SPARQA: Skeleton-based Semantic Parsing for Complex Questions over Knowledge Bases

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Outline

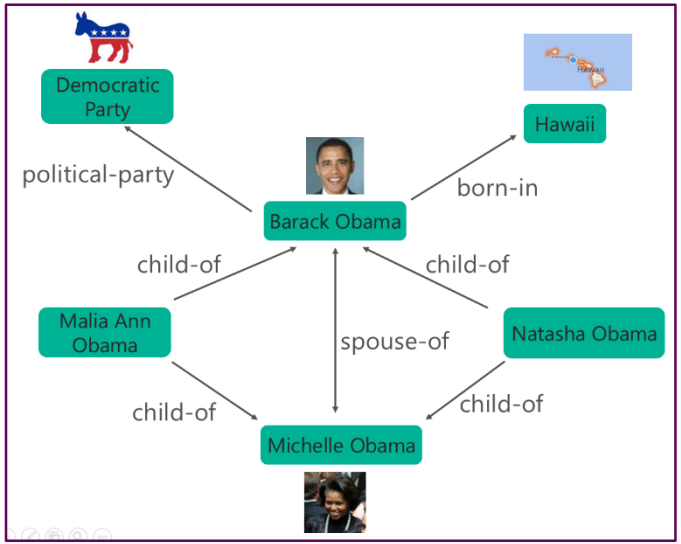
- Background
- Our approach
  - Overview
  - Skeleton Parsing
  - Multi-Strategy Scoring
- Experiment
- Conclusion

Question Answering over Knowledge Base (KBQA)

Question: Who is the wife of Barack Obama ?

Question Answering

Answer: Michelle Obama



Knowledge Base

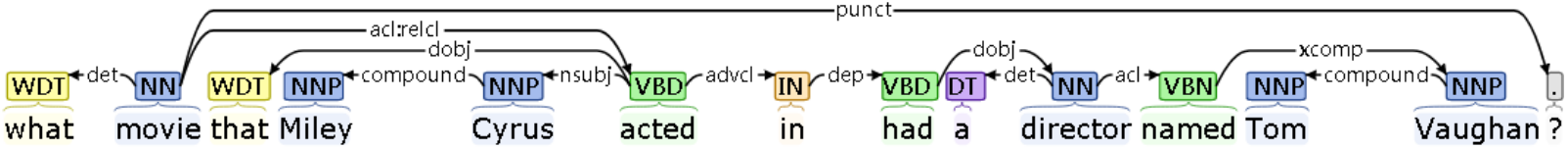
KBQA Classification

- Simple KBQA
  - Single Predicate
- Complex KBQA
  - **Multiple Predicates** or Aggregation

Example: What movie that Miley Cyrus acted in had a director named Tom Vaughan ?

