Educational Technologies
WS2006

Knowledge Representation

Source: Erica Melis
Approximate Plan of the Course

18.10. Introduction
25.10. XML- Knowledge Representation
  8.11. Student Modelling
15.11. Web technologies and security
22.11. Tutorial Planning and instructional design
29.11. Media Principles
  6.12. Interactive exercises
13.12. Authoring tools, CTAT
20.12. Diagnosis: model tracing and domain reasoning

10.1. Diagnosis: constraint based
17.1. Tutorial dialogues
24.1. Action analysis and Machine Learning techniques
31.1. Cognitive tools
  7.2. Meta-cognitive support
14.2. student projects
Typical AI-representations

- **Semantic networks** with labelled links: member, isA, hasXX
  - XML/metadata – annotated (varieties) objects and properties
  - RDF: relations = labeled links [www.dfki.de/~melis/links# designatedPerson document defines]
  - labeled link...ontologies
  - RDF language refers to URIs (subject property object)
  - rdf:type: specific instance of a category

- **Frames**
  - RDFS: isA link for class (with slots **domain**, **range**) and subclass

- **Logics, decision logics** (formal language for subsumption and classification, satisfyability)
  - OWL, OWL-DL (RDFS+terms for describing properties symm, 1-1) + (class, property-value restrictions e.g. cardinality)
  - Prolog reasoners
Semantic Networks -- Ontologies

Legends

Exhaustive Concept
Non Exhaustive Concept
RB Concept
NB Concept

Sports
Basketball
Football
Professional
Non_Professional
College
Preparation
NHL
MinorLeague_Hockey
College_Hockey
Player
Team
NBA
ABL
CBA
WNBA
USBL
HighSchool_Basketball
College_Basketball
NFL
CFL
College_Football
HighSchool_Football
Labelled link ….OWL descriptions…ontologies

http://www.dfki.de/melis/links#designatedPerson

http://.../melis/index.html

http://.../melis/pict1.jpg

:designatedPerson

rdf:Property

rdfs:domain: Person

rdfs:range: Photograph:

<owl:Class rdf:about="#Feline-Leukemia">  
<rdfs:subClassOf rdf:resource="NCI:Leukemia"/>  
<rdfs:Restriction>  
  <owl:onProperty rdf:resource="#NCI:Organism-affected"/>  
  <owl:allValuesFrom rdf:resource="CYC:cat"/>  
</rdfs:subClassOf>  
</owl:Class>
AI Knowledge Representation for ITSs

Frames in Cognitive Tutors

Problem WME

(make-wme composed-cen-insc
   isa problem
   key-quantities (angle-KHP-measure arc-KP-measure angle-KQP-measure)
   key-reasons (angle-KHP-measure ...)
   questions (question1)
   given-relational-quantities (central-angle-KHP inscribed-angle-KQP)
   table composed-cen-insc-table
)

Relation WME... inscribed-angle...
   inputs (arc-KP-measure)
   output (angle-KQP-measure)

Quantity WME ... angle-KHP-measure...unit..dimension..labels..
Knowledge Representation for Web-based ITSs

requirements

- **Capture domain and educational knowledge**
  - Content, instructional knowledge, tutorial strategies

- **Reusability in different contexts**

- **Semantic encoding for functionalities**
  - Automatic search in documents
  - Automatic manipulation of documents
  - Adaptive presentation of documents

=> automatic processing of documents
Reusability

- Courses for BWL, Mathematics, Engineering
- Courses for different learning contexts
- Courses by several authors and various formats and languages
- Previously: html 😞
Topics to be investigated

- Compliance with standards
- Granularity of instructional objects
- Modularity
- Domain dependent structure and annotations
- Pedagogical structure and annotations
- Semantics
Requirements for Maths Application: Semantics

Machine readable and interoperable

- Mathematica
- Maple
- Formula/Expression
- MuPad
- Calculator
- Search
2.3.7 Definition Let \( a \in \mathbb{R} \) and \( \epsilon > 0 \). Then the \( \epsilon \)-neighborhood of \( a \) is the set \( V_\epsilon(a) = \{ x \in \mathbb{R} : |x - a| < \epsilon \} \).

For \( a \in \mathbb{R} \), the statement that \( x \) belongs to \( V_\epsilon(a) \) is equivalent to either of the statements

\[
-\epsilon < x - a < \epsilon \iff a - \epsilon < x < a + \epsilon.
\]

(See Figure 2.3.2.)

