

Class 11: Anaphora and co-reference resolution

Things and naming things

What is co-reference resolution?

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May confessed to Patel that although having secret meetings with the Israelis was a sackable offence, it paled in comparison to her own dire performance but “sadly nobody’s willing to pull the trigger.”

Patel said: “It was so awkward. She said ‘You don’t know how often I’ve dreamt of sitting on your side of the desk, finally being summarily dismissed for my gross incompetence.’

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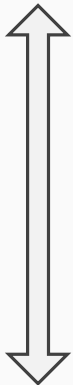
Noun phrases and reference

- NPs usually refer to entities in the world
- NPs may co-refer, meaning they refer to the same entity
- They may also be nested

Однажды Пушкин написал письмо Рабиндранату Тагору .
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Kinds of reference

Easier



Harder

Interesting linguistics

Bound variables

She hurt *herself*

Я имею *свой* баян

Free variables

Maša read *her* book

Ей очень нравилась.

Referring expressions

Carles Puigdemont

Catalan president

Puigdemont

president of Catalonia

President Puigdemont

More frequent

Coreference, anaphora, cataphora

- **Coreference**
 - Two *mentions* (NPs) refer to the same entity
 - May be identical or completely different
- **Anaphora, Cataphora**
 - Interpretation is in some way dependent on an antecedent
 - Traditionally the antecedent came first, but not always the case.

Cataphora

(Oscar Wilde – The Picture of Dorian Grey)

Other types of anaphora

- Bridging Anaphora:
- "Other" Anaphora:
- Non-NP Anaphora (e.g. events, propositions)

Anaphora vs. coreference

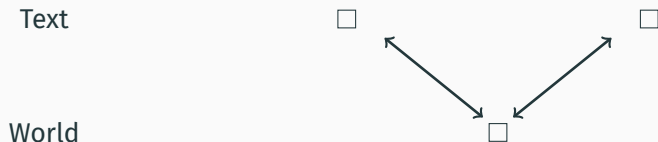
- Not all anaphoric relations are coreferential, e.g. bridging anaphora
- Multiple identical NP matches are often coreferential but not anaphoric

Two different things

Anaphora resolution



Co-reference resolution



Applications

Machine translation:

Text summarisation:

Information extraction:

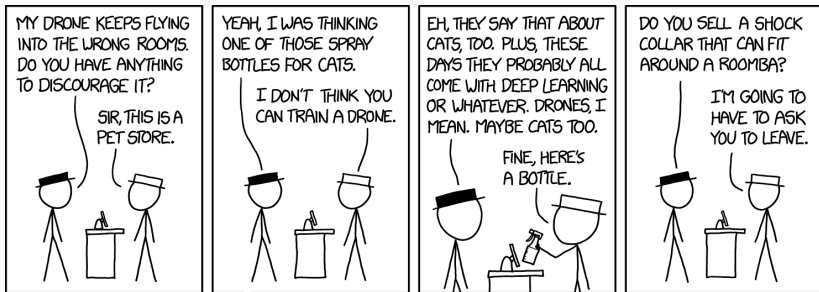
Pronominal anaphora resolution

Hobbs' (1978) algorithm/1

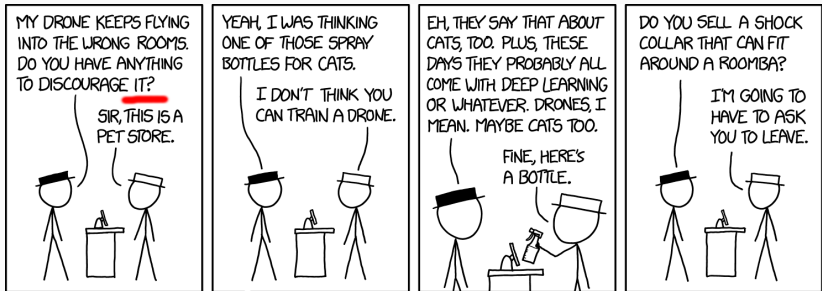
- Simple syntax-based algorithm for 3rd person anaphoric pronouns
- Requires:
 - Constituency parser
 - Gender and number 'checker'
 - Parsers for English rarely include gender information for nouns
- Searches current and preceding sentences in a breadth-first, left-to-right manner, stops when it finds a matching NP

