Annotating Events, Time and Place Expressions in Arabic Texts

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Abstract

We present in this paper an unsupervised approach to recognize events, time and place expressions in Arabic texts. Arabic is a resource –scarce language and we don't easily have at hand annotated corpora, lexicons and other needed NLP tools.   We show in this work that we can recognize events, time and place expressions in Arabic texts without using a POS annotated corpus and without lexicon. We use an unsupervised segmentation algorithm then a minimalist set of rules allows us to get a partial POS annotation of our corpus. This partially annotated corpus will serve as a basis for the recognition process which implements a set of rules using specific linguistic markers to recognize events, and expressions of time and place.

1   Introduction

The considerable development of information and communication technology has fundamentally changed the way we access knowledge. To deal with the huge volumes of information, constantly increasing, efficient and robust technologies are needed. In this context, named entities (persons, places, organizations, dates ...) are requested in order to categorize, index, summarize, this information.

A very useful resource for conducting research in the area of NLP is an annotated corpus which can be used as data in the development of algorithms and as data in the evaluation of those algorithms (Mazur, 2012). However, natural languages are not all equal regarding the availability of such corpora. Arabic is among the resource-scarce languages and the Arabic NLP (ANLP) community still suffers from the lack of free available annotated corpora, electronic lexicons and other needed NLP tools. Moreover, there are no established (theoretical) linguistic studies to rely on, in the field of NER though there is recently an increasing interest from the ANLP community. We propose in this work a minimalist approach that allows recognition and annotation of key expressions in a raw corpus using only formal indices in the texts. This is not an exhaustive annotation of NEs but rather an empirical approach to provide a useful ANLP resource. The rest of the paper is organized as follows: section 2 is a survey of related work, section 3 describes our minimalist approach to event, time and place expressions recognition in Arabic texts, section 4 reports the results and evaluation of the approach and finally, we end with a conclusion and future work in section 5.

2   Related work

In the growing field of Information Extraction (IE), Named Entity Recognition (NER) refers to the recognition and categorization by types of person names, organizations, locations, numerals as well as time/dates. Nadeau and Sekine (2009) provide a pretty large survey of work on NER where we can find a large variety of NER tools for a few widely used languages. There are generally three main approaches to NER. Linguistic rule based, statistical based, and hybrid.

Rule-based methods are usually based on an existing lexicon of proper names and a local grammar that describes patterns to match NEs using internal evidence (gazetteers) and external evidence provided by the context in which the NEs appear (Zaghouani, 2012). Statistical and machine learning approaches generally require a large amount of manually annotated training data. Hybrid methods are a combination of the statistical and the rule-based approaches. A remaining challenge in the field is how to develop such systems quickly with minimal costs.

Unfortunately, the main efforts to build reliable NER systems for Arabic has been conducted in a commercial framework and the approach used as well as the accuracy of the performance are not known. Nevertheless, we can find recently interesting research works in this topic. Zaghouani (2012) surveys the most significant works in the field. Most of the reported work concerns recognition of proper names of persons and organizations. In (Traboulsi, 2006), we find a rule-based named-entity recognition model using local grammar and dictionaries and which gives good results when tested in a small- scale experiment with a Reuter corpus. Shaalan and Raza (2009) presented an Arabic NER system based on a rule-based approach, a dictionary of names, a local grammar and a filtering mechanism that rejects the incorrect NEs. The system obtained an F-measure of 87.7% for persons, 85.9% for locations, 83.15% for organizations and 91.6% for dates. Zaghouani (2012) described a rule-based system for Arabic NER which adapts a multilingual NER system to Arabic. The system obtained an F-measure of 61.54% for persons and 52.23% for organizations.

