Overview for today

- Look ahead: Events
- Aspect (definition)
- Aktionsarten
- Compositionality of Aspect
- Viewpoint
- Indexicals
- Theory of the Tense

Reading:
- Coppock, E., and Champollion, L. (2021). Invitation to formal semantics. Manuscript, Boston University and New York University (Ch.12)
Events in Time and Space

Example

Mary mailed five letters while still in France.
Events in Time and Space

Example

Mary mailed five letters while still in France.

We do not know exactly what really happened, unless specific information is given: time of an eventuality, location of an event, type of eventuality (punctual, repetitive, durative), action completed, still in progress, has a potential to be terminated, etc.
The term *aspect* to refer to the *perfective/imperfective* opposition. *Aktionsart* emerged in the German linguistic tradition to distinguish between *terminative/durative* aspect.
The term *aspect* to refer to the **perfective/imperfective** opposition. *Aktionsart* emerged in the German linguistic tradition to distinguish between **terminative/durative** aspect.

Example: terminative/durative test

(1) a. Judith ate a sandwich (**terminative**)  
   b. # Judith ate a sandwich for an hour  
   c. Judith ate a sandwich in an hour

(2) a. Judith ate sandwiches (**durative**)  
   b. Judith ate sandwiches for an hour  
   c. ? Judith ate sandwiches in an hour

(3) a. Nobody ate a sandwich (**durative**)  
   b. For an hour nobody ate a sandwich  
   c. ? In an hour nobody ate a sandwich

(4) a. Judith dislike a sandwich (**durative**)  
   b. Judith disliked a sandwich for an hour  
   c. ? Judith disliked a sandwich in an hour
Distinction between A - e.g. *write* and B - e.g. *write a letter*

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energeia</td>
<td>Kineses (Aristotle)</td>
</tr>
<tr>
<td>Imperfective</td>
<td>Perfective</td>
</tr>
<tr>
<td>Cursive</td>
<td>Terminative</td>
</tr>
<tr>
<td>Irresultative</td>
<td>Resultative</td>
</tr>
<tr>
<td>Durative</td>
<td>Terminative</td>
</tr>
<tr>
<td>Non-punctual</td>
<td>Punctual</td>
</tr>
<tr>
<td>Non-conclusive</td>
<td>Conclusive</td>
</tr>
<tr>
<td>Non-cyclic</td>
<td>Cyclic (Bull, 1963)</td>
</tr>
<tr>
<td>Atelic</td>
<td>Telic (Garey, 1957)</td>
</tr>
<tr>
<td>Non-bounded</td>
<td>Bounded (Allen, 1966)</td>
</tr>
<tr>
<td>Activity</td>
<td>Accomplishment (Vendler, 1957)</td>
</tr>
<tr>
<td>Activity</td>
<td>Performance (Kenny, 1963)</td>
</tr>
<tr>
<td>Nepredel'nyj</td>
<td>Predel'nyj (Russian)</td>
</tr>
<tr>
<td>Nicht-grenzbezogen</td>
<td>Grenzbezogen (German)</td>
</tr>
<tr>
<td>Holding</td>
<td>Culminating (Parsons, 1985)</td>
</tr>
</tbody>
</table>
**Durative vs Terminative**

A situation, process, action etc. or the verb phrase, sentence, etc, expressing this situation, etc, has the property iff

- It is directed toward attaining a goal or limit at which the action exhausts itself and passed into something else (Andersson, 1972)
- It leads up to a well-defined point behind which the process cannot continue (Comrie, 1976)
- has actual or potential terminal point (Dahl, 1981)

A terminal point $t$ is defined such that

1. if $t$ is reached, the process cannot continue
2. $t$ will be reached in the normal course of events (= if nothing unexpected intervenes)
3. $t$ will be reached in all possible courses of events.
Durative vs Terminative (cont.)

Potential (intended or probable) terminal point and actually achieved terminal point. Consider the following sentences:

Examples

a. John is studying for a bachelor’s degree (potential result)
b. John has completed a bachelor’s degree (actually achieved result)
c. I am going to France for two months (potential duration)
d. I travelled in France for two months (actual duration)
e. I am staying until he returns (potential temporal limit)
g. I stayed until he returned (actual temporal limit)
Durative vs Terminative: tests

Conjunction test

a. Mary drove her car on Monday and on Tuesday (ambiguous; durative)
b. May ran a mile on Monday and on Tuesday (unambiguous; terminative)

Progressive test

a. Mary was driving the car → Mary drove the car (durative)
b. Mary was running a mile → Mary ran a mile (terminative)
Aktionsart (Vendler, 1957)

1. **States** are static, extended in time, and lack a natural end point.  
2. **Activities** are like states except they typically involve or lead to some kind of change.  
3. **Accomplishments** are like activities except they have a natural end point.  
4. **Achievements** are like accomplishments except they are punctual rather than extended in time.

