# Grey Literature citations in the age of Digital Repositories and Open Access

Silvia Giannini, Stefania Biagioni
*CNR, Istituto di Scienza e Tecnologie dell'Informazione "A. Faedo", Italy*
Sara Goggi, Gabriella Pardelli
*CNR, Istituto di Linguistica Computazionale*, "*Antonio Zampolli*", *Italy*

## Abstract

The work measures grey citations in the years 2012, 2013 and 2014 and then describes the features of GL documents cited in different areas of knowledge: Computational Linguistics, Computer Science and Engineering. With the aim of surveying a wide and varied range of resources, we selected a sample data based on the bibliographical references of articles contained in four journals - all indexed by Scopus Citation Database and ISI Web of Science, with an Impact Factor (IF) over the last three years - and two proceedings of international conferences held in 2012 and 2014.

## 1. Introduction

About ten years ago we studied the impact of grey literature (GL) on conventional literature by observing the impact of grey citations in two different scientific fields, «after the growth in the use of the WWW» [Di Cesare et al. 2005]. Over the last decade the international scientific community and its players have undergone (and still undergo) essential changes with respect to the representation and dissemination of knowledge. The formalization of the Open Access (OA) model dates back to the beginning of the last decade: OA is a movement born in the 1990s with the purpose to contrast the monopoly of commercial publishing houses thus making knowledge accessible for free without violating the intellectual property rights or threaten the quality of a scientific work. Along with the success of OA, the prototype of the 90s e-print archives evolved into the current digital repositories (institutional or subject based). The new paradigms of scientific communication and the most advanced computer science technologies fostered the achievement and use of these novel infrastructures: in particular, institutional repositories have gained a specific and relevant role in storing, preserving and disseminating scientific information.

The international Declarations of Budapest 2002, Bethesda 2003 and Berlin 2004 contributed to the definition of OA principles and opened the way to the movement from a normative point of view thus fostering the promulgation of national laws and European legislation as well (reference n° 2012/417/UE). Nowadays many academic and research institutions choose to adhere to the OA movement by issuing policies which compel to deposit/file their research products in OA repositories. Nevertheless the debate on this themes is extremely heated and many issues still need to be cleared up: from problems related to the quality of open access products, the peer-review processes, the integration between the OA world and the evaluation of research to – last but not least - the impact of citations of OA works [Guerrini 2010; De Bellis 2005; Eysenbach 2006]. In our current digital era bibliographical citations has gained a strategic role within the mechanisms of scientific communication, especially due to the implementation of the citation indexing services [Cassella 2011]. Citation has thus become «….the currency in scientific communication trade. It is a small denomination bill (quoting does not cost that much) but with a very high symbolic buying power…» [De Bellis 2014][1]. Besides it is undeniable that from a bibliometric point of view the two more widely recognized and used standards are those based on the number of citations per article and on the impact factor per journal.

In this scenario, it seemed interesting to investigate once again the "world" of scientific citations for proving if - and eventually to which extent – this "revolution" in the communication of knowledge might actually reflect on the GL approach to citations. Today institutional archives allow to store and make accessible any research "product", whether "official" publications or various types of grey literature: from the more traditional technical reports or dissertations to the newest datasets, experiments, software, web sites, blogs.

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[1] From the Italian original work: «…moneta corrente nel commercio della comunicazione scientifica ufficiale. Moneta di piccolo taglio (costa poco citare), ma dal potere d'acquisto simbolico non indifferente…» (DeBellis 2014).

Our hypothesis is then driven by the idea that grey literature, more easily identified and accessed, may have a greater visibility. Similarly it is possible to assume a greater impact of GL citations on the overall total of citations.

