Discourse Applications

Slides were adapted
from Regina Barzilay

Homework questions

- Testing an hypothesis
- Pyramid: use one document set from the training data that you had
- Can you use your late days?
  - Yes
- HW 2: If you think you were penalized for sentences that run, see me.

What is text?

- A product of cohesive ties (cohesion)

ATHENS, Greece (Ap) A strong earthquake shook the Aegean Sea island of Crete on Sunday but caused no injuries or damage. The quake had a preliminary magnitude of 5.2 and occurred at 5:28 am (0328 MT) on the sea floor 70 kilometers (44 miles) south of the Cretan port of Chania. The Athens seismological institute said the temblor's epicenter was located 380 kilometers (238 miles) south of the capital. No injuries or damage were reported.

What is text?

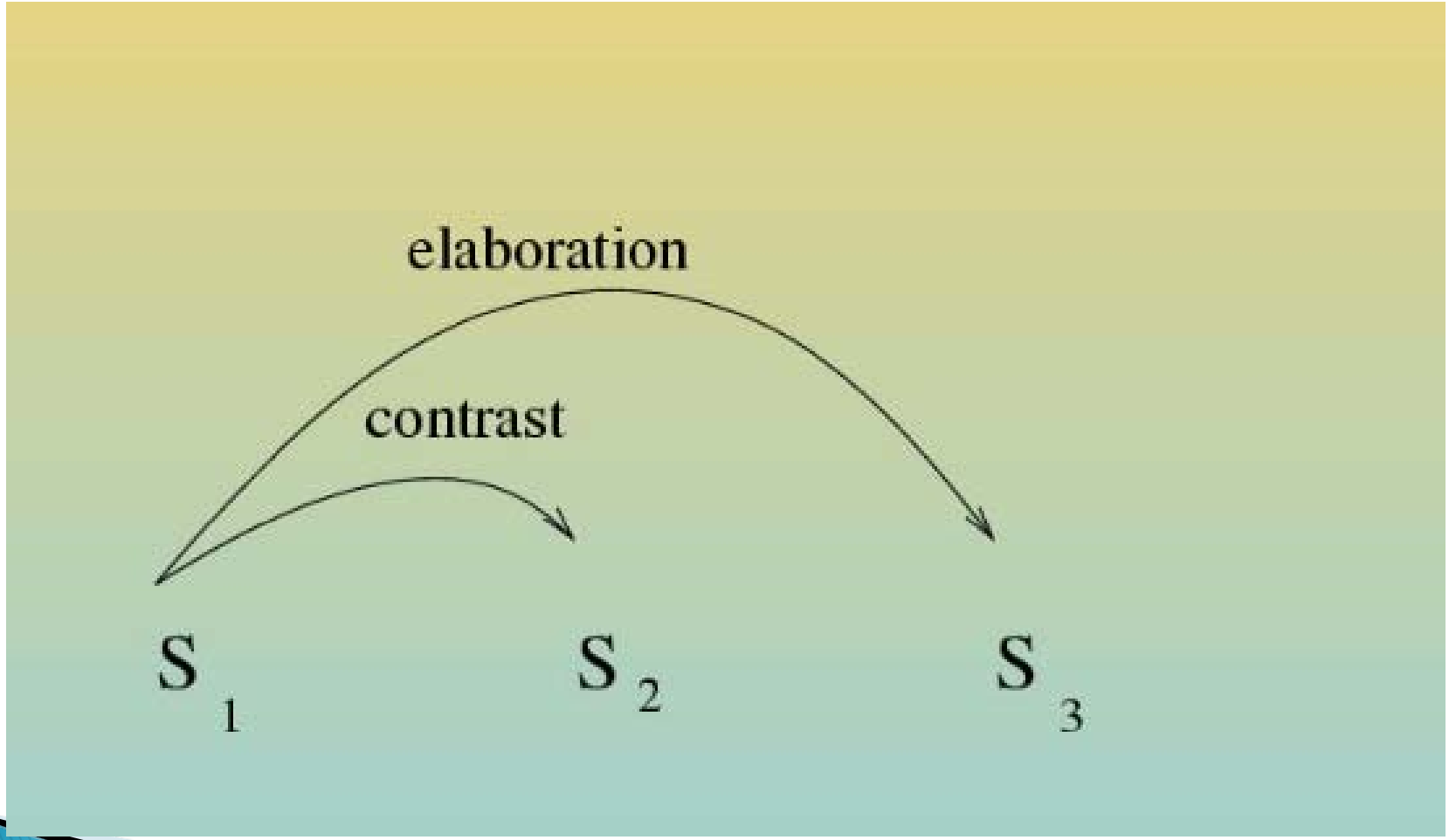
- A product of structural relations (coherence)

S1:	A strong earthquake shook the Aegean Sea island of Crete on Sunday
S2:	but caused no injuries or damage.
S3:	The quake had a preliminary magnitude of 5.2

Content based structure

- Describe the strength and the impact of an earthquake
- Specify its magnitude
- Specify its location
- …

Rhetorical Structure



Analogy with syntax

- Domain-independent Theory of Sentence Structure
- Fixed set of word categories (nouns, verbs, …)
- Fixed set of relations (subject, object, …)
- P(A is sentence this weird.)