<table>
<thead>
<tr>
<th>Type</th>
<th>Eventuality</th>
<th>Durative</th>
<th>Dynamic</th>
<th>Telic</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>States</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>know, desire, want, love, hate, dominate</td>
</tr>
<tr>
<td>Activities</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>run, walk, swim, push (a cart)</td>
</tr>
<tr>
<td>Accomplishments</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>cross the street, run a mile, paint a picture, grow up, recover from illness</td>
</tr>
<tr>
<td>Achievements</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td></td>
<td>recognize, reach, find, win (the race), start/stop/resume, be born/die</td>
</tr>
</tbody>
</table>

{o.petukhova; n.dascalu}@lsv.uni-saarland.de

Introduction to Formal Semantics, Summer 2022
Aktionsart (Dowty, 1979)

<table>
<thead>
<tr>
<th>Aktionsart</th>
<th>Symbolisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>$V(x_1, ..., x_n)$</td>
</tr>
<tr>
<td>Activity</td>
<td>$DO(x_1, V(x_1, ..., x_n))$</td>
</tr>
<tr>
<td>Accomplishment</td>
<td>$DO(x_1, V(x_1, ..., x_n)) \text{CAUSE}(BECOME \ V(x_1, ..., x_n))$</td>
</tr>
<tr>
<td>Achievement</td>
<td>$(BECOME \ V(x_1, ..., x_n))$</td>
</tr>
</tbody>
</table>

**Example**

(a) Mary walked miles $V(Act)$
(b) Mary walked three miles $V(Acc)(=\uparrow V(Act))$
Example

a. My program ran for a few minutes.
b. My program ran in less than four minutes (this morning).
c. Suddenly, I knew the answer.
d. John played the sonata for about eight hours.
e. For months, the train arrived late.
Verkuyl (1972, 1993): Compositionality of Aspect

Grew into the Montagovian framework because it provided answers to most open questions and brought his aspectual theory in the framework of generalized quantification.

The domain of inner aspectuality is the domain of the VP (or predicate): contributed by the verb and its arguments or complements together, i.e. ‘amalgamating’ the meanings of the verb and its arguments into larger unit (VP).

The domain of the outer aspect is determined by the contextually or explicitly given frequency/duration/delimiting adverbials like for an hour, in an hour, yesterday, between 5 and 7 p.m., etc. The outer aspect is determined by context.
Verkuyl (1972, 1993): Inner aspectuality

expressed by the features \(\pm ADDTO\) and \(\pm SQA\) where

\(\pm ADDTO\) property of the verb expresses dynamic progress, change, nonstativity

\(\pm SQA\) a **Specified Quality of A** where A stands for N from the NP. This feature expresses that NP is related to a specified quantity of thins or mass denoted by its head noun

<table>
<thead>
<tr>
<th>SQA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. She played a sonata, three sonatas, some sonatas, a piece of music, that sonata, Schumann’s last sonata for piano</td>
<td></td>
</tr>
<tr>
<td>b. She played music, sonatas, that (sort of) music, from that to the end</td>
<td></td>
</tr>
</tbody>
</table>
Verkuyl (1972, 1993): Inner aspectuality (cont.)

Example

(a) Mary walked three miles
\[ V[+\text{Addto}] + NP(\text{int})[+\text{SQA}] \rightsquigarrow [+T(\text{VP})] \]

(b) Mary walked miles
\[ V[+\text{Addto}] + NP(\text{int})[-\text{SQA}] \rightsquigarrow [-T(\text{VP})] \]

Example

a. 

b. 

c. 

d. 

\{o.petukhova; n.dascalu\}@lsv.uni-saarland.de
Introduction to Formal Semantics, Summer 2022

14
Verkuyl (1972, 1993): Inner aspectuality (cont.)

Example

(a) Mary walked three miles  \( V[+Addto] + NP(int)[+SQA] \xrightarrow{} [+T(VP)] \)
(b) Mary walked miles  \( V[+Addto] + NP(int)[-SQA] \xrightarrow{} [-T(VP)] \)

Calculate the plus/minus value of terminativity at the sentence level:

Example

a.

b.

c.

d.
### Example

<table>
<thead>
<tr>
<th>(a) Mary walked three miles</th>
<th>$V[+Addto] + NP(int)[+SQA] \leadsto [+T(VP)]$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b) Mary walked miles</td>
<td>$V[+Addto] + NP(int)[-SQA] \leadsto [-T(VP)]$</td>
</tr>
</tbody>
</table>

Calculate the plus/minus value of terminativity at the sentence level:

### Example

<table>
<thead>
<tr>
<th>a. [S Mary [VP walk [NP three miles]]]</th>
</tr>
</thead>
<tbody>
<tr>
<td>b.</td>
</tr>
<tr>
<td>c.</td>
</tr>
<tr>
<td>d.</td>
</tr>
</tbody>
</table>
Verkuyl (1972, 1993): Inner aspectuality (cont.)

Example

(a) Mary walked three miles \( V[+Addto] + NP(int)[+SQA] \rightarrow [+T(VP)] \\
(b) Mary walked miles \( V[+Addto] + NP(int)[−SQA] \rightarrow [−T(VP)] \\

Calculate the plus/minus value of terminativity at the sentence level:

Example

a. \([S Mary [VP walk [NP three miles]]] [+ Ts[+SQA] [+ Tvp[+ADDTO] [+SQA]]] \) (terminative)

b. 

c. 

d. 

{o.petukhova; n.dascalu}@lsv.uni-saarland.de

Introduction to Formal Semantics, Summer 2022
Verkuyl (1972, 1993): Inner aspectuality (cont.)

Example

(a) Mary walked three miles  \[ V[+Addto] + NP(int)[+SQA] \leadsto [+T(VP)] \]
(b) Mary walked miles  \[ V[+Addto] + NP(int)[−SQA] \leadsto [−T(VP)] \]

Calculate the plus/minus value of terminativity at the sentence level:

Example

a. [S Mary [VP walk [NP three miles]]] (terminative)
   [+Ts[+SQA] [+Tvp[+ADDTO] [+SQA]]]

b. [S Mary [VP walk [NP miles]]]

   [+Tvp[+ADDTO] [+SQA]]

c. 

d.
Verkuyl (1972, 1993): Inner aspectuality (cont.)