## 2. Materials and method

We analyzed a sample of journals indexed by the Science Citation Index (SCI) and included in the ISI-Journal Citation Report (JCR)[2]. Two journals on four are Open Access journals: *EURASIP Journal on Advances in Signal Processing* and *Computational Linguistics* (Table 1). Moreover we analyzed a sample of two conference proceedings in order to evaluate any differences in the citation model (Table 2).

| Journals Titles | IF* 2012 | Rank* 2012 | IF* 2013 | Rank* 2013 | IF 2014 | Rank* 2014 |
|---|---|---|---|---|---|---|
| ACM Transactions on Information Systems | 1.070 | 59/132 | 1.300 | 53/135 | 1.021 | 70/139 |
| EURASIP Journal on Advances in Signal Processing | 0.807 | 155/243 | 0.808 | 164/248 | 0.777 | 170/249 |
| Computational Linguistics | 0.940 | 72/115 | 1.468 | 49/121 | 1.226 | 72/123 |
| Language Resources and Evaluation | 0.659 | 79/100 | 0.518 | 94/102 | 0.619 | 89/102 |

*Table 1 – Sampled Journals*

| Proceedings Titles | Years |
|---|---|
| JCDL - ACM/IEEE-CS Joint Conference on Digital Libraries | 2012 and 2014 |
| EACL - Conference of the European Chapter of the Association for Computational Linguistics | 2012 and 2014 |

*Table 2 – Sampled Proceedings*

The chosen journals are all indexed under the ISI-JCR subject category "Computer Science" (CS), except for the *EURASIP Journal on Advanced in Signal Processing* (EURASIP) which is under the subject category ENGINEERING, ELECTRICAL & ELECTRONIC (E&E). *ACM Transactions on Information Theory* (ACM TOIS) is under the sub-category "Information systems"; *Computational Linguistics* (CL) is under the sub-categories "Artificial Intelligence" and "Interdisciplinary Applications"; *Language Resources and Evaluation (LR&E)* is under the sub-category "Interdisciplinary Applications". Table 1 compares the IF and rank in CS and E&E subject categories in the selected years.

Scopus citation database places the journals CL and LR&E in areas related also to the Humanities and Social Sciences: Language and Linguistics for CL; Language and Linguistics, Education and Library and Information Sciences for LR&E. Indeed, Computational Linguistics is a discipline that draws contributions from different fields of study such as linguistics, psychology, mathematics and statistics, in addition to computer science. For all these reasons we considered the selected journals and conference proceedings as belonging to two different scientific communities: Computer science and Engineering and Computational Linguistics.

The journals present a value of IF substantially stable in the considered timespan, with the exclusion of CL showing a higher IF in 2013. This value also determines a significant shift of rank in the same year and makes CL the journal with the higher IF.

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We extracted the information directly from primary sources, that is the bibliographical references of the articles in the selected journals and proceedings. The corpus was built by grouping the gathered data in six informative classes: year, issue number, bibliographical reference, kind of document – Grey (G) or Published (P), document type, standardized document type (Table 3).

| Year | Issue | Reference | G/P | Doc. Type | SDType |
|------|-------|-----------|-----|-----------|--------|
| 2012 | 38(2)_2 | Horn, Laurence R. 1972. On the Semantic Properties of Logical Operators in English. Ph.D. thesis, UCLA. Distributed by the Indiana University Linguistics Club, 1976. | G | PHD | Thesis |

*Table 3 – example extracted from Computational Linguistics (2012)*

We analyzed 40.511 bibliographical references on 1.270 articles. For each journal and proceedings we counted:
1. the number of articles provided with references[3];
2. the number of references in each article;
3. the number of GL references in each article;

For each GL reference we examined: document type; year of publication; GL linked references according to the following criteria:

1) Definition of GL starting from the York recommendations (1978) and the later integrations to its definition;
2) Classification of documentation produced by *no-profit* Associations, Institutions and Publishers (e.g. ACL Anthology, ISCA archive, OA journals) as grey literature;
3) Use of specialized indexes, catalogues and the Google search engine to clarify unclear or incomplete citations;
4) Categorization of GL document types as follows:

