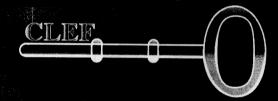
Carol Peters
Martin Braschler
Julio Gonzalo
Michael Kluck (Eds.)

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SINAI at CLEF 2002: Experiments with Merging Strategies

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Abstract. For our first participation in the CLEF multilingual task, we present a new approach to obtain a single list of relevant documents for CLIR systems based on query translation. This new approach, which we call two-step RSV, is based on the re-indexing of the retrieval documents according to the query vocabulary, and it performs noticeably better than traditional methods¹.

Introduction

isual approach in CLIR is to translate the query to each language present the corpus, and then run a monolingual query in each language. It is then accessary to obtain a single ranking of documents merging the individual lists of the separate retrieved documents. However, a problem is how to carry ut such a merge? This is known as the merging strategies problem and is not rivial problem, since the weight assigned to each document (Retrieval Status alue - RSV) is calculated not only according to the relevance of the document of the IR model used, but also with respect to the rest of the monolingual ripus to which the document belongs [1].

There are various approaches to standardise the RSV, but in all cases a large ecrease of precision is generated in the process (depending on the collection, etween 20% and 40%) [2, 3]. Perhaps for this reason, CLIR systems based on comment translation tend to obtain results which are noticeably better than those which only translate the query.

The rest of the paper is organized as follows. Firstly, we present a brief evision of the most extended methods for merging strategies. Sections 3 and 4 describe our proposed method. In Section 5, we detail the experiments carried out with the results obtained. Finally, we present our conclusions and future lines of work.

A Brief Review of the Merging Strategies

for each N language, we have N different lists of relevant documents, each obtained independently of the others. The problem is that it is necessary to obtain

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A. Peters (Ed.): CLEF 2002, LNCS 2785, pp. 187–196, 2003. Springer-Verlag Berlin Heidelberg 2003 a single list by merging all the relevant languages. If we suppose that each retrieved document of each list has the same probability to be relevant and the similarity values are therefore directly comparable, then an immediate approach would be simply to order the documents according to their RSV (this method is known as raw scoring) [4, 5]. However, this method is not adequate, since the document scores computed for each language are not comparable. For example, a document in Spanish that includes the term "información", can calculate a radically different RSV from another document in English with the same term "information". In general, this is due to the fact that the different indexing techniques take into account not only the term frequency in the document (tf), but also consider how frequent such a term is in the rest of the documents, that is the inverse document frequency (idf) [6]. Thus, the idf depends on each particular monolingual collection. A first attempt to make these values comparable is to standardise in some way the RSV of each document:

- By dividing each RSV by the maximum RSV obtained in each collection:

$$RSV_i' = \frac{RSV_i}{\max(RSV)}, 1 <= i <= N$$

 A variant of the previous method is to divide each RSV by the difference between the maximum and minimum document score values obtained in each collection [7]:

$$RSV_i' = \frac{RSV_i - \min(RSV)}{\max(RSV) - \min(RSV)}, 1 \le i \le N$$

in which RSV_i is the original retrieval status value, and $\max(RSV)$ and $\min(RSV)$ are the maximum and minimum document score values achieved by the first and last documents respectively. N is the number of documents in the collection.

However, the problem is only solved partially, since the normalization of the document score is accomplished independently of the other collections and, therefore, the differences in the RSV are still great.

Another approach is to apply a round-robin algorithm. In this case, the RSV obtained for each retrieved document is not taken into account, but rather the relative position reached by each document in their collection. A single list of documents is obtained and the document score m is in the position m in the list. Thus for example, if we have five languages and we retrieve five lists of documents, the first five documents of the single result list will coincide with the first document of each list; the next five, with the second document of each list; and so on. This approach is not completely satisfactory because the position reached by each document is calculated exclusively considering the documents of the monolingual collection to the one which belongs.

Finally, another approach, perhaps the most original, is to generate a single index with all the documents without taking into account the multilingual nature of the collection [8, 9, 10]. In this way, a single index is obtained in which the

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languages. If we suppose that each ame probability to be relevant and to imparable, then an immediate approars according to their RSV (this method, this method is not adequate, since to inguage are not comparable. For example, the term "información", can calculate the fact that the different indexing technical that the different indexing technical that the document (tf), but is in the rest of the documents, that the tiff depends on each partial to make these values comparable each document:

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$$(i)$$
, $1 <= i <= N$

to divide each RSV by the different document score values obtained in each

$$\frac{(RSV)}{\min(RSV)}, 1 <= i <= N$$

val status value, and $\max(RSV)$ and $\max(RSV)$ and m document score values achieved by N is the number of documents in the

