

Approximate Entailment

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1 Introduction

We have been treating the hyponymy relation given by WordNet as a partial ordering on the vector space of contexts, however this is not consistent if we take into account synonyms, if we treat them as satisfying $u \leq v$ and $v \leq u$, where u and v are the context vectors of two terms, which is only possible if $u = v$. This can be satisfied either by constructing a quotient space to make the vectors equal, or by relaxing the constraints on the relationship \leq . Here we consider the latter option.

Given a partially ordered vector space V and a vector $\delta \in V$, we define a new relation \lesssim on V by $u \lesssim v$ if and only if $u \leq v + \delta$. We can then define a relation \simeq by $u \simeq v$ if and only if $u \lesssim v$ and $v \lesssim u$; its interpretation is that the terms associated with u and v are approximately synonymous. Note that this is only possible if $\delta \geq 0$, since $u \leq v + \delta \leq u + 2\delta$.

2 Learning Approximate Relations

If we assume this more general situation, we now have the problem of learning not just the ordering \leq , but also the vector δ .

One option is to assume that $u \lesssim v$ means there exists a δ_{uv} such that $u \leq v + \delta_{uv}$ and $\|\delta_{uv}\|_2 \leq \epsilon$ for some fixed ϵ . This leads to an overall value of $\delta = (\epsilon, \epsilon, \dots, \epsilon)$. In this construction, we have to learn a single parameter ϵ , which acts in a similar manner to the bias in support vector machines.

Another option is to try and learn \leq and δ simultaneously using support vector machines. Let p_i be a set of hyperplanes and b_i a set of associated biases, which together define a set of half-spaces S_i , by $u \in S_i$ if and only if $p_i \cdot u \geq b_i$. If the p_i are linearly independent, then the intersection of these half-spaces forms a displaced cone: let M be the matrix with p_i as rows, and δ the vector with b_i as elements, then u is in the intersection of half spaces if $Mu \geq \delta$.

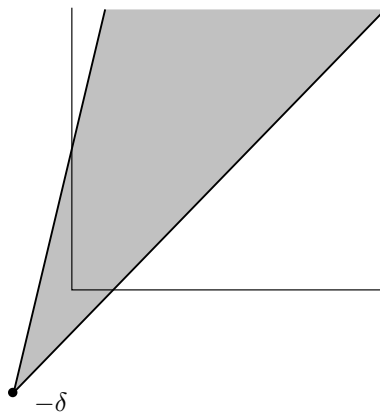


Figure 1: The set of points $u \gtrsim 0$ are those such that $u \geq -\delta$.

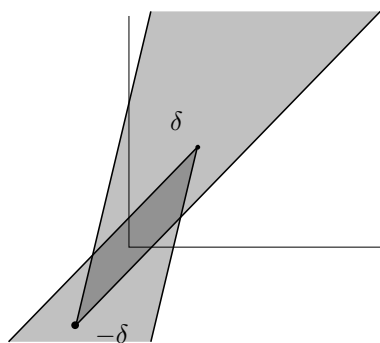


Figure 2: Approximate synonym vectors u and v satisfy $|u - v| \leq \delta$ (the darker shaded region).