Learning Latent Forests for Medical Relation Extraction

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Medical Relation Extraction

- Input Sentence

Crystallographic analysis of the human ***phenylalanine hydroxylase*** catalytic domain with bound ***catechol*** inhibitors at 2.0 A resolution.

- Output Relation

Down regulator

Related Work

- Sequence-based Methods
- Dependency-based Methods

Related Work

- Sequence-based Method

Operates only on the text sequences, **RNN** (Liu et al., 2017) or **Transformer** (Verga et al., 2018) is used as the ***sequence encoder.***

Related Work

- Dependency-based Method

Incorporates ***dependency structures*** into the model, **Graph LSTM** (Peng et al., 2017) or **GRN** (Song et al., 2019) is used as the encoder.

Related Work

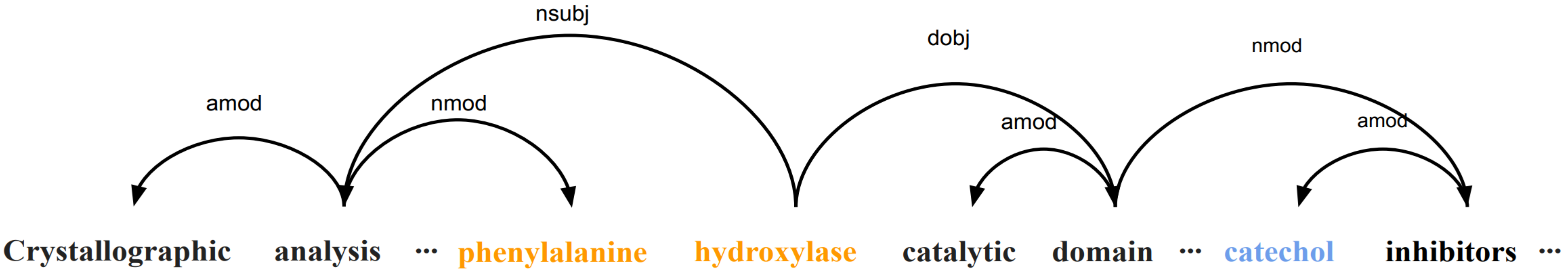
- Dependency-based Method

Dependency-based models are able to ***capture non-local relations*** that are obscure from the surface form alone (Zhang et al., 2018).

Related Work

- Dependency Tree

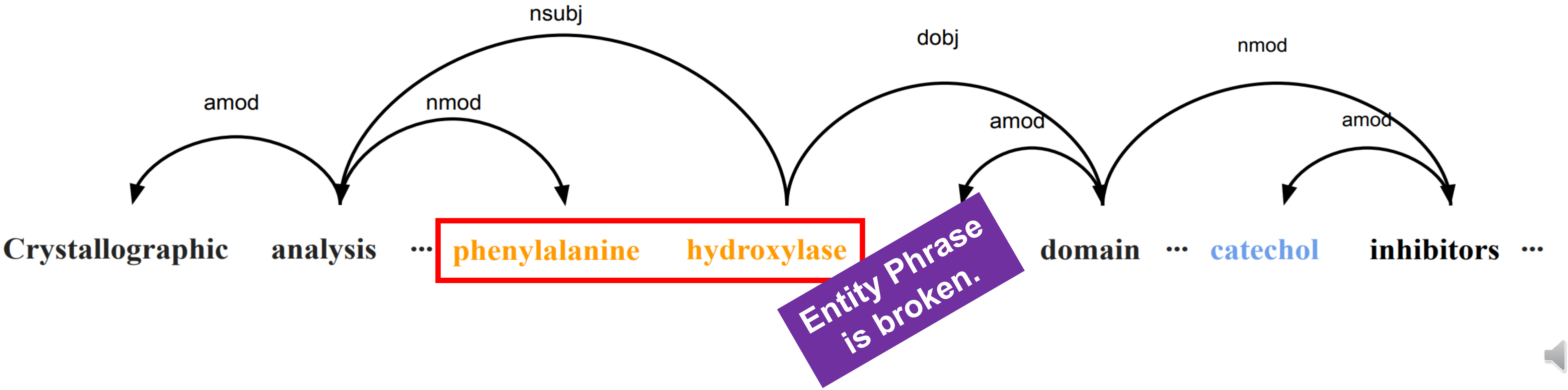
Graph LSTM (Peng et al., 2017) is used to encode the ***1-best dependency tree*** generated by an off-the-shelf parser.



Related Work

- Dependency Tree

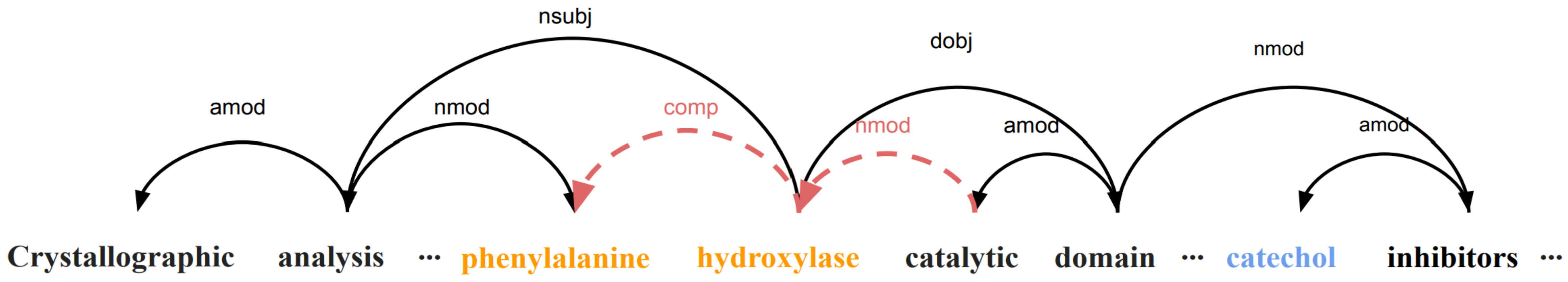
For the medical domain, ***parsing accuracies drop significantly*** (Lease and Charniak, 2005), which leads to ***error propagation***.



