Dynamic Semantics (4)
Temporality

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Theoretical background: English

**LANGUAGE TYPE:** tense-based temporal reference

- **Mainstream view:** English tenses are **temporal anaphors**
  - anaphora to an aforementioned *reference point*, construed either as a *time* (e.g. Reichenbach 1947) or as an *event* (e.g. Kamp 1981, Webber 1988).
  - parallels with *nominal anaphora*
    - *tense ~ anchored (in)definite* (e.g. Webber 1988, Moens & Steedman 1988; see also Kamp & Reyle 1993)

- **Competing view:** English tenses are **temporal indefinites**
  - *tenses* (introduce new times) ~ *indefinites* (introduce new individuals)
  - *indexical anchor* to speech act only, no discourse anaphora
  - possible *pragmatic enrichment* to establish coherence may lead to additional inferences about temporal relations
    (e.g. Comrie 1981, Lascarides & Asher 1993, Kehler 1994, 2002)
Theoretical background: Mandarin

Language Type: aspect-based temporal reference, no grammatical tense

- **Mainstream view** (formal syntax & semantics): Temporal reference in Mandarin can be analyzed in terms of **English-based categories**, including:
  - English-style syntactic sentences (e.g. Huang 1982, Huang et al. 2009)
  - English-based aspectual classes (e.g. achievement, accomplishment), grammatical aspects (e.g. perfective, progressive), reference times, … (see Li & Thompson 1981, Smith 1991/7, Smith & Erbaugh 2005, Wu 2003, 2009, Xiao & McEnery 2004, Lin 2006, and many others).

- **Competing view** (a few Mandarin scholars, Chinese language textbooks) Proper analysis of Mandarin discourse requires **Mandarin-based categories**, including:
  - Mandarin-based pragmatic ‘sentences’ (‘’), zero anaphora, topic chains, … (e.g. Tsao 1979, 1990, Chu 1998, Li 2005)
  - Mandarin-based aspectual classes (e.g. dur. ‘action’ v. pnc. ‘resultative action’) (e.g. Chao 1968, Henne et al. 1977, Tai 1984, DeFrancis, J. ed. 2003)
Main goal: Unified approach to temporal reference that factors out *semantic universals* while allowing for different *language types* and *contextual variation* (Bittner 2014)

Basic idea: *Universally*, temporal reference relies on grammatical centering systems of obligatory grammatical categories that keep track of top-ranked temporal drefs (events, states, times). Within this space, there is room for *linguistic diversity*, e.g.:

- **English** has a grammatical system of **tense markers** (*TNS*, e.g. past *PST* v. present *PRS*) which introduce or refer to *top-ranked times* (usually *topic time*, sometimes *background time*) and may anchor them to input *background event*.

- **Mandarin** has a grammatical system of **aspect features** (*ASP*, e.g. eventive *E*/ v. stative *S*) which introduce *background eventualities* (events or states) and anchor them to input *topic state* or input *background eventuality* (event or state).

Universal logic: Nobody’s categories are universal; but all can be analyzed in terms of *universal primitives* (e.g. *event*, *state*, *time*, *consequent state*, *dref hierarchy*, etc). To represent temporal reference, extend UC$_{\varepsilon}$ to UC$_{\tau}$, with *time drefs* and generalized *temporal dref algebra* (building on Bach 1986, Moens & Steedman 1988).
Outline

- English: TNS-based temporality
- Mandarin: ASP-based temporality
- Implementation in UC$\tau$
- Conclusion
Outline

- English: TNS-based temporality
- Mandarin: ASP-based temporality
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- Conclusion
Indefinite np\textsuperscript{x} ~ TNS\textsuperscript{t} (Comrie 1981, Lascarides & Asher 1993, Kehler 1994)

(N) An indefinite np (e.g. a man\textsuperscript{x}) introduces a new individual into discourse 
(possibly restricted by a pragmatic coherence relation)

(T) An indefinite TNS marker (e.g. PST\textsuperscript{t}, FUT\textsuperscript{t}) introduces a new time into discourse 
(possibly restricted by a pragmatic coherence relation)

e.g.

(1) i. Al went (PST\textsuperscript{t1} go\textsuperscript{e1}) into a florist shop\textsuperscript{x}.
   ii. He promised (PST\textsuperscript{t2} promise\textsuperscript{e2}) his wife fresh flowers.
   iii. He bought (PST\textsuperscript{t3} buy\textsuperscript{e3}) some\textsuperscript{y} beautiful roses.

