

Introduction to Formal Semantics

Lecture 9: Aspect & Tense

Volha Petukhova & Nicolaie Dominik Dascalu

Spoken Language Systems Group
Saarland University

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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.

Aspect

The term *aspect* to refer to the **perfective/imperfective** opposition.
Aktionsart emerged in the German linguistic tradition to distinguish between **terminative/durative** aspect

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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

Aspect (cont.)

Distinction between A - e.g. *write* and B - e.g. *write a letter*

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

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: other 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 \rightarrow Mary drove the car (durative)
- b. Mary was running a mile \nrightarrow 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.

Aktionsart (Dowty, 1979)

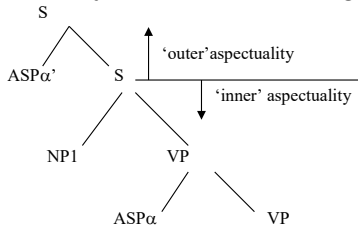
State	$V(x_1, \dots, x_n)$
Activity	$DO(x_1, V(x_1, \dots, x_n))$
Accomplishment	$DO(x_1, V(x_1, \dots, x_n)) CAUSE(BECOME V(x_1, \dots, x_n))$
Achievement	$(BECOME V(x_1, \dots, x_n))$

Example

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

Verkuyl (1972, 1993): Compositionality of Aspect

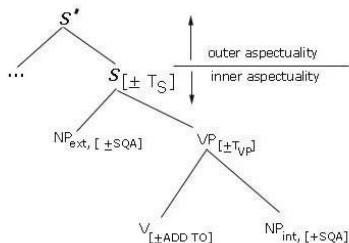
Grew into the **Montagovian** framework because it provided answers to most open questions and brought his aspectual theory in the framework of generalized quantification.



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

SQA

- a. She played a sonata, three sonatas, some sonatas, a piece of music, that sonata, Schumann's last sonata for piano
- b. She played music, sonatas, that (sort of) music, from that to the end

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

Example

- (a) Mary walked three miles
(b) Mary walked miles

$$\begin{aligned} V[+Addto] + NP(int)[+SQA] &\rightsquigarrow [+T(VP)] \\ V[+Addto] + NP(int)[-SQA] &\rightsquigarrow [-T(VP)] \end{aligned}$$

Example

- a.
b.
c.
d.

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

Example

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

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

Example

a.

b.

c.

d.

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

Example

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

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

Example

a. [S Mary [VP walk [NP three miles]]]

b.

c.

d.

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

Example

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

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

Example

- (a) Mary walked three miles $V[+Addto] + NP(int)[+SQA] \rightsquigarrow [+T(VP)]$
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Verkuyl (1972, 1993): Inner aspectuality (cont.)

Example

- (a) Mary walked three miles $V[+Addto] + NP(int)[+SQA] \rightsquigarrow [+T(VP)]$
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Calculate the plus/minus value of terminativity at the sentence level:

Example

- a. [S Mary [VP walk [NP three miles]]]
 $[+Ts[+SQA] \quad [+Tvp[+ADDTO] \quad [+SQA]]$ (terminative)
- b. [S Mary [VP walk [NP miles]]]
 $[Ts[+SQA] \quad [-Tvp[+ADDTO] \quad [-SQA]]$ (durative)
- c.
- d.

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

Example

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

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

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

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

Example

- (a) Mary walked three miles $V[+Addto] + NP(int)[+SQA] \rightsquigarrow [+T(VP)]$
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Calculate the plus/minus value of terminativity at the sentence level:

Example

- a. [S Mary [VP walk [NP three miles]]]
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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.

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

Example

- (a) Mary walked three miles $V[+Addto] + NP(int)[+SQA] \rightsquigarrow [+T(VP)]$
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Calculate the plus/minus value of terminativity at the sentence level:

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- a. [S Mary [VP walk [NP three miles]]]
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[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 $V[+Addto] + NP(int)[+SQA] \rightsquigarrow [+T(VP)]$
(b) Mary walked miles $V[+Addto] + NP(int)[-SQA] \rightsquigarrow [-T(VP)]$

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

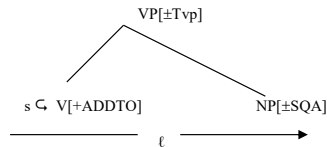
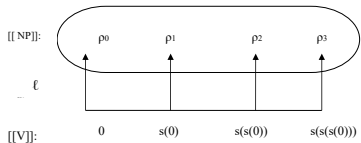
Example

- 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.



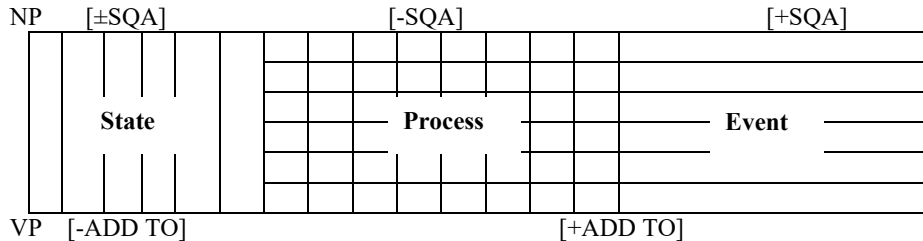
The internal argument provides its quantificational information and this makes the Path bounded or unbounded.

Coercion (Partee and Rooth, 1983)

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): Tripartition: State-Process-Event



Aspectual Operators

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

$[Tense[Aspect * [eventuality\ description]]]$

The Kleene star $*$ 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

$[Pres[Perf[Mary\ meet\ the\ president]]]$

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.

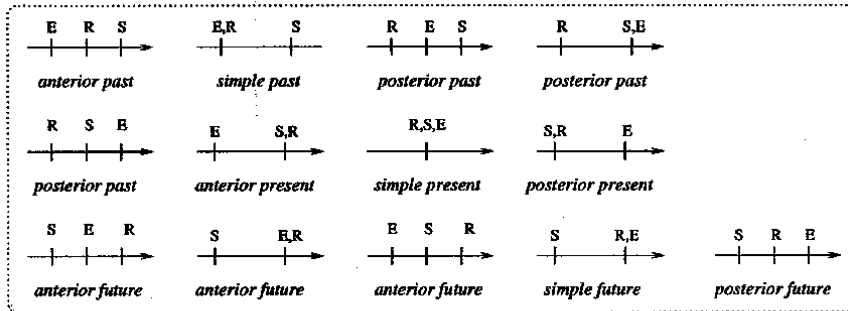
The delimited predicates in (a) can trigger a sequence interpretation; in (b) an overlap interpretation arises: eventualities are not temporally ordered.

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).

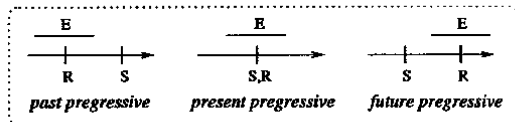
Viewpoint Aspect (cont.)

