

# An Automatic System for Modality and Negation Detection

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**Abstract.** The article presents the experiments carried out as part of the participation in the pilot task (Modality and Negation)<sup>1</sup> of QA4MRE@CLEF 2012. Modality and Negation are two main grammatical devices that allow to express extra-propositional aspects of meaning. Modality is a grammatical category that allows to express aspects related to the attitude of the speaker towards statements. Negation is a grammatical category that allows to change the truth value of a proposition. The input for the systems is a text where all events expressed by verbs are identified and numbered the output should be a label per event. The possible values are: *mod*, *neg*, *neg-mod*, *none*. In the developed system, we first build a database for modal verbs of two categories: *epistemic* and *deontic*. Also, we used a negative verb list of 1877 verbs. This negative verb list has been used to identify negative modality. We extract the each tagged events from each sentences. Then our system check modal verbs by that database from each sentences. If any modal verbs is found before that an event then that event should be modal verb and tagged as *mod*. If modal verb is there and also negeted words is found before that evet then that event should negeted mod and tagged as *neg-mod*. If no modal verb is found before that an event but negeted word are found before that event then that event should be negeted and tagged as *neg*. Otherwise the event should tagged as *none*. We trained our system by traing data (sample data) that was provided by QA4MRE organizer. Then we are tested our system on test dataset. In test data set there are eight documents, two per each of the four topics such as Alzheimer, music and society, AIDS and climate change. Our system overall accuracy is 0.6262 (779 out of 1244).

**Keywords:** QA4MRE Data Sets, Modal Verbs List.

## 1 Introduction

The main objective of QA4MRE<sup>2</sup> [1] is to develop a methodology for evaluating Machine Reading systems through Question Answering and Reading Comprehension Tests. Beside the Main Task, also two pilot tasks are offered by organizer this year at QA4MRE, i.e. *Processing Modality and Negation for Machine Reading*, *Machine Reading of Biomedical Texts about Alzheimer*. This task (*Processing Modality and Negation for Machine Reading*) is defined as an annotation task where systems have to determine whether an event mentioned in a text is presented as negated, modalised (i.e. affected by an expression of modality), or both. This information can be relevant for machine reading systems, since negated and modalised events should be treated differently than factual events in the inference making process. We have participated in RespubliQA@CLEF 2010 [2], QA4MRE@CLEF 2011 [3] and QA4MRE@2012 [4]. This year we have participated in Main Task [1] and Pilot Task [1].

Section 2 describes the corpus statistics. Section 3 describes the system architecture. The experiments carried out on test data sets are discussed in Section 4 along with the results.

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<sup>1</sup> <http://celet.fbk.eu/QA4MRE/index.php?page=Pages/modalityTask.html>

<sup>2</sup> <http://celet.fbk.eu/QA4MRE/index.php>

## 2 Corpus Statistics

The organizer provided a test set consisting of 8 documents, 2 per topic. Documents annotated as shown in Table 1 in (1), where events are marked in the text, assigned an identification number and label per event with the format shown in Table 1 in (2). The possible values are: *mod, neg, neg-mod, none*.

**Table 1.** QA4MRE Corpus Detail

Corpus	
(1)	<i>Europe's climate policy &lt;event id=1&gt;Being&lt;/event&gt;ambitious The European Commission maps a path to a low-carbon future. Now to &lt;event id=2&gt;walk&lt;/event&gt;it Mar 10th 2011 from the print edition About half Europe's electricity &lt;event id=3&gt;comes&lt;/event&gt; from fossil fuels, with CO2 emissions as an unwanted by-product. By 2050, &lt;event id=4&gt;proposes&lt;/event&gt; a `` road map '' &lt;event id=5&gt;released&lt;/event&gt; by the European Commission this week, all that gassy baggage must &lt;event id=6&gt;go&lt;/event&gt;.</i>
(2)	<i>e1=NONE e2=MOD e3=NONE e4=NONE e5=NONE e6=MOD</i>

There are eight documents, two per each of the four topics, such as: Alzheimer, music and society, AIDS and climate change. For each document organizer provided the text version in the directory "txt" and the version with marked events in the directory "events" is shown in Table 2. This task was defined as an annotation task where systems have to determine whether an event mentioned in a text is presented as negated, modalised (i.e. affected by an expression of modality), or both.

