

COUNTER - CORpus of Urdu News TExt Reuse

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Abstract Text reuse is the act of borrowing text from existing documents to create new texts. Freely available and easily accessible large online repositories are not only making reuse of text more common in society but also harder to detect. A major hindrance in the development and evaluation of existing/new mono-lingual text reuse detection methods, especially for South Asian languages, is the unavailability of standardized benchmark corpora. Amongst other things, a gold standard corpus enables researchers to directly compare existing state-of-the-art methods. In our study, we address this gap by developing a benchmark corpus for one of the widely spoken but under resourced languages i.e. Urdu. The COUNTER (CORpus of Urdu News TExt Reuse) corpus contains 1,200 documents with real examples of text reuse from the field of journalism. It has been manually annotated at document level with three levels of reuse: wholly derived, partially derived and non derived. We also apply a number of similarity estimation methods on our corpus to show how it can be used for the development, evaluation and comparison of text reuse detection systems for the Urdu language. The corpus is a vital resource for the development and evaluation of text reuse detection systems in general and specifically for Urdu language.

Keywords mono-lingual text reuse · Urdu news corpus · Urdu text reuse detection · corpus generation

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1 Introduction

Text reuse occurs when pre-existing text(s) (source(s)) are reused to create a new text (derived). It is the process of reusing someone else's work by changing its form. Text reuse has become a common phenomenon in recent years due to the large amount of readily available text on the Web. It can vary from literal word-by-word reuse or paraphrasing the content using substitutions, insertions, deletions and reorderings (Clough et al. 2002a; Maurer et al. 2006), or reuse of facts, concepts and even style. In general, reuse is not limited to text only but ideas, software source code, images and music, are often subjects of reuse, however, our focus is on text reuse only.

As the amount of text that is reused varies, text reuse is commonly classified as either local or global. When small phrases, sentences or paragraphs are borrowed from the source, it is considered *local text reuse* whereas when the text from the entire source document(s) is considered to create new document, we name it as *global text reuse* (Seo and Croft 2008; Mittelbach et al. 2010).

Text reuse can be mono-lingual or cross-lingual. In *mono-lingual*, source-derived text pair is in the same language while in the case of *cross-lingual*, the derived text is in a different language than the source text. In journalism, text reuse is known to be a standard practice. Plagiarism, on the other hand, represents unacknowledged text reuse in which no proper reference to the source is provided.

In recent years, due to the exponential growth of World Wide Web with vast amounts of information easily accessible, exposure to social media and collaborative content authoring systems, the reuse of text is on the rise (Butakov and Scherbinin 2009; Osman et al. 2012; Sousa-Silva 2014). Consequently, it has become a serious issue for educational institutions, online publishers and researchers worldwide (Maurer et al. 2006). To address this challenge, text reuse detection has become vitally important. Moreover, detecting text reuse has a number of key applications in different fields such as automatic plagiarism detection (Hoad and Zobel 2003; Sánchez-Vega et al. 2013), paraphrase identification (Thenmozhi and Aravindan 2015; Tsatsaronis et al. 2010), detecting breach of copyright (Aplin 2010) and news monitoring systems (Clough et al. 2002a).

Automatic text reuse detection is the task of determining whether a text, either full or partial, has been produced by exploiting another as its source. However, in both cases the task depends heavily on the underlying algorithm. The task is much simpler in the case of global text reuse detection whereas in local text reuse detection, the algorithm requires not only to find all the source(s) from where a small part of the document may have been borrowed but also the location of the borrowed fragment within the derived document (Seo and Croft 2008).

One key bottleneck in the development and evaluation of computational methods for automatic text reuse detection, is the lack of benchmark corpora which contain various levels of reuse, e.g. exact copy, minor paraphrasing, extensive paraphrasing and so on. Although in the past, the research community has developed benchmark datasets but the majority (see Section 2) are for English language and we see much less focus been devoted on South Asian languages (Becker and Riaz 2002). The research on these languages is still in its infancy (Anwar et al. 2006) and we are not aware of any sizeable corpora with real examples of text reuse cases. However, the Natural Language Processing (NLP) community seems highly desirous in research of South Asian languages (McEnery et al. 2000), and a re-

view by Baker and McEnery (1999) showed that there is a deficiency of work on these under resourced Indic (or Indo-Aryan¹) languages. Hence, there is a need to develop standard evaluation resources to foster research in these languages.

In this paper, we present research on developing a benchmark Urdu text reuse corpus. Urdu, belonging to the Indo-Aryan language family, is the official language of Pakistan and one of the most popular languages spoken by around 175 million people around the globe. In contrast to English, Urdu is conventionally written right-to-left in Nastaliq style and relies heavily on Arabic and Persian sources for literary and technical vocabulary. However, for NLP it is a low-resource language with respect to even the core processing tasks like part-of-speech (POS) tagging or morphological analysis. Our corpus, named COUNTER² (COrpus of Urdu News TExt Reuse) is developed with an approach that is closely related to the METER corpus (Gaizauskas et al. 2001). It contains real examples of Urdu text reuse from the field of journalism. There are a total of 1,200 documents in the corpus, half of them are source documents and the remaining half, derived documents. The source documents are produced by leading news agencies of Pakistan, whereas the derived documents are a collection of corresponding newspapers stories published in the major newspapers of Pakistan. The derived collection contains documents with various degrees of text reuse. Some of the newspaper stories (derived documents) are rewritten (either verbatim or paraphrased) from the news agency's text (source document) while others have been written by the journalists independently on their own. For the former case, source-derived document pairs are either tagged as Wholly Derived (WD) or Partially Derived (PD) depending on the volume of text reused from the news agency's text for creating the newspaper article while for the latter case, they are tagged as Non Derived (ND) as the journalists have not reused anything from the news agency's text but based on their own observations and findings, developed and documented the story.

The need for such a corpus is clear from the above discussion, and for us, it represents the first stage in a larger project. First, we intend to use this corpus to inform the design of an Urdu text reuse detection system. Second, the corpus will serve as a benchmark standard for evaluation of the proposed methods to automatically detect mono-lingual text reuse for Urdu language. Third, it can be used to develop automatic techniques which can be employed in journalism, for measuring the amount of news source copy reused, for taking appropriate actions.

The rest of the paper is organized as follows: Section 2 describes existing corpora developed for the text reuse detection. Section 3 introduces the COUNTER corpus, explaining in detail the corpus generation process, its statistics and annotations, sample documents from the corpus and an analysis on the linguistic properties of the corpus. Section 4 explains the similarity estimation methods that we applied on our corpus to show how it can be useful in the development and evaluation of text reuse detection systems for Urdu language. Section 5 presents the experimental setup. In Section 6, we report and discuss the experimental results and Section 7 concludes the paper.

¹ http://en.wikipedia.org/wiki/Indo-Aryan_languages - Last visited: 16-06-2016

² The corpus is freely available to download at <http://ucrel.lancs.ac.uk/textreuse/counter.php> and through Lancaster's DOI <http://dx.doi.org/10.17635/lancaster/researchdata/96>

2 Related Work

To develop large scale freely available resources to investigate the problem of text reuse detection is not a trivial task. However, there has been a number of efforts in the recent past, to develop standard evaluation datasets for text reuse detection, although mostly for the English language. The outcome of these efforts are the METER corpus (Clough et al. 2002a) and the Lancaster Newsbooks corpus (McEnery et al. 2010). There are a few others, the Reuters-21578 news corpus (Lewis et al. 2004) and the Text REtrieval Conference (TREC)³ collections, that contain repeated news stories released by news-wire services. While these have not been designed to study text reuse, some researchers have used them for this purpose (Chowdhury et al. 2002; Metzler et al. 2005).

The most prominent effort in the recent years, for the development of monolingual text reuse corpora for English language, is the METER corpus (Gaizauskas et al. 2001). It consists of 1,716 documents with over 500,000 words. The corpus contains 771 Press Association (PA) articles as source documents. The remaining 945 documents are news stories published in 9 British newspapers (5 tabloids and 4 broadsheets) that are derived from some of the source(s) documents. These derived documents are categorised as (1) Wholly Derived (WD); where the newspaper text is entirely based on the source document, (2) Partially Derived (PD); where the newspaper text is partly based on the source document and (3) Non Derived (ND); the situation in which the news story is written completely independent of the source document. The corpus includes documents from two domains: court and law (769 documents) and show-business (176 documents). From the 945 derived documents, 301 are tagged as WD, 438 as PD and 206 as ND. Although, in journalism, text reuse is acceptable, but as suggested by Clough (2003) the corpus has been used in the past to evaluate the performance of extrinsic plagiarism detection systems Barrón-Cedeño et al. (2009).

