

Outline

- Linguistic Theories of semantic representation
 - Case Frames – *Fillmore* – FrameNet
 - Lexical Conceptual Structure – *Jackendoff* – LCS
 - Proto-Roles – *Dowty* – PropBank
 - English verb classes (diathesis alternations) -
Levin - VerbNet
- Manual Semantic Annotation
- Automatic Semantic annotation
- Parallel PropBanks and Event Relations



Thematic Proto-Roles and Argument
Selection, David Dowty,
Language 67: 547-619, 1991

Thanks to Michael Mulyar



Context: Thematic Roles

- Thematic relations (Gruber 1965, Jackendoff 1972)
- Traditional thematic roles types include:
Agent, Patient, Goal, Source, Theme, Experiencer,
Instrument (p. 548).
- “Argument-Indexing View”: thematic roles objects at syntax-
semantics interface, determining a syntactic derivation or the
linking relations.
- Θ -Criterion (GB Theory): each NP of predicate in lexicon
assigned unique θ -role (Chomsky 1981).



Problems with Thematic Role Types

- Thematic role types used in many syntactic generalizations, e.g. involving empirical thematic role hierarchies. Are thematic roles syntactic universals (or e.g. constructionally defined)?
- Relevance of role types to syntactic description needs motivation, e.g. in describing transitivity.
- Thematic roles lack independent semantic motivation.
- Apparent counter-examples to θ -criterion (Jackendoff 1987).
- Encoding semantic features (Cruse 1973) may not be relevant to syntax.



Problems with Thematic Role Types

- Fragmentation: Cruse (1973) subdivides Agent into four types.
- Ambiguity: Andrews (1985) is Extent, an adjunct or a core argument?
- Symmetric stative predicates: e.g. “This is similar to that” Distinct roles or not?
- Searching for a Generalization: What is a Thematic Role?



Proto-Roles

- Event-dependent Proto-roles introduced
- Prototypes based on shared entailments
- Grammatical relations such as subject related to observed (empirical) classification of participants
- Typology of grammatical relations
- Proto-Agent
- Proto-Patient



Proto-Agent

■ Properties

- ❑ Volitional involvement in event or state
- ❑ Sentience (and/or perception)
- ❑ Causing an event or change of state in another participant
- ❑ Movement (relative to position of another participant)
- ❑ (exists independently of event named)
 - *may be discourse pragmatic



Proto-Patient

- Properties:
 - Undergoes change of state
 - Incremental theme
 - Causally affected by another participant
 - Stationary relative to movement of another participant
 - (does not exist independently of the event, or at all) *may be discourse pragmatic



Argument Selection Principle

- For 2 or 3 place predicates
- Based on empirical count (total of entailments for each role).
- Greatest number of Proto-Agent entailments → Subject; greatest number of Proto-Patient entailments → Direct Object.
- Alternation predicted if number of entailments for each role similar (nondiscreteness).



Worked Example:

Psychological Predicates

Examples:

Experiencer Subject

x likes y

x fears y

Stimulus Subject

y pleases x

y frightens x

Describes “almost the same” relation

Experiencer: sentient (P-Agent)

Stimulus: causes emotional reaction (P-Agent)

Number of proto-entailments same; but for stimulus subject verbs, experiencer also undergoes change of state (P-Patient) and is therefore lexicalized as the patient.



Symmetric Stative Predicates

Examples:

This one and that one rhyme / intersect / are similar.

This rhymes with / intersects with / is similar to that.

(cf. *The drunk embraced the lamppost. / *The drunk and the lamppost embraced.*)



Symmetric Predicates: Generalizing via Proto-Roles

- Conjoined predicate subject has Proto-Agent entailments which two-place predicate relation lacks (i.e. for object of two-place predicate).
- Generalization entirely reducible to proto-roles.
- Strong cognitive evidence for proto-roles: would be difficult to deduce lexically, but easy via knowledge of proto-roles.



Diathesis Alternations

Alternations:

- Spray / Load
- Hit / Break

Non-alternating:

- Swat / Dash
- Fill / Cover



Spray / Load Alternation

Example:

Mary loaded the hay onto the truck.

Mary loaded the truck with hay.

Mary sprayed the paint onto the wall.

Mary sprayed the wall with paint.

- Analyzed via proto-roles, not e.g. as a theme / location alternation.
- Direct object analyzed as an Incremental Theme, i.e. either of two non-subject arguments qualifies as incremental theme. This accounts for alternating behavior.



Hit / Break Alternation

John hit the fence with a stick.

John hit the stick against a fence.

John broke the fence with a stick.

John broke the stick against the fence.

- Radical change in meaning associated with *break* but not *hit*.
- Explained via proto-roles (change of state for direct object with break class).



Swat doesn't alternate...

swat the boy with a stick

**swat the stick at / against the boy*



Fill / Cover

Fill / Cover are non-alternating:

Bill filled the tank (with water).

**Bill filled water (into the tank).*

Bill covered the ground (with a tarpaulin).

**Bill covered a tarpaulin (over the ground).*

- Only goal lexicalizes as incremental theme (direct object).

