

# CS47300: Web Information Search and Management

*Question Answering*

Prof. Chris Clifton

1 November 2017



## Web Search in 2020?

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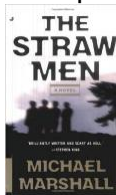
The web, it is a changing.

What will people do in the 2020s?

- Type key words into a search box?
- Use the Semantic Web / Web 2.0
  - (and what will this be?)
- Speak to your computer with natural language search?
- Use social or “human powered” search?

The common person's view? [From a novel]

"I like the Internet. Really, I do. Any time I need a piece of shareware or I want to find out the weather in Bogota ... I'm the first guy to get the modem humming. But as a source of information, it sucks. You got a billion pieces of data, struggling to be heard and seen and downloaded, and anything I want to know seems to get trampled underfoot in the crowd."



Michael Marshall. *The Straw Men*. HarperCollins,

- The name "information retrieval" is standard, but as traditionally practiced, it's not really right
- All you get is document retrieval, and beyond that the job is up to you

## The future?

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- Some scattered ideas from the corporate world  
*Courtesy Chris Manning*

## Google (2014-2015) What's been happening?

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- “Mobilegeddon” (Apr 21, 2015):
  - “Mobile friendliness” as a major ranking signal
- “Pigeon” update (July 2014):
  - More use of distance and location in ranking signals
- “App Indexing” (Android, iOS support May 2015)
  - Search results can take you to an app
- Why?
  - About half of all searches are now from mobile
  - Making/wanting good changes, but obvious self-interest in trying to keep people using mobile web rather than apps

## Google: What's been happening? 2014

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- New search index at Google: “Hummingbird”
  - <http://www.forbes.com/sites/roberthof/2013/09/26/google-just-revamped-search-to-handle-your-long-questions/>
- Answering long, “natural language” questions better
  - Partly to deal with spoken queries on mobile
- More use of the Google Knowledge Graph
  - Concepts versus words

## What's been happening

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- Google Knowledge Graph
- Facebook Graph Search
- Bing's Satori
- Things like Wolfram Alpha

Common theme: Doing graph search over structured knowledge rather than traditional text search

# PURDUE UNIVERSITY. What's been happening

- More semi-structured information embedded in web pages – schema.org



```

275 <p class="byline-column">
276   On Tennis </p>
277 <p class="byline">By <span itemprop="author creator" itemscope
itemtype="http://schema.org/Person"
itemid="http://topics.nytimes.com/top/reference/timestopics/people/c/christopher_clarey/index.html">
278   <a href="http://topics.nytimes.com/top/reference/timestopics/people/c/christopher_clarey/index.html" rel="author"
title="More Articles by CHRISTOPHER CLAREY"> <span class="byline-author" data-byline-
name="Christopher Clarey" itemprop="name">CHRISTOPHER CLAREY</span>
279   </a> </span>
280 </p>

```

# PURDUE UNIVERSITY. What's been happening

- Move to mobile favors a move to speech which favors “natural language information search”
  - Will we move to a time when over half of searches are spoken?



## **PURDUE** Towards intelligent agents UNIVERSITY.

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Two goals

- Things not strings
- Inference not search

## **PURDUE** Two paradigms for question answering UNIVERSITY.

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- Text-based approaches
  - TREC QA, IBM Watson
- Structured knowledge-based approaches
  - Apple Siri, Wolfram Alpha, Facebook Graph Search

(And, of course, there are hybrids, including some of the above.)

At the moment, structured knowledge is back in fashion, but it may or may not last

## Example from Fernando Pereira (GOOG)

Search results for "painkillers that don't thin blood":

- painkillers that don't **thin blood**
- painkillers that don't **cause constipation**
- painkillers that don't **cause nausea**
- painkillers that don't upset stomach** frequent query
- painkillers that don't

About 89,300 results (0.14 seconds) [Advanced search](#)

Search results for "painkillers that don't upset stomach":

About 29,700 results (0.15 seconds) [Advanced search](#)

**Symptoms of Crohn's** Sponsored link  
[www.crohnonline.com](http://www.crohnonline.com) Do You Know the Signs of Crohn's? Read About Symptoms and More Now.

**Best Pain Reliever, Over the Counter Pain Relievers, Prescription ...**  
For **stomach upset**, eating or drinking milk before you take a painkiller can help. ... **Don't** expect **painkillers** to relieve all your pain, but the best pain ...  
[www.healthblurbs.com/best-pain-reliever-over-the-counter-pain-relievers-prescription-analgesic-painkillers/](http://www.healthblurbs.com/best-pain-reliever-over-the-counter-pain-relievers-prescription-analgesic-painkillers/) - Cached - Similar

**Why do painkillers make your stomach hurt? - Yahoo! Answers**  
Aug 30, 2008 ... **stomach upset**, reflux/indigestion, or if severe ulcers ... I often take **painkillers** FOR **stomach** aches lol. **Don't** do this again. 2 years ago ...  
[answers.yahoo.com](http://answers.yahoo.com) > Health > Other - Health - Cached - Similar

[How are painkillers bad for you?](#) - Apr 13, 2010  
[What effect do painkillers have on you?](#) - Sep 30, 2009  
[What's the difference between OTC painkillers? \(Advil, Aleve ...\)](#) - Nov 19, 2008  
[Is it bad to take painkillers on an empty stomach ?](#) - Aug 20, 2008  
[More results from answers.yahoo.com »](#)

**Phys Ed: Does Ibuprofen Help or Hurt During Exercise? - NYTimes.com**  
Sep 1, 2009 ... When are ibuprofen and other anti-inflammatory **painkillers** justified? ... Can't take NSAIDS due to **upset stomach**. — bonemri ... Perhaps part of the problem is that you **don't** always have the option to rest your injury if ...  
[well.blogs.nytimes.com/.../phys-ed-does-ibuprofen-help-or-hurt-during-exercise/](http://well.blogs.nytimes.com/.../phys-ed-does-ibuprofen-help-or-hurt-during-exercise/) - Cached - Similar

## class negation synonyms

painkillers that don't upset stomach

X Search

About 29,700 results (0.15 seconds)

Advanced search

### Symptoms of Crohn's

[www.crohnsnline.com](http://www.crohnsnline.com)

Do You Know the Signs of Crohn's? Read About Symptoms and More Now.

Sponsored link

### Best Pain Reliever, Over the Counter Pain Relievers, Prescription ...

For **stomach upset**, eating or drinking milk before you take a painkiller can help. ... **Don't** expect **painkillers** to relieve all your pain, but the best pain ...

[www.healthblurbs.com/best-pain-reliever-over-the-counter-pain-relievers-prescription-analgesic-painkillers/](http://www.healthblurbs.com/best-pain-reliever-over-the-counter-pain-relievers-prescription-analgesic-painkillers/) - Cached - Similar

### Why do painkillers make your stomach hurt? - Yahoo! Answers

Aug 30, 2008 ... **stomach upset**, reflux/indigestion, or if severe ulcers ... I often take **painkillers** FOR **stomach** aches lol. **Don't** do this again. 2 years ago ...