Two Approaches to text structure

- Domain-dependent models (Today)
  - Content-based models
  - Rhetorical models

- Domain-independent mode
  - Rhetorical Structure Theory

Motivation

- Summarization
  - Extract a representative subsequence from a set of sentences
- Question-Answering
  - Find an answer to a question in natural language
- Text Ordering
  - Order a set of information-bearing items into a coherent text
- Machine Translation
  - Find the best translation taking context into account

Domain Specific Models

- Rhetorical Model:
  - **Argumentative Zoning of Scientic Articles** (Teufel, 1999)
- Content-based Model:
  - **Unsupervised (Barzilay&Lee, 2004)**

Argumentative Zoning

Many of the recent advances in Question Answering have followed from the insight that systems can benefit from by exploiting the redundancy in large corpora. Brill et al. (2001) describe using the vast amount of data available on the WWW to achieve impressive performance …The Web, while nearly infinite in content, is not a completerepository of useful information … In order to combat these inadequacies, we propose a strategy in which in information is extracted from …

Argumentative Zoning

- BACKGROUND
  Many of the recent advances in Question Answering have followed from the insight that systems can benefit from by exploiting the redundancy …
- OTHER WORK
  Brill et al. (2001) describe using the vast amount of data available on the WWW to achieve impressive performance …
- WEAKNESS
  The Web, while nearly infinite in content, is not a complete repository of useful information …
- OWN CONTRIBUTION
  In order to combat these inadequacies, we propose a strategy in which in information is extracted from : :

Motivation

- Scientic articles exhibit (consistent across domains) similarity in structure
  - BACKGROUND
  - OWN CONTRIBUTION
  - RELATION TO OTHER WORK

- Automatic structure analysis can benefit:
  - Q&A
  - Summarization
  - citation analysis

Approach

- Goal: Rhetorical segmentation with labeling
- Annotation Scheme:
  - Own work: aim, own, textual
  - Background
  - Other Work: contrast, basis, other
- Implementation: Classification

Examples

Category	Realization
Aim	We have proposed a method of clustering words based on large corpus data
Textual	Section 2 describes three parsers which are …
Contrast	However, no method for extracting the relationship from supercial linguistic expressions was described in their paper.

Kappa Statistics

- (Siegal&Castellan, 1998; Carletta, 1999)
- Kappa controls agreement P(A) for chance agreement P(E)

$$K = \frac{P(A) - p(E)}{1 - p(E)}$$

- Kappa from Argumentative Zoning:
  - Stability: 0.83
  - Reproducibility: 0.79

Features

- Position
- Verb Tense and Voice
- History
- Lexical Features (“other researchers claim that”)

Results

- Classification accuracy is above 70%
- Zoning improves classification

Content Models

(Barzilay&Lee, 2004)

- Content models represent topics and their ordering in text.

Domain: newspaper articles on earthquake
Topics: “strength”, “location”, “casualties”, . . .
Order: “casualties” prior to “rescue efforts”.

- Assumption: Patterns in content organization are recurrent

Similarity in domain texts

- TOKYO (AP) A moderately strong earthquake with a preliminary magnitude reading of 5.1 rattled northern Japan early Wednesday, the Central Meteorological Agency said. There were no immediate reports of casualties or damage. The quake struck at 6:06 am (2106 GMT) 60 kilometers (36 miles) beneath the Pacic Ocean near the northern tip of the main island of Honshu. . . .

