

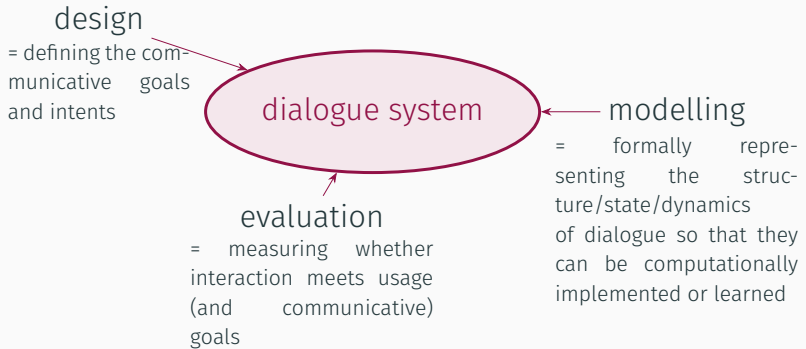
Dialogue Engineering

Dialogue

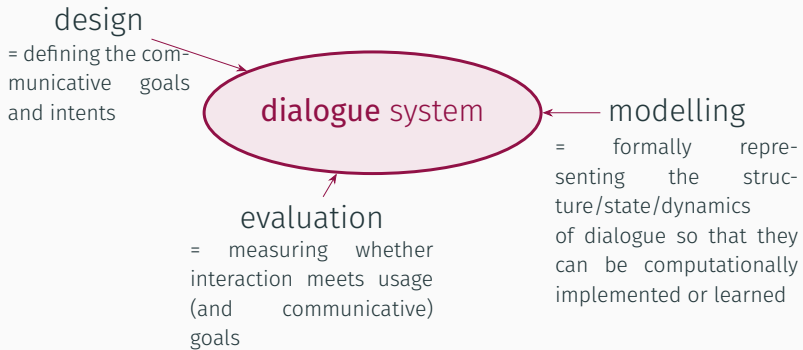
Amandine Decker, *amandine.decker@loria.fr*

M2 NLP 2025–2026

Dialogue Engineering?



Dialogue Engineering?



Content of the Course

- Features of Dialogue
 - ▶ Dialogue is our primary communication mode;
 - ▶ It is also way more complex than it looks;
- Dialogue Systems
 - ▶ They are becoming more and more prevalent;
 - ▶ Being able to associate a real understanding of dialogue functioning with technical development ability is crucial;
- Dialogue Resources & Evaluation
 - ▶ Resources are (or should be) the basis of NLP;
 - ▶ A system without proper evaluation is meaningless.

- Final Exam (date to be decided);
- Some kind of involvement grade (most likely in the form of bonus points) for the exercise sessions.

Dialogue

When do we say that something is a dialogue?

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Is it enough that there are two speakers?

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What delay between turns is acceptable?

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Information exchange?

What delay between turns is acceptable?

Let's look at a few examples.

Examples – Daily Dialog

A: May I come in?

B: Yes, please. I'm Mr. Peter, the Director of Personnel. What can I do for you?

A: Nice to meet you, Mr. Peter. I'm Wang Sian. I've come for an interview as requested.

B: Oh, yes. How do you do, Miss Wang? Sit down, please.

A: Thank you.

B: What was your major in school?

A: I majored in Public Relations.

B: Have you done any work in this field?

A: Yes, after my graduation, I worked in a trade company in Macao for one year.

B: What section did you work in?

A: The export Business Section.

B: So you must be very familiar with export procedures.

A: Yes, very much.

B: That's good.

Examples – BNC Spoken, J9Y

- A : Good this is an interview with Douglas from Blackwood part of Motherwell.
A : Is it
B : Well yes the postcode's Motherwell Blackwood's er just south of Hamilton about four miles south of Hamilton two miles north of Lesmahagow.
B : Er so it's just just on the M seventy four.
A : Just <unclear> .
A : Is it Lesmahagow is it?
A : Erm
B : It is Lesmahagow.
A : I just wondered how that was re erm er er pronounced.
A : Now on my er you and I spoke didn't we er Douglas?
B : Yes we did.
A : I've got circled circled good voice here.
B : Well I am used to the telephone.
A : Okay.
B : Yes yes.
A : Erm you're now you're not doing anything at the moment, we we agreed it was resting.
A : Erm sales and computers you were with Martin's?
B : Retail Group yeah yeah.
A : Thank you.
A : Right now if you've got your application form, you've got a C V there haven't you?
B : Yes I have.
A : Good that's great.
... (907 utterances in total)

Examples – Friends, Season 7, Ep. 20

RG : Hey! Out of all of us, who do you think is gonna get married next?