Related Work

- Dependency Forest

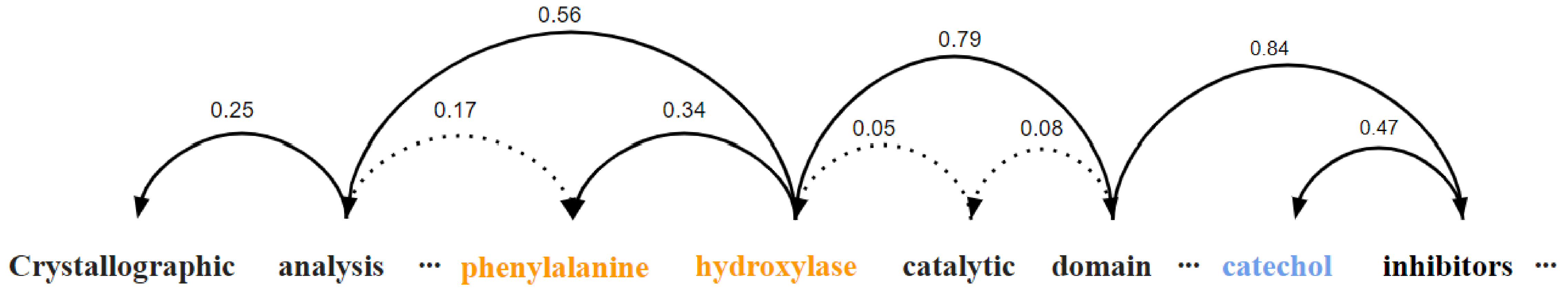
Recent works (Song et al., 2019; Jin et al., 2020) use ***dependency forests*** that consist of arcs that a parser is ***relatively confident*** about.



Related Work

- Dependency Forest Construction

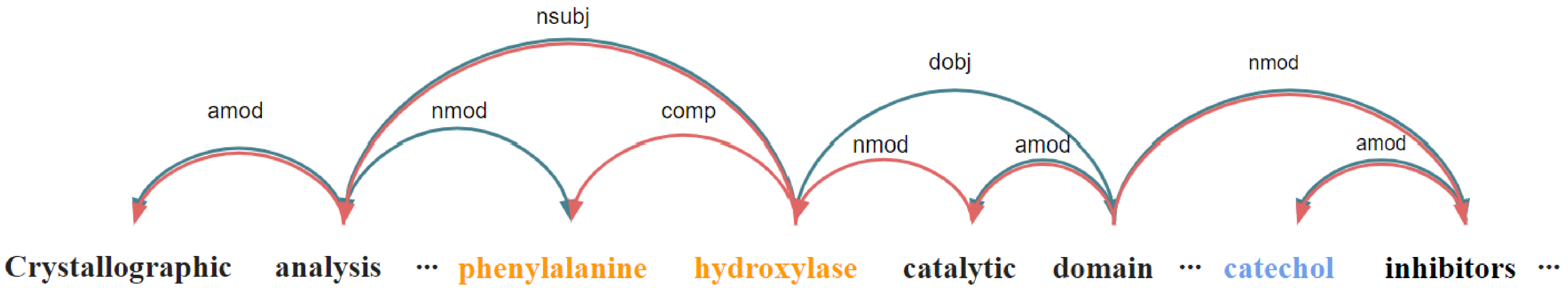
Edgewise (Song et al., 2019): keeps all the edges with ***scores greater than a threshold***. Scores are given by a parser trained on ***news domain***.



Related Work

- Dependency Forest Construction

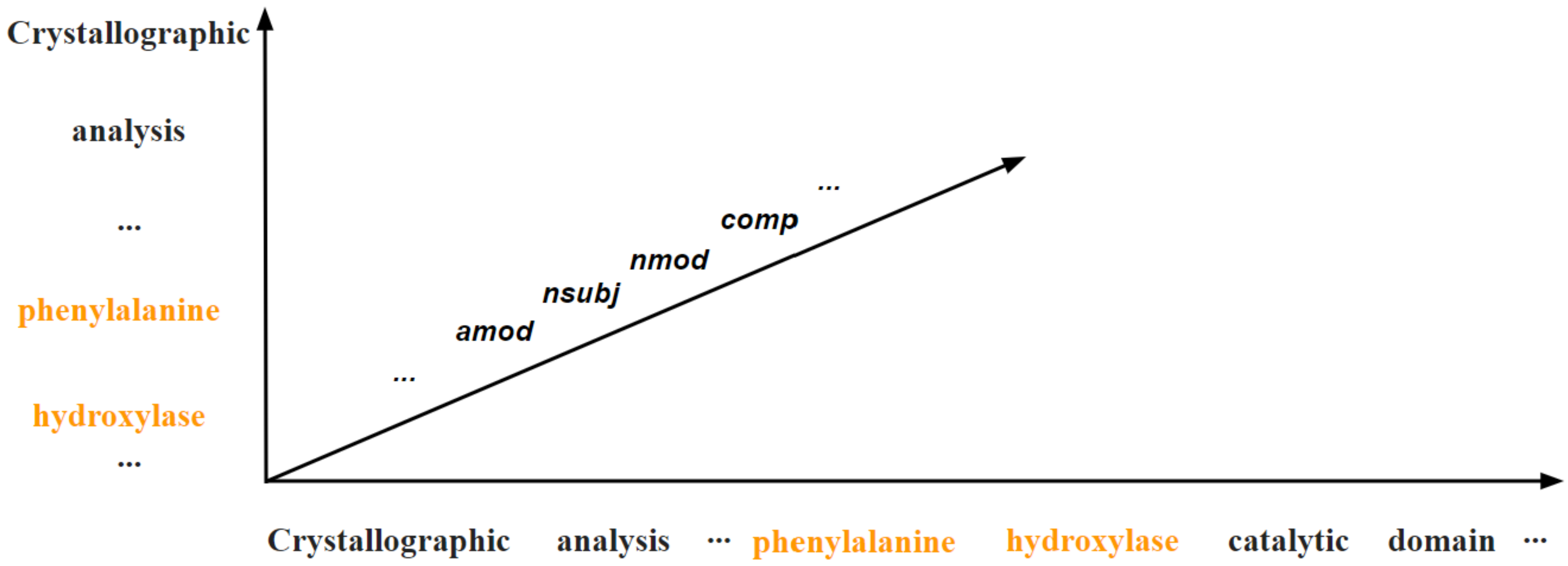
KBests (Song et al., 2019): finds ***K highest-scored trees***, then merge them by ***combining identical dependency edges*** to make the forest.



