Lexical ambiguity and Word sense annotation
Outline

1. What is a word sense?
2. Choosing a sense inventory for word sense annotation
   ▫ Sense granularity
   ▫ Multi-word expressions
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Rampant ambiguity

- A single word can be used in many different ways
  - *Drew* the water from the well
  - *Drew* the curtains
  - *Drew* the cart
  - *Drew* a crowd
  - *Drew* a picture

- 20 most frequent nouns: an average of 8 senses.
- 20 most frequent verbs: an average of 20 senses.
Automatic word sense disambiguation

- People vs. computers
  - He drew a gun
  - He drew a picture
Automatic word sense disambiguation

- People vs. computers
  - He drew a gun with his new colored pencils.
  - He drew a picture from the pile on his desk.
- Supervised machine learning requires annotation, which requires a list of senses for each word.
- Which senses do you want to distinguish between?
  - Drawing a picture sense vs. pulling an object sense
  - Make a mark or lines on a surface (draw a line) vs. represent by making a drawing of (draw an elephant)?
Classical approach

• A word is a symbol for a set of things in the world, or a possible world
• Membership in the set is determined by a list of necessary and sufficient conditions
• The word *tree* refers to things with all the necessary properties (roots, trunk, photosynthesis)
• Anything without one or more properties does not belong to the set
Relations between words

- Logical combinations of sets
- Hierarchical with subsets inheriting from supersetse (Dalmatians have all the properties of dogs, plus a few more specific ones)
- Phrases are the intersection of sets
  - Red books: intersection of set of red things and set of books
- Problems
  - Former friend
  - Relative concepts, e.g. big and small
Polysemy

• Some words require more than one representation, with different sets of conditions
• Bank
  ▫ A mound of earth holding in a body of water
  ▫ A financial institution
    • The bank issued me new checks
    • I walked to the bank
• Some qualities overlap, so when does a set of usages represent a different sense?
Ambiguity vs. vagueness

• Ambiguity arises when there are different meanings inherent in the word

• Vagueness arises from contextual modification of a single sense (Cruise, 1986)

• Tests
  ▫ That feather is light and it is not light (weight vs. color).
  ▫ John went to the bank and so did Paul (Rhine vs. First National Bank)
Prototype theory

- Word and senses are categories that do not have clear cut boundaries or identical status for all members (Rosch, 1973, 1975; Lakoff, 1987; Brugman, 1988)
  - Robins vs. penguins
- Inconsistent results with ambiguity/vagueness tests (Tuggy, 1993)
  - I am painting and so is Jane
- Shading of senses from one to another (Geeraerts, 1993; Tuggy, 1993)
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What does this mean for ML?

- It requires annotation
- Annotation means labels—a list of senses
- A different list for different contexts? (Kilgarriff, 1997)
  - Different domains can require specialized senses (e.g., medical)
  - Machine translation vs. Reasoning tasks
English to French

- He **drew** her face.
  - Il a **dessiné** son visage.
- The ox **drew** the cart.
  - Le boeuf à labour a **tiré** la charrette.
- They **drew** a very positive reaction.
  - Ils ont **suscité** une réaction très positive.
- He **drew** the obvious conclusion.
  - Il a **tiré** la conclusion apparente.
- She **drew** a check on her account.
  - Elle a **tiré** un chèque sur son compte.
- 3 senses of **draw**: **dessiné, tiré, suscité**
Do other tasks need different sense inventories?

- Tutoring systems
- Question answering
- Text summarization
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What do we know about word sense for NLP?

• Several studies show benefits of WSD for NLP tasks (Sanderson, 2000; Stokoe, 2003; Carpuat and Wu, 2007; Chan, Ng and Chiang, 2007)
• But only with higher accuracy (90%+)
## Sense inventory and system performance

<table>
<thead>
<tr>
<th>Sense Inventory</th>
<th>System Performance</th>
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<tbody>
<tr>
<td>WordNet (SensEval2)</td>
<td>62.5%</td>
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Variation in sense specificity

• Fine distinctions (WordNet); more general (OntoNotes); very general (PropBank)
  ▫ WordNet: 36 senses for the verb *draw*
  ▫ OntoNotes: 11 senses for the verb *draw*
  ▫ PropBank: 3 senses for the verb *draw*

• But discussion shows that sense boundaries are fluid, so it’s probably not that one of these is just “wrong”
Interannotator Agreement (ITA)

- The percentage of instances for which annotators have agreed on a sense label
- If they tagged 8 instances of the verb *draw* with the same sense but disagreed on the sense for 2 other instances, ITA = 80%
- Indicates the reliability of the annotation
System performance closely tied to ITA rates

