



YAHOO!
LABS



Beyond Ranking: Optimizing Whole-Page Presentation (WSDM 2016)

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情報検索におけるランキング

- 10ブルーリンクに基づいたランキングアルゴリズム:
- 仮定
 - 文書が他の情報源と独立
 - ユーザーがランキングの上位からクリックするという仮定

[Simpsons predicted Broncos-Seahawks Super Bowl in 2005 ...](#)

[www.cbssports.com/nfl/eye-on-football/24425621/simpsons...](#) ▼
Las Vegas currently has the Broncos as 2.5-point favorites but the betting line actually should be 5 because, well, the Simpsons predicted the final score back in 2005.

[2005 New England Patriots Super Bowl XXXIX Champs Orange ...](#)

[www.ebay.com/itm/2005-NEW-ENGLAND-PATRIOTS-SUPER-BOWL...](#) ▼
2005 NEW ENGLAND PATRIOTS SUPER BOWL XXXIX CHAMPS ORANGE VERSION TICKET
PSA 7 in Sports Mem, Cards & Fan Shop, Vintage Sports Memorabilia, Ticket Stubs | eBay

[Amazon.com: NFL America's Game: 2005 STEELERS \(Super Bowl XL ...](#)

[www.amazon.com/NFL-Americas-Game-STEELERS-Super/dp/B001...](#) ▼
Amazon.com: NFL America's Game: 2005 STEELERS (Super Bowl XL): Jerome Bettis, Bill Cowher, Joey Porter: Movies & TV

[The Wilson Super Bowl XXXIX Game Football - Wilson Footballs](#)

[www.wilson.com/en-us/football/nfl/game-balls/super-bowl...](#) ▼
The Wilson Super Bowl XXXIX American Football. ... Super Bowl XXXIX Game Ball. February 6, 2005 Alltel Stadium Jacksonville, Florida New England Patriots 24

[Super Bowl XXXIX: Patriots and Eagles - Santa...](#)

[photos.santacruzsentinel.com/2016/02/04/super-bowl-xxxix...](#) ▼
Feb 03, 2016 · super bowl xxxix - feb. 6, 2005 - alltel stadium - jacksonville new england patriots 24 - philadelphia eagles 21 back-to-back: the patriots' defense ...

[2005 Super Bowl Pictures, Images & Photos | Photobucket](#)

[photobucket.com/images/2005 super bowl](#)
Browse 2005 Super Bowl pictures, photos, images, GIFs, and videos on Photobucket

[2005 Super Bowl Video - YouTube](#)

[www.youtube.com/watch?v=wKXRSTmE68](#) ▼
Want to watch this again later? Sign in to add this video to a playlist. "My Humps" parody

[2005 - Super Bowl XXXIX Posters at AllPosters.com](#)

[www.allposters.com/-st/2005-Super-Bowl-XXXIX-Posters_c...](#) ▼
2005 - Super Bowl XXXIX Posters at AllPosters.com. Choose from over 500,000 Posters and Art Prints. Value Framing, Fast Delivery, 100% Satisfaction Guarantee.

[2005 Seattle Seahawks Statistics & Players | Pro-Football ...](#)

[www.pro-football-reference.com/teams/sea/2005.htm](#) ▼
Lost Super Bowl XL to Steelers, 13-3 (po:2-1), , ProBowl ... Mobile Site You Are Here > PFR Home > Teams > Seattle Seahawks > 2005 Statistics & Players. News: s-r ...

[ESPN.com - NFL - Super Bowl XL: Seahawks vs....](#)

[sports.espn.go.com/nfl/playoffs05/series?series=seapit](#) ▼
ESPN'S TAKE: Question: What was the turning point of Super Bowl XL? The turning point of this game was when Ike Taylor picked off Matt Hasselbeck near the goal line.

Beyond ranking?

- Cuil search engine (2008 ~ 2010)

The screenshot shows the Cuil search engine interface with a search bar containing 'william wolff' and a 'Search' button. The page displays 9,345 results. The results are organized into a grid of search snippets, each with a title, a brief description, and a small image. The snippets include:

- Rotten Tomatoes: William Wolff Celebrity Profile**: A snippet mentioning fan sites and registration options.
- William Wolff (1922-0)**: A snippet about art prices and a website for finding art.
- William Wolff Society & Schepens Eye Research Institute**: A snippet about Billy's legacy and the institute's mission.
- William Wolff - The Invisible City - San Francisco ...**: A snippet about an event in San Francisco.
- Healers, gurus, and spiritual guides le William Wolff ...**: A snippet about a cataloging and social networking site.
- Healers, gurus, and spiritual guides of William Wolff ...**: A snippet about a similar cataloging and social networking site.
- William Wolff | Blurb**: A snippet about a book titled 'The Invisible City'.
- Price Compare Books by William Wolff: Spot Cost**: A snippet about a book by Mary Dugan.

The interface also features a 'Safe Search off' indicator, a 'Preferences' link, and a footer with navigation controls and a column selection option (2 Columns | 3 Columns).

