Quiz #5

1. Give an example advanced web page (components or some advanced page property) for which the original DENIM tool is inefficient or insufficient. In other words, describe the motivating example in the paper.

2. How did the authors evaluate their final design? Describe briefly.

Introduction

- Types of Adaptation
  - Adaptable
  - Adaptive
  - Mixed Initiative
- Definition of Adaptive Interfaces: “Interactive systems that invoke machine learning to improve their interaction with humans (Langley, 1999).”

Adaptive vs. Adaptable

- Adaptive
  - System adapts itself to tasks & users
  - Knowledge is contained in the system
  - Little or no effort is needed from the user [+]
  - Loss of user control [-]
- Adaptable
  - Users can change functionality
  - Knowledge is extended by user
  - User is in control [+]
  - User must do substantial work [-]


Why have adaptive systems?

*To enhance the user experience*

- Information filtering
  - Individual interests
  - Shared interests
  - Tailored content & navigation
Adaptive Menus

- Commercial applications
  - MS Office font split menu
  - MS Office adaptable menus
  - Windows 2000 start menu
  - XP start menu frequent application list

User Models

- “…An explicit representation of the properties of an individual user; it can be used to reason about the needs, preferences or future behaviour of the user. (Ross, 2000)”
- Data collection
  - Self Reporting (eg. Some movie recommenders)
  - Detecting user actions (eg. tracking clicks, frequency of actions)

User Modeling

Beneficial in:
- Personalization
- Filtering systems
- Adaptive systems
- Adaptive user interfaces
- Recommender systems

User Modeling

- Sometimes called User Profiling
- Methods of capturing user preferences and behaviour
  - Handcrafted stereotypical models
  - Handcrafted models based on traditional questionnaires (expert systems)
  - Learned (statistical) models based on use of system
- Can be collaborative or individual

Collaborative profiling

Based on the items you’ve purchased from and the behaviour of other customers who’ve bought the same items, Recommendations change immediately when you purchase or rate a title, Can change recommendation by clicking – ‘not interested’ or ‘own it’ -http://www.amazon.co.uk

- Collaborative filtering
  - Association by user and object
  - Explicit data, shopping history
  - Implicit data, stereotypes
- Issues
  - May creates inaccurate stereotypes
Data Used to Develop User Profiles

- Explicit data:
  - Questions/answers
  - User preferences, options chosen
- Implicit data (less obtrusive):
  - Navigation
  - Keystroke and mouse traces
  - Click stream from web browsing
  - Content
  - Record of purchases/actions

User Modeling: The Basics

- Collect implicit and explicit data
- Process data and develop a mathematical or logical model to predict user preferences or product interests
- Apply user models to adapt the format or content of a system’s interface
- Such systems are named **adaptive user interfaces** or **intelligent user interfaces**
- Examples: Amazon, Google, …

User Modeling & Adaptation

![Diagram showing the process of user modeling and adaptation](image)

Elements of an Adaptive Interface

![Diagram showing the elements of an adaptive interface](image)
Implicit Data

- Server logs & Cookies
  - Patterns of use
  - IP address
  - Time stamp
  - Referring URL
  - Operating system
  - User ID & session number
  - Number of visits/pages viewed
  - Data collection
  - Pattern discovery
  - Automated user model

Explicit Data

- User Profiles & Preferences
  - Supplied data
  - Age
  - Gender
  - Location
  - Content preferences
  - Layout preferences
  - Shopping history
  - User input
  - Pattern discovery
  - Informed user model

Using the Learned Model

Another essential step in the development process can be stated:

Given: An approach to learning a user model for some task;
Find: Some way to invoke the model that helps the user perform the task more effectively.

This decision includes making clear design choices about:
- when and how to present the model’s predictions to user;
- how to handle cases in which these predictions are wrong.

The ideal adaptive interface lets the user take advantage of good predictions and ignore bad ones.

Gaining User Acceptance

A final important facet of the development process can be stated:

Given: A complete adaptive user interface for some task;
Find: Ways to get people to try the system and to become long-term users.

Attracting first-time users involves marketing much more than technology, but, without it, a good system may be ignored.

