MARS: Applying Multiplicative Adaptive User Preference Retrieval to Web Search Zhixiang Chen & Xiannong Meng U.Texas-PanAm & Bucknell Univ.

### **Outline of Presentation**

- Introduction -- the vector model over R+
- Multiplicative adaptive query expansion algorithm
- MARS -- meta-search engine
- · Initial empirical results
- Conclusions

### Introduction

- · Vector model
  - A document is represented by the vector  $\mathbf{d} = (d1, \dots, dn)$  where di's are the relevance value of i-th index
  - A user query is represented by q = (q1,...,qn) where qi's are query terms
  - Document d' is preferred over document d iff  $q \bullet d < q \bullet d'$

### Introduction -- continued

- Relevance feedback to improve search accuracy
  - In general, take user's feedback, update the query vector to get closer to the target  $\mathbf{q}(k+1) = \mathbf{q}(k) + \mathbf{a}\mathbf{1}\cdot\mathbf{d}\mathbf{1} + \dots + \mathbf{as}\cdot\mathbf{ds}$
  - Example: relevance feedback based on similarity
  - Problem with linear adaptive query updating: converges too slowly

# Multiplicative Adaptive Query Expansion Algorithm

- Linear adaptive yields some improvement, but it converges to an initially unknown target too slowly
- Multiplicative adaptive query expansion promotes or demotes the query terms by a constant factor in i-th round of feedback
  - promotes:  $q(i,k+1) = (1+f(d)) \bullet q(i,k)$
  - demotes: q(i, k+1) = q(i,k)/(1+f(d))

### MA Algorithm -- continue

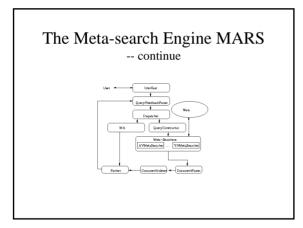
```
while (the user judged a document d) {
for each query term in \mathbf{q}(k)
if (d is judged relevant) // promote the term
\mathbf{q}(i,k+1) = (1+f(\mathbf{d}i)) \cdot \mathbf{q}(i,k)
else if (d is judged irrelevant) // demote the term
\mathbf{q}(i, k+1) = \mathbf{q}(i,k) / (1+f(\mathbf{d}i))
else // no opinion expressed, keep the term
\mathbf{q}(i, k+1) = \mathbf{q}(i, k)
}
```

# MA Algorithm -- continue

- The f(di) can be any positive function
- In our experiments we used f(x) = 2.71828 • weight(x)
- where x is a term appeared in di
- We have detailed analysis of the performance of the MA algorithm in detail in another paper
- Overall, MA performed better than linear additive query updating such as Rocchio's similarity based relevance feedback in terms of time complexity and search accuracy
- · In this paper we present some experiment results

# The Meta-search Engine MARS

- We implemented the algorithm MARS in our experimental search engine
- The meta-search engine has a number of components, each of which is implemented as a module
- It is very flexible to add or remove a component



# The Meta-search Engine MARS

- User types a query into the browser
- The QueryParser sends the query to the Dispatcher
- The Dispatcher determines whether this is an original query, or a refined one
- If it is the original, send the query to one of the search engines according to user choice
- If it is a refined one, apply the MA algorithm

# The Meta-search Engine MARS

-- continue

- The results either from MA or directly from other search engines are ranked according to the scores based on similarity
- The user can mark a document relevant or irrelevant by clicking the corresponding *radio button* at the MARS interface
- The algorithm MA refines document ranking by either promoting or demoting the query term



and a second sec	eg budrell éduligi binjiger aplimeng harolitæt	• circo linto
	Search Viete Search	
	Seath Wield	
Relevant?	OoodMatchar	
C yes @ no 40.000	http://www.mam.com/	
	http://www.jpl.owm.ptvf	
	http://pde.jpd.axen.prv/planeta/webroartisaat.htm	
C 386 C 80 37.000		
C yes C ao 36.000		
C yes C to 35,000	http://www.aukeviews.com/ogloses.htm	
C yes C to 34000	latig. Owners ends orghump launtations familiations is	
C yes C ao 33,000	http://www.ande.org/-apides/nam/nam.html	
C yes C at 32000		
C yes C no 31.000	http://www.bookleved.com/spileg.main.shtml	
Balayard		
C 396 C tet 1000		
C yes C ns 2000		
C yrs C to 3.000		
C yes C to 4000		
Сун Сво 3000		
Сун Сы 6000		
C yrs C to 7000		
C yes C no 2000		
C yes C to 9,000		
C 3NE C 10 10.000	http://www.awar.ak	
feedback		

tere en projaketa beskure nen proj		With Seach		
en problemteter kunne	tear lite			
	man him			
INS. grid				
tried and information	html			
TIN MARK COL				
	autos.			
Accurctlen and				
internet in count				
es read datases bea				
calal				
serfrigenet (Cro				
at.com/				
n2030.set/				
icts tripod cond				
insuciety he/				
an a del				
ninharithanith	Steel			
Vectors and				
to waterface can				
	sdovati orachy hypos anorachypoti en markithen itan kahi seeftensen real seeftensen real seeftensen real staten mai keit hypotensi serotettal anadal ansidel	ankersafannskaphignana aktual ansmarka zund ansmarka zund ansmarka zund ansmarka zund ansmarka zund ansmarka zund ansmarka zund ansmarka zund ansmarka zuld ansmarka zuld ansmarka zuld	adarest menoting and memoti and senset and senset and senset senset and memory and senset sen	adverses investiging angement schaft angement ange standet ange schaft angement ange

# Initial Empirical Results

- We conducted two types of experiments to examine the performance of MARS
- The first is the response time of MARS
  - The initial time retrieving results from external search engines
  - The refine time needed for MARS to produce results
  - Tested on a SPARC Ultra-10 with 128 M memory

### Initial Empirical Results -- continue

- Initial retrieval time:
  - mean: 3.86 seconds
  - standard deviation: 1.15 seconds
  - 95% confidence interval 0.635
  - maximum: 5.29 seconds
- Refine time:
  - mean: 0.986 seconds
  - standard deviation: 0.427 seconds
  - 95% confidence interval: 0.236
  - maximum: 1.44 seconds

#### Initial Empirical Results -- continue

- The second is the search accuracy improvement
  - define
    - · A: total set of documents returned
    - R: the set of relevant documents returned
    - Rm: set of relevant documents among top-m-ranked
    - m: an integer between 1 and |A|
    - recall rate =  $|\mathbf{Rm}| / |\mathbf{R}|$
    - precision =  $|\mathbf{Rm}| / \mathbf{m}$

# Initial Empirical Results --continue

- randomly selected 70+ words or phrases
- send each one to AltaVista, retrieving the first 200 results of each query
- manually examine results to mark documents as relevant or irrelevant
- compute the precision and recall
- use the same set of documents for MARS

Recall	(200, 10)	(200, 20)	Precision	(200,10)	(200,20)
AltaVista	0.11	0.19		0.43	0.42
MARS	0.20	0.25		0.65	0.47

### Initial Empirical Results --continue

- Results show that the extra processing time of MARS is not significant, relative to the whole search response time
- Results show that the search accuracy is improved by in both recall and precision
- General search terms improve more, specific terms improve less

# Conclusions

- Linear adaptive query update is too slow to converge
- Multiplicative adaptive is faster to converge
- User inputs are limited to a few iterations of feedback
- The extra processing time required is not too significant
- Search accuracy in terms of precision and recall is improved