An Empirical Study of Graph Neural Networks Based Semantic Parsing

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What is semantic parsing?

Are there any jobs with Microsoft involving sql ?

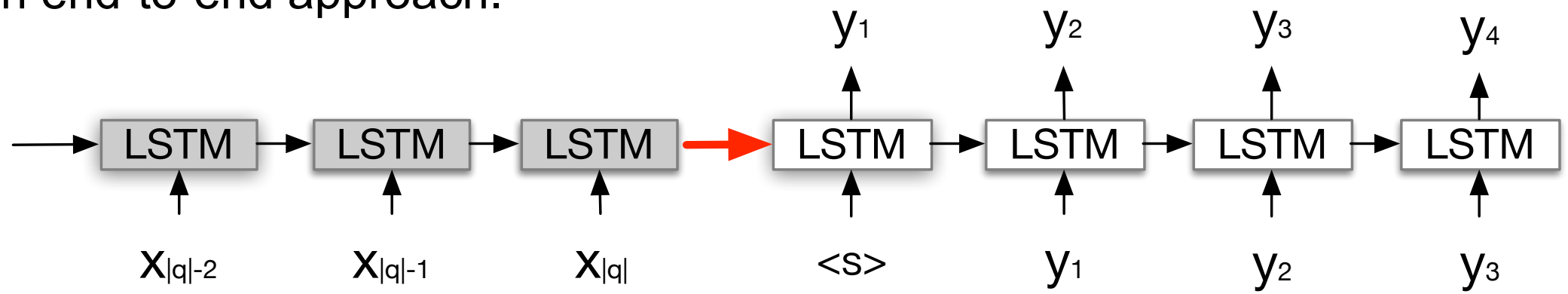
After semantic parsing

Answer(A,(job(A),company(A,C),const(C,'Microsoft'),language(A, L),const(L,'sql'))))

Previous semantic parser

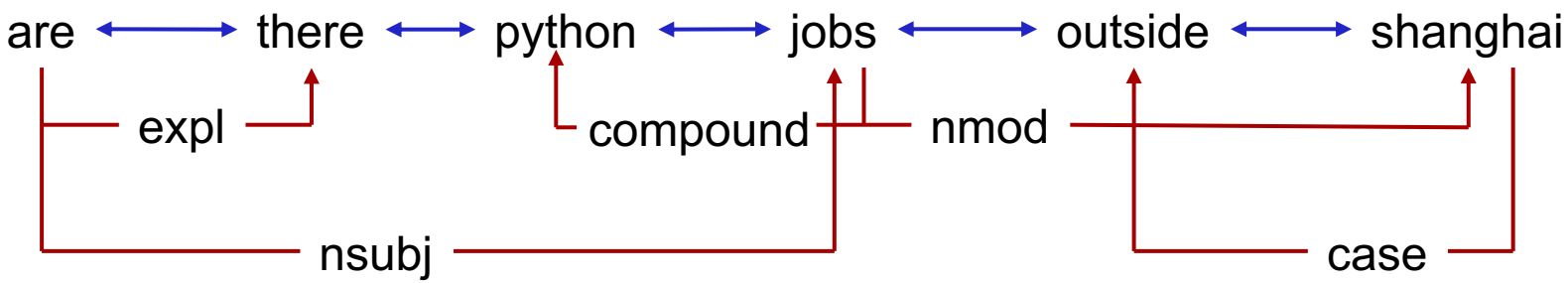
Translate problem: from natural language sentences to hierarchical output like logical forms

- Seq2seq model: an encoder-to-decoder architecture, an end-to-end approach.



