Deep Lexical Semantics, Case, Constructions, and FrameNet

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Outline

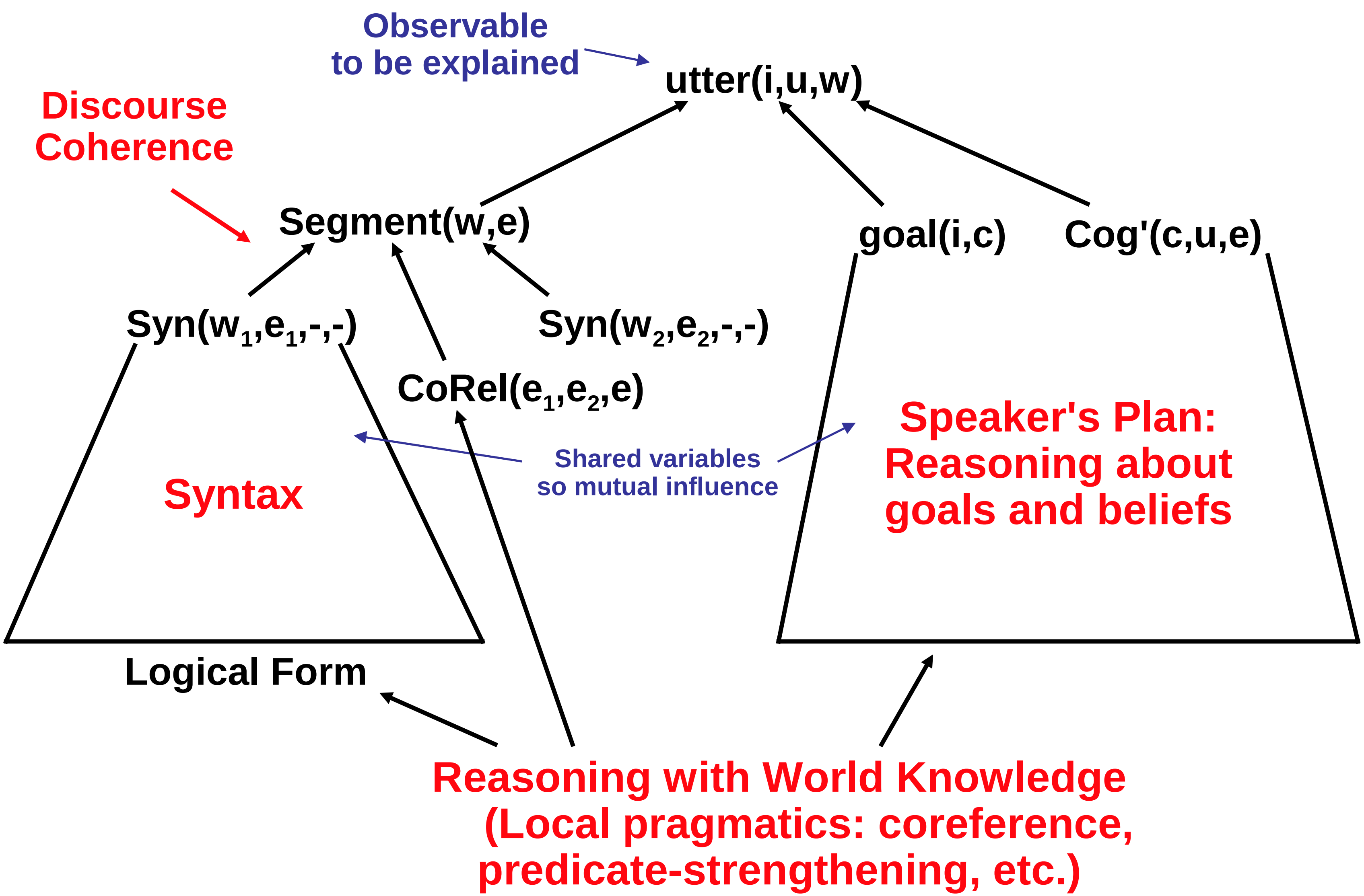
1. Deep Lexical Semantics

2. Case

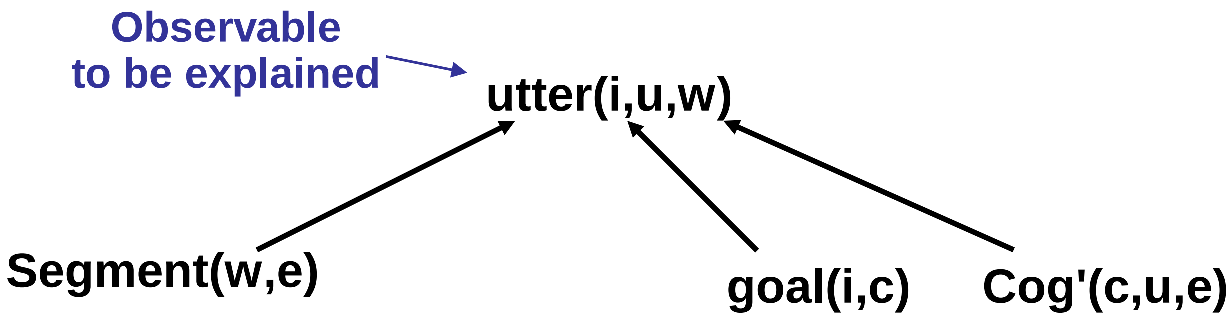
3. Constructions

4. FrameNet

The Big Picture

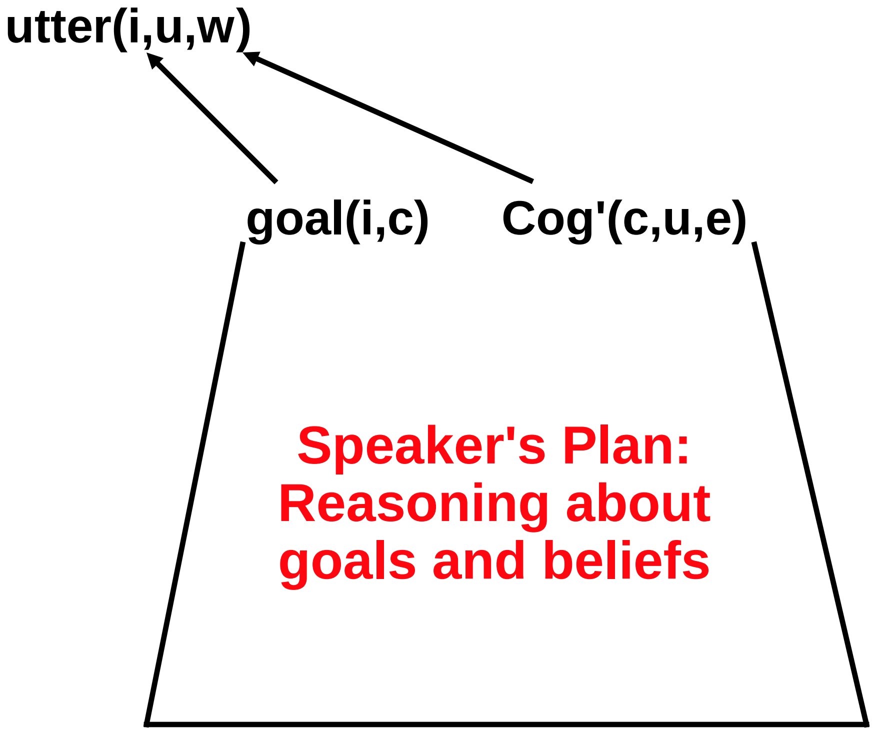


The Big Picture



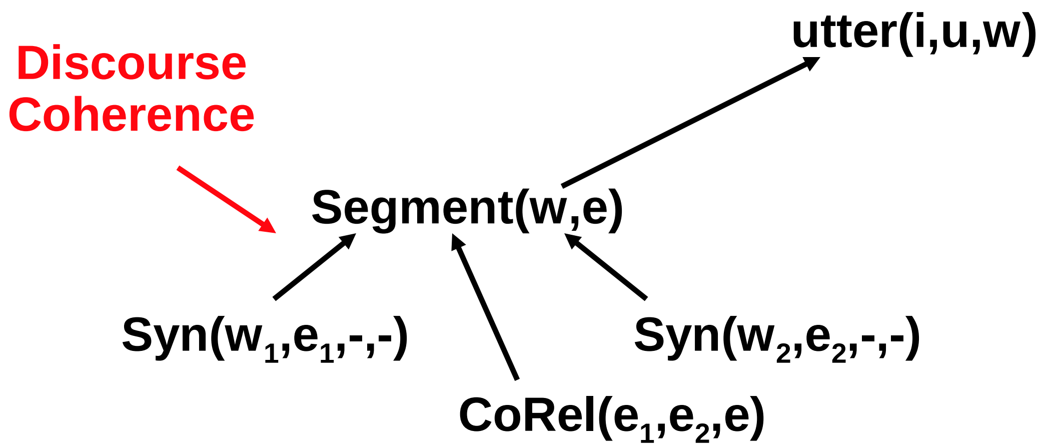
Utterance is an intentional act, intended to cause the hearer u to think about the conventional meaning e of string of words w.

