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
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- 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
Harnessing Context to Support Proactive Behaviours

- Context history/training data used by classifier:

<table>
<thead>
<tr>
<th>Time Stamp</th>
<th>t1</th>
<th>t2</th>
<th>t3</th>
<th>t4</th>
<th>t5</th>
<th>t6</th>
<th>t7</th>
<th>t8</th>
<th>t9</th>
<th>t10</th>
<th>t11</th>
<th>t12</th>
</tr>
</thead>
<tbody>
<tr>
<td>UserInOffice</td>
<td>true</td>
<td>true</td>
<td>true</td>
<td>false</td>
<td>true</td>
<td>true</td>
<td>false</td>
<td>false</td>
<td>false</td>
<td>true</td>
<td>true</td>
<td>true</td>
</tr>
<tr>
<td>TempCup</td>
<td>cold</td>
<td>hot</td>
<td>hot</td>
<td>hot</td>
<td>hot</td>
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<td>cold</td>
<td>cold</td>
<td>cold</td>
<td>cold</td>
<td>hot</td>
<td>hot</td>
</tr>
</tbody>
</table>
Harnessing Context to Support Proactive Behaviours

- 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)
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
Collaborative Filtering

- Measures user similarity using Pearson correlation coefficient

\[
W_{a,u} = \frac{\sum_{i=1}^{m} (r_{a,i} - \bar{r}_a) \cdot (r_{u,i} - \bar{r}_u)}{\sigma_a \cdot \sigma_u}
\]
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
  - Define a similarity function for each context type

\[ C = (C_1, C_2, \ldots, C_z) \]

\[ sim_t(x, y) \]
Incorporate context into CF

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

\[ R_{u,i,c} = k \sum_{x \in C} \sum_{t=1}^{z} r_{u,i,x} \cdot \text{sim}_t(c, x) \]
Context-Aware Collaborative Filtering System

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

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