ACL Tutorial: Unification in the Syntax/Semantics Interface
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Syntax/Semantics Interface
in the

Unification
Many-sorted logics
Partial (many-valued) logics
Situation semantics
Semantic
Constraint programming
Unification
Algorithmic
Novel enabling features

Unification in Semantics
Unification in Semantics: Issues

- New possibilities for linguistic description (ellipses, quantification etc.)
- Computation with partial semantic information
- The nature of semantic rules
  - Semantics without homomorphisms
  - New views of modularity (coordination of syntax and compositionality)
  - Syntacticly without a requirement for unification and constraints
- Representation and the nature of semantic rules of
- New means of compositionality: Implications for semantic
Write them.

- The nature of semantic rules: Their effects and how to
descriptive language

- The language for describing logical forms (the

- The logic (syntax and semantics)

- Descriptive Apparatuses

- Semantics

- Past Approaches: Comparison with Montague

- From syntactic to descriptive in his goals

- What's the problem: How semantic analysis differs

Outline
Modularity: New ways of structuring of the relationship between linguistic form and semantic interpretation

- Extensions and new possibilities for analyses:
  - Quantifier scope and functional uncertainty
  - Ellipsis and higher order unification

Example analyses
the introduction of multiple levels

Information Flow: Questions of control and risk from

to operations on "real" semantic objects

Operations on the representations correspond

Procot-Protocol (maybe)

Model theory

a theory of truth and entailment

Semantic representations must serve as a basis for
Architectures for Semantic Interpretation

- Logic grammars, CHAT-80: Horn clauses for the logic
- Tightly coupled, but ad hoc; correspondence between syntax and semantics (Thompson 1969)
- Rule-by-rule interpretation
- Sharing at run time
- Modularity in the specification combined with information
- Cascaded ATN (Woods 1980)
- Interpreted, but arbitrarily complex, operations in the
  Coordinated, but arbitrarily complex, operations in the
  "Backboard" architectures

Computation Approaches
Architectures for Semantic Interpretation

- Direct Interpretation
- Syntactic/Semantic Coordination Through Homomorphisms
- Montague Grammar

Logical Approaches

- Rule-by-Rule Interpretation
- GPSC/HoPLA/LFG
- The tree transformations and procedural restructuring of
  from logical form to surface structure through
- Generative Semantics
- Projection Rules
- Singular and Generalized Transformations
- Early Transformational Grammar

Linguistic Approaches
Parameterized Information about Interpretation

- Meaning providing complete, exhaustively
- Function application

Tools for Semantic Composition

In Montague Grammar
Semantic Interpretation using Lambda Calculus

ACT Journal 3 June '90
Higher-Order Information—Quantification

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Semantics Based Semantic Interpretation

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\[ \text{Note:} \]

\[ \forall x \cdot \text{walk}(x) \iff (\exists y \cdot \text{child-of}(y, x)) \wedge \neg \text{same}\text{-hand}(y) \]

Semantic/Logical Solution: Negate, back up.

Semantics & Ambiguity vs. Under specification

**Type-Raising Solution Using LF: Definition**

\[ \text{Semantics, } \]
Structure Sharing

A Revision—Interfacing Syntax and Semantics

A More Semantic Rule

Semantic Formulation: Unification-Based Semantic Interpretation
Exercise: Specify the rule needed.

(∀x)(∀y)(∀z) walk(x) walk(y) walk(z)

Each child

[Quantified Example Realized]

A Quantified Example Realized

ACL Toronto 5 June 90
Unification-Based Semantics

Summary of Introductory Illustration

- analogy: lambda-binding :: unification
- descriptions of logical forms are unified
- semantic inference is separate
- extensive structure sharing between syntax and semantics
3.3 AVM Specifications for ICG

AVM Specifications for ICG
Allowable Specifications

AVM Specifications for LCG
1. The Unification-Based Approach

2. Structure-sharing in Semantics—Motivation

2.1. Anaphora and Paraphrase

3. Structure-sharing

4. Anaphora and Paraphrase
3.1 Some Examples

A Formalization that Allows Sharing
Phrasal structure isn't remarkably lexical speech.

S

NP

Vp

aux

V

N

to

leave

want(s) to leave.

Control

Structure-Sharing

Control
Lexical Entry

Specifying Control—A Structure-Sharing Solution

We can't simply specify control using lexical semantics alone! The property may be arbitrarily complex.

want(x, 'train') → ∀ x (initial-over(x, 'train'))

Sam wants to invite everyone over if it rains.

want(x, 'invite')

((x, y), 'invite')
Adnominal pp's

Other applications of Control-like analyses

Control
Semantics of Gaps

Structure-Sharing

A Logical Type for Questions—Lambda Expressions
Rule for Possessive Np Semantics

Structure-Sharing
Exercise on semantics of quantified complements.

Results of linking:

Linking Piller + Gapy Constituent

Some text in English.
Inheriting use

Retrieving use

sem: v

Logic: \( \land \)

Value: \( n \)

Type: tech

Possess (person)

Whose technician did Smith hire?

N

N

S

S

NP

S/NP

员工: 王

职位: 技术

possess (person)

Where is tech's

who's technician did Smith hire?
Precious Pearl
Which customers wanted more software than they had ordered the
comparative.

DID Smith review the others whose parts had been reported as defective?
In which case?
Which part was reported to have been defective?

In semantic representation, long-distance dependencies involve structure-sharing.

