

# Automated Template Generation for Question Answering over Knowledge Graphs

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# Question Answering over KG

*“Where did John Steinbeck go to college?”*

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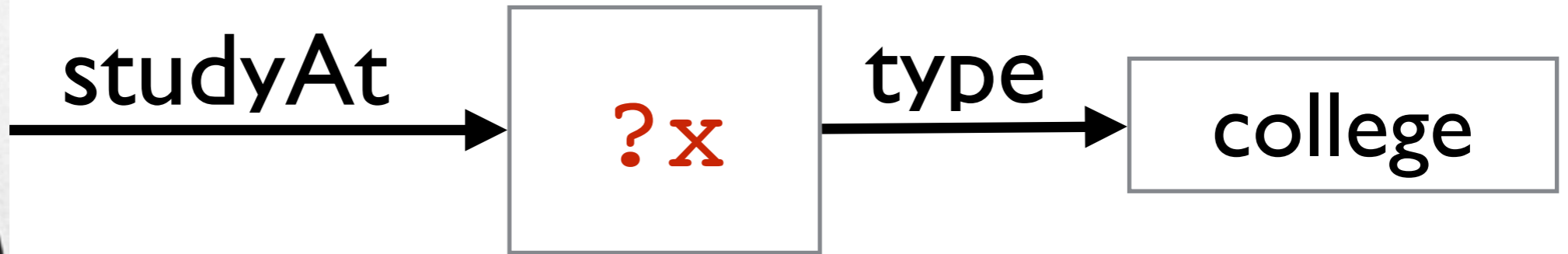


studyAt

?x

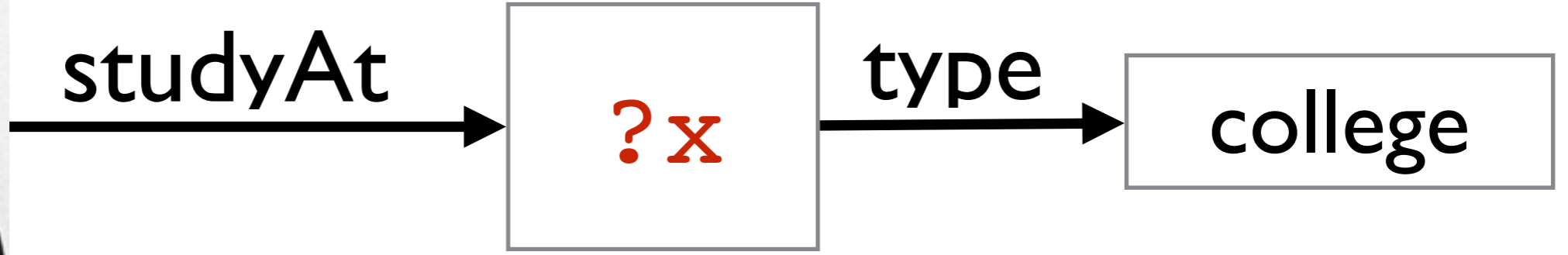
type

college



# Question Answering over KG

*“Where did John Steinbeck go to college?”*



# Current Approaches

- Hand-crafted templates [Unger et al. (WWW'12), Yahya et al. (EMNLP'12), Fader et al. (KDD'14), Yao and Durme, (ACL'14), Bast and Hausmann, (CIKM'15)]

Templates by Fader et al. (2014)

Question Template	Query Template	Example
Who VP <sub>PRED</sub> NP <sub>ENT</sub>	(?x, PRED, ENT)	<i>“Who founded Google?”</i>

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## 1. Human Expertise

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1. Human Expertise

2. Coverage

# Current Approaches

- No/Naive answer typing
  - “Who” —> **person**
  - “Where” —> **location**



# QUINT

- Generates role-aligned question-query templates *automatically*

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- Handles **compositional** questions  
*“Who has played for Manchester United and Real Madrid?”*

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- Handles **compositional** questions  
*“Who has played for Manchester United and Real Madrid?”*
- Improved **answer typing**

# Outline

- Template Generation
- Question Answering with Templates
- Experiments
- Conclusion

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# From Question-Answer to Query

