# SemLink - Linking PropBank, VerbNet, FrameNet


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February 12, 2013
LING 7800


Computational Language and EducAtion Research
C L E A R




## Semlink: Overview

- WordNet, OntoNotes Groupings, PropBank
- VerbNet
  - Verbs grouped in hierarchical classes
  - Explicitly described class properties
- FrameNet
- Links among lexical resources
  - PropBank, FrameNet, WordNet, OntoNotes groupings
- Automatic Semantic Role Labeling with PropBank/Verbnet

## WordNet – Princeton

*(Miller 1985, Fellbaum 1998)*

On-line lexical reference (dictionary)

- Nouns, verbs, adjectives, and adverbs grouped into synonym sets
- Other relations include hypernyms (ISA), antonyms, meronyms
- Typical top nodes - 5 out of 25
  - *(act, action, activity)*
  - *(animal, fauna)*
  - *(artifact)*
  - *(attribute, property)*
  - *(body, corpus)*



## WordNet – Princeton – *leave, n.4, v.14*

*(Miller 1985, Fellbaum 1998)*

- Limitations as a computational lexicon
  - Contains little syntactic information
  - No explicit lists of participants
  - Sense distinctions very fine-grained,
  - Definitions often vague
- Causes problems with creating training data for supervised Machine Learning – SENSEVAL2
  - Verbs > 16 senses (including *call*)
  - Inter-annotator Agreement ITA 71%,
  - Automatic Word Sense Disambiguation, WSD 64%

*Dang & Palmer, SIGLEX02*

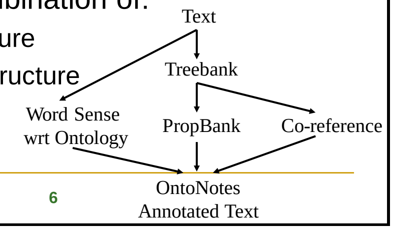
## Creation of coarse-grained resources

- Unsupervised clustering using rules (Mihalcea & Moldovan, 2001)
- Clustering by mapping WN senses to ODE (Navigli, 2006).
- OntoNotes - Manually grouping WN senses and annotating a corpus (Hovy et al., 2006)
- Supervised clustering WN senses using OntoNotes and another set of manually tagged data (Snow et al., 2007) .



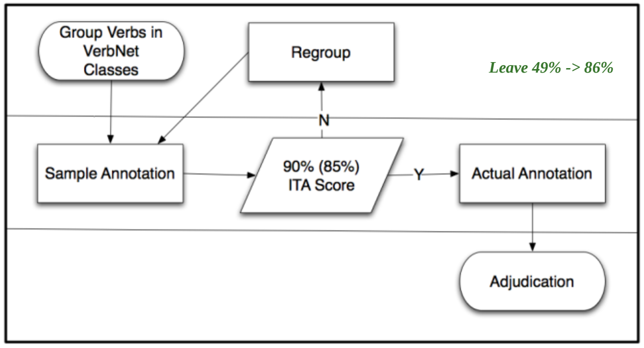
## OntoNotes Goal: Modeling Shallow Semantics DARPA-GALE

- AGILE Team: BBN, Colorado, ISI, Penn
- Skeletal representation of literal meaning
- Synergistic combination of:
  - Syntactic structure
  - Propositional structure
  - Word sense
  - Coreference






## Empirical Validation – Human Judges the 90% solution (1700 verbs)






## Groupings Methodology – Human Judges (w/ Dang and Fellbaum)

- Double blind groupings, adjudication
- Syntactic Criteria (VerbNet was useful)
  - Distinct subcategorization frames
    - *call him an idiot*
    - *call him a taxi*
  - Recognizable alternations – regular sense extensions:
    - *play an instrument*
    - *play a song*
    - *play a melody on an instrument*

*SIGLEX01, SIGLEX02, JNLE07, Duffield, et. al., CogSci 2007*

## Groupings Methodology (cont.)

- Semantic Criteria
  - Differences in semantic classes of arguments
    - Abstract/concrete, human/animal, animate/inanimate, different instrument types,…
  - Differences in the number and type of arguments
    - Often reflected in subcategorization frames
    - *John left the room.*
    - *I left my pearls to my daughter-in-law in my will.*
  - Differences in entailments
    - Change of prior entity or creation of a new entity?
  - Differences in types of events
    - Abstract/concrete/mental/emotional/….
  - Specialized subject domains



