Information Extraction

Lecture 10 – Ontological and Open IE

CIS, LMU München
Winter Semester 2015-2016

Dr. Alexander Fraser, CIS

Administravia

- Suggested Klausur date is in the last week of the Vorlesung (the week before Fasching)
  - Klausur: February 3rd
  - There will be a review for the Klausur on Wed January 27th

  - NEW: there is a conflict with a different course, I will look into this

- Before I start on Ontological IE, two topics I wanted to briefly talk about today:
  - Semantic Role Labeling
  - Wikification

Syntactic Parsing and Relation Extraction

- We saw in the previous two lectures that syntactic features are useful for relation extraction (and event extraction)
- For instance...

Parse Features for Relation Extraction

American Airlines*, a unit of AMR, immediately matched the move, spokesman* ***Tim Wagner*** *said*

Mention 1 Mention 2

- Base syntactic chunk sequence from one to the other

  NP NP PP VP NP NP

- Constituent path through the tree from one to the other

  NP ↑ NP ↑ S ↑ S ↓ NP

- Dependency path

  Airlines matched Wagner said

Slide from D. Jurafsky

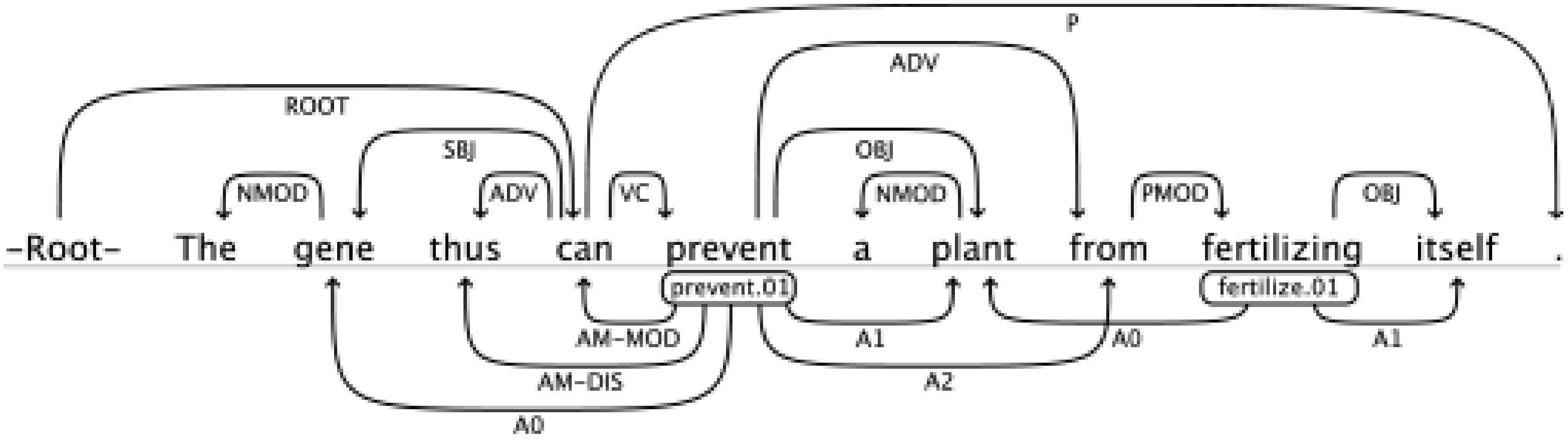
Semantic Role Labeling

- A generalization beyond syntactic parsing is Semantic Role Labeling (often abbreviated to SRL)
- Here the idea is to identify the arguments to a verb
  - So this can capture the same information as, e.g., a dependency parse
  - It should be clear that this will be useful in IE
- But the difference is that the arguments are captured in terms of their semantic function rather than their syntactic function

Subcategorization Frame

- Consider the sentences:
  - The man was bitten by the dog
  - The dog bit the man
- In terms of the verb and the subcategorized arguments, there is no difference here
- In Semantic Role Labeling, these will have the same representation!
- Consider also:
  - The man was bitten.

Semantic Role Labeling



Example from Kozhevnikov and Titov

List of SRL tools (see also the comments):
http://www.kenvanharen.com/2012/11/comparison-of-semantic-role-labelers.html

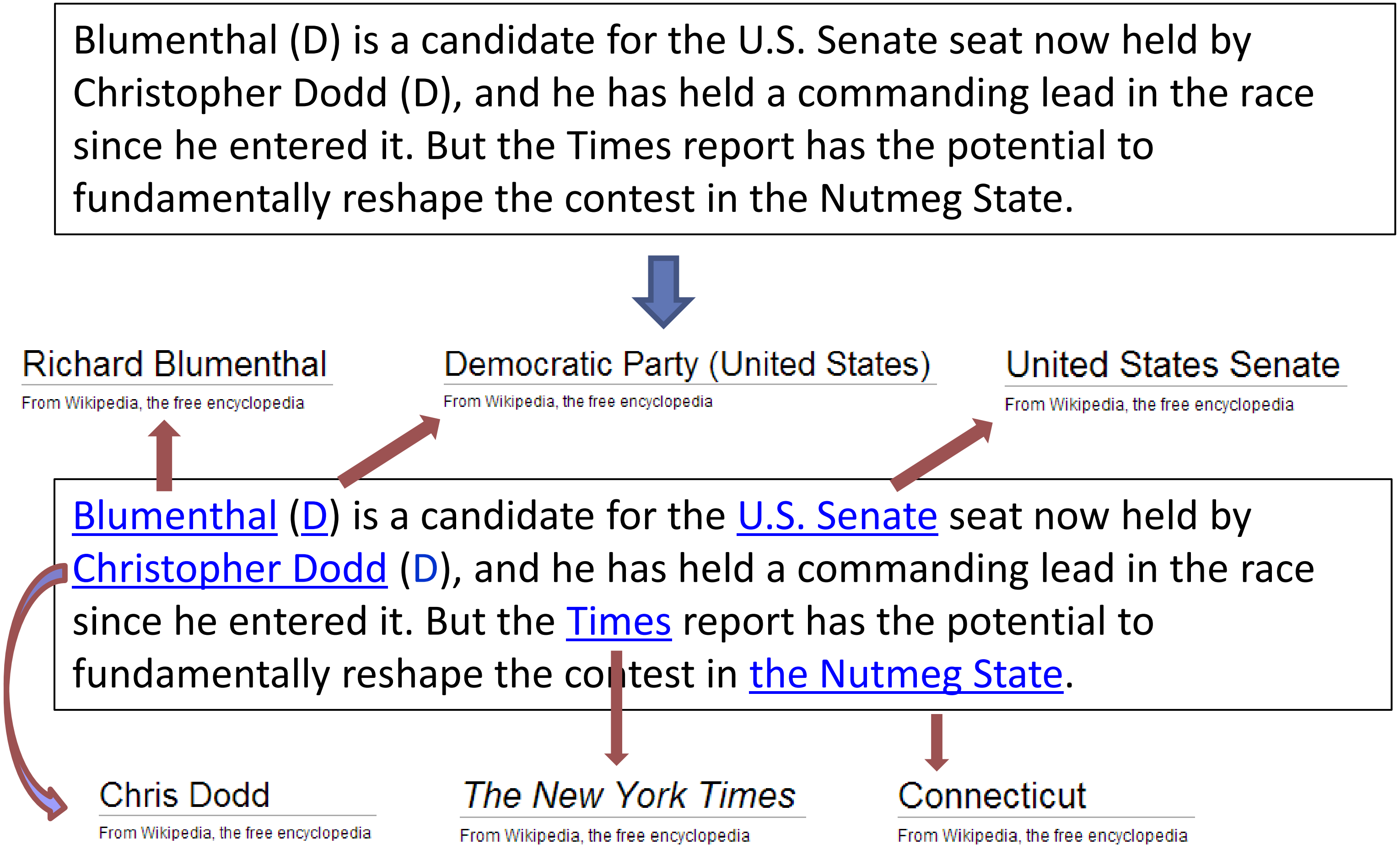
Last Word: Training Data

- The critical problem for statistical approaches is labeled training data
- There are two mature data sets for training semantic role labelers for English
  - **Framenet** is the one that may be more useful for many IE purposes (but **Propbank** is also interesting)
- There has been some work on projecting these two resources to other languages using machine translation techniques
  - E.g., for German, the "Salsa" project at Uni SB

Wikification

- Wikification is the problem of automatically annotating entities in free text with their (English) Wikipedia page
- Let's start with motivation...