*“Where did John Steinbeck go to college?”*



question

Stanford University



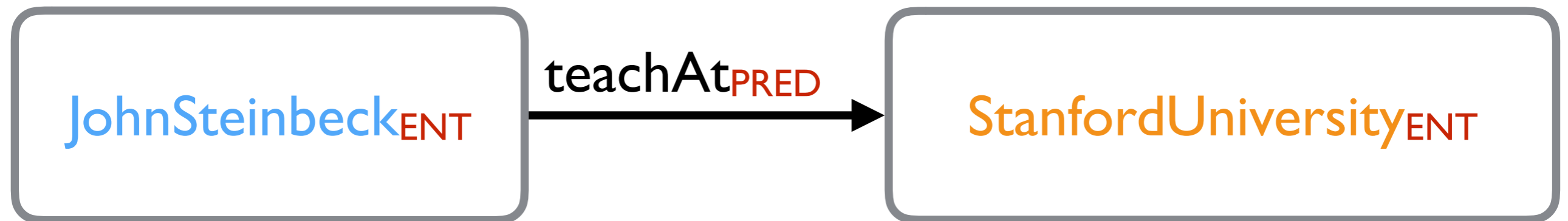
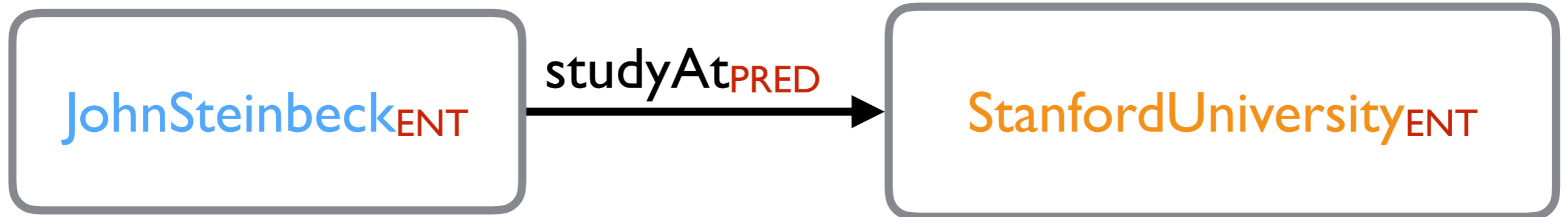
answer