**Figure 2.3.2** An \( \epsilon \)-neighborhood of \( a \).

2.3.8 Theorem Let \( a \in \mathbb{R} \). If \( x \) belongs to the neighborhood \( V_\epsilon(a) \) for every \( \epsilon > 0 \), then \( x = a \).

**Proof.** If a particular \( x \) satisfies \( |x - a| < \epsilon \) for every \( \epsilon > 0 \), then it follows from 2.2.9 that \( |x - a| = 0 \), and hence \( x = a \). Q.E.D.

2.3.9 Examples (a) Let \( U := \{ x : 0 < x < 1 \} \). If \( a \in U \), then let \( \epsilon \) be the smaller of the two numbers \( a \) and \( 1 - a \). Then \( V_\epsilon(a) \) is contained in \( U \). Thus each element of \( U \) has some \( \epsilon \)-neighborhood of it contained in \( U \).

(b) If \( I := \{ x : 0 \leq x \leq 1 \} \), then for any \( \epsilon > 0 \), the \( \epsilon \)-neighborhood \( V_\epsilon(0) \) of 0 contains points not in \( I \), and so \( V_\epsilon(0) \) is not contained in \( I \). For example, the number \( x_\epsilon := -\epsilon/2 \) is in \( V_\epsilon(0) \) but not in \( I \).

(c) If \( |x - a| < \epsilon \) and \( |y - b| < \epsilon \), then the Triangle Inequality implies that

\[
|(x + y) - (a + b)| = |(x - a) + (y - b)| \leq |x - a| + |y - b| < 2\epsilon.
\]

Thus if \( x, y \) belong to the \( \epsilon \)-neighborhoods of \( a, b \), respectively, then \( x + y \) belongs to the \( 2\epsilon \)-neighborhood of \( a + b \) (but not necessarily to the \( \epsilon \)-neighborhood of \( a + b \)).

Exercises for Section 2.3

1. Let \( a \in \mathbb{R} \). Show that we have:
   (a) \( |a| = \sqrt{a^2} \),
   (b) \( |a^2| = a^2 \).
2. If \( a, b \in \mathbb{R} \) and \( b \neq 0 \), show that \( |a/b| = |a|/|b| \).
3. If \( a, b \in \mathbb{R} \), show that \( |a + b| = |a| + |b| \) if and only if \( ab > 0 \).
Content Representation, Granularity

- **Content items**
  - unique ID

- **Concept**
  - Definition
  - Assertion
    - Axiom
    - Proof
      - Algorithm

- **Satellite**
  - Elaboration
  - Exercise
    - Example
  - Motivation

**Relations:**
- Mathematical dependency
- Pedagogical prerequisite

- Pedagogical dependency
Mathematical Element Types

Abstract Layer

Content Layer

Satellite Layer

Source: Erica Melis Educational Technologies WS 2006/07
Standard Metadata and Languages

- Dublin Core (dc)
- Learning Object Metadata (LOM)
- IMS Global Learning Consortium
- OpenMath / OMDoc
Domain Metadata

Type of item
definition, assertion, difficult

Relation
prerequisite, for, isA, ...

theory
groups, calculus, ..
Educational Metadata

Typical learning time

Field
- mathematics, biology, physics, ..

Difficulty
- easy, medium, difficult

Competency
- think, argue, model, solve, ..

Competency level
- knowledge, multistep, complex

Representation
- audio, symbolic, graphical, numeric, ..

Abstractness
- abstract, neutral, concrete

Learning context
- school, university, ..
Position of the metadata
Classification of Metadata

- Administrative
  - General
  - Lifecycle
  - Rights
- Mathematical
  - Relation
  - Classification
- Application-dependent
  - Educational
  - Publishing
  - Formal-maths-calculi
Administrative Metadata: General

- dc:title
- dc:description
  - dcq:abstract
- dc:creator, dc:contributor
  - omdoc:role (aut, edt, clb, trl, etc.)
  - identifier
- dc:publisher
- dc:source
- dc:identifier
Administrative Metadata: Lifecycle

- **dc:date**
  - omdoc:action (new, updated, etc.)
  - omdoc:who

- **lom:version**
  - previous_version

- **lom:status** (draft, final, revised, unavailable)
Example of simple metadata record

<dc:title> an example of metadata annotation</dc:title>
<dc:creator role="aut" identifier="JD">John Doe</dc:creator>
<dc:contributor role="clb" identified="MW">Mary Waters</dc:contributor>
<dc:date omdoc:action="updated" omdoc:who="MW">2003-03-21 / 00:03:48</dc:date>
Administrative Metadata: Technical