- *ARTICLE includes: journals, newspapers, newsletters and magazines articles;*
- *BLOG/FORUM;*
- *BOOK/BOOK CHAPTER;*
- *CONFERENCE PAPER includes: papers presented at conferences, seminars, workshops, meeting;*
- *CORPORA includes: downloadable linguistic resources;*
- *COURSE MATERIAL includes: tutorials and teaching material;*
- *DATABASE;*
- *DATASET;*
- *DELIVERABLE;*
- *GUIDELINES and NORMATIVE DOCUMENT includes: standards, guidelines, protocols;*
- *PATENT;*
- *PREPRINT/POSTPRINT includes: documents "submitted-to", "to-be-published", "in press", "forthcoming"; "accepted"; "to appear";*
- *POSTER/PRESENTATION includes: demo, poster and presentation;*
- *REPORT includes: working notes, technical reports, white papers, working papers, research reports, project reports, discussion papers, occasional papers;*
- *SOFTWARE includes: only downloadable software;*
- *TECHNICAL DOCUMENTATION includes: user guides, manuals, technical specifications and technical documentation of computer programs and for statistical surveys;*

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[3] Including:"editorial", "obituary", "squibs", "book review"; "report", "brief report", "project note", "editors' notes", "introduction" etc.

- *TERTIARY DOCUMENT includes: dictionaries, catalogues and encyclopedia entries;*
- *THESIS includes: PhD thesis, dissertations, master thesis;*
- *UNDEFINED includes: all documents that could not be identified;*
- *WEBSITE includes: simple URLs' or home pages.*

We measured the different impact of GL on the different areas of knowledge, using the following indicators:

1) the frequency of GL citing (i.e. the proportion of GL references out of all the references examined);
2) the frequency of GL use (i.e. the proportion of articles with GL citation, out of all articles examined);
3) the intensity of GL use (i.e. the frequency of GL citing divided by the frequency of GL use).

# 3. Analysis of data and results

## 3.1 Frequency of GL citing

In our corpus the frequency of GL citing is 24% out of all references examined and it varies from a minimum of 7,8 to a maximum of 62,9.

| Title | 2012 | | | 2013 | | | 2014 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of references | Number of GL references | Frequency of GL citing (%) | Number of references | Number of GL references | Frequency of GL citing (%) | Number of references | Number of GL references | Frequency of GL citing (%) |
| ACM TOIS | 1.413 | 285 | 20.2 | 1.097 | 135 | 12.3 | 1.096 | 150 | 13.7 |
| Computational Linguistic | 1.575 | 739 | 46.9 | 2.008 | 1.263 | 62.9 | 1.958 | 1.158 | 59.1 |
| EURASIP Journal on Advances in SP | 7.876 | 616 | 7.8 | 5.805 | 459 | 7.9 | 5.651 | 455 | 8.1 |
| Language Resources and Evaluation | 1.220 | 384 | 31.5 | 2.052 | 740 | 36.1 | 1.267 | 495 | 39.1 |
| EACL Proceedings | 2.307 | 884 | 38.3 | ni | ni | ni | 2.368 | 1.332 | 56.3 |
| JCDL Proceedings | 1.304 | 329 | 25.2 | ni | ni | ni | 1.514 | 384 | 25.4 |

*Table 4 (ni=not included)*

What is remarkable in Table 4 is:

– CL presents the highest frequency of GL citing as well as the highest IF;
– the frequency of GL citing in JCDL proceedings is stabler than in EACL proceedings;
– the frequency in journals alternates increase and decrease of the value over the years;
– the frequency of GL citing is higher for journals and proceedings belonging to the area of Computational Linguistics than for journals belonging to the area of Computer Science-Information Systems and the journal of E&E area;
– EURASIP presents the lowest number of GL citations: this journal shows a good stability of frequency of GL citing, followed by LR&E.
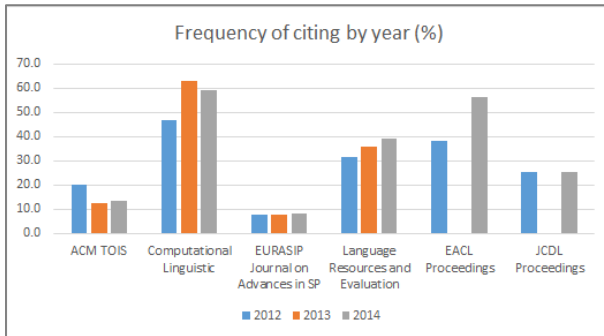
## 3.2 Frequency of GL use

