Extensive Evaluation of a FrameNet-WordNet mapping resource

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LREC 2010, Malta

Outline

Frame Semantics

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- Conceptual constraints: Frames are characterized by *roles*, as *Frame elements*
- Semantic constraints: Predicate arguments are selectionally constrained by a system of semantic types

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- The FrameNet project was developed for english.
- Some FrameNet projects in other language are starting (e.g. Italian, Spanish)
- May be Lexical resources used as support to develop FrameNet in other language?

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Challenge

Is it possible to make an automatic mapping between FrameNet Lexical Units and WordNet synsets?

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- (Tonelli and Pighin, 2009) a mapping between FrameNet Lexical Units and WordNet synsets is studied as a classification task according to a supervised learning model.

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The relationship between word senses and frames is very rich, the latter including synonimic/antinomic lexical units as well as topically related LU pairs.

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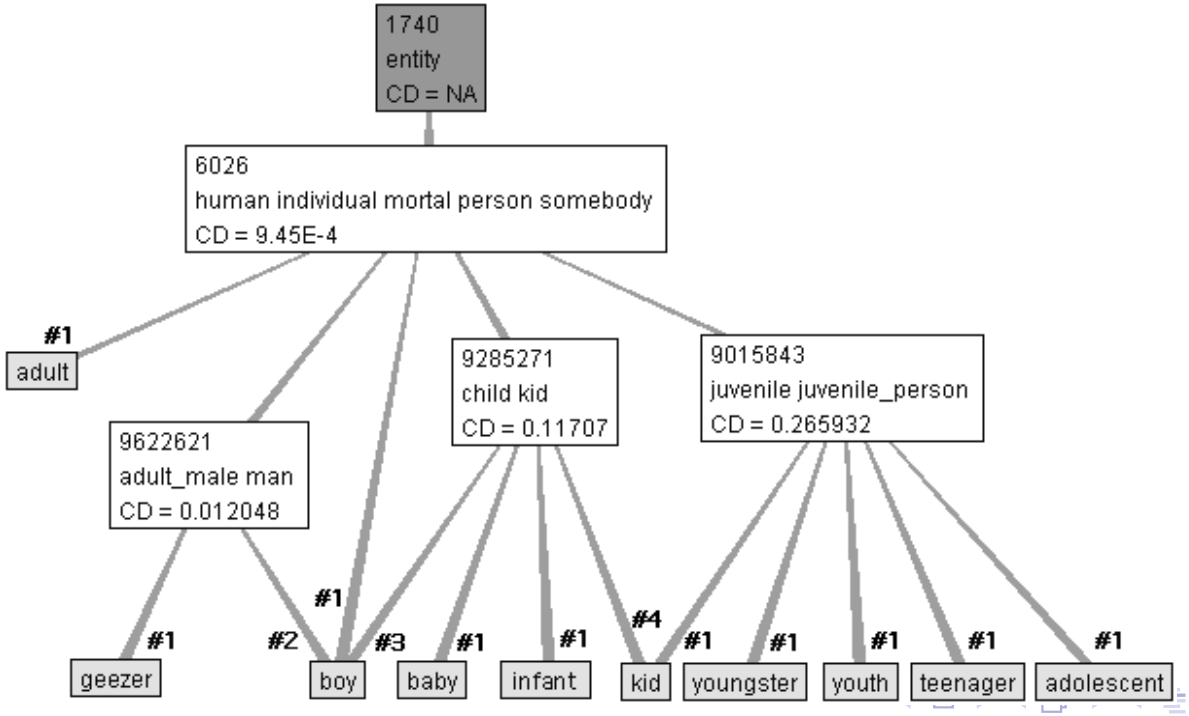
- A sense can also evoke more than one frame (e.g. "*child, kid*" for `Kinship` and `People_by_age`).
- A sense can be a narrower notion than a frame, and *more than one sense* evoke the same frame (e.g. "*child, kid*" and "*child, kid, youngster, ...*" for `People_by_age`)

Developing a Paradigmatic Model for frames

Task Definition

Given the set of lexical units $lu \in F$
Determine the suitable generalizations α in WN able to subsume most of the lexical units in F

An example:



A Paradigmatic model of Frames

Definition

The WordNet model $WN_F(\Gamma, W)$ of a frame F, is a graph

$$WN_F(\Gamma, W) =< W, S_F, L_F, h, sim_{WN}, m >$$

where:

- $W \subset F$ are the subset of all LUs in F having the same part-of-speech $\Gamma \in \{verb, noun, adjective\}$,
- S_F are synsets in WN needed to generalize words $w \in W$
- $L_F \subset S_F$ are the lexical senses of $w \in W$ subsumed by S_F
- $h \subseteq S_F \times S_F$ is the projection of the hyponymy relation in S_F
- $m \subseteq W \times 2^{L_F}$ is the lexical relation between words $w \in W$ and synsets in L_F
- $sim_{WN} : S_F \rightarrow \Re$ is a weighting function of senses $\sigma \in S_F$

The Paradigmatic Model for nouns

Solution: Conceptual Density metric (Basili et al., 2004)

For each $w \in W$, the semantic similarity in F_W is computed according to the conceptual density metric (Basili et al., 2004).

Given W, a synset α in WordNet used to generalize n different nouns $w \in W$, the conceptual density, $cd^{F_W}(\alpha)$, of α with respect to F_W is defined as:

$$cd^{F_W}(\alpha) = \frac{\sum_{i=0}^{h} \mu^i}{area(\alpha)}$$

where h is the estimated depth of a tree able to generalize the n nouns, i.e.

$$h = \begin{cases} \lfloor log_\mu n \rfloor & \textbf{iff } \mu \neq 1 \\ n & \textbf{otherwise} \end{cases}$$

μ is the average branching factor in the Wordnet subhierarchy dominated by α, $area(\alpha)$ is the number of nodes in the α subhierarchy.

