Search Log Analysis

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Search Log Analysis

- Why is search log analysis important?
- What does a search log look like?
- Using search logs to infer document relevance and ranking mistakes

Methods for IR Experimentation and Evaluation

- Test-collection (batch) evaluation
- User studies
- Search log analysis

Test Collection-based Evaluation
advantages

- The experimental set-up is fixed: same queries, same corpus, same judgements
- Evaluations are reproducible: keeps us honest and allows us to easily measure improvement
- Modifying the system and re-evaluating is easy and free!
- A good way to tune parameters
- Makes error-analysis possible

Test Collection-based Evaluation
disadvantages

- Test-collection-building is time and resource intensive
- Human assessors are not users
- Makes assumptions that do not hold true in “real” life:
  - relevance is topical
  - context independent
  - user independent
  - stable over time

User Study Evaluation
advantages

- Can collect lots of data about users' reactions to a system
- The experimenter can control or manipulate the search task and the searcher's internal/external context
- Can collect lots of information about search outcomes
- Can be used to study unique populations of users

User-Study Evaluation
disadvantages

- Time and resource intensive
- The laboratory setting is not the user's normal environment
- Study participants know they are being 'observed'
- Not a good way to determine the frequency of natural events (especially rare ones)

Search-Log Analysis
general idea

- Can we use search-log information to provide new services that enhance the user experience?
- Can we reason about how well the system is performing by analyzing the search log?
- Can we use search-log information to improve its performance?

What is a Search-Log?

- Most search engines save information about every search
  - the query
  - a time-stamp
  - the IP address of the search client
  - the user id (stored in a cookie)
  - information about the search client (OS, browser, etc.)
  - the results that are presented
  - the results that are clicked
  - dwell time on a clicked result
  - ....

What is a Search-Log?

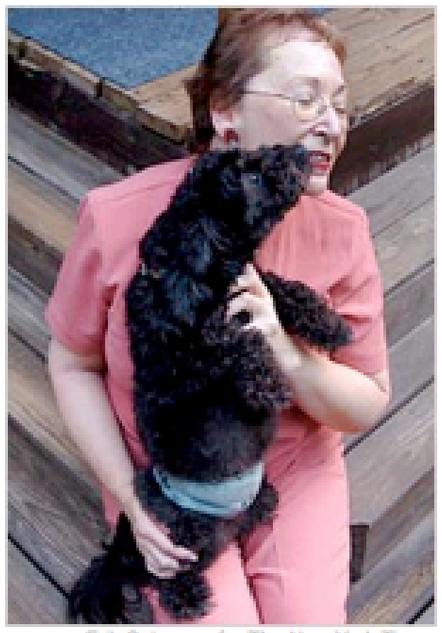
- This information is very sensitive and very valuable
- There are few publicly available Web search query-logs
  - the Excite Log (1997): ~18K users, ~50K queries
  - the AOL Log (2006): 650K users, ~20M queries
- Why aren't more search logs publicly available?
  - competitive reasons
  - privacy reasons

What is a Search-Log?

A Face Is Exposed for AOL Searcher No. 4417749

By MICHAEL BARBARO and TOM ZELLER Jr.
Published: August 9, 2006

Buried in a list of 20 million Web search queries collected by AOL and recently released on the Internet is user No. 4417749. The number was assigned by the company to protect the searcher's anonymity, but it was not much of a shield.



Erik S. Lesser for The New York Times

Thelma Arnold's identity was betrayed by AOL records of her Web searches, like ones for her dog, Dudley, who clearly has a problem.

Multimedia

Graphic: What Revealing Search Data Reveals

No. 4417749 conducted hundreds of searches over a three-month period on topics ranging from "numb fingers" to "60 single men" to "dog that urinates on everything."

And search by search, click by click, the identity of AOL user No. 4417749 became easier to discern. There are queries for "landscapers in Lilburn, Ga," several people with the last name Arnold and "homes sold in shadow lake subdivision gwinnett county georgia."

It did not take much investigating to follow that data trail to Thelma Arnold, a 62-year-old widow who lives in Lilburn, Ga., frequently researches her friends' medical ailments and loves her three dogs. "Those are my searches," she said, after a reporter read part of the list to her.

AOL removed the search data from its site over the weekend and apologized for its release, saying it was an unauthorized move by a team that had hoped it would benefit academic researchers.