## WordNet: - call, 28 senses, 9 groups

WN5, WN16,WN12
Loud cry

WN15 WN26
Bird or animal cry

WN3 WN19
WN1 WN22
Label

WN4 WN 7 WN8 WN9
Request

WN20 WN25
Call a loan/bond

WN18 WN27
Challenge

WN2 WN 13
WN28
Phone/radio

WN6 WN23
Visit

WN17 , WN 11
WN24,

WN10, WN14, WN21,
Bid

## OntoNotes Status

- More than 2,500 verbs grouped
- Average ITA per verbs = 89%
- http://verbs.colorado.edu/html_groupings/
- More than 150,000 instances annotated
- WSJ, Brown, ECTB, EBN, EBC, WebText
- Training and Testing
- *How do the groupings connect to PropBank?*



## Frames File Example: *expect*

Roles:

Agent$_{ARG0}$: expecter
Theme$_{ARG1}$: thing expected

Example: Transitive, active:

*Portfolio managers expect further declines in interest rates.*

| | |
|---|---|
| Agent: | *Portfolio managers* |
| REL: | *expect* |
| Theme: | *further declines in interest rates* |

## Where we are now - DETAILS

- DARPA-GALE, OntoNotes 5.0
  - BBN,  Brandeis, Colorado, Penn
  - Multilayer structure: NE, TB, PB, WS, Coref
  - Three languages: English, Arabic, Chinese
  - Several Genres (@ ≥ 200K ): NW, BN, BC, WT
    - Close to 2M words @ language (less PB for Arabic)
  - Parallel data, E/C, E/A
  - PropBank frame coverage for rare verbs
  - Recent PropBank extensions



## Included in OntoNotes 5.1: Extensions to PropBank

- Original annotation coverage:
  - PropBank: verbs; past participle adjectival modifiers
  - NomBank: relational and eventive nouns.
- Substantial gap – trying to bridge
  - light verbs, other predicative adjectives, eventive nouns



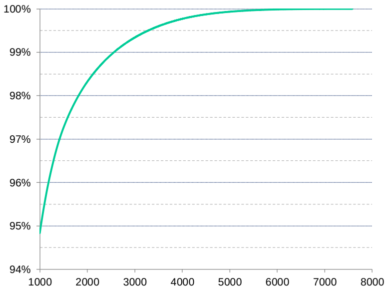
## English Noun and LVC annotation

- Example Noun: *Decision*
  - Roleset: Arg0: decider, Arg1: decision…
  - "…[your$_{ARG0}$] [decision$_{REL}$] [to say look I don't want to go through this anymore$_{ARG1}$]"
- Example within an LVC: *Make a decision*
  - "…[the President$_{ARG0}$] [made$_{REL-LVB}$] the [fundamentally correct$_{ARGM-ADJ}$] [decision$_{REL}$]  [to get on offense$_{ARG1}$]"



## PropBank Verb Frames Coverage

- The set of verbs is open
- But the distribution is highly skewed
- For English, the 1000 most frequent lemmas cover 95% of the verbs in running text.
  - Graphs show counts over English Web data containing 150 M verbs.



# Verb Frames Coverage By Language

| *Language* | *Projected Final Count* | *Estimated Coverage in Running Text* |
|---|---|---|
| **English** | **5,100** | **99%** |
| **Chinese** | **18,200*** | **96%** |
| **Arabic** | **5,250*** | **99%** |

* This covers all the verbs and most of the predicative adjectives/nouns in ATB, and CTB

*How do the PropBank verb frames relate to Word Senses?*

*Answer requires more explanation about OntoNotes senses*



# Word Senses in PropBank

- Orders to ignore word sense not feasible for 700+ verbs
  - *Mary left the room*
  - *Mary left her daughter-in-law her pearls in her will*

Frameset **leave.01** "move away from":
Arg0: entity leaving
Arg1: place left

Frameset **leave.02** "give":
Arg0: giver
Arg1: thing given
Arg2: beneficiary

*How do these relate to word senses in other resources?*



# Sense Hierarchy

*(Palmer, et al, SNLU04 - NAACL04, NLE07, Chen, et. al, NAACL06)*

- PropBank Framesets – ITA >90%
  coarse grained distinctions
  20 Senseval2 verbs w/ > 1 Frameset
  Maxent WSD system, 73.5% baseline, 90%
  - Sense Groups (Senseval-2) - ITA 82%
    Intermediate level
    (includes Levin classes) – 71.7%
    - WordNet – ITA 73%
      fine grained distinctions, 64%

