An Overview of Computational Advertising

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in collaboration with many colleagues throughout the company

What is “Computational Advertising”?:

• New scientific sub-discipline that provides the foundation for building online ad selection platforms

• At the intersection of
  – Large scale search and text analysis
  – Information retrieval
  – Statistical modeling and machine learning
  – Classification
  – Optimization
  – Microeconomics
Key messages

1. The financial scale is huge
   ⇒ Small constants matter!!

2. Advertising is a form of information
   ⇒ Adding ads to a context is similar to the integration problem of other types of information

3. Finding the “best ad” is a kind of information retrieval and NLP problem
   ⇒ Multiple, possibly contradictory utility functions
Textual advertising

1. Ads driven by search keywords – **Sponsored Search** (a.k.a. “keyword driven ads”, “paid search”, etc.)

2. Ads directly driven by the content of a web page – **Content match** (a.k.a. “context driven ads”, “contextual ads”, etc.)

3. **About half of the online ad revenue**

Textual advertising on the Web heavily related to NLP and IR

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Content match ads

Text-based ads driven by a page content

Content match ad

Anatomy of an ad

Bid phrase: computational advertising

Title

Creative

Display URL

Landing URL:
http://research.yahoo.com/acl08_compadv
Digging deeper: beyond keyword matching

- Relatively simple on bidded keywords. What about queries on which there is no bid?
- Advertiser can bid on "broad queries" and/or "concept queries"
  - Suppose your ad is:
    - "Good prices on Seattle hotels"
  - Can bid on any query that contains the word Seattle
- Problems
  - What about query "Alaska cruises start point"?
  - What about "Seattle's Best Coffee Chicago"
- Ideally
  - Bid on any query related to Seattle as a travel destination

A (biased) sample of research papers

Technologies described might or might not be in actual use at Yahoo!
General principles

• Using external sources of information
  – Search results
  – Classification w.r.t. an external taxonomy
• Developing unified approaches to sponsored search and content match

Robust Classification of Rare Queries Using Web Knowledge (SIGIR 2007)
Humans often find it hard to readily see what the query is about …
- But they can easily make sense of it once they look at the search results…

- Let computers do the same thing
- Infer the query intent from the top algorithmic search results (“relevance feedback”)
  - Classify search results (either summaries or full pages)
  - Let these results “vote” to determine the query class(es) in a large taxonomy of commercial topics
- Goal: Use class information to match advertising

Example: determine class of query ex5601ku
If we know it is about actiontec usb modem then we have plenty of ads ...

Target: Actiontec USB 56k External Modem
Buy actiontec USB 56k external modem online. Save 10-20% at Target.com.

Actiontec 56k External Modem
Before you buy, compare prices at Calibex. We have a complete selection of computers, electronics, video games and office products from consumer-rated online stores.

Example: determine class of query
Heated intraoperative intraperitoneal chemotherapy

CATEGORIES
1. Health and Beauty/Medical Conditions/Respiratory Disorders/Mesothelioma
2. Professional Services/Legal Services/Class Action Legal Services/Asbestos Class Actions
If we know it is about **Mesothelioma** then we have plenty of ads

![Yahoo! Search Results for Mesothelioma](image)

**Traditional approach:**

- **Query** → **Classifier** → Insufficient data

**Our approach:**

- **Query** → **Search engine**
  - **Search results**
    - Using Web as external knowledge
    - **Classifier**
Research questions

- Snippets or full pages?
- Number of search results to obtain
- Number of classes per search result
- Aggregation: bundling or voting?

The effect of external knowledge

![Graph showing the effect of external knowledge on precision and recall.](image)

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Our approach: Sponsored search via result analysis (extract both classes and terms) [Broder et al. CIKM 2008]

Optimizing Relevance and Revenue in Ad Search: A Query Substitution Approach (SIGIR 2008)
Query rewriting using Web search results and bidding meta-data

- Mapping queries to “good” bid phrases ahead of time
  - Offline computation can use more information than working online only
  - Covering head and torso queries (~10M)

### Offline phase

- **Query**
  - Augment with search results

- **Augmented query**
  - Words
  - Classes
  - Phrases

- **Ads**

- **Candidate bid phrases**

- **Augmented bid phrases**
  - Words
  - Classes
  - Phrases
  - Bidding features

- **Ranked bid phrases**

  - Reorder by optimizing revenue and relevance to the original query

  - Ordinal classification using SVM
  - Trained using ~4,500 editorially-labeled examples

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Ad relevance (editorial results)

Revenue-optimized ad retrieval (editorial results)
Just-in-Time Contextual Advertising (CIKM 2007)

Problem statement
Our goal

- Relevant ads
- No pre-crawling ahead of time
- Modest processing and communication resources

Just-in-time ad matching: an overview

Web page

User's browser

Ad server

Page gist + extra info

No extra load on the publisher's site

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**Information flow**

1. **Text**
2. Retrieved ads
3. Ad index
4. Bag of words & classes
5. 95%

**Empirical evaluation**

- Graph showing scores for different scenarios:
  - F
  - F-U-R
  - T
  - U-R-T-M-H

Scores range from 0.65 to 0.95.
Research challenges

Tagging / chunking / parsing: dealing with texts different from WSJ articles

• Cope with lack of contexts in short pieces of texts (e.g., queries, ads)

• Be robust against ungrammatical texts
  – Unintentional errors and Web usage
Example: recognizing place names

Motivation:
location awareness and geo-targeting

• Recognizing query/ads with local intent
• Determining the appropriate distance between the service and the user’s location depending on the type of the service
  – Ads for “pizza” vs. “car dealership” vs. “heart surgery”

Example: Named entity recognition

• Motivation
  – No “Discount London Hotels” for “Jack London”
• Challenge
  – It is critical to recognize “un-breakable” phrases in queries without having a lot of context (again, search results may help)
When not to advertise

• Motivation
  – Repeatedly showing non-relevant ads can have detrimental long-term effects
  – Want to be able to automatically decide when to advertise or not to, by analyzing individual ads or a set of ads

Research challenges (cont’d)

• Machine translation
  – Automatically transfer the matching process to another language at low-cost (e.g., how to translate classifiers)
• Language generation and summarization
  – Making ads campaign management automatic (e.g., suggest ad content for related keywords)
Summary

• Web advertising is scientifically young
• It is intellectually diverse – need to deal with:
  – Economics
  – The human element
  – The social element
  – Solving huge problems ridiculously fast
• The technology mirrors the economic, legal and sociological reality

Thank you!

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We are hiring!