From Adaptive Educational Hypermedia to Adaptive Information Access

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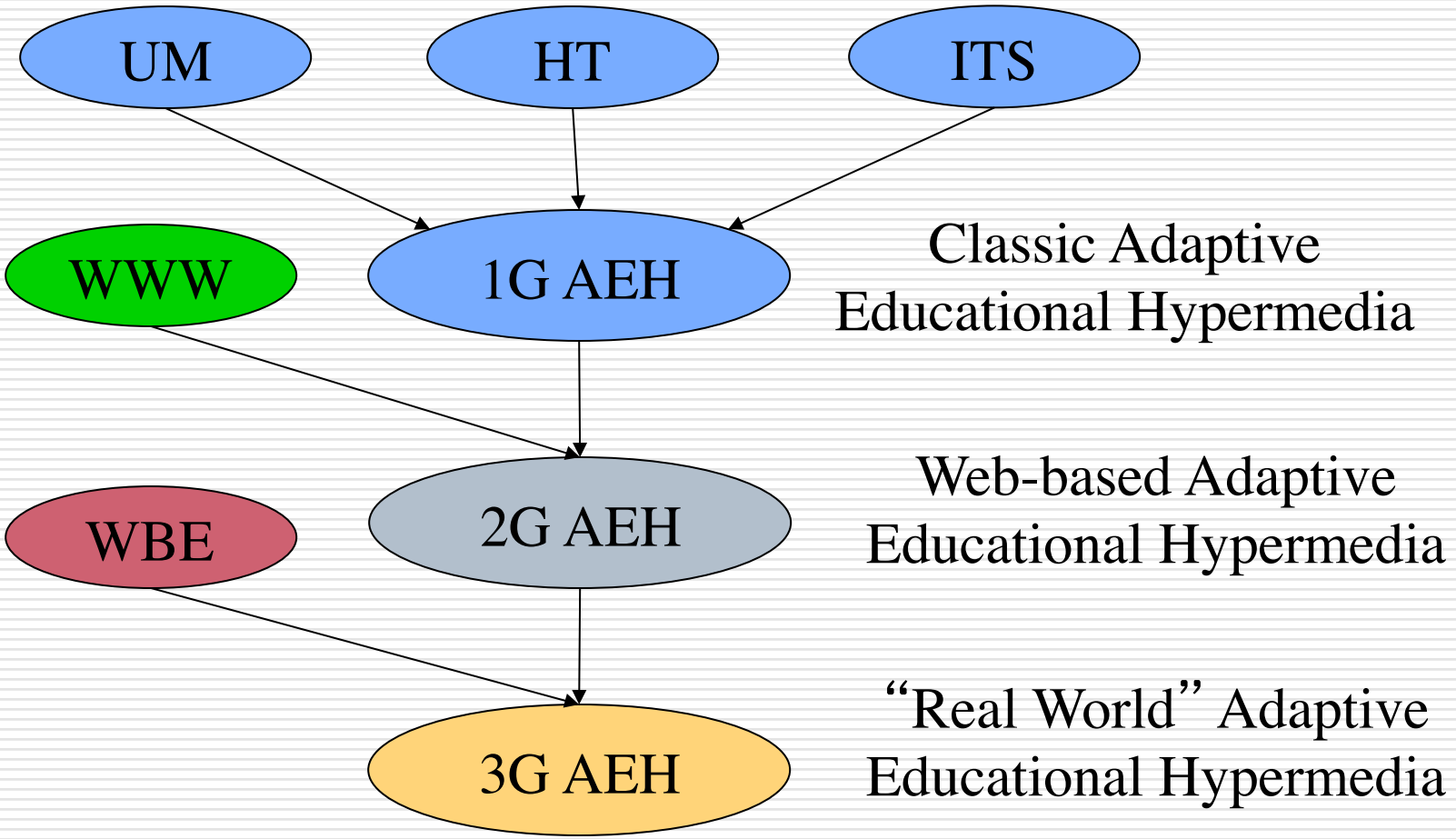
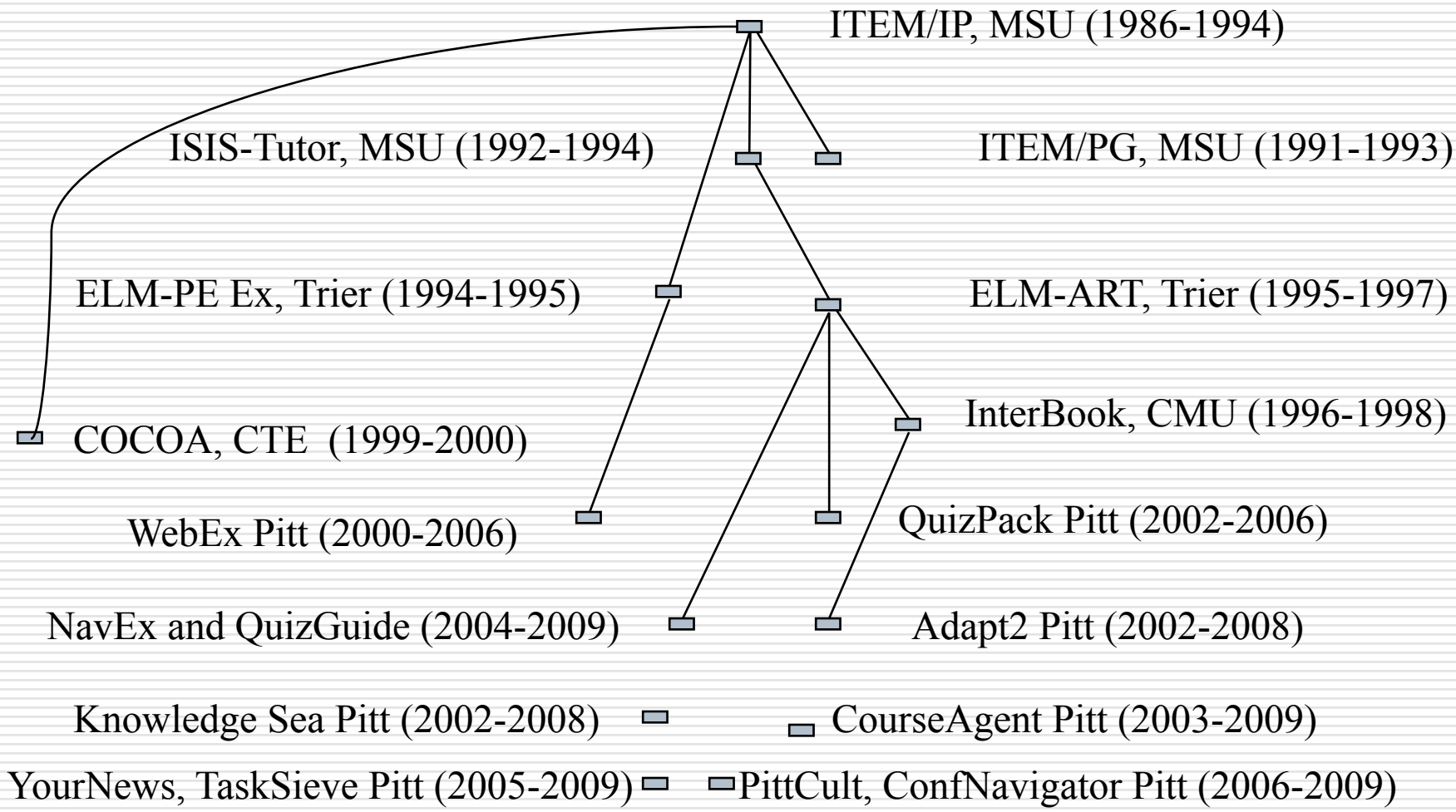
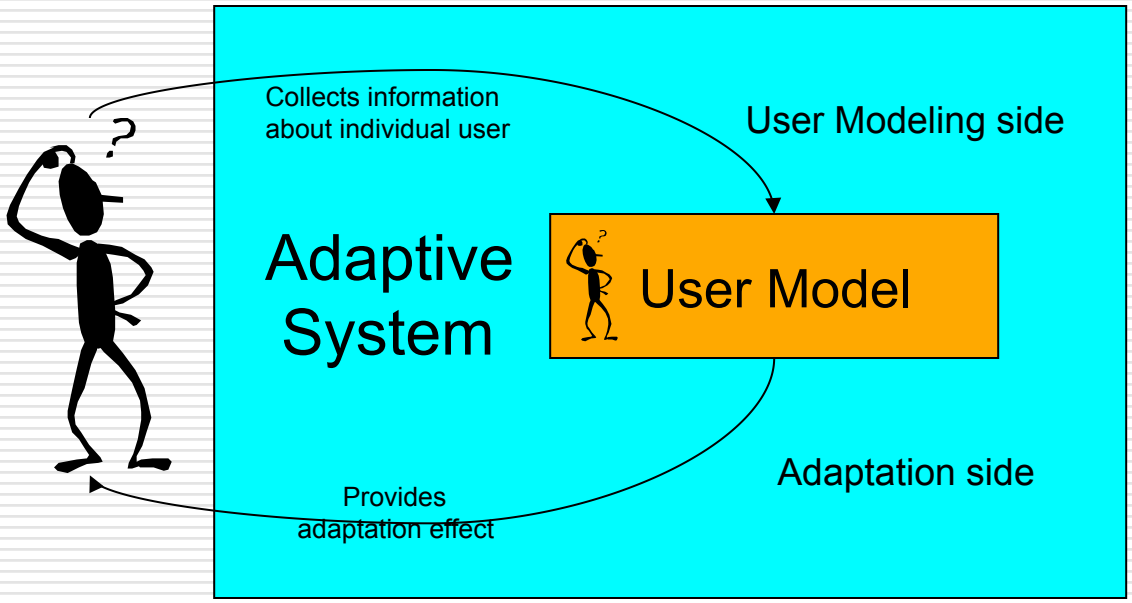
From Generation to Generation



Personal View

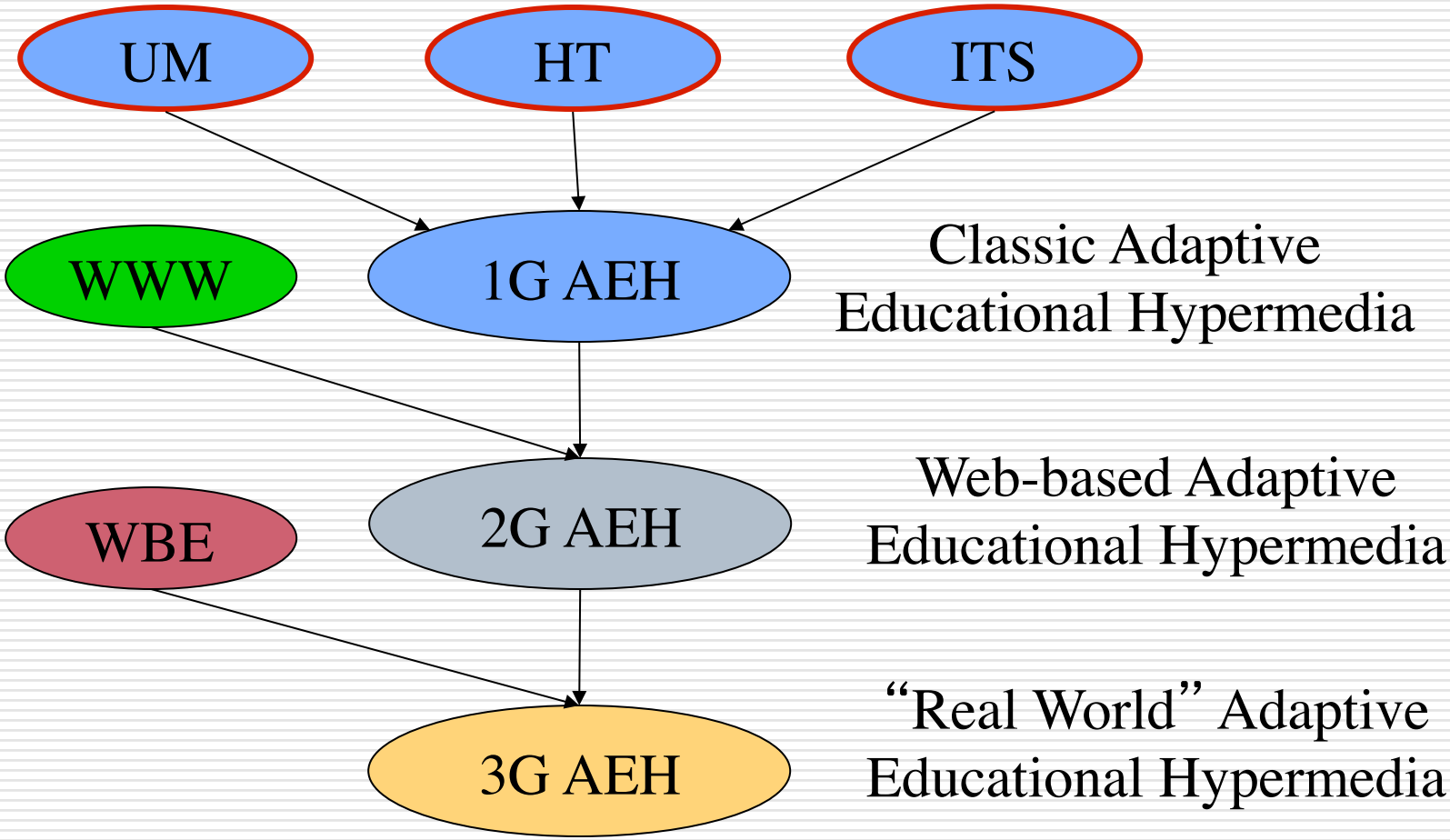


Adaptive systems

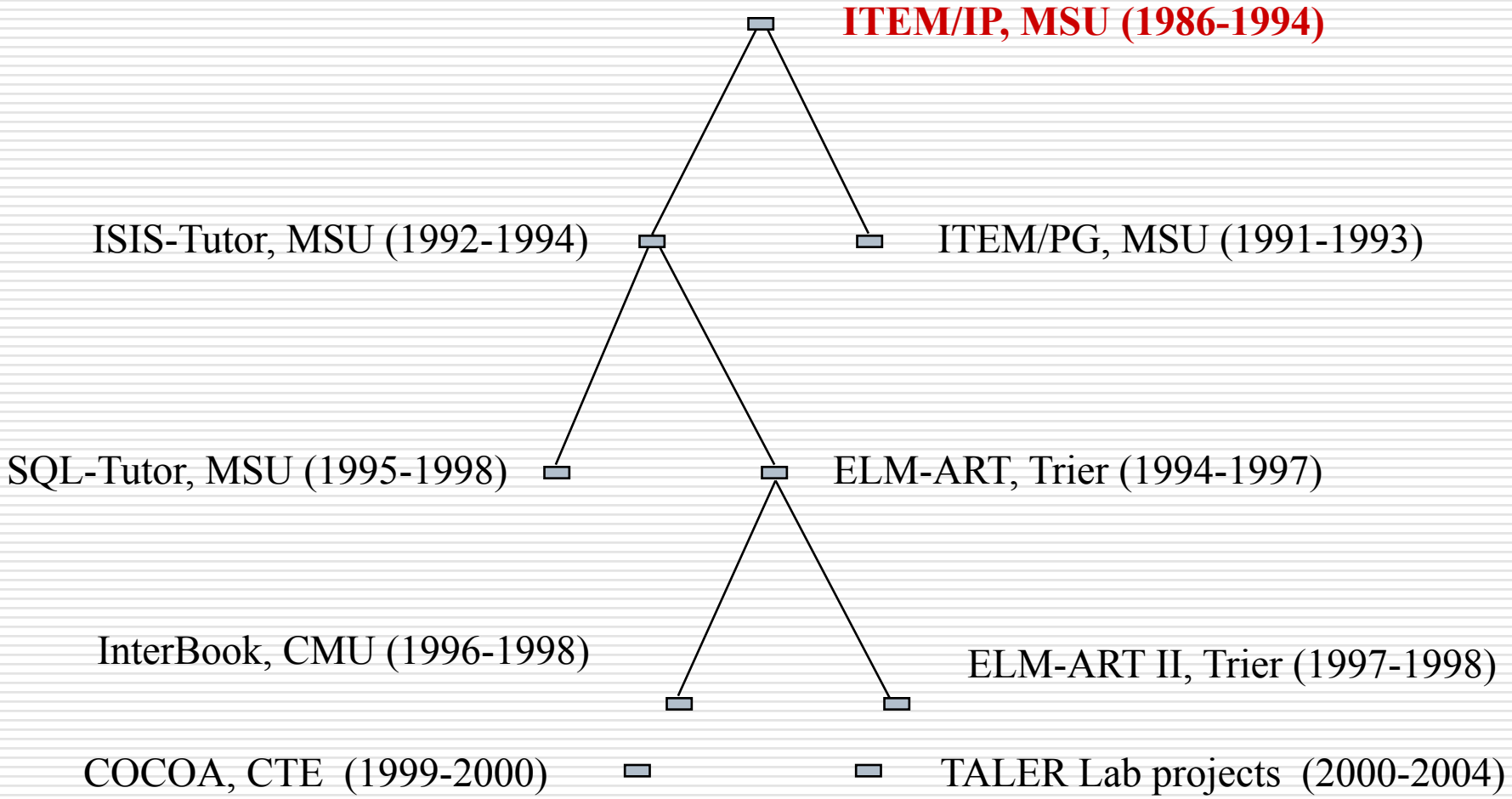


Classic loop “user modeling - adaptation” in adaptive systems

Generation 0



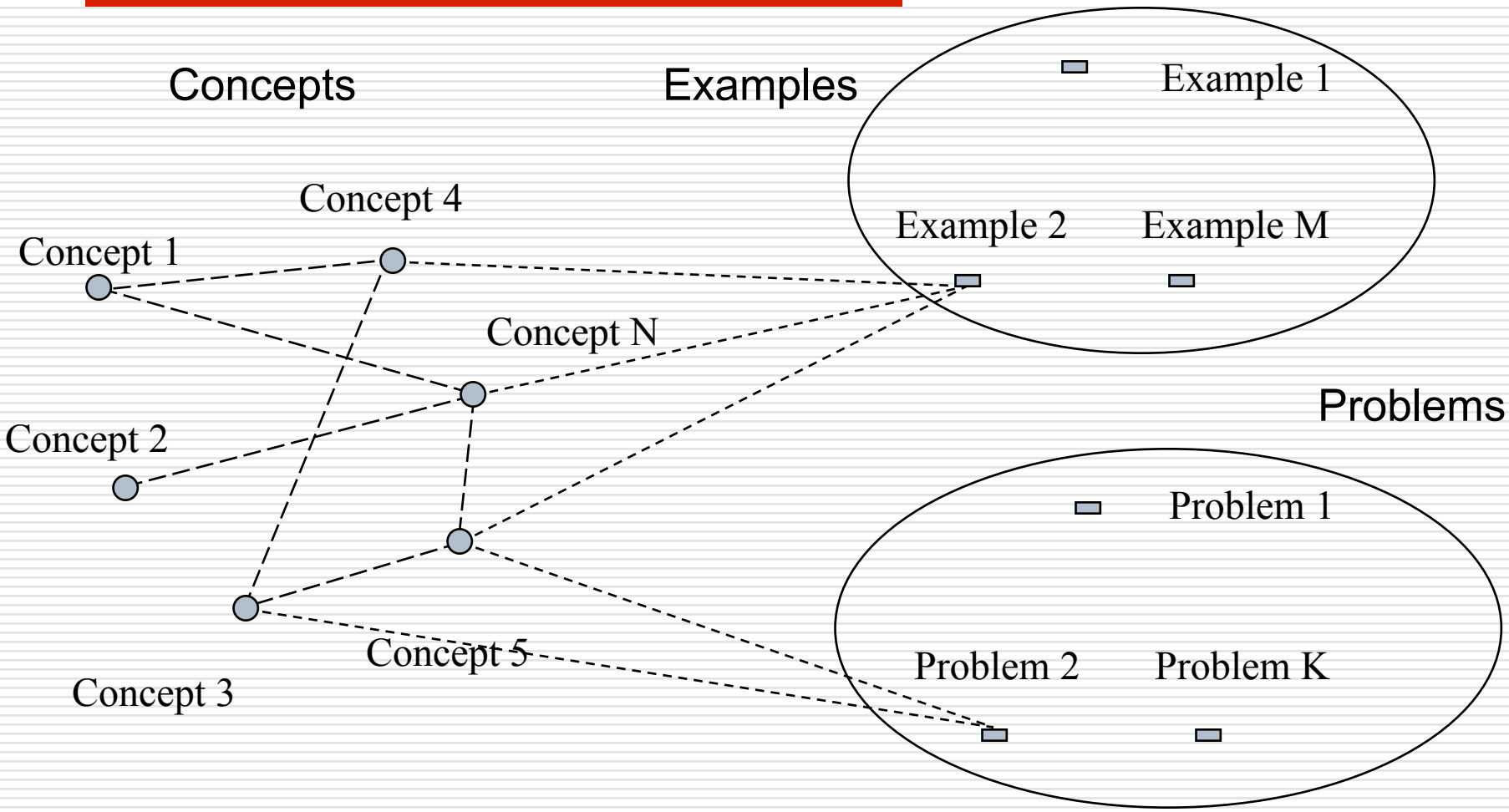
Personal View: Generation 0



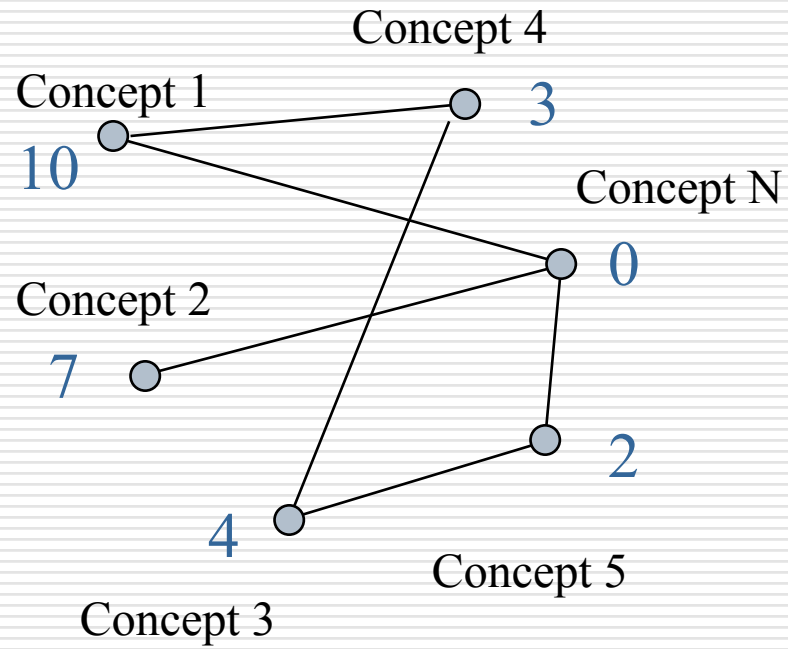
ITEM/IP

- ILE for Introductory Programming
- Integrated system
  - Tutorial (presentation of optimal sequence of explanations, examples and problems)
  - Environment (playing with examples, design and debug problem solutions)
  - Manual (a manual for reference-style access to studied information, examples, solved problems)