The Lancaster Newsbooks corpus (McEnery et al. 2010) is a compilation of news stories texts from newsbooks published in the 17th century (especially foreign and political news). Journalists of that time used more or less the same paraphrasing mechanisms we use today for reproducing the source text about similar events in generating the newsbooks. To develop the corpus, the text was extracted from newsbooks between December 1653 and May 1654 and comprised of approximately 800,000 words. The authors used a sentence alignment algorithm (Piao et al. 2003) to determine the extent of similarity between two newsbook stories. However, the corpus has rarely been used for the development and evaluation of text reuse detection systems.

There are similar efforts for building datasets that contains artificial as well as simulated (manual) examples of plagiarism (a superficial type of text reuse). We discuss two such datasets, (1) the Short Answer Corpus (Clough and Stevenson 2011) (simulated plagiarism), and (2) the PAN-PC Corpora (Webis and NLEL 2009; Potthast et al. 2010b, 2011, 2012, 2013, 2014) (simulated and artificial plagiarism). The Short Answer corpus consists of 100 documents of length between 200-300 words. The documents are manually created with four levels of reuse i.e. Near copy, Light revision, Heavy revision and Non-plagiarism. The corpus has 5 source documents which are used to create 57 plagiarised and 38 non-plagiarised

³ <http://trec.nist.gov/> - Last visited: 16-06-2016

documents. The PAN-PC corpora (Stein et al. 2009; Potthast et al. 2010a, 2011, 2012, 2013, 2014) have been developed and matured over the years, and contain documents from Project Gutenberg⁴. In these corpora, the plagiarised documents contain either artificial, simulated or both cases of plagiarism. The majority of plagiarism cases are mono-lingual (in English language). A number of modification strategies were applied to create different levels of obfuscation. PAN-PC corpora provides an opportunity for NLP researchers to evaluate plagiarism detection systems using common resources and evaluation criteria, in a competition held annually⁵.

Although this research is aimed at developing a mono-lingual text reuse corpus for Urdu language, a recently released cross-lingual plagiarism corpus for Urdu-English language pair (CLUE) is worth mentioning here. The CLUE Text Alignment Corpus Hanif et al. (2015) contains 1,000 documents (500 Urdu source and 500 English suspicious documents). 270 of the suspicious documents are plagiarised while the remaining 230 are non-plagiarised. The documents of the corpus are collected from on-line sources (mainly Wikipedia⁶) and belong to two domains i.e. computer science and general topics. Volunteers (university students) were asked to generate (by manual and semi automated means) plagiarism cases (fragments) of lengths i.e. small (<50 words), medium (50-100 words) and large (100-200 words) and three levels of obfuscation i.e. Near Copy (CP), Light Revision (LR) and Heavy Revision (HR). These fragments were then inserted into the suspicious documents. The basic purpose of the corpus is to facilitate research in cross-language (Urdu-English) plagiarism detection.

Table 1 Summary of the available text reuse (and plagiarism) corpora (English)

Corpus	Source docs	Derived docs	Levels of rewrite	Domain
METER	771	945	WD, PD, ND	Journalism
Lancaster Newsbooks	N/A	N/A	N/A	Journalism
Short Answer	5	95	NC, LR, HR, NP	Wikipedia
PAN-PC*	11,094	11,094	P, NP	Literature

*Statistics of the PAN-PC-11 corpus which contains both artificial and simulated cases of plagiarism

Table 1 summarizes the corpora and their properties discussed above. It can be seen that the mono-lingual corpora are available only for English language and contain artificial and simulated cases of reuse (plagiarism) only. In order to stimulate research in Urdu, there is a need to develop standard evaluation resources for this language as well. As far as we are aware, no Urdu language text reuse corpus with real cases of text reuse has been previously developed.

⁴ <https://www.gutenberg.org/> Last visited: 16-06-2016

⁵ <http://pan.webis.de/> Last visited: 16-06-2016

⁶ https://en.wikipedia.org/wiki/Main_Page Last visited: 16-06-2016

3 Corpus

3.1 Corpus generation process

Our main intention was to develop a standard benchmark resource for the evaluation of existing systems available for text reuse detection in general and specifically for Urdu language. To generate a corpus with realistic examples, we opted for the field of journalism. In journalism, the same news story is published in different newspapers in different forms. It is a standard practice followed by all the newspapers (reporters and editors) to reuse (verbatim or modified) a news story released by the news agency.

It has been observed (Bell 1991; Fries 1997; Jing and McKeown 1999) that newspaper editors use different paraphrase mechanisms such as lexical or syntactical substitution, inflectional or derivational changes and summarisation to rewrite a newspaper story. Mostly these operations include deletion due to redundancy, making syntactic changes, use of appropriate synonyms, word re-ordering, splitting or merging sentences, tense and voice changes, use of abbreviation and verb/noun nominalisation. The choice of data collection from the press was further motivated by the fact that it is straightforward to collect news stories data with the majority of it readily and freely available on the Web in electronic form. However, some of the Urdu newspapers publish text on Web in graphics (images) form. These images were saved and later converted into electronic form (Urdu text) manually.

The COUNTER corpus consists of news articles (source documents) released by five news agencies in Pakistan i.e. Associated Press of Pakistan (APP), International News Network (INN), Independent News Pakistan (INP), News Network International (NNI) and South Asian News Agency (SANA). The corresponding news stories (derived documents) were extracted from nine daily published and large circulation national news papers of the All Pakistan Newspapers Society (APNS), who are subscribed to these news agencies. These include Nawa-e-Waqt, Daily Dunya, Express, Jang, Daily Waqt, Daily Insaf, Daily Aaj, Daily Islam and Daily Pakistan. All of them are part of the mainstream national press, long established dailies with total circulation figures of over 4 million⁷. News agency texts (source documents) were provided (in electronic form) by the news agencies on a daily basis when they released the news. Newspaper stories (derived documents) were collected by three volunteers over a period of six months (from July to December 2014). National, Foreign, Business, Sports and Showbiz were the domains targeted for data collection. Table 2 shows distribution of documents in the proposed COUNTER corpus.

3.2 Corpus properties and analysis

The corpus is composed of two main document types: (1) source documents and (2) derived documents. There are total 1,200 documents in the corpus: 600 are news agency articles (source documents) and 600 are newspapers stories (derived

⁷ <https://pakpressfoundation.wordpress.com/2006/05/05/pakistan-press-foundation>
- Last visited: 16-06-2016

Table 2 Distribution of documents by News agencies, Newspapers and Domains

News Agencies		News Papers		Domains	
APP	543	Nawa-e-Waqt	145	Sports	222
INN	39	Daily Dunya	132	National	181
NNI	8	Express	115	Foreign	121
SANA	6	Daily Waqt	89	Showbiz	49
INP	4	Daily Insaf	55	Business	27
		Daily Islam	36		
		Jang	21		
		Daily Aaj	6		
		Daily Pakistan	1		

documents). The corpus contains in total 275,387 words (tokens⁸), 21,426 unique words and 10,841 sentences. The average length of a source document is 227 words while for derived documents it is 254 words. Table 3 shows detailed statistics of the proposed COUNTER corpus.

Table 3 Corpus statistics

	Source	Derived
Total number of documents	600	600
Average no of words per document	227	254
Average no of sentences per document	9	8
Smallest document (by words)	52	43
Largest document (by words)	1,377	2,481

3.3 Annotations and inter-rater agreement

The annotations were performed by three annotators (A, B and C), who were native Urdu language speakers and experts of paraphrasing mechanisms. All three were graduates, experienced in text annotations and having an advanced Urdu level. The corpus has been annotated at the document level with three classes of reuse i.e. Wholly Derived (WD), Partially Derived (PD) and Non Derived (ND). The annotations were carried out in three phases: (1) training phase, (2) annotations, (3) conflict resolving. During the training phase, annotators A and B manually annotated 60 document pairs, following a preliminary version of the annotation guidelines. A detailed meeting was carried out afterwards, discussing the problems and disagreements. It was observed that the highest number of disagreements were between PD and ND cases, as both found it difficult to distinguish between these two classes. The reason being that adjusting the threshold where a text is heavily paraphrased or new information added to it that it becomes independently written (ND). Following the discussion, the annotation guidelines were slightly revised, and the first 60 annotations results were saved. In the annotation phase, the remaining 540 document pairs were manually examined by the two annotators (A and B). Both were asked to judge, and classify (at document level)

⁸ Compound words in Urdu were treated as single words during tokenisation.

whether a document (newspaper story) depending on the volume of text rewritten from the source (news agency article) falls into one of the following categories:

Wholly Derived (WD): The News agency text is the only source for the reused newspaper text, which means it is a verbatim copy of the source. In this case, most of the reused text is word-to-word copy of the source text.

