

# Language Technology 2: Natural Language Interaction

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## dialogue phenomena

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a dialogue system engages in interaction with a human  
*as a participant/agent*

so, it needs to have a model of what such interaction(s) looks like  
→ a model of dialogue(s)

easy and pleasant interaction is an essential design aspect  
→ what characterizes an easy and pleasant interaction?

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how do we know what conversations look like?

study human-human conversations

→ ultimate benchmark for “naturalness”

→ BUT dialogue systems have specific requirements

study human-computer conversations;

data collected in interactions with actual systems

→ realistic, but confined to implemented functionality

study simulated human-computer conversations;

data collected in Wizard-of-Oz studies, where a human simulates the system

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characteristics of conversation

human-human conversation shows specific characteristics

humans do simplify their language in human-computer interaction, however, the essential characteristics remain

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### spontaneous spoken dialog

linguistic properties: cohesive devices

structure manifested in the dialog partys' contributions

speech-related phenomena:

pauses and fillers („uh“, „um“, „...“, like, you know,...“)

prosody, articulation

disfluencies

overlapping speech

dialog specific phenomena:

dialog acts/speech acts, dialog sequences, grounding

### spontaneous vs. practical dialogs

topic drifts vs. goal-orientedness → joint activity

### both (narrative) monologue and dialogue involve interpreting

information status

coherence/rhetorical relations

contextual references

intentions

### dialogue additionally involves:

turn-taking

initiative and confirmation strategies

grounding

repairing misunderstandings

### today: dialogue phenomena

turn taking

initiative and collaboration

common ground

joint activity

speech acts

dialogue structure

### turn taking

## turn taking

dialogue participants take turns, much like in a game: A, B, A, B

dialogue turn → a continuous “contribution” to the dialogue by one speaker

though it is not entirely obvious when a turn in natural dialog is finished, turn-taking appears fluid in normal conversation:

minimal pauses between speakers (few hundred ms)  
less than 5% speech overlap

how does it work?

## turn taking

conversation analysis (Sacks et al. 1974)

when can one take a turn:

Transition-Relevance Points (TRP) → places where the dialog/utterance structure allows speaker shift to occur (typically at utterance boundaries, but also smaller units)

syntax (phrase boundaries), intonation, gaze, gesture;  
cultural conventions may apply

who speaks next:

at each TRP (current speaker A):

1. if A selected B as next speaker, B should speak
2. if A did not select the next speaker, then anyone may take a turn
3. if no-one else takes a turn, then A may (continue)

to get a turn if not selected, a speaker must “jump in” at a TRP

## initiative and collaboration

## initiative and collaboration

who is in control of the dialogue progression?

being the one who's talking does not necessarily mean being in control, e.g., just answering a question

how to decide whether to take initiative?

dialogue initiative vs. task initiative

human-human conversation: varied initiative pattern

either participant can assume initiative, depending on knowledge, skills, situation, etc.

## initiative and collaboration

conversation (communication in general) is a **joint activity**

has a purpose (agreed on by the participants)

involves collaboration/cooperation

collaboration (being cooperative): helping each other to accomplish communicative goals by, for example,

cooperative interpretation beyond literal meaning (inference)

cooperative answering

complying with requests or directives when possible

providing more information than requested (when it is relevant or useful)

correcting false presuppositions or misconceptions

intensional answers and generalizations

taking initiative when this helps to accomplish the joint activity

## collaboration: common ground

entering a conversation, dialogue participants presuppose that there exists certain shared knowledge → **common ground**

introduced by Stalnaker (1978) based on older family of notions: *common knowledge* (Lewis, 1969), *mutual knowledge* or *belief* (Schiffler, 1972)

## collaboration: common ground

entering a conversation, dialogue participants presuppose that there exists certain shared knowledge → **common ground**

stock of knowledge taken for granted, i.e. assumed to be known both by the Speaker and the Hearer

sum of their mutual, common or joint knowledge, beliefs, and suppositions

sources of the assumptions:

evidence about social, cultural communities people belong to, academic backgrounds, etc. (*communal common ground*)

direct personal experiences (*personal common ground*)

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What does it mean „You and I (mutually) know that *p*“?

collaboration: common ground

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What does it mean „You and I (mutually) know that  $p$ “?

