Situating Sentence Embedders with Nearest Neighbor Overlap

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N2O: a procedure for comparing sentence embedding models

general experimental results

case study: BERT
Text as data

How do we represent text numerically?
  • counting n-grams
  • word embeddings
  • ...
  • something via deep learning with big data
Sentences are useful!

“Federal government should provide economic support to help our communities thrive.”

“This federal assistance would help provide economic development in the community.”

...how do we represent sentences?

(examples from TADA ’18: Dreier, Lin, Serrano, Gade, Smith)
Sentence embedding models

**Def.** map sentences to fixed-length vectors

*Federal government should provide economic support to help our communities thrive.*
Sentence embedding models

• Different embedding models may put different sentences near each other
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How do we choose?

**Extrinsic.** downstream task, optimized metrics (e.g., GLUE benchmark by Wang et al., 2019)

**Intrinsic.** linguistic/interpretable properties (Ettinger et al., 2016; Conneau et al., 2018; Zhu et al., 2018; among many others)

N2O: comparative approach; no additional annotation.
Nearest neighbor overlap (N2O)

Two embedding models are more similar if, for the same set of inputs, there is greater overlap between the inputs’ nearest neighbors.

*Common intuition:*
Semantic similarity $\Leftrightarrow$ nearness in embedding space.
Nearest neighbor overlap (N2O)

- Embed every sentence in the corpus
- Identify $k$ nearest neighbors per embedding model for a fixed set of queries
Nearest neighbor overlap (N2O)

\[ N2O = \frac{2 \text{ common neighbors}}{k = 6} = 0.33 \]

• Compute overlap in nearest neighbors
Experimental setup

Corpus. English Gigaword (7 news sources, 2010) approx. 8m unique sentences

Queries. sample uniformly from news article ledes; \( n = 100 \)

Neighbors. \( k = 50 \)

Embedding \( x^{21} \) models.

Aside: robust to different query samples & \( k! \)
Case study: BERT
Contextual word embeddings

**Intuition.** Word embeddings should depend not just on the word, but also its context.

Recent popular method: **BERT** (Devlin et al., 2019)
Contextual word embeddings

How do we get sentence embeddings?

[CLS] → BERT-cls

Federal → BERT-avg

government

... →
support
Britain’s biggest mortgage lender says that average house prices fell 3.6 percent in September, but analysts believe the market isn’t that weak.

“Popular” neighbor (across all 21 embedding models). Average house prices in Britain fell 3.6 percent in September from a month earlier, the country’s biggest mortgage lender said Thursday, although analysts believe the market isn’t that weak.
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Query.
Britain’s biggest mortgage lender says that average house prices fell 3.6 percent in September, but analysts believe the market isn’t that weak.

Near neighbor for BERT-cls only.
Japanese consumer prices fell for 13th straight month in March, though the GDP data suggests that deflationary pressures are starting to ease.
Query.
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Paraphrase ⇔ nearness?

*Exp.* use paraphrase pairs from STS (Cer et al. 2018) “needle in a haystack”

*tl;dr.* BERT-cls does really poorly,
BERT-avg does so-so
(aside: there are better models for this)

“Arkansas Supreme Court strikes down execution law.”

↓

“Arkansas justices strike down death penalty.”
Should I use BERT-cls or BERT-avg or something else?

It depends on:

• what kinds of text you’re embedding
• how you plan to use the sentence embeddings
• ...and other factors!

N2O helps guide comparison of embedding models.
N2O: a procedure for comparing sentence embedding models

general experimental results

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Thanks!

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