

Foundations of Speech and Language Technology:

Discourse and Dialogue

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Purpose

- Purpose:
 - There is a reason why S and H interact: they have some goal(s) they want to achieve
 - There is a reason why any part of the discourse is there: it contributes to achieving some goal(s)
- S and H may have joint (shared) goals or individual (different) goals
 - Cooking dinner together vs. Getting someone to come to a surprise party

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Discourse

- = a unit of language (language use) consisting of more than one utterance
 - Utterance = the use of a NL expression (sentence, ...) speaker S, to hearer(s) H, at time t, in situation s
- Monologue vs. dialogue
- Written vs. spoken, or multimodal
- Characteristics:
 - Purpose; Collaboration; Coherence; Cohesion

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Collaboration

- Collaboration:
 - Communication is inherently a collaborative activity: S and H work together to establish and achieve their goals
- Cooperative Principle (Grice)
 - Make your contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged
 - Maxims of Conversation
 - Maxim of quality
 - Maxim of quantity
 - Maxim of relevance
 - Maxim of manner

Cf. [1]: Chapter 19

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Cohesion

- Cohesive devices: linguistic means that make a discourse stick together
 - anaphoric expressions, discourse connectives, lexical chains ...

Two guys were working for the city. One would furiously dig a hole, then the other would come behind him and quickly fill the hole. They were drenched in sweat.

Two guys were working for the city. He likes cake. A townhall is near a river.

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Coherence

= Making sense together, as a whole:
the parts contribute in a meaningful way

Two guys were working for the city. One would furiously dig a hole, then the other would come behind him and quickly fill the hole. They were drenched in sweat.

Two guys were working for the city. He likes cake. A townhall is near a river.

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Outline

- Anaphoric reference
- Discourse relations
- Discourse structure
- Speech acts
- Grounding

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Anaphoric Reference

Basic reading:

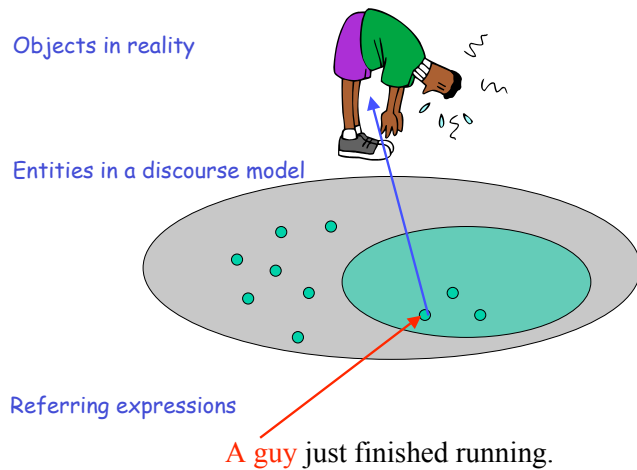
[1]: Chapter 18, Section 18.1

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Reference



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Discourse Model

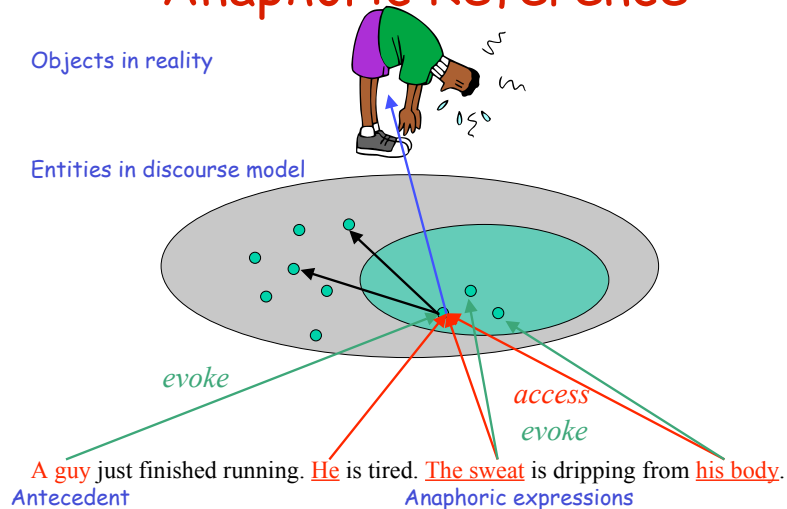
- Universe of discourse entities introduced as "referents" of linguistic expressions
 - Operations:
 - Evoke (new) discourse entity
 - Access (old) discourse entity
 - Discourse entity status:
 - New, old, inferable
 - Basic types of discourse entities:
 - Objects (concrete/abstract) vs. events (states)
- Basic types of referring expressions:
 - Noun phrases, pronouns
 - Temporal and spatial expressions