- dc:format (mime types)
- dc:type (text, dataset, image etc.)
- lom:size (bytes)
- lom:requirement
  - lom:name (technology required)
  - resource_of_technology
  - lom:minimumversion
  - lom:maximumversion
Example of lifecycle+technical metadata

<dc:title> Example of a lifecycle metadata</dc:title>
...
<dc:type>dataset</dc:type>
<lom:size>251245230123213</lom:size>
<lom:requirement lom:name="COQ"
      rdf:resource="http://pauillac.inria.fr/coq/distrib-eng.html">
    <lom:minimumversion>7.2.0</lom:minimumversion>
    <lom:maximumversion>7.3.1</lom:maximumversion>
</lom:requirement>
Administrative Metadata: Rights

- dc:rights
  - cc:permissions (reproduction, distribution, derivative works)
  - cc:prohibitions (commercial_use)
  - cc:requirements (notice, attribution, copyleft)
  - copyright_holder
Mathematical Metadata:

- dc:subject (controlled vocabulary)
  - MathClassificationScheme (LSCH, MSC, DDC, CCS)
- dc:keyword (uncontrolled vocabulary)

- relation
  - kind (requires, for, etc.)
  - omdoc:entailed-by
  - omdoc: entails
  - omdoc: equivalent
Application-Dependent Metadata: Educational

- dc:relation (prerequisite..)
- lom:difficulty (easy, medium, etc.)
- am:abstractness (concrete, neutral, abstract)
- lom:learning_context (higher_education, etc.)
- lom:field (mathematics, engineering, etc.)
- am:competence_level
- am:competency (model, compute, argue...)
Presentation-oriented markup:
- markups are processed to create layout
- e.g. LaTeX, HTML

Semantic/Structure-oriented markup:
- markups describe ‘semantics’, ‘logic structure’ and ‘relations’ of content
- e.g. XML based languages OpenMath, OMDoc used in ActiveMath
XML

- eXtensible Markup Language
- Goal: machine-readable structured documents

Technically:
- XML defines grammar rules to interpret documents as trees consisting of elements
- Basic rules are shared by all XML dialects
- For concrete XML dialect: define further rules for specifying a subset of trees as admissible (e.g., by DTD = Document Type Definition)
- Platform independence

XML is standard for a family of languages of similar structure
XML

XML related to family of tools

• XML defines tags and attributes

More Modules:

• Xlink for extending XML by Hyperlinks
• XPointer/XFragments for references in an XML-document
• XSL für Style Sheets
• DOM for standard functions for processing XML or HTML-files
Example: Newspaper Ontology As XML Tree

[Diagram showing Protégé-2000 interface with ontology and XML representation of a newspaper article]

Source: Erica Melis Educational Technologies WS 2006/07
Example XML Document

```xml
<?xml version='1.0' encoding='UTF-8' standalone='no'?>
<!DOCTYPE family SYSTEM 'family.dtd'>
<fAMILY id="f1">
  <member role="father" sex="male">
    <name> John </name>
    <surname> Doe </surname>
    <date-of-birth>
      <day> 29 </day>
      <month> 02 </month>
      <year> 1978 </year>
    </date-of-birth>
    <character> mild </character>
    <hobby> chess </hobby>
    <hobby> collecting butterflies </hobby>
    <hobby> watching soap operas </hobby>
  </member>
  ...
</family>
```
Example DTD (family.dtd)

```xml
<!ELEMENT family (member)*/>
<!ATTLIST family id ID #REQUIRED>
<!ELEMENT member (name,surname?,date-of-birth,character,hobby*)>
<!ATTLIST member role
(father|mother|child|grandfather|grandmother|dog|cat)
#REQUIRED sex (male|female) #REQUIRED>
<!ELEMENT name (#PCDATA)>
<!ELEMENT surname (#PCDATA)>
<!ELEMENT date-of-birth (day,month,year)>
<!ELEMENT character (#PCDATA)>
<!ELEMENT hobby (#PCDATA)>
<!ELEMENT day (#PCDATA)>
<!ELEMENT month (#PCDATA)>
<!ELEMENT year (#PCDATA)>
```
Automatic Processing

- XML document describes structure of content
- Automatic processing by XSL transformations
  (XSL = eXtensible Stylesheet Language)
- Technically: set of rules describing the transformation of XML tree parts into some output format

Applications:
- Presentation oriented transformations
  - e.g., XSL transformation producing HTML
  - e.g., XSL producing LaTeX
  - e.g., XSL producing natural language
- Message oriented transformations for data exchange