Knowledge and learning material

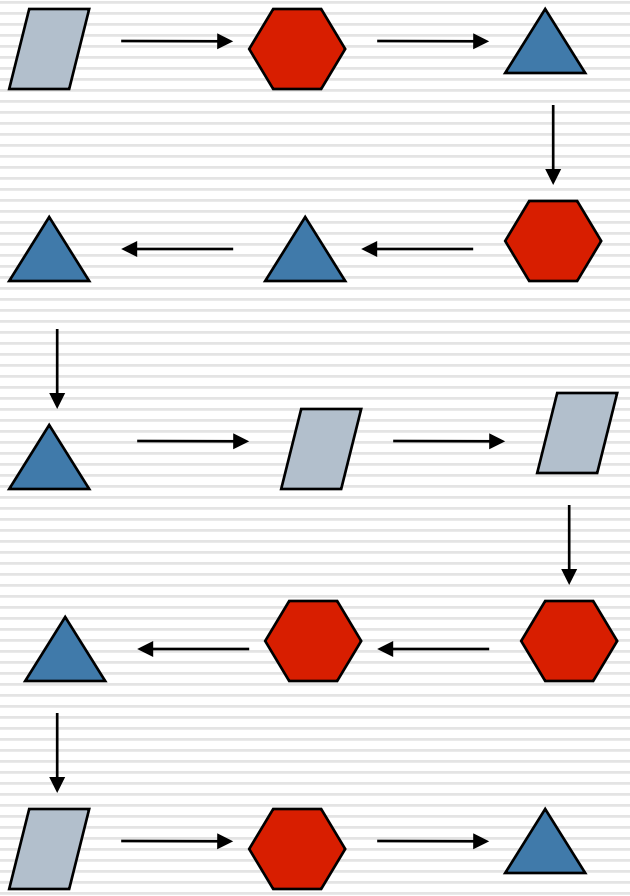


Weighted overlay model



Course Sequencing

- Oldest ITS technology
  - SCHOLAR, BIP, GCAI...
- Goal: individualized "best" sequence of educational activities
- ITEM/IP: multi-type
  - information to read
  - examples to explore
  - problems to solve ...

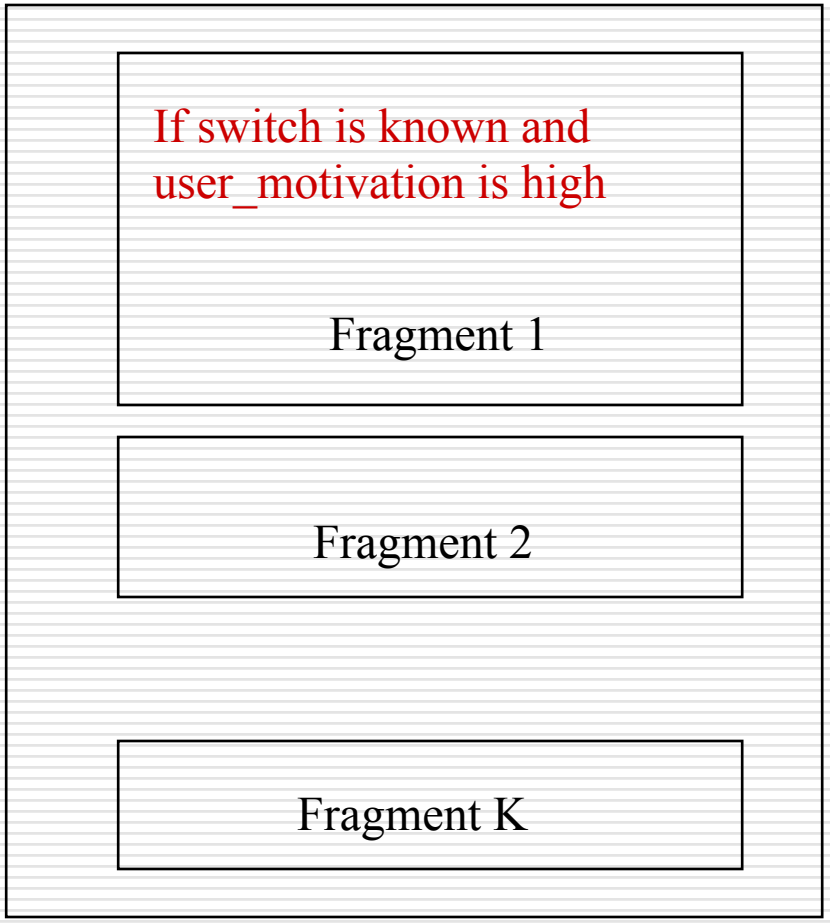


Adaptive presentation

- Goal: make the same “page” suitable for students with different knowledge
  - beginners (in tutorial mode)
  - advanced (in manual mode)
  - smooth transition
- Methods to achieve the goals
  - comparisons of several concepts
  - extra explanations for beginners
  - more complete information for advanced

Conditional text filtering

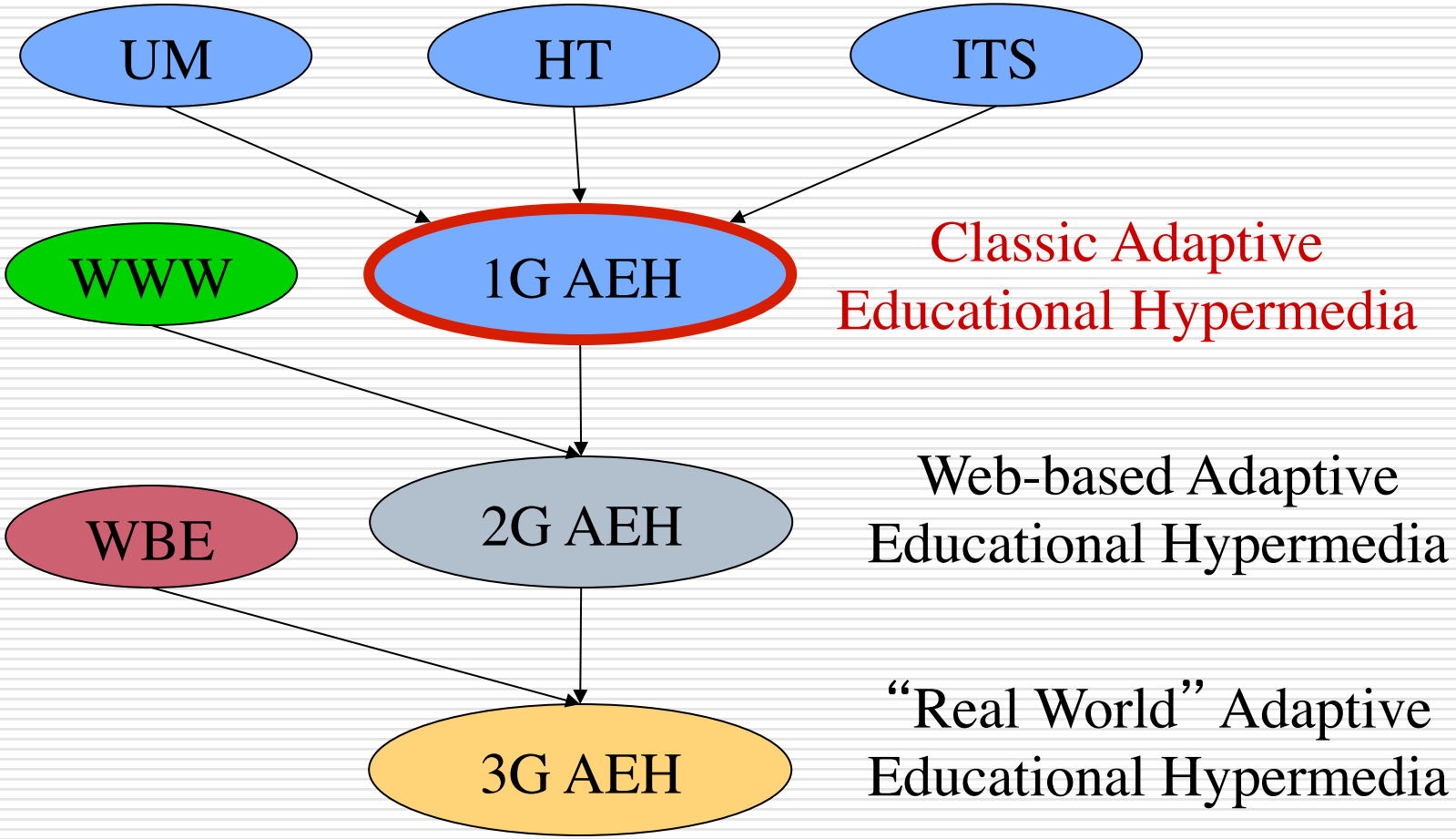
- Similar to UNIX cpp
- Universal technology
  - Altering fragments
  - Extra explanation
  - Extra details
  - Comparisons
- Low level technology
  - Text programming



Problems

- A category of students wanted to make the choice of next thing to do themselves
- Combining guidance and freedom?
- Added menu-based access to new material
- Two information spaces with separate access…
  - Explored material (past)
  - New material (future)
- And in 1991 we have found hypertext…

Generation 1



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?

- Hypermedia = Pages + Links
- Adaptive presentation
  - content adaptation
- Adaptive navigation support
  - link adaptation

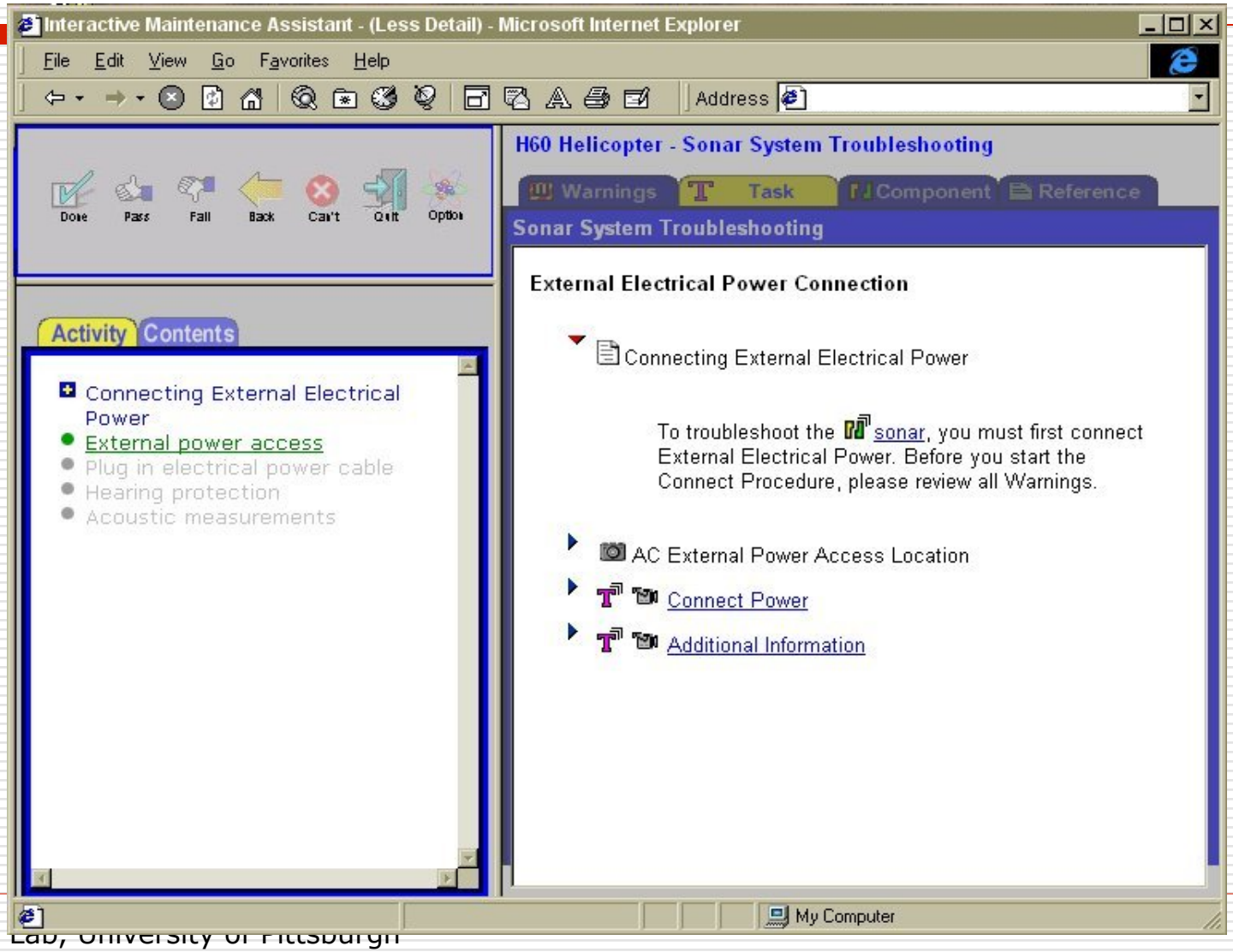
Adaptive Presentation: Goals

- Provide the different content for users with different knowledge, goals, background
- Provide additional material for some categories of users
  - comparisons
  - extra explanations
  - details
- Remove irrelevant piece of content
- Sort fragments - most relevant first

Adaptive Presentation Techniques

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

Example: Stretchtext (ADAPTS)



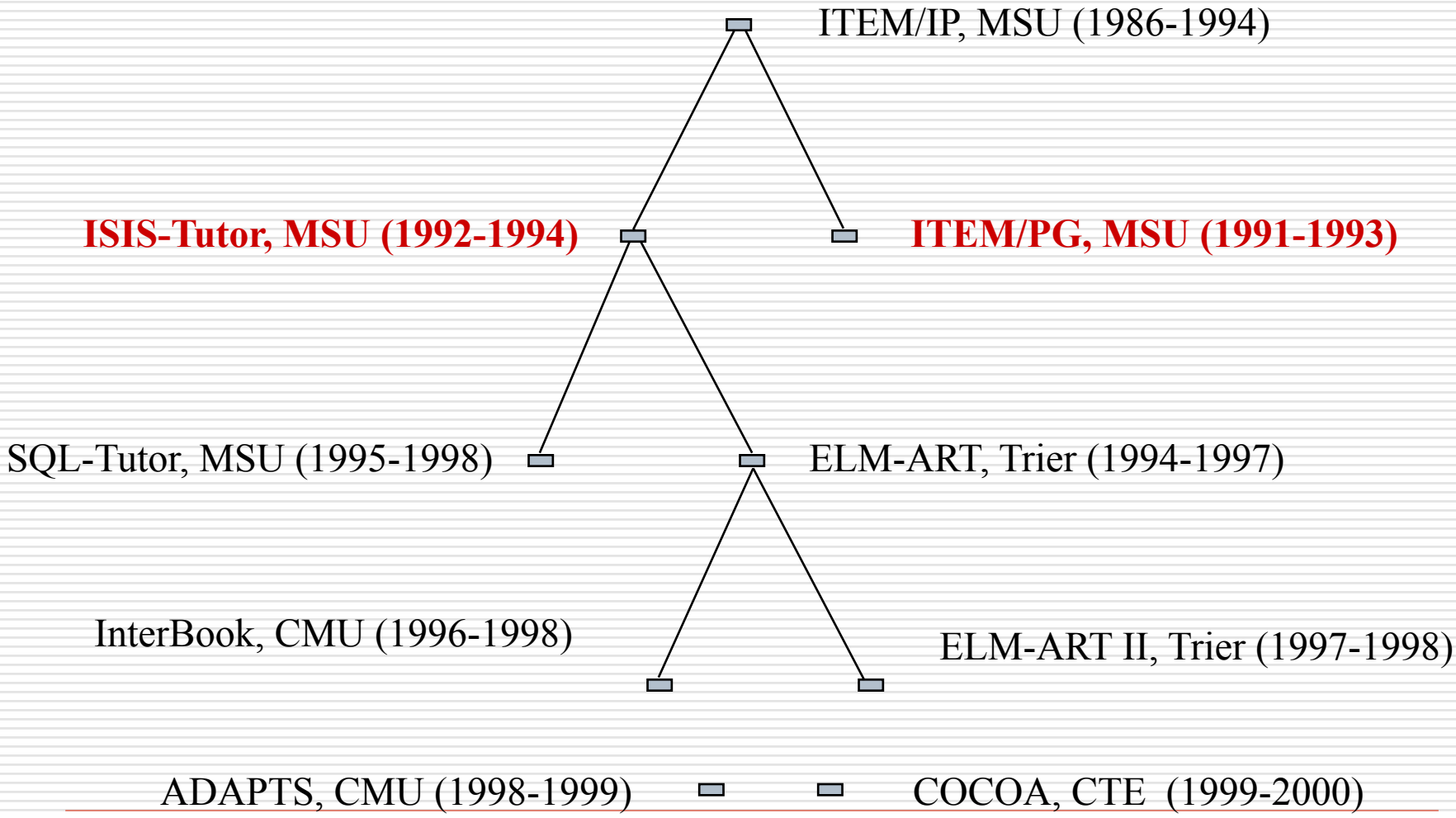
Adaptive Presentation: Evaluation

- MetaDoc: On-line documentation system, adapting to user knowledge on the subject
- Reading comprehension time decreased
- Understanding increased for novices
- No effect for navigation time, number of nodes visited, number of operations

Adaptive Navigation Support: Techniques

- Direct guidance
- Restricting access
  - Removing, disabling, hiding
- Sorting
- Annotation
- Generation
  - Similarity-based, interest-based
- Map adaptation techniques

