Mind-reading for fun and profit

...

or, Abductive Understanding of Dialogues about Joint Activities

Langley, Meadows, Gabaldon, and Heald

A brief history of the great schism in AI

- Statistical vs. ... whatever Hofstadter's doing
- OK, so it might just be the rest of the world vs. Hofstadter
- Really, I'm just happy to see a 2014 paper using Prolog

A word on abduction

- Many jokes come to mind, but I cannot condone federal crime

Deduction

(A -> B) ^ A = B

All men are mortal
Socrates is a man
therefore
Socrates is mortal

Induction

- Not as strict
- Infer B from A if B seems reasonable

“All chocolate I’ve seen so far is brown, so chocolate is brown”

Abduction

- B, therefore A (if A makes sense)
- Occam’s Razor

The sample dialogue

Medic: We have a man injured!

Expert: Where is he hurt?

Medic: He's bleeding from the left leg.

Expert: How bad is the bleeding?

Medic: Pretty bad. I think it's the artery.

Expert: Okay, use a tourniquet to stop the bleeding.

Medic: Right, where shall I put it?

Expert: Just below the joint above the wound. Keep turning until it stops bleeding.

Medic: Okay, the bleeding has stopped.

Motivating theory

Because the authors were nice enough to write these bullets for me (though not in this order), dialogue understanding:

- Relies on participants' mental state
- *[therefore]* Can be generalized into meta-level predicates
- Proceeds incrementally
- Is inherently abductive

Fine; I'll talk about speech acts

...past me hates current me

- Some communication doesn't just convey knowledge; it affects the conversation's global state
- Proposing a goal, acknowledging/accepting/rejecting that proposal, signalling that more information is needed
- I don't remember why I don't like Searle; it's a blood feud at this point

I, for one, welcome our shadowy overlords

- UMBRA
  - The name is either a tortured psychological acronym or a threat of psychological torture
- Domain-level and meta-level predicates
  - Domain-level: `is-stable`, `has-injury`, etc.
  - Meta-level: `belief`, `goal`, `constraint` (i.e., speech acts)
- Some meta-level dialogue components (mostly compound predicates):

```
dialogue-open
question-answer-exchange
propose-response-exchange
reject-reason-exchange
inform-ack-exchange
dialogue-close
```

So predicate. Much Prolog.

The first line of the sample dialogue (***Medic:*** We have a man injured!) results in the following system state:

```
constraint(UMBRA, (medic /= expert), 09:01, _20)
constraint(UMBRA, (_3 < 08:59), 09:01, _21)
constraint(UMBRA, (09:00 < _4), 09:01, _22)
belief(UMBRA, constraint(expert, (_10 < 08:59), 09:00, _23), 09:01, _24)
belief(UMBRA, constraint(expert, (09:00 < _11), 09:00, _25), 09:01, _26)
belief(UMBRA, constraint(expert, (_14 < 08:59), 09:00, _27), 09:01, _28)
belief(UMBRA, constraint(expert, (09:00 < _15), 09:00, _29), 09:01, _30)
belief(UMBRA, inform-utterance(medic, expert, has-injury(p1, i1), 08:59, 09:00), 09:01, _1)
belief(UMBRA, goal(medic, belief(expert, has-injury(p1, i1), 09:00, _2), _3, _4), 09:01, _5)
belief(UMBRA, belief(medic, belief(expert, has-injury(p1, i1), 09:00, _6), 09:00, _7), 09:01, _8)
belief(UMBRA, belief(expert, goal(medic, belief(expert, has-injury(p1, i1), 09:00, _9), _10, _11),
                                 09:00, _12), 09:01, _13)
belief(UMBRA, belief(expert, belief(medic, has-injury(p1, i1), _14, _15), 09:00, _16), 09:01, _17)
belief(UMBRA, belief(expert, has-injury(p1, i1), 09:00, _18), 09:01, _19)
belief(UMBRA, inform(medic, expert, has-injury(p1, i1), 08:59, 09:00), 09:01, _1)
```

Let's get meta

The entire dialogue, represented as dialogue components:

```
belief(medic, initiate-dialogue(medic, expert, establish-radio-contact))
belief(medic, inform-utterance(medic, expert, is-injured(p1, i1)))
belief(medic, acknowledge-utterance(expert, medic, is-injured(p1, i1)))
belief(medic, propose-utterance(medic, expert, stable(p1)))
belief(medic, accept-utterance(expert, medic, stable(p1)))
belief(medic, question-utterance(expert, medic, location(i1, lc1)))
belief(medic, inform-utterance(medic, expert, where(lc1, left-leg)))
belief(medic, acknowledge-utterance(expert, medic, where(lc1, left-leg)))
[...]
belief(medic, propose-utterance(expert, medic, apply-tourniquet(tq1, left-leg)))
belief(medic, accept-utterance(medic, expert, apply-tourniquet(tq1, left-leg)))
belief(medic, propose-utterance(expert, medic, turn-tourniquet(tq1)))
belief(medic, accept-utterance(medic, expert, turn-tourniquet(tq1)))
belief(medic, inform-utterance(medic, expert, stopped(b1)))
belief(medic, acknowledge-utterance(expert, medic, stopped(b1)))
belief(medic, end-dialogue(medic, expert, over-and-out))
```

Filling in blanks

UMBRA does pretty well given a properly parsed, complete dialogue; but its design also means that it can operate passably given incomplete information (e.g., a bad connection/unreliable network)

	TP	FP	FN	Inputs	Precision	Recall
Basic						
Scenario 1	380	0	0	25	100.0%	100.0%
Scenario 2	410	8	12	28	98.1%	97.2%
Scenario 3	400	0	0	27	100.0%	100.0%
Scenario 4	390	29	32	28	93.1%	92.4%
Total	*1580*	*37*	*44*	*108*	*97.7%*	*97.3%*
Elided						
No Implicit Speech Acts	310	6	76	19	98.1%	80.3%
Only Medic's Utterances	217	8	174	14	96.3%	55.5%
Only Expert's Utterances	259	38	135	11	87.2%	65.7%
Total	*786*	*52*	*385*	*44*	*93.8%*	*67.1%*

Outside the box

- Every user interaction is, to some extent, a dialogue with a shared goal
- How can we represent a dialogue for, say, ordering a product?
    - No Prolog allowed, because no one's going to let you push that to prod

Outside the box

- CQRS
  - Every user action/“intent” represents a belief or goal that the user has; how well does that align with the system’s goal(s)?
  - Missing intents could be inferred (abducted?)

Questions?