Dialogue Systems

NPFL123 Dialogové systémy

3. Data & Evaluation

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Before you build a dialogue system

Two significant questions, regardless of system architecture:

1) **What data** to base it on?
   - even if you handcraft, you need data
     - people behave differently
     - you can't enumerate all possible inputs off the top of your head
   - ASR can't be handcrafted – always needs data

2) **How to evaluate** it?
   - is my system actually helpful?
   - did recent changes improve/worsen it?
   - actually the same problem as data
     - you can't think of all possible ways to talk to your system

Data: Corpus (pl. Corpora)

- **Corpus** = **collection of** (linguistic) **data**
  - assuming access for automatic processing
  - used to train your system / inform yourself
  - also called **dataset**
- Some of them are released openly
  - usage rights depend on a **license**
  - e.g. Creative Commons
    - BY (attribution) – SA (share alike) – NC (non-commercial) – ND (no derivatives)
- Useful for linguistic research/description, too

Definition of *corpus* in English:

https://en.oxforddictionaries.com/definition/corpus

corpus

NOUN

1 A collection of written texts, especially the entire works of a particular author writing on a particular subject.
'the Darwinian corpus'

+ More example sentences + Synonyms

1.1 A collection of written or spoken material in machine-readable form, ass
purpose of linguistic research

WORD SKETCH ACL Anthology Reference Corpus (ARC)

corpus as noun 142,171×

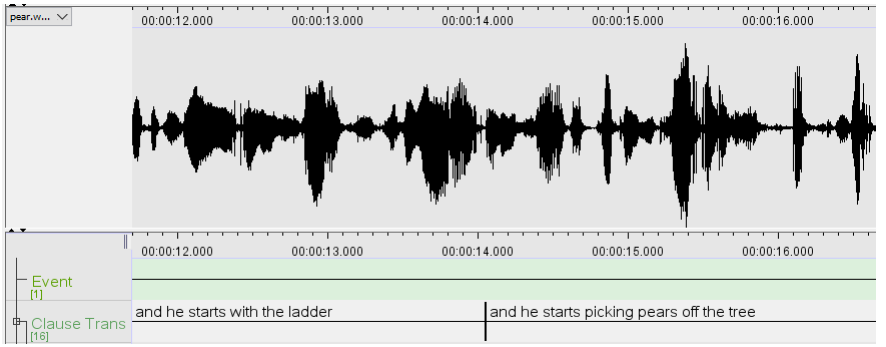
modifiers of "corpus"	nouns modified by "corpus"	verbs with "corpus" as object	verbs with "corpus" as subject
parallel parallel corpus	statistic corpus statistics	annotate annotated corpus	contain corpus contains
training the training corpus	size corpus size	tag tagged corpus	consist corpus consists of
large large corpus	study a corpus study	use	use corpus using
comparable comparable corpora	frequency corpus frequency	align aligned corpus	be corpus is

https://app.sketchengine.eu/#open

Dialogue Corpora/Dataset Types

- **modality**: written / spoken / multimodal
- **data source**:
  - human-human conversations
    - real dialogues
    - scripted (e.g. movies)
  - human-machine (talking to a dialogue system)
  - automatically generated ("machine-machine")
- **domain**
  - closed/constrained/limited domain
  - open domain (any topic, chitchat)

https://tla.mpi.nl/tools/tla-tools/elan/



INDY: Let's get out of here!
MARION: Not without that piece you want!
INDY: It's here?
Marion nods, kicks aside a burning chair. Another burning beam falls from the roof. Indy close to him protectively.
INDY: Forget it! I want you out of here. Now! *He begins dragging her out.*
MARION: *pointing.* There! *She breaks away from him, darts back and picks the hot medal loose cloth of her blouse.*
INDY: Let's go!
MARION: (looking around) You burned down my place!
INDY: I owe you plenty!

Walker et al., LREC 2012

Scenario:

Determine the type of aircraft used on a flight from Cleveland to Dallas that leaves before noon.

x02011sx: may i see all the flights from cleveland to , dallas

x02021sx.sro: can you show me the flights that leave before noon , only

x02031sx.sro: could you sh- please show me the types of aircraft used on these flights

Dahl et al., ARPA-HLT 1994

Dialogue Data Collection

Typical options:

