

False Positive and Cross-Relation Signals in Distant Supervision Data

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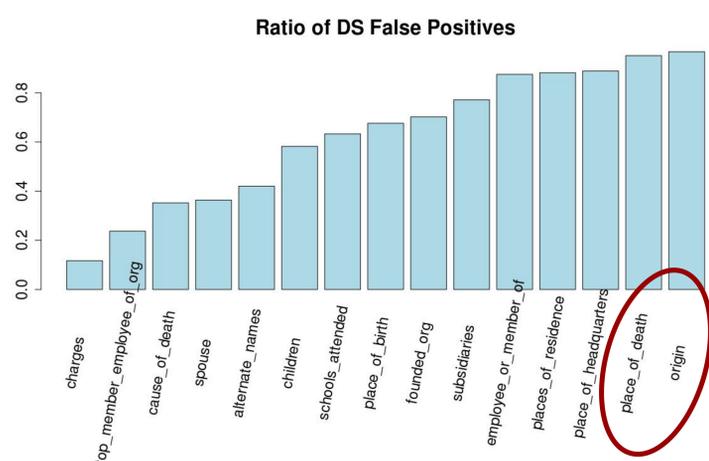
Distant Supervision (DS) is a method for annotating sentences with relations by aligning a knowledge base with a text corpus. However, the assumption that, given a triple in the knowledge base, every sentence in the corpus that contains the triple will also contain the relation, generates a **lot of noisy data**.

CrowdTruth is a methodology for crowdsourcing ground truth data by harnessing inter-annotator disagreement. Key metrics:

- **sentence-relation score (SRS)**: ratio of workers that picked the relation in the sentence over all workers, weighted by worker quality
- **false positive (FP) ratio**: ratio of false positive over total positive sentence labels, calculated using SRS as ground truth, at 0.5 threshold to separate between positive and negative labels
- **relation causality power (RCP)**: $RCP(R_i, R_j) = \frac{P(R_j|R_i) - P(R_j|\neg R_i)}{1 - P(R_j|\neg R_i)}$

Crowdsourcing Results over 2,500 Sentences and 17 Relations

Crowd reveals considerably different FP ratios for different relations in DS



Causality between relations is different in the crowd compared to DS

- **Place of Death** causes **Places of Residence** in DS, but not in crowd
- co-causality between **Place of Birth** and **Origin** in crowd, but not in DS
- co-causality between **Employee or Member** and **Top Employee or Member** weakly appears in DS, is strong in crowd
- **Places of Residence** causes **Origin** in crowd, not in DS

False Positive DS Sentences due to multiple relations in the KB over Person - Location term types

Origin relation:

- **Noam Chomsky** recently wrote that **America** thinks that it owns the world.
- 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) was elected by the Romans on the death of **Pope John XII** (955-964) .

False Negative DS Sentences due to missing causal connections

False Negative for **Employee or Member** relation, but True Positive for **Top Employee or Member** relation:

- More than 3,000 taxi drivers blocked **Rome's** historic city center Wednesday to protest extra licenses given by mayor **Vetroni**.

False Negative for **Origin** relation, but True Positive for **Place of Birth** relation:

- **Joey Harrington** was born and raised in **Portland, Oregon**, where he has resided his entire life.

Enhancing Distant Supervision with CrowdTruth

Relation Extraction Model

- **convolutional neural network** (*)
- **features**: word2vec word embeddings, term pair position embeddings
- **loss function**: sigmoid cross-entropy, computed on continuous labels

(*) Nguyen, Thien Huu, and Ralph Grishman. "Relation Extraction: Perspective from Convolutional Neural Networks." VS@ HLT-NAACL. 2015.

Training Data

- **DS**: sentences with DS labels
- **DS merged**: in DS sentences, merge relations with symmetric causality (**Origin & Place of Birth**), add implication for asymmetric causality (**Top Employee or Member & Employee or Member**)
- **DS RCP**: update DS with RCP from the crowd, such that given a sentence s and a relation j :

$$DS_RCP(s, j) = \max[1, DS(s, j) + \sum_{i \neq j} RCP(i, j) \cdot DS(s, i)]$$

- **DS FP**: remove causal relation when relation pair with overlap in KB terms has one relation with high FP ratio (**Place of Death & Places of Residence**)

Evaluation Results

	Precision	Recall	F1
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

CrowdTruth.org // github.com/CrowdTruth/Open-Domain-Relation-Extraction // data.CrowdTruth.org