Weakly Supervised Part-of-speech Tagging Using Eye-tracking Data

Why this paper?

- Interesting combination of two seemingly unrelated fields

- A good motivation for cross-domain thinking!

What do they do?

- POS tagging using raw text, a dictionary, and eye-tracking data from naive participants.
- They show that the eye-tracking data helps improving the baseline significantly

Motivation

- Difficult to manually annotate linguistic resources
- Dictionaries can be harvested/created comparatively easily
- Eye-tracking data can be obtained without trained participants

The Dundee Treebank

- Universal Dependency annotation layer on The Dundee Eye-tracking Corpus
- English corpus has 51,502 tokens and 9,776 types in 2,368 sentences.
- The corpus contains eye-tracking data for 10 native English participants reading 20 news articles from The Independent, recorded at 1000 Hz.

Type-constrained second-order HMM with maximum entropy emissions

$$p(\mathbf{x}, \mathbf{y}) = \prod_{i=1}^{\text{length}(\mathbf{x})} p_t(y_i \mid y_{i-1}, y_{i-2}) p_o(x_i \mid y_i),$$

Here, x is the sentence, y is the POS tag sequence (hidden state sequence)

p_t is the transition probability, probability of being in state y_i , given two previous states y_{i-1}, y_{i-2}

p_o emission probability, probability of observing word x_i in state y_i

Maximum entropy emissions

$$p_o(x|y) = \frac{\exp(\theta \cdot \mathbf{f}(x, y))}{\sum_{x'} \exp(\theta \cdot \mathbf{f}(x', y))}$$

f is a feature function, θ are the model parameters.

Type constraint

For each tag y, the observations probabilities $p_o(x \mid y)$ were initialized randomly for every word type that allows tag y according to the Wiktionary and zero otherwise

Gaze features

- 22 gaze features and 9 non-gaze features used.
- Examples are, fixation probability, fixation duration, fixation probability, number of fixations, regression to/from, regression duration
- Similar features on context words, too

Results

	Token-level	**Type averaged**
Only text features (baseline)	79.77	-
Only gaze features	79.56	81.94
All features	81.00	**82.44**

Discussion?