On the machine learning side, Zitouni *et al* (2005) developed a system which allows recognition of nominals, pronominals, references to entities and named entities. They used a maximum entropy markov model and the evaluation of their system on the ACE data set gave an F-measure of 69%. Benajiba also has a continuing work in this approach: Benajiba *et al* (2008) proposed a system that combines Support Vector Machine and Conditional Random Fields approaches. The system also used lexical, morphological and syntactic features and a multi- classifier approach where each classifier was designed to tag a NE class. The system obtained an F-measure of 83.5%. In his thesis, Benajiba (2009) concluded that no single Machine Learning approach is better than another for the Arabic NER task and that the best results were obtained when he used a multi- classifier approach where each classifier used the best ML technique to specific NE class. In another experiment, Benajiba *et al* (2009) explored a combination of lexical, contextual and morphological features. The impact of the different features has been measured in isolation and combined and an F-measure of 82.71% was obtained.

Related to event extraction, Abuleil (2007) presented a work for event detection in Arabic texts that is based on collecting key-word events like in natural disasters, bombing, elections ...

The system was able to identify 439 events out of 467 on the test corpus.

Saleh *et al* (2011) described a Machine Learning approach to automatic detection of temporal and numerical expressions in Arabic texts based on processing the dashtag- TMP used in the Arabic tree- bank. The system obtained an F-measure of 73.1% for temporal expressions and 94.4% for numerical expressions.

3 A minimalist approach to recognition of event, time and place expressions in Arabic texts

3.1 Arabic Language

Arabic is a Semitic language spoken by more than 330 million people as a native language, in an area extending from the Arabian/Persian Gulf in the East to the Atlantic Ocean in the West. Arabic is a highly structured and derivational language where morphology plays a very important role. Arabic NLP applications must deal with several complex problems pertinent to the nature and structure of the Arabic language. For instance, Arabic is written from right to left. Like Chinese, Japanese, and Korean there is no capitalization in Arabic. In addition, Arabic letters change shape according to their position in the word. Modern Standard Arabic (the modern version of classical Arabic) does not have orthographic representation of short letters which requires a high degree of homograph resolution and word sense disambiguation.

3.2 Detecting Key expressions in Arabic texts

In order to provide an Arabic resource that will be useful for our NLP applications such as text summarization and question- answering, we propose an approach which is minimalist in the sense that it allows annotation of key expressions in a raw corpus of Arabic texts without any exhaustive pre- processing like POS tagging and without using dictionaries.
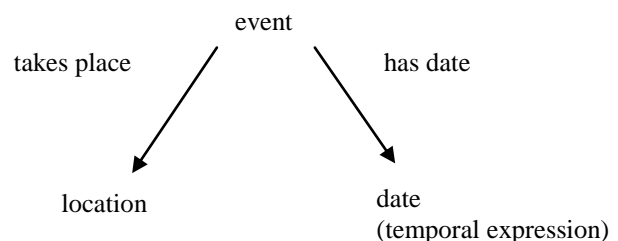

Figure1: structure of an event

The structure of event is relevant since at a conceptual point of view a structure of event engages participants such as actor, time and location. In this work, we adopt the conceptual event scheme as defined by Saval *et al* (2009) who built an ontology for natural disasters and which is shown in figure above.

We then, try to identify events, time and place expressions using surface indices from the texts. We don't deal with named entities of persons yet.

Segmentation and Partial POS tagging: As we have chosen to work by using only surface indices from the texts, we opted to adapt to our needs the algorithm described in (Aliane, 2011) which is an algorithm of segmentation based on Arabic linguistic theory. It is an unsupervised, knowledge-free discovery algorithm in the sense of (Bieman, 2006). It allows the discovery of the morphemes and affixes of the corpus without using lexicons or predefined tables of affixes as schematized in figure 2:

Raw texts ⇒ affixes discovery

⇓

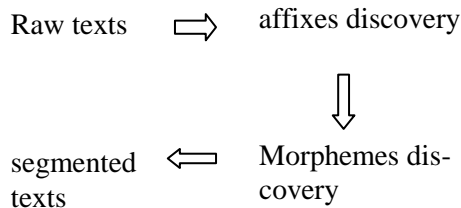segmented ⇐ Morphemes dis-
texts   covery

figure2: the segmentation algorithm

Nevertheless, this algorithm doesn't give the categories of the segmented units. It aims to simulate the underlying distributional analysis of the Arabic linguistic theory in a larger work (Aliane, 2011). The result of the segmentation process is [left affix +morpheme+ right affix]$_{<Lexie>}$; a lexie here, is a word between two pauses (a blank or a punctuation sign).