Advantage: Separation of content (and its structure) and presentation format or data-exchange format
Example of an XSL Stylesheet

```xml
<?xml version="1.0" encoding="iso-8859-1"?>
<xsl:stylesheet
 xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
   version="1.0"> <xsl:output method="html" />
<xsl:template match="family">
  <html><body>
  <h2> The <xsl:value-of
    select="member[@role='father']/surname"/> family
  </h2>
  <xsl:apply-templates />
</body></html>
</xsl:template>
<xsl:template match="member">
  <br /><table border="1">...
</xsl:template>
</stylesheet>
```
### XSL producing HTML

#### The Doe family

<table>
<thead>
<tr>
<th></th>
<th>Doe, John</th>
<th>Doe, Johny</th>
<th>Rex</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>father</strong></td>
<td>Doe, John</td>
<td>Doe, Johny</td>
<td>Rex</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td>male</td>
<td>male</td>
<td>male</td>
</tr>
<tr>
<td><strong>Born</strong></td>
<td>29/02/1978</td>
<td>10/01/2001</td>
<td>24/12/1985</td>
</tr>
<tr>
<td><strong>Character</strong></td>
<td>mild</td>
<td>no</td>
<td>evil</td>
</tr>
<tr>
<td><strong>Hobbies</strong></td>
<td>chess, collecting butterflies, watching soap operas</td>
<td>smoking cigars, boxing, extreme games</td>
<td>biting</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Walker, Mary</th>
<th>Walker, Mary</th>
<th>Walker, Mary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>mother</strong></td>
<td>Walker, Mary</td>
<td>Walker, Mary</td>
<td>Walker, Mary</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td>female</td>
<td>female</td>
<td>female</td>
</tr>
<tr>
<td><strong>Born</strong></td>
<td>31/02/1981</td>
<td>10/01/2001</td>
<td>24/12/1985</td>
</tr>
<tr>
<td><strong>Character</strong></td>
<td>hectic</td>
<td>no</td>
<td>evil</td>
</tr>
<tr>
<td><strong>Hobbies</strong></td>
<td>smoking cigars, boxing, extreme games</td>
<td>smoking the soother</td>
<td>biting</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Doe, Johny</th>
<th>Doe, Johny</th>
<th>Doe, Johny</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>child</strong></td>
<td>Doe, Johny</td>
<td>Doe, Johny</td>
<td>Doe, Johny</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td>male</td>
<td>male</td>
<td>male</td>
</tr>
<tr>
<td><strong>Born</strong></td>
<td>10/01/2001</td>
<td>10/01/2001</td>
<td>10/01/2001</td>
</tr>
<tr>
<td><strong>Character</strong></td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td><strong>Hobbies</strong></td>
<td>sucking the soother</td>
<td>biting</td>
<td>biting</td>
</tr>
</tbody>
</table>
# XSL producing LaTeX

## The Doe family

<table>
<thead>
<tr>
<th>father</th>
<th>Doe, John</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>male</td>
</tr>
<tr>
<td>Born</td>
<td>29 — 02 — 1978</td>
</tr>
<tr>
<td>Character</td>
<td>mild</td>
</tr>
<tr>
<td>Likes</td>
<td>chess, collecting butterflies, watching soap operas</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>mother</th>
<th>Walker, Mary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>female</td>
</tr>
<tr>
<td>Born</td>
<td>31 — 02 — 1981</td>
</tr>
<tr>
<td>Character</td>
<td>hectic</td>
</tr>
<tr>
<td>Likes</td>
<td>smoking cigars, boxing, extreme games</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>child</th>
<th>Doe, Johny</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>male</td>
</tr>
<tr>
<td>Born</td>
<td>1 — 01 — 2001</td>
</tr>
<tr>
<td>Character</td>
<td>no</td>
</tr>
<tr>
<td>Likes</td>
<td>sucking the soother</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>dog</th>
<th>Rex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>male</td>
</tr>
<tr>
<td>Born</td>
<td>24 — 12 — 1985</td>
</tr>
<tr>
<td>Character</td>
<td>evil</td>
</tr>
<tr>
<td>Likes</td>
<td>biting</td>
</tr>
</tbody>
</table>
The Doe family

father - John Doe, born at 29.02.1978 is a man with mild character; he likes chess, collecting butterflies, watching soap operas

mother - Mary Walker, born at 31.02.1981 is a woman with hectic character; she likes smoking cigars, boxing, extreme games

child - Johny Doe, born at 1.01.2001 is a child with no character; he likes sucking the soother

dog - Rex, born at 24.12.1985 is a dog with evil character; he likes biting
Semantic XML: examples

