



# Improving Ad Relevance in Sponsored Search

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# Motivation

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- Improve ad relevance for search users
- Develop a model to predict relevance
- Leverage user interactions in learning
- Use predicted relevance to improve system
  - As a filter to remove bad ads
  - As a feature to improve ad ranking
  - As a score for improving ad page placement

# Outline

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- Motivation
- Ad Relevance Models
  - Baseline model
  - Learning from user clicks
- Sponsored Search Applications
- Conclusion

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# An Ad Relevance Model

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- Develop a model to predict how relevant an ad is for a particular query
- Incorporate typical IR features such as word and character overlap, word novelty
- Train a machine learned model based on human generated editorial judgments

# Relevance Modeling Data

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- Retrieve about 20 ads per query with a typical information retrieval system
- Stratified query sample from web logs
- Binary ‘good’ vs. ‘bad’ editorial judgments

Data	Queries	Query-Ad Pairs
Train	4.8k	95k
Test	2.3k	47k

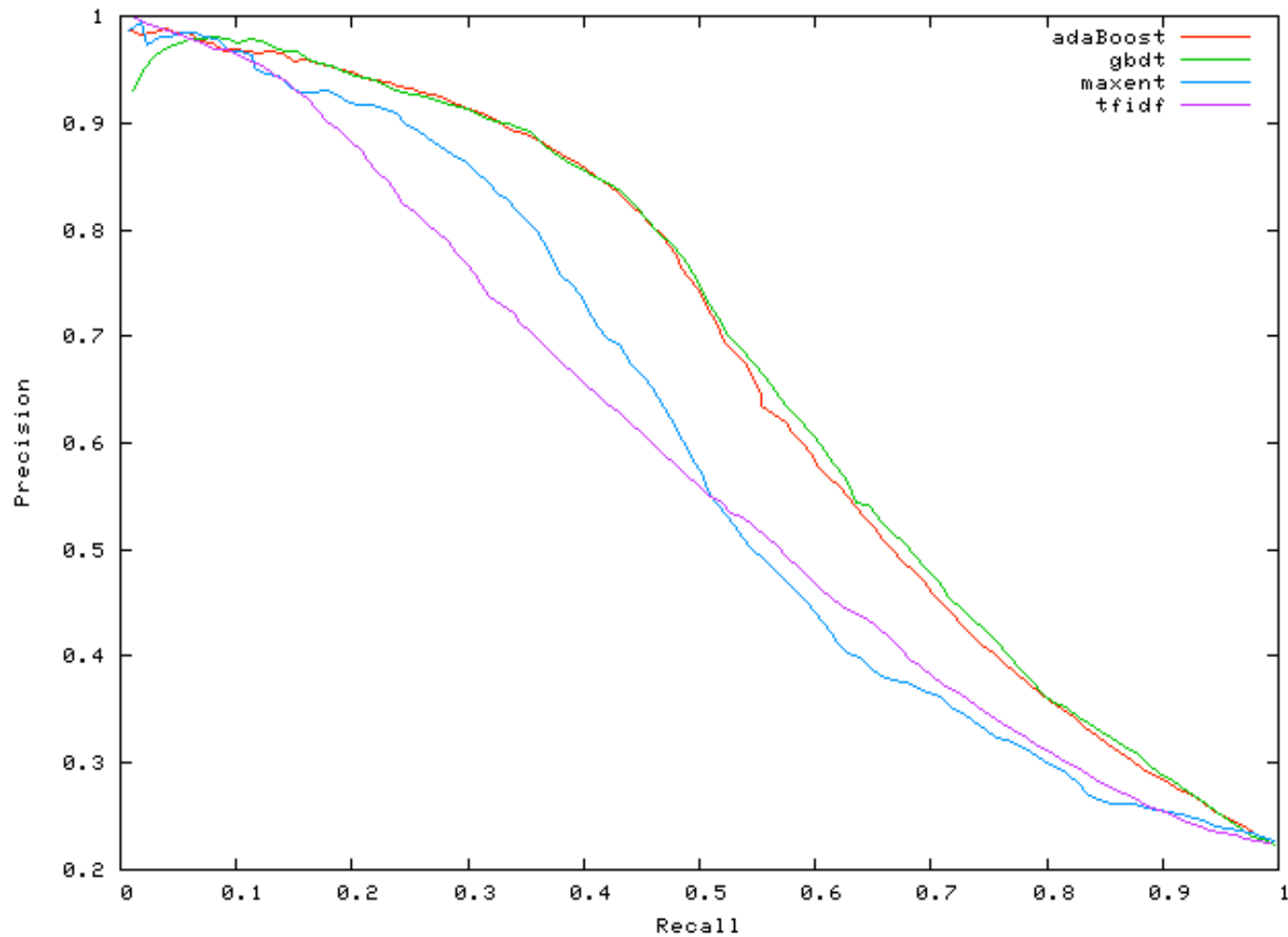
# Baseline Model: Results

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- Baseline features:
  - Character, word and bigram overlap
  - Ordered bigram overlap
  - Cosine match (TF/IDF)
  - Query length

	Precision	Recall	F-Score
