



Multilingual Temporal Annotation

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LSA Summer Institute



Question Answering

- When did Yale first admit women?
 - 1869
- How long does it take to climb Everest?
 - Depending in the weather conditions it can take less than one day to several weeks to climb Mt. Everest.
- Who is the Prime Minister of France?
 - **François Charles Amand Fillon** is the Prime Minister of France. Fillon has been serving France as a Prime Minister since 2007 May 17 when appointed by the French President Nicolas Sarkozy.



Question Answering

- How many illegal immigrants have crossed the border this year?
 - As of 2003, the US Citizenship and Immigration Services put the number at 7 million. Since then, United States immigration officials have said the number has grown by as much as 500,000 a year.
- How many Iraqi civilians were killed during the attack on Falluja?
 - ??
- Who was the American ambassador to Japan before Walter Mondale?
 - ??



Types of temporal relations needed

- Between an event E and a temporal expression T
- Between an event E and another Event E'
- Between two temporal values T and T'



Question Answering

- When did Yale first admit women? *E~T*
 - 1869
- How long does it take to climb Everest? *E~T*
 - Depending in the weather conditions it can take less than one day to several weeks to climb Mt. Everest.
- Who is the Prime Minister of France? *E~T*
 - **François Charles Amand Fillon** is the Prime Minister of France. Fillon has been serving France as a Prime Minister since 2007 May 17 when appointed by the French President Nicolas Sarkozy.



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- How many Iraqi civilians were killed during the attack on Falluja? $E \sim E'$
 - ??
- Who was the American ambassador to Japan before Walter Mondale?
 - ?? $T \sim T'$



Annotation of events, times and their relations: an overview

- Events
 - Detection: which text spans are anchors of events?
 - Classification: what types of events are there?
- Times
 - Detection: identifying the text spans of time expressions
 - Normalization of these time expressions
- Relations between them
 - Which time expressions are linked to which events?
 - How events are temporally ordered?



Event detection

- Find and classify all the events in a text.
 - ◆ Most verbs introduce events/states
 - But not all (*take a bath*)
 - ◆ Nominalizations often introduce events
 - *Collision, destruction, the running...*

Events

CHICAGO (AP) — **Citing** high fuel prices, United Airlines **said** Friday it has **increased** fares by \$6 per round trip on flights to some cities also served by lower-cost carriers. American Airlines, a unit AMR, immediately **matched the move**, spokesman Tim Wagner **said**. United, a unit of UAL, **said** the **increase** took effect Thursday night and applies to most routes where it competes against discount carriers, such as Chicago to Dallas and Atlanta and Denver to San Francisco, Los Angeles and New York



Time expressions

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“The TIMEBANK Corpus” (2003)

“TIMEBANK contains [186] newswire articles with careful, detailed annotations of terms denoting events, temporal expressions, and temporal signals, and, most importantly, of links between them denoting temporal relations. This collection, the largest temporal-event annotated corpus to date, provides a solid empirical basis for future research into the way texts actually express and connect series of events. It will support research into areas as diverse as the semantics of tense and aspect, the explicit versus implicit communication of temporal relational information, and the variation in typical event structure across narrative domains [.....].”

“From a practical computational perspective, it will become possible to consider training and evaluating algorithms which determine event ordering and time-stamping [.....].”

TimeBank data characteristics

TimeML tags (# occurrences)

Events	7962
Instances	7966
Timexes	1422
Signals	2117
ALinks	282
SLinks	2619
TLinks	6681
Total	29049

- TimeBank 1.1:
 - 186 documents; 68.5K words
- TimeBank 1.2
 - 183 documents
 - 3 corrupted documents from 1.1 removed
- IAA
 - 68.2% for the annotation of the time expressions only and 78.0 for the annotations of events and signals.
(Pustejovsky et al 2003)



Introduction to TimeML

- A Proposed Metadata Standard for Markup of events, their temporal anchoring, and how they are related to each other in News articles.
- Timebank is annotated based on this standard

The Conceptual and Linguistic Basis

- TimeML presupposes the following temporal entities and relations.
- **Events** are taken to be situations that occur or happen, punctual or lasting for a period of time. They are generally expressed by means of tensed or untensed verbs, nominalisations, adjectives, predicative clauses, or prepositional phrases.
- **Times** may be either points, intervals, or durations. They may be referred to by fully specified or underspecified temporal expressions, or intensionally specified expressions.
- **Relations** can hold between events and events and times. They can be temporal, subordinate, or aspectual relations.