EXPLANATION: $e_2 < e_1$

RESULT: $e_1 < e_3$

But problems with negation & quantification (see Partee 1973), e.g.:

(2) i. Al went (PST\textsuperscript{t1} go\textsuperscript{e1}) into a florist shop.
   ii. He didn't buy (PST\textsuperscript{t2} not buy\textsuperscript{e2}) anything.
      too strong: $\neg\exists t_2(t_2 < \text{now} \land \exists e_2(e_2 \subseteq t_2 \land e_1 < e_2 \land \exists y\text{ buy}(e_2, \text{al}, y)))$
      too weak: $\exists t_2(t_2 < \text{now} \land \neg\exists e_2(e_2 \subseteq t_2 \land e_1 < e_2 \land \exists y\text{ buy}(e_2, \text{al}, y)))$
{indexical, anaphoric} pronoun ~ TNS (Partee 1973, Stone 1997, etc)

(N) A pronoun refers to an individual that satisfies its presuppositions about the relation to the speaker (e.g. *I*) or to an antecedent individual (e.g. *he* in (3ii))

(T) A TNS marker refers to a time that satisfies its presuppositions about the relation to the speech time (e.g. PRS) or to an antecedent time (e.g. PST\(_{t1}\) in (3ii)).

\[
\text{e.g.}
\]

(3) i. Once upon a time\(t\) there was (PST\(_{t1}\) be\(^{s1}\)) an old king\(^x\).
ii. He\(_x\) was (PST\(_{t1}\) be\(^{s2}\)) very rich.

ELABORATION: \(t_1 \subseteq s_1\)

But pn ~ TNS in discourse-initial contexts (e.g. ✓(4a) v. #(4b))

(4) Entering a store, Customer addresses an unfamiliar Shop Assistant:

a. I bought (PST\(^{t1}\) go) something here and I want (PRS want) to exchange it.
   (~ ‘dog’ in langs. w/o articles, e.g. anaphoric ‘dog\(_x\)’ ⇒ ‘dog\(^x\)’ if no antecedent)

b. #He\(^x\) bought (PST go) something here and he wants (PRS want) to exchange it.
anchored np ~ tns (Webber 1988, building on Moens & Steedman 1988)

An anchored np (e.g. np\_x\_y in (5)) introduces a new individual (…\_y) that is anaphorically anchored to a salient antecedent individual (…\_x).

An anchored TNS (e.g. TNS\_e\_t in (5)–(7)) introduces a new time (…\_t) that is anaphorically anchored to a salient antecedent event (…\_e).

event algebra (Moens & Steedman 1988 in MB notation):

\( e = \text{consequent state of event } e, \ \downarrow e = \text{preparatory process of event } e, \ldots \)

(5) i. A bus\_x drove up (PST\_t\_1 drive.up\_e\_1).

ii. The driver\_x\_y\_1 opened (PST\_e\_1\_2 open\_e\_2) the doors\_x\_y\_2.

iii. A passenger\_x\_z got off (PST\_e\_2\_3 get.off\_e\_3).

RESULT: \( \vartheta e_1 \subseteq t_1 \)

(6) i. Al\_x went into (PST\_t\_1 go.into\_e\_1) a florist shop.

ii. He promised (PST\_e\_1\_2 promise\_e\_2) Bea fresh flowers.

EXPLANATION: \( \vartheta e_2 \subseteq t_2 \subseteq \vartheta \uparrow \downarrow e_1 \)

(7) i. Al\_x went into (PST\_t\_1 go.into\_e\_1) a florist shop.

ii. He did not buy (PST\_e\_1\_t not buy\_e) anything.

RESULT: \( \neg \exists t, e: \vartheta e \subseteq t \subseteq \vartheta \uparrow e_1 \ldots \)
### English: Aspectual shifts

- **Generalized event algebra** (M&S + Bach + Bittner):
  \[ \langle D_\varepsilon \cup D_\sigma, \subseteq, \triangleright, \triangleleft, \triangledown, \uparrow, \downarrow, \rightarrow \rangle \]

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- **grinding:** \( \text{vp}[\text{process} \rightarrow \text{state}] \sim \text{np}[\text{object} \rightarrow \text{mass}] \) (modified Bach 1986)

  (8) **vp.** Al is\( s \) \{working\( ^e \), leaving\( ^e \}\).
  \( \{s \subseteq \triangleright e', s \subseteq \triangledown (\triangleleft e)\} \)

  **np.** Al added \( \_y \) \{oil\( ^y \), egg\( ^x \}\) to the salad.
  \( \{y \subseteq y', y \subseteq \triangledown x\} \)

