Semantic and Multimodal Annotation

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Program: Monday

- Big picture
- Coffee break
- Lexical ambiguity and word sense annotation
- Lunch break
- Introduction to the annotation tool Stamp
- Coffee break
- Hands-on annotation
Semantic annotation

The big picture
Outline

1. Semantics: Definition and significance for NLP
2. Annotation: Its role in NLP
3. Design and implementation of annotation projects
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1. Semantics: Definition and significance for NLP
2. Annotation: Its role in NLP
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What do we want computers to be able to do with human languages?

- Machine translation
- Text summarization (medical, business, military)
- Question-answering systems
- Tutoring systems
What we have now

- Search key terms
- Domain-specific interaction with computers (airline reservations, prescription ordering)
- Some question answering
  - Wolfram Alpha
  - IBM’s Watson
- Rudimentary translation
Next step

- Need to move beyond surface level of text
  - Words in isolation
  - Part of speech
  - Syntax
- To deeper meaning of sentences, paragraphs, entire texts
- Need semantics
Example: Identifying relevant information

• Query
  • List crimes of John Lee

• Possible Answers
  • Lee smuggled heroin across the border
  • Lee participated in a bank robbery
  • The arson was committed by Lee
  • Lee blew up a bus
  • Lee stole second base
  • Lee stole a kiss from Mary
  • A drug dealer shot Lee
  • Lee blew up
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Senses for *steal*

- **Sense 1:** take possession without consent or right
  Someone stole my wallet on the train.

- **Sense 2:** do or achieve something surreptitiously or stealthily
  I leaned close and stole a kiss.
  She stole a glance at her watch.

- **Sense 3:** draw attention or have successful performance
  He stole the show with his offbeat puns and no-fear analogies.

- **Sense 4:** BASEBALL-gain base without hit
  He might be the last person in baseball you'd expect to steal a base.
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Who actually did these things?
Example: Identifying relevant information

- **Query**
  - List crimes of John Lee

- **Possible Answers**
  - Lee smuggled heroin across the border
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criminal?
Semantic roles

• Syntax only gets you so far in answering “Who did what to whom?”

Lee blew up the bus.

Syntax:

NP\textsubscript{SUB} \quad V \quad NP\textsubscript{OBJ}

The bus blew up.

Syntax:

NP\textsubscript{SUB} \quad V
Semantic roles

• Syntax only gets you so far in answering “Who did what to whom?”

Lee blew up the bus.

Syntax:
NP\text{SUB} \quad V \quad NP\text{OBJ}

Semantics:
Exploder \quad REL \quad thing exploded

The bus blew up.

Syntax:
NP\text{SUB} \quad V

Semantics:
thing exploded \quad REL
Example: Identifying relevant information

• Query
  • List crimes of John Lee

• Possible Answers
  ✔ Lee smuggled heroin across the border
  ✔ Lee participated in a bank robbery
  ✔ The arson was committed by Lee
  ❌ Lee stole second base
  ❌ Lee stole a kiss from Mary
  ❌ A drug dealer shot Lee
  ❌ Lee blew up.
Different aspects of semantics

- Word sense
- Thematic (semantic) roles
- Event structure
- Discourse structure
- Sentiment analysis
Event and temporal structure

- “Carlos Rivera, president of the drama club, said last week that all the after-school clubs would host a fundraiser because the school lost its funding for the arts.”
- Temporal aspects of entities
- Anchoring events in time
- Ordering events with respect to one another
- Aspectual and modal predication
- Time ML (Pustejovsky et al., 2003)
Discourse structure

• Rhetorical relations between clauses and sentences
  ▫ Lexically signalled (e.g., but, because, as a result)
  ▫ Inferred from proximity (I needed a lot of money for books. My dad offered to lend me $100.)

• RST Corpus (Carlson, Marcu & Okurowski, 2001)

• The Discourse GraphBank (Wolf & Gibson, 2005)

• Penn Discourse TreeBank (Prasad et al., 2008)
Sentiment analysis

• Attitude of speaker/write toward a topic
• Sentiment polarity of document, sentence, feature
• JDPA Sentiment Corpus (Kessler et al., 2010)
  ▫ Negators
  ▫ Neutralizers
  ▫ Committers
  ▫ Intensifiers
  ▫ Entities are annotated for expressed attitude
Semantics in text

- Deeper meaning than
  - A bag of words
  - syntax
- Means of discovering is growing
  - Word sense
  - Semantic roles
  - Event analysis
  - Discourse analysis
  - Sentiment analysis . . .
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3. Design and implementation of annotation projects
Why annotation?

• Real-world data for linguistics research (corpus linguistics)
• Training data for supervised machine learning
Supervised machine learning for NLP

Choose corpus and categories

Annotate text

Extract features

Run machine learning algorithm

Automatically annotate new text

Categories for the computer to distinguish
- Draw 1: to pull toward
- Draw 2: attract
- Draw 3: create a picture

Integrate into a more complex task
Supervised machine learning for NLP

1. Choose corpus and categories
2. Annotate text
3. Extract features
4. Run machine learning algorithm
5. Automatically annotate new text
6. Label each instance of *draw* in the corpus as *draw1*, *draw2* or *draw3*
7. Integrate into a more complex task
Supervised machine learning for NLP

1. Choose corpus and categories
2. Annotate text
3. Extract features
4. Run machine learning algorithm
5. Automatically annotate new text
6. Integrate into a more complex task

Tell computer to look at certain features of the text, e.g., words surrounding target word.
Supervised machine learning for NLP

- Choose corpus and categories
- Annotate text
- Extract features
- Run machine learning algorithm
- Automatically annotate new text

