

Learning with Humans in the Loop

CS4780/5780 – Machine Learning
Fall 2014

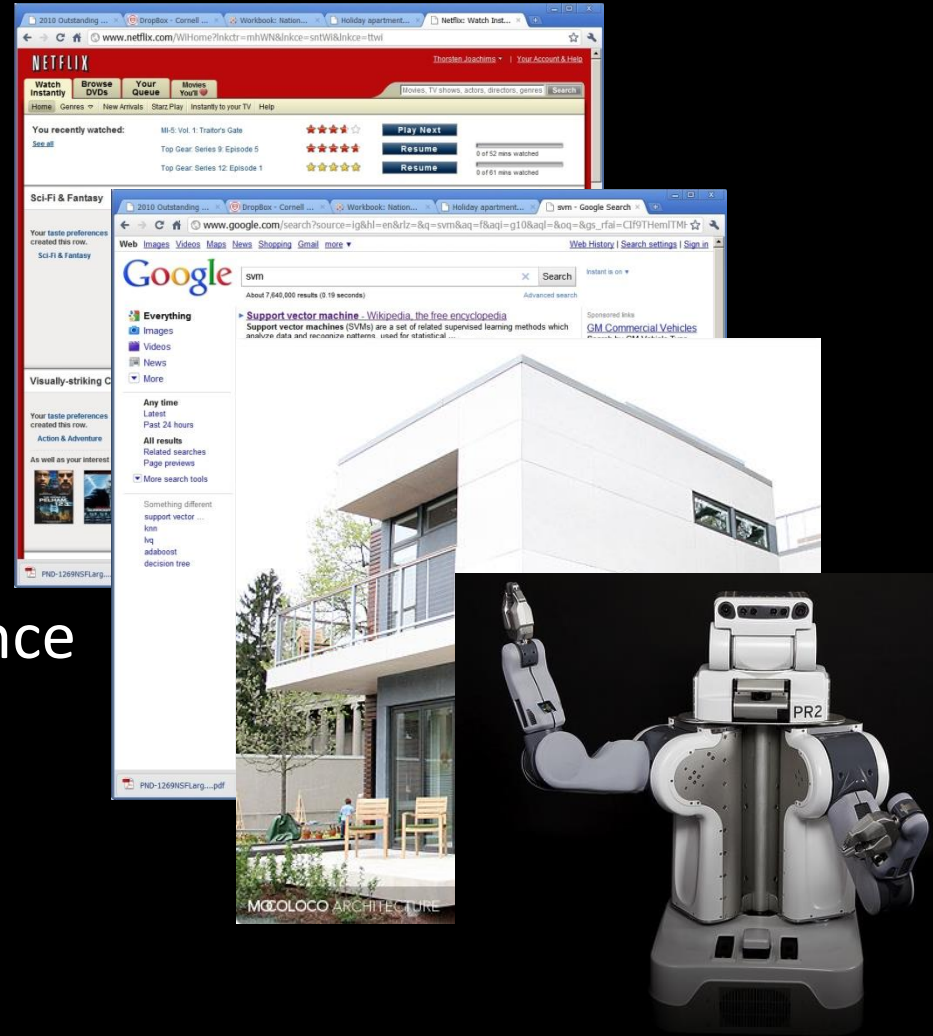
Thorsten Joachims
Cornell University

Optional Reading:

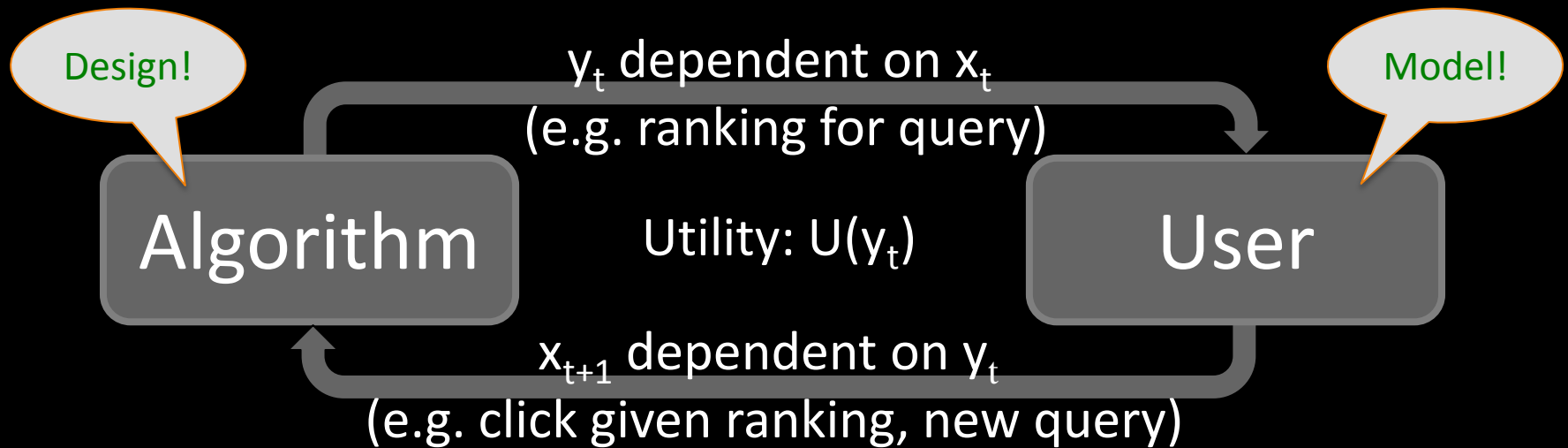
- Yisong Yue, J. Broder, R. Kleinberg, T. Joachims, *The K-armed Dueling Bandits Problem*, Conference on Learning Theory (COLT), 2009.
- P. Shivaswamy, T. Joachims, *Online Structured Prediction via Coactive Learning*, International Conference on Machine Learning (ICML), 2012.

User-Facing Machine Learning

- Examples
 - Search Engines
 - Netflix
 - Smart Home
 - Robot Assistant
- Learning
 - Gathering and maintenance of knowledge
 - Measure and optimize performance
 - Personalization



Interactive Learning System



- Observed Data \neq Training Data
 - Observed data is user's decisions
 - Even explicit feedback reflects user's decision process
- Decisions \rightarrow Feedback \rightarrow Learning Algorithm

Decide between two Ranking Functions

Distribution $P(u,q)$
of users u , queries q

\vdots
 $(t_j, \text{"SVM"})$
 \vdots

Retrieval Function 1

$$f_1(u,q) \rightarrow r_1$$

Which one
is better?

Retrieval Function 2

$$f_2(u,q) \rightarrow r_2$$

1. Kernel Machines
<http://svm.first.gmd.de/>
2. SVM-Light Support Vector Machine
<http://svmlight.joachims.org/>
3. School of Veterinary Medicine at UPenn
<http://www.vet.upenn.edu/>
4. An Introduction to Support Vector Machines
<http://www.support-vector.net/>
5. Service Master Company
<http://www.servicemaster.com/>

\vdots

$U(t_j, \text{"SVM"}, r_1)$

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2. Service Master Company
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3. Support Vector Machine
<http://jbolivar.freesevers.com/>
4. Archives of SUPPORT-VECTOR-MACHINES
<http://www.jiscmail.ac.uk/lists/SUPPORT...>
5. SVM-Light Support Vector Machine
[http://ais.gmd.de/~thorsten/svm light/](http://ais.gmd.de/~thorsten/svm%20light/)

\vdots

$U(t_j, \text{"SVM"}, r_2)$

Measuring Utility

Name	Description	Aggregation	Hypothesized Change with Decreased Quality
Abandonment Rate	% of queries with no click	N/A	Increase
Reformulation Rate	% of queries that are followed by reformulation	N/A	Increase
Queries per Session	Session = no interruption of more than 30 minutes	Mean	Increase
Clicks per Query	Number of clicks	Mean	Decrease
Click@1	% of queries with clicks at position 1	N/A	Decrease
Max Reciprocal Rank*	1/rank for highest click	Mean	Decrease
Mean Reciprocal Rank*	Mean of 1/rank for all clicks	Mean	Decrease
Time to First Click*	Seconds before first click	Median	Increase
Time to Last Click*	Seconds before final click	Median	Decrease

(*) only queries with at least one click count

ArXiv.org: User Study

User Study in ArXiv.org

- Natural user and query population
- User in natural context, not lab
- Live and operational search engine
- Ground truth by construction

