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Language resource management — Semantic annotation framework (SemAF) —

Part 1: Time and events (SemAF-Time, ISO-TimeML)

Gestion des ressources langagières — Cadre d'annotation sémantique (SemAF) —

Partie 1: Temps et événements (SemAF-Time, ISO-TimeML)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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ISO 24617-1 was prepared by Technical Committee ISO/TC 37, *Terminology and other language and content resources*, Subcommittee SC 4, *Language resource management*.

ISO 24617 consists of the following parts, under the general title *Language resource management — Semantic annotation framework (SemAF)*:

— *Part 1: Time and events (SemAF-Time, ISO-TimeML)*

— *Part 2: Dialogue acts*

The following parts are under preparation:

— *Part 4: Semantic roles (SemAF-SRL)*

— *Part 5: Discourse structure (SemAF-DS)*

The following parts are planned:

— *Part 3: Named entities (SemAF-NE)*

— *Part 6: Principles of semantic annotation*

— *Part 7: Spatial information (ISO-Space)*

— *Part 8: Relations in Discourse (SemAF-DRel)*

Introduction

This part of ISO 24617 results from the agreement between the TimeML Working Group and the ISO Working Group, ISO/TC 37/SC 4/WG 2, *Language resource management – Semantic annotation*, that a joint activity should take place to accommodate the two existing documents for annotating temporal information, *TimeML 1.2.1* and *TimeML Annotation Guidelines*, into ISO international standards. This work should lead to the achievement of two objectives:

— modification of the two documents in conformance to the ISO International Standards;

— verification of the annotation guidelines for a wide coverage of multilingual resources.

It should be noted that this part of ISO 24617 provides normative guidelines not just for temporal information, but also for information content in various types of events in English as well as other languages.

Language resource management — Semantic annotation framework (SemAF) —

Part 1:
Time and events (SemAF-Time, ISO-TimeML)

1 Scope

Temporal information in natural language texts is an increasingly important component to the understanding of those texts. This part of ISO 24617, *SemAF-Time*, specifies a formalized XML-based markup language called *ISO-TimeML,* with a systematic way to extract and represent temporal information, as well as to facilitate the exchange of temporal information, both between operational language processing systems and between different temporal representation schemes. The use of guidelines for temporal annotation has been fully attested with examples from the TimeBank corpus, a collection of 183 documents that have been annotated by TimeML before the current version of *ISO-TimeML* was formulated.

NOTE Throughout this document, *SemAF-Time* refers to the ISO 24617-1, while *ISO-TimeML* refers to the annotation language specified in this document.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE The first reference shows how dates and times are represented and the second provides a format for the standoff representation of *ISO-TimeML* annotation presented here.

ISO 8601:2004, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO 24612:2011, *Language resource management — Linguistic annotation framework* (*LAF*)

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO 8601:2004 and the following apply.

NOTE The terms and definitions provided below are provided to clarify the terminology relating to the metamodel, specification, and semantics of *ISO-TimeML*. Terminology derived from XML and other formal languages as well as from general temporal logics is not defined here.

3.1
ALINK
linking tag that represents a phase relation between an aspectual verb (or morpheme) and a predicate denoting an **event** (3.5)

3.2
annotation
process of adding information to segments of language data or that information itself

3.3
beginning
instant (3.6) at which a **temporal interval** (3.17) begins

NOTE Adapted from Hobbs and Pan (2004).

3.4
end
instant (3.6) at which a **temporal interval** (3.17) ends

NOTE Adapted from Hobbs and Pan (2004).

3.5
event
eventuality
something that can be said to obtain or hold true, to happen or to occur

NOTE The term "event" is used here with a very broad notion of event, which includes all kinds of actions, states, processes, etc. It is not to be confused with the more narrow notion of event as something that happens at a certain point in time (such as the clock striking 2, or waking up) or during a short period of time (such as laughing).

3.6
instant
point in time with no interior points

NOTE Time is often viewed as a straight line from minus infinity to plus infinity. In this view, time is formed by an infinite sequence of points. An instant can also be seen as an infinitesimally small interval. Cf. OWL-Time Ontology for "instant": http://www.w3.org/TR/owl-time/.

3.7
markable
entity in general, or segment of a text in particular, that is subject to an annotation (3.2)

3.8
MLINK
linking tag that represents the measurement of the duration of an **event** (3.5) or the measurement of the length of a (possibly discontinuous) time span

3.9
point of event
instant (3.6) at which the **event** (3.5) mentioned in a given utterance occurs

NOTE Next to a point of speech, a point of event also needs to be defined in order to interpret tense. For example, in "Arthur smiled", the temporal location of the point of event can be defined as being prior to the point of speech.

