

# **Part III**

# **Semantic Search**

# Semantic search

- What is “semantic” search?
  - understanding intent, contextual meaning
  - finding actual answers for information needs
  - combining text and structure
- “Entity-centric search”

# Named Entities in Queries

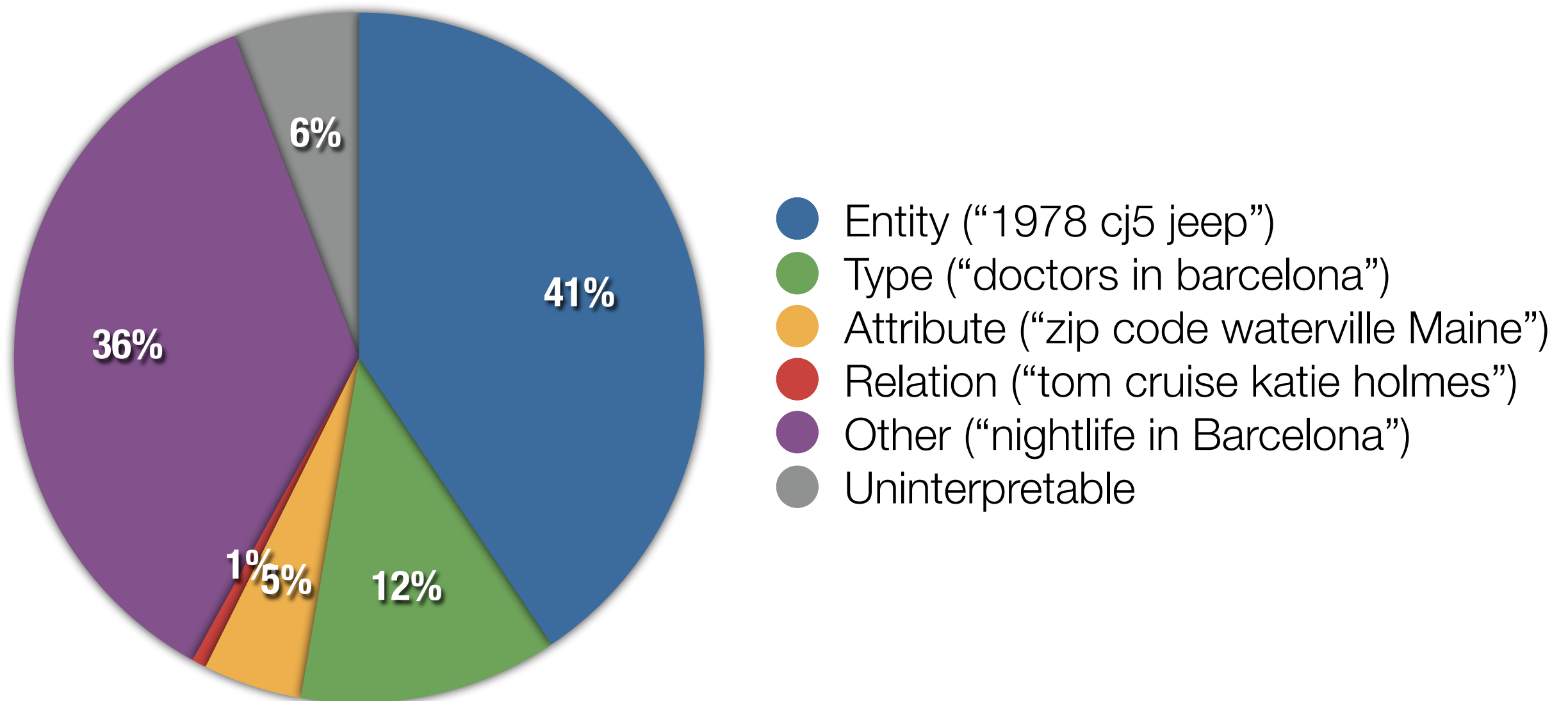
[Guo et al. 2009]

- Entities in 71 % of queries
- Context per type:

Movie	Game	Book	Music
# movie	# games	# summary	# lyrics
# photos	# cheats	# book	# video
# soundtrack	lego #	# review	# song
# pics	# download	# star	lyrics #
# movies	# wallpaper	# synopsis	lyrics to #

# Distribution of web search queries

[Pound et al. 2010]



# Semantic search

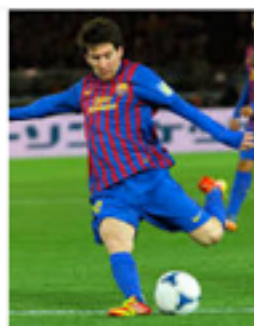
- First step: recognize, label, and disambiguate entities in queries
  - add: attributes/aspects
  - add: types
  - add: relationships
  - add: actions/verbs
  - etc.
- Then: query understanding
  - what is the intent?
  - currently: mostly template-based [\[Agarwal et al. 2010\]](#)

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About 5,170,000 results (0.49 seconds)

16 million EUR (2013)

Lionel Messi, Salary



Cristiano  
Ronaldo  
21M EUR



Neymar  
7M EUR



Gareth Bale  
15.6M GBP

Feedback

[Lionel Messi - Forbes](#)

[www.forbes.com/profile/lionel-messi/](http://www.forbes.com/profile/lionel-messi/) Forbes

Lionel Messi on Forbes - #39 Celebrity 100, #10 The World's Highest-Paid Athletes. ...  
How many millionaire earners does your state have? [...] more>>.

