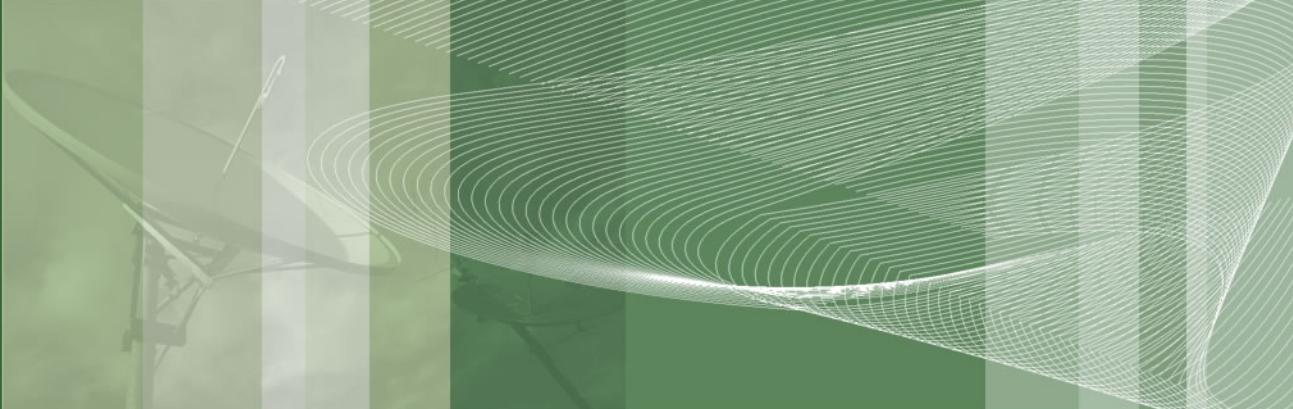


POLITECNICO DI MILANO

Dipartimento di  
Elettronica e Informazione



# Search Computing User Interaction

Alessandro Bozzon

# Information Need and Query Intent

“[W]hen an individual requires any information to complete a task, or to satisfy the curiosity of the mind, independent of the method used to address the need, and regardless of whether the need is satisfied or not.”

- User intent taxonomy (Broder2002)
  - **Informational**—want to learn about something ( $\sim 40\% / 65\%$ )  
**History nyonya food**
  - **Navigational**—want to go to a given page ( $\sim 25\% / 15\%$ )  
**Singapore Airlines**
  - **Transactional** – want to do something (web-mediated) ( $\sim 35\% / 20\%$ )  
**Jakarta Weather**  
**Nikon Finepix**
  - Grey Areas
    - Find a good hub
    - Exploratory search  
**Car Rental Kuala Lumpur**

[from SIGIR 2008 Tutorial, Baeza-Yates and Jones]

# From information needs to queries

- **Natural Language**
  - For instance through vocal interfaces
- **Keyword**
  - Set of text items, plus Boolean (AND/OR/NOT), proximity (lexical nearness) and/or wildcard conditions
- **Fielded Keyword**
  - Text items defined on one or more fields
  - Queries to semi-structured search-engines and **Faceted queries**
- **Content-based**
  - Query by example (text, image, video, audio, etc.)
- **Geographic and other special dimensions**
  - Geographic coordinates plus spatial operator terms (near, north of, within X kilometers from, etc.)
  - Timestamps plus temporal operator terms (recent, near, interval, etc.)

# Contextual Content Delivery

- Context Vs. Personalization
- Trigger the right search depending on the context
  - Task
  - Location
  - User Engagement
- Not interested in your personal profile
  - Your favorite restaurant?
    - It depends on where you are!

Usage data at a very large scale	
More data over longer periods of time brings more insights	
<b>Contextualization</b> More data via larger communities, makes data less personalized <i>wisdom of crowds does not work well on small corpora</i>	<b>Privacy</b> Over contextualization endangers privacy Long-term logs endanger privacy

from Ricardo Baeza-Yates,  
*Next Generation Search*,  
2<sup>nd</sup> Search Computing  
Workshop, Milan, 24/06/2010

Demo:

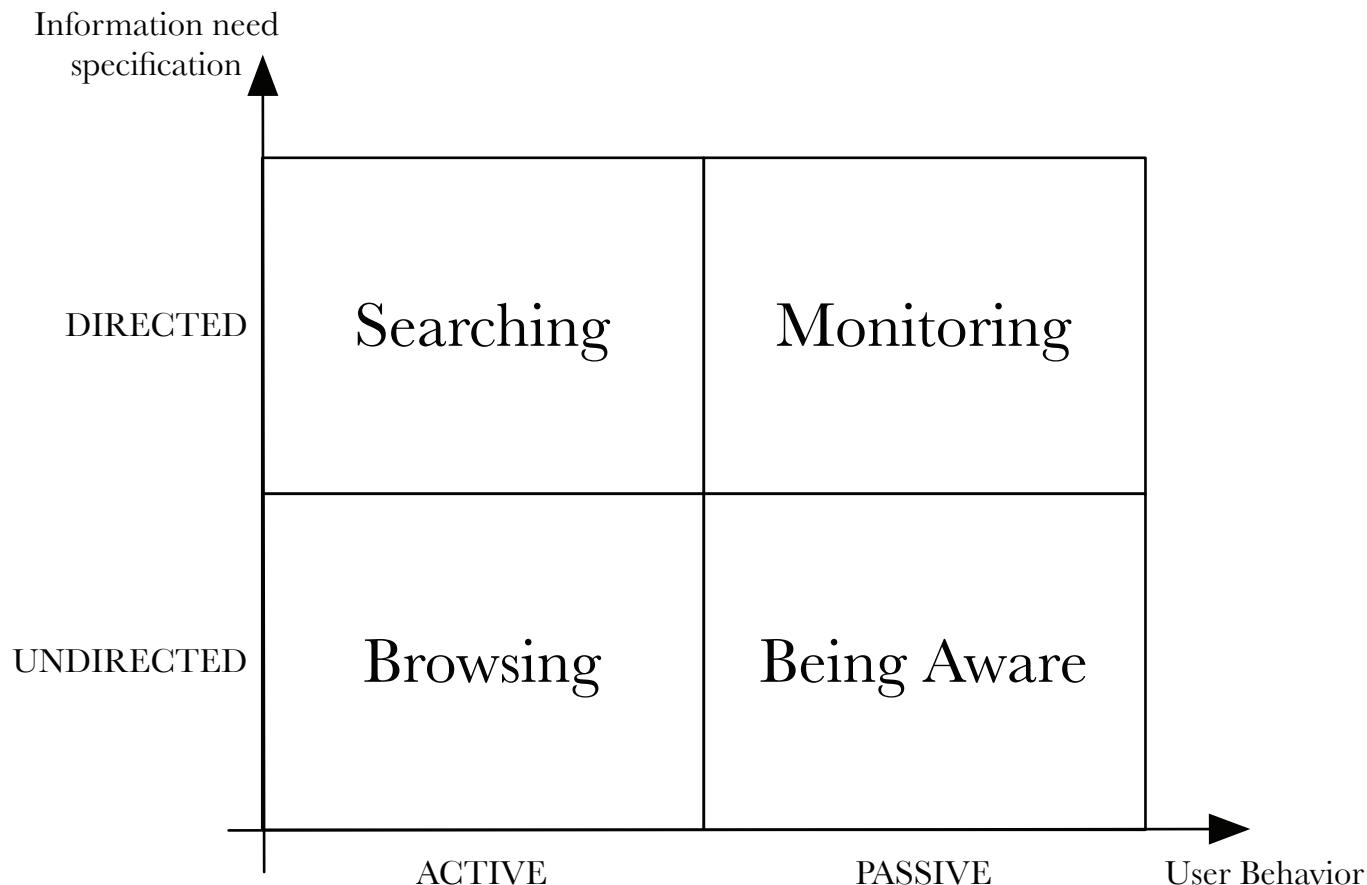
<http://sandbox.yahoo.com/Motif>

## How humans search for information?

**“Information-seeking is a special case of problem solving. It includes recognizing and interpreting the information problem, establishing a plan of search, conducting the search, evaluating the results, and if necessary, iterating through the process again.”**

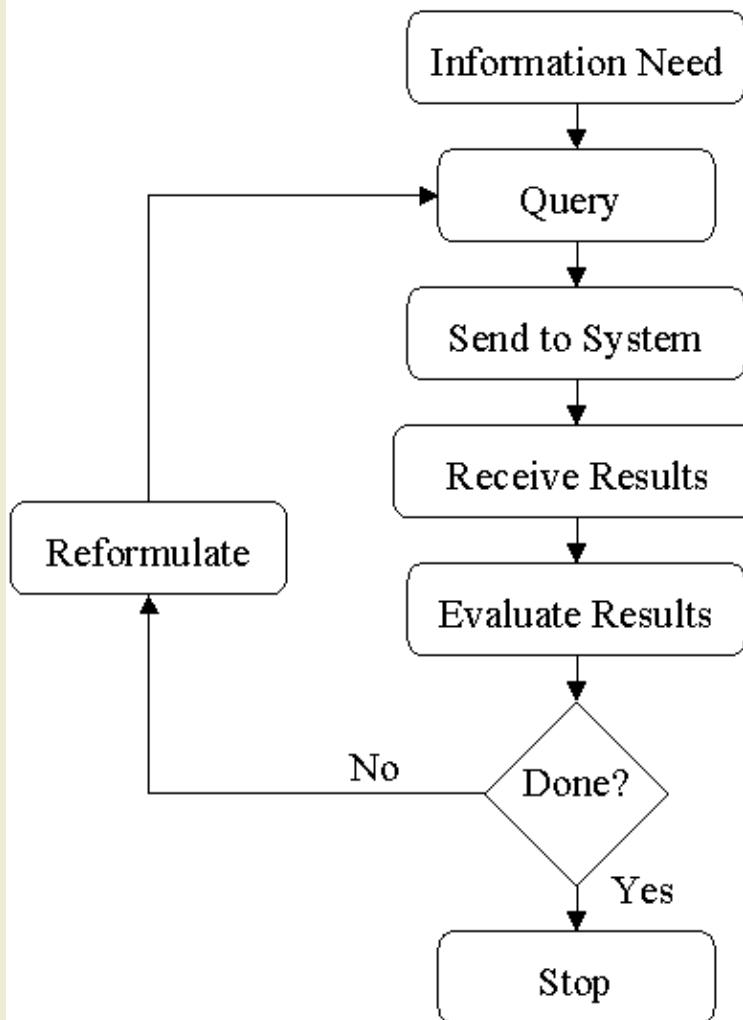
G. Marchionini. Information-seeking strategies of novices using a full-text electronic encyclopedia.

# Information Seeking [Bates, 2002]



Bates, Marcia J. 2002. Toward an integrated model for information seeking and searching. In: The Fourth International Conference on Information Needs, Seeking and Use in Different Contexts.

# The Standard Retrieval Interaction Model



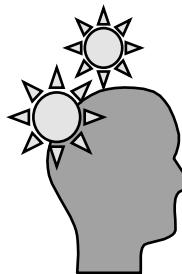
- **Assumptions:**

- The goal is maximizing **precision** and **recall** simultaneously
- The information need remains static
- The value is in the resulting document set

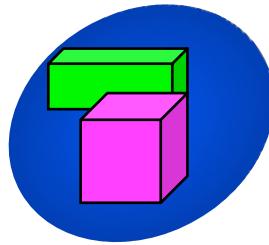
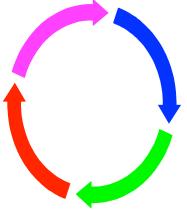
- **Problems:**

- Users learn during the search process:
  - Scanning titles of retrieved documents
  - Reading retrieved documents
  - Viewing lists of related topics/thesaurus terms
  - Navigating hyperlinks
- Some users don't like long (apparently) disorganized lists of documents

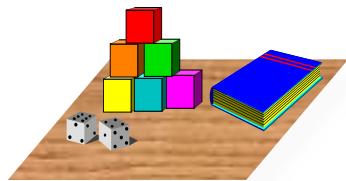
# IR is an Iterative Process\_1



Goals



Repositories



Workspace

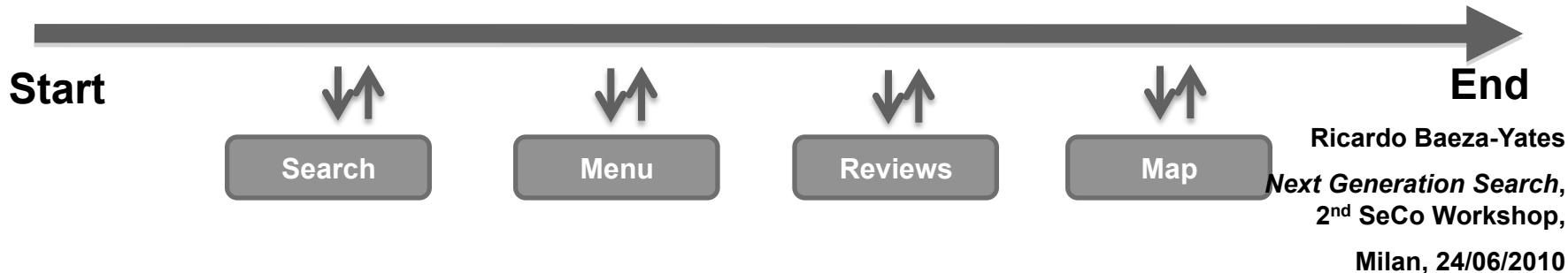
- The exchange doesn't end with first answer
- Users can recognize elements of a useful answer, even when incomplete
- Questions and understanding changes as the process continues

<http://courses.sims.berkeley.edu/i240/s11/>

# IR is an iterative Process\_2

- Search is evolving
  - Content Vs. Intent
    - People don't want to search
    - People want to get task done and get answers
  - Moving towards **identifying a user's task**
  - Enabling means for **task completion**
- **Search as a Process**

I am craving for a good *Wiener Schnitzel* and a *Sachertorte* in Vienna



- ▶ Search applications must
  - ▶ Support the user in the search process
  - ▶ (try to) Infer the user intent to help him accomplishing his task

# Information Foraging

- Information foraging applies the ideas from **optimal foraging theory** to understand how human users search for information.
- Assumption: humans use "built-in" foraging mechanisms that evolved to help our animal ancestors find food.