Structure-sharing

{∀x. person(x) \land (\exists z. tech(z) \land \exists y. possess(x, y)) \rightarrow S(x, z, y)}

{∀x. person(x) \land (\exists z. tech(z) \land \exists y. possess(x, y)) \rightarrow S(x, z, y)}
Semantics-Phonology Interface: Information

Compositionality Questions

ACT Number: 674.690
Incorporation of Subject must result in reflexive binding.

\[ \text{Subject} \text{ [ } \text{Incorporation} \text{ } \text{Subject} \text{ ]} \text{ } \text{[ } \text{Incorporation} \text{ [ } \text{Subject} \text{ ]} \text{ ]} \]

\[ \text{Incorporation [ } \text{Subject} \text{ ]} \text{ [ } \text{Incorporation} \text{ [ } \text{Subject} \text{ ]} \text{ ]} \text{ ]} \]

Results of Reflexive Processing

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Since slash must unify with subject, any reflexives contained in

Apparent Object Incorporation

Normal Object Incorporation

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Insight: Slash may contain reflexives

Hitherto, same here.

Without picture of lexical dit ever composition want.

Apparent Exceptions to Heleve-Binding Condition (English):
Compositional Semantics: Semantics of phrase is function of semantics of constituent.

Thus, semantics of $S = \text{like}(\text{e}, s)$

$\Rightarrow e = s \Rightarrow S = e$.

Diagram shows the structure and relationships between different parts of the sentence.
Advantage of Unification-Based Approach:

- Enforce compatibility
- Specify sorts required in argument positions of relations and functions
- Specify sorts of terms (and constraints, etc.)

Strategy:

Sortal Disambiguation via Unification

Who bought books in May?

Who bought books in Spanish?
Sortal Disambiguation via Unification

A Sortally Ambigous "

Sortal Disambiguation via Unification

Domain Sorts

English

Temporal

Social

Language

Time

May

Book

Spanish...
Nominal and Event Semantics

Sortal Disambiguation via Utilization

Nominal Semantics with Domain Sort Specifications

Sortal Disambiguation via Utilization
Cautions

Sortal Disambiguation via U nitication

Object Language Results

A book can't be in any way the same way it's a Sparsh.

Pitch: Coexisting Well-Formed and Correct in English

Danger: Overworking, Sort.

(\text{book}(x) \land \text{Sparsh}(x))

\text{book}(x)

\text{Sparsh}(x)
Non-monotonic effects in the model space
Monotonicity in the description space
Interpretation by successive approximation
Utilization of partially specified objects
New means of composition
Partial logics
Models of partial information (situation semantics)
Partially

Appraoches
Endabling Features of Constraint-Based
A Model of Interpretation in Unification Grammars

Interpretation through translation:

- Informational dependences expressed through constraints:
  - Physical and pragmatic constraints on the described situation
  - Background information
  - Discourse context
  - Constituent structure, phonological structure, functional structure...
  - Multiple levels of semantic significance

NP → Vp
S ← ADVP
New analytic possibilities arise from working with descriptions of logical forms as opposed to descriptions of semantical objects.

These limits (Montague's Intensional Logic: Situation Semantics) of FO, but most linguistic semantical descriptions go beyond such correspondences and establish between utilization and restricted

Prolog

Syntact: Logical Form Model

MG Homomorphisms:

Established correspondences between syntactic operations (in the

Prerequisites for direct interpretation

Vs. Construction of Semantical Objects

Description of Logical Forms
Example: \( f(p(x)^t) \)

\[ \begin{bmatrix} f \\ g \\ c \\ b \\ a \end{bmatrix} \]

- \( e.g. (f(a)) \)

Through an AVG, it meeting the conditions of a regular expression, a

Functional Uncertainty permits the characterization of classes of paths

Functional Uncertainty: Concept and Notation
The book which Bill wants

The book which John thinks Bill wants

The book which Vera said John thought Bill wanted

Long-distance syntactic (functional) dependencies

- Path: OB1, SCOMP, SCOMP, SCOMP, OB1

Functional Uncertainty: Applications
The book which Vera said John thought Bill wanted.

Functional Uncertainty: Relative Clauses
Generalization: \( \{ \text{ARG1} \mid (\text{ARG1} \text{ ARG1})^{+} \} \)

Path: \( \circ \text{ ARG1 ARG2 } \circ \text{ ARG1 } \)

\[ \begin{array}{c}
\text{ARG2} \\
\text{ARG1} \\
\text{REL} \\
\text{find} \\
[\text{a pretty dog}] \\
\text{ARG2} \\
\text{ARG1} \\
\text{REL} \\
\text{find} \\
[\text{a pretty dog}] \\
\end{array} \]

\[ \begin{array}{c}
\text{ARG2} \\
\text{ARG1} \\
\text{REL} \\
\text{Bill} \\
[\text{trying}] \\
\text{Bill} \\
\text{find} \\
\text{a pretty dog}(x) \\
\end{array} \]

\[ \begin{array}{c}
\text{Bill} \\
\text{Bill} \\
\text{REL} \\
\text{Bill} \\
[\text{trying}] \\
\text{Bill} \\
\text{find} \\
\text{a pretty dog}(x) \\
\end{array} \]

**Bill is trying to find a pretty dog** (assumption)

Quantifiers can take scope over any complement (simplified)

**Quantification**
All rules introducing quantified Ns receive an annotation:

Quantification: Simplied Analysis
All rules introducing quantified NPs receive an annotation:

Quantification: Analyses with projections
The semantic correlates of syntactic operations on
The significance of compositionality

• New and unresolved issues arise regarding

• Apparatus or extensions to the notion of unification

• New analytic possibilities due new descriptive

interpretation

• New ways of correlating linguistic form and its

information

• New mechanisms for combining semantic

Unification and unification grammars provide:

Conclusions