ORIG \succ SWAP2 \succ SWAP4

- ORIG: Hand-tuned fielded
- SWAP2: ORIG with 2 pairs swapped
- SWAP4: ORIG with 4 pairs swapped

ORIG \succ FLAT \succ RAND

- ORIG: Hand-tuned fielded
- FLAT: No field weights
- RAND : Top 10 of FLAT shuffled

arXiv.org Full Text Search Results

Displaying hits 1 to 10 of 622. [Reorder by date.](#)

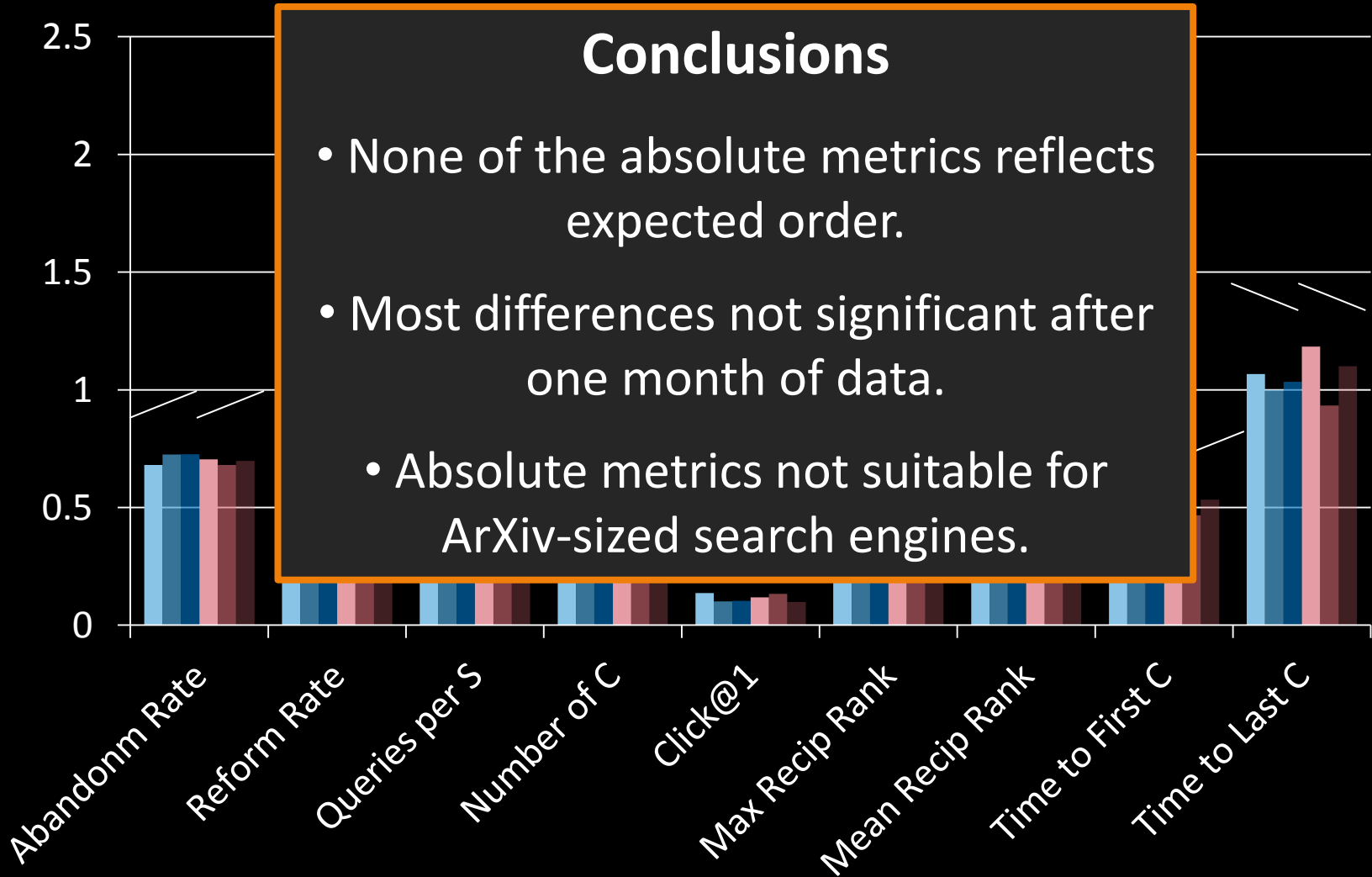
- [Emmanuel Monfni, Yann Guemour, A Quadratic Loss Multi-Class SVM \(2008\)](#)
abstract: ... on the leave-one-out error of the pattern recognition SVM have been derived. Among these bounds, the most popular one ... bound. It applies to the hard margin pattern recognition SVM, and by extension to the 2-norm SVM. In this report, we introduce a quadratic loss M-SVM, the M-SVM^q, as a di ...
<http://arxiv.org/abs/0804.4898>
- [Nathalie Villa, Fabrice Rossi, Un résultat de consistance pour des SVM fonctionnels par interpolation spline \(2007\)](#)
abstract: ... for function classification with Support Vector Machine (SVM). Rather than relying on projection on a truncated ... an implicit spline interpolation that allows us to compute SVM on the derivatives of the studied functions. To that end, w ...
<http://arxiv.org/abs/0705.0210>
- [François Rapoport, Emmanuel Berthet and Jean-Philippe Vert, Classification of arrayCGH data using a fused SVM \(2008\)](#)
abstract: ... a new method for supervised classification of arrayCGH data. The method is a variant of support vector machine (SVM) that incorporates the biological specificities of DNA copy number variations along the genome as prior knowledge. The ...
<http://arxiv.org/abs/0801.3007>
- [Seung-ho Wu, Hui Zou, Ming Yuan, Structure variable selection in support vector machines \(2007\)](#)
abstract: When applying the support vector machine (SVM) to high-dimensional classification problems, we often impose a sparse structure in the SVM to eliminate the influences of the irrelevant predictors. ... selection techniques have been successfully used in the SVM to perform automatic variable selection ...
<http://arxiv.org/abs/0710.0508>
- [Marco Frullis, Oriana Mansutti, Praveen Boinne et al., A third level trigger programmable on FPGA for the gamma/hadron separation in a Cherenkov telescope using pseudo-Zernike moments and the SVM classifier \(2005\)](#)
abstract: ... computed Pseudo-Zernike features as classification parameters. We implemented on a FPGA board a kernel function of the SVM and the Pseudo-Zernike features to build a third level trigger for the gamma-hadron separation task of the MAGIC Expen ...
<http://arxiv.org/abs/cs/0602083>
- [Hao Helen Zhang, Yufeng Liu, Yichao Wu et al., Variable selection for the multiclass SVM via adaptive sup-norm regularization \(2008\)](#)
abstract: The Support Vector Machine (SVM) is a popular classification paradigm in machine learning ... great success in real applications. However, the standard SVM can not select variables ... of regularization in the context of the multiclass SVM (MSVM) for simultaneous classification and variable sel ...
<http://arxiv.org/abs/0803.3676>
- [Seung-chan Ahn, Gene Kim and MyungHo Kim, A Note on Applications of Support Vector Machine \(2001\)](#)
abstract: We describe in a rudimentary fashion how SVM (support vector machine) plays the role of classifier in a mathematical setting. We then discuss its application in the ...
<http://arxiv.org/abs/math/0105169>
- [Haoshen Li, J. W. Clark, E. Mavrommatis et al., Modeling Nuclear Properties with Support Vector Machines \(2005\)](#)
abstract: ... studies of the potential of support vector machines (SVM) for providing statistical models of nuclear systematics with demonstrable predictive power. Using SVM regression and classification procedures, we have created ...
<http://arxiv.org/abs/nuc-th/0506080>
- [Gilles Blanchard, Olivier Bousquet, Pascal Massart, Statistical performance of support vector machines \(2008\)](#)
abstract: ... the support vector machine (SVM) algorithm is well known to the computer learning community ... builds on the observation made by other authors that the SVM can be viewed as a statistical regularization procedure. Fr ... how does it compare to the penalty actually used in the SVM algorithm; (2) is ...
<http://arxiv.org/abs/0804.0931>
- [Emidio Capriotti and Rita Casadio, The evaluation of protein folding rate constant is improved by predicting the folding kinetic order with a SVM-based method \(2006\)](#)
abstract: ... first we describe a support vector machine-based method (SVM-KO) to predict for a given protein the kinetic order of the ... value can be obtained as a linear regression task with a SVM-based method. In this paper we show that linear correlation ...
<http://arxiv.org/abs/q-bio.BM/0602013>

