Prominence Facilitates Communication between Predictive Agents

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This presentation offers a formal model of prominence as an adaptive epiphenomenon in communication between predictive agents.

The model of communication is presented here in terms of *speakers* and *listeners*, although it applies equally to non-speech communication media. *Forms* are signals produced by a *speaker* and potentially interpretable by a *listener*, changing their *discourse state*. The goal of the speaker is to lead the listener from a default starting discourse state to a desired target discourse state, perhaps representing information new to the listener.

The model is based on 5 assumptions:

(A1) There is a joint distribution over discourse state transitions and forms. Agents use a single model of the relationship between a form f and transitions from one discourse state s_1 to another s_2, namely a probability over triples $P(f, s_2, s_1)$. The activation of a form f in a given discourse state s_1 is the conditional margin probability $P(f \mid s_1) = \frac{\sum_{s_2} P(f, s_2, s_1)}{\sum_{f,s_2} P(f, s_2, s_1)}$.

(A2) Listeners adjust state distributions given received forms. Pickering & Garrod (2013, see also Pickering & Gambi 2018) describe a forward-modelling account of linguistic interaction in which the listener simulates the speaker's production and makes predictions about forthcoming productions. They correct their understanding of speaker intentions when heard forms do not match their predictions. The current model likewise assumes that listeners correct their predicted discourse state distribution given input forms using the conditional probability $P(f \mid s_2, s_1) = \frac{P(f, s_2, s_1)}{\sum_f P(f, s_2, s_1)}$, and Bayes' theorem (1) (see Rouder & Morey 2018).

(1) $$P(s_2 \mid f, s_1) = \frac{P(f \mid s_2, s_1)}{P(f \mid s_1)} \; P(s_2 \mid s_1)$$

(A3) Speakers find state transition paths from common ground to informed states. Given a default shared discourse state s_0, and a state s_n where the listener knows what the speaker wishes to convey, speakers construct a sequence of states $(s_0, s_1, s_2, \ldots, s_n)$ and forms $(f_1, \ldots f_n)$ such that the following hold:

(A4) Speakers seek consistent levels of interpretational confidence in the listener. Speakers maintain a certain level of confidence in the listener, so that the posterior probability of the discourse state never falls below a threshold θ, $P(s_2 \mid f, s_1) \geq \theta$. This assumption ensures that the forms produced by the speaker are effective in rendering the target discourse state probable to the listener.

(A5) Speaker minimises production effort. Finally, speakers attempt to achieve the desired threshold of listener confidence with a minimum of effort. Effort expended is approximated by a measure of how unlikely the form is to appear. It is expected that the less likely a form is, the more effort is required to express it. One measure fitting this requirement equates effort with the negative log likelihood $-\log_2 P(f \mid s_1)$ of producing form f after state s_1.

The resulting model of communication represents both:

Discourse Prominence. Schumacher & van Heusinger (2019) identify discourse prominence with the likelihood with which a discourse referent will be picked out by a referring expression. This is represented by $P(s_2 \mid s_1)$ the likelihood of a particular new discourse state (e.g. after rementioning a referent) given the previous one.

Code Prominence: the ability of a form to steer the listener away from a predicted discourse state to another. The larger $\frac{P(f \mid s_2, s_1)}{P(f \mid s_1)}$, the more strongly state s_2 will be picked out.

The model will illustrated with results from SFB1252 projects, including work by Savino et al. (2020).

References

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