

Lexical Cohesion and Coherence

Regina Barzilay

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Leftovers from Last Time

Input Type	C_{seg} for ABC
ASR	0.1723
Closed Captions	0.1515
Transcripts	0.1356

Note the impact for ASR!

Lack of Coherence

Hobbs' Example(1982)

When Teddy Kennedy paid a courtesy call on Ronald Reagan recently, he made only one Cabinet suggestion. Western surveillance satellites confirmed huge Soviet troop concentrations virtually encircling Poland.

Coherence in Automatically Generated Text

- DUC results: most of automatic summaries exhibit lack of coherence
- Is it possible to automatically compute text coherence?
 - text representation
 - inference procedure

Text Representation

Sentence:	05	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95		
14 form	1	111	1	1						1	1	1	1	1	1	1	1	1			
8 scientist				11			1	1			1		1	1	1						
5 space	11	1	1												1						
25 star	1			1								11	22	111112	1	1	1	11	1111	1	
5 binary												11	1		1					1	
4 trinary												1	1		1					1	
8 astronomer	1			1								1	1		1	1	1	1			
7 orbit	1				1								12	1	1						
6 pull					2		1	1						1	1						
16 planet	1	1		11			1		1				21	11111					1	1	
7 galaxy	1											1			1	11	1			1	
4 lunar			1	1	1		1														
19 life	1	1	1					1	11	1	11	1	1			1	1	1	111	1	1
27 moon		13	1111	1	1	22	21	21	21		11	1									
3 move									1	1	1										
7 continent								2	1	1	2	1									
3 shoreline											12										
6 time					1			1	1	1	1									1	
3 water									11		1										
6 say							1	1		1		11			1						
3 species								1	1	1											

Today's Topics

- Two linguistic theories of text connectivity
 - Text Cohesion (Halliday&Hasan'76)
 - Centering Theory (Grosz&Joshi&Weinstein'83)
- Application to automatic essay scoring

Text cohesion

Hobbs' Example(1982)

The concept of cohesion refers to relations of meaning that exist within the text, and that defines it as a text. Cohesion occurs where the interpretation of some element in the discourse dependent on that of another.

Text Cohesion

Cohesion captures devices that link sentences into a text

- Lexical cohesion
- References
- Ellipsis
- Conjunctions

Example

Halliday&Hasan(1982)

Time flies.

- You can't; they fly too quickly.

Find three cohesive ties!

Lexical Chains: Example

1. There was once a little girl and a little boy and a dog
2. And the sailor was their daddy
3. And the little doggy was white
4. And they like the little doggy
5. And they stroke it
6. And they fed it
7. And they ran away
8. And then daddy had to go on a ship
9. And the children missed 'em
10. And they began to cry

Lexical Chains: Applications

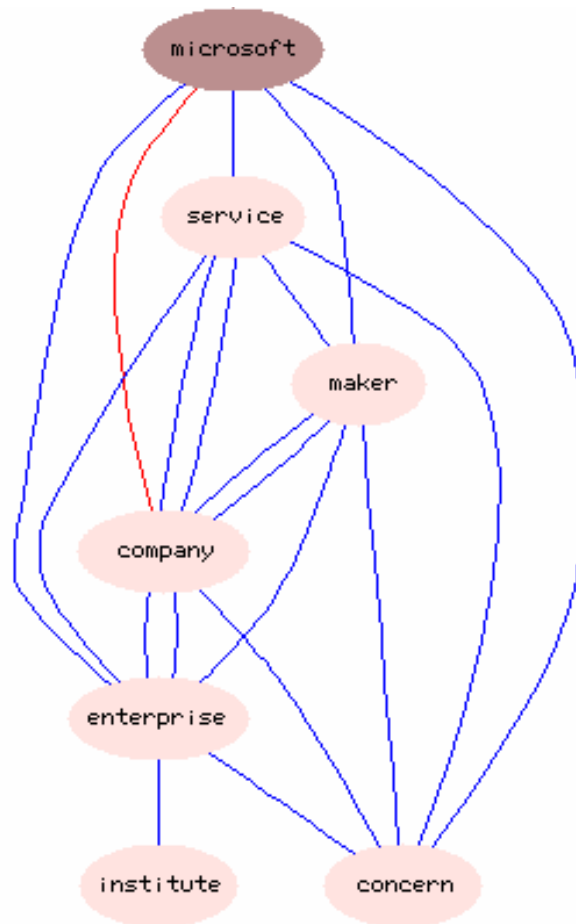
- Summarization
- Segmentation
- Malapropism Detection
- Information Retrieval

Lexical Chains: Computation

“Associative text models“

- Define word similarity function
- Define “insertion conflict” strategy (greedy vs. dynamic strategy)

Lexical Chains: Example



Lexical Chains: Accuracy

Example: Entertainment-service 1 auto-maker 1 enterprise 1
massachusetts-institute 1 technology-microsoft 1 microsoft 10 concern
1 company 6

- The accuracy bounded by the quality of a lexical resource
- The need in disambiguation makes the task harder
Disambiguation accuracy around 60%

For more examples see:

<http://www.cs.columbia.edu/nlp/summarization-test/index.html>

Automatic Measurement of Text Coherence

- Cohesive ties reflect the degree of text coherence
- First attempts to (semi-) automate cohesion judgments rely on:
 - propositional modeling of text structure (Kintsch&van Dijk'78)
time consuming and requires training
 - readability measures (Flesch'48)
weak correlation with comprehension measures

Vector-Based Coherence Assessment

- Each sentence is represented as a weighted vector of its terms
SENTENCE₁: 1 0 0 0 1 1 0
SENTENCE₂: 1 1 1 1 0 0 1
- Distance between two adjacent sentences is measured using cosine

$$\text{sim}(b_1, b_2) = \frac{\sum_t w_{y,b_1} w_{t,b_2}}{\sqrt{\sum_t w_{t,b_1}^2 \sum_{t=1}^n w_{t,b_2}^2}}$$

- Lexical continuity is measured as average distance between sentences in a paragraph

Term similarity

Latent Semantic Analysis (Deerwester'90)

- Goal: identification of semantically similar words
birth, born, baby
- Assumption: the context surrounding a given word provides important information about its meaning
- Method: Singular Vector Decomposition

Experimental Set-Up

Data from (Britton& Gulgoz'88)

- Source: text on the airwar in Vietnam from an Air Force training textbook
- Various revision methods to improve text readability:
 - Principled (based on propositional model)
 - Heuristic (based on reader's intuition)
 - Readability (based on readability index)

Experimental Set-Up

Data from (Britton& Gulgoz'88)

- Evaluation: based on recall, efficiency recall and scores on a multiple choice
- Assessment: Principled and Heuristic is better than Readability and Original

Results

Text	LSA coherence	Weighted word overlap	No. props recalled	Efficiency (props/min)	Inference mult. choice
Original	0.192	0.047	35.5	3.44	37.11
Readability rev.	0.193	0.073	32.8	3.57	29.74
Principled rev.	0.347	0.204	58.6	5.24	46.44
Heuristic rev.	0.403	0.225	56.2	6.01	48.23

Understanding the Results

- No significant difference between LSA and the baseline model in this experiment
- Other experiments showed that LSA may perform better, but note need in parameter estimation
- Neither model is used for prediction

Centering Theory

(Grosz&Joshi&Weinstein'95)

- Goal: to account for differences in perceived discourse
- Focus: local coherence
global vs immediate focusing in discourse
(Grosz'77)
- Method: analysis of reference structure

Phenomena to be Explained

Johh went to his favorite music store to buy a piano.

He had frequented the store for many years.

He was excited that he could finally buy a piano.

He arrived just as the store was closing for the day.

John went to his favorite music store to buy a piano.

It was a store John had frequented for many years.

He was excited that he could finally buy a piano.

It was closing just as John arrived.

Analysis

- The same content, different realization
- Variation in coherence arises from choice of syntactic expressions and syntactic forms

Another Example

John really goofs sometimes.

Yesterday was a beautiful day and he was excited about trying out his new sailboat.

He wanted Tony to join him on a sailing trip.

He called him at 6am.

He was sick and furious at being woken up so early.

Centering Theory: Basics

- Unit of analysis: centers
- “Affiliation” of a center: utterance (U) and discourse segment (DS)
- Function of a center: to link between a given utterance and other utterances in discourse

Center Typology

- Types:
 - Forward-looking Centers C_f (U, DS)
 - Backward-looking Centers C_b (U, DS)
- Connection: C_b (U_n) connects with one of C_f (U_{n-1})

Example

John went to his favorite music store to buy a piano.
It was a store John had frequented for many years.
He was excited that he could finally buy a piano.
It was closing just as John arrived.

Constraints on Distribution of Centers

- C_f is determined only by U ;
- C_f are partially ordered in terms of salience
- The most highly ranked element of C_f (U_{n-1}) is realized as C_b (U_n)
- Syntax plays role in ambiguity resolution: $\text{subj} > \text{ind obj} > \text{obj} > \text{others}$
- Types of transitions: center continuation, center retaining, center shifting

Center Continuation

Continuation of the center from one utterance not only to the next, but also to subsequent utterances

- $C_b(U_{n+1}) = C_b(U_n)$
- $C_b(U_{n+1})$ is the most highly ranked element of $C_f(U_{n+1})$ (thus, likely to be $C_b(U_{n+2})$)

Center Retaining

Retention of the center from one utterance to the next

- $C_b(U_{n+1}) = C_b(U_n)$
- $C_b(U_{n+1})$ is not the most highly ranked element of $C_f(U_{n+1})$ (thus, unlikely to be $C_b(U_{n+2})$)

Center Shifting

Shifting the center, if it is neither retained no continued

- $C_b(U_{n+1}) \langle \rangle C_b(U_n)$

Coherent Discourse

Coherence is established via center continuation

John went to his favorite music store to buy a piano.

He had frequented the store for many years.

He was excited that he could finally buy a piano.

He arrived just as the store was closing for the day.

John went to his favorite music store to buy a piano.

It was a store John had frequented for many years.

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Application to Essay Grading

(Miltakaki&Kukich'00)

- Framework: GMAT e-rater
- Implementation: manual annotation of coreference information
- Grading: based on ratio of shifts
- Data: GMAT essays

Study results

- Correlation between shifts and low grades (established using t-test)
- Improvement of score prediction in 57%