DEANNA: Natural Language Questions for the Web of Data

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“Classical” QA

“Who played in Casablanca and was married to a writer born in Rome?”

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Ingrid Bergman (29 August 1915 – 29 August 1982) was a Swedish actress who starred in a variety of European and American films. She won three Academy Awards, two Emmy Awards, and the Tony Award for Best Actress. She is ranked as the fourth greatest female star of American cinema of all time by the American Film Institute. She is best remembered for her **roles as Ilsa Lund in *Casablanca*** (1942), a World War II drama co-starring Humphrey Bogart and as Alicia Huberman in *Notorious* (1946), an Alfred Hitchcock thriller co-starring Cary Grant.

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In 1950, after a decade of stardom in American films, she starred in the Italian film *Stromboli*, which led to a love affair with director Roberto Rossellini while they were both already married. The affair and then **marriage with Rossellini** created a scandal that forced her to remain in Europe until 1956, when she made a successful Hollywood return in *Anastasia*, for which she won her second Academy Award, as well as the forgiveness of her fans. Many of her personal and film documents can be seen in the Wesleyan University Cinema Archives.[4]

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Rossellini was born in Rome. His mother, Elettra (née Bellan), was a housewife, and his father, Angiolo Giuseppe "Beppino" Rossellini, owned a construction firm. His mother was of part French descent, from immigrants who had arrived in Italy during the Napoleonic Wars. He lived on the Via Ludovisi, whereBenito Mussolini had his first Roman hotel in 1922 when Fascism obtained power in Italy.

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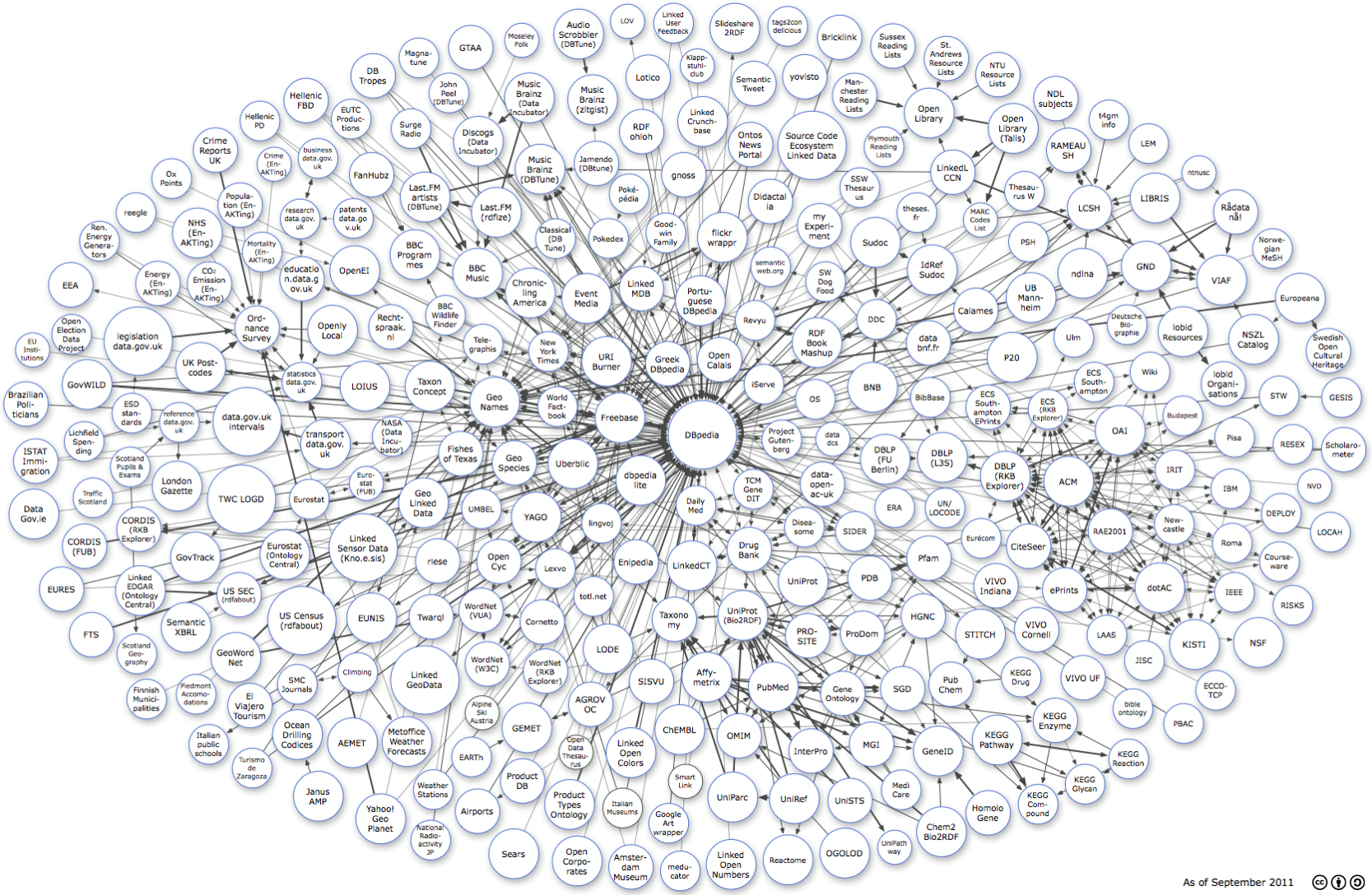
QA, meet the (semantic) Web of Data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Ontology Drug Bank
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Ontology Affy-metrix
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Ontology Kegg Reaction
Ontology Kegg Glycan
Ontology Kegg Com-pound
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Ontology Sears
Ontology Airports
Ontology Weather Stations
Ontology National Radio-activity JP
Ontology Janus AMP
Ontology Yahoo! Geo Planet
Ontology Metoffice Weather Forecasts
Ontology AEMET
Ontology Climbing
Ontology SMC Journals
Ontology El Viajero Tourism
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Ontology Piedmont Accomo-dations
Ontology Finnish Munici-palities
Ontology Scotland Geo-graphy
Ontology FTS
Ontology EURES
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Ontology ISTAT Immi-gration
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Ontology LOIUS
Ontology Recht-spraak. nl
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Ontology BBC Programmes
Ontology BBC Music
Ontology Taxon Concept
Ontology NASA (Data Incu-bator)
Ontology Euro-stat (FUB)
Ontology Eurostat
Ontology Eurostat (Ontology Central)
Ontology TWC LOGD
Ontology GovTrack
Ontology US SEC (rdfabout)
Ontology US Census (rdfabout)
Ontology Semantic XBRL
Ontology GeoWord Net
Ontology EUNIS
Ontology Twarql
Ontology WordNet (VUA)
Ontology WordNet (W3C)
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Ontology totl.net
Ontology LODE
Ontology SISVU
Ontology AGROV OC
Ontology GEMET
Ontology EARTh
Ontology Alpine Ski Austria
Ontology Metoffice Weather Forecasts
Ontology riese
Ontology Geo Species
Ontology Fishes of Texas
Ontology Uberblic
Ontology dbpedia lite
Ontology Enipedia
Ontology Daily Med
Ontology Disea-some
Ontology SIDER
Ontology UniProt
Ontology UniProt (Bio2RDF)
Ontology PRO-SITE
Ontology ProDom
Ontology PDB
Ontology totl.net
Ontology ChEMBL
Ontology OMIM
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Ontology PubMed
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Ontology Ulm
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Ontology LOCAH
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Ontology JISC
Ontology KISTI
Ontology NSF
Ontology ECCO-TCP
Ontology PBAC
Ontology bible ontology
Ontology HGNC
Ontology Pfam
Ontology Pub Chem
Ontology Drug Bank
Ontology Kegg Drug
Ontology Kegg Enzyme
Ontology Kegg Pathway
Ontology Kegg Reaction
Ontology Kegg Glycan
Ontology Kegg Com-pound
Ontology Homolo Gene
Ontology Medi Care
Ontology Chem2 Bio2RDF
Ontology Gene Ontology
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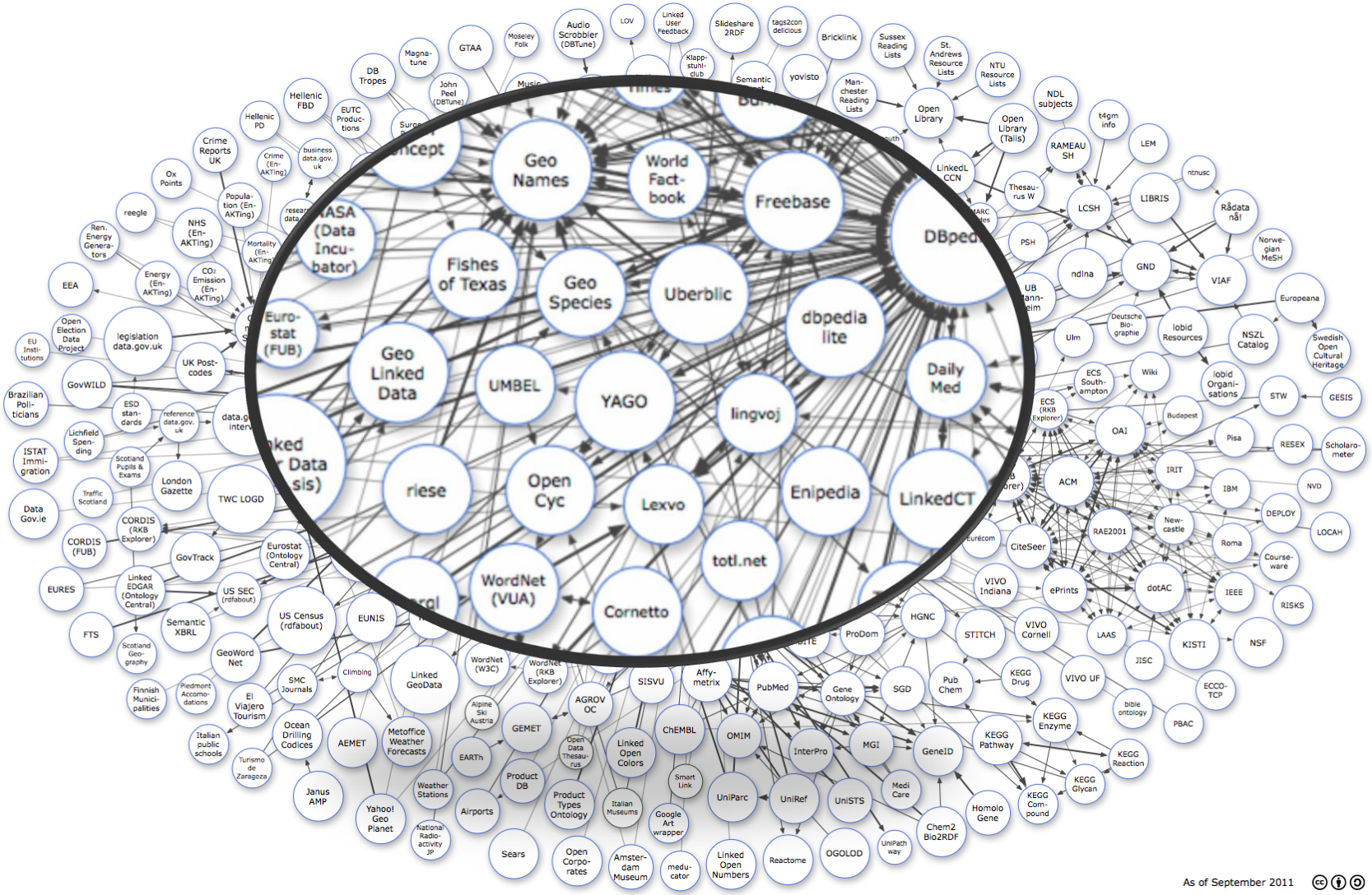
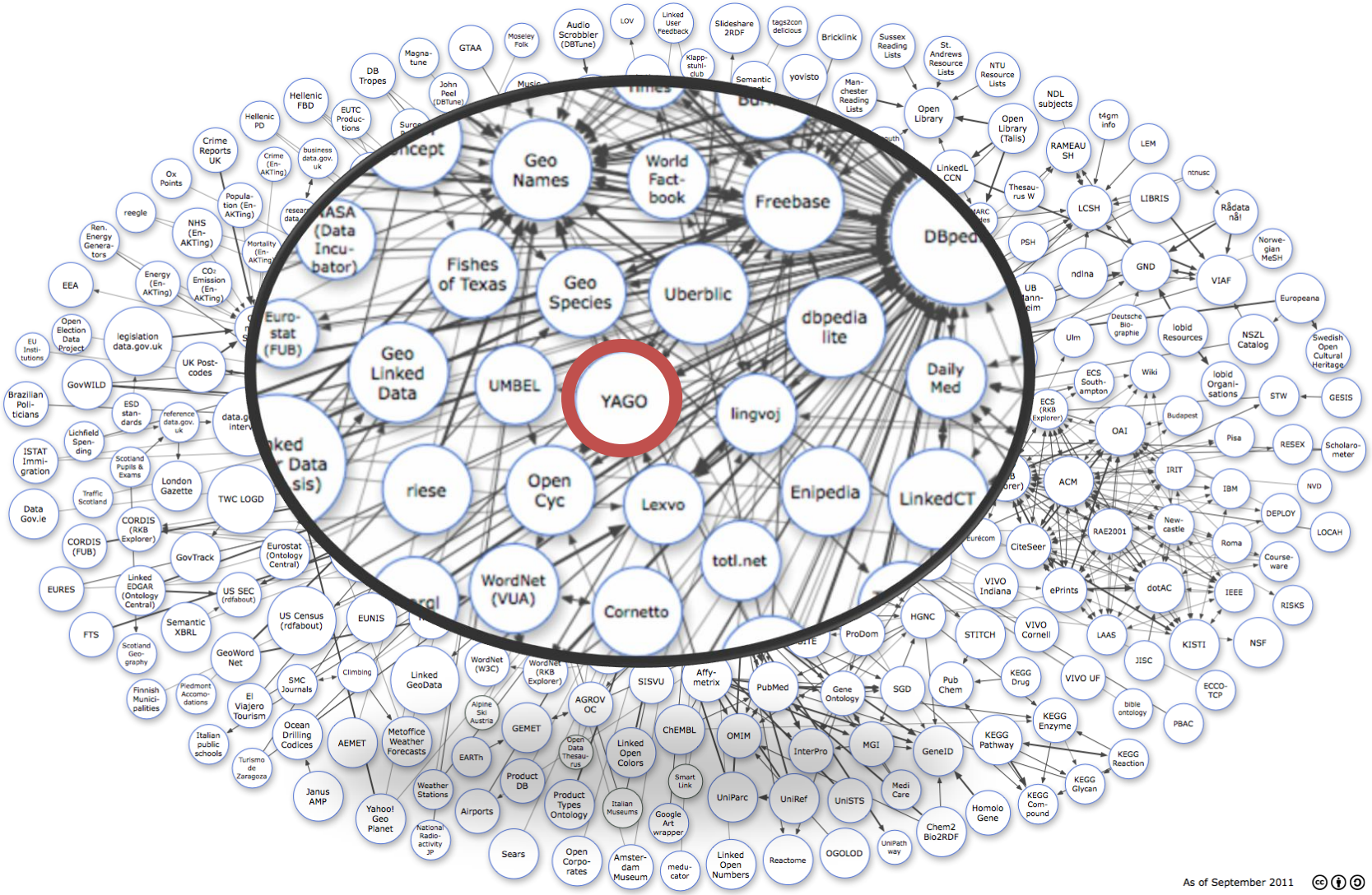
QA, meet the (semantic) Web of Data



As of September 2011

QA, meet the (semantic) Web of Data



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WordNet

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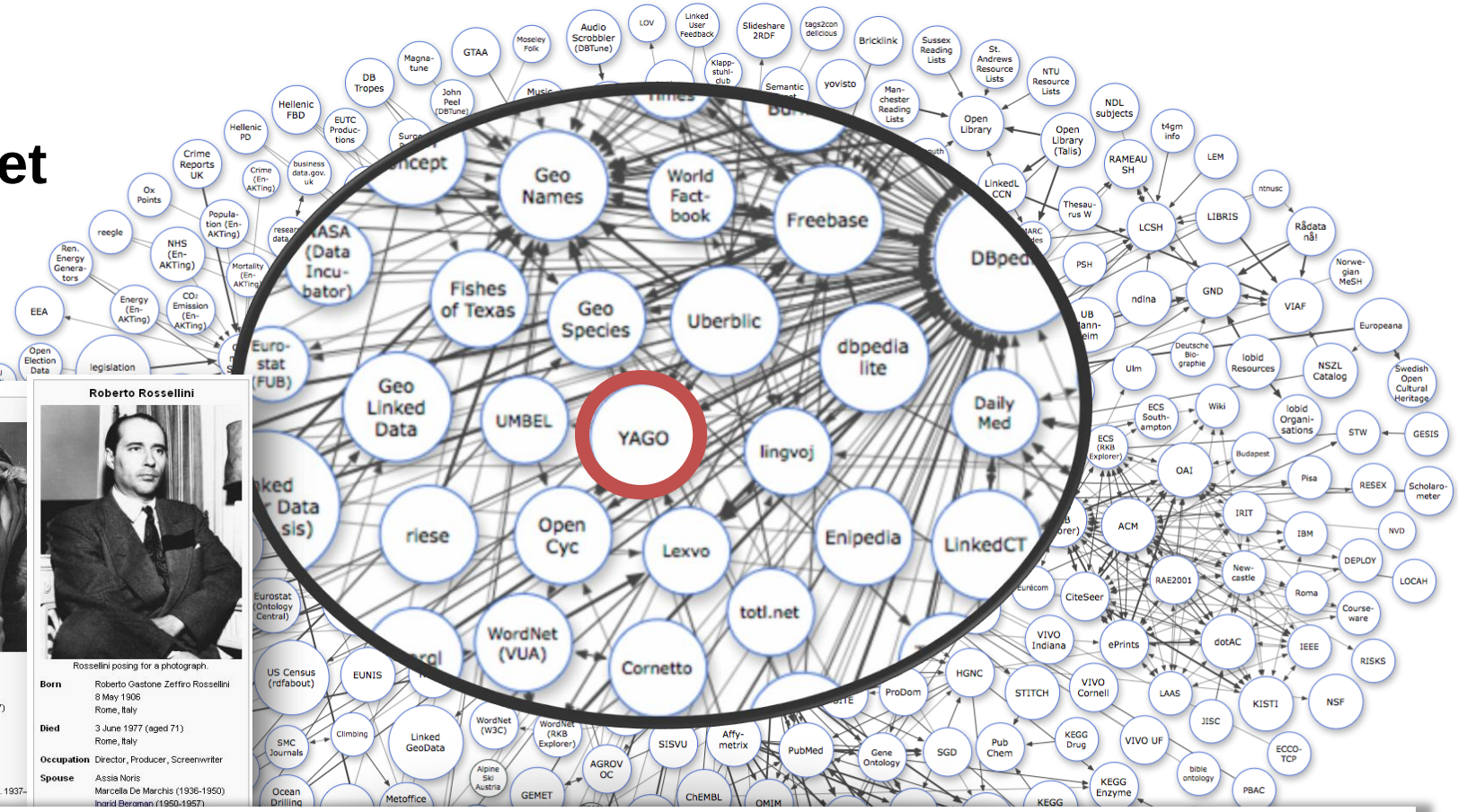

Subject	Predicate	Object
Rome	isA	city
city	subclassOf	location
Roberto_Rossellini	mariedTo	Ingrid_Bergman

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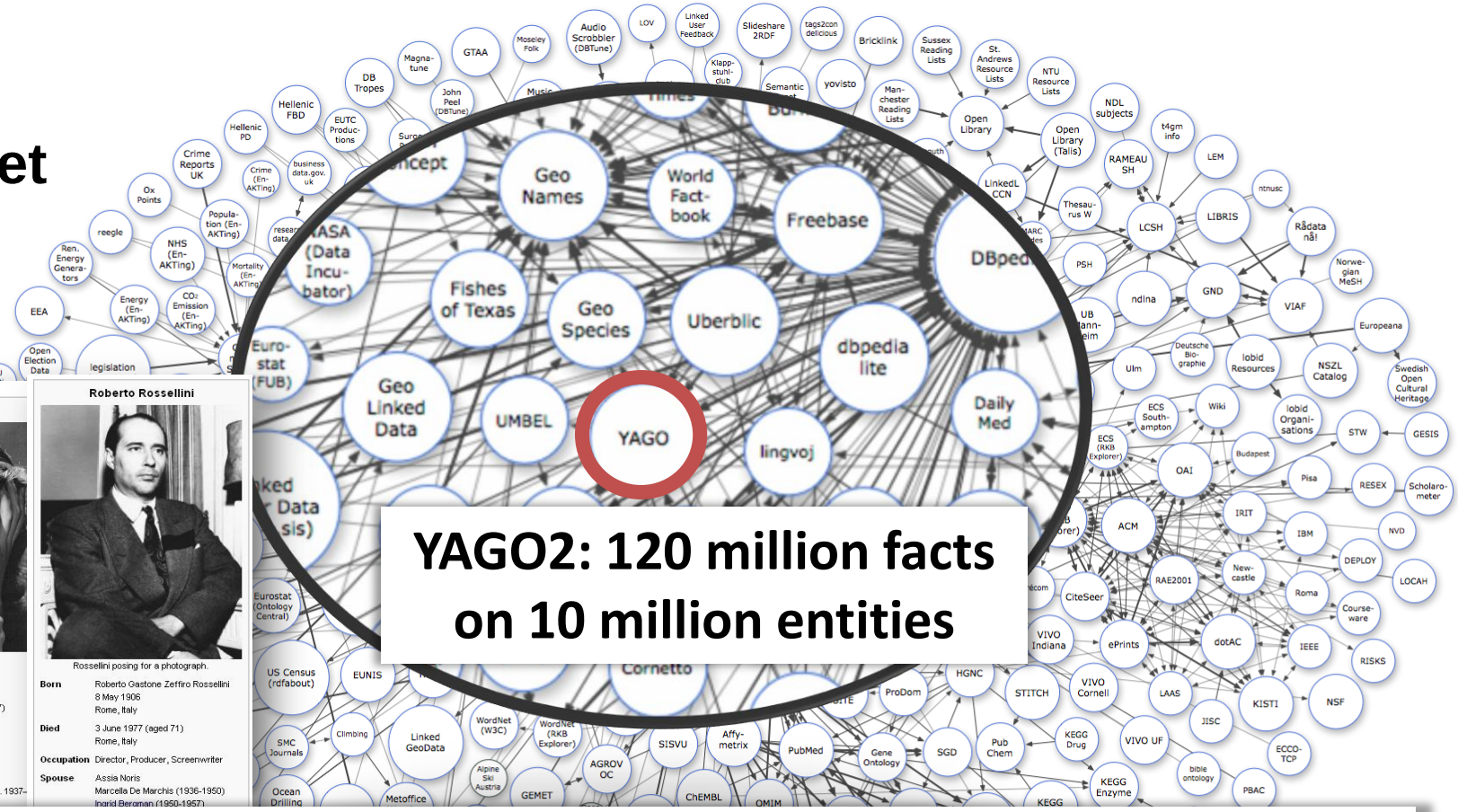