- MathML
  - presentation MathML
  - content MathML
- OpenMath
  - OpenMath Content Dictionaries
  - OMDoc: the language for mathematical Documents
Content MathML and OpenMath

\( a \cdot (b + c) \)
OMDoc Language for Mathematics

- items of knowledge have types
  - definition
  - assertion (theorem, lemma, proposition ...)
  - axiom
  - proof
  - example
  - exercise

- items are annotated with metadata

- formulas are machine understandable
ActiveMath Knowledge Representation

- Using OMDoc for representing Domain Ontology
- Extending OMDoc with educational metadata
- Extending the microstructure of exercises
- Adding new Elements to the ontology (misconceptions)
Example OMDoc

<definition id="def_diff" for="deriv_symbols/diff">
  <metadata>
    <Title xml:lang="de">Definition der Ableitung bzw. des Differentialquotienten</Title>
    <Title xml:lang="en">Definition of the derivative, resp., differential quotient</Title>
    <Title xml:lang="es">Definición de la derivada, resp., cociente diferencial</Title>
    <Title xml:lang="zh"></Title>
    <extradata>…</extradata>
  </metadata>
  <CMP xml:lang="de">
    Eine <textref xref="functions Symbols/function">Funktion</textref> $f$ heißt differenzierbar an der Stelle $x_0$ …
  </CMP>
  <CMP xml:lang="en">
    A <textref xref="functions Symbols/function">function</textref> $f$ is called differentiable at $x_0$ …
  </CMP>
  <CMP xml:lang="es">
    Una <textref xref="functions Symbols/function">función</textref> $f$ se dice diferenciable en $x_0$ …
  </CMP>
  <CMP xml:lang="zh">
    $f$
    <highlight type="important">$x_0$</highlight> …
  </CMP>
  <CMP xml:lang="x-all">
    $ap(diff(f),x_0)=lim(x_0,both_sides,lambda(x,(ap(f,x)-ap(f,x_0))/(x-x_0)))$.
  </CMP>
</definition>
Example OMDoc Metadata

<metadata>

<Title xml:lang="de">Definition der Ableitung bzw. des Differentialquotienten</Title>
<Title xml:lang="en">Definition of the derivative, resp., differential quotient</Title>
<Title xml:lang="es">Definición de la derivada, resp., cociente diferencial</Title>
<Title xml:lang="zh"></Title>

<extradata>

<relation type="domain_prerequisite">
<ref xref="diffquot_symbols/diff_quot"/>
<ref xref="maplimits_symbols/maplimit"/>
</relation>
<learningcontext value="secondary_education"/>
<learningcontext value="higher_education"/>
<learningcontext value="university_first_year"/>
<field value="all"/>
<typicallearningtime value="00:01:00"/>
<representation value="verbal"/>
<representation value="symbolic"/>
<abstractness value="abstract"/>
</extradata>

</metadata>
A monoid is a structure in which is a semi-group with e.
Generation of Presentation of Mathematics

- **Mathematics on the Web is a problem**
  - Often only as images
  - No semantics

- **ActiveMath:**
  - HTML, MathML, (SVG)
  - Cross-browser: Internet Explorer, Mozilla
  - Usage of semantics to add invisible information

- **Authorable appearance**

\[ m_{PQ} = \frac{y_Q - y_P}{x_Q - x_P}. \]
The slope as an example for a derivative (differential quotient)

The slope of a curve \( y = f(x) \) in some point \( P = (x_P, y_P) = (x_P, f(x_P)) \) is given by

\[
slope (f, P) = \lim_{x \to x_0} \frac{f(x) - f(x_0)}{(x - x_0)},
\]

whenever the limit of this function exists. Such a limit of difference quotients is also called **differential quotient** or **derivative of the function** \( f \) at \( x_0 \).
Math: XHTML+MathML**

The slope as an example for a derivative (differential quotient)

The slope of a curve \( y = f(x) \) in some point \( P = (x_P, y_P) = (x_P, (f(x_P))) \) is given by

\[
\text{slope}(f, P) = \lim_{x \to x_0} \frac{f(x) - f(x_0)}{x - x_0},
\]

whenever the limit of this function exists. Such a limit of difference quotients is also called differential quotient or derivative of the function \( f \) at \( x_0 \).
The slope as an example for a derivative (differential quotient)
The slope of a curve $y = f(x)$ in some point $P = (x_P, y_P) = (x_P, f(x_P))$ is given by
\[\text{slope}(f, P) = \lim_{x \to x_0} \frac{f(x) - f(x_0)}{(x - x_0)},\]
whenever the limit of this function exists. Such a limit of difference quotients is also called differential quotient or derivative of the function $f$ at $x_0$. 
The slope as an example for a derivative (differential quotient)