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most original, is to generate a single g into account the multilingual nature single index is obtained in which the

s from each language are intermixed. In the same way as when all the iments in a single index are merged, we obtain a single query where the terms everal languages are also intermixed. That is, the query must be translated heach of the languages present in the multilingual collection. However, we bt generate a query for each translation, but merge all the translations ning a single query. This query will then be the one which we compare with document collection. As with the approach based on document translation, ins approach the system will always return a single list of documents for query. In spite of this, the problem is not eliminated: the ranking of each ment is dependent on the language in which it is written. Although a single ex is generated, the vocabulary of each language is practically exclusive. Two merent languages rarely share terms. For this reason, the weight obtained by term will refer to the language to which it belongs, and therefore, the mularity between documents will be correct with respect to the documents coressed in the same language. It should be mentioned that a notable exception r proper names, which are frequently invariable in different languages. In this this approach proves very effective.

A Useful Structure to Describe IR Models

to this section we present a notation that will be used to describe the proposed model. A large number of retrieval methods are based on this structure [11]:

$$< T, \Phi, D; ff, df >$$

where:

D is the document collection to be indexed.

 Φ is the vocabulary used in the indices generated from D.

T is the set of all tokens au present in the collection D, commonly the words or terms. Thus, the function

$$\varphi: T \to \Phi, \tau \to \varphi(\tau)$$

maps the set of all tokens, T, to the indexing vocabulary Φ . The function φ can be a simple process such as removing accents or another more complex process such as root extraction (stemming), lemmatization...

ff is the feature frequency and denotes the number of occurrences of φ_i in a document d_i :

$$ff(\varphi_i,d_j) := \mid \{\tau \in T \mid \varphi(\tau) = \varphi_i \wedge d(\tau) = d_j\} \mid$$

where d is the function that makes each token au correspond to its document:

$$d: T \to D, \tau \to d(\tau)$$

df is the document frequency and denotes the number of documents containing the feature φ_i at least once:

$$df(\varphi_i) := \mid \{d_j \in D \mid \exists \tau \in T : \varphi(\tau) = \varphi_i \land d(\tau) = d_j\} \mid$$

4 Two-Step Retrieval Status Value

The proposed method [12] is a system based on query translation and it calculates RSV in two phases, a pre-selection phase and a re-indexing phase. Although the method is independent of the translation technique, it is necessary to know how each term translates.

1. The document pre-selection phase consists of translating and running the query on each monolingual collection, D_i , as is usual in CLIR systems based on query translation. This phase produces two results:

we obtain a single multilingual collection of preselected documents (D' collection) as a result of joining all retrieved documents for each language.

— we obtain the translation to the other languages for each term of the original query as a result of the translation process. That is, we obtain a T' vocabulary, where each element τ is called "concept" and consists of each term together with its corresponding translation. Thus, a concept is a set of terms expressed independently of the language.

2. The re-indexing phase consists of re-indexing the multilingual collection D', but considering solely the T' vocabulary. That is, only the concepts are re-indexed. Finally, a new query formed by the concepts in T' is generated and this query is executed against the new index. Thus, for example, if we have two languages, Spanish and English, and the term "casa" is in the original query and is translated by "house", both terms represent exactly the same concept. If "casa" occurs a total of 100 times in the Spanish collection, and "house" occurs a total of 150 times in the English collection, then the term frequency would be 250. From a practical point of view, in this second phase each occurrence of "casa" is treated exactly as each occurrence of "house".

Formally, the method can be described as follows: For each monolingual collection we begin with the already-known structure:

$$< T_i, \Phi_i, D_i, ff, df >, 1 <= i <= N$$

Where N is the number of languages present in the multilingual collection to be indexed. Let $Q = \{Q_i, 1 <= i <= N\}$ be the set formed by the original query together with its translation into the other languages, in such a way that Q_i is the query expressed in the same language as the collection D_i . After each translation Q_i has been run against its corresponding structure $< T_i, \Phi_i, D_i, ff, df>$, it is possible to obtain a new and single structure:

$$< T', \Phi', D, D', ff', df' >$$

where:

- D is the complete multilingual document collection: $D = \{D_i, 1 \le i \le N\}$.

Value

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$$>, 1 <= i <= N$$

resent in the multilingual collection to the set formed by the original query r languages, in such a way that Q_i as the collection D_i . After each transmiding structure $\langle T_i, \Phi_i, D_i, ff, df \rangle$ ructure:

D' is the set of multilingual documents retrieved in as consequence of running the query Q.

T' is the set of concepts τ_j , and denotes the vocabulary of the D' collection. Since each query Q_i is a translation of another, it is possible to align the queries at term level.

$$\tau_j := \{\tau_{ij} \in Q_i, 1 <= i <= N\}, 1 <= j = M, M = |Q|$$

where τ_{ij} represents all the translations of the term j of the query Q to the language i. Thus, τ_j denotes the concept j of the query Q independently of the language.

