

INFSCI 2480: Adaptive Information Systems

Adaptive Navigation Support


Peter Brusilovsky

School of Information Sciences

University of Pittsburgh, USA

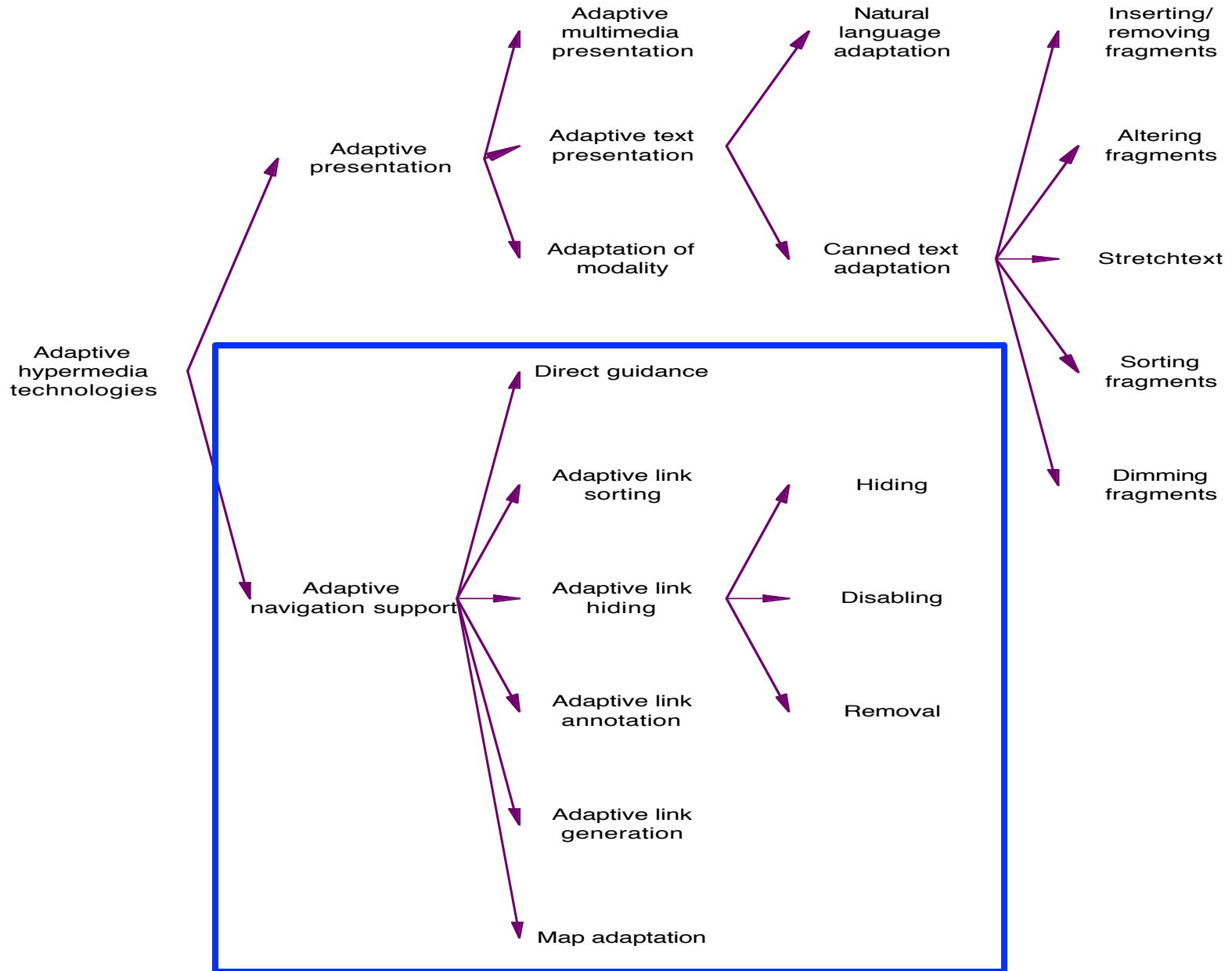
<http://www.sis.pitt.edu/~peterb/>

Where we are?

	Search	Navigation	Recommendation
Content-based			
Semantics / Metadata			
Social			

A Part of Adaptive Hypermedia

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



Adaptive navigation support: goals

- Guidance: Where I can go?
 - Local guidance (“next best”)
 - Global guidance (“ultimate goal”)
- Orientation: Where am I?
 - Local orientation support (local area)
 - Global orientation support (whole hyperspace)

Adaptive navigation support

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

Example: Adaptive annotation

The screenshot shows a Netscape browser window titled "Netscape: ACT-R Lesson Units". The main content area displays a hierarchical list of lesson units:

- ACT-R Lesson Units
 - Unit 0: Interpreting Production Rules
 - Section 0.1: Production Rule Forms
 - 0.1.1 Declarative Units in ACT-R
 - 0.1.2 Production Rules in ACT-R
 - 0.1.3 Production Rule Format
 - 0.1.4 ACT-R's Condition Form
 - 0.1.5 ACT-R's Action Side

The current section, "0.1.1 Declarative Units in ACT-R", is expanded to show the following text:

In ACT-R, elements of declarative knowledge are called **chunks** or **WMEs** (for working memory elements).

On the right side of the browser window, there is a table of contents with buttons for "Content", "Glossary", "Help", "Search", and "Hint", each with a question mark icon. Below this is a "Background:" section with a dropdown menu currently set to "ACT-R" and a "declarative knowledge" link.

Four blue circles with numbers 1, 2, 3, and 4 are positioned to the left of the browser window, with lines pointing to specific elements:

- 1: Points to the text "In ACT-R, elements of declarative knowledge are called **chunks** or **WMEs** (for working memory elements)." in the main content area.
- 2: Points to the "0.1.1 Declarative Units in ACT-R" section header in the main content area.
- 3: Points to the "0.1.1 Declarative Units in ACT-R" section header in the table of contents.
- 4: Points to the "ACT-R Lesson Units" title in the table of contents.

1. Concept role

2. Current concept state

3. Current section state

4. Linked sections state

What can be adapted: links

- Contextual links (“real hypertext”)
- Local non-contextual links
- Index pages
- Table of contents
- Links on local map
- Links on global map

Link types and technologies

	Direct guidance	Sorting	Hiding	Annotation	Map adaptation
Contextual links	OK		(disabling)	OK	
Non-contextual links	OK	OK	?	OK	
Table of contents	OK		?	OK	
Index	OK		?	OK	
Local map	OK		OK	OK	OK
Global map	OK		OK	OK	OK

Some Popular ANS Mechanisms

- Relevance-based navigation support
 - Expresses link relevance to user interests
 - Mechanism is similar to adaptive search, but interface is different
- Prerequisite-based navigation support
- Progress-based navigation support
- *A mechanism is different from an interface*
 - Same mechanism, different presentation