- **packaging:** \( \text{vp}[\text{pl} \rightarrow \text{atomic event}] \sim \text{np}[\text{pl} \rightarrow \text{atomic object}] \) (modified Bach 1986)

  (9) **vp.** Al did a bit\( ^{''} \) of \{work\( ^e \), *leaving\( ^e \}\).
  \( \{e'' = \triangleup e', \text{no } \triangleup e\text{ for atomic } e\} \)

  **np.** Al ate a portion\( ^{''} \) of \{eggs\( ^x \), *an egg\( ^x \}\).
  \( \{x'' = \triangleup x', \text{no } \triangleup x\text{ for atomic } x\} \)
**English TNS as temporal centering**

- **Top-level reference by English TNS**
  - $\top$-reference: speech event  
    - topic time
  - $\bot$-reference: background event  
    - background time

**e.g.**
- relation 1: relation 2 (\& 3)
  - time-$\top\varepsilon$  
    - situation-time($\top\bot\varepsilon$)
  - source  
  - coherence relation

(1)
- i. Al *went* into (**PST$_\top$t** go.into$^e$) a florist shop.
  - $t_1 < \mathcal{E}_0$  
    - $\mathcal{E}_1 \subseteq t_1$  
    - **PST$_\top$t**
- ii. He *promised* (**PST$_\bot$t** promise$^e$) his wife fresh flowers.
  - $t_2 < \mathcal{E}_0$  
    - $\mathcal{E}_2 \subseteq t_2 \subseteq \mathcal{E}_1$  
    - **PST$_\bot$t**
  - **EXPLANATION** (i-ii)
- iii. He *asked* (**PST$_\top\top$t** ask$^e$) the assistant for some roses.
  - $t_1 < \mathcal{E}_0$  
    - $\mathcal{E}_3 \subseteq t_1 \subseteq \mathcal{E}_2$  
    - **PST$_\top\top$t**
  - **RESULT** (ii-iii)
English TNS as temporal centering

- Top-level reference by English TNS
  - $\top$-reference: speech event  topic time
  - $\bot$-reference: background event  background time

  e.g. time$\top \varepsilon$  situation-time$(-\bot \varepsilon)$  source  coherence relation

  (10) i. Al played chess (PST$^{\top}$ play.chess$^{e}$) today.
      $t_1 < \theta e_0$  $\theta e_1 \subseteq t_1$  PST$^{\top}$
      He started (PST$^{\bot}$ start$^{\bot}$) badly ...
      $t_2 < \theta e_0$  $\theta e_2 \subseteq t_2 \subseteq \theta \nabla e_1$  PST$^{\top \bot}$  start$^{\bot}$
      $e_2 = \nabla \nabla e_1$

    ii'. ... but in the end$\leq \varepsilon$ ...
    $t_2' \subseteq \theta \nabla \nabla e_1$  but in the end$\leq \varepsilon$  CONTRAST (ii-ii')
    ... he won (PST$^{\top \top}$ win$^{\bot \varepsilon}$).
    $t_2' < \theta e_0$  $\theta e_3 \subseteq t_2'$  PST$^{\top \top}$
    $e_3 = \nabla \nabla e_1$  win$^{\bot \varepsilon}$

    ELABORATION (i-ii')
Outline

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- Conclusion
Mandarin discourse consists of topic chains (Tsao 1979, Chu 1998, Li 2005, etc), i.e. chains of $1^+$ open stop ‘sentences’ (units marked by ) about a topical individual.

(11) i. Xiǎoli niánqīng piàoliang, gōnzuò yě hǎo。 
   Xiaoli is young and pretty. She has a good job, too.

   ii. Suīrán yǒu ge nánpěngyou, kěshì bù xiǎng jiēhūn。
   although she has a boyfriend, but not wish to get married.

(12) i. Nà-liàng chē, jiàqián tài guì, yánsè yě bù hǎo, Lisi bù xǐhuan。
   That car is too expensive and it has an ugly color. Lisi doesn’t like it.

   ii. Zuótiān qù kàn-le, hái kāi-le yíhuǐr, hái shì bù xǐhuan,...
   Yest. he went to look at it and even took it for a spin. He still didn’t like it, ...
A Mandarin verb is compositionally built out of:

- an **ASP feature** (eventive $E$/ or stative $S$/), which introduces an eventuality (event or state) and relates it to the input **topic state** ($E_T$/ or $S_T$/) or **background eventuality** ($E_⊥$/ or $S_⊥$/)