The slope of a curve \( y = f(x) \) in some point \( P = (x_P, y_P) = (x_P, f(x_P)) \) is given by

\[
\text{slope } (f,P) = \lim_{x \to x_0} \frac{f(x) - f(x_0)}{x - x_0},
\]

whenever the limit of a function is function exists. Such a limit of difference quotients is also called differential quotient or derivative of the function \( f \) at \( x_0 \).
Interactive Exercises

![Diagram of Interactive Exercises]

- **Interaction**
  - Metadata
  - Stimulus
  - Response

- **Transition**
  - Condition
  - Diagnosis

- **Interaction**
  - Metadata
  - Stimulus
  - Response

- **Transition**
  - Condition
  - Diagnosis
Components of an exercise

Interaction
- Metadata
- Stimulus
- Response

Task Definition
- selection
- fill_in_blank

Task Definition (continued)
- mcq single answer
- mcq multiple answer
- marking
- mapping
- ordering
- puzzle

- simple blank
- blanks in a formula
- literal blank
- prompt
- Item reference
Fill-in-blank and feedback

Calculate the derivative of the following function: \[ \frac{(x^2 + 2x + 5)}{(x+7)} \]

Now we perform the derivation on each of the factors to be derived.

\[ \frac{(x^2 + 2x + 5)'(x+7) - (x^2 + 2x + 5)(x+7)'}{(x+7)^2} \]

Now we perform some simplifications of the expression obtained.

\[ \frac{2x^2 + 2x + 14x + 14 - x^2 - 2x - 5}{(x+7)^2} \]

No, that's not correct. Carefully check the bracketing, or the correctness of coefficients of common members.

You have to simplify the expression. Use elementary arithmetic transformations.

Evaluate  Hint  Input syntax: Maple™  Input syntax help  Display format: HTML
Selection interactivity

FERTIGKEITEN - BRÜCHE - MULTIPLIZIEREN UND DIVIDIEREN VON BRÜCHEN

Bruch als Rechnung

Welche Rechnung wird durch den Bruch \( \frac{2}{5} \) dargestellt?

- Erst "mal 2", dann "geteilt durch 5".
- Erst "geteilt durch 5", dann "mal 2".
- Erst "geteilt durch 2", dann "mal 5".
- "Geteilt durch 2", dann "geteilt durch 5".

Die richtige Antwort wäre:

- Erst "mal 2", dann "geteilt durch 5".
- Erst "geteilt durch 5", dann "mal 2".
- Erst "geteilt durch 2", dann "mal 5".
- "Geteilt durch 2", dann "geteilt durch 5".

Zurück

Hilfe

Fehler melden

Source
Selection by marking interactivity

Erroneous Proof Example 1 ⭐⭐

Can you find the error(s)?
Please indicate where the incorrectness of Eve's solution starts by clicking on the first wrong line:

Eve shall prove or disprove: \( \lim_{n \to \infty} (-1)^n = 0 \)

Eve's solution is:
Prove: \( \lim_{n \to \infty} (-1)^n = 0 \)

To show this, we want to obtain the inequality

\( \exists n \in \mathbb{N} \) such that \( |(-1)^n - 0| < \varepsilon \)

First, we simplify the left-hand expression:
\( |(-1)^n - 0| = |-1| = 1 \)

Therefore we only need to show:

\( \exists n \in \mathbb{N} \) such that \( 1 < \varepsilon \)

Let's choose \( \varepsilon = 2 \), we have

\( 1 < 2 \)

which is true

Hence

\( \lim_{n \to \infty} (-1)^n = 0 \)

is correct.
Usage of Knowledge Representation

- Modularity, reusable in different contexts
- Efficient Multi-stage presentation process
- Extensible maths symbol presentation
- Multiple output format
- Support of multiple languages
- Adaptive course generation
- Semantic search
- Semantic drag and drop
- Interoperability of services
Exercise Architecture

Knowledge Base

Exercise Manager

Diagnoser

Maxima

Sloper

Feedback Generator

Presentation

Learner model

Tutorial strategies

Source: Erica Melis

Educational Technologies WS 2006/07