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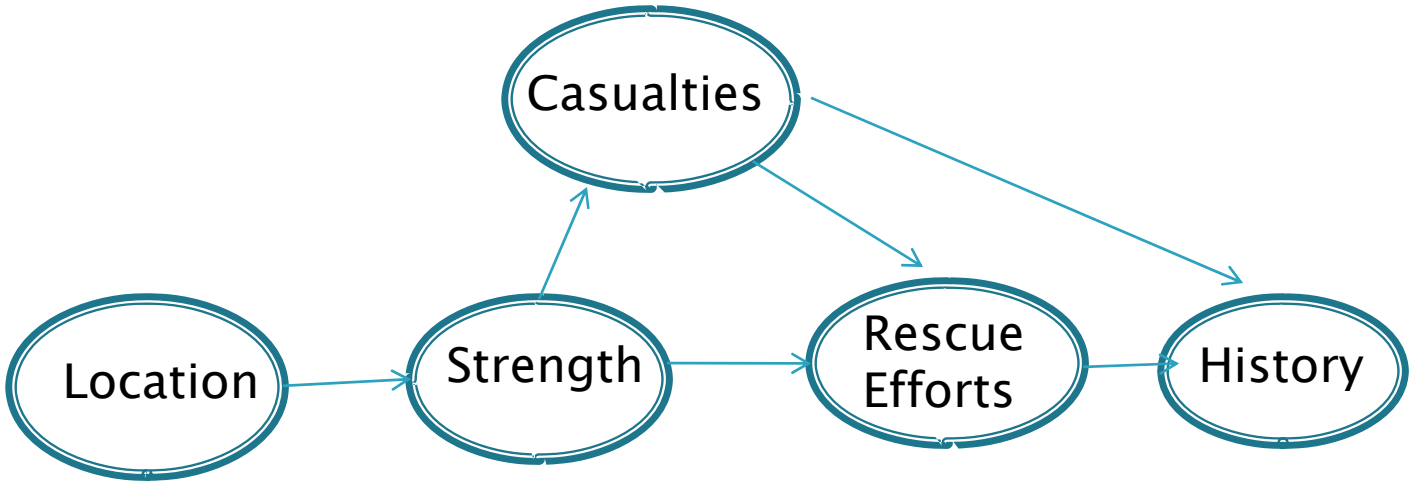
Narrative Grammars

- Propp (1928): fairy tales follow a “story grammar”.
- Barlett (1932): formulaic text structure facilities reader's comprehension
- Wray (2002): texts in multiple domains exhibit significant structural similarity

Computing Content Models

Implementation: Hidden Markov Model

- States represent topics
- State-transitions represent ordering constraints



Model Construction

- Initial topic induction
- Determining states, emission and transition probabilities
- Viterbi re-estimation

Initial Topic Construction

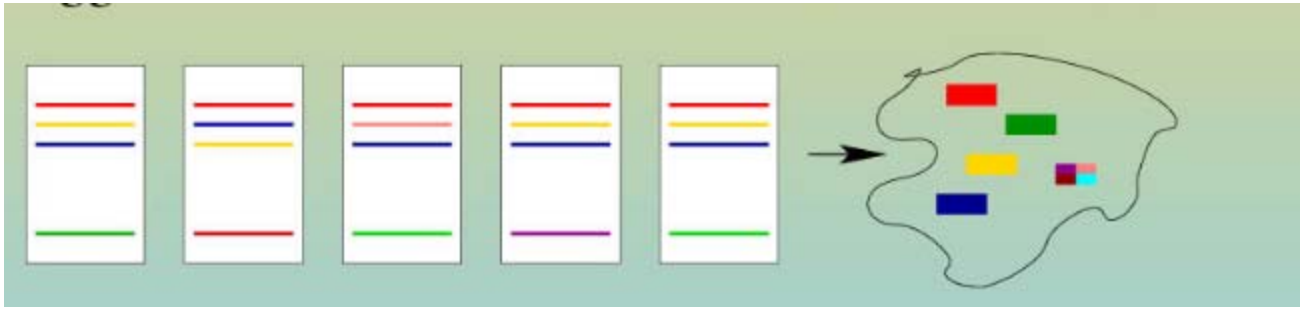
Agglomerative clustering with cosine similarity measure

(Iyer&Ostendorf:1996,Florian&Yarowsky:1999, Barzilay&Elhadad:2003)

The Athens seismological institute said the temblor's epicenter was located 380 kilometers (238 miles) south of the capital.
Seismologists in Pakistan's Northwest Frontier Province said the temblor's epicenter was about 250 kilometers (155 miles) north of the provincial capital Peshawar.
The temblor was centered 60 kilometers (35 miles) northwest of the provincial capital of Kunming, about 2,200 kilometers (1,300 miles) southwest of Beijing, a bureau seismologist said.

From clusters to states

- Each large cluster constitutes a state
- Agglomerate small clusters into an *insert state*



Estimating Emission Probabilities

State s-I emission probability:

$$p_{s_i}(w_0, \ldots, w_n) = \prod_{j=0}^{n} p_{s_i}(w_j | w_{j-1})$$

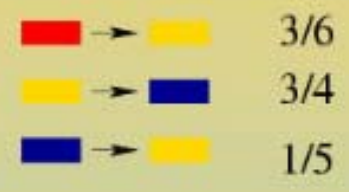
Estimation for a normal state:

$$p_{s_i}(w'|w) \stackrel{def}{=} \frac{f_{c_i}(ww') + \delta_1}{f_{c_i}(w) + \delta_1 |V|},$$

