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Language resource management — Semantic annotation framework —

Part 7: Spatial information

Gestion des ressources linguistiques — Cadre d'annotation sémantique —

Partie 7: Information spatiale

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Foreword

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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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see Foreword - Supplementary information.

This document was prepared by Technical Committee ISO/TC 37, *Language and terminology*, Subcommittee SC 4, *Language resource management*.

This second edition cancels and replaces the first edition (ISO 24617-7:2014), which has been technically revised. It aims at satisfying the requirements and recommendations laid down in ISO 24617-6.

The main changes compared to the previous edition are as follows.

— Event-paths (<eventPath>), which are triggered by motions, are restored as objects of a basic entity type in concrete syntaxes as well as in the abstract syntax.

— It focuses on spatial relations only, thus tagging them as <sRelation>. There are no <motionSignal> or <measureSignal> as such. Path adjuncts are treated as pathDefining spatial relations, tagged as <sRelation type="pathDefining"/>.

— The movement link (<moveLink>) is very much modified to conform to the general link structure, as specified in ISO 24617-6. This general link structure minimally consists of a relation type and two required arguments, represented by two attribute names, @figure and @ground, which are single entity structures and sets of entity structures, respectively. The addition of optional (implied) attributes such as @trigger (relator) for <moveLink> or @bounds for <mLink> is allowed.

— The measure link (<mLink>) is generalized to accommodate not only spatial measures such as distances but temporal or spatio-temporal measures that include durations, time amounts or speeds. The two optional attributes @endPoint1 and @endPoint2 are also generalized to apply to areas (oceans) or borderlines (rivers, mountain ranges) with a new attribute @bounds, replacing those two attributes.

— As a result, most of the specifications of the attribute-value assignments to each of the entity types and those of the link types, represented in extended BNF, or XML DTD (data type declarations), are revised. The UML figures representing them are also revised or deleted.

— The list of tags associated with entity structures and link structures is presented in a tabular form to make these structures more comparable in a visual way. This list has been given in Clause 4, Table 1.

— To make the document more compact and less burdensome for the readers, Annex A, Guidelines, has been deleted.

A list of all parts in the ISO 24617 series can be found on the ISO website.

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.

Introduction

The automatic recognition of spatial information in natural language is currently attracting considerable attention in the fields of computational linguistics and artificial intelligence. The development of algorithms that exhibit "spatial awareness" promises to add needed functionality to natural language processing (NLP) systems, from named entity recognition to question-answering and text-based inference. However, in order for such systems to reason spatially, they require the enrichment of textual data with the annotation of spatial information in language. This involves a large range of linguistic constructions, including spatially anchoring events, descriptions of objects in motion, viewer-relative descriptions of scenes, absolute spatial descriptions of locations, and many other constructions.

This document provides normative specifications not only for spatial information, but also for information content in motion and various other types of event in language.

In this document, Clause 8 treats the representation of static and dynamic spatial annotations by introducing an XML-based concrete syntax for representing spatial-related or motion-related annotations. This concrete syntax is based on the abstract syntax that is presented in Clause 7 with a metamodel as a part of the specification of the spatial annotation structure. An informative Annex A is provided with a brief introduction to the annotation and interpretation of quantified spatial entities and eventualities including motions and event-paths.

A formal semantics, based on the abstract syntax, will be provided as part of a future new work item within the semantic annotation framework. This will be coordinated with the temporal semantics and specification of ISO 24617-1, thereby producing a rich semantics that will be directly useable by practitioners in computational linguistics and other communities (see Clause 6).

Language resource management — Semantic annotation framework —

Part 7: Spatial information

1 Scope

This document provides a framework for encoding a broad range of spatial information and spatiotemporal information relating to motion as expressed in natural language texts. This document includes references to locations, general spatial entities, spatial relations (involving topological, orientational, and metric values), dimensional information, motion events, paths, and event-paths triggered by motions.

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 24617-1, *Language resource management — Semantic annotation framework (SemAF) — Part 1: Time and events (SemAF-Time, ISO-TimeML)*

ISO 24617-6, *Language resource management — Semantic annotation framework — Part 6: Principles of semantic annotation (SemAF Principles)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 24617-1 and ISO 24617-6, and the following apply.

3.1
document creation location
dcl
unique place or set of places associated with a document that represents the *location* (3.7) in which the document was created

Note 1 to entry: Some collaboratively written documents, such as GoogleDoc[1] documents and chat logs, might refer not only to a single location but also to a set of locations spread out across the world. Besides, for example, the creation place of the Hebrew bible or the creation place of each of the books in it is uncertain. The attribute @ dcl will, therefore, have the value "false", understood to mean "unspecified", while the value "true", is understood to mean"specified".

