The TREC Conferences: An Introduction

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Talk Outline

- General introduction to TREC
  - TREC history
  - TREC impacts
- Cranfield tradition of laboratory tests
  - mechanics of building test collections
  - test collection quality
  - legitimate uses of test collections
- IR evaluation primer

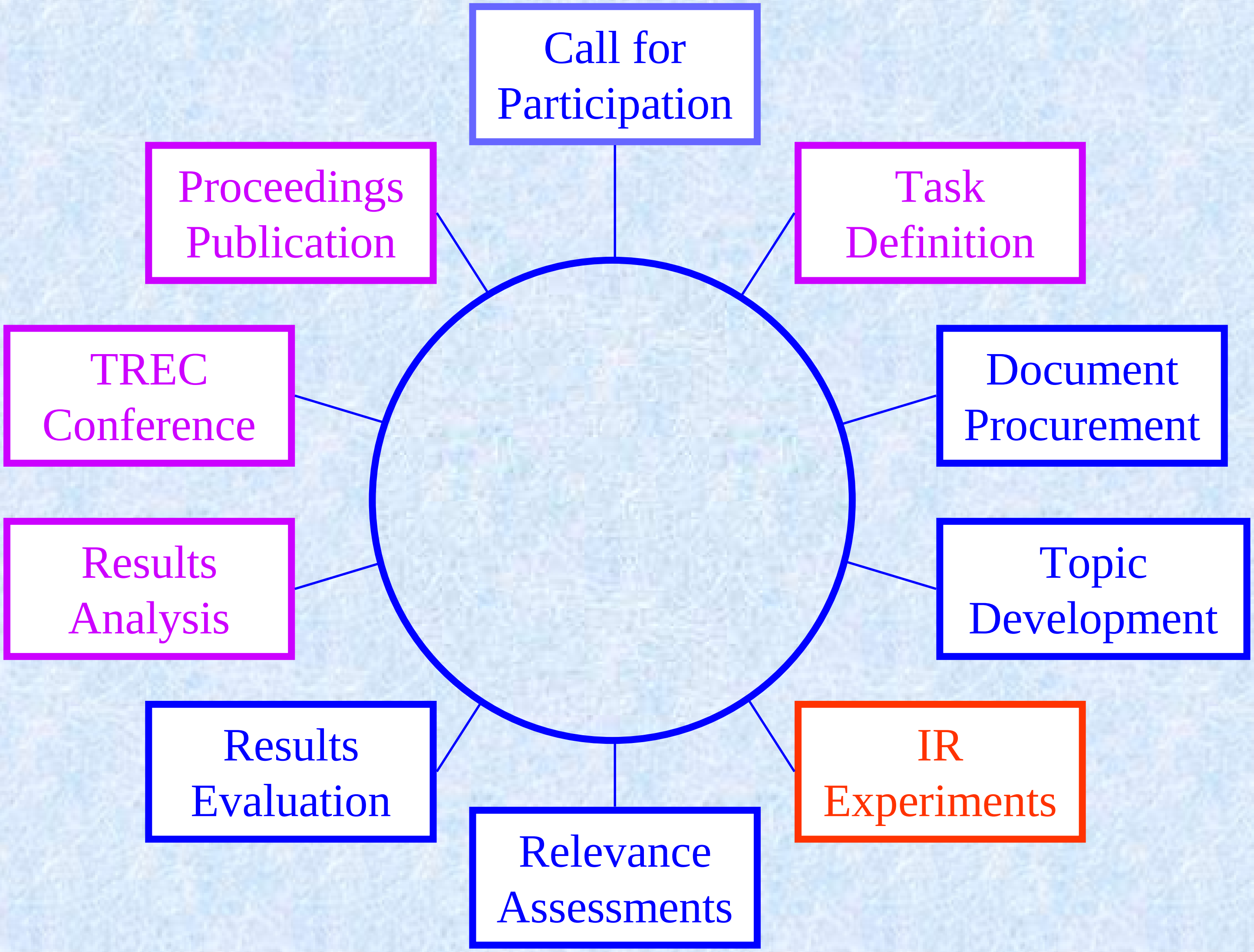
What is TREC?

- A workshop series that provides the infrastructure for large-scale testing of (text) retrieval technology
  - realistic test collections
  - uniform, appropriate scoring procedures
  - a forum for the exchange of research ideas and for the discussion of research methodology

TREC Philosophy

- TREC is a modern example of the Cranfield tradition
  - system evaluation based on test collections
- Emphasis on advancing the state of the art from evaluation results
  - TREC's primary purpose is <u>not</u> competitive benchmarking
  - experimental workshop: sometimes experiments fail!

Yearly Conference Cycle



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HARD: James Allan

Novelty: Ian Soboroff

Question Answering: Ellen Voorhees

Robust Retrieval: Ellen Voorhees

Terabyte: Charlie Clarke, Ian Soboroff

Web: David Hawking, Nick Craswell, Ian Soboroff

A Brief History of TREC

- 1992: first TREC conference
  - started by Donna Harman and Charles Wayne as 1 of 3 evaluations in DARPA's TIPSTER program
  - first 3 CDs of documents from this era, hence known as the "TIPSTER" CDs
  - open to IR groups not funded by DARPA
    - 25 groups submitted runs
  - two tasks: ad hoc retrieval, routing
    - 2GB of text, 50 topics
    - primarily an exercise in scaling up systems

A Brief History of TREC

- 1993 (TREC-2)
  - true baseline performance for main tasks
- 1994 (TREC-3)
  - initial exploration of additional tasks in TREC
- 1995 (TREC-4)
  - official beginning of TREC track structure
- 1998 (TREC-7)
  - routing dropped as a main task, though incorporated into filtering track
- 2000 (TREC-9)
  - ad hoc main task dropped; first all-track TREC

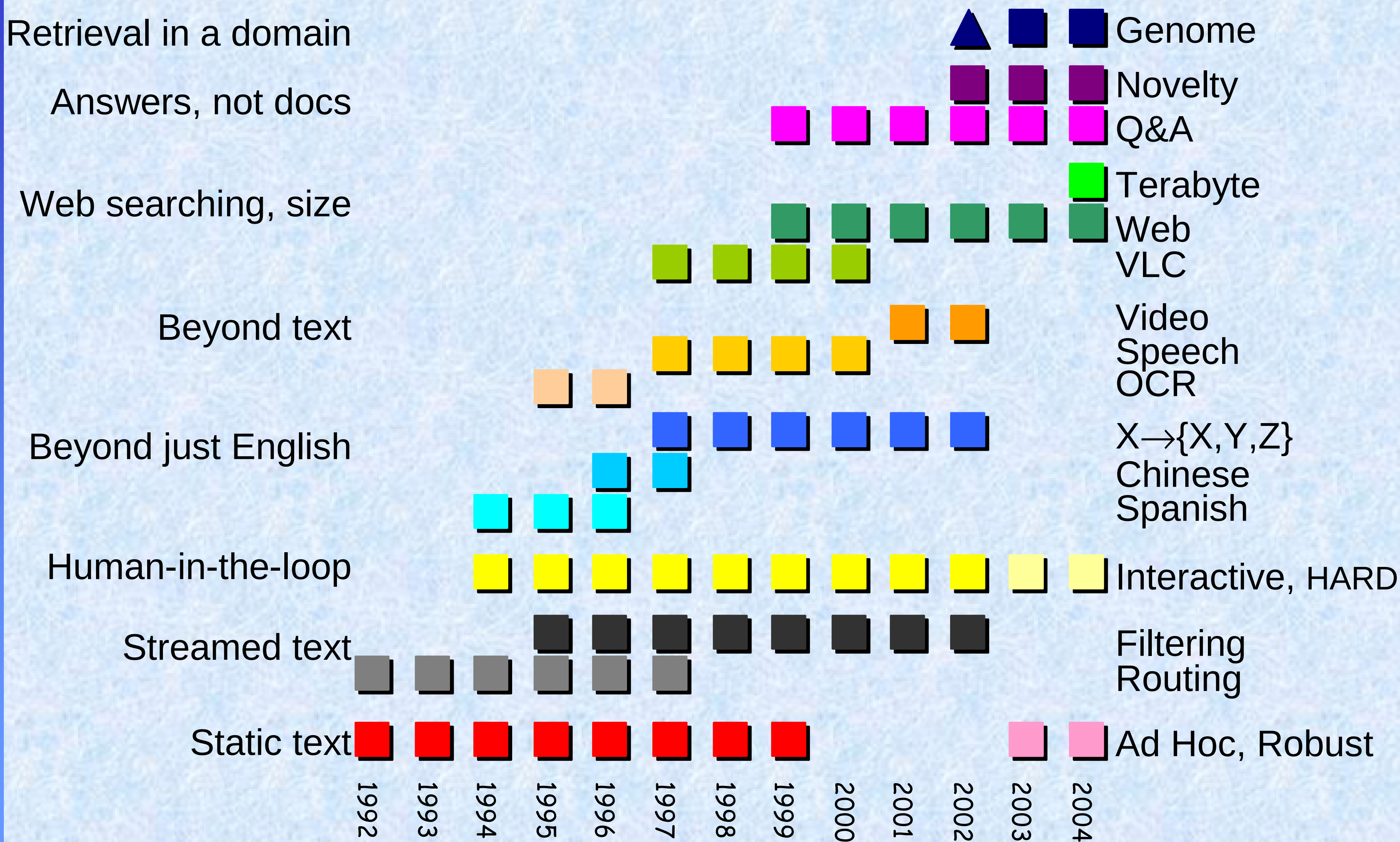
TREC Tracks

- Task that focuses on a particular subproblem of text retrieval
- Tracks invigorate TREC & keep TREC ahead of the state-of-the-art
  - specialized collections support research in new areas
  - first large-scale experiments debug what the task <u>really</u> is
  - provide evidence of technology's robustness