YAGO2: 120 million facts on 10 million entities

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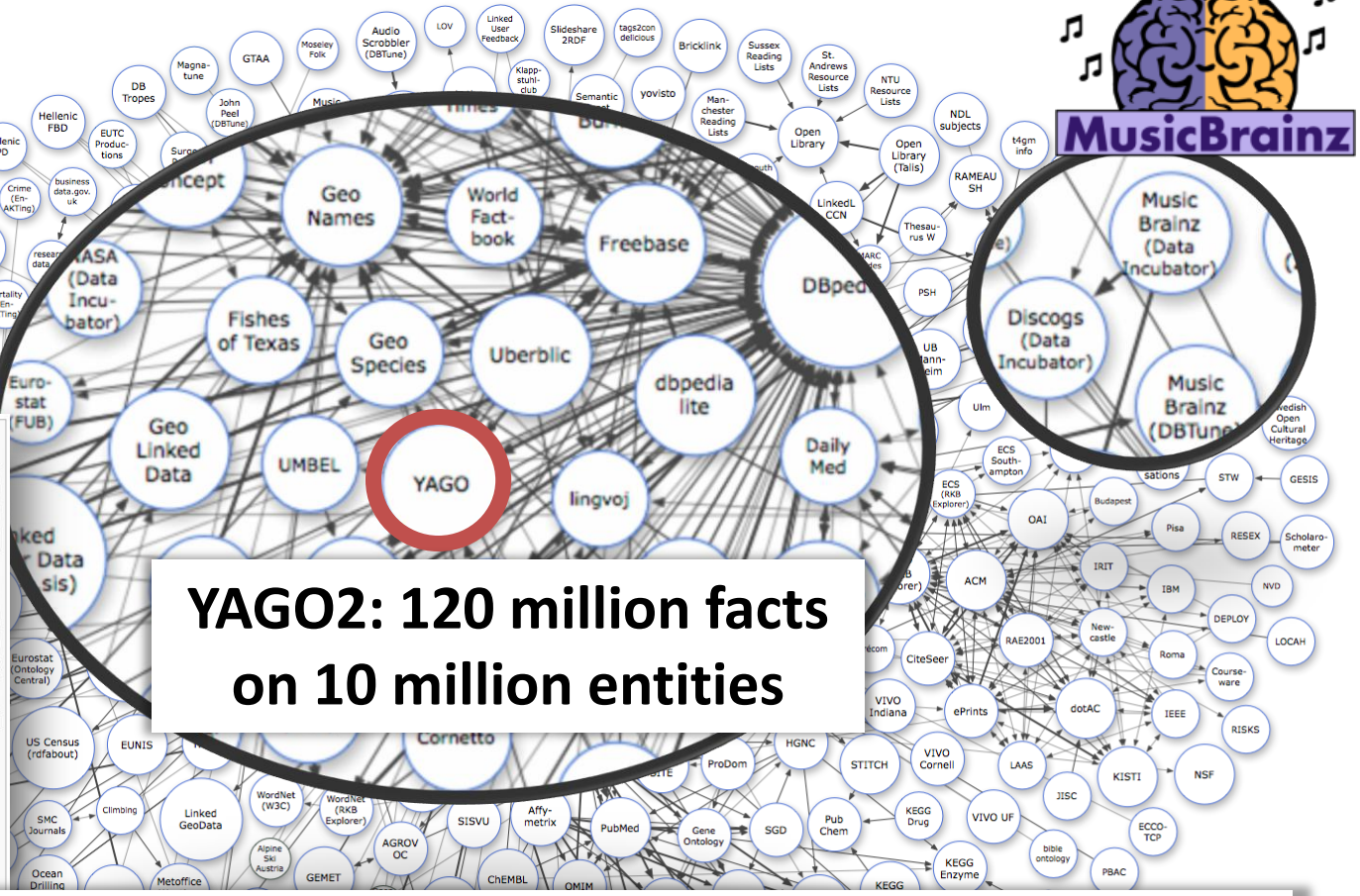

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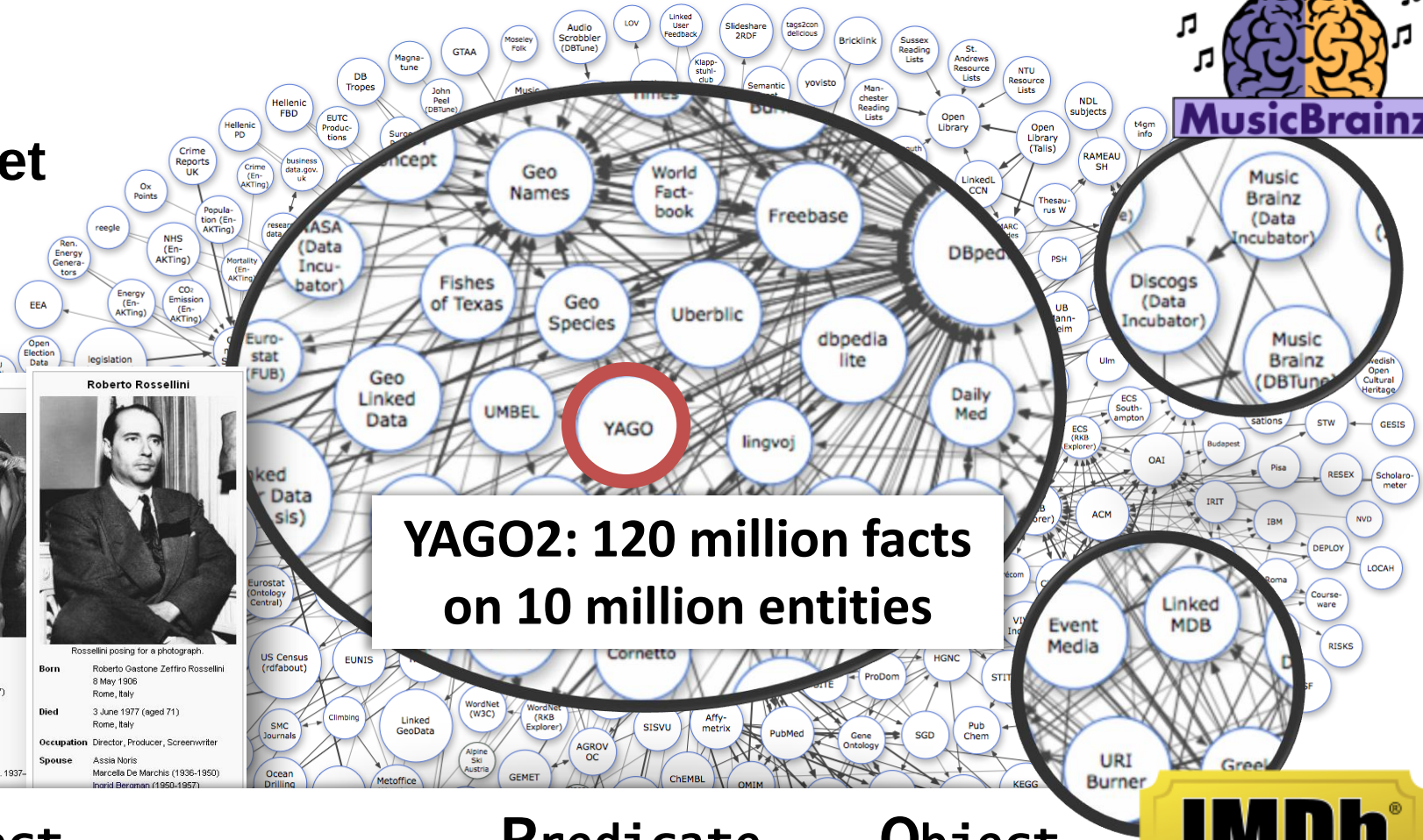

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LOD: > 31 BILLION triples

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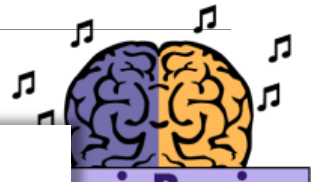

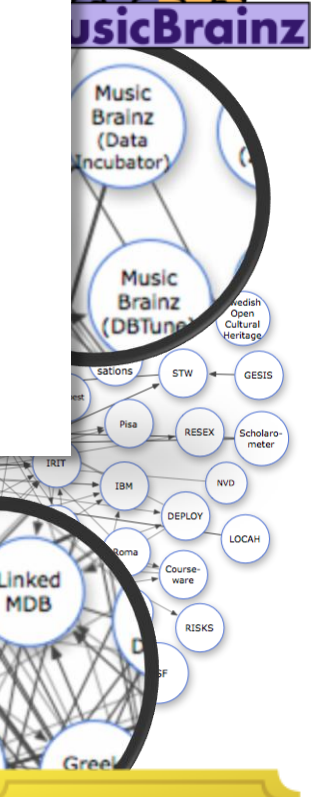

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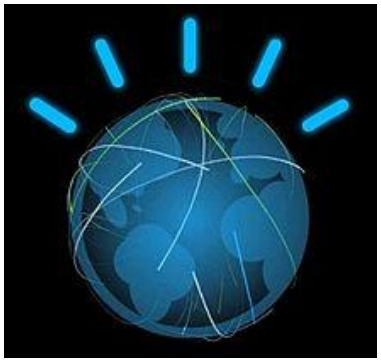
Semantics Types



U.S. Cities

ITS LARGEST AIRPORT WAS NAMED FOR A WORLD WAR II HERO; ITS SECOND LARGEST, FOR A WORLD WAR II BATTLE

What is Toronto???

Crash Course: Querying the Web of Data

"Who played in Casablanca and was married to a writer born in Rome?"

Crash Course: Querying the Web of Data

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SPARQL

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SELECT ?p WHERE{
   ?p type person .
   ?p actedIn Casablanca_(film).
   ?p isMarriedTo ?w .
   ?w type writer .
   ?w bornIn Rome }
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Crash Course: Querying the Web of Data

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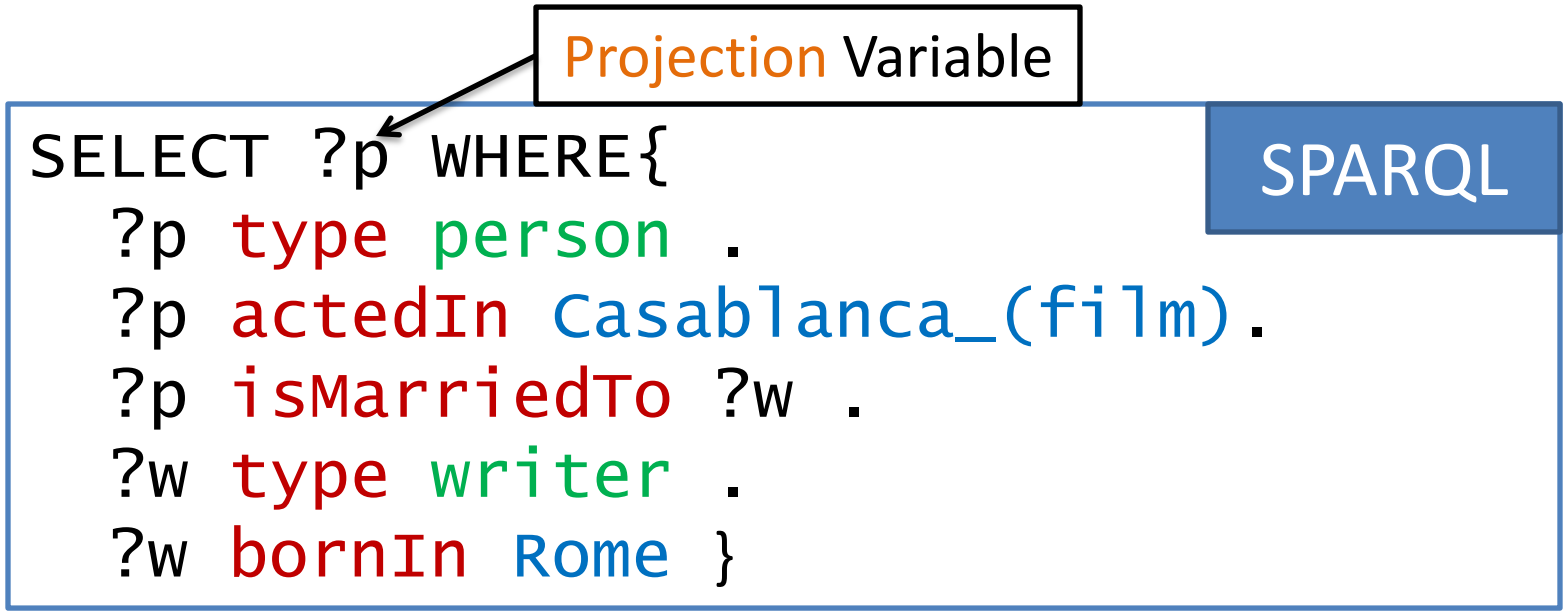

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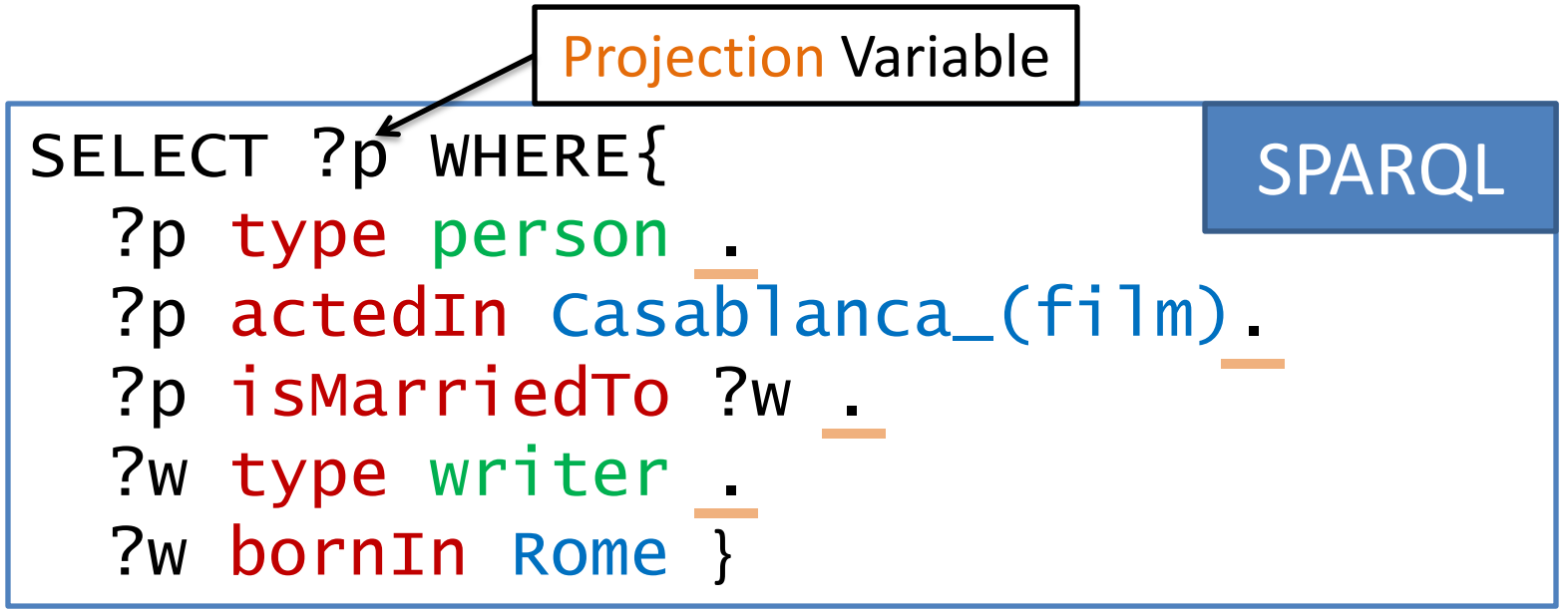

Dot: conjunction

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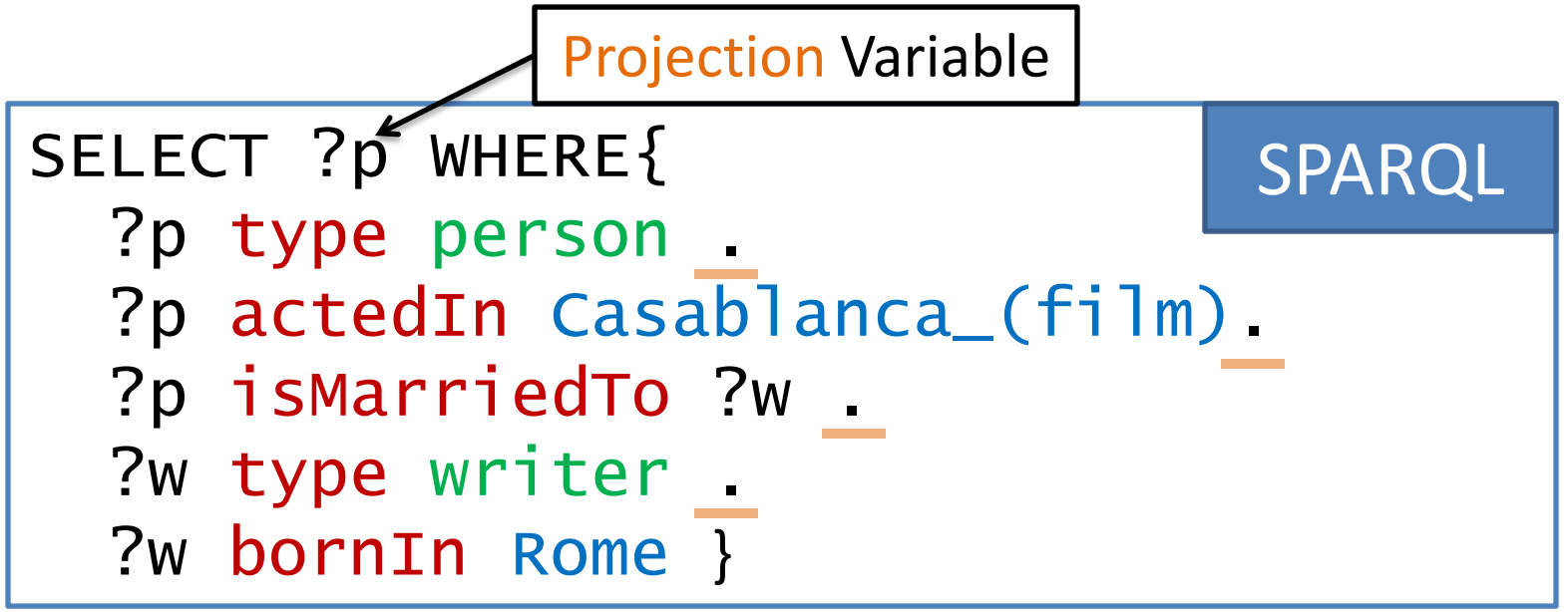

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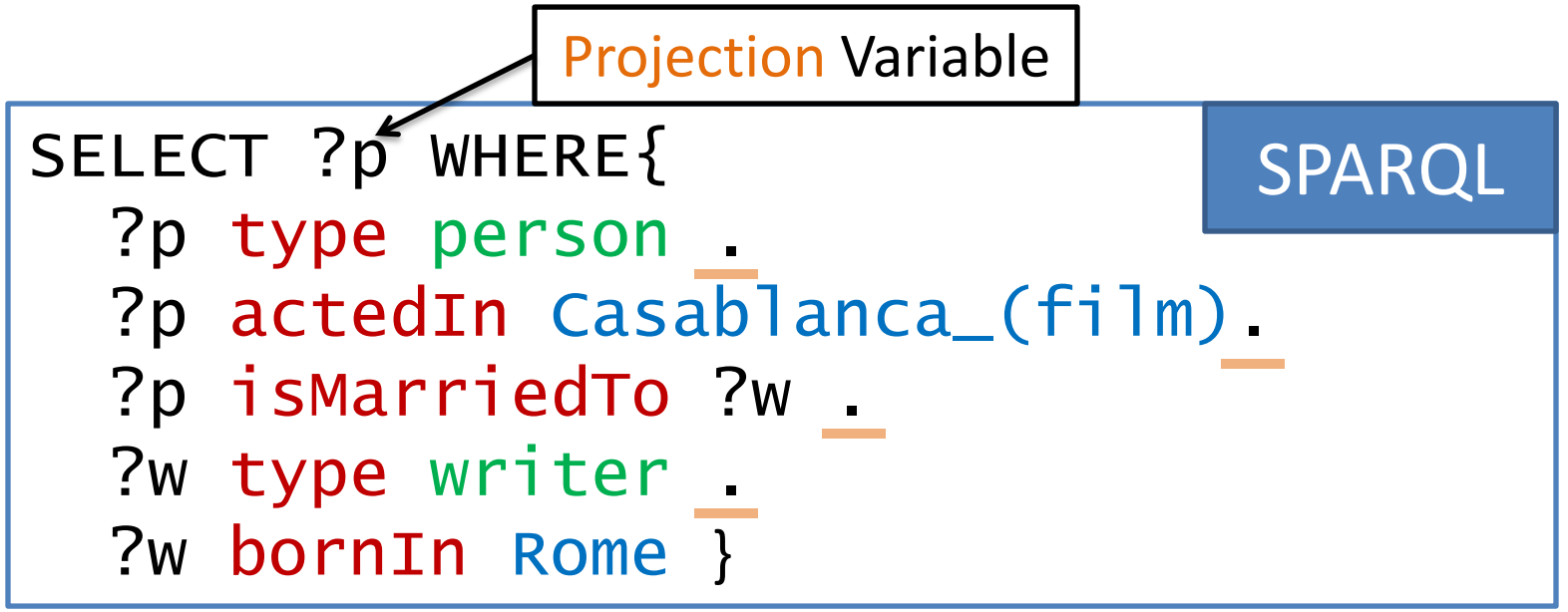

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Same variable → same binding (join)

Crash Course: Querying the Web of Data

"Who played in Casablanca and was married to a writer born in Rome?"

