Introduction to Natural Language Processing

Chapter 18

Outline

Homework 3

Nov 22: John Dowding (NASA) at CIRCLE Seminar

Pragmatics: Discourse Analysis

Reference Resolution

Text Coherence

Discourse Structure

The Problem of Discourse

Discourse

Monologue and dialogue (dialog)

Human-computer interaction

Examples

- *John* went to Bill's car dealership to check out *an Acura Integra*. *He* looked at *it* for about half an hour.
- I'd like to get from Boston to San Francisco, on either December 5th or December 6th. It's okay if *it* stops in another city along the way.

Another Example

Gracie: Oh yeah ... and then Mr. and *Mrs. Jones* were having matrimonial trouble, and my brother was hired to watch *Mrs. Jones*.

George: Well, I imagine *she* was a very attractive woman.

Gracie: *She* was, and my brother watched *her* day and night for six months.

George: Well, what happened?

Gracie: *She* finally got a divorce.

George: *Mrs. Jones*?

Gracie: No, my brother's wife.

Reference Resolution

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

Reference

- the process of associating *John* and *he* with a particular person

Referring expressions

- *John*, *he*

Referents

- the person named John

Coreferring referring expressions

- *John*, *he*

Antecedent

- *John*

Anaphor

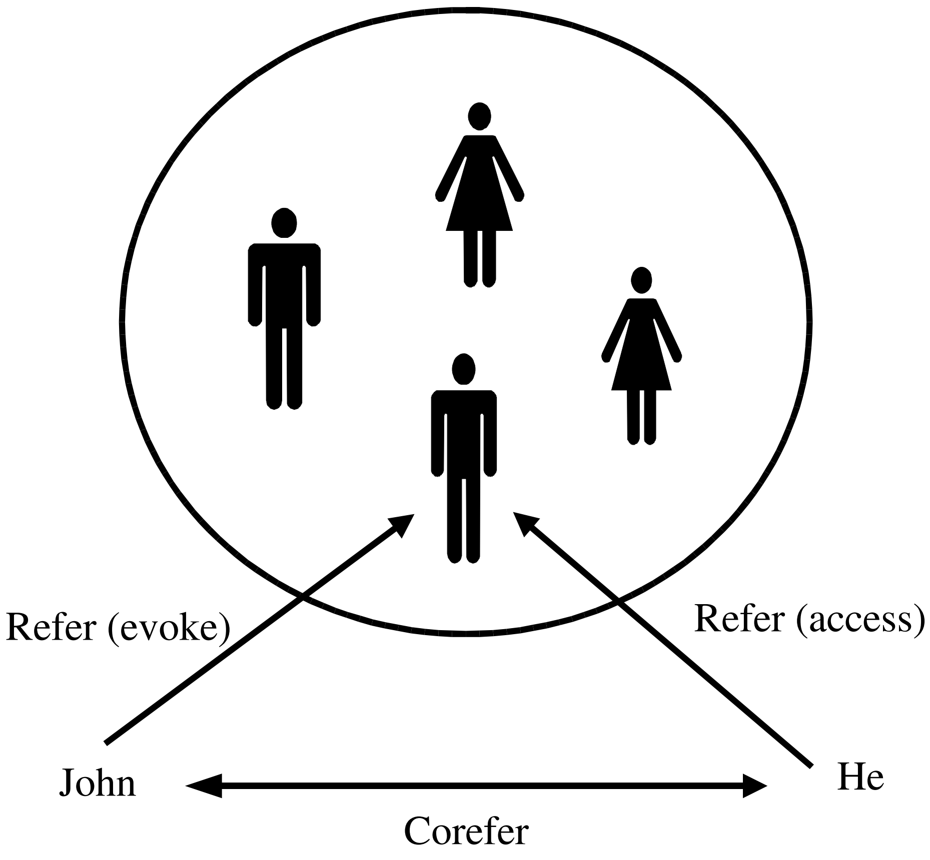
- *he*

Discourse Model

Needed because referring expressions (e.g. *it, this, that, this car, that car, the car, the Acura, the Integra, ...*) encode information about beliefs about the referent.

When a referent is first mentioned in a discourse, a representation for it is <u>evoked</u> into the model.

Upon subsequent mention, it is <u>accessed</u> from the model.



Many Types of Reference

Non-entity examples (from Webber 91)

According to John, Bob bought Sue an Integra, and Sue bought Fred a Legend.

