Temporal Logic and Tense/Aspect

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CS 112
Tense

• Grammatical expression of the time of the situation described, relative to some other time (e.g., moment of speech)

George admires Mary.
George admired Kennedy.
Reichenbach

- Tensed utterances introduce references to 3 ‘time points’
  - Speech Time: $S$
  - Event Time: $E$
  - Reference Time: $R$

$sI$ had $[mailed$ the letter]$_E$ $[when$ John came & told me the news]$_R$

$E < R < S$

- The concept of ‘time point’ is an abstraction — it can map to an interval
- Three temporal relations are defined on these time points
  - at, before, after
- 13 different relations are possible
Reichenbachian Tense Analysis

<table>
<thead>
<tr>
<th>Relation</th>
<th>Reichenbach’s Tense Name</th>
<th>English Tense Name</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>E&lt;R&lt;S</td>
<td>Anterior past</td>
<td>Past perfect</td>
<td>I had slept</td>
</tr>
<tr>
<td>E=R&lt;S</td>
<td>Simple past</td>
<td>Simple past</td>
<td>I slept</td>
</tr>
<tr>
<td>R&lt;E&lt;S</td>
<td>Posterior past</td>
<td>E&gt;R&lt;S</td>
<td>I would sleep</td>
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<tr>
<td>R=S=E</td>
<td>Posterior present</td>
<td>S=R&lt;E</td>
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</tr>
<tr>
<td>S&lt;E&lt;R</td>
<td>Simple future</td>
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</tr>
<tr>
<td>S=R&lt;E</td>
<td>Posterior future</td>
<td></td>
<td>I shall be going to sleep</td>
</tr>
</tbody>
</table>

- Tense is determined by relation between R and S
  - R=S, R<S, R>S
- Aspect is determined by relation between E and R
  - E=R, E < R, E> R
- Relation of E relative to S not crucial
  - Represent R<S=E as E>R<S
- Only 7 out of 13 relations are realized in English
  - 6 different forms, simple future being ambiguous
  - Progressive no different from simple tenses
    - But I was eating a peach $

Je vais dormir

I shall be going to sleep

I ate a peach
### Tense as Operator: Prior

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<tr>
<th>Relation</th>
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</table>

- Free iteration captures many more tenses,  
  - *I would have slept*
  - *Je dormirai*

- But also expresses many non-NL tenses
  - *It was the case*  
  - *John had slept*
Aspect

• Two Varieties
  – Grammatical Aspect
    • Distinguishes viewpoint on event
  – Lexical Aspect
    • Distinguishes types of events (situations)(eventualities)
    • Also called Aktionsarten
Grammatical Aspect

• Perfective – focus on situation as a whole
  – John built a house

• Imperfective – focus on internal phases of situation
  – John was building a house
Aktionsarten

- **STATIVES** *know, sit, be clever, be happy, killing, accident*
  - can refer to state itself (ingressive) *John knows*, or to entry into a state (inceptive) *John realizes*
  - *John is knowing Bill, *Know the answer, *What John did was know the answer*

- **ACTIVITIES** *walk, run, talk, march, paint*
  - if it occurs in period t, a part of it (also an activity) must occur for every/most sub-periods of t
  - X is Ving entails that X has Ved
  - *John ran for an hour, *John ran in an hour

- **ACCOMPLISHMENTS** *build, cook, destroy*
  - culminate (telic)
  - x Vs for an hour does not entail x Vs for all times in that hour
  - X is Ving does not entail that X has Ved.
  - *John booked a flight in an hour, John stopped building a house*

- **ACHIEVEMENTS** *notice, win, blink, find, reach*
  - instantaneous accomplishments

<table>
<thead>
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<th></th>
<th>Telic</th>
<th>Dynamic</th>
<th>Durative</th>
<th>E.g.</th>
</tr>
</thead>
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<tr>
<td><strong>Stative</strong></td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>know, have</td>
</tr>
<tr>
<td><strong>Activity</strong></td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>walk, paint</td>
</tr>
<tr>
<td><strong>Accomplishment</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>destroy, build</td>
</tr>
<tr>
<td><strong>Achievement</strong></td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>notice, win</td>
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Different types of tense systems across languages

• Using verbal inflection:
  – Languages with a two-way contrast:
    • **English**: Past (before the moment of speaking) vs. Nonpast
      past -*ed*: *She worked hard.*
      nonpast (unmarked): *We admire her. I will leave tomorrow.*
    • **Dyirbal** (Australian language): Future vs. nonfuture:
      future -*ñ*: *bani-ñ* ‘will come’
      nofuture -*ñu*: *bani-ñu* ‘came, is coming’
  – Languages with a three-way distinction:
    • **Catalan, Lithuanian**: Past vs. Present vs. Future
      (Cat.) past: *treball-à.* (Lit.) *Dirb-au.* ‘I worked’
      present: *treball-a.* *Dirb-u.* ‘I work’
      future: *treball-arà.* *Dirb-siu.* ‘I will work’
Different types of tense systems across languages