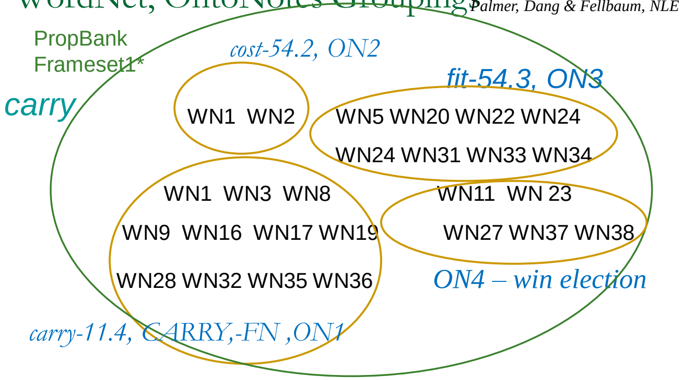
*Tagging w/groups,*
*ITA 90%, 200@hr,*
*Taggers - 86.9%*
*Semeval07*

*Chen, Dligach & Palmer, ICSC 2007*
*Dligach & Palmer, ACL-11, - 88%*



# SEMLINK-PropBank, VerbNet, FrameNet, WordNet, OntoNotes Groupings

*Palmer, Dang & Fellbaum, NLE*




**ON5-ON11 carry oneself,carried away/out/off, carry to term*

## Limitations to PropBank

- WSJ too domain specific,
  - Additional Brown corpus annotation & GALE data
  - FrameNet has selected instances from BNC
- Args2-4 seriously overloaded, poor performance
  - VerbNet and FrameNet both provide more fine-grained role labels



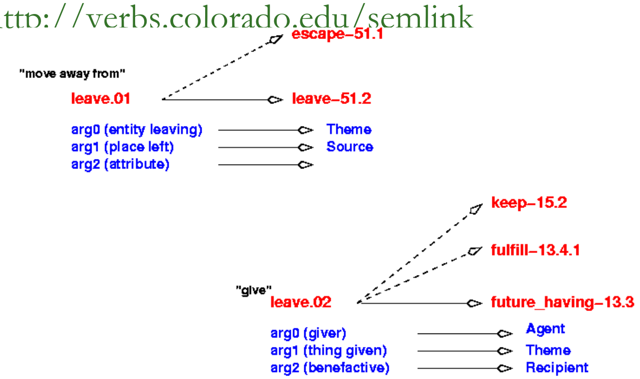
## VerbNet – based on Levin, B.,93

*Kipper, et. al., LRE08*

- Class entries:
  - Capture generalizations about verb behavior
  - Organized hierarchically
  - Members have common semantic elements, semantic roles, syntactic frames, predicates
- Verb entries:
  - Refer to a set of classes (different senses)
  - each class member linked to WN synset(s), ON groupings, PB frame files, FrameNet frames,



## Mapping from PB to VerbNet
http://verbs.colorado.edu/semlink






## FrameNet: Telling.*inform*

| | |
|---|---|
| Time | In 2002, |
| Speaker | the U.S. State Department |
| Target | INFORMED |
| Addressee | North Korea |
| Message | that the U.S. was aware of this program , and regards it as a violation of Pyongyang's nonproliferation commitments |

## Mapping from PropBank to VerbNet (similar mapping for PB-FrameNet)

| Frameset id = ***leave.02*** | Sense = *give* | VerbNet class = ***future-having 13.3*** |
|---|---|---|
| Arg0 | Giver | Agent/Donor* |
| Arg1 | Thing given | Theme |
| Arg2 | Benefactive | Recipient |

