



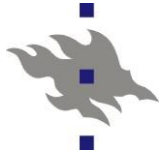
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# Introduction to User Modeling

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# Introduction: What is User Modeling?

## Introduction

Process

Techniques

Ubiquitous Systems

Example

Resources

n A cross-disciplinary research topic

n human-computer interaction

n artificial intelligence

n psychology

n philosophy

n design

n linguistics

n The seminar will mainly focus on the artificial intelligence side of user modeling



# Introduction: What is User Modeling?

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## n User-adaptive software systems

- n Systems that adapt interaction based on the user and his/her needs
- n In order to achieve the adaptation effect, the system must have a representation of the relevant aspects of a user
  - **Adaptation effect** = the system behaves differently for different users
- n This representation is called a **user model**
- n **User modeling** is defined as the process of constructing maintaining and using user models



# Introduction: What is User Modeling?

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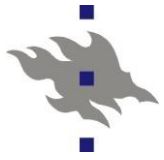
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- n A **user model** is a representation of a user that captures
  - n goals/tasks: what is the user attempting to achieve?
  - n knowledge/background/experience: what does the user know of the subject? What can we expect the user to know?
  - n interests: what web pages or songs the user likes (etc.)?
  - n traits: personality features that can influence the user's behavior and expectations
    - e.g., introvert or extrovert
    - cognitive styles: holist or serialist (etc.)
  - n context of work (platform, location, activity)
- n A closely related term is **user profile**
  - n Usually contains user-specified information (vs. Information captured about the user)



# Types of User Models

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## n Empirical Models

- n Based on empirical observations about the user, do not attempt to understand the user's cognitive processes

- n Various types of empirical models:

- Feature-based: model specific features (previous slide)
- Stereotype: map users to groups and treat all users in a group similarly

## n Analytical models

- n Attempt to simulate the cognitive processes that take place during the interaction between the user and the system

- n Can be also integrated with empirical models as expert knowledge



# What can be adapted?

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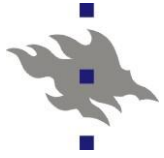
## n Adaptive presentation

### n Modifying content according to the user model (and context)

- Determining input/output modalities
- Adapting contents:
  - Inserting/removing fragments
  - Dimming (information hiding)
  - Sorting/re-ordering fragments

## n Link-level adaptation, help users navigate the system

- n Hiding: hide inactive/unused links (e.g., Microsoft Office)
- n Direct guidance: suggest shortcuts (e.g., tags in Flickr)
- n Sorting: order links according to relevance



## Domains

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### n Information retrieval and filtering:

- n User model (or profile) represents user's interests in terms of keywords, concepts or topics

### n Intelligent tutoring systems

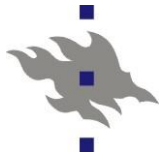
- n Select educational activities and deliver individual feedback that is most relevant to the user's level of knowledge

### n Intelligent User Interfaces

- n Adapt features of the interface according to the user needs

### n Adaptive Web Applications

- n Adapt the contents of a web page or provide navigation support to the user



# Steps in User Modeling: General Process

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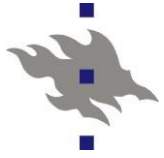
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1. Choose the domain and perform domain analysis
  - n In which tasks can we assist the users? How?
2. Create the user model
  - n Manual:
    - Observe users and use experts to build a cognitive model of the users
  - n Automated:
    - Collect data about the user and use machine learning algorithms to learn the model
3. Apply the model and perform adaptation
4. Evaluate



# Collaborative User Modeling and Preference-based User Modeling

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- n An alternative process is *collaborative user modeling*
  - n System learns actively about the user
  - n But user can edit and revise the model manually
  - n Thus, can be seen as an iterative refinement of the generic process
  
- n Preference-based user modeling
  - n user specifies the model entirely
  - n example: email filters



## Domain analysis

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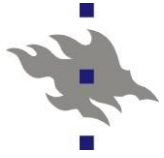
n The design and specification of the intended system

n Requirements process:

- Determining technical requirements for the system
- Task knowledge analysis
  - What mental models users associate with the tasks that the system is supposed to accomplish?
  - How users would perform these tasks?

n Preliminary evaluation

- Verifying that the system performs the tasks it's supposed to
- Re-examining the results of task knowledge analysis with a prototype



## Collecting data

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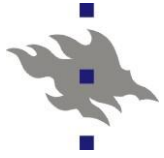
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- n The first step in collecting data about the users is to be able to **identify** the users
  - n agents, logins, proxies, cookies, ids and usage logs
- n The actual information collection uses either explicit or implicit observations (or both)
  - n Explicit = information inputted by the user
    - Requires effort from the user
    - Forms, checkbox, user opinions etc.
  - n Implicit = information gathered without user intervention
    - logs, proxies, agents
    - easy to collect usage data
    - but hard to evaluate



# Evaluation

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## n Expert evaluation

### n Usability analysis

- Checking that the system meets certain usability criteria

### n "Performance" analysis

- See how well users can accomplish the intended tasks
- Proper selection of test users important

## n Manual evaluation & life long learning

n A complementary view is to allow the users to give feedback and to adapt the system based on user feedback

n Life long learning = the system automatically adapts itself to user feedback and continuously updates its user model



## Techniques I: User Modeling Systems (11.9)

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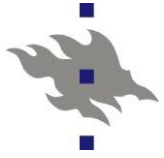
**Techniques**

Ubiquitous Systems

Example

Resources

- n Initially user modeling was application-specific
  - n i.e., the modeling and adaptation mechanism could only be used in a single application
    - è difficult and expensive to use adaptivity in commercial applications
- n Alternative: user modeling systems
  - n Generic systems that provide means for constructing, using and maintaining user models
  - n Generic user modeling systems and, more recently, user modeling servers are this kind of user modeling systems
    - differ in the used technical solutions



## Techniques II: Expert Systems (18.9)

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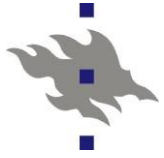
**Techniques**

Ubiquitous Systems

Example

Resources

- n Automated user modeling requires techniques that:
  - n construct models from data
  - n support determining adaptation decisions
- n Expert systems are a paradigm that has been applied for decision support in traditional artificial intelligence
  - n Two main techniques:
    - Knowledge representation
      - Rely on a knowledge base that represent relevant information about the domain and the users
      - E.g., rule-based and logic-based systems
    - Statistical techniques
      - E.g., Bayesian networks



## Techniques III: Filtering (25.9)

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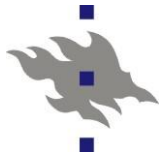
**Techniques**

Ubiquitous Systems

Example

Resources

- n Expert system paradigm is suited for decision support...
- n ...but often we simply need to determine what content is relevant to a user
- n Filtering addresses this question
  - n Given information about user preferences, i.e., what items has the user liked before, the goal is to determine
    - Whether user likes a particular item
    - Or to find relevant items
  - n Two kinds of filtering techniques:
    - Content-based: similarities between content
    - Collaborative: similarities between users



## Techniques IV: Usability and Evaluation (2.10)

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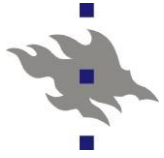
**Techniques**

Ubiquitous Systems

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Resources

- n User modeling systems attempt to facilitate the user è important to verify that this really is the case
- n A closely related concept is usability, i.e., how easy and pleasant is the system to use
  - n Good usability does not mean that a system is good in terms of user modeling
  - n But poor usability cannot be used to achieve good user modeling performance
- n Evaluation
  - n Requires real users
  - n Background and characteristics of the users are important
  - n As well as the number of test users
  - n Designing the evaluation setup = experiment design



