

CS 533
Natural Language Processing
Lecture 4 – February 24, 2003

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Context and Context Change Outline

Anaphora and ellipsis
Coordination and coordination devices
The conversational record
Representing context
Representing context change

Language and context (from last time)

Key point:

Utterances use general information (*semantics*)
to construct *interpretations* that fit a specific
ongoing context.

Language and context

Consider:

[At a restaurant]

Q: Would you like a drink with dessert?

A: I'd like coffee.

Language and context

Consider:

[At an ice-cream shop]

Q: Which of these flavors do you want?

A: I'd like coffee.

Anaphora and ellipsis

Language offers many reduced expressions
that seem to be interpreted by accessing the
history of the discourse rather than *general
knowledge* about the world.

Anaphora = description of an entity that has
been previously introduced into the
discourse.

Ellipsis = construction which describes
something without an overt constituent that
identifies it

Anaphora and ellipsis: examples

Ordinary pronouns

John went to Bill's car dealership to check out an Acura integra. *He* looked at *it* for about an hour.

Anaphora and ellipsis: examples

Demonstrative pronouns:

According to John, Bob bought Sue an integra, and Sue bought Fred a legend.

But *that* turned out to be a lie.

But *that* was false.

That struck me as a funny way to describe the situation.

That caused Sue to become rather poor.

That caused them both to become rather poor.

Anaphora and ellipsis: examples

One-anaphora

I saw no less than six Acura integras today.
Now I want *one*.

Anaphora and ellipsis: examples

Alternative phrases

What is the drinking age in Afghanistan, and what is the drinking age in *other* countries?

Bushwackers are very comfortable. Where can I find *such* shoes?

Anaphora and ellipsis: examples

VP-ellipsis

George likes his mother and Al *does* too.

Anaphora and ellipsis: examples

Elliptical responses:

Who left?

Bill.

Anaphora and ellipsis: examples

Constituent ellipsis

Did Bo leave?

Bo?

Anaphora and ellipsis

These constituents *describe domain objects* just as we talked about last time.

But understanding these descriptions – figuring out what they describe – depends on *coordination* in dialogue, not just accessing information about the world.

Coordination

Two people have a coordination problem when they have common interests or goals and each person's actions depend on the actions of the other.

Discourse example:

A + B want to understand one another.

A: Say *he*, meaning John.

B: Understand *he* as John.

People are great at solving coordination problems

Ask 40 Yale undergrads this:

You are to meet somebody in NYC on day X. You have not been instructed where to meet, you have no prior understanding, you cannot communicate. You just have to show up some place some time. Where and when do you go?

People are great at solving coordination problems

Ask 40 Yale undergrads this:

You are to meet somebody in NYC on day X. You have not been instructed where to meet, you have no prior understanding, you cannot communicate. You just have to show up some place some time. Where and when do you go?

Half go to the info booth at Grand Central. Almost all show up there at noon.

Language involves a special kind of coordination

In general, coordination can require open-ended reasoning.

Language uses coordination only when it is very easy.

Let's go to NYC today.

?? I'll meet you there then.

General principles in linguistic coordination

Solvability

All the participants can expect that the speaker
chose the problem
designed its form
has a particular solution in mind
believes all will find it

General principles in linguistic coordination

Sufficiency

All the participants can expect that the speaker
gave all the information required to solve the
problem

General principles in linguistic coordination

Immediacy

All the participants can expect that they can
solve the problem without appreciable delay

Specific rules

You can use a pronoun only when its
referent is *in focus* – a special status that
depends on the referent's recent activation.

John went to Bob's party and parked next to a
beautiful Acura integra. He went inside and
talked to Bob for more than an hour. Bob told
him that he recently got engaged.
??He also said that he bought *it* yesterday.

Solving coordination problems

Use *preferences* or *coordination devices*

a specific rationale for adopting a particular
solution

"the ideal solution to a coordination problem is
the solution that is most salient, prominent or
conspicuous with respect to their current
common ground"

Example: Preferences in pronoun resolution

Recency

Entities introduced in recent utterances are more
salient than entities introduced further back.

John has an Integra.
Bill has a Legend.
Mary likes to drive *it*.

**Example:
Preferences in pronoun resolution**

Grammatical role

Entities introduced in more prominent grammatical positions are more salient.

John went to the Acura dealership with Bill.
He bought an Integra.

**Example:
Preferences in pronoun resolution**

Repeated mention

Entities that have been focused on in the prior discourse are more likely to continue to be focused on in subsequent discourse.

John needed a car to get to his new job. He decided that he wanted something sporty. Bill went to the Acura dealership with him.
He bought an Integra.

**Example:
Preferences in pronoun resolution**

Parallelism

Pronouns in parallel sentences are more likely to take antecedents from structurally parallel places.

Mary went with Sue to the Acura dealership.
Sally went with *her* to the Mazda dealership.

**Example:
Preferences in pronoun resolution**

Verb semantics

Certain verbs appear to place a semantically-oriented emphasis on one of their arguments, which biases the way subsequent pronouns are interpreted.

John telephoned Bill. *He* lost the pamphlet on Acuras.
John criticized Bill. *He* lost the pamphlet on Acuras.

Computational Challenges

Keeping track of discourse information
Stating preferences precisely
Computing preferred interpretations

Keeping track of discourse information

The conversational record
Discourse structure
Discourse relations
Attentional state

Conversational record

An agreed “transcript” of what has happened in the conversation
(an important part of the common ground)

including

- utterances
- interpretations
- actions
- events, etc.

making clear the ongoing status of discussion

Discourse structure

We identify connections between juxtaposed utterances.

John hid Bill’s car keys. He was drunk.
??John hid Bill’s car keys. He likes spinach.

