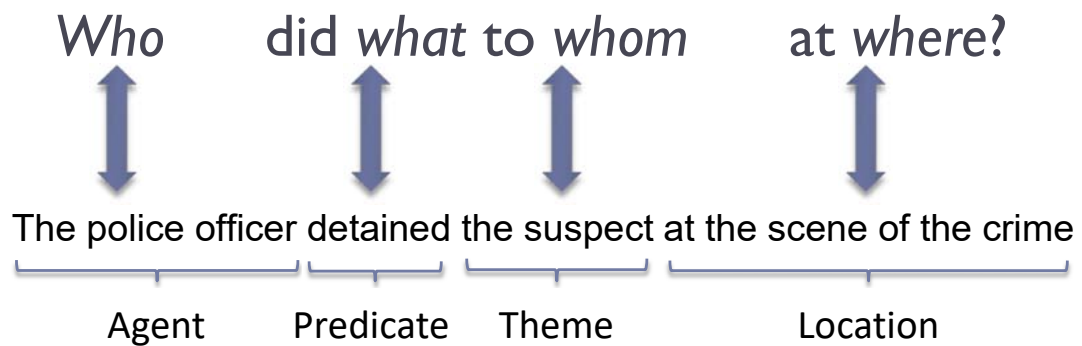


Semantic Role Labeling

Chapter 20

Semantic Role Labeling



Can we figure out that these have the same meaning?

XYZ corporation **bought** the stock.

They **sold** the stock to XYZ corporation.

The stock was **bought** by XYZ corporation.

The **purchase** of the stock by XYZ corporation...

The stock **purchase** by XYZ corporation...

3

A Shallow Semantic Representation: Semantic Roles

Predicates (bought, sold, purchase) represent an **event** and **semantic roles** express the abstract role that arguments of a predicate can take in the event



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Getting to semantic roles

What roles are involved in a breaking event?

First order logic event representation for **Sasha broke the window**:

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Getting to semantic roles

First order logic event representation:

Sasha broke the window	$\exists e, x, y \text{ Breaking}(e) \wedge \text{Breaker}(e, \text{Sasha})$ $\wedge \text{BrokenThing}(e, y) \wedge \text{Window}(y)$
Pat opened the door	$\exists e, x, y \text{ Opening}(e) \wedge \text{Opener}(e, \text{Pat})$ $\wedge \text{OpenedThing}(e, y) \wedge \text{Door}(y)$

Subjects of break and open: **Breaker** and **Opener**

Deep roles specific to each event (breaking, opening)

Hard to reason about them for NLU applications like QA

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Thematic roles

- **Breaker** and **Opener** have something in common!
 - Volitional actors
 - Often animate
 - Direct causal responsibility for their events
- Thematic roles are a way to capture this semantic commonality between *Breakers* and *Openers*.
- They are both AGENTS.
- The *BrokenThing* and *OpenedThing*, are THEMES.
 - 7 • prototypically inanimate objects affected in some way by the action

Thematic roles

- One of the oldest linguistic models
 - Indian grammarian Panini between the 7th and 4th centuries BCE
- Modern formulation from Fillmore (1966,1968), Gruber (1965)
 - Fillmore influenced by Lucien Tesnière's (1959) *Éléments de Syntaxe Structurale*, the book that introduced dependency grammar
 - Fillmore first referred to roles as *actants* (Fillmore, 1966) but switched to the term *case*

Thematic roles

- A typical set:

Thematic Role	Definition	Example
AGENT	The volitional causer of an event	<i>The waiter</i> spilled the soup.
EXPERIENCER	The experiencer of an event	<i>John</i> has a headache.
FORCE	The non-volitional causer of the event	<i>The wind</i> blows debris from the mall into our yards.
THEME	The participant most directly affected by an event	Only after Benjamin Franklin broke <i>the ice</i> ...
RESULT	The end product of an event	The city built a <i>regulation-size baseball diamond</i> ...
CONTENT	The proposition or content of a propositional event	Mona asked " <i>You met Mary Ann at a supermarket?</i> "
INSTRUMENT	An instrument used in an event	He poached catfish, stunning them <i>with a shocking device</i> ...
BENEFICIARY	The beneficiary of an event	Whenever Ann Callahan makes hotel reservations <i>for her boss</i> ...
SOURCE	The origin of the object of a transfer event	I flew in <i>from Boston</i> .
GOAL	The destination of an object of a transfer event	I drove <i>to Portland</i> .

