Tell Me Everything You Know: A Conversation Update System for the Rational Speech Acts Framework

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THE RATIONAL SPEECH ACTS FRAMEWORK

Conversation participants reason about each others' behavior to optimize their contributions (Frank & Goodman 2012)



Speaker: $p(u | w) \propto p(w | u) p(u)$ Listener: $p(w | u) \propto p(u | w) p(w)$

The Rational Speech Acts model

Frank & Goodman (2012)

Listener: p(meaning | utterance) p(meaning | utterance) ∝ p(utterance | meaning)p(meaning)

Speaker: p(utterance | meaning) p(utterance | meaning) ∝ p(meaning | utterance) p(utterance)

Literal Truth is Discounted by Prior Probability



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MULTI-TURN CONVERSATIONS IN THE RSA





WHAT DOES THE RSA CURRENTLY DO?



Listener: $p(w | u) \propto p(u | w) p(w)$

Speaker: $p(u | w) \propto p(w | u) p(u)$

WHAT DOES THE RSA CURRENTLY DO?



UTTERANCES UPDATE THE COMMON GROUND

The goal of conversation is to pool information (Lewis 1979)



UTTERANCE SELECTION DEPENDS ON THE COMMON GROUND



BUT PARTICIPANTS HOLD PRIVATE BELIEFS!



BELIEFS ARE SOMEWHAT STABLE...



BUT PARTICIPANTS ALSO LEARN FROM EACH OTHER



WAIT, DO WE ALWAYS UNDERSTAND EACH OTHER?



KEY ISSUES FOR MULTI-TURN CONVERSATIONS

Issue 1: How should the Common Ground be modeled?
Issue 2: How should the Common Ground be updated?
Issue 3: How should the beliefs of participants be updated?
Issue 4: How should observations be sampled?

ISSUE I: HOW SHOULD THE COMMON GROUND BE MODELED?

Proposal:

Model the Common Ground as a distribution over possible worlds.

Proposal:

Each participant maintains their own representation of the Common Ground (CG_A, CG_B, etc).

In a coherent discourse, there is no divergence between Common Ground representations.

ISSUE 2: HOW SHOULD THE COMMON GROUND BE UPDATED?

Proposal:

The Common Ground is updated with the result of the Pragmatic Listener computation multiplied by a learning rate.

(Listeners do not always accept the speaker's contribution fully.)

Variant 1:

The speaker and listener use different learning rates.

Variant 2:

The listener's learning rate varies based on their uncertainty (measured as the entropy of their belief distribution).

ISSUE 3: HOW SHOULD PARTICIPANTS BELIEFS BE UPDATED?

Proposal:

The listener updates their belief representation with the result of the Pragmatic Listener computation multiplied by a learning rate.

(Listeners do not always believe the speaker.)

ISSUE 4: HOW SHOULD OBSERVATIONS BE SAMPLED?

Weighted Sampling:

Sample a world from the speaker's belief distribution according to its probability.

Thresholded Sampling:

Only sample worlds that meet a certain probability threshold in the speaker's belief distribution.

Difference-based Sampling:

Sample worlds based on their Common Ground update potential.

MULTI-TURN CONVERSATION



A NEW DIRECTION FOR THE RSA

Controversial claim:

If the goal of the RSA is to model rational conversational behavior, it **maximizes the wrong probability**.

The RSA speaker currently selects the utterance that best describes the observed world.

But for multi-turn conversations, the right objective is to select the utterance that minimizes the entropy of the Common Ground.



Figure 5: 4 moves with Shared Common Ground



Figure 7: 4 moves with Approximate Common Ground



Figure 9: Belief updates (learning rate=0.2)



Figure 11: Entropy-based update example



Figure 12: Sampling from a uniform belief distribution leads to flipflopping in the Common Ground



Figure 13: A threshold lets noncommittal speakers pass



Figure 14: Redundancy with weighted sampling



Figure 15: Thresholded difference-based sampling