

Authoring of Semantic Mathematical Content for Learning on the Web



**Vortrag zur Dissertationsprüfung,
Universität des Saarlandes, 30. Juli 2012**

**Paul Libbrecht
paul@hoplahup.net**

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Outline

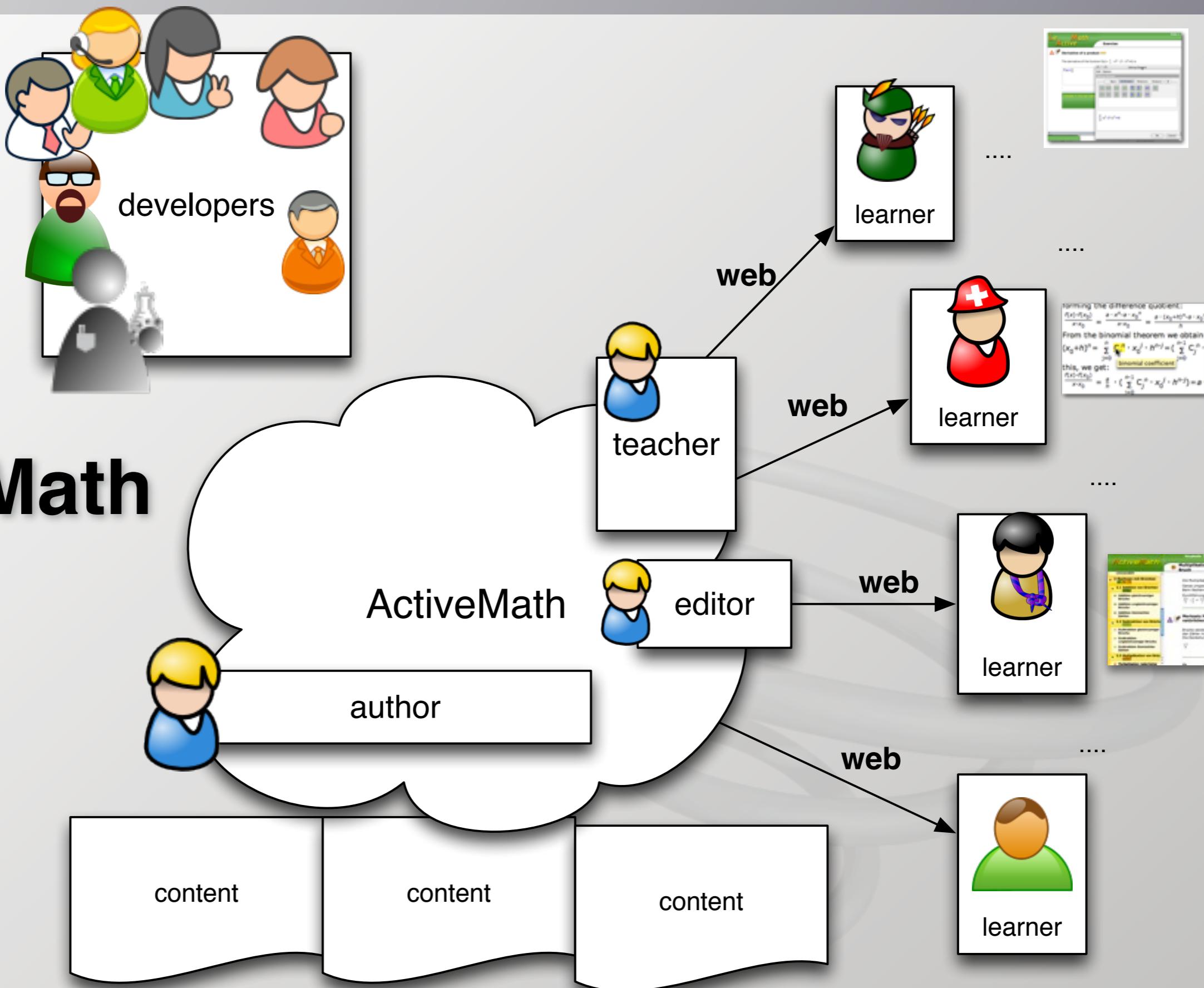
- mission: authoring for ActiveMath
- related work
- my contribution
 - WYCIWYG
 - facilitating the input
 - storage & search
 - case studies
- summary
- future work

Outline

- **mission: authoring for ActiveMath**
- related work
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- future work

The Mission

Roles in ActiveMath



The Mission

Role
in
Action

Le Active Math

Print | I

Exercise

X **Derivative of a product ★★**

The derivative of the function $f(x) = \frac{2}{3} \cdot x^2 \cdot (7 \cdot x^3 + 4)$ is

$f'(x) =$

Indicate in the box below

Editing Element

Edit Option

Editing Element

Basic Arithmetic Relations Analysis ►

$\begin{matrix} - & + & \cdot & ^n & \prod_{i=1}^n & \sum_{i=1}^n & \gcd & c \\ - & | & \frac{\cdot}{\cdot} & \sqrt[n]{\cdot} & \prod_{i=1}^n & \sum_{i=1}^n & \text{lcm} & \end{matrix}$

$\frac{2}{3} \cdot x^2 \cdot (7 \cdot x^3 + 4)$

Ok Cancel

Forming the difference quotient:
$$\frac{f(x+h) - f(x)}{x+h - x} = \frac{x^2 \cdot (x^3 + h^3) - x^2 \cdot (x^3 + 4)}{x+h - x} = \frac{x^2 \cdot x^3 + x^2 \cdot h^3 - x^2 \cdot x^3 - 4x^2}{h} = \frac{x^2 \cdot h^3}{h} = x^2 \cdot h^2$$

From the binomial theorem we obtain
$$(x_0 + h)^n = \sum_{j=0}^{n-1} \binom{n-1}{j} x_0^{n-j} \cdot h^j = \left(\sum_{j=0}^{n-1} \binom{n-1}{j} x_0^{n-j} \right) \cdot h^j$$

this, we get:
$$\frac{f(x+h) - f(x)}{x+h - x} = \frac{h}{h} \cdot \left(\sum_{j=0}^{n-1} \binom{n-1}{j} x_0^{n-j} \cdot x_0^j + h^{n-j} \right) = x^2 \cdot h^2$$

Binomial coefficient

Navigation

Home | About | Help | Log In | Log Out | Logout

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Home | About | Help | Log In | Log Out | Logout

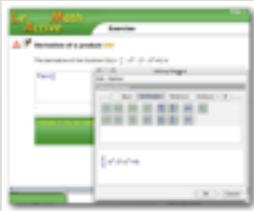
The Mission



developers



learner



Roles in ActiveM

forming the difference quotient:

$$\frac{f(x) - f(x_0)}{x - x_0} = \frac{a \cdot x^n - a \cdot x_0^n}{x - x_0} = \frac{a \cdot (x_0 + h)^n - a \cdot x_0^n}{h}$$