JT : Probably Monica and Chandler.

(A woman walks up to X in the background.)

MW : Hi. Could I have a pack of Newport Lights, please?

X : Oh umm, uh we don't sell cigarettes, but they have them at the newsstand across the street.

MW : That'd be great, thanks.

RG : Oh my God, MW. I don't think I have the energy for this.

MW : Oh my God! Ray-ray Green?!

RG : Melissa!

MW : You have been M.I.A for the past seven sorority newsletters, what's up with you?!

RG : Wh-Why don't I tell you over here?

MW : So last I heard you were gonna get married. Oh poor Ray-ray.

RG : Oh no-no, no! It's good! It's all good! I-I actually work at Ralph Lauren!

MW : Shut up!

RG : I will not! I'm the divisional head of men's sportswear!

MW : Oh shut up more! Now, are you friends with Ralph?

RG : Oh please...

MW : Are you?!

RG : No.

Examples – BNC Spoken, KDM_029802

N : Oh dear god <pause> <sigh><pause> Those chrysanthemums done well.<pause>

P : They have, yes <pause> they're er <pause> they're good value those a pot, I mean <unclear> but <pause> they're reasonably <pause> when did you get it?

P : It must be about three weeks ago.

N : Can't think what it was for now.

P : I think it was one of those impromptu ones.

P : <pause> I know it wasn't my birthday you just came in with it didn't you?

N : It's <unclear> birthday.

N : <pause> I mean the only trouble is they're no use afterwards are they?

P : Must have had a brainstorm <unclear> <pause>

N : I said they're no use afterwards are they?<pause>

P : I don't <pause> I don't know.

N : Because they're forced I reckon.

P : Oh.

P : I think they'll grow if you put them in the garden <pause> eventually.

Examples – STAC, Example 1 from Asher (2016)

A: anyone want sheep for clay?

B: got none, sorry :(

B: so how do people know about the league?

C: no

A: i did the trials

D: i know about it from my gf

B: yeah me too, are you an Informatics student then, lj?

D: did not do the trials

C: has anyone got wood for me?

B: I did them a because a friend did

B: lol wm, you cad

B: afraid not :(

A: no, I'm about to start math. I just hang around appleton a lot

D: sry no

B: my single wood is precious

C: what's a cad?

Examples – Switchboard

A: Okay, um. How has it been this week for you?

B: Weather-wise, or otherwise?

A: Weather-wise.

B: Weather-wise. Damp, cold, warm

A: Oh, no, damp.

B: We have, we have gone through, what might be called the four seasons, uh, in the last week.

A: Uh-huh.

B: We have had highs of seventy-two, lows in the twenties.

Defining Dialogue

A definition

Dialogue is a joint activity in which two or more participants take turns at producing and interpreting utterances, coordinating their actions to build mutual understanding and accomplish social or practical goals.

But clearly there are different types of dialogue...

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But clearly there are different types of dialogue...

“The language of face-to-face conversation is the basic and primary use of language, all others being best described in terms of their manner of deviation from that base.”

– Fillmore, 1981, p.152

How can we Characterise a Dialogue?

We can attempt to describe dialogue in terms
of a few key **parameters** :

People • Interaction • Environment • Function

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We can attempt to describe dialogue in terms of a few key **parameters** :

People • Interaction • Environment • Function

Precise features are necessary to guide how we model and evaluate conversational systems.

A few Definitions

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A₁ : Okay, um. How has it been this week for you?

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A₃ : Weather-wise.

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A₇ : Uh-huh.

B₈ : We have had highs of seventy-two, lows in the twenties.

In dialogue, several participants take **turns** speaking.

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Real conversations tend to contain **disfluencies**.

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In dialogue, several participants take turns speaking.

Real conversations tend to contain disfluencies.

Language can be more fragmented with non-sentential units.

Hence we tend to use the term **utterance** rather than sentence.