Estimation for the insertion state:

$$p_{s_m}(w'|w) \stackrel{def}{=} \frac{1 - \max_{i<m} p_{s_i}(w'|w)}{\sum_{u \in V} (1 - \max_{i<m} p_{s_i}(u|w))}.$$

Estimating Transition Probabilities



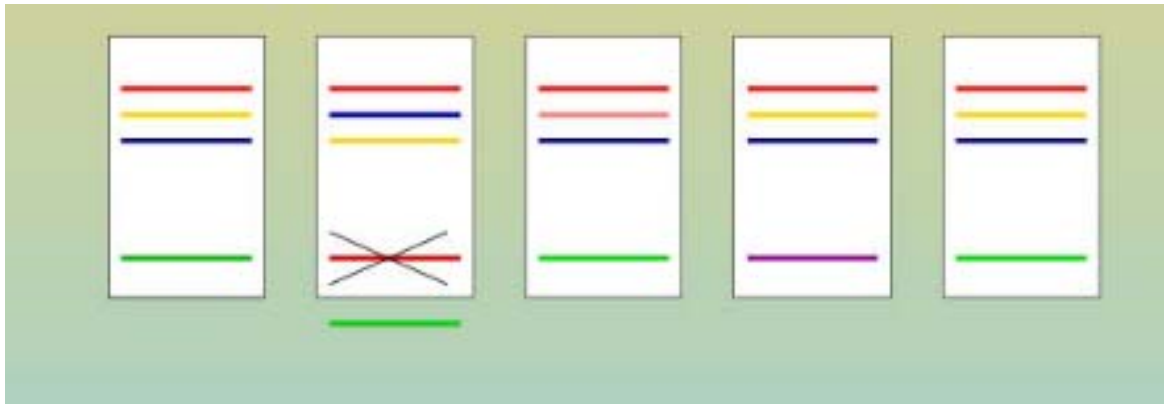
$$p(s_j|s_i) = \frac{g(c_i, c_j) + \delta_2}{g(c_i) + \delta_2 m}$$

$g(c_i, c_j)$ is a number of adjacent sentences (c_i, c_j)

$g(c_i)$ is a number of sentences in c_i

Viterbi Re-estimation

- Goal: incorporate ordering information
- Decode the training data with Viterbi decoding



Use the new clustering as the input to the parameter estimation procedure

Application: Information Ordering

- Input: set of sentences
- Applications:
  - Text summarization
  - Natural Language Generation
- Goal: Recover most likely sequences
- *"get marry" prior to "give birth" (in some domains)*

Information Ordering: Algorithm

- Input: set of sentences
  - Produce all permutations of the set

  Rank them based on the content model

Summarization: Algorithm

- Input: source text
- Training data: parallel corpus of summaries and source texts (aligned)
- Employ Viterbi on source texts and summaries
- Compute state likelihood to generate summary sentences:

$$p(s \in summary | s \in source) = \frac{summary\_count(s)}{source\_count(s)},$$

- Given a new text, decode it and extract sentences corresponding to “summary” states

Evaluation: Data

Domain	Average Length	Vocabulary Size	Token/ type
Earthquake	10.4	1182	13.158
Clashes	14	1302	4.464
Drugs	10.3	1566	4.098
Finance	13.7	1378	12.821
Accidents	11.5	2003	5.556

Baselines

- "Straw" baseline: Bigram Language model

- "State-of-the-art" baseline: (Lapata:2003)
  - represent a sentence using lexico-syntactic features
  - compute pairwise ordering preferences
  - find optimally global order

Results: Ordering

Domain	Algorithm	Prediction Accuracy	Rank	τ
Earthquake	Content	72%	2.67	0.81
	Lapata '03	24%	(N/A)	0.48
	Bigram	4%	485.16	0.27
Clashes	Content	48%	3.05	0.64
	Lapata '03	27%	(N/A)	0.41
	Bigram	12%	635.15	0.25
Drugs	Content	38%	15.38	0.45
	Lapata '03	27%	(N/A)	0.49
	Bigram	11%	712.03	0.24
Finance	Content	96%	0.05	0.98
	Lapata '03	17%	(N/A)	0.44
	Bigram	66%	7.44	0.74
Accidents	Content	41%	10.96	0.44
	Lapata '03	10%	(N/A)	0.07
	Bigram	2%	973.75	0.19

Baselines for Summarization

- "Straw" baseline: n leading sentences
- "State-of-the-art"Kupiec-style classier
  - Sentence representation: lexical features and location
  - Classifier: BoosTexter

Results: Summarization

Summarizer	Extraction accuracy
Content-based	**88%**
Sentence classifier (words + location)	76%
Leading n sentences	69%

Next Class

- Final exam review (Dec. 17th 1-4pm, 1024 Mudd)
- Future