

Pairwise Webpage Coreference Classification using Distant Supervision



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Introduction

A person or other entity is often associated with multiple URL endpoints on the web

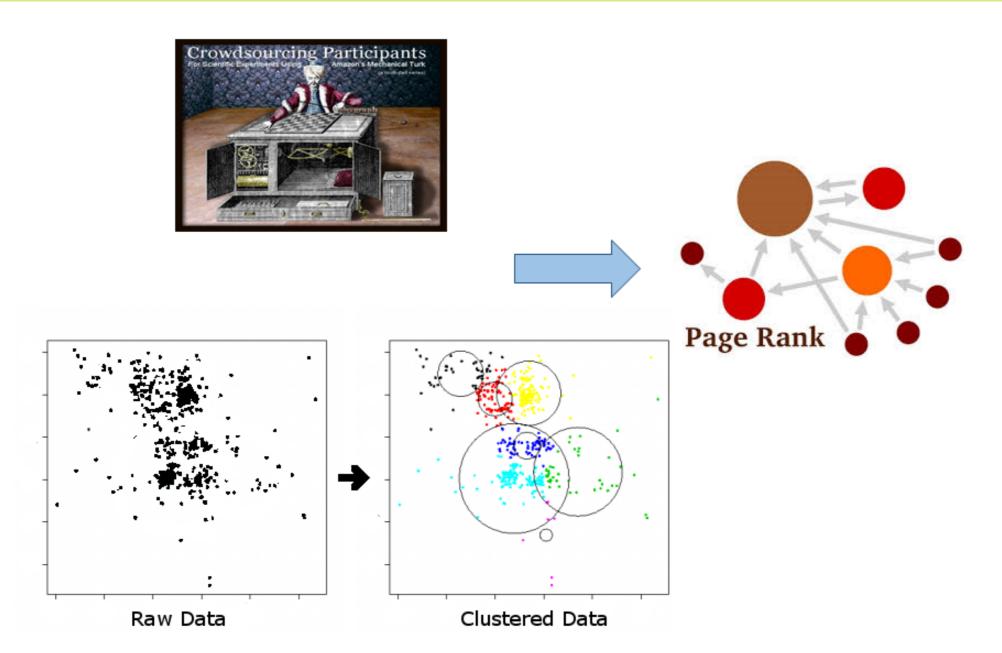
- ▶ Barack Obama ⇔ https://barackobama.com/ and https://en.wikipedia.org/wiki/Barack_Obama

Motivates the task of webpage coreference classification for a given entity!

Problem Setup

- ► We assume access to web KBs based on automatic crawling
- > social networks (e.g. facebook.com/*), news aggregation endpoints (e.g.
 nytimes.com/topic/person/*) and organisation directories (e.g.
 www.gtlaw.com/People/*)
- ► Given a training dataset *D* with pairs of web URLs
- lnitially all the pairs are unlabeled $(D_u \leftarrow D, D_p, D_n = \phi)$
- Learn a model $f(\phi(U_i, U_i)) \rightarrow y$, for URL pair U_i and U_j
- ► Target $y \in \{0, 1\}$

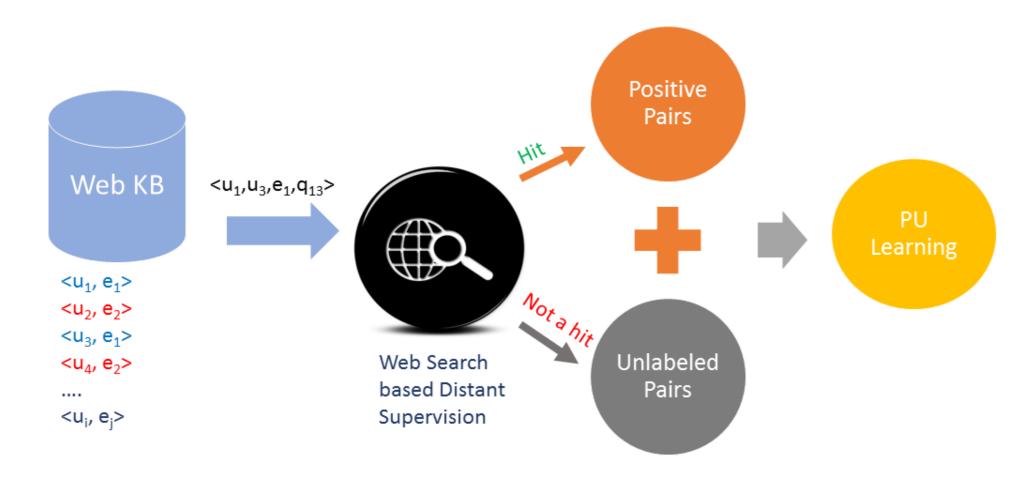
Distant Supervision



- ► We obtain positive examples using web-search-based distant supervision
- ➤ Search query George Clinton AND P-Funk fetches https://en.wikipedia.org/wiki/George_Clinton_(musician)
- ► But not http://www.biography.com/people/george-clinton-537674
- ► We build a positive and unlabelled (PU) learning model

