Introduction to Computational Advertising

MS&E 239

Stanford University

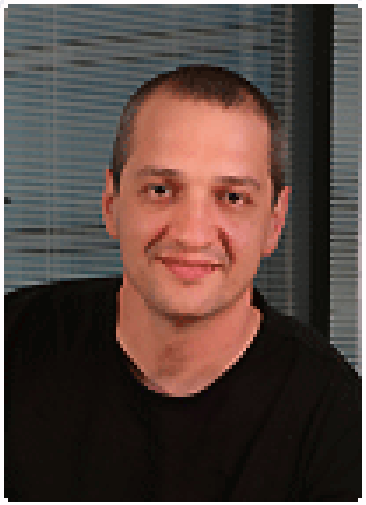
Autumn 2011

Instructors: Dr. Andrei Broder and Dr. Vanja Josifovski, Yahoo! Research

General course info

- Course Website: http://www.stanford.edu/class/msande239/
- TA: **Krishnamurthy Iyer**
  - Office hours: Tuesdays 6:30pm-7:00pm, Huang
- Course email lists
  - Staff:msande239-aut1112-staff
  - All: msande239-aut1112-students
  - Please use the staff list to communicate with the staff
- Lectures: 10am ~ 12:30pm Fridays in HP
- Office Hours:
  - After class
  - Andrei and Vanja will be on campus for 2 times each to meet and discuss with students. Feel free to come and chat about even issues that go beyond the class.

Instructor



- **Dr. Vanja Josifovski**
  - Senior Director at Yahoo! Research
  - Research Area: Computational Advertising, Search
  - Previously at IBM Research working on databases and enterprise search
  - M.Sc. from University of Florida, PhD from Linkopings University in Sweden
    - vanjaj@yahoo-inc.com
    - http://research.yahoo.com/Vanja_Josifovski

Instructor

- **Dr. Andrei Broder**
  - Fellow and Vice President for Computational Advertising in Yahoo! Research
  - Chief Scientist of Yahoo's Advertising Technology Group
  - Research interests: computational advertising, web search, context-driven information supply, and randomized algorithms
  - B. Sc. Summa cum Laude from the Technion, M.Sc. and Ph.D. in Computer Science at Stanford University under Don Knuth
    - broder@yahoo-inc.com
    - http://research.yahoo.com/Andrei_Broder

Course Overview (subject to change)

1. 09/30 Overview and Introduction
2. 10/07 Marketplace and Economics
3. 10/14 Textual Advertising 1: Sponsored Search
4. 10/21 Textual Advertising 2: Contextual Advertising
5. 10/28 Display Advertising 1
6. 11/04 Display Advertising 2
7. 11/11 Targeting
8. 11/18 Recommender Systems
9. 12/02 Mobile, Video and other Emerging Formats
10. 12/09 Project Presentations

This lecture

1. Logistics of the course
2. Introduction & Overview of Computational Advertising
3. Detailed discussion of the requirements, goals of the course, questions, anything else

Logistics

General lecture structure

- Overview of the area: 1:15 hour
- Break: 10 minutes
- Student presentation 15 min
- In depth, discussion, and occasional quizzes: 1 hour

Class requirements

- Homework 40%
- Project 40%
- Quizzes 10%
- In-class short presentation 10%
- Active attendance strongly encouraged!

Grading and Requirements

Projects – 40%

- Group assignment
  - Preferred group size is 3
- Start forming groups!
- Project commenced at the second class
- Chose one of two projects
  - Real world online advertising
  - Algorithmic project

Real world advertising project

- Craft a campaign for a real world company
- Find a company that can benefit from online advertising
  - Local business
  - Upcoming company (startup)
- Funding provided ($300)
- Craft campaigns
  - Major search engines
  - Display advertising Facebook/Google/Yahoo/MSFT
  - Smaller outlets that allow for customization/optimization
- Adjust campaign mid flight
- Important to learn something insightful!
- Write report and present at the last lecture (15min)

Algorithmic project

- Implement a small scale similarity search engine
- We provide a dataset based on a real world ad corpus
- Build an inverted index
- Implement two algorithms
- Explore multiple variants of the algorithms
- Write a report and present at the last class (15min)

Homework – 40%

- Total of 3 homework assignments
- Take home, open book one week to finish
- Third assignment to be a take-home, final with problems covering the while course
- Homework are individual assignments
  - Please do not work together on the homework assignments
  - If you have any questions please contact the staff

Quizzes – 10%

- Total of 2 quizzes
- In class after the break for 10 minutes
- A few short questions covering the salient points from the class
- The goal of the quizzes is to motivate attendance

In-class presentation – 10%

- Every student should participate in a in-class presentation
- after the break, 15 minutes
- Describe the business model and the technology of a given company in the computational advertising field
- Kris, our TA will do a presentation in the next class to demonstrate the format
- Please start forming groups (3-4 people per group), and contact Kris about the scheduling.
- We might need to have 2 presentations in some classes to accommodate everybody.

Introduction to Computational Advertising

Disclaimers

- This talk presents the opinions of the authors. It does not necessarily reflect the views of Yahoo! inc or any other entity.
- Algorithms, techniques, features, etc mentioned here might or might not be in use by Yahoo! or any other company.
- These lectures benefitted from the contributions of many colleagues and co-authors at Yahoo! and elsewhere. Their help is gratefully acknowledged.

Lecture 1 plan

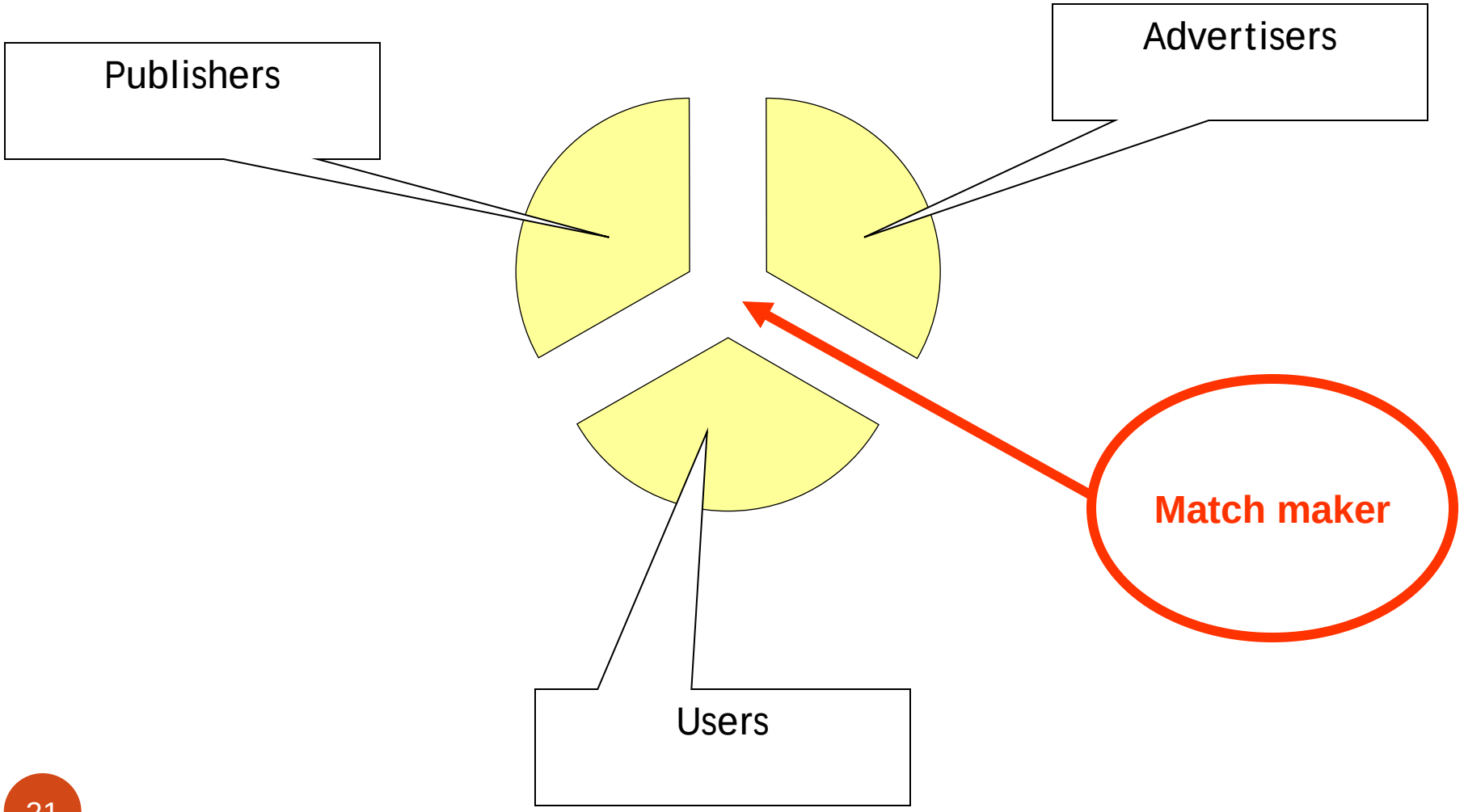
- Overview and key messages
- Classical advertising
  - Difference between classic and computational
- The opportunity: revenue and beyond
- Computational Advertising landscape
  - Graphical ads: guaranteed delivery, performance delivery, exchanges
  - Textual ads
- Ad selection
  - Textual ad selection
  - Performance graphical ads
- Mobile advertising
- Closing remarks

Computational advertising – the central challenge

Find the "best match" between a given user in a given context and a suitable advertisement.

- Examples
  - Context = Web search results → Sponsored search
  - Context = Publisher page → Content match, banners
  - Other contexts: mobile, video, newspapers, etc

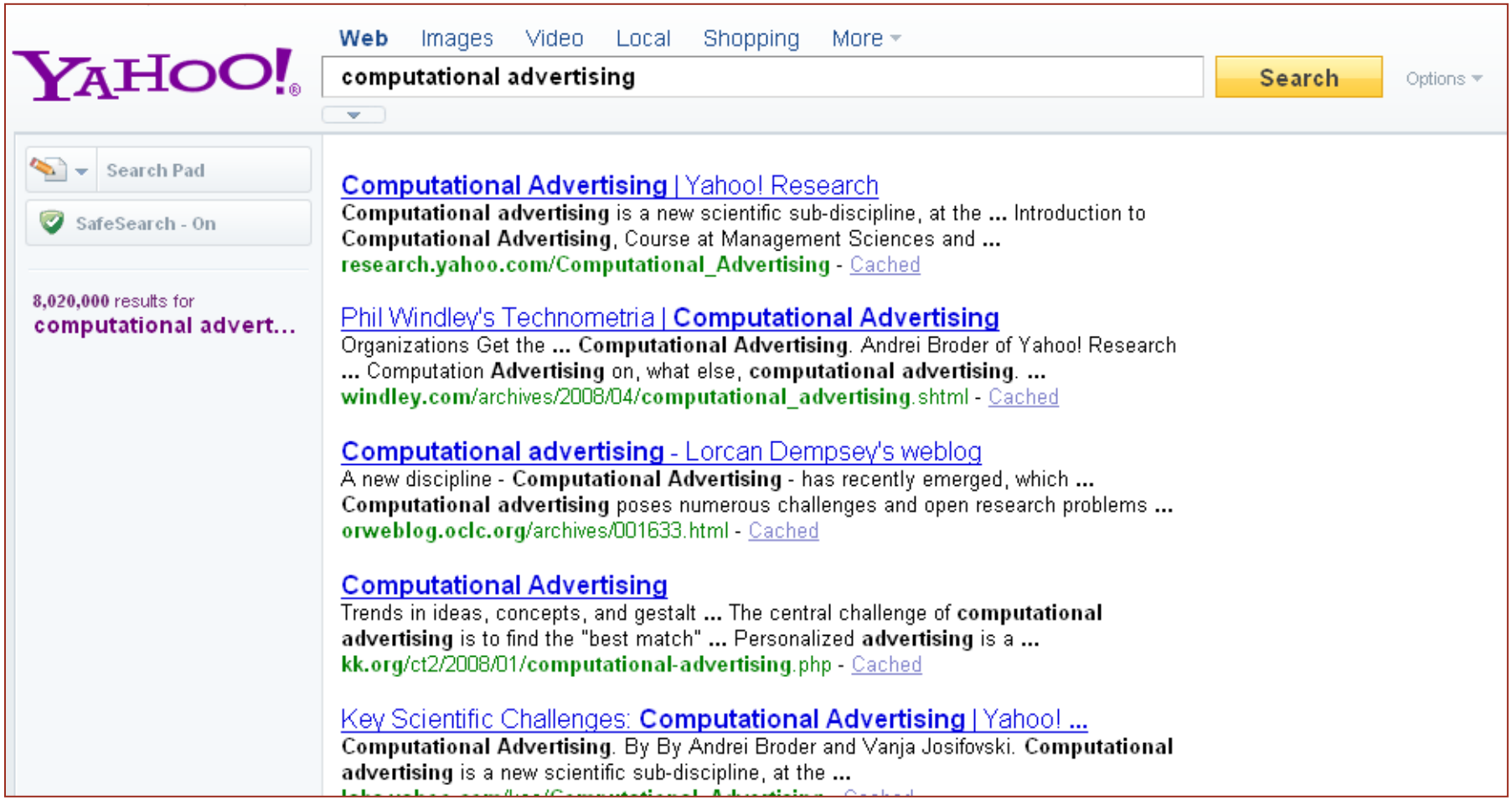
Participants: Publishers, Advertisers, Users, & "Matcher"



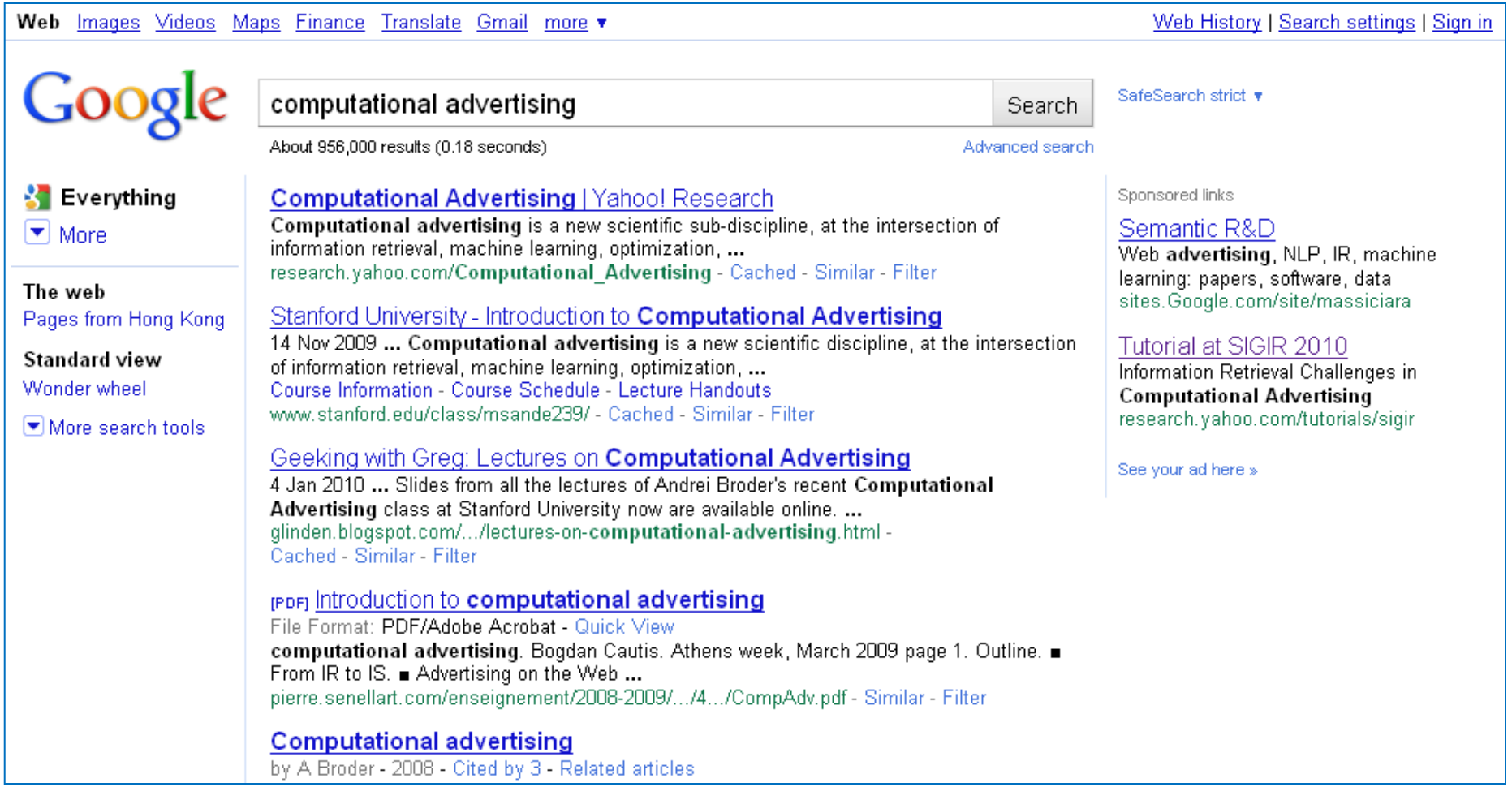
What is “Computational Advertising”?

