



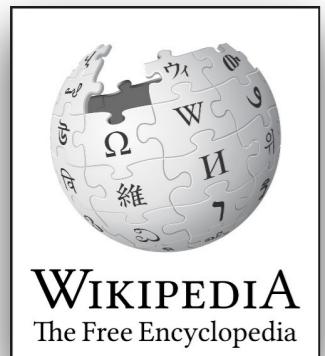
max planck institut  
informatik

# YAGO3:

## A Knowledge Base from Multilingual Wikipedias

Farzaneh Mahdisoltani  
Joanna Biega  
Fabian M. Suchanek

CIDR 2015



## John Coltrane

From Wikipedia, the free encyclopedia

*"Coltrane" redirects here. For other uses, see [Coltrane \(disambiguation\)](#).*

**John William Coltrane**, also known as "Trane" (September 23, 1926 – July 17, 1967) was an American jazz saxophonist and composer. Working in the bebop and hard bop idioms early in his career, he became one of the central figures in the mid-1960s expression known as free jazz.

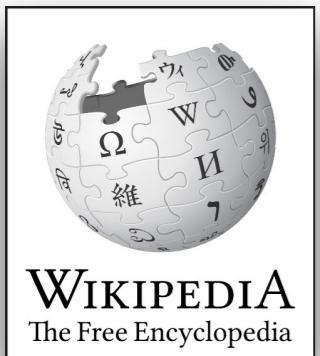
**Categories:** [John Coltrane](#) | [1926 births](#) | [1967 deaths](#)  
| [American jazz bandleaders](#) | [American jazz composers](#)  
| [Anglican saints](#) | [Atlantic Records artists](#) | [Avant-garde](#)



Coltrane in 1963

### Background information

Birth name	John William Coltrane
Also known as	"Trane"
Born	September 23, 1926 Hamlet, North Carolina, USA
Died	July 17, 1967 (aged 40) Huntington, New York



**John Coltrane**



Coltrane in 1963

**Background information**

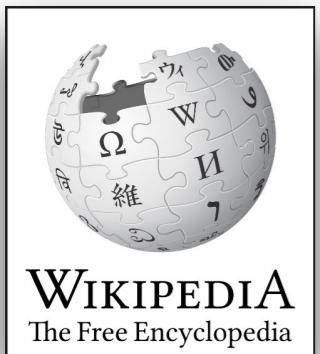
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<b>Born</b>	September 23, 1926 Hamlet, North Carolina, USA
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*"Coltrane" redirects here. For other uses, see [Coltrane \(disambiguation\)](#).*

**John William Coltrane**, also known as "Trane" (September 23, 1926 – July 17, 1967) was an American jazz saxophonist and composer. Working in the bebop and hard bop idioms early in his career, Coltrane later became an innovator in free jazz.

**Categories:** [John Coltrane](#) | [1926 births](#) | [1967 deaths](#) | [American jazz bandleaders](#) | [American jazz composers](#) | [Anglican saints](#) | [Atlantic Records artists](#) | [Avant-garde](#)





John Coltrane



Coltrane in 1963

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# John\_Coltrane



WIKIPEDIA  
The Free Encyclopedia

John Coltrane



Coltrane in 1963

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John William Coltrane, also known as "Trane" (September 23, 1926 – July 17, 1967) was an American jazz saxophonist and composer. Working in the bebop and hard bop idioms early in his career, he helped pioneer the use of modal jazz and was influential in the free jazz movement.

Categories: John Coltrane | 1926 births | 1967 deaths | American jazz bandleaders | American jazz composers | Anglican saints | Atlantic Records artists | Avant-garde



John\_Coltrane

wasBornOnDate

“1926-09-23”

wasBornIn

Hamlet\_(Town)

label

“John William Coltrane”



WIKIPEDIA  
The Free Encyclopedia

John Coltrane



Coltrane in 1963

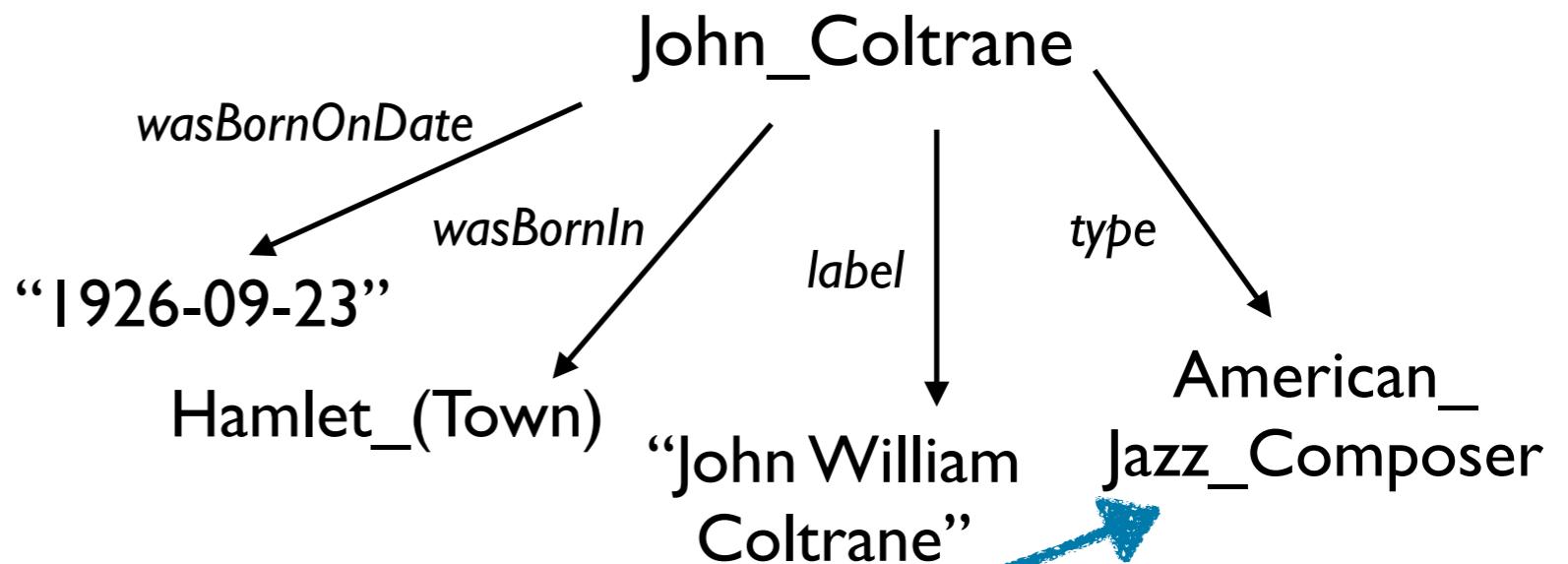
Background Information

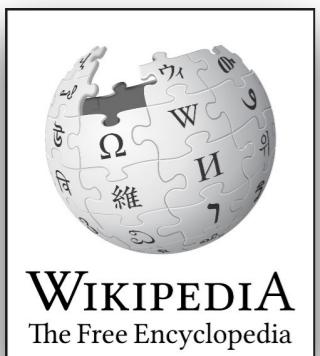
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John William Coltrane, also known as “Trane” (September 23, 1926 – July 17, 1967) was an American jazz saxophonist and composer. Working in the bebop and hard bop idioms early in his career, Coltrane later became an Avant-garde icon.