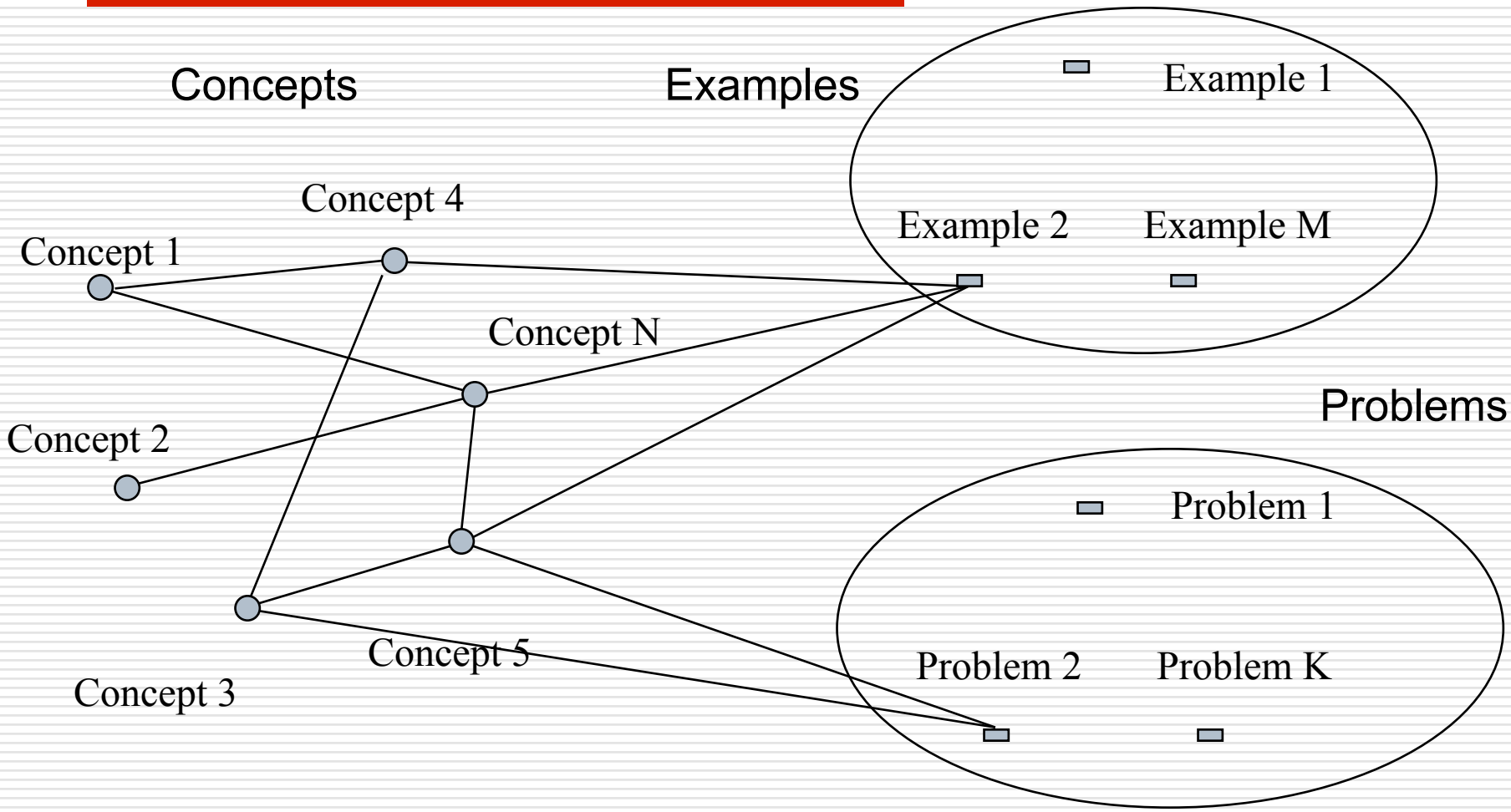
Personal View: Generation 1



ISIS-Tutor: ILE + hypertext

- An adaptive tutorial for CDS/ISIS/M users
- Domain knowledge: concepts and constructs
- Hypertext - a way to access learning material:
  - Description of concepts and constructs
  - Examples and problems indexed with concepts (could be used in an *exploratory environment*)
- Educational status of explanations, examples and problems is shown with link annotation

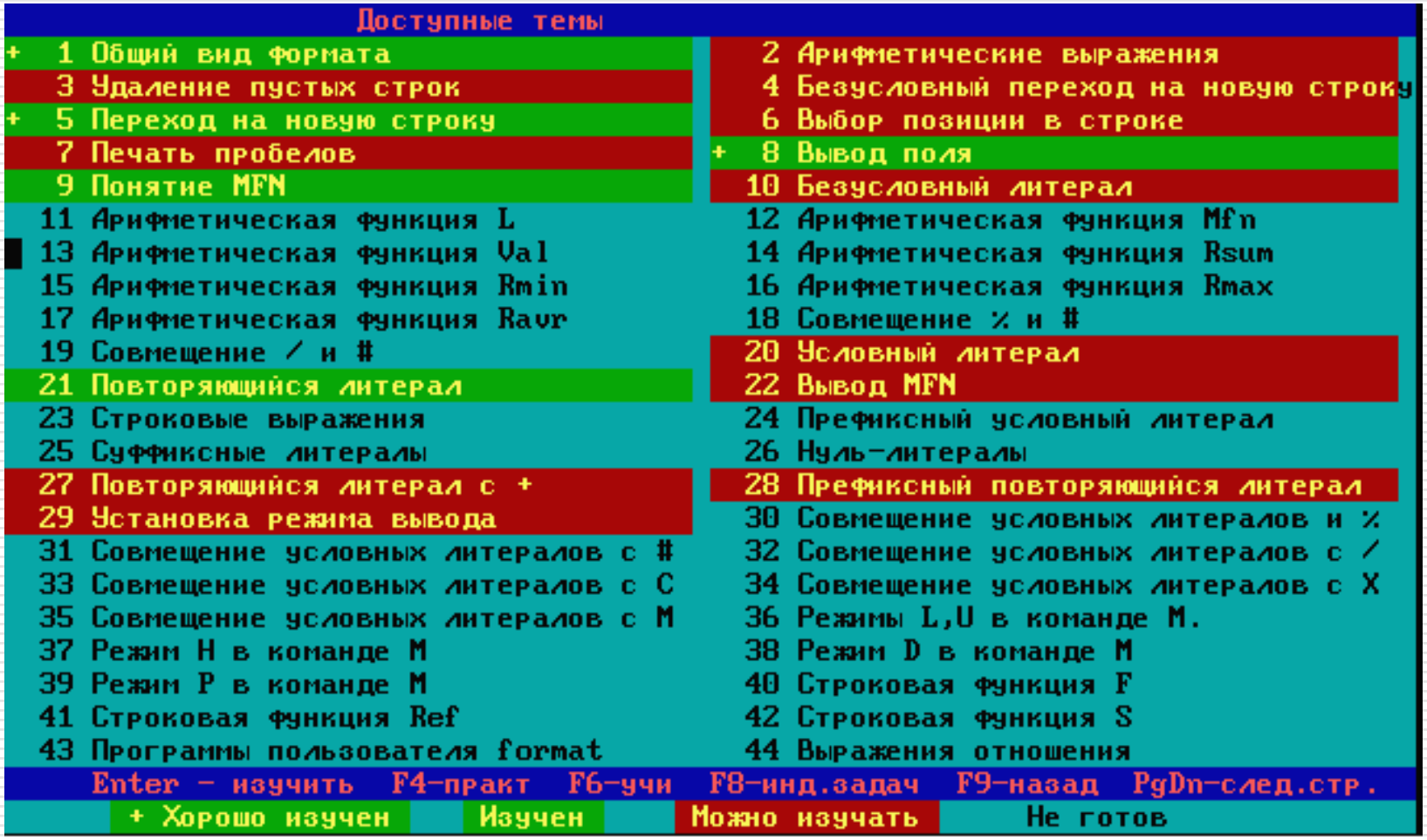
Knowledge and learning material



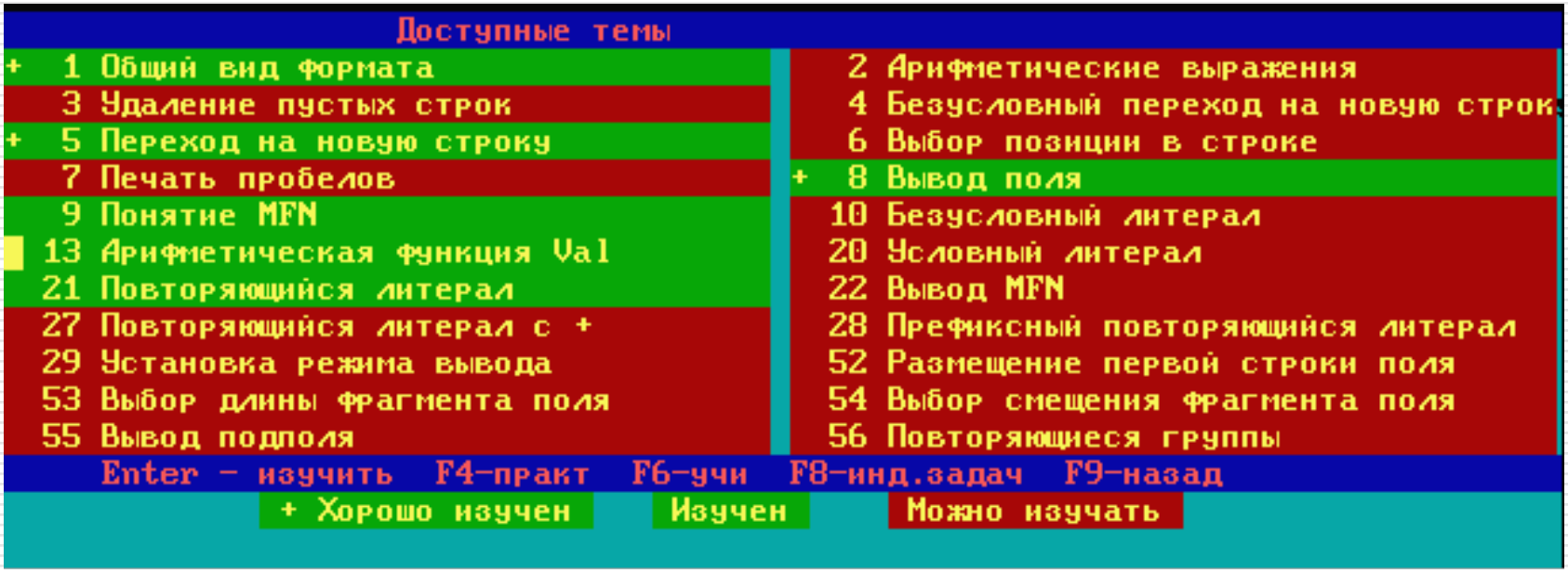
Student modeling and adaptation

- States for concepts:
  - not ready (may be hidden)
  - ready (red)
  - known (green)
  - learned (green and '+')
- State for problems/examples:
  - not ready (may be hidden)
  - ready (red)
  - solved (green and '+')

Sample index page (annotation)



Sample index page (annotation and hiding)



ISIS-Tutor: Evaluation

- 26 first year CS students of MSU
- 3 groups:
  - control (no adaptation)
  - adaptive annotation
  - adaptive annotation + hiding
- Goal: 10 concepts (of 64), 10 problems, all examples

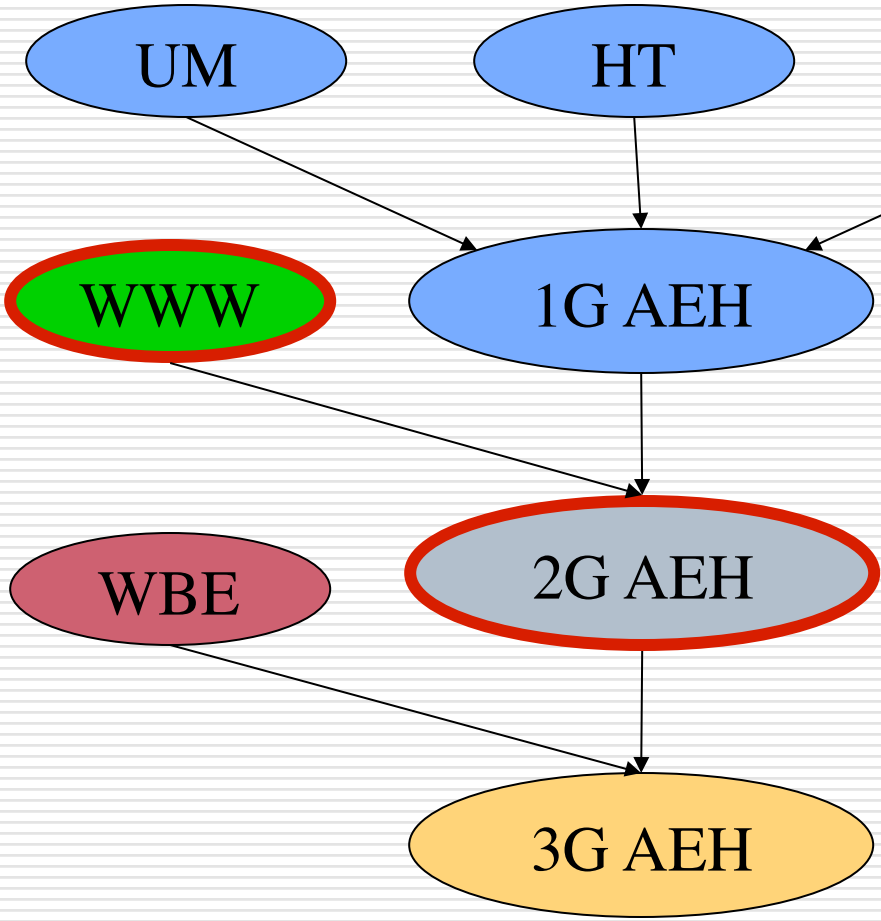
ISIS-Tutor: Evaluation Results

- The students are able to achieve the same educational goal almost twice as faster
- The number of node visits (navigation overhead) decreased twice
- The number of attempts per problem to be solved decreased almost 4 times (from 7.7 to 1.4-1.8)

Similar works 1991-1994

- γπAdaptερ (Hohl, Böker, Gunzenhauser, 1991)
  - Sorting page fragments and links by relevance
- Manuel Excel (de La Passardiere, Dufresne, 1992)
  - Adaptive link annotation with icons
- ANATOM-Tutor (Beaumont, 1994)
  - Adaptive presentation, hypertext + ITS
- MetaDoc (Boyle, Encarnacion, 1994)
  - Adaptive stretchtext

Generation 2



Classic Adaptive Educational Hypermedia

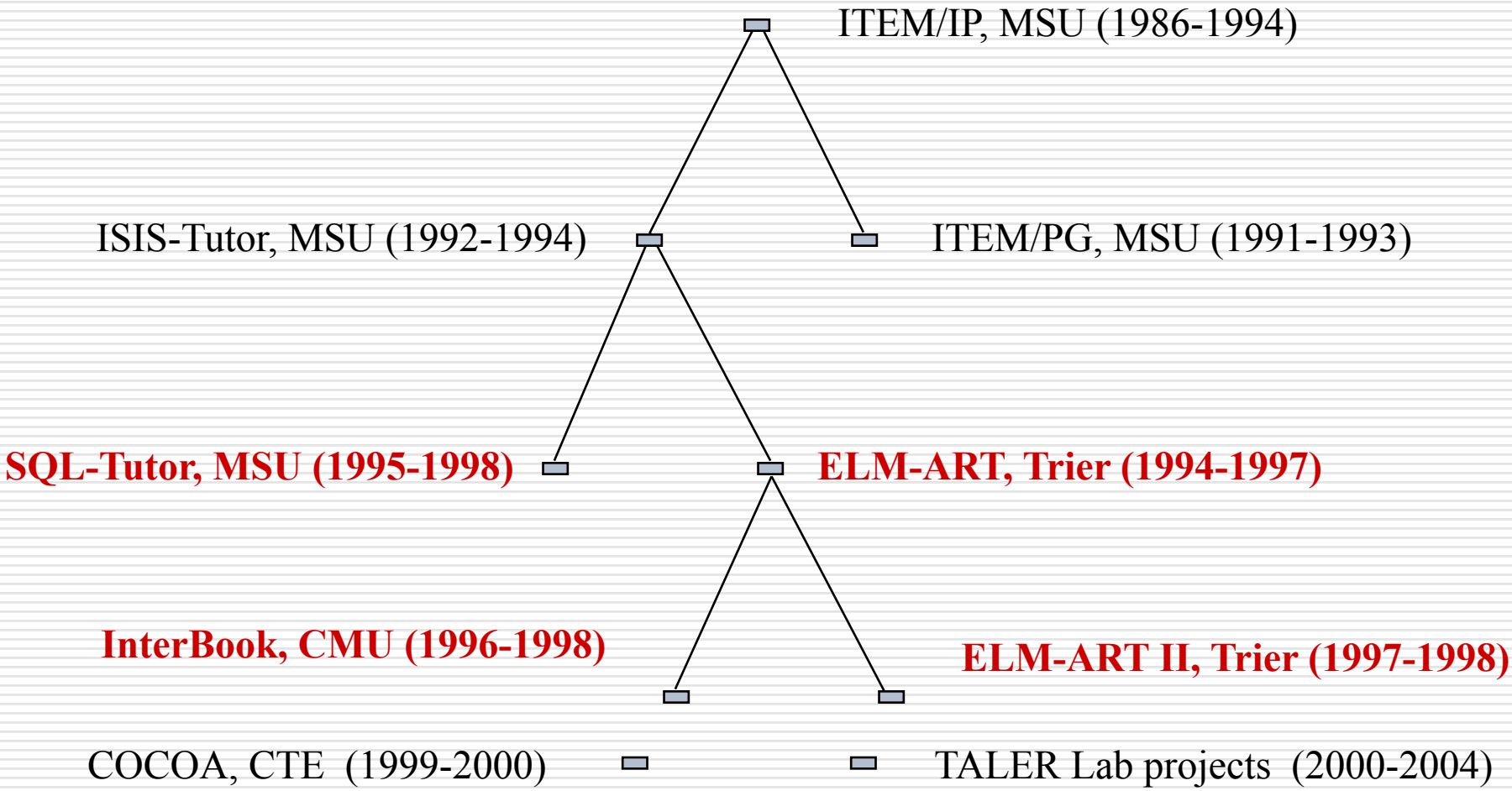
Web-based Adaptive Educational Hypermedia

"Real World" Adaptive Educational Hypermedia

Generation 2 vs Generation 1

- Generation 1 systems:
  - Research oriented
  - Traditional hypertext/hypermedia
  - Developed independently
- Generation 2 systems
  - Practically oriented
  - Web-based hypermedia
  - Influenced by earlier research
  - Less value on evaluation

Personal View: Generation 2



ELM-ART: Lisp ITS on WWW

- ELM-ART:
  - ELM-PE (ILE with problem solving support)
  - Adaptive Hypermedia (all educational material)
- Model: adaptive electronic textbook
  - tests
  - examples
  - problems