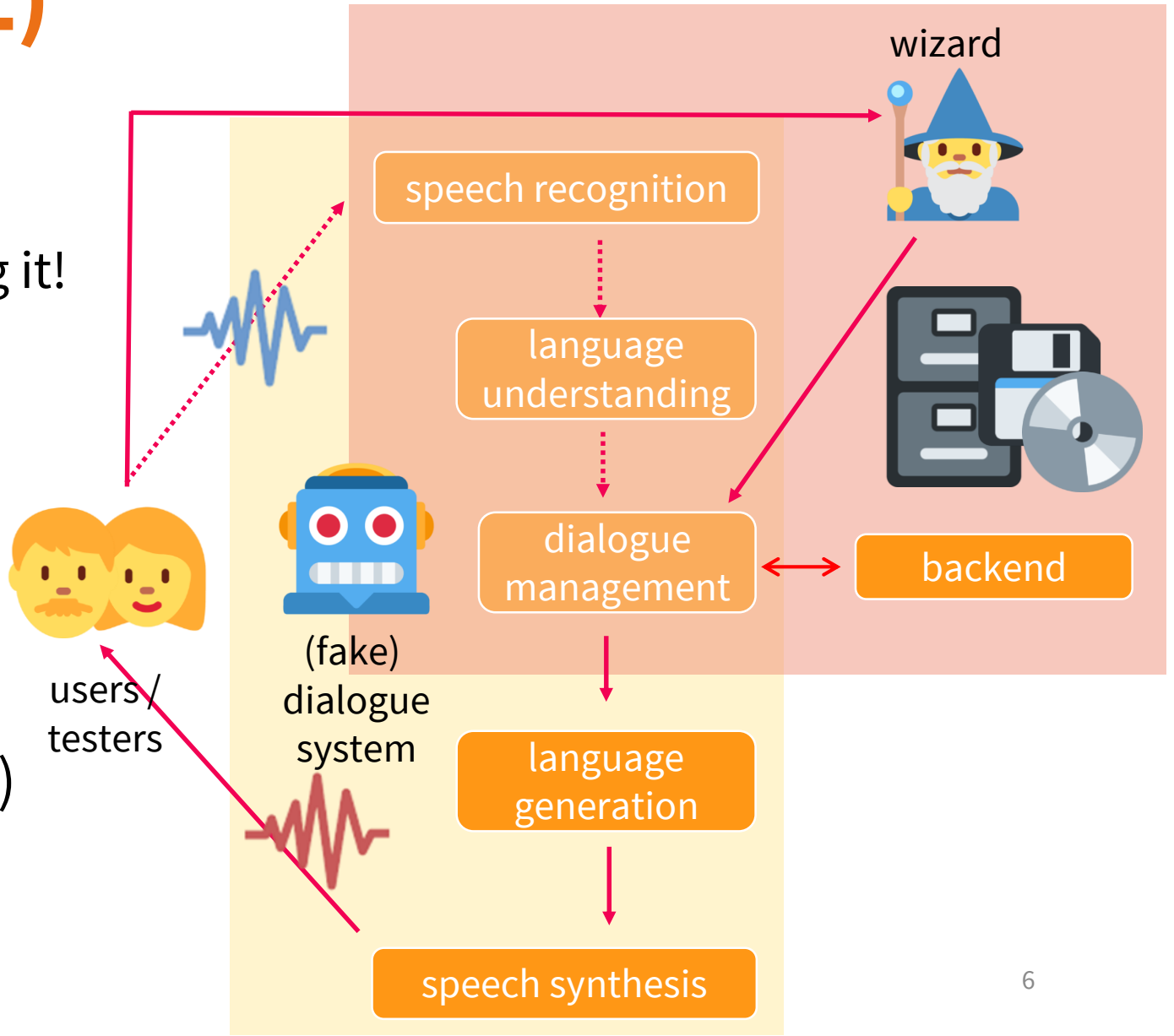
- **in-house collection** using experts (or students)
  - safe, high-quality, but very expensive & time-consuming
  - scripting whole dialogues / Wizard-of-Oz

- **web crawling**
  - fast & cheap, but typically not real dialogues
    - may not be fit for purpose
  - potentially unsafe (offensive stuff)
  - need to be careful about the licensing

- **crowdsourcing**
  - compromise: employing (untrained) people over the web

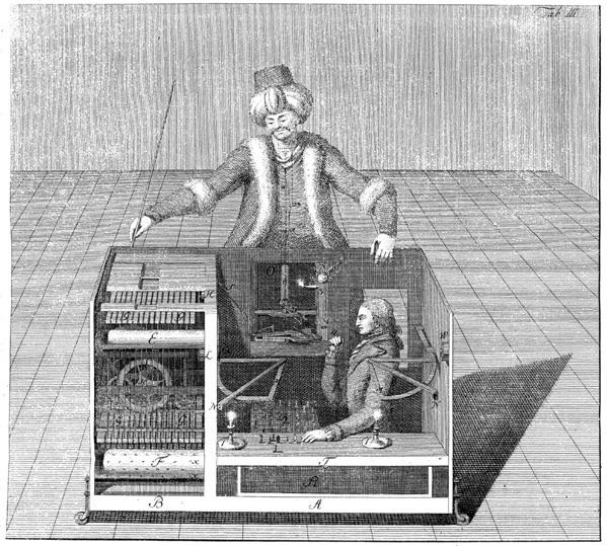
Wizard-of-Oz (WoZ)

- for in-house data collection
  - also: to prototype/evaluate a system before implementing it!
- users believe they're talking to a system
  - different behaviour than when talking to a human
  - typically simpler
- system **in fact controlled by a human "wizard"** (=you)
  - typically selecting options (free typing too slow)