Projection Variable

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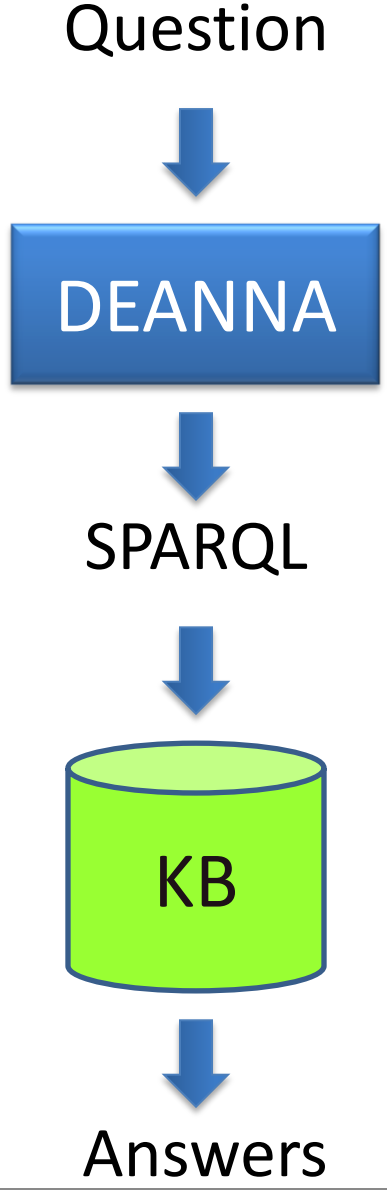

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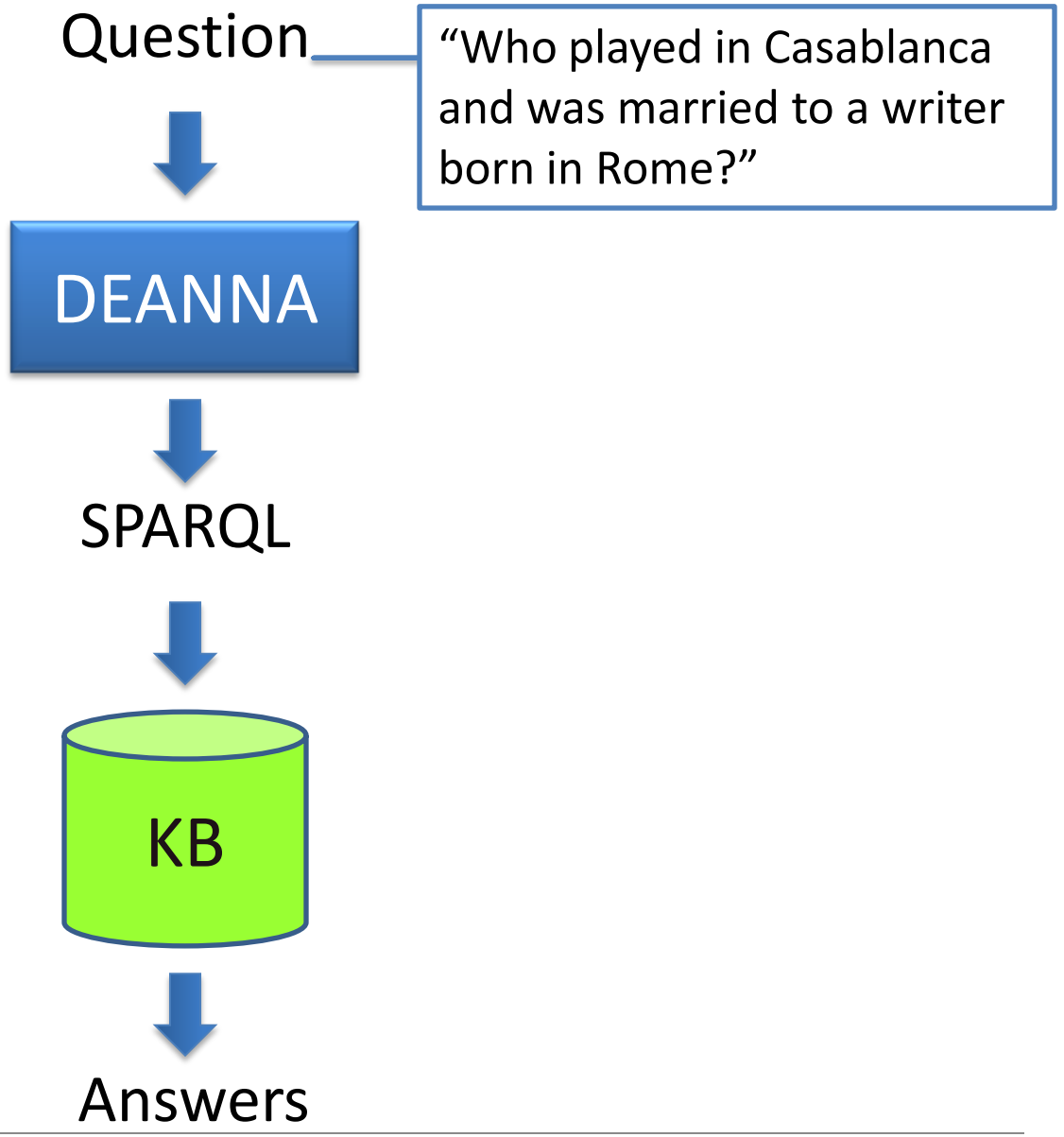

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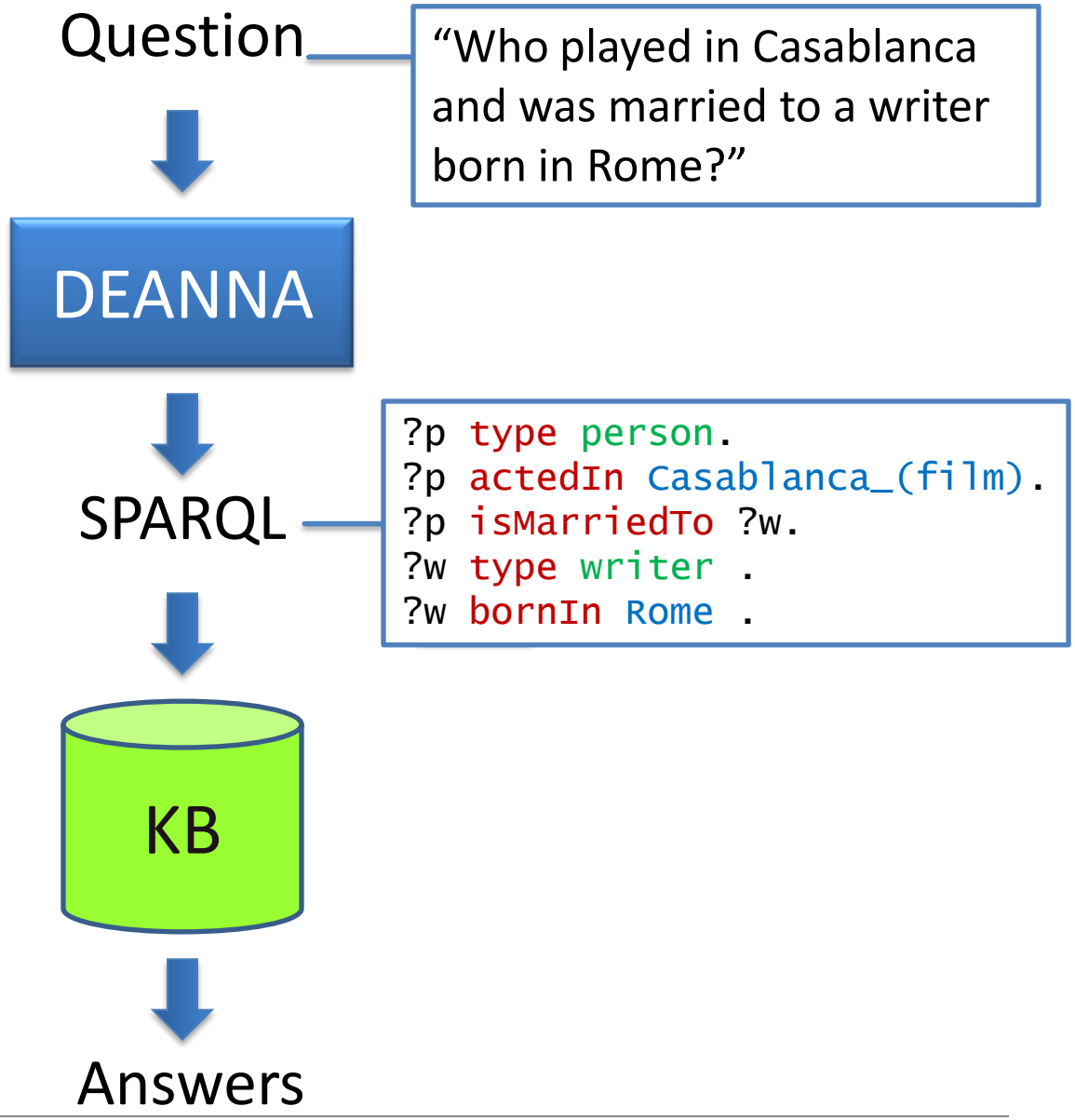

What is DEANNA?

Question

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DEANNA

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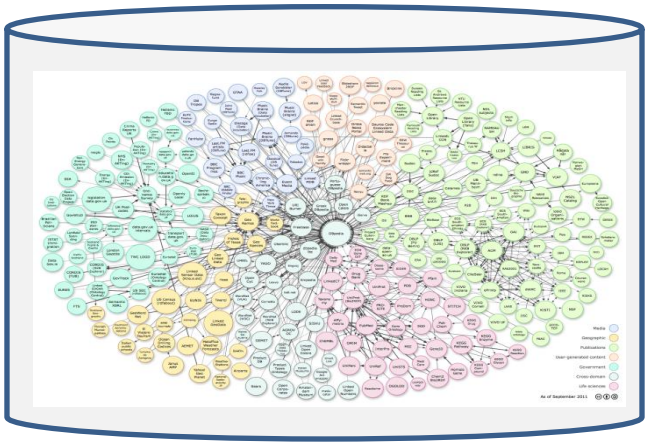

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Answers

What is DEANNA?

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DEANNA

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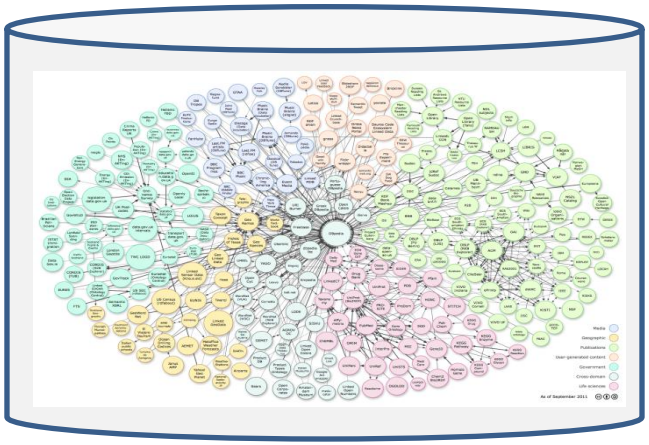

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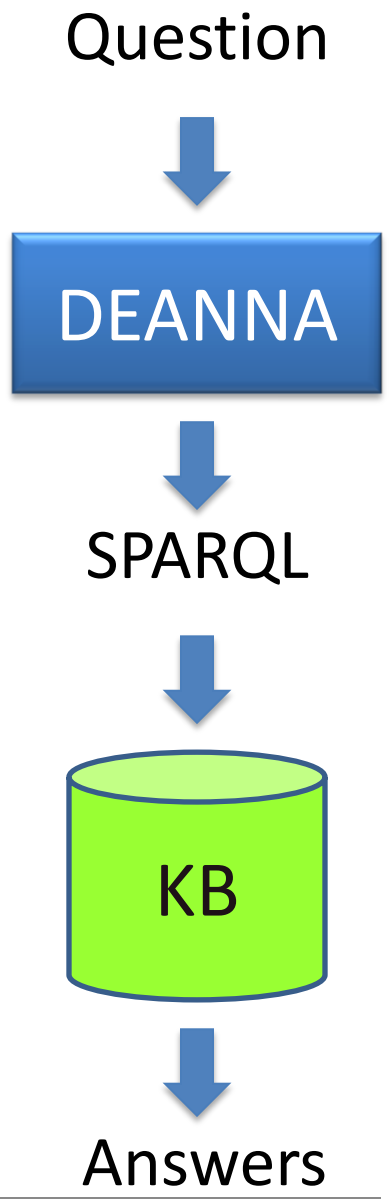
Answers

Inside DEANNA



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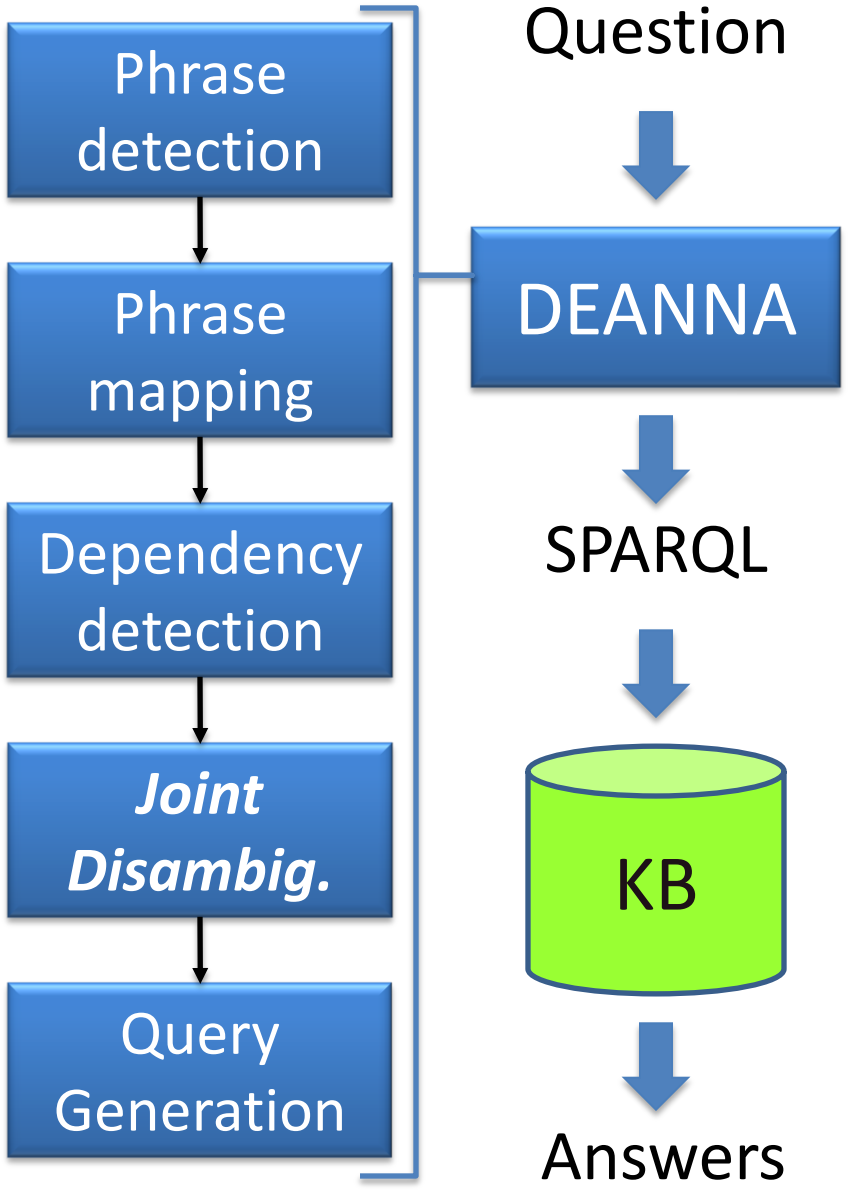

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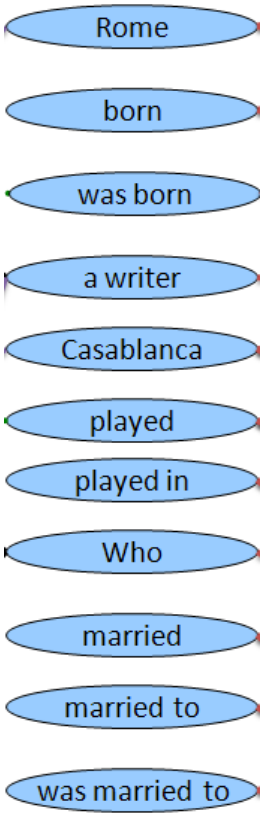

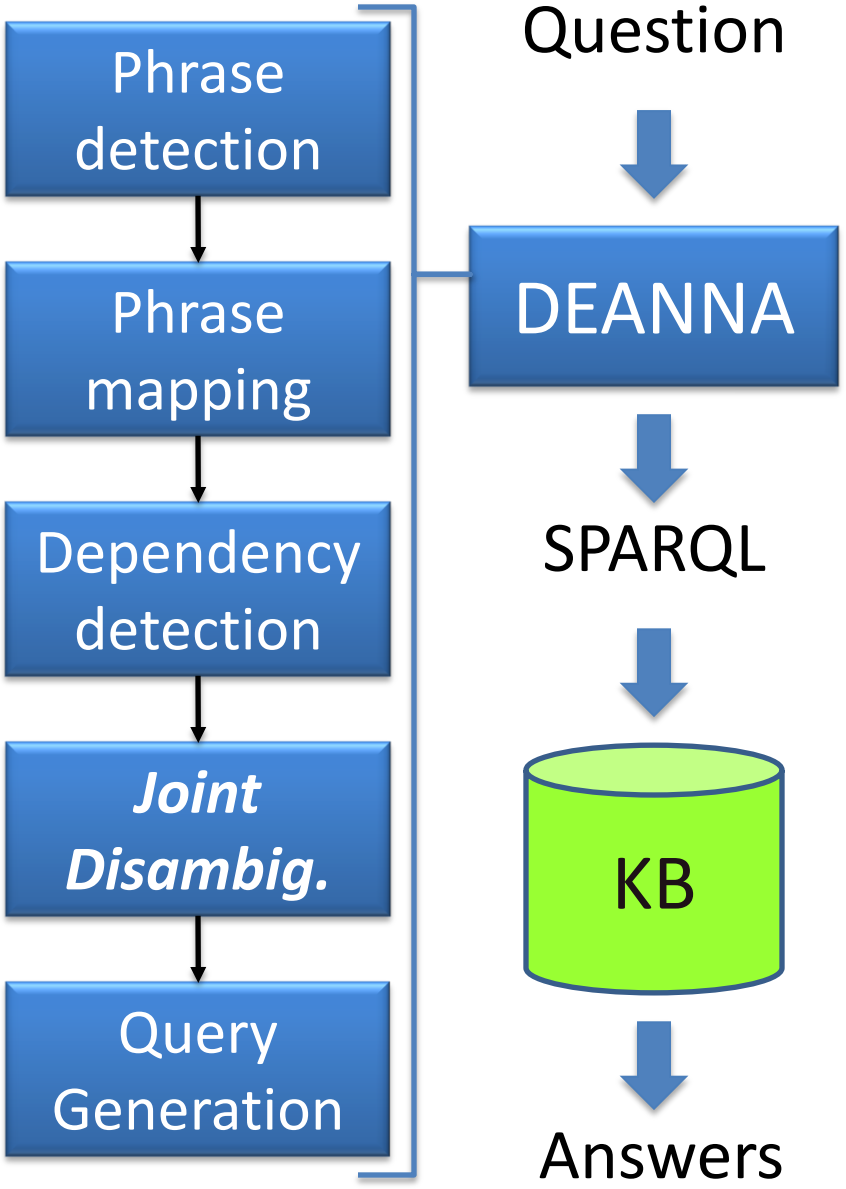

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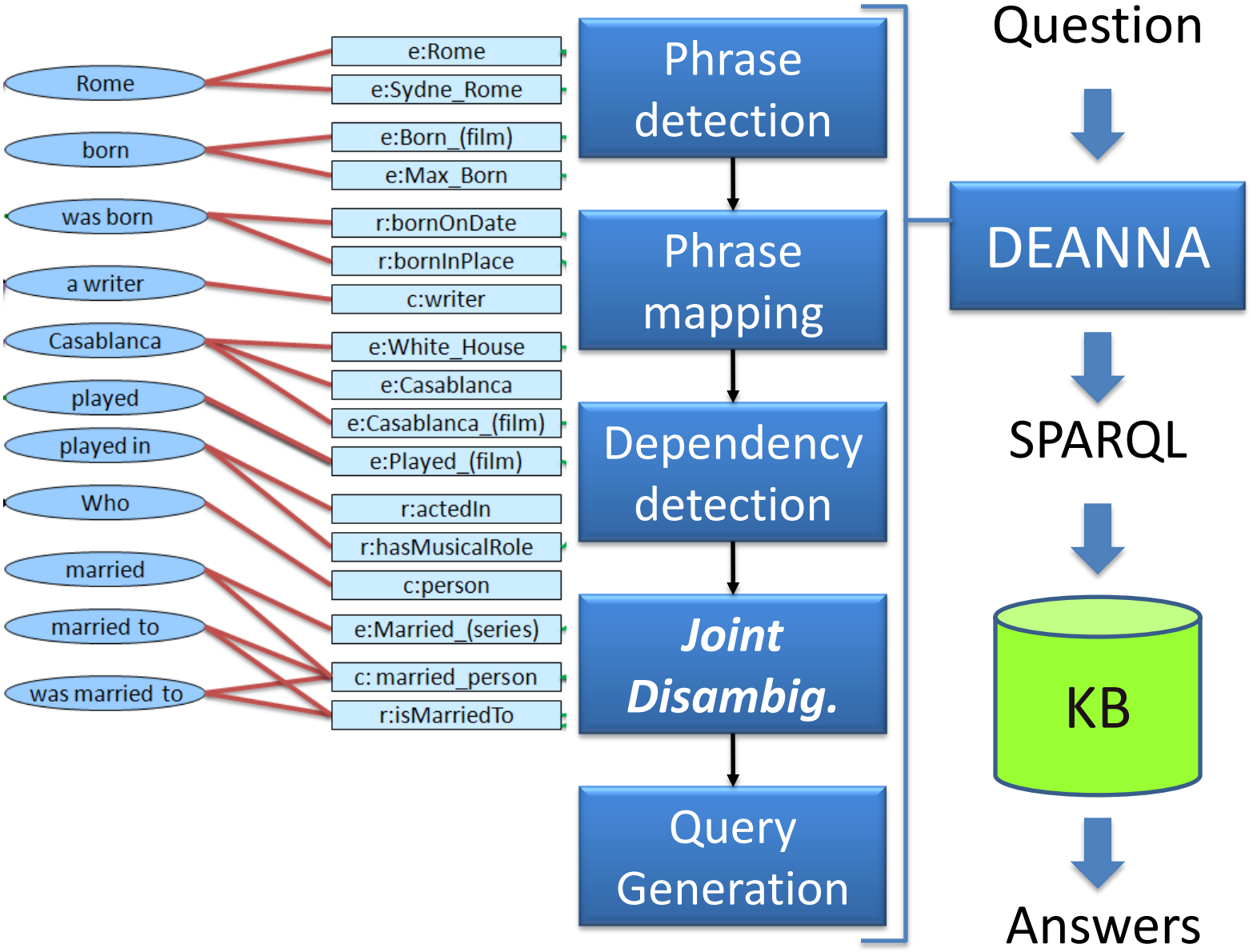

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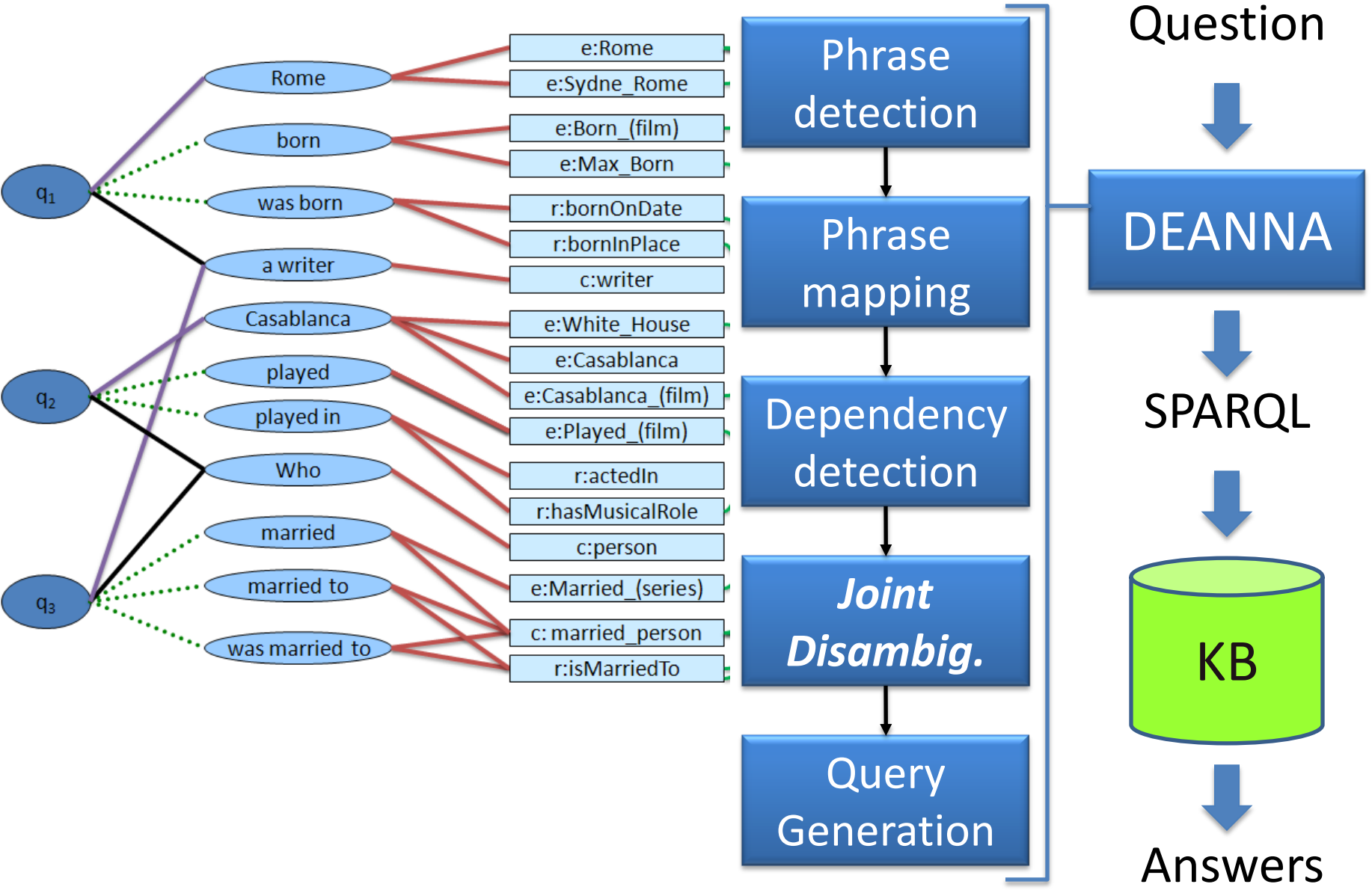

