Semantic Role Labeling

Outline

- Semantic role theory
- Designing semantic role annotation project
  - Granularity
  - Pros and cons of different role schemas
  - Multi-word expressions

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Semantic role theory

- Predicates tie the components of a sentence together
- Call these components arguments
- [John] opened [the door].

Discovering meaning

- Syntax only gets you so far in answering "Who did what to whom?"

John opened the door.

Syntax: NP_{SUB} V NP_{OBJ}

The door opened.

Syntax: NP_{SUB} V

Discovering meaning

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John opened the door.

Syntax:	NP_{SUB} V NP_{OBJ}
Semantic roles:	Opener **REL** thing opened

The door opened.

Syntax:	NP_{SUB} V
Semantic roles:	thing opened **REL**

Can the lexicon account for this?

- Is there a different sense of *open* for each combination of roles and syntax?
- **Open 1**: to cause something to become open
- **Open 2**: become open
- Are these all the senses we would need?

(1) John opened the door with a crowbar. **Open1**?

(2) They tried the tools in John's workshop one after the other, and finally the crowbar opened the door.
Still **Open1**?

Fillmore's deep cases

- Correspondence between syntactic case and semantic role that participant plays
- "Deep cases": Agentive, Objective, Dative, Instrument, Locative, Factitive
- Loosely associated with syntactic cases; transformations result in the final surface case

The door opened.

Syntax:	NP_{SUB} V
Semantic roles:	Objective **REL**

John opened the door.

Syntax:	NP_{SUB} V NP_{OBJ}
Semantic roles:	Agentive **REL** Objective

The crowbar opened the door.

Syntax:	NP_{SUB} V NP_{OBJ}
Semantic roles:	Instrumental **REL** Objective

John opened the door with the crowbar.

Syntax:	NP_{SUB} V NP_{OBJ} PP
Semantic roles:	Agentive **REL** Objective Instrumental

Fillmore: Theta grids

- Number and type of “deep cases” is determined by the meaning of the verb
- Open: [(Agentitive,) Objective, (Instrument)]
- Put: [Agentitive, Objective, Location]
  - Carla put the coffee on the table.
  - *Carla put the coffee.

Promotes generalizations across verbs

Grad students like free food.

Syntax:	NP_{SUB}	V	NP_{OBJ}
Semantic roles:	Liker (Objective)	**REL**	thing liked (Dative)

Free food pleases grad students.

Syntax:	NP_{SUB}	V	NP_{OBJ}
Semantic roles:	Thing liked (Dative)	**REL**	liker (Objective)

Some standard semantic roles

Agent	Initiator of action, capable of volition
Patient	Affected by action, under-goes change of state
Theme	Entity moving, or being “located”
Beneficiary Experiencer	For whose benefit action is performed Perceives action but not in control
Instrument	Intermediary/means used to perform an action
Location	Place of an object or action
Source	Starting point
Goal	Ending point

Exercises from table 1.2 (Palmer et al., 2010)

- [The ball] flew [into the outfield.]
- [Jim] gave [the book] [to the professor.]
- [Laura] talked [to the class] [about the bomb threats.]
- [Laura] scolded [the class.]
- [Bill] cut [his hair] [with a razor.]
- [Gina] crashed [the car] [with a resounding boom.]

Discussion

- Were the role definitions adequate?
- Would you add any roles?
- If so, what would they be?

Other common thematic roles

- Cause — The wind blew the door open.
- Topic — They discussed the merger.
- Stimulus — She smelled the tang in the air.
- Recipient — She sent the president an angry letter.
- Co-agent — Peter met Tom in the conference room.

Real world examples

- [Some of Tuesday night's rioters] bragged [of booze-fueled rampages.]

Real world examples

- Police ranks have been depleted by summer vacations, and social media sites - coupled with dramatic video of the rioting - have bolstered a mob mentality and spread disobedience.

Real world examples

- [Police ranks] **have been depleted** by [summer vacations,] and
- [social media sites - coupled with dramatic video of the rioting -] **have bolstered** [a mob mentality] and
- **spread** [disobedience].

Dowty's proto-agent and proto-patient

- Simplify the proliferating roles.
- Concentrate on mapping roles to syntax.
- The most important being subject and object.
- Subject often agent, cause, instrument, patient

Prototype theory

- Account of category membership
- No “necessary and sufficient” conditions of membership in a category
- Prototypical members, fuzzy boundaries
- Semantic roles are categories
- Prototypical agents: sentient, volitional, causes a change of state in another participant
- Not all agents fit every property

Proto-Agents

- 1. Volitional involvement in event or state
- 2. Sentience (and/or perception)
- 3. Causing an event or change of state in another participant
- 4. Movement (relative to position of another participant) (exists independently of event named)

- Agent, Experiencer, Instrument, Causer, etc.

Proto-Patient

- Undergoes a change of state
- Incremental theme
- Causally affected by another participant
- Stationary relative to movement of another participant, or
- does not exist independently of the event, or at all
  - [She] said [a few words about proto-patients.]

- Patient, Theme, Percepts, etc.

Argument selection principle

- In predicates with subject and object, the argument with the most proto-agent entailments is lexicalized as the subject; the argument with the most proto-agent entailments is lexicalized as the direct object.

Groups semantic roles

- Agent, Experiencer, Cause, Instrument
- Patient, Theme, Recipient
- Many verbs take more than 2 roles
- Oblique, Source, Goal

Two participants with similar properties

- Kevin loaded the cart with mangoes.
- Proto- patient properties for
- Cart
  - Causally affected by another participant
  - Undergoes change of state
- Mangoes
  - Causally affected by another participant
  - Undergoes change of state

Incremental theme

- The one that is the undergoing a change of state
- AND the completion of that change of state signals the end of the event.
- Predicts alternations.
- Kevin loaded [the cart] [with mangoes.]
- Kevin loaded [the mangoes] [onto the cart.]

