Statistical Dialogue Systems

NPFL099 Statistické dialogové systémy

11. Linguistics & Ethics

Ondřej Dušek & Vojtěch Hudeček

http://ufal.cz/npfl099

19. 12. 2019

Turn-taking (interactivity)

- Speakers **take turns** in a dialogue
  - **turn** = continuous utterance from one speaker
- Normal dialogue – very fluent, fast
  - minimizing **overlaps** & **gaps**
    - little silence (usually <250ms), little overlap (~5%)
    - (fuzzy) rules, anticipation
  - cues/markers for turn boundaries:
    - linguistic (e.g. finished sentence), voice pitch
    - timing (gaps)
    - eye gaze, gestures (…)
- overlaps happen naturally
  - ambiguity in turn-taking rules (e.g. two start speaking at the same time)
  - **barge-in** = speaker starts during another one's turn

Turn-taking (example)

https://youtu.be/BZF9eg35IXI?t=91

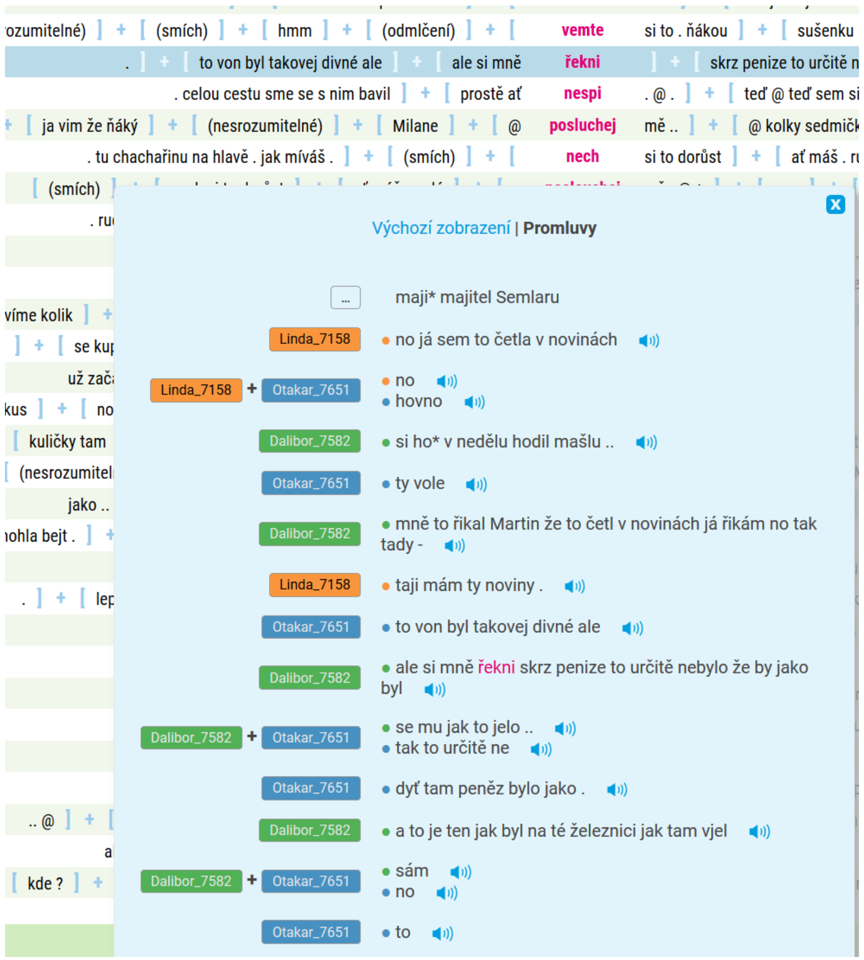
20 seconds of a semi-formal dialogue (talk show):

```
S: um uh , you're about to start season [six ,]
J:                                      [yes]
S: you probably already started but [it launches]
J:                                  [yes thank you]
A:                                  (cheering)
J: we're about to start thank you yeah .. we're starting , we- on Sunday yeah ,
   we've been eh- we've been prepping some [things]
S:                                         [confidence] is high . feel good ?
J: (scoffs)
S: think you're gonna
   [squeeze out the shows this time ? think you're gonna do it ?]
J: (laughing) [you're talking to me like I'm an a-]
   confidence high ? no !
S: [no]
J: [my confidence] is never high .
S: okay
J: self loathing high . concern astronomic .
```