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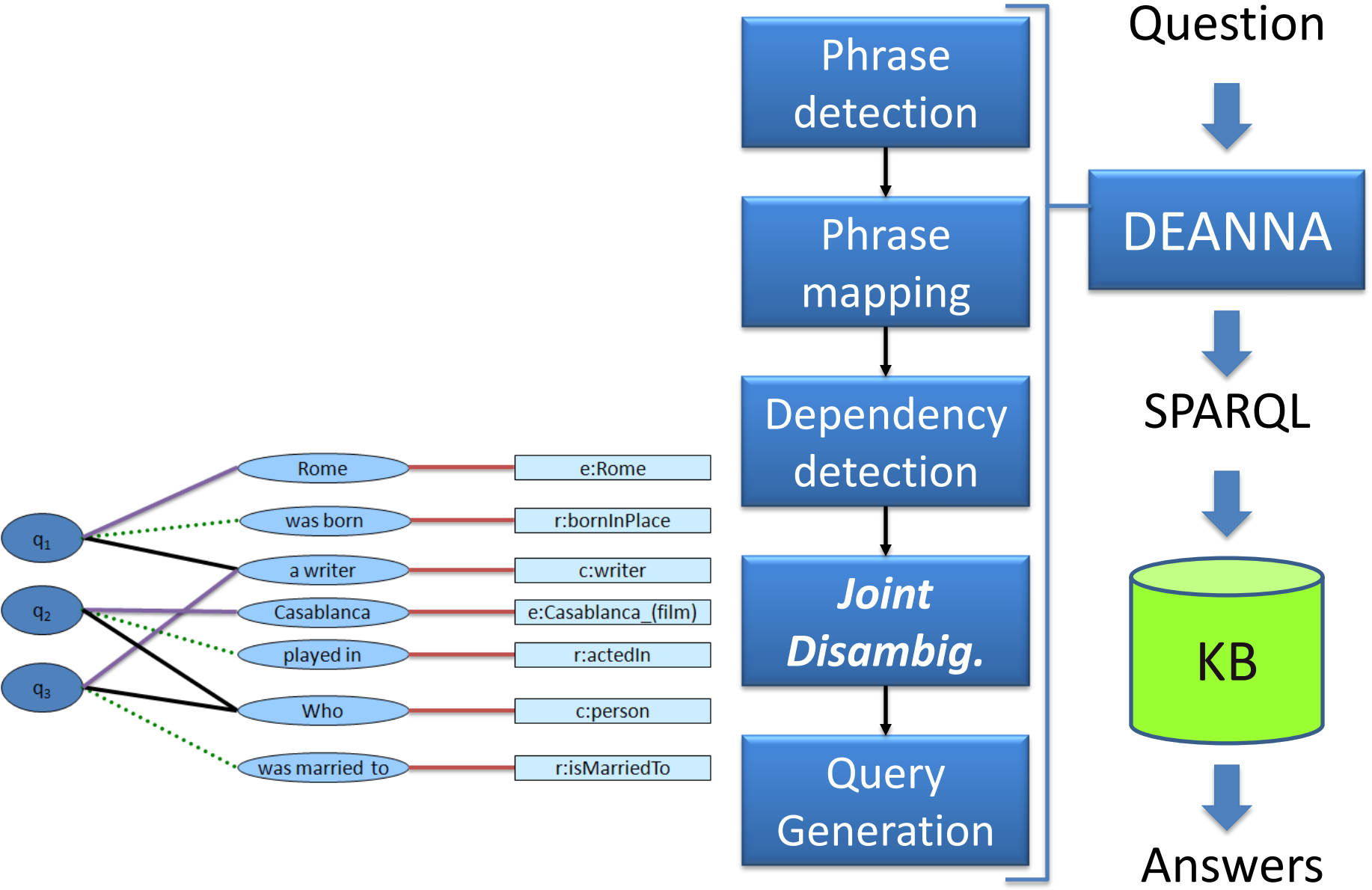

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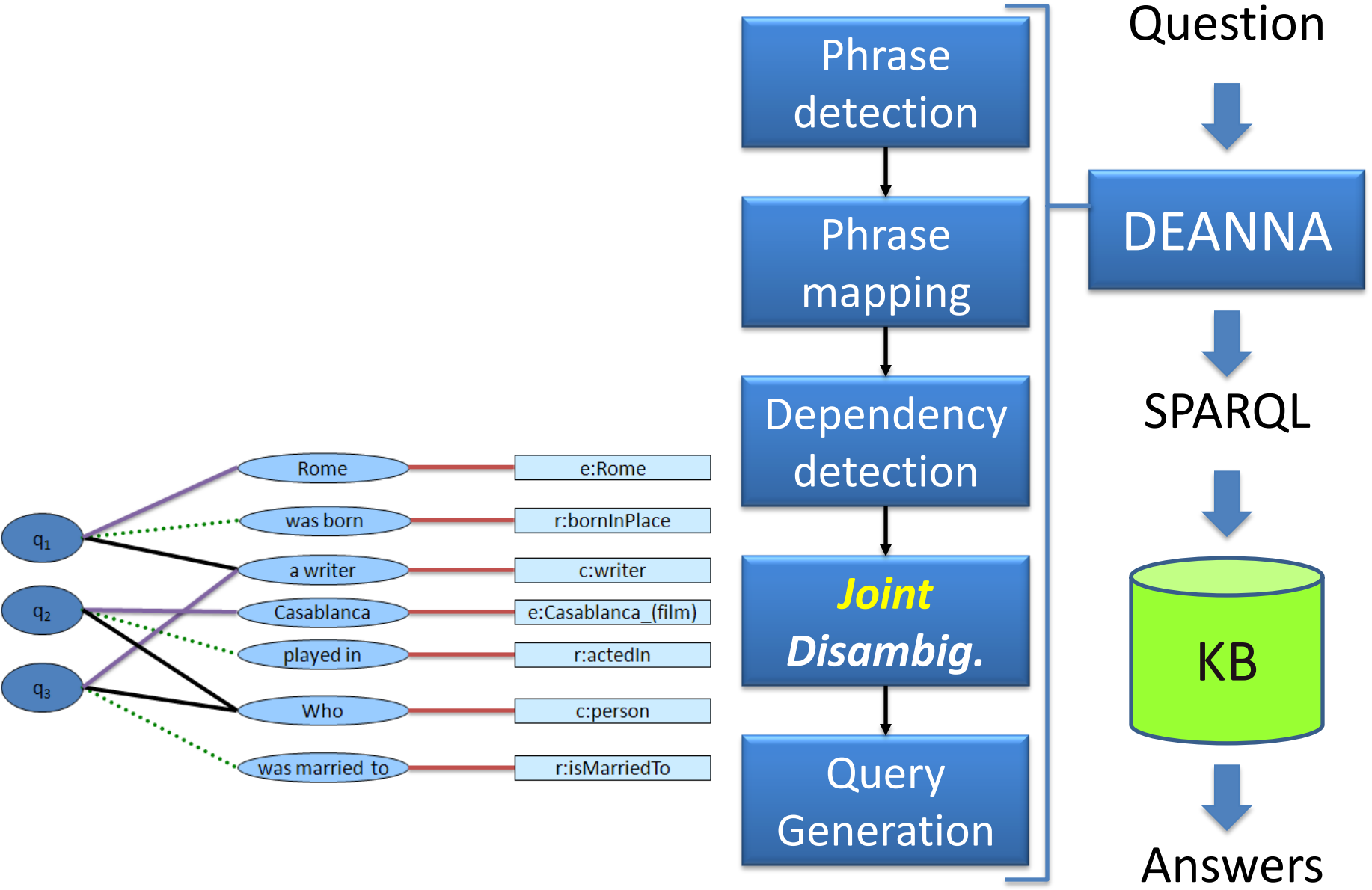

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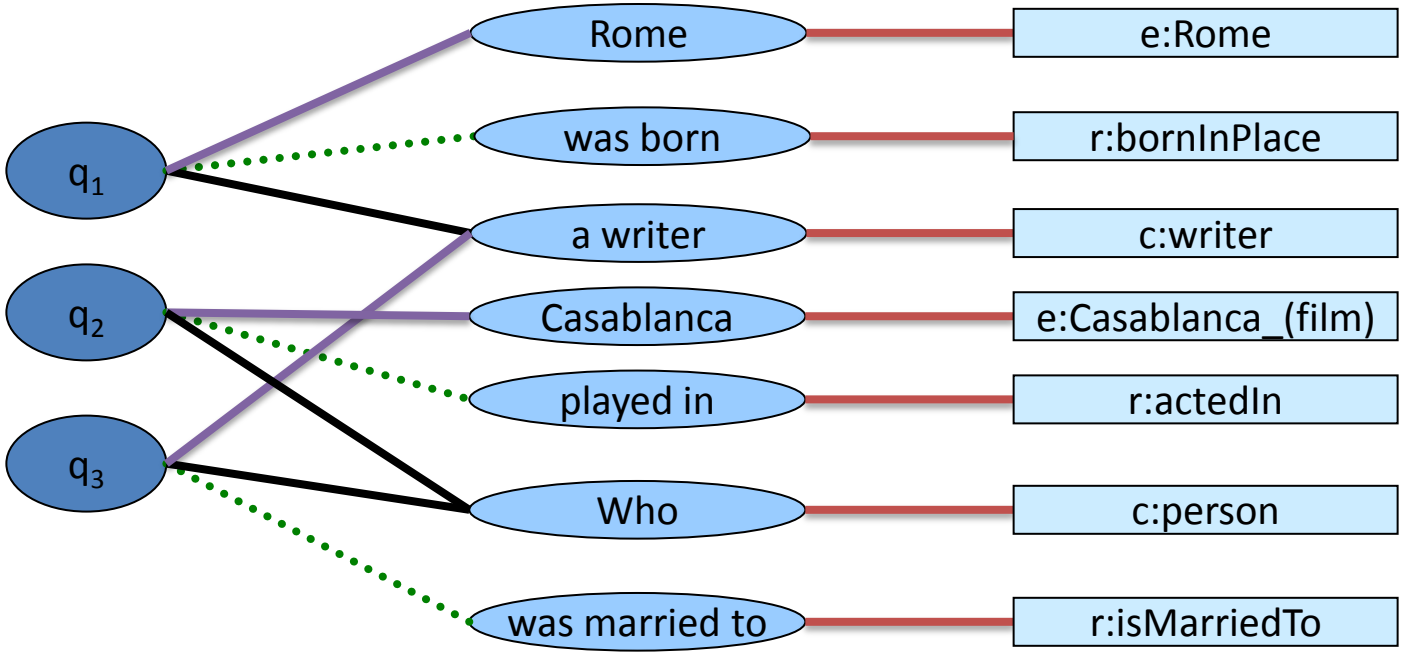


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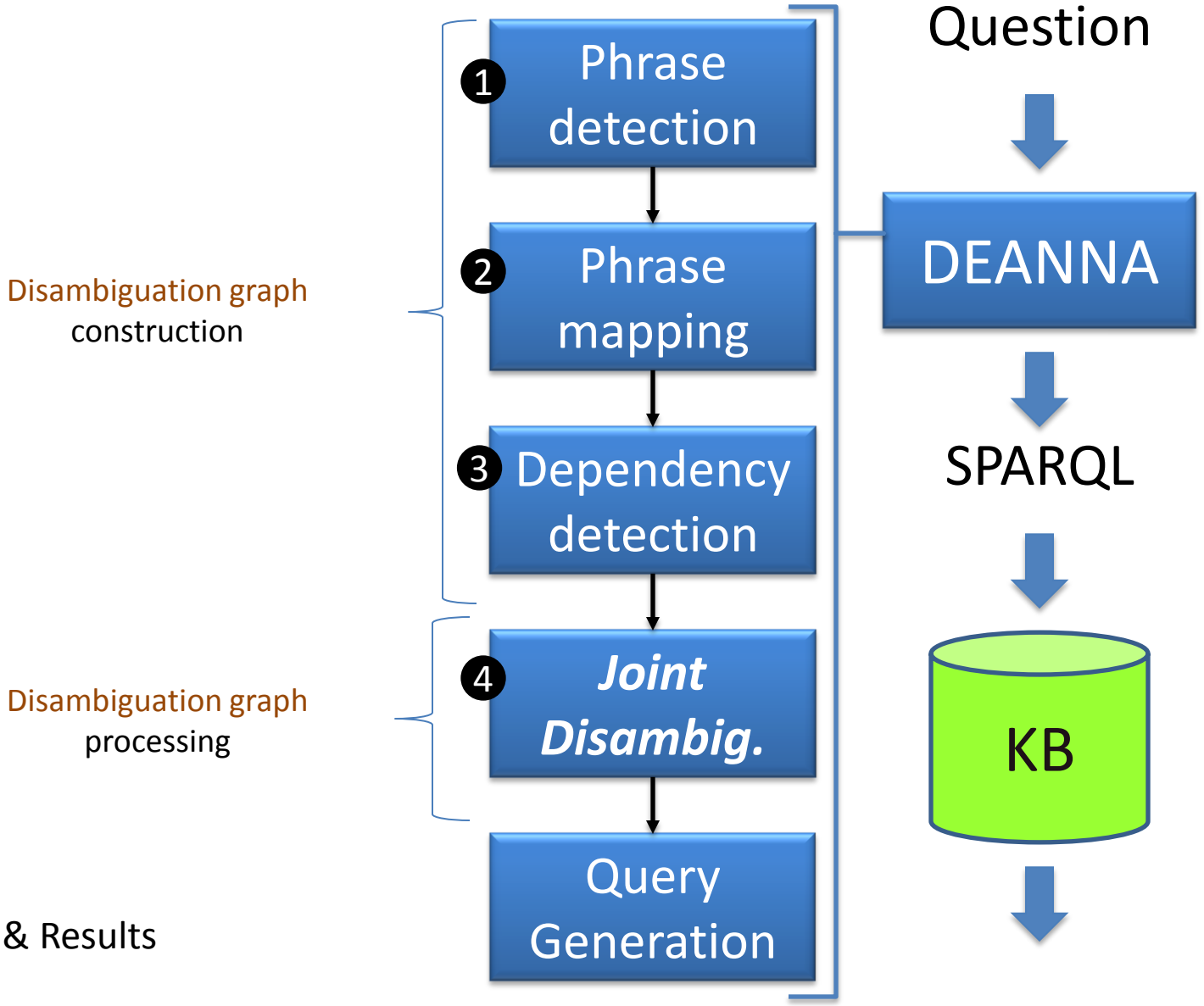
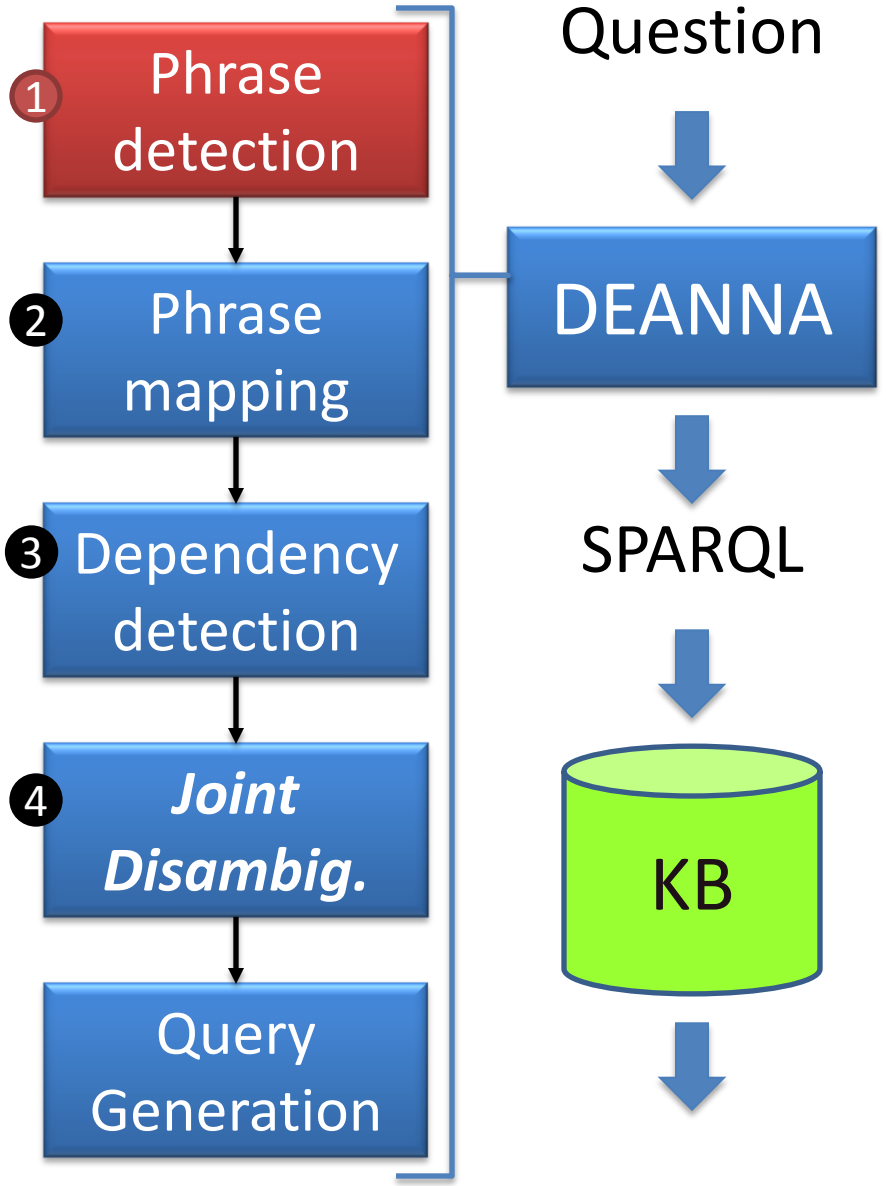


❺ Experiments & Results

Outline



5 Experiments & Results

Phrase Detection

- **Concepts: entities & classes:**

Dictionary-based

Concept	Phrase
`Casablanca`	Casablanca
`Casablanca`	Casablanca, Morocco
`Casablanca_(film)`	Casablanca the film
`Casablanca_(film)`	Casablanca
…	…

- **Relations:**

Mainly use Reverb [Fader et al. EMNLP'11]: `V | VP | VW*P`

… was/VBD married/VBN to/TO a/DT…

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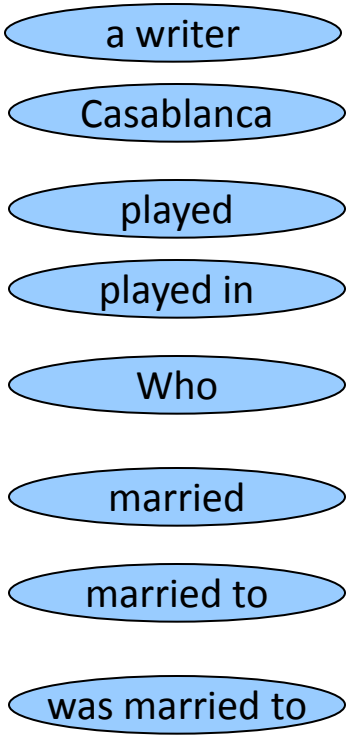

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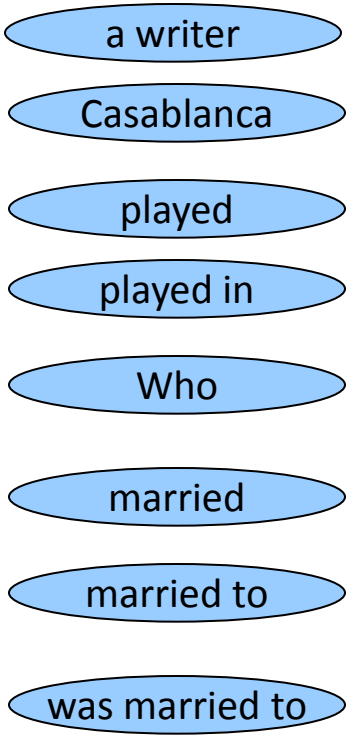

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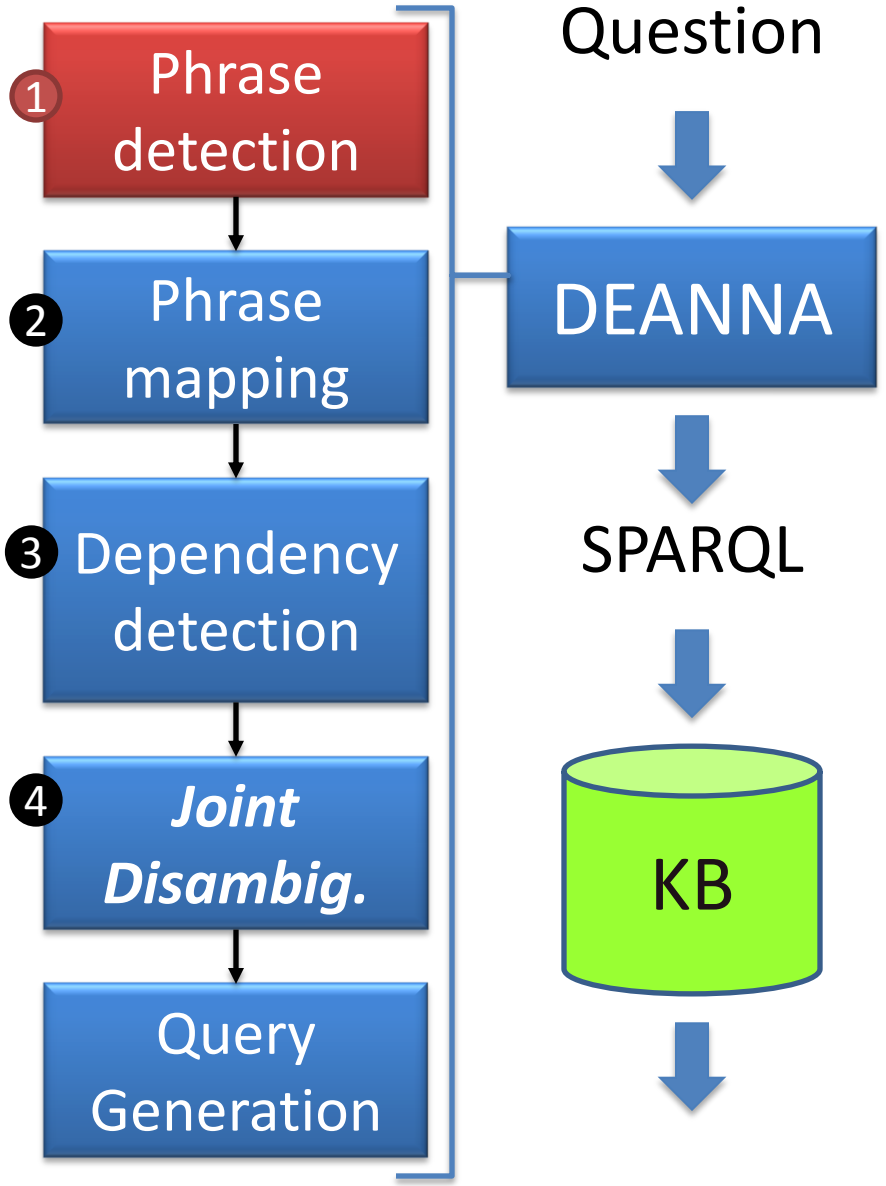
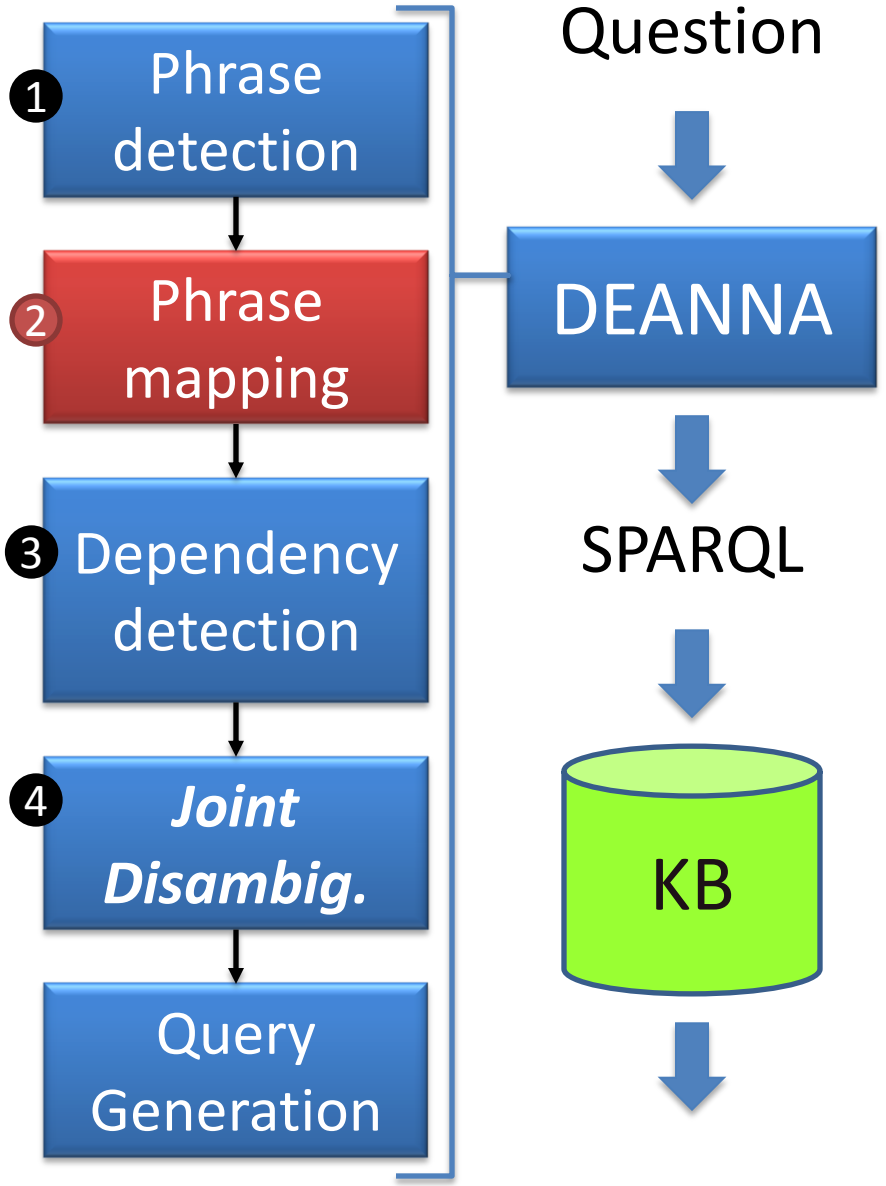


