INTERNATIONAL STANDARD

ISO 12381

First edition
2019-07

Health informatics — Explicit time-related expressions for healthcare-specific problems

Informatique de santé — Expressions relatives au temps explicites utilisées dans le domaine de la santé

Reference number
ISO 12381:2019(E)

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Published in Switzerland

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 215, *Health informatics*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Time is an important variable in healthcare, and standards are needed about how to represent information with explicit references to time. This document is a first contribution to this harmonization process, focusing on "representation" and "explicit reference".

Indeed, a system for time-standards should have as a minimum requirement the capacity to order temporal facts (situations, events, episodes) in three major ways, independent of any specific ontology of time itself:

— by relating situations to a calendar;

— by relating situations to "reference" situations;

— by relating events together in "before- and after-" chains.

The main reason for this threefold organization is that our everyday temporal discourse contains a variety of expressions that can only be regimented into a uniform style of analysis with a certain artificiality.

The purpose of this document is to enhance, in a perspective of machine-machine and person-machine communication, the generation of statements that are guaranteed to be understood unambiguously with respect to the time-related expressions that are embedded within them.

The purpose of this document is not to develop a full-blown temporal logic, but a standardized way of representing time-related expressions, such that all kinds of questions about the temporal organization of situations can be answered on the basis of the information available. Nor is it the intention of the framework presented here to provide a means to interpret the information in its original format. Interpretation of the source information is the task of the provider of information itself. The framework presented in this document allows information providers to express their time-related information in such a way that the intended meaning can be unambiguously understood by a receiver.

This of course requires the use of a "restricted", regimented model or language, allowing the disambiguation of many time-related expressions uttered in natural language. The model (language) presented in this document is restricted enough to allow such disambiguation for time-related expressions in "traditional" medical language but is not expressive enough to account for all time related linguistic phenomena that can be encountered in natural language.

This document provides representational tools for "explicit" time-related information. It does not allow (nor encourage) the ad hoc interpretation of implicit temporal information. In an expression such as "diabetes since childhood", "since childhood" is an explicit temporal reference for the diabetes, but the implicit information what "childhood" might mean (e.g. starting at the age of 2?), is not addressed. However, the framework presented in this document has enough expressive power to allow a specific provider of information to state explicitly what his or her understanding is of "childhood" is.

This document describes some conformance characteristics by means of which developers of health care information systems can label specific modules of their systems as to the degree they are compliant with the document. Although the framework itself does not deal with temporal reasoning, the conformance characteristics can be used to evaluate to what level temporal reasoning is possible with the information collected in a given system.

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Health informatics — Explicit time-related expressions for healthcare-specific problems

1 Scope

This document specifies a set of representational primitives and semantic relations needed for an unambiguous representation of explicit time-related expressions in health informatics. This document does not introduce or force a specific ontology of time, nor does it force the use of a fixed representation scheme for such an ontology. Rather this document provides a set of principles for syntactic and semantic representation that allow the comparability of specific ontologies on time, and the exchange of time-related information that is expressed explicitly.

This document applies to both the representation of actual phenomena occurring in the real world (e.g. registrations in medical records) and to the description of concepts (e.g. medical knowledge bases).

This document is applicable to

a) developers of medical information systems where there might be a need for explicit time-related concepts for internal organization (e.g. temporal data bases, temporal reasoning systems),

b) information modellers or knowledge engineers building models for the systems mentioned in a),

c) experts involved in the development of semantic standards on precise subdomains in health care where time-related information needs to be covered, (e.g. in the study of pathochronology, i.e. the discipline dealing with the time course of specific diseases), and

d) developers of interchange formats for messages in which time-related information is embedded.

This document is not intended to be used directly for

— representing what is true in time,

— reasoning about time, or

— representation of metrological time.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 8601-1, *Data elements and interchange formats — Information interchange — Representation of dates and times — Part 1: Basic rules*

ISO 8601-2, *Data elements and interchange formats — Information interchange — Representation of dates and times — Part 2: Extensions*

ISO 80000-3, *Quantities and units — Part 3: Space and time*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
situation
phenomenon occurring (or having the potential to occur) at a particular time or over a particular time period, in a given world context

Note 1 to entry: Situations cover phenomena which can occur in past, present or future time.

EXAMPLE "The patient suffered from pain which occurred over night", "pain occurring overnight."

