(7) π_1 John took an engine from Avon to Dansville.
      π_2 He picked up a boxcar.

Grammar produces (slightly simplified):

π_1
j, x, e_1, a, d
π_1 : $john(j)$, $engine(x)$, $avon(a)$, $dansville(d)$ $take(e_1, j, x)$, $e_1 \prec n$ $from(e_1, a)$, $to(e_1, d)$

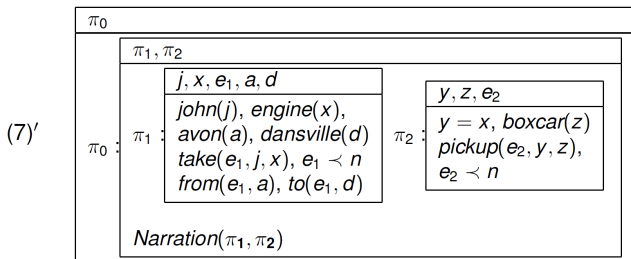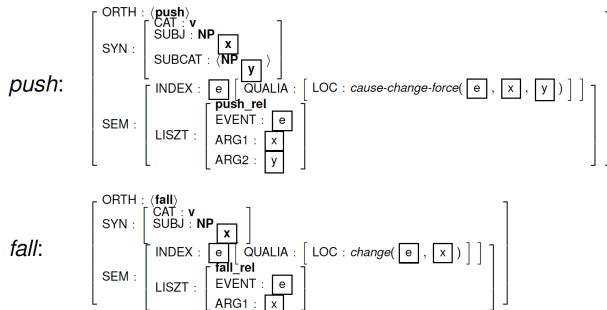| π_2 |
|---|
| y, z, e_2 |
| π_2 : $y =?,$ $boxcar(z)$ $pickup(e_2, y, z)$ $e_2 \prec n$ |
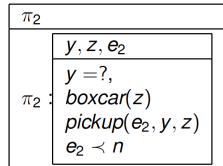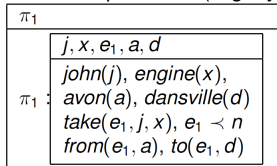
Discourse Update: Assume *coherence*!

- Only π_1 is available; so π_0 :?(π_1, π_2); so $y = x$ *whatever* the rhetorical relation.

- *Narration*(π_1, π_2) inferred on basis of various clues (more later).
- This has spatio-temporal consequences.

$(7)'$

π_0

$\pi_0 :$ | π_1, π_2 |

$\pi_1 :$

j, x, e_1, a, d
$john(j)$, $engine(x)$,
$avon(a)$, $dansville(d)$
$take(e_1, j, x)$, $e_1 \prec n$
$from(e_1, a)$, $to(e_1, d)$

$\pi_2 :$

y, z, e_2
$y = x$, $boxcar(z)$
$pickup(e_2, y, z)$,
$e_2 \prec n$

$Narration(\pi_1, \pi_2)$

Some Lexical Semantics

push:

$$
\begin{bmatrix}
\text{ORTH} : \langle \textbf{push} \rangle \\
\text{SYN} : \begin{bmatrix} \text{CAT} : \textbf{v} \\ \text{SUBJ} : \textbf{NP}\,\boxed{x} \\ \text{SUBCAT} : \langle \textbf{NP}\,\boxed{y} \rangle \end{bmatrix} \\
\text{SEM} : \begin{bmatrix} \text{INDEX} : \boxed{e}\ \begin{bmatrix} \text{QUALIA} : [\text{LOC} : \textit{cause-change-force}(\boxed{e}, \boxed{x}, \boxed{y})] \end{bmatrix} \\ \text{LISZT} : \begin{bmatrix} \textbf{push\_rel} \\ \text{EVENT} : \boxed{e} \\ \text{ARG1} : \boxed{x} \\ \text{ARG2} : \boxed{y} \end{bmatrix} \end{bmatrix}
\end{bmatrix}
$$

fall:

$$
\begin{bmatrix}
\text{ORTH} : \langle \textbf{fall} \rangle \\
\text{SYN} : \begin{bmatrix} \text{CAT} : \textbf{v} \\ \text{SUBJ} : \textbf{NP}\,\boxed{x} \end{bmatrix} \\
\text{SEM} : \begin{bmatrix} \text{INDEX} : \boxed{e}\ [\text{QUALIA} : [\text{LOC} : \textit{change}(\boxed{e}, \boxed{x})]] \\ \text{LISZT} : \begin{bmatrix} \textbf{fall\_rel} \\ \text{EVENT} : \boxed{e} \\ \text{ARG1} : \boxed{x} \end{bmatrix} \end{bmatrix}
\end{bmatrix}
$$

The Logical Form of the Sentences

(3)   Max fell. John helped him up.
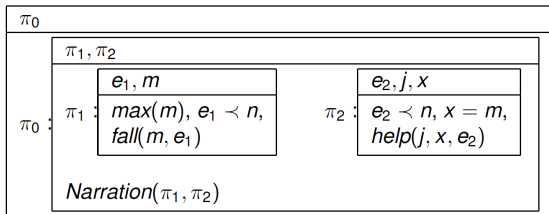
π_1 $max(m), e_1 \prec n, fall(m, e_1)$