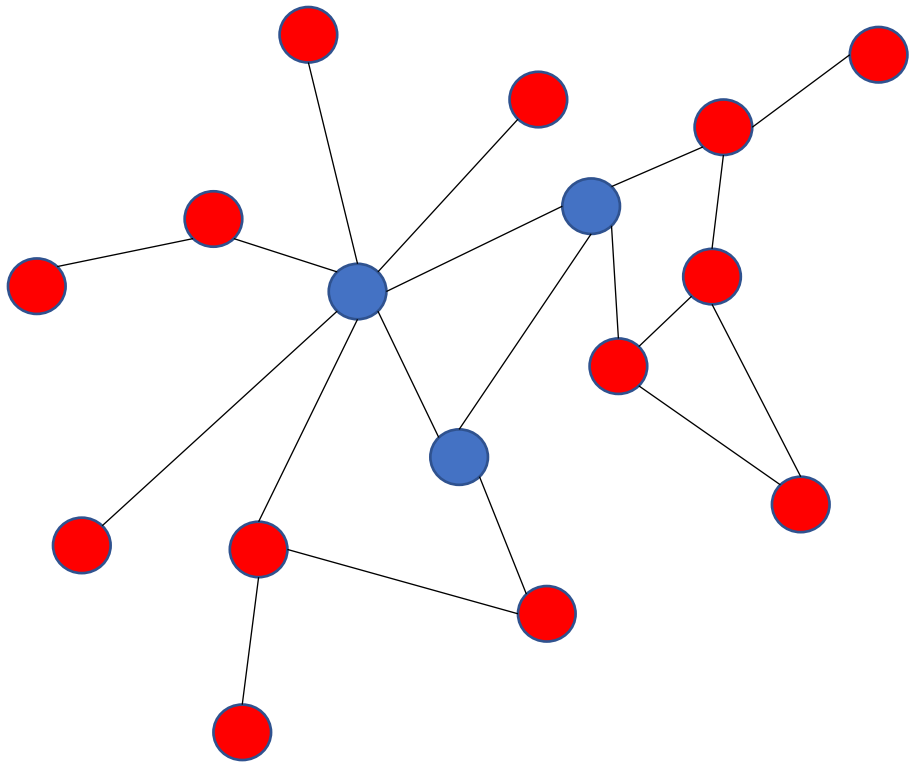
Problem

- Sequence encoder and decoder encode word order features but ignore more syntactic information such as dependency and constituency features.



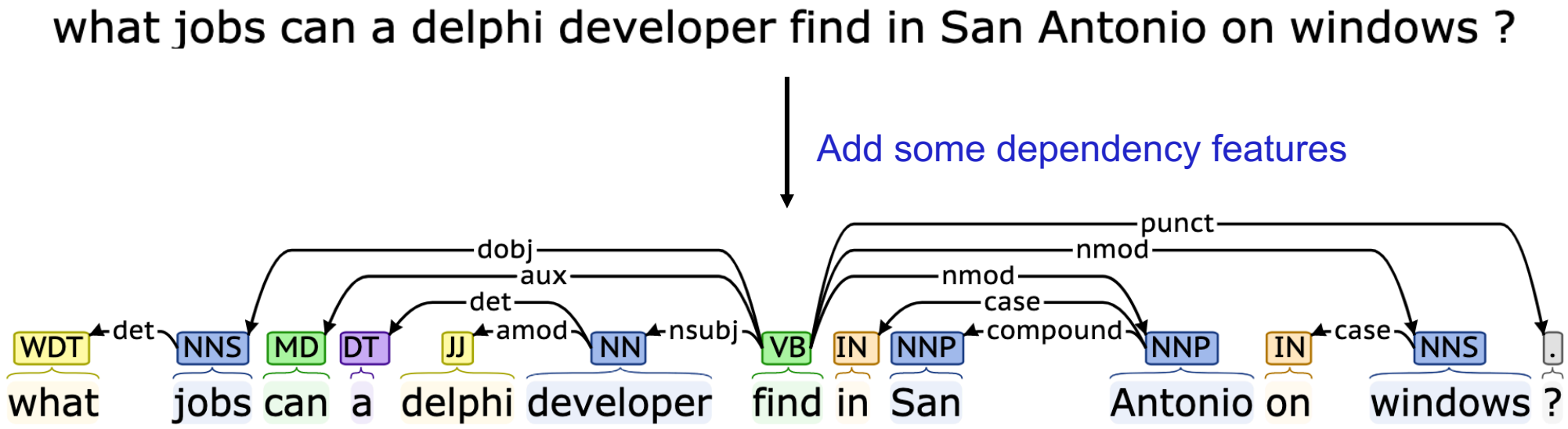
Why should we choose Graph Neural Network(GNN) for semantic parsing task?