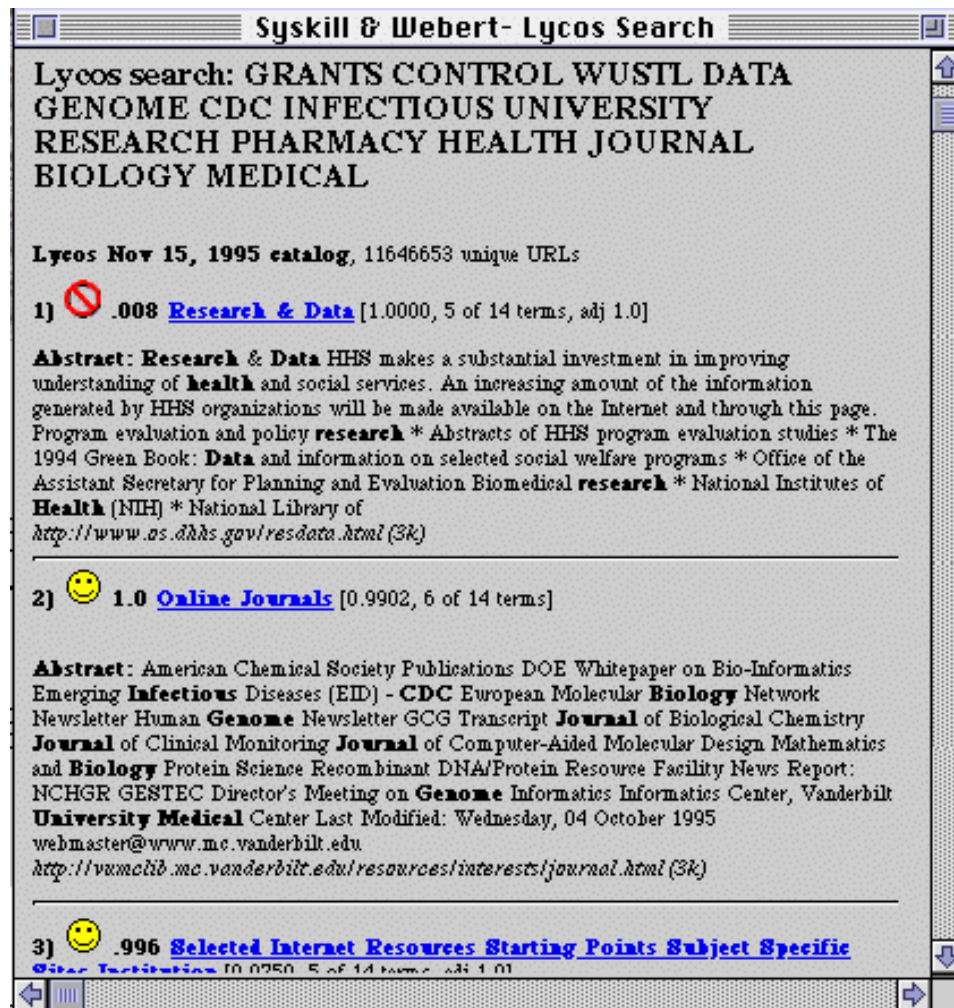
Relevance-based navigation support

- Sorting
 - HYPERFLEX, 1993
- Annotation (icons)
 - Siskill & Webert 1996
- Annotation (font)
 - ScentTrails 2003
- Annotation (icons) + Sorting
 - YourNews, 2007

Evaluation of Relevance-based AND using sorting

- HYPERFLEX: IR System
 - adaptation to user search goal
 - adaptation to “personal cognitive map”
- Number of visited nodes decreased (significant)
- Correctness increased (not significant)
- Goal adaptation is more effective
- No significant difference for time/topic


Syskill & Webert vs. ScentTrails




Syskill & Webert - Lycos Search

Lycos search: GRANTS CONTROL WUSTL DATA
GENOME CDC INFECTIOUS UNIVERSITY
RESEARCH PHARMACY HEALTH JOURNAL
BIOLOGY MEDICAL


Lycos Nov 15, 1995 catalog, 11646653 unique URLs

1)  [.008 Research & Data](#) [1.0000, 5 of 14 terms, adj 1.0]

Abstract: **Research & Data** HHS makes a substantial investment in improving understanding of **health** and social services. An increasing amount of the information generated by HHS organizations will be made available on the Internet and through this page. Program evaluation and policy **research** * Abstracts of HHS program evaluation studies * The 1994 Green Book: **Data** and information on selected social welfare programs * Office of the Assistant Secretary for Planning and Evaluation **Biomedical research** * National Institutes of **Health** (NIH) * National Library of <http://www.as.dhhs.gov/resdata.html> (3k)

2)  [1.0 Online Journals](#) [0.9902, 6 of 14 terms]

Abstract: American Chemical Society Publications DOE Whitepaper on Bio-Informatics Emerging **Infectious** Diseases (EID) - CDC European Molecular **Biology** Network Newsletter Human **Genome** Newsletter GCG Transcript **Journal** of Biological Chemistry **Journal** of Clinical Monitoring **Journal** of Computer-Aided Molecular Design Mathematics and **Biology** Protein Science Recombinant DNA/Protein Resource Facility News Report: NCHGR GESTEC Director's Meeting on **Genome** Informatics Informatics Center, Vanderbilt **University Medical** Center Last Modified: Wednesday, 04 October 1995 webmaster@www.mc.vanderbilt.edu <http://vumclib.mc.vanderbilt.edu/resources/interests/journal.html> (3k)

3)  [.996 Selected Internet Resources Starting Points Subject Specific](#) [0.9950, 5 of 14 terms, adj 1.0]

Departmental and Production Copiers

(60 & up Copies per Minute; Volume above 75,000 Copies per Month)

5665 Copier: 60 copies/min. Space efficient design, highlight color, versatile and feature rich with extensive sorter finishing options.

5065 Copier: 62 copies/min. Zoom R/E, up to 171"x22" originals & 11"x17" copies, feeder, duplex, other high end features.

5365 Copier: 62 copies/min. 100 sheet feeder, zoom R/E, up to 171"x22" originals & 11"x17" copies, duplex, other high end features.

Document Centre 265 Digital Copier: 65 copies/min. Scans your originals only once, and then prints as many copies as you need. Duplex, zoom reduce/enlarge.

5385 Copier: 80 copies/min. Up to 171"x22" originals & copies, 100 sheet feeder, highlight color, image editing, many features & options.

5680 Copier: 80 copies/min. Space efficient design, 100 sheet feeder, auto insertion of covers & transparency slipsheets, collating, stapling.

5388 Copier: 92 pages/min. Updated and enhanced design of the popular 1090 copier. Wide range of capabilities and capacities.

5892 Copier: 92 pages/min. Compact size, photo mode, background suppression, and 100-sheet universal document feeder. Easy-to-use control panel with message display and color graphics.

Content-Based Link Annotation in YourNews

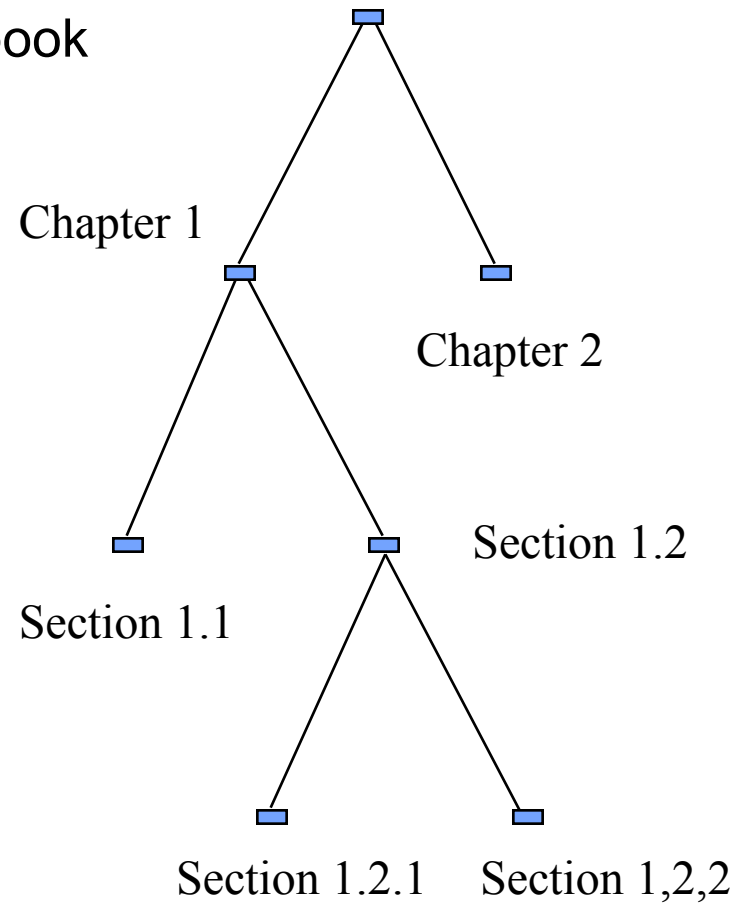
The screenshot shows the 'YourNews' web application in Mozilla Firefox. The browser's address bar displays the URL: `http://ir.exp.sis.pitt.edu/gale/news-study/personalize`. The page title is 'YourNews'. The user 'jahn' is logged in, with options for 'Logout', 'Preference', and 'Session 1'. The navigation menu includes 'All', 'Headlines', 'National', 'World', 'Business', 'Technology', 'Sports', 'Entertainment', and 'Health'. Below the menu, there are options to 'Show all duplicate articles', 'Short term', 'Long term', 'Recent News', and 'Recommended News'. The main content area displays a list of news articles. The first article is titled 'Spinach Plants Probed; E. Coli Kills Boy (10 hours ago)' with a 5-star rating. The second article is 'Idaho blames toddler's death on E. coli (AP) (10 hours ago)' with a 5-star rating. The third article is 'Report Ties Cancers to 1959 Lab Meltdown (11 hours ago)'. The fourth article is 'Breast-Feeding, Intelligence Link Probed (11 hours ago)'. The fifth article is 'Study: Drug Prevents Postpartum Bleeding (11 hours ago)'. A keyword annotation tool is overlaid on the page, showing 'jahn's Keywords for Health News [Hide]'. The tool displays a list of keywords: COLI, SPINACH, BOY, IDAHO, PLANT, BOISE, PROBE, KIDNEY, INFECT, DEATH, BACTERIA, TODDLER, NATIONWIDE, STRAIN, OFFICIAL, FAILURE, OUTBREAK, CRIMINAL, FRESH, PROMPT, BLAME, WARNING, CONSUMER, LINK, HEALTH, LAUNCH, DIE, OLD, MONTH, THURSDAY, KILL. A search box contains the word 'CONTAMINATION'. Below the search box, there is a text input field with 'contamination' and an 'OK' button.