Complex KBQA – Challenge 1

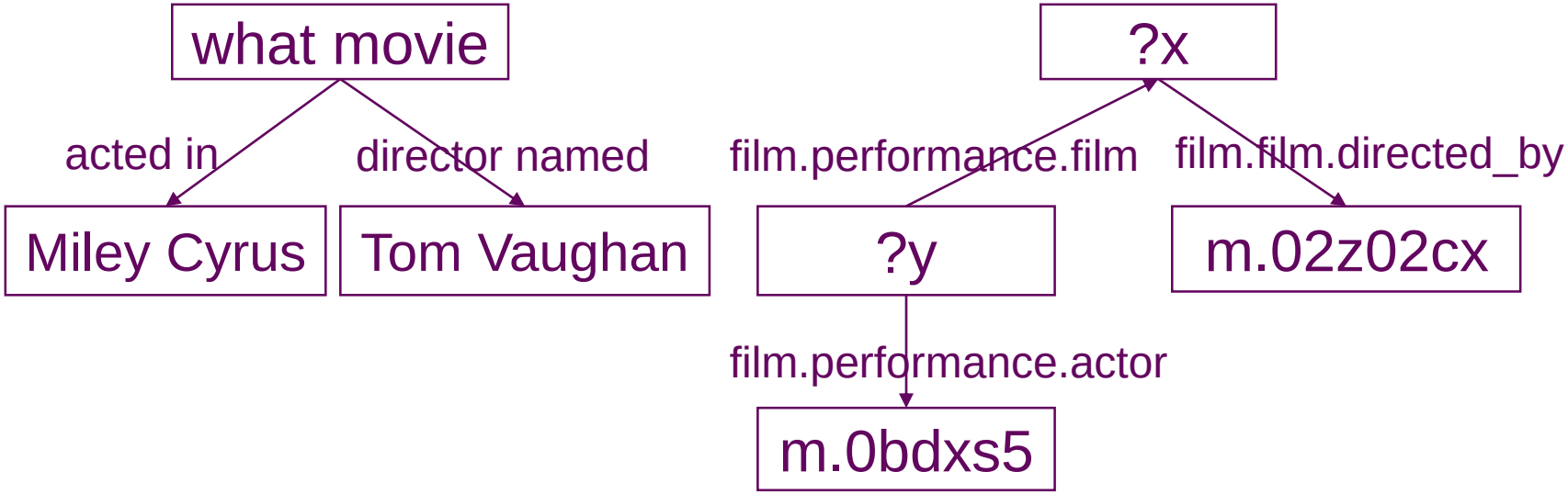
- Syntactic Parsing Error



Incorrect relation between “in” and “had”
Miss long-distance dependency relation between “movie” and “had”

Complex KBQA – Challenge 2

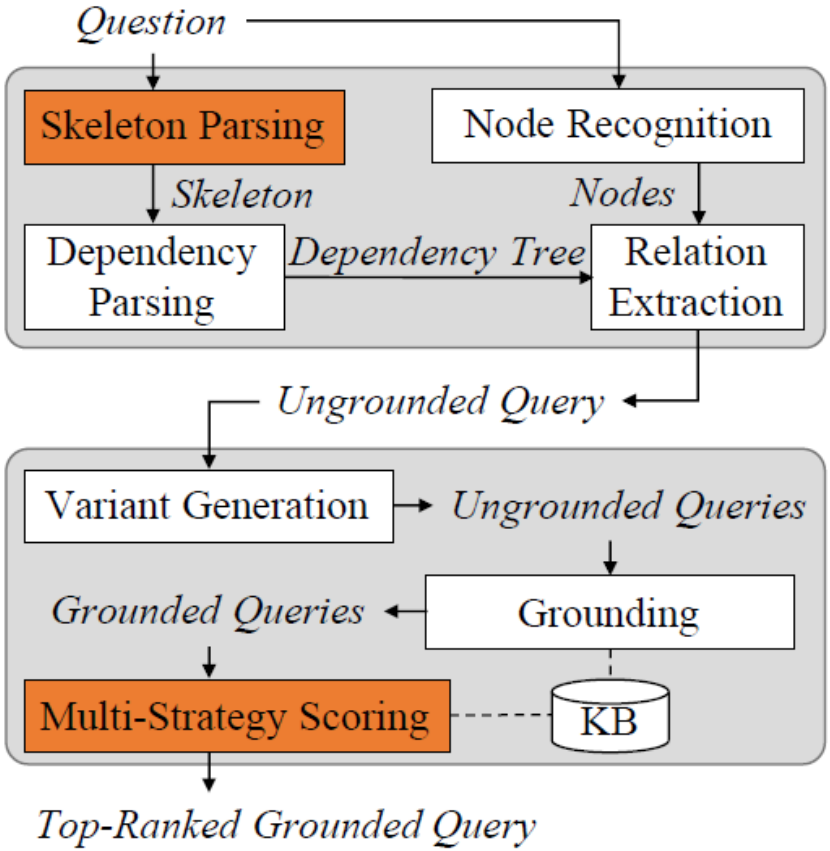
- Structural Heterogeneity



Our approach

Challenges	Our solutions
Syntactic Parsing Error	Skeleton Parsing
Structural Heterogeneity	Multi-Strategy Scoring

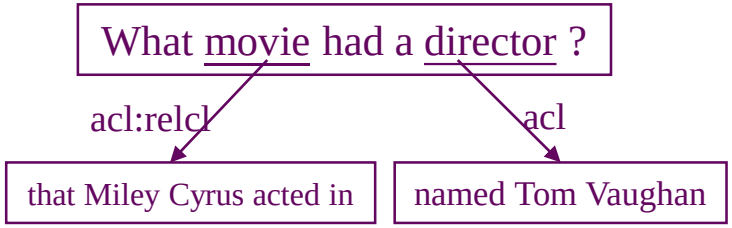
Overview


Question
Skeleton Parsing
Node Recognition
Skeleton
Nodes
Dependency Parsing
Dependency Tree
Relation Extraction
Ungrounded Query
Variant Generation
Ungrounded Queries
Grounded Queries
Grounding
Multi-Strategy Scoring
KB
Top-Ranked Grounded Query

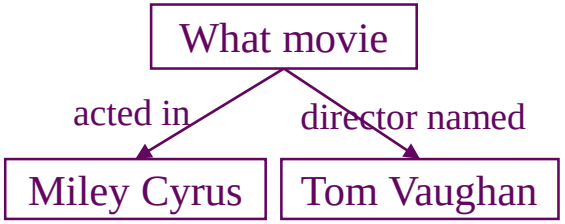
Example

What movie that Miley Cyrus acted in had a director named Tom Vaughan ?