From the binomial theorem we obtain

$$(x_0 + h)^n = \sum_{j=0}^n C_j^n \cdot x_0^j \cdot h^{n-j} = (\sum_{j=0}^{n-1} C_j^n \cdot$$

this, we get:

binomial coefficient

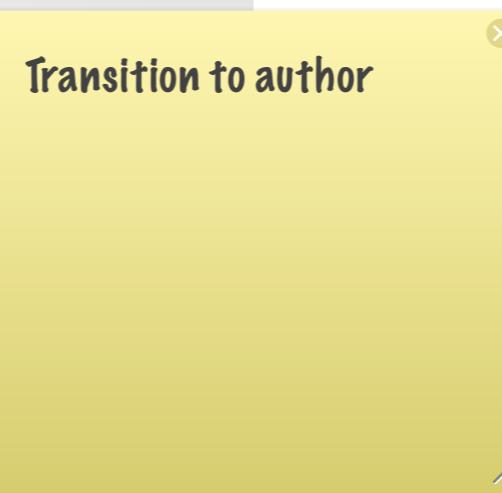
$$\frac{f(x) - f(x_0)}{x - x_0} = \frac{a}{h} \cdot (\sum_{j=0}^{n-1} C_j^n \cdot x_0^j \cdot h^{n-j}) = a \cdot$$

The Mission

The screenshot shows a user interface for the ActiveMath learning platform. At the top, there is a header bar with icons of four people (two boys, two girls) and a small character on the right. Below the header is a navigation menu with links: Hauptseite, Suchen, Notizen, Mein Profil, Werkzeuge, Drucken, Abmelden, and Hilfe. The main content area has a title: **Multiplikation natürlicher Zahlen mit einem Bruch**. To the right of the title is a progress indicator: 22/54. On the left, there is a sidebar titled "umwandeln" with a yellow background. It lists several sub-sections under "2 Rechnen mit Brüchen": 2.1 Addition von Brüchen (with sub-points: Addition gleichnamiger Brüche, Addition ungleichnamiger Brüche, Addition Gemischter Zahlen), 2.2 Subtraktion von Brüchen (with sub-points: Subtraktion gleichnamiger Brüche, Subtraktion ungleichnamiger Brüche, Subtraktion Gemischter Zahlen), and 2.3 Multiplikation von Brüchen (with sub-point: Multiplikation natürlicher). Each sub-section has a corresponding icon of colored squares below it. The main content area contains text explaining the multiplication of a fraction by a whole number, mentioning simplification and the result being a mixed number. It also includes a mathematical derivation of the binomial theorem. A blue pen icon is next to the text. Below this, there is a section titled "Merksatz Multiplikation von Brüchen mit einer natürlichen Zahl" with a pencil icon. It explains that multiplying a fraction by a whole number involves multiplying the numerator and leaving the denominator unchanged. An example is shown with a fraction $\frac{1 \cdot 3}{4}$. At the bottom right, the word "learner" is visible.

The Mission ActiveMath Content

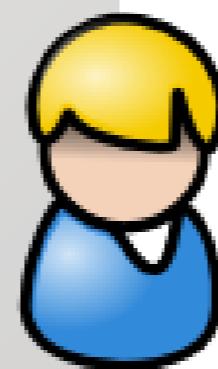
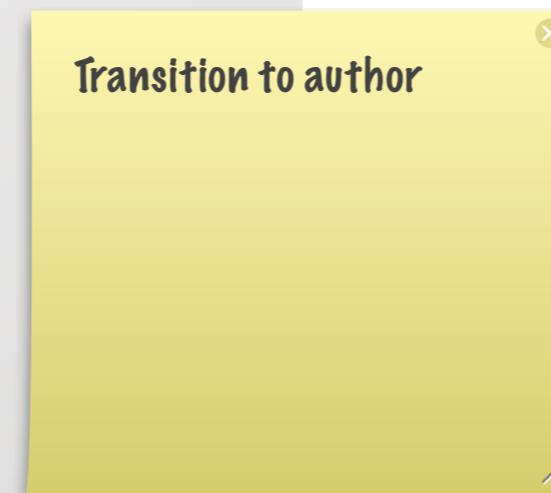
E D A M T X P T



The Mission ActiveMath Content

E D A M T X P T

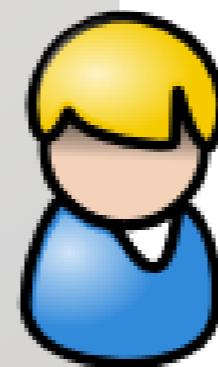
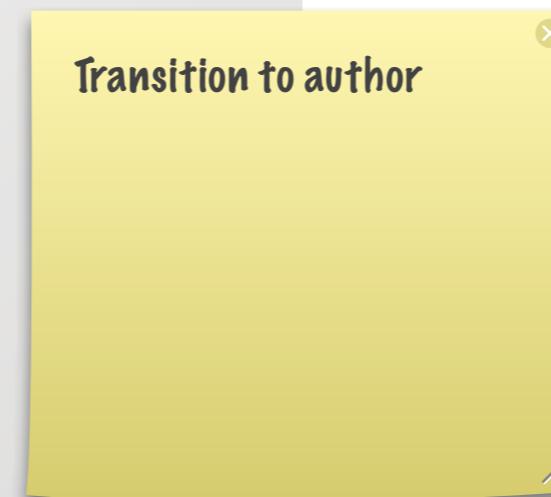
a set of items



The Mission ActiveMath Content



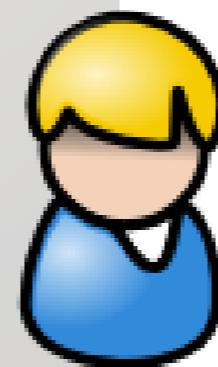
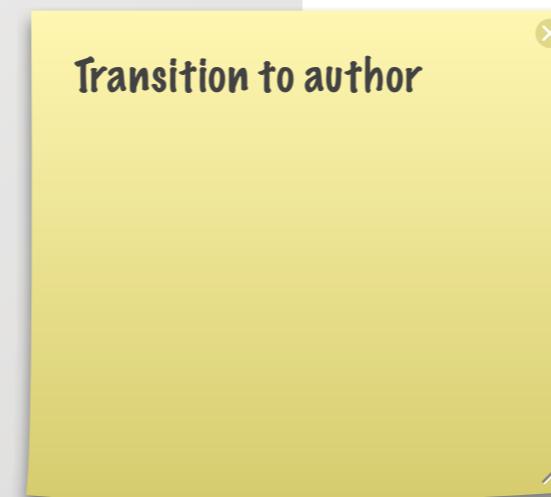
a set of items