I know that  $p$

You know that  $p$

collaboration: common ground

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What does it mean „You and I (mutually) know that  $p$ “?

I know that  $p$

I know that you know that  $p$

You know that  $p$

You know that I know that  $p$

collaboration: common ground

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You know that  $p$

You know that I know that  $p$

You know that I know that you know that  $p$

collaboration: common ground

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What does it mean „You and I (mutually) know that  $p$ “?

I know that  $p$

I know that you know that  $p$

I know that you know that I know that  $p$

**...ad infinitum!...**

You know that  $p$

You know that I know that  $p$

You know that I know that you know that  $p$

collaboration: joint activity

### communication relies on collaboration

Gricean Cooperative Principle + principles of rational behaviour  
cooperatively interpret and contribute  
establishing shared knowledge (adding to common ground) → grounding

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collaboration: joint activity

### the Cooperative Principle

participants expect that each will make a “conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange” (Grice 1975)

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collaboration: joint activity

cooperation manifests itself in **Maxims of Conversation** by which conversation participants abide

- maxim of quality
- maxim of quantity
- maxim of relevance
- maxim of manner

adherence is assumed, but violation (of course) possible  
flouting maxims → conversational implicatures

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collaboration: joint activity

discourse participants

“read between the lines”

conversational implicatures due to Gricean maxims  
informativity principle: try strongest interpretation

cooperatively accommodate implicit assumptions if possible  
accommodation of presuppositions: adjusting common ground  
unless conflicting information  
resolving reference to entities in common ground

if not possible, repair problems (if relevant)

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## speech act theory

entering a conversation we (typically) have a certain intention

paradigmatic use of language: making statements...

...BUT there are also other things we can *do* with words

I name this baby Jonathan  
I christen this ship „Queen Mary“  
I promise I'll never do this again  
I bet it'll rain this evening  
Do this again and see what happens!  
Leave me alone!  
The University accepts no responsibility for.....  
I declare war on Lilliput.  
I apologise.  
I object.

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## speech act theory

entering a conversation we (typically) have a certain intention

aspects of the speaker's intention:

the act of saying something  
what one does in saying it (requesting or promising)  
how one is trying to affect the audience

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## speech act theory

certain *actions* we take in communication are designed to get our interlocutor(s) to do things on the basis of understanding of what we mean

doing things with words: Austin, 1962, later Searle, Davis

→ **speech acts**

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## speech act theory

Austin dubbed utterances such as I christen this ship „Queen Mary“ **performatives** in contrast to **constatives**

observe:

1. performatives cannot be false, but they can fail to do things
2. performatives are not a special class of sentences;  
some sentences are explicitly performative, others can be implicitly so  
performative/constative dichotomy does not really exist;  
both are special cases of illocutionary acts

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## speech act theory

constatives vs. performatives

constatives: utterances used to make true/false statements or assertions

The snow is green.

performatives: utterances used to change the world

performatives are ordinary declarative sentences which are not used with any intention of making true or false statements; they are not true/false

## speech act theory

constatives vs. performatives

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The snow is green.

performatives: utterances used to change the world

performatives are ordinary declarative sentences which are not used with any intention of making true or false statements; they are not true/false

## speech act theory

how can things go wrong?

assertives fail when they are false

failed performatives?...

...not false, but rather improper, unsuccessful → **infelicitous**

## speech act theory

**felicity conditions** → conditions that must be fulfilled for a performative to succeed

- A. (i) there must be a conventional **procedure** having a conventional effect (e.g., wedding, declaring war, christening, betting, etc.)  
(ii) the **circumstances** and persons must be appropriate, as specified in the procedure
- B. the procedure must be **executed**
  - (i) **correctly** (e.g., using the right words) and
  - (ii) **completely** (according to conventional expectations)
- C. (i) persons involved must have the requisite thoughts, feelings and **intentions**, as specified in the procedure and  
(ii) if consequent **conduct** is specified, the relevant parties must follow the rules of conduct

## speech act theory

if conditions not fulfilled performatives may fail to do things

categories of infelicities:

**misinvocations**, which disallow a purported act (see A. above)

**misexecutions**, in which the act is impaired by errors or omissions (see B.)

**abuses**, where the act succeeds, but participants do not have the expected thoughts and feelings (C.i.)

## speech act theory

examples of violations of felicity conditions:

spouse to spouse in a society without divorce: "I hereby divorce you"

random individual saying the words of the marriage ceremony

a clergyman baptising a baby with a wrong name

A: Wilt thou have the woman to thy wedded wife ... so long as you shall live?