# From Question-Answer to Query

*“Where did John Steinbeck go to college?”*

Stanford University

# From Question-Answer to Query



⋮

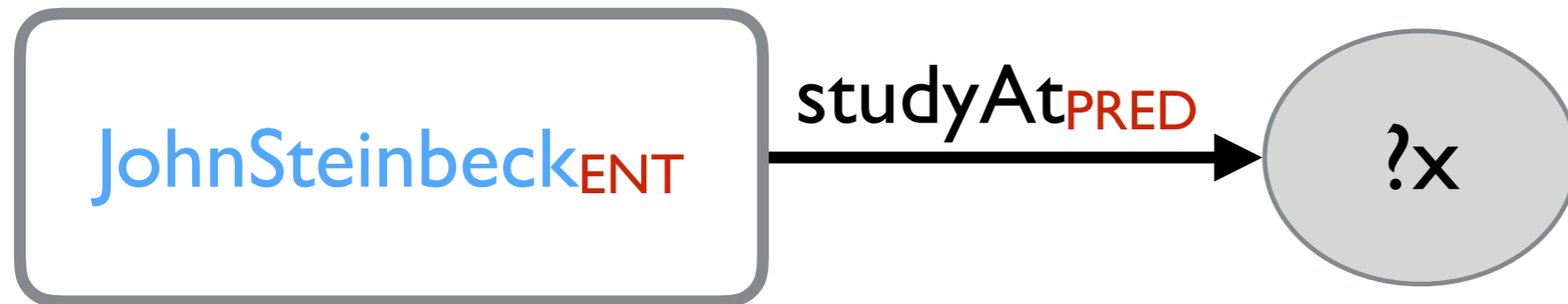


# From Question-Answer to Query

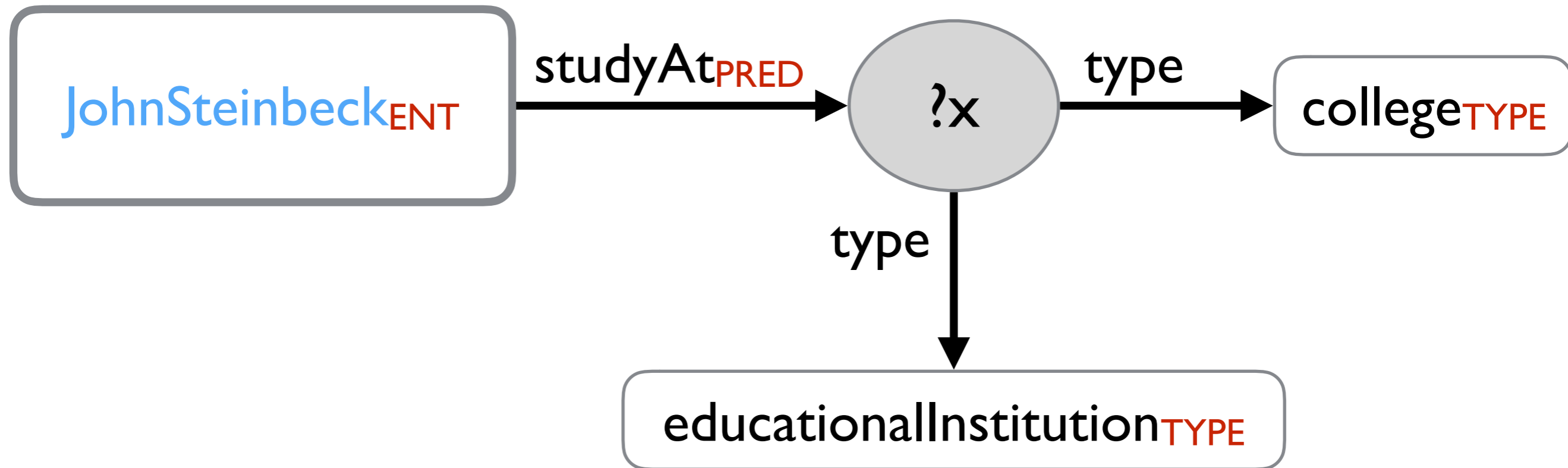


⋮

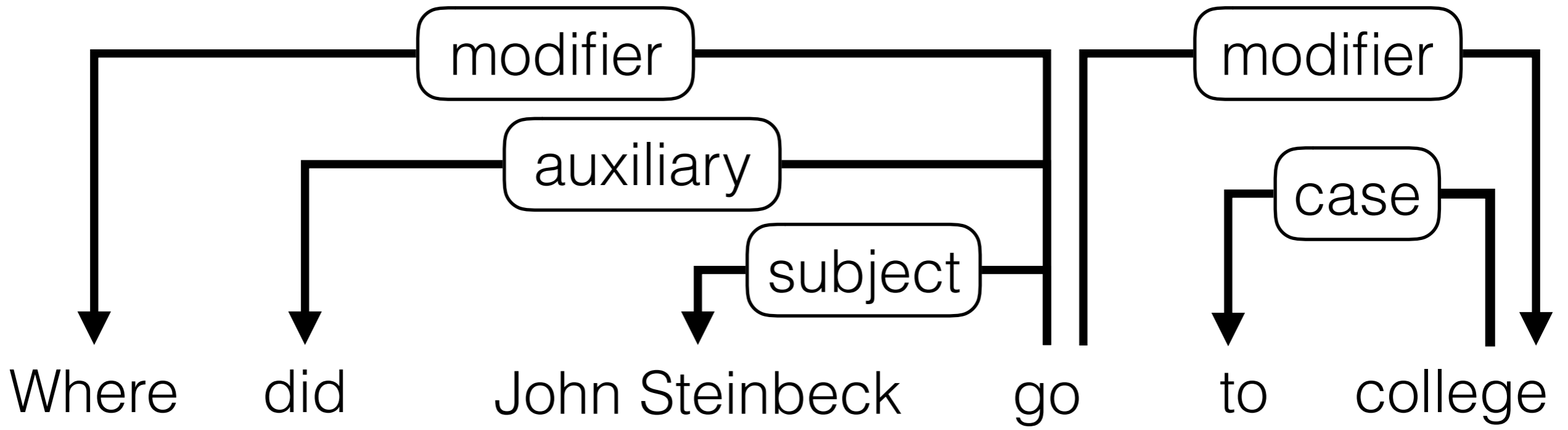
# From Question-Answer to Query

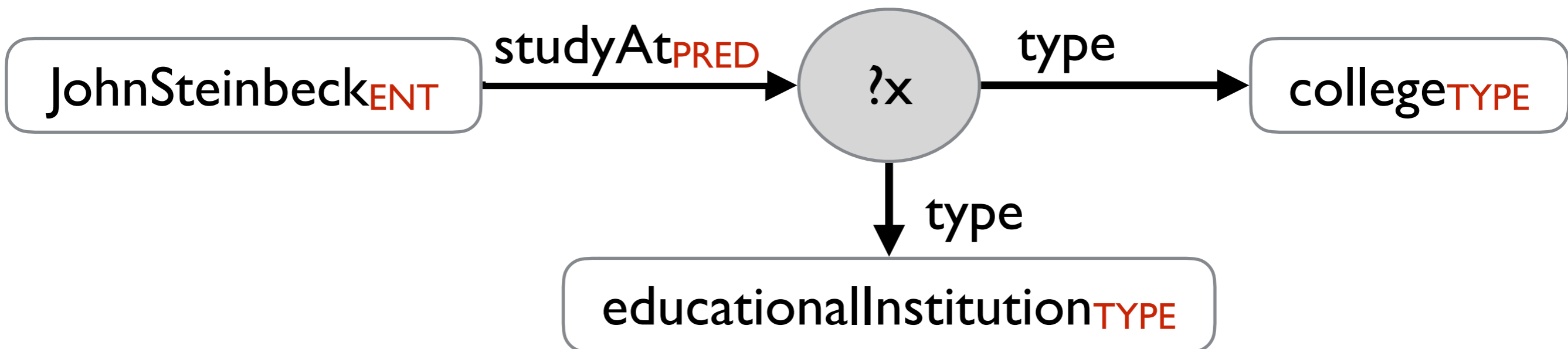
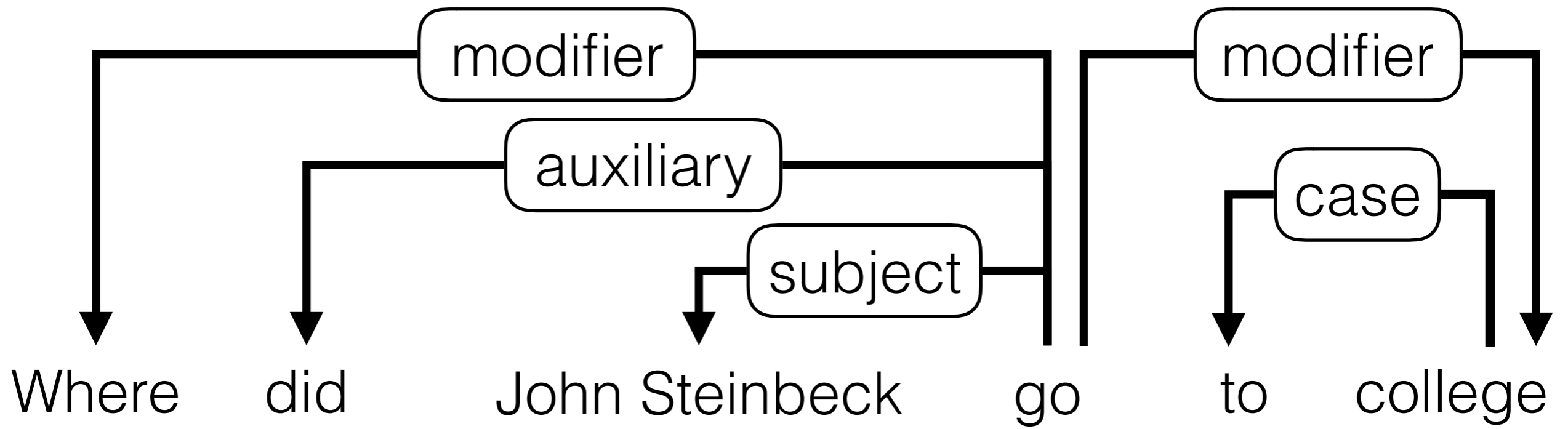