The Mission ActiveMath Content



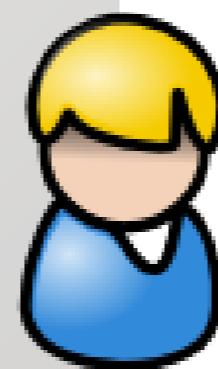
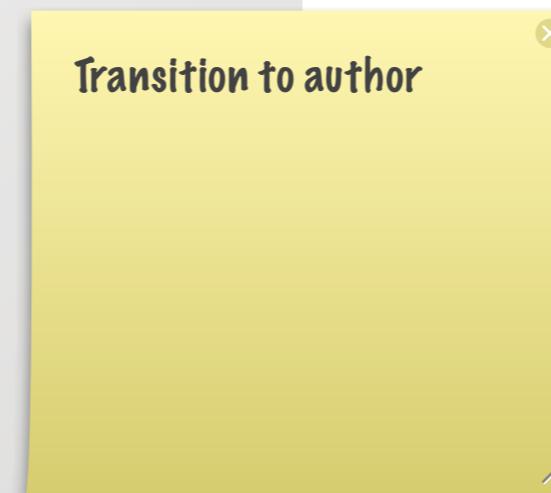
a set of items



The Mission ActiveMath Content



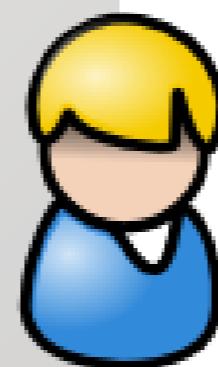
a set of items



The Mission ActiveMath Content



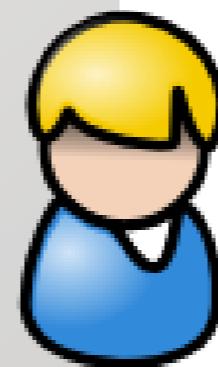
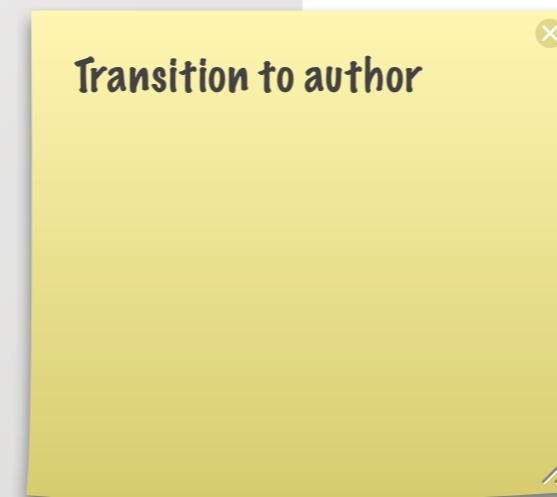
a set of items



ActiveMath Content



a set of items



ActiveMath Content



a set of items

<CMP>

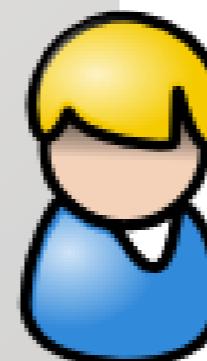
Z
R

are all examples for
but also e.g., the set of all maps
since these maps can be added and su

Transition to author

, , , and are all examples for abelian groups ,
 , , and

with text,



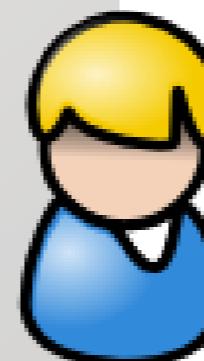
ActiveMath Content



a set of items

- \mathbb{Z} , \mathbb{Q} , \mathbb{R} , and \mathbb{C} are all examples for abelian groups ,
- $(f + g)(x) = f(x) + g(x)$, $(f - g)(x) = f(x) - g(x)$, and

**with text,
with formulæ**



The Mission ActiveMath Content



a set of items

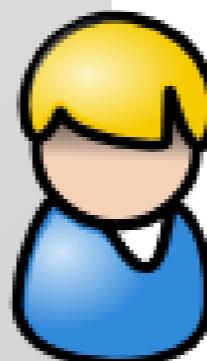
with annotations
with relations



Transition to author

- \mathbb{Z} , \mathbb{Q} , \mathbb{R} , and \mathbb{C} are all examples for abelian groups ,
 $(f + g)(x) = f(x) + g(x)$, $(f - g)(x) = f(x) - g(x)$, and

with text,
with formulæ



```
<example id="ex1_ab_group"
    <ref xref="functions_symbols/fun"
    <ref xref="functions_symbols/zer"
    </relation>
    <learningcontext value="university"
    <difficulty value="medium" />
    </extradata>
</metadata>

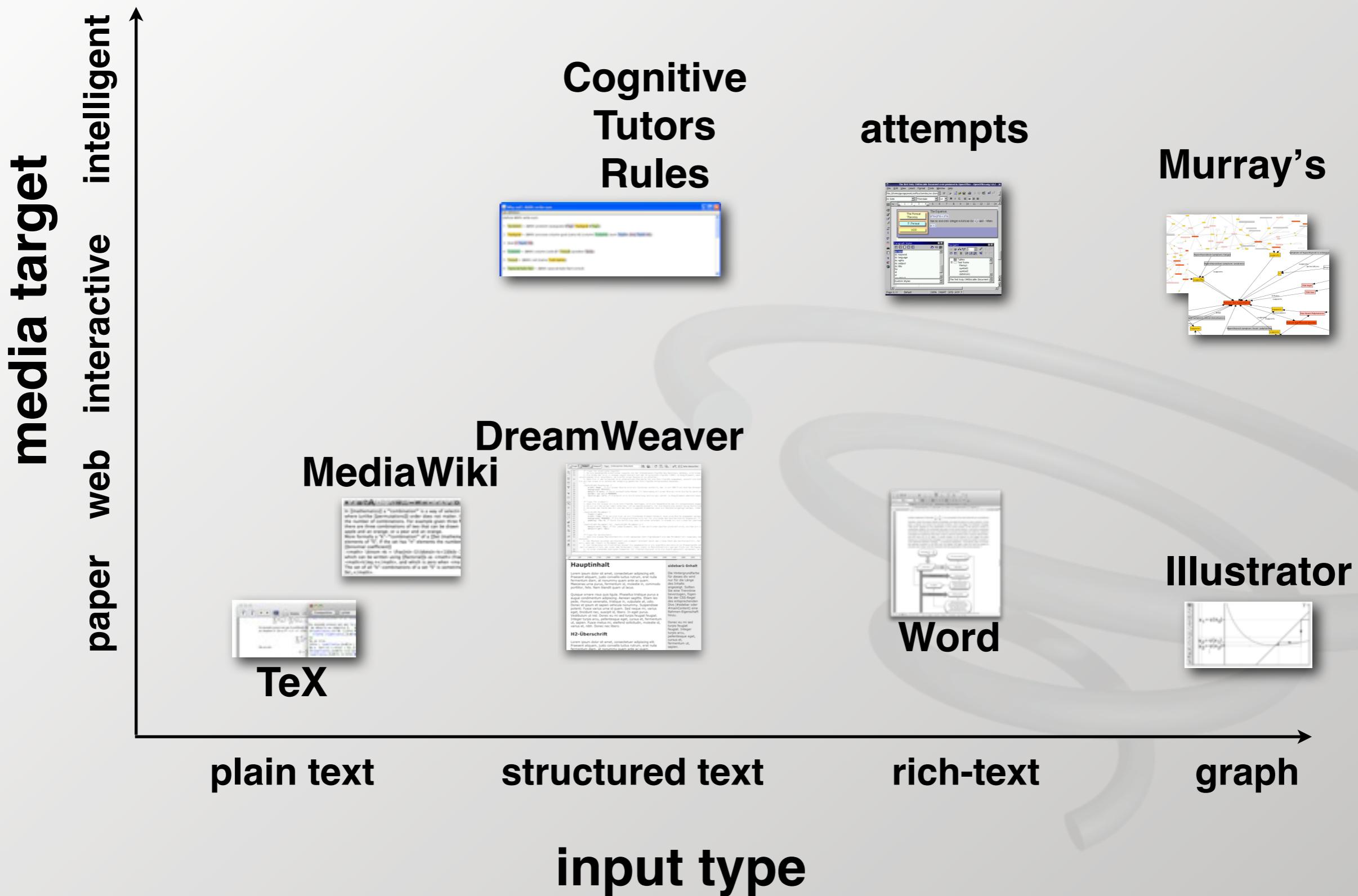
<CMP>
    <OMOBJ><OMS cd="setname1" name="Z" />
    <OMOBJ><OMS cd="setname1" name="R" />
    are all examples for <textref xref=
    but also e.g., the set of all maps <
    since these maps can be added and su
    <OMOBJ>
        <OMA>
            <OMS cd="relation1" name="eq" />
        <OMA>
            <OMA>
                <OMS cd="arith1" name="plus" />
                <OMV name="f" />
                <OMV name="g" />
            </OMA>
            <OMV name="x" />
        </OMA>
        <OMA>
            <OMS cd="arith1" name="plus" />
            <OMA>
                <OMV name="f" />
                <OMV name="x" />
            </OMA>
            <OMA>
```