1) GoogleDoc is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

3.2
event
eventuality
something that can be said to obtain or hold true, to happen or to occur

Note 1 to entry: This is a very broad notion of event that includes all kinds of actions, states, processes, etc. It is not to be confused with the narrower notion of event (as opposed to the notion of "state") as something that happens at a certain point in time (e.g. the clock striking two or waking up) or during a short period of time (e.g. laughing). In TimeML, the term “event” is used in a broader sense and is equivalent to the term “eventuality”.

[SOURCE: ISO 24617-1:2012, 3.4, modified – The Note 1 to entry has been reworded.]

3.3
event-path
dynamic path
trajectory
dynamic route
directed *path* (3.15) followed by a *mover* (3.12) and coincident with a *motion-event* (3.10)

Note 1 to entry: Unlike (static) paths such as roads or circular tracks, event-paths are each triggered by a specific motion-event, characterized as being finite directed paths each with a start and an end.

3.4
extent
textual segment that is a string of character segments in text to be annotated

EXAMPLE Tokens, words, and non-contiguous phrases (e.g. a complex verb like "look ... up") are extents.

3.5
figure
entity that is considered the focal object, which is related to some reference object

3.6
ground
landmark
entity that acts as reference for a *figure* (3.5)

Note 1 to entry: “landmark” is often used by cognitive semanticists.

3.7
location
point or finite area that is positioned within a *space* (3.19) or a series of such points or areas

Note 1 to entry: *places* (3.16), *paths* (3.15), and *event-paths* (3.3) are subtypes of locations.

3.8
measure
magnitude of a spatial dimension or relation

EXAMPLE Distance is a spatial relation.

3.9
measure relation
link that relates a *measure* (3.8) to an object that is being measured

Note 1 to entry: The bounds of a measured object are sometimes specified for a measure relation. They can be points or areas like a city, or lines like a river or mountain range.

3.10
motion
motion-event
action or process involving the translocation of a spatial object, transformation of some spatial property of an object, or change in the conformation of an object

Note 1 to entry: A motion is a particular kind of *eventuality* (3.2).

3.11
movement relation
link that relates a *mover* (3.12) to an *event-path* (3.3) which the *mover* (3.12) traverses

Note 1 to entry: A movement link is triggered by a *motion* (3.10).

3.12
mover
moving object
entity that undergoes a change of its location

Note 1 to entry: A mover can either be the agent of a motion as one who walked to the station or one that is simply caused to move like a stone thrown into a well, while the thrower is not considered to be the mover in the sense of the term defined.

3.13
non-consuming tag
tag (3.19) that has no associated *extent* (3.4)

Note 1 to entry: The *extent* (3.4) of a non-consuming tag is a null string.

EXAMPLE In an example, *John ate an apple but Mary a pear*, there are at least two ways of marking up the <event> tag, one with its extent or target filled in with a nonnull string of characters, or audio or visual elements, and the other with an empty string:

a) John ate$_{e1}$ an apple, but Mary $\emptyset_{e2}$ a pear;

b) 1) <event xml:id="e1" target="ate"/>

2) <event xml:id="e2" target=" "/> (non-consuming <event> tag)

3.14
orientation relation
orientational relation
directional relation
link that relates one location as a *figure* (3.5) to another location as a *ground* (3.6) that expresses the spatial disposition or direction of a spatial object within a frame of reference

3.15
path
static path
route
location (3.7) that consists of a series of locations

Note 1 to entry: A spatial object *path* is a location where the focus is on the potential for traversal or which functions as a boundary. This includes common nouns like *road*, *coastline,* and *river* and proper names like *Route 66* and *Kangamangus Highway*. Some nouns, such as *valley*, can be ambiguous. It can be understood as a *path* (3.15) in *we walked down the valley* or as a *place* (3.16) in *we live in the valley*.

Note 2 to entry: A path might be represented as an undirected graph whose vertices are locations and whose edges signify continuity; i.e., unlike an *event-path* (3.3), a path has no inherent directionality.

3.16
place
geographic or administrative entity that is situated at a *location* (3.7)

3.17
qualitative spatial relation
topological link
abstract static relation between *regions* (3.18) or *spaces* (3.19), expressing their connectedness or continuity

3.18
region
connected, non-empty point-set defined by a domain and its boundary points

Note 1 to entry: The term "region" as defined does not refer to a political or administrative region such as "the Canary Islands" or "Hong Kong, SAR", where SAR is the acronym of “Special Administrative Region”.

