A Method of Recognizing Entity and Relation

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INTRODUCTION

Entity and relation recognition, i.e. assigning semantic classes (e.g., person, organization and location) to entities in a given sentence and determining the relations (e.g., born-in and employee-of) that hold between the corresponding entities, is an important task in areas such as information extraction (IE) (Califf and Mooney, 1999; Chinchor, 1998; Freitag, 2000; Roth and Yih, 2001), question answering (QA) (Voorhees, 2000; Changki Lee et al., 2007) and story comprehension (Hirschman et al., 1999). In a QA system, many questions ask for the specific entities involved in some relations. For example, the question that "Where was Poe born?" in TREC-9 asks for the location entity in which Poe was born. In a typical IE extraction task such as constructing a jobs database from unstructured text, the system has to extract many meaning entities like title and salary, ideally, to determine whether the entities are associated with the same position.

BACKGROUND

In all earlier works as we know of, except for Roth and Yih' work (2002), the entity and relation recognition task is treated as two separate subtasks, which are typically carried out sequentially, i.e. firstly, use an entity recognizer to identify entities, and then use a relation classifier to determine the relations. This procedure is problematic: firstly, errors made by the entity recognizer are propagated to the relation classifier with an accumulative effect and may degrade its performance significantly. For example, if "Boston" is mislabeled as a person, it will never be classified as the location of Poe's birthplace. Secondly, some relation information can be available only during the relation recognition, and the information is sometimes crucial to resolve ambiguity of entity recognition. For example, if we know that the class of an entity corresponds to the first argument X in the relation born-in (X, China), the class of the entity cannot be a location but a person.

To resolve the first problem described above, Roth and Yih (2002) developed a method, in which the two subtasks are carried out simultaneously. Firstly, two classifiers are trained for entities and relations independently, and their outputs are treated as the conditional probability distributions for each entity and relation. Secondly, this information together with the constraint knowledge induced among relations and entities are represented in a belief network (Pearl, 1998) and used to make global inferences for all entities and relations of interest. The idea of making global inferences is very good because it blocks the errors propagation. But the approach has still several problems. Firstly, the belief network cannot fully model the entity and relation recognition question since it allows no cycles, and the question need a probability model that can deal with loop. For example, relation R_{12} and R_{21} actually depend on each other (e.g., if R_{12} is born-in, then R_{21} will not be born-in), so there exists a loop between entity E_1 and E_2 through R_{12} and R_{21}. Secondly, the method cannot use some constraint knowledge that is only available during relation recognition and helpful to improve the precision of entity recognition.

To overcome the shortages described above, Fan and Sun (2005, 2006) presented a solution, which includes (1) to present the model dubbed "entity relation propagation diagram" and "entity relation propagation tree", and (2) to develop a method for this task based on the model. The presented method allows subtasks entity recognition and relation recognition to be linked more closely together. At the same time, the method can model the loopy dependencies among entities and relations, and can use two kinds of constraint knowledge learned from the annotated dataset.

MAIN FOCUS

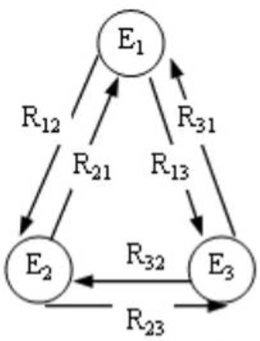
The Problem of Entity and Relation Recognition

For readability, an example sentence is illustrated as Figure 1. Conceptually, the entities and relations in a sentence can be viewed, while taking account of the mutual dependencies among them, as the labeled graph in Figure 2. In Figure 2(a), a node represents an entity and a link denotes the relation held between two entities. The arrowhead of a link represents the direction of the relation. Each entity or relation has several attributes respectively, which are denoted as a corresponding table (Figure 2(b) and Figure 2(c)). These attributes can be classified into two classes. Some of them that are easy to acquire via learned classifiers, such as words inside an entity and parts of speech of words in the context, are called local attribute; and other attributes that are difficult to acquire, such as semantic classes of phrases and relations among them, are called decision attribute. The question of recognizing entity and relation is to determine a unique value for each decision attribute of all entities and relations, while taking account of the local attributes of all entities and all relations. To describe the problem in a formal way, some basic definitions are given as follows.

Figure 1. A sentence that has three entities

$\underbrace{\boxed{\text{Dole}}}_{E_1}$'s wife, $\underbrace{\boxed{\text{Elizabeth}}}_{E_2}$, is a native of $\underbrace{\boxed{\text{Salisbury, N.C.}}}_{E_3}$

Figure 2. Conceptual view of entity and relation



(a)

Entity Name	E_1	E_2	E_3
Attribute-1 (words)	Dole	Elizabeth	Salisbury, N.C.
Attribute-2 (POS)	Noun	Noun	Noun
…	…	…	…
Attribute-m	…	…	…

(b)

Relation Name	R_{12}	R_{23}
Attribute-1 (special pattern)	E_1's wife, E_2	E_2 be naïve of E_3
…	…	…
Attribute-n	…	…

(c)