1 Common Evaluation Measures

- Recall
  A measure of the ability of a system to present all relevant items.

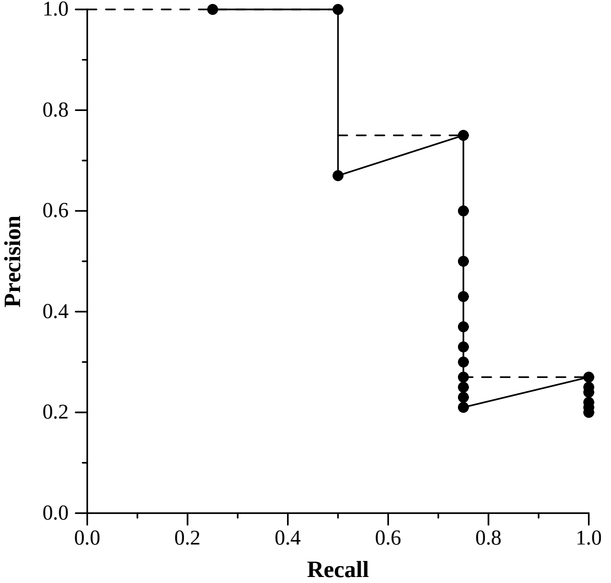
$$\text{recall} = \frac{\text{number of relevant items retrieved}}{\text{number of relevant items in collection}}$$

- Precision.
  A measure of the ability of a system to present only relevant items.

$$\text{precision} = \frac{\text{number of relevant items retrieved}}{\text{total number of items retrieved}}$$

Precision and recall are set-based measures. That is, they evaluate the quality of an unordered set of retrieved documents. To evaluate ranked lists, precision can be plotted against recall after each retrieved document as shown in the example below. To facilitate computing average performance over a set of topics— each with a different number of relevant documents— individual topic precision values are interpolated to a set of standard recall levels (0 to 1 in increments of .1). The particular rule used to interpolate precision at standard recall level i is to use the maximum precision obtained for the topic for any actual recall level greater than or equal to i. Note that while precision is not defined at a recall of 0.0, this interpolation rule does define an interpolated value for recall level 0.0. In the example, the actual precision values are plotted with circles (and connected by a solid line) and the interpolated precision is shown with the dashed line.

> Example: Assume a document collection has 20 documents, four of which are relevant to topic t. Further assume a retrieval system ranks the relevant documents first, second, fourth, and fifteenth. The exact recall points are 0.25, 0.5, 0.75, and 1.0. Using the interpolation rule, the interpolated precision for all standard recall levels up to .5 is 1, the interpolated precision for recall levels .6 and .7 is .75, and the interpolated precision for recall levels .8 or greater is .27.



2 trec_eval Evaluation Report

The results from the cross-language track, the topic distillation task in the web track, and the routing task in the filtering track are ranked lists of documents. These lists are evaluated using `trec_eval`, a program written by Chris Buckley when he was at Cornell University that can be obtained by anonymous ftp from Cornell in the directory pub/smart at ftp.cs.cornell.edu. An evaluation report for a run evaluated by `trec_eval` is comprised of a header (containing the task and organization name), 3 tables, and 2 graphs as described below. The feature and search tasks in the video track are also ranked list tasks that were evaluated with `trec_eval`, though no averages are reported for the feature task and the output has been relabeled.

2.1 Tables

I. "Summary Statistics" Table
Table 1 is a sample "Summary Statistics" Table

Table 1: Sample "Summary Statistics" Table.

Summary Statistics	
Run	Cor7A1clt–automatic, title
Number of Topics	50
Total number of documents over all topics	
Retrieved:	50000
Relevant:	4674
Rel_ret:	2621

A. Run
A description of the run. It contains the run tag provided by the participant, and various details about the runs such as whether queries were constructed manually or automatically.

B. Number of Topics
Number of topics searched in this run (generally 50 topics are run for each task).

C. Total number of documents over all topics (the number of topics given in B).

i. Retrieved
Number of documents submitted to NIST. This is usually 50,000 (50 topics × 1000 documents), but is less when fewer than 1000 documents are retrieved per topic.

ii. Relevant
Total possible relevant documents within a given task and category.

iii. Rel_ret
Total number of relevant documents returned by a run over all the topics.

II. "Recall Level Precision Averages" Table.
Table 2 is a sample "Recall Level Precision Averages" Table.

A. Precision at 11 standard recall levels
The precision averages at 11 standard recall levels are used to compare the performance of different systems and as the input for plotting the recall-precision graph (see below). Each recall-precision average is computed by summing the interpolated precisions at the specified recall cutoff value (denoted by $\sum P_\lambda$ where P_λ is the interpolated precision at recall level λ) and then dividing by the number of topics.

$$\frac{\sum_{i=1}^{NUM} P_\lambda}{NUM} \qquad \lambda = \{0.0, 0.1, 0.2, 0.3, \ldots, 1.0\}$$

Table 2: Sample “Recall Level Precision Averages” Table.