Related Work

- Dependency Forest Construction

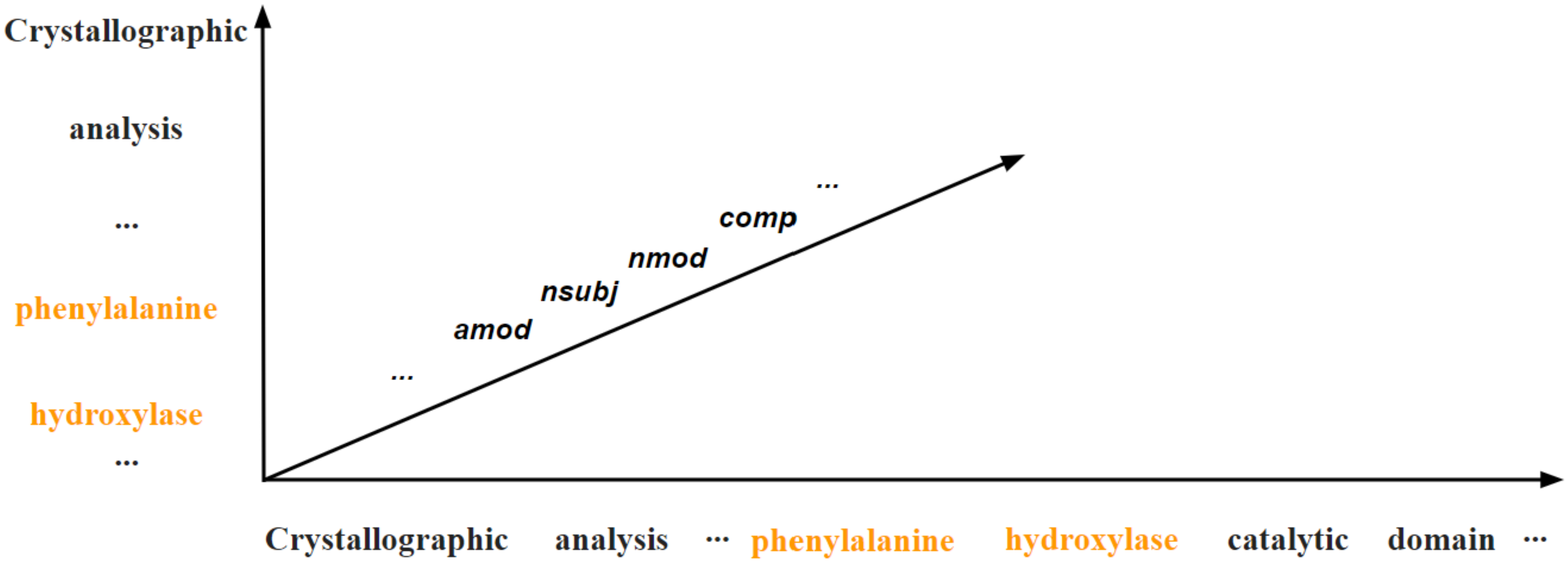
FullForest (Jin et al., 2020): defines the forest as a ***3-dimensional tensor.***



Related Work

- Dependency Forest Construction

3D Tensor: each point representing the conditional probability $p(w_j, l|w_i)$ of one word w_i modifying another word w_j with a relation l.

