



# Natural Language Processing

## Ikernels Question Answering pipeline

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# Outline

- I. High-level QA domain overview
- II. Ikernels Advanced Answer Passage reranking pipeline
- III. (Lab) RelTextRank in action

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- I. **High-level QA domain overview**
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# Question Answering Task

- Overall objective: answering questions in natural language

# Question Answering Task

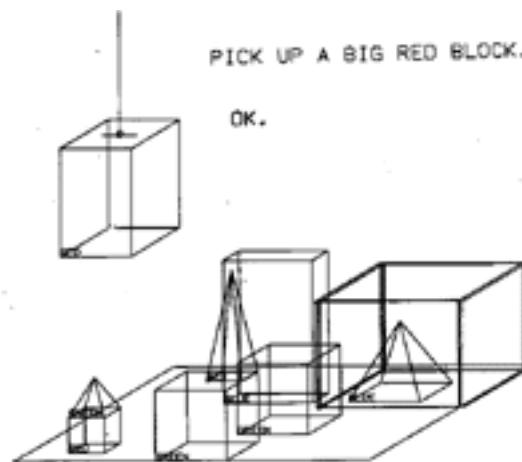
- Overall objective: answering questions in natural language
- A very broad domain of research:
  - **Closed-domain vs Open-Domain**
    - ❖ questions about a specific domain, e.g. medicine/automobile parts
    - ❖ no restrictions, world knowledge (**Q:** *What sports stadium has been billed as “the eighth wonder of the world”?* **A:** *Astrodome*)
  - **Factoid vs subjective**
    - ❖ “*Who is the prime minister of Italy?*” vs “*Where should we go for dinner in Trento?*”

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- The first automated approaches to QA originated in 1970s

# First QA systems

- **1971: LUNAR**, analysis of moon rocks by Apollo
- **1968-1970: SHRDLU**, T. Winograd, MIT
  - robot operating in a toy “blocks” (e.g cubes) world could answer the question about its state
  - ~50 words to describe objects/locations
  - rule-based system



**Person:** WHAT DOES THE BOX CONTAIN?

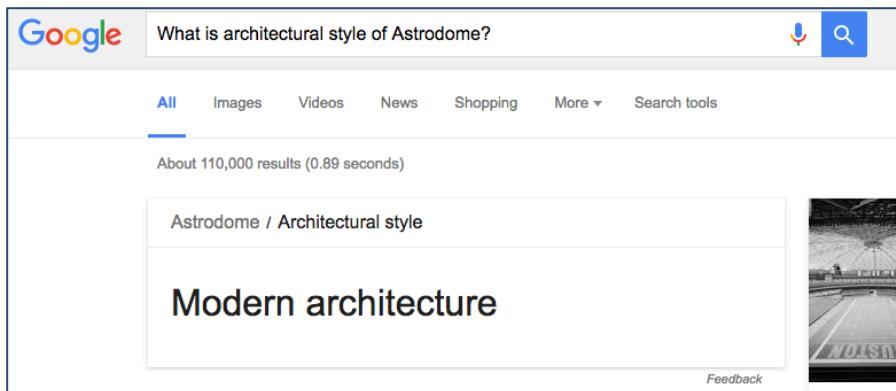
**Computer:** THE BLUE PYRAMID AND THE BLUE BLOCK.

**Person:** WHAT IS THE PYRAMID SUPPORTED BY?

**Computer:** THE BOX.

# Modern QA systems

- Personal assistants: **Siri (Apple), Cortana (Microsoft)**
- **Google search**



- **2011 Jeopardy challenge by IBM**
  - **Watson** beat humans at answering complex questions

**Category:** General Science

**Clue:** When hit by electrons, a phosphor gives off electromagnetic energy in this form.

**Answer: Light (or Photons)**

# Partial list of QA research directions

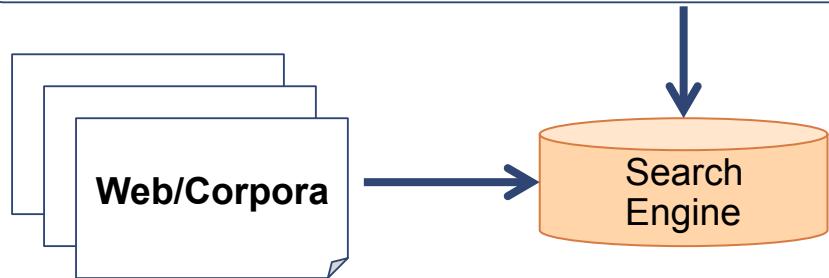
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- QA on knowledge bases
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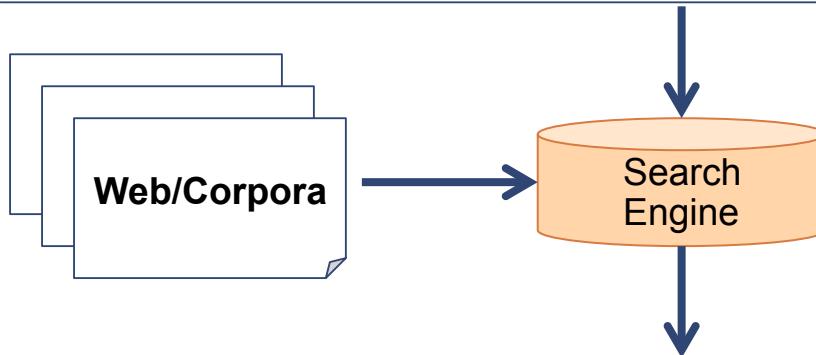
# IR-based QA

What sports stadium has been billed as “the eighth wonder of the world”?



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What sports stadium has been billed as “the eighth wonder of the world”?



1. It once was the Taj Mahal of **sports**. When the **stadium** opened in 1965 it was **billed as the Eighth Wonder of the World**.

X

2. The man behind the project, Judge Roy Hofheinz, modestly suggested the **stadium** be dubbed **the Eighth Wonder of the World**.

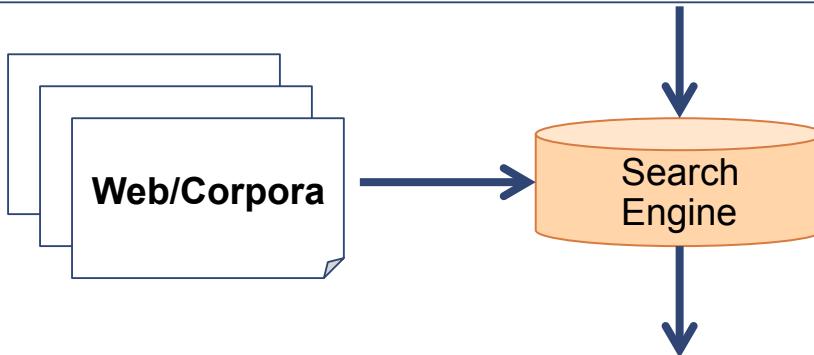
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16. The Titans ... played in the dilapidated **Astrodome**; if this was **the eighth wonder of the world**, we live on a shabby little planet indeed.

✓

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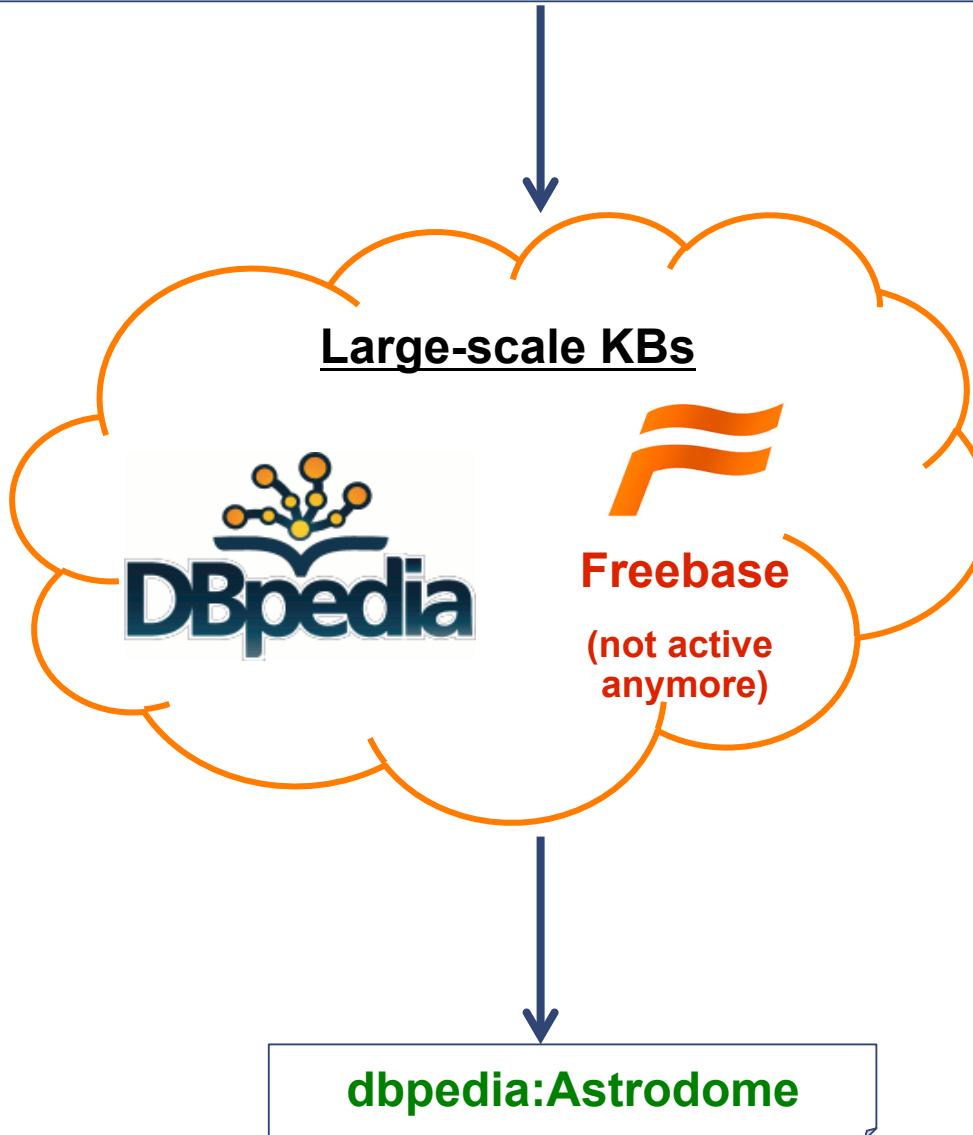
Task of reranking answer passages/sentences is also called **Answer Sentence Selection**

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# QA on Knowledge Bases (KB)

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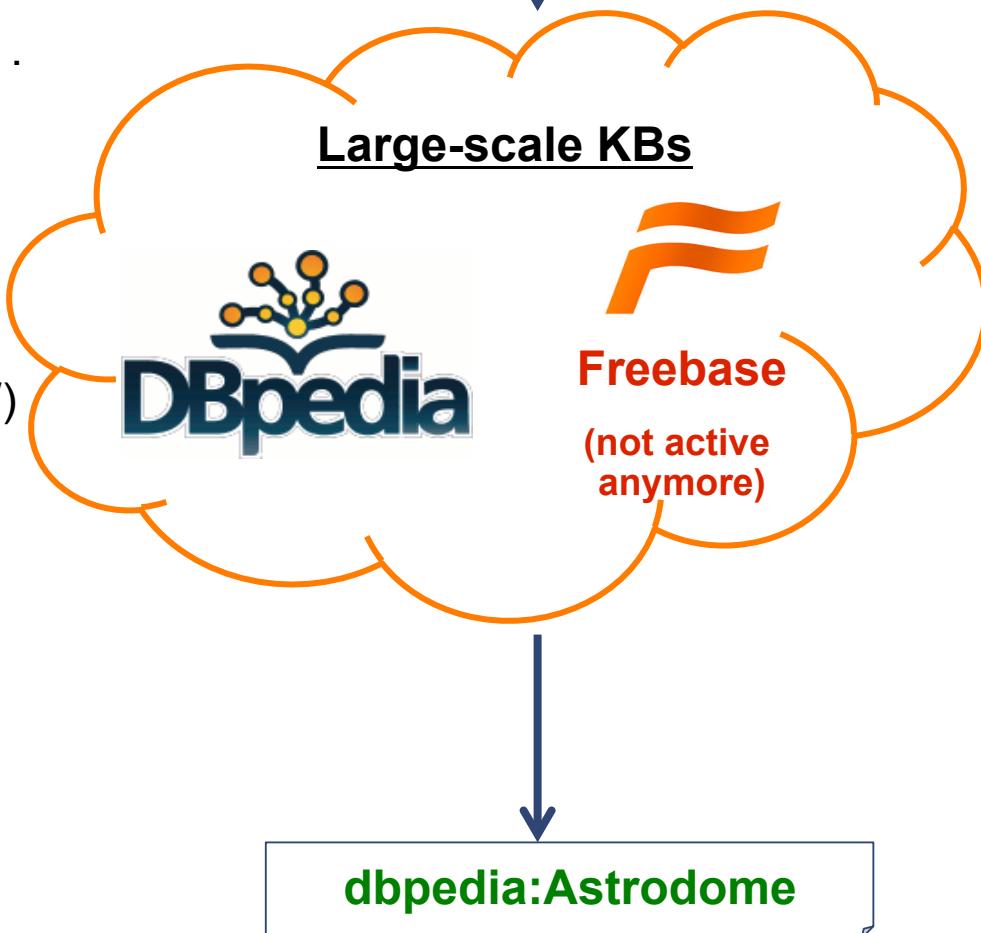
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What sports stadium has been billed as “the eighth wonder of the world”?