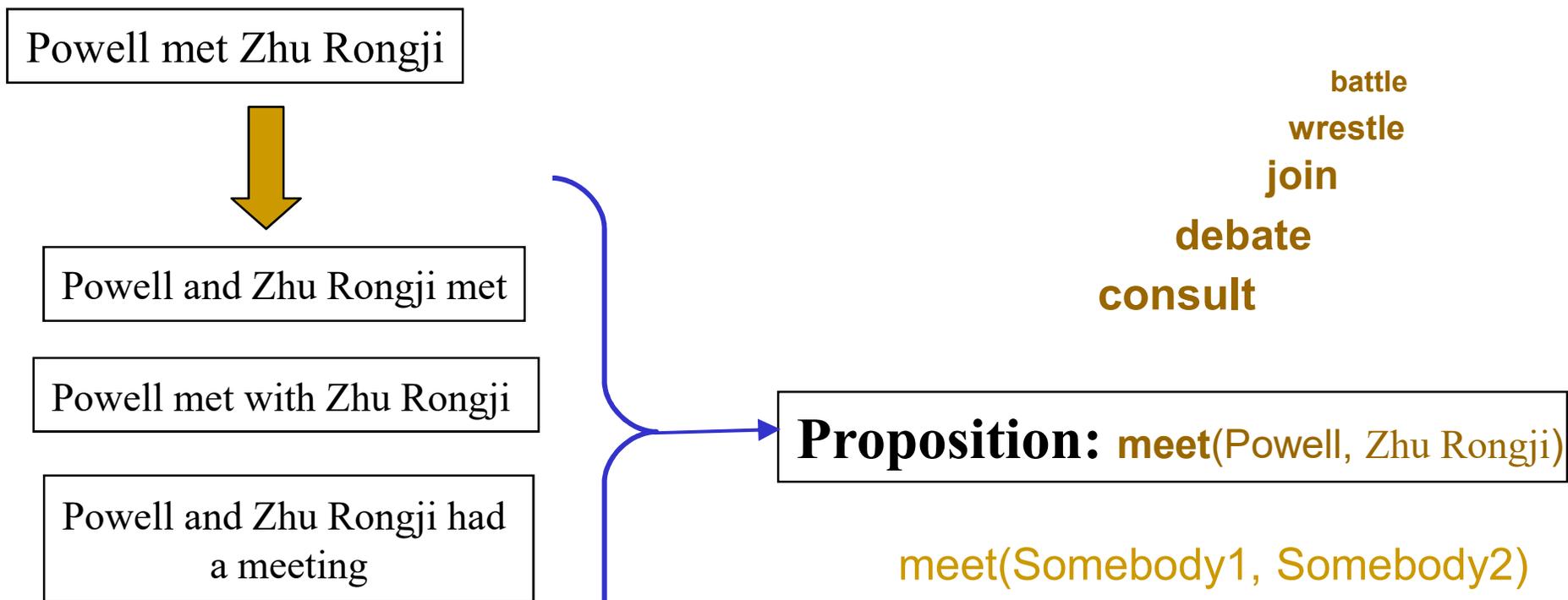


Conclusion

- Dowty argues for Proto-Roles based on linguistic and cognitive observations.
- Objections: Are P-roles empirical (extending arguments about hit class)?



Proposition Bank: From Sentences to Propositions



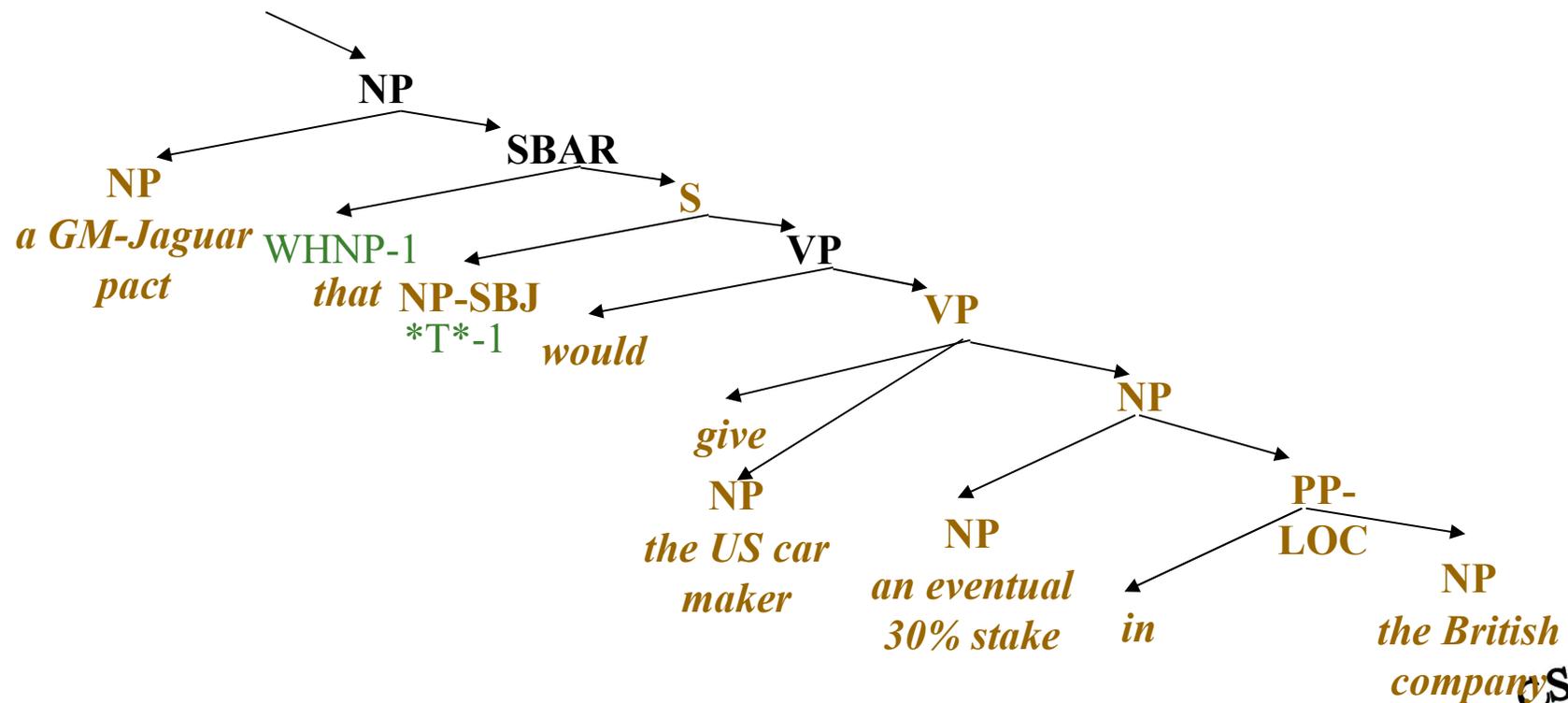
When Powell met Zhu Rongji on Thursday they discussed the return of the spy plane.