[Next >>](#)

ArXiv.org: Experiment Setup

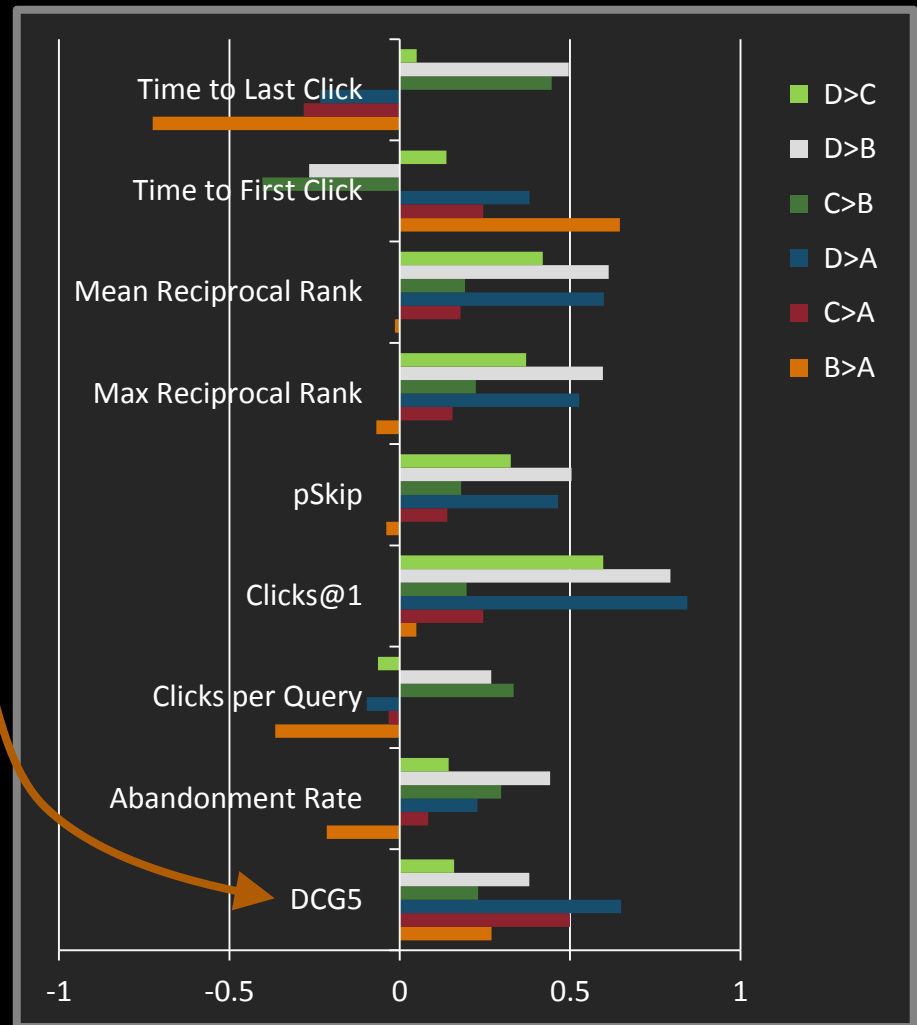
- Experiment Setup
 - Phase I: 36 days
 - Users randomly receive ranking from Orig, Flat, Rand
 - Phase II: 30 days
 - Users randomly receive ranking from Orig, Swap2, Swap4
 - User are permanently assigned to one experimental condition based on IP address and browser.
- Basic Statistics
 - ~700 queries per day / ~300 distinct users per day
- Quality Control and Data Cleaning
 - Test run for 32 days
 - Heuristics to identify bots and spammers
 - All evaluation code was written twice and cross-validated

Arxiv.org: Results

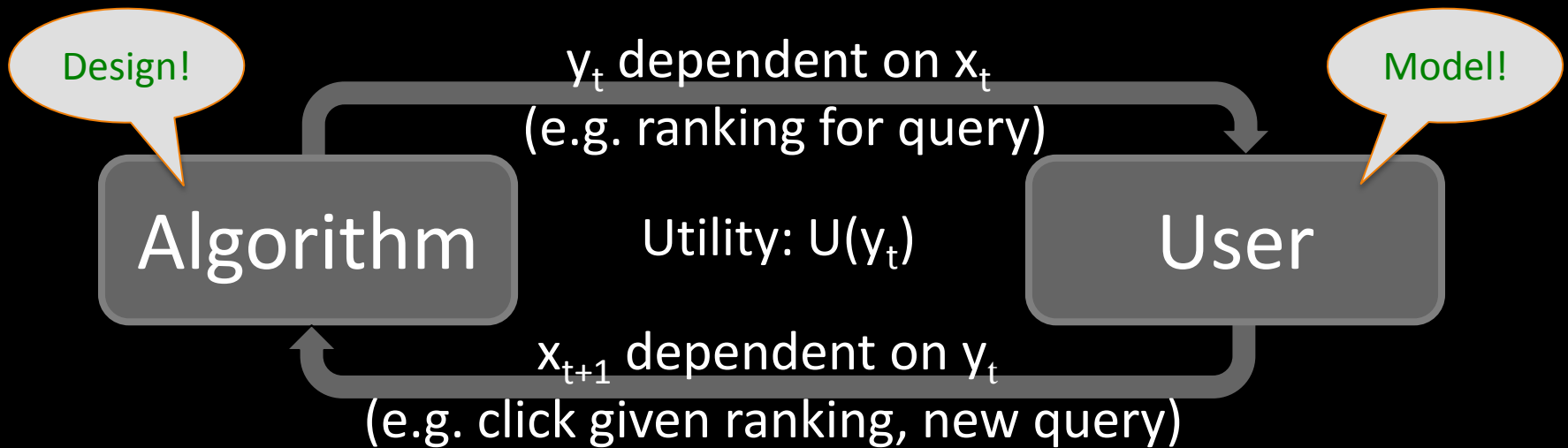


Yahoo! Search: Results

- Retrieval Functions
 - 4 variants of production retrieval function
- Data
 - 10M – 70M queries for each retrieval function
 - Expert relevance judgments
- Results
 - Still not always significant even after more than 10M queries per function
 - Only Click@1 consistent with DCG@5.



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\vdots

$U(t_j, \text{"SVM"}, r_2)$

A Model of how Users Click in Search

- Model of clicking:
 - Users explore ranking to position k
 - Users click on most relevant (looking) links in top k
 - Users stop clicking when time budget up or other action more promising (e.g. reformulation)
 - Empirically supported by [Granka et al., 2004]

Google Search: svm - Microsoft Internet Explorer

Address: <http://www.google.com/search?sourceid=navclient&ie=UTF-8&oe=UTF-8&q=svm>

Google Search

Web Images Groups Directory News

Searched the web for **svm**. Results 1 - 10 of about 329,000. Search took 0.29 seconds.

Categories: [Computers > Artificial Intelligence > Machine Learning](#)
[Computers > Artificial Intelligence > Neural Networks > Software](#)

[Show stock quotes for SVM \(ServiceMaster Company The\)](#)

[Bienvenue sur svm.vnunet.fr !](#) - [Translate this page]

... Les forums de SVM. Participez aux grands débats de la rédaction. De vous à vous. Les meilleures réponses sélectionnées sur le forum de SVM. ...

[svm.vnunet.fr/](#) - 39k - Mar 1, 2004 - Cached - Similar pages

[SVM-Light Support Vector Machine](#)

SVM-Light Support Vector Machine. Hier finden Sie Informationen zu den folgenden Themen: Thorsten Joachims, SVMlight, Support Vector ...

Description: Training software for SVMs. [Free for non-commercial use]

Category: [Computers > Artificial Intelligence > Software](#)

[svmlicht.joachims.org/](#) - 3k - Mar 1, 2004 - Cached - Similar pages

[Support Vector Machine](#)

... Support Vector Machine. The most recent SVM light page can now be found at <http://svmlicht.joachims.org/>. Older versions are still available from here. ...