Partially Derived (PD): The Newspaper text has been either derived from more than one news agency or most of the text is paraphrased by the editor when rewriting from news agency text source. In this case, most parts of the derived document contain paraphrased text or new facts and figures added by the journalist’s own findings.

Non Derived (ND): The News agency text has not been used in the production of the newspaper text (though words may still co-occur in both documents), it has completely different facts and figures or is heavily paraphrased from the news agency’s copy. In this case, the derived document is independently written and has a lot more new text.

Table 4 Classification of document pairs in the COUNTER corpus and its comparison with METER corpus (Gaizauskas et al. 2001)

Classification	COUNTER	METER
WD	135 (22.5%)	301 (31.8%)
PD	288 (48.0%)	438 (46.3%)
ND	177 (29.5%)	206 (21.7%)

After the annotation phase, the inter-annotator agreement was computed. The inter-rater score was calculated to be 85.5% as the annotators had agreement on 513 of the 600 pairs. The Kappa Coefficient was computed to be 77.28% (Weighted Kappa 81.4%) (Cohen et al. 1960; Cohen 1968). The inter-rater agreement score of 85.5% is good, considering three levels of classification involved in the difficulty of the rating task. In the third and last phase, the conflicting 87 pairs were given to the third annotator (C) for conflict resolution. The decision of the third annotator was considered final. Out of the 600 document pairs, the final gold standard annotated dataset contains 135 (22.5%) WD, 288 (48%) PD and 177 (29.5%) ND documents. Table 4 lists the classification of documents in the COUNTER corpus and compares it with the METER corpus (Gaizauskas et al. 2001). It highlights the similarity of our corpus with METER as both corpora have majority of the documents in the PD class i.e. 48% (METER) and 46.3% (COUNTER).

3.4 Examples of text reuse cases from the corpus

This section shows examples of the WD, PD and ND document pairs from the corpus. As expected, the derived document in WD (see Figure 1) is word-to-word copy of the source document⁹. The information described in the derived text is the same as in the text reported by the news agency. In case of PD (see

⁹ Words common in both documents are underlined.

Fig. 1 Example of a WD document pair

```

<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<COUNTER_document classification="" domain="foreign" filename="0472.xml" newsdate="19.07.14"
newspaper="APP" noofwordswithSWR="96" totalnoofsentences="4" totalnoofwords="130">
<headline>
دہلی میں منعقد ہونے والی بین الاقوامی تجارتی نمائش میں شرکت کے خواہشمند اداروں سے درخواستیں طلب
</headline>
<body>
ٹریڈ ڈیولپمنٹ اتھارٹی آف پاکستان (ٹی ڈی اے پی) نے دہلی متحدہ عرب امارات میں منعقد ہونے والی تین روزہ بین الاقوامی تجارتی نمائش ”میڈیا ان
ایشیا“ میں شرکت کے خواہشمند اداروں سے درخواستیں طلب کی ہیں۔ اتھارٹی کی جاری تفصیلات کے مطابق عالمی تجارتی میلے میں ٹیکسٹائل، لیڈر اور
عام ضروریات کی اشیاء تیار و برآمد کرنے والے ادارے شرکت کے ذریعے عالمی خریداروں سے کاروباری معاملات طے کر سکیں گے جس سے ملکی
برآمدات کو فروغ حاصل ہوگا۔ ٹی ڈی اے پی نے نمائش میں شرکت کے خواہشمند اداروں سے 30 جولائی 2014 تک درخواستیں طلب کی ہیں جبکہ
عالمی تجارتی میلے 12 تا 14 اکتوبر 2014ء کے دوران دہلی میں منعقد ہوگا۔
</body>
</COUNTER_document>
-----
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<COUNTER_document classification="WD" domain="foreign" filename="0472p.xml"
newsdate="20.07.14" newspaper="daily_dunya" noofwordswithSWR="120" totalnoofsentences="6"
totalnoofwords="169">
<headline>
دہلی میں عالمی تجارتی نمائش میں شرکت کیلئے درخواستیں طلب
</headline>
<body>
ٹیکسٹائل، لیڈر اور عام ضروریات کی اشیاء تیار و برآمد کرنے والے ادارے شرکت کریں گے نمائش میں شرکت کیلئے درخواستیں 30 جولائی تک جمع کروائی
جاسکتی ہیں۔ ٹریڈ ڈیولپمنٹ اتھارٹی آف پاکستان (ٹی ڈی اے پی) نے دہلی متحدہ عرب امارات میں منعقد ہونے والی 3 روزہ بین الاقوامی تجارتی
نمائش ”میڈیا ان ایشیا“ میں شرکت کے خواہشمند اداروں سے درخواستیں طلب کی ہیں۔ اتھارٹی کی جاری تفصیلات کے مطابق عالمی تجارتی میلے میں
ٹیکسٹائل، لیڈر اور عام ضروریات کی اشیاء تیار و برآمد کرنے والے ادارے شرکت کے ذریعے عالمی خریداروں سے کاروباری معاملات طے کر سکیں گے
جس سے ملکی برآمدات کو فروغ حاصل ہوگا۔ ٹی ڈی اے پی نے نمائش میں شرکت کے خواہشمند اداروں سے 30 جولائی 2014 تک درخواستیں طلب
کی ہیں جبکہ عالمی تجارتی میلے 12 تا 14 اکتوبر 2014ء کے دوران دہلی میں منعقد ہوگا۔ میلے میں شرکت کیلئے دیگر تفصیلات اتھارٹی کی ویب سائٹ سے
بھی حاصل کی جاسکتی ہیں۔
</body>
</COUNTER_document>

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Figure 2), source text has been rephrased by changing the passages with different paraphrasing techniques. Also, in some cases, the derived text contains additional events not reported by the new agency source. For ND (see Figure 3), a lot more new information has been added in the derived document independently without using the source. For standardisation purposes, the documents in the corpus have been saved as standard XML documents. Details of the XML tags and DTD can be found in the README file available with the corpus.

3.5 Linguistic analysis of the corpus

There are numerous ways to rewrite texts and in the previous studies, researchers have classified the ‘edit operations’ (paraphrase mechanisms) into different types, in different corpora, to form paraphrase topologies (Clough 2003; Barrón-Cedeño et al. 2013; Vila et al. 2014). Following the same approach, we also identified the paraphrase mechanisms used (by journalists) to formulate the newspaper story (derived document), in our corpus.

Fig. 2 Example of a PD document pair