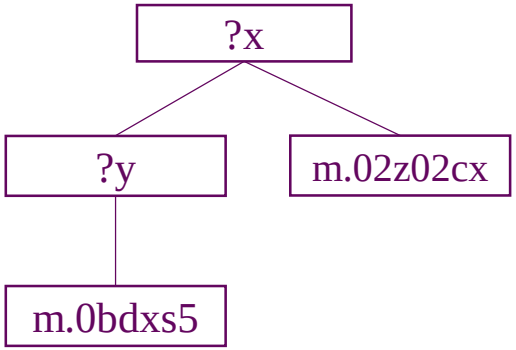
(1) Question



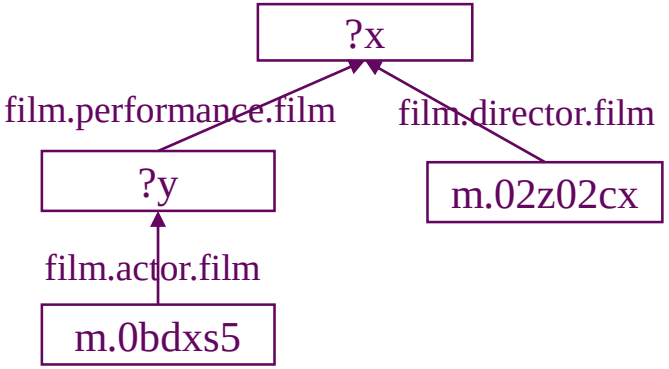
(2) Skeleton



(3) Ungrounded Query



(4) Variant



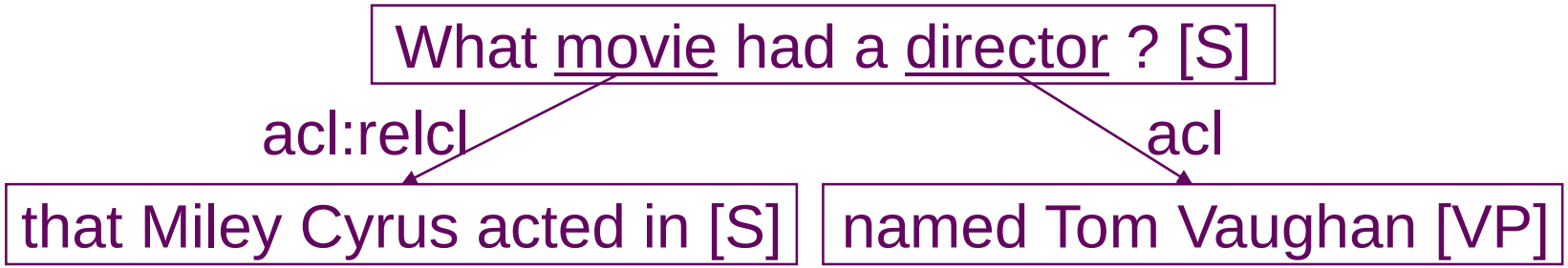
(5) Grounded Query

So Undercover

(6) Answer

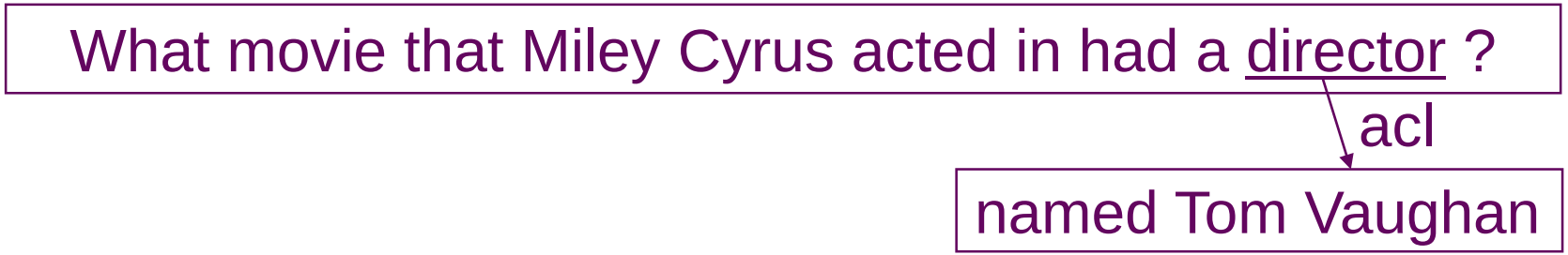
Skeleton Parsing

- Skeleton
  - Span: minimum semantic unit (S, NP, VP, PP)
  - Attachment relation: seven dependency relations (acl, acl:relcl, nmod, nmod:poss, conj, xcomp, advcl)

