Adaptive Information Systems: From Adaptive Hypermedia to the Adaptive Web

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Information Systems: One Size Fits All?

- Number of users is increasing
- Yet almost all of them offer the same content and the same links to all
  - Stores
  - Museums
  - Courses
  - News sites
- Adaptive information systems offer an alternative. They attempt to treat differently users that are different from the system’s point view
Adaptive systems

Classic loop “user modeling - adaptation” in adaptive systems
What can be taken into account?

- Knowledge about the content and the system
- Short-term and long-term goals
- Interests
- Navigation / action history
- User category, background, profession, language, capabilities
- Platform, bandwidth, context…
What Can be Adapted?

• Intelligent Tutoring Systems
  – adaptive course sequencing
  – adaptive group formation
  …

• Adaptive GUI
  – menu adaptation
  – dialog form adaptation

• …

• Adaptive Hypermedia Systems
  – adaptive presentation
  – adaptive navigation support

• Adaptive Help Systems

• Adaptive . . .
Personalized Information Access

- **Adaptive IR systems (IR, from 1980)**
  - Use word-level profile of interests and remedial feedback to adapt search and result presentation

- **Adaptive hypermedia (HT, ITS, from 1990)**
  - Use explicit domain models and manual indexing to deliver a range of adaptation effects to different aspects of user models

- **Web recommenders (AI, ML, from 1995)**
  - Use explicit and implicit interest indicators, apply clickstream analysis/log mining to recommend best resources for detected use interests
    - Content-based recommenders
    - Collaborative recommenders
Why Search Personalization?

• Different users need different documents in response to the same query

• Relevance is not enough if the volume of data is high
  – R. Larsen: With the growth of DL even a good query can return not just tens, but thousands of "relevant" documents

• Personalization is an attempt to find most relevant documents using information about user's goals, knowledge, preferences, navigation history, etc.

Adaptive Search

• How search process can be adapted to the user?
• How we can model the user in adaptive search?
• Which adaptation technologies can be applied?
How Search Can be Adapted?

• Let’s look by stages
Modeling Users in Adaptive Search

- Most essential feature: user interests
- Observing user document selection, adaptive IR systems build profile of user interests
- Keyword-level modeling
  - Uses a long list of keywords (terms) in place of domain model
  - User interests are modeled as weighted vector or terms
  - More advanced systems use several profiles for different domains or timeframes
### Keyword User Profiles

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<th>Watercolor</th>
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<table>
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<tr>
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<th>Symphony</th>
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<td>0.15</td>
<td>0.87</td>
<td></td>
<td>0.31</td>
<td>0.63</td>
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</tbody>
</table>
Pre-Process: Query Expansion

- User profile is applied to add terms to the query
  - Popular terms could be added to introduce context
  - Similar terms could be added to resolve indexer-user mismatch
  - Related terms could be added to resolve ambiguity
  - Works with any IR model or search engine
Post-Processing

• The user profile is used to organize the results of the retrieval process
  – present to the user the most interesting documents
  – Filter out irrelevant documents
• Extended profile can be used effectively
• In this case the use of the profile adds an extra step to processing
• Similar to classic information filtering problem
• Typical way for adaptive Web IR
Post-Filter: Re-Ranking

• Re-ranking is a typical approach for post-filtering
• Each document is rated according to its relevance (similarity) to the user or group profile
• This rating is fused with the relevance rating returned by the search engine
• The results are ranked by fused rating
  – User model: WIFS, group model: I-Spy
YourNews: Adaptive Search and Filtering with Open User Profile

http://amber.exp.sis.pitt.edu/yournews/
Adaptive Hypermedia

• How hypertext and hypermedia can become adaptive?
• Which adaptation technologies can be applied?
• How we can model the user in adaptive hypertext?
Why Adaptive Hypermedia?

Hypermedia systems are almost adaptive but ...

☑ Different people are different
☑ Individuals are different at different times
☑ "Lost in hyperspace"

We may need to make hypermedia adaptive where ..

