Multimedia Information Retrieval and Technology

Lecture 9 Evaluation II

By : Laura Liu

Room: EE314

Tel. no. 7756

Xi'an Jiaotong-Liverpool University

西交利物浦大学

Evaluation of unranked retrieval results

Evaluation of ranked retrieval results

- Eleven-point interpolated average precision
- MAP (Mean Average Precision)
- Precision@K
- Normalized Discounted Cumulative Gain

Average Precision

For any information need $q_j \in Q$, we denote the set of relevant documents as $\{d_1, \cdots, d_{m_j}\}$

Precision(d_k) is the precision of retrieved results when we reach the document d_k.

Average Precision

For a single information need, Average Precision is the average of the precision value obtained for the set of top *k* documents existing after **each relevant document** is retrieved.

$$AP = \frac{1}{m_j} \sum_{k=1}^{m_j} Precision(d_k)$$

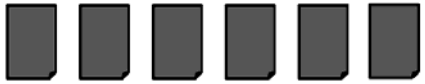
Average Precision

For an information need $q_j \in Q$, the IR system to be evaluated has returned the following documents:

		P	R	
1	R	1	0.01	d_1
2	R	1	0.02	d_2
3	N	2/3	0.02	
4	N	2/4	0.02	
5	R	3/5	0.03	d_3
6	N	3/6	0.03	

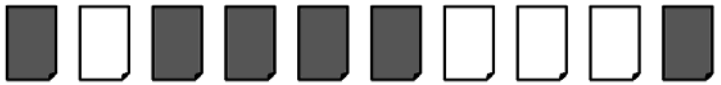
Here, m_j=3, AP=?

Average Precision



= the relevant documents

Ranking #1



Recall	0.17	0.17	0.33	0.5	0.67	0.83	0.83	0.83	0.83	1.0
Precision	1.0	0.5	0.67	0.75	0.8	0.83	0.71	0.63	0.56	0.6

Ranking #2

6 relevant docs in total.

Recall? Precision?

Xi'an Jiaotong-Liverpool University
西交利物浦大學

3-6

Average Precision


= the relevant documents

Ranking #1

Recall	0.17	0.17	0.33	0.5	0.67	0.83	0.83	0.83	0.83	1.0
Precision	1.0	0.5	0.67	0.75	0.8	0.83	0.71	0.63	0.56	0.6

Ranking #2

Recall	0.0	0.17	0.17	0.17	0.33	0.5	0.67	0.67	0.83	1.0
Precision	0.0	0.5	0.33	0.25	0.4	0.5	0.57	0.5	0.56	0.6

AP=?

Mean Average Precision

Then:

$$MAP(Q) = \frac{1}{|Q|}\sum_{j=1}^{|Q|}\frac{1}{m_j}\sum_{k=1}^{m_j} Precision(d_k)$$

MAP is Average Precision across multiple queries and rankings

Exercise II: MAP

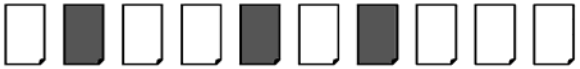

= relevant documents for query 1

Ranking #1

Recall	0.2	0.2	0.4	0.4	0.4	0.6	0.6	0.6	0.8	1.0
Precision	1.0	0.5	0.67	0.5	0.4	0.5	0.43	0.38	0.44	0.5


= relevant documents for query 2

Ranking #2



Recall	0.0	0.33	0.33	0.33	0.67	0.67	1.0	1.0	1.0	1.0
Precision	0.0	0.5	0.33	0.25	0.4	0.33	0.43	0.38	0.33	0.3

Xi'an Jiaotong-Liverpool University
西交利物浦大學

3-12

Mean average precision

MAP is macro-averaging: each query counts equally

Now perhaps most commonly used measure in research papers. Among evaluation measures, MAP has been shown to have especially good discrimination and stability.

Using MAP, fixed recall levels are not chosen, and there is no interpolation.

Mean average precision

MAP assumes user is interested in finding many relevant documents for each query

MAP requires many relevance judgments in text collection

Good for web search?

What matters is rather how many good results there are on the first page or the first three pages.

Evaluation of unranked retrieval results

Evaluation of ranked retrieval results

- Eleven-point interpolated average precision
- MAP
- Precision@K
- Normalized Discounted Cumulative Gain

Precision@K

Measuring precision at fixed low levels of retrieved results, such as 10 or 30 documents.

