Natural Language Processing

Lecture 15

FASTUS: Basic Phrase Extractor

Company	Bridgestone Sports Co.
Verb Group	said
Noun Group	Friday
Noun Group	it
Verb Group	had set up
Noun Group	a joint venture
Preposition	in
Location	Taiwan
Preposition	with
Noun Group	a local concern
Conjunction	and
Noun Group	a Japanese trading house
Verb Group	to produce
Noun Group	golf clubs
Verb Group	to be shipped
Preposition	to
Location	Japan

FASTUS: Semantic Templates

(1)	Relationship:	TIE-UP
	Entities:	“Bridgestone Sports Co.”
		“a local concern”
		“a Japanese trading house”
(2)	Activity	PRODUCTION
	Product	“golf clubs”
(3)	Relationship:	TIE-UP
	Joint Venture Company	“Bridgestone Sports Taiwan Co.”
	Amount	NT$20000000
(4)	Activity	PRODUCTION
	Company	“Bridgestone Sports Taiwan Co.”
	Start Date	DURING: January 1990
(5)	Activity	PRODUCTION
	Product	“iron and “metal wood” clubs”

Today's Outline

Announcements

Review

Lexical Semantics

- Meaning of Words
- Lexical Relations
- WordNet
- Thematic Roles
- Selectional Restrictions
- Conceptual Dependency

My Friday ISP Seminar

When: 1:15 - 2:45, 9th Floor LRDC, lunch provided

Title: Prosodic Analysis of Misrecognitions and Corrections in Spoken Dialogue Systems

Abstract: Understanding how people speak when they interact with spoken dialogue systems is critical to improving the performance of those systems. For several years I have been investigating whether speakers' prosodic behavior provides useful indicators of (a) whether a speaker turn will be recognized correctly or not by an automatic speech recognition system; (b) whether a speaker is reacting to a system error; and c) whether a speaker is correcting such an error. For today's talk I will focus on (a).

We have discovered prosodic features which more accurately predict when a recognition hypothesis contains a word error than the acoustic confidence score thresholds traditionally used in automatic speech recognition. I will present analytic results indicating that there are significant prosodic differences between correctly and incorrectly recognized turns in the TOOT train information corpus. I will then present machine learning results showing how the use of prosodic features to automatically predict correct versus incorrectly recognized turns improves over the use of acoustic confidence scores alone.

Announcements (cont.)

December 7 ISP seminar:

- Antal van den Bosch (University of Tilburg, Netherlands, currently visiting Whizbang Labs!)
- a talk on machine learning for natural language processing (e.g. feature construction and selection)

CS 3710, next semester:

- Advanced Topics in Artificial Intelligence (also ISSP 3565)
- MW 2:00 PM - 03:20 PM
- LRDC 814
- presentation and discussion of papers in discourse and dialogue
- also a "research-related project"

Review: Meaning Representations

The approach to meaning that we'll present is based on the systematic creation of meaning representations–representations that bridge that gap from linguistic forms to knowledge of the world.

Review: Semantic Analysis

Semantic analysis is the process of taking in some linguistic form and producing a meaning representation for it.

Most methods rely in some way on a prior or concurrent syntactic analysis (parse).

We'll outline a compositional rule-to-rule approach.

Review: Compositional Semantics

At the core of most methods is the principle compositionality which states that the meaning of the whole is based on the meaning of parts.

The parts are the words and syntactic constituents specified by the grammar.

Review: Semantic Attachments

Given semantic attachments to context free grammar rules there are two approaches possible:

1. Alter a syntactic parser so that when completed constituents are created, the semantic function attached to the rule is applied and a meaning representation is created and stored with that state.
2. Let the parser run to completion and walk the resulting tree running the semantic attachments from the bottom-up.

Finish: Robust Approaches

Lexical Semantics

Meanings of words

Lexemes, lexicon, sense(s)

Examples

- Red, n: the color of blood or a ruby
- Blood, n: the red liquid that circulates in the heart, arteries and veins of animals
- Right, adj: located nearer the right hand esp. being on the right when facing the same direction as the observer

Do dictionaries give us definitions?

