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Jena University Language & Information Engineering Lab

The Influence of Down-Sampling Strategies on SVD Word Embedding Stability

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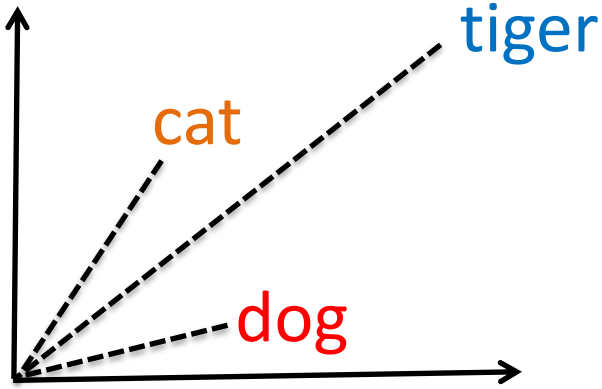
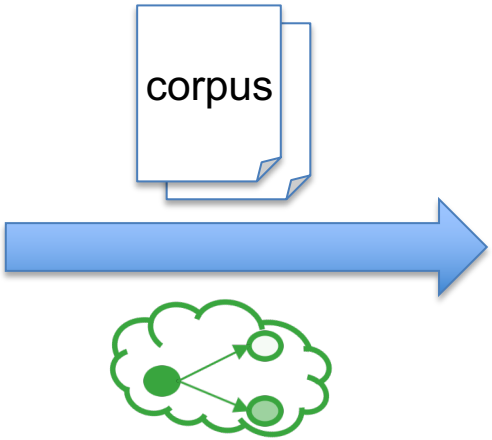
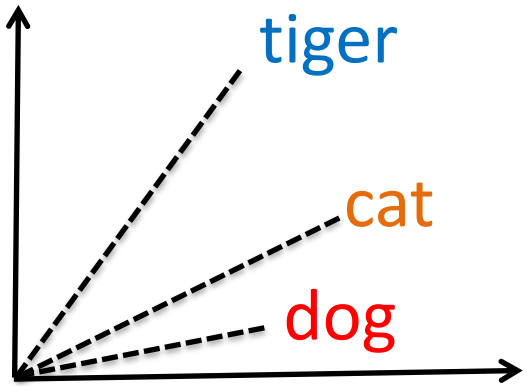
Typical Word Embeddings are Unstable



