INFSCI 2480
Adaptive Web Systems
User Models for
Adaptive Hypermedia and
Adaptive Educational Systems
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Adaptive systems

Data about user

User Modeling

System

User Model

Adaptation

Adaptation effect

Classic loop user modeling - adaptation in adaptive systems
Intelligent vs. Adaptive

1. Intelligent but not adaptive (no user model!)
2. Adaptive but not really intelligent
3. Intelligent and adaptive

3 Dimensions of User Models

- What is being modeled (nature)
- How this information is represented (structure)
- How the models are constructed and maintained

How to Model User Knowledge

• Scalar model
  – The user knowledge level is modeled as one value
  – Example: MetaDoc, CAT

• Structural model
  – What kind of knowledge?
    • Declarative, procedural, episodic
  – How it relates to expert knowledge?
    • Overlay model -> Bug mode -> Genetic model

Overlay Model of Knowledge

• Domain model
  – The whole body of domain knowledge is decomposed into set of smaller knowledge units
  – A set of concepts, topics, etc

• User knowledge model (aka student model)
  – Overlay of the Domain model
  – Student knowledge is measured independently for each knowledge unit
Vector vs. Network Domain Models

- Vector - no relationships
- Precedence (prerequisite) relationship
- is-a, part-of, analogy
  - Wescourt et al, 1977
- Genetic relationships
  - Goldstein, 1979

Vector model
Network model

Simple overlay model
Simple overlay model

Weighted overlay model
Student Modeling Approaches

- Ad Hoc (1-100)
- Heuristic and rule-based (qualitative)
- Simple statistical (Bush, Atkinson)
- Probabilistic and Bayesian (BN, D-S…)
- Fuzzy
- Neural networks
- Combine approaches and layered models

How to do Course Sequencing

- Needs a Domain Model
- Uses classic or weighted overlay model
- Needs indexing of learning material with domain model
- May also need a learning goal (also based on domain model)
Indexing teaching material

• Types of indexing
  – One concept per ULM
  – Indexing of ULMs with concepts

• How to get the ULMs indexed?
  – Manual indexing (closed corpus)
  – Computer indexing (open corpus)

Simple case: one concept per learning activity

• Random selection if there are no links - Scholar
• Links can be used to restrict the order
Indexing content with concepts

Simple goal model

- Learning goal as a set of topics
More complicated models

• Sequence, stack, tree

Sequencing with models

• Given the state of UM and the current goal pick up the best topic or ULM within a subset of relevant ones (defined by links)
• Special cases with multi-topic indexing and several kinds of ULM
• Applying explicit pedagogical strategy to sequencing
Maintaining Overlay Models

- Adaptive educational systems use problems, questions, and other evaluation activities to model student knowledge.
- If a page is read, an example is browsed, or a problem is solved, knowledge of all involved concepts increases (example: jWADEN).
  - Links could be used to propagate knowledge.
- If problem is not solved, the system needs to allocate “blame” for involved concepts.
  - Links could be helpful to avoid noise.

Models in SIETTE
Models for interactive problem-solving support and diagnosis

- Domain model
  - Concept model (same as for sequencing)
  - Bug model
  - Constraint model
- Student model
  - Generalized overlay model (works with bug model and constraint model too)
- Teaching material - feedback messages for bugs/constraints

Bug models

- Each concept/skill has a set of associated bugs/misconceptions and sub-optimal skills
- There are help/hint/remediation messages for bugs
Do we need bug models?

• Lots of works on bug models in the between 1974-1985
• Bugs has limited applicability
  – Problem solving feedback only. Sequencing does not take bugs into account: whatever misconceptions the student has - effectively we only can re-teach the same material
  – Short-term model: once corrected should disappear, so not necessary to keep

Constraint Model: SQL-Tutor

• Domain model: Set of constraints (procedural, evaluation knowledge); Student model: Bug model
Models for example-based problem solving support

• Need to represent problem-solving cases

• Episodic learner model
  – Every solution is decomposed on smaller components, but not concepts!
  – Keeping track what components were used and when - not an overlay!

• ELM-PE and ELM-ART - only systems that use this model

ADAPTS - an adaptive IETM
What’s in adaptive content?

ADAPTS dynamically assembles custom-selected content.

Domain model example

<table>
<thead>
<tr>
<th>CONCEPT</th>
<th>Principles of Operation</th>
<th>Removal Instructions</th>
<th>Testing Instructions</th>
<th>Illustrated Parts Breakdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reeling Machine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sonar Data Computer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sonar System</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
User model

- Characterizes user ability at each element of the domain model
  - Size of model is bounded by domain
  - Weights on different types of elements account for learning styles and preferences
  - Can be time sensitive
- Constrains the diagnostic strategy
Adaptive content selection

• Information is custom-selected for a user
  – Level of detail offered depends upon who the user is (i.e., his level of expertise)
  – Selected at a highly granular level, e.g., for each step within a procedure
• Performance-oriented training is presented as part of content
Interest Modeling

- User interests are typically modeled by overlay models as well
- Keyword model of user interests (profile)
  - Keyword overlay
- Concept model of user interests
  - Concept overlay

Domain Models

- A domain model is required for interest modeling
  - Traditional domain model for interest modeling in educational context
  - A taxonomy of interest areas for non-educational areas

Example:
Domain model for adaptive News system
Overlay Model of Interests

- For each domain concept or taxon an overlay model stores estimated level of interest

![Diagram of Overlay Model of Interests](image)

Ontological Interest Modeling

- Interests are deduced from the content of “interesting documents”

![Diagram of Ontological Interest Modeling](image)

Spreading Activation

• Spreading activation over the model may be used for more reliable modeling and to deal with sparsity


Overlay model + indexing

• Indexing nodes with concepts
  – InterBook, ELM-ART, ISIS-Tutor, AHA
• Indexing anchors with concepts
  – StrathTutor
• Indexing fragments with concepts
  – MetaDoc, AHA, PT
• Nodes are concepts
  – InterBook, ELM-ART, ISIS-Tutor
Overlay model + indexing

- Indexing nodes with concepts
  - InterBook, ELM-ART, ISIS-Tutor, AHA
- Indexing anchors with concepts
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Generalized overlay model

- Knowledge
  - overlay for set of concepts, network of concepts
- Goals
  - overlay for set of possible goals, tree of goals
- Stereotypes
  - overlay for set of stereotypes
Indexing with generalized model

• fragments are indexed with goals
  – PUSH
• nodes are indexed with user’s tasks
  – HYNECOSUM:
• nodes are indexed with stereotypes
  – EPIAIM, Anatom-Tutor, C-Book
• goals are nodes
  – HYPERFLEX