Cross-linguistic annotation of tense and aspect syntax and semantics

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Outline

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Tense and aspect in multilingual semantic construction

- Research project at the University of Konstanz
- Funded by the Nuance foundation
- Project goals:
  - Annotation of tense and aspect informed by formal semantics
  - Creating resources for NLP research and applications
  - Researching tense and aspect in under-resourced languages
  - Bringing together temporal annotation and deep linguistic parsing

NUANCE FOUNDATION

ParTMA and INESS

- ParGram and ParTMA work in collaboration with the INESS infrastructure (Rosén et al. 2012)
  INESS website: `http://clarino.uib.no/iness`
- XLE parses are online and available to partners of the ParGram project
- Parses to be integrated into ParGramBank (Sulger et al. 2013)
- Working on visualization of semantic annotation for webpages

iness

Data II

- ParGramBank: parsebank/treebank for 11 languages, developed in INESS (Sulger et al. 2013)
- ParTMA treebank: Collection of treebanks expressing tense and aspect variation; steadily growing in collaboration with ParGram members
- **Currently:** 491 sentences in 13 treebanks from 11 languages. Parallel treebank for semantically past tense sentences (inspired by Dahl (1985))

In this talk ...

- We aim to present a comprehensive annotation scheme for the linguistic category of tense
  - We aim to bring together state-of-the-art formal semantic research and computational models of temporal mark-up
  - We address the semantic properties of tense within and across languages
  - Explicit annotation of its variation in terms of syntactic and semantic instantiation

Outline

Basics of temporal annotation

*"**Once** there **was** a scorpion **standing** by a river. The scorpion **was looking** for a way to **cross**, **when** he **noticed** a frog behind him. He **asked** the frog to **carry** him across the river."*

Basics of temporal annotation

*"**Once** there **was** a scorpion **standing** by a river. The scorpion **was looking** for a way to **cross**, **when** he **noticed** a frog behind him. He **asked** the frog to **carry** him across the river."*

a. **Eventualities:**
was standing(e_1), was looking(e_2)
noticed(e_3), asked(e_4)
cross(e_5), carry(e_6)

b. **Temporal variables:**
Speech time(t_0),
topic_time(e_1,t_1),
topic_time(e_2,t_2),
topic_time(e_3,t_3),
topic_time(e_4,t_4), once(t_5)

c. **Temporal relators:**
when(t_2,t_3)

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Tense and aspect annotation

b. **Temporal variables:**
Speech time(t_0),
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once(t_5)

c. **Temporal relators:**
when(t_2,t_3)

Temporal annotation

A timeline

*"**Once$_{t5}$** there **was$_{e1}$** a scorpion **standing$_{e1}$** by a river. The scorpion **was looking$_{e2}$** for a way to **cross$_{e5}$**, **when** he **noticed$_{e3}$** a frog behind him. He **asked$_{e3}$** the frog to **carry$_{e6}$** him across the river."*

Table 1: Narrative time line[1]

$[w_0]$	t_5 $t_1 \subset e_1$ $t_2 \subset e_2$ $t_3 \supseteq e_3$	$t_4 \supseteq e_4$		t_0	
$[w_1]$		e_5			
$[w_2]$			e_6		

→ **Temporal progression** →

[1] Roughly following Gast et al. (2016), Pustejovsky et al. (2010, 2002)

TimeML cross-linguistically

- The cross-linguistic adaption of TimeML has brought up various challenges
- Korean morphology $\rightarrow$ stand-off annotation (Im et al. 2009)
- Italian tense and aspect paradigma $\rightarrow$ annotation of contextual values (Caselli et al. 2011)
- Adaption to morphologically highly different languages(from English), such as Chinese (Pustejovsky et al. 2017)

TimeML – desired improvements

- Several proposals for TimeML have been made, that argue for the independence of syntactic and semantic mark-up of tense categories, e.g.
  - Functional vs. Structural annotation (Gast et al. 2015)
  - Overhaul of ISO-TimeML tense values (Lefeuvre-Halftermeyer et al. 2016)
  - Our own annotation of syntactic and semantic variation of tense and aspect categories
  - **furthermore:** Mapping from (abstract) syntax to semantic representation (Bunt 2010)

Outline

Semantic construction of meaning

- Sometimes meaning is semantically or pragmatically constructed rather than syntactically marked
- This leads to semantic variation within a language but also distinguishes languages from one another
- **Our goal:** We want to mark up and explore these meaning shifts and test various possibilities of semantic construction