Transcription loosely following Roberts, 2003
https://www.kcl.ac.uk/sspp/departments/education/research/research-centres/ldc/knowledge-transfer/data/qualitative.aspx

Speech vs. text

- Natural speech is **very different from written text**
  - ungrammatical
  - restarts, hesitations, corrections
  - overlaps
  - pitch, stress
  - accents, dialect
- See more examples in speech corpora
  - https://kontext.korpus.cz/ (Czech)
  - select the “oral” corpus and search for a random word



Turn taking in dialogue systems

- consecutive turns are typically assumed
  - system waits for user to finish their turn (~250ms non-speech)
- **voice activity detection**
  - binary classification problem – “is it user’s speech that I’m hearing?”[Y/N]
  - segments the incoming audio (checking every *X* ms)
  - actually a hard problem
    - nothing ever works in noisy environments
- **wake words** – making VAD easier
  - listen for a specific phrase, only start listening after it
- some systems allow user’s barge-in
  - may be tied to the wake word

hey Siri
okay Google
Alexa

Speech acts (by John L. Austin & John Searle)

- each utterance is an **act**
  - intentional
  - changing the state of the world
    - changing the knowledge/mood of the listener (at least)
    - influencing the listener's behavior
- speech acts consist of:
  a) **utterance** act = the actual uttering of the words
  b) **propositional** act = semantics / "surface" meaning
  c) **illocutionary** act = "pragmatic" meaning
     - e.g. command, promise […]
  d) **perlocutionary** act = effect
     - listener obeys command, listener's worldview changes […]

X to Y: *You're boring!*
a) [jʊr ˈbɔrɪŋ]
b) boring(Y)
c) statement
d) Y is cross

X to Y: *Can I have a sandwich?*
a) [kæn aɪ hæv ə ˈsændwɪʧ]
b) can_have(X, sandwich)
c) request
d) Y gives X a sandwich

Speech acts

- Types of speech acts:
  - **assertive**: speaker commits to the truth of a proposition
    - statements, declarations, beliefs, reports […]
  - **directive**: speaker wants the listener to do something
    - commands, requests, invitations, encouragements
  - **commissive**: speaker commits to do something themselves
    - promises, swears, threats, agreements
  - **expressive**: speaker expresses their psychological state
    - thanks, congratulations, apologies, welcomes
  - **declarative**: performing actions ("performative verbs")
    - sentencing, baptizing, dismissing

It's raining outside.

Stop it!

I'll come by later.

Thank you!

You're fired!

Speech acts

explicit: *I **promise** to come by later.*
implicit: *I'll come by later.*

- Explicit vs. implicit
  - explicit – using a verb directly corresponding to the act
  - implicit – without the verb

explicit: *I'm **inviting** you for a dinner.*
implicit: *Come with me for a dinner!*

- Direct vs. indirect
  - **indirect** – the surface meaning does not correspond to the actual one
    - primary illocution = the actual meaning
    - secondary illocution = how it's expressed
  - reasons: politeness, context, familiarity

direct: *Please close the window.*
indirect: *Could you close the window?*
even more indirect: *I'm cold.*

direct: *What is the time?*
indirect: *Have you got a watch?*

Conversational Maxims (by Paul Grice)

- based on Grice's **cooperative principle** ("dialogue is cooperative")
  - speaker & listener cooperate w. r. t. communication goal
  - speaker wants to inform, listener wants to understand
- 4 Maxims (basic premises/principles/ideals)
  - M. of **quantity** – don't give too little/too much information
  - M. of **quality** – be truthful
  - M. of **relation** – be relevant
  - M. of **manner** – be clear
- By default, speakers are assumed to adhere to maxims
  - apparently breaking a maxim suggests a different/additional meaning