     π_2 $e_2 \prec n, x =?, help(j, x, e_2)$

Assume Coherence: $\pi_0 : ?(\pi_1, \pi_2)$

1. $x =?$ resolves to $x = m$
2. scriptal information $\mid\!\sim$ OCCASION(π_1, π_2)
3. DMP on `Narration` yields $\pi_0 :$ NARRATION(π_1, π_2)

Minimal SDRS

π_0

π_0 :
π_1, π_2

π_1 :
e_1, m
$max(m), e_1 \prec n,$
$fall(m, e_1)$

π_2 :
e_2, j, x
$e_2 \prec n, x = m,$
$help(j, x, e_2)$

$Narration(\pi_1, \pi_2)$

- By 'minimal' I mean minimum number of nodes.
- This entails $e_1 \prec e_2$; John and Max in the same 'place'.

TimeML: Temporal Ordering of Events
Verhagen (2005), Pustejovsky (2017)

- how a temporal closure component can be embedded in a temporal annotation environment.
- Temporal closure takes known temporal relations in a text and derives new implied relations from them, in effect making explicit what was implicit.
- A temporal closure component helps to create an annotation that is complete and consistent.

Temporal Ordering of Events

(1) Turkey (AP) – Some 1,500 ethnic Albanians marched Sunday in downtown Istanbul, burning Serbian flags to protest the killings of ethnic Albanians by Serb police in southern Serb Kosovo province. The police barred the crowd from reaching the Yugoslavian consulate in downtown Istanbul, but allowed them to demonstrate on nearby streets.

This text is easy to understand and we all know what happened and when things happened. But what do we exactly need to know when we answer specific questions? Take the three questions below.

(2) What happened on Sunday?

(3) Were Serbian flags burned before the killings?

Temporal Ordering of Events
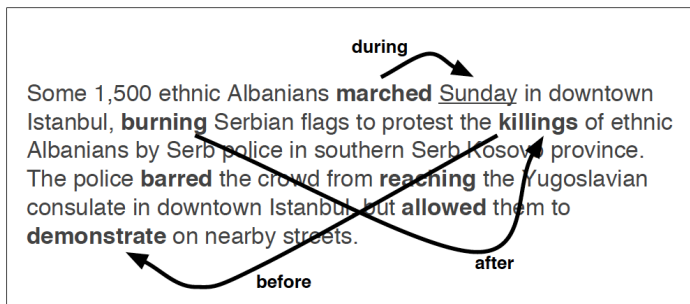
Figure 1. Enriching a text with temporal information
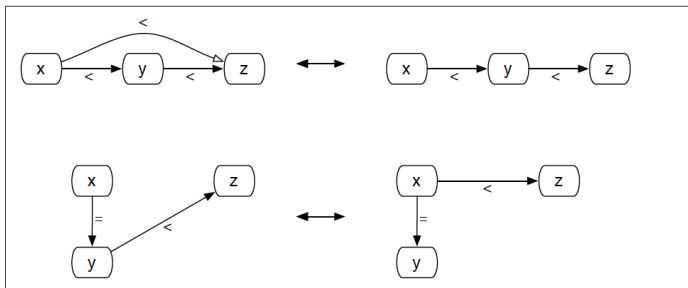
Figure 3. Two pairs of identical annotations

Table I. The transitive behavior of basic relations

⊙	<	>	d	di
<	<	all	< o m d s	<
>	all	>	> oi mi d f	>
d	<	>	d	all
di	< o m di fi	> oi di mi si	o oi d s f di si fi =	di

Table II. Mapping interval relations to point relations

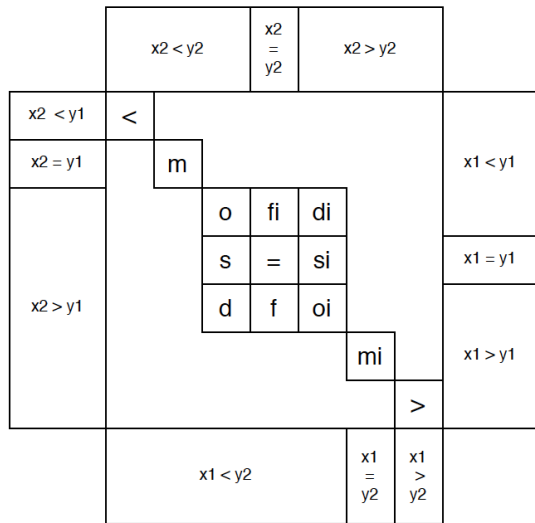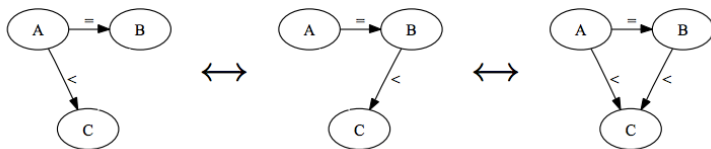|	
X before Y	$x_2 < y_1$
X starts Y	$x_1 = y_1 \wedge x_2 < y_2$
X during Y	$x_1 > y_1 \wedge x_2 < y_2$
X overlap Y	$x_1 < y_1 \wedge x_2 > y_1 \wedge x_2 < y_2$
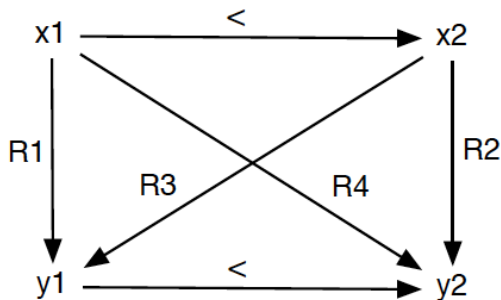
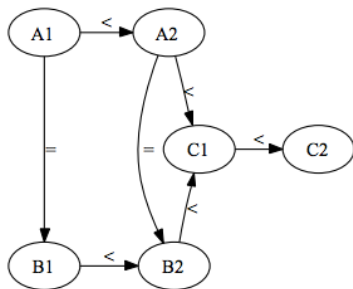*Figure 7.* Decomposing an interval relation

