End-to-End Bootstrapping Neural Network for Entity Set Expansion

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  - What's entity set expansion (ESE)?
  - How does bootstrapping for ESE work?
  - What are the problems of previous methods?
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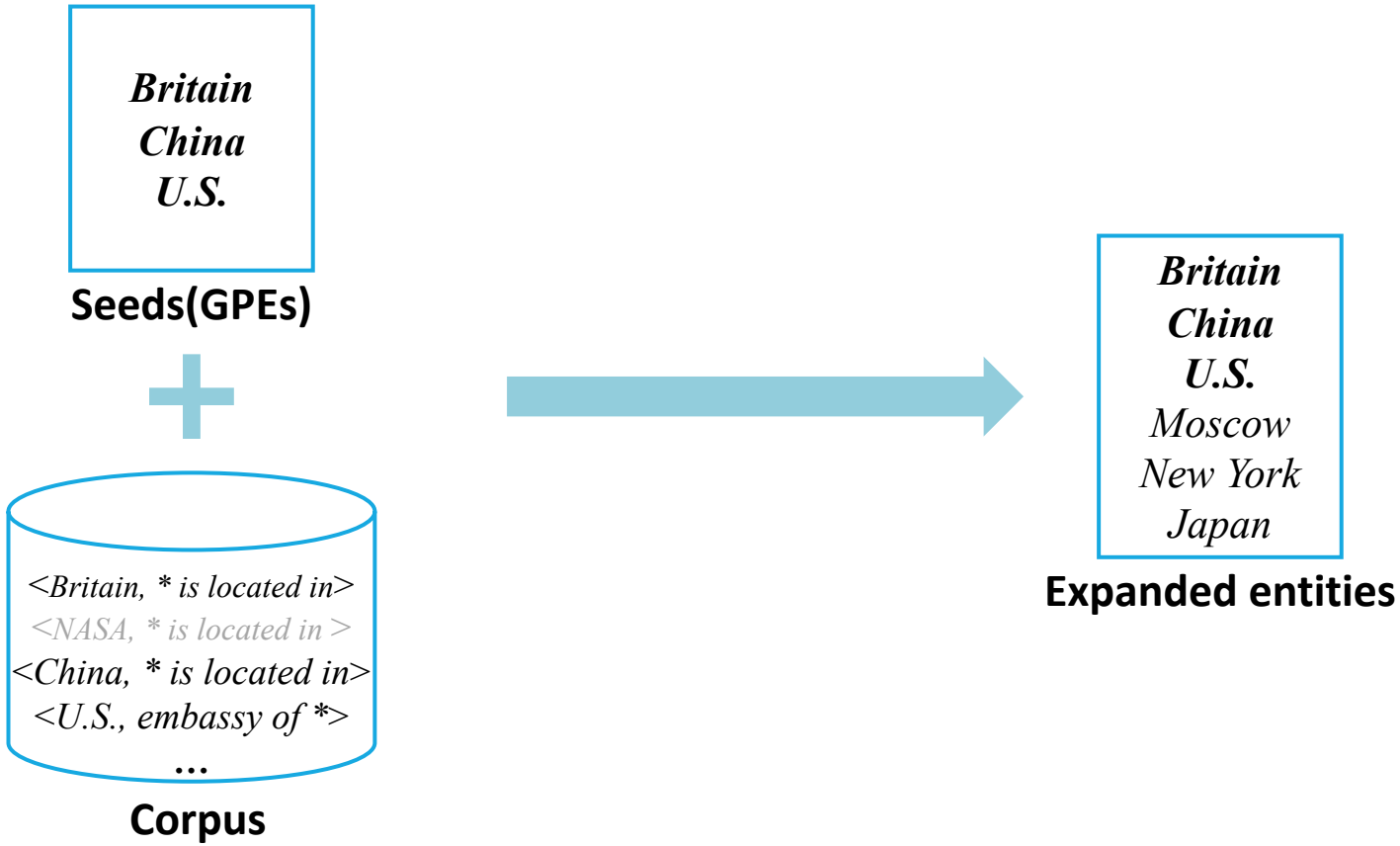
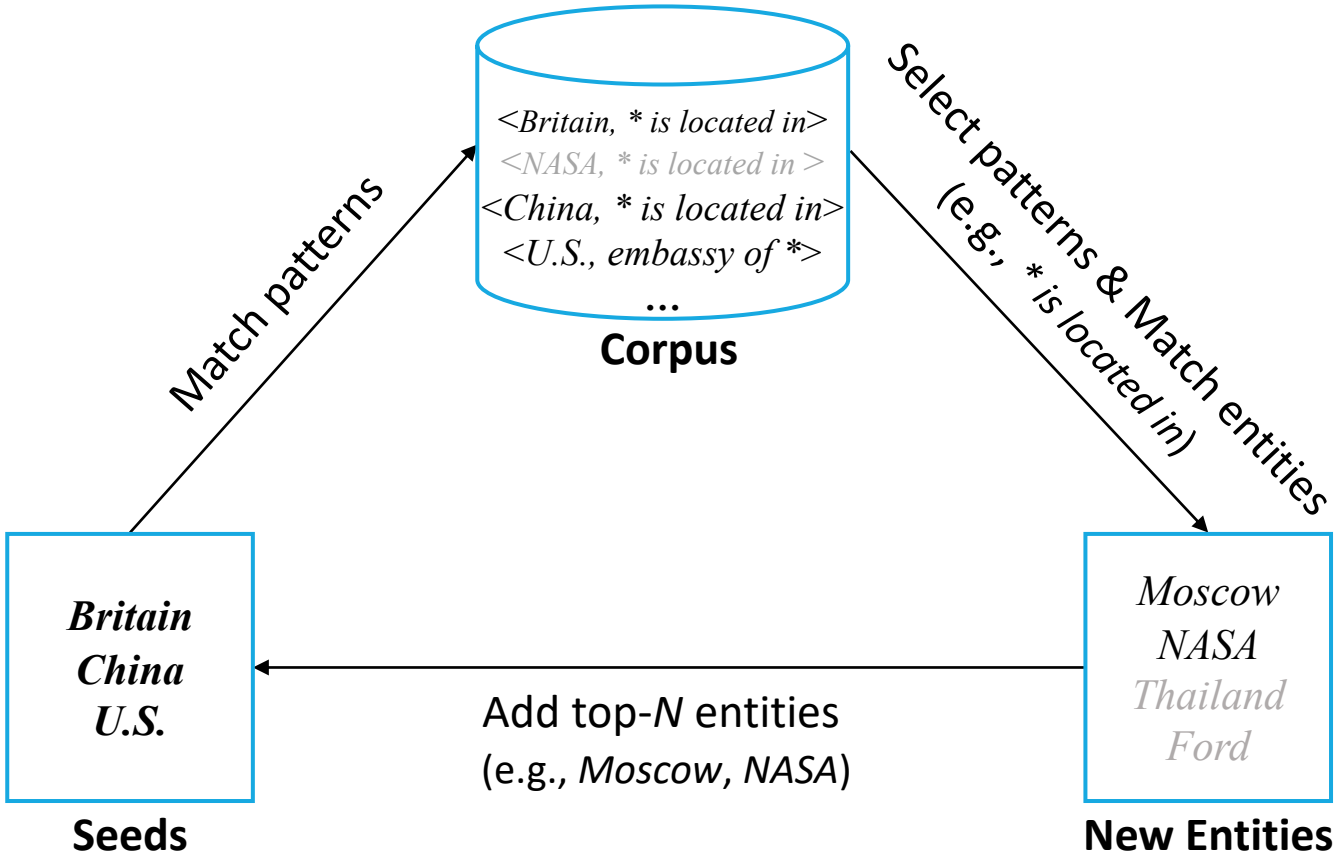
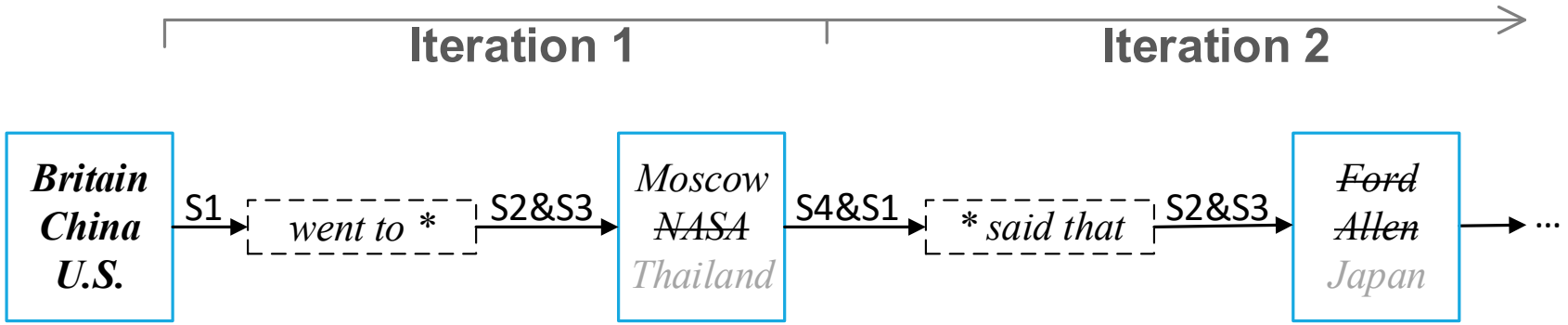
- Entity Set Expansion (ESE)
  - Expanding seeds to new entities belonging to the same category



