Natural Language Processing
CMSC 723 (spring, 2001)

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- Chapter 14: Semantics
- Meaning Representations
- Verifiability
- Ambiguity, Vagueness
- Canonical Form
- Predicate-Argument Structure
- FOPC
- inference

Semantics

What does it all mean?

Why do we need meaning representations?

- Answering questions
- Determining truth
- Making inferences

Meaning Representations

Meaning representations: formal structures that correspond to the underlying significance of a word or sentence.

Meaning Representations (continued)

[Figure 14.1]

Basic Assumptions

Focus on literal meaning:

- conventional meanings of words
- ignore context

Verifiability

Why are meaning representations needed—what do they do for us?

Examples:

Does Maharani serve vegetarian food?

Serves(Maharani,VegetarianFood)

verifiability: The system's ability to compare representation to facts in KB.

Ambiguity

I wanna eat someplace that's close to UMD

Vagueness

Vagueness: Uncertainty; exact specifics of the entity not known

I want to eat Italian food

Canonical Form

Canonical Form: “standardized” representation of meaning for (potentially) multiple utterances.

- Does Maharani have vegetarian dishes?
- Do they have vegetarian food at Maharani?
- Are vegetarian dishes served at Maharani?
- Does Maharani serve vegetarian fare?

Alternatives:

- Four different semantic representations.
- Store all possible meaning representations in KB.

Doctrine of Canonical Form

Inputs that mean the same thing have the same representation.

How do we produce a canonical form?

- Systematic meaning representations can be derived from thesaurus.
- Systematically relation between syntactic constructions.

Inference

Inference: Draw valid conclusions based on the meaning representation of inputs and its store of background knowledge.

Can vegetarians eat at Maharani?

Non-Yes-No Questions: Variables

I'd like to find a restaurant where I can get vegetarian food.

serve(x,VegetarianFood)

Meaning Structure of Language

Human languages:

- display a basic predicate-argument structure
- make use of variables
- make use of quantifers
- display a partially compositional semantics

What is Predicate-Argument Structure?

- Predicate-like elements: Verbs, VPs, prepositions, adjectives, some nouns.
- Argument-like elements: Nouns, Nominals, NPs, etc

Syntax:

NP give NP2 NP1

NP give NP1 to NP2

Semantics:

give(x,y,z)

Predicate-Argument Structure Example

John gave Mary a book.

Give(John,Mary,Book)

Two New Notions

- **Semantic Roles**
- **Semantic Restrictions on Roles**

Verb subcategorization: Allows **linking** of arguments in surface structure with semantic roles.

Note: Prepositions act a lot like verbs!

Elements of FOPC

[Figure 14.2]

Truth Table for Logical Connectives

[Figure 14.3]

Quantifiers

- A restaurant that serves Mexican food near UMD
- All vegetarian restaurants serve vegetarian food

FOPC

Before: John gave Mary a book

Better: $\exists x$ Giving(x) $\wedge$ Giver(John,x) $\wedge$ Givee(Mary,x) $\wedge$ Given(Book,x)

Definition of Give: $\exists w, x, y, z$ Giving(x) $\wedge$ Giver(w,x) $\wedge$ Givee(z,x) $\wedge$ Given(y,x)

Why "Variableize" ??

1. I ate.
2. I ate a turkey sandwich.
3. I ate a turkey sandwich at my desk.
4. I ate at my desk.
5. I ate lunch.
6. I ate a turkey sandwich for lunch
7. I ate a turkey sandwich for lunch at my desk.

Examples

- Is Denver north of Pueblo?
- What is north of Denver?
- Additional assertions needed

Inference

Given:

$\alpha \Rightarrow \beta$

α

Infer:

β

Used for **forward chaining** and **backward chaining**.