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<tr>
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<td>90%</td>
<td>94%</td>
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WSD: Key points

- Supervised machine learning needs a discrete list of senses for each word
- To be useful, it must have highly accurate output
- It requires highly reliable human annotation
- Sense granularity seems to be a factor
Number vs. nuance of senses

• Experiments compared fine-grained sense annotation with coarse-grained annotation
  ▫ Same words
  ▫ Same corpus
• Regression analysis showed that number of senses had no effect on annotation reliability
• Granularity had a highly significant effect, with coarse-grained senses resulting in much more reliable annotation (Brown, 2010)
Sense granularity exercise

• Using English WordNet senses, create coarser-grained, more general senses
• Compare to OntoNotes sense groupings
WordNet
A lexical database for English
WordNet senses
break-v; 59 senses

- **synonym set**
- **gloss**
- **examples**

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- **S:** (v) **interrupt, break** (terminate) "She interrupted her pregnancy"; "break a lucky streak"; "break the cycle of poverty"
- **S:** (v) **break, separate, split up, fall apart, come apart** (become separated into pieces or fragments) "The figurine broke"; "The freshly baked loaf fell apart"
- **S:** (v) **break** (render inoperable or ineffective) "You broke the alarm clock when you took it apart!"
- **S:** (v) **break, bust** (ruin completely) "He busted my radio!"
- **S:** (v) **break** (destroy the integrity of; usually by force; cause to separate into pieces or fragments) "He broke the glass plate"; "She broke the match"
- **S:** (v) **transgress, offend, infract, violate, go against, breach, break** (act in disregard of laws, rules, contracts, or promises) "offend all laws of humanity"; "violate the basic laws or human civilization"; "break a law"; "break a promise"
- **S:** (v) **break, break out, break away** (move away or escape suddenly) "The horses broke from the stable"; "Three inmates broke jail"; "Nobody can break out--this prison is high security"
- **S:** (v) **break** (scatter or part) "The clouds broke after the heavy downpour"
• Course-grained groupings based on WordNet
• Syntactic and semantic criteria, with verb-specific information considered
OntoNotes sense groupings

**sense 1:** come apart, separate, split

**Examples:**
- The figurine broke.
- He broke the glass plate.
- The surf was breaking on the rocks.
- Break the bread into small pieces.
- They are afraid the dam will break.
- Could you break a $20 for me?
- The book dealer would not break the set.
- The referee broke the boxers.
- Were they able to break the tie?
- The branch broke when he swung on it.
- The glass broke when it was heated.
- She didn't break her foot playing volleyball.
- The artillery fire was breaking the ranks of soldiers into disorganized bands.

**Mappings:**
- VerbNet: break-45.1,hurt-40.8.3-1-1,split-23.2
- FrameNet: Cause_harm,Experience_bodily_harm,Cause_to_fragment
- PropBank: break.01
- WordNet 2.1 Sense Numbers: 2, 3, 8, 18, 19, 20, 36, 38, 39, 41, 43, 54, 57

**WordNet senses**
Example comparison

  - Distinguishes between:
    - The figurine *broke*.
    - He *broke* the glass plate.
    - 59 senses
  - **OntoNotes-CU verb groupings** ([http://verbs.colorado.edu/html_groupings/](http://verbs.colorado.edu/html_groupings/))
    - But does not distinguish:
      - The figurine *broke*. (2)
      - He *broke* the glass plate. (5)
    - 16 senses
OntoNotes Sense Grouping Criteria

- Aspectual features of the verb
- Semantic roles & features of arguments
- Syntactic frames
- Collocations
- Speaker intuition
break-v; 16 Senses

Sense 1: come apart, separate, split
Examples:
The figurine broke.
He broke the glass.
Break the bread into small pieces.
The branch broke when he swung on it.

Sense 4: transgress, infract
Examples:
Did he break the law?
The dictator has broken every accord.
The will was broken.

