Natural Language Processing

Lecture 16

Today's Outline

Announcements

Homework 3

Finish Lexical Semantics

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

Word Sense Disambiguation

ISP Seminars

1) Me on Friday: 1:15 - 2:45, 9th Floor LRDC, w/ lunch

Prosodic Analysis of Misrecognitions and Corrections in Spoken Dialogue Systems

2) Nov 30 (note date change!): Antal van den Bosch (WhizBang! Labs-Research and Tilburg University, The Netherlands)

Current issues in machine learning of natural language: memory and representation

In machine learning, natural language processing tasks have attracted a markedly large amount of interest as applications, with mutual benefits. For machine learning, language data has been used for symbolic feature representation and classification research. For computational linguistics, machine learning has offered a way out of its knowledge acquisition bottleneck. This talk centers around two current issues relevant to both communities: memory and representation. As for memory, empirical evidence exists showing that retaining full memory of experienced language data in machine-learned language processing systems outperforms abstraction-based (minimal-description-length driven) learning, As for representation, there is a growing feeling that discovering good feature representations yields much shorter pathways to developing good machine-learned NLP systems than comparing machine learning algorithms. The talk will summarize empirical findings and open up discussion about their meaning to both scientific communities.

HW3

Due: December 3, 2001

- (5 pts) Simplify the following formulas using lambda reduction:
  - ((lambda x (P x)) A)
  - ((lambda x ((lambda y (P y)) x)) A)
- (15 pts) Exercise 15.4, Jurafsky and Martin (p. 586). Be sure to show a derivation to validate your answer.
- (20 pts) Exercise 16.6, Jurafsky and Martin (p. 629), but just for the verb "drink".
- (20 pts) Exercise 16.7, Jurafsky and Martin (p. 629). For your examples, use the American portion of the CoBuildDirect Corpus at http://titania.cobuild.collins.co.uk/form.html. Try queries such as drink@/VERB.
- (20 pts) Exercise 17.2, Jurafsky and Martin (p. 664). Use as your corpus sentences 16.1, 16.2, 16.3, 16.4, 16.7, and 17.11 from Chapters 16 and 17.
- (20 pts) Exercise 17.3, Jurafsky and Martin (p. 664).

Word Sense Disambiguation

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

The Problem

Associating tokens with meanings

Potentially extremely useful problem, but ...

Very difficult to formulate and evaluate

Semantic parsers need this information

Selectional Restriction WSD

"In our house, everybody has a career and none of them includes washing *dishes*," he says.

In her tiny kitchen at home, Ms. Chen works efficiently, stir-frying several simple *dishes*, including braised pig's ears and chicken livers with green peppers.

- *wash, stir-fry* have different selectional restrictions on their arguments

WordNet Entry for “dish”

The noun “dish” has 6 senses in WordNet.

1. dish – a piece of dishware normally used for holding or serving food; “we gave them a set of dishes for a wedding present”
2. dish – a particular item of prepared food; “she prepared a special dish for dinner”
3. dish, dishful – the quantity that a dish will hold; “they served me a dish of rice”
4. smasher, stunner, knockout, beauty, sweetheart peach, lulu, looker, mantrap, dish – a very attractive or seductive looking woman
5. dish, dish aerial, dish antenna, saucer - a parabolic reflector for microwave or radio frequency radiation that is used as a directional antenna
6. cup of tea, bag, dish - an activity that you like or at which you are superior; “chemistry is not my cup of tea”; “his bag now is learning to play golf”; “marriage was scarcely his dish”

WordNet Entry for "serve"

The verb "serve" has 13 senses in WordNet.

1. serve, function – serve a purpose, role, or function; "The tree stump serves as a table"; "The female students served as a control group"; "This table would serve very well"; "His freedom served him well"; "The table functions as a desk"
2. serve – do duty or hold offices; serve in a specific function; "He served as head of the department for three years"; "She served in Congress for two terms"; "They served as medics in Vietnam"
3. serve - contribute or conduce to; "The scandal served to increase his popularity."
4. service, serve - be used by; as of a utility; "The sewage plant served the neighboring communities"; "The garage served to shelter his horses"
5. serve, help - help to some food; help with food or drink; "I served him three times, after that he helped himself"
6. serve, serve up, dish out, dish up, dish – provide food; "We serve meals for the homeless"; "She dished out the soup at 8 P.M."

Example

Well, there was the time they *served* green-lipped mussels from New Zealand.

Which Airlines *serve* Denver?

Which ones *serve* breakfast?

- In this example, the object determines the meaning of sense.
- In some other cases, both the predicate and the argument can have multiple senses:
  - I am looking for a restaurant that *serves* vegetarian *dishes*.
- Problem:
  - What kind of *dishes* do you recommend?

