A Textual Entailment System using Anaphora Resolution

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Abstract

The note describes the Recognizing Textual Entailment (RTE) system developed at the Computer Science and Engineering Department, Jadavpur University, India. In this competition, we have participated and submitted the results in the RTE-7 Main Task (3 runs), Novelty Task (3 runs) and RTE-7 KBP Validation task (2 unique runs for generic task and 2 unique runs for tailored task). For the RTE-7 Main and Novelty Tasks, the systems are based on pre-processing task which includes Anaphora Resolution using JavaRAP tool then the system is the composition of Lexical Entailment module, Syntactic Entailment module, Chunk module and Named Entity module. For the RTE-7 Main task test set, the following micro-average results were obtained for Run 1: F-Score 29.81, Run 2: F-Score 30.47 and Run 3: F-score 29.90. For the RTE-7 Novelty task test set, the following micro-average results were obtained for Run 1: Novelty Evaluation F-Score 86.26 and Justification Evaluation F-Score 20.02, Run 2: Novelty Evaluation F-Score 78.49 and Justification Evaluation F-Score 26.56 and Run 3: Novelty Evaluation F-score 73.94 and Justification Evaluation F-Score 25.55 were obtained. The RTE-7 KBP Validation Task is based on the assumption that extracted slot filler is correct if and only if the supporting document entails a hypothesis created on the basis of the slot filler. In RTE KBP, we participated for generic task and tailored task. For the RTE-7 KBP Validation task test set for Generic Task, micro-average results for Run 1: F-Score 0.148 and Run 2: F-Score 0.1902 were obtained. For RTE-7 KBP test set for Tailored Task, micro-average results for Run 1: F-Score 0.1813, Run 2: F-Score and 0.1834 were obtained.

1 Introduction

The TAC RTE-7 tasks focus on recognizing textual entailment in two application settings: Summarization[1] and Knowledge Base Population[2].

i. **Main Task (Summarization setting)**: Given a corpus and a set of "candidate" sentences retrieved by Lucene from that corpus, RTE systems are required to identify all the sentences from among the candidate sentences that entail a given Hypothesis. The RTE-7 Main Task is based on the TAC Update Summarization Task.

ii. Novelty Detection subtask (Summarization setting): Based on the Main Task, the subtask is focused on Novelty Detection, which means that RTE systems are required to judge whether the information contained in each H is novel with respect to (i.e., not entailed by) the information contained in the corpus.

iii. KBP Validation Task (Knowledge Base Population setting): Based on the TAC Knowledge Base Population (KBP) Slot-Filling

[1] http://www.nist.gov/tac/2011/RTE/RTE7_Main_NoveltyDetection_Task_Guidelines.pdf

[2] http://www.nist.gov/tac/2011/RTE/RTE7_KBP_Validation_Task_Guidelines.pdf

task, the new KBP validation pilot task determines whether a given relation (Hypothesis) is supported in an associated document (Text).

We participated in the TAC RTE-5 [1], TAC RTE-6 Challenge [2] and QA4MRE@CLEF [3] in 2011. Section 2 describes the RTE-7 Data Set and Section 3 describes the RTE system architecture. The various experiments carried out on the development and test data sets are described in Section 4 along with the results. The ablation tests are reported in Section 5. The conclusions are drawn in Section 6.

2 RTE-7 Data Set Description

2.1 RTE-7 Main and Novelty Task Data Set

The RTE-7 Main Task data set is based on the data created for the TAC 2008 and 2009 Update Summarization task. The data consist of a number of topics, each containing two sets of documents, namely,

i) Cluster A, made up of the first 10 texts in chronological order (of publication date), and

ii) Cluster B, made up of the last 10 texts. The RTE-7 data set is composed of 20 topics, 10 used for the Development Set and 10 for the Test Set.

For each topic, the RTE-7 Main Task data consists of:

a) A number of Hypotheses (between 25 and 45) referring to the topic. H‟s are standalone sentences taken from the TAC Update Summarization corpus – i.e. both Cluster A and 3 Cluster B documents.

b) A set of 10 documents, corresponding to the Cluster A corpus.

c) For each H, a list of up to 100 candidates entailing sentences from the Cluster A corpus and their location in the corpus. The candidate sentences are the 100 top-ranked sentences retrieved by Lucene, using H verbatim as the search query.

DEVELOPMENT SET

The following items were distributed as the Development Set:

The gold standard Development Set and for each topic:

Item A: a list of hypotheses.