Assign Dowty's roles

- [The ball] flew [into the outfield.]
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Assign Dowty's roles

- [Police ranks] **have been depleted** by [summer vacations,] and
- [social media sites - coupled with dramatic video of the rioting -] **have bolstered** [a mob mentality] and
- **spread** [disobedience].

Levin's verb classes

- Beth Levin, *English Verb Classes and Alternations* (1993)
- *"Behavior of a verb . . . is to a large extent determined by its meaning"* (p. 1)

  Amanda **hacked** the wood with an ax.
  Amanda **hacked** at the wood with an ax.
  Craig **notched** the wood with an ax.
  *Craig **notched** at the wood with an ax.
- Can we move from syntactic behavior back to semantics?

Syntactic alternations

- Levin created classes of verbs based on semantic similarity and similar syntactic behavior
- Allowing the same alternations
- Hack is part of the cut class, along with cut, chop, saw, and snip
- Levin does not supply a list of semantic roles, but the alternations depend on the idea of roles consistent across different syntactic realizations.
- VerbNet

Filmore's Frame Semantics

- Semantic representations of common scenarios
- Lexical items are related in these frames with more detailed, specific roles
- Classes of verbs (and eventive nouns)
- Concerned with semantic coherency of the frames, not syntactic coherency like Levin
- Instantiated in FrameNet

Closure frame

- An Agent manipulates a Fastener to open or close a Containing_object (e.g. coat, jar). Sometimes an Enclosed_region or a Container_portal may be expressed.

- *Buckle, button, cap, close, fasten, lace, open, seal, tie, unbutton, uncap, unfasten, unscrew, unzip, zip*

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Generality/Granularity of the Roles

- PropBank
  - Most general
- VerbNet
  - General, broad
- FrameNet
  - More specific, narrow
- PropBank
  - Most specific

VerbNet

Agent	Source	Time
Patient	Destination	Extent
Theme	Topic	Asset
Location	Predicate	Value
Instrument	Beneficiary	Attribute
Experiencer	Stimulus	
Recipient	Material	
Cause	Product	

FrameNet

- 2,500 frame elements (semantic roles) and growing
- Create_representation
- A **Creator** produces a physical object, which is to serve as a **Representation** of an actual or imagined entity or event, the **Represented**.
- [Picasso] drew [some violent looking birds].
  Creator Represented

carve.v, cast.v, draw.v, paint.v, photograph.v, sketch.v

PropBank

- Uses numbered arguments: Arg0, Arg1, Arg2 . . .
- Defined differently for each sense of a verb
- Open.01 “open”
  - **Arg0**: *opener*
    Arg1: *thing opening*
    Arg2: *instrument*
    Arg3: *benefactive*

Draw.01

- **Arg0**: *artist*
- **Arg1**: *art*
- **Arg2**: *benefactive*

- [Picasso] drew [some violent looking birds].
  Artist Art

These roles only apply to *draw*.

Why numbered arguments?

- Avoids lack of consensus concerning a specific set of semantic role labels
- Numbers correspond to labels that are verb-sense-specific
- Arg0 and Arg1 correspond to Dowty's (1991) proto-agent and proto-patient

Argument number assignment

- Arg0 is reserved for the agent role
- **Seem.01**
  - **Arg1**: *thing seeming*
  - **Arg2**: *perceiver*

- All others assigned in order
- Args 2-5 are highly variable

Typical correspondences

- Arg0 = agent
- Arg1 = patient
- Arg2 = benefactive / instrument / attribute / end state
- Arg3 = start point / benefactive / instrument / attribute
- Arg4 = end point

Increase: 5 roles

Roles:

Arg0: causer of increase
Arg1: thing increasing
Arg2: amount increased by
Arg3: starting point
Arg4: end point

Example: Net income increased to $274 million from $130 million.

Arg1:	*net income*
REL:	increase
ARG4:	to $274 million
ARG3:	from $130 million

Use the Unified Verb Index to find FrameNet and PropBank roles

- http://verbs.colorado.edu/verb-index/index.php
- [The ball] flew [into the outfield.]
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- [Police ranks] **have been depleted** by [summer vacations,] and
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Discussion

- What pros and cons do you see with the different role sets?

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VerbNet

- Pros:
  - This level of generality produces many examples of each role.
  - Connection to predicate-logic type semantic representations
- Cons:
  - Needs better coverage of verbs and verb senses
  - Clearer definitions of thematic roles

FrameNet

- Pros:
  - Clear definitions of roles
- Cons:
  - Needs better coverage of verbs and verb senses
  - Narrow roles can result in a sparse data problem

PropBank

- Pros:
  - Very easy to apply argument labels
  - Arg0 and arg1 consist across verbs
- Cons:
  - Verb-specific numbered arguments make it difficult to make generalizations across verbs
- Most practical applications of PB have converted numbered args to consistent thematic roles
- Arg0/ Arg1 constitute 85% of arguments, have consistent correspondences
- Arg2-5 performance drops significantly

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Light verbs

- Labeling arguments in the usual way with light verbs is misleading
- [He] took [a walk.] (??)
- Walk is really the predicating element
- [She] made [a comment about his hair]. (??)

Argument structure

- The predicating noun projects the argument structure
- She made a comment about his hair.
- [She] commented [about his hair.]

  Agent Topic

- *She made to buy the company.