The Paradigmatic Model for adjectives and verbs

Adjectives

Similarity among *adjectives* is computed on the basis of the synonymy relation, as follows:

$$sim_{WN}(ul) = \begin{cases} 1 & \textbf{iff } \exists l \in F \text{ such that} \\ & l \text{ is a synonym of } ul \\ \varepsilon & \text{otherwise} \end{cases}$$

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Verbs

For *verbs* the co-hyponymy relation is applied. The similarity $sim_{WN}(ul)$ is defined as follows:

$$sim_{WN}(ul) = \begin{cases} 1 & \textbf{iff } \exists K \subset F \text{ such that} \\ & |K| > \tau \textbf{ AND} \\ & \forall l \in K, l \text{ is a co-hyponim of } ul \\ \varepsilon & \text{otherwise} \end{cases}$$

A Paradigmatic Model of Frames

Properties

- The WordNet model $WN_F(\Gamma, W)$ is the *best* projection of Wordnet for the target frame F, according to the *hyperonimy relation* among senses of the LUs and the *conceptual density* metrics

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- Potential polisemy effects are captured as more than one lexical sense can be retained
- Irrilevant senses for F are discarded

Resource Statistics

	Nouns	Verbs	Adjectives
Targeted Frames	364	412	111
Targeted LUs	3.602	3.325	762
Average LUs per frame	9,89	8,07	6,86
Number of Evoked Senses	11.034	18.781	2.320
Average Polysemy	3,06	5,64	3,04
Active Lexical Senses	4.221	4.868	921
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About 10K Lexical Unit - Synset pairs

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Analysis

- Empirical Analysis on a Gold Standard
- Comparative Analysis with respect to other resources

Empirical Analysis: Experimental Setup

Gold Standard - (Tonelli and Pighin, 2009)

The gold standard includes:

- 386 Frames

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FrameNet version 2.0
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Evaluation Metrics

$$P = \frac{TP}{TP+FP} \quad R = \frac{TP}{TP+FN} \quad F1 = \frac{2*P*R}{P+R}$$

Results

	Precision	Recall	F-Measure
Tonelli-Pighin 1	0,761	0,613	0,679
Tonelli-Pighin 2	0,794	0,569	0,663
Noun	0,795	0,815	0,805
Verb	0,522	0,665	0,585
Adjectives	0,694	0,735	0,714

Comparative Analysis: Experimental Setup

Systems

- The paradigmatic *PM* model of (De Cao et al., 2008)
- The SVM-based method of (Tonelli and Pighin, 2009) hereafter *TP*
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Statistics

- *PM* and *TP* (w, F) common pairs 3,479
- *PM* , *TP* and *F2W* (w, F) common pairs 1,027

Results

Comparison between PM and TP

	Cohen's k	Agreement
Overall	0,69	86,0%
Noun	0,70	85,3%
Verb	0,65	86,7%
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Comparison between PM , TP , F2W using only verbs

	Cohen's k	Agreement
MapNet (*TP* verbs only)	0,65	85,8%
FnWnVerbMap (*F2W*)	0,58	82,5%

Examples of PM resource

Frame	Frame Def.	Lexical Unit	Score	Senses	WordNet Gloss
BUILDING_SUBPARTS	This frame includes words that name subparts of buildings that can be occupied by people.	*room.n*	1	4	an area within a building enclosed by walls and floor and ceiling; "the rooms were very small but they had a nice view"
FLUIDIC_MOTION	In this frame a Fluid moves from a Source to a Goal along a Path or within an Area.	*flow.v*	0.9	7	move along, of liquids; "Water flowed into ; the cave" "the Missouri feeds into the Mississippi"
CAUSE_TO_MOVE_IN_PLACE	An Agent causes a Theme to move with respect to a certain Fixed_location, generally with a certain Periodicity, ...	*rotate.v*	0.6	7	turn on or around an axis or a center; "The Earth revolves around the Sun"; "The lamb roast rotates on a spit over the fire"
CONNECTORS	The Connector is an artifact created to affix a Connected_item or to bind onto a Fixed_location and is primarily so used.	*chain.n*	0.69	10	a necklace made by a stringing objects together; "a string of beads"; "a strand of pearls";

Caparison between PM and TP

Frame	Frame Definition	LU	WordNet Gloss	System
ACCOUTREMENTS	A Wearer wears accessories, which are made of some Material and may have a Style.	*choker.n*	necklace that fits tightly around a woman's neck	PM
			a high tight collar	TP
GROOMING	In this frame, an Agent engages in personal body care. An Instrument can be used in this process as well as a Medium.	*soap.v*	rub soap all over, usually with the purpose of cleaning	PM
			cover with soap; "lather your body when you shower"	TP
ELECTRICITY	Lexical units in this frame refer to Electricity, in particular as a form of energy harnessed for particular uses (such as powering machines). The Source of the Electricity may also be expressed, or incorporated in the meaning of the LUs.	*electrical.a*	using or providing or producing or transmitting or operated by electricity; "electric current"; "electric wiring"	PM
			relating to or concerned with electricity; "an electrical engineer"; "electrical and mechanical engineering industries"	TP
POSTURE	An Agent supports their body in a particular Location. ...	*stance.n*	a rationalized mental attitude	PM
			standing posture	TP

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- Lexical Unit - Synset pairs validated through different systems will be used as entry point for iFrame (the Italian FrameNet Project)
- An extension through distributional evidence to make domain specific FrameNets

Resource Download

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