Categories: John Coltrane | 1926 births | 1967 deaths | American jazz bandleaders | American jazz composers | Anglican saints | Atlantic Records artists | Avant-garde





**John Coltrane**

From Wikipedia, the free encyclopedia

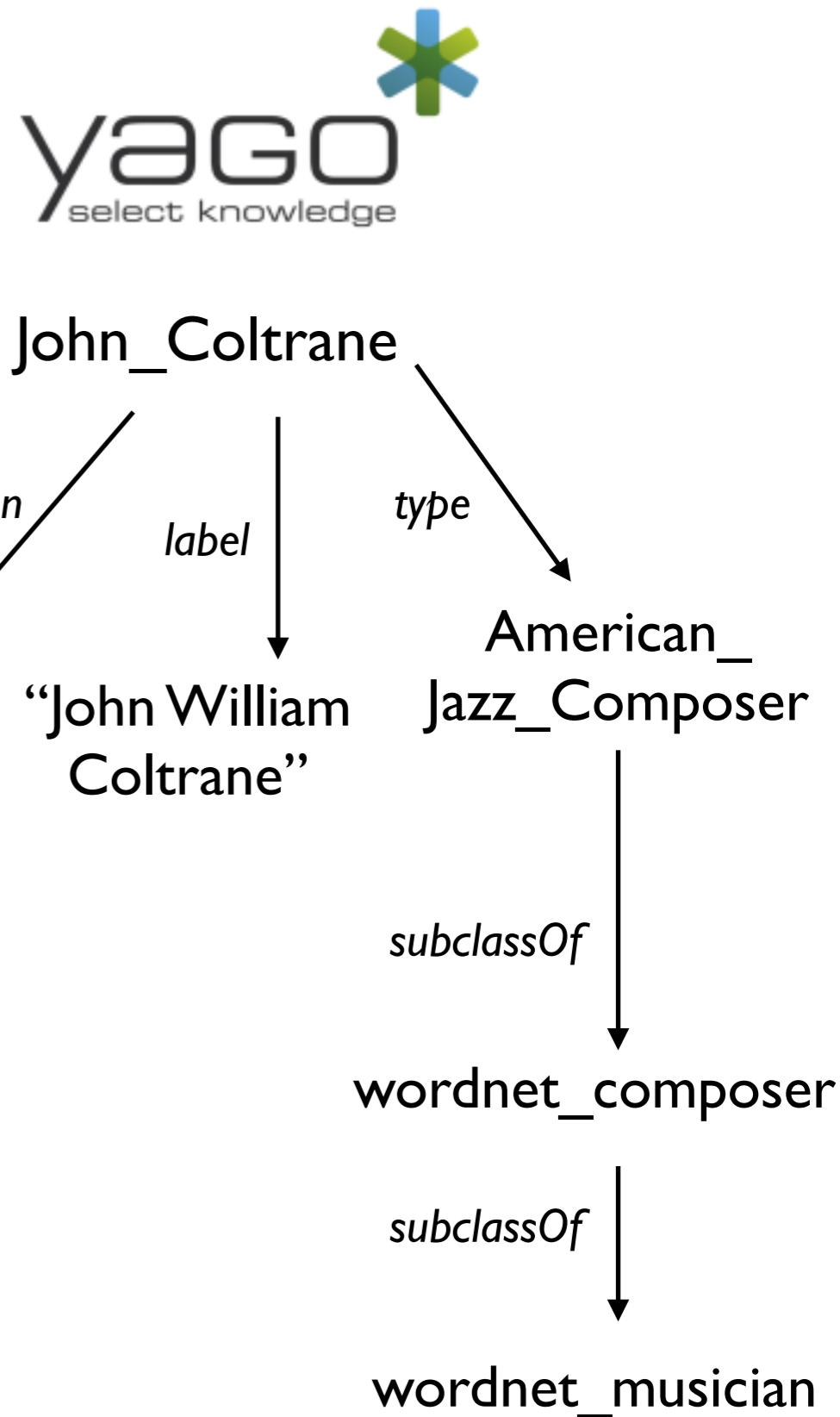
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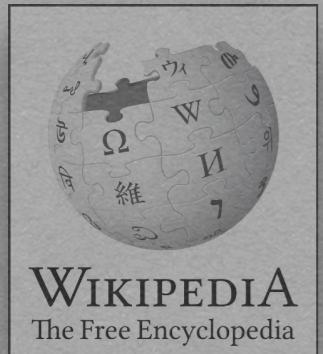
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**Background Information**

Birth name	John William Coltrane
Also known as	"Trane"
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## John Coltrane

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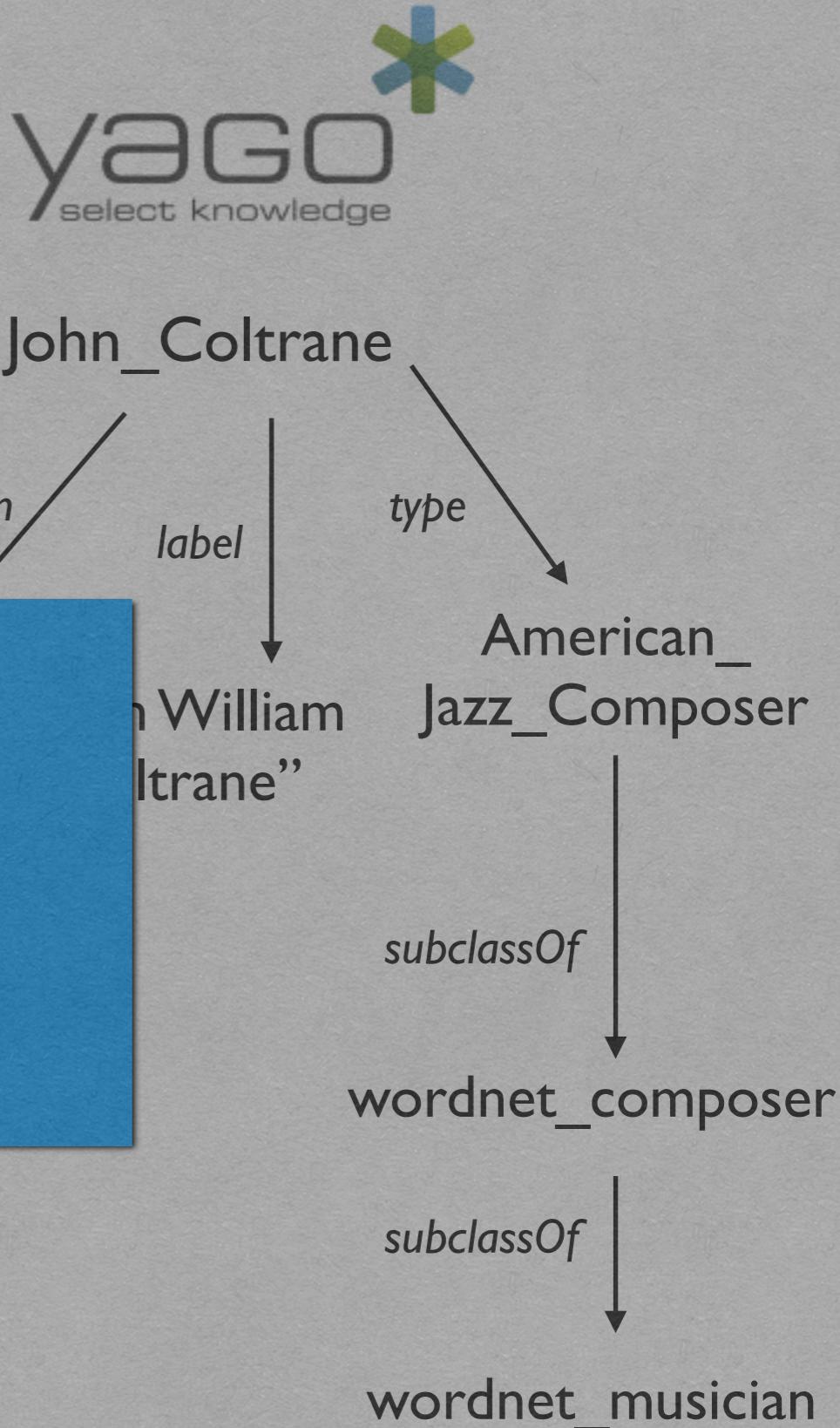
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# Geonames