- Bootstrapping for ESE
  - Iteratively expanding by adding new entities to the seeds



- Previous paradigm—Multi-step Pipeline (*Riloff and Jones, 1999; Gupta and Manning, 2014*)



S1: Matching patterns via expanded entities

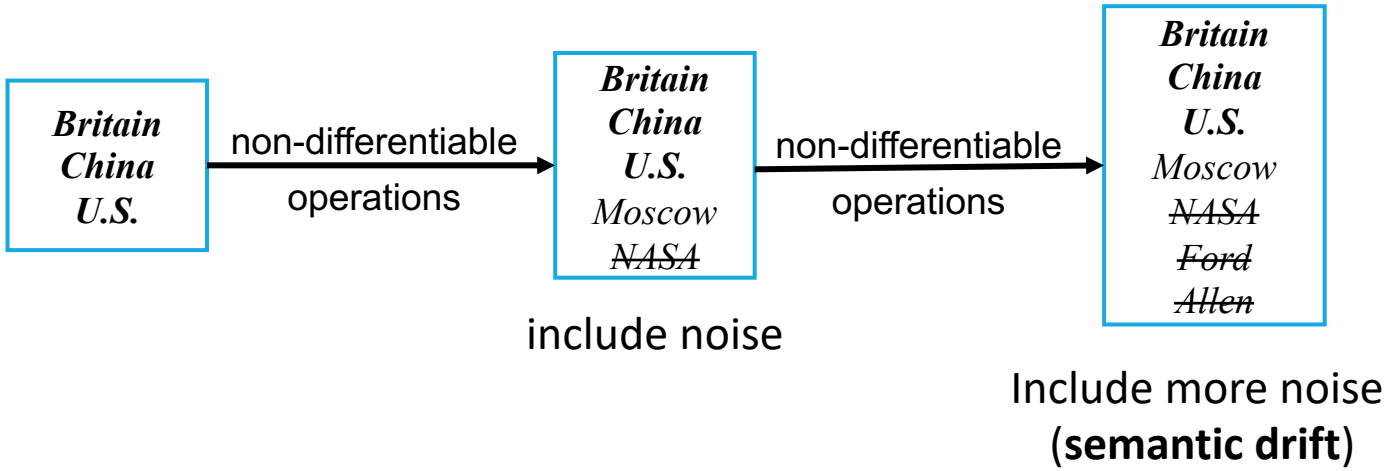
S2: Evaluating and selecting patterns

S3: Matching entities via selected patterns

S4: Evaluating and expanding entities

Ellen Riloff and Rosie Jones. 1999. Learning Dictionaries for Information Extraction by Multi-Level Bootstrapping.
Sonal Gupta and Christopher Manning. 2014. Improved Pattern Learning for Bootstrapped Entity Extraction.

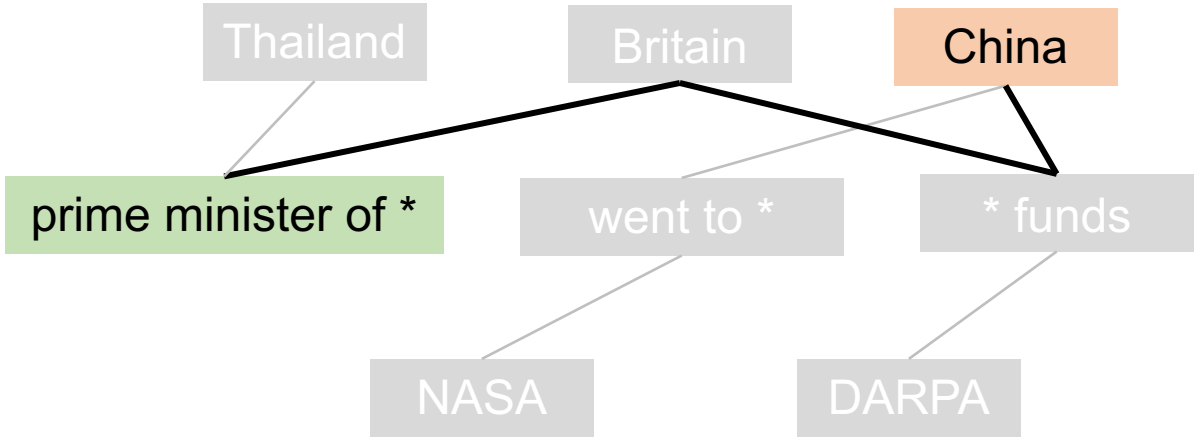
- Problem 1: Separate multi-step expansion
  - Previous noisy expanded entities are directly used as golden entities, which tends to include more noise.



- Problem 2: Ignoring high-order information
  - Mainly using first-order relations, ignoring high-order relations (which are also important)

<China, went to *>
<China, * agreed to>
<China, * funds>
<Thailand, prime minister of *>
<NASA, went to *>
<Britain, prime minister of *>
<Britain, funds *>
<DARPA, * funds>
<DARPA, * is trying to>

First-order relations



High-order relations

- Main ideas to solve these problems
  1. Tightly coupling expansion steps
     - Previous expansions have different confidence scores to guide next expansions.
     - Expansion results can be used as feedback to improve previous expansion.

  2. Capturing both the first- and the higher-order relation information

- And above ideas can be modeled in an end-to-end framework
  - Encoder (capturing first- and the higher-order information)
  - Decoder (tightly expanding by considering long-term dependencies)