3.19
space
dimensional extent in which objects and *events* (3.2) have a relative position and direction

3.20
spatial entity, non-locational
non-locational spatial entity
object that is situated at a unique *location* (3.7) for some period of time, and typically has the potential to undergo translocation

Note 1 to entry: A non-locational spatial entity, tagged <entity>, as defined, is distinct from genuine spatial entities that consists of three types of locational entities, places, paths, and event-paths. It is an object that participates in a spatial or motional relation. In *John is sitting in a car*, both *John* and *car* could be understood as *spatial entities* or as being the *figure* (3.5) and the *ground* (3.6), respectively, of the sitting-in situation.

Note 2 to entry: In the first edition of this document, non-locational spatial entities were tagged <spatialEntity>. They are now tagged <entity> to allow their use in both spatial and non-spatial contexts, as in: *I left a purse in the car* (spatial context) *that I had rented Φ* (non-spatial context) *last week*.

3.21
spatial relation
segment or series of segments of a text that rebounds to *qualitative spatial relations* (3.17) or *orientational relations* (3.14), or to *movement relations* (3.11) indirectly through the specification of the bounds of *paths* (3.15) or *event-paths* (3.3)

3.22
tag
element name
name associated with textual segments for annotation or for a relation between these segments

Note 1 to entry: The following are three kinds of tag for annotation:

a) extent tag, which is associated with textual segments referring to basic entities or signals;

b) link tag, for representing spatial relations; and

c) root tag, for the closure of annotations.

4 List of tags

See Table 1, where each tag is braced with a pair of angled brackets for the name of an XML element. For other representation formats, the tags have no such brackets. These tags, especially the event-path tag, may be non-consuming tags (see 3.13) having an empty string of characters as @target value, called "extent".

Table 1 — Tags with ID prefixes

Entities	Tags	ID prefixes	Examples	Comments
Basic entities: spatial entities, relations, and eventualities				
place	<place>	pl	*Osaka, city*	
path	<path>	p	*Highway 1,* *street, river*	
non-locational spatial entity	<entity>	x	*(in a) car*	non-locational entities that are spatially involved
spatial relation	<sRelation>	sr	*in, on, north-east,* *from, to, for, towards*	type = “topological” | “directional” | “topoDirectional” | “pathDefining” | “goal-defining”
motion	<motion>	m	*drive, travel*	translocational
non-motional eventuality	<event>	e	*live, work*	inherited from ISO 24617-1 TimeML
event-path	<eventPath>	ep	*empty extent*	non-consuming tag, spatio-temorally definable
measure	<measure>	me	*500 miles* *100 km/h*	extendible to spatio-temporal measures
Links: link structures <@figure, @ground, @relType>				
qualitative spatial link	<qsLink>	qsL		Relates one location as a figure to another as a ground
orientational link	<oLink>	oL		Relates one location to another possibly with some point of reference
movement link	<moveLink>	mvL		Relates a mover to an event-path
measure link	<mLink>	meL		Relates a measure to an object, possibly with the specification of its bounds
Root element				
spatial annotation	<spatial>	sp		closure of spatial annotation

5 Overview

Human languages impose diverse linguistic constructions for expressing concepts of space, of spatially-anchored events, and of spatial configurations that relate in complex ways to the situations in which they are used. One area that deserves further development regarding the connection between natural language and formal representations of space is the automatic enrichment of textual data with spatial annotations. There is a growing demand for such annotated data, particularly in the context of the semantic web. Moreover, textual data routinely make reference to objects moving through space over time. Integrating such information derived from textual sources into a geosensor data system can enhance the overall spatiotemporal representation in changing and evolving situations, such as when tracking objects through space with limited image data. It follows that verbal subjective descriptions of spatial relations need to be translated into metrically meaningful positional information. A central research question currently hindering progress in interpreting textual data is the lack of a clear separation of the information that can be derived directly from linguistic interpretation and further information that requires contextual interpretation. In order to avoid building incorrect deductions into the annotations themselves, mark-up schemes should avoid over-annotating the text. Solutions to the language-space mapping problem and its grounding in geospatial data are urgently required for this purpose.

There are many applications and tasks that would benefit from a robust spatial mark-up language, such as the one specified in this document.

These applications and tasks include the following:

a) creating a visualization of objects from a verbal description of a scene;

b) identifying the spatial relations associated with a sequence of processes and events from a news article;

c) determining an object location or tracking a moving object from a verbal description;

d) translating viewer-centric verbal descriptions into other relative descriptions or absolute coordinate descriptions;

e) constructing a route given a route description;

f) constructing a spatial model of an interior or exterior space given a verbal description;

g) integrating spatial descriptions with information from other media.