Proposed Approach

- ► We generate queries for URL pairs that share same entity name
- ► Employ a label propagation technique to expand the set of positive examples



► Any binary classifier can be trained on the expanded labeled set

Query Generation

- ► We construct web search queries for distant supervision as follows:
- $\triangleright Q_i$: Using the target entity name and context information from U_i
- $\triangleright Q_j$: Similar to the above, we generate context information from U_j .
- ► E.g., for URL pairs: www.imperial.ac.uk/people/f.allen and https://www.linkedin.com/in/franklin-allen-0557906 a query constructed is "Franklin Allen Brevan Howard Centre"

Initialize Labels

- For each query in Q_i , we check to see if U_j is present in the top-K search results S_{ij}
- ightharpoonup Conversely if U_i is present in the top-K results, S_{ji} for each query in Q_j

 - $D_p \leftarrow D[\hat{y}_{ij} = 1], D_u \leftarrow D_u \setminus D[\hat{y}_{ij} = 1].$

Labelling Unlabelled Pairs

- ▶ Step 1: Randomly select N instances from D_p , and hold them out in S_p .
- Step 2: Train a binary classifier θ , taking $D'_p = D_p \setminus S_p$ as positive instances and D_u as negative instances.
- Step 3: $\mu_p = \frac{1}{|S_p|} \sum_{i:S_p} p(x_i = 1|\theta)$, (using Platt scaling)
 - $D_p^* = x_u \in D_u : p(x_u = 1) > \mu_p.$
 - $D_p \leftarrow D_p \cup D_p^*, \ D_n \leftarrow D_u \setminus D_p^*$

Datasets

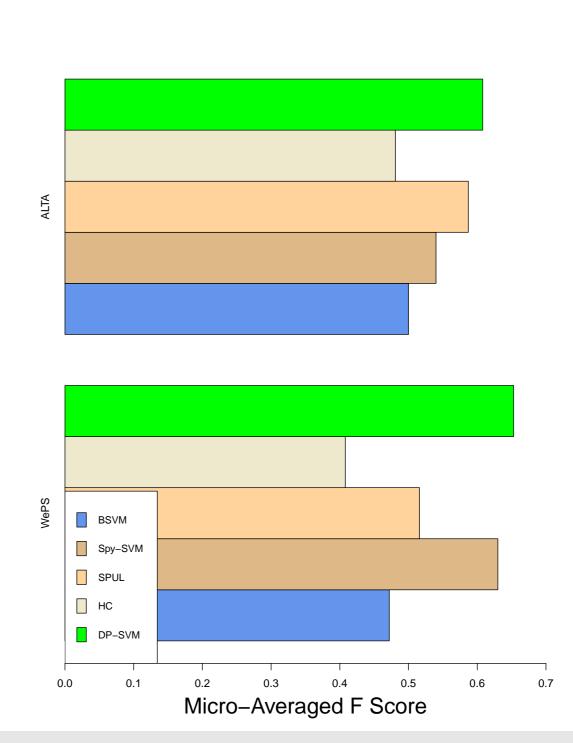
- ► SemEval-2007 WePS development set
 - ► Balanced 1000 end-point URL-pairs dataset from webpages for 49 people.
- ► ALTA-2016 shared task dataset
 - ▶ Balanced 400 end-point URL-pairs dataset that can refer to any entity

Feature Representation

- ➤ Structural features such as document length difference, URL path length difference
- Semantic features such as unigram cosine similarity, cosine similarity over an average word-level word2vec representation, machine translation scores (BLEU, METEOR, TER)

Experimental Results

- Baselines
 - ► Hierarchical Clustering (HC) Unsupervised Approach
 - ▶ Biased SVM (BSVM) with costs for positive and negative classes
 - ► Spy-SVM (B. Liu et. al., ICML 2002)
 - ► SPUL (C. Elkan et. al., KDD 2008)
- Proposed Approach
- ▶ DP-SVM (Linear Kernel SVM built using propagated distant labels)



Conclusions

- ► Approach to determining whether two endpoint URLs refer to the same entity.
- ► Two key contributions:
- use of distant supervision
- application of PU Learning to the task