SPLIT: Smart Preprocessing (Quasi) Language Independent Tool

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Abstract

Text preprocessing is an important and necessary task for all NLP applications. A simple variation in any preprocessing step may drastically affect the final results. Moreover replicability and comparability, as much as feasible, is one of the goals of our scientific enterprise, thus building systems that can ensure the consistency in our various pipelines would contribute significantly to our goals. The problem has become quite pronounced with the abundance of NLP tools becoming more and more available yet with different levels of specifications. In this paper, we present a dynamic unified preprocessing framework and tool, *SPLIT*, that is highly configurable based on user requirements which serves as a preprocessing tool for several tools at once. *SPLIT* aims to standardize the implementations of the most important preprocessing steps by allowing for a unified API that could be exchanged across different researchers to ensure complete transparency in replication. The user is able to select the required preprocessing tasks among a long list of preprocessing steps. The user is also able to specify the order of execution which in turn affects the final preprocessing output.

Keywords: Text Preprocessing, NLP, Corpus Linguistics

1. Introduction

Text preprocessing and preparation plays an important role in all NLP tasks. Uysal and Gunal (2014) show that choosing the appropriate preprocessing tasks significantly improves classification accuracy. Therefore in any NLP research project, experimenting with different preprocessing schemes is an important component of the research space. But due to the various possibilities for text cleaning and preparation, this task could be a significant source of error not to mention pain. Actually, it could also be a source of poor system performance if a certain preprocessing step has been implemented erroneously. Furthermore, different implementations of preprocessing steps, however minor, could very well result in variation which could impact research replication.

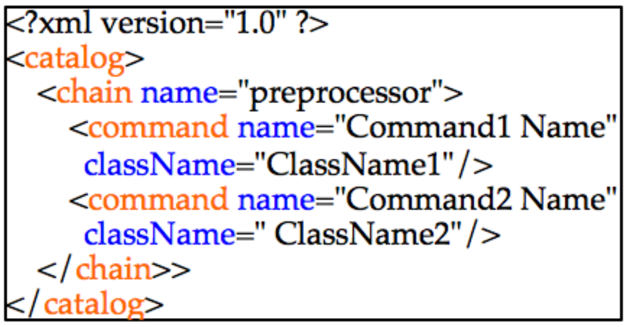
It is worth noting that some preprocessing steps are applicable only to some genres/languages. For example in the task of punctuation segmentation in English words such as an attached apostophe should not be blindly applied to romanized Arabic used in social media known as Arabizi as some of these punctuation marks are in fact part of the orthography.

Such difficulties motivate the need for a simple standard preprocessing framework that has a unified implementation of the most important preprocessing steps taking into consideration the different behaviors of various languages and genres. This enables the researcher to focus more on the research point. Some attempts toward this objective have been introduced. *PRETO* is a preprocessing tool developed specifically for preprocessing Turkish texts only (Tunali and Bilgin, 2012). *JPreText* is another tool that focuses on stemming, stopword removal, and term weighting (TF/IDF) for English text (Nogueira et al., 2008). Grover et al. (2000) introduced a tool called "A Flexible Tokenisation Tool" that includes ready-made components to segment text into paragraphs, sentences, words and other kinds of tokens. *GetItFull* is a tool for downloading and preprocessing full-text journals. It performs various commonly used preprocessing steps and puts the output in a structured XML document for each article with tags identifying the various sections and journal information articles (Natarajan et al., 2006). *AraNLP* is a preprocessing tool developed specifically for preprocessing Arabic texts. It includes a sentence detector, tokenizer, light stemmer, root stemmer, part-of-speech tagger, and a punctuation and diacritic remover (Althobaiti et al., 2014).

In this paper, we introduce *SPLIT*, the Smart Preprocessing (Quasi) Language Independent Tool. By language independence we mean that the tool is built in allows it to be as flexible as possible and not be restricted to a certain language. The tool consists of a list of commands. Where each of them performs only one task. The users can then build their own preprocessing pipeline using a simple configuration file. This list of commands can easily be expanded just by adding a file that contains the code of the new preprocessing task to the source directory of the tool. *SPLIT* is then able to use the new file automatically without any need to make changes in the tool itself. The ultimate goal of *SPLIT* is to provide a standard preprocessing framework which can work with most of the commonly used languages and text encodings.