`meet(Powell, Zhu)` `discuss([Powell, Zhu], return(X, plane))`



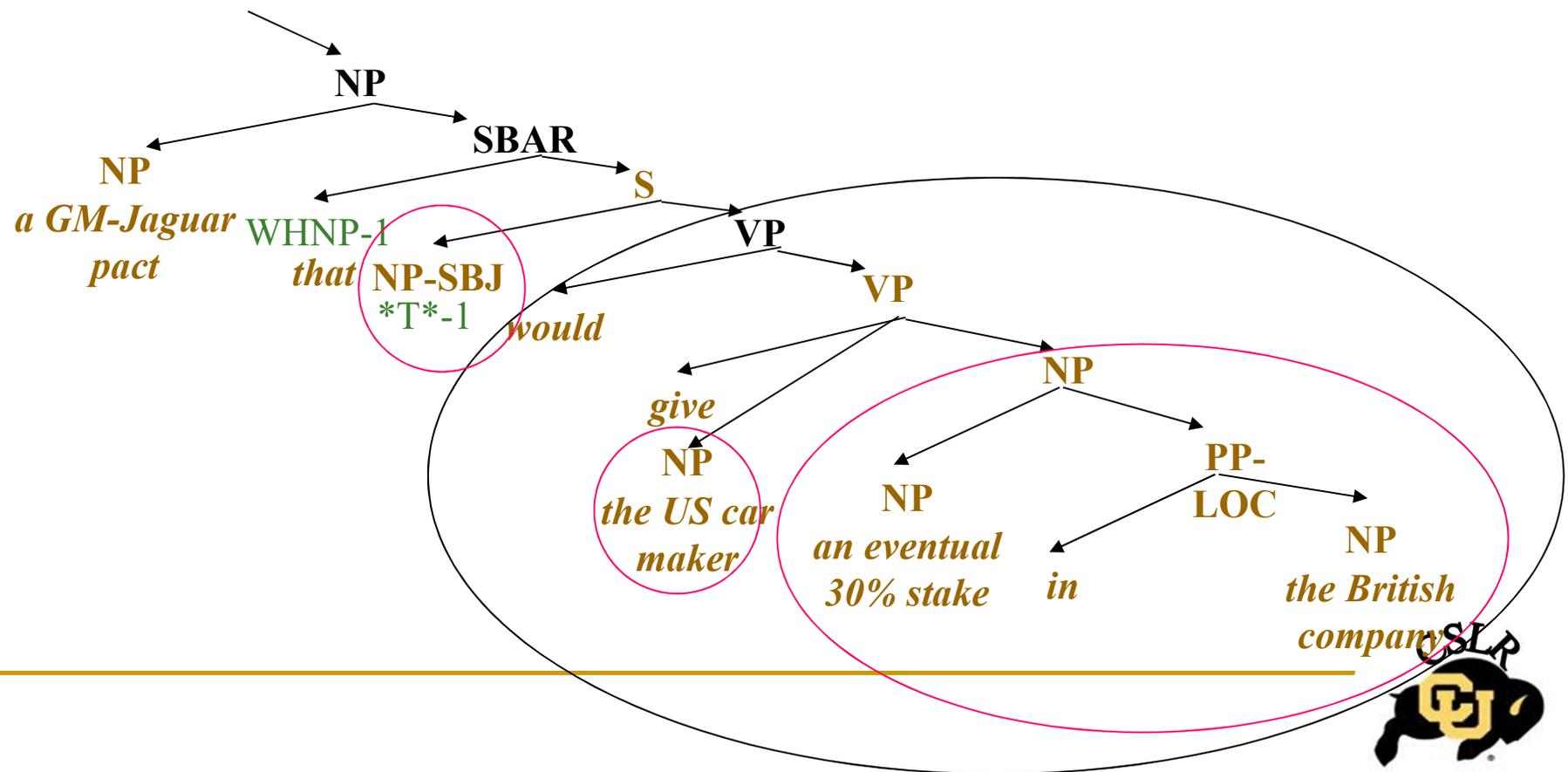
A TreeBanked phrase

a GM-Jaguar pact that would give the U.S. car maker an eventual 30% stake in the British company.



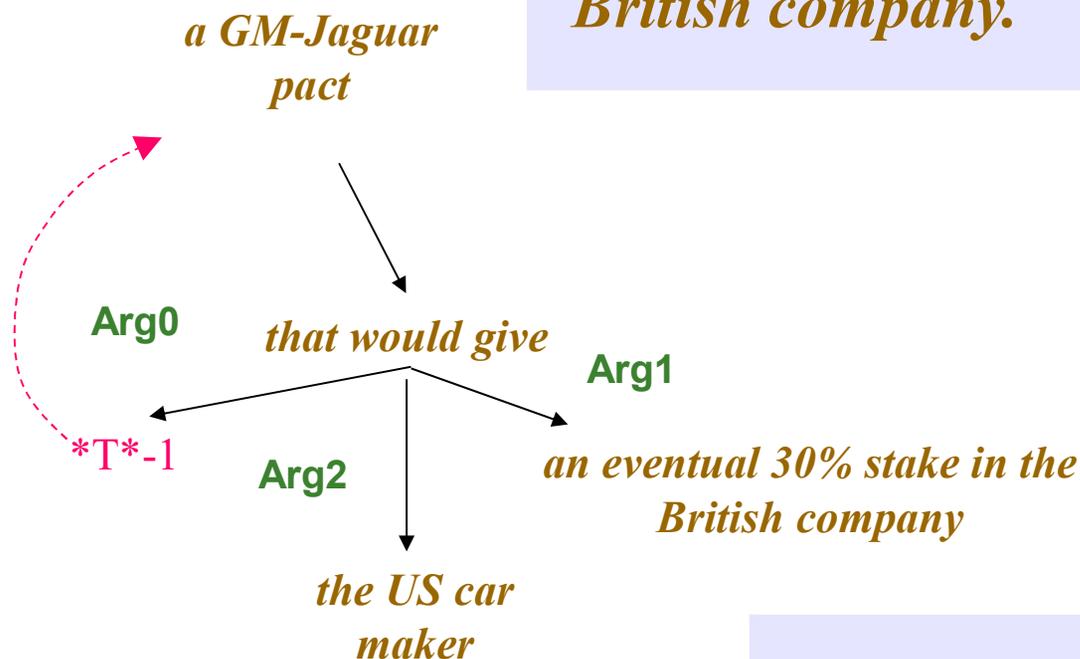
A TreeBanked phrase

a GM-Jaguar pact that would give the U.S. car maker an eventual 30% stake in the British company.