InterBook: Prerequisite-based navigation in ET

- “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

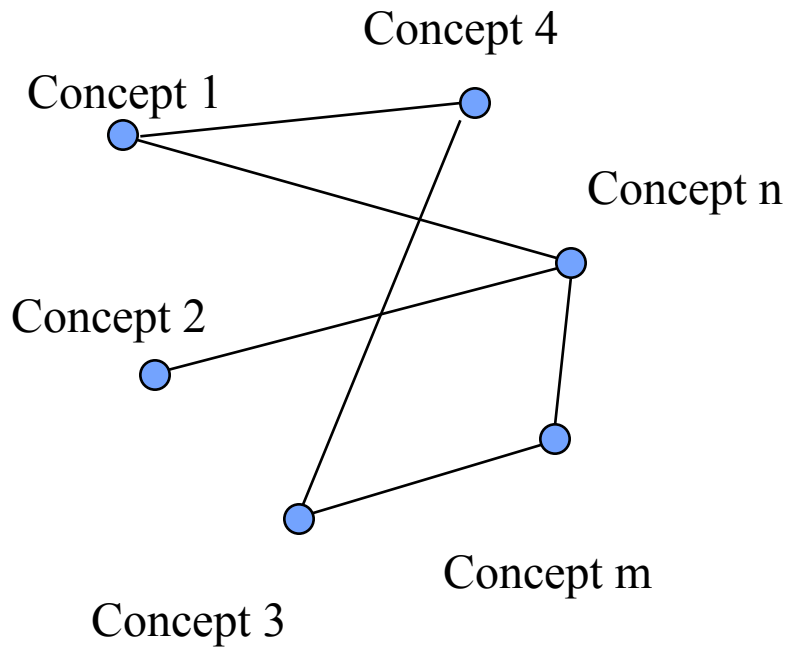
Sections and concepts

Textbook

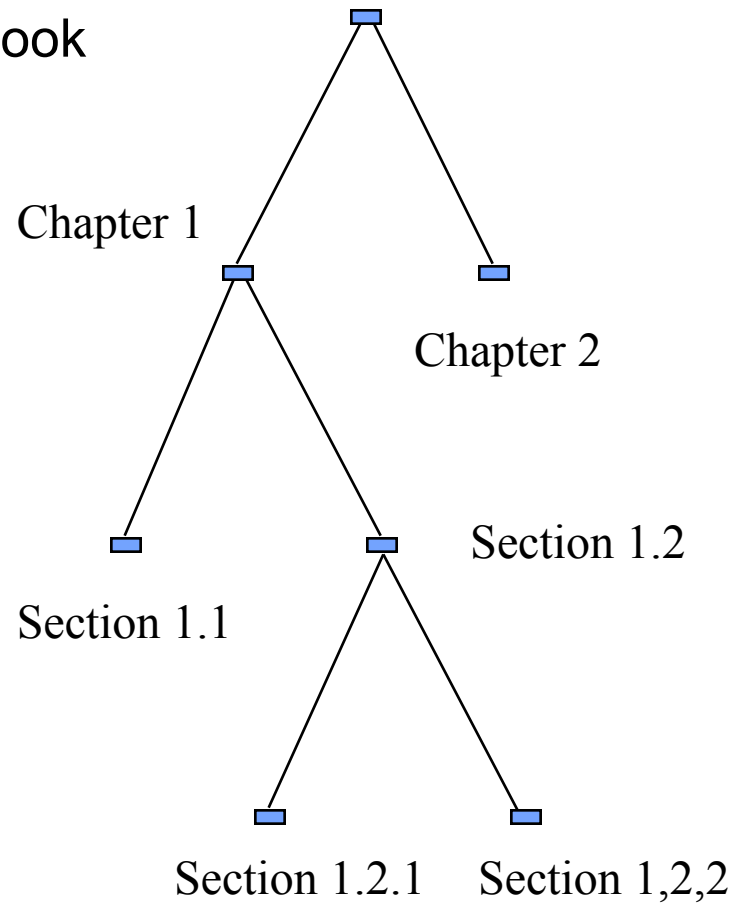


Sections and concepts

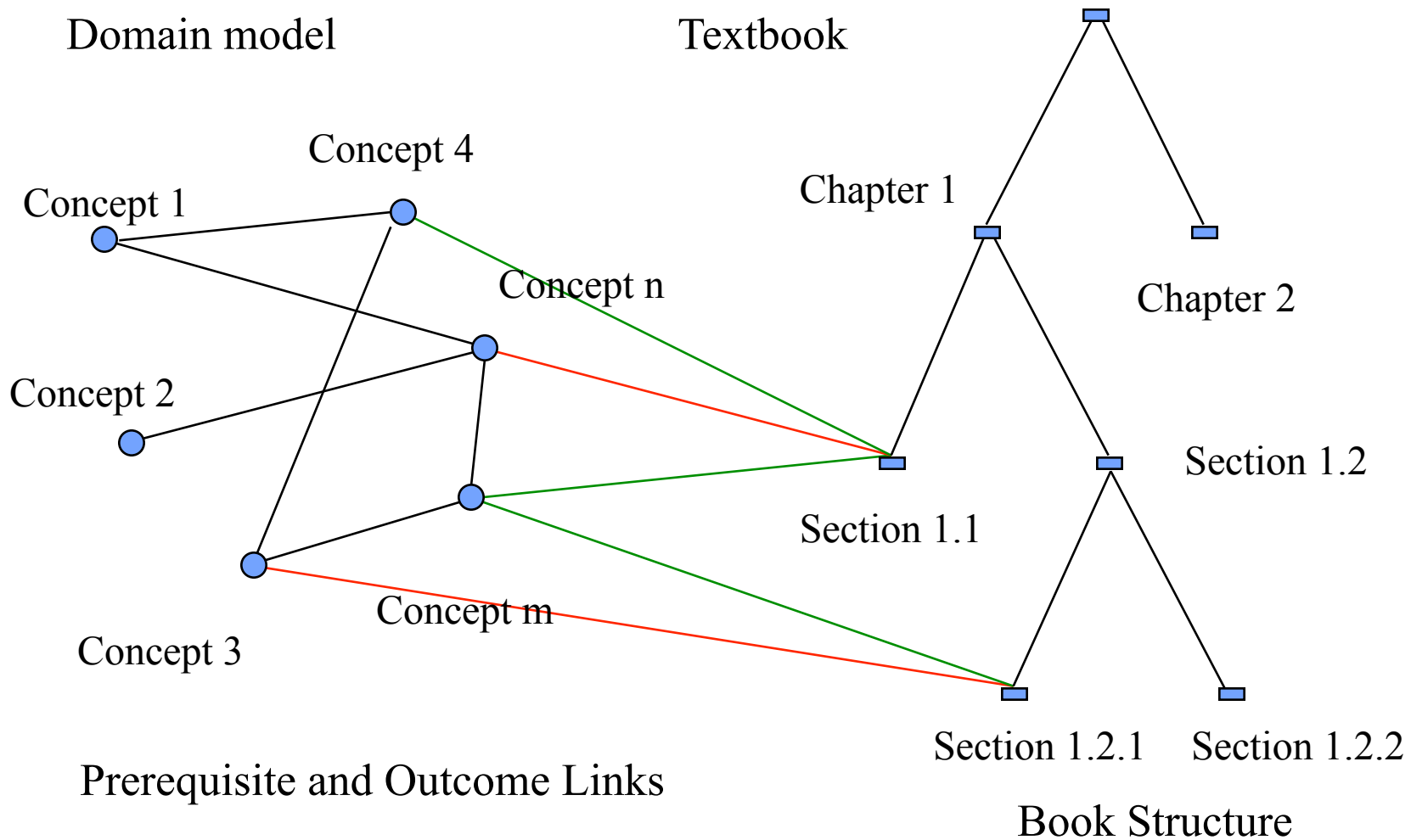
Domain model



Textbook



Indexing and navigation



[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.

Background:

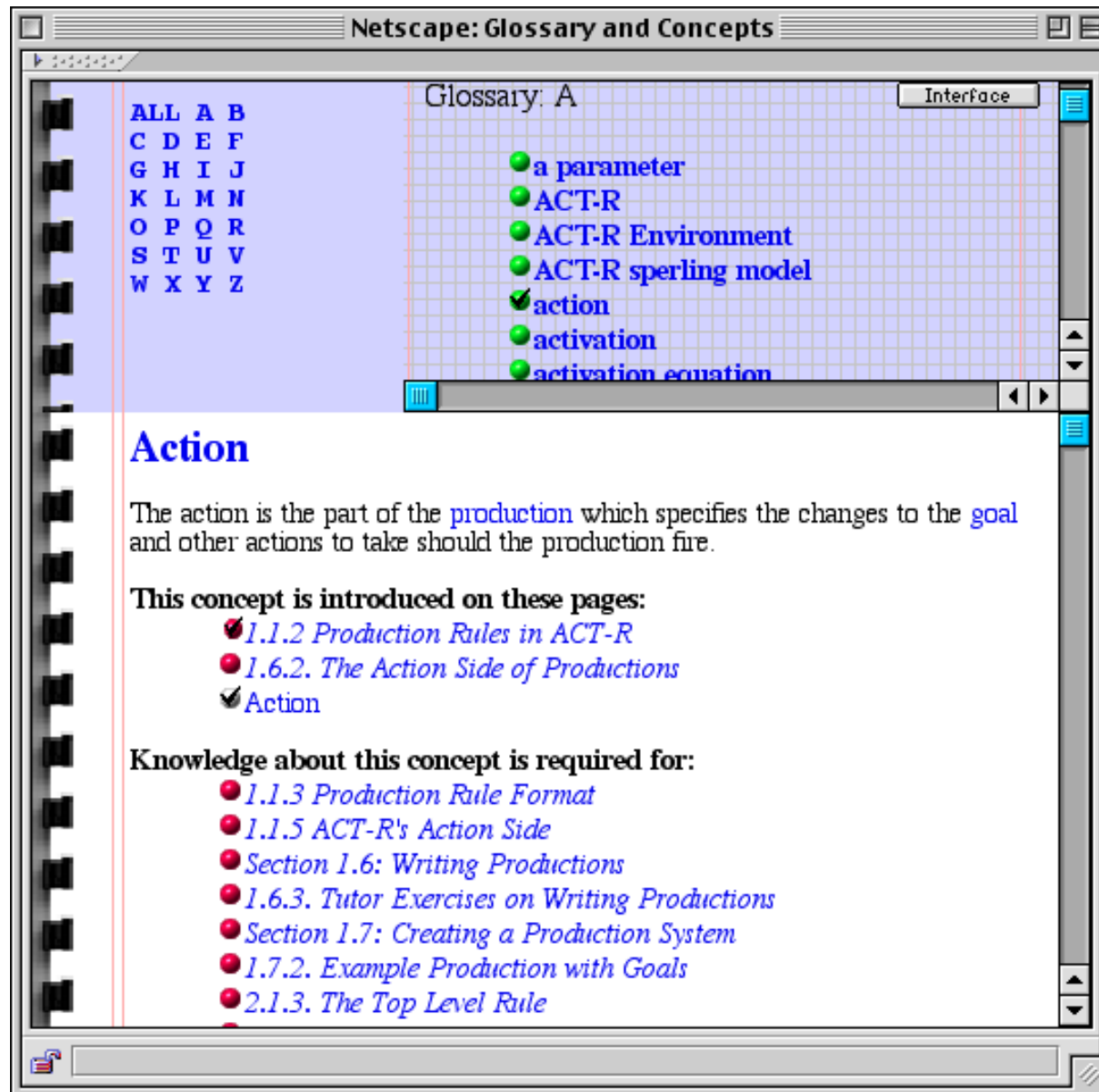
- [concept](#) ✓
- [domain model](#) ✓
- [glossary](#)
- [section](#)

Outcome:

- [background concept](#)
- [outcome concept](#)
- [spectrum](#)

Continue Teach me

Glossary view



The screenshot shows a Netscape browser window titled "Netscape: Glossary and Concepts". The address bar is empty. The main content area is divided into two sections. The top section, titled "Glossary: A", contains a list of terms with green circular icons next to them: "a parameter", "ACT-R", "ACT-R Environment", "ACT-R sperling model", "action" (with a checked checkbox), "activation", and "activation equation". To the left of this list is a vertical navigation menu with letters from "ALL" to "Z". The bottom section, titled "Action", contains a definition: "The action is the part of the production which specifies the changes to the goal and other actions to take should the production fire." Below the definition are two sections: "This concept is introduced on these pages:" and "Knowledge about this concept is required for:". The first section lists three items with red circular icons and a checked checkbox for "Action". The second section lists seven items with red circular icons.

