

Chapter 16: Discourse

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A Definition of Discourse

A discourse is a sequence of sentences: a text or a conversation

A discourse is made of words or phrases that refer to things: the **discourse entities**

A discourse normally links the entities together to address topics

Within a single sentence, grammatical structures provide with a model of relations between entities.

Discourse models extend relations to more sentences



Reference

Discourse entities – or discourse referents – are the real, abstract, or imaginary objects introduced by the discourse. **Referring expressions** are mentions of the discourse entities through the text

- ① Susan drives a Ferrari
- ② She drives too fast
- ③ Lyn races her on weekends
- ④ She often beats her
- ⑤ She wins a lot of trophies



Discourse Entities

Mentions (or referring expressions)	Discourse entities (or referents)	Logic properties
<i>Susan, she, her</i>	'Susan'	'Susan'
<i>Lyn, she</i>	'Lyn'	'Lyn'
<i>A Ferrari</i>	X	ferrari(X)
<i>A lot of trophies</i>	E	$E \subset \{X \mid \text{trophy}(X)\}$



Reference and Named Entities

Named entities are entities uniquely identifiable by their name.

Some definitions/
clarifications:

- Named entity recognition (NER): a partial parsing task, see Chap. 10;
- Reference resolution for named entities: find the entity behind a mention, here a name.

Words	POS	Groups	Named entities
U.N.	NNP	I-NP	I-ORG
official	NN	I-NP	O
Ekeus	NNP	I-NP	I-PER
heads	VBZ	I-VP	O
for	IN	I-PP	O
Baghdad	NNP	I-NP	I-LOC
.	.	O	O

As it is impossible to set a physical link between a real-life object and its mention, we use unique identifiers or tags in the form of URIs instead (from Wikidata, DBpedia, Yago).



Mentions of Named Entities are Ambiguous

Cambridge: England, Massachusetts, or Ontario?

Given the text (from Wikipedia):

*One of his translators, Roy Harris, summarized **Saussure**'s contribution to linguistics and the study of language in the following way...*

Which Saussure? *Saussure* has 11 entries in Wikipedia:

- *Ferdinand de Saussure*:
 - Wikidata: <http://www.wikidata.org/wiki/Q13230>
 - DBpedia: http://dbpedia.org/resource/Ferdinand_de_Saussure
- *Henri de Saussure*: <http://www.wikidata.org/wiki/Q123776>
- *René de Saussure*: <http://www.wikidata.org/wiki/Q13237>



Collecting Entity-Mention Pairs from Wikipedia

Wikipedia has a mark up that enables an editor to link a word or phrase to a page:

- `[[Ferdinand_de_Saussure|Saussure]]` or
- `[[target or link|text or label or anchor]]`

In our case, it is an association between a mention and an entity:

`[[Entity|Mention]]`

All the links can be extracted from a wikipedia dump to derive two probabilities:

- The probability of a mention given an entity, how we name things: $P(M|E)$
- The probability of a entity given a mention, the ambiguity of a mention: $P(E|M)$



Göran Persson in Swedish







In Wikipedia, at least four entities can be linked to the name *Göran Persson*:

























- ❶ **Göran Persson** (född 1949), socialdemokratisk partiledare och svensk statsminister 1996–2006 (Q53747)
- ❷ **Göran Persson** (född 1960), socialdemokratisk politiker från Skåne (Q5626648)
- ❸ Göran Persson (militär), svensk överste av 1:a graden
- ❹ **Göran Persson** (musiker), svensk proggmusiker (Q6042900)
- ❺ Göran Persson (litterär figur), överkonstapel i 1930-talets Lysekil
- ❻ Göran Persson (skulptör) (född 1956), konstnär representerad i bl.a. Karlskoga
- ❼ **Jöran Persson**, svensk ämbetsman på 1500-talet (Q2625664)



$P(\text{Mention}|\text{Entity})$, An Exemple

Mentions of *Göran Persson*, Q53747, in Swedish:
How do we name Q53747?