Then, our idea is that we can detect significant key expressions in the texts by adding to such segmented corpus some POS tagging by observing the texts in order to build a minimal set of rules depending on the form of the affixes. Arabic linguistic theory defines three part of speech which are: Noun (ism), Verb (fi'l) and Particle (harf) (Sibawayh, 77). Further sub- categorization can be found in (Ghoul, 2011). However, we don't aim at an exhaustive tagging so we manually build using the right and left affixes obtained by the segmentation process and other surface indices, a set of rules to annotate verbs and nouns in the corpus. From the indication of the affixes we obtained four rules, one for Noun (ism) and three for verbs: past, present and future. Nouns

are labeled as <LN> for nominal lexie and verbs are labeled as <LV> for verbal lexie. We don't use the tense indication in this paper but we've made it for later work.

Besides the rules induced from the affixes, we have also two contextual rules which are:

R1/ if a lexie is preceded by "سوف" then annotate the lexie as verb at present time.

R2/ if a lexie is preceded by lexie₁ ϵ L then annotate the lexie as noun. L= { إلى، في، من، عن، على، عدا، حاشا، غير، إلا، لولا ،غير، إلا، لولا، سوى}.

Verbal Event detection: We are interested in this work only in the annotation of verbal events. Arabic grammarians define a verb as a form denoting "a happening" (حدث). This definition is sufficient to assume that any verb denotes à priori an event. Nevertheless, there are some lexies that have the form of verbs but that rather denotes modalities. The study of the classification and semantic of Arabic modalities is out of the scope of this work, thus, we apply a filtering rule to exclude the lexies which belong to the list of modalities and then every lexie annotated as verb in the partial POS tagging step described in the precedent sub-section will be annotated as a verbal event by adding the label <event>.

Temporal expressions detection: In this step, we identify non verbal linguistic units that convey temporal information by detecting temporal markers and then applying a contextual analysis right and left of the identified markers. This approach is inspired from (Vazov, 2001) and (Décles *et al*,1997). The detection phase looks for a particular set of markers (regular expressions) encoding temporal information. These markers can be stand- alone or trigger markers. The stand- alone markers represent autonomous temporal expressions. The contextual analysis is launched if the system identifies a trigger marker. A trigger marker signals the presence of a larger temporal expression and triggers a rule for the limitation and annotation of this expression. The contextual analysis determines the boundaries of the temporal expression in the analyzed utterance. The trigger markers are of two kinds:

M1 contains the markers which are linguistic units always appearing in the most right position in the temporal expression and that trigger a contextual analysis from right to left like: حين، منذ (when, since).

M2 contains markers which can be involved in any position in the temporal expression and that trigger contextual analysis both from right to left and from left to right such as: يوم، جانفي، دقيقة (day, January, minute,).

We have grouped the observed stand- alone markers in Arabic texts in the set £ shown in table1. example: جاء صباحا. (he came morning.)

£
صباحا،مساءا،ظهرا،عصرا،عشاءا، مغربا، نهارا، ليلا، سحرا، فجرا، امسا، زوالا، غدا، ابدا، برهة، غدوة، الان، قط، هنيهة، قرنا، اسبوعا، يوما، عاما، خريفا، ربيعا، صيفا، شتاءا.

Table1: Stand-alone markers

The trigger markers are grouped in two sets M1 and M2 shown in Table2.