TREC Tracks

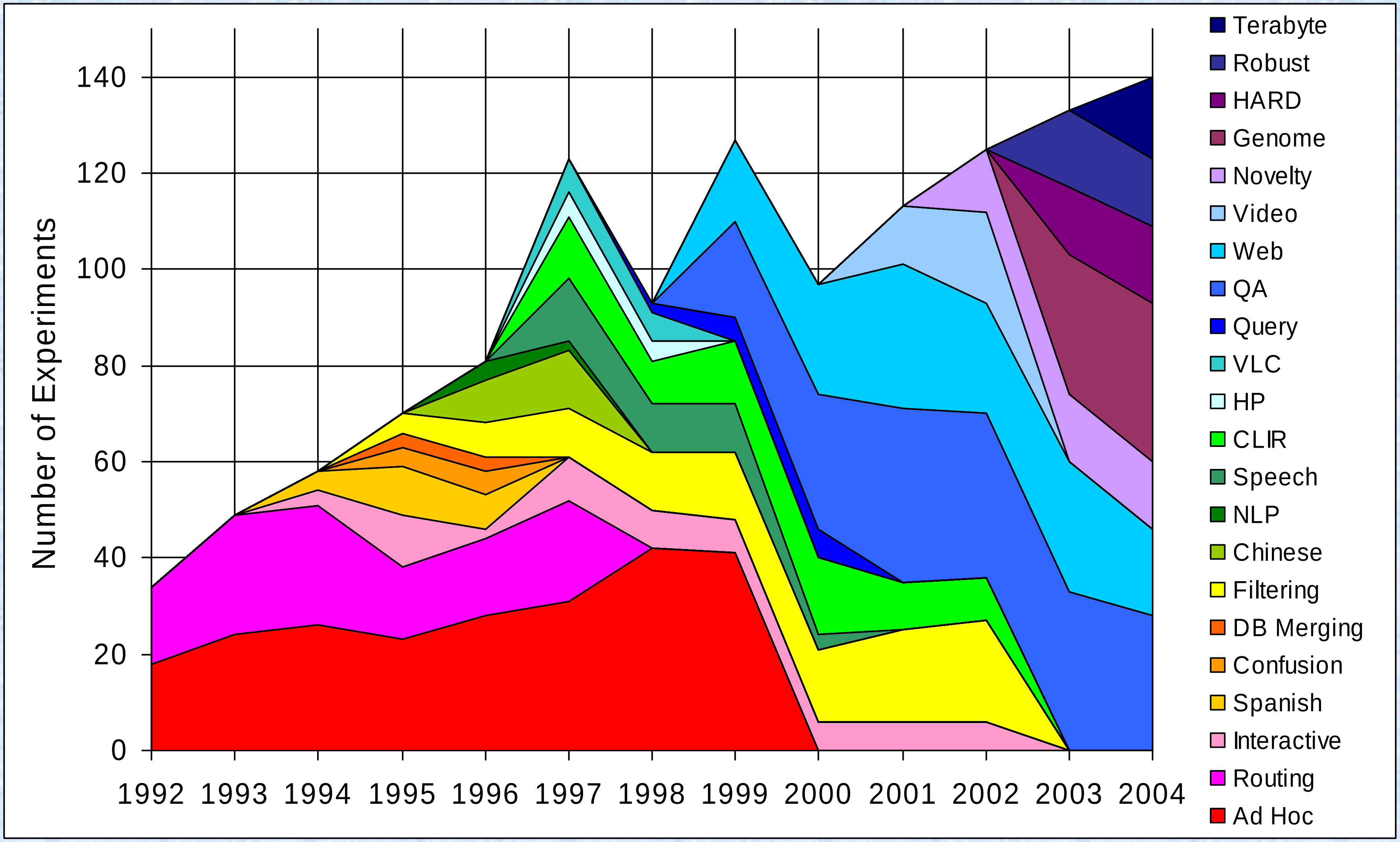
- Set of tracks in a particular TREC depends on:
  - interests of participants
  - appropriateness of task to TREC
  - needs of sponsors
  - resource constraints
- Need to submit proposal for new track in writing to NIST

TREC Tracks



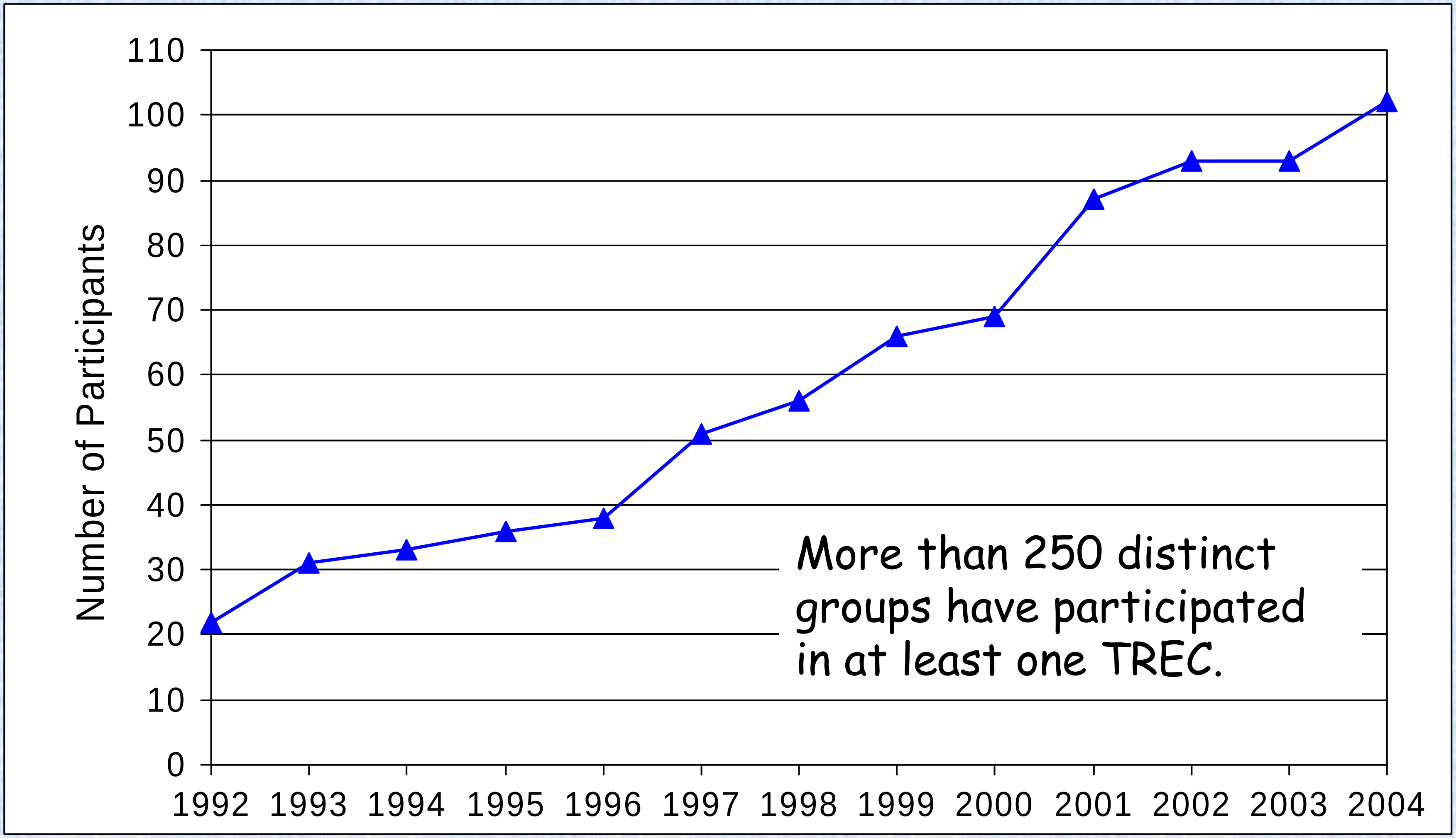
Retrieval in a domain
Answers, not docs
Web searching, size
Beyond text
Beyond just English
Human-in-the-loop
Streamed text
Static text
Genome
Novelty
Q&A
Terabyte
Web
VLC
Video
Speech
OCR
X→{X,Y,Z}
Chinese
Spanish
Interactive, HARD
Filtering
Routing
Ad Hoc, Robust
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004

TREC Tasks



Number of Experiments
0
20
40
60
80
100
120
140
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Terabyte
Robust
HARD
Genome
Novelty
Video
Web
QA
Query
VLC
HP
CLIR
Speech
NLP
Chinese
Filtering
DB Merging
Confusion
Spanish
Interactive
Routing
Ad Hoc