The frequency of GL use shows the percentage of articles with at least one GL citation out of the overall amount of articles: it is globally very high and varies from a minimum of 69,8% to a maximum of 100%.

| Title | 2012 | | | 2013 | | | 2014 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of articles | Number of articles with GL references | Frequency of GL use (%) | Number of articles | Number of articles with GL references | Frequency of GL use (%) | Number of articles | Number of articles with GL references | Frequency of GL use (%) |
| ACM TOIS | 25 | 25 | 100.0 | 22 | 22 | 100.0 | 21 | 18 | 85.7 |
| Computational Linguistic | 36 | 32 | 88.9 | 35 | 33 | 94.3 | 34 | 33 | 97.1 |
| EURASIP Journal on Advances in SP | 252 | 176 | 69.8 | 188 | 136 | 72.3 | 183 | 128 | 69.9 |
| Language Resources and Evaluation | 31 | 31 | 100.0 | 56 | 54 | 96.4 | 31 | 31 | 100.0 |
| EACL Proceedings | 85 | 82 | 96.5 | ni | ni | ni | 78 | 78 | 100.0 |
| JCDL Proceedings | 96 | 81 | 84.4 | ni | ni | ni | 97 | 75 | 77.3 |

*Table 5*

Table 5 shows:
1) the frequency of GL use is very high for each journal and proceedings;
2) the frequency of GL use increases steadily for CL and for EACL proceedings, decreases for ACM TOIS in 2014 while increases for LR&E and EURASIP in 2013 but decreases again in 2014 (alternation). Finally the frequency for JCDL proceedings decreases from 2012 to 2014.



*Graph 1*
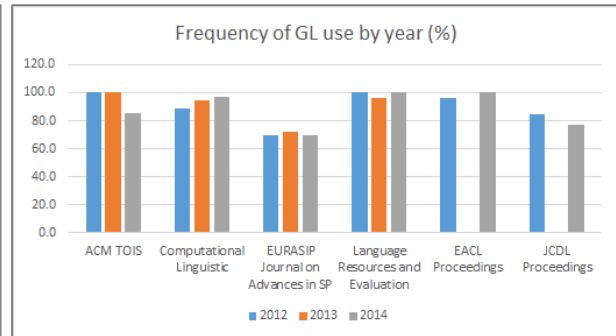


*Graph 2*

Graphs 1 and 2 show the variability of frequency of GL citing and use for each source over the years.

## 3.3 Frequency/Intensity of GL use

The intensity of GL use varies from a minimum of 10,9% (*EURASIP*) to a maximum of 66,7% (*Computational Linguistics*). Table 6 shows that generally the intensity of GL use increases for both proceedings and *LR&E*, it alternates between increase and decrease of values in *ACM TOIS* and *CL* while is stable for *EURASIP.*

| Title | 2012 | | | 2013 | | | 2014 | | |
|---|---|---|---|---|---|---|---|---|---|
| | IF | Frequency of GL use (%) | Intensity of GL use (%) | IF | Frequency of GL use (%) | Intensity of GL use (%) | IF | Frequency of GL use (%) | Intensity of GL use (%) |
| ACM TOIS | 1.070 | 100.0 | 20.2 | 1.300 | 100.0 | 12.3 | 1.021 | 85.7 | 16.0 |
| Computational Linguistic | 0.940 | 88.9 | 52.8 | 1.468 | 94.3 | 66.7 | 1.226 | 97.1 | 60.9 |
| EURASIP Journal on Advances in SP | 0.807 | 69.8 | 11.2 | 0.808 | 72.3 | 10.9 | 0.777 | 69.9 | 11.5 |
| Language Resources and Evaluation | 0.659 | 100.0 | 31.5 | 0.518 | 96.4 | 37.4 | 0.619 | 100.0 | 39.1 |

*Table 6*

The overview of the frequency and intensity in GL use related to the journals' IF does not allow to make any general consideration applicable to all journals.