```

<?xml version="1.0" encoding="UTF-8"?>
<COUNTER_document totalnoofwords="181" totalnoofsentences="5" noofwordswithSWR="118"
newspaper="APP" newsdate="24.11.14" filename="0318.xml" domain="national" classification="">
<headline>
وزیر اعظم محمد نواز شریف کا اعلان صدر اشرف غنی کو فون صوبہ پکٹیا میں خود کش دھماکے میں 50 سے زائد افراد کی ہلاکت پر گہرے دکھ اور افسوس کا اظہار کرتے ہوئے
اظہار
</headline>
<body>
وزیر اعظم محمد نواز شریف نے اعلان صوبہ پکٹیا میں خود کش حملے کے نتیجے میں 50 سے زائد افراد کی ہلاکت پر گہرے دکھ اور افسوس کا اظہار کرتے ہوئے
کہا ہے کہ پاکستان اور افغانستان مشترکہ جدوجہد کے ذریعے دہشت گردی کا خاتمہ کرنے میں کامیاب ہونگے۔ پیر کو وزیر اعظم نے افغانستان کے صدر
اشرف غنی کو ٹیلیفون کیا جس میں انہوں نے گزشتہ روز افغان صوبہ پکٹیا میں خود کش دھماکے کے نتیجے میں 50 سے زائد افراد کی ہلاکت پر گہرے دکھ اور
افسوس کا اظہار کیا۔ اعلان صدر سے بات چیت کرتے ہوئے وزیر اعظم محمد نواز شریف نے خود کش حملے کی مذمت کی اور اسے بزدلانہ اقدام قرار دیا۔
وزیر اعظم نے اعلان ہما نیوں کے ساتھ چیچکی کا اظہار کرتے ہوئے اس تھین کا اظہار کیا کہ پاکستان اور افغانستان باہم مل کر دہشت گردی کا خاتمہ کرنے
میں کامیاب ہونگے۔
</body>
</COUNTER_document>
-----
<?xml version="1.0" encoding="UTF-8"?>
<COUNTER_document totalnoofwords="161" totalnoofsentences="8" noofwordswithSWR="101"
newspaper="daily_dunya" newsdate="25.11.14" filename="0318p.xml" domain="national"
classification="PD">
<headline>
دہشتگرد مشترکہ دشمن ہیں، نواز شریف کا اعلان صدر غنی کو فون بزدلانہ کارروائیوں سے دونوں ملکوں کے عوام گھبرانے والے نہیں رہیں گے دھماکے پر
افسوس
</headline>
<body>
وزیر اعظم محمد نواز شریف نے اعلان صدر اشرف غنی کو ٹیلی فون کیا اور پکٹیا میں ہونے والے دھماکے پر اظہارے افسوس کیا ہے۔ وزیر اعظم ہلاکت کے
مطابق وزیر اعظم محمد نواز شریف نے ہر دھماکے میں انسانی جانوں کے ضیاع پر افسوس کا اظہار کیا۔ وزیر اعظم کا کہنا تھا کہ دہشت گرد پاکستان اور افغان عوام
کو کبھی شکست نہیں دے سکتے۔ بزدلانہ کارروائیوں سے دونوں ملکوں کے عوام گھبرانے والے نہیں ہیں۔ انہوں نے دہشت گردوں کو ممالک کے
مشترکہ دشمن ہیں اور دونوں ممالک مشترکہ طور پر اس پر لعنت کا خاتمہ کر رہے ہیں۔ اس موقع پر افغان صدر نے وزیر اعظم کا شکر ادا کیا۔ ذرائع کے
مطابق وزیر اعظم نے اعلان صدر سے منظر کی صورت حال پر بھی تبادلہ خیال کیا۔ دونوں رہنماؤں کے درمیان پانچ منٹ تک گفتگو ہوئی رہی۔
</body>
</COUNTER_document>

```

The typology (see Table 5) we followed, to present a linguistic analysis of our corpus, consists of a concise but concrete list of linguistic phenomena underlying paraphrasing. It is a two level typology, with 6 classes and 14 paraphrasing types. At the first level, each class describes the nature of paraphrase phenomenon while a second more fine-grained level lists the actual paraphrase mechanism used.

In the following discussion, we describe each of the 14 types of our typology with examples¹⁰ from our corpus.

Morphology-based changes

Inflectional changes often involves changing a grammatical category (e.g. from singular to plural or vice versa) with a prefix/suffix. In the example below, word [wickets] is transformed into [wicket] to produce the change.

S: پاکستان کے 4 [وکٹوں] پر 261 رنز

D: پاکستان کے 4 [وکٹ] پر 261 رنز

¹⁰ The examples shown here are just small fragments extracted from the source/derived documents. Refer to Section 3.4 to see full examples of source/derived documents. The words/phrases in focus of discussion are enclosed in square brackets to emphasize them.

Fig. 3 Example of a ND document pair

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<COUNTER_document classification="" domain="national" filename="0581.xml" newsdate="28.10.14"
newspaper="APP" noofwordswithSWR="295" totalnoofsentences="15" totalnoofwords="511">
<headline>
تمام سیاحی تمامش ایشیا کے ہٹ کر ملک کی بہتر کیلئے ورنگلہ دیشپ کو بہتر کریں۔ سندھ اس کا متحمل نہیں ہو سکتا کہ یہاں قوتیں کے
مچھلے بڑھیں، خوردیہ شاہ سید ہیں وہاں پہنچنے والی تو قین نہیں کر سکتے، مسلم لیگ ق قتلش اس مسئلہ کے حل کے لئے اپنا کردار ادا کرے۔ ایسے ہی جماعت
اسلامی سراج اعلیٰ کی پیر صاحب پھارا سے ملاقات کے بعد میڈیا سے گفتگو
</headline>
<body>
ایسے جماعت اسلامی سراج اعلیٰ نے کہا ہے کہ تمام سیاحی تمامش کو چاہئے کہ وہ سیاحی ایشیا کے ہٹ کر ملک کی بہتر کیلئے آہیں میں ورنگلہ دیشپ
کو بہتر کریں، سندھ اس کا متحمل نہیں ہو سکتا کہ یہاں قوتیں کے مچھلے بڑھیں سندھ کی ترقی پاکستان کی ترقی ہے۔ خوردیہ شاہ سید ہیں وہاں پہنچنے
والی تو قین نہیں کر سکتے، مسلم لیگ ق قتلش اس مسئلہ کے حل کے لئے اپنا کردار ادا کرے۔ ان خیالات کا اظہار انہوں نے منگل کو راجہ پور اس کراچی میں پیر
صاحب پھارا پیر صفت اللہ سے ملاقات کے بعد میڈیا سے گفتگو کرتے ہوئے کیا۔ اس موقع پر وفاقی وزیر سندھ پکا پستانانی وفاقی ترقی پیر صدر الدین شاہ
راشدی، چیئر مین راجہ پور، حضرت عمر عباسی، کامران نیسوری، خیر حیات منگل پور اور دیگر بھی موجود تھے۔ سراج اعلیٰ نے کہا کہ پیر صاحب پھارا سے
ملاقات کی کافی عرصے سے خواہش تھی، آج ان سے اور ان کے بھائی پیر صدر الدین راشد سے تفصیلی ملاقات ہوئی ہے۔ انہوں نے کہا کہ ملک میں عام
آدی کے مسائل ہیں لیکن اس جانب کوئی توجہ نہیں، سے رہا ہم چاہتے ہیں تمام سیاحی قیادت آپس کے اختلافات بھلا کر بیٹھیں اور عام آدمی جو جوت
مزدوری کر کے اپنے بچوں کو کھاتا ہے وہ عطا ہے وہ عطا ہے وہ عطا ہے۔ انہوں نے کہا کہ موجودہ لکھنؤ کیلئے قہر آکر لکھنؤ سے تو پھر ملک کی بحالی ہو گا
اس لئے لکھنؤ، ریلوے سروس اور لکھنؤ سسٹم کو بہتر کیا جائے۔ انہوں نے یہ بھی کہا ہے کہ ایک پلڈا ہے اسلام آباد میں دھرنے کے خاتمے کا اعلان کیا
ہے لیکن ملک کا سیاحی پیران غم کرتے کیلئے حکومت اور عمران خان کو مزاکرات کی بجائے جتنی جتنی سراج اعلیٰ نے کہا کہ عزم اور کامیابی ہے اس
لئے میں لکھنؤ کرنا ہوں کہ آپس کے اتفاق کو بھلا جائے حضرت امام حسینؑ کی ایک فرسٹ کہ نہیں تھے اس لئے پوری دنیا میں اچھا پیغام جا رہا ہے۔ انہوں
نے کہا کہ میں نے پیر صاحب پھارا اور ان کے بھائی پیر صدر الدین راشد کو ضروری طور پر ملنے کے لئے دعوت دی ہے جو انہوں نے قبول کی ہے۔ اس موقع پر
پاکستان لیگ ق قتلش سندھ کے صدر پیر صدر الدین راشد نے کہا کہ ہمیں ایسے جماعت اسلامی اور ان کے ساتھ راجہ پور اس آکر شکر ادا کرنا ہوتا ہے۔
انہوں نے کہا کہ ہمارے اور ان کے بزرگوں کے تعلقات تھے۔ انہوں نے کہا کہ ہماری ملاقات میں فیڈریشن کیلئے ہونے کے لئے عمل کرنا کو مشکل ہے
اتفاق ہوا ہے۔ انہوں نے کہا کہ اس ملاقات کے اچھے نتائج تھیں گے۔
</body>
</COUNTER_document>
-----
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<COUNTER_document classification="ND" domain="national" filename="0581p.xml"
newsdate="29.10.14" newspaper="nawa-e-waqt" noofwordswithSWR="281" totalnoofsentences="17"
totalnoofwords="470">
<headline>
4 سو سے جا کر لاکھوں پر 20 بنا، سراج اعلیٰ: پیر پھارا سے ملاقات، جمہوری سسٹم کے تحفظ پر اتفاق
</headline>
<body>
جماعت اسلامی کے امیر سراج اعلیٰ اور چیئر پھاری کے رہنما سابق وزیر اعظم یوسف رضا گیلانی نے گزشتہ روز کراچی میں قتلش لیگ کے سربراہ پیر پھارا
صیغہ اللہ راشد سے اکی بائش گھنٹہ طویل ملاقاتیں کیں۔ جن میں ملک کی موجودہ صورت حال پر تبادلہ خیال کیا گیا۔ سراج اعلیٰ نے صحافیوں سے
گفتگو کرتے ہوئے کہا کہ جب تک ملک میں عدل و انصاف کا موثر نظام قائم نہیں ہو گا تو ملک میں امن نہیں ہو سکتا۔ پیر پھارا کے ساتھ ملاقات بہت اچھی
رہی۔ ہم نے اتفاق کیا ہے کہ ملک کی سلامتی، عقائد اور جمہوری نظام کے تحفظ کے لئے ہم آپس میں تعاون کریں گے اور مشاورت کا یہ عمل جاری رکھیں
گے۔ انہوں نے کہا کہ عوام کے اندر مایوسی، غم و فساد ہے کہ سیاحی قہر نے مل کر مسائل کا حل نہ نکالا تو عوام کی یہ خاموشی اور اضطراب کسی حد سے
طوفان کا پھول بنے گا۔ سراج اعلیٰ نے کہا کہ ملاقات میں اس بات پر اتفاق کیا گیا کہ موجودہ لکھنؤ سسٹم کے اندر ریلوے سروس اور
ان ریلوے کے لئے سب کو اچھوٹا کر لیا جائے، موجودہ سسٹم کے تحت ہونا اچھا ہے۔ ملاقات سے تازہ جات کا خاتمہ نہیں ہو سکے گا۔ سراج اعلیٰ نے کہا کہ پیر
4 سو سے جا کر لاکھوں پر 30، چالیس بنائیں، 4 سو سے چلنے نہیں باقی کیسے چلا جائے۔ انہوں نے کہا کہ جلد از جلد پلڈا پٹی اتفاق ہوتے کہ اسے جائیں، لڑائی
سے کچھ ہاتھ نہیں آئے، ہو سکتا ہے سیاست اور جمہوریت کا خاتمہ ہو جائے۔ دریں اثنا چیئر پھاری کے رہنما سابق وزیر اعظم یوسف رضا گیلانی نے بھی
پیر پھارا سے اکی بائش گھنٹہ ملاقات کے سیر کی صورت حال پر تبادلہ خیال کیا۔ اس موقع پر لکھنؤ کر کے ہوئے پیر پھارا نے کہا کہ کوئی فورس ہے جو
کریٹین کریٹواؤں کا استیصال کرے۔ استیصال سے پہلے انکیشن کو کافی فائدہ نہیں ہو گا۔ انہوں نے کہا کہ وزیر اعظم نواز شریف کو صرف پنجاب کی گھر سے
دیگر صوبوں یا وفاقی کی نہیں، مذاہم ملک کیلئے خطرناک ہو سکے، موجودہ دور میں کریٹین کے سارے ریکارڈ ڈوٹ گئے۔ دوسری طرف کراچی میں
تقریب سے خطاب کرتے ہوئے سراج اعلیٰ نے کہا کہ پاکستان کو ترقی دینے کے لئے زیادہ خطہ ہارٹھ ہے۔ کراچی والوں نے 20 سال اگیا کیوں کہ
دوٹ دیئے، ہم انہیں متفق نہیں لے۔ انہوں نے کہا کہ ایک ڈاکٹر کا نام ہو تو دوسرے کے پاس ملائے کیلئے ہانا چاہئے ہے کراچی والوں کی طرف پلڈا آؤ۔
انہوں نے کہا کہ میں 70 دن سے دھرنے والوں کے پاس جا رہا ہوں دو دنوں کے رہناؤں سے موہ گئی اور غربت کیلئے کلمہ چہا کرنے کو کہا ہے۔
جو اب یہاں ہمارا کام نہیں ہم آپس میں لڑینگے میں نے بھی کہا لڑتے ہو گئی تم ایک کی چوٹا ایک کی دم۔
</body>
</COUNTER_document>
```