**Example**

(a) Mary walked three miles   \[ V[+Addto] + NP(int)[-SQA] \rightarrow [+T(VP)] \]
(b) Mary walked miles          \[ V[+Addto] + NP(int)[+SQA] \rightarrow [-T(VP)] \]

Calculate the plus/minus value of terminativity at the sentence level:

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>[S Mary</td>
<td>[VP walk</td>
<td>[NP three miles]]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[+Ts[+SQA]</td>
<td>[+Tvp[+ADDTO]</td>
<td>[+SQA]]</td>
<td></td>
<td>(terminative)</td>
</tr>
<tr>
<td>b.</td>
<td>[S Mary</td>
<td>[VP walk</td>
<td>[NP miles]]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Ts[+SQA]</td>
<td>[−Tvp[+ADDTO]</td>
<td>[−SQA]]</td>
<td></td>
<td>(durative)</td>
</tr>
<tr>
<td>c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Verkuyl (1972, 1993): Inner aspectuality (cont.)

Example

(a) Mary walked three miles
V[+Addto] + NP(int)[+SQA] \leadsto [+T(VP)]
(b) Mary walked miles
V[+Addto] + NP(int)[−SQA] \leadsto [−T(VP)]

Calculate the plus/minus value of terminativity at the sentence level:

Example

a. [S Mary [VP walk [NP three miles]]] [+Ts[+SQA] [+Tvp[+ADDTO] [NP three miles]]] (terminative)

b. [S Mary [VP walk [NP miles]]] [Ts[+SQA] [−Tvp[+ADDTO] [−SQA]]] (durative)

c. [S Children [VP walk [NP three miles]]]

d. 

{o.petukhova; n.dascalu}@lsv.uni-saarland.de

Introduction to Formal Semantics, Summer 2022
Verkuyl (1972, 1993): Inner aspectuality (cont.)

### Example

(a) Mary walked three miles  
\[ V[+Addto] + NP(int)[+SQA] \Leftrightarrow [+T(\text{VP})] \]

(b) Mary walked miles  
\[ V[+Addto] + NP(int)[−SQA] \Leftrightarrow [−T(\text{VP})] \]

Calculate the plus/minus value of terminativity at the sentence level:

### Example

<table>
<thead>
<tr>
<th>Example</th>
<th>Structure</th>
<th>Calculated Value</th>
<th>Terminativity</th>
</tr>
</thead>
</table>
| a.      | [S Mary  
\[ +Ts[+SQA] \]  
\[ +Tvp[+ADDTO] \]  
\[ +SQA\]] | (terminative) |
| b.      | [S Mary  
\[ +Ts[+SQA] \]  
\[ −Tvp[+ADDTO] \]  
\[ −SQA\]] | (durative) |
| c.      | [S Children  
\[ −Ts[−SQA] \]  
\[ +Tvp[+ADDTO] \]  
\[ +SQA\]] | (durative) |
| d.      |           |                 |              |

{o.petukhova; n.dascalu}@lsv.uni-saarland.de  
Introduction to Formal Semantics, Summer 2022  
14
Verkuyl (1972, 1993): Inner aspectuality (cont.)

Example

(a) Mary walked three miles  \( V[+\text{Addto}] + NP(\text{int})[+\text{SQA}] \rightarrow [+T(VP)] \)
(b) Mary walked miles  \( V[+\text{Addto}] + NP(\text{int})[-\text{SQA}] \rightarrow [-T(VP)] \)

Calculate the plus/minus value of terminativity at the sentence level:

Example

a. [S Mary] [VP walk] [NP three miles]] [+Ts[+SQA] [+Tvp[+ADDTO] [+SQA]]] (terminative)

b. [S Mary] [VP walk] [NP miles]] [+Ts[+SQA] [+Tvp[+ADDTO] [-SQA]]] (durative)

c. [S Children] [VP walk] [NP three miles]] [-Ts[−SQA] [+Tvp[+ADDTO] [+SQA]]] (durative)

d. [S Mary] [VP save] [NP three miles]]
Verkuyl (1972, 1993): Inner aspectuality (cont.)

Example

(a) Mary walked three miles $V[+Addto]+NP(int)[+SQA] \succsim [+T(VP)]$

(b) Mary walked miles $V[+Addto]+NP(int)[−SQA] \succsim [−T(VP)]$

Calculate the plus/minus value of terminativity at the sentence level:

Example

a. [S Mary [VP walk [NP three miles]]] [Ts[+SQA] +Tvp[+ADDTO] [+SQA]] (terminative)

b. [S Mary [VP walk [NP miles]]] [Ts[+SQA] −Tvp[+ADDTO] [−SQA]] (durative)

c. [S Children [VP walk [NP three miles]]] [Ts[−SQA] +Tvp[+ADDTO] [+SQA]] (durative)

d. [S Mary [VP save [NP three miles]]] [Ts[+SQA] −Tvp[−ADDTO] [+SQA]] (durative)
Verkuyl (1972, 1993): Notion of Path

Example

Mary mailed five letters while still in France.

The internal argument provides its quantificational information and this makes the Path bounded or unbounded.

NP  [±SQA]  [-SQA]  [+SQA]
    State
    Process
    Event

VP  [-ADD TO]  [+ADD TO]
Aspectual Operators

Tense operates are applied after all aspectual operators have done their work. Schematically, the model can be represented as follows:

\[ \text{Tense[Aspect} \ast [\text{eventuality description}] \]

The Kleene star \( \ast \) indicates zero, one or more operations.