Search-Logs and Privacy

- It's surprisingly easy to identify a person based on their queries
- Users prefer to remain anonymous
- We issue lots of "interesting" queries:
  - "how to tell a fake rolax"
  - "pictures of stars in the solar system"
  - "effective ways to fish a lizard"
  - "why does my iguana bob its head"

(AOL query-log)

What does a Search-Log Look Like?

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1024071	1490 am radio	2006-03-15 14:48:01	8	http://www.1490wwpr.com
1024071	1490 am radio fl	2006-03-15 14:50:08	2	http://www.ontheradio.net
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what kinds of things could we do with this?

(AOL query-log)

Usefulness of Search-Logs

- Spelling corrections
- Query suggestions
- Query expansion
- Query classification: informational, navigational, transactional
- Vertical selection and presentation
- Personalization
- Detecting commercial intent (ad placement)
- Predicting query ambiguity
- Evaluation
- Detecting ranking mistakes
- …

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are these queries independent?

(AOL query-log)

Search Sessions

- Search is a “dialogue” between a user and a search engine
  - user: query
  - search engine: search results
  - user: reformulated query
  - search engine: new search results
- Each “dialogue” is called a search session
- Each dialogue corresponds to an information need (at some level of granularity)
- A dialogue ends when the user is satisfied or gives up

Search Sessions

- Question: what proportion of search sessions result in user-satisfaction?
- The answer may be in the search log
- But, first, we have to recover each individual dialogue
- Requires some amount of “detective work”
- The simplest approaches assume that same-dialogue queries are sequential
- In other words, users engage in one dialogue at a time
- Are there environments where this is or is not a valid assumption?

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1024071	ufc 60 live play by play	2006-05-27 23:07:16	4	http://www.24wrestling.com
1024071	how to tell a fake rolax	2006-05-29 14:53:53	1	http://www.aplusmodel.com
1024071	how to tell a fake rolax	2006-05-29 14:53:53	8	http://www.inc.com
1024071	locating serial number on rolex	2006-05-30 21:51:34	1	http://www.qualitytyme.net

(AOL query-log)

Heuristics for Recovering Search Sessions

- Time difference: subsequent queries are part of the same session if the difference between time-stamps is < t
  - 30 minutes works well for library search
  - no value is better than random for web search!
- Common term: subsequent queries are part of the same session if they have at least one common term
  - high precision, low recall strategy

Heuristics for Recovering Search Sessions

- Rewrite classes: subsequent queries are part of the same session if they follow common reformulation patterns
  - add terms, delete terms, replace terms
    - Q1: “dog coughing after being boarded”
    - Q2: “dog kennel cough”
    - Q3: “kennel cough remedies”
  - Q1 and Q3 have no terms in common, but are still considered part of the same session.
  - Q1-Q2 and Q2-Q3 follow common reformulation patterns

What about clicks?

- Explicit relevance feedback: asking the user whether a result is relevant/non-relevant to a query
- Implicit relevance feedback: predicting relevance based on user interactions

- People don't like to provide explicit feedback
- Can we use clicks to predict relevance?
  - non-obtrusive
  - inexpensive
  - lots of data

Implicit Relevance Feedback

- Question: can we use clicks to predict relevance?
- Answering this question requires understanding how users behave
  - Are all clicks equally predictive of relevance?
  - Are their other "forces" (other than relevance) that motivate us to click on certain results?
  - What does click position tell us about where the user looked but didn't click?
  - Applications: on-line learning, session-based retrieval