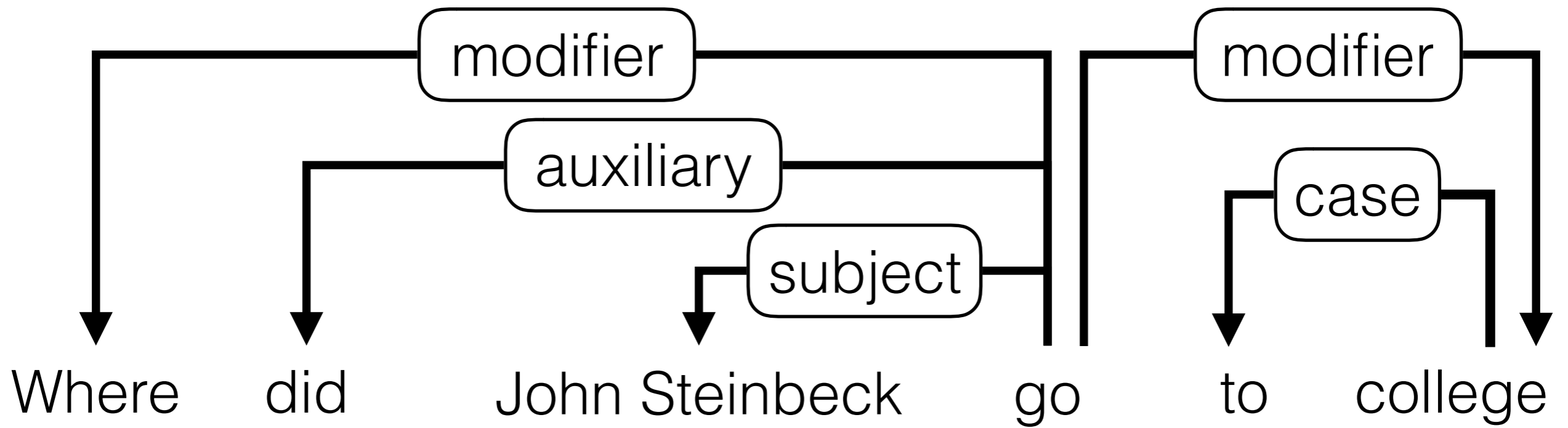
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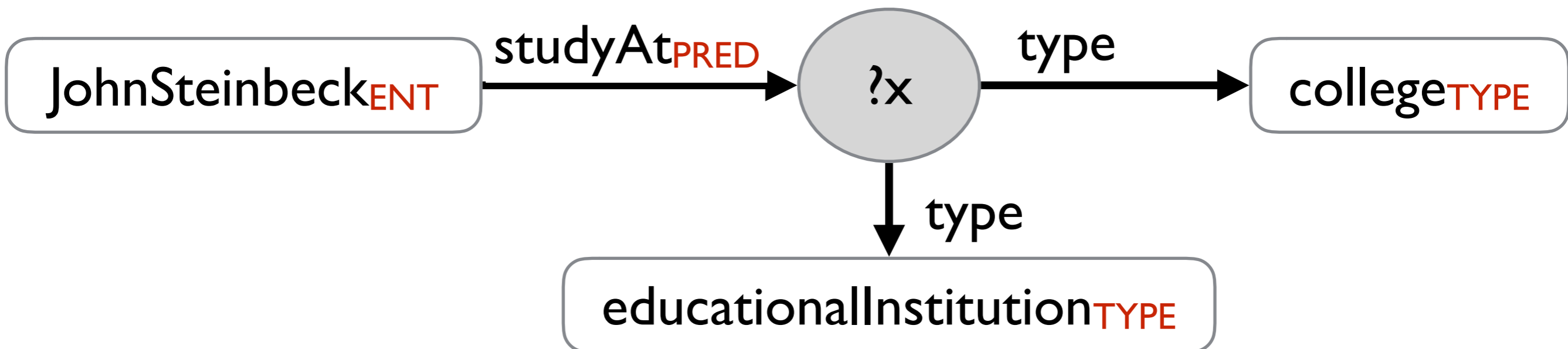
# Question-Query Alignment