**Aspectual** operators can be applied to an atomic eventuality type and are interpreted as eventuality *modifiers*, so they map sets of eventualities of a certain type onto sets of eventualities of some possibly other type.

**Tense** operators introduce existential closure over this set of eventualities, and map the event onto the time axis via its location time in relation to the speech time.

**Example**

Mary has met the president

\[ \text{[Pres[Perf[Mary meet the president]]]} \]
Viewpoint Aspect

Delimiting temporal expressions influence temporal interpretation of sentences in discourse

Example

(a) [It was a lovely performance]. The entertainer told jokes for fifteen minutes, sang for half an hour and danced for another half an hour.
(b) [It was a lovely performance]. The entertainer told jokes, sang and danced.

The delimited predicates in (a) can trigger a sequence interpretation; in (b) an overlap interpretation arises: eventualities are not temporally ordered.

Delimiting adverbials do not operate on a predicate itself and, therefore, do not modify, change or influence the properties of a predicate. What delimiting adverbials are taken to restrict is actually the Reference time interval (more precisely, the relation between Reference time and Speech time).
Reichenbach (1947) introduced notions of **Speech time**, **Event time** and **Reference time**.

**Viewpoint Aspect (cont.)**

(a) **Tenses**

- **Anterior past**
- **Simple past**
- **Posterior past**
- **Posterior past**
- **Posterior present**
- **Anterior future**
- **Anterior future**
- **Anterior future**
- **Simple future**
- **Posterior future**

(b) **The progressive**

- **Past progressive**
- **Present progressive**
- **Future progressive**

**Notes:**
- **S**: speech time
- **R**: reference time
- **E**: event time

{ o.petukhova; n.dascalu@lsv.uni-saarland.de }
Viewpoint Aspect (cont.)

- Simple past
- Future in the past
- Present perfect
- Present
- Future perfect
- Future

Diagram:

```
E ← E → E ← E → E ← E → E
R ← R → R ← R → R ← R
S
```

{ o.petukhova; n.dascalu }@lsv.uni-saarland.de
# Viewpoint Aspect (cont.)

<table>
<thead>
<tr>
<th>Temporal relations</th>
<th>Tense category</th>
<th>Traditional label</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. E–R–S</td>
<td>Anterior Past</td>
<td>Past Perfect</td>
<td>I had passed the exam by the end of the winter.</td>
</tr>
<tr>
<td>2. E,R–S</td>
<td>Simple Past</td>
<td>Simple Past</td>
<td>I passed the exam.</td>
</tr>
<tr>
<td>3.a R–E–S</td>
<td>Posterior Past</td>
<td>–</td>
<td>I did not know that he would win. (yesterday)</td>
</tr>
<tr>
<td>3.b R–S,E</td>
<td>Posterior Past</td>
<td>–</td>
<td>I did not know that he would be here. (right now)</td>
</tr>
<tr>
<td>3.c R–S–E</td>
<td>Posterior Past</td>
<td>–</td>
<td>I did not know that he would come. (tomorrow)</td>
</tr>
<tr>
<td>4. E–S,R</td>
<td>Anterior Present</td>
<td>Present Perfect</td>
<td>I have passed the exam.</td>
</tr>
<tr>
<td>7a S–E–R</td>
<td>Anterior Future</td>
<td>Future Perfect</td>
<td>I will have passed the exam by the end of the winter.</td>
</tr>
<tr>
<td>7.b S,E–R</td>
<td>Anterior Future</td>
<td>Future Perfect</td>
<td>John will have fixed the car by tonight. (already repaired)</td>
</tr>
<tr>
<td>7.c E–S–R</td>
<td>Anterior Future</td>
<td>Future Perfect</td>
<td>I will have fixed the car by tonight. (just repairing it)</td>
</tr>
</tbody>
</table>
Viewpoint Aspect: Intervals

- The E-R relation is fixed, i.e. $E \subseteq R$ by default (except for progressive, here $R \subseteq E$);
- The S-E relation determines the truth conditions and the temporal interpretation of a sentence;
- The S-R relation determines perspective and morphological tense.

An eventuality described by a *durative* predicate, can bear three different relations to the R-time: it can include, be included or overlap with the current R-time.

**Example**

a. Last week Mary was sick.
b. Last week Mary was sick but Friday she had recovered.
c. Last week Mary was (still) sick and she has not recovered (yet).

a-b presuppose the existence of some interval $I$ at which *Mary was sick* and which is contained in the interval of time denoted by the last week. Reinhart proposes to take this as basic underlying relation of E- and R-intervals for all predicates: an interval $I$ at which a given eventuality holds is contained in the R-time interval.
Viewpoint Aspect: S-E relation

S-E configuration determines the truth conditions and the temporal interpretation of a sentence. In the case of overlap the temporal interpretation is present. If S and E are ordered, then we get either past or future interpretation. In other words, the position of E relative to S, tells us whether the eventuality described in a given sentence is anterior to, overlapping with, or posterior to the S-time.

Example

a. John ate breakfast.
b. John has (already) eaten breakfast.

a and b have the same truth conditions and temporal interpretation, because they both refer to some temporal interval at which the predicate ‘eat breakfast’ holds and which precedes S-time.
The S-R relation is crucially important for the theory of aspect. This relation is responsible for morphological tense and perspective. The special effect of the **present perfect** in English is that the situation described is conceived as relevant for the present moment. ‘Relevance for the present moment’ is captured by the relation between R and S.