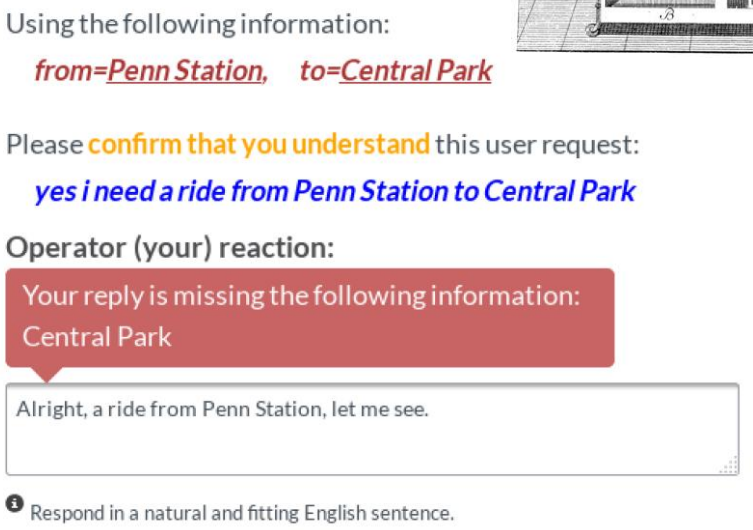


Crowdsourcing

https://en.wikipedia.org/wiki/The_Turk



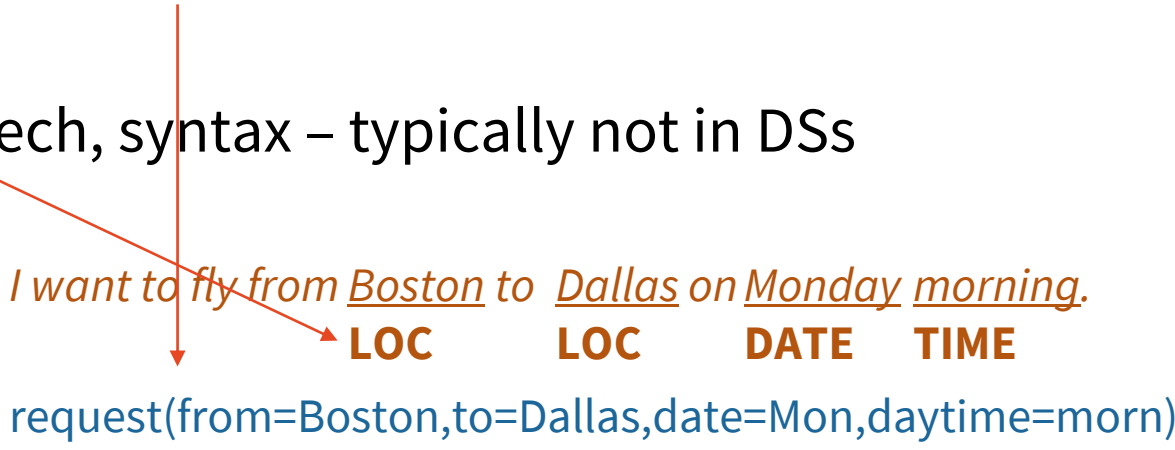
- **hire people over the web**
  - create a webpage with your task
    - data collection / evaluation
  - no need for people to come to your lab
  - faster, larger scale, cheaper
- **platforms**/marketplaces
  - Amazon Mechanical Turk
  - CrowdFlower/FigureEight
- problems
  - can't be used in some situations (physical robots, high quality audio…)
  - **crowd workers tend to game the system** – noise/lower quality data
  - a lot of English speakers, but forget about e.g. Czechs



Dušek & Jurčíček, RE-WOCHAT 2016

Corpus Annotation

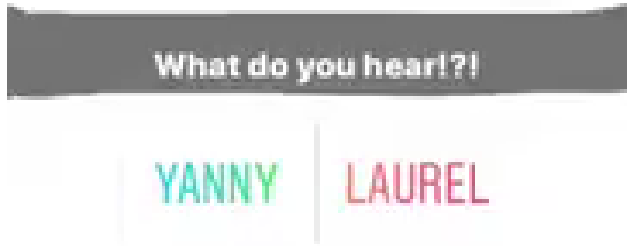
- more often than not, you'll need more than just recordings
- **annotation** = labels, description added to the collected data:
  - **transcriptions** (textual representation of audio, for ASR&TTS)
  - **semantic annotation** such as dialogue acts (NLU)
  - **named entity** labelling (NLU)
  - other linguistic annotation: part-of-speech, syntax – typically not in DSs
- getting annotation
  - similar task as getting the data itself
  - DIY / hiring **experts**
  - **crowdsourcing**
  - (semi-)**automatic** annotation
    - use rules + manual fixes, annotate small dataset & use machine learning for the rest



Inter-annotator Agreement (IAA)

https://twitter.com/CloeCouture/status/996218489831473152
https://www.vox.com/2018/5/15/17357684/yanny-or-laurel-audio

