LEXICAL SEMANTICS (AGAIN)

Basic premises

- Semantics at the sentential (and phrasal) level has been compositional, model-theoretic, truth-conditional
- Same principles can apply for lexical (word-level) semantics
  - Decomposition
  - Logical relations
  - Semantics/morphology interface
  - Type coercion
  - Fuzzy evaluations

Sources of entailment

- X sneezed and coughed.
  X coughed.
- X does not hate Hamlet.
  X might like Hamlet.
- X wiped the counter clean.
  X cleaned the counter by wiping it.
- X loaded the wagon with hay.
  X loaded hay on the wagon.
- X opened the door.
  The door is open.
- X shaved.
  X shaved himself.
- X ate.
  X ate food.
- X is my uncle.
  X is male.
- X drank water.
  X drank some liquid.

Selectional restrictions

- Clear example of the interplay of pragmatics and semantics
  - #My hammer is happy.
  - #I am being hungry.
- Certain verbs only allow certain types of arguments.
- Certain modification patterns are not allowed.
- Constraints like animacy, gender, TAM, groundedness, etc.

- Extends to co-occurrence too
- Implications for how to define/specify/constrain/interpret lexical usage

Verb classes and entailment

- Causatives
  - X causes Y (e.g. opened the door, emptied the tub, etc.)
- Inchoatives
  - Change of state (e.g. The door opened. The boat sank.)
- Causation entails inchoatives, which in turn entail the consequence.
  - Joan emptied the tub.
    The tub emptied.
    The tub is empty.

Verb morphology

- English –en inchoative suffix (“become”, change of state)
  - blacken, whiten, *bluen, *yellowen
- Causative morpheme (English uses syntax, not morphology)
  - Chichewa
    Mtsikana a-na-u-gw-*ets*-a
    girl SP-PAST-OP-fall-CAUS-ASP
    The girl made (the waterpot) fall.

- General (maybe universal?) schema for causation and becoming:

(27) *a.* CAUSE(x, BECOME($P(b)$))
b. BECOME($P(b)$)
c. $P(b)$

Semantic primitives

- BECOME, CAUSE, etc.
- Capture the atomic nature of relationships that are putative universals
- Various inventories by different researchers
- Analogous to thematic roles for verb arguments: AGENT, PATIENT, INSTRUMENT, PROPOSITION, etc.

Becoming and causing

(28) "BECOME(ϕ)" is true at instant i iff ϕ is true at an i' that immediately follows i and is false at an i'' that immediately precedes i.

(29) *a.* If ϕ, ψ are formulas, then $C(\phi, \psi)$, to be read as "ϕ causes ψ," is also a formula.

b. "$C(\phi, \psi)$" is true at instant i in world w iff (i) ϕ and ψ are both true at i in w and (ii) in the worlds that differ minimally from w, where ψ is not the case, ϕ is also not the case.

(30) CAUSE$(x, \phi) = C(P(x), \phi)$ (for some property P)

Lexical decomposition

- Basic insights from generative semanticists of 1960's
- Use λ operator
- mother′ = λx[parent′(x) & female′(x)]
- Enables standard deductive techniques
- Aspectual classes: states, actions, telic verbs (Dowty's diagnostics)

(32) $\text{open}'_t = \lambda y \lambda x[\text{CAUSE}(x, \text{BECOME}(\text{open}'_a(y)))]$

$$[\![\lambda x \lambda y[\phi]]\!]^{M,w,i,c,g} = \{\langle u, u' \rangle : [\![\phi]\!]^{M,w,i,c,g[[u/x]u'/y]} = 1\}.$$

More relations

type shifting

a. die, V_i, λx BECOME(dead′(x))
b. kill, V_t, $\lambda y \lambda x$[CAUSE(x, BECOME(dead′(y)))]

a. dead, Adj, λx [¬alive′(x)]
b. alive, Adj, λx[¬dead′(x)]

a. If α is in Adj, then α (or α + en) is in V_t.
b. $\alpha'_t = \lambda y \lambda x$[CAUSE($x$, BECOME($\alpha'_a(y)$))]
c. α = clean, dirty, smooth, . . . , flat, moist, fat, . . .

a. If α is in Adj, then α or α + en is in V_i.
(If α ends in a nonnasal consonant, then α + en is the verbal form.)
b. $\alpha(+\text{en})'_i = \lambda y$[BECOME($\alpha'_a(y)$)]
α = open, empty, warm, red, black, short, . . .

a. If α is in V_i, then α is in V_t.
b. $\alpha'_t = \lambda y \lambda x$[CAUSE(x, $\alpha'_i(y)$)]
α = sink, drown, open, empty, . . .