### Morphological tenses in Reinhart’s system

<table>
<thead>
<tr>
<th>Tense</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. future</td>
<td>$\exists E \exists R \exists S (P(x_1, x_2, \ldots, x_n, E) \land E \subseteq R \land S &lt; R)$</td>
</tr>
<tr>
<td>b. present</td>
<td>$\exists E \exists R \exists S (P(x_1, x_2, \ldots, x_n, E) \land E \subseteq R \land E \cap S \neq \emptyset)$</td>
</tr>
<tr>
<td>c. past</td>
<td>$\exists E \exists R \exists S (P(x_1, x_2, \ldots, x_n, E) \land E \subseteq R \land R &lt; S)$</td>
</tr>
<tr>
<td>d. present perfect</td>
<td>$\exists E \exists R \exists S (P(x_1, x_2, \ldots, x_n, E) \land E \subseteq R \land S \cap R \neq \emptyset \land E &lt; S)$</td>
</tr>
<tr>
<td>e. present progressive</td>
<td>$\exists E \exists R \exists S (P(x_1, x_2, \ldots, x_n, E) \land R \subseteq E \land E \cap S \neq \emptyset)$</td>
</tr>
<tr>
<td>f. past progressive</td>
<td>$\exists E \exists R \exists S (P(x_1, x_2, \ldots, x_n, E) \land R \subseteq E \land R &lt; S)$</td>
</tr>
</tbody>
</table>
Perspective is associated with the view of a speaker, which is presumably ‘located’ at S. If a speaker is ‘inside’ the R-time domain, the perspective is internal. If the position of a speaker is ‘outside’ the R-time domain, the perspective is external.

R-time movement, proposed by Partee (1984) and Hinrichs (1986), makes a crucial difference between stative and eventive sentences, sentences with durative and terminative predicates respectively. Eventive sentences in narrative discourse move the R-time forward, creating a sequence interpretation. A terminative predicate, every time it occurs, holds only at a single interval $I$. Each interval at which a predicate $P$ holds is included in its R-time. A predicate $P$ that describes a following event is included in another, its own R-time and so forth.
The final definitions have been formulated as follows:

For all $P$, $I$, $x_1$, $x_2$, ..., $x_n$, a predicate $P(x_1, x_2, ..., x_n, I)$ is **durative** iff

$$P(x_1, x_2, ..., x_n, I) \land \exists I' \subset I(P(x_1, x_2, ..., x_n, I'))$$

For all $P$, $I$, $x_1$, $x_2$, ..., $x_n$, a predicate $P(x_1, x_2, ..., x_n, I)$ is **terminative** iff

$$P(x_1, x_2, ..., x_n, I) \land \forall I' \subset I(P(x_1, x_2, ..., x_n, I') \rightarrow I' = I)$$
Interaction between Aspect and Tense

Example

a. Mary ate a sandwich (yesterday/in an hour/for an hour/ on Monday and on Tuesday)
b. Mary was eating a sandwich (yesterday/in an hour/for an hour/ on Monday and on Tuesday)

(a) and (b) terminative, but (a) is PERFECTIVE and (b) is IMPERFECTIVE.
Speech time, Event time and Reference

Speech time concerns CONTEXT OF USE, i.e. context of an utterance: who is speaking, to whom, where and when, and much more (everything what influence the successful interpretation of an utterance).

- provide semantic content - referential determination
- resolve ambiguities and vagueness

CONTEXT OF UTTERANCE is a parameter according to which semantic value of linguistic expression is determined

Example

Be back in an hour
Indexicals

interpretation of indexicals
- providing referents for anaphora
- providing deictic referents

Example

John gave Mary a present and she liked it
John gave Martin a present and he liked it
We will start on Monday
Indexicals

interpretation of indexicals

- providing referents for anaphora
- providing deictic referents

Example

John gave Mary a present and she liked it
Indexicals

interpretation of indexicals

- providing referents for anaphora
- providing deictic referents

Example

John gave Mary a present and she liked it

John gave Martin a present and he liked it
Indexicals

interpretation of indexicals

- providing referents for anaphora
- providing deictic referents

Example

John gave Mary a present and she liked it

John gave Martin a present and he liked it

We will start on Monday
Kaplan (1977) interprets indexicals as constants:
\[ c = \langle sp, ad, t, loc, w \rangle \]

Interpretation of indexical constants:

a. \[ [i]^{M,g,c} = sp(c) \]
b. \[ [u]^{M,g,c} = ad(c) \]
c. \[ [\text{now}]^{M,g,c} = t(c) \]
d. \[ [\text{here}]^{M,g,c} = loc(c) \]

where

a. \( I \leadsto i \)
b. \( you \leadsto u \)
c. \( \text{now} \leadsto \text{now} \)
d. \( \text{here} \leadsto \text{here} \)

and not as definite descriptions like \( I \leadsto \forall x. \text{Speaker}(x) \). Thus, indexicals are directly referential, they refer to the same individuals in every possible world.
Indexicals (cont.)