5 Experiments & Results

Outline



5 Experiments & Results

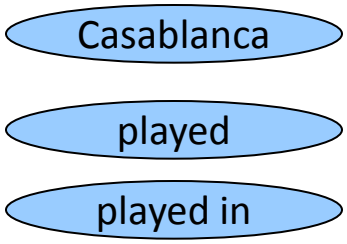
Phrase Mapping

Casablanca

played

played in

Phrase Mapping



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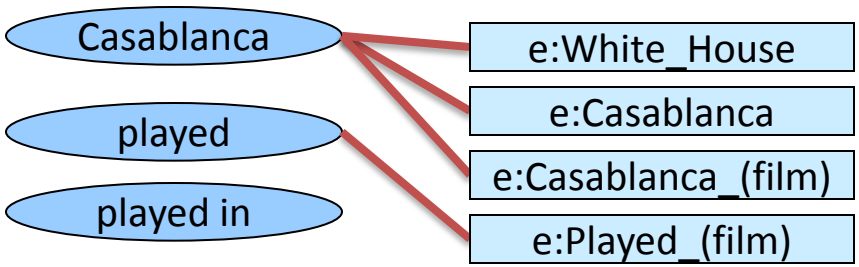

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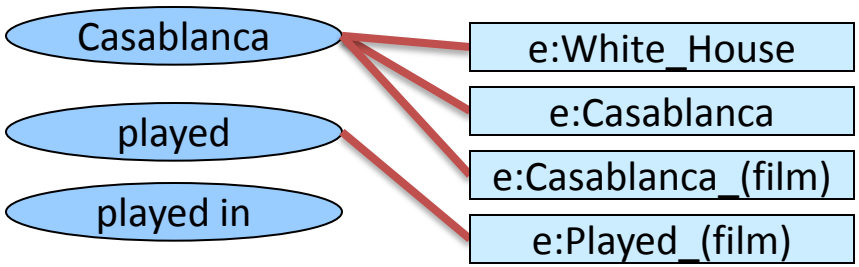

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`actedIn`	played in
`hasMusicalRole`	plays
`hasMusicalRole`	mastered

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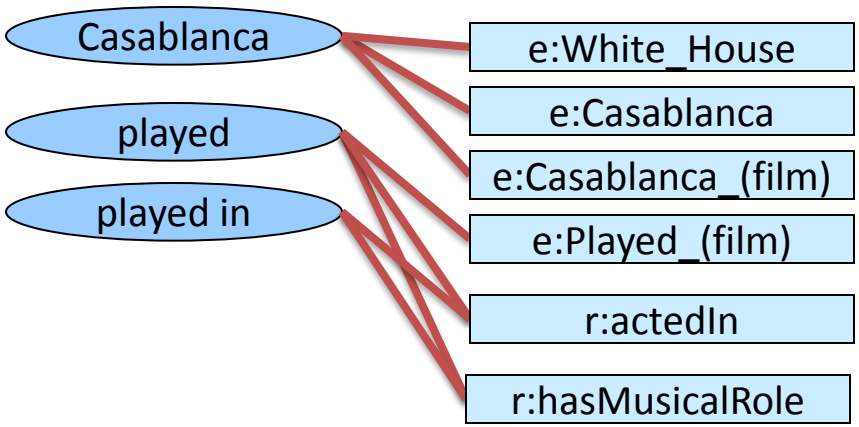

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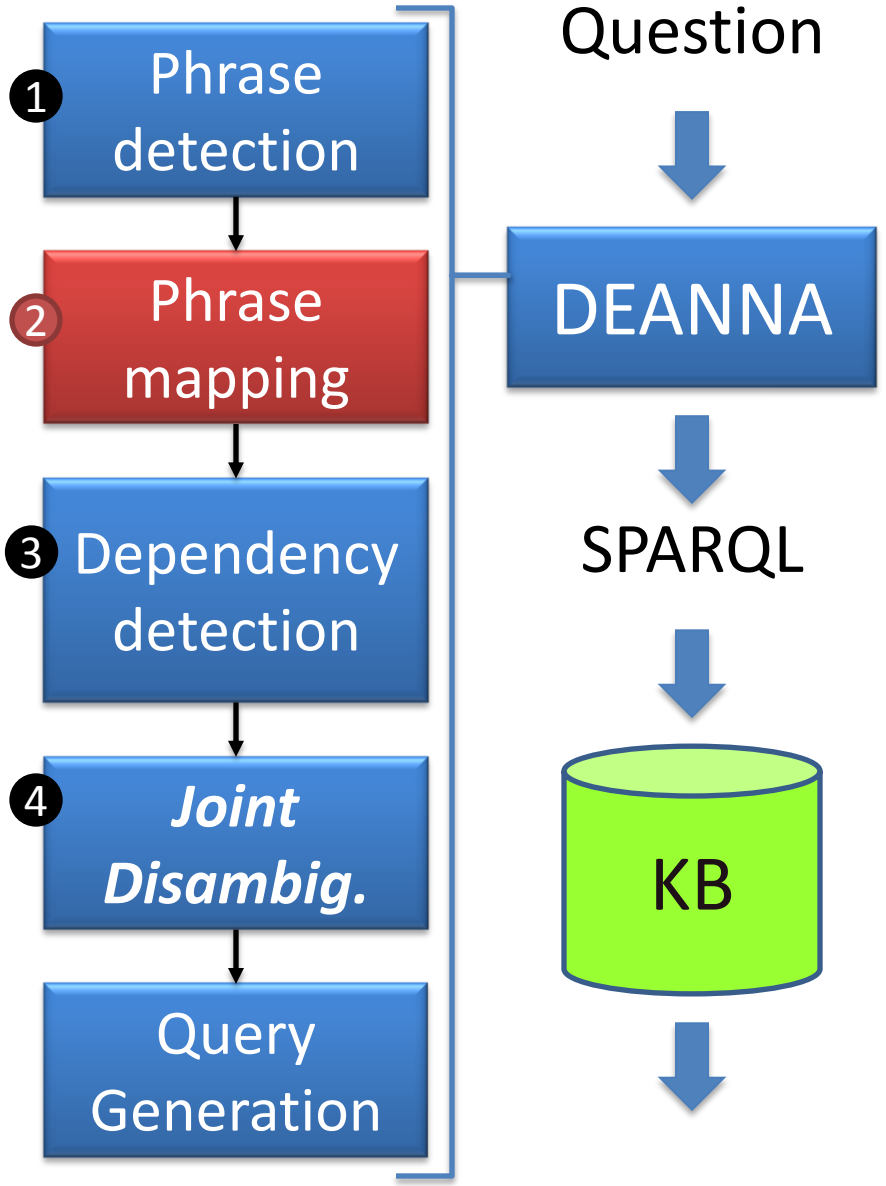
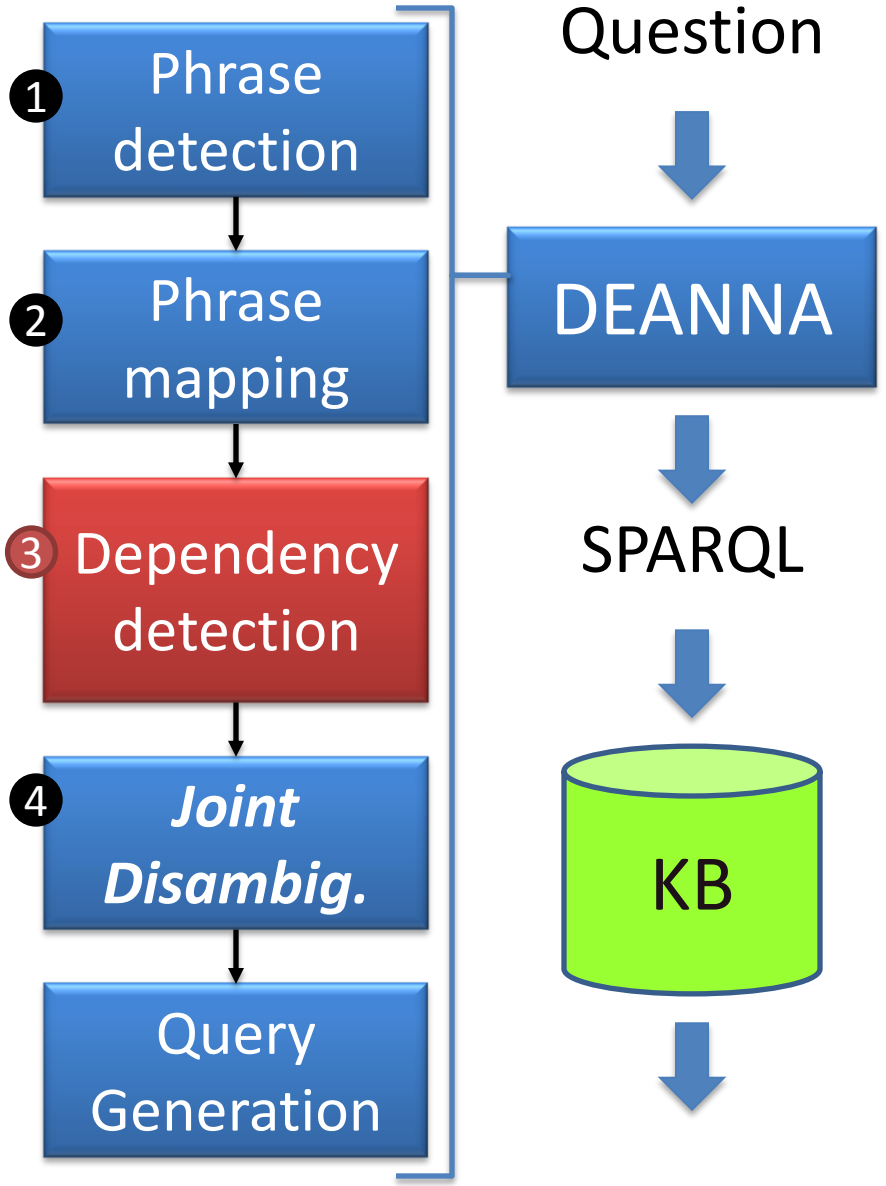


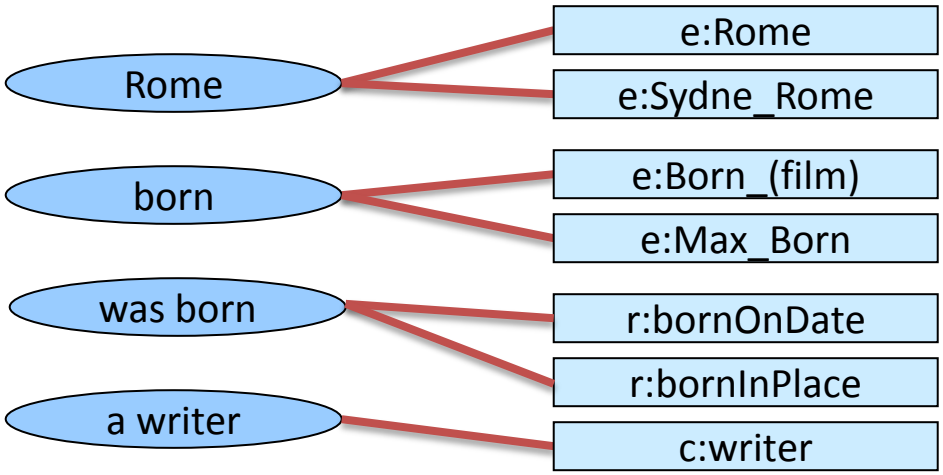
5 Experiments & Results

Outline

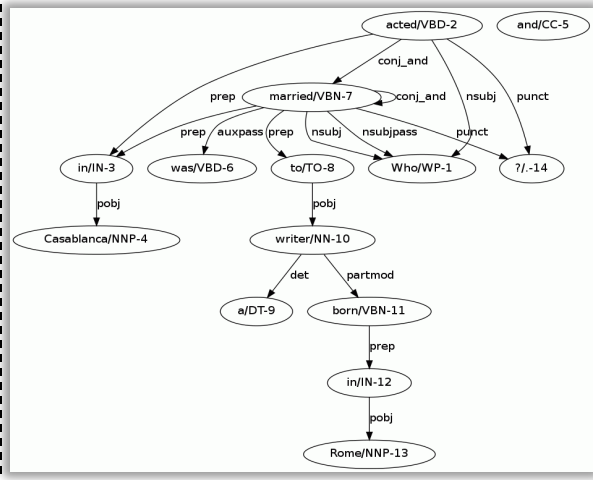


5 Experiments & Results

Dependency Detection



Look for specific patterns in dependency parses [de Marneffe et al. LREC'06]



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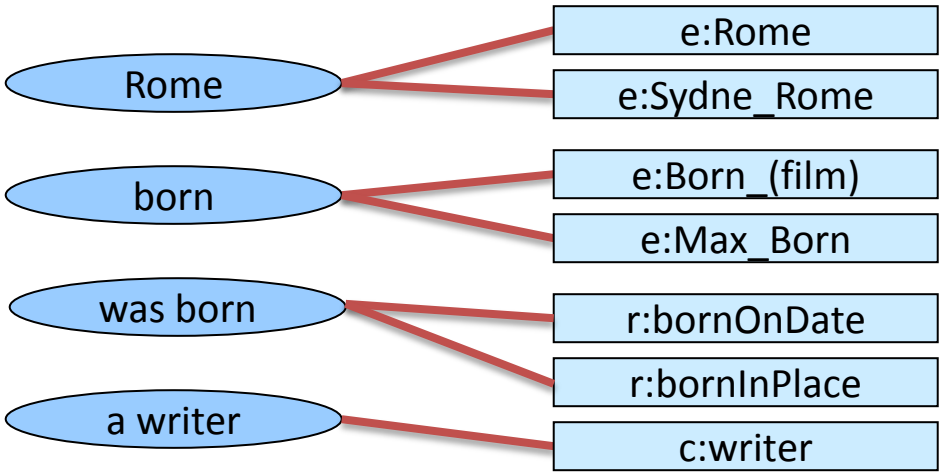

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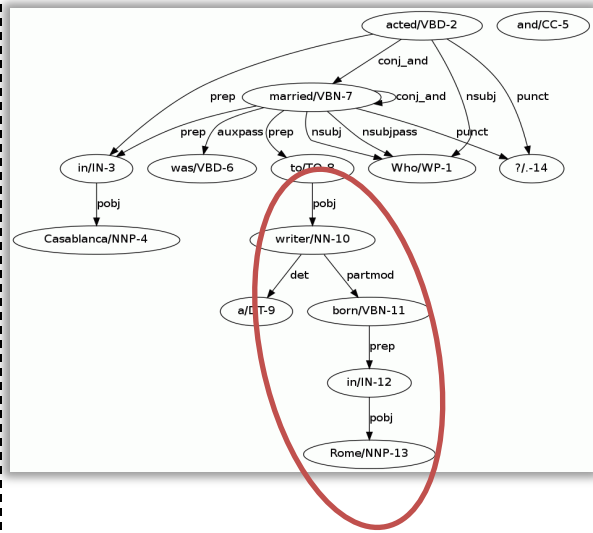

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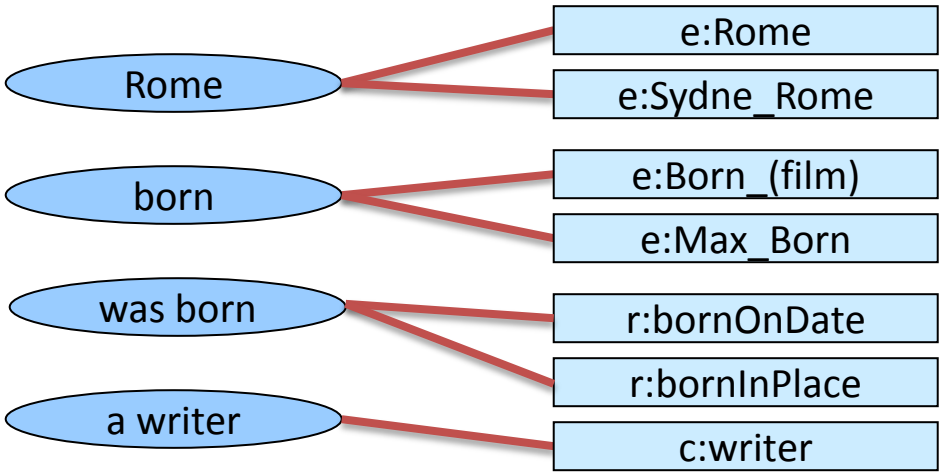

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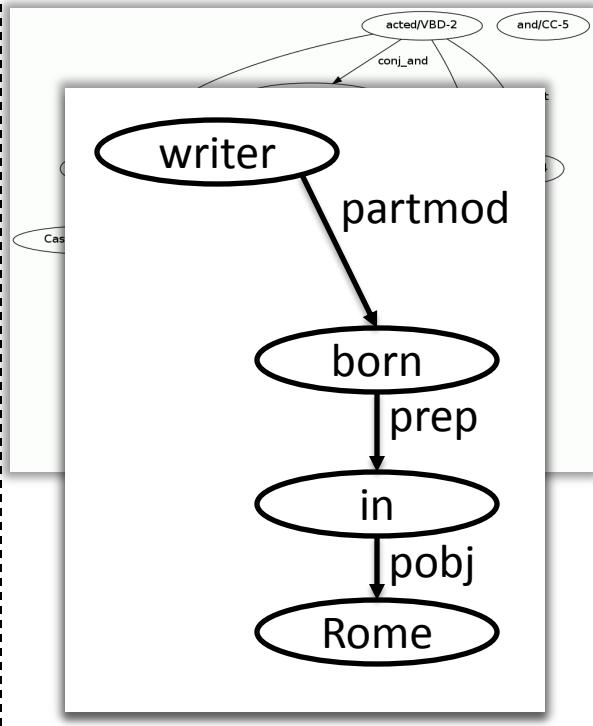

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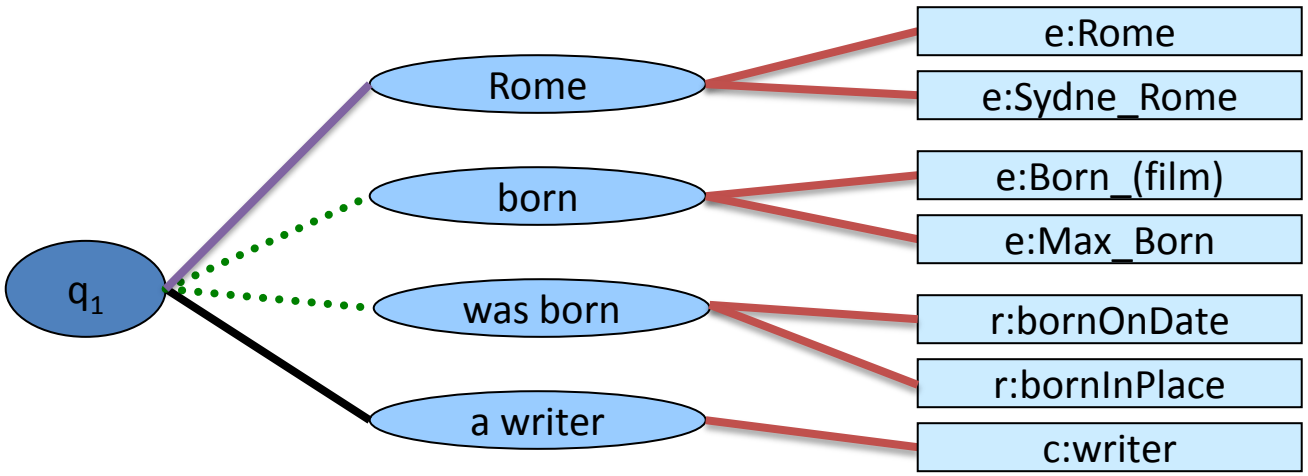

