

# Chapter IR:VIII

## VIII. Evaluation

- ❑ Laboratory Experiments
- ❑ Performance Measures
- ❑ Training and Testing
- ❑ Logging

# Laboratory Experiments

## Retrieval Tasks

Ad hoc retrieval:

- ❑ One question, one result set.
- ➔ Amenable to laboratory environments
- ➔ Canonical measurement of retrieval performance
- ➔ Reproducibility and scalability

Interactive retrieval / task-based retrieval:

- ❑ The user has a goal or a task that requires many queries and exploration, refining the information need along the way.
- ❑ Depends not only on result quality, but also on human factors, context, user interface and experience, and the search engine's supporting facilities.
- ➔ Performance is difficult to be measured

## Remarks:

- ❑ “ad hoc” (Latin: “for this”) means “for the particular end or case at hand without consideration of wider application” [\[Merriam Webster\]](#)

# Laboratory Experiments

## Experimental Setup

A laboratory experiment for ad hoc retrieval requires three items:

1. A document collection (corpus)

A “representative” sample of documents from the domain of interest. The sampling method of how documents are drawn from the population determines a corpus’s validity. Statistical representativeness may be difficult to achieve (e.g., in case of the web). In that case, the larger a corpus can be built for a given domain, the better.

2. A set of information needs (topics)

Formalized, written descriptions of users’ tasks, goals, or gaps of knowledge. Alternatively, descriptions of desired search results. Often accompanied by specific queries the users (would) have used to search for relevant documents.

3. A set of relevance judgments (ground truth)

Pairs of topics and documents, where each document has been manually assessed with respect to its relevance to its associated topic. Ideally, the judgments are obtained from the same users who supplied the topics, but in practice judgments are collected from third parties. Judgments may be given in binary form, or on a Likert scale.

Every search engine has parameters. Parameter optimization must use an experimental setup (training, validation) different from that used for evaluation (test).

## Remarks:

- ❑ This setup is sometimes referred to as an experiment under the Cranfield paradigm, in reference to Cleverdon's series of projects at the Cranfield University in the 1960s, which first used this evaluation methodology. [\[codalism.com 1\]](#) [\[codalism.com 2\]](#)
- ❑ In linguistics, a corpus (plural corpora) or text corpus is a large and structured set of texts. They are used to do statistical analysis and hypothesis testing, checking occurrences or validating linguistic rules within a specific language territory. [\[Wikipedia\]](#)

The term has been adopted in various other branches of the human language technologies.

- ❑ The evaluation corpus split between training, validation, and test set should be used in conjunction with  $k$ -fold cross-validation, since the variance of performance results is often high. [\[Fuhr 2017\]](#)

# Laboratory Experiments

## Experimental Setup: Document Collections / Corpora

For ad hoc retrieval, the [Text Retrieval Conference \(TREC\)](#) has organized evaluation tracks since 1992, inviting scientists to compete.

Key document collections used:

Collection	Documents	Size	Words/Doc.	Topics	Words/Query	Jdgmts/Query
CACM	3,204	2.2 MB	64	64	13.0	16
AP	242,918	0.7 GB	474	100	4.3	220
GOV2	25 million	426.0 GB	1073	150	3.1	180
ClueWeb09	1 billion	25.0 TB	304	200	2.5	821
ClueWeb12	733 million	27.3 TB	n/a	200	3.6	793

- ❑ CACM: Communications of the ACM 1958-1979 (only titles and abstracts)
- ❑ AP: Associated Press newswire documents 1988–1990
- ❑ GOV2: Crawl of .gov domains early 2004
- ❑ ClueWeb: Web crawls from 2009 and 2012

Reusing experimental setups renders previous approaches comparable.

## Remarks:

- ❑ TREC is organized by the United States National Institute of Standards and Technology (NIST). It has been key to popularize laboratory evaluation of search engines, organizing evaluation tracks on many different retrieval-related tasks every year: [trec.nist.gov](https://trec.nist.gov).
- ❑ Ad hoc retrieval has been studied in the [ad hoc tracks](#), the [terabyte tracks](#) and the [web tracks](#).
- ❑ Several similar initiatives have formed, namely [CLEF](#), [NTCIR](#), and [FIRE](#).

