

INFSCI 2480: Adaptive Information Systems

# Adaptive E-Learning Systems

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Find out more about any of these Grand Challenges:



Make solar energy economical




Provide energy from fusion



Develop carbon sequestration methods



Manage the nitrogen cycle



Provide access to clean water




Restore and improve urban infrastructure



Advance health informatics



Engineer better medicines




Reverse-engineer the brain



Prevent nuclear terror



Secure cyberspace



Enhance virtual reality



Advance personalized learning



Engineer the tools of scientific discovery



# Overview

- The Context
- Technologies
- Adaptive E-Learning Systems vs.  
Learning Management Systems (LMS)

# Major Aspects of AIS

- What is adaptive?
  - Adaptive sequencing of educational tasks
  - Adaptive content presentation
  - Adaptive ordering of search results
- What kinds of information about user?
  - User knowledge
  - User interests
  - User individual traits

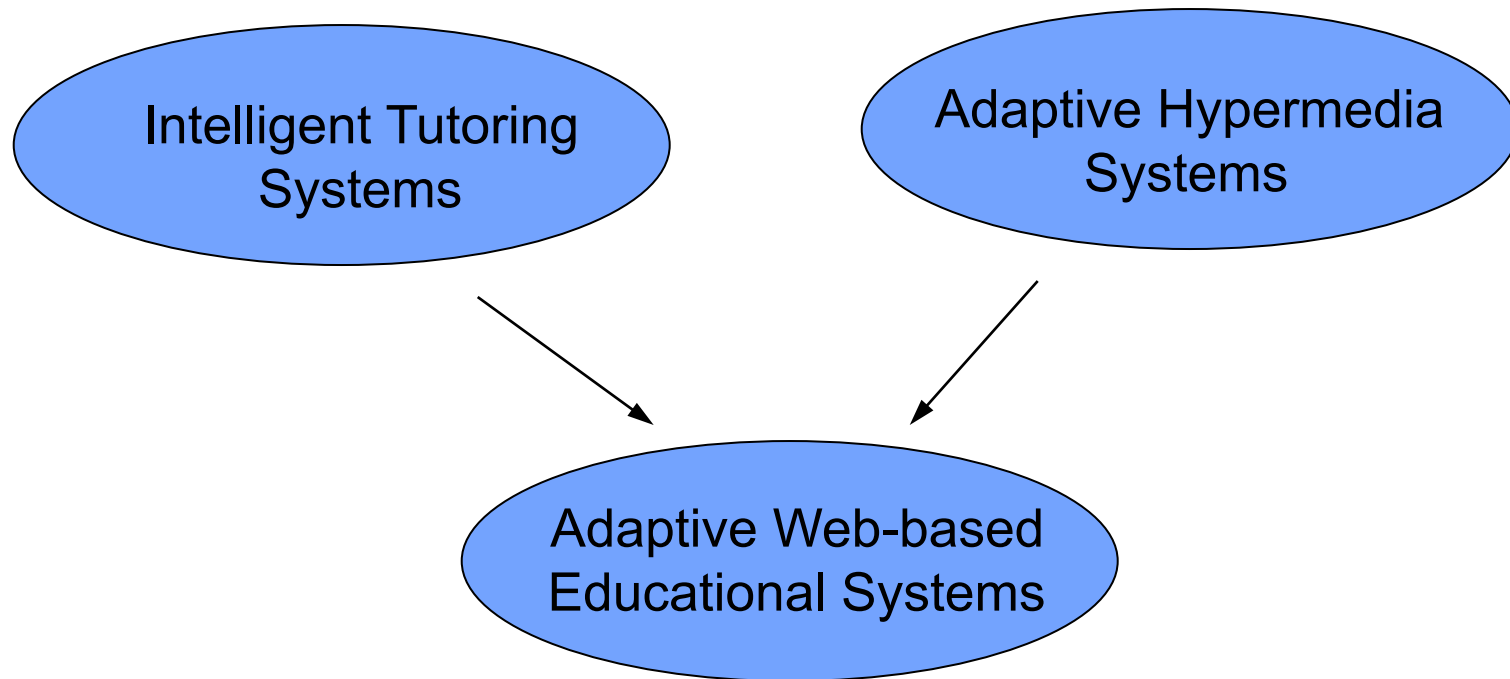
# Why Adaptive E-Learning?

- Adaptation was always an issue in education - what is special about the Web?
- greater diversity of users
  - “user centered” systems may not work
- new “unprepared” users
  - traditional systems are too complicated
- users are “alone”
  - limited help from a peer or a teacher

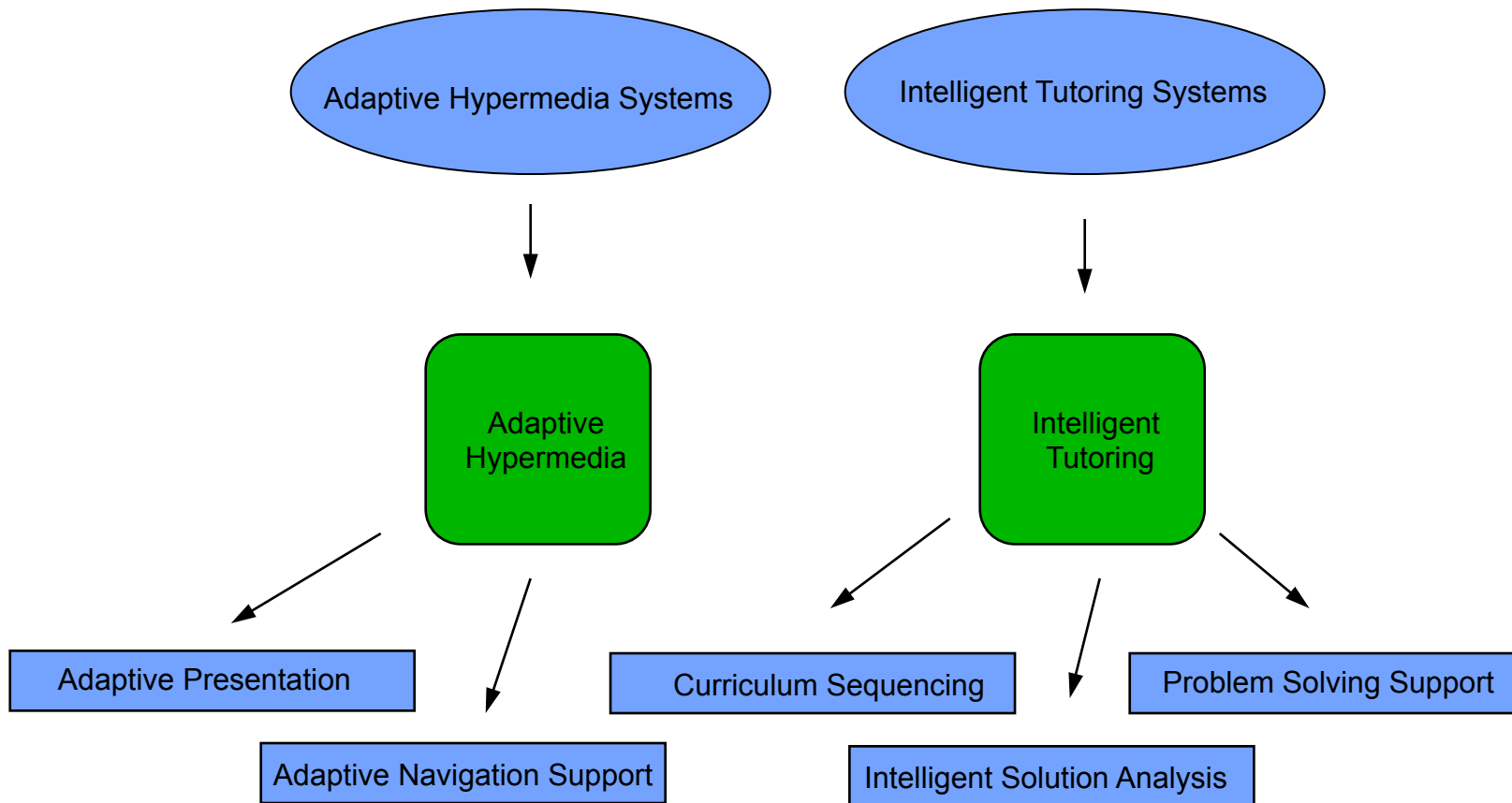
# Technologies

- Origins of AEL technologies
- ITS Technologies
- AH Technologies
- “Native” Web Technologies

# Origins of AEL Technologies



# Origins of AEL Technologies (1)





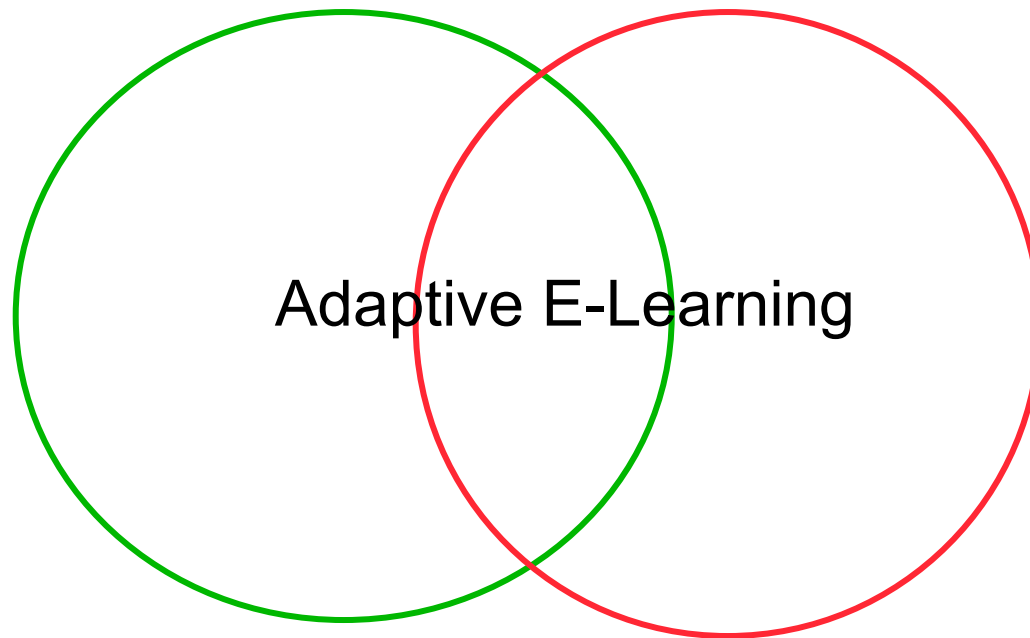
# Technology inheritance examples

- Intelligent Tutoring Systems (since 1970)
  - CALAT (CAIRNE, NTT)
  - PAT-ONLINE (PAT, Carnegie Mellon)
- Adaptive Hypermedia Systems (since 1990)
  - AHA (Adaptive Hypertext Course, Eindhoven)
  - KBS-HyperBook (KB Hypertext, Hannover)
- ITS and AHS
  - ELM-ART (ELM-PE, Trier, ISIS-Tutor, MSU)