3.2
property
attribute, quality, or characteristic of something

EXAMPLE "The temperature of a person."

3.3
time interval
portion of time of which the duration in a given context is considered to be significant and relevant

3.4
time point
portion of time of which the duration in a given context is considered to be insignificant or irrelevant

Note 1 to entry: This document does not specify any requirements on what entities should occupy time points, and what entities should occupy time intervals, users are responsible for making such decisions (Clause 5). Temporal references such as “Friday the 13th” can thus refer to a time point or a time interval, depending on the context.

3.5
episode
situation (3.1) considered to occupy a *time interval* (3.3)

Note 1 to entry: Whether a situation is to be considered an episode or an event, is a decision taken by the provider of the information, based on his or her perception of the phenomenon in a given context.

Note 2 to entry: It is possible to further subcategorize episodes into “states”, “culminations”, “processes”, “actions”, or other conceptual entities that can be defined using additional conceptual aspects describing particular properties of each of the various episodes. However, there is no need to do so within the scope of this document.

EXAMPLE A patient’s stay in the hospital, the “episode of care” related to a medical problem.

3.6
event
situation (3.1) considered to occur at a *time point* (3.4)

3.7
predication
representation of a *situation* (3.1) in a language

EXAMPLE “The removal of Mr Jones’ appendix on 21 July 1994, at 9 o’clock in the morning.”

3.8
temporal reference
component of a *predication* (3.7) representing information related to time

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3.9
propositional clause
component of a *predication* (3.7) to which *temporal references* (3.8) refer implicitly or explicitly

EXAMPLE In the expression "taking syrup three times a day for 2 weeks", the propositional clause is "taking syrup". To it are attached the temporal references "three times a day" and "for 2 weeks".

Note 1 to entry: The term propositional clause is used here in a broader sense than in formal logic where a proposition denotes a statement on what is true in a given world. In the context of this document, propositional clauses do not impose a truth-value on the phenomena that are represented.

Note 2 to entry: This document allows for a recursive representation of information related to time (see Annex A for a formal description). In expressions such as "severe headache lasting for half an hour after each meal", both "severe headache" and "severe headache lasting for half an hour" are propositional clauses, each at a different level in the recursion. A propositional clause that is at the deepest level of recursion, i.e. to which no temporal references are attached, is called propositional clause zero. In this example: "severe headache" is propositional clause zero.

3.10
temporal link
component of a *temporal reference* (3.8) capturing the semantic relation in a *predication* (3.7) between the *propositional clause* (3.9) and the *temporal expression* (3.13)

Note 1 to entry: In natural language, the temporal link can be grammaticalized with prepositions or other constructs, such as in "on Monday". Often, the link is not expressed explicitly, as in "tomorrow". In formal representations in conformity to this document, the temporal link shall be represented explicitly, or should be unambiguously derivable from a data model.

3.11
basic temporal link
temporal link (3.10) specifying purely time-related information

EXAMPLE Has-occurrence, has-duration (see 4.4).

3.12
complex temporal link
temporal link (3.10) composed of a *basic temporal link* (3.11) and an embedded *propositional clause* (3.9)

Note 1 to entry: Complex temporal links can be used to express the contents of relational data bases according to the provisions of this document.

EXAMPLE The predication "Severe headache this morning" can be analyzed into the propositional clause "severe headache" and the temporal reference "this morning". In a database management system, such predications can be represented in a table with fields "ProblemId", "Problem" and "TimeOfHappening".

Problem Id	Problem	Time of happening
I1	severe headache	this morning
I2 ...	ingestion of acetylsalicylic acid	immediately after I1

In this table, the contents of the "Problem" column refer to situations, and hence shall be considered propositional clauses and the contents of the "Time of Happening" column are all temporal references.

Often, the time of recording of problems is also recorded as useful meta-information. According to the model above, this should be done by adding two records in the table:

I3	recording of I1	1994-07-01:18:00:32

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I4	recording of I2	1994-07-01:18:00:35

In fact, this could be repeated for each record, even for the records in which the recording of the recording of the ... is recorded. Because only the recording time of a problem is of interest, and not the recording event itself, the above scheme is simplified by adding an additional field, labelled "TimeOfRecording", which is a complex temporal link.