- an **eventuality predicate**, which specifies the eventuality introduced by ASP
Hence **ASP-PROMINENCE** at every level:

- **lexicon:**
  - *compound verb* = **ASP** feature + complex eventuality predicate of compositionally predictable type
  - *reduplicated verb* = **ASP** feature + complex eventuality predicate of compositionally predictable type

- **syntax:**
  - *serial verb construction (SVC)* = **ASP** feature + compositional series of eventuality predicates which all co-specify the eventuality introduced by **ASP**
  - grammatical *aspect markers* (e.g. punctual *le ‘PNC’*, durative *zhe ‘DUR’*) form anaphoric chains with antecedent **ASP** features (e.g. *E/ … PNC*)

- **discourse:**
  - **aspectual topic chain** (‘○’): topic state update (terminating in topic-setting pause │) followed by 1+ comment clauses with **Tσ**-anaphors (**ASP_T*/, **PNC_T*/).
  - **(individual) topic chain** (zero anaphora): 1+ aspectual topic chains about topic states that are (a) centered on the same individual, and (b) related closely enough for zero anaphora (e.g. *central-part* as in (11i–ii)).
E/ (\(\checkmark n\)-ci ‘n-events’) combines with:
\(v_\varepsilon\): event predicate (\(\checkmark \)zài ‘be in prg’)
\(v_\varepsilon\): xué ‘study/learn’, mǎi ‘shop/buy’,
\(\varepsilon\)-\(v_\varepsilon\): dǎ ‘beat/hit’, kàn ‘look/see/read’,
\(\varepsilon\)-\(v_\varepsilon\): xiǎng ‘think’, zuò ‘sit down’
\(v_\varepsilon\)-\(v_\varepsilon\): gòu-mǎi (purchase-buy) ‘buy’
\(v_\varepsilon\)-\(n\): kàn-shū (read-book) ‘read’
\(\sigma\)-\(v_\varepsilon\): àn-shā (dark-kill) ‘assassinate’
\(v_\varepsilon\): pt event predicate (*zài ‘be in prg’)
\(v_\varepsilon\): lái ‘come’, qù ‘go’, dào ‘get to’,
wán ‘finish’, yín ‘win’, sǐ ‘die’
\(v_\varepsilon\)-\(v_\varepsilon\): kàn-kàn ‘take a look, read a bit’
\(v_\varepsilon\)-\(v_\varepsilon\): dā-sǐ (beat-die) ‘beat to death’
\(v_\varepsilon\)-\(\sigma\): xǐ-cuò ‘write wrong’
\(v_\varepsilon\)-\(n\): dào-jīa (arr-home) ‘come home’

S/ (‘n-ci ‘n-events’) combines with:
\(v_\sigma\): state predicate (\(\checkmark \)hěn ‘very’)
\(v_\sigma\): qīng\(_1\) ‘clean/clear’, qīng\(_2\) ‘light/low’, lèi ‘tired’
\(\sigma\)-\(v_\sigma\): duō ‘many/much’, tèng ‘ache’, āi ‘love’,
\(\sigma\)-\(v_\sigma\): xiāng ‘wish/miss’, yǒu ‘have’
\(v_\sigma\)-\(v_\sigma\): gān-zào (dry-arid) ‘dry’
\(v_\sigma\)-\(n\): ài-guó (love-country) ‘patriotic’
\(n\)-\(v_\sigma\): tóu-téng (head-ache) ‘have a headache’
\(v_\sigma\): pt scale state predicate (*hěn ‘very’)
\(v_\sigma\): zuò\(_\sigma\) ‘seated’, zhàn\(_\sigma\) ‘stand’, cuò ‘wrong’,
zài ‘be in/on/at/in prg’, méiyǒu ‘have no’
\(v_\sigma\)-\(v_\sigma\): qīngqīngchūchǔ ‘perfectly clear’
\(v_\sigma\)-\(v_\sigma\): lèi-sì (tired-die) ‘dead tired’
\(v_\sigma\)-\(v_\sigma\): zhù-zài (live-be.in) ‘live in’
\(v_\varepsilon\)\( ⟨v_\sigma\⟩\)\( v_\varepsilon\)\( ⟨v_\sigma\⟩\): kāi\( ⟨bǔ\_\sigma⟩\) guò ‘unable to drive across’
serial verb construction (SVC) = ASP feature + compositional series of eventuality predicates which all co-specify the eventuality introduced by ASP