[www.ai.cs.uni-dortmund.de/SOFTWARE/SVM_LIGHT/svm_light.html](#) - 6k - Cached - Similar pages

[ServiceMaster -- We Are Home](#)

ServiceMaster Issues Information on Tax Treatment of Dividends. ServiceMaster Reports 2003 Fourth Quarter Revenues and Profits. ServiceMaster ...

[www.svm.com/](#) - 13k - Mar 1, 2004 - Cached - Similar pages

[Kernel Machines](#)

Description: A central source of information on kernel based methods, including support vector machines, Gaussian...

Category: [Computers > Artificial Intelligence > Support Vector Machines](#)

[www.kernel-machines.org/](#) - 1k - Cached - Similar pages

[SVM Application List](#)

SVM Application List. This list of Support Vector Machine applications grows thanks to visitors like you who ADD new entries. ... svm learning. ...

$$\operatorname{argmax}_{y \in \text{Top } k} U(y)$$

Balanced Interleaving

$(u=tj, q=\text{"svm"})$

$f_1(u, q) \rightarrow r_1$

$f_2(u, q) \rightarrow r_2$

1. Kernel Machines
<http://svm.first.gmd.de/>
2. Support Vector Machine
<http://jbolivar.freesevers.com/>
3. An Introduction to Support Vector Machines
<http://www.support-vector.net/>
4. Archives of SUPPORT-VECTOR-MACHINES ...
<http://www.jiscmail.ac.uk/lists/SUPPORT...>
5. SVM-Light Support Vector Machine
http://ais.gmd.de/~thorsten/svm_light/

1. Kernel Machines
<http://svm.first.gmd.de/>
2. SVM-Light Support Vector Machine
http://ais.gmd.de/~thorsten/svm_light/
3. Support Vector Machine and Kernel ... References
<http://svm.research.bell-labs.com/SVMrefs.html>
4. Lucent Technologies: SVM demo applet
<http://svm.research.bell-labs.com/SVT/SVMsvt.html>
5. Royal Holloway Support Vector Machine
<http://svm.dcs.rhnc.ac.uk>

Interleaving(r_1, r_2)

- | | | |
|----|---|---|
| 1. | Kernel Machines | 1 |
| | http://svm.first.gmd.de/ | |
| 2. | Support Vector Machine | 2 |
| | http://jbolivar.freesevers.com/ | |
| 3. | SVM-Light Support Vector Machine | 2 |
| | http://ais.gmd.de/~thorsten/svm_light/ | |
| 4. | An Introduction to Support Vector Machines | 3 |
| | http://www.support-vector.net/ | |
| 5. | Support Vector Machine and Kernel ... References | 3 |
| | http://svm.research.bell-labs.com/SVMrefs.html | |
| 6. | Archives of SUPPORT-VECTOR-MACHINES ... | 4 |
| | http://www.jiscmail.ac.uk/lists/SUPPORT... | |
| 7. | Lucent Technologies: SVM demo applet | 4 |
| | http://svm.research.bell-labs.com/SVT/SVMsvt.html | |

Model of User:

Better retrieval functions
is more likely to get more
clicks.

Invariant:

For all k , top k of
balanced interleaving is
union of top k_1 of r_1 and
top k_2 of r_2 with $k_1 = k_2 \pm 1$.

Interpretation: $(r_1 \succ r_2) \Leftrightarrow \text{clicks}(\text{topk}(r_1)) > \text{clicks}(\text{topk}(r_2))$

\rightarrow see also [Radlinski, Craswell, 2012] [Hofmann, 2012]

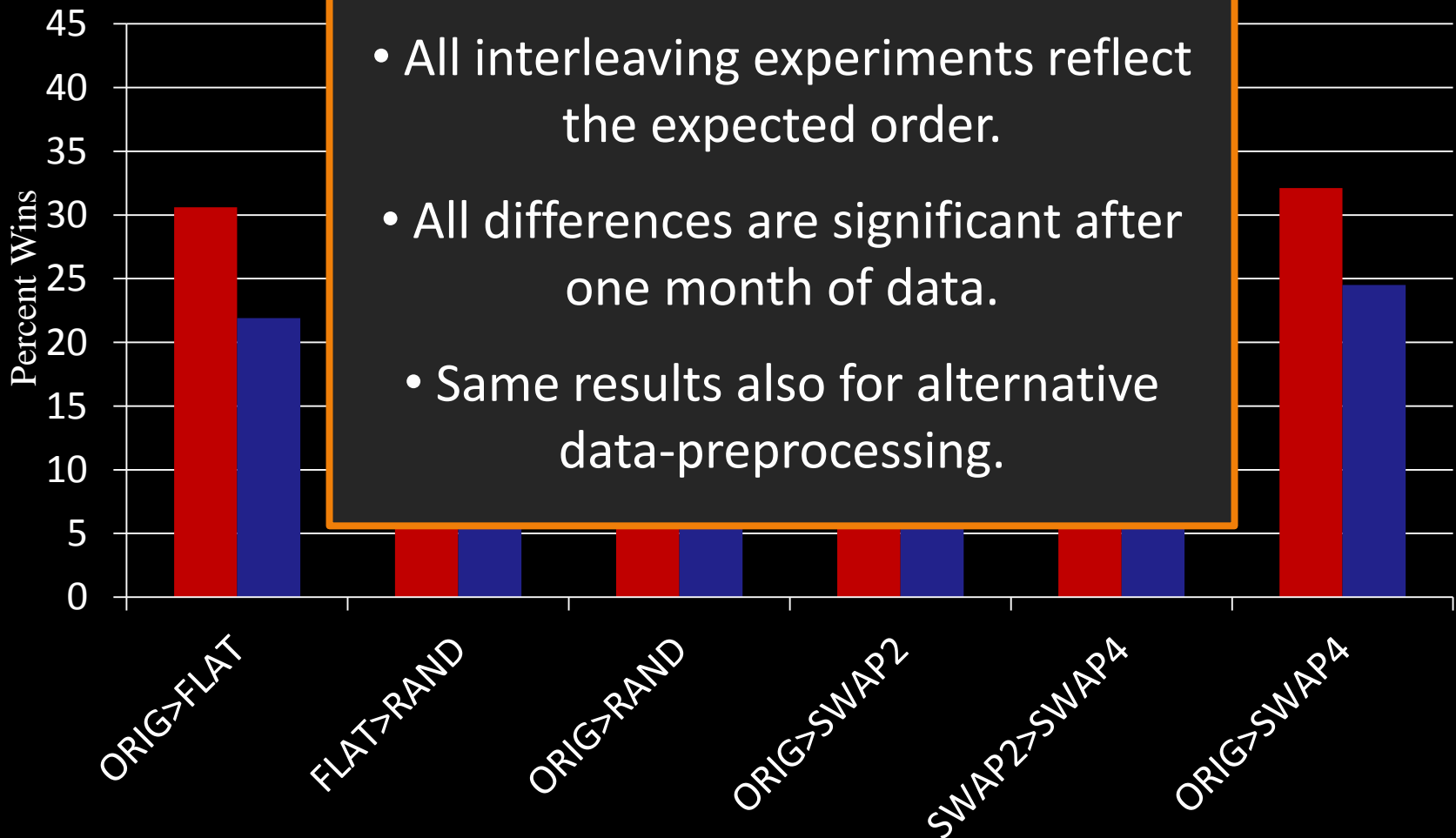
Arxiv.org: Interleaving Experiment

- Experiment Setup
 - Phase I: 36 days
 - Balanced Interleaving of (Orig,Flat) (Flat,Rand)
(Orig,Rand)
 - Phase II: 30 days
 - Balanced Interleaving of (Orig,Swap2) (Swap2,Swap4)
(Orig,Swap4)
- Quality Control and Data Cleaning
 - Same as for absolute metrics

