TO EACH HIS OWN: PERSONALIZED CONTENT SELECTION BASED ON TEXT COMPREHENSIBILITY

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MOTIVATION

Various factors explain users' choices in content consumption

- Topic (personalized search, user modeling etc)
- Beyond Topical Relevance

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Text comprehensibility

- The degree of difficulty of text, e.g. as judged by average sentence length and vocabulary size
- Motivating example

  A search on antibiotic resistance:

  a physician vs. a patient

PAGES ON "ANTIBIOTICS"

An antibacterial is a compound or substance that kills or slows down the growth of bacteria. The term is often used synonymously with the term antibiotic(s); today, however, with increased knowledge of the causative agents of various infectious diseases, antibiotic(s) has come to denote a broader range of *antimicrobial* compounds, including *antifungal* and other compounds.

Antibiotics are medicine that kills bacteria or slows the growth of bacteria. They are used to cure diseases. Antibiotics do not harm people. Penicillin is a popular antibiotic. Antibiotics started to be produced in 1939. Antibiotics can not stop a virus. Antibiotics are not the same thing as antibodies.

Intuitively, we see these texts differ in:

- Complexity of syntax
- Technical terms
- Topic independent vocabulary
- …

CHALLENGES

Estimate the comprehensibility of text

Model and predict users' comprehensibility preferences without explicit preference information

- Topic independent
- Topic dependent

Improve the ranking in more than one setting

- Web search
- Community question answering

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Related work

Characterizing Web Content, User Interests, and Search Behavior by Reading Level and Topic [Kim et al. 2012]

Personalizing web search results by reading level [Collins-Thompson et al. 2011]

ESTIMATE TEXT COMPREHENSIBILITY

English Wikipedia **VS.** ***Simple English Wikipedia***

(40,032 aligned article pairs with the same title)

Features

- 6 linguistic readability indexes based on the length of sentences, the syllables of words, etc [CL, G, KFRC, M, M]
- A basic English word list: just 850 unigrams

Hard vs. Easy classification with logistic regression

Global threshold: 88.3%

Per-title comparison: 97.4%

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Regular English Wikipedia

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MODEL USER PREFERENCES: TOPIC INDEPENDENT (BASIC)

We get preference pairs for each user

- From click log in web search
- From choosing the best answer in community question answering

GENERATE PREFERENCE PAIRS

Click log

- Three different ways, e.g. click > skip above
- Weight

    the closer two search results are, the larger the weight is

Best answer

- Best > Any other
- Weight

    1/#answers

MODEL USER PREFERENCES: TOPIC INDEPENDENT (BASIC)

We get preference pairs for each user

$$\Omega_u^{pref} = \{(< a_i, b_i >, w_i) \mid a_i >_u b_i, \text{with weight } w_i\}$$

Treat each tuple as a sample

P_u: the probability that user *u* prefers harder text

MLE estimation with smoothing

$$P_u = \frac{\#\text{Samples where } u \text{ prefers harder text} + 1}{\#\text{Samples} + 2}$$

Weighted version

$$P_u = \frac{\#\text{Weighted samples where } u \text{ prefers harder text} + 1}{\#\text{Weighted Samples} + 2}$$

MODEL USER PREFERENCES: TOPIC DEPENDENT (TOPICAL)

Topic dependent

- Topic hierarchy (e.g. Yahoo!'s classifier for queries, or categories in Yahoo! answers)

$$t_2 <_h t_1 \Leftrightarrow t_2 \text{ is a descendant of } t_1$$

- Pairwise preferences for a topic *t* and a user *u*

  All the preference pairs in the descendants of *t* and *t*

$$\Omega_{u,t}^{pref} = \{pp_i \in \Omega_u^{pref} | t_i \leq_h t\}$$

MODEL USER PREFERENCES: TOPIC DEPENDENT (COLLABORATIVE)

Data sparseness

- Predict comprehensibility preferences for unseen topics
- Collaborative filtering

  Maximum margin matrix factorization [Weimer et al. 2007]

$$\sum_{i,j,G_{ij}\neq 0} ||U^T V_{(ij)} - G_{ij}||^2 + ||U||_F + ||V||_F$$

COMBINE THE RANKINGS

$R(d)$: the original topic-relevance-based ranking

$R_u(d)$: the ranking in the descending order of the difficulty of the text

P_u: the probability that user u prefers harder text

β: a parameter tuned on a development set

Combined Score: $V = R(d) + \beta * (2 * P_u - 1) * R_u(d)$

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$P_u < 0.5 \Rightarrow (2 * P_u - 1) < 0$,
text *easier*
$R_u(d)$ *larger*
V smaller
final rank *higher*