- New scientific sub-discipline bringing together
  - Information retrieval
  - Large scale search and text analysis
  - Statistical modeling
  - Machine learning
  - Microeconomics
  - Game theory, auction theory, mechanism design
  - Classification
  - Optimization
  - Recommender systems
  - ….

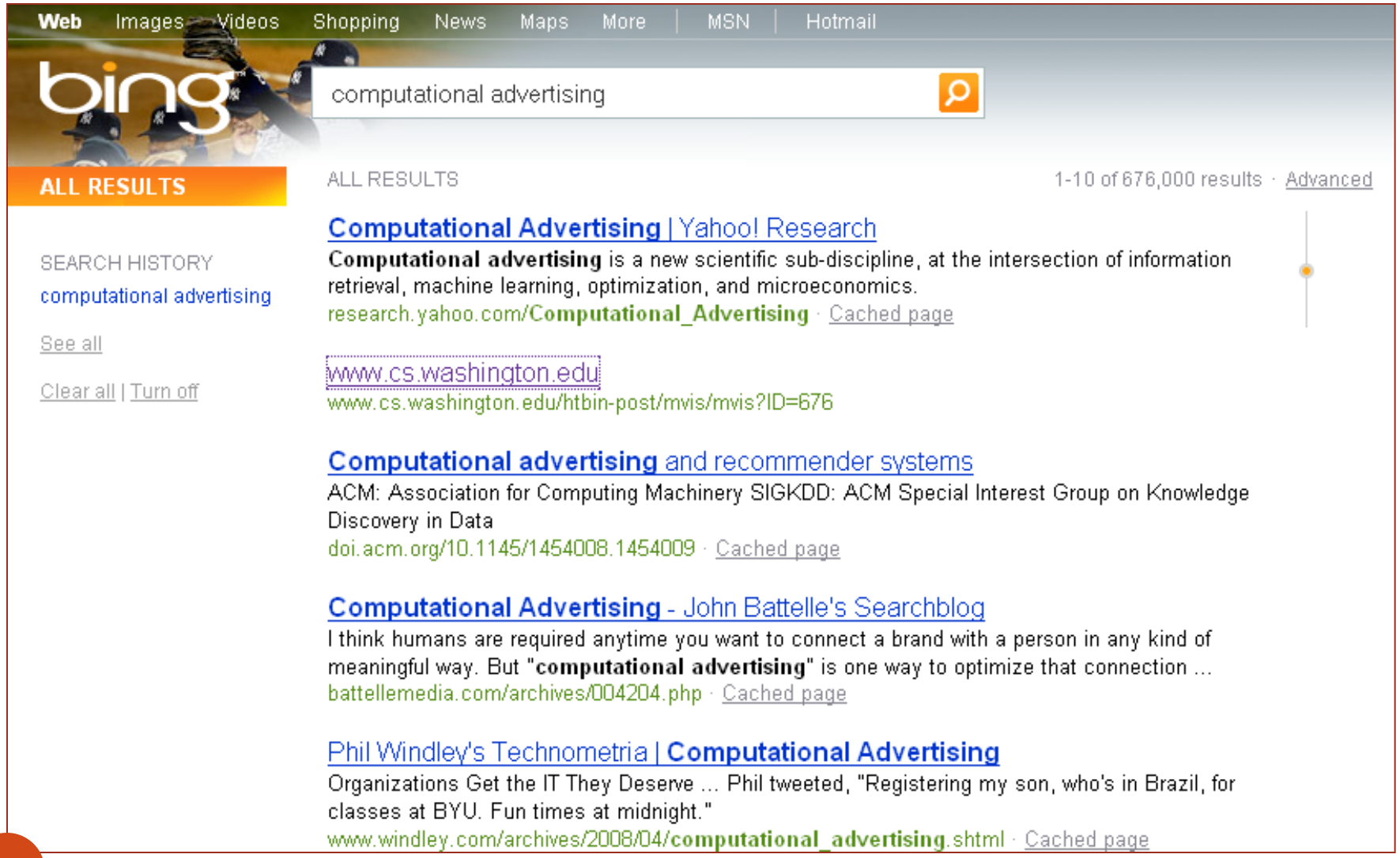
Establishing a new discipline…



Establishing a new discipline…



Establishing a new discipline…



CACM

Technology | DOI:10.1145/1506409.1506415 David Essex

Matchmaker, Matchmaker

Computational advertising seeks to place the best ad in the best context before the right customer.

Andrei Broder, vice president for computational advertising at Yahoo! Research, presenting a tutorial on Web search and advertising at the 30th Annual International ACM SIGIR Conference in Amsterdam.

THE RAPIDLY CHANGING advertisements that appear on Web pages are often chosen by sophisticated algorithms that match ad keywords to words on a Web page. Take the Chevy ad, for example, that frequently appears on your favorite news site. A real-time ad network at one of the major search engines—Google, MSN, and Yahoo!—might place it on a page of automotive news. But what if the news page's featured article is about a tragic accident caused by a mechanical failure in a Chevy SUV? That's not a page General Motors wants to be associated with, let alone pay good money to advertise on.

Costly mishaps like this could be avoided by a new discipline called computational advertising, which seeks to put the best ad in the best context before the right customer. It draws from numerous fields, including information retrieval, machine learning, natural-language processing, microeconomics, and game theory, and tries to match ads with a variety of user scenarios, such as querying a search engine, reading a Web page, watching a video on YouTube, or instant messaging a friend.

Computational advertising could spur the Web's growth as a medium of mass customization. Better ad matching could quicken the trend toward personalization, making highly specialized magazines, Web sites, and TV channels more financially viable. "Advertising has been the engine that has powered the huge development of the Web," says Andrei Broder, fellow and vice president for computational advertising at Yahoo! Research. "Without advertising, you would not have blogs and search engines."

Computational advertising is a type of automation that tries to replicate what humans might do if they had the time to read Web pages to discern their content and find relevant ads among the millions available. "In the old world of advertising, they deal with few choices and large amounts of money for each choice," Broder says. "We deal with maybe a hundred million potential ads, each worth a fraction of a cent."

A Perfect Match

There are basically three kinds of Web ads. Sponsored search ads are matched to the results of search engine queries; banner ads target particular demographics and venues, typically without regard to a page's content; and contextual advertising, also called context match, applies to other types of Web pages, such as the home page of a financial news site. Computational advertising addresses all three types of ads.

Google, MSN, and Yahoo! use electronic auctions to assign ads to their own results pages and the pages of other Web sites. "Google is a yenta," or matchmaker, says Google chief economist Hal Varian. "The goal is to get a perfect match."

In sponsored search, advertisers bid to place ads that contain keywords correlated to words in a user's search string. For contextual advertising, the keywords are related to words on the entire page, and the search engine's advertising service places the ads. For banner ads, online ad networks place ads on sites whose topics and audiences match the advertiser's criteria.

Before the advent of computational advertising, ad engines could make mistakes more simple-minded than the Chevy SUV scenario. Suppose, for example, a news page contains the word "flowers." If the article isn't about flowers but instead revisits the Rolling Stones' underrated 1967 record *Flowers*, the reader is unlikely to want ads from florists. The old method of analyzing co-occurring words and phrases doesn't help much, and neither does frequency. "You could extract a word used many times in the article and it still is not what the article is about," Broder says.

Therefore, Broder and the 30 researchers who work for him are finding ways to glean the meaning of a page. One promising avenue combines semantic and syntactic features. A semantic phrase categorizes the page and the ads into a 6,000-node topic taxonomy and compares the proximity of the two types of classes as a factor in ranking ads. The hierarchical taxonomy also improves the matching of ads that don't fit a page's exact topic. Keyword matching is still needed to capture more granular content, such as a specific brand of automobile. "We decided that what the article is about should count for about 80% and the words should count for 20%," Broder says.

Another area of interest is using statistical analysis to measure the effect of exogenous events on browsing behavior and adjust the advertisements accordingly. Varian cites short-lived examples, such as this year's rare snowfall in England, or longer-term ones such as the worldwide recession. "In the last few months, there is a big increase in interest in price-sensitive products," Varian says. "The advertisers, in turn, are trying to respond."

All three companies are close-lipped about which of their research has been commercialized, but say that new ideas for algorithms are quickly incorporated into their bidding mechanisms and advertiser tools. Bottom-line results are secret, but the search engines all collect metrics such as revenue per search.

Machine learning, another major focus, concentrates on training algorithms to scan pages for meaning, a technique employed successfully on single-topic documents with the aid of machine-generated labels, but trickier to perform on Web pages, with their assortment of graphics, text, and topics. Microsoft researchers have learned how to employ a type of multiple instance learning to automate classification of sub-documents on pages with incomplete labels and to detect the presence of certain types of content.

"Most of what we do can be boiled down to understanding intent," says Eric Brill, general manager of Microsoft adCenter Labs. By analyzing search strings, for example, algorithms can predict if a person is interested in ads. Some strings are pure attempts at finding information, while others, such as "buy Canon digital camera," have clear commercial intent. "When consumers don't have commercial intent, you don't want to put ads in front of them," Brill says.

Much work focuses on ensuring that new bidding mechanisms don't have incentives for advertisers to misrepresent click-through rates to get better ad placement. In the decentralized economy of the Internet, truthfulness is a currency reinforced by carefully crafted algorithms. "People are out there to make money," says Thore Graepel, a senior researcher at Microsoft Research. "We need to build mechanisms where everyone benefits."

One might expect the speed and volume of data to create a capacity problem, but the researchers express mixed opinions. Graepel says semantic analysis creates an extra burden. "You will hit a computational bottleneck, that's pretty clear," he says. To avoid this, researchers optimize algorithms to make the best decisions with the smallest possible data sets. But they also have faith in engineers' ability to exploit techniques such as parallel processing. "It's surprising how they are always able to scale to deal with these new algorithms," Varian says.

Privacy regulations remain an obstacle to personalizing ads, says Graepel. The existing opt-in, opt-out model lets users choose to reveal personal data in exchange for discounts and other incentives. Researchers are also investigating aggregating data on Web traffic to more accurately match ad categories with coarsely defined groups of users who identify their interests simply by visiting certain types of Web sites.

Fortunately, there is hope for avoiding embarrassments like the ill-placed Chevy ad. Researchers at Microsoft adCenter Labs claim their sub-document classification methods can prevent incompatible ads and Web sites from ever hooking up. You might call it a reverse matchmaker, just the sort of odd little entity the Internet's inventors might never have imagined. ■

David Essex is a freelance science writer based in Peterborough, NH.

Education

Computer Science Enrollment Increases

Enrollment in computer science classes in the United States has increased for the first time in six years, according to the Computing Research Association's (CRA's) annual Taulbee Survey.

Total enrollment by majors and pre-majors in computer science is up 6.2% per department over last year. If only majors are considered, the increase is 8.1%, according to the CRA survey, which collected enrollment data in fall 2008 from computer science and computer engineering departments at 192 Ph.D.-granting universities.

"The upward surge of student interest is real and bigger than anyone expected," says Peter Lee, incoming chair of CRA. "The fact that computer science graduates usually find themselves in high-paying jobs accounts for part of the reversal. Increasingly students also are attracted to the intellectual depth and societal benefits of computing technology."

Computer science graduates on average earn 13% more than the average college graduate, according to the U.S. Department of Labor, and future job prospects for computer science graduates are higher than for any other science or engineering field.

The average number of new students per department majoring in computer science is up 9.5% over last year. Computer science departments are replenishing the freshman and sophomore ranks with larger groups than they are graduating as seniors, and computer science graduation rates should increase in two to four years as these new students graduate.

The total number of Ph.D. graduates among responding departments grew to 1,877 for the period July 2007 to June 2008, a 5.7% increase over the previous year.

One area that didn't show improvement is the number of women pursuing computer science degrees, which held steady at 11.8%.

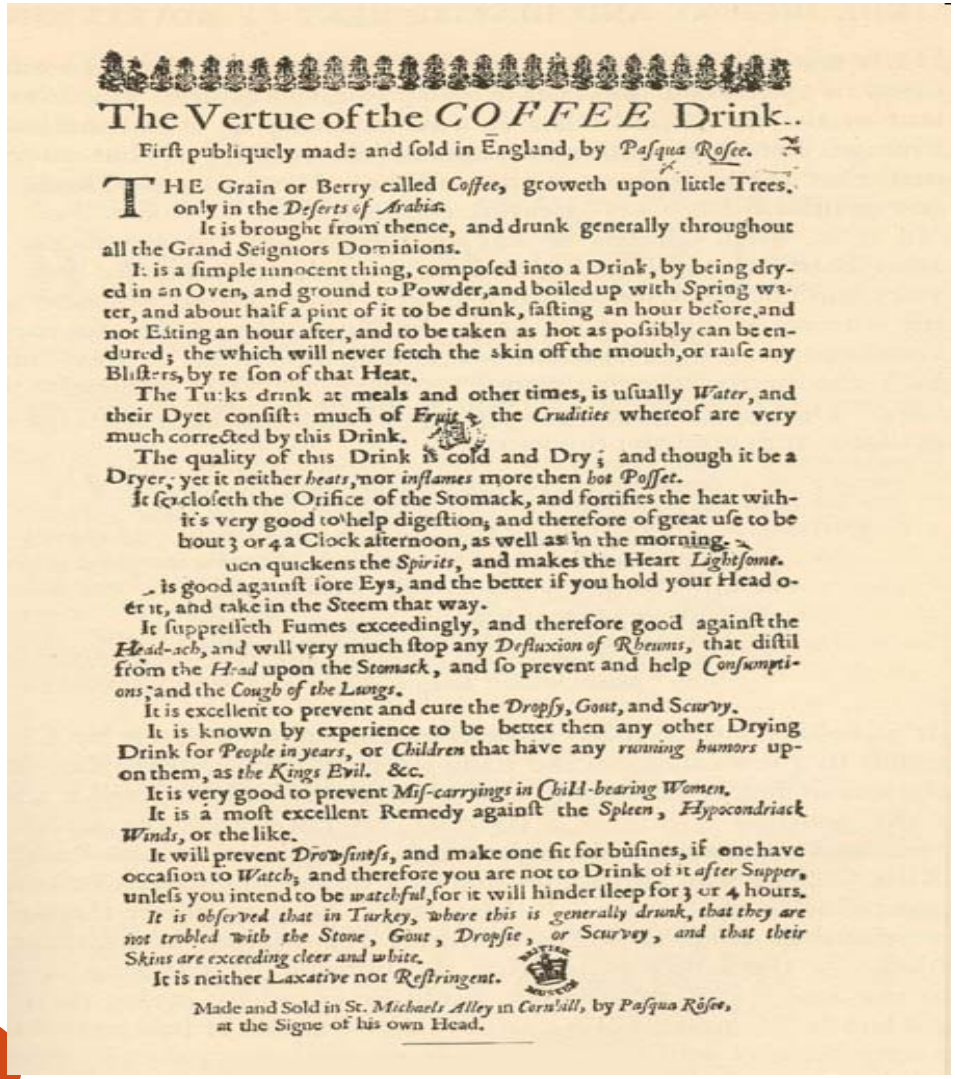
CACM, May 2009: http://mags.acm.org/communications/200905/?pg=18

Key messages

1. **Computational advertising = A principled way to find the "best match" between a user in a context and a suitable ad.**
2. **The financial scale for computational advertising is huge**
   - Small constants matter
   - Expect plenty of further research
3. **Advertising is a form of information**.
   - Adding ads to a context is similar to the integration problem of other types of information
   - Finding the “best ad” is a type of information retrieval problem with multiple, possibly contradictory utility functions
4. **New application domains and new techniques are emerging every day**
   - Good area for research + new businesses!