Wikification: The Reference Problem



Blumenthal (D) is a candidate for the U.S. Senate seat now held by Christopher Dodd (D), and he has held a commanding lead in the race since he entered it. But the Times report has the potential to fundamentally reshape the contest in the Nutmeg State.

Richard Blumenthal
From Wikipedia, the free encyclopedia

Democratic Party (United States)
From Wikipedia, the free encyclopedia

United States Senate
From Wikipedia, the free encyclopedia

Blumenthal (D) is a candidate for the U.S. Senate seat now held by Christopher Dodd (D), and he has held a commanding lead in the race since he entered it. But the Times report has the potential to fundamentally reshape the contest in the Nutmeg State.

Chris Dodd
From Wikipedia, the free encyclopedia

The New York Times
From Wikipedia, the free encyclopedia

Connecticut
From Wikipedia, the free encyclopedia

Slide from ACL 2014 Roth Tutorial

Wikification: Motivation

- Dealing with Ambiguity of Natural Language
  - Mentions of entities and concepts could have multiple meanings
- Dealing with Variability of Natural Language
  - A given concept could be expressed in many ways

- Wikification addresses these two issues in a specific way:

- The Reference Problem
  - What is meant by this concept? (WSD + Grounding)
  - More than just co-reference (within and across documents)

Slide from ACL 2014 Roth Tutorial

Ontological IE

- In the last two lectures, we discussed how to extract relations and events from text
  - We looked in detail at relations expressed in a single sentence
  - Event extraction captures relations which are often expressed at either the sentence or at the document level (i.e., in multiple sentences)
    - Consider the CMU Seminar task – the task is to extract events (seminars), with speaker, location, start time and end time
- Today we will discuss updating a knowledge base with the extracted relations or events
  - This is called "Ontological IE"

Ontologies

An **ontology** is a consistent knowledge base without redundancy

Person	**Nationality**
Angela Merkel	German
Merkel	Germany
A. Merkel	French

✗

Entity	**Relation**	**Entity**
Angela Merkel	citizenOf	Germany

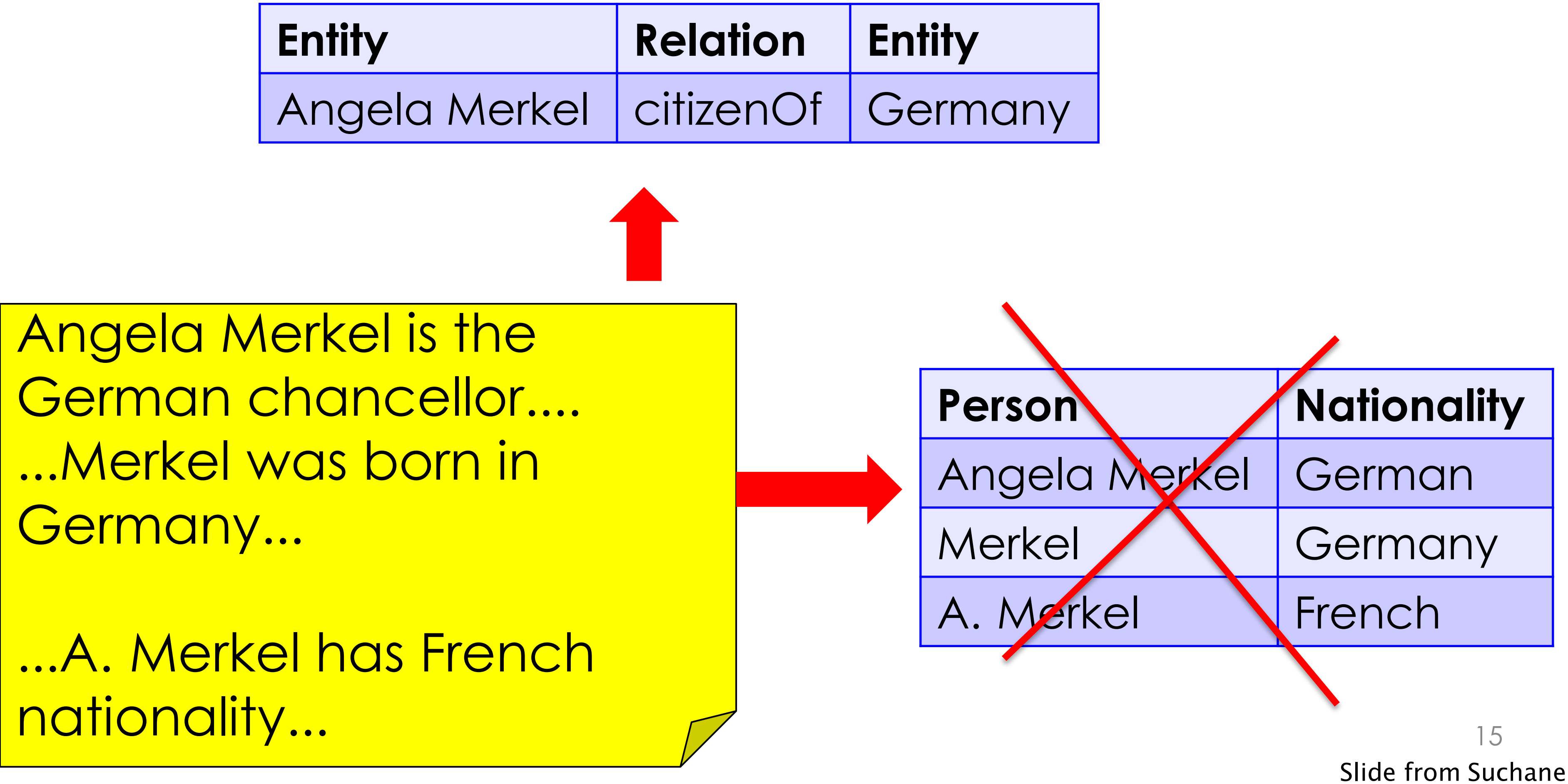
✓

- Every entity appears only with exactly the same name
- There are no semantic contradictions

Slide from Suchanek

Ontological IE

Ontological Information Extraction (IE) aims to create or extend an ontology.



Entity	Relation	Entity
Angela Merkel	citizenOf	Germany

Angela Merkel is the German chancellor....
...Merkel was born in Germany...

...A. Merkel has French nationality...