Netscape: Glossary and Concepts

Glossary: A

Interface

ALL A B
C D E F
G H I J
K L M N
O P Q R
S T U V
W X Y Z

- a parameter
- ACT-R
- ACT-R Environment
- ACT-R sperling model
- action
- activation
- activation equation

Action

The action is the part of the [production](#) which specifies the changes to the [goal](#) and other actions to take should the production fire.

This concept is introduced on these pages:

- [1.1.2 Production Rules in ACT-R](#)
- [1.6.2. The Action Side of Productions](#)
- [Action](#)

Knowledge about this concept is required for:

- [1.1.3 Production Rule Format](#)
- [1.1.5 ACT-R's Action Side](#)
- [Section 1.6: Writing Productions](#)
- [1.6.3. Tutor Exercises on Writing Productions](#)
- [Section 1.7: Creating a Production System](#)
- [1.7.2. Example Production with Goals](#)
- [2.1.3. The Top Level Rule](#)

Navigation in InterBook

- Regular navigation
 - Linear (Continue/Back)
 - Tree navigation (Ancestors/Brothers)
 - Table of contents
- Concept-based navigation
 - Glossary (concept -> section)
 - Concept bar (section -> concept)
 - Hypertext links (section -> concept)

Adaptive navigation support

- Adaptive annotations
 - Links to sections
 - Links to concepts
 - Pages
- Adaptive sorting
 - Background help
- Direct guidance (course sequencing)
 - Teach Me