EXPERIMENT ON SEARCH DATASET

Task: Use our approach to improve the original web rank by personalization based on text comprehensibility

Evaluation Measures [Dou et al. 2007]

- Average Clicked Rank
- Rank Scoring

Our Approach

3*2*3=18

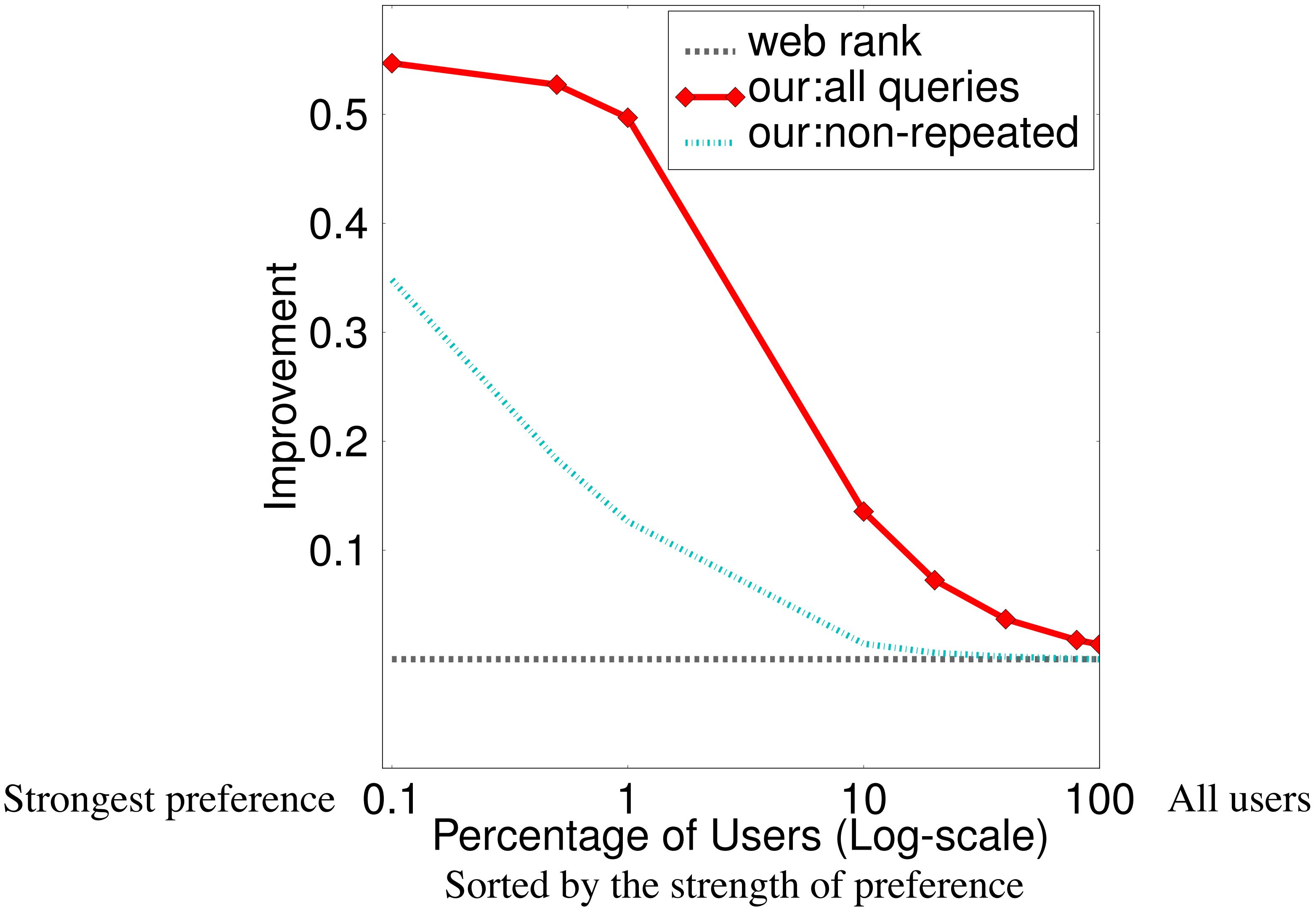
Click1 Click2 Click3	X	Weighted Unweighted	X	Basic Topical Collaborative