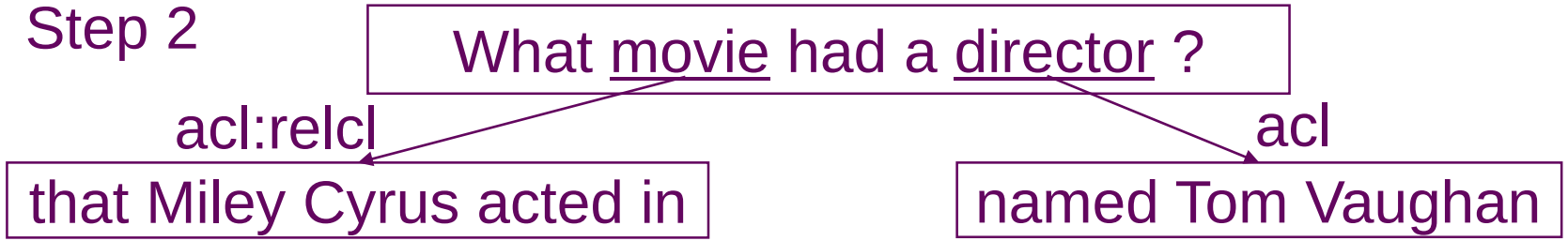


Parsing example – What movie that Miley Cyrus acted in had a director named Tom Vaughan ?