Reichenbach (1947) introduced notions of **S**peech time, **E**vent time and **R**eference time

(a) Tenses



(b) The progressive



S: speech time

R: reference time

E: event time

Viewpoint Aspect (cont.)

<i>Relation</i>	<i>Reichenbach's Tense Name</i>	<i>English Tense Name</i>	<i>Example</i>
$E < R < S$	Anterior past	Past perfect	<i>I had slept</i>
$E = R < S$	Simple past	Simple past	<i>I slept</i>
$R < E < S$	Posterior past		<i>I expected that I would sleep</i>
$R < S = E$			
$R < S < E$			
$E < S = R$	Anterior present	Present perfect	<i>I have slept</i>
$S = R = E$	Simple present	Simple present	<i>I sleep</i>
$S = R < E$	Posterior present	Simple future	<i>I will sleep (Je vais dormir)</i>
$S < E < R$	Anterior future	Future perfect	<i>I will have slept</i>
$S = E < R$			
$E < S < R$			
$S < R = E$	Simple future	Simple future	<i>I will sleep (Je dormirai)</i>
$S < R < E$	Posterior future		<i>I shall be going to sleep</i>

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.

Viewpoint Aspect: S-R relation

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

- a. future $\exists E \exists R \exists S (P(x_1, x_2, \dots, x_n, E) \wedge E \subseteq R \wedge S < R)$
- b. present $\exists E \exists R \exists S (P(x_1, x_2, \dots, x_n, E) \wedge E \subseteq R \wedge E \cap S \neq \emptyset)$
- c. past $\exists E \exists R \exists S (P(x_1, x_2, \dots, x_n, E) \wedge E \subseteq R \wedge R < S)$
- d. present perfect $\exists E \exists R \exists S (P(x_1, x_2, \dots, x_n, E) \wedge E \subseteq R \wedge S \cap R \neq \emptyset \wedge E < S)$
- e. present progressive $\exists E \exists R \exists S (P(x_1, x_2, \dots, x_n, E) \wedge R \subseteq E \wedge E \cap S \neq \emptyset)$
- f. past progressive $\exists E \exists R \exists S (P(x_1, x_2, \dots, x_n, E) \wedge R \subseteq E \wedge R < S)$

Viewpoint Aspect: Perspective and R-time movement

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.

Viewpoint Aspect: Terminative and Durative Predicates

The final definitions have been formulated as follows:

For all $P, I, x_1, x_2, \dots, x_n$, a predicate $P(x_1, x_2, \dots, x_n, I)$ is **durative** iff
 $P(x_1, x_2, \dots, x_n, I) \wedge \exists I' \subset I (P(x_1, x_2, \dots, x_n, I'))$

For all $P, I, x_1, x_2, \dots, x_n$, a predicate $P(x_1, x_2, \dots, x_n, I)$ is **terminative** iff
 $P(x_1, x_2, \dots, x_n, I) \wedge \forall I' \subset I (P(x_1, x_2, \dots, x_n, I') \rightarrow I' = I)$

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

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**

Indexicals (cont.)

Kaplan (1977) interprets indexicals as constants:

$$c = \langle sp, ad, t, loc, w \rangle$$

Interpretation of indexical constants:

- a. $\llbracket i \rrbracket^{M,g,c} = sp(c)$
- b. $\llbracket u \rrbracket^{M,g,c} = ad(c)$
- c. $\llbracket now \rrbracket^{M,g,c} = t(c)$
- d. $\llbracket here \rrbracket^{M,g,c} = loc(c)$

where

- a. $I \rightsquigarrow i$
- b. $you \rightsquigarrow u$
- c. $now \rightsquigarrow now$
- d. $here \rightsquigarrow here$

and not as definite descriptions like $I \rightsquigarrow \iota x. Speaker(x)$. 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

$$\{M : \llbracket i \rrbracket^{M,g,c,w} = 1\}$$

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

$$f(c) = \{M : \llbracket i \rrbracket^{M,g,c,w} = 1\}$$

Theory of Tense: model structure

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

where

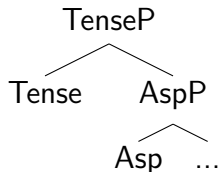
- D is the domain of individuals D
- I is an interpretation function assigning semantic values to each of the non-logical constants in the language
- W is a set of worlds
- T is a set of times
- $<$ is a precedence relation among times
- \subseteq is a containment relation among times

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

Theory of Tense: formalization

$[Tense[Aspect * [eventuality\ description]]]$

where the Kleene star $*$ indicates zero, one or more operations.



PAST $PAST_n \rightsquigarrow \iota t.[t = t_n \wedge t_n < now]$

PRESENT $PRESENT \rightsquigarrow now$

$P \rightsquigarrow \lambda x \lambda t. P(t, x)$

$dance \rightsquigarrow \lambda x \lambda t. Dance(t, x)$

Theory of Tense: formalization (cont.)

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

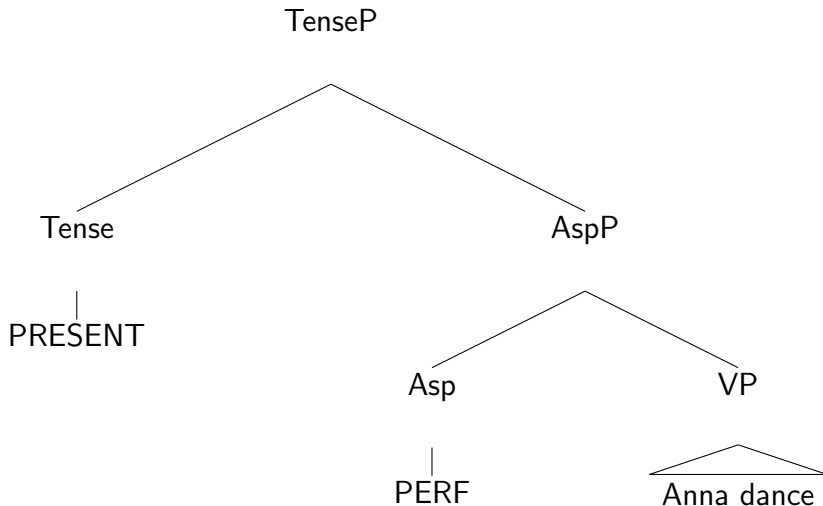
$$PERF \rightsquigarrow \lambda P_{\langle i, t \rangle}. \lambda t. \exists t'. t' \subseteq t \wedge P(t')$$

$$IMP \rightsquigarrow \lambda P_{\langle i, t \rangle}. \lambda t. \exists t'. t \subseteq t' \wedge P(t')$$