⇒ There us a large variety of users
⇒ Same user may need a different treatment
⇒ The hyperspace is relatively large
What Can Be Adapted?

• Web-based systems = Pages + Links

• Adaptive presentation
  – content adaptation

• Adaptive navigation support
  – link adaptation
Adaptive presentation

• Conditional text filtering
  – ITEM/IP
• Adaptive *stretchtext*
  – MetaDoc, KN-AHS
• Frame-based adaptation
  – Hypadapter, EPIAIM
• Natural language generation
  – PEBA-II, ILEX
Adaptive Stretchtext (PUSH)

In our work, we perform and document an object-oriented analysis of a subsystem. The model should include the abstractions (represented as object types) necessary to understand how the subsystem described by the functional requirements is expressed in an object-oriented world. This analysis will render us a high-level view of the subsystem without any consideration (or at least as little consideration as possible) taken to distribution, persistence aspects or other design and implementation considerations. The goal is a model that clearly describes and gives an understanding of a subsystem without the gory details of design and implementation.

The ideal object model resulting from the ideal object modelling process, is functionally complete in the sense that it covers all areas of the functional specification of a subsystem.

The intention behind the ideal object modelling process is to focus on...
Adaptive navigation support

- Direct guidance
- Hiding, restricting, disabling
- Generation
- Sorting
- Annotation
- Map adaptation
Adaptive annotation in InterBook

1. State of concepts (unknown, known, ..., learned)
2. State of current section (ready, not ready, nothing new)
3. States of sections behind the links (as above + visited)
QuizGuide: Dual Annotations

Question 1

main()
{
    int i = 0;
    if (i % 2)
        i += 2;
    else
        i++;
}

What is the final value of i

i = ___

Submit
Annotations in CourseAgent
User Modeling in Classic AH

• Classic AH use external models
  – Domain models, pedagogical modes, stereotype hierarchy, etc.
• Users are modeled in relation to these models
  – User is field-independent
  – User knowledge of loops is high
  – User is interested in 19th century architecture styles
• Resources are connected (indexed) with elements of these models (aka knowledge behind pages)
  – This section presents while loop and increment
  – This page is for field-independent learners
  – This church is built in 1876
Domain Model

![Diagram showing relationships between Concepts 1, 2, 3, 4, and N.]

- Concept 1
- Concept 2
- Concept 3
- Concept 4
- Concept N
- Concept 5
Indexing of Nodes

External (domain) model

Concept 1
Concept 2
Concept 3

Concept 4
Concept m

Hyperspace
Indexing of Fragments

Concepts

Concept 1
Concept 2
Concept 3
Concept 4
Concept N

Node

Fragment 1
Fragment K
Concept-Level User Model
AH: Evaluation Data

• Adaptive presentation makes user to understand the content faster and better

• Adaptive navigation support reduces navigation efforts and allows the users to get to the right place at the right time

• Altogether AH techniques can significantly improve the effectiveness of hypertext and hypermedia systems
Recommender Systems

• “Native” adaptive information access approach
• How we can model the user in recommender systems?
• Which adaptation technologies can be applied?
Recommender Systems

• Started as extension of work on adaptive information filtering
• What is filtering? Search without explicit query
• Started as SDI – user provided profiles
• Later considered user feedback (yes/no or ratings) to automatically improve profile
• Modern IF can start without profile, constructing it by observation and user feedback
  – Rating, bookmarking, downloading, purchasing
Example: Syskill and Webert
Log in or sign up and we’ll suggest some shows and movies we think you’ll enjoy.

Top Recommendations

- **Mexican Made Easy**: Recommended because it’s highly rated by other Hulu users.
- **The Cisco Kid**: Recommended because it’s highly rated by other Hulu users.
- **House Hunters**: Recommended because it’s highly rated by other Hulu users.
- **Alfred Hitchcock Hour**: Recommended because it’s highly rated by other Hulu users.