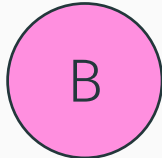
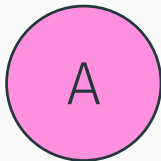
Parameters for Characterising Dialogue

Who participates in dialogue?

The configuration and relationships among participants shape how interaction unfolds and how meaning is constructed.

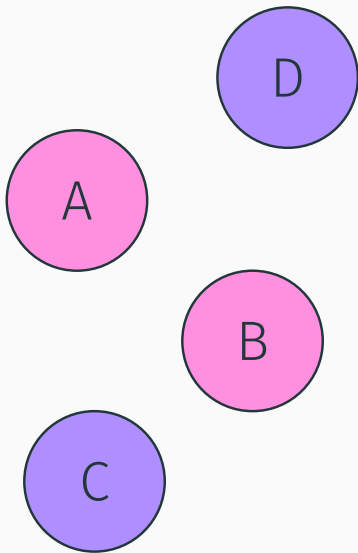
People – Number

- 2–4 participants are typical :
 - ▶ **Duologue** (two speakers) : orderly turn-taking, focused topic;



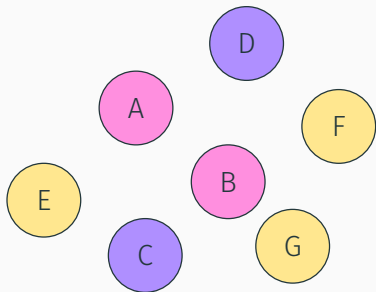
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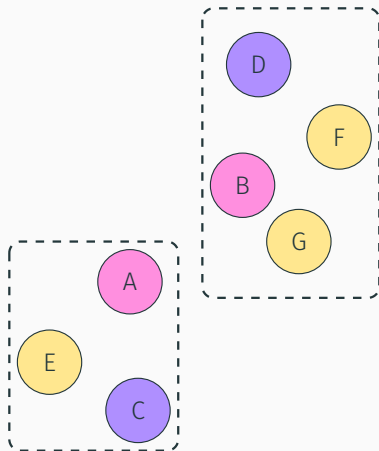
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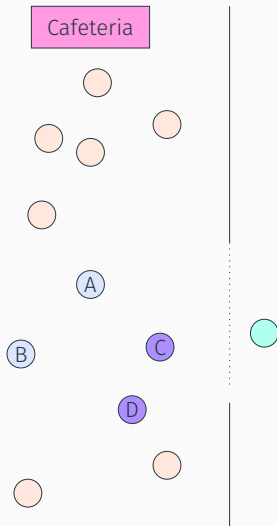
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 - ▶ Topic fragmentation (parallel sub-conversations);
 - ▶ Complex turn management and interruptions;
 - ▶ “Long-distance attachments” : replies referencing earlier turns far back.

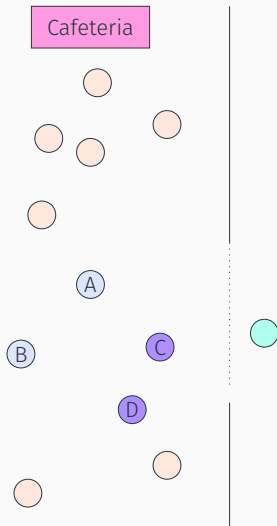
STAC – Example 1 from [1]

A: anyone want sheep for clay?
B: got none, sorry :(
B: **so how do people know about the league?**
C: no
A: **i did the trials**
D: **i know about it from my gf**
B: **yeah me too,**
are you an Informatics student then, lj?
D: **did not do the trials**
C: has anyone got wood for me?
B: **I did them because a friend did**
B: lol C, you cad
B: afraid not :(
A: *no, I'm about to start math.*
I just hang around appleton a lot
D: sry no
B: my single wood is precious
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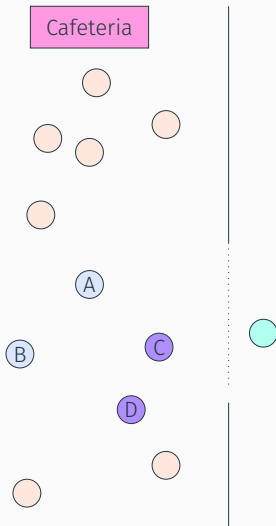
- Roles in dialogue :
 1. Participants :
 - 1.1 Speaker as self-monitor
 - 1.1 Other participants :
 - 1.2.1 Addressees
 - 1.2.2 Side participants