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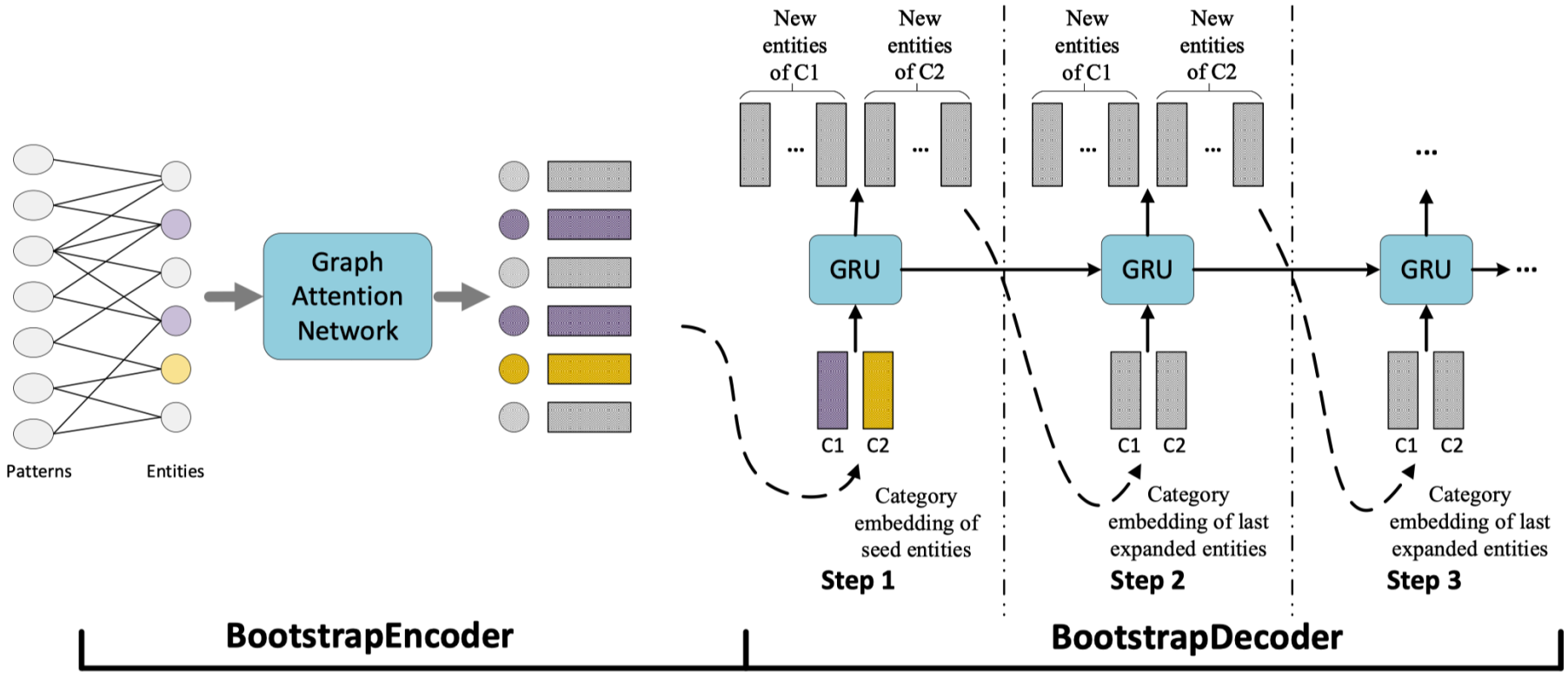
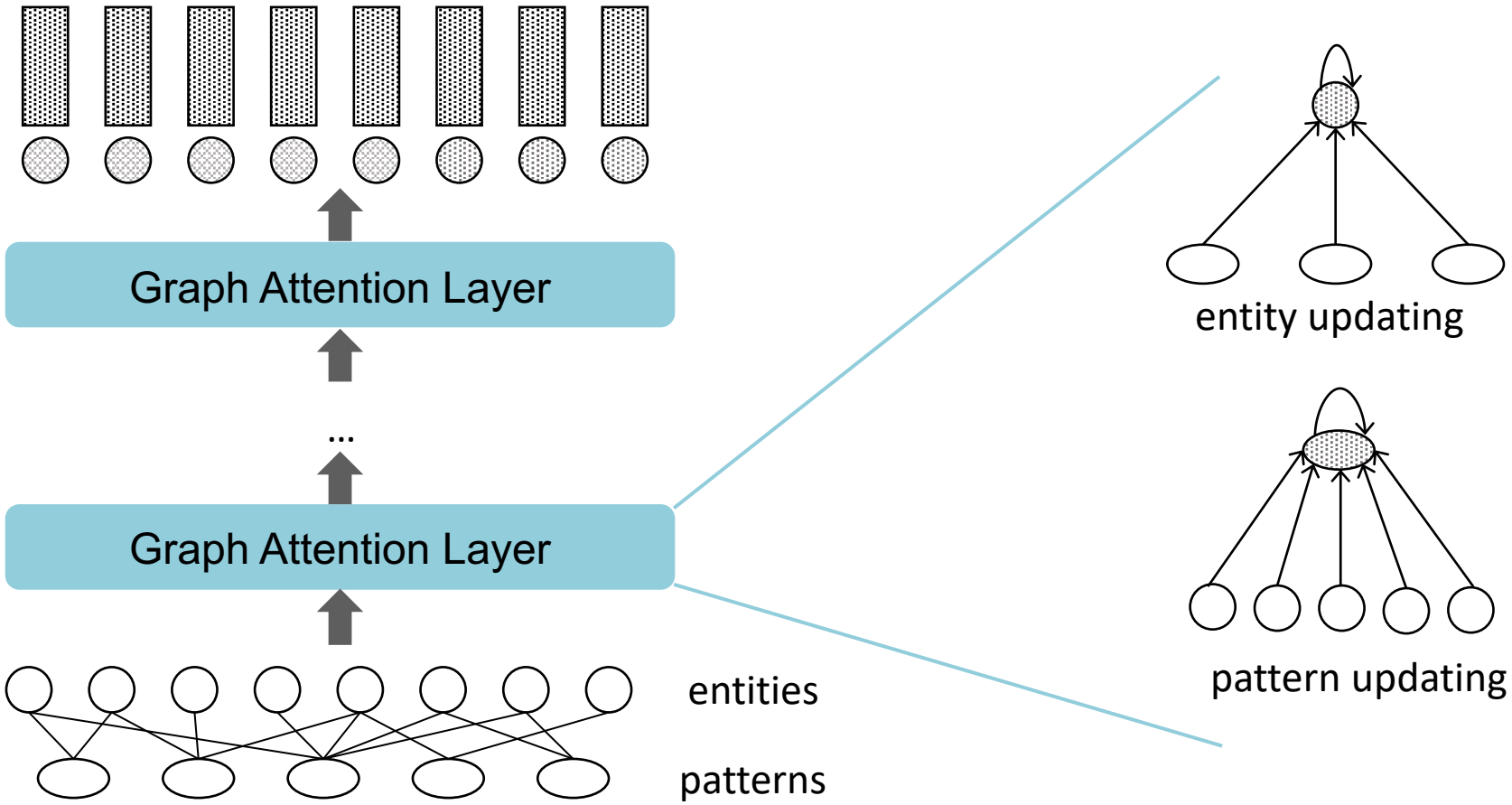
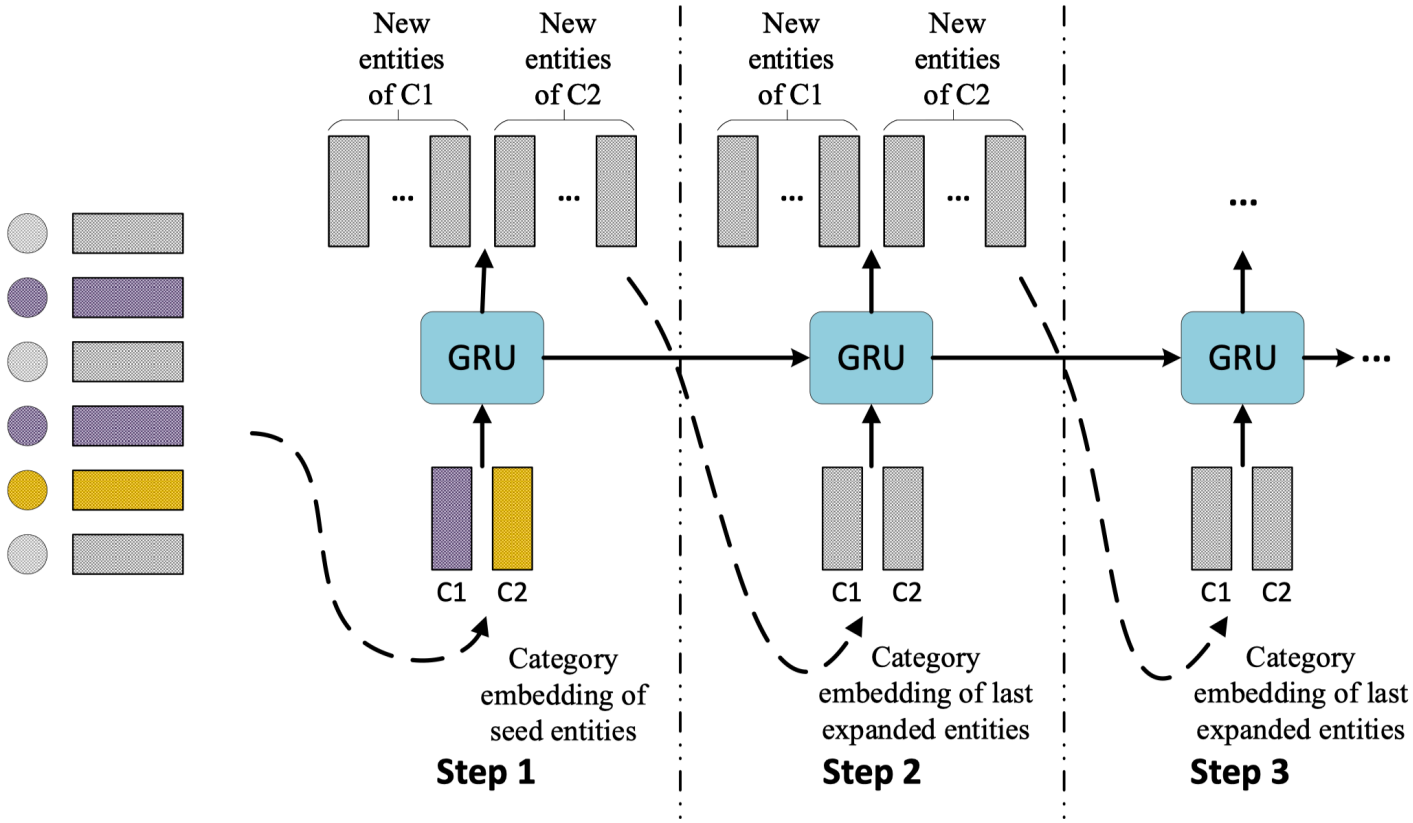
- End-to-End Bootstrapping NN—**BootstrapNet**
  - Encoder: encoding the first- and high-order entity-pattern relations
  - Decoder: modeling the entity expansion as the expansion generation