M1	M2
منذ حين	فترة، يوم، شهر, قرن، سنة،
مدة،	عام، ساعة، دقيقة،
غداة	عصر، ظهر، فجر، زوال، صباح،
طوال،	مساء، ليلة، ليل، نهار، أمسية،
طيلة	عشية، أمس، مساء، صبيحة،
بتاريخ	البارحة، ربيع، شتاء، صيف، خريف،
	السبت، الأحد، الاثنين، الثلاثاء،
	الأربعاء، الخميس، الجمعة
	جانفي، فيفري، مارس، افريل،
	ماي، جوان، جويلية، اوت، سبتمبر،
	أكتوبر، نوفمبر، ديسمبر
	تاريخ مثل: 15/12/ 2012، 10-12-2010

Table2: Trigger markers

Besides the markers in M1 and M2, we use some "heuristic" other markers which may determine the search space for the context analysis rules and they are the following sets:

D1 contains some adverbs that may precede a temporal expression as well as a location expression like: قبل، بعد (before, after)

D2 contains words that we find near to temporal expressions like: منتصف، بداية (middle, beggining)

D3 contains words that denote numerals like: سبعة، ثمانية،

Context analysis rules: We have two rules: Rule1 which is triggered by markers from M1. On encountering a marker from M1, a left con-

text analysis is launched (from right to left) by adding all encountered lexies left to the marker until we find a punctuation sign or a lexie which is labeled <LV> (verbal lexie) or a lexie labeled <L> (this means it remains ambiguous from the partial POS tagging step) and that does not belong to **£.**

example1: temporal expression detected by Rule1, a left context analysis is performed on encountering the trigger marker منذ.
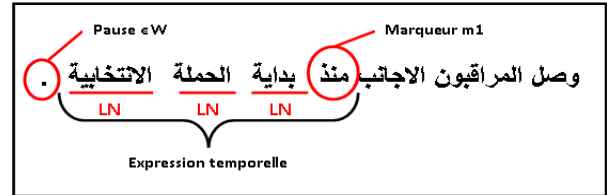

Rule2 is triggered on encountering a marker from M2, both left and right context of the marker are scanned. Analyzing the left context consists in building a larger temporal expression by adding all the lexies encountered until finding a punctuation sign or a lexie which is labeled <LV> (verbal lexie) or a lexie labeled <L> and that does not belong to **£.** The right context analysis adds all the lexies that are right to the marker if they belong to one of M1, M2, D1, D2, D3 and until encountering a lexie that doesn't belong to one of these sets.

Example2: temporal expression recognized when Rule2 is triggered by the marker العام (year)

Example3: Rule2 is triggered on encountering the marker يوم (day).
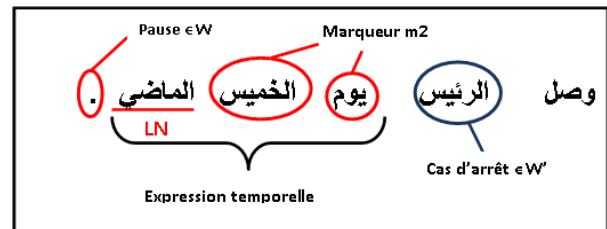
Place expressions detection: In order to detect location expressions, we also use surface markers from the texts. These markers are stand-alone markers or trigger markers. The trigger markers are lexies that always come in the most right position of the expression and trigger a con-

textual analysis from right to left. The location markers are shown in table3 below:

£	M
شرقا، غربا، شمالا، جنوبا، يسارا، يمينا	خلف، أمام، فوق، تحت، جنب، بجنب، قدام، وراء، اسفل، خارج، داخل، اتجاه، باتجاه، قرب، شرق، غرب، شمال، جنوب، وسط، يمين، يسار، في، بين

Table3: Stand-alone and trigger markers for place expression recognition

Then, we have one contextual analysis rule which is Rule3 and which principle is:

On encountering a marker *m* from M, a left contextual analysis is launched that builds a larger location expression by adding all the words encountered left to the marker until finding a punctuation sign or a lexie which is labeled <LV> (verbal lexie) or a lexie labeled <L> (this means it remains ambiguous from the partial POS tagging step) and that does not belong to £.or a particle (lexie which length is<3).

example4: place expression detected by rule3, the left context analysis here stops on encountering the two letter word ثم.
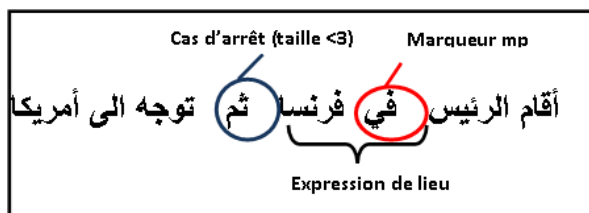
The overall approach is resumed in figure3

4   Results and evaluation

We have tested our system on a corpus of 30 articles from the web, written in Modern standard Arabic. The texts are not vowelized. The corpus is annotated by the tags <event> for verbal events detected, <Timex> for time expressions and <Pl> for place expressions, example is given in appendix1. The system was able to recognize 168 verbal events out of 268 and shows an F-measure of 84% for temporal expressions and 45% for place expressions. These recognition

rates are influenced by the ambiguities left from the partial POS tagging step which didn't detect all the verbs and the nouns of the corpus.

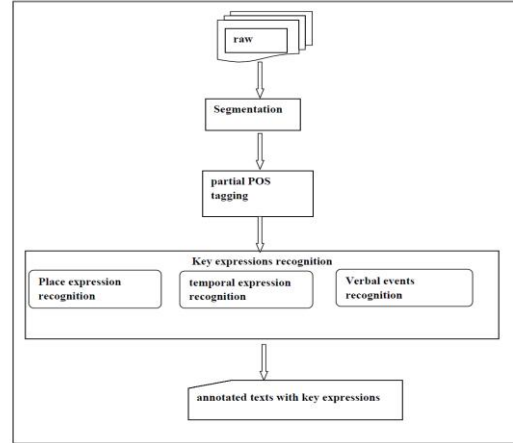Appendix1 shows an example of annotated text after processing.

Figure 3 Architecture of the approach

5 Conclusion

We have shown in this work that we can perform annotation of key expressions in Arabic texts without any resources at hand. We have proposed a minimalist approach that uses only surface indices from the texts. We used those indices as markers to manually build a minimal set of general rules: two rules for time expressions recognition and one rule for location expression recognition.

This approach is independent from the nature of the texts. The results are encouraging and competitive with other works which use lexical resources or machine learning techniques. We aim to use these results to get further recognition and annotation by building contextual analysis rules where the time and location expressions already recognized help recognizing verbs and nouns that have not been annotated in the partial POS tagging step. This is possible by enlarging the conceptual schema of an event to involve the actor of the event. Hence, we can reiterate the whole annotation process to improve the scores.

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Appendix1. Example of annotated text after key expressions recognition

واشنطن من كريغ غوردون : لقد مثل البيان الذي <EVENT> قدمته <EVENT/> هيئة الاستخبارات للرئيس بوش بخصوص
<EVENT> تنظيم<EVENT/> القاعدة قبل وقوع هجمات <TIMEX> الحادي عشر من سبتمبر<TIMEX/> محك اختبار للرئيس
بوش<EVENT> وادارته <EVENT/> .وقد اتضح بعد وقائع جلسة استماع <TIMEX> امس الاول<TIMEX/> ان هيئة لاستخبارات
الاميركية كانت قد اكدت للادارة الاميركية احتمال قيام <EVENT> تنظيم <EVENT/> القاعدة بحملات اختطاف وشن بعض الهجمات
الارهابية على الاراضي الاميركية.