# Laboratory Experiments

## Experimental Setup: Topics

**<topic** number="794" type="single">

**<query>** pet therapy **</query>**

**<description>**

How are pets or animals used in therapy for humans and what are the benefits?

**</description>**

**<narrative>**

Relevant documents must include details of how pet or animal-assisted therapy is or has been used. Relevant details include information about pet therapy programs, descriptions of the circumstances in which pet therapy is used, the benefits of this type of therapy, the degree of success of this therapy, and any laws or regulations governing it.

**</narrative>**

**</topic>**



## Remarks:

- ❑ The description element is a longer version of the query, clarifying it, since the short query itself may be ambiguous.
- ❑ The narrative field is optional and usually describes the criteria for relevance and is used by assessors to carry out relevance judgments.
- ❑ Another topic type are faceted topics:

```
<topic number="265" type="faceted">
  <query>F5 tornado</query>
  <description>What were the ten worst tornadoes in the USA?</description>
  <subtopic number="1" type="inf">What were the ten worst tornadoes in the USA?</subtopic>
  <subtopic number="2" type="inf">Where is tornado alley?</subtopic>
  <subtopic number="3" type="inf">What damage can an F5 tornado do?</subtopic>
  <subtopic number="4" type="inf">Find information on tornado shelters.</subtopic>
  <subtopic number="5" type="nav">What wind speed defines an F5 tornado?</subtopic>
</topic>
```

- ❑ At TREC, every year usually 50 topics are provided. The ones from previous years can be used for training.

# Laboratory Experiments

## Experimental Setup: Relevance Judgments

**<topic** number="794" type="single">

**<query>** pet therapy **</query>**

**<description>**

How are pets or animals used in therapy for humans and what are the benefits?

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Relevant documents must include details of how pet or animal-assisted therapy is or has been used. Relevant details include information about pet therapy programs, descriptions of the circumstances in which pet therapy is used, the benefits of this type of therapy, the degree of success of this therapy, and any laws or regulations governing it.

**</narrative>**

**</topic>**

# Laboratory Experiments

## Experimental Setup: Relevance Judgments

<topic number="794" type="single">

<query> pet therapy </query>

<description>

How are pets or animals used in the  
are the benefits?

</description>

<narrative>

Relevant documents must include details of  
**animal**-assisted **therapy** is or has  
details include information about  
descriptions of the circumstances  
used, the benefits of this type of  
success of this therapy, and any laws  
governing it.

</narrative>

</topic>

Secure | [https://en.wikipedia.org/wiki/Canine\\_physical\\_therapy](https://en.wikipedia.org/wiki/Canine_physical_therapy)

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## Canine physical therapy

From Wikipedia, the free encyclopedia

**Physical therapy** for canines, or **canine rehabilitation**, adapts human physical therapy techniques to increase function and mobility of joints and muscles in animals. Animal rehabilitation can reduce pain and enhance recovery from injury, surgery, degenerative diseases, age-related diseases, and obesity.<sup>[1]</sup>

The goal of physical therapy for animals is to improve quality of life and decrease pain. Although most veterinary practices offering physical therapy are geared toward canines, techniques used in this discipline can also be applied to horses, cats, birds, rabbits, rodents and other small animals.<sup>[2]</sup>



**Canine physical therapy**

Hydrotherapy is one of the many physical therapy techniques used at animal physical therapy practices. Above, a veterinary technician assists a dog to swim.

**Classification and external resources**

[\[edit on Wikidata\]](#)

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### History [edit]

The benefits of physical therapy for animals have been widely accepted in the veterinary community for many years. However, clinical practice of physical therapy for animals is a relatively new field in the U.S. In Europe, [equine](#) and canine physical therapy have been widely recommended and used for at least the last fifteen years. In the last three to five years, the veterinary community in the U.S. has seen a large growth in physical therapy practices for animals, making it a more available resource for practicing veterinarians.

irrelevant

# Laboratory Experiments

## Experimental Setup: Relevance Judgments

<topic number="794" type="single">

<query> pet therapy </query>

<description>

How are pets or animals used in therapy and what are the benefits?