Item B: for each hypothesis H, the list of the id numbers of Cluster A candidate sentences to be judged for entailment.

Item C: the set of Cluster A documents for that topic.

The data set distributed for the Novelty Detection task was mostly different from the Main Task data set but was having the same structure.

2.2 RTE-7 KBP Validation Data Set

The RTE-7 KBP Validation data set is based on the data created for the KBP 2009, 2010 and 2011 Slot Filling Task, specifically,

i. The RTE-7 Development set consists of over 25,000 T-H pairs from the combined RTE-7 Development and Test sets.

ii. The RTE-7 Test set will be created from corresponding test data from KBP 2011.

3 System Architecture

We submitted 3 unique runs for Main Task, 3 unique runs for Novelty Detection sub-task and 4 unique runs for KBP Validation task.

3.1 Pre-processing

The system accepts pairs of text snippets (T-H pair) as the input and gives an entailment value at the output: “YES” if the Hypothesis (H) entails the Text (T) and “NO” otherwise.

The corpus has some noise as well as some special symbols that create problems during parsing. The list of noise symbols and the special symbols is initially developed manually by looking at a number of documents and then the list is used to automatically replace or remove such symbols from the documents. Table 1 lists the tokens that are replaced by blank as well as by other tokens. All the above pre-processing methods are applied on the development and test set as well.

Replace by blank	Replace by Symbol	
	Original Token	Replaced Token
. –	Á	a
();	Č	c
[...]	È	e
()	&amp;	&
...	Š	S
--		

Table 1. Token Replacement List.

Anaphora Resolution: The RTE-7 Main and Novelty Task data sets are parsed and pre –

processed before passed through other TE module. RTE-7 data includes several Topics (e.g. Topic_D0806) and every Topic includes corpus, Main task and Novelty task. Corpus includes several texts, which has a major part in the T-H pair. The evaluation pairs of Main and Novelty task showing this relation between the hypothesis and the texts of the corpus.

```
<?xml version="1.0" encoding="UTF-8" ?>
<topic id="D0806">
<H h_id="1075">
<CANDIDATE
doc_id="AFP_ENG_20041201.0855"          s_id="1"
lucene_score="0.06223315" />
<CANDIDATE
doc_id="AFP_ENG_20041201.0855"          s_id="2"
lucene_score="0.11504887" />
<CANDIDATE
doc_id="AFP_ENG_20041201.0855"          s_id="4"
lucene_score="0.060067534"/>
```

Figure 1: Data structure of main_evaluation_pairs.xml

In the above figure, for a particular hypothesis (h_id=1075) the corresponding texts are shown and every individual text or sentence with a sentence id (s_id) from a candidate document with a doc_id has as lucene search engine score. For example the text with s_id=2 and doc_id= AFP_ENG_20041201.0855 is a simple sentence from given corpus *"Florida's state Supreme Court has already issued a ruling that cleared the way to remove Terri Schiavo's feeding tube, striking down a law Bush had pushed through the state legislature to reinsert the tube after her husband had had it taken out."*

Our main objective of doing the pre-processing of data is to resolve the anaphoric expression (like "her" in the above sentence) from the given text corpus and then pass it through the other TE module to increase the score of entailment percentage. Anaphora refers to a word or phrase in the sentence is used to refer to an entity introduced earlier into the discourse, and the word or phrase is said to be an anaphor, or anaphoric. Accordingly, anaphora resolution is the process of identifying an anaphor's antecedent(s) thus to conceptually link it with its referent. To address this problem we used a tool called JavaRAP [3] **(**A java based implementation of Resolution of Anaphora Procedure (RAP) – an algorithm by Lappin and Leass, 1994**)** [4]. RAP is an algorithm for identifying both intersentential and intrasentential antecedents of third person pronouns (in their nominative, accusative or possessive case) and lexical anaphors (including reflexives – pronouns like "myself", "yourself", etc.)

3.2 Lexical Entailment Module based RTE methods

In this section, we describe our Lexical Entailment Module. The architecture of the proposed system is described in Figure 2. For Main Task (Run 1) and Novelty Task (Run 1) runs are based on this architecture.