Person	Nationality
Angela Merkel	German
Merkel	Germany
A. Merkel	French

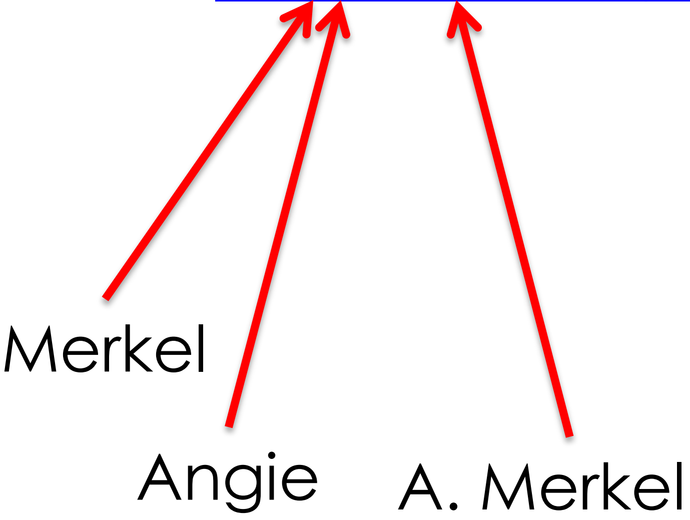
Slide from Suchanek

Ontological IE Challenges

Challenge 1:

Map names to names that are already known

Entity	Relation	Entity
Angela Merkel	citizenOf	Germany



Merkel

Angie

A. Merkel

Slide from Suchanek

Ontological IE Challenges

Challenge 2:
Be sure to map the names to the right known names

Entity	Relation	Entity
Angela Merkel	citizenOf	Germany
Una Merkel	citizenOf	USA

?

Merkel is great!

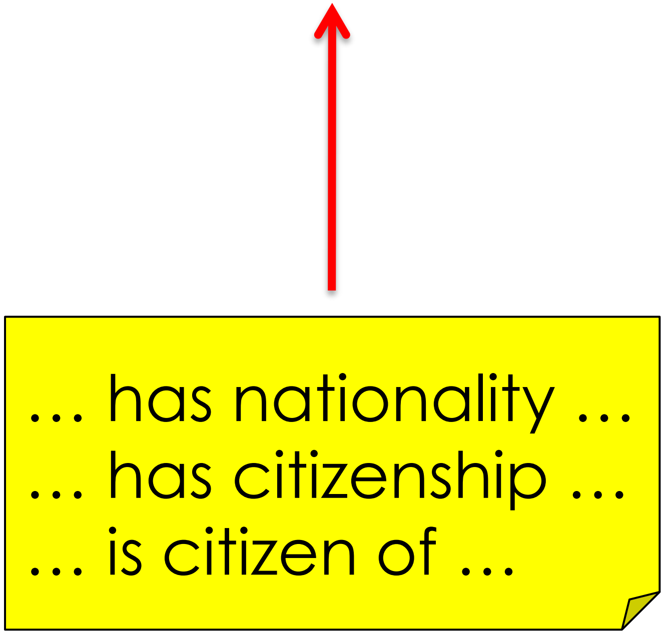
Slide from Suchanek

Ontological IE Challenges

Challenge 3:

Map to known relationships

Entity	Relation	Entity
Angela Merkel	citizenOf	Germany



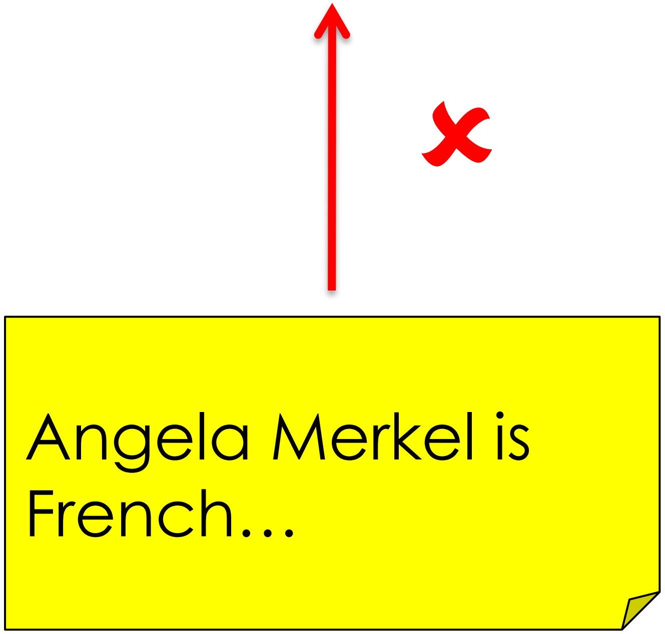
… has nationality …
… has citizenship …
… is citizen of …

Slide from Suchanek

Ontological IE Challenges

Challenge 4:
Take care of consistency

Entity	**Relation**	**Entity**
Angela Merkel	citizenOf	Germany



Angela Merkel is French…

Slide from Suchanek

Triples

A **triple** (in the sense of ontologies) is a tuple of an entity, a relation name and another entity:

Entity	Relation	Entity
Angela Merkel	citizenOf	Germany

Most ontological IE approaches produce triples as output. This decreases the variance in schema.

~~Person~~	~~Country~~
~~Angela~~	~~Germany~~

~~Citizen~~	~~Nationality~~
~~Angela~~	~~Germany~~

~~Person~~	~~Birthdate~~	~~Country~~
~~Angela~~	~~1980~~	~~Germany~~

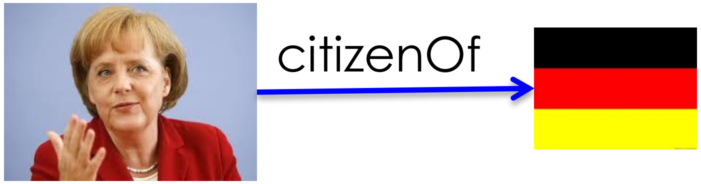
Slide from Suchanek

Triples

A triple can be represented in multiple forms:

Entity	**Relation**	**Entity**
Angela Merkel	citizenOf	Germany

=



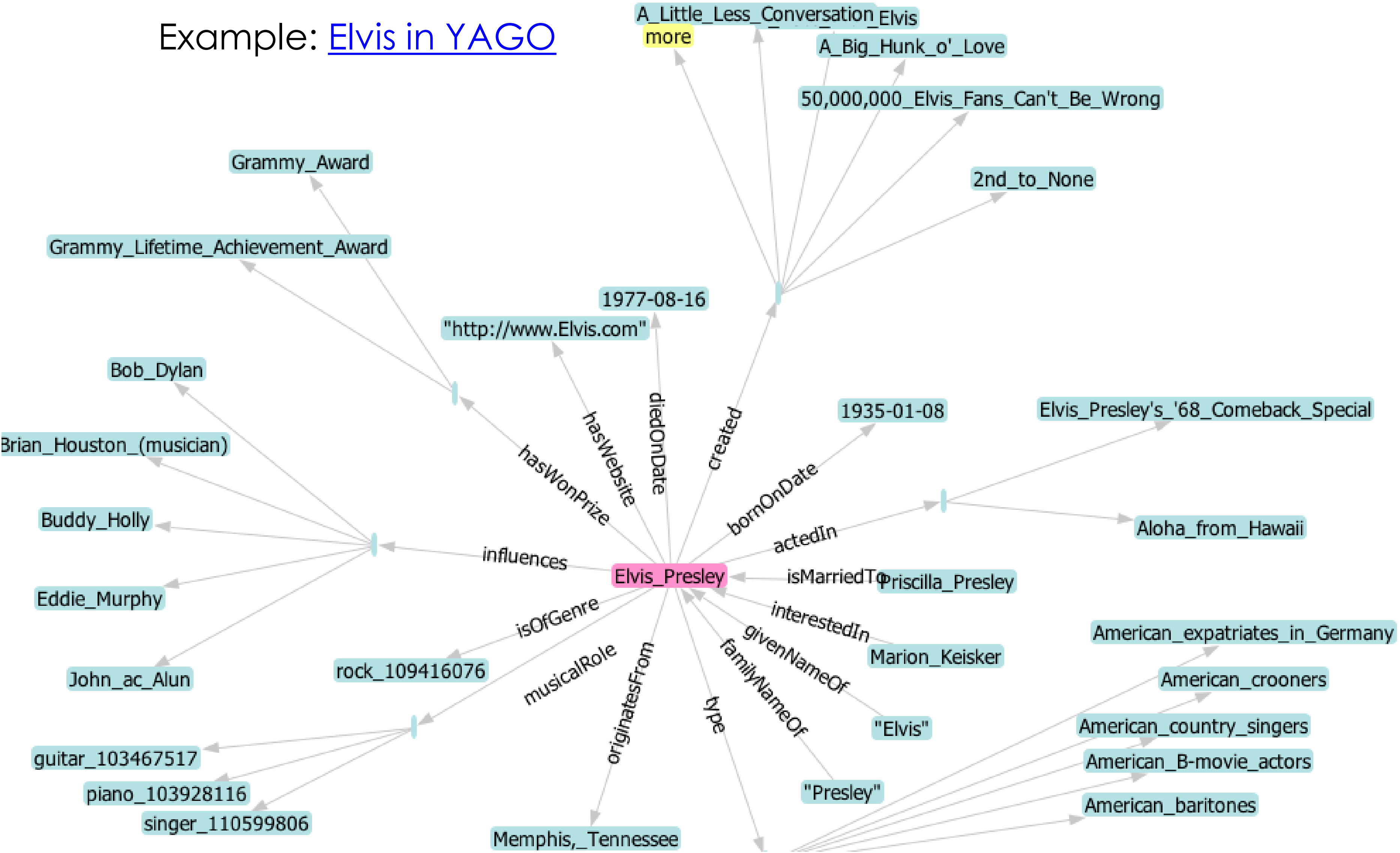
=

<Angela Merkel, citizenOf, Germany>

Slide from Suchanek

YAGO

Example: Elvis in YAGO



Slide from Suchanek

- Let's talk about ontological IE using extraction from Wikipedia as an example
- Then we will go on to open IE, which uses similar ideas to extract from all the text on the web!

Wikipedia

Wikipedia is a free online encyclopedia

- 3.4 million articles in English
- 16 million articles in dozens of languages

Why is Wikipedia good for information extraction?

- It is a huge, but homogenous resource
  (more homogenous than the Web)
- It is considered authoritative
  (more authoritative than a random Web page)
- It is well-structured with infoboxes and categories
- It provides a wealth of meta information
  (inter article links, inter language links, user discussion,...)

Slide from Suchanek

Ontological IE from Wikipedia

Wikipedia is a free online encyclopedia

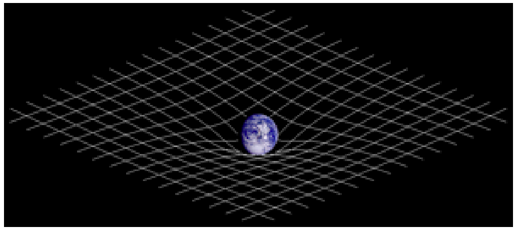
- 3.4 million articles in English
- 16 million articles in dozens of languages

Every article is (should be) unique
=> We get a set of unique entities
that cover numerous areas of interest

