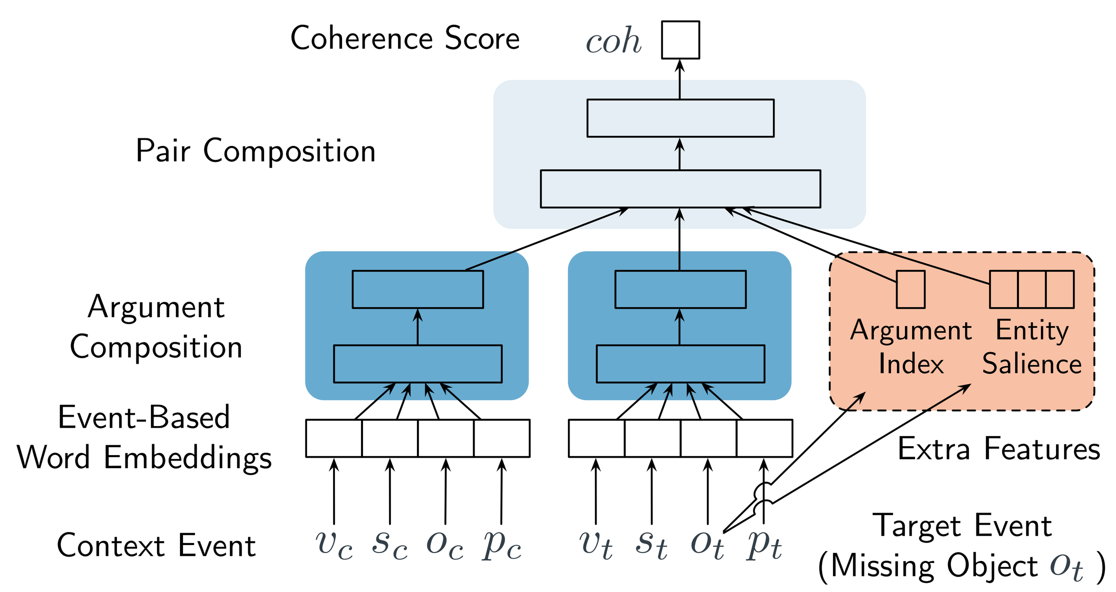
Methods

- **Event knowledge** is key to implicit argument detection: We select candidate x_j with the highest narrative coherence score S_j:

$$S_j = \max_{c=1,\ldots,n\ c\neq t} coh\left(e_t(j), e_c\right), \quad j = 1, \ldots, m$$

where e_c are context events, $e_t(j)$ is the target event with candidate x_j filling in as the implicit argument.

- We compute the coherence scores between event pairs using a variant of the event composition model [2].



- Implicit arguments tend to be salient entities, so we include **entity salience** features [3].
  - Numbers of named, nominal, pronominal, and total mentions of the entity.

Argument Cloze Task

- We address the data issue by a simple cloze task, for which data can be generated automatically at scale for both training and evaluation.

> Manville Corp. said it will build a $ 24 million power plant to provide electricity to its Igaras pulp and paper mill in Brazil .
>
> The company said the plant will ensure that it has adequate energy for the mill and will reduce the mill's energy costs .

(a) A piece of raw text from OntoNotes corpus.

> x_0 = The company x_1 = mill x_2 = power plant
>
> e_0: (*build-pred*, x_0*-subj*, x_2*-dobj*, —)
> e_1: (*provide-pred*, —, *electricity-dobj*, x_1*-prep_to*)
> e_2: (*ensure-pred*, x_2*-subj*, —, —)
> e_3: (*has-pred*, x_0*-subj*, *energy-dobj*, x_1*-prep_for*)
> e_4: (*reduce-pred*, x_2*-subj*, *cost-dobj*, —)

(b) Extracted events ($e_0 \sim e_4$) and entities ($x_0 \sim x_2$), using gold annotations from OntoNotes.