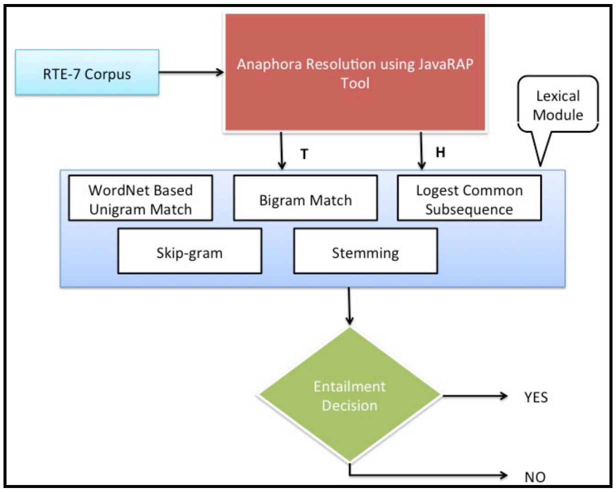
RTE-7 Corpus
Anaphora Resolution using JavaRAP Tool
Lexical Module
T
H
WordNet Based Unigram Match
Bigram Match
Logest Common Subsequence
Skip-gram
Stemming
Entailment Decision
YES
NO

Figure 2: System Architecture for Lexical Entailment

In this section the various lexical based RTE methods [1] are described in detail.

i) WordNet based Unigram Match: In this method, the various unigrams in the hypothesis for each text-hypothesis pair are checked for their presence in the text. WordNet synsets are identified for each of the unmatched unigrams in the hypothesis. If any synset for the hypothesis unigram matches with any synset of a word in the text then the hypothesis unigram is considered as a WordNet based unigram match.

[3] http://aye.comp.nus.edu.sg/~qiu/NLPTools/JavaRAP.html

If n1= common unigram or WordNet Synonyms between text and hypothesis and n2= number of unigram in Hypothesis then Wordnet_Unigram_Match=n1/n2.

If the value of Wordnet_Unigram_Match is 0.75 or more, i.e., 75% or more unigrams in the hypothesis match either directly or through WordNet synonyms, then the text-hypothesis pair is considered as entailment. The text-hypothesis pair is then assigned the value of 1 meaning entailment, otherwise, the pair is assigned the value of 0. The cut-off value for the Wordnet_Unigram_Match is based on experiments carried out on the RTE-7 Main and Novelty Task development set.

ii) Bigram Match: Each bigram in the hypothesis is searched for a match in the corresponding text part. The measure Bigram_Match is calculated as the fraction of the hypothesis bigrams that match in the corresponding text, i.e., Bigram_Match=(Total number of matched bigrams in a text-hypothesis pair /Number of hypothesis bigrams).

If the value of Bigram_Match is 0.5 or more, i.e., 50% or more bigrams in the hypothesis match in the corresponding text, then the text-hypothesis pair is considered as entailment. The text-hypothesis pair is then assigned the value of 1 meaning entailment; otherwise, the pair is assigned the value of 0. The cut-off value for the Bigram_Match is based on experiments carried out on the RTE-7 Main and Novelty Task development set.

iii) Longest Common Subsequence (LCS): The Longest Common Subsequence of a text-hypothesis pair is the longest sequence of words, which is common to both the text and hypothesis. LCS (T, H) estimates the similarity between text T and hypothesis H, as LCS_Match=*LCS* (*T, H*)/length of H.

If the value of LCS_Match is 0.8 or more, i.e., the length of the longest common subsequence between text T and hypothesis H is 80% or more of the length of the hypothesis, then the text-hypothesis pair is considered as entailment. The text-hypothesis pair is then assigned the value of 1 meaning entailment; otherwise, the pair is assigned a value of 0. The cut-off value for the LCS_Match is based on experiments carried out on the RTE-7 main and novelty task development set.

iv) Skip-grams: A skip-gram is any combination of n words in the order as they appear in a sentence, allowing arbitrary gaps. In the present work, only 1-skip-bigrams are considered where 1-skip-bigrams are bigrams with one word gap between two words in a sentence following the order. The measure 1-skip_bigram_Match is defined as *1_skip_bigram_Match* = *skip_gram* (*T, H*) / n, where *skip_gram* (*T,H*) refers to the number of common 1-skip-bigrams (pair of words in a sentence with one word gap) found in T and H and *n* is the number of 1-skip-bigrams in the hypothesis H.