[answers.yahoo.com](http://answers.yahoo.com) > Health > Other - Health - Cached - Similar

[How are painkillers bad for you?](#) - Apr 13, 2010

[What effect do painkillers have on you?](#) - Sep 30, 2009

[What's the difference between OTC painkillers? \(Advil, Aleve ...\)](#) - Nov 19, 2008

[Is it bad to take painkillers on an empty stomach?](#) - Aug 20, 2008

More results from answers.yahoo.com »

### Phys Ed: Does Ibuprofen Help or Hurt During Exercise? - NYTimes.com

Sep 1, 2009 ... When are ibuprofen and other anti-inflammatory **painkillers** justified? ... Can't take NSAIDs due to **upset stomach**. — bonemri ... Perhaps part of the problem is that you **don't** always have the option to rest your injury if ...

[well.blogs.nytimes.com/.../phys-ed-does-ibuprofen-help-or-hurt-during-exercise/](http://well.blogs.nytimes.com/.../phys-ed-does-ibuprofen-help-or-hurt-during-exercise/) - Cached - Similar

**PURDUE**  
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## Related concepts may not match question

"painkillers such as \* tylenol"

X Search

About 19,200 results (0.21 seconds)

Advanced search

### TYLENOL® Official Site

[Tylenol.com](http://Tylenol.com) Pain Relief from TYLENOL. Get Information and Coupons Here.  
Head & Body Pain - Arthritis Pain - Sinus - Cold & Flu

Sponsored link

### Ovarian hyperstimulation syndrome (OHSS): Treatments and drugs ...

To ease abdominal discomfort, take over-the-counter **painkillers** such as acetaminophen (**Tylenol**) others) or ibuprofen (Advil, Motrin, others). ...

[www.mayoclinic.com/.../DSECTION=treatments-and-drugs](http://www.mayoclinic.com/.../DSECTION=treatments-and-drugs) - Cached - Similar

tylenol ⇒ painkiller



# PURDUE Text can identify synonyms

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painkiller "adverse effects include" stomach

X Search

About 266,000 results (0.14 seconds)

Advanced search

## [Painkiller Comparison Chart](#)

Oct 31, 2008 ... Chart showing prescription and non-prescription painkillers and what they are used for. ... menstrual pain, fever, Common **adverse effects include**: nausea, ... asthma, **upset stomach**, not for last pregnancy trimester. ...

[www.disabled-world.com/.../painkiller-chart.shtml](http://www.disabled-world.com/.../painkiller-chart.shtml) - Cached - Similar

## [\[PDF\] List of Painkillers and what they are used for: Over the Counter ...](#)

File Format: PDF/Adobe Acrobat - [Quick View](#)

Common **adverse effects include**: nausea, dyspepsia, gastrointestinal u lce ration/bleed ing. ... upset **stomach**, not for last pregnancy trimester. Individuals ...

[healingwithsoftlasers.com/.../Painkiller%20side%20effects%20chart%20.pdf](http://healingwithsoftlasers.com/.../Painkiller%20side%20effects%20chart%20.pdf)

upset stomach ⇒ adverse effect (on stomach)

# PURDUE

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tylenol stomach

X Search

About 1,390,000 results (0.28 seconds)

Advanced search

## [Pain Relievers And Upset Stomach - Tylenol Extra Strength Pain ...](#)

**Tylenol** Extra Strength Pain Reliever Fever Reducer 100 Caplets - User Rating: 5 stars.

Review Summary: Taking the wrong pain reliver can cause you **stomach** ...

[www.epinions.com > Wellness & Beauty > Health Aids](http://www.epinions.com > Wellness & Beauty > Health Aids) - Cached - Similar

## [Treatment: Pain: Merck Manual Home Edition](#)

**TYLENOL** has virtually no useful anti-inflammatory activity, does not affect the blood's ability to clot, and has almost no adverse effects on the **stomach** ...

[www.merck.com/mmhe/sec06/ch078/ch078d.html](http://www.merck.com/mmhe/sec06/ch078/ch078d.html) - Cached - Similar

tylenol ⇒ no adverse effects (on stomach)  
⇒ no upset stomach

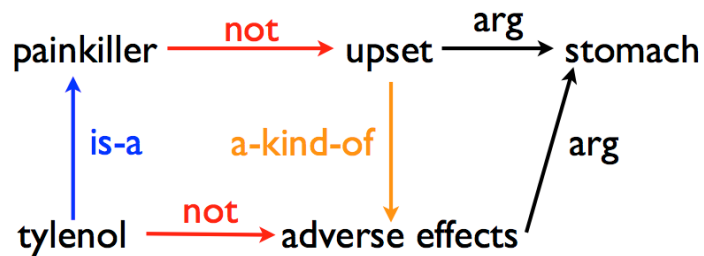
**PURDUE** UNIVERSITY. This took us from Query

painkiller

upset

stomach

**PURDUE** UNIVERSITY. To Answer



# “Things, not strings”

From	To	Requires
Term	Concept	Parsing, disambiguation, coreference
Term identity	Entailment	Concept relations
Co-occurrence	Syntactic relation	Document structure, parsing
Term index	Semantic index	Concept disambiguation, inference

**PURDUE UNIVERSITY** Slides from Patrick Pantel (MSFT)

The screenshot shows a Yahoo! search result for "Seven Samurai". Annotations include:

- Entity Detection:** Points to the search term "Seven Samurai" in the search bar.
- Structured Recommendations:** Points to the "RELATED MOVIES" section on the left, which lists "Dreams", "Ran", "Dersu Uzala", "Throne of Blood", "Yojimbo", and "Stray Dog".
- Play trailer:** Points to the "Play trailer" button below the movie poster.
- Structured Data:** Points to the structured information block for the movie, including "Running Time: 2 hr 40 min", "Directed by: Akira Kurosawa", and "Starring: Takashi Shimura, Toshiro Mifune, Yoshio Inaba, Seiji Miyaguchi, ... more".

**bing** flights to maui

Web Flights More ▾

**Flights from Seattle, WA to Maui, HI**

FROM Seattle, WA (SEA) - Seatt TO Kahului, HI (OGG) - Kahul

WEEKEND ESTIMATES

LEAVE 03/23/2012 RETURN 03/25/2012 Find flights

bing.com/travel

Price prediction

Task completion

WEEKEND ESTIMATES

- ↑ \$639 Depart March 09
- ↓ \$748 Depart March 16
- ↑ \$649 Depart March 23

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**bing** royal lahaina resort

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**Royal Lahaina Resort - Bing Travel**

2780 Kekaa Dr · Lahaina  
(808) 661-9469  
Details · Photos · Amenities · Directions · Website

★★★★★ (12)  
Sample rate: \$230

Aggregate ratings

Compare rates from major travel sites

CHECK IN 03/15/2012 CHECK OUT 03/17/2012 Find rate

bing.com/travel/hotels/search?q=royal+lahaina+resort

Task completion

**bing** mel gibson movies

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9 Sign in

**Mel Gibson - movies** All genres Popular first

The Expendables 3 (2014) ★★☆☆

Mad Max (1980) ★★☆☆

Braveheart (1995) ★★☆☆

Mad Max 2: The Road Warrior (1982) ★★☆☆

Get the Gringo (2012) ★★☆☆

Edge of Darkness (2010) ★★☆☆

The Passion of the Christ (2004) ★★☆☆

Apocalypse (2006) ★★☆☆

Mad Max Beyond Thunderd... (19) ★★☆☆

**Mel Gibson - IMDb**  
www.imdb.com/name/nm0001154  
Born: Jan 03, 1956 - 56 years old - 368 photos  
Mel Gibson, Actor: Braveheart. Mel Columicillo Gerrard Gibson was born January 3, 1956 in Posokiskil, New York, USA, as the sixth of eleven children of Hutton Gibson, a...  
Biography · Awards · Films · News