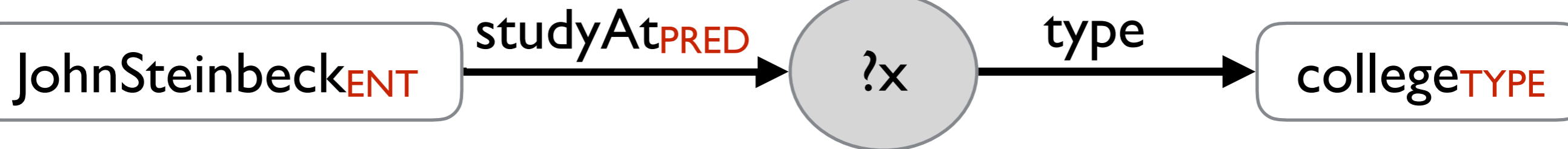
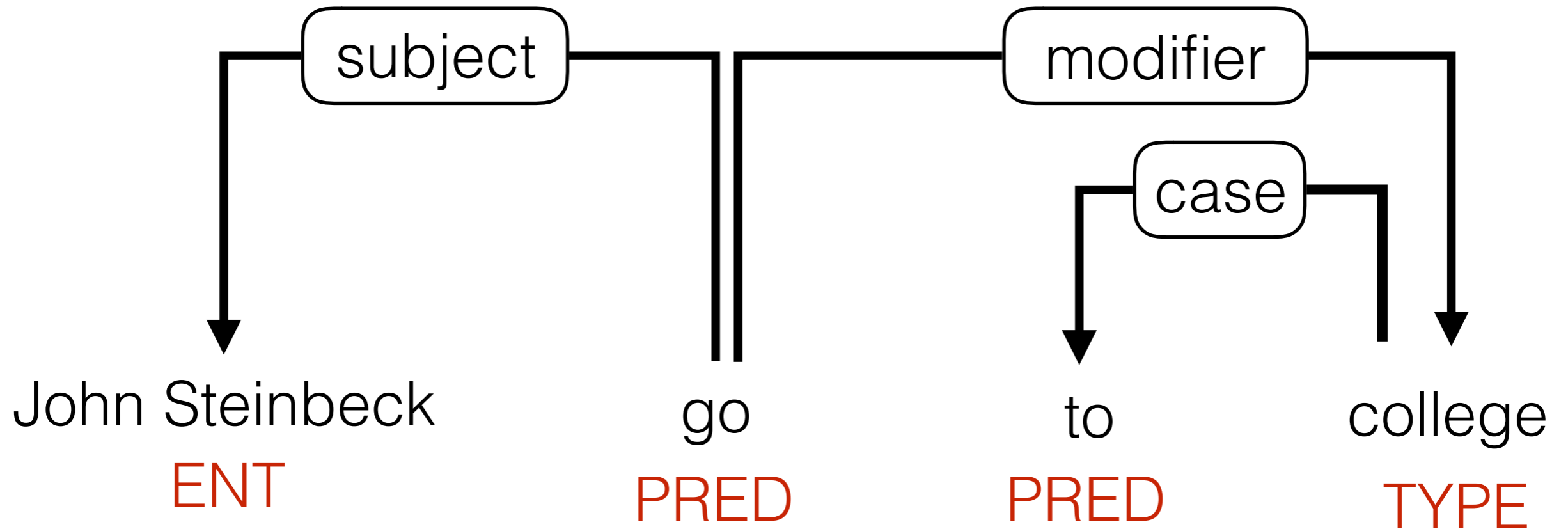