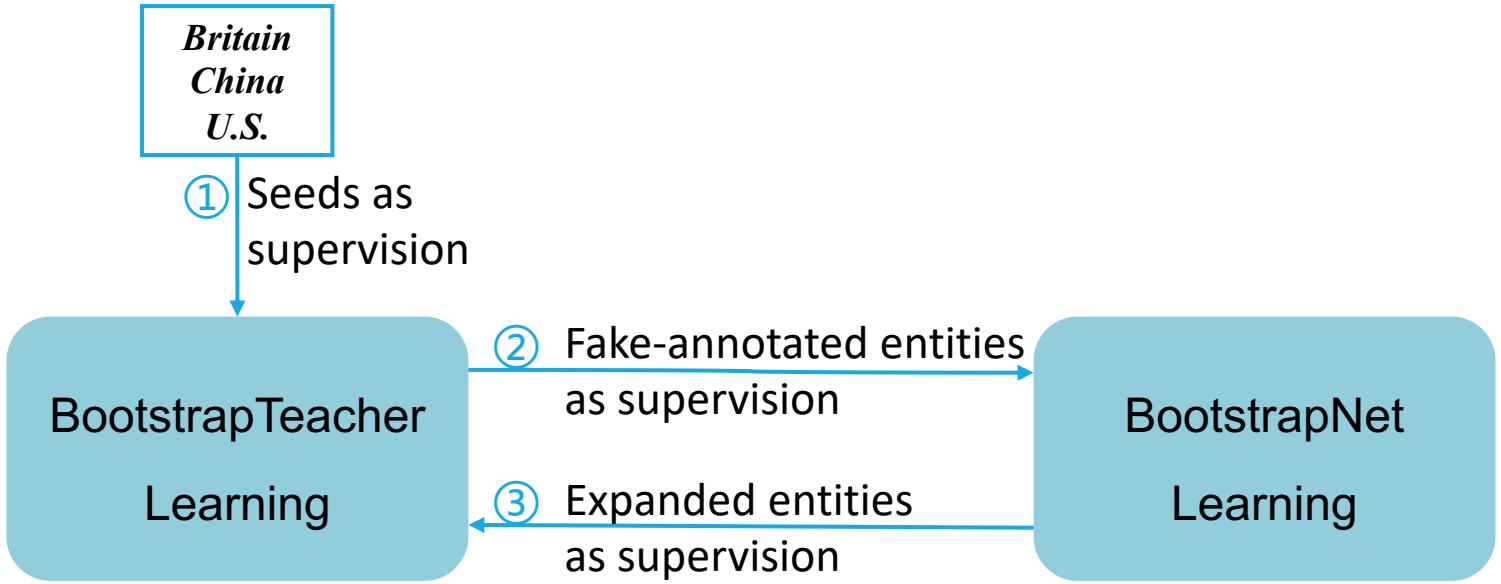
- Encoder—**BootstrapEncoder**
  - Graph Attention Network over entity-pattern bipartite graph