The same phrase, PropBanked

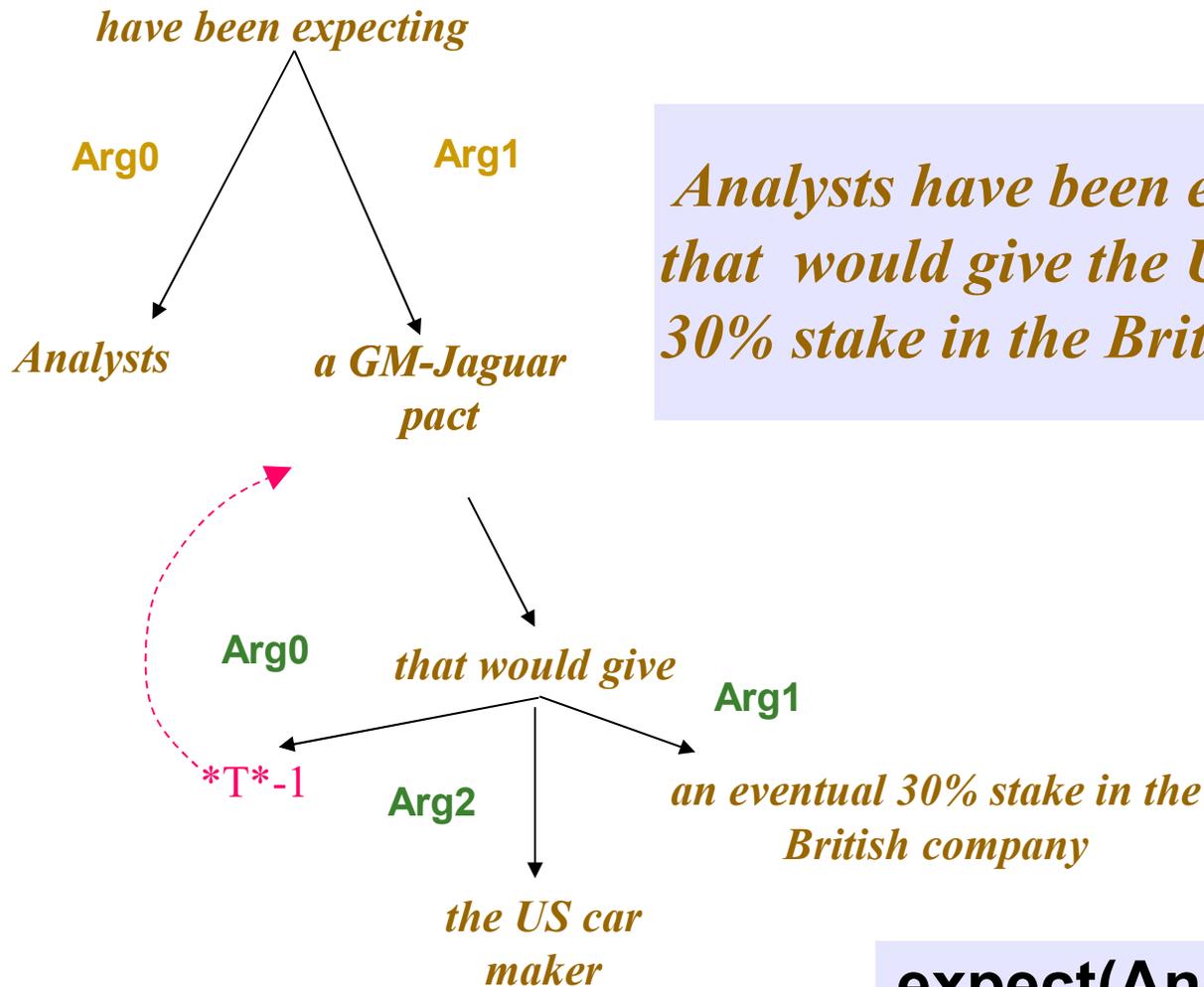
a GM-Jaguar pact that would give the U.S. car maker an eventual 30% stake in the British company.



give(GM-J pact, US car maker, 30% stake)



The full sentence, PropBanked



Analysts have been expecting a GM-Jaguar pact that would give the U.S. car maker an eventual 30% stake in the British company.

expect(Analysts, GM-J pact)
give(GM-J pact, US car maker, 30% stake)



Frames File Example: *expect*

Roles:

Arg0: *expecter*

Arg1: *thing expected*

Example: Transitive, active:

Portfolio managers expect further declines in interest rates.

Arg0: *Portfolio managers*

REL: *expect*

Arg1: *further declines in interest rates*



Frames File example: *give*

Roles:

Arg0: giver

Arg1: thing given

Arg2: entity given to

Example: double object

The executives gave the chefs a standing ovation.

Arg0: *The executives*

REL: *gave*

Arg2: *the chefs*

Arg1: *a standing ovation*



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 traditional word senses in VerbNet and WordNet?



Annotation procedure

- PTB II - Extraction of all sentences with given verb
- Create Frame File for that verb *Paul Kingsbury*
 - (3100+ lemmas, 4400 framesets, 118K predicates)
 - Over 300 created automatically via VerbNet
- First pass: Automatic tagging (*Joseph Rosenzweig*)
 - <http://www.cis.upenn.edu/~josephr/TIDES/index.html#lexicon>
- Second pass: Double blind hand correction
Paul Kingsbury
- Tagging tool highlights discrepancies *Scott Cotton*
- Third pass: *Solomonization* (adjudication)
 - *Betsy Klipple, Olga Babko-Malaya*



Semantic role labels:

Jan broke the LCD projector.

break (agent(Jan), patient(LCD-projector))

Filmore, 68

cause(agent(Jan),

change-of-state(LCD-projector))

(broken(LCD-projector))

Jackendoff, 72

agent(A) -> intentional(A), sentient(A),

causer(A), affector(A)

Dowty, 91

patient(P) -> affected(P), change(P),...