Classic Advertising

Long history: Advertising for coffee, London 1657



The Vertue of the *COFFEE* Drink.

First publiquely made and sold in England, by *Pasqua Rosee.*

THE Grain or Berry called *Coffee*, groweth upon little Trees, only in the *Deserts of Arabia.*

It is brought from thence, and drunk generally throughout all the Grand Seignors Dominions.

It is a simple innocent thing, composed into a Drink, by being dryed in an Oven, and ground to Powder, and boiled up with Spring water, and about half a pint of it to be drunk, fasting an hour before, and not Eating an hour after, and to be taken as hot as possibly can be endured; the which will never fetch the skin off the mouth, or raise any Blisters, by reason of that Heat.

The Turks drink at meals and other times, is usually *Water*, and their Dyet consists much of *Fruit*, the *Crudities* whereof are very much corrected by this Drink.

The quality of this Drink is cold and Dry; and though it be a Dryer, yet it neither *heats*, nor *inflames* more then *hot Posset.*

It *scloseth* the Orifice of the Stomack, and fortifies the heat within, it's very good to help digestion, and therefore of great use to be taken about 3 or 4 a Clock afternoon, as well as in the morning.

It quickens the *Spirits*, and makes the Heart *Lightsome.*

It is good against sore Eys, and the better if you hold your Head over it, and take in the Steem that way.

It suppresseth Fumes exceedingly, and therefore good against the *Head-ach*, and will very much stop any *Defluxion of Rheums*, that distil from the *Head* upon the *Stomack*, and so prevent and help *Consumptions*, and the *Cough of the Lungs.*

It is excellent to prevent and cure the *Dropsy*, *Gout*, and *Scurvy.*

It is known by experience to be better then any other Drying Drink for *People in years*, or *Children* that have any *running humors* upon them, as *the Kings Evil.* &c.

It is very good to prevent *Mis-carryings in Child-bearing Women.*

It is a most excellent Remedy against the *Spleen*, *Hypocondriack Winds*, or the like.

It will prevent *Drowsinesse*, and make one fit for business, if one have occasion to *Watch*, and therefore you are not to Drink of it *after Supper*, unless you intend to be *watchful*, for it will hinder sleep for 3 or 4 hours.

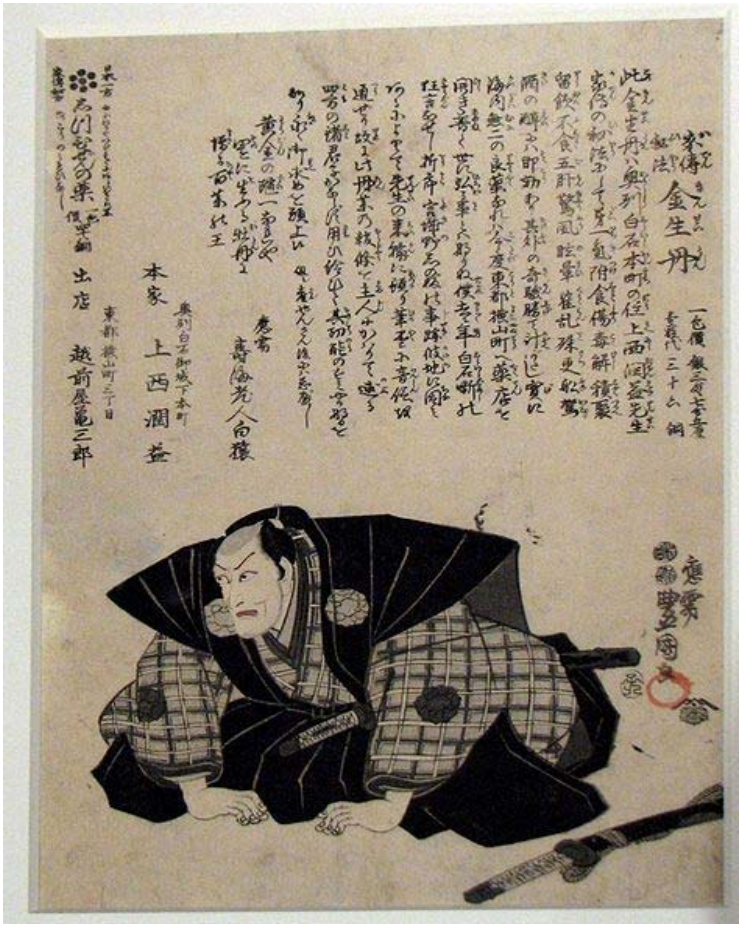
It is observed that in Turkey, where this is generally drunk, that they are not troubled with the Stone, Gout, Dropsie, or Scurvey, and that their Skins are exceeding cleer and white.

It is neither Laxative nor *Restringent.*

Made and Sold in St. *Michaels Alley* in *Cornhill*, by *Pasqua Rosee*, at the Signe of his own Head.

The ad explains "*The Vertue of the COFFEE drink*" what coffee is, how it grows, how it cures numerous maladies, including Dropsy, Gout, and Scurvy, …

Long history….



Japan ,1806

USA,1890

Brand advertising

Goal: create a distinct favorable image

Direct marketing

Advertising that involves a "direct response": buy, subscribe, vote, donate, etc, now or soon

Why “computational” advertising?

Lots of computational this and that …

- Computational Linguistics
- Computational Biology
- Computational Chemistry
- Computational Finance
- Computational Geometry
- Computational Neuroscience
- Computational Physics
- Computational Mechanics
- Computational Economics
- …

All are about

a) Mixing an old science with **computing capabilities**

b) **Thinking** algorithmically about an old challenge

Why go “computational” ?

- Classical:
  - Relatively few venues – magazines, billboards, newspapers, handbills, TV, etc
  - High cost per venue ($3Mil for a Super Bowl TV ad)
  - No personalization possible
  - Targeting by the wisdom of ad-people
  - Hard to measure ROI
- Computational – almost the exact opposite:
  - Billions of opportunities
  - Billions of creatives
  - Totally personalizable
  - Tiny cost per opportunity
  - Much more quantifiable

- "Half the money I spend on advertising is wasted; the trouble is I don't know which half.“

John Wanamaker, ~ 1875

Computational advertising – the central challenge

Find the "best match" between a given user in a given context and a suitable advertisement.

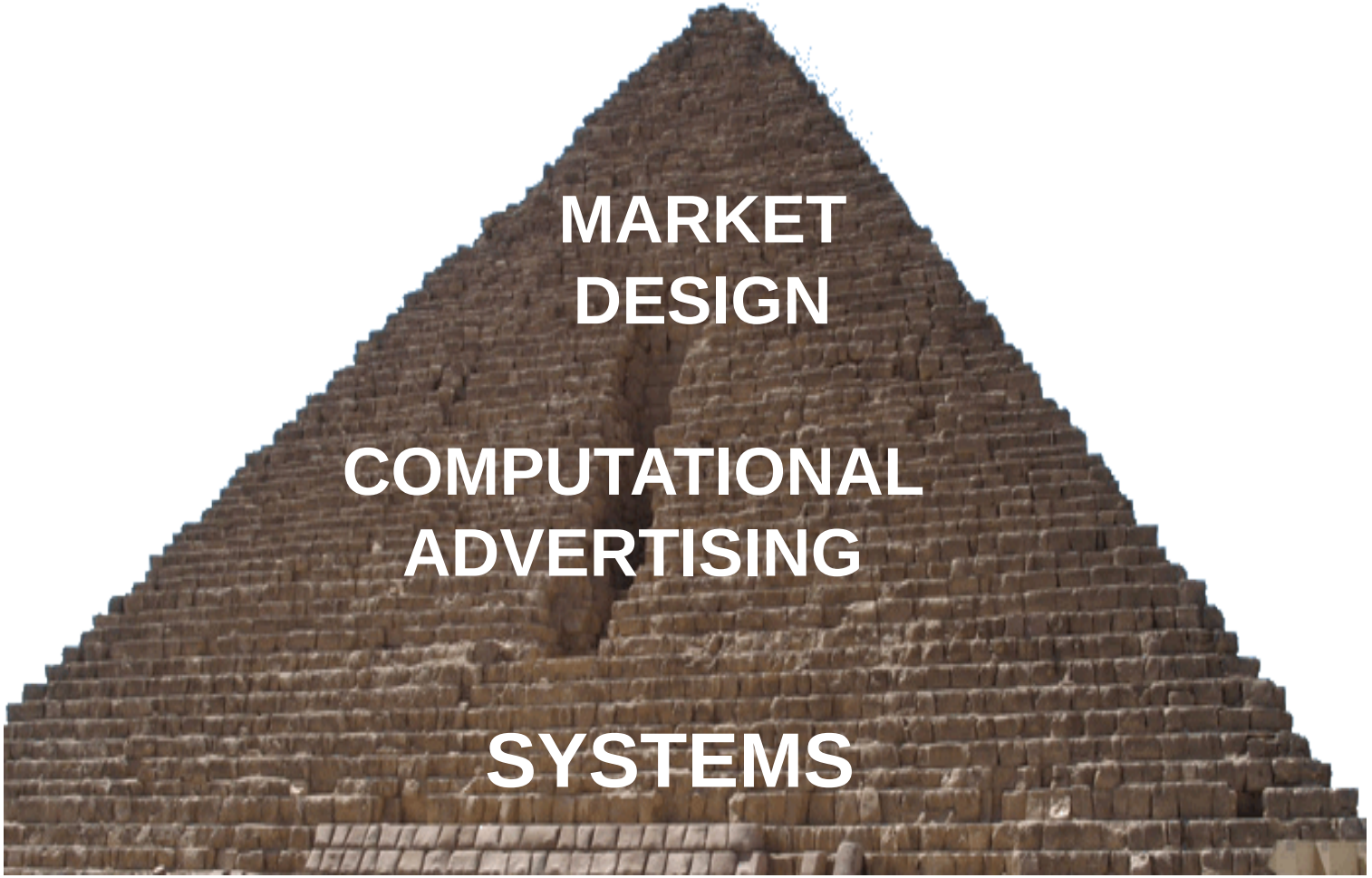
- Examples
  - Context = Web search results → Sponsored search
  - Context = Publisher page → Content match, banners
  - Other contexts: mobile, video, newspapers, etc
- Related challenge 1: Design markets and exchanges that help in this task, and maximize value for users, advertisers, and publishers
- Related challenge 2: Build the infrastructure to support this process

The central challenge decomposed

Find the "best match" between a given user in a given context and a suitable advertisement.

1. **Representation** = represent the user, the context, and the ads in an **effective & efficient** way
2. **Definition** = define the mathematical optimization problem to capture the actual marketplace constraints and goals
3. **Solution** = solve the optimization problem in an **effective & efficient** way

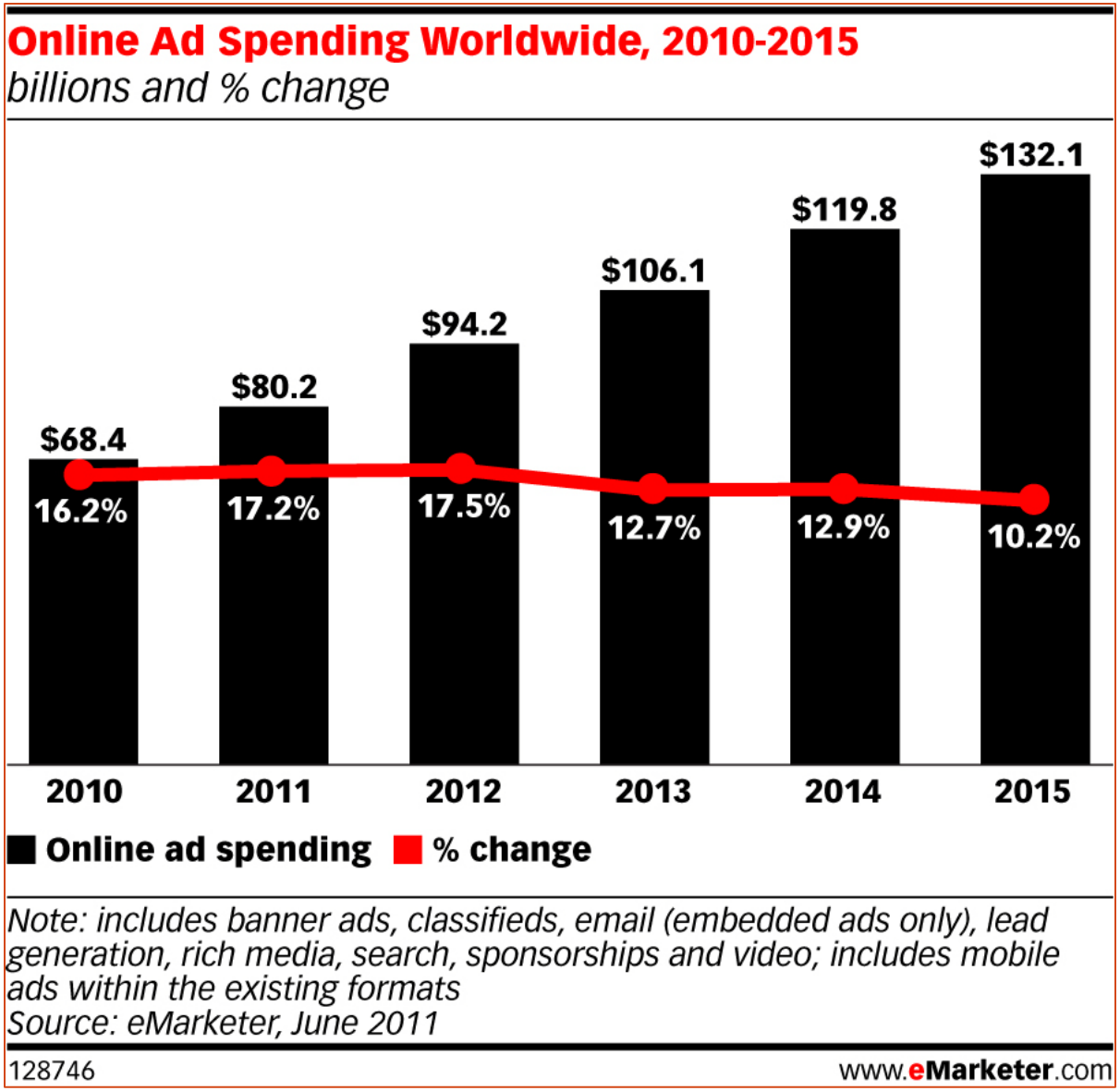
Computational Advertising and Market Design



