An Information-Theoretic Explanation of Adjective Ordering Preferences
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Background

Adjectives are subject to ordering preferences: “the big blue plate” > “the blue big plate” “the beautiful old house” > “the old beautiful house” “the delicious boiling curry” > “the boiling delicious curry”

Generalizations include ‘Specificity’, ‘Inherentness’, ‘Concept-Formality’, ‘Subjectivity’

Scontras et al. (2017): The more subjective an adjective, the farther away from the noun it occurs

Can this be explained in terms of general principles of language use and processing?

Corpus Analysis: Subjectivity and MI

Previous hypotheses ‘specificity’, ‘inherentness’. We formalize using Pointwise Mutual Information:

PMI(Adj,Noun) = log P(Adj|Noun) − log P(Adj)

This is a common measure of collocation and a plausible quantitative measure of specificity.

Prediction: Adjectives with higher mutual information with the noun come closer to the noun.

We test this on BookCorpus and Gigaword.

Results: Prediction is confirmed

Subjectivity and Mutual Information independently impact ordering.

The Use of Adjectives

Goal: Provide a model of adjective use that explains effects of subjectivity and mutual information.

Adjectives can:
1. pick out a referent (Restrictive)
2. describe and comment on a referent (Non-Restrictive)

We focus on non-restrictive use.

RSA Model of Adjective Use

In a typical world state:

- Speakers mostly agree on objective judgments (METAL, GREEN)
- More disagreement for more subjective judgments (LARGE, BEAUTIFUL)

Formally, adjectives have different inter-speaker correlations under prior distribution over possible worlds.

Speaker utters sequence Adjective₁-Adjective₂-Noun

Listener performs Bayesian Inference about judgments of speaker and other people.

\[ P_{\text{listener}}(w|u) \propto P_{\text{prior}}(w|u) \delta_{\text{utterance } u \text{ is true of the speaker in the world } w} \]

Speaker chooses utterance by trading off informativity and cost of utterance:

\[ P_{\text{speaker}}(u) \propto \exp(\alpha \cdot (U(u) - \beta \cdot C(u))) \]

Informativity of utterance ‘u’:

\[ U(u) := -KL(P_{\text{speaker}}|P_{\text{listener}}(w)) = \sum_{w} P_{\text{speaker}}(w) \log \frac{P_{\text{_listener}}(w)}{P_{\text{speaker}}(w)} \]

Cost of producing ‘u’:

\[ C(A_{1}A_{2}N) = -\log P(A_{1}A_{2}N) \]

Memory Loss Breaks Symmetry

Formal model by Futrell and Levy, 2017:

Assumption 1: Previous words in the input may be lost from memory stochastically

Assumption 2: Probability of loss increases as one goes further back.

Consequence: First adjective less likely to be integrated with noun by the listener.

Testing against Corpus Data

Predict adjective order in corpus data

Model Parameters:
- Inter-speaker correlation = 1 - subjectivity
- Other parameters inferred using Bayesian Data Analysis

Evaluation Datasets:
1. Set from corpus analysis (~ 4,700 examples)
2. Unseen data set (~ 10,000 examples)

Conclusion

- Subjectivity and MI impact adjective ordering.
- Both effects can be explained by integrating Bayesian reasoning with memory limitations.
- Adjective ordering can be explained by general principles of human communication and language processing.