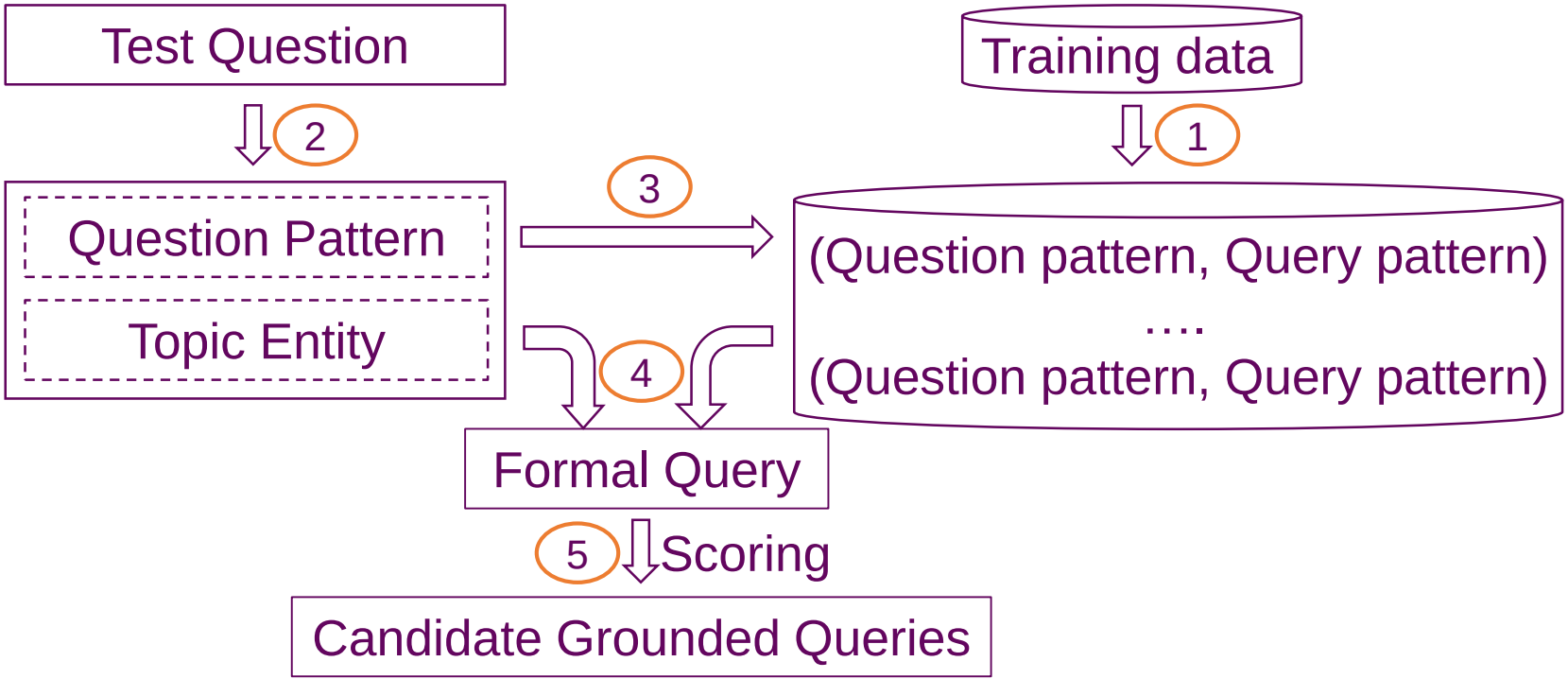
Step 1



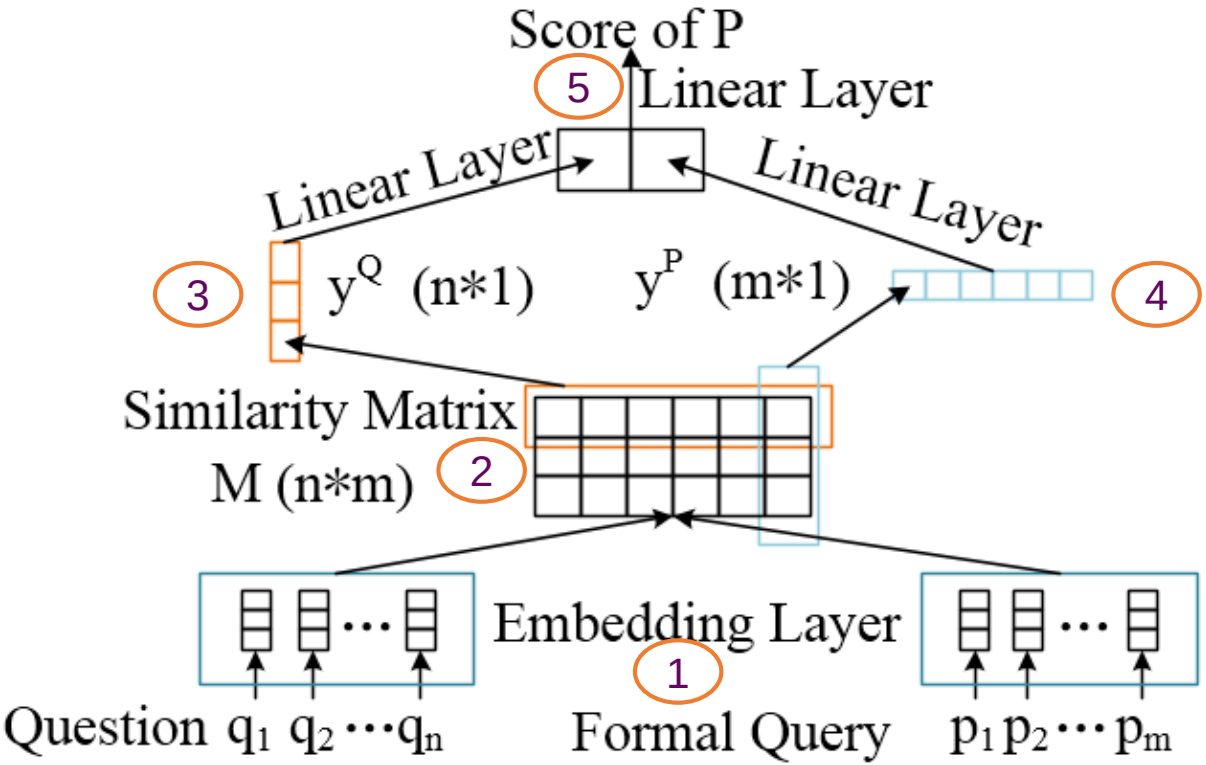
Step 2



Multi-Strategy Scoring – Sentence-level Scorer



Multi-Strategy Scoring – Word-level Scorer



Experiment – Dataset, Baseline and Metric

Dataset	GraphQuestions	ComplexWebQuestions
Baseline	SEMPRE PARASEMPRE JACANA UDEPLAMBDA SCANNER PARA4QA	MHQA-GRN SIMPQA + PRETRAINED SPLITQA + PRETRAINED SPLITQA + data augment... PullNet
Metric	F1	Precision@1(P@1)