SPLIT is currently at version 1.01. This version focuses on different Arabic text encodings; UTF8 Arabic script (e.g., عربية), Buckwalter (BW) encoding (Habash et al., 2007) (e.g., Erbyp), and the Arabizi script (e.g., 3rabya). Though, some of the presented commands are Arabic specific, the majority of the commands are generic (e.g. separating numbers, dates, emails, emoticons, URL, and time markers). We offer the tool to the community from the following link with an open source license, so that researchers who are working on different languages can contribute to the tool and share their work with the community.[1]

2. Approach



```
<?xml version="1.0" ?>
<catalog>
  <chain name="preprocessor">
    <command name="Command1 Name"
      className="ClassName1"/>
    <command name="Command2 Name"
      className=" ClassName2"/>
  </chain>>
</catalog>
```

Figure 1: The configuration file template

SPLIT, uses the popular chain of responsibility technique as "Apache Commons Chain".[2] This technique is used for organizing the execution of complex processing flows. Accordingly, the tool is not restricted by a predefined sequence in executing the various preprocessing steps. Instead, the users are able to define their own preferred preprocessing pipeline using a simple xml file. In this file, the user selects the preprocessing steps and their order of execution.
Figure 1 shows an example of a configuration file. The figure shows that each preprocessing step is being defined using a "command" xml tag, where the "name" and "className" properties represent the name and the class name of the required preprocessing step. The commands are then processed in the same order presented in the xml pipeline file.
Figure 2 shows an example of a preprocessing pipeline. In this example, the tool separates dates first, then numbers, and finally punctuation marks.

3. Usage

SPLIT can be used in two modes: standalone mode using a command line interface (CLI) and an API mode. The standalone mode is provided for testing the application and getting familiar with its interface independent of any inter-process communication. The API mode enables the user to integrate the tool in any Java application and use it as a function.
SPLIT yields two outputs: the input text after applying the preprocessing pipeline alongside a tag for each token based on the required steps. If there are some remaining tokens without tags at the end of the pipeline, they get assigned the final encoding of the output text. For example, if the input is in Arabic UTF8 script, the remaining untagged tokens at the end of the pipeline are assigned a UTF8 tag. But if the configurations are set to convert from UTF8 to BW, then the remaining untagged tokens are tagged with a BW tag.
In some situations, the alignment between the text before and after the preprocessing step could be important. Therefore, we add a configurable flag in the tool to enable or disable input/output alignment. Hence, the number of tokens remains the same. But if some tokens are required to be separated during the preprocessing pipeline, they get linked through a user defined separator (the default value is [+]) to indicate the splitting point.

CLI Mode To execute *SPLIT* in the standalone mode, we simply call it from the Windows Command Prompt or Unix/Linux Shell. It takes the input plain text file name, the output file name, the input character encoding (BW, UTF8, or Arabizi), and the preprocessing pipeline.

```
java -jar Preprocessor.jar -i inputFile -o
outputFile -e encoding -p pipelineFile.xml
```

The -i argument is used to specify the input plain text file name, the -o argument is used to specify the output file name, and the -e argument is used to specify the input characters encoding (BW, UTF8, or Arabizi). Finally, the -p argument is optional. It is being used to override the default preprocessing pipeline.
The output is then written in a simple xml format as shown in figure 3.

API Mode To use the API functionality of *SPLIT*, the user needs to add the *SPLIT* Jar file to the referenced libraries in a Java application. The user will then be able to define a new object of *SPLIT* and call it as a regular java function.

```
Preprocessor preprocessor=new
Preprocessor(pipelineFile);
```

And to run the tool on a certain sentence, the user can use the following command:

```
OutputObj procContext =
preprocessor.preprocessStream (inputStream,
textEncoding);
```

Where "inputStream" is an InputStream object of the input sentence and "textEncoding" is the encoding of the input text. It could be (Encoding.utf8, Encoding.bw, or Encoding.arabizi). "OutputObj object" is the output object from the tool. It can be read as shown in figure 4