Lexical Relations I: Homonomy

What is homonomy?

- A *bank* holds investments in a custodial account.
- Agriculture is burgeoning on the east *bank*.

Variants

- homophones - “read” and “red”
- homographs - “bass” and “bass”

Applications

- spelling correction
- speech recognition
- text to speech

Lexical Relations II: Polysemy

What is polysemy?

- They rarely *serve* red meat.
- He *served* as U.S. ambassador.
- He might have *served* his time in prison.

Homonymy: distinct and unrelated meanings, possibly with different etymology (multiple lexemes)

Polysemy: single lexeme with two meanings

Example: an "idea bank"

Word Sense Disambiguation

For any given lexeme, how can its sense be reliably distinguished?

Lex. Rel. III: Metaphor, Metonymy

What is metaphor?

- That doesn't *scare* Digital.

What is metonymy?

- GM *killed* the Fiero.

Extension of existing sense to a new meaning.

Lexical Relations IV: Synonomy

What is synonomy? Substitutability.

- How *big* is that plane?
- How *large* is that plane?

Compare:

- A *big* fat apple
- ?A *large* fat apple
- A *big* sister
- ?A *large* sister

Influences on substitutability:

- subtle shades of meaning differences
- polysemy
- register
- collocational constraints

Lexical Relations V: Hyponomy

What is hyponomy?

General: hyponym

Specific: hypernym

- Example: "car" is a hyponym of "vehicle" and "vehicle" is a hypernym of "car."
- Test: "That is a car" implies "That is a vehicle"

What is ontology?

What is taxonomy?

What is object hierarchy?

Semantic Networks

Used to represent relationships between words

Example: WordNet - created by George Miller's team at Princeton

- http://www.cogsci.princeton.edu/∼wn

WordNet (1.6)

WordNet is the most widely used hierarchically organized lexical database for English – Fellbaum (1998).

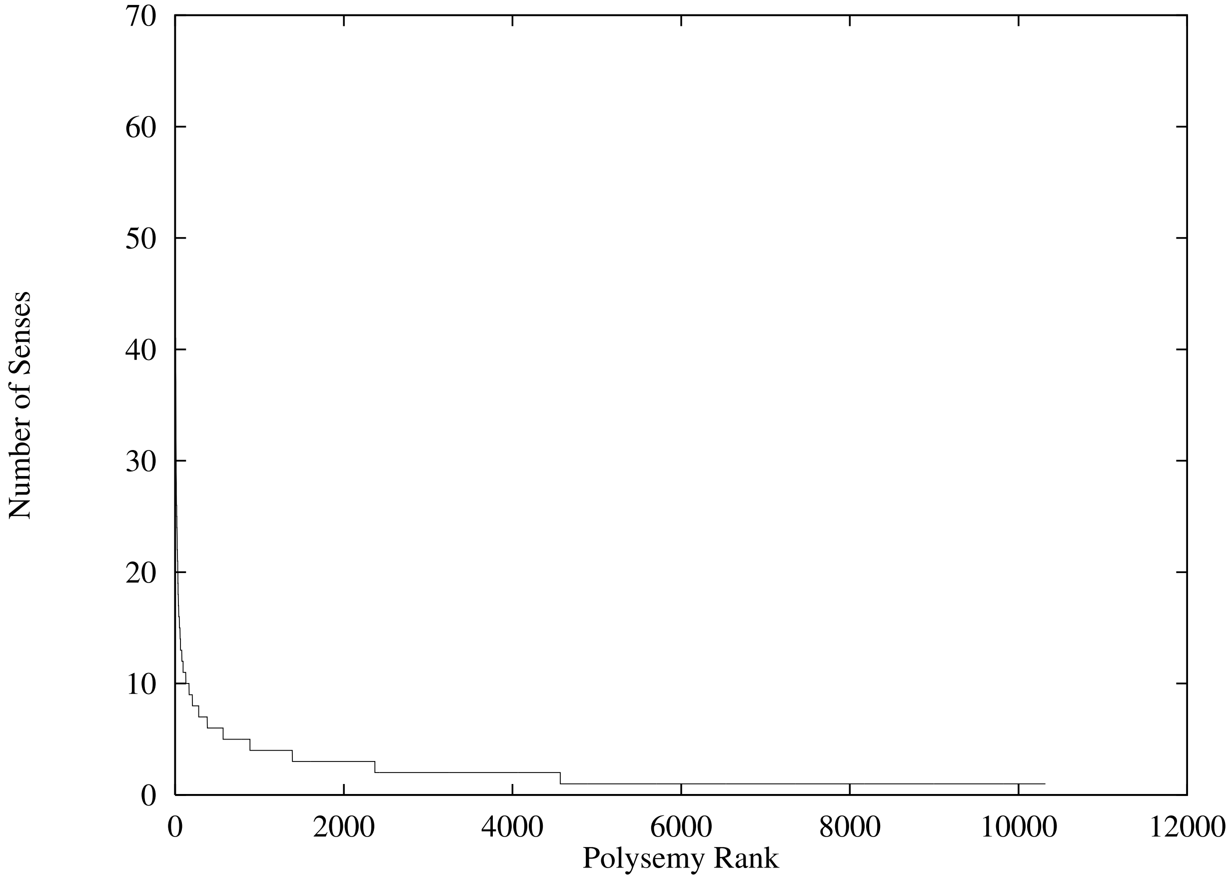
Category	Unique Forms	Number of Senses
Noun	94474	116317
Verb	10319	22066
Adjective	20170	29881
Adverb	4546	5677