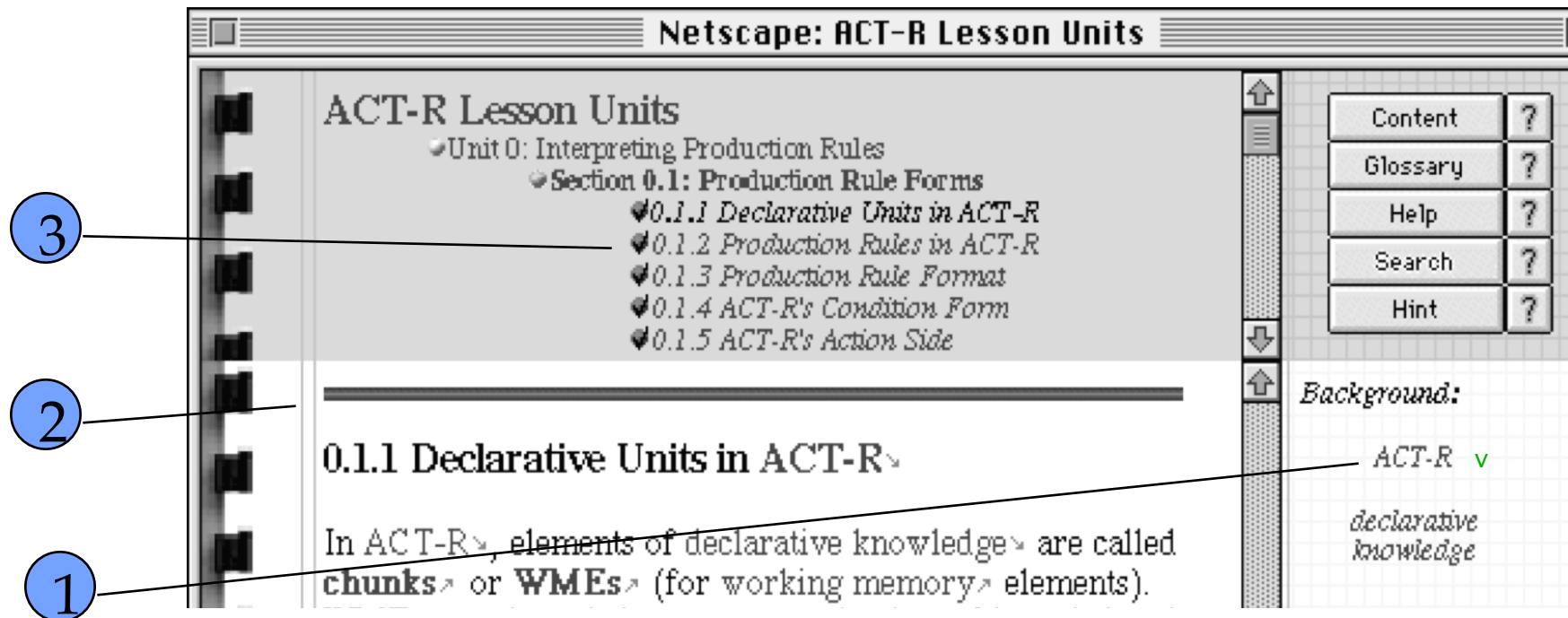
User modeling

- Overlay student model for domain concepts
- Knowledge states for each concept
 - unknown (never seen)
 - known (visited some page)
 - learned (passed a test)
- Information for sections
 - visited/not visited
 - time spent
- Information for tests: last answers

Adaptive annotation

- Educational status for concept
 - unknown
 - ✓ known
 - ✓ learned
- Educational status for sections
 - not ready to be learned
 - ready to be learned
 - suggested

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)

Backward learning: “help” and “teach this”

The screenshot shows a Netscape browser window titled "Netscape: ACT-R Lesson Units". The main content area has a light blue header with the text "ACT-R Lesson Units" and a tree view of the lesson structure:

- Unit 2: Knowledge Representation in ACT-R
 - Section 2.2: Designing Chunk Types
 - 2.2.1 Goals as Sources of Chunk Types
 - 2.2.2 Paper Exercises on Chunk Types
 - 2.2.3 Answer to Chunk Type Exercise

Below the header, there is a "Back" button and a "Teach this Page" button. A red horizontal line is drawn across the page, passing through the "Teach this Page" button.

On the right side, there is a vertical menu with buttons for "Content", "Glossary", "Help", "Search", and "Interface". Below this menu, there is a "Background:" section with a list of terms: "chunk type", "goal", "initial goal", "ISA slot", and "slot". Below that is an "Outcome:" section with a list of terms: "chunk creation", "Designing Chunk Types" (with a green checkmark), "goal", and "chunk".

An overlapping help window titled "Netscape: Help on '2.2.1 Goals as Sources of Chunk Types'" is open in the foreground. It contains the following text:

These pages could help you understanding '2.2.1 Goals as Sources of Chunk Types':

- 1.1.4 ACT-R's Condition Form
- Goal
- 1.5.2. Creating Declarative Chunks
- ISA
- 1.1.1 Declarative Units in ACT-R
- Section 1.7: Creating a Production System
- 1.6.1. Condition Form
- Chunk type
- Slot
- Defining Chunk Types
- 1.3.1 The Initialize-Addition Production

The help window also shows a list of related pages, including "the following addition fact", "which was perhaps solved by a repeated", "s a set of arguments (ARG1 and ARG2)", "ng of objects from the environment.", "f a line of symbols into a left and right", "t and right hand side would be the result.", and "be".

ELM-ART: Lisp ITS on WWW

- Model: adaptive electronic textbook
 - hierarchical textbook
 - tests
 - examples
 - problems
 - programming laboratory
- Navigation Support
 - Uses both progress-based and prerequisite-based navigation support

ELM-ART: Navigation Support

Netscape: ELM-ART: Lisp-Course

elm TUTOR HELP MODEL BACK NEXT Prefs CONTENT SEARCH EVAL EXERCISE

- LISP Course
 - Lesson 1
 - Datatypes
 - Atoms (exercises solved) ...
 - S-Atom (exercises solved) ...
 - **Numbers (with exercises) ...**
 - Lists (exercises solved) ...
 - Nested Lists (exercises solved) ...
 - Empty List, NIL, and T (with exercises) ...
 - Tests on Data Types ...

Chat Room

LISP Constructs

Private Notes on this Page

store

EXERCISE

All tasks in the last exercises were solved correctly.
However, you should work at some more tasks.

Exercises

Is the character string a *number*?

-0,4e+4

Yes
 No

HELP

Is the character string a *number*?

1

Yes
 No

HELP

submit

Working at this page is not yet recommended.



Learner Model:

Page	Link-Status	% learned	User Modification
Datatypes	The system suggests to work at this section.		<input type="checkbox"/> already known (Modification will be inherited to all subordinated pages)
Atoms (exercises solved)	You successfully worked at this page.	100 %	<input type="checkbox"/> already known
S-Atom (with exercises)	The system assumes the content of this page is known to you already.	10 %	<input type="checkbox"/> already known
Numbers (with exercises)	The system suggests to work at this page.	17 %	<input type="checkbox"/> already known
Lists (exercises solved)	You successfully worked at this page.	100 %	<input type="checkbox"/> already known
Nested Lists (exercises solved)	You successfully worked at this page.	100 %	<input type="checkbox"/> already known
Empty List, NIL, and T (with exercises)	The system suggests to work at this page.	0 %	<input type="checkbox"/> already known
Tests on Data Types	Working at this page is not yet recommended.	0 %	<input type="checkbox"/> already known

Change Model

[Back to current page \(Datatypes\)](#)



Effects of Prerequisite ANS

- Reduces navigation efforts
- Reduces repetitive visits to presentation and problem pages
- Educational goal achieved faster
- Increases learning outcome
- Adaptive annotation encourage non-sequential navigation
- Make system more attractive for students

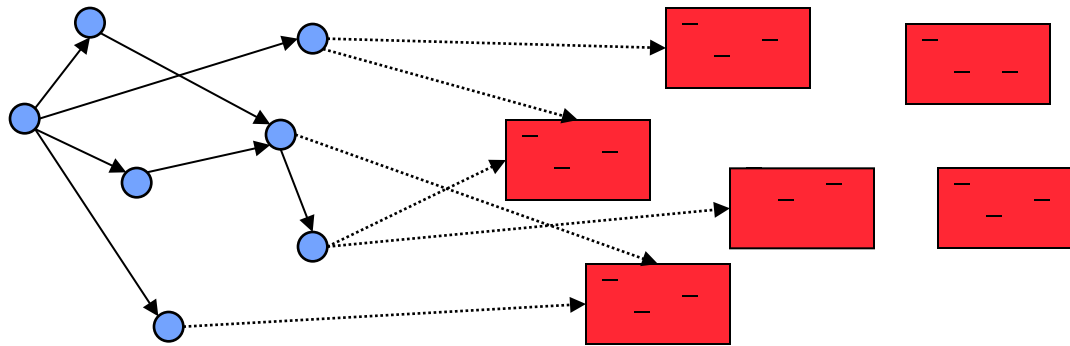
Where is the Magic?

