Measuring frame relatedness

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Outline

- Introduction
  - Motivation
  - Related work
- Frame relatedness
  - FrameNet
  - Manually ranking Frames
- Frame relatedness measures
- Conclusions

What it's all about?

Defining and proving a notion of frame relatedness

Developing frame relatedness measures

Motivation

- Ontologies and taxonomies provide precise information about the relationship of words and concepts.
- Semantic similarity / relatedness is a important component in knowledge-driven applications.
- Support of advanced knowledge-driven NLP tasks
- Resources available

Related Work

Semantic relationships between words are intensively researched

- structure-based approaches
- information-based approaches

Word Similarity

Two words are *related* if any type of relation stands between them.

Two words are *similar* if they are connected through an “is-a” like relation.

Budanitsky and Hirst 2006

Frame relatedness

Definition:

1) Two frames are *similar* if they are linked via „is-a“ like relations.

2) Two frames are *related* if any relation stands between them.

Frame

Frame: STATEMENT		
This frame contains verbs and nouns that communicate the act of a SPEAKER to address a MESSAGE to some ADDRESSEE using language. A number of the words can be used performatively, such as *declare* and *insist*.		
FEs	SPEAKER	**Evelyn** said she wanted to leave.
	MESSAGE	Evelyn announced **that she wanted to leave**.
	ADDRESSEE	Evelyn spoke **to me** about her past.
	TOPIC	Evelyn's statement **about her past**
	MEDIUM	Evelyn preached to me **over the phone**.
LUs	acknowledge.v, acknowledgment.n, add.v, address.v, admission.n, admit.v, affirm.v, affirmation.n, allegation.n, allege.v, announce.v, ...	

Frame name

Definition

Semantic roles
Frame Elements

Words associated with the frame
Lexical Units

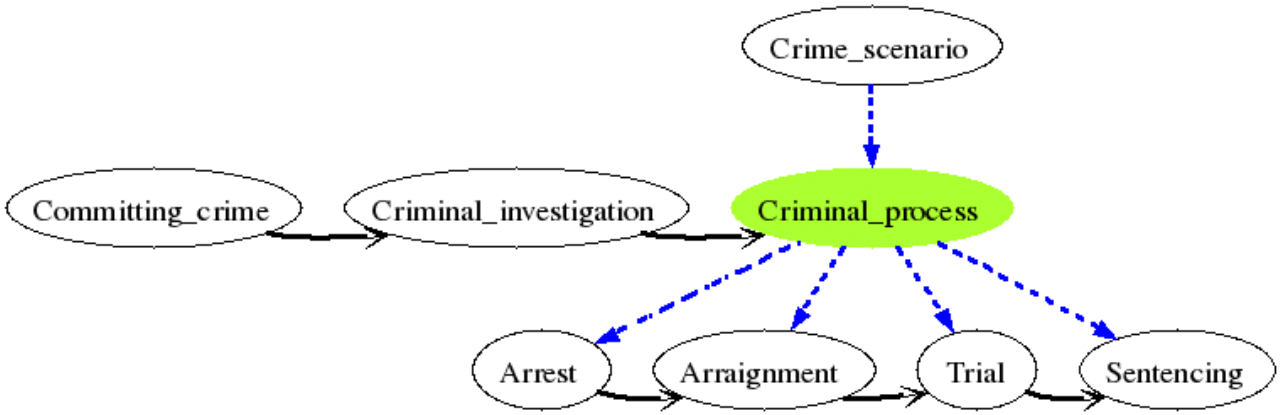
FrameNet

(Ruppenhofer et al. 2005)

- Frames are concepts describing situations / events
- Frames are the basic units of FrameNet
- Structured semantic lexicon
- Words (lexical units) associated with frames
- ~ 10 000 lexical units
- ~ 800 Frames
- ~ 135 000 annotated sentences (BNC corpus)

Frame-to-Frame-Relations

- hierarchical
  - Inheritance
  - Using
  - Subframe
- non-hierarchical
  - Perspective_on
  - Causative_of
  - Inchoative_of
  - Precedes
  - See_also



FrameNet Hierarchy

(Release 1.3)

- Number of frames : 795
- Number of roots : 86
- Number of isolated nodes : 7
- Number of independent sub-graphs : 26