Outline

- mission: authoring for ActiveMath
- related work
- my contribution
 - WYCIWYG
 - facilitating the input
 - storage & search
 - case studies
- summary
- future work

Related Work

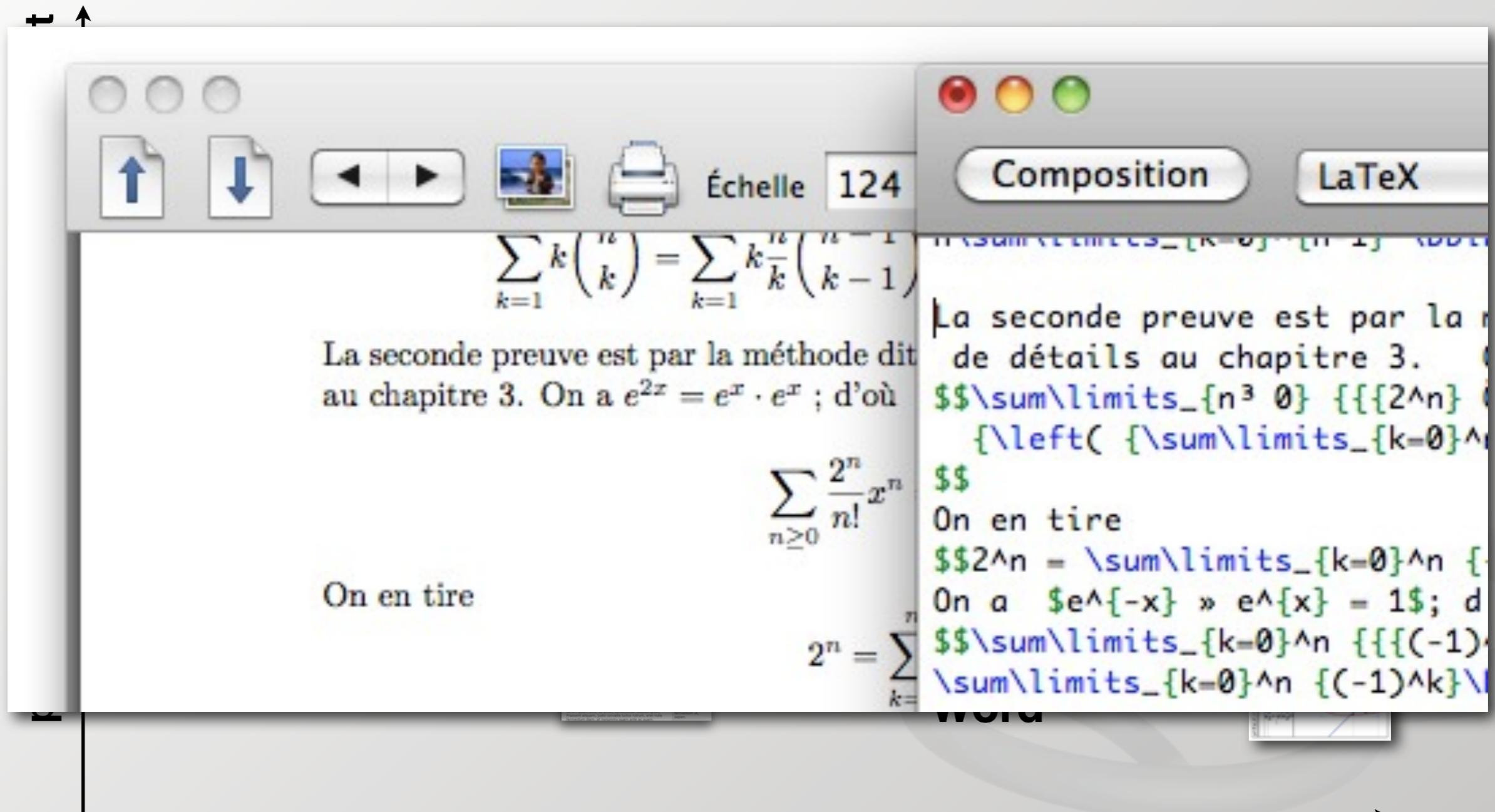
Authoring Tools



Related Work

Authoring Tools TeXshop