- But *that* turned out to be a lie. (a speech act)
- But *that* was false. (proposition)
- *That* struck me as a funny way to describe the situation. (manner of description)
- *That* caused Sue to become rather poor. (event)
- *That* caused them both to become rather poor. (combination of several events)

Reference Phenomena

Indefinite noun phrases

- I saw *an Acura Integra* today.
- *some, this*

Definite noun phrases

- I saw an Acura Integra today. *The Integra* was white.
- *The Indianapolis 500* (kb)
- *The fastest car in ...* (unique)

Demonstratives

- *This Acura* is white.

One-anaphora

- I saw 6 Acuras today. Now I want *one*.

Reference Phenomena (cont.)

Pronouns

- I saw an Acura Integra today. *It* was white.
- compared to definite noun phrases, pronouns require more referent salience in the discourse model
- salience via recency
  - 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.
  - He also said that he bought *the Acura* yesterday.
- salience via structural recency
  - E: So you have the engine assembly finished. Now attach *the rope*. By the way, did you buy <u>the gas can</u> today?
  - A: Yes.
  - E: Did <u>it</u> cost much?
  - A: No.
  - E: OK, good. Have you got *it* attached yet?

Reference Phenomena (cont.)

Inferrables

- I almost bought an Acura Integra today, but *a door* had a dent and *the engine* seemed noisy.
- Mix the flour, butter, and water. Knead *the dough* until smooth and shiny.

Discontinuous sets

- *John* has an Acura and *Mary* has a Subaru. *They* drive them all the time.

Generics

- I saw 6 Acuras today. *They* are the coolest cars.

Constraints on Coreference

Number agreement

- John has *an Acura*. *It* is red.

Singular	Plural	Unspecified
she, her, he, him, his, it	we, us, they, them	you

Person and case agreement

- (⋆) *John and Mary* have <u>Acuras</u>. *We* love <u>them</u>. (where We=John and Mary)

	First	Second	Third
Nominative	I, we	you	he, she, they
Accusative	me, us	you	him, her, them
Genitive	my, our	your	his, her, their

Gender agreement

- John has an Acura. He/it/she is attractive.

masculine	feminine	nonpersonal
he, him, his	she, her	it

Constraints (continued)

Syntactic constraints

- John bought himself a new Acura. (himself = John)
- John bought him a new Acura (him = not John).

Selectional restrictions

- John parked *his Acura* in <u>the garage</u>. He had driven *it* around for hours.

Pronoun Interpretation Preferences

Recency

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

Grammatical role

- *John* went to the Acura dealership with Bill. *He* bought an Integra.
- *Bill* went to the Acura dealership with John. *He* bought an Integra.
- (?) John and **Bill** went to the Acura dealership. *He* bought an Integra.

Repeated mention

- *John* needed a car to go to his new job. *He* decided that *he* wanted something sporty. Bill went to the Acura dealership with *him*. *He* bought an Integra.
- Note: overrides grammatical role preference

Preferences (continued)

Parallelism

- Mary went with *Sue* to the Acura dealership. `Sally` went with *her* to the Mazda dealership.
- Mary went with *Sue* to the Acura dealership. `Sally` told her not to buy anything.

Verb semantics, thematic roles

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

Pronoun Resolution Algorithm

Two steps

- discourse model update
- pronoun resolution

Salience values are introduced when a noun phrase that evokes a new entity is encountered.

These values are computed as a sum of weights assigned by salience factors (set empirically).

Salience Factors and Weights

From Lappin and Leass's system:

Sentence recency	100
Subject emphasis	80
Existential emphasis	70
Accusative (direct object) emphasis	50
Indirect object and oblique complement emphasis	40
Non-adverbial emphasis	50
Head noun emphasis	80

Recency

- weights are cut in half after each sentence is processed
- this, and a sentence recency weight, captures the recency preferences discussed earlier

Lappin and Leass (continued)

Grammatical role preference

- subject > existential predicate nominal > object > indirect object or oblique > demarcated adverbial PP

Examples

- *An Acura Integra* is parked in the lot. (subject)
- There is *an Acura Integra* parked in the lot. (existential predicate nominal)
- John parked *an Acura Integra* in the lot. (object)
- John gave *his Acura Integra* a bath. (indirect object)
- In *his Acura Integra*, John showed Susan his new CD player. (demarcated adverbial PP)

Head noun emphasis gives above examples 80 points, but following embedded NP nothing:

- The owner's manual for *an Acura Integra* is on John's desk.

