GLARF and the 2nd Stage of Parsing
Combining Parsing, SRL, NE tagging, Temporal Tagging, ...

CUNY-NLP Seminar
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• Others at NYU Proteus Group
Outline

• Approaches to Combining Annotation
• Introduction to GLARF
• Merging into one GLARF-based Theory
• Some GLARF results
• Future Work
Terminology

- **Linguistic Annotation**: A formal description of linguist properties of a text
- **Automatic Annotation**
  - Examples: parser output, NE tagging, other taggers
- **Manual Annotation**
  - Examples: Penn treebank, Manual NE labels, TimeBank and other “Banks”, etc.
- **Transducer**
  - System for automatically creating annotation
Approach 1: Annotating Multiple Linguistic Phenomena within a Single Theoretical Framework

- All annotation must share some assumptions: POS, segmentation, tokenization, headedness (if possible), constituents (if possible), etc.
- Possibly augment/modify theory over time
- Possibly revise previous annotation schemes
- Disadvantages:
  - Theory (unless revised) may overly constrain annotation of some phenomena
  - Limits input to those willing to work in that framework
- Examples:
  - Tübingen Treebank of Written German
  - Czech Dependency Treebank
  - Kyoto Corpus Treebank
  - Copenhagen Dependency Treebank
Approach 2: Merging Annotation A La Carte

• Given a set of annotations, convert each annotation into a common **physical form**, typically character offset-based XML.

• Possible to incorporate the work of many different research projects (with no theory in common).

• Disadvantage: Glosses over incompatibilities between annotations (segmentation, tokenization, constituents, headedness, etc.) which may make cross-phenomenon generalizations difficult.

• Examples:
  – *Ontonotes: The 90% Solution* (Hovy, et. al. 2006)
  – *Combining Independent Syntactic and Semantic Annotation Schemes* (Verhagen, et. al. 2007)
Our Approach: Merging A la Carte Annotation while Changing it in Our Own Biased Way

• Advantages:
  – Resulting annotation fits together (like Approach 1), sharing segmentation, tokenization, headedness (if possible), constituents (if possible)
  – Incorporates annotation undertaken by several research projects which assume different theories (like Approach 2)
  – Corrects some annotation errors through conflict resolution

• Disadvantages
  – Our theory may be inappropriate for some phenomena (like Approach 1)
  – Some information may be lost/mishandled during translation

• Similar to CONLL 2008/2009 Shared Task
  – GLARF is more ambitious (a possibly more difficult shared task)
  – GLARF's Logic1 “level” that is easier to generate automatically and covers all words in the sentence.
Outline

• Approaches to Combining Annotation
• Introduction to GLARF
  – Grammatical and Logical Argument Representation Framework
• Merging into one GLARF-based Theory
• Some GLARF results
• Future Work
Why GLARF?

• Annotation of different linguistic phenomena are incompatible with each other.
• It is difficult to create NLP applications that use evidence from representations of several phenomena.
• It is difficult to correlate disparate types of linguistic evidence from corpora.
• GLARF provides one way of solving these problems
GLARF is:

• **Grammatical and Logical Argument Representation Framework**
  – A framework for representing linguistic information
    • A GLARF-based theory
    – Any theory within that framework
      • In GLARF, we assume...
    – A GLARF representation of a sentence or phrase
      • In the GLARF of sentence X, ...

• A system for automatically producing GLARF
  – Available for Download
  – Most Common Feedback from Users:
    • *It is better than I expected it would be*
  – This suggest that a Good tag line for GLARF might be:
    • **GLARF, It's Better Than You Think it is**
Introduction to GLARF

- Languages: English, Chinese, Japanese
- Typed Feature Structure: Maximal Information
- Multiple Dependency Tuples: Less Info + headedness assumptions
- Produces a single-theory analysis
  - Not 100% Reversible
- GLARF System combines:
  - hand-annotation
  - automatically generated annotation
  - combination of manual/automatic annotation
- GLARF approach to merging annotation was part of the NSF-funded ULA (Unified Linguistic Annotation) project involving: The Penn Treebank, PropBank, NomBank, The Penn Discourse Treebank, TimeBank and the Pittsburg Opinion TreeBank
2 Main Purposes for GLARF