FrameNet Hierarchy

(Release 1.3)

- Number of frames reachable from more than 1 root : 559
- Number of incoming edges : 1136
- Average number of edges per frame: 2.86
- Maximum path length : 15

Manually ranking frames Experiment

- 15 subjects -> 155 frame pairs
  - 15 frame pairs
    - 10 judged only by this subject
    - 5 judged by all subjects
- sort the pairs according to their similarity
- rate every pair on a scale from 0 to 4

Manually ranking frames Experiment

- Data
  - A set of controlled frame pairs
    → Controlled Set (155 pairs)
  - A set of randomly selected frame pairs
    → Simple Set (155 pairs)

Manually ranking frames Results

- high significant correlation among the annotators
  - Simple Set $\tau = 0.600$ $\alpha < 0.005$
  - Controlled Set $\tau = 0.547$ $\alpha < 0.005$

⟹ The notion of “frame relatedness” is intuitive and principled for humans.

Manually ranking frames Results

- significant correlation on the gold standard ranking
  - Simple Set gold standard

    $\tau = 0.530$ StdDev = 0.146 $\alpha < 0.01$
  - Controlled Set gold standard

    $\tau = 0.566$ StdDev = 0.173 $\alpha < 0.01$

⇒ gold standard ranking is reliable

Manually ranking frames
Gold Standards

SIMPLE SET	CONTROLLED SET
Measure volume - Measure mass (1)	Knot creation - Rope manipulation (1,5)
Communication manner - Statement (2)	Shoot projectiles - Use firearm (1,5)
Giving - Sent items (3)	Scouring - Scrutiny (3)
Abundance - Measure linear extent (4)	Ambient temperature - Temperature (4)
Remembering information - Reporting (5)	Fleeing - Escaping (5)
...	...
Research - Immobilization (126)	Reason - Taking time (142)
Resurrection - Strictness (126)	Rejuvenation - Physical artworks (142)
Social event - Word relations (126)	Revenge - Bungling (142)
Social event - Rope manipulation (126)	Security - Likelihood (142)
Sole instance - Chatting (126)	Sidereal appearance - Aggregate (142)

Human gold standard ranking: first and last 5 pairs (in brackets ranks allowing ties)

Frame relatedness measures

Measure	
wn_jcn wn_hso	WordNet-based measures
cr_occ_sent cr_wgt_sent cr_occ_doc cr_wgt_doc	corpus-based measures
cr_dist_doc	distributional measure
hr_wu hr_hso hr_fe	FrameNet-based measures
def overlap baseline *LU overlap baseline* *human upper bound*	

Frame relatedness measures

- WordNet-based measures
  - map lexical units to WordNet senses
  - calculate the sense similarity using two different WordNet similarit measures:
    - wn_jcn : Jiang and Conrath (1997)
    - wn_hso : Hirst and St.Onge (1998)

Frame relatedness measures

- corpus-based measures
  - using the SemCor corpus
  - calculate the point wise mutual information of two frames
    - simple point wise mutual information
      cr_occ_
    - weighted point wise mutual information
      cr_wgt_
  - using two different types of context
    - sentences → cr_occ_sent, cr_wgt_sent
    - documents → cr_occ_doc, cr_wgt_doc

Frame relatedness measures

- distributional measure
  - using the TREC-2002 Vol.2 corpus
  - each frame is modelled by a distributional vector
  - documents are dimensions
  - the value of a dimension expresses the association between the document and the frame
  - relatedness computed by using cosine similarity

Frame relatedness measures Results

Measure	*Simple Set*	*Controlled Set*
wn_jcn	0.114	0.141
wn_hso	0.106	0.141
cr_occ_sent	0.239	0.340
cr_wgt_sent	**0.281**	**0.349**
cr_occ_doc	0.143	0.227
cr_wgt_doc	0.173	0.240
cr_dist_doc	0.152	0.240
hr_wu	0.139	0.286
hr_hso	0.134	0.296
hr_fe	0.252	0.326
def overlap baseline	*0.056*	*0.210*
LU overlap baseline	*0.080*	*0.253*
human upper bound	*0.530*	*0.566*