**Table 2.** Test corpus files

Name of the Test Files <b>Pilot task: PROCESSING MODALITY AND NEGATION</b>		
No	Txt files	Event files
1	<i>aids-all-colors-of-the-brainbow.txt</i>	<i>aids-all-colors-of-the-brainbow-EVENTS.txt</i>
2	<i>aids-darc-continent.txt</i>	<i>aids-darc-continent-EVENTS.txt</i>
3	<i>alz-barking-up-wrong-trip.txt</i>	<i>alz-barking-up-wrong-trip-EVENTS.txt</i>
4	<i>alz-have-have-not.txt</i>	<i>alz-have-have-not-EVENTS.txt</i>
5	<i>climate-a-record-making-effort.txt</i>	<i>climate-a-record-making-effort-EVENTS.txt</i>
6	<i>climate-are-economists-erring-on-climate-change.txt</i>	<i>climate-are-economists-erring-on-climate-change-EVENTS.txt</i>
7	<i>music-can-hiphop-change-the-world.txt</i>	<i>music-can-hiphop-change-the-world-EVENTS.txt</i>
8	<i>music-how-to-sink-pirates.txt</i>	<i>music-how-to-sink-pirates-EVENTS.txt</i>

## 3 System Architecture

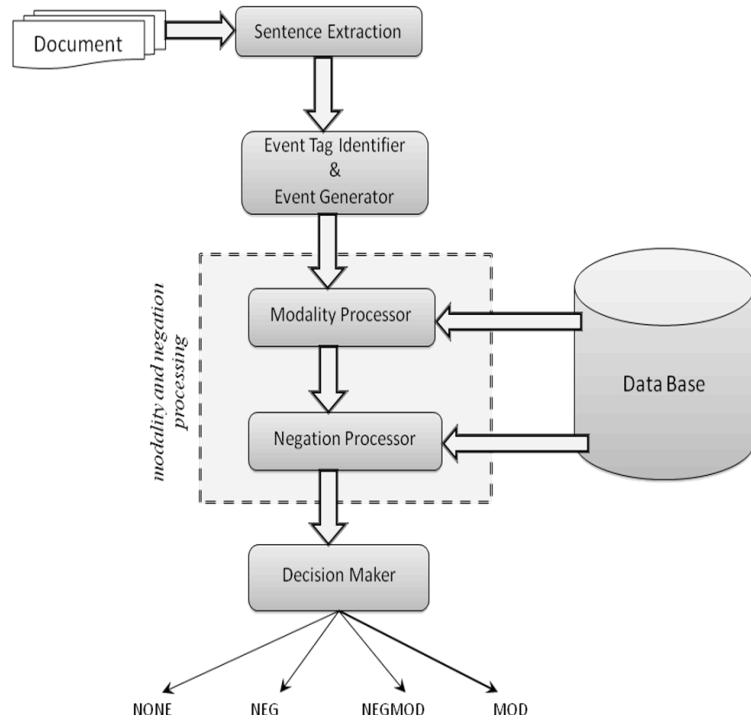
The architecture of machine reading system is described in Figure 1. The describing system consists of database and four following modules:

- i. Sentence Extractor
- ii. Event Tag Identifier and Event Generator
- iii. Modality and Negation Processing
- iv. Decision Maker

Further, *Modality and Negation Processing* module divides in two sub modules: (i) Modality Processor and (ii) Negation Processor

**Database:** The modal lists contain the following lists: modal verbs, epistemic adjectives, epistemic adverbs, epistemic nouns, propositional attitude verbs and adjectives, epistemic judgment verbs, epistemic evidential verbs, epistemic deductive verbs.

Explicit negation lists have been also prepared manually to handle explicit negations. Those lists include negative nouns, negative verbs, negative prepositions, negative determiners, negative pronouns, and negative conjunctions.



**Fig. 1.** System Architecture

**Sentence Extractor Module:** The input to this module is single document and output is a list of sentences  $S = \{S_1, S_2, S_3 \dots S_{n-1}, S_n\}$ . The objective of this module is to identify each sentence and make list  $S$  for next level.