Trends in Argument Numbering

- Arg0 = agent
- Arg1 = direct object / theme / patient
- Arg2 = indirect object / benefactive / instrument / attribute / end state
- Arg3 = start point / benefactive / instrument / attribute
- Arg4 = end point
- Per word vs frame level – more general?



Additional tags

(arguments or adjuncts?)

- Variety of ArgM's (Arg#>4):
 - TMP - when?
 - LOC - where at?
 - DIR - where to?
 - MNR - how?
 - PRP -why?
 - REC - himself, themselves, each other
 - PRD -this argument refers to or modifies another
 - ADV –others



Inflection

- Verbs also marked for tense/aspect
 - Passive/Active
 - Perfect/Progressive
 - Third singular (*is has does was*)
 - Present/Past/Future
 - Infinitives/Participles/Gerunds/Finities

- Modals and negations marked as ArgMs



Frames: Multiple Framesets

- Framesets **are not** necessarily consistent between different senses of the same verb
- Framesets **are** consistent between different verbs that share similar argument structures, (*like FrameNet*)
- Out of the 787 most frequent verbs:
 - 1 FrameNet – 521
 - 2 FrameNet – 169
 - 3+ FrameNet - 97 (includes light verbs)



Ergative/Unaccusative Verbs

Roles (no ARG0 for unaccusative verbs)

Arg1 = Logical subject, patient, thing rising

Arg2 = EXT, amount risen

Arg3* = start point

Arg4 = end point

Sales rose 4% to \$3.28 billion from \$3.16 billion.

The Nasdaq composite index added 1.01 to 456.6 on paltry volume.



PropBank/FrameNet

Buy

Sell

Arg0: buyer

Arg0: seller

Arg1: goods

Arg1: goods

Arg2: seller

Arg2: buyer

Arg3: rate

Arg3: rate

Arg4: payment

Arg4: payment

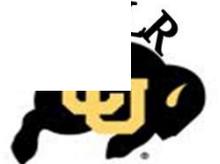
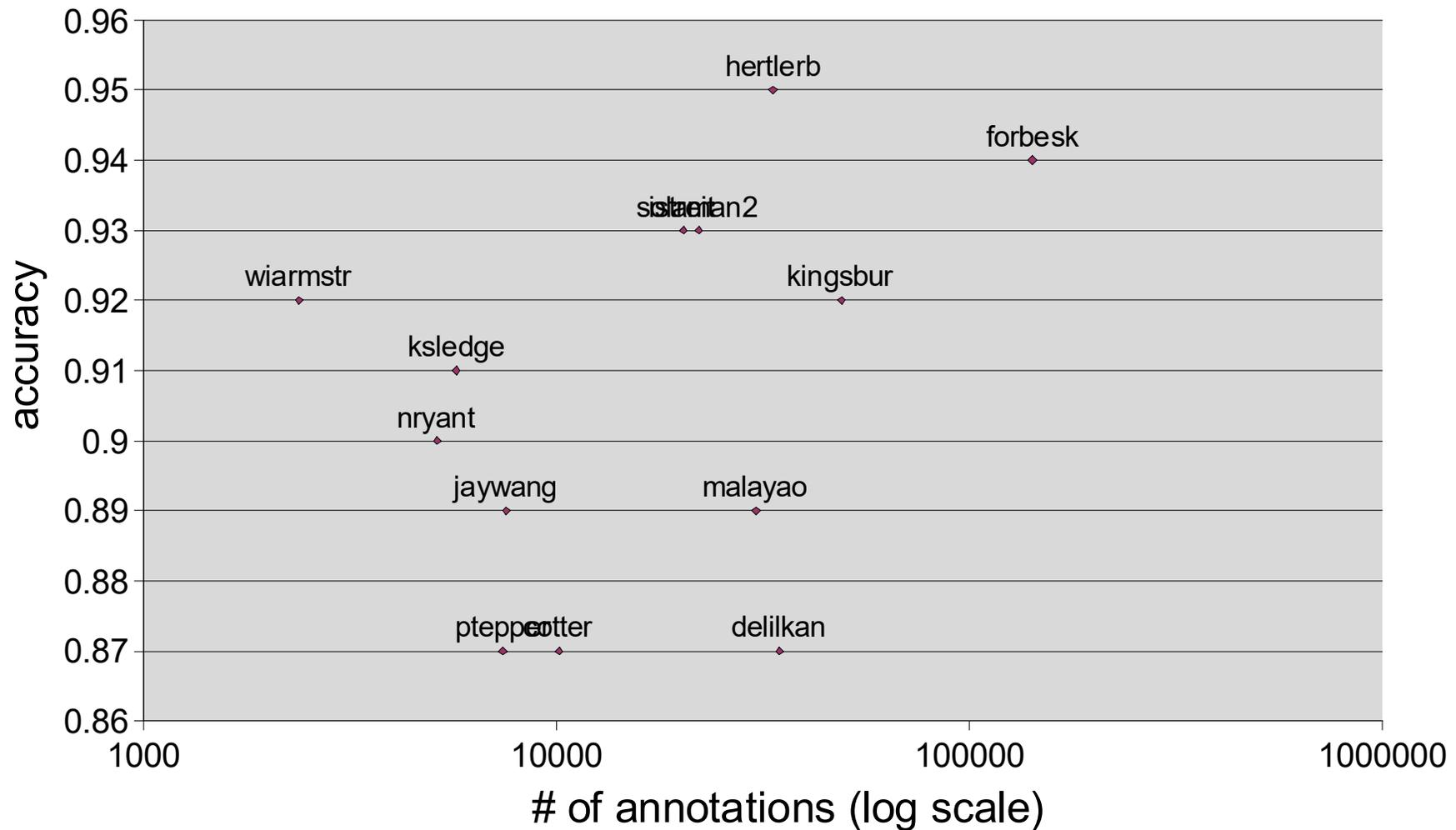
More generic, more neutral – maps readily to VN, TR

Rambow, et al, PMLB03



Annotator accuracy – ITA 84%

Annotator Accuracy-primary labels only



Limitations to PropBank

- Args2-4 seriously overloaded, poor performance
 - VerbNet and FrameNet both provide more fine-grained role labels
- WSJ too domain specific, too financial, need broader coverage genres for more general annotation
 - Additional Brown corpus annotation, also GALE data
 - FrameNet has selected instances from BNC



Levin – English Verb Classes and Alternations: A Preliminary Investigation, 1993.