3.10
point of reference
instant (3.6) of temporal perspective on the **event** (3.5) in a given utterance

NOTE 1 "Arthur will have gone by tomorrow", where the point of speech is now, the point of event is some time in the future, but before the point of reference referred to by "tomorrow".

NOTE 2 To locate certain tenses in time, a third anchor point is also required, defined as the point of reference.

3.11
point of speech
time unit (3.17) at which a given utterance occurs

NOTE 1 The notion of point of speech is needed in order to interpret tense. This requires the use of anchor points in time, of which the point of speech is one (point of text, see 3.12, is another one). For example, in "Arthur smiled", the point of speech is the time that the utterance is made.

NOTE 2 For a document as a whole, this may be considered to be the same as the document creation time.

3.12
point of text
instant (3.6) at which reported speech is anchored

NOTE It is the point of time considered in the text of the speech. So for example, when a person is telling a story, it is not enough to know the point of the speech itself (the document creation time), but the point at which the speech in the story is taking place.

3.13
representation
format in which an **annotation** (3.2) is rendered, for instance in XML, independent of its content

3.14
SLINK
linking tag that represents a subordinating relation between two **events** (3.5)

3.15
temporal interval
period
uninterrupted stretch of time, with internal point structure.

NOTE 1 Adapted from WordNet.

NOTE 2 Time is often viewed as a straight line from minus infinity to plus infinity. A temporal interval is a part of that line without any holes, containing all the points between its beginning and its end.

NOTE 3 In mathematics, an important issue is whether an interval includes its beginning and its end (is "closed") or not (is "open" or "half-open"). In natural language descriptions of intervals this may also be relevant, as when describing an interval in terms of a number of days, but not with the same granularity as in mathematics. Cf. OWL-Time Ontology for "interval": http://www.w3.org/TR/owl-time/.

3.16
temporal ordering relation
relation that determines how objects are ordered in time

EXAMPLE precedence, simultaneity.

NOTE There is a limited number of ways to order objects which are collectively called ordering relations.

3.17
temporal unit
element in a **time amount** (3.18) that quantifies the length of a **temporal interval** (3.15) or a set of **temporal intervals** (3.15)

NOTE 1 Adapted from Bunt (1985).

NOTE 2 In measurement systems, various units are defined for different purposes. Small units such as seconds and minutes are defined to measure small temporal intervals; as one may want to avoid working with big numbers, for larger temporal intervals, units such as week, year, decade, and century are defined.

NOTE 3 The amount of a temporal unit is called a measure.

3.18
time amount
quantity of time, measured by **temporal units** (3.17) over **temporal intervals** (3.15)

NOTE 1 Adapted from Bunt (1985).

NOTE 2 A time amount is a measure of time that can be expressed in terms of a number of temporal units, such as "half an hour" or "30 minutes".

3.19
tense
way that languages express the time at which an **event** (3.5) described by a sentence occurs

NOTE This is characterized as a property of a verb form. Noun forms will not be said to exhibit tense but rather temporal markers.

3.20
TLINK
linking tag that represents a temporal relation between two temporal entities: namely, between two **events** (3.5), two temporal expressions, or between a temporal expression and an event

NOTE 1 Adapted from Pustejovsky *et al*. (2004).

NOTE 2 Some ordering relations cannot be expressed by an ordering relation between two events because a signal, like a temporal preposition, complicates the ordering or there is an ordering relation between a temporal signal and an event.

4 Overview

An understanding of temporal information is needed to better understand natural language texts in general. Previous work in time stamping is a step in the right direction, but to fully appreciate the complexity of a text with respect to time, the ability to order events and temporal expressions is needed. This part of ISO 24617 defines *ISO-TimeML*, a markup language for time and events, which has been specifically designed for this task.

ISO-TimeML annotates all expressions having temporal import, broadly categorized as temporal expressions and eventualities (situations, events, states, and activities). Temporal expressions and events participate in temporal relationships (e.g. "before", "simultaneous"), subordinating relationships (e.g. "intensional", "factive"), and aspectual relationships (e.g. "initiates", "continues"). *ISO-TimeML* provides an additional expressive capability of capturing and representing the complexities of these relationships.