Strength of preference

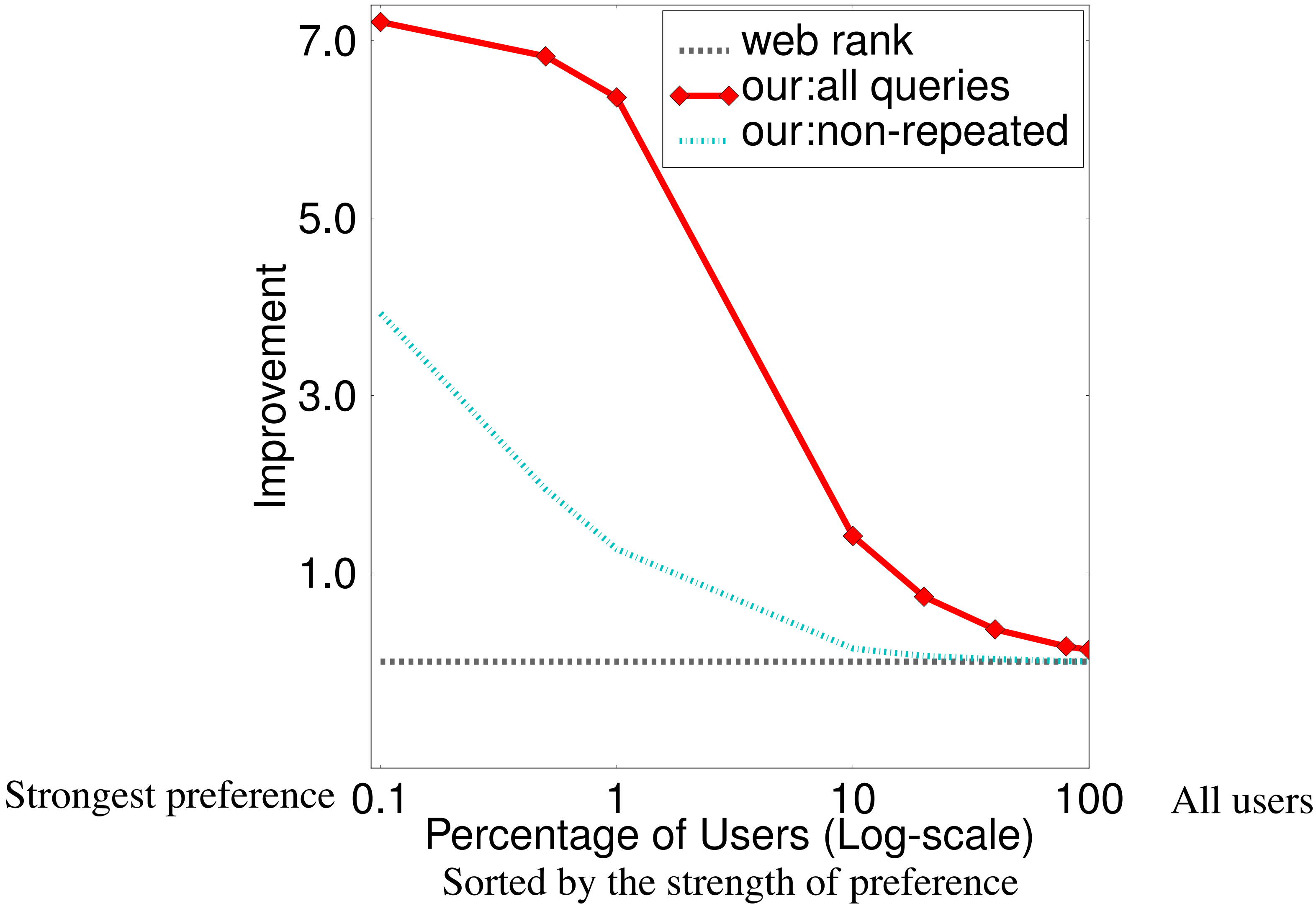
$$Q_u = |P_u - 0.5|$$

The larger Q_u is, the stronger preference towards harder or easier text *u* has

OVERALL PERFORMANCE: AVERAGE CLICKED RANK



OVERALL PERFORMANCE: RANK SCORING



PAIRED T-TEST AGAINST WEB RANK ON AVERAGE CLICKED RANK

$*(p < 0.05)$, $**(p < 0.01)$, $***(p < 0.001)$

Method			strong 10%	50%	all 100%
WEIGHTED	Click1	BASIC	***	***	***