- in (13i), \( E_T/ \) introduces a process \( (e_1) \) whose progress state \( (\nabla e_1) \) starts with Xiaoli going to town \( (\searrow e_1) \) and culminates in her buying something \( (\nearrow e_1) \)
- in (13ii), \( E_T/ \) introduces a point \( (e_2) \) whose preparatory process \( (\downarrow e_2) \) is Xiaoli’s walk (part of process \( e_1 \)) and whose consequent state is a state of her being tired \( (\nearrow e_2) \)
- in (13ii), \( E_T/ \) introduces a point \( (e_3) \) in which Xiaoli sits down (with the intention that) the consequent state culminate in her resting a bit \( (\nearrow e_3) \)

(13) i. Xiǎoli jǐntiān jǐn.chéng qù mǎi dōngxi le .
Xiaoli\(^\top\) today \( \downarrow^s E_T/\text{enter.town} \) \( \text{go buy things} \) PNC\(^\top\) .
Xiaoli\(^\top\) went shopping in town today.

ii. Tā zǒu lèi le , zuò.xiàlai xiūxi~xiūxi .
s/he\(^\top\) \( E_I/\text{walk} \) \text{tired} PNC\(^\top\) ,\( \downarrow^s E_T/\text{sit.down} \) \text{rest.a.bit} .
When she\(^\top\) got tired of walking, she\(^\top\) sat down to rest a bit.
punctual aspect marker (-)le ‘PNC’ (a.k.a ‘perfective’) highlights a verifiable point

- INPUT e•. point event e. (n-atom) event s•. pt scale state s. (n-degree) state
- OUTPUT e• e s•, s, s s, s

(14) e•. Wǒ xiē-wán-le xīn.  
1SG E/write-finish-PNC letter  
e•. I finished writing a letter (verifiable pt event, e•).

e. Wǒ xiě-le xīn kēshí mei xiē-wán.  
1SG E/write-PNC letter but not writee-finish•  
▲e. I did a bit of letter writing but didn’t finish. (verifiable pt equivalent, ▲e)

s•. Chènshān xiǎo-le yì diǎn.  
shirt [s/small-PNC a.Mbit•]  
s•. The shirt is a bit small. (verifiable scalar pt, s•).  
▲s•. The shirt got a bit smaller. (verifiable start pt, ▲s•)

s. Tā bīng-le sān tiān.  
3SG [s/sick-PNC three-Mday]  
▲s, ▲s. He was sick for three days (verifiable start pt, ▲s; 3 days from ▲s to ▲s)
The minimal unit of Mandarin discourse is an open stop sentence (‘.’).

- It begins with the introduction of a topic state (terminating in topic-setting pause |‘|) followed by one or more comments about this topic state (terminating in ‘.’).
- Each comment is a clause with an ASP-feature, which introduces a background eventuality and relates it to the current topic state, either directly (Eₜₒ̇ or Sₜₒ̇) or via an anaphoric chain with a dependent aspect marker (e.g. S/… PNCₜₒ̇)

The next larger unit is an (individual) topic chain (zero anaphora)

- It begins with the introduction of a topical individual as part of topic state update, and consists of one or more open stop sentences whose topic states are:
  - centered on that topical individual
  - related closely enough for zero anaphora (e.g. ‘central part’ as in (11i–ii))
(Individual) topic chain (11i–ii) (zero anaphora) consists of 2 aspectual topic chains (‘⊂’):

(11)  

i. [Xiaoli is young and pretty. She has a good job too.]

   topic state $^T\text{s}_1$: present state of $^T\text{Xiaoli}$
   Xiaoli $^T\ |_s \ldots$

   comment 1: $^T\text{s}_1$ is a central part of a state $s_{11}$ of $^T\text{Xiaoli}$ being young and pretty
   $s_{\text{young}}$, $s_{\text{pretty}}$, …

   comment 2: $^T\text{s}_1$ is also a central part of a state $s_{12}$ of $^T\text{Xiaoli}$ having a good job
   $s_{\text{job}}$, $s_{\text{good}}$, …(end of comments about $^T\text{s}_1$)

ii. [Although she has a boyfriend, she doesn’t wish to marry.]

   topic state $^T\text{s}_2$: larger state of $^T\text{Xiaoli}$ ($s_1 \subsetneq s_2$), extended to current boyfriend
   although $s_{\text{have}}$, $s_{\text{boyfriend}}$, $s_{\text{CL}}$, …

   comment 1: $^T\text{s}_2$ is a central part of a state $s_{21}$ of Xiaoli not wanting to marry
   but not $s_{\text{wish}}$, $s_{\text{E/marry}}$, …(end of comments about $^T\text{s}_2$)
Tsao’s (1990) experiment

Native English speakers, and native Mandarin speakers learning English, were shown English and Mandarin texts with capitalization and full stops removed. They were asked to restore the full stops. Native English speakers were mostly in agreement on English sentence boundaries (‘.’). Native Mandarin speakers were found to …

… mostly agree with English speakers on English sentence boundaries (‘.’)