The Big Picture



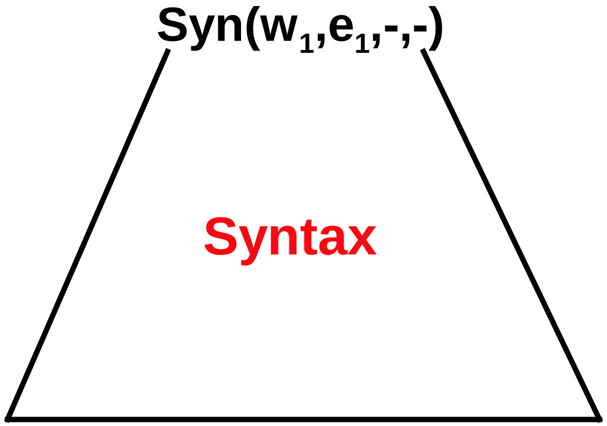
Pragmatics: Explain why speaker i wants to convey information e

The Big Picture



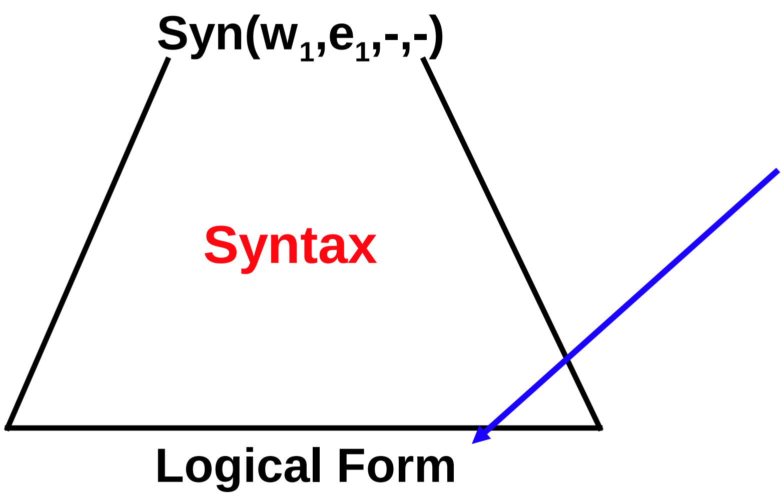
Explain adjacency of discourse segments as conveying coherence relations

The Big Picture



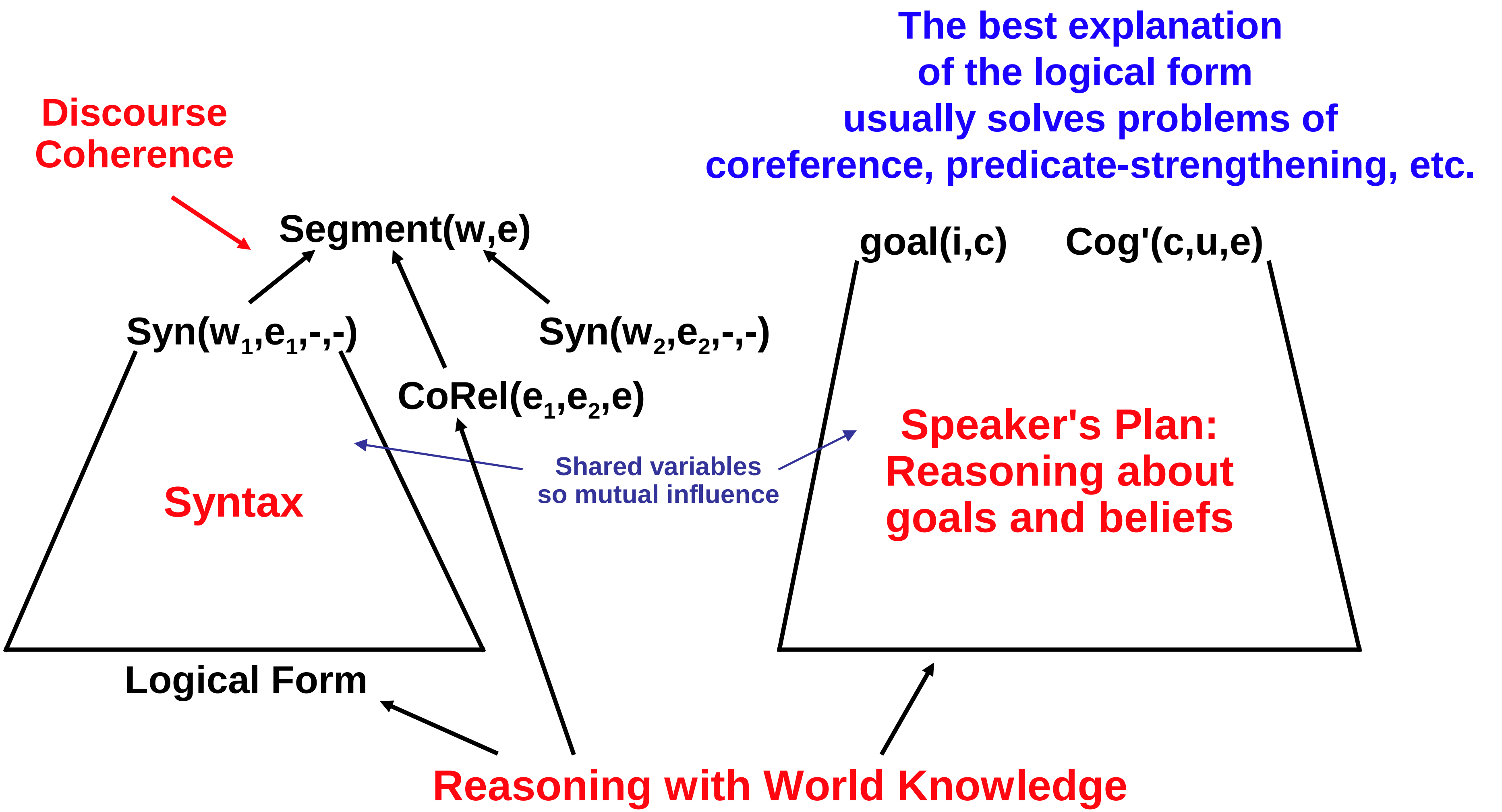
Syntax is
the explanation of adjacency
as
predicate-argument relations