However, a system that is well-designed and easy to use is more likely to retain users over long periods.
Privacy Policy

Information Collection and Use

- “Once you register with Yahoo! and sign in to our services, you are not anonymous to us”
  - Explicit Data
    - name, email address, birth date, gender, post code, occupation, industry, and personal interests.
  - Implicit Data
    - IP address
    - Cookies
- Use
  - customise advertising and content you see, based on registration and activity at Yahoo!
  - Third party exchange

Privacy: Questions to Ask

- Disable and delete cookies
- Will the system still work?
- Sharing purchase history or wish lists
  - Is it optional?
- Using my data to create collaborative filters without my consent
  - Can I opt out?
- Third party use
  - Who else is accessing my data?
- Privacy and Use
  - Are rights negated upon use?

Pattern Discovery

Machine Learning & Statistical Models

- Clustering
  - Grouping users with common browsing behaviour
  - Grouping web pages with similar content
- Classification
  - Model the behaviour of users and the classification of Web pages
  - Keyword or page views = represent user interests
  - Pages that often links have a relationship
- Association discovery
  - Represent causal relations about a number of variables
  - Bayesian networks = Statistical inference in which probabilities are discovered not in terms of frequencies but, as degrees of belief
  - Gaining popularity in the Artificial Intelligence community
- Sequential pattern discovery
  - The element of time, event sequences
  - Markov model - the distant past is irrelevant given knowledge of the recent past
  - Navigation patterns to predict future visits based upon past page views

Examples of Adaptive User Interfaces

Adaptive interfaces have been developed for many different tasks:

- Command and form completion
- Email filtering and filing
- News selection and layout
- Browsing the World Wide Web
- Selecting movies and TV shows
- On-line shopping
- In-car navigation
- Interactive scheduling
- Dialogue systems

These efforts cover a wide spectrum but also raise common issues.
The Task of Route Selection

A decision-making task that confronts drivers can be stated as:

- Given: The driver’s current location \( C \);
- Given: The destination \( D \) that the driver desires;
- Given: Knowledge about available roads (e.g., a digital map);
- Find: One or more desirable routes from \( C \) to \( D \).

Computational route advisors already exist in both rental cars and on the World Wide Web. However, they do not give personalized navigation advice to individual drivers.

The Adaptive Route Advisor

The proposed approach is implemented in the *Adaptive Route Advisor* (Fiechter, Rogers, & Langley, 1999), which:

- models driver preferences in terms of 14 global route features
- gives the driver two alternative routes he might take
- lets the driver refine these choices along route dimensions
- uses driver choices to refine its model of his preferences
- invokes the driver model to recommend future routes

Note that providing drivers with choices lets the system collect data on route preferences in an unobtrusive manner.

Driver Model and Training Cases

The Adaptive Route Advisor represents the driver model as a weighted linear combination of route features.

\[
\text{Time} \times w_0 + \text{Distance} \times w_1 + \text{Intersections} \times w_2 + \text{Turns} \times w_3 = \text{Cost}
\]

Training data: \([x_0, x_1, x_2, x_3] \) is better than \([y_0, y_1, y_2, y_3] \).

The system uses each training pair as constraints on the weights found during the learning process.

An Approach to Route Selection

Here is a one approach to learning route preferences, though not the first we considered:

- **Formulation:** Learn a “subjective” function to evaluate entire routes
- **Representation:** Global route features computable from digital maps
- **Data collection:** Preference of one complete route over another
- **Induction:** A method for learning weights from preference data
- **Utilizing model:** Apply subjective function to find “optimal” route

This method learns a user model with respect to the entire route.

Experimental Results on Route Advice

Experiments with 24 subjects show the Route Advisor improves its predictive ability rapidly with experience.
Analyses also show that personalized user models produce better results than generalized models, even when given more data.

Experimental Results on Route Advice

The Adaptive Email Reader

- Consider an email program that highlights emails that the user is particularly likely to read.
- Email Characteristics (Boolean)
  - Known - The sender is known to the reader
  - New - This email is not part of an existing thread
  - Short - The email is short
  - Home - The email is being read from home
  - Reads - Dependent variable: Whether the user reads the message

Personalized Bookmarks

Another example

- Many games can be complex for players to learn/manage
- Need for interfaces that do more than simply act as a means for players to input commands/actions
- Intelligent interfaces between players and games will enable games to reason about the needs, desires and motivations of players and to react accordingly.
- Intelligent vs. Adaptive interfaces?
  - Next:
    - describe some possible benefits of such an interface in game playing
    - discuss some of the challenges that will have to be overcome to make them a reality in mainstream game production

