

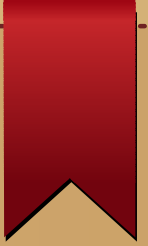
# Approaches for Handling Anaphora



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# Anaphora – The Textbook Definition



*“In linguistics, anaphora (/ə'næfərə/) is the use of an expression whose interpretation depends upon another expression in context (its antecedent or postcedent). In a narrower sense, anaphora is the use of an expression that depends specifically upon an antecedent expression and thus is contrasted with cataphora, which is the use of an expression that depends upon a postcedent expression.”*

*- The Wikipedia Page on Anaphora(Linguistics)*

# Examples of Anaphora


- **Susan** was a caring girl. She loved her pet raccoon very much.
  - Anaphor refers to subject of the preceeding sentence.
- Susan had a **pet raccoon**, who was very naughty.
  - Anaphor refers to object of the preceeding clause.
- Susan's pet raccoon dug through the **dumpster**, upending it onto the road.
  - Anaphor refers to inanimate object of the preceeding clause

# Examples of Anaphora

- **The raccoon caused a huge noise, which upset the whole neighbourhood.**
  - Anaphor referring to a VP
- Susan was **confused**. So were the neighbours.
  - Anaphor referring to an antecedent adjective
- The raccoon, following in its owner's example, was a kind animal, and had done it so that **Susan could also partake in the warm, nourishing, sweet-smelling trash**. However, *it* was not to be so.
  - Anaphors are not always pronouns; they can also be expressions or MWEs that refer to an antecedent.
  - Anaphors can summarise verb phrases or entire events. Eg: “done it” refers to the raccoon upending the dumpster.
  - “it” is not an anaphor, as it does not refer to a situation in the text. In this context, it is an *exophor*.
  - We can see “be so” referring to the entire VP “Susan could ... trash.”

# Ambiguous Anaphora Problems



- Ambiguity:  
“**Susan** had a **female raccoon**. She loved her very much.”
  - Even human beings have problems in interpreting this kind of ambiguity.
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# Centering Theory (CT)

- Proposed by Grosz, Joshi, and Weinstein in 1983.
- At any given point in a discourse, the attention of the participants is ‘centered’ on a set of entities that are a subset of all the entities in the discourse.
- For a given utterance, the attention of the participants is centered on a single entity.
- Degree of centrality of an entity imposes constraints on what can be the antecedent.
- Within the theory, there are different types of centers:

- Forward facing centers:

A set of discourse entities evoked by an utterance in a discourse segment. These discourse entities are sometimes ranked according to degree of centrality. (Subject > Object > Other)

- Backwards facing center


The highest ranked discourse entity in the previous utterance.

- Preferred center

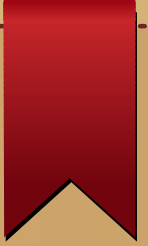
The highest ranked discourse entity in the previous utterance realised in the current utterance.

# Algorithms Based on CT



- Algorithms for handling anaphora use Centering Theory to:
    - Identify the antecedent of an anaphor.
    - If multiple entities, or ‘centers of discourse’, are present in a discourse, Centering Theory provides us a way to assign a single most probable antecedent to an anaphor.
    - Antecedents of an anaphor assigned based on ranking of forward facing centres of previous sentence.
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# The Problem of Abstract Anaphora



- While coreference resolution works on resolving relations between sets of real-world entities (people, objects, corporations, etc.) and anaphor mentions.
- On another hand, there are types of abstract anaphors, where references are made to propositions, facts, events or properties.
- Abstract anaphors typically have non-nominal antecedents.
- We refer to the sentence that contains the abstract anaphor as the *anaphoric sentence*, and the **constituent** that the anaphor refers to as the *antecedent*.





# Entity-Centered Model : Definitions

- Mentions: an observed textual reference to a latent real-world entity.  
Types:
  - Proper (Referring)
  - Nominal (Referring)
  - Pronominal
- Entity: a specific individual or object in the world, realised in this algorithm as a mapping from a set of properties to a set of lists of ‘canonical’ words used for each property.
- Types: represent classes of entities, and place constraints (in the form of ‘fertility’ - a constraint on entity list lengths) on the properties those entities can possess.

# Entity-Centered Model - Architecture

The entity-centred module, resting on the base structure, relies on a pipeline of three modules to complete the end-to-end task of coreference resolution.

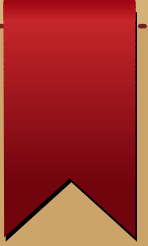
There exists one parameter group for types,

$$T = \{ t_1, t_2, \dots \}$$

Where  $t_1$ ,  $t_2$  and so on are parameters for each individual type. A second group comprises of parameters for discourse choices.

We will attempt to explain the modules of the entity-centered model in the abstract.

# Entity-Centered Model: Semantic Module

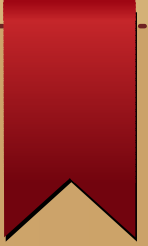


Semantic Module – Generates a sequence  $E$  of entities.

Each entity consists of a type indicator  $T$ , as well as a collection of word lists for every property of the entity (head, etc.)



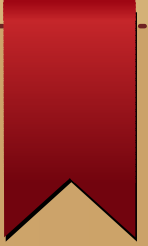
# Entity-Centered Model: Discourse Module



- The discourse module assigns an entity to each mention. It returns pairwise relations between mentions and their antecedents- the antecedent of each mention is either an anaphor itself pointing to a 'root' entity, or a new entity.
- A feature-based approach is taken to identify coreferents.
- Features used between a mention and an antecedent are: tree distance, sentence distance and the syntactic positions (subject, object and oblique) of the mention and its antecedent.
- Features used to identify a new entity are: a 'definiteness' feature (extracted from the mention's determiner, the top CFG rule of the mention parse node, its syntactic role, a 'bias' feature. These features are conjoined with the form of the mention (nominal or pronoun).
- Pronoun antecedents are limited to the current and last two sentences.
- Nominal antecedents are restricted to the current and last three sentences.
- Nominals are not allowed to have direct pronoun antecedents.
- In contrast to nominals and pronouns, the choice of entity for a proper mention are governed more by entity frequency than antecedent distance.



# Entity-Centered Model: Mention Generation Module



Mention Generation Module: independently renders the sequence of mentions – as a set of word values corresponding to underlying properties- from their underlying entities.

Word values can either be selected from the property list of the entity associated with that mention, or from the property list of the type associated with that mention. (Indicated to the system by a given parameter.)