- Some inputs can be naturally expressed in graph, for example, protein network



Why should we choose Graph Neural Network(GNN) for semantic parsing task?

- Hybrid Graph with some augmented information

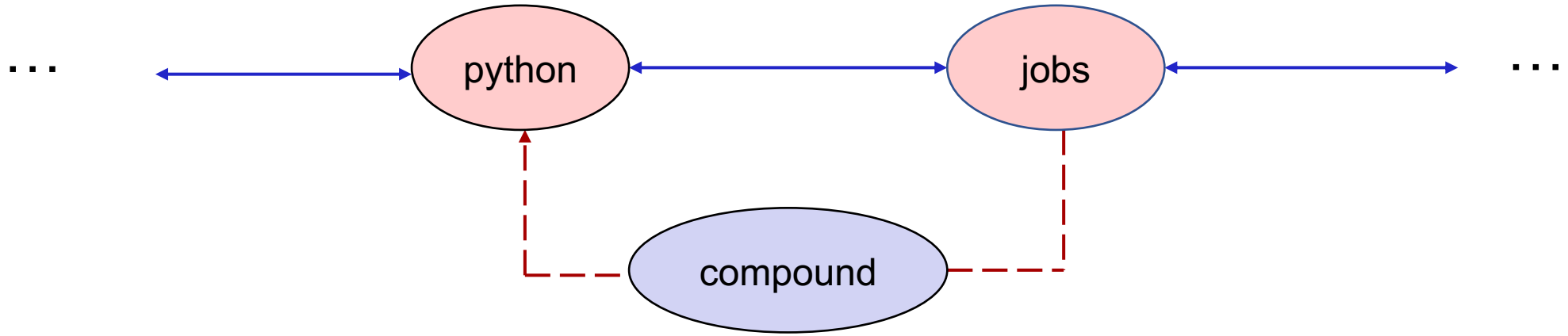


Key word "jobs" is far away from its attribute "windows", but with dependency features, it's more easy to learn a high-quality input representation (from 10 hops to 2 hops in graph).

Our approach

- How to construct our graph input ?