Events and Relations

Event expressions;

tensed verbs; has left, was captured, will resign;

stative adjectives; sunken, stalled, on board;

event nominals; merger, Military Operation, Gulf War;

Dependencies between events and times:

Anchoring; John left on Monday.

Orderings; The party happened after midnight.

Embedding; John said Mary left.

Relating Events and Times

Anchoring:

- *John taught on Monday*

$\exists e1[\text{teaching}(e1,\text{john}) \ \& \ \text{on}(e1,\text{Monday}) \ \& \ \text{PAST}(e1)]$

Relations:

- *John said he taught*

$\exists e1 \exists e2[\text{saying}(e1,\text{john}) \ \& \ \text{teaching}(e2,\text{john}) \ \& \ \text{PAST}(e1)] \ \& \ \text{PAST}(e2) \ \& \ e1 > e2]$

Temporal Expressions 1

AP-NR-08-15-90 1337EDT

Iraq's Saddam Hussein, facing U.S. and Arab troops at the Saudi border, **today** sought peace on another front by promising to withdraw from Iranian territory and release soldiers captured during the Iran-Iraq war. Also **today**, King Hussein of Jordan arrived in Washington seeking to mediate the Persian Gulf crisis. President Bush on **Tuesday** said the United States may extend its naval quarantine to Jordan's Red Sea port of Aqaba to shut off Iraq's last unhindered trade route.

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Temporal Expressions 2

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``No one should doubt our staying power or determination," he said.

The U.S. military buildup in Saudi Arabia continued at fever pace, with Syrian troops **now** part of a multinational force camped out in the desert to guard the Saudi kingdom from any new thrust by Iraq.

In a letter to President Hashemi Rafsanjani of Iran, read by a broadcaster over Baghdad radio, Saddam said he will begin withdrawing troops from Iranian territory **a week** from **tomorrow** and release Iranian prisoners of war.

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Timex3 Links 1

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TIMEX3 Annotation Scheme

Time Points <TIMEX2 VAL="2000-W42">the third week of October</TIMEX2>

Durations <TIMEX2 VAL="PT30M">half an hour long</TIMEX2>

Indexicality <TIMEX2 VAL="2000-10-04">tomorrow</TIMEX2>

Sets <TIMEX2 VAL="XXXX-WXX-2" SET="YES" PERIODICITY="F1W"
GRANULARITY="G1D">every Tuesday</TIMEX2>

Fuzziness <TIMEX2 VAL="1990-SU">Summer of 1990 </TIMEX2>

<TIMEX2 VAL="1999-07-15TMO">This morning</TIMEX2>

Non-specificity <TIMEX2 VAL="XXXX-04" NON_SPECIFIC="YES">April</TIMEX2>
is usually wet.

TIMEX3 is an extension of ISO 8601 standard



Normalization of Time expressions

- Finding all time expressions is not all
- Normalize them based on some reference points
 - ISO 8601 standard for encoding temporal values



ISO 8601 standard: Numeric representation of dates and times

- Easily readable/writable by software
- Easily comparable / sortable (str compare)
 - Ditto for dates followed by times
- Language independent
- Unambiguous (wrt other date formats)
- Notation is short and of constant length
- “year, month, day” order widely used
 - Japan, Korea, Hungary, Sweden, Finland, DK,...