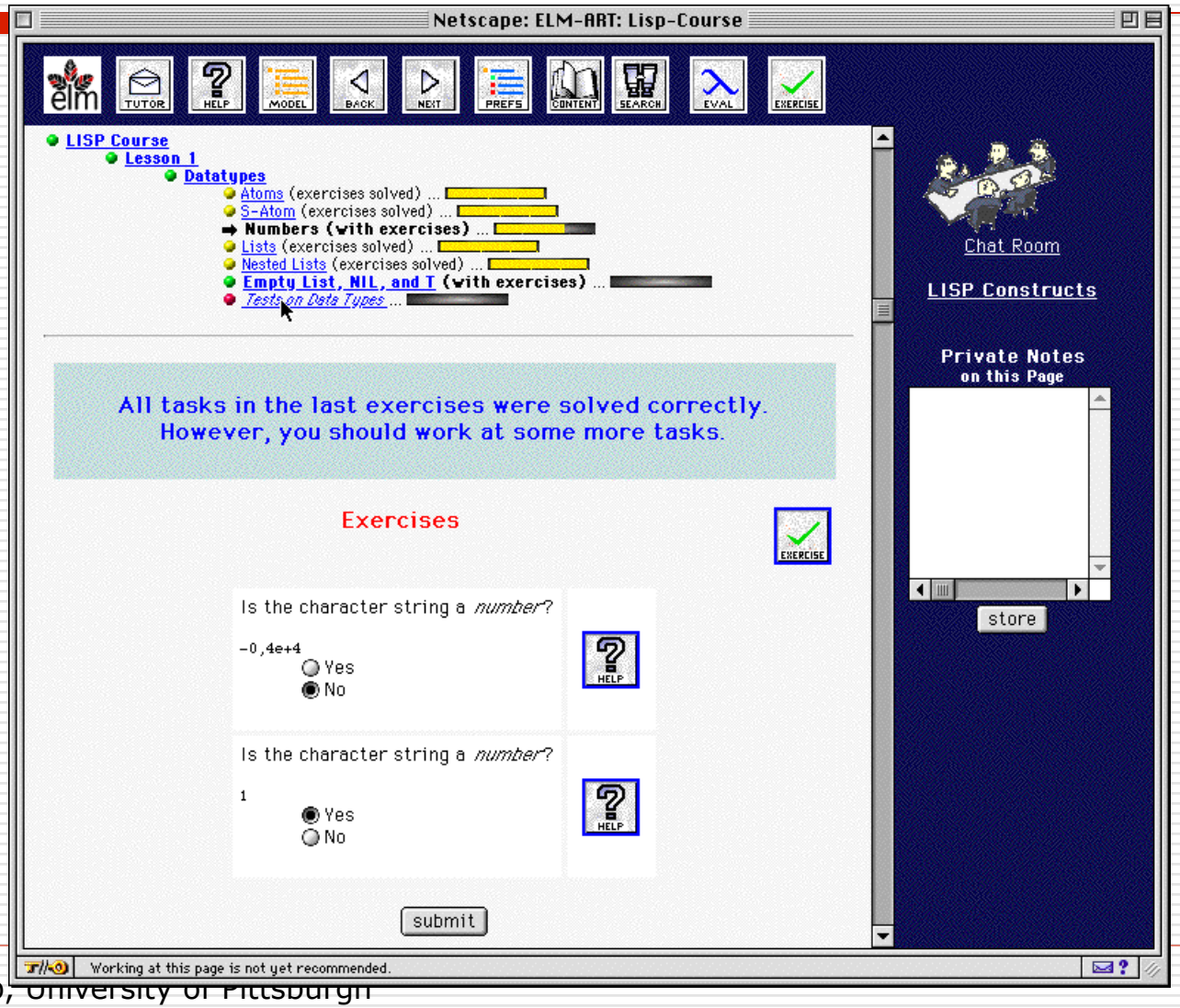
Knowledge representation

- Domain knowledge
  - conceptual network for Lisp
  - problem solving plans
  - debugging knowledge
- Student model
  - Overlay model for Lisp concepts
  - Episodic model for problem-solving knowledge

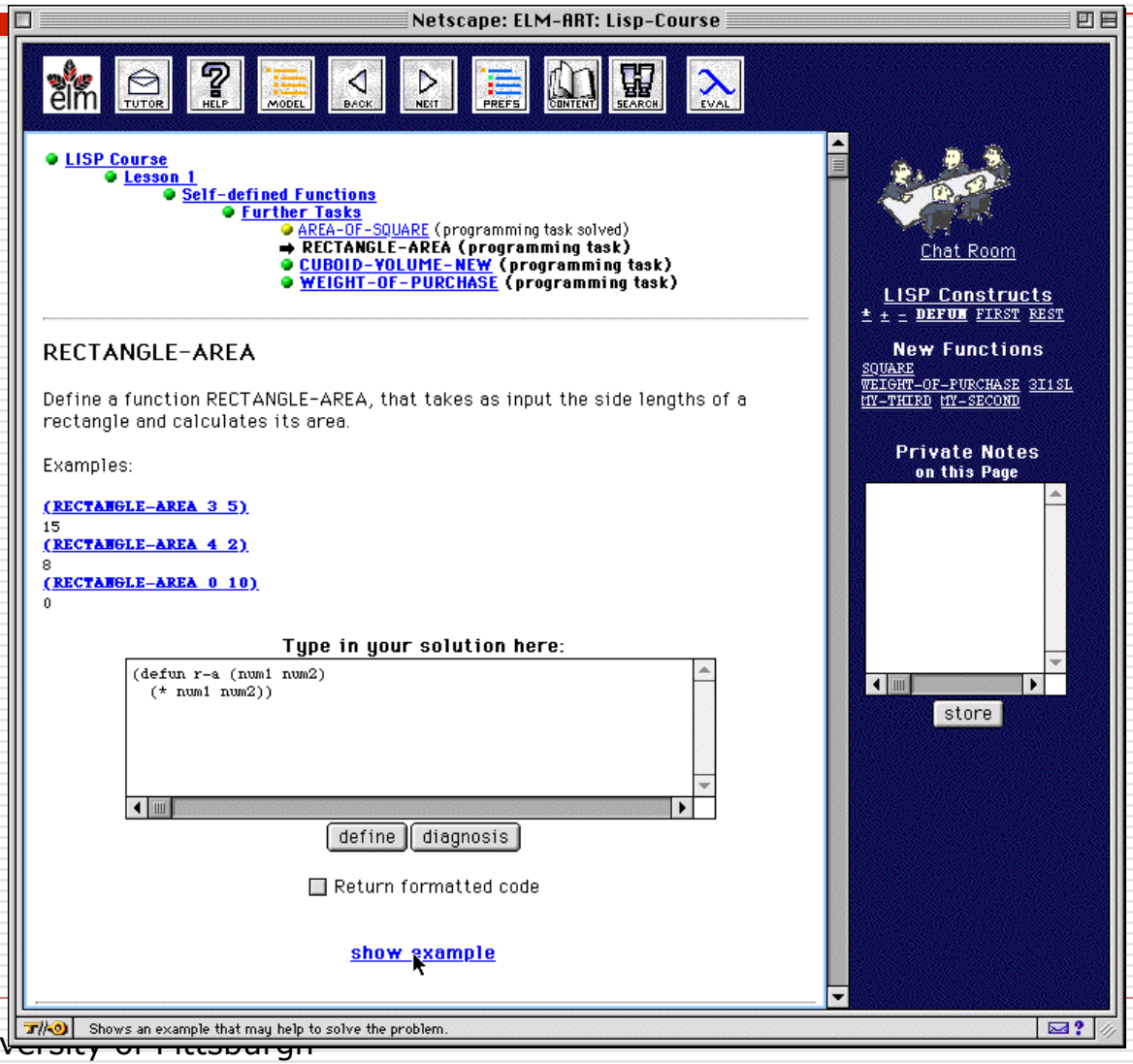
ELM-ART: Adaptive Textbook

- Electronic Textbook
  - Intelligent, adaptive, interactive
- Adaptive navigation support
- Adaptive sequencing (pages and questions)
- Adaptive similarity-based navigation
- Adaptive selection of relevant examples
- Intelligent program diagnosis
- Open student modeling

Adaptive navigation support



Adaptive Diagnostics



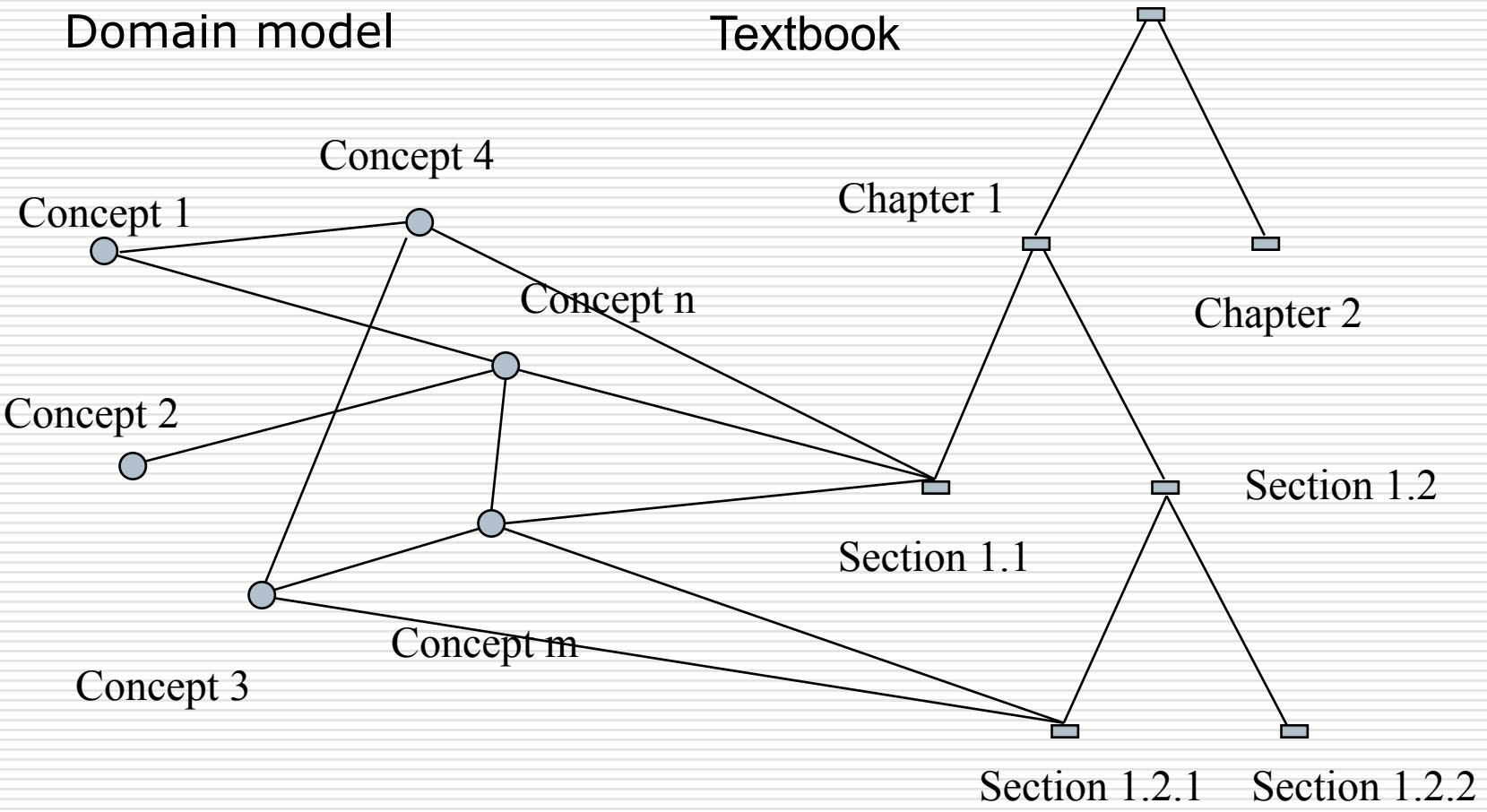
ELM-ART: Evaluation Results

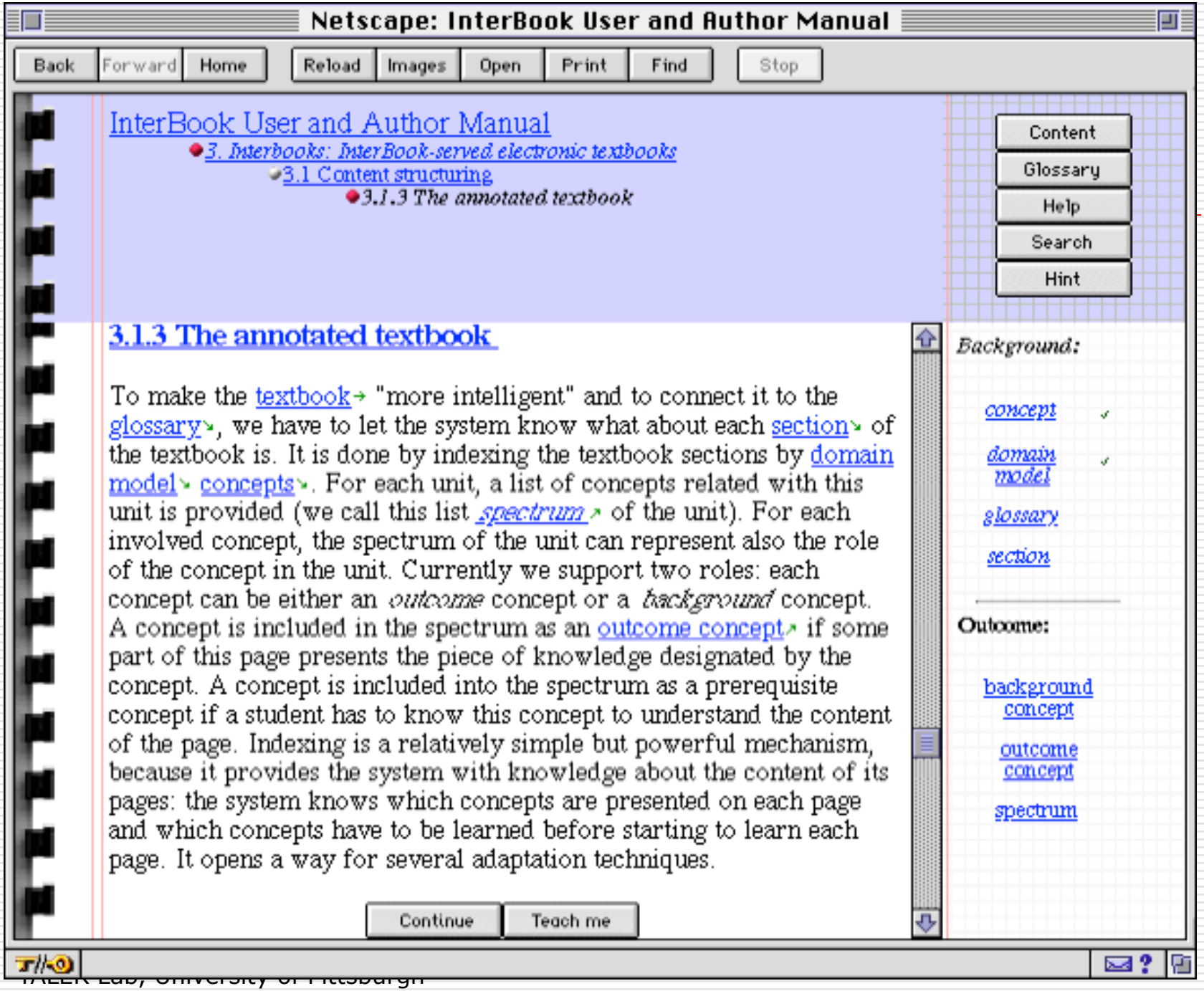
- Users with no previous programming and Web experience worked twice as longer if adaptive guidance was provided. No effect of adaptive annotation
- Users with starting programming and Web experience worked twice as longer if adaptive annotation was provided. No effect of adaptive guidance.

InterBook: a Shell for AET

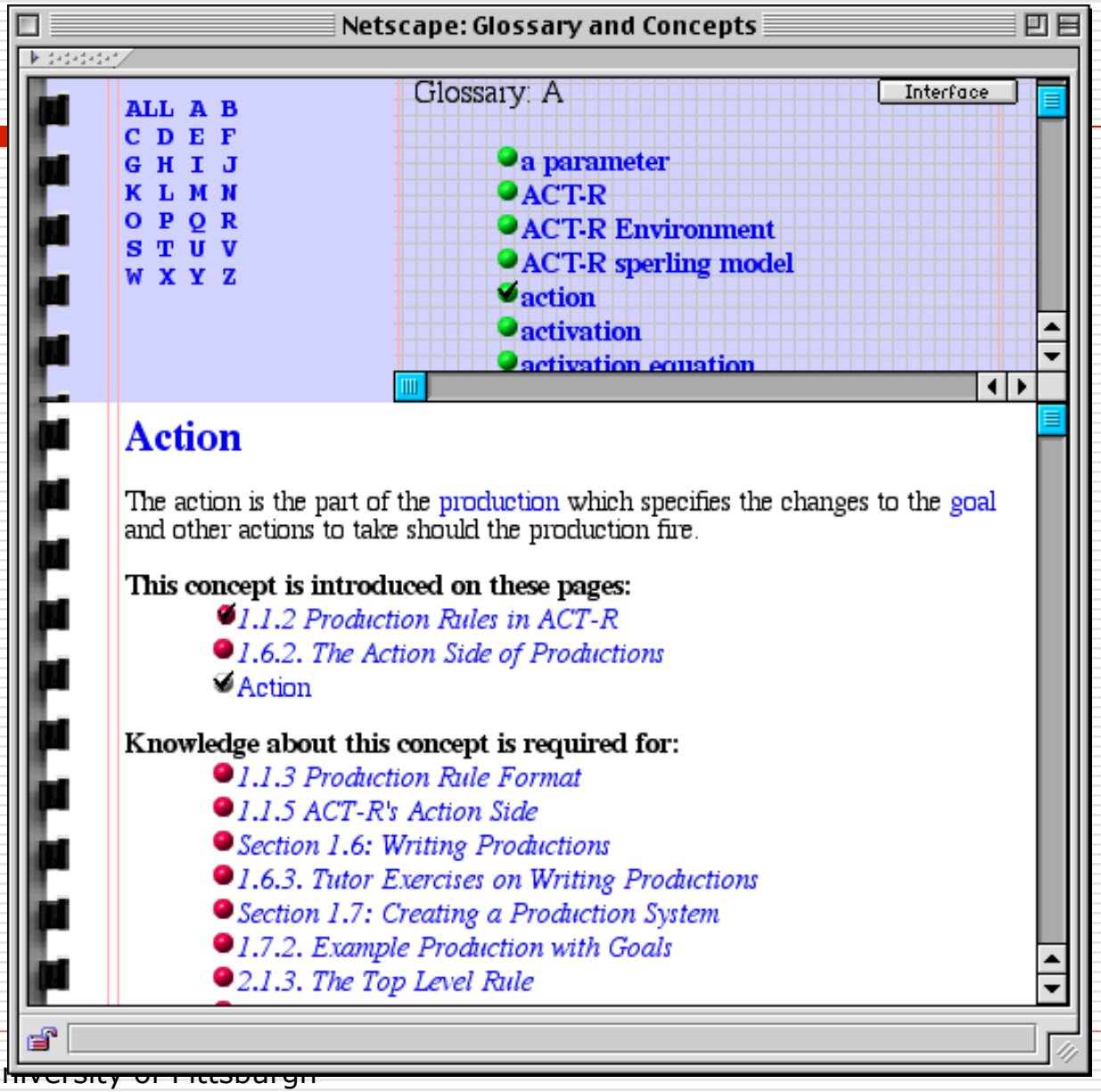
- "Knowledge behind pages"
- Structured electronic textbook (a tree of "sections")
- Sections indexed by domain concepts
  - Outcome concepts
  - Background concepts
- Concepts are externalized as glossary entries
- Shows educational status of concepts and pages

Knowledge and hyperspace

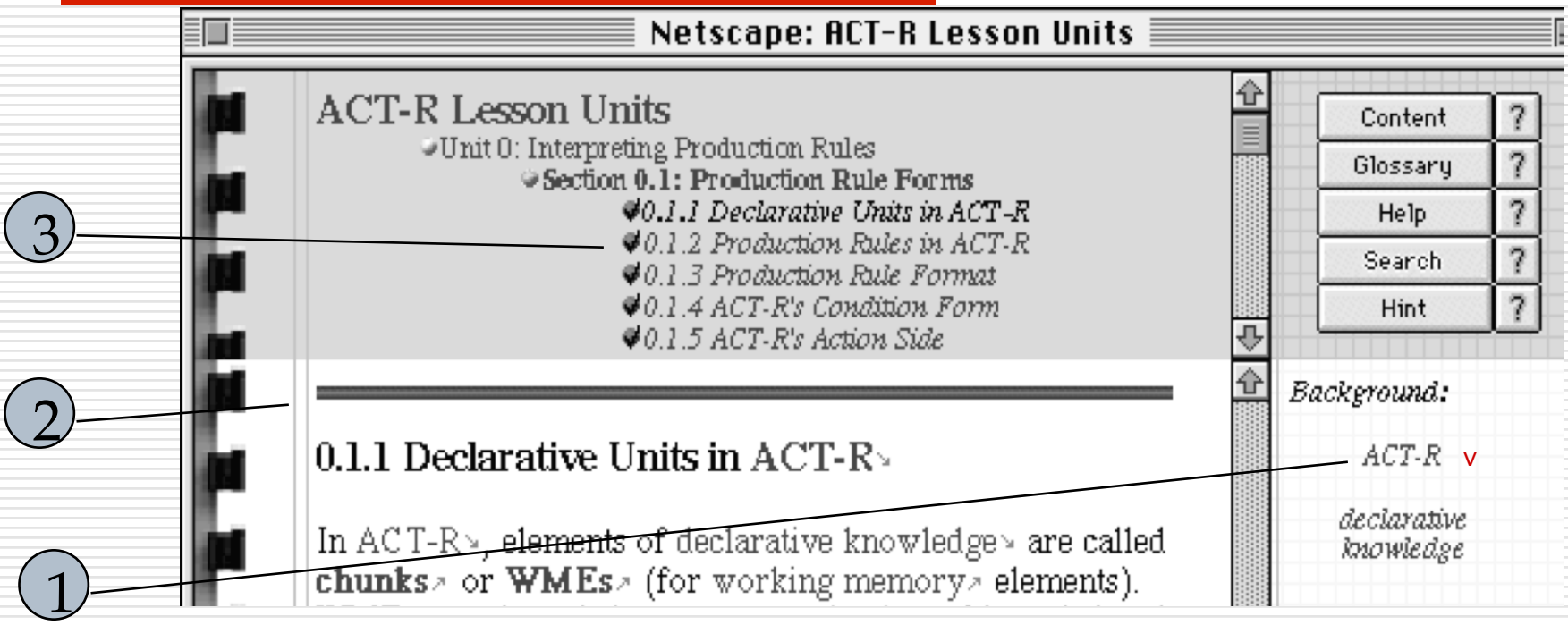



Netscape: InterBook User and Author Manual
Back
Forward
Home
Reload
Images
Open
Print
Find
Stop
InterBook User and Author Manual
3. Interbooks: InterBook-served electronic textbooks
3.1 Content structuring
3.1.3 The annotated textbook
Content
Glossary
Help
Search
Hint
3.1.3 The annotated textbook
To make the textbook "more intelligent" and to connect it to the glossary, we have to let the system know what about each section of the textbook is. It is done by indexing the textbook sections by domain model concepts. For each unit, a list of concepts related with this unit is provided (we call this list spectrum of the unit). For each involved concept, the spectrum of the unit can represent also the role of the concept in the unit. Currently we support two roles: each concept can be either an outcome concept or a background concept. A concept is included in the spectrum as an outcome concept if some part of this page presents the piece of knowledge designated by the concept. A concept is included into the spectrum as a prerequisite concept if a student has to know this concept to understand the content of the page. Indexing is a relatively simple but powerful mechanism, because it provides the system with knowledge about the content of its pages: the system knows which concepts are presented on each page and which concepts have to be learned before starting to learn each page. It opens a way for several adaptation techniques.
Continue
Teach me
Background:
concept
domain model
glossary
section
Outcome:
background concept
outcome concept
spectrum

