Pragmatic Reasoning in Structured Signaling Games

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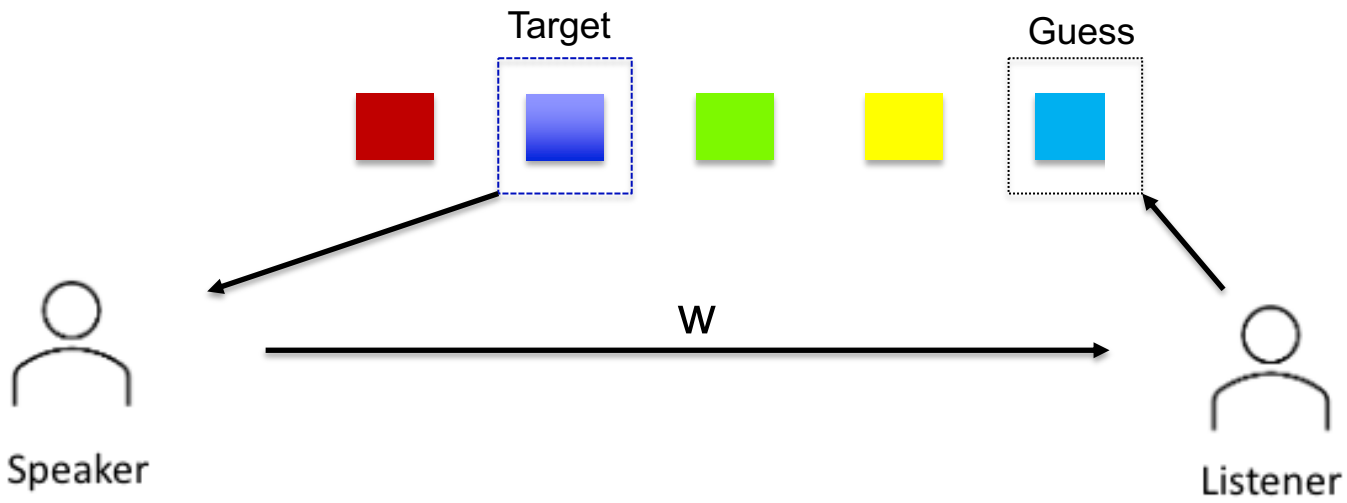
Structured Signaling Game

	w_1	w_2	w_3
	1	0	0
	0	0.8	0
	0	0	0.4
	0	0	0.5
	0	0.7	0.1



- Agent has access to a meaning function and a similarity measure between meanings $Z_{mm'} = e^{-\sigma||x_m - x_{m'}||^2}$

- Perfect communication not possible
  => Need to minimise the total distortion

Rational Spech Act Framework

RSA

$$L_0(m|\mathrm{w}, C) \propto \mathcal{L}(m, w)$$

$$S_t(w|m, C) \propto e^{\alpha U_t(m,w,C)}$$
$$L_t(m|w, C) \propto S_t(w, m, C)p(m|C)$$

$$U_t(w, m, C) = \log L_{t-1}(m|w, C)$$

Frank and Goodman 2012

sRSA

Similarity sensitive surprisal (Leinster 2021):

$$S_t(w|m, C) \propto (\sum_{m' \in C} Z_{mm'} L_{t-1}(m'|w, C))^{\alpha}$$

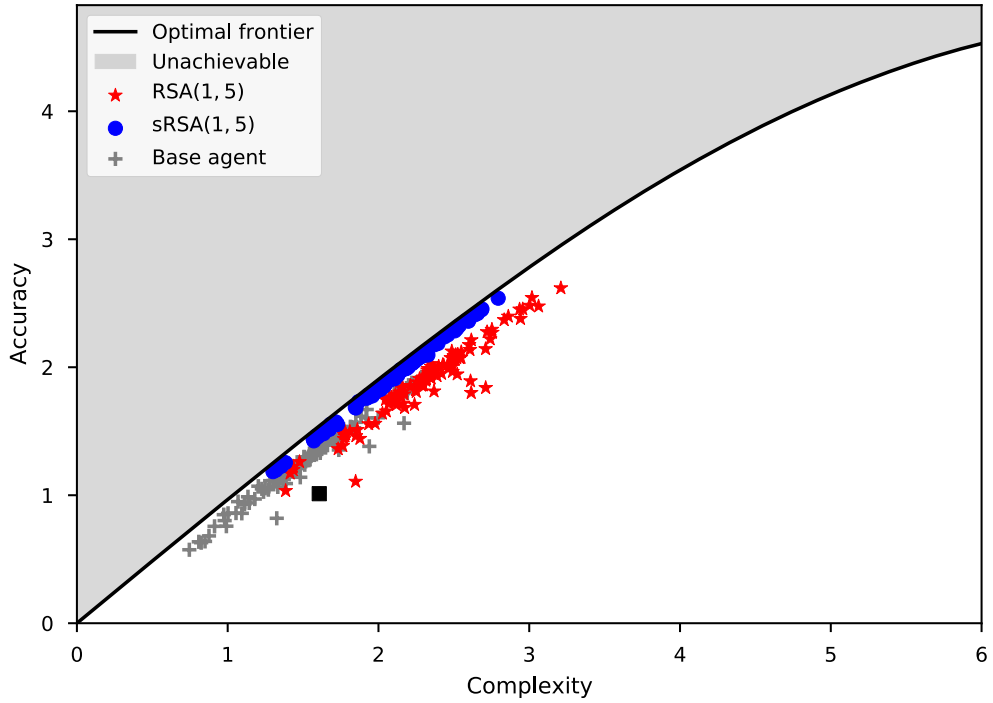
Two Studies

- Meaning functions derived from the World Color Survey (WCS) (Berlin and Kay 1969).
- Meaning functions developed by artifical agents in a reinforcement learning framework.