Variation in the category tense

- *I met Pater at the market yesterday.*

NORWEGIAN:	jeg **møtte** Peter på markedet i går.						
	I **meet.Past** Peter at market yesterday						
URDU:	maiN	kal	Peter=se	bazaar=meN	**milaa**		
	I	yesterday	Peter=with	market=in	**meet-Perf**		
	(thaa).						
	be.Past						
INDONESIAN:	saya	**bertemu**	Peter	di	pasar	(itu)	kemarin.
	1st	**meet**	Peter	at	market	(that)	yesterday

Variation in the English past tense

(1) Karen was sick
Karen be.Past sick

(2) Tom said that Karen **was** sick
Tom say.Past COMP Karen be.**Past** sick

(3) If Karen **was** sick, she **would** be at home.
If Karen be.Past sick she **will.Past** be at home

Annotation of semantic construction

- Analysis of semantic construction processes as exemplified above, comes with a theoretic load
  - Competing analyses available without a (clear) "winner"
    - pragmatic vs. co-indexing account in Sequence-of-tense
    - fake tense as proper past vs. as modal in counterfactuals
    - ....

→ Templatic analysis of secondary meanings

The ParTMA annotation scheme

- Consists of three modules:
- **Syntax**
  - The expressiveness of the ParTMA annotation scheme is directly linked to the richness of the syntactic representation
  - For a concrete implementation we refer to LFG

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- **Semantics**
  - A set of cross-linguistically attested formally founded semantic features (represented as logic formulas)
- **Syntax/Semantics interface**
  - A set of language-specific inference rules (or relations) that hold between syntactic and semantic features
  - Follow a set of cross-linguistically universal constraints to restrict variability

Lexical Functional Syntax

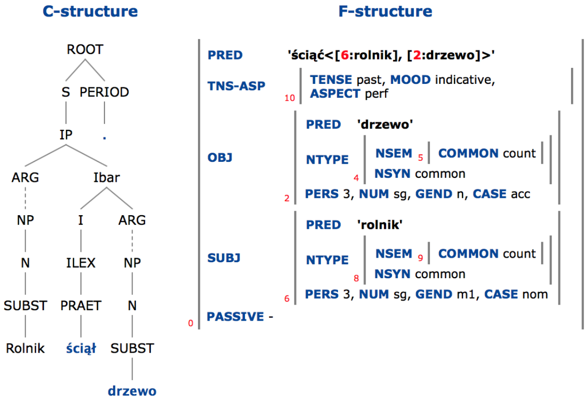

Figure 1: The farmer cut down the tree.

ParTMA semantics

- We assume a semantics with events and situations
- The semantics can be flatted into purely temporal semantics
- $[\![$John climbed the wall for two hours$]\!]$ =
  $\lambda s.s \prec s_0 \wedge s \leq_p [\![\text{last night}]\!]^{s_0} \wedge$
  $\exists e[climb(e, s) \wedge ag(e) = j \wedge th(e) = \text{the-wall(x)}$
  $\wedge \tau(e) = [\![\text{2hours}]\!]]$
- $[\![\text{PAST}]\!]^{w,g} = \lambda P.\lambda s.s \prec s_0 \wedge P(s)$
- **Simplification:**
  $[\![\text{PAST}]\!]^{w,g} = \lambda P.\lambda t.t \prec t_0 \wedge P(t)$
  existential closure => $\exists t[P(t)]$

The syntax/semantics interface

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  s.t.: $\alpha \rightarrow \phi$ means, that ϕ obligatorily follows from α (morphosyntactically realized semantic features)
- $\circ$ describes the **compatibility** relation,
  s.t.: $\alpha \circ \phi$ means, that ϕ is optionally available for α (implicatures, non-overtly realized(contextual) semantic features)

Outline

An actual example I

(4) Q: Do you know Peter?

(5) jeg møtte Peter på markedet i går
I meet.pst Peter at market yesterday
'I met Peter at the market yesterday.' Norwegian

F-Structure:

$$\left[\text{TNS-ASP} \begin{bmatrix}\text{TENSE 'past'} \\ \text{MOOD 'indicative'}\end{bmatrix}\right]$$

An actual example I

(6) Q: Do you know Peter?

(7) jeg møtte Peter på markedet i går
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F-Structure:

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ParTMA Temporal reference:

$\left[\text{TEMP-REF} \quad \text{'past'} : t \prec t_0\right]$

An actual example I

(8) Q: Do you know Peter?