Recall Level Precision Averages	
Recall	Precision
0.00	0.6169
0.10	0.4517
0.20	0.3938
0.30	0.3243
0.40	0.2715
0.50	0.2224
0.60	0.1642
0.70	0.1342
0.80	0.0904
0.90	0.0472
1.00	0.0031
Average precision over all relevant docs	
non-interpolated	0.2329

- Interpolating recall-precision
  Standard recall levels facilitate averaging and plotting retrieval results.

B. Average precision over all relevant documents, non-interpolated
This is a single-valued measure that reflects the performance over all relevant documents. It rewards systems that retrieve relevant documents quickly (highly ranked).

The measure is not an average of the precision at standard recall levels. Rather, it is the average of the precision value obtained after each relevant document is retrieved. (When a relevant document is not retrieved at all, its precision is assumed to be 0.) As an example, consider a query that has four relevant documents which are retrieved at ranks 1, 2, 4, and 7. The actual precision obtained when each relevant document is retrieved is 1, 1, 0.75, and 0.57, respectively, the mean of which is 0.83. Thus, the average precision over all relevant documents for this query is 0.83.

III. “Document Level Averages” Table
Table 3 is a sample “Document Level Averages” Table.

Table 3: Sample “Document Level Averages” Table.

Document Level Averages	
	Precision
At 5 docs	0.4280
At 10 docs	0.3960
At 15 docs	0.3493
At 20 docs	0.3370
At 30 docs	0.3100
At 100 docs	0.2106
At 200 docs	0.1544
At 500 docs	0.0875
At 1000 docs	0.0524
R−Precision (precision after R docs retrieved (where R is the number of relevant documents))	
Exact	0.2564

A. Precision at 9 document cutoff values

The precision computed after a given number of documents have been retrieved reflects the actual measured system performance as a user might see it. Each document precision average is computed by summing the precisions at the specified document cutoff value and dividing by the number of topics (50).

B. R-Precision

R-Precision is the precision after R documents have been retrieved, where R is the number of relevant documents for the topic. It de-emphasizes the exact ranking of the retrieved relevant documents, which can be particularly useful in TREC where there are large numbers of relevant documents.

The average R-Precision for a run is computed by taking the mean of the R-Precisions of the individual topics in the run. For example, assume a run consists of two topics, one with 50 relevant documents and another with 10 relevant documents. If the retrieval system returns 17 relevant documents in the top 50 documents for the first topic, and 7 relevant documents in the top 10 for the second topic, then the run's R-Precision would be $\frac{\frac{17}{50}+\frac{7}{10}}{2}$ or 0.52.

2.2 Graphs

I. Recall-Precision Graph

Figure 1 is a sample Recall-Precision Graph.

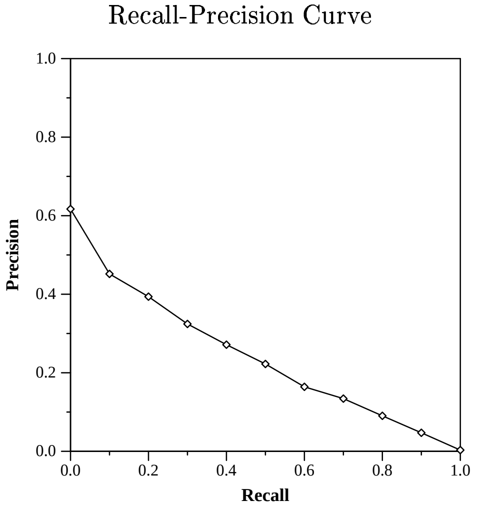


Figure 1: Sample Recall-Precision Graph.

The Recall-Precision Graph is created using the 11 cutoff values from the Recall Level Precision Averages. Typically these graphs slope downward from left to right, enforcing the notion that as more relevant documents are retrieved (recall increases), the more nonrelevant documents are retrieved (precision decreases).

This graph is the most commonly used method for comparing systems. The plots of different runs can be superimposed on the same graph to determine which run is superior. Curves closest to the upper right-hand corner of the graph (where recall and precision are maximized) indicate the best performance. Comparisons are best made in three different recall ranges: 0 to 0.2, 0.2 to 0.8, and 0.8 to 1. These ranges characterize high precision, middle recall, and high recall performance, respectively.