**Mel Gibson Movies | Movies.com**  
www.movies.com/actors/mel-gibson/mel-gibson-movies/p191347  
50 rows - Get the full list of all Mel Gibson movies. See who they starred with and ...  
Linda Hunt · Beth O'Leary · Watch all Home · Contact Us · Bill Kern · Mad Max

**Videos of mel gibson movies**  
bing.com/videos

1:00:37 Ransom (1996) - Full Movie YouTube

2:27 'The Beaver' Trailer YouTube

2:30 Ransom Trailer HQ (1996) YouTube


1:31 Payback Trailer YouTube

See more videos of mel gibson movies

**Mel Gibson - Wikipedia, the free encyclopedia**  
en.wikipedia.org/wiki/Mel\_Gibson  
Mel Columicillo Gerrard Gibson AO (born January 3, 1956) is an American actor and filmmaker. He is most well known as an action hero, for roles such as Martin Riggs in ...  
Early life · Career · Film work · Prospective films · Personal life

**Mel Gibson filmography - Wikipedia, the free encyclopedia**

**Mel Gibson**  
American Actor

 Mel Columicillo Gerrard Gibson AO is an American actor and filmmaker. He is most well known as an action hero, for roles such as Martin Riggs in the Lethal Weapon buddy cop film series and Max Rockatansky in the first three films in the ...

W IMDb Facebook

Born: Jan 03, 1956 (age 59) · Poetskill

Height: 5' 10" (1.77 m)

Romance: Oksana Grigorieva · Oksana Pochepa

Spouse: Robyn Moore Gibson (1980 - 2011)

Children: Hannah Gibson (Daughter) · Christian Gibson (Son) · Edward Gibson (Son) · Louis Gibson (Son) · William Gibson (Son) +

Upcoming movies: Hackshaw Ridge

**People also search for** See all (10+)

Oksana Grigorieva · Sylvester Stallone · Harrison Ford · Arnold Schwarzenegger · Robert Downey Jr.

Google How old is mariah carey

Web Images News Shopping Videos More Search tools

About 102,000,000 results (0.55 seconds)

**45 years (March 27, 1970)**  
Mariah Carey, Age

Direct Answer

**Mariah Carey** Structured Data

Singer-songwriter

Listen now

Google Play Listen with free trial

Spotify Listen for free


Mariah Carey is an American singer, songwriter, record producer, and occasional actress. She rose to prominence after releasing her self-titled debut studio album Mariah Carey in 1990; it went multiplatinum ...  
Wikipedia

**Born:** March 27, 1970 (age 45), Huntington, NY  
**Height:** 5' 9" (1.75 m)  
**Children:** Moroccan Scott Cannon, Monroe Cannon  
**Spouse:** Nick Cannon (m. 2008), Tommy Motola (m. 1993–1998)

**Songs**

Without You	1993	Music Box
Hero	1993	Music Box
I Want to Know Wh...	2009	Memoirs of an I...
I'll Be There	1990	Mariah Carey
We Belong Together	2005	The Emancipatio...

**Albums** View 20+ more



**Mariah Carey - Wikipedia, the free encyclopedia**  
en.wikipedia.org/wiki/Mariah\_Carey - Wikipedia -  
Mariah Carey was born on March 27, 1969 or 1970 in Huntington, New York. Her father, Alfred Roy, was of African American and Venezuelan (including Afro-Venezuelan) descent, while her mother, Patricia (Hickey), is of White Irish descent.  
Nick Cannon - Tommy Motola - Albums - Me, I Am Mariah... The Elusive ...

**Nick Cannon & Mariah Carey Fighting: Split Caused By ...**  
hollywoodlife.com/.../nick-cannon-mariah-carey-fightin... - Hollywood Life -  
Aug 22, 2014 - Nick Cannon and Mariah Carey announced their separation after six years of marriage, and now HollywoodLife.com has learned EXCLUSIVELY what caused the power couple to split up. Nick Cannon, 33, and Mariah Carey, 44, have separated after six years of marriage, and two beautiful children together.

**Mariah Carey - Biography - Music Producer, Film Actress ...**  
www.biography.com/people/mariah-carey-9542177 - FYI -  
Mariah Carey was born March 27, 1970, in Huntington, Long Island, New York, and began taking voice lessons at age four. At 18 she signed with Columbia ...

**Mariah Carey Divorce Explained: Nick Cannon Cheating ...**  
www.celebritylounge.com/.../mariah-carey-divorce-nick-cannon-cheat... -  
Aug 29, 2014 - Mariah Carey Divorce Explained: Nick Cannon Cheating and Paying For 23-Year Old Mistress Jasmine Sanders and Dancer Brittany Dailey.

**PURDUE UNIVERSITY** Query Answering

Google how old is christopher manning

Web News Shopping Images Videos More Search tools

About 11,000,000 results (0.54 seconds)

**48 years (September 18, 1965)**  
Christopher D. Manning, Age

Feedback

**Christopher Manning, Stanford NLP - The Stanford NLP**  
nlp.stanford.edu/manning/ -  
Mar 1, 2013 - **Chris Manning** works on systems and formalisms that can intelligently process and produce human languages. His research concentrates on ...

**Rocchio algorithm - Wikipedia, the free encyclopedia**  
en.wikipedia.org/wiki/Rocchio\_algorithm - Wikipedia -  
From Wikipedia, the free encyclopedia .... **Christopher D. Manning**, Prabhakar Raghavan, Hinrich Schütze: An Introduction to Information Retrieval, page 181.  
Algorithm - Time complexity - Usage - Limitations

A screenshot of a Google search page. The search bar contains the text "how old is Pandu Nayak". The search results show approximately 1,440,000 results in 0.42 seconds. The top results include:

- Pandu Nayak** with a link to [www.pandunayak.com/](http://www.pandunayak.com/). The snippet reads: "About me. I am currently at Google, working on various aspects of Search Quality. I am particularly interested in query understanding and helping users ..."
- Pandu Nayak | LinkedIn** with a link to [www.linkedin.com/pub/pandu-nayak/1/ab7/b20](http://www.linkedin.com/pub/pandu-nayak/1/ab7/b20). The snippet reads: "Houston, Texas Area - Engineering Manager, Product Management at FMC Technologies. As a LinkedIn member, you'll join 250 million other professionals who are sharing connections, ideas, and opportunities. See who you and Pandu Nayak know ..."
- PANDU NAYAK profiles | LinkedIn** with a link to [www.linkedin.com/pub/dir/PANDU/NAYAK](http://www.linkedin.com/pub/dir/PANDU/NAYAK). The snippet reads: "View the profiles of professionals named PANDU NAYAK on LinkedIn. There are 5 professionals named PANDU NAYAK, who use LinkedIn to exchange ..."

