Factors Influencing the Surprising Instability of Word Embeddings
Laura Wendlandt, Jonathan K. Kummerfeld, Rada Mihalcea
University of Michigan \{wenlaura,jkummerf,mihalcea\}@umich.edu

The Problem
Many common embedding algorithms have large amounts of instability.

What is Stability?
Stability = percent overlap between ten nearest neighbors in an embedding space

Lessons Learned: What Contributes to the Stability of an Embedding

1. Curriculum learning is important.
   - Curriculum learning = order of training data given to an algorithm
   - The top two features (by magnitude) of the regression model capture where the word first appears in the training data.

2. Stability within domains is greater than across domains.
   - Stability of word2vec as a property of the starting word position in the training data.

3. POS is one of the biggest factors in stability.
   - Primary POS = Adposition
   - Avg. Stability
     - Numerical: 47%
     - Verb: 31%
     - Determiner: 31%
     - Adjective: 31%
     - Noun: 30%
     - Adverb: 29%
     - Pronoun: 29%
     - Conjunction: 28%
     - Particle: 26%
     - Adposition: 25%

4. Overall, GloVe is the most stable embedding algorithm.

5. Frequency is not a major factor in stability.
   - Frequency does correlate with stability. However, in the presence of all of these other features, frequency becomes a minor factor.

   - Word stability correlates slightly with performance on word similarity tasks.
   - For POS tagging using an LSTM-based model, the LSTM compensates for instability by shifting unstable word vectors.

This material is based upon work supported by the National Science Foundation (NSF #1344257) and the Michigan Institute for Data Science (MIDAS).