• A much richer distinction:
  – ChiBemba (Bantu language):
    For past:
    • Remote past (before yesterday)  \textit{Ba-àlí-bomb-ele}  ‘they worked’
    • Removed past (yesterday)       \textit{Ba-àlíí-bomba}  ‘they worked’
    • Near past (earlier today)      \textit{Ba-àcí-bomba}  ‘they worked’
    • Immediate past (just happened) \textit{Ba-á-bomba}  ‘they worked’
    For future:
    • Immediate future (very soon)   \textit{Ba-áláá-bomba}  ‘they’ll work’
    • Near future (later today)      \textit{Ba-léé-bomba}  ‘they’ll work’
    • Removed future (tomorrow)      \textit{Ba-kà-bomba}  ‘they’ll work’
    • Remote future (after tomorrow) \textit{Ba-ká-bomba}  ‘they’ll work’
Aspect

• Internal temporal organization of the situation described by an event.

• Most common:
  – **Perfective**: Situation viewed as a bounded whole.
  – **Imperfective**: Looking inside the temporal boundaries of the situation.
    • Habitual
    • Progressive

• Other related aspectual distinctions:
  – **Iterative**: The action is repeated.
  – **Inceptive**: The action is began.
  – **Inchoative**: Entering into a state.
Different types of aspect systems across languages

- Some languages use auxiliaries and particles associated with the verb:

  **English:**
  - **Perfective:** *have* + Past Participle \( \rightarrow \) *I have eaten.*
  - **Progressive:** *be* + Present Participle \( \rightarrow \) *I am eating.*
  - **Habitual:** *use to* + Base form \( \rightarrow \) *I used to sing.*

  **Catalan:**
  - **Habitual:** *soler* + Infinitive
    \[
    \text{Sol parler.} \quad \text{‘She generally talks.’} \\
    \text{Solia cantar.} \quad \text{‘She used to talk’}
    \]
  - **Iterative:** *anar*\(_{\text{past}}\) (‘to go’) + Present Part
    \[
    \text{Va tornant ‘She keeps coming back’} \\
    \text{go\_past coming\_back}
    \]
Different types of aspect systems across languages

• Other languages use a derivational component:
  
  **Russian**: by means of a system of verbal prefixes
  - Imperfective: simple verbs  
    \[ \text{Ja ťcitāl} \] ‘I was reading’
  - Perfective: prefixed verbs  
    \[ \text{Ja prońcitāl} \] ‘I (did) read’

  **Finnish**: by means of the case of the object
  - Perfective:  
    \[ \text{Hän luki kirjan} \] (acc.) ‘He read the book’
  - Imperfective:  
    \[ \text{Hän luki kirjaā} \] (part.) ‘He was reading the book’.

  Basic meaning: only part of the object being referred to is affected by the situation.
Tense and Aspect

- Aspect and Tense generally cross-classify:
  - Russian:
    - Present:
      - Only imperfective: ˇcitáju ‘I read’
    - Past:
      - Imperfective: Ja ˇcitál ‘I was reading’
      - Perfective: Ja proˇcitál ‘I (did) read’
    - Future:
      - Imperfective: ??
      - Perfective: Ja proˇcitáju ‘I shall read’
Tense and Aspect

- **Basque:**
  - Present:
    - Imperfect (Gerund + Present tense auxiliary) \( ekartzen \ du \) ‘he is bringing it’
    - Perfect (Past Participle + Present tense aux.) \( ekarri \ du \) ‘he has brought it’
  - Past:
    - Imperfect (Gerund + Past tense aux.) \( ekartzen \ zuen \) ‘he brought, used to bring’
    - Perfect (Past Participle + Past tense aux.) \( ekarri \ zuen \) ‘he brought, had brought’
  - Future:
    - Simple (Future Participle + Pres. tense aux.) \( ekarriko \ du \) ‘he will bring it’
    - Past Future (Future Participle + Past tense aux.) \( ekarriko \ zuen \) ‘he would bring’
An interesting case

- Tense and Aspect in 2 different creoles, evolved independently from each other:

<table>
<thead>
<tr>
<th></th>
<th>Hawaiian Creole</th>
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<tbody>
<tr>
<td>Base Form (he walks, he walked)</td>
<td>He walk</td>
<td>Li maché</td>
</tr>
<tr>
<td>Progressive (he is walking, he was walking)</td>
<td>He stay walk</td>
<td>L’ap maché (Li ap maché)</td>
</tr>
<tr>
<td>Perfective (he has walked, he had walked)</td>
<td>He bin walk</td>
<td>Li té maché</td>
</tr>
<tr>
<td>Perfective Progressive (he has/had been walking)</td>
<td>He bin stay walk</td>
<td>Li t’ap maché (Li té ap maché)</td>
</tr>
<tr>
<td>Irreal (he would walk, he will walk)</td>
<td>He go walk</td>
<td>L’av maché</td>
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