ISO 8601 Dates

- YYYY-MM-DD : 2005-07-29 (20050729)
2005-07
2005
- YYYY-WNN : 2005-W32 (2005W32)
2005-W32-5 =
2005-07-29
- YYYY-DDD : 2005-001 (2005001)
2005-217 =
2005-07-29



ISO 8601 Times

- `hh:mm:ss` : `23:59:59` (235959)
 `23:59`
 `23`
 `23:59:59.9942`
 (5.8ms before midnight)
- `2005-02-04 24:00` = `2005-02-05 00:00`
 `2005-02-04T23:59` ; `20050204T235959`
- fixes many disadvantages of the old English 12h notation



ISO 8601 Durations

- 6-dimensional space: Gregorian year, month, day, hour, minute, second:

`PnYnMnDTnHnMnS : P1Y2M3DT10H30M
-120D`

- reduced precision & truncation allowed
: `P.5Y ; P1D, P24H`
- order-relation: partial order



Timex value attribute

July 29, 2005	: 2005-07-29
Friday	: 2005-07-29
today	: 2005-07-29
1993	: 1993
the 1990's	: 199X
midnight, July 16, 2005	: 2005-07-16T00:00:00
5pm	: 2005-07-29T17:00
the previous day	: 2005-12-24
last October	: 2004-10
last autumn	: 2004-FA
last week	: 2005-W31
Thursday evening	: 2005-07-28:TEV
three months ago	: 2005:04



Timex value attribute

the early 1990's : value="199X" MOD="START"

the past 10 years : value="P10Y"

anchor_val="2005"

anchor_dir="BEFORE"

the next week : value="P1W"

anchor_val="2005- W32"

anchor_dir="AFTER"

the previous day : [cf. point above]

recent : value="PAST_REF"

anchor_val="2005-07-29T12:00"

anchor_dir="BEFORE"



TimeML Event Classes

- Occurrence:
 - die, crash, build, merge, sell, take advantage of, ..
- State:
 - Be on board, kidnapped, recovering, love, ..
- Reporting:
 - Say, report, announce,
- I-Action:
 - Attempt, try, promise, offer
- I-State:
 - Believe, intend, want, ...
- Aspectual:
 - begin, start, finish, stop, continue.
- Perception:
 - See, hear, watch, feel.

Event Expressions 1

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Event Expressions 2

President Bush today **denounced** Saddam's ``ruinous policies of **war**," and **said** the United States is ``**striking a blow** for the principle that might does not **make** right."

In a **speech delivered** at the Pentagon, Bush **seemed** to **suggest** that American forces could **be** in the gulf region for some time.

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TimeML Example 1

The young industry's rapid growth also is attracting regulators eager to police its many facets.

```
The young industry's rapid
<EVENT eid="e1" class="OCCURRENCE">
growth
</EVENT>
also is
<EVENT eid="e2" class="OCCURRENCE">
attracting
</EVENT>
regulators
<EVENT eid="e4" class="I_STATE">
eager
</EVENT>
to
<EVENT eid="e5" class="OCCURRENCE">
police
</EVENT>
its many facets.
```




Temporal relations

- Between events
- Between events and time expressions
- Between events and document creation time
- Formalized as TLINKS, SLINKS and ALINKS in TimeML

TLINK

TLINK or Temporal Link represents the temporal relationship holding between events or between an event and a time, and establishes a link between the involved entities, making explicit if they are:

Simultaneous (happening at the same time)

Identical: (referring to the same event)

John drove to Boston. During his drive he ate a donut.

One **before** the other:

The police looked into the slayings of 14 women.

In six of the cases suspects have already been arrested.

One **after** the other:

One **immediately before** the other:

All passengers died when the plane crashed into the mountain.

One **immediately after** than the other:

One **including** the other:

John arrived in Boston last Thursday.

One **being included** in the other:

One **exhaustively during** the duration of the other:

John taught for 20 minutes.

One being the **beginning** of the other:

John was in the gym between 6:00 p.m. and 7:00 p.m.

One being **begun by** the other:

One being the **ending** of the other:

John was in the gym between 6:00 p.m. and 7:00 p.m.

One being **ended by** the other:

TLINK: Example 1

(4) John taught 20 minutes every Monday.

John

```
<EVENT eid="e1" class="OCCURRENCE">taught</EVENT>
<MAKEINSTANCE iid="ei1" eventID="e1" tense="PAST" aspect="NONE"
negation="false"/>
<TIMEX3 tid="t1" type="DURATION" value="P20TM">20 minutes</TIMEX3>
<TIMEX3 tid="t2" type="SET" value="xxxx-wxx-1" quant="EVERY">
every Monday
</TIMEX3>
<TLINK timeID="t1" relatedToTime="t2" relType="IS_INCLUDED"/>
<TLINK eventInstanceID="ei1" relatedToTime="t1" relType="DURING"/>
```

TLINK: Example 2

(8) John taught twice on Monday but only once on Tuesday.