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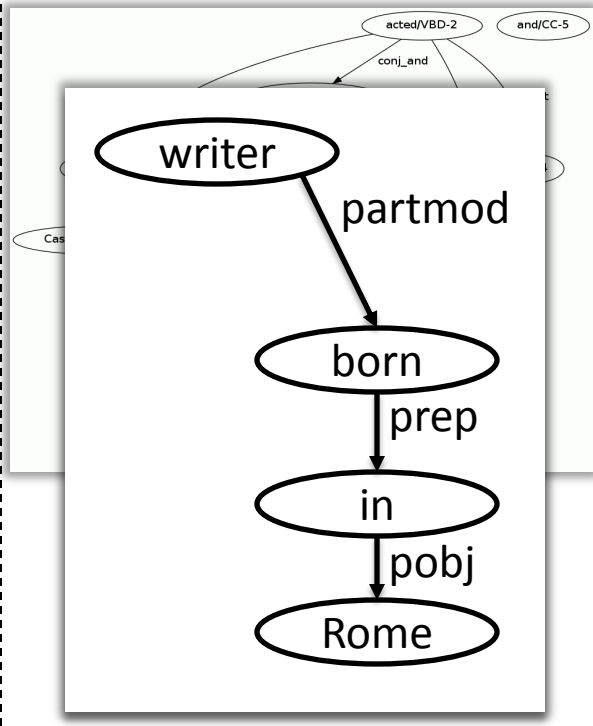
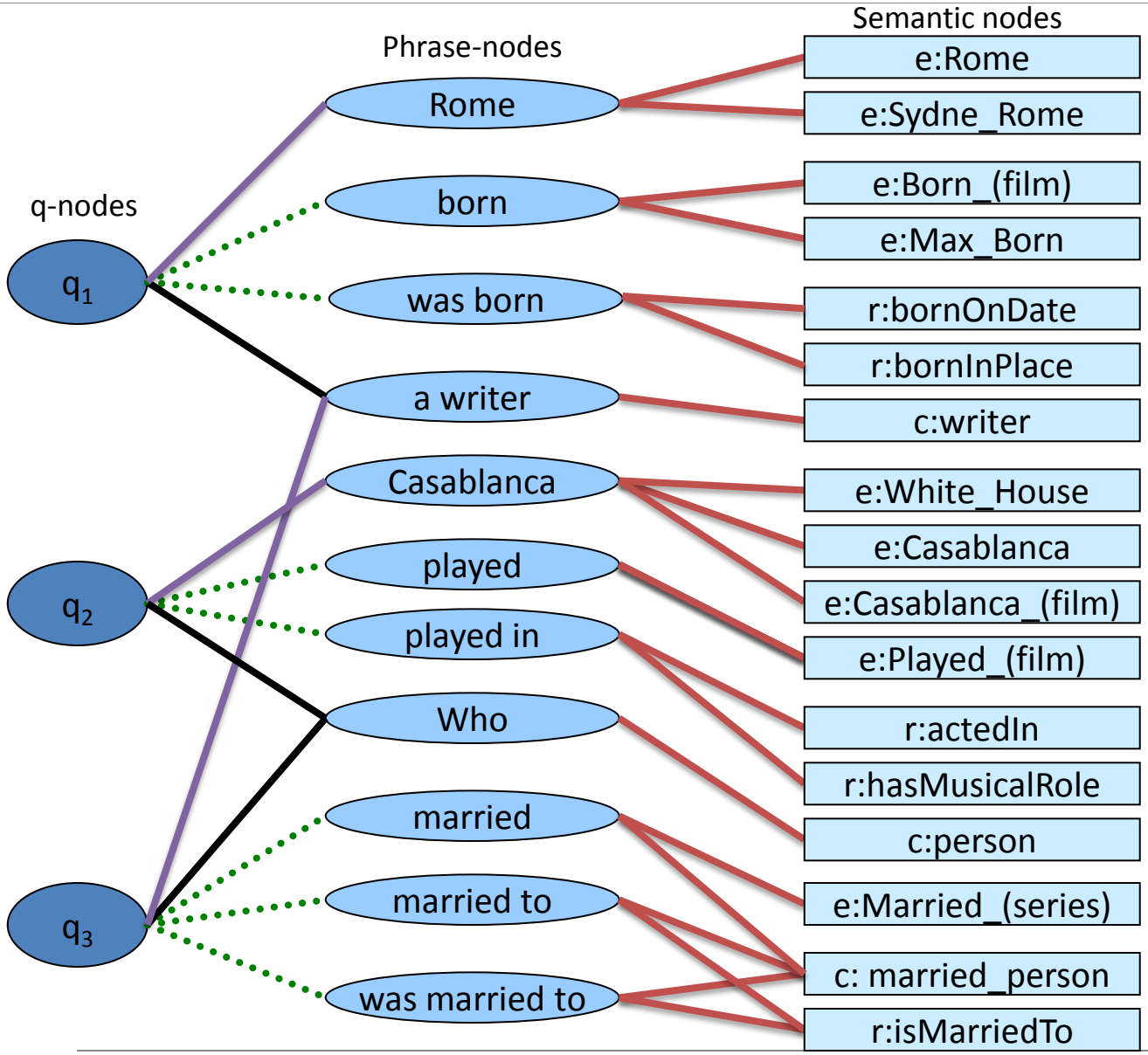
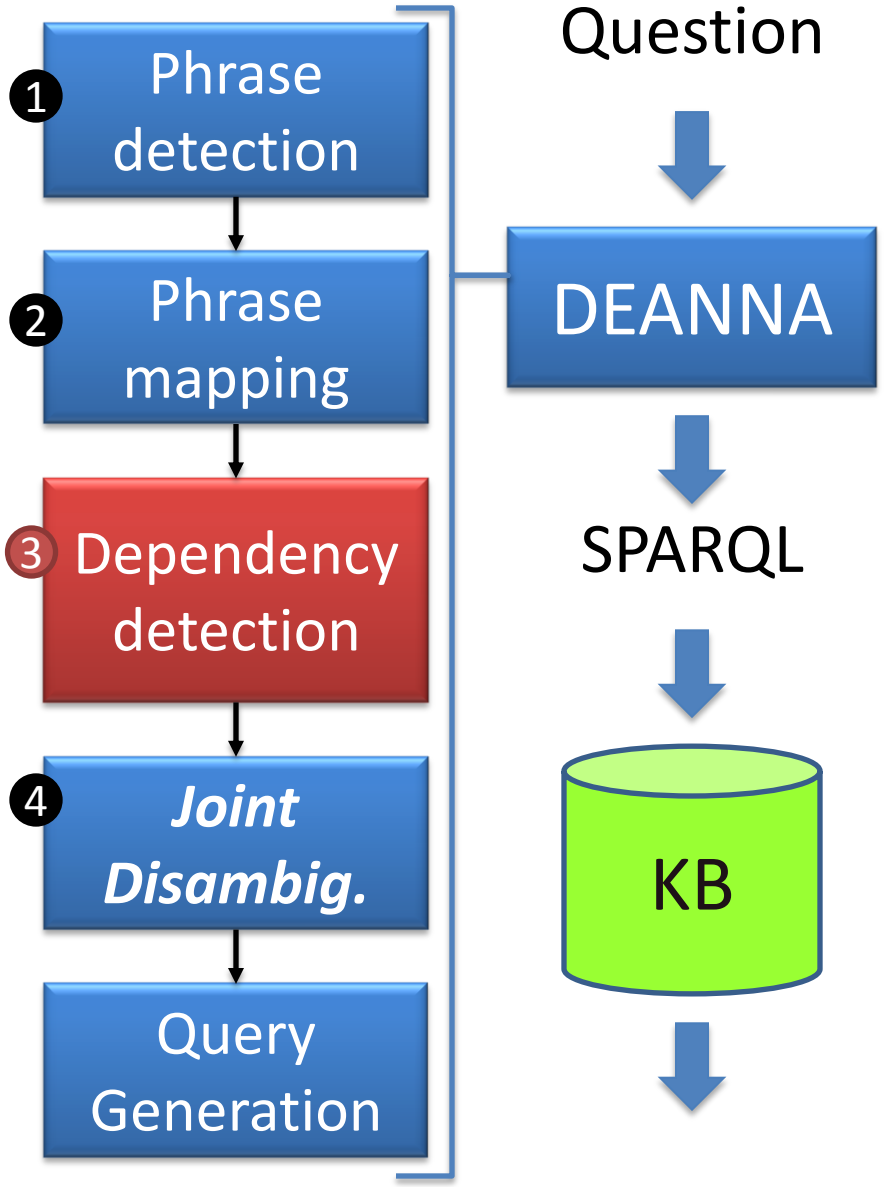


RESULT

Disambiguation Graph

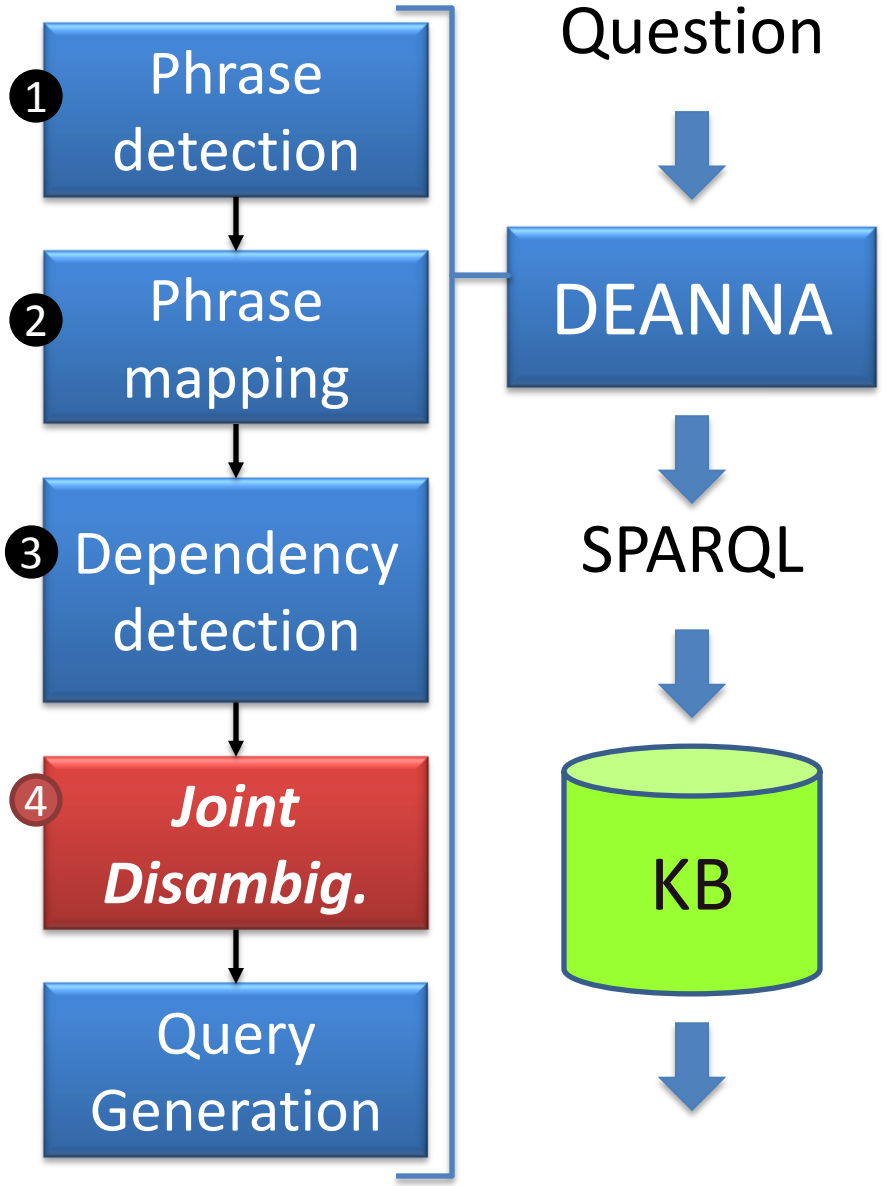


Outline



5 Experiments & Results

Outline



5 Experiments & Results

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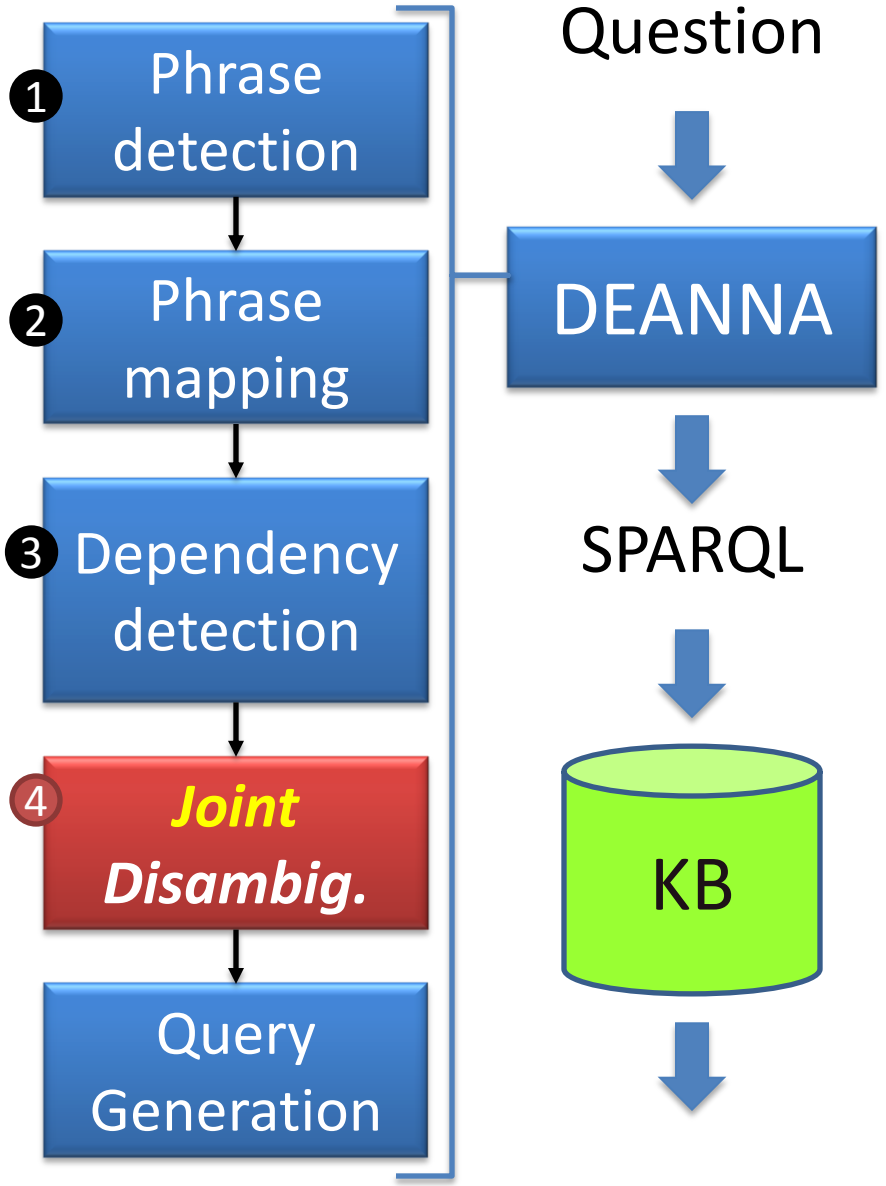
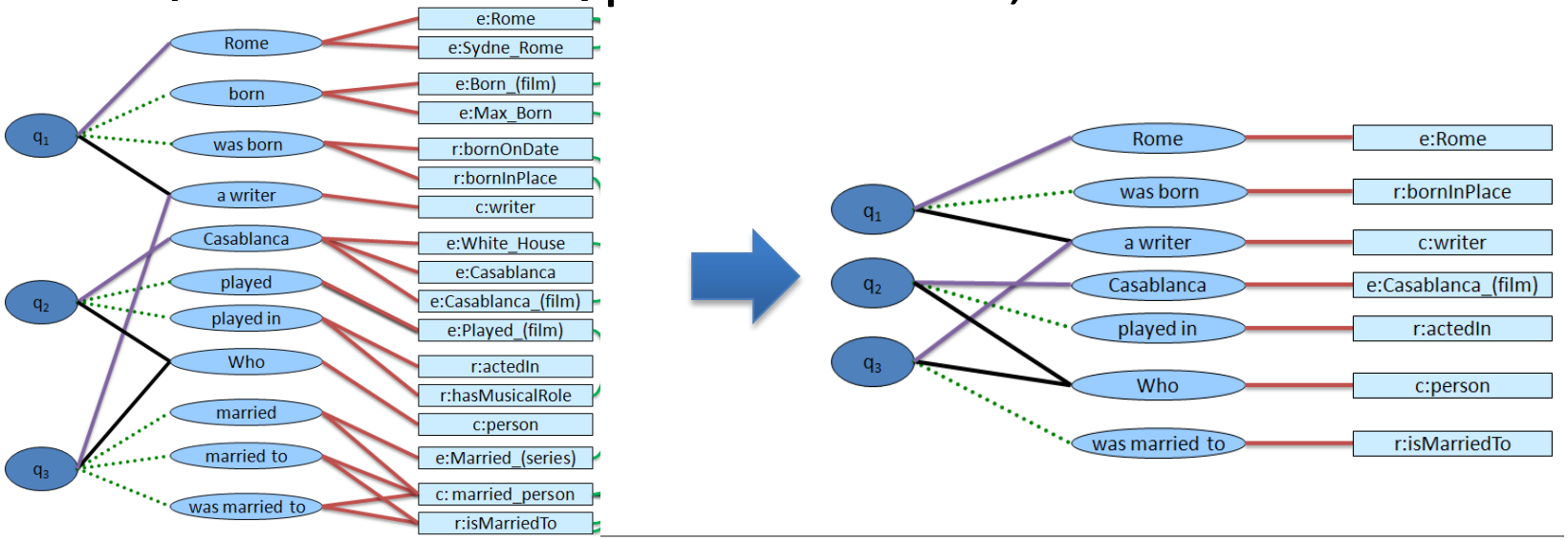


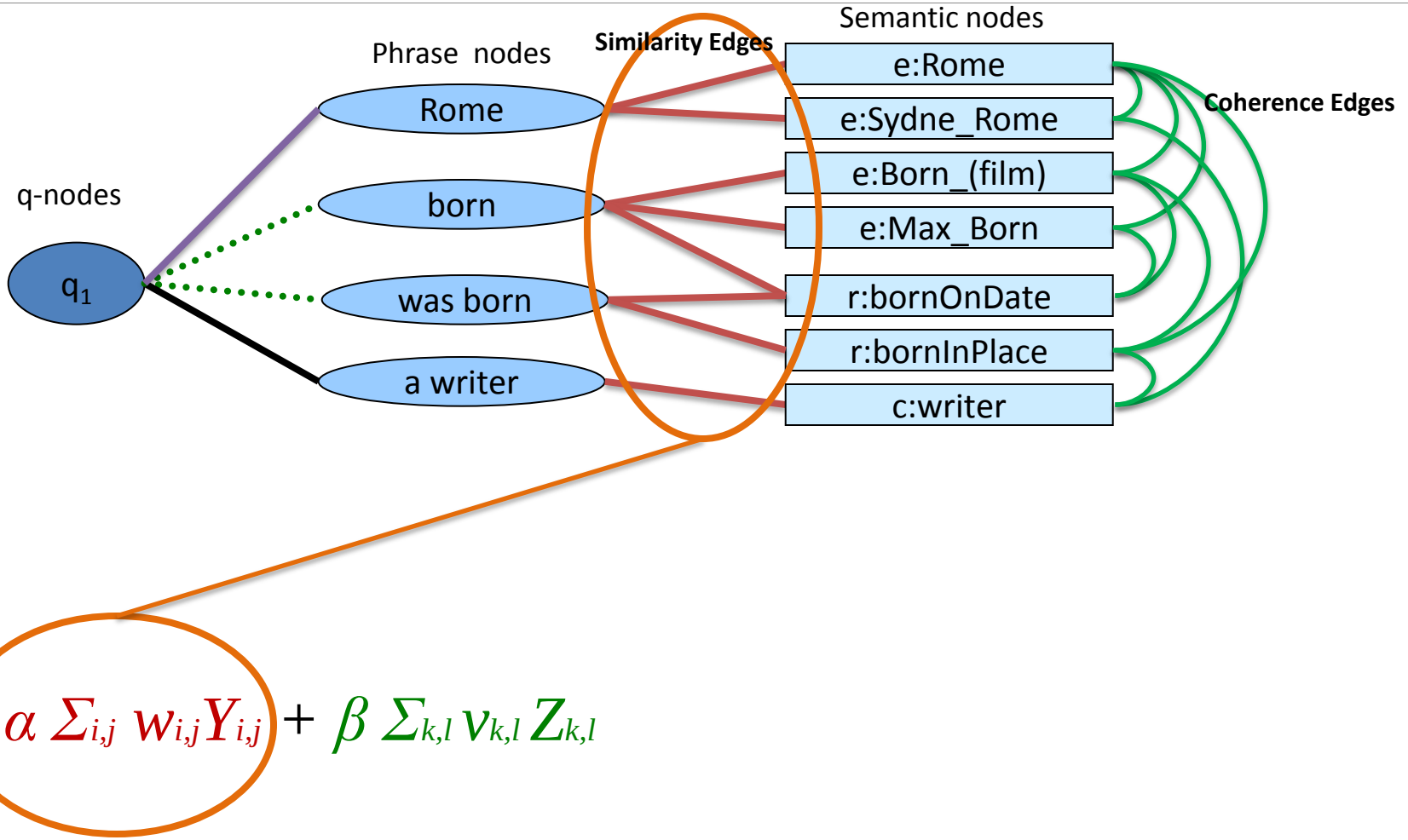
5 Experiments & Results

Joint Disambiguation - ILP

- *ILP:* Integer Linear Programming
- *maximize* $\alpha \sum_{i,j} w_{i,j} Y_{i,j} + \beta \sum_{k,l} v_{k,l} Z_{k,l} + \ldots$
- Subject to:
  - No token in multiple phrases,
  - Triples observe type constraints, …



Joint Disambiguation – Objective



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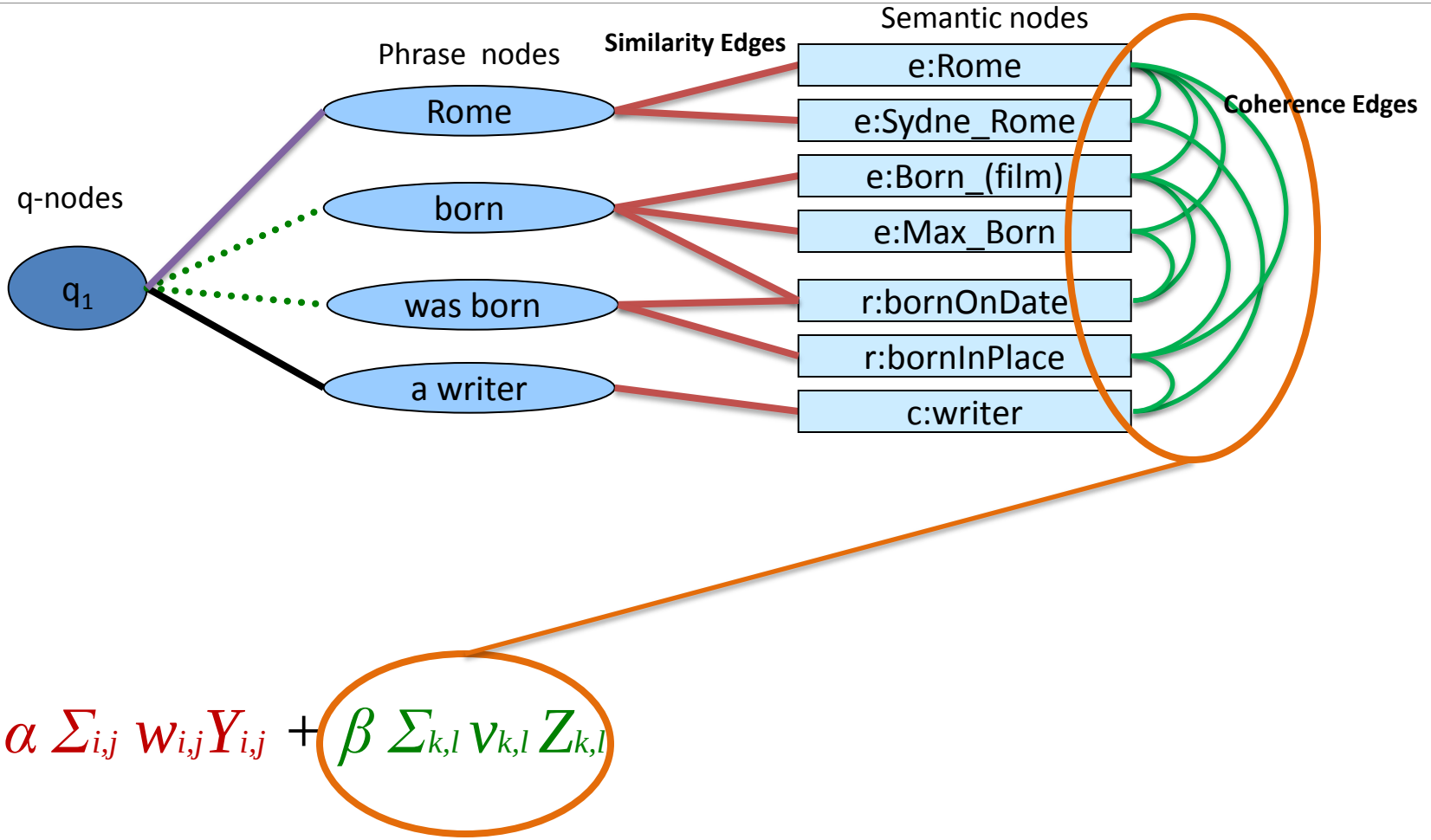
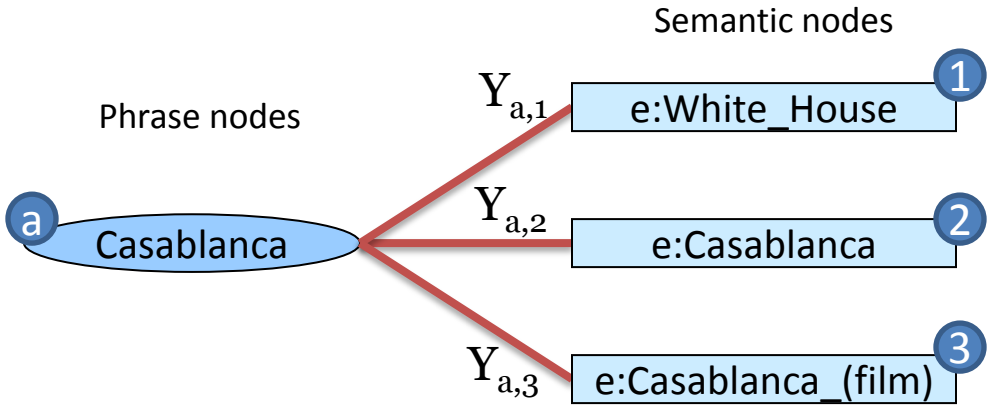


