Search Neutrality debate: arguments and mathematical modeling

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Search engines

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  - most used way to reach webpages
  - about 20 billion requests treated per month from the US home and work desktops only
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Search engines are more and more suspected to tamper with the ranking
Search engines

- Used Cars
  - MortizChevrolet.com/Used_Cars
  - Low Prices On Used Cars - Get A Free Internet Quote!


- New & Used Cars for Sale, Auto Dealers, Car Reviews and Car ...
  - [Traduire cette page]

  Search 2.6 million new & used car listings, price a new car, get a dealer quote, read expert reviews, or sell your car at thousands over trade-in.
  - Advanced Search - Buy a Car - How Much Is Your Car Worth - SUVs
  - www.cars.com/ - États-Unis - En cache - Pages similaires

- Used Cars for Sale, New Cars, & Auto Buying Guide at AutoMallUsa.net
  - [Traduire cette page]

  View used cars for sale, read car reviews, or research new cars at AutoMallUsa.net, your auto buying guide online.
  - Used Cars - Cars for Sale - Toyota - Nissan
  - www.automallusa.net/ - En cache - Pages similaires

- New Cars, Used Cars - Find Cars at AutoTrader.com
  - [Traduire cette page]

  Find used cars for sale at AutoTrader.com. With over 3.5 million cars, finding your ... I want to stay and look for cars on AutoTrader.com in the U.S.A. ...
  - www.autotrader.com/ - États-Unis - En cache - Pages similaires

- en stock aux États-Unis et au Canada - DENKER US CARS | Import New ...
  - Sale New US Cars, Used US-Cars, Import Vehicles from USA, SUV, Offroad, 4x4, ... Collector Car - oldtimer. S'il faut remplir le ZIP Code, remplissez-le pour ...
  - french.denker.cz/outre-mer/ - En cache - Pages similaires
Term coined in 2009 by Adam Raff, co-founder of Foundem (a price-comparison company).

Google admitted penalizing Foundem and other specialized search services “to protect users from spam.”

But this can also be seen as hindering competition: Google offers similar services (Maps, Shopping, Images, videos...).

Search neutrality is a term close to net neutrality: limitations on users’ access to all relevant services on the Internet.

Search neutrality would impose that all contents have the same chances of being displayed.

⇒ a ranking based on relevance (to be defined objectively).
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Search Neutrality: the debate

Arguments in favor:

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- Neutrality elicits efforts from websites to improve their content quality

Arguments against:

⇒ new businesses can emerge more easily

⇒ worse results for users

Imposing transparency of the ranking algorithms facilitates the job of spammers

Competition is just one click away...
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Percentage of Google or Bing search results with own content not ranked similarly by any rival search engine (Wright, 2012).

Percentage

Google  Microsoft (Bing)

Top 1 97.9 94.4
Top 3 99.2 95.1
Top 5 98.4 95.3
First page 97.5 93.4
Do search engines return biased results?

Comparison between Google, Bing, and Blekko (Wright, 2012):

- Microsoft content is 26 times more likely to be displayed on the first page of Bing than on any of the two other search engines
- Google content appears 17 times more often on the first page of a Google search than on the other search engines

Search engines do favor their own content
Regulatory intervention

- The European Commission, is progressing toward an antitrust settlement deal with Google
  
  *Google must be even-handed. It must hold all services, including its own, to exactly the same standards, using exactly the same crawling, indexing, ranking, display, and penalty algorithms.*

- The European Commission is running a market testing (started in April 2013) to estimate the extent to which the Google ranking algorithm respects these guidelines (Google may face a fine as large as $5 billion)
Building a mathematical model

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Relevance of the ranking $\pi$ ($\pi_i =$position of webpage $i$):

$$r = \sum_{i} \theta_{\pi_i} r_i.$$
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Relevance of the ranking $\pi$ ($\pi_i$ = position of webpage $i$):

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Expected gain per search:

$$g = \beta + \sum_i \theta_{\pi_i} g_i$$

from ads
Trade-off relevance *versus* revenue

Favoring revenue-yielding webpages increases the revenue per search. But users are interested in relevance: they may switch to another search engine.

Model: a number of searches per time unit $\lambda(r)$, increasing with the relevance $r \Rightarrow$ expected revenue per time unit $= \lambda(r) \times g$. 

P. Maillé, B. Tuffin (IMT - Inria)

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June 2013
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\begin{align*}
\text{expected revenue per time unit} &= \lambda(r) \times g \nonumber 
\end{align*}
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Neutral and non-neutral rankings

Neutral ranking: based on relevance \( r_i \) ⇒ maximizes the average relevance, and thus the number of requests

Non-neutral ranking: aimed at maximizing the revenue \( \lambda(r) \)

Maximization over the set of permutations

Say with \( m \) candidate pages and \( \lambda(r) = r_{\text{max}} \) permutations

\[ \sum_{i=1}^{m} \theta_{\pi(i)} r_i \cdot (\beta + m \sum_{i=1}^{m} \theta_{\pi(i)} g_i) \]

not an easy task...
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\[
\max_{\text{permutations } \pi} \left( \sum_{i=1}^{m} \theta_{\pi_i} r_i \right) \cdot \left( \beta + \sum_{i=1}^{m} \theta_{\pi_i} g_i \right)
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An example

One keyword, three pages, click probabilities $\theta_i = \frac{1}{2^i}$, $\lambda(r) = r$

<table>
<thead>
<tr>
<th>$i$</th>
<th>Relevance $r_i$</th>
<th>Gain $g_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Relevance ($r$)</th>
<th>Engine revenue per time unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1; 2; 3</td>
<td>2.125</td>
<td>$2.125 (\beta + \frac{1}{4})$</td>
</tr>
<tr>
<td>1; 3; 2</td>
<td>2</td>
<td>$2 (\beta + \frac{1}{2})$</td>
</tr>
<tr>
<td>3; 1; 2</td>
<td>1.5</td>
<td>$1.5 (\beta + 1)$</td>
</tr>
</tbody>
</table>

Depending on the revenues from ads (value of $\beta$), each of these three can be the best one.
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- keywords treated as random: for each search we have
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  $\Rightarrow$ one ranking $\pi(R, G)$ to perform for each search
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\[
\text{Revenue} = \lambda \left( \mathbb{E} \left[ \sum_{i=1}^{m} \theta_{\pi_i} R_i \right] \right) \cdot \left( \beta + \mathbb{E} \left[ \sum_{i=1}^{m} \theta_{\pi_i} G_i \right] \right)
\]

We have a few results regarding that problem
What we want to do

- Analyze the non-neutral ranking
- Compare the performance of neutral and non-neutral policies

- Cost of non-neutrality: loss of relevance for users
- Cost of neutrality (for search engines): loss of revenue for search engines

Discuss the need for regulation
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This topic (and many others), in a book to appear:

TELECOMMUNICATION NETWORK ECONOMICS: From Theory to Practice

Patrick Maillé and Bruno Tuffin