- No magic: Knowledge behind material
- Knowledge about domain (subject)
- Knowledge about documents
 - Simple concept indexing
- Knowledge about students
 - Learning goal model
 - Overlay student model
- Straightforward techniques of user modeling and adaptation

Adaptive Hypertext: The Secret

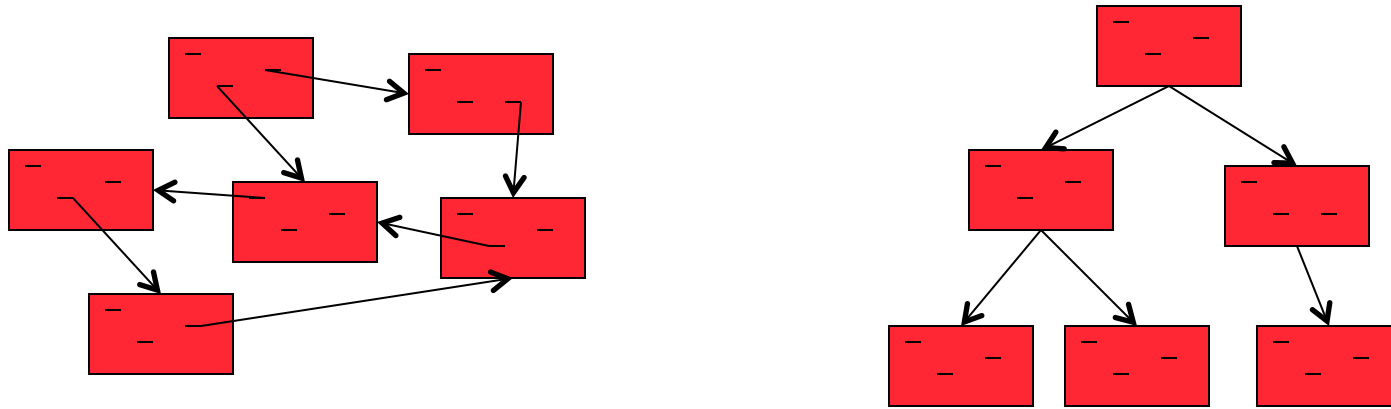
Domain Model

Pool of Learning Items



- Adaptive hypertext has knowledge “behind” the pages
- A network of pages like a regular hypertext plus a network of concepts connected to pages

Hyperspace structuring



- Concept-based hyperspace
- No imposed structure
- Hierarchy
- ASK approach - conversational relationships

Progress-Based Mechanism

- The idea of the mechanism to express the progress of user knowledge/experience
 - With domain concepts
 - With content pages
- Possible interfaces
 - Removing links to well-known concepts (AHA)
 - Annotating links to concepts and pages (InterBook, Inspire, QuizGuide, NavEx)

Progress-Based Hiding

- Adaptive course on Hypertext (De Bra)
- Hiding “not ready” links
- Hiding obsolete links to support content
- Small-scale evaluation
- No significant differences
- Students are not comfortable with disappearing links

Progress-Based Annotation

The screenshot shows a web browser window titled "INSPIRE - Βασικές Λειτουργίες - Microsoft Internet Explorer". The browser's address bar and menu bar are visible. The website's header features the "INSPIRE" logo and several navigation icons with labels: Γλωσσάρι, Σημειώσεις, Αποηρημένα, E-mail, Βοήθεια, Μοντέλο, and Μάθημα. The main content area is titled "Βασικές Λειτουργίες Κρυφής Μήμης" (Basic Functions of the Hidden Message). On the left, there is a sidebar menu with categories like "Κρυφή Μήμη" (Hidden Message) and "Βασικές Λειτουργίες" (Basic Functions), with sub-items such as "Οργάνωση Κρυφής Μήμης", "Τεχνικές Αποστολής", "Εισαγωγή", "Ασκήσεις Αξιολόγησης", "Μεταφορές Δεδομένων", "Ασκήσεις Αξιολόγησης", "Κέντρο μπλοκ", "Ανακεφαλαίωση", "Τοποθέτηση", "Εντοπισμός", "Ανακατάσταση", and "Εγγραφή στην Κρυφή Μήμη". The main content area includes a section titled "Εκκοός" (Excerpt) with a paragraph explaining the role of the hidden message and its basic functions. Below this is a list of five bullet points describing the functions. There are also sections for "Προσπαιτούμενες Έννοιες" (Concepts to be taught) and "Σχετικές Έννοιες" (Related concepts), each with a list of related terms. Navigation links like "Επόμενη" (Next) and "Επιστροφή στην Αρχή" (Return to Home) are present.

INSPIRE - Βασικές Λειτουργίες - Microsoft Internet Explorer

File Edit View Favorites Tools Help

INSPIRE Γλωσσάρι Σημειώσεις Αποηρημένα E-mail Βοήθεια Μοντέλο Μάθημα

Κρυφή Μήμη [Επόμενη](#)

Οργάνωση Κρυφής Μήμης Layer 1

Τεχνικές Αποστολής Layer 2

Βασικές Λειτουργίες Layer 2

Εισαγωγή

Ασκήσεις Αξιολόγησης

Μεταφορές Δεδομένων

Ασκήσεις Αξιολόγησης

Κέντρο μπλοκ

Ανακεφαλαίωση

Τοποθέτηση

Εντοπισμός

Ανακατάσταση

Εγγραφή στην Κρυφή Μήμη

Βασικές Λειτουργίες Κρυφής Μήμης

Εκκοός

Θα αναφερθούμε στο ρόλο της κρυφής μήμης και θα ορίσουμε τη μικρότερη μονάδα πληροφορίας της. Θα αναφερθούμε στις έννοιες της επιτυχίας, της αποτυχίας και της ποιής αποτυχίας. Θα διακρίνουμε τις τέσσερις βασικές λειτουργίες της κρυφής μήμης και θα περιγράψουμε τη σχέση που έχουν με τη λειτουργία ανάγνωσης ή εγγραφής του επεξεργαστή.

Όταν θα έχετε μελετήσει τις βασικές λειτουργίες της κρυφής μήμης, θα μπορείτε να:

- ▶ να προσδιορίζετε το ρόλο της κρυφής μήμης σε ένα υπολογιστικό σύστημα
- ▶ να ορίζετε τη μικρότερη μονάδα προσπέλασης στην κρυφή μήμη
- ▶ να περιγράψετε τη σχέση που έχει η λειτουργία της κρυφής μήμης με τη λειτουργία της ανάγνωσης ή της εγγραφής του επεξεργαστή
- ▶ να ορίζετε τις έννοιες επιτυχία, αποτυχία και ποιή αποτυχίας στην κρυφή μήμη
- ▶ διακρίνετε τις βασικές λειτουργίες της κρυφής μήμης

Προσπαιτούμενες Έννοιες

[Οργάνωση κύριας μήμης](#)

Σχετικές Έννοιες

[Επεξεργαστής](#), [Λέξη](#), [Κbyte](#), [Byte](#), [Αλγόριθμος](#), [Διευθυνοδοτημένη Μήμη](#), [Κύρια Μήμη](#)

[Επιστροφή στην Αρχή](#) [Επόμενη](#)

What Size of “concept”?