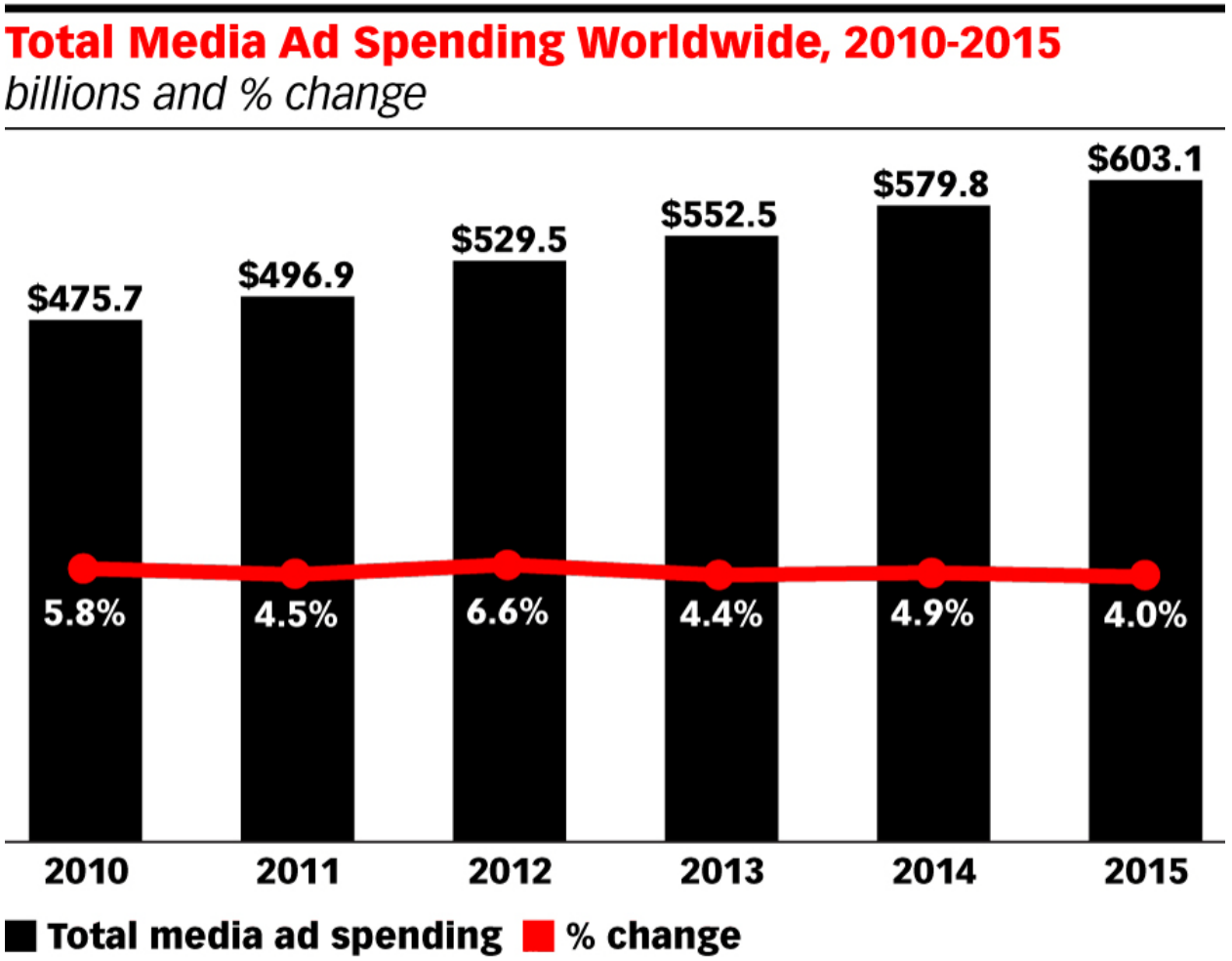
The Opportunity

The money and beyond

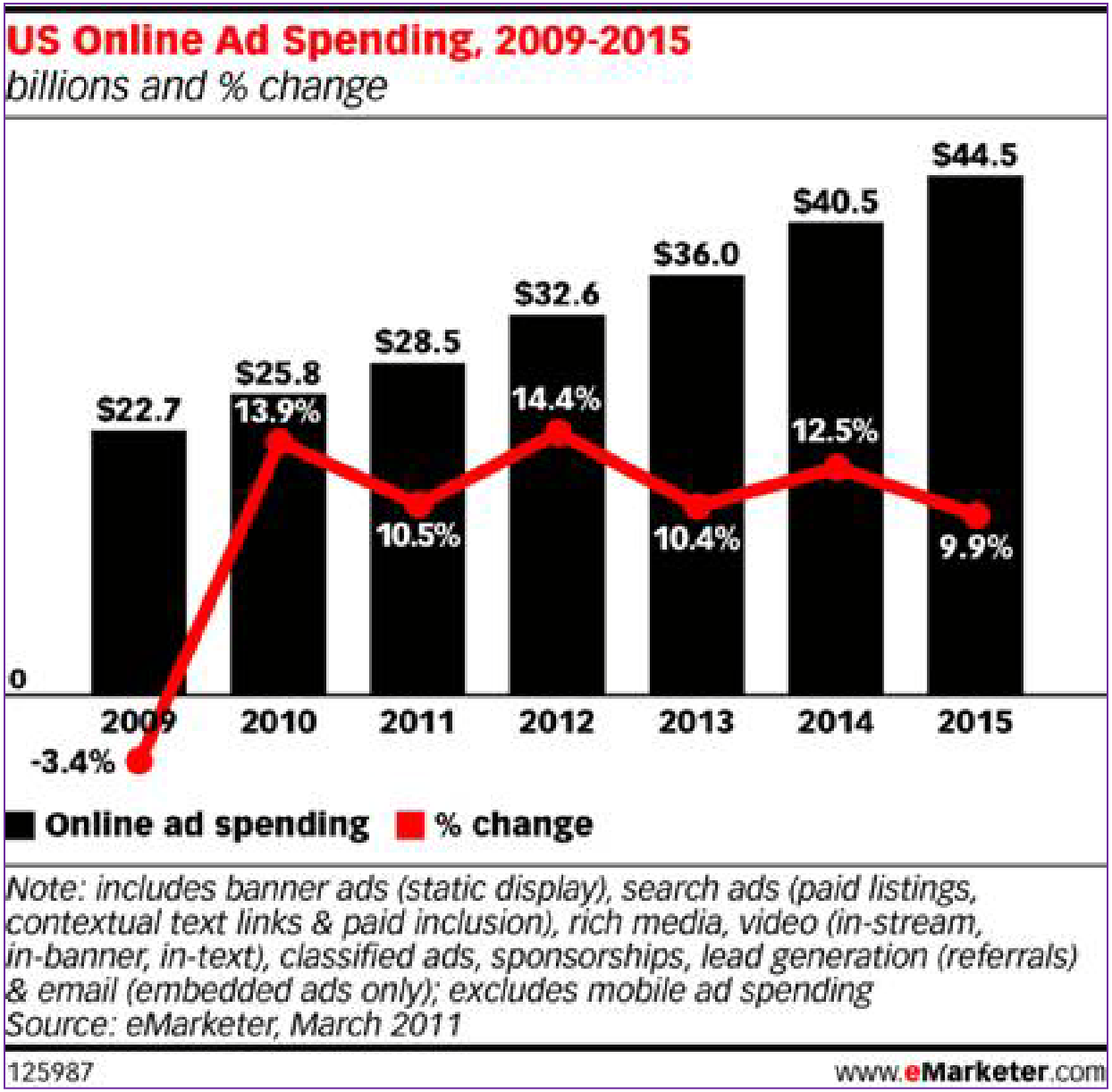
Online advertising is a huge business



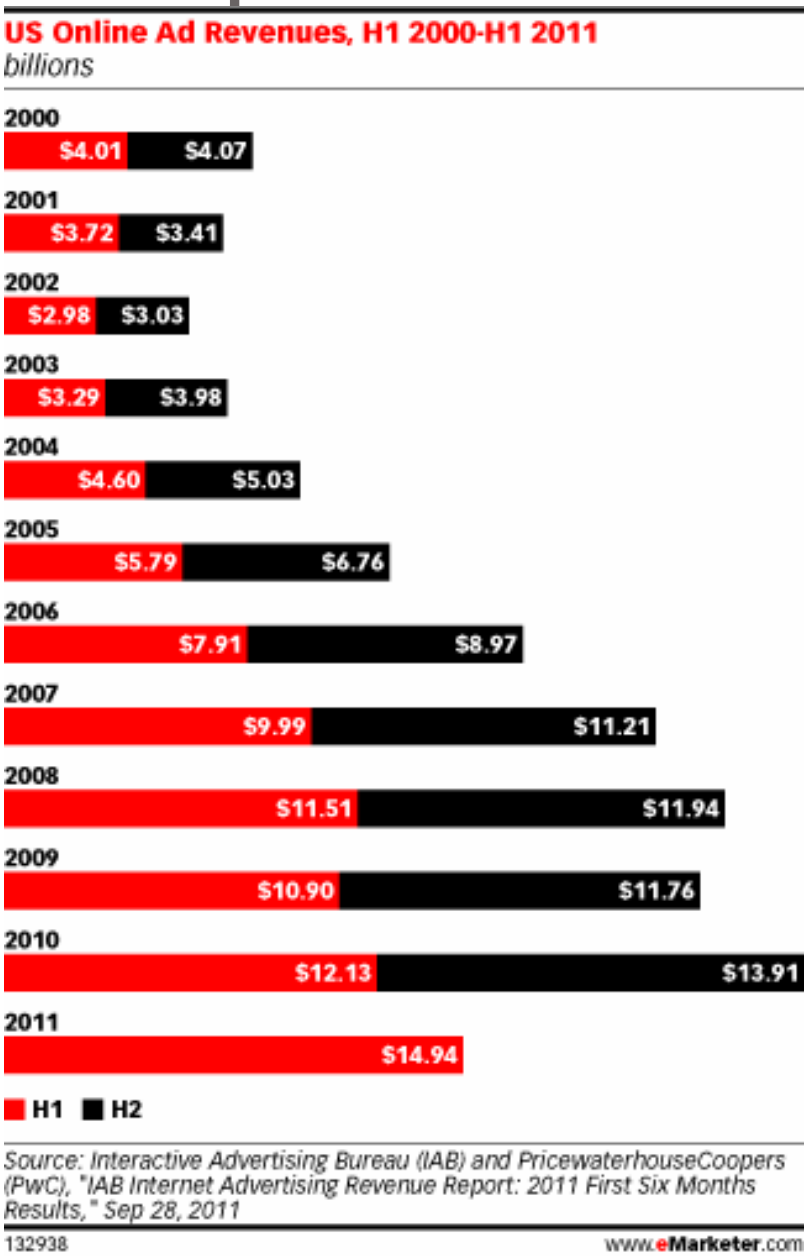
Total worldwide advertising spend



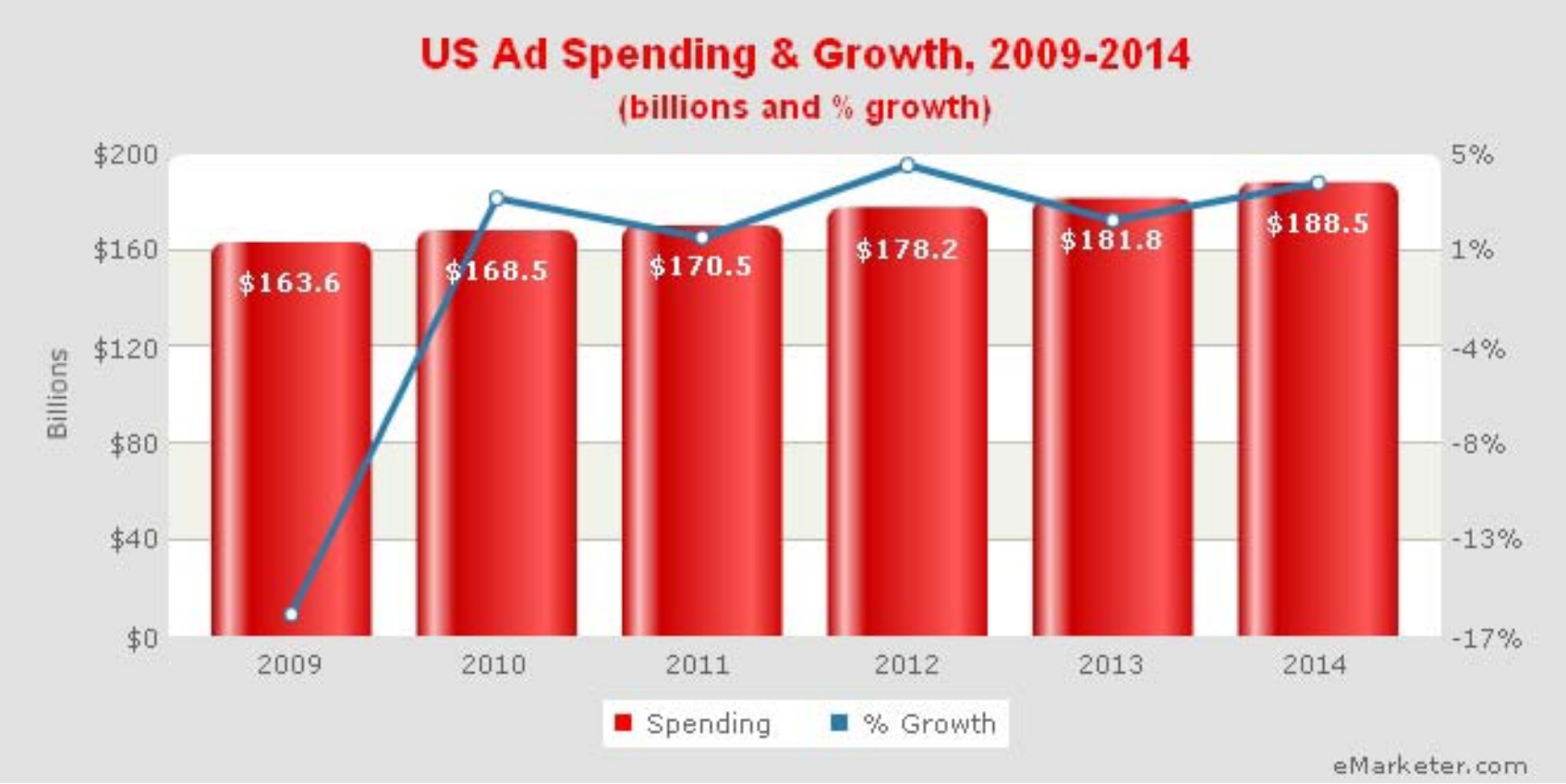
US Online Ad Spending



Hot off the press!