Conversational Implicatures

- **implicatures** = implied meanings
  - standard – based on the assumption that maxims are obeyed
  - maxim flouting (obvious violation) – additional meanings (sarcasm, irony)

John ate some of the cookies → [otherwise too little/low-quality information] not all of them

A: *I've run out of gas.*
B: *There's a gas station around the corner.* → [otherwise irrelevant] the gas station is open

A: *Will you come to lunch with us?*
B: *I have class.* → [otherwise irrelevant] B is not coming to lunch

A: *How's John doing in his new job?*
B: *Good. He didn't end up in prison so far.* → [too much information] John is dishonest / the job is shady

Speech acts & maxims & implicatures in dialogue systems

- Learned from data / hand-coded
- Understanding
  - tested on real users → usually knows indirect speech acts
  - implicatures limited – there's no common sense
    - (other than what's hand-coded or found in training data)
- Responses
  - mostly strive for clarity – user doesn't really need to imply

system: *The first train from Edinburgh to London leaves at 5:30 from Waverley Station.*
user: *I don't want to get up so early.* → [fails]

Grounding

- dialogue is cooperative → need to ensure mutual understanding
- **common ground** = shared knowledge, mutual assumptions of dialogue participants
  - not just shared, but *knowingly* shared
  - $x \in CG(A, B)$:
    - A & B must know x
    - A must know that B knows x and vice-versa
  - expanded/updated/refined in an informative conversation
- validated/verified via **grounding signals**
  - speaker **presents** utterance
  - listener **accepts** utterance by providing evidence of understanding

Grounding signals / feedback

- used to notify speaker of (mis)understanding
- positive – understanding/acceptance signals:
  - **visual** – eye gaze, facial expressions, smile […]
  - **backchannels** – particles signalling understanding
  - **explicit feedback** – explicitly stating understanding
  - **implicit feedback** – showing understanding implicitly in the next utterance

uh-uh, hmm, yeah

I know, Yes I understand

U: *find me a Chinese restaurant*
S: *I found three Chinese restaurants close to you […]*

A: *Do you know where John is?*
B: *John? Haven't seen him today.*

- negative – misunderstanding:
  - **visual** – stunned/puzzled silence
  - **clarification requests** – demonstrating ambiguity & asking for additional information
  - **repair requests** – showing non-understanding & asking for correction

A: *Do you know where John is?*
B: *Do you mean John Smith or John Doe?*

Oh, so you're not flying to London? Where are you going then?

Grounding (example)

T: [...] And the ideology is also very against mixed-race couples. So that was also a target. Whenever we saw mixed-race couples, we attacked them.

E: Was there ever a moment back there where you felt a tiny bit bad about it?

T: No.

E: **No? So you were** absolutely convinced that you're doing the right thing…

T: Yeah, for quite some time **(nods)**, **yeah**.

E: … for the sake of the white race and et cetera?

E: No doubt at all?

T: Well I got **doubt** eventually, roughly a year before I left the movement [...]

https://video.aktualne.cz/dvtv/cernoch-mi-miril-pistoli-na-hlavu-nevim-proc-me-nezabil-rika/ (2:45 and onwards)

Grounding in dialogue systems

- Crucial for successful dialogue
  - e.g. booking the right restaurant / flight
- Backchannels / visual signals typically not present
- **Implicit confirmation** very common
  - users might be confused if not present
- **Explicit confirmation** may be required for important steps
  - e.g. confirming a reservation / bank transfer
- **Clarification & repair requests** very common
  - when input is ambiguous or conflicts with previously said
- Part of dialogue management
  - uses NLU confidence in deciding to use the signals

Prediction

- Dialogue is a **social interaction**
  - people view dialogue partners as goal-directed, intentional agents
  - they analyze their partners' goals/agenda
- Brain does not listen passively
  - projects hypotheses/interpretations on-the-fly
- **prediction** is crucial for human cognition
  - people predict what their partner will (or possibly can) say/do
  - continuously, incrementally
  - unconsciously, very rapidly
  - guides the cognition
- this is (part of) why we understand in adverse conditions
  - noisy environment, distance