Algorithm

1. Collect the potential referents (up to four sentences back).

2. Remove potential referents that do not agree in number or gender with the pronoun.

3. Remove potential referents that do not pass intrasentential syntactic coreference constraints.

4. Compute the total salience value of the referent by adding any applicable values for role parallelism (+35) or cataphora (-175) to the existing salience value.

5. Select the referent with the highest salience value. In case of a tie, select the closest referent in terms of string position.

Example

John saw a beautiful Acura Integra at the dealership last week. He showed it to Bob. He bought it.

See tables on pages 687-689 in Jurafsky and Martin.

Test Results

Lappin and Leass applied their algorithm to computer manuals and got 86% accuracy on unseen data.

Centering Algorithm (BFP)

Centering(Grosz, Joshi, and Weinstein): additional concept of a *center*.

Transitions

	$C_b(U_{n+1}) = C_b(U_n)$ or undefined $C_b(U_n)$	$C_b(U_{n+1}) \neq C_b(U_n)$
$C_b(U_{n+1}) = C_p(U_{n+1})$	Continue	Smooth-Shift
$C_b(U_{n+1}) \neq C_p(U_{n+1})$	Retain	Rough-Shift

Rules

1. If any element of $C_f(U_n)$ is a pronoun in utterance U_{n+1}, then $C_b(U_{n+1})$ must be a pronoun.
2. Continue is preferred to Retain is preferred to Smooth-Shift is preferred to Rough-Shift.

Algorithm

1. Generate $C_b - C_f$ combinations for all reference assignments.
2. Filter by constraints.
3. Rank by transition orderings.

Trace

John saw a beautiful Acura Integra at the dealership. *He* showed `it` to Bob. He bought it.

Grammatical role hierarchy

- $C_f(U_1)$: { John, Integra, dealership }
- $C_p(U_1)$: John
- $C_b(U_1)$: undefined

Assume *it* refers to the Integra

- $C_f(U_2)$: { John, Integra, Bob }
- $C_p(U_2)$: John
- $C_b(U_2)$: John
- Continue ($C_p(U_2) = C_b(U_2)$; $C_b(U_1)$ undefined)

Assume *it* refers to the dealership

- $C_f(U_2)$: { John, dealership, Bob }
- $C_p(U_2)$: John
- $C_b(U_2)$: John
- Continue ($C_p(U_2) = C_b(U_2)$; $C_b(U_1)$ undefined)

Trace (continued)

Going with first option and assuming he refers to $John$ ...

- $C_f(U_3)$: { John, Acura }
- $C_p(U_3)$: John
- $C_b(U_3)$: John
- Continue $(C_p(U_3) = C_b(U_3) = C_b(U_2))$

Going with first option and assuming he refers to Bob ...

- $C_f(U_3)$: { Bob, Acura }
- $C_p(U_3)$: Bob
- $C_b(U_3)$: Bob
- Smooth-Shift ($C_p(U_3) = C_b(U_3)$ does NOT $= C_b(U_2)$)

Since Continue preferred over Smooth-Shift, algorithm picks John as as the referent.

Today's Outline

Announcements

- Homework 3 due Tuesday
- Dialogue questions due Tuesday
- PARTIAL Coref Annotations Available
- Reminder: John Dowding (NASA) at CIRCLE Seminar

Review Reference Resolution

Discourse Analysis

- Text Coherence
- Discourse Structure

Coref Project Annotations

(RUSSIA, July, 1987) - Today, a girl named
Lynne Cox swam from the United States to Russia!

(<COREF ID="508" REF="501"><MARKABLE>RUSSIA
</MARKABLE></COREF>,
<COREF ID="509"><MARKABLE>July, 1987
</MARKABLE></COREF>) -

COREF ID="510" REF="509"><MARKABLE>Today
</MARKABLE></COREF>,
a
<COREF ID="511" REF ="502"><MARKABLE>girl
</MARKABLE></COREF>
named
<COREF ID="502"><MARKABLE>Lynne Cox
</MARKABLE></COREF>
swam from the
<COREF ID="503"><MARKABLE>United States
</MARKABLE></COREF>
to
<COREF ID="512" REF="501"><MARKABLE>Russia
</MARKABLE></COREF>!

Review: Reference Resolution

John went to Bill's car dealership to check out <u>an Acura Integra</u>. *He* looked at <u>it</u> for about half an hour.

Reference Phenomena

Constraints on Coreference

Pronoun Interpretation Preferences

Pronoun Resolution Algorithms

- discourse model update; salience
- Lappin and Leass
- Centering

Centering, final comments

Centering sometimes resolves a pronoun to something Lappin and Leass (or Hobbs, see text) would consider low salience.

