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Context Prediction based on Context Histories: Expected Benefits, Issues and Current State-of-the-Art

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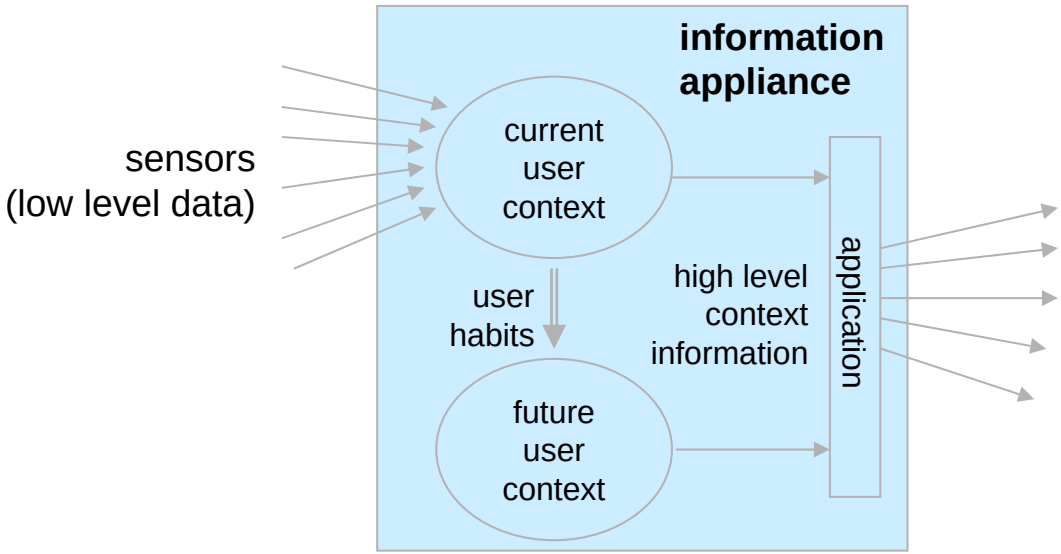
Why Context Prediction?

- Reactivity is not enough to provide “pervasive” services ⇒ compare a “personal digital assistant” with a human assistant
- Personal information appliances should learn from user‘s habits and exploit this knowledge for better services
- Proactivity implies the prediction of future context
- Predicting future (user) context by learning from the past ⇒ extrapolate context histories into the future

Approach



Potential Benefits and Possible Application Areas

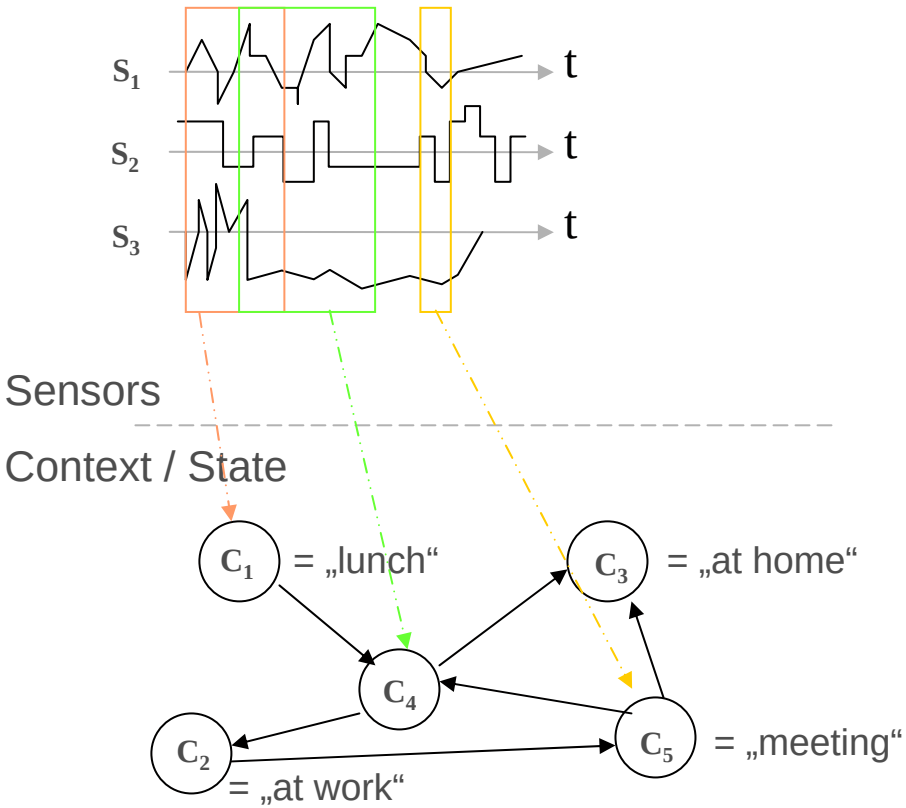
General benefits

- Obvious: performing actions on behalf of the user, based on context predictions
  Problematic
- Detecting irregularities and errors
- Improve user interaction

Current Application Areas

- Reconfiguration
- Accident prevention
- Alerting
- Planning Aid

Concept



- Sensors yield time series
- Common patterns in input vectors can be regarded as states of a finite state machine
- States are seen as user / device contexts
- Assign user defined names for integration with applications
- Prediction of future contexts by monitoring and extrapolating the state trajectory

Aspects of predicting future context

Time series aspects

- Periodic patterns (regular events) in the class trajectories: contexts which are active at regular time intervals
  e.g. meetings, working times, lunch, dinner, etc.
- Sequential patterns: sequences of context classes
  e.g. preparing for a conference
- Trends: changing behavior
- Exceptions: e.g. conferences, holidays, etc.