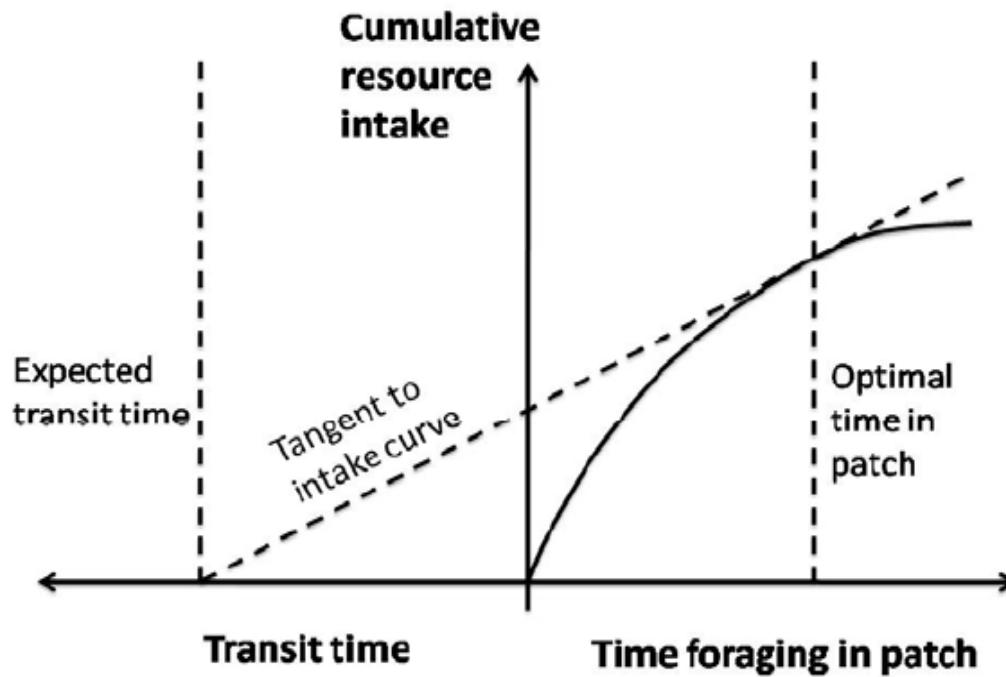


## Some References

- ▶ Fu, Wai-Tat; Pirolli, Peter (2007), "SNIF-ACT: a cognitive model of user navigation on the world wide web", *Human-Computer Interaction*: 335–412
- ▶ Jason Withrow, "Do your links stink?", *American Society for Information Science Bulletin*, June 1, 2002
- ▶ Pirolli, Peter (2009), "An elementary social information foraging model", *Proceedings of the 27th international conference on Human factors in computing systems*: 605–614

# Moving between patches

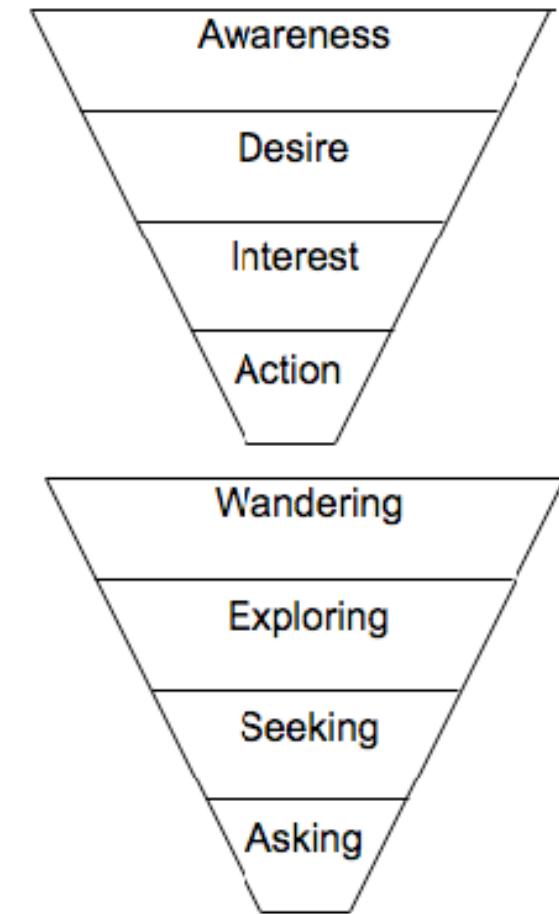
- Patches of information = websites
- Problem: **should I continue foraging in the current patch or look for another patch?**
- → Expected gain from continuing in current patch vs. moving to another



# Information seeking funnel

[D. Rose, 2008]

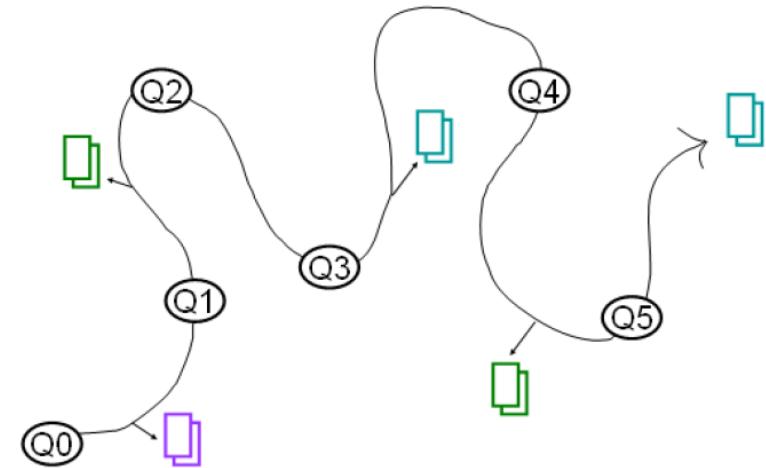
- **Wandering:** the user **does not have an** information seeking-goal in mind.
- **Exploring:** the user has a **general goal** but not a plan for how to achieve it.
- **Seeking:** the user has **started to identify** information needs that must be satisfied but the needs are open-ended.
- **Asking:** the user has a **very specific** information need that corresponds to a closed-class question



# Berrypicking vs. Orienteering vs. Teleporting ...

- **Information needs change during interactions**

- M.J. Bates. The design of browsing and berrypicking techniques for the online search interface. *Online Review*, 13(5):407–431, 1989.



- **Orienteering** [Teevan et al., CHI 2004]: Searcher issues a quick, imprecise to get to approximately the right information space region and then follows known paths that require small steps that move them closer to their goal. **Easy!** (“perfect” query not needed)
- **Teleporting:** Expert searchers issue longer queries to jump directly to the target. Requires more effort and experience.

# ... vs. exploratory search

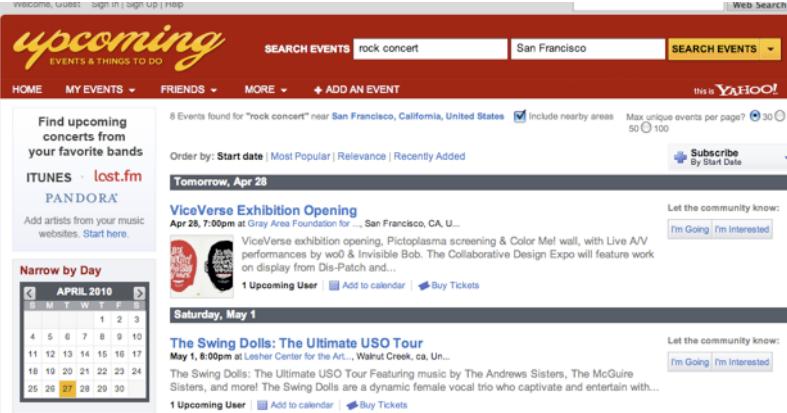
- **Exploratory Search:** user's intent is primarily to learn more on a topic of interest, by exploring various directions and sources
  - “... **exploratory search** blends querying and browsing strategies” and is different “from **retrieval** that is best served by analytical strategies...”
    - Marchionini, G. Exploratory search: from finding to understanding. *Communications ACM* 49(4): 41-46 (2006)



- ▶ Some references
  - ▶ Definition and analysis of the problem
    - ▶ White, R.W., and Drucker, S. M. **Investigating behavioral variability in web search.** 16th WWW Conf. (Banff, Canada, 2007)
  - ▶ Complex Search and Exploratory Search
    - ▶ Aula, A., and Russell, D.M. **Complex and Exploratory Web Search.** ISSS: Information Seeking Support Systems Workshop (Chapel Hill, June 2008)

# Multi-domain Exploratory Search

“... search for upcoming **concerts** close to an *attractive location* (like a beach, lake, mountain, natural park, and so on), considering also availability of good, close-by **hotels**”



Welcome, Guest | sign in | sign up | Help

**upcoming**  
EVENTS & THINGS TO DO

SEARCH EVENTS rock concert San Francisco SEARCH EVENTS

HOME MY EVENTS FRIENDS MORE + ADD AN EVENT

Find upcoming concerts from your favorite bands

ITUNES lost.fm PANDORA Add artists from your music websites. Start here.

Narrow by Day

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

Order by: Start date | Most Popular | Relevance | Recently Added

Tomorrow, Apr 28

ViceVerse Exhibition Opening Apr 28, 7:00pm at Gray Area Foundation for ... San Francisco, CA, U...

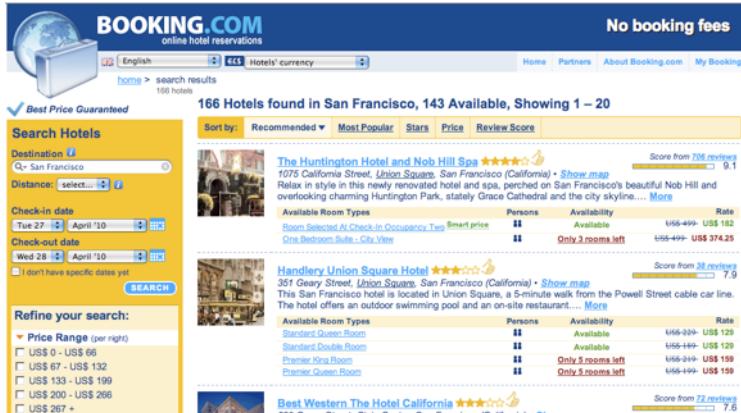
ViceVerse exhibition opening. Pictoplasma screening & Color Mel wall, with Live A/V performances by wod & Invisible Bob. The Collaborative Design Expo will feature work on display from Dis-Patch and...

1 Upcoming User | Add to calendar | Buy Tickets

The Swing Dolls: The Ultimate USO Tour May 1, 8:00pm at Lasher Center for the Art... Walnut Creek, ca, Un...

The Swing Dolls: The Ultimate USO Tour Featuring music by The Andrews Sisters, The McGuire Sisters, and more! The Swing Dolls are a dynamic female vocal trio who captivate and entertain with...

1 Upcoming User | Add to calendar | Buy Tickets



Web Search

BOOKING.COM online hotel reservations

No booking fees

166 Hotels found in San Francisco, 143 Available, Showing 1 – 20

Sort by: Recommended ▾ Most Popular Stars Price Review Score

Score from 700 reviews	Room Selected At Check-In Occupancy Type	Persons	Availability	Rate
9.1	Smart price	2	Available	US\$ 499 - US\$ 182
7.9	One Bedroom Suite - City View	2	Only 3 rooms left	US\$ 499 - US\$ 374.25
7.6	Score from 26 reviews	2	Available	US\$ 129
7.6	Score from 72 reviews	2	Only 5 rooms left	US\$ 199

The Huntington Hotel and Nob Hill Spa ★★★★☆ 1075 California Street, Union Square, San Francisco (California) • Show map

Relax in style in this newly renovated hotel and spa, perched on San Francisco's beautiful Nob Hill and overlooking charming Huntington Park, stately Grace Cathedral and the city skyline.... More

Handley Union Square Hotel ★★★★☆ 301 Powell Street, Union Square, San Francisco (California) • Show map

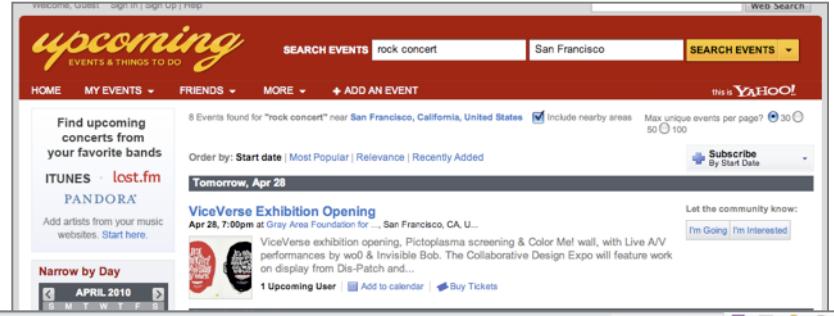
This San Francisco hotel is located in Union Square, a 5-minute walk from the Powell Street cable car line. The hotel offers an outdoor swimming pool and an on-site restaurant.... More

Best Western The Hotel California ★★★★☆ 420 Mason Street, Club Center, San Francisco (California) • Show map

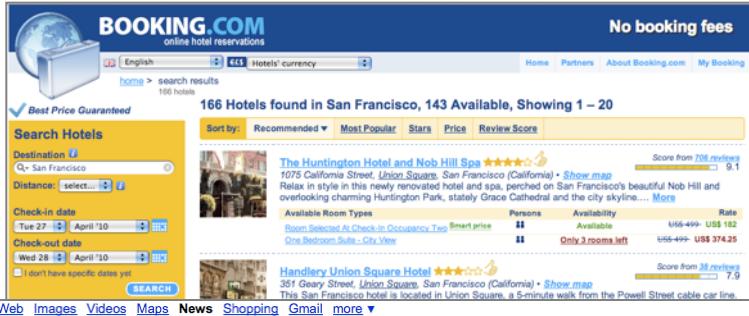
- Current approach the user can adopt:
  - Independently explore search services
  - Manually combine findings

# Multi-domain Exploratory Search

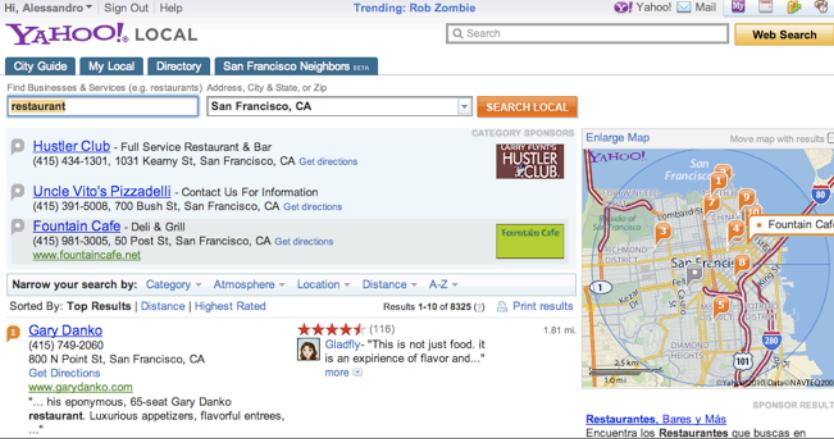
- “... expand the search to get information about available restaurants near the candidate concert locations, news associated to the event and possible options to combine further events scheduled in the same days and located in a close-by place with respect to the first one...”



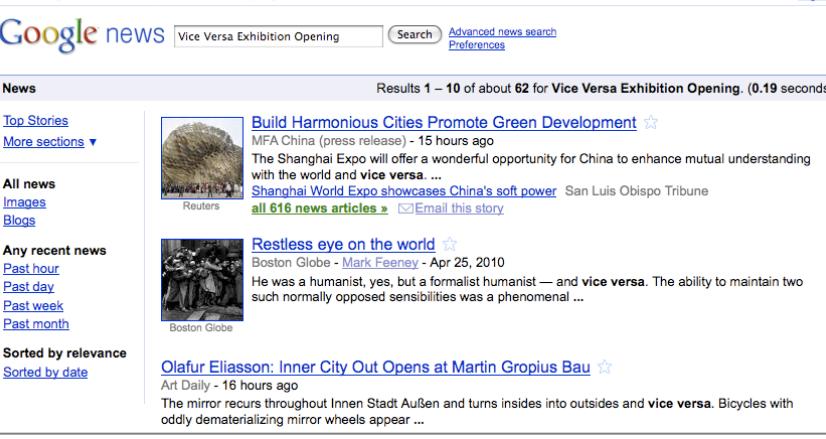
Upcoming.org search results for "rock concert" in San Francisco, showing 8 events found.



Booking.com search results for "San Francisco" showing 166 hotels found.



Yahoo! Local search results for "restaurant" in San Francisco, showing results like Hustler Club, Uncle Vito's Pizzadeli, and Fountain Cafe.