Continue preference in centering mistakenly gives

- *Bob* opened up a new dealership last week. John took a look at the Acuras in his lot. *He* ended up buying one.

Centering is just now being specified enough to be automatically tested on actual data.

- The Role of Centering Theory's Rough-Shift in the Teaching and Evaluation of Writing Skills (Miltsakaki and Kukich, ACL 2000)
- Specifying the Parameters of Centering Theory: A Corpus-Based Evaluation using Text from Application-Oriented Domains (Poesio et al., ACL 2000)

Text Coherence

Cohesion

- referring expressions
- ellipsis, conjunction, lexical, ...
- see *Cohesion in English* by Halliday and Hasan

Coherence

- John hid Bill's car keys. He was drunk
- ? John hid Bill's car keys. He likes spinach.
- ? Bill went to see his mother. The trunk is what makes the bonsai, it gives it both its grace and power.

Coherence Relations: Hobbs

Result

- Infer that the state or event asserted by the meaning of the first sentence (S_0) causes or could cause the state or event asserted by the meaning of the second sentence (S_1).
- John bought an Acura. His father went ballistic.

Explanation

- Infer that the state or event asserted by S_1 causes or could cause the state or event asserted by S_0.
- John hid Bill's car keys. He was drunk.

Elaboration

- Infer the same proposition P from the assertions of S_0 and S_1.
- John bought an Acura this weekend. He purchased a beautiful new Integra for 20 thousand dollars at Bill's dealship on Saturday afternoon.

An Inference-Based Algorithm

Abduction

- A implies B
- B
- infer A

Example

- "All Acuras are fast. John's car is fast."
- abductively infer "John's car is an Acura."

Abduction is unsound

- defeasible
- "John's car is a Porsche though."

Furthermore, want the *best* explanation

- probabilities
- heuristics
- hybrid (Hobbs)

Example Trace

John hid Bill's car keys. He was drunk.

Coherence Relation Axioms

- $\forall e_i, e_j Explanation(e_i, e_j) \Rightarrow CoherenceRel(e_i, e_j)$
- $\forall e_i, e_j cause(e_j, e_i) \Rightarrow Explanation(e_i, e_j)$

World Knowledge Axioms

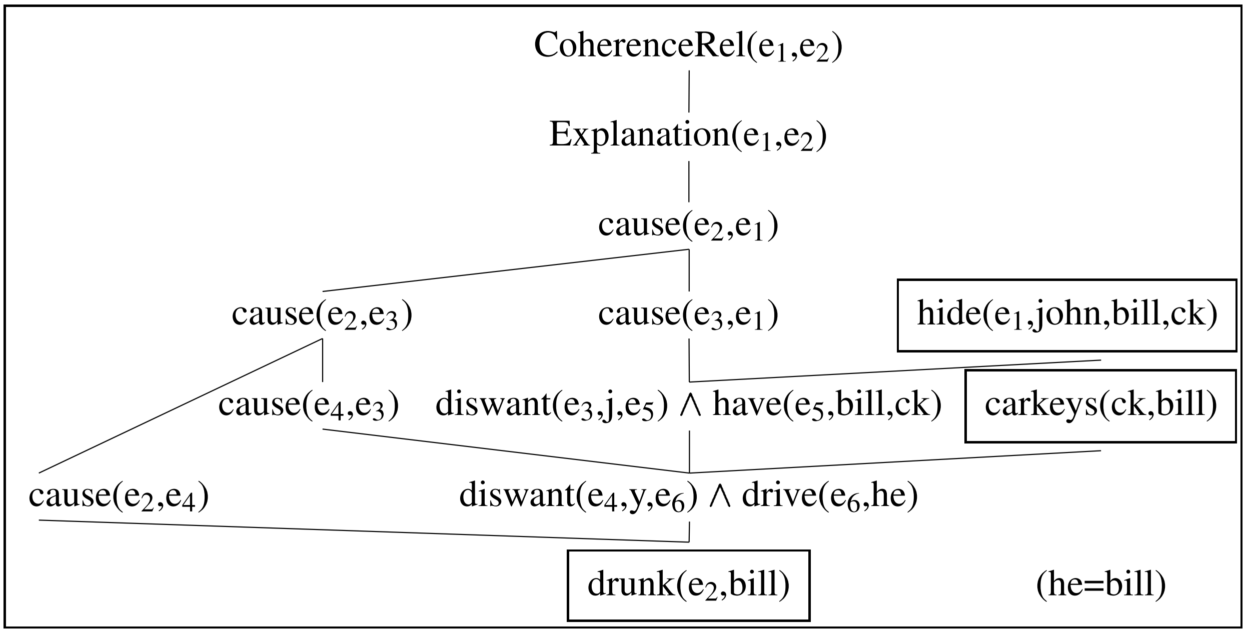
- $\forall x, y, e_i drunk(e_i, x) \Rightarrow \exists e_j, e_k diswant(e_j, y, e_k) \wedge drive(e_k, x) \wedge cause(e_i, e_j)$
- $\forall x, y, e_i, e_k diswant(e_j, y, e_k) \wedge drive(e_k, x)$
- $\Rightarrow \exists z, e_l e_m diswant(e_l, y, e_m) \wedge have(e_m, x, z) \wedge carkeys(z, x) \wedge cause(e_j, e_l)$
- $\forall x, y, z, e_i, e_j diswant(e_l, y, e_m) \wedge have(e_m, x, z)$
- $\Rightarrow \exists e_n hide(e_n, y, x, z) \wedge cause(e_l, e_n)$
- $\forall e_i, e_j, e_k, cause(e_i, e_j) \wedge cause(e_j, e_k) \Rightarrow cause(e_i, e_k)$