Beyond ranking

“obama”

Ads

Ad related to obama

OBAMA Loan Forgiveness - Say Good-Bye to Student Loan Debt!
[StudentLoanForgivenessPlans.com](#) (855) 568-2904 Ad
 Say Good-Bye to Student Loan Debt! Get Your Student Loans Forgiven Now
[Call Now & Save Money!](#) [Fast Easy Qualification!](#)
[Get Your Loans Forgiven](#) [Lower Payments to ZERO](#)
[Be Approved in Minutes!](#) [Call to Check Eligibility](#)

See more ads for: [obama](#), [obama health care plan](#), [michelle obama](#), [barack obama](#)

News

Barack Obama News

Obama's Half-Brother Misses Home-Brew Days Ahead of Kenya Visit
 Bloomberg via Yahoo! Finance 5 hours ago
 Obama designates national monuments in Texas, Calif., Nevada
 Associated Press via Yahoo! News 2 days ago
 Why Obama will be the first president to visit a federal prison
 Christian Science Monitor via Yahoo! News 1 day ago
 More Barack Obama Headlines

Image

Obama - Image Results



More Obama images

Web

Barack Obama - Official Site

[www.barackobama.com](#) v
 OFA works to ensure the voices of ordinary Americans are heard in Washington, while training the next generation of grassroots organizers who will keep fighting for ...

Barack Obama - Wikipedia, the free encyclopedia

[en.wikipedia.org/wiki/Barack_Obama](#) v
 Barack Hussein Obama II (US / b ə ˈ r ɑː k h uː ˈ s eɪ n ə ˈ b ɑː m ə /; born August 4, 1961) is the 44th and current President of the United States ...

Video

Obama - Video Results

[Barack Obama Kicks Door Open](#)
 youtube.com 0:15

[Obama Victory Speech 2008](#)
 youtube.com 25:59

More San Francisco Stories

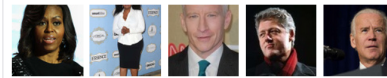


Barack Obama
 44th President of the United States

Barack Hussein Obama II (born August 4, 1961) is the 44th and current President of the United States, and the first African American to hold the office. Born in Honolulu, Hawaii, Obama is a graduate of Columbia... [wikipedia.org](#)

Born: August 4, 1961 (age 53), Honolulu, Hawaii
Nationality: United States of America
Height: 6' 1" (1.85m)
Spouse: Michelle Obama (m. 1992-present)
Parents: Ann Dunham, Barack Obama, Sr.
Children: Malia Ann Obama, Nattasha Obama

People also search for



Michelle Obama Oprah Winfrey Anderson Cooper Bill Clinton Joe Biden

Feedback

See more ads for:

[obama](#)
[obama health care plan](#)
[michelle obama](#)
[barack obama](#)
[obama approval rating](#)

Ads

[Obama Health Care Plans](#)
[ObamacareUSA.org/California](#) Ad
 See if You Qualify for Obamacare After Open Enrollment. Learn More!

[Obamacare Health Plans](#)
[Obamacare.Healthplans.com](#) Ad
 Check for Enrollment Extensions - Avoid Penalties - Get Insured Today!

Knowledge card

Ads

[Sweet Caroline - A Neil Diamond fan community](#)

[www.sweetcaroline.com/](#) v
 Neil Diamond fan community: The source for fans to find information about Neil Diamond music, concerts, and the latest news.

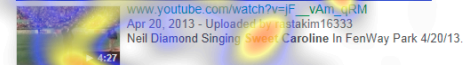
[Sweet Caroline - Wikipedia, the free encyclopedia](#)

[en.wikipedia.org/wiki/Sweet_Caroline](#) v
 "Sweet Caroline" is a soft rock song written and performed by Neil Diamond and officially released on September 16, 1969, as a single. It was later released on ...

Neil Diamond - [Sweet Caroline High Quality neildiamond](#) - YouTube



Neil Diamond Singing [Sweet Caroline In FenWay Park 4/20/13 ...](#)



NEIL DIAMOND LYRICS - [Sweet Caroline - A-Z Lyrics](#)

[www.azylyrics.com/lyrics/neildiamond/sweetcaroline.html](#)
 Lyrics to "Sweet Caroline" song by NEIL DIAMOND: Where it began, I can't begin to knowin' But then I know it's growing strong WAND in the spring And ...

Neil Diamond - [Sweet Caroline - Listen and discover music at Last.fm](#)

[www.last.fm/music/Neil+Diamond/_/Sweet+Caroline](#) v
 Watch the video & listen to Neil Diamond - Sweet Caroline for free. Sweet Caroline appears on the album In My Lifetime. "Sweet Caroline" is a pop song written ...

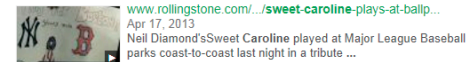
[Sweet Caroline by Neil Diamond Songfacts](#)

[www.songfacts.com/detail.php?id=6420](#) v
 Sweet Caroline by Neil Diamond song meaning, lyric interpretation, video and chart position.

'Sweet Caroline': [Why is it a Boston Red Sox song? - News](#)

[news.msn.com/pop.../sweet-caroline-why-is-it-a-boston-red-sox-song](#) v
 Apr 17, 2013 - 'Sweet Caroline' has become a Fenway Park tradition, but now the song is being belloved at other parks as well. It was even played at the MLB ...