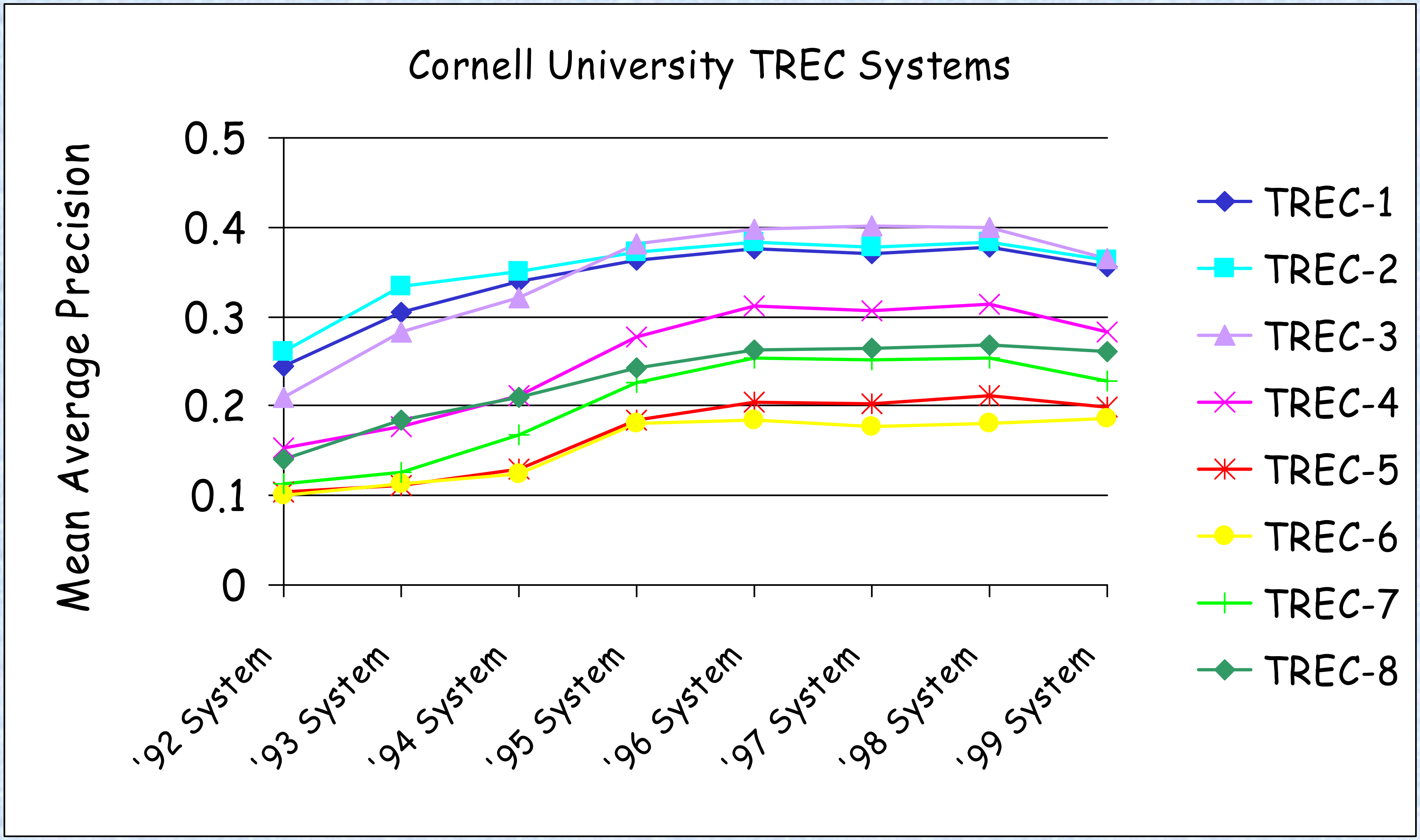
Participant Growth in TREC



TREC Impacts

- Test collections
- Incubator for new research areas
- Common evaluation methodology and improved measures for text retrieval
- Open forum for exchange of research
- Technology transfer

TREC Impacts



Ad Hoc Technologies

	TREC-2	TREC-3	TREC-4	TREC-5	TREC-6	TREC-7
Term weights	baseline start of Okapi wts	Okapi perfects "BM25" algorithm	new wts for SMART, INQUERY, PIRCS	Okapi/ SMART wts used by others	adaptations of Okapi/SMART algorithm in most systems	new Twente and BBN models
Passages	use of subdocs by PIRCS	heavy use of passages/ subdocs	decline in use of passages		use of passages in relevance feedback	multiple uses of passages
Auto query expansion		start of expansion using top X documents	heavy use of expansion using top X documents	start of more complex expansion	more sophisticated expansion experiments by many groups	
Manual query mods		manual expansion using other sources	experiments in manual editing/user-in-the-loop	extensive user-in-the-loop experiments	simpler user-specific strategies tested	
Other new areas		initial use of data fusion		start of concentration on initial topic	more complex use of data fusion continued focus on initial topic, especially the title	

TREC Impacts

- Test collections
  - 28/57 SIGIR 2004 papers used TREC data
- Common evaluation methodology and improved measures for text retrieval
  - documents best practices in IR research methodology for new researchers
- Incubator for new research areas
  - PhD theses resulting from CLIR, SDR, QA participation

TREC Impacts

- Open forum for exchange of research
  - TREC proceedings unreviewed but have CiteSeer impact rating in top 30% of all CS venues (greater than CACM or ACM DL, for example)
  - TREC papers figure prominently in IR syllabi on the web
  - publication of all results prevents unsuccessful research from being duplicated
- Technology transfer
  - impact is far greater than just those who actually participate

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  - TREC impacts
- Cranfield tradition of laboratory tests
  - mechanics of building test collections
  - test collection quality
  - legitimate uses of test collections
- IR evaluation primer

Cranfield Tradition

- Laboratory testing of system components
  - fine control over variables
  - abstraction from operational setting
  - <u>comparative</u> testing
- Test collections
  - set of documents
  - set of questions
  - relevance judgments

TREC approach

Assessors create topics at NIST

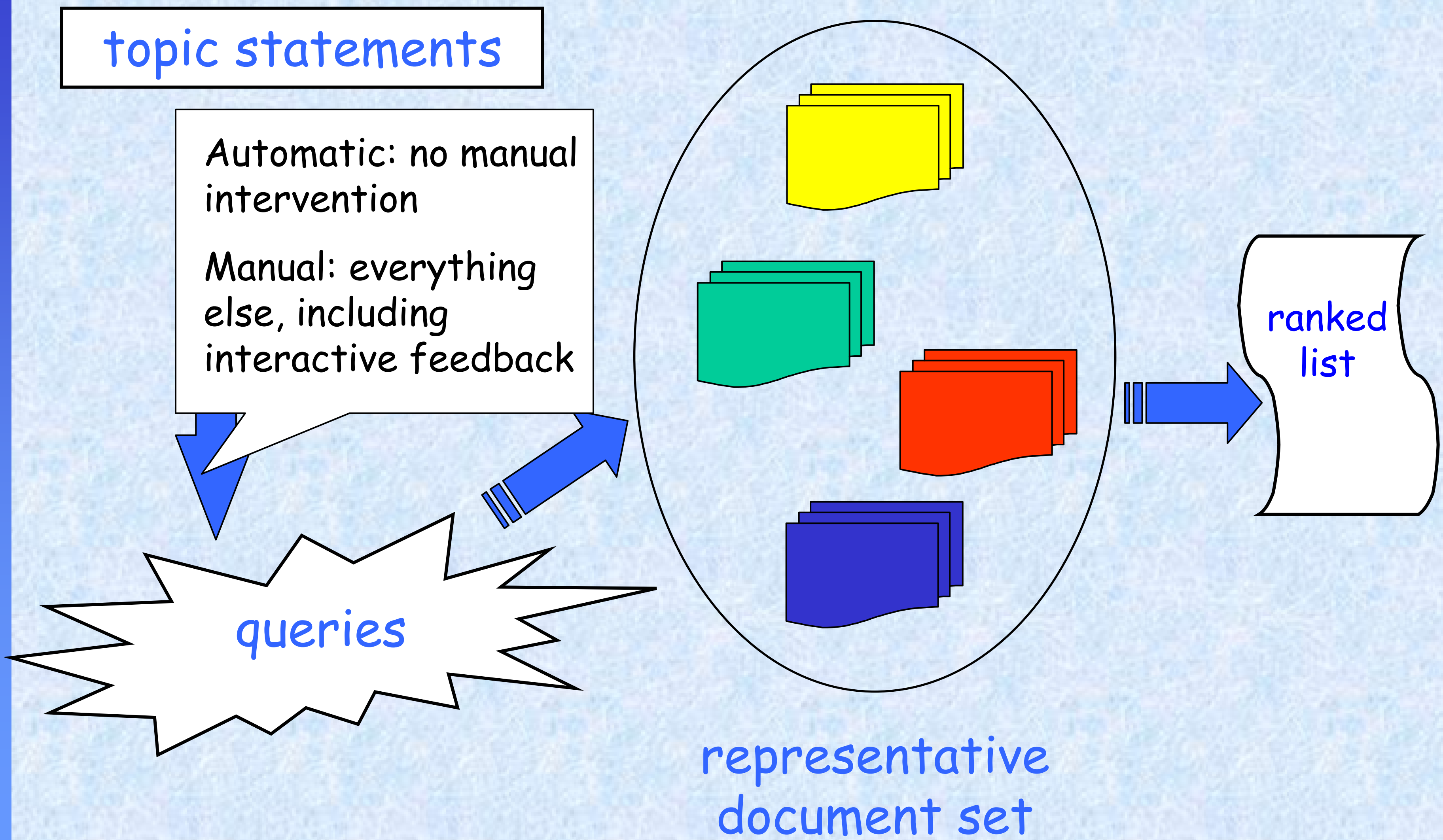
Topics are sent to participants, who return ranking of best 1000 documents per topic