Glossary view

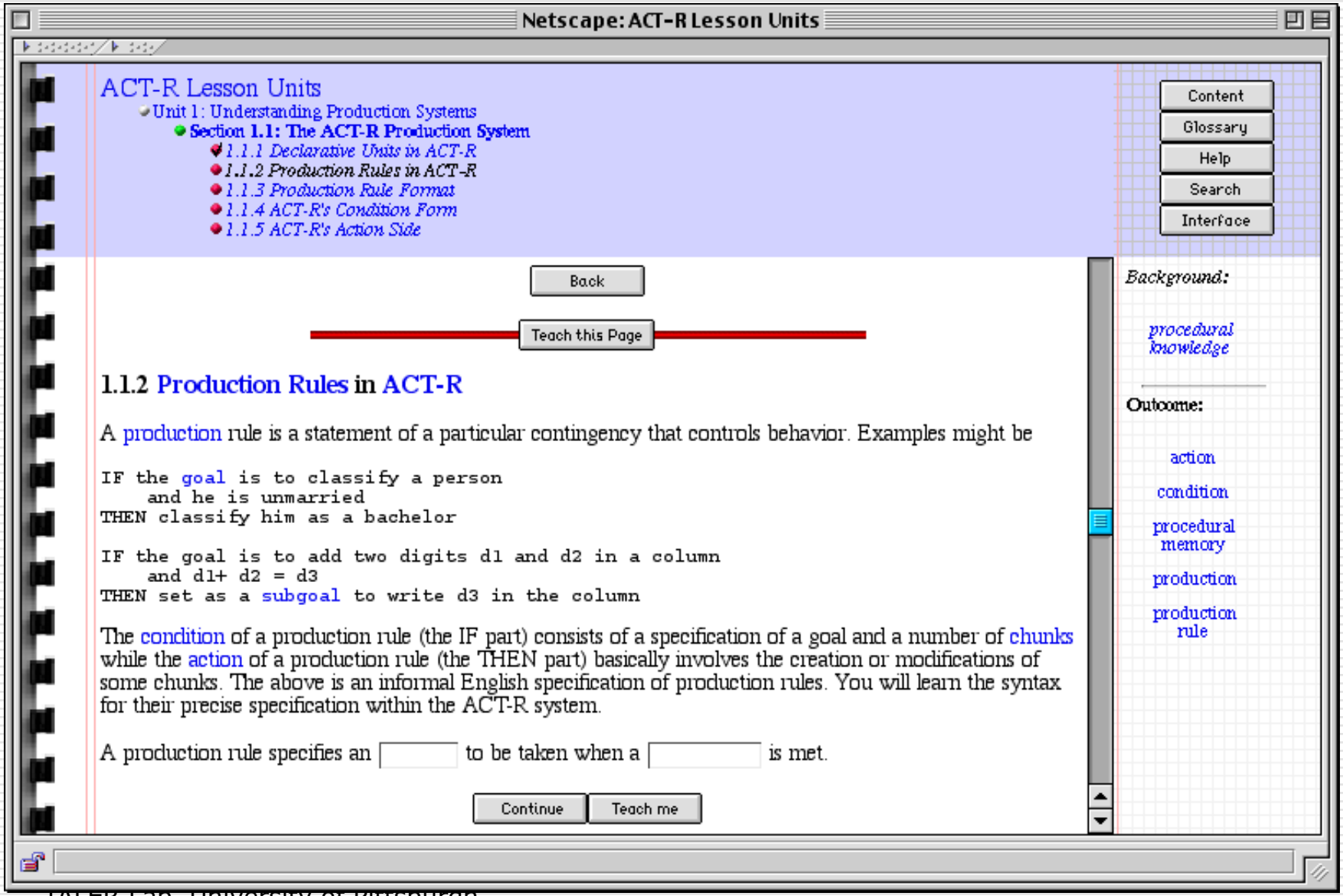


Adaptive annotation in InterBook



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)

Book view


Netscape: ACT-R Lesson Units
ACT-R Lesson Units
Unit 1: Understanding Production Systems
Section 1.1: The ACT-R Production System
1.1.1 Declarative Units in ACT-R
1.1.2 Production Rules in ACT-R
1.1.3 Production Rule Format
1.1.4 ACT-R's Condition Form
1.1.5 ACT-R's Action Side
Content
Glossary
Help
Search
Interface
Back
Teach this Page
1.1.2 Production Rules in ACT-R
A production rule is a statement of a particular contingency that controls behavior. Examples might be
IF the goal is to classify a person
and he is unmarried
THEN classify him as a bachelor
IF the goal is to add two digits d1 and d2 in a column
and d1+ d2 = d3
THEN set as a subgoal to write d3 in the column
The condition of a production rule (the IF part) consists of a specification of a goal and a number of chunks while the action of a production rule (the THEN part) basically involves the creation or modifications of some chunks. The above is an informal English specification of production rules. You will learn the syntax for their precise specification within the ACT-R system.
A production rule specifies an to be taken when a is met.
Continue
Teach me
Background:
procedural knowledge
Outcome:
action
condition
procedural memory
production
production rule

InterBook Evaluation Results

- No performance difference between groups
- About 90% of clicks were made with sequential navigation buttons
- Adaptive annotation encourages non-sequential navigation
- Adaptive annotation benefits those who use it as expected

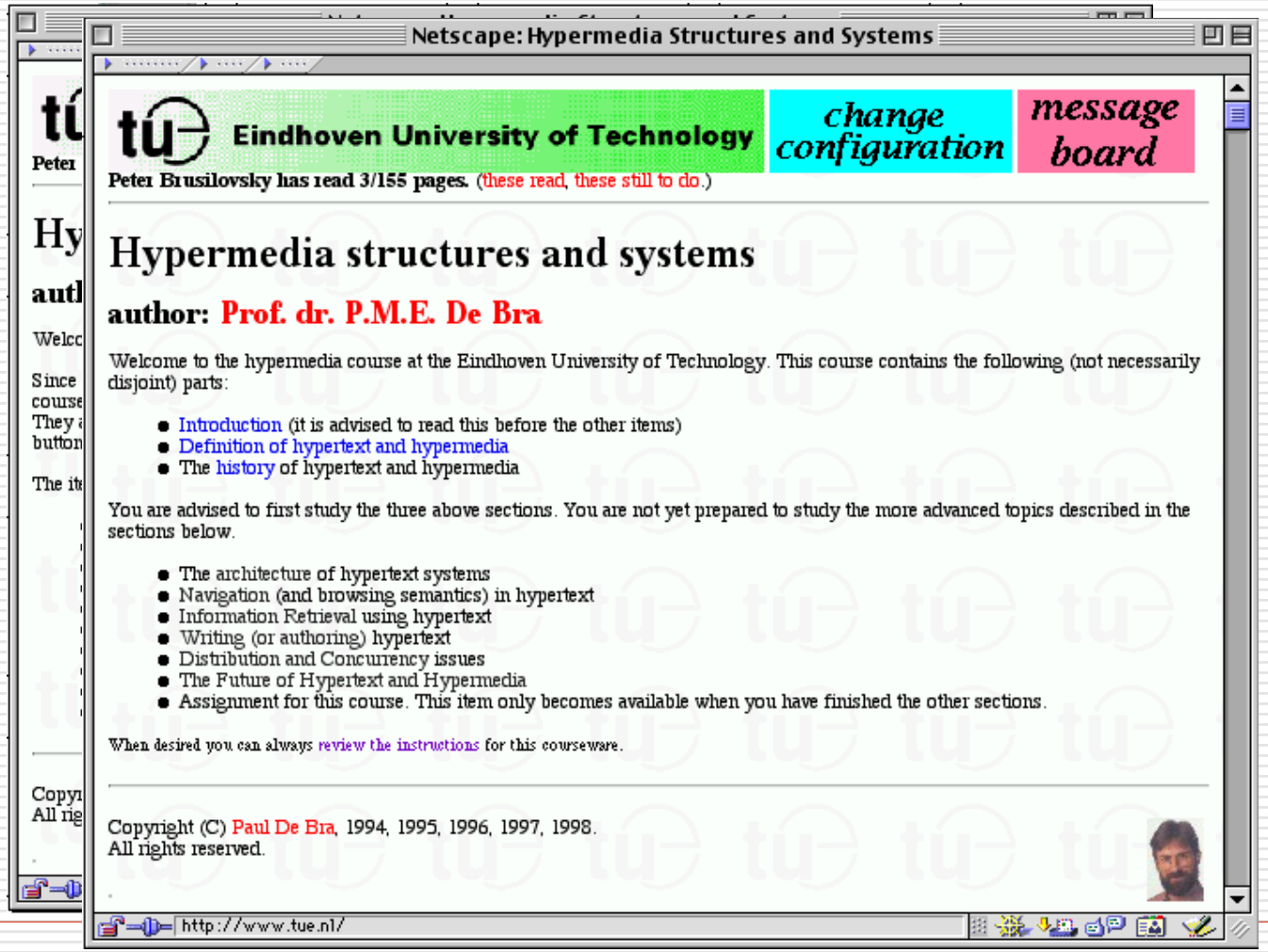
Adaptive annotation can:

- Reduce navigation efforts
- Reduce repetitive visits to learning items
- Encourage non-sequential navigation
- Make system more attractive for students
- But we still need to understand better
  - When it is helpful
  - How to match functionality to students

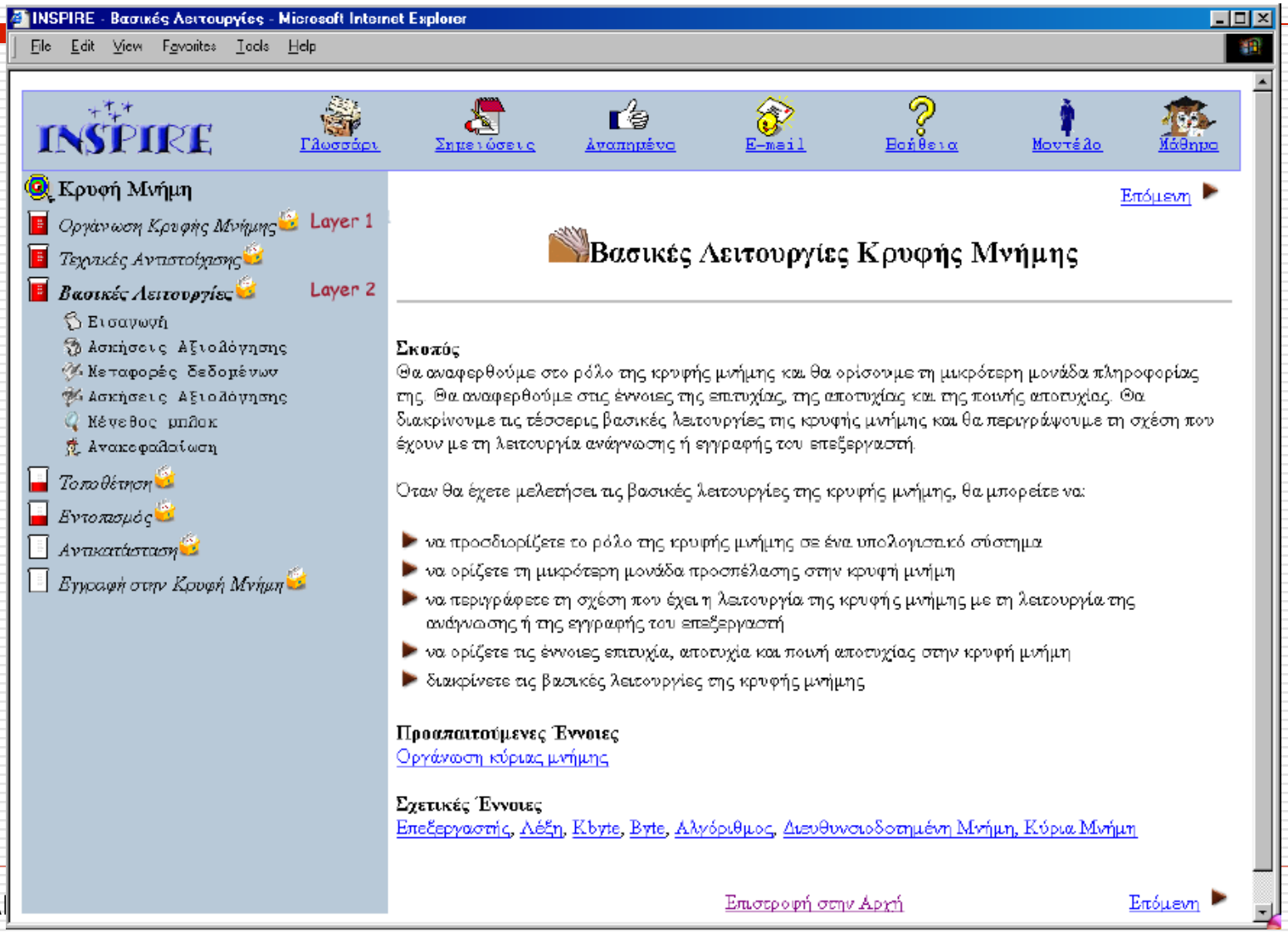
Other Generation 2 AEHS

- ELM-ART stream: Exploring new approaches and techniques
  - AHA!, INSPIRE, MetaLinks, MANIC
- InterBook stream: Creating authoring frameworks and tools
  - Frameworks:
    - KBS-HyperBook, Multibook
  - Authoring Tools:
    - AHA!, NetCoach, MetaLinks

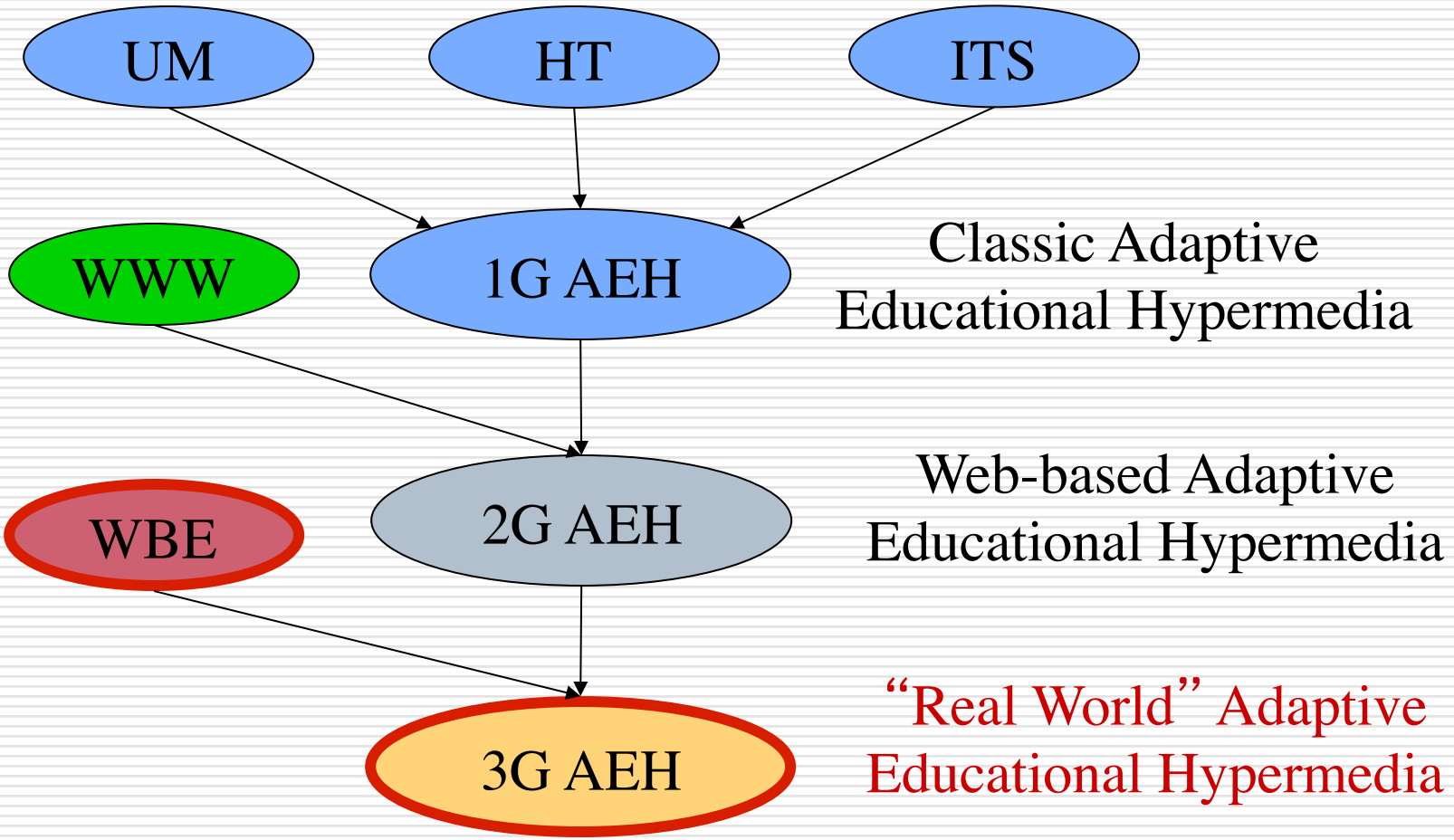
AHA! (De Bra)


Netscape: Hypermedia Structures and Systems
Eindhoven University of Technology
change configuration
message board
Peter Brusilovsky has read 3/155 pages. (these read, these still to do.)
Hypermedia structures and systems
author: Prof. dr. P.M.E. De Bra
Welcome to the hypermedia course at the Eindhoven University of Technology. This course contains the following (not necessarily disjoint) parts:
Introduction (it is advised to read this before the other items)
Definition of hypertext and hypermedia
The history of hypertext and hypermedia
You are advised to first study the three above sections. You are not yet prepared to study the more advanced topics described in the sections below.
The architecture of hypertext systems
Navigation (and browsing semantics) in hypertext
Information Retrieval using hypertext
Writing (or authoring) hypertext
Distribution and Concurrency issues
The Future of Hypertext and Hypermedia
Assignment for this course. This item only becomes available when you have finished the other sections.
When desired you can always review the instructions for this courseware.
Copyright (C) Paul De Bra, 1994, 1995, 1996, 1997, 1998.
All rights reserved.
http://www.tue.nl/

INSPIRE (Grigoriadou, Papanikolaou, Kornilakis, Magoulas)



Generation 3



Practical E-Learning

- Integrated Course Management Systems
  - Blackboard, WebCT, …
- Support almost all aspects of E-Learning
  - Course material presentation
  - Assessment with quizzes
  - Threaded discussions
  - Student management and grading
- “MS Word”-style all-in-one tool for WBE

Adaptive E-Learning?