Angela_Merkel

Una_Merkel

Germany

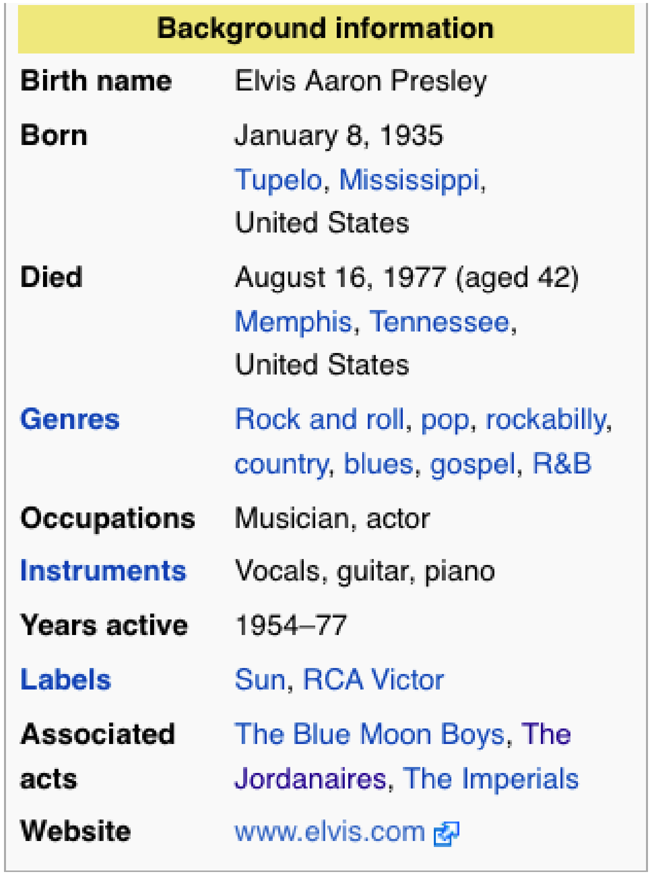


Theory_of_Relativity

Slide from Suchanek

Wikipedia Source

Example: Elvis on Wikipedia

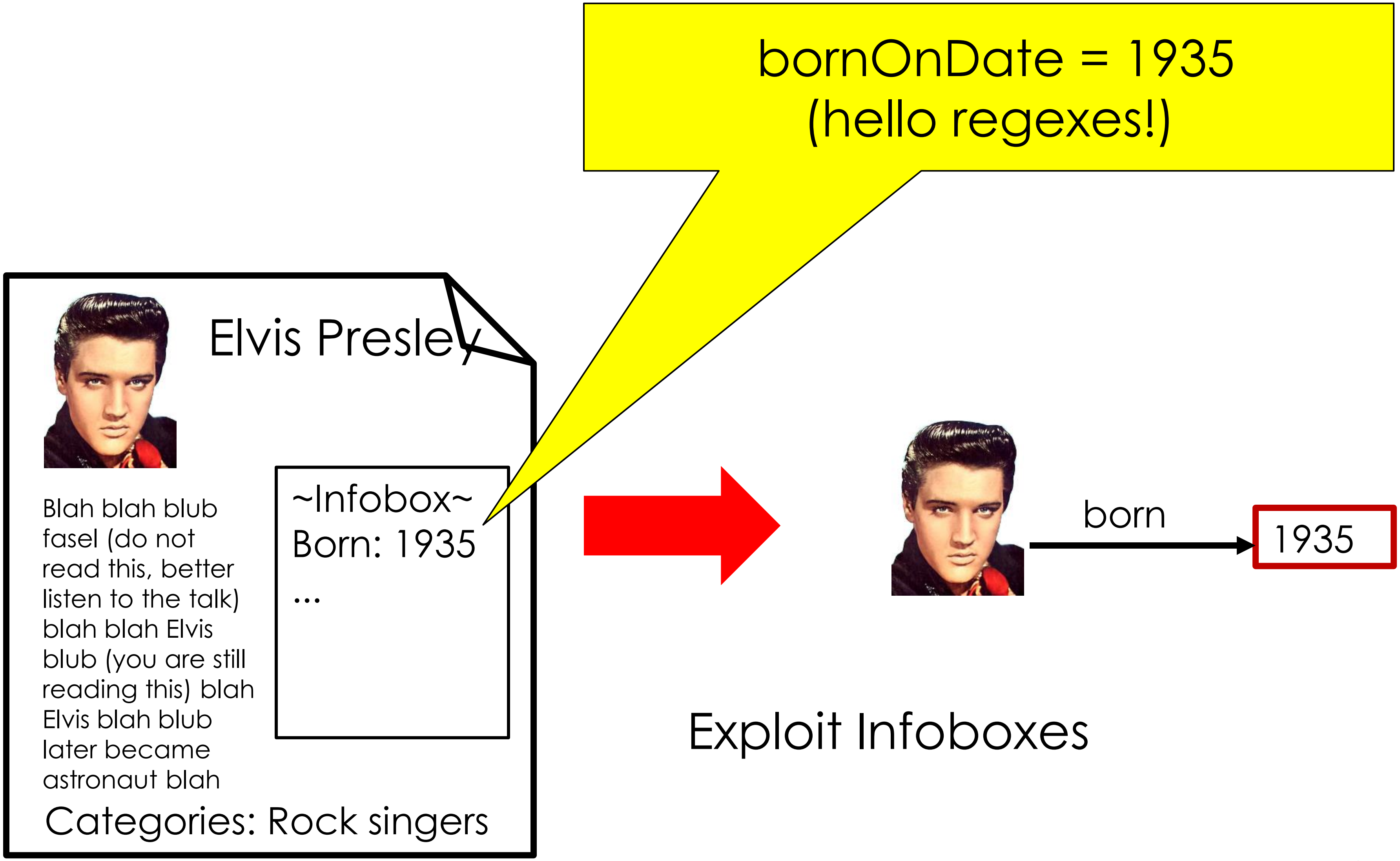


Background information	
Birth name	Elvis Aaron Presley
Born	January 8, 1935 Tupelo, Mississippi, United States
Died	August 16, 1977 (aged 42) Memphis, Tennessee, United States
Genres	Rock and roll, pop, rockabilly, country, blues, gospel, R&B
Occupations	Musician, actor
Instruments	Vocals, guitar, piano
Years active	1954–77
Labels	Sun, RCA Victor
Associated acts	The Blue Moon Boys, The Jordanaires, The Imperials
Website	www.elvis.com

```
| Birth_name = Elvis Aaron Presley
| Born = {{Birth date | 1935 | 1 | 8}}<br />
          [[Tupelo, Mississippi | Tupelo]]
```

Slide from Suchanek

IE from Wikipedia



bornOnDate = 1935
(hello regexes!)

Elvis Presley

Blah blah blub fasel (do not read this, better listen to the talk) blah blah Elvis blub (you are still reading this) blah Elvis blah blub later became astronaut blah

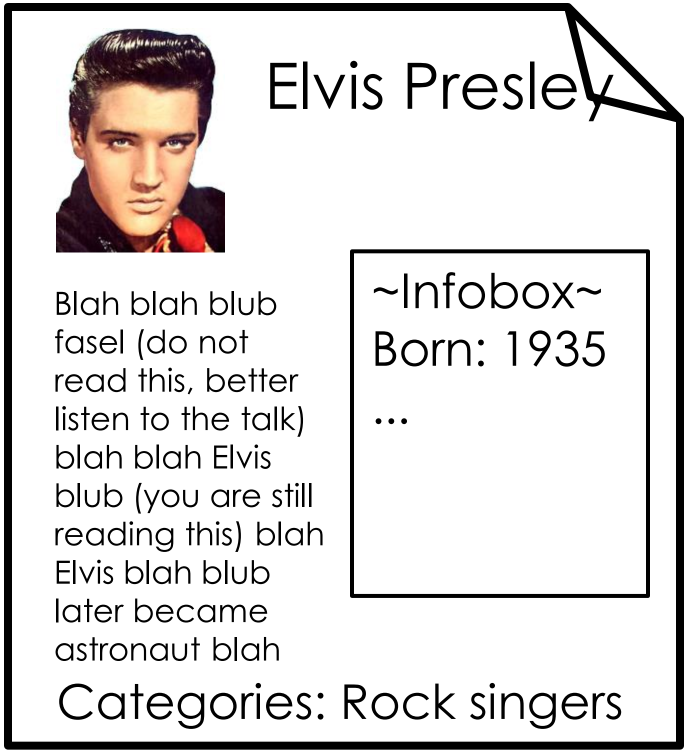
~Infobox~
Born: 1935
...

Categories: Rock singers

Exploit Infoboxes

Slide from Suchanek

IE from Wikipedia

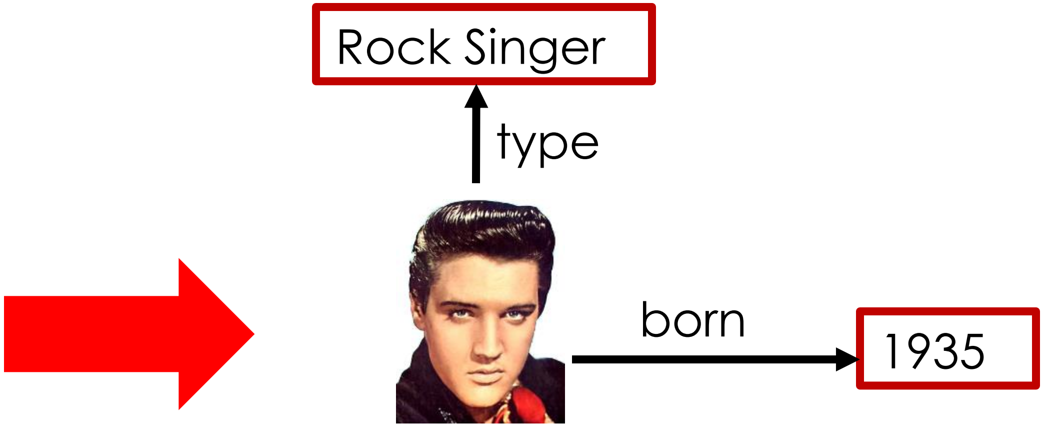


Elvis Presley

Blah blah blub fasel (do not read this, better listen to the talk) blah blah Elvis blub (you are still reading this) blah Elvis blah blub later became astronaut blah

~Infobox~
Born: 1935
...

