

Information Retrieval

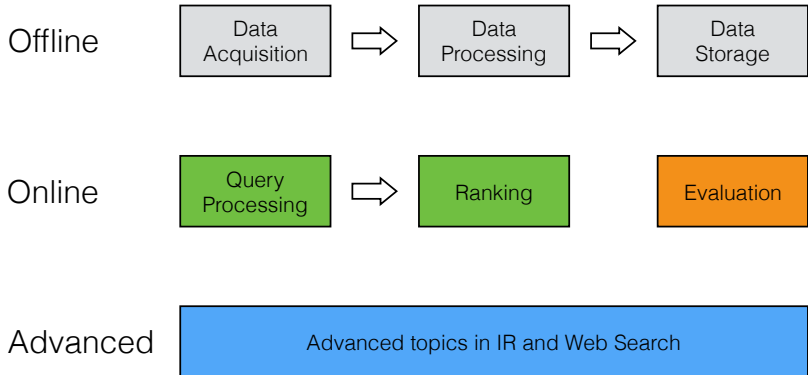
Click Models

Ilya Markov

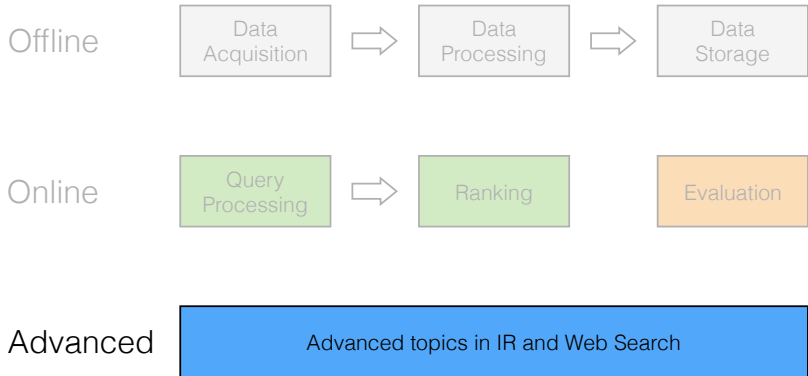
i.markov@uva.nl

University of Amsterdam

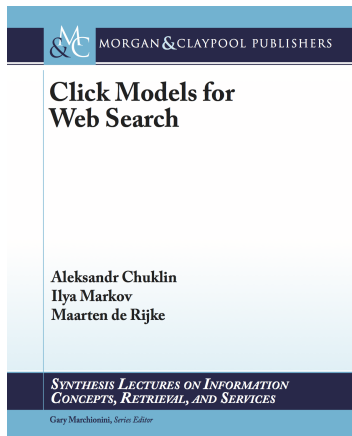
Course overview



Advanced topics in IR



The book



<http://clickmodels.weebly.com/the-book.html>

Tutorials

- SIGIR 2015, Santiago, Chile
- AINL-ISMW FRUCT 2015, St. Petersburg, Russia
- WSDM 2016, San Francisco, USA
- RuSSIR 2016, Saratov, Russia

`http://clickmodels.weebly.com/tutorials.html`

Outline

- 1 Applications
- 2 Advanced models
- 3 Summary

Click models summary so far

- Basic click models
 - CTR models
 - Position-based model
 - Cascade model
- Click probabilities
 - Full click probabilities
 - Conditional click probabilities
- Evaluation
 - Perplexity
 - Log-likelihood
- Parameter estimation
 - Maximum likelihood estimation
 - Expectation-maximization

What do click models give us?

General:

- Understanding of user behavior

Specific:

- Conditional click probabilities
- Full click probabilities
- Attractiveness and satisfactoriness for query-document pairs

Applications

Click model's output	Application
Understanding of user behavior	User interaction analysis
Conditional click probabilities	User simulation
Full click probabilities	Model-based metrics
Parameter values	Ranking

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User interaction analysis

- Random click model (global CTR): $\rho = 0.122$
- Rank-based CTR:
 $\rho_1 = 0.429, \rho_2 = 0.190, \rho_3 = 0.136, \dots, \rho_{10} = 0.048$
- Position-based model:
 $\gamma_1 = 0.998, \gamma_2 = 0.939, \gamma_3 = 0.759, \dots, \gamma_{10} = 0.260$
- Dynamic Bayesian network model: $\gamma = 0.9997$

Click models are trained on the first 10K sessions of the WSCD 2012 dataset.

