

Semantic Roles & Selectional Restrictions

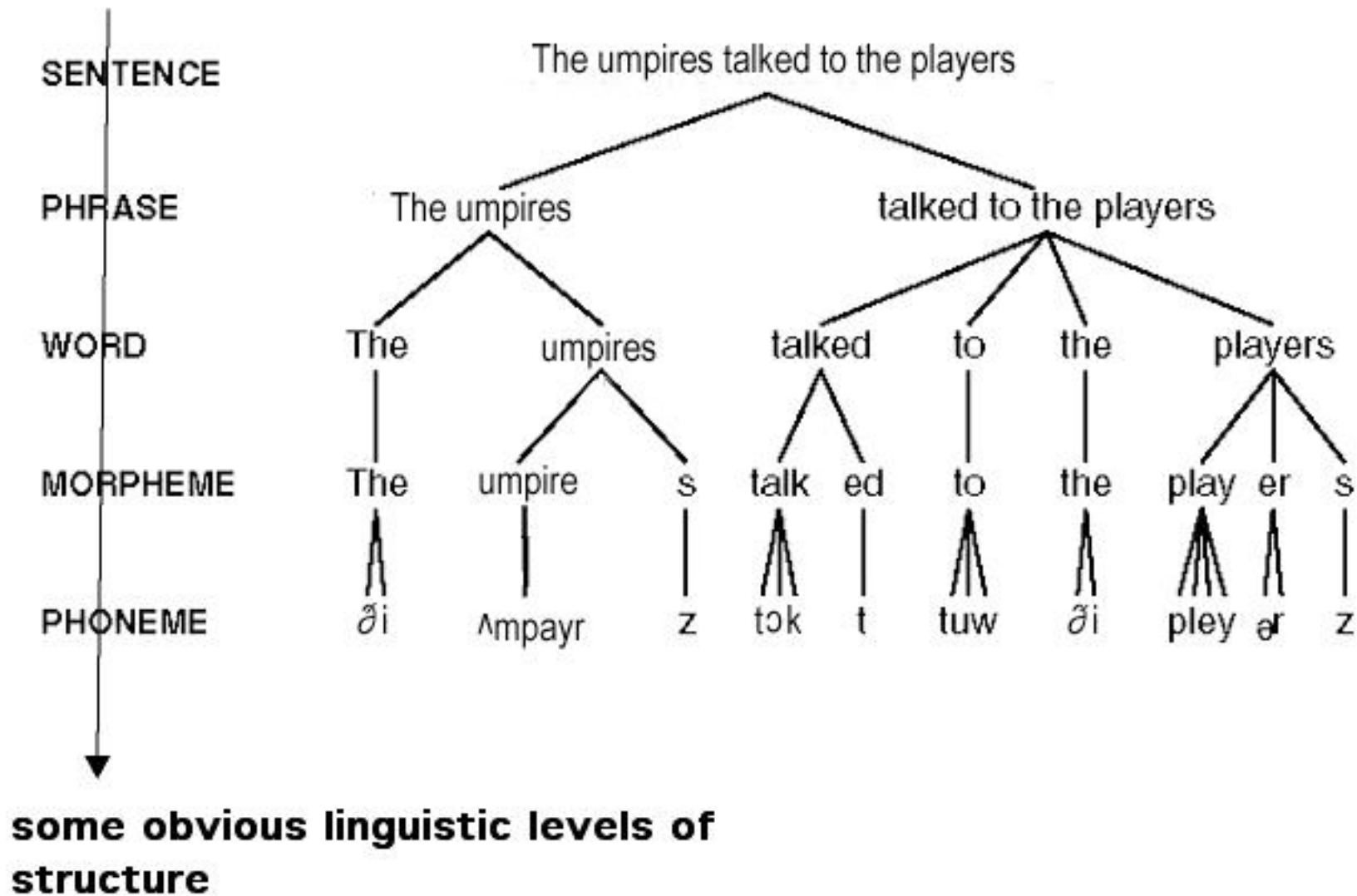
By:
B.Senthil Kumar
Asst. Prof / CSE
Natural Language Processing