Assistance with Micro-Management

- Strategy games: Macro and micro-management
  - As armies grow, more and more time on micro-management (chore) and less on macro-management (fun)
- Some games already make use of agents to help in these tasks
  - "Civilization" advisors
  - Intelligent Interface assistants learn during the game
- Make micro-management decisions similar to the players
- RPGs: Re-distributing items & selling off acquired loot
  - Take minutes of play time and dozens of mouse clicks
  - Repeated dozens of times in a single session of play
  - Interfaces that learn how a given player likes to distribute equipment or to propose lists of items to sell could drastically reduce the time spent by players on "housekeeping"

Adapting the UI to the User

- Range of games (strategy, role-playing and adventure) which present large amounts of information to the player
  - As armies grow, more and more time on micro-management (chore) and less on macro-management (fun)
- Some games already make use of agents to help in these tasks
  - "Civilization" advisors
  - Intelligent Interface assistants learn during the game
  - Make micro-management decisions similar to the players
- RPGs: Re-distributing items & selling off acquired loot
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  - Interfaces that learn how a given player likes to distribute equipment or to propose lists of items to sell could drastically reduce the time spent by players on "housekeeping"
**Assistance in Task Execution**

- If interface can detect what a player is trying to do, it can offer help in completing the task
  - Not to have the computer play the game for the player!
  - Scope for assistance that reduces the need for players to carry out all tasks by themselves (similar to micro-management)
- Example: Squad-based game
  - With intelligent interface analyzing the players’ intent, squad members would be able to pro-actively offer to carry out tasks
  - Decrease the need for the player to manage other characters
  - Control task reduced to accepting or rejecting offers of help
  - In place of sequences of commands and key combinations
- Increase perceived intelligence of the computer controlled squad members, and degree of immersion in the game overall?

**From Tutorials to Mentors**

- Currently: Interactive Tutorials
  - Often first stages or levels of a game
  - Cycle through a range of actions and activities.
- Possible for players to forget how to perform infrequent actions
  - Or when game has not been played for some time
  - Pro-active help can be offered to explain how tasks may be carried out
  - Ask: Offer guidance based on previous activity of player
- As simple as pop-up dialogs, or better...
  - Embodied Mentor characters and sidekicks
    - E.g. Mentors in educational and massively multiplayer games
  - Can allow richer interaction with mentor where possible
    - Allow players to kill them off when they get too annoying?

**Frustration detection**

- Hint Systems – Yorda in “Ico”
  - Unless the player rapidly solves the puzzle in a location, Yorda will notice something – then point to whatever and call out
  - Scripted for many locations, no clues on how to solve the puzzle
  - Natural extension: Additional clues if player remains stuck
- Detecting when player is stuck in non-linear games
  - Not so simple: might require some amount of AI to detect
  - How to decide what help to offer, and when to offer it, without understanding what the player is trying to achieve?
- Intelligent interfaces might be able to offer help before player turns to online walkthroughs or quits game

**Enhancing Gameplay**

- Enhancing and Adapting Gameplay
  - Instead of helping the player, an intelligent interface can adapt a game in other ways.
    - Adjusting the gameplay to suit the player
  - Adaptive Difficulty
    - Very simple non-AI methods exist in range of games (e.g. catch-up slow-down in racing games)
    - AI methods being presented at this workshop
      - Intelligent interfaces which monitor players can help a game decide when to adapt the difficulty
      - May e.g. learn from the player to adapt AI strategies in response

**Implementing Intelligent Interfaces**

- Most applications discussed require a player model
  - User Modeling itself a focus of a significant amount of study
    - (UM in tutoring systems formed the background of Beal et al. 2002)
- Model player ‘trained’ on data from how player is playing the game
  - Count frequencies of different actions (Houllette 2004)
  - Neural nets trained on player data have been demonstrated for opponent A.I. – similar could be used to build player model
  - CBR approaches. Determine possible player/game states, and actions possible for each state
    - Good at initiating players, may be less useful for reasoning about them!
    - Learn from player actions, able to predict what they will do next
- Analyze players during testing
  - Construct models corresponding to different players types / play styles
  - Interface to categorize players – and if necessary re-categorize them.
- Need to decide what data to collect and how to interpret it