Top Recommendations

- **Diners, Drive-ins and Dives**: Recommended because you recently watched The Best Thing I Ever Ate.
- **Chopped**: Recommended because you recently watched The Best Thing I Ever Ate.
- **The Simpsons**: Recommended because you recently watched American Dad!
- **The Cleveland Show**: Recommended because you recently watched American Dad!

Are you interested?

- **Yes**
- **No**

I’ve seen it

- **Yes**
- **No**
Recommender Technologies

- Classic content-based recommendation
  - Content-based user profile
- Collaborative recommender systems
  - Started with proactive push and pull systems, but merged the “filtering” movement
  - User profile as rating history
- Rule-based (purchasing printer)
- Case-based
  - Metadata-based user profile
- Demographic
  - User demographic data
Web Personalization 2000

Adaptive Hypermedia

- Explicit domain model
- Concept-level user model
- Manual indexing
- Use “classic” AI
- Use many adaptation techniques
- Reliable adaptation
- Adapt to many user factors

Adaptive IR/IF

- No domain model
- Keyword-level user model
- No manual indexing
- Adapt to user interests
- Use ranked list of links/docs
- Use “modern” AI

HCI / HT

AI / IR
Access Type vs. Engine

- Recommendation is a type of information access – proactive ranked suggestion based on user data and observing behavior
- Engine behind decides to what extent information is relevant (answers goals, interests, knowledge)
- Types of engines:
  - Classic content based (keywords, same as IR)
  - Medatada-based (still content!)
  - Collaborative
  - Hybrid
A Look under the Hood

Types of information access

Navigation
Adaptive Hypermedia

Search
Adaptive IR

Recommendation
Web Recommenders

Various Adaptation Mechanisms:
- Metadata-based mechanism
- Keyword-based mechanism
- Community-based mechanism
Personalized Information Access

2012

Adaptive Hypermedia

Search

Adaptive IR

Recommendation

Web Recommenders

Metadata-based mechanism

Keyword-based mechanism

Community-based mechanism

Adaptation Mechanisms
Personalized Information Access

- No Manual indexing
- Use ML and log mining
- Extensive use of BN
- Adapt to many user factors
- Use many adaptation techniques

Open Corpus

Adaptive Hypermedia

Adaptive IR/IF

Web Recommenders

- No manual indexing
- Explicit or derived domain ontology
- Concept-level user model
- Adapt to more than just interests

Ontology-based

2012
Personalized Information Access: Integrated Prospect

- Adaptive Hypermedia
- Adaptive Info Vis
- Adaptive IR/IF
- Web Recommenders

- With and without domain models
- Keyword- and concept-based UM
- Use of any AI techniques that fit
- Use many forms of information access
- Use a range of adaptation techniques
- Adapt to more than just interests
Why Integrated Prospect?

• Use larger variety of user models
• Use larger variety of user modeling techniques
  – Even for the same kind of models
• Use larger variety of information access techniques and adaptation techniques
  – Especially for the same kind of models
  – About 90% of user information needs are not solved by classic search-based access
What will we learn?

Document Modeling  User Modeling

Adaptive Information Access Technologies
How to implement adaptive information access: interfaces and engines

Special Topics
Personalized Information Access

• Adaptive search
• Adaptive filtering (recommendation)
  – Content-based
  – Collaborative
  – Hybrid
• Adaptive navigation support
• Adaptive presentation
Special Topics

• Some special kinds of personalization
  – Mobile, 3D, collaborative work
• Personalization in special domain
  – Cultural heritage, education
• Cross-cutting issues and challenges
  – Privacy, evaluation, group-level personalization
Mobile Personalization

- Mobile platform emerges as a leader
- New personalization approaches
  - Taking into account location/time/other context
  - Sensors and affective computing
  - Adapting to screen, power, bandwidth
- Mobile personalized systems
  - News and entertainment recommender
  - Location-based recommenders
  - Adaptive mobile guides