# Technology Fusion

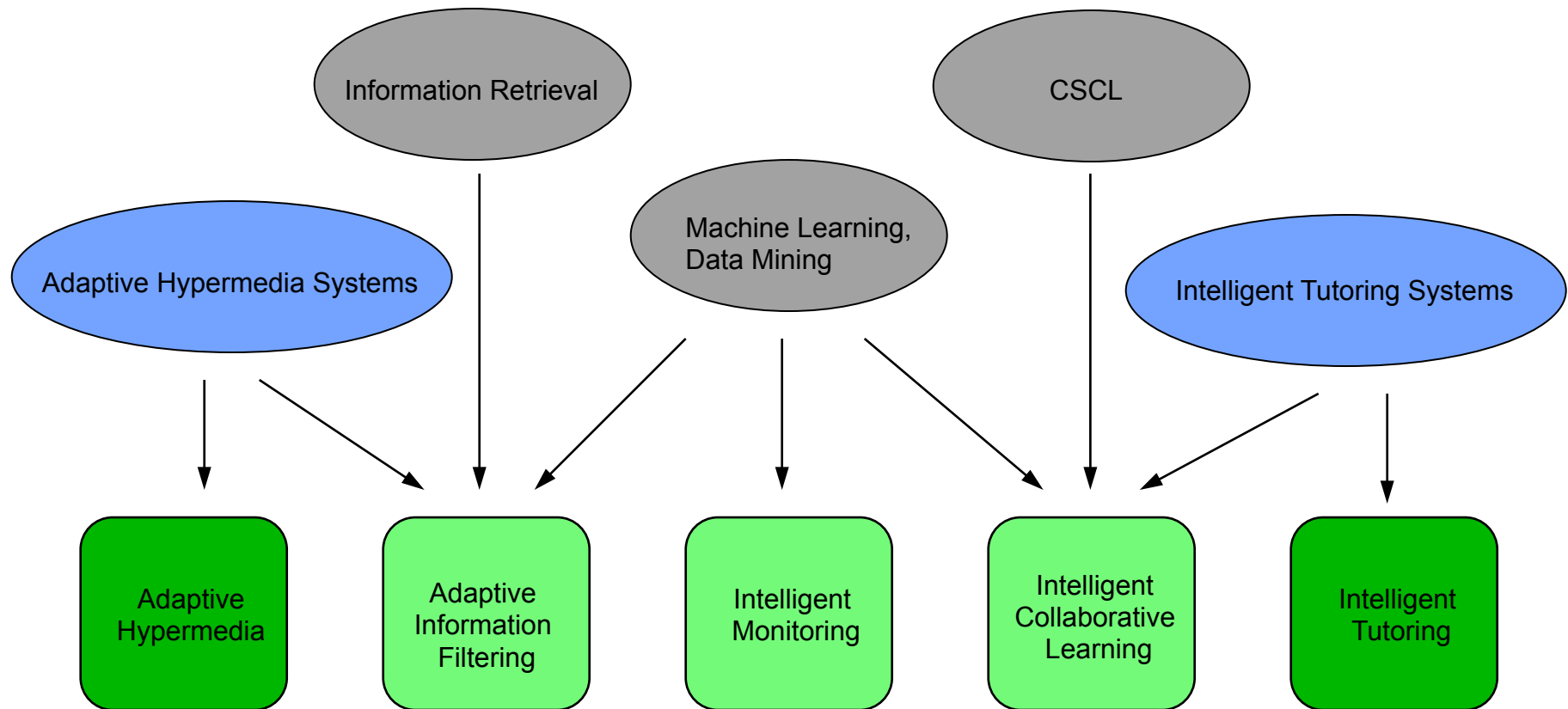
Adaptive Web

Adaptive Educational  
Systems



Adaptive E-Learning

# Origins of AEL Technologies (2)



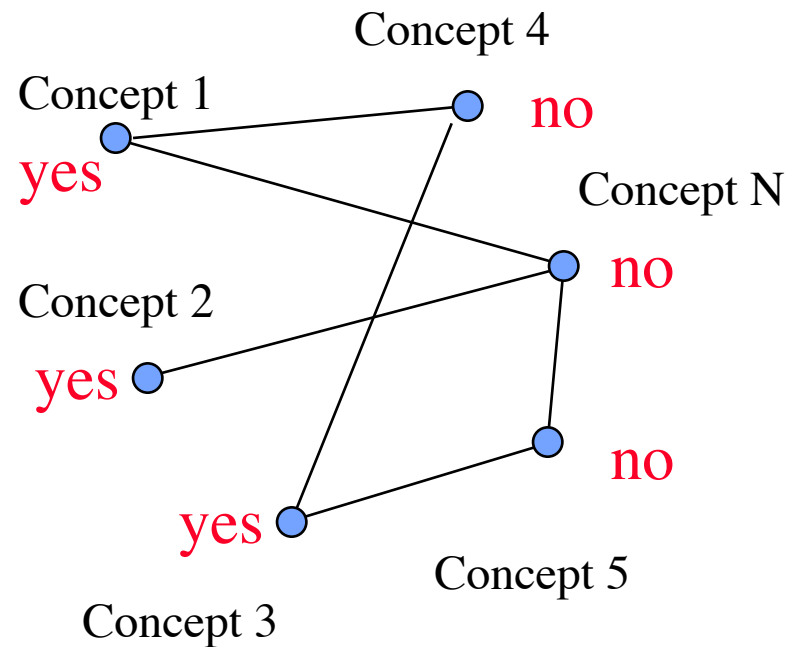
# Inherited Technologies

- Intelligent Tutoring Systems
  - course sequencing
  - intelligent analysis of problem solutions
  - interactive problem solving support
  - example-based problem solving
- Adaptive Hypermedia Systems
  - adaptive presentation
  - adaptive navigation support

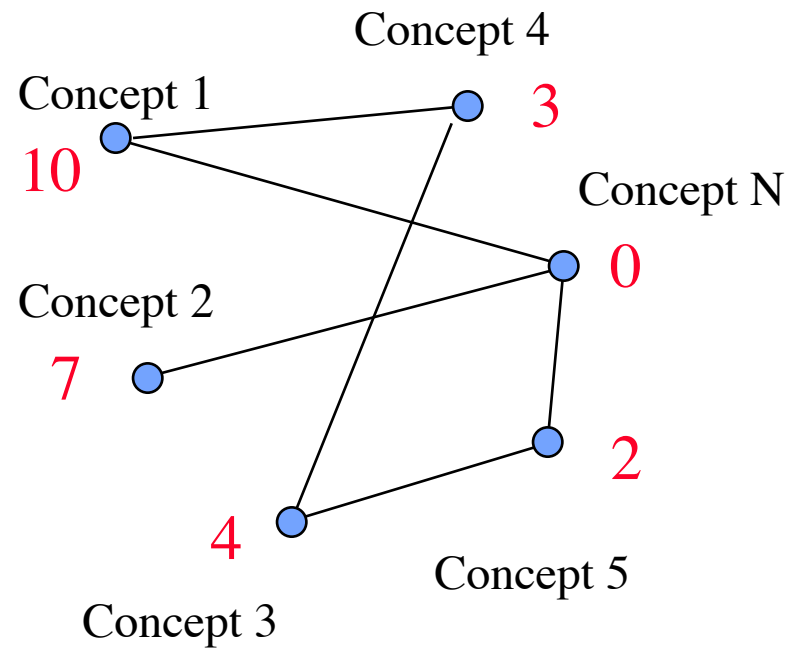
# How to Model User Knowledge

- Domain model
  - The whole body of domain knowledge is decomposed into set of smaller knowledge units
  - A set of concepts, topics, etc
- Student model
  - Overlay model
  - Student knowledge is measured independently for each knowledge unit

# Simple overlay model

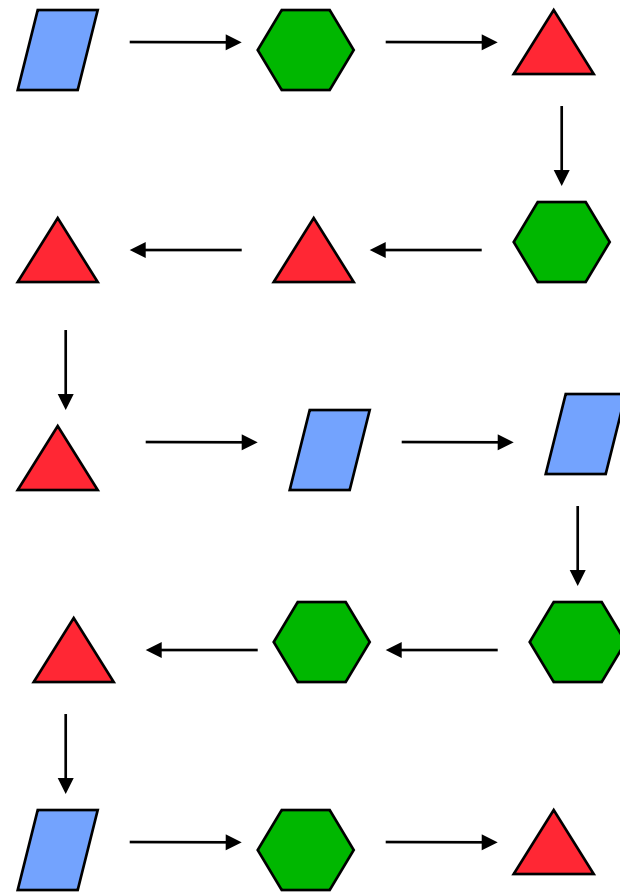


# Weighted overlay model



# Course Sequencing

- Oldest ITS technology
  - SCHOLAR, BIP, GCAI...
- Goal: individualized “best” sequence of educational activities
  - information to read
  - examples to explore
  - problems to solve ...
- Curriculum sequencing, instructional planning, ...