When we can’t connect utterances, they don’t make sense together!

Discourse structure

When two utterances fit together:

John hid Bill’s car keys. He was drunk.
they create a *discourse segment* that achieves a coherent *overall purpose*

Discourse structure

Multiple utterances go together recursively, into a *hierarchical structure*.

Siblings in this structure are closely related.

[John went to the bank to deposit his paycheck.
[He then took a train to Bill’s car dealership.
[He needed to buy a car.
The company he works for isn’t near any public transportation.]
He also wanted to talk to Bill about their softball league]]

Discourse structure

The same applies to dialogue.

[C: I need to travel in May
[A: And what day in May did you want to travel?
C: OK uh I need to be there for a meeting that’s from the 12th through the 15th.]
[A: And you’re flying into what city?
C: Seattle.]
[A: And what time would you like to leave Pittsburgh?]
[C: I don’t think there’s many options for non-stop.
A: Right. There’s three non-stops today...

Discourse structure – an incremental perspective

At any point, you have a stack of progressively larger segments in progress.

[C: I need to travel in May
[A: And what day in May did you want to travel?
[John went to the bank to deposit his paycheck.
[He then took a train to Bill’s car dealership.
[He needed to buy a car.

Discourse structure – an incremental perspective

Each corresponds to a potentially unsatisfied intention or *open question* that new events could help resolve.

[C: I need to travel in May

[A: And what day in May did you want to travel?

[John went to the bank to deposit his paycheck.

[He then took a train to Bill's car dealership.

[He needed to buy a car.

Discourse relations

Each utterance then attaches by finding an element on this stack that it is related to.

Kinds of relations:

cause-effect

resemblance

occasion

followup

Cause-effect

Result

George is a politician and therefore he's dishonest.

Explanation

George is dishonest. He's a politician.

Violated expectation

George is a politician, but he's honest.

Denial of preventer

George is honest, even though he's a politician.

Resemblance

Parallel

Dick Gephardt organized rallies for Al Gore, and Tom Daschle distributed pamphlets for him.

Contrast

Gephardt supported Gore but Arney supported Bush.

Exemplification/generalization

Young aspiring politicians often support their party's pres. cand. For example, Bayh campaigned hard for Gore in 2000.

Occasion

Relate the two situations described.

George picked up the speech. He began to read.

Larry went into a restaurant. The baked salmon sounded good and he ordered it.

Followup

Examples: question and answer

A: Who came to the party?

B: John and Mary.

Utterance and request for clarification

A: John and Mary came to the party.

B: Which party?

Utterance and correction

A: John got the top prize for his essay.

B: No, it was Sue who got it.

Discourse structure and relations

Stack of segments

New utterances attach to segments by specific relations

[John went to the bank to deposit his paycheck.
[He then took a train to Bill's car dealership.
[He needed to buy a car.

Attentional state

Saliency is associated with segments

You prefer to draw other referents from the same segment that you attach to.

...it should be possible to identify certain functions as being unnecessary for thought by studying patients whose cognitive abilities are unaffected by locally confined damage to the brain. {1 For example, binocular stereo fusion is known to take place in a specific area of cortex near the back of the head. {2 Patients with damage to this area of the cortex have visual handicaps but {3 they show no obvious impairment in their ability to think. 3} 2} This suggests that stereo fusion is not necessary for thought. 1} This is a simple example, and the conclusion is not surprising.

Computational Challenges

Keeping track of discourse information

Stating preferences precisely

Computing preferred interpretations

Stating preferences precisely

Pronoun case:

If u contains a pronoun p

and u is related to v in discourse structure

and v puts x in focus

and p agrees with x

you have a coordination device to link p to x

Explaining preferences

Recency

Entities introduced in recent utterances are more salient than entities introduced further back.

[John has an Integra.
[Bill has a Legend.
Mary likes to drive *it*.]]

Explanation: hypothesis about attachment in discourse: prefer to attach low.

Explaining preferences

Grammatical role

Entities introduced in more prominent grammatical positions are more salient.

John went to the Acura dealership with Bill.
He bought an Integra.

Explanation: hypothesis about saliency within segments.

Explaining preferences

Repeated mention

Entities that have been focused on in the prior discourse are more likely to continue to be focused on in subsequent discourse.

[John needed a car to get to his new job. [He decided that he wanted something sporty. Bill went to the Acura dealership with him.]

He bought an Integra.]

Explanation: consequence of high attachment.

Explaining preferences

Parallelism

Pronouns in parallel sentences are more likely to take antecedents from structurally parallel places.

Mary went with Sue to the Acura dealership.
Sally went with *her* to the Mazda dealership.

Explanation: pronoun resolution must support inferred coherence relation

Explaining preferences

Verb semantics

Certain verbs appear to place a semantically-oriented emphasis on one of their arguments, which biases the way subsequent pronouns are interpreted.

John telephoned Bill. *He* lost the pamphlet on Acuras.
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Explanation: pronoun resolution must support inferred coherence relation.

Computational Challenges

Keeping track of discourse information

Stating preferences precisely

Computing preferred interpretations

Search

```
solve([]).  
solve([C|Cs]) :-  
  clause(C, true),  
  solve(Cs).
```

Search with preferences

```
solvep([], Pref, Pref).  
solvep([C|Cs], In, Out) :-  
  salient_fact(C, Weight),  
  combine_weights(In, Weight, Next),  
  solvep(Cs, Next, Out).
```

Iterative deepening

```
solvep([], _, Pref, Pref).  
solvep([C|Cs], Max, In, Out) :-  
    salient_fact(C, Weight),  
    combine_weights(In, Weight, Next),  
    Next < Max,  
    solvep(Cs, Max, Next, Out).
```