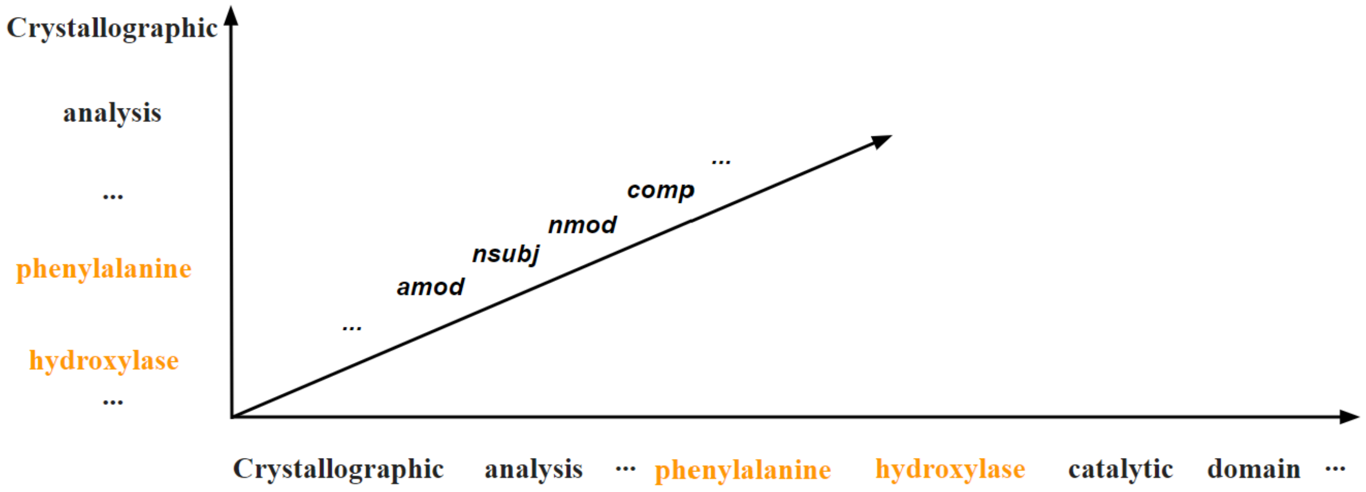


Related Work

- Dependency Forest Construction

3D Tensor: use the dependency parser trained on the news domain to obtain the tensor and ***adjust the parser by relation extraction loss***.

Deep bi-affine parser
(Dozat and Manning, 2017)



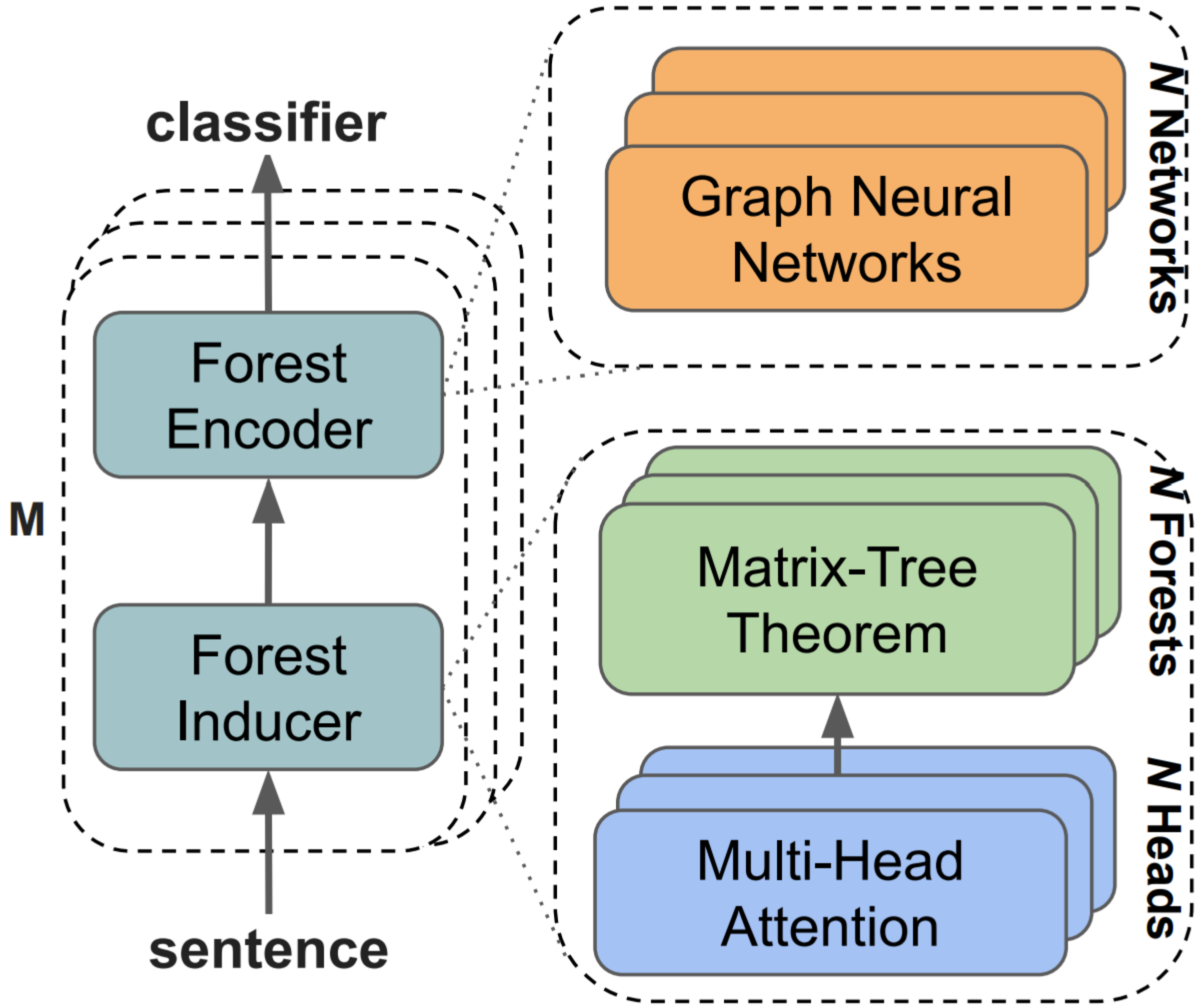
Motivation

- **Research Question**: Can we build a model without relying on an out-of-domain parser?

