

Towards fine-grained frame-based sentiment analysis

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Overview

- Goal: Support recognition of explicit sentiment and inference on implicit opinions
 - ▶ need to work on the word sense level because e.g. of effect inconsistency across senses (Choi and Wiebe 2014)
 - ▶ need to use information on syntax-semantics mappings
- We work with FrameNet, whose frames and hierarchical organization provide a rich basis for deep Sentiment Analysis.
- We survey how FrameNet has been used so far for Sentiment Analysis and discuss where we see its unique potential for deeper analysis.
- We show how FrameNet is being further enriched for the purposes of deep sentiment analysis (cf. Ruppenhofer and Rehbein 2012).

The sentiment analysis task

- Convergence of research from diverse backgrounds
- terminological diversity: subjectivity analysis, opinion mining, evaluative language, attitude analysis, . . .
- No widely agreed delimitation of its scope
- Usually ostensive definitions

In particular, we propose a detailed annotation scheme that identifies key components and properties of opinions, emotions, sentiments, speculations, evaluations, and other private states (Quirk et al. 1985), i.e., internal states that cannot be directly observed by others.

(Wiebe, Wilson, and Cardie 2005)

- For particular applications, only subsets may be relevant.

Granularity of analysis

| | Shallow/Coarse | Deep/Fine |
|--------------------|--|---|
| Unit of Analysis | aggregates: documents, data streams | individual expressions: words, morphemes |
| Text types | restricted: e.g. tweets, product reviews | general |
| Role extraction | from meta-data | from text |
| Mode of expression | explicit | implicit |
| Methods | simple features (e.g. no parsing) | more complex features (e.g. parsing, word sense disambiguation) |
| Result | polarity, intensity | roles, polarity, intensity |

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Topic

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


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 - 5 Presentation of the subjective attitude as real/actual or imagined/hypothetical Realis/Irrealis
 - 6 Speech and reference time of the opinion expressed Tense & Aspect

Some Research that has used FrameNet

- Assembling features/clues/polarity lexicons
 - ▶ Wilson, Wiebe, and Hwa 2006 (use of Pittsburgh Subjectivity Clues for recognizing strong vs weak opinion clauses)
 - ▶ Vechtomova 2010 (FN for opinion retrieval from blogs)
 - ▶ Yang and Cardie 2013 (frames as clues for recognizing opinions)
 - ▶ Seongsoon Kim et al. 2015 (use frame distribution for opinion spam detection)
 - ▶ ...
- Source and Target extraction
 - ▶ Bethard et al. 2004 (opinion propositions and holders)
 - ▶ Soo-Min Kim and Hovy 2006 (holders of 'judgment opinions')
 - ▶ Hawes and David 2012 (mappings for 81 frames with 681 verbs)
 - ▶ Wiegand and Ruppenhofer 2015 (inducing verbal categories with characteristic source/target mappings to semantic roles)

Mapping opinion roles to semantic roles

Example Frame: Complaining

FES of the Complaining frame

| | |
|------------|--|
| Complainer | The Complainer is the sentient entity that produces the Complaint (whether spoken or written). |
| Topic | The Topic is the subject matter to which the Complaint pertains. |
| Complaint | The lamentable situation that the Complainer is communicating to the Addressee. |
| Addressee | The Addressee is the person to whom the Complaint is communicated. |
| Time | The Time when the complaint is made. |
| ... | ... |

- Inherits from: Statement
- Lexical units: belly-ache.v, bitch.v, complaint.n, complain.v, grievance.n, gripe.n, gripe.v, grouse.v, grouching.n, grumble.v, lament.v, moan.v, piss and moan.v, whine.v, whinge.v
- [Now *Time*] [he *Complainer*] was **bitching** *Complaining* [about all matters technical *Topic*].
- [He *Complainer*] **complained** [about Tory colleagues *Topic*]: [' They don't know what it is to run out of money at the end of the week . " *Complaint*]

Mapping opinion roles to semantic roles: frame-internal source

Example: role mappings for FrameNet's Complaining frame

| Semantic roles | Opinion roles |
|----------------|---------------|
| Complainer | Source |
| Topic | Target |
| Complaint | Target |
| Addressee | - |
| Time | - |
| ... | - |

[Now *Time*] [he *Complainer*] was **bitching** *Complaining* [about all matters technical *Topic*] .

Now [he *Source*] was **bitching** *Opinion* [about all matters technical *Target*] .

Mapping opinion roles to semantic roles: frame-external source

- Some predicates convey the opinion of an external viewer.
- We map relevant roles to Target but let the Source default to an external viewer.

Role mappings for the *Isolated places* frame

| Semantic roles | Opinion roles |
|-------------------|---------------|
| - | Source |
| Place | Target |
| Relative location | - |
| ... | - |

LUs: backcountry.n,
back_of_beyond.n,
backwater.n, backwoods.n,
boondocks.n, boonies.n,
Bumblefuck.n, fly-over
country.n, godforsaken.a,
middle_of_nowhere.n,
outback.n, out-of-the-way.a,
Podunk.n, the_sticks.n, *East
Jesus.n

I live in a small town and I don't consider [our town ^{Place}] **Podunk** ^{Isolated_places} .
I live in a small town and I don't consider [our town ^{Target}] **Podunk** ^{Opinion} .