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Anaphoric Reference



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Anaphoric Reference

- Coreference
 - Anaphoric expression refers to the same entity as its antecedent (identity of referent)
- Bridging
 - Anaphoric expression refers to a different entity than the antecedent there is an association relationship between the referents, e.g., part-whole, set-member, entity-attribute... (the entity is inferable)

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Exercise

Two guys were working for the city. One would furiously dig a hole, then the other would come behind him and quickly fill the hole. They were drenched in sweat.

A man watching from the sidewalk couldn't believe how hard they were working, but also couldn't understand what they were doing. Finally he said:

"I'm confused. You dig a hole and then your partner comes behind you and fills it up again!"

The digger leaned on his shovel and replied,

"Oh yeah, it must look funny. You see, the lazy jackass who plants the trees is sick again today!"

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Anaphora Resolution

- Anaphora is a device of language economy, it's natural and mostly easy for humans
- Why is it a problem for NLP?
 - Information extraction (topic segmentation)
 - Summarization
 - Machine translation
 - Dialogue systems:
 - (1) U: Do any samples contain magnesium?
S: Yes. R560 and R668.
U: And do they contain ruthenium?
 - (2) S: Do any samples contain magnesium?
U: No.
S: And do they contain ruthenium?

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Anaphora Resolution

- Task of reference resolution:
 - Determine referents
(= for each referring expression, determine how the discourse model is to be updated)
- Task of anaphora resolution:
 - Identify anaphors
 - Identify antecedents
 - Identify relationships

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Anaphora Resolution

- Criteria on antecedent/anaphor pairs:
 - Agreement (person, gender, number)
 - Syntactic relationships (binding)
 - Lexical repetition (edit distance)
 - Selectional restrictions on arguments
 - Salience: recency, grammatical role, semantic orientation, etc.
 - Repeated mention count
 - Parallelism
 - World knowledge

Cf. [1]: Chapter 18, pp. 678-684

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Anaphora Resolution

- Search:
 - Given an anaphor, systematically consider one potential antecedent after another
 - Best-first (in structured search-space)
 - Hard to optimize multiple decisions
- Classification:
 - Given all potential anaphor-antecedent pairs, decide yes/no (and optionally assign score)
 - Compute&evaluate all pairs
 - Local and global optimization: machine learning

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Coreference Resolution Algorithms

- Simplest: recency-based:
 - Look back & rule out incompatible candidates
- There are various other approaches:
 - Hobb's 1978: syntactic search
 - Brennan et al. 1987: Centering-based
 - Lappin&Leass 1994: weighted salience factors
 - Baldwin 1995: specialized high precision rules
 - Recent machine learning methods

Cf. [1]: Chapter 18: pp. 684-694
but do not need to know for exam

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Exercise

Two guys were working for the city. One would furiously dig a hole, then the other would come behind him and quickly fill the hole. They were drenched in sweat.

A man watching from the sidewalk couldn't believe how hard they were working, but also couldn't understand what they were doing. Finally he said:

"I'm confused. You dig a hole and then your partner comes behind you and fills it up again!"

The digger leaned on his shovel and replied,

"Oh yeah, it must look funny. You see, the lazy jackass who plants the trees is sick again today!"

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Discourse Relations (coherence/ rhetorical relations)

Basic reading:

[1] Chapter 18, Section 18.2, 18.3;

[1] Chapter 19, Section 19.4

[2]

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Discourse Relations

1. Two guys were working for the city.

Elaboration

2. One would furiously dig a hole,

Occasion

3. then the other would come behind him

Occasion

4. and quickly fill the hole.