Modified Earley Algorithm

Need to modify the ENQUEUE function to enforce selectional restrictions.

This is accomplished by comparing the selection restrictions associated with the arguments to typed information associated with the actual argument.

Needed: hierarchical type information about the arguments and selection restrictions on the argument roles of predicates.

First: hypernym information from WordNet.

Second; associated synsets with the arguments to each predicate-bearing lexical item.

Some (More) Problems

But it fell apart in 1931, perhaps because people realized that you can't *eat* gold for lunch if you're hungry.

In his two championship trials, Mr. Kulkarni *ate* glass on an empty stomach, accompanied only by water and tea.

If you want to *kill* the Soviet Union, get it to try to *eat* Afghanistan.

Robust WS Disambiguation

Machine learning (for classification).

Typically represent context and use decision trees or rules (e.g., C5, RIPPER), neural networks, MBR (Timbl), Naive Bayes, ...

Naive Bayes

- $ArgmaxP(s \mid V)$: choosing the most probable sense s given vector V.
- rewriting this using $Bayes\ Rule$ yields $argmax\frac{P(V|s)P(s)}{P(V)}$

Inputs: Feature Vectors

An electric guitar and $bass$ player stand off to one side ...

Collocation

- $\{guitar, NN1, and, CJC, player, NN1, stand, VVB\}$

Co-occurance

- The 12 most frequent content words in the $bass$ sentences in the corpus are *fishing, big, sound, player, fly, rod, pound, double, runs, playing, guitar, band*
- Assuming a window size of 10, $\{0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0\}$

In general, the feature vectors that have been used consider a context, and information such as POS, morphology, parsing.

Supervised Algorithms

Inputs

- class and feature (symbolic, continuous, sets) definitions
- labeled training data

Output: a classification model, such as a decision list:

Rule		Sense
fish within window	$\Rightarrow$	**bass**^{1}
striped bass	$\Rightarrow$	**bass**^{1}
guitar within window	$\Rightarrow$	**bass**^{2}
bass player	$\Rightarrow$	**bass**^{2}
piano within window	$\Rightarrow$	**bass**^{2}
tenor within window	$\Rightarrow$	**bass**^{2}
sea bass	$\Rightarrow$	**bass**^{1}
play/V *bass*	$\Rightarrow$	**bass**^{2}
river within window	$\Rightarrow$	**bass**^{1}
violin within window	$\Rightarrow$	**bass**^{2}
salmon within window	$\Rightarrow$	**bass**^{1}
on bass	$\Rightarrow$	**bass**^{2}
bass are	$\Rightarrow$	**bass**^{1}

Evaluation

- error rate on unseen labeled test set (or, cross-validated estimate)
- baseline: most frequent sense
- partial credit?

Other Approaches

Bootstrapping

Unsupervised Algorithms

- *discover* word senses
- clustering, self-organizing maps, ...

Dictionary-Based Approaches

One Sense Per Collocation

Extracted *bass* sentences from the WSJ using *play* and *fish*

Klucevsek **play**s Giulietti or Titano piano accordions with the more flexible, more difficult free **bass** rather than the traditional Stradella **bass** with its preset chords designed mainly for accompaniment. We need more good teachers – right now, there are only a half a dozen who can **play** the free **bass** with ease. An electric guitar and **bass play**er stand off to one side, not really part of the scene, just as a sort of nod to gringo expectations perhaps. When the New Jersey Jazz Society, in a fund-raiser for the American Jazz Hall of Fame, honors this historic night next Saturday, Harry Goodman, Mr. Goodman's brother and **bass play**er at the original concert, will be in the audience with other family members.
The researchers said the worms spend part of their life cycle in such **fish** as Pacific salmon and striped **bass** and Pacific rockfish or snapper. Associates describe Mr. Whitacre as a quiet, disciplined and assertive manager whose favorite form of escape is **bass fish**ing. And it all started when **fish**ermen decided the striped **bass** in Lake Mead were too skinny. Though still a far cry from the lake's record 52-pound **bass** of a decade ago, "you could fillet these **fish** again, and that made people very, very happy," Mr. Paulson says. Saturday morning I arise at 8:30 and click on "America's best-known **fish**erman," giving advice on catching **bass** in cold weather from the seat of a bass boat in Louisiana.

Using Machine-Readable Dictionaries

What sense of *cone* is in *pine cone*?

- pine
  1. kinds of evergreen tree with needle-shaped leaves
  2. waste away through sorrow or illness
- cone
  1. solid body which narrows to a point
  2. something of this shape whether solid or hollow
  3. fruit of certain evergreen trees

Answer: sense 3 (due to *evergreen*, *tree*)

For Next Time

Chapter 18

Acknowledgements

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