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Thematic grid, case frame

Example usages of "break"

- John broke the window
- John broke the window with a rock
- The rock broke the window
- The window broke
- The window was broken by John

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Thematic grid, case frame

Example usages of “break”

John broke the window.

AGENT THEME

John broke the window with a rock.

AGENT THEME INSTRUMENT

The rock broke the window.

INSTRUMENT THEME

The window broke.

THEME

The window was broken by John.

THEME AGENT

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Thematic grid, case frame

Example usages of “break”

John broke the window.

AGENT THEME

John broke the window with a rock.

AGENT THEME INSTRUMENT

The rock broke the window.

INSTRUMENT THEME

The window broke.

THEME

The window was broken by John.

THEME AGENT

thematic grid, case frame

Break:

AGENT, THEME, INSTRUMENT.

Some realizations:

AGENT/Subject, THEME/Object

AGENT/Subject, THEME/Object, INSTRUMENT/PP_{with}

INSTRUMENT/Subject, THEME/Object

THEME/Subject

What type of parsing?

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Diathesis alternations (or verb alternation)

Doris gave the book to Cary.

AGENT THEME GOAL

Break: AGENT, INSTRUMENT, or THEME as subject

Doris gave Cary the book.

AGENT GOAL THEME

Give: THEME and GOAL in either order

Dative alternation: particular semantic classes of verbs like *give*, “verbs of future having” (*advance, allocate, offer, owe*), “send verbs” (*forward, hand, mail*), “verbs of throwing” (*kick, pass, throw*), etc.

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Problems with Thematic Roles

Hard to create standard set of roles or formally define them

Often roles need to be fragmented to be defined.

Levin and Rappaport Hovav (2015): two kinds of INSTRUMENTS

intermediary instruments that can appear as subjects

The cook opened the jar with the new gadget.

The new gadget opened the jar.

enabling instruments that cannot

Shelly ate the sliced banana with a fork.

**The fork ate the sliced banana.*

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Alternatives to thematic roles

- 1. Fewer roles:** generalized semantic roles, defined as prototypes (Dowty 1991)
PROTO-AGENT
PROTO-PATIENT
[PropBank](#)
- 2. More roles:** Define roles specific to a group of predicates
[FrameNet](#)

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PropBank

- Palmer, Martha, Daniel Gildea, and Paul Kingsbury. 2005. The Proposition Bank: An Annotated Corpus of Semantic Roles. *Computational Linguistics*, 31(1):71–106
- <http://verbs.colorado.edu/~mpalmer/projects/ace.html>

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PropBank Roles

Following Dowty 1991

Proto-Agent

- Volitional involvement in event or state
- Sentience (and/or perception)
- Causes an event or change of state in another participant
- Movement (relative to position of another participant)

Proto-Patient

- Undergoes change of state
- Causally affected by another participant
- Stationary relative to movement of another participant

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PropBank Roles

- Following Dowty 1991
 - Role definitions determined verb by verb, with respect to the other roles
 - Semantic roles in PropBank are thus verb-sense specific.
 - Each verb sense has numbered argument: Arg0, Arg1, Arg2, ...
 - Arg0: PROTO-AGENT
 - Arg1: PROTO-PATIENT
 - Arg2: usually: benefactive, instrument, attribute, or end state
 - Arg3: usually: start point, benefactive, instrument, or attribute
 - Arg4 the end point
- 18 *(Arg2-Arg5 are not really that consistent, causes a problem for labeling)*

PropBank Frame Files

<http://verbs.colorado.edu/proppbank/frames-ets-english-aliases/agree.html>

) **agree.01**

Arg0: Agreeer
Arg1: Proposition
Arg2: Other entity agreeing

Ex1: [Arg0 The group] *agreed* [Arg1 it wouldn't make an offer].

Ex2: [ArgM-TMP Usually] [Arg0 John] *agrees* [Arg2 with Mary] [Arg1 on everything].

fall.01

Arg1: Logical subject, patient, thing falling

Arg2: Extent, amount fallen

Arg3: start point

Arg4: end point, end state of arg1

Ex1: [Arg1 Sales] *fell* [Arg4 to \$25 million] [Arg3 from \$27 million].

Ex2: [Arg1 The average junk bond] *fell* [Arg2 by 4.2%].

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Advantage of a PropBank Labeling

increase.01 “go up incrementally”

Arg0: causer of increase

Arg1: thing increasing

Arg2: amount increased by, EXT, or MNR

Arg3: start point

Arg4: end point

This would allow us to see the commonalities in these 3 sentences:

Big Fruit Co. increased the price of bananas.