**Event Tag Identifier and Event Generator:** This module takes list of sentences  $S$  as input and processes each sentence to extract individual event. This module has the ability to identify *event tag*. For each sentence in sentence list  $S$  individual events have been identified using event tag and a list of events  $E = \{e_1, e_2, e_3 \dots e_{n-1}, e_n\}$  has been generated.

**Modality and Negation Processing:** This module is the core module of the system. This module has two sub-modules- modality processor and negation processor.

Modality Processor module is responsible for identifying an event is modalised or not. The manually prepared lists described at database section are applied to the processing event and a pair {event, modality} has been generated for each event. Next, the Negation Processor module uses the negative lists to check whether it appears before the event.

If that do not occur then marks it as negative. So, for each event a new pair has been generated by this module-  
 $e_i = \{\text{modality}, \text{negation}\}$ ; i.e  $e_i = \{\text{yes, no}\}$ ,  $e_i \in E = \{e_1, e_2, e_3 \dots e_{n-1}, e_n\}$ .

**Decision Maker:** This modules takes event list  $E = \{e_1, e_2, e_3 \dots e_{n-1}, e_n\}$  and decides one of the four output based on the table is shown in Table 3.

**Table 3.** Event List

Options	Modality	Negation	Results
1	no	no	NONE
2	no	yes	NEG
3	yes	no	MOD
4	yes	yes	NEGMOD

Where,

**NONE:** The event is presented as certain and it happened

**NEG:** The event is presented as certain and did not happen

**MOD:** The event is not presented as certain and is not negated

**NEGMOD:** The event is not presented as certain and is negated

## 4 Evaluation

We have trained our system by train data (sample data) and tested on test data set. Experiments result is shown in Table 4.

**Table 4.** Experiment results on Test Data

Dataset name	Tag	Precision	Recall	F-Score
eval.JUCSENLP-aids-all-colors-of-the-brainbow-r1.txt	MOD	0.2500	0.4737	0.3273
	NONE	0.7857	0.6627	0.7190
	<b>Overall Accuracy:</b> 0.5766 (64 out of 111)			
eval.JUCSENLP-aids-darc-continent-r1.txt	MOD	0.4118	0.5385	0.4667
	NONE	0.8000	0.7500	0.7742
	<b>Overall Accuracy:</b> 0.6379 (74 out of 116)			
eval.JUCSENLP-alz-barking-up-wrong-trip-r1.txt	MOD	0.7667	0.6053	0.6765
	NONE	0.7324	0.8387	0.7820
	<b>Overall Accuracy:</b> 0.7009 (75 out of 107)			
eval.JUCSENLP-alz-have-have-not-r1.txt	MOD	0.7727	0.6296	0.6939
	NEGMOD	0.1250	0.3333	0.1818
	NONE	0.6744	0.7838	0.7250
<b>Overall Accuracy:</b> 0.6438 (47 out of 73)				
eval.JUCSENLP-climate-a-record-making-effort-r1.txt	MOD	0.5926	0.5369	0.5634
	NONE	0.6034	0.7447	0.6667
	<b>Overall Accuracy:</b> 0.5867 (220 out of 375)			
eval.JUCSENLP-climate-are-economists-errng-on-climate-change-r1.txt	MOD	0.7889	0.5917	0.6762
	NEGMOD	0.0667	0.0909	0.0769
	NONE	0.5727	0.8289	0.6774
<b>Overall Accuracy:</b> 0.6279 (135 out of 215)				
eval.JUCSENLP-music-can-hiphop-change-the-world-r1.txt	MOD	0.6875	0.5500	0.6111
	NONE	0.6753	0.7429	0.7075
	<b>Overall Accuracy:</b> 0.6028 (85 out of 141)			
eval.JUCSENLP-music-how-to-sink-pirates-r1.txt	MOD	0.6452	0.5714	0.6061
	NONE	0.8429	0.8551	0.8489
	<b>Overall Accuracy:</b> 0.7453 (79 out of 106)			
<b>Overall</b>	MOD	0.6268	0.5633	0.5933
	NEGMOD	0.0286	0.0488	0.0360
	NONE	0.6818	0.7669	0.7219
	<b>Macroaveraged F-measure (beta=1.0): 0.3378</b>			
	<b>Microaveraged F-measure (beta=1.0): 0.6132</b>			
	<b>Overall Accuracy: 0.6262 (779 out of 1244)</b>			

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