Sample aspectual operators

- DO: binary relation between individuals and properties (e.g. DO(j,MOTION))
- BECOME: one-place operator with temporal implications
- CAUSE: two-place relation between individuals and circumstances
- Predicatives, intransitives, transitives: associated
  - $open'_t = \lambda y \lambda x[CAUSE(x, BECOME(open'_a(y)))]$

Semantic classes, operations, and constraints

- Inchoative rule: form intransitives from adjectives
- Causative rule: form transitives from intransitives
- States: lack a natural culmination, subject is nonagentive, extend over a period of time, cannot be put in the progressive, odd in imperative
  - #I am knowing French.
    #Like durians!
    #It took an hour to be proud.
- Activities: lack a natural culmination, subject is agentive, not instantaneous, admit progressive/imperative
  - She is driving a car.
    Drive a car!
- Telic eventualities: have a natural culmination, admit progressive/imperative
  - She is falling asleep.
    Fall asleep!

Summary

- States
  - Homogeneous; lack natural culmination point; subject is nonagentive
  - Like snapshots of a given circumstance
  - Usually infelicitous: progressive, odd in imperative, *It took a year to VP
  - I am hungry. I am learning French.
- Activities
  - Agentive action; lack natural culmination point
  - NOT a snapshot of a circumstance
  - OK: progressive, imperative; *It took a year to VP
  - John is eating. Fred sneezed.
- Telic eventualities
  - Natural endpoint/culmination
  - OK: progressive, imperative, It took a year to VP
  - Joan is falling asleep. Michelangelo painted the Sistine Chapel ceiling.

Meaning postulates

- Axioms that can replace decompositional analysis in spelling out the semantic part of morphological rules
- Constraints on lexical relations
  - $\square\forall x\forall y[open'_t(x, y)) \leftarrow\rightarrow CAUSE(x, BECOME(open'_a(y)))]$
- Differences from lexical decomposition?
  - Issues of basic semantic categories, lexical and conceptual acquisition, and complexity
  - Much work being done in psycholinguistics, cognitive science, AI, etc. etc.
- Possible to combine both approaches

a. $\square\forall x[\alpha'_i(x) \leftrightarrow \textsc{become}(\alpha'_a(x))]$

b. $\square\forall x\forall y[\alpha'_t(x, y) \leftrightarrow \textsc{cause}(x, \alpha'_i(y))]$

where α = *open*, *empty*, *break* (*broken*), etc.

a. If α is in V_i, then α is also in V_t

b. $\square\forall x\forall y[\alpha'_t(x, y) \leftrightarrow \textsc{cause}(x, \alpha'_i(y))]$

where α = open, close, empty, sink, redden, fatten, etc.

$\square\forall y\forall x[\text{kill}'(x, y) \leftrightarrow \textsc{cause}(x, \textsc{become}(\text{dead}'(y)))]$

$\square\forall x\forall y[\alpha'_t(x, y) \rightarrow \textsc{cause}(x, \alpha'_i(x, y))]$

Type shifting/coercion

- "walk": no natural end point (i.e. activity)
  "walk to school": there is one (i.e. telic eventuality)
- Compositional syntactic combination yields semantic shifting to a different type
- English: common
  - adjectives ←→ adverbs
  - time nouns ←→ adverbs
  - intransitives ←→ transitives
  - etc. etc.
- Other languages too
- Huge literature on this topic

a. If α is in V_t, then $\alpha + able$ is in Adj.

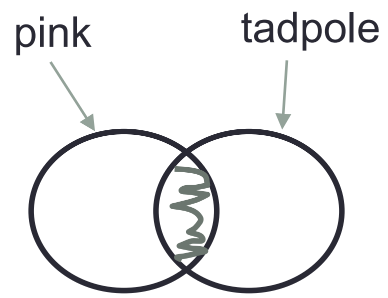
b. $\Box\forall x[[\alpha + able]'(x) \rightarrow \Diamond\exists y(\alpha'(y, x)]$
where α = *like*, *hate*, *wash*, etc.

