Class 11: Anaphora and co-reference resolution

Things and naming things

What is co-reference resolution?

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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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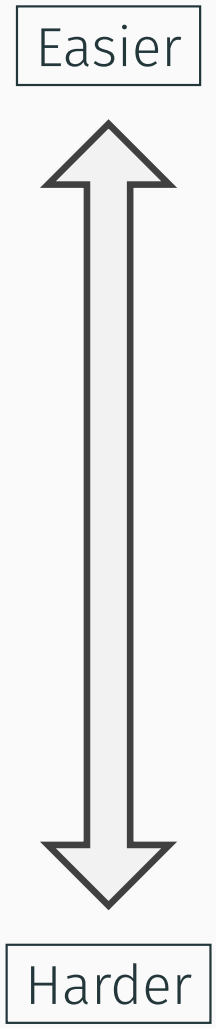
Noun phrases and reference

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

Однажды Пушкин написал письмо Рабиндранату Тагору. «Дорогой далекий друг, — писал он, — я Вас не знаю, и Вы меня не знаете. Очень хотелось бы познакомиться. Всего хорошего. Саша». Когда письмо принесли, Тагор предавался самосозерцанию. Так погрузился, хоть режь его. Его жена толкала, толкала, письмо подсовывала — не видит. Он, правда, по-русски читать не умел. Так и не познакомились.

Kinds of reference



Interesting linguistics

Bound variables

She hurt *herself*
Я имею *свой* баян

Free variables

Maša read *her* book
Ей очень нравилась.

Referring expressions

Carles Puigdemont
the Catalan president
Puigdemont
Puchi
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

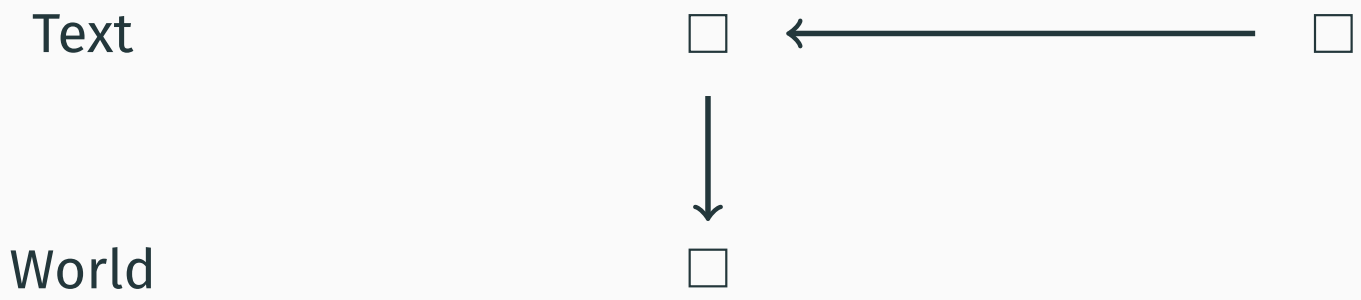
- Bridging Anaphora:
- ”Other” Anaphora:
- Non-NP Anaphora (e.g. events, propositions)

Anaphora vs. coreference

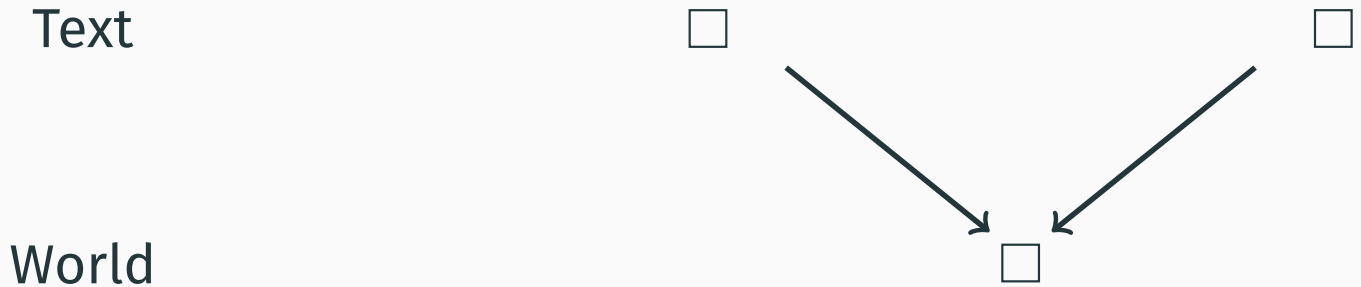
- Not all anaphoric relations are coreferential, e.g. bridging anaphora
- Multiple identical NP matches are often coreferential but not anaphoric