*FrameNet Label

*Baker, Fillmore, & Lowe, COLING/ACL-98*
*Fillmore & Baker, WordNetWKSHP, 2001*

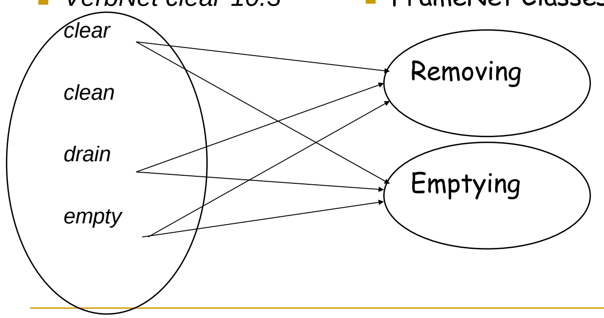
## PropBank/VerbNet/FrameNet

- Complementary
- Redundancy is harmless, may even be useful
- PropBank provides the best training data
- VerbNet provides the clearest links between syntax and semantics
- FrameNet provides the richest semantics
- Together they give us the most comprehensive coverage
- So…. We're also mapping VerbNet to FrameNet



## Mapping Issues (2)
## VerbNet verbs mapped to FrameNet

- *VerbNet clear-10.3*
- FrameNet Classes






## Mapping Issues (3)
## VerbNet verbs mapped to FrameNet

**VN Class: *put 9.1***

Members: *arrange**, *immerse*, *lodge*, *mount*, *sling***

Thematic roles:
- agent (+animate)
- theme (+concrete)
- destination (+loc, -region)

Frames:
- …

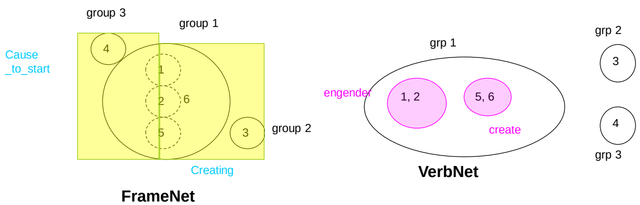
*different sense
** not in FrameNet

**FrameNet frame: *place***

Frame Elements:
- Agent
- Cause
- Theme
- Goal

Examples:
- …

## Class formation Issues: *create*
## Susan Brown

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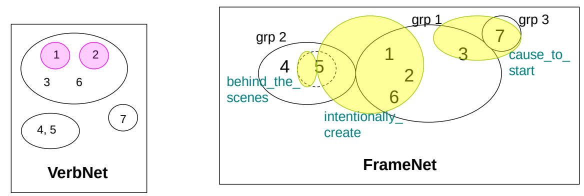
## Class formation Issues: *produce*
## Susan Brown

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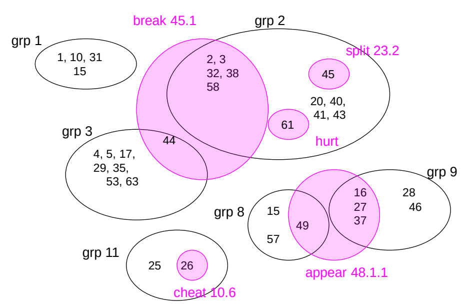
## Class formation Issues: *break*/Verbnet
## Susan Brown

*WN44 – the skin broke*
*WN49 – the simple vowels broke in many Germanic languages*

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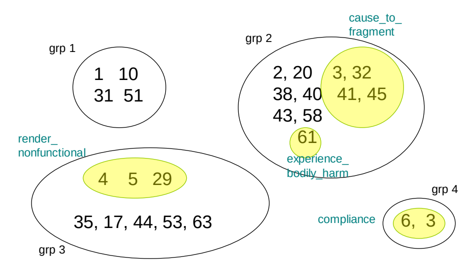
## Class Formation Issues: *break*/FrameNet
## Susan Brown

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## WordNet: - leave, 14 senses, grouped

WN1, WN5,WN8

Depart, a job, a room, a dock, a country

WN6 WN10 WN2 WN 4 WN9 WN11 WN12

WN14 Wnleave_off2,3 WNleave_behind1,2,3

Leave behind, leave alone

WNleave_alone1 WN13

WN3 WN7

Create a State

WNleave_off1

"leave off" stop, terminate

WNleave_out1, Wnleave_out2

exclude



## WordNet: - leave, 14 senses, groups, PB

WN1, WN5,WN8

Depart, a job, a room, a dock, a country (for X)