• The Second Stage of a 2-stage (LFG-style) parser – the first stage is a standard tree-bank-based parse (PTB, Chinese PTB, Kyoto Corpus)
  – Other automatic output (at least NE) is incorporated
  – Before PTB-based parsers, 2 stage parsers (Hobbs and Grishman 1976) were popular.
    • 1\textsuperscript{st} stage = Syntax
    • 2\textsuperscript{nd} stage = Regularized (fill gaps, transform passives, etc.)
• A merging program for manual/automatic annotation (plus additional info derived via rules, dictionary information, etc.).
• These 2 functions are indistinguishable from each other.
Example Sentence

• **Afterwards, she decided to perform the operation.**
  – Current Sentence (Sentence Number 1) Offset of first character = 29
  – Previous Sentence (Sentence Number 0) is *The doctor ran some tests*

• **PDTB (and TimeML):**
  – *Afterwards*: ARG1 = previous S, ARG2 = current S

• **PropBank**
  – *decided*: ARG0 = *she*, ARG1= *to perform the operation*, ARGM-TMP = *Afterwards*
  – *perform*: ARG0 = *she*, ARG1= *the operation*

• **NomBank**
  – *operation*: ARG0 = *she*, Support = *perform*

• **Penn Treebank**
  – (S (ADVP (RB Afterwards)) (, ,)
    (NP (PRP she))
    (VP (VBN decided))
    (S (VP (TO to))
     (VP (VB perform))
      (NP (DT the) (NN operation)))))))) (. .))
## GLARF Dependency Tuples (Abbreviated)

<table>
<thead>
<tr>
<th>Logic1</th>
<th>Surface</th>
<th>Logic2</th>
<th>Functor</th>
<th>Off</th>
<th>POS +</th>
<th>Argument</th>
<th>Off</th>
<th>POS +</th>
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<td>VBD PAST</td>
<td>Afterwards</td>
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<td>RB TMP</td>
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<td>COMP</td>
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<td>perform</td>
<td>56</td>
<td>VB</td>
</tr>
<tr>
<td>SBJ</td>
<td>NIL</td>
<td>ARG0</td>
<td>perform</td>
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<td>VB</td>
<td>she</td>
<td>41</td>
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<td>OBJ</td>
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<tr>
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<td>AUX</td>
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<td>perform</td>
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<td>to</td>
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<td>NN</td>
<td>perform</td>
<td>56</td>
<td>VB</td>
</tr>
<tr>
<td>NIL</td>
<td>NIL</td>
<td>ARG1</td>
<td>Afterwards</td>
<td>29</td>
<td>RB TMP</td>
<td>ran</td>
<td>11</td>
<td>VBD PAST</td>
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<tr>
<td>NIL</td>
<td>NIL</td>
<td>ARG2</td>
<td>Afterwards</td>
<td>29</td>
<td>RB TMP</td>
<td>decided</td>
<td>45</td>
<td>VBD PAST</td>
</tr>
</tbody>
</table>
Triple Dependency Graph

- **Solid Red Lines**
  - surface/L1
  - surface/L1/L2
- **Dashed Red Lines**
  - L1/L2
  - L1 only
- **Solid Blue Lines**
  - L2 only
- **Red Labels**
  - Surface/L1
- **Blue Labels**
  - L2
Logic1 and Surface Dependencies

• Surface dependencies form a tree
  – like S-Structure or C-Structure
• Logic1 dependencies form a directed acyclic graph
  – like F-Structure or D-Structure (if Empty Category = Antecedent)
• Many Logic1 and Surface Dependencies are the same
• Logic1/Surface Distinction represents syntactic regularization and gap filling
  – Passive, Relative Clause Gaps, Subjects of Infinitives, VP Deletion, etc.
• Apparent cycles are removed via Logic1/Surface distinction
  – PARENTHETICAL and RELATIVE are Surface dependencies, but their gaps represent logic1 dependencies
    • *Mary, [John believed __], was a vampire*
    • *I want [the book [that John was reading __]]*