Derivational changes consists of word alteration that forms a new word by adding an affix to the root form of the word. In the example below, the word [Pakistan-i] (adjective) is changed to [Pakistan] (noun).

Table 5 The paraphrase typology showing 6 classes and 14 types.

Class	Type
Morphology-based changes	Inflectional changes Derivational changes
Lexicon-based changes	Spelling and format changes Same-polarity substitutions Synthetic-analytic substitutions Opposite-polarity substitutions
Syntax-based changes	Diathesis alterations Negation switching
Discourse-based changes	Punctuation and format changes Direct/Indirect style alterations
Semantics-based changes	Semantic changes
Miscellaneous changes	Change of order Addition/deletion of information English to Urdu translation changes

S: امریکی منڈیوں میں [پاکستانی] مصنوعات کیلئے بہتر رسائی کی ضرورت ہے

D: [پاکستان] کی ایشیا کی امریکی منڈیوں تک رسائی ضروری ہے

Lexicon-based changes

Spelling and format changes are lexical changes that occur in the spellings and representation of the text (e.g. abbreviations, or digit/letter alternations). In example below, abbreviations are changed to their full forms.

S: پشاور بینتھرز، [این بی پی]، راولپنڈی ریمز، [یو بی ایل] شامل ہیں

D: پشاور بینتھرز، [نیشنل بینک آف پاکستان]، ...، راولپنڈی ریمز اور [یونائیٹڈ بینک لمیٹڈ] شامل ہیں

Same-polarity substitutions comprises of replacing the appropriate word or phrase with similar meaning (synonym). The corpus text has many such examples, the sentence below shows a word in the source text [victim] substituted with [suspected case] in the derived text.

S: ایبولا وائرس سے [متاثرہ شخص] ہسپتال میں علاج کے دوران جاں بحق ہو گیا

D: فیصل آباد میں ایبولا کا [مشتبہ مریض] دم توڑ گیا

Synthetic/analytic substitutions involves addition/deletion of single to multiple lexical terms that do not affect the meaning of the word. The example that follows shows specifier deletions in the derived text.

S: اس فلم میں شاہد کپور کے والد [معمّر اداکار پنکج کپور] اور [سوتیلی] بین ثناء نے بھی کام کیا ہے

D: اس فلم میں میرے والد اور بین ثناء نے بھی کام کیا ہے

Opposite-polarity substitutions contains change in the word or phrase with its antonym. However, to preserve the meaning, either double polarity change or inverse argument is needed. In the first example text from our corpus, [lose] is replaced with [success] and another substitution [win] is added in the derived text.

S: نیوزی لینڈ نے پاکستان کو دلچسپ مقابلے کے بعد 2-3 گول سے [ہرا] دیا

D: نیوزی لینڈ نے میچ 2-3 سے [جیت] کر ٹورنامنٹ میں پہلی [کامیابی] حاصل کر لی

The second example again shows an antonym substitution, but to preserve the meaning, the order of the subject (country name i.e. New Zealand) is shuffled.

S: کیوی ٹیم 2-3 گولز سے [فتح یاب]

D: پاکستان کو نیوزی لینڈ سے [شکست]

Diathesis alternations are changes that occur when a participating verb can be used in its various diathesis frames.

S: امریکی یرغمال کے والدین کی داعش سے رحم نلی کی اپیل

D: رحم کریں اور ہمارے بیٹے کو چھوڑ دیں، امریکی والدین کی داعش سے اپیل

Syntax-based changes

Negation switching in a text occurs when swapping a ‘negation term’ occurrence. The below example depicts one such occurrence in our corpus.

S: ویسٹ انڈیز نے سنیل نارائن کو بھارت کے خلاف [تہ] کھلانے کا فیصلہ کر لیا

D: مایہ ناز آف سپر سنیل نارائن دورہ بھارت کے دوران ٹیم کی نمائندگی [نہیں] کریں گے

Discourse-based changes

Direct/indirect style alternations changes employ active to passive style changing and vice versa. In the example below, the statement is expressed in direct and indirect style.