- Adaptive E-Learning systems can provide a more advanced support for most functions
  - Course material presentation - InterBook, AHA
  - Assessment with quizzes - SIETTE
  - Threaded discussions - help agents
  - Student management - intelligent monitoring
- Why they are rarely used in practical E-Learning?

Practical Adaptive E-Learning

- Model 1: Adapting to current E-Learning Paradigm - CMS
- More versatile adaptive systems
- An ability to integrate open corpus content
- Improving CMS content
- Giving more power to the teacher
  - Customize the system to specific course and material

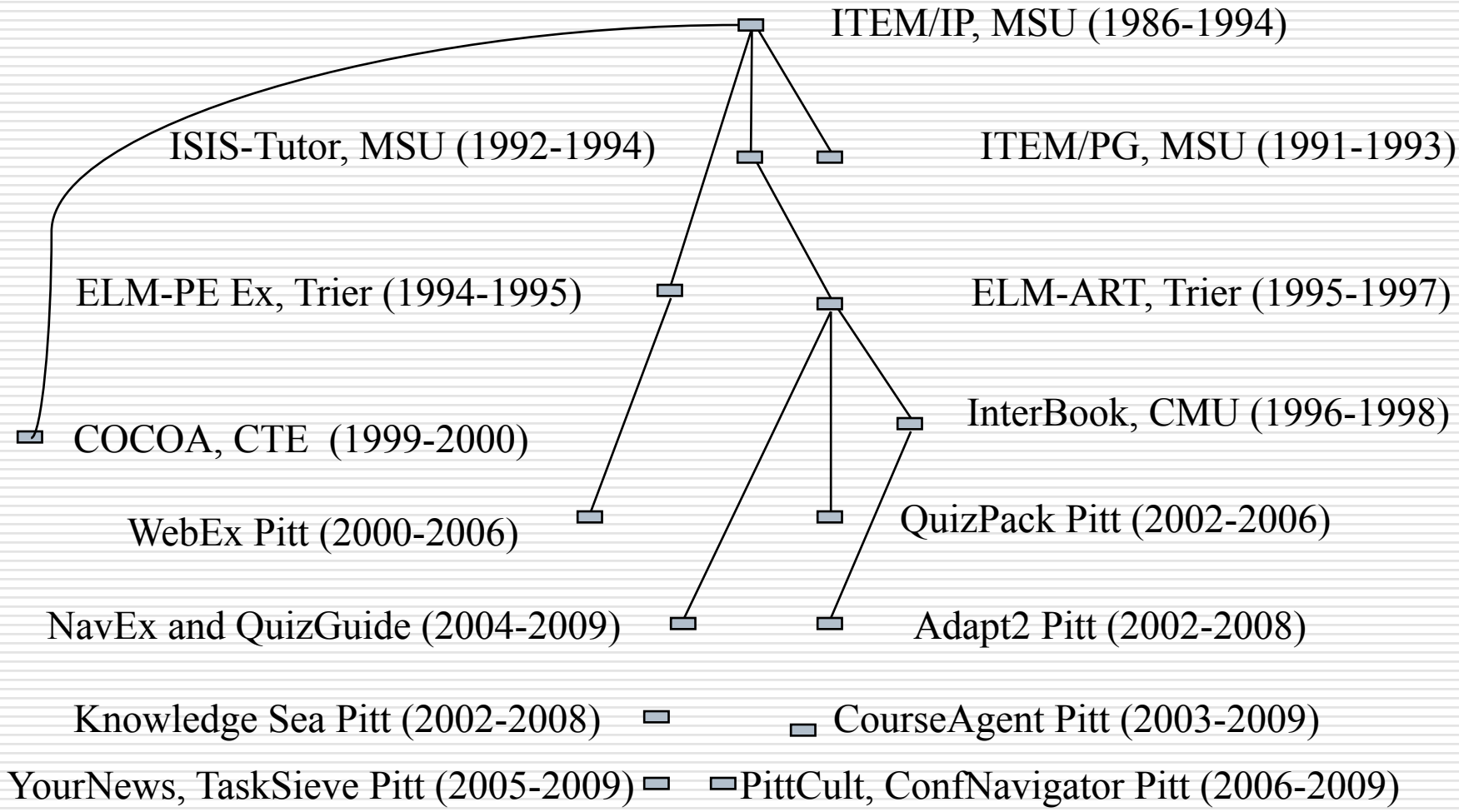
Emerging E-Learning

- Interoperability and standards
  - IEEE CMI, SCORM
- Semantics and metadata
  - LOM
- Component-based architectures
  - OKI, uPortal
- Resource reusability
- Distributed learning content
- Semantic Web

Practical Adaptive E-Learning

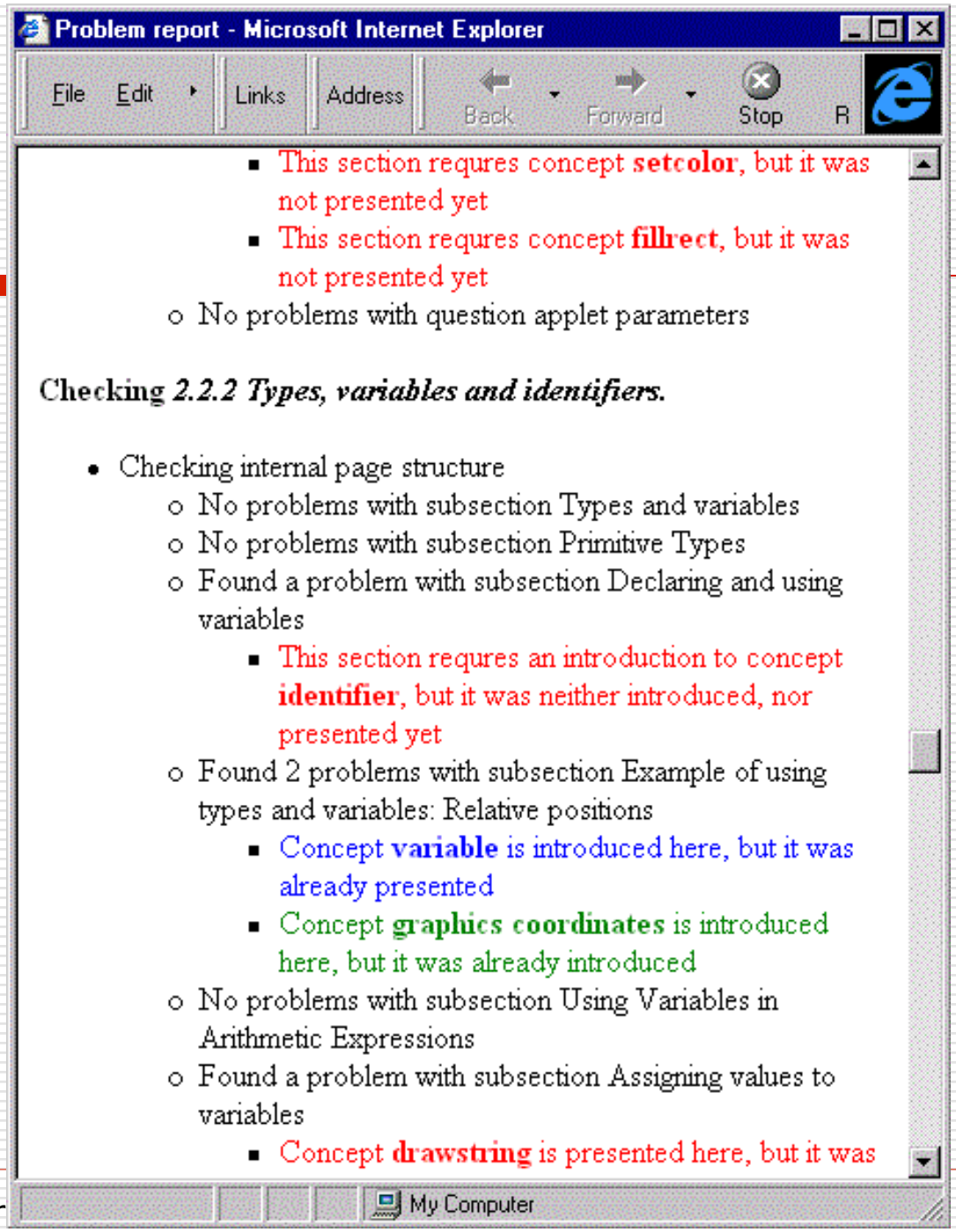
- Model 2: Embedding adaptivity into emerging E-Learning
- Use of current interoperability standards (SCORM, LOM)
- Developing new interoperability architectures
- Resource discovery
- The use of Semantic Web

Personal View: Generation 3



CoCoA - Static Sequencing

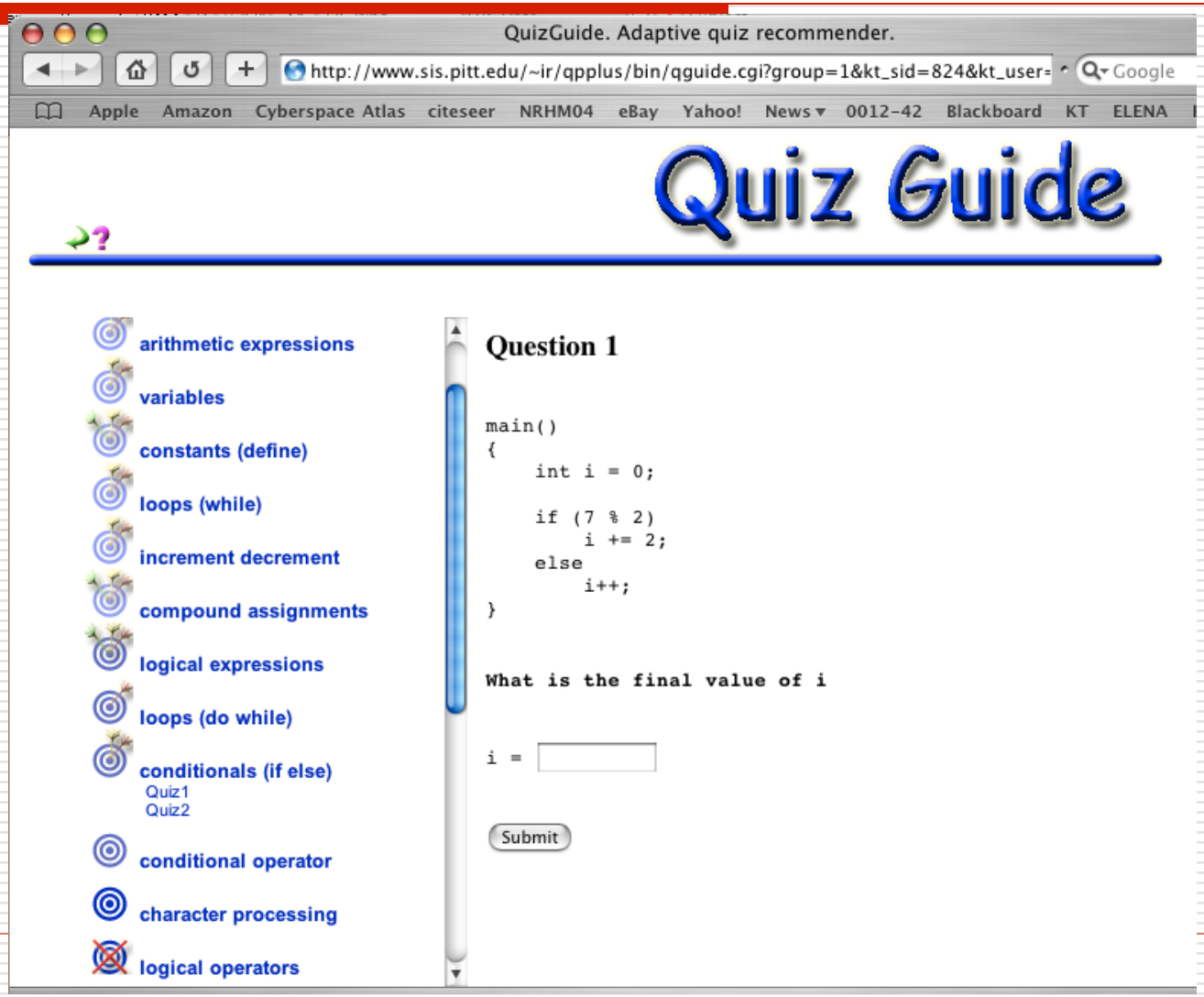
- Many contributors for a single course
- Almost impossible to keep the course consistent without special tool
- Courseware engineering: From course authoring in small to course authoring in large
- CoCoA - Static sequencing
  - Prerequisite checking
  - Goal focusing
  - Learning activity balance


Problem report - Microsoft Internet Explorer
File Edit Links Address Back Forward Stop R
This section requres concept setcolor, but it was not presented yet
This section requres concept fillrect, but it was not presented yet
No problems with question applet parameters
Checking 2.2.2 Types, variables and identifiers.
Checking internal page structure
No problems with subsection Types and variables
No problems with subsection Primitive Types
Found a problem with subsection Declaring and using variables
This section requres an introduction to concept identifier, but it was neither introduced, nor presented yet
Found 2 problems with subsection Example of using types and variables: Relative positions
Concept variable is introduced here, but it was already presented
Concept graphics coordinates is introduced here, but it was already introduced
No problems with subsection Using Variables in Arithmetic Expressions
Found a problem with subsection Assigning values to variables
Concept drawstring is presented here, but it was
My Computer

Open Corpus Adaptive Hypermedia

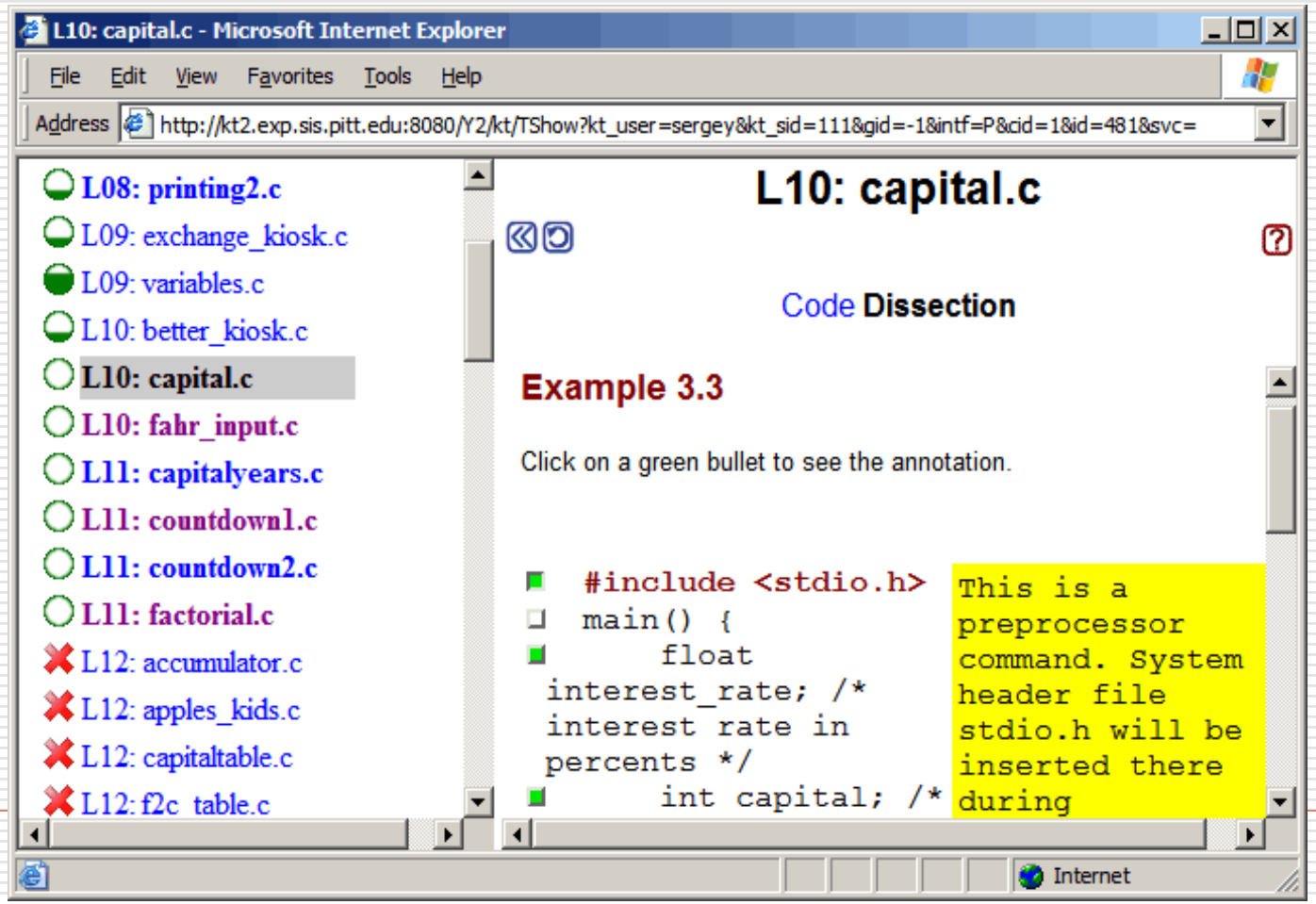
- Classic AH - Closed Corpus of pre-processed content
- Integrate Open Corpus content
- Bringing open corpus content in by indexing
  - KBS-HyperBook, SIGUE
- Processing open corpus content without manual idexing
  - Knowledge Sea