Google News search results for "Vice Versa Exhibition Opening" showing top stories and recent news items.

# Existing Approaches <sub>1</sub>

- **Topic based search:** instance of exploratory search centered on the goal of collecting information on a subject matter of interest from multiple sources

- **Kosmix:** topic discovery engine, keyword search, a topic page summarizes the most relevant information on the subject

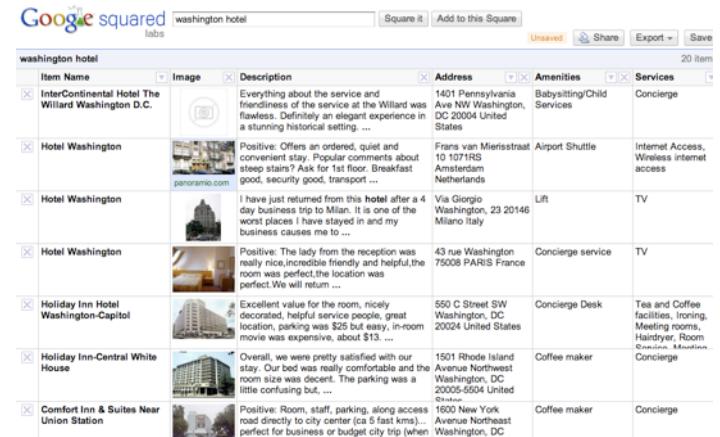


The screenshot shows the Kosmix topic page for "Washington Hotel". At the top, it says "Kosmix Washington Hotel Explore". Below that is a navigation bar with links: Overview, Hotels & Lodging, Events & Activities, Images, Maps, Deals, Reviews & Guides, Travel Forums, News, and Video. The main content area has two sections: "Hotels & Lodging" and "Related in the Kosmos". The "Hotels & Lodging" section lists several hotels: Four Seasons, Mandarin Oriental, Washington, D.C., The Hotel George, Hotel Monaco Washington D.C., Sofitel Lafayette Square, Washington, D.C., Luxurious 2 Bedroom Apartment, and Washington DC Vacation Rental. The "Related in the Kosmos" section lists categories like "Hotels in Washington, D.C.", "Buildings and structures in Washington, D.C.", and "Tunnels in Washington, D.C.", each with a list of specific locations.

- **Hakia:** resume pages for topics associated with user's queries, natural language processing techniques

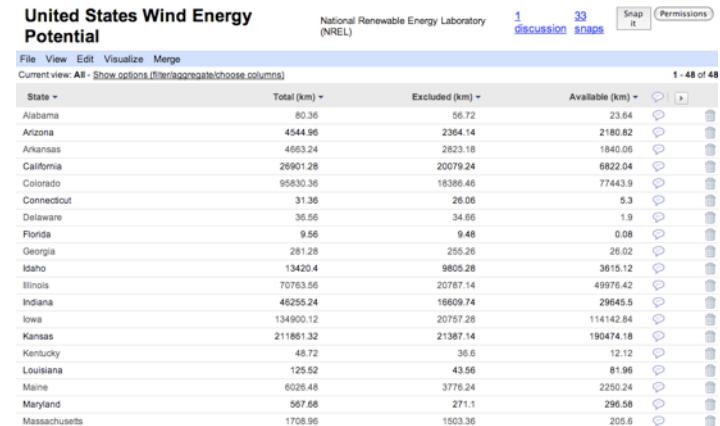
# Existing Approaches \_2

- **Structured Object Search:** process queries and present results that address entities or real world objects described in Web pages
- ▶ **Google Squared:** keyword search, results collected in a table (called a square) featuring all the attributes relevant to the result items as columns headers
- ▶ **Google Fusion Tables:** upload data tables (e.g., spreadsheet files) and join (or “fuse”) the data in some column with other tables



The screenshot shows a Google Squared interface for a search query "washington hotel". The results are presented in a table with the following columns: Item Name, Image, Description, Address, Amenities, and Services. There are 20 items listed.

Item Name	Image	Description	Address	Amenities	Services
InterContinental Hotel The Willard Washington D.C.		Everything about the service and friendliness of the service at the Willard was flawless. Definitely an elegant experience in a stunning historical setting. ...	1401 Pennsylvania Ave NW Washington, DC 20004 United States	Babysitting/Child Services	Concierge
Hotel Washington		Positive: Offers an ordered, quiet and convenient stay. Popular comments about steep stairs? Ask for 1st floor. Breakfast good, security good, transport ...	Frans van Mierisstraat 10 1071 RS Amsterdam Netherlands	Airport Shuttle	Internet Access, Wireless internet access
Hotel Washington		I have just returned from this hotel after a 4 day business trip to Milan. It is one of the worst places I have stayed in and my business causes me to travel a lot.	Via Giorgio Washington, 23 20146 Milano Italy	Lift	TV
Hotel Washington		Positive: The lady from the reception was really nice,incredible friendly and helpful,the room was perfect,the location was perfect. We will return ...	43 rue Washington 75008 PARIS France	Concierge service	TV
Holiday Inn Hotel Washington-Capitol		Excellent value for the room, nicely decorated, helpful service people, great location, parking was \$25 but easy, in-room movie was expensive, about \$13. ...	550 C Street SW Washington, DC 20244 United States	Concierge Desk	Tea and Coffee facilities, Ironing, Meeting rooms, Hairdryer, Room service, Laundry, Concierge
Holiday Inn-Central White House		Overall, we were pretty satisfied with our stay. Our bed was really comfortable and the room size was decent. The parking was a little confusing but, ...	1501 Rhode Island Avenue Northwest Washington, DC 20005-5504 United States	Coffee maker	
Comfort Inn & Suites Near Union Station		Positive: Room, staff, parking, along access road directly to city center (ca 5 fast kms)... perfect for business or budget city trip (when	1600 New York Avenue Northeast Washington, DC	Coffee maker	Concierge

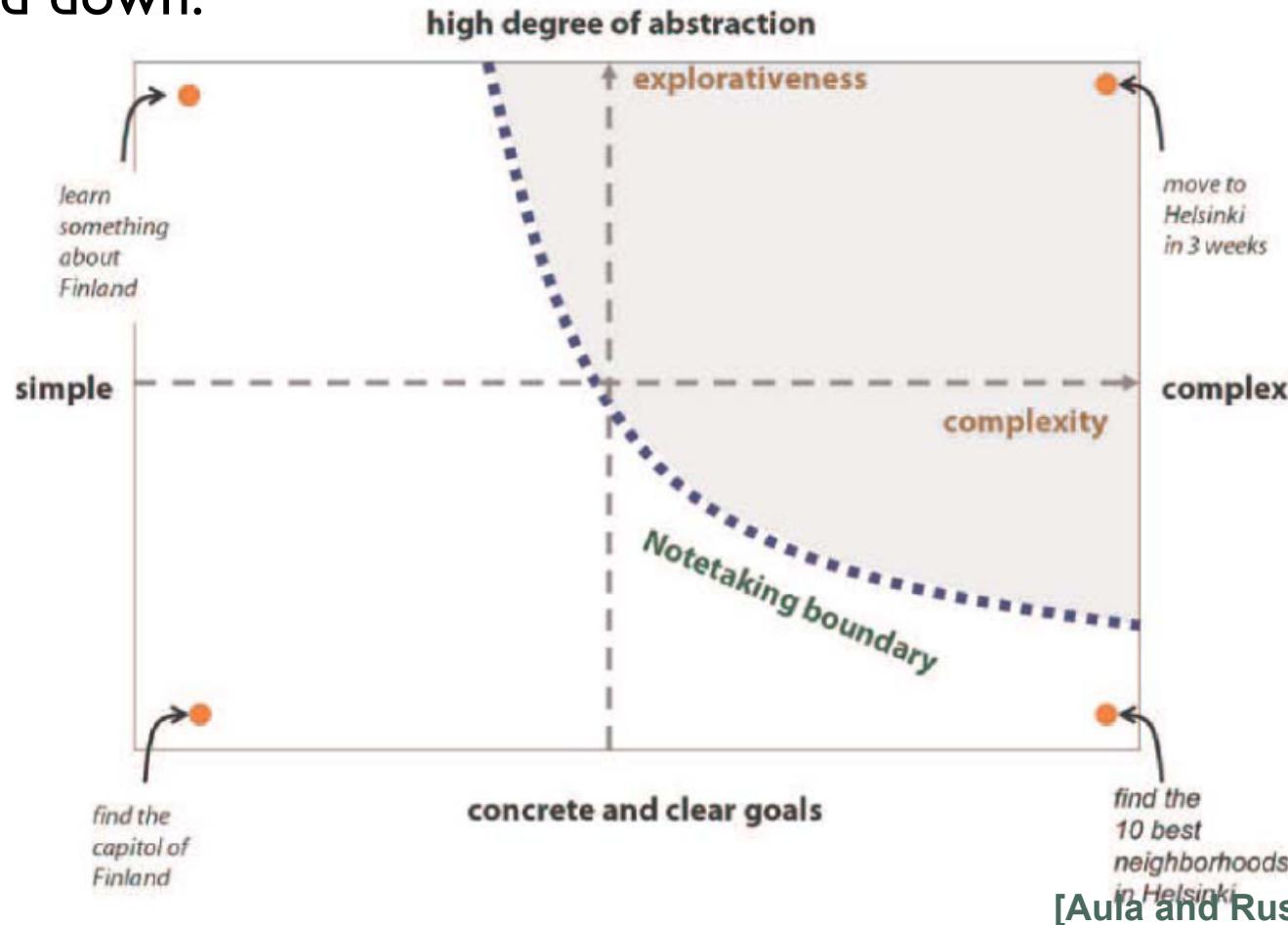


The screenshot shows a Google Fusion Tables interface for a table titled "United States Wind Energy Potential". The table includes columns for State, Total (km), Excluded (km), Available (km), and various edit icons. The data shows wind energy potential across different US states.

State	Total (km)	Excluded (km)	Available (km)
Alabama	80.36	56.72	23.64
Arizona	4544.96	2364.14	2180.82
Arkansas	4663.24	2823.18	1840.06
California	26901.28	20079.24	6822.04
Colorado	95830.36	16386.46	77443.9
Connecticut	31.36	26.06	5.3
Delaware	36.56	34.66	1.9
Florida	9.56	9.48	0.08
Georgia	281.28	255.26	26.02
Idaho	13420.4	9805.28	3615.12
Illinois	70763.56	20787.14	49976.42
Indiana	45255.24	16609.74	29645.5
Iowa	134900.12	20757.28	114142.84
Kansas	211661.32	21387.14	190474.18
Kentucky	48.72	36.6	12.12
Louisiana	125.52	43.56	81.96
Maine	6026.48	3775.24	2250.24
Maryland	567.68	271.1	296.58
Massachusetts	1708.96	1503.36	205.6

# The note-taking limit

- There is a limit after which the found options need to be marked down.



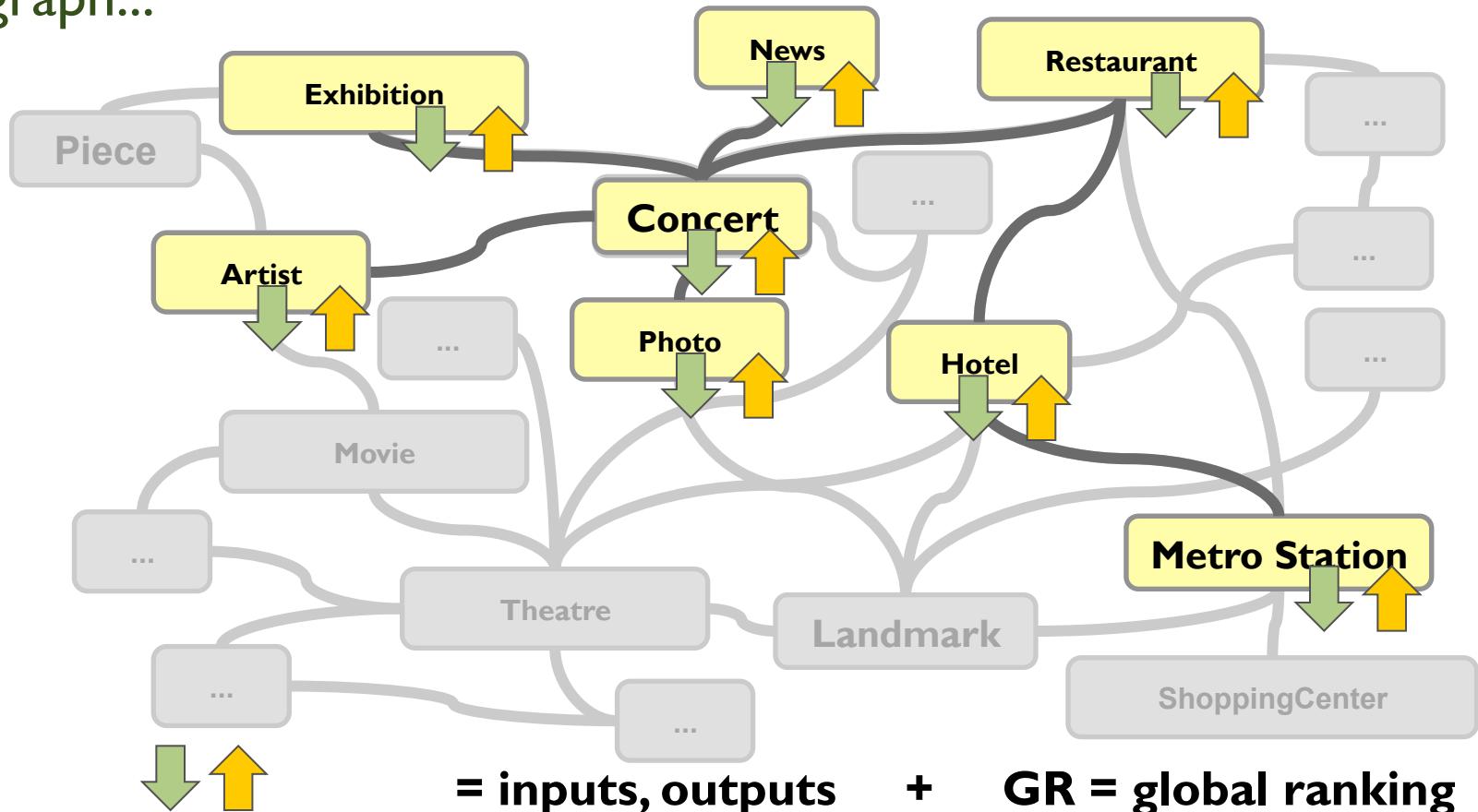
# Liquid Queries

“ A new paradigm allowing users to **formulate** and get **responses** to **multi-domain** queries through an **exploratory information seeking** approach, based upon **structured** information sources exposed as software services...”