GLARF and the 2nd Stage of Parsing
March 25, 2011
Logic 1 Role Labels regularize relations between predicate/argument pairs

- **Red**: Predicate
- **Blue**: Logic1 OBJ
- **Yellow**: Logic1 SBJ

_They were eaten by the giant clam_

≈

_The giant clam ate them_
Logic 2 Dependencies

- Logic2 dependencies form a directed graph with cycles
- Logic2 includes argument relations that do not fit neatly into the Surface vs Logic1 dichotomy.
- Includes semantics-based argument relations that are in complementary distribution, because the functors belong to distinct parts of speech:
  - Arguments of Verbs: PropBank
  - Arguments of (subset of) nouns: NomBank
  - Arguments of (subset of) adverbs, prepositions, coord/subord conjunctions: overt PDTB. TimeML TLINK and analogous relations with NP arguments
Full GLARF TFS and Tuples

- More detail: morphology, semantic classes, senses from PropBank/NomBank, etc.
- Regularizes across productive syntactic regularities, distinguishing logical and surface SBJ/OBJ, e.g., passive, relative clause, etc.
- Regularizes Conjunctions, distinguishing the functor (conjunction) from the conjuncts, the latter acting like heads for purposes of tuples.
- Incorporates recognition of Named Entities, Time Expressions, Numbers, and similar phenomena.
- Handles non-headed constructions (multi-word expressions, range phrases, the-more-the-merrier constructions, etc.)
- Handles degree/comparative/superlative complements.
- Current Research in MT, time sequencing/causation relations among events, times and other elements.
- Current tuples are 25-tuples including base forms, senses, etc.
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Annotation Merging with GLARF

TEXT → Combination of Human Annotators and automatic processors, e.g., segmenter, sentence-splitter parser, NE-tagger, PropBanker, etc. → Parse, NE tags, Propositions, etc.

FS to Dependency Converter

Dependencies as 25-Tuples

GLARFer for Language X

Feature Structure
Current (English) System

- **Expected Input:**
  - Sentence-split input with offsets
  - Named entity input for ACE classes (GPE, PER, FAC, LOC, ORG)
    - Automatic annotation (JET) or BBN's hand annotation of Penn Treebank
    - Syntactic Tree: PTB-parse (Charniak) or manual treebank (PTB)
- **Manually created rules add additional information to all input**
  - Syntactic Regularizations (Logic1)
  - Error Correction (Part of Speech, Constituent Structure)
  - Special constructions: Time/Number Expressions, Legal Cases, etc.
  - TimeML information
- **Can incorporate input annotation or produce as part of GLARF system:**
  - PropBank, NomBank, Overt PDTB relations
- **Cascade of filters starting with parse tree and assuming strict rule ordering**
Merging Considerations

• When are 2 relations part of the same “level”?  
• When can 2 annotations be assumed to represent different parts of a single relation?  
• What if 2 annotations assume Different Constituent Structures?  
• What if merging causes undesirable dependency structures, e.g., loops?
Justification for Levels

• Surface and Logic1 levels
  – Sentence-internal regularizations based on consensus of popular theories
  – Passive, standard gap filling constructions (WH, relative, parenthetical, control, raising, VP-deletion), and a other phenomena compatible with surface/logic1 distinction
  – Distinction prevents loops in Logic1
    • Modifier relations are SURFACE if they contain gaps that modify the containing structure (parentheticals, relatives)

• The Level Logic2
  – Phenomena that don't neatly fit into Logic1
  – Phenomena are compatible with each other
    • Mergeable or in Complementary Distribution
  – Do not prevent loops or constrain to sentence-internal phenomena, etc.
Logic2: PropBank/NomBank

– PropBank includes verb alternations that may not be syntactic
  • *The pilot*/ARG0 *flew the plane*/ARG1
  • *The plane*/ARG1 *flew*.