Mentions







   Göran Persson	 <input type="checkbox"/> <input type="checkbox"/> Göran Persson (s)
   Göran Perssons	 <input type="checkbox"/> <input type="checkbox"/> Göran Persson (statsminister)
 <input type="checkbox"/>  Persson	 <input type="checkbox"/> <input type="checkbox"/> Göran Persson i Stjärnhov
 <input type="checkbox"/>  (Hans) Göran Persson	 <input type="checkbox"/> <input type="checkbox"/> Hans G. Persson
 <input type="checkbox"/>  Han Som Bestämmer	 <input type="checkbox"/> <input type="checkbox"/> Hans Göran Persson
 <input type="checkbox"/>  Perssonplanen	 <input type="checkbox"/> <input type="checkbox"/> Persson, Göran
 <input type="checkbox"/>  Perssons	 <input type="checkbox"/> <input type="checkbox"/> Påven vid Båven
 <input type="checkbox"/> <input type="checkbox"/> Goran Persson	
 <input type="checkbox"/> <input type="checkbox"/> Göran Person	

From <http://klang.cs.lth.se:8888/en/data/wiki>















$P(\text{Entity}|\text{Mention})$, An Exemple

Entities linked to the mention *Göran Persson* in Swedish:
The things behind *Göran Persson*

sv mention:Göran Persson 🔍

▶ 6 hits in 0,003 s

- ▶  **Göran Persson (född 1960)**
wikidata:Q5626648 
- ▶  **Göran Persson (musiker)**
wikidata:Q6042900 
- ▶  **Lars Göran Persson**
wikidata:Q6043257 
- ▶  **Göran Persson**
wikidata:Q53747 
- ▶  **Jöran Persson**
wikidata:Q2625684 
- ▶  **Regeringen Persson**
wikidata:Q4570330 

From <http://klang.cs.lth.se:8888/en/data/wiki>



Disambiguation of Named Entities

Given:

*One of his translators, Roy Harris, summarized **Saussure**'s contribution to linguistics and the study of language...*

Disambiguation is a classification problem dealing with mention-entity pairs:

Mention	Entity	Q number	T/F
Saussure	Ferdinand de Saussure	Q13230	1
Saussure	Henri de Saussure	Q123776	0
Saussure	René de Saussure	Q13237	0
...			

Feature vectors represent pair of mentions and entities:

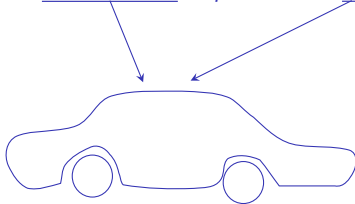
- Cosine similarity between the mention context and the named entity page in Wikipedia and bag-of-word vectors of the mention context
- Training set built from Wikipedia markup:
[[Ferdinand_de_Saussure|Saussure]]



Coreference

[entity1 Garcia Alvarado], 56, was killed when [entity2 a bomb] placed by [entity3 urban guerrillas] on [entity4 his vehicle] exploded as [entity5 it] came to [entity6 a halt] at [entity7 an intersection] in [entity8 downtown] [entity9 San Salvador].

on his vehicle exploded as it came to a halt



Anaphora

Anaphora, often pronouns

Pronouns: it, she, he, this, that

Cataphora

*I just wanted to touch **it**, this stupid animal.*

***They** have stolen my bicycle.*

Antecedents

Ellipsis is the absence of certain referents

I want to have information on caterpillars. And also on hedgehogs.



Coreference Annotation: CoNLL 2011 simplified

0		"	"	...	-
1	Vandenberg	NNP		(8 0)	-
2	and	CC		-	-
3	Rayburn	NNP		(23) 8)	-
4	are	VBP		-	-
5	heroes	NNS		-	-
6	of	IN		-	-
7	mine	NN		(15)	-
8	,	,		-	-
9	"	"		-	-
10	Mr.	NNP		(15	-
11	Boren	NNP		15)	-
12	says	VBZ		-	-
13	,	,		-	-
14	referring	VBG		-	-
15	as	RB		-	-
16	well	RB		-	-
17	to	IN		-	-
18	Sam	NNP		(23	-
19	Rayburn	NNP		-	-
20	,	,		-	-
21	the	DT		-	-
22	Democratic	JJ		-	-
23	House	NNP		-	-
24	speaker	NN		-	-
25	who	WP		-	-
26	cooperated	VBD		-	-
27	with	IN		-	-
28	President	NNP		-	-
29	Eisenhower	NNP		23)	-
30	.	.		-	-

Entities and mentions:

$e_0 = \{Vandenberg\}$

$e_8 = \{Vandenberg \text{ and } Rayburn\}$

$e_{15} = \{mine, Mr. Boren\}$

$e_{23} =$

$\{Rayburn, Sam Rayburn, 'the Democratic House speaker who cooperated with President Eisenhower\}$



Coreference Chains

In the MUC competitions, coreference is defined as symmetric and transitive:

- If A is coreferential with B, the reverse is also true.
- If A is coreferential with B, and B is coreferential with C, then A is coreferential with C.

