Semantic Frame Induction

Course: Natural Language Processing I

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What is a semantic frame?

- A **semantic frame** is a schematization of the situation/event/state expressed by a predicative lexical item through the set of lexical items typically associated with it and their semantic roles.

Example

Mary eats an apple. $\rightsquigarrow$ Frame: Ingestion
Mary `[NP-Subject-Ingestor]` eats `[VP-Predicate]` an apple `[NP-Direct Object - Ingestible ]`.

- **Framenet** is a computational lexicon that contains frame-semantic descriptions of English lexical items, together with semantically annotated attestations in corpora.

Framenet: an example

Ingestion

Lexical Unit Index

Definition:

An Ingestor consumes food or drink (Ingestibles), which entails putting the Ingestibles in the mouth for delivery to the digestive system. This may include the use of an Instrument. Sentences that describe the provision of food to others are NOT included in this frame.
The wolves DEVOURED the carcass completely.

FEs:

Core:

Ingestibles [Ingible]	The Ingestibles are the entities that are being consumed by the Ingestor.
Ingestor [Ing] **Semantic Type:** Sentient	The Ingestor is the person eating or drinking.
Non-Core:	
Degree [Degr] **Semantic Type:** Degree	The extent to which the Ingestibles are consumed by the Ingestor. The wolves DEVOURED the carcass completely
Duration [Dur]	The length of time spent on the ingestion activity. They 've been EATING for hours !
Instrument [Ins] **Semantic Type:** Physical_entity	The Instrument with which an intentional act is performed.
Manner [Manr] **Semantic Type:** Manner	Manner of performing an action.
Means [Mns] **Semantic Type:** State_of_affairs	An act performed by the Ingestor that enables them to accomplishes the whole act of ingestion. The thing ATE by snaking its long tongue out and grabbing with it.

Lexical Unit	LU Status	Lexical Entry Report	Annotation Report
breakfast.v	**Finished_Initial**	Lexical entry	Annotation
consume.v	**Finished_Initial**	Lexical entry	Annotation
devour.v	**Finished_Initial**	Lexical entry	Annotation
dine.v	**Finished_Initial**	Lexical entry	Annotation
down.v	**Finished_Initial**	Lexical entry	Annotation
drink.v	**Finished_Initial**	Lexical entry	Annotation
eat.v	**Finished_Initial**	Lexical entry	Annotation
feast.v	**Finished_Initial**	Lexical entry	Annotation
feed.v	**Finished_Initial**	Lexical entry	Annotation

Clustering verbs according to frames

- **Frame parsing** is the task of extracting frames from semantic predicate-argument structures.
- In this case: clustering verbs according to frames given their arguments *Subject* and *Direct Object*.

Example

Mary eats an apple $\rightsquigarrow$ `V: eat S: Mary DOBJ: apple`

Building the dataset

Google Syntactic N-grams - English 1 Million Verbargs

Set of n-grams (130M) consisting of verbs with all their immediate arguments

Example

```
eats while/IN/mark/3 he/PRP/nsubj/3 eats/VBZ/advcl/0 breakfast/NN/dobj/3 10

1950,2 1970,1 1976,1 1979,1 1993,2 1999,1 2001,1 2003,1
```

Preprocessing

1. Extraction of triples: $V - S - DO$
2. Stemming
3. Collapsing repetitions
4. Filtering by the top n verbs/entries

Model 0

- **Frame lexicon:** Dirichlet prior β. For each $f = 1..F$, sample three word multinomials: $\phi_f^{(v)}, \phi_f^{(s)}, \phi_f^{(o)} \sim Dir(\beta)$
- **Tuple data:** For each tuple $i..N$,
  - Draw its frame indicator f_i (from a fixed prior)
  - Draw the three words from their respective multinomials: $w_i^{(v)} \sim \phi_{f_i}^{(v)}; w_i^{(s)} \sim \phi_{f_i}^{(s)}; w_i^{(o)} \sim \phi_{f_i}^{(s)}$

Inference algorithm

EM

Assumption

Every tuple is modeled independently

Model 1

- F frames, and Dirichlet priors α, β
- **Frame lexicon:** For each frame $f \in 1..F$, and argument position $a \in \{1, 2, 3\}$
  - Draw word multinomial $\phi_f^{(a)} \sim Dir(\beta)$
- **Document-tuple data:** For each document $d \in 1..D$
  - Draw frame multinomial $\theta_d \sim Dir(\alpha)$
  - For each tuple i in the document,
    - Draw frame indicator $f_i \sim \theta_d$
    - Draw word triple: for each argument position $a \in \{1, 2, 3\}$
      Draw $w_i^{(a)} \sim \phi_{f_i}^{(a)}$

Inference algorithm

Can be seen as LDA with "frames" instead of "topics"

- Latent variable models syntactic arguments selection and document-level effects
- Collapsed Gibbs sampling

Evaluation

- Determine similarity between found clusters and those given by Framenet
- E.g. **Jaccard coefficient**: $Jacc(A, B) = \frac{|AB|}{A \cup B}$, where A is the set of found items and B the set of wanted items