– NomBank clusters arguments due to related verbs and other factors
  • *Rome's*/ARG1 *destruction by tourists*/ARG0
  • *John's*/ARG0 *capacity for understanding*/ARG1

– PropBank/NomBank argument relations are finer grained than Logic1
Logic2: Overt PDTB, TimeML/TLINK, Extensions

• PDTB relations and TimeML TLINK relations are not compatible with sentence-internal Surface/Logic1 relations

• When a TLINK signal and a PDTB predicate are the same, they also have the same arguments and their information is mergeable
  – *The doctor ran some tests.*/ARG1 *Afterwards, she decided to perform the operation.*/ARG2
  – ARG1 = EventInstance, ARG2 = relatedToEventInstance

• Other times, they are in complementary distribution
  – *The test was performed*/*ARG2, but I don't know the results*/*ARG1. (ONLY PDTB)
  – *She left*/*ARG1 on Tuesday*/*ARG2 (Only TimeML)

• Natural Extensions of analysis, e.g., to non-time-related PPs
  – *She left*/*ARG1 because of the problem*/*ARG2
Segment/Token/Constituent Compatibility Assumptions

1. Non parse-tree units are compatible with parse-tree units if there are no “crossing boundaries”. There are 2 subcases:
   a) they correspond to parse-tree units OR
   b) they can be analyzed as evidence sub-constituents

2. When 1 is not possible, the difference is predictable by rules or heuristics
Adding Subconstituents

• Nombank
  – (NP cotton and acetate fibers) →
    (NP (NP cotton and acetate) fibers)
  – (NP a Thursday night practice) →
    (NP a (NP Thursday night) practice)

• BBN NEs
  – (NP New York-based Loews Corp.) →
    (NP (ADJP (NP New York) - based) (NP Loews Corp.))
  – (NP Republican Rudolph Guliani 's) →
    (NP (NP Republican) (NP Rudolph Guliani) 's)
Resolving Token Level Conflicts

• BBN Named Entities
  – (ADJP (NNP New) (JJ York-based)) \rightarrow
    (ADJP (STEM (NP New York))
      (PUNCTUATION (HYPH -))
      (HEAD (VBN based)))
  – (NP (JJ U.S.-Japanese) (NNS relations)) \rightarrow
    (NP (N-POS (NP (CONJ1 (NP U.S.))
             (CONJUNCTION (HYPH -))
             (CONJ2 (NP Japanese))))
    (HEAD (NNS relations)))

• NomBank
  – higher/ARG1 student/ARG0-test/ARG2 scores
  – (NP (A-POS (ADJP (HEAD (JJR higher 9)) (INDEX 1)))
    (N-POS (NP (N-POS (NX (HEAD (NN student 10.1)) (INDEX 2))
                (PUNCTUATION (HYPH - 10.2))
                (HEAD (NX (HEAD (NN test 10.3)) (INDEX 3))))))
    (HEAD (NX (HEAD (NN scores))
                (P-ARG1 (NP (EC-TYPE PB) (INDEX 1))))
                (P-ARG0 (NP (EC-TYPE PB) (INDEX 2))))
                (P-ARG2 (NP (EC-TYPE PB) (INDEX 3))))))

• PTB ↔ Text alignment problems (I found 15 cases)
  – Predictable misalignments between text and hand-coded trees – cannot \rightarrow can + not, tis \rightarrow -t + is
  – Rare Errors deletions, unpredictable textual changes
Logic2: Formal Difficulties

• Cycles resulting from interactions between predicate types
  – NomBank Support Verbs and PropBank Arguments
    • NomBank: *Mary*/ARG0 *took*/Support *a walk*
    • PropBank: *Mary*/ARG0 *took a walk*/ARG1
  – PDTB predicates are PropBank modifiers
    • PDTB: *Afterwards, she slept*/ARG2.
    • PropBank: *Afterwards*/ARGM-TMP, *she*/ARG0 *slept*
  – These cycles seem unavoidable without a Surface2/Logic2 distinction