Simulating users

Algorithm Simulating user clicks

Input: click model M , query session s

Output: vector of simulated clicks (c_1, \dots, c_n)

- 1: **for** $r \leftarrow 1$ to $|s|$ **do**
 - 2: $P_r \leftarrow P_M(C_r = 1 \mid C_1 = c_1, \dots, C_{r-1} = c_{r-1})$
conditional click probability
 - 3: Generate c_r from *Bernoulli*(P_r)
 - 4: **end for**
-

Model-based metrics

- Utility-based metrics

$$uMetric = \sum_{r=1}^n P(C_r = 1) \cdot U_r$$

- Effort-based metrics

$$eMetric = \sum_{r=1}^n P(S_r = 1) \cdot F_r$$

The screenshot shows a Yandex search engine interface. The search bar contains the text "san francisco" and indicates "62 million answers". Below the search bar, there are several search results categorized by type:




- Web:**
 - San Francisco Travel** (sanfrancisco.travel) - A hand cursor is hovering over this link. The snippet reads: "San Francisco is home to a bit of everything. Whether you're a first time visitor or a long-time local. This is the place to find out about all things San Francisco."
- Images:** (No visible results)
- Video:** (No visible results)
- Translate:**
 - San Francisco - Wikipedia, the free encyclopedia** (en.wikipedia.org) - A hand cursor is hovering over this link. The snippet reads: "San Francisco (sæn frənˈsɪskoʊ), officially the City and County of San Francisco, is the cultural, commercial, and financial center of Northern California and the only consolidated city-county in California."
- More:**
 - San Francisco travel guide - Wikitravel** (wikitravel.org) - A hand cursor is hovering over this link. The snippet reads: "San Francisco is a major city in California, the centerpiece of the Bay Area, well-known for its liberal community, hilly terrain, Victorian architecture, scenic beauty, summer fog, and great ethnic and cultural diversity."
 - San Francisco City Guide | Hotels, Restaurants, Nightlife, Real...** (sanfrancisco.com) - A hand cursor is hovering over this link. The snippet reads: "The job market may seem to navigate these days, but employment and career opportunities can be found in San Francisco's Financial District and Silicon Valley's..."
 - City and County of San Francisco** (sf.gov) - A hand cursor is hovering over this link. The snippet reads: "SF Gov Visitors Key Services: SF Travel Resources. ... Table of links to San Francisco districts and supervisors. District, Supervisor."


Expected reciprocal rank


$$\begin{aligned} ERR &= \sum_r \frac{1}{r} \cdot P(S_r = 1) \\ &= \sum_r \frac{1}{r} \cdot R_{u_r q} \cdot \prod_{i=1}^{r-1} (\gamma \cdot (1 - R_{u_i q})) \end{aligned}$$



Features for ranking



Yandex — 62 million answers ✕ ↔ Search




Web  **San Francisco Travel**
sanfrancisco.travel  
 San Francisco is home to a bit of everything. Whether you're a first time visitor or a long-time local. This is the place to find out about all things **San Francisco**. $\alpha_{u_1 q}$



Images 

Video 

Translate  **San Francisco - Wikipedia, the free encyclopedia**
en.wikipedia.org > [San Francisco](#) 
 San Francisco (/sæn frənˈsɪskoo/), officially the City and County of **San Francisco**, is the cultural, commercial, and financial center of Northern California and the only consolidated city-county in California. $\alpha_{u_2 q}$

More  **San Francisco travel guide - Wikitravel**
wikitravel.org > [en/San_Francisco](#) 
 San Francisco is a major city in California, the centerpiece of the Bay Area, well-known for its liberal community, hilly terrain, Victorian architecture, scenic beauty, summer fog, and great ethnic and cultural diversity. $\alpha_{u_3 q}$

 **San Francisco City Guide | Hotels, Restaurants, Nightlife, Real...**
sanfrancisco.com  
 The job market may seem to navigate these days, but employment and career opportunities can be found in San Francisco's Financial District and Silicon Valley's... $\alpha_{u_4 q}$

 **City and County of San Francisco**
sfgov.org 
 SFGov Visitors Key Services: **SF** Travel Resources. ... Table of links to **San** Franisco districts and supervisors. District. Supervisor. $\alpha_{u_5 q}$