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F-Structure:

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ParTMA Temporal reference:

$$[\text{TEMP-REF} \quad \text{'past'} : t \prec t_0]$$

- TENSE past $\rightarrow$ TEMP-REF 'past' : $t \prec t_0$
- $t \subseteq \textit{yesterday} \wedge t \prec t_0$

Outline

Meaning family

- A family of meaning is a collection of related meanings, i.e. meanings of the same type
- The default value 'unspec' for each feature denotes a language family comprising of all the possible values of the respective feature
  EXAMPLE:
  - TEMP-REF 'unspec' : $(\!| t \prec t_0, t \otimes t_0, t_0 \prec t, \ldots |\!)$
- We assume zero-marked events to denote meaning families (for now)

Meaning families in composition

- To compose meaning families with other elements, we employ a version of pointwise functional application (PWA).
- ϕ,ψ are meaning families ($(\!|\phi'_{<\rho,\tau>}, \phi''_{<\rho,\tau>}, \phi'''_{<\rho,\tau>}, \ldots|\!)$)[2]
- ϕ'...''' are semantic functions
- ρ and τ are semantic types

$$[\![\text{PWA}(\phi \subseteq D_{<\rho,\tau>}, \psi \subseteq D_{\tau})]\!] = (\!|\ f(x) \in D_{\tau} : f \in \phi \wedge x \in \psi\ |\!)$$

- Every object in a given language family is applied to every object in a second language family

[2] propositions are shifted into singleton families

An actual example II

(10) saya bertemu Peter di pasar (itu) kemarin
I mid-meet Peter at market (that) yesterday
'I met Peter at the market yesterday.' Indonesian

F-Structure:

[TNS-ASP [MOOD indicative]]

An actual example II

(11)	saya	bertemu	Peter	di	pasar	(itu)	kemarin
	I	mid-meet	Peter	at	market	(that)	yesterday

'I met Peter at the market yesterday.' Indonesian

F-Structure:

[TNS-ASP [MOOD indicative]]

ParTMA Temporal reference:

[TEMP-REF <'past'> [ref ::= **'past,t2'** / restr ::= 'unspec']]

An actual example II

(12) saya bertemu Peter di pasar (itu) kemarin
I mid-meet Peter at market (that) yesterday
'I met Peter at the market yesterday.' Indonesian

F-Structure:

[TNS-ASP [MOOD indicative]]

ParTMA Temporal reference:

[TEMP-REF <'past'> [ref ::= **'past,t2'**; restr ::= 'unspec']]

tier-1 MOOD indicative ∘ TEMP-REF 'unspec' : $\llparenthesis\, t \prec t_0,\ t \otimes t_0,\ t_0 \prec t \,\rrparenthesis$,t1

tier-2 $t \subseteq \mathit{yesterday} \wedge$ TEMP-REF 'unspec',t1 $\rightarrow$ TEMP-REF 'past',t2

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- **Complex rules:**
  - $\alpha \wedge \beta \wedge ... \wedge \gamma \rightarrow \phi$
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- **Complex rules:**
  - $\alpha \wedge \beta \wedge ... \wedge \gamma \rightarrow \phi$
  - $\alpha \wedge \phi \rightarrow \psi$
- **Contextual/higher level rules:**
  - *ctx* $\wedge\, \alpha ... \wedge\, \phi \circ \psi$
  - ✗ *ctx* $\rightarrow \phi$

Primary and secondary meaning

- **Primary meaning (tier-1):**
  - The primary meaning is denoted by the most simple rule that includes the respective syntactic exponent as premise and implies a certain meaning. Lexical semantics also belong to tier-1, ideally: $\alpha \rightarrow \phi$

Primary and secondary meaning

- **Primary meaning (tier-1):**
  - The primary meaning is denoted by the most simple rule that includes the respective syntactic exponent as premise and implies a certain meaning. Lexical semantics also belong to tier-1, ideally: $\alpha \rightarrow \phi$
- **Secondary meaning(tier-2):**
  - Meanings that arise from more complex, or contextual/compatibility rules.
    Consumes tier-1 meaning, e.g.
    $\alpha \rightarrow \phi$,
    $\phi \wedge \beta \wedge \gamma \wedge ... \rightarrow \phi'$

Sequence of tense

- The Sequence-of-tense phenomenon is a occurrence of tense deletion (or weakening) in embedded contexts:

(13)

Tom	said	that	Karen	**was**	sick
Tom	say.Past	COMP	Karen	be.**Past**	sick

a. Tom said: "Karen is sick."

b. Tom said: "Karen was sick."