… but not with other Mandarin speakers on Mandarin sentence boundaries (‘.’)

Explanation

- *English sentences* are units of syntax. Their boundaries are usually recoverable from syntactic markers (e.g. TNS).

- *Mandarin sentences* are units of information structure, not syntax. A topic state update (terminating in a topic-setting pause, \( \uparrow \)) is followed by \( n \) comment(s) (clauses with topic state anaphors \( E_{\uparrow}/, S_{\uparrow}/, \) or \( PNC_{\uparrow} \)). Since states do not have visible boundaries, speakers may disagree where one topic state ends and the next one begins (e.g. whether the Mandarin discourse (11i–ii) is about two topic states (\( ^{TS}_1 \) and \( ^{TS}_2 \), as on the previous slide), or one (\( ^{TS}'_1 \), present state of Xiaoli).
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Typed dref entities

- **type:** \( \delta, \epsilon, \sigma, \tau \)
- **dref entity:** \( x \) (individual), \( e \) (event), \( s \) (state), \( t \) (time)
- **UC\( _{\tau} \) variable:** \( x, e, s, t \)

Centering-based anaphora, e.g.

- center of attn., backgr. of attn.

\[ \langle \langle t_2, s_1, x_1, e_0 \rangle, \langle e_2, e_1, s_2, t_1 \rangle \rangle \]

**dref hierarchy**

\( T\tau T\sigma T\delta T\epsilon \perp\epsilon \perp^'\epsilon \perp\sigma \perp\tau \)

**typed anaphors**

Start-up update

Speaking up \( (e_0) \) focuses attention, giving rise to \( (e_0-) \)minimal info-state:

\[ \{\langle e_0 \rangle, \langle \rangle \} \]

Reference to \( f \)-values (á la Moens & Steedman 1988, see also next slide)

- \( \triangleright e \) time of event \( e \)
- \( \uparrow e \) central individual in event \( e \)
- \( \downarrow e \) background individual in event \( e \)
- \( \triangleright s \) time of state \( s \)
- \( \uparrow s \) central individual in state \( s \)
- \( \downarrow s \) background individual in state \( s \)
Figure 3. \( \text{UC}_\tau \) event algebra: \( \langle D_\varepsilon \cup D_\sigma, \subseteq_\varepsilon, \subseteq_\sigma, \triangleright, \triangleleft, \triangledown, \triangle, \bigcirc, \bigstar, \ldots \rangle \)

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<td>state equivalent, s'</td>
<td>●●●●</td>
<td>Bach 1986</td>
</tr>
<tr>
<td>process, e'</td>
<td>( \triangle e' = e'' )</td>
<td>point equivalent, e''</td>
<td>●●●●</td>
<td>Bach 1986</td>
</tr>
<tr>
<td>state, s'</td>
<td>( \triangledown s' = e''' )</td>
<td>start point, e'''</td>
<td>●</td>
<td>Bittner 2014</td>
</tr>
<tr>
<td>state, s'</td>
<td>( \triangle s' = e )</td>
<td>culmination point, e</td>
<td>●</td>
<td>Bittner 2014</td>
</tr>
</tbody>
</table>
(13) i. Xiǎoli jīntiān jìn.chéng qù mǎi dōngxi le.
Xiaoli\(^\top\) today \(\vdash^s E_T/\text{enter.town} \quad \text{go buy things} \quad \text{PNC}_{\downarrow T} \).
Xiaoli\(^\top\) went shopping in town today.

Model for Mandarin (13i)

<table>
<thead>
<tr>
<th>Dref</th>
<th>Symbol: Description</th>
<th>Temp. conds.</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\tau e_0): (\uparrow e_0) speaks up</td>
<td>(t_1 \subseteq e_0)-day</td>
<td>(e_0) today'</td>
<td></td>
</tr>
<tr>
<td>(\tau s_1): (\tau) Xiaoli x(_1) within t(_1)</td>
<td>(s_1 \subseteq t_1)</td>
<td>(E_T/\nu_{\varepsilon} \cdot \nu_{\varepsilon} \cdot \nu_{\varepsilon}) PNC(_{\downarrow T})</td>
<td></td>
</tr>
<tr>
<td>(e_1): x(_1) goes to town ((\nu e_1)) &amp; buys things ((\tau e_1))</td>
<td>(\nu e_1 \subseteq \uparrow s_1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(13’i) Xiāoli went shopping in town today.