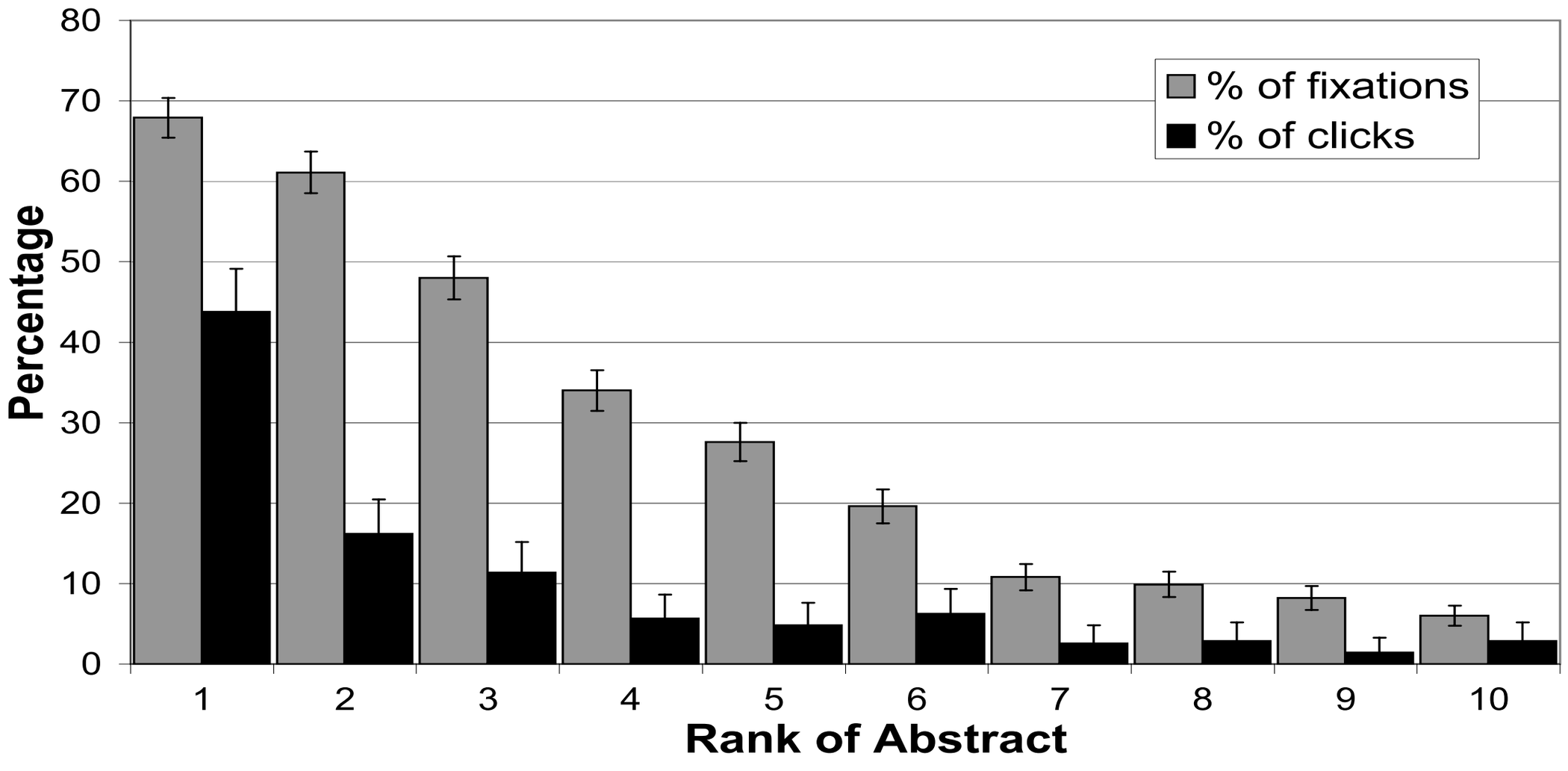
Implicit Relevance Feedback
(Joachims *et al.*, 2005)

- First Study
  - 34 subjects (all Cornell undergrads)
  - 10 search tasks (5 navigational + 5 informational)
  - top-10 Google results
  - Eye tracking + click-logging
  - Fixation: spatially stable gaze lasting approximately 0.2-0.3 seconds

Implicit Relevance Feedback

(Joachims *et al.*, 2005)

- Which results do users view and click?



- % of searches where user fixated on a result in rank *r*
- % of searchers where the user's first click was on rank *r*

Eye Tracking
(Joachims *et al.*, 2005)