From Table 6 we can note the following:

1) In *ACM TOIS* the IF value seems to affect more the intensity of use than the frequency (of use): if the IF increases the intensity of use decreases while the frequency remains stable; conversely, if the IF of *Computational Linguistics* increases even the frequency and intensity of GL use increase;
2) in LR&E the alternation of the IF value coincides with the stable growth of the intensity while the frequency alternates between increase and decrease;
3) in EURASIP both the IF value and the indicator values are substantially stable.

## 3.4 Frequency of use of GL-linked (with a link to a URL) references

The frequency of the use of GL-linked references varies from a minimum of 1,5% to a maximum of 50,8%.

| Title | 2012 | | | 2013 | | | 2014 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of GL references | Number of *linked*-GL references | Frequency of *linked*-GL references (%) | Number of *linked*-GL references | Number of *linked*-GL references | Frequency of *linked*-GL references (%) | Number of *linked*-GL references | Number of *linked*-GL references | Frequency of *linked*-GL references (%) |
| ACM TOIS | 285 | 32 | 11.2 | 135 | 16 | 11.9 | 150 | 34 | 22.7 |
| Computational Linguistic | 739 | 13 | 1.8 | 1.263 | 19 | 1.5 | 1.158 | 17 | 1.5 |
| EURASIP Journal on Advances in SP | 616 | 172 | 27.9 | 459 | 145 | 31.6 | 455 | 141 | 31.0 |
| Language Resources and Evaluation | 384 | 51 | 13.3 | 740 | 113 | 15.3 | 495 | 41 | 8.3 |
| EACL Proceedings | 884 | 27 | 3.1 | ni | ni | ni | 1.332 | 16 | 1.2 |
| JCDL Proceedings | 329 | 167 | 50.8 | ni | ni | ni | 384 | 133 | 34.6 |

*Table 7*

Table 7 shows:
1) the highest percentage belongs to JCDL proceedings;
2) the lowest percentage belongs to CL (which has the highest IF among the journals chosen). The journal is *the premiere publication devoted exclusively to the design and analysis of natural language processing Systems[4]*.
3) The percentage is high (though with different values) for EURASIP (dedicated to the theoretical and practical aspects of signal processing) and for LR&E, belonging to the Computational Linguistics area but with strongly interdisciplinary features.

Graph 3 shows instead the variability of frequency of use of GL-linked references for each source over the years.



*Graph 3*

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[4] Cfr. http://www.mitpressjournals.org/page/about/coli.
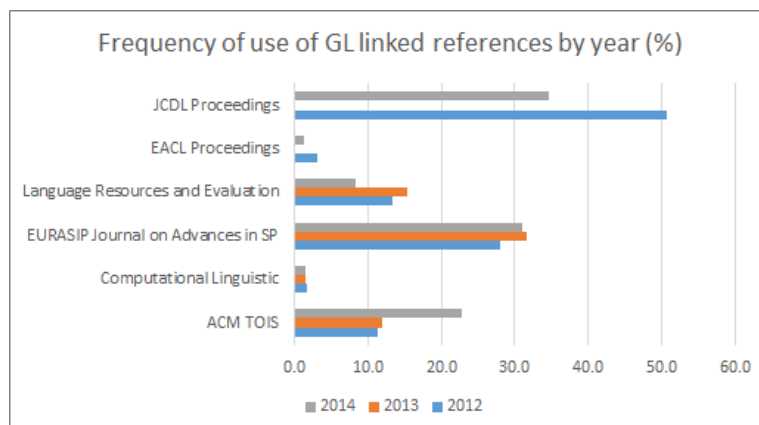
As expected we found that the majority of GL-linked citations is concentrated in JCDL proceedings which is a publication dedicated to the study of multiple aspects of digital libraries as infrastructures metadata, contents, services, electronic publishing, multimedia etc. Conversely, we did not expect ACM TOIS, devoted to scholarly studies in all areas of information retrieval, would present a limited number of GL-linked citations. In the Computational Linguistics area, only LR&E seems to use *GL* linked citations.