WordNet senses:
2, 3, 8, 18, 19, 20, 36, 38, 39, 41, 43, 54, 57

WordNet senses:
6, 13, 30
Sense granularity exercise

• Gather in groups of 3-4
• Cite
• Discover
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Multi-word expressions

• “Idiosyncratic interpretations that cross word boundaries (spaces)” (Sag et al., 2002)
  ▫ Kick the bucket
  ▫ Every which way
  ▫ Part of speech
  ▫ Throw up

• Any automatic NLP system will encounter these, so annotation must be consistent and appropriate
The dilemma

- Treat as if they are a single lexical item
  - Only works with truly fixed expressions (ad hoc)
  - Even many idioms inflect (kicked the bucket) or can have inserted material (make political hay while the sun shines)
  - Misses many generalizations between lexical items (performance artist is a kind of artist)
- Treat as if they are decomposable and/or productive
  - Degree and type of productivity is hard to control
  - Telephone booth, telephone box, *telephone closet
  - Take a walk, take a stroll, *take a sprint
Types of MWEs

• Lexicalized phrases
  ▫ Fixed expressions
  ▫ Semi-fixed expressions
  ▫ Syntactically flexible expressions

• Institutionalized phrases
  ▫ Compositional, both syntactically and semantically; *traffic light, fresh air*
  ▫ Components occur together with very high frequency
Idioms

• Semantically decomposable
  ▫ Spill the beans
    reveal secret
  ▫ Sweep something under the rug
    hide thing to be hidden

• Non-decomposable
  ▫ Kick the bucket
  ▫ Trip the light fantastic
Fixed expressions

- *In short, every which way, by and large*
- Do not follow grammatical conventions
  - *by and larger*
  - *in very short*
- Have no compositional interpretation
  - includes foreign phrases that may be compositional in the original language
  - *ad hoc, Des Plaines, Los Angeles*
- Treat as a single lexical item
Semi-fixed expressions

- Strict word order and composition; some lexical variation
- Non-decomposable idioms with internal inflection
  - Verb: kicked the bucket
  - Reflexive: wet him/herself
- Compound nominals
  - Car parks
  - Parts of speech
- No syntactic variability other than inflection
  - *The bucket was kicked by John.
  - *A speech’s part
Strategy for the lexicon/annotation

- Treat as a single lexical item, giving it the part of speech of the head word
- Have a list of lexemes instead of a list of words, so the expression inherits properties from the inflecting word (part of speech would inherit “count noun” status from part)
Syntactically flexible expressions

- Verb particle constructions
- Decomposable idioms
- Light verbs
Verb particle constructions

• Semantically idiosyncratic: Brush up on
• Compositional: Eat up
  ▫ Semi-productive: eat up, gobble up, ?nibble up
• Transitive vpcs can usually alternate the placement of the object
  ▫ Called off the meeting/called the meeting off
  ▫ Called on the director/*called the director on
Strategies for lexicon/annotation

- Compositional approach
  - Too idiosyncratic; would create overgeneralizations
- Single lexical item with verbal head
  - Feasible
  - Misses generalizations with the verb lexeme (*eat up* is related to *eat*)
  - Misses generalizations with the particle (*up* is often used as a completetive, e.g. *drink up, clean up*)
- Connected lexeme approach
  - Feasible
  - Misses generalizations with the particle
Semantically decomposable idioms

- Syntactically and lexically flexible
  - The cat was let out of the bag yesterday.
  - She has skeletons in the closet.
  - She has skeletons hiding/rattling/locked in the closet.

- Unpredictably flexible
  - She let/*helped/*released the cat out of the bag.
  - *The daylights were scared out of me.
Strategies for lexicon/annotation

- Compositional approach
  - Too idiosyncratic
- Single lexical item with inflecting head
  - Not syntactically flexible enough
- Connected lexeme approach
  - Which lexeme?
  - Difficult to ID given their syntactic flexibility
- Bag of words + predicate-argument relations
  - Cat + bag + let + out
  - Would you let the cat out and bring my bag?
  - Very hard to implement
Light verbs

• Verb + noun constructions
• The verbs are “bleached”; contribute little to the semantics of the predication
• The nouns contribute much more to the predication
  ▫ She took a walk/ She walked.
  ▫ He gave a demonstration/ He demonstrated.
• Full syntactic variability
  ▫ How many walks did she take last week?
  ▫ The walk was taken with no consideration for safety.
Strategies: compositional approach

- OntoNotes: a “light verb” sense in the lexicon that combines freely with nouns
- WordNet: multiple senses
  - experience or feel or submit to: *Take a test; Take the plunge*
  - make a film or photograph of something: *take a scene; shoot a movie*
  - make use of or accept for some purpose: *take a risk; take an opportunity*
- Hard to identify in text
- Potentially overgeneralizes: have a talk/a cry/a rest/*a speech
- Unsatisfactory for identifying semantic roles or synonyms
Call vpc exercise
Multilingual exercise

• Groups of speakers with the same or similar native languages.
• Discuss the types of multiword expressions that appear in your language.
• Nominate one person to present briefly (5 minutes) to the class one or more types