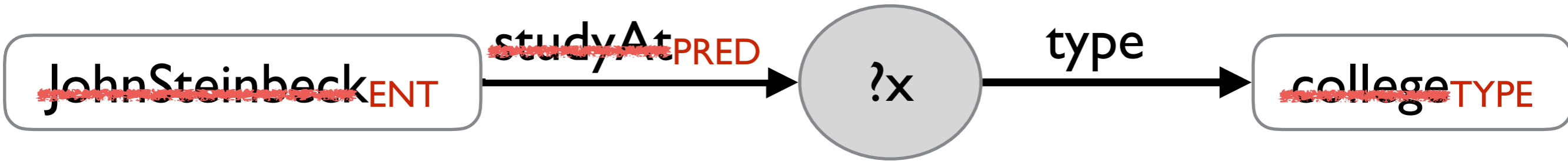
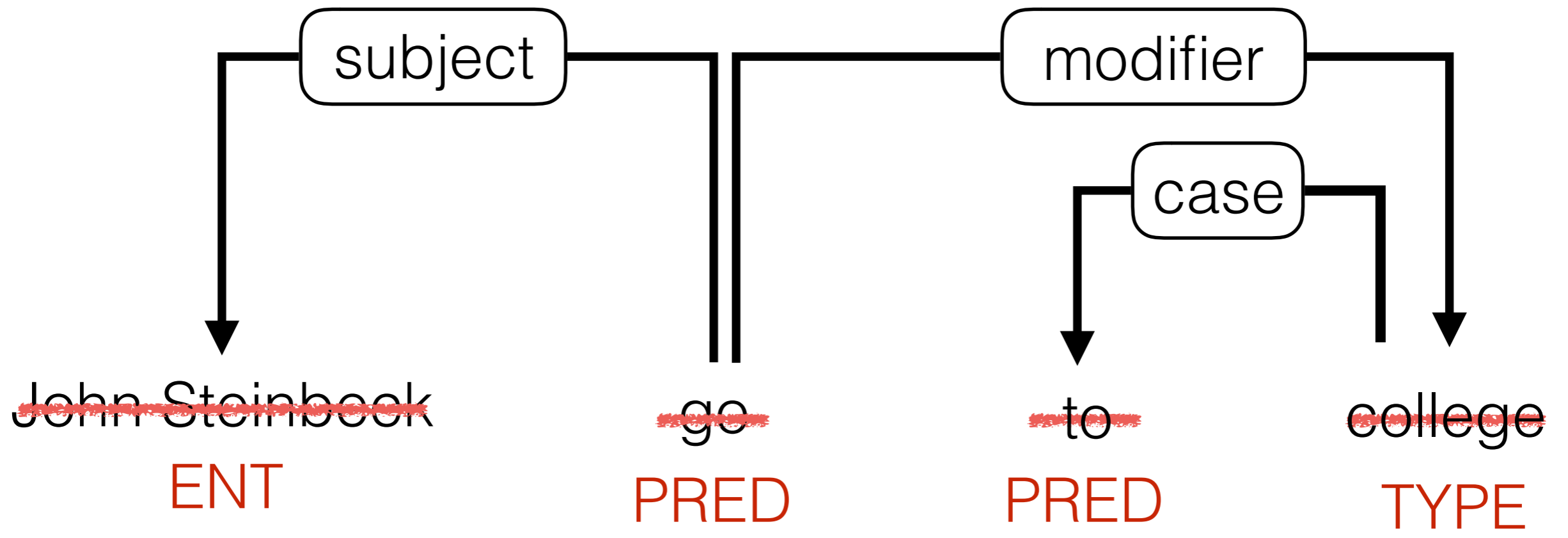
## Integer Linear Programming