B: ??? Mhm.

A: I bet you 6 pence it will rain

B. Oh, rain would be great!

place a bet without intending to pay it off

to promise to do something with no intention to do it; "paper marriage"

## speech act theory

„the performative formula“

explicit performatives have a specific linguistic structure → normal form (NF)

1st pers. sing., present tense,

allows "hereby"

"performative" main verb etc.

I (hereby) warn you.

## speech act theory

BUT utterances that do not have the NF of a performative can nevertheless be performative → implicit performatives:

You are hereby warned. (not 1.p.sg.)

Watch out! (none of NF characteristics)

You are going to burn your hands.

AND a sentence in performative NF need not be used as a performative at all:

A: How do you get me to throw all these parties?

B: I promise to come

conclusion: performatives are not a special class of sentences;  
rather the term "performative" designates a function any utterance can have.

## speech act theory

performative **and** constative utterances

an utterance can be both constative (“truth-bearer”) and performative (“action-performer”)

A storm is coming.

constatives and performatives are both subject to felicity conditions; when felicity conditions do not obtain, one can argue these sentences are neither true nor false, just inappropriate (cf. presupposition failure!)

both felicity and truth are gradual matters

France is hexagonal.

conclusion: constatives and performatives are not necessarily disjoint phenomena

## speech act theory

utterances have both a (propositional) meaning (they say things) and a force (they do things)

a theory should clarify in what ways by uttering sentences one might be said to be performing actions

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a theory should clarify in what ways by uttering sentences one might be said to be performing actions

→ utterances are multi-dimensional *acts* that affect the context in which they are spoken

**locutionary act:** uttering something with a certain „meaning”

**illocutionary act:** act performed by means of uttering the words  
→ utterance’s „conventional force”

**perlocutionary act:** what is brought about as a result (intentionally or not)  
→ how hearer is affected: convincing the hearer, persuading, surprising, making sad, laugh, etc.

## speech act theory

assertive	<b>S</b> commits to sth being the case; get <b>H</b> to form or attend to a belief
directive	<b>S</b> attempts to get <b>H</b> do sth
commissive	<b>S</b> commits to future course of action
expressive	<b>S</b> expresses psychological state, feeling twrd. <b>H</b>
declarative	<b>S</b> changes the state of the world

## speech act theory

assertive	<b>S</b> commits to sth being the case; get <b>H</b> to form or attend to a belief	„comment“, „suggest“, „swear“, „boast“, „conclude“, „claim“
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expressive	<b>S</b> expresses psychological state, feeling twrd. <b>H</b>	„thank“, „apologize“, „welcome“, „deplore“, „hate“, „love“
declarative	<b>S</b> changes the state of the world	

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## speech act theory

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declarative	<b>S</b> changes the state of the world	„resign“, „name“, „fire“, „baptize“, „pronounce husband and wife“

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## conversation structure

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## conversation structure

global: overall structure of an entire conversation

local: relations between pairs or sequences of turns

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## conversation structure

global structure

generic structure of a conversation:

opening: “initialization” (establish contact, greetings, pleasantries)

body: exchange about the subject matter(s) (accomplishing task(s),  
discussing topic(s)), sometimes a task is ended by a summary

closing: winding down, farewell, breaking contact

conventions apply in all sections

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## conversation structure

### local structure

some turns specifically select who the next speaker will be

→ **adjacency pairs** (Schegloff 1968)

regularly occurring, conventionalized sequences

adjacent turns

produced by different speakers

ordered: First^Second

typed: particular First requires a particular Second

## conversation structure

### local structure

some turns specifically select who the next speaker will be

→ **adjacency pairs** (Schegloff 1968)