Agenda

- Semantic Roles
 - Thematic roles
 - Shallow Semantic Interpretation
- PropBank
- Selectional Restriction

Linguistic Levels



Thematic Roles

- What is the commonality between the following two sentences?
- (19.19) *Sasha* broke the window
(19.20) *Pat* opened the door
- Roles of *breaking* event – *Breaker*, *BrokenThing*
Roles of *opening* event – *Opener*, *OpenedThing*
- Both *Breaker* and *Opener* have something in common. What?
 - they are volitional actors – they have direct causal responsibility for their events
- Thematic roles are one attempt to capture this semantic commonality between *Breaker* and *Opener* – **AGENT**

Thematic Roles

- Objects which are affected in some way by the action

BrokenThing, OpenedThing – **THEME**

- Proposed first by the Indian grammarian Panini – 7th to 4th century BCE

Thematic Role	Definition
AGENT	The volitional causer of an event
EXPERIENCER	The experiencer of an event
FORCE	The non-volitional causer of the event
THEME	The participant most directly affected by an event
RESULT	The end product of an event
CONTENT	The proposition or content of a propositional event
INSTRUMENT	An instrument used in an event
BENEFICIARY	The beneficiary of an event
SOURCE	The origin of the object of a transfer event
GOAL	The destination of an object of a transfer event
Figure 19.5 Some commonly-used thematic roles with their definitions.	

Thematic Roles

- (16.24) Mr.Johnson broke his collarbone
- No implication that he was the AGENT of this event
- This kind of participant is labelled – EXPERIENCER
- (16.25) The quake broke glass in several downtown skyscrapers
- Quake is not a volitional causer of an event
- FORCE – similar to AGENT but lacks any notion of volitionality
- (16.26) *It* broke his jaw
- *It* refers to event participant whose role is as the instrument of some other AGENT or FORCE – INSTRUMENT

Thematic Roles

Thematic Role	Example
AGENT	<i>The waiter</i> spilled the soup.
EXPERIENCER	<i>John</i> has a headache.
FORCE	<i>The wind</i> blows debris from the mall into our yards.
THEME	Only after Benjamin Franklin broke <i>the ice</i> ...
RESULT	The French government has built a <i>regulation-size baseball diamond</i> ...
CONTENT	Mona asked “ <i>You met Mary Ann at a supermarket</i> ”?
INSTRUMENT	He turned to poaching catfish, stunning them <i>with a shocking device</i> ...
BENEFICIARY	Whenever Ann Callahan makes hotel reservations <i>for her boss</i> ...
SOURCE	I flew in <i>from Boston</i> .
GOAL	I drove <i>to Portland</i> .
Figure 19.6 Some prototypical examples of various thematic roles.	

Shallow Semantic Interpretations

- Use of thematic roles in computational systems is as a shallow semantic language

- Shallow semantic language allow us to make simple inferences

Company A acquired Company B

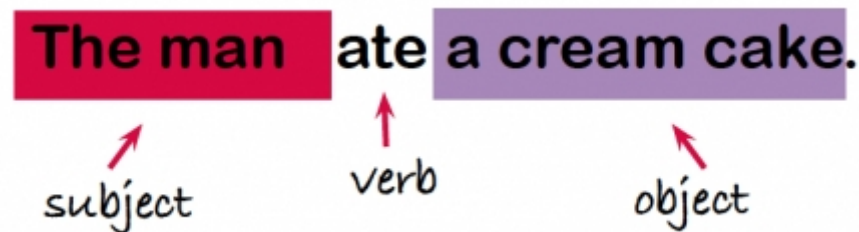
Was Company B acquired?