NIST forms pools of unique documents from all submissions which the assessors judge for relevance

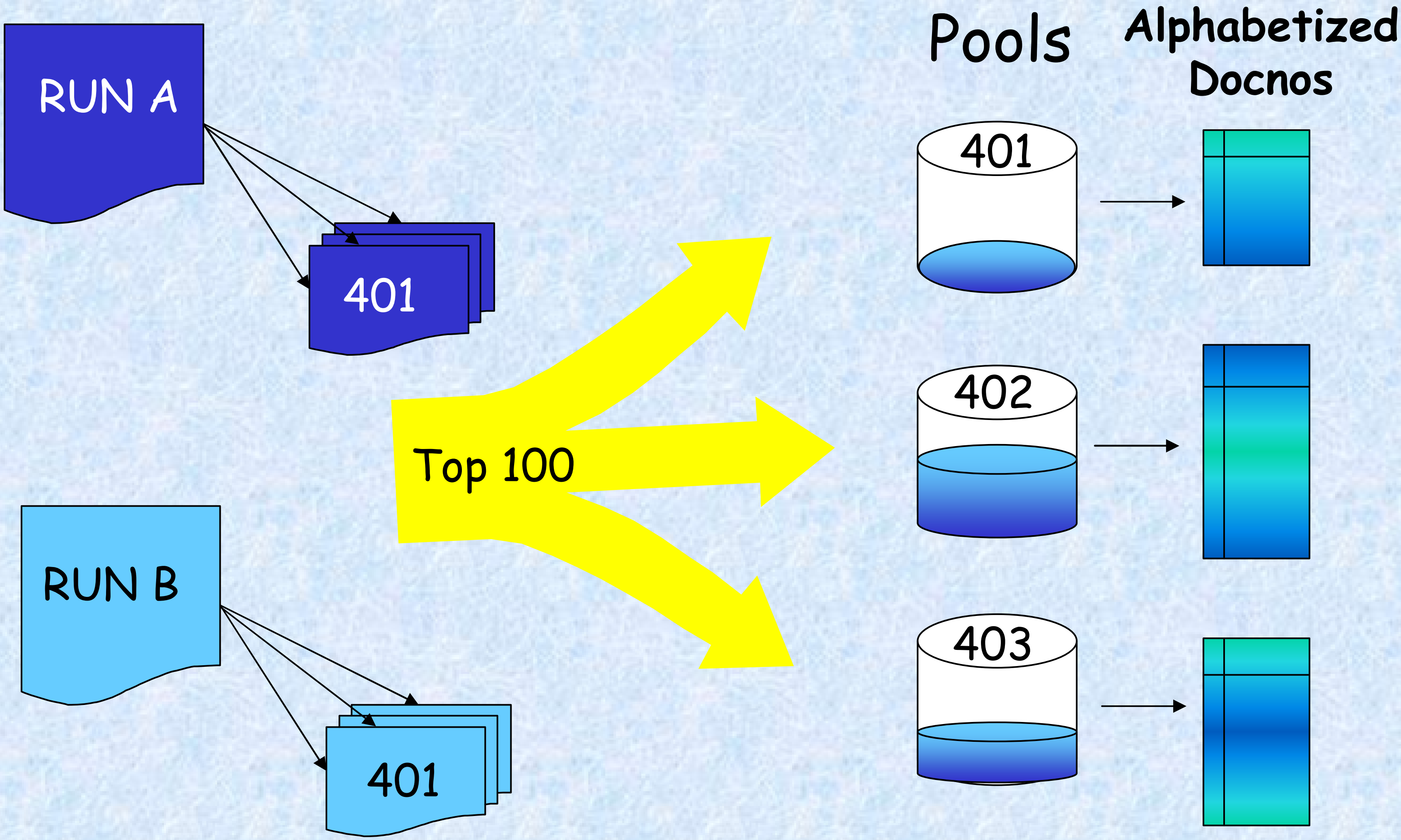
Systems are evaluated using relevance judgments

Text REtrieval Conference (TREC)

Creating a test collection for an ad hoc task



Creating Relevance Judgments



Documents

- Must be representative of real task of interest
  - genre
  - diversity (subjects, style, vocabulary)
  - amount
  - full text vs. abstract
- TREC
  - generally newswire/newspaper
  - general interest topics
  - fulltext

Topics

- Distinguish between stmt of user need (topic) & system data structure (query)
  - topic gives criteria for relevance
  - allows for different query construction techniques
- TREC topics are NOT all created equal
  - 1-150: very detailed, rich content
  - 151-200: method of topic creation resulted in focused, easy topics
  - 201-250: single sentence only
  - 301-450: title is set of hand-picked keywords

Relevance Judgments

- Main source of criticism of Cranfield tradition
  - In test collections, judgments are usually binary, static, and assumed to be complete.
  - But...
    - "relevance" is highly idiosyncratic
    - relevance does not entail utility
    - documents have different degrees of relevance
    - relevance can change over time for the same user
    - for realistic collections, judgments cannot be complete

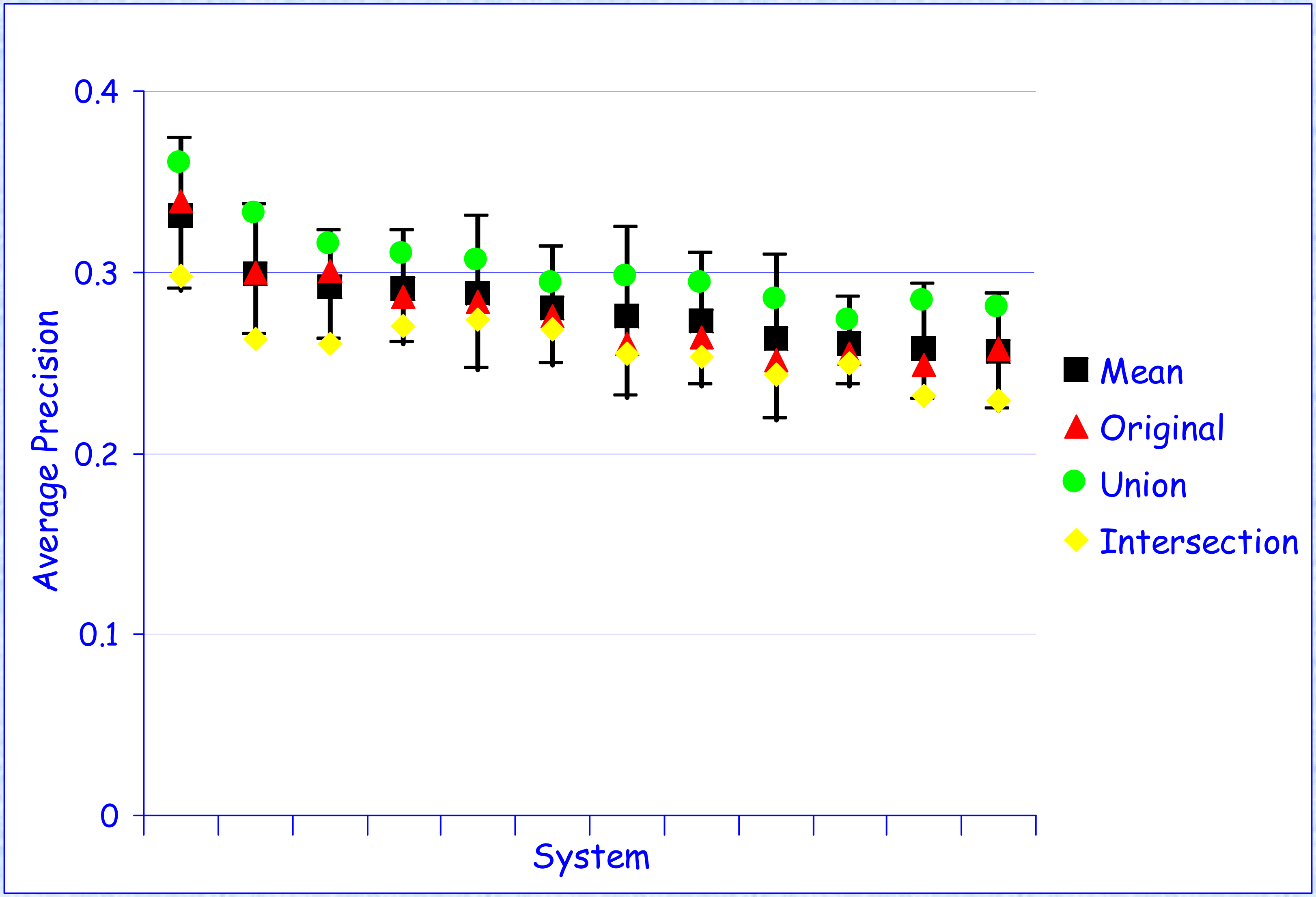
Relevance Judgments

- Consistency
  - idiosyncratic nature of relevance judgments does not affect comparative results
- Incompleteness
  - the important issue is that relevant judgments be unbiased
    - complete judgments must be unbiased
  - TREC pooling has been adequate to produce unbiased judgments