The goal of this document is not to provide a formalism that fully represents the complexity of spatial language, but rather to capture these complex constructions in text in order to provide an inventory of how spatial information is presented in natural language. For example, many texts have no explicit frame of spatio-temporal reference, thus making it impossible to annotate such an unspecified frame of reference. The interpretation of spatial prepositions, such as *on* in *a book on the desk* vs *a picture on the wall* requires a handbook of its own dealing with different senses or uses of spatial prepositions beyond a set of annotation guidelines. Any detailed classification of motion verbs in English alone is again beyond the scope of this document.

All of the examples in the current document have been taken from English datasets. The specification language for spatial annotation proposed in this document can be seen as a version for English only and its applicability to other languages is still pending.

6 Motivation and requirements

This document aims to formulate the requirements for static and dynamic spatial annotation standards. It considers ISO 24612, which requires standoff annotation, and ISO 24617-6, which provides a set of basic guidelines to formulate annotation structures for semantic interpretation, and builds on previous work, including ISO 24617-1 and other spatial representations and calculi, especially Reference [10].

Natural language abounds with descriptions of motion. Our experience of our own motion, together with our perception of motion in the world, have given human languages substantial means to verbally express many different aspects of movement, including its temporal circumstances, spatial trajectory and manner. In every natural language, verbalizations of motion can specify changes in the spatial position of an object over time. In addition to when and where the motion takes place, languages additionally characterize how the motion takes place (e.g., its path, its manner, and how it was caused). In particular, the path of motion, called “event-path” in this document, involves conceptualizations of the various spatial relationships that an object can have to other objects in the space in which it moves. An understanding of such spatial information in natural language is necessary for many computational linguistics and artificial intelligence applications.

Any specification language for spatial information in language needs to support the following computational tasks:

— identification of the appropriate topological configuration between two regions or objects (e.g. containment, identity, disjointedness, connectedness, overlap, and closure over these relations, when possible);

— identification of directional and orientational relations between objects and regions, including the distinction between frames of reference;

— identification of metric properties of objects and metric values between regions and objects, when possible (e.g. distance, height and width);

— identification of the motion of objects through space and time and a characterization of the nature of this movement;

— provision of clear interoperable interfaces to existing representations and geo-databases (e.g. GeoNames, ArcGIS, and Google Earth[2)]).

NOTE 1 Texts are often completely unspecified for frames of reference (texts are, so to speak, "not situated") and therefore it appears that the annotation of a frame of reference cannot be provided for many texts.

NOTE 2 Measure expressions, such as *20 miles*, have two attributes, numeric @value "20" and @unit "miles", but expressions like *near* and *far* have no unit specified. The annotation scheme proposed in this document can only state that they are measure-related expressions only with its attribute @value specified, say with "near" or "far". As will be seen, many of the annotation cases are left underspecified.

7 Specification of the spatial annotation scheme

7.1 Overview: annotation vs. representation

As with other areas of work on semantic annotation, each of the annotation schemes that are specified in ISO 24617 draws a fundamental distinction between the concepts of annotation and representation, as is required by ISO 24612. The term “annotation” is used to refer to the process of adding information to segments of language data or to refer to that information itself. This notion is independent of the format in which this information is represented. The term “representation” is used to refer to the format in which an annotation is rendered (for instance, in XML) independent of its content. As is required by ISO 24612, annotations are the proper level of standardization, not representations. This document, therefore, defines a specification language for annotating documents with information about spatial entities and spatial relations at the level of annotations and then for representing these annotations in a specific way, either with XML or with a predicate-logic-like format.

Following ISO 24617-6:2016 principles, the spatial annotation scheme of this document is introduced in two steps: (1) Construction of a metamodel and (2) Formulation of the abstract syntax. The metamodel provides a UML-based conceptual frame of establishing the abstract syntax, which lays down a set-theoretic basis of implementing concrete syntaxes as well as a formally definable semantics.

The semantic annotation scheme consists of an abstract syntax, a semantically equivalent set of concrete syntaxes, which is structurally isomorphic to the abstract syntax, and a semantics. The abstract syntax defines in set-theoretic terms annotation structures which consist of entity structures and link structures. Each entity structure is anchored to a markable carrying some information. Entity structures are also typed, each referring, for instance, to a place, path, event-path, eventuality, motion, spatial entity or measure which is involved in spatial information. Link structures relate these entity structures with each other.

7.2 Metamodel

The metamodel of the spatial annotation scheme depicted by Figure 1 represents the general conceptual frame of spatial annotation. It consists of the following five components:

1) a collection of datasets, called “communicative segments”;

2) a nonempty set of markable expressions, called “markables”, the source of which is the communicative segments;

3) a list of four entity types, each of which is anchored to a markable:

   a) **spatial entity** with three **locational** subtypes: **place, path,** and **trajectory (event-path)**,

2) GeoNames, ArcGIS, and Google Earth are examples of a suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.