greeting : greeting

compliment : downplayer

offer : acceptance

question : answer

accusation : denial

request : grant

## conversation structure

### local structure

some turns specifically select who the next speaker will be

→ **adjacency pairs** (Schegloff 1968)

greeting : greeting

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question : answer

accusation : denial

request : grant

set up next speaker expectations ('significant silence' dispreferred)

conventions introduce *obligations* to respond (and preferred responses)

insertion sequences: APs can be embedded (e.g., "sub-dialogue",  
misapprehension-correction, clarification)

## conversation structure

### significant silence (option 1 at a TRP)

it A selects B to speak next, but B doesn't speak,  
then (assuming B has heard & understood) B's silence can be interpreted  
as a hesitation to give a dispreferred Second

e.g., B does not know the answer to A's question,  
B's response to A's offer or request is negative, etc.

other cases (silence at options 2 or 3 at a TRP) are just insignificant delays  
(pauses or lapses)

next

how dialogues can be modelled  
and how all this is used in dialogue systems

## dialogue systems: turn taking models

### rigid turn taking

system speaks till it completes turn, stops, and only then listens to user  
system waits till user stops speaking and responds again

problems: users must wait for system to finish turn  
users often speak too early,  
how to determine end of user's turn? (users make too long  
pauses while speaking which are interpreted as end of turn)

### flexible turn taking

user barge-in; as in natural conversation → more efficient

problems: backchannel or noise misinterpreted as user turn  
system interprets own output as input



„push-to-talk“ instead of „open microphone“ if possible  
system sound when microphone open

## dialogue systems: initiative strategies

### directive prompt:

explicit instruction on what information user should supply at given point

### open prompt

no/few constraints on what user can say

### restrictive grammar

constrains the ASR/NLU system based on dialogue state

### non-restrictive grammar

open language model, not restricted to a particular dialogue state

grammar \ prompt	open	directive
restrictive	—	system initiative
non-restrictive	user initiative	mixed initiative

## dialogue systems: initiative strategies

### system initiative


S: Please give me your arrival city name.  
U: Baltimore.  
S: Please give me your departure city name....

### user initiative

S: How may I help you?  
U: I want to go from Boston to Baltimore on November 8.

### mixed initiative

S: How may I help you?  
U: I want to go to Boston.  
S: What day do you want to go to Boston?

 dynamically adjust strategy e.g. change from mixed initiative to system initiative  
if, e.g. ASR problems detected, many user corrections (dialogue history), based on user model and/or context model

## dialogue systems: grounding

### levels of interpretation of performed communicative act:

channel:	S executes, H attends
signal:	S presents, H identifies
proposition:	S signals that $p$ , H recognizes that $p$
intention:	S proposes $p$ , H considers $p$

## dialogue systems: grounding

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Hearer must *ground* or *acknowledge* Speaker's utterance

OR

signal, *at the level that satisfies the Speaker*, that there was a problem in reaching common ground

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*grounding feedback* possible at all levels:

- continued attention
- relevant next contribution
- acknowledgement
- demonstration (e.g. paraphrase, completion)
- display (verbatim)

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relevant next contribution

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problems ...possible at all levels:

lack of perception

lack of understanding

ambiguity

misunderstanding

→ clarification and repair strategies

## dialogue systems: grounding

levels of interpretation of performed communicative act:

- channel: S executes, H attends
- signal: S presents, H identifies
- proposition: S signals that  $p$ , H recognizes that  $p$
- intention: S proposes  $p$ , H considers  $p$

S: I can upgrade you to an SUV at that rate.  
H gazes appreciatively at S (continued attention)  
H: Do you have a RAV4 available? (relevant next contribution)  
H: ok / mhmmm / Great! (acknowledgement/backchannel)  
H: An SUV. (demonstration/paraphrase)  
H: You can upgrade me to an SUV at the same rate? (display/repetition)  
H: I beg your pardon? (request for repair)

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## dialogue systems: grounding