- annotation is **inherently ambiguous**
  - people sometimes don't even hear the same thing
  - let alone interpret the same semantics
- need to test if it's reasonably **reliable** – **measuring IAA**
  - 2 or more people annotate/transcribe the same thing
  - need to account for agreement by chance
    - transcriptions – too many options (words) – no big deal
    - NER – just a few categories (e.g. 7) – may play a role
- typical measure: **Cohen's Kappa** ($0<\kappa<1$)
  - for categorial annotation
  - 0.4 ~ fair, >0.7 ~ great



$$\kappa = \frac{\text{agreement} - \text{chance}}{1 - \text{chance}}$$

Corpus Size

- Size matters here
  - need enough examples for an accurate model
  - depends on what and how you're modelling
- Speech – 10s-100s of hours
- NLU, DM, NLG
  - handcrafting – 10s-100s of dialogues may be OK to inform you
  - simple model/limited domain – 100s-1000s dialogues might be fine
  - open domain – sky's the limit
- TTS – single person, several hours at least

Available Dialogue Datasets

- There's a number of research datasets available
  - typically built as part of various research projects
  - license: some of them research-only, some completely free
- Drawbacks:
  - domain choice is rather limited
  - size is very often not enough – big AI firms have much more
  - vast majority is English only
  - few free datasets with audio
    - but there are non-dialogue ones (see http://www.openslr.org/)

Dialogue Datasets: Human-Machine

For NLU, state tracking, (possibly) DM:

- **Dialogue state tracking challenges (DSTC)**
  - real systems, single domain
  - DSTC1 Let's go – bus information
  - DSTC2/3 Cambridge restaurants
- **ATIS** – WoZ, flight booking (90's)
- Maluuba **Frames** – WoZ travel booking

DSTC1 (Let's go)
Williams et al. SIGDIAL 2013

SYS: East Pittsburgh Bus Schedules. Say a bus route, like 28X, or say I'm not sure.
USR: *61A*
SYS: Okay, 61A. To change, say go back. Where are you leaving from?
USR: *Downtown*
SYS: Okay, downtown. You can always say go back. And where are you going to?

S: Clown café is a cheap restaurant in the north part of town.	S: Which part of town? *request(area)*
U: Do you have any others like that, maybe in the south part of town? *reqalts(area=south)*	U: A cheap place in the north *inform(area=north, pricerange=cheap)*

DSTC2 (Restaurants)
Henderson et al. SIGDIAL 2014

User	I'd like to book a trip to boston from London on Saturday, August 13, 2016 for 8 adults. I have a tight budget of 1700.	Frame #1
Act 1	**inform**(intent=book)	
Act 2	**inform**(dst_city = boston, or_city = London, str_date = Saturday\, August 13\, 2016, n_adults = 8, budget = 1700)"	
Wizard	"Hi...I checked a few options for you, and unfortunately, we do not currently have any trips that meet this criteria. Would you like to book an alternate travel option?"	Frame #1
Act 1	**no_result**	
Act 2	**suggest**(dst_city)	

Maluuba Frames
https://datasets.maluuba.com/Frames

Show	*flights*	*from*	*Boston*	*to*	*New*	*York*	*today*
O	O	O	**B-dept**	O	**B-arr**	**I-arr**	**B-date**

ATIS
https://chsasank.github.io/spoken-language-understanding.html

Datasets: Human-Human Spoken

Spontaneous:

- **Switchboard**
  - 260hr phone conversations
  - 2 people randomly connected to chat on a given topic
  - speech + transcription, but basic intent annotation also available
- **Callfriend**
  - phone conversations, just speech + transcription
  - friends calling each other
  - available for several languages

[backchannel] B.22 utt1: *Uh-huh. /*
[statement, non-opinion] A.23 utt1: *I work off and on just temporarily and usually find friends to babysit, /*
[statement, non-opinion] A.23 utt2: *{C but } I don't envy anybody who's in that <laughter> situation to find day care. /*
[backchannel] B.24 utt1: *Yeah. /*

Switchboard http://compprag.christopherpotts.net/swda.html

*S1: you there Dick
*S2: yeah
*S1: ok
*S2: what's going on ⌈hhh hhh
*S1: ⌊no, it's, uh funny thing, I got this uhh my mother in law called me
*S2: yeah
*S1: and she said said you can make th-the deal you can make free call, anywhere in the us or canada
*S2: yeah
*S1: for a half hour
*S2: yeah
*S1: and another free call anywhere in the world like to uh show off to my sister or whatever
*S2: you're kidd⌈ing
*S1: ⌊also for a half hour

Callfriend
https://ca.talkbank.org/access/CallFriend/

Datasets: Human-Human Spoken

Constrained:

- Walking around
  - over-the-phone navigation
  - used to study dialogue alignment
- Verbmobil
  - business meetings EN–DE
- DSTC4/5
  - tourist-tour guide Skype conversations
- Many more (debates, games, emotions…)

```
I'd> like to get together <#> with you sometime during August
to <;comma> <A> talk to you <#> for <#> about two hours
<;period> <#Klicken>:> <;seos>

YYY001: <#Klicken> <Schmatzen> <A> okay <;period> <;seos> <P> the first
week in August is out <;period> <;seos> I can not <!2 can't>
make any days there <;period> <;seos> <A> but the second week
in <!1 ist> August looks fairly free <;period> <;seos> <A> how
'bout the ninth eleventh or twelfth <;period> <A> <#Klicken>
<#> <;seos>
XXX000: gr"u"s Gott , mein Name ist <!1 is'> G"urtner . ich h"atte
gern<Z> Sie gesprochen , um ein<Z>en <!1 ein'> Termin
auszumachen f"ur ein f"unft"agiges Arbeitstreffen in
Saarbr"ucken . <A> <Ger"ausch> w"urden Sie <Ger"ausch> bereit
sein , +/mi=/+ m<Z>ir ein paar Ausk"unfte zu geben <A> ?

YYY001: hallo , mein Name ist <Ger"ausch> J"ansch , $J $"A $N $S $C $H
. <A> <#> <Schlucken> und <"ah> bei mir w"urde gehen <P> der
Termin vom ersten bis zum<Z> <A> f"unften M"arz .
```

