CMSC818G: Learning from Context II

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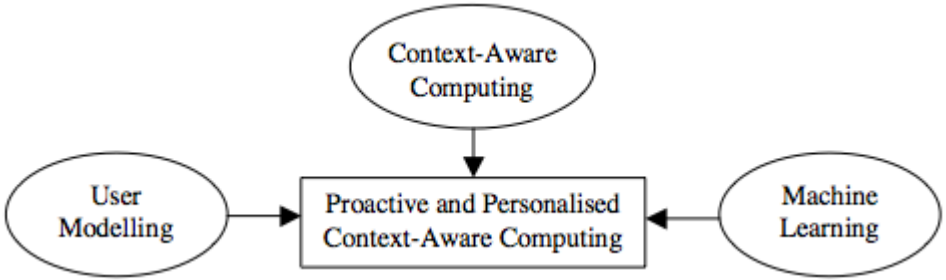
Harnessing Context to Support Proactive Behaviours

- Byun and Cheverst
- Suggest using context history along with user modelling and machine learning to achieve ubiquitous computing



Harnessing Context to Support Proactive Behaviours

- Context-awareness - adaptation of systems to the user and environment by capturing and understanding context
- Intelligent behavior - acting proactively on induced knowledge

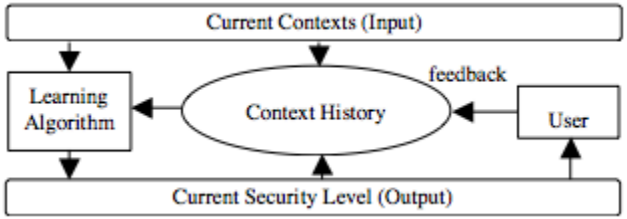
Harnessing Context to Support Proactive Behaviours

- Proactive behavior should be understandable by the user
  - Decision tree learning is more suitable
  - Neural network learning is less suitable

Harnessing Context to Support Proactive Behaviours

- Three inference designs to obtain a higher level conceptual context
- Example: Calculate the level of security risk in a user's office
  - User has a smart MediaCup that detects when the mug is hot or cold
  - Sensors detect when the door is open or closed
  - System knows when user is in the office or not

Harnessing Context to Support Proactive Behaviours



- Design 1: Single learning algorithm
  - Given a situation, apply a machine learning algorithm to determine whether there is a security risk (User is not in office and door is open)
  - Present the user with an alert when there is a risk

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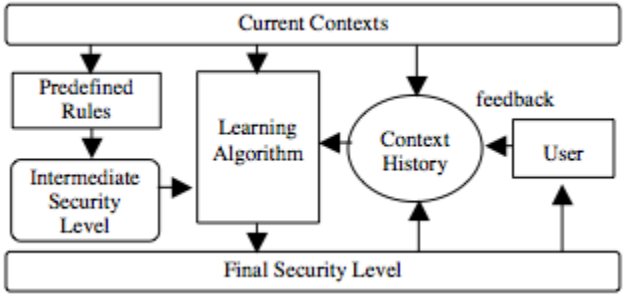

- Design 2: Predefined rules and a single learning algorithm
  - Add predefined rules to the previous design
  - Use a learning algorithm to find exceptions to the rules

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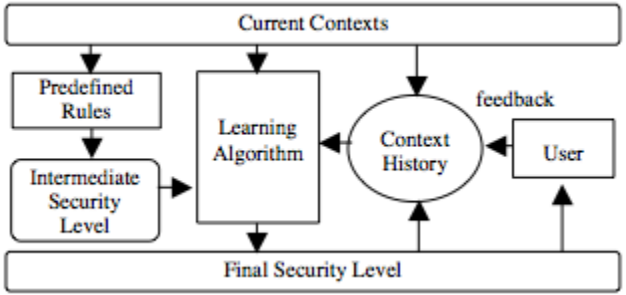

- Predefined rules:
  - High risk - Door is open when user has left office
  - Low risk - Door is closed when user has left office