The price of bananas was increased again by Big Fruit Co.

The price of bananas increased 5%

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Advantage of a ProbBank Labeling

· **increase.01** “go up incrementally”

Arg0: causer of increase

Arg1: thing increasing

Arg2: amount increased by, EXT, or MNR

Arg3: start point

Arg4: end point

This would allow us to see the commonalities in these 3 sentences:

[Arg0 Big Fruit Co.] increased [Arg1 the price of bananas].

[Arg1 The price of bananas] was increased again [Arg0 by Big Fruit Co.]

[Arg1 The price of bananas] increased [Arg2 5%].

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Modifiers or adjuncts of the predicate:

Arg-M

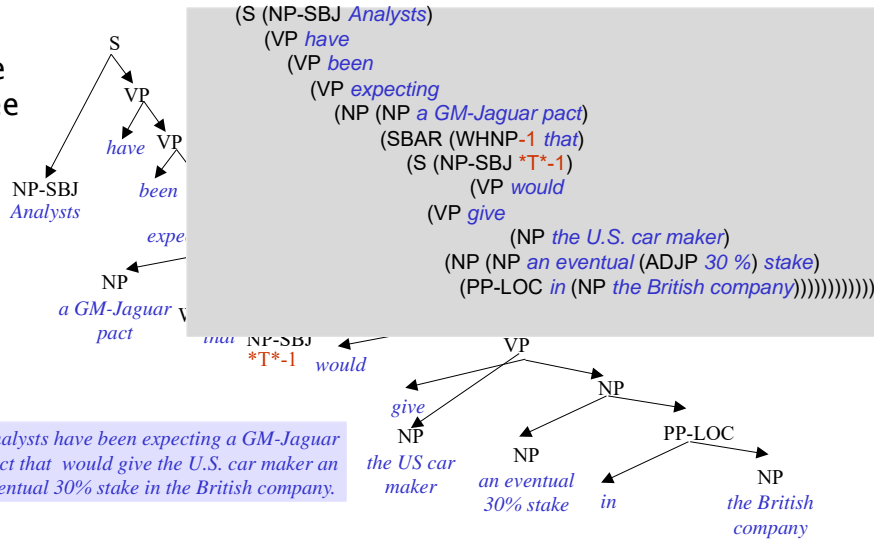
ArgM-TMP	when?	yesterday evening, now
LOC	where?	at the museum, in San Francisco
DIR	where to/from?	down, to Bangkok
MNR	how?	clearly, with much enthusiasm
PRP/CAU	why?	because ... , in response to the ruling
REC		themselves, each other
ADV	miscellaneous	
PRD	secondary predication	...ate the meat raw

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PropBanking a Sentence

Martha Palmer 2013

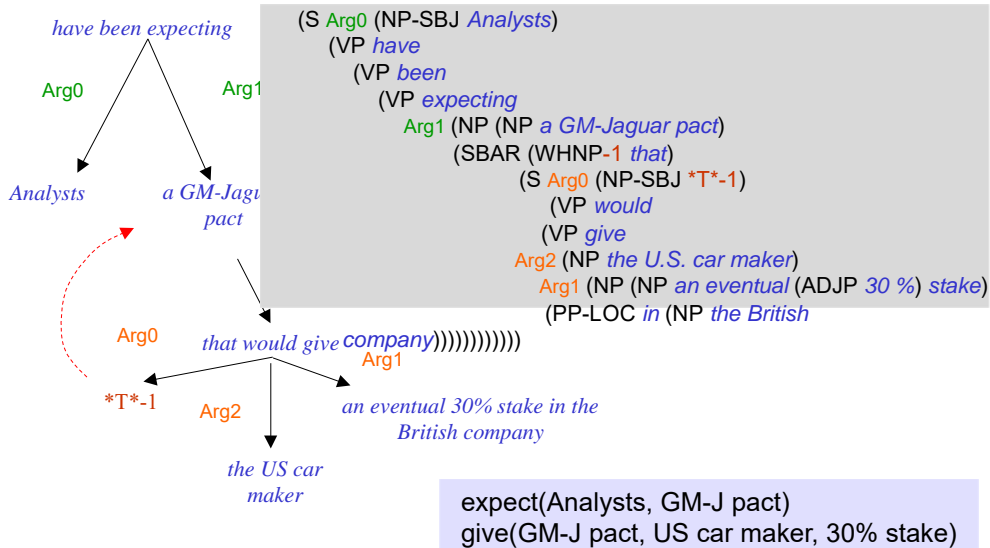
A sample parse tree



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The same parse tree PropBanked