The CONTENT (intension) of an utterance will be defined after all indexicals have been fixed

\( \{ M : \semantics{i}^{M,g,c,w} = 1 \} \)

The CHARACTER of an sentence (meaning across different contexts) is defined as a function from contexts to contents

\( f(c) = \{ M : \semantics{i}^{M,g,c,w} = 1 \} \)
Theory of Tense: model structure

\[ M = \langle D, I, W, T, <, \subseteq \rangle \]

where

- \( D \) is the domain of individuals \( D \)
- \( I \) is an interpretation function assigning semantic values to each of the non-logical constants in the language
- \( W \) is a set of worlds
- \( T \) is a set of times
- \( < \) is a precedence relation among times
- \( \subseteq \) is a containment relation among times

A semantic value of an expression is determined relative to a model \( M \), an assignment function \( g \), a world \( w \) and a context \( c \): \( [\alpha]^{M,g,c,w} \)

{o.petukhova; n.dascalu}@lsv.uni-saarland.de  
Introduction to Formal Semantics, Summer 2022
Theory of Tense: formalization

\[ \text{Tense}[\text{Aspect} \ast [\text{eventuality description}]] \]

where the Kleene star \( \ast \) indicates zero, one or more operations.

\[
\text{TenseP} \\
\text{Tense} \quad \text{AspP} \\
\text{Asp} \quad \ldots
\]

\begin{align*}
\text{PAST} & \quad \text{PAST}_n \leadsto \nu t. [t = t_n \land t_n < \text{now}] \\
\text{PRESENT} & \quad \text{PRESENT} \leadsto \text{now}
\end{align*}

\[
P \leadsto \lambda x \lambda t. P(t, x) \\
dance \leadsto \lambda x \lambda t. \text{Dance}(t, x)
\]
Theory of Tense: formalization (cont.)

Aspect node will dominate either PERF or IMP with the following interpretations:

\[
\text{PERF} \rightsquigarrow \lambda P_{\langle i, t \rangle}. \lambda t. \exists t'. t' \subseteq t \land P(t') \\
\text{IMP} \rightsquigarrow \lambda P_{\langle i, t \rangle}. \lambda t. \exists t'. t \subseteq t' \land P(t')
\]

\[
P \rightsquigarrow \lambda x \lambda t. P(t, x) \\
dance \rightsquigarrow \lambda x \lambda t. \text{Dance}(t, x)
\]
Tense: derivation for present (perfective)

TenseP

Tense ⊆ AspP

PRESENT

Asp ⊆ PERF

VP ⊆ Anna dance

Anna dance

{ o.petukhova; n.dascalu }@lsv.uni-saarland.de

Introduction to Formal Semantics, Summer 2022
Tense: derivation for present (perfective)

TenseP

Tense

PRESENT

AspP

Asp

VP

PERF

\( \lambda t. Dance(t, a) \)

Anna dance
Tense: derivation for present (perfective)

\[
\begin{align*}
\text{TenseP} \\
\text{Tense} & \quad \text{AspP} \\
\text{PRESENT} & \quad \text{Asp} \\
\lambda P_{\langle i,t \rangle}. \lambda t. \exists t'. t' \subseteq t \land P(t') \\
\text{PERF} & \quad \lambda t. \text{Dance}(t, a) \\
\text{Anna dance} & 
\end{align*}
\]
Tense: derivation for present (perfective)

TenseP

Tense

PRESENT

AspP

\[ \lambda t. \exists t'. t' \subseteq t \land \text{Dance}(t', a) \]

Asp

\[ \lambda P_{\langle i, t \rangle}. \lambda t. \exists t'. t' \subseteq t \land P(t') \]

PERF

VP

\[ \lambda t. \text{Dance}(t, a) \]

Anna dance

\{ o.petukhova; n.dascalu \}@lsv.uni-saarland.de

Introduction to Formal Semantics, Summer 2022
Tense: derivation for present (perfective)

\[
\text{TenseP} \quad \text{TenseP} \\
\text{Tense} \quad \text{AspP} \\
\quad \text{PRESENT} \\
\quad \lambda t. \exists t'. t' \subseteq t \land \text{Dance}(t', a) \\
\quad \text{Asp} \\
\quad \lambda P_{(i,t)}. \lambda t. \exists t'. t' \subseteq t \land P(t') \\
\quad \text{PERF} \\
\quad \lambda t. \text{Dance}(t, a) \\
\quad \text{Anna dance}
\]
Tense: derivation for present (perfective)

\[
\exists t'. t' \subseteq [\nu t. [t = t_n \land t_n = \textit{now}]] \land \text{Dance}(t', a)
\]

\[
\nu t. [t = t_n \land t_n = \textit{now}]
\]

\[
\text{PRESENT}
\]

\[
\lambda t. \exists t'. t' \subseteq t \land \text{Dance}(t', a)
\]

\[
\lambda P_{\langle i, t \rangle}. \lambda t. \exists t'. t' \subseteq t \land P(t')
\]

\[
\text{PERF}
\]

\[
\lambda t. \text{Dance}(t, a)
\]

\[
\text{Anna dance}
\]
Tense: derivation for present (imperfective)

\[ TenseP \]

\[ \exists t'. \left[ t = t_n \land t_n < now \right] \subseteq t' \land Dance(t', a) \]

\[ \text{TenseP} \]

\[ \text{Tense} \]

\[ \text{AspP} \]

\[ \text{PAST}_n \]

\[ \text{Asp} \]

\[ \text{VP} \]

\[ \text{IMP} \]

\[ \text{Anna dance} \]
Introduction to Formal Semantics, Summer 2022

Tense: derivation for present (imperfective)

\[ \exists t'. \left[ \iota t. \left[ t = t_n \land t_n < \text{now} \right] \subseteq t' \land \text{Dance}(t', a) \right] \]
Tense: derivation for present (imperfective)

\[
\begin{align*}
& \text{TenseP} \\
& \text{Tense} \quad \text{AspP} \\
& PAST_n \\
& \text{Asp} \\
& \lambda P_{\langle i, t \rangle}. \lambda t. \exists t'. t \subseteq t' \land P(t') \\
& \text{IMP} \\
& \text{VP} \\
& \lambda t. \text{Dance}(t, a) \\
& \text{Anna dance}
\end{align*}
\]
Tense: derivation for present (imperfective)