Convert the question to a query...

```
SELECT ?s WHERE
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(See QALD challenge  
<http://qald.sebastianwalter.org/>)



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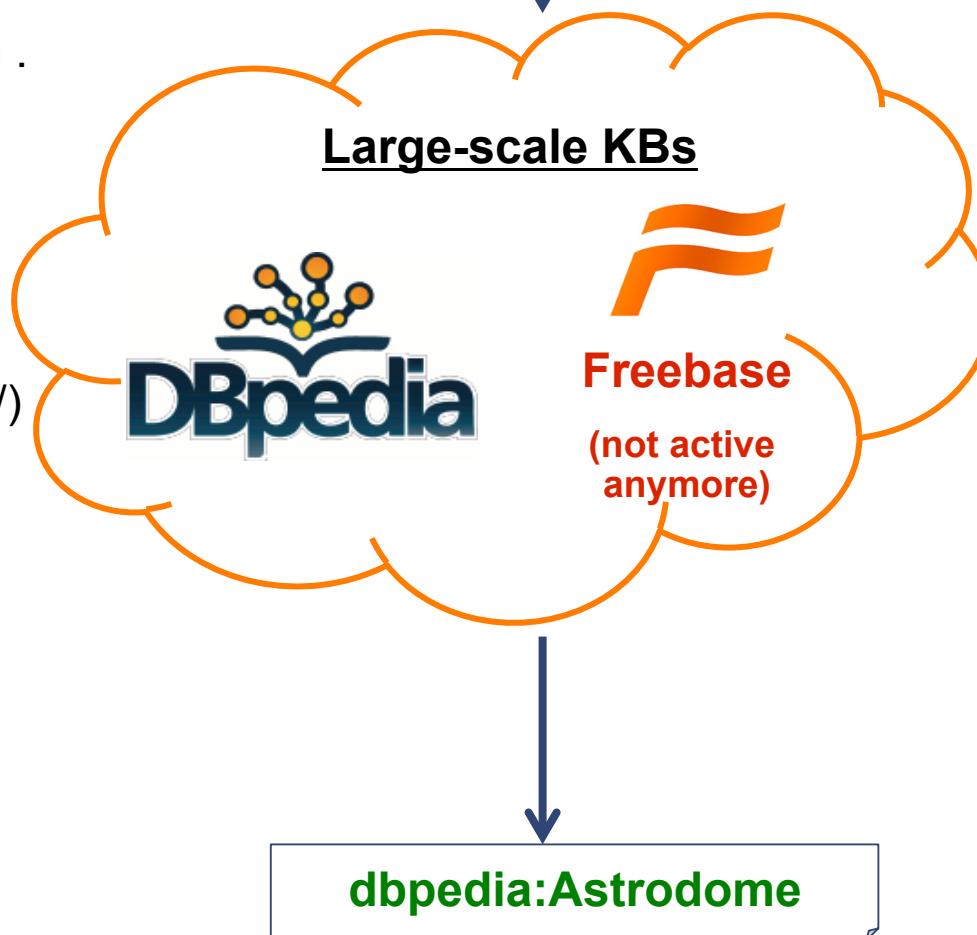
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... or use a deep Learning approach  
for example, (Bordes et al. 2014)



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# Community Question Answering (cQA)

- Searching of answers on Community Question Answering resources: **Stackoverflow, Quora, Yahoo Questions**
- Subtasks
  - Question-question similarity
    - ❖ User asks a new question, find an already answered question with the similar intent
  - Question comment reranking
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- Challenges
  - Ongoing Quora Question Pairs challenge (<https://www.kaggle.com/c/quora-question-pairs>)
  - SemEval 2016 Qatar Living cQA challenge, Task 3 (<http://alt.qcri.org/semeval2016/task3/>)

# SemEval 2016 Qatar Living cQa challenge

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## Task A. Question-Comment similarity

*Subj: Psychiatrist in DOHA*

*by princess\_naila*

Could someone advise the best  
psychiatrist/psychologist in DOHA?

### Comments:

- **feba mariyam:** i heard a good doctor  
in doha clinic... (**potentially useful**)
- **princess\_naila:** ok..shall check that  
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- **EquinOx:** "Visit Psychiatrist clinic of  
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## Task B. Question-Question similarity

*Subj: Where is Doha clinic?*

Can anybody tell me where is Doha clinic?

### Duplicate Candidates:

- Help .. Good pediatrics at Doha clinic ?  
**(Relevant)**
- Knee Surgery @ Doha Clinic (**Relevant**)
- Can anyone recommend a good  
Chiropractor?? (**Irrelevant**)
- Is there any private clinic in qatar or hospital  
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# Machine comprehension: answering questions about a text

In meteorology, precipitation is any product of the condensation of atmospheric water vapor that falls under **gravity**. The main forms of precipitation include drizzle, rain, sleet, snow, **graupel** and hail...

Precipitation forms as smaller droplets coalesce via collision with other rain drops or ice crystals **within a cloud**. Short, intense periods of rain in scattered locations are called “showers”.

*What causes precipitation to fall?*  
**Gravity**

*What is another main form of precipitation besides drizzle, rain, snow, sleet and hail?*

**Graupel**

*Where do water droplets collide with ice crystals to form precipitation?*

**within a cloud**

Example taken from (**Rajpurkar et al., 2016**)

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## Some Relevant corpora:

- SQuAD (Rajpurkar et al., 2016), <https://rajpurkar.github.io/SQuAD-explorer/>
  - Crowdsourced, based on Wikipedia
- Ms Marco(Rajpurkar et al., 2016), <http://www.msmarco.org/>
  - User query logs as questions, Relevant web-pages as a source of answers

# **Types of question answering**

- Information-retrieval (IR) based factoid question answering
- QA on knowledge bases
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# Ikernels Advance pipeline applied to...

- **Information-retrieval based factoid question answering**
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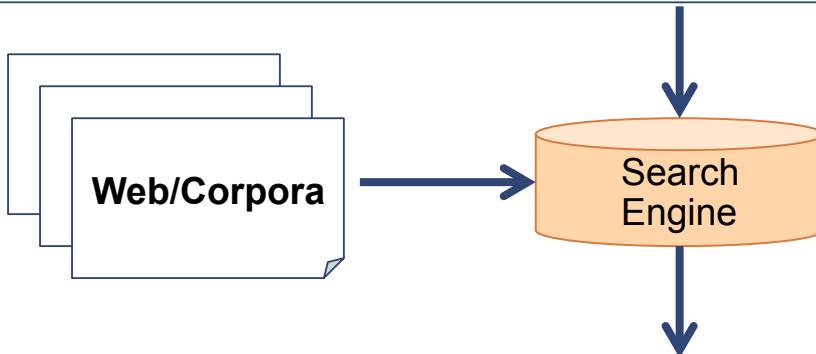
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- Learning with kernels
  - Tree kernels recap
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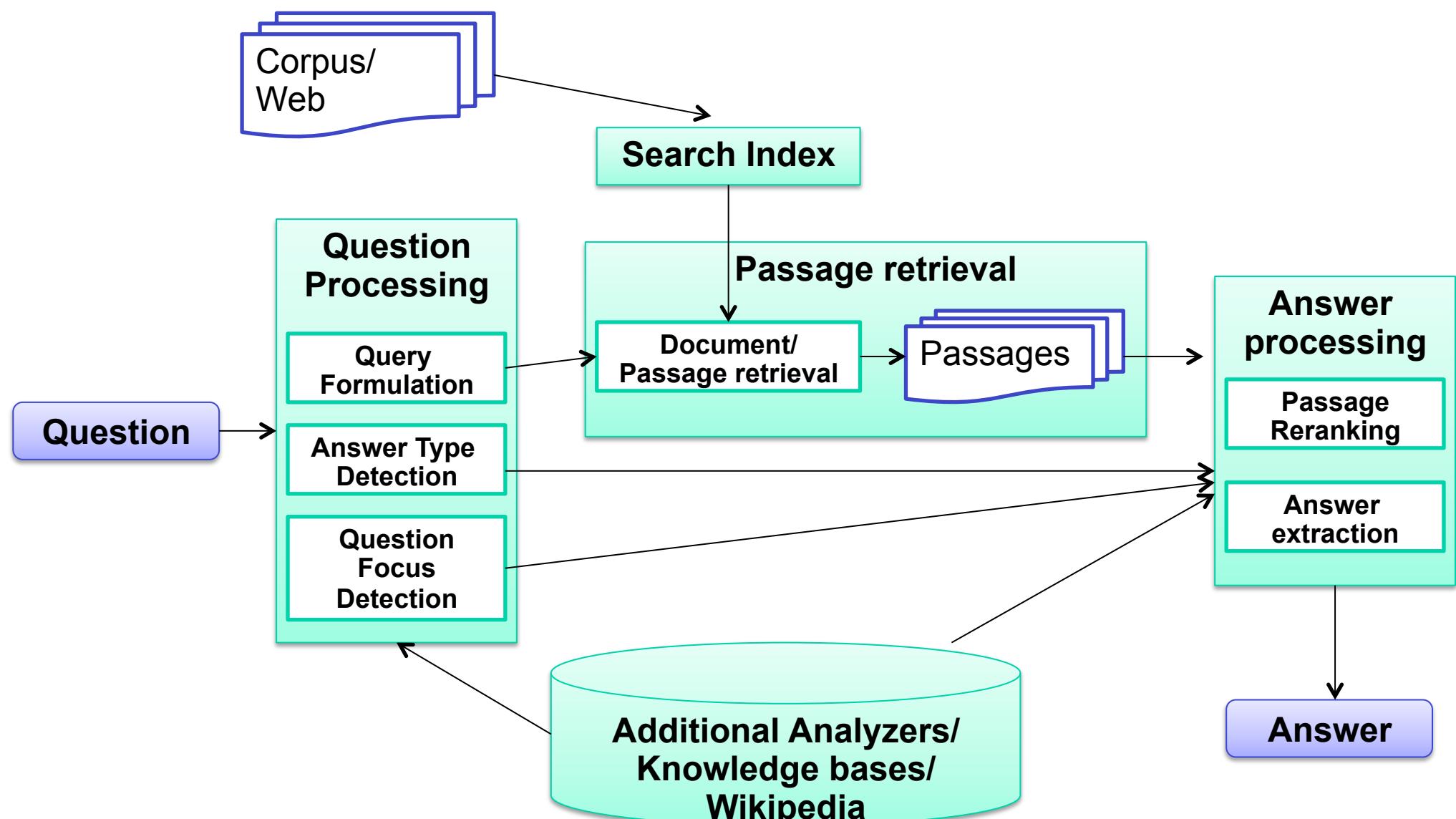


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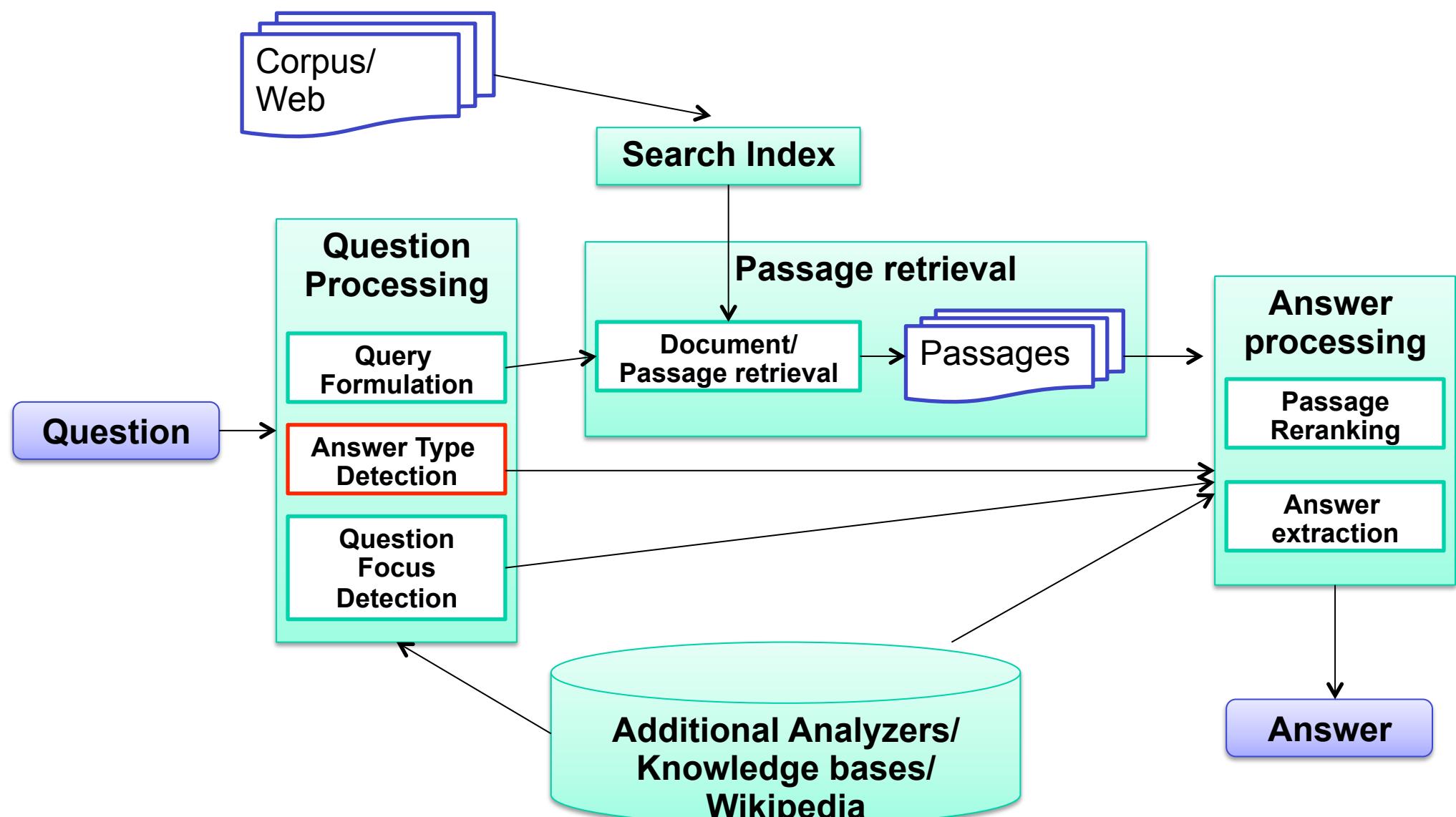


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# Answer type detection

- Expected answer type/Question Class
  - Definition, description, entity, human, location, manner, number organization...
    - ❖ *What sports stadium has been billed as “the eighth wonder of the world”?* -> **LOCATION**
- We use a labeled QC corpus (Li&Roth, 2002)
  - HUM, ENTY, LOC, ABBR, DESC, NUM
  - 32 fine-grained classes
  - <http://cogcomp.cs.illinois.edu/Data/QA/QC/>

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- The pipeline employs a tree kernel-based based approach for question classification (Croce at al., 2011)
  - Accuracy 85-95 %

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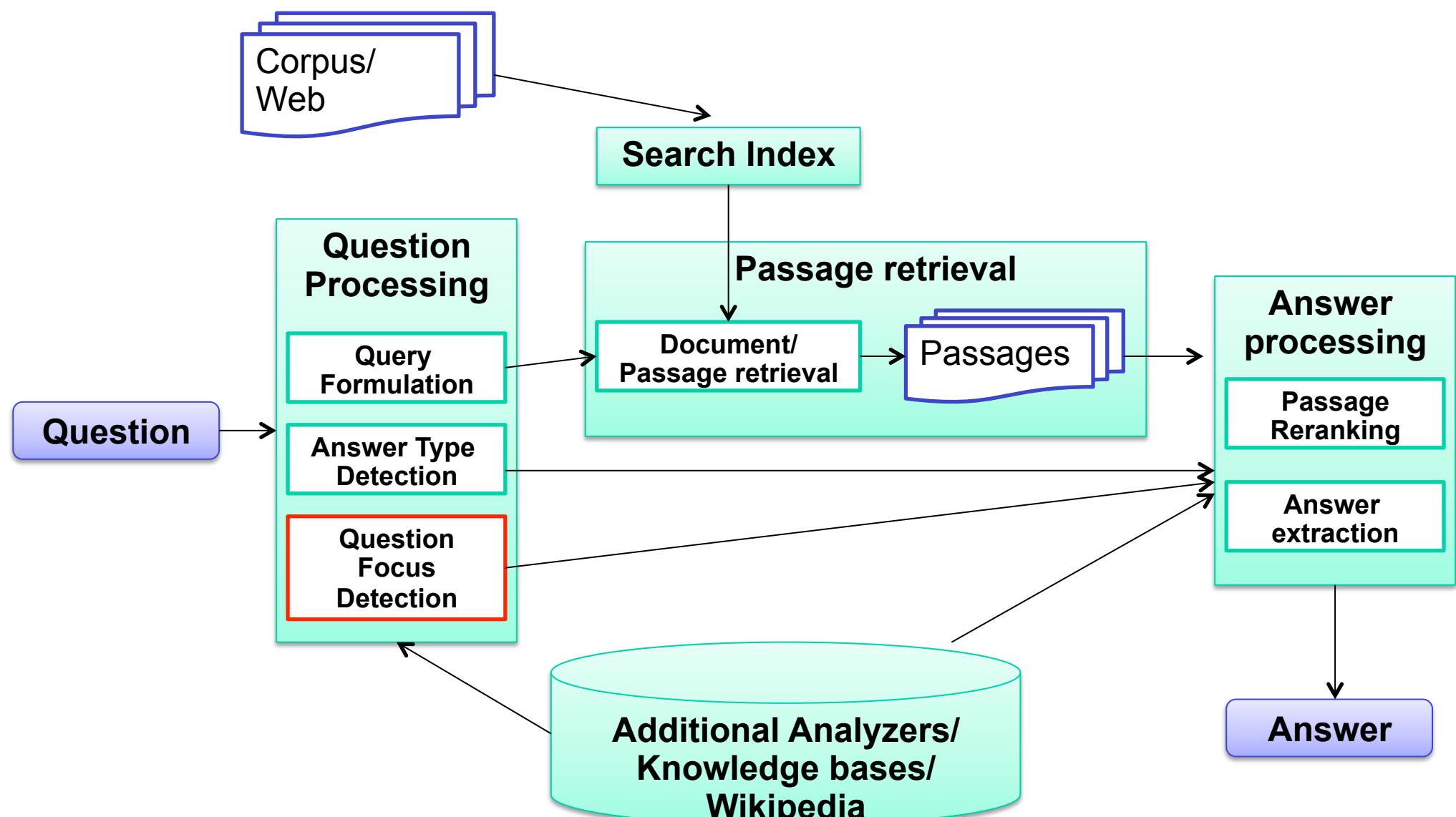


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- Question focus is a
  - “noun that is property or entity being sought by the question” (Prager, 2006)
  - “the set of all maximal noun phrases in the question that corefer with the answer” (Bunescu and Huang, 2010)
  - Example: What **sports stadium** has been billed as “*the eighth wonder of the world*”?

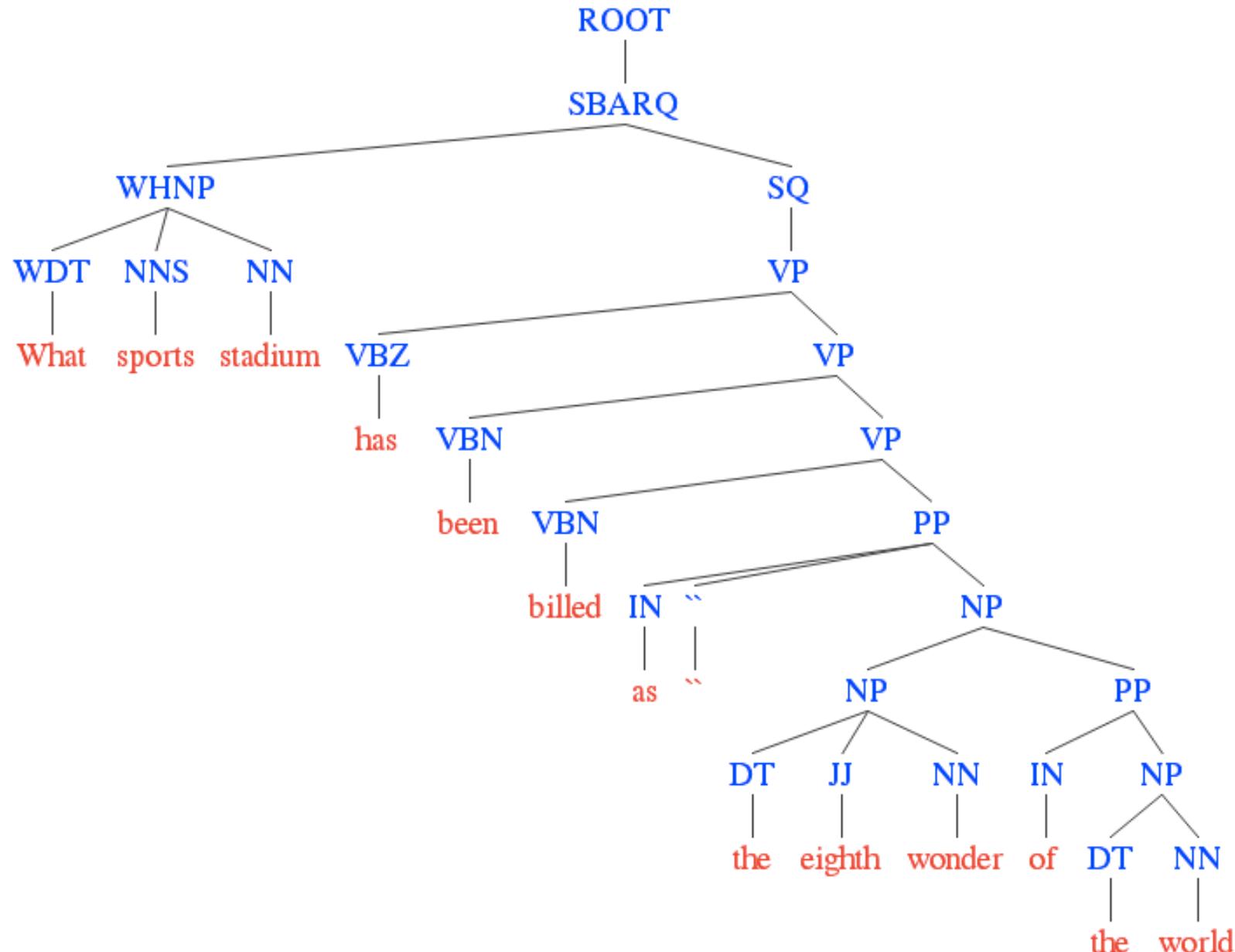
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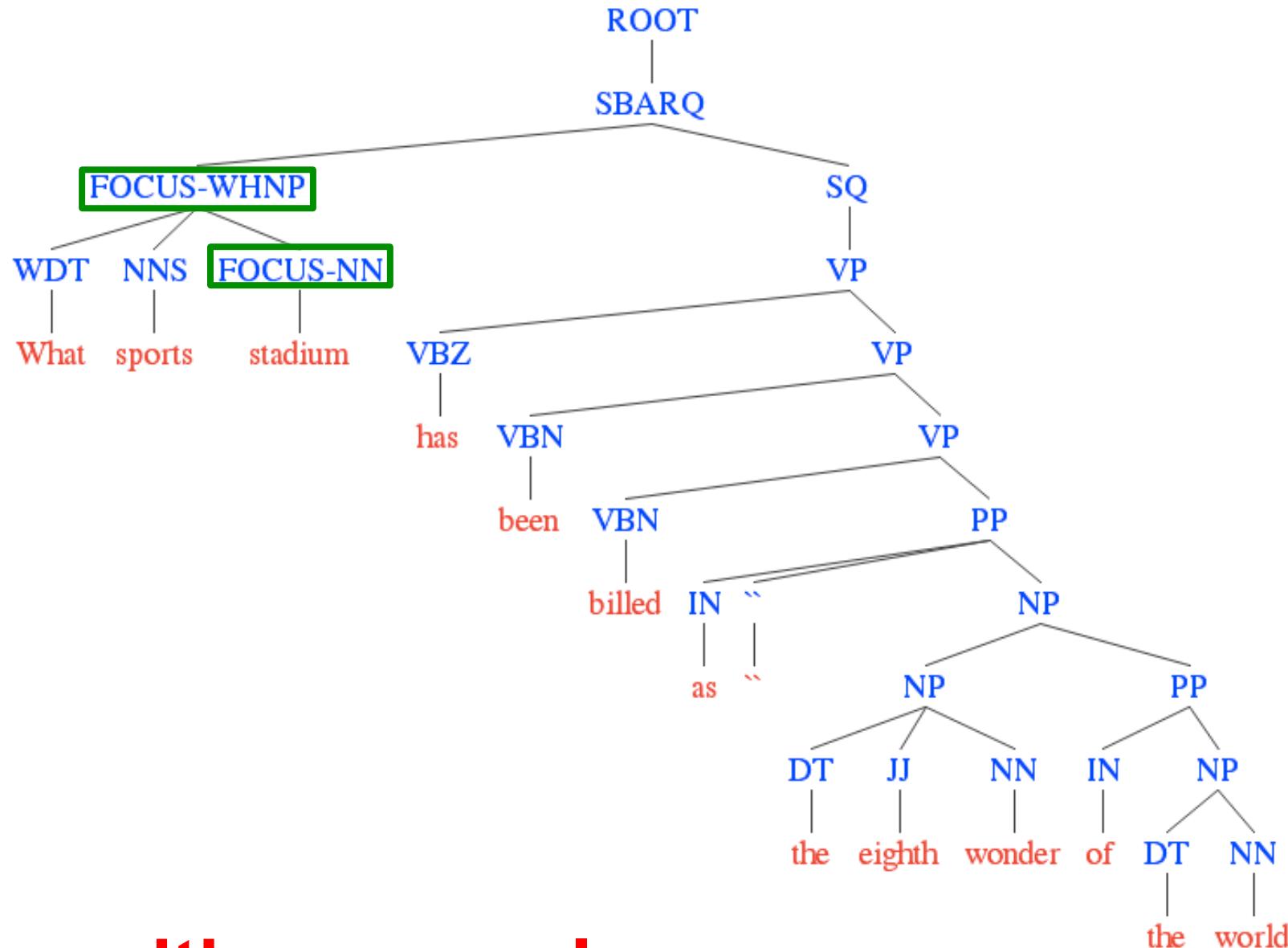
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  - Example: What sports **stadium** has been billed as “the eighth wonder of the world”?
- Corpora available
  - SeCo-600 (Quarteroni et al., 2012), Mooney GeoQuery (Damljanovic et al., 2010), (Bunescu and Huang, 2010)