- Decoder—**BootstrapDecoder**
  - RNN-based model to sequentially generate expansion by considering long-term dependencies



- Multi-view Learning
  - View 1: Sequential expanding process
    - Expansion generation by considering long-term dependencies (via BootstrapNet)
  - View 2: Non-sequential expanding process
    - Classification based on the embeddings (via auxiliary model—BootstrapTeacher)



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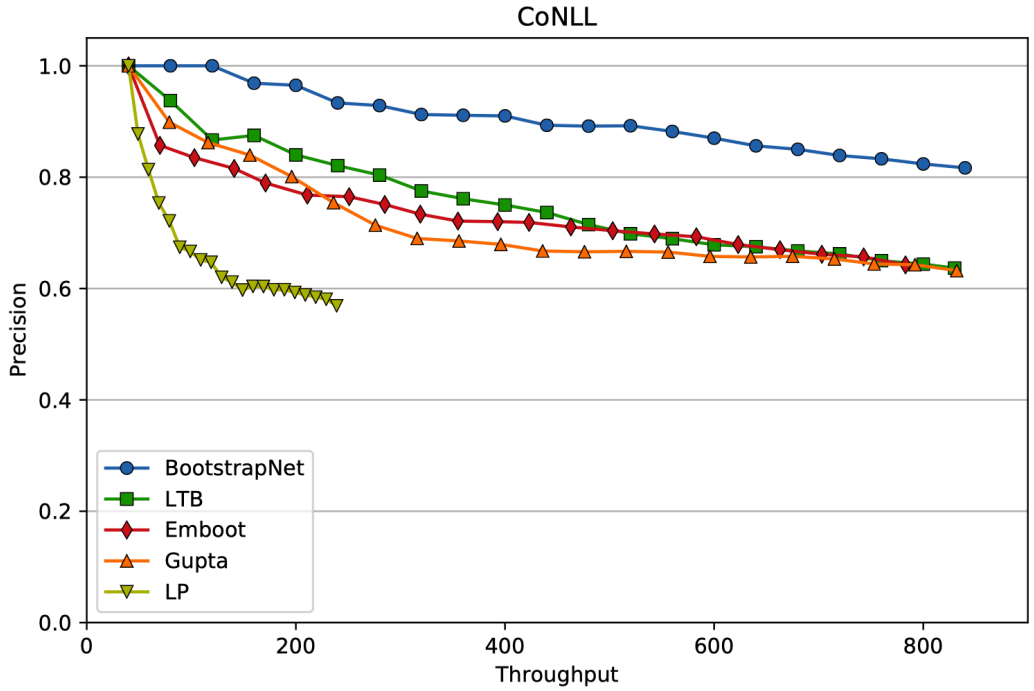
- Dataset:
  - CoNLL and OntoNotes (Zupon et al., 2019)