\[
\begin{align*}
TenseP & \\
\quad & \left( PAST_n \right) \\
\quad & \text{Tense} \\
\quad & \quad \text{AspP} \\
\quad & \quad \quad \lambda t. \exists t'. t \subseteq t' \land \text{Dance}(t', a) \\
\quad & \quad \quad \text{Asp} \\
\quad & \quad \quad \quad \lambda P_{\langle i, t \rangle} \lambda t. \exists t'. t \subseteq t' \land P(t') \\
\quad & \quad \quad \quad \text{IMP} \\
\quad & \quad \quad \quad \lambda t. \text{Dance}(t, a) \\
\end{align*}
\]

Anna dance
Tense: derivation for present (imperfective)

\[
\begin{align*}
\text{TenseP} & \\
\text{Tense} & \quad \exists t.\ [t = t_n \land t_n < \text{now}] \\
\text{PAST}_n & \\
\lambda t. \exists t'. t \subseteq t' \land \text{Dance}(t', a) & \\
\lambda P_{(i, t)}. \lambda t. \exists t'. t \subseteq t' \land P(t') & \\
\lambda t. \text{Dance}(t, a) & \\
\text{Anna dance} & \\
\end{align*}
\]
Tense: derivation for present (imperfective)

$\exists t'. [\lambda t. [t = t_n \land t_n < \text{now}]] \subseteq t' \land \text{Dance}(t', a)$

TenseP

$\exists t'. [\lambda t. [t = t_n \land t_n < \text{now}]] \subseteq t' \land \text{Dance}(t', a)$

Tense

$\lambda t. [t = t_n \land t_n < \text{now}]$

$PAST_n$

AspP

$\lambda t. \exists t'. t \subseteq t' \land \text{Dance}(t', a)$

Asp

$\lambda P(i, t). \lambda t. \exists t'. t \subseteq t' \land P(t')$

IMP

VP

$\lambda t. \text{Dance}(t, a)$

Anna dance

{o.petukhova; n.dascalu}@lsv.uni-saarland.de
Derivation for past (perfective)

TenseP

Tense

AspP

Asp

VP

\( PAST_n \)

PERF

Anna dance

"Anna dance"
Derivation for past (perfective)
Derivation for past (perfective)

\[
\begin{align*}
TenseP \\
\text{Tense} && \text{AspP} \\
\mid PAST_n \\
\lambda P_{\langle i,t \rangle}. \lambda t. \exists t'. t' \subseteq t \land P(t') \\
\mid \text{PERF} \\
\lambda t. Dance(t, a) \\
\end{align*}
\]
Derivation for past (perfective)

\[
\begin{aligned}
&\text{TenseP} \\
&\quad \mid \text{Tense} \\
&\quad \quad \mid \text{PAST} \_n \\
&\quad \quad \mid \lambda t. \exists t'. t' \subseteq t \land \text{Dance}(t', a) \\
&\quad \quad \mid \lambda P_{(i,t)}. \lambda t. P(t') \land \text{PERF} \land \lambda t. \text{Dance}(t, a) \\
&\quad \quad \mid \text{Anna dance}
\end{aligned}
\]
Derivation for past (perfective)

\[
\begin{align*}
&\text{TenseP} \\
&\quad \downarrow \\
&\quad \text{Tense} \\
&\quad \quad \mu t. [t = t_n \land t_n < \text{now}] \\
&\quad \quad \quad \downarrow \\
&\quad \quad \quad \text{PAST}_n \\
&\quad \downarrow \\
&\quad \text{AspP} \\
&\quad \quad \lambda t. \exists t'. t' \subseteq t \land \text{Dance}(t', a) \\
&\quad \quad \downarrow \\
&\quad \quad \text{Asp} \\
&\quad \quad \quad \lambda P_{\langle i, t \rangle} \lambda t. \exists t'. t' \subseteq t \land P(t') \\
&\quad \quad \quad \downarrow \\
&\quad \quad \quad \text{PERF} \\
&\quad \downarrow \\
&\quad \text{VP} \\
&\quad \quad \lambda t. \text{Dance}(t, a) \\
&\quad \downarrow \\
&\quad \text{Anna dance}
\end{align*}
\]
Derivation for past (perfective)

\[ \exists t'. t' \subseteq [\iota t. t = t_n \land t_n < \text{now}] \land \text{Dance}(t', a) \]

\[ \iota t. [t = t_n \land t_n < \text{now}] \]

\[ PAST_n \]

\[ \lambda t. \exists t'. t' \subseteq t \land \text{Dance}(t', a) \]

\[ \lambda P_{(i,t)}. \lambda t. \exists t'. t' \subseteq t \land P(t') \]

\[ \lambda t. \text{Dance}(t, a) \]

\[ \text{Anna dance} \]
Derivation for past (imperfective)

\[
\begin{align*}
\text{TenseP} & \quad \exists t'. \quad \left[ \begin{array}{l}
\iota t. \\
\left( t = t_n \land t_n < \text{now} \right) \end{array} \right] \subseteq t' \land \text{Dance}(t', a) \\
\text{Tense} & \quad \exists t'. \quad t \subseteq t' \land \text{Dance}(t', a) \\
\text{AspP} & \quad \exists t'. \quad \left[ \begin{array}{l}
\lambda t. \\
\left( t = t_n \land t_n < \text{now} \right) \end{array} \right] \lambda t. \exists t'. \quad t \subseteq t' \land \text{P}(t') \\
\text{Asp} & \quad \exists t'. \quad t \subseteq t' \land \text{Dance}(t', a) \\
\text{VP} & \quad \text{Anna dance}
\end{align*}
\]
Derivation for past (imperfective)

\[
\begin{align*}
\text{TenseP} & \quad \text{AspP} \\
\text{Tense} & \quad \text{Asp} \\
\text{PAST}_n & \quad \text{IMP} \\
\end{align*}
\]

\[
\lambda t.\text{Dance}(t, a)
\]