		TOPICAL	***	***	***
		COLLABORATIVE	***	***	
	Click2	BASIC	**	*	*
		TOPICAL	***	**	**
		COLLABORATIVE	***	***	
	Click3	BASIC	***	***	***
		TOPICAL	***	***	***
		COLLABORATIVE	***	***	
UNWEIGHTED	Click1	BASIC	***	***	***
		TOPICAL	***		
		COLLABORATIVE	***		
	Click2	BASIC	**		
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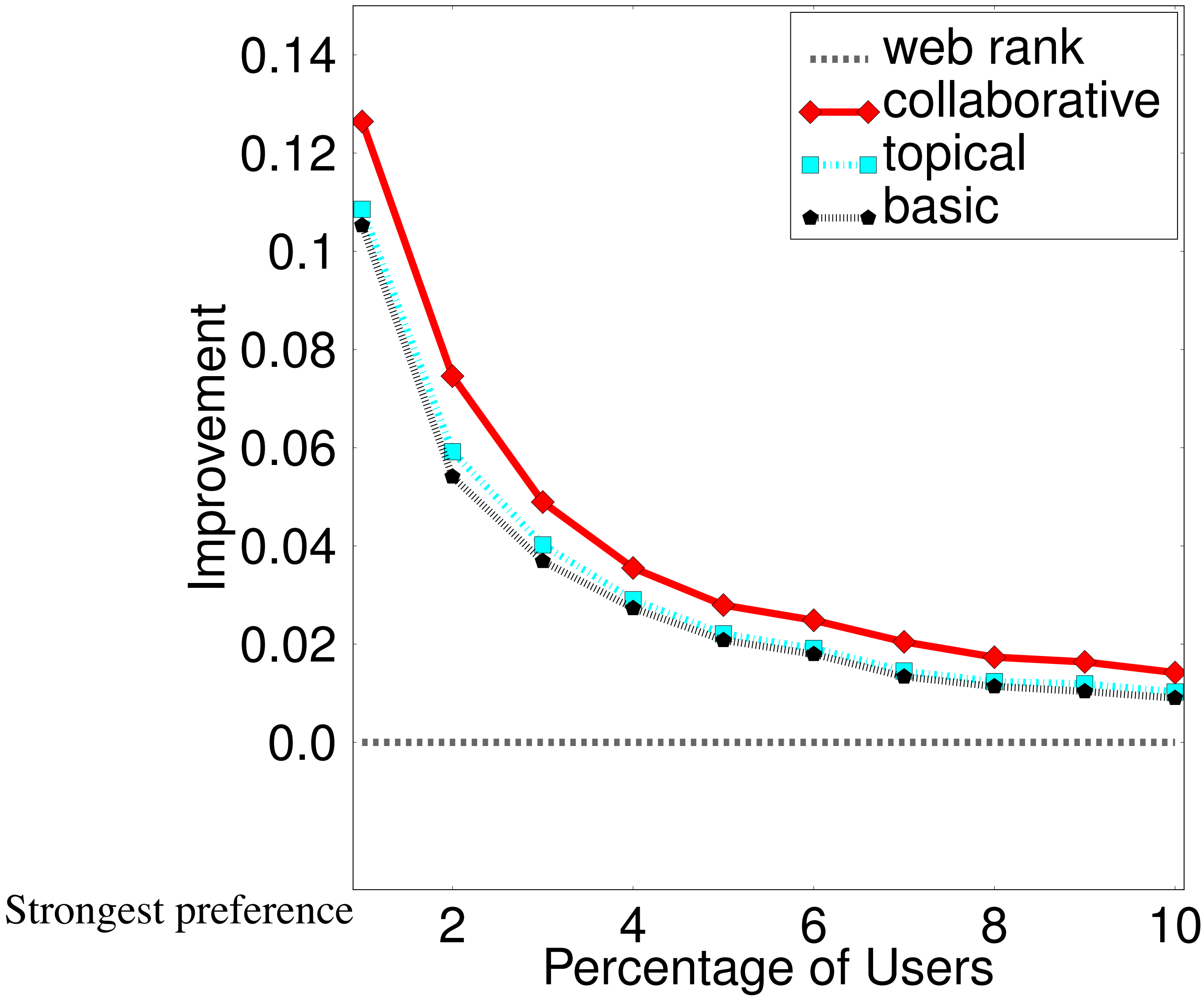
DIFFERENT USER PROFILE MODELS