Problem Id	Problem	Time of happening	Time Of Recording
I1	severe headache	this morning	1994-07-01:18:00:32
I2	ingestion of acetylsalicylic acid	immediately after I1	1994-07-01:18:00:35
...			

Other examples of complex temporal links are: StartDateOfSampleCollection (laboratory context), DateOfBirth (administrative context), StartDateOfProblem, EndDateOfProblem (clinical history or diagnostic module of electronic medical record systems), ...

3.13
temporal expression
component of a *temporal reference* (3.8) specifying a *time point* (3.4), a *time interval* (3.3) or any allowed combination of time points and time intervals.

Note 1 to entry: This document does not imply any restrictions on what combinations of time points and time intervals are "allowed" as this depends entirely on the ontology of time defined in a particular context. However, such an ontology can only be claimed to conform to this document when such combinations can be represented by the temporal expressions described in this document.

3.14
absolute temporal expression
temporal expression (3.13) whose exact meaning in a given context can directly be derived from the temporal expression itself

EXAMPLE "9'oclock", "1994-04-12", "Christmas"

Note 1 to entry: "exact meaning" refers here to the fact that absolute temporal expressions (by definition) contain all the information required to relate the situation to a calendar.

3.15
relative temporal expression
temporal expression (3.13) whose exact meaning in a given context can only be derived from the *temporal references* (3.8) of the *predications* (3.7) referred to in the temporal expression

EXAMPLE "headache starting after eating chocolate". When the headache starts can only be known if it is known when the eating of chocolate takes place.

Note 1 to entry: The "relativeness" or "absoluteness" of a temporal expression does not imply any qualitative preference. For pure temporal reasoning issues, absolute temporal expressions shall be preferred, but for medical reasoning, this is not true. Reducing the two predications "eating chocolate at three o'clock" and "headache after eating chocolate", to "headache after three o'clock" would imply a dramatic loss of information from the clinical point of view.

3.16
deictic temporal expression
temporal expression (3.13) whose exact meaning in a given context can only be derived from information outside that context

EXAMPLE Expressions such as "now", "yesterday", "last Monday", "in three weeks", can only be given precise meaning if the time of utterance is known.

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3.17
time interval expression
temporal expression (3.13) denoting a *time interval* (3.3)

3.18
duration expression
temporal expression (3.13) referring to the length of a *time interval* (3.3)

EXAMPLE "Three years", "a long time".

3.19
rate expression
temporal expression (3.13) denoting the change of a *property* (3.2) over a *time interval* (3.3)

Note 1 to entry: The change of the property is to be considered the situation on which information related to time is given.

EXAMPLE "The patient's temperature dropped 0,5 degrees Celsius per hour".

3.20
frequency expression
temporal expression (3.13) denoting the number of repetitions of a phenomenon during a *time interval* (3.3)

Note 1 to entry: A frequency may be considered a special case of a rate ("number rate").

Note 2 to entry: The time interval does not need to be represented explicitly as is the case in the examples below of "often", "frequently" and "after each meal".

EXAMPLE "Twice a day", "every 5 minutes", "often", "frequently", "after each meal", "never" "always".

3.21
time series expression
temporal expression (3.13) denoting the occurrence of a *situation* (3.1) in a series of *time point* (3.4) or *time interval* (3.3)

3.22
temporal comparator
specifier of the temporal relation expressed by the *temporal link* (3.10) between the *propositional clause* (3.9) and a *temporal expression* (3.13)

EXAMPLE Temporal comparators that can be added to the temporal link has-occurrence are amongst others: "AT, BEFORE, AFTER,..." (see 5.6).

4 Explicit semantic labelling of predicational components

4.1 General

Temporal references do not necessarily give unambiguous meaning to the temporal relationship they bear with the propositional clause of the predication. Also, from expressions in natural language, it cannot always be deduced whether the situations described are to be considered events or episodes. For this reason, this document requires the explicit labelling of the various components of a predication. In this document, a frame-based notation is used to represent predications in a more formal way. A full syntactic specification of the notation is given in Annex A. In Clause 4, the semantic building blocks are presented. Predications that are represented according to the syntactic semantic rules of this notation, are called standard predications.

4.2 Labelling of temporal expressions

Each temporal expression shall be labelled by the originator of the information as being a time point expression, time interval expression, frequency expression, rate expression, time series expression, or

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