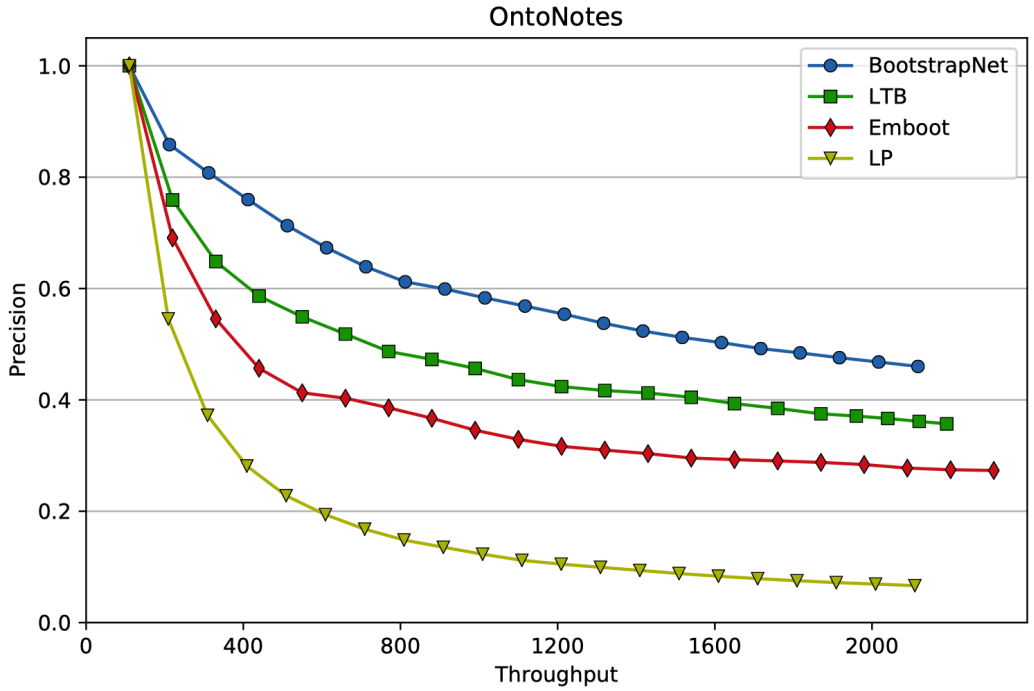
Dataset	# Categories	# Entities	# Patterns	# Links
CoNLL	4	5,522	8,477	13,916
OntoNotes	11	19,984	33,985	67,229

- Main settings:
  - Seed number: 10 seeds/category
  - Iteration number: 20

Zupon, Andrew, Maria Alexeeva, Marco Valenzuela-Escárcega, Ajay Nagesh, and Mihai Surdeanu. 2019. Lightly-Supervised Representation Learning with Global Interpretability.

