TIME

Lars Rönnbäck @HAN 2011
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 orders 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
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
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

Defining key* with valid time:

- (Identity*, Value, Valid interval*)
- (Identity*, Changed Value, New valid interval*)

Maintain a history of changes
Changing knowledge

Defining key* with transaction time:

- (Identity*, Value, Valid interval*, Transaction interval*)
- (Identity*, Value, Changed valid interval*, Different transaction interval*)

Handling clerical errors
Concurrent values

Defining key\(^*\) with perspectives:

\[(\text{Identity}^*, \text{Value}, \text{Perspective}^*, \\
\quad \text{Valid interval}^*, \text{Transaction interval}^*)\]

\[(\text{Identity}^*, \text{Concurrent value}, \text{Different perspective}^*, \\
\quad \text{Different valid interval}^*, \text{Transaction interval}^*)\]
Concurrent knowledge

Defining key* with agents:


2. (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.