A screenshot of a Bing search page. The search bar contains the text "jetbeam rrt-0". The search results show 1-10 of 6,600 results. The top results include:

- JETBeam RRT-0 R5 with Infinite Ramping LED Flashlight ...** with a link to [www.goinggear.com/index.php?main\\_page=product\\_info&CPath=14\\_22&products\\_id=438](http://www.goinggear.com/index.php?main_page=product_info&CPath=14_22&products_id=438). The snippet reads: "Going Gear JETBeam RRT-0 R5 with Infinite Ramping LED Flashlight [jetbeamrt0r5] - The popular RRT-0 has been updated to be an even more versatile flashlight, ..."
- Jetbeam RRT-0** with a link to [www.jetbeamusa.com/products/RR1%2d0.html](http://www.jetbeamusa.com/products/RR1%2d0.html). The snippet reads: "New In Stock! Model: RRT-0 (S2) Specially designed for Military, Law Enforcement, Self-defense, Hunting, Search & Rescue and General Outdoors The Rapid ..."
- JETBeam RRT-0 Overview With Lots of Pictures** with a link to [www.candlepowerforums.com/vb/showthread.php?248375-JETBeam-RRT-0-Overview-With-Lots-of-](http://www.candlepowerforums.com/vb/showthread.php?248375-JETBeam-RRT-0-Overview-With-Lots-of-). The snippet reads: "I got my JETBeam RRT-0 Raptor today. All I can say is to JETBeam! This thing is a ... PICTURES QUICKLY... BEFORE MY HEAD EXPLODES!!! Ok... it didnt ... 323 replies since November 2009"
- JETBeam Flashlights** with a link to [jetbeamblog.com](http://jetbeamblog.com). The snippet reads: "Specification: Model: JETBeam RRT-0(R2) Flashlight; Specially designed for Military, Law Enforcement, Self-defense, Hunting, Search & Rescue and Outdoorsman"



# Desired experience: Towards actions

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bing MS Beta

jetbeam rrt-0

Web Videos More

ENTITY

ALL RESULTS 1-10 of 6,600 results - [Advanced](#)

**JETBeam RRT-0 R5 with Infinite Ramping LED Flashlight** ...  
Going Gear JETBeam RRT-0 R5 with infinite Ramping LED Flashlight [jetbeamrt0r5] - The popular RRT-0 has been updated to be an even more versatile flashlight, ...  
goinggear.com/index.php?main\_page=product\_info&cPath=14\_22&products\_id=438 - Mark as spam

**Jetbeam RRT-0**  
Now In Stock! Model: RRT-0 (S2) Specially designed for Military, Law Enforcement, Search & Rescue and General Outdoors The Rapid ...  
Amazon.com products/RR1%200.html - Mark as spam

**Jetbeam RRT-0**  
review With Lots of Pictures  
FlashlightReviews.com I Raptor today. All I can say is to JETBeam! This thing is more ...  
323 replies since November 2009  
www.candlepowerforums.com/tb/showthread.php?246375-JETBeam-RRT-0-Overview-With-Lots-of... - Mark as spam

RELATED SEARCHES

**JETBeam Flashlights**  
Specification: Model: JETBeam RRT-0(R2) Flashlight; Specially designed for Military, Law Enforcement, Self-defense, Hunting, Search & Rescue and Outdoorsman  
jetbeamblog.com - Mark as spam

Actions easily accessible

Recognize entity in query

- Read Reviews
- Watch Demo Video
- Product Comparisons
- Social Discouants
- Find Locally
- Buy Online
- Price Predictions

# Politician

Web Images Videos Shopping News Maps More | MSN Hotmail

bing MS Beta

Obama

Web Visual Search News Images Videos More

ENTITY

ALL RESULTS 1-10 of 511,000 results - [Advanced](#)

**Official Obama Website** Ad  
www.BarackObama.com - Respect. Empower. Include. Win. Join Barack Obama's campaign now.  
Other ideas: obama barack bio - president obama website

**Obama for America | 2012**  
Barackobama.com is the official re-election campaign website of President Barack Obama. Visit the site for the latest updates from the Obama campaign, 2012 election news ...  
www.barackobama.com - Mark as spam  
Ronjojoy Chakrabarti and Caroline Mackey like Barack Obama

**Barack Obama**  
(President)

ACTIONS

**Watch Weekly Address**

**Follow Social Updates**

- Facebook
- Twitter
- LinkedIn
- MySpace

**Read Biography**

**View Approval Ratings**

**Support Candidacy**

RELATED SEARCHES

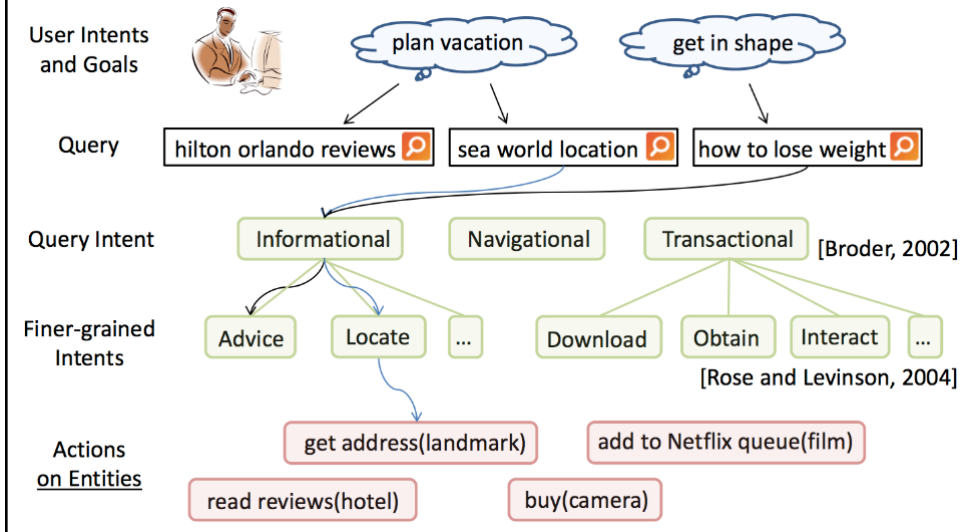
**Barack Obama - Wikipedia, the free encyclopedia**  
career - Legislative career ... - Presidential campaigns  
in Obama II (born August 4, 1961) is the 44th and current President of the United States. He is the first African American to hold the office. Obama ...  
en:Wikipedia/Obama - Mark as spam

**Barack Obama and other U.S. politicians by office, state, and branch of government**

Actions easily accessible

Recognize entity in query

# Actions vs. Intents



# Learning actions from web usage logs

- Three months of us-en web logs
- Annotate with Freebase entities
- Keep queries with an entity in set of 21 types
- Filter out navigational queries
- Filter out clicked hosts that weren't clicked at least 100 times

2,164,579 (query, host) pairs over 3 months	235,385 entities	21 types
	129,088 contexts	58,123 hosts