Consistency

- Mean Kendall τ between system rankings produced from different qrel sets: .938
- Similar results held for
  - different query sets
  - different evaluation measures
  - different assessor types
  - single opinion vs. group opinion judgments

Average Precision by Qrel



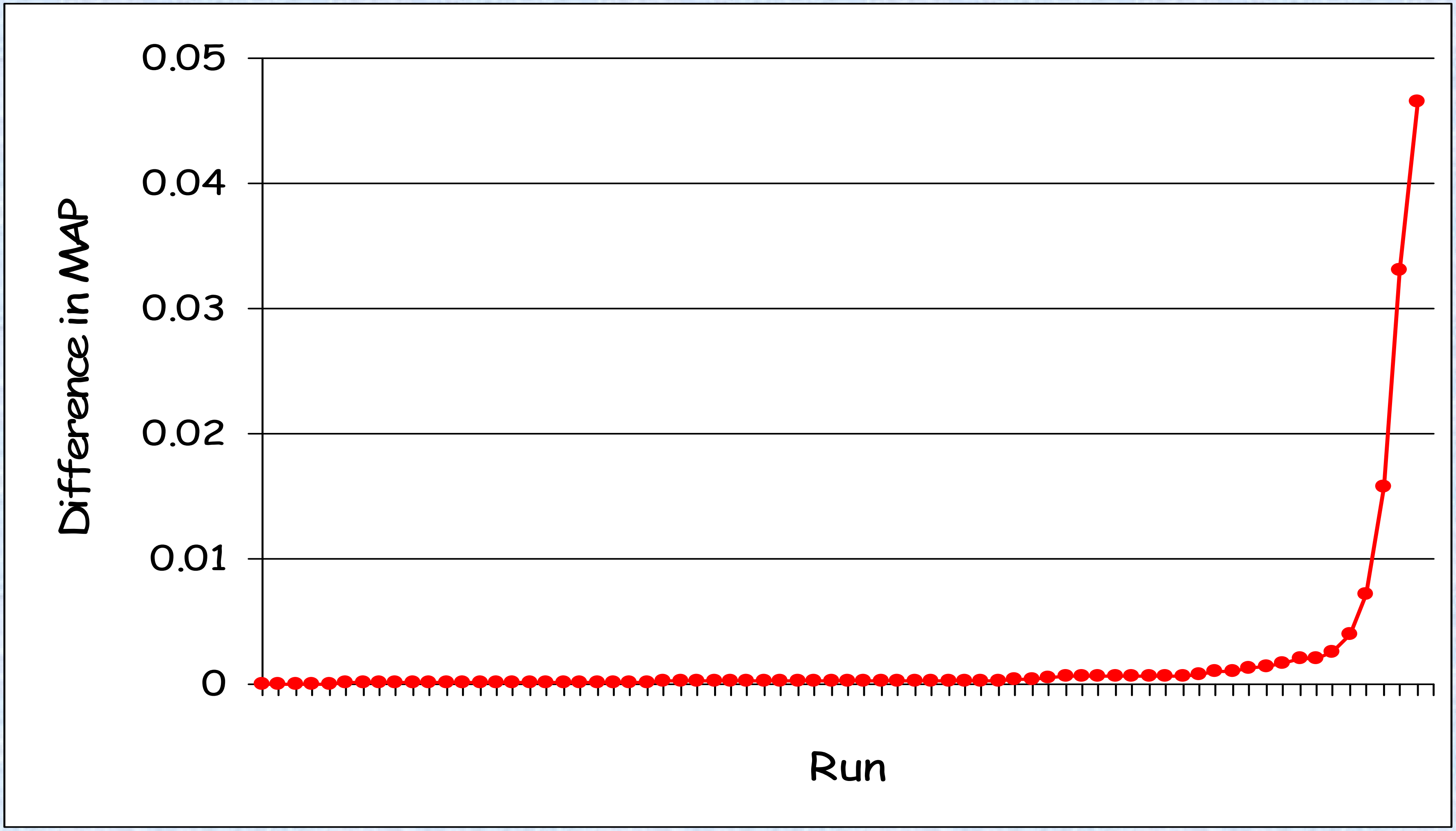
QA Judgments

- Judging correctness, not relevance
- Assessors have differences of opinions as to what constitutes a correct answer
  - granularity of names, dates
  - assumed context
- Comparative evaluation stable despite those differences

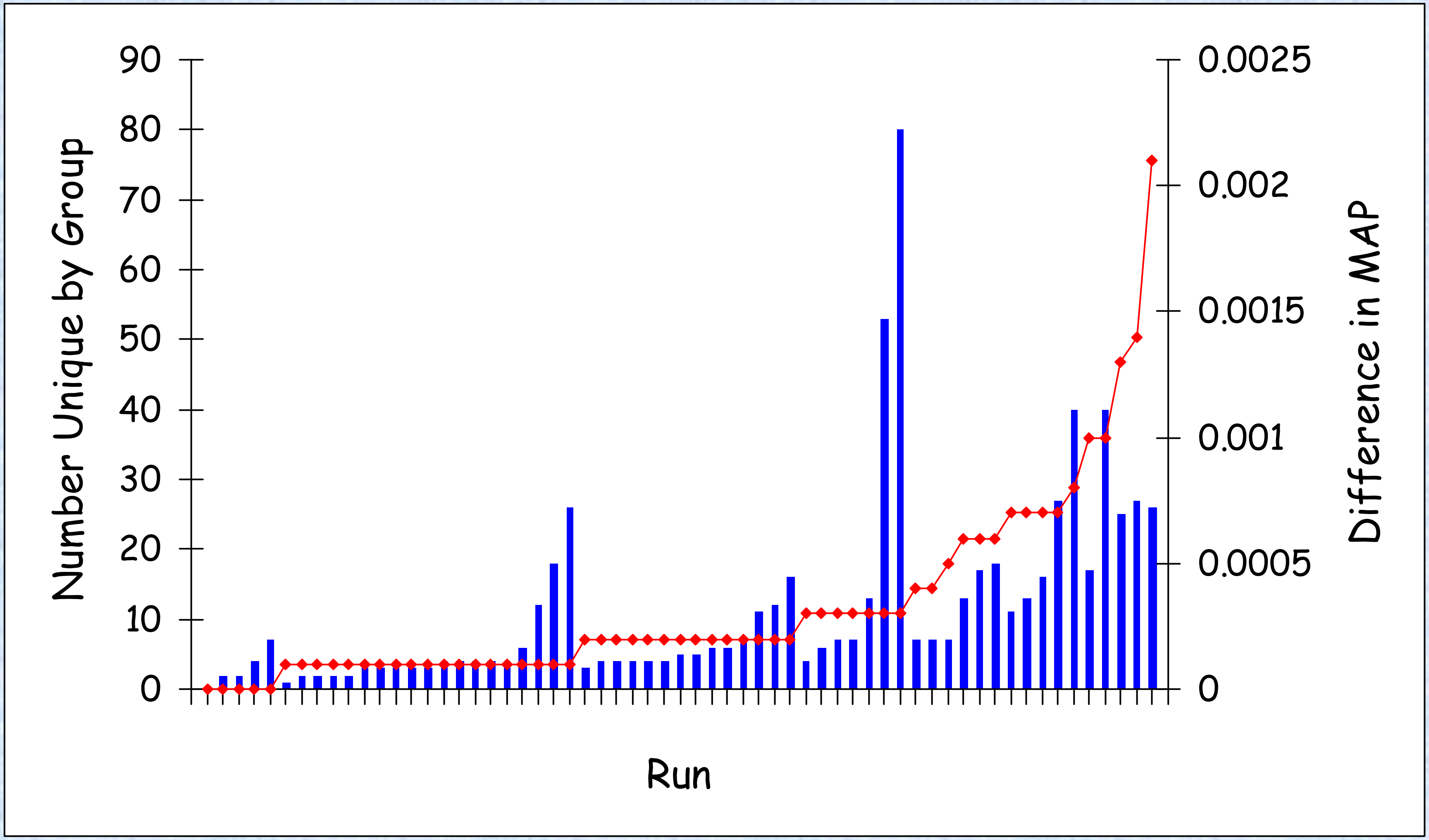
Incompleteness

- Study by Zobel [SIGIR-98]:
  - Quality of relevance judgments does depend on pool depth and diversity
  - TREC ad hoc collections not biased against systems that do not contribute to the pools
  - TREC judgments not complete
    - additional relevant documents distributed roughly uniformly across systems but highly skewed across topics

Uniques Effect on Evaluation



Uniques Effect on Evaluation: Automatic Only



Cranfield Tradition

- Test collections are abstractions, but laboratory tests are useful nonetheless
  - evaluation technology is predictive (i.e., results transfer to operational settings)
  - different relevance judgments almost always produce the same comparative results
  - adequate pools allow unbiased evaluation of unjudged runs