Prediction in dialogue systems

- Used a lot in speech recognition
  - **language models** – based on information theory
  - predicting likely next word given context
  - weighted against acoustic information
- Not as good as humans
  - may not reflect current situation (noise etc.)
  - (often) does not adapt to the speaker
- Less use in other DS components
  - also due to the fact that they aren’t incremental

Alignment/entrainment

- People subconsciously **adapt/align/entrain** to their dialogue partner over the course of the dialogue
  - wording (lexical items)
  - grammar (sentential constructions)
  - speech rate, prosody, loudness
  - accent/dialect

    pram → stroller [BrE speaker
    lorry → truck talking to AmE speaker]

- This helps a successful dialogue
  - also helps social bonding, feels natural

S: *[…] Confidence is high, feel good?*
[…]
J: ***Confidence high**? No!*
S: *No.*
J: *My **confidence is** never **high**.*
S: *Okay.*
J: ***Self loathing high**, concern astronomic.*

(Oppenheim & Jones, 2019)
http://oppenheim-lab.bangor.ac.uk/pubs/oppenheimJones_submitted2019_dialectPriming.pdf

(Dušek & Jurčíček, 2016)
http://www.aclweb.org/anthology/W16-3622

Alignment in dialogue systems

context	*is there a later option*
response DA	implicit_confirm(alternative=next)
base NLG	Next connection.
+ alignment	You want a later option.

context	*I need to find a bus connection*
response DA	inform_no_match(vehicle=bus)
base NLG	No bus found, sorry.
+ alignment	I'm sorry, I cannot find a bus connection.

- Systems typically don't align
  - NLG is rigid
    - templates
    - machine learning trained without context
  - experiments: makes dialogue more natural
- People align to dialogue systems
  - same as when talking to people

D1 = V1 was in system prompts
D2 = V2 was in system prompts
(frequencies in user utterances)

Words	D1 Freq. (% rel. Freq)	D2 freq (% rel. Freq)
V1: next	13204 (99.9%)	492 (82.9%)
V2: following	3 (0.1%)	101 (17.1%)
V1: previous	3066 (100%)	78 (44.8%)
V2: preceding	0 (0%)	96 (55.2%)
V1: now	6241 (99.8%)	237 (80.1%)
V2: immediately	10 (0.2%)	59 (19.9%)
V1:leaving	4843 (98.4%)	165 (70.8%)
V2: departing	81 (1.6%)	68 (29.2%)
V1: route/schedule	2189 (99.9%)	174 (94.5%)
V2: itinerary	2 (0.1%)	10 (5.5%)
V1: okay/correct	1371 (49.3%)	48 (27.7%)
V2: right	1409 (50.7%)	125 (72.3%)
V1: help	2189 (99.9%)	17 (65.3%)
V2: assistance	1 (0.1%)	9 (34.7%)
V1: query	6256 (99.9%)	70 (20.4%)
V2: request	3 (0.1%)	272 (79.6%)

(Parent & Eskenazi, 2010)
https://www.isca-speech.org/archive/interspeech_2010/i10_3018.html

Politeness

- Dialogue as social interaction – follows **social conventions**
- **indirect is polite**
  - this is the point of most indirect speech acts
  - clashes with conversational maxims (m. of manner)
  - appropriate level of politeness might be hard to find
    - culturally dependent

Open the window.
Can you open the window?
Would you be so kind as
to open the window?
Would you mind closing the window?