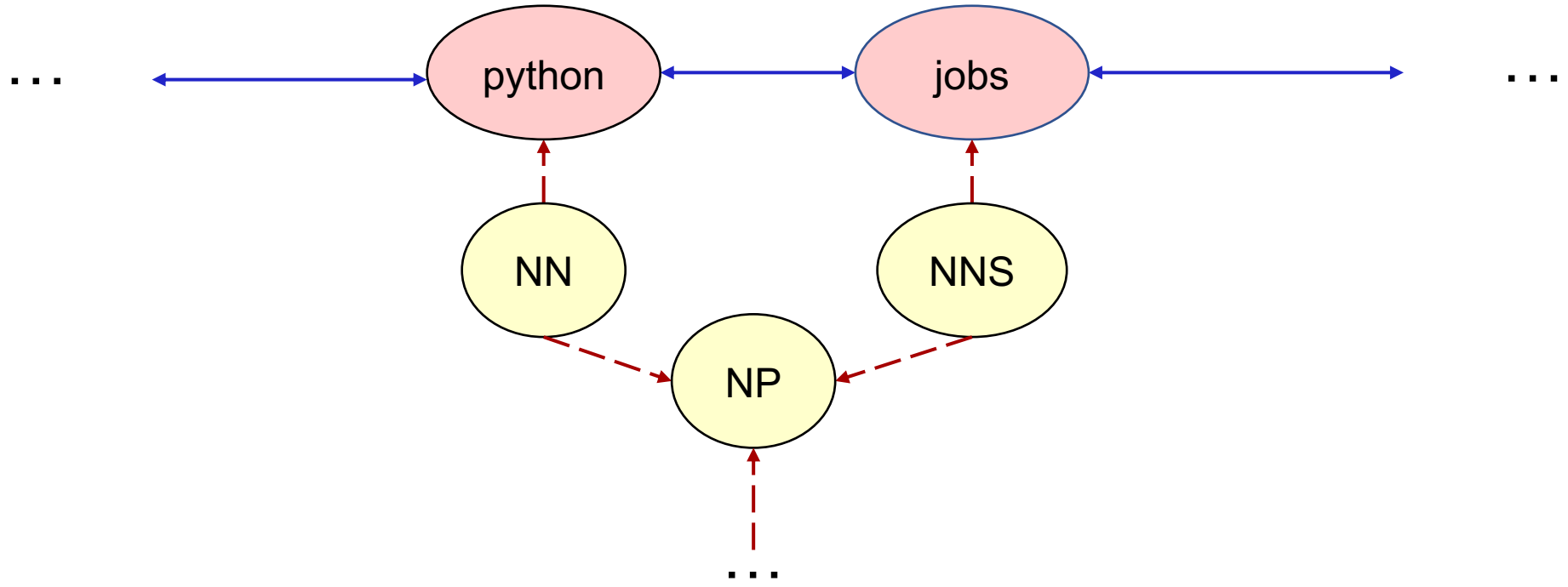
1) dependency parsing tree, turn dependency features to new nodes and link them with two nodes in sentence.



Our approach

- How to construct our graph input ?

2) constituency parsing tree, incorporate constituency tree nodes and word nodes into a single graph.



Our approach