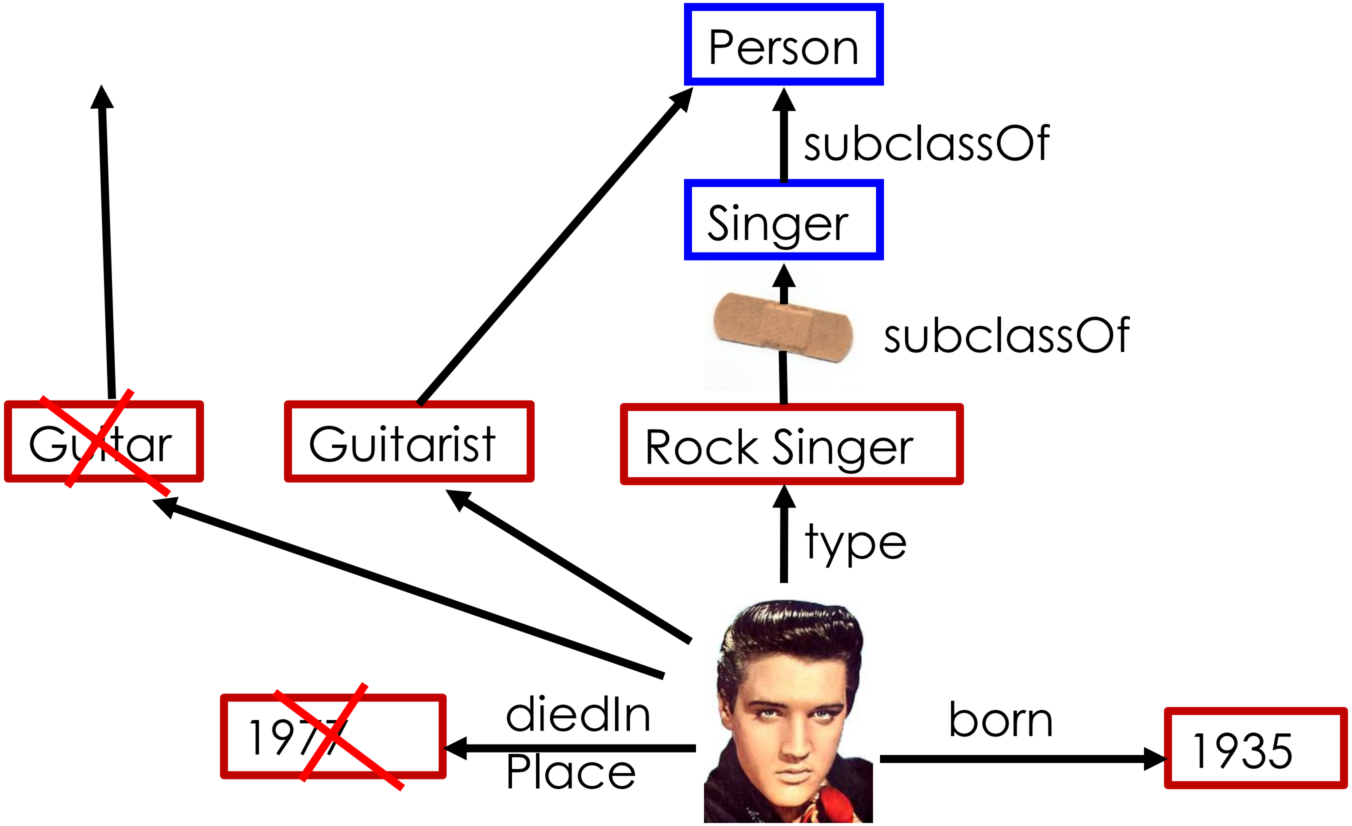
Categories: Rock singers



Exploit Infoboxes
Exploit conceptual categories

Slide from Suchanek

Consistency Checks



Check uniqueness of functional arguments

Check domains and ranges of relations

Check type coherence

Slide from Suchanek

Ontological IE from Wikipedia

YAGO

- 3m entities, 28m facts
- focus on precision 95%
  (automatic checking of facts)

http://yago-knowledge.org

DBpedia

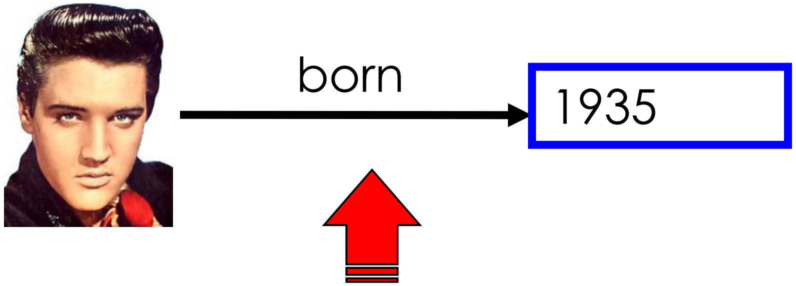
- 3.4m entities
- 1b facts (also from non-English Wikipedia)
- large community

http://dbpedia.org

Community project on top of Wikipedia
(bought by Google, but still open)
http://freebase.com
--- Now integrated into **Wikidata**!!!

Slide modified from Suchanek

Ontological IE by Reasoning



born

1935

Elvis was born in 1935

Recap: The challenges:

- deliver canonic relations
- deliver canonic entities
- deliver consistent facts

died in, was killed in

Elvis, Elvis Presley, The King

born (Elvis, 1970)
born (Elvis, 1935)

Idea: These problems are interleaved,
solve all of them together.

Slide from Suchanek

Using Reasoning

Ontology

Documents

Elvis was born in 1935

Consistency Rules

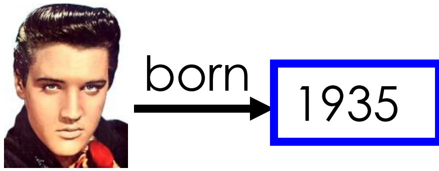
birthdate<deathdate

First Order Logic

type(Elvis_Presley,singer)
subclassof(singer,person)
...

appears("Elvis","was born in",
"1935")
...
means("Elvis",Elvis_Presley,0.8)
means("Elvis",Elvis_Costello,0.2)
...

born(X,Y) & died(X,Z) => Y<Z
appears(A,P,B) & R(A,B)
=> expresses(P,R)
appears(A,P,B) & expresses(P,R)
=> R(A,B)
...



SOFIE
system

Slide from Suchanek

Ontological IE by Reasoning

Reasoning-based approaches use logical rules
to extract knowledge from natural language documents.

Current approaches use either

- Weighted MAX SAT
- or Datalog
- or Markov Logic

Input:

- often an ontology
- manually designed rules

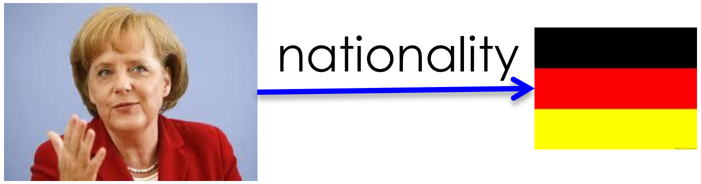
Condition:

- homogeneous corpus helps

Slide from Suchanek

Ontological IE Summary

Ontological Information Extraction (IE) tries to create or extend an ontology through information extraction.



Current hot approaches:

- extraction from Wikipedia
- reasoning-based approaches
- integrating uncertainty

Slide modified from Suchanek

Open Information Extraction

Open Information Extraction/Machine Reading aims at information extraction from the entire Web.

Vision of Open Information Extraction:

- the system runs perpetually, constantly gathering new information
- the system creates meaning on its own from the gathered data
- the system learns and becomes more intelligent, i.e. better at gathering information

Slide from Suchanek

Open Information Extraction

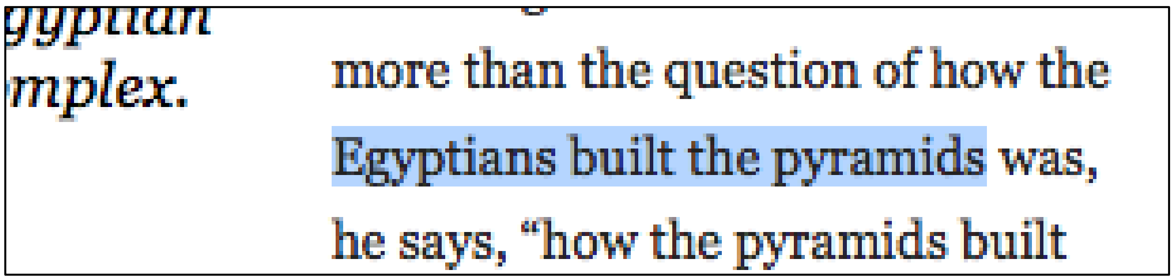
Open Information Extraction/Machine Reading aims at information extraction from the entire Web.