120M facts  
10M entities  
100 relations  
95% precision



**WordNet**  
A lexical database for English



# YAGO can be used in many ways

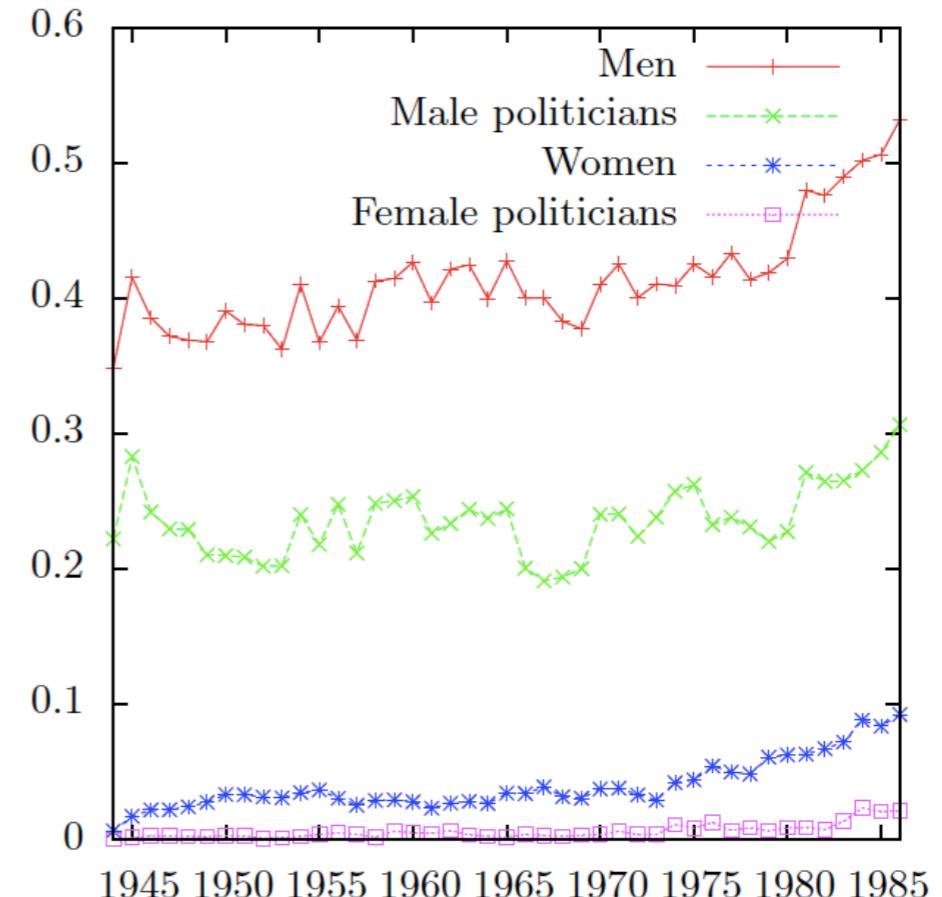


## Named Entity Disambiguation

# YAGO can be used in many ways



Named Entity  
Disambiguation



Semantic Culturomics

T. Huet, J. Biega, F. M. Suchanek, Mining History with Le Monde, AKBC2013

F. M. Suchanek, N. Preda, Semantic Culturomics, VLDB2014

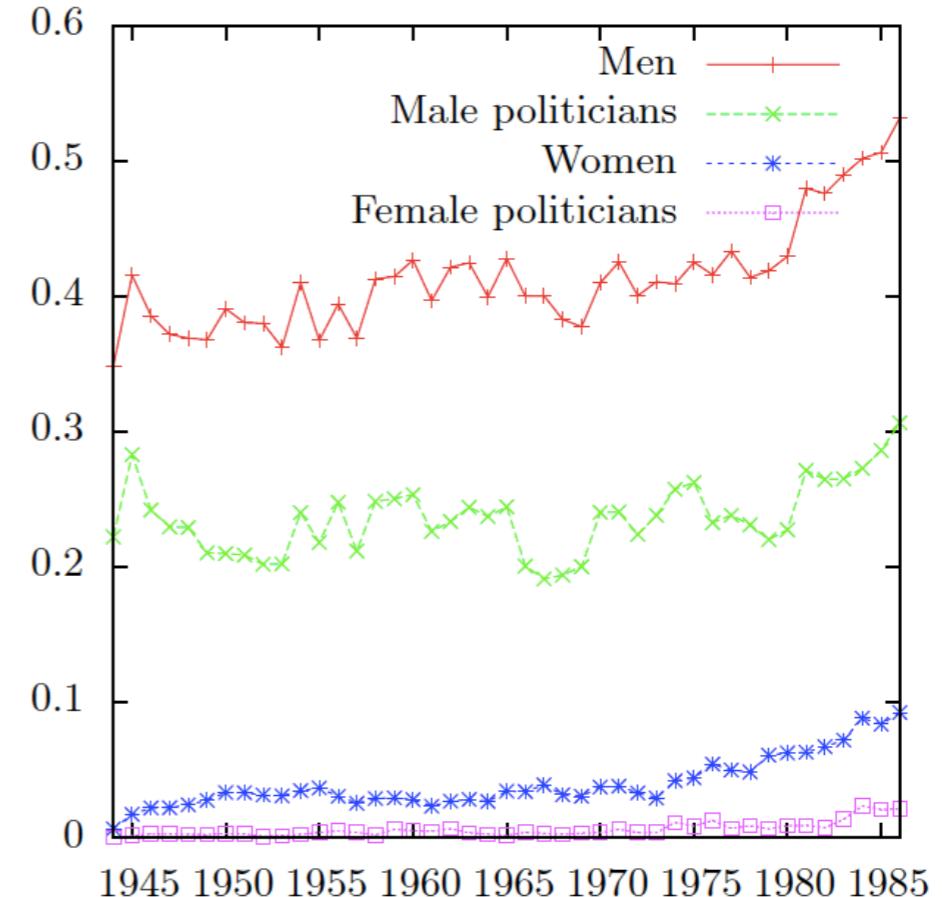
J. Hoffart et al., Robust Disambiguation of Named Entities in Text, EMNLP2011

# YAGO can be used in many ways



Named Entity  
Disambiguation

Extending YAGO coverage would yield better results!



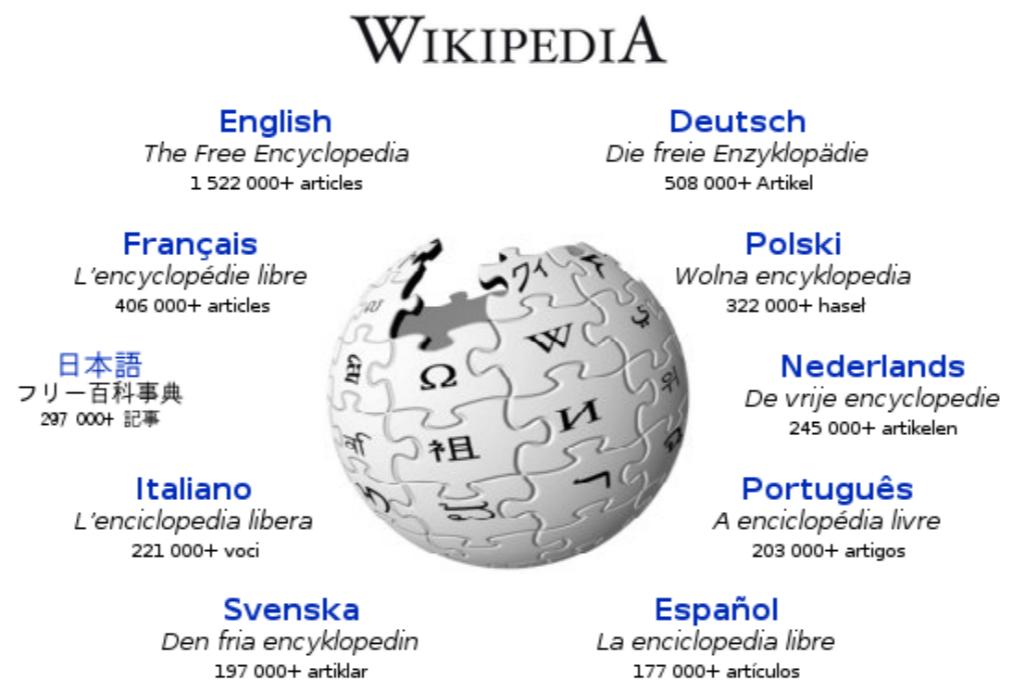
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J. Hoffart et al., Robust Disambiguation of Named Entities in Text, EMNLP2011

# Multilingual wikipedias



# Multilingual wikipedias



# Multilingual wikipedias



Izabella\_Olszewska

isMarriedTo

Tadeusz\_Jurasz

Local entities

# Running YAGO on multilingual wikipedias

## WIKIPEDIA

<b>English</b> <i>The Free Encyclopedia</i> 1 522 000+ articles	<b>Deutsch</b> <i>Die freie Enzyklopädie</i> 508 000+ Artikel
<b>Français</b> <i>L'encyclopédie libre</i> 406 000+ articles	<b>Polski</b> <i>Wolna encyklopedia</i> 322 000+ hasel
<b>日本語</b> フリー百科事典 297 000+ 記事	<b>Nederlands</b> <i>De vrije encyclopedie</i> 245 000+ artikelen
<b>Italiano</b> <i>L'enciclopedia libera</i> 221 000+ voci	<b>Português</b> <i>A encyclopédia livre</i> 203 000+ artigos
<b>Svenska</b> <i>Den fria encyklopedin</i> 197 000+ artiklar	<b>Español</b> <i>La encyclopédia libre</i> 177 000+ artículos



Extraction EN

?



