Addendum to "Proposed Temporal Database Concepts—May 1993"*

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Abstract

The paper "Proposed Temporal Database Concepts—May 1993" contained a complete set of glossary entries proposed by members of the temporal database community from Spring 1992 until May 1993. The aim of the proposal was to define a consensus glossary of temporal database concepts and names. Several glossary entries (Section 3) were included in the proposal, but were still unresolved at the time of the deadline. This addendum reflects on-going discussions and contains revised versions of several unresolved entries. The entries here thus supersede the corresponding entries in Section 3 of the proposal.

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1 Revised Glossary Entries

1.1 History

Definition

A *history* is the temporal representation of an "object" of the real world or of a database. Depending on the object, we can have *attribute histories, entity histories, relationship histories, schema histories, transaction histories,* etc.

Alternative Names

Time sequence, time-series, temporal value, temporal evolution.

Discussion

"History" is a general concept, intended in the sense of "train of events connected with a person or thing". Although it usually has to do with *past* events (−E5), its use for the future—as introduced by prophecies, science fiction, scientific forecasts—does not seem to present comprehension difficulties (there are much more problems with the adjective "historical"). Talking about future history, requires the same extension of meaning as required by talking about future data.

In the realm of temporal databases, the concept of history is intended to include multiple time dimensions as well as the data models (+R1). Thus we can have valid-time histories, transaction-time histories, bitemporal histories, user-defined histories, etc. However, multi-dimensional histories can be defined from mono-dimensional ones (e.g. a bitemporal history can be seen as the transaction-time history of a valid-time history).

Formally or informally, the term "history" has been often used in many temporal database papers (+R4), also to explain other terms. For instance, salary history, object history, transaction history are all expressions used in this respect.

The alternative term "temporal value" is less general, since it applies when "history" specializes into at-

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tribute history (value history). Moreover, "history" is a slightly more general concept than "time sequence": differnet time sequences (with different time granularities) could be extracted from the same history. Therefore the definition of "history" does not prevent defining "time sequence."

"History" is also preferred over alternative names because it allows a better definition of related terms. Since it implies the idea of time, "history" does not require futher qualifications as "sequence" or "series" do (+E2). In particular, "history" well lends itself to be used as modifier (+E1), even though "time sequence" is an alternative consolidated term (−E3,−E6).

"History" is natural (+E8) and precise (+E9), whereas "temporal value" may recall a temporal element (e.g. timestamp value) and "time sequence" may recall a sequence of temporal elements.

1.2 History-oriented

Definition

A temporal DBMS is said to be *history-oriented* if:

1. It supports history unique identification (e.g. via time-invariant keys, surrogates or OIDs);

2. The integrity of histories is inherent in the model, in the sense that history-related integrity constraints might be enforced and the language provides a mechanism (history variables and quantification) for direct reference to histories;

3. The DML allows easy manipulation of histories, in the sense that the language provides for user-friendly history selection, history retrieval and history modification primitives.

Alternative Names

With temporal value integrity, grouped, object-oriented.

Discussion

"History-oriented" is preferred over "with temporal value integrity" since its meaning seems to be more direct. Furthermore, in a more general perspective, integrity constraints can be introduced in a history-oriented model (e.g. history uniqueness, entity history integrity, referential history integrity).

"History-oriented" is also preferred over "grouped" (+E7) in order to avoid confusion with other kinds of grouping (e.g. defined terms "[dynamic/static] valid time grouping").

"History-oriented" is not a synonim for "object-oriented", even though a good temporal object-oriented model should also be history-oriented. In general, object-orientation requires more features that are inherited from snapshot O-O models (+E7). For instance, also (attribute/tuple—point/interval-stamped) relational models can be history-oriented, provided that suitable integrity constraints and algebraic operators are defined.

Once *history* has been defined, "history-oriented" is quite intuitive (+E8).

1.3 History Equivalent

Definition

Two objects are *history equivalent* if they are equal for all n-dimensional time boxes over which they are defined. *History equivalence* is a binary relation that can be applied to objects of any kind (of the real world or of a database).

Alternative Names

Value equivalent, snapshot equivalent.

Discussion

The "value equivalence" defined for tuples could be extended to consider histories. However, such an extension would be rather inappropriate (+E1): value equivalence concerns attribute values and completely disregards time, whereas history equivalence implies a common evolution along with time (implicitly assumes equality of timestamps prior to compare data values). The extension would violate the rationale of the introduction of history-oriented models.

"History equivalent" is a concept closer to "snapshot equivalent" (−E3) rather than to "value equivalent" (+E5). Anyway, "history equivalent" seems to be more general and intuitive (+E8). An alternative definition could be: "Two objects are *history equivalent* if their *histories* are *shapshot equivalent.*

1.4 Instant

Definition

An *instant* is a point on the time axis. It belongs to a single chronon t. Many instants could belong to the same chronon. All the instants that belong to a chronon are represented by that chronon.

Alternative Names

Event, moment.

Discussion

"Event" is often given a different meaning (−E5), while "moment" my be confused with the distinct term "chronon" (−E7).

1.5 Event

Definition

An *event* is an instantaneous fact, i.e. something occurring at an instant. An event is said to occur at a chronon t if it occurs at any instant during t.

Alternative Names

Event relation, instant relation.

Discussion

"Event relation" is not consistent with the distinction between "instant" and "event" (−E7). "Instant relation" is longer than event (−E2).

1.6 Event Occurrence Time

Definition

The *event occurrence time* is the instant at which the event occurs in the real-world. The valid time associated with the event is the chronon t to which the event occurrence time belongs.

Alternative Names

Event time.

Discussion

Event occurrence time is more precise than event time (+E9). Nevertheless, when the context is clear, the event occurrence time may be shortened to the event time.