Correlation measure with gold standard using Kendall's Tau

Frame relatedness measures Evaluation

- WordNet-based measures

wn_jcn	0.114	0.141
wn_hso	0.106	0.141
def overlap baseline	*0.056*	*0.210*
LU overlap baseline	*0.080*	*0.253*
human upper bound	*0.530*	*0.566*

  - fail to predict relatedness for many pairs
    - wn_hso assigns zero to 137 (Simple Set) pairs and 119 (Controlled Set) pairs
  - WordNet misses situational relations
  - 18% of FrameNet LUs are adjectives or adverbs
  - 7% of verbal FrameNet LUs don't have a WordNet mapping

Frame relatedness measures Evaluation

- corpus-based measures

cr_occ_sent	0.239	0.340
cr_wgt_sent	**0.281**	**0.349**
cr_occ_doc	0.143	0.227
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  - correlation decreases using documents as context
  - corpus-based measures promote frame pairs in non-hierarchical relations
  - the distributional measure promotes frame pairs in hierarchical relations

Frame relatedness measures Evaluation

- FrameNet-based measures

hr_wu	0.139	0.286
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  - FrameNet hierarchy is a good indicator for frame relatedness
  - hierarchy-based measures promote pairs related by diverse relations
  - measures slightly penalized by low coverage

Conclusions

- the notion of frame relatedness is cognitively principled
- introduce a variety of measures for automatically estimating frame relatedness
- measures offer good performance (significant at the 99% level)

Bibliography

- Marco Pennachiotti and Michael Wirth. 2009. Measuring frame relatedness. In: Proceedings of the 12th Conference of the European Chapter of the Association for Computational Linguistics (EACL 2009). Athens, Greece. to appear.

Frame relatedness measure

WordNet-based measures

$$wn(F_1, F_2) = \frac{\sum_{s_1 \in S_{F_1}} \sum_{s_2 \in S_{F_2}} wn\_rel(s1, s2)}{|S_{F_1}| \cdot |S_{F_2}|}$$

S_F : the set of WordNet senses mapping to lexical units of frame *F*

$wn\_rel(s1, s2)$: a function estimating the relatedness of two WordNet senses

used functions: Jiang and Conrath (1997) wn_jcn
Hirst and St.Onge (1998) wn_hso

Frame relatedness measure

corpus-based measures

$$cr\_occ(F_1, F_2) = log_2 \frac{|C_{F_1,F_2}|}{|C_{F_1}||C_{F_2}|}$$

$$C_{F_i} = \{c \in C : \exists l_{F_i} \text{ in } c\}$$

$$C_{F_1,F_2} = \{c \in C : \exists l_{F_1} \text{ and } \exists l_{F_2} \text{ in } c\}$$

C : the corpus
c : context in Corpus C

l_F : a lexical unit of frame *F*

Frame relatedness measure

corpus-based measures

$$cr\_wgt(F_1, F_2) = log_2 \frac{\sum_{c \in C_{F_1,F_2}} w_{F_1}(c) \cdot w_{F_2}(c)}{\sum_{c \in C_{F_1}} w_{F_1}(c) \cdot \sum_{c \in C_{F_2}} w_{F_2}(c)}$$

$$w_F(c) = \underset{l_F \in L_F \text{ in } c}{\arg\max} P(S_{l_F}|l_F) \qquad P(S_{l_F}|l_F) = \frac{|S_{l_F}|}{|S_l|}$$

L_F : the set of LUs of frame *F*

Frame relatedness measure

FrameNet-based measures

$$hr\_wu(F_1, F_2) = \frac{2 \cdot dp(LCS)}{ln(F_1, LCS) + ln(F_2, LCS) + 2 \cdot dp(LCS)}$$

dp(F) : the depth of frame F in the FrameNet hierarchy

ln(F1,F2): the path length between the frames F1 and F2

LCS : least common subsumer

Frame relatedness measure

FrameNet-based measures

$$hr\_hso(F_1, F_2) = M - \text{ path length } - k \cdot d$$

M, k : constants
d : number of changes of direction

Frame relatedness measure

FrameNet-based measures

$$hr\_fe(F_1, F_2) = \frac{|FE_1 \cap FE_2|}{max(|FE_1|, |FE_2|)}$$

FE : the set of frame elements