Experiment – Result

- GraphQuestions

Method	F1
SEMPRE	10.80
PARASEMPRE	12.79
JACANA	5.08
UDEPLAMBDA	17.70
SCANNER	17.02
PARA4QA	20.40
SPARQA	**21.53**

Experiment – Result

- ComplexWebQuestions

Method	P@1
MHQA-GRN	30.10
SIMPQA + PRETRAINED	19.90
SPLITQA + PRETRAINED	25.90
SPLITQA + data augmentation	34.20
PullNet	**45.90**
SPARQA	31.48

Experiment – Ablation Study

- ComplexWebQuestions

Method	P@1
SPARQA	31.48
SPARQA w/o skeleton parsing	29.39
SPARQA w/o sentence-level scorer	26.45
SPARQA w/o word-level scorer	26.11

Experiment – Simple KBQA

- 1,172 simple questions

Method	F1
PARA4QA	27.42
SPARQA	27.68

Experiment – Skeleton Evaluation

- 1,000 complex questions

Overall Skeleton	93.73(LAS)
Split	99.42(ACC)
TextSpanPrediction	97.17(ACC)
HeadwordIdentification	97.22(ACC)
AttachmentRelationClassification	99.14(ACC)

Experiment – Error Analysis

- Node Recognition and Linking
  - Who have a concert tour named Rihanna: Live in Concert Tour ?
- Skeleton Parsing
  - What country speaks Germanic languages with a capital called Brussels ?
- Structural Heterogeneity
  - Who is the prime minister of the country that has national anthem March Forward, Dear Mother Ethiopia ?
- Candidate Queries Scoring

Conclusion

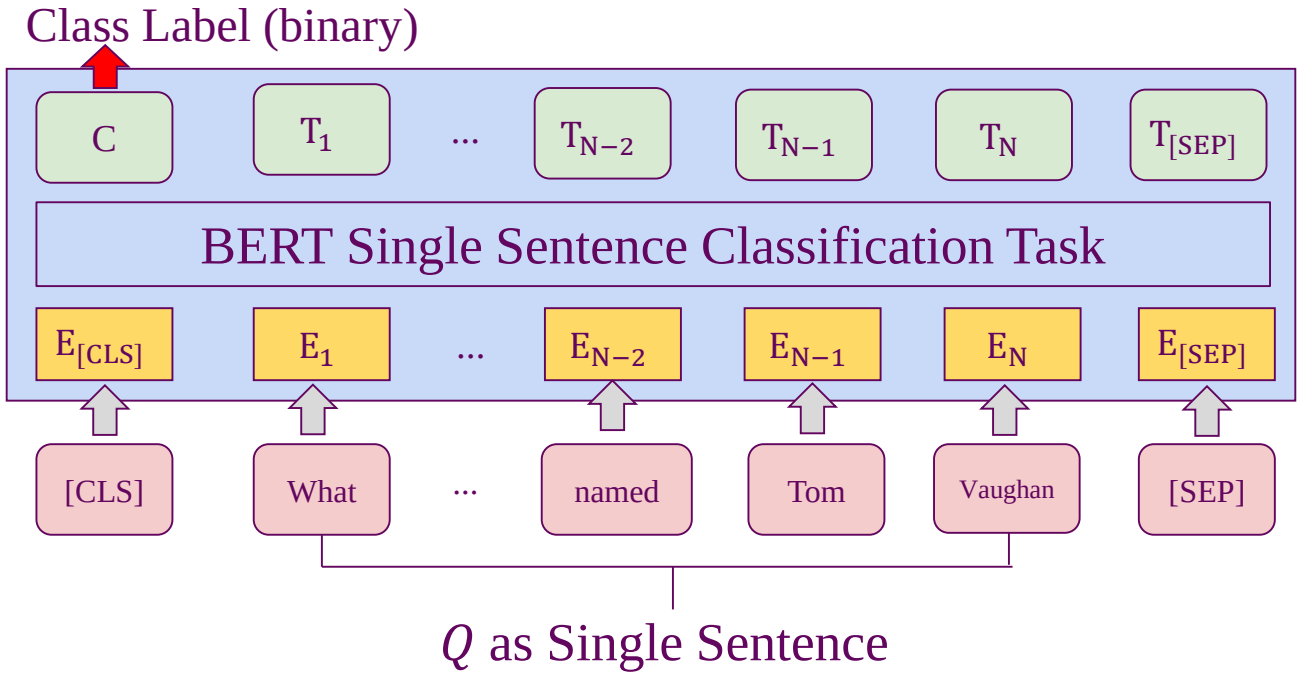
- SPARQA
  - Skeleton Parsing
  - Multi-Strategy Scoring
- Future Work
  - Node Recognition and Linking
  - Structural Heterogeneity
  - Aggregation Question