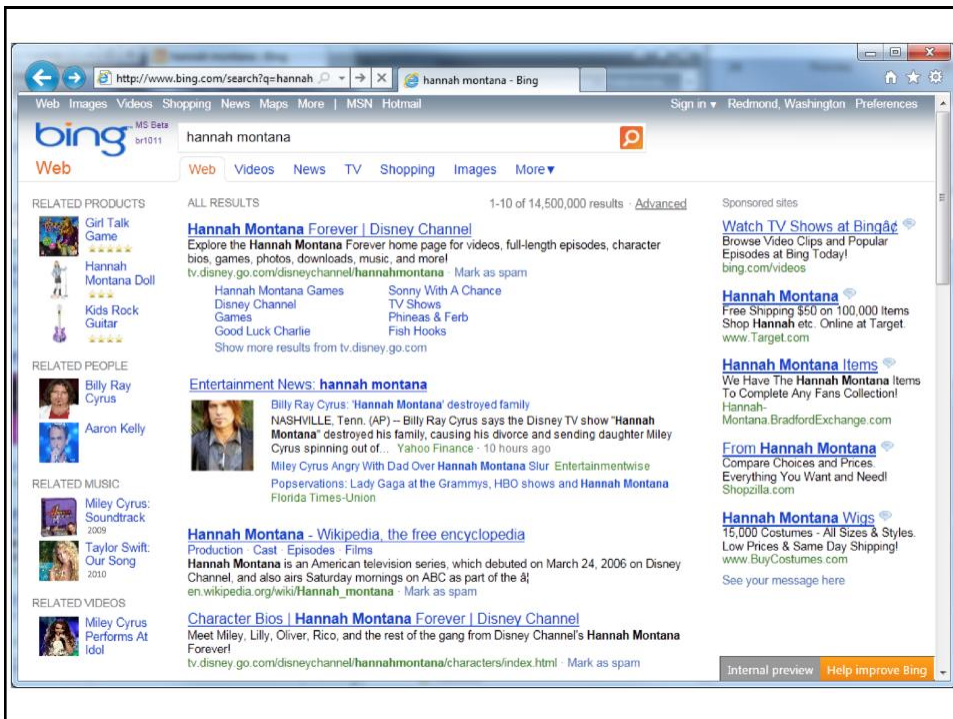
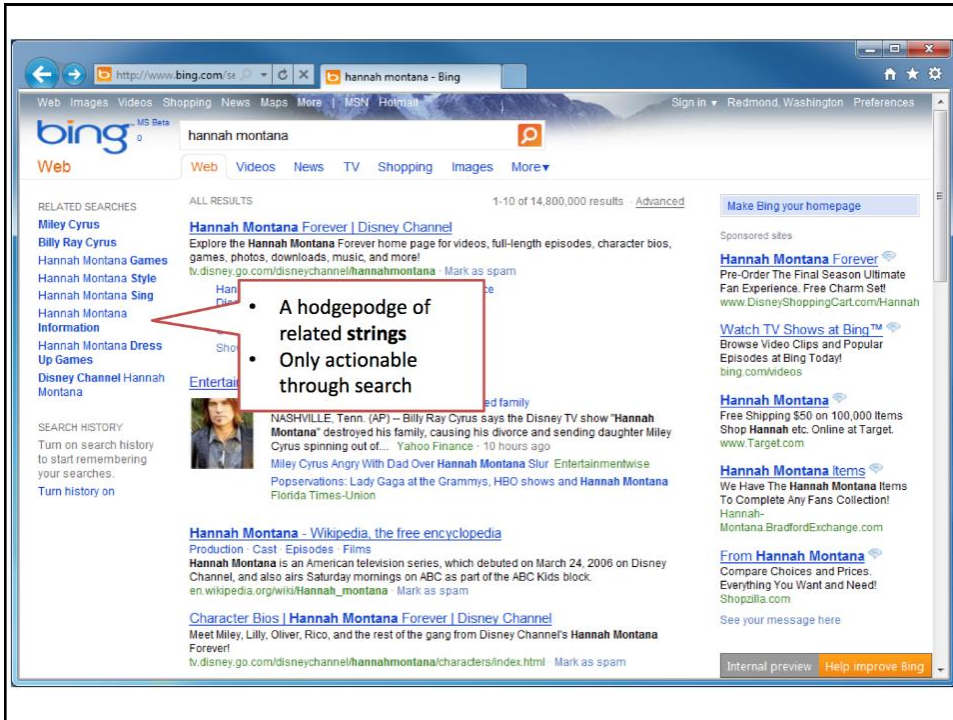
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http://www.bing.com/search?q=hannah montana - Bing

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bing Web

RELATED PRODUCTS

- Girl Talk Game
- Hannah Montana Doll
- Kids Rock Guitar

RELATED PEOPLE

- Billy Ray Cyrus
- Aaron Kelly

RELATED MUSIC

- Miley Cyrus Soundtrack
- Taylor Swift Our Song

RELATED VIDEOS

- Miley Cyrus Performs At Idol

ALL RESULTS

**Hannah Montana Forever | Disney Channel**  
 bios, games, photos, downloads, music, and more!  
 tv.disney.go.com/disneychannel/hannahmontana - Mark as spam

**Entertainment Weekly: Hannah Montana**  
 Billy Ray Cyrus: 'Hannah Montana' destroyed his family, causing his divorce and sending daughter Miley Cyrus spinning out of... Yahoo Finance - 10 hours ago

**Miley Cyrus Angry With Dad Over Hannah Montana Slur** Entertainmentwise  
 Popservations: Lady Gaga at the Grammys, HBO shows and Hannah Montana Florida Times-Union

**Hannah Montana - Wikipedia, the free encyclopedia**  
 Production Cast Episodes Films  
**Hannah Montana** is an American television series, which debuted on March 24, 2006 on Disney Channel, and also airs Saturday mornings on ABC as part of the *ã*  
 en.wikipedia.org/wiki/Hannah\_montana - Mark as spam

**Character Bios | Hannah Montana Forever | Disney Channel**  
 Meet Miley, Lilly, Oliver, Rico, and the rest of the gang from Disney Channel's Hannah Montana Forever!  
 tv.disney.go.com/disneychannel/hannahmontana/characters/index.html - Mark as spam

Internal preview Help improve Bing

**Big Wins**

- Typed relations
- User Interface accesses structured data
- Click through experience can now leverage strongly-typed identifier

http://www.bing.com/search?q=hannah montana - Bing

Web Images Videos Shopping News Maps More | MSN Hotmail Sign in Redmond, Washington Preferences

bing Web

RELATED PRODUCTS

- Girl Talk Game
- Hannah Montana Doll
- Kids Rock Guitar

RELATED PEOPLE

- Billy Ray Cyrus
- Aaron Kelly

RELATED MUSIC

- Miley Cyrus Soundtrack
- Taylor Swift Our Song

RELATED VIDEOS

- Miley Cyrus Performs At Idol

ALL RESULTS

**Hannah Montana Forever | Disney Channel**  
 bios, games, photos, downloads, music, and more!  
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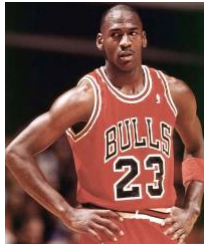
Internal preview Help improve Bing