• Predicates embedded inside their arguments
  – *The cow*/ARG1, *John*/ARG0 *said, jumped over the moon*/ARG1.
  – The ARG1 is a discontinuous constituent (perhaps irrelevant for dependency representation)
  – This is unavoidable – Further discussion on next few slides
Discontinous Arguments are interrupted by a Self-Phrase Containing the Predicate

- **Self-Phrase P’**
  - Given: Predicate \( P \), Argument \( A \), Adverbial \( P’ \)
    - \( P’ \) is a PP, ADVP, parenthetical, etc.
    - Where \( P’ \) is a child of \( A \), \( P’ \) is an ancestor of \( P \)
  - Convention: Listing \( A \) as the argument will be understood to mean \( A \) minus \( P’ \)

- **PropBank Parentheticals**
  - \((S-1 (NP The cow) (PRN (S (NP John) (VP (VBD said) (SBAR (-NONE- 0) (S –NONE- *T*-1)))))) (VP jumped over the moon))\)
  - \( \text{ARG1 of } said = The cow + jumped over the moon \)

- **NomBank:**
  - \((S (NP The legislation) (PP at their request) (VP was (VP introduced (ADVP (RB early))))))\)
  - \( \text{ARG1 of } request = The legislation + was + introduced early \)

- **PDTB**
  - \((S (NP the company) (ADVP also) (VP disclosed what it did))\)
  - \( \text{ARG2 of } also = the company + disclosed what it did \)
Adjunction Rule Unites Contiguous Clausal arguments

• (S (SBAR although
   (S preliminary findings suggest X))
   (NP the latest results)
   (VP suggest Y)) ➔
(S (SBAR although
   (S preliminary findings suggest X)) )
(S (NP the latest results)
   (VP suggest Y)))

• Rule allows *although* to select whole Ss as arguments
• Preserves dependency structure
• Defensible Constituent Structure
Eliminating apparent SBJ + VP discontinuities using PTB empty categories

• If an S contains an EC bound to an external NP, an argument need not include that NP
  – John$_i$ seems (S e$_i$ to leave)
    • If ARG1 of *seem* is *John* + *to leave*
    • *John* can be deleted for purposes of LOGIC2
• If PDTB argument of a coordinate conjunction is a VP plus its SBJ, add an EC to the VP and delete the SBJ
  – (S They try to (VP (VP watch the other ropes) and thus (VP time their pulls)))
  – Args of *thus*: *They* + *time their pulls* and *They* + *watch the other ropes*
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GLARF Evaluation Description

• Evaluate exact match of 4 out of 25-tuples
  – Logic1 Role Label, +/-Transparent, Functor, Argument
  – 4 English: 46-100 sentences or 450 to 1500 tuples
    • 2 Written (WSJ and LET) and 2 Spoken (TEL and NAR)
  – CTB & KYO: 20 sentences or 400 to 600 tuples

• +/- Transparent refers to whether or not a functor is semantically empty
  – Conjunctions (and/or), Transparent Nouns (variety of birds), copulas, etc.

• F-score (F-T) also calculated ignoring transparency
  – Reduces Number Correct
    • precision = correct/output-length
    • recall = correct/answerkey-length

• Answer Keys: different for tb/parse system output
  – Genuine Ambiguity
  – Features measured not always specified as correct/incorrect
  – Sometimes more than one way to represent same concept in framework
Evaluation on Test Corpora

- English: WSJ = Wall Street Journal, LET = correspondence, TEL = telephone transcripts, NAR = transcripts of narratives (LET, TEL, NAR are from OANC)
- Chinese: CTB = Chinese Treebank
- Japanese: KYO = Kyoto Corpus
- The Chinese/Japanese systems less developed compared to English
- English Evaluations: 46-100 sentences, Chinese/Japanese: 20 sentences (number of relations = 400-1500)