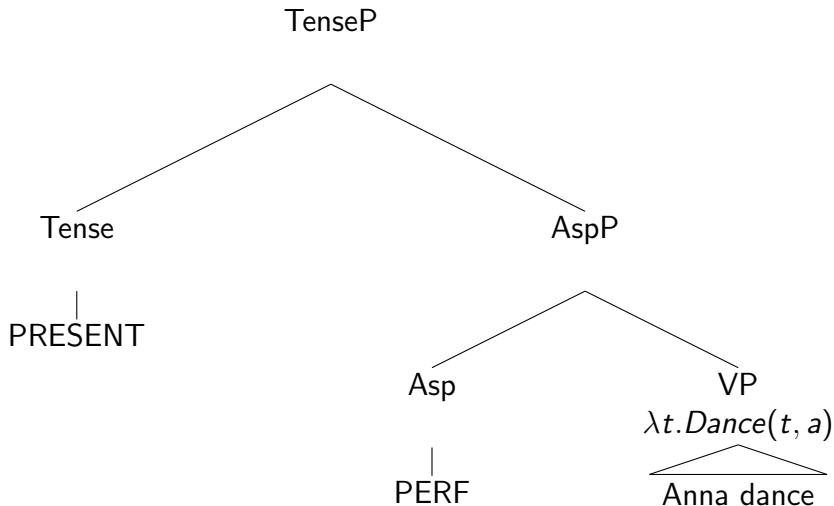
$$P \rightsquigarrow \lambda x \lambda t. P(t, x)$$

$$dance \rightsquigarrow \lambda x \lambda t. Dance(t, x)$$

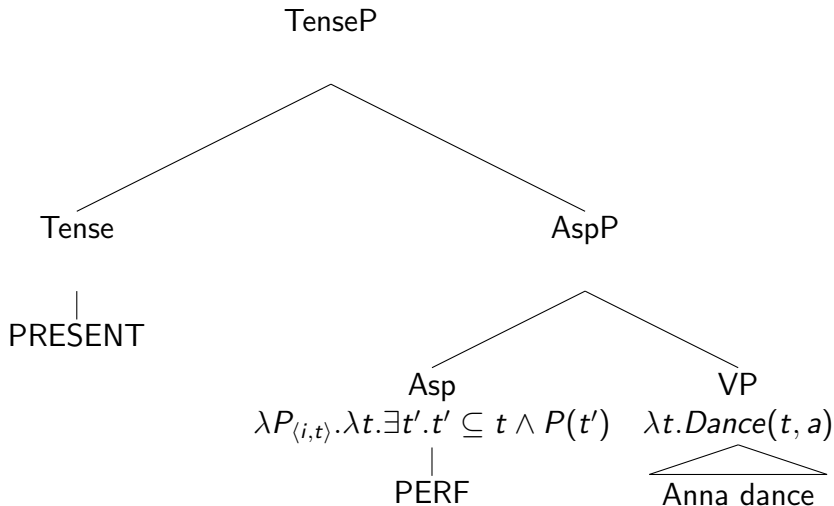
Tense: derivation for present (perfective)