It forms an equivalence class called a **coreference chain**.

The TYPE attribute specifies the link between the anaphor and its antecedent.

IDENT is the only possible value of the attribute

Other types are possible such as part, subset, etc.



Solving Coreferences: A Simplistic Method

Coreferences define a class of equivalent references

Backward search with a compatible gender and number

~90% of the antecedents are in the current or previous sentence

*Garcia Alvarado, 56, was killed when **a bomb** placed by urban guerrillas*

2 ←

*on **his vehicle** exploded as **it** came to a halt at an intersection in*

← 1

downtown San Salvador



Machine Learning to Solve Coreferences

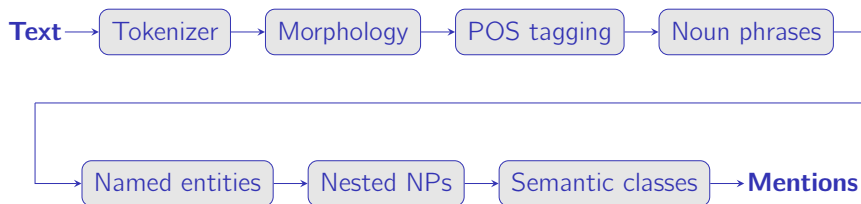
Instead of manually engineered rules, machine learning uses an annotated corpus and trains the rules automatically.

The coreference solver (classifier)

- Considers pairs of noun phrases (NP_i, NP_j)
- Represents each pair by a feature vector.
- Decides for each pair whether it corefers or not.
- Using the transitivity property, identifies all the coreference chains in the text.



Architecture



The coreference engine takes a pair of extracted noun phrases (NP_i, NP_j) For a given index j , the engine considers from right to left, NP_i as a potential antecedent and NP_j as an anaphor. It classifies the pair as positive if both NPs corefer or negative if they don't.



Performances

At this point, it is useful to have the current performances in mind

- Morphological parsing can parse correctly 99 % of the words in many languages (Koskenniemi 1984)

Bilolyckorna "bil#olycka" N UTR DEF PL NOM

- Part-of-tagging reached and exceeded 97% as early as Church (1991)

En bilolycka med tre bilar

En/dt_utr_sin_ind bilolycka/nn_utr_sin_ind_nom med/pp
tre/rg_nom bilar/nn_utr_plu_ind_nom

- Sentence parsing reaches ~89% in Swedish (CoNLL 2018) – labeled dependencies.



Performances (II)

- Semantic parsing (extraction of predicate–argument structures.)
The F-measure reaches about 85.5 in 2019 (CONLL 2009).

[*Judge* **She**] **blames** [*Evaluee* **the Government**] [*Reason* **for failing to do enough to help**]
`blames(judge, evaluatee, reason)`

`blames('She', 'The Government', 'for failing to do enough to help').`

- Coreference solving reaches a F-measure of ~ 83 in 2021 using the CoNLL 2012 CoNLL script up from 60 in Pradhan et al. (2011)
- A site to have up-to-date figures:
<https://github.com/sebastianruder/NLP-progress>
- Another site: <https://paperswithcode.com/sota/>



Discourse Theories and Models

Discourse theories are used to develop organization models of texts
They have three objectives: **represent**, **parse automatically**, and **generate** a discourse.

There are many ways to represent a text and competing theories.
In 1992, Mann and Thompson compared 12 different representations obtained from experts in the field.

The most significant are:

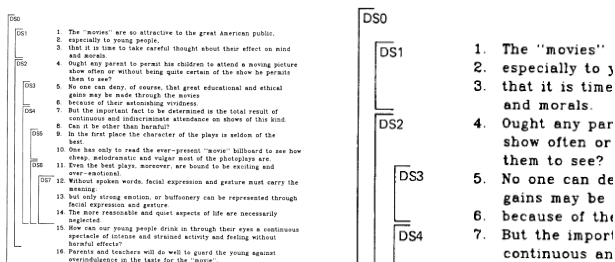
- Grosz and Sidner's theory (1986) and Centering (1995)
- Rhetorical structure theory (RST) (Mann and Thompson 1988)



Grosz and Sidner's Theory

Discourse consists of discourse segments.

Grosz and Sidner posit they can be organized as a hierarchical tree



See another example: <https://www.nature.com/documents/nature-summary-paragraph.pdf>

<https://www.nature.com/documents/nature-summary-paragraph.pdf>



Centers

Centers (topics) are entities that ensure the coherence of discourse
They link one a sentence to another one.