وحسبما ذكر احد اعضاء هيئة المستشارين<PL/> في لجنة التحقيق فقد اكد البيان الذي قدمه جورج <EVENT> <PL>
تينيت<EVENT/> للرئيس الاميركي<TIMEX> في السادس من اغسطس عام 2001 <TIMEX/> على ان اعضاء<EVENT> تنظيم
<EVENT/> القاعدة كانوا<EVENT/> يعيشون <EVENT> <PL/> في الولايات المتحدة <PL/> <TIMEX> لسنوات عديدة
<TIMEX/> وقد<EVENT> تمكنوا <EVENT/> لابعد من ذلك من تنظيم شبكة للدعم والتمويل <PL> في الولايات المتحدة .
<PL/> وكان مكتب التحقيقات الفيدرالي قد ابدى قلقا بالغا ازاء <EVENT> تواجد <EVENT/> اعضاء القاعدة <PL> في اميركا
لدرجة <EVENT> <PL/> جعلت<EVENT/> المكتب<EVENT> <EVENT/> يوظف <EVENT/> نحو 70 من المحققين الميدانيين لتعقب
اعضاء القاعدة <TIMEX> في صيف 2001 <TIMEX/>.

<EVENT> واوضحت <EVENT/> مذكرة هيئة الاستخبارات الاميركية ايضا ان اهتمام القاعدة بالخطف كوسيلة من وسائل الارهاب
لم <EVENT> يتوان <EVENT/> للحظة وقال ريتشارد<PL>بين <PL/> <EVENT> <EVENT/> فينسيت <EVENT/> عضو لجنة
التحقيق <PL> في احداث <PL/> <TIMEX>الحادي عشر من سبتمبر<TIMEX/> ان مكتب التحقيقات الفيدرالي كان
<EVENT>يقوم <EVENT/> بتعقب الانشطة المشتبه<PL/> في صلتها<PL/> مع حوادث الاختطاف<TIMEX/> في شهر اغسطس
عام 2001 <TIMEX/>.

وبالرغم من تأكيدات ادارة الرئيس بوش على ان المصادر الاستخباراتية التي <EVENT> قدمت<EVENT/>لها <TIMEX> في صيف
2001 <TIMEX/> قد اكدت فقط على الهجمات المحتملة لتنظيم القاعدة <PL> خارج الاراضي الاميركية بيد <PL/> ان عنوان البيان
الذي<EVENT> قدمت <EVENT/> هيئة الاستخبارات الاميركية للرئيس الاميركي كان <EVENT> يتضمن<EVENT/> معلومات
اخرى وهو <EVENT> تصميم <EVENT/> القاعدة على القيام بمهاجمة الاهداف الاستراتيجية <PL> داخل الاراضي الاميركية
<PL/>وهذا ما<EVENT> يمكن<EVENT/>ان <EVENT> لحظه<EVENT/> من ثنايا <EVENT> تصريحات <EVENT/>
كوندوليزا رايس مستشارة الامن القومي الاميركي خلال مثولها للشهادة <PL> امام لجنة التحقيق <PL/> في
اعتداءات <PL/> <TIMEX >الحادي عشر من سبتمبر يوم الخميس الماضي<TIMEX/> وذلك بالاضافة الى التصريحات والبيانات
التي ادلى بها اعضاء هذه اللجنة. وقد<EVENT> اظهرت<EVENT/> هذه التصريحات والبيانات ان هيئة الاستخبارات الاميركية
ومكتب التحقيقات الفيدرالية كانا على علم باحتمال وقوع بعض الهجمات الارهابية على الاراضي الاميركية ومحاولة هيئة الاستخبارات
الاميركية لفت نظر الرئيس بوش الى وقوع هذه الاحتمالية وذلك من خلال التأكيد عليها<PL/> في البيان <PL/>
<EVENT>قدمته <EVENT/>الهيئة للرئيس الاميركي <TIMEX> السادس من اغسطس عام 2001<TIMEX/> والذي كان
<EVENT>يسمى<EVENT/> بالبيان الرئاسي اليومي وقد<EVENT> تسلم<EVENT/> بوش هذا البيان بعد طرحه بوش لتساؤل
عن احتمالية قيام القاعدة بمهاجمة الولايات المتحدة.
<EVENT>ومالت<EVENT/> رايس الى التأكيد على الاعتقاد السائد لدى البيت الابيض ان البيان ما هو الا معلومات قديمة قائمة
على تقارير قديمة جدا<EVENT/> وقالت<EVENT/> ان المذكرة لم <EVENT> تحذر <EVENT/> من هجمات محتملة على
الولايات المتحدة الاميركية.