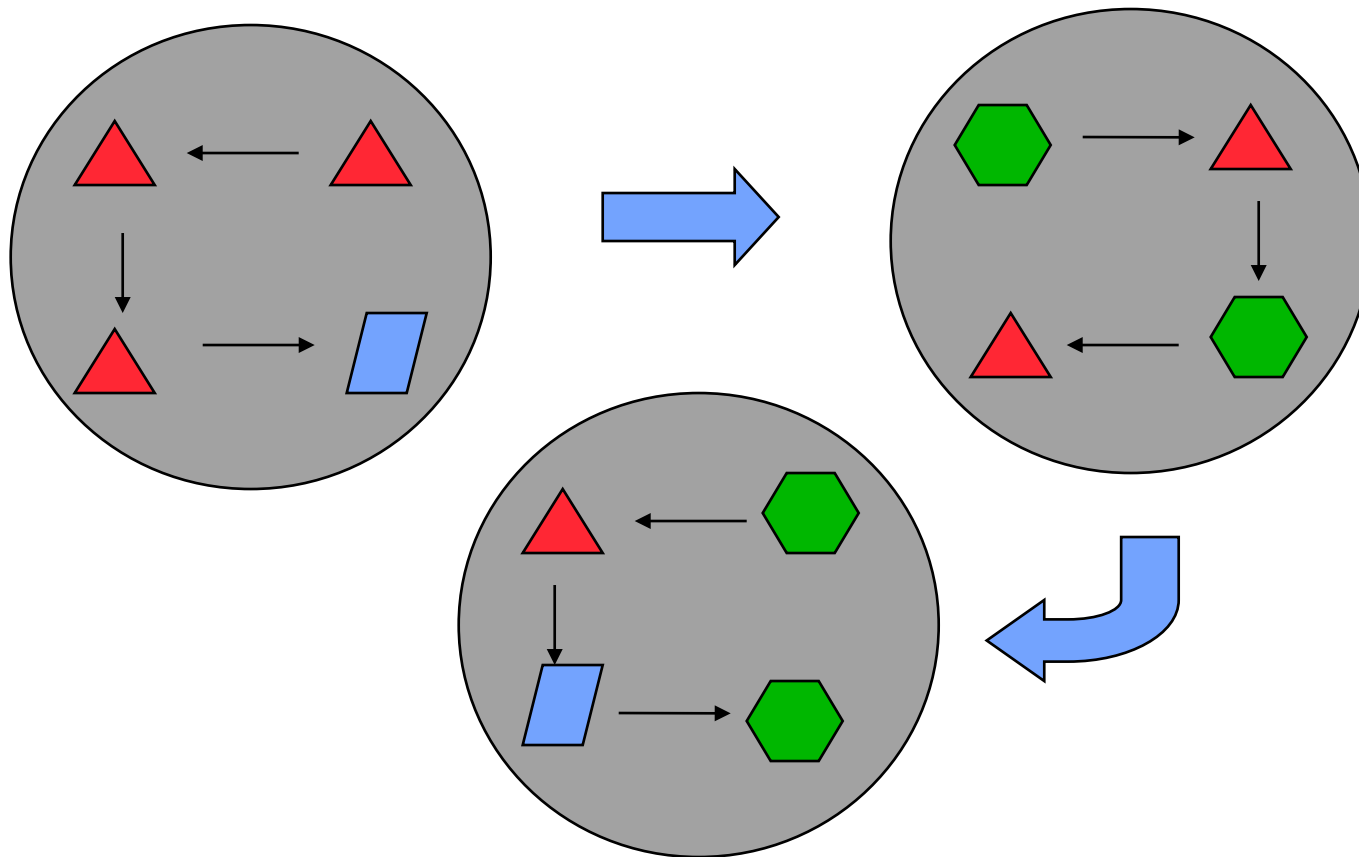
# Course Sequencing

- What is modeled?
  - User knowledge of the subject
  - User individual traits
- What is adapted?
  - Order of educational activities
  - Presentation of hypertext links
  - Presented content
  - Problem solving feedback

# Active vs. Passive Sequencing

- Active sequencing
  - goal-driven expansion of knowledge/skills
  - achieve an educational goal
    - predefined (whole course)
    - flexible (set by a teacher or a student)
- Passive sequencing (remediation)
  - sequence of actions to repair misunderstanding or lack of knowledge

# Levels of sequencing



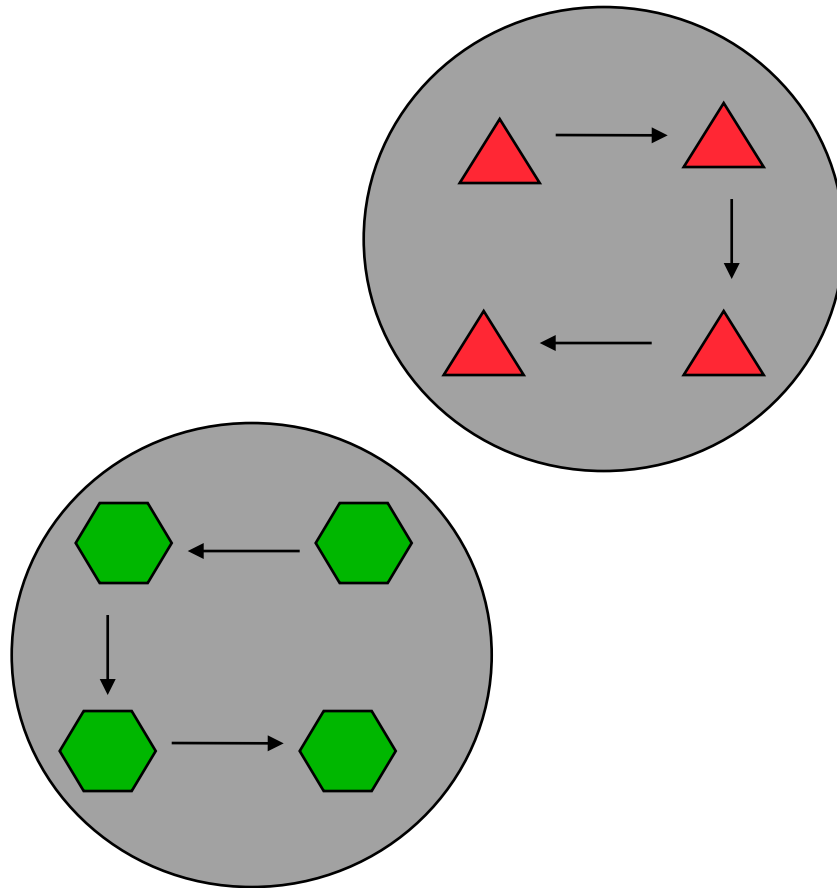
- High level and low level sequencing

# Sequencing options

- On each level sequencing decisions can be made differently
  - Which item to choose?
  - When to stop?
- Options
  - predefined
  - random
  - adaptive
  - student decides

# Simple cases of sequencing

- No topics
- One task type
  - Problem sequencing and mastery learning
  - Question sequencing
  - Page sequencing



# 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

# Sequencing for AES

- Simplest technology to implement with CGI
- Important for WBE
  - “no perfect order”
  - lack of guidance
- No student modeling capability!
  - Requires external sources of knowledge about student
  - Problem/question sequencing is self-sufficient

# ELM-ART: question sequencing

The screenshot shows a Netscape browser window titled "Netscape: ELM-ART: Lisp-Course". The interface is dark blue with a white content area. At the top, there is a navigation bar with icons for "elm", "TUTOR", "HELP", "MODEL", "BACK", "NEXT", "PREFS", "CONTENT", "SEARCH", "EVAL", and "EXERCISE".

The main content area is organized as follows:

- Navigation Menu:**
  - 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 ...

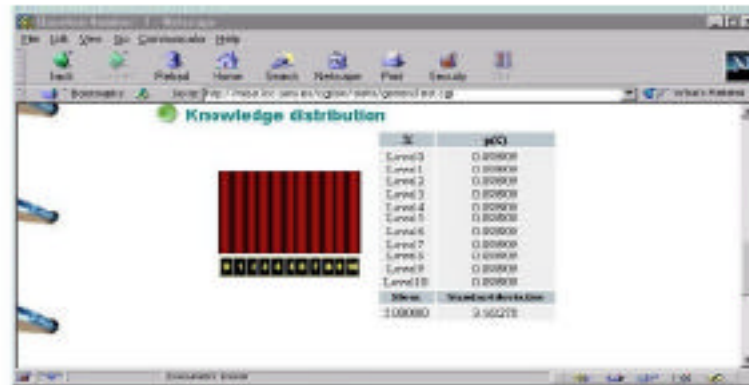
- Feedback Message:** A light blue box containing the text: "All tasks in the last exercises were solved correctly. However, you should work at some more tasks."
- Exercises Section:** A red heading "Exercises" is followed by a green checkmark icon with the word "EXERCISE" below it.
- Question 1:** "Is the character string a *number*?" with the value "-0,4e+4". Radio buttons for "Yes" and "No" are present, with "No" selected. A "HELP" icon is to the right.
- Question 2:** "Is the character string a *number*?" with the value "1". Radio buttons for "Yes" and "No" are present, with "Yes" selected. A "HELP" icon is to the right.
- Submit Button:** A "submit" button is located at the bottom of the question area.
- Right Sidebar:** Contains a "Chat Room" icon, the text "LISP Constructs", and a "Private Notes on this Page" section with a scrollable text area and a "store" button.

At the bottom of the browser window, a status bar reads: "Working at this page is not yet recommended."



# SIETTE: Adaptive Quizzes

Combination of  
CAT and concept  
Based adaptation



SIETTE

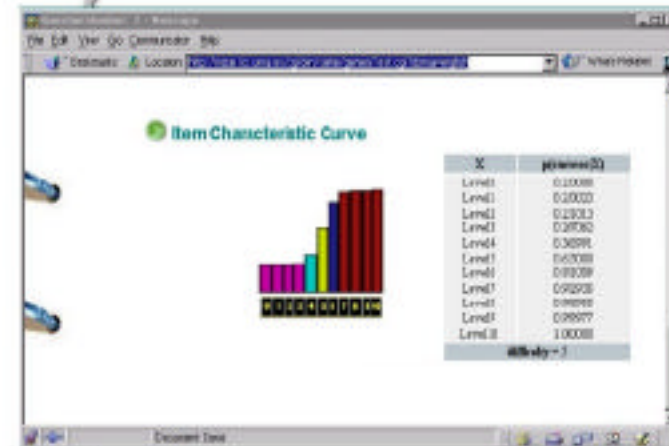
Question Number: 1

What is the specie name following picture?