Two different things

Anaphora resolution



Co-reference resolution



Applications

Machine translation:

- Translating pronouns like *себя* — myself, yourself, herself, ...
- Translating from languages with no gender distinction in pronouns *här — он, она*

Text summarisation:

- [Maša]$_i$ read [Wikipedia]$_j$ with unbridled enthusiasm. [She]$_i$ spent so long reading [it]$_j$ that [she]$_i$ forget about her homework.
  - $\rightarrow$ Maša read Wikipedia and forgot about her homework.

Information extraction:

- What did Maša do ?
  - read Wikipedia
  - forgot about her homework

Pronominal anaphora resolution

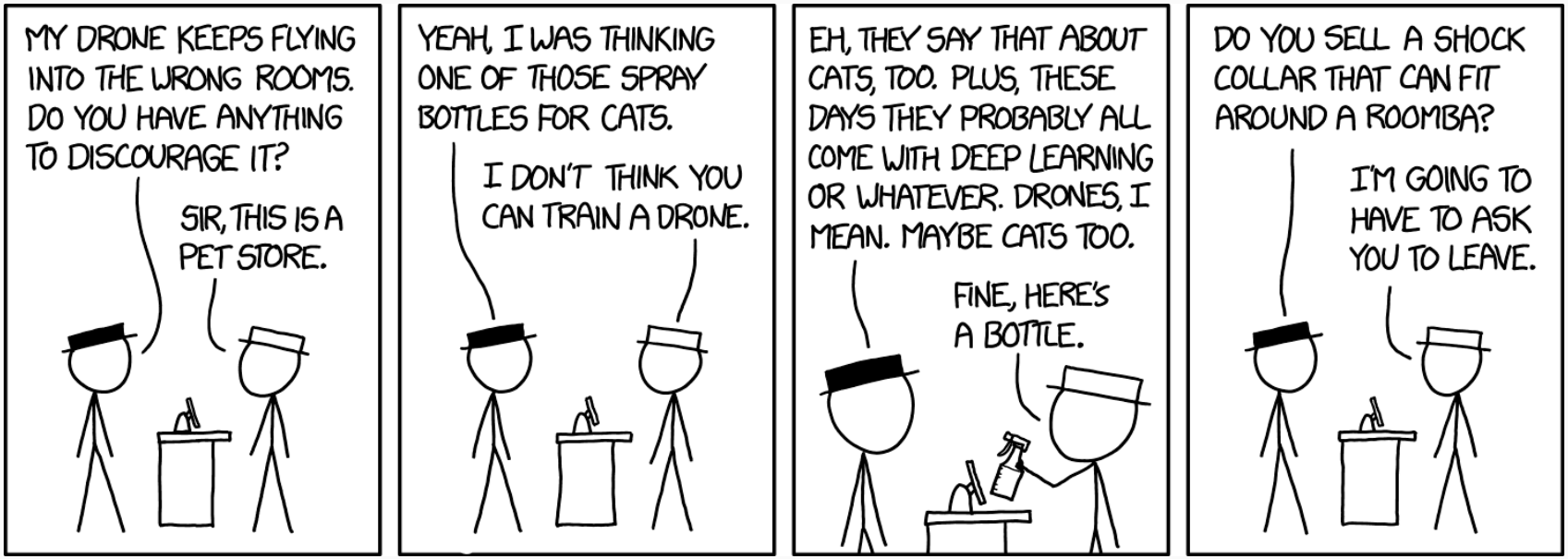
Hobbs' (1978) algorithm/1

- 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

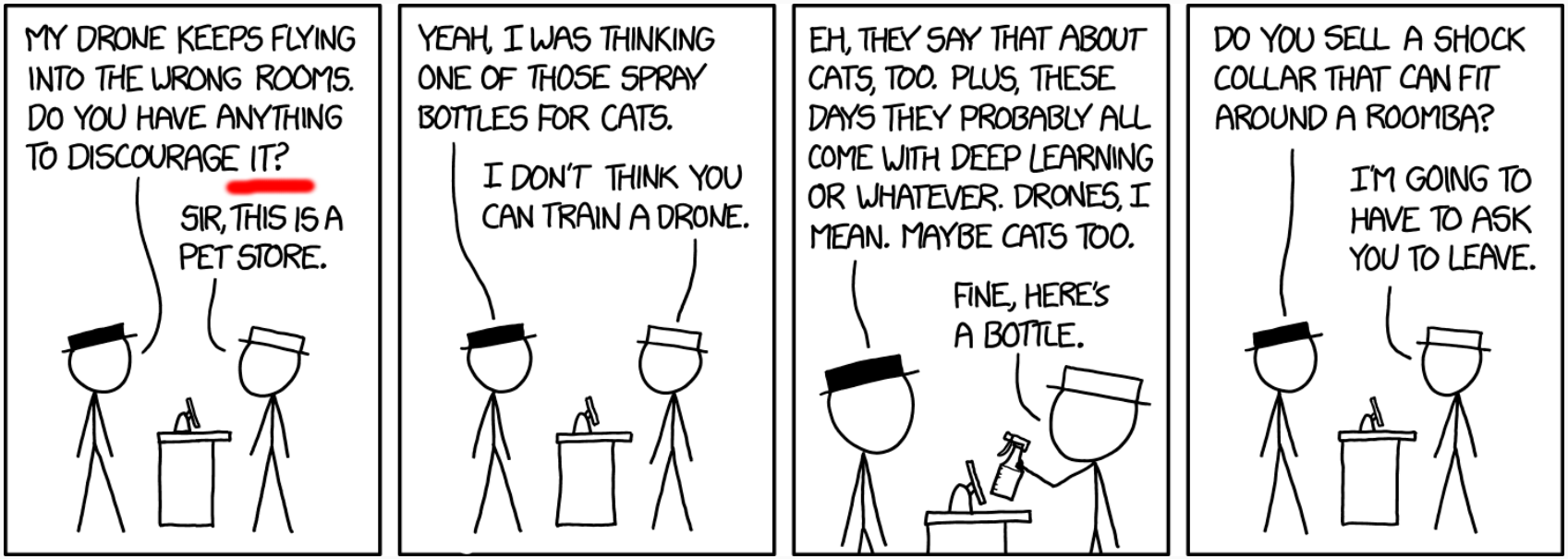
Hobbs' (1978) algorithm/2

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

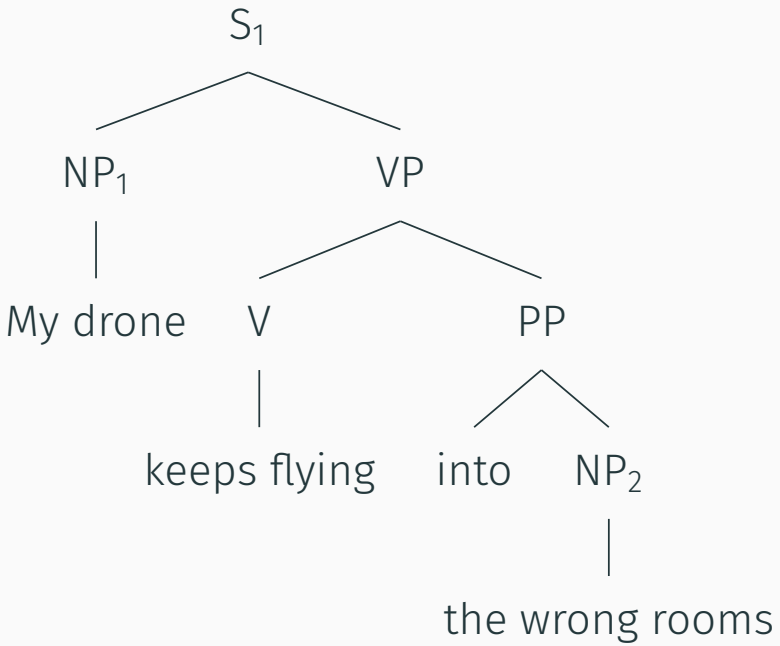