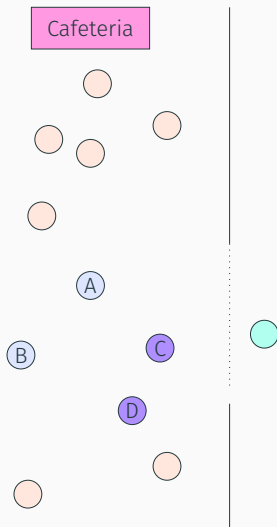
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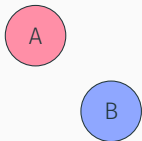


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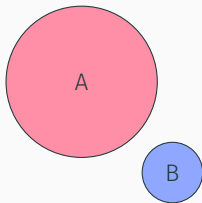


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 - 2.2 Eavesdroppers
- In recorded corpora, **we act as overhearers** interpreting the exchange.





- Dialogue participants are **typically peers**, but :
 - ▶ Task or institution may impose **hierarchical relations**.
- Hierarchy influences :
 - ▶ **Tone** : polite vs. directive speech ;
 - ▶ **Turn rights** : who initiates, who closes topics ;
 - ▶ **Friction** : asymmetry can lead to misalignment or tension.
- Many dialogue datasets show **asymmetry** (e.g., customer-agent, user-bot).



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- Dialogue builds on **shared history** :
 - ▶ **Short-term** : within the same interaction;
 - ▶ **Long-term** : across multiple encounters.
- Participants can refer to past events or utterances :
“As you said earlier...” / “Like last time...”
- This continuity supports :
 - ▶ Reference resolution and common ground;
 - ▶ Social bonding and relationship maintenance.

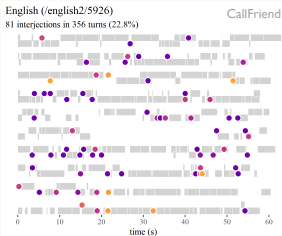
- **Number** : how many voices shape complexity.
- **Function** : who speaks, who listens, who observes.
- **Hierarchy** : equality or asymmetry in roles.
- **History** : shared past shaping interpretation.

→ Each aspect modulates interactional dynamics and meaning.

Interaction = Co-construction

Dialogue is not a sequence of isolated acts,
but a **joint action** (Clark) grounded in
cooperation (Grice).

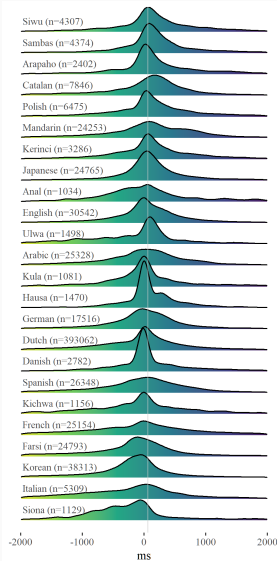
Interaction – Feedback



Occurrence of
backchannels in
10-minute extracts [6]

- **Feedback** keeps communication flowing :
 - ▶ Small listener responses : “uh-huh,” “yeah,” nodding ;
 - ▶ These **backchannels** signal understanding, attention, or agreement.
- Correctly timed feedback **supports processing** and reduces cognitive load for both speakers.
- Poorly placed feedback (too early/late) disrupts rhythm and comprehension.
- **Most dialogue systems lack feedback** :
 - ▶ They wait for full turns ;
 - ▶ They cannot exploit partial cues or incremental understanding.

Interaction – Turn-taking



Turn-transition timing [7]

- In conversation, turns are exchanged **smoothly and rapidly**.
- Short gaps (around 200 ms) show that speakers :
 - ▶ Plan their response early, while still listening;
 - ▶ Predict upcoming turn endings.
- Occasional overlaps occur, but are **repaired quickly**.
- Turn-taking depends on cues :
 - ▶ Syntax, intonation, gaze, and breathing.
- Dialogue systems often **lack this fluidity**, responding only after full input.

