

## 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!

## 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

## Lexical Cohesion and Coherence

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## 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.

## 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

Cohesion captures devices that link sentences into a text

- Lexical cohesion
- References
- Ellipsis
- Conjunctions

## 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	1		
8 scientist				11			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	1	1		
7 orbit	1				1							12	1	1							
6 pull					2		1	1						1	1						
16 planet	1	1		11				1					21	11111				1	1	1	
7 galaxy	1											1				1	11	1	1	1	
4 lunar			1	1	1	1		1													
19 life	1	1	1						1	11	1	11	1	1			1	1	1	111	1
27 moon			13	1111	1	1	22	21	21	21	1	1	1	11	1						
3 move										1	1	1	1								
7 continent										2	1	1	2	1							
3 shoreline												12									
6 time				1				1	1	1	1	1								1	
3 water								11			1	1									
6 say								1	1				1	11						1	
3 species										1	1	1									

## 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.

## 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

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9/34

## Lexical Chains: Computation

“Associantist text models“

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

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11/34

## Example

Halliday&Hasan(1982)

Time flies.  
- You can't; they fly too quickly.

Find three cohesive ties!

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8/34

## Lexical Chains: Applications

- Summarization
- Segmentation
- Malapropism Detection
- Information Retrieval

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10/34

## 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>

## Vector-Based Coherence Assessment

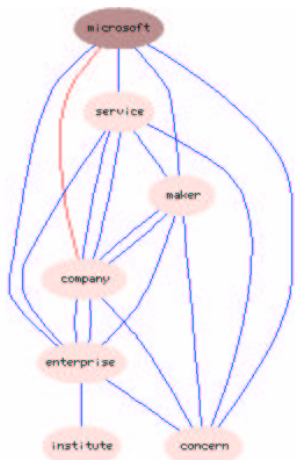
- Each sentence is represented as a weighted vector of its terms  
SENTENCE<sub>1</sub>: 1 0 0 0 1 1 0  
SENTENCE<sub>2</sub>: 1 1 1 1 0 0 1

- 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

## Lexical Chains: Example



## 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

## 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)

## Results

Text	LSA	Weighted	No.	Efficiency	Inference
	coherence	word	props		
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

## 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)

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

## 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

## Analysis

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

## 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

## 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.

## Centering Theory: Basics

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- 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

## Example

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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.

## Another Example

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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.

## Center Typology

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

## 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 Shifting

Shifting the center, if it is neither retained nor continued

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

## 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: subj > ind obj > obj > others
- Types of transitions: center continuation, center retaining, center shifting

## 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  $C_b(U_{n+2})$ )

## 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

## 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.

He was excited that he could finally buy a piano.

It was closing just as John arrived.

## Study results

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