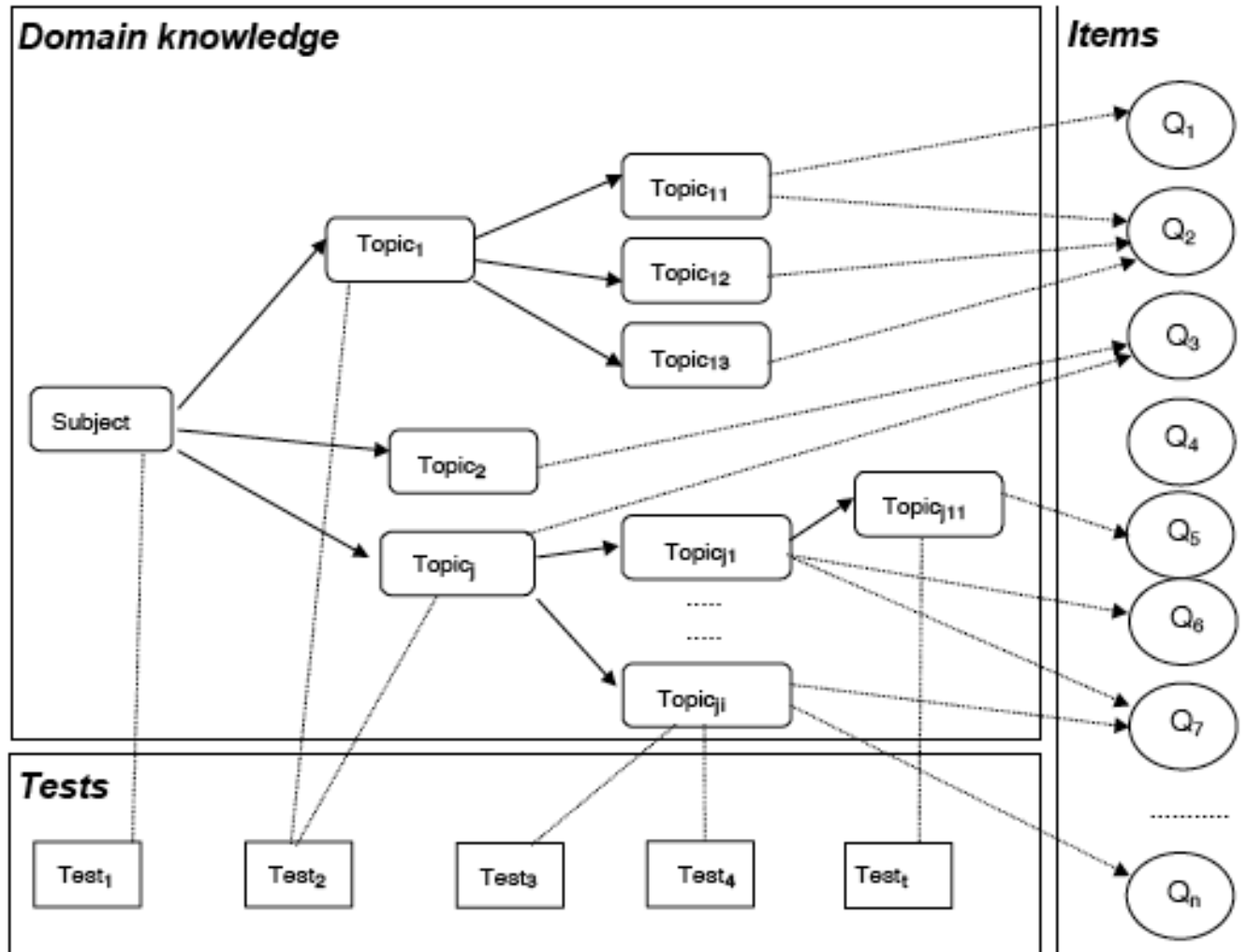
Monarch, swallowtail      Monarch, swallowtail  
Hibiscus, monarch      Hibiscus, monarch

Papilio monarch  
 Danaus monarch  
 Danaus orontus  
 Dorsa monarchia

Giveup



# Models in SIETTE



# Beyond Sequencing: Generation

Static Referencing Environment

Format View Generate Options Help

Assuming static scoping is used, select all the variables which lie within the non-local referencing environment of `lambda`.

```
program main;
  var a: Boolean;
  var q: Boolean;

  procedure lambda;
    var q: Integer;
    var b: Integer;
    var a: Char;

    procedure chi;
      var c: Boolean;
      var r: Char;
      var p: Char;

      procedure iota;
        var a: Boolean;
        begin {iota}
          ...
        end {iota}
      begin {chi}
        ...
      end {chi}

    procedure kappa;
      var q: Char;
      var c: Char;
      var x: Char;

      procedure rho;
        var q: Integer;
        begin {rho}
          ...
        end {rho}
      begin {kappa}
        ...
      end {kappa}
    begin {lambda}
      ...
    end {lambda}

  procedure zeta;
    var q: Real;
    var x: Boolean;
    var a: Real;

    procedure tau;
      var a: Char;

    procedure xi;
      var x: Char;
      begin {xi}
        ...
      end {xi}
  begin {main}
    ...
  end {main}
```

	a	b	c	p	q	r	x
chi	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
iota	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
kappa	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
lambda	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
main	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
rho	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
tau	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
xi	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
zeta	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Check My Answer

Your response: main.a  
Correct answer: None

These were incorrect: main.a  
main.a: The variable a has been redeclared in lambda. Therefore, main.a is not in the non-local referencing environment of lambda.

Select **New problem** to generate another problem of this type, or select any menu option.

New Problem

Elapsed Time 2:56 Time Remaining 0:24

Java Applet Window

# Adaptive Problem Solving Support

- The “main duty” of ITS
- From diagnosis to problem solving support
- Highly-interactive support
  - interactive problem solving support
- Low-interactive support
  - intelligent analysis of problem solutions

# Adaptive Problem Solving Support

- What is modeled?
  - User knowledge of the subject
  - User individual traits
- What is adapted?
  - Order of educational activities
  - Presentation of hypertext links
  - Presented content
  - Problem solving feedback

# Intelligent analysis of problem solutions

- Intelligent analysis of problem solutions
- Classic system: PROUST
- Support: Identifying misconceptions (bug model) and broken constraints (CM)
- Provides feedback adapted to the user model: remediation, positive help
- Low interactivity: Works after the (partial) solution is completed

# Example: ELM-ART

Netscape: ELM-ART: Lisp-Course

[elm](#) [TUTOR](#) [HELP](#) [MODEL](#) [BACK](#) [NEXT](#) [PREFS](#) [CONTENT](#) [SEARCH](#) [EVAL](#)

- [LISP Course](#)
  - [Lesson 1](#)
    - [Self-defined Functions](#)
      - [Further Tasks](#)
        - [AREA-OF-SQUARE](#) (programming task solved)
        - [RECTANGLE-AREA](#) (programming task)
        - [CUBOID-VOLUME-NEW](#) (programming task)
        - [WEIGHT-OF-PURCHASE](#) (programming task)

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## RECTANGLE-AREA

Define a function RECTANGLE-AREA, that takes as input the side lengths of a rectangle and calculates its area.

Examples:

[\(RECTANGLE-AREA 3 5\)](#)  
15

[\(RECTANGLE-AREA 4 2\)](#)  
8

[\(RECTANGLE-AREA 0 10\)](#)  
0

Type in your solution here:

```
(defun r-a (num1 num2)
  (* num1 num2))
```

Return formatted code

[show example](#)

Chat Room

LISP Constructs  
[+](#) [-](#) [DEFUN](#) [FIRST](#) [REST](#)

New Functions  
[SQUARE](#)  
[WEIGHT-OF-PURCHASE](#) [3I1SI](#)  
[MY-THIRD](#) [MY-SECOND](#)

Private Notes on this Page

store

Shows an example that may help to solve the problem.

# Example: SQL-Tutor

http://132.181.10.22:8000/sql-tutor/respond-to-main-form - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Search Favorites History Print

Address http://132.181.10.22:8000/sql-tutor/respond-to-main-form Go Links

**SQL-Tutor** Change Database New Problem History Student Model Run Query Help Log Out

**Problem 3** Retrieve the name and address of all employees who work for the Research department

Select

From

Where

Group by

Having

Order by

Feedback Level Error Flag Submit Answer Reset

There are some errors in your solution, try again

**Schema for the COMPANY Database**

The general description of the database is available [here](#). Clicking on the name of a table brings up the table details. Primary keys in the attribute list are underlined, foreign keys are in *italics*.

Table name Attribute list

DEPARTMENT DNAME DNUMBER MGR MGRSTARTDATE

EMPLOYEE ID LNAME MINIT FNAME BDATE ADDRESS SEX SALARY SUPERVISOR *DNO*

DEPT\_LOCATIONS DNUMBER DLOCATION

PROJECT PNAME PNUMBER PLOCATION *DNAME*

WORKS\_ON *EJOB* *DNO* HOURS

DEPENDENT *EJOB* DEPENDENT\_NAME SEX BDATE RELATIONSHIP

Done Internet



# Interactive Problem Solving Support







- Classic System: Lisp-Tutor
- The “ultimate goal” of many ITS developers
- Several kinds of adaptive feedback on every step of problem solving
  - Coach-style intervention
  - Highlight wrong step
  - What is wrong
  - What is the correct step
  - Several levels of help by request

# Example: PAT-Online

You have just been promoted at PAT-E-OH Furniture Inc. and have received a raise to \$5.50 per hour.

1. How much would you get paid if you worked 5 hours?
2. How much would you get paid if you worked 25 hours?
3. How much would you get paid if you worked 10 1/2 hours?
4. How much would you get paid if you worked 100 hours?
5. How much would you get paid if you worked 200 hours?
6. If you plan on working 10 hours a week during a forty week school year, what would be your total earnings be for the entire year?

For the formula, define a variable for the time worked and use this variable to write a rule for your total pay.

Heading	Time worked		Earnings	
Unit	<input type="text" value="Hours"/>		<input type="text"/>	
Formula	<input type="text"/>		<input type="text"/>	
Question 1	<input type="text"/>		<input type="text"/>	

# Example: WADEIn

The screenshot displays the WADEIn software interface. On the left is a sidebar titled "Goals and Progress" with several input fields. The main area is titled "Switch to Exploration Mode" and contains the following elements:

- 1. Expression:** A radio button for "Predefined" is selected, with the expression `--K * 3 / 2 + L++` in a dropdown menu. A "STOP !" button is located to the right.
- 2. Variables:** Integer variables A (10), B (20), and C (30) are shown in input boxes. Double variables K (9.0) and L (20.0) are also shown.
- Original Expression:** `--K * 3 / 2 + L++`
- Correct Order:** A sequence of five numbered circles (1-5) with circle 2 highlighted in green.
- Variable Values:** `K 9.0` and `L 20.0` are displayed.
- Current Expression:** `9.0 * 3 / 2 + L++` is shown in green text.
- Evaluate Expression Dialog:** A small window titled "Evaluate Expression" is open, showing "The value of '9.0 \* 3' is ..." and a text input field containing "27.0".
- Navigation:** A bar at the bottom contains buttons for "Step", "Operator", and "Expression".

At the bottom left, there is a link "back to topics list". At the bottom right, the user information "User: peterb | Current topic: Increment / Decrement" is displayed.

<http://adapt2.sis.pitt.edu/cbum/>

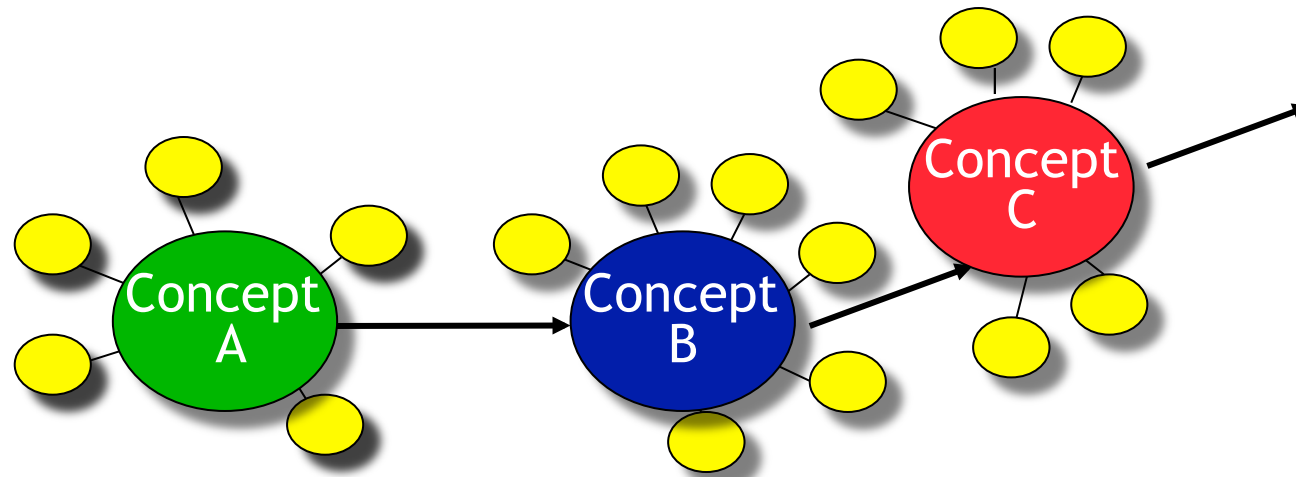
# Problem-solving support

- Important for WBE
  - problem solving is a key to understanding
  - lack of problem solving help
- Hardest technology to implement
  - research issue
  - implementation issue
- Excellent student modeling capability!