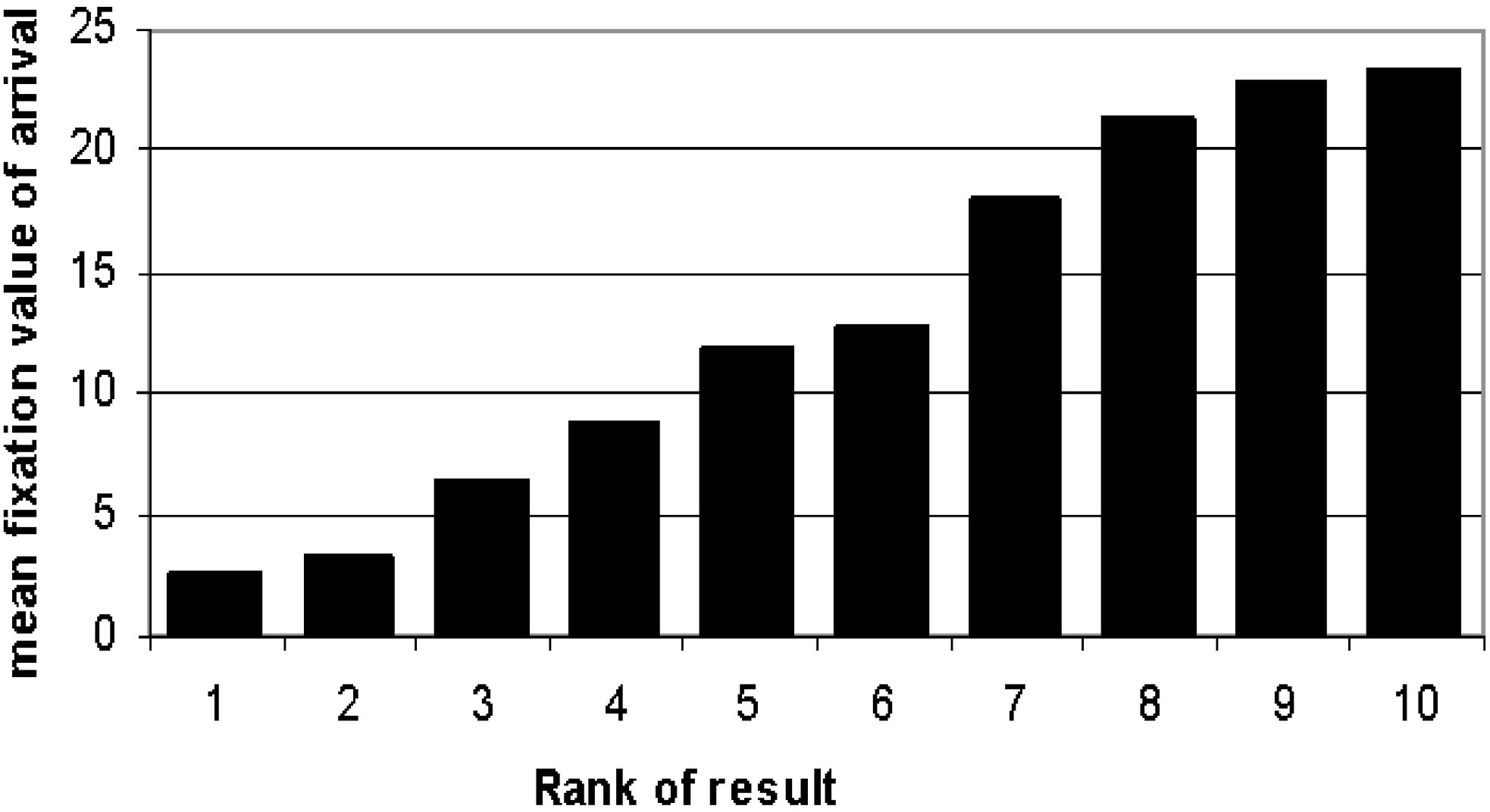
- Which results do users view?
- Most people view the first two results (almost equally)
- Fewer than half view the third result!
- Only about 10% scroll down to view results below the fold!
- Views below the fold are fairly evenly distributed. Any ideas why?

Clicks
(Joachims *et al.*, 2005)

- Which results do users click?
- While the top-two results are viewed almost equally, the first result is clicked a lot more than the second
  - Why? Because the first result is better? Because people trust it more?
- Clicks below rank 3 are fairly evenly distributed

Implicit Relevance Feedback
(Joachims *et al.*, 2005)