Semantic Construction – Sequence of tense

- *Tom <u>said</u>$_{matrix}$ that Karen <u>was sick</u>$_{comp}$.*

tier-1
  - TENSE$_{\text{matrix}}$ past $\wedge$ MOOD indicative $\rightarrow$ TEMP-REF$_{\text{matrix}}$ 'past' : $t \prec t_0$
  - TENSE$_{\text{comp}}$ past $\wedge$ MOOD indicative $\rightarrow$ TEMP-REF$_{\text{comp}}$ 'past' : $t' \prec t_0$

tier-2
  - TEMP-REF$_{\text{matrix}}$ 'past' $\wedge$ TEMP-REF$_{\text{comp}}$ 'past' $\wedge$ COMP(E$_{\text{matrix}}$,E$_{\text{comp}}$) $\rightarrow$ TEMP-REF$_{\text{comp}}$ 'non-successive' : $(\!| t'' \prec t', t'' \otimes t' |\!)$

- This rule is simplified.
  the sequence-of-tense phenomenon is modeled in terms of a set of rules with varying configurations of viewpoint and lexical aspect.

Semantic Composition – Sequence of Tense

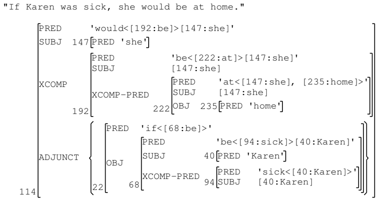
- $[\![\text{PAST}]\!]^{w,g} = \lambda P.\lambda t.t \prec t_0 \wedge P(t)$
  $[\![\text{Tom said that Q}]\!]^{w,g}\ \lambda t.t \prec t_0 \wedge say(t, tom, Q)$
- $[\![\text{NON-SUCCESSIVE}]\!]^{w,g} =$
  $(\!| \lambda P.\lambda t'.\lambda t.t' \prec t \wedge P(t), \lambda P.\lambda t'.\lambda t.t' \circ t \wedge P(t) |\!)^{w,g}$
- $[\![\text{Karen was sick}]\!]^{w,g} = [\![\text{Q}]\!]^{w,g} = \lambda t.t' \prec t \wedge be - sick(t', karen)$
  $[\![\text{Q'}]\!]^{w,g} = \lambda t.t' \circ t \wedge be - sick(t', karen)$
- $[\![\text{Tom said that Karen was sick}]\!]^{w,g} =$
  $(\!| \lambda t.t \prec t_0 \wedge say(t, tom, \exists t'[t' \prec t \wedge be - sick(t', karen)]),$
  $\lambda t.t \prec t_0 \wedge say(t, tom, \exists t'[t' \circ t \wedge be - sick(t', karen)]) |\!)$

Counterfactuality

- Counterfactuals are marked with a blend of counterfactual and past tense morphology (Romero 2014).
- Counterfactuals make the event marked by the counterfactual morphology hypothetical, i.e. it cannot hold at the actual world, e.g.:

  a. If Susan was sick, she would be at home.
  b. I wish I had a car.

Semantic construction – Counterfactuals



- Syntactic ingredients of a counterfactual conditional:
  - A consequent sentence
  - An adjunct sentence representing the antecedent of the conditional; headed by an *if*
  - syntactic past tense in the antecedent
  - a modal auxiliar (*would*) in the consequent (VTYPE modal, TENSE pres)

Semantic construction – Counterfactuals

- If Susan was sick$_{\text{ant}}$, she would be at home$_{\text{cons}}$.

tier-1
- TENSE$_{\text{ant}}$ past $\rightarrow$ TEMP-REF$_{\text{ant}}$ 'past' : $t \prec t_0$
- TENSE$_{\text{cons}}$ pres $\wedge$ VTYPE modal $\rightarrow$ TEMP-REF$_{\text{cons}}$ 'successive' : $t \prec t'$

tier-2
- ADJUNCT(cons) $\wedge$ PRED$_{\text{cons}}$ 'if' $\wedge$ TENSE$_{\text{cons}}$ past $\wedge$ TEMP-REF$_{\text{ant}}$ 'successive' $\rightarrow$ TEMP-REF$_{\text{cons}}$ 'non-past' : $\neg(t \prec t_0)$ $\wedge$ TEMP-REF$_{\text{ant}}$ 'non-past' : $\neg(t \prec t_0)$