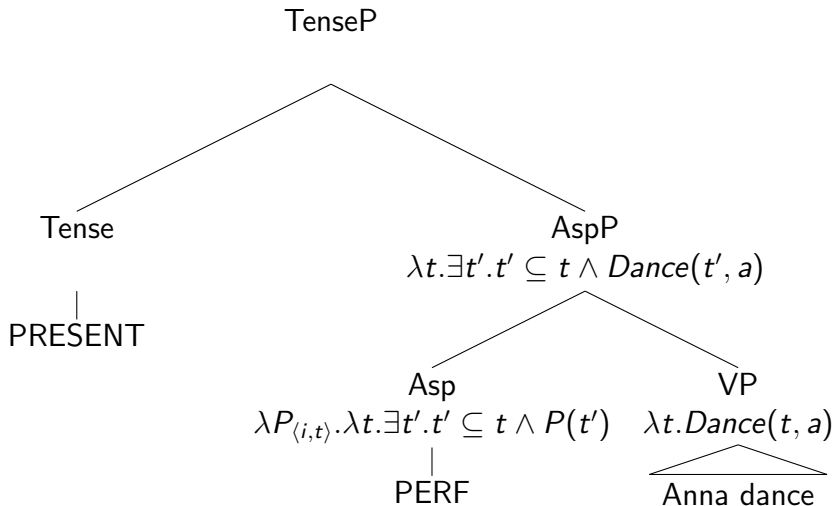
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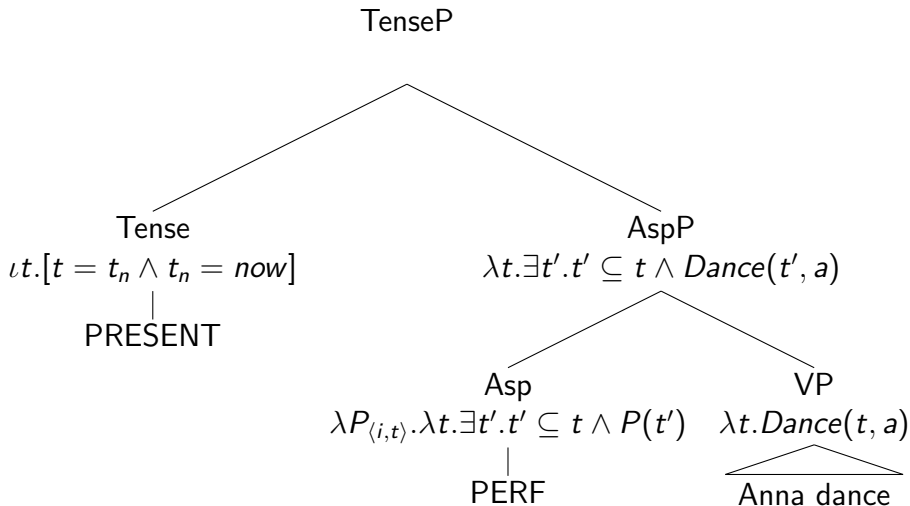
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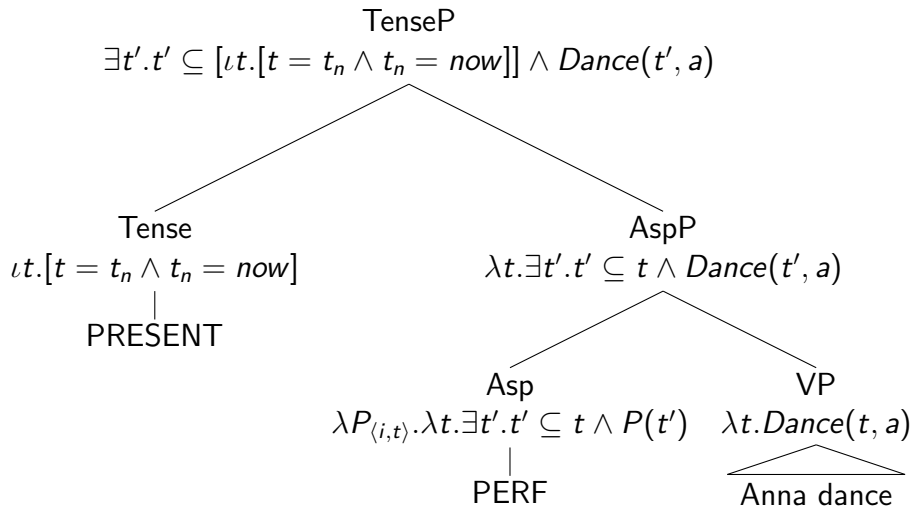
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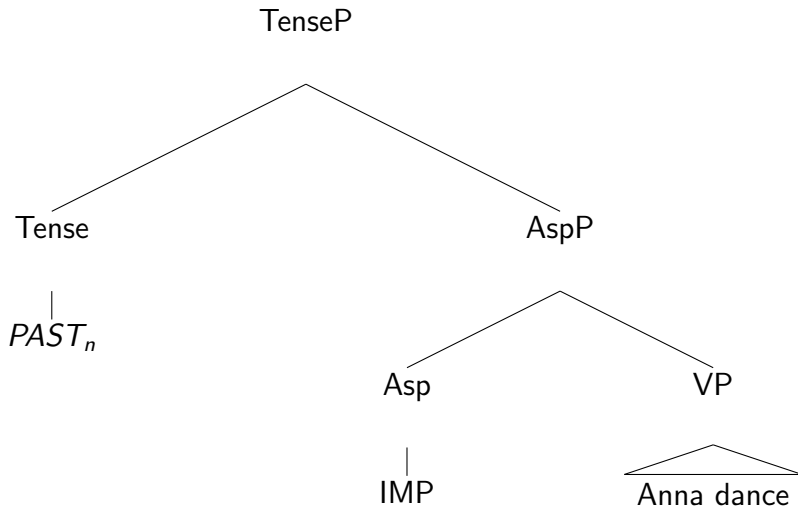
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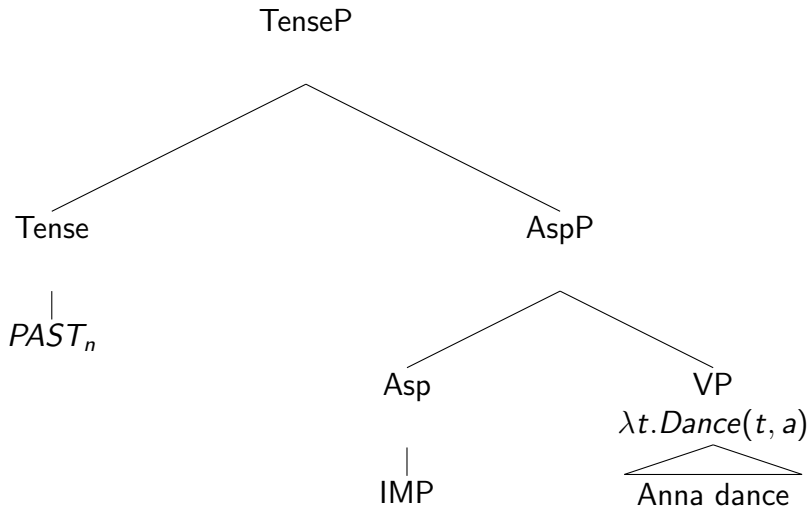
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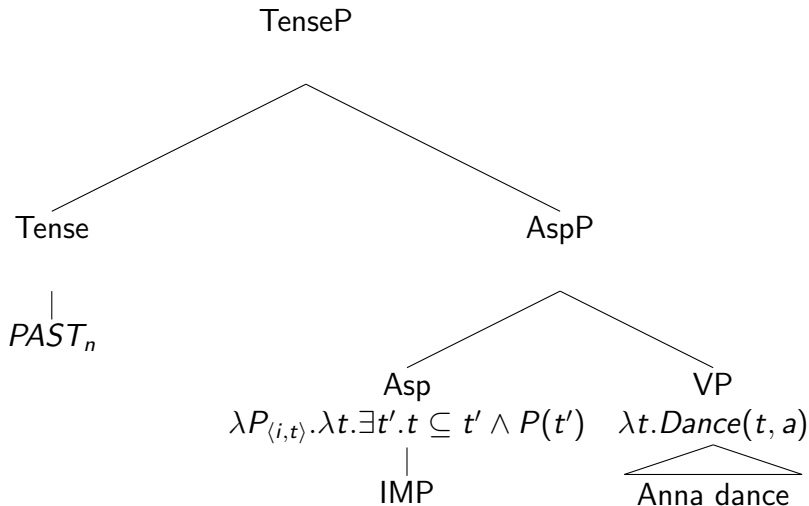