Training aspects

- Supervised vs. unsupervised
- Automatic model construction vs. involvement of human experts

Context history aspects

- Ground truth
- Centralized vs. decentralized
- Level of context data: raw sensor values, features, abstract context classes, …

Current Issues and Open Challenges

Acquisition of context histories

- Accuracy
- Fault tolerance
- Unobtrusive operation
- User acceptance
- Privacy

Exploitation of context histories

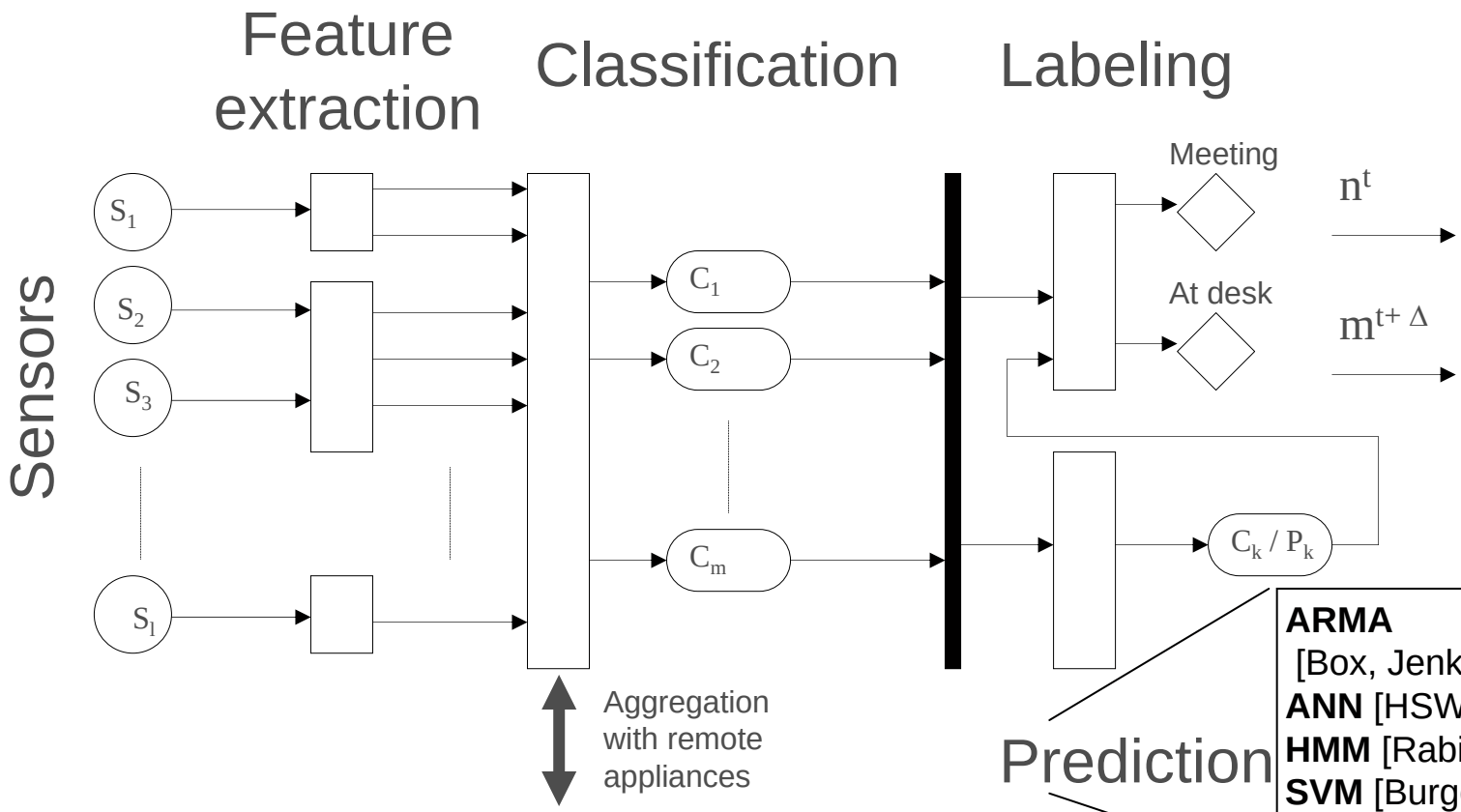
- Unsupervised operation
- Automatic model construction
- Problem complexity
- Uncertainty
- Online processing
- Heterogeneity

⇒ **Can be solved (at least partially)**

Currently open challenges

- Improving prediction accuracy
- “Downsizing”: coping with limited resources
- Sharing context histories: central repository vs. P2P
- Unobtrusive labeling
- User acceptance
- Predicting uncertainty

Architecture



$<s_1, s_2, ..., s_l>_t \rightarrow <f_1, f_2, ..., f_n>_t \rightarrow <c_1, c_2, ..., c_m>_t \rightarrow <c_1, c_2, ..., c_m>_{t+\Delta}$

Input vector (Sensor vector) | Feature vector | Class vector | Future class vector

[MRF 2003a] R. Mayrhofer, H. Radi, A. Ferscha: „Recognizing and Predicting Context by Learning From User Behavior“, Proceedings of MoMM2003, OCG, September 2003

“It is hard to predict, especially the future.”

Niels Bohr

Winner of the 1922 Nobel Prize in Physics

Context Database

http://www.soft.uni-linz.ac.at/Research/Context_Database/