ASR and input interpretation are error prone

grounding helps to make sure system interpreted correctly


users of speech-based interfaces are confused when system doesn't give them an explicit acknowledgement signal (Stifelman et al.93, Yankelovich et al.95)

→ in fact, *crucial* in design of dialog systems

grounding strategies

pessimistic: immediate explicit verification (awfully inefficient)

optimistic: delayed accumulated verification (errors accumulate, recovery difficult)

 *carefully optimistic*: implicit verification → incorporate data to be verified in next system turn

choosing strategy: ASR confidence (e.g. combined with system's belief about task state)

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## dialog systems: grounding

grounding examples:

carefully optimistic strategy: acknowledgement + relevant next contribution

U: I need to travel in May.  
S1: What day in May did you want to travel?  
S2: And you're flying into what city?  
S3: And what time would you like to leave?

grounding negative responses:

S: Did you want to review some more of your personal profile?  
U: No.  
S1: What's next? **(bad!)**  
S2: Okay, what's next?

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## dialog systems: grounding

(some) considerations:

if system rejects user's utterance or displays misunderstanding/non-understanding, then user will probably make a correction:

reply „no" to confirmation question, repeat, rephrase, etc.

BUT corrections are typically **harder** to recognize than normal sentences (misrecognized twice as often as non-corrections...)

why? hyperarticulation, users tend to speak louder, user's rephrasing may aggravate because out-of-grammar

→ need for efficient error recovery strategies

e.g. dynamicaly change prompt strategy, switch to restrictive grammar

if dialog does nowhere, should the system be allowed to hang-up on a user?...

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## dialog systems: grounding, clarification

A: Welcome to Busman, the Tampere bus information service! How may I help you?  
U: When does the next bus leave from Central Square to Her ehhh correction from Central Square to Hervanta?  
A: Sorry, I didn't recognize that. Please speak clearly.  
U: What now?  
A: Busman understands questions such as "When does the next bus to Hervanta depart?", ... [help continues]  
U: I'm leaving from Central Square, and I'm going to Hervanta.  
A: Sorry, I still didn't recognize that.  
A: Please tell me where you are leaving from.  
U: From Central Square.  
A: What is your destination?  
U: Hervanta.  
A: From Central Square to Hervanta use lines 13, 20, 23 and 30.  
A: Do you want to hear timetables?  
U: Yes.  
A: From Central Square to Hervanta on weekdays at 11:15 bus in line 23...

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## dialogue systems: dialogue moves

Generalization of speech acts to conversational functions of utterances at various levels

Various taxonomies, typically tuned for a specific task or domain

Attempts at reusable schemes:

Conversation acts (Traum and Hinkelman 1992, Traum 1994)

DAMSL, DATE, DIT++

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- DAMSL: hierarchical general DA classification scheme for task-oriented dialogue
  - Forward looking function (like speech act)
  - Backward-looking function: relationship to previous utterance(s) by other speaker (including grounding)
  - Information level
    - Task: doing the task
    - Task management: talking about the task
    - Communication management: managing communication
    - Other
  - Communicative status: intelligibility, interpretability, self-talk...

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## dialogue systems: dialogue moves

### DAMSL: Forward Looking Function

- Statement a claim
- Information request a question
  - Check a question confirming info
- Influence-on-addressee (= Searle's directives)
  - Open-option a weak suggestion or list of options
  - Action-directive command or instruction
- Influence-on-speaker (= Searle's commissives)
  - Offer offer to do something (subject to confirmation)
  - Commit commitment to do something
- Conventional
  - Opening greetings
  - Closing farewell
  - Thanking thanking and responding to thanks

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## dialogue systems: dialogue moves

### DAMSL: Backward Looking Function

- Agreement (speaker's attitude toward an action, plan, object, etc.)
  - Accept
  - Accept part
  - Maybe
  - Reject
  - Reject part
  - Hold
- Answer (answer to question)
- Understanding (whether speaker understood previous turn)
  - Signal-non-understanding
  - Signal-understanding
    - Acknowledgement (demonstrated by a continuer or assessment)
    - Repeat-paraphrase (demonstrated by a repetition or rephrase)
    - Completion (demonstrated by collaborative completion)

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