- How to learn good representation from this kind of graph and get high-quality hierarchical output ?

1) Graph encoder

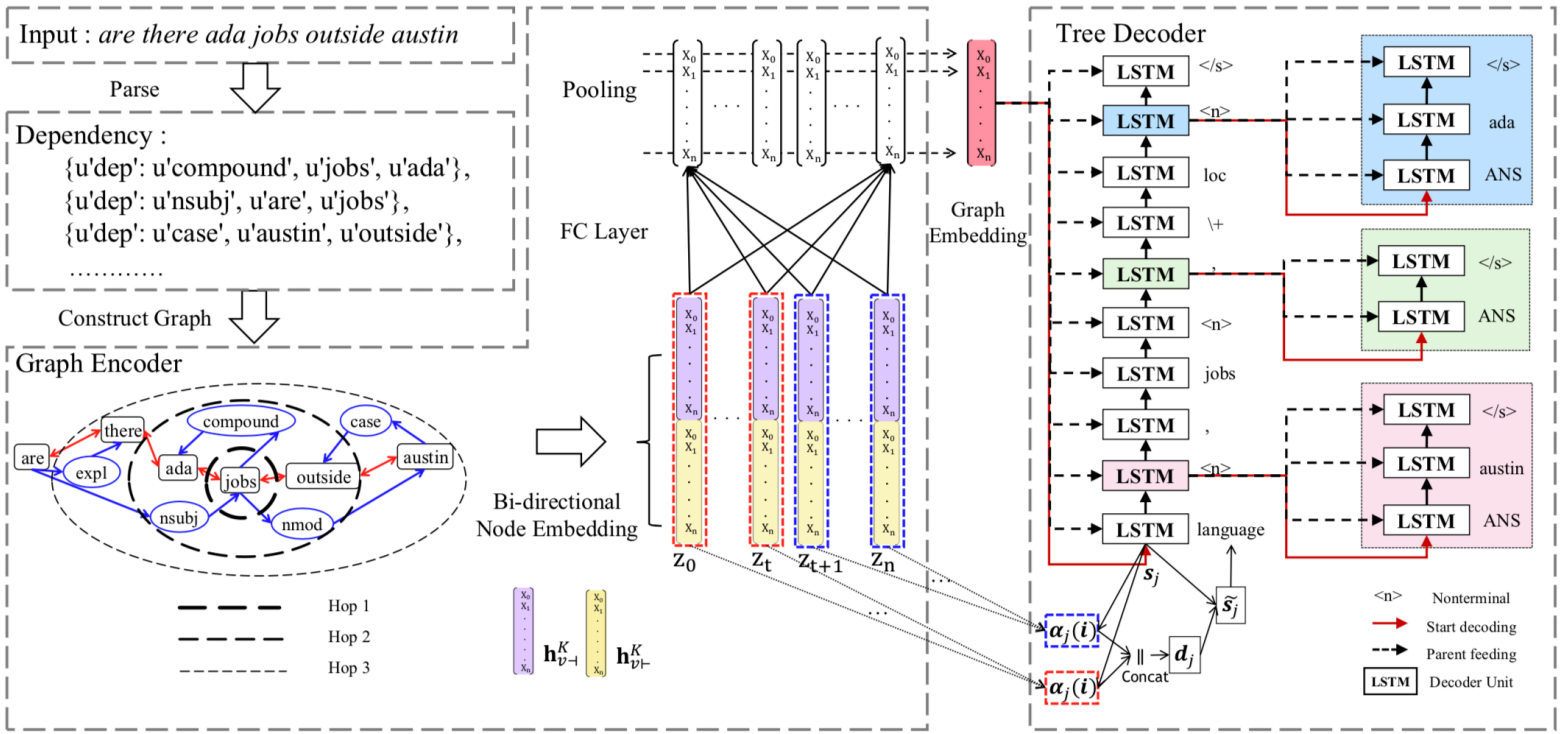
- Our graph encoder adapts an inductive node embedding algorithm. We generate each node embedding in graph by bi-directionally aggregating information from its local neighborhood in *K* hops.