Rationale for Open Information Extraction:

- We do not need to care for every single sentence, but just for the ones we understand
- The size of the Web generates redundancy
- The size of the Web can generate synergies

KnowItAll &Co

KnowItAll, KnowItNow and TextRunner are projects at the University of Washington (in Seattle, WA).



gyptian
mplex.

more than the question of how the
Egyptians built the pyramids was,
he says, "how the pyramids built

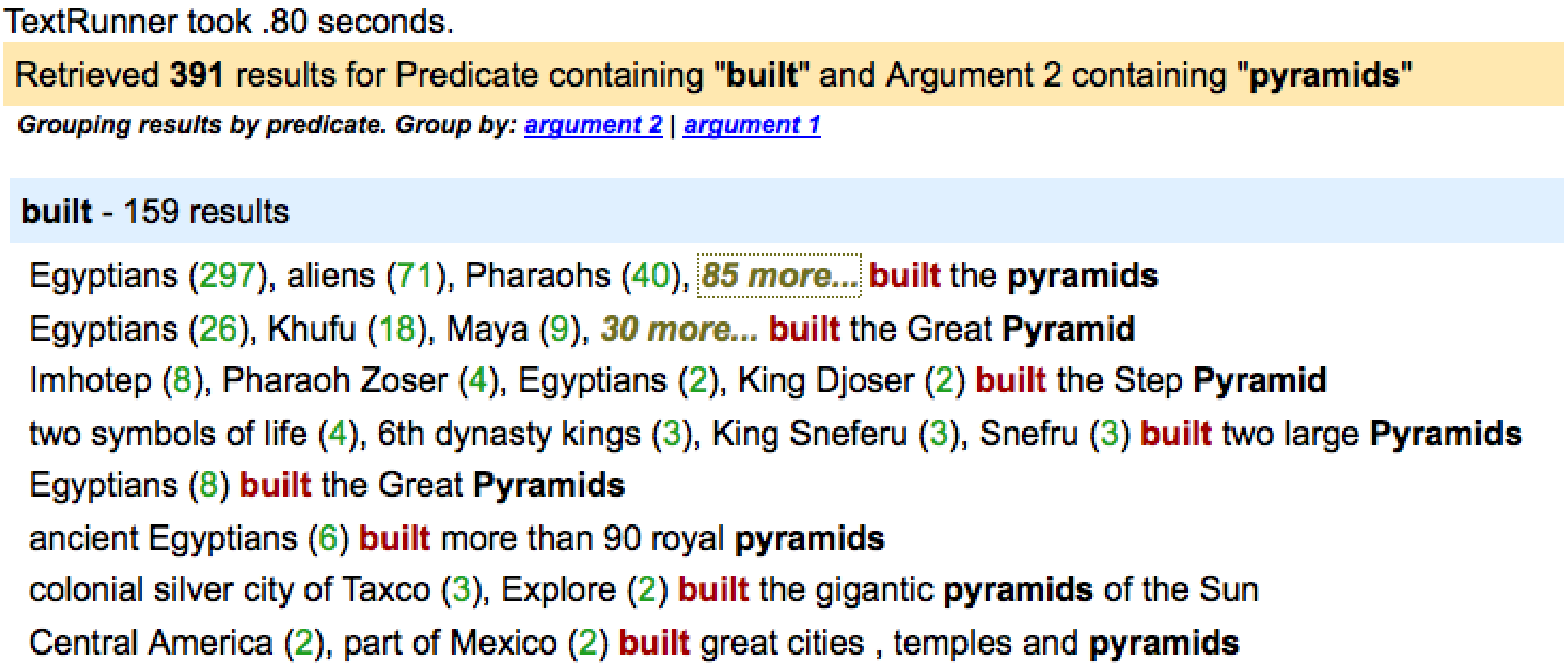
Subject	Verb	Object	Count
Egyptians	built	pyramids	400
Americans	built	pyramids	20
…	…	…	…

Valuable common sense knowledge (if filtered)

http://www.cs.washington.edu/research/textrunner/

Slide from Suchanek

KnowItAll &Co



TextRunner took .80 seconds.

Retrieved **391** results for Predicate containing "**built**" and Argument 2 containing "**pyramids**"

Grouping results by predicate. Group by: *argument 2* | *argument 1*

built - 159 results

Egyptians (297), aliens (71), Pharaohs (40), *85 more...* **built** the **pyramids**

Egyptians (26), Khufu (18), Maya (9), *30 more...* **built** the Great **Pyramid**

Imhotep (8), Pharaoh Zoser (4), Egyptians (2), King Djoser (2) **built** the Step **Pyramid**

two symbols of life (4), 6th dynasty kings (3), King Sneferu (3), Snefru (3) **built** two large **Pyramids**

Egyptians (8) **built** the Great **Pyramids**

ancient Egyptians (6) **built** more than 90 royal **pyramids**

colonial silver city of Taxco (3), Explore (2) **built** the gigantic **pyramids** of the Sun

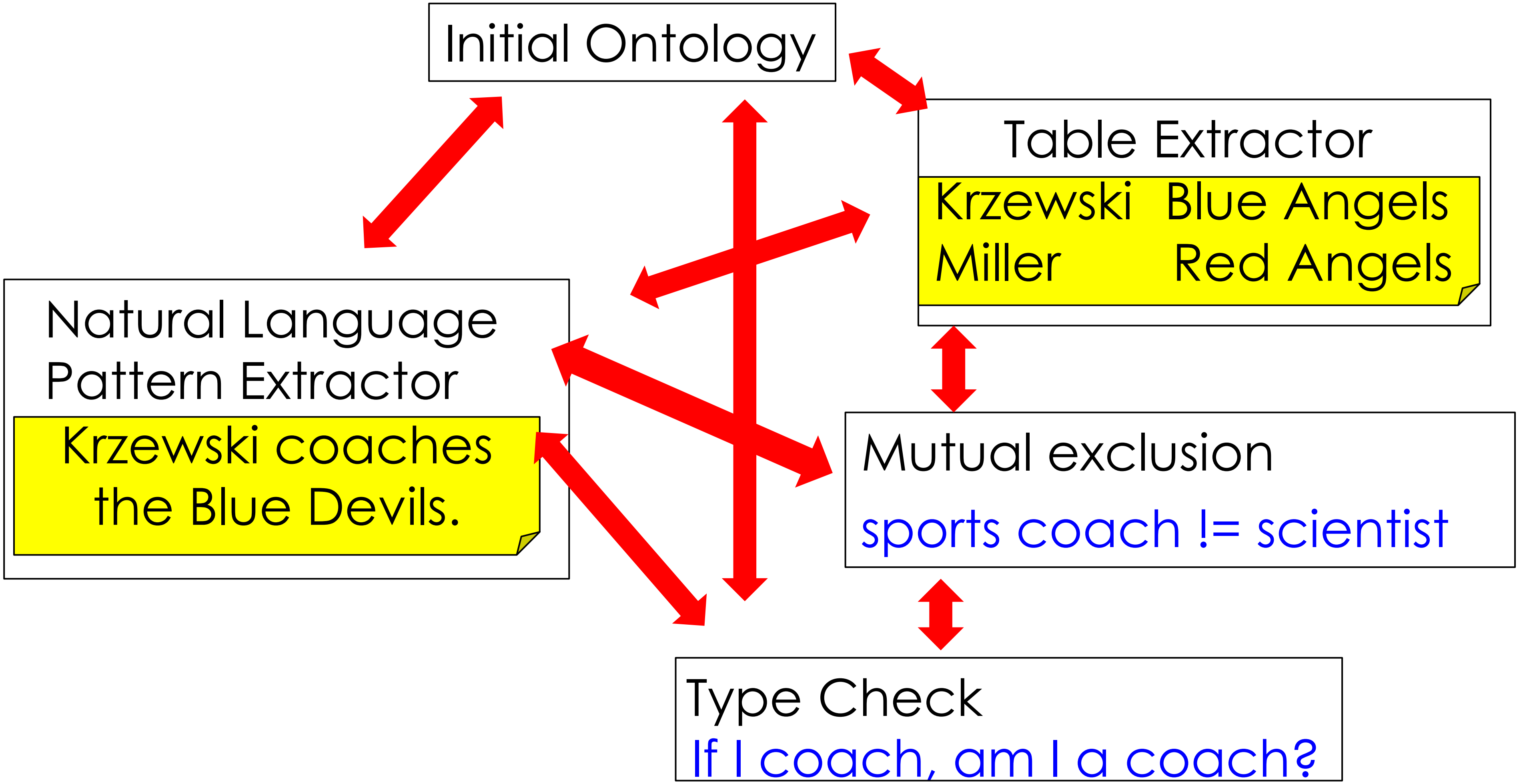
Central America (2), part of Mexico (2) **built** great cities , temples and **pyramids**

http://www.cs.washington.edu/research/textrunner/

Slide from Suchanek

Read the Web

“Read the Web” is a project at the
Carnegie Mellon University in Pittsburgh, PA.