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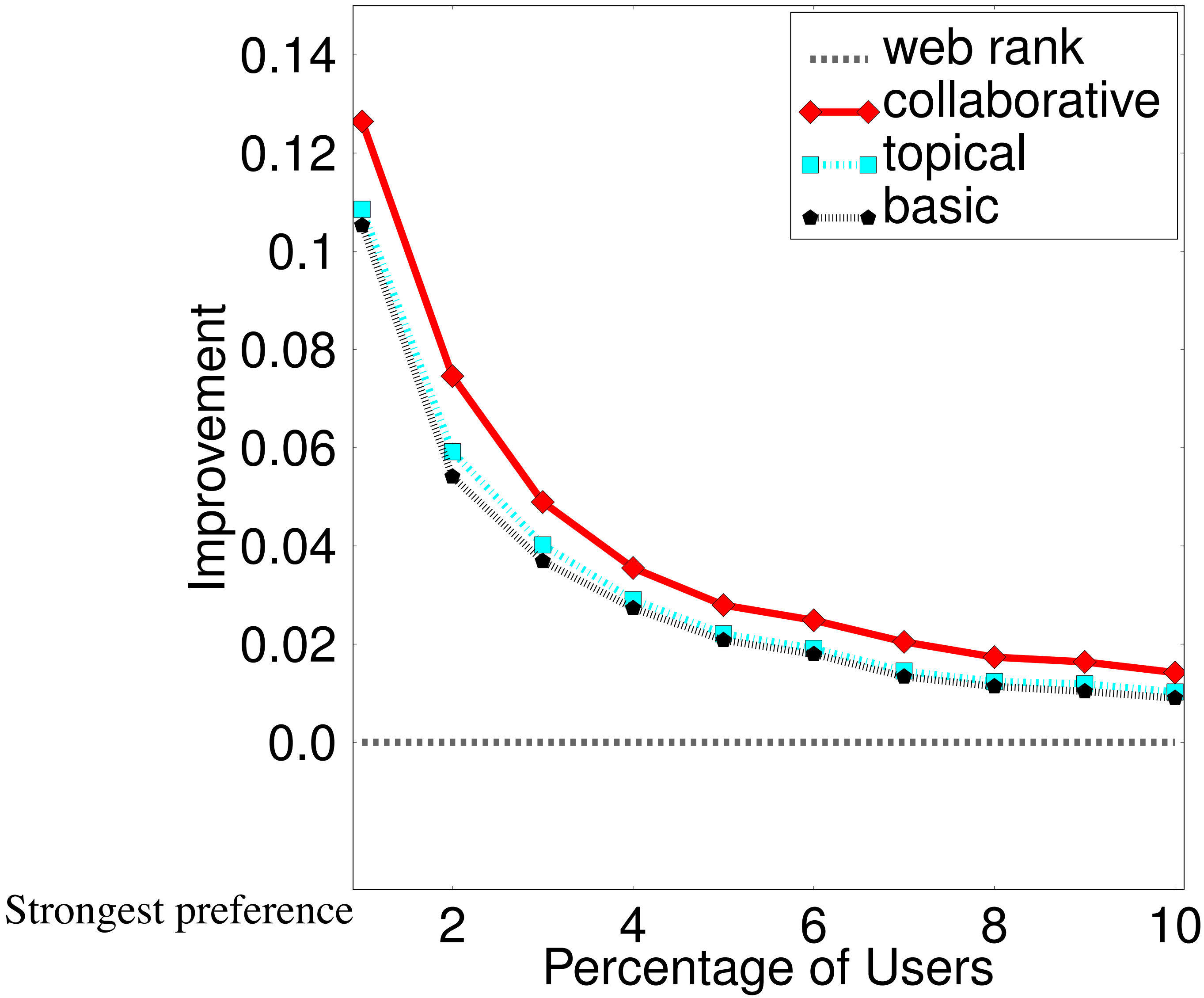

See paper for more experiments and analysis!

EXPERIMENT ON YAHOO! ANSWERS

Task: Users can choose the best answer for questions they posted, we rank all the answers and try to make the rank of the best answer as small as possible

Method

- Random
- Majority (a preference for harder text)
- Our model

Performance

*($p < 0.05$), **($p < 0.01$),***($p < 0.001$)

Fraction of users	Random	Majority	Our model
5% (strongest)	3.375	2.947	2.895 (***, ***)
10%	3.596	3.096	3.079 (***, ***)
100% (all)	4.525	4.093	4.149 (***,)

DIFFERENCES FROM COLLINS-THOMPSON ET AL. 2011

	Collins-Thompson et al.	Our work
Readability/ comprehensibility classifier	Explicitly models school reading levels	Trained on English Wikipedia vs. simple English Wikipedia. More general, e.g., improvement in topic health
Approach	A generative model	Extract preference pairs Collaborative filtering
Application	Web search	Web search Community question answering

CONCLUSION

Develop a unified framework for personalized content selection using text comprehensibility

Model users' comprehensibility preferences by extracting preference pairs and apply collaborative filtering to alleviate the problem of data sparseness

Modeling text comprehensibility can significantly improve content ranking in both web search and community question answering

Thank you!

Q & A