Verbmobil https://www.phonetik.uni-muenchen.de/Bas/BasVM1eng.html

Sub-dialog Segment #2

Guide: Let's try this one, okay?

Tourist: Okay.

Guide: It's InnCrowd Backpackers Hostel in Singapore. If you take
dollars. If you take a room, it's two single beds at fifty nine

Tourist: Um. Wow, that's good.

Guide: Yah, the prices are based on per person per bed or dorm.
fifty nine for the two room. So you're actually paying abou

Tourist: Oh okay. That's- the price is reasonable actually. It's good.

Annotations for Segment #2

{Topic: Accommodation; NAME: InnCrowd Backpackers Hostel; Gui

DSTC4
http://www.colips.org/workshop/dstc4/

Datasets: Human-Human Spoken

Scripted:

- **OpenSubtitles** (OST)
  - movie subtitles from the web
  - 60 languages, 2.6bn sentences
    - parallel – used for translation, too
  - messy
    - turn annotation none or automatic
- **Cornell Movie Dialogs**
  - smaller, English-only
  - cleaner – extracted from movie scripts
    - lines paired with characters
- caveats: lots of swearing, missing visual context

```
<s id="799">
  <time id="T600S" value="00:43:58,262" />
  <w id="799.1">You</w>
  <w id="799.2">'re</w>
  <w id="799.3">a</w>
  <w id="799.4">dead</w>
  <w id="799.5">man</w>
  <w id="799.6">.</w>
  <time id="T600E" value="00:43:59,722" />
</s>
<s id="800">
  <time id="T601S" value="00:43:59,847" />
  <w id="800.1">Bala-Tik</w>
  <w id="800.2">.</w>
</s>
<s id="801">
  <w id="801.1">What</w>
  <w id="801.2">'s</w>
  <w id="801.3">the</w>
  <w id="801.4">problem</w>
  <w id="801.5">?</w>
  <time id="T601E" value="00:44:02,558" />
</s>
```

OST – image from Lison & Meena, SLT 2016
http://opus.nlpl.eu/OpenSubtitles2016.php

```
                    HOLDEN
Don't move.

                    LEON
Sorry.

He tries not to move, but finally his lips can't help
a sheepish smile.

                    LEON
I already had I.Q. test this year...
but I don't think I never had a...

                    HOLDEN
Reaction time is a factor in this so
please pay attention. Answer as quickly
as you can.

                    LEON
Uh... sure...
```

Blade Runner script
http://www.dailyscript.com/scripts/blade-runner_shooting.html

Datasets: Human-Human Written

- easier to get than spoken
  - caveats: specific language, may be offensive

Spontaneous:

- **Twitter**
  - need to mine it yourself (Twitter's business model)
  - dialogues, with short replies and lot of data
- **Reddit**
  - huge dumps exist (https://pushshift.io/ and elsewhere)
  - less dialogue-y (some posts are really long)
- **DailyDialog**
  - crawled from language learning sites
  - cleaner, non-offensive, annotated with emotion & intent
  - much smaller

https://www.reddit.com/r/ukpolitics/comments/as4bbr

A: I'm worried about something.
B: What's that?
A: Well, I have to drive to school for a meeting this morning, and I'm going to end up getting stuck in rush-hour traffic.
B: That's annoying, but nothing to worry about. *Just breathe deeply when you feel yourself getting upset.*

Li et al., ACL 2017
http://yanran.li/dailydialog

Datasets: Human-Human Written

Constrained:

- **Ubuntu dialogue corpus**
  - >1M dialogues, from Ubuntu chat
- **MultiWOZ**
  - 8k dialogues, collected for dialogue systems
  - multiple domains (hotels, restaurants, taxi…)
  - annotated
- other
  - movie dialogues
  - Settlers of Catan
  - …

Time	User	Utterance
03:44	Old	I dont run graphical ubuntu, I run ubuntu server.
03:45	kuja	Taru: Haha sucker.
03:45	Taru	Kuja: ?
03:45	bur[n]er	Old: you can use "ps ax" and "kill (PID#)"
03:45	kuja	Taru: Anyways, you made the changes right?
03:45	Taru	Kuja: Yes.