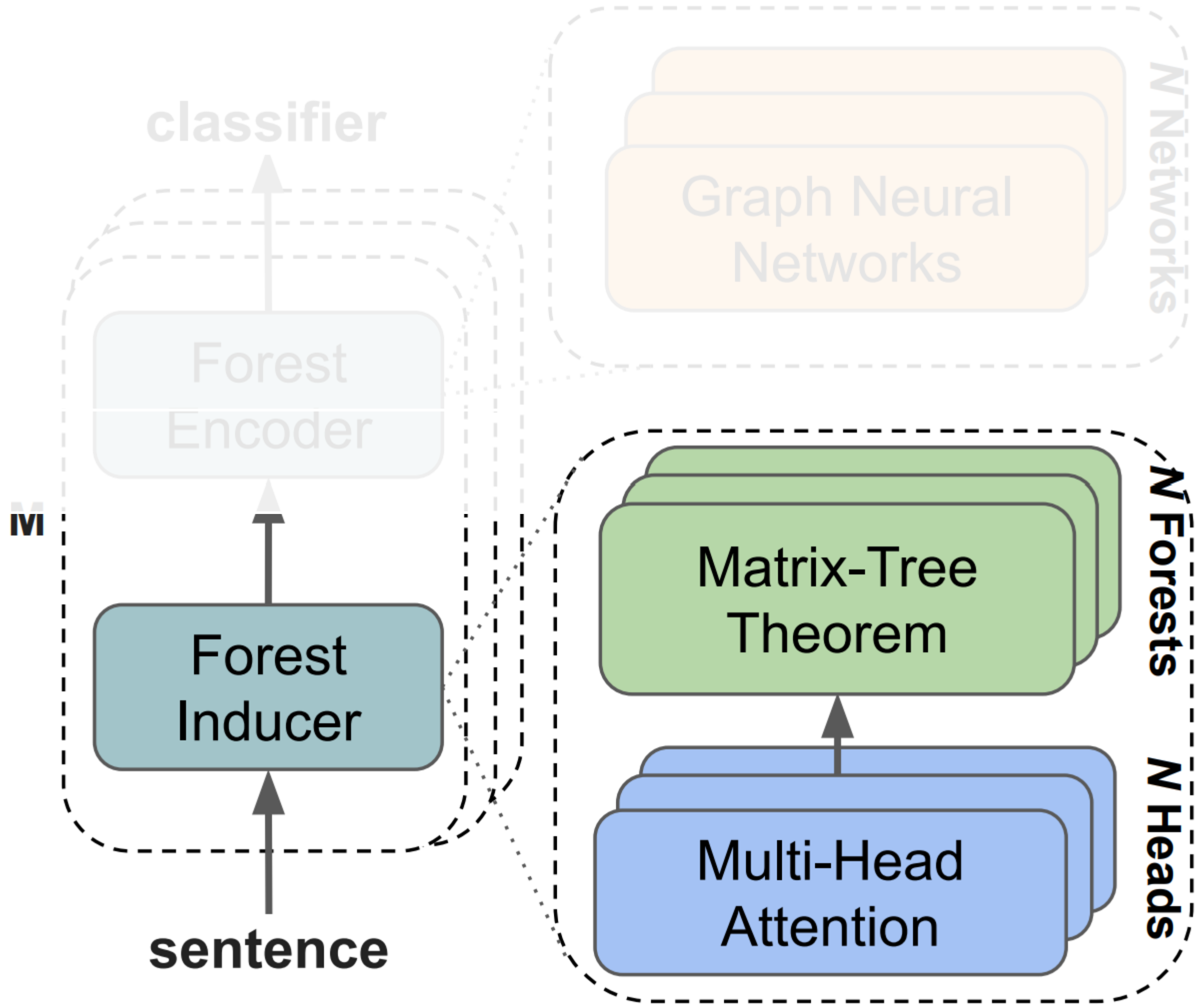
Motivation

- **Yes!** We treat the dependency structure as ***a latent variable*** and induce it ***end-to-end***.

Model


classifier
M
Forest Encoder
Forest Inducer
sentence
Graph Neural Networks
N Networks
Matrix-Tree Theorem
N Forests
Multi-Head Attention
N Heads