- **Composite** answers obtained by aggregating search results from various domains
  - **Highlight** the contribution of each search service
  - **Join** of results based on the structural information afforded by the search service interfaces
  - **Refine** the user query
  - **Re-shape** the result list
- ▶ **Alessandro Bozzon, Marco Brambilla, Piero Fraternali, Stefano Ceri. Liquid Query: multi-domain exploratory search on the Web. WWW 2010, Raleigh, USA**

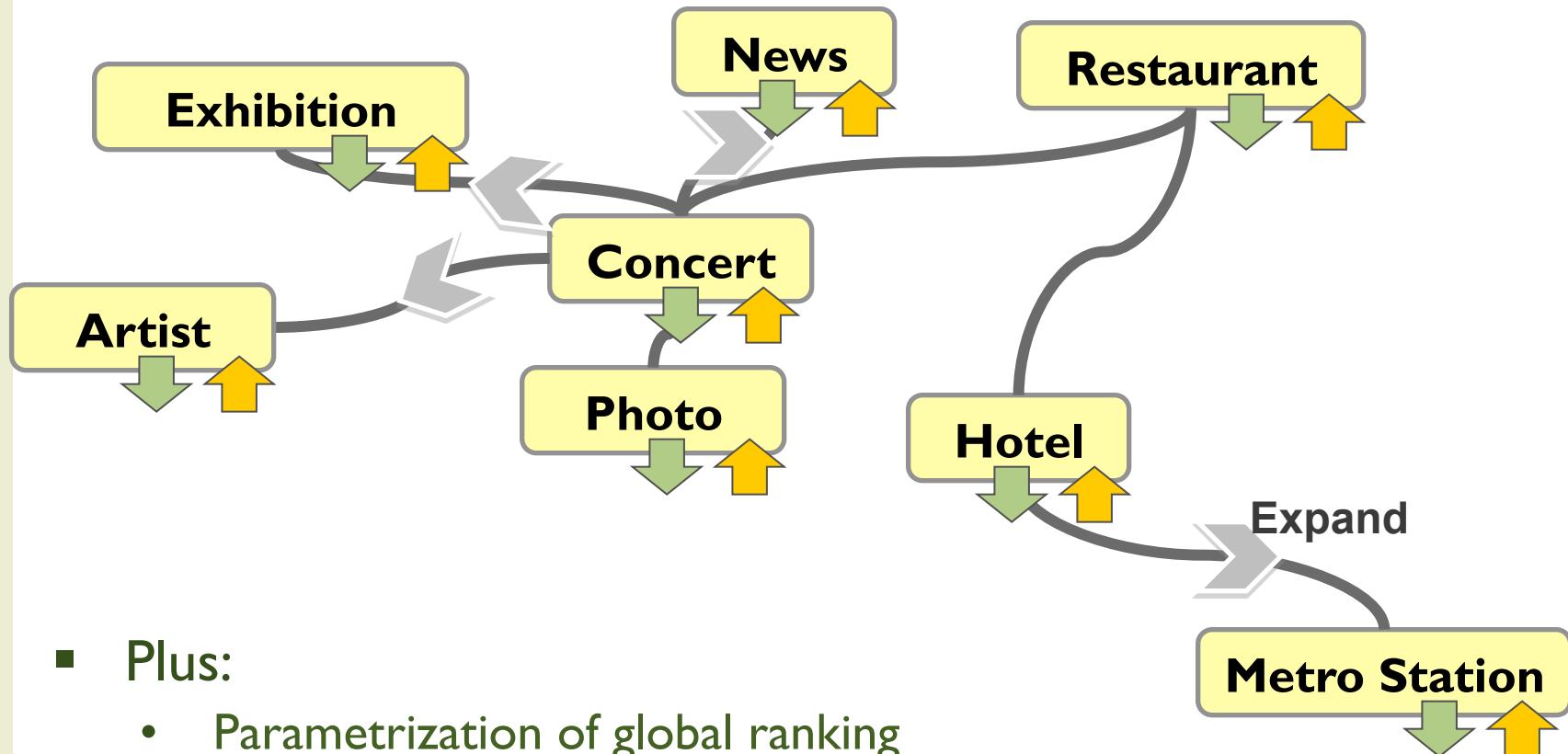
# Liquid Queries Definition \_1

- Template-based approach
- It consists of subsetting and parametrizing the resource graph...



## Liquid Queries Definition \_2

- And then characterizing the user interaction



- Plus:
  - Parametrization of global ranking
  - Data visualization options
  - .. and so on

# Result Exploration Support

- If the current set of combinations is not satisfactory, the user may ask for **more** values for a service (more one) or for all services (more all)
  - More concerts, more hotels, or more combinations
- **Add new information** about further domains for selected combinations (expand)
  - Find close-by restaurants or co-located events
- **Aggregate** information to ease analysis and readability (clustering, grouping)
  - Group events by venue
- **Reduce** the number of shown items through filtering
  - Total walked distance for the night
- **Re-order** (ranking or sorting)
  - Calculate derived values from existing ones
  - Total walked distance for the night
- Alternative **data visualization**
  - Map, parallel coordinates, ...

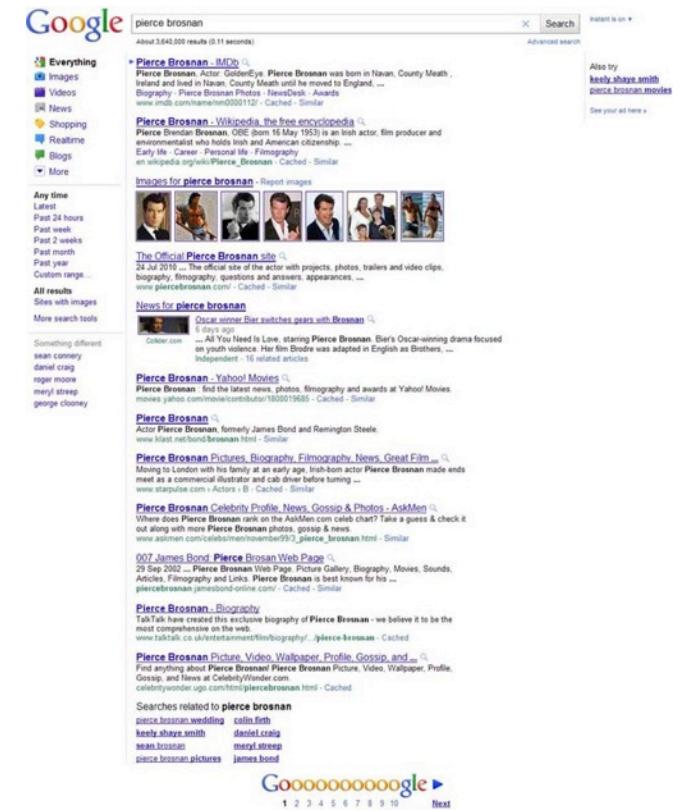
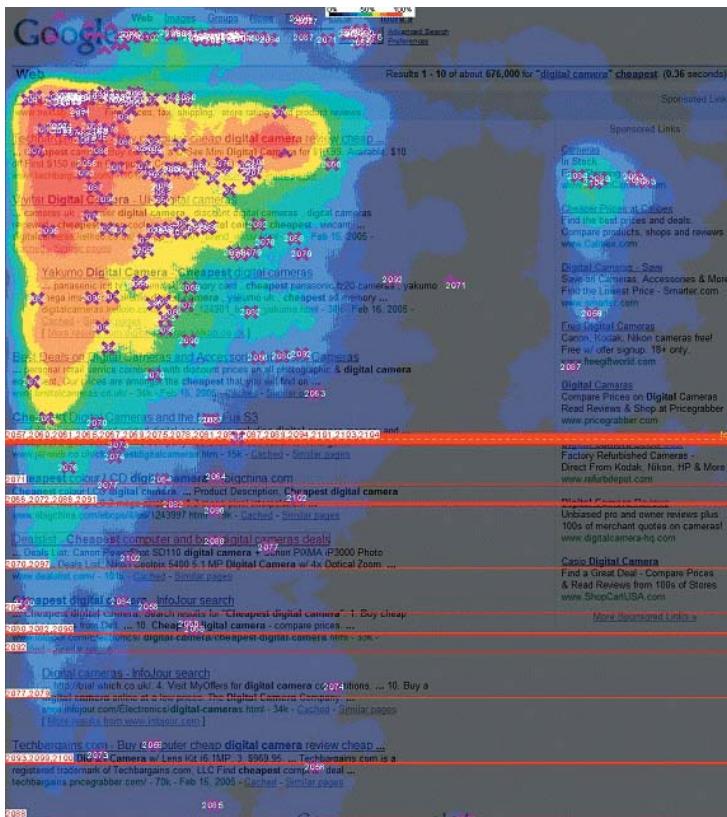


▶ **DEMO:**

<http://demo.search-computing.org>

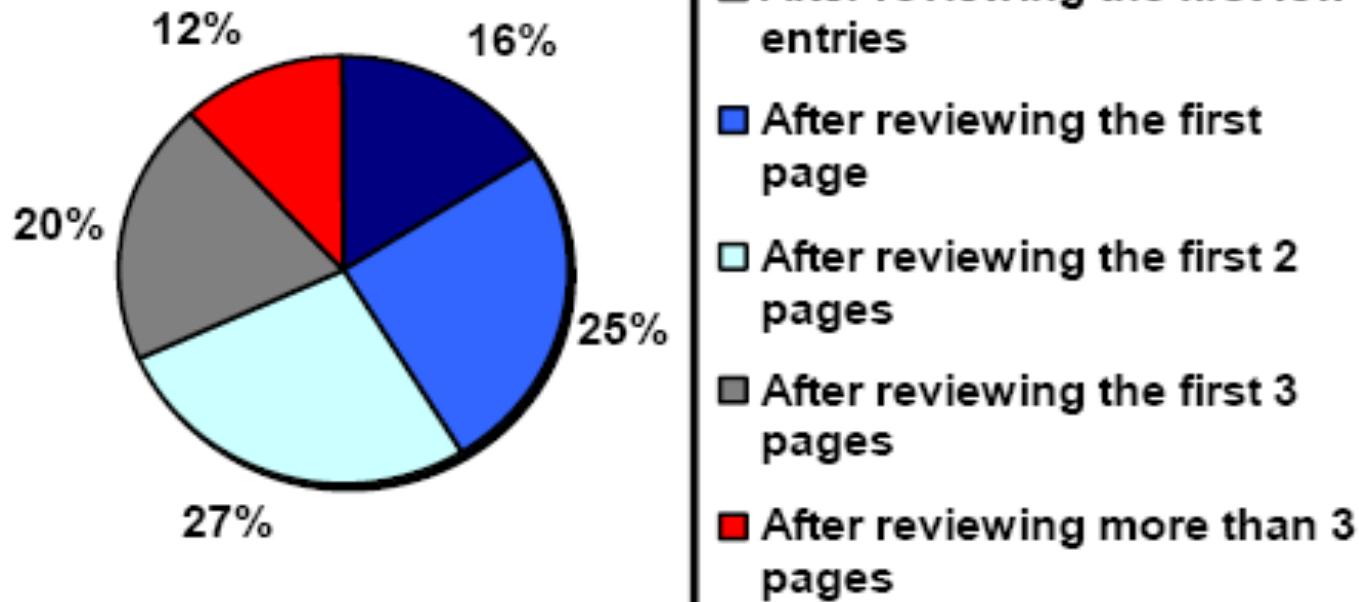
# Search interfaces

- Visualization of search results is a core asset in the search process and is accountable for a big part of the perceived quality in the user experience



## Not all results are likely to be reviewed

"When you perform a search on a search engine and don't find what you are looking for, at what point do you typically either revise your search, or move on to another search engine? (Select one)"



(Source: [iprospect.com](http://iprospect.com) WhitePaper\_2006\_SearchEngineUserBehavior.pdf)

# Clicks and views depend on rank

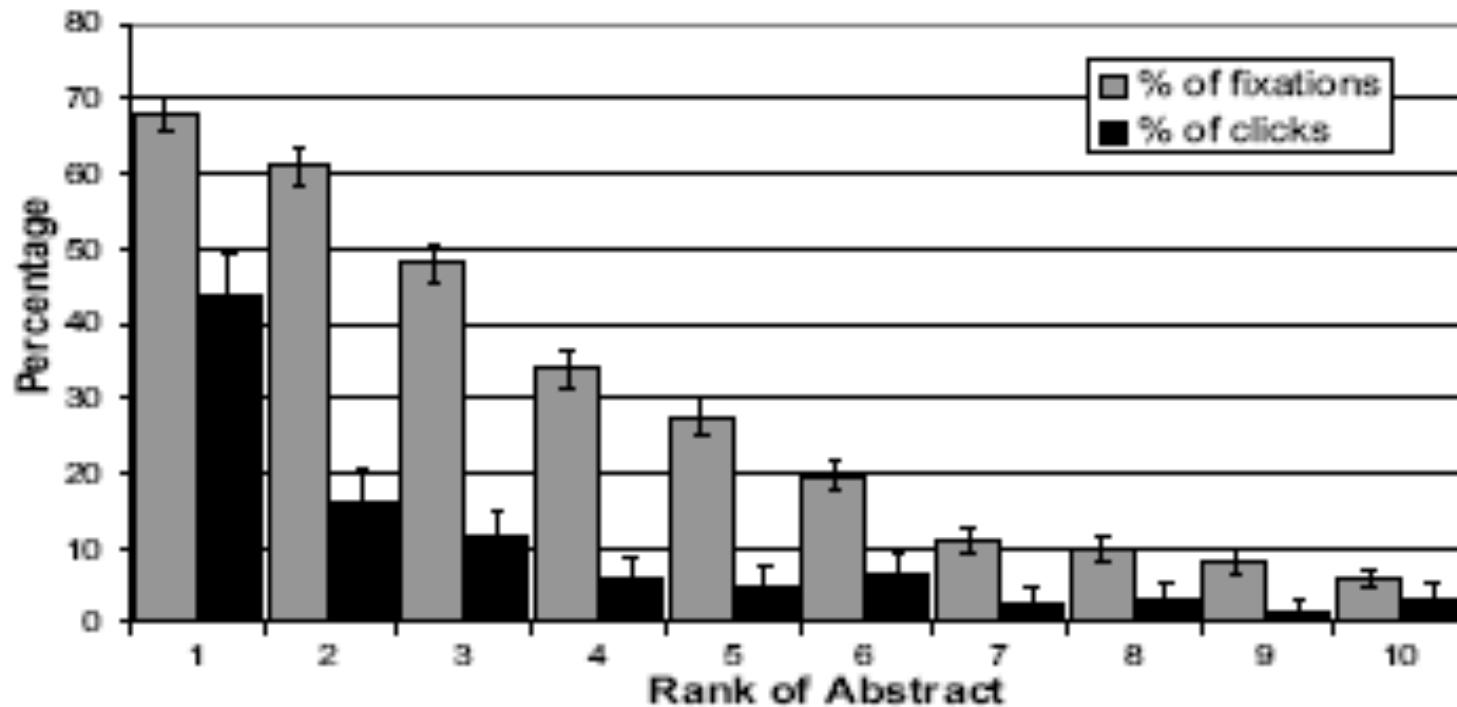


Figure 1: Percentage of times an abstract was viewed(clicked depending on the rank of the result.