2) Hierarchical decoder

- Logic form output are usually hierarchical, and traditional sequence decoder need to memory some auxiliary information like brackets to keep the structure.
- So we adapt a tree decoder in our model, it decodes logic form outputs in a coarse-to-fine way.

Our approach: Graph2Tree

- Use Bi-LSTM to process word order features
- Calculate different attention vectors for different types of nodes in graph input



Experiment

- Datasets
  - Jobs640
  - Geo880
  - ATIS

- Baseline
  - Graph2Seq model consists of graph encoder and sequence decoder[1]
  - Seq2Seq model and Seq2Tree[2] model

[1] Kun Xu*, Lingfei Wu*, Zhiguo Wang, Yansong Feng, Michael Witbrock, and Vadim Sheinin (both authors contributed equally), "Graph2Seq: Graph to Sequence Learning with Attention-based Neural Networks", arXiv preprint 2018.
[2] Li Dong and Mirella Lapata. 2016. Language to logical form with neural attention. arXiv preprint arXiv:1601.01280 (2016).

Results

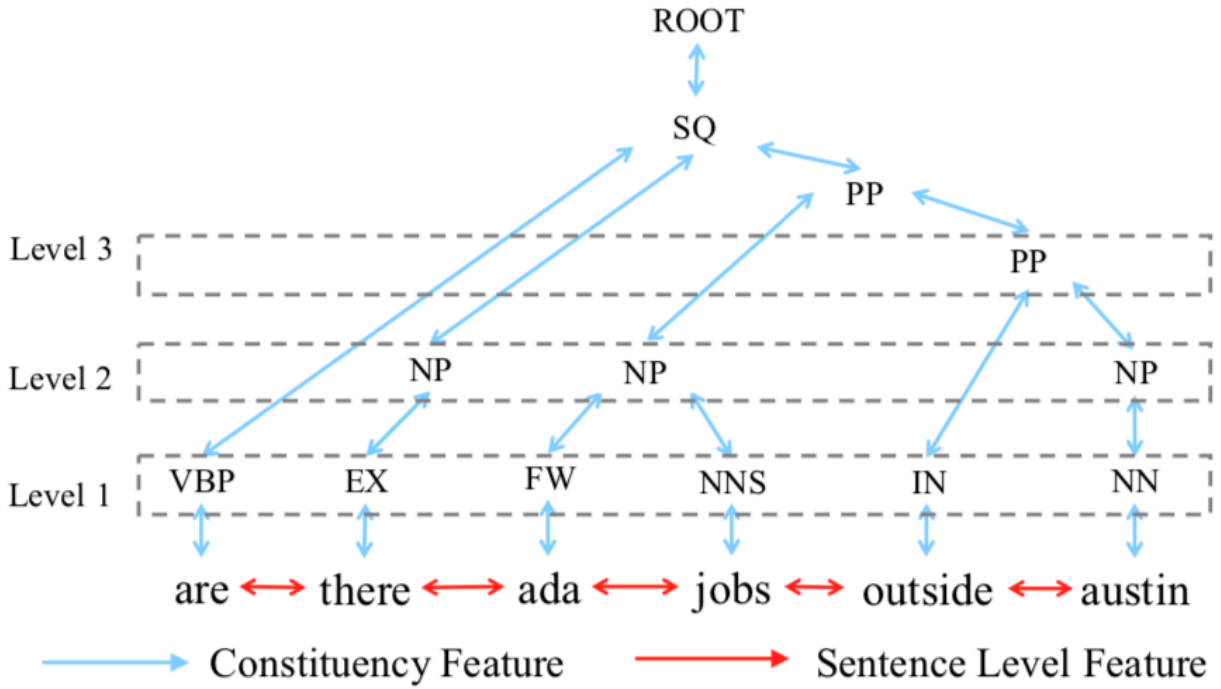
Methods	*JOBS*	*GEO*	*ATIS*
Jia and Liang (2016)	-	85.0	76.3
Dong and Lapata (2016)-Seq2Seq	87.1	85.0	84.2
Dong and Lapata (2016)-Seq2Tree	90.0	87.1	84.6
Rabinovich et al. (2017)	92.9	85.7	**85.3**
Xu and Wu (2018)-Graph2Seq	88.6	85.7	83.8
Graph2Tree	**92.9**	**88.2**	84.6

- Graph2tree model achieves remarkable performance in JOBS & GEO
- In bigger datasets like ATIS, Graph2tree has limited performance

Results

- Syntactic graph with constituency tree features from a simple and short sentence

"Are there ada jobs outside austin?"



- Syntactic graph with some noise or complex structure may be detrimental to semantic parsing.

Results

- Try constituency parsing tree with different structure complexity.
- Remove some noise nodes in dependency parsing tree manually.

Methods	Graph2Tree	Graph2Seq
Word Order	91.4	87.1
Output correction: WO+DEP	92.1	88.6
Original condition: WO+DEP	91.5	85.0
Constituency two layer cut: WO+CON	91.4	86.4
Constituency one layer cut: WO+CON	**92.9**	88.6
Constituency tree all layer: WO+CON	92.1	85.0

Why Graph2tree?

- Decoding results compared to baseline

Methods	Prediction results
Reference str	job (ANS) , language (ANS , 'delphi') , title (ANS , 'developer') , loc (ANS , 'san antonio') , platform (ANS , 'windows')
Graph2tree	job (ANS) , language (ANS , 'delphi') , title (ANS , 'developer') , loc (ANS , 'san antonio') , platform (ANS , 'windows')
Graph2seq	job (ANS) , language (ANS , 'delphi') , title (ANS , 'developer') , platform (ANS , 'windows')
Seq2seq	job (ANS) , language (ANS , 'delphi') , title (ANS , 'developer') , loc (ANS , 'san antonio')

Conclusion

- We presented Graph2Tree model, a generalized model for graph inputs and tree structured outputs.

- We made some primary attempts on how to construct a proper choice of graph for this type of neural semantic parsing.

Thank You!

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