**Challenges**

- Offer help without being intrusive or irritating
  - To some, Clippy is annoyance – deactivated as soon as possible
  - Need an off switch – An escape clause, not a solution
- Be able to reliably interpret not just players’ intentions, but their emotional state
  - Understand player preferences and motivations
  - Progress on measuring the emotional state of players without additional non-game peripherals to monitor the player
  - Additional means of observing players (“EyeToy” or heart-rate monitors) may help, but cannot be assumed
- Keep game difficulty at the right level of player challenge
  - Players dislike games being too easy as well as too hard
  - Careful balancing: just enough intervention
    - To maintain interest in the game
- With benefits unproven, not many developers will be keen to implement Intelligent Interfaces
Challenges of Adaptive Interfaces

Adaptive user interfaces have clear attractions but also pose some challenges to developers:

- formulation of user modeling as an induction task
- engineering of representation to support learning process
- unobtrusive collection of training data from users
- effective application of learned user model
- requirement for some form of online learning
- necessity for induction from few training cases

These challenges overlap with other applications of machine learning, but also raise some new issues.

Criticisms of Adaptive Interfaces

- Loss of Control
- Transparency
- Predictability
- Trust
- Redesigning a system can often overcome the problems addressed by adaptive features (Breuker, 1990)

Another example:

- Web-based User Profiling

The Internet and WWW

- The Internet has achieved tremendous growth in the past decade

The Internet’s Dilemma

- A lot more information
- A lot harder to find the piece you desire
- How can users be provided the information they want without being overwhelmed?
- How can E-Commerce companies help their customers find the products and services they desire?
The Need for Intelligent Assistance
As information and choices become more available, users need help in finding, and selecting among, the many alternatives. This has led to the development of recommendation systems, which attempt to locate and recommend relevant items.

The Need for Personalized Assistance
At the same time, society is becoming ever more diversified. Differences in private and professional preferences are growing. Internet users are becoming increasingly selective about what they want to see and purchase. We need personalized systems that can give users the information or product they want. But personalized response requires some model or profile of the user.

Example application
- Navigate.ca has 62 shopping categories, organized into several folders and subfolders
- Hard to find product categories of related interest when shopping
- Facilitate the use of Navigate.ca through user profiling and an adaptive interface

The Solution
- Track the categories that users visit and use the information to predict the next best category
- Adapt the content of the web pages so as to recommend the next best category
- Assumption: Users will follow similar trajectories when shopping for similar purposes

Data Preparation & Collection
Click stream interfile Training Examples Input: Math functions Output: applet.java User Modeling
Click stream interfile Training Examples Input: Math functions Output: applet.java User Modeling

Navigate.ca applet.java ourModel.c
ourModel.c Navigate.ca applet.java ourModel.c
ourModel.c Navigate.ca applet.java ourModel.c
ourModel.c Navigate.ca applet.java ourModel.c
ourModel.c Navigate.ca applet.java ourModel.c
ourModel.c
Testing Strategy

- User testing (Effectiveness)
  - Model vs. Random

- User testing (Usefulness)
  - Will links be used?

User Testing (Effectiveness)

<table>
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<tr>
<th></th>
<th>0 – Useless</th>
<th>1 – Somewhat Useful</th>
<th>2 – Very Useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td>69.9%</td>
<td>24.4%</td>
<td>5.8%</td>
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<tr>
<td>Model</td>
<td>42.1%</td>
<td>32.8%</td>
<td>25.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1 or more Very Useful</th>
<th>1 or more Very OR Somewhat Useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td>15.4%</td>
<td>63.5%</td>
</tr>
<tr>
<td>Model</td>
<td>49.2%</td>
<td>93.4%</td>
</tr>
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Results

- Model was capable of creating successful profiles

- Users seemed to benefit from the suggested links
The Promise of New Sensors

Adaptive interfaces rely on user traces to drive their modeling process, so they stand to benefit from developments like:

- GPS and cell phone locators
- robust software for speech recognition
- accurate eye and head trackers
- real-time video systems
- wearable body sensors (GSR, heart rate)
- portable brain-wave sensors

As such devices become cheap and widespread, they will give us new sources of data and support new types of adaptive services.

Conclusions

In summary, adaptive interfaces integrate ideas from machine learning, intelligent agents, and human-computer interaction.

This approach to automated personalization of online services:

- has many examples already in regular and successful use,
- but many unexplored niches for research and application,
- and challenges involving integration rather than new methods.

These adaptive systems promise to change the way we interact with, and think about, computer software.

Reading #6

- A Comparison of Static, Adaptive, and Adaptable Menus
  - Leah Findlater and Joanna McGrenere, Dept. of Computer Science, University of British Columbia
  - SIG CHI 2004