Lowe et al., SIGDIAL 2015
http://dataset.cs.mcgill.ca/ubuntu-corpus-1.0/

{'train': {'semi': {'arriveBy': '21:15', 'day': 'sunday'}}}

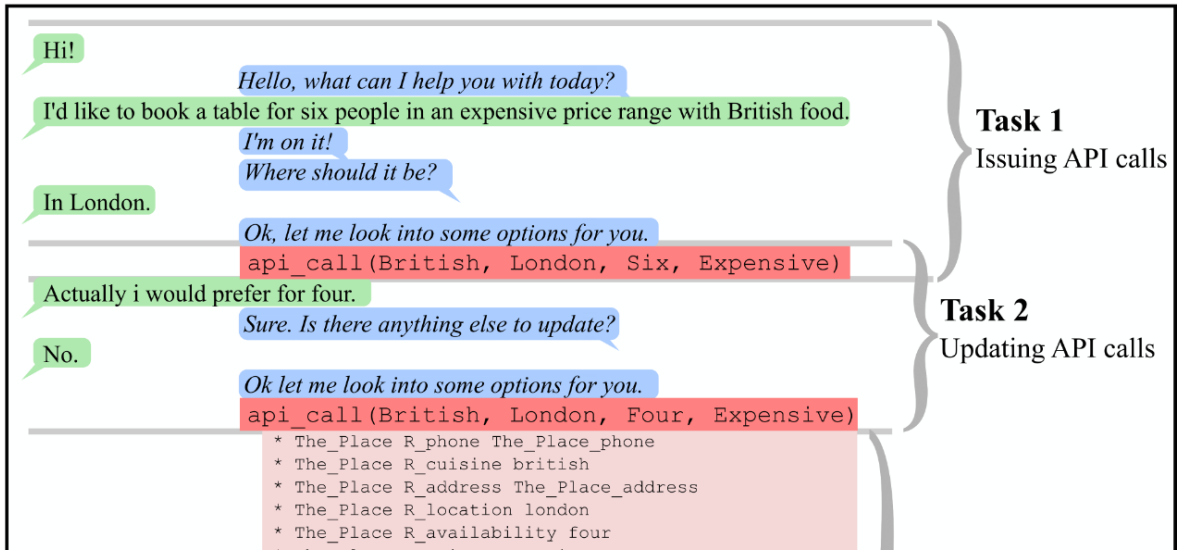
I need a train leaving on a Sunday and arriving by 21:15.
Okay, I can help you with that. Where will you be traveling?
From London Kings Cross to Cambridge.
TR1681 will arrive at 20:08, would that work for you?
Yes, that sounds good. Please book a ticket on TR1681 for 6 people for me.
The booking was successful, your reference number is EAWIQ7HX. Is there anything else I can help you with?

Budzianowski et al., EMNLP 2018
http://dialogue.mi.eng.cam.ac.uk/index.php/corpus/

Dialogue Datasets: Machine Generated

bAbI, Bordes et al., ICLR 2017
https://arxiv.org/abs/1605.07683
https://research.fb.com/downloads/babi/

- Still good for testing dialogue models
  - can the model learn a dataset of this complexity?
- Can be generated in any size
- Facebook **bAbI**
  - various tasks, mainly inference
  - auto-generated restaurant dialogues
- **SimDial**
  - auto-generating dialogues based on domain descriptions



Zhao & Eskenazi, SIGDIAL 2018
https://arxiv.org/pdf/1805.04803.pdf
https://github.com/snakeztc/SimDial

Domain: Restaurant
Sys: Welcome to the restaurant recommendation system. What do you need?
User (0.83): Hello robot. I am looking for a restaurant.
Sys: Which city are you interested in?
User (0.75): I am in San Jose. And Korean. Uhm sorry, I am interested in Chinese food.
Sys: I believe you said San Jose. I believe you said Chinese.
Sys: QUERY goal: restaurant food-pref: Chinese location: San Jose
KB: RET restaurant: 17

NLG Datasets

- Specific – other datasets typically not usable
  - unless you want to generate directly, without explicit NLU & DM
- **Cambridge RNNLG**
  - restaurants, hotels, laptop, TVs (5-10k instances each)
  - crowdsourced, good for delexicalization (template style)
- **E2E NLG data**
  - restaurants, bigger (50k instances)
  - more complex, more messy
  - partially based on images to get more diversity

RNNLG Wen et al., NAACL 2016
http://arxiv.org/abs/1603.01232

inform(type=restaurant;count='2';food=basque;kidsallowed=no;price range=moderate)
there are 2 restaurant -s where no child -s are allowed in the moderate price range and serving basque food

?request(near)
where would you like it to be near to

Loch Fyne is a kid-friendly restaurant serving cheap Japanese food.