  - 80-98% accuracy with Tree Kernel-based approaches

# Focus detection with TK

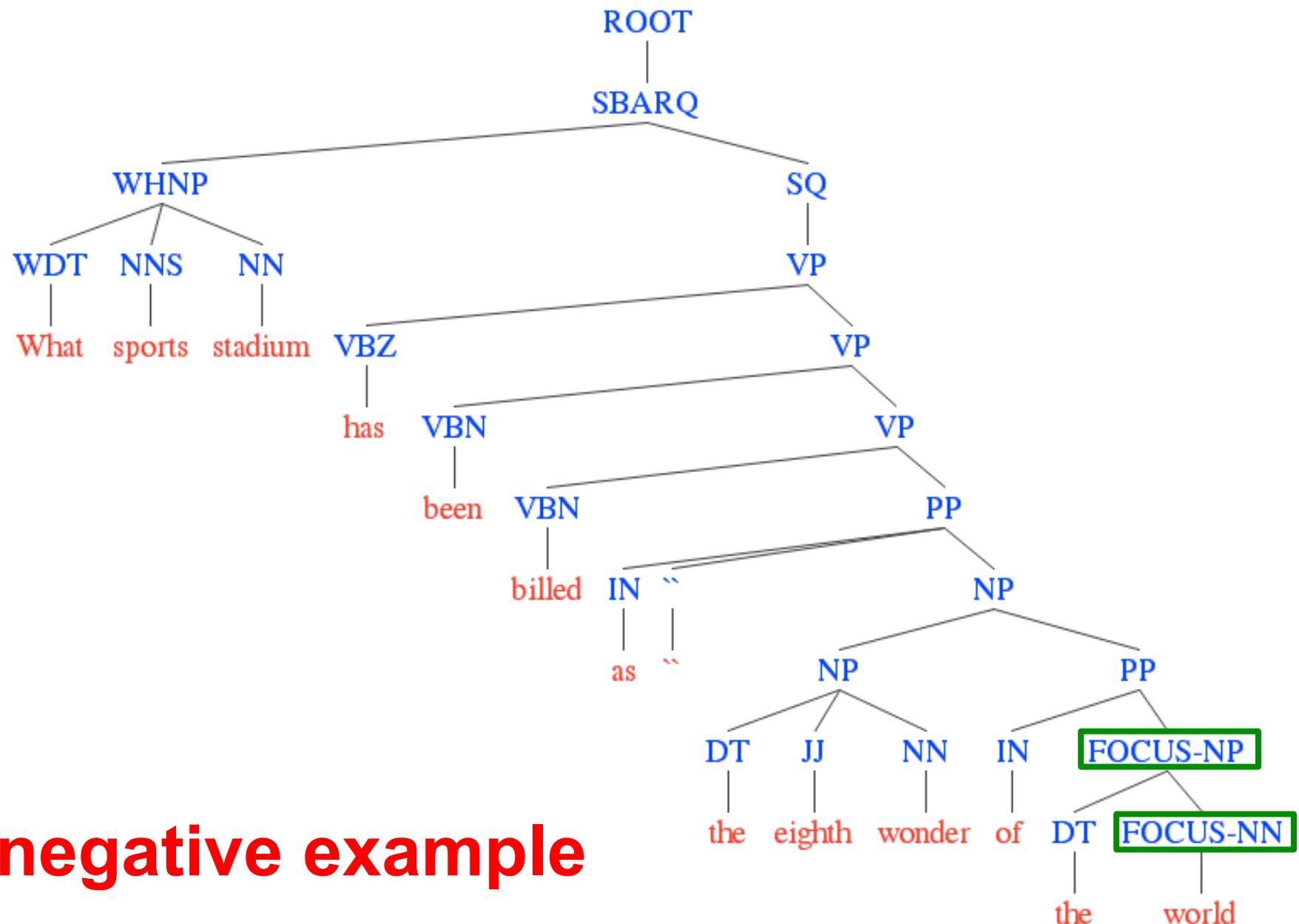


# Focus detection with TK



+1: positive example

# Focus detection with TK



-1: negative example

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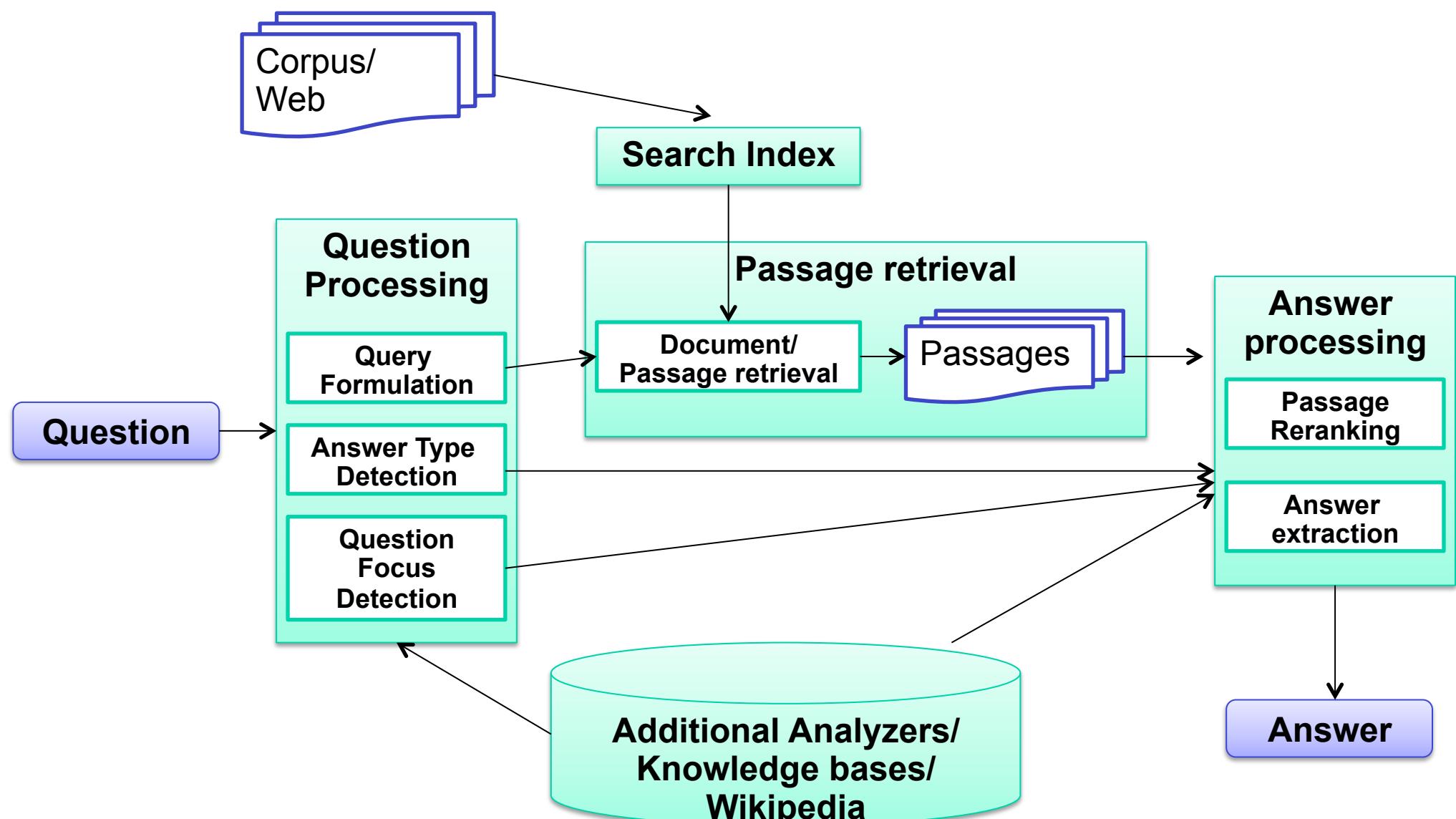


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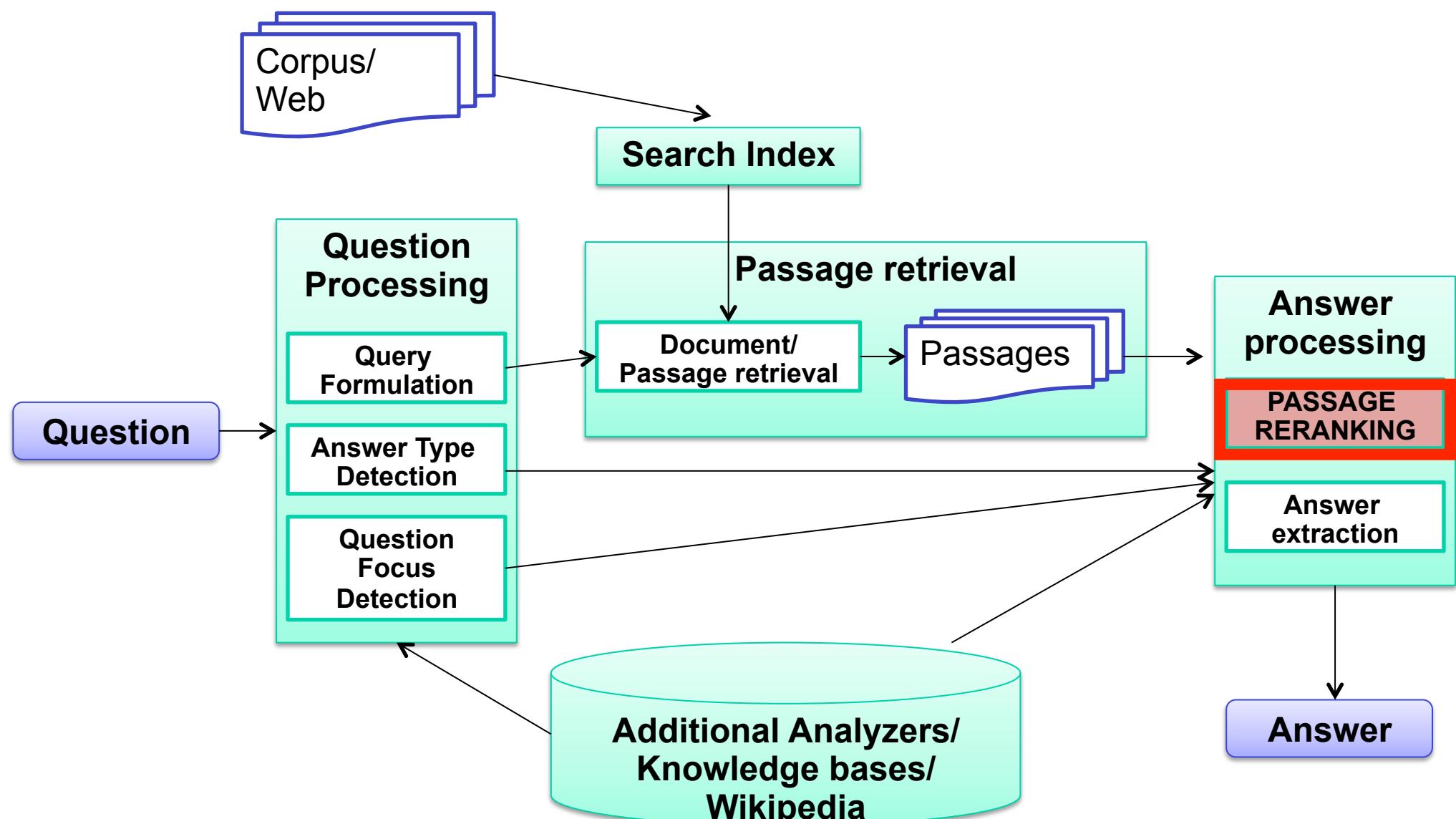


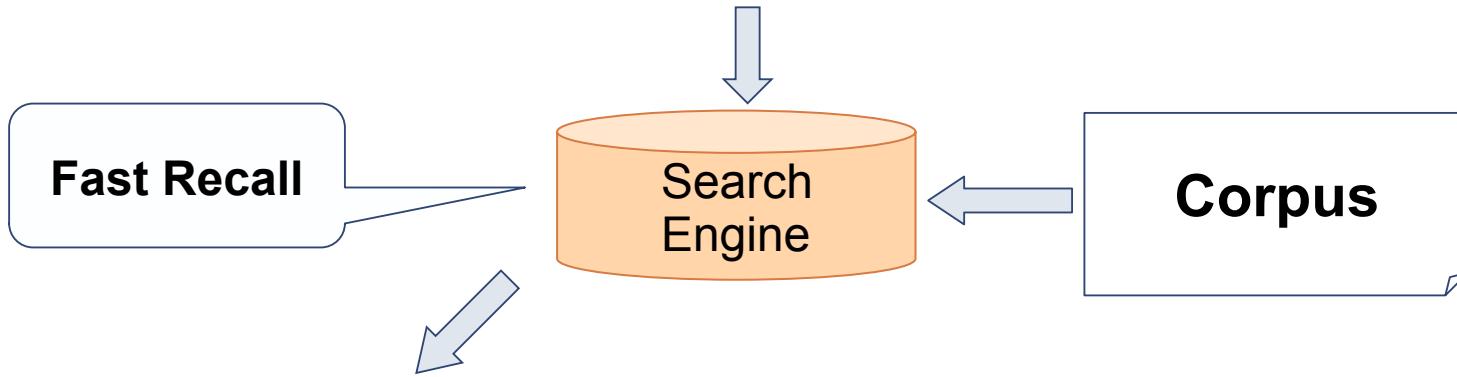
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# Candidate answer passage reranking

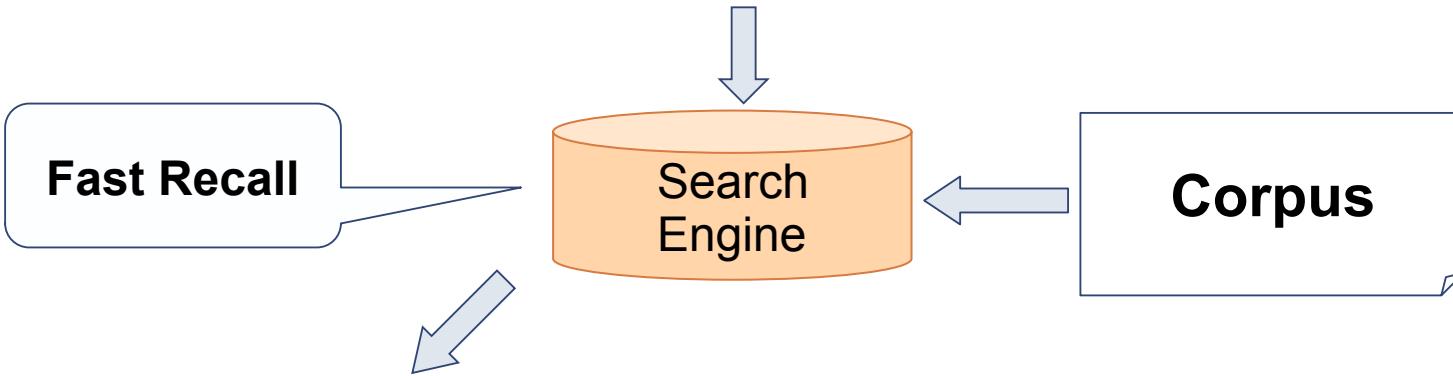
What sports stadium has been billed as “the eighth wonder of the world”?



1. It once was the Taj Mahal of **sports**. When **the stadium** opened in 1965 it **was billed as** the **Eighth Wonder of the World.** **X**
2. The man behind the project, Judge Roy Hofheinz, modestly suggested the **stadium** be dubbed the **Eighth Wonder of the World.** **X**
- ⋮
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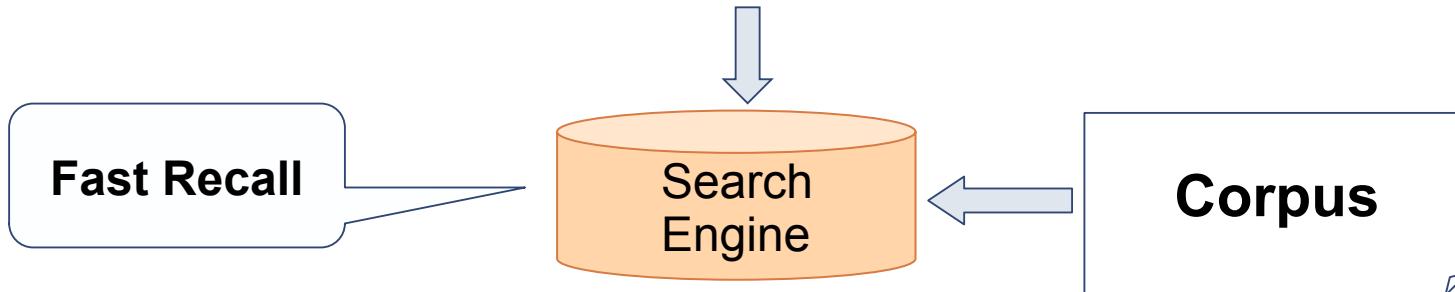
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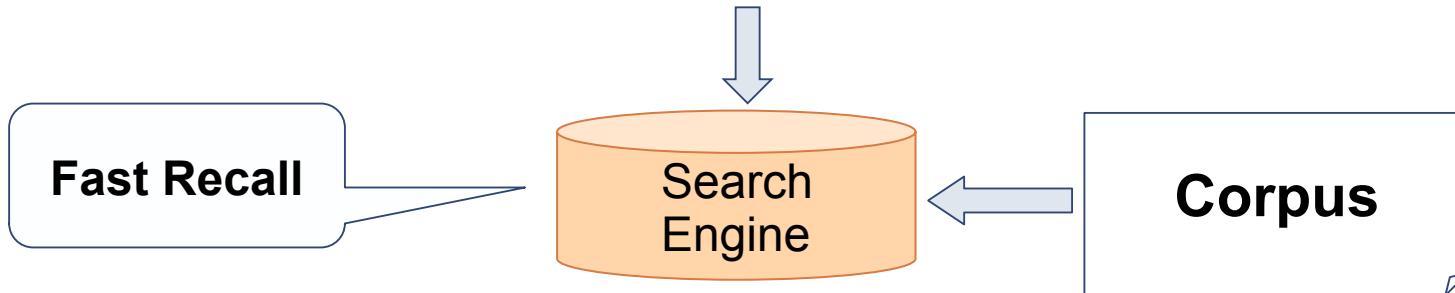
## Useful clues:

- Lexical overlap between Q/A
- Specific syntactic/semantic patterns
  - ✓ When was <X> born? -> <X>, born on <Y>,...
- Answer type/Question focus match with named entities in the Candidate Answer

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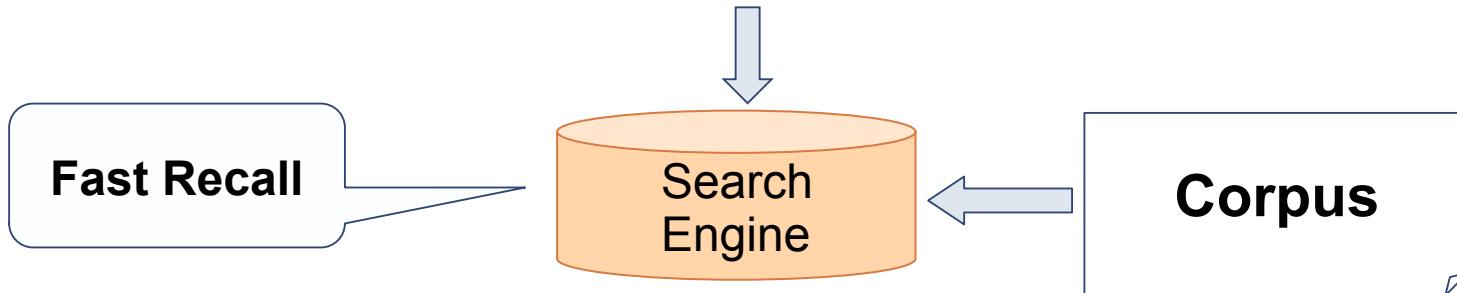


The solution requires  
a combination of  
**Syntax** and **Semantics**

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## Possible solution

Shallow and deep syntactic trees



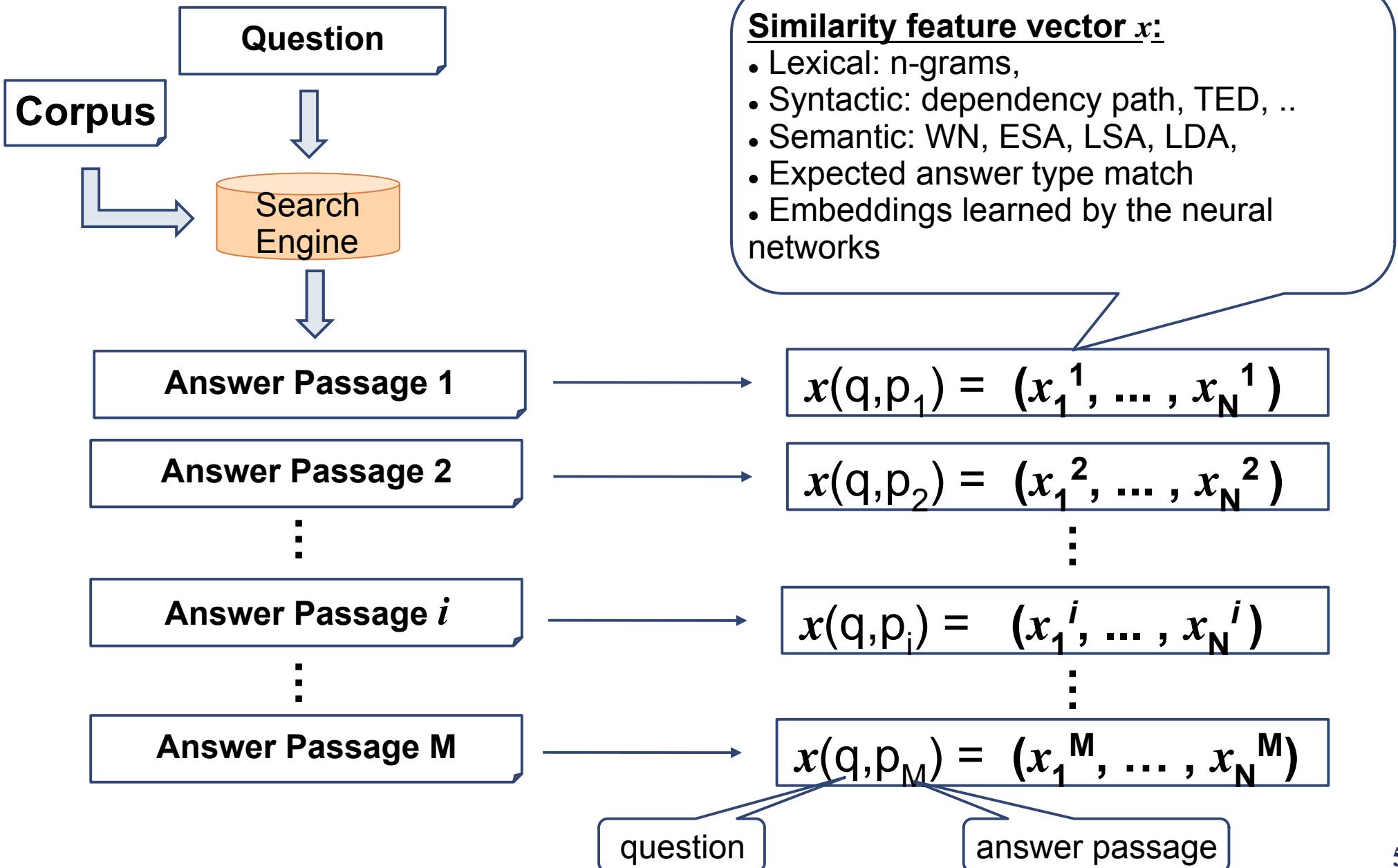
Question classifiers, NER,  
Linked Data, Wikipedia

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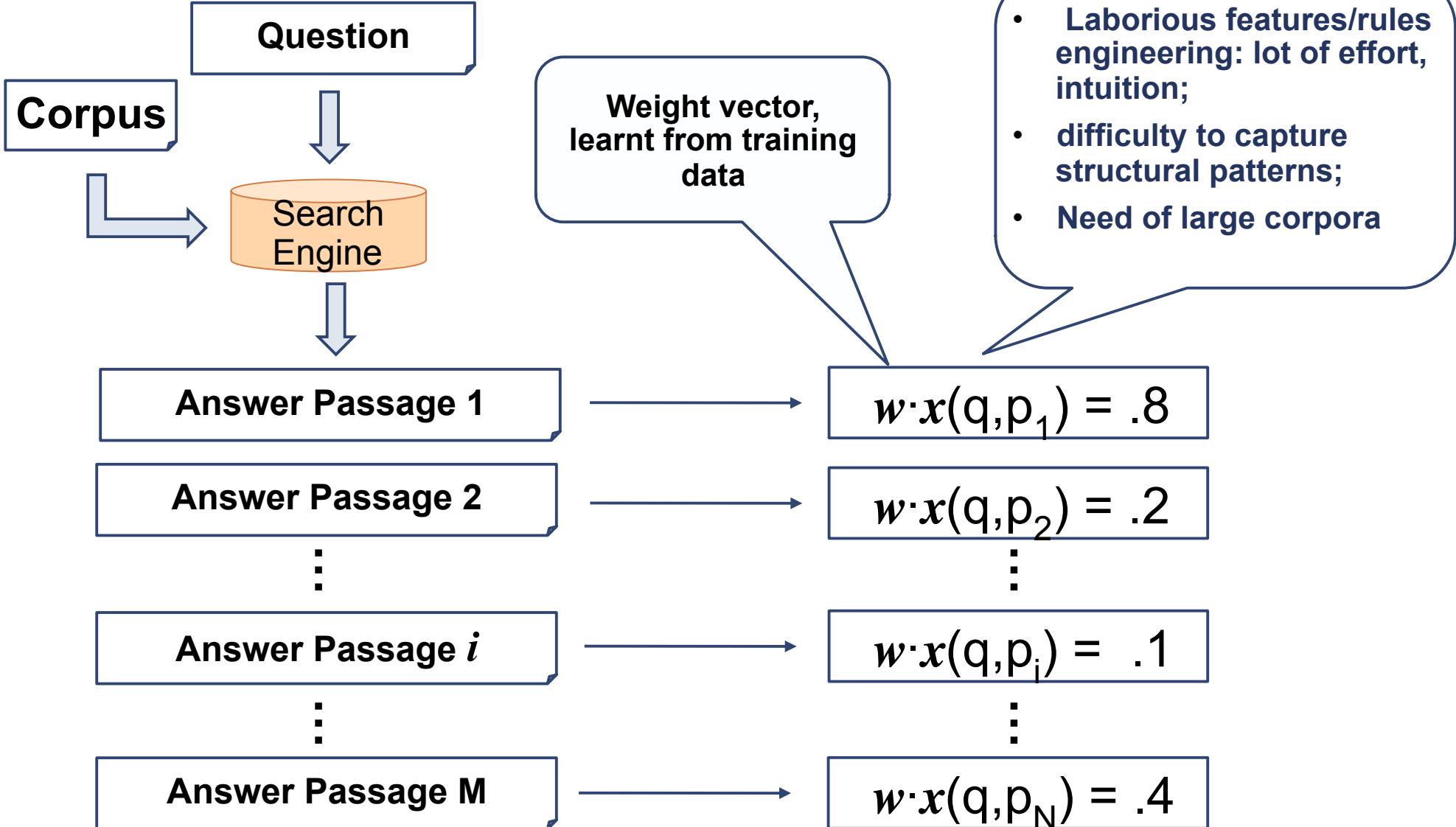
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- IR-based QA and its components
- Motivation behind the approach
- **Learning with kernels**
  - **Tree kernels recap**
- Structural representations and relational links for Answer Sentence Selection (IR-based QA)
- Structural representations for Community Question Answering
- Metrics and results

# Feature vector representation



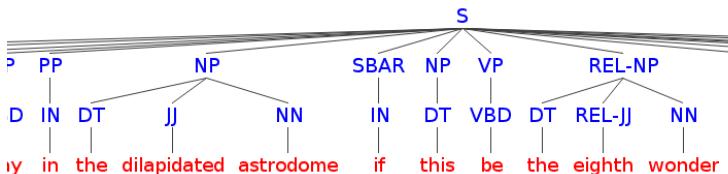
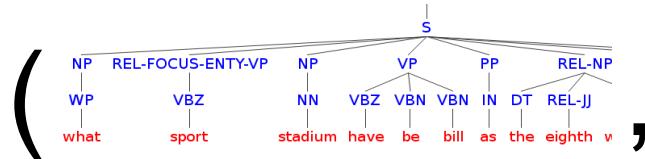
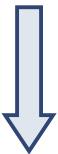
# Feature vector representation



# Implicit Feature Representation

Q

What sports stadium has been billed as “the eighth wonder of the world”?



;  $(x_1, x_2, \dots, x_N)$  )

- Model Q/P pairs as structures
- Tree Kernels (TK) and SVM to learn patterns

Similarity vector

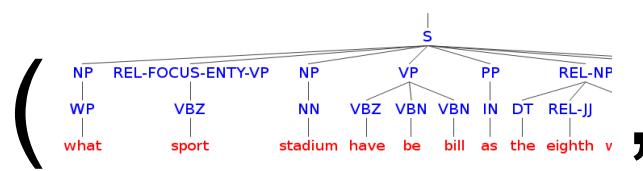


A

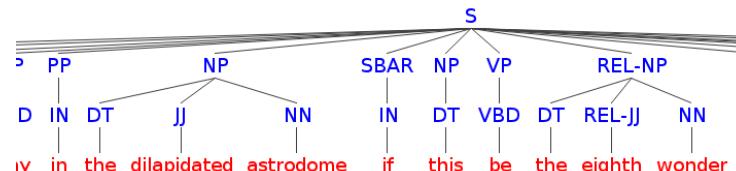
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# Learning with Kernels: an example

Question 1

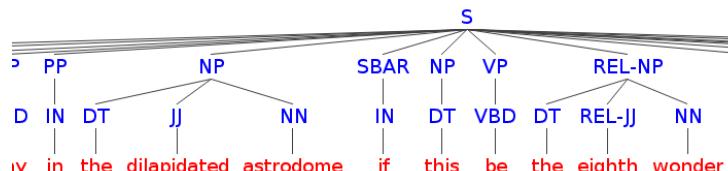
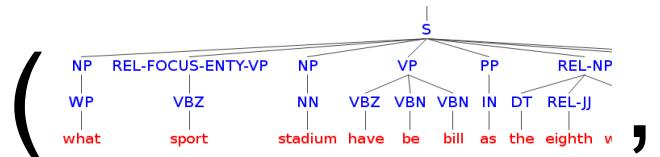


Answer 1



Feature Vector 1

;  $(x_1, x_2, \dots, x_N)$  )



;  $(x_1, x_2, \dots, x_N)$  )

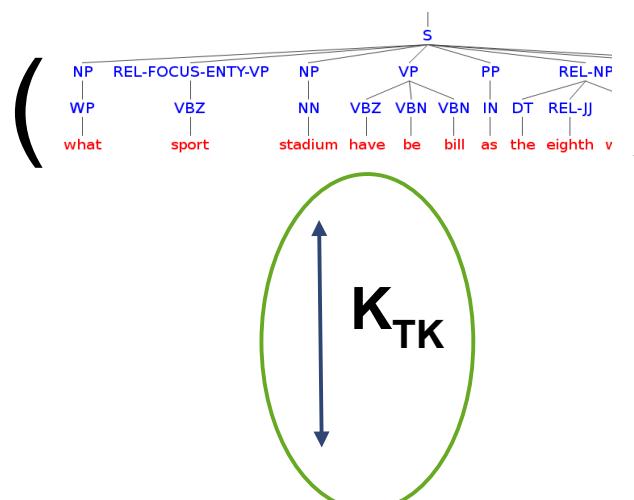
Question 2

Answer 2

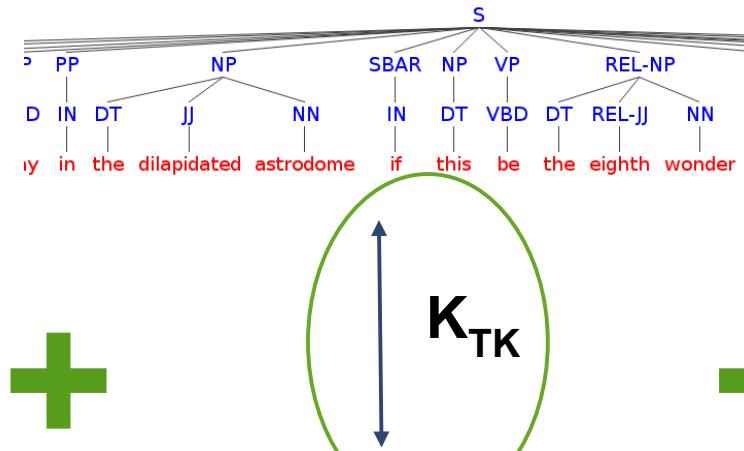
Feature Vector 2

# Learning with Kernels: an example

Question 1

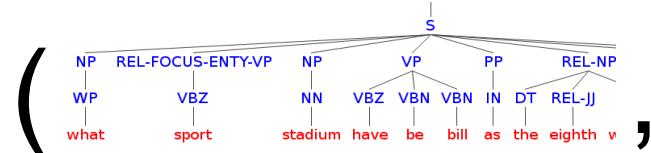
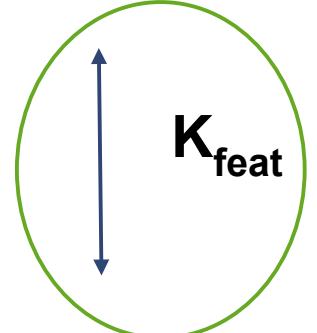


Answer 1

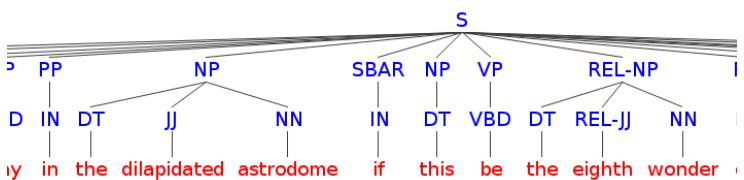


Feature Vector 1

$$; (x_1, x_2, \dots, x_N)$$



Question 2



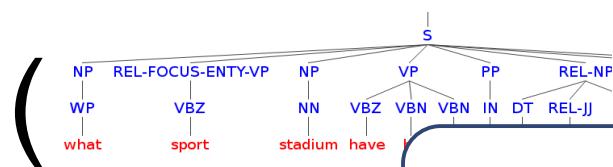
Answer 2

Feature Vector 2

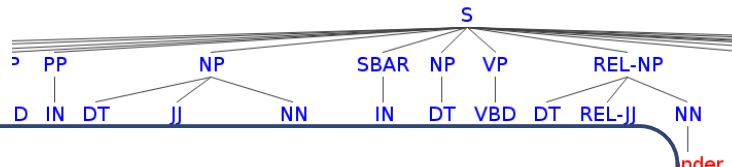
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# Learning with Kernels: an example

Question 1



Answer 1

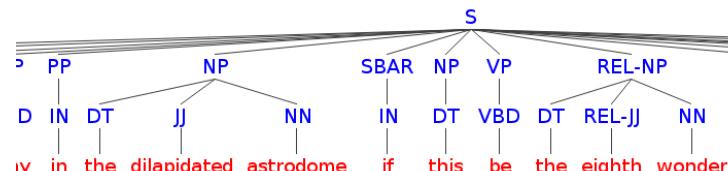
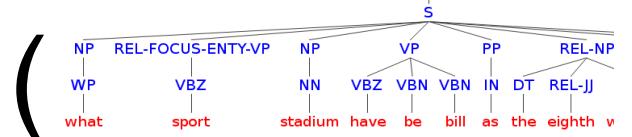


Feature Vector 1

$$; (x_1, x_2, \dots, x_N)$$

$K_{\text{feat}}$

Kernel applied to feature vectors,  
e.g., scalar product or polynomial kernel



$$; (x_1, x_2, \dots, x_N)$$

Question 2

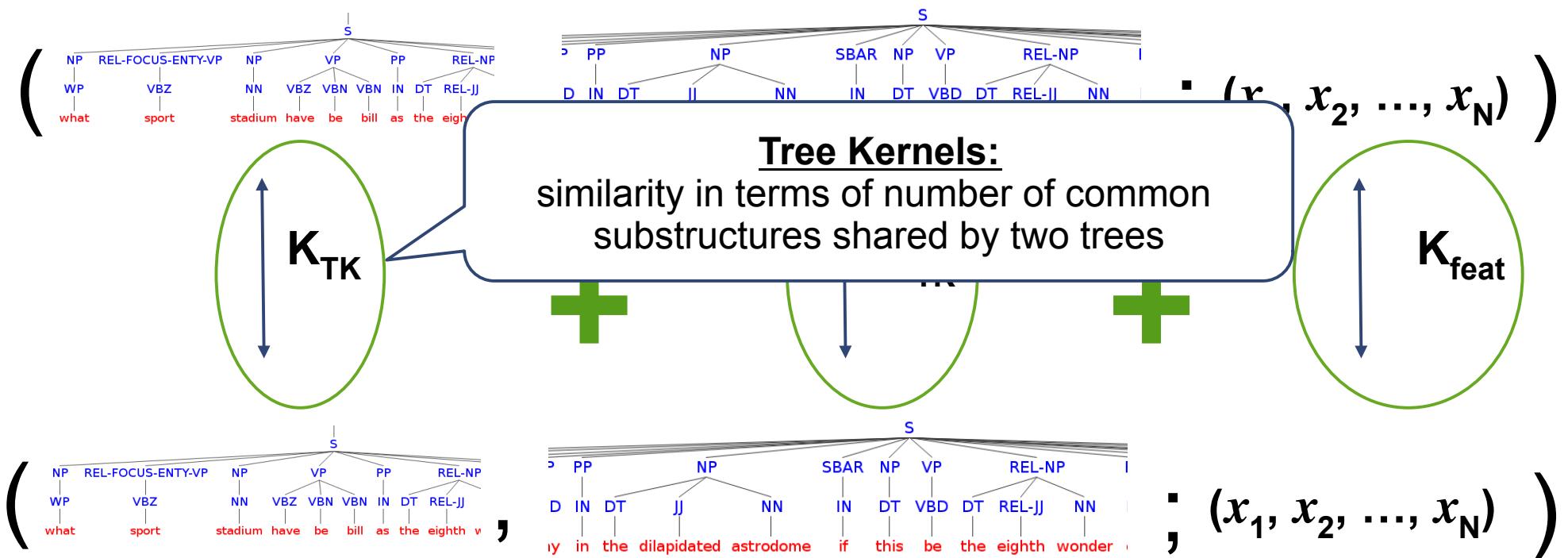
Answer 2

Feature Vector 2

# Learning with Kernels: an example

Q

What sports stadium has been billed as “the eighth wonder of the world”?



A

The Titans played in the dilapidated Astrodome; if this was the eighth wonder of the world, we live on a shabby little planet indeed.

# Classification function of Kernel Machines

- The equation of a hyperplane is

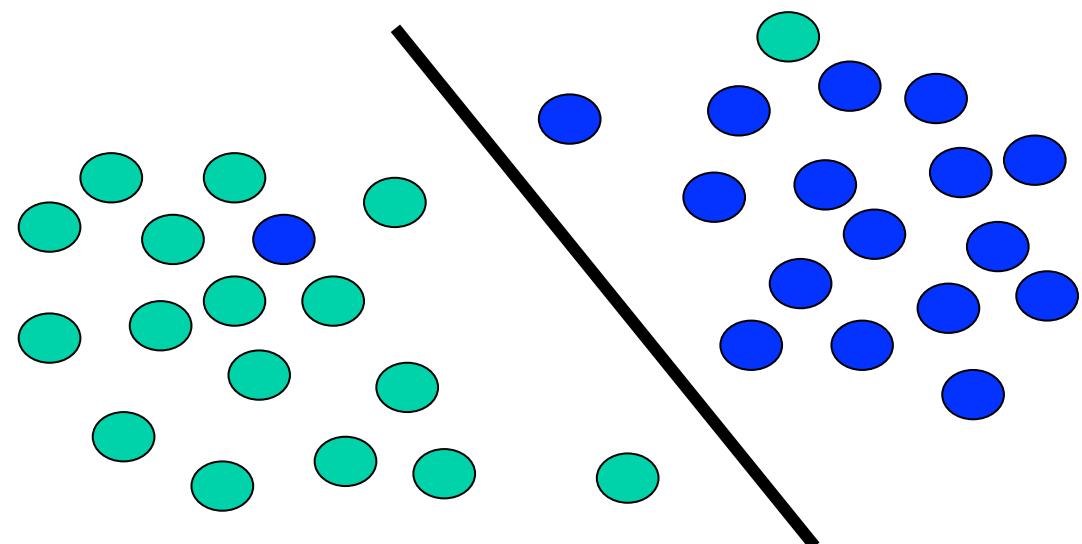
$$f(\vec{x}) = \vec{x} \cdot \vec{w} + b = 0, \quad \vec{x}, \vec{w} \in \Re^n, b \in \Re$$

- $\vec{x}$  is the vector representing the classifying example
- $\vec{w}$  is the gradient of the hyperplane (learned model)
- The classification function is

$$h(\vec{x}) = \text{sign}(f(\vec{x}))$$

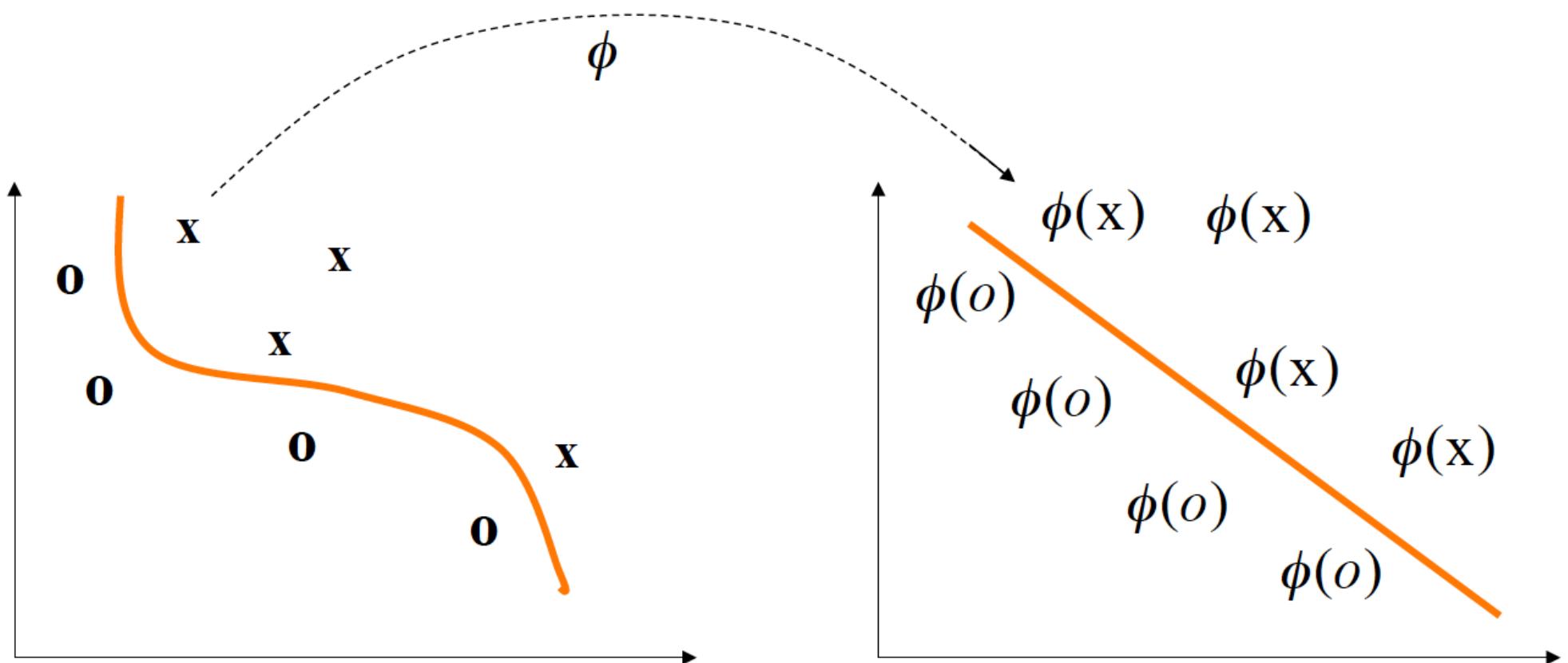
Note that the hyperplane classifier is just:

$$\vec{x} \cdot \vec{w} > -b$$



# The main idea of the kernel functions

- Mapping vectors in a space where they are linearly separable,  $\vec{x} \rightarrow \phi(\vec{x})$



# The Kernel Trick

- Kernel Machines (e.g., SVMs or perceptron) are such that

$$\vec{w} = \sum_{j=1..l} \alpha_j y_j \vec{x}_j$$

- Hence the classification function results:

$$\text{sgn}(\vec{w} \cdot \vec{x} + b) = \text{sgn}\left( \sum_{j=1..l} \alpha_j y_j \vec{x}_j \cdot \vec{x} + b \right)$$

- Note that data only appears in the scalar product