## Techniques V: Intelligent User Interfaces (9.10)

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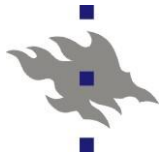
**Techniques**

Ubiquitous Systems

Example

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- n Intelligent user interfaces are a special case of adaptive systems
  - n instead of adapting contents of applications, adapt the actual interface through which the user interacts
- n Intelligent interface can be
  - n Adaptive
    - automatically modifies its performance
  - n Adaptable
    - user can modify the interface according to his/her preferences
  - n or a combination of both



## Techniques VI: Cross-cultural modeling (13.11)

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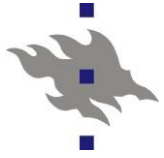
**Techniques**

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Resources

- n As the final topic of the seminar we discuss cross-cultural user modeling
  - n In addition to individual differences, cultural background causes differences to users behavior
  - n For example, posture can serve as a (weak) indicator of emotions
    - But the way postures indicate emotions varies across cultural boundaries
- n Another aspect is the cultural familiarity with technology
  - n Japan, Korea, Singapore: advanced communication infrastructure, users more familiar with novel technologies than elsewhere in the world



# Adaptive Ubiquitous Systems

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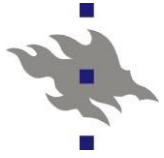
n Ubiquitous computing:

n "post-desktop" paradigm

n information processing has been thoroughly integrated into everyday objects and activities

n hence users can use information systems everywhere and at all times

n Adaptive ubiquitous system = system for ubiquitous computing that adapts to its user



# Adaptive Ubiquitous Systems

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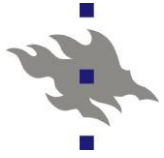
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**Ubiquitous Systems**

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- n In desktop environments, the interaction situation is fixed whereas in ubiquitous environment the interaction can take place wherever
  - n The goals (and hence also information needs) of a user vary according to his/her situation
  - n Furthermore, interaction with devices requires the user's cognitive resources
- è adaptive ubiquitous systems should also consider the situation of the user/interaction in their decisions



# Adaptive Ubiquitous Systems - Examples

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**Ubiquitous Systems**

Example

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## n Museum guides

- n Personalized presentation of information based on the interests and location of a user

## n Navigation systems

- n Facilitate finding relevant (personalized) places/points of interest

## n Shopping assistants

- n Targeted promotions, navigation help, provide product information



## Case Study: Lumière

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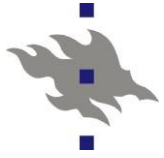
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**Example**

Resources

- n As an example, we consider the Lumière system
  - n Developed by Microsoft Research in the 90s
  - n The first research prototype was developed for MS Excel
  
- n Goal:
  - n Determine the user's goal (i.e., what task the user is attempting to perform in Excel)
  - n Evaluate whether the user is likely to need help and what is the cost of disrupting the user
  - n When the system thinks that the user needs assistance and the cost of interrupting is not too high, the system provides context-sensitive help (i.e., how to achieve the goal)