- Again, this rule is simplified and also only one of a set of rules describing counterfactual behavior

Semantic Composition – Counterfactuals

- $[\![\text{COND}_{CF}]\!]^{w,g} = [\![P]\!] > [\![Q]\!]$
- $[\![\text{NON-PAST}]\!]^{w,g} = \lambda P.\lambda t.\neg(t \prec t_0) \wedge P(t)$
- Existential closure: $\exists t.P(t)$
- $[\![\text{P}]\!]^{w,g} = \lambda t.\neg(t \prec t_0) \wedge \text{be-sick}(\text{susan}_1)$
- $[\![\text{Q}]\!]^{w,g} = \lambda t'.\neg(t' \prec t_0) \wedge \text{be-at-home}(\text{she}_1)$
- $\exists t[\neg(t \prec t_0) \wedge \text{be-sick}(\text{susan}_1)] >$
  $\exists t'[\neg(t' \prec t_0) \wedge \text{be-at-home}(\text{she}_1)]$

Summary – The paradigm of tense

- Tenses can be:
  - absolute vs. deictic (e.g. past vs precedence)
  - ambiguous vs. vague
    - ambiguity is modeled in terms of meaning families
    - vagueness is modeled as a separate operator, e.g. $\neg(t \prec t_0)$
- Not all temporal properties are strictly overtly expressed. Some require semantic or pragmatic processing
- More properties emerge, if we research the interaction between tense and aspect
- Some languages further restrict temporal reference overtly via temporal remoteness markers

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Thanks for listening

ParTMA feature space

ID

TOKEN 'value'	
NUM < 'sg' | 'pl' | 'unspec' >	**number** ::= 'sg' | 'pl' | 'unspec' **type** ::= 'temporal' | 'participant' | 'spatial' | 'manner' | 'unspec'
CLASS <'state | 'process' | 'event_mom' | 'event_dur' '>	**onset** ::= 'pos' | 'unspec' | 'neg' **change** ::= 'pos' | 'unspec' | 'neg' **end** ::= 'pos' | 'unspec' | 'neg' **extent** ::= 'mom' | 'dur' **result** ::= 'pos' | 'unspec' | 'neg'
TELOS <'telic' | 'atelic' '>	**quant** ::= 'pos' | 'neg' **boundary** 'pos' | 'unspec' | 'neg'
TEMP-REF <'past' | 'present' | 'future' | ... >	**ref** ::= 'past' | 'present' | 'future' | 'non-past' | 'non-present' | 'unspec' **t-restr** 'immediate' | 'non-recent' | 'remote' | 'unspec'
VIEWPOINT <'imperfective' | 'imperfective'>	**aspect** ::= 'imperfective' | 'imperfective' | ['unspec'] **a-restr** ::= 'progressive' | 'iterative' | 'continuous' | 'unspec'
MOOD 'indicative' | 'subjunctive' ...	

Figure 2: Template for ParTMA eventuality annotation

Parsing inference rules for temporal annotation

- *Mary was sick yesterday.*
  TENSE past ∧ MOOD indicative → TEMP-REF 'past' : t $\prec t_0$

→ F_1 : $interval(t, 2017 - 14 - 12\ 15 : 29 : 59)$

- PRED 'yesterday' → ⟦yesterday⟧ : $\lambda t.t \subset yesterday \wedge P(t)$

→ $F2$: $interval(2017 - 13 - 1200 : 00 : 00, 2017 - 13 - 12\ 00 : 23 : 59)$

- Two features F_1 and F_2 can only be merged, iff for their intervals: $t_{F1} \cup t_{F2} \neq \varnothing$

Implicatures

- Oftentimes optional tenses carry a cessation implicature in contrast to their unmarked counter parts (Plungian and van der Auwera 2006).

a. maiN kal Peter=se bazaar=meN milaa thaa.
I yesterday Peter=with market=in meet-perf be.pst

b. maiN kal Peter=se bazaar=meN milaa
I yesterday Peter=with market=in meet-perf

- We model cessation as a boundary operator that is satisfied if a certain event terminates before the evaluation time: $\tau(e) \prec t_0$
  - ASPECT perf → TEMP-REF 'past' : $t \prec t_0$
  - TENSE past → TEMP-REF 'past' : $t \prec t_0 \wedge$ $\llparenthesis\, \lambda P.\exists e[\tau(e) \prec t_0 \wedge P(e)], \lambda P.P \,\rrparenthesis$