- We can use the function  $k$  in place of the scalar product

$$\text{sgn}\left( \sum_{i=1..l} \alpha_i y_i k(\vec{x}_i, \vec{x}) + b_\phi \right) = \text{sgn}\left( \sum_{i=1..l} \alpha_i y_i k(o_i, o) + b_\phi \right)$$

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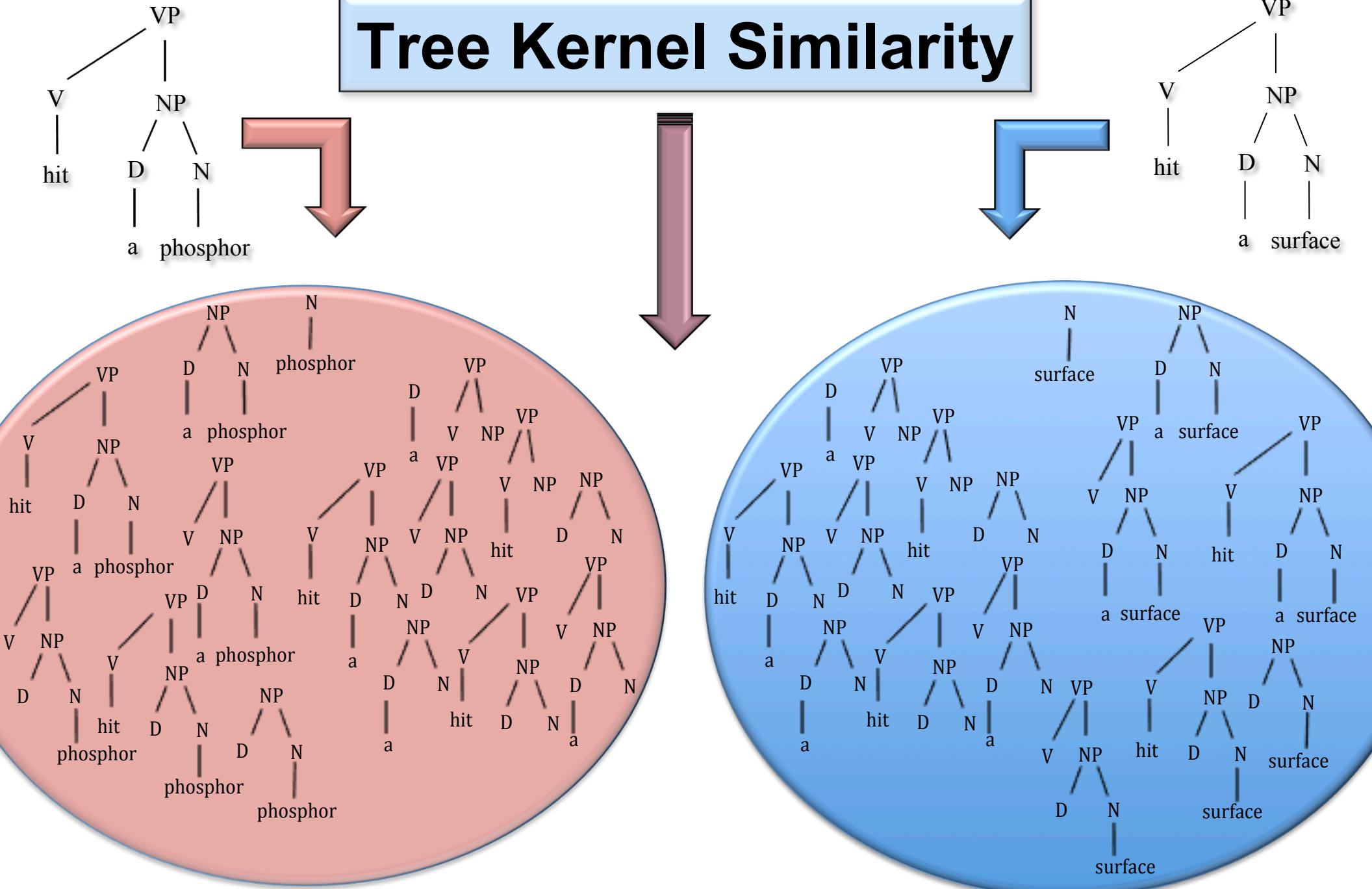
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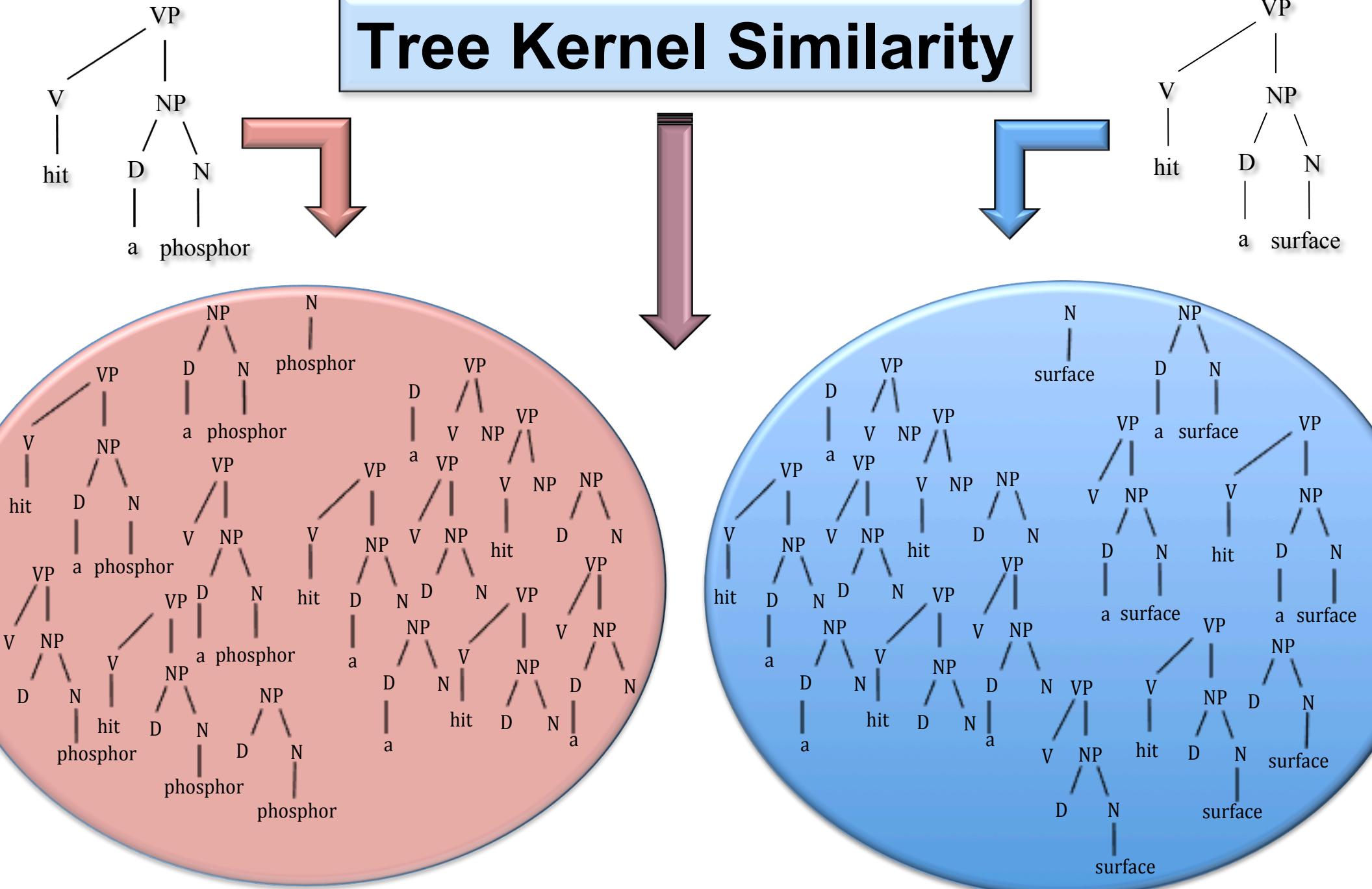
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# Tree Kernel Similarity

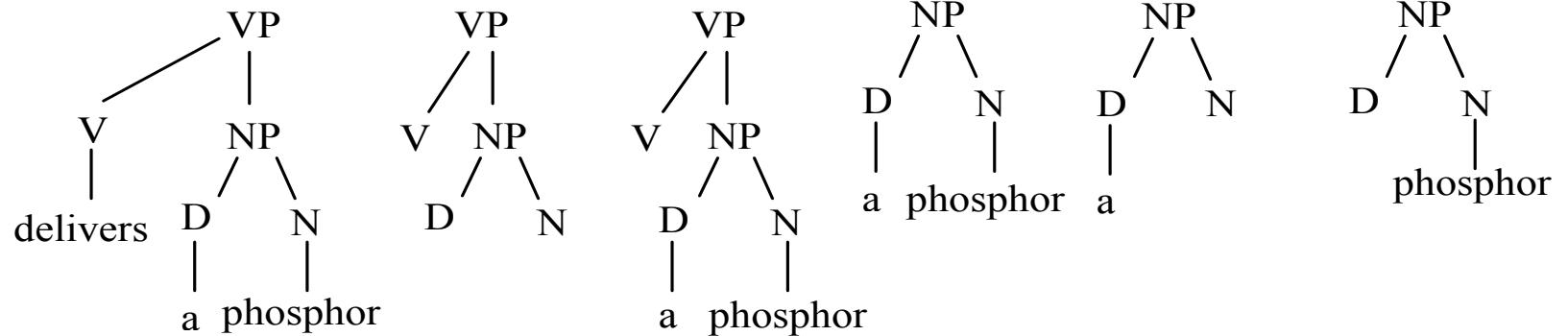


# Tree Kernel Similarity



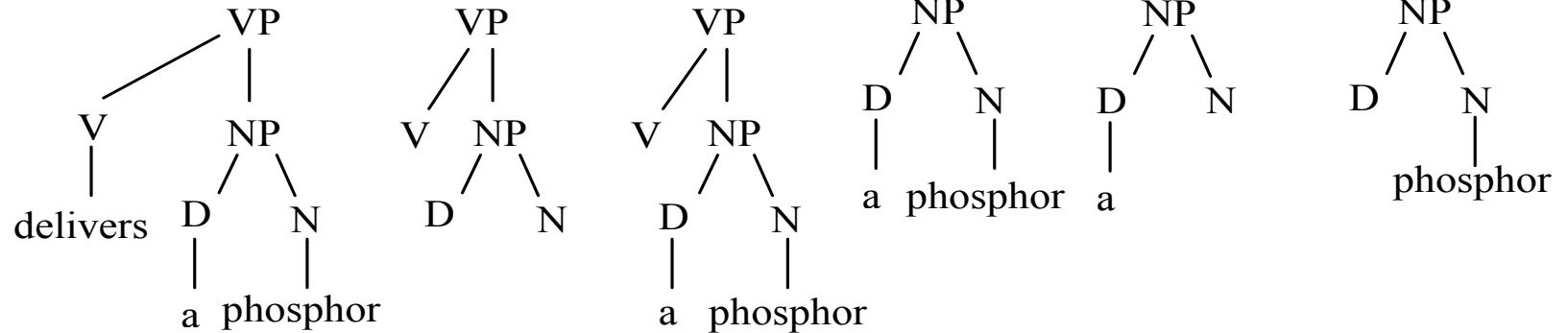
# Explicit kernel space

$$\phi(T_x) = \vec{x} = (0, \dots, 1, \dots, 0, \dots, 1, \dots, 0)$$

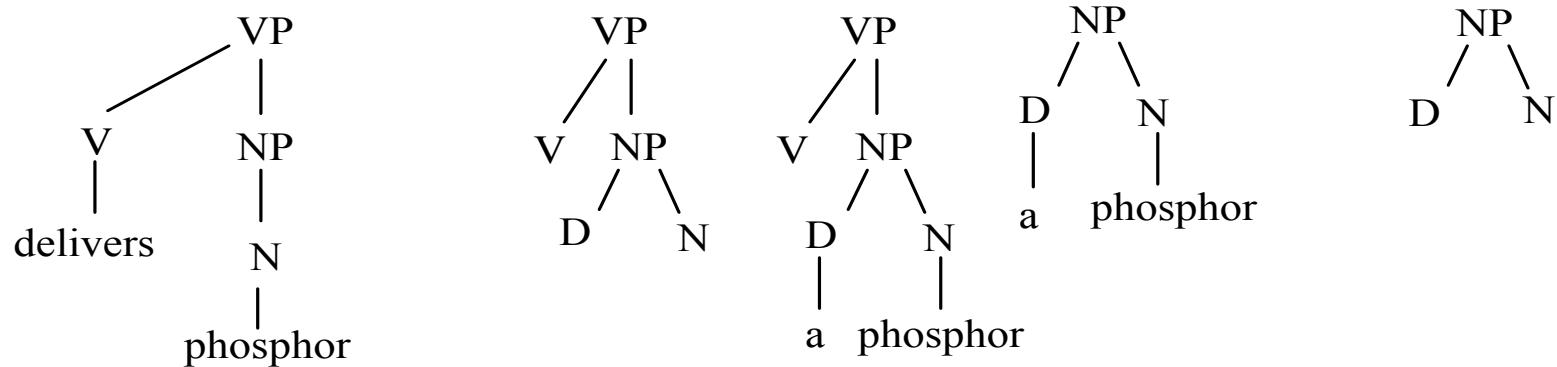


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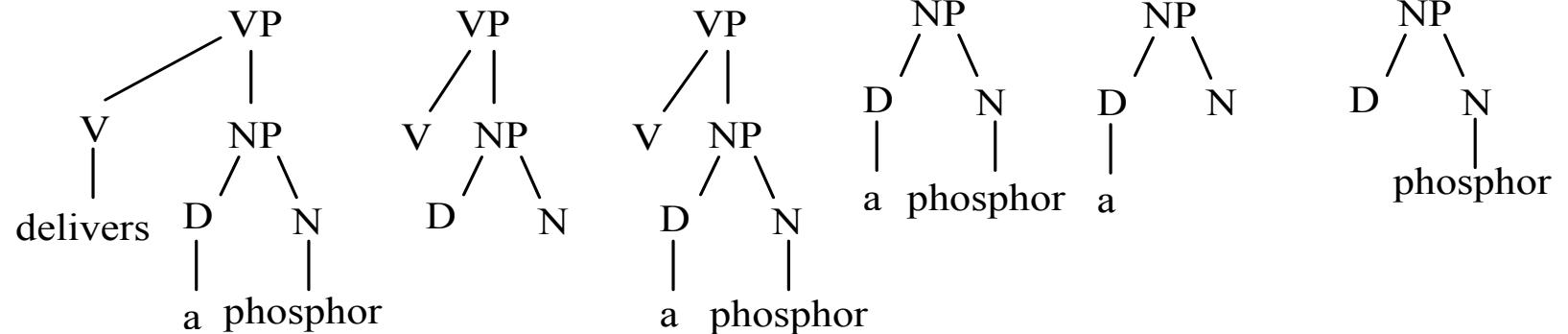


$$\phi(T_z) = \vec{z} = (1, \dots, 0, \dots, 0, \dots, 1, \dots, 0, \dots, 1, \dots, 0, \dots, 1, \dots, 0, \dots, 1, \dots, 0, \dots, 0)$$

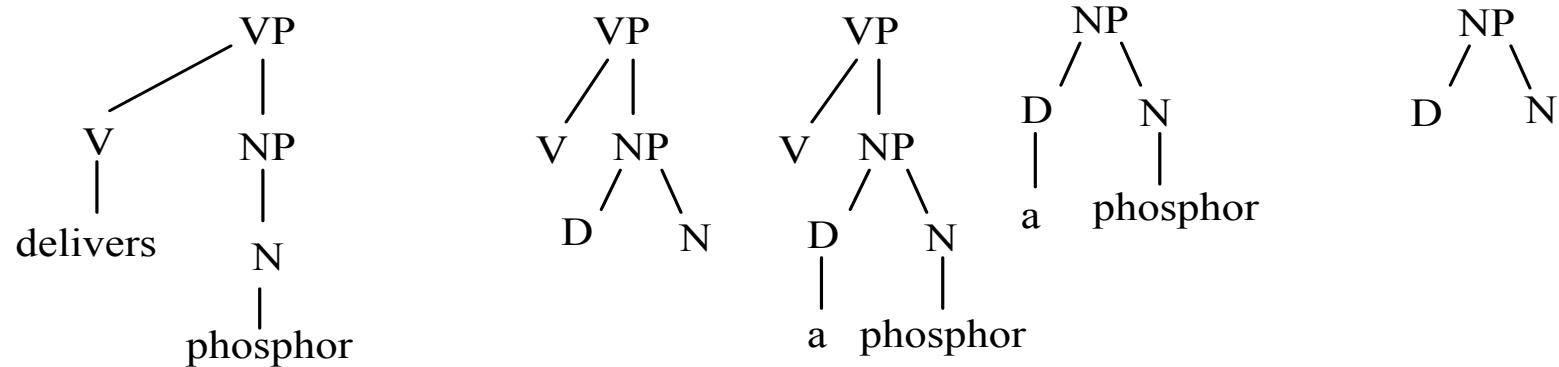


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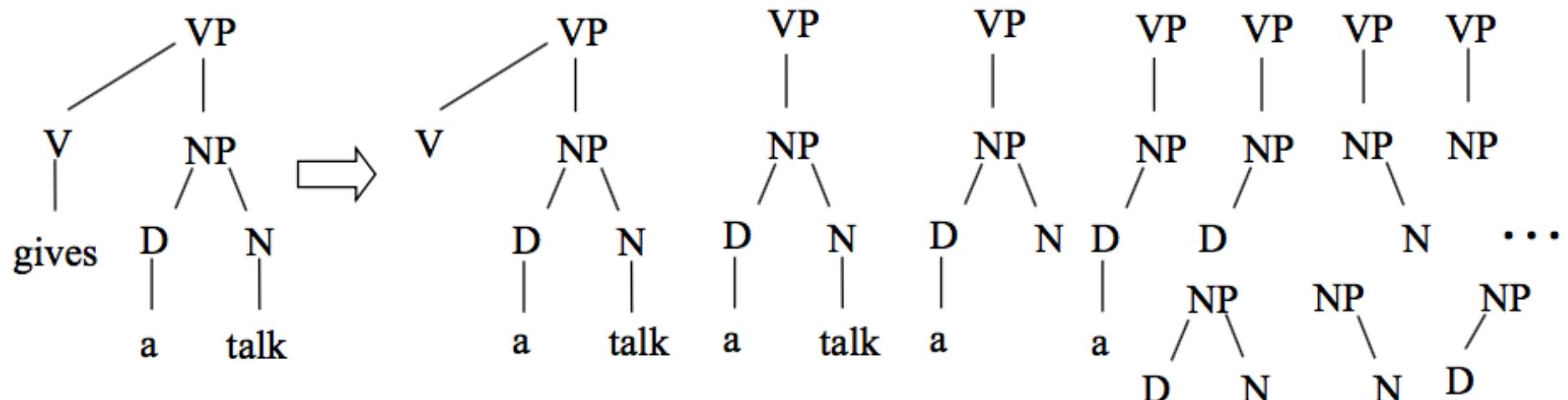


- $\vec{x} \cdot \vec{z}$  counts the number of common substructures

# Structures by Syntactic Tree Kernel

(Moschitti, 2006)

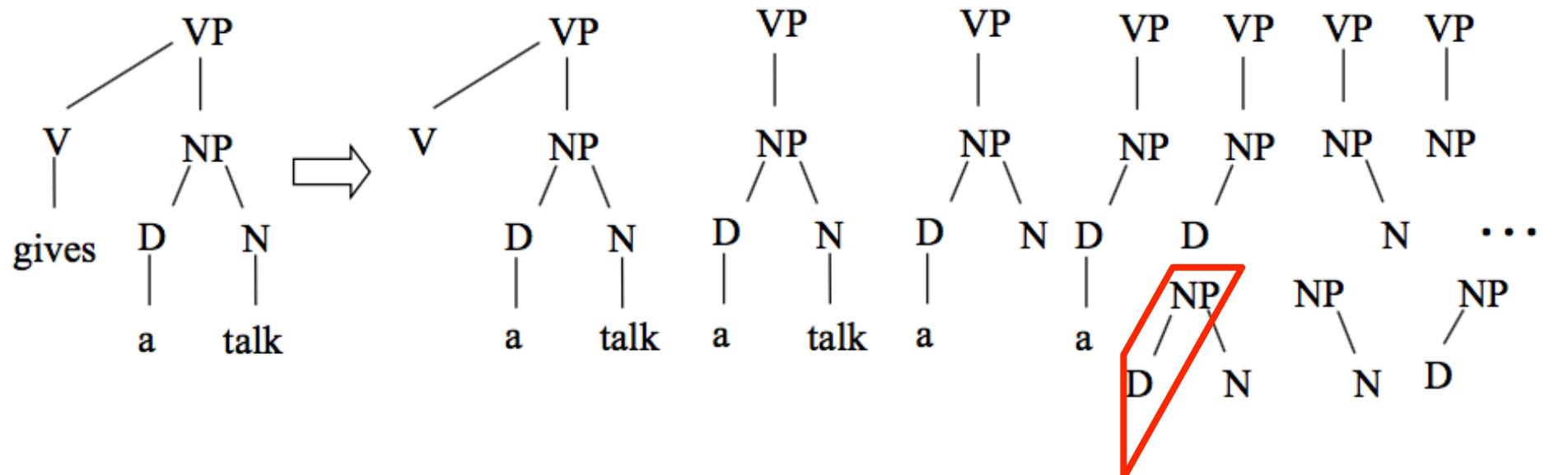
- Subtree: any node with its descendants
- Grammatical rules cannot be broken



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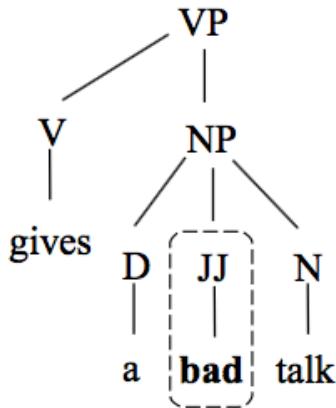
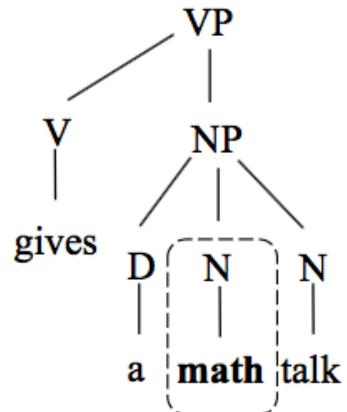
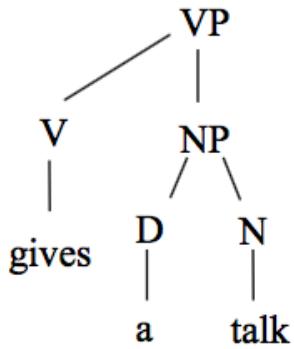
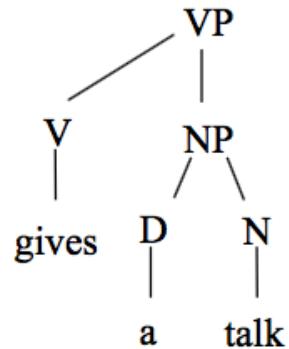
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[NP [D]] Not a valid STK structure

# Partial tree kernel

(Moschitti, 2006)

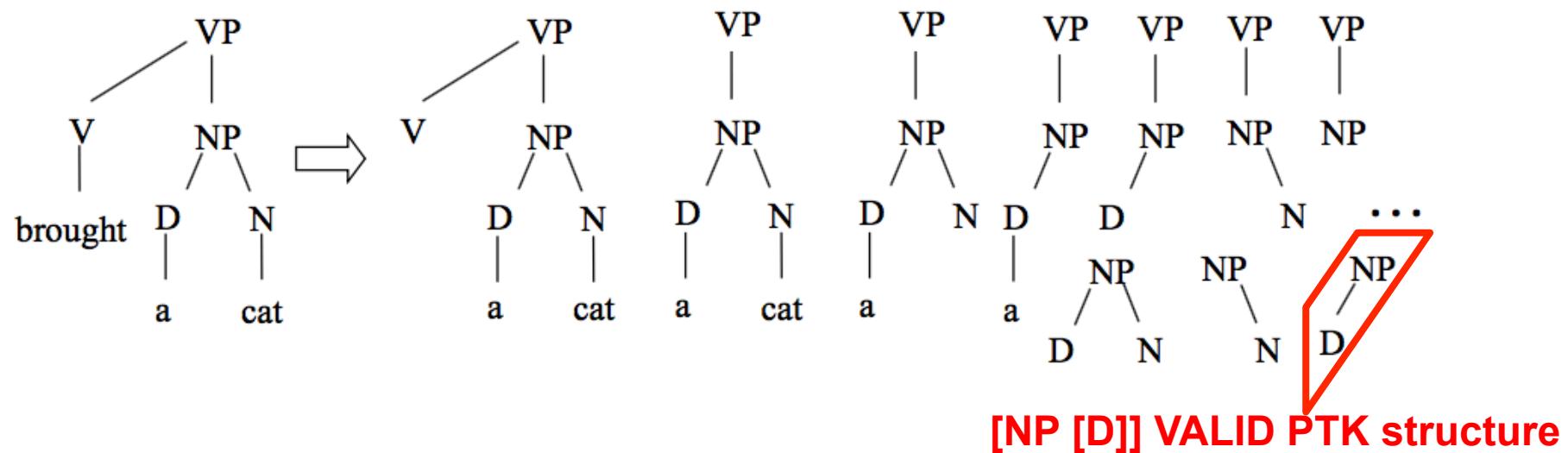


- Both matched pairs give the same contribution
- Gap based weighting is needed
- A novel efficient evaluation has to be defined

# Partial tree kernel

(Moschitti, 2006)

- STK + String Kernel with weighted gaps on nodes' children



# Outline

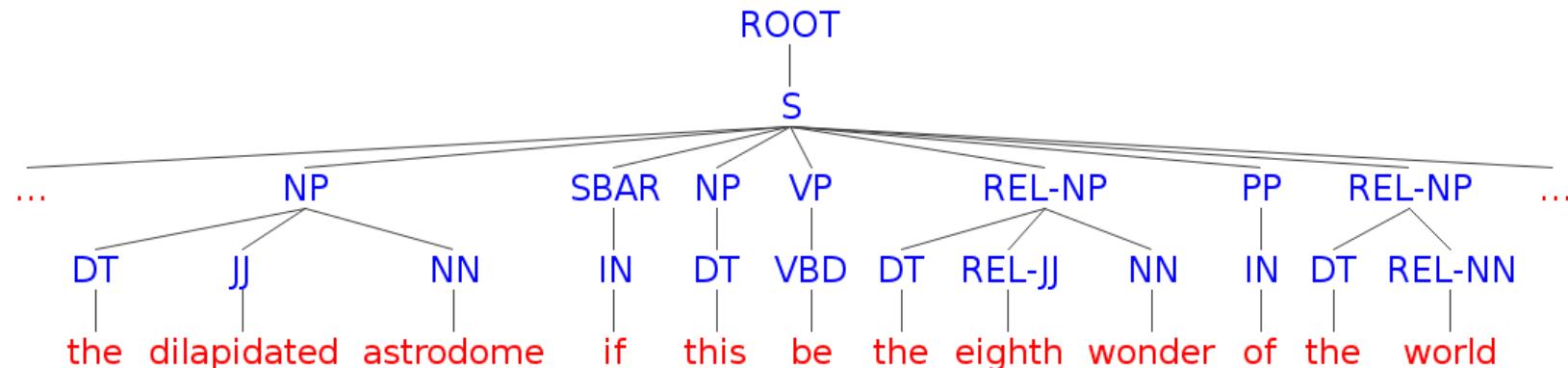
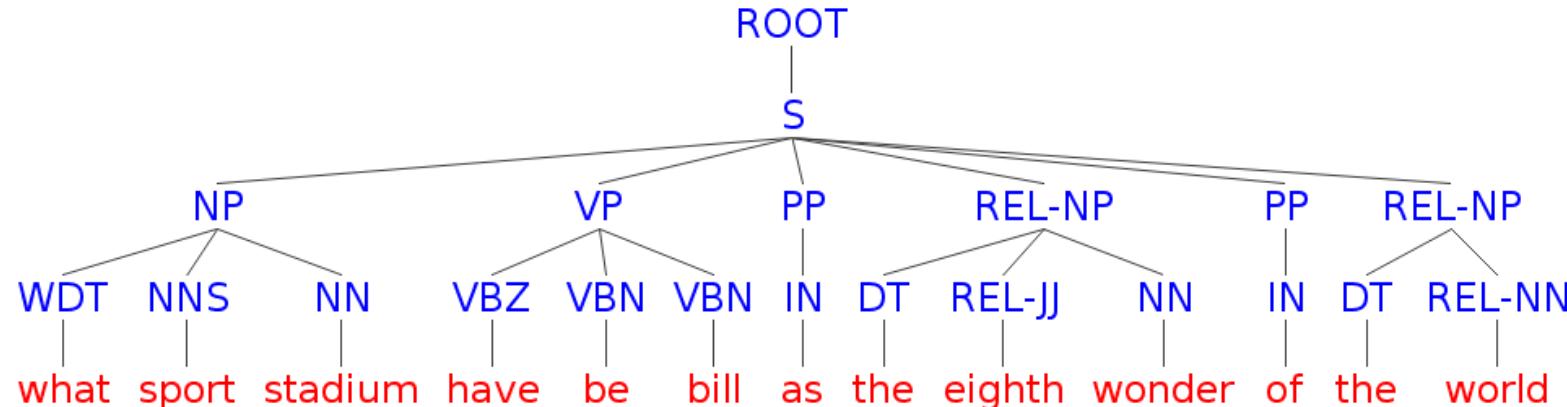
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(Severyn & Moschitti, SIGIR2012)

Q

What sports stadium has been billed as “the eighth wonder of the world”?



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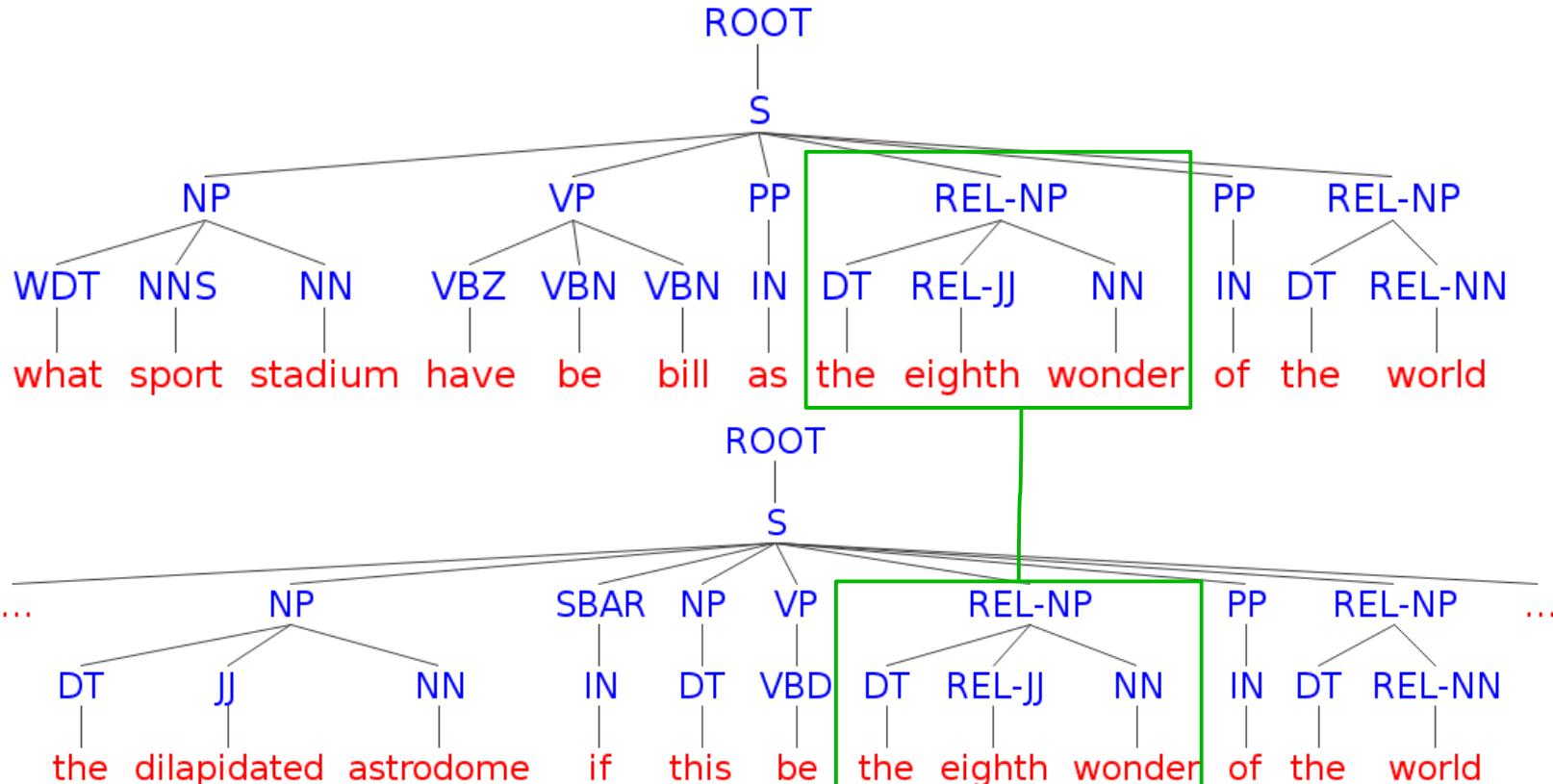
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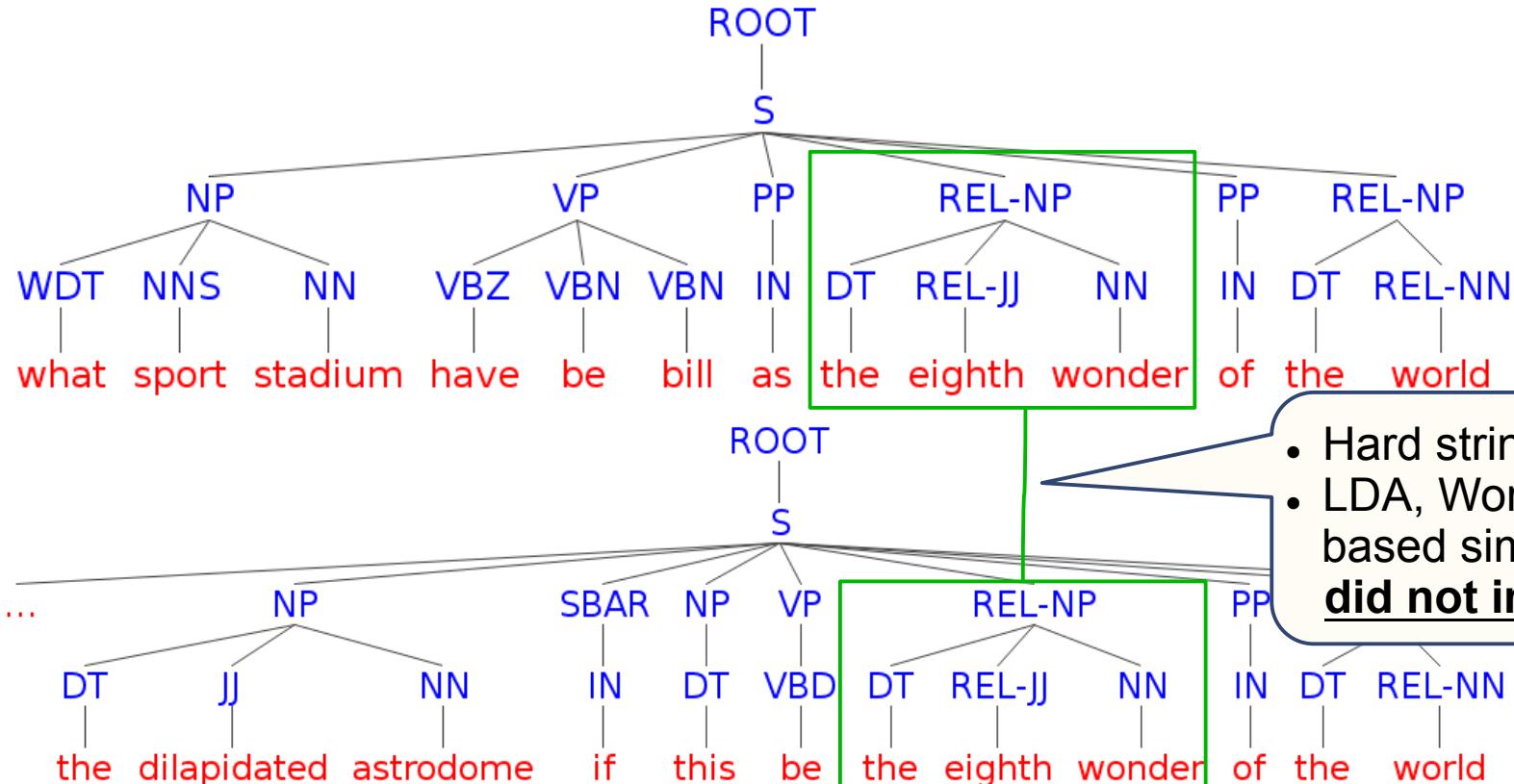
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# CH+FREL

(Severyn et al., 2013)

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FOCUS and  
Question Class  
derived by  
classifiers

ROOT

S

REL-FOCUS-LOC-NP

VP

PP

REL-NP

PP

REL-NP

WDT

NNS

NN

VBZ

VBN

VBN

IN

DT

REL-JJ

NN

IN

DT

REL-NN

what

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ROOT

S

... REL-FOCUS-LOC-NP

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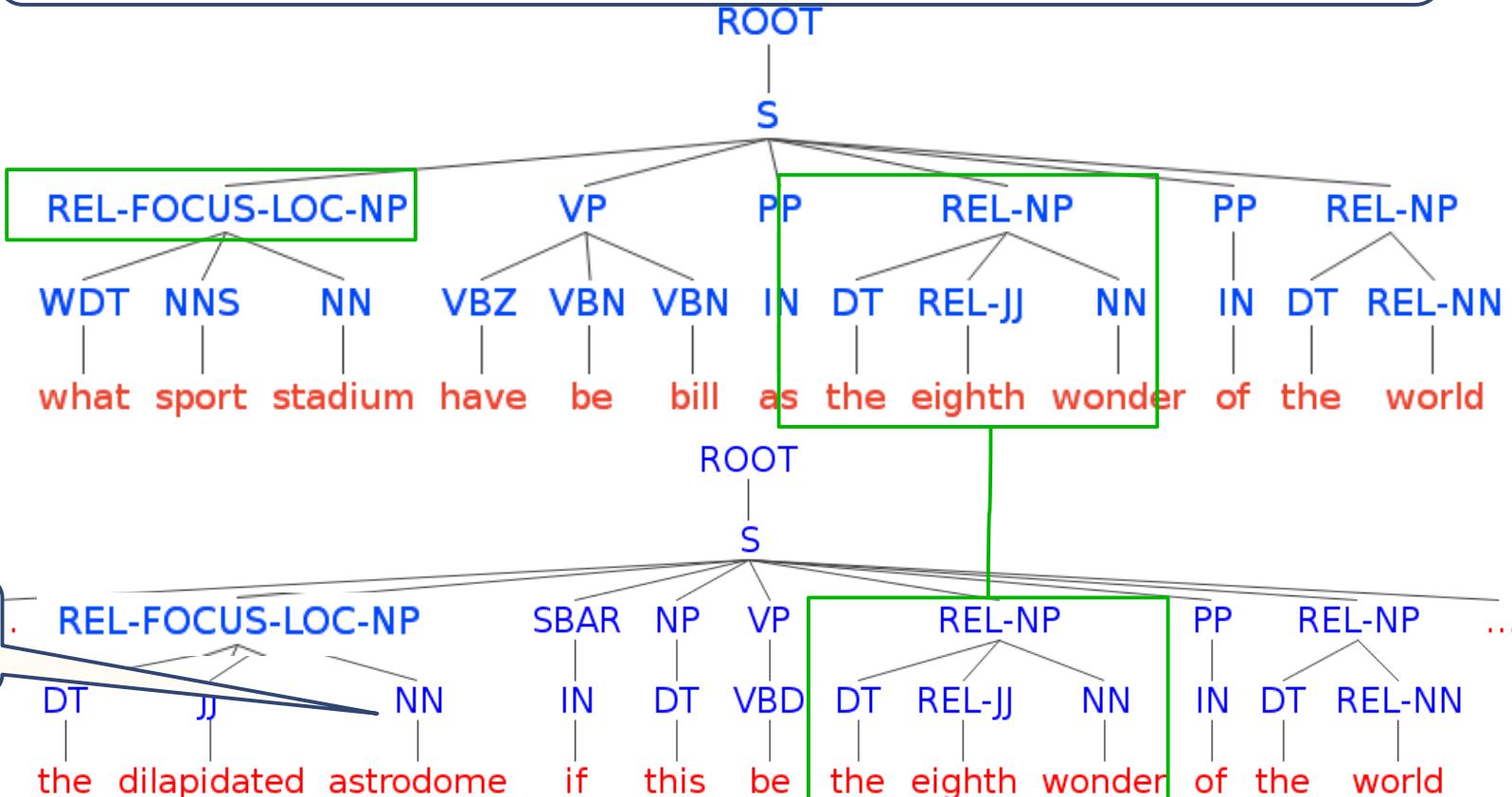
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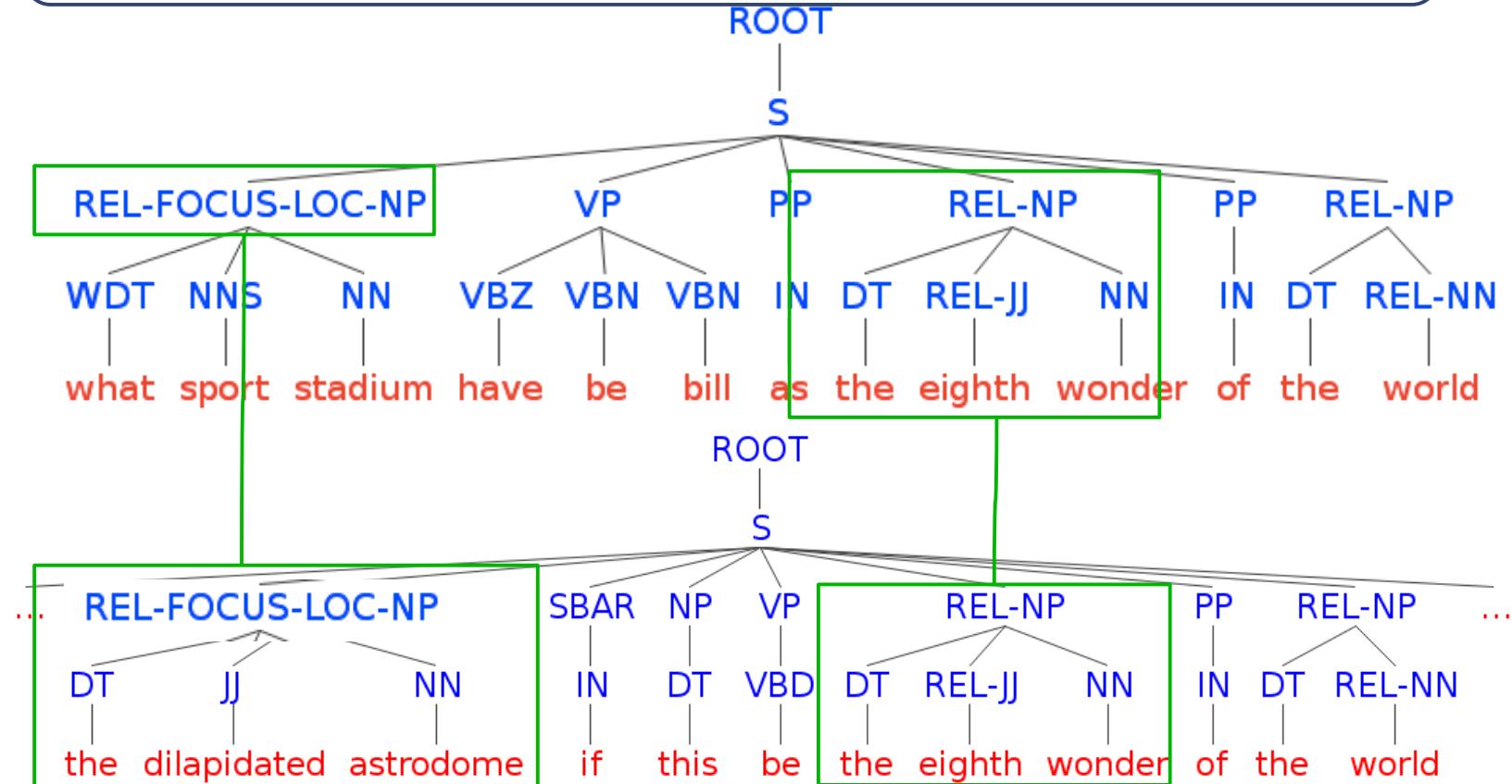
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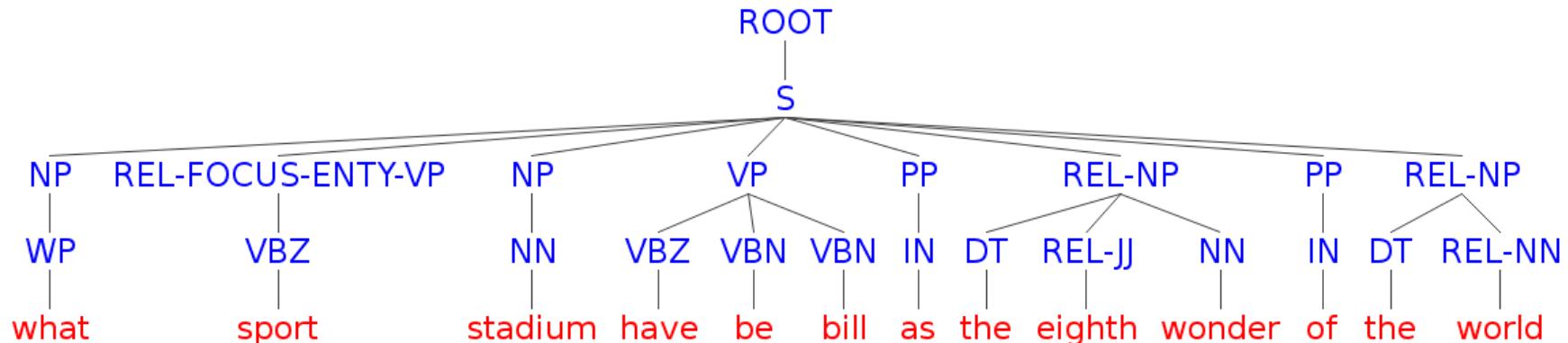
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# Type match intuition

(Tymoshenko et al., 2014)

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What sports **stadium** has been billed as “the eighth wonder of the world”?



ROOT

S

NP    REL-FOCUS-ENTY-VP    NP    VP    PP    REL-NP    PP    REL-NP  
WP                              VBZ    NN    VBZ    VBN    VBN    IN    DT    REL-JJ    NN    IN    DT    REL-NN  
what                            sport    stadium    have    be    bill    as    the    eighth    wonder    of    the    world

ROOT

S

...    NP    SBAR    NP    VP    REL-NP    PP    REL-NP    ...  
DT    JJ    NN    IN    DT    VBD    DT    REL-JJ    NN    IN    DT    REL-NN  
the    dilapidated    astrodome    if    this    be    the    eighth    wonder    of    the    world

A

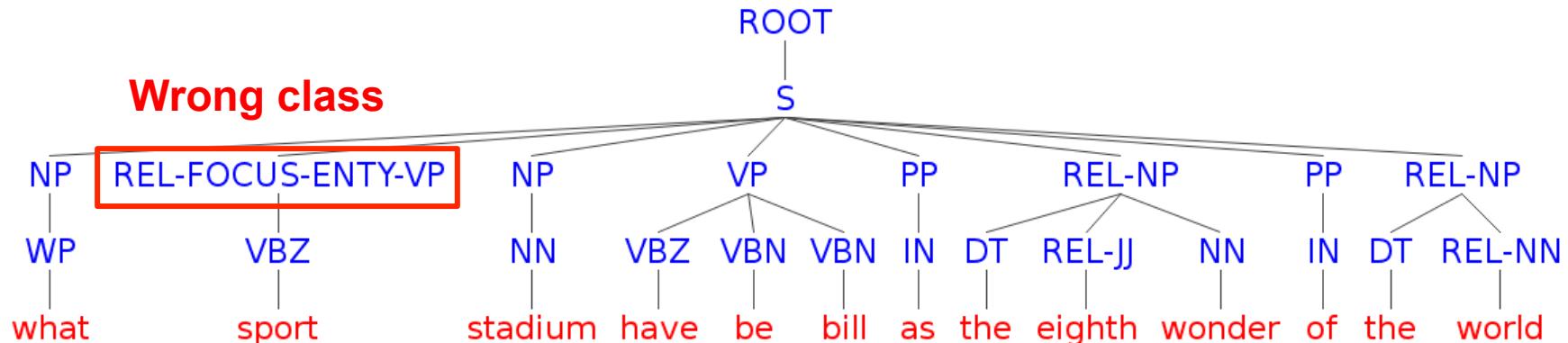
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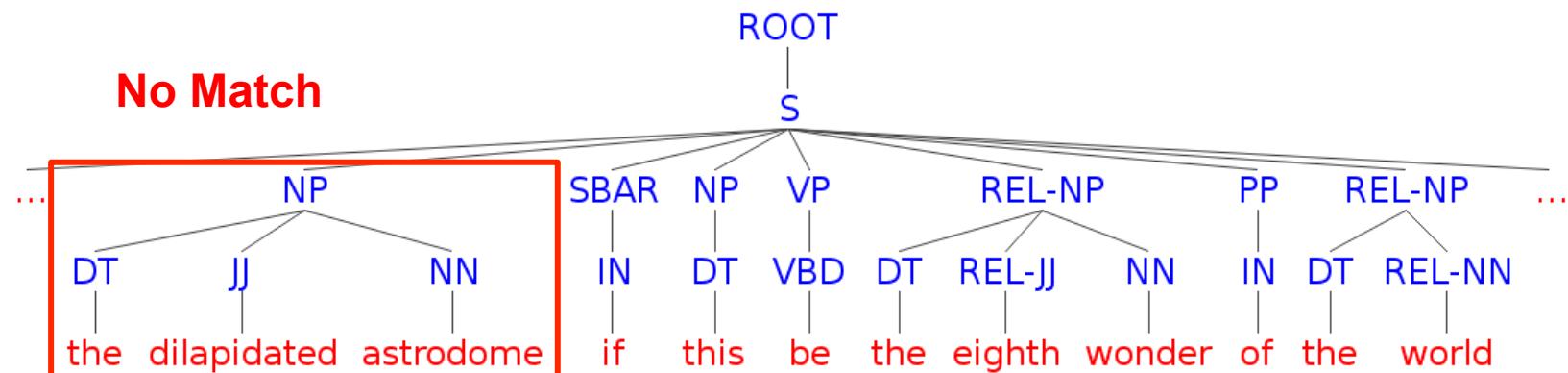
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**No Match**



A

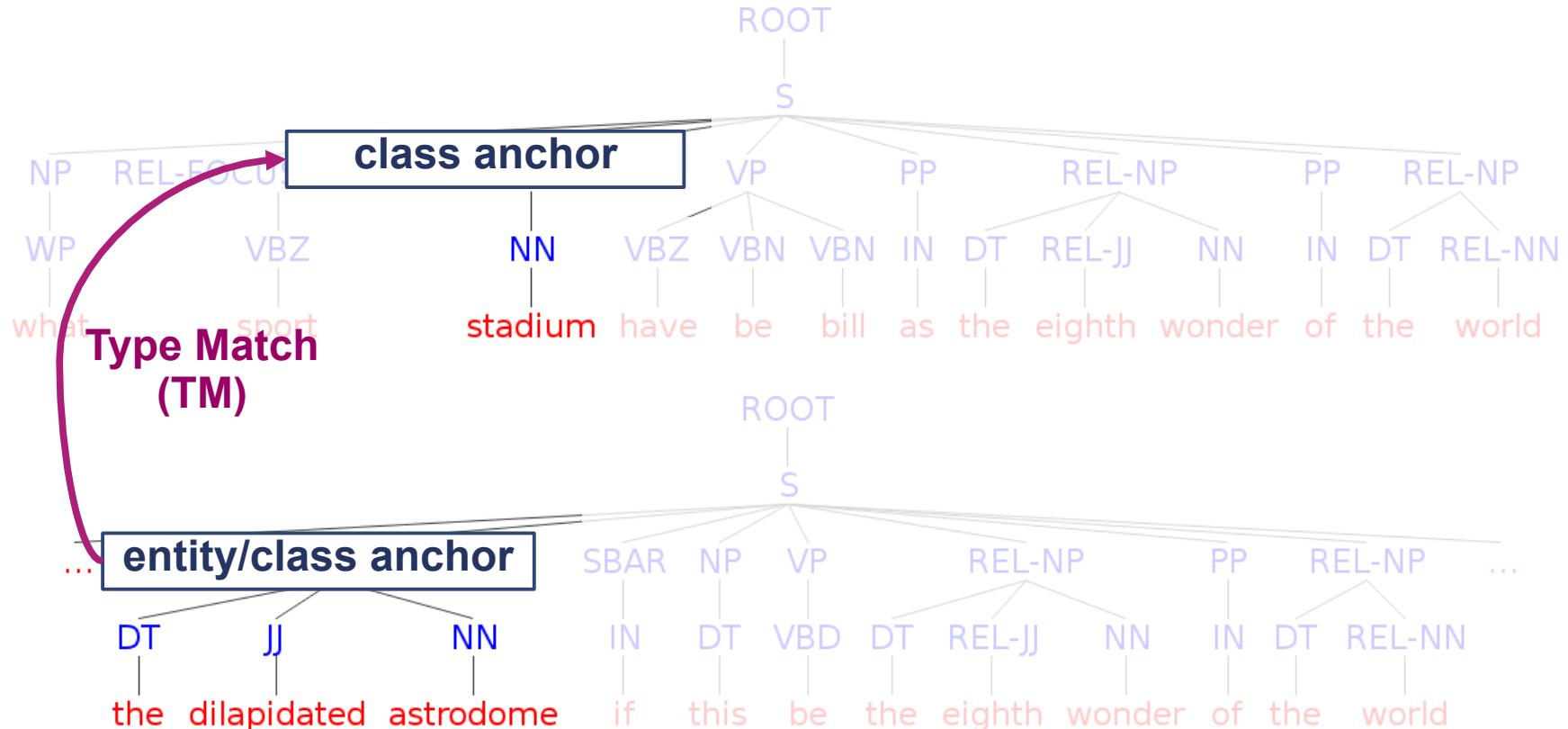
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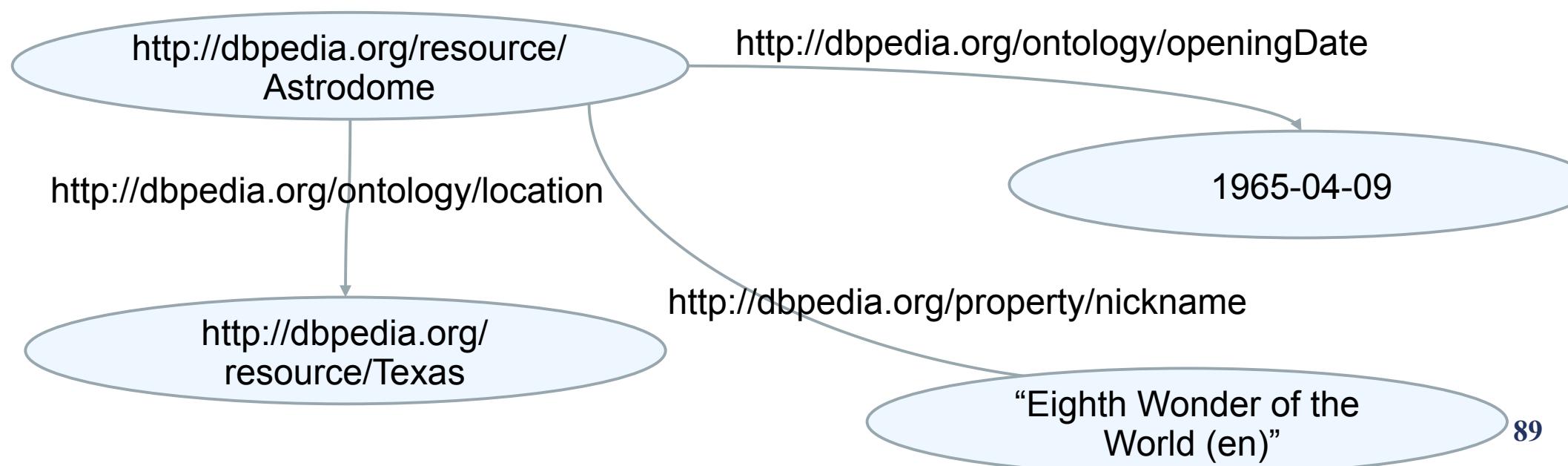
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# Linked Open Data

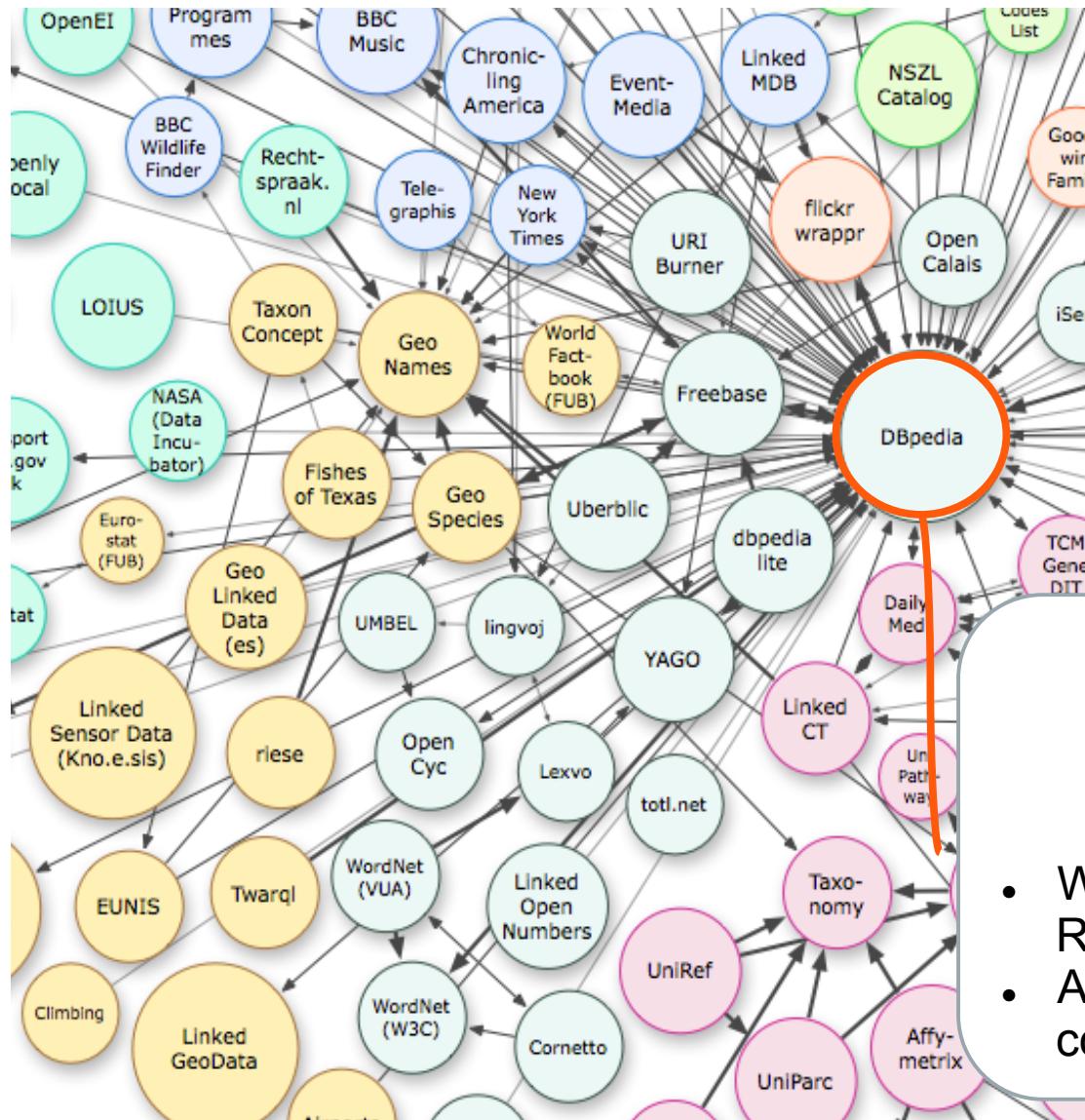
- Structured knowledge published according to LOD principles
  - organized as directed graph/statements
  - can be queried using SPARQL language
  - commonly shared knowledge schemes
    - ❖ rdfs:subClassOf, rdf:type, rdf:label

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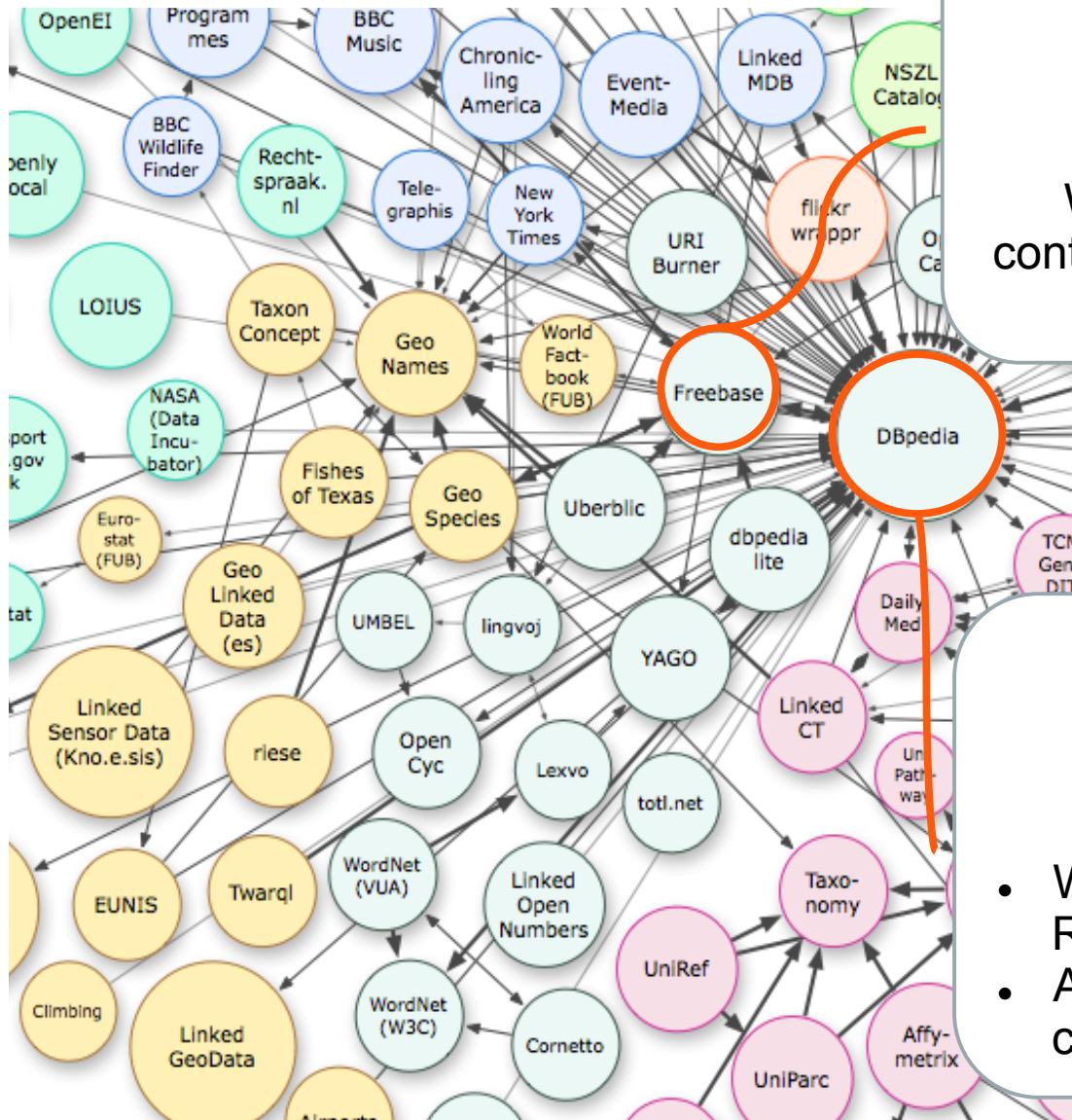


# LOD datasets



- Wikipedia converted to RDF
- Aligned to Wikipedia on concept-level

# LOD datasets



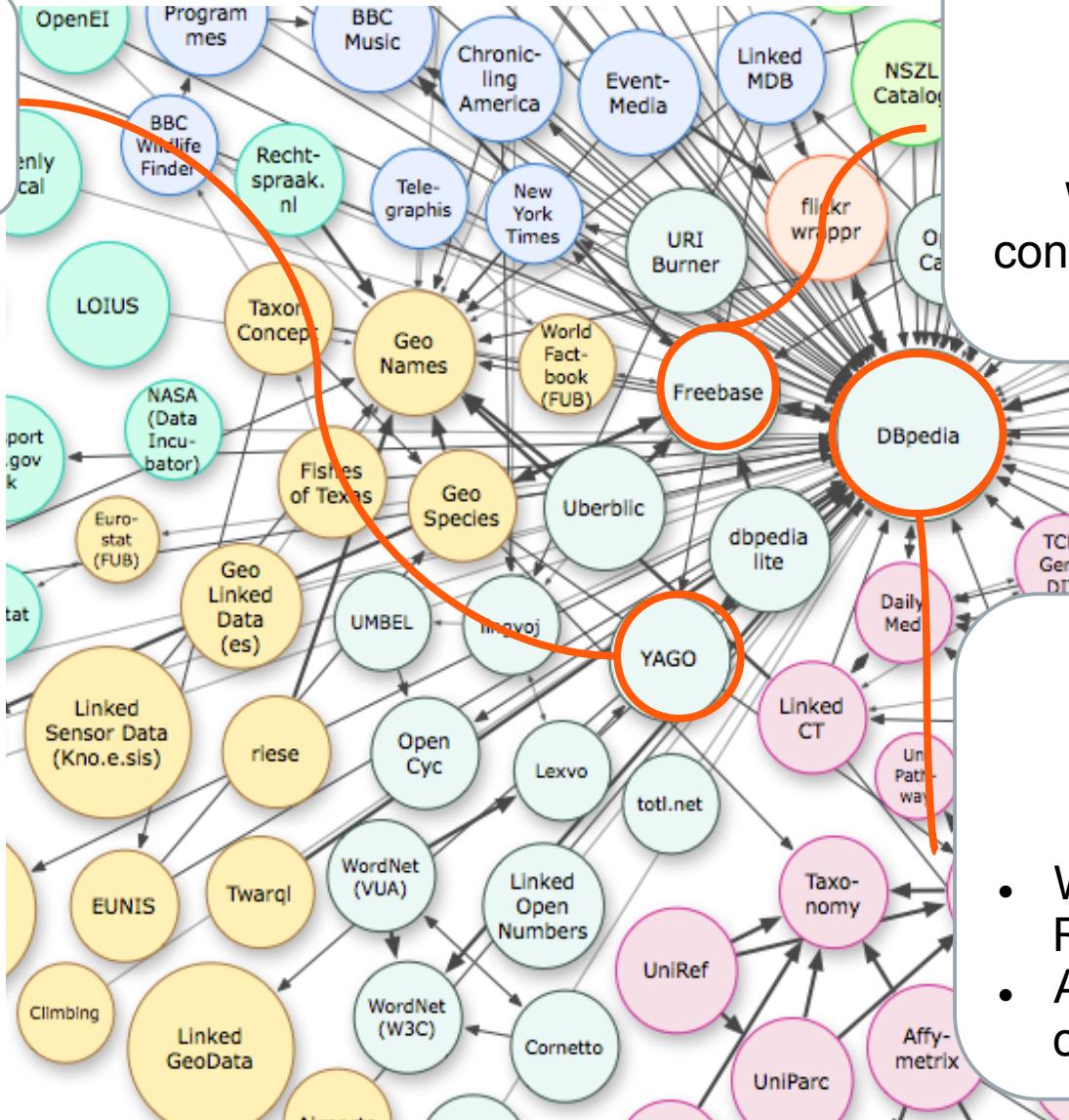
Wikipedia + human  
contributors + MusicBranz  
+ OurAirports +...



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**YAGO**  
Wikipedia + Wordnet



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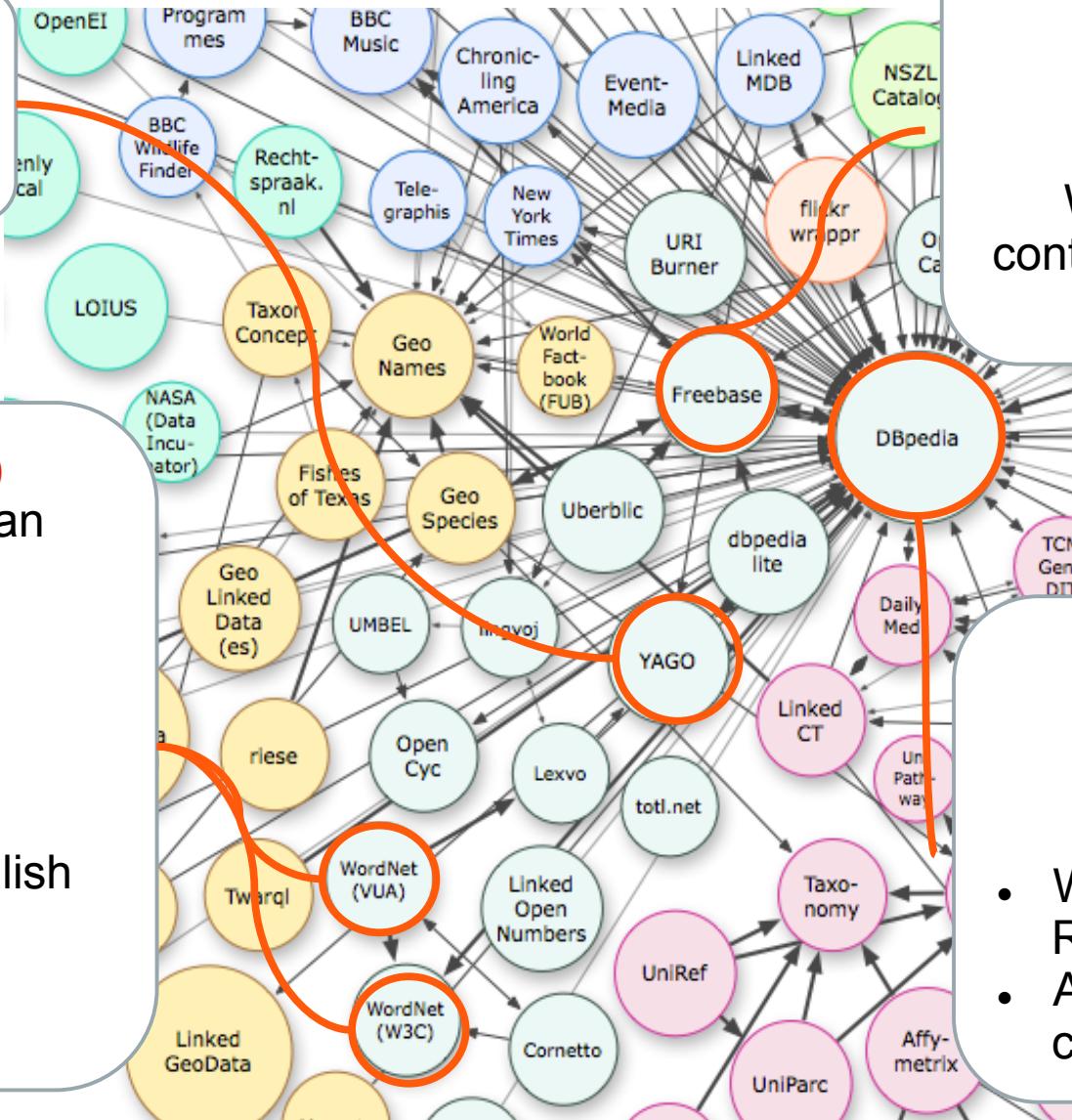


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# LOD datasets

**YAGO**  
Wikipedia + Wordnet