The Big Picture

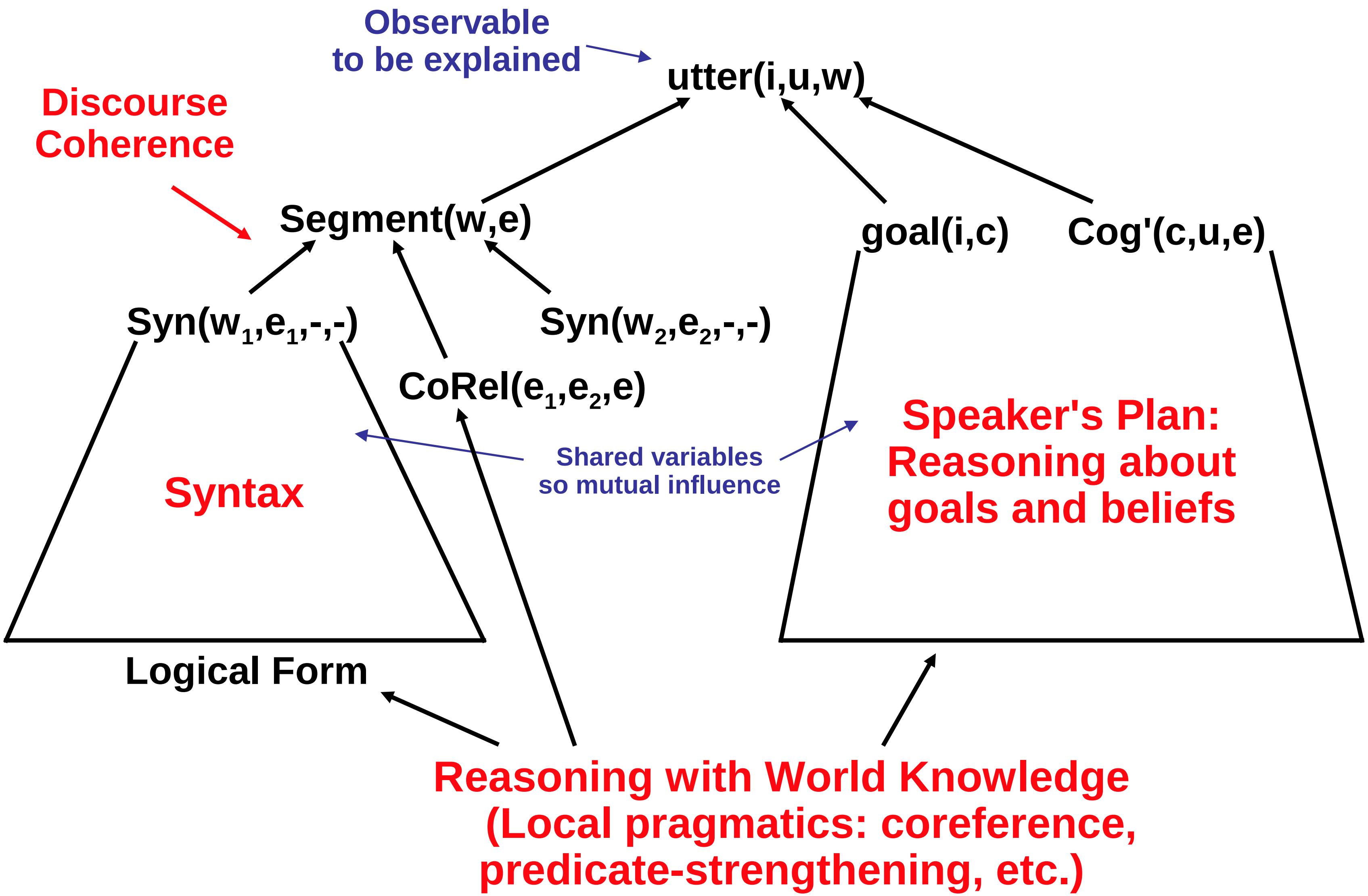


The best explanation of the occurrence of individual words is that they are intended to convey their conventional meanings.

The Big Picture



The Big Picture



Representation

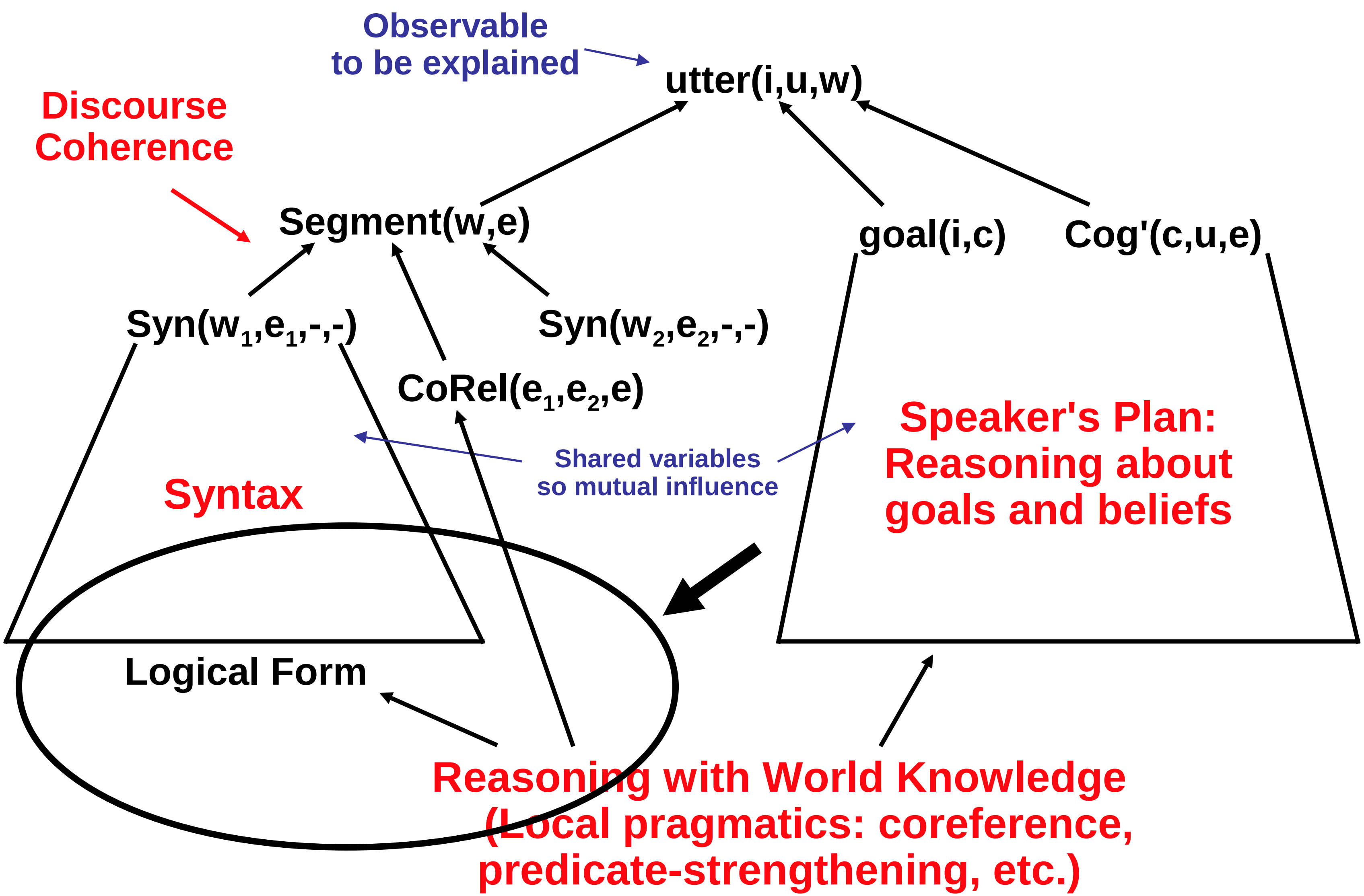
We need a common representation scheme for all these levels:

Ontologically promiscuous first-order logic

↑

**Reify states and events (eventualities)
for scope-free logical forms,
representational adequacy, etc.**

Zoom In


Observable
to be explained
utter(i,u,w)
Discourse
Coherence
Segment(w,e)
goal(i,c)
Cog'(c,u,e)
Syn(w_1,e_1,-,-)
Syn(w_2,e_2,-,-)
CoRel(e_1,e_2,e)
Speaker's Plan:
Reasoning about
goals and beliefs
Shared variables
so mutual influence
Syntax
Logical Form
Reasoning with World Knowledge
(Local pragmatics: coreference,
predicate-strengthening, etc.)

“Levels” of Processing

S --> NP VP

Syntax and Compositional Semantics:

$Syn(w_1,x,N,-,-,-,-)$ & $Syn(w_2,e,V,x,N,-,-,-)$
--> $Syn(w_1\ w_2,e,V,-,-,-,-)$

Syn is specialization of mean

$Syn(w_2,e,V,x,N,-,-,-)$ says string or VP w_2 describes situation e provided an NP subject describing x can be found in the right place

The rule says if w_1 is an NP describing x and w_2 is a VP describing e (if it had a subject x), then the concatenation w_1w_2 describes e (and doesn’t need a subject)

HPSG converted into FOL

“Levels” of Processing

Lexical Axioms:

kill’(e,x,y) & living-thing(y) --> Syn(“kill”,e,V,x,N,y,N)

pred-arg structure (incl word sense)

selectional constraint

spelling or phonology

category

subcategorization

Generative Semantics Revisited

Lexical Decomposition:

$$\text{kill}(x,y) \longleftrightarrow \text{cause}(x, \text{become}(\text{not}(\text{alive}(y))))$$

$$\text{kill}'(e_1,x,y) \longleftrightarrow \text{cause}'(e_1,x,e_2) \;\&\; \text{changeTo}'(e_2,e_3) \;\&\; \text{not}'(e_3,e_4) \;\&\; \text{alive}'(e_4,y)$$

Need this to understand:

My roommate killed all my plants.
He didn’t water them once while I was gone.