# 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

# 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



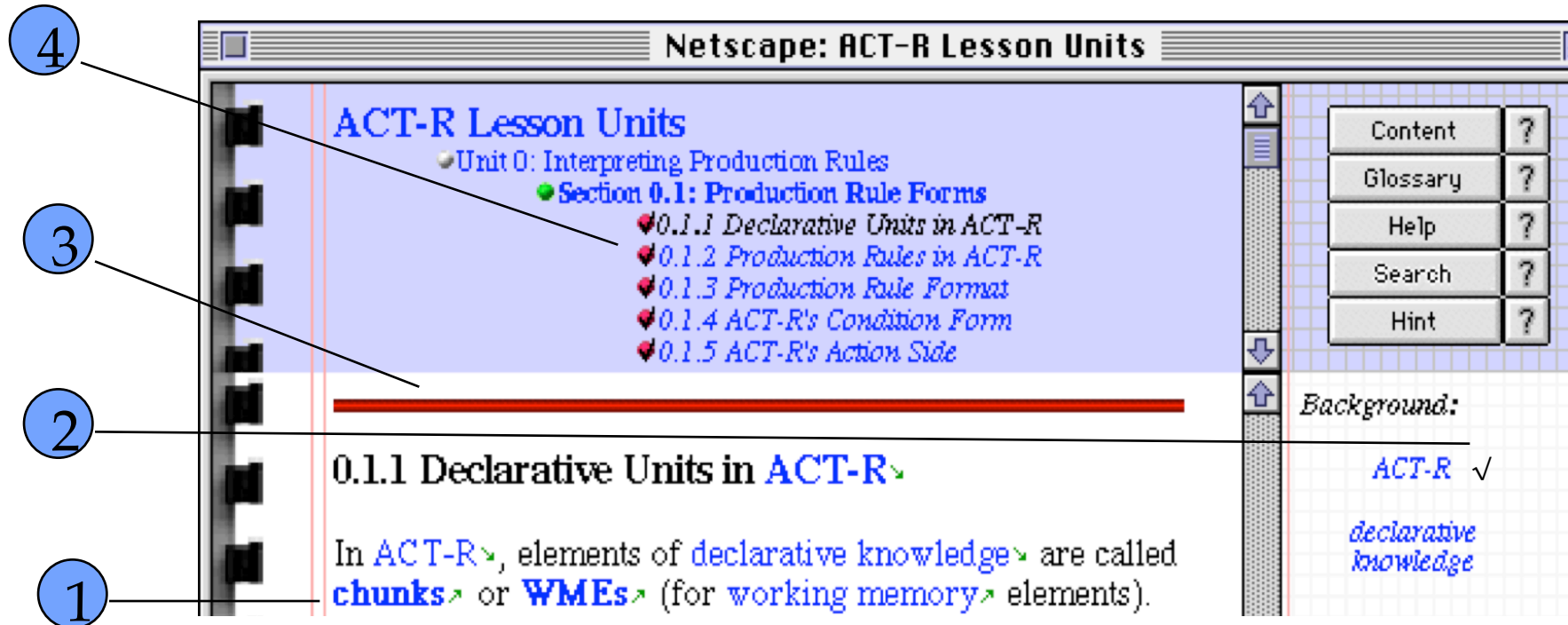
# Adaptive hypermedia

- Hypermedia systems = Pages + Links
- Adaptive presentation
  - content adaptation
- Adaptive navigation support
  - link adaptation
- Could be considered as “soft” sequencing
  - Helping the user to get to the right content

# Adaptive Navigation Support

- What is modeled?
  - User knowledge of the subject
  - User individual traits
- What is adapted?
  - Order of educational activities
  - Presentation of hypertext links
  - Presented content
  - Problem solving feedback

# Adaptive Annotation: Icons



InterBook system

1. Concept role

2. Current concept state

3. Current section state

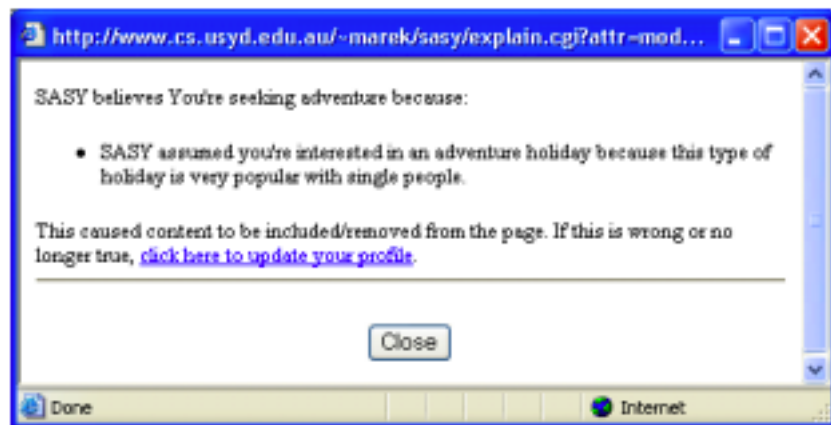
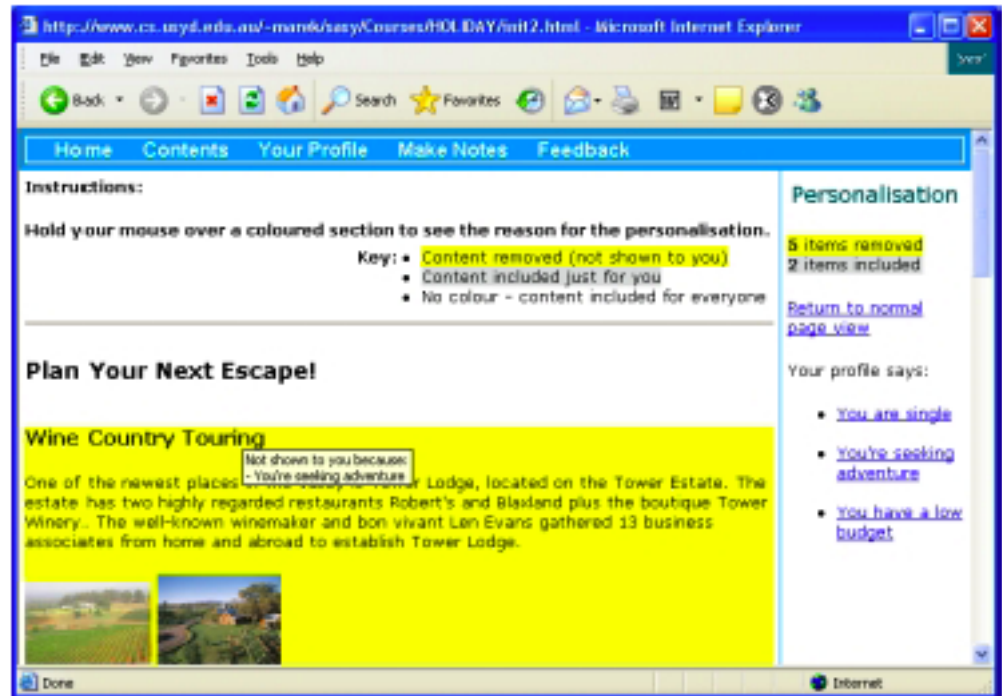
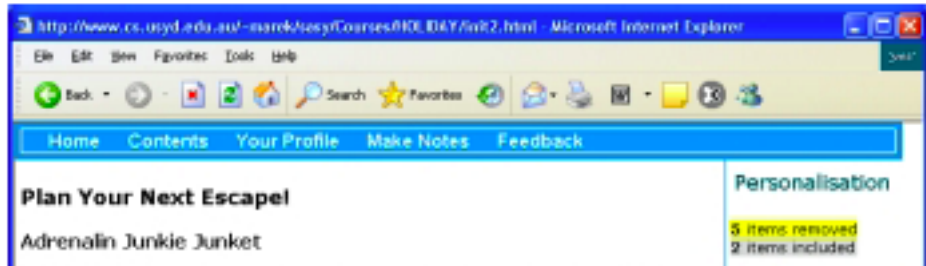
4. Linked sections state

# Adaptive Presentation

- What is modeled?
  - User knowledge of the subject
  - User individual traits
- What is adapted?
  - Order of educational activities
  - Presentation of hypertext links
  - Presented content
  - Problem solving feedback

# Example: SASY

Scrutable adaptive presentation



<http://www.cs.usyd.edu.au/~marek/sasy/>

# Adapting to User Knowledge: Other Ideas

- Adaptive interface
  - Presence of menus and widgets in an educational applet can be adapted to user knowledge
- Educational animation and simulation
  - Adaptive explanations
  - Adaptive visualization

# Demo: WADEIn

**Monitor your progress with operations that are your current goals**

The length of the bar indicates the amount of exploration (Exploration Mode), and the color saturation indicates the confirmed knowledge (Knowledge Evaluation Mode)

Use the progress indicators to identify operations that need your attention

The interface is divided into several sections:

- Goals and Progress:** A vertical bar on the left with colored segments representing progress for different operations.
- Configuration:**
  - 1. Expression: A dropdown menu showing a predefined expression  $3 / 2 - (4 + 5) * 6$ .
  - 2. Mode: Radio buttons for 'Exploration' (selected) and 'Knowledge Evaluation'.
  - 3. Variables: Input fields for Integer variables A (10), B (20), C (30) and Double variables K (10.0), L (20.0).
- Expression Evaluation:**
  - Original Expression:  $1 + (K * 3 / 2) - (4 + 5) * 6$
  - Correct Order: A sequence of numbers 4, 3, 1, 2, 8, 6, 5, 7, with '3' highlighted in green.
  - Variable Value: K 10.0
  - Current Expression:  $1 + (15.0) - (4 + 5) * 6$
  - Visualization: A tree diagram showing the evaluation of the sub-expression  $(15.0)$ .
  - Explanation: A text box stating "The value of ( 15.0 ) is 15.0. Parentheses never change the value of the expression inside them, they only change the precedence of operations."
- Navigation:** A bottom control bar with buttons for 'Step', 'Operator', and 'Expression'.