Levin classes *(Levin, 1993)*

- 3100 verbs, 47 top level classes, 193 second and third level
- Each class has a syntactic signature based on alternations.
John broke the jar. / The jar broke. / Jars break easily.

*John cut the bread. / *The bread cut. / Bread cuts easily.*

*John hit the wall. / *The wall hit. / *Walls hit easily.*



Levin classes (*Levin, 1993*)

- Verb class hierarchy: 3100 verbs, 47 top level classes, 193
- Each class has a syntactic signature based on alternations.
John broke the jar. / The jar broke. / Jars break easily.

change-of-state

*John cut the bread. / *The bread cut. / Bread cuts easily.*

**change-of-state, recognizable action,
sharp instrument**

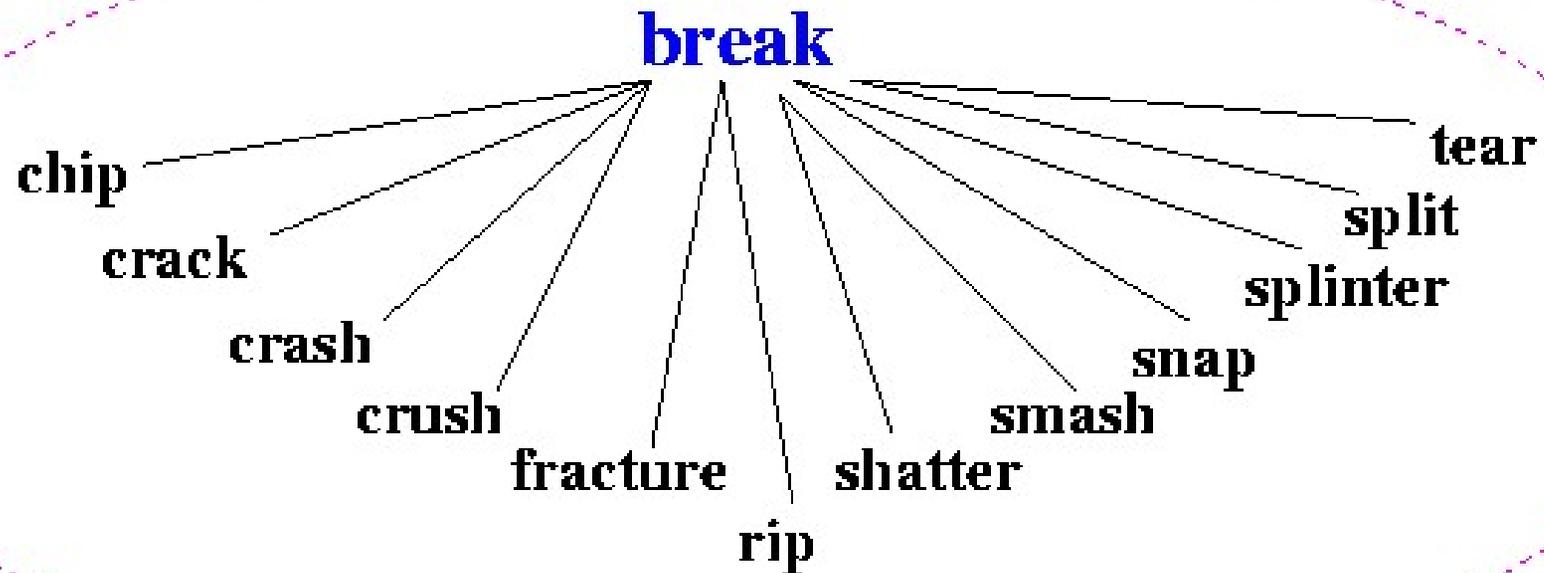
*John hit the wall. / *The wall hit. / *Walls hit easily.*

contact, exertion of force



Break Levin class -

Change-of-state



Limitations to Levin Classes

Dang, Kipper & Palmer, ACL98

- Coverage of only half of the verbs (types) in the Penn Treebank (1M words, WSJ)
- Usually only one or two basic senses are covered for each verb
- Confusing sets of alternations
 - Different classes have almost identical “syntactic signatures”
 - or worse, contradictory signatures