QuizGuide: Topic-Based AH

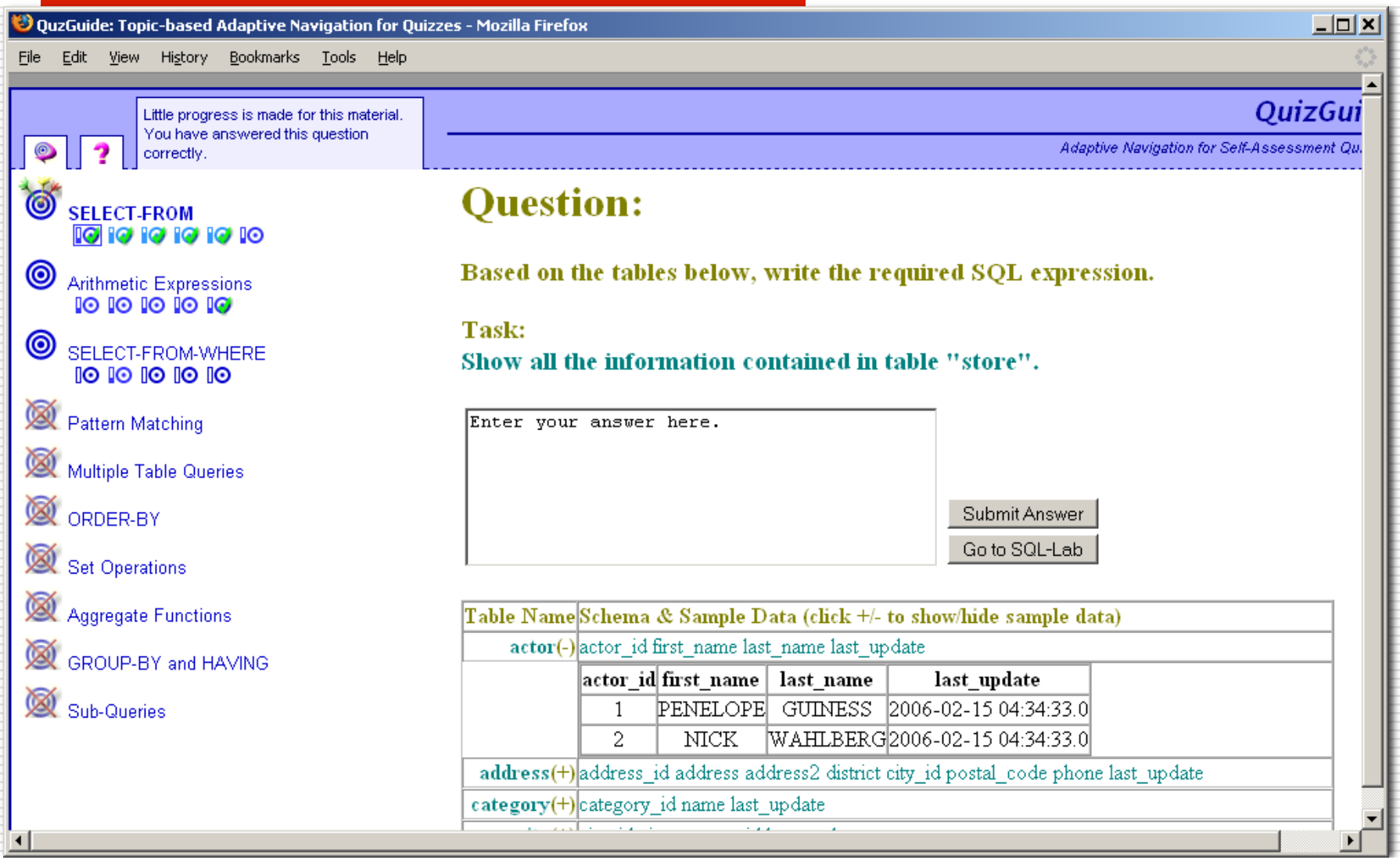


NavEx: Automatic Indexing

Classic "traffic light" prerequisite-based mechanism based on automatic indexing

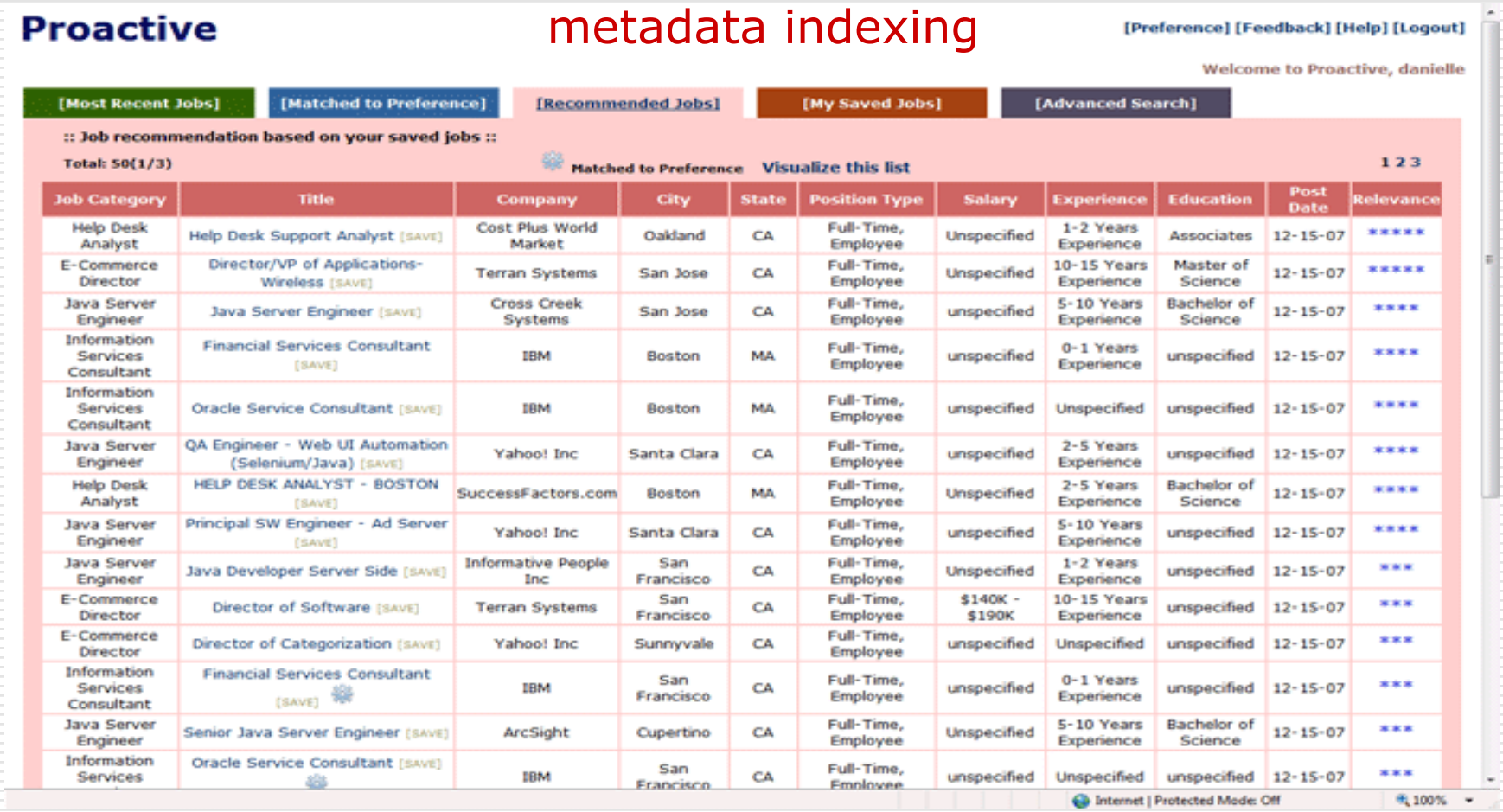


Concept-Based QuizGuide



Proactive: Metadata for ANS

Recommendation and navigation support based on available metadata indexing



Proactive

[Preference] [Feedback] [Help] [Logout]

Welcome to Proactive, danielle

[Most Recent Jobs] [Matched to Preference] [Recommended Jobs] [My Saved Jobs] [Advanced Search]

:: Job recommendation based on your saved jobs ::

Total: 50(1/3) Matched to Preference Visualize this list 1 2 3

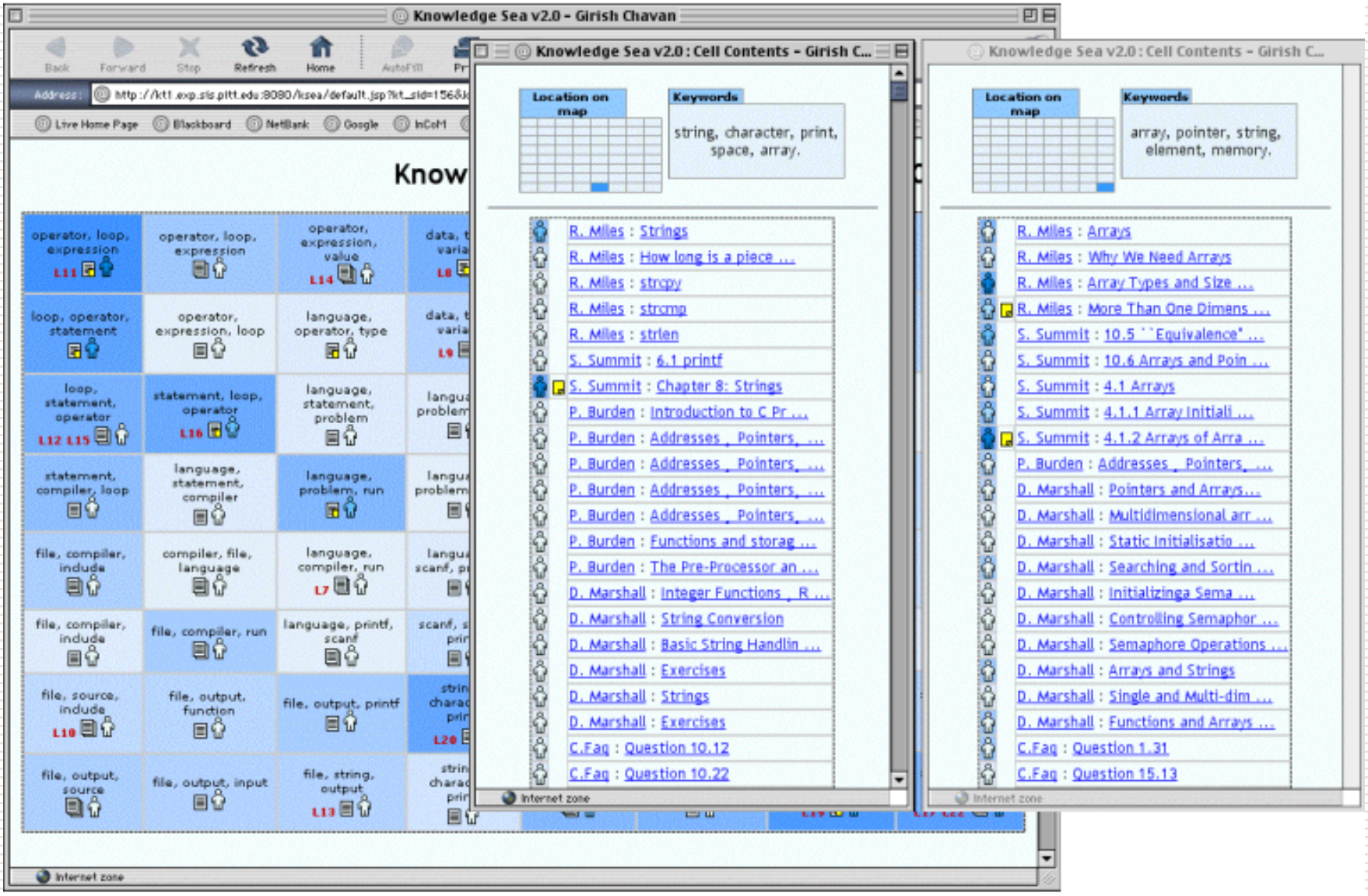
Job Category	Title	Company	City	State	Position Type	Salary	Experience	Education	Post Date	Relevance
Help Desk Analyst	Help Desk Support Analyst [SAVE]	Cost Plus World Market	Oakland	CA	Full-Time, Employee	Unspecified	1-2 Years Experience	Associates	12-15-07	*****
E-Commerce Director	Director/VP of Applications-Wireless [SAVE]	Terran Systems	San Jose	CA	Full-Time, Employee	Unspecified	10-15 Years Experience	Master of Science	12-15-07	*****
Java Server Engineer	Java Server Engineer [SAVE]	Cross Creek Systems	San Jose	CA	Full-Time, Employee	unspecified	5-10 Years Experience	Bachelor of Science	12-15-07	****
Information Services Consultant	Financial Services Consultant [SAVE]	IBM	Boston	MA	Full-Time, Employee	unspecified	0-1 Years Experience	unspecified	12-15-07	****
Information Services Consultant	Oracle Service Consultant [SAVE]	IBM	Boston	MA	Full-Time, Employee	unspecified	Unspecified	unspecified	12-15-07	****
Java Server Engineer	QA Engineer - Web UI Automation (Selenium/Java) [SAVE]	Yahoo! Inc	Santa Clara	CA	Full-Time, Employee	unspecified	2-5 Years Experience	unspecified	12-15-07	****
Help Desk Analyst	HELP DESK ANALYST - BOSTON [SAVE]	SuccessFactors.com	Boston	MA	Full-Time, Employee	Unspecified	2-5 Years Experience	Bachelor of Science	12-15-07	****
Java Server Engineer	Principal SW Engineer - Ad Server [SAVE]	Yahoo! Inc	Santa Clara	CA	Full-Time, Employee	unspecified	5-10 Years Experience	unspecified	12-15-07	****
Java Server Engineer	Java Developer Server Side [SAVE]	Informative People Inc	San Francisco	CA	Full-Time, Employee	Unspecified	1-2 Years Experience	unspecified	12-15-07	***
E-Commerce Director	Director of Software [SAVE]	Terran Systems	San Francisco	CA	Full-Time, Employee	$140K - $190K	10-15 Years Experience	unspecified	12-15-07	***
E-Commerce Director	Director of Categorization [SAVE]	Yahoo! Inc	Sunnyvale	CA	Full-Time, Employee	unspecified	Unspecified	unspecified	12-15-07	***
Information Services Consultant	Financial Services Consultant [SAVE]	IBM	San Francisco	CA	Full-Time, Employee	unspecified	0-1 Years Experience	unspecified	12-15-07	***
Java Server Engineer	Senior Java Server Engineer [SAVE]	ArcSight	Cupertino	CA	Full-Time, Employee	Unspecified	5-10 Years Experience	Bachelor of Science	12-15-07	***
Information Services	Oracle Service Consultant [SAVE]	IBM	San Francisco	CA	Full-Time, Employee	unspecified	Unspecified	unspecified	12-15-07	***

Internet | Protected Mode: Off 100%

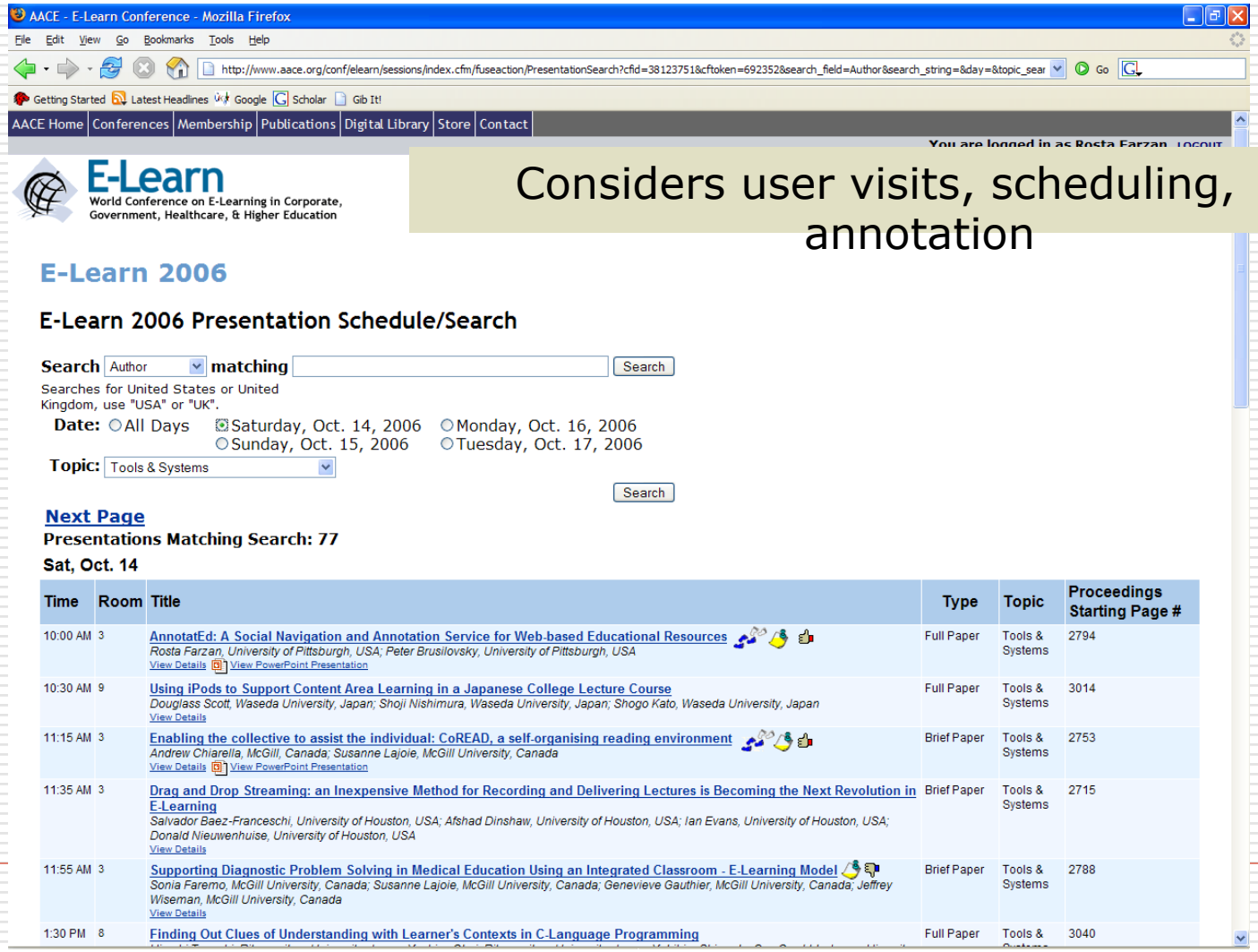
Community-based OCAH

- Footprint-based social navigation
  - Footprints, CoWeb, Knowledge Sea II, ASSIST
- Action-based social navigation (annotation, scheduling…)
  - Knowledge Sea II, Conference Navigator
- Direct feedback for navigation support
  - CourseAgent, PittCult
- Tag-based social navigation
  - Any example???