4

1

2

WN6 WN10 WN2 WN 4 WN9 WN11 WN12

WN14 WNleave_off2,3 WNleave_behind1,2,3

Leave behind, leave alone

WNleave_alone1 WN13

5

WN3 WN7

Create a State /cause an effect:
Left us speechless, leave a stain

WNleave_off1

WNleave_out1, WNleave_out2

exclude

3

stop, terminate:
the road leaves off, not
leave off your jacket, the result

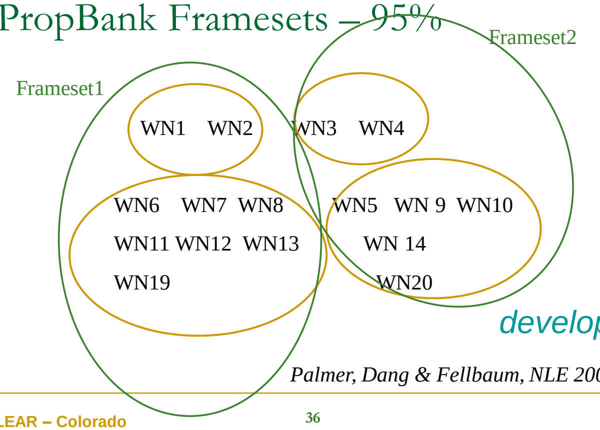


## Leave behind, leave alone…

- ***John left his keys at the restaurant.***
  *We left behind all our cares during our vacation.*
  *They were told to leave off their coats.*
  *Leave the young fawn alone.*
  ***Leave the nature park just as you found it.***
  *I left my shoes on when I entered their house.*
  *When she put away the food she left out the pie.*
  *Let's leave enough time to visit the museum.*
  ***He'll leave the decision to his wife.***
  *When he died he left the farm to his wife.*
  *I'm leaving our telephone and address with you.*



## Overlap between Groups and PropBank Framesets – 95%




*develop*

*Palmer, Dang & Fellbaum, NLE 2007*

## Broader coverage still needed

- Only 78% of PropBank verbs included in VN
- Most classes focused on verbs with NP and PP complements
- Neglected verbs that take adverbial, adjectival, and sentential complements

## SEMLINK

- Extended VerbNet: 5,391 senses (91% PB)
- Type-type mapping PB/VN, VN/FN
  - (100+ new classes from *(Korhonen and Briscoe, 2004; Korhonen and Ryant, 2005)*)
- Semi-automatic mapping of WSJ PropBank instances to VerbNet classes and thematic roles, hand-corrected. (now FrameNet also)
- VerbNet class tagging as automatic WSD

*Brown, Dligach, Palmer, IWCS 2011*

- Run SRL, map Arg2 to VerbNet roles, Brown performance improves

*Yi, Loper, Palmer, NAACL07*



## Summary

- Reviewed available lexical resources
  - WordNet, Groupings, PropBank, VerbNet, FrameNet
- We need a whole that is greater than the sum of the parts – Semlink
- Greater coverage, greater richness, increased training data over more genres, opportunities for generalizations



## Lexical resources can provide

- Generalizations about subcat frames & roles
- Backoff classes for OOV items for portability
- Semantic similarities/"types" for verbs
- Event type hierarchies for inferencing
- Need to be unified and empirically validated and extended: Semlink+
  - VN & FN need PB like coverage, and techniques for automatic domain adaptation - **Lexlink**
- ***Hybrid lexicons – symbolic and statistical lexical entries?***

## Acknowledgments


- We gratefully acknowledge the support of the National Science Foundation Grants for , Consistent Criteria for Word Sense Disambiguation, Robust Semantic Parsing, Richer Representations for Machine Translation, A Bayesian Approach to Dynamic Lexical Resources for Flexible Language Processing and DARPA-GALE via a subcontract from BBN.
- Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.




## And thanks to


- Postdocs: Paul Kingsbury, Dan Gildea, Nianwen Xue,
- Students: Joseph Rosenzweig, Hoa Dang, Tom Morton, Karin Kipper Schuler, Jinying Chen, Szu-Ting Yi, Edward Loper, Susan Brown, Dmitriy Dligach, Jena Hwang, Will Corvey, Claire Bonial, Jinho Choi, Lee Becker, Shumin Wu, Kevin Stowe
- Collaborators: Christiane Fellbaum, Suzanne Stevenson, Annie Zaenen, Orin Hargraves