Model



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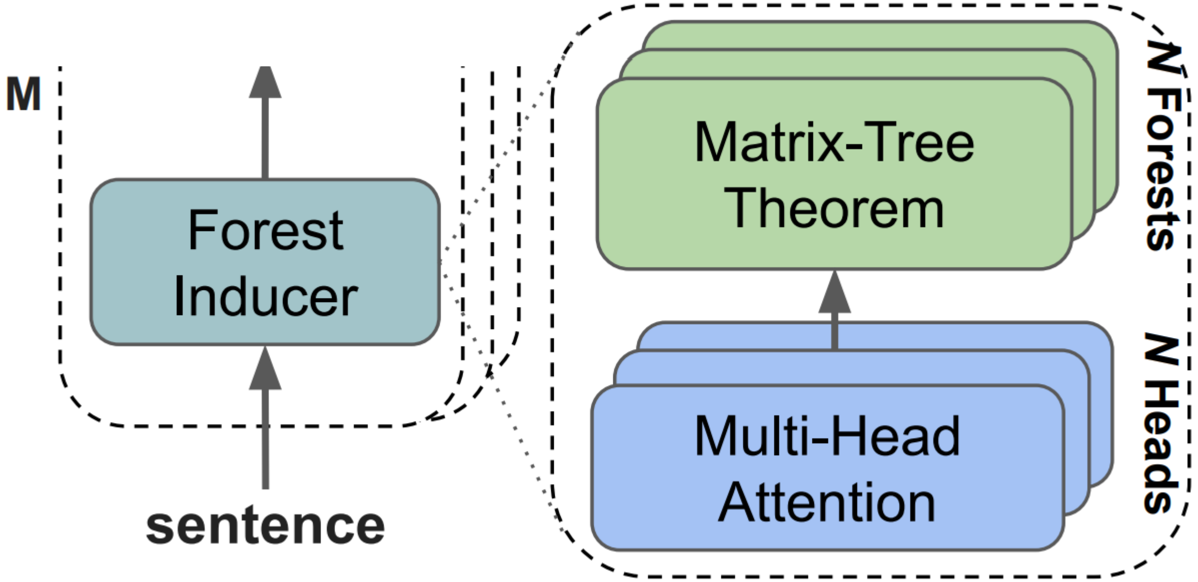
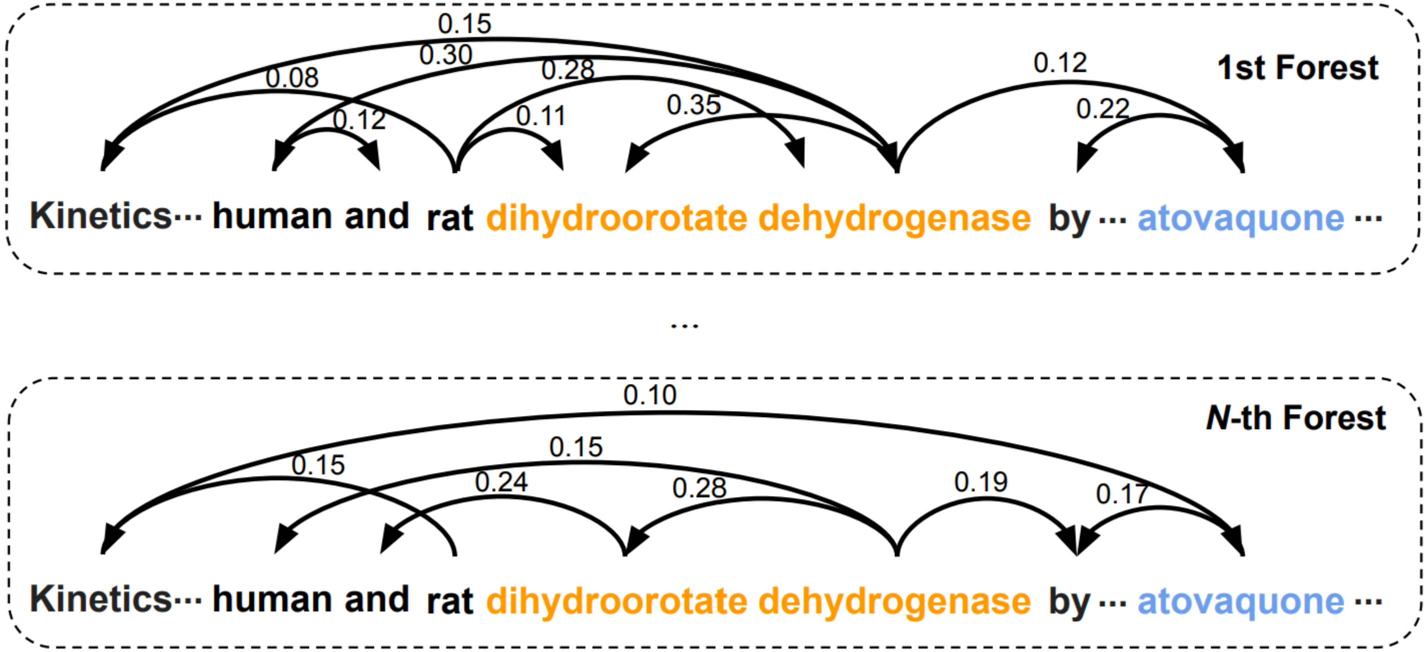
Forest Inducer

- ***Multi-head attention*** is used to construct ***N attention matrices***, which will be fed into the next module to obtain ***N latent forests*** in order to capture different dependencies in different representation subspaces.