[David Letterman - Adam Sandler - Back](#)

[Lionel Messi Net Worth | Celebrity Net Worth](#)

[www.celebritynetworth.com](http://www.celebritynetworth.com) Richest Athletes Footballers

How much is Lionel Messi worth? \$115 Million ... Messi makes additional millions every year from endorsements. ... How much money does Lionel Messi have?

[Lionel Messi tops the football rich list | Mail Online - Daily Mail](#)

[www.dailymail.co.uk/.../Lionel-Messi-tops-football-rich-list.ht...](http://www.dailymail.co.uk/.../Lionel-Messi-tops-football-rich-list.ht...) Daily Mail

Mar 20, 2012 - Lionel Messi can add the accolade of the world's best paid footballer



How many seats at Camp Nou



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About 141,000 results (0.52 seconds)

98,787

Camp Nou, Capacity



Santiago  
Bernabéu  
Stadium  
85,454



Old Trafford  
75,811



Wembley  
Stadium  
90,000

Feedback

### Camp Nou

[www.fcbarcelona.com/camp-nou](http://www.fcbarcelona.com/camp-nou) ▾ Translate this page

4.6 ★★★★★ 487 Google reviews · Write a review



Carrer d'Aristides Maillol, 12, 08028 Barcelona, Spain  
+34 902 18 99 00

### Camp Nou - Wikipedia, the free encyclopedia

[en.wikipedia.org/wiki/Camp\\_Nou](https://en.wikipedia.org/wiki/Camp_Nou) ▾ Wikipedia ▾

The **Camp Nou seats** 99,786, reduced to 96,336 in matches organized by UEFA, making it the largest stadium in Europe and the 11th largest in the world in ...

[History](#) - [Future](#) - [Other uses](#) - [Transport connections](#)



How tall was Abraham Lincoln



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About 3,150,000 results (0.36 seconds)

6' 4" (1.93 m)

Abraham Lincoln, Height



George Washington  
6' 3"



Daniel Day-Lewis  
6' 2"



Barack Obama  
6' 1"

Feedback

[Abraham Lincoln - Wikipedia, the free encyclopedia](#)

[en.wikipedia.org/wiki/Abraham\\_Lincoln](https://en.wikipedia.org/wiki/Abraham_Lincoln) - Wikipedia

For other uses, see **Abraham Lincoln** (disambiguation). Page semi- ..... At 6 feet 4 inches (193 cm), he was tall and "strong enough to intimidate any rival". At his ...

Sexuality - William Wallace Lincoln - Assassination of Abraham - Daguerreotype

[Sexuality of Abraham Lincoln - Wikipedia, the free encyclopedia](#)

[en.wikipedia.org/wiki/Sexuality\\_of\\_Abraham\\_Lincoln](https://en.wikipedia.org/wiki/Sexuality_of_Abraham_Lincoln) - Wikipedia

The sexuality of **Abraham Lincoln** (1809–1865), the 16th President of the United ... The "Tall Sucker" was a very strange man, one of the strangest in American ...

Historical scholarship and debate - Co-sleeping - Relationship with Joshua Speed

[Heights of presidents and presidential candidates of the United States](#)

[en.wikipedia.org/wiki/Heights\\_of\\_presidents\\_and\\_presidential\\_candidates\\_of\\_the\\_United\\_States](https://en.wikipedia.org/wiki/Heights_of_presidents_and_presidential_candidates_of_the_United_States)





How tall is Abraham Lincoln



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About 7,280,000 results (0.60 seconds)

6' 4" (1.93 m)

Abraham Lincoln, Height



George Washington  
6' 3"



Daniel Day-Lewis  
6' 2"



Barack Obama  
6' 1"

Feedback

[Abraham Lincoln - Wikipedia, the free encyclopedia](#)

[en.wikipedia.org/wiki/Abraham\\_Lincoln](#) - Wikipedia

**Abraham Lincoln** was born February 12, 1809, the second child of Thomas Lincoln and Nancy Lincoln (née Hanks), in a one-room log cabin on the Sinking ...

[Sexuality](#) - [William Wallace Lincoln](#) - [Assassination of Abraham](#) - [Daguerreotype](#)

[Heights of presidents and presidential candidates of the United States](#)

[en.wikipedia.org/.../Heights\\_of\\_presidents\\_and\\_presidential\\_c...](#) - Wikipedia

Presidents, like the U.S. population, have grown taller over time. A record ... **Abraham Lincoln** tied Lyndon B. Johnson as the tallest president at 6 ft 4 in (193 cm).

