

TIME

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What is time?

— [Time is defined as:

that which we measure using clocks.

Clocks have problems

- [Clocks drift.

- No two clocks can ever be in perfect synchronization.

- [Clocks are imprecise.

- A chronon is the shortest measurable interval.

How does this affect us?

- [Multiple information sources implies multiple clocks.
- [Multiple clocks may mess up cause and effect.
 - One clock in the light switch.
 - One clock in the lamp.
 - Sensitive to drifts and needs a very short chronon.
 - Not unlike many real-time systems.

What do we do?

- [Pick a master clock and “adjust” the sources.

- Assuming we can make good enough adjustments, events from different sources will always be ordered correctly.

- [The chronon must be granular enough to preserve the order of events.

- Rapidly following events must not appear simultaneous.

What is a timeline?

- [A timeline is a concept that order events (preserving causality where it applies).
- [The boundaries of an event is defined by clock measurements.

— Instantaneous – one timepoint

— With duration – two timepoints

Databases store
measurements
not timelines



Domain selection

— [Depending on how the domain is selected, events will fall into (at least) three categories:

— Those that belong (is information) in the domain.

— Those that describe changes (of that information) in the domain.

— Those that represent knowledge (of that information) in the domain.

— [Changing the domain changes the distribution!

Data and Metadata

- Information in the domain = data
- Changes of that information = borderline
- Knowledge of that information = metadata

Example

Marketing plan:

- W10 - Create a campaign with an offer valid during W14 and W15
- W11 - Targeting
- W12 - Print
- W13 - Post
- W14 - Campaign period
- W15 - Campaign period
- W16 - Followup

Example (cont.)

— [Actual unfolding of events:

- W10 - Created a campaign with an offer valid during W14 and W15
- W11 - Targeting
- W12 - Print
- W13 - Post and Packaging
- W14 - Delivery delayed until the end of W14, offer extended to include W16
- W15 - Campaign period
- W16 - Campaign period
- W17 - Followup

Change

— [A change in the information is when the same identity appears at different times with different properties.

— The offer had an original claiming period.

— The same offer had its claiming period extended.

— [The appearance of entities, properties or relationships also constitute changes.

— Packaging had not been taken into account (schema evolution).

Changing values

Maintain a history
of changes

—— [Defining key* with valid time:

—— (Identity*, Value,
Valid interval*)

—— (Identity*, Changed Value,
New valid interval*)

Changing knowledge

Handling
clerical errors

- [Defining key* with transaction time:
 - (Identity*, Value, Valid interval*, Transaction interval*)
 - (Identity*, Value, Changed valid interval*, Different transaction interval*)

Concurrent values

Multi-language
databases

- [Defining key^{*} with perspectives:
 - (Identity^{*}, Value, Perspective^{*}, Valid interval^{*}, Transaction interval^{*})
 - (Identity^{*}, Concurrent value, Different perspective^{*}, Different valid interval^{*}, Transaction interval^{*})

Concurrent knowledge

Multiple
source systems

— [Defining key* with agents:

— (Identity*, Value, Perspective*, Valid interval*,
Agent*, Transaction interval*)

— (Identity*, Value, Perspective*, Valid interval*,
Different agent*, Different transaction interval*)

Multiple timelines

- [“Subjectivity” in the database:
 - Every perspective runs along its own timeline.
 - Every agent runs along their own timeline.
- [Bi-temporality (valid + transaction time) is not enough.
 - Event boundaries should not be ‘hidden’, they should be joinable.