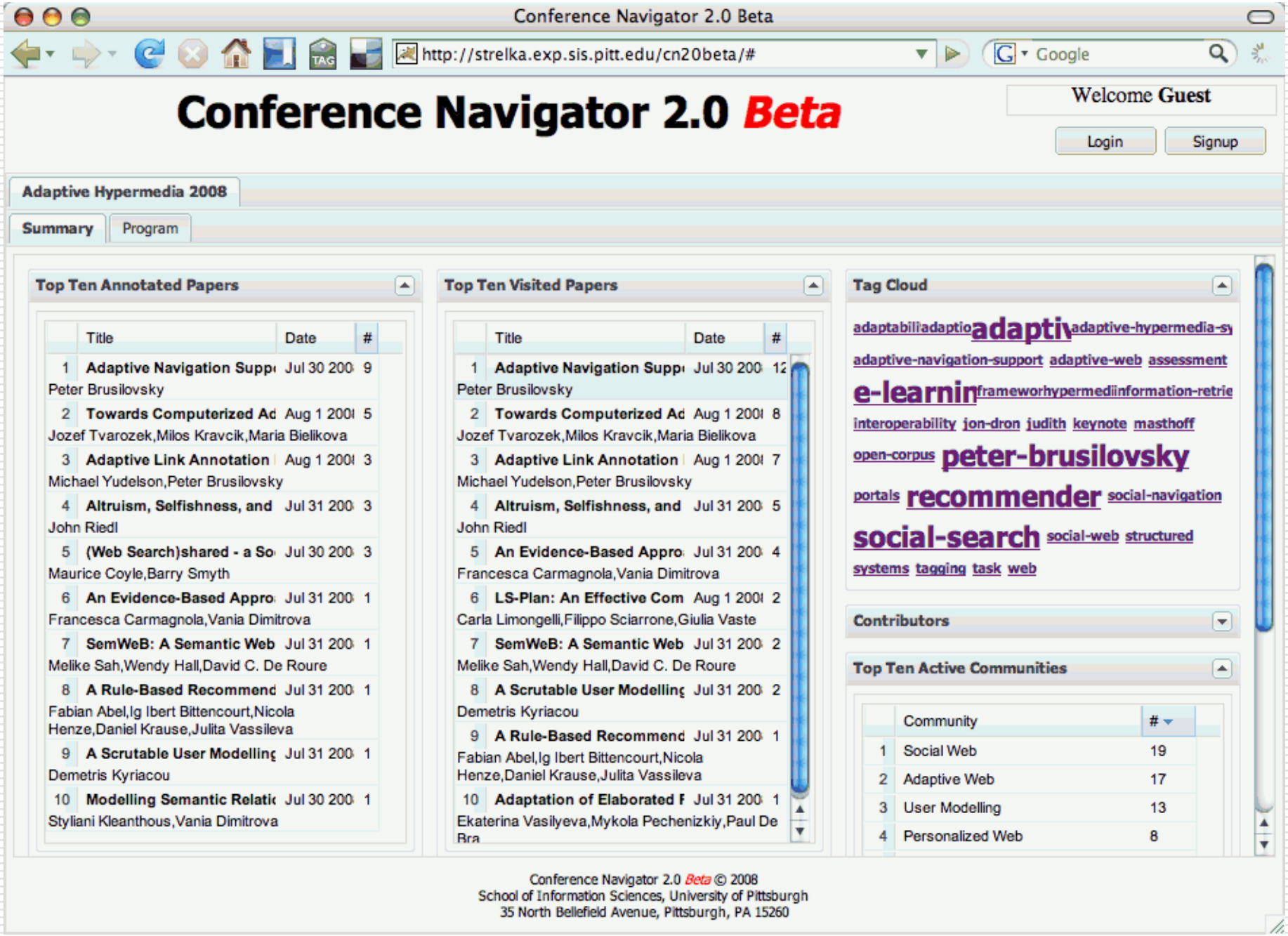
Knowledge Sea II



Conference Navigator



Considers user visits, scheduling, annotation


Conference Navigator 2.0 Beta
http://strelka.exp.sis.pitt.edu/cn20beta/#
Google
Conference Navigator 2.0 Beta
Welcome Guest
Login
Signup
Adaptive Hypermedia 2008
Summary
Program
Top Ten Annotated Papers
Title
Date
#
1 Adaptive Navigation Supp Jul 30 200 9
Peter Brusilovsky
2 Towards Computerized Ad Aug 1 200 5
Jozef Tvarozek,Milos Kravcik,Maria Bielikova
3 Adaptive Link Annotation Aug 1 200 3
Michael Yudelson,Peter Brusilovsky
4 Altruism, Selfishness, and Jul 31 200 3
John Riedl
5 (Web Search)shared - a So Jul 30 200 3
Maurice Coyle,Barry Smyth
6 An Evidence-Based Appro Jul 31 200 1
Francesca Carmagnola,Vania Dimitrova
7 SemWeB: A Semantic Web Jul 31 200 1
Melike Sah,Wendy Hall,David C. De Roure
8 A Rule-Based Recommend Jul 31 200 1
Fabian Abel,Ig Ibert Bittencourt,Nicola Henze,Daniel Krause,Julita Vassileva
9 A Scrutable User Modelling Jul 31 200 1
Demetris Kyriacou
10 Modelling Semantic Relati Jul 30 200 1
Styliani Kleanthous,Vania Dimitrova
Top Ten Visited Papers
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Peter Brusilovsky
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Jozef Tvarozek,Milos Kravcik,Maria Bielikova
3 Adaptive Link Annotation Aug 1 200 7
Michael Yudelson,Peter Brusilovsky
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5 An Evidence-Based Appro Jul 31 200 4
Francesca Carmagnola,Vania Dimitrova
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Carla Limongelli,Filippo Sciarrone,Giulia Vaste
7 SemWeB: A Semantic Web Jul 31 200 2
Melike Sah,Wendy Hall,David C. De Roure
8 A Scrutable User Modelling Jul 31 200 2
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10 Adaptation of Elaborated F Jul 31 200 1
Ekaterina Vasilyeva,Mykola Pechenizkiy,Paul De Bra
Tag Cloud
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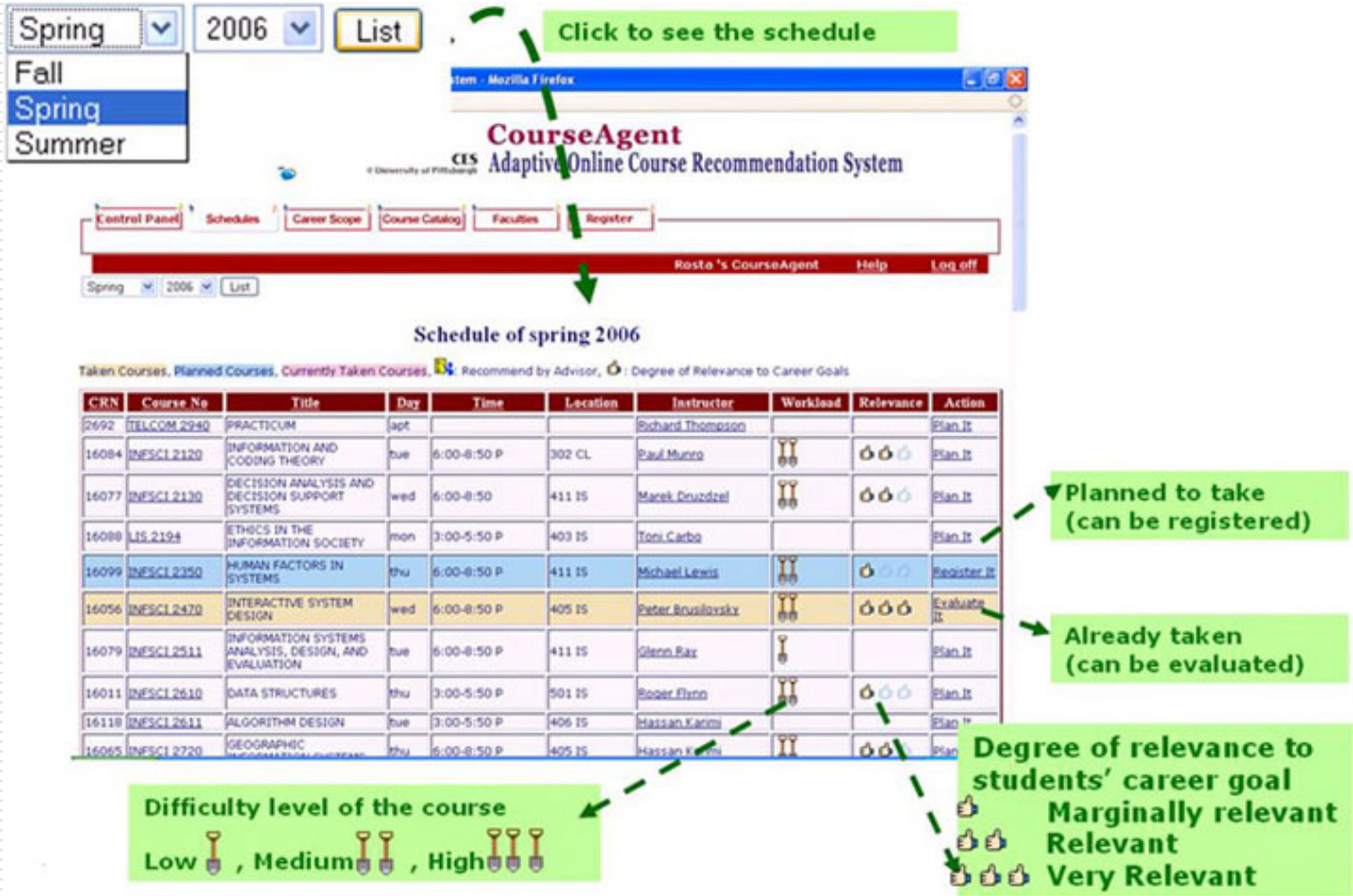
adaptive-navigation-support adaptive-web assessment
e-learnin framework hypermedi information-retrie
interoperability jon-dron judith keynote masthoff
open-corpus peter-brusilovsky
portals recommender social-navigation
social-search social-web structured
systems tagging task web
Contributors
Top Ten Active Communities
Community
#
1 Social Web 19
2 Adaptive Web 17
3 User Modelling 13
4 Personalized Web 8
Conference Navigator 2.0 Beta © 2008
School of Information Sciences, University of Pittsburgh
35 North Bellefield Avenue, Pittsburgh, PA 15260

CourseAgent



PittCult

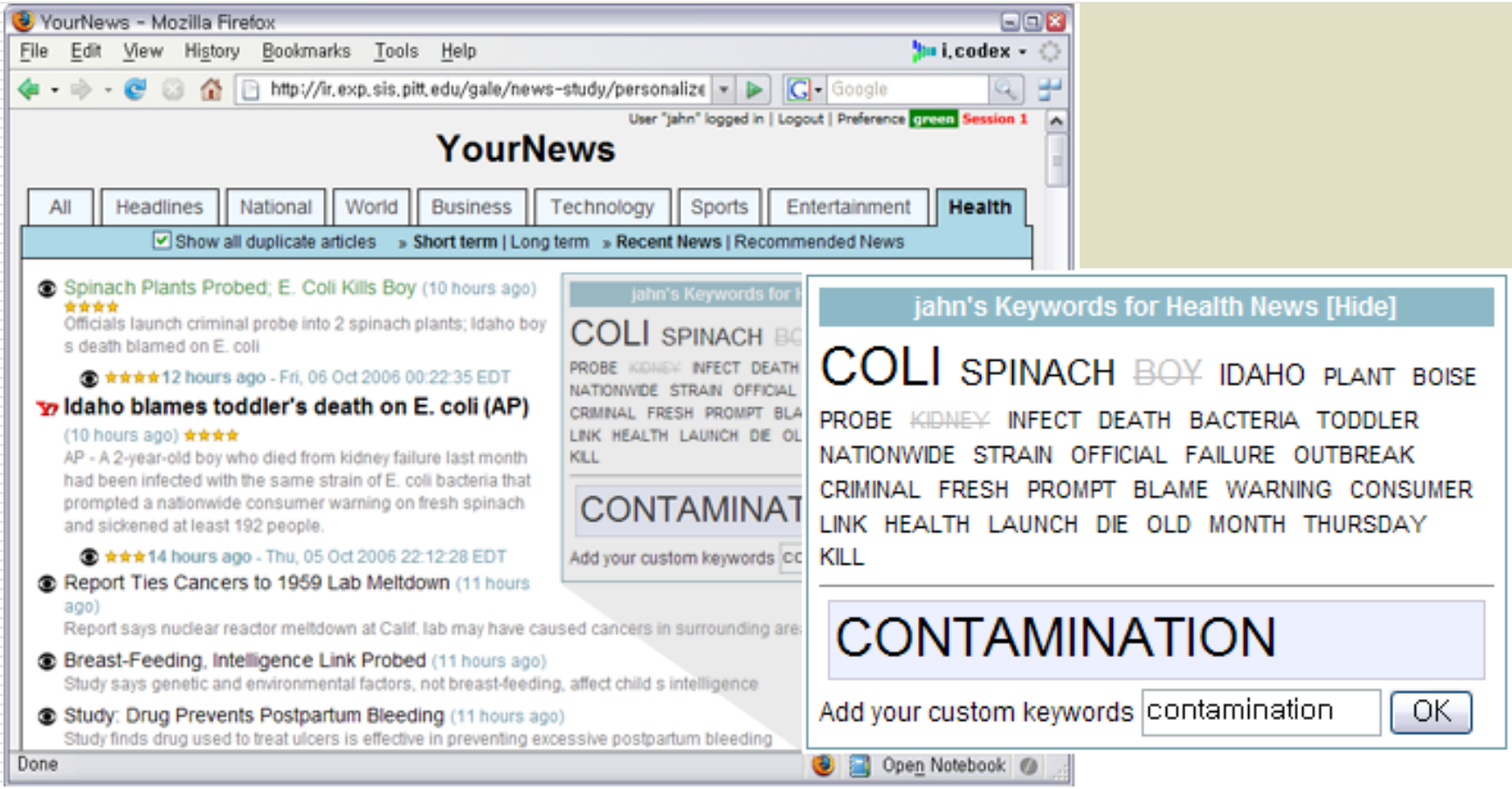
Social networks for contextual recommendation

Keyword-based OCAH

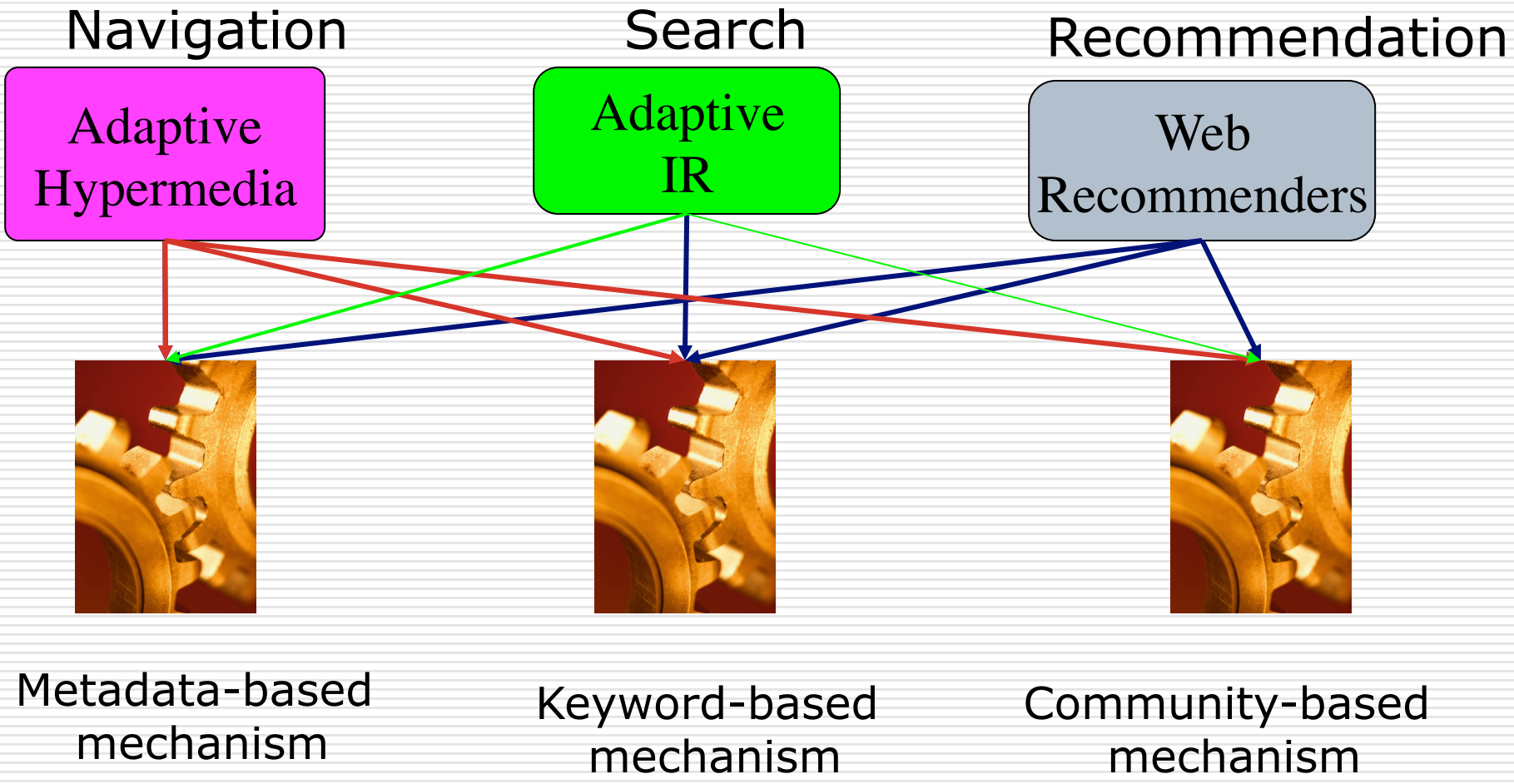
- Siskill and Webert
  - Link ordering and annotation
- ML-Tutor
  - Link ordering and generation
- ScentTrails
  - Link annotation
- YourNews/TaskSieve
  - Link ordering and generation

YourNews: Open Keyword-Level User Models

Keyword-level user model is visible and editable

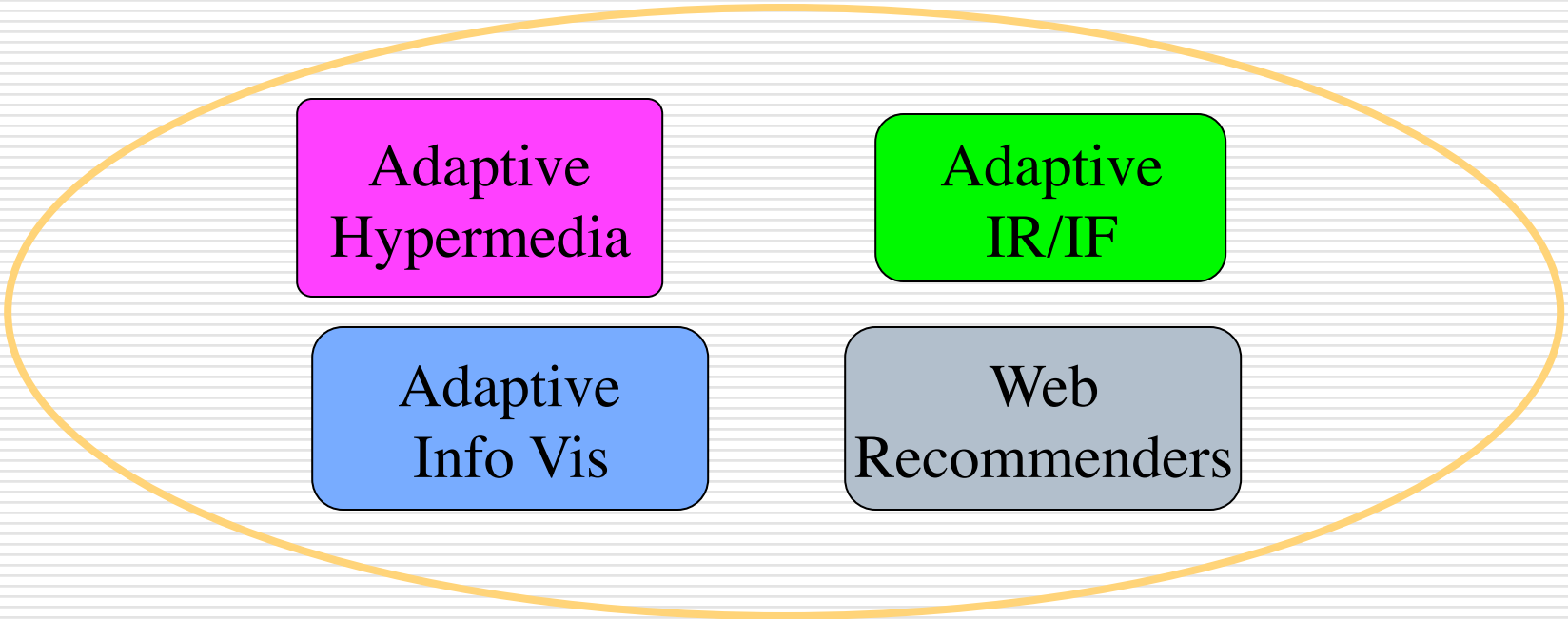


Personalized Information Access 2016



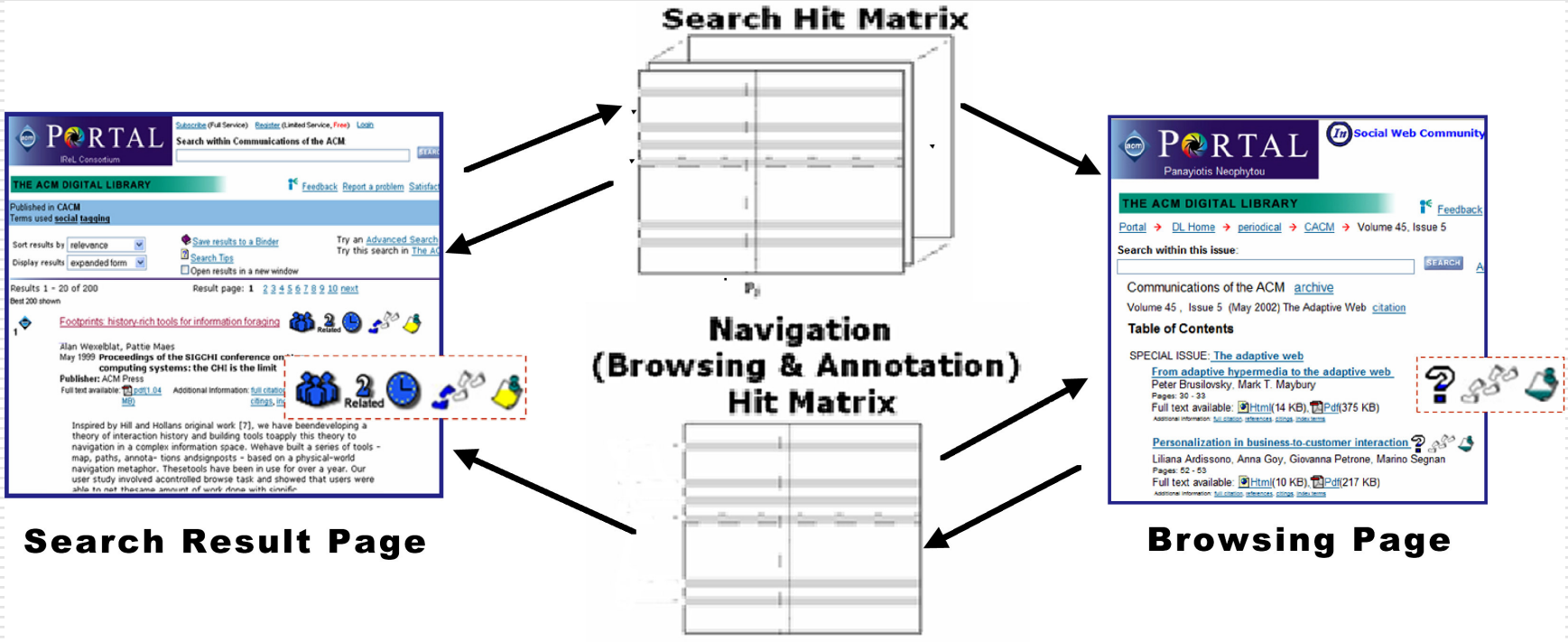
Adaptation Mechanisms

Personalized Information Access 2016



- 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

ASSIST-ACM



Re-ranking result-list based on search and browsing history information

Augmenting the links based on search and browsing history information

More Information

- Read
  - Brusilovsky, P. (1996) Methods and techniques of adaptive hypermedia. *User Modeling and User-Adapted Interaction* 6 (2-3), 87-129
  - Brusilovsky, P. and Henze, N. (2007) Open corpus adaptive educational hypermedia. *The Adaptive Web: Methods and Strategies of Web Personalization*. Lecture Notes in Computer Science, Vol. 4321, Springer-Verlag, pp. 671-696.
- Explore
  - Try our systems at PAWS Community portal: http://www.sis.pitt.edu/~paws
  - http://adapt2.sis.pitt.edu/wiki/Main_Page
  - Use Eventur, CoMeT, CourseAgent