II. Average Precision Histogram.
Figure 2 is a sample Average Precision Histogram.

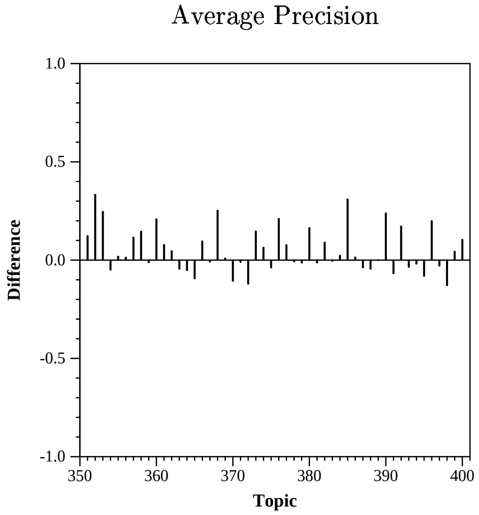


Figure 2: Sample Average Precision Histogram.

The Average Precision Histogram measures the average precision of a run on each topic against the median average precision of all corresponding runs on that topic. This graph is intended to give insight into the performance of individual systems and the types of topics that they handle well.

(Since the emphasis in the topic distillation task in the web track is high precision, the median histogram for that task uses Precision at a cut-off of 10, rather than average precision, as the underlying measure.)

3 Question Answering Evaluation Report

The tasks in the question answering track used different evaluation metrics and have different evaluation reports. For both tasks, responses were judged as being wrong, inexact, unsupported, or right. Right responses were considered correct, and all other responses as incorrect.

3.1 Main task

The primary evaluation measure used in the main task of the QA track is called the "confidence-weighted" score. This measure was inspired by the average uninterploated precision measure of ranked retrieval. Systems returned exactly one response for each of 500 questions, where the *questions* were ranked by the system's confidence in its response. That is, the question the system was most sure it answered correctly was ranked first and the question it was least sure it had answered correctly was ranked last. The confidence weighted score is then computed as

$$\frac{\sum_{i=1}^{500} \text{number correct in first } i \text{ ranks}/i}{500}.$$

The evaluation report for the main task consists of a table giving details for the run and a graph that plots the confidence-weighted score versus question rank. An example of the table is shown in Table 4. The data given in the table include the raw counts of the number of questions judged in each category and the final confidence-weighted score. Also included are the precision and recall for the system's ability to recognize when there was no correct answer in the collection. Precision of recognizing no answer is defined

Table 4: Sample QA Main Task Table.

Summary Statistics	
Run ID	LCCmain2002
Num questions	500
Number wrong	63
Number unsupported	14
Number inexact	8
Number right	415
Confidence-weighted score	0.856
Number of times NIL correctly returned	38
Precision of recognizing no answer	37/64 = .0578
Recall of recognizing no answer	37/46 = 0.804

as the ratio of the number of times NIL was returned and correct to the number of times it was returned; recall as the ratio of the number of times NIL was returned and correct to the number of times it was correct (46).

The graph of confidence-weighted score versus question rank was created by plotting the confidence-weighted score computed up to rank i against i. It presents a graphical depiction of how well the system ranked the questions.

3.2 List task

The evaluation metric used for the list task is mean accuracy, where the accuracy of a single question is the number of distinct instances retrieved divided by the target number of instances (i.e., the number of instances the question specified should be retrieved). The evaluation report gives the run's mean accuracy computed over the 25 question in the test set. Also included is a histogram that shows the difference between the system's accuracy score and the median accuracy score for each question.

4 Filtering Evaluation Report

The result of a filtering run is an unordered set of documents, so it cannot be evaluated using `trec_eval`. (Routing runs do produce a ranked list of documents and are thus evaluated using `trec_eval`.) The evaluation measures used in the TREC 2002 filtering track were a linear utility function (scaled when averaged) and a variant of F-beta. If R^+ is the number of relevant documents a run retrieved, R^- the number of relevant documents that were not retrieved, and N^+ the number of non-relevant documents that were retrieved, the F-beta score used in the track is defined as

$$\mathrm{T11F} = \begin{cases} 0 & \text{if } \mathrm{R}^+ = \mathrm{N}+ = 0 \\ \dfrac{1.25\mathrm{R}^+}{.25\mathrm{R}^- + \mathrm{N}^+ + 1.25\mathrm{R}^+} & \text{otherwise} \end{cases}$$

and the utility function as

$$\mathrm{T11U} = 2\mathrm{R}^+ - \mathrm{N}^+.$$

Average utility over a set of topics is computed using scaled utilities. The averaging proceeds as follows:

- normalize an individual topic's utility score by the maximum possible utility for that topic (2*total-relevant);
- scale that value according to a minimum acceptable level (-0.5 for TREC-2002);
- average the scaled, normalized utilities

The evaluation report for an adaptive filtering run consists of a table giving run characteristics and summary measures, a table and plot of average utility scores over different time periods, and a median graph. The batch filtering report contains just the characteristics table and median graph. The median graph shows the difference between the run's evaluation score and the median score for each topic. The evaluation score is either the F-beta score or the utility score, depending on what the run was optimized for.