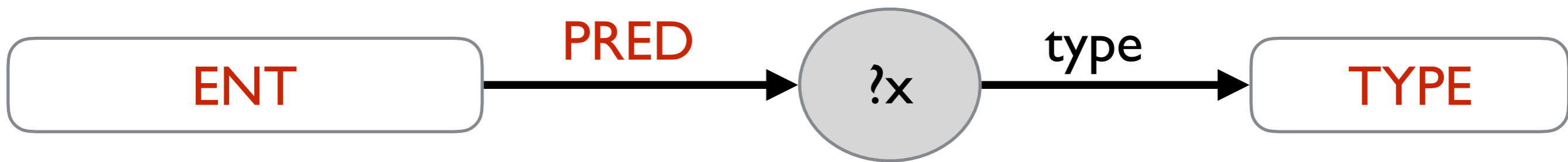
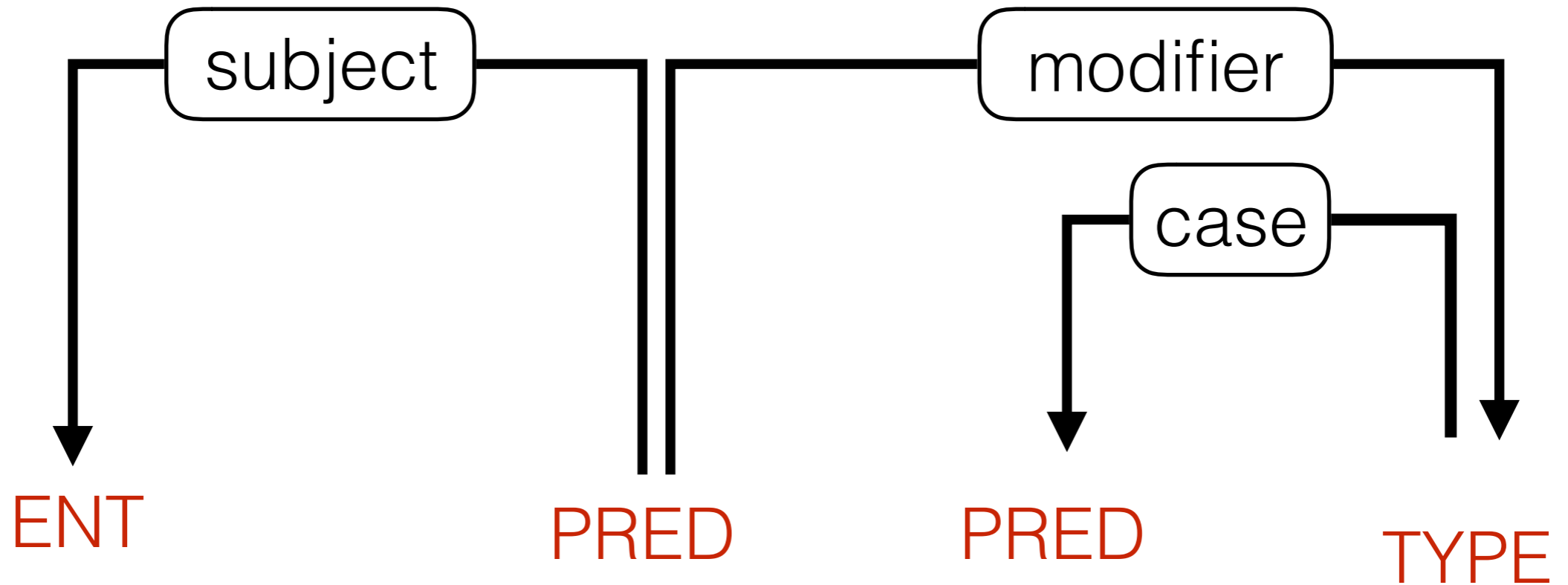
# Aligned Question-Query Pair







# Aligned Question-Query Template



# Outline

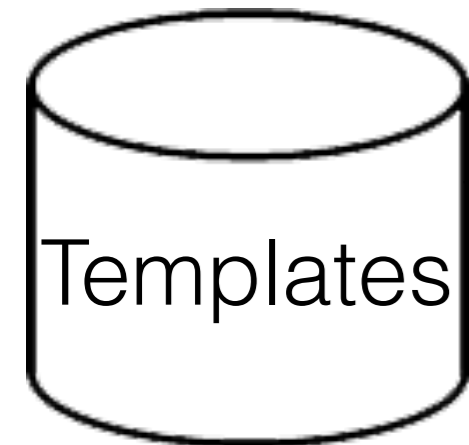
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# Answering with Templates

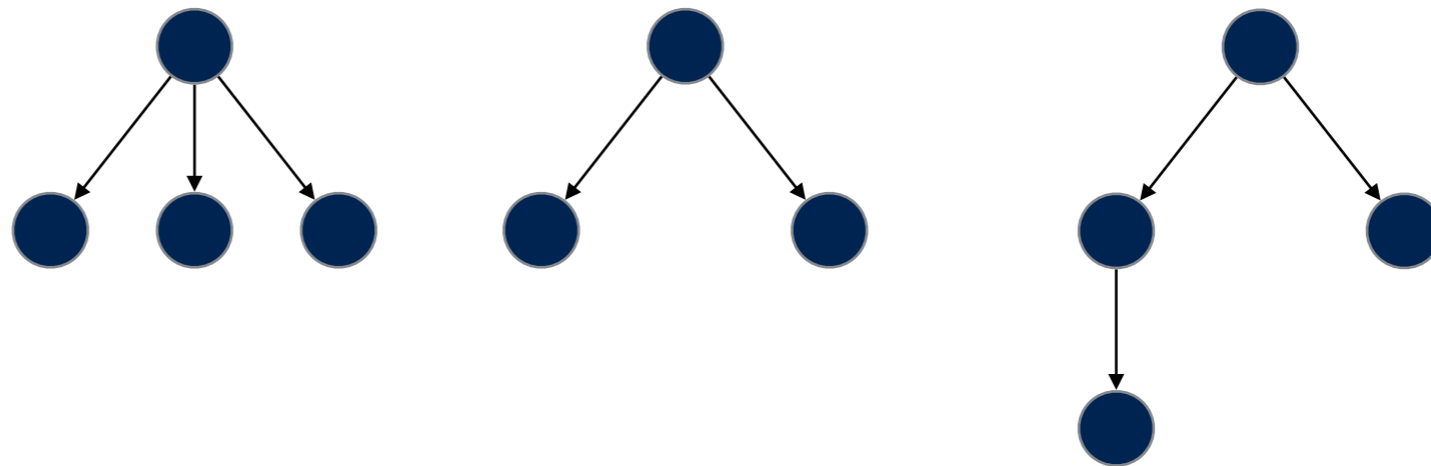
*“Where did Aaron Rodgers go to high school?”*