Result

5. They were drenched in sweat.

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Discourse Relations

- Various specific types of connections relating utterances in discourse
- These connections add meaning beyond the propositional content of each of the segments alone
- Sometimes they are explicitly signaled by discourse connectives and other markers

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Discourse Relations

- Result(b,a): e_a causes e_b
 - Peter eats vegetables. He is healthy.
- Explanation(b,a): e_b causes e_a
 - Peter is healthy. He eats vegetables.
- Elaboration(b,a): e_b included in e_a
 - Peter went to the mountains. He skied every day.
- Occasion: e_a before e_b
 - Peter bought skis. He went to the mountains.
- Parallel(a,b): e_a and e_b are similar
 - Peter eats vegetables. Paul regularly sports.

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Exercise

Two guys were working for the city. One would furiously dig a hole, then the other would come behind him and quickly fill the hole. (As a result) They were drenched in sweat.

A man watching from the sidewalk couldn't believe how hard they were working, but also couldn't understand what they were doing.

Finally he said: "I'm confused. You dig a hole and then your partner comes behind you and fills it up again!"

The digger leaned on his shovel and replied,

"Oh yeah, it must look funny. You see, the lazy jackass who plants the trees is sick again today!"

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Discourse Relation Resolution

- Why?
 - Information extraction (topic segmentation)
 - Summarization
 - Dialogue systems:
e.g., **revision vs. occasion**
U: OK. That's good. Now I'd like you to find and show the song Jingle Bells. **Please search for the song Jingle Bells.**

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Discourse Relation Recognition

- Knowledge-intensive (suitable in limited domains):
 - Inference-based:
 - Encode discourse relations as axioms
 - Construct a proof for discourse (abduction)
 - Plan-based
 - Encode discourse relations as plan operators
 - Instantiate plan for discourse goal
- Knowledge-poor (suitable on large scale):
 - Discourse grammar-based (brittle)
 - Encode discourse relations as structural rules
 - Parse discourse
 - Shallow use of various surface clues (robust)
 - Supervised machine learning (needs annotated data)
(cf. work by Daniel Marcu or Simone Teufel)

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Discourse Structure

- Discourse is not just a flat linear sequence of utterances, but has hierarchical structure
 - Subordination (embedding)
e.g., elaboration, result, explanation
 - Coordination (linear precedence)
e.g., parallel, occasion
- Recursively built discourse segments
- Each segment has a purpose

Cf. [1]: 18.3, 19.4

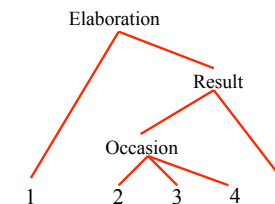
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Discourse Structure

1. Two guys were working for the city.
2. One would furiously dig a hole,
3. then the other would come behind him
4. and quickly fill the hole.
5. They were drenched in sweat.



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Discourse Structure

- Discourse segment recognition
 - Discourse markers (cue phrases), e.g., now, well, so
 - Prosodic indicators:
 - Change of pitch range
 - decreasing within segment, reset at boundary
 - Speed
 - Faster for embedded segment
 - Pauses at boundaries
 - Tense and mood changes
 - Topic changes tend to correlate with segment boundaries
 - Use of anaphoric expressions
 - Antecedents accessible within segment
 - Antecedent inaccessible across segment boundaries

Cf. [2]: Section 11.3
but need not know for exam

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Three Layers of Discourse Structure

Grosz and Sidner 1986:

- Linguistic structure
 - Segments marked by linguistic means
- Intentional structure
 - Hierarchically related discourse purposes
- Attentional structure
 - Stack of "focus spaces" (accessible entities)

Cf. [2]: p. 442
but need not know for exam

The levels are mutually co-constraining.

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Global Discourse Structure

- Particular discourse genres typically exhibit regular structural patterns
 - Scientific paper: abstract, introduction, body sections, related work, conclusions
 - Story: introduction, climax, ending
 - Recipe: ingredients, procedural steps, serving suggestions
 - News article: summary, detailed story
 - Telephone call: greetings, body section(s), closing
 - ...