Joint Disambiguation – Constraints

A phrase node can be assigned to one semantic node:



$$\alpha \sum_{i,j} w_{i,j} Y_{i,j} + \beta \sum_{k,l} v_{k,l} Z_{k,l}$$

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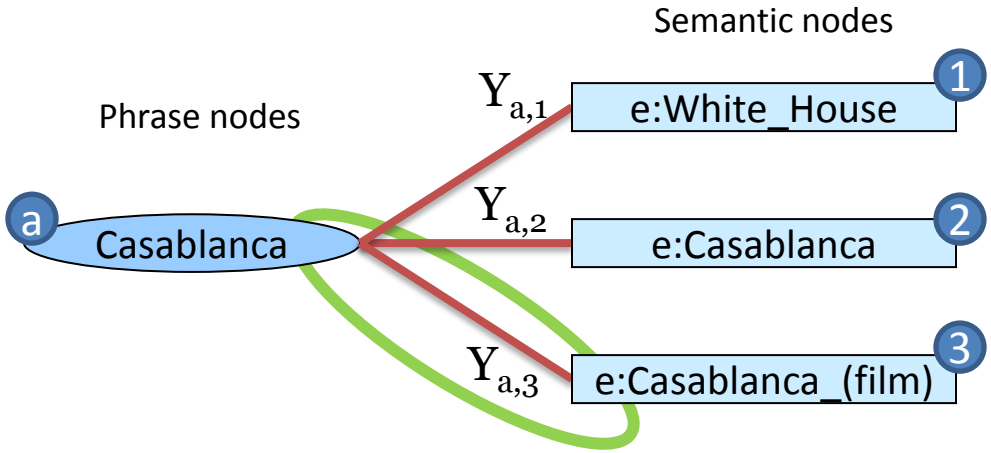

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Joint Disambiguation – Constraints

Classes translate to type-constrained variables

→ Every semantic triple should have a class to *join* & *project*!

```
person actedIn Casablanca_(film)
```

▼

```
?x type person . ?x actedIn Casablanca_(film)
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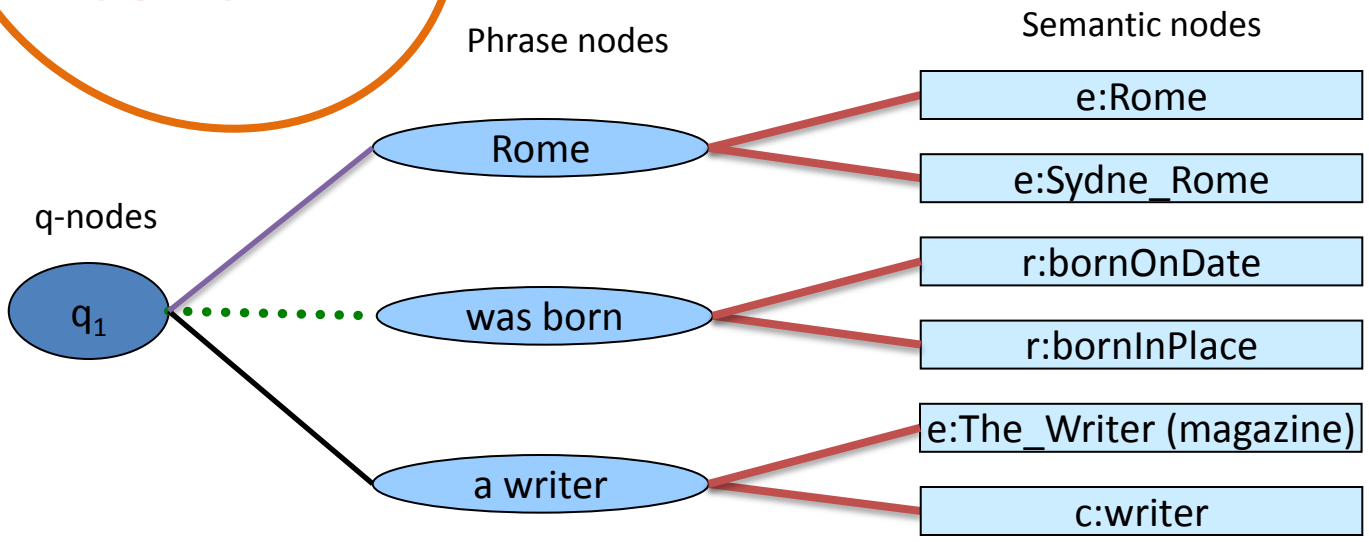

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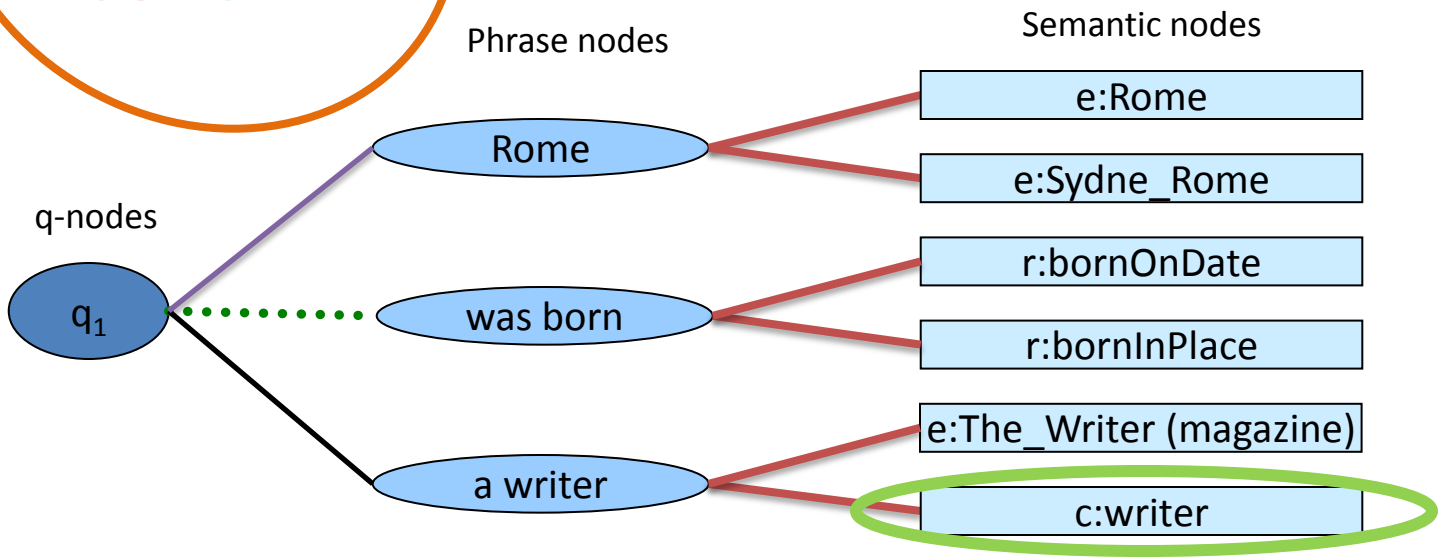

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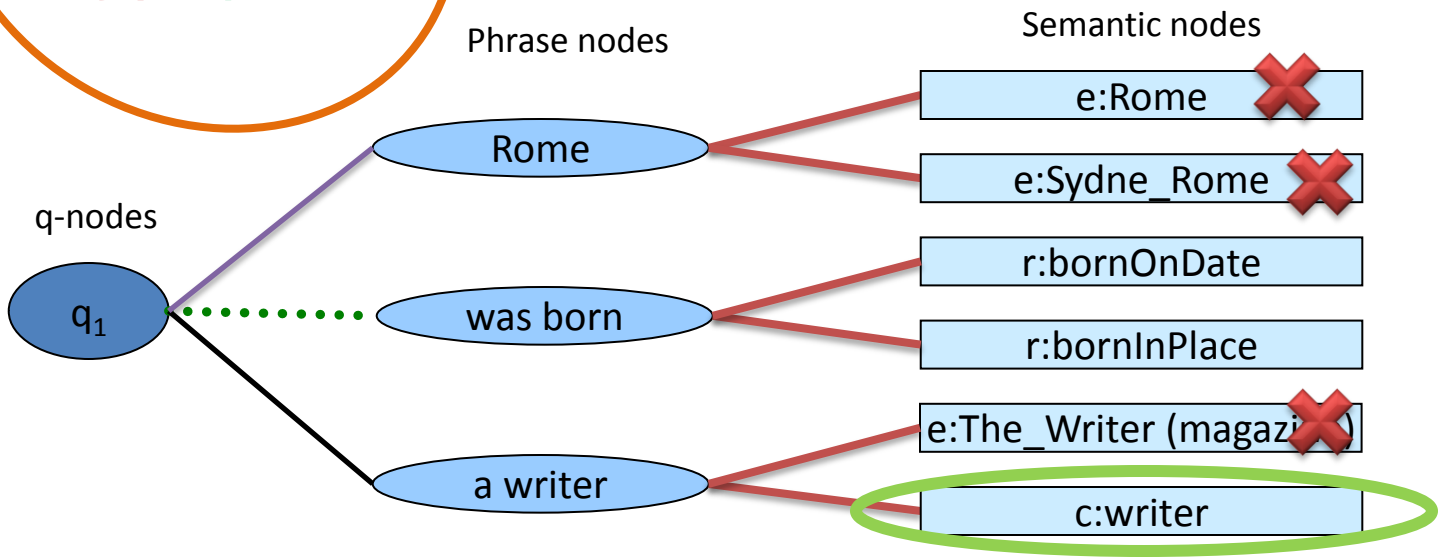

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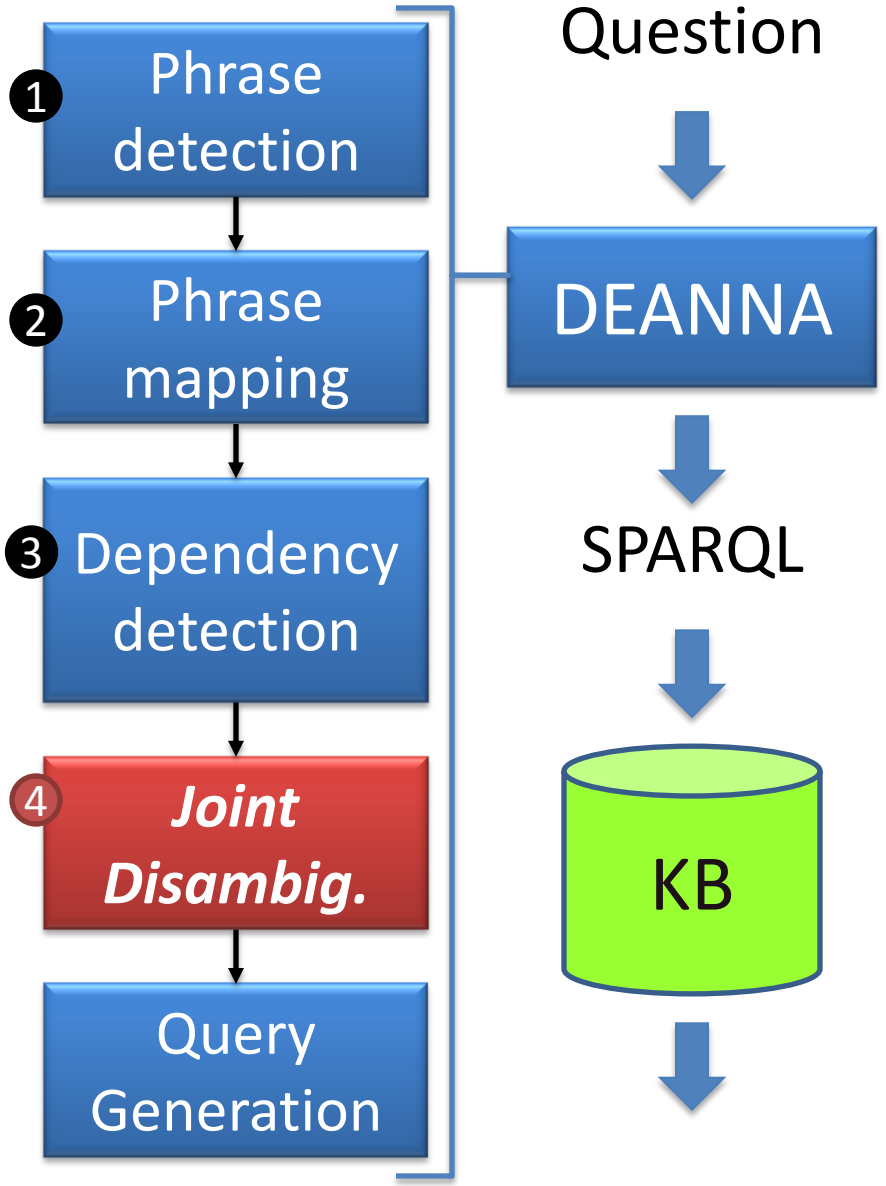

5 Experiments & Results

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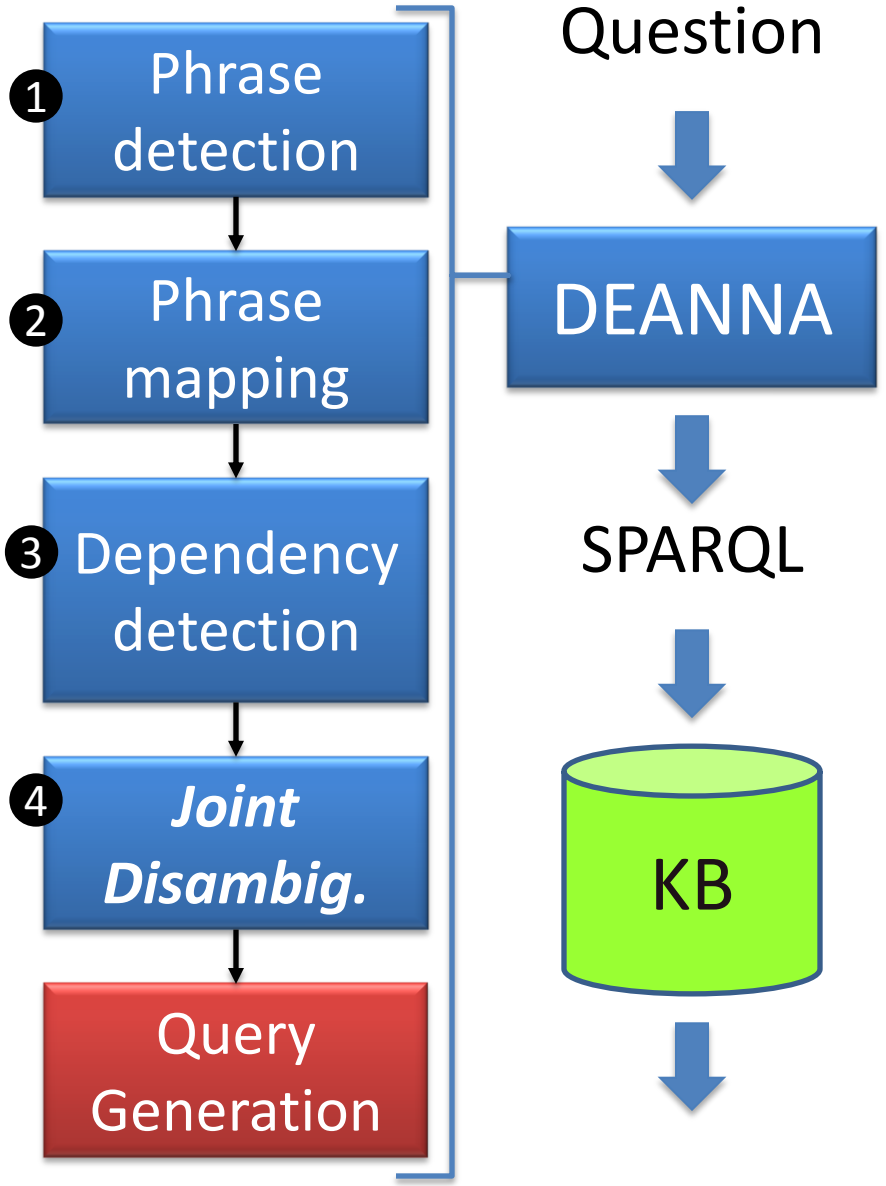
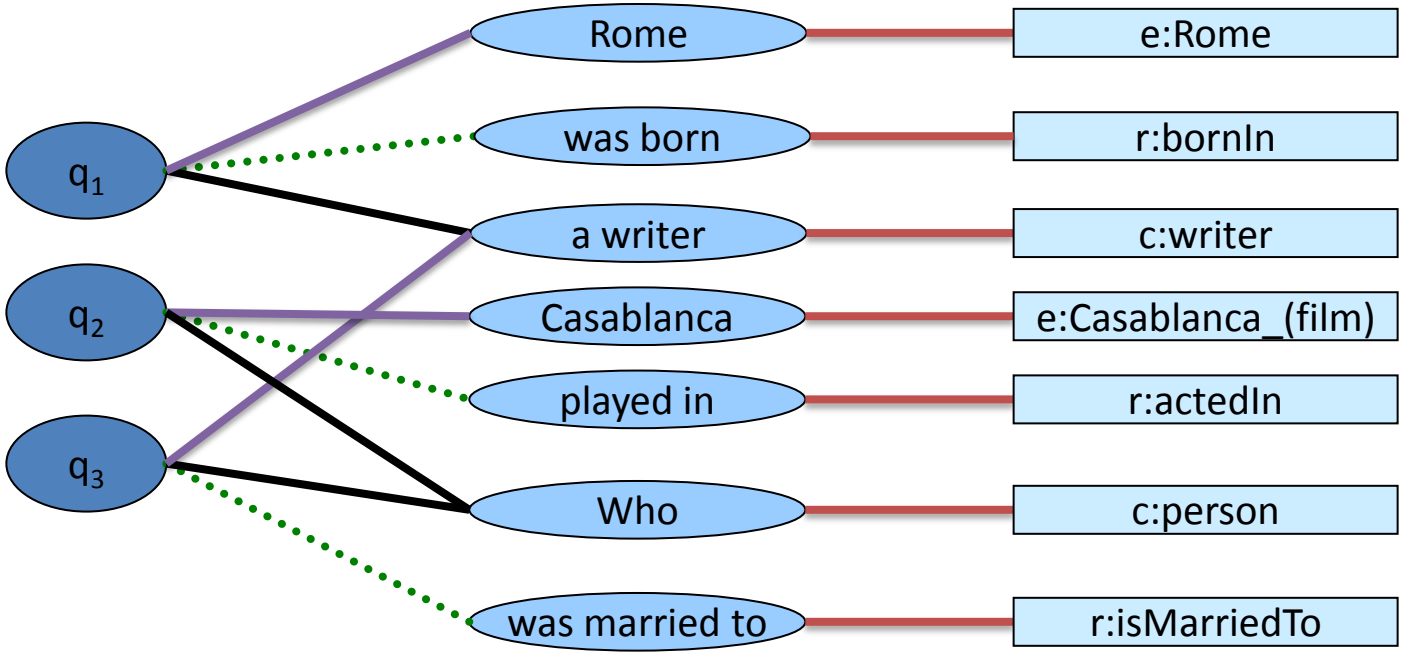


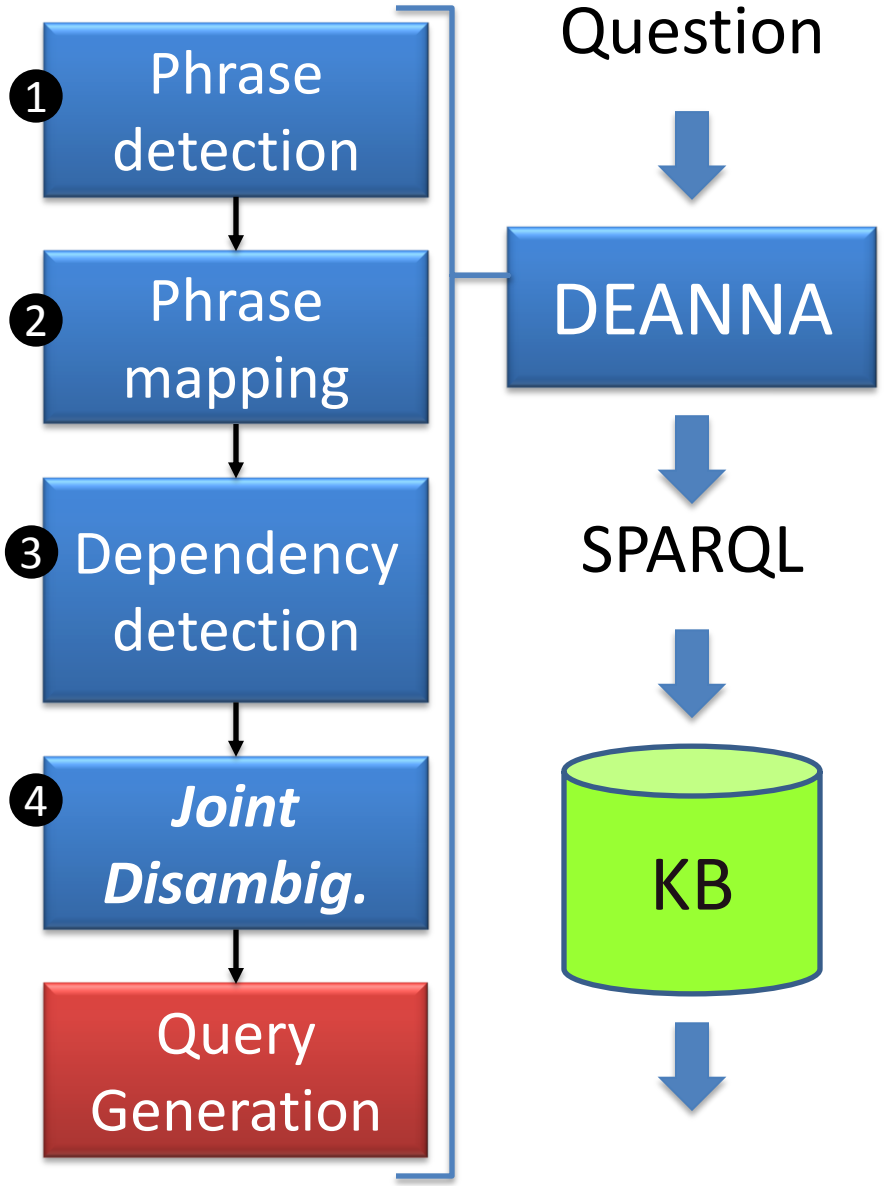
5 Experiments & Results

Structured Query Generation