maxent	0.658	0.458	0.540
adaBoost	0.670	0.543	0.600
GBDT	0.671	0.551	0.605

# Baseline Precision/Recall





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# Learning From User Clicks

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- Incorporate information from user click behavior to improve relevance modeling
- Include historical click information:
  - Directly for specific observed click rates
  - Broadly with a query->ad click translation model

# Observed Click History

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- Previous click history is the best predictor of future click behavior
- Collect aggregate click rate statistics from our logs at multiple levels of granularity
  - Query-Ad, Query-Advertiser levels
  - Ad, Advertiser levels
  - Query level
- Broader aggregates are less precise but have higher coverage

# Insufficient Click History

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- No history is available for previously unseen ads, or infrequent query-ad pairs
- Develop a model that predicts click propensity based only on query-ad text
- Learn a relationship between a query and an ad title that can be applied to unseen query-ad pairs

# A Click Translation Model

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- Learn a query->title translation model

$$p(D|Q) = p(Q|D)p(D)/p(Q)$$

- IBM Model I, with web logs as corpus

$$p(Q|D) = \prod_{j=0}^m \sum_{i=0}^n \text{trans}(q_j|d_i) \quad \text{trans}(q_j|d_i) = \frac{\sum_{\text{logs}} \text{count}(q_j|d_i)}{\sum_q \sum_{\text{logs}} \text{count}(q|d_i)}$$