'Sweet Caroline' [Plays at Ballparks Nationwide in Boston Tribute ...](#)



[Sweet Caroline's](#)



[sweetcarolinesboston.com/](#) v
 Welcome To Sweet Caroline's Boston. The Fenway's Newest Restaurant & Bar. Sweet Caroline's is Fenway's newest restaurant & bar! This 4,000 square foot

Credit: Matthew Campion. Eye tracking study: Google results with videos. 2013/9.

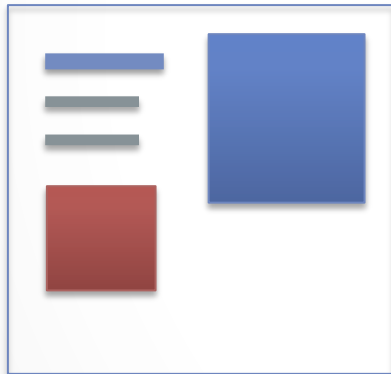
Question?

どうすればウェブページの表示を(クリック率が最大となるように)最適化できるか？



人工例

検索結果 = { , ,  }

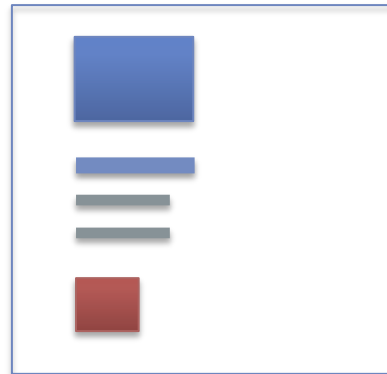
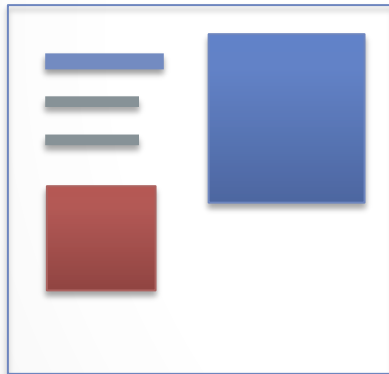
表示オプション:



人工例

検索結果 = { , ,  }

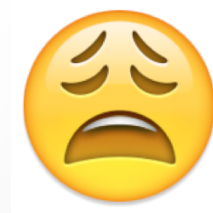
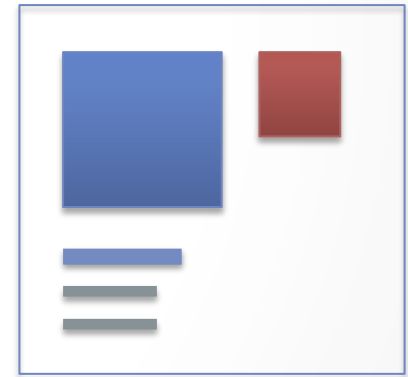
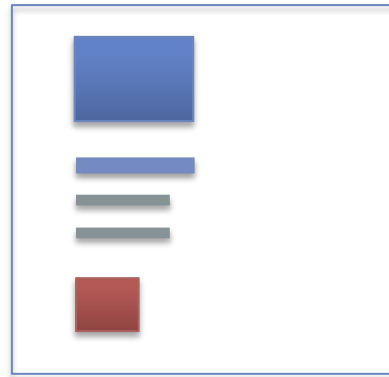
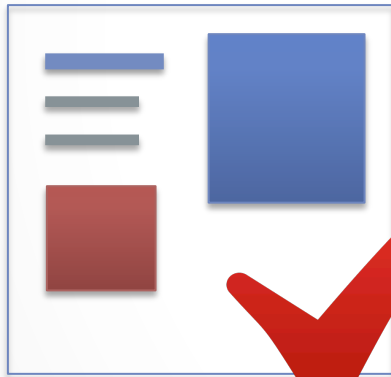
表示オプション:



人工例

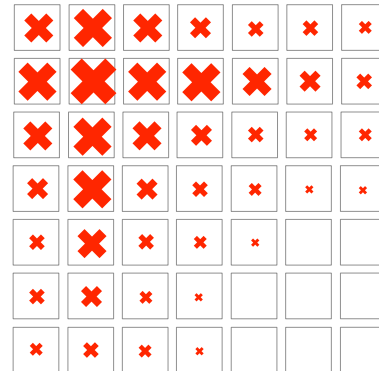
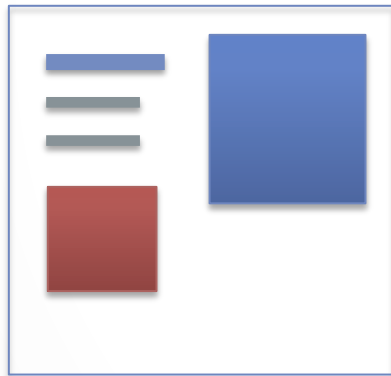
検索結果 = { , ,  }

表示オプション:

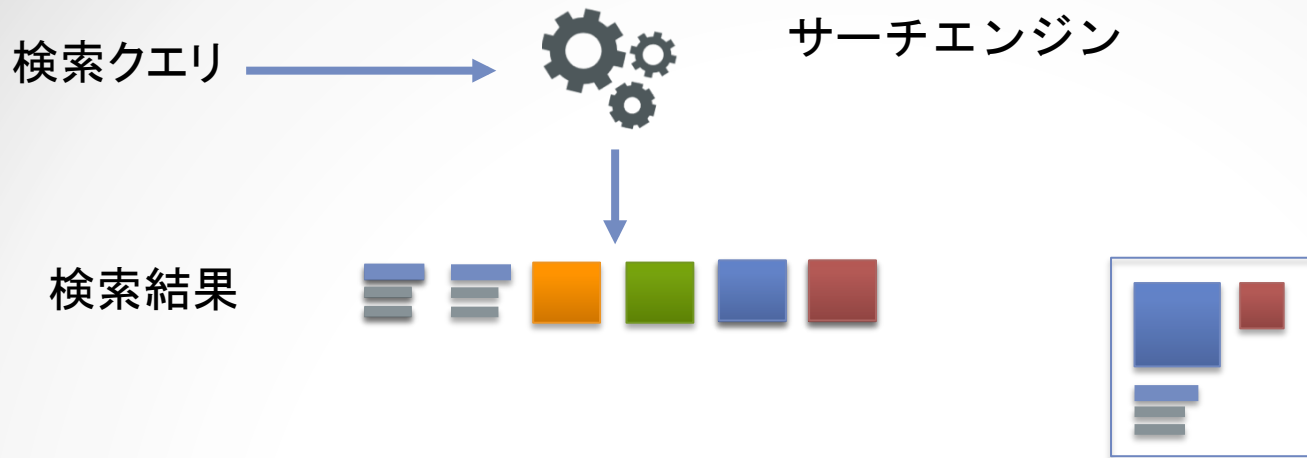


表示 >> レイアウト

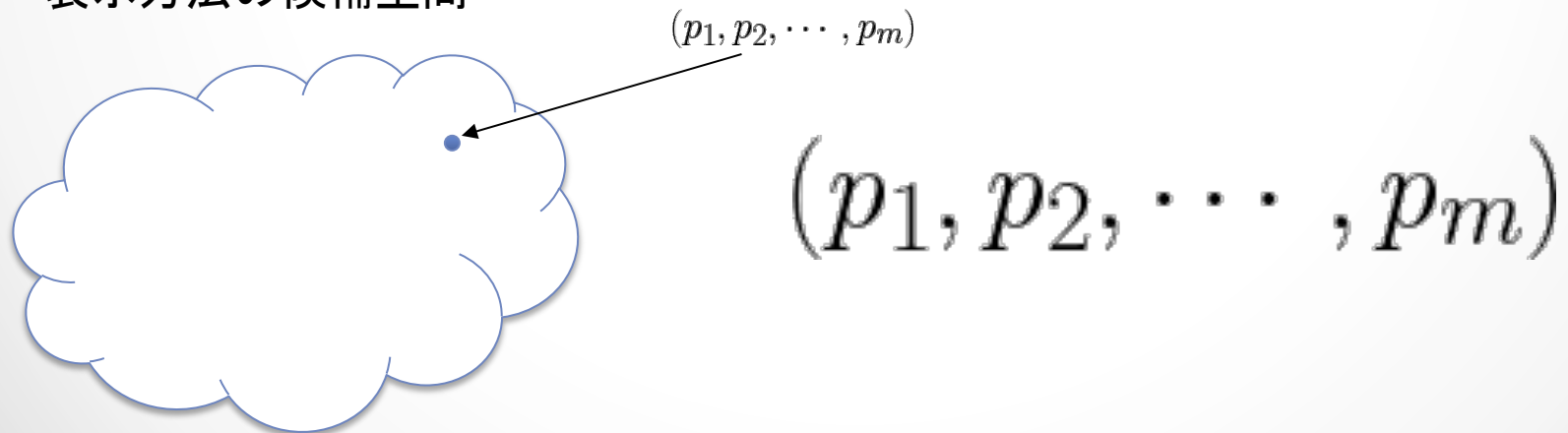
検索結果 = { , ,  }



Optimizing two-dimensional search results presentation
Chierichetti, Kumar, and Raghavan. WSDM '11