John

```
<EVENT eid="e1" class="OCCURRENCE">taught</EVENT>
```

```
<SIGNAL sid="s1"> twice </SIGNAL>
```

```
<SIGNAL sid="s2"> on </SIGNAL>
```

```
<TIMEX3 tid="t1" type="DATE" value="xxxx-wxx-1">Monday</TIMEX3>
```

but only

```
<SIGNAL sid="s3">once</SIGNAL>
```

```
<SIGNAL sid="s4">on</SIGNAL>
```

```
<TIMEX3 tid="t2" type="DATE" value="xxxx-wxx-2">Tuesday</TIMEX3>
```

```
<MAKEINSTANCE eiid="ei1" eventID="e1" tense="PAST" aspect="NONE" negation="false"
signalID="s1" cardinality="2"/>
```

```
<MAKEINSTANCE eiid="ei2" eventID="e1" tense="PAST" aspect="NONE" negation="false"
signalID="s3" cardinality="1"/>
```

```
<TLINK eventInstanceID="ei1" signalID="s2" relatedToTime="t1" relType="IS_INCLUDED"/>
```

```
<TLINK eventInstanceID="ei2" signalID="s4" relatedToTime="t2" relType="IS_INCLUDED"/>
```

SLINK

SLINK or Subordination Link is used for contexts introducing relations between two events, or an event and a signal, of the following sort:

Modal: This relation is brought up by events introducing a reference to a possible world

Factive: Certain verbs introduce an entailment (or presupposition) of the argument's veracity. They include **forget** in the tensed complement, **regret**, **manage**:

John forgot that he was in Boston last year.

Mary regrets that she didn't marry John.

Counterfactive: The event introduces a presupposition about the non-veracity of its argument: **forget (to)**, **unable to** (in past tense), **prevent**, **cancel**, **avoid**, **decline**, etc.

John forgot to buy some wine.

John prevented the divorce.

Evidential: Evidential relations are introduced by REPORTING or PERCEPTION:

John said he bought some wine.

Mary saw John carrying only beer.

Negative evidential: Introduced by REPORTING (and PERCEPTION?) events conveying negative polarity:

John denied he bought only beer.



Subordinated Links 1

AP-NR-08-15-90 1337EDT

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Subordinated Links 2

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Reported Speech 1

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SLINK: Example 1

Bill wants to teach on Monday.

Bill

<EVENT eid="e1" class="I_STATE">wants</EVENT>

<MAKEINSTANCE iid="ei1" eventID="e1" tense="PRESENT" aspect="NONE"/>

**<SLINK eventInstanceID="ei1" signalID="s1" subordinatedEvent="ei2"
relType="MODAL"/>**

<SIGNAL sid="s1"> to </SIGNAL>

<EVENT eid="e2" class="OCCURRENCE" >teach</EVENT>

<MAKEINSTANCE iid="ei2" eventID="e2" tense="nil" aspect="NONE"/>

<SIGNAL sid="s2">on</SIGNAL>

<TIMEX3 tid="t1" type="DATE" temporalFunction="true" value="XXXX-WXX-1">Monday
</TIMEX3>

<TLINK eventInstanceID="ei2" relatedToTime="t1" relType="IS_INCLUDED"/>



ALINK

ALINK or Aspectual Link represent the relationship between an aspectual event and its argument event. Examples of the possible aspectual relations we will encode are:

1. Initiation:

John started to read.

2. Culmination:

John finished assembling the table.

3. Termination:

John stopped talking.

4. Continuation:

John kept talking.



Aspectual Links 1

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ALINK

He will begin withdrawing troops from Iranian territory ...