Interaction – Synchrony

- Human dialogue relies on **synchrony** :
 - ▶ We **produce and interpret simultaneously**;
 - ▶ Speakers adapt their timing and tone to one another.
- This enables :
 - ▶ **Real-time self-repair** (“uh—sorry, I mean...”);
 - ▶ Fast adaptation to partner cues.
- When synchrony is lost (e.g. lag, text-based chat) :
 - ▶ Clarifications become heavier;
 - ▶ Interaction can feel slower and less natural.

- Spoken dialogue is **ephemeral** :
 - ▶ It exists only in the moment of interaction;
 - ▶ Once spoken, it vanishes – recordings are a degraded trace.
- This **evanescence** affects :
 - ▶ Memory and accountability (what was said, by whom);
 - ▶ The type of evidence available for study (transcriptions).
- Dialogue systems rely on **persistent and past data**, which contradicts the way language works.

Interaction – Summary

- **Feedback** : continuous listener responses maintain flow.
- **Turn-taking** : fine-tuned timing of speaking rights.
- **Synchrony** : simultaneous understanding and production.
- **Evanescence** : transient, momentary nature of speech.

→ Each participant continuously monitors and adapts to the other's signals, timing, and understanding.

Where and How does conversation happen?

Conversation is inherently **multimodal**,
involving words, signals, and context.

- The **physical setting** shapes conversation :
 - ▶ Natural triggers for interaction (e.g., shared objects, visual cues);
 - ▶ Possibility to refer to visible things (“*Look at that!*”);
 - ▶ Space affects **permeability and privacy** : intimate vs. public conversations.
- Mediated conversation limits the mutual access to physical context;
- Most dialogue systems are not aware of the physical world.

Environment & Medium – Gaze / Facial Expression

- Facial expressions and gaze convey additional information **non-compositionally**.
- Example : identical utterances can have different meanings depending on expression :
 - ▶ Sarcasm : “Great job” + displeasure ;
 - ▶ Genuine compliment : “Great job” + smile.
- Absence of these cues in text-based dialogue leads to **ambiguity** → emojis sometimes compensate.



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Environment & Medium – Gestures

- Gestures augment or replace spoken words :
 - ▶ Pointing, showing, miming actions ;
 - ▶ Example : “Cut it like this” + hand motion.
- Gestures are interpreted relative to the **physical context**.
- They convey meaning efficiently and can signal attention or emphasis.



- Prosody and tone of voice add a **layer of meaning** :
 - ▶ Pitch, loudness, tempo, intonation;
 - ▶ Convey attitude, emotion, and intent;
 - ▶ Example : Sarcasm vs. sincerity.
- Prosodic cues are largely absent in text-only systems → harder to interpret subtleties.
- Highlights again that dialogue is multimodal : words + tone + body signals.

Environment & Medium – Summary

- **Physical context** : shared space affects reference, privacy, and triggers.
- **Gaze/facial expression** : conveys implicit meaning, emotion, and attitude.
- **Gestures** : supplement or replace words; enhance efficiency.
- **Prosody/tone** : adds emotional and pragmatic layers.

→ Dialogue is a multimodal, context-dependent activity, and lacking some of the modalities requires to report the cognitive load elsewhere.

Why do we do conversation?

Beyond words and signals, dialogue serves **purposes** and conveys **layers of meaning**.

Function & Meaning – Task

- The **task** dimension is most studied :
 - ▶ Task-oriented dialogue is easier to record, structure, and annotate ;
 - ▶ Examples : booking a flight, ordering food, solving a specific problem.
- Task constraints influence :
 - ▶ Conversation flow ;
 - ▶ Turn-taking and initiative ;
 - ▶ Allocation of cognitive resources.
- Asymmetries naturally arise (e.g. user vs. assistant roles).

Function & Meaning – Social Factor

- Social aspects are often ignored in formal dialogue studies;
 - ▶ Yet many daily life conversations are primarily carried out for bonding;
 - ▶ In practice most conversations mesh social and practical purposes.
- Latest open-domain conversational agents (eg. ChatGPT) were initially meant for social conversation :
 - ▶ But they are now widely used for web-browsing / information retrieval.

Function & Meaning – Topical Structure

- Topical structure varies by conversation type :
 - ▶ Task-oriented : constrained, predictable topic flow;
 - ▶ Casual/social : less constrained, more variable (debated and under-studied).
- Industrial focus drives research toward task-oriented genres;
- Casual conversation remains a rich, but complex, area of study.