# Running YAGO on multilingual wikipedias

## WIKIPEDIA

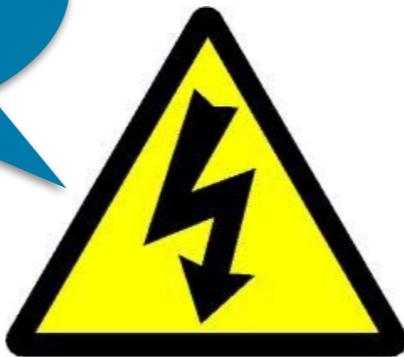
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Extraction EN

?

Duplicate entities



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Extraction EN

?



Duplicate entities

Entities with no type discarded



# Running YAGO on multilingual wikipedias

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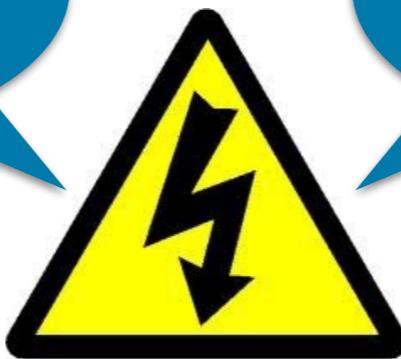
Extraction EN

?



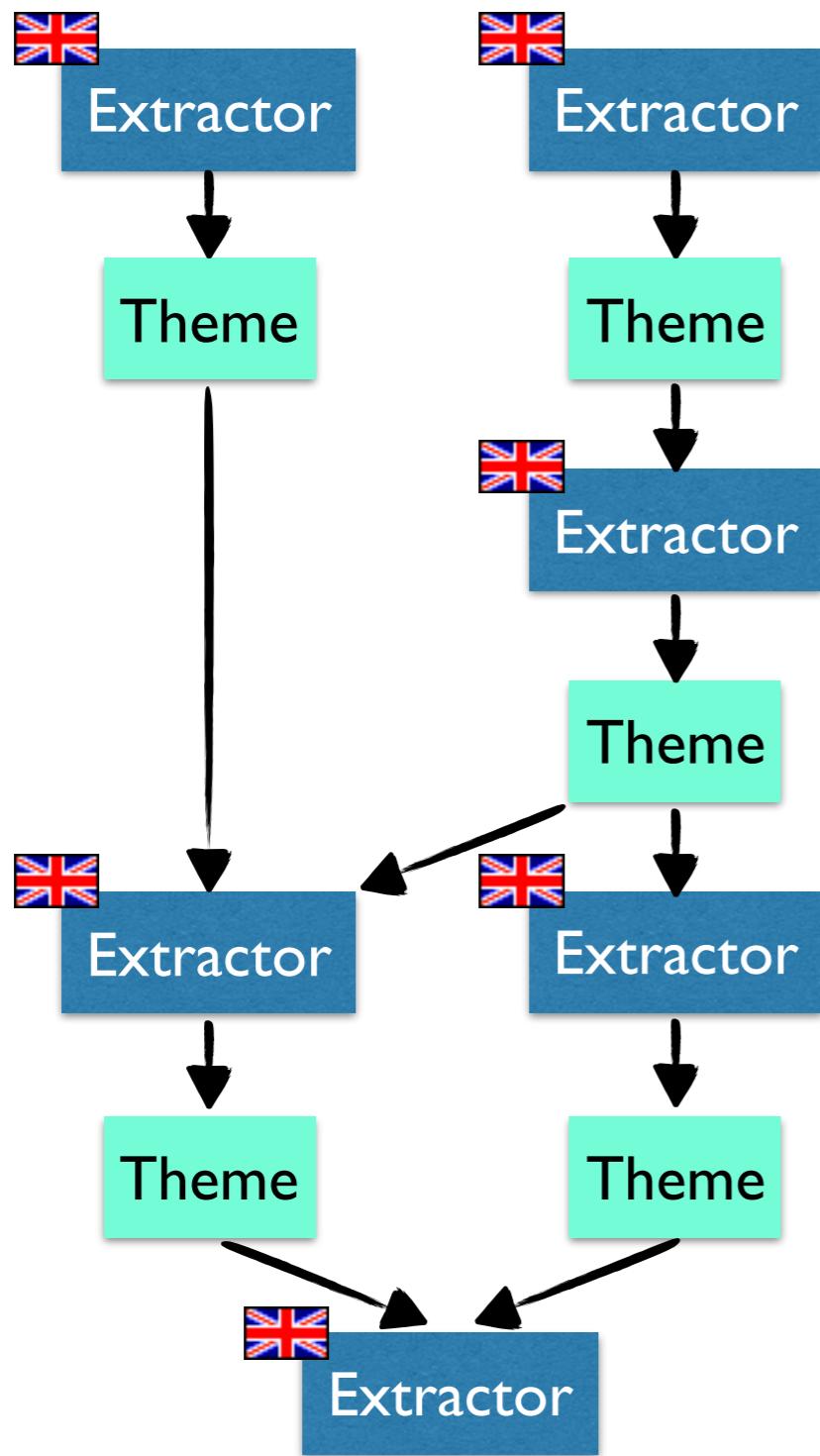
Duplicate entities

Entities with no type discarded



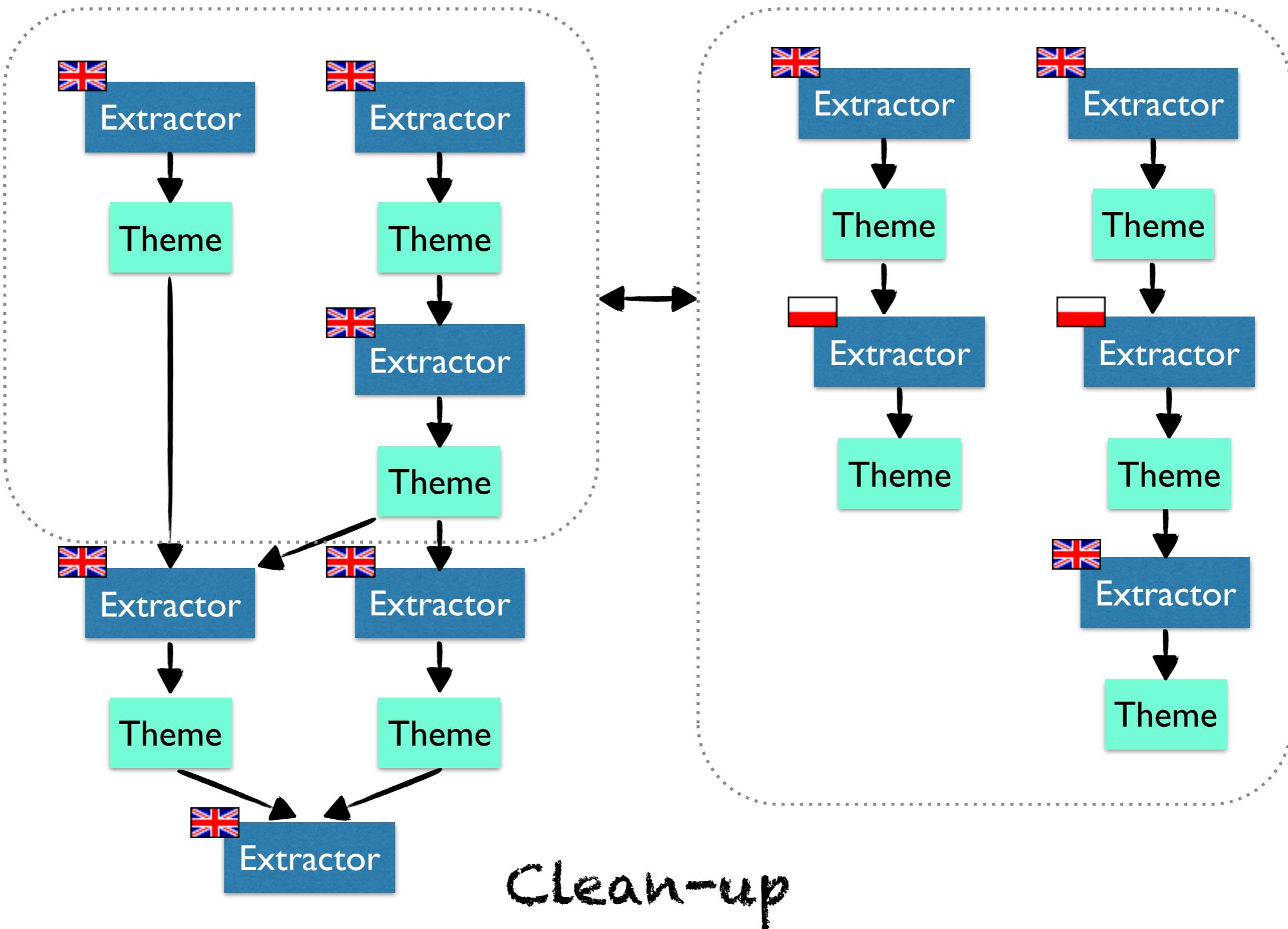
No facts  
extracted from  
foreign inboxes