**Set everything and START the evaluation**

Select one of the predefined expressions OR type in your own

Select the mode

Set the values of variables

START the evaluation

**Navigate the evaluation of the current expression**

Go slowly on a step-by-step basis attending all the changes on the screen

Go quicker skipping operators

Quickly jump to the beginning or the end of the evaluation

Check your current context

Check the current Topic

**Learn by watching animations and reading explanations**

At any time consult the original expression AND the order of execution (precedence of operators)

Monitor values of variables appearing in the current expression

Watch all visualizations, observe how the current expression changes as it is being evaluated

Read the explanations of the visual actions happening above

Watch for controls indicating that more complicated concepts are involved in the context of the current operation

# Adapting to Individual Traits

- Source of knowledge
  - educational psychology research on individual differences
- Known as cognitive or learning styles
  - Field dependence, wholist/serialist (Pask)
  - Kolb, VARK, Felder-Silverman classifiers



# Style-Adaptive Hypermedia

- What is modeled?
  - User knowledge of the subject
  - User individual traits
- What is adapted?
  - Order of educational activities
  - Presentation of hypertext links
  - Presented content
  - Problem solving feedback

# Style-Adaptive Hypermedia

- Different content for different style
  - Recommended/ordered links
  - Generated on a page
  - Mixed evidences in favor
- Different navigation tools for different styles
  - Adding/removing maps, advanced organizers, etc.
- Good review:
  - Bajraktarevic, N., Hall, W., and Fullick, P. 2003. Incorporating Learning Styles in Hypermedia Environment: Empirical Evaluation, In Proceedings of Workshop on Adaptive Hypermedia and Adaptive Web-Based Systems, Nottingham, 41-52. <http://wwwis.win.tue.nl/ah2003/proceedings/paper4.pdf>

# Example: AES-CS

The screenshot displays the AES-CS web application interface. On the left, a vertical menu is labeled "Menu" with an arrow pointing to it. The menu items are: 1ο Κιφάλαιο, ΝΕΕΣ - ΠΡΟΔΥΜΕΝΑ & ΥΠΕΡΜΕΣΑ ✓, 2ο Κιφάλαιο, 2.1 ΨΗΦΙΑΚΗ ΑΝΑΠΑΡΑΣΤΑΣΗ ✓, 2.2 ΨΗΦΙΟΤΗΤΑ ✓, 3ο Κιφάλαιο, 3.1 ΚΙΝΗΣΗ ✓, 3.2 ΕΙΚΟΝΑ ✓, 3.3 ΗΧΟΣ, 3.4 2D-3D, and 3.5 VIDEO. An arrow labeled "Adaptive Annotation" points to the "3.2 ΕΙΚΟΝΑ" item. The main content area shows the page title "Σελίδα Πολυμέσων > 3.2 Ψηφιακή εικόνα >" and the section heading "3.2.1 Η δομή μιας ψηφιακής εικόνας". Below this, the sub-section "Α) Ψηφιογραφική ή Χαρτογραφική (bitmap) εικόνα" is shown. An image of a watch is displayed, with a magnifying glass over a portion of the dial. To the right of the image, there is a text block explaining that a bitmap image is composed of many small elements (pixels) and that each pixel represents a specific color. Below the image, there are two bullet points: the first states that digital images can be processed using software or hardware, and the second states that a basic characteristic of digital images is that they are composed of discrete elements (pixels) and that their size can be changed (e.g., zooming in) without losing quality, unlike analog images where zooming in results in a loss of detail.

Menu

Adaptive Annotation

ΑΕΣ-CS - Microsoft Internet Explorer


Παύλος Ομήριος μέλιτης Διόσκωρος Σάββας Σαββάνης Μανόλης Μάθησις Τσιφλίδης Στεφανίνας Σιδηρόπουλος

Περιεχόμενα

Σελίδα Πολυμέσων > 3.2 Ψηφιακή εικόνα >

3.2.1 Η δομή μιας ψηφιακής εικόνας

Α) Ψηφιογραφική ή Χαρτογραφική (bitmap) εικόνα



Είναι ο πιο κοινός τύπος αρχαίων εικόνας. Αποτελείται από πολλές χαρτογραφημένα στοιχεία εικόνας (ακουσσοστοιχεία, picture elements = pixels) καθένα από τα οποία εμφανίζει ένα συγκεκριμένο χρώμα στην οθόνη. Οι εικόνες αναπαριστούνται ως ένας διατεταγμένος πίνακας ακουσσοστοιχείων. Ο πίνακας αυτός ονομάζεται κομμάτι (bitmap). Η τρέχουσα εικόνα που αναλαμβάνεται είναι το αποτέλεσμα του συνολικού ψηφιογραφικού αλγορίθμου και δημιουργούν τα ακουσσοστοιχεία.

- Ψηφιογραφικές (ή χαρτογραφικές) εικόνες παράγονται α) με την χρήση ηλεκτρονικού λογισμικού β) με την χρήση διαφόρων συσκευών (φαρμάκη, ψηφιακή φωτογραφική μηχανή, βίνυσο κώμαρα)
- Βασικό χαρακτηριστικό των ψηφιογραφικών εικόνων είναι ο διακριτός χαρακτήρας των ακουσσοστοιχείων από τα οποία αποτελούνται. Με μεταβολή στο μέγεθός τους (π.χ. μεγέθυνση) μπορεί να επηρεαστεί σημαντικά την ποιότητα της εικόνας καθώς το μέγεθος των ακουσσοστοιχείων μπορεί να αρχίσει να γίνεται ορατό (όπως στον μεγεθυσμένο κύκλο στην παραπάνω εικόνα) και να καταστρέψει την οπτική αίσθηση της εικόνας.

Interface for field-independent learners

# Example: AES-CS

**Toolbar**

**Concept Map**

**Navigation Support**

**Graphic Path Indicator**

**Ολοκληρωμένο κύκλωμα CCD**

- Σε μία κάμερα το CCD έχει τη μορφή ορθογώνιου πλαισίου πάνω στο οποίο εσάφει η τον φακό. Όσο παρκοότερα οπτικότερα βρίσκονται τοποθετημένα στο πλαίσιο τόσο τ σπικότες η ποιότητα της αποκρίτωσης εικόνας. Π.χ. το CCD που βρίσκεται στην ψηφρ ελαιλάται από 3060 φωτοκύτταρα στην οριζόντια διάσταση και 2060 στην κεικόρρη εζόο εικόνα που να αποκτάται από περίπου 6 εκατομύρια εικονοτοχεία.
- Στην έξοδο του CCD τα ηλεκτρικά σήματα ψητικοποιούνται με ένα DAC (Digital to Analog Converter) και το προϊόν της ψητοποίησης αποθηκεύεται ως αρχείο εικόνας.

32 Έξοδο

321 322 323 324 325 326

Interface for field-dependent learners

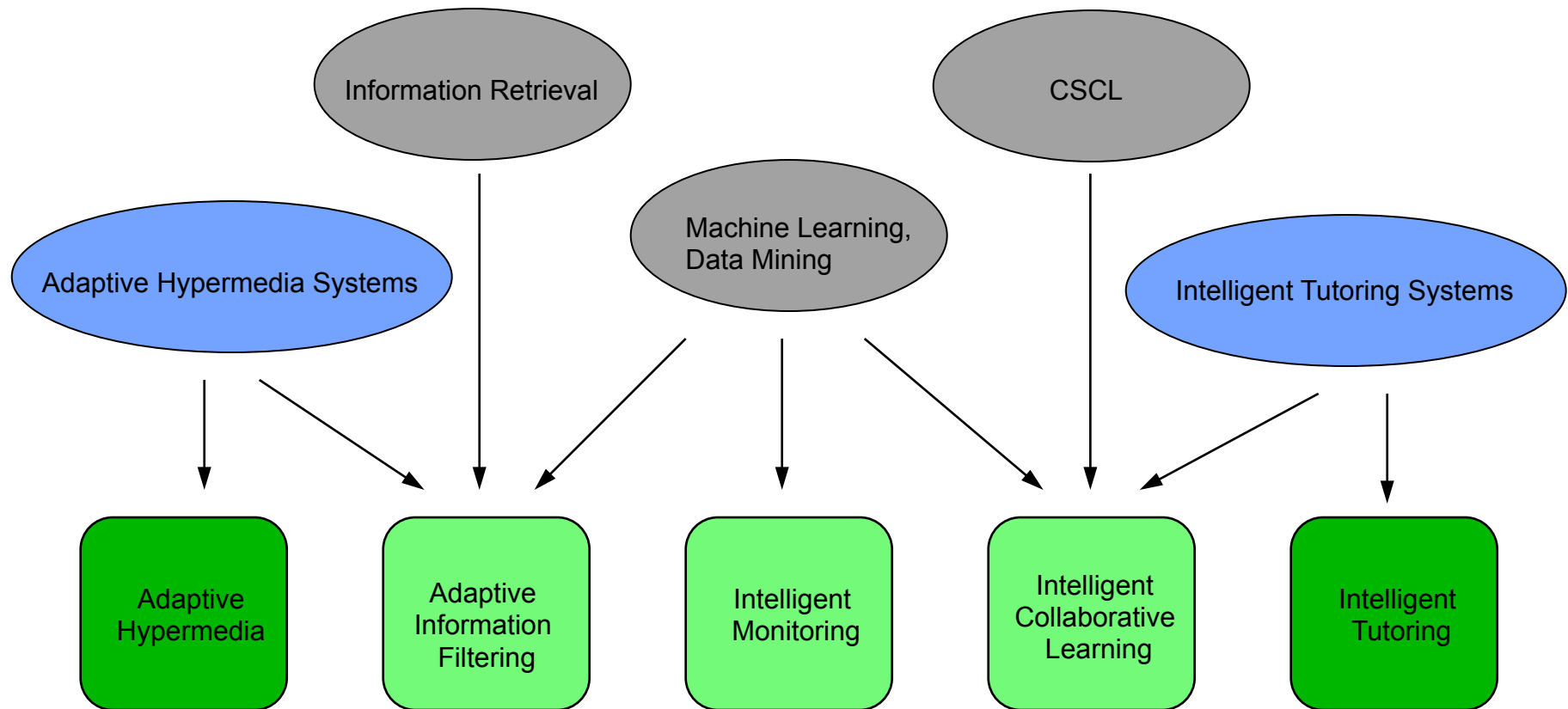
# Style-Adaptive Feedback

- What is modeled?
  - User knowledge of the subject
  - User individual traits
- What is adapted?
  - Order of educational activities
  - Presentation of hypertext links
  - Presented content
  - Problem solving feedback

# Overview: Classic Technologies

What?	Knowledge	Styles
Order of activities	Sequencing	?
Feedback	Adaptive diagnosis	Style-adaptive feedback
Content	Adaptive presentation	Adaptive presentation
Links	Adaptive navigation support	Adaptive navigation support

# Origins of AEL Technologies (2)



# Native Web Technologies

- Availability of logs
  - *Log-mining*
  - *Intelligent class monitoring*
  - *Class progress visualization*
- One system, many users - group adaptation!
  - *Adaptive collaboration support*
- Web is a large information resource - helping to find relevant *open corpus* information
  - *Adaptive content recommendation*