 Φ' is a new vocabulary to be indexed, such that each $\varphi_j \in \Phi'$ is generated as follows:

$$\varphi_j := \{\varphi(\tau_{ij}), 1 <= i <= N\}, 1 <= j <= M$$

The ff' function and df' function are interpreted as usual:

• ff' is the number of occurrences of the concept j in the document k.

That is, the sum of the occurrences of the term j in the query, expressed in language i:

$$ff'(\varphi_j, d_k) := ff(\varphi_{ij}, d_k)$$

• df' is the number of documents with the concept j in the collection D. That is, the sum of the documents with the term j in the query, expressed in language i:

$$df'(\varphi_j) := | \{d_k \in D_i \mid \exists \tau \in T : \varphi(\tau) = \varphi_j \land d(\tau) = d_k\} |$$

:= $\Sigma df(\varphi_{ij}), \forall \varphi_{ij} \in \varphi_j, d_k \in D, 1 <= i <= N$

where $df(\varphi_{ij})$ is all the documents that contain the concept j in the monolingual collection D_i .

Given this structure, a new index is generated in run time, but only taking into account the documents that are found in D'. The df function operates on the whole collection D, not only on the retrieved documents in the first chase, D'. This is because, in practice, we have found that the results obtained were slightly better when the whole collection was considered when calculating the idf factor. Once the indices have been generated in this way, the query Q formed by concepts, not by terms, is re-run on the D' collection.

In some ways, this method shares some ideas with CLIR systems based on orpus translation, but instead of translating the complete corpus, it only translates the words that appear in the query and the retrieved documents. These we simplifications allow the development of the system in run-query time since he necessary re-indexing process in the second phase is computationally possible due to the small size of the collection D' and to the scarce vocabulary T' approximately, the query terms multiplied by the number of present languages in D').

Some relevant aspects of two-step RSV are:

Table 1. Descript

xperiment

- It is easily scalable to several languages.

The system requires the term-level alignment of the original query and the translation of its terms. Depending on the approach followed for the translation, this process varies in complexity.

- A term together with its translation are treated in exactly the same wav in the proposed model. This is not too realistic since it is not usual for the source term and its translations to be equally weighted. For example, it is possible that for a given language i, we maintain more than one translation for a given concept of the original query. Consequently, the concept frequency will be increased artificially in the documents expressed in the i language. In this case, if we know the translation probability of each term, we can weight each term according to its translation probability with respect to the source term. This can be modelled as follows:

$$ff'(\varphi_j, d_k) := \Sigma ff(\varphi_{ij}, d_k) * w(\tau_{ij}), \forall \varphi_{ij} \in \varphi_j, \varphi(\tau_{ij}) = \varphi_{ij}, 1 <= i <= N$$

where $w(\tau_{ij})$ represents the translation probability of each translation of term j in the query to language i, by default it will be 1.

Description of Experiments and Results

Multilingual Experiments

The experiment has been carried out for the five languages of the multilingual task. Each collection has been pre-processed as usual, using the stopword lists and stemming algorithms available for the participants, with the exception of Spanish, where we have used a stemming algorithm provided by the ZPrise system ². We have added terms such as "retrieval", "documents", "relevant"... to the stopword lists. Due to the morphological wealth of German, compound words have been reduced to simple words using the MORPHIX package [13]. Once the collections have been pre-processed, they are indexed with the Zprise IR system, using the OKAPI probabilistic model [14]. This OKAPI model has also been used for the on-line re-indexing process required by the calculation of two-step RSV.

For each query, we have used the Title and Description sections. The method for query translation is very simple: we used the Babylon³ electronic dictionary to translate query terms [15]. For each term, we considered the first two translations given by Babylon. Words not found in the dictionary were been translated. This approach allows us to carry out query alignment at term level easily.

The results obtained show that the calculation of the two-step RSV improves more than seven points (36% more) the precision reached with respect to other approaches (Table 2). This improvement is approximately constant with short, medium and large queries (Table 3).

3 Babylon is available at http://www.babylon.com

Task Multilingual auto UJAMLTDRR **IAMLTDNORM** Multilingual auto

IJAMLTDRSV2 Multilingual autor AMLTDRSV2RR Multilingual auto UJABITD Bilingual auto SP,DE,FR,IT)

Table 2. Performance using dis

Experiment	Avg.
UJAMLTDRR	0.2
UJAMLTDNORM	0.2
UJAMLTDRSV2	0.2

Table 3. Average precision using di

Merging strategy	Tit.
round-robin	0.1593
normalized score	0.1592
2-step RSV	0.2159

Table 4. Bilingual ex

Experiment	Lang
UJABITDSP	
UJABITDDE	
UJABITDFR	english -
UJABITDIT	english -

Bilingual Experiments

he differences in accuracy between emming algorithms used, the quality implest stemming algorithm is that iffixes such as singular and plural v ld it is in this language where the