If the value of 1_skip_bigram_Match is 0.5 or more, then the text-hypothesis pair is considered as entailment. The text-hypothesis pair is then assigned the value of 1 meaning entailment; otherwise, the pair is assigned the value of 0. The cut-off value for the 1_skip_bigram_Match is based on experiments carried out on the RTE-7 Main and Novelty Task development set.

v) Stemming: Stemming is the process of reducing terms to their root form. For example, the plural forms of a noun such as ‘boxes’ are transformed into ‘box’, and derivational endings with ‘ing’, ‘es’, ‘s’ and ‘ed’ are removed from verbs. Each word in the text and hypothesis pair is stemmed using the stemming function provided along with the WordNet 2.0. If s1= number of common stemmed unigrams between text and hypothesis and s2= number of stemmed unigrams in Hypothesis, then the measure Stemming_match is defined as Stemming_Match=s1/s2.

If the value of Stemming_Match is 0.7 or more, i.e., 70% or more stemmed unigrams in the hypothesis match in the stemmed text, then the text-hypothesis pair is considered as entailment. The text-hypothesis pair is assigned the value of 1 meaning entailment; otherwise, the pair is assigned the value of 0. The cut-off value for the Stemming_Match is based on experiments carried out on the RTE-7 Main and Novelty Task development set.

WordNet [Fellbaum, 1998] is one of most important resource for lexical analysis. The WordNet 2.0 has been used for WordNet based unigram match and stemming step. The API for WordNet Searching (JAWS)[4] is an API that provides Java applications with the ability to retrieve data from the WordNet database.

[4] http://lyle.smu.edu/~tspell/jaws/index.html

3.3 Syntactic Similarity Module

This module is based on the Stanford Parser[5], which normalizes data from the corpus of text and hypothesis pairs, accomplishes the dependency analysis and creates appropriate structures. Our Entailment system [2] uses the following features.

a) Subject: The dependency parser generates nsubj (nominal subject) and nsubjpass (passive nominal subject) tags for the subject feature. Our entailment system uses these tags.

b) Object: The dependency parser generates dobj (direct object) as object tags.

c) Verb: Verbs are wrapped with either the subject or the object.

d) Noun: The dependency parser generates nn (noun compound modifier) as noun tags.

e) Preposition: Different type of prepositional tags are prep_in, prep_to, prep_with etc. For example, in the sentence "A plane crashes in Italy.", the identified prepositional tag is prep_in(in, Italy).

f) Determiner: Determiner denotes a relation with a noun phase. The dependency parser generates det as determiner tags. For example, the parsing of the sentence "A journalist reports on his own murders." generates the determiner relation as det(journalist,A).

g) Number: The numeric modifier of a noun phrase is any number phrase. The dependency parser generates num (numeric modifier). For example, the parsing of the sentence "Nigeria seizes 80 tonnes of drugs." generates the relation num (tonnes, 80).

For the sentence, "John Yoo served in the Justice Department.", the Stanford Dependency Parser generates the following set of dependency relations:

[nn(Yoo-2, John-1), nsubj(served-3, Yoo-2), det(Department-7, the-5), nn(Department-7, Justice-6), prep_in(served-3, Department-7)]

3.3.1 Matching Module

After dependency relations are identified for both the text and the hypothesis in each pair, the hypothesis relations are compared with the text relations. The different features that are compared are noted below. In all the comparisons, a matching score of 1 is considered when the complete dependency relation along with all of its arguments match in both the text and the hypothesis. In case of a partial match for a dependency relation, a matching score of 0.5 is assumed.

a) Subject-Verb Comparison: The system compares hypothesis subject and verb with text subject and verb that are identified through the nsubj and nsubjpass dependency relations. A matching score of 1 is assigned in case of a complete match. Otherwise, the system considers the following matching process.

b) Subject-Subject Comparison: The system compares hypothesis subject with text subject. If a match is found, a score of 0.5 is assigned to the match.

c) Object-Verb Comparison: The system compares hypothesis object and verb with text object and verb that are identified through dobj dependency relation. In case of a match, a matching score of 0.5 is assigned.

d) Cross Subject-Object Comparison: The system compares hypothesis subject and verb with text object and verb or hypothesis object and verb with text subject and verb. In case of a match, a matching score of 0.5 is assigned.

e) Number Comparison: The system compares numbers along with units in the hypothesis with similar numbers along with units in the text. Units are first compared and if they match then the corresponding numbers are compared. In case of a match, a matching score of 1 is assigned.

f) Noun Comparison: The system compares hypothesis noun words with text noun words that are identified through nn dependency relation. In case of a match, a matching score of 1 is assigned.

g) Prepositional Phrase Comparison: The system compares the prepositional dependency relations in the hypothesis with the corresponding relations in the text and then checks for the noun words that are arguments of the relation. In case of a match, a matching score of 1 is assigned.

h) Determiner Comparison: The system compares the determiner in the hypothesis and in the text that are identified through det relation. In case of a match, a matching score of 1 is assigned.

j) Other relation Comparison: Besides the above relations that are compared, all other remaining relations are compared verbatim in the hypothesis and in the text. In case of a match, a matching score of 1 is assigned.