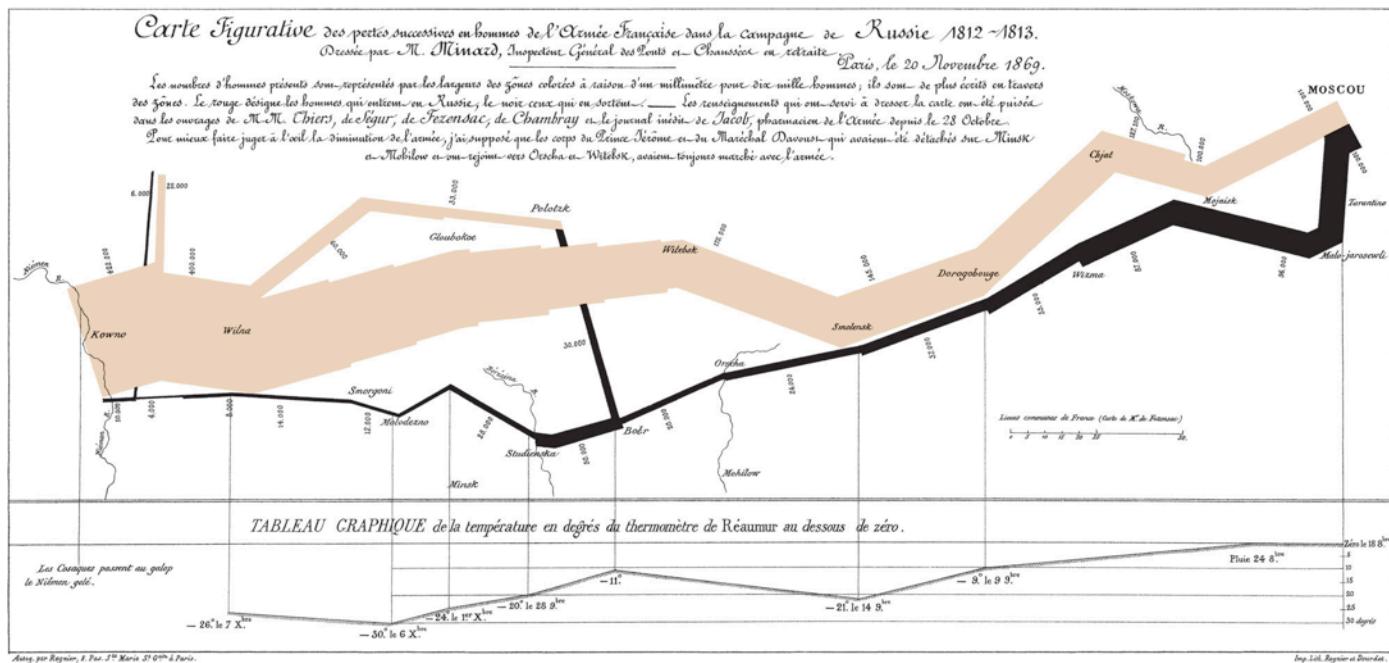
[Joachims et al, 2005]

# Data Visualization

- “... to convey information through visual representations.”
- Why?
  - Make decision
  - See data in context
  - Support graphical calculation
  - Find patterns

# Examples

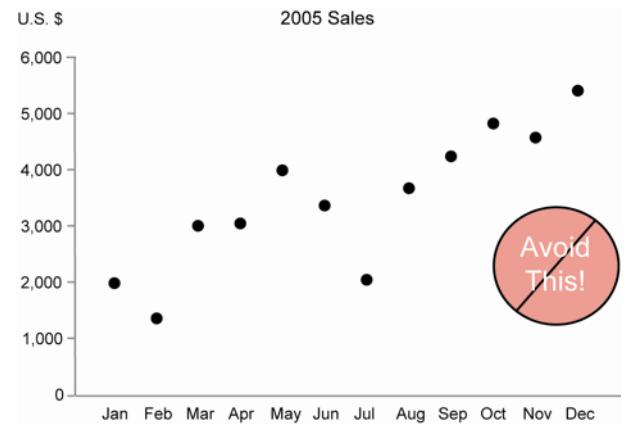
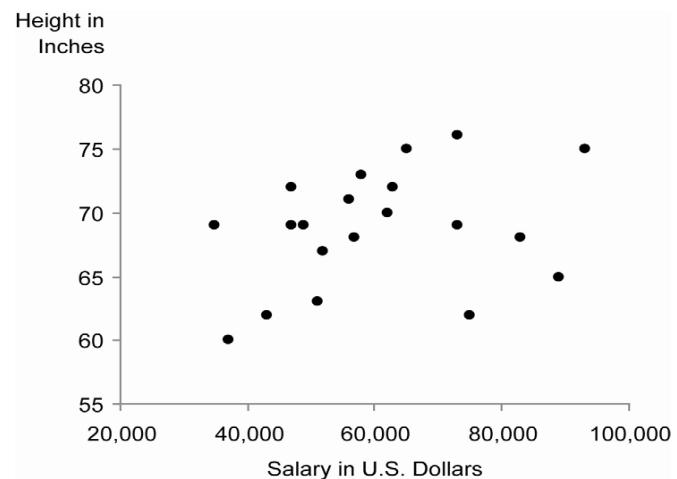
- The French engineer, Charles Minard (1781-1870), illustrated the disastrous result of Napoleon's failed Russian campaign of 1812. The graph displays several variables in a single two-dimensional image:
  - the army's location and direction, showing where units split off and rejoined
  - the declining size of the army
  - the low temperatures during the retreat.
- Many consider Minard's original the best statistical graphic ever drawn.



<http://www.math.yorku.ca/SCS/Gallery/minard/march-animated.gif>

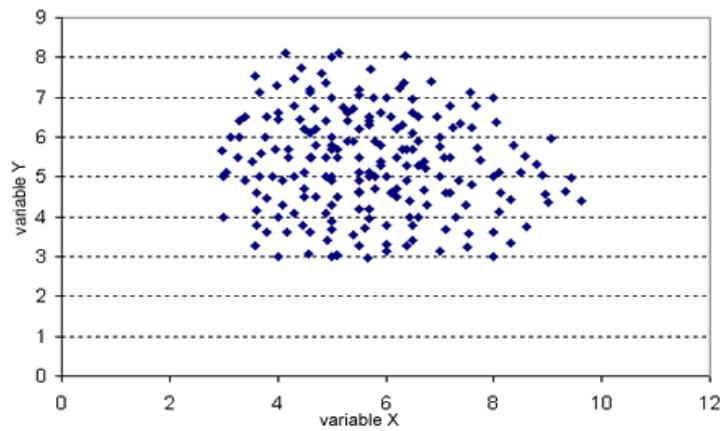
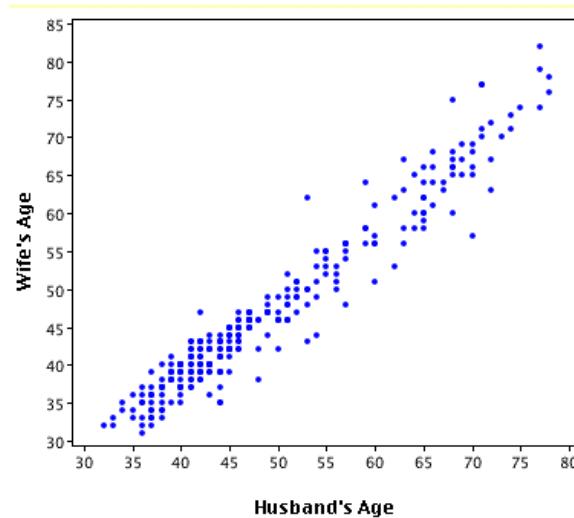
# Points

- Points
  - simplest object
  - pinpoint a specific location in space
  - can take any simple shape
  - not a good option for encoding a series of values through time

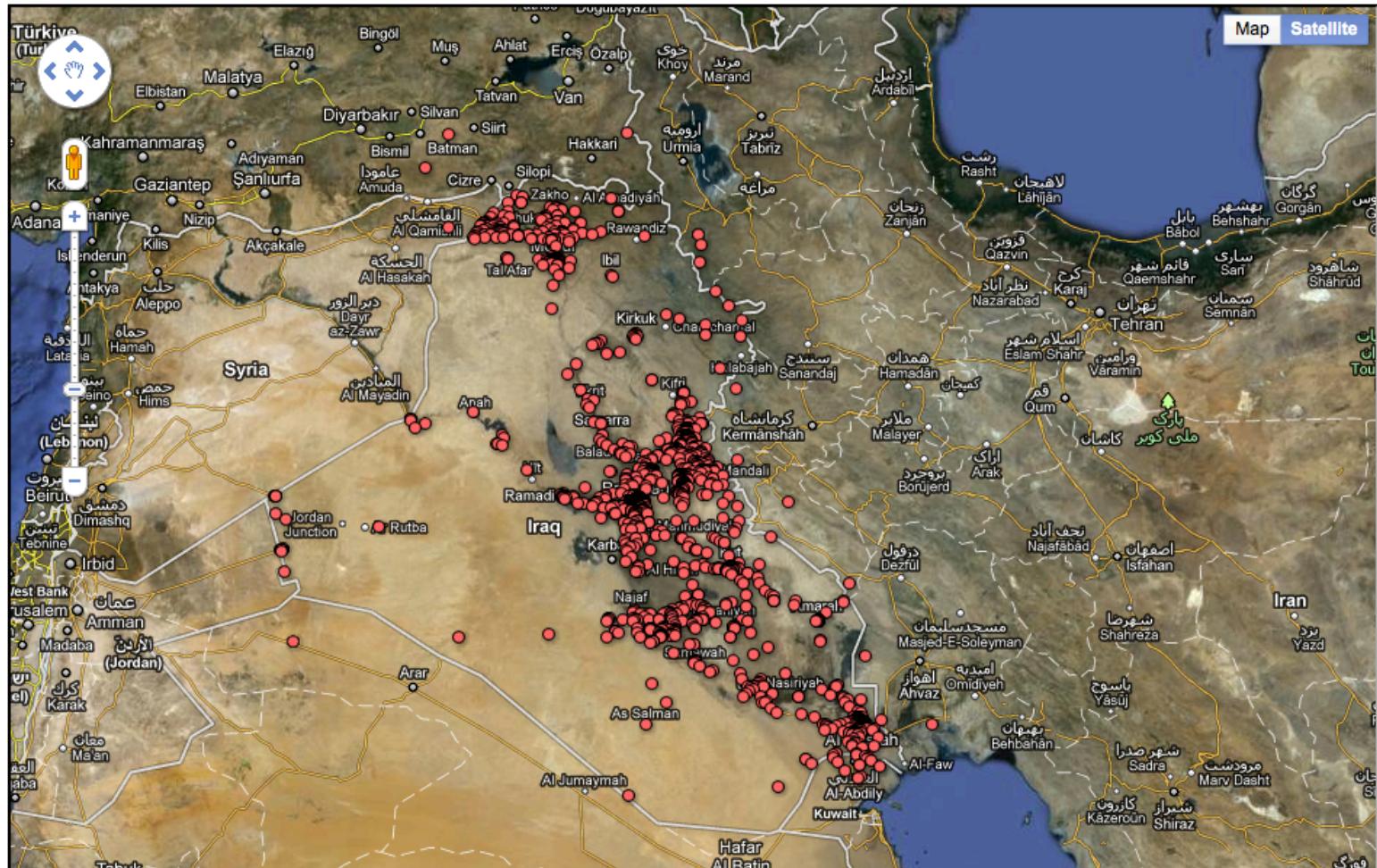


# The Scatter Plot

- Easily represents the measurements of two variables
- Effectively demonstrate the existence or lack or a relationship between variables

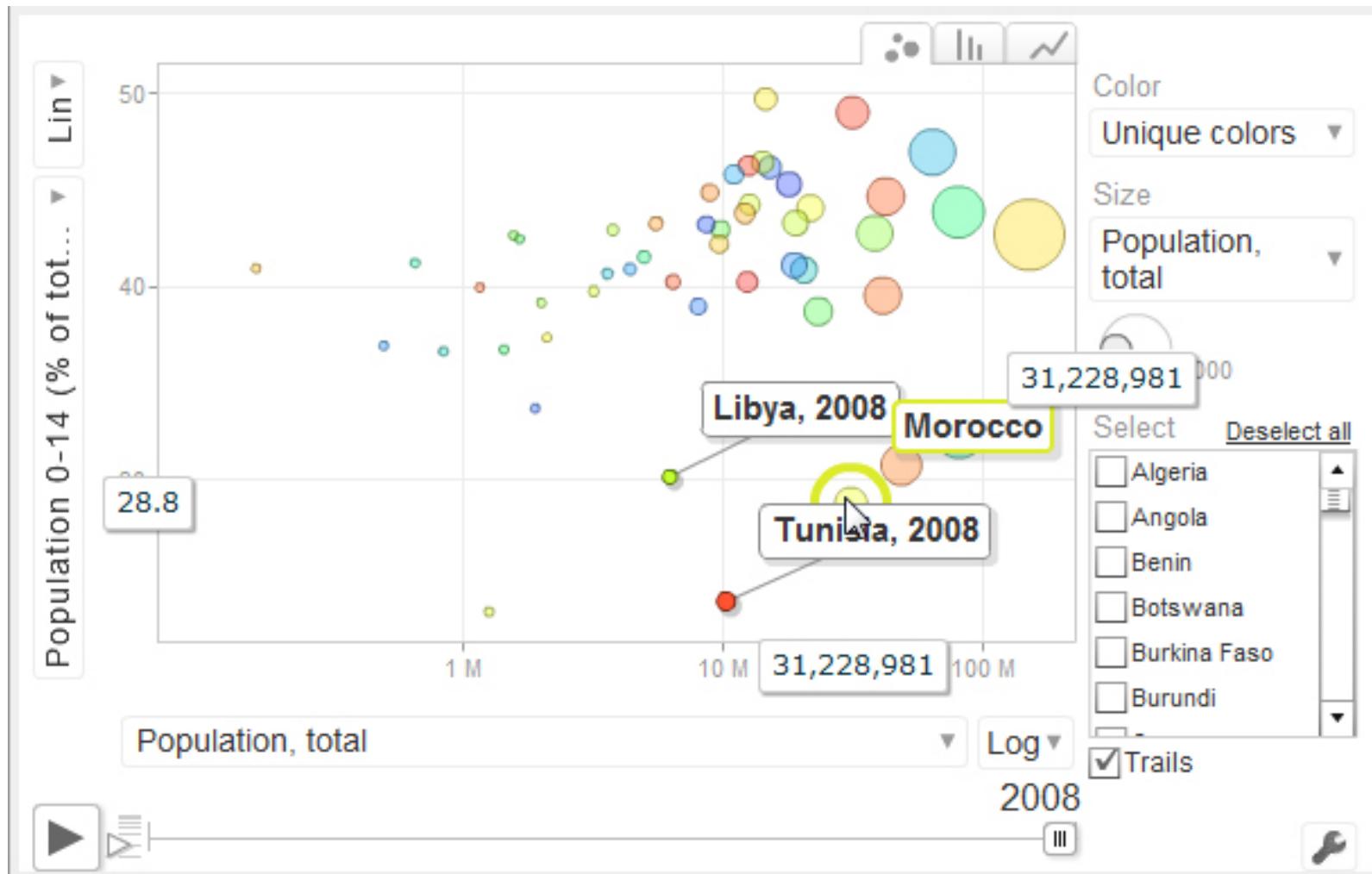


# Examples



<http://www.guardian.co.uk/world/datablog/interactive/2010/oct/23/wikileaks-iraq-deaths-map>

## Examples



[http://www.ted.com/talks/hans\\_rosling\\_reveals\\_new\\_insights\\_on\\_poverty.html](http://www.ted.com/talks/hans_rosling_reveals_new_insights_on_poverty.html)

# Result Visualizations\_1

- There are **well-established visualization concerns** in traditional search interfaces (e.g., simplicity)
- Recently, **more sophisticated presentation of results** are emerging, driven by the type (and properties) of extracted data

## Famous English Poets and Poems

A List of Famous English Poets includes Poems and Biographical information of the most Famous English Poets. Read and Enjoy Poetry by English Poets.

[famouspoetsandpoems.com/country/.../English\\_poets.html](http://famouspoetsandpoems.com/country/.../English_poets.html) - Cached - Similar

### 19th Century English Poets and Poems

A list of Famous 19th Century English Poets. The authors listed on this page include s the greatest poets of 19th Century.