Note that the multilingual docu e document lists obtained in the b the UJAMLTDRSV2 experiment

ZPrise, developed by Darrin Dimmick (NIST). Available on demand at http://www.itl.nist.gov/iaui/894.02/works/papers/zp2/zp2.html

Table 1. Description of official experiments

Task	Horm		
M-14:1:	Form	Query	Merging Strateg
Multilingual	automatic	Title+Description	Bound D. Li
Managuar	automatic	Title+Description	N. II
Multilingual	automatic	Title+Description	2-Step RSV
Multilingual	automatic	Title+Description	2-Step RSV+
			D
Bilingual	automatic '	Title+Description	Toulid-Robin
	Multilingual Multilingual	Multilingual automatic Multilingual automatic	Multilingual automatic Title+Description Multilingual automatic Title+Description Multilingual automatic Title+Description

Table 2. Performance using different merging strategies (official runs)

Avg. prec.	R-Precision	0 11 5
		Overall Recall
	0.2787	4246/8068
3.2000	0.2647	4297/8068
0.2774	0.3280	4551/8068
	0.2038 0.2068 0.2774	0.2068 0.2647

Table 3. Average precision using different merging strategies and query lengths

merging strategy	Tit.	Tit.+Desc.	Tit.+Desc.+Nam
TODIII	1111543	0 0000	AND DESCRIPTION OF THE PARTY OF
normalized score	0.1592	0.2068	0.2425
	0.2159		0.2554
	0.2103	0.2114	0.3209

Table 4. Bilingual experiments (Title+Description)

Experiment	Language	Ave	<u> </u>
UJARITDER	on alial	Avg. prec.	R-Precision
UJARITODE	english \rightarrow spanish english \rightarrow german		0.3141
UJARITDER	engush → german	0.2747	0.3077
UJARITOIR	$\begin{array}{c} \text{english} \rightarrow \text{german} \\ \text{english} \rightarrow \text{french} \end{array}$	0.3467	0.3365
COMBITDIT	english → italian	0.2438	0.2620

Bilingual Experiments

The differences in accuracy between the bilingual experiments may be due to the stemming algorithms used, the quality of which varies according to language. The supplest stemming algorithm is that used for Italian: it removes only inflectional unit it is in this language where the lowest level of accuracy is achieved.

Note that the multilingual document list has been calculated starting from his document lists obtained in the bilingual experiments. The accuracy obtained in the UJAMLTDRSV2 experiment is similar to that obtained in the bilingual

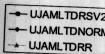


Fig. 1. 11 pt-precision

experiments (Table 4), surpassing even the accuracy for German and Ita and only two points short of that reached in Spanish.

5.3 Merging Several Approaches

Finally, we carried out an experiment merging several approaches through a ple linear function. We calculated document relevance with the function:

$$Pos_i' = 0.6*Pos_i^{rsv2} + 0.4*Pos_i^{merge-approach}$$

Where Pos_i' is the new document position i. Pos_i^{rsv2} is the document position two-step RSV, and $Pos_i^{merge-approach}$ is the document position the Round-Robin or normalized score approach. As shown in Table 5, only is there no improvement, but the accuracy even decreases slightly.

Table 5. Merge of two-step RSV and round-robin/normalized score tle+Description)

Experiment	Merging strategies	Ave pres	D D · ·
UJAMLTDRSV2		rivg. prec.	R-Precision
UJAMLTDRSV2RR	RSV2	0.2774	0.3280
	IIIdol-huma round-lopiu	0.2758	0.3265
ujamltdrsv2norm	RSV2 and normalized score	0.2631	0.3162

Future Work

We have presented a new approach to solve the problem of merging relevant occuments in CLIR systems. This approach has performed noticeably better han other traditional approaches. To achieve this performance, it is necessary align the query with its respective translations at term level. Our next efforts re directed towards three aspects:

We suspect that with the inclusion of more languages, the proposed method will perform better than other approaches. Our objective is therefore to confirm this suspicion.

We intend to test the method with other translation strategies. We have a special interest in the Multilingual Similarity Thesaurus, since this provides a measure of the semantic proximity of two terms. This semantic proximity can be used by our method as the translation probability of a term.

Finally, we could study the effect of pseudo-relevance feedback in the first and second phase of the method proposed.

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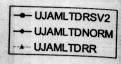
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 $1*Pos_i^{merge-approach}$

i. Pos_i^{rsv2} is the document position ge-approach is the document position e approach. As shown in Table 5, no uracy even decreases slightly.

round-robin/normalized score (T

egies	Avg. prec.	R-Precision	
	0.2774	0.3280	
d-robin	0.2758	0.3265	
ized score	0.2631	0.3162	

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