[5] http://nlp.stanford.edu/software/lex-parser.shtml

Each of the matches through the above comparisons is assigned some weight learned from the RTE-7 development corpus. A threshold of 0.30 has been set on the fraction of matching hypothesis relations based on the development set results that gives optimal precision and recall values for both YES and NO entailment. The threshold score has been applied on the RTE-7 test set using the same methods of dependency parsing followed by comparisons.

In this section, we describe our Lexical Textual Entailment and Syntactic Textual Entailment. The architecture of the proposed system is described in Figure 3. For Main Task (Run 2) and Novelty Task (Run 2) runs are based on this architecture.

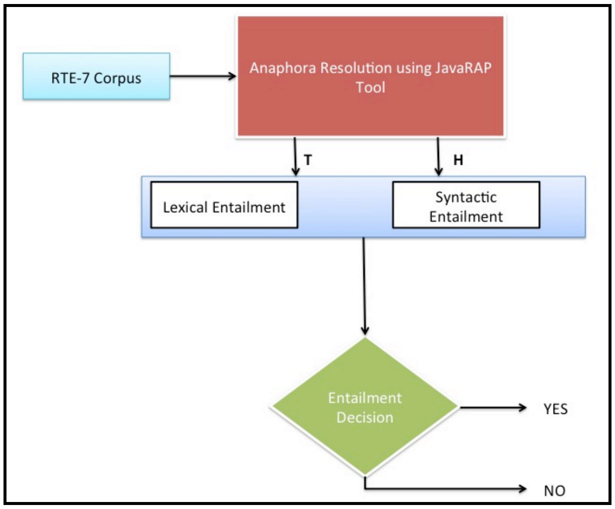

Figure 3: System Architecture for Lexical Entailment and Syntactic Entailment

3.4 Chunking Module

In this module [2], we have first worked on the hypothesis side. We have extracted the part of speech (POS) tags of the hypothesis sentences using Stanford POS tagger. After getting the POS information we have extracted the chunk output using CRF Chunker [5]. Our chunk boundary detector detects each individual chunk such as noun chunk, verb chunk etc. Thus, all the chunks for each sentence in the hypothesis are identified. On the text side we have considered the specified (*.sgm) file and have extract the sentence which contain at least one noun chunk or noun word, i.e., the head word of the noun chunk. Each sentence of the text side is also processed in the same way as has been done for the hypothesis sentences.

This module contains the following sub-modules:

3.4.1 Key chunk analyzer

The key chunk analyzer identifies the key chunk in the hypothesis. We have extracted subject and object noun from the hypothesis by using Stanford dependency parser. From the dependency output we considered nsubj and nsubjpass relation for identifying subject noun and dobj relation for identifying object noun. Now we have checked each chunk for subject and object noun and consider those chunks containing subject and object noun as key chunks. In case of verb chunk we have extracted the main verb to find out the corresponding synset in the WordNet. Additional verb chunks are generated by replacing the main verb with members from its sysnet.

3.4.2 Chunk matching and scoring module

Each key chunk of the hypothesis is now searched in the text side and the sentences are extracted that contain the key chunk words. The extracted sentences are analyzed into chunks as we have done for the hypothesis.

Each individual chunk, including key chunks and generated verb chunks of the hypothesis are matched with the chunk output of the text side sentences. If chunks are matched then we give score for each individual text corresponding to the hypothesis. The scoring values are changed according to the matching of chunk and word containing the chunk. The entire scoring calculation is given in Figure 4.

N= Total number of chunk containing hypothesis.
M[i]=Match score for [i]th chunk.
Wm[i]=Number of words matched in [i]th chunk.
Wc[i]=Total number of words containing the [i]th chunk.
M[i]=Wm[i] / Wc[i];

Overall score (S) = $\sum_{i=1}^{N} M[i] / N$

Figure 4: System Architecture for Lexical Entailment

The score (S) will be assigned more weight by adding a constant value if it matches with a key chunk.

3.4.3 Ranking

After giving score for each text sentence corresponding to the individual hypothesis, we have ranked them according to their score and taken the best 3 ranked text sentences. Here we have considered some cutoff scores. If the ranked score is below the cutoff score then we simply discard them otherwise we have taken all the three sentences with the best rank scores.