# Running YAGO on multilingual wikipedias



# Running YAGO on multilingual wikipedias

## Raw extraction



# Tasks

1. Entities
2. Types
3. Facts

# I. Set of Entities



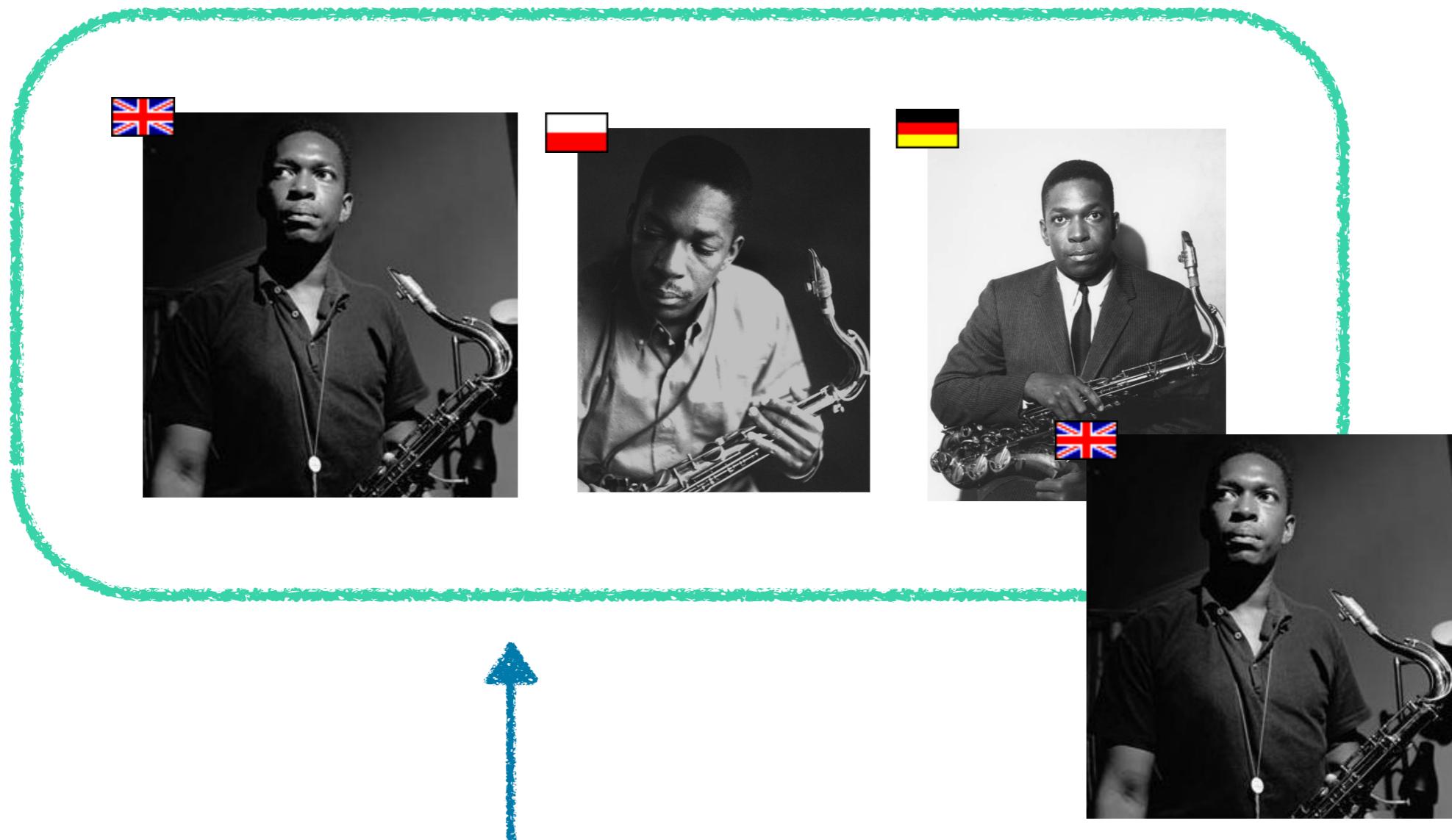
=?



=?



# I. Set of Entities



specifies the abstraction classes

# I. Set of Entities



specifies the abstraction classes

## 2. Taxonomy construction



en/John\_Coltrane inCategory "Jazz Music"

en/John\_Coltrane inCategory "American Composers"

## 2. Taxonomy construction



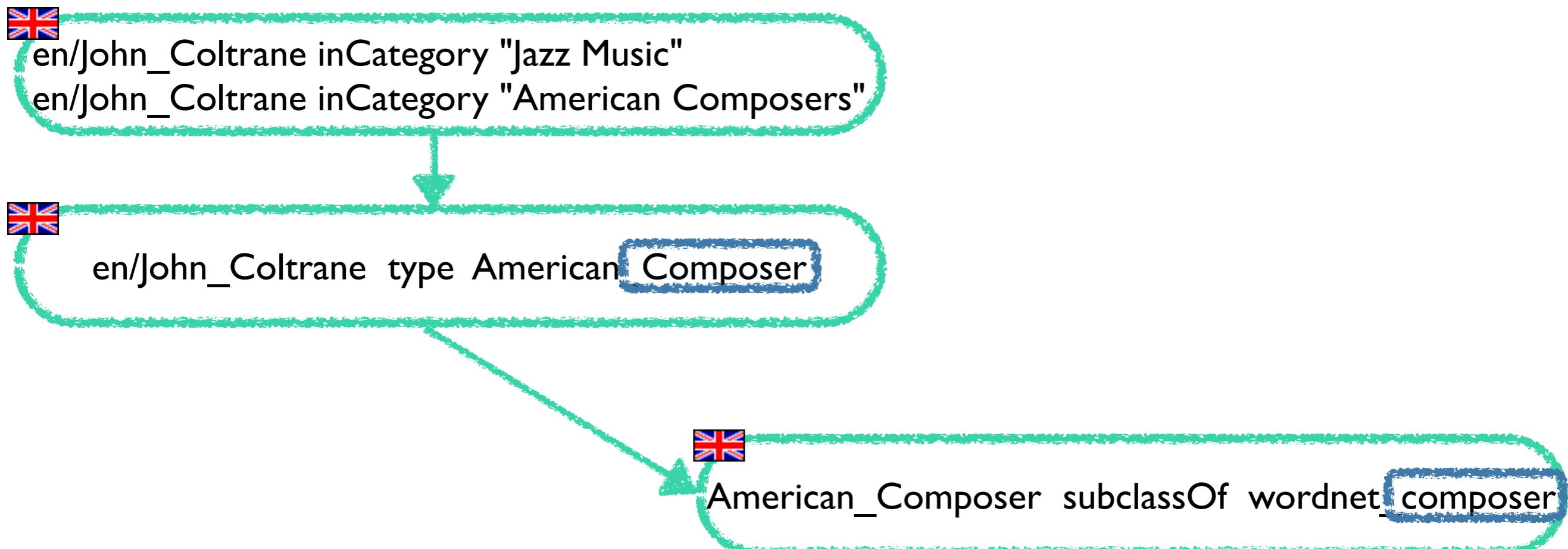
en/John\_Coltrane inCategory "Jazz Music"

en/John\_Coltrane inCategory "American Composers"



en/John\_Coltrane type American Composer

## 2. Taxonomy construction



## 2. Taxonomy construction

English-centric!