Martha Palmer 2013



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Annotated PropBank Data

2013 Verb Frames Coverage
Count of word sense (lexical units)

- Penn English TreeBank, OntoNotes 5.0.
 - Total ~2 million words
- Penn Chinese TreeBank
- Hindi/Urdu PropBank
- Arabic PropBank

<i>Language</i>	<i>Final Count</i>
English	10,615*
Chinese	24,642
Arabic	7,015

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From Martha Palmer 2013 Tutorial

Capturing descriptions of the same event by different nouns/verbs

[Arg1 The price of bananas] increased [Arg2 5%].

[Arg1 The price of bananas] rose [Arg2 5%].

There has been a [Arg2 5%] rise [Arg1 in the price of bananas].

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FrameNet

- Baker et al. 1998, Fillmore et al. 2003, Fillmore and Baker 2009, Ruppenhofer et al. 2006
- Roles in PropBank are specific to a verb
- Role in FrameNet are specific to a **frame**: a background knowledge structure that defines a set of frame-specific semantic roles, called **frame elements**,
 - includes a set of predicates that use these roles
 - each word evokes a frame and profiles some aspect of the frame
- <https://framenet.icsi.berkeley.edu/fndrupal/>

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The “Change position on a scale” Frame

This frame consists of words that indicate the change of an ITEM’s position on a scale (the ATTRIBUTE) from a starting point (INITIAL VALUE) to an end point (FINAL VALUE)

[ITEM Oil] *rose* [ATTRIBUTE in price] [DIFFERENCE by 2%].

[ITEM It] has *increased* [FINAL_STATE to having them 1 day a month].

[ITEM Microsoft shares] *fell* [FINAL_VALUE to 7 5/8].

[ITEM Colon cancer incidence] *fell* [DIFFERENCE by 50%] [GROUP among men].

a steady *increase* [INITIAL_VALUE from 9.5] [FINAL_VALUE to 14.3] [ITEM in dividends]

a [DIFFERENCE 5%] [ITEM dividend] *increase*...

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The “Change position on a scale” Frame

VERBS:	dwindle	move	soar	escalation	shift	
	advance	edge	mushroom	swell	explosion	tumble
	climb	explode	plummet	swing	fall	
	decline	fall	reach	triple	fluctuation	ADVERBS:
	decrease	fluctuate	rise	tumble	gain	increasingly
	diminish	gain	rocket		growth	
	dip	grow	shift	NOUNS:	hike	
	double	increase	skyrocket	decline	increase	
	drop	jump	slide	decrease	rise	

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The “Change position on a scale” Frame

Core Roles	
ATTRIBUTE	The ATTRIBUTE is a scalar property that the ITEM possesses.
DIFFERENCE	The distance by which an ITEM changes its position on the scale.
FINAL_STATE	A description that presents the ITEM’s state after the change in the ATTRIBUTE’s value as an independent predication.
FINAL_VALUE	The position on the scale where the ITEM ends up.
INITIAL_STATE	A description that presents the ITEM’s state before the change in the ATTRIBUTE’s value as an independent predication.
INITIAL_VALUE	The initial position on the scale from which the ITEM moves away.
ITEM	The entity that has a position on the scale.
VALUE_RANGE	A portion of the scale, typically identified by its end points, along which the values of the ATTRIBUTE fluctuate.
Some Non-Core Roles	
DURATION	The length of time over which the change takes place.
SPEED	The rate of change of the VALUE.
GROUP	The GROUP in which an ITEM changes the value of an ATTRIBUTE in a specified way.

