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 supersets (*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

Sense Inventory	System Performance
WordNet (SensEval2)	62.5%
OntoNotes (Chen et al. 2007)	82%
PropBank (Palmer 2008)	90%

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

Sense Inventory	System Performance	ITA
WordNet (SensEval2)	62.5%	71%
OntoNotes (Chen et al. 2007)	82%	87%
PropBank (Palmer 2008)	90%	94%

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
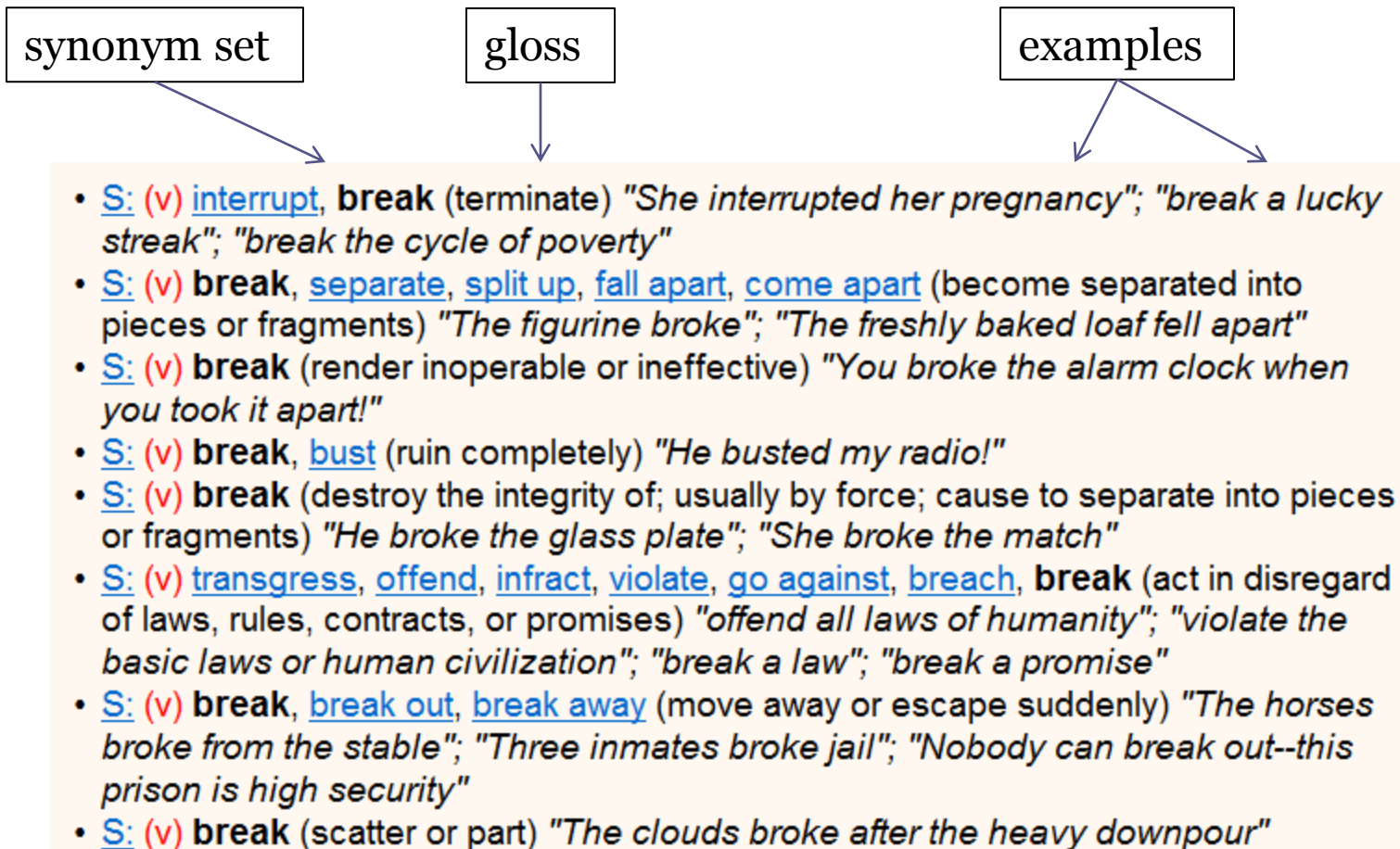- Compare to OntoNotes sense groupings

WordNet senses
break-v; 59 senses

synonym set   gloss   examples

- **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

break-v; 16 Senses

Sense Number 1: come apart, separate, split

Sense

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.

Examples

Mappings to:
•VerbNet
•FrameNet
•PropBank
•WordNet

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

- WordNet (http://wordnet.princeton.edu/)
  - Distinguishes between:
    - The figurine **broke**. → WN 2
    - He **broke** the glass plate. → WN 5
    - 59 senses
- OntoNotes-CU verb groupings (http://verbs.colorado.edu/html_groupings/)
  - But does not distinguish:
    - The figurine **broke**. (2) → ON 1
    - He **broke** the glass plate. (5) → ON 1
  - 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.

WordNet senses:

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

Sense 4: transgress, infract

Examples:
Did he break the law?
The dictator has broken every accord.
The will was broken.

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