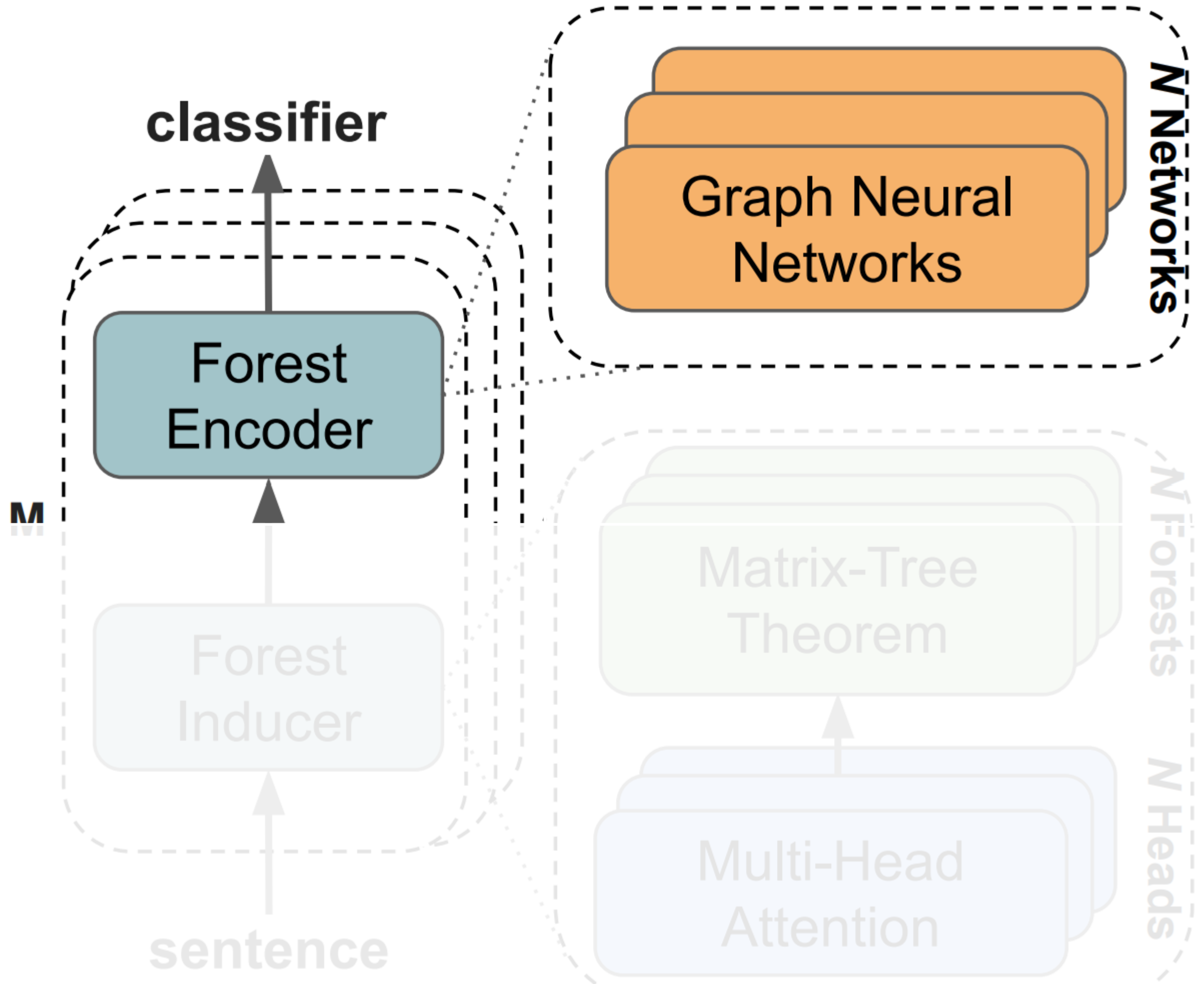


Forest Inducer

- ***Matrix-Tree Theorem*** (Tutte, 1984; Koo et al., 2007) is used to induce ***N*** latent structures, i.e., edge-weighted dependency forests.



Model



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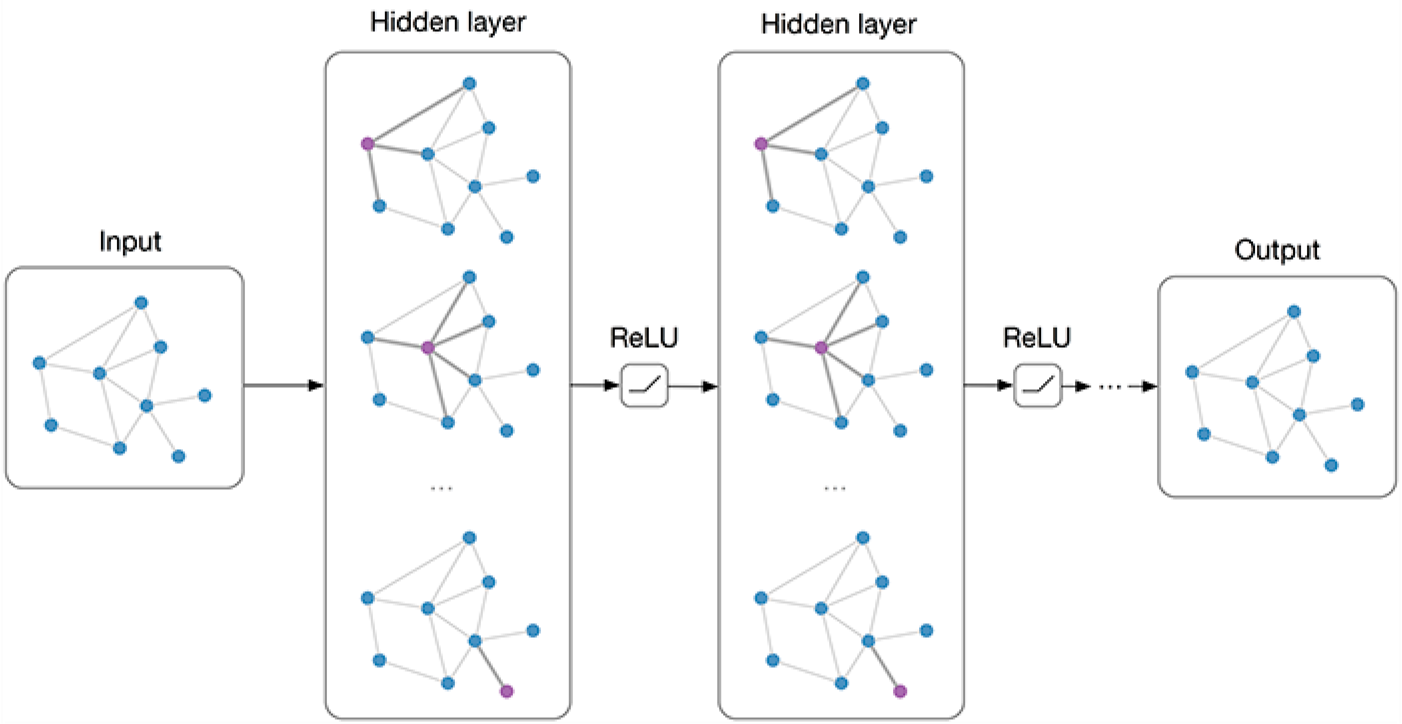
Forest Encoder

- Given the generated latent forests, we use the ***densely-connected graph convolutional networks*** (Guo et al., 2019) as the encoder.



