Foundations of Natural Language Processing
Lecture 16
Semantic Role Labelling and Argument Structure

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(Slides based on those of Schneider, Koehn, Lascarides)

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Language is Flexible

- Often we want to know *who did what to whom (when, where, how and why)*
- But the same event and its participants can have different syntactic realizations.

Sandy broke the glass.	vs.	The glass was broken by Sandy.
She gave the boy a book.	vs.	She gave a book to the boy.

- Instead of focusing on syntax, consider the **semantic roles** (also called **thematic roles**) defined by each event.

Argument Structure and Alternations

- Mary opened the door
  The door opened

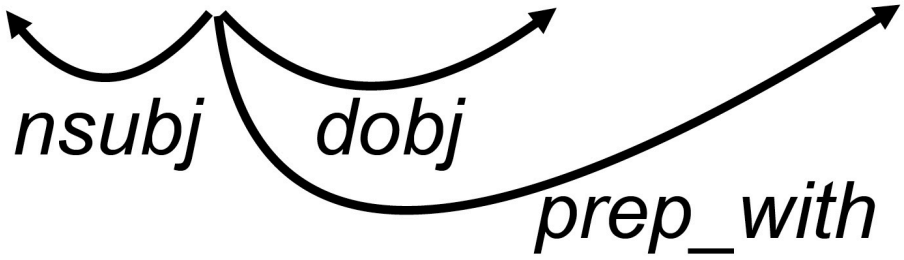
- John slices bread with a knife
  This bread slices easily
  The knife slices cleanly

- Mary loaded the truck with hay
  Mary loaded hay onto the the truck
  The truck was loaded with hay (by Mary)
  The hay was loaded onto the truck (by Mary)

- John gave a present to Mary
  John gave Mary a present

Stanford Dependencies

- Mary loaded the truck with hay.



- Hay was loaded onto the truck by Mary.

Syntax is not enough!

cf Mary ate the sandwich with Kim!

Syntax-Semantics Relationship

Outline

- syntax $\neq$ semantics
- The **semantic roles** played by different participants in the sentence are not trivially inferable from syntactical relations
- . . . though there are patterns!
- The idea of semantic roles can be combined with other aspects of meaning (beyond this course).

Commonly used thematic roles

Role	Example
Agent	*The boy* kicked his toy
Theme	The boy kicked *his toy*
Experiencer	*The boy* felt sad
Result	The girl built *a shelf* with power tools
Instrument	The girl built a shelf *with power tools*
Source	She came *from home*
...	...

- J&M give definitions and additional roles

Issues with thematic roles

- No universally agreed-upon set of roles
- Items with the "same" role (e.g., Instrument) may not behave quite the same

  Sandy opened the door with a key The key opened the door
  Sandy ate the salad with a fork *The fork ate the salad

- The two main NLP resources for thematic roles avoid these problems by defining very fine-grained roles:
  - Specific to individual verbs only (PropBank)
  - Specific to small groups of verbs (FrameNet)

Semantic role labelling

- The NLP task of identifying which words/phrases play which roles in an event.

- Supervised classification:
  - Resource data is **PropBank**: Repository of **frame files** for each verb (more shortly) plus annotations on constituents in Penn treebank with their semantic roles (wrt the relevant frame file).
  - Features are mostly related to syntactic structure and the particular words involved
    (i.e., assumes pipeline architecture)

- Current research focuses on reducing the need for training data (e.g., to work on non-English languages)

Example Frame Roles: *load*

Mary loaded the truck with hay at the depot on Friday

- *load:* load.01 'cause to be burdened'

  Frame roles:

Arg0-PAG:	loader,agent
Arg1-GOL:	beast of burden
Arg2-PPT:	cargo
Arg3-MNR:	instrument

- *load_up*: load.02 'phrasal cause to be burdened'
  Frame roles are the same as load.01

- *load*: load.03 'fix, set up to cheat'

  Frame roles:

Arg0-PAG:	cheater
Arg1-GOL:	thing loaded (dice, the deck, etc)
Arg2-PPT:	with what

- All sentences can have temporal, spatial adjuncts (AM-TMP, AM-LOC). . .