Handling opinions at multiple levels

- Participant vs. reporter-level (Maks and Vossen 2011)
- Potentially distinct polarity, intensity (cf. *brag*)

Example: role mappings for FrameNet's Bragging frame

| Semantic roles | Internal view | External view |
|----------------|---------------|---------------|
| Speaker | Source | Target |
| Topic | Target | |
| Message | Target | - |
| Addressee | - | - |
| Time | - | - |
| ... | - | - |

- ["I read the Observer and Times," ^{Message}] **bragged** [one ^{Speaker}]. frame
- ["I read the Observer and Times," ^{Target}] ⊕ **bragged** [one ^{Source}]. internal
- "I read the Observer and Times," ⊖ **bragged** [one ^{Target}]. external

Opinion inference

- In addition to explicit sentiment and evaluation, texts prompt readers / hearers to infer contextually defeasible implicit attitudes:
 - ① She is **disappointed** that Peter is **happy** because the Colts lost .
- Early discussion in Ruppenhofer, Somasundaran, and Wiebe 2008 but more recently explored in depth by, among others, Choi, Deng, and Wiebe 2014; Wiebe and Deng 2014; Klenner, Amsler, and Hollenstein 2014; Reforgiato Recupero et al. 2015.
- Important: here focus of inference is on assessing the attitude of an external observer on the event. E.g. in (1), we do not care about the Colts' sentiments towards the loss!

Two related approaches

- Event evaluativity functors (Anand and Reschke 2010; Reschke and Anand 2011)
 - ▶ Lexicon → corpus
- Good-for/bad-for ; effect-based inference (Deng, Choi, and Wiebe 2013; Choi, Deng, and Wiebe 2014)
 - ▶ Corpus → lexicon

Functor approach

- Anand and Reschke 2010 model inferences as functors which map sets of participants to event evaluations.
- Focus on entailments of existence, **possession**, affectedness
- Work by Ruppenhofer and Brandes 2015 proposes additional functors.

| | x | y | E_{have} | E_{lack} | $E_{withhold}$ | $E_{deprive}$ | E_{spare} |
|---|---|---|------------|------------|----------------|---------------|-------------|
| a | + | + | + | - | - | - | # |
| b | + | - | - | + | + | # | + |
| c | - | + | - | + | + | + | # |
| d | - | - | + | - | - | # | - |

x,y: argument variables
#: blocked by presupposition

- a My friend was given a promotion.
- b My friend has cancer.
- c That bastard has a lot of support among voters.
- d That idiot got the worst assignment ever.
- ? Sadly, my neighbor didn't win the prize.

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- ? Sadly, my neighbor didn't win the prize. Poor Tony!

Full example: Kidnapping Frame

- I am currently manually annotating entailment information for LUs in FrameNet frames.
- Intentional FEs: Perpetrator

Blame/Praise \propto Intentionality

| LUs | Pol | Affected | Cause | Arg1 | Func | Arg2 | Val |
|-----|-----|----------|-------|-------|------|--------|------|
| all | + | Perp. | Perp. | Perp. | POSS | Vic. | n/a |
| all | - | Vic. | Perp. | Vic. | LOC | Source | n/a |
| all | + | Vic. | Perp. | Vic. | LOC | Perp. | n/a |
| all | + | Vic. | Perp. | Vic. | AFF | n/a | neg. |

- At approximately 08:30 hours on Saturday 10 September [an unknown offender ^{Perpetrator}] has attempted to **abduct** [a girl ^{Victim}] [during her paper round ^{Time}] [in the Henley area ^{Place}].
- Mittal asserted that [he ^{Victim}] had been **abducted** [from outside his home ^{Source}] ...

Pol: sentence polarity; Val: valence / sentiment polarity

Related work on GermaNet synsets: Ruppenhofer and Brandes 2015

Enriching FN with presuppositions

- Support handling of negation/irrealis via annotations
- Distinguish entailments and presuppositions
 - ▶ [Possums and some other creatures ^{Evader}] **evade**^{Evading} [predators ^{Pursuer}]
[by playing dead ^{Means}]

Intentional FEs: Evader, Pursuer

| LUs | Pol | Affected | Cause | Arg1 | Func | Arg2 | Val | Status |
|-------|-----|----------|---------|---------|------|--------|-----|---------|
| evade | - | Pursuer | Evader | Pursuer | POSS | Evader | n/a | Entail |
| evade | - | Pursuer | Evader | Pursuer | POSS | Evader | n/a | Presupp |
| evade | - | Evader | Pursuer | Evader | AFF | neg. | n/a | Entail |

Sentiment analysis rests on lexical semantics

- A great deal of information that is needed for sentiment analysis comes out of the lexicon (and the construction).
- Semantic roles are indispensable.
- The knowledge requirements of sentiment analysis encourage work on core areas of semantics:
 - ▶ semantic roles
 - ▶ gradable predicates
 - ▶ implicatives
 - ▶ ...