“Levels” of Processing

Lexical Decomposition:

cause’(e,x,become(not(alive(y)))) <--> kill’(e,x,y)

Core Theories:

water --> nourish;   enable(nourish,alive)

“Levels” of Processing

S --> NP VP

Syntax and Compositional Semantics:

Syn(w_1,x,N,-,-,-,-) & Syn(w_2,e,V,x,N,-,-,-)
--> Syn(w_1 w_2,e,V,-,-,-,-)

Lexical Axioms:

kill’(e,x,y) & living-thing(y) --> Syn(“kill”,e,V,x,N,y,N)

pred-arg structure (incl word sense)

selectional constraint

spelling or phonology

category

subcategorization

Lexical Decomposition:

cause’(e,x,become(not(alive(y)))) <--> kill’(e,x,y)

Core Theories:

water --> nourish; enable(nourish,alive)

A Sentence Interpreted

Syntax:

Syn("My roommate killed my plant.",e,-,-)

He didn't water them.

Syn("My roommate",x,-,-)

Syn("killed my plant.",e,x,-)

roommate(x,i)

Syn("killed",e,x,y)

Syn("my plant.",y,-,-)

Lexical Axioms:

kill'(e,x,y)

plant(y)

Lexical Decomposition:

cause(x,become(not(alive(y))))

cause(not(nourish(x,y)),not(alive(y)))

Core Theories:

cause(not(water(x,y)),not(nourish(x,y)))

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The Case for Case

The relations between predicates and arguments can be classified into a small number of categories.

Fillmore's original list:

- **Agentive**
- **Instrumental**
- **Dative**
- **Factitive**
- **Locative**
- **Objective**
- **Comitative**
- **Benefactive**

This proposal had a huge appeal among computational linguists; many lists developed, e.g., Source, Goal, (Inanimate) Cause, Time, etc.

Case and Lexical Decomposition

Chris moved the flower pots from the front yard to the back yard with a wheelbarrow.

$\text{cause}'(e_1,c,e_2)$ & $p'(e_2,w)$ & $\text{cause}'(e_3,e_2,e_4)$ & $\text{change}'(e_4,e_5,e_6)$ & $\text{at}'(e_5,p,f)$ & $\text{at}'(e_6,p,b)$

c causes an event involving w, which causes a change from p being at f to p being at b

Case and Lexical Decomposition

Chris moved the flower pots from the front yard to the back yard with a wheelbarrow.

$$\text{cause}'(e_1,c,e_2)\ \&\ p'(e_2,w)\ \&\ \text{cause}'(e_3,e_2,e_4)\ \&\ \text{change}'(e_4,e_5,e_6)\ \&\ \text{at}'(e_5,p,f)\ \&\ \text{at}'(e_6,p,b)$$

Agent: the entity initiating a causal chain

Instrument: an entity mediating a causal chain

Object: (Patient, Theme) entity undergoing change of state or location

Source: beginning of the change

Goal: end of the change

Variations

Agent vs. Instrument (vs. Cause):

The tornado destroyed the barn.

Dative vs. Object:

+animate vs. -animate

Comitative:

cause'(e1, {c,d}, e2) & ....

Problem

These standard cases or semantic roles seem appropriate exactly insofar as the verb decomposes into a pattern resembling that of "move".

"X lets Y Verb": What is X? Agent?

$not'(e_1,e_2)$ & $cause'(e_2, x, e_3)$ & $not'(e_3, e_4)$

x is the entity that *doesn't* initiate a causal chain

"X outnumbers Y": What are X and Y? (Patient and Locative?)

==> In FrameNet case labels are idiosyncratic and only mnemonics

Me: Forget the case labels; do the decomposition

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Constructions

A linguistic pattern whose meaning or function is not strictly predictable from the rules of compositional semantics and from the lexical semantics of its parts

The majority:

A linguistic pattern whose conventionalized meaning or function is among the possible interpretations generated from the rules of compositional semantics and from the lexical semantics of its parts (its motivation), but would not necessarily be chosen as the correct interpretation without the convention

“Let’s”

“Let us go.”: You and I should go together. [stilted]
You should release us. [victims to kidnapper]

“Let’s go.”: You and I should go together.

“Let’s”

utter’(e_0,i,u,“Let’s go”)

Syn(“Let’s go”,e,V,u,a,-,-)

Interpret “Let’s go” as a grammatical sentence

“You” is the addressee in utterance e_0

you(u,e_0)

“Let’s”

utter’(e_0,i,u,“Let’s go”)

Syn(“Let’s go”,e,V,u,a,-,-)

Contraction expanded

Syn(“Let us go”,e,V,u,a,-,-)

you(u,e_0)

“Let’s”

utter’(e_0,i,u,“Let’s go”)

Syn(“Let’s go”,e,V,u,a,-,-)

Syn(“Let us go”,e,V,u,a,-,-)

Syn(“Let”,e,V,u,a,y,N,e2,V.Tnsless.OC)

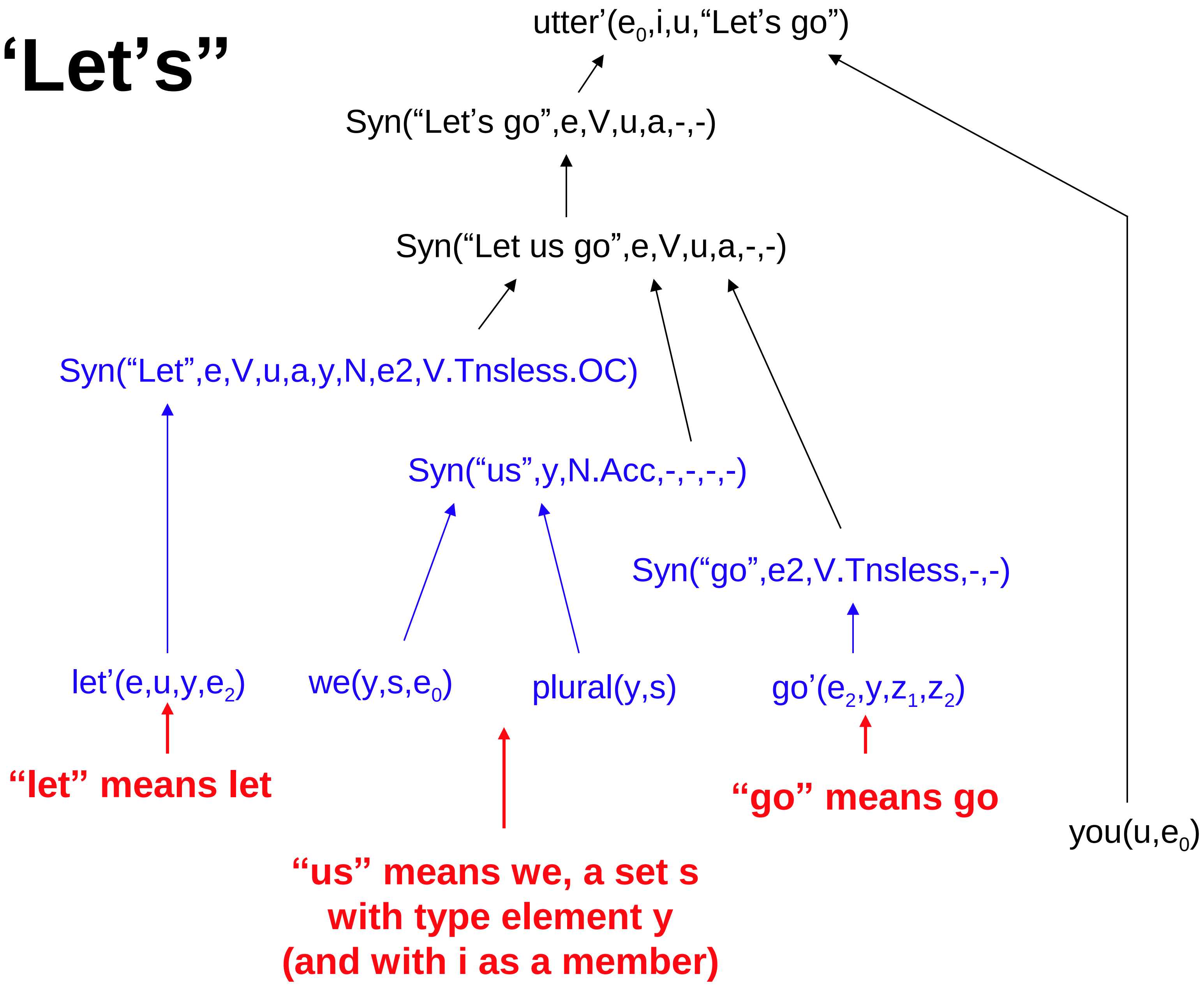
Syn(“us”,y,N.Acc,-,-,-,-)