# Modern Fusion Technologies

- *Collaborative Content Recommendation*
  - *Logs, CF, sequencing*
  - *Challenge – changing context*
- *Social navigation*
  - *Collaboration, logs, ANS*
- *Learning Analytics*
  - *Helping the teacher and the process*
  - *Logs, visualization, data mining*

# What You Can Get from Logs?

- Log processing and presentation
  - Presenting student progress on topic and concept level: making sense of class
- Course/site improvements
- Grouping users by learning styles
- Intelligent class monitoring
  - Comparing progress, identifying students way ahead and behind

# Adaptive Collaboration Support

- Peer help
- Collaborative group formation
- Group collaboration support
  - Collaborative work support
  - Forum discussion support
- Mutual awareness support

# Personalized Access to Educational Resources

- A lot of resources are available on the Web and in educational DL/Reposititories
- A new direction of adaptation - provide personalized access to these resources
  - Content based recommender
- Adding advantage of community wisdom
  - Collaborative recommender systems
  - Social navigation systems

# Modeling User Interests

- Concept-level modeling
  - Same domain models as in knowledge modeling, but the overlay models level of interests, not level of knowledge
- Keyword-level modeling
  - Uses a long list of keywords (terms) in place of domain model
  - User interests are modeled as weighed vector or terms
  - Originated from adaptive filtering/search area

# Use of Profiles in AES: ML Tutor

MLTutor's suggestions



# Social Computing for WBE

- Web 2.0 for education
- Collaborative resource discovery systems
  - CoFIND
  - UMtella (Demo)
- Presence-based collaboration (Educo)
- Social navigation support for open corpus resources (Knowledge Sea II)
- Social guidance (Progressor)

# Example: UMtella

The screenshot displays the UMtella web application interface. At the top, there is a yellow header with the UMtella logo on the left, the text 'The Social Web at Pitt' in the center, and a 'Logout' link and user profile 'Peter' on the right. Below the header is a navigation menu with links: Welcome, Select Community, Search, Create Community, Share Link, Share File, Discussion, and Community. The 'Search' link is highlighted.

Below the navigation menu, the current community is identified as 'The Social Web at Pitt'. There are links for 'Favorites', 'Add to My Communities', and 'Help'. A search form is present with fields for 'Keyword', 'Start Time', and 'End Time', a 'Global Search' checkbox, and a 'Search' button. The 'Tags' field is also visible.

The search results are displayed in a table with the following columns: Resource, Shared by, Earned Ratings, View Times, Reviews, Favorite?, and Info. The table contains 12 rows of results. The 10th row, '100 Funnest Web 2.0 Words to Say (YouTube)', is highlighted in yellow. The 'Reviews' column for this row includes 'Delete' and 'Edit' links. The 'Info' column for all rows includes 'Detail' and 'Remark' links.

At the bottom of the table, there are navigation links: '<<Previous', 'Next>>', 'Total: 12 Page(s)', and 'Current Page: 1'.

Resource	Shared by	Earned Ratings	View Times	Reviews	Favorite?	Info
<a href="#">PHD Comics: Facebook</a>	Hoyt	3	6	1	+	<a href="#">Detail</a> <a href="#">Remark</a>
<a href="#">Web 2.0 ... The Machine Is Us/Ing Us</a>	John Harkins	3	6	1	+	<a href="#">Detail</a> <a href="#">Remark</a>
<a href="#">Chris Anderson discusses the long tail</a>	Savinell	2	2	1	+	<a href="#">Detail</a> <a href="#">Remark</a>
<a href="#">Social Navigation</a>	Hoyt	2	8	1	+	<a href="#">Detail</a> <a href="#">Remark</a>
<a href="#">Social Networking in Plain English</a>	John Harkins	2	3	1	+	<a href="#">Detail</a> <a href="#">Remark</a>
<a href="#">Top Ten Second Life Tutorial Videos</a>	Hoyt	2	3	1	+	<a href="#">Detail</a> <a href="#">Remark</a>
<a href="#">Teach Yourself Programming in Ten Years</a>	Rosta	1	1	1	+	<a href="#">Detail</a> <a href="#">Remark</a>
<a href="#">Mashup on digg</a>	Rosta	1	1	1	+	<a href="#">Detail</a> <a href="#">Remark</a>
<a href="#">100 Funnest Web 2.0 Words to Say (YouTube)</a>	Peter	1	5	<a href="#">Delete</a> <a href="#">Edit</a>	+	<a href="#">Detail</a> <a href="#">Remark</a>
<a href="#">Flock: A Social Web Browser</a>	Matthew Wood	1	5	1	+	<a href="#">Detail</a> <a href="#">Remark</a>
<a href="#">Page Rank Checker</a>	Savinell	1	7	<input type="text"/> <a href="#">Rate</a>	+	<a href="#">Detail</a> <a href="#">Remark</a>
<a href="#">Finding A City's Google Page Rank</a>	Savinell	1	5	<input type="text"/> <a href="#">Rate</a>	+	<a href="#">Detail</a> <a href="#">Remark</a>



# Example: EDUCO

File Edit View Go Communicator Help

Back Forward Reload Home Search Print Security Stop

Bookmarks Location: <http://eduoca.cs.helsinki.fi/educodemo/>

Welcome to EDUCO!

Virtual Learning Environments

EDUCO

## Course Sequencing for Static Courses? Applying ITS Techniques in Large-Scale Web-based Education

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**Abstract.** We argue that traditional sequencing technology developed in the field of intelligent tutoring systems could find an immediate place in large-scale Web-based education as a core technology for concept-based course maintenance. This paper describes a concept-based course maintenance system that we have developed for Carnegie Technology Education. The system can check the consistency and quality of a course at any moment of its life and also assist course developers in some routine operations. The core of this system is a refined approach to indexing the course material and a set of "scripts" for performing different operations.

## 1 Introduction

Course sequencing is one of the oldest technology in the field of intelligent tutoring systems (ITS). The idea of course sequencing is to generate an individualized course for each student by dynamically selecting the most optimal teaching operation (presentation, example, question, or problem) at any moment of education. An ITS with course sequencing represents knowledge about the subject as a network of concepts where each concept represents a small piece of subject knowledge. The learning material is stored in a database of teaching operations. Each teaching operation is indexed by concepts it deals with. The driving force behind any sequencing mechanism is a student model that is a weighed overlay of the domain model - for every domain model concept it reflects the current level of student knowledge about it. Using this model and some teaching strategy a sequencing engine can decide which one of the many teaching operations stored in the data base is the best for the student given his or her level of knowledge and educational goal.

Various approaches to sequencing were explored in numerous ITS projects. The majority of existing ITS can sequence only one kind of teaching operations. For example, a number of sequencing systems including the oldest sequencing systems [2, 14] and some others [8, 12, 15] can only manipulate the

Comments:

Tästä aiheesta ajankohtainen esimerkki:  
[www.hiit.fi/eduoca/](http://www.hiit.fi/eduoca/)

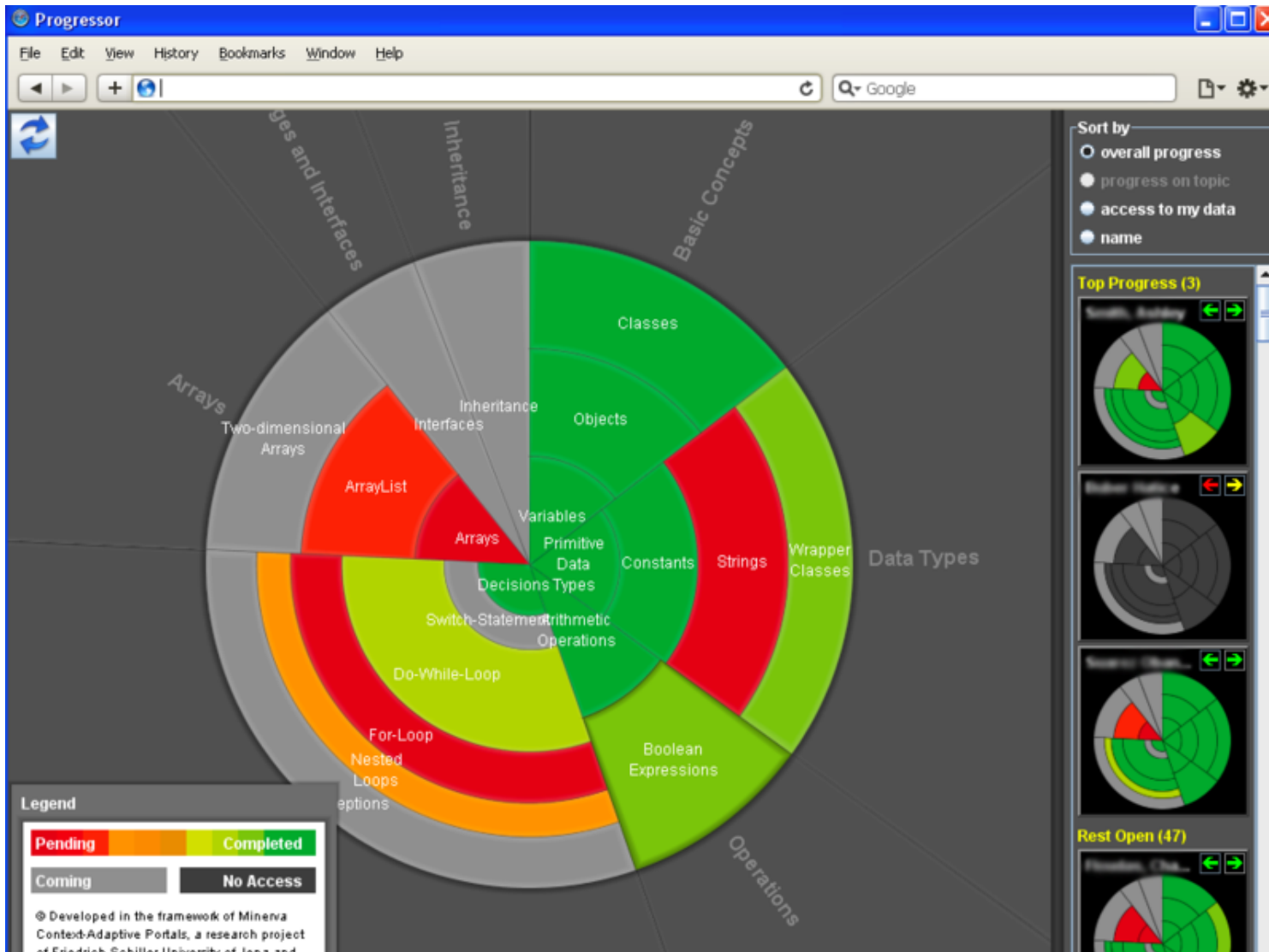
- michael.keller (20.1.14.22)

Joe oppinut paljon tekee hyvin, on taloudellisen panos varmasti suurempi kuin mitä hyvän oppikijan tekeminen