## 4. GL Typology

Table 8 reports the distribution of GL documents by document type.

| Title | Article | Blog/Forum | Book/Book chapter | Conference paper | Corpora | Course material | Database | Dataset | Deliverable | Guidelines/ Normative document | Patent | Poster/ Presentation | Preprint/ Postprint | Report | Software | Technical Documentation | Tertiary document | Thesis | Undefined | Website |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2012** | | | | | | | | | | | | | | | | | | | | |
| ACM TOIS | 10 | 1 | 0 | 215 | 0 | 0 | 0 | 0 | 1 | 4 | 1 | 0 | 4 | 18 | 2 | 1 | 0 | 16 | 1 | 11 |
| EURASIP Journal on Advances in SP | 6 | 1 | 5 | 213 | 0 | 2 | 16 | 2 | 2 | 32 | 19 | 3 | 33 | 85 | 16 | 45 | 10 | 80 | 3 | 43 |
| Computational Linguistic | 1 | 0 | 3 | 632 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 36 | 2 | 6 | 13 | 38 | 1 | 1 |
| Language Resources and Evaluation | 1 | 0 | 1 | 291 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 1 | 4 | 35 | 9 | 8 | 3 | 21 | 0 | 7 |
| JCDL Proceedings | 46 | 6 | 7 | 86 | 0 | 3 | 2 | 0 | 8 | 11 | 2 | 3 | 4 | 38 | 9 | 10 | 0 | 6 | 3 | 85 |
| EACL Proceedings | 0 | 2 | 3 | 771 | 1 | 4 | 2 | 0 | 0 | 2 | 0 | 1 | 10 | 46 | 3 | 3 | 6 | 24 | 0 | 6 |
| **2013** | | | | | | | | | | | | | | | | | | | | |
| ACM TOIS | 3 | 0 | 0 | 86 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 3 | 18 | 3 | 5 | 1 | 10 | 0 | 3 |
| EURASIP Journal on Advances in SP | 11 | 1 | 2 | 123 | 0 | 2 | 7 | 3 | 1 | 45 | 8 | 0 | 23 | 58 | 19 | 49 | 2 | 50 | 2 | 53 |
| Computational Linguistic | 4 | 0 | 0 | 1107 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 9 | 2 | 40 | 2 | 14 | 10 | 71 | 0 | 3 |
| Language Resources and Evaluation | 11 | 2 | 0 | 567 | 22 | 0 | 0 | 1 | 4 | 17 | 0 | 1 | 7 | 32 | 6 | 7 | 5 | 50 | 3 | 5 |
| **2014** | | | | | | | | | | | | | | | | | | | | |
| ACM TOIS | 4 | 0 | 0 | 97 | 0 | 0 | 1 | 0 | 0 | 5 | 0 | 1 | 4 | 15 | 1 | 1 | 5 | 9 | 2 | 5 |
| EURASIP Journal on Advances in SP | 1 | 2 | 0 | 113 | 0 | 2 | 21 | 8 | 5 | 22 | 9 | 0 | 21 | 71 | 11 | 56 | 3 | 60 | 4 | 46 |
| Computational Linguistic | 5 | 0 | 4 | 1031 | 1 | 2 | 1 | 0 | 0 | 4 | 0 | 0 | 4 | 38 | 1 | 11 | 7 | 44 | 2 | 3 |
| Language Resources and Evaluation | 2 | 2 | 0 | 402 | 2 | 6 | 2 | 0 | 3 | 5 | 0 | 2 | 7 | 26 | 2 | 3 | 1 | 30 | 0 | 0 |
| JCDL Proceedings | 47 | 8 | 2 | 118 | 2 | 0 | 1 | 0 | 10 | 15 | 0 | 8 | 13 | 62 | 12 | 26 | 1 | 10 | 2 | 47 |
| EACL Proceedings | 15 | 1 | 2 | 1206 | 0 | 0 | 0 | | 0 | 2 | 1 | 0 | 12 | 41 | 4 | 7 | 6 | 32 | 0 | 3 |

*Table 8*

The most cited types of GL documents are: Conference papers (this group presents the highest number of GL citations), Reports, Thesis and Preprint/Postprint. These four types of document are the most cited regardless of the year, the nature of the products analyzed (journals and proceedings) and the area of knowledge to which they belong. The type Article, although less frequently, is present in each subject category and year (except for EACL 2012).