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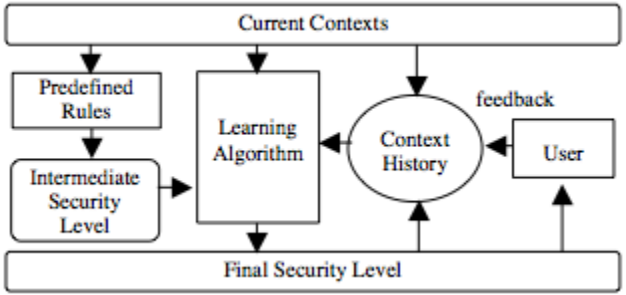

- Apply naive bayes classifier
  - Predicts the probability that the user will be in the office soon
  - Cancel warning if the classifier predicts the user will be there soon

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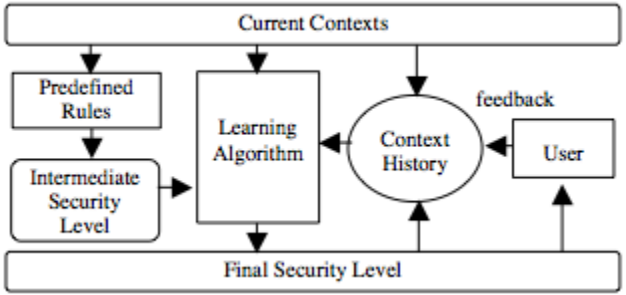

- Context history/training data used by classifier:

Time Stamp	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10	t11	t12
UserInOffice	true	true	true	false	true	true	false	false	false	true	true	true
TempCup	cold	hot	hot	hot	hot	cold	cold	cold	cold	cold	hot	hot

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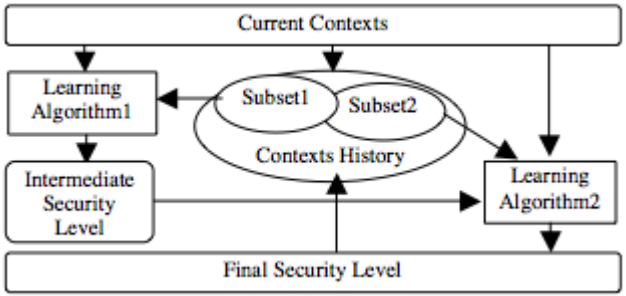

- Design 3: Multi learning algorithms
  - Replace predefined rules with another learning algorithm
  - Suggest decision tree learning algorithms for the security risk example

Context-Aware Collaborative Filtering System

- Chen
- Design a context-aware system that predicts user preferences based on past experiences of like-minded users

Context-Aware Collaborative Filtering System

- Problem: Most previous work relied on predefined rules
- Solution: Combine context with Collaborative Filtering (CF)

Context-Aware Collaborative Filtering System

- Collaborative Filtering - produces personalized recommendations to users
  - Works by combining opinions of users who have similar preferences as you
  - Examples: Amazon, Netflix
  - Previous works do not take into account dynamic contexts

Context-Aware Collaborative Filtering System

- Collaborative Filtering
  - Measures user similarity using Pearson correlation coefficient

$$w_{a,u} = \frac{\sum_{i=1}^{m} (r_{a,i} - \bar{r}_a) \cdot (r_{u,i} - \bar{r}_u)}{\sigma_a \cdot \sigma_u}$$

Context-Aware Collaborative Filtering System

- Collaborative Filtering
  - Predicts users rating of an item as a weighted average of similar users

$$p_{a,i} = \bar{r}_a + k \sum_{u=1}^{n} (r_{u,i} - \bar{r}_u) \cdot w_{a,u}$$

Context-Aware Collaborative Filtering System

- Incorporate context into CF
  - Define different context types

$$C = (C_1, C_2, \cdots, C_z)$$

  - Define a similarity function for each context type

$$sim_t(x, y)$$

Context-Aware Collaborative Filtering System

- Incorporate context into CF
  - Define a weighted rating of a user for an item with a given context

$$R_{u,i,\mathsf{c}} = k \sum_{\mathsf{x} \in \mathsf{C}} \sum_{t=1}^{z} r_{u,i,\mathsf{x}} \cdot sim_t(\mathsf{c}, \mathsf{x})$$

Context-Aware Collaborative Filtering System

- Incorporate context into CF
  - Replace the users' ratings with weighted ratings in the predicted rating

$$p_{a,i,\mathbf{c}} = \bar{r}_a + k \sum_{u=1}^{n} (R_{u,i,\mathbf{c}} - \bar{r}_u) \cdot w_{a,u}$$