<table>
<thead>
<tr>
<th>Treebank</th>
<th>Prec</th>
<th>Rec</th>
<th>F</th>
<th>F-T</th>
<th>Prec</th>
<th>Rec</th>
<th>F</th>
<th>F-T</th>
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<tr>
<td><strong>WSJ</strong></td>
<td>83.0%</td>
<td>84.2%</td>
<td>83.6%</td>
<td>87.1%</td>
<td>80.2%</td>
<td>78.9%</td>
<td>79.5%</td>
<td>81.8%</td>
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<td><strong>LET</strong></td>
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<td>92.3%</td>
<td>92.6%</td>
<td>93.3%</td>
<td>89.9%</td>
<td>85.9%</td>
<td>87.8%</td>
<td>87.8%</td>
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<td><strong>TEL</strong></td>
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<td>81.2%</td>
<td>78.6%</td>
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<td><strong>CTB</strong></td>
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<td>89.1%</td>
<td>88.4%</td>
<td>88.7%</td>
<td>87.3%</td>
<td>80.4%</td>
<td>83.7%</td>
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<td><strong>KYO</strong></td>
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<td>91.1%</td>
<td>91.1%</td>
<td>84.9%</td>
<td>86.2%</td>
<td>85.5%</td>
<td>87.8%</td>
</tr>
</tbody>
</table>
More Evaluations

- Number of sentences: 50 En News, 46 En Blog, 53 Ch News, 40 Ja News
- Parser Output Only

<table>
<thead>
<tr>
<th>Corpus</th>
<th>Precision</th>
<th>Recall</th>
<th>F-Score</th>
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<tr>
<td>En NEWS (JENAAD)</td>
<td>731/815=89.7%</td>
<td>715/812=90.0%</td>
<td>89.9%</td>
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<tr>
<td>En BLOG</td>
<td>704/844=83.4%</td>
<td>704/899=78.3%</td>
<td>80.8%</td>
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<tr>
<td>Ch Nwire</td>
<td>1031/1415=72.9%</td>
<td>1031/1352=76.3%</td>
<td>74.5%</td>
</tr>
<tr>
<td>Ja NEWS (JENAAD)</td>
<td>764/843=91.0%</td>
<td>764/840=90.6%</td>
<td>90.8%</td>
</tr>
</tbody>
</table>
2 Indirect Evaluations of Automatically Generated GLARF

• Improved Giza++ score for 2010 MT research at NYU
  – Automatically aligned English/Chinese Logic1 GLARF graphs
  – Derived mappings to reordered English text to be like Chinese
  – Lowered Alignment Error Rate from 51.9% (raw text) to 50.6% on Test Corpus (1505 sentences hand-aligned by LDC released GALE Y1 Q4)

<table>
<thead>
<tr>
<th>NYU ACE Event 12/2005 on DEV-TEST</th>
<th>VDR</th>
<th>VMD</th>
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<tbody>
<tr>
<td>Chunker + SBJ/OBJ Heuristics</td>
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<td>20.9</td>
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<tr>
<td>Parser + SBJ/OBJ/Passive Heur.</td>
<td>21.3</td>
<td>24.8</td>
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<tr>
<td>GLARF Logic1</td>
<td>25.8</td>
<td>31.2</td>
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<tr>
<td>GLARF Logic1 + Logic2</td>
<td>27.6</td>
<td>32.8</td>
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Other Work Using GLARF

- Part of 5-W System for 2009 SRA team GALE
  - NYU's part of an ensemble system for answering: *Who, What, Why, Where & How* questions
  - Parton, et. al. (2009), Yaman, et. al. (2009)

- Several IE systems used GLARF-based patterns
  - NYU dissertations: Zhao (2005), Shinyama (2007)

- Creating Data: CONLL 2008 & 2009 English Shared Task
  - Automatic NP-internal relations from GLARF (Prec: 83.9%-88%)
  - Automatic Split Tokenization due to hyphens (Prec: 85.5%-92.2%)
  - NomBank dependencies (filtered through GLARF)
  - Surdeanu, et. al. (2008) and Hajič, et. al. (2009)
Outline

- Approaches to Combining Annotation
- Introduction to GLARF
- Merging into one GLARF-based Theory
- Some GLARF results
- Current and Future Work
Alpha Version of GLARF for Download

• English only
• Packaged with version of Charniak parser and JET NE tagger/sentence splitter
• Intended for automatically created annotation
• Open Source, except for encrypted version of Comlex Syntax (due to LDC license)
• Free for Non-Profit and Research Use
• Commercial inquiries are welcome
• http://nlp.cs.nyu.edu/meyers/GLARF.html
What's Next?