- Right to left search in current sentence
- If not valid antecedent fine, try previous sentence
 - Left to right breadth-first search

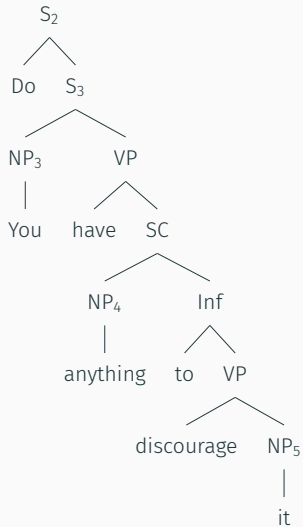
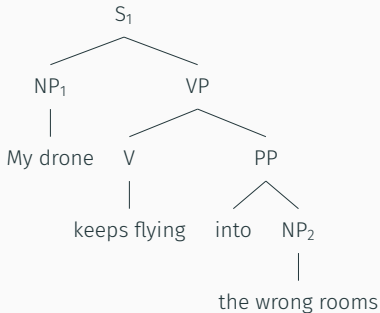
Hobbs' (1978) algorithm/3



Hobbs' (1978) algorithm/3



Hobbs' (1978) algorithm/4



- Start search in NP₅ in S₂
- Reject NP₄, no intervening NP
- Reject NP₃, feature mismatch
- Move to S₁
- Accept NP₁

- Supervised machine learning approach
- Requires corpus where each pronoun has been linked with its antecedent
- Extract positive and negative examples
- Train binary classifier
 - True: is co-referent
 - False: is not co-referent

Let's take our previous example:

Positive example:

- (it, my drone)

Negative examples:

- (it, anything)
- (it, you)
- (it, the wrong rooms)

- **strict gender** [true, false]
- **compatible gender** [true, false]
- **strict number** [true, false]
- **compatible number** [true, false]
- **sentence distance** [0, 1, 2, ...]
- **Hobbs distance** [0, 1, 2, ...]
- **grammatical role** [subject, object, ...]
- **linguistic form** [proper, def, indef, pronoun]

Can you think of some other useful features ?

- For each pronoun,
 - For each NP we have seen so far,
 - Classify if NP is an antecedent of the pronoun

Co-reference resolution

Reference models

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Пушкин, он₁, я₁, меня₁

Рабиндранату Тагору, Дорогой далекий друг, Вас₁, Вы₁, Тагор, его₁, Он

Additional features

Input is a dependency tree.

Constraint-based, rules like:

$C = \langle ANA, ANT, DIST, PROP \rangle$

- ANA, ANT = constraints on the anaphor and antecedent
- DIR = direction (e.g. forward, backwards)
- DIST = how far to look (in sentences)
- PROP = should features (e.g. gender) be propagated?

Example rules:

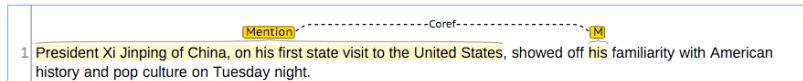
Evaluation

Model-Theoretic coreference scoring

Tools and resources

Tools and resources

Coreference:



<https://stanfordnlp.github.io/CoreNLP/index.html>

- includes coreference for English + Chinese
- rule-based, statistical and neural models
- based on Java
- very “heavy” (> 1G for code + model)



eXternally configurable REference and Non Named Entity Recogniser

<https://github.com/amir-zeldes/xrenner>

- based on Python
- Rule-based (constraints)
- Functioning model for English
- (relatively) small footprint (< 100M)

Shared tasks

Practical

For the practical, select a short paragraph or document and write some coreference rules using Xrenner.

Further instructions:

<https://ftyers.github.io/028-komp-ling/classes/11.html>