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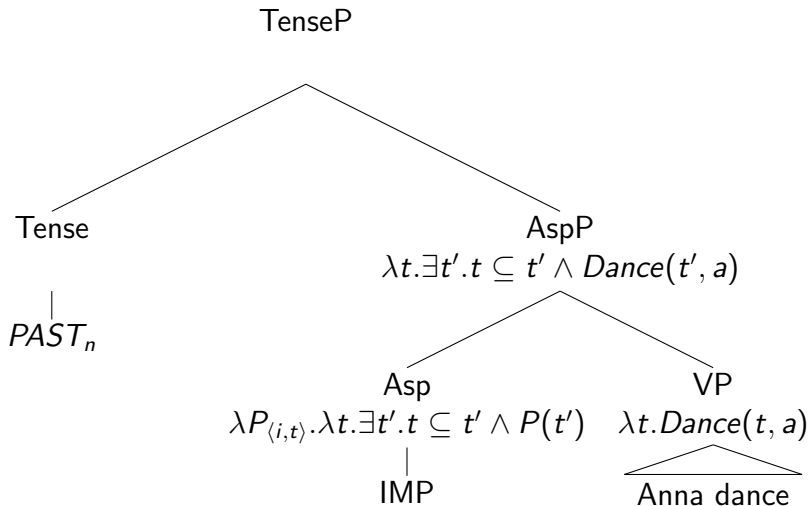
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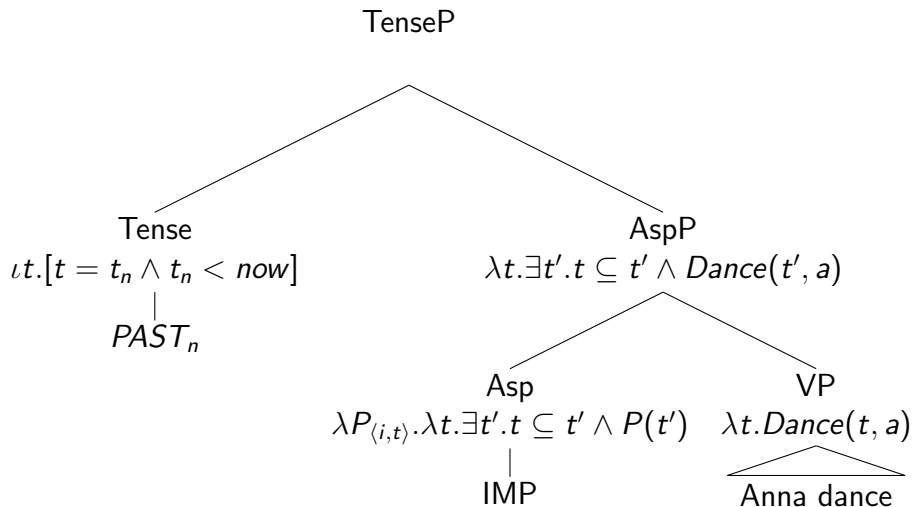
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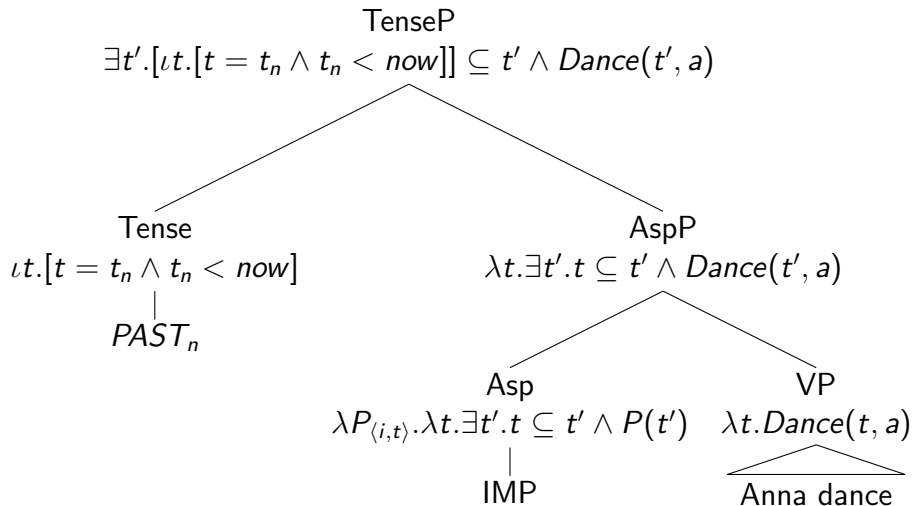
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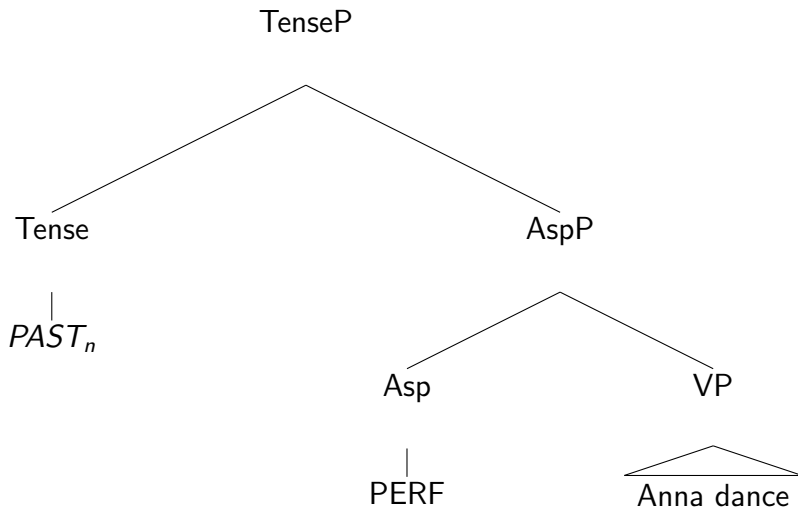
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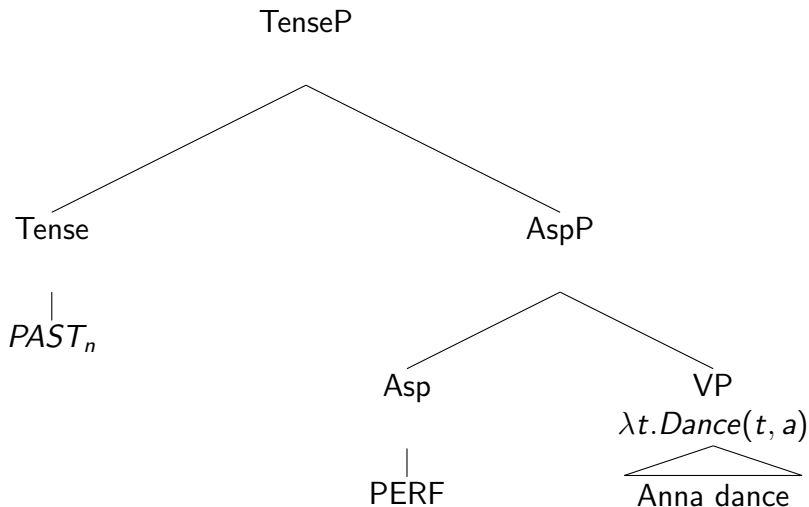
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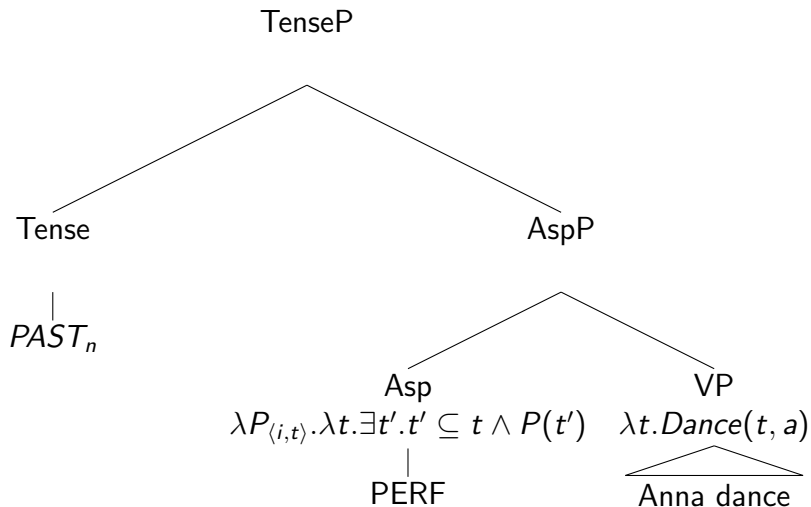