Lexical enrichment: beyond sentiment analysis

- Extensions to a general purpose lexical resource (FrameNet) are broadly useful.
- In particular, for tasks that can be reduced to entailment
 - ▶ Scalar information also relevant for e.g. understanding indirect answers (*Was it good? – It was great.*)
 - ▶ Knowledge about implicatives (e.g. *fail, manage*) is generally relevant for deep understanding (and applications like information retrieval, question answering, etc).
 - ▶ Evaluation data for automatic approaches to semantic relation detection: two lexical items cannot entail each other, if they don't share a functor.
 - ▶ ...

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Polarity as Semantic type in FrameNet

Lexical Entry

acclaim.v

Frame: Judgment_communication

Definition:

COD: praise enthusiastically and publicly

Semantic Type: Positive_judgment

Lexical Entry

boast.v

Frame: Bragging

Definition:

COD: talk with excessive pride and self-satisfaction about oneself

Effect approach

- ② As president, Reagan raised taxes in seven of his eight years in office.
- Need to look at the positive or negative **effect** that an event has **on its object** (semantic role).
 - ▶ Effects and affected entities are not explicitly captured by the functor account.
- In combination with the attitude towards the object, this yields the evaluation of the state that results from the event (=the effect).
- That evaluation can then be transferred onto the agent or cause responsible for bringing about the effect, and onto the overall action brought about by the agent or cause.

Effect inconsistency

- Among 726 Germanet synsets annotated with functors by Ruppenhofer and Brandes 2015 , 148 unique lemmas with more than one synset.
- 110 of the 148 lemmas (74.3%) have an inconsistent effect on an affected entity (polarity / affected entity, or both)
 - ▶ ausstoßen 'emit': positive on object (creation)
 - ▶ ausstoßen 'expel': figure~ground (location)
- Choi & Wiebe 2014 report that in the corpus of Deng et al. 2013, which contains 1,411 +/-effect instances, 196 different +effect words and 286 different -effect words. Among them, 10 words appear in both +effect and -effect instances, accounting for 9.07% of all annotated instances.

Effect inconsistency within the same frame

The verbs in FrameNet's Cure frame typically allow two different FEs to be realized as objects.

This frame deals with a Healer treating and curing an Affliction (the injuries, disease, or pain) of the Patient, sometimes also mentioning the use of a particular Treatment or Medication. This frame differs from Medical_intervention in that this frame deals only with cases in which the Patient is cured of the Affliction, not just treated for the Affliction.

- The doctor **cured** [the patient *Patient*]. (+Affectedness)
- The doctor **cured** [the disease *Disease*]. (-Creation)

Alternative: handle such cases by considering syntactic subcategorization in combination with selectional restrictions. [Klenner and Amsler 2016](#)

New functor: Similarity

| Item1 | Item2 | <i>similar</i> | <i>differ</i> |
|-------|-------|----------------|---------------|
| + | + | + | - |
| + | - | - | + |
| - | + | + | - |
| - | - | - | + |

Functor for predicates of similarity

- 1 Charles Krauthammer said ... “[Putin *Item1*] is **like** [Hitler *Item2*] but he’s more subtle and he’s also weaker, ...”
- 2 Look, [he’s *Item1*] not **like** [you and me *Item2*]. He’s not going to school. He’s not interested in a career.

Meta-Sentiment

Intuition: We routinely have feelings about other people's feelings!

| Experiencer | Stimulus | <i>love</i> | <i>hate</i> |
|-------------|----------|-------------|-------------|
| + | + | + | - |
| + | - | - | + |
| - | + | -? | - |
| - | - | +? | + |

Functor for predicates expressing sentiment

- [My sister *Experiencer*] **loves** [that idiot cousin of yours *Stimulus*] . . .
- They should know that [a creep *Experiencer*] is in **love** [with her *Stimulus*]

A further extension: propositional attitude predicates

- The properties of propositional attitude predicates are also relevant for an understanding of inferred sentiment.
 - ▶ She doesn't *know* that he's **annoying**.
 - ▶ He *denied* having **stolen** the car.
- I explicate the properties of these items in FrameNet

| LUs | Pol | Aff. | Cause | Arg1 | Func | Arg2 | Val | Temp | Status |
|-----------------|-----|-------|-------|-------|--------|-------|------|------|---------|
| learn | + | Cogn. | n/a | Cogn. | KNOW | Cont. | n/a | E | Entail |
| aware | + | Cogn. | n/a | Cogn. | KNOW | Cont. | n/a | S | Entail |
| ignorant | - | Cogn. | n/a | Cogn. | KNOW | Cont. | n/a | S | Entail |
| aware, ignorant | + | n/a | n/a | Spk* | KNOW | Cont. | n/a | S | Presupp |
| believe | + | Cogn. | n/a | Cogn. | BELIEF | Cont. | pos. | S | Entail |
| doubt | + | Cogn. | n/a | Cogn. | BELIEF | Cont. | neg. | S | Entail |

- Reasoning now more complex, involving not only attitudes but also notions like truth and credibility.

For this we can build on seminal work by Karttunen and others (Karttunen 1971; Karttunen 1973).