Anna dance
Derivation for past (imperfective)

\[ PAST_n \]

\[
\begin{align*}
  & \text{TenseP} \\
  & \quad \text{Tense} \\
  & \quad \quad PAST_n \\
  & \quad \quad \text{AspP} \\
  & \quad \quad \quad \text{Asp} \\
  & \quad \quad \quad \quad \lambda P_{\langle i, t \rangle}. \lambda t. \exists t'. t \subseteq t' \land P(t') \\
  & \quad \quad \quad \quad \quad \text{IMP} \\
  & \quad \quad \quad \quad \quad \text{VP} \\
  & \quad \quad \quad \quad \quad \lambda t. \text{Dance}(t, a) \\
  & \quad \quad \quad \quad \quad \text{Anna dance}
\end{align*}
\]
Derivation for past (imperfective)

\[ \exists t'. t \subseteq t' \land Dance(t', a) \]

\[ \lambda t. \exists t'. t \subseteq t' \land P(t') \]

\[ \lambda t. Dance(t, a) \]

Anna dance
Derivation for past (imperfective)

\[
\begin{align*}
\text{TenseP} & \quad \lambda t. \exists t'. t \subseteq t' \land \text{Dance}(t', a) \\
\text{Tense} & \quad \iota t. [t = t_n \land t_n < \text{now}] \\
& \quad \text{PAST}_n \\
\text{AspP} & \quad \lambda t. \exists t'. t \subseteq t' \land \text{Dance}(t', a) \\
\text{Asp} & \quad \lambda P_{\langle i, t \rangle}. \lambda t. \exists t'. t \subseteq t' \land P(t') \\
& \quad \text{IMP} \\
\text{VP} & \quad \lambda t. \text{Dance}(t, a) \\
& \quad \text{Anna dance}
\end{align*}
\]
Derivation for past (imperfective)

\[ \exists t'. [\iota t. [t = t_n \land t_n < \text{now}]] \subseteq t' \land \text{Dance}(t', a) \]

\[ \iota t. [t = t_n \land t_n < \text{now}] \]

Tense

PAST\_n

TenseP

AspP

\[ \lambda t. \exists t'. t \subseteq t' \land \text{Dance}(t', a) \]

\[ \lambda P_{<i,t>}. \lambda t. \exists t'. t \subseteq t' \land P(t') \]

Asp

IMP

\[ \lambda t. \text{Dance}(t, a) \]

VP

Anna dance

\{o.petukhova; n.dascalu\}@lsv.uni-saarland.de

Introduction to Formal Semantics, Summer 2022

38
Derivation for (English) future

{TenseP
  |--- Tense
  |   |--- PRESENT
  |   |     |--- Asp
  |   |     |     |--- WOLL
  |     |--- AspP
  |     |     |--- VP
  |     |     |     |--- Anna dance}
Derivation for (English) future

\[
\exists t'. \left[ \begin{array}{c}
\tau t.
\end{array} \right] t = t_n \land t_n = \text{now} < t' \land \text{Dance}(t', a)
\]

TenseP

AspP

Tense

Asp

PRESENT

VP

\lambda t. \text{Dance}(t, a)

WOLL

Anna dance

Anna dance
Derivation for (English) future
Derivation for (English) future

\[
\begin{align*}
\text{TenseP} & \quad \text{Tense} \\
& \quad \text{PRESENT} \\
\lambda t. \exists t'. t < t' \land \text{Dance}(t', a) & \quad \text{AspP} \\
& \quad \text{Asp} \\
& \quad \lambda P_{(i, t)}. \lambda t. \exists t'. t < t' \land P(t') \\
& \quad \text{WOLL} \\
\lambda t. \text{Dance}(t, a) & \quad \text{VP} \\
& \quad \text{Anna dance}
\end{align*}
\]
Derivation for (English) future

TenseP

\[ \lambda t. \exists t'. t < t' \land Dance(t', a) \]

AspP

\[ \lambda P_{\langle i, t \rangle} . \lambda t. \exists t'. t < t' \land P(t') \]

Asp

\[ \lambda t. Dance(t, a) \]

WOLL

PRESENT

\[ \forall t. [ t = t_n \land t_n = now ] \]

Anna dance
Derivation for (English) future

\[ \exists t'.[\lambda t.[t = t_n \land t_n = \text{now}]] < t' \land \text{Dance}(t', a) \]

TenseP

AspP

\[ \lambda t. \exists t'. t < t' \land \text{Dance}(t', a) \]

Asp

\[ \lambda P_{(i,t)}. \lambda t. \exists t'. t < t' \land P(t') \]

WOLL

\[ \lambda t. \text{Dance}(t, a) \]

Anna dance

\[ \lambda t. \text{Dance}(t, a) \]

\[ \lambda t. \exists t'. t < t' \land \text{Dance}(t', a) \]

PRESENT

\[ \lambda t. [t = t_n \land t_n = \text{now}] \]
Quizz for Today

TBA