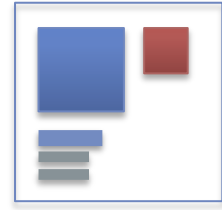


表示方法の候補空間



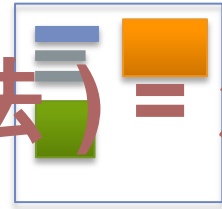
クエリ →  サーチエンジン

検索結果

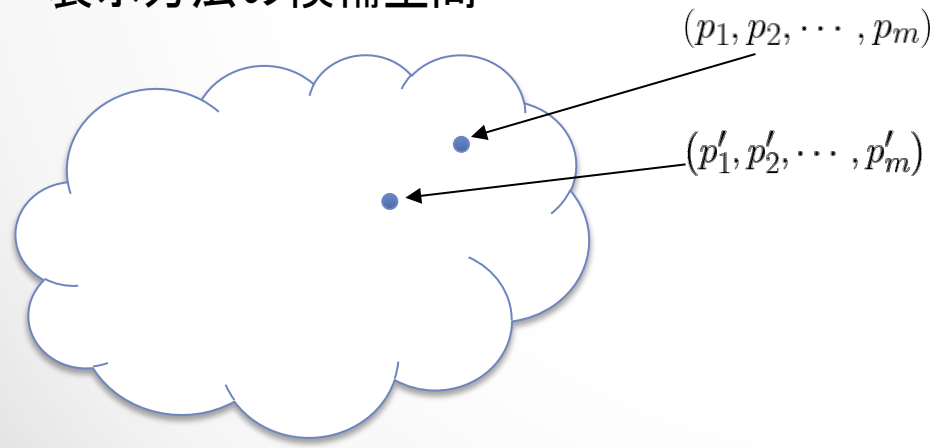


↑
満足度

$Q(\text{検索結果}, \text{表示方法}) = \text{満足度}$



表示方法の候補空間



提案フレームワーク

- ステップ1:

満足度 = $Q(\text{検索結果}, \text{表示方法})$

となるような Q を学習する.

- ステップ2:

$\operatorname{argmax}_{\text{表示方法}} Q(\text{検索結果}, \text{表示方法})$

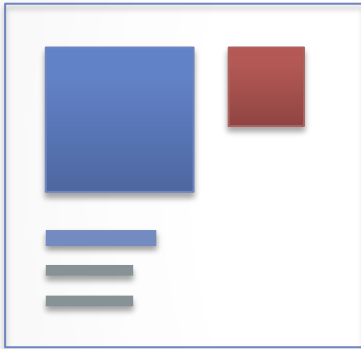
表示方法

を用いて最適な表示方法を選択

Qの学習: ラベルはどうするか?

(検索結果, 表示方法)

満足度



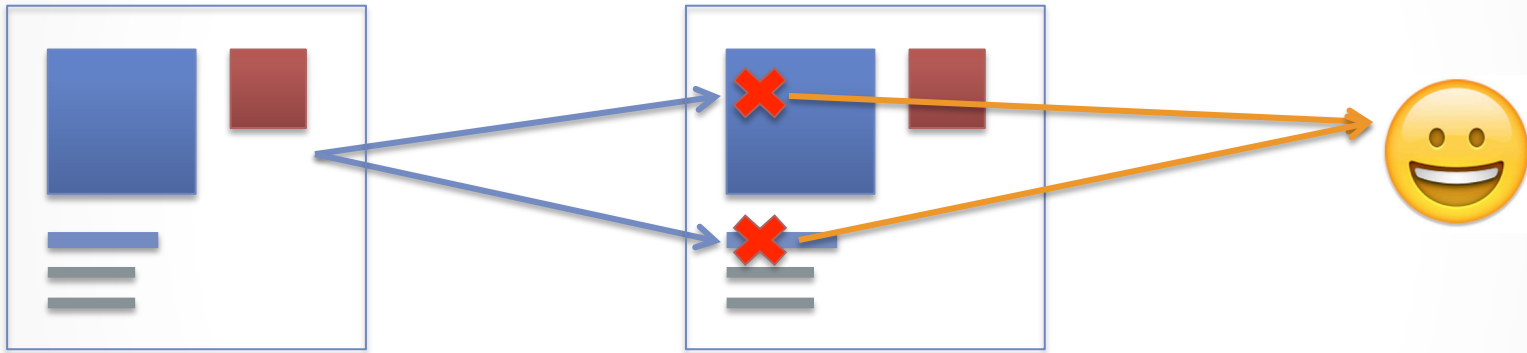
ユーザーが評価?

Qの学習: 満足度の定義

(検索結果, 表示方法)

ユーザーレスポンス

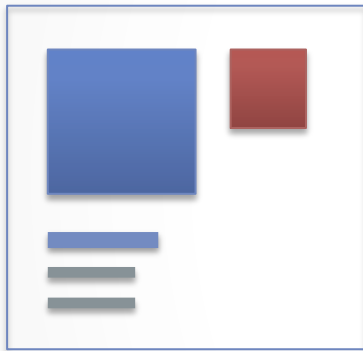
満足度



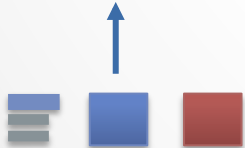
Qの学習: 選択バイアス

(検索結果, 表示方法)