• Work on Causation and Temporal Relations
  – Automatic system influenced by TimeML and PDTB specifications
  – Incorporates more PPs and NPs

• Further work on Machine Translation
  – Expanding using Chinese/Modified-English with MOSES translation system

• Online System
  – Functionality, Feedback and Collaboration
Summary

• GLARF is a framework for cutting out a theory from a merger of several different annotation schemata.

• Our transducer derives the analysis from:
  – Manual and/or automatic annotation
  – An ordered series of filters

• A theoretically-biased merger provides consistent structures for use in applications
  – We believe its consistency outweighs negative impact of our biases

• GLARF has been used successfully as part of many systems at NYU.

• English GLARF has been 10 years in the making and is now available for download.
Extra Slides

• Some Explanations
  – Multiple Correct Answers
  – Transparency Clarification
• Chinese and Japanese Examples
• Slides about contribution to CONLL
## Multiple Correct Answers

<table>
<thead>
<tr>
<th>Ambiguity</th>
<th>Corp</th>
<th>Treebank</th>
<th>Parser</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tokenization</td>
<td>NAR</td>
<td>2 - hour, 2 - cent</td>
<td>2-hour, 2-cent</td>
</tr>
<tr>
<td>2. Prefix?</td>
<td>KYO</td>
<td>大 /big + 枠 /framework</td>
<td>大枠 /the big picture</td>
</tr>
<tr>
<td>3. Encoding of zero</td>
<td>CTB</td>
<td>二000年/year 2000</td>
<td>二000年/year 2000</td>
</tr>
<tr>
<td>4. Attachment (relative)</td>
<td>LET</td>
<td>thousands [of people] [who face obstacles]</td>
<td>thousands of [people [who face obstacles]]</td>
</tr>
<tr>
<td>5. Conj Scope</td>
<td>TEL</td>
<td>[pearls or [beads of some sort of necklace]]</td>
<td>[[pearls or beads] of some sort of necklace]</td>
</tr>
<tr>
<td>6. Mod ambiguity 多種多様な/varied + 事業/businesses</td>
<td>KYO</td>
<td>Relative Clause businesses that are varied</td>
<td>Adjectival Modifier various businesses</td>
</tr>
<tr>
<td>7. POS ambiguity 进口/export = N or V</td>
<td>CTB</td>
<td>进口五十亿 Exportation of 5 billion</td>
<td>进口 五十亿 Exported 5 billion</td>
</tr>
</tbody>
</table>
Transparency Explanation

• Transparency: conjunctions, partitives, light Vs, copulas
  – Arguments act like semantic head(s)
  – *[John and Mary] ate [a bag of sandwiches]*
  • red = functor of NP, yellow = semantic heads
Chinese: 汉语中，关联词和被动句也有很明显的特点。

In Chinese, conjunctions and passive sentences also have very obvious features.

<table>
<thead>
<tr>
<th>Surf</th>
<th>L1</th>
<th>L2</th>
<th>Func</th>
<th>Arg</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADV</td>
<td>ADV</td>
<td></td>
<td>有/ have</td>
<td>中/in</td>
</tr>
<tr>
<td>SBJ</td>
<td>SBJ</td>
<td>A0</td>
<td>有/ have</td>
<td>和/and</td>
</tr>
<tr>
<td>ADV</td>
<td>ADV</td>
<td></td>
<td>有/ have</td>
<td>也/also</td>
</tr>
<tr>
<td>OBJ</td>
<td>OBJ</td>
<td>A1</td>
<td>有/ have</td>
<td>特点/features</td>
</tr>
<tr>
<td>OBJ</td>
<td>OBJ</td>
<td></td>
<td>中/in</td>
<td>汉语/Chinese</td>
</tr>
<tr>
<td>CONJ</td>
<td>*CONJ</td>
<td></td>
<td>和/and</td>
<td>关联词/conjunctions</td>
</tr>
<tr>
<td>CONJ</td>
<td>*CONJ</td>
<td></td>
<td>和/and</td>
<td>被动句/passive sentences</td>
</tr>
<tr>
<td>A-POS</td>
<td>A-POS</td>
<td></td>
<td>特点/features</td>
<td>的/DE</td>
</tr>
<tr>
<td>COMP</td>
<td>*COMP</td>
<td></td>
<td>的/DE</td>
<td>明显/obvious</td>
</tr>
<tr>
<td>ADV</td>
<td>ADV</td>
<td></td>
<td>明显/obvious</td>
<td>很/very</td>
</tr>
</tbody>
</table>
生命・財産を守ることは国家の責務だ。
*It is the state's duty to protect lives and assets.*

