

# FrameNet: A Knowledge Base for Natural Language Processing

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# Part I

## Introduction

# Chuck Fillmore and FrameNet

- Prof. Charles J. Fillmore had a life-long interest in lexical semantics
- This culminated in the latter part of his life in the FrameNet research project at the International Computer Science Institute.
- This talk will cover
  - ▶ the origins of FrameNet,
  - ▶ relation to case grammar, frame semantics, construction grammar
  - ▶ NLP applications of FrameNet and
  - ▶ current directions of growth, including
  - ▶ FrameNets in languages other than English.

# Case Grammar

- Fillmore (1968) showed how a limited number of case roles could provide elegant explanations of such diverse phenomena as
  - ▶ morphological case marking:
    - ★ nominative-accusative vs.
    - ★ nominative-ergative vs.
    - ★ active-stative
  - ▶ and anaphoric processes such as Japanese subject drop.
- Clarified distinction between case forms and case uses, case with and without prepositions—deep vs. surface. E.g. Locative requires a prep, which adds semantics (with some exceptions!)
- Lexical entries for Vs carry case frames
- Lexical entries for Ns have features that determine how they fit into case frames

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- Generative Semantics, as developed by George Lakoff, Haj Ross, and James McCawley, which shared with Case Grammar. . .
- “. . . a plan to present almost everything that had to do with meaning in a single initial level of representation and to take care of everything else, such as surface form and grammatically related paraphrasings, by means of a generous variety of transformations: including movement, reattachment, deletion, substitution, copying, lexical insertion, and magic”. (Fillmore *et al.* 2003:vii)

# “Towards a Modern Theory of Case” (1969a)

- $S \rightarrow \text{Mod} - \text{Aux} - \text{Prop}$
- $\text{Obj, Dat, Loc, } \dots \rightarrow \text{NP}$
- $\text{NP} \rightarrow \text{P (Det) (S) N}$
- $\text{Prop} \rightarrow \text{V Obj (Dat) (Ag)}$
- $\text{Prop} \rightarrow \text{V Obj Loc (Dat) (Ag)}$
- $\dots$
- Features: Objective, Instrumental, Dative, Locative, Comitative, Agentive



## “Types of Lexical Information” (1969b)

- “... *rob* and *steal* conceptually require three arguments. . . the CULPRIT, the LOSER and the LOOT”
- But the next section says: “It seems to me, however, that this sort of detail is unnecessary, and that what we need are abstractions from these specific role descriptions, abstractions which will allow us to recognize that certain elementary role notions recur in many situations, . . . Thus we can identify the CULPRIT of *rob* and the CRITIC of *criticize* with the more abstract role of AGENT . . . in general . . . the roles that [predicates’] arguments play are taken from an inventory of role types fixed by grammatical theory.”

## “Case for Case Reopened” (1977a)

- “Meanings are relativized to scenes”
- “[A]s I have conceived them, the repertory of cases is NOT identical to the full set of notions that would be needed to make an analysis of any state or event. . .
- One of the cases I proposed was the agent, identifying the role of an active participant in some event; yet EVENTS are not restricted in the number of active participants they can have.”
- Commercial transaction
- Transitive/comitative, *spray, load, fill*

## Part II

# Frames, Scenes, and Frame Semantics

## On the term *frame*

- The concept of frames became part of the academic zeitgeist of the 1960s and 70s.
- Roger Schank was using the term **script** to talk about situations like eating in a restaurant (Schank & Abelson 1977)
- and the term *frame* was being used in a more-or-less similar sense by Marvin Minsky 1974, and Eugene Charniak 1977.
- Erving Goffman used the term in discourse analysis 1974.
- This tradition has been carried forward and popularized in Deborah Tannen's books, and
- George Lakoff's recent writings on the framing of political discourse.
- NOT equivalent to **syntactic frame** as used in CL

## "Scenes-and-frames Semantics" (1977b)

"I intend to use the word scene – a word I am not completely happy with – in a maximally general sense, so include not only visual scenes, but familiar kinds of interpersonal transactions, standard scenarios, familiar layouts, institutional structures, enactive experiences, body image, and in general, any kind of coherent segment, large or small, of human beliefs, actions, experiences, or imaginings."

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- Frames are connected to each other via frame-to-frame relations.
- A crucial decision: FEs are not inherited automatically in FN– FE inheritance links must be made explicitly, along with frame-to-frame relations.

# Putting together a frame for “revenge”

- Verbs: *avenge, revenge, retaliate, get back, get even, pay back*
- Nouns: *revenge, vengeance, reprisal, retaliation*
- Adjectives: *vengeful, vindictive*

# Results of simple corpus search

- Fabio **paid back** the money that he owed to his grandfather.
- Victoria **retaliated** against her boss for being dismissed by leaving with the keys.
- Mariana **got even** more gifts than she expected for her birthday.