Appendix – Skeleton Parsing

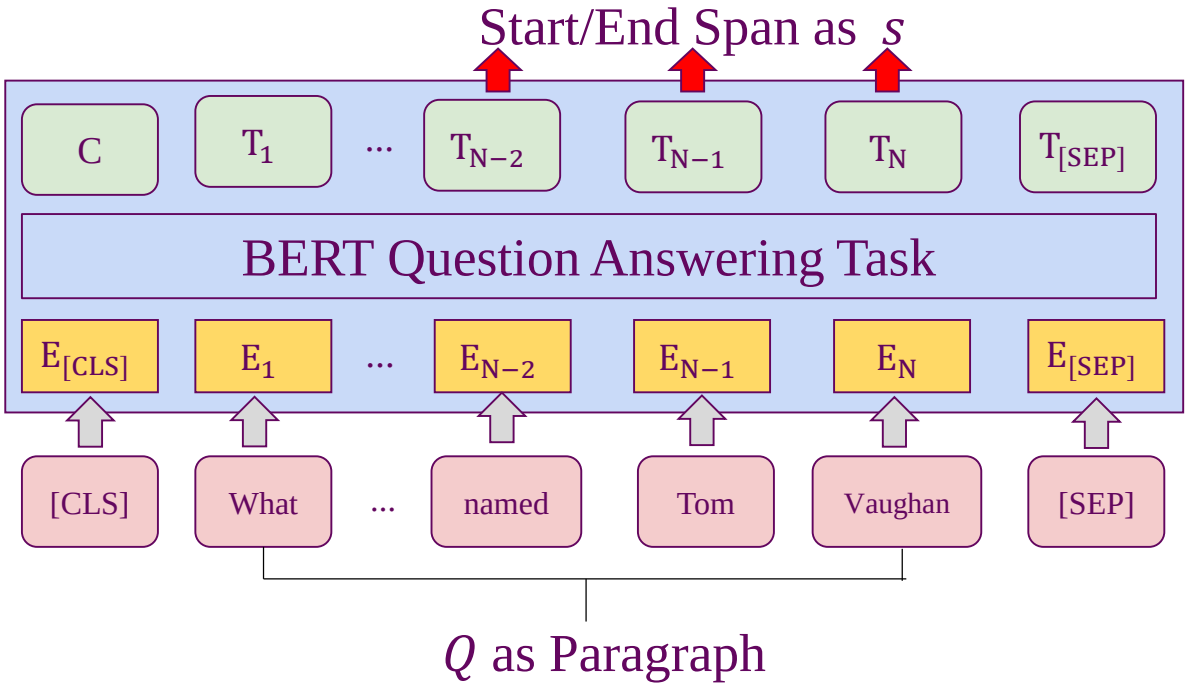
Algorithm 1 Skeleton Parsing

Require: A sentence Q
Ensure: The skeleton of Q
  $T \leftarrow$ tree with a root node Q
  while Split(Q) is true **do**
    $s \leftarrow$ TextSpanPrediction(Q)
    $h \leftarrow$ HeadwordIdentification(s, Q)
    $r \leftarrow$ AttachmentRelationClassification(s, Q)
    Remove s from Q
    Grow T with relation r from $h \in Q$ to s
  end while
  return T