4. Pipeline Commands

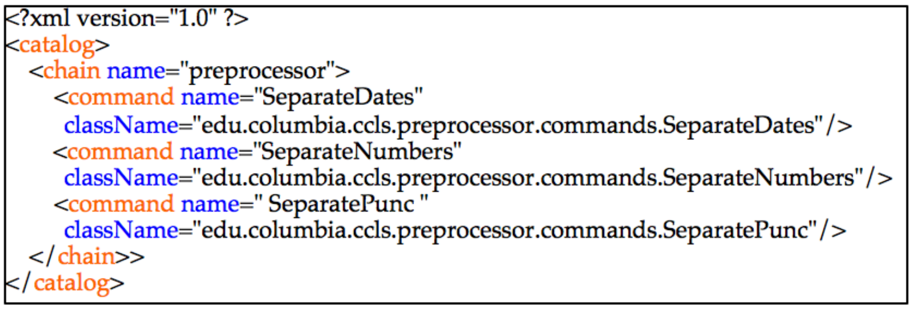
SPLIT has 21 preprocessing commands. Each handles only one task. However, we offer *SPLIT* as an open source framework to encourage researchers to integrate their own preprocessing commands and share them with the community.

ConvertBWToUTF8 changes the character encoding into Arabic UTF8 script.

ConvertUTF8ToBW changes the character encoding into BW encoding.

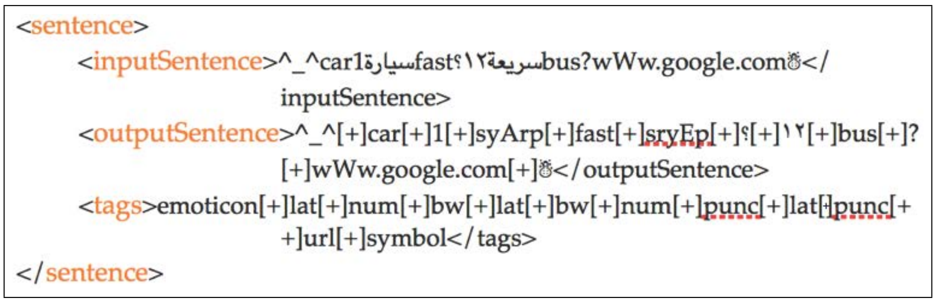
FixNonStandardChars is mainly used for the Arabizi encoding. It converts the non-standard characters into their corresponding ones as shown in table 1.

[1]`http://care4lang1.seas.gwu.edu/split.php`
[2]`http://commons.apache.org/proper/commons-chain/`



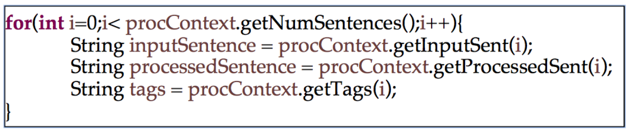
```
<?xml version="1.0" ?>
<catalog>
  <chain name="preprocessor">
    <command name="SeparateDates"
     className="edu.columbia.ccls.preprocessor.commands.SeparateDates"/>
    <command name="SeparateNumbers"
     className="edu.columbia.ccls.preprocessor.commands.SeparateNumbers"/>
    <command name=" SeparatePunc "
     className="edu.columbia.ccls.preprocessor.commands.SeparatePunc"/>
  </chain>>
</catalog>
```

Figure 2: Typical pipeline example



```
<sentence>
     <inputSentence>^_^car1سيارةfastسريعة؟١٢bus?wWw.google.com☃</
                    inputSentence>
     <outputSentence>^_^[+]car[+]1[+]syArp[+]fast[+]sryEp[+]؟[+]١٢[+]bus[+]?
                    [+]wWw.google.com[+]☃</outputSentence>
     <tags>emoticon[+]lat[+]num[+]bw[+]lat[+]bw[+]num[+]punc[+]lat[+]punc[+
                    +]url[+]symbol</tags>
</sentence>
```

Figure 3: A sample of an output file from the CLI mode. [+] is used as a separator to indicate splitting in order to keep the alignment between the input and the output



```
for(int i=0;i< procContext.getNumSentences();i++){
        String inputSentence = procContext.getInputSent(i);
        String processedSentence = procContext.getProcessedSent(i);
        String tags = procContext.getTags(i);
}
```

Figure 4: Accessing the processed data in the API mode

Input	Output
à, â, and ä	a
ñ	n
ö	o
ü	u
ÿ	y
è or é	e
î or ï	i
ç	c
$\frac{1}{2}$	oe
x{FEF5} or x{FEF6}	convert one symbol Lam Alef-Mad to two characters Lam+Alef-Mad
x{FEF7} or x{FEF8}	convert one symbol Lam Alef-Hamza above to two characters Lam+Alef-Hamza above
x{FEF9} or x{FEFA}	convert one symbol Lam Alef-Hamza below to two characters Lam+Alef-Hamza below
x{FEFB} or x{FEFC}	convert one symbol Lam Alef to two characters Lam+Alef

Table 1: The non-standard character mapping

InsertSpaceAfterNonMiddleChars inserts a space after the characters that cannot appear in the middle of a word (taa marbuta (p) or alef maksura (Y)). All repetitions of the same letter are treated as a single letter (e.g., hdYYYYmn becomes hdYYY mn). The repetition can be handled after that by RemoveSpeechEffects command. However, The command must be used before the RemoveSpeechEffects command.