Arxiv.org: Interleaving Results

Conclusions

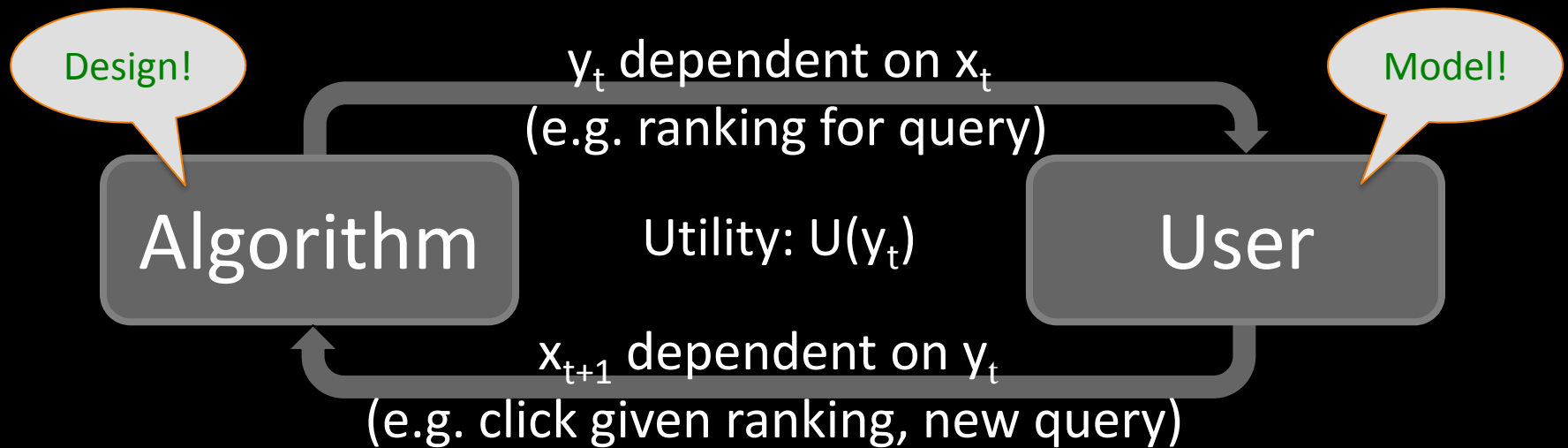
- All interleaving experiments reflect the expected order.
- All differences are significant after one month of data.
- Same results also for alternative data-preprocessing.



Yahoo and Bing: Interleaving Results

- Yahoo Web Search [Chapelle et al., 2012]
 - Four retrieval functions (i.e. 6 paired comparisons)
 - Balanced Interleaving
 - All paired comparisons consistent with ordering by NDCG.
- Bing Web Search [Radlinski & Craswell, 2010]
 - Five retrieval function pairs
 - Team-Game Interleaving
 - Consistent with ordering by NDGC when NDCG significant.

Interactive Learning System



- Observed Data \neq Training Data ✓
- Decisions \rightarrow Feedback \rightarrow Learning Algorithm
 - Model the users decision process to extract feedback ✓
 - \rightarrow Pairwise comparison test $P(y_i \succ y_j \mid U(y_i) > U(y_j))$
 - Design learning algorithm for this type of feedback

Learning on Operational System

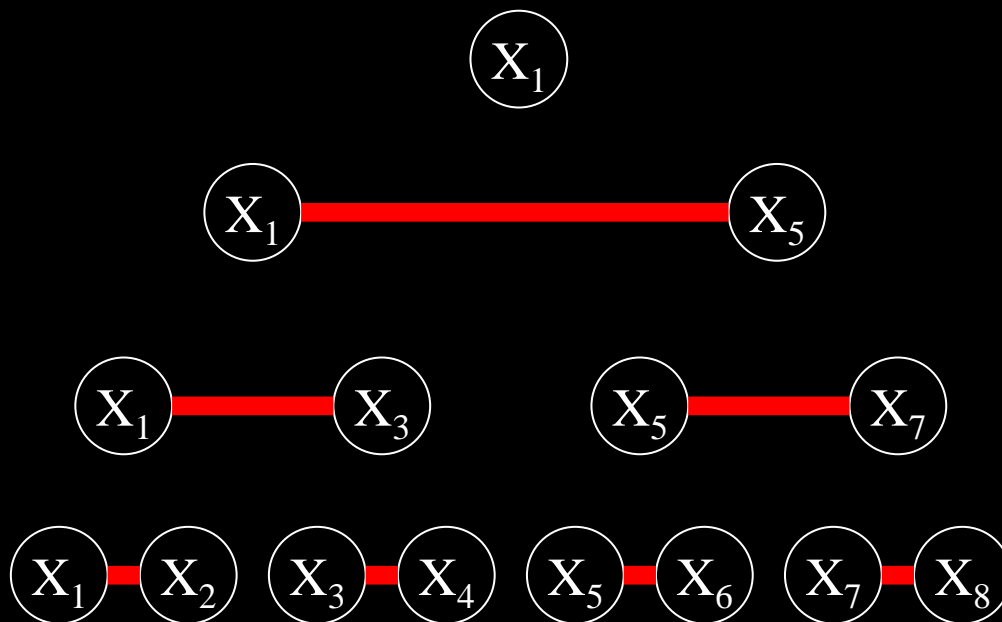
- Example: 4 retrieval functions: $A > B \gg C > D$
 - 10 possible pairs for interactive experiment
 - (A,B) \rightarrow low cost to user
 - (A,C) \rightarrow medium cost to user
 - (C,D) \rightarrow high cost to user
 - (A,A) \rightarrow zero cost to user
 - ...
- Minimizing Regret
 - Don't present "bad" pairs more often than necessary
 - Trade off (long term) informativeness and (short term) cost
 - Definition: Probability of (f_t, f'_t) losing against the best f^*

$$R(A) = \sum_{t=1}^T [P(f^* \succ f_t) - 0.5] + [P(f^* \succ f'_t) - 0.5]$$

\rightarrow Dueling Bandits Problem

First Thought: Tournament

- Noisy Sorting/Max Algorithms:
 - [Feige et al.]: Triangle Tournament Heap $O(n/\varepsilon^2 \log(1/\delta))$ with prob $1-\delta$
 - [Adler et al., Karp & Kleinberg]: optimal under weaker assumptions



Algorithm: Interleaved Filter 2

- Algorithm

InterleavedFilter1($T, W = \{f_1 \dots f_k\}$)

- Pick random f' from W
- $\delta = 1/(TK^2)$
- WHILE $|W| > 1$
 - FOR $b \in W$ DO
 - » $\text{duel}(f', b)$
 - » update P_f
 - $t = t + 1$
 - $c_t = (\log(1/\delta)/t)^{0.5}$
 - Remove all f from W with $P_f < 0.5 - c_t$ [WORSE WITH PROB $1 - \delta$]
 - IF there exists f'' with $P_{f''} > 0.5 + c_t$ [BETTER WITH PROB $1 - \delta$]
 - » Remove f' from W
 - » Remove all f from W that are empirically inferior to f'
 - » $f' = f''$; $t = 0$
- UNTIL T : $\text{duel}(f', f')$

f_1	f_2	$f' = f_3$	f_4	f_5
0/0	0/0		0/0	0/0

f_1	f_2	$f' = f_3$	f_4	f_5
8/2	7/3		4/6	1/9

f_1	f_2	$f' = f_3$	f_4	
13/2	11/4		7/8	XX

$f' = f_1$	f_2		f_4	
0/0	0/0	XX	XX	XX

Assumptions

- Preference Relation: $f_i \succ f_j \Leftrightarrow P(f_i \succ f_j) = 0.5 + \varepsilon_{i,j} > 0.5$
- Weak Stochastic Transitivity: $f_i \succ f_j$ and $f_j \succ f_k \rightarrow f_i \succ f_k$

Theorem: IF2 incurs expected average regret bounded by

- $$\frac{1}{T} E(R_T) \leq O\left(\frac{K \log T}{\varepsilon_{1,2} T}\right)$$

- Stochastic Triangle Inequality: $f_i \succ f_j \succ f_k \rightarrow \varepsilon_{i,k} \leq \varepsilon_{i,j} + \varepsilon_{j,k}$

$$\varepsilon_{1,2} = 0.01 \text{ and } \varepsilon_{2,3} = 0.01 \rightarrow \varepsilon_{1,3} \leq 0.02$$

- ε -Winner exists: $\varepsilon = \max_i \{ P(f_1 \succ f_i) - 0.5 \} = \varepsilon_{1,2} > 0$