en/John\_Coltrane inCategory "Jazz Music"

en/John\_Coltrane inCategory "American Composers"



en/John\_Coltrane type American\_Composer



American\_Composer subclassOf wordnet\_composer

## 2. Taxonomy construction



pl/John\_Coltrane inCategory pl/Amerykańscy\_Jazzmani



en/John\_Coltrane inCategory "Jazz Music"

en/John\_Coltrane inCategory "American Composers"



en/John\_Coltrane type American\_Composer



American\_Composer subclassOf wordnet\_composer

## 2. Taxonomy construction



pl/John\_Coltrane inCategory pl/Amerykańscy\_Jazzmani



en/John\_Coltrane inCategory en/American\_Jazzmen



en/John\_Coltrane inCategory "Jazz Music"

en/John\_Coltrane inCategory "American Composers"

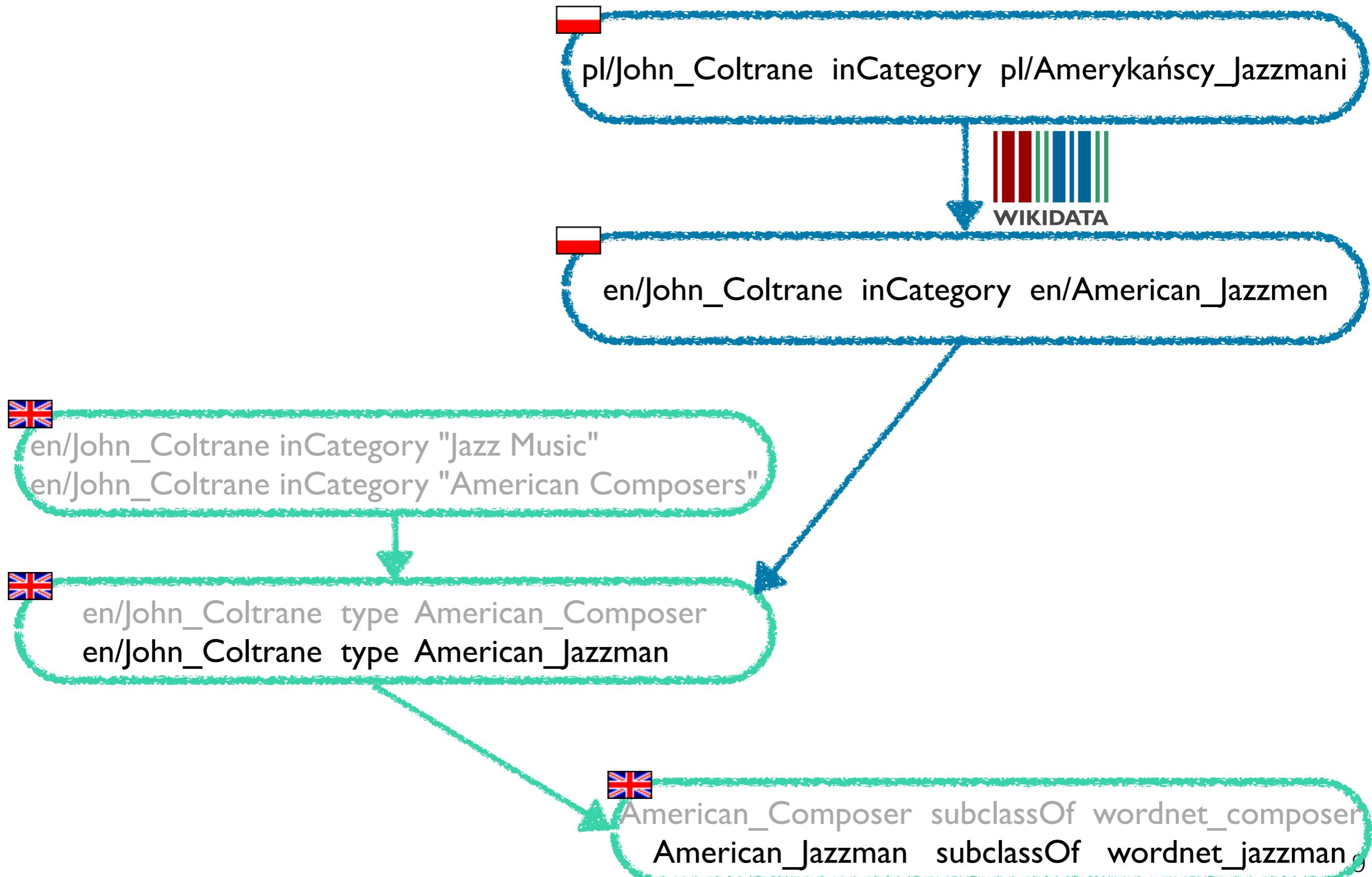


en/John\_Coltrane type American\_Composer



American\_Composer subclassOf wordnet\_composer

## 2. Taxonomy construction



## 2. Taxonomy construction



pl/John\_Coltrane inCategory pl/Amerykańscy\_Jazzmani



en/John\_Coltrane inCategory en/American\_Jazzmen



en/John\_Coltrane inCategory "Jazz Music"

en/John\_Coltrane inCategory "American Composers"



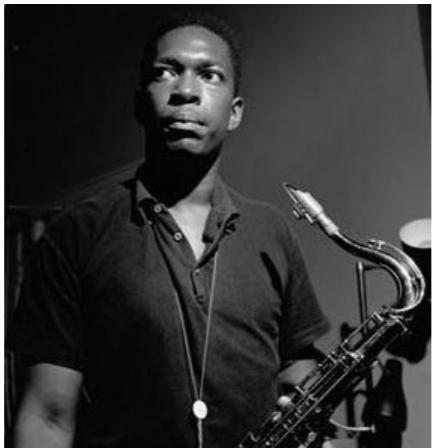
en/John\_Coltrane type American\_Composer

en/John\_Coltrane type American\_Jazzman



American\_Composer subclassOf wordnet\_composer  
American\_Jazzman subclassOf wordnet\_jazzman

### 3. Fact extraction



en/infobox/married



### 3. Fact extraction



en/infobox/married



isMarriedTo



Manually defined in YAGO-EN

# 3. Fact extraction



en/infobox/married



isMarriedTo



pl/infobox/małżonek



### 3. Fact extraction



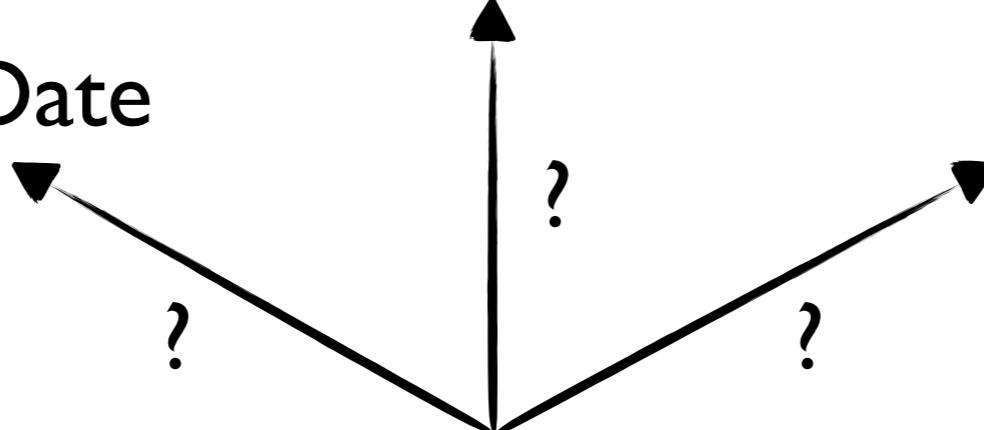
en/infobox/married



isMarriedTo

wasBornOnDate

hasChild



pl/infobox/małżonek

# Infobox attributes mapping

pl/infobox/małżonek

=?