Total US advertising spend



Spending by format

US Online Ad Revenues, by Format, H1 2010 & H1 2011

millions and % change

	H1 2010	H1 2011	% change
Search	$5,747	$7,286	26.8%
Display	$4,356	$5,535	27.1%
—Banner ads	$2,744	$3,414	24.4%
—Rich media	$743	$763	2.7%
—Digital video	$627	$891	42.1%
—Sponsorship	$242	$467	93.0%
Classifieds	$1,262	$1,237	-2.0%
Lead generation	$642	$805	25.4%
Email	$120	$79	-34.2%
Total	**$12,127**	**$14,942**	**23.2%**

Source: Interactive Advertising Bureau (IAB) and PricewaterhouseCoopers (PwC), "IAB Internet Advertising Revenue Report: 2011 First Six Months Results," Sep 28, 2011

132943 www.eMarketer.com

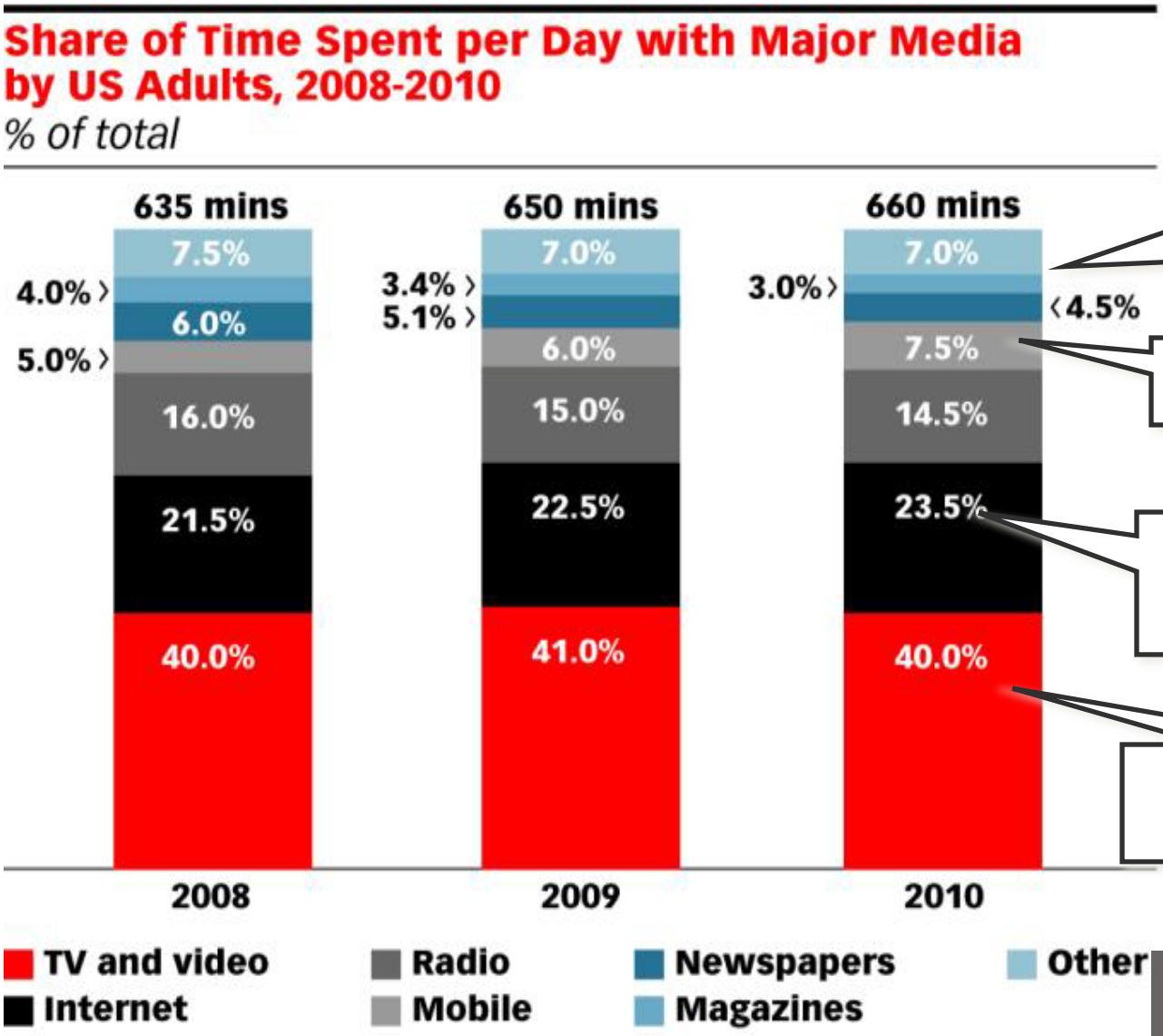
Who is spending the money?

US Online Ad Revenues, by Major Industry Category, H1 2010 & H1 2011
millions and % change

	H1 2010	H1 2011	% change
Retail	$2,425	$3,437	41.7%
Telecom	$1,698	$2,092	23.2%
Financial services	$1,455	$1,942	33.5%
Auto	$1,334	$1,644	23.2%
Computing products	$1,213	$1,494	23.2%
Consumer packaged goods	$970	$897	-7.6%
Leisure travel	$849	$1,195	40.8%
Pharma & healthcare	$606	$598	-1.4%
Media	$485	$598	23.2%
Entertainment	$485	$598	23.2%
Other	$606	$448	-26.1%
Total	**$12,127**	**$14,942**	**23.2%**

Note: industry definitions may have changed over the time period depicted, both within the survey process and definitionally by survey respondents; numbers do not add up to 100% because minor categories are not displayed
Source: Interactive Advertising Bureau (IAB) and PricewaterhouseCoopers (PwC), "IAB Internet Advertising Revenue Report: 2011 First Six Months Results," Sep 28, 2011

132944 www.eMarketer.com



Newspapers: 30 mins
Magazines:
20 mins

Mobile: 50 mins

Internet:
2 hrs, 35 mins

TV:
4 hrs, 24 mins

Internet Today:

23.5% of time
15.3% of dollars
8.2 p.p. gap

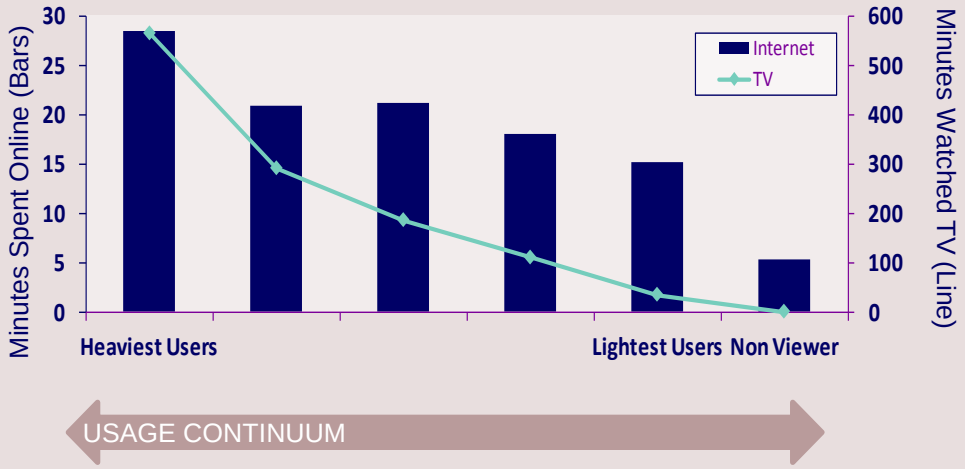
Over Half of Consumers are Simultaneously Online and Watching TV

M-F 6p-9p / Adults 25-54[1]

57%

Simultaneous Internet + TV

Media Consumption Level By Usage Quintile[2]



Source: [1]Knowledge Networks SRI, Fall studies, [2] Nielsen TV/Internet Convergence Research Panel

Dominant players

Net US Online Ad Revenues at Top 5 Ad-Selling Companies, 2009-2012

billions

	2009	2010	2011	2012
Google	$7.90	$10.03	$12.77	$16.53
Yahoo!	$3.66	$3.47	$3.46	$3.57
Facebook	$0.56	$1.21	$2.19	$2.87
Microsoft	$1.18	$1.49	$1.92	$2.66
AOL	$0.99	$0.88	$0.85	$0.86
Total top 5	**$14.28**	**$17.07**	**$21.19**	**$26.49**
Total internet	**$22.66**	**$26.04**	**$31.30**	**$36.80**

Note: net ad revenues after companies pay traffic acquisition costs (TAC) to partner sites

Source: company reports, April-May 2011; eMarketer, Jan & June 2011

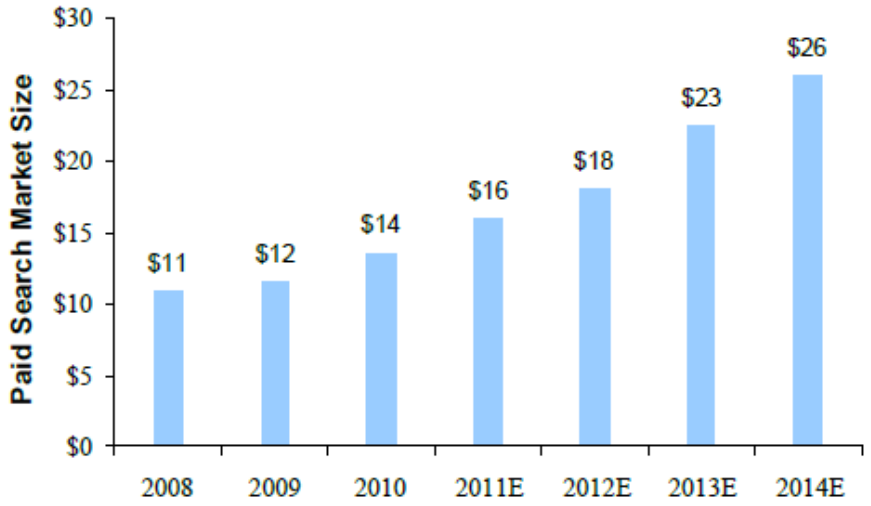
128187 www.eMarketer.com

Paid search marketshare

- Worldwide Internet users conduct over 200 billion searches each month
- Google drives roughly 46% of overall online ads with annual growth estimated at +20%
- Search should continue to be driven by leaders Google, Yahoo! and bing
- Search expected to benefit from growth of the mobile Internet

Leading the Search

($ in billions)



bing (~14% Market Share)

Google (~65% Market Share)

YAHOO! (~16% Market Share)

Source: Baird Equity Research, Gridley estimates and Search Engine Journal

Why spend on-line?

"Economic unrest means more spending for online advertising—even as ad budgets remain tight. Marketers see online advertising as safe because the ads are typically more measurable, more efficient and more targetable, making the internet a more accountable medium than nearly all traditional channels"

-- E-marketeer, December 29, 2010

The Value of Web Advertising

Advertising supports a vast eco-system on the Web

1. Publisher revenue makes macro & micro publishers viable
2. Focused reach & targeting makes niche interests businesses possible
3. Advertiser revenue makes large scale “free” services possible: Facebook, Google, Twitter, Yahoo, …

- The web would be a lot smaller without advertising ➔ Advertising creates huge direct and indirect value for consumers !

Computational Advertising Landscape

Marketplace basics

- What do advertisers pay?
  - CPM = cost per thousand impressions
    - Typically used for graphical/banner ads (brand advertising)
    - Could be paid in advance → “Guaranteed delivery”
  - CPC = cost per click
    - Typically used for textual ads
  - CPT/CPA = cost per transaction/action a.k.a. referral fees or affiliate fees
    - Typically used for shopping (“buy from our sponsors”), travel, etc.
    - … but now also used for textual ads (risk mitigation)

The central challenge decomposed

Find the "best match" between a given user in a given context and a suitable advertisement.

1. **Representation** = represent the user, the context, and the ads in an **effective & efficient** way
2. **Definition** = define the mathematical optimization problem to capture the actual marketplace constraints and goals
3. **Solution** = solve the optimization problem in an **effective & efficient** way

Graphical ads

Graphical ads – Guaranteed Delivery

- Two types of online graphical advertising
  - Guaranteed delivery (GD)
  - Performance graphical advertising (non-guaranteed delivery, NGD)
- Guaranteed delivery
  - Contract booked based on targeting attributes of an impression: age, income, location,…
  - Each contract has a duration and a desired number of impressions
  - Issues in GD
    - Contract pricing
    - Traffic forecasting
    - Impression allocation to the active contracts
    - …

Representation

Definition of the Optimization Problem

Performance graphical ads

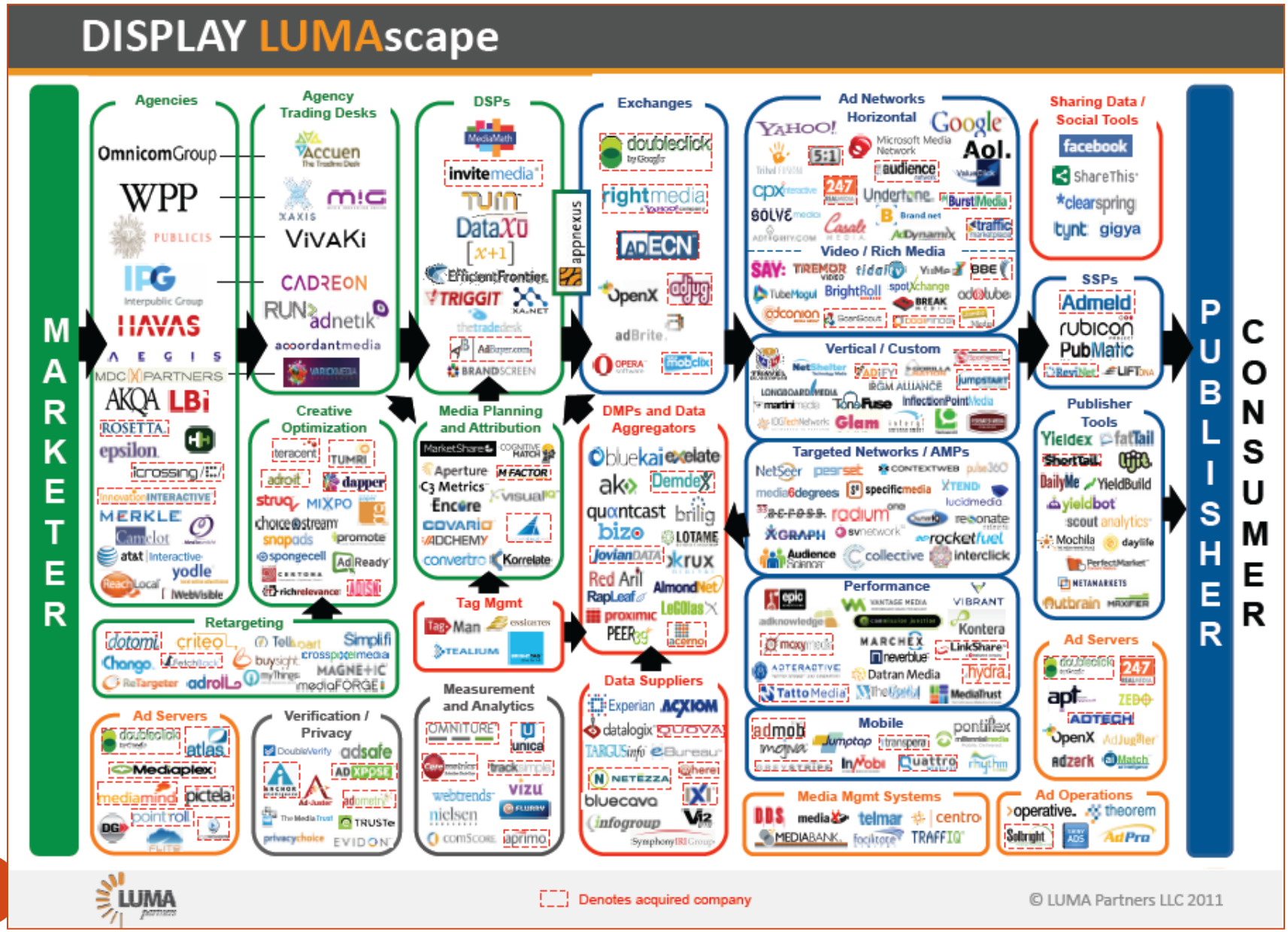
- Graphical ads can also be placed based on performance – CPM/CPC/CPA
- Assume for the moment

  Optimization Problem Definition = Max CTR
- Matching approaches:
  1. **Reactive**: explore the placement of a particular ad on different pages; for each page observe achieved CTR; once the CTRs are learned, given page, pick the ad with highest observed CTR
  2. **Predictive**: generate features for the ad using related ads (same advertiser), landing page, or advertiser metadata – predict performance based on page and ad features
  3. **Hybrid**: (1) and (2) are complementary and can be combined