Function & Meaning – Interpretation Layers

- Multiple layers of meaning are conveyed simultaneously :
 - ▶ Literal content;
 - ▶ Pragmatic intent;
 - ▶ Social/relational nuances;
 - ▶ Imaginative or “make-believe” aspects.
- Capturing these in systems is challenging :
 - ▶ Requires modelling context, beliefs, and intentions;
 - ▶ Often underrepresented in dialogue corpora.

Function & Meaning – Summary

- **Task** : purpose-driven, structured, resource allocation and asymmetry.
- **Social Factor** : subtle, complex, often overlooked in formal studies.
- **Topical Structure** : constrained in tasks, looser in casual conversation.
- **Interpretation Layers** : literal, pragmatic, social, and imaginative.

→ Function and meaning shape the purpose, flow, and depth of dialogue.

Human-Human vs Human-Machine Dialogue

- Humans use language to **represent and exchange knowledge about the world.**
- Grounding is **embodied and experiential** :
 - ▶ Based on perception, action, and shared understanding;
 - ▶ Constrained by social and physical rules.
- Machines (large language models) :
 - ▶ Learn **co-occurrence probabilities**, not meaning;
 - ▶ Language is **detached from experience and world knowledge**;
 - ▶ Can mimic human-like text, but lack real understanding.
- Embodied/grounded models exist but are rare and limited.

- Humans in conversation make **commitments** :
 - ▶ Statements carry responsibility;
 - ▶ Can apologize, negotiate, or face consequences.
- Machines cannot be held accountable :
 - ▶ No personhood or moral status;
 - ▶ Statements are generated patterns, not commitments.
- Implications :
 - ▶ Tension between usual speech act power and AI-generated assertions;
 - ▶ We interpret AI text as meaningful, but AI has no intention.

- Models represent an **average of their training data** :
 - ▶ Biases and norms are amplified;
 - ▶ Individual variation is lost.
- Despite this, the output can still **pass as human enough** depending on context.
- Ethical considerations :
 - ▶ Reinforces stereotypes;
 - ▶ Limits representativity of underrepresented groups.

Models of Dialogue Structure

Models of Dialogue Structure – What and Why

- **Dialogue models** are frameworks for describing and predicting how conversations unfold.
- They provide **formal representations** of :
 - ▶ Turn-taking and speaker roles;
 - ▶ Task progress or social goals;
 - ▶ Meaning and interpretation of utterances.
- Why they are useful :
 - ▶ Help understand human conversation ;
 - ▶ Guide design of dialogue systems ;
 - ▶ Enable evaluation of dialogue strategies.
- Different models focus on different aspects : speech acts, game-like interaction, information state updates.

From Truth Conditions to Dialogue Structure

Historically, formal semantics focused on :

- **Truth conditions** of isolated sentences (Frege, Montague).

But in dialogue, many utterances are **not truth-evaluable** :

- questions, commands, acknowledgments,
- referent introductions, repairs.

Consequence : meaning cannot be reduced to truth values.

Speech Act Theory (Austin, 1975; Searle, 1979)

- We use language not only to make statements but also to 'do' things [2]:
 - ▶ "Could you open the window, please?"
 - ▶ "I apologise."
 - ▶ "Get out."
- Distinction between constatives (descriptive sentences) and performatives ("doing" sentences):
 - ▶ Performatives do not have truth-conditions;
 - ▶ Instead they have felicity conditions;
 - ▶ The speech act performed by an utterance (its illocutionary force) is the making of a statement, offer, promise, etc.
 - ▶ The result on the audience is the perlocutionary act of the utterance.
- Benefits :
 - ▶ Provides a structured way to label and analyse dialogue;
 - ▶ Useful for dialogue system input/output representation.

Dialogue Games Theory (Lewis, 1979)

Conversation = a **game with rules**.

- Each utterance changes the **conversational score**, including :
 - ▶ **Common ground** : mutually accepted propositions;
 - ▶ **Presuppositions** : assumptions taken for granted;
 - My roommate's cat is cute.
 - *My roommate's pet dinosaur is cute.
- Explains :
 - ▶ how referents are introduced;
 - ▶ how presuppositions are accommodated;
 - ▶ how context evolves turn by turn.

Note : Entirely theoretical — no computational implementation.
But foundational for later dynamic theories.