- **WordNet (W3C)**  
(WordNet 2.0 [Van Assem et al.])
- **WordNet (VUA)**  
(WordNet 3.0)
- Large lexical database of English  
(synonymy/antonymy/hypernymy)



**Freebase**

Wikipedia + human  
contributors + MusicBranz  
+ OurAirports +...

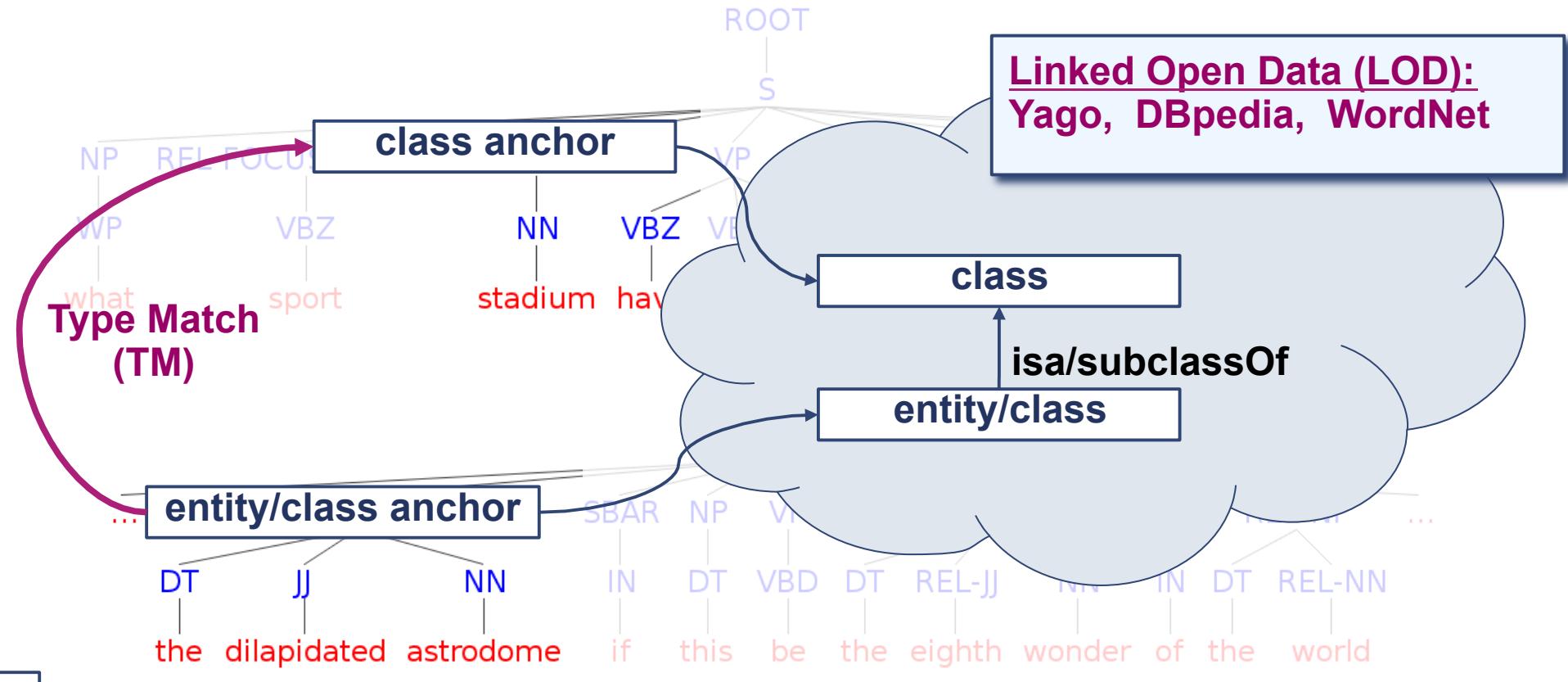
**DBpedia**

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## Astrodome

From Wikipedia, the free encyclopedia Coordinates:  29°41'6"N 95°24'28"W

This article is about the stadium in Houston, Texas. For aeronautical use, see [Astrodome \(aeronautics\)](#).

The **Astrodome**, also known as the **Houston Astrodome**, and officially named the **NRG** **Astrodome**, is the world's first multi-purpose, domed sports stadium, located in Houston, Texas, USA. It served as the second home to the [Houston Astros](#) of Major League Baseball.

**Astrodome**  
*Eighth Wonder of the World*



View of the Astrodome in Houston from a parking lot near NRG Arena in 2014

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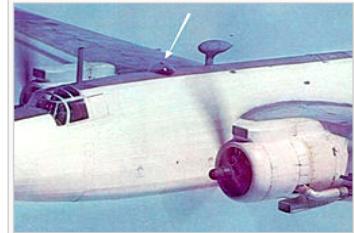
## Astrodome (aeronautics)

From Wikipedia, the free encyclopedia

This article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed. (July 2012)

An **astrodome** is a hemispherical transparent dome fitted in the cabin roof of an aircraft to allow the use of a sextant during astro-navigation.<sup>[1]</sup>

Prior to the introduction of electronic means of navigation the only way to fix an aircraft's position at night was by taking star sights using a sextant in



The astrodome (arrowed) on a Warwick B/ASR Mk 1

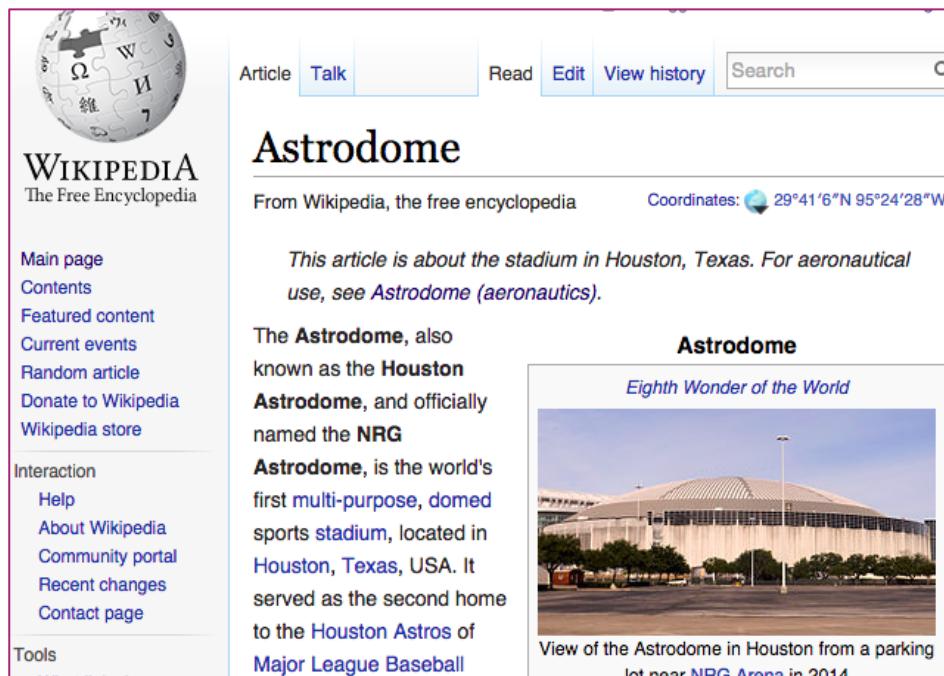
A

The Titans played in the dilapidated **Astrodome**; if this was the eighth wonder of the world, we live on a shabby little planet indeed.

# Matching algorithm

Q

What sports **stadium** has been billed as “the eighth wonder of the world”?



The screenshot shows the Wikipedia article for the Astrodome. The page title is "Astrodome". Below the title, it says "From Wikipedia, the free encyclopedia" and "Coordinates: 29°41'6"N 95°24'28"W". A note at the top states: "This article is about the stadium in Houston, Texas. For aeronautical use, see [Astrodome \(aeronautics\)](#)". The main text describes the Astrodome as the world's first multi-purpose, domed sports stadium, located in Houston, Texas, USA. It served as the second home to the Houston Astros of Major League Baseball. To the right of the text is a thumbnail image of the Astrodome, labeled "Astrodome" and "Eighth Wonder of the World". Below the image is a caption: "View of the Astrodome in Houston from a parking lot near NRG Arena in 2014".



A

The Titans played in the dilapidated **Astrodome**; if this was the eighth wonder of the world, we live on a shabby little planet indeed.

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Q

What sports **stadium** has been billed as “the eighth wonder of the world”?

yago:Reliant\_Astrodome



A

The Titans played in the dilapidated **Astrodome**; if this was the eighth wonder of the world, we live on a shabby little planet indeed.

# Matching algorithm

Q

What sports **stadium** has been billed as “the eighth wonder of the world”?

yago:Reliant\_Astrodom



yago:wikicat\_Covered\_stadiums

yago:wordnet\_stadium\_104295881

YAGO

A

The Titans played in the dilapidated **Astrodom**; if this was the eighth wonder of the world, we live on a shabby little planet indeed.

# Matching algorithm

Q

What sports **stadium** has been billed as “the eighth wonder of the world”?

yago:Reliant\_Astrodom



A

The Titans played in the dilapidated **Astrodom**; if this was the eighth wonder of the world, we live on a shabby little planet indeed.

yago:wordnet\_stadium\_104295881

"stadium"@eng

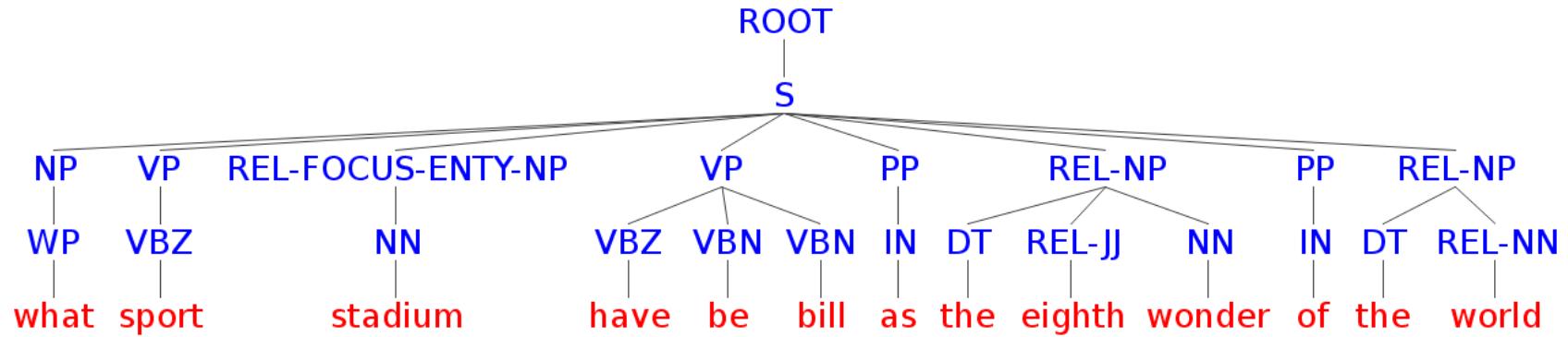
yago:wikicat\_Covered\_stadiums

YAGO

# Encoding type match

Q

What sports **stadium** has been billed as “the eighth wonder of the world”?



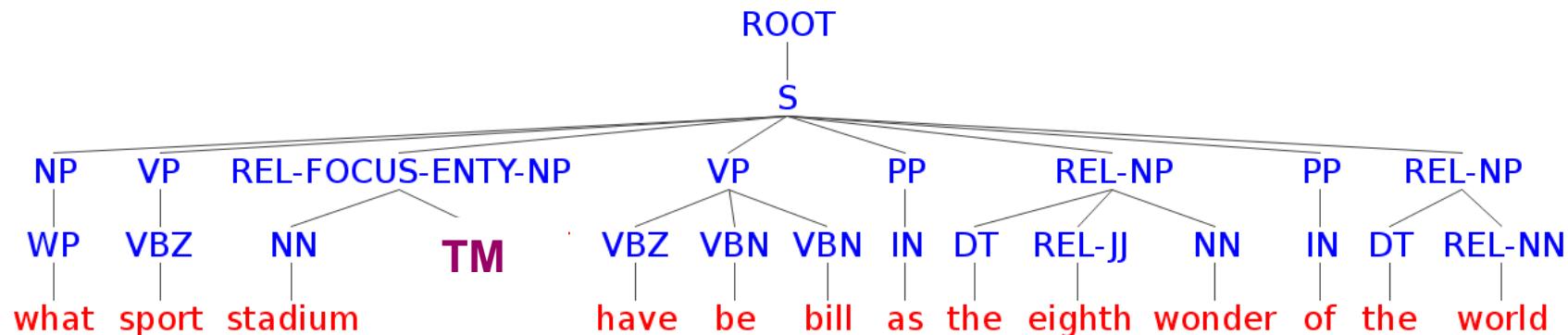
A

The Titans played in the dilapidated **Astrodomo**; if this was the eighth wonder of the world, we live on a shabby little planet indeed.

# Encoding type match: TM

Q

What sports **stadium** has been billed as “the eighth wonder of the world”?



ROOT  
S

NP VP REL-FOCUS-ENTY-NP VP PP REL-NP PP REL-NP  
WP VBZ NN TM VBZ VBN VBN IN DT REL-JJ NN IN DT REL-NN  
what sport stadium have be bill as the eighth wonder of the the world

ROOT  
S

... NP SBAR NP VP REL-NP PP REL-NP ...  
DT IN DT VBD DT REL-JJ NN IN DT REL-NN  
the dilapidated if this be the eighth wonder of the world

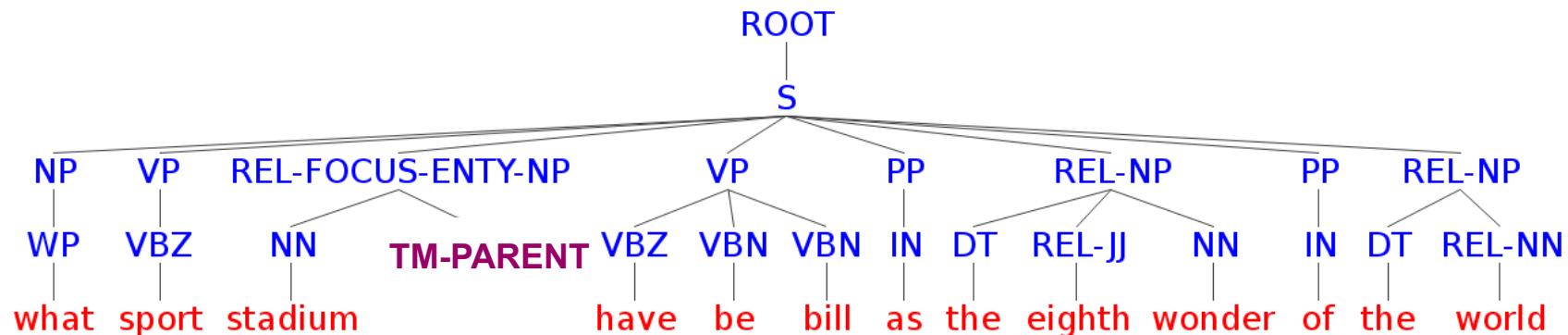
A

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# Encoding type match: TMND

Q

What sports **stadium** has been billed as “the eighth wonder of the world”?



ROOT  
S

NP VP REL-FOCUS-ENTY-NP VP PP REL-NP PP REL-NP  
WP VBZ NN TM-PARENT VBZ VBN VBN IN DT REL-JJ NN IN DT REL-NN  
what sport stadium have be bill as the eighth wonder of the the world

ROOT  
S

... NP SBAR NP VP REL-NP PP REL-NP ...  
DT IN DT VBD DT REL-JJ NN IN DT REL-NN  
the dilapidated if this be the eighth wonder of the world

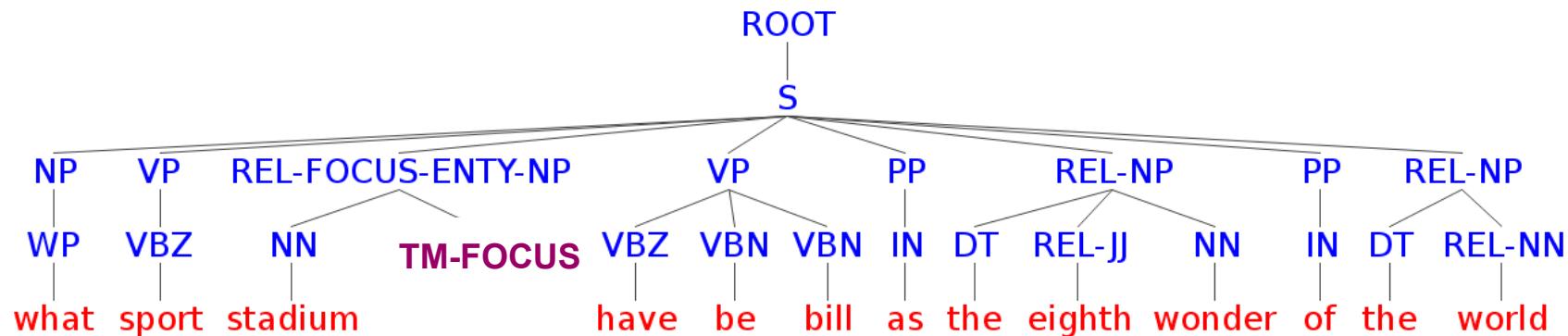
A

The Titans played in the dilapidated **Astrodomo**; if this was the eighth wonder of the world, we live on a shabby little planet indeed.