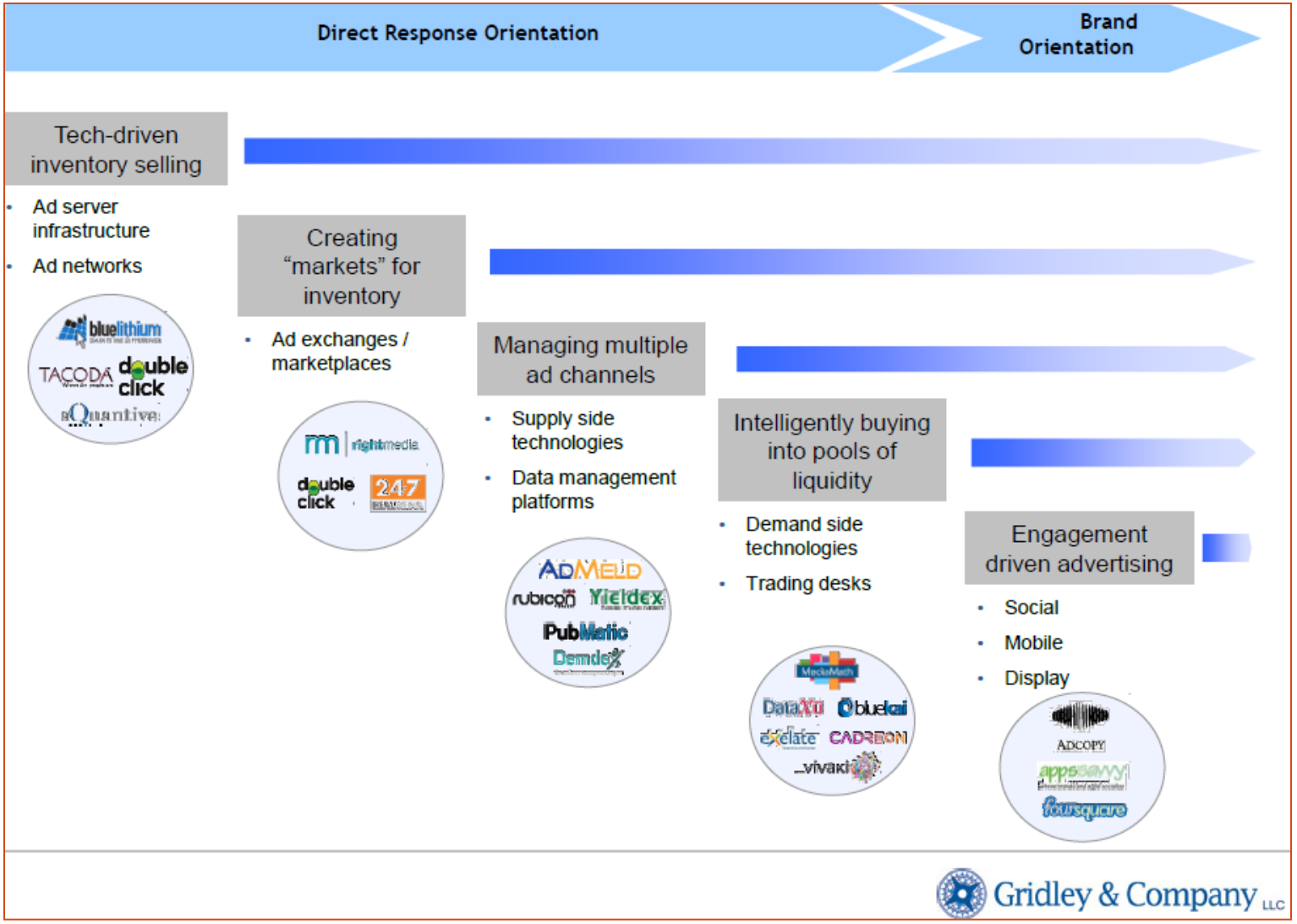
Representation

1. **Reactive**: explore the placement of a particular ad on different pages; for each page observe achieved CTR; once the CTRs are learned, given page, pick the ad with highest observed CTR
   ➔ Ads represented by achieved CTR/page + weights
1. **Predictive**: generate features for the ad using related ads (same advertiser), landing page, or advertiser metadata – predict performance based on page and ad features
   ➔ Ads (pages) represented by features of ads (resp. pages) + weights
2. **Hybrid**: (1) and (2) are complementary and can be combined
   ➔ Combined representation

The world of display advertising



Display ad technology evolution



Gridley & Company LLC

Textual Ads

Textual ads

1. Ads driven by search keywords = "**sponsored search**" (a.k.a. "keyword driven ads", "paid search", "adwords", etc)
   - Advertiser chooses a "bid phrase" = query on which to display
   - Can also subscribe to "advanced match" = display me on related queries
     - Needed to achieve volume
     - Huge challenge

2. Ads driven by the content of a web page = "**content match**" (a.k.a. "context driven ads", "contextual ads", "adsense", etc)

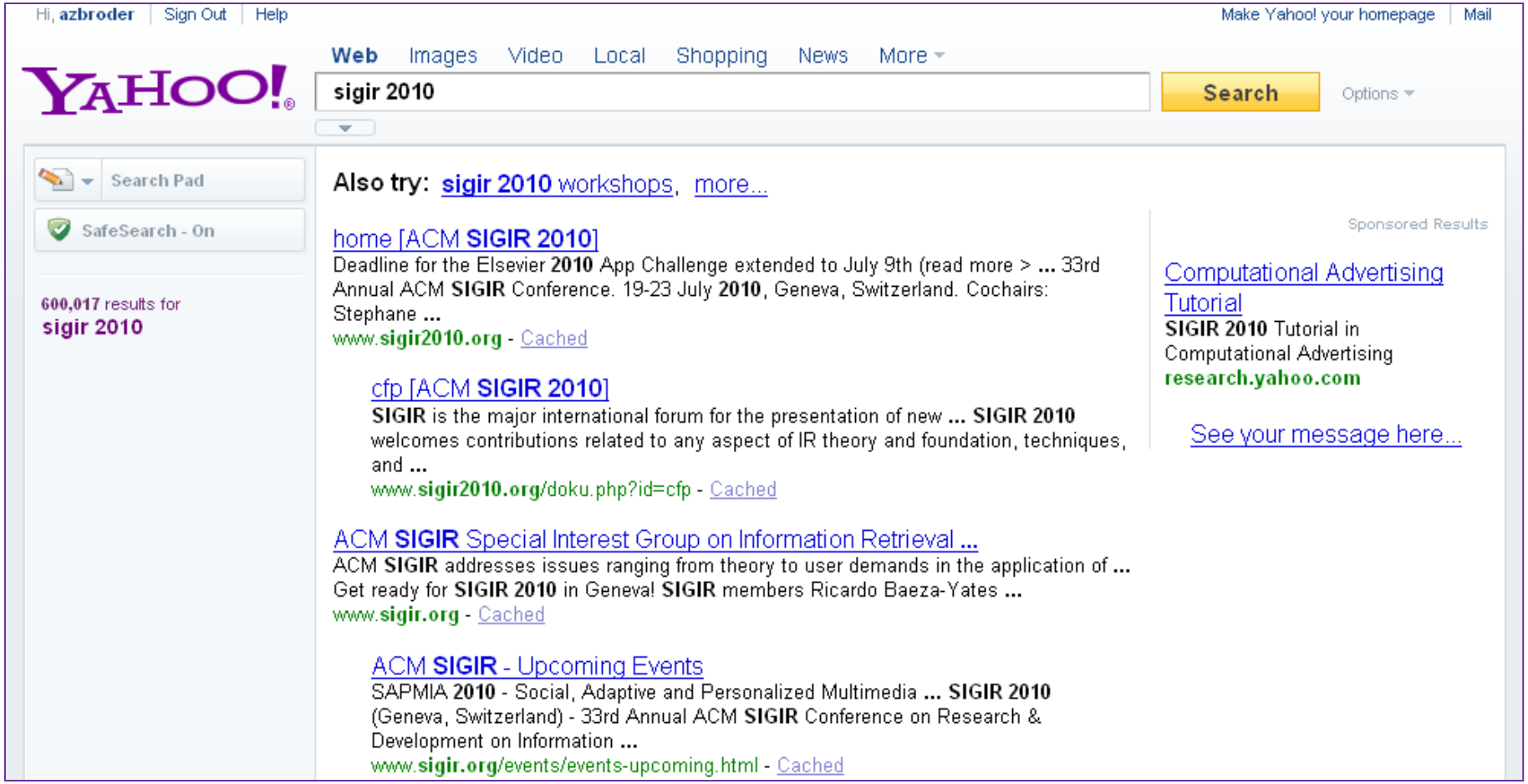
Textual ads are heavily related to Search and IR

Historical view on textual advertising

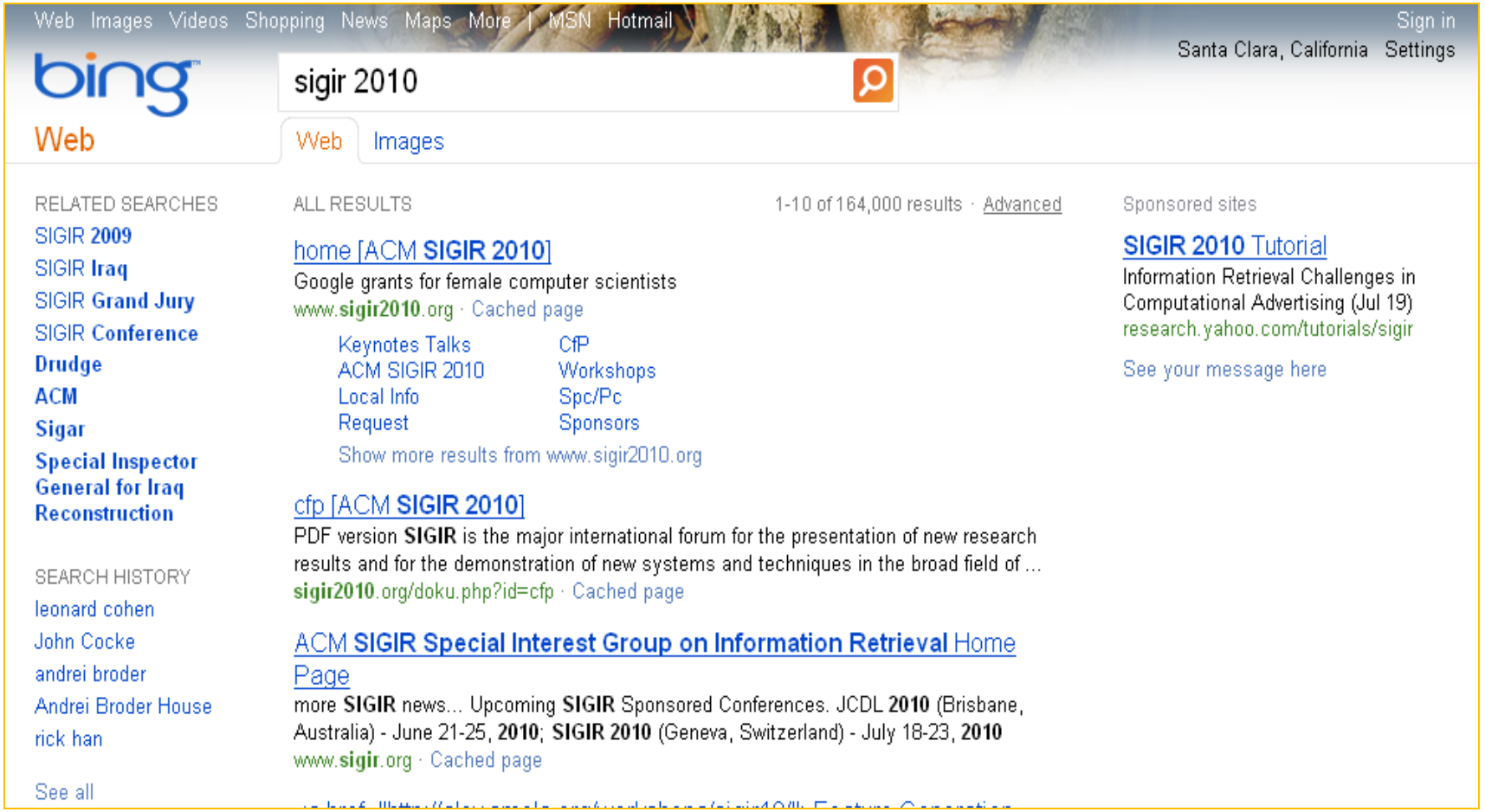
- Late 1990s Alta Vista tried the Sponsored Search model
  - Rejected by the early search engine users
- Goto.com (acquired later by Overture) develops a search engine for paid ads
  - Users with commercial interest go to this engine
  - At the peak, a billion dollar business
- Google tries the Sponsored Search model again
  - This time a success
- Advertisers cannot get enough volume
  - Content match to provide more impressions