Cranfield Tradition

- Note the emphasis on ***comparative*** !!
  - absolute value of effectiveness measures not meaningful
    - absolute value changes as relevance judgments change
    - theoretical maximum of 1.0 for both recall and precision not obtainable by humans (inter-assessor judgments suggest 65% precision at 65% recall)
  - evaluation results are only comparable when they are from the same collection
    - a subset of a collection is a different collection
    - comparisons between different TREC collections are invalid

Sensitivity Analysis

- With archive of TREC results, have empirically determine relationship between number of topics, Δ of scores, & error rate [Voorhees & Buckley, 2002]
  - error rates generally larger than accounted for in literature
  - confidence increases with topic set size
  - confidence also increases with larger Δ, but then power of comparison reduced
  - confidence can be increased by repeating experiment on multiple collections

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➠ IR evaluation primer

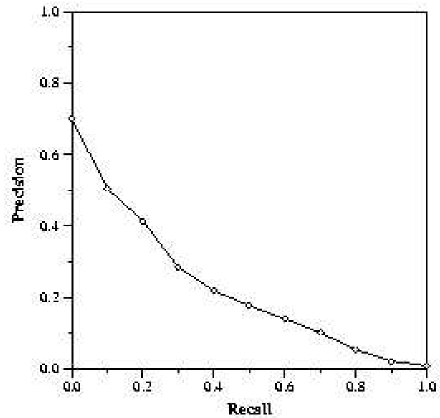
trec_eval Evaluation Report

Ad hoc results — Cornell University

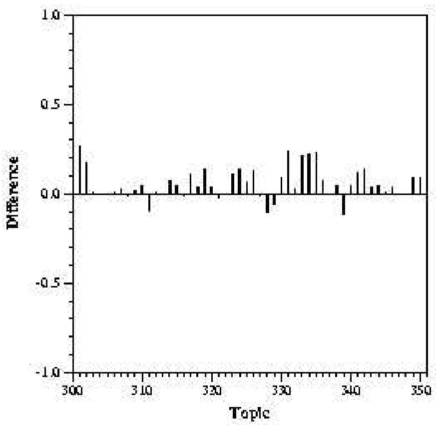
Summary Statistics	
Run Number	Cor6A3cll
Run Description	Category A, Automatic, long
Number of Topics	50
Total number of documents over all topics	
Retrieved:	50000
Relevant:	4611
Rel-ret:	2590

Recall Level Precision Averages	
Recall	Precision
0.00	0.7013
0.10	0.5050
0.20	0.4150
0.30	0.2846
0.40	0.2187
0.50	0.1775
0.60	0.1402
0.70	0.1015
0.80	0.0538
0.90	0.0224
1.00	0.0091
Average precision over all relevant docs	
non-interpolated	0.2139

Document Level Averages	
	Precision
At 5 docs	0.4480
At 10 docs	0.4260
At 15 docs	0.4013
At 20 docs	0.3630
At 30 docs	0.3200
At 100 docs	0.2010
At 200 docs	0.1418
At 500 docs	0.0823
At 1000 docs	0.0518
R-Precision (precision after R docs retrieved (where R is the number of relevant documents))	
Exact	0.2415



Recall-Precision Curve

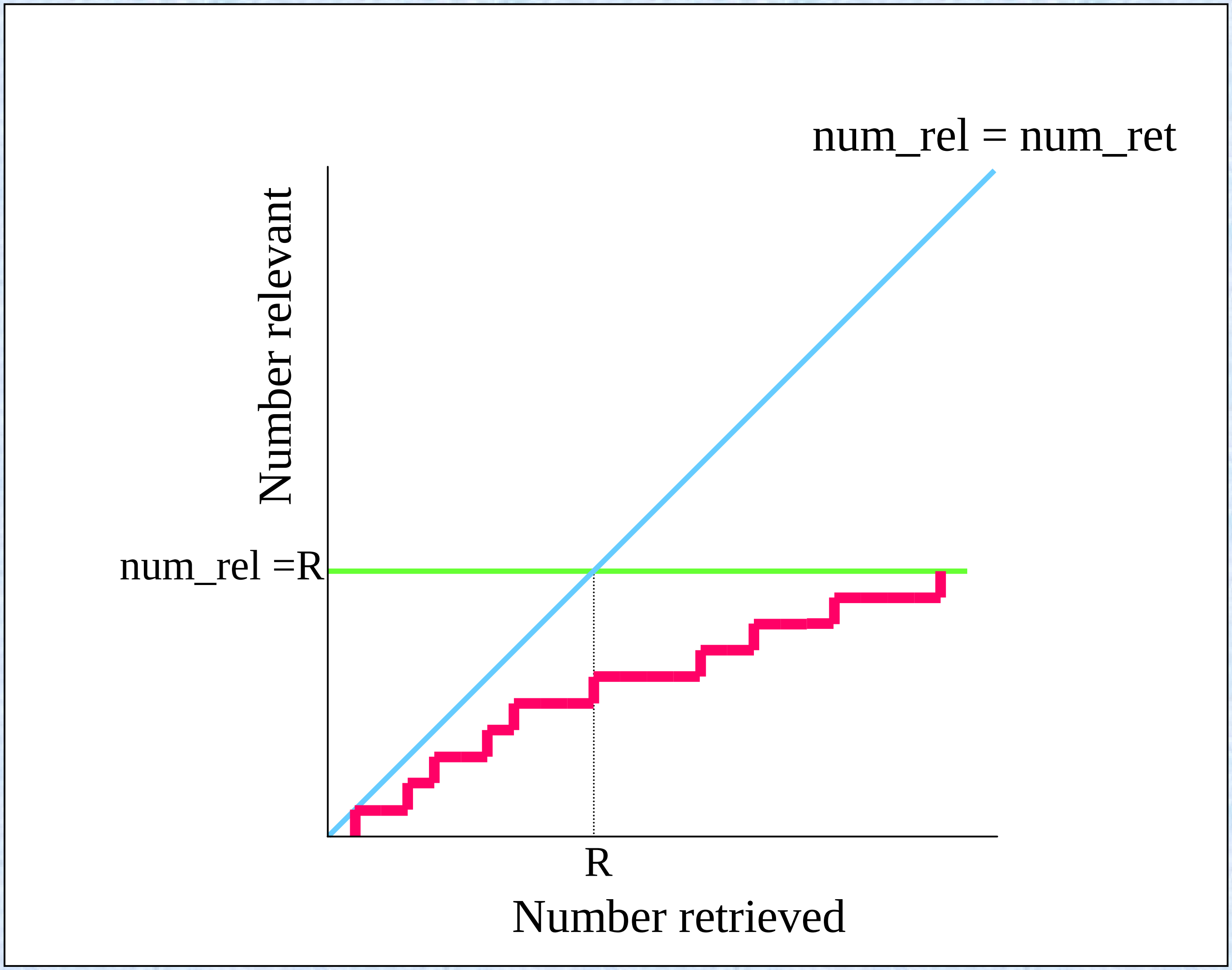


Difference from Median in Average Precision per Topic

Evaluation Measure Criteria

- Related to a user satisfaction
- Interpretable
- Able to average or collect
- Have high discrimination power
- Able to be analyzed

