Item-based Prediction of Reaction Times in Priming: an Evaluation of Distributional Semantic Models

Gabriella Lapesa
University of Osnabruck
glapesa@uos.de

Stefan Evert
FAU Erlangen Nürnberg
stefan.evert@fau.de

Models

Distributional Semantic Models (DSMs) represent word meaning in terms of co-occurrence patterns encoded in distributional vectors. Depending on the choices of specific parameters, different DSMs are sensitive to different relations (Sahlgren, 1996). This study is a large scale evaluation of a number of DSMs parameters (38800 combinations).

Correlation to RTs

Verb-Noun (Ferretti et al. 2001)

Noun-Verb (McRae et al. 2005)

Noun-Noun (Hare et al. 2009)

How to interpret modeling results when as many combinations of parameters are involved? Analysis of mean/range of performance and/or identification of ‘best model’ are not fully satisfactory (see Lapesa & Evert, 2013).

References & Acknowledgments


We are grateful to Ken McRae for providing the data and for his contribution to the development of this study.

Method

Task 1: Pearson correlation between semantic distance and RTs (congruent)

Q: Which parameters have a significant effect on model performance? Are there differences among datasets? Method: We analyze the influence of parameters and interactions using linear models with absolute correlation as a dependent variable and model parameters as independent variables.

Task 2: Item-based prediction of RTs with different corpus-based predictors

Q: Can DSMs predict priming at the item level? Hutchinson et al. (2008): no effect for DSMs. How about big-of-words DSMs? Method: We conduct linear regression with priming effect in ms as a dependent variable and different types of corpus-based predictors as independent variables.

Item-based Prediction

First-order predictors

- Target–prime co-occurrence frequency in free (fo_freq)
- Rank of target in prime’s collocates (fo_forw)
- Rank of prime in target’s collocates (fo_back)

DSM predictors

Based on semantic relatedness in 4 DSMs, identified by Lapesa and Evert (2013) as best model and best setting in two tasks (global dataset): accuracy in picking up consistent primes (bow_1, best model; 95.5%; bow_2, best setting; 93.9%). Pearson correlation to congruent RTs (bow_3, best model; .47; bow_4, best setting; .43).

- Target–prime semantic distance (dsm_dist)
- Rank of target in prime’s nearest neighbors (dsm_forw)
- Rank of prime in target’s nearest neighbors (dsm_back)

Term-document predictors

Based on a LSA-like term-document, similar parameters, Wp500 corpus:

- Target–prime semantic distance (lsa_dist)
- Rank of target in prime’s nearest neighbors (lsa_forw)
- Rank of prime in target’s nearest neighbors (lsa_back)

We performed linear regression with priming effect in ms as a dependent variable and semantic relation, first order, term-document, and DSM predictors as independent variables. We tested all two way interactions between corpus parameters, used backward stepwise regression (based on AIC) to select the best model.

Results

Discussion

- Corpus-based predictors do have an effect in item-based prediction.
- Lot of variation by changing DSM: importance of evaluation (possible improvement: running regression with all models in the study).
- Interactions are powerful, but not always straightforward to interpret (possible improvement: selecting “meaningful” interaction before regression).
- Ongoing analyses show that explained variance improves significantly with z-scores (e.g., Box 4: N-N; R²=42, AIC=220).

Item-based predictors

N-V

N-N

V-N

Data

Materials from a number of priming studies (Ferretti et al., 2001; McRae et al. 2005; Hare et al. 2009)

404 word triples composed by a target, a congruent prime and an incongruent prime.

For every triple, the following information is available:

- Decision or naming latencies for correct decisions
- Semantic relation holding between target and prime (16 relations over the 3 datasets).

Distributional modeling of priming is usually carried out in terms of significance analysis of the difference of means. Problems: a) DSMs have been found to overestimate priming effects. b) Significance analysis does not take into account RTs.

- How to interpret modeling results when as many combinations of parameters are involved? Analysis of mean/range of performance and/or identification of “best model” are not fully satisfactory (see Lapesa & Evert, 2013).

- We analyze the influence of parameters and interactions using linear models with absolute correlation as a dependent variable and model parameters as independent variables.

- We performed linear regression with priming effect in ms as a dependent variable and semantic relation, first order, term-document, and DSM predictors as independent variables. We tested all two way interactions between corpus parameters, used backward stepwise regression (based on AIC) to select the best model.

- We are grateful to Ken McRae for providing the data and for his contribution to the development of this study.