Syn(“go”,e2,V.Tnsless,-,-,-)

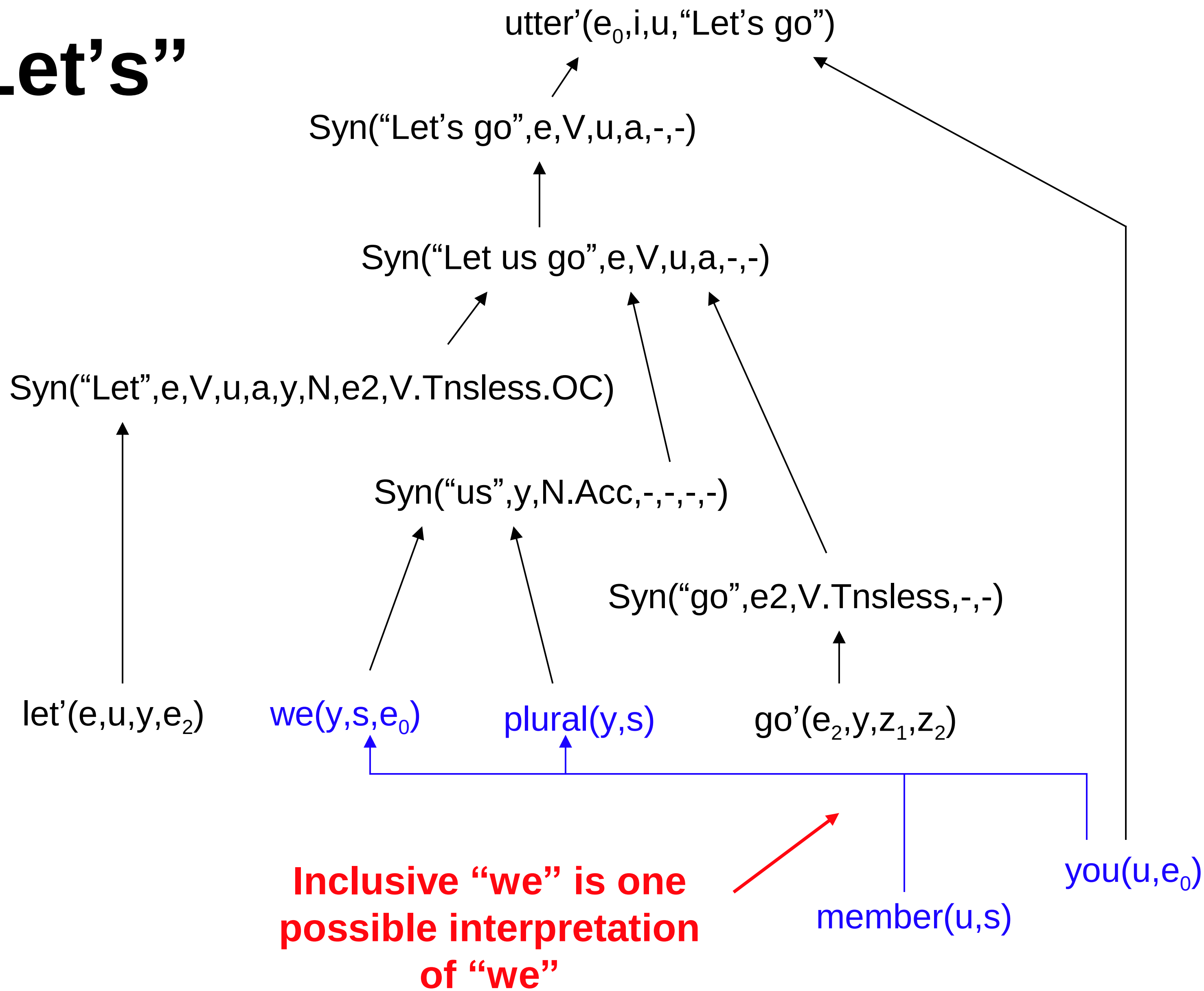
VP deconcatenated into Verb and Small Clause

you(u,e_0)

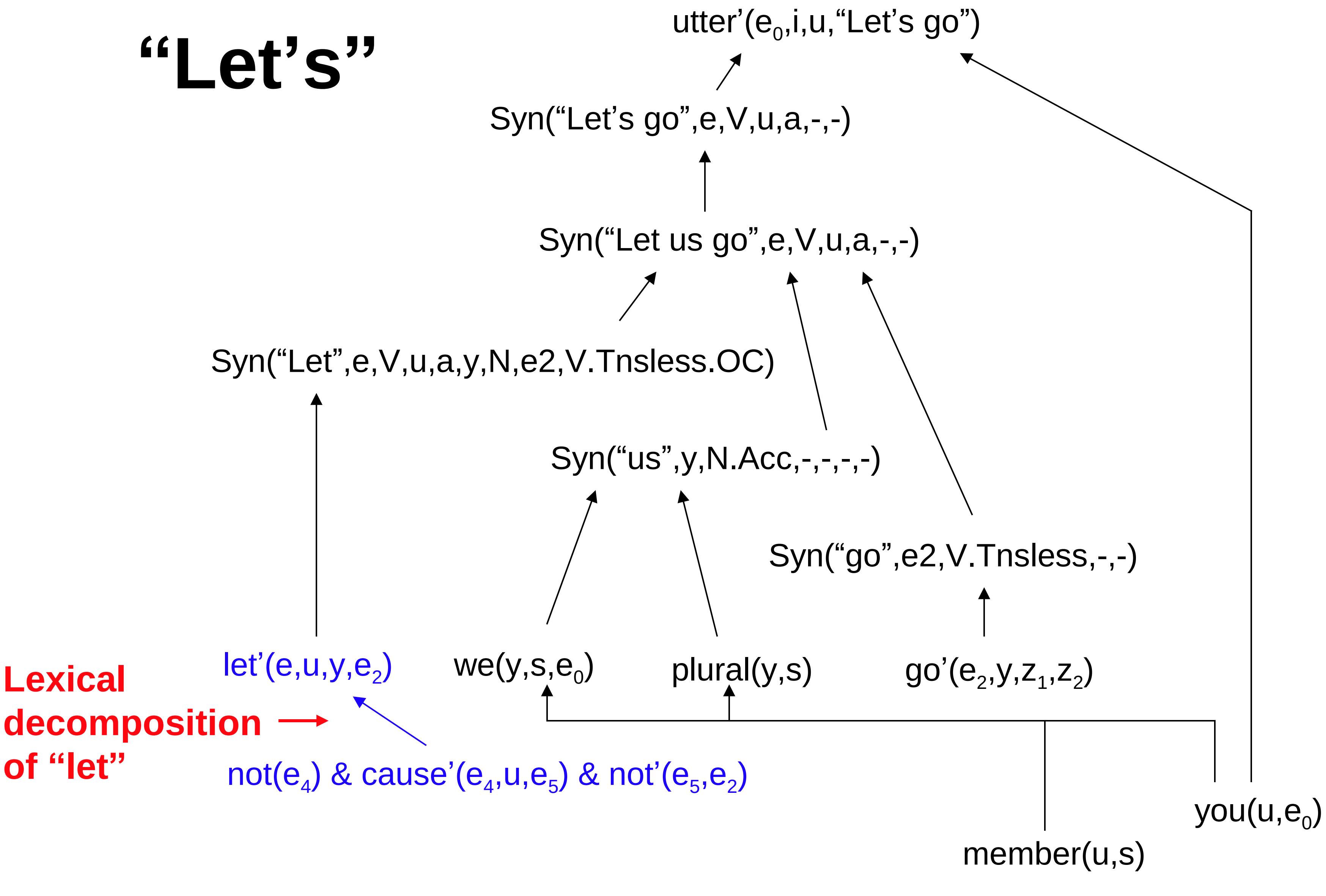
“Let’s”


utter’(e_0,i,u,“Let’s go”)
Syn(“Let’s go”,e,V,u,a,-,-)
Syn(“Let us go”,e,V,u,a,-,-)
Syn(“Let”,e,V,u,a,y,N,e2,V.Tnsless.OC)
Syn(“us”,y,N.Acc,-,-,-,-)
Syn(“go”,e2,V.Tnsless,-,-)
let’(e,u,y,e_2)
we(y,s,e_0)
plural(y,s)
go’(e_2,y,z_1,z_2)
you(u,e_0)
“let” means let
“go” means go
“us” means we, a set s
with type element y
(and with i as a member)