Word formation rules

- Derivational morphology and its interface with semantic analysis
- Two basic approaches
  - Rules specify interpretation
  - Rules only constrain interpretation
  - Not incompatible, rather a continuum
- Much work remains to be done on this point, especially for morphologically rich languages

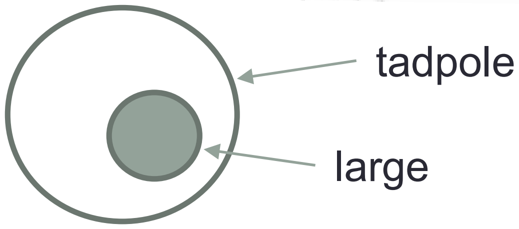
- Causatives and light verbs
  - Decompose verb meaning in the syntax
  - Motivation for Larsonian *v*-shell layer in phrase structure
  - Empty pronouns for reflexives

Adjectives and logical types



- Intersective adjectives (*pink*): properties
  - Has an extension at every index <w,i>
  - Set intersection

$$[\![[\text{pink tadpole}]']\!]^{M,w,i,g} = [\![\text{pink}']\!]^{M,w,i,g} \cap [\![\text{tadpole}']\!]^{M,w,i,g}$$



$$[\![[\text{large tadpole}]']\!]^{M,w,i,g} \subseteq [\![\text{tadpole}']\!]^{M,w,i,g}$$

- Subsective adjectives (*large*): properties
  - Contextual, relational, set of comparison classes
  - Subset selection
- Nonpredicative adjectives (*former*)
  - Property that modifies another property
  - *alleged*, *so-called*, *putative*, etc.
  - *X is an alleged killer*. would be wrong as: λx(killer′(x) & alleged′(x))
    - Instead, we want something like: alleged′(λx(killer′(x))

Another operator for IPC:

- OP-Pred$_1$: An operator on one-place predicates
- Function that maps from input properties to output properties
  - Remember: properties are functions from circumstances to sets
- Syntax: 1-place predicate that combines with another 1-place predicate

(79) *a.* If O is in Op-Pred$_1$ and β is in Pred$_1$, $O(^\wedge\beta)$ is in Pred$_1$.
b. If O is in Op-Pred$_1$ and β is in Pred$_1$, $[\![O(^\wedge\beta)]\!]^{M,w,i,c,g} = [\![O]\!]^{M,w,i,c,g}([\![^\wedge\beta]\!]^{M,w,i,c,g})$, where $[\![^\wedge\beta]\!]^{M,w,i,c,g}$ is the property r that is the intension of β, that is, for every $\langle w', i'\rangle$, $r(\langle w', i'\rangle) = [\![\beta]\!]^{M,w',i',c,g}$.

(87) *a.* $\bar{\mathrm{N}} \rightarrow \mathrm{Adj}\ \bar{\mathrm{N}}$
a′. If $\Delta = [_{\mathrm{N}}\ \mathrm{Adj}\ \bar{\mathrm{N}}]$, $\Delta' = \mathrm{Adj}' \wedge \mathrm{N}'$, if Adj′ is in Pred$_1$
$= \mathrm{Adj}'(^\wedge\mathrm{N}')$, if Adj′ is in Op-Pred$_1$
b. VP → be Adj
b′. If $\Delta = [_{\mathrm{VP}}\ \text{be Adj}]$, $\Delta' = \mathrm{Adj}'$

(80) *a.* $[_{\bar{\mathrm{N}}}$ former senator$]$
b. former′($^\wedge$senator′)

(81) *a.* $[_{\bar{\mathrm{N}}}$ alleged killer$]$
b. alleged′($^\wedge$killer′)

(82) $\Box\forall x[\mathrm{former}'(^\wedge Q)(x) \leftrightarrow \mathbf{P}Q(x)]$

(83) *a.* $O(^\wedge\beta)(x)$
b. $\beta(x)$

(a) → (b): X not licensed

Comparison classes

- a few elephants
  a few ants
  } how many?

- a large tadpole
  a large airplane
  } how big?