Hobbs' (1978) algorithm/3

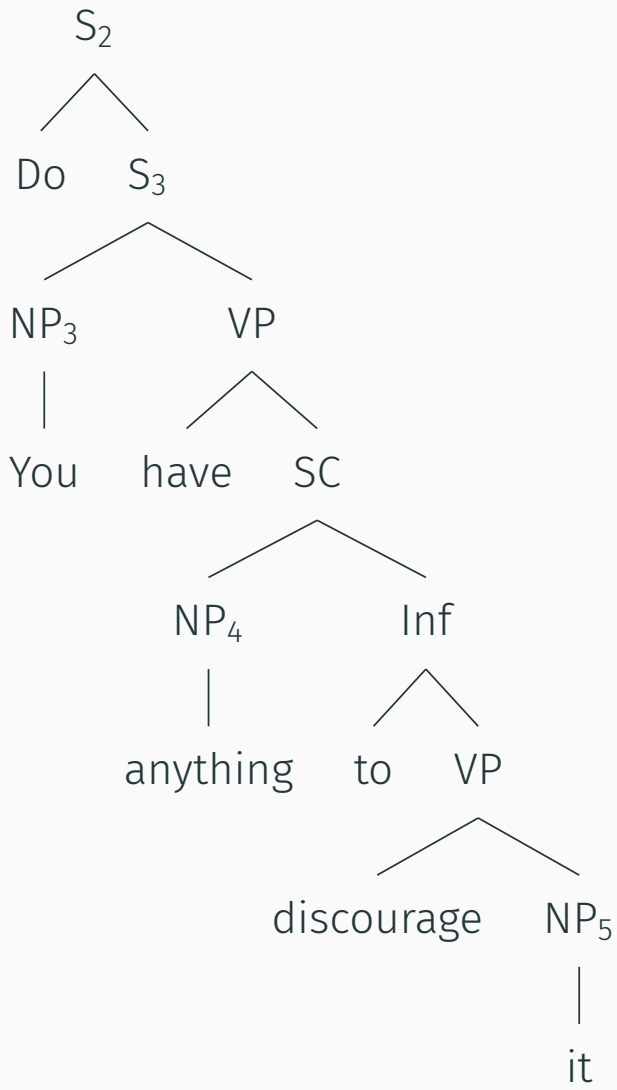


Hobbs' (1978) algorithm/3



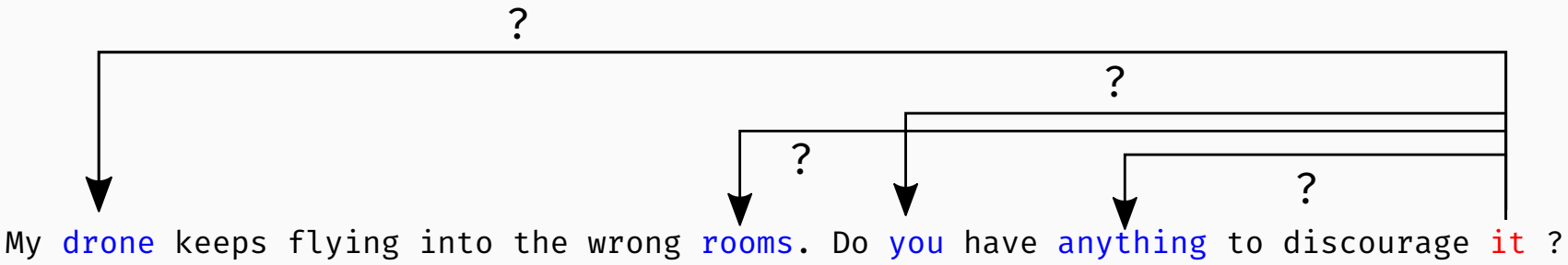
Hobbs' (1978) algorithm/4





- Start search in NP_5 in S_2
- Reject NP_4, no intervening NP
- Reject NP_3, feature mismatch
- Move to S_1
- Accept NP_1

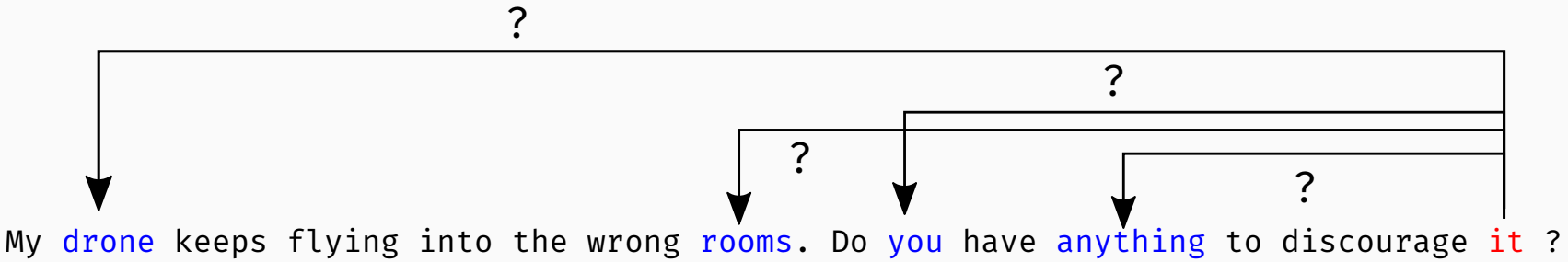
Log-linear model/1



- 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

Log-linear model/2



Positive example:

- (it, my drone)

Negative examples:

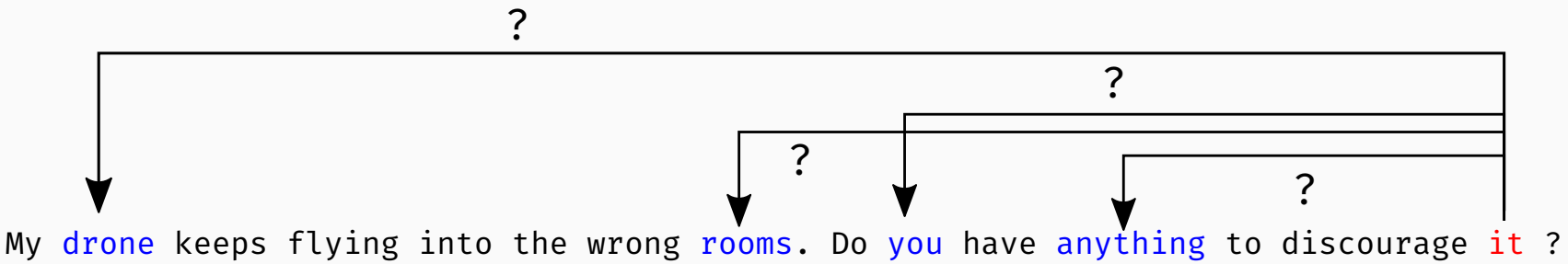
- (it, anything)
- (it, you)
- (it, the wrong rooms)

Log-linear model/3

- **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 ?

Log-linear model/4



- 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, он$_1$, я$_1$, меня$_1$

Рабиндранату Тагору, Дорогой далекий друг, Вас$_1$, Вы$_1$, Тагор, его$_1$, Он

General algorithm

Additional features

Rule-based models/1

Input is a sequence of dependency trees representing the document.

Constraint-based, rules like:

$C =< ANA, ANT, DIST, PROP >$

- 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?

Rule-based models/2

Example rules:

- Mark full-text matches as coreferent
- Two 1st person pronouns in the same quoted speech corefer
- A surname matching a previous firstname + surname corefers

Evaluation

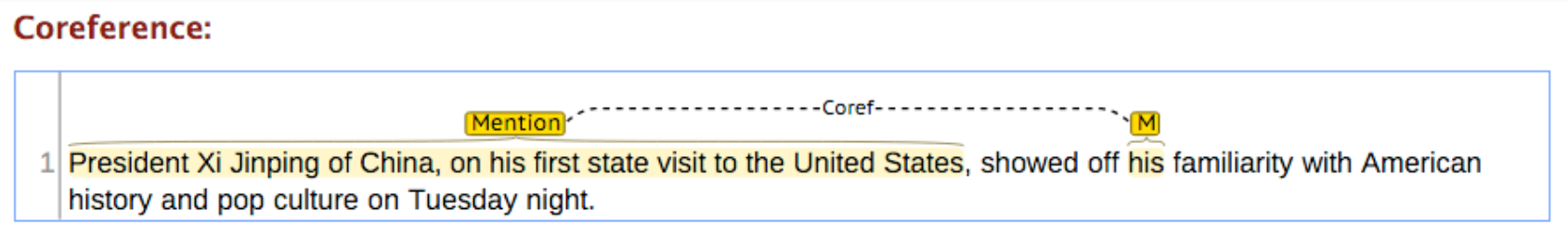
Model-Theoretic coreference scoring

Other metrics

- B^3 scoring
- CEAF

Tools and resources

Stanford CoreNLP



`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)

xrenner

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

SemEval 2010

RuEval-2014

Two tracks:

- Pronominal anaphora resolution (8 teams)
  - personal, possessive, relative and reflexive pronouns
  - antecedent should be in the gold-standard coreference chain
- Co-reference resolution (3 teams)

Practical

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`