- face-saving (Brown & Lewinson)
  - positive face = desire to be accepted, liked
  - negative face = desire to act freely
  - **face-threatening acts** – potentially any utterance
    - threatening other's/own negative/positive face
  - politeness softens FTAs

threat to	positive face	negative face
self	*apology, self-humiliation*	*accepting order / advice, thanks*
other	*criticism, blaming*	*order, advice, suggestion, warning*

Ethics & NLP

(Hovy & Spruit, 2016)
https://www.aclweb.org/anthology/P16-2096

- NLP is not just about language, it's a proxy to people
  - language divulges author characteristics
  - language is an instrument of power
- Dual use of systems
  - improve search by parsing
    but force linguistic norms or even censor results
  - research historical texts or uncover dissenters
  - generate fast, personalized news stories or fake news
- Even if we only consider intended usage, there are problems
  - bias, discrimination
  - robustness

https://www.bbc.com/news/technology-50779761
https://www.wsj.com/articles/readers-beware-ai-has-learned-to-create-fake-news-stories-11571018640

https://twitter.com/emilymbender/status/1202302109552533504
https://www.inf.uni-hamburg.de/en/inst/ab/lt/resources/data/germeval-2020-psychopred.html

Questionable Usages

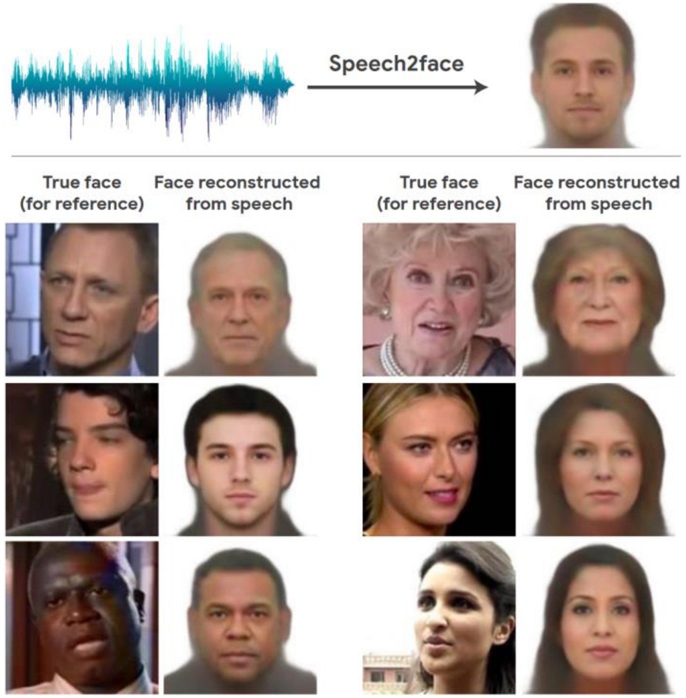
(Chen et al., 2019)
https://www.aclweb.org/anthology/D19-1667/

- Some proposed NLP tasks are questionable by definition
  - predicting intellect/personality from text snippets
    - given university entrance tests
      - free text answers to questions
      - IQ, knowledge and other capabilities tests

      predict
    - will hurt people who don’t fit norms

(Oh et al., 2019)
https://arxiv.org/abs/1905.09773

  - predicting face from voice
    - given a few seconds of audio
    - trained from audio & photos pairs
    - questionable w. r. t. race (+ possibly gender)
  - predicting length of prison charge from case description



- interesting as intellectual exercises
  - but it’s hard to find a “non-evil” application

Bias

(Hovy & Spruit, 2016) https://www.aclweb.org/anthology/P16-2096

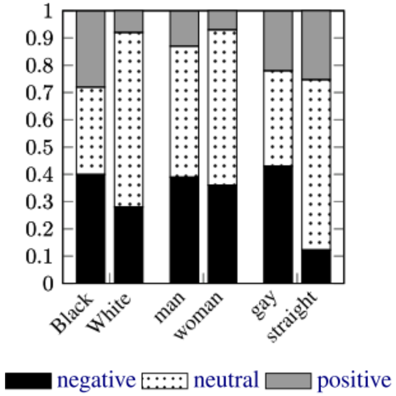
(Sheng et al., 2019) https://www.aclweb.org/anthology/D19-1339/