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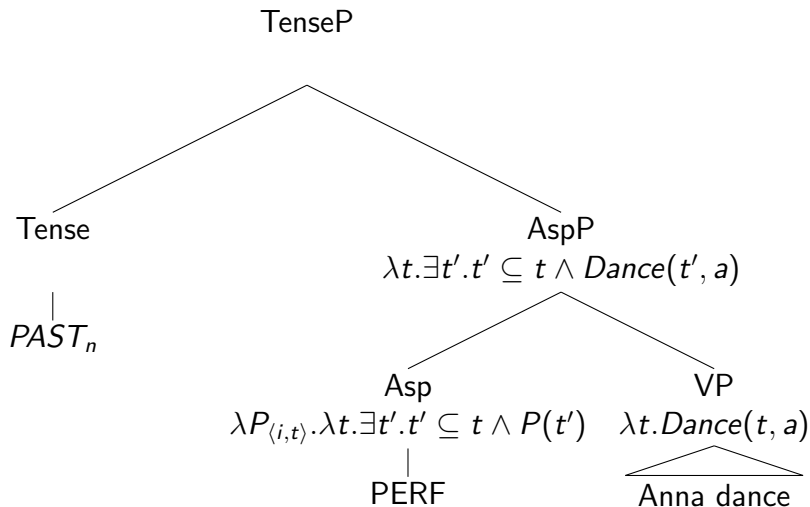
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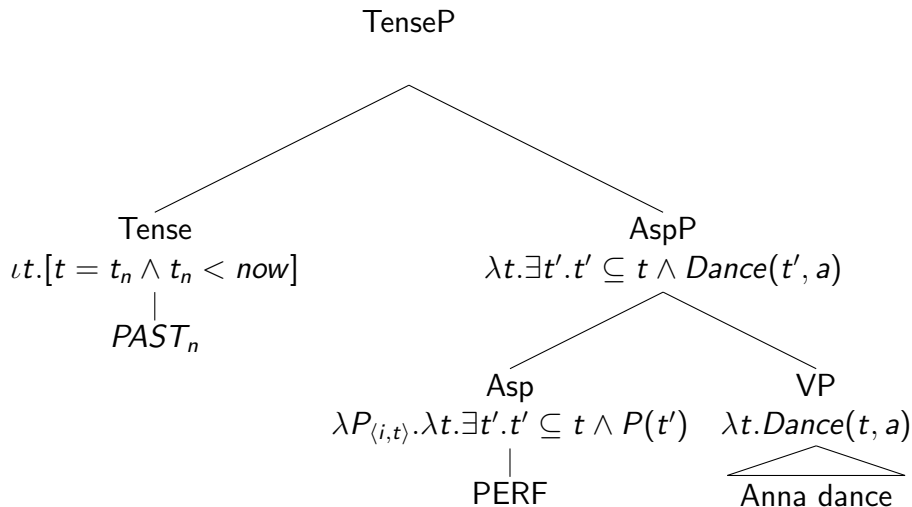
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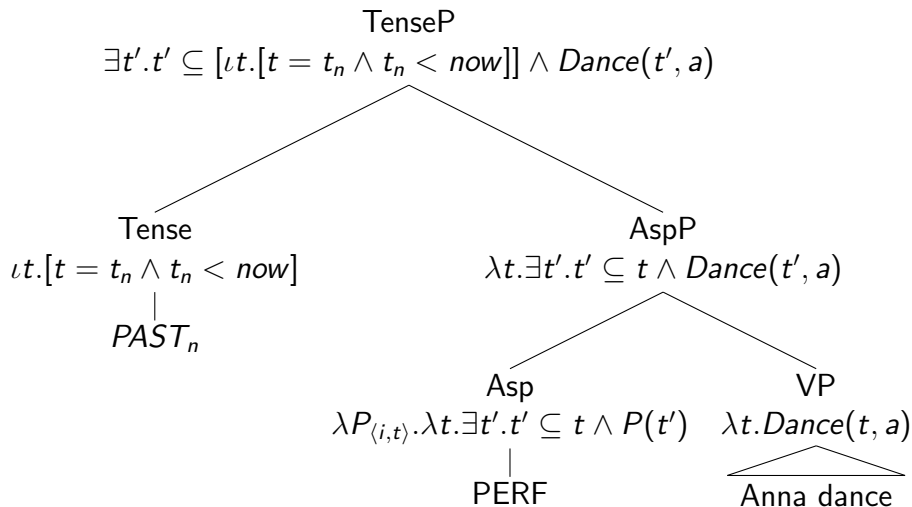
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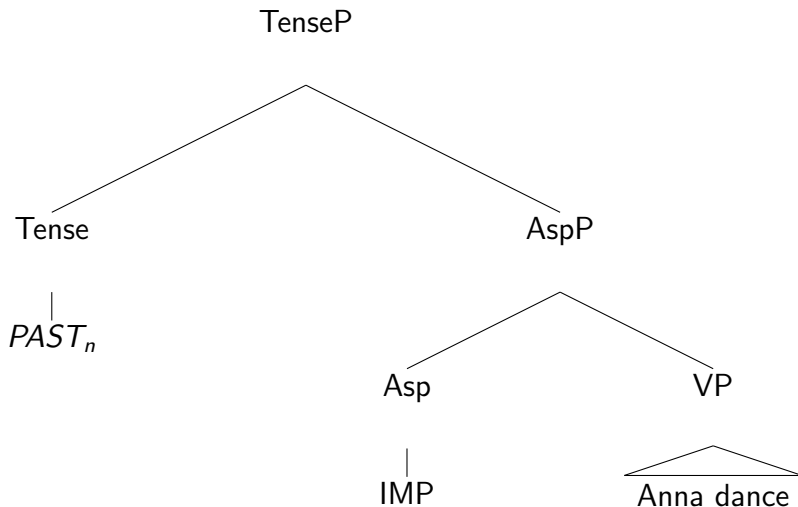
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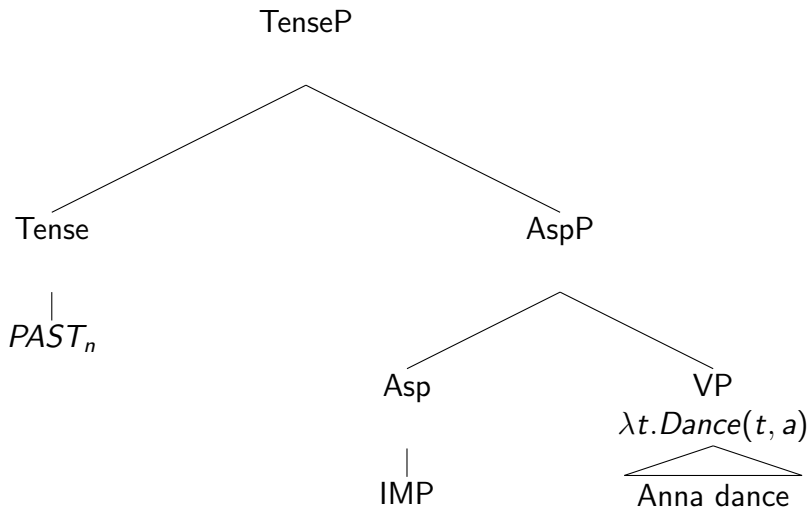
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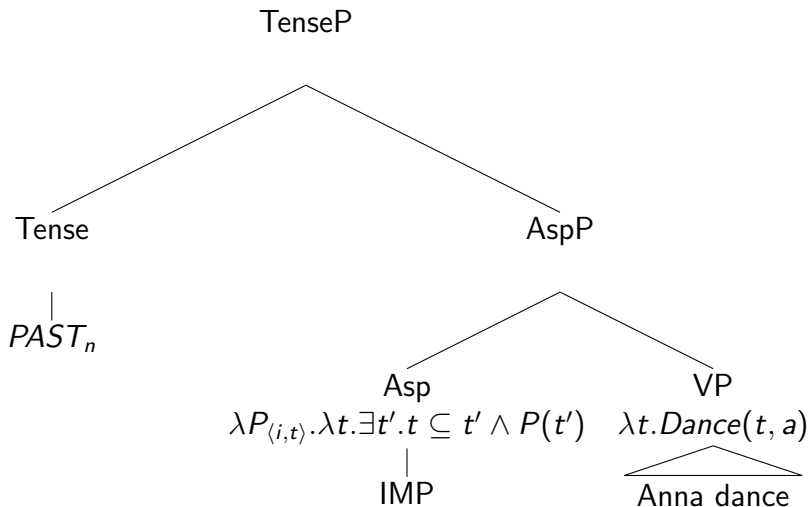
