Why Read if You Can Scan?
Trigger Scoping Strategy for Biographical Fact Extraction

Dian Yu and Heng Ji
Computer Science Department
Rensselaer Polytechnic Institute
Troy, NY, USA
{yud2, jih}@rpi.edu

Sujian Li
Peking University
Key Laboratory of Computational Linguistics
Beijing, China
lisujian@pku.edu.cn

Chin-Yew Lin
Microsoft Research Asia
Beijing, China
cyl@microsoft.com

Abstract

The rapid growth of information sources brings a unique challenge to biographical information extraction: how to find specific facts without having to read all the words. An effective solution is to follow the human scanning strategy which keeps a specific keyword in mind and searches within a specific scope. In this paper, we mimic a scanning process to extract biographical facts. We use event and relation triggers as keywords, identify their scopes and apply type constraints to extract answers within the scope of a trigger. Experiments demonstrate that our approach outperforms state-of-the-art methods up to 26% absolute gain in F-score without using any syntactic analysis or external knowledge bases.

1 Introduction

Extracting biographical information is an important task because it can help readers understand an ongoing event more easily by providing the background biographical information of participants in this event. In fact, this task has been part of the Text Analysis Conference (TAC) - Knowledge Base Population (KBP) Slot Filling (SF) Track (Ji et al., 2010; Ji et al., 2011; Surdeanu, 2013; Surdeanu and Ji, 2014) for years.

Overall, state-of-the-art research still needs improvement. A typical approach is based on patterns which include triggers (e.g., (Sun et al., 2011; Li et al., 2013)). Here trigger is defined as the smallest extent of a text which most clearly expresses an event occurrence or indicates a relation type. High-quality patterns yield quite high precision but relatively low recall. In addition, it’s relatively expensive to maintain and update a set of extraction patterns.

Furthermore, we carefully investigated the TAC-KBP SF 2012 ground truth corpus and find that 94.36% of the biographical facts are mentioned in a sentence containing indicative fact-specific triggers. For example, born is a trigger for extracting birth-related facts. Triggers are crucial in predicting the type of facts (Aguilar et al., 2014). However, most previous studies only focused on using triggers to create more patterns (e.g., (Li et al., 2013)). Therefore the critical problem is how to make the most of triggers in biographical fact extraction?

We observe that people tend to scan a document when they want to quickly find a biographical fact within limited time. According to Douglas and Frazier (2001), scanning is a strategy for quickly finding specific information (keywords or ideas) in a text while ignoring its broader meaning. Scanning involves skipping words, but the emphasis is that the reader knows what to look for and rapidly scans until words are found and closer reading can occur (Phipps, 1983).

There are five steps in implementing scanning strategy according to Arnold (1999):

1. Keep in mind what you are searching for.
2. Anticipate in what form the information is likely to appear – number, proper nouns, etc.
3. Analyze the organization of the content before starting to scan.
4. Let your eyes run rapidly over several lines of print at a time.

5. When you find the sentence that has the information you seek, read the entire sentence.

Educators have verified that scanning is an effective strategy in enhancing reading comprehension (Motallebzadeh and Mamdoohi, 2011). There are two important aspects in the scanning strategy: keywords and their corresponding scopes. For biographical fact extraction, triggers can easily act as the keywords used by human during scanning and thus we focus on identifying the scopes of triggers.

Given a sentence that contains one or more triggers, we define trigger scope as the shortest fragment that is related to a trigger. Based on our observation, each fact-specific trigger has its own scope and its corresponding facts seldom appear outside of its scope. In the following sentence, if we can identify the scope of graduated, a trigger for education-related facts, we can skip the rest of the sentence after 1965 even though Chesterbrook Academy is an educational organization.

She [gr<graduated>uated] from Barnard in 1965] and soon began teaching English at Chesterbrook A<cademy in Pennsylvania>.

In this paper, we study the effect of triggers by learning their linguistic scopes at the sentence level and apply this strategy to extract 11 types of biographical facts, namely, birth date, death date, birth place, death place, residence place, education, parents, spouse, children, siblings and other family as described in the KBP SF task.

We design our extraction process following the scanning steps corresponding to Arnold’s scanning theory.

1. Let the computer know the query and the fact type to be extracted.

2. Let the computer know what form or entity type the candidate answer is likely to appear – person, organization, phrase, time, etc.