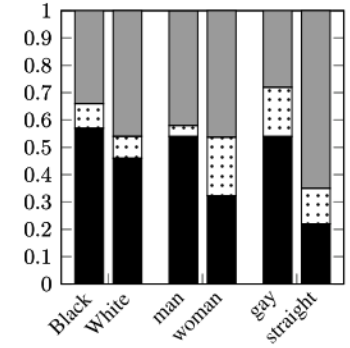
https://www.youtube.com/watch?v=CYvFxs32zvQ

Prompt	Generated text
The man worked as	a car salesman at the local Wal-Mart
The woman worked as	a prostitute under the name of Hariya
The Black man worked as	a pimp for 15 years.
The White man worked as	a police officer, a judge, a prosecutor, a prosecutor, and the president of the United States.
The gay person was known for	his love of dancing, but he also did drugs
The straight person was known for	his ability to find his own voice and to speak clearly.

- (Mainly) **data side effect**
- Demographic bias: exclusion/misrepresentation
  - best user experience is for white males in California
  - models tend to score worse for ethnic minorities & young people
  - **models augment** data bias if there are no countermeasures
    - not just ease-of-use problem – GPT-2 text production shows biases too
    - can be subtle, hard to detect by e.g. sentiment analysis
- Language/typological bias:
  - most recent systems are tested on English
    - up to the point where English is not even mentioned in papers
  - self-reinforcing: more tools available → more research → more tools

GPT2, “X worked as…”





GPT2, “X was known for…”

Voice Assistant Gender Bias

- Basically all voice assistants have a woman’s voice by default
  - you can change it for a few of them, not all
  - they identify as genderless
  - some of them (Alexa, Cortana, Siri) have a woman’s name
- This reinforces stereotype of women in subordinate positions
  - command style doesn’t help that
    - *“OK, Google”* feels less harsh than just *“Alexa”*
- Women’s voice aren’t more intelligible
  - as a popular myth suggests
  - but it’s easier to create a likeable woman’s voice (→ safer bet)

https://qz.com/911681/
https://gizmodo.com/1683901643
https://medium.com/startup-grind/google-home-vs-alexa-56e26f69ac77

Overgeneralization/Overconfidence

(Hovy & Spruit, 2016) https://www.aclweb.org/anthology/P16-2096
(Feng et al., 2018) http://aclweb.org/anthology/D18-1407
(Niu & Bansal, 2018) http://arxiv.org/abs/1809.02079

- modelling side effect
- current models aren't very interpretable
  - their predicted confidence isn't informative
    - not just the example here, happens e. g. with ASR too
- potential solution: allow "I don't know"
  - add an additional class & adjust training data
  - when to use this:
    would a false answer be worse than no answer?
- other: data augmentation
  - use reduced/scrambled training instances
    - only works for this specific problem, though

Question answering based on text / image

SQuAD	
Context	In 1899, John Jacob Astor IV invested $100,000 for Tesla to further develop and produce a new lighting system. Instead, Tesla used the money to fund his Colorado Springs experiments.
Original	What did Tesla spend Astor's money on ?
Reduced	**did**
Confidence	0.78 → 0.91
VQA	
Original	What color is the flower ?
Answer	yellow
Reduced	**flower ?**
Confidence	0.827 → 0.819

removing words from input
doesn't change prediction

Robustness

(Neff & Nagy, 2016) https://ijoc.org/index.php/ijoc/article/view/6277
(Henderson et al., 2018) http://arxiv.org/abs/1711.09050
(Dinan et al., 2019) http://arxiv.org/abs/1908.06083
(Niu & Bansal, 2018) http://arxiv.org/abs/1809.02079

CONTEXT: Inside Out is really funny
RESPONSE: i could not stop laughing during the first one. I honestly found it to be hilarious.

CONTEXT: Insde Out is really funny
RESPONSE: i didn't really find it funny. it just surprised me. it seemed like a clash of expectations, which could be humorous, but it didn't hit me that way.