**Big Wins**

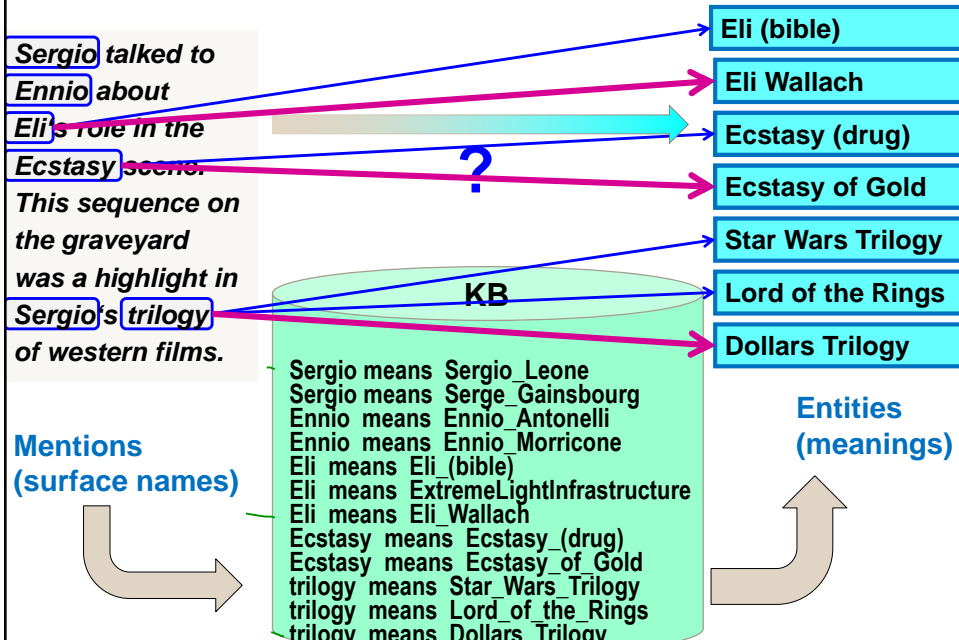
- Typed relations
- User Interface accesses structured data
- Click through experience can now leverage strongly-typed identifier
- Brokered Actions (one click conversions)

# Entity disambiguation and linking

- Key requirement is that entities get identified
  - Named entity recognition (e.g., Stanford NER!)
- and disambiguated
  - Entity linking (or sometimes “Wikification”)
    - e.g., Michael Jordan the basketballer or the ML guy



## Mentions, Meanings, Mappings



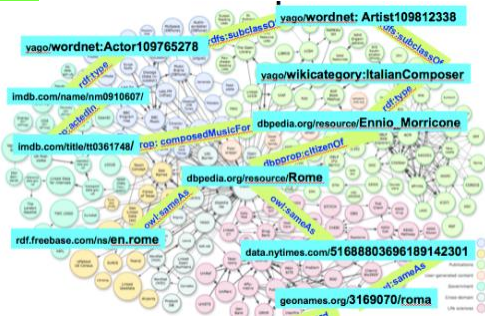
# PURDUE UNIVERSITY. Incorporate structured info?

- and linked to a canonical reference
  - Freebase, dbPedia, Yago2, (WordNet)

[http://.../wiki/Dollars\\_Triology](http://.../wiki/Dollars_Triology)  
[http://.../wiki/The\\_Good,\\_the\\_Bad,\\_and\\_Beautiful](http://.../wiki/The_Good,_the_Bad,_and_Beautiful)  
[http://.../wiki/Clint\\_Eastwood](http://.../wiki/Clint_Eastwood)  
[http://.../wiki/Honorary\\_Academy\\_of\\_Arts\\_and\\_Letters](http://.../wiki/Honorary_Academy_of_Arts_and_Letters)

[http://.../wiki/The\\_Good,\\_the\\_Bad,\\_and\\_Beautiful](http://.../wiki/The_Good,_the_Bad,_and_Beautiful)  
<http://.../wiki/Metallica>  
[http://.../wiki/Bellagio\\_\(casino\)](http://.../wiki/Bellagio_(casino))  
[http://.../wiki/Ennio\\_Morricone](http://.../wiki/Ennio_Morricone)

[http://.../wiki/Sergio\\_Leone](http://.../wiki/Sergio_Leone)  
[http://.../wiki/The\\_Good,\\_the\\_Bad,\\_and\\_Beautiful](http://.../wiki/The_Good,_the_Bad,_and_Beautiful)  
[http://.../wiki/For\\_a\\_Few\\_Dollars\\_You\\_Get\\_to\\_Walk\\_away](http://.../wiki/For_a_Few_Dollars_You_Get_to_Walk_away)  
[http://.../wiki/Ennio\\_Morricone](http://.../wiki/Ennio_Morricone)



# PURDUE UNIVERSITY. Facebook Graph Search

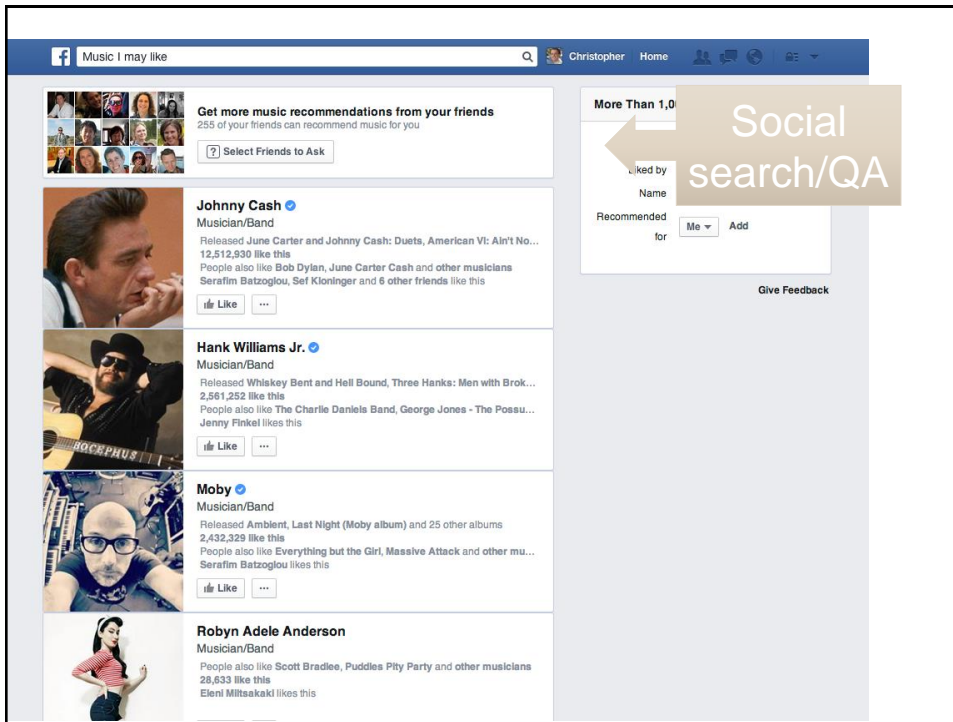
Search for people, places and things

- My friends
- Photos of my friends
- Restaurants nearby
- Games my friends play
- Music my friends like
- Photos I have liked