[US Presidents by height order](#) - [Electoral success as a ...](#)

[Sexuality of Abraham Lincoln - Wikipedia, the free encyclopedia](#)

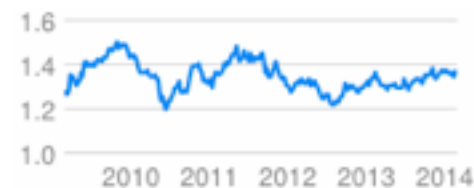
[en.wikipedia.org/wiki/Sexuality\\_of\\_Abraham\\_Lincoln](#) - Wikipedia

About 101,000,000 results (0.35 seconds)

1 Euro equals

1.37 US Dollar

1	Euro
1.37	US Dollar



### Disclaimer

[Currency Calculator \(Euro, US Dollar\) - X-Rates](#)

[www.x-rates.com/calculator/](http://www.x-rates.com/calculator/) ▼

This Free Currency Exchange Rates Calculator helps you convert any amount from one currency to another.

[Graphs](#) - [Rates Table](#) - [US Dollar](#), [Euro](#) - [British Pound](#), [US Dollar](#)

[Convert Euros \(EUR\) and United States Dollars \(USD\): Currency ...](#)

[coinmill.com/EUR\\_USD.html](http://coinmill.com/EUR_USD.html) ▼

Use "Swap currencies" to make United States Dollar the default currency. Click on United States Dollars or Euros to convert between that currency and all other ...

[XE Currency Converter - Live Rates](#)

[www.xe.com/currencyconverter/](http://www.xe.com/currencyconverter/) ▼ XE.com ▼

AUD - Australian Dollar, CAD - Canadian Dollar, CHF - Swiss Franc, CNY ... EUR - Euro, GBP - British Pound, HKD - Hong Kong Dollar, HUF - Hungarian Forint ...

# Query understanding

- Rule-based approaches (editorial)
  - high precision
  - difficult to generalize
  - costly to create/maintain
- Research into more generic approaches is ongoing, e.g., ...

# Query understanding

- Approaches
  - Structured annotation of web queries  
**[Sarkas et al. 2010]**
  - Interpreting keyword queries over KBs  
**[Pound et al. 2012]**
  - Ranking for structured queries **[Elbassuoni et al. 2009]**
  - Trends
    - purely structured queries
    - keyword-augmented structured queries
    - relaxed queries
  - QALD

# Evaluation

- Do traditional metrics cover semantic search?
  - do we know the user's intent from a keyword query?
  - haven't users grown accustomed to not getting actual answers?
  - no interaction when the correct answer is shown
- Other “dimensions” of relevance
  - recency
  - interestingness
  - popularity
  - social

# **But, we have some tools now: How to go about QU?**

- Entity linking
  - assume some knowledge base/structure/graph
  - link to the entity that is mentioned in the input
    - “recognize, label, and disambiguate”
  - leverage various signals
    - titles, redirects, anchor text, ...
    - graph information
    - machine learning: clicks/editorial data

# **But, we have some tools now: How to go about QU?**

- Entity retrieval
  - retrieve the actual answer
    - single entity
    - set/list of entities
    - attribute value(s)
    - snippet
  - from the KB, the web, a vertical, ...
- In some cases, EL/ER can be one and the same...

# Let's take a step back

- Assume you want to build a “semantic” search engine
  - What would you need?
  - What would you do?
  - Which of the building blocks we have seen do we need and how do they fit together?



# **The life of a query**

# **The life of a query**

- “How tall is the eiffel tower”
  - “eiffel tower height”

# The life of a query

- “Which airlines fly the Airbus A380?”
  - “airbus a380 airlines”

# **The life of a query**

- “woody allen movies”

# The life of a query

- “Who was the oldest person in outer space?”
  - “oldest person outer space”

# The life of a query

- “jfk arrivals”

# Open challenges

- Tail entities
- (Hyper)local
- Social
- Aggregation/Summarization<sup>1</sup>
- “Provenance” ~ result explanation
- (Online) evaluation
- Freshness

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<sup>1</sup>[http://www.bing.com/blogs/site\\_blogs/b/search/archive/2014/02/21/timeline-understanding-important-event-s-in-people-s-lives.aspx](http://www.bing.com/blogs/site_blogs/b/search/archive/2014/02/21/timeline-understanding-important-event-s-in-people-s-lives.aspx)

# Wrap-up

- Introduction
- Part 1 – Entity Linking
- Part 2 – Entity Retrieval
- Part 3 – Semantic Search



# Questions?

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**Krisztian Balog** – @krisztianbalog

**Daan Odijk** – @dodijk

See <http://ejmeij.github.io/entity-linking-and-retrieval-tutorial/> for the slides, bibliography, and links.