S: رابن ولیمز کی پراسرار موت سے متعلق تحقیقات شروع ہو گئی ہیں جس میں خودکشی کے پہلو کو بھی مد نظر رکھا جائے گا

D: ان کی موت بظاہر خود کشی کا نتیجہ معلوم ہوتی ہے لیکن ابھی تحقیقات جاری ہے

Punctuation and format changes often include changes that appear due to placement of punctuation marks or change in format of text. Normally these changes do not effect the lexical units. The first part of the following example shows punctuation mark (,) added in the derived text. Further, the sentence delimiter (.) is replaced with a comma to add a new clause in the derived sentence.

S: کشمیر اور تلنگانہ بھارت کا حصہ نہیں بھارتی رکن پارلیمنٹ

D: کشمیر، تلنگانہ بھارت کا حصہ نہیں، سرحد بدلی جائے، رکن لوک سبھا

Semantics-based changes

Semantic changes consist of rephrasing lexical units in the derived text by adding new words or word patterns but of the similar contents. The COUNTER corpus has plentiful examples of such cases. The one case shown in the example below highlights the words [Iraqi militants] replaced with [ISIS] and [approved] rephrased as [declared] in the derived sentence.

S: اوباما نے [عراقی عسکریت پسندوں] کے خلاف فضائی حملوں کی [منظوری دے دی]

D: امریکا نے [داعش] کے خلاف فضائی حملوں کا [اعلان کر دیا]

Miscellaneous changes

Add/delete information often implies compression or expansion of the source text. The lexical and functional units are added to or deleted from the source text to recompose it.

S: تیراہ میں امن لشکر پر خودکش حملہ، 5 افراد جاں بحق، 7 زخمی ہو گئے

D: وادی تیراہ میں امن لشکر پر خود کش حملہ، 7 افراد جاں بحق

Change of order includes any type of change of order from the word level to the sentence level. In the example, a word [noun: Nawaz Sharif] and a phrase [verb: do not care] changed their position in the derived text.

S: وزیر اعظم [نواز شریف] نے کہا ہے کہ عوام تبدیلی اور انقلاب والوں کی [پروا نہ کریں] وہ ملک کا کچھ نہیں بگاڑ سکتے

D: عوام [پروا نہ کریں]، تبدیلی اور انقلاب والے ملکی ترقی نہیں روک سکتے: [نواز شریف]

English to Urdu translation changes consists of changes that occur when an English word written using Urdu script can be rewritten by translating it into Urdu language word. Our corpus is rich with such examples, some of which are added below.

S: آسٹریلیا نے 49 [گولڈن]، 42 [سلور] اور 46 [برائنز] [میڈلز] کے ساتھ دوسری پوزیشن حاصل کی

D: آسٹریلیا 49 [سونے]، 42 [چاندی]، 46 [کانسی] سمیت 137 [تمغوں] کیساتھ دوسرے نمبر پر رہا

S: مچل جونسن اور مچل اسٹارک نے [نصف سنچریاں] جڑیں

D: مچل جونسن اور اسٹارک [فٹتیز] بنانے میں سرخرو رہے

To show which paraphrase mechanisms are most frequently used (by journalists) to constitute the newspaper stories, we took a subset of first 50 documents from the corpus¹¹ and calculated the paraphrase type frequencies for each of the 14 types (see Table 5).

Table 6 Paraphrase type frequencies occurring within the 50 document subset corpus. Bold values are the sum of the corresponding types within the main classes.

	$frequencies_{abc}$	$frequencies_{rel}$
Morphology-based changes	17	0.030
— Inflectional changes	8	0.014
— Derivational changes	9	0.016
Lexicon-based changes	212	0.379
— Spelling and format changes	6	0.011
— Same-polarity substitutions	174	0.312
— Synthetic/analytic substitutions	24	0.043
— Opposite-polarity substitutions	8	0.014
Syntax-based changes	18	0.032
— Diathesis alternations	11	0.019
— Negation switching	7	0.012
Discourse-based changes	47	0.084
— Punctuation and format changes	18	0.032
— Direct/indirect style alternations	29	0.052
Semantics-based changes	112	0.200
— Semantic changes	112	0.200
Miscellaneous changes	152	0.272
— Change of order	32	0.057
— Addition/deletion of information	94	0.168
— English to Urdu translation changes	26	0.046

Table 6 shows that ‘Same-polarity substitutions’ emerges as the most frequent (0.312) paraphrase type present in the subset of the corpus, followed by ‘Semantic

¹¹ This sub-corpus is also available to download with the main corpus.

changes' (0.200) and 'Addition/deletion of information' (0.168) which also contribute to a major extent¹². This was expected as the corpus text (of derived documents) is reformulated by journalists and in the process they have opted for the most simple paraphrase mechanism i.e. substituting words with others of more or less the same meaning. Closely related to this, and in general, are the semantic changes which involve replacing lexical units. Moreover, journalistic writing involves an editor's own observations which naturally results in the addition/deletion of information. We conclude that same polarity substitutions, semantic changes and addition/deletion of information are the most favourite mechanism used by journalists as they are relatively easy to apply and preferable by individuals when reusing text.

4 Text reuse similarity estimation methods

In the past, different text similarity estimation methods have been proposed based on syntactic or semantic features (Clough et al. 2002a; Mihalcea et al. 2006; Daniel et al. 2012). This section describes a few popular text similarity estimation methods that we choose to apply on the corpus in order to show how it can be used in the evaluation of state-of-the-art methods for text reuse detection. These methods generate similarity scores, by comparing each source-derived document pair, based on features which can be derived from the given texts. The higher the score the more similar the contents of the two documents (Wise 1992; Brin et al. 1995; Gitchell and Tran 1999; Lyon et al. 2001).

We choose to apply a range of methods, based on three different characteristics i.e. content, structure or style of the given text (Daniel et al. 2012). For content based methods, we chose Word n -grams overlap (see Section 4.1), Vector Space Model (VSM) (see Section 4.3), Longest Common Subsequence (LCS) (see Section 4.4) and Greedy String-Tiling (GST) (see Section 4.5). For structural similarity we opted for Stop-words based n -grams overlap (see Section 4.2) and for stylistic features extraction, we applied sentence/token ratio (see Section 4.6).

4.1 Word n -grams overlap

One of the popular methods, word n -grams overlap, computes the resemblance of a document pair by simply calculating the common n -grams and dividing it by the length of one or both documents. The method has already proven to provide good results for detecting plagiarism (on mono-lingual English corpora) (Lane et al. 2006; Barrón-Cedeño et al. 2009; Clough and Stevenson 2011), detection of near duplicates (Shivakumar and Garcia-Molina 1995) and measuring text reuse (Clough et al. 2002a; Chiu et al. 2010). In our experiments, we used the Containment similarity co-efficient measure¹³ (Broder 1997) to compute similarity between document pairs (see Equation 1).

¹² We expect that the paraphrase types occurring most frequently in the subset of the corpus will be reflected with similar proportions in the whole corpus since this subset is a substantial representative sample of the whole corpus.

¹³ We also applied Jaccard, Dice and Overlap similarity coefficients but the results were low when compared to Containment similarity measure. Therefore, we only reported results with Containment measure in this study.

$$C_n(X, Y) = \frac{|S(X, n) \cap S(Y, n)|}{|S(X, n)|} \quad (1)$$

In the above equation, $S(X, n)$ and $S(Y, n)$ represents the number of unique word n -grams (tokens) of size n in documents X and Y , respectively. The method computes how much content (word n -grams) of the document X is shared by Y . Further, it generates a similarity score between 0 and 1. A similarity score of 0 means that the two documents have no common word n -grams whereas 1 means that all the word n -grams are common. The scores are reported for sets of n -grams of length $[1 - 5]$, to indicate the degree of similarity between source-derived document pairs for various lengths of n . Moreover, we experiment both with and without text preprocessing. During text preprocessing, all punctuation marks, illegal characters¹⁴ (if any) and stop-words were removed.

4.2 Stop-words based n -grams overlap

Another method, however grounded on the syntactic similarity, between source and derived document pair, is stop-words based n -grams overlap (Stamatatos 2011). The method works with a list of stop-words (also known as very frequent words) and the fact that these words are often preserved while modifying texts where the editor commonly replaces or rearranges content words (with synonyms). In our experiments, we first extracted all the stop-words¹⁵ from a source-derived document pair. Secondly, all the stop-words based n -grams of both documents were then compared using the same Equation 1 i.e. Containment measure.