Grosz divides centers in

- unique **backward-looking center** that is the most important entity in the segment and
- others **forward-looking** centers.

Two relations link segments: dominance and satisfaction-precedence.



Rhetoric

- Invention (*Inventio*).
- Arrangement (*Dispositio*): introduction (*exordium*), a narrative (*narratio*), a proposition (*propositio*), a refutation (*refutatio*), a confirmation (*confirmatio*), and finally a conclusion (*peroratio*).
- Style (*Elocutio*): emote (*movere*), explain (*docere*), or please (*delectare*).
- Memory (*Memoria*)
- Delivery (*Actio*).



Rhetorical Structure Theory

The rhetorical structure theory is a text grammar that analyzes argumentation: A text consists of:

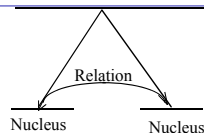
- **Text spans** that can be sentences or clauses
- **Rhetorical relations** that link the text spans

Relations are richer than with Grosz and Sidner.

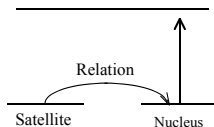


Relations

Relations between segments can be symmetrical when spans have the same importance: Both spans are **nuclei**.



When relations are asymmetrical, we have a **nucleus** and a **satellite** where the nucleus is the most important



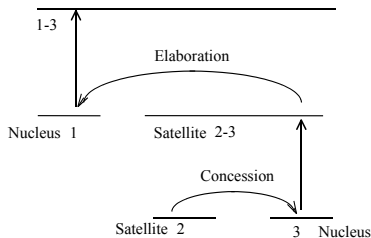
The text analysis produces a tree of text spans that are linked by different relation types.



Graphical Representation

Example cited by Mann and Thompson (1987):

- ① *Concern that this material is harmful to health or the environment may be misplaced.*
- ② *Although it is toxic to certain animals,*
- ③ *evidence is lacking that it has any serious long-term effect on human beings.*

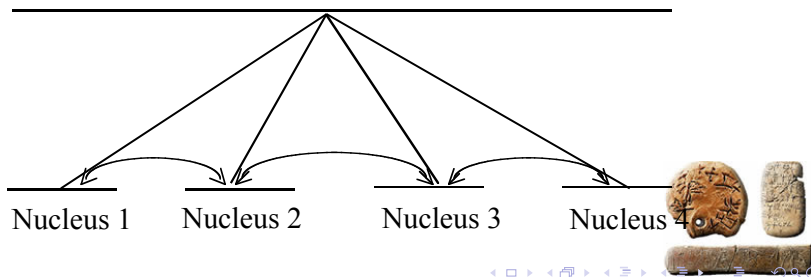


Links Between Nuclei

Spans can have a same importance and are linked by a sequence relation:

- ① *Napoleon met defeat in 1814 by a coalition of major powers, notably Prussia, Russia, Great Britain, and Austria.*
- ② *Napoleon was then deposed*
- ③ *and exiled to the island of Elba*
- ④ *and Louis XVIII was made ruler of France.*

Microsoft Encarta, cited from Simon Corston-Oliver (1998)



RST Relations

The original relations in RST are:

Nucleus-satellite relations

Circumstance	Evidence	Otherwise
Solutionhood	Justify	Interpretation
Elaboration	Cause	Evaluation
Background	Antithesis	Restatement
Enablement	Concession	Summary
Motivation	Condition	

Multi-nucleus relations

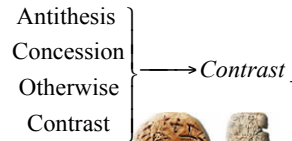
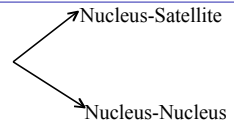
Sequence	Contrast	Joint
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Relation Number

The number of relations is somewhat arbitrary.
Mann and Thompson first proposed 15 relations, then 23.
It is possible to group and simplify them.

Symmetrical (nucleus-nucleus) and asymmetrical
relations (nucleus-satellite)



Group classes in a superclass

Definition of the Relations

The following text corresponds to an **evidence** relation that links a nucleus (segment 1) and a satellite (segment 2):

- ① *The program as published for calendar year 1980 really works.*
- ② *In only a few minutes, I entered all the figures from my 1980 tax return and got a result which agreed with my hand calculations to the penny.*

Mann and Thompson defined each relation in the RST model using a set of “constraints”.