Computer correlates features with different senses of *draw*

Integrate into a more complex task
Supervised machine learning for NLP

1. Choose corpus and categories
2. Annotate text
3. Extract features
4. Run machine learning algorithm
5. Automatically annotate new text

When given new text, the system looks at those features to label instances of *draw* with *draw1*, *draw2*, or *draw3*

Integrate into a more complex task
Supervised machine learning for NLP

Choose corpus and categories

Annotate text

Extract features

Run machine learning algorithm

Automatically annotate new text

Integrate into a more complex task

Use the sense disambiguation system to improve information retrieval, tutoring systems, etc.
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1. Semantics: Definition and significance for NLP
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3. Design and implementation of annotation projects
   - Corpus choice
   - Categories/classes choice
   - Task design
   - Annotation reliability
   - Annotation efficiency
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The more data the better

- To see patterns, ML algorithm needs many instances of those patterns
- Need examples of all the categories in order to learn how to distinguish them
  - Skewed data
  - Rare categories
- Active learning can reduce the amount needed
The more varied the data, the better

- Must have examples in order to generalize
  - Of categories
  - Of contexts
- Different genres
  - Fiction, non-fiction
  - Conversation, blogs, broadcast news
- Different domains
  - Financial
  - Current events
  - Medical
Desired features can influence corpus choice

- Is the corpus tagged with parts of speech?
- How it can help
  - The **sail** tore./We will **sail** at dawn.
  - She **left** at 8:00.
  - She **left** her diamonds to her daughter.
Syntactic structure

- **Transitive vs. intransitive**
  - She left at 8:00.
  - She left her diamonds to her daughter.

- **Is there a PP in the sentence?**
  - The paint ran.
  - The boy ran to the store.

- **If so, which preposition?**
  - The paint ran down her face.
  - The boy ran around the park.
Corpus choice

• Part of speech tagged?
• Syntactically parsed?
• Varied (balanced)?
  ▫ Different domains of non-fiction
  ▫ Fiction
  ▫ Transcribed speech
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Category generality

• How broad or narrow will the labels be?
• Word sense
  ▫ WordNet: 36 senses for the verb *draw*
  ▫ OntoNotes: 11 senses for the verb *draw*
  ▫ PropBank: 3 senses for the verb *draw*
• Semantic roles
  ▫ Scott ate with a fork.
    agent        instrument
    eater        utensil
Other considerations

• Theoretical
  ▫ Demonstrate a particular theory
  ▫ Follow an established model

• Practical
  ▫ Can annotators distinguish between the labels?
  ▫ How much time does it take to annotate with the labels?
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Organization of annotation tasks

- Goals
  - Speed
  - Consistency
- Limit choices
- Limit switching between sets of choices
Divide into tasks based on specific words

- All and only instances of *draw* in the same task
- Annotator becomes familiar with the choices
- And familiar with the contexts
- Excellent for word sense and semantic role labeling
- Not feasible for certain types of annotation
  - Event course annotation
  - Discourse annotation
  - Ontology annotation with many rare terms
Divide into categories (two-stage annotation)

• Annotate for broad categories first
• Collect all instances of one broad category into a task
• Then annotate with finer grained categories
• Ontology annotation, such as medical ontologies
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Ensuring reliable annotation

- Machine learning requires clear patterns to work
- Consistent training, with written guidelines
- Multiple annotators tagging the same material
  - Less idiosyncratic
  - Can calculate the level of agreement between annotators
  - Indicates how reliable the annotators and/or the annotation scheme is
- Adjudication
Types of multiple annotation

- Concensus annotation
  - Reliable but slow
- Independent multiple annotation
  - Double annotation is common
  - Crowd annotation is growing
- If independent, need an adjudication method
  - Specially trained adjudicator
  - Algorithm using most common choice, annotator statistics, etc.
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Improving annotation efficiency

- Making annotation faster and cheaper
- Crowdsourcing
- Active learning
- Other semi-supervised annotation methods
Crowdsourcing: Games with a Purpose

- Web-based games
- Free labor
- High up-front costs
- Only feasible for very large projects and simple tasks
- NLP and semantic annotation examples
  - Phrase Detectives (coreference annotation; http://anawiki.essex.ac.uk/phrasedetectives/index.php)
  - ESP Game (image recognition; http://www.gwap.com/gwap/gamesPreview/espgame/)
Crowdsourcing: Wisdom of the Crowd

- Use volunteers
  - Altruism and/or interest in using the resulting resource
- Difficult to find and maintain a corps of volunteers; best success with:
  - Open-source resources
  - Domain-specific resources
- Feasible for non-time-sensitive projects
- Language-related examples
  - Oxford English Dictionary
  - Open Mind Initiative (word relations, word sense)
Crowdsourcing: Mechanical Turk

- Clearinghouse for web-based labor

**Pros**
  - Very low cost
  - Large pool of laborers
  - Infrastructure for task creation and management
  - Screen annotators

**Cons**
  - Laborers have little expertise
  - Money incentive promotes cheating

**Semantic annotation examples**
  - Word similarity
  - Event ordering
  - Word sense annotation
Improving annotation efficiency: Active learning

- Find most informative examples to manually annotate
- Manually annotate a small “seed” set of instances
- Train a classifier on them
- Have the classifier choose next instances to annotate
- Dramatically reduces the amount of annotation
Active learning: missed cluster effect

• Skewed data can be a problem
  ▫ E.g., word senses
• Hand select seed set (Tomanek et al. 2009)
• Automatic method using language modeling (Dligach and Palmer, 2011)
Improving annotation efficiency: Other types of semi-automatic annotation

- Building off existing resources
- Semlink
  - Used a corpus annotated with PropBank thematic roles
  - Created a mapping from PB roles and rolesets to VerbNet roles and classes
  - Applied to corpus
  - Hand corrected