random embeddings

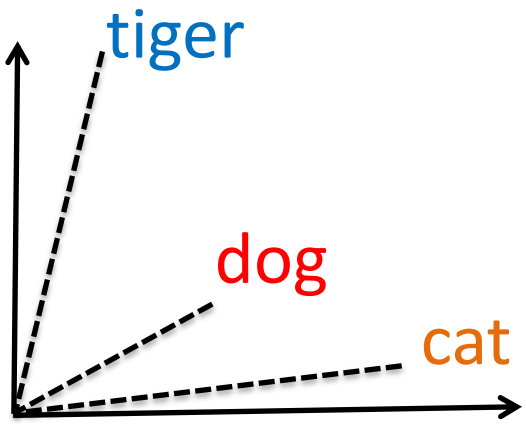


random processing

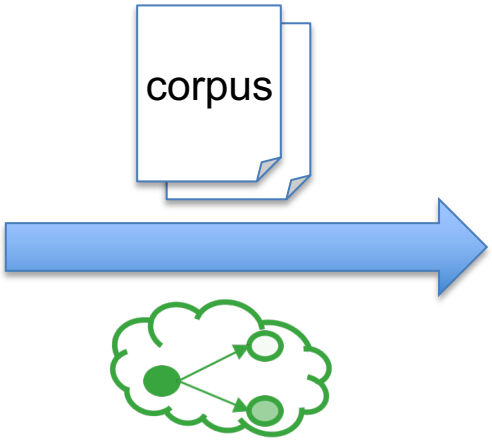


final embeddings

Typical Word Embeddings are Unstable



random embeddings



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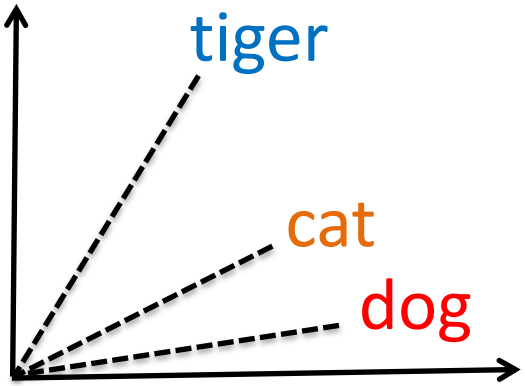
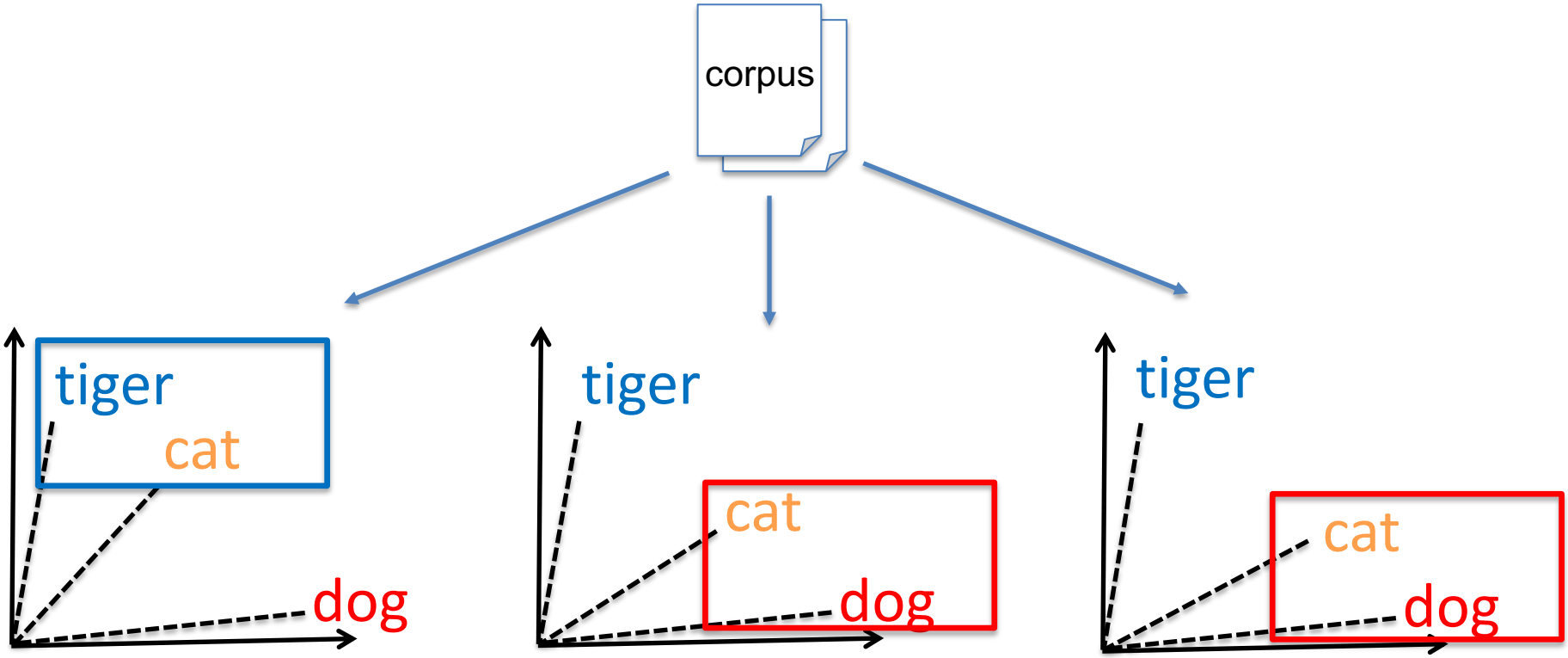


