Discourse Structure for Content Selection

NLP Systems & Applications
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Text Coherence

- Cohesion – repetition, etc – does not imply coherence
- Coherence relations:
  - Possible meaning relations between utts in discourse
  - Examples:
    - **Result:** Infer state of S_0 cause state in S_1
      - The Tin Woodman was caught in the rain. His joints rusted.
    - **Explanation**: Infer state in S_1 causes state in S_0
      - John hid Bill's car keys. He was drunk.
    - **Elaboration**: Infer same prop. from S_0 and S_1.
      - Dorothy was from Kansas. She lived in the great Kansas prairie.
  - Pair of locally coherent clauses: discourse segment

Rhetorical Structure Theory

- Mann & Thompson (1987)
- Goal: Identify hierarchical structure of text
  - Cover wide range of TEXT types
    - Language contrasts
  - Relational propositions (intentions)
- Derives from functional relations b/t clauses

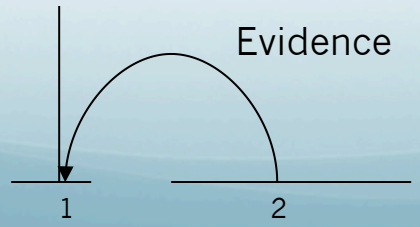
Components of RST

- Relations:
  - Hold b/t two text spans, nucleus and satellite
    - Nucleus core element, satellite peripheral
    - Constraints on each, between
    - Units: Elementary discourse units (EDUs), e.g. clauses

RST Relations

- Evidence
  - The program really works. (N)
  - I entered all my info and it matched my results. (S)

Relation Name:	Evidence
Constraints on N:	R might not believe N to a degree satisfactory to W
Constraints on S:	R believes S or will find it credible
Constraints on N+S:	R's comprehending S increases R's belief of N
Effects:	R's belief of N is increased



RST Relations

- Core of RST
  - RST analysis requires building tree of relations
  - Relations include:
    - Circumstance, Solutionhood, Elaboration. Background, Enablement, Motivation, Evidence, etc

- Captured in:
  - RST treebank: corpus of WSJ articles with analysis
  - RST parsers: Marcu, Peng and Hirst 2014

GraphBank

- Alternative discourse structure model
  - Wolf & Gibson, 2005
- Key difference:
  - Analysis of text need not be tree-structure, like RST
  - Can be arbitrary graph, allowing crossing dependency
- Similar relations among spans (clauses)
  - Slightly different inventory

Penn Discourse Treebank

- PDTB (Prasad et al, 2008)
  - "Theory-neutral" discourse model
  - No stipulation of overall structure, identifies local rels
- Two types of annotation:
  - Explicit: triggered by lexical markers ('but') b/t spans
    - Arg2: syntactically bound to discourse connective, ow Arg1
  - Implicit: Adjacent sentences assumed related
    - Arg1: first sentence in sequence
- Senses/Relations:
  - Comparison, Contingency, Expansion, Temporal
    - Broken down into finer-grained senses too

Discourse & Summarization

- Intuitively, discourse should be useful
  - Selection, ordering, realization
- Selection:
  - Sense: some relations more important
    - E.g. cause vs elaboration
  - Structure: some information more core
    - Nucleus vs satellite, promotion, centrality
- Compare these, contrast with lexical info
  - Louis et al, 2010

Framework

- Association with extractive summary sentences
  - Statistical analysis
    - Chi-squared (categorical), t-test (continuous)

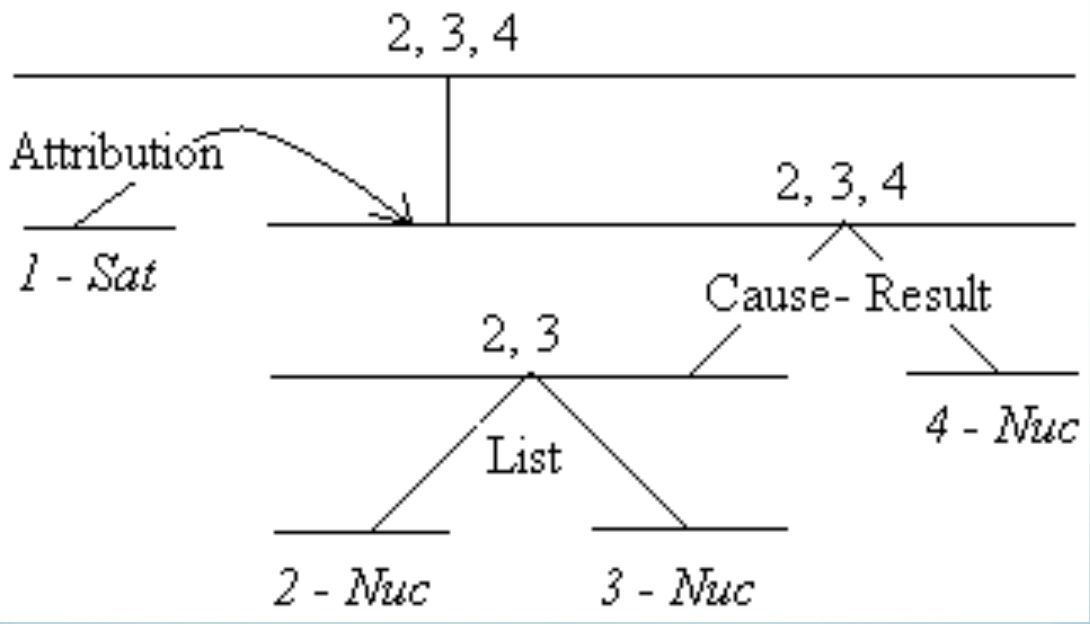
- Classification:
  - Logistic regression
    - Different ensembles of features
  - Classification F-measure
  - ROUGE over summary sentences