> e_0, e_2, e_3, e_4: same as above
> e_1: (*provide-pred*, —, *electricity-dobj*, *??-prep_to*)
>
> x_0 = The company x_1 = mill x_2 = power plant

(c) Example of an argument cloze task for *prep_to* of e_1.

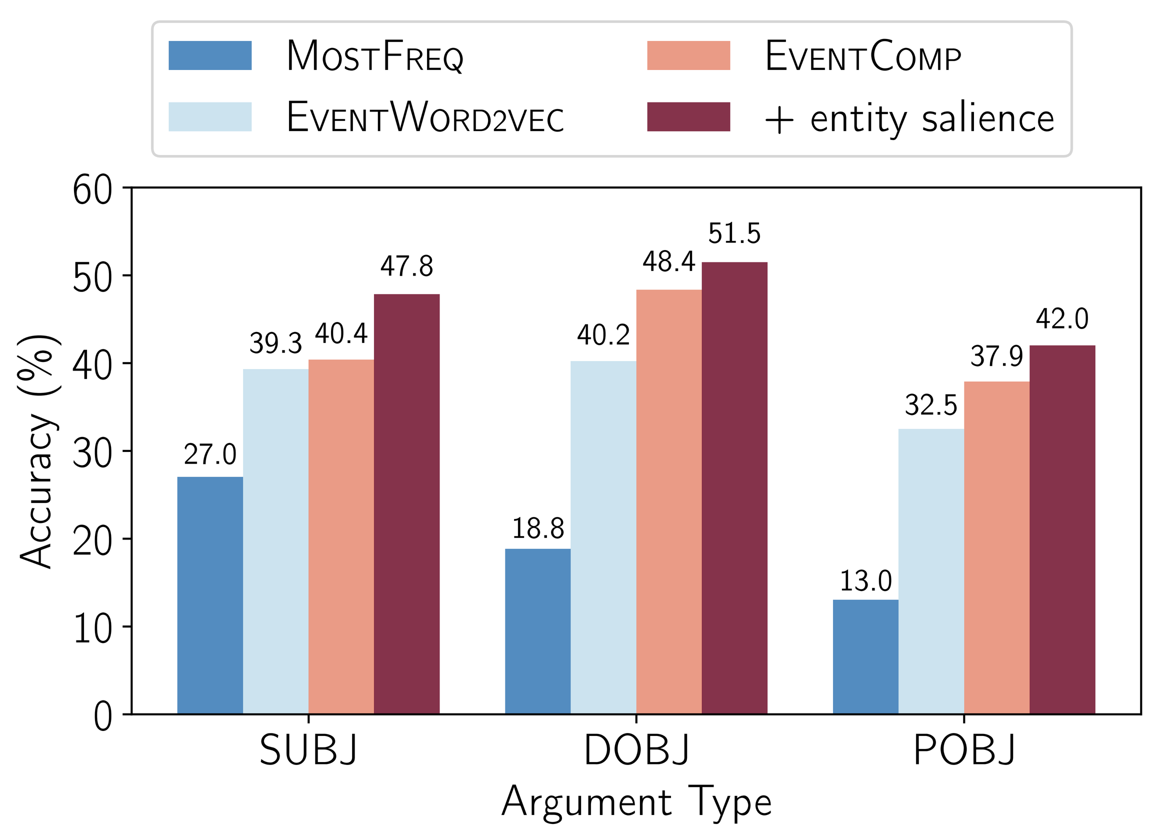
- **Training**: English Wikipedia.
- **Evaluation**: OntoNotes.
  - OntoNotes contains human-labeled dependency and coreference annotation, providing **gold** test data.
  - We construct two datasets, ON-SHORT and ON-LONG.