\[ \text{Xiaoli}^\top \text{ PST}' \text{ go}^e \text{ shopping in town today}_T \]

Model for English (13’i)

<table>
<thead>
<tr>
<th>Dref</th>
<th>Symbol: Description</th>
<th>Temp. conds.</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e_0)</td>
<td>(\uparrow e_0) speaks up</td>
<td></td>
<td>(e_0)</td>
</tr>
<tr>
<td>(t_1)</td>
<td>(e_0)-past, (t_1 &lt; \emptyset e_0) (t_1 \subseteq e_0)-day (\emptyset e_1 \subseteq t_1)</td>
<td>(PST') (today) (PST' \ V^e)</td>
<td></td>
</tr>
</tbody>
</table>
When she got tired of walking, she sat down to rest a bit.

Model for Mandarin (13i–ii)

<table>
<thead>
<tr>
<th>Dref</th>
<th>Symbol: Description</th>
<th>Temp. conds.</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>$\uparrow e_0$: $\uparrow e_0$ speaks up</td>
<td>$t_1 \subseteq e_0$-day</td>
<td>$e_0$</td>
</tr>
<tr>
<td>1----</td>
<td>$\uparrow s_1$: $\uparrow$ Xiaoli $x_1$ within $t_1$</td>
<td>$s_1 \subseteq t_1$, $\nabla e_1 \sqsubseteq_1 s_1$</td>
<td>$t_1 \Rightarrow t$, $v_\varepsilon$, $v_\varepsilon$, $v_\sigma$, $\perp_T$</td>
</tr>
<tr>
<td>●●●●</td>
<td>$e_1$: $x_1$ goes to town ($\nabla \nabla e_1$) &amp; buys things ($\nabla \nabla e_1$)</td>
<td>$\nabla e_1 \sqsubseteq_1 s_1$, $\nabla (\nabla e_1) = \nabla s_1 &lt; e_0$</td>
<td>$E_{\perp_T} / v_\varepsilon$, $v_\varepsilon$, $v_\varepsilon$</td>
</tr>
<tr>
<td>●</td>
<td>$e_2$: $x_1$ gets tired ($\nabla e_2$) from walking ($\nabla e_2$)</td>
<td>$e_2 \sqsubseteq_1 e_1$, $e_2 = \nabla s_2 &lt; e_0$</td>
<td>$E_{\perp_T} / v_\varepsilon$, $v_\sigma$</td>
</tr>
<tr>
<td>1----</td>
<td>$\uparrow s_2$: $\uparrow$ Xiaoli $x_1$ within $t_1$ after $e_2$</td>
<td>$s_2 \subseteq t_1$, $\nabla e_3 \sqsubseteq_1 s_2$</td>
<td>$E_{\perp_T} / v_\varepsilon$, $v_\varepsilon$</td>
</tr>
<tr>
<td>●●●●</td>
<td>$e_3$: $x_2$ sits down ($\nabla \nabla e_3$) to rest a bit ($\nabla \nabla e_3$)</td>
<td>$\nabla e_3 \sqsubseteq_1 s_2$</td>
<td>$E_{\perp_T} / v_\varepsilon$, $v_\varepsilon$</td>
</tr>
</tbody>
</table>
When she got tired of walking, she sat down to rest a bit.

[when \[she_PST\bot get^e tired of walking\]]^t, she\_PST\_T\bot sit\_down^e to rest a bit