# Thinking about roles

*Victoria retaliated against her boss for being dismissed by leaving with the keys.*

- someone who was harmed
- the harm done
- someone who did the harming
- someone who did something in turn (often the same person)
- something done in turn

# Coming up with names for FEs

*Victoria retaliated against her boss for being dismissed by leaving with the keys.*

**Injured party:** someone who was harmed

**Injury:** the harm done

**Offender:** someone who did the harming

**Avenger:** someone who did something in turn (maybe the same person)

**Punishment:** something done in turn

## Formal definition of **Revenge** frame

An AVENGER inflicts a PUNISHMENT on an OFFENDER as a consequence of an earlier action by the OFFENDER, the INJURY. The AVENGER need not be the same as the INJURED\_PARTY who suffered the INJURY, but the AVENGER must share the judgment that the OFFENDER'S action was wrong. The judgment that the OFFENDER had inflicted an INJURY is made without regard to the law.

# Sample annotation

[Victoria AVENGER] RETALIATED [against her boss OFFENDER] [for being dismissed INJURY] [by leaving with the office keys PUNISHMENT].



# Simple annotation set with GF and PT

- [Victoria AVENGER/EXT/NP] RETALIATED [against her boss OFFENDER/DEP/PP] [for being dismissed INJURY/DEP/PPING] [by leaving with the office keys PUNISHMENT/DEP/PPing].
- This annotation is all in one **annotation set**. Each annotation set contains 8 layers, although for a given sentence, many may not contain labels. Each sentence in the FN database should have POS labels, even if it has no manual annotation.

# Core vs. non-core Frame Elements in the **Revenge** frame

- In the **Revenge** frame, all of the FEs discussed so far are “core” FEs: OFFENDER, INJURED\_PARTY, INJURY, AVENGER, and PUNISHMENT
- But there are also available for annotation a number of “non-core” FEs, such as TIME, PLACE, PURPOSE, RESULT, INSTRUMENT. All of these specify more information about the revenge-taking event.

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- “Extra-thematic” FEs are really in other frames, facilitate annotation.

# FrameNet started with Lexicographic Annotation

## Method:

- Choose a wide variety of semantic domains (Motion, Communication, Emotion, Movement, Health, etc.) and see what kinds of frames would be needed to “cover” them.
- Rather than proceeding word by word, finding all meanings, proceed meaning by meaning (frame by frame), finding what LUs are in frame, what FEs are needed
- Combine intuitions about what constitutes a conceptual gestalt with corpus search for patterns of usage
- Document **all** syntactic/semantic patterns by annotating a few example sentences of each from a corpus
- Present results in both human- and machine-readable form



# Full-text annotation

- Roughly 1/4 of all annotation in DB is full-text.
- Make one pass through text, using all existing LUs.
- Then create new LUs in existing frames (quick) or new frames (time-consuming)
- Currently skipping named entities, most prepositions

# Current Status of Project

Frames	1179
Lexical frames	1048
Lexical Units	12,761
LUs / lexical frame	12.2
FEs / lexical frame	9.7
Frame relations	1,752
LUs with “full” annotation	8,186 (64%)
Annotation sets	195,697

**Table:** Current Status of FrameNet Database

# Null Instantiation

When core FEs do not appear in the sentence, this is called **null instantiation** (Fillmore 1986), which falls into three categories:

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**Constructional null instantiation (CNI)** The FE is allowed to be omitted due to a grammatical construction, e.g. imperatives omit their subjects (*Peel me a grape*), recipes (containing imperatives) often omit both subject and object: *Simmer until transparent, then drain thoroughly.*

# Uses of Null Instantiation

- Marking NIs allows more regular generalizations about argument structure of predicates and the FE set of frames.
- NIs also mark sites where NLP systems need to try to recover information from context, much like pronouns.

# Frame-frame relations

Inheritance	704	All parent FEs have corresponding child FEs, child is subtype of parent
Perspective_on	107	Child is a subtype of parent, from the point of view of one of the participants
Using	548	Child is <b>not</b> subtype of parent, but some FEs correspond to parent FEs; parent provides “conceptual background”

Subframe	123	Child is a subevent of a complex event,
Precedes	82	temporal relation between subevents (subframes) of a complex event
Causative_of	55	Most with names like “Cause to X”; causative adds Agent FE, so must be treated as a separate frame
Inchoative_of	16	Many with names like “Become X”, the related frame can be either an event or state
(See_also	52	Frames that might be confused; no inferences to be drawn.)