[famouspoetsandpoems.com/.../19th\\_century\\_English\\_poets.html](http://famouspoetsandpoems.com/.../19th_century_English_poets.html) - Cached - Similar

[+ Show more results from famouspoetsandpoems.com](#)

## Famous English Poets

Visit this site dedicated to Famous English Poets. Enjoy the poems by all of the Famous English Poets. Read a great selection of poems - dedicated to Famous ...

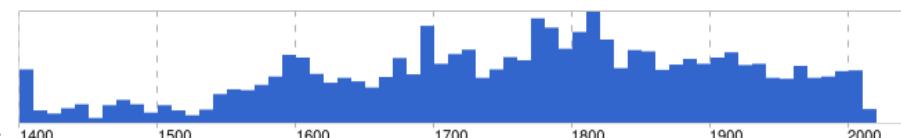
[www.love-poems.me.uk/a\\_english\\_poets.htm](http://www.love-poems.me.uk/a_english_poets.htm) - Cached - Similar

## Images for English poets - Report images



### Timeline

1400-2010 [Search other dates](#)



[1400](#) Oct 1400 - [Geoffrey Chaucer](#), the greatest English poet of pre-Elizabethan times, had been accorded a grave in [Westminster Abbey](#) in [October 1400](#). It was association with the royal household rather than poetic eminence which accounted for his interment in the national

[+ Show more](#)

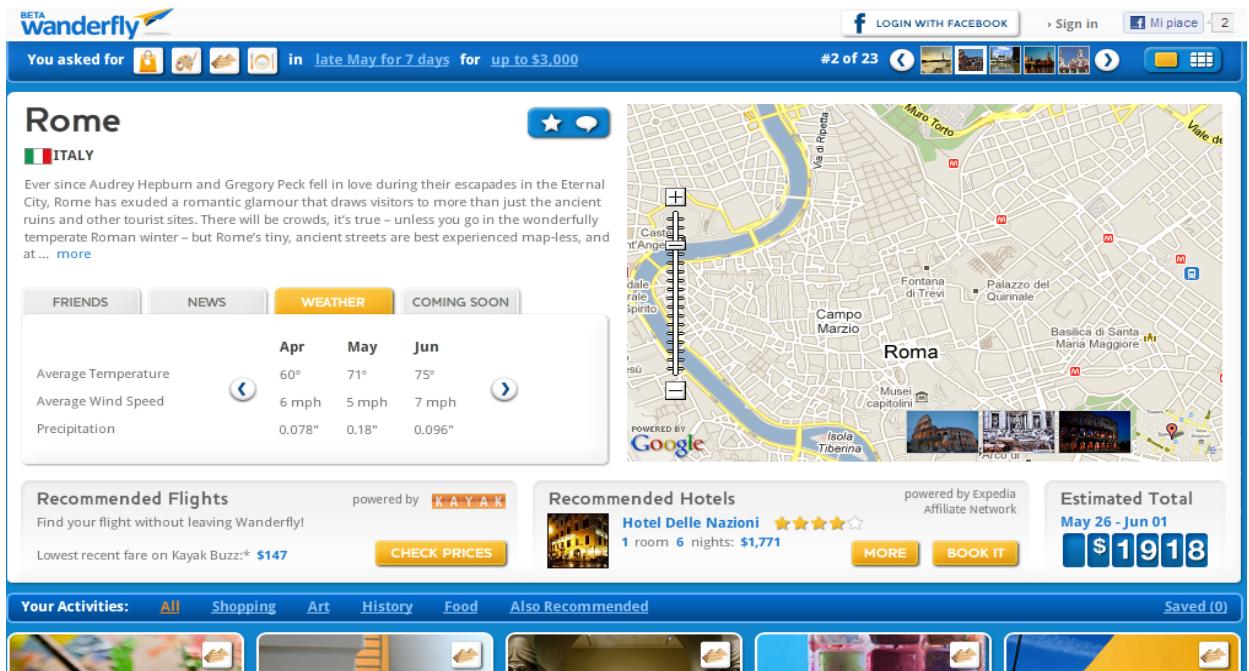
From [A Life of William Shakespeare](#) - Related web pages  
[books.google.com/books?id=jXULAAAAIAAJ&pg...](http://books.google.com/books?id=jXULAAAAIAAJ&pg...)

[1598](#) 1598 - In this section he secured for his book, by chance, lasting connection with the study of [Shakespeare](#) by giving a list of plays of Shakespeare known to him in 1598. [+ Show more](#)  
 From [English Writers](#) - Related web pages  
[books.google.com/books?id=XYQ6AAAAMAAJ&pg...](http://books.google.com/books?id=XYQ6AAAAMAAJ&pg...)

[1675](#) 1675 - Author: [Edward Phillips Sir Egerton Brydges](#). Phillips, Edward, THEATRUM POETARUM ANGLICANORUM; containing brief characters of the English Poets down to the year 1675. Containing the name and characters of all the English poets, from the reign  
[+ Show more](#)  
 From [... Containing Brief Characters Of The English Poets Down To The Year By ...](#) - Related web pages  
[charles-2399.dontexist.com/theatrum-poetarum...](http://charles-2399.dontexist.com/theatrum-poetarum...)

# Result Visualizations\_2

- Vertical search engines also feature new sophisticated approaches to result visualization
  - Domain knowledge optimizes the display of retrieved results



**Wanderfly**

You asked for in late May for 7 days for up to \$3,000

#2 of 23

**Rome**

**ITALY**

Ever since Audrey Hepburn and Gregory Peck fell in love during their escapades in the Eternal City, Rome has exuded a romantic glamour that draws visitors to more than just the ancient ruins and other tourist sites. There will be crowds, it's true – unless you go in the wonderfully temperate Roman winter – but Rome's tiny, ancient streets are best experienced map-less, and at ... [more](#)

**WEATHER**

	Apr	May	Jun
Average Temperature	60°	71°	75°
Average Wind Speed	6 mph	5 mph	7 mph
Precipitation	0.078"	0.18"	0.096"

**Recommended Flights** powered by **KAYAK**

Find your flight without leaving Wanderfly!

Lowest recent fare on Kayak Buzz: **\$147** [CHECK PRICES](#)

**Recommended Hotels** powered by Expedia Affiliate Network

Hotel Delle Nazioni 1 room 6 nights: \$1,771 [MORE](#) [BOOK IT](#)

**Estimated Total**  
May 26 - Jun 01 **\$1918**

Your Activities: [All](#) [Shopping](#) [Art](#) [History](#) [Food](#) [Also Recommended](#) [Saved \(0\)](#)

[www.wonderfly.com](#)

Wonderfly trip planner – [www.wonderfly.com](http://www.wonderfly.com)

## Adequate visualizations

- Flexible and dynamic assembly of the result layout as in horizontal search engines
- Result presentation tuned to the **type of objects** (images, maps, news) retrieved as in vertical search engines
- Visualization techniques that vary quite radically, e.g., using maps to chart multiple geo-referenced objects, time lines to convey temporal series, and ad hoc widgets for multidimensional data

# (List) Tabular visualization

**Global Rank**    **Local Rank**

**HOTEL**

**Object Composition**

**RESTAURANT**

**EVENT**

**Object Attribute**

**Join Attributes**

**Selection Attributes**

Score	Name	Rate	Address	#Stars	Price	Category	Address	Name	Price	Date	Time	Address	Artist
0.923	Baviera Mokimba Hotels	8.4	Via P. Castaldi 7	4	199	Italian	P.zza Repubblica 20	Casanova	55	2010/10/07	08:00PM	Via Boffalora	Le Sinapsi - Maela
0.909	Baviera Mokimba Hotels	8.4	Via P. Castaldi 7	4	199	Italian	P.zza Repubblica 20	Casanova	55	2010/10/09	08:00PM	Via Francesco Pozzi 29	Gianluca Ferro
0.888	Baviera Mokimba Hotels	8.4	Via P. Castaldi 7	4	199	Italian	P.zza Repubblica 20	Casanova	55	2010/10/09	09:00PM	Via Watt 37	B_Team - Ed Solo
0.874	Baviera Mokimba Hotels	8.4	Via P. Castaldi 7	4	199	Italian	P.zza Repubblica 20	Casanova	55	2010/10/06	08:00PM	Via Valtellina 21	Shadow Gallery - Maplerun
0.837	Baviera Mokimba Hotels	8.4	Via P. Castaldi 7	4	199	Italian	P.zza Repubblica 20	Casanova	55	2010/10/08	09:00PM	Via Enrico Cosenz 61	Zombina & The Skeletones
0.824	Baviera Mokimba Hotels	8.4	Via P. Castaldi 7	4	199	Chinese	Via G. Spontini 6	Spontini 6	25	2010/10/07	08:00PM	Via Boffalora	Le Sinapsi - Maela
0.823	Baviera Mokimba Hotels	8.4	Via P. Castaldi 7	4	199	Chinese	Via G. Spontini 6	Spontini 6	25	2010/10/09	08:00PM	Via Francesco Pozzi 29	Gianluca Ferro
0.789	Baviera Mokimba Hotels	8.4	Via P. Castaldi	4	199	Chinese	Via G. Spontini 6	Spontini 6	25	2010/10/09	09:00PM	Via Watt 37	B_Team - Ed Solo
0.737	Baviera Mokimba Hotels	8.4	Via P. Castaldi 7	4	199	Chinese	Via G. Spontini 6	Spontini 6	25	2010/10/06	08:00PM	Via Valtellina 21	Shadow Gallery - Maplerun
0.676	Baviera Mokimba Hotels	8.4	Via P. Castaldi 7	4	199	Chinese	Via G. Spontini 6	Spontini 6	25	2010/10/08	09:00PM	Via Enrico Cosenz 61	Zombina & The Skeletones
0.646	Hotel del Sole	7.3	Via G. Spontini 6	1	51	Italian	P.zza Repubblica 20	Casanova	55	2010/10/07	08:00PM	Via Boffalora	Le Sinapsi - Maela
0.640	Hotel del Sole	7.3	Via G. Spontini 6	1	51	Italian	P.zza Repubblica 20	Casanova	55	2010/10/09	08:00PM	Via Francesco Pozzi 29	Gianluca Ferro
0.635	Hotel del Sole	7.3	Via G. Spontini 6	1	51	Italian	P.zza Repubblica 20	Casanova	55	2010/10/09	09:00PM	Via Watt 37	B_Team - Ed Solo
0.609	Hotel del Sole	7.3	Via G. Spontini 6	1	51	Italian	P.zza Repubblica 20	Casanova	55	2010/10/06	08:00PM	Via Valtellina 21	Shadow Gallery - Maplerun
0.606	Hotel del Sole	7.3	Via G. Spontini 6	1	51	Italian	P.zza Repubblica 20	Casanova	55	2010/10/08	09:00PM	Via Enrico Cosenz 61	Zombina & The Skeletones
0.599	Hotel del Sole	7.3	Via G. Spontini 6	1	51	Chinese	Via G. Spontini 6	Spontini 6	25	2010/10/07	08:00PM	Via Boffalora	Le Sinapsi - Maela
0.576	Hotel del Sole	7.3	Via G. Spontini 6	1	51	Chinese	Via G. Spontini 6	Spontini 6	25	2010/10/09	08:00PM	Via Francesco Pozzi 29	Gianluca Ferro
0.566	Hotel del Sole	7.3	Via G. Spontini 6	1	51	Chinese	Via G. Spontini 6	Spontini 6	25	2010/10/09	09:00PM	Via Watt 37	B_Team - Ed Solo
0.562	Hotel del Sole	7.3	Via G. Spontini 6	1	51	Chinese	Via G. Spontini 6	Spontini 6	25	2010/10/06	08:00PM	Via Valtellina 21	Shadow Gallery - Maplerun
0.556	Hotel del Sole	7.3	Via G. Spontini 6	1	51	Chinese	Via G. Spontini 6	Spontini 6	25	2010/10/08	09:00PM	Via Enrico Cosenz 61	Zombina & The Skeletones

# Map Visualization

Google maps

[Get Directions](#) [My Maps](#)

Hotel, Vienna, Austria

Hotel near Vienna, Austria  
Hotel near Austrian Theatre Museum, Lobkowitzplatz, Vienna, Austria  
Hotel Vienna GmbH, Vienna, Austria - Große Stadtgutgasse

Show search options

[Print](#) [Send](#) [Link](#)

Hotel, Vienna, Austria

[250 Hotels in Vienna](#)

Book your hotel in Vienna online.  
Save up to 75% on your reservation!  
[www.booking.com/Hotels-Vienna](http://www.booking.com/Hotels-Vienna)

Check-in 07/07/2010 Nights 1

A Hotel Sacher Wien [more info](#)

Philharmonikerstrasse 4, 1010 Wien,  
Austria - 01 514560  
★★★★★ 833 reviews  
"Staff friendly. Easy to find. Pastries  
good but not amazing. Non smoking

B Graben Hotel-Kremslehner Hotels GmbH [more info](#)

Dorotheergasse 3, 1010 Wien,  
Österreich - 01 51215310  
★★★★★ 139 reviews  
"The Graben is a great little hotel  
located in the heart of Vienna. ..."

C Hotel Imperial, Vienna [more info](#)

Kaerntner Ring 16, 1015 Vienna,  
Austria - 01 501100  
★★★★★ 198 reviews - 1 coupon  
"In Peter's opinion Hotel Imperial in  
Vienna is a perfect family friendly ..."

D Hotel Erzherzog Rainer - Schick Hotels

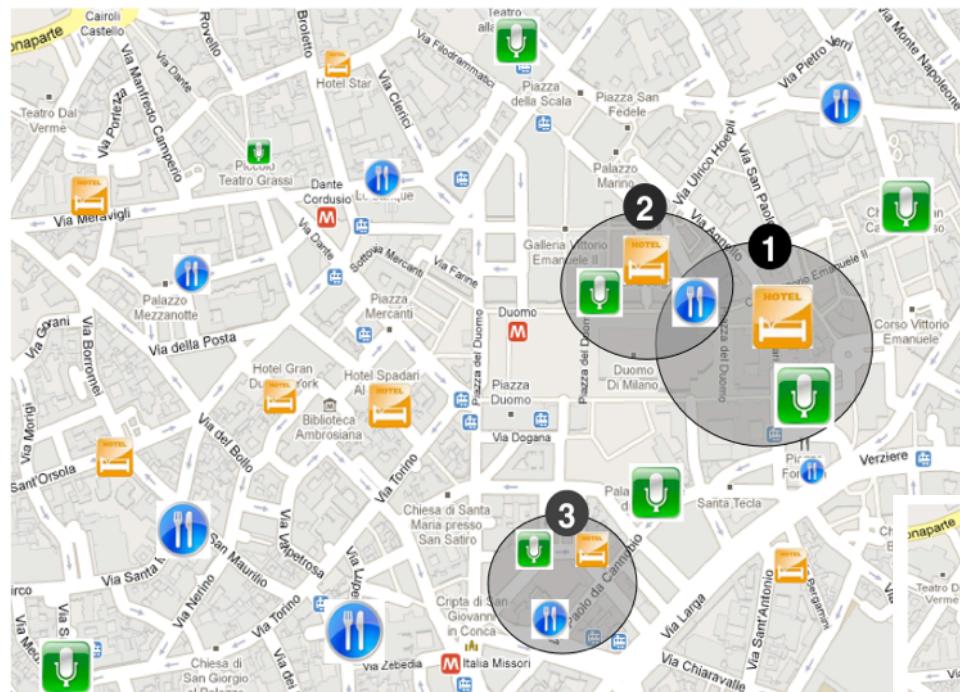
Wien [more info](#)  
Wiedner Hauptstr. 27-29, 1040 Wien,  
Austria - 01 22111  
★★★★★ 260 reviews  
"Positive: Staff were welcoming. The  
food was of good quality and ..."