Format of WordNet Entries

WordNet sense entries consist of a set of synonyms, a dictionary-style definition (or gloss), and some examples of uses.

The noun "bass" has 8 senses in WordNet.
1. bass - (the lowest part of the musical range)
2. bass, bass part - (the lowest part in polyphonic music)
3. bass, basso - (an adult male singer with the lowest voice)
4. sea bass, bass - (flesh of lean-fleshed saltwater fish of the family Serranidae)
5. freshwater bass, bass - (any of various North American lean-fleshed freshwater fishes especially of the genus Micropterus)
6. bass, bass voice, basso - (the lowest adult male singing voice)
7. bass - (the member with the lowest range of a family of musical instruments)
8. bass - (nontechnical name for any of numerous edible marine and freshwater spiny-finned fishes)

Sense Distribution for WordNet Verbs



Lexical (N) Relations in WordNet

Relation	Definition	Example
Hypernym	From concepts to superordinates	*breakfast* → *meal*
Hyponym	From concepts to subtypes	*meal* → *lunch*
Has-Member	From groups to their members	*faculty* → *professor*
Member-Of	From members to their groups	*copilot* → *crew*
Has-Part	From wholes to parts	*table* → *leg*
Part-Of	From parts to wholes	*course* → *meal*
Antonym	Opposites	*leader* → *follower*

Verb Relations in WordNet

Relation	Definition	Example
Hypernym	From events to superordinate events	*fly* $\rightarrow$ *travel*
Troponym	From events to their subtypes	*walk* $\rightarrow$ *stroll*
Entails	From events to the events they entail	*snore* $\rightarrow$ *sleep*
Antonym	Opposites	*increase* $\Longleftrightarrow$ *decrease*

Adj. and Adv. Relations in WordNet

Relation	Definition	Example
Antonym	Opposite	*heavy* $\Longleftrightarrow$ *light*
Adverb	Opposite	*quickly* $\Longleftrightarrow$ *slowly*

Synsets in WordNet

WordNet is organized around the notion of synset.

{ chump, fish, fool, gull, mark, patsy, fall guy, sucker, schlemiel, shlemiel, soft touch, mug }

Important: It is this exact synset that makes up one of the sense for each of the entries listed in the synset.