Ranked Retrieval Chart



Evaluation Contingency Table

	Relevant	Non-Relevant
Retrieved	r	n-r
Non-Retrieved	R-r	N-n-R+r

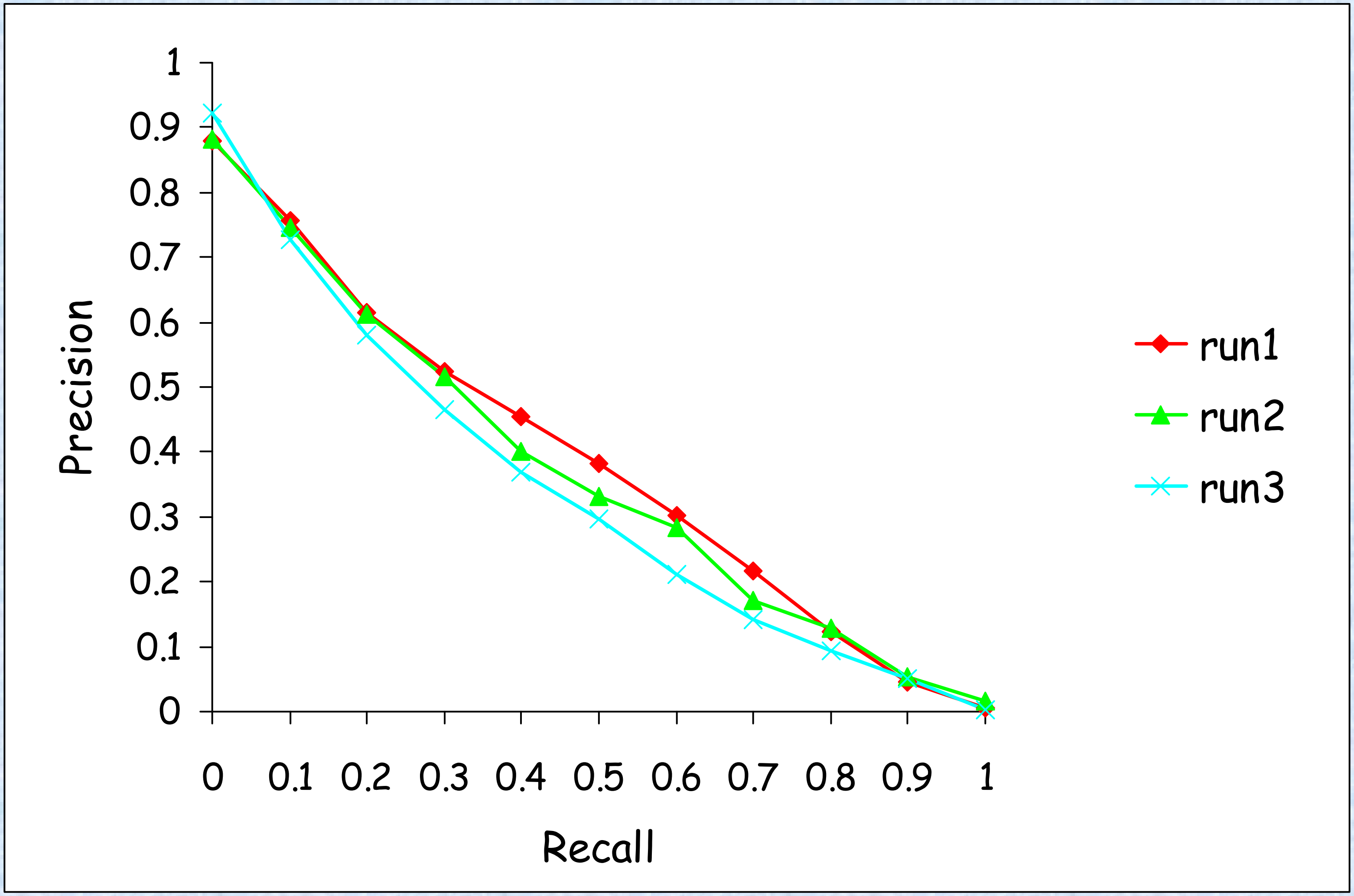
N = number docs in collection

n = number docs retrieved

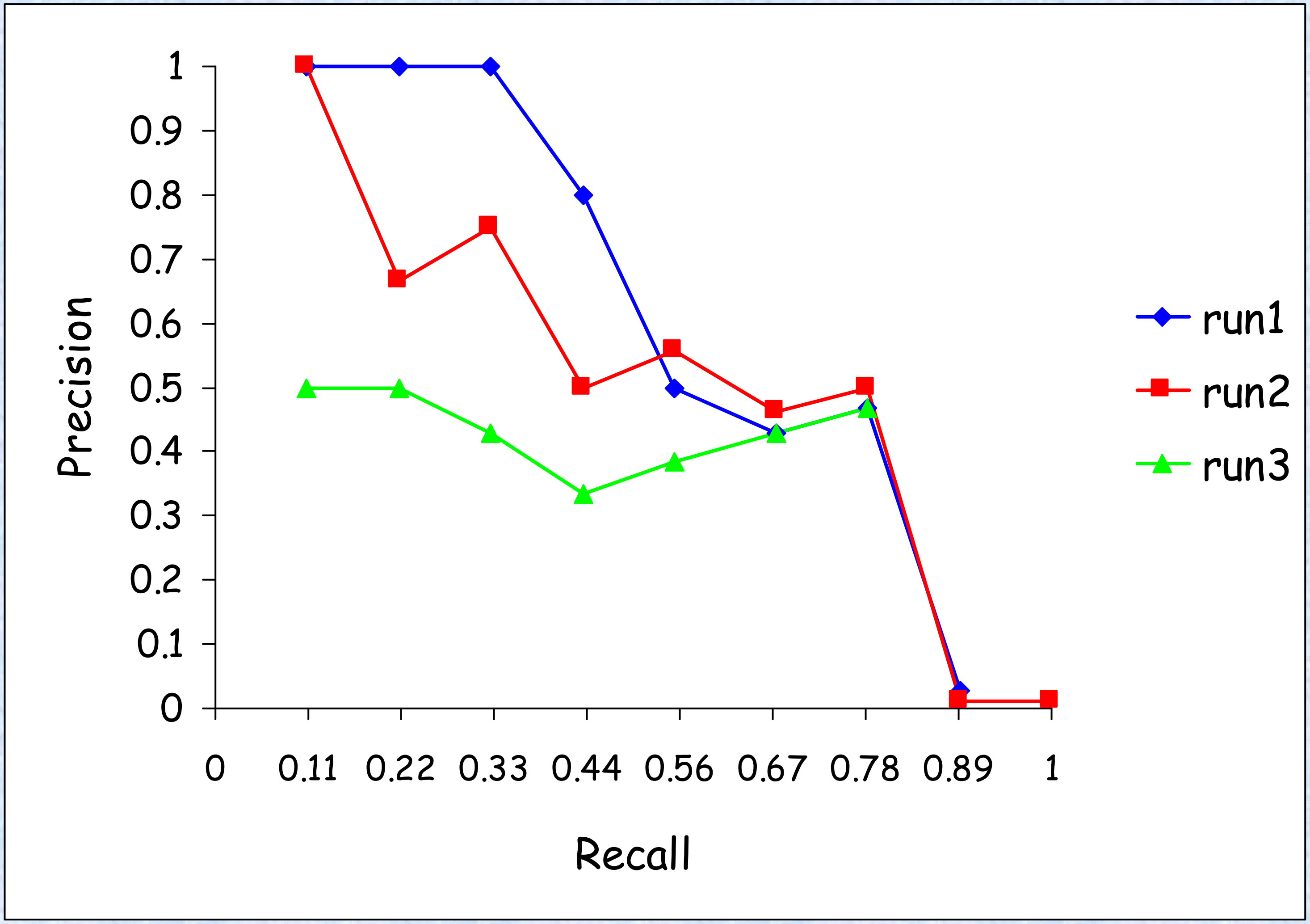
R = number relevant docs

r = number relevant retrieved

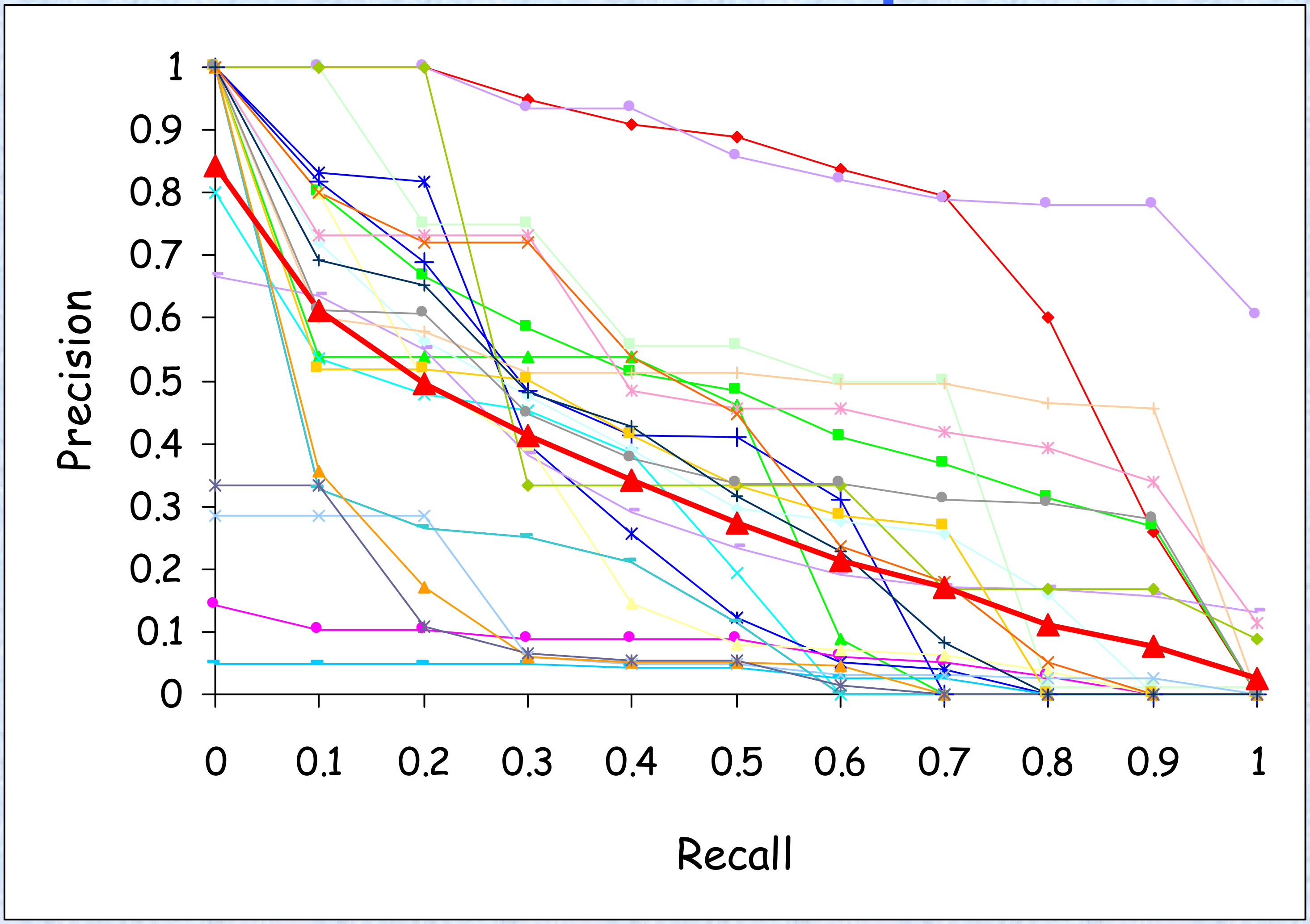
Recall-Precision Graph



Uninterpolated R-P Curve for Single topic



Interpolated R-P Curves for Individual Topics



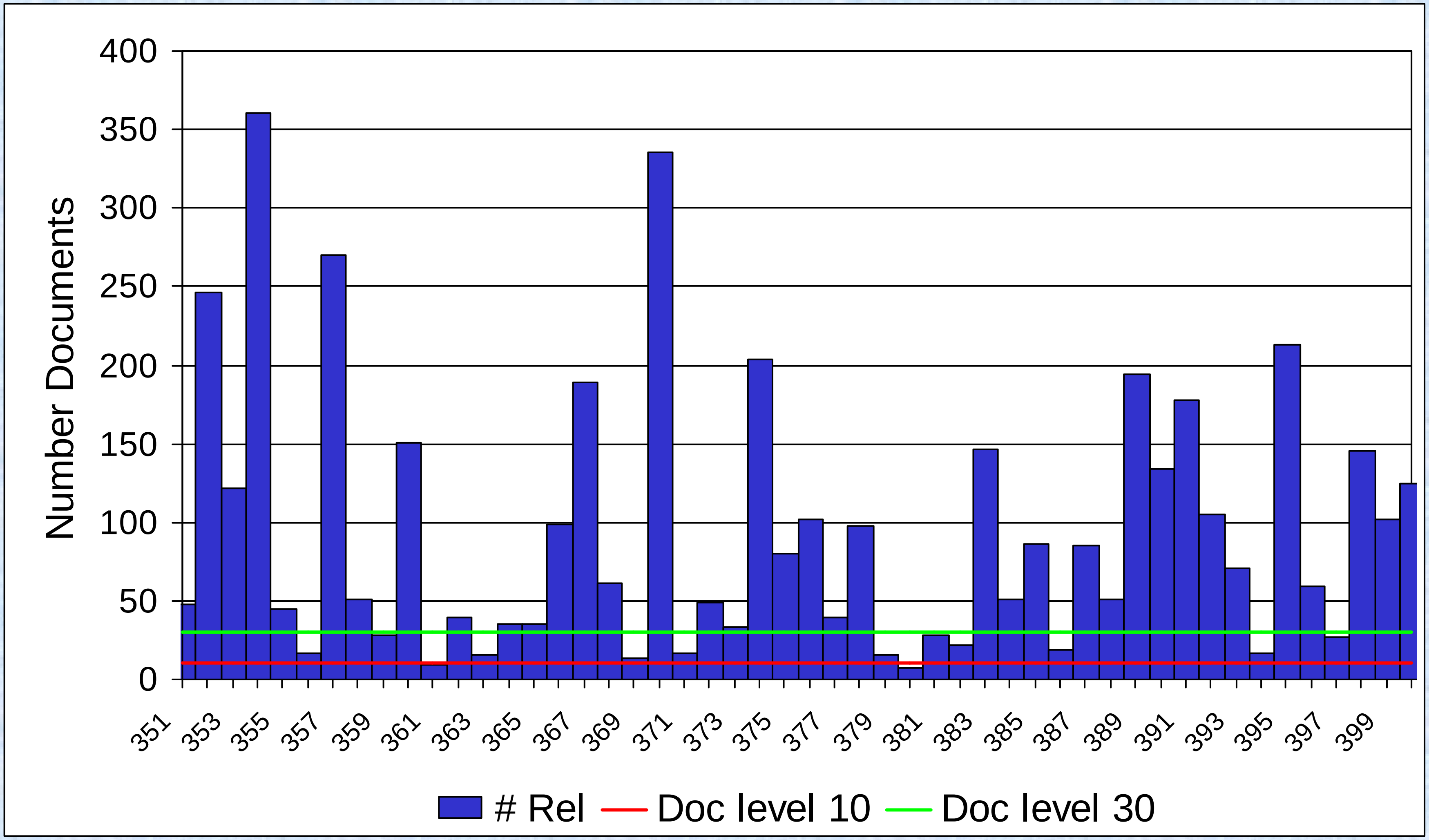
Single Number Summary Scores

- Precision (n): r / n
- Recall(n): r / R
- Average precision: Avg_{rd} (Prec(rank of rd))
- R-Precision: Prec(R)
- Recall at .5 precision
  - use Prec(10) if precision < .5 in top 10
- Rank of first relevant (expected search length)

Document Level Measures

- Advantage
  - immediately interpretable
- Disadvantages
  - don't average well
    - different number of relevant implies topics are in different parts of recall-precision curve
    - theoretical maximums impossible to reach
  - insensitive to ranking: only # rels that cross cut-off affect ranking
    - less useful for tuning a system

Number Relevant



Average Precision

- Advantages
  - sensitive to entire ranking: changing a single rank will change final score
  - stable: a small change in ranking makes a relatively small change in score
  - has both precision- and recall-oriented factors
    - ranks closest to 1 receive largest weight
    - computed over all relevant documents
- Disadvantages
  - less easily interpreted

Runs Ranked by Different Measures

P(10)	P(30)	R-Prec	Ave Prec	Recall at .5 Prec	Recall (1000)	Total Rel	Rank of 1^{st} Rel
INQ502	INQ502	ok7ax	ok7ax	att98atdc	ok7ax	ok7ax	tno7tw4
ok7ax	ok7ax	INQ502	att98atdc	ok7ax	tno7exp1	tno7exp1	bbn1
att98atdc	INQ501	ok7am	att98atde	mds98td	att98atdc	att98atdc	INQ502
att98atde	att98atdc	att98atdc	ok7am	ok7am	att98atde	bbn1	nect'chall
INQ501	nect'chall	att98atde	INQ502	INQ502	Cor7A3rrf	att98atde	tnocbm25
nect'chall	att98atde	INQ501	mds98td	att98atde	ok7am	INQ502	MerAbtnd
nect'chdes	ok7am	bbn1	bbn1	INQ501	bbn1	INQ501	att98atdc