# Encoding type match: TMNF

Q

What sports **stadium** has been billed as “the eighth wonder of the world”?



ROOT  
S

NP VP REL-FOCUS-ENTY-NP VP PP REL-NP PP REL-NP  
WP VBZ NN TM-FOCUS VBZ VBN VBN IN DT REL-JJ NN IN DT REL-NN  
what sport stadium have be bill as the eighth wonder of the the world

ROOT  
S

... NP SBAR NP VP REL-NP PP REL-NP ...  
DT IN DT VBD DT REL-JJ NN IN DT REL-NN  
the dilapidated if this be the eighth wonder of the world

A

The Titans played in the dilapidated **AstroDome**; if this was the eighth wonder of the world, we live on a shabby little planet indeed.

# Dependency representations

What sports stadium has been billed as “the eighth wonder of the world”?

- **case(world,of)**
- **nsubjpass(billed,stadium)**
- **auxpass(billed,been)**
- **nmod(wonder,world)**
- **amod(wonder,eighth)**
- **det(world,the)**
- **punct(billed,?)**
- **root(ROOT, billed)**
- **det(wonder,the)**
- **punct(wonder,“)**
- **nmod(billed,wonder)**
- **case(wonder,as)**
- **aux(billed,has)**
- **compound(stadium,sports)**
- **det(stadium,What)**

# Dependency representations

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- **compound(stadium,sports)**
- **det(stadium,What)**

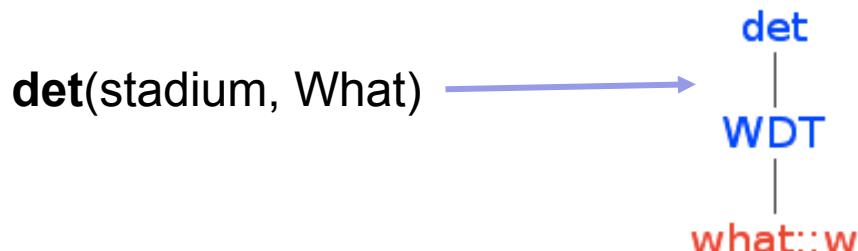
**We use dependency information to  
build several kinds of tree representations**

# Dependency Tree 1 (DT1)

(Severyn et al., 2013)

Q

What sports stadium has been billed as “the eighth wonder of the world”?

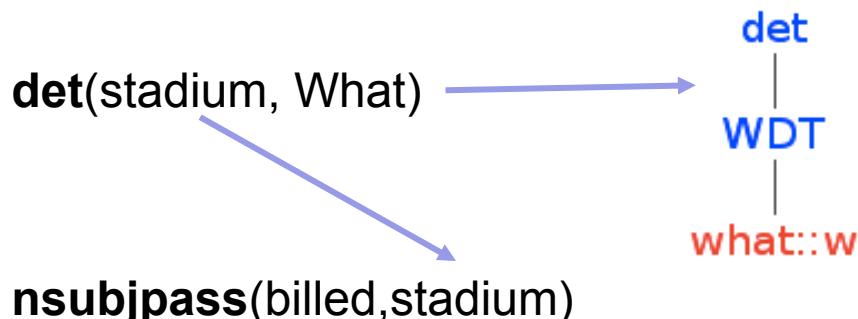


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(Severyn et al., 2013)

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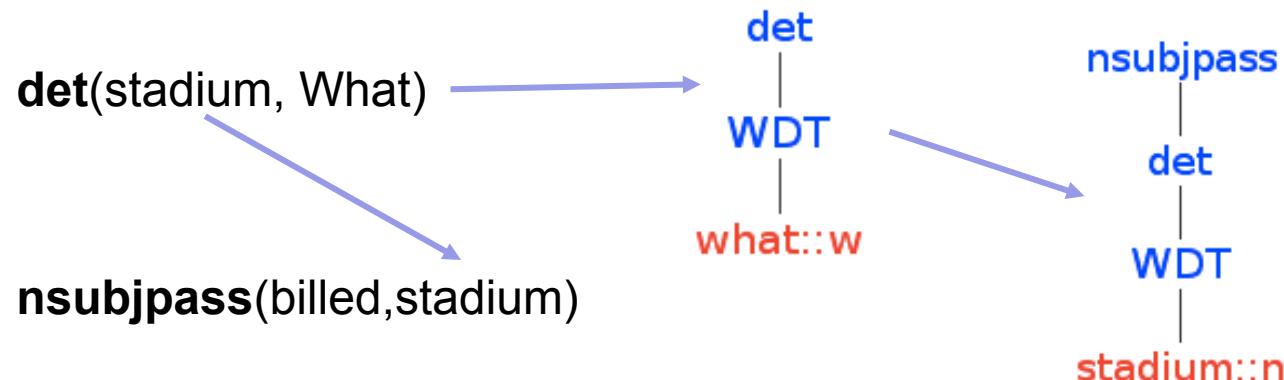


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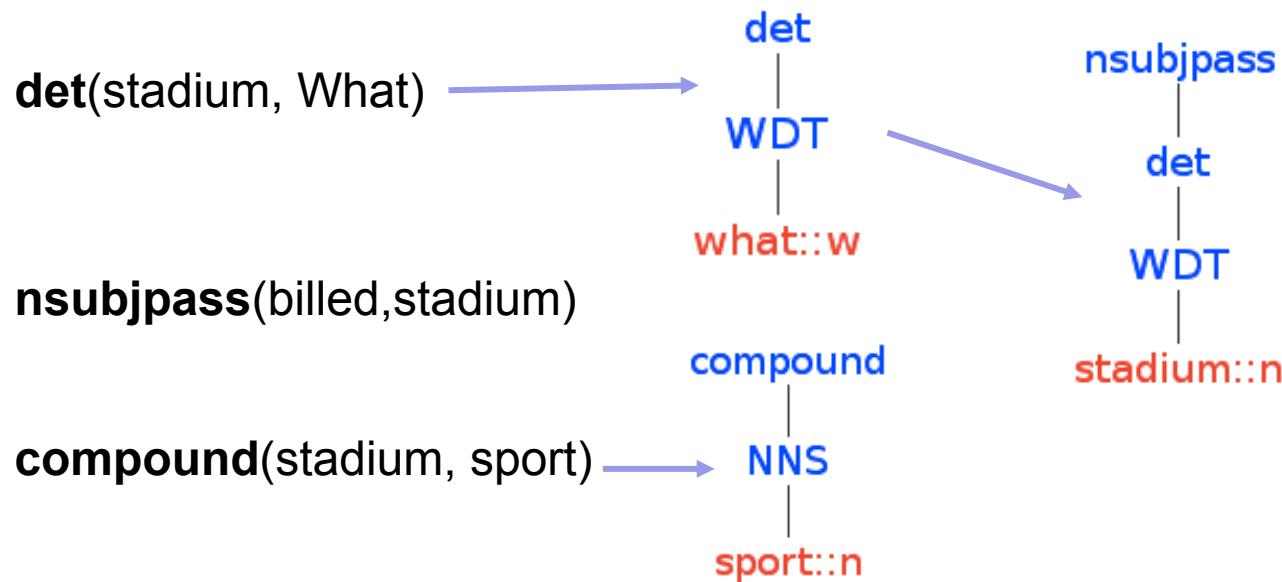


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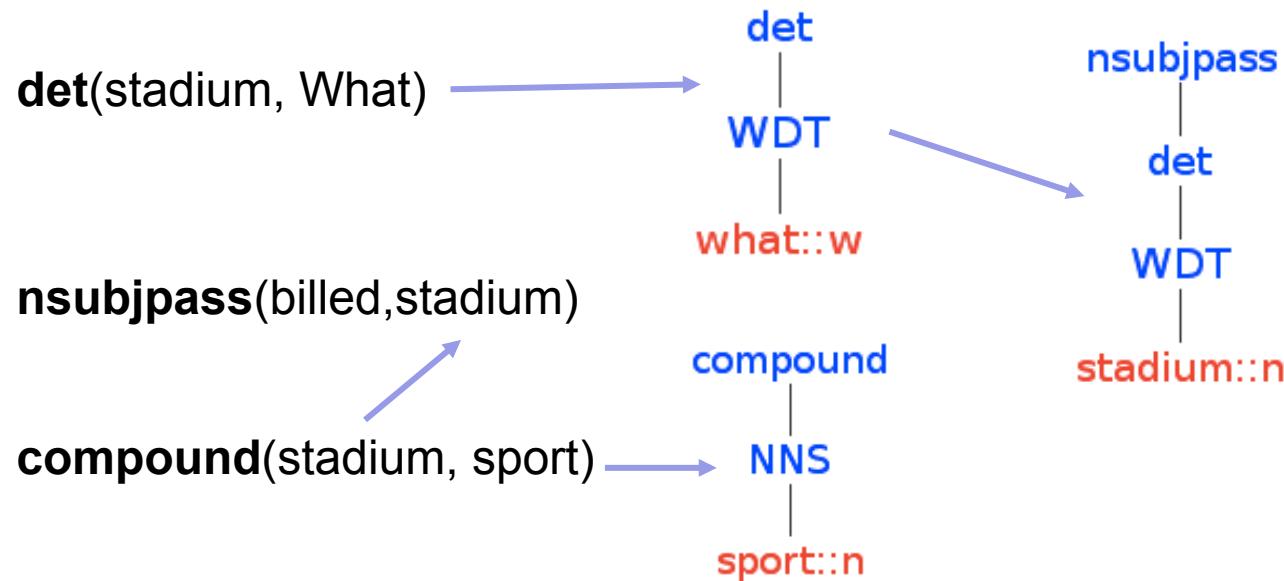


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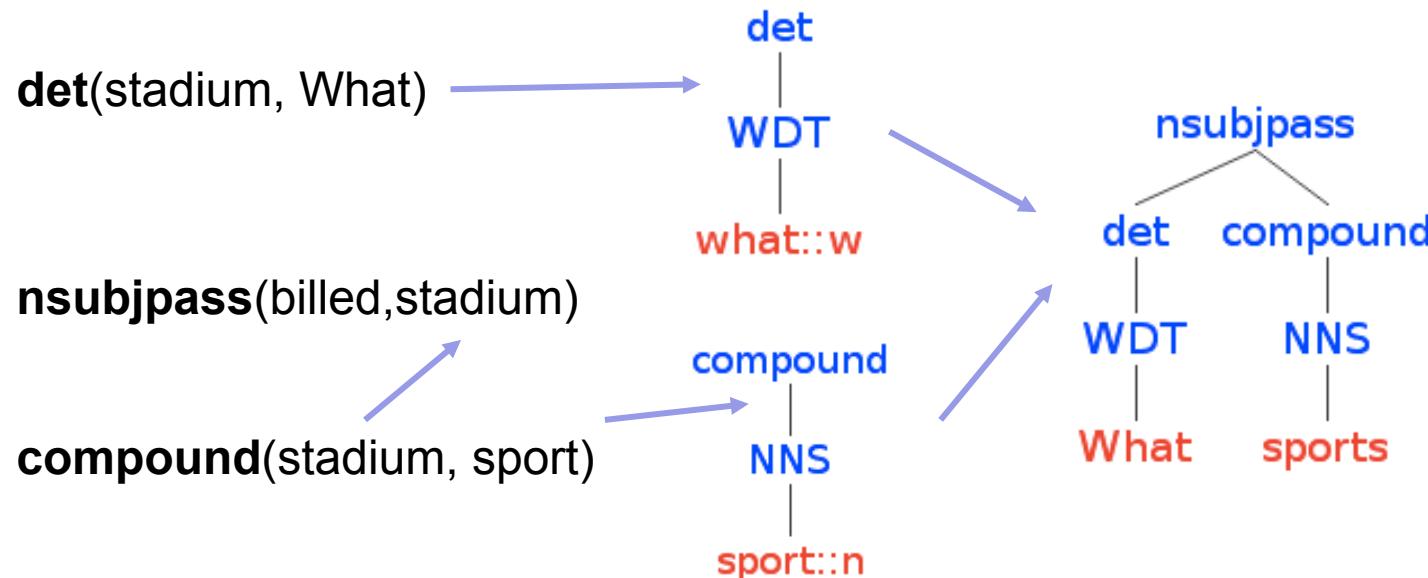


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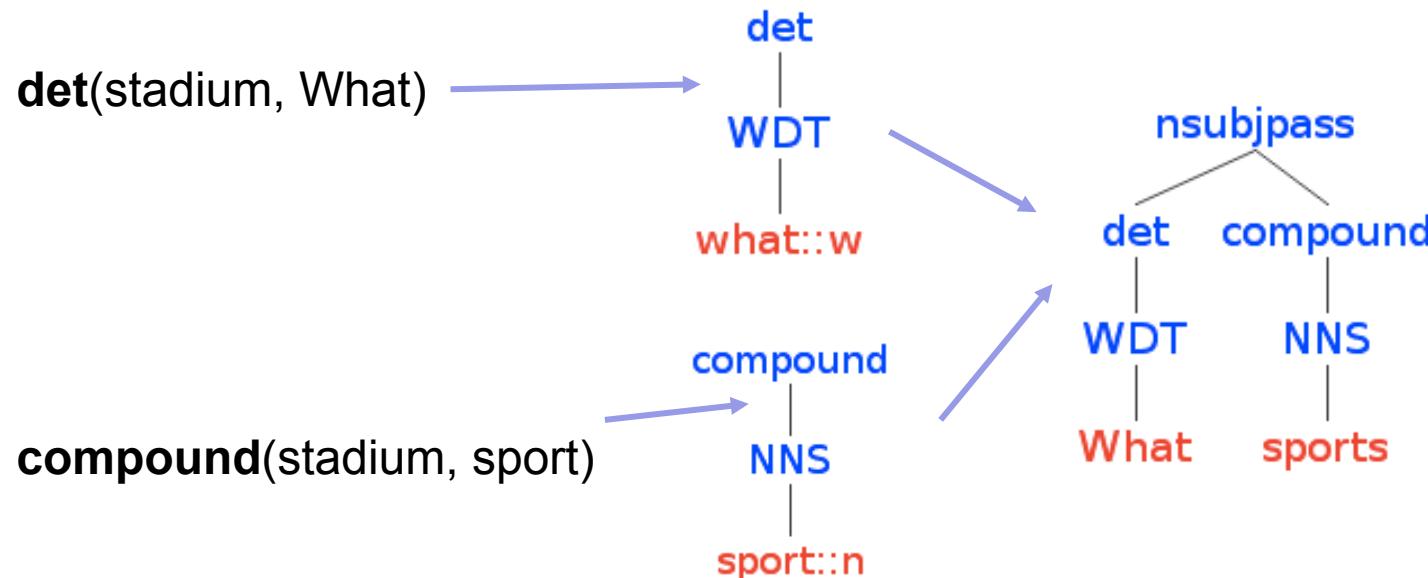


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What sports **stadium** has been billed as “the eighth wonder of the world”?



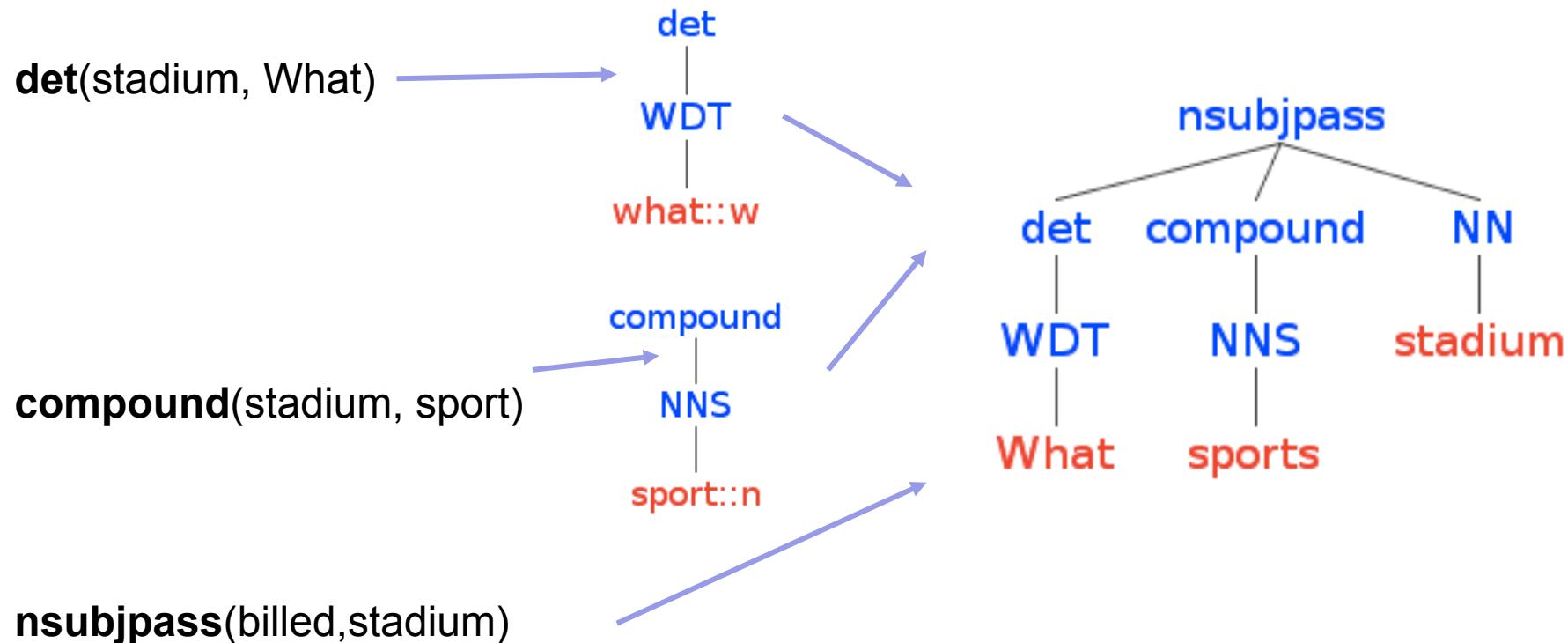
**nsubjpass(billed,stadium)**

# Dependency Tree 1 (DT1)

(Severyn et al., 2013)

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What sports **stadium** has been billed as “the eighth wonder of the world”?

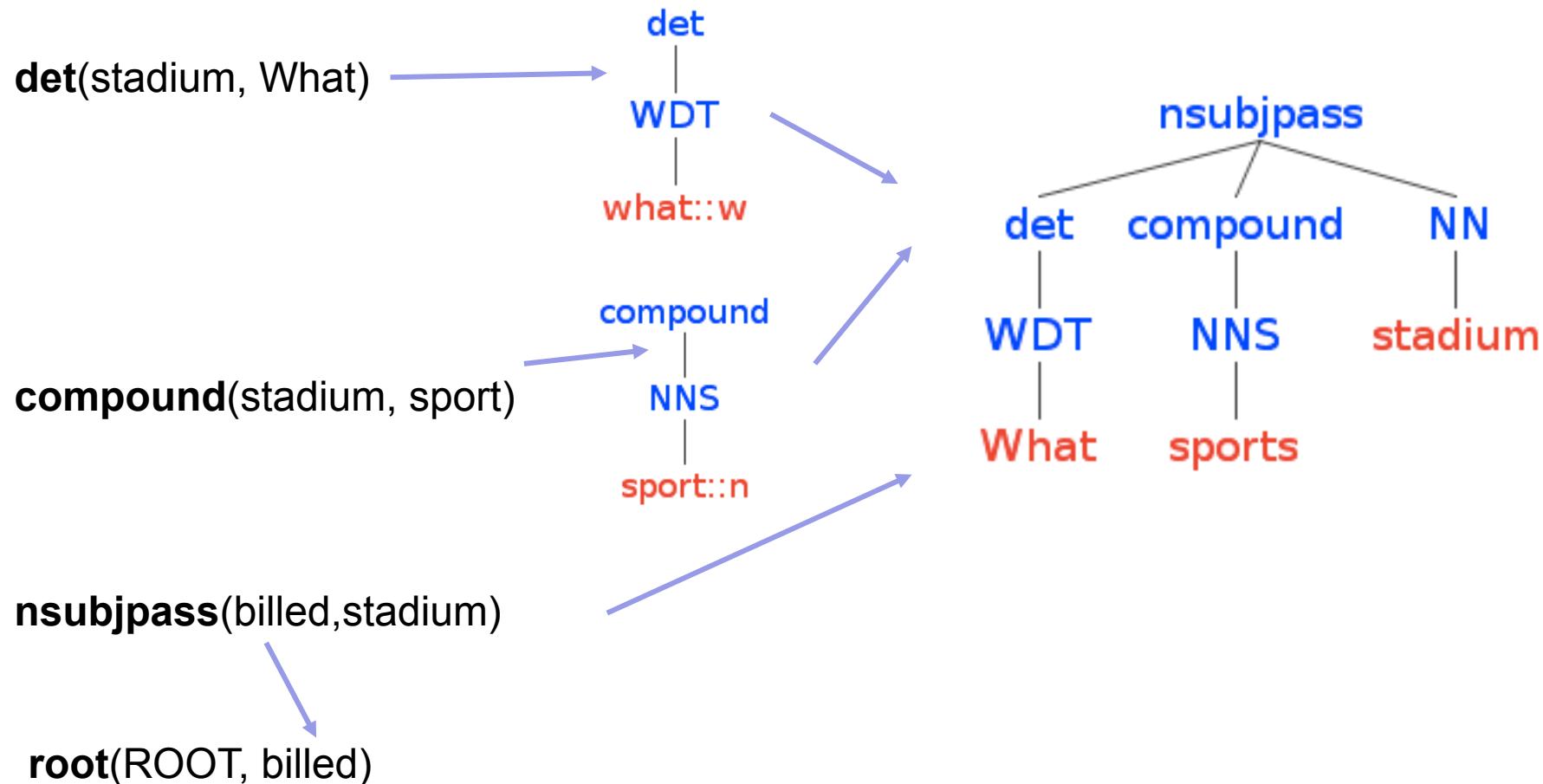


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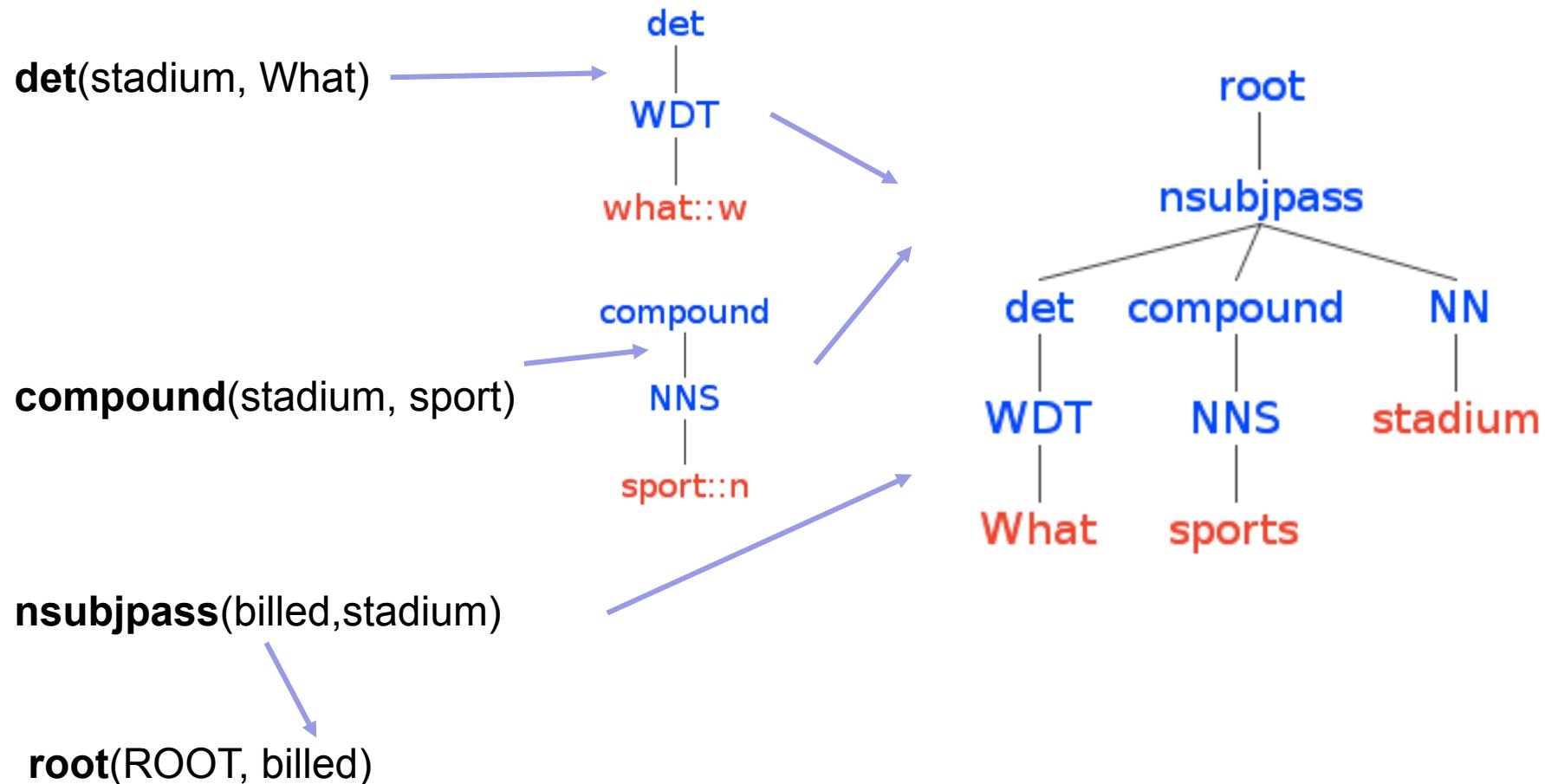


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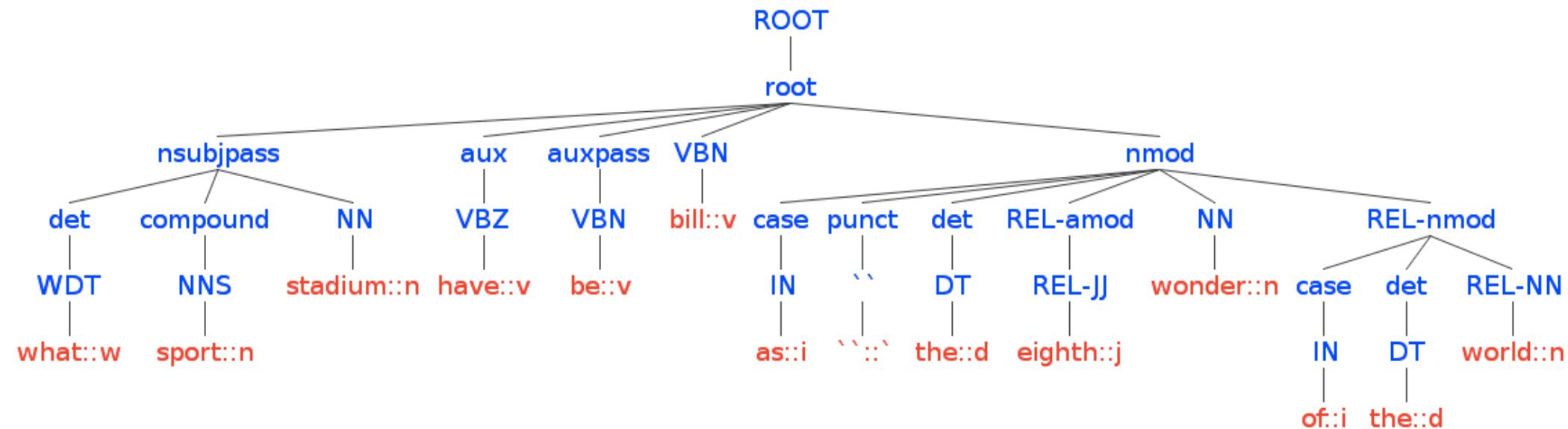


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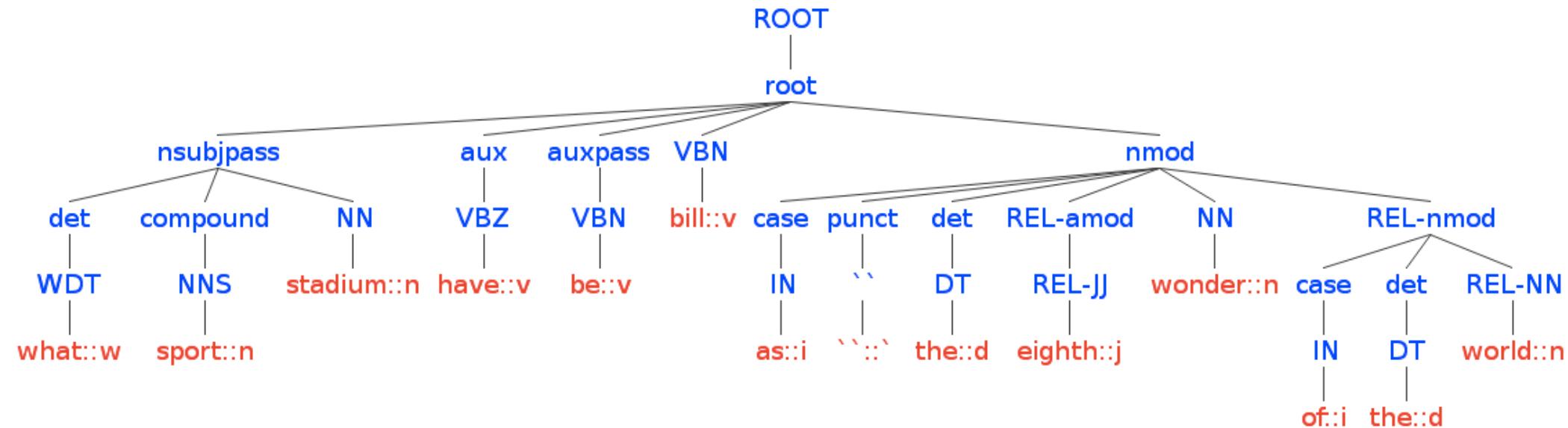


# Dependency Tree 1 (DT1)

(Severyn et al., 2013)

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What sports stadium has been billed as “the eighth wonder of the world”?



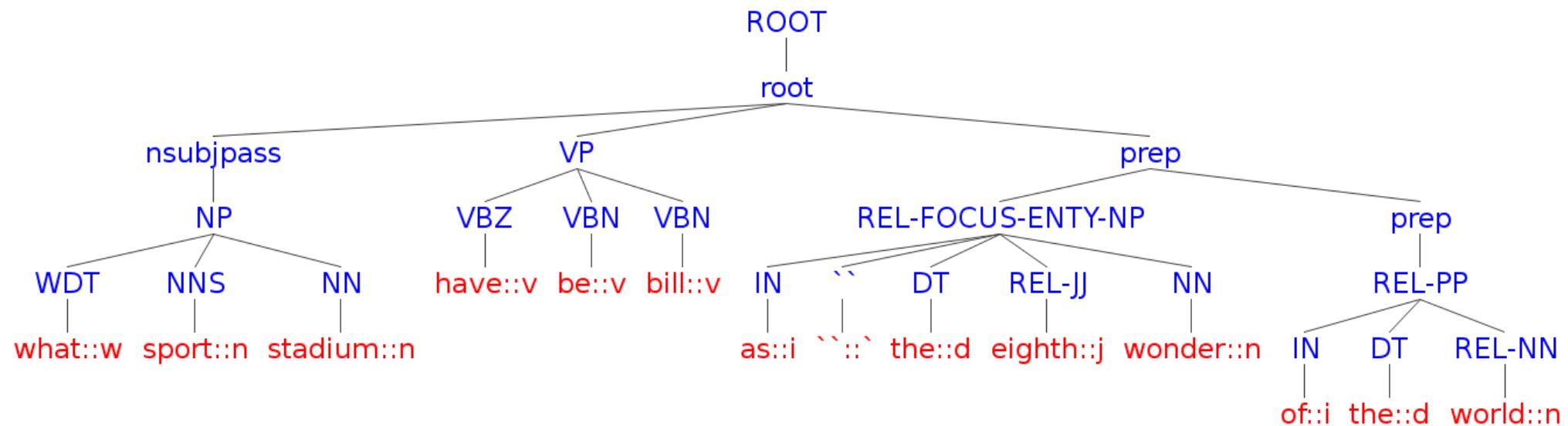
The structure is deep and may result in a too sparse feature space

# Dependency Tree 2 (DT2)

(Severyn, 2015) (Tymoshenko and Moschitti, 2015)

Q

What sports stadium has been billed as “the eighth wonder of the world”?



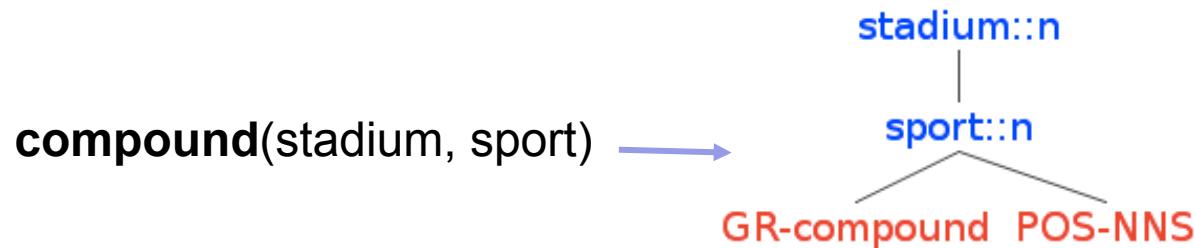
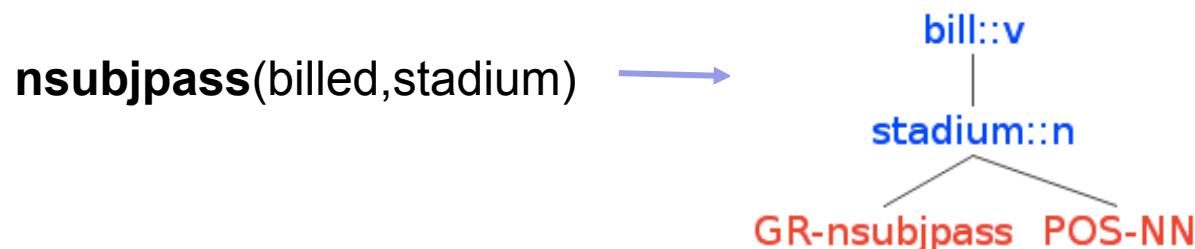
Flatten DT1 -> do not use dependency relations within a chunk

# Dependency Tree 3 (DT3)

(Croce et al., 2011)

Q

What sports stadium has been billed as “the eighth wonder of the world”?

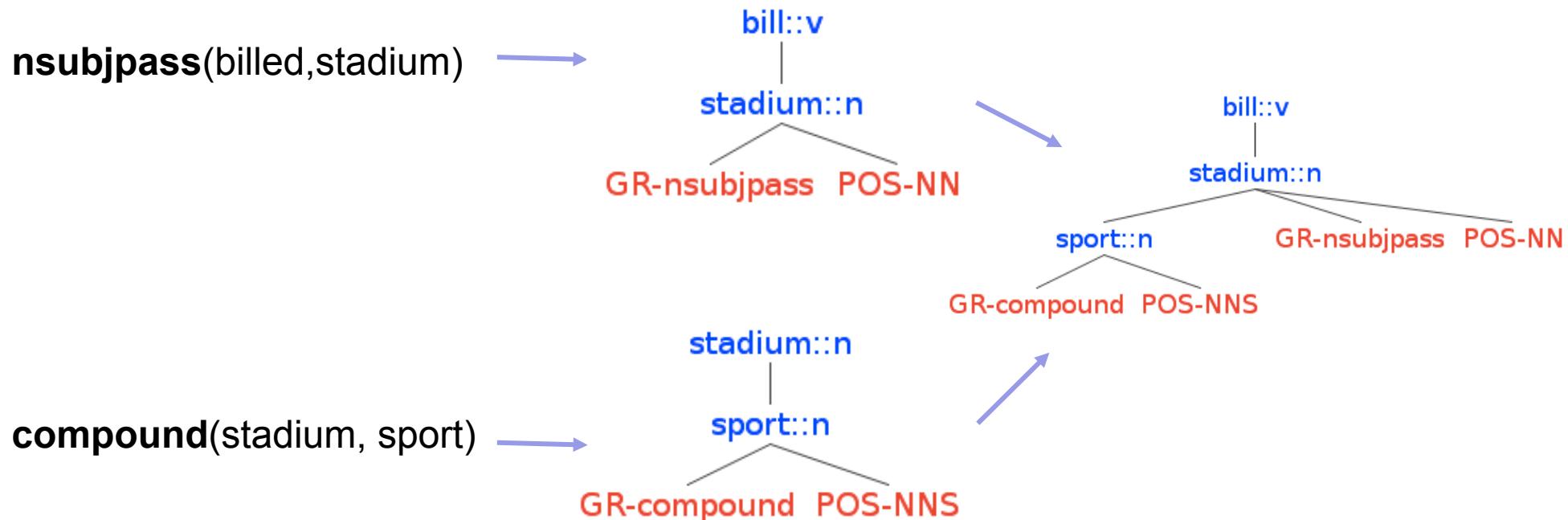


# Dependency Tree 3 (DT3)

inspired by (Croce et al., 2011)

Q

What sports stadium has been billed as “the eighth wonder of the world”?

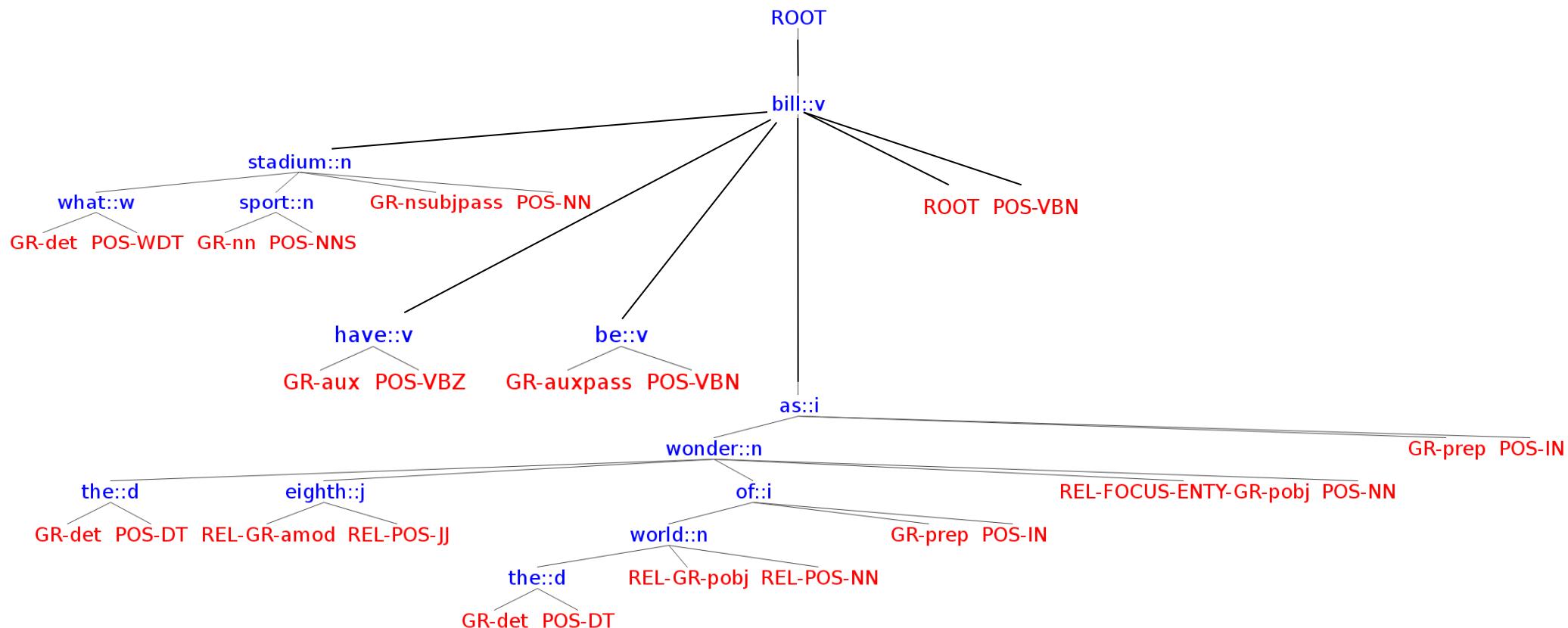


# Dependency Tree 3 (DT3)

(Croce et al., 2011)

Q

What sports stadium has been billed as “the eighth wonder of the world”?

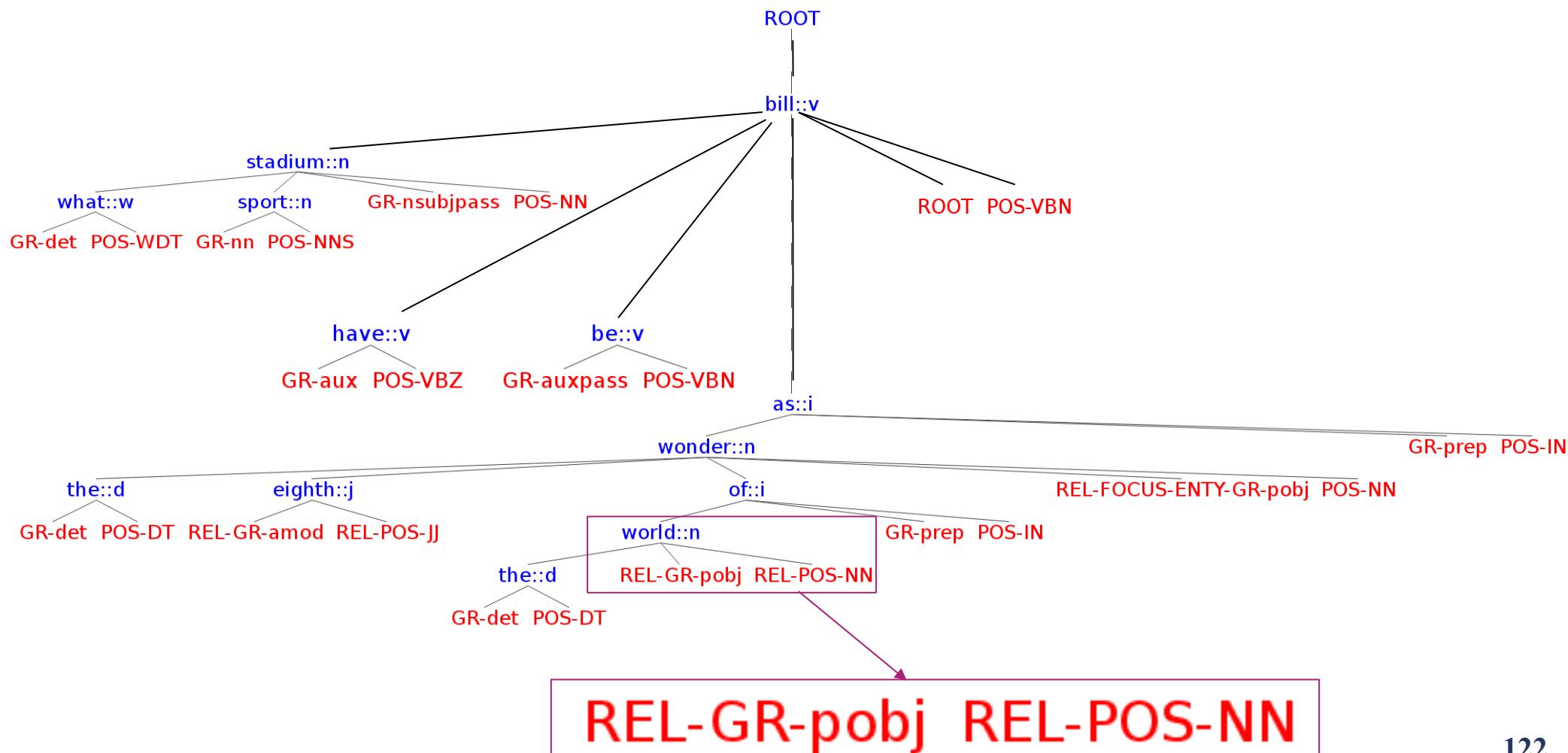


# DT3+REL

(Croce et al., 2011) (Tymoshenko and Moschitti, 2015)

Q

What sports stadium has been billed as “the eighth wonder of the **world**”?



# Outline

- IR-based QA and its components
- Motivation behind the approach
- Learning with kernels
  - Tree kernels recap
- Structural representations and relational links for Answer Sentence Selection (IR-based QA)
- **Structural representations for Community Question Answering**
- Metrics and results

# Shallow structures of cQA

Subject: Psychiatrist in DOHA

Could someone advise the best psychiatrist/psychologist in DOHA?

princess\_naila

Comment 1

i heard a good doctor in doha clinic...

feba mariyam

Comment 2

ok..shall check that out..thank you :)

princess\_naila

Comment 3

Visit Psychiatrist clinic of Hamad Hospital located opposite ""The Center""

Equin0x

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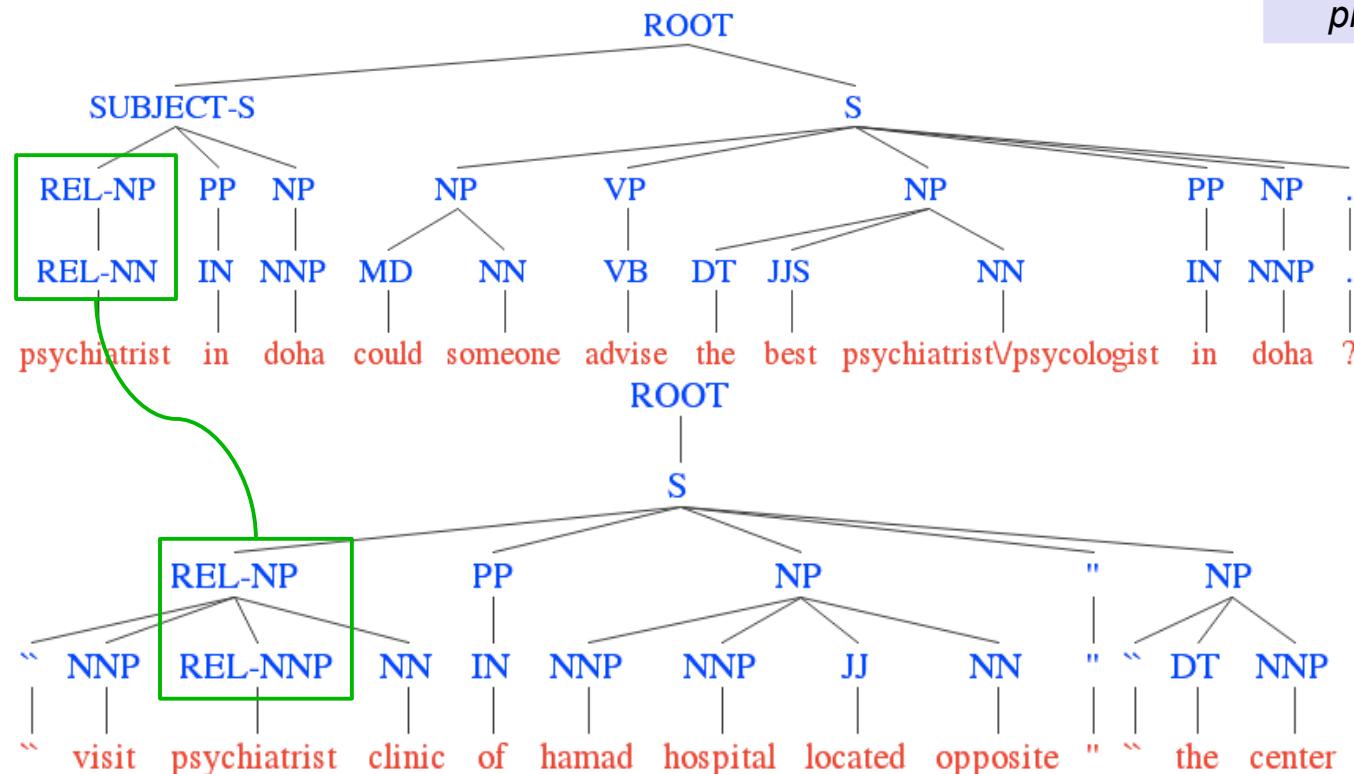
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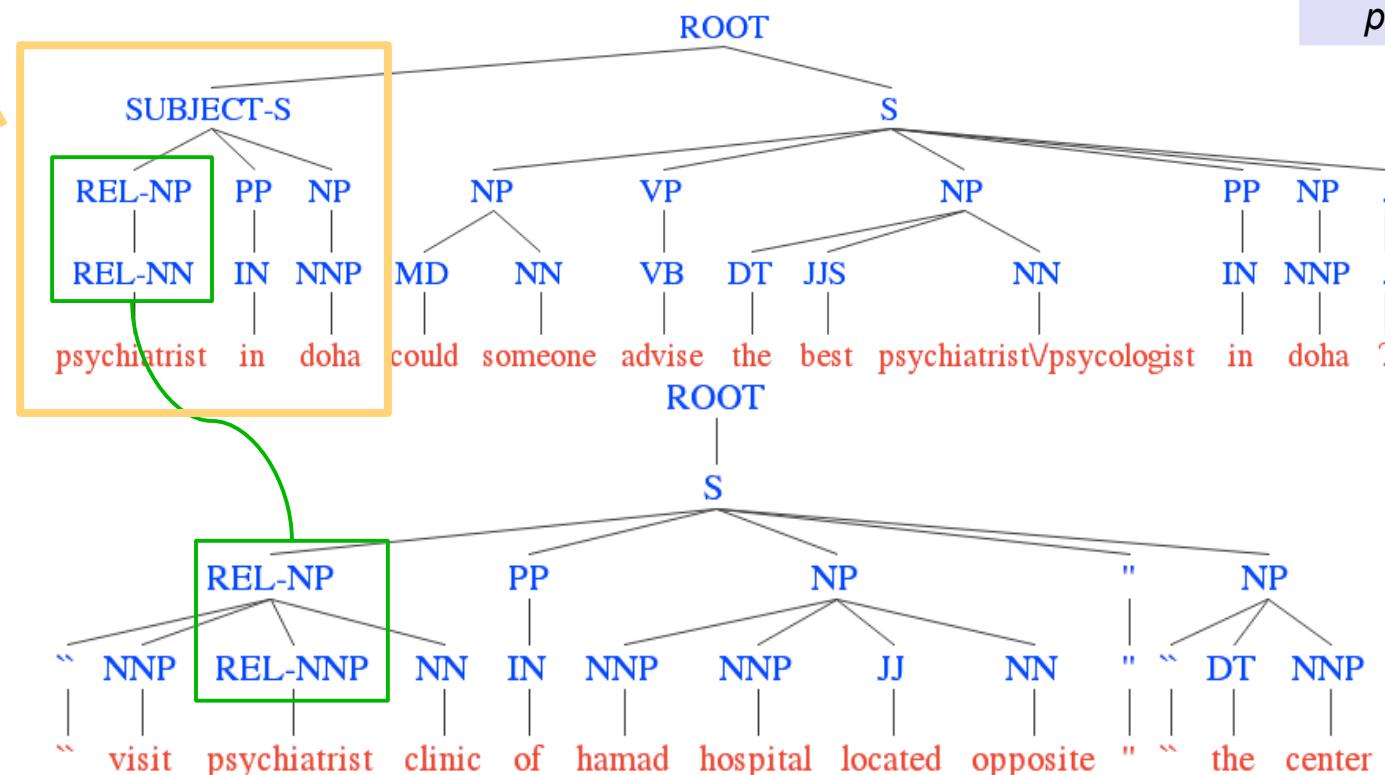
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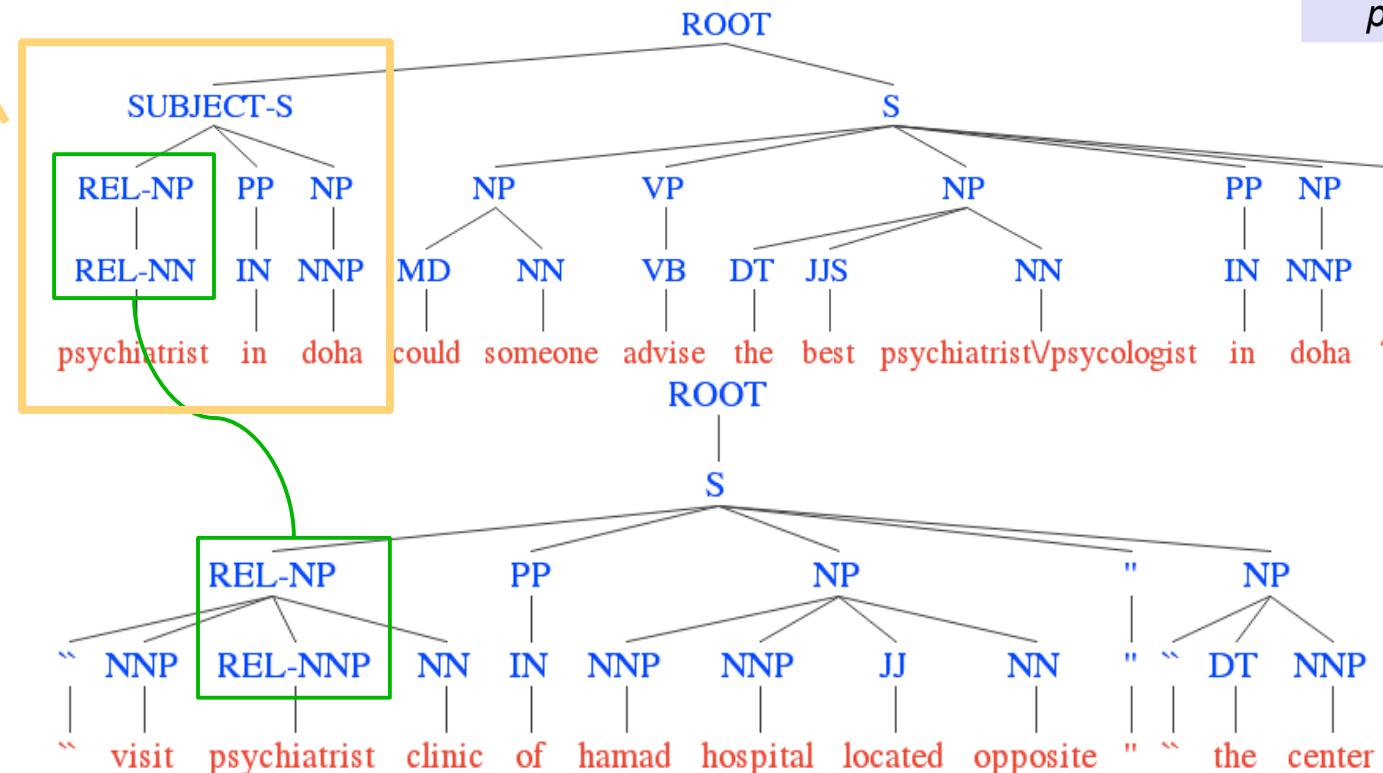
Equin0x

# Shallow structures of cQA

## **Subject: Psychiatrist in DOHA**

Could someone advise the best psychiatrist/psychologist in DOHA?

*princess\_naila*