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Relation between frames

Inherits from:
Is Inherited by:
Perspective on:
Is Perspectivized in:
Uses:
Is Used by:
Subframe of:
Has Subframe(s):
Precedes:
Is Preceded by:
Is Inchoative of:
Is Causative of:

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Relation between frames

“cause change position on a scale”

Is Causative of: Change position on a scale

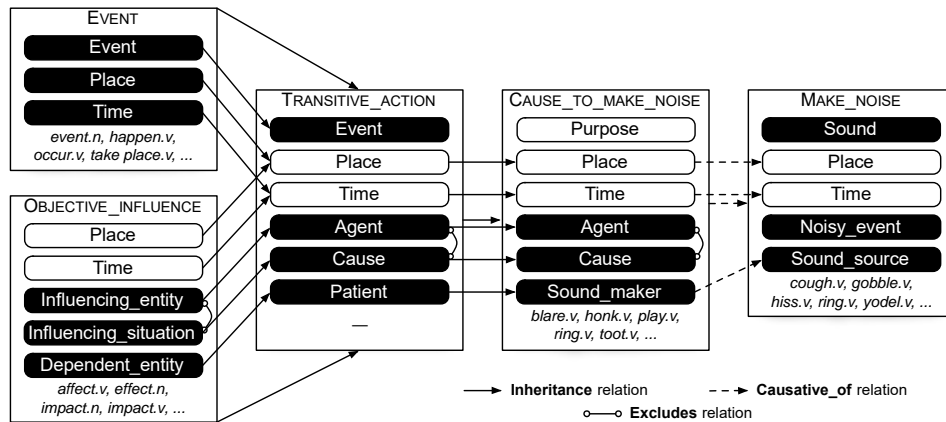
Adds an agent Role

[AGENT They] *raised* [ITEM the price of their soda] [DIFFERENCE by 2%].

- *add.v, crank.v, curtail.v, cut.n, cut.v, decrease.v, development.n, diminish.v, double.v, drop.v, enhance.v, growth.n, increase.v, knock down.v, lower.v, move.v, promote.v, push.n, push.v, raise.v, reduce.v, reduction.n, slash.v, step up.v, swell.v*

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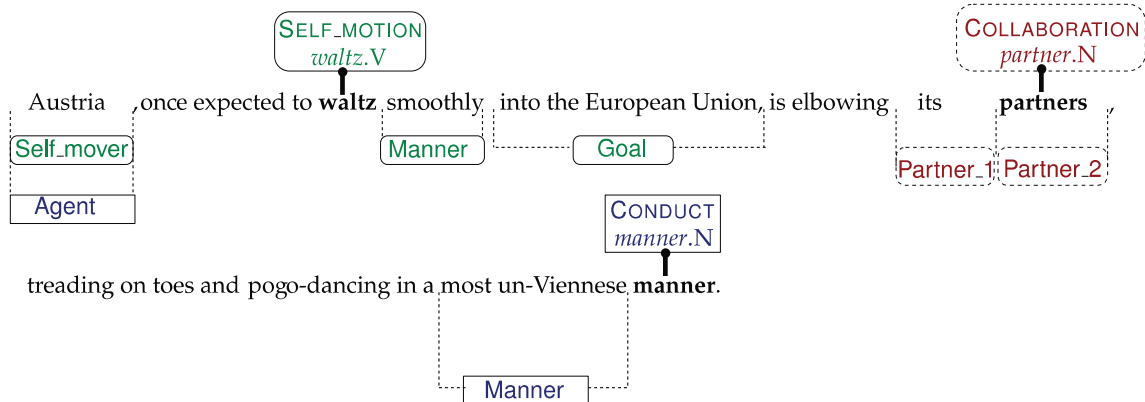
Relations between frames



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Figure from Das et al 2010

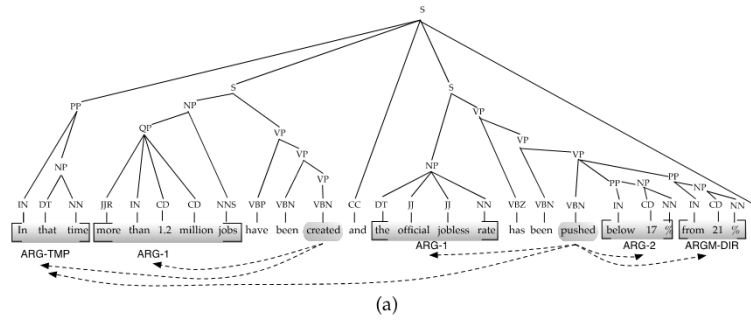
Schematic of Frame Semantics



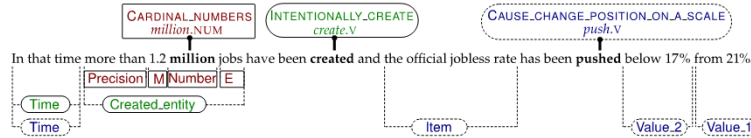
34

Figure from Das et al (2014)

FrameNet and PropBank representations



(a)



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