“Let’s”


utter’(e0,i,u,“Let’s go”)
Syn(“Let’s go”,e,V,u,a,-,-)
Syn(“Let us go”,e,V,u,a,-,-)
Syn(“Let”,e,V,u,a,y,N,e2,V.Tnsless.OC)
Syn(“us”,y,N.Acc,-,-,-,-)
Syn(“go”,e2,V.Tnsless,-,-)
let’(e,u,y,e2)
we(y,s,e0)
plural(y,s)
go’(e2,y,z1,z2)
you(u,e0)
member(u,s)
Inclusive “we” is one possible interpretation of “we”

“Let’s”



utter’(e0,i,u,“Let’s go”)
Syn(“Let’s go”,e,V,u,a,-,-)
Syn(“Let us go”,e,V,u,a,-,-)
Syn(“Let”,e,V,u,a,y,N,e2,V.Tnsless.OC)
Syn(“us”,y,N.Acc,-,-,-,-)
Syn(“go”,e2,V.Tnsless,-,-)
let’(e,u,y,e2)
we(y,s,e0)
plural(y,s)
go’(e2,y,z1,z2)
Lexical decomposition of “let”
not(e4) & cause’(e4,u,e5) & not’(e5,e2)
you(u,e0)
member(u,s)

"Let's"

utter'(e_0,i,u,"Let's go")

Syn("Let's go",e,V,u,a,-,-)

Syn("Let us go",e,V,u,a,-,-)

Syn("Let",e,V,u,a,y,N,e2,V.Tnsless.OC)

Syn("us",y,N.Acc,-,-,-,-)

Syn("go",e2,V.Tnsless,-,-)

let'(e,u,y,e_2) we(y,s,e_0) plural(y,s) go'(e_2,y,z_1,z_2)

not(e_4) & cause'(e_4,u,e_5) & not'(e_5,e_2)

you(u,e_0)

Your not going causes the set "us" not to go

member(u,s)

cause(e_6,e_5) & not'(e_6,e_7) & go'(e_7,u,z_1,z_2)

“Let’s”

This is the motivation for the convention, but it’s only one interpretation among among many possible

utter’(e_0,i,u,“Let’s go”)

Syn(“Let’s go”,e,V,u,a,-,-)

Syn(“Let us go”,e,V,u,a,-,-)

Syn(“Let”,e,V,u,a,y,N,e2,V.Tnsless.OC)

Syn(“us”,y,N.Acc,-,-,-,-)

Syn(“go”,e2,V.Tnsless,-,-)

let’(e,u,y,e_2) we(y,s,e_0) plural(y,s) go’(e_2,y,z_1,z_2)

not(e_4) & cause’(e_4,u,e_5) & not’(e_5,e_2)

you(u,e_0)

member(u,s)

cause(e_6,e_5) & not’(e_6,e_7) & go’(e_7,u,z_1,z_2)

“Let’s”

The convention:
You and we go
as one set

utter’(e_0,i,u,“Let’s go”)

Syn(“Let’s go”,e,V,u,a,-,-)

Syn(“Let us go”,e,V,u,a,-,-)

Syn(“Let”,e,V,u,a,y,N,e2,V.Tnsless.OC)

Syn(“us”,y,N.Acc,-,-,-,-)

Syn(“go”,e2,V.Tnsless,-,-)

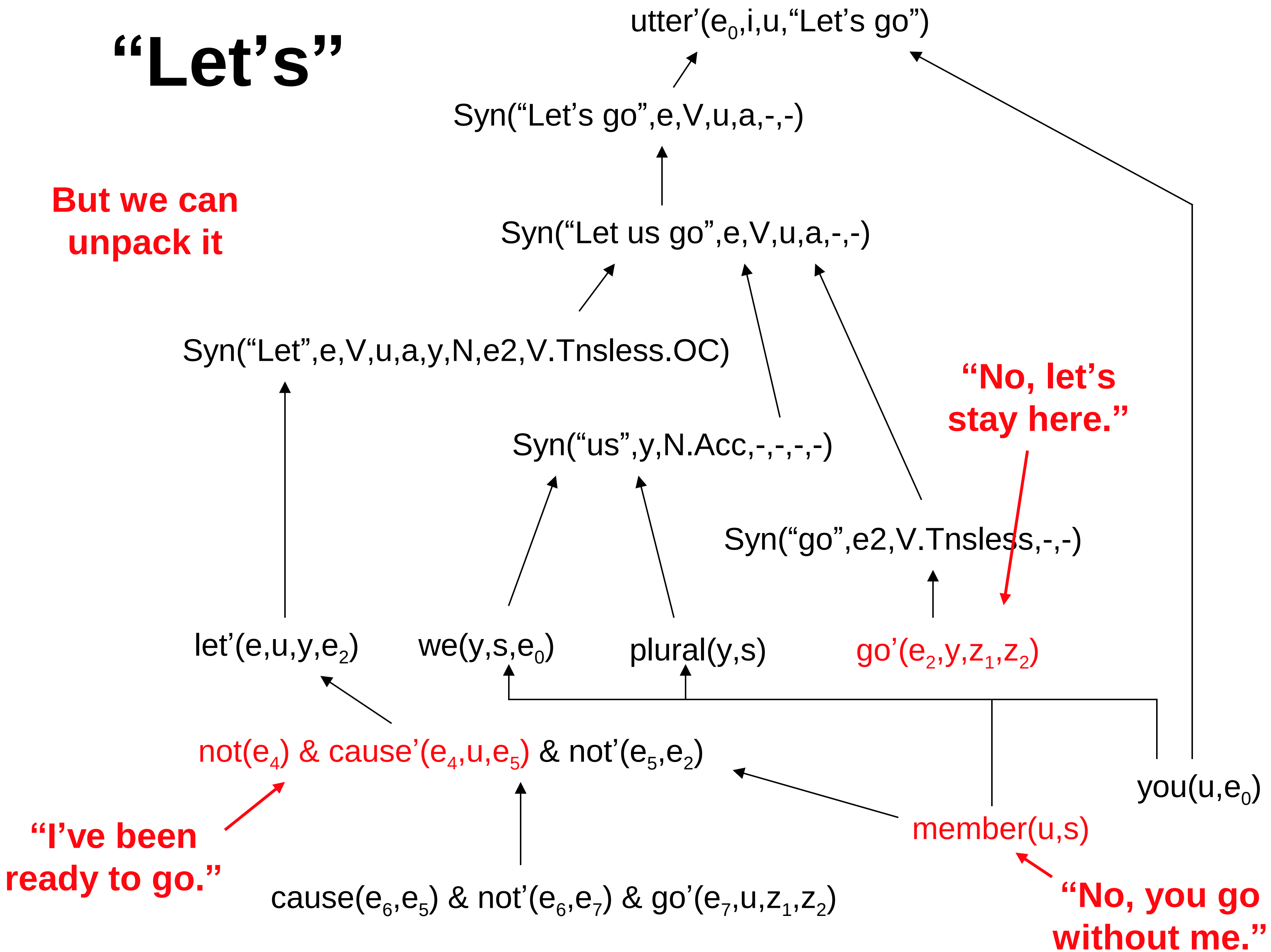
let’(e,u,y,e_2) **we(y,s,e_0)** **plural(y,s)** **go’(e_2,y,z_1,z_2)**

not(e_4) & cause’(e_4,u,e_5) & not’(e_5,e_2) **you(u,e_0)**

member(u,s)

cause(e_6,e_5) & not’(e_6,e_7) & **go’(e_7,u,z_1,z_2)**

“Let’s”



utter’(e_0,i,u,“Let’s go”)
Syn(“Let’s go”,e,V,u,a,-,-)
But we can unpack it
Syn(“Let us go”,e,V,u,a,-,-)
Syn(“Let”,e,V,u,a,y,N,e2,V.Tnsless.OC)
“No, let’s stay here.”
Syn(“us”,y,N.Acc,-,-,-,-)
Syn(“go”,e2,V.Tnsless,-,-)
let’(e,u,y,e_2)
we(y,s,e_0)
plural(y,s)
go’(e_2,y,z_1,z_2)
not(e_4) & cause’(e_4,u,e_5) & not’(e_5,e_2)
you(u,e_0)
member(u,s)
“I’ve been ready to go.”
cause(e_6,e_5) & not’(e_6,e_7) & go’(e_7,u,z_1,z_2)
“No, you go without me.”