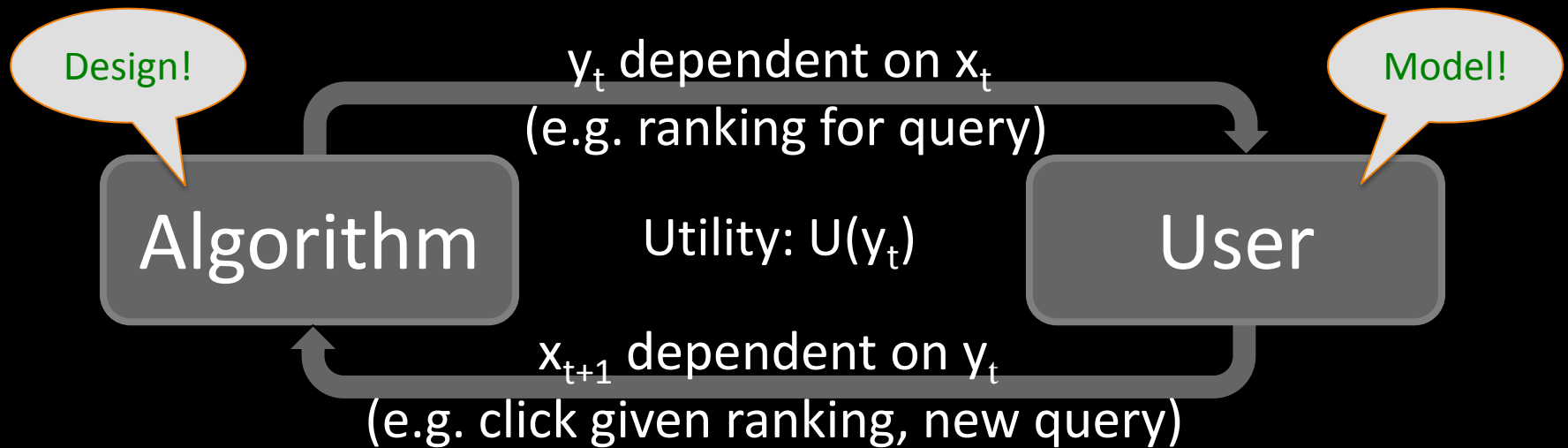
Lower Bound

- **Theorem:** Any algorithm for the dueling bandits problem has regret

$$R_T \leq \Omega \left(\frac{K}{\epsilon_{1,2}} \log T \right)$$

- Proof: [Karp, Kleinberg, 2007] [Kleinberg et al., 2007]
- Intuition:
 - Magically guess the best bandit, just verify guess
 - Worst case: $\forall f_i \succ f_j: P(f_i \succ f_j) = 0.5 + \epsilon$
 - Need $O(1/\epsilon^2 \log T)$ duels to get $1 - 1/T$ confidence.

Interactive Learning System



- Observed Data \neq Training Data ✓
- Decisions \rightarrow Feedback \rightarrow Learning Algorithm
 - Model the users decision process to extract feedback ✓
 - \rightarrow Pairwise comparison test $P(y_i \succ y_j \mid U(y_i) > U(y_j))$
 - Design learning algorithm for this type of feedback ✓
 - \rightarrow Dueling Bandits problem and algorithms (e.g. IF2)

Who does the exploring? Example 1

The image shows a screenshot of a web browser displaying the Netflix website. The browser window is titled "Netflix" and the address bar shows "movies.netflix.com/WiHome". The page content includes a red navigation bar with "NETFLIX", "Watch Instantly", "Just for Kids", "Taste Profile", "DVDs", and "DVD Queue". A search bar contains the text "Movies, TV shows, actors, directors, genres" and a user profile icon for "Thorsten". Below the navigation bar, there is a section for "Recently Watched" featuring "AZIZ ANSARI" and "DANGEROUSLY DELICIOUS". A "My List" section is also visible. The main content area displays "More Like Lie to Me" with a row of movie posters: NUMB3RS, BONES, FLASHPOINT, AWAKE, CSI: NY, and KEEPER. The footer contains copyright information for 2013 Netflix, Inc. and various links for Membership, Subtitles & Captions, Test Participation, Gifts, Buy / Redeem, Support, Company, About Us, Affiliates, Investor Relations, Media Center, Jobs, Contact Us, and Blog. A "Service Code" section is also present at the bottom.

Who does the exploring?

Example 2

The image shows a screenshot of a Google search for 'svm'. The search results are displayed in a browser window. The search bar contains 'svm' and the results show 'About 16,600,000 results (0.11 seconds)'. The results are categorized by type: Everything, Images, Maps, Videos, News, Shopping, and More. The 'Everything' category is selected. The results list includes:

- Support vector machine - Wikipedia, the free encyclopedia**
en.wikipedia.org/wiki/Support_vector_machine
A **support vector machine (SVM)** is a concept in statistics and computer science for a set of related supervised learning methods that analyze data and recognize ...
Formal definition - History - Motivation - Linear SVM
- SVM: Summary for Silvercorp Metals Inc Ordinary - Yahoo! Finance**
finance.yahoo.com/q?s=SVM
View the basic **SVM** stock chart on Yahoo! Finance. Change the date range, chart type and compare Silvercorp Metals Inc Ordinary against other companies.
- SVM, LP**
www.svmcards.net/
SVM. A leader in the gift card industry and devoted to helping your business reward, promote, entice and grow. Established in 1997, we handle the sales, ...
- SVM Asset Management - Home**
www.svmonline.co.uk/
Founded in 1990, **SVM** Asset Management is a privately-owned firm based in Edinburgh. The three founding directors continue to own 100% of the equity, with ...
- LIBSVM -- A Library for Support Vector Machines**
www.csie.ntu.edu.tw/~cjlin/libsvm/
5 Nov 2011 - An integrated software tool for support vector classification and regression.

Annotations on the screenshot include:

- A red starburst with the word 'Click' pointing to the LIBSVM link.
- An orange arrow pointing from the 'Past 24 hours' filter to the LIBSVM link.
- An orange box highlighting the LIBSVM link and its description.

Who does the exploring? Example 3

The image displays two browser windows side-by-side, illustrating a search process. The left window shows a Google search for 'svm' with approximately 16,600,000 results. The right window shows a Google search for 'sv meppen' with approximately 939,000 results. An orange arrow points from the 'svm' search results to the 'sv meppen' search results, highlighting a specific result with a red starburst and the word 'Click'.

Left Window: svm - Google Search
www.google.com/search?aq=f&gcx=c&sourceid=chrome&ie=UTF-8

Search: About 16,600,000 results (0.11 seconds)

Everything: [Support vector machine - Wikipedia, the free encyclopedia](#)
en.wikipedia.org/wiki/Support_vector_machine
A support vector machine (SVM) is a concept in statistics and computer science and related fields that concerns finding the best separating hyperplane between two classes of examples. SVMs are a type of supervised learning model that analyze data and recognize patterns, used for classification and regression analysis. Formal definition - History - Motivation - Linear SVM

Images: [SVM: Summary for Silvercorp Metals Inc Ordinary - Yahoo! Finance](#)
finance.yahoo.com/q?s=SVM
View the basic SVM stock chart on Yahoo! Finance. Change the data and compare Silvercorp Metals Inc Ordinary against other companies

Maps: [SVM LP](#)
www.svmcards.net/
SVM. A leader in the gift card industry and devoted to helping your business promote, entice and grow. Established in 1997, we handle the sales, distribution and marketing of gift cards.

Videos: [SVM Asset Management - Home](#)
www.svmonline.co.uk/
Founded in 1990, SVM Asset Management is a privately-owned firm that provides investment management services to a wide range of clients. The three founding directors continue to own 100% of the equity, with a focus on long-term value creation.

News: [LIBSVM -- A Library for Support Vector Machines](#)
www.csie.ntu.edu.tw/~cjlin/libsvm/
5 Nov 2011 - An integrated and easy-to-use tool for support vector classification and regression.

Shopping: [SVM Asset Management - Home](#)
www.svmonline.co.uk/
Founded in 1990, SVM Asset Management is a privately-owned firm that provides investment management services to a wide range of clients. The three founding directors continue to own 100% of the equity, with a focus on long-term value creation.

More: [SVM Asset Management - Home](#)
www.svmonline.co.uk/
Founded in 1990, SVM Asset Management is a privately-owned firm that provides investment management services to a wide range of clients. The three founding directors continue to own 100% of the equity, with a focus on long-term value creation.

Any time: Past hour, Past 24 hours, Past 2 days, Past week, Past month, Past year, Custom range...

