

False Positive and Cross-Relation Signals in Distant Supervision Data

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Relation Extraction

Typically a classification task, given a:

- Sentence:

Willem van Alen is well known for being the architect of the **Chrysler Building**.

- pair of terms:
 - **Willem van Alen**
 - **Chrysler Building**
- relation: **designed by**



Is the relation is *expressed* between the terms in the sentence?

Distant Supervision

Mintz et al. ACL, 2009. [*Distant Supervision for Relation Extraction without Labeled Data.*](#)

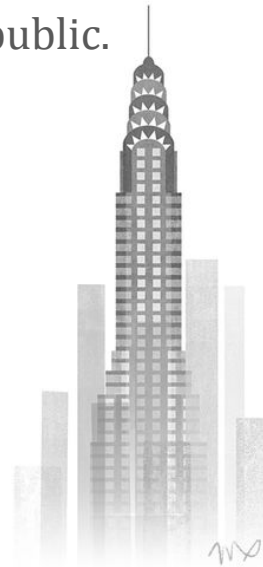
Welty et al, NAACL-HLT 2010. [*Large Scale Relation Detection.*](#)

- state-of-the-art unsupervised algorithm for relation extraction
- **main assumption:** if a (large) KB contains a relation R between a pair of entities, any sentence that contains that pair is likely to express R
 - reduces relation extraction to entity resolution
- **data:**
 - text corpus
 - knowledge base of relation triples (e.g. Freebase, KG, DBpedia, IMDb)
- **features:**
 - syntactic: *dependency paths between the entities*
 - lexical: *words, part of speech, word position in the sentence*
- **model:** logistic regression (Mintz), dep. path patterns (Welty)

Issues with Distant Supervision

What happens when the knowledge base *term pair is in the sentence*, but the *relation is not*?

- ✓ **Willem van Alen** is well known for being the architect of the **Chrysler Building**.
- ✗ **Willem van Alen** received the **Chrysler Building** commission from Walter Chrysler.
- ✗ **Willem van Alen** was there when the **Chrysler Building** first opened to the public.

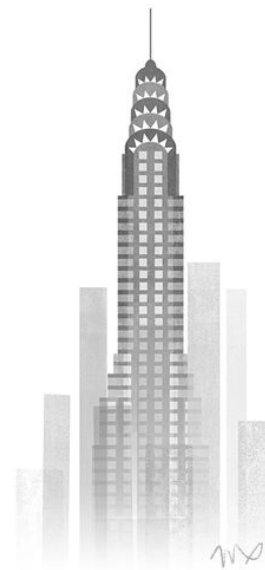


Issues with Distant Supervision

Cross-relation signals are not modeled in Distant Supervision.

Allen **architect of** Chrysler Building \Rightarrow Allen **designed** Chrysler Building

Allen **designed** Chrysler Building \Rightarrow Allen **creator of** Chrysler Building



Issues with Distant Supervision

- **Problem:** DS has errors caused by
 - **false positives** when term pair from KB is in sentence but relation is not
 - **false negatives** because cross-relation signals ignored
- **Solution:** crowdsourcing to identify and correct errors in DS

CrowdTruth

- Methodology for **crowdsourcing ground truth**
- Annotator disagreement is **signal, not noise**
- It is indicative of the **variation in human semantic interpretation**
- It can indicate **ambiguity, vagueness, similarity, over-generality**, as well as **quality**

Approach: use CrowdTruth to identify and correct errors in DS

Crowdsourcing Setup

The sentence:

There were performances by Chester Bennington , lead singer for Linkin Park , **CAMP FREDDY** members Chris Chaney and **DAVE NAVARRO** , Stephen Perkins of Jane 's Addiction and Billy Morrison of the Cult .

STEP 1: Select ALL THE STATEMENTS between the terms **DAVE NAVARRO** and **CAMP FREDDY** that are expressed in the sentence above.