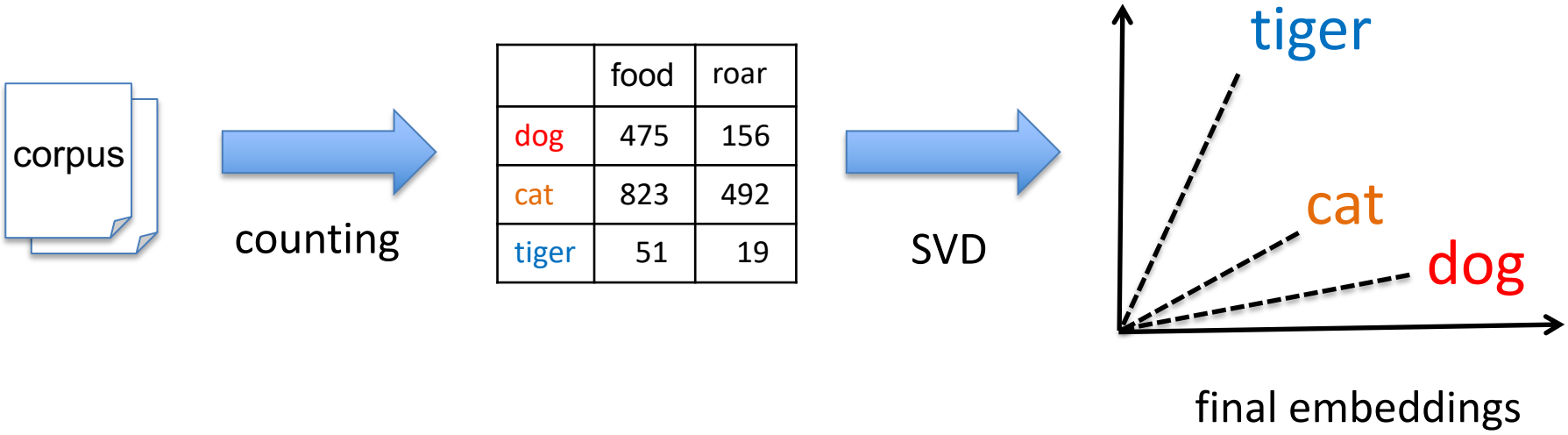
final embeddings

Measuring Stability

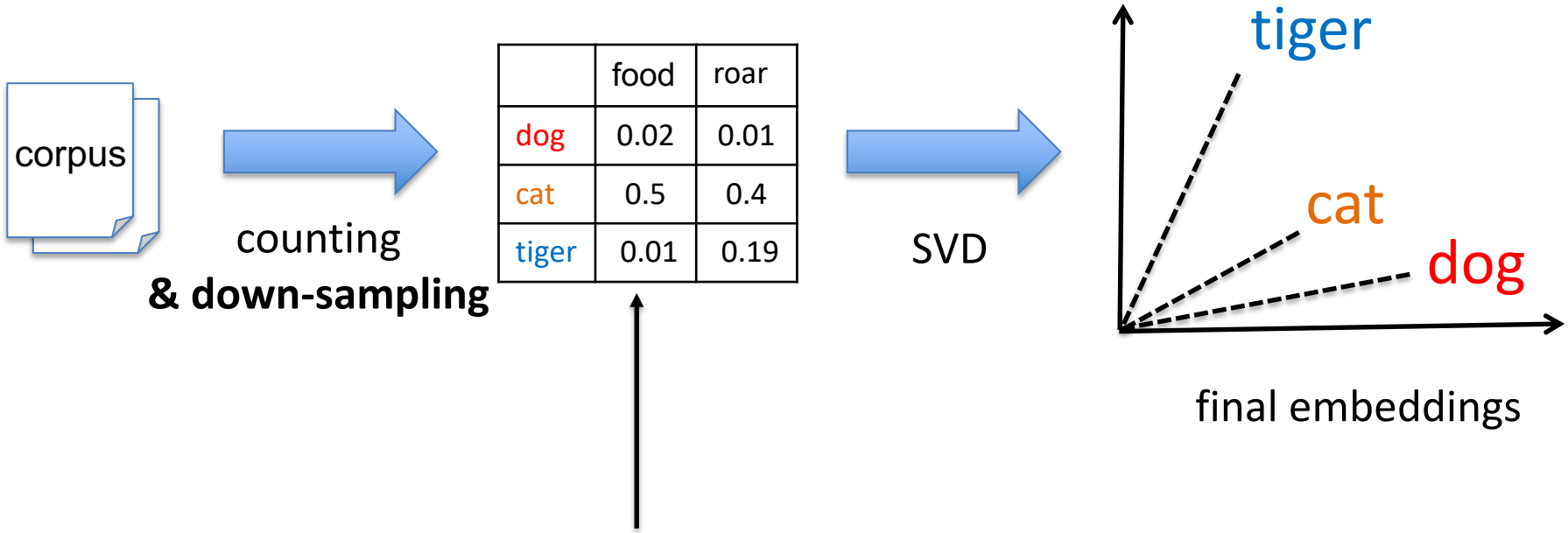


$$j@n := \frac{1}{|A|} \sum_{a \in A} \frac{|\bigcap_{m \in M} \text{msw}(a, n, m)|}{|\bigcup_{m \in M} \text{msw}(a, n, m)|}$$

Why SVD Embeddings?



Why SVD Embeddings?



Why Down-Sampling?