Definition of the Relations (II)

Relation name	EVIDENCE
Constraints on the nucleus N	The reader R might not believe to a degree satisfactory to the writer W
Constraints on the satellite S	The reader believes S or will find it credible
Constraints on the $N + S$ combination	R 's comprehending S increases R 's belief of N
The effect	R 's belief of N is increased
Locus of the effect	N



Automatic Processing of Discourse

Basically a text categorization task

As humans, we can also map a certain relation to certain words.

Words like *and*, *so*, *but*, *although*, and commas denote frontiers and ideas in a text.



Dialogue

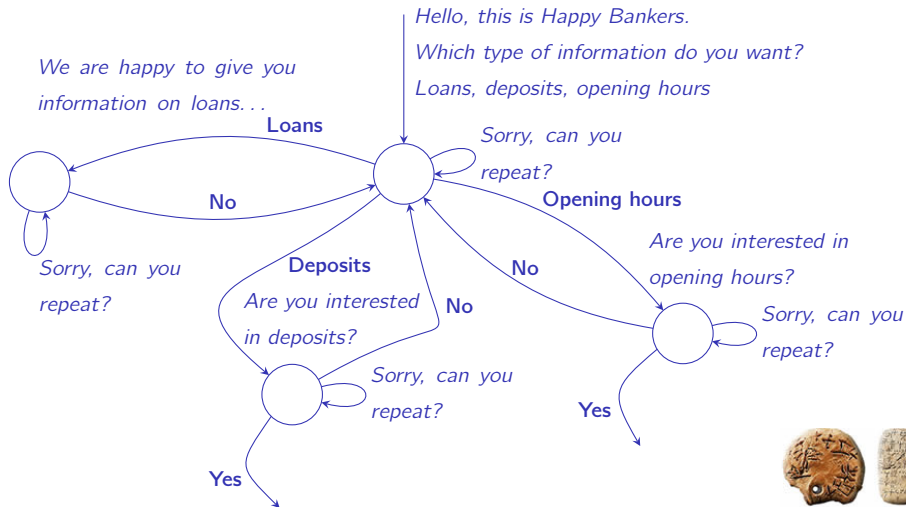
Interacting persons:

- Information can be missing
- Some words or constructions can be ambiguous,
- Errors in speech recognition.

Coreferences are central in a dialogue context.



Automata



Dialogue Pairs

First member	Preferred second member	Dispreferred second member
Offer, Invitation	Acceptance	Refusal
Request	Compliance	Refusal
Assessment	Agreement	Disagreement
Question	Expected answer	Unexpected answer, no answer
Blame	Denial	Admission



More Elaborate Pairs

- *initiative interventions*, which open an exchange (*I*)
- *reaction interventions*, which are answers to initiatives (*R*)
- *evaluation interventions*, which assess exchanges and possibly close them (*E*)

Utt. no.	Turns	Utterances
1	S:	<i>Which type of information do you want: loans, deposits, opening hours?</i>
2	U:	<i>Loans</i>
3	S:	<i>We are happy to give you information on loans</i>



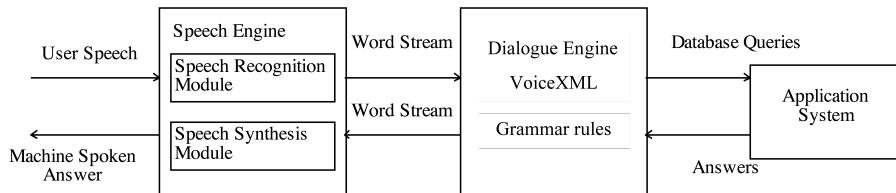
Pairs with Closed Questions

Utt. no.	Turns	Utterances	Tags
1	S:	<i>Which type of information do you want: loans, deposits, opening hours?</i>	I_1
2	U:	<i>Deposits</i>	$\left. \begin{array}{l} R_1 \\ I_1^2 \\ R_1^2 \end{array} \right]$
3	S:	<i>Are you interested in deposits?</i>	
4	U:	<i>Yes</i>	



Structure of a Dialogue System

Often uses external speech recognition and synthesis modules
It is frequently used in speech server applications



EVAR (Mast et al., 1994)

EVAR structures the dialogue process in a sequence of phases:

- A greeting by the system,
- A request from the user,
- A clarification consisting of a confirmation of data requested by the user and possible requests for details and specifications,
- An answer from the system, and finally
- A closing.



EVAR's Automata (Mast et al., 1994)

