

# Reinforcement Learning for Relation Classification from Noisy Data

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## Abstract

Existing relation classification methods that rely on distant supervision assume that a bag of sentences mentioning an entity pair are all describing a relation for the entity pair. Such methods, performing classification at the bag level, cannot identify the mapping between a relation and a sentence, and largely suffers from the noisy labeling problem. In this paper, we propose a novel model for relation classification at the sentence level from noisy data. The model has two modules: an instance selector and a relation classifier. The instance selector chooses high-quality sentences with reinforcement learning and feeds the selected sentences into the relation classifier, and the relation classifier makes sentence-level prediction and provides rewards to the instance selector. The two modules are trained jointly to optimize the instance selection and relation classification processes. Experiment results show that our model can deal with the noise of data effectively and obtains better performance for relation classification at the sentence level.

## Introduction

Relation classification, aiming to categorize semantic relations between two entities given a plain text, is an important problem in natural language processing, particularly for knowledge graph completion and question answering. Most existing works for relation classification adopt supervised learning approaches, either based on traditional handcrafted features (Mooney and Bunescu 2005; Zhou et al. 2005) or based on the features automatically generated by deep neural networks (Zeng et al. 2014; dos Santos, Xiang, and Zhou 2015), but all require high-quality annotated data.

In order to obtain large-scale training data, distant supervision (Mintz et al. 2009) was proposed by assuming that if two entities have a relation in a given knowledge base, all sentences that contain the two entities will mention that relation. Although distant supervision is effective to label data automatically, it suffers from the *noisy labeling problem*. Taking the triple (Barack.Obama, *BornIn*, United.States) as an example, the noisy sentence “Barack Obamba is the 44th president of the United State” will be regarded as a positive instance by distant supervision and a *BornIn* relation is

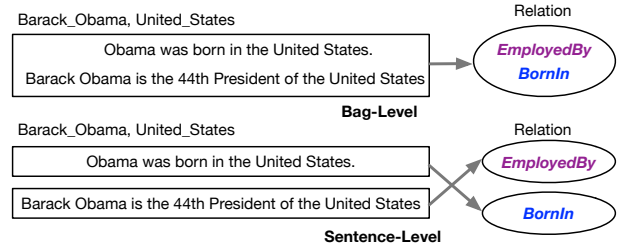


Figure 1: Bag-level: Relations are mapped to a bag of sentences, each of which contains the same entity pair; Sentence-level: Each sentence is mapped to a specific relation.

assigned to this sentence, although the sentence does not describe the relation *BornIn* at all.

To address the issue of noisy labeling, previous studies adopt multi-instance learning to consider the noises of instances (Riedel, Yao, and McCallum 2010; Hoffmann et al. 2011; Surdeanu et al. 2012; Zeng et al. 2015; Lin et al. 2016; Ji et al. 2017). In these studies, the training and test process is proceeded at the bag level, where a bag contains noisy sentences mentioning the same entity pair but possibly not describing the same relation. As a result, previous studies suffer from two limitations: 1) Unable to handle the sentence-level prediction; 2) Sensitive to the bags with all noisy sentences which do not describe a relation at all.

To better explain the first limitation, we show an example in Figure 1. Bag-level prediction can find the two relations “*EmployedBy*” and “*BornIn*” between the entity pair “*Barack.Obama*” and “*United.States*”. However, sentence-level prediction is able to further map each relation to the corresponding sentences. As for the second limitation, for each bag, previous bag-level methods retain at least one sentence, even if all the sentences in a given bag are noisy (not describing the relation). Such bags, produced by distant supervision, are quite common. For instance, our investigation on a widely used dataset<sup>1</sup> shows that 53% out of 100 sample bags have no sentences that describe the relation. Such noisy bags will definitely decrease the performance of relation classification.

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<sup>1</sup><http://iesl.cs.umass.edu/riedel/ecml/>