"Let Alone"

"let" means not-cause-not
"let" subcategorizes for small clauses
"alone" means not part of some larger structure

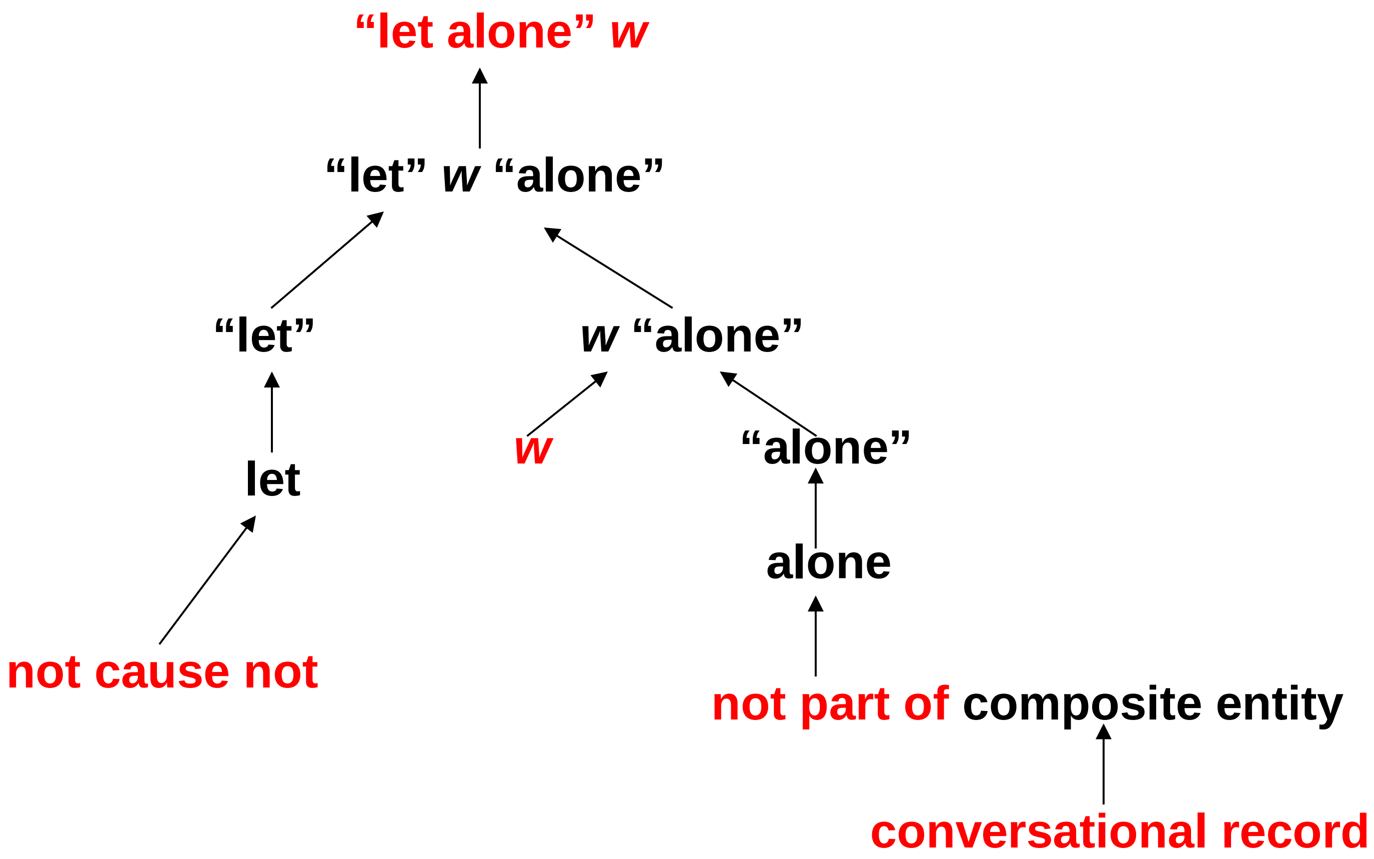
Let that dog alone. It's vicious:
  Don't cause the dog to be not alone by interacting with it.

Let "general" alone. He didn't make colonel:
  Don't cause "general" to be not alone by entering it into the conversational record

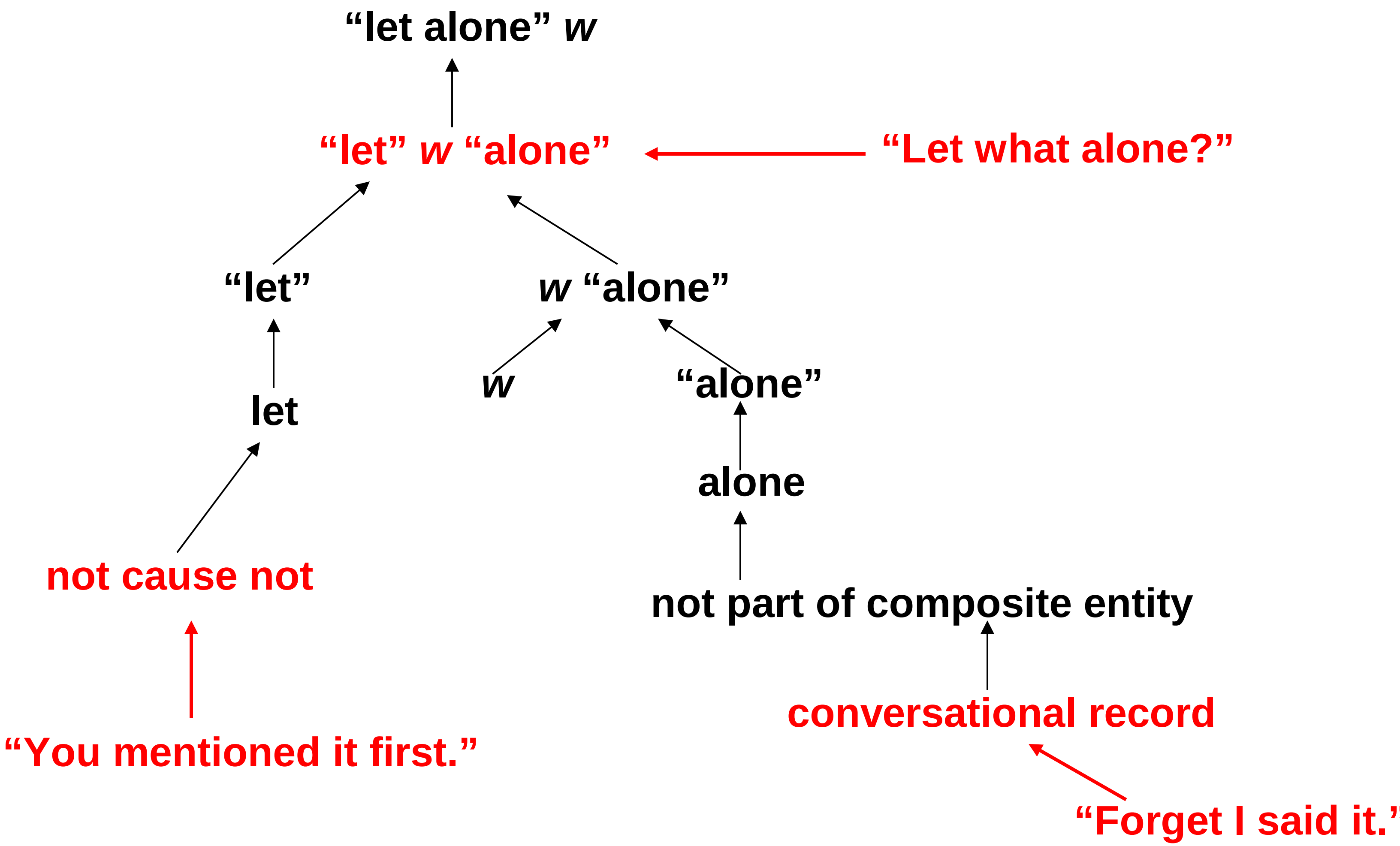
Invert NP and Pred in small clause:
  Let alone the very idea of him being general. He didn't make colonel.