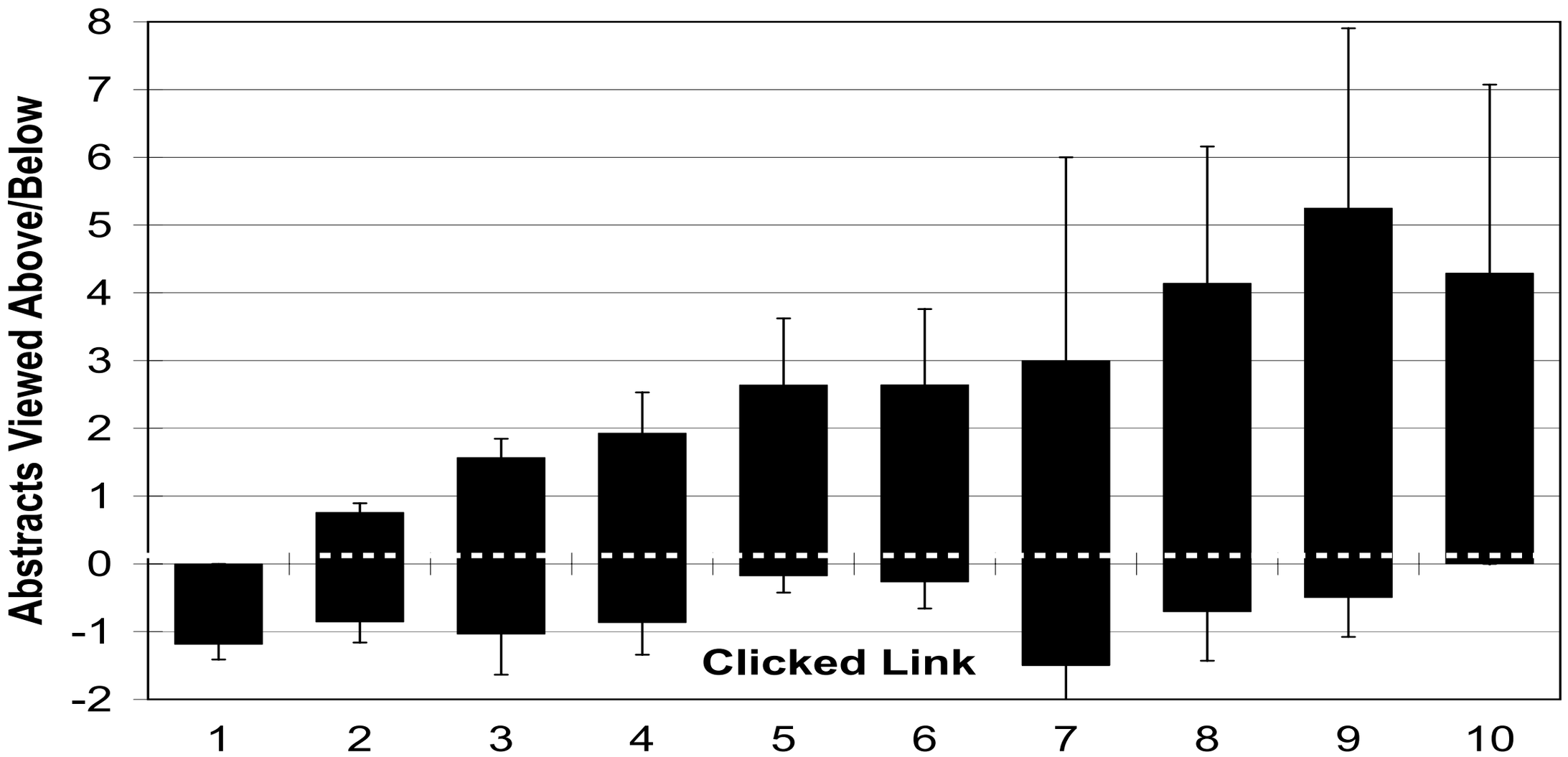
- Users scan results from top to bottom



Implicit Relevance Feedback

(Joachims *et al.*, 2005)

- Which results do users evaluate before clicking?



Implicit Relevance Feedback

(Joachims *et al.*, 2005)

- Which results do users evaluate before clicking?

Viewed Rank	Clicked Rank					
	1	2	3	4	5	6
1	90.6%	76.2%	73.9%	60.0%	54.5%	45.5%
2	56.8%	90.5%	82.6%	53.3%	63.6%	54.5%
3	30.2%	47.6%	95.7%	80.0%	81.8%	45.5%
4	17.3%	19.0%	47.8%	93.3%	63.6%	45.5%
5	8.6%	14.3%	21.7%	53.3%	100.0%	72.7%
6	4.3%	4.8%	8.7%	33.3%	18.2%	81.8%

Implicit Relevance Feedback
(Joachims *et al.*, 2005)

- Useres tend to look close to where they click.
- They view higher-ranks before clicking on a result
- They do so less for lower-ranked clicks.
- They also look at the one ranked immediately below the clicked result (if there is one)

Implicit Relevance Feedback
(Joachims *et al.*, 2005)

- Second Study
  - 34 subjects (all Cornell undergrads)
  - 10 search tasks (5 navigational + 5 informational)
  - top-10 Google results (all results judged by assessors)
  - 3 conditions
    - normal: Google results 1-10
    - swapped: Google results 1 and 2 swapped
    - reversed: results 1-10 reversed

Implicit Relevance Feedback
(Joachims *et al.*, 2005)

- Are clicks influenced by relevance (or just rank)?
- Relevance matters
- In the “reversed” condition (Google results 1-10 reversed), lower-ranked results were clicked more often than expected

Implicit Relevance Feedback

(Joachims *et al.*, 2005)

- So, a click = a relevance judgement?
- Not quite
- Users click on rank 1 more than rank 2 even when rank 2 is more relevant (Trust Bias!)