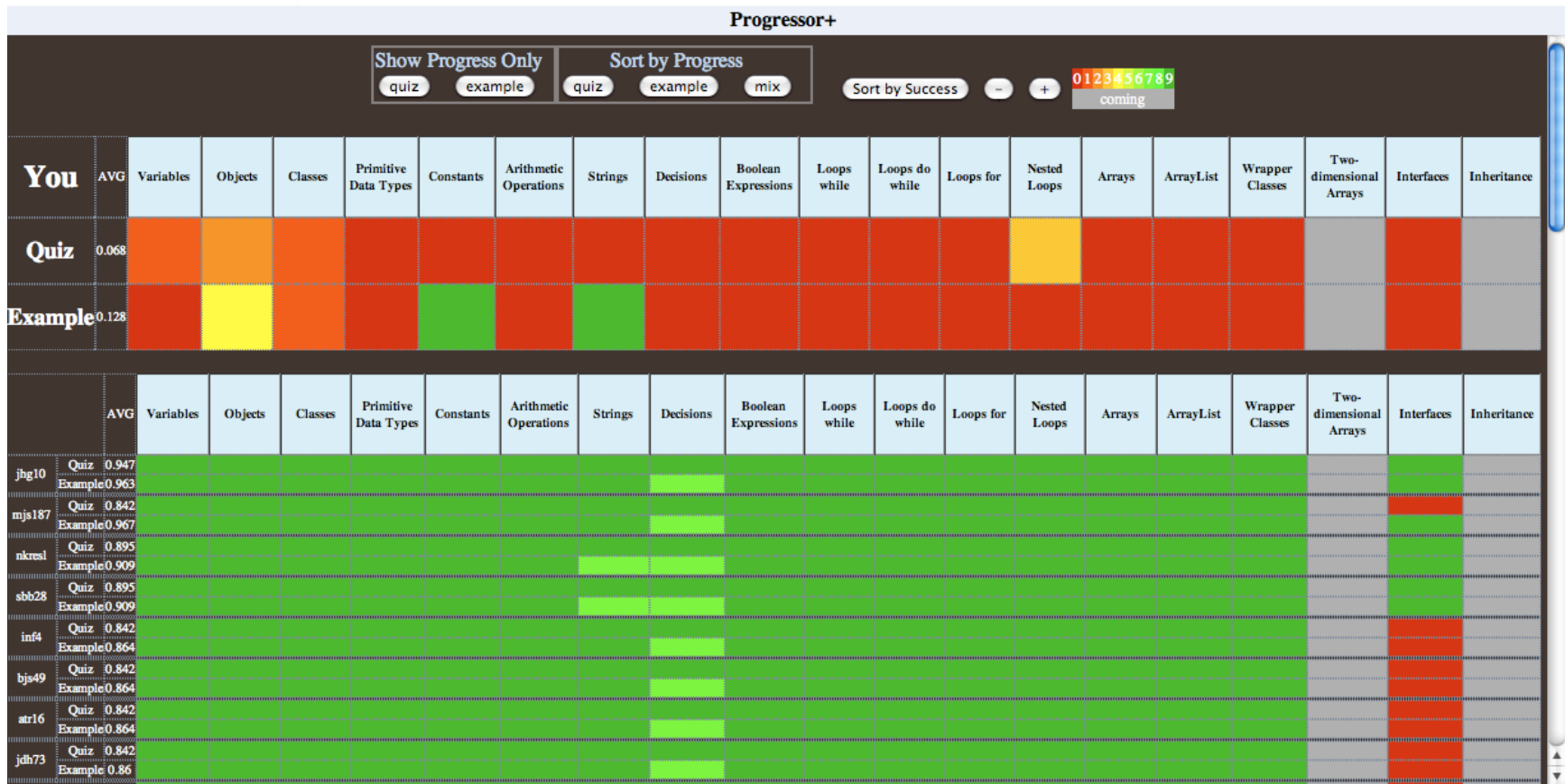
Add comment



# Progressor



# Demo: Progressor<sup>+</sup>



# What LMS Can Do

- For students
  - Course information and content delivery
  - Assessment and grades
  - Communication and collaboration
- For teachers
  - Authoring
  - Learning control
  - Student monitoring
  - Communication

# What AES Can Do for Students

- Presentation
  - Adaptive presentation, adaptive navigation support, adaptive sequencing
- Assessment
  - Adaptive testing
- Communication and collaboration
  - Peer help and collaborative group formation
  - Collaboration coach
- Learning by doing
  - Problem solving support

# What AES Can Do for Teachers

- Student monitoring
  - Identifying students in trouble
- Control
  - Sequencing
  - Adaptive navigation support
- Authoring
  - Concept-based authoring and courseware engineering

# AES vs. LMS

- Adaptive E-Learning systems can provide a more advanced support for most functions
  - Course material presentation - InterBook, AHA
  - Assessment with quizzes - SIETTE
  - Threaded discussions - collaboration agents
  - Student management - intelligent monitoring
- Why LMS are not really adaptive?
  - Except simple control and learning design



# Challenges

- How to make it working in practice?
  - AES systems use advanced techniques - hard to develop
  - AWBES content is based on knowledge - hard to create
  - AES require login and user modeling - hard to integrate
- Possible solutions - (watch, PhD students!)
  - Component-based architectures for AWBES
  - Authoring support
  - Open Corpus adaptive systems

# Component-based Architectures

- Research systems can provide a better support of almost each function of E-Learning process
- Adaptive systems show how to implement nearly each component adaptively
- We need the ability to assemble from components
  - Course authors can choose best components and best content for their needs
  - Components providers and content providers have a chance to compete in developing better products

# Current State

- Several component-based frameworks
  - ADAPT<sup>2</sup>, ActiveMath, MEDEA,...
- Attempts to develop systems with internal components
- Reusable user/student model servers
- Some matching work in the standardization movement

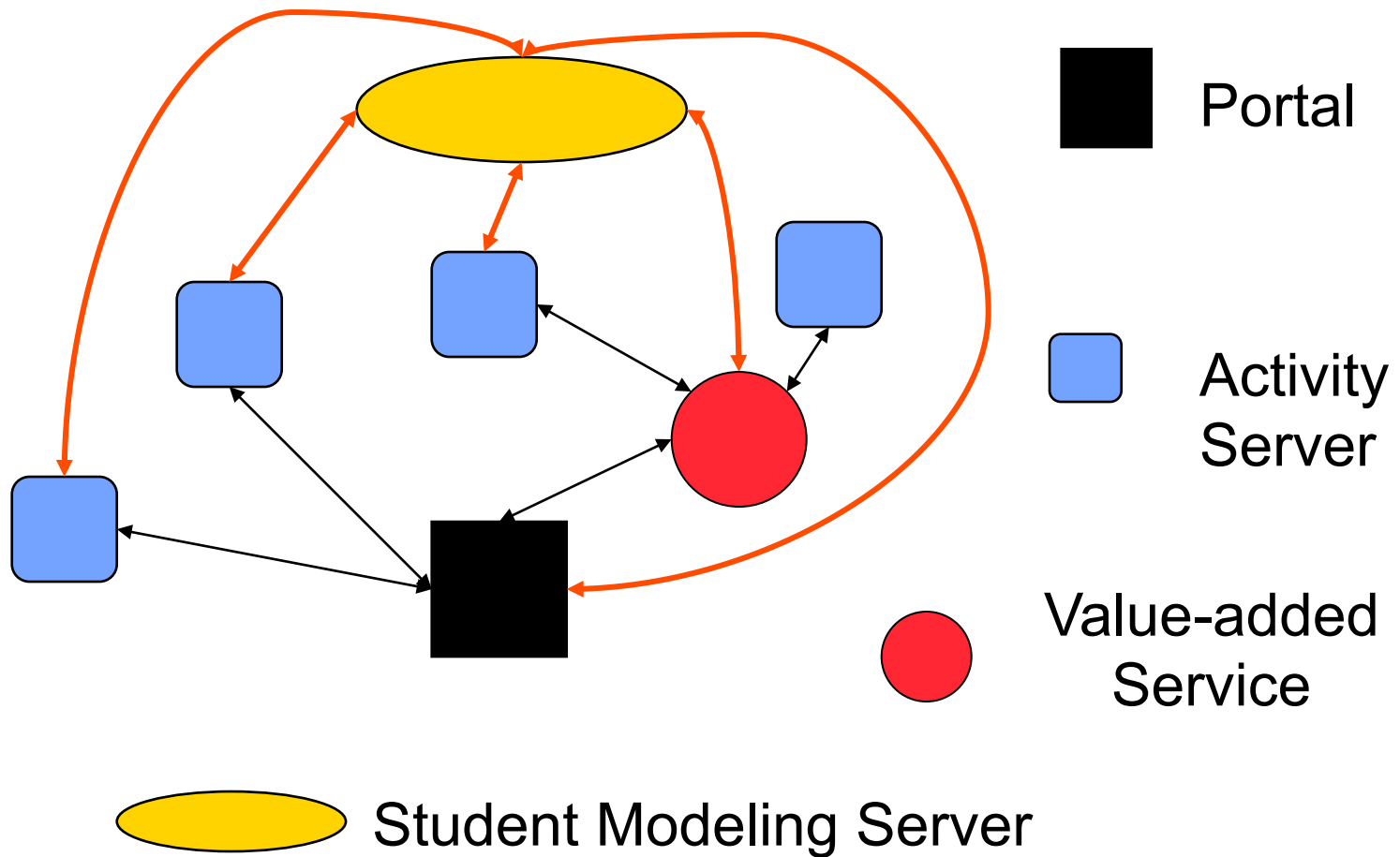
# Re-use/Standards Movement

- Learning Object Re-use supported by coming standards is another major research direction in E-Learning
- The re-use movement joins many existing streams of work driven by similar ideas
  - Create content once, use many times
  - Content independent from the “host” system
  - Content and interfaces with the host system are based on standards (metadata, CMI, etc)
- Let content providers be players in E-Learning
- The future is components and re-use

# What is the Future?

- How to use good component/content if you have a Blackboard, Moodle or other major CMS?
- Is the future model a Blackboard-style giant system where all components are advanced and adaptive?
  - Wait for the CMS giants to integrate better tools?
  - Create our own “adaptive Blackboards”
- Is there any other choice?

# ADAPT<sup>2</sup> Architecture



# Knowledge Tree II Portal

Database Course [Yudelson, Michael]

Refer to Instructions document below for help on working with the course material

**Folders/Documents**

- Instructions
- Table Creation
- Table Deletion and Alteration
- Key Constraints
- General Constraints
- Tuple Insertion
- Tuple Deletion
- Tuple Update
- SELECT FROM**
- Arithmetic Expressions
- SELECT-FROM-WHERE
- Pattern Matching
- Multiple Table Queries
- ORDER BY

Database Course » SELECT FROM [Yudelson, Michael]

**Folders/Documents**

- Q SELECT-FROM question1
- Q SELECT-FROM question2
- Q SELECT-FROM question3
- Q SELECT-FROM question4
- Q SELECT-FROM question5
- D Selecting One Attribute
- D Selecting Multiple Attributes
- D Selecting All Attributes
- D Skipping Duplicates
- D Selecting Multiple Attributes (Projection)

My rating: ☆☆☆☆☆ N/A

Group rating: ☆☆☆☆☆ N/A