</description>

<narrative>

Relevant documents must include details about **animal-assisted therapy** is or has details include information about descriptions of the circumstances used, the benefits of this type of success of this therapy, and any laws governing it.

</narrative>

</topic>

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Animal-assisted therapy

From Wikipedia, the free encyclopedia

Animal-assisted therapy (AAT)

Animal-assisted therapy (AAT) is a type of therapy that involves animals as a form of treatment. The goal of AAT is to improve a patient's social, emotional, or cognitive functioning. Advocates state that animals can be useful for educational and motivational effectiveness for participants.<sup>[1]</sup> A therapist who brings along a pet may be viewed as being less threatening, increasing the rapport between patient and therapist.<sup>[2]</sup> Animals used in therapy include domesticated pets, farm animals and marine mammals (such as dolphins). The research literature states concerns about the poor quality of medical evidence underpinning AAT.<sup>[3]</sup>

Wilson's (1984) *biophilia hypothesis* is based on the premise that our attachment to and interest in animals stems from the strong possibility that human survival was partly dependent on signals from animals in the environment indicating safety or threat. The biophilia hypothesis suggests that now, if we see animals at rest or in a peaceful state, this may signal to us safety, security and feelings of well-being which in turn may trigger a state where personal change and healing are possible.<sup>[4]</sup> A contrast is sometimes made with *Animal assisted activity* (AAA).<sup>[5]</sup> AAA is more casual and unstructured than AAT, involving perhaps more than one patient and with the primary focus on the presence of the animal itself. By contrast, AAT includes a handler which together with the animal has been trained for the role. AAT is more structured with specific objectives for each session. However, in common usage terms like these for animal assisted interventions are often used rather loosely.<sup>[5]</sup>

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Dogs are common in animal-assisted therapy.

relevant

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# Laboratory Experiments

## Experimental Setup: Relevance Judgments

A relevance judgment requires the **manual** assessment whether a document returned by a search engine for a given query is relevant under a given topic.

- ❑ **Assessment depth**

Assessing every document's relevance for every topic quickly becomes infeasible with growing collection size, numbers of topics, and (variants of) search engines to be evaluated. Partial assessments are made based on a sampling strategy called pooling.

- ❑ **Assessment scale**

Typically, binary assessments are made, judging documents as relevant or irrelevant. Less often, degrees of relevance are distinguished (e.g., relevant and highly relevant).

- ❑ **Assessor selection and instruction**

Ideally, the persons who supplied topics also assess relevance, presuming they genuinely perceived the underlying information need. In practice, this usually cannot be achieved. Hence, a topic's description must be sufficiently exhaustive to serve as instruction.

- ❑ **Assessor reliability**

Humans are unreliable judges, their judgments depend on many outside influences. One cannot expect objective results from just one assessment per document for a given topic. Multi-assessments yield more reliable judgments; assessor reliability can be measured.

## Remarks:

- ❑ At TREC, assessors are recruited from retired NIST staff:



# Laboratory Experiments

## Experimental Setup: Pooling

Pooling is a sampling strategy for documents retrieved by to-be-evaluated search engines for a given set of topics.

For each topic:

1. Collect the top  $k$  results returned by each search engine (variant).
2. Merge the results, omitting duplicates, obtaining a “pool” of documents.
3. Present the pool of documents in random order to assessors.

Caveats:

- ❑ Presuming a certain correlation between search engines’ results on a topic, only documents considered relevant by search engines are analyzed.
- ❑ New retrieval algorithms that are evaluated later may retrieve unjudged documents, requiring new judgments, probably from different assessors.
- ❑ All documents ranked below the pooling depth are deemed irrelevant by default, regardless the truth.

# Laboratory Experiments

## Assessor Reliability

The degree of agreement between assessors and the degree of consistency of the same assessor are quantified using assessor reliability measures. Lack of agreement or consistency indicate flawed setups or insufficient training.

Assessor reliability is measured whenever ambiguous or subjective decisions have to be made. Relevance is a subjective notion.

Several alternative approaches have been proposed:

- ❑ **Joint probability of agreement**

Percentage of times the raters agree. Here, agreement by chance is not taken into account.