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Speech Acts (Dialogue Acts/Moves)

Basic Reading:

[1] Chapter 19

(need know details of 19.3 and 19.5)

[3] (need not know details)

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Speech Acts

Speech act theory [Austin, Searle]

- how to do things with words
- Utterances bring about acts on context
 - Locutionary act: the act of uttering the words with their semantic content
 - Illocutionary act: the communicative act the speaker intends to perform by saying the words = speech act
 - Perlocutionary act: the act that occurs as a result/effect of the utterance, intended or unintended (e.g., making someone laugh, scared...)

Speech Act Types

Assertive	S commits to sth being the case	Comment, suggest, swear, boast, conclude
Directive	S attempts to get H do sth	Ask, order, request, beg, invite, advise
Commissive	S commits to future course of action	Promise, plan, vow, bet, oppose
Expressive	S expresses psychological state	Thank, apologize, welcome, deplore
Declarations	S changes world	Resign, name, fire

Conversation Structure

- Common overall organization
 - Expected SAs
 - E.g., Opening, body, closing of telephone call(s)
- Some SA sequences occur regularly, are even conventionalized (obligation to respond, preferred responses)
 - Greeting-greeting
 - Question-answer
 - Compliment-downplayer
 - Accusation-denial
 - Offer-acceptance
 - Request-grant
 - ...

Speech Act Recognition

- Why?
 - To determine what user wants
 - And to decide about an appropriate response, e.g., accept/reject statement vs. fulfill/turn-down request
- How do we decide what DA a user input is, e.g., statement vs. info-request
 - At first glance, this looks simple: different syntax:
 - Yes-no-questions have subj-verb inversion
 - Statements have declarative syntax
 - Commands have imperative syntax
- However, the mapping between surface form and illocutionary act is not one-to-one

Speech Act Recognition

- For example, what looks like a yes/no question
Can you give me a list of the flights from A to B
Can be a polite form of directive or request
Please give me a list of flights from A to B
- What looks like a statement
And you said you wanted to travel next week
Can actually be a question, used to verify sth.
(intonation?)

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Speech Act Recognition

- Another example of "indirectness":
A: That's the telephone.
B: I'm in the bath.
A: OK.
- Can be paraphrased as follows:
A requests B to perform action (answer phone)
B states reason why he cannot comply (in bath)
A undertakes to perform action (answer phone)

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Speech Act Recognition

- Idiom-based model:
 - Literal meaning (direct speech act)
 - Idiomatic meaning (indirect speech act)the grammar lists idiomatic meanings for each construction, e.g., "Can you X?" has request as one possible meaning
- Inferential model: indirect speech acts arrived at by inference

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Automatic SA Recognition

- Plan-based interpretation
 - Essentially the inference model, differences lie in amount and depth of actual reasoning
 - Symbolic
 - Requires hand-coding and domain-knowledge
- Cue-based recognition
 - Essentially derived from the idiom model
 - Using a combination of utterance features and context features (supervised machine learning methods)
 - Requires hand-annotated data

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Example/Exercise

Grounding

Basic reading:
[1] Chapter 19
[4]

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Grounding

- Establishing common ground
- Levels of interpretation (Clark 1996):

Intention	S proposes project w	H considers project w
Proposition	S signals that p	H recognizes that p
Signal	S presents signal s	H identifies signal s
Channel	S executes behavior t	H attends to behavior t

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Positive Grounding Feedback

- Continued attention
- Relevant next contribution
- Acknowledgement (nod or "continuer", e.g., uh-huh, yeah; or assessment, e.g., that's great)
- Demonstration (by paraphrasing, reformulating or cooperatively completing)
- Display (verbatim repetition)



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Positive Grounding Feedback

A: I'm confused. You dig a hole and then your partner comes behind you and fills it up again!

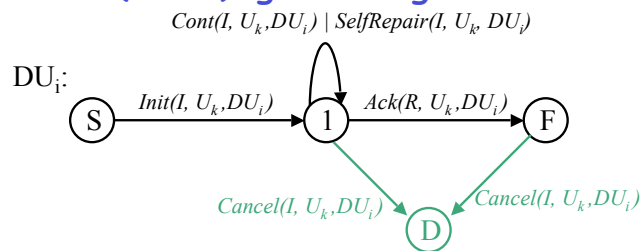
B: Oh yeah, it must look funny. You see, the lazy jackass who plants the trees is sick again today!