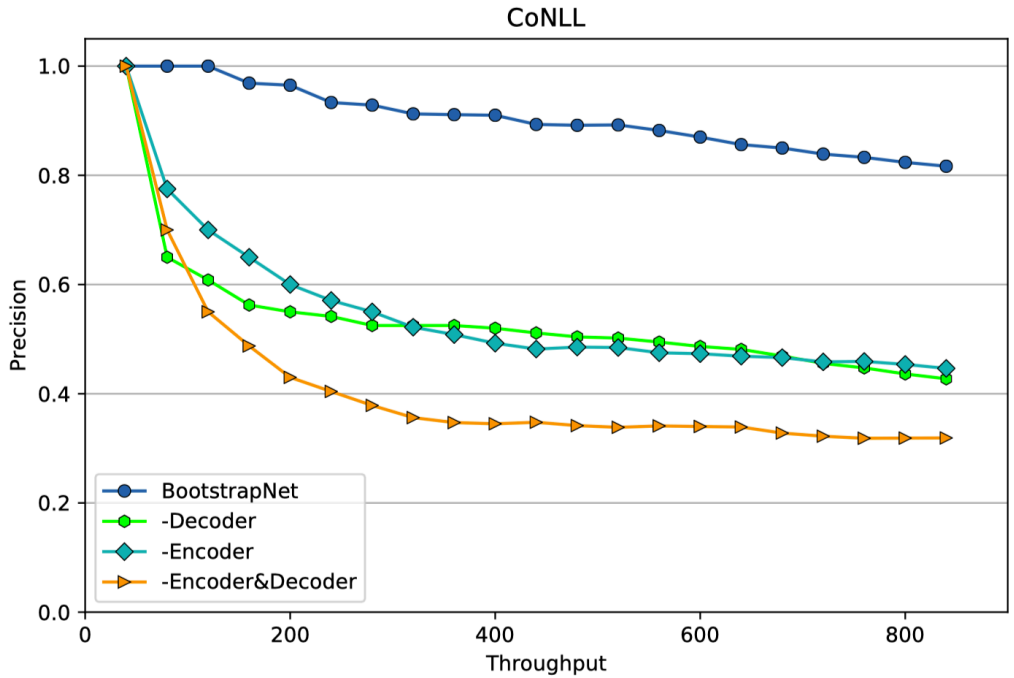
- Overall results

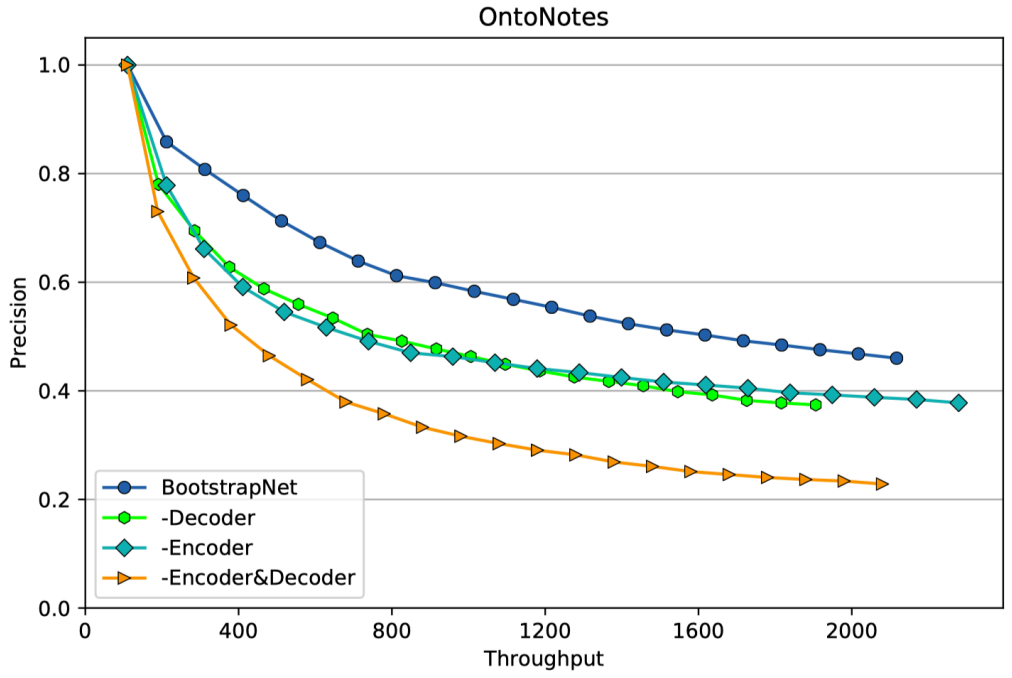




- BootstrapNet can significantly reduce the semantic drift problem in the bootstrapping technique.

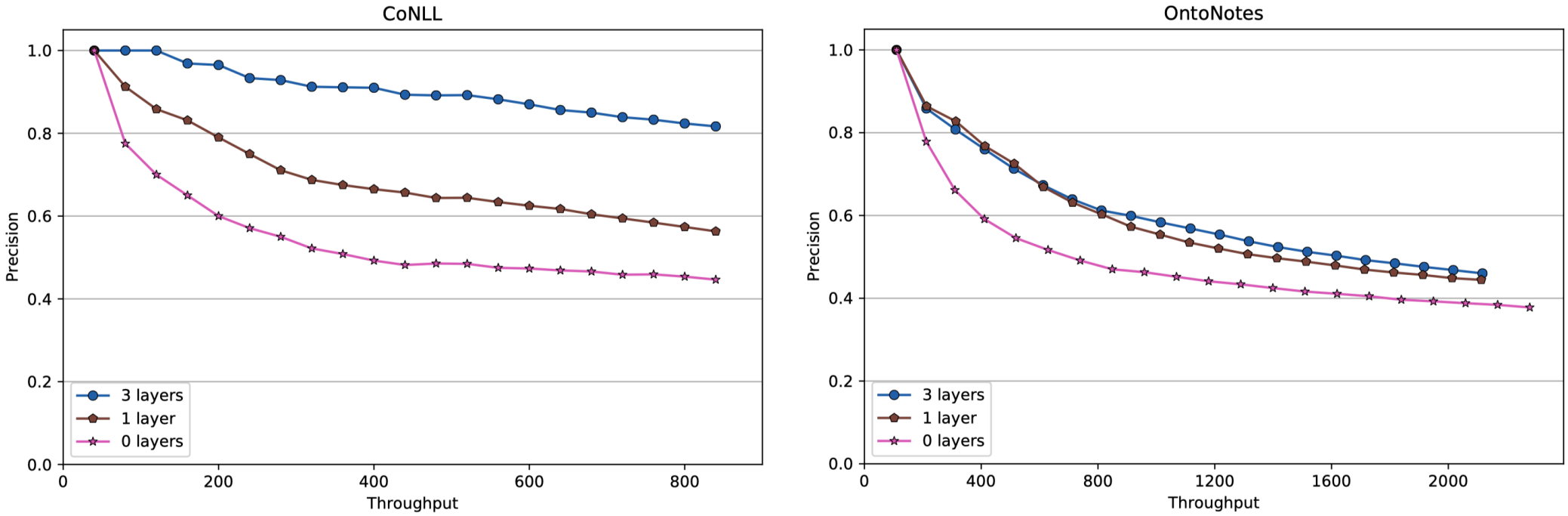
- Ablation study





- Capturing high-order information and modeling the sequential expanding process are both important in bootstrapping for ESE.

- Performance with different layer



- Bootstrapping methods can benefit from capturing first-order information and further capturing higher-order information.

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1. We propose the first end-to-end neural network for bootstrapping for entity set expansion.
2. This model can be further used in other IE tasks. For example, we use the <*head entity, tail entity*> pair as the instance and the *context* around it as the pattern, this model can be easily for relation extraction/expansion task.
3. We design a multi-view learning algorithm to efficiently using sparse supervision signals.

Thanks!
Any Question?