وقد فند اعضاء لجنة التحقيق من الديمقراطيين من الاعتقاد والادعاء ولكنهم<EVENT> اتفقوا<EVENT/> على ان البيان لم يكن
<EVENT>يحتوي<EVENT/> على معلومات<TIMEX> دقيقة بشأن<TIMEX/> موعد مكان الهجمات .وعلى الرغم من ذلك فقد
<EVENT> طرحت<EVENT/> جلسات الاستماع للجنة التحقيقات بعض المسائل المهمة والمركزية وهي ما هي المعلومات التي
<EVENT>نقلت<EVENT/> لبوش عن التهديدات الارهابية ومتى اخبر بوش بهذه المعلومات وهذا هو سبب التركيز على بيان
<TIMEX>السادس من اغسطس <TIMEX/> الذي قدم للرئيس بوش اثناء قضائه لاجازته السنوية<PL>في ولاية
<EVENT></PL> تكساس<EVENT/> وينظر البيت الابيض الآن <PL> في مسألة اعادة </PL><EVENT> تقييم
<EVENT/>ودراسة هذه المذكرة بيد ان رايس وبعض اعضاء لجنة التحقيق<EVENT>قاموا<EVENT/> بالكشف عن بعض من
محتويات هذه المذكرة <TIMEX> يوم الخميس الماضي <TIMEX/>.وقد<EVENT> اوضحت <EVENT/> جلسة الاستماع ان
ادارة الرئيس بوش كانت على علم بثلاث حقائق قبل احداث <TIMEX> الحادي عشر من سبتمبر<TIMEX/> فقد كانت الادارة
الاميركية<EVENT> تعلم <EVENT/> بتواجد اعضاء القاعدة<PL> في الاراضي الاميركية وهذا<PL/> ما كان<EVENT> ينبئ
<EVENT/>بحدوث بعض الهجمات الارهابية على الاراضي الاميركية وان القاعدة كانت<EVENT> تخطط<EVENT/> لمهاجمة
الولايات المتحدة عن طريق انتهاج اسلوب الاختطاف لتنفيذ هذه المخططات. ولكن رايس اكدت على ان التهديدات التي يتم <EVENT>
تحذيرنا <EVENT/> منها لم تكن محددة<PL/>في الوقت ولا <PL><PL/>في المكان ولا<PL/> <PL>في اسلوب الهجمات
وعليه فلم تكن هذه البيانات ذات جدوى واضحة <PL/> <EVENT> <EVENT/> واوضحت <EVENT/> جلسة الاستماع ايضا الخلل الرهيب
<PL>في التنسيق والتواصل بين البيت الابيض ومكتب التحقيقات الفيدرالي <PL/> <EVENT> <EVENT/>وقالت<EVENT/> رايس ان مكتب
التحقيقات الفيدرالي كان قد قام بجهود مضنية لتعقب اعضاء القاعدة <PL> في الاراضي الاميركية بيد<PL/> ان هيئة المستشارين
<EVENT>قامت<EVENT/> بتنفيد ونفى<EVENT> تصريحات <EVENT/> رايس.