isMarriedTo

$F_{malzonek}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Ravi Coltrane)  
(pl/Izabella\_Olszewska, pl/Tadeusz\_Jurasz)

$E_{isMarriedTo}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Alice\_Coltrane)

# Infobox attributes mapping

pl/infobox/mążonek

=?

isMarriedTo

$F_{malzonek}$

- (Barack\_Obama, Michelle\_Obama)
- (Elvis\_Presley, Priscilla\_Presley)
- (John\_Coltrane, Ravi Coltrane)
- (pl/Izabella\_Olszewska, pl/Tadeusz\_Jurasz)

$E_{isMarriedTo}$

- (Barack\_Obama, Michelle\_Obama)
- (Elvis\_Presley, Priscilla\_Presley)
- (John\_Coltrane, Alice\_Coltrane)

Corresponding attributes will share  
some subject-object pairs



# Infobox attributes mapping

pl/infobox/mążonek

=?

isMarriedTo

$F_{malzonek}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Ravi Coltrane)  
(pl/Izabella\_Olszewska, pl/Tadeusz\_Jurasz)

$E_{isMarriedTo}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Alice\_Coltrane)

$$support(F_a, E_r) = |matches(F_a, E_r)|$$

# Infobox attributes mapping

pl/infobox/mążonek

=?

isMarriedTo

$F_{malzonek}$

$E_{isMarriedTo}$

(Barack\_Obama, Michelle\_Obama)

(Elvis\_Presley, Priscilla\_Presley)

(John\_Coltrane, Ravi Coltrane)

(pl/Izabella\_Olszewska, pl/Tadeusz\_Jurasz)

(Barack\_Obama, Michelle\_Obama)

(Elvis\_Presley, Priscilla\_Presley)

(John\_Coltrane, Alice\_Coltrane)

Too restrictive for attributes with few contributions

$$support(F_a, E_r) = |matches(F_a, E_r)|$$

# Infobox attributes mapping

pl/infobox/mążonek

=?

isMarriedTo

$F_{malzonek}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Ravi Coltrane)  
(pl/Izabella\_Olszewska, pl/Tadeusz\_Jurasz)

$E_{isMarriedTo}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Alice\_Coltrane)

$$confidence(F_a, E_r) = \frac{|matches(F_a, E_r)|}{|contrib(F_a)|}$$

# Infobox attributes mapping

pl/infobox/mążonek

=?

isMarriedTo

$F_{malzonek}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Ravi Coltrane)  
(pl/Izabella\_Olszewska, pl/Tadeusz\_Jurasz)  
pl/Krystyna\_Pyrkosz, pl/Witold\_Pyrkosz  
pl/Grażyna\_Torbicka, pl/Adam\_Torbicki  
pl/Szymon\_Majewski, pl/Magda\_Majewska

$E_{isMarriedTo}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Alice\_Coltrane)

Too restrictive for attributes  
with a lot of new facts  
but few matches

$$confidence(F_a, E_r) = \frac{|matches(F_a, E_r)|}{|contrib(F_a)|}$$

# Infobox attributes mapping

pl/infobox/mążonek

=?

isMarriedTo

$F_{malzonek}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Ravi Coltrane)  
(pl/Izabella\_Olszewska, pl/Tadeusz\_Jurasz)  
pl/Krystyna\_Pyrkosz, pl/Witold\_Pyrkosz  
pl/Grażyna\_Torbicka, pl/Adam\_Torbicki  
pl/Szymon\_Majewski, pl/Magda\_Majewska

$E_{isMarriedTo}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Alice\_Coltrane)

Open-world assumption

$$pca(F_a, E_r) = \frac{|matches(F_a, E_r)|}{|matches(F_a, E_r)| + |clashes(F_a, E_r)|}$$

# Infobox attributes mapping

pl/infobox/mążonek

=?

isMarriedTo

$F_{malzonek}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Ravi Coltrane)  
(pl/Izabella\_Olszewska, pl/Tadeusz\_Jurasz)  
pl/Krystyna\_Pyrkosz, pl/Witold\_Pyrkosz  
pl/Grażyna\_Torbicka, pl/Adam\_Torbicki  
pl/Szymon\_Majewski, pl/Magda\_Majewska

$E_{isMarriedTo}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Alice\_Coltrane)

Can get misled by clashes  
Open-world assumption

$$pca(F_a, E_r) = \frac{|matches(F_a, E_r)|}{|matches(F_a, E_r)| + |clashes(F_a, E_r)|}$$

# Infobox attributes mapping

pl/infobox/mążonek

=?

isMarriedTo

$F_{malzonek}$

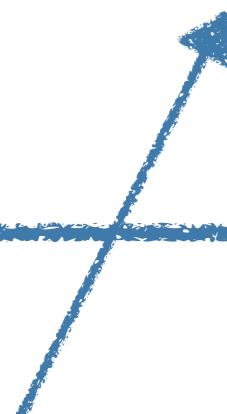
(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Ravi Coltrane)  
(pl/Izabella\_Olszewska, pl/Tadeusz\_Jurasz)

$E_{isMarriedTo}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Alice\_Coltrane)

$F^*_{malzonek}$

Random Sample



# Infobox attributes mapping

pl/infobox/mążonek

=?

isMarriedTo

$F_{malzonek}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Ravi Coltrane)  
(pl/Izabella\_Olszewska, pl/Tadeusz\_Jurasz)

...

$F_{malzonek}^*$

$E_{isMarriedTo}$

(Barack\_Obama, Michelle\_Obama)  
(Elvis\_Presley, Priscilla\_Presley)  
(John\_Coltrane, Alice\_Coltrane)