3.5 Named Entities Module

In this module we have tagged named entities in both hypothesis and text using Stanford POS tagger. The named entities identified in the hypothesis are matched in the text file. If named entities are matched in both the sides, the text entails the hypothesis; otherwise the text does not entail the hypothesis.

3.5.1 Acronym Generator

Sometimes, multi word named entities may be present as an acronym either in the text or in the hypothesis. For every multi word named entities identified in the hypothesis, the acronym is generated by taking the first letter of each word in the named entity. The multi word named entity and its acronym forms a set and this set is compared with the named entities identified in the text. The generation of the acronym for a multi word named entity and its use in the named entity comparison process has improved the performance of the entailment decision.

3.5.2 Combined chunk-named entity module

During the matching of the key chunks and the generated verb chunks, the named entities are considered along with the acronym generated. Text sentences are assigned scores for ranking and the best three sentences according to the rank score are identified.

In this section, we describe our Lexical Textual Entailment, Syntactic Textual Entailment, Chunk Matching and Named Entities. The architecture of the proposed system is described in Figure 5. For Main Task (Run 3) and Novelty Task (Run 3) runs are based on this architecture.

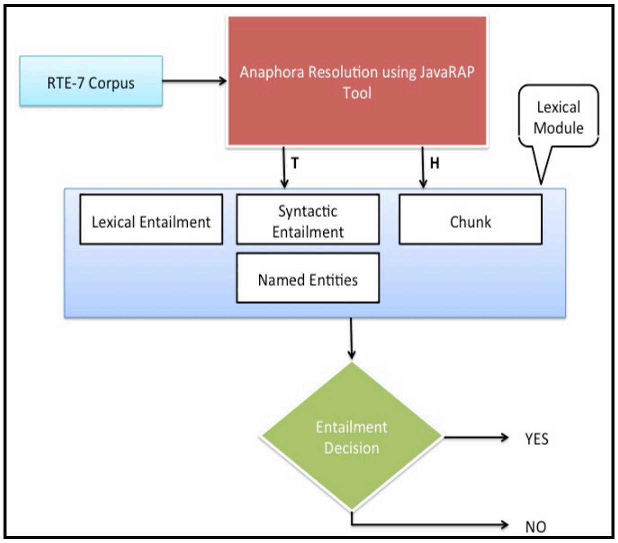

Figure 5: System Architecture for Lexical Entailment, Syntactic Entailment, Named Entities, Chunk.

3.7 RTE-7 KBP Validation Pilot

We developed two systems for RTE-7 KBP, one for generic task and another for the tailored task. The Apache Lucene[6] IR system has been used for the RTE-7 KBP task. Lucene follows the standard IR model with Document parsing, Document Indexing, TF-IDF calculation, query parsing and finally searching/document retrieval. Some modules in Lucene have been upgraded for our present need as described below. For TAC RTE-7 KBP 2010, the source web documents are full of noise mixed with the actual content. In that case it is very difficult to identify and separate this noise from the actual content. The corpus has much noise in the documents and the documents are in tagged format. First of all the documents have to be preprocessed. The document structure is checked and reformatted according to the system requirements. For the RTE-7 KBP generic task, we create the Query Word by the disjunction of hypothesis text after removal of the stop words along with the conjunction of the values of the "<entity>" and the "<value>" tags.

From the RTE-7 KBP (*.xml) source file, we extracted the following features for a particular pair id such as query, entity type, entity, value, attribute, text file name and a set of hypothesis.

[6] http://lucene.apache.org/

i. Generic Task

Method 1:

RTE-7 KBP Lexical engine: In the lexical engine we have passed the entity, value and attribute information and the corresponding set of hypothesis and text files. If the entity type is a named entity such as person, organization etc in Table 2, the generated acronym of the named entity is also provided as an input. If the entity or its acronym as well as the value are found in the sentences of the text file then these sentences are further considered. If no match is found in any of the text file sentences, no further processing is done and the text file is considered as not entailing the hypothesis. For those text file sentences where a match of the entity and value are found, the main verbs in the hypothesis sentences are identified. In the corresponding text file we have extracted the list of all the main verbs in between the matched entity and value. The verb of the hypothesis side and the verb of the text side are checked to see whether they belong to the same hypernym tree or are members of the same synset. If so then an entailment decision of "YES" is taken, otherwise the entailment decision is "NO".