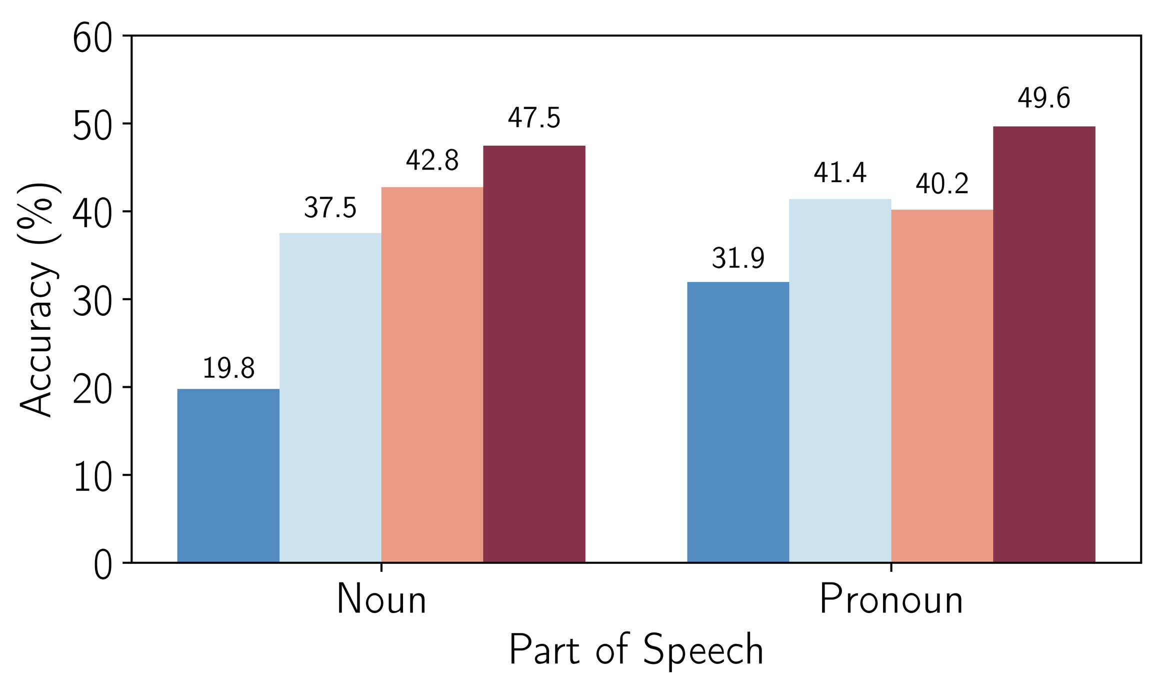
Results on OntoNotes

- We compare our model with 3 baselines.
- ON-LONG is significantly harder than ON-SHORT, with much longer documents and much more candidates.

Accuracy (%)	ON-SHORT	ON-LONG
RANDOM	8.29	2.71
MOSTFREQ	22.76	17.23
EVENTWORD2VEC	38.40	21.49
EVENTCOMP	41.89	21.79
+ entity salience	**47.75**	**27.87**

- We break down the results by argument type and part of speech of the implicit argument.





Results on G&C

- G&C [1] is a human-labeled implicit argument dataset.
- Less than 1,000 examples on 10 nominal predicates.

	PP	R	F_1
Gerber & Chai (2012) [1]	57.9	44.5	50.3
GCAUTO	49.9	40.1	44.5
EVENTCOMP	46.7	47.3	47.0
+ entity salience	49.3	49.9	**49.6**

Conclusion

- Neural model with event knowledge has superior performance on both synthetic and natural data.
- Entity salience is important throughout for performance.

References

[1] Matthew Gerber and Joyce Y. Chai. "Semantic Role Labeling of Implicit Arguments for Nominal Predicates". In: *Computational Linguistics* 38.4 (2012).
[2] Mark Granroth-Wilding and Stephen Clark. "What Happens Next? Event Prediction Using a Compositional Neural Network Model". In: *AAAI*. 2016.
[3] Jesse Dunietz and Daniel Gillick. "A New Entity Salience Task with Millions of Training Examples". In: *EACL*. 2014.

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- Code available at `https://github.com/pxch/event_imp_arg`.