Ignores documents ranked lower than K

Precision@K

Example:

Prec@3 of 2/3

Prec@4 of 2/4

Prec@5 of 3/5

In similar fashion we have Recall@K

Evaluation of unranked retrieval results

Evaluation of ranked retrieval results

- Eleven-point interpolated average precision
- MAP
- Precision@K
- Normalized Discounted Cumulative Gain

Xi'an Jiaotong-Liverpool University
西交利物浦大學

3-21

Discounted Cumulative Gain

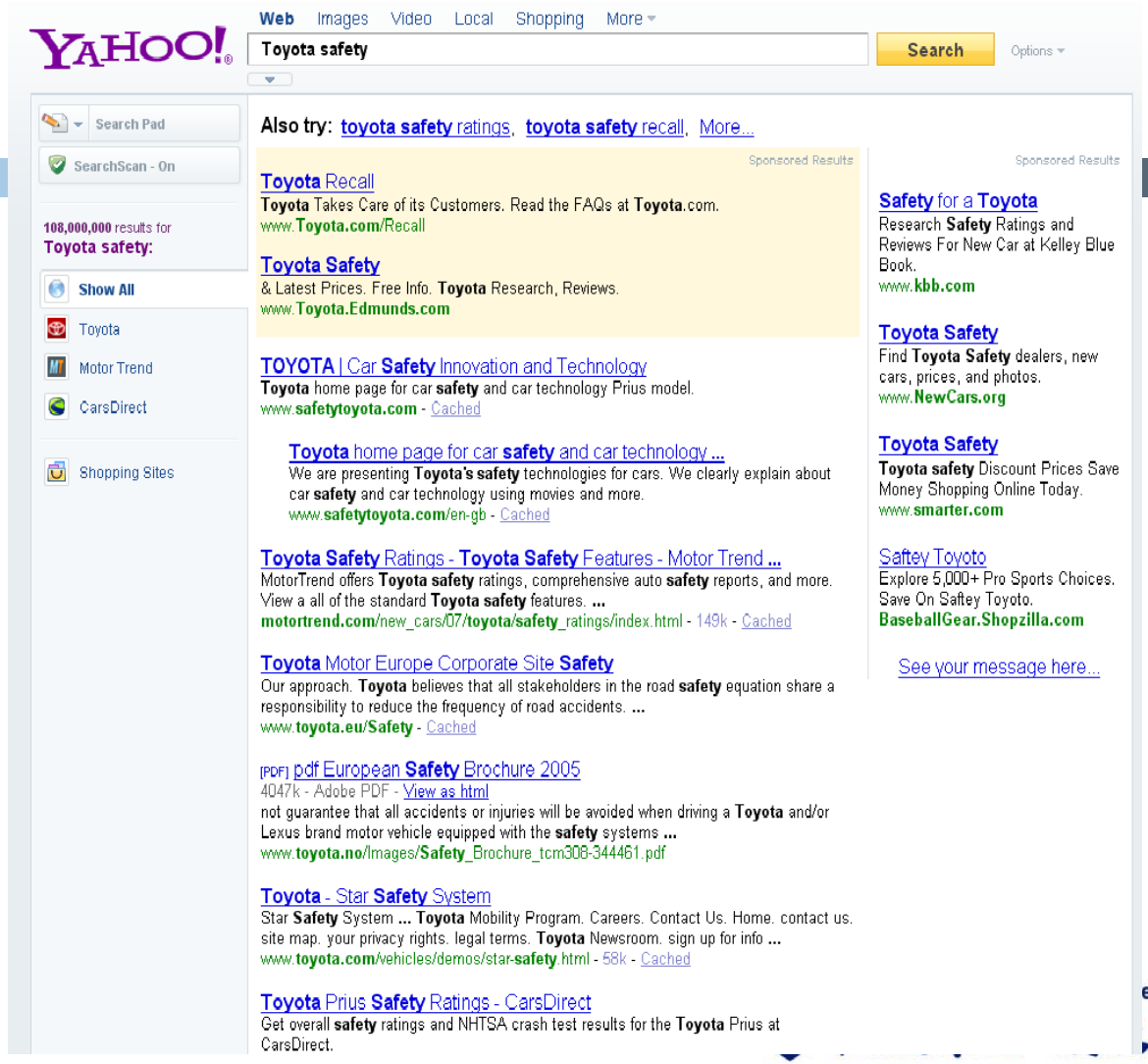
A Popular measure for evaluating web search and related tasks. A measure of ranking quality.

Two assumptions:

- Highly relevant documents are more useful than marginally relevant documents;
- the lower the ranked position of a relevant document, the less useful it is for the user, since it is less likely to be examined.