- Avoids over-representing frequent words
- Closer context words are more salient than distant ones

→ Increased Performance (Mikolov, NIPS 2013)

Down-Sampling Mechanism

Probabilistic

- word2vec
- SVD_{PPMI}

Weighting

- GloVe
- New: SVD_{wPPMI}

Experimental Design I/II

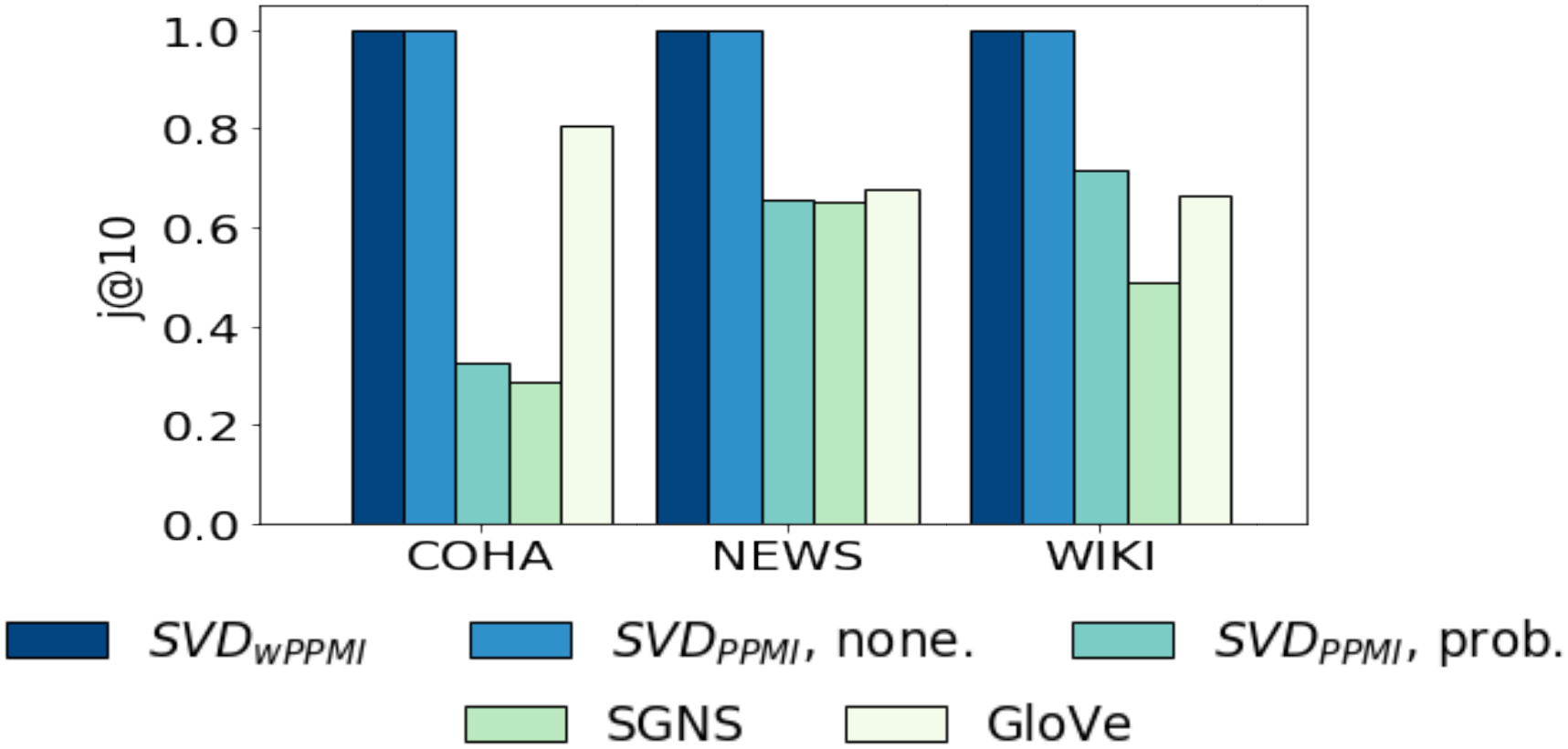
- Three Corpora:
  - Corpus of Historical American English 2000s decade (COHA; 28M tokens.)
  - English News Crawl Corpus (NEWS; 550M tokens)
  - Wikipedia (WIKI; 1.7G tokens)

→ Other studies used mostly COHA-sized corpora!