- ❑ **Kappa Statistics**

Improvement over joint probability, taking into account agreement by chance.

- ❑ **Correlation coefficient**

Pairwise correlation among assessors on ordered scales. Full rankings are required.



# Laboratory Experiments

## Assessor Reliability: Kappa Statistics

Given the judgments of two annotators on a given topic, a kappa statistic measures their agreement as follows:

$$\kappa = \frac{p_o - p_e}{1 - p_e},$$

where  $p_o$  denotes the proportion of agreement observed, and  $p_e$  the expected proportion of agreement by chance.

Properties:

- $\kappa \in (-\infty, 1]$ , where 1 indicates perfect agreement, 0 random agreement, and  $\kappa < 0$  has no meaningful interpretation [\[Kvålseth 2015\]](#)
- At  $p_e = 1$ ,  $\kappa$  is undefined.
- $1 - p_e$  denotes the agreement **attainable** above chance
- $p_o - p_e$  denotes the agreement **attained** above chance

# Laboratory Experiments

## Assessor Reliability: Kappa Statistics

Given the judgments of two annotators on a given topic, a kappa statistic measures their agreement as follows:

$$\kappa = \frac{p_o - p_e}{1 - p_e},$$

where  $p_o$  denotes the proportion of agreement observed, and  $p_e$  the expected proportion of agreement by chance.

Suppose A and B are two annotators asked to make  $n$  relevance judgments. Then a simple kappa statistic can be computed as follows:

		B		$\Sigma$
		yes	no	
A	yes	$a$	$b$	$c$
	no	$d$	$e$	$f$
$\Sigma$		$g$	$h$	$n$

$$p_o = \frac{a + e}{n}$$

$$p_e = P(\text{yes})^2 + P(\text{no})^2$$

$$P(\text{yes}) = \frac{c + g}{2n}, \quad P(\text{no}) = \frac{f + h}{2n}$$

# Laboratory Experiments

## Assessor Reliability: Kappa Statistics

Given the judgments of two annotators on a given topic, a kappa statistic measures their agreement as follows:

$$\kappa = \frac{p_o - p_e}{1 - p_e},$$

where  $p_o$  denotes the proportion of agreement observed, and  $p_e$  the expected proportion of agreement by chance.

Suppose A and B are two annotators asked to make  $n = 400$  relevance judgments. Then a simple kappa statistic can be computed as follows:

		B		$\Sigma$
		yes	no	
A	yes	300	20	320
	no	10	70	80
$\Sigma$		310	90	400

$$p_o = \frac{300 + 70}{400}$$

$$p_e = P(\text{yes})^2 + P(\text{no})^2$$

$$P(\text{yes}) = \frac{320 + 310}{2 \cdot 400}, \quad P(\text{no}) = \frac{80 + 90}{2 \cdot 400}$$

$$\kappa = 0.776$$

## Remarks:

- ❑ Well-known kappa statistics include Cohen's  $\kappa$ , Scott's  $\pi$ , and Fleiss'  $\kappa$ .
- ❑ Scott's  $\pi$  is the one exemplified.
- ❑ Fleiss'  $\kappa$  is a generalization of Scott's  $\pi$  to arbitrary numbers of annotators and categories. It also does not presume that all cases have been annotated by the same group of people.
- ❑ Presuming that raters A and B work independently, the probability  $P(\text{yes})^2$  ( $P(\text{no})^2$ ) denotes the probability of both voting yes (no) by chance. Another way of computing  $p_e$  is to sum the multiplication of the rater-specific probabilities of each rater voting yes (no).
- ❑ Some assign the following interpretations to  $\kappa$  values measured (disputed):

$\kappa$	<b>Agreement</b>
$< 0$	poor
0.01 – 0.20	slight
0.21 – 0.40	fair
0.41 – 0.60	moderate
0.61 – 0.80	substantial
0.81 – 1.00	almost perfect

[\[Wikipedia\]](#)

- ❑ Within TREC evaluations, typically a “substantial” agreement ( $\kappa \approx [0.67, 0.8]$ ) is achieved.

[Manning 2008]