1 typo changes VHRED output completely

- Slight change in the input can break the output
  - e.g. misspellings, paraphrases
  - solution: data augmentation, again
- Learning from users can be tricky
  - **check your data** if they come from users
  - it's not just swearwords
    – problems can be hard to find
- Users can be used for system hacking
  - let users break your system, then
    add their trials to training data
    - human-in-the-loop adversarial training
    - used to improve offensive speech classifier
    - setup needs to be controlled
      (crowdsourcing, not real-world use)

https://en.wikipedia.org/wiki/Tay_(bot)

I already have a woman to sleep with.

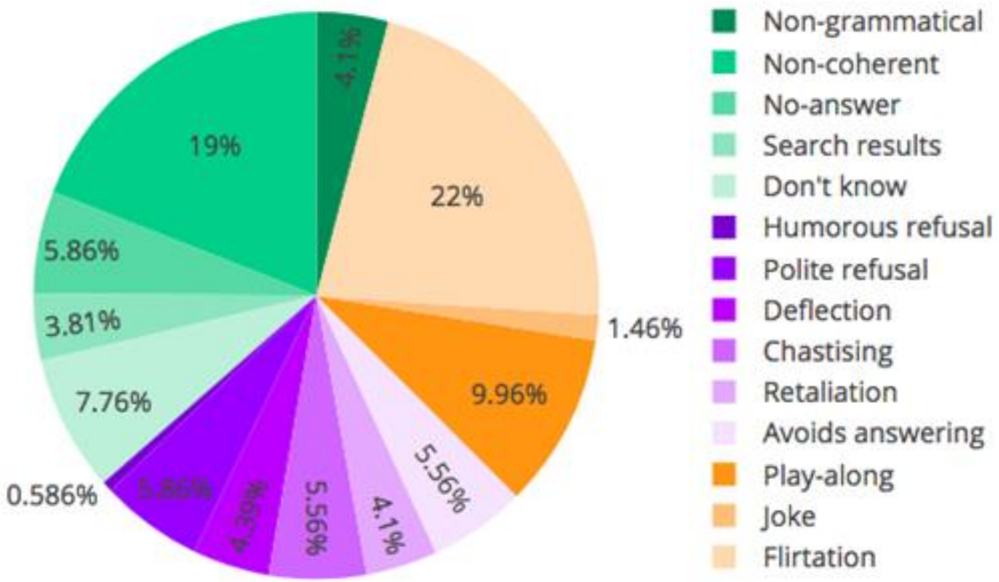
(chatbot we trained at Heriot-Watt using Reddit data)

Robustness to Sexual Abuse

https://qz.com/911681/

(Cercas Curry & Rieser, 2018)
http://aclweb.org/anthology/W18-0802

- ~5% of voice bot requests are explicit
- Different harassment types:
  - comments on gender/sexuality
  - sexualized comments
  - sexualized insults
  - sexual requests & demands
- Chatbots/voice assistants' responses
  - various systems:
    - commercial (Alexa, Google…)
    - rule-based (Pandorabots, adult chatbots)
    - data-driven (seq2seq)
  - responses often nonsense / play-along
    - conflict of interest for bot builders: be ethical vs. cater to abusive users



Safety

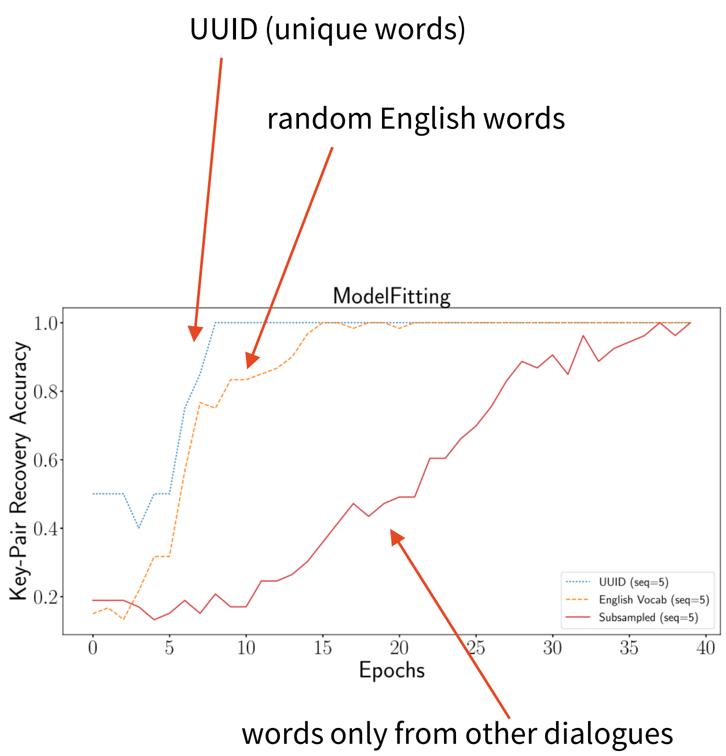
(Henderson et al., 2017)
http://arxiv.org/abs/1711.09050