Method 2:

At first we parsed the (*.sgm) files. After parsing, the documents are indexed using Lucene, an open source full text search engine. The basic architecture of Lucene is shown in Figure 6.

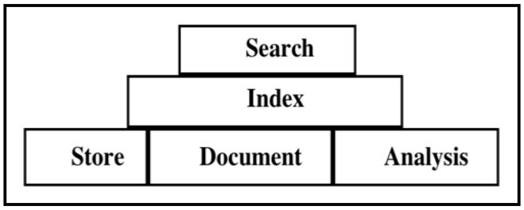

Figure 6. Lucene Architecture

After indexing has been done, the queries have to be fired to retrieve relevant documents. We take only the top ranked retrieved document assuming that it is the most relevant document for the query generated from the hypothesis. If the text file corresponding to a hypothesis is included in the most relevant document retrieved by Lucene, then the text-hypothesis pair is considered to have entailed, otherwise there is no entailment.

ii. Tailored Task:

For the tailored task, we developed the validation rules for each attribute from the development data. At first we have identified the entity and value in each hypothesis using the RASP NER [7]. Some RASP Named Entity tags are shown in the following Table 2.

	NE Tag	NE Tag Example
Number	<phr c="cd">	<phr c="cd">one</phr>
Person Name	<enamex type="person">	<enamex type="person">Chris Simcox</enamex>
Organization Name	<enamex type="organization">	<enamex type="organization">Minuteman Civil Defense Corps</enamex>
Location Name	<enamex type="location">	<enamex type="location">Argentina</enamex>
Role/ Title	<role>	<role>President</role>
Date/ Time	<timex type="date">	<timex type="date">2004</timex>

Table 2**.** RASP NE Table

Some of validation rules are described as follows:

Attribute:: title

For attribute *title*, we developed a list of possible titles using the development set data and the Wikipedia. Then we check the value of <value> tag of this pair id, looking for a word match with the title list. If there is a match then the entailment value for the pair is evaluated as "YES" otherwise "NO".

We recognize the particular pattern for which the title can occur. For example the pattern "is a", "was a", "become a". Suppose "He is a Dentist".In this example "Dentist" is the Title. Often "Title" can occur before the person name. Suppose "PRESIDENT OBAMA".

Attribute:: city of birth

At first we check whether the value of <value> tag is a location or not based on the RASP NE output. We have developed a list of city names of various countries of the world using the list available on the web[7]. Then value of <value> tag is compared with the corresponding database file. If a match is

[7] http://www.maxmind.com/app/worldcities

found then we look for phrases similar to "born in" in the text. If a match is found then the entailment value for the pair is "YES" otherwise "NO".

Attribute:: city of death

At first we check whether the value of <value> tag is location or not based on the RASP NE output. We have compared the value of <value> tag with the list of city names as developed. If a match is found then we look for phrases similar to "passed away " in the text. If a match is found then the entailment value for the pair is "YES" otherwise "NO".

Attribute:: website

At first we check whether the value of <value> tag is url or not based on the RASP NE output. If it is an url then the entailment value for the pair is "YES" otherwise "NO".

Attribute:: cause_of_death

At first we make a list of cause of diseases and a causal verbs list using information available in the WordNet and the development set. Then we compare the value of the <value> tag with this causal list. If a match is found then the entailment value for the pair is "YES" otherwise "NO".

Attribute::members

For this attribute, we check whether the value of <value> tag is organization or not based on the RASP NE output. If the <value> tag is an organization, then the entailment value for the pair is "YES" otherwise "NO".

Attribute::spouse

For spouse we find for the spouse related keyword such as "wife", "husband". If we get such these keywords in a sentence where value and entity both exists then we set "YES" for that particular value otherwise "NO".

Attribute::siblings

For spouse we find for the spouse related keyword such as "brother", "sister". If we get such these keywords in a sentence where value and entity both exists then we set "YES" for that particular value otherwise "NO".

For named entity recognition, the RASP Parser (Briscoe et al., 2006) [7] nertag component has been used. The nertag component is a rule-based named entity recognizer which recognizes and marks up the following kinds of named entity: numex (sums of money and percentages), timex (dates and times) and enamex (persons, organizations and locations).