TimeML, the precursor of *ISO-TimeML*, is already in use in a number of applications focusing on analysis (manual and automatic) of news articles. The TimeBank corpus contains approximately 185 such documents and has been validated against the most recent version of TimeML. The resulting output of a TimeML annotated document is in XML, which allows for general XML validation methods to be used. In addition to supporting interoperability among different temporal representation schemes, TimeML has been shown adequate to support a mapping from the temporal information in a text to its formal representation in a Web Ontology Language such as OWL-Time.

Unlike prior event annotation schemes, *ISO-TimeML*'s somewhat unique definition of an event does not limit the standard's applicability to specific natural language genres. An *ISO-TimeML* event is simply something that can be related to another event or temporal expression using an *ISO-TimeML* relationship — thus an *ISO-TimeML*-compliant representation can be adapted (derived) from the full standard specification, appropriate to different genres, styles, domains, and applications. Future work will involve applying the standard in such different contexts, and formulating guidelines and principles for appropriate use of *ISO-TimeML* in a variety of language engineering environments.

5 Motivation and requirements

The identification of temporal and event expressions in natural language text is a critical component of any robust information retrieval or language understanding system, and recently this has become an area of intense research in computational linguistics and Artificial Intelligence. The importance of temporal awareness to question answering systems has become more obvious as current systems strive to move beyond keyword and simple named-entity extraction. Named-entity recognition has moved the fields of information retrieval and information exploitation closer to access by content, by allowing some identification of names, locations and products in texts. One of the major problems that has not been solved is the recognition of events and their temporal anchorings in text. Events are naturally anchored in time within a narrative. Without a robust ability to identify and extract events and their temporal anchoring from a text, the real aboutness of the text can be missed. Moreover, since entities and their properties change over time, a database of assertions about entities will be incomplete or incorrect if it does not capture how these properties are temporally updated. To this end, event recognition drives basic inferences from text.

As it happens, however, much of the temporal information in an article or narrative is left implicit in the text. The exact temporal designation of events is rarely explicit and many temporal expressions are vague at best. A crucial first step in the automatic extraction of information from such texts, for use in applications such as automatic question answering or summarization, is the capacity to identify what events are being described and to make explicit when these events occurred.

Another important point is that, although most of the information on the web is in natural language, it is unlikely that it will ever be marked up for semantic retrieval, if that entails hand annotation. Natural language programs will have to process the contents of web pages to produce annotations. Remarkable progress has been made in the last decade in the use of statistical techniques for analysing text. However, these techniques, for the most part, depend on having large amounts of annotated data, and annotations require an annotation scheme. Hence, in addition to developing the necessary tools for temporal analysis, it is important to enable for seamless integration into existing and emerging ontologies, such as OWL. Interest in temporal analysis and event-based reasoning has contributed to the development of a specification language for events and temporal expressions and their orderings (TimeML). Some issues relating to temporal and event identification have remained unresolved, however, and *ISO-TimeML* has been designed to address these issues. Specifically, four basic problems in event-temporal identification have been addressed in the design of *ISO-TimeML*:

— time anchoring of events (identifying an event and anchoring it in time);

— ordering events with respect to one another (distinguishing lexical from discourse properties of temporal ordering);

— reasoning with contextually underspecified temporal expressions (temporal functions such as “last week” and “two weeks before”);

— reasoning about the persistence of events (how long does an event or the outcome of an event last).

The specification language, *ISO-TimeML*, is designed to address these issues, in addition to handling basic tense and aspect features.

Linking a formal theory of time with an annotation scheme aimed at extracting rich temporal information from natural language text is significant for at least two reasons. It will allow us to use the multitude of temporal facts expressed in text as the ground propositions in a system for reasoning about temporal relations. It will also constitute a forcing function for developing the coverage of a temporal reasoning system, as we encounter phenomena not normally covered by such systems, such as complex descriptions of temporal aggregates.

6 Basic concepts and metamodel

Regarding the temporal information in a document, a distinction can be made between (1) the temporal metadata, regarding when the document was created, published, distributed, received, revised, etc., and (2) the temporal properties of the events and situations that are described in the document. The former type of information is associated with the document as a whole; information of the latter type will be associated in annotations with parts of the text in the document, “markables” such as words and phrases.