- How much domain knowledge should a concept cover?
- Two practical approaches
- Topic-based student modeling
 - Large topics, one per ULM/page
- Concept-based student modeling
 - Small concepts, many per ULM/page

Topic-based Student Modeling

- Benefits
 - Easier for students and teachers to grasp
 - Easier for teachers to index content
 - Clear interface for presentation of progress
- Shortcomings
 - The user model is too coarse-grained
 - Precision of user modeling is low

Topic-Based ANS: QuizGuide

The screenshot shows a web browser window titled "QuizGuide. Adaptive quiz recommender." with the URL `http://www.sis.pitt.edu/~ir/qplus/bin/qguide.cgi?group=1&kt_sid=824&kt_user=`. The browser's address bar includes a search engine icon and the text "Google". Below the address bar is a navigation bar with various links: Apple, Amazon, Cyberspace Atlas, citeseer, NRHM04, eBay, Yahoo!, News, 0012-42, Blackboard, KT, and ELENA. The main content area features a large blue "Quiz Guide" title with a question mark icon to its left. A vertical sidebar on the left lists various programming topics, each with a target icon: arithmetic expressions, variables, constants (define), loops (while), increment decrement, compound assignments, logical expressions, loops (do while), conditionals (if else) (with sub-items Quiz1 and Quiz2), conditional operator, character processing, and logical operators (with a red 'X' over the icon). The main content area displays "Question 1" with a code block:

```
main()
{
    int i = 0;

    if (7 % 2)
        i += 2;
    else
        i++;
}
```

Below the code, the text "What is the final value of i" is followed by a text input field containing "i =". A "Submit" button is located below the input field.

QuizGuide: Topic-level Adaptive Annotations

- Target-arrow abstraction:
 - Number of arrows – level of knowledge for the specific topic (from 0 to 3). *Individual, event-based adaptation.*



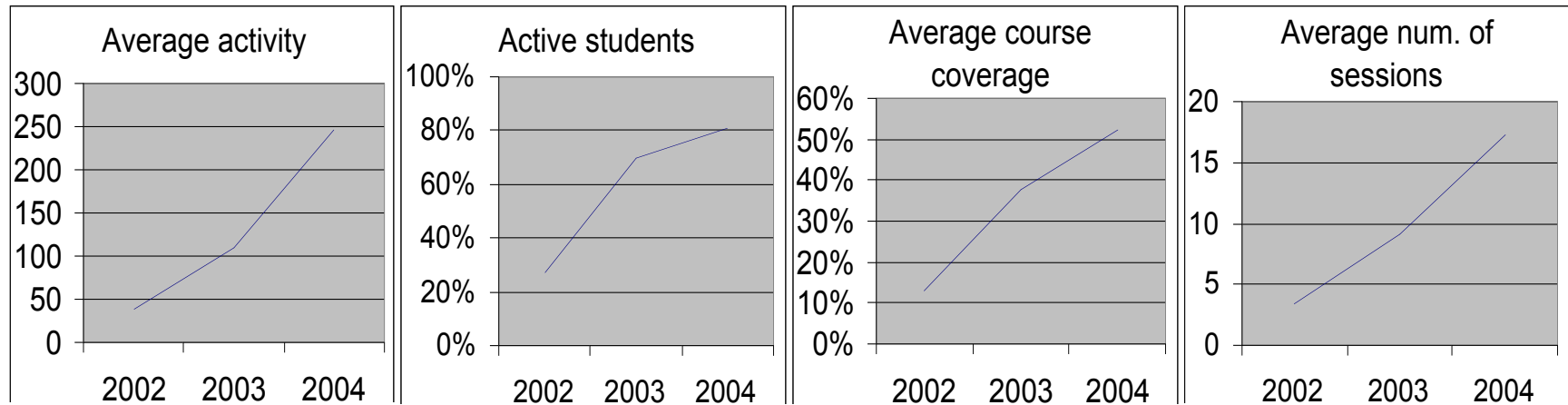
- Color Intensity – learning goal (current, prerequisite for current, not-relevant, not-ready). *Group, time-based adaptation.*



	loops (while) Quiz1 Quiz2
	increment decrement
	compound assignments Quiz1
	logical expressions Quiz1
	loops (do while) Quiz1 Quiz2
	conditionals (if else)

QuizGuide: Influence on Motivation

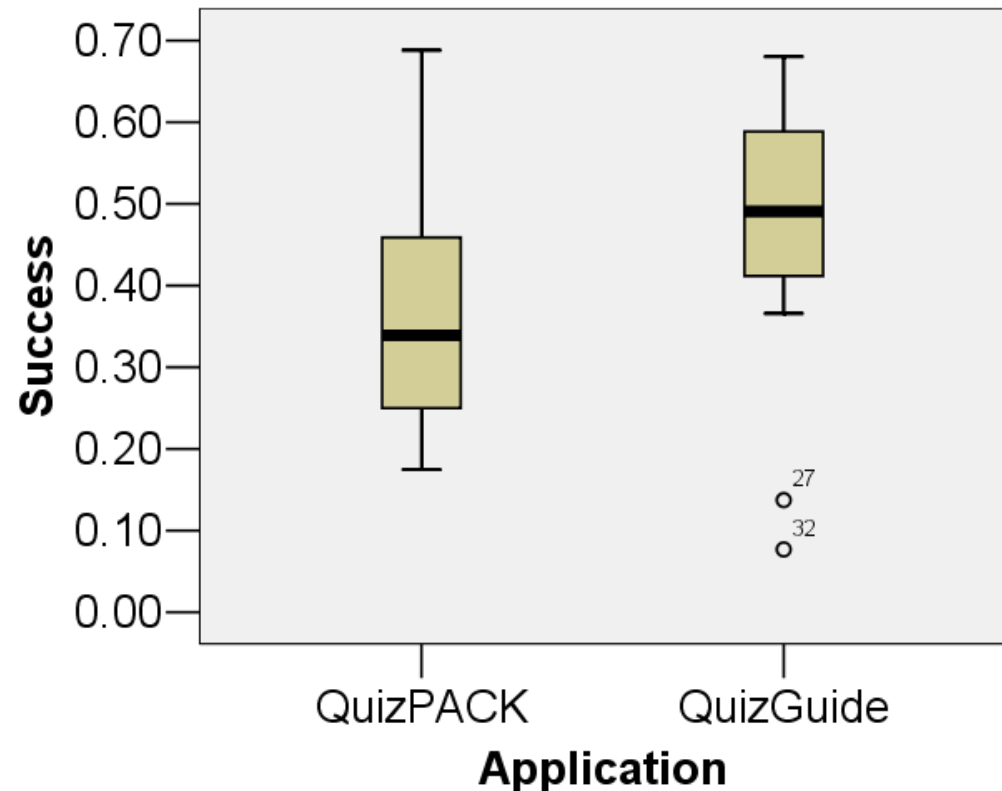
- Adaptive navigation support increased student's activity and persistence of using the system