E Hotel City Central - Schick Hotel Wien [more info](#)

Taborstrasse 8, 1020 Wien, Austria -  
01 211050  
★★★★★ 244 reviews  
"Positive: Warm welcome, friendly  
personal, good location and affordable



# Multi-domain Map Visualization

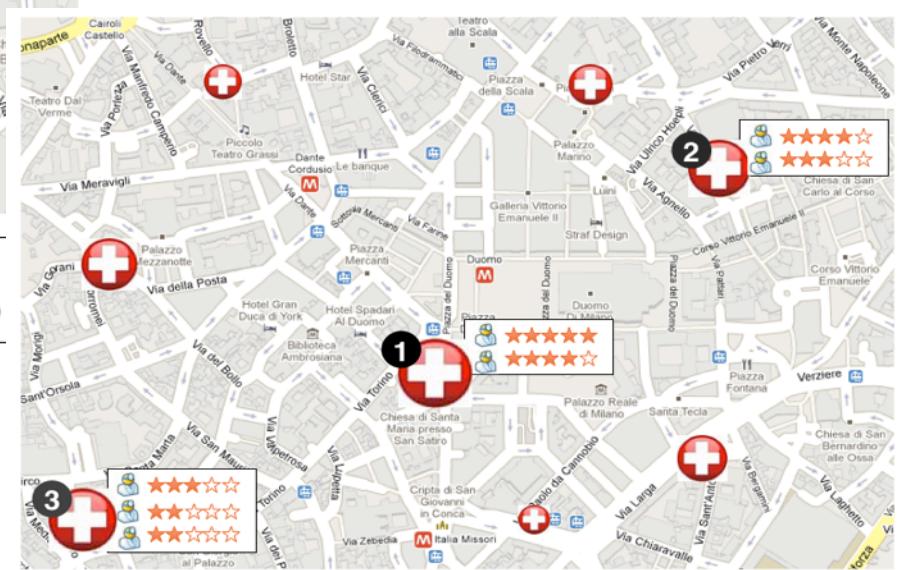


RESULT COMBINATIONS

**1** **2** **3** **4** **5** **6** **7** **8** **9** **10**



Page 1 of 20



RESULT COMBINATIONS

**1** **2** **3** **4** **5** **6** **7** **8**

# Atom View

**Paper - DBLP**

Title	Address
(Sem through Prob)	<a href="#">Show Details</a> <a href="#">Expand</a> <a href="#">Filter</a>
A Caching Mechanism for Semantic Web Service Discovery.	2007
A Collaborative Semantic Web Layer to Enhance Legacy Systems.	2007
A Constraint-Based Graph Visualisation Architecture for Mobile Semantic Web Interfaces	2007

**Author - DBLP**

Name	Num Paper
Dimitris Kotzinos	8
Yannis Tzitzikas	52
Jörg Hoffmann	67
Martin Hepp	49
Michael Stollberg	17
Alberto Salvati	3
Aldo Gangemi	45
Alfio Massimiliano Gliozzo	15
Elena Cardillo	3

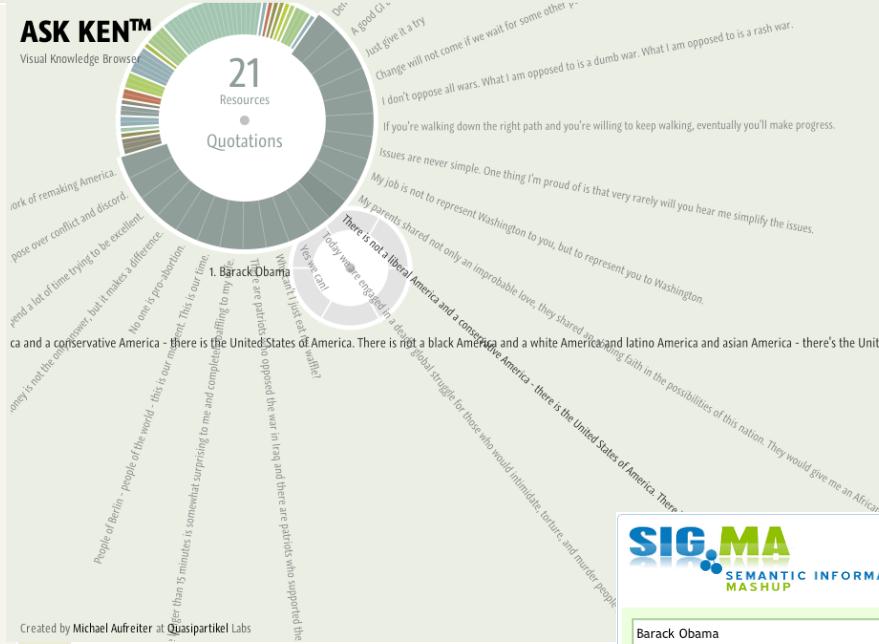
**Conference - Citeseer**

Title	Impact Rating
Artificial Intelligence and Applications	N.A.
SMRR	N.A.
ICDCIT	0.01
SAMT (Posters and Demos)	N.A.
ICEIS (Selected Papers)	0.01
EUROCAST	N.A.
CIT	N.A.
ICECCS	N.A.

## Ranked Combinations

- 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38

# Provenance and Relationships



<http://askken.herokuapp.com/>

Version: 1.1

# SIGMA SEMANTIC INFORMATION MASHUP

Help About Forum

Barack Obama Add More Info Start New Order Options Use it

## Barack Obama

picture:  [11]

comment: Barack Hussein Obama II (born August 4, 1961) is the 44th and current President of the United States. The first African American to hold the office, he previously served as the junior United States Senator from Illinois from January 2005 until he resigned after his election to the presidency in November 2008. Obama is a graduate of Columbia University and Harvard Law School, where he was the president of the Harvard Law Review. He was a community organizer in Chicago before earning his law degree. He worked as a civil rights attorney in Chicago and taught constitutional law at the University of Chicago Law School from 1992 to 2004. Obama served three terms in the Illinois Senate from 1997 to 2004. Following an unsuccessful bid for a seat in the U.S. House of Representatives in 2000, Obama ran for United States Senate in 2004. His victory, from a crowded field, in the March 2004 Democratic primary raised his visibility. His prime-time televised keynote address at the Democratic National Convention in July 2004 made him a rising star nationally in the Democratic Party. He was elected to the U.S. Senate in November 2004 by the largest margin in the history of Illinois. He began his run for the presidency in February 2007. After a close campaign in the 2008 Democratic Party presidential primaries against Hillary Rodham Clinton, he won his party's nomination, becoming the first major party African American candidate for president. In the 2008 general election, he defeated Republican nominee John McCain and was inaugurated as president on January 20, 2009. [11]

President of the United States. The first United States Senator from Illinois from November 2008. Obama is a graduate of the Harvard Law Review. [1]

President of the United States. The first United States Senator from Illinois from November 2008. Obama is a graduate of the Harvard Law Review. He was worked as a civil rights attorney in law school from 1992 to 2004. Obama made an unsuccessful bid for a seat in the Senate in 2004. His victory, from a city. His prime-time televised keynote speech him a rising star nationally in the by the largest margin in the history of those campaign in the 2008 Democratic party's nomination, becoming the first general election, he defeated Republican 09. [1]

Version: 1.1.18

Order ↗ Options ⚙ Use it ↘

Sources (20)  Approved (0)  Rejected (0)

1 [Piano Obama, salvi 2,4 m...](#) 5 facts | 2010-03-02  
KKAM http://www.ansta.it/web/enrichednews/topne...

2 [Crisi: Obama, sfide dava...](#) 5 facts | 2010-03-02  
KKAM http://www.ansta.it/web/enrichednews/topne...

3 [Obama vuol ridurre arsen...](#) 5 facts | 2010-03-02  
KKAM http://www.ansta.it/web/enrichednews/topne...

4 [Riforma sanità', Obama: sa...](#) 5 facts | 2010-03-19  
KKAM http://www.ansta.it/web/enrichednews/topne...

5 [Crisi: Obama, evitata ca...](#) 4 facts | 2010-03-03  
KKAM http://www.ansta.it/web/enrichednews/topne...

6 [Usa: per 52% Obama non m...](#) 5 facts | 2010-03-02  
KKAM http://www.ansta.it/web/enrichednews/topne...

7 [Start2: Medvedev, evento...](#) 5 facts | 2010-04-08  
KKAM http://www.ansta.it/web/enrichednews/topne...

8 [Untitled document](#) 4 facts | 2010-03-03  
KKAM http://www.ansta.it/web/enrichednews/topne...

9 [Obama-Medvedev auspiciano...](#) 5 facts | 2010-03-02  
KKAM http://www.ansta.it/web/enrichednews/topne...

10 [Check up a Obama: sta be...](#) 5 facts | 2010-03-02  
KKAM http://www.ansta.it/web/enrichednews/topne...

11 [Barack Obama](#) 591 facts | 2010-04-03  
http://dbpedia.org/resource/Barack\_Obama

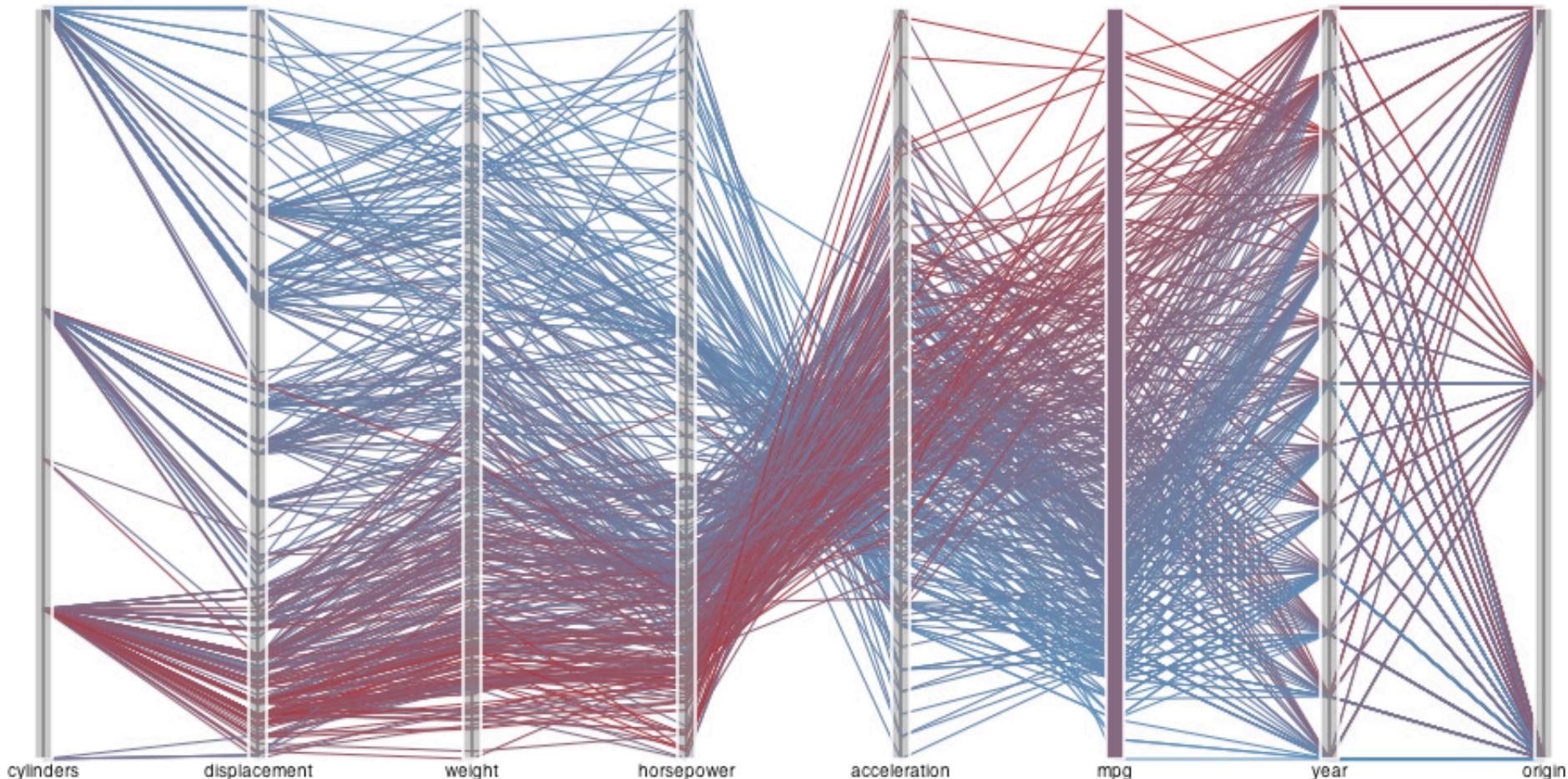
12 [Start2:Obama a Praga per...](#) 5 facts | 2010-04-08  
KKAM http://www.ansta.it/web/enrichednews/topne...

< 1 2 >

reject all ↑ approve all ↑

<http://example.loc/document.rdf> add source un

# Parallel Coordinates



<http://vis.stanford.edu/protovis/ex/cars.html>

# Faceted Search

## CIA World Factbook – People

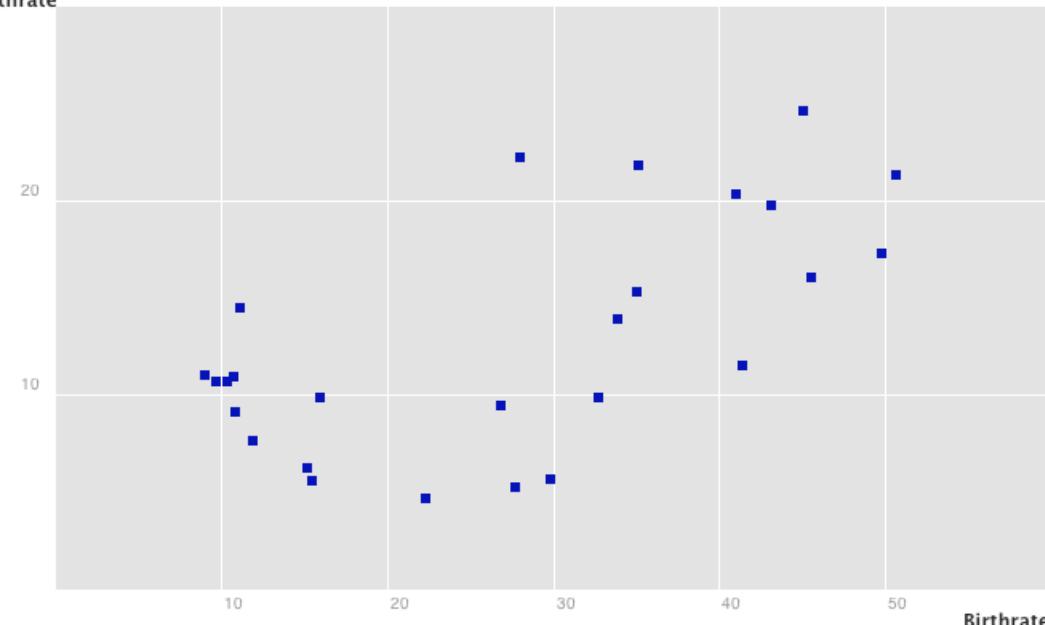
### Languages

- 2 Amerindian
- 2 Arabic
- 1 Aramaic
- 1 Armenian
- 1 Bambara
- 1 Bantu
- 1 Bemba
- 1 Cakchiquel
- 4 Castilian Spanish
- 1 Chichewa
- 1 Circassian
- 1 Czech
- 1 Dioula
- 1 Djerma
- 2 Dutch
- 6 English
- 12 French
- 1 Frisian
- 2 Ga
- 1 Garifuna
- 1 German
- 1 Greek
- 2 Hasaniya Arabic