Experimental Design II/II

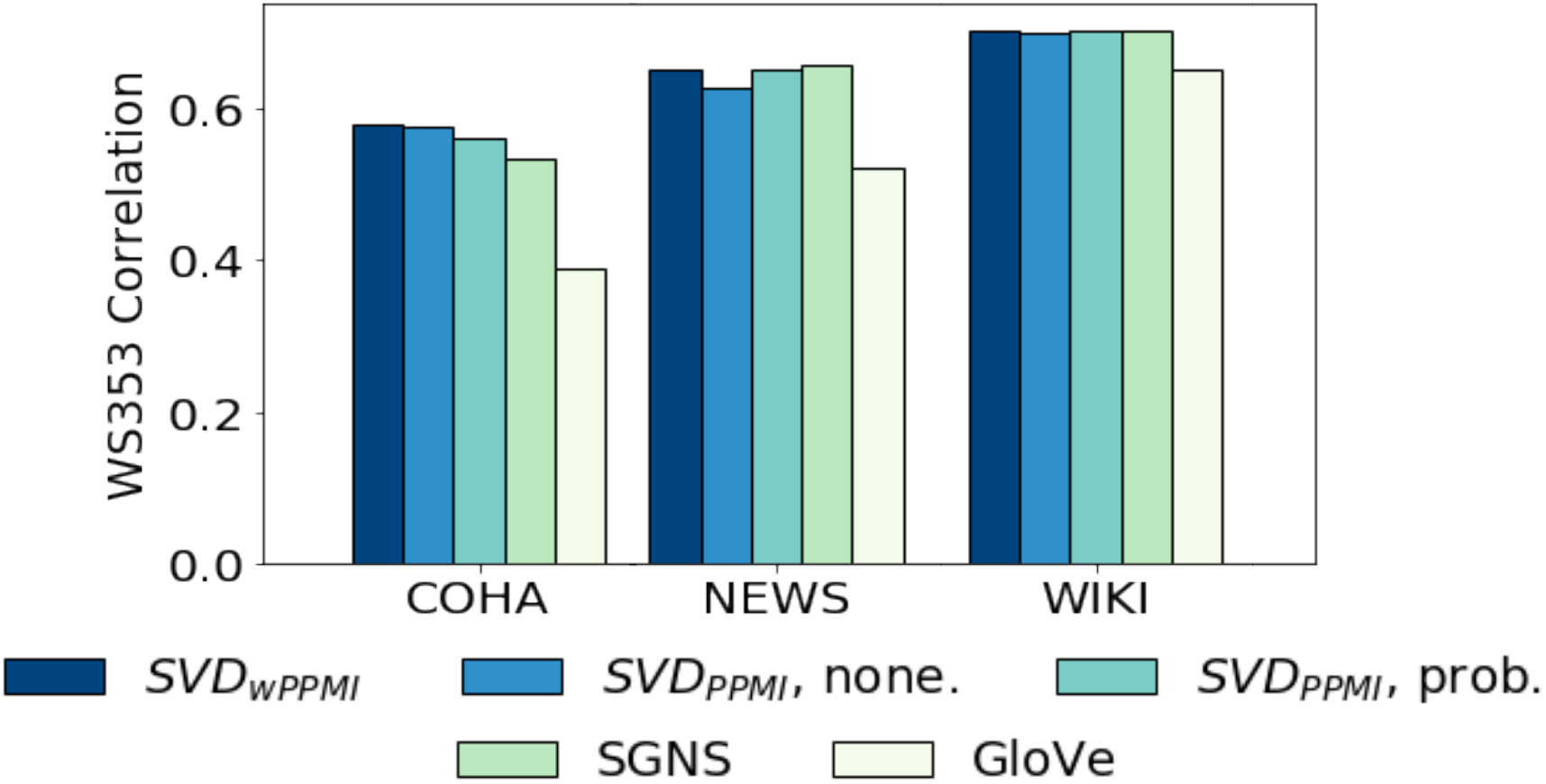
- Train 10 models each with SGNS, GloVe, SVD_{PPMI} (none / prob. down-sampling), SVD_{wPPMI}
- Evaluate intrinsically with four word similarity & two analogy test sets
- Measure stability with j@10 for 1k most frequent words

Stability Results



GloVe's high stability (Antoniak & Mimno, TACL 2018; Wendlandt et al., NAACL 2018) is true only for small corpora

Exemplary Accuracy Results



Wilcoxon rank-sum test shows SVD_{wPPMI} and SGNS to be indistinguishable in accuracy over all test sets and corpora

Conclusion

- Typical word embeddings are unstable
- Down-sampling details greatly affect stability
- GloVe's stability is worse than claimed in literature
- SVD_{wPPMI} embeddings provide SGNS-like performance and perfect stability
- See paper for additional results (and bootstrapping)

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