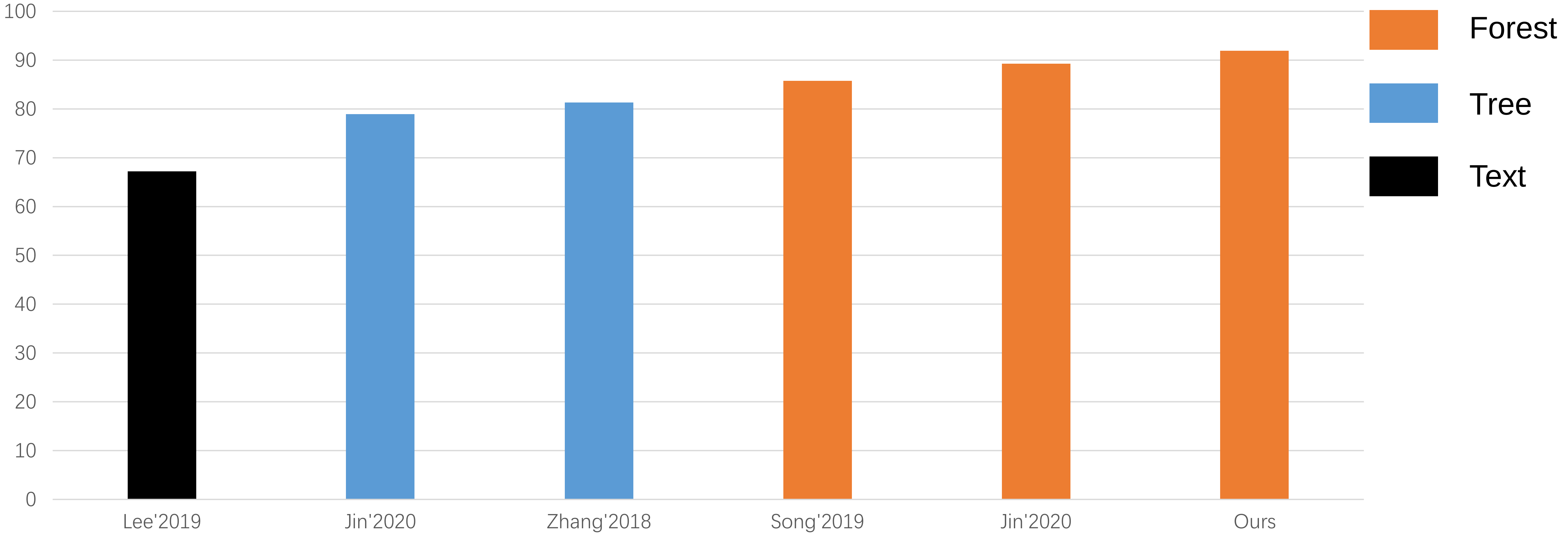
Experiments

- Data Statistics

Dataset	**Relations**	**Domain**	**Train**	**Dev**	**Test**
PGR	2	Medical	*11,780*	*N/A*	*219*
CPR	5	Medical	*16,107*	*10,030*	*14,269*
Semeval 10-task8	10	News	*10,717*	*N/A*	*N/A*

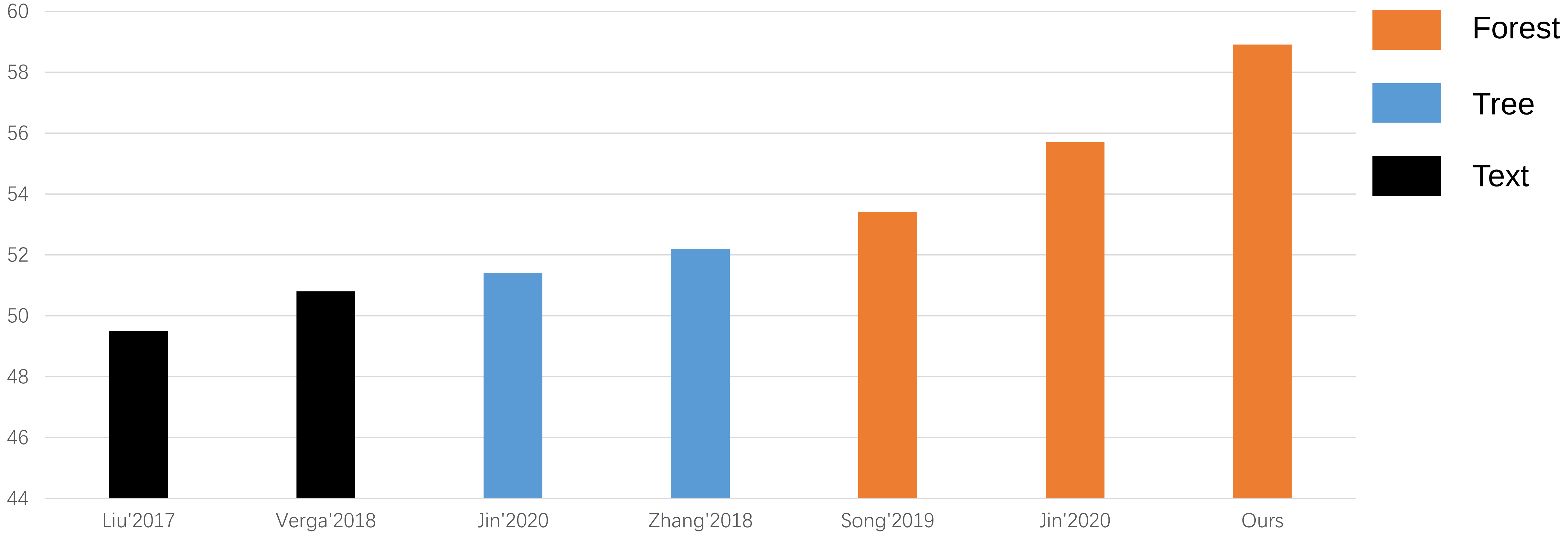
Experiments

- Results on medical dataset: PGR



Experiments

- Results on medical dataset: CPR



Experiments

- Results on news dataset: Semeval-2010 task 8

Type	**Model**	***w Parser***	***F1***
Tree	Song et al., 2019	*Y*	84.6
Tree	Zhang et al., 2018	*Y*	84.8
Forest	Jin et al., 2020	*Y*	85.7
Forest	Guo et al., 2019	*Y*	85.7
Forest	Song et al., 2019	*Y*	**86.3**
Forest	Ours	***N***	85.7

Conclusion

- Instead of using an ***out-of-domain*** parser, we treat the ***dependency structure*** as a ***latent variable*** and induce the ***task-specific forests***.

- Extensive experiments show that our proposed method is able to achieve state-of-the-art results on ***medical relation extraction*** tasks.

Thank you!

Code Available:

https://github.com/Cartus/Latent-Forests