With 95% probability  
the true proportion  
of matches falls into

$[c - \delta, c + \delta]$



$$wilson(F_a, E_r) = c - \delta$$

### 3. Fact extraction



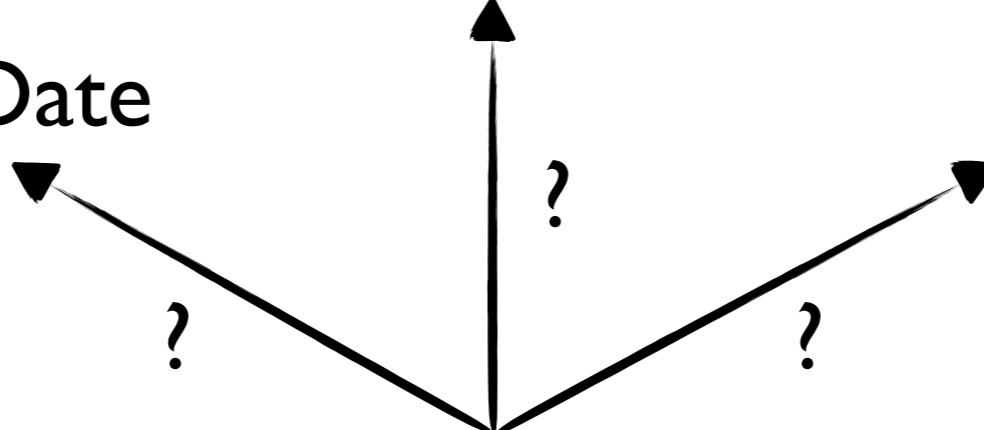
en/infobox/married



isMarriedTo

wasBornOnDate

hasChild



pl/infobox/małżonek

### 3. Fact extraction



en/infobox/married



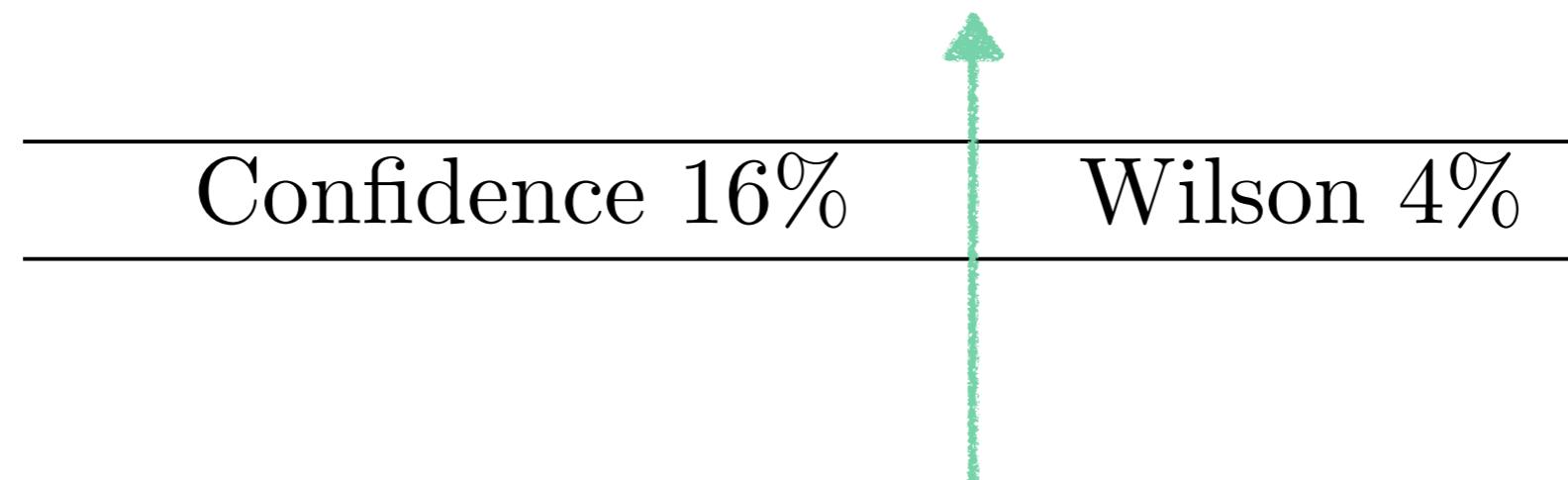
isMarriedTo



pl/infobox/małżonek

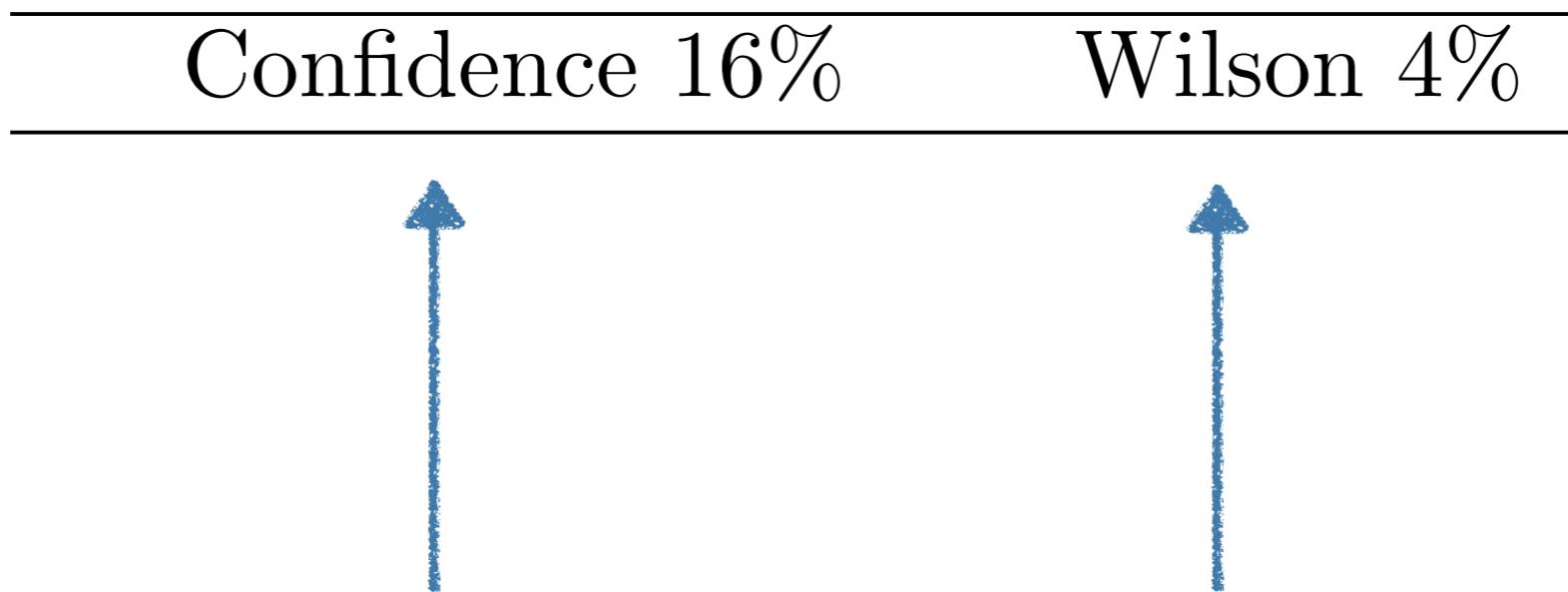


# Mapping quality



Estimated on a manually  
annotated sample

# Mapping quality



Good performance across  
different languages

# Mapping quality

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Confidence 16%	Wilson 4%
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---



Chosen so that we get high  
recall at precision > 95%

# Mapping quality

	Confidence 16%			Wilson 4%		
	Prec	Rec	F1	Prec	Rec	F1
ar	100	73	85	100	82	90
de	100	37	54	98	56	72
es	96	19	32	95	29	45
fa	100	49	66	97	54	69
fr	100	16	27	100	69	82
it	100	7	12	98	23	37
nl	100	19	32	100	22	36
pl	95	10	19	97	64	77
ro	96	52	67	95	70	81

# Mapping quality

	Confidence 16%			Wilson 4%		
	Prec	Rec	F1	Prec	Rec	F1
ar	100	73	85	100	82	90
de	100	37	54	98	56	72
es	96	19	32	95	29	45
fa	100	49	66	97	54	69
fr	100	16	27	100	69	82
it	100	7	12	98	23	37
nl	100	19	32	100	22	36
pl	95	10	19	97	64	77
ro	96	52	67	95	70	81

High precision consistent across languages.

# Mapping quality

	Confidence 16%			Wilson 4%		
	Prec	Rec	F1	Prec	Rec	F1
ar	100	73	85	100	82	90
de	100	37	54	98	56	72
es	96	19	32	95	29	45
fa	100	49	66	97	54	69
fr	100	16	27	100	69	82
it	100	7	12	98	23	37
nl	100	19	32	100	22	36
pl	95	10	19	97	64	77
ro	96	52	67	95	70	81

Higher recall for smaller wikipedias.

# Mapping quality

	Confidence 16%			Wilson 4%		
	Prec	Rec	F1	Prec	Rec	F1
ar	100	73	85	100	82	90
de	100	37	54	98	56	72
es	96	19	32	95	29	45
fa	100	49	66	97	54	69
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nl	100	19	32	100	22	36
pl	95	10	19	97	64	77
ro	96	52	67	95	70	81

Lower threshold for Wilson helps increase recall.

# YAGO3



# YAGO3



```
de/Kirdorf_(Bedburg),  
    hasNumberOfPeople, "1204"^^xsd:integer  
fr/Château_de_Montcony,  
    isLocatedIn, Burgundy  
pl/Henryk_Pietras, wasBornIn  
de/Debiensko
```

1M new entities (3.5M for English)

2.5M new facts (6.5M for English)

# YAGO3



```
de/Kirdorf_(Bedburg),  
hasNumberOfPeople, "1204"^^xsd:integer  
fr/Château_de_Montcony,  
isLocatedIn, Burgundy  
pl/Henryk_Pietras, wasBornIn  
de/Debiensko
```

1M new entities (3.5M for English)

2.5M new facts (6.5M for English)

Large, clean knowledge base from multilingual wikipedias.

Single coherent taxonomy.

Mapping of infobox attributes to YAGO relations.

# YAGO3



rg  
Thank you!

<http://yago-knowledge.org>