As for other types, some peculiarities related primarily to the topic of the selected journals and proceedings emerged. For example, document types as Software/Tool, Technical Documentation, Database, Guideline/Normative document, Patent and Website are cited much more frequently in E&E area than in Computer Science and Computational Linguistics areas. In the same way the type Corpora is cited much more frequently in the Computational Linguistics and, in particular, in the LR&E Journal. None of the disciplines presents a considerable number of citations of Blog/Forum, Books, Dataset, Deliverable and Course material.

The Graphs in the following page show the distribution of GL types for each source over the years: Graphs 4, 5, 6 show the document types in Computer Science and Engineering while Graphs 7, 8, 9 show the document types in Computational Linguistics.
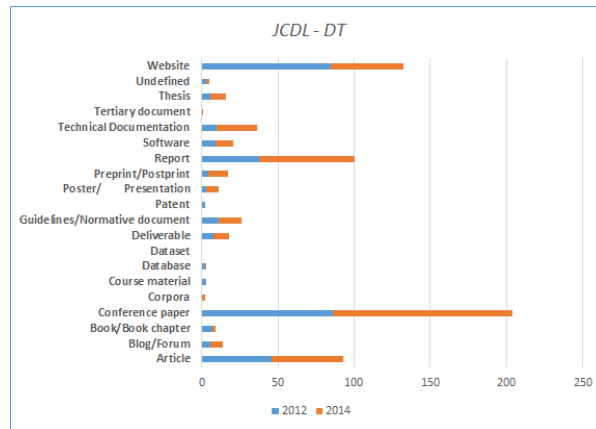
The graphical visualization allows us to better understand the intensity of use of the individual types of document by each resource analyzed.
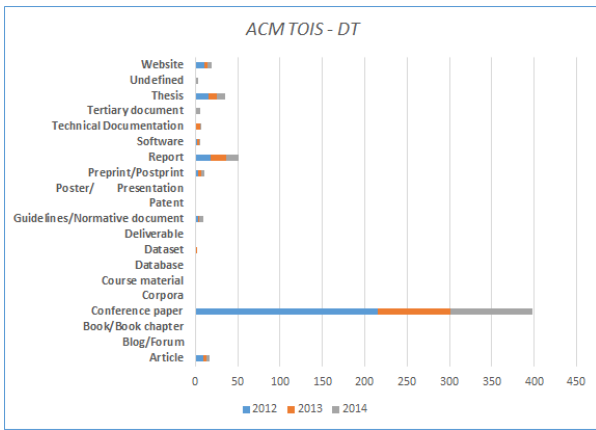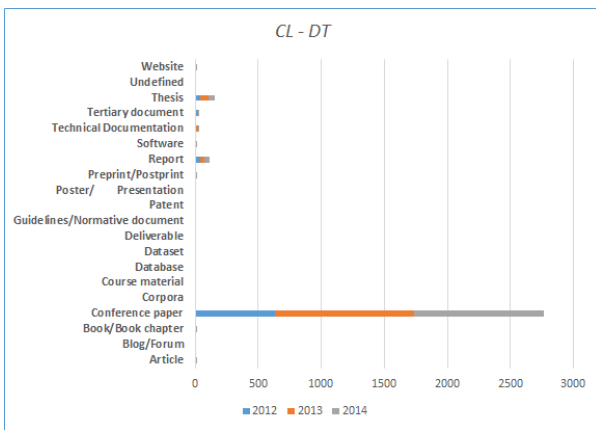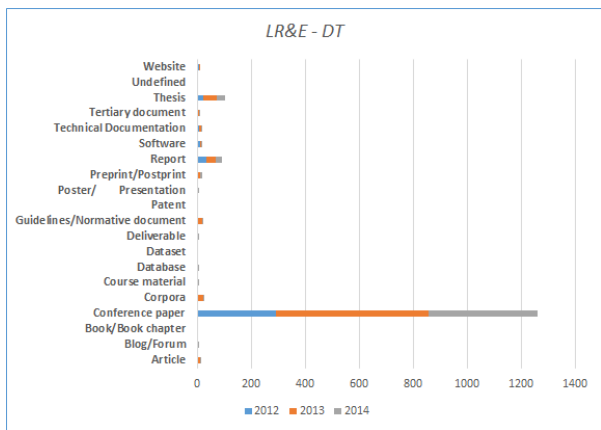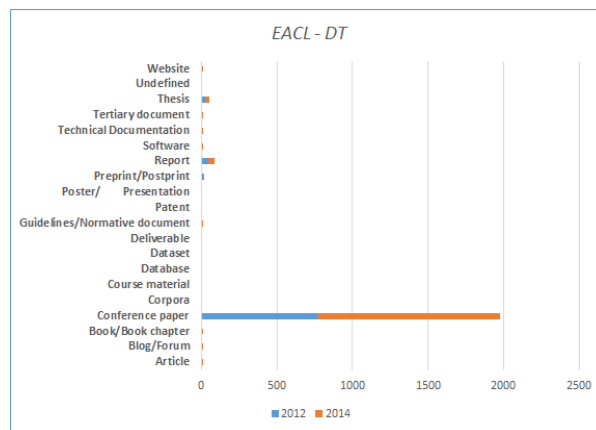
*Graph 4*
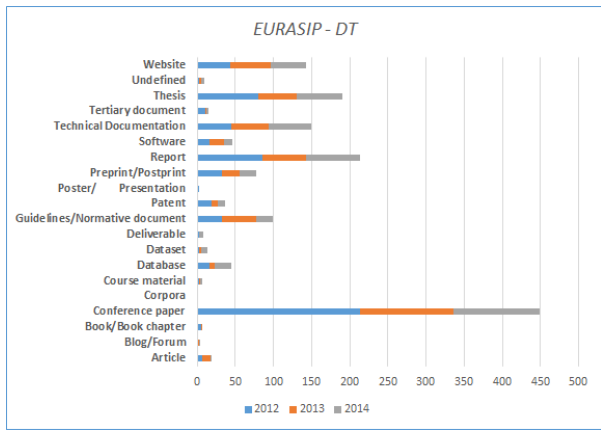