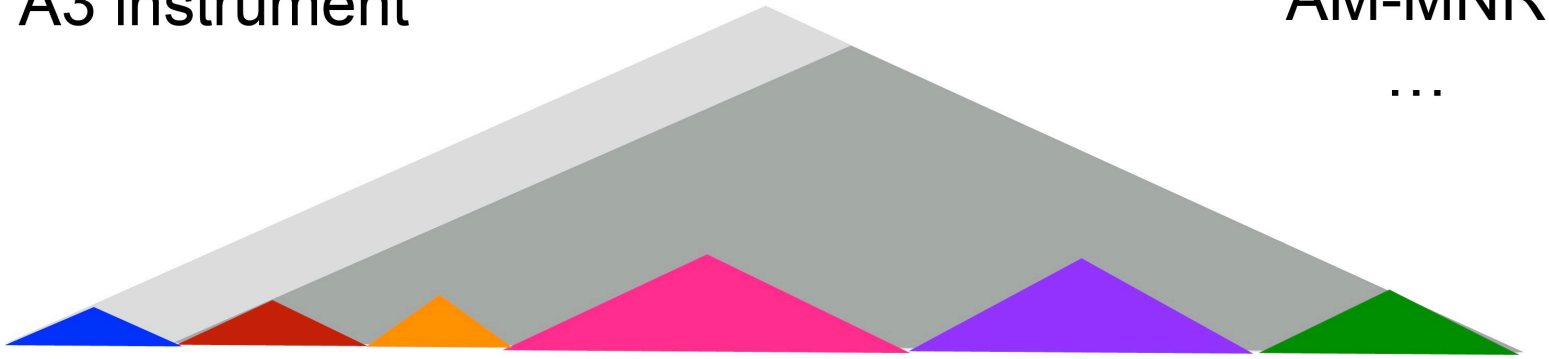
PropBank

Penn treebank annotated with Arg0, Arg1 etc, and verb with its sense; so specific semantic role recoverable.

Mary **loaded** the truck with hay at the depot on Friday.

load.01
A0 loader
A1 bearer
A2 cargo
A3 instrument

AM-LOC
AM-TMP
AM-PRP
AM-MNR
...



Mary **loaded** hay onto the truck at the depot on Friday.

Semantic Role Labelling

Traditional pipeline:

1. Either assume or compute syntactic parse and predicate senses

2. **Argument identification** (deterministic): select the predicate's argument phrases (by parsing the parse tree)

3. **Argument classification:** select a role for each argument (wrt to the frame role for the predicate's sense).

   - Useful feature: predicate-to-argument path in the tree (e.g., NP-S-VP-V).

Problems

- Numbered roles are predicate specific:
  - load.01.ARG1: beast of burden
    put.01.ARG1: thing.put
    put.01.ARG2: beast of burden.

- FrameNet tries to generalise via verb classes;
  but less treebank data.

Paraphrase

James snapped a photo of me with Sheila.
Sheila and I had our picture taken by James