満足度



search engine
presentation
strategy

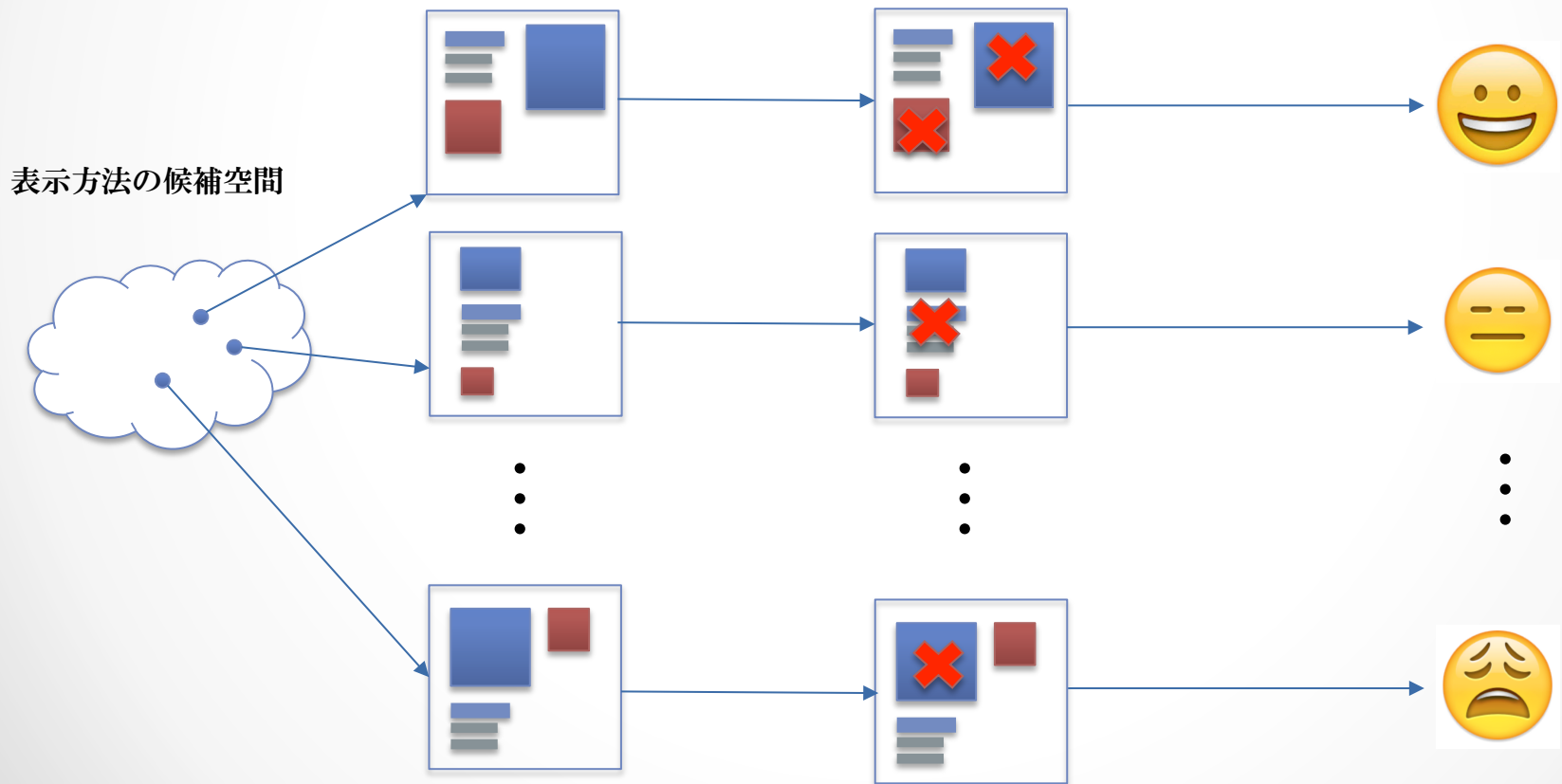


Qの学習: 表現方法の探索

(検索結果, 表示方法)

ユーザーレスポンス

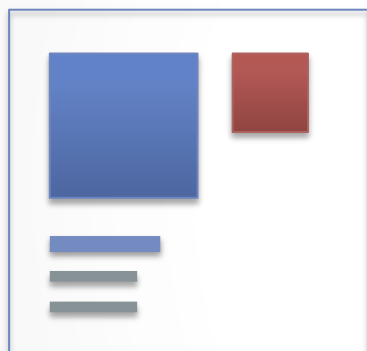
満足度



Qの学習: 数理モデル

(検索結果, 表示方法)

満足度



Q 線形関数?

$$Q = a^T \text{content} + b^T \text{presentation} \\ + \text{content}^T \mathbf{W} \text{presentation} + \dots$$

コンテンツ特徴

- Global result and features
 - コンテンツが利用可能かどうかの特徴
- Query features
 - クエリのユニグラム, バイグラム等の特徴
- Corpus level features
 - 各文書の過去のCTR等
- Search result features
 - 各サーチエンジンから返ってくる特徴

Qの学習: モデル例

Quadratic interaction model (Factorization machine)

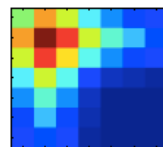
$$Q(\mathbf{x}, \mathbf{p}) = \mathbf{a}^\top \mathbf{x} + \mathbf{b}^\top \mathbf{p} + \mathbf{x}^\top \mathbf{W} \mathbf{p} + c$$
$$\mathbf{x} \in \mathbb{R}^d, \mathbf{p} \in \{0, 1\}^{k^2},$$

$$\mathbf{a} \in \mathbb{R}^d, \mathbf{b} \in \mathbb{R}^{k^2}, \mathbf{W} \in \mathbb{R}^{d \times k^2}$$
$$p^* = \underset{\mathbf{p}}{\operatorname{argmax}} Q(\mathbf{x}, \mathbf{p})$$