- DAVE NAVARRO** is an organization with the alternate name **CAMP FREDDY**
- CAMP FREDDY** is/was a subsidiary of **DAVE NAVARRO**
- CAMP FREDDY** was founded by **DAVE NAVARRO**
- DAVE NAVARRO** is a person with the alternate name **CAMP FREDDY**
- DAVE NAVARRO** is/was charged with **CAMP FREDDY**
- DAVE NAVARRO** is a person who lives/lived in **CAMP FREDDY**
- DAVE NAVARRO** is a person who died in **CAMP FREDDY**
- DAVE NAVARRO** is a person originating from **CAMP FREDDY**
- DAVE NAVARRO** is a person with the title of **CAMP FREDDY**
- none of these*
- headquarters of **DAVE NAVARRO** are/were located in **CAMP FREDDY**
- DAVE NAVARRO** is/was a member/employee of **CAMP FREDDY**
- DAVE NAVARRO** is/was a top member/employee of **CAMP FREDDY**
- DAVE NAVARRO** died because of **CAMP FREDDY**
- DAVE NAVARRO** is the father/mother of **CAMP FREDDY**
- DAVE NAVARRO** is a person who is/was born in **CAMP FREDDY**
- DAVE NAVARRO** attended school(s) **CAMP FREDDY**
- DAVE NAVARRO** is/was married to **CAMP FREDDY**
- DAVE NAVARRO** is a person aged **CAMP FREDDY**

i It is important that you understand what the different statements mean. Carefully read the EXAMPLE by hovering over each statement.

STEP 2a: Highlight in the sentence ONLY the words that support the statement(s) from STEP 1.

members

i Highlight ONLY the words that relate to the STATEMENT(S) you have selected in STEP1. DO NOT copy the whole sentence.

2,500 sentences, 15 workers / sentence



CrowdTruth metrics

- **Sentence-Relation Score (SRS):**

- the likelihood that a relation is expressed in the sentence
- = ratio of workers that picked the relation / all the workers that read the sentence

- **False Positive Rate:**

- per relation ration of False Positive sentences
- ground truth is SRS at 0.5 threshold