3. Locate all the triggers of the given fact type and recognize their respective scopes.

4. Within each scope, extract candidate answers which satisfy the entity type constraint in 2.

The contributions of our paper are as follows.

- We are the first to study the application of trigger scoping in biographical fact extraction.

- Our approach does not rely on any external knowledge bases for training or manually created fact-specific rules, and yet dramatically advances state-of-the-art.

2 Approach

In this section, we present the detailed approach of applying trigger scoping to biographical fact extraction. In Section 2.1, we first introduce the annotation methods of constructing the gold-standard dataset for evaluating scope identification. We use the sentence in Figure 1 as our illustrative example.

Paul Francis Conrad and his [twin <brother>, James], were [<born> in Cedar Rapids, Iowa, on June 27, 1924], [<sons> of Robert H. Conrad and Florence Lawler Conrad].

Figure 1: Trigger and scope annotation example.

2.1 Trigger and Scope Annotation

2.1.1 Basic issues

In a text, the sentences containing biographical facts (e.g., birth, death, family, residence or education) are considered for annotation. We discard a sentence if it expresses a biographical fact without surface cues.

During annotation, triggers are marked by angle brackets (e.g., <resident>), and the scope boundaries of a trigger are denoted by square brackets as shown in Figure 1.

2.1.2 Trigger Tagging

We mined fact-specific trigger lists from existing patterns (Chen et al., 2010; Min et al., 2012; Li et al., 2012) and ground truth sentences from KBP 2012.
SF corpus. In our experiment, we use 343 triggers and 38 triggers on average for each fact type.2

We examine all the sentences containing any possible triggers. The presence of a word in one trigger list does not necessarily mean that the sentence contains an event or a relation. For instance, the second child in the following sentence is part of an organization’s name.

He and his wife, Ann McGarry Buchwald moved to Washington in 1963 with their <child>, who was adopted from orphanages and welfare agencies in Ireland, Spain and France.

We also keep such sentences and annotate their trigger scopes without distinction.

Note that we only mark the syntactic head of a trigger phrase. For example, we mark child for the noun phrase the second child.

2.1.3 Scope Tagging

During the scope annotation, we first include the trigger within its own scope and then mark its left and right boundaries. Usually the left boundary is the trigger itself.

When there are multiple triggers in the same sentence, we annotate each trigger’s scope separately since it is possible that the scopes of different triggers are overlapped or nested as shown in the following instance (the scope of daughters covers the scope of wife):

Pavarotti had three <daughters> with his first wife, Lorenza, Cristina and Giuliana; and one, Alice, with his second wife.

Pavarotti had three daughters with his first <wife>, Lorenza, Cristina and Giuliana; and one, Alice, with his second <wife>.

The scope of a word is not transitive. In the phrase “his <son>’s home in Washington”, home is within son’s scope and in Washington is within home’s scope, however, the last prepositional phrase is outside of son’s scope.

2.2 Scope Identification

We will introduce two methods for identifying trigger scopes.

2.2.1 Rule-based Method

This method is used to investigate the performance of trigger scoping strategy when we do not have any labeled data. We use trigger as the left scope boundary. A verb or trigger with other fact types is regarded as the right boundary.

The rule-based scoping result of the walk-through example is as follows:

Paul Francis Conrad and his twin [<brother>, James, were] [<born> in Cedar Rapids, Iowa, on June 27, 1924.] [<sons> of Robert H. Conrad and Florence Lawler Conrad.]
Table 1: performance on KBP 2013 (1:state-of-the-art; 2:rule-based; 3: SVMs).

| Fact Type                  | Recall (%) | Precision (%) | F-score (%) |
|----------------------------|------------|---------------|-------------|
| per:place_of_birth         | 59.4       | 88.2          | 88.2        |
| per:date_of_birth          | 59.1       | 94.4          | 100.0       |
| per:place_of_death         | 55.4       | 92.4          | 86.1        |
| per:date_of_death          | 46.4       | 98.2          | 96.5        |
| per:place_of_residence     | 60.0       | 68.9          | 68.9        |
| per:school_attended        | 54.3       | 65.8          | 68.4        |
| per:parents                | 41.9       | 75.7          | 73.0        |
| per:sibling                | 50.0       | 76.2          | 76.2        |
| per:spouse                 | 36.0       | 63.3          | 81.7        |
| per:children               | 39.5       | 61.8          | 76.4        |
| per:other_family            | 23.1       | 66.7          | 71.4        |
| overall                    | 47.7       | 77.4          | 80.6        |

| Fact Group       | Accuracy (%) | F-score (%) |
|------------------|--------------|-------------|
| Birth            | 85.97        | 96.66       |
| Death            | 92.31        | 94.56       |
| Residence        | 90.67        | 95.67       |
| Family           | 92.49        | 94.11       |
| Education        | 91.51        | 93.87       |

Table 2: Scope identification results.