# Answering with Templates

*“Where did Aaron Rodgers go to high school?”*

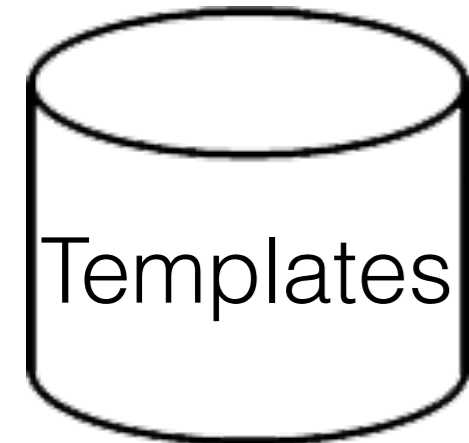


Identify matching question templates



# Answering with Templates

*“Where did Aaron Rodgers go to high school?”*



Identify matching question templates

Instantiate corresponding query templates

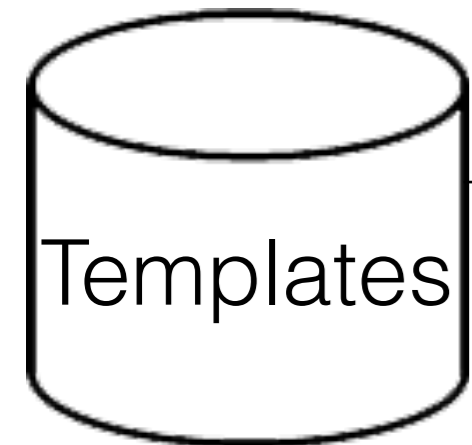
**AR studyAt ?x**  
**?x type highSchool**

**AR playFor ?x**

**AR bornIn ?x**

# Answering with Templates

*“Where did Aaron Rodgers go to high school?”*



Identify matching question templates

Instantiate corresponding query templates

Rank query candidates

**AaronRodgers studyAt ?x  
?x type highSchool**



# Answering Compositional Questions

- Coordinating conjunction
  - *“Who acted in the Green Mile and Forrest Gump?”*
- Relative clauses
  - *“actors starring in The Departed who were born in Cambridge”*
- A set of rules to decompose a question into sub-questions
  - *“Who acted in the Green Mile?” and “Who acted in Forrest Gump?”*



# Sub-question Answering

*“Who acted in the Green Mile?”*

?x actedIn TheGreenMile	Tom Hanks, David Morse, ..	1
TheGreenMile directedBy ?x	Frank Darabont	2

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*“Who acted in Forrest Gump?”*

?x actedIn ForrestGump	Tom Hanks, Sally Field, ..	1
ForrestGump directedBy ?x	Robert Zemeckis	2

# Stitching

*“Who acted in the Green Mile?”*

?x actedIn TheGreenMile	Tom Hanks, David Morse, ..	1
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*“Who acted in Forrest Gump?”*

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- WebQuestions
  - 3775 question/answer training pairs
  - 2032 testing questions

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  - 3775 question/answer training pairs
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- ComplexQuestions
  - 150 questions
    - “Who has played for Manchester United and Real Madrid?”*

# Results on WebQuestions

<b>System</b>	<b>WebQuestions Avg. F1</b>
<b>QUINT-untyped</b>	50.8
<b>QUINT-typed</b>	51



# Results on WebQuestions

<b>System</b>	<b>WebQuestions Avg. F1</b>
AQQU (CIKM 2015)	49.4
STAGG (ACL 2015)	<b>52.5</b>
Reddy et al. (ACL 2016)	50.3
<b>QUINT-untyped</b>	50.8
<b>QUINT-typed</b>	51

# Anecdotal Results

## Question

*“Where did Aaron Rodgers go to high school?”*

## QUINT (typed)

Pleasant Valley High School



## QUINT (untyped)

Butte College,  
UC Berkeley,  
Pleasant Valley High School



# Results on ComplexQuestions

<b>System</b>	<b>Avg. F1</b>
AQQU-basic (CIKM 2015)	27.8
AQQU++ (CIKM 2015)	46.7
<b>QUINT</b>	<b>49.2</b>

# Anecdotal Results

## Question

*“Who has played for Manchester United and Real Madrid?”*

## QUINT

Michael Owen, Gabriel Heinze, David Beckham,  
Cristiano Ronaldo



## AQQU-basic

Bob Donaldson, Fred Erentz, Joe Cassidy,  
James McNaught, Dick Smith, Walter  
Cartwright, Harry Stafford



# Conclusion

- QUINT **automatically** learns role-aligned question-query templates
- QUINT handles **compositional questions**
- QUINT supports answer typing

Thanks!