INF5830
Introduction to Semantic Role Labeling

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Semantic Role Labeling
Semantic Role Labeling

The police officer detained the suspect at the scene of the crime.

Agent  Predicate  Theme  Location
Contents

Introduction

Semantic roles in general

PropBank: Proto-roles

FrameNet: Frame Semantics

Summary
Semantics

- Study of meaning, expressed in language;
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- Morphemes, words, phrases, sentences;
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- Morphemes, words, phrases, sentences;
- Lexical semantics;
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(Pragmatics: how the context affects meaning)
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- (Pragmatics: how the context affects meaning).
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  - Meaningful or not:
    - Word – *flick* vs *blick*
    - Sentence – *John swims* vs *John metaphorically every*
  - Several meanings (WSD):
    - Word – *fish*
    - Sentence – *John saw the man with the binoculars*
  - Same meaning (semantic similarity):
    - Word – *sofa* vs *couch*
    - Sentence – *John gave Hannah a gift* vs *John gave a gift to Hannah*
  - Truth conditions:
    - *All kings are male*
    - *Molybdenum conducts electricity*
  - Entailment:
    - *Alfred murdered the librarian*
    - *The librarian is dead*
  - Participant roles:
    - John is the ‘giver’, Hannah is the ‘receiver’
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- For dialogue agents, question-answering system, machine translation etc. we often need deeper representations.
Semantic roles

- Semantic roles: alternative sentence-level representation of semantic content.
- Generalization over different surface forms of predicate arguments.
- Who did what to whom, where when and how?
- Intermediate between parsing and full semantics.
- Predicate of a clause determines the main event, e.g., 'eat', 'break', 'kiss'.
- Semantic roles describe participants in the event.
- AGENT (who eats?)
- PATIENT (what is broken?)
- etc.
- Semantic role labeling is the task of assigning these roles to sentence parts (for example, words).
- Often preceded by parsing.
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Argument structure

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  - *find, hit, chase* (how many arguments?)
  - *dance, sleep* (how many arguments?)
- Argument structure of a verb (*thematic grid*) is part of its meaning.
- Verbs also limit semantic properties of arguments (*selectional restrictions*)
  - *Colorless green ideas sleep furiously*
Argument structure

Components of verb meaning influence the choice of arguments

- John threw/tossed/kicked/flung the boy the ball
- *John pushed/pulled/lifted/hauled the boy the ball
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- verbs of motion: single quick motion vs. extended use of force
- verbs of communications: external apparatus vs. type of voice
Mismatches between syntax and semantics

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  - **Impersonal passives**

**Det ble danset hele natta** (Norwegian)

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- Goal: to compute the meaning of a sentence.
- There are regularities in mapping between syntax and semantics...
- ...but not a one-to-one correspondence between syntactic and semantic arguments.
- So what are these semantic arguments?
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PropBank: Proto-roles

FrameNet: Frame Semantics

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    - the girl – endpoint in a change of location.
Role types

- AGENT: the participant that initiates the action, capable of acting with ‘volition’
  - *David cooked the meat*
  - *The fox jumped out of the ditch*
Role types

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  - *Edna cut back these bushes*
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- **EXPERIENCER**: the entity which is aware of the action or state described by predicate, but which is not in control
  - *Edna felt ill*
  - *David saw the smoke*
Role types (continued)

- BENEFICIARY: the entity for whose benefit the action was performed
  - David filled in the form for his grandmother
  - Jane baked me a cake
Role types (continued)

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- **SOURCE**: the entity from which something moves
  - *The plane came back from Kinshasa*
  - *We got the idea from a magazine*
Semantic (thematic) roles

▶ The initial example:

\textit{The boy threw the red ball to the girl}

AGENT THEME GOAL
Semantic (thematic) roles

- The initial example:
  \textit{The boy threw the red ball to the girl}
  \begin{itemize}
    \item AGENT
    \item THEME
    \item GOAL
  \end{itemize}

- Tests for semantic roles
  - AGENT: add \textit{on purpose}
    - \textit{Jon took the book on purpose}
  - THEME/PATIENT
    - \textit{What happened to Y was . . .}
    - \textit{What X did to Y was . . .}
Quiz

▶ https://b.socrative.com/login/student/
▶ Room name: 'KUTUZOV'
Problems for semantic roles

Assumptions:
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Problems for semantic roles

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  - Semantic roles are atomic;
  - Every argument position is assigned exactly one role;
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- Every assumption has been contested at some point.
Problems for semantic roles

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- Difficult to formulate formal definitions of role types.
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1. \(\Rightarrow\) more generalized semantic roles [Dowty 1991]
   - PROTO-AGENT, PROTO-PATIENT
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Let’s describe these two approaches (and resources) in more detail.
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Dowty’s Proto-roles

▶ An influential theoretical approach.

