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.
- 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.
Verb classes

• Causatives
  • X causes Y (e.g. X opened the door, emptied the tub, etc.)

• Inchoatives
  • Change of state (e.g. The door opened. The boat sank.)

• Causatives entail inchoatives, which in turn entail the consequence.
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.

\[(27) \ a. \ \text{CAUSE}(x, \text{BECOME}(P(b))) \\
\hspace{1cm} b. \ \text{BECOME}(P(b)) \\
\hspace{1cm} c. \ P(b)\]
Causing and becoming

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

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

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

(30) \text{CAUSE}(x, \phi) = C(P(x), \phi) \text{ (for some property } P)
Lexical decomposition

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

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

\[
[\lambda x \lambda y \phi]_{M,w,i,c,g}^{M,w,i,c,g} = \{ (u, u') : [\phi]_{M,w,i,c,g}^{M,w,i,c,g}[u/x][u'/y] = 1 \}.
\]
More relations

a. die, \( V_i \), \( \lambda x \text{ BECOME(dead'}(x)) \)
b. kill, \( V_t \), \( \lambda y \lambda x[\text{CAUSE}(x, \text{ BECOME(dead'}(y)))] \)

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

a. If \( x \) is in \( V_i \), then \( x \) is in \( V_t \).
b. \( x'_t = \lambda y \lambda x[\text{CAUSE}(x, x'_t(y))] \)
   \( x = \) sink, drown, open, empty, ...
Sample aspectual operators

- **DO**: binary relation between individuals and properties (e.g. $\text{DO}(j,\text{MOTION})$)
- **BECOME**: one-place operator with temporal implications
- **CAUSE**: two-place relation between individuals and circumstances
- Predicatives, intransitives, transitives: associated
  - $\text{open}^t = \lambda y \lambda x [\text{CAUSE}(x, \text{BECOME}(\text{open}^t a(y)))]
- Type coercion is possible
Meaning postulates

- Constraints on lexical relations
  - $\Box \forall x \forall y[\text{open'}_t(x, y) \iff \text{CAUSE}(x, \text{BECOME}(\text{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

\begin{align*}
  a. \quad & \Box \forall x [x'_1(x) \iff \text{BECOME}(x'_a(x))] \\
  b. \quad & \Box \forall y \forall y [x'_1(x, y) \iff \text{CAUSE}(x, x'_1(y))] \\
  \text{where } & x = \text{open, empty, break (broken), etc.} \\
  \Box y \forall x [\text{kill'}(x, y) \iff \text{CAUSE}(x, \text{BECOME}(\text{dead'}(y)))]
\end{align*}

\begin{align*}
  a. \quad & \text{If } \alpha \text{ is in } V_i, \text{ then } \alpha \text{ is also in } V_t \\
  b. \quad & \Box \forall y \forall y [x'_1(x, y) \iff \text{CAUSE}(x, \alpha'_1(y))] \\
  \text{where } & \alpha = \text{open, close, empty, sink, redden, fatten, etc.} \\
  \Box y \forall x [\text{kill'}(x, y) \iff \text{CAUSE}(x, \text{BECOME}(\text{dead'}(y)))]
\end{align*}
Modality

a. If $x$ is in $V_t$, then $x + able$ is in Adj.

b. $\forall x[[x + able]'(x) \rightarrow \exists y(x'(y, x))]$

where $x = like, hate, wash, etc.$
More verb classes

• 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.
Type shifting

- “walk”: no natural end point (i.e. activity)
- “walk to school”: there is (i.e. telic eventuality)
- English: common
  - adjectives $\leftrightarrow$ adverbs
  - time nouns $\leftrightarrow$ adverbs
  - intransitives $\leftrightarrow$ transitives
  - etc. etc.
- Other languages too
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
Adjectives and logical types

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

- **Subsective adjectives (large): properties**
  - Contextual, relational, set of comparison classes
  - Subset selection

- **Nonpredicative adjectives (former)**
  - Property modifiers (functions from properties to properties) (a new type for us)
  - alleged, so-called, putative, etc.

$a. \ [\tilde{\eta} \text{ alleged killer}]$

$b. \ \text{alleged'}(\ ^\text{killer}')$

$\forall x[\text{former'}(\ ^Q)(x) \leftrightarrow P Q(x)]$
Comparison classes

• a few elephants
  a few ants

• a large tadpole
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

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

\[ a. \text{ Kim kissed Lee passionately on the mouth.} \]
\[ a'. \exists e [\text{kiss}'(\text{Kim}', \text{Lee}', e) \land \text{passionate}(e) \land \text{on-the-mouth}(e)] \]

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

\[ c. \text{ Kim kissed Lee passionately.} \]
\[ c'. \exists e [\text{kiss}'(\text{Kim}', \text{Lee}', e) \land \text{passionate}(e)] \]

\[ \Box \forall x \forall y [\text{kiss}'(x, y) \rightarrow \text{move-x's-lips}(x)] \]
Event variables and thematic roles

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

\[(102)\]
\[
a. \text{Lee kissed Kim.} \\
   b. \exists e \left( \text{kiss}''(e) \land \text{AGENT}(e) = l \land \text{THEME}(e) = k \right)
\]

\[(103)\]
\[
a. \text{Lee liked Kim.} \\
   b. \exists e \left( \text{like}''(e) \land \text{EXPERIENCER}(e) = l \land \text{THEME}(e) = k \right)
\]

\[(104)\]
\[
a. \Box \forall e \left( \text{kiss}''(e) \rightarrow \exists x (\text{AGENT}(e) = x) \right) \\
   b. \Box \forall e \left( \text{kiss}''(e) \rightarrow \exists y (\text{THEME}(e) = y) \right)
\]

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

\[
a. \Box \forall e \left( \text{like}''(e) \rightarrow \exists x (\text{EXPERIENCER}(e) = x) \right) \\
   b. \Box \forall e \left( \text{like}''(e) \rightarrow \exists y (\text{THEME}(e) = y) \right)
\]
Event time

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

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

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

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

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

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