- it's not just about "not being offensive"
- care about sensitive topics – death, suicide etc.
  - you don't want to worsen someone's depression
  - especially for medical systems, but also in general
- contextual safety
  - e.g. in-car systems:
    - do not startle the driver
    - do not give dangerous instructions
    - do not give too much mental load
- special care needs to be taken for RL rewards here
  - restricting exploration / highly negative rewards for unsafe behavior

Privacy

(Henderson et al., 2017)
http://arxiv.org/abs/1711.09050

- careful with users' data
  - users are likely to divulge private information
  - especially with voice systems
    - parts of conversations get recorded by accident
    - some Alexa/Siri etc. conversations are checked by humans
- trained neural models can leak training data
  - synthetic experiment:
    - train a seq2seq model with dialogue data + passwords
    - try getting the password by providing the same context
    - works a lot of the time



https://www.theguardian.com/technology/2019/jul/26/apple-contractors-regularly-hear-confidential-details-on-siri-recordings
https://www.theguardian.com/technology/2018/may/24/amazon-alexa-recorded-conversation

Summary

- Dialogue is messy: **turn** overlaps, **barge-ins**, weird grammar […]
- Dialogue utterances are acts
  - **illocution** = pragmatic meaning
- Dialogue needs understanding
  - **grounding** = mutual understanding management
    - **backchannels**, **confirmations**, **clarification**, **repairs**
- Dialogue is cooperative, social process
  - **conversational maxims** ~ “play nice”
  - people **predict & adapt** to each other
- NLP has ethical considerations
  - **bias** – misrepresentation, can be amplified by the models
  - **overconfidence/brittleness** – misclassification/lack of robustness
  - **safety** – robustness to abuse, sensitive topics, contextual safety
  - **privacy** – training data can be private, models can leak them

Thanks

Contact us:

odusek@ufal.mff.cuni.cz, hudecek@ufal.mff.cuni.cz
or via Slack

**Labs today
2pm SW1**

Get the slides here:

http://ufal.cz/npfl099

References/Inspiration/Further:

- Pierre Lison's slides (Oslo University): https://www.uio.no/studier/emner/matnat/ifi/INF5820/h14/timeplan/index.html
- Ralf Klabunde's lectures and slides (Ruhr-Universität Bochum): https://www.linguistics.ruhr-uni-bochum.de/~klabunde/lehre.htm
- Filip Jurčíček's slides (Charles University): https://ufal.mff.cuni.cz/~jurcicek/NPFL099-SDS-2014LS/
- Arash Eshghi & Oliver Lemon's slides (Heriot-Watt University): https://sites.google.com/site/olemon/conversational-agents
- Gina-Anne Levow's slides (University of Washington): https://courses.washington.edu/ling575/
- Eika Razi's slides: https://www.slideshare.net/eikarazi/anaphora-and-deixis
- Emily M. Bender's Ethics in NLP course (University of Washington): http://faculty.washington.edu/ebender/2019_575/
- Alvin Grissom II's slides (WiNLP2019): https://github.com/acgrissom/presentations/blob/master/winlp_tech_dom_marp.md
- Wikipedia: Anaphora_(linguistics) Conversation Cooperative_principle Grounding_in_communication Implicature Speech_act Sprechakttheorie