Temporal objects and relations have been studied from logical and ontological points of view; well-known studies include those by Allen (1984), Prior (1967), and more recently Hobbs and Pan (2004); see also the collection of papers in Mani *et al*. (2005). The most common view of time, which underlies most natural languages, is that time is an unbounded linear space running from a metaphorical “beginning of time” at minus infinity to an equally metaphorical “end of time” at plus infinity. This linear space can be represented as a straight line, the points of which correspond to moments in time; following Hobbs and Pan (2004), we will also use the term “instant” to refer to time points. From a mathematical point of view, the points on the time line are line segments of infinitesimally small size, corresponding to the intuition that a moment in time can, in principle, be determined with any precision that one may wish.

For linguistic and philosophical reasons, several classifications have been proposed of verbs describing various types of states or events, the Vendler classification being the best known (Vendler, 1967). For the annotation of temporal information in text, not only verbs with their tenses and temporal modifications should be considered, but also nouns, since nouns may also denote events and situations (“The meeting tomorrow”; “The six o'clock news”). In TimeML, Pustejovsky *et al*. (2007) have proposed a classification of states and events into seven categories. In the literature, a distinction is often made between events and states, where events are commonly characterized as occurring at a point in time or during a certain definite interval, whereas states may obtain for any indefinite stretch of time (“The Mediterranean Sea separates Europe from Africa”). On a terminological note: the term “event” will henceforth be used as a generic term that also covers such notions as “state”, “situation”, “action”, “process”, etc.; this broad notion of event has also been termed “eventuality” (Bach, 1986).

In reality, nothing happens in infinitesimally small time; every event or state that occurs in reality (or in someone's mind) requires more than zero time, although natural languages offer speakers the possibility to express themselves as if something occurs at a precise instant (such as “I will call you at twelve o'clock”). Since instants are formally a special kind of interval, a consistent approach to modelling the time that an event occurs is to always use intervals, where it may happen that the interval associated with a particular event is regarded as having zero length, and thus being an instant. This is reflected in the metamodel presented in Figure 1, which uniformly relates events with temporal intervals.

The length of an interval can also occur as temporal information in a text, as in “I used twelve hours to read that book” and “It takes seven minutes to walk to the station”. An expression such as “seven minutes” does not denote an interval, but the length of an interval. It is the temporal equivalent of spatial distance (“seven miles”). To describe the length of a temporal interval, one needs a unit of measurement, which may be combined with a numerical expression to obtain an amount of time. The metamodel presented below therefore includes the concept of an amount of time, related to intervals through the function *length*, and the auxiliary concepts of temporal units and real numbers. (Moreover, in the *ISO-TimeML* semantics, different temporal units are related through a conversion function, stipulating such things as 1 hour = 60 minutes; 1 day = 24 hours, etc. An amount of time can be characterized equivalently by as many pairs <*numeral, temporal unit*> as there are temporal units, the equivalence being defined through the numerical conversions between units [see Bunt (1985)].

Regarding the temporal anchoring of events in time, it may be noted that the association of a temporal interval with an event does not necessarily mean that the event took place during every moment within that interval. When someone says “I've been working on my presentation from 8.30 to 12 o'clock”, that presumably does not mean that the speaker has been working on his presentation for every single moment between 8.30 and 12 o'clock; there must have been interruptions for having some coffee, going to the bathroom, etc. In such a case it is more accurate to anchor the event at the time span starting at 8.30 and ending at 12 o'clock, a “time span” being understood as a period of time that may have “holes”, where the event was interrupted. The metamodel shown in Figure 1 does not distinguish time spans, but reflects the assumption that whether an event occurs during an interval, with or without any interruptions, can only be decided on a case by case basis, and is best modelled as a property of the temporal anchoring relation applied to a specific event.

ISO 24612:2011 insists on the use of stand-off annotation, i.e. the construction of annotations in separate files, separate from the document containing the primary language data, as contrasted with in-line annotation. Stand-off annotations refer to specific locations in the primary data by addressing byte offsets, linguistic elements such as words, or times associated with recorded data, to which the annotation applies. Compared to in-line annotation, stand-off annotation has the advantages of respecting the integrity of the primary data and of allowing multiple annotations to be layered over a given primary document. Since semantic annotations typically occur at a relatively high level in a layered annotation structure, they do not necessarily refer directly to segments in the primary data, but may also refer to structures in other annotation layers. The generic term “markable” is used to refer to the entities that the annotations are associated with.