Serving low cost Japanese style cuisine, Loch Fyne caters for everyone, including families with small children.

name [Loch Fyne], eatType[restaurant], food[Japanese], price[cheap], kid-friendly[yes]

E2E Novikova et al., SIGDIAL 2017
http://www.macs.hw.ac.uk/InteractionLab/E2E/

Dialogue System Evaluation

- Depends on dialogue system type / specific component
- Types:
  - **extrinsic** = how the system/component works in its intended purpose
  - x • effect of the system on something outside itself, in the real world (i.e. user)
  - **intrinsic** = checks properties of systems/components in isolation, self-contained
  - **subjective** = asking users' opinions, e.g. questionnaires (~manual)
  - x • should be more people, so overall not so subjective ☺
  - **objective** = measuring properties directly from data (~automatic)
    - might or might not correlate with users' perception
- Evaluation discussed here is mostly **quantitative**
  - i.e. measuring & processing numeric values
  - (*qualitative* ~ e.g. in-depth interviews, more used in social science)

Getting the Subjects
(for extrinsic evaluation)

- Can't do without people
  - **simulated user** = another (simple) dialogue system
    - can help & give guidance sometimes, but it's not the real thing – more for intrinsic
- **In-house** = ask people to come to your lab
  - students, friends/colleagues, hired people
  - expensive, time-consuming, doesn't scale (difficult to get subjects)
- **Crowdsourcing** = hire people over the web
  - much cheaper, faster, scales (unless you want e.g. Czech)
  - not real users – mainly want to get their reward
- **Real users** = deploy your system and wait
  - best, but needs time & advertising & motivation
  - you can't ask too many questions

Extrinsic – Task-Oriented (Objective)

How to measure:

1) **Record people** while interacting with your system
2) **Analyze the logs**

Metrics:

- **Task success** (boolean): did the user get what they wanted?
  - testers with agenda → check if they found what they were supposed to
    - [warning] sometimes people go off script
  - basic check: did we provide any information at all? (any bus/restaurant)
- **Duration**: number of turns (fewer is better here)
- Other: % returning users, % turns with null semantics …

Extrinsic – Task-Oriented (Subjective)

- **Questionnaires** for users/testers
  - based on what information you need
- Question types
  - **Open-ended** – qualitative
  - **Yes/No** questions
  - **Likert scales** – agree … disagree (typically 3-7 points)
    - with a middle point (odd number) or forced choice (even number)
- Question guidelines:
  - easy to understand
  - not too many
  - neutral: not favouring/suggesting any of the replies

Extrinsic – Task-Oriented (Subjective)

Example questions:

- **Success rate:** Did you get all the information you wanted?
  - typically different from objective measures!
- **Future use:** Would you use the system again?
- **ASR/NLU**: Do you think the system understood you well?
- **NLG**: Were the system replies fluent/well-phrased?
- **TTS**: Was the system's speech natural?

System	# calls	Subjective Success Rate	Objective Success Rate
HDC	627	82.30% (±2.99)	62.36% (±3.81)
NBC	573	84.47% (±2.97)	63.53% (±3.95)
NAC	588	89.63% (±2.46)	66.84% (±3.79)
NABC	566	90.28% (±2.44)	65.55% (±3.91)

Jurčíček et al., Comp. Speech & Language 2012

Extrinsic – Non-Task-Oriented

Objective metrics:

- **Duration** – most common, easiest to get
  - longer = better here
- other (non-standard):
  - % returning users
  - checks for users swearing vs. thanking the system

Subjective:

- Future use + other same as task-oriented (except task success)
- **Likeability/Engagement**: Did you enjoy the conversation?

Intrinsic – ASR

- **Word error rate**
  - ASR output (hypothesis) compared to human-authored reference

$$\text{WER} = \frac{\#\text{substitutions} + \#\text{insertions} + \#\text{deletions}}{\text{reference length}}$$

  - ~ length-normalized edit distance (**Levenshtein distance**)
  - sometimes insertions & deletions are weighted 0.5x
  - can be >1
  - assumes one correct answer

true: **I** want a **restaurant**
ASR: want a **rest** **or** **rant**

WER = 1 + 2 + 1 / 4 = 1

Intrinsic – NLU

- Slot **Precision** & **Recall** & **F-measure** (F1)

(F1 is evenly balanced & default, other F variants favor *P* or *R*)

precision $$P = \frac{\#\text{correct slots}}{\#\text{detected slots}}$$

how much of the identified stuff is identified correctly

recall $$R = \frac{\#\text{correct slots}}{\#\text{true slots}}$$

how much of the true stuff is identified at all

F-measure $$F = \frac{2PR}{P + R}$$

harmonic mean – you want both *P* and *R* to be high (if one of them is low, the mean is low)

true: inform(name=Golden Dragon, food=Chinese)
NLU: inform(name=Golden Dragon, food=Czech, price=high)

P = 1 / 3
R = 1 / 2
F = 0.2

Intrinsic – NLU

- **Accuracy** (% correct) used for intent/act type
  - alternatively also **exact matches** on the whole semantic structure
    - easier, but ignores partial matches
- Again, one true answer assumed
- NLU on ASR outputs vs. human transcriptions
  - both options make sense, but measure different things!
  - intrinsic NLU errors vs. robustness to ASR noise

Intrinsic – Dialogue Manager

- Objective measures (task success rate, duration) can be measured with a **user simulator**
  - works on dialogue act level
  - responds to system actions

- Simulator implementation
  - **handcrafted** (rules + a bit of randomness)
  - ***n*-gram** models over DA/dialogue turns + sampling from distribution
  - **agenda-based** (goal: constraints, agenda: stack of pending DAs)
- Problem: simulator implementation cost
  - the simulator is basically another dialogue system