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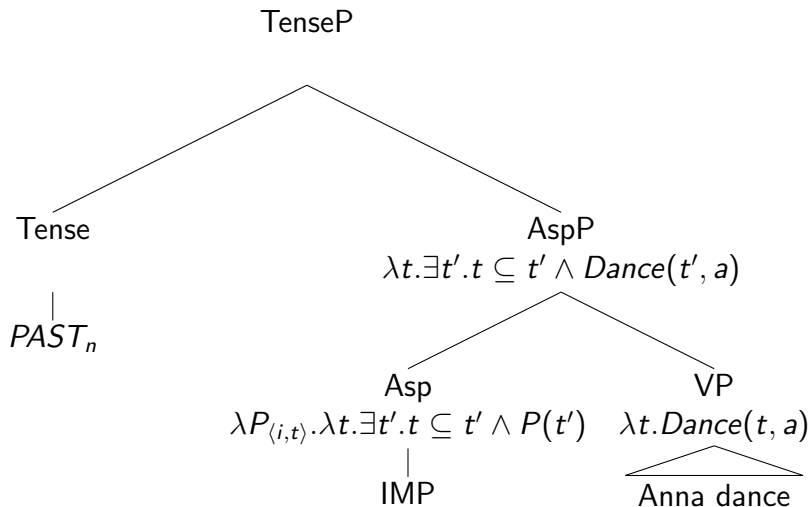
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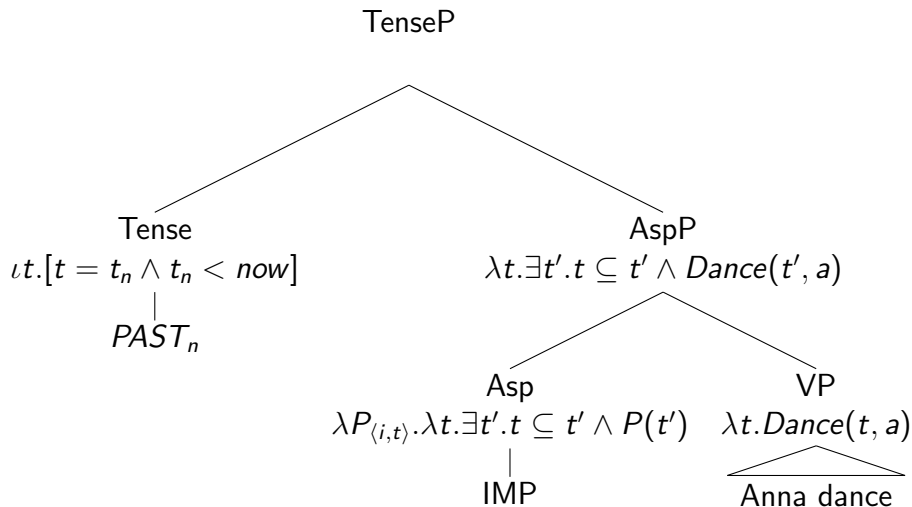
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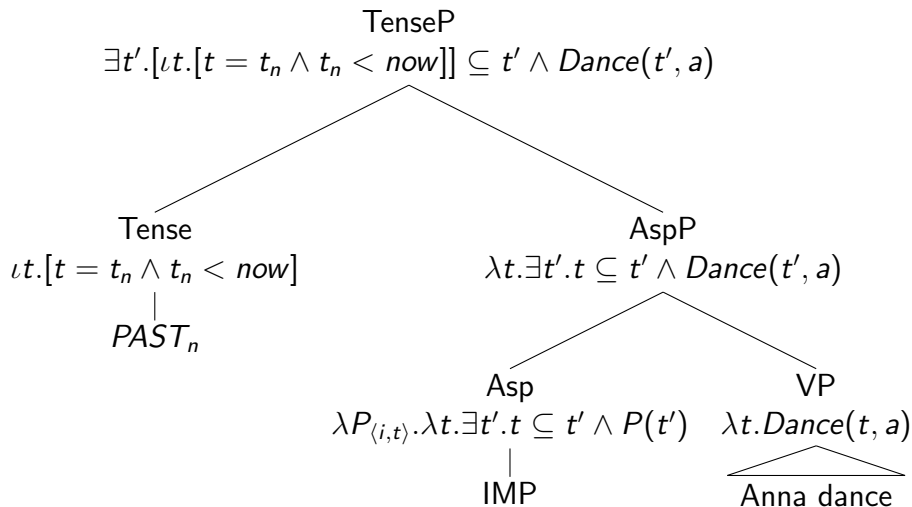
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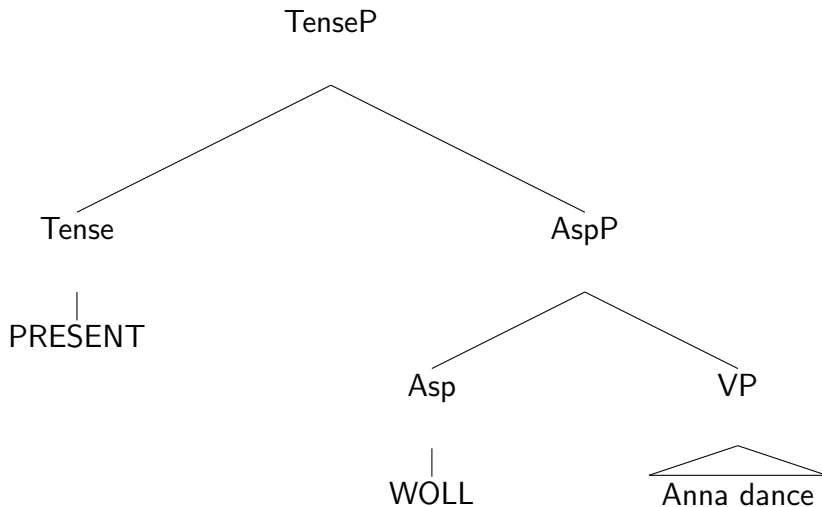
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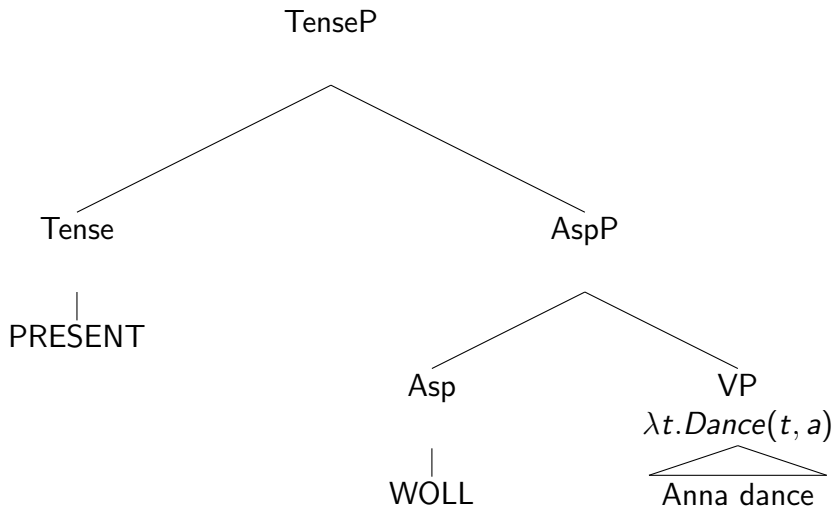
Derivation for past (imperfective)