places

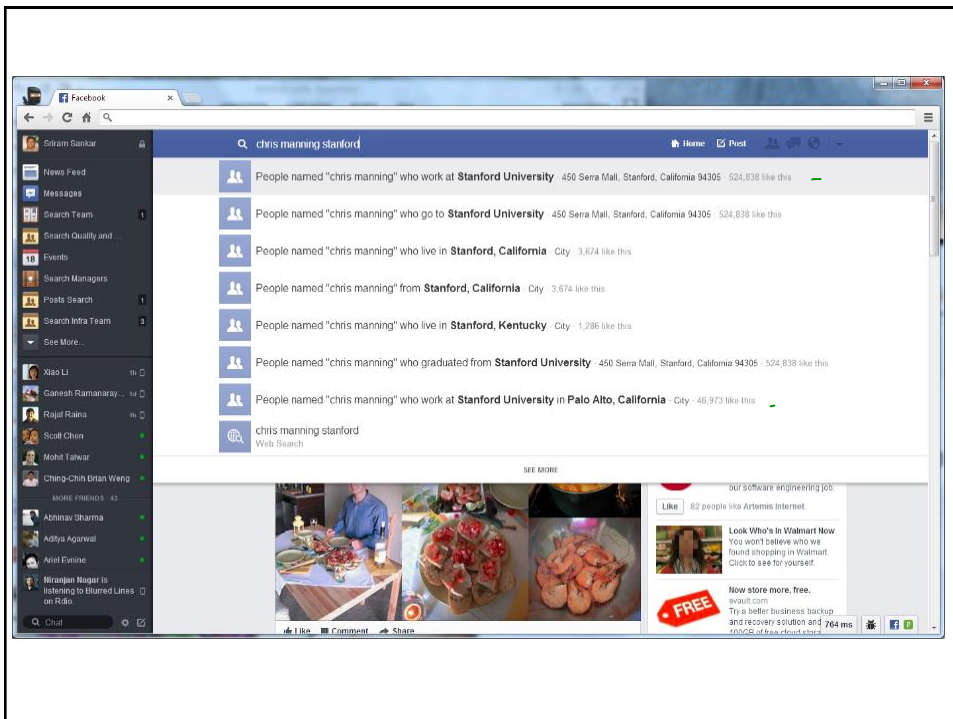
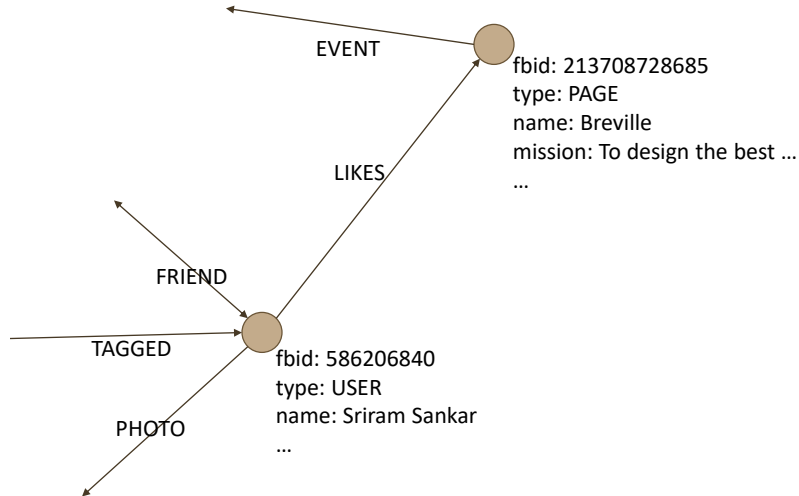
- Cities visited by my family
- Restaurants in **San Francisco, California**
- Indian restaurants liked by my friends from **India**
- Tourist attractions in **Italy** visited by my friends
- Restaurants in **New York** liked by Chefs
- Countries my friends have visited

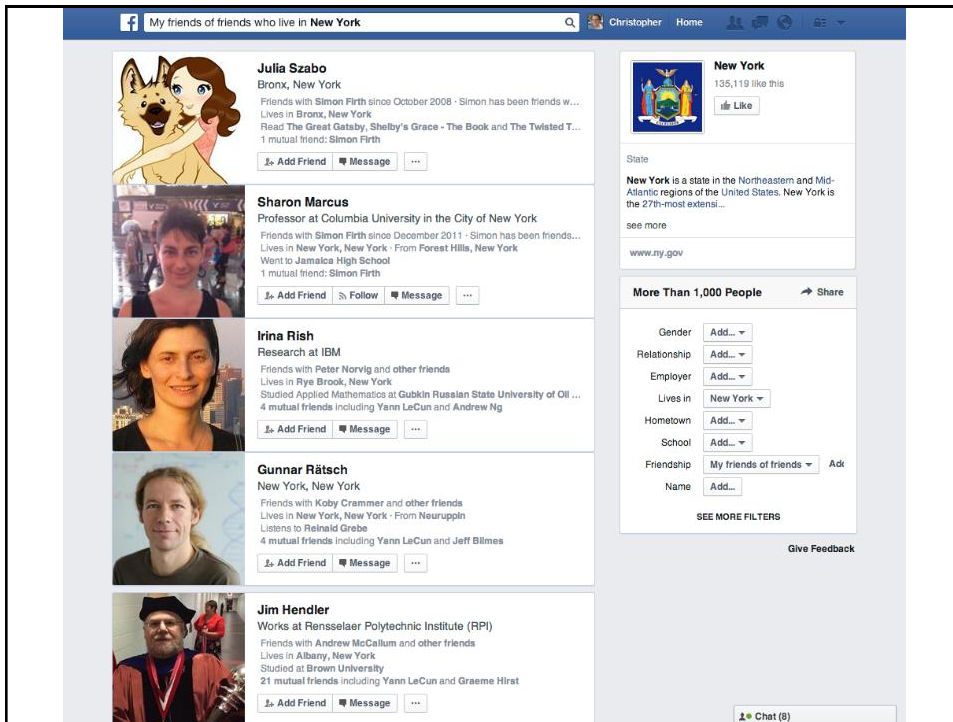




- Collection of entities and their relationships
- Entities (users, pages, photos, etc.) are *nodes*
- Relationships (friendship, checkins, tagging, etc.) are *edges*
- Nodes and edges have metadata
- Nodes have a unique id – the *fbid*