Reinterpret "let alone" as a conjunction, conveying order on a scale:
  He didn't make colonel, let alone general.
  Don't cause "general" to be not alone by entering it into the conversational record, because something lower on a scale is already false

“Let Alone”


“let alone” *w*
“let” *w* “alone”
“let”
w “alone”
w
“alone”
let
alone
not cause not
not part of composite entity
conversational record

“Let Alone”



“let alone” *w*
“let” *w* “alone”
“Let what alone?”
“let”
w “alone”
w
“alone”
let
alone
not cause not
not part of composite entity
conversational record
“You mentioned it first.”
“Forget I said it.”

Cause Motion

He hit the ball out of the park.
They laughed him off the stage.
She blinked the snow from her eyelashes.

cause

Interpret adjacency as “cause”, since predicate-argument relation is unavailable

$\text{move}_1\text{(snow, eyelashes, z)}$

Motion implicit in “from”

She blinked   the snow   from her eyelashes.

May reinterpret verb as subcategorizing for small clause with cause motion interpretation

$\text{Syn}(w_1,e_1,v,\ldots)\ \&\ \text{Syn}(w_2,e_2,\text{p.dir},\ldots)\ \&\ \text{cause}'(e,e_1,e_2)$
$\rightarrow \text{syn}(w_1 w_2,e,v,\ldots)$

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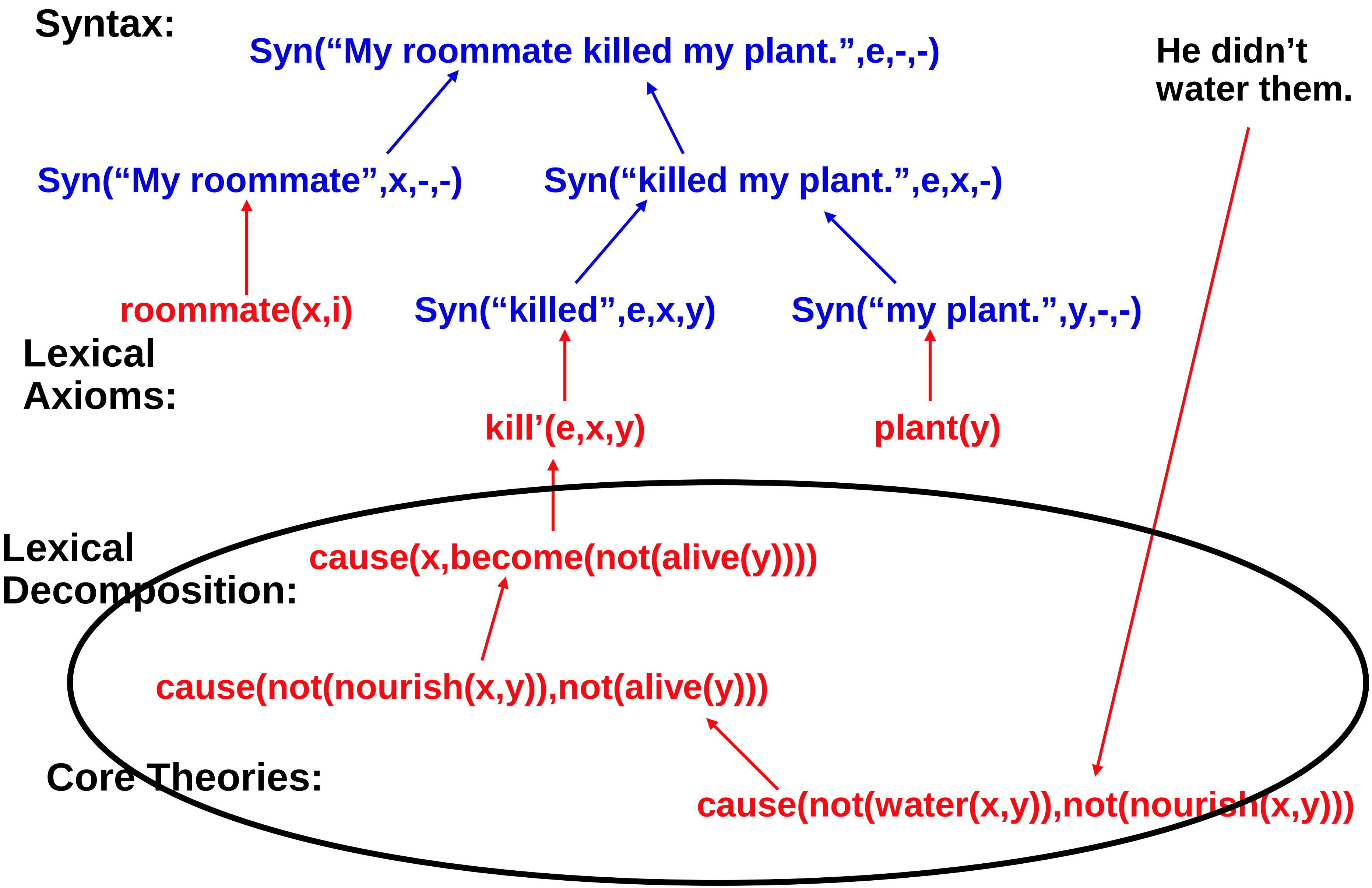
Where Does the Knowledge Come From?



FrameNet into Axioms

(Ovchinnikova)

Giving Frame:

$Giving(e_1,x_1,x_2,x_3)$ & $Donor(x_1,e_1)$ & $Recipient(x_2,e_1)$ & $Theme(x_3,e_1)$
--> $give'(e_1,x_1,x_3)$ & $to'(e_2,e_1,x_2)$

$Giving(e_1,x_1,x_2,x_3)$ & $Donor(x_1,e_1)$ & $Recipient(x_2,e_1)$ & $Theme(x_3,e_1)$
--> $hand'(e_1,x_1,x_3)$ & $to'(e_2,e_1,x_2)$

Frame-Frame Relations:

$Giving(e_1,x_1,x_2,x_3)$ & $Donor(x_1,e_1)$ & $Recipient(x_2,e_1)$ & $Theme(x_3,e_1)$
--> $Getting(e_2,x_1,x_2,x_3)$ & $Source(x_1,e_2)$ & $Recipient(x_2,e_2)$ & $Theme(x_3,e_2)$

Annotated corpus used to set weights

Also converted lexeme-synset relations, synset relations, derivational relations in WordNet into axioms

Size of Knowledge Base

Frame-Lexeme Axioms	49,100
Frame-Frame Axioms	5,300
Axioms from WordNet	383,000

Recognizing Textual Entailment

T: He became a boxing referee in 1964 and became most well-known for his decision against Mike Tyson, during the Holyfield fight, when Tyson bit Holyfield's ear.

H: Mike Tyson bit Holyfield's ear in 1964.

Cost(Int(KB=>H)) >> Cost(Int(KB+T=>H))?

Is the cost of an abductive proof of H much less with T than without T?

Results on RTE-2

No KB (lexical overlap)	57.3%
WordNet alone	59.6%
FrameNet alone	60.1%
WordNet + FrameNet	62.6%

No special tuning for RTE task.
Would have been 3rd in RTE-2; two leaders low 70s; most high 50s.
Substantial improvements in inference engine since then.

Modest improvement with FrameNet
FrameNet a better resource for inference than WordNet
More knowledge sources are needed

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Summary

Chuck Fillmore will be missed