Grounding Problems

- Grounding problems are due to
 - Lack of perception or understanding
 - Ambiguity
 - Conflicts (differences in beliefs)
 - Misunderstanding (misinterpretation)
- Clarification and repair strategies, e.g., ask for clarification, repetition, rephrase

Modeling Grounding Acts

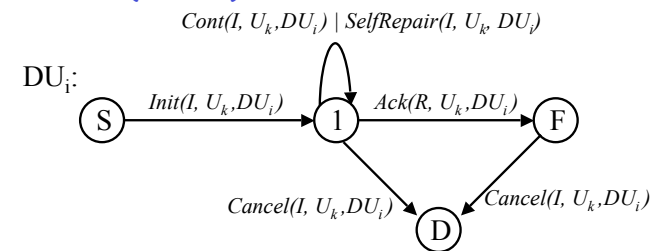
- Traum (1999): grounding acts



(1) 1:A: Move the boxcar to Corning $Init(A,1,DU1)$
 2:A: and load it with oranges $Cont(A,2,DU1)$
 3:B: OK $Ack(B,3,DU1)$

Grounding Acts

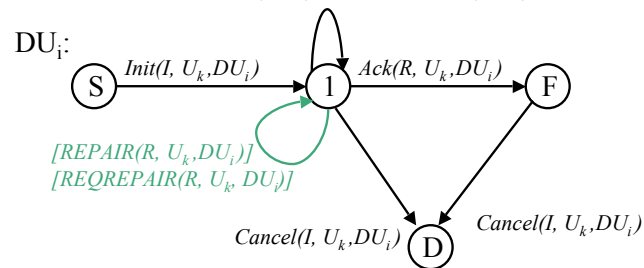
- Traum (1999)



(1) 1:A: Move the boxcar to Corning $Init(A,1,DU1)$
 2:: and load it with oranges $Cont(A,2,DU1)$
 3:B: OK $Ack(B,3,DU1)$

Grounding Acts

$Cont(I, U_k, DU_i) \mid SelfRepair(I, U_k, DU_i)$



(5) 1:A: Move the boxcar to Bath
2:B: Bath?

3:A: Oh, Corning.

4:B: OK

Init(A,1,DU1)
ReqRepr(B,2,DU1)
 \approx Init(B,2,DU2)
Ack(A,3,DU2)
 \approx Repair(A,3,DU1)
Ack(R,4,DU1)

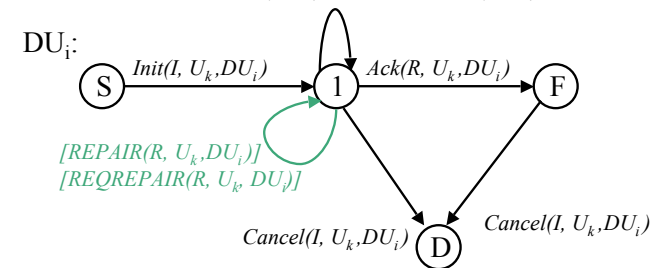
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Grounding Acts

$Cont(I, U_k, DU_i) \mid SelfRepair(I, U_k, DU_i)$



(4) 1:A: Move the boxcar to Bath
2:B: To Corning

3:A: Oh, sure.

Init(A,1,DU1)
Repair(B,2,DU1)
 \approx Init(B,2,DU2)
Ack(A,3,DU2)

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Example/Exercise

Wrap-Up

- Language use is rife with challenging discourse level phenomena:
 - Anaphoric reference
 - Discourse relations
 - Speech acts
 - Grounding acts
- Co-constraining aspects: structure, attention, intention
- Interpretation
 - Ultimately requires inference and world knowledge
 - Possible in limited domains
 - Can be approximated using surface clues (robust, large scale)
- Generation (see [1]: Chapter 20, Section 20.4)
 - Naturalness, economy --> easy to understand for users
 - Approximation according to available resources/information

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Basic Reading

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- [2] B. Grosz, M. Pollack and C. Sidner (1989): Discourse. In
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- [3] D. Jurafsky (2006): Pragmatics and Computational
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<http://people.ict.usc.edu/~traum/Papers/psych.ps>