4 Experiments on RTE-7 dataset and the results

4.1 Main Task

For the RTE-7 Main Task development and test set we have prepared the three runs, which are as follows:

Run 1 (JU_CSE_TAC1_Main): Lexical Entailment.
Run 2 (JU_CSE_TAC2_Main): Lexical Entailment and Syntactic Entailment.
Run 3 (JU_CSE_TAC3_Main): Lexical Entailment, Syntactic Entailment, Chunk and Named Entities.

The results of the RTE-7 Main Task on the development set are shown in Table 3.

Run Id#	Precision	Recall	F-Score
1	75.92	19.98	31.64
2	38.98	26.14	31.30
3	42.69	32.39	36.84

Table 3. Micro Average Result on RTE-7 Main Development Set

The results of the RTE-7 Main Task on the Test set are shown in Table 4.

Run Id#	Precision	Recall	F-Score
1	58.92	19.95	29.81
2	26.66	35.55	30.47
3	25.16	36.85	29.00

Table 4: Micro Average Result on RTE-7 Main Test Set

4.2 Novelty Task

For the RTE-7 Novelty Task development and test set, we have prepared the three runs which are as follows:

Run 1 (JU_CSE_TAC1_Novelty): Lexical Entailment.
Run 2 (JU_CSE_TAC2_Novelty): Lexical Entailment and Syntactic Entailment.
Run 3 (JU_CSE_TAC3_Novelty): Lexical Entailment, Syntactic Entailment, Chunk and Named Entities.

The results of the RTE-7 Novelty Task on the test set are shown in Table 5.

Run Id#	Evaluation	Precision	Recall	F-Score
1	**Novelty Evaluation**	80.18	93.33	86.26
	Justification Evaluation	51.19	16.56	25.02
2	**Novelty Evaluation**	90.60	69.23	78.49
	Justification Evaluation	21.94	33.63	26.56
3	**Novelty Evaluation**	90.37	62.56	73.94
	Justification Evaluation	20.37	34.27	25.55

Table 5. Micro Average Result on RTE-7 Novelty Test Set

4.3 RTE-7 KBP Validation Pilot Task

4.3.1 Generic Task

Run 1 (JU_CSE_TAC1_general): Using Apache Lucene (Using Method 2, Section 3.7)
Run 2 (JU_CSE_TAC2_general): Lexical Entailment (Using Method 1, Section 3.7), Manual Generated Rules and Apache Lucene (Using Method 2, Section 3.7)

The results of the KBP Validation Task on the Test set for generic task are shown in Table 6.

Run Id#	Precision	Recall	F-Score
1	0.0801	0.9755	0.148
2	0.1179	0.4914	0.1902

Table 6. Micro Average Result on RTE-7 KBP Validation Test Set (Generic Task)

4.3.2 Tailored Task

Run 1 (JU_CSE_TAC1_tailored): Use only Manual Generated Rules (Section 3.7)
Run 2 (JU_CSE_TAC2_tailored): Checking the Document and Fine tuned Manual Generated Rules (Section 3.7)

The results of the KBP Validation Task on the Test set for tailored are shown in Table 7.

Run Id#	Precision	Recall	F-Score
1	0.108	0.5643	0.1813
2	0.1097	0.559	0.1834

Table 7. Micro Average Result on RTE-7 KBP Validation Test Set (Tailored Task)

5 Ablations test and results

An ablation test [7] consists of removing one module at a time from a system, and rerunning the system on the test set with the other modules, except the one tested. Comparing the results to those obtained by the system as a whole, it is possible to assess the practical contribution of each single module. In order to better understand the relevance of the knowledge resources used by RTE systems and evaluate the contribution of each of them to the systems' performances, ablation tests for major knowledge resources are required for such systems.
For Main task, we have used the WordNet as a resource. So in Run 1, Run 2 we have ablated the WordNet resource. Table 8 shows the results of the ablation test for the main task with the WordNet resource being ablated.

Run Id#	Run Description	Precision	Recall	F-Score
1	**Micro Average**	68.92	11.70	20.00
	Macro Average	77.01	12.42	21.38
2	**Micro Average**	68.27	13.00	21.84
	Macro Average	76.86	13.57	23.07

Table 8. Ablation Result for RTE-7 Main Test Set

6 Conclusion

The textual entailment system has been developed as part of the participation in the TAC 2011 Recognizing Textual Entailment (RTE) Track organized by National Institute of Standards and Technology (NIST). We have proposed a textual entailment recognition system framework, which is a combination of lexical, syntactic and semantic features. The overall system has been evaluated using the evaluation metrics provided as part of the TAC RTE 2011 track. Future works will be motivated towards improving the performance of the system.

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