Utterance Axioms

- $hide(e_i, John, Bill, ck) \wedge carkeys(ck, Bill)$
- $drunk(e2, he)$

Deriving Coherence

John hid Bill's car keys. He was drunk.



Observations

The coherence derivation causes the inference of implicit information.

The given axioms do not support the coherence of "John hid Bill's car keys. He likes spinach."

Why2 Example Axioms

Discourse

- prove that there is a predicate value for an "it" that was used in place of a predicate name
- the lhs says that you must first prove there is another vector that has been expressed that is compatible with any vector information you have about the anaphoric predicate
- ```
  ((:name predicate-it-anaphora)
   (:lhs
    ((+pred ido2 ?pred) .3)
    ((quantity-rest ido2 ?number ?comp ?mag-der ?der-num1 ?mag-zero
                    ?mag-num ?dir ?dir-num1 ?d-dir1 ?new-dir) .3)
    ((quantity-rest ido1 ?number ?comp ?mag-der ?der-num1 ?mag-zero
                           ?mag-num ?dir ?dir-num1 ?d-dir1 ?new-dir)
   (:rhs
    (+pred ido1 ?pred))
   (:constraints
    (+pron= ido1 ?pred it)
    (neq ido1 ido2)))
  ```

Domain

- you can prove that something has a constant velocity if you can prove it has zero acceleration during the same time interval
  ```

Other Formalizations

Rhetorical Structure Theory (RST) (Ch. 20)

- primarily used for text generation

Plan-Based Relations (Ch. 19)

- Could you mount a magtape for me?
  - a discourse plan to introduce a domain plan to mount a tape
- It's tape 1.
  - specification of a parameter in the domain plan
- see "Linguistic Coherence: A Plan-Based Alternative" (Litman, 86)

More Observations

Coherence and Coreference

- John hid *Bill's* car keys. *He* was drunk
- *John* lost Bill's car keys. *He* was drunk

Coherence and Connectives (aka discourse markers, cue phrases)

- linguistic signals can be used to *constrain* the search
  - *because*: explanation
  - *and*: parallel, occasion, result
- however, connectives do not *create* coherence
  - ?? John hid Bill's car keys because he likes spinach.

Coherence and Applications

- e.g., summarization could merge or eliminate elaborations

Is this knowledge-based approach robust, efficient, practical, . . . ?

Discourse Structure

A (tree) structure of discourse segments (locally coherent utterances)

Structure of discourse segments (task and an interruption):

- E: So you have the engine assembly finished.
- E: Now attach *the rope*.
  - E: By the way, did you buy the gas can today?
  - A: Yes.
  - E: Did it cost much?
  - A: No.
  - E: OK, good.
- E: Have you got *it* attached yet?

Recall how this was mentioned when discussing recency for reference resolution.

Note presence of cue phrases (*by the way, ok*)

Observations

Original motivation: linguistic necessity

Recent applications

- summarization
- information retrieval
- audio browsing (broadcast news, email)
- text generation
- text to speech

Non-hierarchical structural analyses are also useful

Current topics include tagging reliability, statistical approaches

Local expertise

- research of Litman, Wiebe

Will be discussed further in Chapter 19

For Next Time

Chapter 19