# No question classification and focus detection

## Comment 1

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### **Comment 3**

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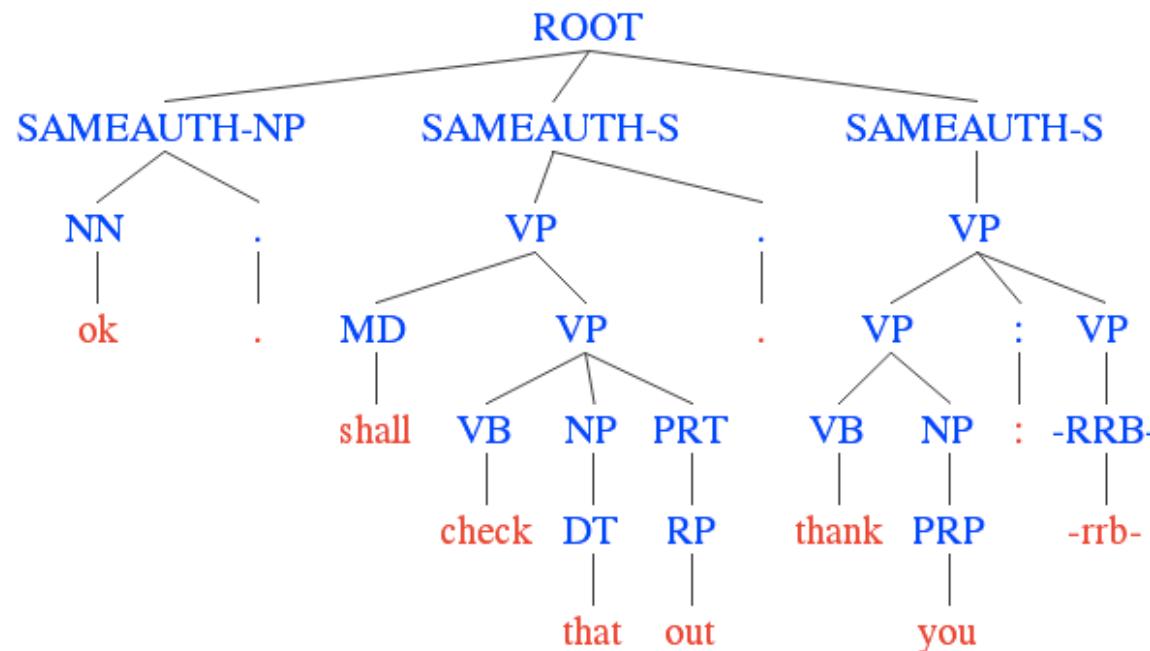
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# Constituency structures for cQA

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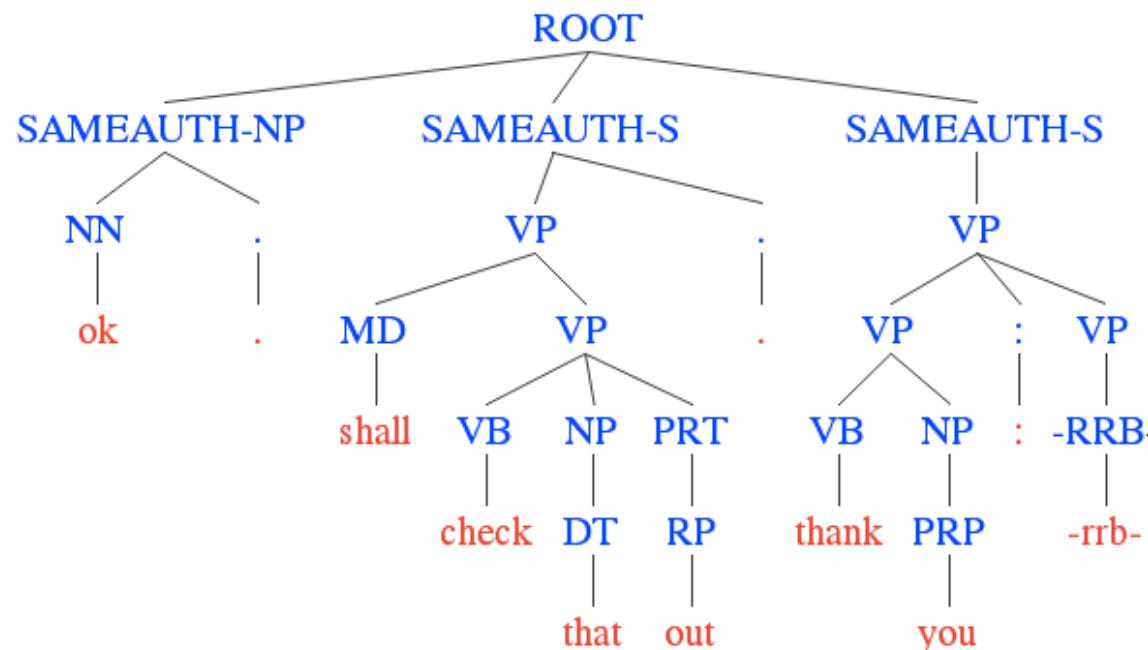
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Same Author



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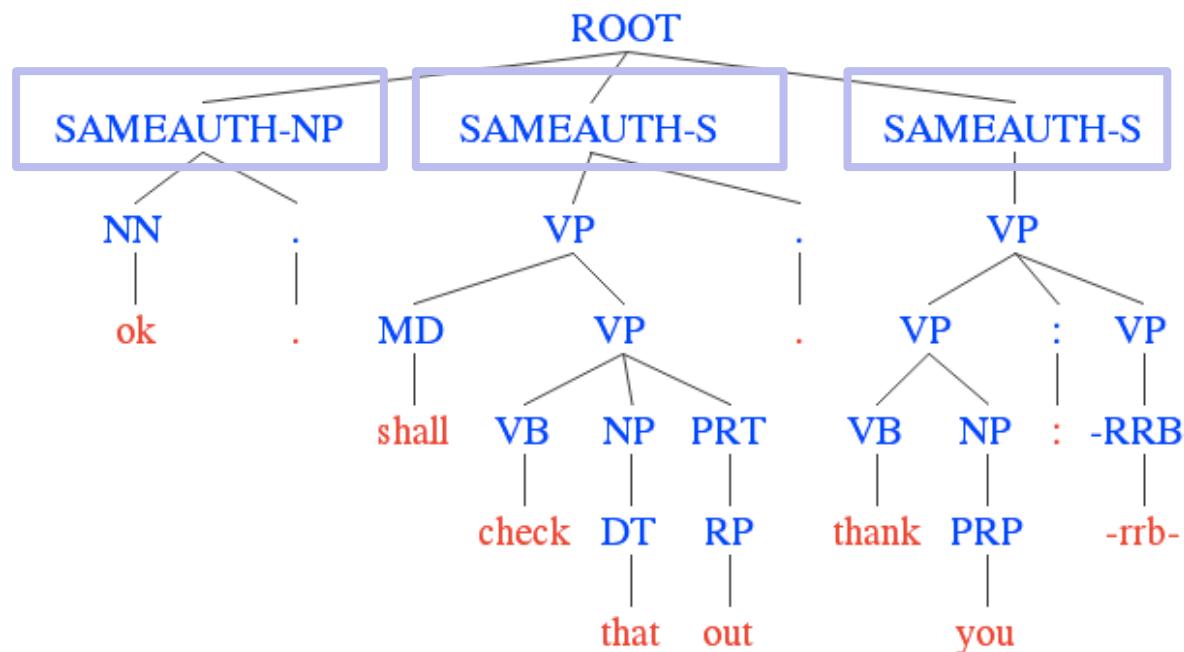
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# Outline

- IR-based QA and its components
- Motivation behind the approach
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- Structural representations and relational links for Answer Sentence Selection (IR-based QA)
- Structural representations for Community Question Answering
- **Metrics and results**

# Evaluation metrics: Precision at rank K (P@K)

- Precision of the system in the first K positions
- P@1 is 0.33 in the example below

Q1
1. Correct
2. Wrong
3. Wrong
4. Correct
5. Wrong

Q2
1. Wrong
2. Wrong
3. Wrong
4. Correct
5. Wrong

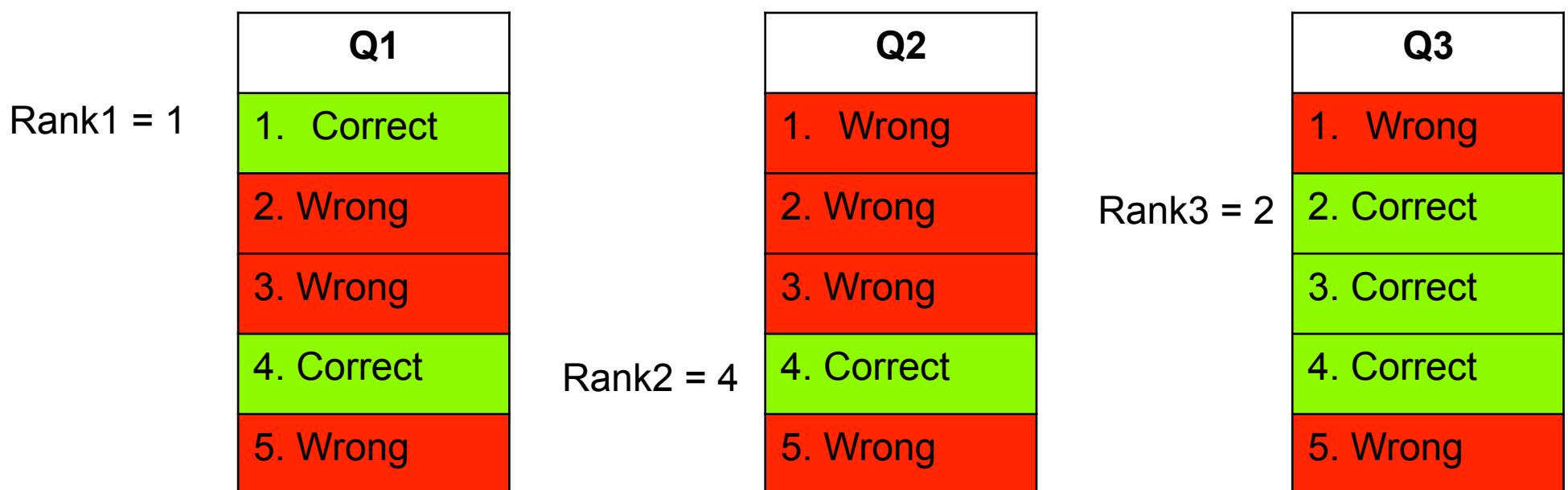
Q3
1. Wrong
2. Correct
3. Correct
4. Correct
5. Wrong

# Evaluation metrics: Mean reciprocal rank (MRR)

$$MRR = \frac{1}{|Q|} \sum_{i=1}^{|Q|} \frac{1}{rank_i}$$

$|Q|$  - amount of questions in the corpus

$rank_i$  - rank of the correct answer for the i-th question



$$MRR = (1 + 0.25 + 0.5)/3 = 0.5833$$

# Evaluation metrics: mean average precision (MAP)

$$MAP = \frac{1}{|Q|} \sum_{q \in Q} AveP(q)$$

$$AveP(q) = \frac{\sum_{k=1}^n (P(k) \times rel(k))}{rel\_doc\_number}$$

$rel(k)$  - 1 if item at rank K is relevant, 0 otherwise

$P(k)$  - precision at rank K

Q1
1. Correct
2. Wrong
3. Wrong
4. Correct
5. Wrong

Q2
1. Wrong
2. Wrong
3. Wrong
4. Correct
5. Wrong

Q3
1. Wrong
2. Correct
3. Correct
4. Correct
5. Wrong

$$AveP(Q1) = (1*1 + 0.5*0 + 1/3*0 + 1/2*1 + 1/5*0)/2 = 0.75 \quad MAP = (0.75 + 0.25 + 0.6388)/3 = 0.5462$$

$$AveP(Q2) = (0.25*1)/1 = 0.25 \quad AveP(Q3) = (0.5*1 + 2/3*1 + 0.75*1)/3 = 0.6388$$

# Answer Sentence Selection datasets

	TRAIN	TEST	TEST annotation
TREC QA 2002/2003	824	5-fold cross-validation	Automatic patterns
TREC 13	1229	68	Manual
WikiQA	873	243	Crowdsourcing

# **Structures comparison on Trec QA 2002/2003: experimental settings**

(Tymoshenko&Moschitti, 2015)

- Pipelines: **Stanford, OpenNLP** (POS-tagging, NER)
- Dependency parsers: **MATE, Stanford, ClearNLP, Malt**
- External LOD knowledge sources for TM match:
  - **YAGO2, Dbpedia 3.9, WordNet 3.0**
  - Wikification: Machine Linking (not available anymore), Wikipedia Miner (TODO: cite)
- SVM-Light-TK for kernel-based learning

# **Structures comparison on Trec QA 2002/2003: experimental settings**

- 10 candidate answers for training, 50 for testing
- Preference reranking with kernels (Severyn et al, 2013)
  - Partial Tree Kernel for structures (Moschitti, 2006)
  - Polynomial kernel for vectors

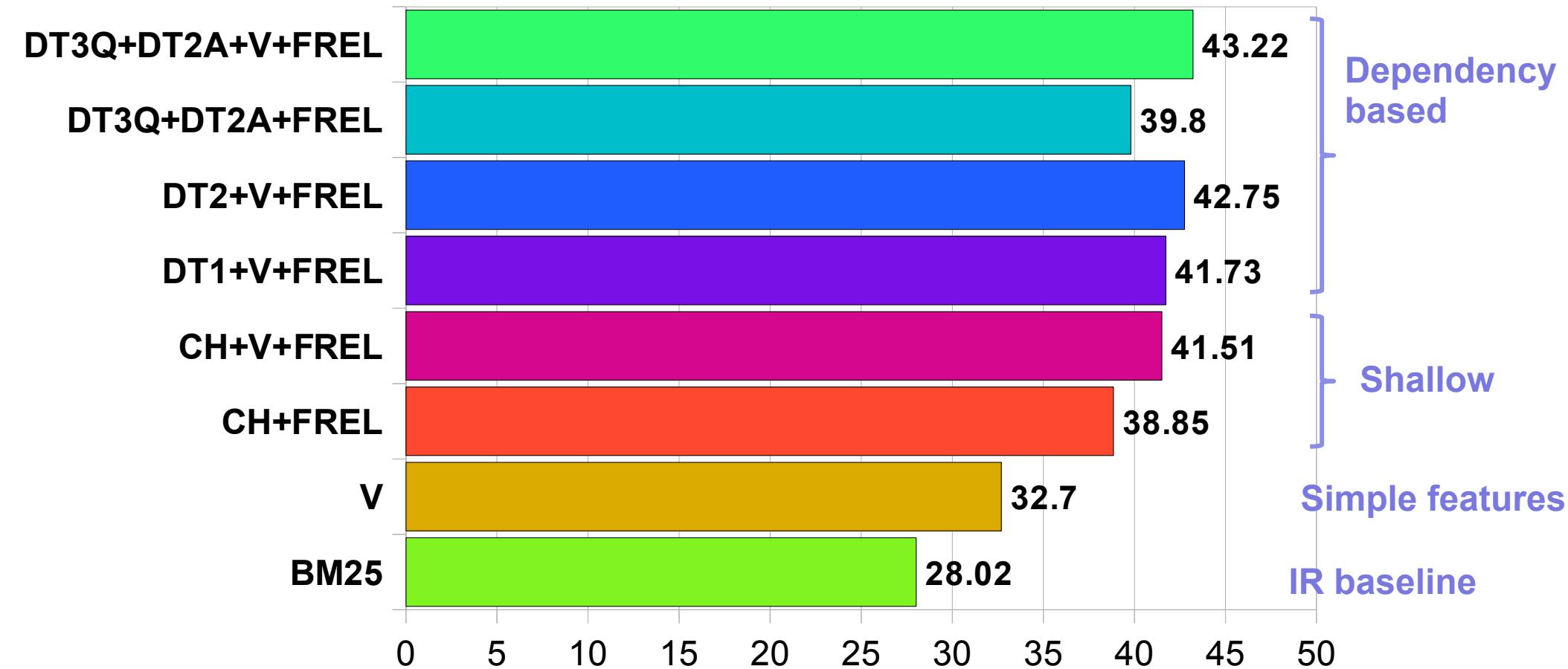
# Structures comparison on Trec QA 2002/2003: models

- IR baseline
  - Terrier engine, BM25 model
- Models: structures+ feature vectors
- V: feature vector
  - Cosine between answer (A) and passage (P)
  - Partial Tree Kernel (PTK) applied to Q and P
  - IR BM25 score

# Trec QA: Structure comparison

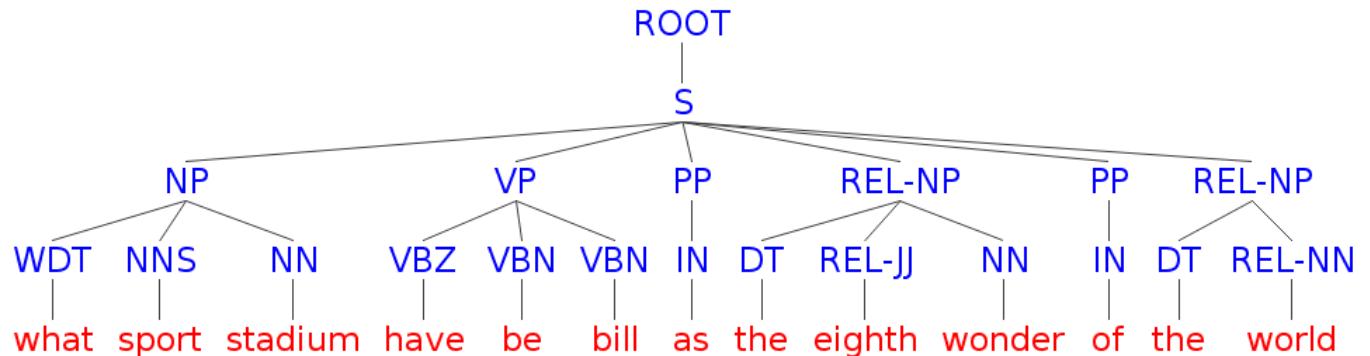
- TREC QA 2002/2003
- Stanford pipeline

Mean Reciprocal Rank (MRR)

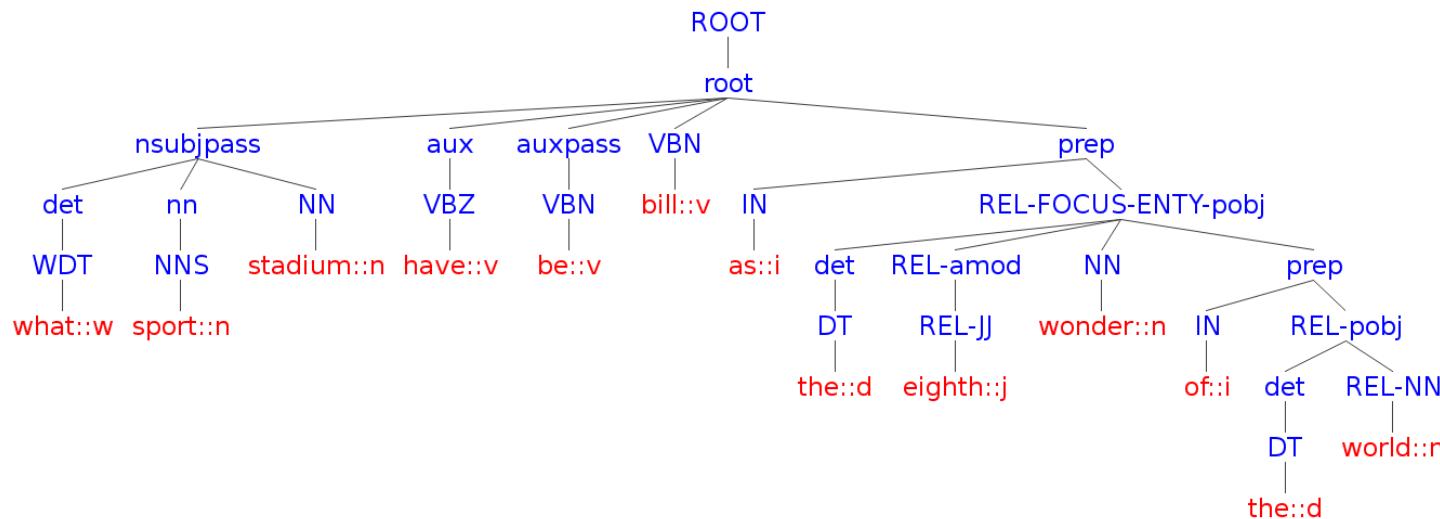


# Recap: shallow and dependency-based structures

Shallow: CH+FREL

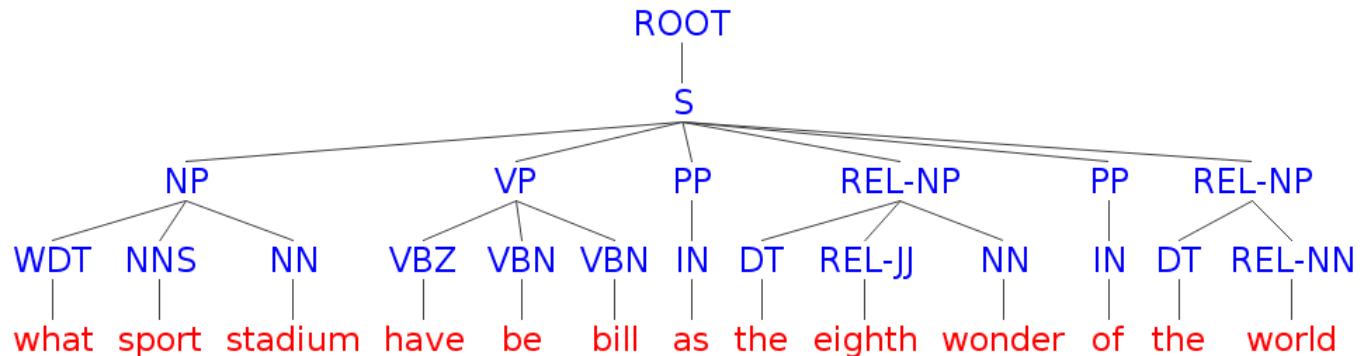


Dependency-based: DT1

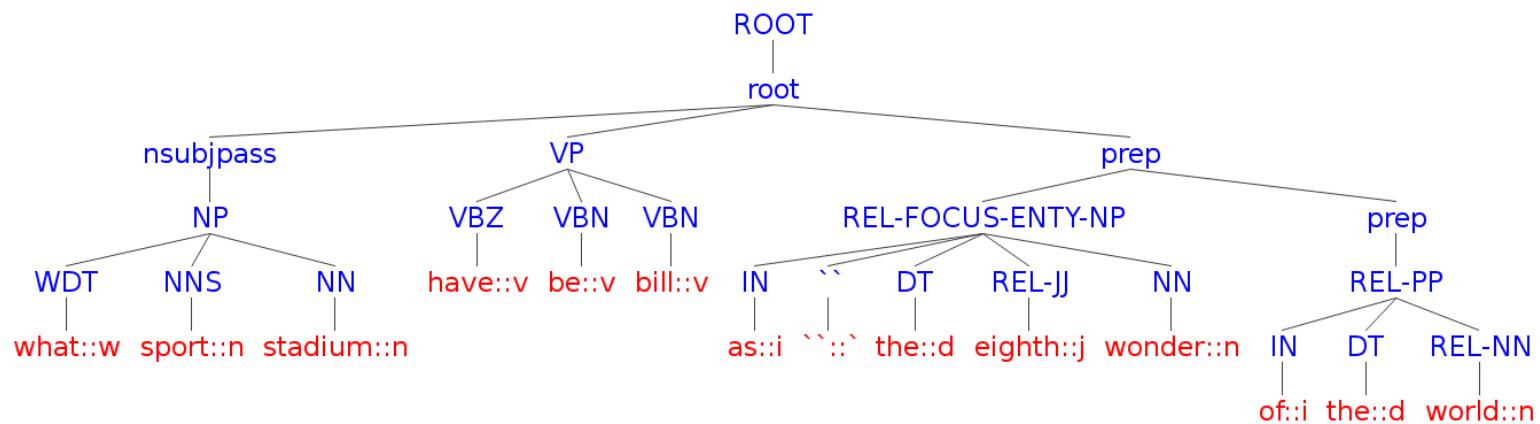


# Recap: shallow and dependency-based structures

Shallow: CH+FREL

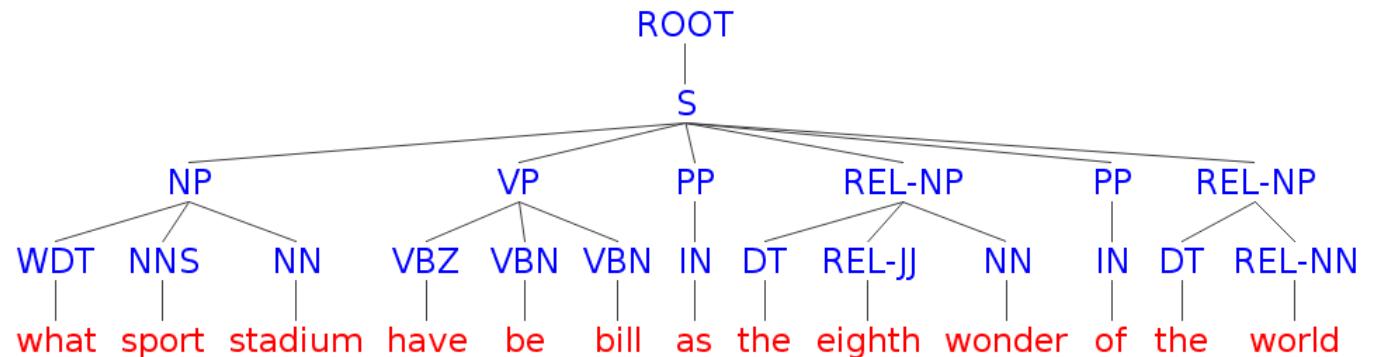


Dependency-based: DT2

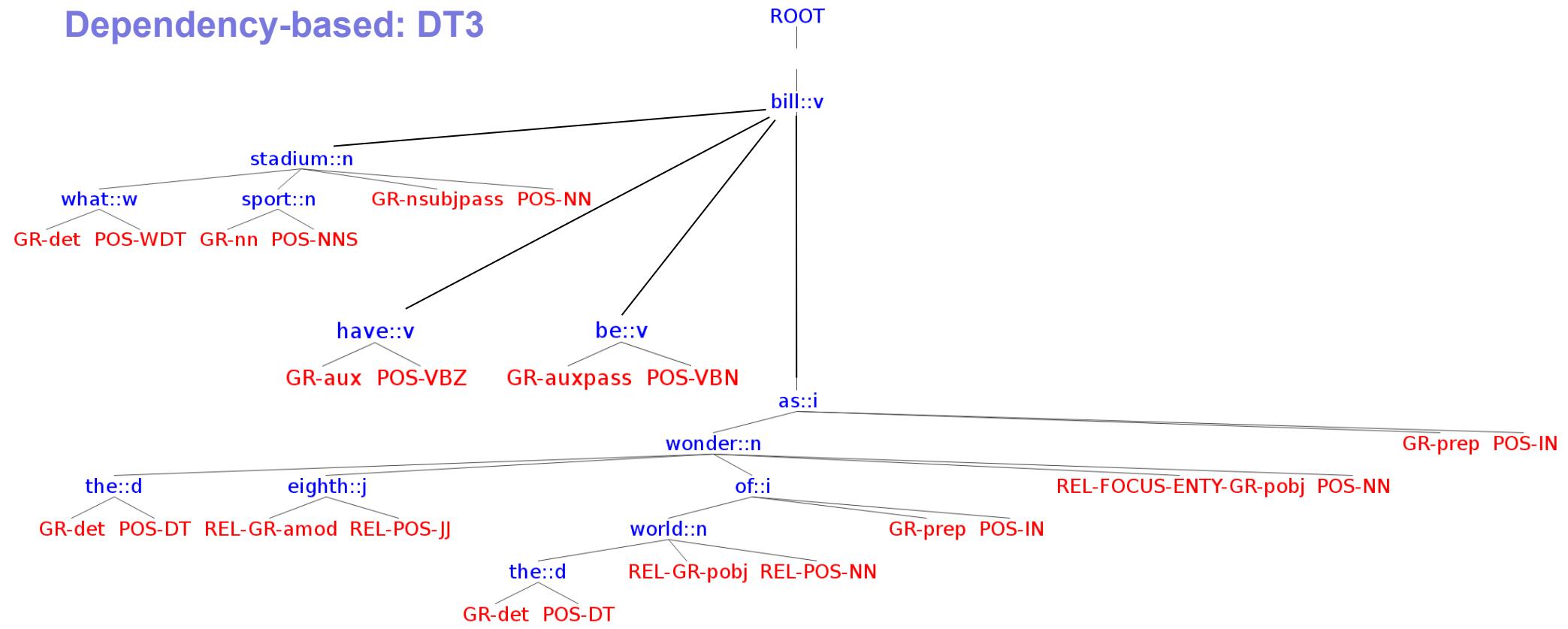


# Recap: shallow and dependency-based structures

Shallow: CH+FREL



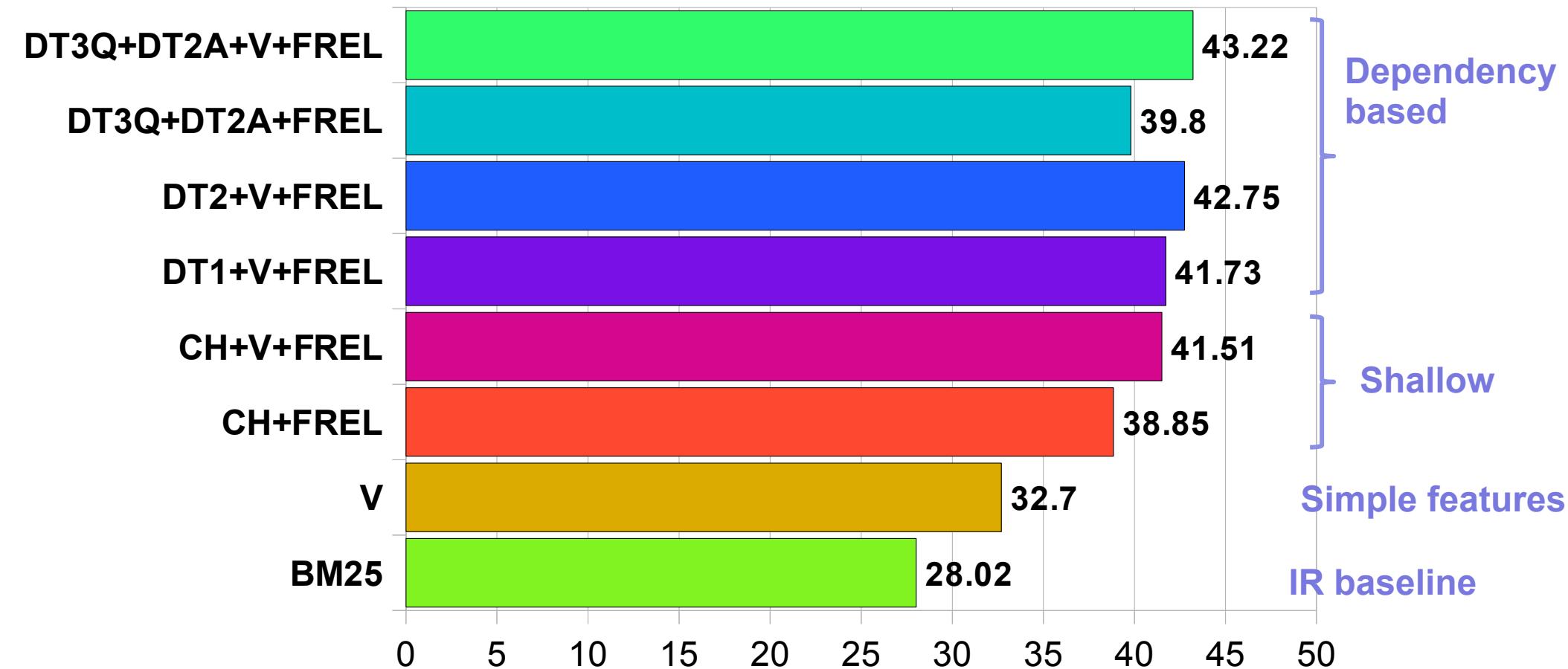
Dependency-based: DT3



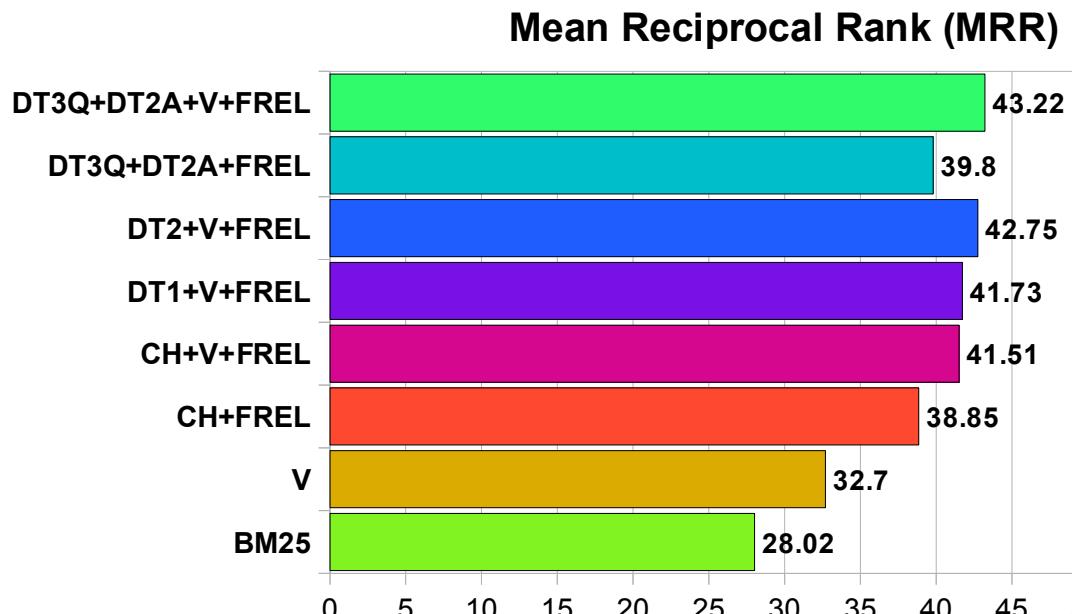
# Trec QA: Structure comparison

- TREC QA 2002/2003
- Stanford pipeline

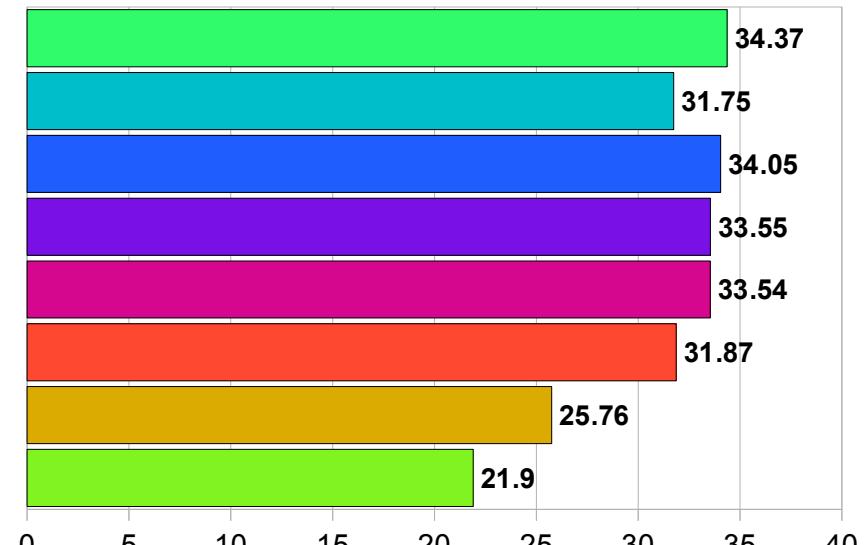
Mean Reciprocal Rank (MRR)



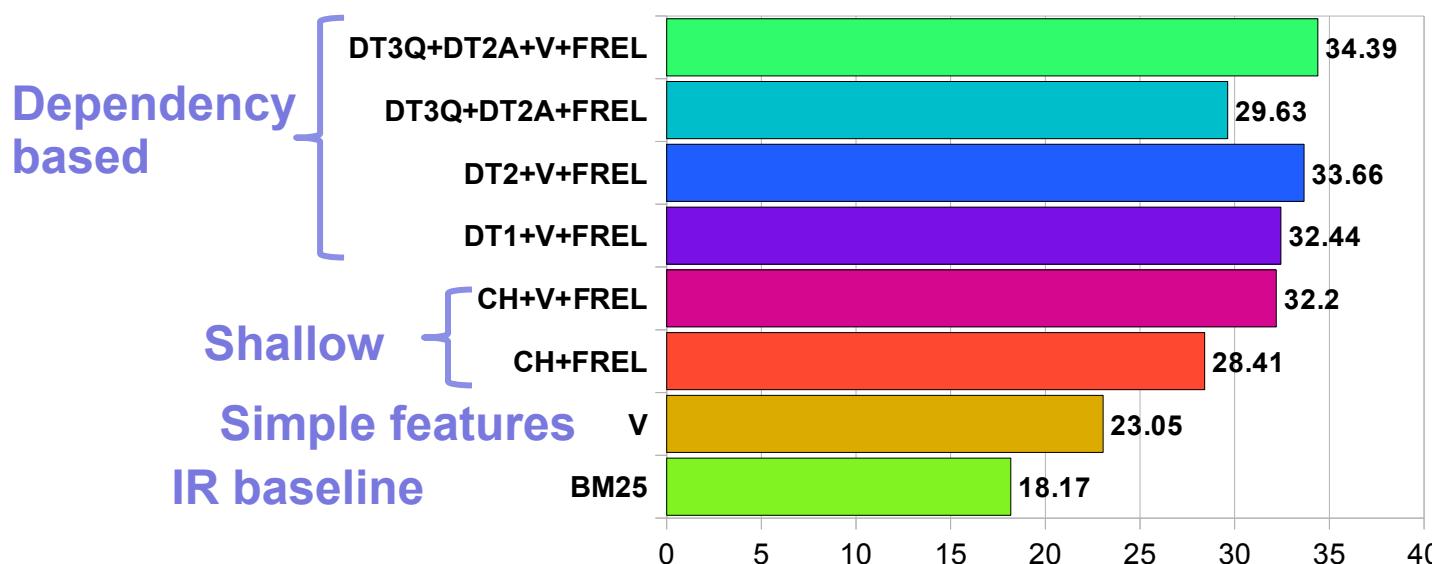
# Structure comparison (MRR, MAP, P@1)



Mean Average Precision (MAP)

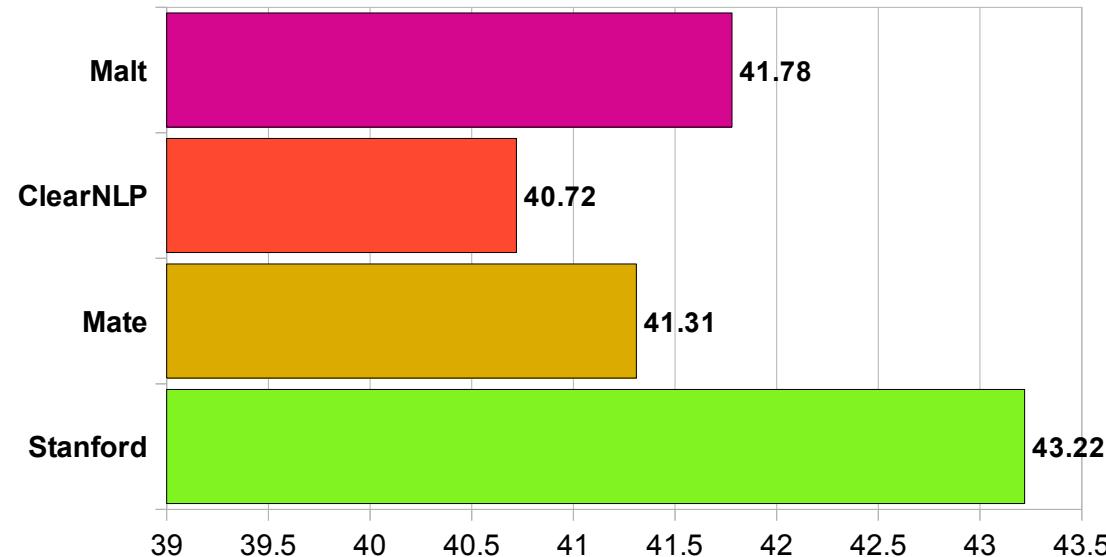


P@1 (Precision at rank 1)

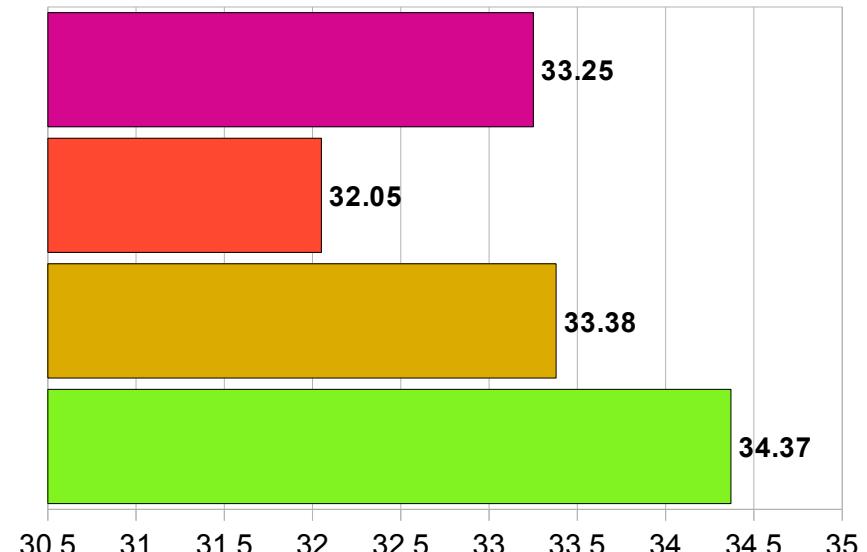


# Dependency parser comparison

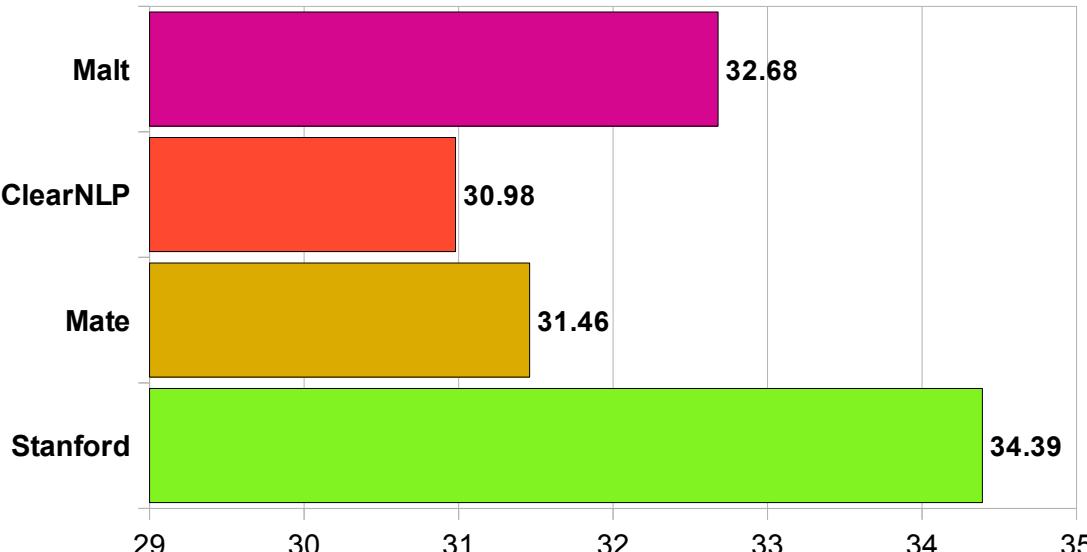
Mean Reciprocal Rank (MRR)



Mean Average Precision (MAP)



P@1 (Precision at rank 1)



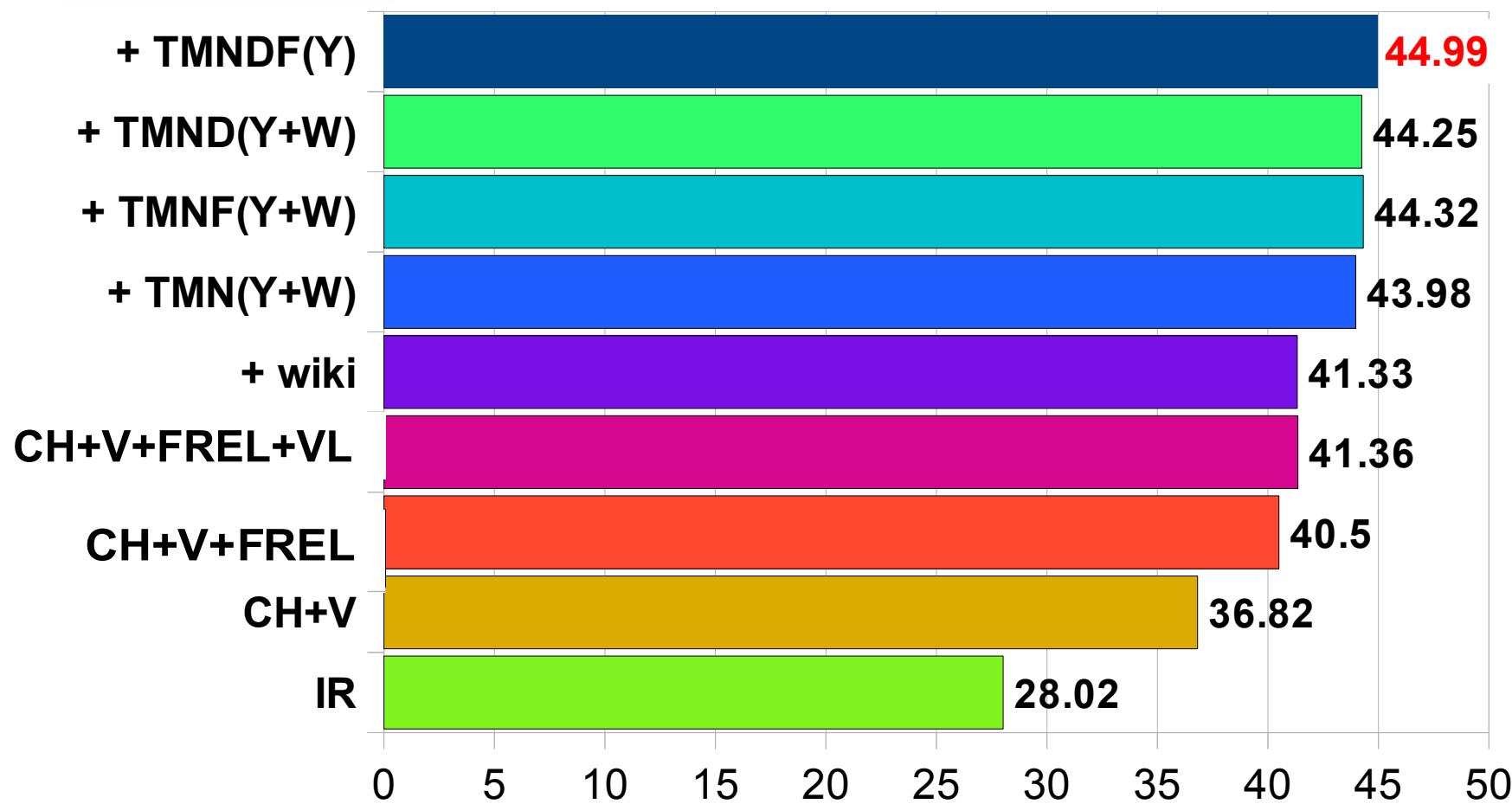
- TREC QA 2002/2003
- DT3Q+DT2A +V+FREL structure

# LOD Contribution

- Y: YAGO
- W: WordNet
- D: DBpedia

- TREC QA 2002/2003
- OpenNLP pipeline
- CH structure

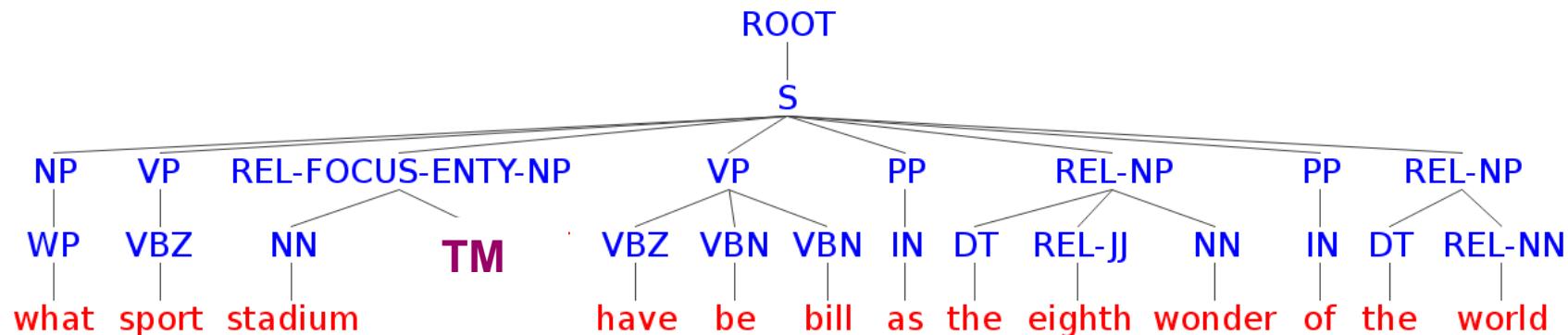
## Mean Reciprocal Rank (MRR)



# Encoding type match: TM

Q

What sports **stadium** has been billed as “the eighth wonder of the world”?



ROOT  
S

NP VP REL-FOCUS-ENTY-NP VP PP REL-NP PP REL-NP  
WP VBZ NN TM VBZ VBN VBN IN DT REL-JJ NN IN DT REL-NN  
what sport stadium have be bill as the eighth wonder of the the world

ROOT  
S

... NP SBAR NP VP REL-NP PP REL-NP ...  
DT IN DT VBD DT REL-JJ NN IN DT REL-NN  