```
SELECT ?p WHERE {
     ?w type writer .
     ?w bornIn Rome .
     ?p type person.
     ?p actedIn Casablanca_(film).
     ?p isMarriedTo ?w }
```

Outline



5 Experiments & Results

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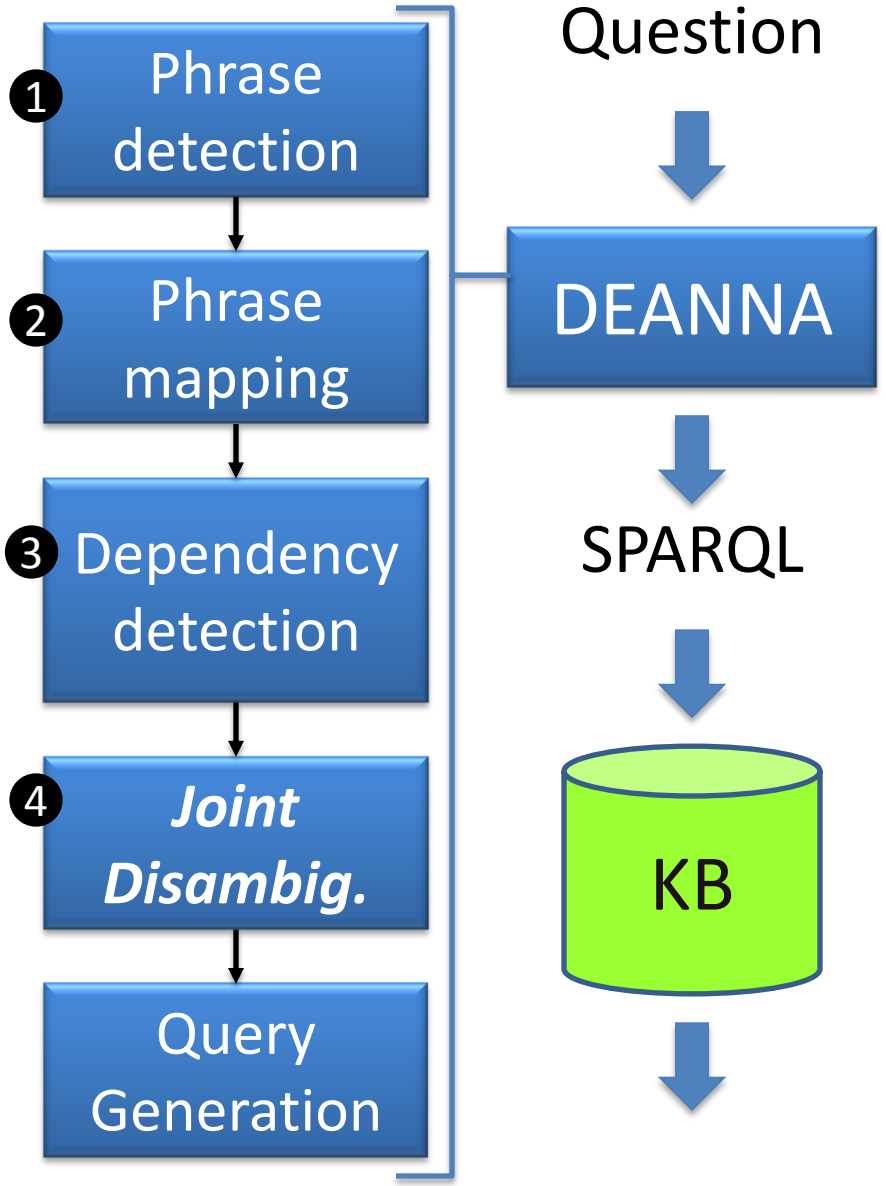
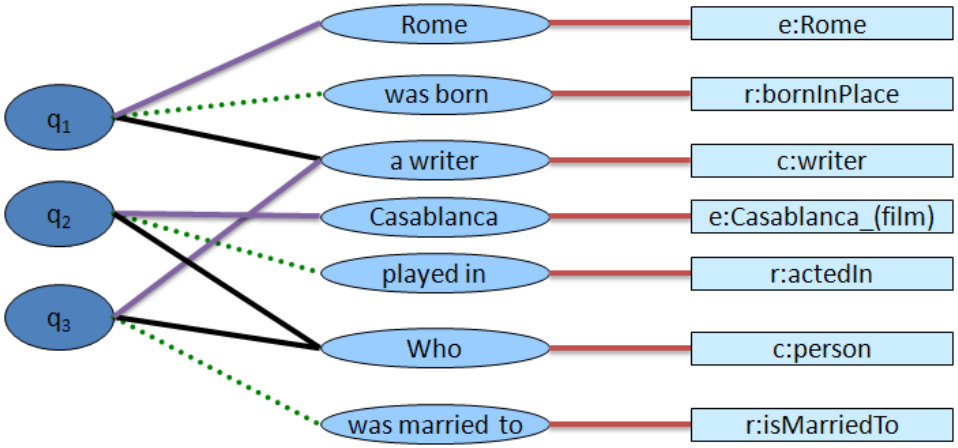


5 Experiments & Results

Evaluation Methodology

- 3-stage evaluation for more insight:
  1. Disambiguation
  2. Query generation
  3. Query answering

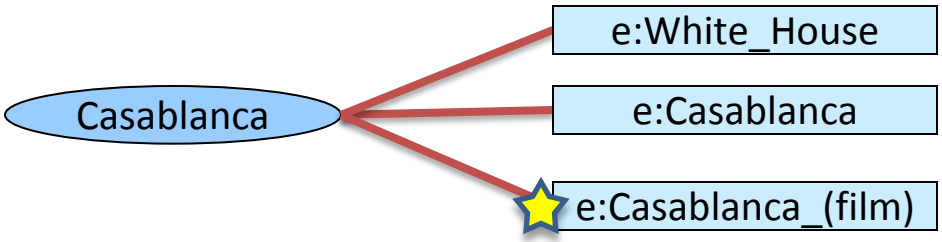


- We rely on human judges

Datasets

- **QALD-1**
  - YAGO2
  - **27/50 questions within scope**
  - *"Which software has been published by Mean Hamster Software?"*
- **NAGA [Elbassuoni et al. CIKM'09]**
  - YAGO+IMDB
  - **44/87 questions within scope**
  - *"Which director has won the Academy Award for Best director and is married to an actress that has won the Academy Award for Best Actress?"*

Results 1/3: Disambiguation



Benchmark	QALD-1	NAGA
cov_{macro}	0.973	0.934
$prec_{macro}$	1.000	0.934
cov_{micro}	0.963	0.945
$prec_{micro}$	1.000	0.941

$$cov = correct/ideal$$
$$prec = correct / retrieved$$

Results 2/3: Query Generation

Issues:

- Incorrect disambiguation
- Incorrect dependencies.

Benchmark	QALD-1	NAGA
cov_{macro}	0.975	0.894
$prec_{macro}$	1.000	0.941
cov_{micro}	0.963	0.847
$prec_{micro}$	1.000	0.906

$$cov = \#correct\ triples/\#ideal\ triples$$
$$prec = \#correct\ triples/\#retrieved\ triples$$

Results 3/3: Answering

Benchmark	QALD-1	NAGA
#questions	27	44
#queries	20	41
#satisfactory	10	15
#relaxed	+3	+3

Results 3/3: Answering

Benchmark	QALD-1	NAGA
#questions	27	44
#queries	20	41
#satisfactory	10	15
#relaxed	+3	+3

unsatisfactory: main problem is **empty result set**

Results 3/3: Answering

Relaxation: Keep type constraints, everything else to keywords

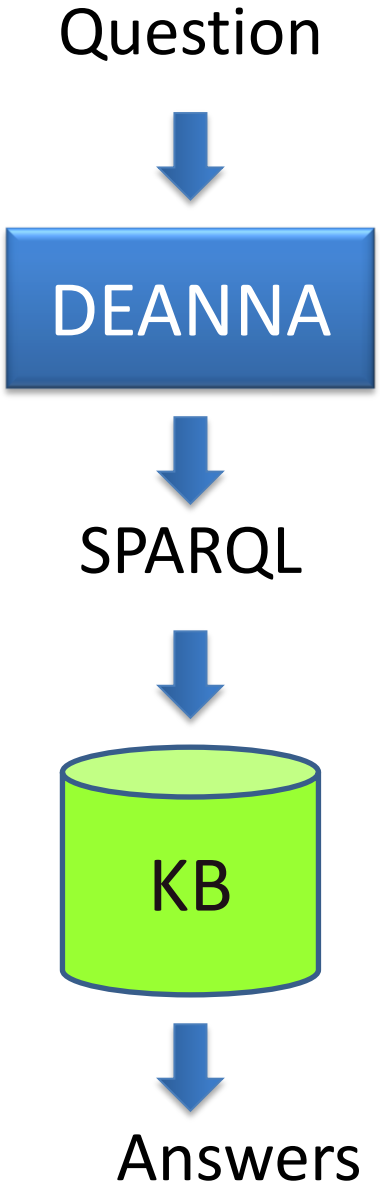
```
?x type writer . ?x bornIn Rome

?x type writer . ?x bornIn ?y ["Rome"]
```

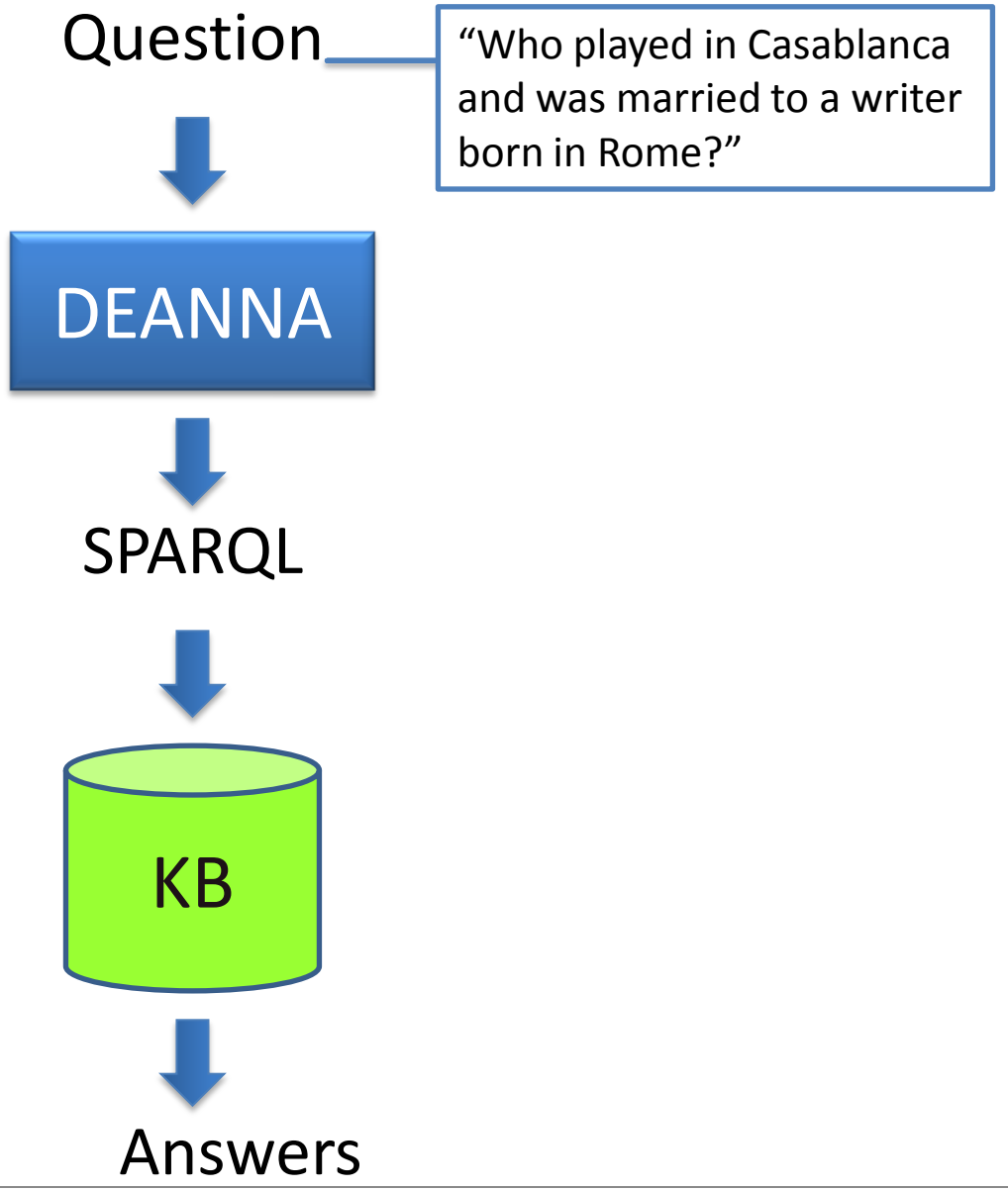
Benchmark	QALD-1	NAGA
#questions	27	44
#queries	20	41
#satisfactory	10	15
#relaxed	+3	+3

unsatisfactory: main problem is **empty result set**

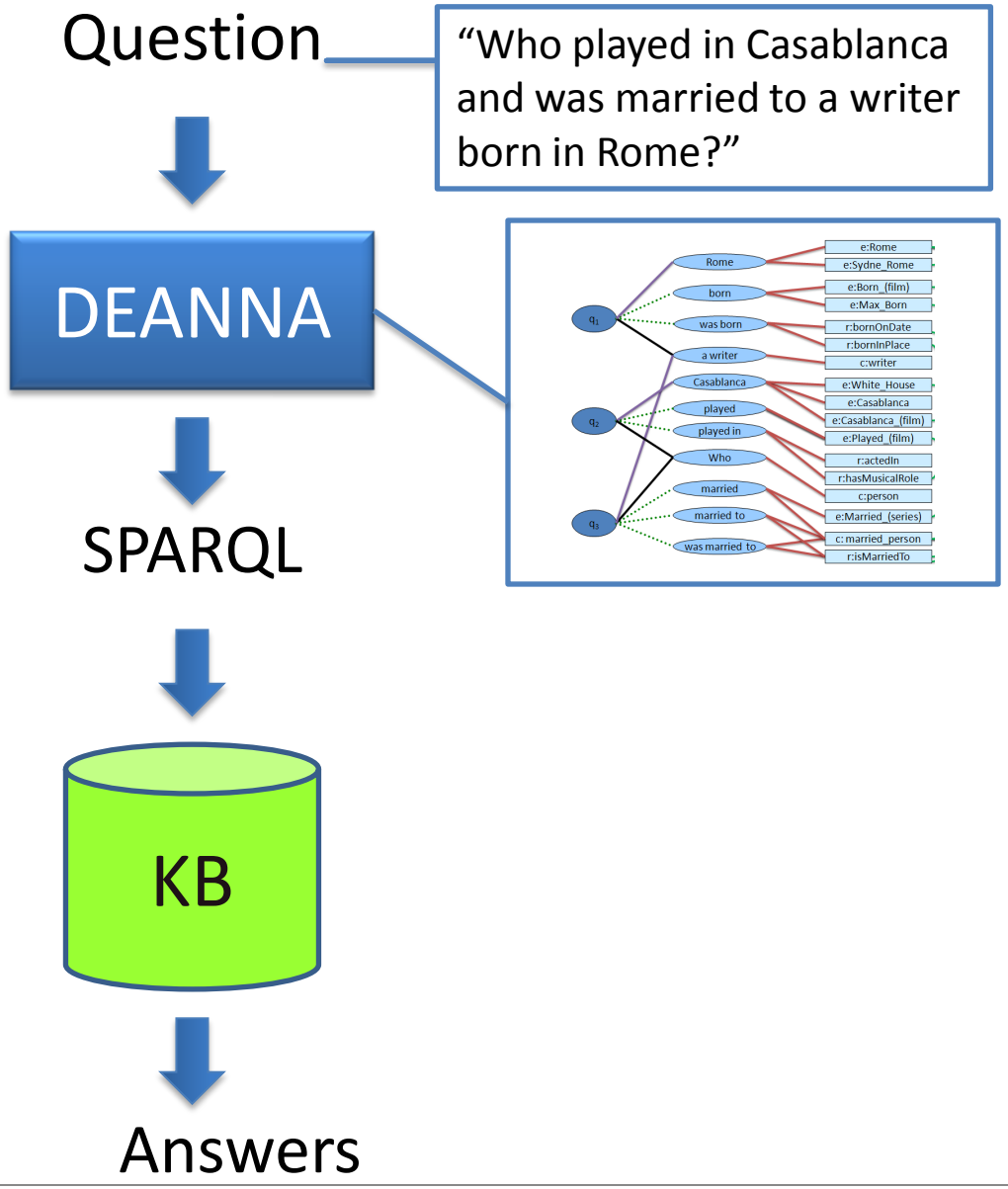
Wrap-up



Wrap-up


Question
"Who played in Casablanca and was married to a writer born in Rome?"
DEANNA
SPARQL
KB
Answers

Wrap-up

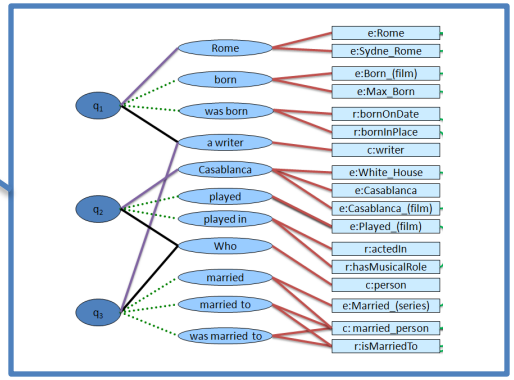

Question
"Who played in Casablanca and was married to a writer born in Rome?"
DEANNA
SPARQL
KB
Answers
Rome
born
was born
a writer
Casablanca
played
played in
Who
married
married to
was married to
e:Rome
e:Sydne_Rome
e:Born_(film)
e:Max_Born
r:bornOnDate
r:bornInPlace
c:writer
e:White_House
e:Casablanca
e:Casablanca_(film)
e:Played_(film)
r:actedIn
r:hasMusicalRole
c:person
e:Married_(series)
c:married_person
r:isMarriedTo

Wrap-up

Question

"Who played in Casablanca and was married to a writer born in Rome?"

DEANNA



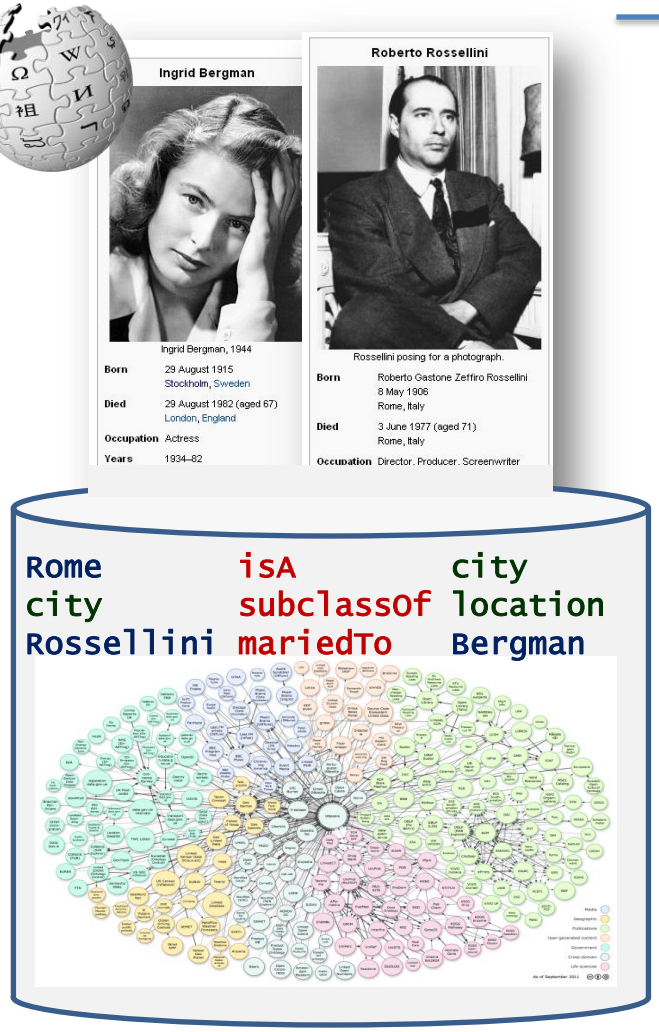
SPARQL

```
?p type person.
?p actedIn Casablanca_(film).
?p isMarriedTo ?w.
?w type writer .
?w bornIn Rome
```

KB

Answers

Wrap-up



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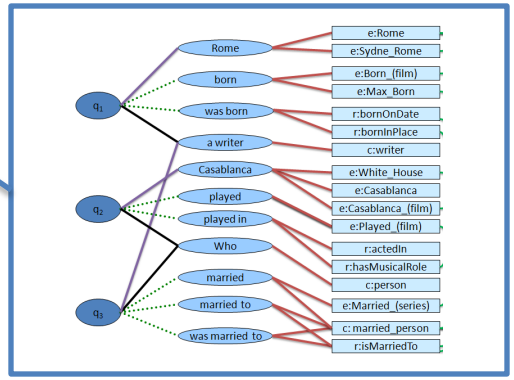
DEANNA



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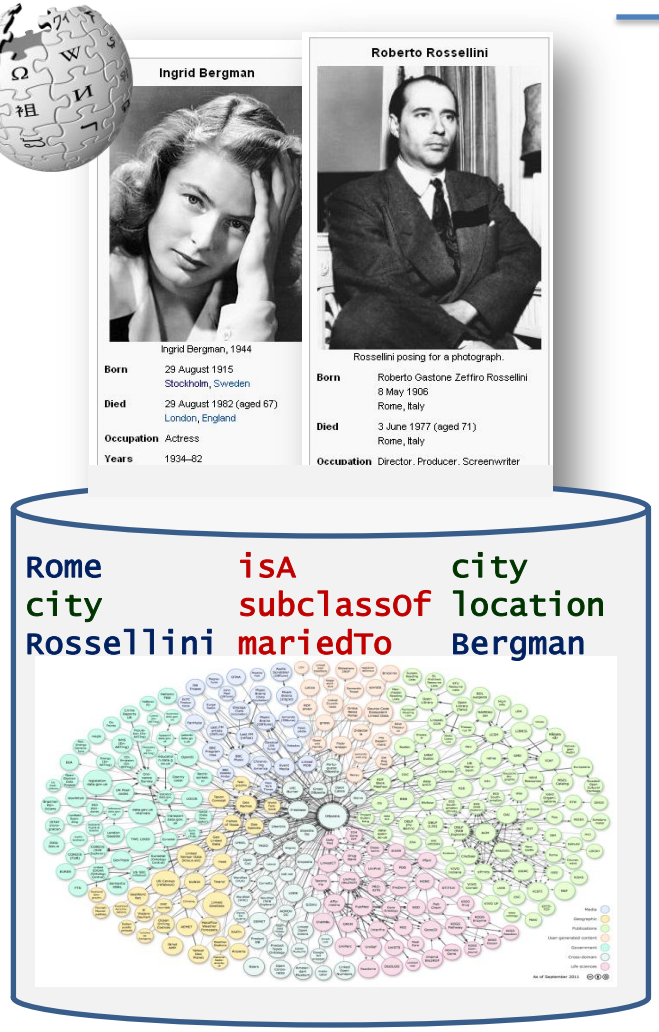
KB

Answers

Wrap-up



Question

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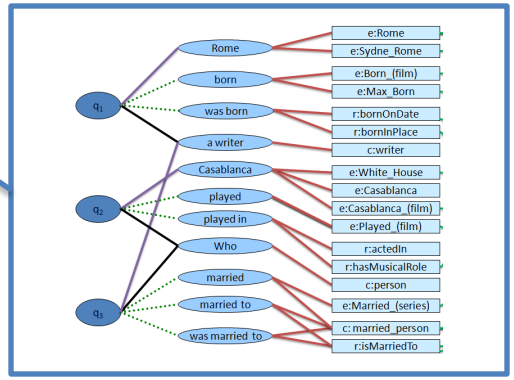
DEANNA



SPARQL

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KB

Answers

Thank you.

QUESTIONS/COMMENTS?

bit.ly/mpi-deanna