Textual ads anatomy

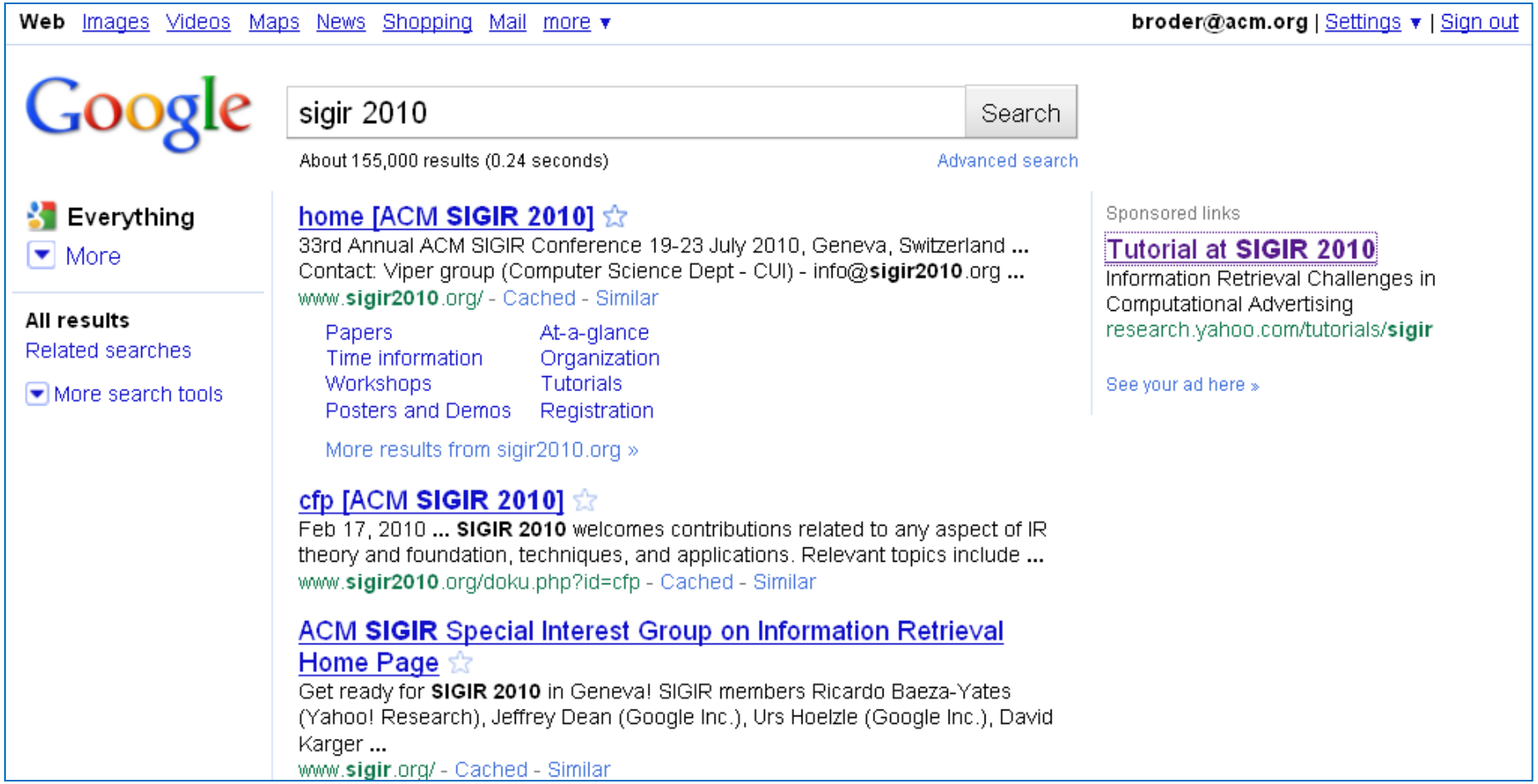
Search Yahoo for `sigir 2010`



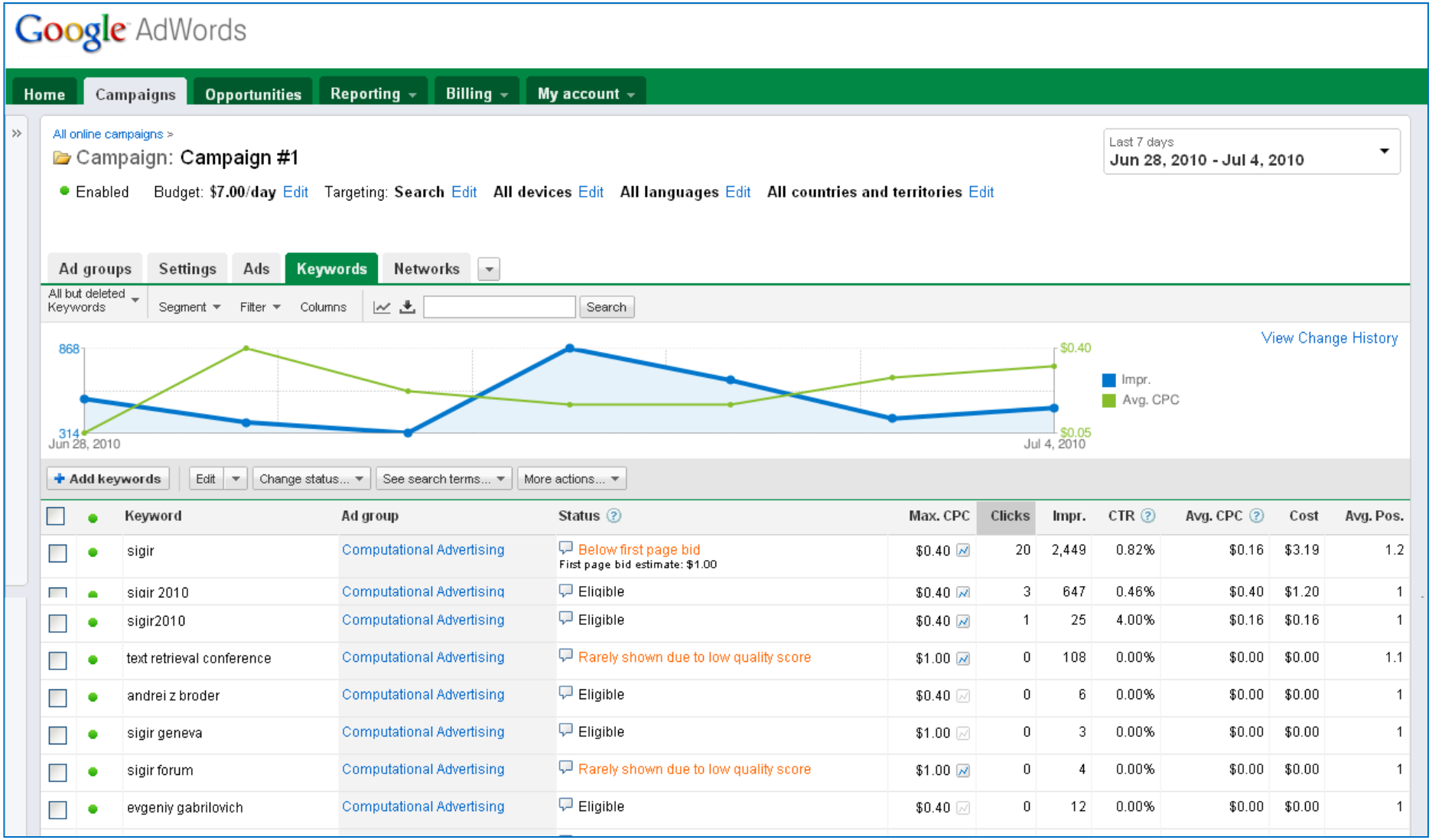
Search Bing for `sigir 2010`



Search Google for `sigir 2010`

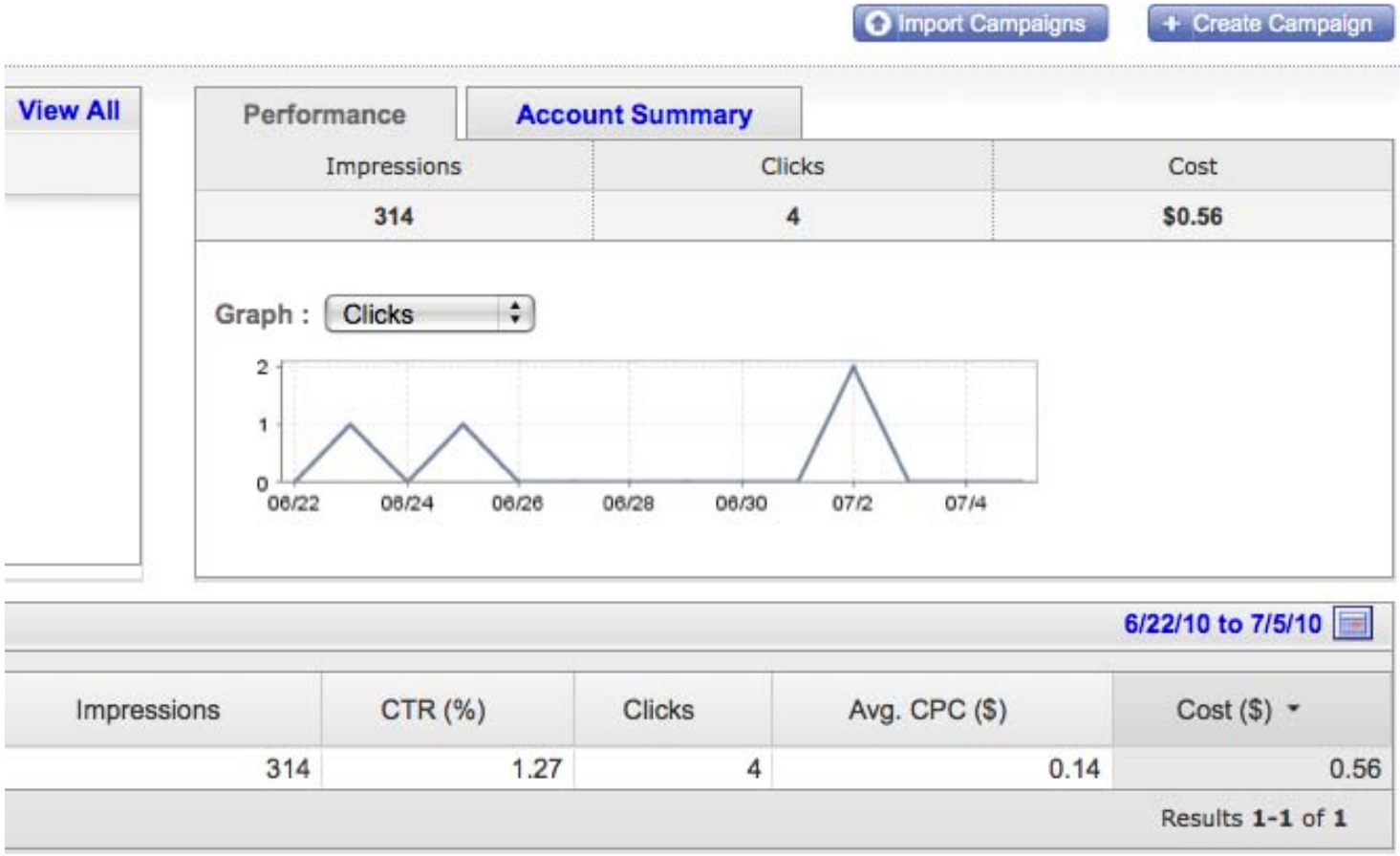


Google campaign

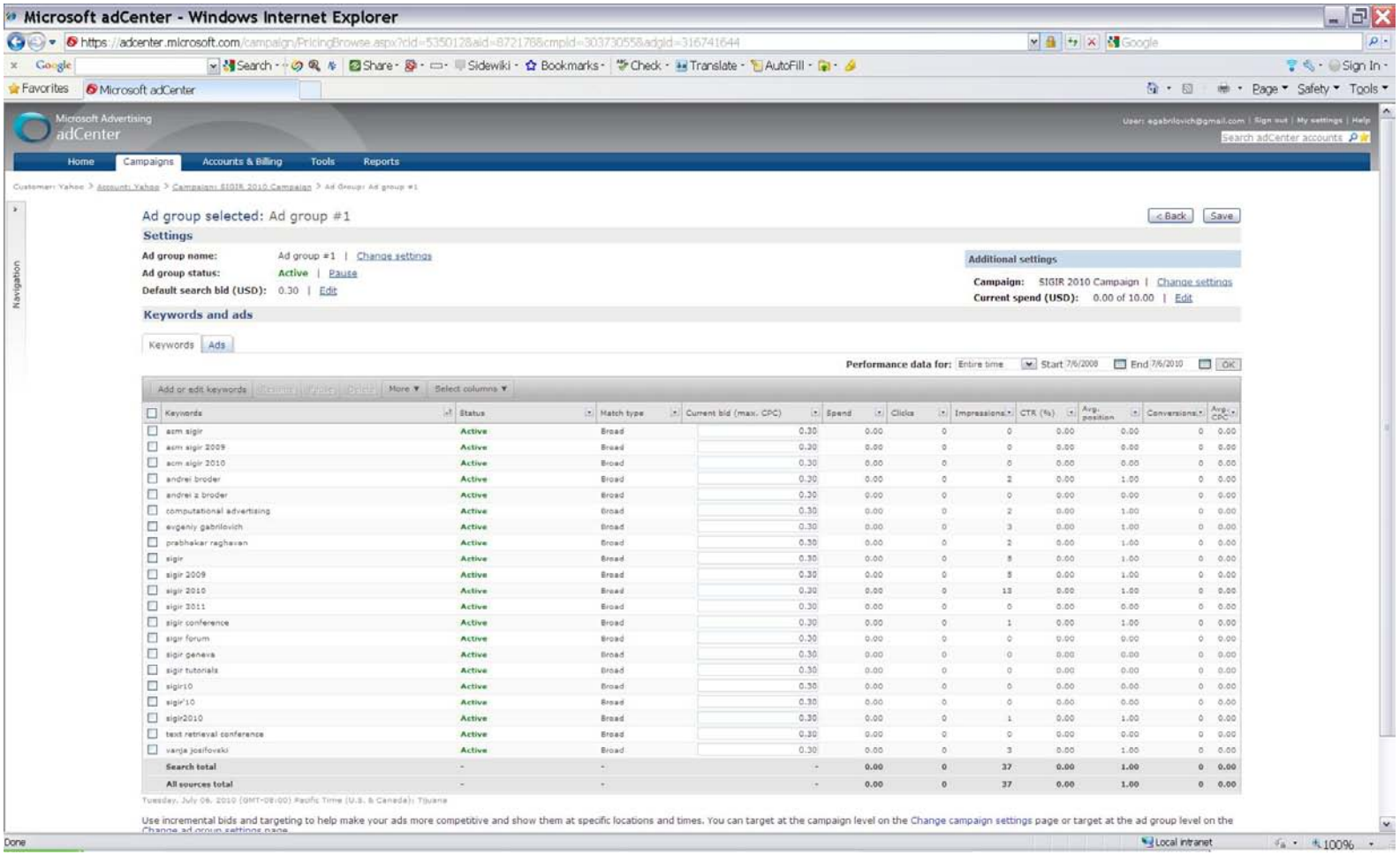


Keyword	Ad group	Status	Max. CPC	Clicks	Impr.	CTR	Avg. CPC	Cost	Avg. Pos.
sigir	Computational Advertising	Below first page bid First page bid estimate: $1.00	$0.40	20	2,449	0.82%	$0.16	$3.19	1.2
sigir 2010	Computational Advertising	Eligible	$0.40	3	647	0.46%	$0.40	$1.20	1
sigir2010	Computational Advertising	Eligible	$0.40	1	25	4.00%	$0.16	$0.16	1
text retrieval conference	Computational Advertising	Rarely shown due to low quality score	$1.00	0	108	0.00%	$0.00	$0.00	1.1
andrei z broder	Computational Advertising	Eligible	$0.40	0	6	0.00%	$0.00	$0.00	1
sigir geneva	Computational Advertising	Eligible	$1.00	0	3	0.00%	$0.00	$0.00	1
sigir forum	Computational Advertising	Rarely shown due to low quality score	$1.00	0	4	0.00%	$0.00	$0.00	1
evgeniy gabrilovich	Computational Advertising	Eligible	$0.40	0	12	0.00%	$0.00	$0.00	1

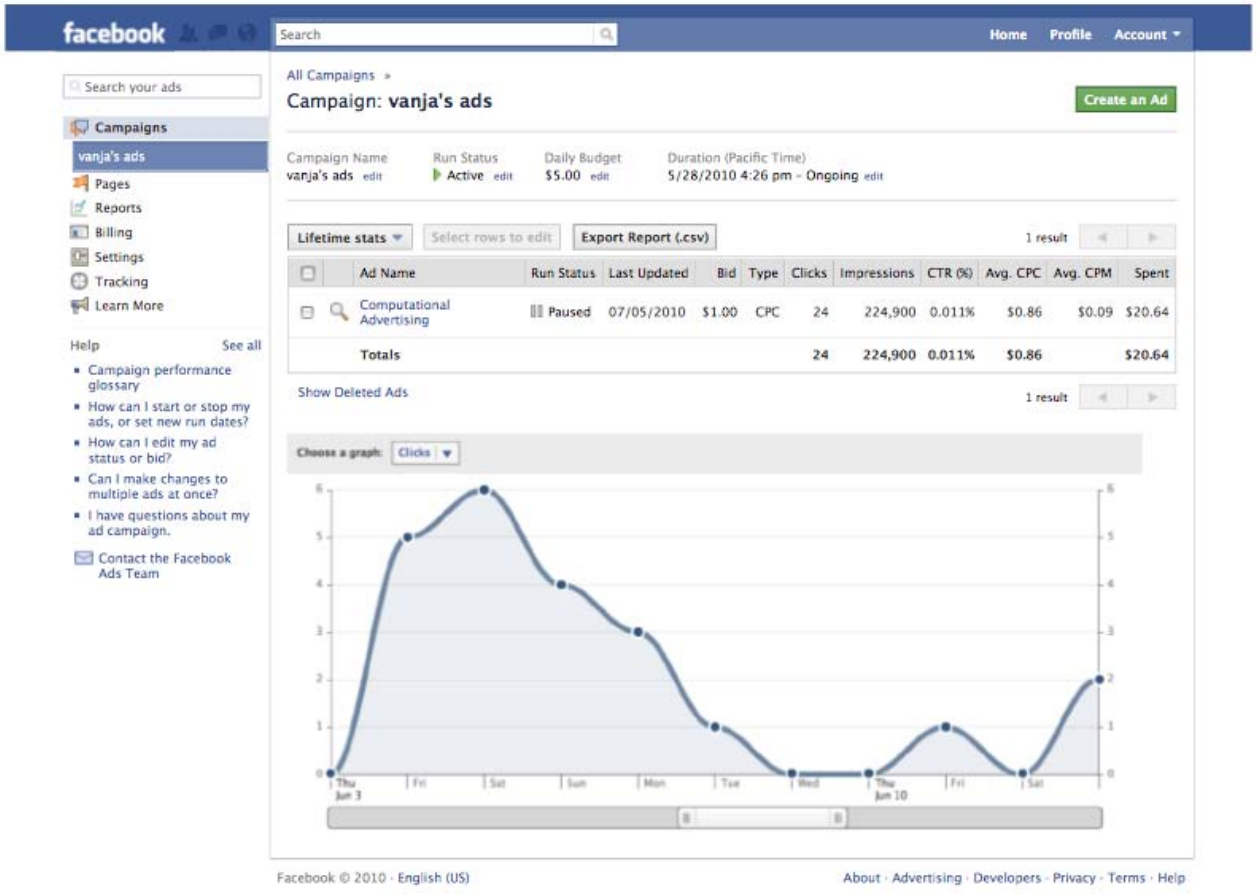
Yahoo! Search



Bing

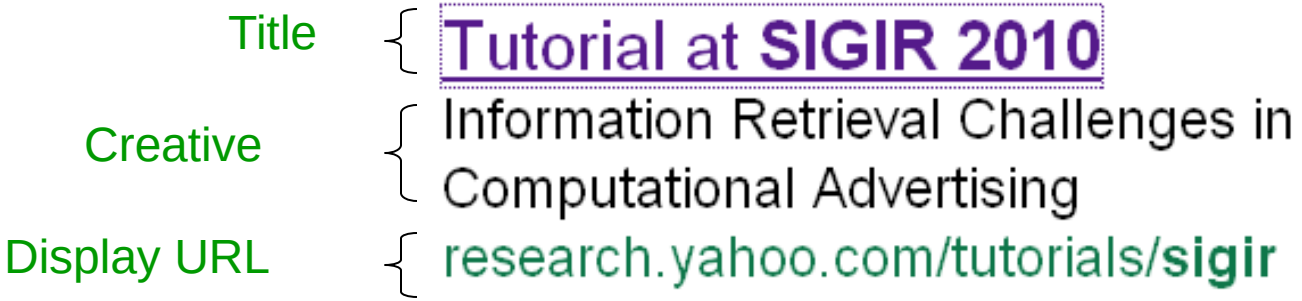

Microsoft adCenter - Windows Internet Explorer
Microsoft Advertising
adCenter
Home
Campaigns
Accounts & Billing
Tools
Reports
Ad group selected: Ad group #1
Settings
Ad group name: Ad group #1 | Change settings
Ad group status: Active | Pause
Default search bid (USD): 0.30 | Edit
Additional settings
Campaign: SIGIR 2010 Campaign | Change settings
Current spend (USD): 0.00 of 10.00 | Edit
Keywords and ads
Keywords
Ads
Use incremental bids and targeting to help make your ads more competitive and show them at specific locations and times. You can target at the campaign level on the Change campaign settings page or target at the ad group level on the