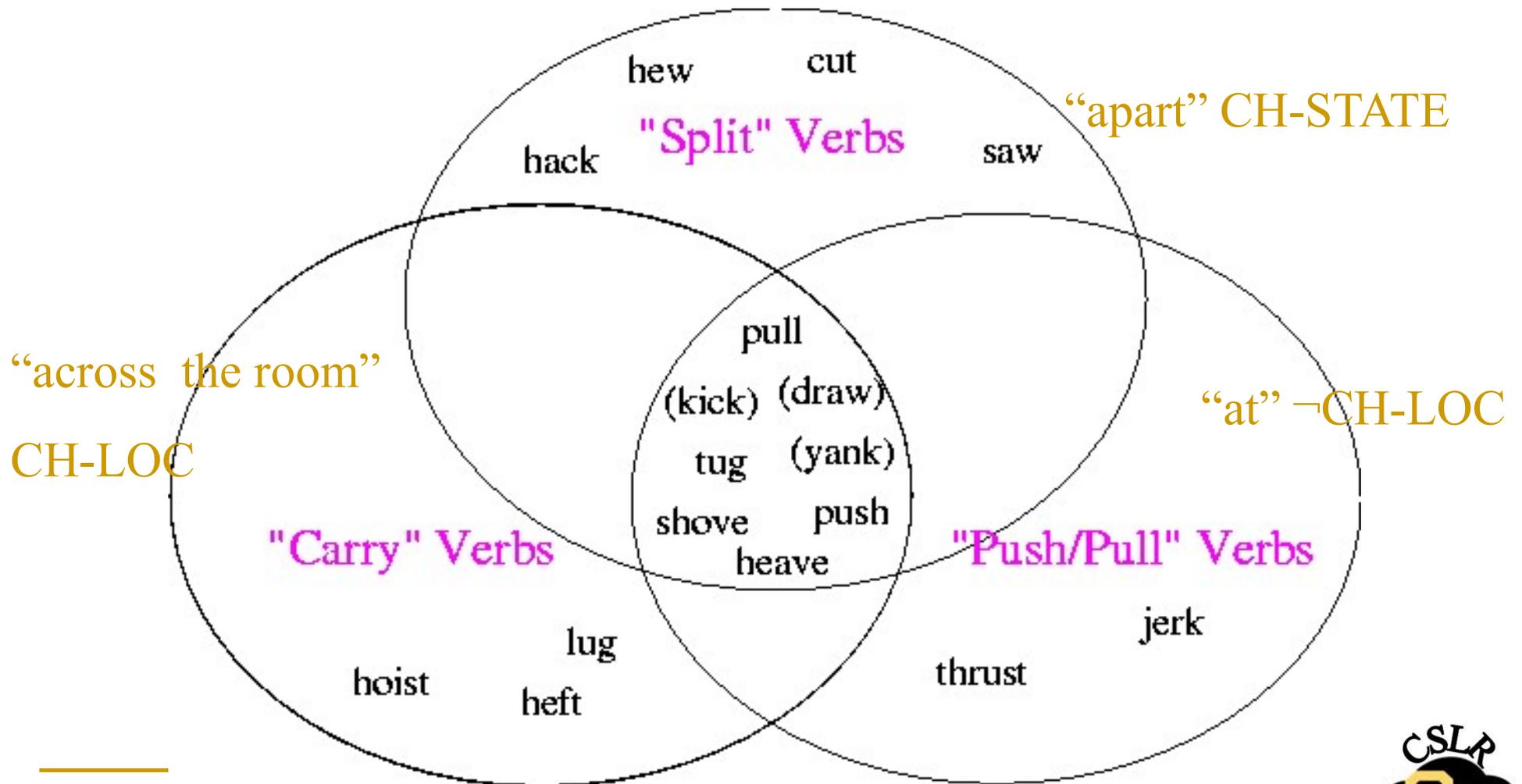


Multiple class listings

- Homonymy or polysemy?
 - *draw a picture, draw water from the well*
- Conflicting alternations?
 - *Carry* verbs disallow the Conative, (**she carried at the ball*), but include {*push, pull, shove, kick, yank, tug*}
 - also in *Push/pull* class, does take the Conative (*she kicked at the ball*)



Intersective Levin Classes

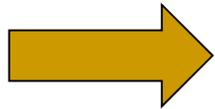


Dang, Kipper & Palmer, ACL98



Intersective Levin Classes

- More syntactically and semantically coherent
 - sets of syntactic patterns
 - explicit semantic components
 - relations between senses



VERBNET

[verbs.colorado.edu/~mpalmer/
verbnet](http://verbs.colorado.edu/~mpalmer/verbnet)

VerbNet – *Karin Kipper*

■ Class entries:

- Capture generalizations about verb behavior
- Organized hierarchically
- Members have common semantic elements, semantic roles and syntactic frames

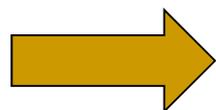
■ Verb entries:

- Refer to a set of classes (different senses)
- each class member linked to WN synset(s) (not all WN senses are covered)



Hand built resources vs. Real data

- VerbNet is based on linguistic theory –
how useful is it?
- How well does it correspond to syntactic
variations found in naturally occurring text?