## Case Study: Lumière

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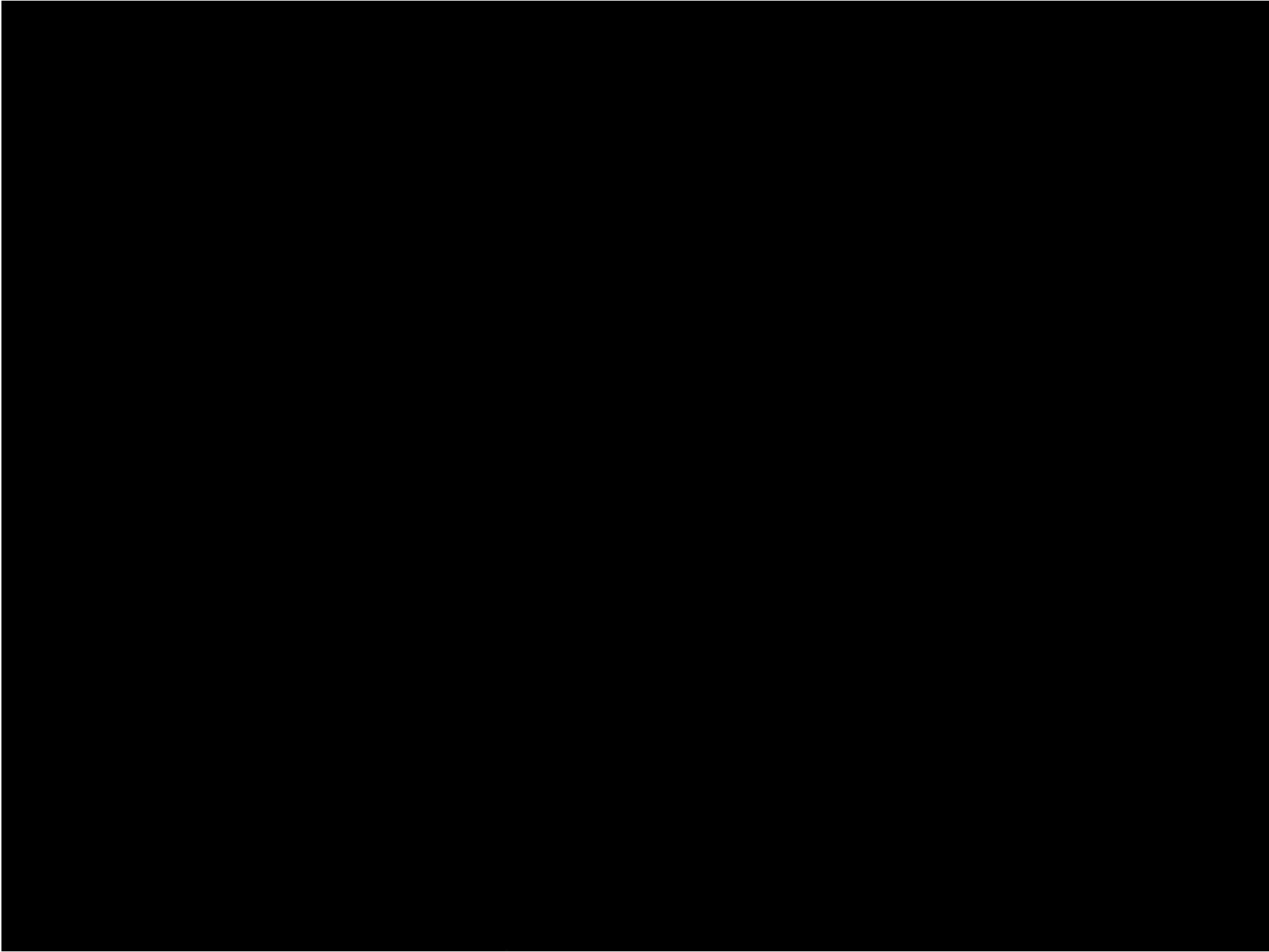
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**Example**

Resources

- At the core of Lumière are Bayesian user models
  - The models were constructed through an iterative process that involved assessments and evaluations with experts (psychologists)
- Also temporal aspects are considered (i.e., sequences of actions)
  - Achieved through dynamic Bayesian networks

Next we will look at a video demonstrating Lumière





# User Modeling Resources

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Resources

## n Books

- n P. Brusilovsky, A. Kobsa, W. Nejdl (eds.), *The Adaptive Web: Methods and Strategies of Web Personalization*, LNCS 4321, Springer-Verlag, 2007

## n Journals

- n User Modeling and User Adapted Interaction (UMUAI):  
<http://www.umuai.org/>
  - 10th anniversary special issue:  
<http://www.umuai.org/anniversary.html>

## n Conferences

- n User Modeling (UM) series of conferences
- n Adaptive Hypermedia (AH) series of conferences
- n Intelligent User Interfaces (IUI) series of conferences