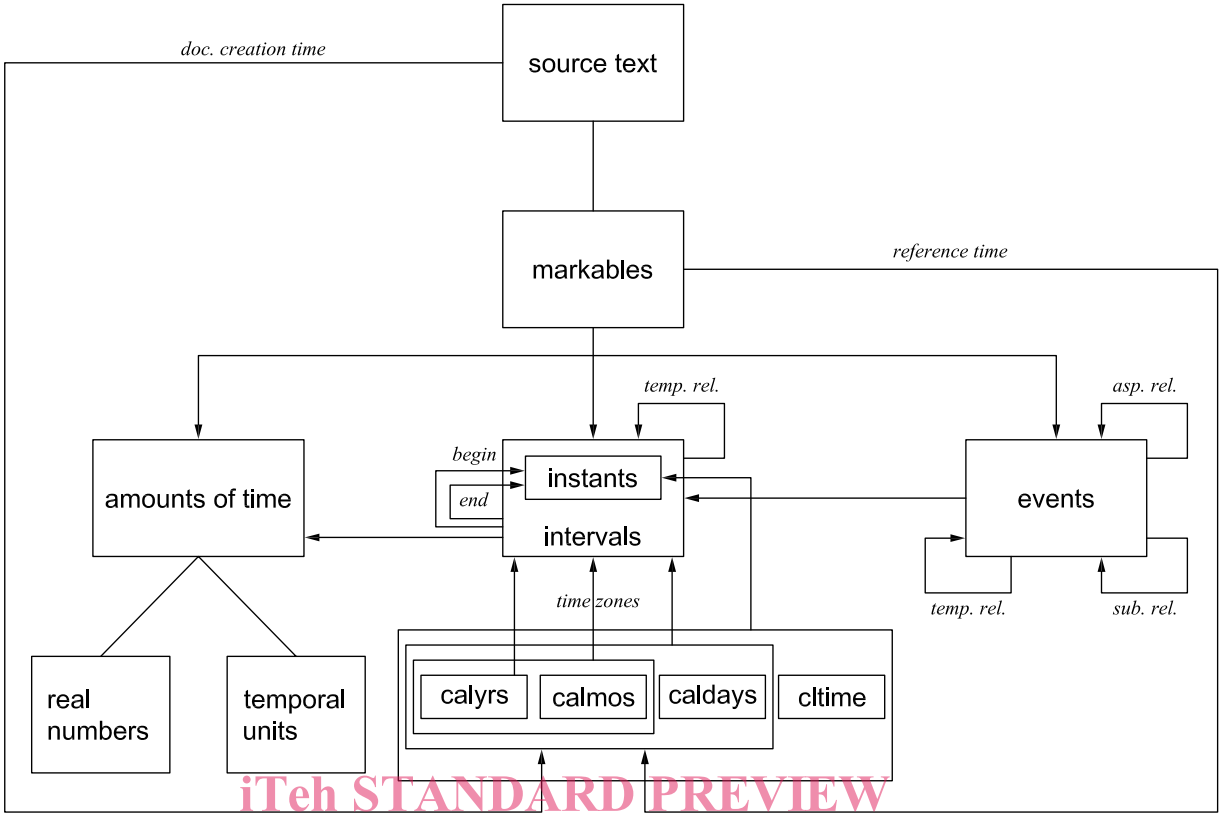

Figure 1 — Metamodel

Markables are derived from documents, which will have certain metadata that are particularly important for the interpretation of temporal annotations. For interpreting the tenses of verb forms and adverbial temporal deixis in a text (“yesterday”; “next week”), for instance, one must know when the text was produced. This will often be defined by the document creation time, and more precisely by the combination of a creation time and a creation location, since the latter defines the time zone within which the creation time is precisely defined. In many documents, the time and place of the document creation will be those of all the markables that may be derived from the document, but it may also happen that the text in a document introduces other times and places relative to which the annotations of the markables should be understood. A time zone, such as Greenwich Mean Time (GMT), can be seen as a way of segmenting the time line into named segments of particular lengths, such as (calendar) years, months, days, hours, and minutes. Accordingly, time zones show up in the metamodel as functions mapping a calendar year (“2008”), a combination of a calendar year and a calendar month (“May 2008”), a date (“May 25, 2008”), or a date plus a clock time (“May 25, 2008, 12.30 p.m.”) onto a temporal interval (in the latter case, an instant).

A markable may refer to more than one, related event, as in “She started to laugh” (two aspectually related events); “John drove to Boston after the concert” (two temporally related events); or “Will you attend the meeting on Tuesday?” (one event having a subordination relation to another). For expressing such relations, the metamodel includes the corresponding classes of relations showing up as inter-event links. Temporal relations between events may also be stated between intervals, hence they show up again in the metamodel.