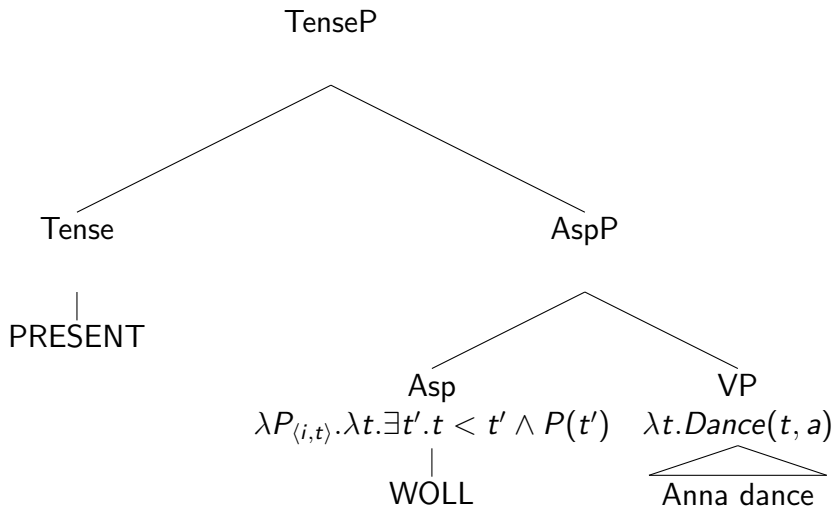
Derivation for (English) future



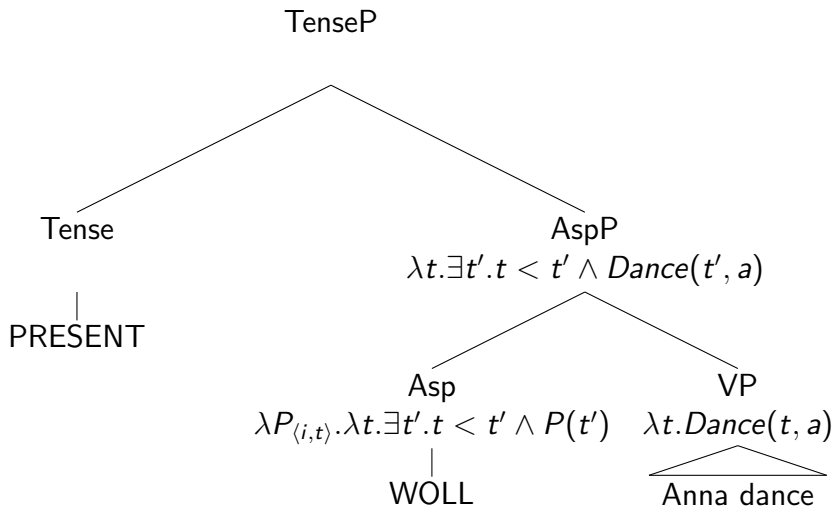
Derivation for (English) future



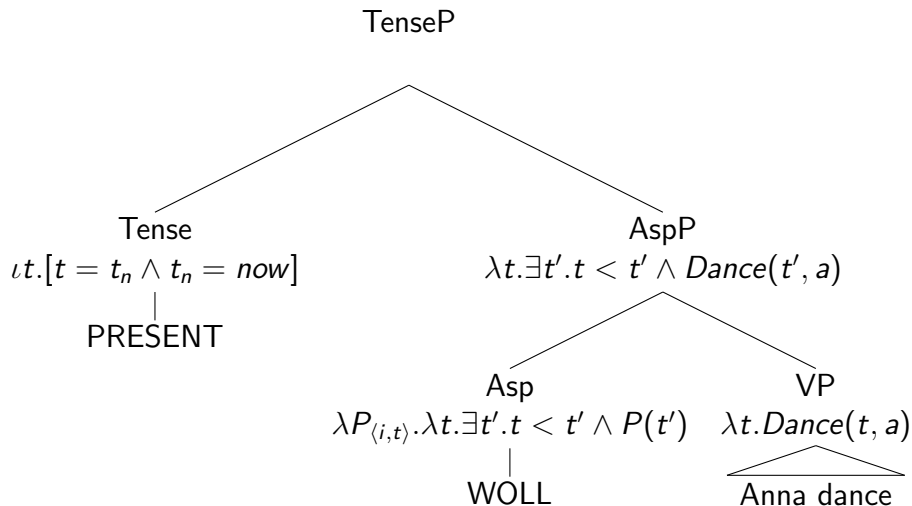
Derivation for (English) future



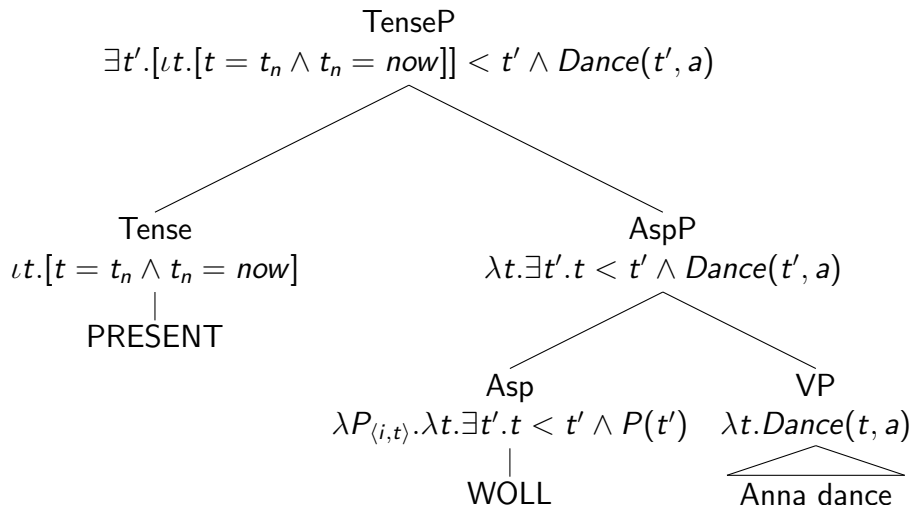
Derivation for (English) future



Derivation for (English) future



Derivation for (English) future



Quizz for Today

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