Facebook


facebook
Search
Home
Profile
Account
Search your ads
Campaigns
vanja's ads
Pages
Reports
Billing
Settings
Tracking
Learn More
Help
See all
Campaign performance glossary
How can I start or stop my ads, or set new run dates?
How can I edit my ad status or bid?
Can I make changes to multiple ads at once?
I have questions about my ad campaign.
Contact the Facebook Ads Team
All Campaigns »
Campaign: vanja's ads
Create an Ad
Campaign Name
vanja's ads edit
Run Status
Active edit
Daily Budget
$5.00 edit
Duration (Pacific Time)
5/28/2010 4:26 pm - Ongoing edit
Lifetime stats
Select rows to edit
Export Report (.csv)
1 result
Ad Name
Run Status
Last Updated
Bid
Type
Clicks
Impressions
CTR (%)
Avg. CPC
Avg. CPM
Spent
Computational Advertising
Paused
07/05/2010
$1.00
CPC
24
224,900
0.011%
$0.86
$0.09
$20.64
Totals
24
224,900
0.011%
$0.86
$20.64
Show Deleted Ads
1 result
Choose a graph:
Clicks
Thu Jun 3
Thu Jun 10
Facebook © 2010 · English (US)
About · Advertising · Developers · Privacy · Terms · Help

Visible and invisible parts

Bid phrase: sigir 2010
Bid: $1

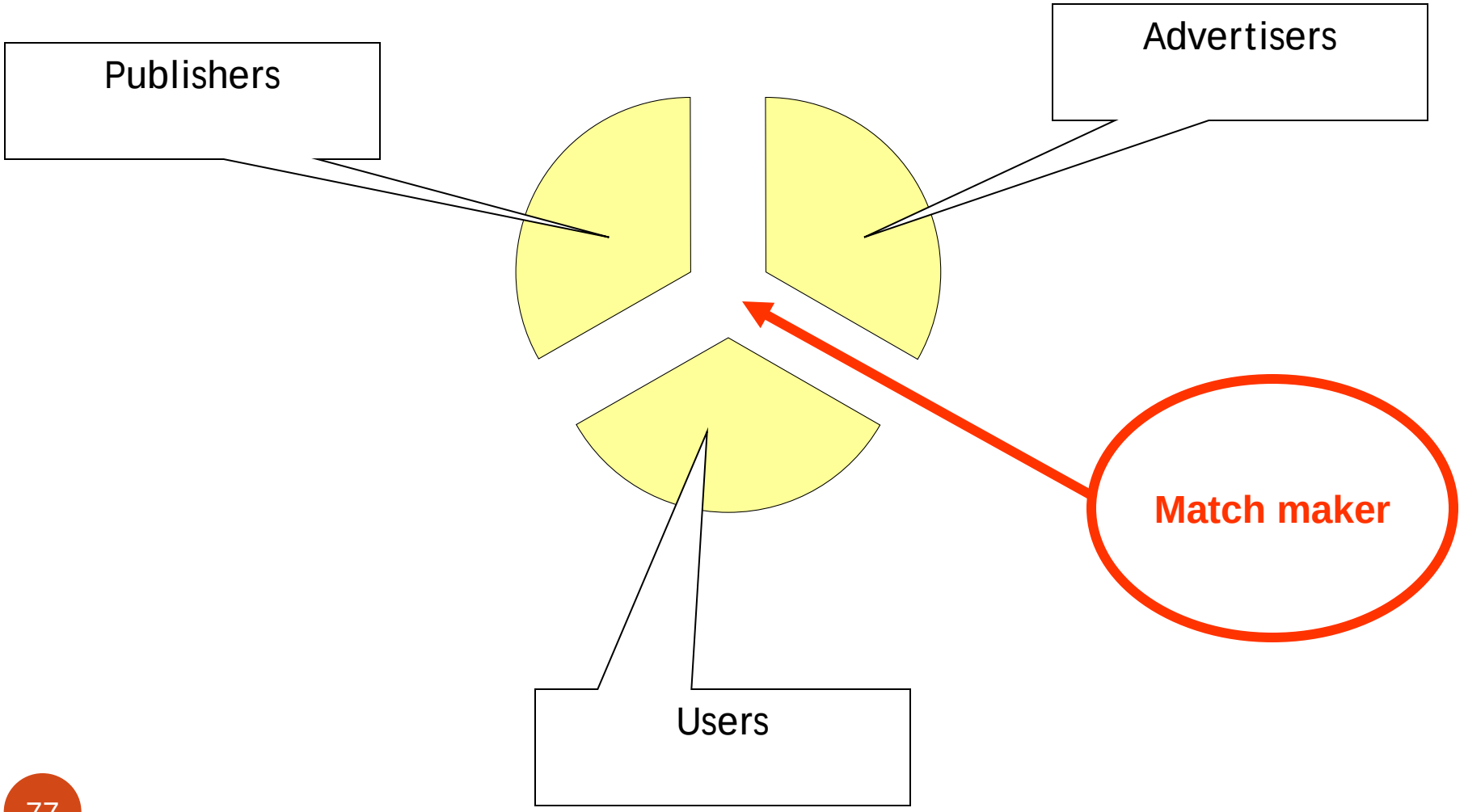


Landing URL:
http://research.yahoo.com/tutorials/sigir10_compadv/

Destination: the landing page

Ad Selection

Participants: Publishers, Advertisers, Users, & "Match maker"



Problem definition: Ad selection objective

- Each participant has its own utility
  1. Advertisers wants ROI and volume
  2. User wants relevance
  3. Publisher wants revenue per impressions/search
  4. Ad network wants revenue and growth
- Ad selection: optimize for a goal that **balances the utilities of the four participants**
- Some tradeoffs are linked with the short term and long term business objectives:
  - Allow for easy adjustments based on periodical changes in objectives

Efficiency requirements: Scale and Cost of Serving

- **The Billions:**
  - Billions of individual ads in sponsored search and content match
  - Billions of unique queries/millions of searches per hour
  - Trillions of page impressions (content match and graphical advertising)
  - Billions of users

- **The Milliseconds:**
  - Requests served while the user ‘waits’: no more than 100ms response time

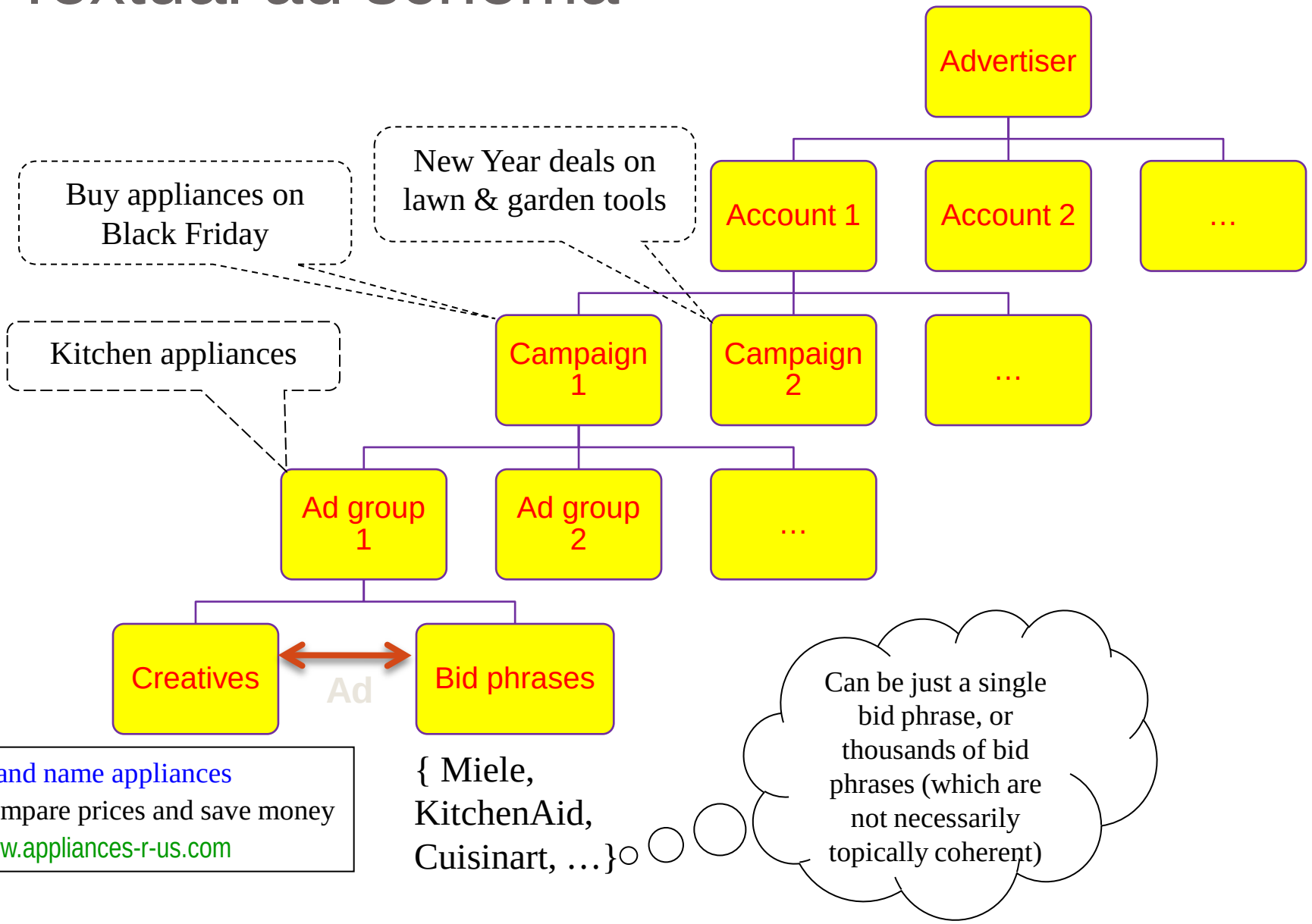
- **The Money:**
  - Serving each requests require some CPU amount
  - Data usually needs to be in memory
  - Per-request cost needs to be lower than the serving cost
  - Low CTR make this a challenging problem

Textual ad selection

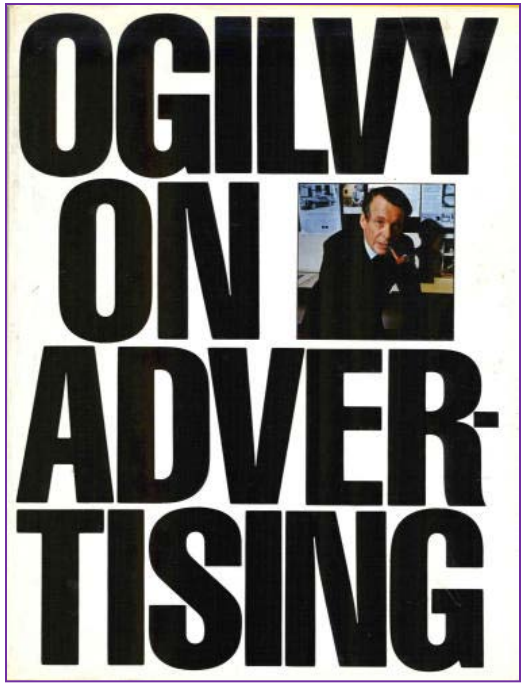
In the beginning: The database approach

- **Thinking of SS as a data base problem**
  - SELECT ads
    FROM ad_table
    WHERE bid_phrase = query
- **Implementation**
  - Sponsored search
    - Match the query to the ad bid phrase (some normalization performed)
    - Advertisers cannot bid on all feasible queries (especially in the tail) → Need advanced match
  - Advanced match → translate the query into bid phrases
    - Very difficult to capture context, relevance, etc.
    - Pricing is misleading – bid on original phrase has little to do with value of AM
  - Content match → bid phrases from pages
    - very difficult to capture context, semantics,. relevance, etc.

Textual ad schema



New old concept: advertising as information



- "I do not regard advertising as entertainment or an art form, but as a medium of information…." [David Ogilvy, 1985]
- "Advertising as Information" [Nelson, 1974]
- Irrelevant ads are annoying; relevant ads are interesting
  - Vogue, Skiing, etc are mostly ads and advertorials

Finding the best textual ad is an information retrieval problem with multiple, possible contradictory utility functions

Finding the “best ad” as an Information Retrieval (IR) problem

- Representation: Treat the ads as documents in IR
  [Ribeiro-Neto et al. SIGIR 2005] [Broder et al. SIGIR2007] [Broder et al. CIKM2008]
- Optimization/solution: Retrieve the ads by evaluating the query over the ad corpus

Details

- Analyze the “query” and extract query-features
  Query = full context (content, user profile, environment, etc)
- Analyze the documents (= ads) and extract doc-features
- Devise a scoring function = predicates on q-features and d-features + weights
- Build a search engine that produces quickly the ads that maximize the scoring function

Setting the ad retrieval problem

- Ads corpus =
  - Textual Ads: Bid phrase(s) + Title + Creative + URL + Landing Page + …
  - Graphical Ads: Advertiser supplied meta data + URL + Landing Page + Content of pages with clicks…
- Query features =
  - Search Keywords + Outside Knowledge Expansion + Context features
- Context features (for sponsored search) =
  - Location + User data + Previous searches + …
- Context features (for content match) =
  - Location + User data + Page topic + Page keywords …

Summary

Key messages

1. **Computational advertising = A principled way to find the "best match" between a user in a context and a suitable ad.**
2. **Key sub-problems:**
   I. Representation of user/context/ads
   II. Definition of optimization problem
   III. Efficient and effective solution
3. **The financial scale for computational advertising is huge**
   - Small constants matter
   - Expect plenty of further research
4. **Advertising is a form of information**.
   - Adding ads to a context is similar to the integration problem of other types of information
   - Finding the “best ad” is often a type of information retrieval problem with multiple, possibly contradictory utility functions
5. **New application domains and new techniques are emerging every day**
   - Good area for research + new businesses!

Conferences where most of the action happens

- WWW (World Wide Web)
- WSDM (Web Search and Data Mining)
- SIGIR (Information Retrieval)
- CIKM (Information and Knowledge Management)
- EC (Electronic Commerce)
- 4 workshops in 2009: SIGIR, KDD, EC, WINE
- First to sixth Workshop on Sponsored Search Auctions

Questions?

We welcome suggestions about all aspects of the course: msande239-aut0910-staff

Thank you!

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http://research.yahoo.com