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Aggregated SERPs

Google [Sign in](#)

[All](#) [Images](#) [Maps](#) [News](#) [Videos](#) [More](#) [Search tools](#)

About 679,000,000 results (0.68 seconds)

San Francisco - Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/San_Francisco
 San Francisco (/sæn frənsɪˈskoʊ/), officially the City and County of San Francisco, is the cultural, commercial, and financial center of Northern California and ...
 List of people from San - Consolidated city-county - 1906 San Francisco earthquake

San Francisco Travel | Visitor Information
www.sanfrancisco.travel/
 Information and features for leisure and business travelers, convention planners, travel trade, and travel media.
[Alcatraz - Things to Do in San Francisco](#) - [Fisherman's Wharf](#) - [Golden Gate Bridge](#)

Images for san francisco Report images

More images for san francisco

San Francisco City Guide | Hotels, Restaurants, Nightlife ...
www.sanfrancisco.com/
 A complete San Francisco, CA Travel & Tourism Guide specializing in hotels, attractions, restaurants, real estate, nightlife and local business information.

San Francisco Tourism: Best of San Francisco, CA ...
www.tripadvisor.com - United States - California (CA)
 San Francisco Tourism: TripAdvisor has 630023 reviews of San Francisco Hotels, Attractions, and Restaurants making it your best San Francisco resource.

In the news

Twin Peaks shooting victim's family talks about recent arrest
 KGO-TV - 11 hours ago
 San Francisco police confirm they made an arrest in Richmond. However, as of 11 p.m., ...

Sunny weather brings new temperature record for San Francisco

San Francisco

City in California

San Francisco, in northern California, is a city on the tip of a peninsula surrounded by the Pacific Ocean and San Francisco Bay. It's known for its hilly landscape, year-round fog, iconic Golden Gate Bridge, cable cars and colorful Victorian houses. The Financial District's Transamerica Pyramid is its most distinctive skyscraper. In the bay sits Alcatraz Island, site of the notorious former prison.

Local time: Tuesday 12:38
Weather: 22°C, Wind W at 3 km/h, 51% Humidity
Getting there: 12 h 20 min flight, around CHF 760.00. [View flights](#)

Events

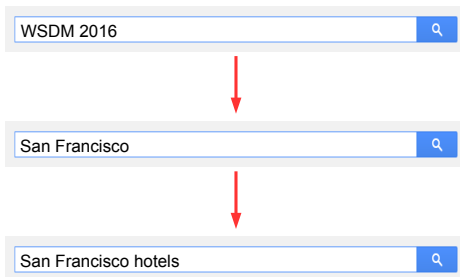
The Wainwright Sisters	Thu 18 Feb
Plastik Funk	Sat 20 Feb
Trevor Noah	Sat 20 Feb
The Masonic	Sat 20 Feb

Points of interest

[View 10+ more](#)

[More about San Francisco](#)

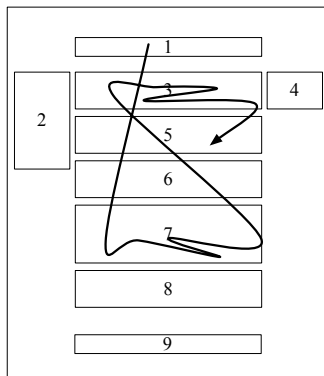
Search tasks



Using features

ID	Feature description
1	Term frequency (TF) of body
2	TF of anchor
3	TF of title
4	TF of URL
5	TF of whole document
6	Inverse document frequency (IDF) of body
7	IDF of anchor
8	IDF of title
9	IDF of URL
10	IDF of whole document
11	TF*IDF of body
12	TF*IDF of anchor
13	TF*IDF of title
14	TF*IDF of URL
15	TF*IDF of whole document
16	Document length (DL) of body
17	DL of anchor
18	DL of title
19	DL of URL
20	DL of whole document
21	BM25 of body
22	BM25 of anchor
23	BM25 of title
24	BM25 of URL
25	BM25 of whole document

Beyond clicks



Picture taken from F. Diaz, R.W. White, G. Buscher, and D. Liebling. Robust models of mouse movement on dynamic web search results pages. In *CIKM*, 2013. ACM Press

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Materials

- Aleksandr Chuklin, Ilya Markov, Maarten and de Rijke
Click Models for Web Search
Morgan & Claypool, 2015

Advanced topics in IR