# PURDUE UNIVERSITY Facebook Graph Snippet

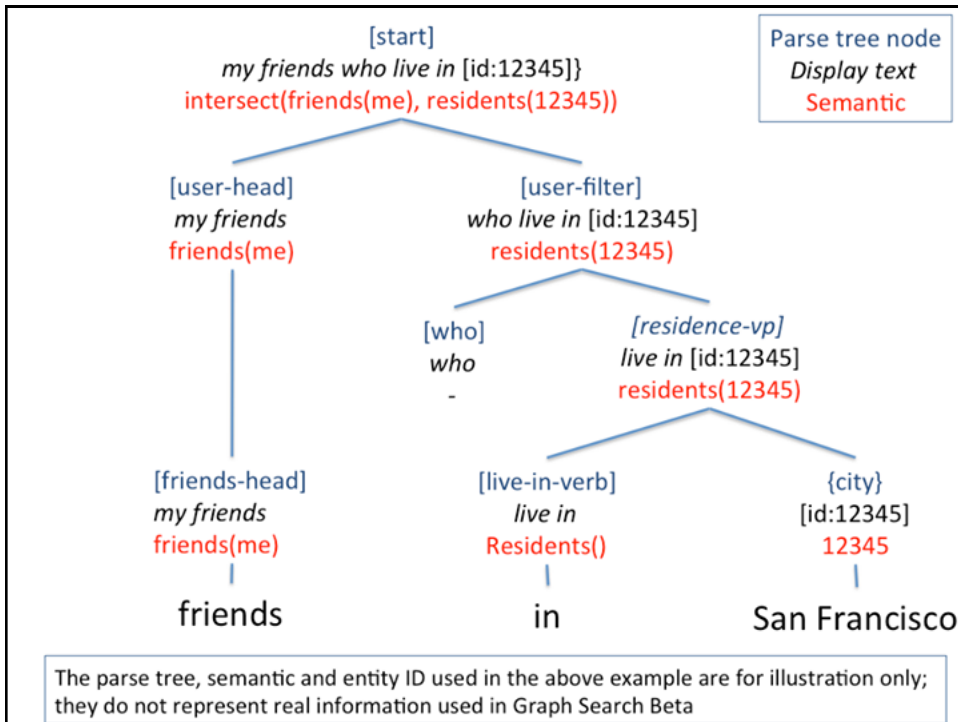




## PURDUE UNIVERSITY Facebook Graph Search

- Uses a weighted context free grammar (WCFG) to represent the Graph Search query language:
- [start] => [users] \$1
- [users] => my friend friends(me)
- [users] => friends of [users] friends(\$1)
- [users] => {user} \$1
- [start] => [photos] \$1
- [photos] => photos of [users] photos(\$1)
- A terminal symbol can be an entity, e.g., {user}, {city}, {employer}, {group}; it can also be a word/phrase, e.g., friends, live in, work at, members, etc. A parse tree is produced by starting from [start] and expanding the production rules until it reaches terminal symbols.

<https://www.facebook.com/notes/facebook-engineering/under-the-hood-the-natural-language-interface-of-graph-search/10151432733048920>  
<http://spectrum.ieee.org/telecom/internet/the-making-of-facebooks-graph-search>



**PURDUE** UNIVERSITY. 3 approaches to question answering:  
Knowledge-based approaches (Siri)

- Build a semantic representation of the query
  - Times, dates, locations, entities, numeric quantities
- Map from this semantics to query structured data or resources
  - Geospatial databases
  - Ontologies (Wikipedia infoboxes, dbPedia, WordNet, Yago)
  - Restaurant review sources and reservation services
  - Scientific databases
  - Wolfram Alpha



## **PURDUE** Text-based (mainly factoid) UNIVERSITY. QA

---

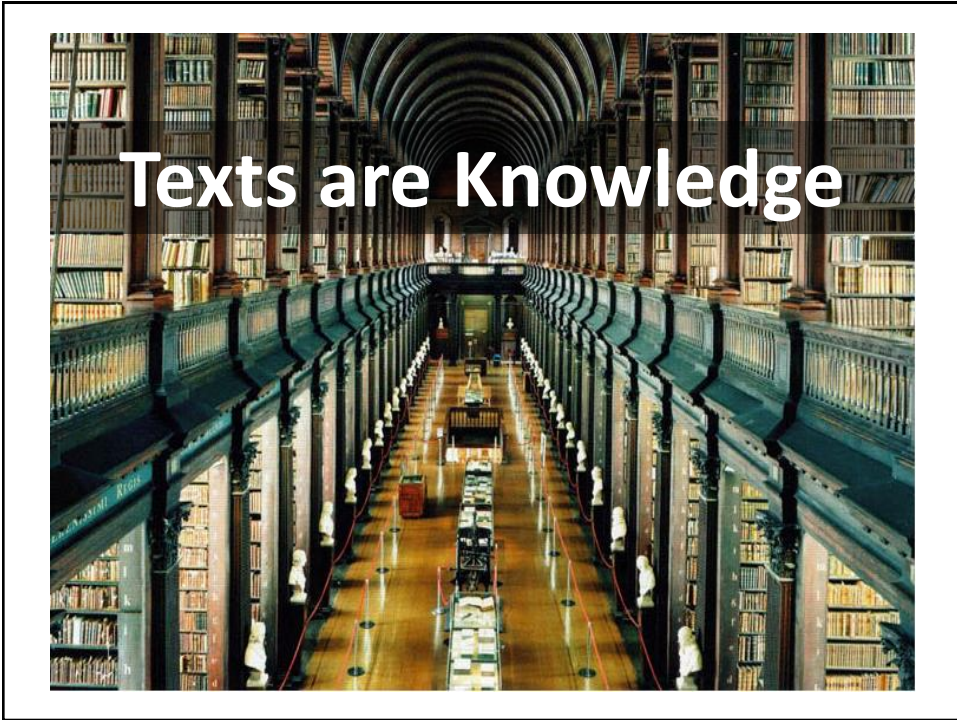
- **QUESTION PROCESSING**
  - Detect question type, answer type, focus, relations
  - Formulate queries to send to a search engine
- **PASSAGE RETRIEVAL**
  - Retrieve ranked documents
  - Break into suitable passages and rerank
- **ANSWER PROCESSING**
  - Extract candidate answers (as named entities)
  - Rank candidates
    - using evidence from relations in the text and external sources

## **PURDUE** Hybrid approaches (IBM UNIVERSITY. Watson)

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- Build a shallow semantic representation of the query
- Generate answer candidates using IR methods
  - Augmented with ontologies and semi-structured data
- Score each candidate using richer knowledge sources
  - Geospatial databases
  - Temporal reasoning
  - Taxonomical classification

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**PURDUE**  
UNIVERSITY.

Is the goal to go from language to knowledge bases?

- For humans, going from the largely unstructured language on the web to actionable information is effortlessly easy
- But for computers, it's rather **difficult!**
- This has suggested to many that if we're going to produce the next generation of intelligent agents, which can make decisions on our behalf
  - Answering our routine email
  - Booking our next trip to Fijithen we still first need to construct **knowledge bases**
- To go *from languages to information*

## Knowledge: Not just semantics but pragmatics

---

- Pragmatics = taking account of context in determining meaning
- Search engines are great because they inherently take into account pragmatics (“associations and contexts”)
  - [the national] → The National (a band)
  - [the national ohio] → The National - Bloodbuzz Ohio – YouTube
  - [the national broadband] → [www.broadband.gov](http://www.broadband.gov)

## Inference directly in text: Natural Logic (van Benthem 2008, MacCartney & Manning 2009)

---

- Q *Who is Beyoncé Knowles’s husband?*  
Q’ *Beyoncé Knowles’s husband is X.*

- A *Beyoncé’s marriage to rapper Jay-Z and portrayal of Etta James in Cadillac Records (2008) influenced her third album I Am... Sasha Fierce (2008).*



# Task – Answer Sentence Selection

- Given a factoid question, find the sentence that
  - Contains the answer
  - Can sufficiently support the answer

Q

S<sub>1</sub>

S<sub>2</sub>

Scott Wen-tau Yih (ACL 2013) paper

The screenshot shows a Bing search interface. The search bar contains the query "Who won the best actor Oscar in 1973?". Below the search bar, there are two main result sections. The left section, titled "Best Supporting Actor Oscar" and "Best Actor Oscar", lists "Mister Roberts" and "Save the Tiger". A red arrow points to "Save the Tiger". The right section is a knowledge panel for "Jack Lemmon", featuring a photo and biographical text: "John Uhler 'Jack' Lemmon III was an American actor and musician. He starred in more than 60 films including Som... + en.wikipedia.org". Below the knowledge panel, there is a link to "Jack Lemmon - Wikipedia, the free encyclopedia" and a link to "Jack Lemmon - IMDb" with a small profile picture. At the bottom, there is a section titled "Images of jack lemmon" with a row of five small images of Jack Lemmon at different stages of his life.

Who won the best actor Oscar in 1973?

- What is the fastest car in the world?



- The Jaguar XJ220 is the dearest, fastest and most sought after car on the planet.