In adaptive filtering, systems can modify profiles based on relevance information of retrieved documents. One strategy is to have a "liberal" retrieval policy early in the process to gain more information and then become more stringent as more is learned. The time graph for adaptive runs plots average utility for four different time periods where time periods are labeled by the document identifiers that exist in the time period.

5 Named Page Evaluation Report

The result of a named page run is a ranked list of documents, but the named page task is a known-item search and thus is not evaluated using `trec_eval`. Instead, the runs are evaluated using the rank at which the first correct named page was retrieved. The evaluation report consists of a table of evaluation scores and a median graph.

An example table of evaluation scores is given in Table 5. The table contains a description of the run that specifies whether document structure was exploited in the run, whether anchor text was exploited in the run, and whether link structure was exploited in the run. The evaluation scores reported include:

Table 5: Sample Named Page Task Table.

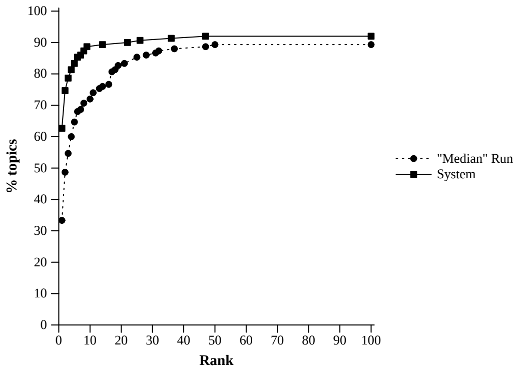
Summary Statistics	
Run ID	thunp3
Run Description	DOCSTRUCT, ANCHORTEXT, NOLINKSTRUCT
Num topics	150
Mean reciprocal rank	0.719
Num found at rank 1	94 (62.7%)
Num found in top 10	133 (88.7%)
Num not found in top 100	12 (8.0%)

- The mean reciprocal rank for the run. The score for an individual topic is the reciprocal of the rank at which the first correct page was returned, or zero if no correct page was returned. The score for the run as a whole is the mean of the reciprocal rank over the test set of topics.
- The number and percentage of topics for which a correct page was retrieved in the first rank.
- The number and percentage of topics for which a correct page was retrieved in the top ten ranks (includes those topics for which the page was returned at rank one).
- The number and percentage of topics for which no correct page was returned in the top 100 ranks.

A sample median graph is shown in Figure 3. The graph plots the cumulative percentage of topics for which a correct page was retrieved by a given rank. Two lines are plotted, the results for the run, and the results for a hypothetical median run that retrieves the page at the median rank for each topic.

6 Novelty Track Evaluation Report

The task in the novelty track was divided into two parts, finding sentences that were relevant and then identifying a subset of those sentences that contained new information. The novelty track evaluation report contains the same set of measures reported twice, once for relevant sentences and once for new sentences.

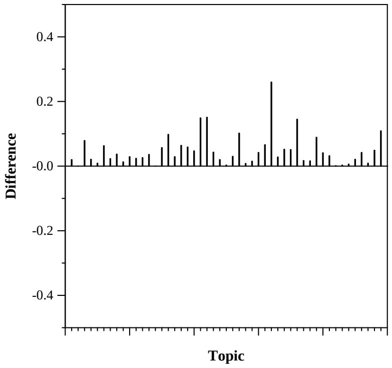


Cumulative % of topics that retrieve named page by given rank

Figure 3: Sample Median Graph for the Named Page Task.

The basic measures for the track are recall and precision. Let M be the number of matched sentences (i.e., the number of sentences selected by both the assessor and the system), A be the number of sentences selected by the assessor, and S be the number of sentences selected by the system. Then recall is M/A and precision is M/S. Because set precision and set recall do not average well, the primary measure used for the track is the product of precision and recall (P × R).

The evaluation report consists of a table giving the average values for precision, recall, and P × R, plus a median graph. The median graph shows the per-topic difference between the run's P × R and the median P × R for that topic. A sample novelty track median graph is shown in Figure 4.



Difference from Median in P*R per topic for new sentences

Figure 4: Sample median graph for the Novelty Track. This median graph is for the new sentence set.