Word Games

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Dialogue

- Communication is rarely unambiguous
  - Ambiguity resolution through dialogue
  - Clarification questions
- Interactive, symmetric reference games
  - Isolates ambiguity resolution
  - Both give and request information

Games

Friends of agent A:

Name	School	Major	Company
Jessica	Columbia	Computer Science	Google
Josh	Columbia	Linguistics	Google
...	...	...	...

A: Hi! Most of my friends work for Google
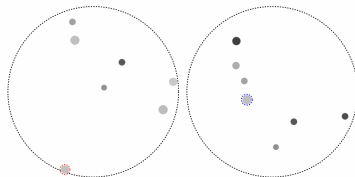B: do you have anyone who went to columbia?
A: *Hello?*
A: I have Jessica a friend of mine
A: and Josh, both went to columbia
B: *or anyone working at apple?*
B: SELECT (Jessica, Columbia, Computer Science, Google)
A: SELECT (Jessica, Columbia, Computer Science, Google)

Human A's view   Human B's view

Human B: three light grey dots in a diagonal line
Human A: i dont have that but i have a black
            dot neer the top to the right, the only
            black dot in the circle
Human B: i have two black dots. find something else
Human A: ok i have a light grey dot by itself
            at the bottom to the left. right on the line
Human B: how big is it
Human A: its one of the bigger ones
Human B: okay just pick it then
Human A: ok
Human B: SELECT blue
Human A: SELECT red

Mutual Friends and OneCommon

Issue: Poor neural reasoning

From Mutual Friends: Neural + Human

- ▶ A: Know anyone who likes chess?
- ▶ B: None of my friends like chess.
- ▶ (conversation continues)
- ▶ A: Crocheting?
- ▶ B: None like crocheting.
- ▶ A: Chess?
- ▶ B: None like chess either, haha.

Issue: Poor neural reasoning

Agent 0: human || 1: human

	0	1
0	1	I see a large grey dot with a smaller black dot right below it
1	0	is the smaller black dot to the right and below
2	1	No, it is slightly to the left and below
3	0	Might not be the same one. Do you have a lot of dots in a fairly vertical conformation
4	1	I have three dots in a kinda vertical line with different shade of gray but close in size
5	0	Is the middle dot curved to the left or right a little bit?
6	1	the middle dot is slighty to the left of the other two and is also a little bit darker than the rest
7	0	Yes pick that middle dot

Issue: Poor neural reasoning
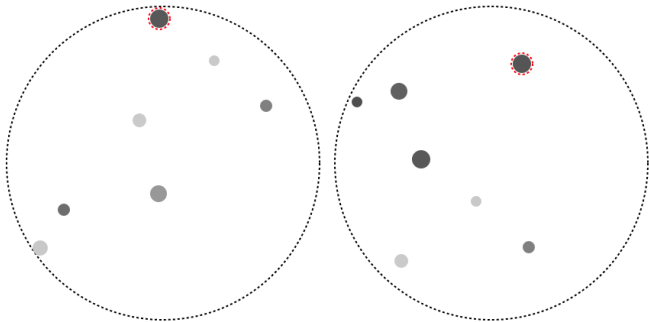
Agent 0: pragmatic_confidence || 1: human

	0	1
0	0	i have one large black dot by itself . do you have it ?
1	1	Yes, I do have that.
2	0	let 's pick that one
3	1	ok
4	0	ok

Issue: Scaling rule-based

System	C	C_T	C_S
Human	.89	.07	.36
Rule	**.88**	**.06**	**.29**
StanoNet	.76	.04	.23
DynoNet	.87	.05	.27

► Rule-based text generation and understanding is viable for Mutual Friends

► Continuous and spatial nature of OneCommon makes writing rules difficult

Current approaches: Two extremes

- ▶ Neural encoder-decoder
    - ▶ Encode past interactions with a neural net
    - ▶ Generate what to say with a neural net
    - ▶ Brittle strategy, less brittle language
- ▶ Rule-based
    - ▶ Encode past interactions in a table
    - ▶ Use rules for what to say next
    - ▶ Nonparametric lookup of utterances
    - ▶ Brittle language, less brittle strategy
- ▶ Meet in middle with interpretable planning + neural language

A dialogue turn

- Engaging in dialogue requires
  - Inference: What do I know? How do I represent it?
  - Planning: What should I do and say?
- Formulate as model-based optimization
  - Plan what to say through a simple model of our partner
 - Model of partner conditions on past information

Problem setup

- ▶ Goal: Mutually select the same item as partner
  - ▶ Row in knowledge base, dot
  - ▶ Coordinate through dialogue
- ▶ Given history h, we need to chose an action a by optimizing value

$$\max_a V(h, a)$$

- ▶ How should we define value V?
- ▶ How do we represent h, a?

Value: Information Gain

- A good action should move us closer to game success
- Game success depends on our knowledge of our partner's context
- Requires
  - Belief distribution over selection item given history $p(i \mid h)$
  - Partner response model $p(o \mid h, a, i)$
- Represent a turn as
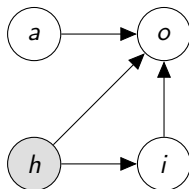
Value: Information Gain

- Picture would be much better here...
- Value = expected information gain

$$IG(h, a) = H(i \mid h) - \mathbb{E}_{p(o \mid h, a)}\left[H(i \mid h, a, o)\right]$$

$$\mathbb{E}_{p(o \mid h, a)}\left[H(i \mid h, a)\right] = \sum_o \sum_{i'} p(o \mid h, a, i) p(i \mid h) H(i \mid h, a, o)$$

- Equivalent to minimizing expected uncertainty after receiving a response
- Cite Yu et al, White et al

Issues with information gain

- ▶ Too much burden on the obs model $p(o \mid h, a, i)$
  - ▶ When o is natural language, conditioning on h is important
  - ▶ If we had a great obs model, would we have really have issues with solving these simple dialogue games?
- ▶ Proposal: Set up models for success by separating language from strategy
  - ▶ Rule-based representations good for strategy
  - ▶ Neural models good for language
- ▶ Set up so that $o \perp\!\!\!\perp h \mid a, i$ is a reasonable assum
- ▶ Reframe dialogue as 'asking about features' for item selection
- ▶ Convert language to and from item features

State and belief

- History: whether features have been asked $h \in \{0, 1\}^N$
- Items: $i \in [M], N >> M$
- $p(i \mid h) = \frac{\sum_n \psi(h_n, i)}{\sum_{i', n} \psi(h_n, i')}$
- $p(i \mid h) \propto 1 + \log 1 + \sum_n \psi(h_n, i)$
- $\psi(h_n, i) = w_n 1(h_n(i))$

Visible units

Hidden units
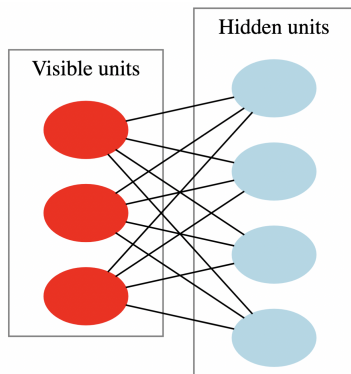
End

Concerns

- Would a large LM solve all of this?
  - Fine tune on small onecommon dataset, are there still repeats?
  - Unlikely to solve strategy / over optimistism

End

Citations I