← Different surface syntax

- Thematic roles are used in MT as an intermediate language
- Thematic roles – used to generalize over different surface realizations of predicate arguments

Shallow Semantic Interpretations

- Subject, Verb, Object (Recap)



*After the final song, the **drummer** hurled his sticks at the crowd*

*Mr. John smashed the electric **guitar** with a sledge hammer*

*Very slowly, Pandora opened the **box***



Shallow Semantic Interpretations

- *Thematic hierarchy* – AGENT > INSTRUMENT > THEME for assigning the **subject** role
- Which argument of a verb will become the **subject** of a sentence
- Possible realization of verb *break*: (verb alternations)

(19.21) *John broke the window*

AGENT THEME

(19.22) *John broke the window with a rock*

AGENT THEME INSTRUMENT

(19.23) *The rock broke the door*

INSTRUMENT THEME

(19.24) *The window broke*

THEME

(19.25) *The window was broken by John*

THEME AGENT

SUBJECT
OBJECT

Shallow Semantic Interpretations

- Dative alternations – certain verbs like *give, send, read* allows THEME or GOAL to appear as the object

(19.26) *Doris gave/sent/read the book to Cary*

AGENT

THEME

GOAL

(19.26) *Doris gave/sent/read Cary the book*

AGENT

GOAL

THEME

SUBJECT

OBJECT

- Verbs of future having (advance, allocate, offer, owe), send verbs (forward, hand, mail), verbs of throwing (kick, pass, throw)

Shallow Semantic Interpretations

- Affect verbs like *frighten* can appear with THEME or EXPERIENCER as subject

(16.32) *That frightens me*

THEME *EXPERIENCER*

(16.32) *That surprises me*

THEME *EXPERIENCER*

SUBJECT

OBJECT

(16.33) *I am frightened of that*

EXPERIENCER *THEME*

(16.33) *I am surprised at that*

EXPERIENCER *THEME*

Issues in Thematic Roles

- Very difficult to formally define the semantic roles.
- Very difficult to come up with a standard set of roles.
- Consider the AGENT role;
 - most cases of AGENTS are animate, volitional, sentient, causal, but any individual noun phrase might not exhibit all of these properties.
- Solution: define **generalized semantic roles** that abstract over the specific thematic roles.
- For example PROTO - AGENT and PROTO - PATIENT are generalized roles that express roughly agent-like and roughly patient-like meanings.
- Two commonly used lexical resources which makes use of semantic roles:

PropBank, FrameNet

The Proposition Bank – PropBank

- A resource of sentences annotated with semantic roles.
- Issue in universal set of thematic roles – hence semantic roles are defined w.r.t an individual verb sense.
- Each verb has a specific set of roles, which are numbered rather than names: **Arg0**, **Arg1**, **Arg2**, and so on.
- **Arg0** – refers to PROTO-AGENT
- **Arg1** – refers to PROTO-THEME
- the semantics of the other roles are specific to each verb sense.

The Proposition Bank – PropBank

- Frameset **agree.01**
- **Arg0**: Agreeer
- **Arg1**: Proposition
- **Arg2**: Other entity agreeing
- Ex1: [**Arg0** The group] **agreed** [**Arg1** it wouldn't make an offer unless it had Georgia Gulf's consent].
- Ex2: [**ArgM-Tmp** Usually] [**Arg0** John] **agrees** [**Arg2** with Mary] [**Arg1** on everything].

The Proposition Bank – PropBank

- **fall.01** “move downward”
- **Arg1**: Logical subject, patient, thing falling
- **Arg2**: Extent, amount fallen
- **Arg3**: start point
- **Arg4**: end point, end state of arg1
- **ArgM-LOC**: medium
- Ex1: [**Arg1** Sales] **fell** [**Arg4** to \$251.2 million] [**Arg3** from \$278.7 million].
- Ex2: [**Arg1** The average junk bond] **fell** [**Arg2** by 4.2%] [**ArgM-TMP** in October].

No **Arg0** role

The Proposition Bank – PropBank

- **increase.01** “go up incrementally”

Arg0: causer of increase

Arg1: thing increasing

Arg2: amount increased by, EXT, or MNR

Arg3: start point

Arg4: end point

- Semantic role label by PropBank despite the differing surface forms.
- [**Arg0** Big Fruit Co.] **increased** [**Arg1** the price of bananas].
- [**Arg1** The price of bananas] was **increased** again [**Arg0** by Big Fruit Co.]
- [**Arg1** The price of bananas] **increased** [**Arg2** 5%].