Semantic role: ‘set of entailments of a group of predicates with respect to one of the arguments of each’ [Dowty 1991]

- x murders y, x nominates y, x interrogates y

→ x does a volitional act (¬ ‘kills’)

→ x intends it to be this kind of act (¬ ‘convince’)

→ x causes an event involving y (¬ ‘looks at’)

→ x moves or changes externally (¬ ‘understands’)

[PropBank: Proto-roles]
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Dowty’s Proto-roles

▶ An influential theoretical approach.
▶ Semantic role: ‘set of entailments of a group of predicates with respect to one of the arguments of each’ [Dowty 1991]
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  - Properties (entailments) of Proto-patient:
    - change of state;
    - incremental theme;
    - causally affected by event;
    - stationary (relative to movement by agent).
Proto-roles and linking

- Argument Selection Principle (ASP)

- The argument with the most PROTO-AGENT properties becomes subject (Arg0);
- The argument with the most PROTO-PATIENT properties becomes object (Arg1).

- If two compete, both will be possible (psychological verbs, for example):
  - Experiencer is sentient/perceiving;
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- Example:
  - x likes y / y pleases x
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PropBank: Proto-roles

Argument structure for ‘break’:

▷ Frameset break.01 ‘break, cause to not be whole’:
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Argument structure for ‘break’:

- Frameset break.01 ‘break, cause to not be whole’:
  - Arg0: breaker
  - Arg1: thing broken
  - Arg2: instrument
  - Arg3: pieces
PropBank: semantic propositions corpus

- Sentences annotated with semantic roles [Bonial et al. 2014]

PropBank is now developed in close conjunction with Abstract Meaning Representation (AMR) [Banarescu et al. 2013] and OntoNotes projects.
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  - `instance = propbank.instances(100)`
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Frame Semantics

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► ‘Meanings are relative to scenes’
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- ‘Meanings are relative to scenes’
- ‘The study of meaning is the study of cognitive scenes that are created or activated by utterances’
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- ‘Meanings are relative to scenes’
- ‘The study of meaning is the study of cognitive scenes that are created or activated by utterances’
- ‘whenever we understand a linguistic expression of whatever sort, we have simultaneously a background scene and a perspective on that scene’

[Fillmore 1977]
Historical roots (60s)

- Fillmore’s case grammar
  - Fillmore was inspired by the works of Lucien Tesniere, the father of the contemporary dependency grammar.
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- Semantic roles (actants, cases) are assigned to participants of the frame.
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### Commercial event frame (partial)

<table>
<thead>
<tr>
<th>BUYER</th>
<th>buy</th>
<th>GOODS</th>
<th>(SELLER)</th>
<th>(PRICE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>subject</td>
<td></td>
<td>object</td>
<td>from</td>
<td>for</td>
</tr>
<tr>
<td>Alfred</td>
<td>bought</td>
<td>the book</td>
<td>from Olivia</td>
<td>for 10 dollars</td>
</tr>
<tr>
<td>Alfred</td>
<td>bought</td>
<td>them</td>
<td></td>
<td>for 1 dollar</td>
</tr>
<tr>
<td>Alfred</td>
<td>bought</td>
<td>a bicycle</td>
<td>from Sarah</td>
<td></td>
</tr>
</tbody>
</table>
# Commercial event frame (partial)

<table>
<thead>
<tr>
<th>VERB</th>
<th>BUYER</th>
<th>GOODS</th>
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<th>MONEY</th>
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</tr>
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<td>sell</td>
<td>to</td>
<td>object</td>
<td>subject</td>
<td>for</td>
<td>at</td>
</tr>
<tr>
<td>cost</td>
<td>ind.obj</td>
<td>subject</td>
<td></td>
<td>object</td>
<td>at</td>
</tr>
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  - `from nltk.corpus import framenet as fn`
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Example of a text annotated in the FrameNet paradigm.
FrameNet lexical database

Killing

Definition:
A Killer or Cause causes the death of the Victim.
John DROWNED Martha.

FEs:

Core:

Cause []
Excludes: Killer

Instrument [Instr]
Semantic Type: Physical_entity
Excludes: Cause
Killer [Kill]
Excludes: Cause
Means []
Semantic Type: State_of_affairs
Excludes: Cause
Victim []
Semantic Type: Sentient

An inanimate entity or process that causes the death of the Victim.
The rockslide KILLED nearly half of the climbers.

The device used by the Killer to bring about the death of the Victim.
It's difficult to SUICIDE with only a pocketknife.

The person or sentient entity that causes the death of the Victim.
The method or action that the Killer or Cause performs resulting in the death of the Victim.
The flood EXTERMINATED the rats by cutting off access to food.

The living entity that dies as a result of the killing.
Quiz

- https://b.socrative.com/login/student/
- Room name: 'KUTUZOV'
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▶ Automatic semantic role labeling (SRL) using machine learning: the next lecture.
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▶ Introduction to Semantic Role Labeling (today);

▶ Modern approaches to Semantic Role Labeling (Nov 14)

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References II