"normal"	l_1^-, l_2^-	l_1^+, l_2^-	l_1^-, l_2^+	l_1^+, l_2^+	total
$rel(l_1) > rel(l_2)$	15	19	1	1	36
$rel(l_1) < rel(l_2)$	11	5	2	2	20
$rel(l_1) = rel(l_2)$	19	9	1	0	29
total	45	33	4	3	85

"swapped"	l_1^-, l_2^-	l_1^+, l_2^-	l_1^-, l_2^+	l_1^+, l_2^+	total
$rel(l_1) > rel(l_2)$	11	15	1	1	28
$rel(l_1) < rel(l_2)$	17	10	7	2	36
$rel(l_1) = rel(l_2)$	36	11	3	0	50
total	64	36	11	3	114

Implicit Relevance Feedback
(Joachims *et al.*, 2005)

- So, if there's a bias in favor of the top results, how can we use clicks to predict relevance?
- It's difficult to use clicks to predict absolute relevance
- Clicks can be used, however, to predict pairwise preferences!

Implicit Relevance Feedback

(Joachims *et al.*, 2005)

Rank	1	2	3	4	5	6	7	8	9	10
Click	✓		✓				✓	✓		✓

- Click > Skip Above: ???
- Last Click > Skip Above: ???
- Click > Earlier Click: ???
- Click > Skip Previous: ???
- Click > No Click Next: ???

Implicit Relevance Feedback

(Joachims *et al.*, 2005)

Rank	1	2	3	4	5	6	7	8	9	10
Click	✓		✓				✓	✓		✓

- Click > Skip Above: (3>2), (7>2), (7>4), (7>5), (7>6), (8>2), (8>4), (8>5), (8>6), (10>2), (10>4), (10>5), (10>6), (10>9)
- Last Click > Skip Above: (10>2), (10>4), (10>5), (10>6), (10>9)
- Click > Earlier Click: (3>1), (7>1), (7>3), (8>1),(8>3), (8>7), (10>1), (10>3), (10>7), (10>8)
- Click > Skip Previous: (3>2), (7>6), (10>9)
- Click > No Click Next: (1>2), (3>4), (8>9)

Implicit Relevance Feedback

(Joachims *et al.*, 2005)

Explicit Feedback	Abstracts					Pages
Data	Phase I	Phase II				Phase II
Strategy	"normal"	"normal"	"swapped"	"reversed"	all	all
Inter-Judge Agreement	89.5	N/A	N/A	N/A	82.5	86.4
Click > Skip Above	80.8 ± 3.6	88.0 ± 9.5	79.6 ± 8.9	83.0 ± 6.7	83.1 ± 4.4	78.2 ± 5.6
Last Click > Skip Above	83.1 ± 3.8	89.7 ± 9.8	77.9 ± 9.9	84.6 ± 6.9	83.8 ± 4.6	80.9 ± 5.1
Click > Earlier Click	67.2 ± 12.3	75.0 ± 25.8	36.8 ± 22.9	28.6 ± 27.5	46.9 ±13.9	64.3 ±15.4
Click > Skip Previous	82.3 ± 7.3	88.9 ± 24.1	80.0 ± 18.0	79.5 ± 15.4	81.6 ± 9.5	80.7 ± 9.6
Click > No Click Next	84.1 ± 4.9	75.6 ± 14.5	66.7 ± 13.1	70.0 ± 15.7	70.4 ± 8.0	67.4 ± 8.2

- % agreement with pairwise preferences derived from relevance judgements from assessors
- Best strategy: a clicked result is more relevant than all higher ranked results that were skipped (not clicked)
  - produces lots of preferences that also happen to agree with explicit judgements

Conclusions and Implications
(Joachims *et al.*, 2005)

- Users' clicking decisions are influenced by relevance
- But, they're also biased in favor of the top results (the ones noticed and the ones trusted)
- Clicks should not be used to derive absolute relevance judgements
- However, they can be used to derive pairwise preference judgements!
- How could we use pairwise preference judgements (derived from clicks) to improve a search engine?