The similarity scores between source-derived document pairs are computed for sets of stop-words based n -grams of length $[1 - 5]$.

4.3 Vector Space Model

Vector Space Model (VSM) or its variants (Salton et al. 1975), originally proposed for IR, have recently been used in the experiments on text reuse (Clough 2003; Bendersky and Croft 2009) and detecting document duplicates (Hoad and Zobel 2003; Runeson et al. 2007). Moreover, it was a popular choice for majority of the participating systems in the PAN Competitions (Sanchez-Perez et al. 2014).

In VSM, both source and derived documents are represented as term (word or phrase) vectors. The number of unique terms in each document corresponds to a dimension in the vector space. The similarity between both (source-derived document pair) vectors is measured by the cosine similarity measure (the angle between them), calculated as:

$$sim(d_{SOU}, d_{DER}) = \frac{\overrightarrow{d_{DER}} \bullet \overrightarrow{d_{SOU}}}{|\overrightarrow{d_{DER}}| \times |\overrightarrow{d_{SOU}}|} = \frac{\sum_{i=1}^n d_{DERi} \times d_{SOUi}}{\sqrt{\sum_{i=1}^n (d_{DERi})^2 \times \sum_{i=1}^n (d_{SOUi})^2}} \quad (2)$$

¹⁴ The characters that are not part of the standard Urdu language character set.

¹⁵ The stop-words list that we used is available with the corpus download.

where $|\overrightarrow{d_{DER}}|$ and $|\overrightarrow{d_{SOU}}|$ represent the lengths of the derived and source document vectors respectively. Before computing the similarity, we applied the popular *tf.idf* (see Equation 3) weighting scheme (Jurafsky et al. 2000) to weight individual terms in the source and derived documents.

$$tfidf_{i,d} = tf_{i,d} \cdot idf_i = \frac{n_{i,d}}{\sum_k n_{k,d}} \cdot \log \frac{|D|}{|D_i|} \quad (3)$$

Using the VSM method, we also investigated the effect of stop-words removal.

4.4 Longest common subsequence

Longest Common Subsequence (LCS) is another similarity estimation method used in our experiments. In LCS, the degree of resemblance between a document pair is calculated by taking into account the total number of changes made when the text was rewritten. In the first step, both documents are represented as sequences of tokens (words or phrases). Given a piece of text (called sub-string), a subsequence is a contiguous stream of tokens even if some terms are removed from that sub-string. Let us assume, X and Y are two strings (texts) to be compared, then *LCS* is the longest subsequence *common* between them. For example, if $X = "123456"$ and $Y = "129456"$, then *456* is a subsequence and *12456* is the longest common subsequence.

A normalised similarity score (LCS_{norm}) (see Equation 4), is computed by dividing the length of LCS ($|LCS(X, Y)|$) with the length of shorter string.

$$LCS_{norm}(X, Y) = \frac{|LCS(X, Y)|}{\min(|X|, |Y|)} \quad (4)$$

Moreover, the LCS algorithm is order preserving. The length of LCS_{norm} shows the modifications in the text caused by lexical substitutions, word re-ordering and other text altering operations. Again, similar to other methods, the effect of pre-processing was explored for this method as well.

4.5 Greedy String-Tiling

The Greedy String-Tiling (GST) algorithm is based on sub-string matching and was proposed for identifying biological sub-sequences and computing similarity between free texts (Wise 1992). GST can detect *block move* (caused by transposition of tokens), which are missed by LCS (Longest Common Subsequence, see Section 4.4) method. GST method tries to find a 1 : 1 match of tokens between two texts, such that one sequence of tokens is covered with maximum length (called tiles) sub-strings from the other. However, to avoid specious matches of very small lengths, a minimum Match Length (mML) value is used.

In our experiments, we were interested to know how much derived text (words) is overlapped with source text. So, given source a document X , a derived document Y and a set of matching tiles of a given length between the two documents, the similarity, $gst\text{-sim}(X, Y)$, is obtained using Equation 5

$$gst - sim(X, Y) = \frac{\sum_{i \in tiles} length_i}{|Y|} \quad (5)$$

The GST experiments are conducted on the corpus, both with and without text preprocessing.

4.6 Sentence/Token ratio

Based on the fact that rewritten texts are, to a certain degree, similar in terms of stylistic features, we also experiment with statistical properties of texts to estimate similarity among them. We applied two simple methods, sentence ratio and token ratio (Yule 1939) to compute average number of sentences and tokens respectively. As the corpus contains news stories, documents are mostly structured as single paragraph essays. Therefore, we computed the number of sentences per document and the average number of tokens per sentence¹⁶. Further, for sentence ratio we computed the ratio of sentences whereas for token ratio we compared the average token length between the reused text and the source text.

5 Experimental set-up

5.1 Dataset

For the set of experiments carried out in this study, the entire COUNTER Corpus is used (see Section 3). There are total 600 document pairs in the corpus (WD = 135, PD = 288 and ND = 177).

5.2 Evaluation methodology

In the experiments performed, to distinguish between multiple levels of Urdu text reuse at document level, the problem is tackled as a supervised classification task. We used both binary and ternary classifications of the task. In the former, the target is to differentiate between 2 classes (i.e. Derived (D) and Non Derived (ND)) while in the latter case, the target is to differentiate between 3 classes (i.e. Wholly Derived (WD), Partially Derived (PD) and Non Derived (ND)). For the binary classification task, the documents categorised as Wholly Derived and Partially Derived are coupled to make the “Derived” class while the documents categorised as Non Derived are part of the “Non Derived” class. Due to the adequate number of examples (600) present in the corpus, and to better evaluate the performance of the similarity estimation methods used, we applied 10-fold cross-validation. The WEKA¹⁷ (Hall et al. 2009; Witten et al. 2011) implementations of the Bayes theorem based Naïve Bayes classifier, with its default parameter settings, is used for the classification task. Naïve Bayes is appropriate for these kind of experiments as

¹⁶ For sentence boundary detection, we used potential sentence termination markers such as ‘,’ and ‘!’.

¹⁷ <http://www.cs.waikato.ac.nz/ml/weka/> Last visited: 16-06-2016

it can handle the numeric features generated by the similarity estimation methods applied on the corpus (see Section 4). The similarity scores for each source-derived document pair are used as features for the classifier. Weighted average F_1 results are computed and reported for both binary and ternary classification tasks.

6 Results and analysis

Table 7: Weighted average F_1 results for binary and ternary classification tasks using different text reuse detection methods

	Binary	Ternary
Content based measures		
Word n-grams overlap		
Uni-gram	0.80	0.73
Uni-gram + SWR	0.80	0.72
Bi-gram	0.66	0.64
Bi-gram + SWR	0.70	0.68
Tri-gram	0.57	0.56
Tri-gram + SWR	0.60	0.64
Four-gram	0.52	0.52
Four-gram + SWR	0.55	0.57
Five-gram	0.49	0.52
Five-gram + SWR	0.50	0.53
Combined	0.56	0.54
Combined + SWR	0.57	0.57
Vector Space Model		
VSM	0.66	0.54
VSM + SWR	0.64	0.53
Longest Common Subsequence		
LCS	0.77	0.70
LCS + SWR	0.77	0.71
Greedy String Tiling		
mML1	0.81	0.72
mML1 + SWR	0.81	0.73
mML2	0.77	0.71
mML2 + SWR	0.74	0.67
mML3	0.70	0.65
mML3 + SWR	0.63	0.60
mML4	0.63	0.60
mML4 + SWR	0.60	0.57
mML5	0.58	0.59

mML5 + SWR	0.55	0.53
mML6	0.56	0.53
mML6 + SWR	0.53	0.51
mML7	0.54	0.52
mML7 + SWR	0.48	0.50
mML8	0.51	0.50
mML8 + SWR	0.46	0.50
mML9	0.47	0.49
mML9 + SWR	0.44	0.47
mML10	0.46	0.49
mML10 + SWR	0.43	0.45
Structure based measures		
Stop-words based n-grams overlap		
Stop-words Uni-gram	0.58	0.40
Stop-words Bi-gram	<u>0.63</u>	0.42
Stop-words Tri-gram	0.47	0.44
Stop-words Four-gram	0.41	<u>0.46</u>
Stop-words Five-gram	0.35	0.34
Stop-words Combined	0.40	0.37
Style based measures		
Sentence/Token Ratio		
Sentence Ratio	<u>0.58</u>	0.32
Token Ratio	<u>0.68</u>	0.45
Combination of features		
All features combined	0.70	0.68