Selectional Restrictions

Selectional Restrictions

- A Selectional restriction is a kind of *semantic type constraint* that a verb imposes on the kind of concepts that are allowed to fill its argument roles
- *I wanna eat **someplace that's close to ICSI***
- Two parses lead to two distinct semantic analyses
- In intransitive case, the phrase is an adjunct that modifies the event
- In transitive case, the phrase provides a true argument to the event
- How do we know that the phrase is not the direct object in this?
- The THEME of EATING event tends to be something that is *edible*
- This restriction placed by the verb *eat* on the filler of its THEME argument – selectional restriction

Selectional Restrictions

- Selectional restriction is a constraint on the semantic type of some argument
- It is associated with senses, not entire lexemes
- (19.51) Well, there was the time they *served* green-lipped mussels from New Zealand
- (19.52) Which airlines *serve* Denver?
- (19.51) *cooking* sense of *serve*, which restricts THEME to be some kind of foodstuff
- (19.52) *provides a commercial service to* sense of *serve*, which restricts its THEME to be appropriate location

Selectional Restrictions

- Selectional restriction vary widely in their specificity
- The verb *imagine* impose strict requirements on its AGENT role – (restricting it to humans and other animate entities) places very few semantic requirements on its THEME role

(16.42) In rehearsal, I often ask the musicians to *imagine* a tennis game.

(16.44) I can not even *imagine* what this lady does all day.
- The verb *lift* limits its THEME to be something liftable – physical object

(16.45) Atlantis *lifted* Galileo from the launch pad at 12:54 pm EDT.

(16.46) When the battle was over, he *lifted* the fish from the water.
- The verb like *diagonalize* places a specific constraint on its THEME role

(16.47) To *diagonalize* a matrix is to find its eigenvalues.

Representing Selectional Restrictions

- Use thematic roles rather than event roles

$\exists e, x, y \text{ Eating}(e) \wedge \text{Agent}(e,x) \wedge \text{Theme}(e,y)$

- To stipulate the selectional restriction that y must be something edible

$\exists e, x, y \text{ Eating}(e) \wedge \text{Eater}(e,x) \wedge \text{Theme}(e,y) \wedge \text{Isa}(y, \text{EdibleThing})$

- A semantic analyzer can form following representation for a phrase:

ate a hamburger

$\exists e, x, y \text{ Eating}(e) \wedge \text{Eater}(e,x) \wedge \text{Theme}(e,y) \wedge \text{Isa}(y, \text{EdibleThing})$

$\wedge \text{Isa}(y, \text{Hamburger})$

- *Hamburger* is consistent with its membership in category *EdibleThing*
whereas *eat someplace* ?

Representing Selectional Restrictions

- Two practical problems:
 - Using FOPC to perform the task of enforcing selectional restrictions is overkill
 - Requires a large logical knowledge-base of facts about the concepts that make up selectional restrictions
- Practical approach to state selectional restrictions is in terms of **WordNet synsets**, rather than logical concepts
- Exploit the **hyponymy relations** present in the WordNet

Representing Selectional Restrictions

- A meaning representation is well-formed if the role filler word is a hyponym of this synset
- Set the selectional restriction on the THEME role of the verb *eat* → synset {**food**, **nutrient**}
- Let us restrict *imagine*'s THEME to {entity} – *imagine a hamburger*
lift's THEME to {physical entity} – *lift a hamburger*
diagonalize to {matrix} – *diagonalize a hamburger*

Representing Selectional Restrictions

- The chain of hypernyms for *hamburgers* reveals that hamburgers are indeed food

```
Sense 1
hamburger, beefburger --
(a fried cake of minced beef served on a bun)
=> sandwich
    => snack food
        => dish
            => nutriment, nourishment, nutrition...
                => food, nutrient
                    => substance
                        => matter
                            => physical entity
                                => entity
```

Figure 19.7 Evidence from WordNet that hamburgers are edible.

References

- Speech and Language Processing, *Jurafsky and H.Martin*
[Chapter 16. Lexical Semantics]