Neural Network

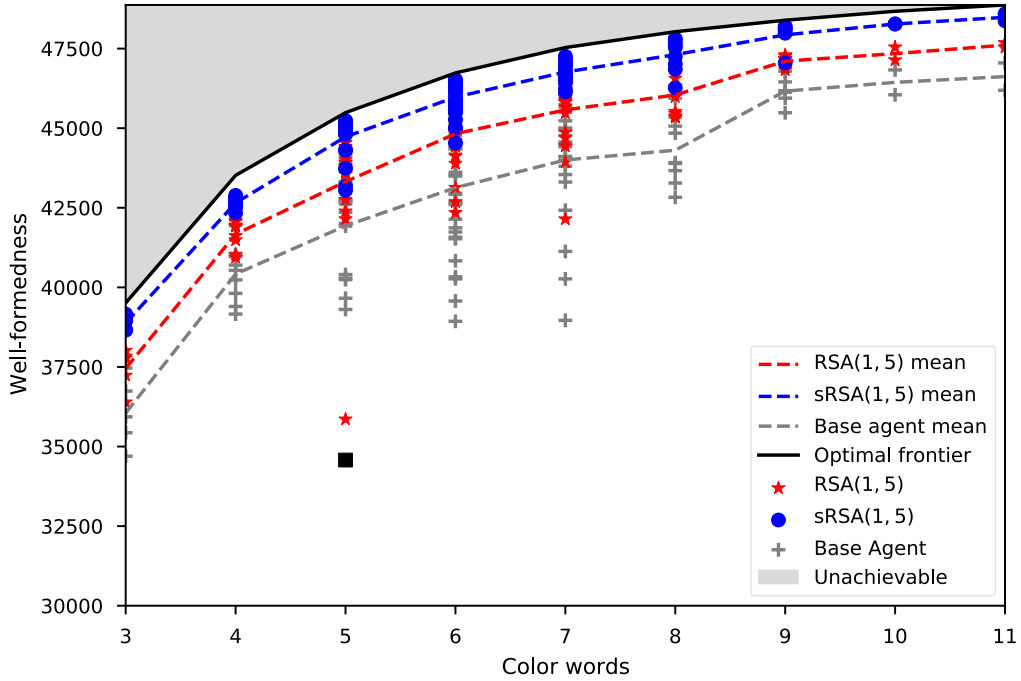
$$L_0(m|w) \propto \mathcal{L}(m,w)$$
$$S_t(w|m,C) \propto e^{\alpha U_t(m,w,C)}$$
$$L_t(m|w,C) \propto S_t(w|m,C)p(m|C)$$

WCS Representations



IB-Frontier

Zaslavsky et al. 18

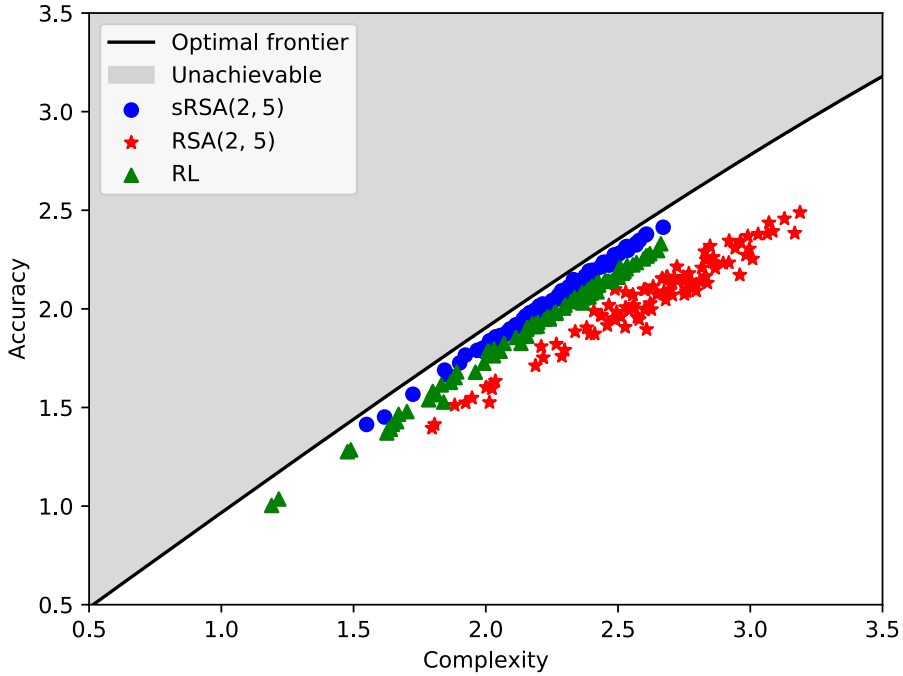


Well-formedness

Regier et al. 07

Reinforcement Learning

- sRSA+RL led to more efficient communication compared to just RL and RSA + RL.
- Explicitly accounting for the structure in the reasoning process improved over only accounting for it in the meaning function.
- Increased recursion depth => increased efficiency and more ambiguity neural representation.



Summary and Future Directions

- Accounting for the structure in the reasoning process greatly improves the efficiency

- In the future,
  - more realistic scenarios (e.g. color setup from Monroe et al., 2017)
  - Uncertainty in the similarity function
  - Other domains

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Link to paper