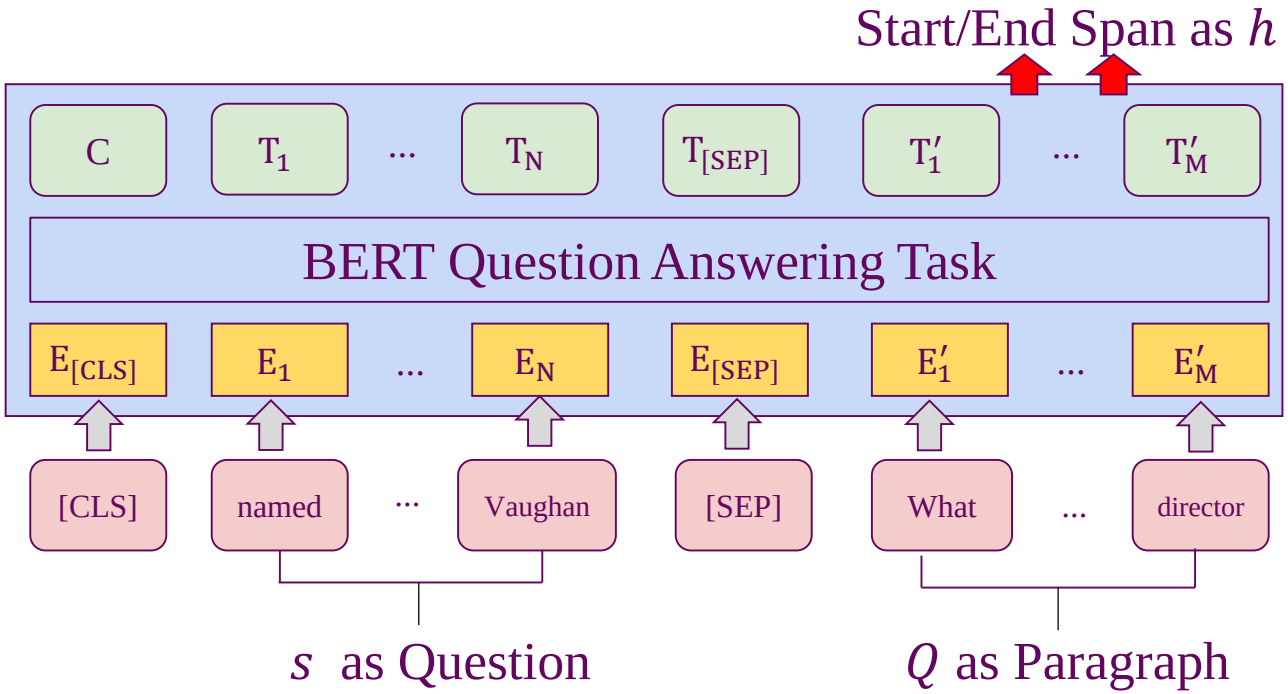
Appendix – Split



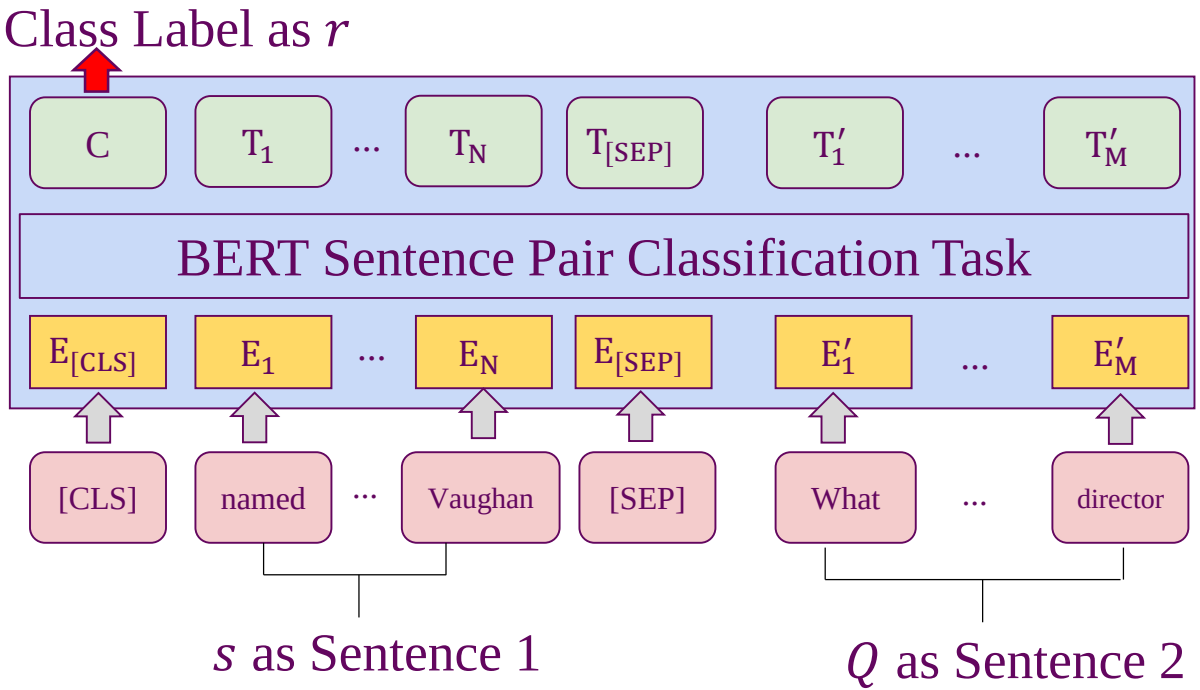
Appendix – TextSpanPrediction



Appendix – HeadwordIdentification



Appendix – AttachmentRelationClassification



Thanks for your listening

- Skeleton

https://github.com/nju-websoft/SPARQA

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