Xi'an Jiaotong-Liverpool University
西交利物浦大學

3-22


YAHOO!
Web Images Video Local Shopping More
Toyota safety
Search
Options
Search Pad
SearchScan - On
108,000,000 results for
Toyota safety:
Show All
Toyota
Motor Trend
CarsDirect
Shopping Sites
Also try: toyota safety ratings, toyota safety recall, More...
Sponsored Results
Toyota Recall
Toyota Takes Care of its Customers. Read the FAQs at Toyota.com.
www.Toyota.com/Recall
Toyota Safety
& Latest Prices. Free Info. Toyota Research, Reviews.
www.Toyota.Edmunds.com
TOYOTA | Car Safety Innovation and Technology
Toyota home page for car safety and car technology Prius model.
www.safetytoyota.com - Cached
Toyota home page for car safety and car technology ...
We are presenting Toyota's safety technologies for cars. We clearly explain about car safety and car technology using movies and more.
www.safetytoyota.com/en-gb - Cached
Toyota Safety Ratings - Toyota Safety Features - Motor Trend ...
MotorTrend offers Toyota safety ratings, comprehensive auto safety reports, and more. View a all of the standard Toyota safety features. ...
motortrend.com/new_cars/07/toyota/safety_ratings/index.html - 149k - Cached
Toyota Motor Europe Corporate Site Safety
Our approach. Toyota believes that all stakeholders in the road safety equation share a responsibility to reduce the frequency of road accidents. ...
www.toyota.eu/Safety - Cached
[PDF] pdf European Safety Brochure 2005
4047k - Adobe PDF - View as html
not guarantee that all accidents or injuries will be avoided when driving a Toyota and/or Lexus brand motor vehicle equipped with the safety systems ...
www.toyota.no/Images/Safety_Brochure_tcm308-344461.pdf
Toyota - Star Safety System
Star Safety System ... Toyota Mobility Program. Careers. Contact Us. Home. contact us. site map. your privacy rights. legal terms. Toyota Newsroom. sign up for info ...
www.toyota.com/vehicles/demos/star-safety.html - 58k - Cached
Toyota Prius Safety Ratings - CarsDirect
Get overall safety ratings and NHTSA crash test results for the Toyota Prius at CarsDirect.
Sponsored Results
Safety for a Toyota
Research Safety Ratings and Reviews For New Car at Kelley Blue Book.
www.kbb.com
Toyota Safety
Find Toyota Safety dealers, new cars, prices, and photos.
www.NewCars.org
Toyota Safety
Toyota safety Discount Prices Save Money Shopping Online Today.
www.smarter.com
Saftey Toyoto
Explore 5,000+ Pro Sports Choices. Save On Saftey Toyoto.
BaseballGear.Shopzilla.com
See your message here...

3-23

Discounted Cumulative Gain

Uses ***graded relevance*** as a measure of usefulness, or *gain,* from examining a document

Eg: 5 ranked documents judged on 0-3 relevance scale

D1	3
D2	2
D3	3
D4	0
D5	1

D1	3
D3	3
D4	0
D2	2
D5	1

Summarize a Ranking: DCG

Let the relevance ratings of the top n documents be $rel_1, rel_2, \ldots, rel_n$ (in ranked order)

Cumulative Gain (CG) at rank n

CG = $rel_1 + rel_2 + \ldots + rel_n$

total gain accumulated at a particular rank *n*

Discounted Cumulative Gain

Gain is accumulated starting at the top of the ranking and may be reduced, or *discounted*, at lower ranks.

Typical discount is:

1/log *(rank)*

With base 2, the discount at rank 4 is 1/2, and at rank 8 it is 1/3

Discounted Cumulative Gain

Discounted Gain:

$$DG = \frac{rel_i}{\log_2 i}$$

DCG is the total discounted gain accumulated at a particular rank *n*:

$$DCG_p = rel_1 + \sum_{i=2}^{p} \frac{rel_i}{\log_2 i}$$

DCG Example

Docs	D1	D2	D3	D4	D5	D6	D 7	D8	D9	D10
Gain	3	2	3	0	0	1	2	2	3	0
Discounted gain	3									
DCG	3									

Recap: Relevance judgments

Relevance can reasonably be thought of as a scale, with some documents highly relevant and others marginally so..

This decision is referred to as the ***gold standard*** or ***ground truth*** judgment of relevance.

NDCG (Normalized DCG)

The ideal (perfect) ranking would first return the documents with the highest relevance level, then the next highest relevance level, etc

The ideal (perfect) ranking is based on the ***gold standard*** or ***ground truth*** judgment of relevance

Summarize a Ranking: NDCG

Normalized Discounted Cumulative Gain (NDCG) at rank *n:*

Normalize DCG at rank *n* by the DCG value at rank *n* of the ideal ranking

$$NDCG_{rank\ n} = \frac{Actual\ DCG_{\ rank\ n}}{Ideal\ DCG_{\ rank\ n}}$$

- Normalization is useful for contrasting queries with varying numbers of relevant results
- Popular in evaluating web search.

Example

Docs	D1	D2	D3	D4	D5	D6	D 7	D8	D9	D10
Gain	3	2	3	0	0	1	2	2	3	0
Discounted gain	3									
DCG	3									

Perfect (ideal) ranking:

3, 3, 3, 2, 2, 2, 1, 0, 0, 0

ideal DCG values:

3-34

NDCG - Exercise

4 documents: d_1, d_2, d_3, d_4

i	Ground Truth		Ranking Function$_1$		Ranking Function$_2$	
	Document Order	r_i	Document Order	r_i	Document Order	r_i
1	d4	2	d3	2	d3	2
2	d3	2	d4	2	d2	1
3	d2	1	d2	1	d4	2
4	d1	0	d1	0	d1	0

Please compare the NDCG at rank 4 for ranking function 1 and 2.

3-38