ok7am	nect'chdes	mds98td	tno7exp1	ok7as	pirc8Aa2	ok7am	acsys7al
mds98td	INQ503	nect'chdes	INQ501	bbn1	INQ502	Cor7A3rrf	mds98td
INQ503	bbn1	nect'chall	pirc8Aa2	nect'chall	pirc8Ad	pirc8Aa2	ibms98a
Cor7A3rrf	tno7exp1	ok7as	Cor7A3rrf	tno7exp1	INQ501	nect'chdes	Cor7A3rrf
tno7tw4	mds98td	tno7exp1	acsys7al	Cor7A3rrf	nect'chdes	mds98td	ok7ax
MerAbtnd	pirc8Aa2	acsys7al	ok7as	acsys7al	nect'chall	acsys7al	att98atde
acsys7al	Cor7A3rrf	pirc8Aa2	nect'chdes	Cor7A2rrd	acsys7al	nect'chall	Brkly25
iowacuhk1	ok7as	Cor7A3rrf	nect'chall	INQ503	mds98td	pirc8Ad	nect'chdes

Ranked by measure averaged over 50 topics

Correlations Between Rankings

	P(30)	R Prec	Ave Prec	Recall at .5 P	Recall (1000)	Total Rels	Rank 1st Rel
P(10)	.8851	.8151	.7899	.7855	.7817	.7718	.6378
P(30)		.8676	.8446	.8238	.7959	.7915	.6213
R Prec			$\boxed{.9245}$	.8654	.8342	.8320	.5896
Ave Prec				.8840	.8473	.8495	.5612
R at .5 P					.7707	.7762	.5349
Recall(1000)						$\boxed{.9212}$	.5891
Total Rels							.5880

Kendall's τ computed between pairs of rankings

Known Item Search Evaluation

- Known item search: find document known to exist in collection
  - named page finding in web track
- Rewarded for retrieving particular target only, not related documents

Known Item Search Evaluation

- Mean reciprocal rank
  - use of reciprocal bounds measure & emphasizes differences that matter
  - equivalent to average precision with 1 rel
  - sensitivity of measure depends on size of ranked list
- Other statistics reported:
  - number of times target in first rank
  - number of times target not retrieved at all

Set-based Evaluation

- Required for some tasks
  - traditional Boolean searches
  - filtering
  - novelty
- 2 main approaches
  - utility functions
  - combinations of recall & precision
    - $F(\beta) = [(\beta^2+1) \times P \times R]/(\beta^2 P+R)$

Summary

- TREC emphasizes individual experiments evaluated on a benchmark task
  - leverages modest government investment into substantially more R&D than could be funded directly
  - improves state-of-the-art
  - accelerates technology transfer