1.7 Interval

Definition

An *interval* is the time between two instants. It may be represented by a set of contiguous chronons.

Alternative Names

Time period.

Discussion

The name "interval" is widely accepted (+E3). The name "period" often implies a cyclic or recurrent phenomenon (−E8,−E9). In addition, "time period" is longer (−E2).

1.8 Interval Relation

Definition

An *interval relation* is a (non-wholistic) fact with duration. An interval relation is said to hold over an interval I if it holds at all time instants belonging to the set of contiguous chronons representing I.

1.9 Interval Relation Holding Time

Definition

The *interval relation holding time* is the set of contiguous instants over which the interval relation holds in the real-world. The valid time interval associated with the interval relation is the pair consisting of the starting and the ending chronons.

Alternative Names

Interval relation time.

Discussion

Interval relation holding time is more precise than interval relation time (+E9). Nevertheless, when the context is clear, the interval relation holding time may be shortened to the interval relation time.

1.10 Macro-Event

Definition

A *macro-event* is a wholistic fact with duration, i.e., something occurring over an interval taken as a whole. A macro-event is said to occur over an interval I if it occurs over the set of contiguous chronons representing I (considered as a whole).

Alternative Names

Process.

Discussion

"Process" is an over-loaded term, that is, a term having quite different meanings in different contexts (−E9).

Examples of macro-events are baking a cake, having a dinner party, flying from Rome to Paris.

It is worth remarking the distinction between macro-events and interval relations. Saying that a macro-event relates to the structure of an interval as whole means that if it consumes a certain interval it cannot possibly transpire during any subinterval thereof.

1.11 Temporal Qualification

Definition

The *temporal qualification* of a statement is the component of the statement that specifies the temporal localization of the denoted fact, namely, an associated instant, span, or interval.

Alternative Names

Time specification.

Discussion

We assume one temporal qualification per statement. Moreover, we assume that implicit temporal qualifications (e.g. tense qualifications) are always made explicit. As an example, we assume that the statement "They went to Arlington" is rewritten as "Sometimes in the past is true that they *go* to Arlington". Finally, if the temporal qualification is absent or missing the default qualification is the current time "now".

We distinguish between two different types of temporal qualifications, namely, chronologically definite and indefinite temporal qualifications.

1.12 Chronologically Definite Temporal Qualification

Definition

Chronologically definite temporal qualifications are specifications of absolute temporal positions.

Alternative Names

None.

Discussion

Examples are: June 15, 1993 (dates), 397 years after the discovering of America. The notion of chronologically definite temporal qualification is different from the notion of absolute time. Consider the case of temporal qualifications relating the occurrence time of an event to the occurrence time of another event rather than to the current (implicit) time *now*. Even if they can be considered relative times, they are chronologically definite. They specify an absolute temporal position which may possibly be unknown (it depends on common sense as well as context knowledge). Examples of statements including these kinds of chronologically definite temporal qualifications are: "the French revolution occurred 397 years after the discovering of America," "Mary's salary was raised before Lucy's."

1.13 Chronologically Indefinite Temporal Qualification

Definition

Chronologically indefinite temporal qualifications are specifications of temporal positions in terms of displacements with respect to the current time (*now*) which is left implicit.

Alternative Names

None.

Discussion

The notion of chronologically indefinite temporal qualification is different from the notion of relative time as shown in the related discussion about chronologically definite temporal qualifications. Examples are: tomorrow, three days ago, next month.

1.14 Chronologically Definite

Definition

Chronologically definite statements are statements whose truth value does not vary, because it does not depend on the time at which they are evaluated. Chronologically definite statements are characterized by chronologically stable temporal qualifications.

Alternative Names

None.

Discussion

Examples are: "Jack was killed on xx/xx/1990," it happened sometime in 1999," "the Jurassic is sometime after the Triassic," "the French revolution occurred 397 years after the discovering of America."

In particular, consider the statement "the French revolution occurred 397 years after the discovering of America", where the occurrence time of "the French revolution" is given with respect to the occurrence time of "the discovering of America" by means of the temporal qualifier "397 years after" (relative time). This statement is chronologically definite, because its truth value does not depend on the time at which it is evaluated.

1.15 Chronologically Indefinite

Definition

Chronologically indefinite statements are statements whose truth value may vary, because it depends on the time at which they are evaluated. Chronologically indefinite statements are characterized by chronologically unstable temporal qualifications or are devoid of any temporal qualification (a statement with no temporal qualification is equivalent to a statement characterized by a zero displacement with the respect to the implicit current time).

Alternative Names

None.

Discussion

Examples are: "Mary's salary was raised yesterday," "it happened sometime last week," "it happened on Easter," "it happened within 3 days of Easter."

1.16 Absolute Time

Definition

The modifier *absolute* indicates that a specific valid time at a given time-stamp granularity is associated with a fact. Such a time depends neither on the valid time of another fact nor on the current time now.

Alternative Names

None.

Discussion

Examples are: "Mary's salary was raised on March 30, 1993," "Jack was killed on xx/xx/1990."

Notice that absolute times are associated with chronologically definite statements only.

1.17 Relative Time

Definition

The modifier *relative* indicates that the valid time of a fact is related to either the valid time of another fact or the current time now.

Alternative Names

None.

Discussion

The relationship between times can be qualitative (before, after, etc.) as well as quantitative (3 days before, 397 years after, etc.).

Examples are: "Mary's salary was raised yesterday," "it happened sometime last week," "it happened within 3 days of Easter," "the Jurassic is sometime after the Triassic," "the French revolution occurred 397 years after the discovering of America."

Notice that both chronologically indefinite and definite statements can involve relative times.