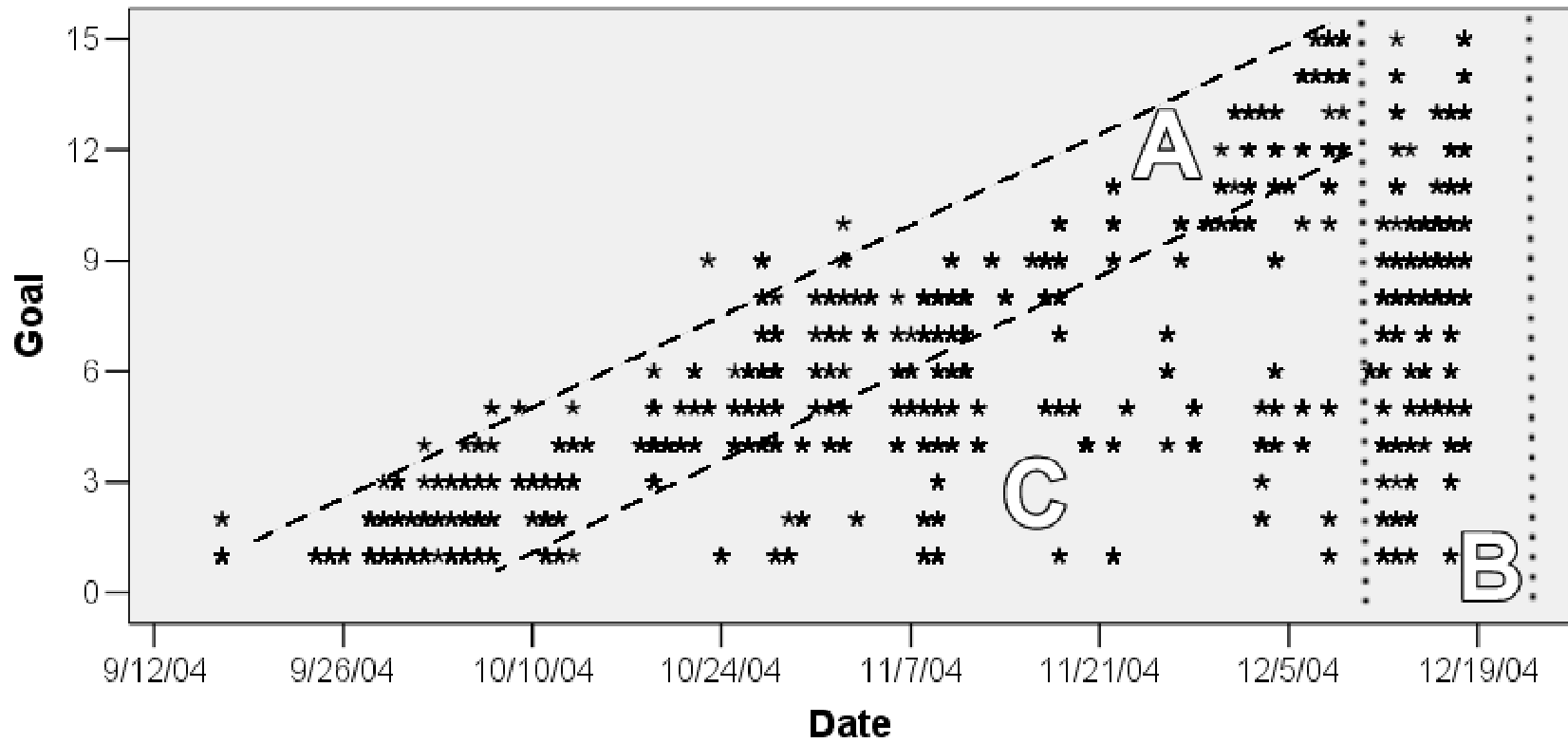
- Within the same class QuizGuide sessions were much longer than QuizPACK sessions: 24 vs. 14 question attempts at average.
- Average Knowledge Gain for the class rose from 5.1 to 6.5

QuizGuide: Success Rate Increase

- One-way ANOVA shows that mean success value for QuizGuide with ANS is significantly larger than:
 $F(1, 43) = 5.07$
(p-value = 0.03).



A Deeper Look



Concept-based Student Modeling

- Benefits
 - The user model is fine-grained
 - Precision of user modeling is good
- Shortcomings
 - Harder for students and teachers to grasp
 - Harder for teachers to index content
 - Presentation of progress is harder to integrate into the system interface

Concept-Based ANS: NavEx

The screenshot shows a Microsoft Internet Explorer window with the title "L10: capital.c - Microsoft Internet Explorer". The address bar contains the URL "http://kt2.exp.sis.pitt.edu:8080/Y2/kt/TShow?kt_user=sergey&kt_sid=111&gid=-1&intf=P&cid=1&id=481&svc=".

The main content area is titled "L10: capital.c" and includes a "Code Dissection" section. On the left, there is a list of files with green circles next to them, indicating they are available for dissection. The file "L10: capital.c" is currently selected and highlighted. Other files in the list include "L08: printing2.c", "L09: exchange_kiosk.c", "L09: variables.c", "L10: better_kiosk.c", "L10: fahr_input.c", "L11: capitayears.c", "L11: countdown1.c", "L11: countdown2.c", "L11: factorial.c", "L12: accumulator.c", "L12: apples_kids.c", "L12: capitatable.c", and "L12: f2c table.c".

The "Code Dissection" section for "L10: capital.c" includes the following code snippet:

```
Example 3.3  
Click on a green bullet to see the annotation.  
  
■ #include <stdio.h>  
□ main() {  
■     float  
    interest_rate; /*  
    interest rate in  
    percents */  
■     int capital; /*
```

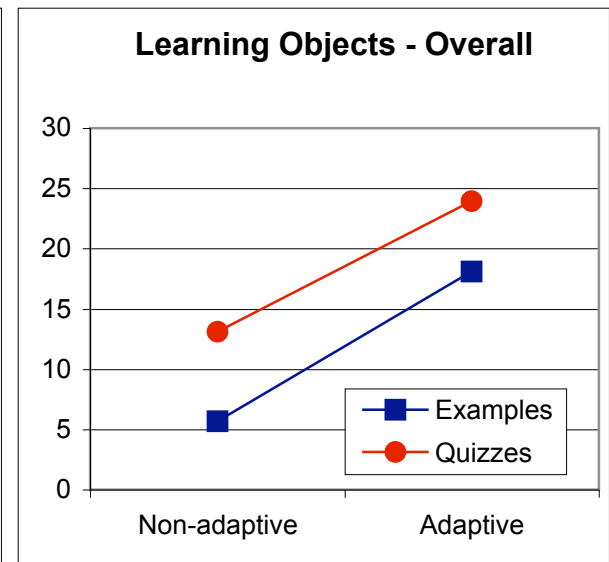
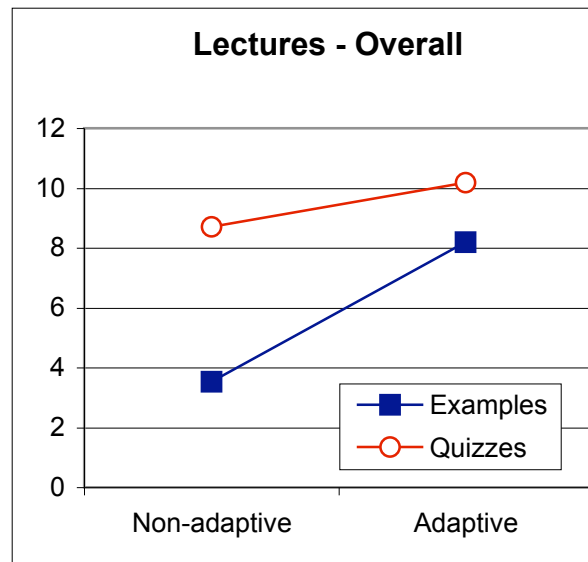
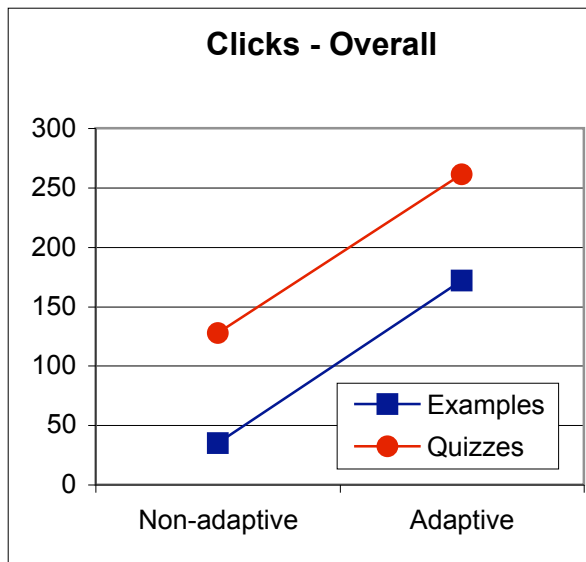
A yellow highlight is placed over the comment "/* This is a preprocessor command. System header file stdio.h will be inserted there during" in the code snippet.

Indexing Examples in NavEx

- Concepts derived from language constructs
 - C-code parser (based on UNIX lex & yacc)
 - 51 concepts totally (include, void, main_func, decl_var, etc)
- Ask teacher to assign examples to lectures
 - Use a subsetting approach to divide extracted concepts into prerequisite and outcome concepts

Increased Motivation

- The increase of the amount of work for the course



ANS vs Recommendations

- Relevance-based ANS vs. recommendations
 - Same engine, different interface
 - In-context guidance vs. ranked list
- More sophisticated ANS vs. recommendations
 - ANS can display simultaneously *several* aspects of importance/interest/relevance
 - Ranking used in recommendation approaches can only display only one dimension