26 Countries filtered from 270 originally (Reset All Filters)

Deathrate

### BIRTHRATE VS. DEATHRATE • POPULATIONS



### Members Of

- 1 (missing this field)
- 12 AFRICA
- 2 ARABSAT
- 3 ASIA
- 18 BWC
- 1 CARIBBEAN

### Population

- 166 0 - 10000000
- 26 10000000 - 20000000
- 15 20000000 - 30000000
- 8 30000000 - 40000000
- 7 40000000 - 50000000
- 1 50000000 - 60000000
- 5 60000000 - 70000000
- 3 70000000 - 80000000
- 3 80000000 - 90000000
- 1 100000000 - 110000000
- 1 120000000 -

<http://vis.stanford.edu/protovis/ex/cars.html>

# Result Page Real Estate

- More Complete information on one search

YAHOO! Web Images Video Local Shopping News More ▾

legal seafood boston Search Options ▾

Search Pad SearchScan - On

8,420,103 results for legal seafood boston:

Legal Seafood local.yahoo.com (617) 378-4000 6 Fid Kennedy Ave Boston, MA ★★★★☆ (4) Show All Yelp Yahoo! Local Wikipedia Local Business Sites

4 Reviews | Directions

Legal Sea Foods - The Standard for Quality and Freshness in ... Legal Sea Foods is a sustainable seafood restaurant chain and mail-order business. Site includes fresh fish news, catering services, location list, and online shopping. ... Legal Sea Foods near you www.legalseafoods.com - Cached

Restaurant Listings - Legal Sea Foods - The Standard for ... Search for your Local Legal Sea Foods Location, Menus, Directions, and more. ... Boston - Legal Test Kitchen. Seaport. 225 Northern Avenue. Boston, MA 02210. 617-330-7430 ... legalseafoods.com/index.cfm?cd=LOCATION&pid=11279&cdid=11845 - 55k - Cached

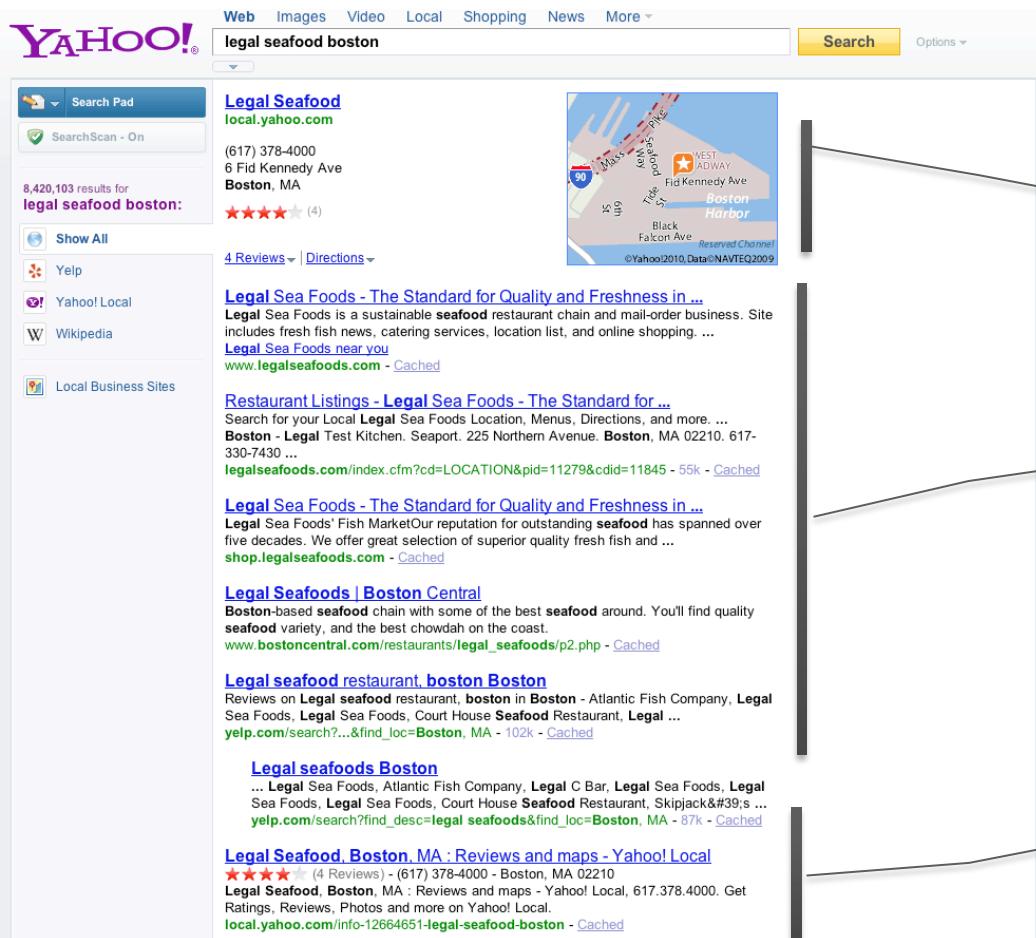
Legal Sea Foods - The Standard for Quality and Freshness in ... Legal Sea Foods' Fish Market Our reputation for outstanding seafood has spanned over five decades. We offer great selection of superior quality fresh fish and ... shop.legalseafoods.com - Cached

Legal Seafoods | Boston Central Boston-based seafood chain with some of the best seafood around. You'll find quality seafood variety, and the best chowdah too. www.bostoncentral.com/restaurants/legal\_seafoods/p2.php - Cached

Legal seafood restaurant, boston Boston Reviews on Legal seafood restaurant, boston in Boston - Atlantic Fish Company, Legal Sea Foods, Legal Sea Foods, Court House Seafood Restaurant, Legal ... yelp.com/search?...&find\_loc=Boston, MA - 102k - Cached

Legal seafoods Boston ... Legal Sea Foods, Atlantic Fish Company, Legal C Bar, Legal Sea Foods, Legal Sea Foods, Legal Sea Foods, Court House Seafood Restaurant, Skipjack's ... yelp.com/search?find\_desc=legal\_seafoods&find\_loc=Boston, MA - 87k - Cached

Legal Seafood, Boston, MA : Reviews and maps - Yahoo! Local ★★★★☆ (4 Reviews) - (617) 378-4000 - Boston, MA 02210 Legal Seafood, Boston, MA : Reviews and maps - Yahoo! Local, 617.378.4000. Get Ratings, Reviews, Photos and more on Yahoo! Local. local.yahoo.com/info-12664651-legal-seafood-boston - Cached



## Shortcuts

## Deep Links

## Enhanced Results

# Page Layout Optimization\_1

- Optimization of the result set layout (and of page space)

[Google](#)

[Everything](#)

[Maps](#)

[News](#)

[Blogs](#)

[Images](#)

[More](#)

**san francisco**

About 203,000,000 results (0.33 seconds)

[Search](#)

[Advanced search](#)

[Any time](#)

[Latest](#)

[Past 2 months](#)

[All results](#)

[Sites with images](#)

[More search tools](#)

[Something different](#)

[los angeles](#)

[san diego](#)

[seattle](#)

[sacramento](#)

[philadelphia](#)





[Hotels](#) - [Restaurants](#) - [Golden Gate Bridge](#) - [Golden Gate Park](#) - [Exploratorium](#) - [Alcatraz Island](#) San Francisco - [Lombard Street](#) - [San Francisco Museum of Modern Art](#)

**Only in San Francisco - San Francisco California Official Travel ...**

San Francisco, California official travel and visitors guide from Only In San Francisco. Find San Francisco hotel reservations, tours, flights, maps, ...  
 Activities - Visitor Info Center - Neighborhoods - Event Search  
[www.onlyinsanfrancisco.com/](#) - Cached - Similar

**What to do in San Francisco - Shows and Events.**

Explore the possibilities at San Francisco! Visit must see attractions to festival and events crowd pleasers. Take sightseeing tours in the day and go to ...  
[www.onlyinsanfrancisco.com/what\\_to\\_do/](#) - Cached - Similar

**San Francisco - Wikipedia, the free encyclopedia**

The City and County of San Francisco is the fourth most populous city in California and the 12th most populous city in the United States, ...  
[en.wikipedia.org/wiki/San\\_Francisco](#) - 17 hours ago - Cached - Similar

# Page Layout Optimization\_2

- Optimization of the result set layout (and of page space)

**Google**

brad pitt

About 16,900,000 results (0.14 seconds)

[Advanced search](#)

[Search](#)

**News for brad pitt**


Truth, Lies & Ted: Will Angelina Jolie Direct **Brad Pitt**? - 2 hours ago

Does Angelina Jolie have plans to direct **Brad Pitt** in a movie? Do Robert Pattinson and Kristen Stewart not understand why fans relate to their Twilight ...

[El Online \(blog\) - 670 related articles »](#)

[Jennifer Aniston enjoys the company of a mystery man - Daily Mail - 12 related articles »](#)

[Pitt not making film on Gulf of Mexico oil spill - Hindustan Times - 62 related articles »](#)

New York  
Daily  
News

**Brad Pitt - Wikipedia, the free encyclopedia** 

William Bradley "Brad" Pitt (born December 18, 1963) is an American actor and film producer. Pitt has received two Academy Award nominations and four Golden ...

[Early life - Career - Other projects - In the media](#)

[en.wikipedia.org/wiki/Brad\\_Pitt](http://en.wikipedia.org/wiki/Brad_Pitt) - [Cached](#) - [Similar](#)

**Brad Pitt** 

**Brad Pitt** was born in 1963 in Oklahoma and raised in Springfield, Missouri... Visit IMDb for Photos, Filmography, Discussions, Bio, News, Awards, Agent, ...

[Biography - By year - Photo gallery - By genre](#)

[www.imdb.com/name/nm0000093/](http://www.imdb.com/name/nm0000093/) - 14 hours ago - [Cached](#) - [Similar](#)

**Brad Pitt Fan • www.bradpittfan.com • Your Source for Everything ...** 

Biography, related links, and filmography. Features a photograph archive with more than 10000 pictures.

[bradpittfan.com/](http://bradpittfan.com/) - [Cached](#) - [Similar](#)

**Images for brad pitt** - Report images









# Page Layout Optimization\_3

- Optimization of the result set layout (and of page space)

**Google**

Search

Advanced search

About 4,140,000 results (0.12 seconds)

**Images for claudia schiffer** - Report images










**Claudia Schiffer - Wikipedia, the free encyclopedia** 

Claudia Schiffer (born 25 August 1970) is a German model and actress, who reached the peak of her popularity during the 1990s, initially due to her ...  
 Background - Modelling and fashion - Media appearances  
[en.wikipedia.org/wiki/Claudia\\_Schiffer](en.wikipedia.org/wiki/Claudia_Schiffer) - Cached - Similar

**Claudia Schiffer** 

The Fan Website of **Claudia Schiffer**. El Sitio Web Fan de **Claudia Schiffer**.  
<www.claudia-schiffer.com.ar/> - Cached - Similar

**Claudia Schiffer** 

aka "Claudia Schiffer's Perfectly Fit" - USA (complete title); "7 sur 7" . .... L'home a la lluna i  
**Claudia Schiffer** (2008) TV episode . ...  
<www.imdb.com/name/nm0000629/> - Cached - Similar

**Videos for claudia schiffer**



**Claudia Schiffer**  
4 min - 23 Jan 2007  
Uploaded by projectcarla  
[www.youtube.com](http://www.youtube.com)



**Claudia schiffer**  
57 sec - 28 Apr 2007  
Uploaded by galadre123  
[www.youtube.com](http://www.youtube.com)

# Page Layout Optimization\_3

- Optimization of the result set layout (and of page space)

**Google**

claudia schiffer

About 4,140,000 results (0.12 seconds)

[Search](#) [Advanced search](#)

[Everything](#) [Images](#) [Videos](#) [Blogs](#)

**Images for claudia schiffer - Report images**



**Good guess of the user intent ☺**

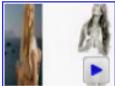
The Fan website of **Claudia Schiffer**. El Sitio web Fan de **Claudia Schiffer**.  
[www.claudia-schiffer.com.ar/](http://www.claudia-schiffer.com.ar/) - Cached - Similar

**Claudia Schiffer**   
 aka "Claudia Schiffer's Perfectly Fit" - USA (complete title); "7 sur 7" . . . L'home a la lluna i  
**Claudia Schiffer** (2008) TV episode . . .  
[www.imdb.com/name/nm0000629/](http://www.imdb.com/name/nm0000629/) - Cached - Similar

**Videos for claudia schiffer**



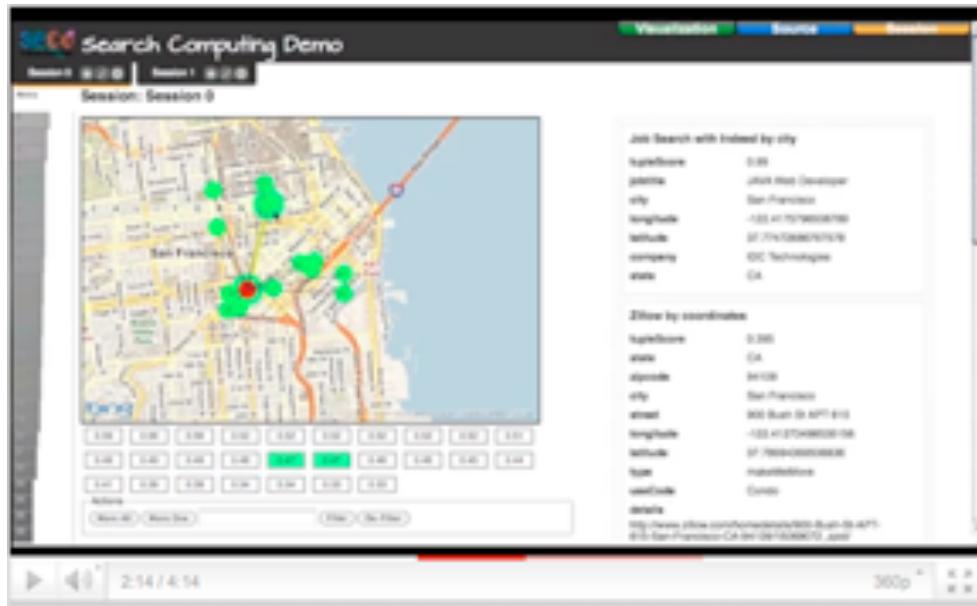
**Claudia Schiffer**  
 4 min - 23 Jan 2007  
 Uploaded by projectcarola  
[www.youtube.com](http://www.youtube.com)



**Claudia schiffer**  
 57 sec - 28 Apr 2007  
 Uploaded by galadre123  
[www.youtube.com](http://www.youtube.com)

DEMO VIDEO: <http://youtu.be/GkF36gUP7Ss>

# Search Computing UI Demos



# Open research problems

- SocialSearch: harnessing social relationship for information seeking
  - How do we include other humans in the search loop?
    - Project N. 10 (Tutors Bozzon, Brambilla)
- Dynamic generation of visualizations for big data
  - How can we analyze huge amount of data with the best visualization paradigms?
    - Project N. 9 (Tutors Matera,Bozzon)
- How can we exploit exploratory search in vertical applications?
  - Projects N.7 and N.8 (Tutors Brambilla, Bozzon)