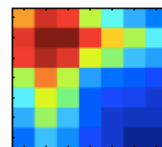


Linear assignment problem: $O(\dim(p)^3)$

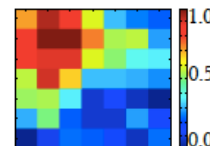
2GHz single core:
 $\dim(p) = 2500 \sim 0.01 \text{ sec}$



(a) Position bias



(b) Ideal presentation



(c) Learned presentation

Gradient boosted decision tree model

$$Q_{\text{GBDT}}(\mathbf{x}, \mathbf{p})$$

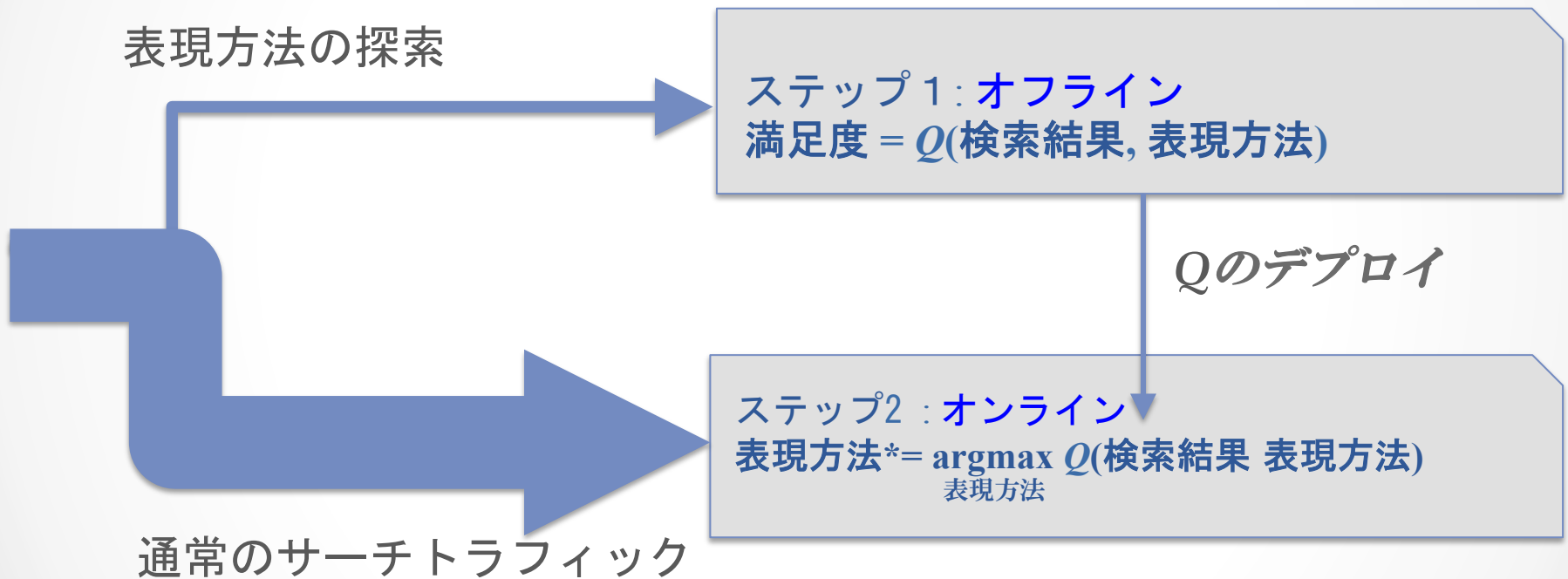
$$p^* = \underset{\mathbf{p}}{\operatorname{argmax}} Q_{\text{GBDT}}(\mathbf{x}, \mathbf{p})$$