Table 7 presents Naïve Bayes classifier reported F_1 results on the COUNTER corpus for the binary and ternary classifications tasks using Word n -grams overlap, Vector Space Model, Longest Common Subsequence, Greedy String Tiling, Stop-words based n -grams overlap and Sentence/Token ratio methods. *Uni-gram* means that the results are obtained using word 1-gram as a single feature for the classifications task. Similarly, *Bi-gram*, *Tri-gram*, *Four-gram* and *Five-gram* means that the results are obtained using word 2-grams, 3-grams, 4-grams and 5-grams respectively as a single feature. *Combined* means that results are obtained by similarity scores of word unigram, bigrams, trigrams, fourgrams and fivegrams as a set of features (5 features) for the classification task. *SWR* after each method means that the similarity score is computed for the method after removing stop-words. Likewise, *Stop-words Uni-gram* means that the results are reported using stop-words based 1-gram, *Stop-words Bi-gram* means stop-words based 2-grams, *Stop-words Tri-gram* means stop-words based 3-grams, *Stop-words Four-gram* means stop-words based 4-grams, *Stop-words Five-gram* means stop-words based 5-grams

and *Stop-words Combined* means that similarity scores of stop-words based n -grams of length 1 – 5 are used as a set of features (5 features) for the classification tasks. *VSM* means results obtained using Vector Space Model, *LCS* means results obtained using Longest Common Subsequence and *GST* means results obtained using Greedy String Tiling methods. For GST, *mML1* to *mML10* means results with minimum match lengths of tiles from 1 to 10, respectively. Again, *SWR* means results computed after stop-words removal. In the last part of the table, “All features combined” means that the results are reported by combining features of all the methods used in this study. The best results obtained overall are presented as bold letters whereas best results obtained category-wise are underlined in the table.

From Table 7, as expected, overall, results are lower for the ternary classification task (best $F_1 = 0.73$) compared to the binary classification task (best $F_1 = 0.81$). For both classifications, the same pattern of differences in the results can be seen across all the methods used in the study. This demonstrates that, in text reuse problem, it is easier to distinguish between two levels of reuse than three. For binary classification problem, best F_1 score is obtained using GST *mML1* ($F_1 = 0.81$), nearly matching the result with Word Uni-gram overlap ($F_1 = 0.80$). It can also be noticed that both of these results didn’t improve after removal of stop-words. For ternary classification task, the highest F_1 score of 0.73 is obtained for both GST *mML1 + SWR* and Word n -grams overlap *Uni-gram* and we can see a small effect of stop-words removal on both methods (improvement of 0.01 in GST while decline of 0.01 in Word n -grams overlap). These results show that GST and Word n -grams overlap are the most appropriate methods for Urdu text reuse detection on the COUNTER Corpus. It also highlights that, in text reuse detection, a smaller length of blocks (tokens) ($n = 1$ or $mML = 1$) is more effective especially when the text has been heavily modified or rephrased (as majority of examples in our corpus are rewritten).

GST outperformed all other methods for binary classification task and its performance for ternary classification task is same as Uni-gram method. Word n -grams overlap was the second best. This shows that GST is able to deal better with paraphrased text, identifying individually longest sub-strings in the rearrangements of tokens (lexical units) of the rephrased text. For both classification tasks, decline in performance was observed as the length of tokens/chunks increases ($n > 1$ or $mML > 1$). The possible reason for this is that the derived text is rewritten in PD and ND documents, which makes it difficult to find matching chunks of longer lengths ($n = 2 - 5$ or $mML = 2 - 10$). Consequently, that makes it difficult to discriminate different levels of text reuse. Note that these observations are consistent with the METER study (Clough et al. 2002b), which also showed that best results are obtained using word unigrams and an mML of 1, and further an increase in the length of n or mML effects performance.

As expected, performance using the LCS method ($F_1 = 0.77$) is lower compared to the GST because it is not able to deal with *block move* problem. Furthermore, the removal of stop-words did not show any improvement in LCS results for the binary classification task, however, there is a slight improvement of 0.01 for ternary classification task.

The results using the VSM method, for both binary ($F_1 = 0.66$) and ternary classifications ($F_1 = 0.54$) are lowest compared to all the other content based methods (Word n -grams overlap, LCS, GST). This is likely to happen because VSM aims to identify topical similarity among document pairs for Information

Retrieval (IR) task, whereas in text reuse detection task, aim is to identify overlap between document pairs.

The performance of the structure-based and stylistic-based methods i.e. Stop-words based n -grams overlap ($F_1 = 0.63$ (Bi-gram) for binary classification; $F_1 = 0.46$ (Four-gram) for ternary classification) and Sentence/Token ratio ($F_1 = 0.58$ and 0.68 for binary classification), is low overall and they demonstrated poor results in both classification tasks. This shows that structure-based as well as stylistic-based methods are comparatively not suitable for the Urdu text reuse detection task.

The results for the combination of features, using Word n -gram overlap feature ‘‘Combined’’ and Stop-words based n -gram overlap feature ‘‘Stop-words Combined’’, does not improve performance. For both classification tasks, from all the methods used in this study, Word n -grams overlap performed consistency better for $n > 1$ and above, after the removal of stop-words from the text. This improvement is statistically significant as tested with Wilcoxon signed-rank test ($p < 0:05$) (Wilcoxon et al. 1970). LCS also demonstrated slightly better results, for ternary classification task, on pre-processed text with stop-words removed. However, results using VSM and GST methods does not show improvement after the removal of stop-words. This highlights the fact that this pre-processing is useful in some cases for text reuse detection on the Urdu text.

We also conducted experiments by combining all the features from all the methods (*All features combined* method) used in this study i.e. similarity scores reported by 12 features of *Word n-grams overlap*, 20 features of *GST*, 6 features of *Stop-words based n-gram overlap* and 2 features of each *VSM*, *LCS* and *Sentence/Token Ratio* methods were combined and best feature selection method applied on the combination of all features. We applied the attribute selected classifier from Weka (again, the highest results were reported by Naïve Bayes’ classifier). However, the *All features combined* method does not improve performance.

Table 8 shows the confusion matrix for the GST ‘‘mML1’’ method (it produced best results for both classification problems, see Table 7). The columns and rows of the matrix represents the instances in the predicted and actual classes respectively.

Table 8 Confusion matrix for ternary classification using GST mML1

	WD	PD	ND
WD	91	43	1
PD	16	232	40
ND	2	68	107

Among all the three classes shown in the confusion matrix, it can be noted that it is easier to discriminate between WD and ND, however, difficult in the cases of WD-PD and PD-ND pairs. Furthermore, many WD instances are misclassified as PD (43) and similarly ND ones are also misclassified as PD (68), highlighting PD as the most problematic class for the classification problem. As a consequence, for ternary classification, the overall performance decreases.

7 Conclusion

Text reuse detection has attracted the attention of researchers for more than a decade now and it has gained increasing attention recently. For any language, the lack of large scale standardized evaluation resources with real examples of text reuse is a major problem in the analyses and development of text reuse detection systems. This paper presented our novel contribution in terms of the development of the first mono-lingual text reuse corpus for the Urdu language. The new corpus is modelled on the original English METER corpus and contains source and derived documents extracted from the news domain. The source documents contain news articles released by the news agencies whereas the derived documents are the news stories published in newspapers rewritten by journalists using the news agencies text as source. The corpus has been manually annotated by three annotators at document level with three classes of rewrite i.e. Wholly Derived, Partially Derived and Non Derived, and we have made it freely available online. A detailed set of twenty-four similarity estimation methods (content, structure, and style based measures) were used to conduct experiments on the corpus to show how such a resource can be useful in the development and evaluation of mono-lingual text reuse detection systems. Results showed that GST with mML1 feature is the most effective in text reuse detection on our corpus.

In the future, we plan to use character n -grams which is capable of capturing both stylistic and content information based on the selected value of n . Furthermore, the corpus will be evaluated on other state-of-the-art semantic similarity estimation methods, after customisation, if necessary, for the Urdu language.

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