media target



plain text

structured text

rich-text

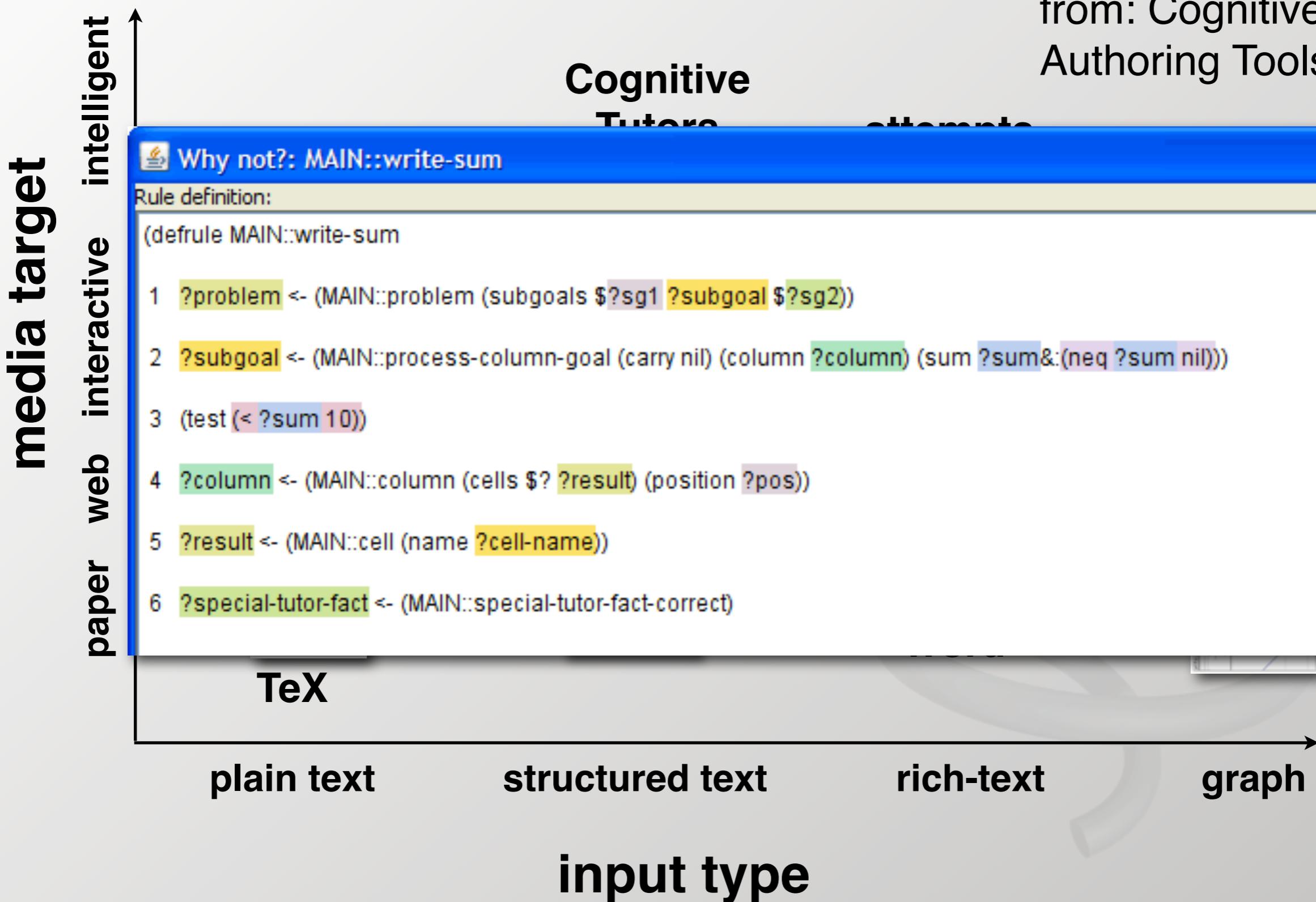
graph

input type

Related Work

Authoring Tools: CTAT Rules

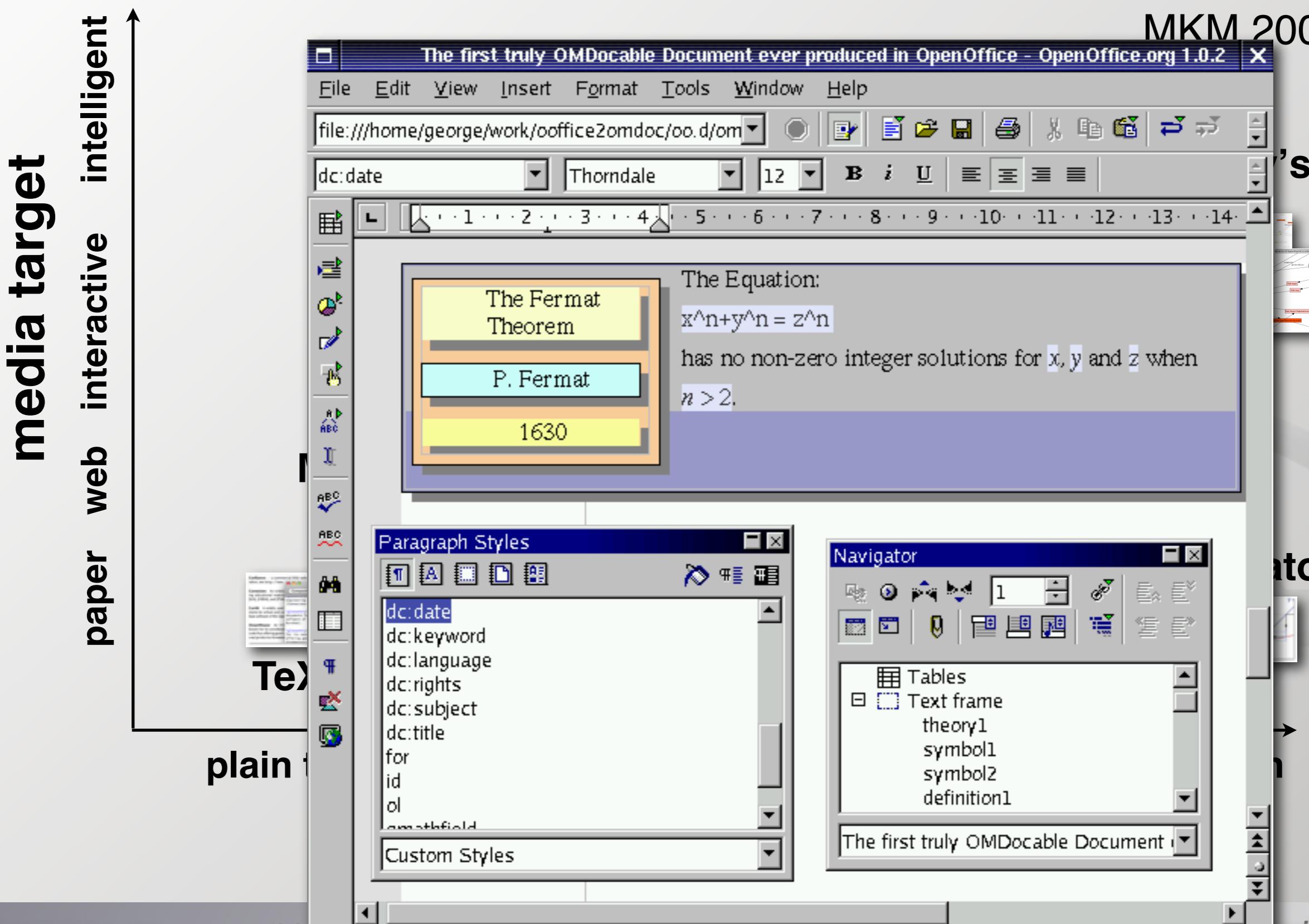
from: Cognitive Tutors'
Authoring Tools' Tutorial



Related Work

Authoring Tools: Word Proc.