Figure 8. Interval relations and point relations

Computing Event Ordering

- Events in isolation with their subevent structure (individual dynamic event graphs)
- Ordering over multiple events in text or discourse

Same Information as a Labeled Transition System Graph

Making Relation Annotation More Informative

Narrative Container is the default interval containing the events being discussed in the text, when no explicit temporal anchor is given.

(1) Put events in temporal containers.

(2) Order events relative to temporal anchors.

(3) Some temporal containers may be implicit.

(4) Temporal containers may be style or genre specific.

10-26-1989

1 Philip Morris Co., New York, *adopted* a defense measure designed to *make* a hostile *takeover* prohibitively expensive.

2 The giant foods, tobacco and brewing company *said* it will *issue* common-share purchase rights to shareholders of record Nov. 8.

4-10-2011
Local officials **reported** **yesterday** *that a car* **exploded** *in downtown Basra.*

TimeBank Annotation Style

- DCT$= t_1$, val=10-04-2011
- $t_2 =$ yesterday, val=09-04-2011
- $e_1 =$ report
- $e_2 =$ explode
- TLINK$_1 =$ before(e_1, t_1)
- TLINK$_2 =$ before(e_2, t_1)
- TLINK$_3 =$ includes(t_2, e_1)

- $\text{TLINK}_4 = \text{includes}(t_2, e_2)$
- $e_2 = \text{explode}$
- $t_2 = \text{yesterday, val}=09\text{-}04\text{-}2011$

9-02-1989
An Orlon spokesman **said** *that the Board* **rejected** *Margo's latest takeover bid.*

TimeBank Annotation Style

- DCT= t_1, val=09-02-1989
- $e_1 =$ say
- $e_2 =$ reject
- $\text{TLINK}_1 = \text{before}(e_1, t_1)$
- $\text{TLINK}_2 = \text{before}(e_2, t_1)$
- $\text{TLINK}_3 = \text{before}(e_2, e_1)$

Missing Temporal Relations

Reference to a Default Narrative Container (DNC)

- t_2 = DNC, val=09-02-1989
- $TLINK_4$ = includes(t_2, e_1)
- $TLINK_5$ = includes(t_2, e_2)
- e_1 = say
- e_2 = reject

Narrative Container

- *Narrative Container* is the default interval containing the events being discussed in the text, when no explicit temporal anchor is given.
- *Narrative Time* is the current temporal anchor for events in a document, and can change as the reader moves through the narrative.
- *Narrative Scope* describes the timespan described in the document, with the left marker defined by the earliest event mentioned, and the right by the event furthest in the future.

April 25, 2010 7:04 p.m. EDT -**t0**

S1: President Obama *paid*-**e1** tribute *Sunday* -**t1** to 29 workers *killed*-**e2** in an *explosion* -**e3** at a West Virginia coal mine *earlier this month*- **t2**, *saying*-**e4** they *died*-**e5** "in pursuit of the American dream."

S2: The *blast*-**e6** at the Upper Big Branch Mine was the worst U.S. mine disaster in nearly 40 years.
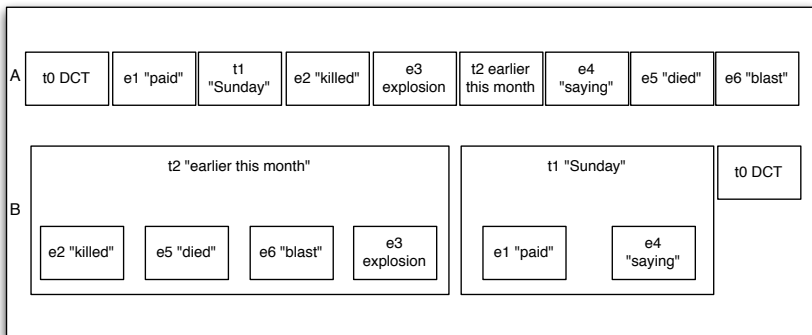
Figure: A: Times and events as appearing in the text; B: events grouped into their appropriate Narrative Times.