- Contextually determined

Event variables

- Reify the event (i.e. make it a "thing")
- Create a variable to refer to the event
- Use predicates over the variable as necessary

$\exists e\ \text{kiss}'(\text{Kim}', \text{Lee}', e)$

a. Kim kissed Lee passionately on the mouth.
a′. $\exists e[\text{kiss}'(\text{Kim}', \text{Lee}', e) \wedge \text{passionate}(e) \wedge \text{on-the-mouth}(e)]$
b. Kim kissed Lee passionately and Kim kissed Lee on the mouth.
b′. $\exists e[\text{kiss}'(\text{Kim}', \text{Lee}', e) \wedge \text{passionate}(e)] \wedge \exists e[\text{kiss}'(\text{Kim}', \text{Lee}', e) \wedge \text{on-the-mouth}(e)]$
c. Kim kissed Lee passionately.
c′. $\exists e[\text{kiss}'(\text{Kim}', \text{Lee}', e) \wedge \text{passionate}(e)]$

$\Box \forall x \forall y[\text{kiss}'(x, y) \rightarrow \text{move-}x\text{'s-lips}(x)]$

Event variables and thematic roles

- Specify a predicate (over the reified event) for each role
- Meta-level about the event (use double-prime)

(102) a. Lee kissed Kim.

b. $\exists e[\text{kiss}''(e) \wedge \text{AGENT}(e) = l \wedge \text{THEME}(e) = k]$

(103) a. Lee liked Kim.

b. $\exists e[\text{like}''(e) \wedge \text{EXPERIENCER}(e) = l \wedge \text{THEME}(e) = k]$

(104) a. $\Box\forall e[\textbf{kiss}''(e) \rightarrow \exists x(\text{AGENT}(e) = x)]$

b. $\Box\forall e[\textbf{kiss}''(e) \rightarrow \exists y(\text{THEME}(e) = y)]$

$\Box\forall e[\text{swallow}'(e) \rightarrow \Diamond\exists y(\text{THEME}(e) = y)]$

a. $\Box\forall e[\text{like}''(e) \rightarrow \exists x(\text{EXPERIENCER}(e) = x)]$

b. $\Box\forall e[\text{like}''(e) \rightarrow \exists y(\text{THEME}(e) = y)]$

Event time

- Reify current time as a constant (now′)
- Reify culminations (CUL) and states (HOLD)
- Specify temporal relations as before

(107) a. $\exists t \exists e[t < \text{now}' \wedge \text{kiss}''(e) \wedge \text{AGENT}(e) = l$
$\wedge\ \text{THEME}(e) = k \wedge \text{CUL}(e, t)]$
b. $\exists t \exists e[t < \text{now}' \wedge \text{like}''(e) \wedge \text{EXPERIENCER}(e) = l$
$\wedge\ \text{THEME}(e) = k \wedge \text{HOLD}(e, t)]$

(108) a. Lee is kissing Kim.
b. $\exists t \exists e[t = \text{now}' \wedge \text{kiss}''(e) \wedge \text{AGENT}(e) = j$
$\wedge\ \text{THEME}(e) = k \wedge \text{HOLD}(e, t)]$

(109) a. Joan awakened.
b. $\exists t \exists e[t < \text{now}' \wedge \text{awaken}''(e) \wedge \text{THEME}(e) = j$
$\wedge\ \text{BECOME}(\text{awake}')(e) \wedge \text{CUL}(e, t)]$

(110) a. Chris awakened Joan.
b. $\exists t \exists e[t < \text{now}' \wedge \text{CUL}(e, t) \wedge \text{AGENT}(e) = c \wedge \text{awaken}''(e)$
$\wedge\ (\exists t \exists e'[t < t' < \text{now}' \wedge \text{THEME}(e') = j \wedge \text{BECOME}(\text{awake}')(e')$
$\wedge\ \text{CAUSE}(e, e') \wedge \text{CUL}(e', t')]]$

Other issues

- Presupposition (again)
  - Discourse markers carry substantial presuppositions: how to capture?
  - Presupposition schema: probabilistic valuations (*even*)
- Imprecise predicates: probabilities

Qualia structures

- … finished the book.
  … finished the pizza.

  … a fast typist.
  … a fast car.
  … a fast road.

- Telic role specification
  - book: book(y) & read(x,y)
    pizza: pizza(y) & eat(x,y)
  - road: road(y) & vehicle(x) & travel(x) & ON(x,y)
    …