*Graph 5*



*Graph 6*



*Graph 7*



*Graph 8*



*Graph 9*

It seems clear that within ACM TOIS grey citations are limited to a small number of types while in EURASIP and JCDL the typology is more extensive. Both in EURASIP and in JCDL all document types are in use, although with little impact, except for Corpora in EURASIP and Dataset in JCDL, that are not present at all.

Let us note that both CL and EACL use only some types of document. CL, for example, never uses Patent, Guidelines/Normative document, Deliverable, Dataset, Database, Corpora and Blog/Forum while EACL never presents Poster/Presentation, Patent, Guidelines/Normative document, Deliverable, Dataset, Database, Course material and Corpora.

## 5. Conclusion

In 2004 we analyzed two sample data belonging to two very different scientific fields.
In this work the disciplinary boundaries of sample data are much less defined: but nevertheless, there are several significant differences, both in frequency and intensity of use of grey citations and about the cited type of documents, especially related to the specific field of study of each resource analyzed.  The results obtained show that the Engineering domain has the least number of grey citations while the area of Computational Linguistics uses them most. In this respect, however, we must keep in mind that this result is strongly influenced by the presence of grey citations related to Conference papers published by the Association of Computational Linguistics. Even in the field of Computer Science, many "grey" Proceedings are collected and distributed freely by Associations, Institutions and no-profit services.

ACM TOIS is the only resource comparable with data analyzed in our work of 2004: the analysis indeed shows that GL frequency of citing and use remains in the range of *11.5* to *21.1* values identified for 1995 and 2003.

The quality of GL citations is still unclear and incomplete thus the analysis was difficult and time-consuming. We can conclude by saying that the traditional citation model - i.e. the habit to cite mainly conventional literature - is still very strong and leaves little room for alternative models. However, this survey returns percentages of frequency and intensity in use of GL substantially important, especially in the field of CL. It is increasingly clear the willingness of Associations and Organizations to collect, preserve and share the research results. The Repositories and the Open Access model have broken new ground and provided important tools for making these emerging communication needs come true.
Everything suggests, therefore, that the number of grey citations could increase in a very close future.

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