<table>
<thead>
<tr>
<th>L1</th>
<th>Surf</th>
<th>L2</th>
<th>Func</th>
<th>Arg</th>
</tr>
</thead>
<tbody>
<tr>
<td>*PRD</td>
<td>PRD</td>
<td></td>
<td>だ /is</td>
<td>責務 /duty</td>
</tr>
<tr>
<td>SBJ</td>
<td>SBJ</td>
<td></td>
<td>だ /is</td>
<td>こと /fact</td>
</tr>
<tr>
<td>SBJ</td>
<td></td>
<td></td>
<td>責務 /duty</td>
<td>こと /fact</td>
</tr>
<tr>
<td>COMP</td>
<td>COMP</td>
<td></td>
<td>責務 /duty</td>
<td>国家 /state</td>
</tr>
<tr>
<td>PRT</td>
<td>PRT</td>
<td></td>
<td>国家</td>
<td>の</td>
</tr>
<tr>
<td>COMP</td>
<td>COMP</td>
<td></td>
<td>こと /fact</td>
<td>守る /protect</td>
</tr>
<tr>
<td>PRT</td>
<td>PRT</td>
<td></td>
<td>こと</td>
<td>は</td>
</tr>
<tr>
<td>OBJ</td>
<td>OBJ</td>
<td></td>
<td>守る /protect</td>
<td>NULL-CONJ</td>
</tr>
<tr>
<td>*CONJ</td>
<td>CONJ</td>
<td>NULL-CONJ</td>
<td>財産 /assets</td>
<td></td>
</tr>
<tr>
<td>PRT</td>
<td>PRT</td>
<td></td>
<td>財産</td>
<td>を</td>
</tr>
<tr>
<td>*CONJ</td>
<td>CONJ</td>
<td>NULL-CONJ</td>
<td>生命 /lives</td>
<td></td>
</tr>
</tbody>
</table>
CONLL Splitting at Hyphens/Slashes 1

• Split tokens:
  – Assign POS tags
    • Automatic results for sample of 179 tokens
      – 153 correct (85.5%), 14 incorrect (7.8%), 12 unclear (6.7%)
  – Decimal token numbers

• (VP (NP (NNP New 6)
  – (NNP York 7.1)))
  – (HYPH – 7.2)
  – (VBN based 7.3))
NP-internal Relations

• NP internal relations used for CONLL
  – Title: Mr. John Smith
  – Post-Hon: John Smith Jr. III, Inc., Ph.D., etc.
  – APPOsite: John Smith, president of the U.S.
  – SUFFIX: John ’s
  – Near 100% accuracy for small sample
    • 45 correct, 2 unclear

• All NP GLARF Roles
  – RELATIVE, COMP, A-POS, T-POS, Q-POS, etc.
  – 224 correct (83.9%), 32 wrong (12%), 11 unclear (4.1%)
CONLL Splitting at Hyphens/Slashes 2

• Split Segments iff:
  – COMLEX words, numbers, prefixes (from a list)
  – Required by BBN NE tags (we made a gazetteer)

• Relations from GLARF
  – Conjunction cases: Japan-U.S. agreement
  – Everything else (distinguish HMOD/HEAD)
    • GLARF distinguishes them further