# Event structure and lexicalization

- The FN event frames presuppose a basic event structure: Pre-state, Transition, Post-state.
- Typically, only the change itself is lexicalized; there may or may not be any words for the pre- and post-states. (exceptions: *widow*, *candidate*, *corpse*, *trainee*)

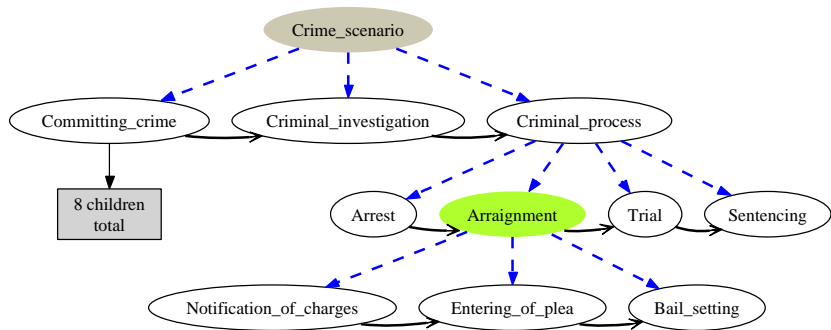


Figure: Frame representation of Criminal Process scenario

# General Structure of the Lattice of Frames

<b>Top</b>	<b>Inherit only</b>	<b>“Extended” relations</b>
Event	300	693
Relation	28	69
State	49	184
Entity	49	178
Locale	17	23
Process	5	51
“smaller graphs”	68	—
Singletons	45	

Note that FrameNet includes only entities that have a significant frame structure; thus we are not interested in most sortal nouns: they would all fall under very general frames, such as Entity or Artifact. We do not want to duplicate WordNet’s hierarchy of 150,000 nouns!

# Browsing the Net of Frames

- Frame Grapher
- Frame Categorization list

`http://www1.icsi.berkeley.edu/~warrenmc/  
FrameCategorization.html`

# Construction Grammar

- During the late 1980s and early 1990s, much of Fillmore's effort went into joint work with Paul Kay, Catherine O'Connor, and others on the development of Construction Grammar.
- But semantic frames were always presupposed in Fillmore's discussion of Construction Grammar (e.g. Kay & Fillmore 1999), just as Construction Grammar was always presupposed in discussions of Frame Semantics.
- The "Constructicon" project annotated examples of 50 constructions, e.g.
  - ▶ **Adjective as nominal abstract:** *And her dislike of the insincere ran so deep that . . .*
  - ▶ **Way manner:** *. . . Charles bulldozed his way through life.*

# FrameNet Users Worldwide



# Automatic Semantic Role Labeling (ASRL) a.k.a “Semantic Parsing”

- The Holy Grail of NLU
- Chicken-and-egg: insufficient hand-labeled data (ca. 20 annotations/lexical unit)
- But lots of smart people making progress:
  - ▶ (Gildea & Jurafsky 2000),(Gildea & Jurafsky 2002) Assumed sentences were “frame disambiguated”
  - ▶ Shameser (Erk & Padó 2006) working on SALSA Project at Saarbrücken
  - ▶ LTH ASRL system for English (Johansson & Nugues 2006a) and Swedish (Johansson & Nugues 2006b)
  - ▶ SEMAFOR (Das *et al.* 2013),(Das *et al.* 2010)

## Part III

# Current Projects and Future Research



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  - ▶ ASRL for text
  - ▶ Xnets for event modeling

# Collaboration with Google

Thanks to interest in FrameNet from a group of Google employees, we are experimenting on two fronts:

- testing what parts of FrameNet can be expanded less expensively through crowd-sourcing without sacrificing accuracy (probably frame discrimination and FE annotation), and
- devising better computational support for expert curation of those parts of FrameNet that require it (i.e. defining new frames and frame relations).



# FrameNets in other Languages and Multi-lingual FrameNet

- Funded projects have built or are currently creating building FrameNet-style lexical databases for German, Spanish, Japanese, Swedish, Chinese, French and Arabic.
- Separate efforts have created Frame Semantics-based resources for many other languages, including Italian, Korean, Polish, Bulgarian, Russian, Slovenian, Hebrew, and Hindi.
- Projects use a range of methodologies, from manual annotation like Berkeley FrameNet to largely automatic projection to target language.
- Active research on cross-linguistic comparisons, e.g. (Boas 2009).
- Planning is now underway for a unified, multi-lingual FrameNet

# Future research

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- Expand the Constructicon, link to ECG, other construction grammar work
- Improve links to other lexical resources
- Come to terms with continuous representations of word senses
- Increase coverage by an order of magnitude

# Shamelss plug

- The Second FrameNet Workshop will be held just after the close of ACL, on Sunday 6/29 at a Hotel near here
- For more information about the workshop or FrameNet in general, please visit <http://framenet.icsi.berkeley.edu>

## Thanks are due:

- to the organizers of this workshop, Miriam Petruck and Gerard de Melo,
- to the NSF for continued support for the original creation of FrameNet and a variety of later projects,
- to DARPA and IARPA and Decisive Analytics Corporation,
- to Google for a Faculty Research award,
- and, of course, to Chuck, the inspiration for both FrameNet and construction grammar.



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