All results: Related searches, More search tools

Right Window: sv meppen - Google Search
www.google.com/search?aq=f&gcx=c&sourceid=chrome&ie=UTF-8

Search: About 939,000 results (0.09 seconds)

Everything: [SV Meppen 1912 e.V. - Offizielle Webseite](#)
www.svmeppen.de/
Die offizielle Homepage des am 29. November 1912 gegründeten Fußballvereins präsentiert einen Live-Ticketverkauf und informiert über die Mannschaft.

Images: [Willkommen auf www.svmeppen.de - SV Meppen 1912 e.V. ...](#)
1912.svmeppen.de/ - Translate this page
SV Meppen e.V. 1912 - Offizielle Website- ... SV Meppen, meppen, emsland, oberliga, oberliga nord, fussball, fußball, lingen, steve haensel, webcomtech.net, ...

Maps: [SV Meppen - Wikipedia, the free encyclopedia](#)
en.wikipedia.org/wiki/SV_Meppen
SV Meppen is a German association football club playing in Meppen, Lower Saxony. The club was founded on 29 November 1912 as Amisia Meppen and ...
History - Stadium - Records - Literature

Videos: [SV Meppen - Nachrichten, Liveticker, Bilder vom SV Meppen in der ...](#)
www.noz.de/sport/sv-meppen - Translate this page
Berichte, Liveticker, Bilder und Audios vom SV Meppen, mehr zur Mannschaft sowie Analysen der Gegner in der Fußball-Regionalliga.

News: [SV Meppen - Fußballverein - transfermarkt.de](#)
www.transfermarkt.de/.../sv-meppen/.../verein_24... - Translate this page
Mit dieser Nachricht hatte Stephen Famewo (Foto) nicht gerechnet. Als unumstrittener Stammspieler trug er dazu bei, dass der SV Meppen in die Regionalliga ...

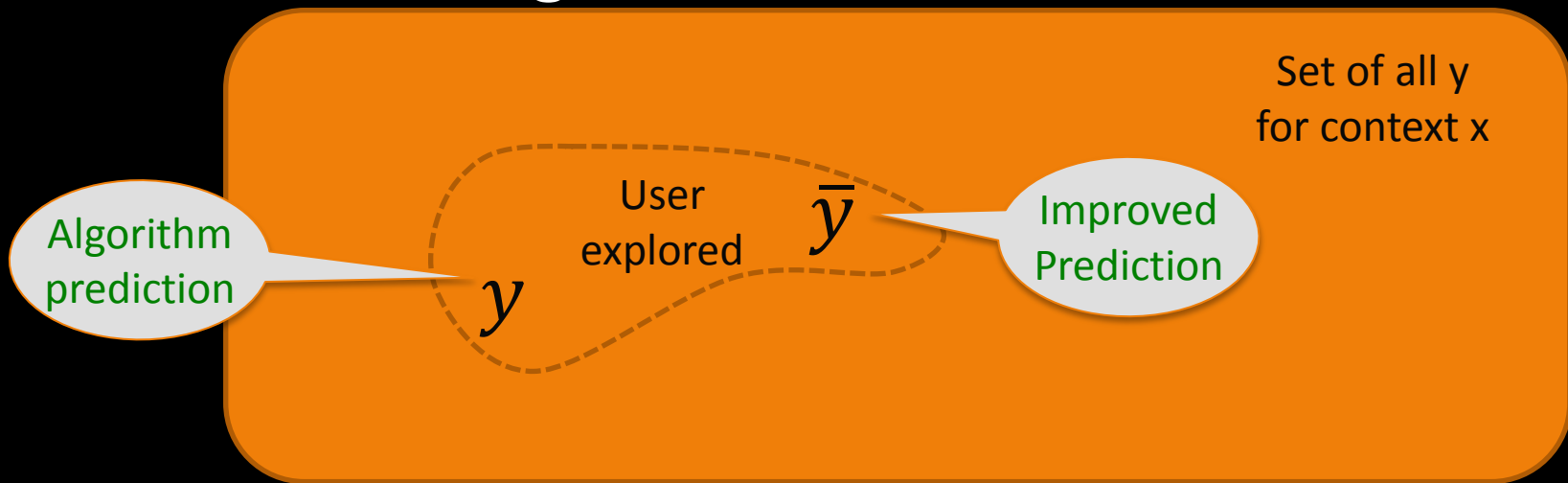
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Show search tools

Coactive Feedback Model

- Interaction: given x



- Feedback:

- Improved prediction \bar{y}_t

$$U(\bar{y}_t | x_t) > U(y_t | x_t)$$

- Supervised learning: optimal prediction y_t^*

$$y_t^* = \operatorname{argmax}_y U(y | x_t)$$

Machine Translation

x_t

We propose Coactive Learning as a model of interaction between a learning system and a human user, where both have the common goal of providing results of maximum utility to the user.

y_t

Wir schlagen vor, koaktive Learning als ein Modell der Wechselwirkung zwischen einem Lernsystem und menschlichen Benutzer, wobei sowohl die gemeinsame Ziel, die Ergebnisse der maximalen Nutzen für den Benutzer.



Wir schlagen ~~vor~~, koaktive Learning als ein Modell ~~der Wechselwirkung des Dialogs~~ zwischen einem Lernsystem und menschlichen Benutzer, wobei ~~sowohl die beide das~~ gemeinsame Ziel ~~haben~~, die Ergebnisse der maximalen Nutzen für den Benutzer ~~zu liefern~~.

\bar{y}_t

Coactive Learning Model

- Unknown Utility Function: $U(y|x)$
 - Boundedly rational user
 - Algorithm/User Interaction:
 - LOOP FOREVER
 - Observe context x (e.g. query)
 - Learning algorithm presents y (e.g. ranking)
 - User returns \bar{y} with $U(\bar{y}|x) > U(y|x)$
 - $\text{Regret} = \text{Regret} + [U(y^* | x) - U(y | x)]$
 - Relationship to other online learning models
 - Expert setting: receive $U(y|x)$ for all y
 - Bandit setting: receive $U(y|x)$ only for selected y
 - Dueling bandits: for selected y and \bar{y} , receive $U(\bar{y}|x) > U(y|x)$
 - Coactive setting: for selected y , receive \bar{y} with $U(\bar{y}|x) > U(y|x)$
- Never revealed:
- cardinal feedback
 - optimal y^*
- Loss for prediction \hat{y}
- Optimal prediction $y^* = \text{argmax}_y \{ U(x, y) \}$

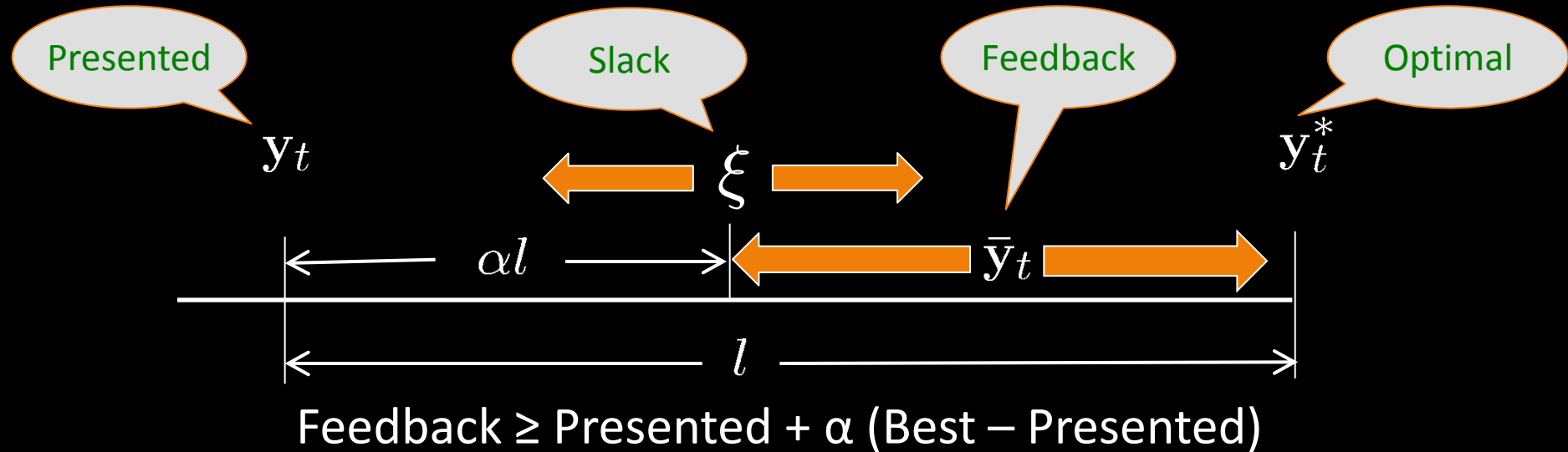
Coactive Preference Perceptron

- Model
 - Linear model of user utility: $U(y|x) = w^T \phi(x,y)$
- Algorithm
 - FOR $t = 1$ TO T DO
 - Observe x_t
 - Present $y_t = \operatorname{argmax}_y \{ w_t^T \phi(x_t, y) \}$
 - Obtain feedback \bar{y}_t from user
 - Update $w_{t+1} = w_t + \phi(x_t, \bar{y}_t) - \phi(x_t, y_t)$
- This may look similar to a multi-class Perceptron, but
 - Feedback \bar{y}_t is different (not get the correct class label)
 - Regret is different (misclassifications vs. utility difference)

