Sense changes & Multi-word Expressions

Martin Emms and Arun Jayapal
Dept of Computer Science, Trinity College, Dublin, Ireland
mtemms@scss.tcd.ie, jayapala@scss.tcd.ie

Introduction

A n-gram might be termed a multiword expression (MWE) because it has a property, possibly a meaning, which is odd given its parts.

a further twist is that in one context a *token* of the n-gram *type* might exhibit the irregular MWE usage, but in a different context it might not.

Still a further twist is added by language *change*: quite possibly the irregular MWE usage *emerged*, and was predated by only more transparent usages.

Following on from [1], we propose a method to detect such cases of emergence by automatic means.

Motivation & Use case

1995 *the wind lifted his three-car garage and* **smashed it** *to the ground.*
S=1: 'destruction' i.e. transparent

2013 *sensational group CEO, totally* **smashed it** *in the BGT (Britain Got Talent)*
S=2: 'excelled' i.e. opaque

The (S=2,'excelled') usage of **smashed it** is a *recent possibility*, and was *predated* by an era in which it was not possible.

> **We would like to detect this by unsupervised means from time-stamped text**

Other examples

1990: *give me time* vs
2013: *enjoy some me time*
1995: *going forward from the entrance* vs
2009: *going forward, the company should*

Possibly useful for detecting that aligned data for an SMT system is out of date and may mistranslate recent examples.

Google translations into German
"and smashed it to the ground." (from 1995, standard destructive usage
→ "und schlug ihn zu Boden" — correct translation
"the sensational group totally smashed it!" (from 2013, meaning 'excelled')
→ "die sensationelle Gruppe völlig zertrümmert es!" — poor translation

References

[1] Martin Emms. Dynamic EM in Neologism Evolution. In *Proceedings of IDEAL*, 2013.

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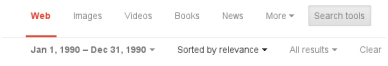
Data and Algorithms

1995 *the wind lifted his three-car garage and* **smashed it** *to the ground.*
⋮
1996
⋮
2013 *sensational group CEO, totally* **smashed it** *in the BGT (Britain Got Talent)*
⋮

data via Google's *custom date range*



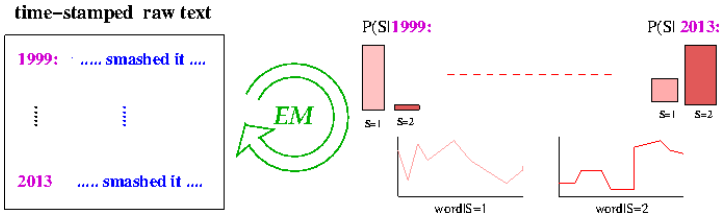
for given n-gram download 100 hits for **year-long** time-spans from 1990–2013 (total ≈ 2k hits per n-gram)

treat each n-gram occurrence as $\langle Y, S, \vec{W} \rangle$ where
$\vec{W}$ = words in the context, Y = year of occurrence, S = the usage variant
— in the downloaded data S is **hidden**.
Define model of $p(Y, S, \vec{W})$ via (2) below

$$
\begin{aligned}
& p(Y, S, \vec{W}) \\
&= p(Y)p(S|Y)p(\vec{W}|S, Y) \\
&\approx p(Y)p(S|Y)p(\vec{W}|S) \quad (1) \\
&\approx p(Y)p(S|Y)\textstyle\prod_i p(W_i|S) \quad (2)
\end{aligned}
$$

Key temporal feature: for the usage-variant S, instead of a *single* prior $p(S)$, $p(S|Y)$ is effectively a *succession of priors*
Conditional words/time independence line (1) assumes that **given S**, context words ($\vec{W}$) and time T are independent.

Model parameters usage-given-time $p(S|Y)$ and word-given-usage $p(W_i|S)$ are estimated with an Expectation-Maximisation technique



E-step *populates a table γ, such that for each data point d, and possible S value s, $\gamma[d][s]$ stores $P(S = s|Y = y^d, \vec{W} = \vec{w}^d)$.*

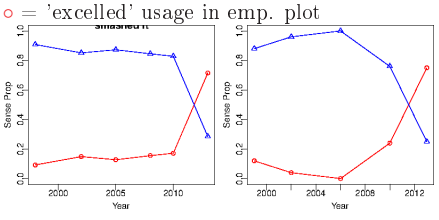
M-step *based on γ, fresh parameter values are re-estimated according to update formulae 1 and 2*

$$P(S = s|Y = y) = \frac{\sum_d (\text{if } Y^d = y \text{ then } \gamma[d][s] \text{ else } 0)}{\sum_d (\text{if } Y^d = y \text{ then } 1 \text{ else } 0)} \quad (1)$$

$$P(w|S = s) = \frac{\sum_d (\gamma[d][s] \times freq(w \in \vec{W}^d))}{\sum_d (\gamma[d][s] \times length(\vec{W}^d))} \quad (2)$$

Outcomes

smashed it (empirical and unsupervised)
○ = 'excelled' usage in emp. plot



me time (empirical and unsupervised)
△ is 'personal time' usage in emp. plot

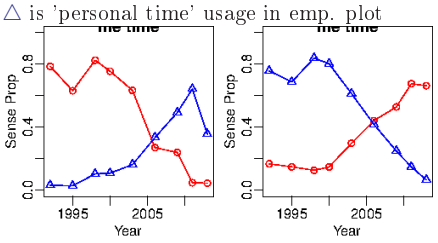


Figure 1: outcomes for $p(S|Y)$ for *smashed it* and *me time*. **unsupervised** = EM estimate. **empirical** = an ML estimate based on a 10% hand-annotated subset.

In empirical plots, for *smashed it* and *me time* the MWE-usages have an upward trend, as expected. Given that with the unsupervised method it is indeterminate which value of S may correspond to a given objectively real usage, the unsupervised plots broadly concur with the empirical.

Unsup favoured vocab apparent recent usage of *smashed it*: *!!, guys, really, completely, They, !*
Unsup favoured vocab apparent old usage of *smashed it*: *smithereens, bits, bottle, onto, phone*

We have looked also at the expressions *biological clock* and *going forward*, finding similar empirical and observed emergence of a recent novel usage. Ongoing we would like to consider possibly related other methods and different time stamped corpora.