the dilapidated if this be the eighth wonder of the world

A

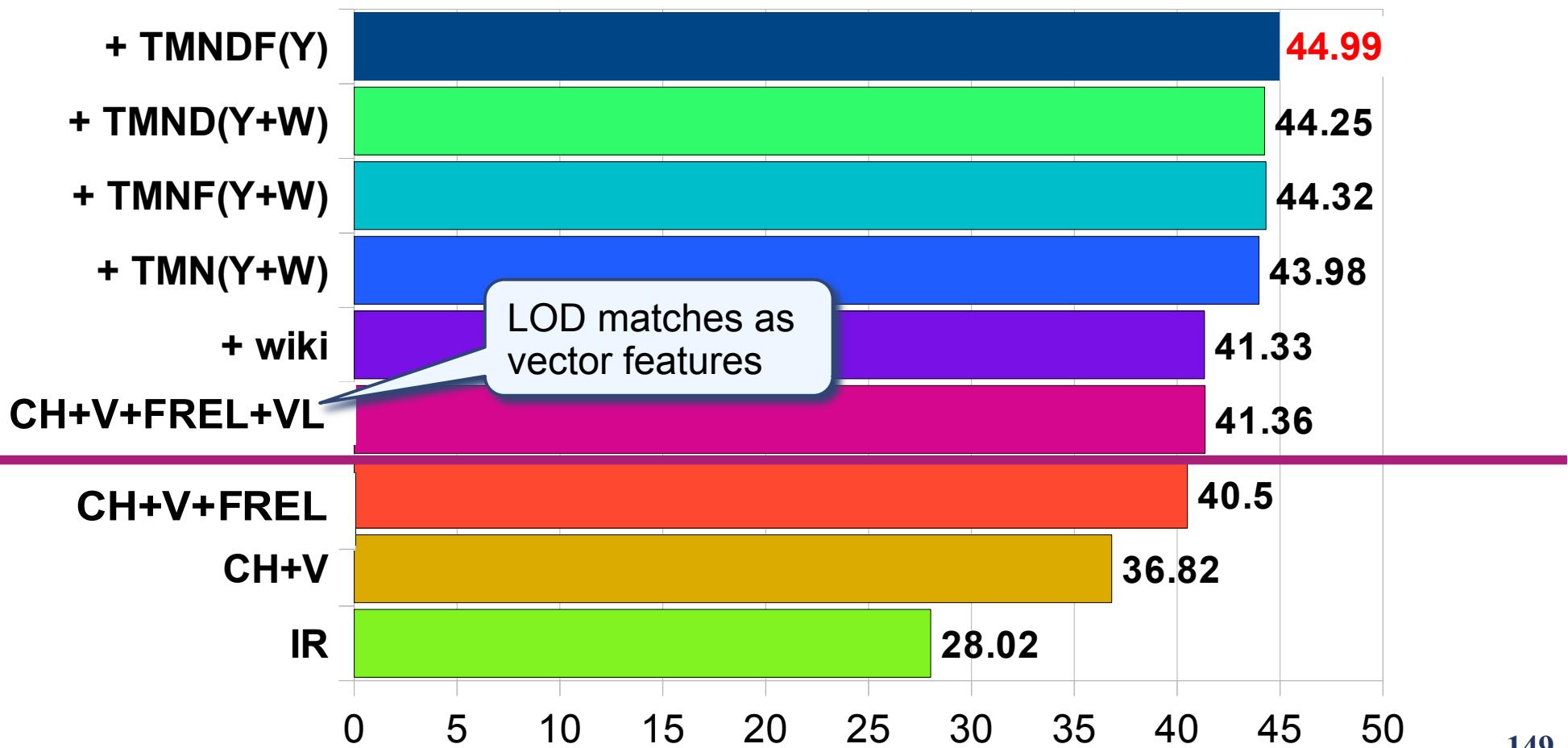
The Titans played in the dilapidated **Astrodomo**; if this was the eighth wonder of the world, we live on a shabby little planet indeed.

# LOD Contribution

- Y: YAGO
- W: WordNet
- D: DBpedia

- TREC QA 2002/2003
- OpenNLP pipeline
- CH structure

## Mean Reciprocal Rank (MRR)

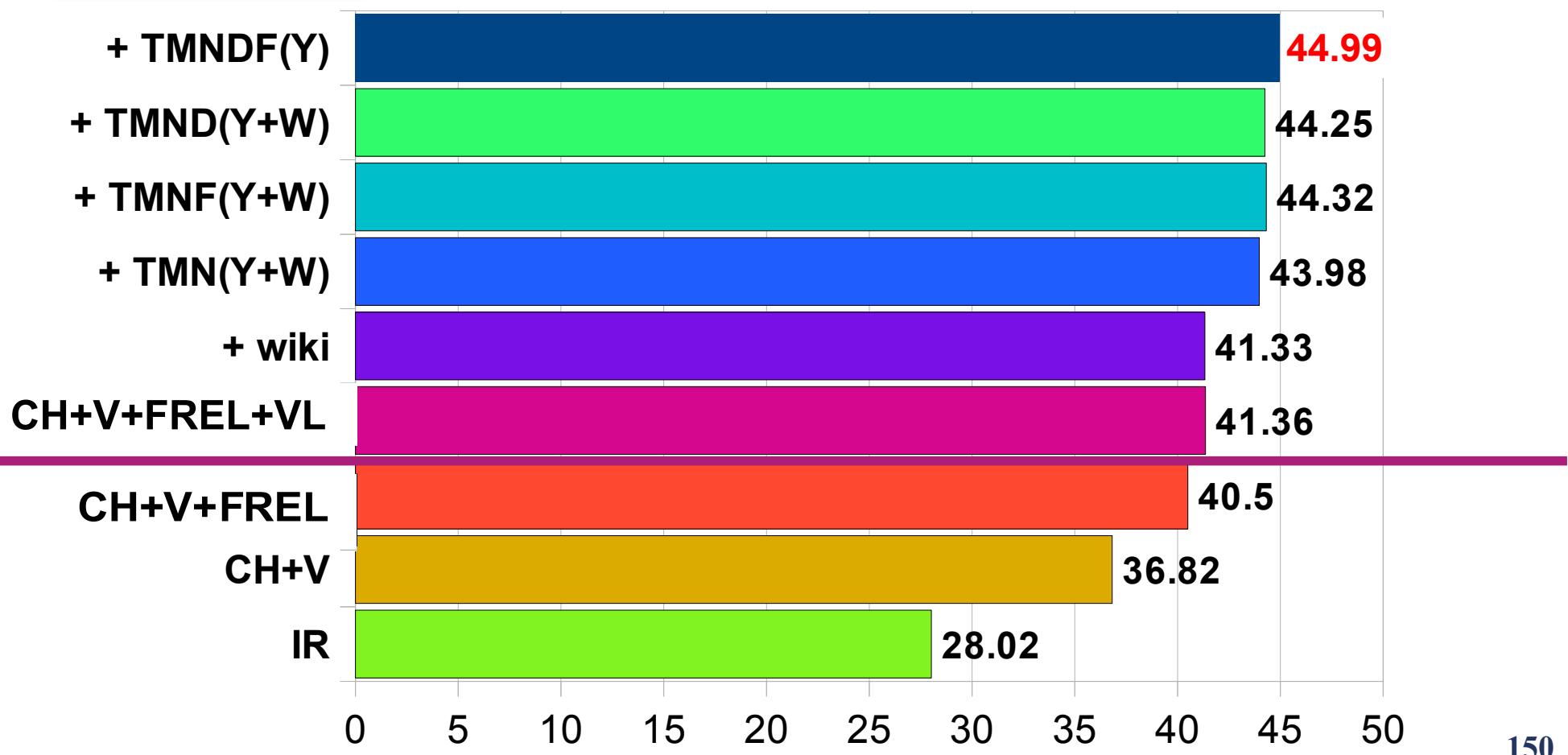


# LOD Contribution

- Y: YAGO
- W: WordNet
- D: DBpedia

- TREC QA 2002/2003
- OpenNLP pipeline
- CH structure

## Mean Reciprocal Rank (MRR)



# Pipeline performance on TREC13

(Tymoshenko et al., 2016a)

Models	MRR	MAP
<b>State of the art</b>		
Wang et al. (2007)	68.52	60.29
Heilman and Smith (2010)	69.17	60.91
Wang and Manning (2010)	69.51	59.51
Yao et al. (2013)	74.77	63.07
Severyn and Moschitti (2013)	73.58	67.81
Yih et al. (2013a)	77.00	70.92
Yu et al. (2014)	78.64	71.13
Wang and Ittycheriah (2015)	77.40	70.63
Tymoshenko and Moschitti (2015)	82.29	73.34
Yin et al. (2015)	76.33	69.51
Miao et al. (2015)	81.17	73.39
<b>Individual Models</b>		
$\text{CNN}_R$	77.93	71.09
$V_{AE+QE}$	79.32	73.37
$V_{JE}$	77.24	71.34
CH	85.53	75.18

Related work  
including  
deep learning  
models

Q/Answer  
embeddings  
learned by  
CNN

CNN (similar  
to the one you  
trained on  
WikiQA)

SVM TK on  
shallow  
structure

# Pipeline performance in SemEval, Task 3.A competition

(Tymoshenko et al., 2016b)

Models	Kernel	DEV		TEST	
		MAP	MRR	MAP	MRR
<b>1. Baseline models</b>					
Kelp-primary [3] (#1)	n/a	n/a	n/a	79.19	86.42
ConvKN-contrastive1 [1]	n/a	n/a	n/a	78.71	86.15
SUpper team-contrastive1 [11]	n/a	n/a	n/a	77.68	84.76
ConvKN-primary [1] (#2)	n/a	n/a	n/a	77.66	84.93
<b>2. CNN and CTK models</b>					
$V_{QF}$	P	63.45	70.51	73.50	82.98
CNN	n/a	67.41	73.64	77.13	83.85
$CTK_{SH}$	PTK	64.10	71.97	76.67	83.53
$CTK_C$	STK	65.30	73.24	75.42	82.35
$CTK_C$	PTK	63.82	70.53	76.39	82.94
$CTK_{SH}+V_{QF}$	PTK, P	68.45	74.49	<b>78.80</b>	86.16
$CTK_C+V_{QF}$	STK, P	67.26	74.07	<b>78.78</b>	86.26

Challenge  
winners

# Pipeline performance in SemEval, Task 3.A competition

(Tymoshenko et al., 2016b)

Models	Kernel	DEV		TEST	
		MAP	MRR	MAP	MRR
<b>1. Baseline models</b>					
Kelp-primary [3] (#1)	n/a	n/a	n/a	79.19	86.42
ConvKN-contrastive1 [1]	n/a	n/a	n/a	78.71	86.15
SUpper team-contrastive1 [11]	n/a	n/a	n/a	77.68	84.76
ConvKN-primary [1] (#2)	n/a	n/a	n/a	77.66	84.93
<b>2. CNN and CTK models</b>					
V <sub>QF</sub>	Same system	P	63.45	70.51	73.50
CNN		n/a	67.41	73.64	77.13
CTK <sub>SH</sub>		PTK	64.10	71.97	76.67
CTK <sub>C</sub>		STK	65.30	73.24	75.42
CTK <sub>C</sub>		PTK	63.82	70.53	76.39
CTK <sub>SH</sub> +V <sub>QF</sub>		PTK, P	68.45	74.49	<b>78.80</b>
CTK <sub>C</sub> +V <sub>QF</sub>		STK, P	67.26	74.07	<b>78.78</b>

Challenge  
winners

Same system

# Pipeline performance in SemEval, Task 3.A competition

(Tymoshenko et al., 2016b)

Models	Kernel	DEV		TEST	
		MAP	MRR	MAP	MRR
<b>1. Baseline models</b>					
Kelp-primary [3] (#1)	n/a	n/a	n/a	79.19	86.42
ConvKN-contrastive1 [1]	n/a	n/a	n/a	78.71	86.15
SUpper team-contrastive1 [11]	n/a	n/a	n/a	77.68	84.76
ConvKN-primary [1] (#2)	n/a	n/a	n/a	77.66	84.93
<b>2. CNN and CTK models</b>					
$V_{QF}$	Domain feature vector	P	63.45	70.51	73.50
CNN	Neural Network	n/a	67.41	73.64	77.13
$CTK_{SH}$	Shallow struct	PTK	64.10	71.97	76.67
$CTK_C$	Constituency struct	STK	65.30	73.24	75.42
$CTK_C$		PTK	63.82	70.53	76.39
$CTK_{SH}+V_{QF}$		PTK, P	68.45	74.49	<b>78.80</b>
$CTK_C+V_{QF}$		STK, P	67.26	74.07	<b>78.78</b>

Challenge  
winners

Structure +  
Feature vector

# Outline

- I. High-level QA domain overview
- II. iKernels Advanced Answer Passage reranking pipeline

## III. **(Lab) RelTextRank in action**

- Go to <https://github.com/iKernels/ANLPIR-2018/tree/master/partIV/qapiipeline/>  
RelationalTextRank for the instructions

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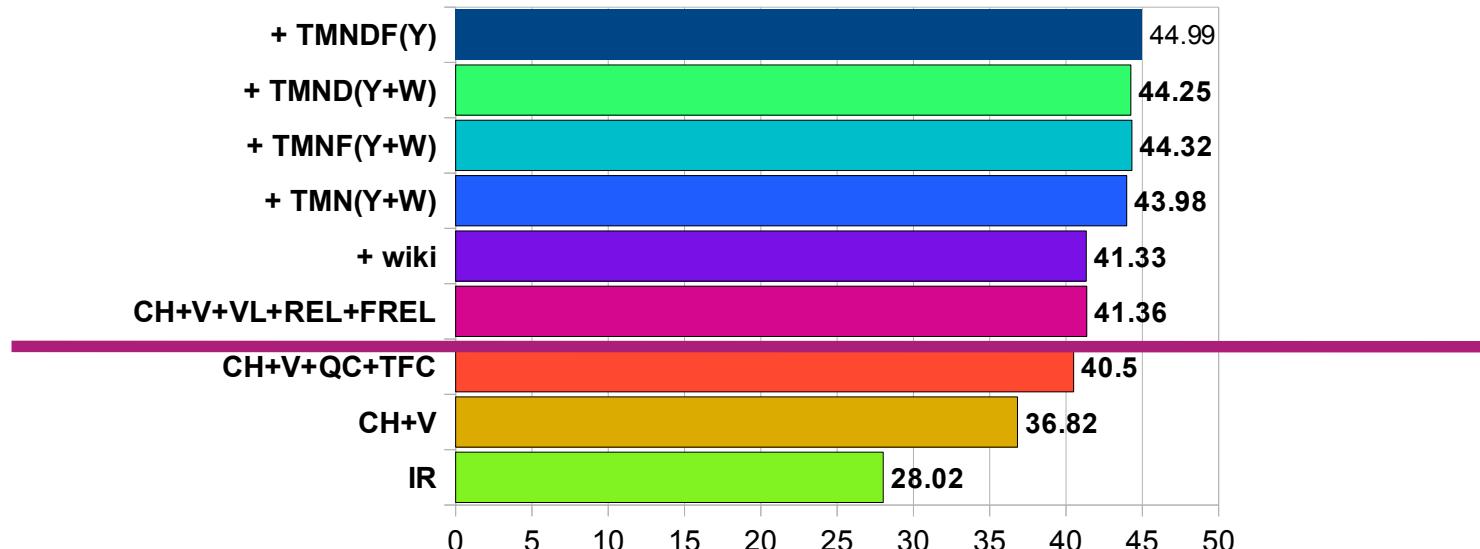
# **Thank You!**

# State of the art in Answer Selection

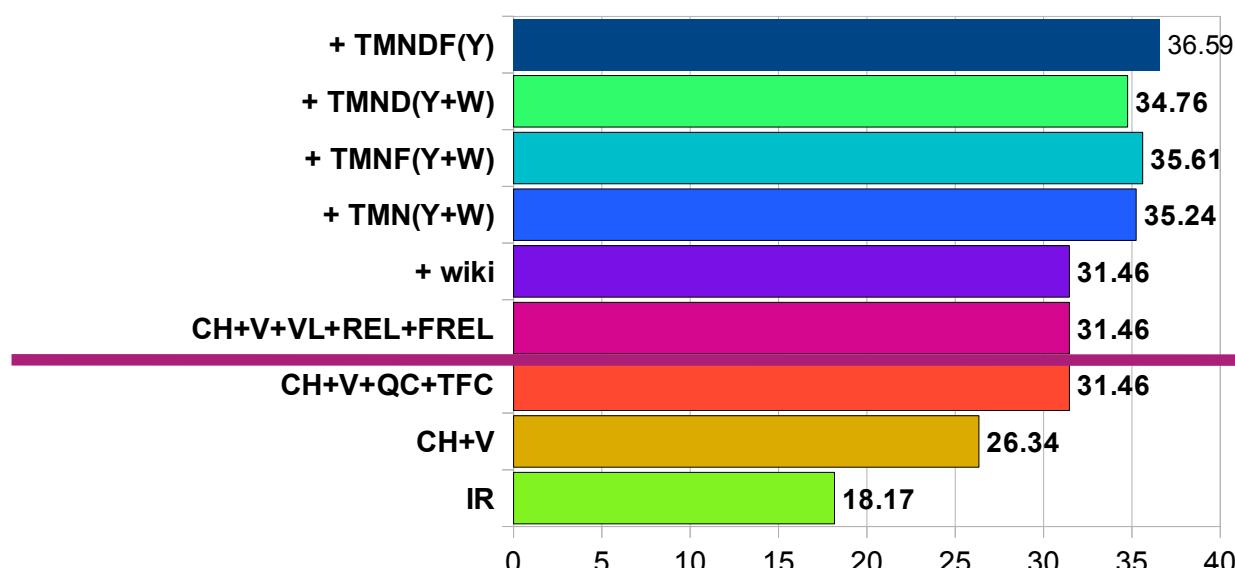
- Quasi-synchronous grammars (Wang, 2007)
- Tree Edit Distance (Heilman & Smith, 2010)
- Probabilistic model to learn TED transformations on dependency trees (Wang & Manning, 2010)
- CRF + TED features (Yao et al., 2013)
- SVM + shallow parse tree representation (Severyn & Moschitti, 2012, 2013)
- **Neural Networks** (Severyn & Moschitti, 2015) (Wang and Nyberg, 2015)

# LOD Contribution

Mean Reciprocal Rank (MRR)



P@1 (Precision at rank 1)

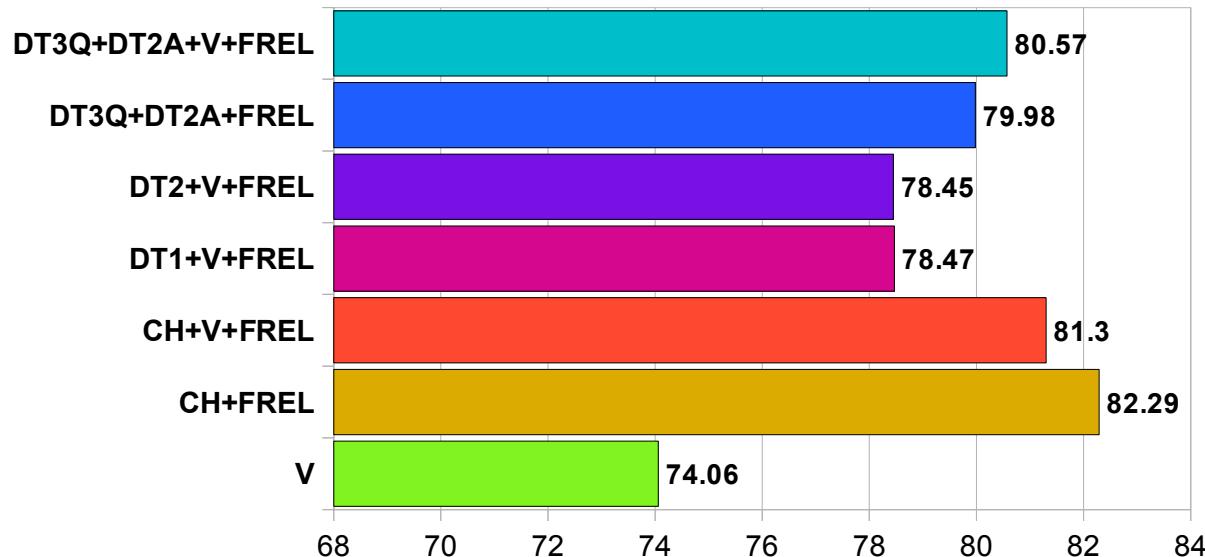


- TREC QA 2002/2003
- OpenNLP pipeline
- CH structure

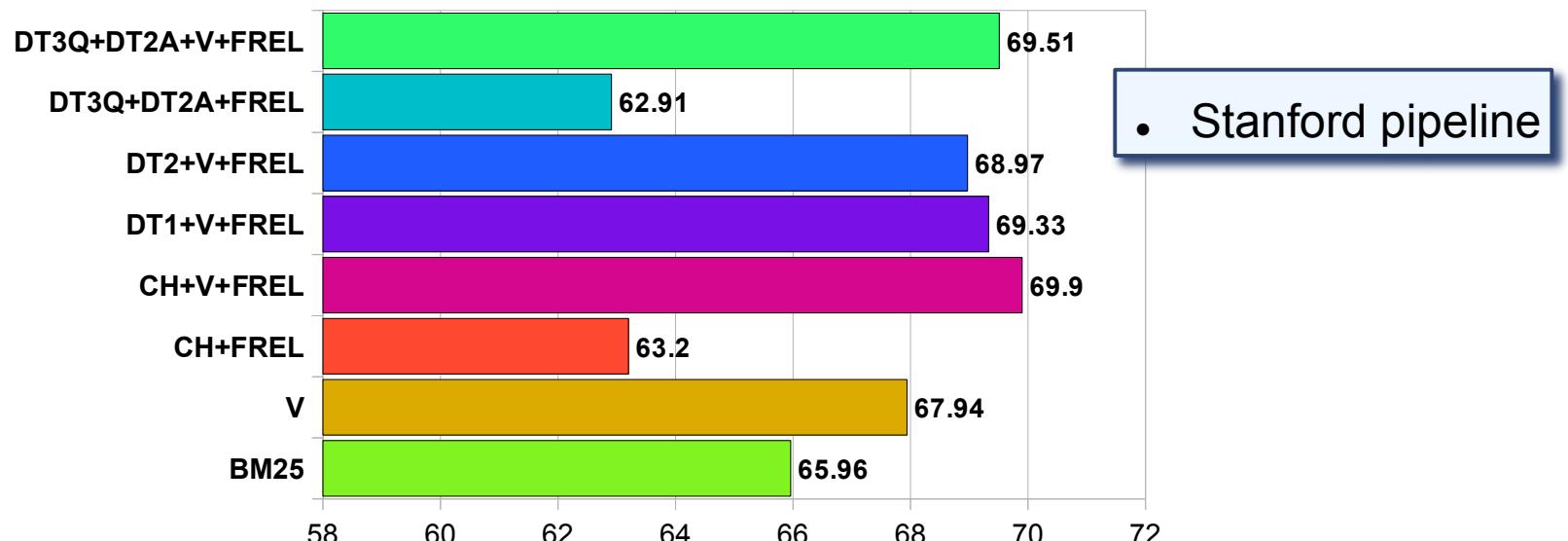
- Y: YAGO
- W: WordNet
- D: DBpedia

# Structures comparison

TREC 13: Mean Reciprocal Rank (MR)



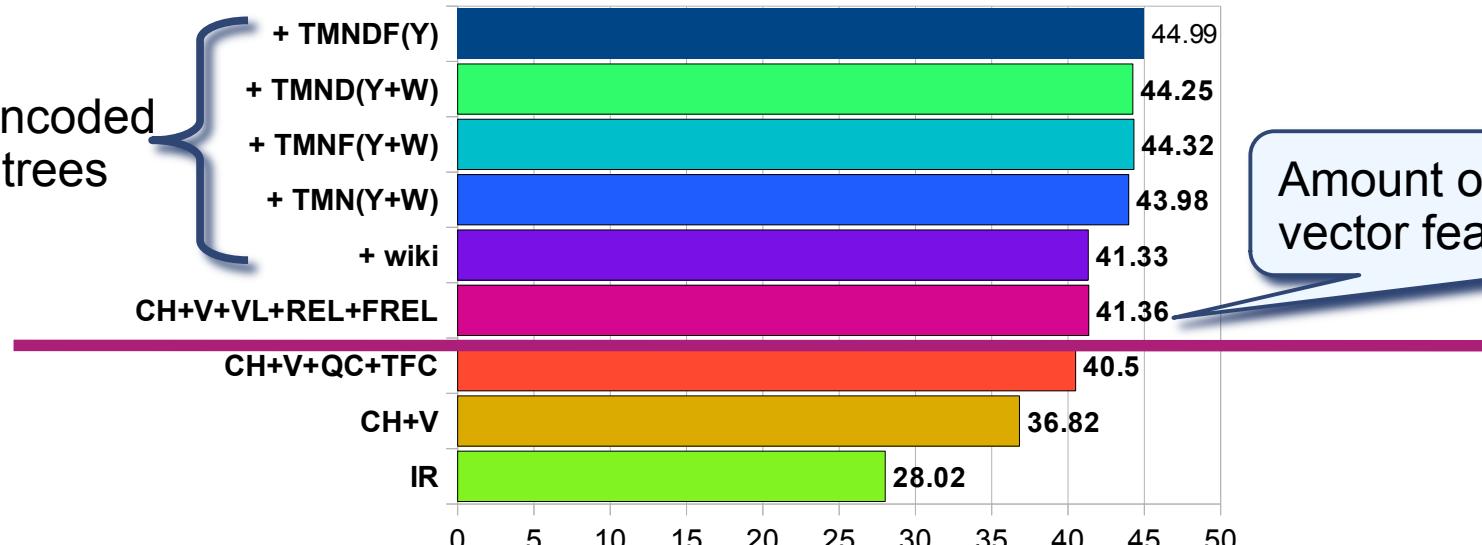
Answerbag: Mean Reciprocal Rank (I)



# LOD Contribution

LOD encoded  
into trees

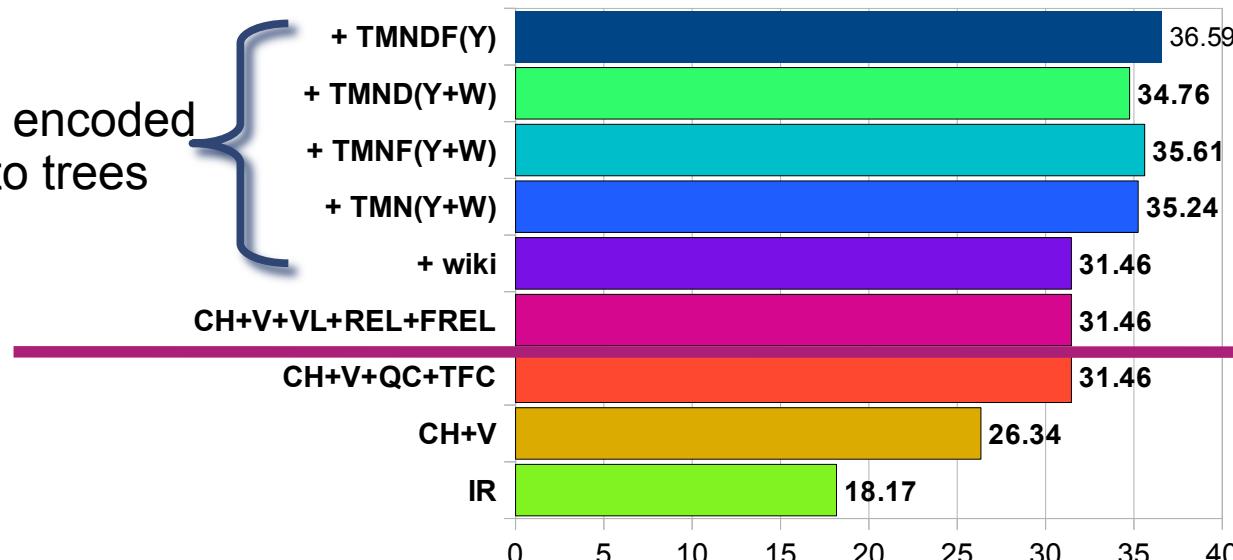
Mean Reciprocal Rank (MRR)



Amount of lod matches as  
vector features

LOD encoded  
into trees

P@1 (Precision at rank 1)

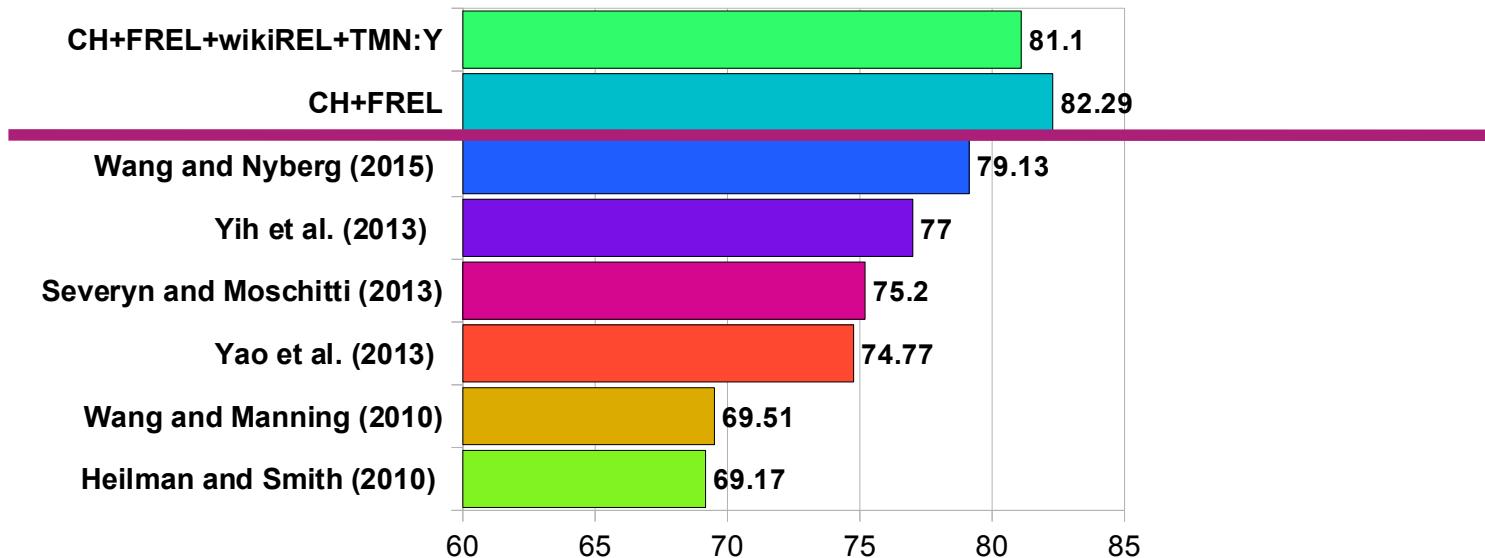


- TREC QA 2002/2003
- OpenNLP pipeline
- CH structure

- Y: YAGO
- W: WordNet
- D: DBpedia

# TREC13 benchmark

Mean Reciprocal Rank (MRR)



P@1 (Precision at rank 1)