Theoretically, each synset can be viewed as a concept in a taxonomy – like the concepts described in Chapter 14.

Hyponomy in WordNet

```
Sense 3
bass, basso --
(an adult male singer with the lowest voice)
=> singer, vocalist
   => musician, instrumentalist, player
      => performer, performing artist
         => entertainer
            => person, individual, someone...
               => life form, organism, being...
                  => entity, something
               => causal agent, cause, causal agency
                  => entity, something

Sense 7
bass --
(the member with the lowest range of a family of
musical instruments)
=> musical instrument
   => instrument
      => device
         => instrumentality, instrumentation
            => artifact, artefact
               => object, physical object
                  => entity, something
```

Internal Structure of Words

What are the meaning components underlying word sense?

Thematic Roles (theta-roles)

What is a thematic role?

$\exists w, x, y, z Giving(x) \wedge Giver(w, x) \wedge Givee(z, x) \wedge Given(y, x)$

$\exists w, x, z Breaking(x) \wedge Breaker(w, x) \wedge Broken(z, x)$

Generic Thematic Roles

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

Examples of Thematic Roles

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

Early Theories of Thematic Roles

1967-1968: "The beginning of Lexical Semantics" (Fillmore; Gruber; Jackendoff (based on Gruber))

Two fundamentally different approaches to linguistics

- Gruber/Jackendoff: account for semantics and use grammar derived to say something about syntax
- Fillmore: account for syntax and use that to describe semantics

Thematic Level

Why posit a thematic level distinct from that of syntactic subcategorization?

1. capture similarity between different (but related) uses of same lexical item)
2. obviate need for subcategorization frames: mapping from syntax to lexical semantics

Selectional Restrictions

What are selectional restrictions?

Recall the "Godzilla" example.

Selectional Restriction Implementation

A WordNet approach: hamburgers are edible

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

Primitive Decomposition

Jim killed his philodendron

Jim did something to cause his philodendron to become not alive

Schank's Primitives

Conceptual Dependency

Primitive	Definition
ATRANS	The abstract transfer of possession or control from one entity to another.
PTRANS	The physical transfer of an object from one location to another
MTRANS	The transfer of mental concepts between entities or within an entity.
MBUILD	The creation of new information within an entity.
PROPEL	The application of physical force to move an object.
MOVE	The integral movement of a body part by an animal.
INGEST	The taking in of a substance by an animal.
EXPEL	The expulsion of something from an animal.
SPEAK	The action of producing a sound.
ATTEND	The action of focusing a sense organ.

Pred. Independence vs. Dependence

Predicate-Independent

- single set of roles is chosen independent of the type of predicates involved (no reference to type of predicates)
- Schank

Predicate-Dependent

- roles identified by particular positions arguments occupy with respect to primitive predicates

Decomposition vs. Non-Decomposition

Decomposition / Compositional Approach (Schank, Jackendoff) vs. Non-decomposition / Noncomposition Approach (Fillmore)

Within compositional approaches: exhaustive (Schank) vs. nonexhaustive (Jackendoff)

Schank: Motivation

Underlying Motivation: "Strong AI"

Focus: understanding. Argues that the representation is reversible.

Rejects syntax during analysis. Allows it during generation.

Attempts to come up with well-defined system of rules and conceptualizations.

Inferences, expectation, syntax, conversational norms, real world.

Conceptual Structure (CD): Language-independent conceptual level.

Schank: Kill vs. Die

Schank: Problem 1

"John caused Mary to die" vs. "John killed Mary"

Identically substitutable?

Flaw of all compositional approaches of this nature.

Schank: Problem 2

The decompositions are very complex.

- Too specific
- Why are these conceptualizations so radically distinct from the syntactic realization?
- Talks CD from NL understanding point of view -what about generation?

The NLP Bottleneck

Acquisition of Computational Lexicons

For Next Time

Chapter 18

Acknowledgements

Some of this material was taken from the course web pages of Philip Resnik and Drago Radev.