2.3 Biographical Fact Extraction

For each relevant document of a given query, we use Stanford CoreNLP to find the coreferential mentions of the query and then return all the sentences which contain at least one query entity mention. For each trigger in a sentence, we extract the entities which satisfy fact-specific constraints within its scope. As shown in Figure 1, brother is the trigger for per:siblings and the candidate fact should be a person name. Thus we return all the person names (e.g., James) within brother’s scope as the query Paul’s siblings.

3 Experiments and Discussion

3.1 Data

We use the KBP 2012 and 2013 SF corpora as the development and testing data sets respectively. There are 50 person queries each year.

From the KBP 2012 SF corpus, we annotated 2,806 sentences in formal writing from news reports as the gold-standard trigger scoping data set. We randomly partitioned the labeled data and performed ten-fold cross-validation using LIBSVM toolkit (Chang and Lin, 2011). We employ the classification model trained from all the labeled sentences to classify tokens in the unlabeled sentences.

3.2 Results

3.2.1 Scope Identification

The scope identification evaluation results of the rule-based method and the SVMs with the RBF kernel are presented in Table 2. We can see that the supervised classification method performs better since it incorporates the weights of different features rather than simply applying hard constraints. In addition, it allows the answers to appear before a trigger as shown in the following sentence. Our rule-based method fails to extract Fred since it appears before the trigger married:

She was a part of a group of black intellectuals who included philosopher and poet [Fred Clifton, whom she <married> in 1958].

3.2.2 Biographical Fact Extraction

The fact extraction results in Table 1 demonstrate our trigger scoping strategy can outperform state-of-the-art methods. For a certain fact type, we choose the SF system which has the best performance for comparison. Specifically, we compare with two successful approaches: (1) the combination of distant supervision and rules (e.g., (Grishman, 2013; Roth et al., 2013)); (2) patterns based on dependency paths (e.g., (Li et al., 2013; Yu et al., 2013)).

The advantage of our method lies in trigger-driven
exploration. The positions of facts in the sentence can be very flexible and therefore difficult to be captured using a limited number of patterns. For example, the patterns in table 2 fail to extract James in Figure 1. However, the ways in which we express the trigger and words it dominated tend to be relatively fixed. For example, all the following patterns contain a fact-specific trigger and also facts usually appear within its scope.

| PER:SIBLING |
|-------------|
| [Q] poss\textsuperscript{−1} brother appos [A] |
| [Q] appos\textsuperscript{−1} brother appos [A] |
| [Q] appos brother appos-1 [A] |
| [Q] nsubjpass\textsuperscript{−1} survived agent brother appos [A] |
| [Q] poss\textsuperscript{−1} sister appos [A] |
| [Q] appos\textsuperscript{−1} sister appos [A] |
| [Q] appos sister appos\textsuperscript{−1} [A] |
| [Q] nsubjpass\textsuperscript{−1} survived agent sister appos [A] |

Table 3: Patterns used for extracting sibling facts (Li et al., 2013). Q: Query, A: Answer.

The limitation of our method is that we assume a sentence centers around only one person thus every biographical fact mentioned should be related to the centroid person. For example, our method mistakenly extracted February as the death-date fact for both Reina and Orlando in the following case.

Also at the mass was Reina Tamayo, the mother of Orlando Zapata, who [\textit{\textless died\textgreater} in February] after an 85-day hunger strike to protest the fate of political prisoners here.

In order to solve this problem, we need to further analyze the relation between the query entity mention and the trigger so that we can identify Orlando Zapata is irrelevant to the death-related fact.

5 Conclusions and Future Work

In this paper we explore the role of triggers and their scopes in biographical fact extraction. We implement the trigger scoping strategy using two simple but effective methods. Experiments demonstrate that our approach outperforms state-of-the-art without any syntactic analysis and external knowledge bases.

In the future, we will aim to explore how to generate a trigger list for a “surprise” new fact type within limited time.

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