No polynomial-time solution

search space pruned by
business and design constraints

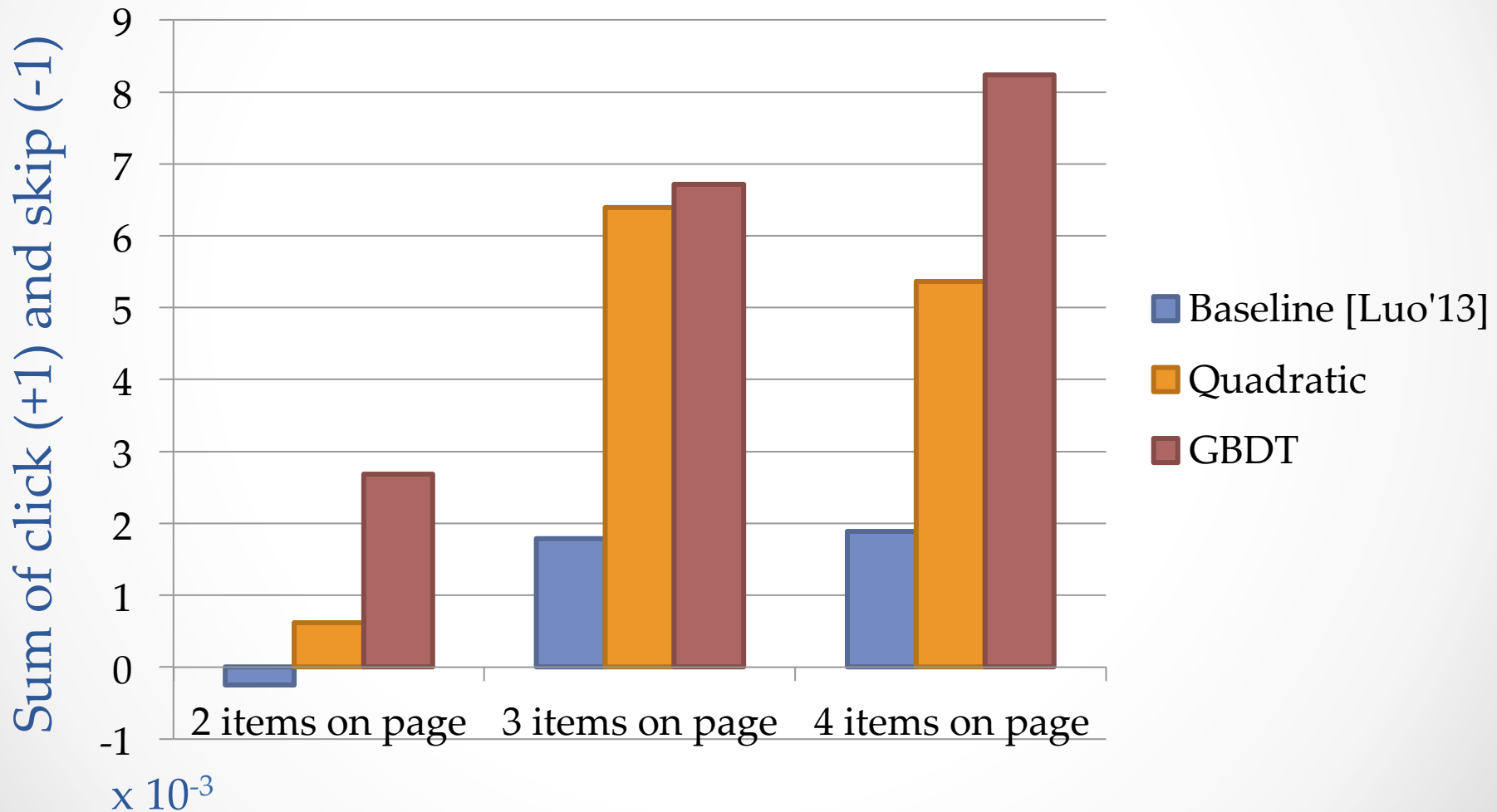
処理の流れ



実験結果: Yahoo Search

- 800万ページビュー, 12ヶ月 (2013)
 - 最初の6ヶ月を学習, 残りをテスト
- 4 verticals: ニュース, ショッピング, ローカルリスト, 複数ローカルリスト
- 満足度 = クリック数 (+1) とスキップ数 (-1) の合計

Less skips, more clicks



“drinks near Columbus circle”

The image is a screenshot of a Yahoo! search engine interface. At the top, the search bar contains the text "drinks near columbus circle" and a "Search" button. Below the search bar, there are navigation tabs for "Web", "Images", "Video", "News", "More", and "Anytime". The search results are displayed in a grid format. The first result is "Drinks near Columbus Circle", which includes a map of the New York City area with a red pin at the location. Below the map, there are two search results listed:

Rank	Business Name	Address	Phone Number
1	Drinks Americas	424 Main St Ridgefield, CT	(203) 403-3622
2	Brooklyn Drinks ★★★☆☆ 2 on Yelp	140 Graham Ave Brooklyn, NY	(718) 218-9778

Below the search results, there are links for "See all 330 results", "Send feedback", and "Add or update your business". A large orange arrow points from the search results area towards the right side of the image, where a detailed view of the "Brooklyn Drinks" listing is shown. This listing includes a photo of people at the bar, a map of the location, the business name "Brooklyn Drinks", a Yelp rating of 2 stars, and the address "140 Graham Ave, Brooklyn, NY 11206". There are also buttons for "Directions" and "Send feedback".

Take home message

- 新規の問題を提案: **whole-page presentation optimization**
 - 様々な検索結果(ブルーリンク, 画像, etc)を利用
 - 機械学習とHCIの融合
- 検索結果の表現を定量化することで, **最適化可能に!**

References

- [Robertson'77] S. E. Robertson. The probability ranking principle in ir. In *Journal of Documentation*, pages 294–304, 1977.
- [Chierichetti'11] F. Chierichetti, R. Kumar, and P. Raghavan. Optimizing two-dimensional search results presentation. In *Proceedings of the fourth ACM conference on Web search and data mining*, pages 257–266, 2011.
- [Luo'13] J. Luo, S. Lamkhede, R. Sapra, E. Hsu, H. Song, and Y. Chang. A unified search federation system based on online user feedback. In *Proceedings of the 19th ACM SIGKDD conference on Knowledge discovery and data mining*, pages 1195–1203. ACM, 2013.