Initial Ontology

Table Extractor

Krzewski	Blue Angels
Miller	Red Angels

Natural Language
Pattern Extractor

Krzewski coaches
the Blue Devils.

Mutual exclusion

sports coach != scientist

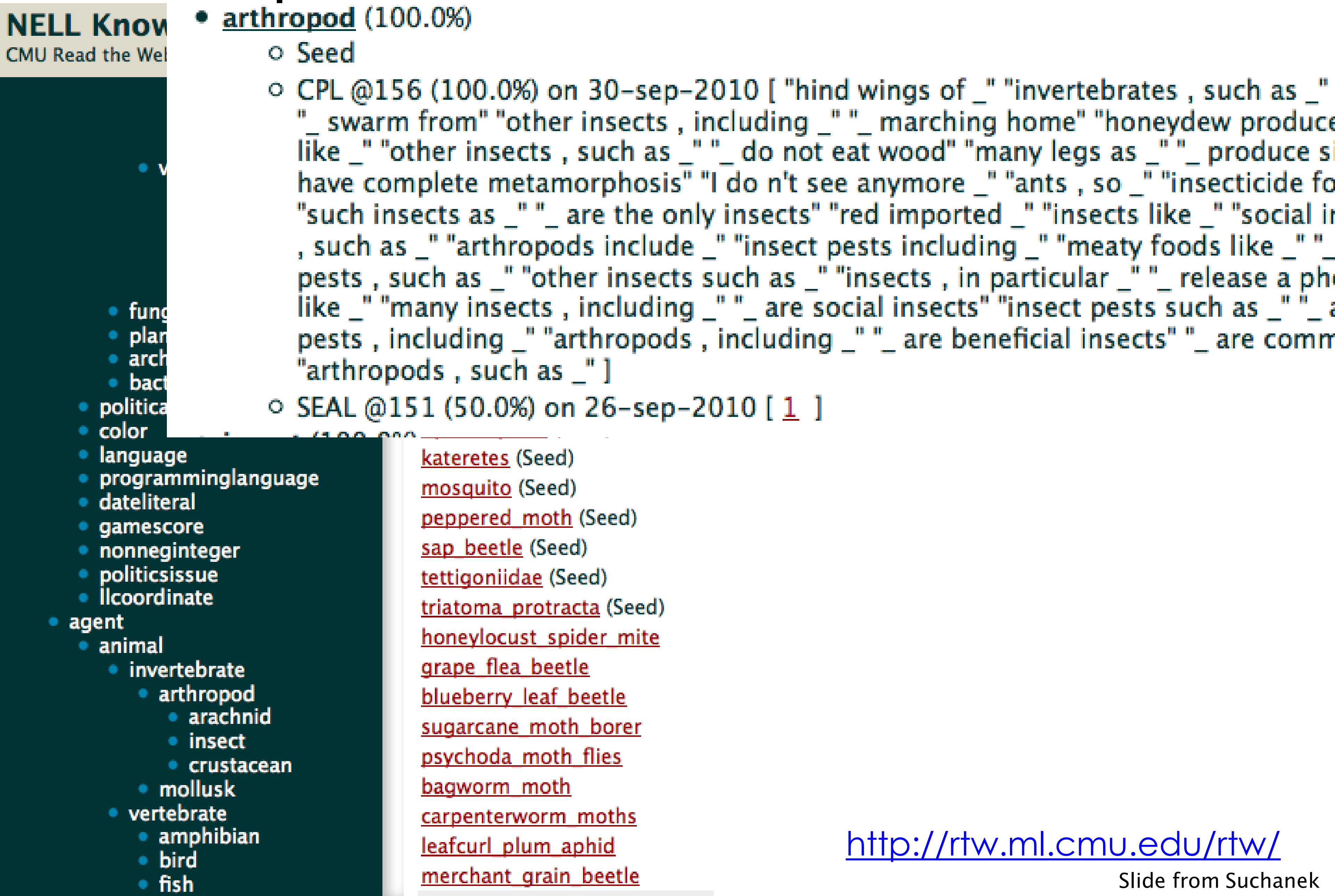
Type Check

If I coach, am I a coach?

http://rtw.ml.cmu.edu/rtw/

Slide from Suchanek

Open IE: Read the Web



NELL Know
CMU Read the Wel

- arthropod (100.0%)
  - Seed
  - CPL @156 (100.0%) on 30-sep-2010 ["hind wings of _" "invertebrates , such as _" "_ swarm from" "other insects , including _" "_ marching home" "honeydew produce like _" "other insects , such as _" "_ do not eat wood" "many legs as _" "_ produce si have complete metamorphosis" "I do n't see anymore _" "ants , so _" "insecticide fo "such insects as _" "_ are the only insects" "red imported _" "insects like _" "social i , such as _" "arthropods include _" "insect pests including _" "meaty foods like _" "_ pests , such as _" "other insects such as _" "insects , in particular _" "_ release a ph like _" "many insects , including _" "_ are social insects" "insect pests such as _" "_ a pests , including _" "arthropods , including _" "_ are beneficial insects" "_ are comm "arthropods , such as _"]
  - SEAL @151 (50.0%) on 26-sep-2010 [1]

- v
    - fung
    - plar
    - arch
    - bact
  - politica
  - color
  - language
  - programminglanguage
  - dateliteral
  - gamescore
  - nonneginteger
  - politicsissue
  - llcoordinate
- agent
  - animal
    - invertebrate
      - arthropod
        - arachnid
        - insect
        - crustacean
      - mollusk
    - vertebrate
      - amphibian
      - bird
      - fish

kateretes (Seed)
mosquito (Seed)
peppered_moth (Seed)
sap_beetle (Seed)
tettigoniidae (Seed)
triatoma_protracta (Seed)
honeylocust_spider_mite
grape_flea_beetle
blueberry_leaf_beetle
sugarcane_moth_borer
psychoda_moth_flies
bagworm_moth
carpenterworm_moths
leafcurl_plum_aphid
merchant_grain_beetle

http://rtw.ml.cmu.edu/rtw/

Slide from Suchanek

Open Information Extraction

Open Information Extraction/Machine Reading aims at information extraction from the entire Web.

Main hot projects

- TextRunner (University of Washington)
- Read the Web (Carnegie Mellon)
- Prospera/SOFIE (Max-Planck Informatics Saarbrücken)

Input

- The Web
- Read the Web: Manual rules
- Read the Web: initial ontology

Conditions

- none

Slide modified from Suchanek

- Slide sources
  - Many of the slides today on Ontological IE and Open IE are from Fabian Suchanek (Télécom ParisTech)
  - See the web page I mentioned for a list of semantic role labelers
  - Some of the Wikification slides are from Dan Roth's tutorial, this is highly recommended

- Thank you for your attention!