Intrinsic – NLG

- No single correct answer here
  - many ways to say the same thing
- **Word-overlap** with reference text(s): **BLEU score**

range [0,1] (percentage)

brevity penalty (1 if output longer than reference, goes to 0 if too short)

$$BLEU = BP \cdot \exp\left(\sum_{n=1}^{4} {}^{1}/_{4} \log\left(p_n\right)\right)$$

geometric mean

***n*-gram precision**:

$$p_n = \frac{\sum_u \#\text{ matching n}-\text{grams in } u}{\sum_u \#\text{ n}-\text{grams in } u}$$

- ***n*-gram** = span of adjacent *n* tokens
  - 1-gram (one word) = unigram, 2-gram (2 words) = bigram, 3-gram = trigram

Intrinsic – NLG

BLEU example:

output: ~~The~~ ~~Richmond~~ 's address ~~is 615 Balboa~~ ~~Street~~ . The phone ~~number~~ ~~is 4153798988~~ ~~.~~

ref1: The number for Richmond is 4153798988 , the address is 615 Balboa .
~~ref2~~: The Richmond is located at 615 Balboa Street and their number is 4153798988 .

matching unigrams: the (2x), Richmond, address, is (2x), 615, Balboa, . (only 1x!), number, 4153798988
p_1 = 11 / 15

matching bigrams: The Richmond, address is, is 615, 615 Balboa, Balboa Street, number is, is 4153798988, 4153798988 .

p_2 = 8 / 14
p_3 = 5 / 13, p_4 = 2 / 12, BP = 1, BLEU = 0.4048

- **BLEU is not very reliable** (people still use it anyway)
  - correlation with humans is questionable
  - never use for a single sentence, only over whole datasets

Intrinsic – NLG

Alternatives (not much):

- Other word-overlap metrics (NIST, METEOR, ROUGE …)
  - there are many, more complex, but frankly not much better
- **Slot error rate** – only for delexicalized NLG in task-oriented systems
  - delexicalized → generates placeholders for slot values
  - compare placeholders with slots in the input DA – WER-style
- **Diversity** – mainly for non-task-oriented
  - can our system produce different replies? (if it can't, it's boring)

$$D = \frac{\#\text{distinct } x}{\#\text{total } x}, \text{ where } x = \text{unigrams, bigrams, sentences}$$

Dataset Splits 

- Never evaluate on data you used for training
  - memorizing training data would give you 100% accuracy
  - you want to know how well your model works **on new, unseen data**
- Typical dataset split:
  - **training set** = to train your model
  - **development/validation set** = for evaluation during system development
    - this influences your design decisions, model parameter settings, etc.
  - **test/evaluation set** = only use for final evaluation
  - need sufficient sizes for all portions
- **Cross-validation** – when data is scarce:
  - split data into 5/10 equal portions, run 5/10x & test on different part each time

Significance Testing

- Higher score is not enough to prove your model is better
  - Could it be just an accident?
- Need **significance tests** to actually prove it
  - Statistical tests, H_0 (**null hypothesis**) = "both models performed the same"
  - H_0 rejected with >95% confidence → pretty sure it's not just an accident
  - more test data = more independent results → can get higher confidence (99+%)
- Various tests with various sensitivity and pre-conditions
  - Student's *t*-test– assumes normal distribution of values
  - Mann-Whitney *U* test – any ordinal, same distribution
  - **Bootstrap resampling** – doesn't assume anything
    1) randomly re-draw your test set (same size, some items 2x/more, some omitted)
    2) recompute scores on re-draw, repeat 1000x → obtain range of scores
    3) check if range overlap is less than 5% (1%...)

Summary

- You **need data (corpus)** to build your systems
  - various sources: human-human, human-machine, generated
  - various domains
  - size matters
- Some models need **annotation** (e.g. dialogue acts)
  - annotation is hard, ambiguous – need to check **agreement**
- **Evaluation** needs to be done on a **test set**
  - **intrinsic** (component per se) / **extrinsic** (in application)
  - **objective** (measurements) / **subjective** (asking humans)
  - don't forget to check **significance**
- Next week: intro to assistants, question answering

Thanks

Contact me:

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Get the slides here:

http://ufal.cz/npfl123

Labs tomorrow
9:00 SU1

Talk to me about
Ph.D./MSc./BSc. theses!

References/Inspiration/Further:

Apart from materials referred directly, these slides are based on:

- Iulian V. Serban et al.'s Survey of corpora for dialogue systems (Dialogue & Discourse 9/1, 2018): https://breakend.github.io/DialogDatasets/
- Filip Jurčíček's slides (Charles University): https://ufal.mff.cuni.cz/~jurcicek/NPFL099-SDS-2014LS/
- Oliver Lemon & Arash Eshghi's slides (Heriot-Watt University): https://sites.google.com/site/olemon/conversational-agents
- Helen Hastie's slides (Heriot-Watt University): http://letsdiscussnips2016.weebly.com/schedule.html
- Wikipedia: Cohen's_kappa Levenshtein_distance Word_error_rate