RST Parsing

- Learn and apply classifiers for
  - Segmentation and parsing of discourse
- Assign coherence relations between spans
- Create a representation over whole text => parse
- Discourse structure
  - RST trees
    - Fine-grained, hierarchical structure
      - Clause-based units

Discourse Structure Example

- 1. [Mr. Watkins said] 2. [volume on Interprovincial's system is down about 2% since January] 3. [and is expected to fall further,] 4. [making expansion unnecessary until perhaps the mid-1990s.]



Discourse Structure Features

- Satellite penalty:
  - For each EDU: # of satellite nodes b/t it and root
    - 1 satellite in tree: (1), one step to root: penalty = 1
- Promotion set:
  - Nuclear units at some level of tree
    - At leaves, EDUs are themselves nuclear
- Depth score:
  - Distance from lowest tree level to EDU's highest rank
    - 2,3,4: score= 4; 1: score= 3
- Promotion score:
  - # of levels span is promoted:
    - 1: score = 0; 4: score = 2; 2,3: score = 3

Converting to Sentence Level

- Each feature has:
  - Raw score
  - Normalized score: Raw/sentence_length
- Sentence score for a feature:
  - Max over EDUs in sentence

“Semantic” Features

- Capture specific relations on spans
- Binary features over tuple of:
  - Implicit vs Explicit
  - Name of relation that holds
    - Top-level or second level
  - If relation is between sentences,
    - Indicate whether Arg1 or Arg2
- E.g. “contains Arg1 of Implicit Restatement relation”
- Also, # of relations, distance b/t args w/in sentence

Example I

- In addition, its machines are easier to operate, so customers require less assistance from software.

- Is there an explicit discourse marker?
  - Yes, ‘so’

- Discourse relation?
  - ‘Contingency’

Example II

- (1)Wednesday's dominant issue was Yasuda & Marine Insurance, which continued to surge on rumors of speculative buying. (2) It ended the day up 80 yen to 1880 yen.
- Is there a discourse marker?
  - No
- Is there a relation?
  - Implicit (by definition)
- What relation?
  - Expansion (or more specifically (level 2) restatement)
- What Args? (1) is Arg1; (2) is Arg2 (by definition)

Non-discourse Features

- Typical features:
  - Sentence length
  - Sentence position
  - Probabilities of words in sent: mean, sum, product
  - # of signature words (LLR)

Significant Features

- Associated with summary sentences
  - Structure: depth score, promotion score
  - Semantic: Arg1 of Explicit Expansion, Implicit Contingency, Implicit Expansion, distance to arg
  - Non-discourse: length, 1st in para, offset from end of para, # signature terms; mean, sum word probabilities

Significant Features

- Associated with non-summary sentences
  - Structural: satellite penalty
  - Semantic: Explicit expansion, explicit contingency, Arg2 of implicit temporal, implicit contingency,...
    - # shared relations
  - Non-discourse: offset from para, article beginning; sent. probability

Observations

- Non-discourse features good cues to summary
- Structural features match intuition

- Semantic features:
  - Relatively few useful for selecting summary sentences
    - Most associated with non-summary, but most sentences are non-summary

Evaluation

- Structural best:
  - Alone and in combination
- Best overall combine all types
  - Both F-1 and ROUGE

Features used	Acc	P	R	F
structural	78.11	63.38	22.77	33.50
semantic	75.53	44.31	5.04	9.05
non-discourse (ND)	77.25	67.48	11.02	18.95
ND + semantic	77.38	59.38	20.62	30.61
ND + structural	78.51	63.49	26.05	36.94
semantic + structural	77.94	58.39	30.47	40.04
structural + semantic + ND	78.93	61.85	34.42	44.23

Graph-Based Comparison

- Page-Rank-based centrality computed over:
  - RST link structure
  - Graphbank link structure
  - LexRank (sentence cosine similarity)
- Quite similar:
  - F1: LR > GB > RST
  - ROUGE: RST > LR > GB

Notes

- Single document, short (100 wd) summaries
  - What about multi-document? Longer?
- Structure relatively better, all contribute
- Manually labeled discourse structure, relations
  - Some automatic systems, but not perfect
    - However, better at structure than relation ID
      - Esp. implicit