- Compare 2 models: click-based, view-based

$$\text{clickLikelihood} = \frac{p_{\text{click}}(Q|D)}{p_{\text{ec}}(Q|D)}$$

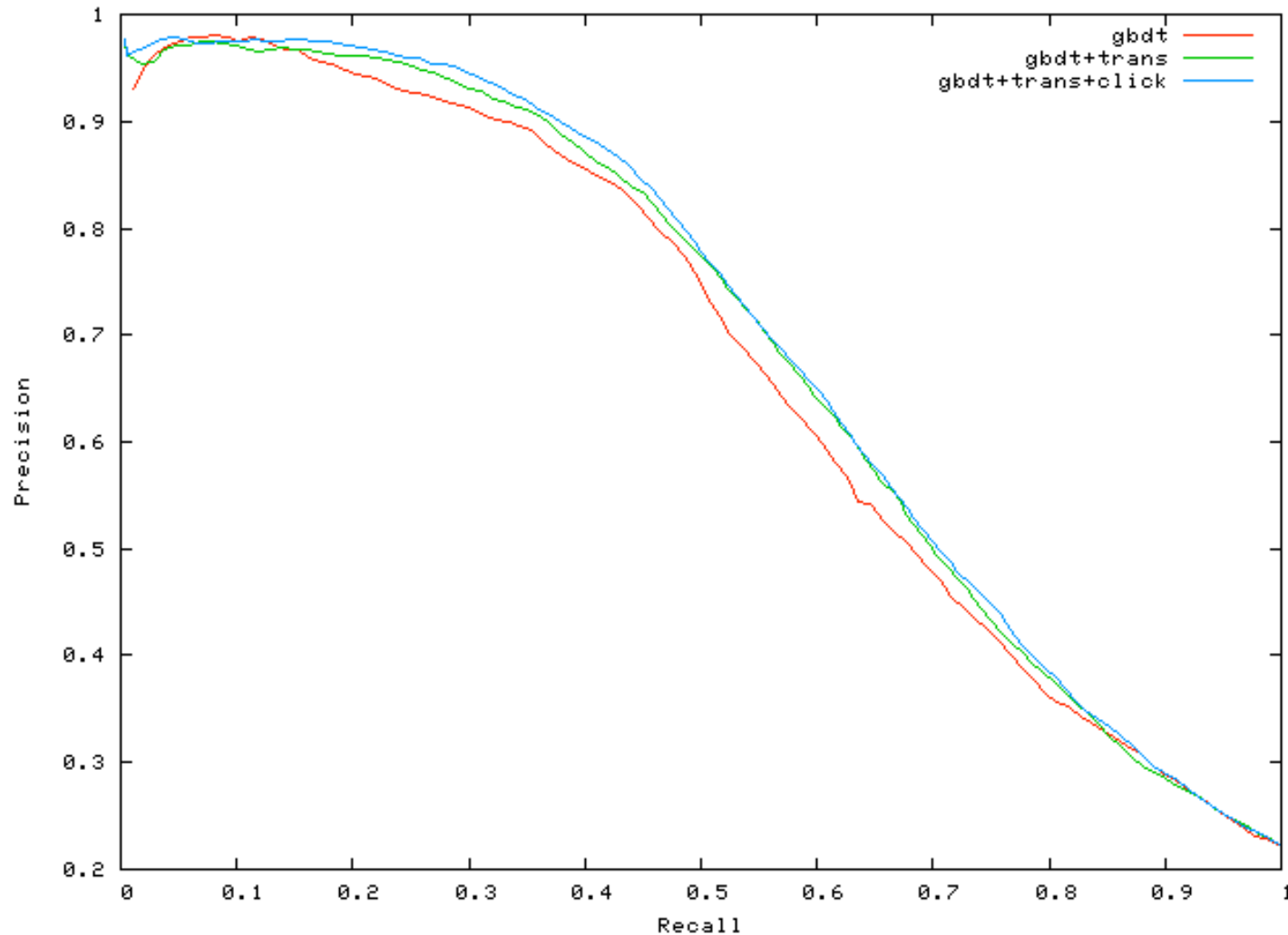
# Using Clicks: Results

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- Start with baseline GBDT model
  - Add observed click history features only
  - Add click translation scores only
  - Add both together

	Precision	Recall	F-Score
Baseline (GBDT)	0.671	0.551	0.605
+click history	0.699	0.557	0.620
+translations	0.658	0.590	0.622
+click +trans	0.673	0.584	0.625

# Precision/Recall With Clicks



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# Example of Sponsored Search

(typical)

The screenshot shows a Yahoo! search results page for the query "digital cameras". The page is divided into several sections:

- Navigation:** "Web", "Images", "Video", "Local", "Shopping", "More" links.
- Search Bar:** Contains the text "digital cameras" and a "Search" button.
- Left Sidebar:** Includes "Search Pad", "SearchScan - On", "627,000,000 results for digital cameras:", "Show All", and a list of shopping sites (Wikipedia, CNET Reviews, Amazon.com, Answers.com, Nikon, Shopping Sites) with search suggestions for "canon ...", "kodak ...", "sony ...", and "best".
- Main Content Area:**
  - Sponsored Results (Yellow background):**
    - Nikon Digital Cameras:** Professional Quality Photos w/ Nikon's Easy to Use Digital Cameras. [www.NikonUSA.com](http://www.NikonUSA.com)
    - Save on Digital Camara:** Lowest Prices on Name Brand Cameras in Stock. Buy Now. [www.TigerDirect.com](http://www.TigerDirect.com)
    - Kodak Sweetheart Deals:** Save up to \$70 on select Kodak Digital Cameras. Only at Kodak. [www.Kodak.com](http://www.Kodak.com)
    - Deals on Digital Cameras:** Canon, Sony, Kodak Digital Cameras @ Low Prices. Save w/ Free Shipping. [www.circuitcity.com](http://www.circuitcity.com)
  - Digital Cameras - Shopping Results:**
    - Brand:** [Sony](#) (448), [Canon](#) (824), [Nikon](#) (513), [Olympus](#) (520), [More...](#)
    - Popular Products:** [Panasonic Lumix DMC-TZ3S...](#) ★★★★★ (3), [Panasonic Lumix DMC-TZ3-K...](#) ★★★★★ (13), [Canon EOS 30D \(Body Only\)...](#) ★★★★★ (15), [Nikon D200 \(Body Only\)...](#) ★★★★★ (33), [More...](#)
  - Digital camera - Wikipedia, the free encyclopedia:** [Types of...](#) | [Conversion of...](#) | [History](#) | [Image...](#)  
A digital camera is a camera that takes video or still photographs,
- Right Sidebar:** Contains additional sponsored results:
  - Digital Camera Deals Are Waiting for You:** Order your name brand camera & film merchandise below dealer cost. [www.ecamerafilms.com](http://www.ecamerafilms.com)
  - A Digital Camera:** Compare Price and Features. Large Selection In Stock Today. [www.Staples.com](http://www.Staples.com)
  - Digital Cameras:** Free shipping on Canon, Sony, Nikon and more. Buy now, during our sale. [www.highperformedigital.com](http://www.highperformedigital.com)
  - Digital Cameras Deals at Target:** See this week's deals on Digital Cameras at your local Target. [www.Target.com](http://www.Target.com)
  - Canon Digital Cameras:** Buy Canon Digital Cameras and More at Sears® Official Site. Shop

# Example of Sponsored Search

(could be better)

The screenshot shows a Yahoo! search results page for the query "mutual information". The search bar at the top contains the text "mutual information" and a yellow "Search" button. Below the search bar, there are navigation tabs for "Web", "Images", "Video", "Local", "Shopping", and "More".

On the left side, there is a "Search Pad" section with a "SearchScan - On" indicator. Below it, it shows "230,000,000 results for mutual information:" and a "Show All" button. A "Wikipedia" link is also visible.

The main search results area is divided into two columns. The left column contains organic search results:

- Information On Mutual Funds** (Sponsored Results): Check Out Local.com To Find **Information On Mutual Funds** In Your Area. [Local.com](#)
- Mutual Fund Information** (Sponsored Results): Find Top Rated Sites For **mutual fund information** Here. [mutual-fund.g3p.org](#)
- Description of mutual - Law.com law dictionary**: Adj., adv. referring to anything in which both parties have reciprocal rights, understanding or agreement. Additional references: [Wikipedia](#)
- Mutual information - Wikipedia, the free encyclopedia**: Definition of... | Relation to other... | Variations of the... | Applications of... In probability theory and **information** theory, the **mutual information** of two random variables is a quantity that measures the **mutual** dependence of the two variables. The most common unit of measurement of **mutual information** is... [en.wikipedia.org/wiki/Mutual\\_information](#) - 58k - [Cached](#)
- Measuring the dependency of different variables — Mutual ...**: The movie is just awful. I hadn't expected an excellent film, but it's just boring. ... © **Mutual Information** — Copyblogger theme design by Chris Pearson ... [www.mutualinformation.org](#) - [Cached](#)
- Mutual information - Scholarpedia**: **Mutual information** is one of many quantities that measures how much ... **Mutual**

The right column contains sponsored results:

- Mutual Fund Information** (Sponsored Results): Finding **mutual fund information**? Compare Top Sites Here. [MutualFundsHub.info](#)
- Mutual Fund Information** (Sponsored Results): Looking For **mutual fund information**? Find **information** here. [buymutualfunds.info](#)
- Mutual Fund Information** (Sponsored Results): Your Source For Info About **mutual fund information**. [BestMutualFundsHub.com](#)
- Free Mutual Fund Research** (Sponsored Results): Do your Portfolio a Favor Today. Earn Supercharged Returns in 2009. [www.InvestingNewsWeekly.com](#)
- Information On Mutual Funds** (Sponsored Results): Investment Tips, News, More. **Information On Mutual Funds**. [Finance Kasmir.com](#)

# Ad Filtering

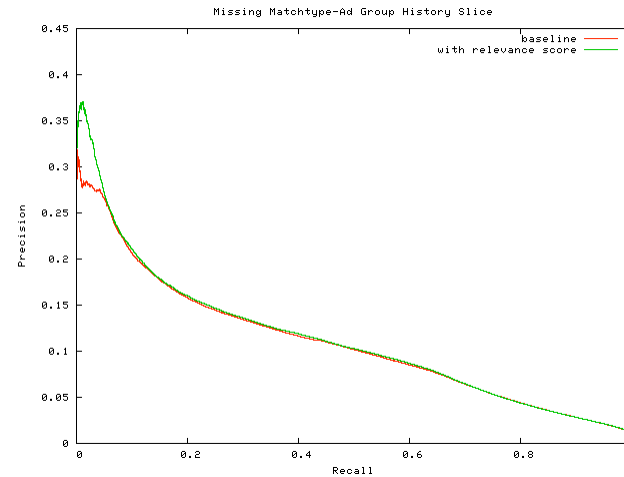
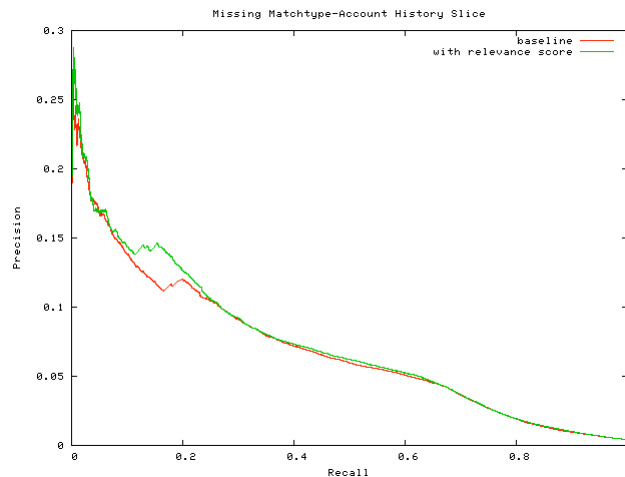
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- Problem: Remove low quality ads
- Approach: Filter low relevance score ads
- Impact:
  - Filtered 50% of Bad ads, less than 10% of Good
  - Bucket metrics:

	Relative Change
coverage	-8.7%
ad depth	-11.9%
ad CTR	+10.1%
total ad clicks	+0.5%

# Ad Ranking

- Problem: Rank ads by bid and  $p(\text{click})$
- Approach: Provide relevance as feature
- Impact:
  - Improves click model when history is sparse



# Optimization

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- Problem: Place ads on the search page
- Approach: Consider ad and web relevance
- Impact:
  - Reduced low quality ads above search results
  - Bucket metrics:

	Relative Change
North Ad Impact	-4.5%
North ad CTR	+1.5%
total ad clicks	+0.8%

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# Summary

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- Developed a useful ad relevance model
- Improved performance with user click data
- Extend to new ads with click trans. model
- Incorporated in sponsored search system:
  - Removed low quality ads
  - Improved ad ranking
  - Improved ad placement

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**THANKS!**  
**QUESTIONS?**