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James snapped a photo of me with Sheila.
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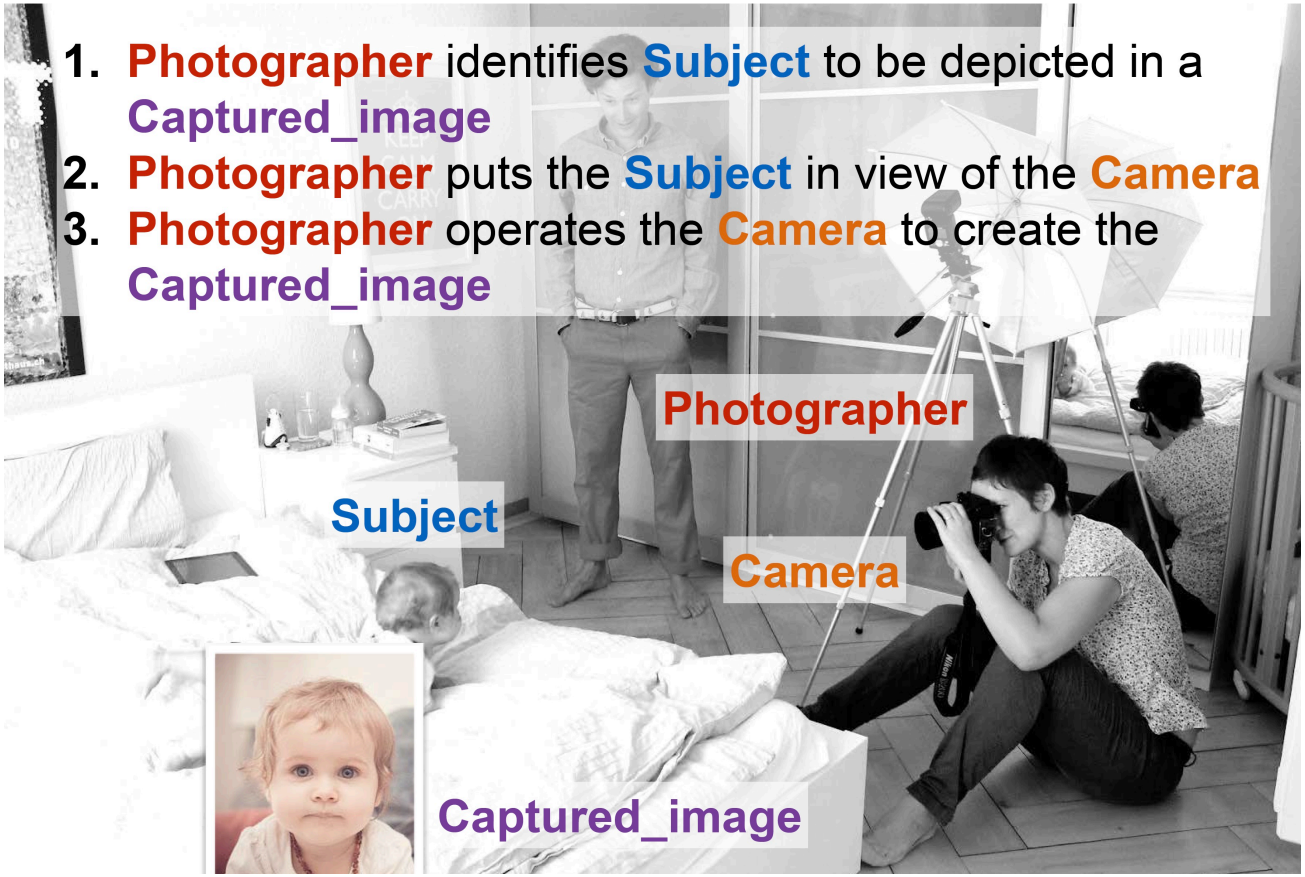
Photo Labelled. . .

photograph vs. take picture vs. snap picture. . .



Idealised Stanford Dependencies

- James snapped a photo of me with Sheila
  nsubj(snap, James)
  dobj(snap, photo)
  prep_of(photo,me)
  prep_with(me,Sheila)
  det(photo,a)

- Sheila and I had our picture taken with James
  nsubjpass(taken,Sheila)
  nsubjpass(taken,I)
  conj_and(Sheila,I)
  aux(taken,had)
  dobj(taken,picture)
  poss(picture,our)
  prep_with(picture,James)

Here, *agent* is the complement introduced with *by* in a passive construction. . .

FrameNet: Meanings are reletavised to scenes!

- Tries to capture relationships among word and phrase meanings by assigning them the same frame (and so captures paraphrases).

- ≈ 1000 frames represent scenarios.
  - Most are associated with lexical units (predicates);
    but some are phrases

- Frames are explained with textual descriptions and linguistic examples.

Example: Create_physical_artwork

Definition:

A Creator creates an artefact that is typically an iconic Representation of an actual or imagined entity or event. The Representation may also be evocative of an idea while not based on resemblance.

- Diagrams must be clearly drawn on construction paper.
  I took his picture and told him it came out well.

Frame Elements:

Core: creator, representation

Non-Core manner, location_of_representation . . .

FrameNet Resources

- FrameNets for several languages
- Some (limited!) data annotated with Frame elements from FrameNet
- SEMAFOR is a frame-semantic parser
  - Ongoing research at CMU, Google, Edinburgh. . .

Summary

- Grammatical relations on their own don't determine who did what to whom
- You need to (also) know about word and phrase meanings and how they relate to grammatical roles
- There is flexibility in how a verb realises its participants syntactically (connected with the kind of event that the verb denotes)
- One must exploit those patterns to obtain NL understanding (e.g., predict entailments, paraphrases etc).