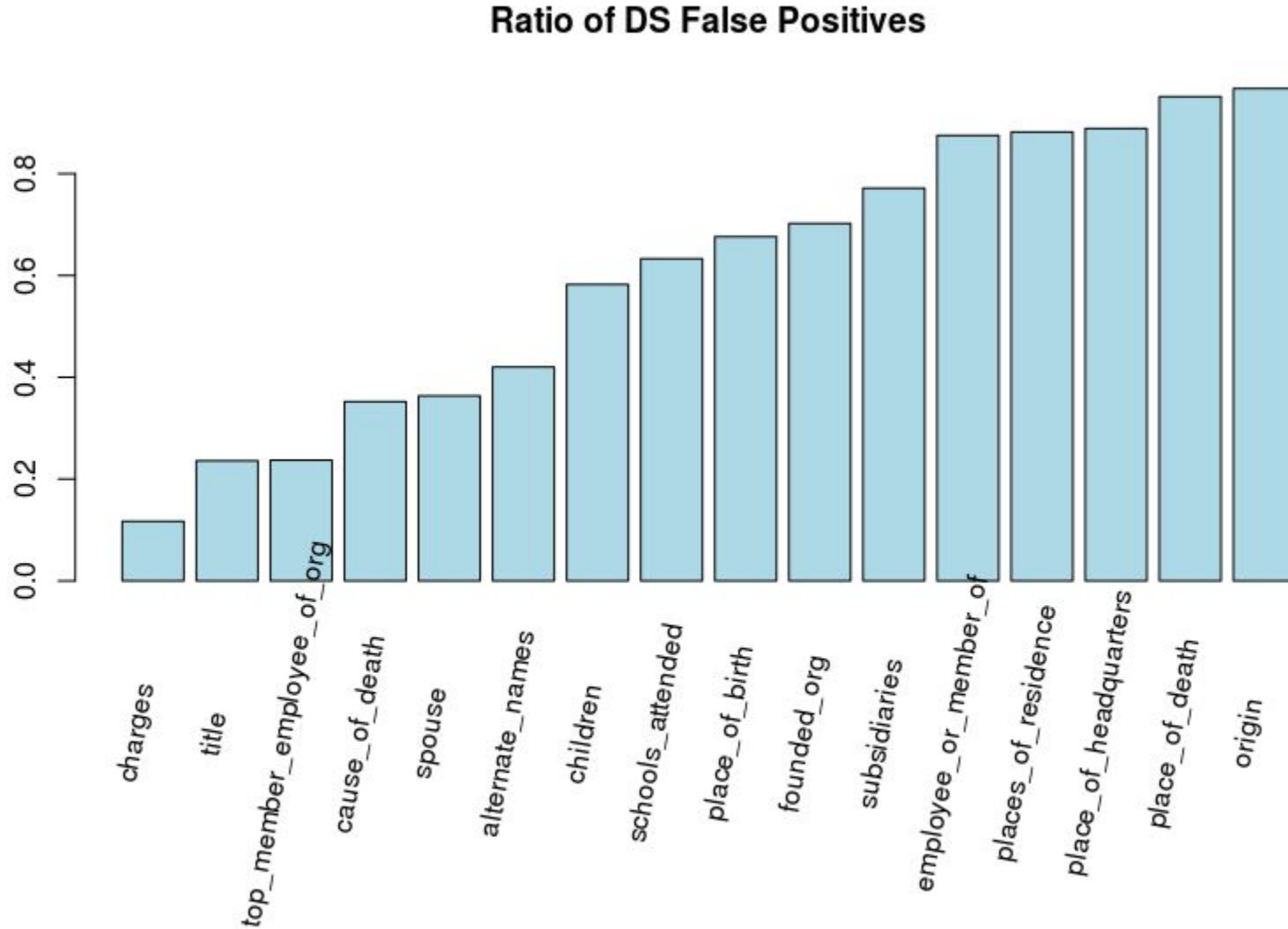
- **Relation Causality Power:**

- the probability that the presence of one relation implies the presence of another

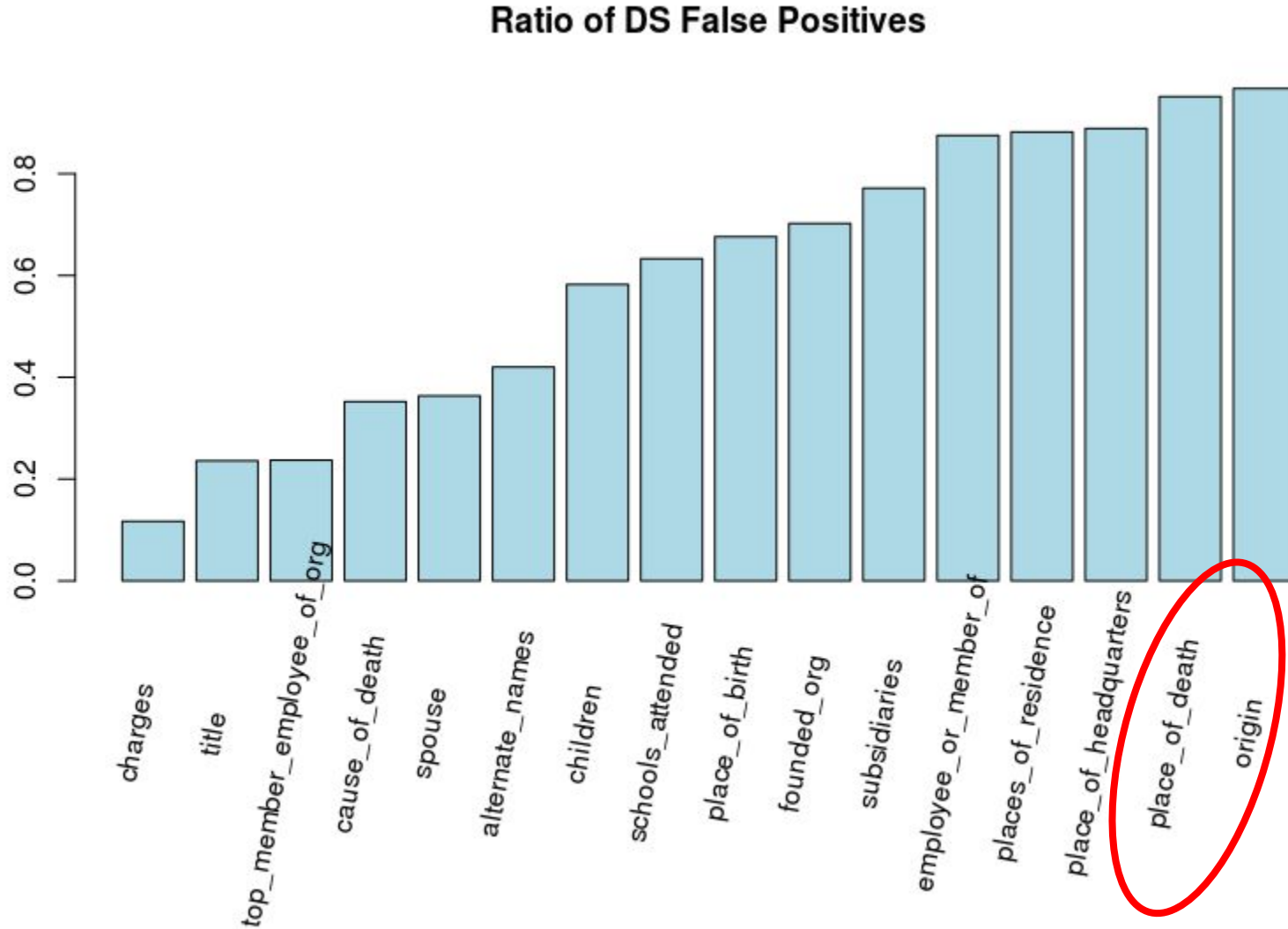
$$RCP(R_i, R_j) = \frac{P(R_j|R_i) - P(R_j|\neg R_i)}{1 - P(R_j|\neg R_i)}$$