$$R(A) = \frac{1}{T} \sum_{t=1}^T [U(y_t^*|x) - U(y_t|x)]$$

Never revealed:
• cardinal feedback
• optimal y^*

α -Informative Feedback



- **Definition: Strict α -Informative Feedback**

$$U(\mathbf{x}_t, \bar{y}_t) \geq U(\mathbf{x}_t, y_t) + \alpha(U(\mathbf{x}_t, y_t^*) - U(\mathbf{x}_t, y_t))$$

- **Definition: α -Informative Feedback**

$$U(\mathbf{x}_t, \bar{y}_t) = U(\mathbf{x}_t, y_t) + \alpha(U(\mathbf{x}_t, y_t^*) - U(\mathbf{x}_t, y_t)) - \xi_t$$

Slacks both
pos/neg

Preference Perceptron: Regret Bound

- Assumption
 - $U(\mathbf{y}|\mathbf{x}) = \mathbf{w}^\top \phi(\mathbf{x}, \mathbf{y})$, but w is unknown

- Theorem

For user feedback $\bar{\mathbf{y}}$ that is α -informative, the average regret of the Preference Perceptron is bounded by

$$\frac{1}{T} \sum_{t=1}^T [U(\mathbf{y}_t^*|\mathbf{x}) - U(\mathbf{y}_t|\mathbf{x})] \leq \frac{1}{\alpha T} \sum_{t=1}^T \xi_t + \frac{2R\|w\|}{\alpha\sqrt{T}}$$

- Other Algorithms and Results

- Feedback that is α -informative only in expectation
- General convex loss functions of $U(\mathbf{y}^*|\mathbf{x}) - U(\hat{\mathbf{y}}|\mathbf{x})$
- Regret that scales $\log(T)/T$ instead of $T^{-0.5}$ for strongly convex

noise

→ zero

Preference Perceptron: Experiment

Experiment:

- Automatically optimize Arxiv.org Fulltext Search

Analogous
to DCG

Model

- Utility of ranking y for query x : $U_t(y|x) = \sum_i \gamma_i w_t^\top \phi(x, y^{(i)})$ [~ 1000 features]
→ Computing argmax ranking: sort by $w_t^\top \phi(x, y^{(i)})$

Feedback

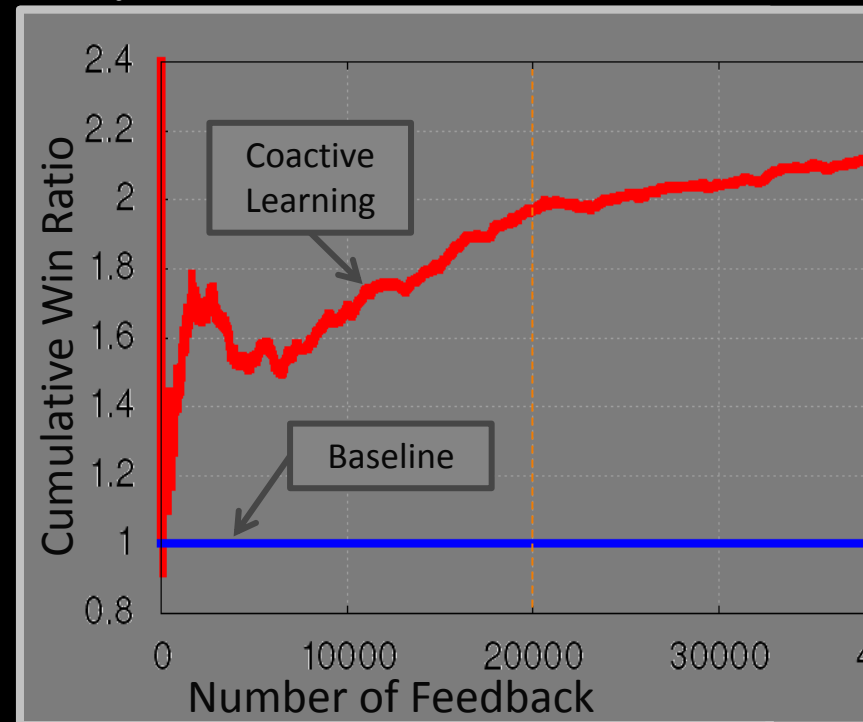
- Construct \bar{y}_t from y_t by moving clicked links one position higher.
- Perturbation [Raman et al., 2013]

Baseline

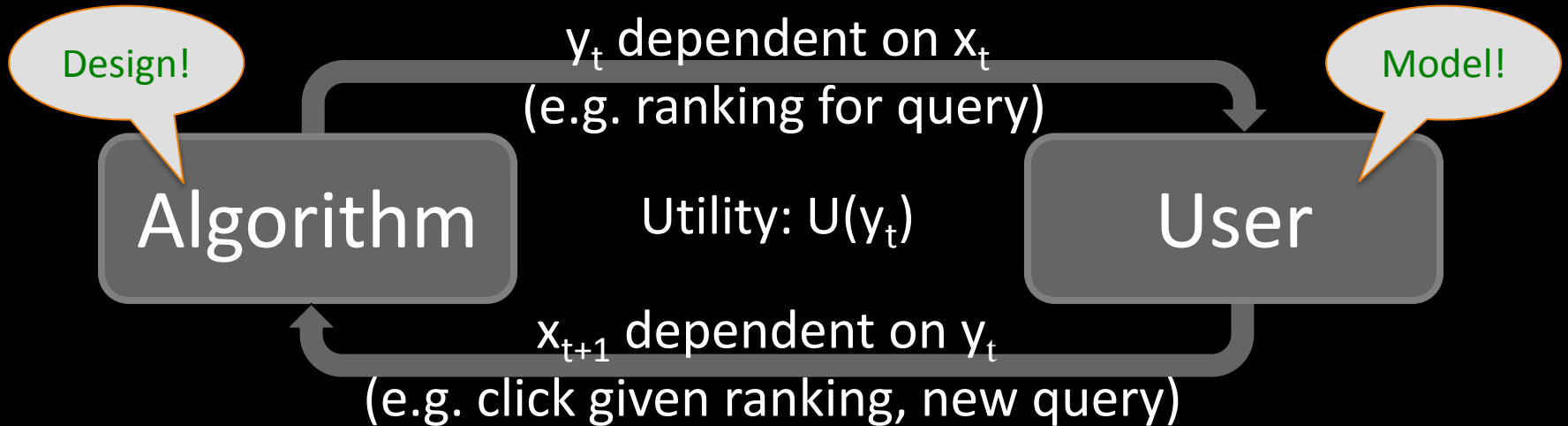
- Handtuned w_{base} for $U_{\text{base}}(y|x)$

Evaluation

- Interleaving of ranking from $U_t(y|x)$ and $U_{\text{base}}(y|x)$



Summary and Conclusions



- Observed Data \neq Training Data
- Decisions \rightarrow Feedback \rightarrow Learning Algorithm
 - Dueling Bandits
 - \rightarrow Model: Pairwise comparison test $P(y_i \succ y_j \mid U(y_i) > U(y_j))$
 - \rightarrow Algorithm: Interleaved Filter 2, $O(|Y| \log(T))$ regret
 - Coactive Learning
 - \rightarrow Model: for given y , user provides \bar{y} with $U(\bar{y} \mid x) > U(y \mid x)$
 - \rightarrow Algorithm: Preference Perceptron, $O(\|w\| T^{0.5})$ regret