He

will

```
<EVENT eid="e1" class="ASPECTUAL">
```

begin

```
</EVENT>
```

```
<MAKEINSTANCE iid="ei1" eventID="e1" tense="PAST" aspect="NONE"  
negation="false"/>
```

```
<EVENT eid="e1" class="OCCURRENCE">
```

withdrawing

```
</EVENT>
```

```
<MAKEINSTANCE iid="ei2" eventID="e2" tense="nil" aspect="PROG"  
negation="false"/>
```

```
<ALINK eventInstanceID="ei1" signalID="s1" relatedToEvent="ei2" relType="INITIATE"/>
```



More on TimeML

- <http://www.timeml.org/site/index.html>



Annotating temporal ordering of events

- Temporal ordering of events is
 - one of the most important temporal annotation tasks
 - also one of the most difficult temporal annotation tasks
- How do we go about annotating temporal ordering?
 - Annotating every event pair? $\binom{n}{2}$ Event pairs
 - Annotating select pairs? How do we choose which pairs to annotate?



TimeBank annotation

- The guideline does not specify certain types of annotations that should be performed;
- The guideline forces some annotations to be performed when they should not always be.

Pustejovsky and Stubbs 2011



Two ideas

- Partial ordering of events through anchoring events to narrative times [Pustejovsky and Stubbs 2011](#)
- Discourse constraint temporal ordering
([Zhou and Xue 2011](#))



Ordering the events through narrative times

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



Discourse guided event ordering

- The first approximation:
 - Annotating temporal ordering between adjacent “main” event pairs
 - Main event pairs defined syntactically (for the most part)
- Low IAA scores (~65%)
 - English: Verhagen et al., 2009
 - Chinese: Xue and Zhou, 2010
- Main problems
 - What is the main event of a sentences? IAA = 74%
 - In some cases there are no meaningful relations between consecutive main events, leading to temporal vagueness

Different layers of discourse structure

S1 宋健 **说**：“如今，中国已能生产上万门数字电话程控交换机，而且这种交换机的总设计师只有二十八岁。”

“ Song Jian **said**, 'nowadays, China is capable of producing tens of thousands of digital telephone PBX and the chief engineer is only 28 years old.'”

S2 去年研制成功的“曙光 1000”计算机研究人员大都**是**三十岁左右的年轻人。

“ Most of the researchers involved in building Dawn 1000, which was successfully completed last year, **are** about 30 years old.”



Which one is a main event in a coordination structure?

今年9月，多家外国石油公司与哈萨克斯坦国家石油公司**签署**了一揽子“世纪合同”，这些合同将在今后40年内**产生**7000亿美元的巨额利润。

“In September of this year, many foreign oil companies **signed** a series of 'century contract' with Kazakhstan National Oil Company. These contracts will **generate** an enormous profit of 700-billion dollars in the following 40 years.”



Towards discourse constrained temporal annotation

- Instead of annotating temporal ordering between consecutive main events, annotating events where there is a discourse relation
- Hypotheses:
 - more likely to find meaningful temporal relations between these events
 - More likely to find temporal relations people care about



An example

据悉，东莞海关共 [e1接受] 企业
According to reports, Dongguan Customs in total accept company

合同备案 八千四百多份，比 试点前 略 [e2有]
contract record 8400 plus CL, compare pilot before slight EXIST

上升，企业 反应 [e3良好]，普遍 [e4表示] 接受。
increase，company respond well，generally acknowledge acceptance .

“According to reports, Dongguan Customs [e1 accepted] more than 8400 records of company contracts, [e2 a slight increase from before the pilot]. Companies [e3 responded] well, generally [e4 acknowledging] acceptance .”



Pairing

AO1 – AO2
e1 – e2

AO3 – AO4
e3 – e4

AO1+2 – AO3+4
e1 e3
e2 e4



Annotation procedure

- Discourse-constrained selection of event pairs
 - One annotator
- Temporal annotation
 - Two-phase
 - Double-blind annotation by two annotators
 - Adjudication by one judge
 - 10-week training period
 - 10 files each week
 - Training session: discussion based on adjudication notes



IAA over the training period

Week	No of tokens	(A,B)	(A,J)	(B,J)
1	310	0.4806		
2	352	0.6278		
3	308	0.7532		
4	243	0.7737		
5	286	0.8007	0.8601	0.8566
6	299	0.7659	0.8662	0.8896
7	296	0.7973	0.8784	0.8784
8	323	0.7988	0.8978	0.8793
9	358	0.8212	0.9106	0.8966
10	378	0.8439	0.9365	0.8995



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