NormalizeAlef normalizes Alef "|, >, <, and {" become "A". The command is recommended to be at the end of the pipeline and has no effect on Arabizi inputs.[3]

NormalizeYaa normalizes yaa "Y and y" become "y". The command is recommended to be at the end of the pipeline and has no effect on Arabizi inputs.

NormalizeTaaMarbuta normalizes taa-marbuta "p and h" become "h". The command is recommended to be at the end of the pipeline and has no effect on Arabizi inputs.

RemoveDiacritics removes all diacritic characters from an input string. If the input string is nothing but diacritics, the command replaces it by "@@deleted@@" and tags this deleted string as "diacritics". This command has no effect on Arabizi input. The command is recommended to run before the RemoveSpeechEffects command, and has no affect on Arabizi inputs.

RemoveTatweels removes the "tatweel" character from an input string. If the input string is nothing but "tatweel", the command keeps it unchanged and tags this string as "tatweel". This command has no effect on Arabizi input. The command is recommended to run after the SeparateEmoticons command, and has no effect on Arabizi inputs.

RemoveSpeechEffects removes the speech effects (also known as elongation) from an input string. For the best performance, this command should be used at the end of the preprocessing pipeline after all (separate and remove) commands. If the input encoding is Arabizi, this command limits any character repetition to only two. But if the input is UTF8 or BW, it applies the following rules:

[3]For more information on Arabic-specific NLP issues, see (Habash, 2010).

1. Convert “{” to “A”
2. Reduce any repetition of (Y, p, |, <, &, }, and ') to a single occurrence
3. For all “AA” cases (exactly two A’s):
   (a) The “yA” case: Every word that starts with yAA\S (where \S is an Arabic letter) should be split after the first A, e.g., yAAbw → yA Abw
   (b) Finally, the default case is to reduce all remaining AA+ occurrences to a single A.
4. For the cases of three or more repetitions, we conducted an analysis on ∼ 392M of Egyptian words from the LDC catalog numbers: LDC2012E30, LDC2012E51, LDC2012E94, LDC2012E96, LDC2012E75, LDC2012E77, LDC2012E107, LDC2012E19, LDC2012E54, and LDC2012E17. We found that the top 400 elongated types are contributing to 73% of elongated tokens, where 371 types have repetitions that are reduced into a single letter, while the rest (29 = 7%) have repetitions that are either reduced into two letters or special cases (e.g.: mmm+tAz → mmtAz and mkrrr+ → mkrr). We also analyzed the bottom 100 cases to see whether these percentage are preserved or not. It was found that all the repetitions in them were reduced into a single letter. Therefore, we decided to put the 29 (7%) cases in a lookup table and reduce all the other repetitions into a single letter.

SeparateDates splits all date patterns. It is recommended to be used before SeparateNumbers and SeparatePunc commands. This command can match the following patterns:

- month/day/year, month\day\year, month-day-year, month.day.year
- day/month/year, day\month\year, day-month-year, day.month.year
- year/month/day, year\month\day, year-month-day, year.month.day

SeparateDates validates the detected date if the validation flag is on. For example, a date that is 29/02/2014 gets rejected. But if the flag is set to off, only the date format is checked.

SeparateEmoticons splits emoticons patterns. The command is recommended to be used before the SeparatePunc, SeparateURL, and SeparateEmails commands.

SeparateEmails splits email patterns. The command is recommended to be used before the SeparateNumbers and SeparatePunc commands.

SeparateURL splits URL patterns. The command is recommended to be called before the SeparateNumbers and SeparatePunc commands.

SeparateLatinArabicSequences splits any Arabic or Latin sequence from one another. If the input encoding is Arabizi or BW, it separates the Arabic sequences and tags them as ”utf8”. And if the input encoding is UTF8, it separates the Latin sequences and tags them as “lat”. The command is recommended to be used after the ConvertArabicToBW command if the input is a mixture of BW and UTF8.