Information State Update Theory

Computational linguistics adopted Lewis' idea of dynamic context.

- **Information State (IS) :**
 - ▶ a structured representation of the dialogue context;
 - ▶ updated after each dialogue move.
- Captures :
 - ▶ dialogue moves and reactions;
 - ▶ clarification, repairs;
 - ▶ shared beliefs and intentions.
- Examples :
 - ▶ **SDRT** (Segmented Discourse Representation Theory)
 - dialogue as linked discourse segments;
 - relations : QAP, Clarification, Elaboration, *etc.*;
 - models anaphora, discourse moves, implicit structure.
 - ▶ **TTR** (Type Theory with Records)
 - dialogue context = record of types and tokens;
 - good for grounding, reference, clarification;
 - flexible in terms of possible entries.

An Example of TTR record

G234_1: mm hmm (0.5s) do you have
a cellphone?

R235_1: I stopped the cellphone

G236_1: stop

R237_1: stop

G238_1: completely

R239_1: complete oulac (xxx) (1s)
air conditioner noises

R239_2: *wouallou but (0.5s) it's*

G240_1: wouallou

R241_1: it's okay it's a (1.5s) (xxx)

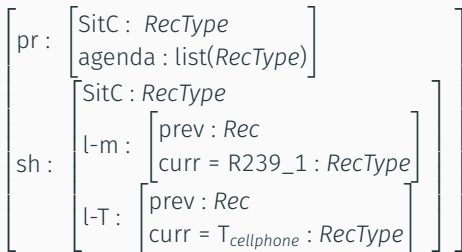
G242_1: (xxx)

G242_2: you see the (tech-)

R243_1: *an old air conditioner*

G244_1: ah

Before the air conditioner noises :



An Example of TTR record

G234_1: mm hmm (0.5s) do you have
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R235_1: I stopped the cellphone

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R241_1: it's okay it's a (1.5s) (xxx)

G242_1: (xxx)

G242_2: you see the (tech-)

R243_1: *an old air conditioner*

G244_1: ah

After the air conditioner noises :

$$\left[\begin{array}{l} \text{pr :} \\ \text{sh :} \end{array} \left[\begin{array}{l} \text{SitC :} \\ \text{agenda =} \\ \text{SitC :} \\ \text{l-m :} \\ \text{l-T :} \end{array} \left[\begin{array}{l} \left[\begin{array}{l} x : \text{Ind} \\ c_1 : \text{air_conditioner}(x) \\ c_2 : \text{noisy}(x) \end{array} \right] \\ [T_{\text{air_conditioner}}] : \text{list}(\text{RecType}) \\ \text{RecType} \\ \left[\begin{array}{l} \text{prev : Rec} \\ \text{curr = R239_1 : RecType} \end{array} \right] \\ \left[\begin{array}{l} \text{prev : Rec} \\ \text{curr = } T_{\text{cellphone}} : \text{RecType} \end{array} \right] \end{array} \right] \right]$$

Strengths and Limits of These Models

- **What they capture well :**
 - ▶ context and information updates;
 - ▶ reference, presuppositions, grounding;
 - ▶ dialogue moves and intentions;
 - ▶ repair and clarification.
- Extensions are proposed based on personal needs (physical context, topoi, topic shifts, etc.)
- **What remains challenging :**
 - ▶ social factors, power dynamics;
 - ▶ affective and relational aspects;
 - ▶ open-domain, casual conversation;
 - ▶ scalability to LLM-based interaction.




→ These models give us strong tools for *logical* and *actional* structure, but still struggle with the *social*, and *human* nature of dialogue...






Summary




Summary

- Dialogue engineering starts with understanding **what dialogue is**
 - studying dialogue is essential before building dialogue systems.
- Dialogue is best seen as a **continuum**, rather than a binary category.
- We discussed a set of features for characterising dialogue :
 - ▶ People, interaction, environment and medium, and function and meaning;
 - ▶ These features are not exhaustive and exist more or less prototypically depending on the type of language use.
- Models of dialogue structure attempt to formalise the logical and actional structure of dialogue :
 - This can serve as a basis to build dialogue systems.

- Human conversation is complex and so is transferring it to dialogue systems :
 - ▶ Look at some technical aspects of designing dialogue systems;
 - ▶ Discuss which features of dialogue must be included or not in the design.

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