---

### Model for English (13’i–ii)

<table>
<thead>
<tr>
<th>Dref</th>
<th>Symbol: Description</th>
<th>Temp. consds.</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>• (\tau e_0): (\uparrow e_0) speaks up</td>
<td></td>
<td>e_0</td>
<td>(\text{PST}^t)</td>
</tr>
<tr>
<td>(\tau t_1): (e_0)-past, part of (e_0)-day</td>
<td>(t_1 &lt; \varrho e_0)</td>
<td>(t_1 \subseteq e_0)-day</td>
<td>today_(\text{T})</td>
</tr>
<tr>
<td>(e_1): Xiaoli (x_1) goes shopping</td>
<td>(\varrho e_1 \subseteq t_1)</td>
<td>(\text{PST}^t \ \text{V}^e)</td>
<td></td>
</tr>
<tr>
<td>(t_2): (e_0)-past, part of (e_1)-prg.time</td>
<td>(t_2 &lt; \varrho e_0, t_2 \subseteq \varrho \downarrow e_1)</td>
<td>(\text{when}^t \ \text{PST} \bot \bot )</td>
<td></td>
</tr>
<tr>
<td>(e_2): (x_1) gets tired ((\downarrow e_2)) of walking ((\uparrow e_2))</td>
<td>(\varrho e_2 \subseteq t_2)</td>
<td>(\text{PST} \bot \bot \ \text{V}^e)</td>
<td></td>
</tr>
<tr>
<td>(\tau t_3): (e_0)-past, part of (e_2)-con.time</td>
<td>(t_3 &lt; \varrho e_0, t_3 \subseteq \varrho \uparrow e_2)</td>
<td>[when (\text{PST} _\bot )</td>
<td></td>
</tr>
<tr>
<td>(e_3): (x_1) sits down ((\downarrow \uparrow e_3)) to rest a bit ((\downarrow \downarrow e_3))</td>
<td>(\varrho e_3 \subseteq t_3)</td>
<td>(\text{PST} _\bot \ \text{V}^e)</td>
<td></td>
</tr>
</tbody>
</table>
Moens & Steedman (1988) idea implemented in UCτ

(15) When they built that bridge, a famous architect drew up the plans.

\[ \text{PST}_\perp \text{build}^e \text{that bridge]}' \quad \text{PST}_\perp \text{draw.up}^e \text{the plans} \]

\[ \text{e}_2: \text{they build that bridge} \quad \text{G}_e_2 \subseteq t_2 \quad \text{PST}_\perp \text{V}^e \]

\[ \text{t}_3: \text{e}_0\text{-past, part of e}_2\text{-pre.time} \quad t_3 < \text{G}_e_0, t_3 \subseteq \text{G}_e_2 \quad [\text{when }]' \text{PST}_\perp \]

(16) … , they used the best materials.

\[ \text{PST}_\perp \text{use}^e \text{the best materials} \]

\[ \text{e}_2: \text{they build that bridge} \quad \text{G}_e_2 \subseteq t_2 \quad \text{PST}_\perp \text{V}^e \]

\[ \text{t}_3: \text{e}_0\text{-past, part of e}_2\text{-prg.time} \quad t_3 < \text{G}_e_0, t_3 \subseteq \text{G}_e_2 \quad [\text{when }]' \text{PST}_\perp \]

(17) … , my commute got a lot easier.

\[ \text{PST}_\perp \text{get}^e \text{a lot easier} \]

\[ \text{e}_2: \text{they build that bridge} \quad \text{G}_e_2 \subseteq t_2 \quad \text{PST}_\perp \text{V}^e \]

\[ \text{t}_3: \text{e}_0\text{-past, part of e}_2\text{-con.time} \quad t_3 < \text{G}_e_0, t_3 \subseteq \text{G}_e_2 \quad [\text{when }]' \text{PST}_\perp \]
Outline

- English: TNS-based temporality
- Mandarin: ASP-based temporality
- Implementation in UC$_{\tau}$
- Conclusion
UC\textsubscript{r} has logical tools for a unified analysis of temporal reference, which factors out semantic universals while allowing for linguistic diversity & coherence-driven variation.

Universally, temporal reference relies on grammatical centering systems of obligatory gramm. categories that keep track of top-ranked temp. drefs (events, states, times).

Linguistic diversity, e.g.

- English has a grammatical system of tense markers (TNS, e.g. PST v. PRS) which introduce or refer to the topic time or background time and may anchor this dref to the input background event.

- Mandarin has a grammatical system of aspect features (ASP, e.g. E/ v. S/) which introduce background eventualities (events or states) and anchor them to the input topic state (either directly or via anaphorically linked aspect markers) or to the input background eventuality (event or state).

Coherence-driven semantic variation

- lexical meaning adjustments ∼ phonological adjustments (e.g. assimilation)
- accommodation (e.g. discourse-initial \text{PST}_T \rightarrow (\text{PST}_T)' or coherence (e.g. △ v. ◯)
Basic ideas

- In discourse, plurals and quantifiers can function as antecedents or anaphors, because they can introduce or refer to \textit{ranked drefs for sets}.
- Logical representation in \( \text{UC}_0 \) extended with drefs and anaphors for sets of individuals (\( \text{UC}_{\delta\iota} \)).

Suggested readings

- Berg, M. van den, 1994. A direct definition of generalized dynamic quantifiers. \textit{Proceedings of the 9\textsuperscript{th} Amsterdam Colloquium}.