SeparateNumbers splits all numerical patterns including fractional numbers. The command is recommended to be used after the SeparateDates command and before the SeparatePunc command. Examples: (ABC123DEF → ABC 123 DEF, abc1.5gfd → abc 1.5 gfd, and abc1/2gfd → abc 1/2 gfd). Furthermore, the command can be configured to normalize all tagged numbers into a certain fixed value.

TagNumbers is exactly like the SeparateNumbers command, but it only tags numerical patterns that are not connected to letters.

SeparatePunc separates any punctuation mark from their attached words in the sentence. The command takes the encoding of the input sentence into consideration as follows:

- “bw”: The special punctuation marks of “bw” do not get separated out;
- “utf8”: All punctuation marks get separated out;
- “arabizi”: The special punctuation marks of “arabizi” do not get separated out.

SeparatePunc is recommended to be used after the SeparateSymbols, SeparateEmoticons, SeparateDates, SeparateTime, SeparateURL, and SeparateEmails commands.

SeparateSymbols splits any characters other than Latin characters, punctuation marks, numbers, and Arabic characters. The command recommended to be used after the FixNonStandardCharacters command.

SeparateTime splits the time pattern “hh:mm:ss”, where “hh” corresponds to the hours as a range from zero to 23, while “mm” and “ss” indicate the minutes and seconds, respectively, both of which ranging from zero to 59. This command is recommended to be used before the SeparateNumbers and SeparatePunc commands.

TagSounds detects sound patterns in an input String (e.g., hmmm, ahh, etc.).

5. Case Study

As we are a specialized group in Arabic processing with many publicly available projects, the need for having a consistent preprocessing behavior across our projects is a must. Though, it is not necessary to have the same preprocessing pipeline for all projects, having the same implementation of the shared steps is crucial. Figures 5, 6, and 7 show the preprocessing pipelines of our publicly available tools for Arabic; AIDA for Arabic dialect identification and classification (Al-Badrashiny et al., 2015), MADAMIRA for morphological analysis and disambiguation of Egyptian and modern standard Arabic text (Pasha et al., 2014), and 3ARRIB, for converting dialectal Arabic written in Latin characters in social media to normalized Arabic orthography (Al-Badrashiny et al., 2014) and (Eskander et al., 2014). *SPLIT* has maintained the same system performance for these tools, but it significantly simplified the code by separating the text preprocessing part from the core engines. This enabled us to simply try different preprocessing schemes in a streamlined manner expediting the turn around for the experimental investigations.

```
<command name="RemoveTatweels"/>
<command name="SeparateURL"/>
<command name="SeparateEmails"/>
<command name="SeparateLatinArabicSequences"/>
<command name="SeparateDates"/>
<command name="SeparateTime"/>
<command name="SeparateNumbers"/>
<command name="SeparateEmoticons"/>
<command name="SeparateSymbols"/>
<command name="SeparatePunc"/>
<command name="TagSounds"/>
<command name="InsertSpaceAfterNonMiddleChars"/>
<command name="RemoveSpeechEffects"/>
```

Figure 5: AIDA preprocessing pipeline

```
<command name="SeparateLatinArabicSequences"/>
<command name="CleanUTF8"/>
<command name="RemoveTatweels"/>
<command name="SeparateNumbers"/>
<command name="SeparatePunc"/>
<command name="ConvertUTF8ToBW"/>
<command name="RemoveDiacritics"/>
<command name="InsertSpaceAfterNonMiddleChars"/>
<command name="RemoveSpeechEffects"/>
<command name="NormalizeAlef"/>
<command name="NormalizeYaa"/>
```

Figure 6: MADAMIRA preprocessing pipeline

6. Conclusions

In this paper, we introduced version 1.01 of *SPLIT*. The tool provides the most preprocessing tasks that are needed to clean and prepare Arabic texts, where it handles different Arabic encoding scripts; UTF8 Arabic script, BW, and Arabizi. The approach of implementing a small preprocessing unit per command makes the tool easily extensible to cover other languages just by adding new commands. *SPLIT* is intended to be a unified platform for text preprocessing for the most commonly used languages.

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```
<command name="FixNonStandardChars"/>
<command name="SeparateEmoticons"/>
<command name="SeparatePunc"/>
<command name="SeparateSymbols"/>
<command name="SeparateLatinArabicSequences"/>
<command name="TagSounds"/>
```

Figure 7: 3ARRIB preprocessing pipeline

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