$P(R_i)$: probability that relation R_i appears in a sentence

False Positive Ratio



False Positive Ratio



A few examples of why

“origin” relation:

- **Donald Tsang** is expected to win because the job is picked by a committee loyal to **Hong Kong**'s political overlords in Beijing .
- Chinito Junior, owned by **Valetska Radtke** of **NYC** became the breed's first champion.

“place of death” relation:

- Peters Church in **Baltimore** memorializes **James Lowry Donaldson** .
- Benedict V (born in **Rome** ; died July 4 , 966) , Pope from 964 to 966 , was elected by the Romans on the death of **Pope John XII** (955–964) .

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Term pair from KB is in the sentence, but the relation is not expressed, causing **False Positive** problem.

Relation Causality Power

Relation i	Relation j	Crowd RCP	DS RCP
Place of Birth	Origin	0.64	-0.6
Origin	Place of Birth	0.88	-0.2
Place of Residence	Place of Death	-0.1	0.45
Top Employee of	Employee of	0.86	0.24
Employee of	Top Employee of	0.82	0.66

Relation i causes Relation j

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Relation i causes Relation j

DS does not capture *Place of Birth* \leftrightarrow *Origin*, *Top Employee* \rightarrow *Employee* results in **False Negative** problem.

Experimental Setup

- **Goal:** fix DS with crowd results
- **Method:** compare results from relation extraction trained with
 - **DS:** baseline, 235 000 sentences
 - **DS merged:** manually merged relations with symmetric RCP (*origin & place of birth; employee of & top employee of*)
 - **DS + RCP:** when R_i has a positive DS label for a sentence, the labels of all other R_j are updated as $\pm RCP(R_i, R_j)$
 - **DS + FP:** removed relations with high FP rate (*place of death, origin*) when other relation is present
- **Model:**
 - convolutional neural network
(Nguyen et al. "Relation Extraction: Perspective from Convolutional Neural Networks." NAACL. 2015.)
 - 3 layers: convolutional, max pooling, logistic regression
 - loss function: sigmoid cross-entropy over continuous values
 - features: word2vec word embeddings, position embeddings

Experimental Results

	Precision	Recall	F1 score
DS	0.19	0.22	0.2
DS merged	0.43	0.33	0.37
DS + RCP	0.19	0.48	0.27
DS + FP	0.21	0.22	0.21

- Manual merging has high precision, less relations in the eval set probably one of the reasons.
- RCP can be used to fix False Negative problem.
- FP rate for fixing False Positive problem is still under investigation.

Conclusions

- DS has errors caused by
 - varying degree of false positives across different relations
 - causal connection between relations not considered by the DS method
- crowdsourcing can be used to correct DS in training a relation extraction classifier
- check us out at:
 - **Project website:** <http://CrowdTruth.org>
 - **Data for this paper:**
github.com/CrowdTruth/Open-Domain-Relation-Extraction
 - **Data for other related experiments:** <http://data.CrowdTruth.org>