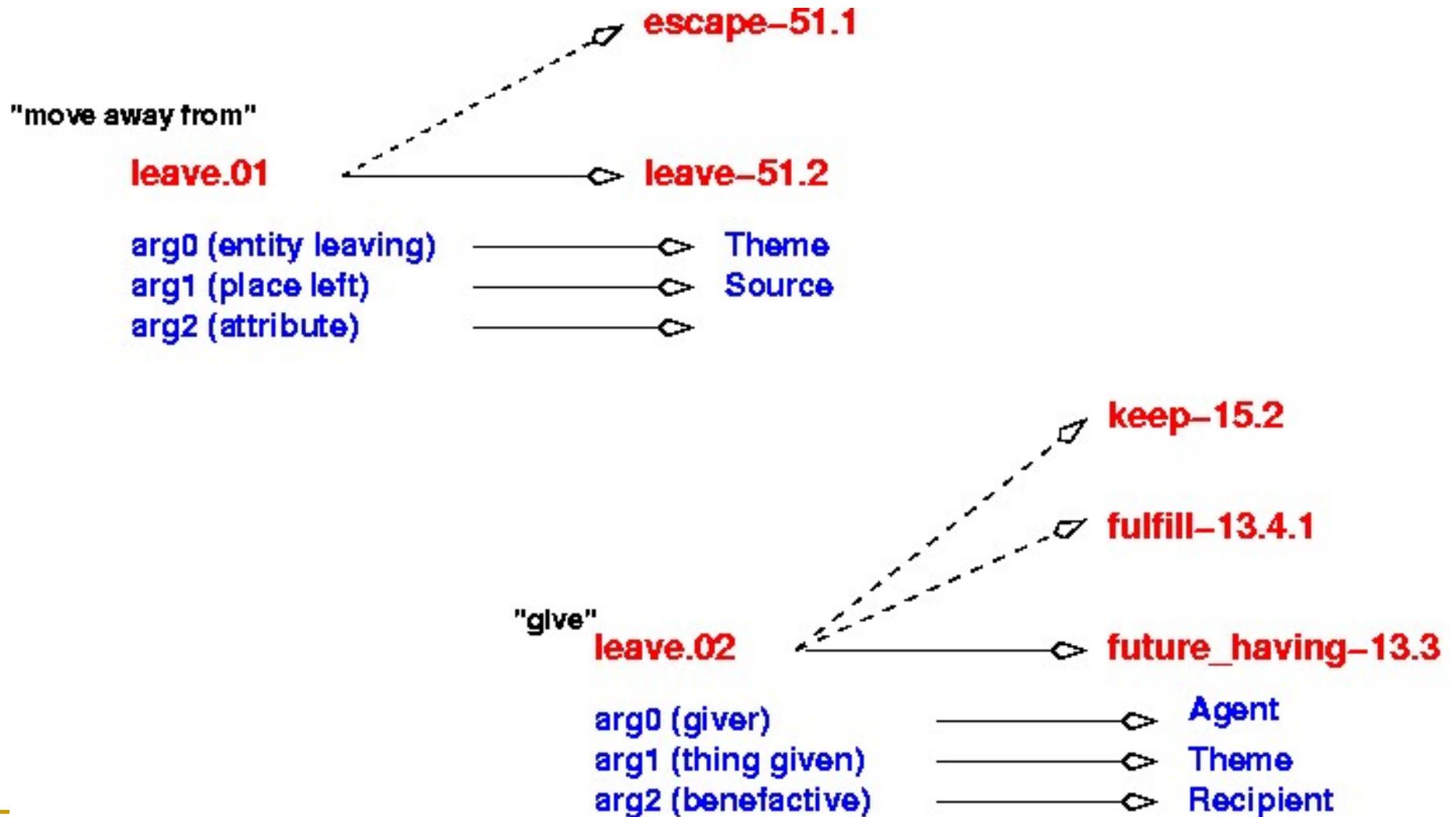


PropBank

Mapping from PropBank to VerbNet

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

Mapping from PB to VerbNet



Mapping from PropBank to VerbNet

- Overlap with PropBank framesets
 - 50,000 PropBank instances
 - < 50% VN entries, > 85% VN classes
- Results
 - MATCH - 78.63%. (80.90% relaxed)
 - *(VerbNet isn't just linguistic theory!)*
- Benefits
 - Thematic role labels and semantic predicates
 - Can extend PropBank coverage with VerbNet classes
 - WordNet sense tags



Mapping PropBank/VerbNet

- Extended VerbNet now covers 80% of PropBank tokens. *Kipper, et. al., LREC-04, LREC-06* (added Korhonen and Briscoe classes)
- Semi-automatic mapping of PropBank instances to VerbNet classes and thematic roles, hand-corrected. (final cleanup stage)
- VerbNet class tagging as automatic WSD
- Run SRL, map Args to VerbNet roles



Can SemLink improve Generalization?

- Overloaded Arg2-Arg5
 - PB: verb-by-verb
 - VerbNet: same thematic roles across verbs
- Example
 - Rudolph Agnew,..., was **named** [ARG2 {**Predicate**} a nonexecutive director of this British industrial conglomerate.]
 -the latest results appear in today's New England Journal of Medicine, a forum likely to **bring** new attention [ARG2 {**Destination**} to the problem.]
- Use VerbNet as a bridge to merge PB and FN and expand the Size and Variety of the Training



Automatic Labelling of Semantic Relations – Gold Standard, 77%

- Given a constituent to be labelled
- Stochastic Model
- Features:
 - Predicate, (*verb*)
 - Phrase Type, (*NP or S-BAR*)
 - Parse Tree Path
 - Position (*Before/after predicate*)
 - Voice (*active/passive*)
 - Head Word of constituent



Additional Automatic Role Labelers

- Performance improved from 77% to 88%

Automatic parses, 81% F, **Brown corpus, 68%**

- Same features plus

- Named Entity tags
- Head word POS
- For unseen verbs – backoff to automatic verb clusters

- SVM's

- Role or not role
- For each likely role, for each Arg#, Arg# or not
- No overlapping role labels allowed

Pradhan, et. al., ICDM03, Sardeneau, et. al, ACL03, Chen & Rambow, EMNLP03, Gildea & Hockemaier, EMNLP03, Yi & Palmer, ICON04
CoNLL-04, 05 Shared Task



Arg1 groupings; (Total count 59710)

Group1 (53.11%)	Group2 (23.04%)	Group3 (16%)	Group4 (4.67%)	Group5 (.20%)
Theme; Theme1; Theme2; Predicate; Stimulus; Attribute	Topic	Patient; Product; Patient1; Patient2	Agent; Actor2; Cause; Experiencer	Asset

Arg2 groupings; (Total count 11068)

Group1 (43.93%)	Group2 (14.74%)	Group3 (32.13%)	Group4 (6.81%)	Group5 (2.39%)
Recipient; Destination; Location; Source; Material; Beneficiary	Extent; Asset	Predicate; Attribute; Theme; Theme2; Theme1; Topic	Patient2; Product	Instrument; Actor2; Cause; Experiencer



Process

- Retrain the SRL tagger
 - Original:
 - Arg[0-5,A,M]
 - ARG1 Grouping: (similar for Arg2)
 - Arg[0,2-5,A,M] Arg1-Group[1-6]
- Evaluation on both WSJ and Brown
- More Coarse-grained or Fine-grained?
 - more specific: data more coherent, but more sparse
 - more general: consistency across verbs even for new domains?



SRL Performance (WSJ/BROWN)

Loper, Yi, Palmer, SIGSEM07

System	Precision	Recall	F-1
Arg1-Original	89.24	77.32	82.85
Arg1-Mapped	90.00	76.35	82.61
Arg2-Original	73.04	57.44	64.31
Arg2-Mapped	84.11	60.55	70.41
Arg1-Original	86.01	71.46	78.07
Arg1-Mapped	88.24	71.15	78.78
Arg2-Original	66.74	52.22	58.59
Arg2-Mapped	81.45	58.45	68.06