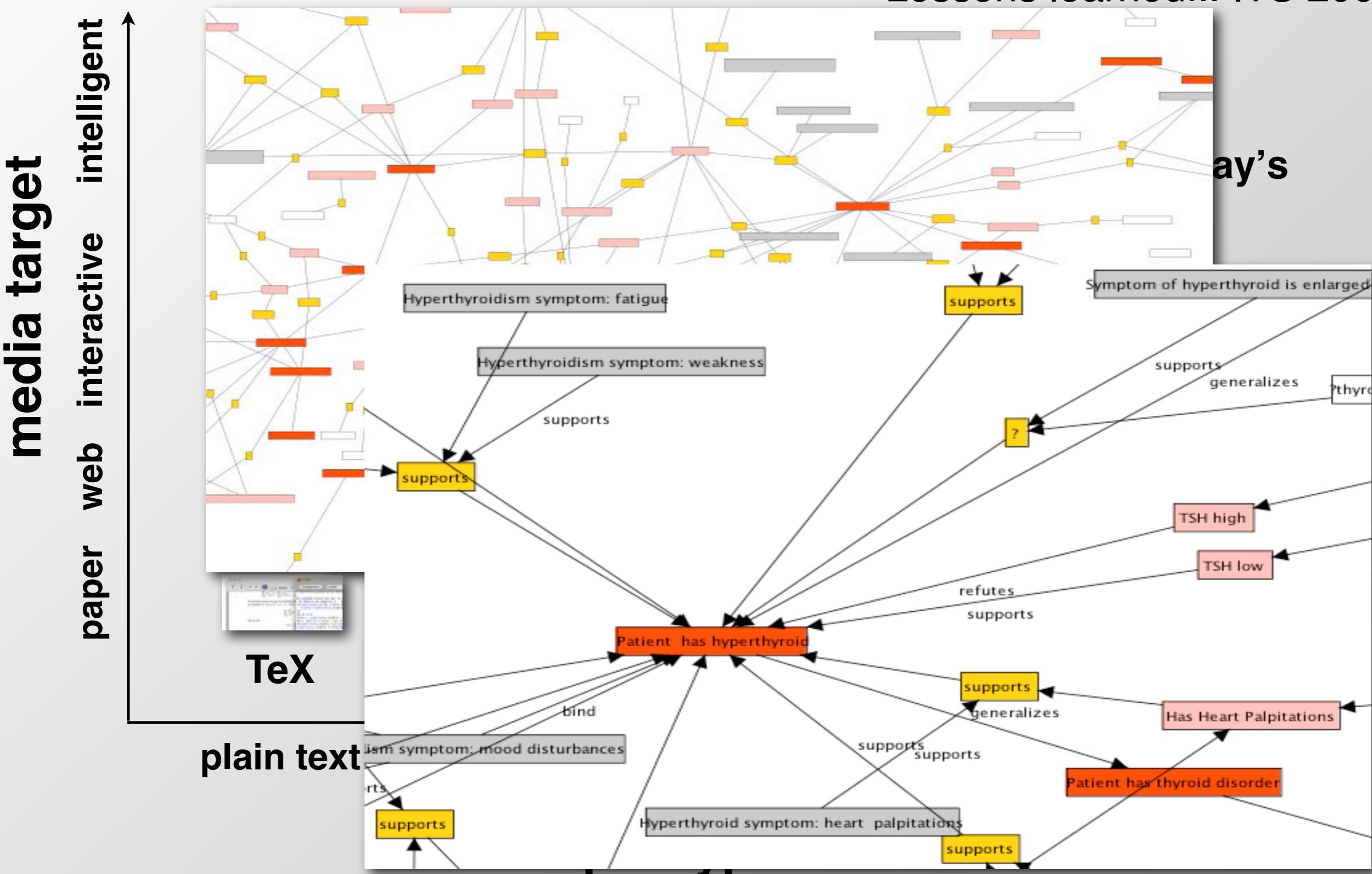
from: Goguadze
Gonzalez-Palomo
MKM 2003



Related Work

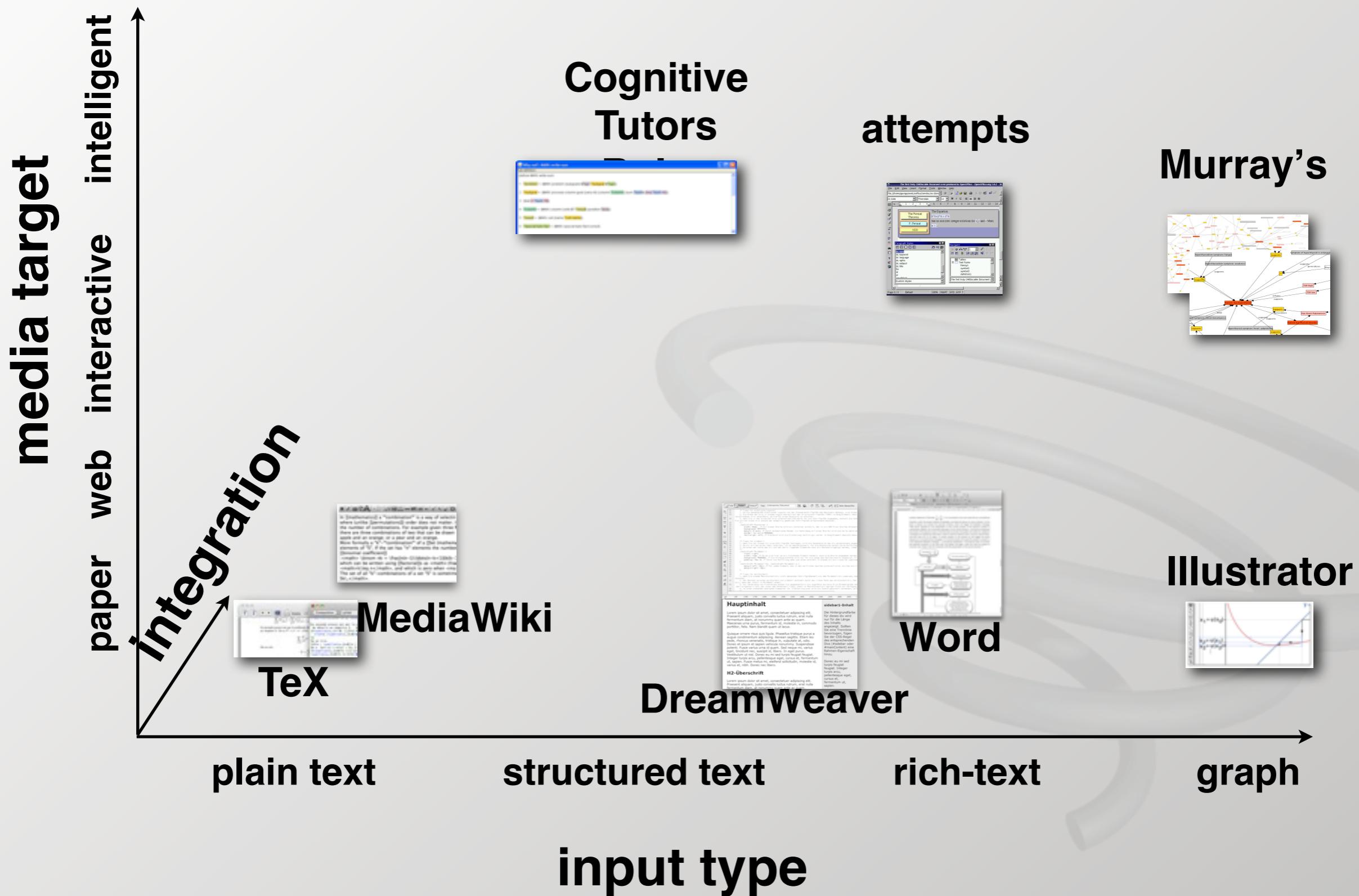
Authoring Tools

from: Murray, Woolf, Marshall
Lessons learned... ITS 2004



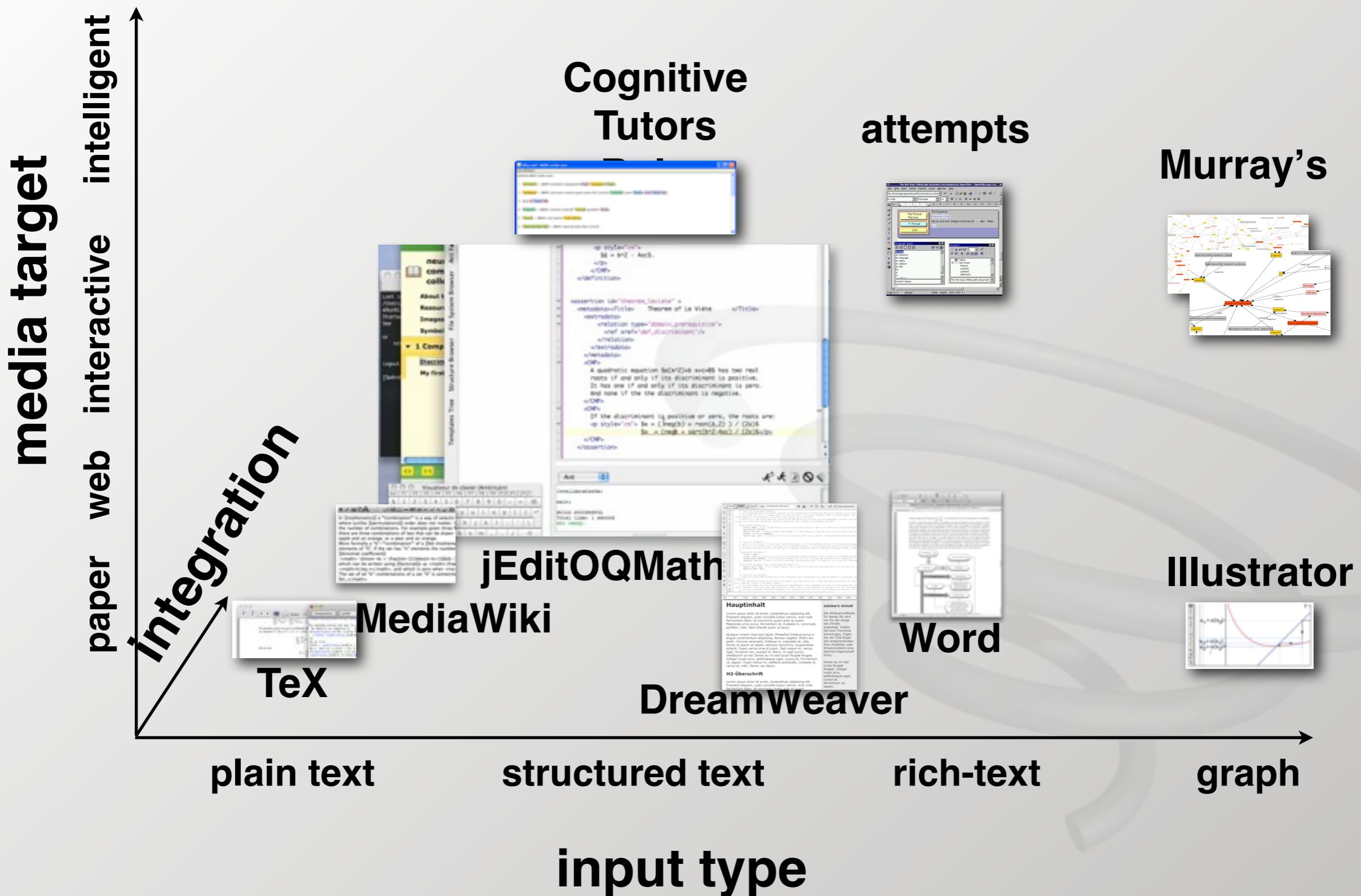
Related Work

Authoring Tools



Related Work

Authoring Tools

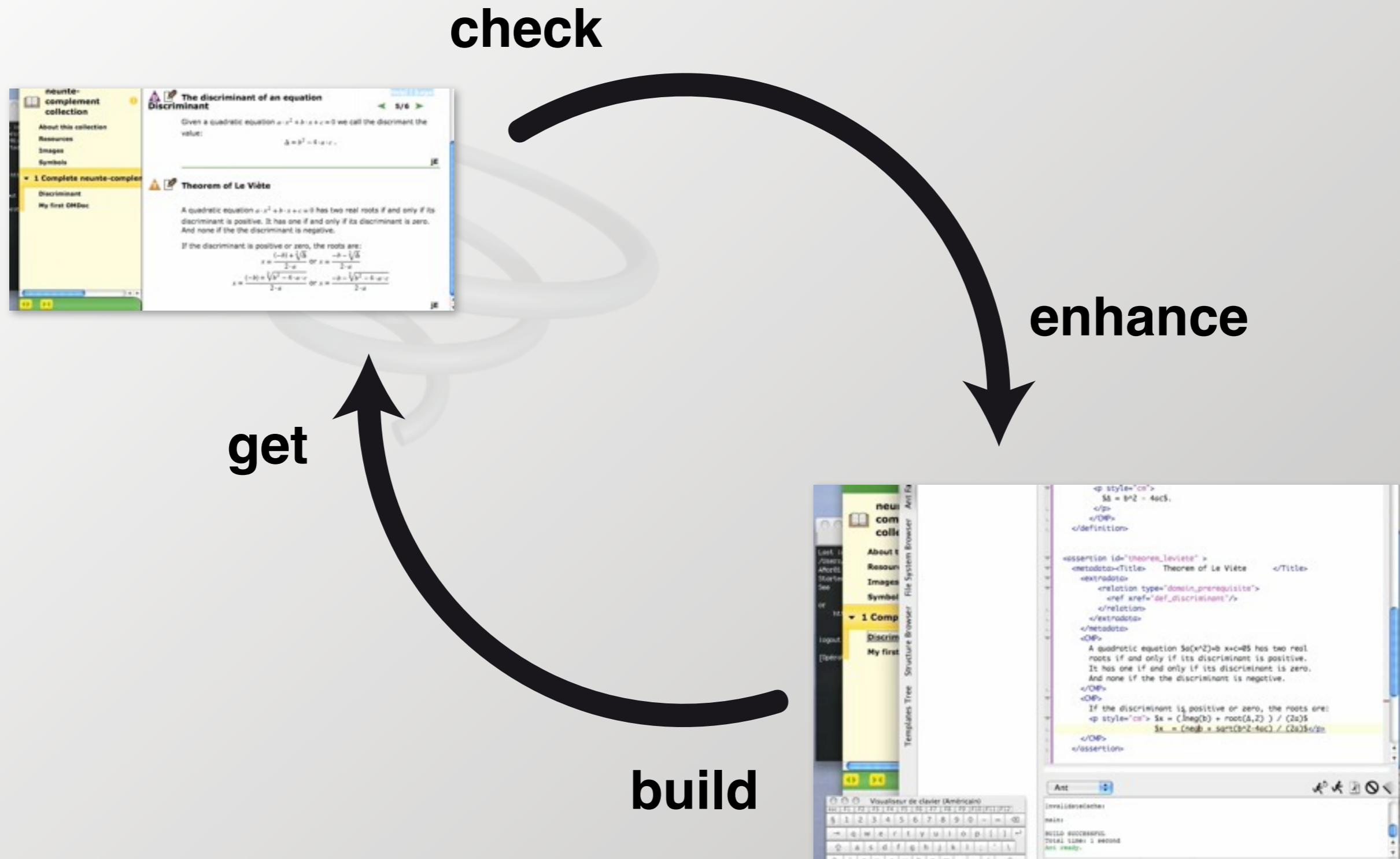


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The Core Paradigm: WYCIWYG

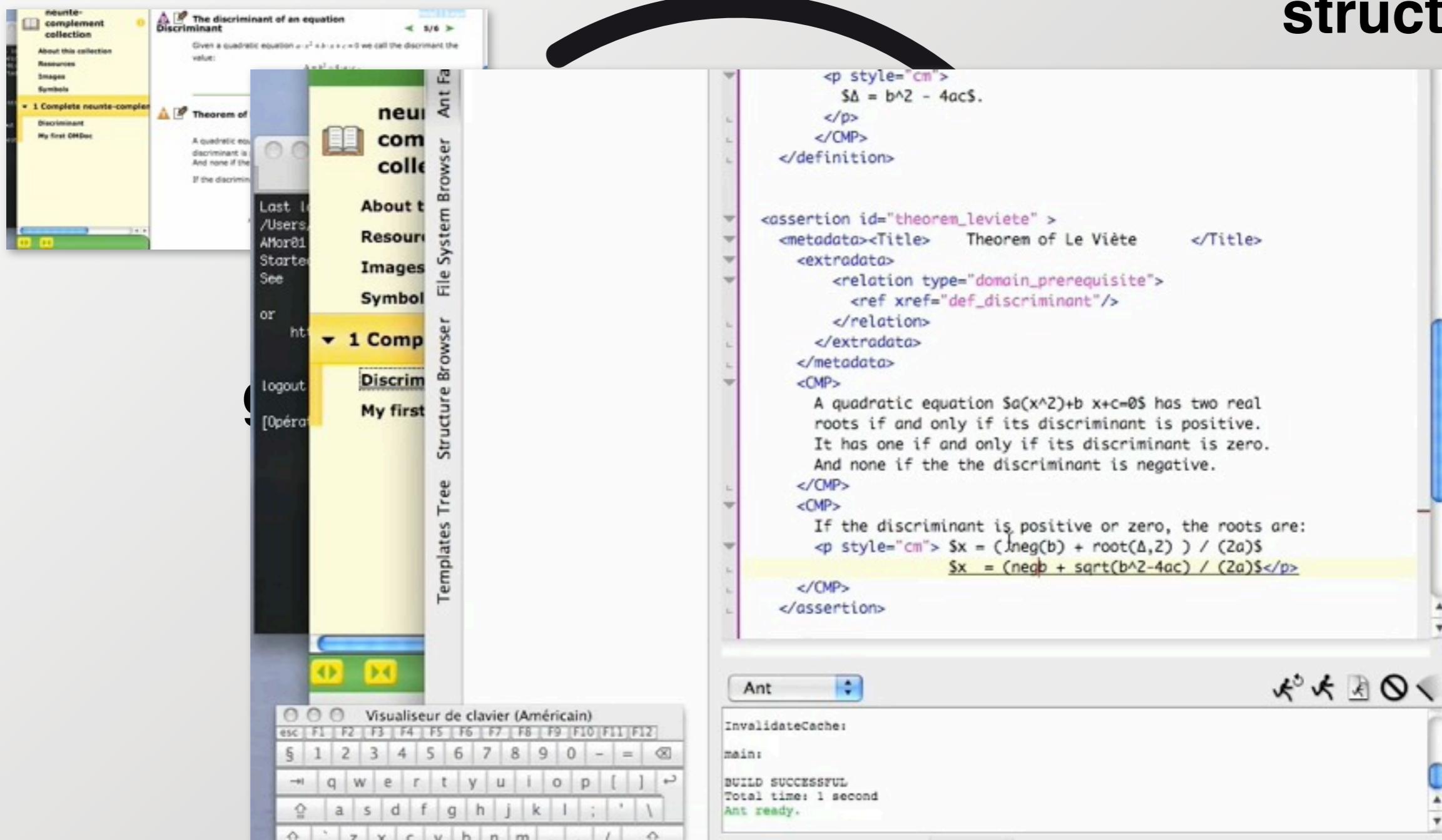
What You Check is What You Get



What You Check is What You Get

check

input
structured
text



The Core Paradigm: WYCIWYG

What You Check is What You Get

check

The screenshot shows a web-based mathematics application interface. On the left, there is a sidebar with a yellow header "neunte-complement collection" containing links for "About this collection", "Resources", "Images", and "Symbols". Below this is a section titled "1 Complete neunte-complement" with "Discriminant" and "My first OMDoc" listed. At the bottom of the sidebar are navigation icons for back, forward, and search.

The main content area has a title "The discriminant of an equation" with a sub-section "Discriminant". It contains text: "Given a quadratic equation $a \cdot x^2 + b \cdot x + c = 0$ we call the discriminant the value:

$$\Delta = b^2 - 4 \cdot a \cdot c .$$

Below this is another section titled "Theorem of Le Viète" with a warning icon. It states: "A quadratic equation $a \cdot x^2 + b \cdot x + c = 0$ has two real roots if and only if its discriminant is positive. It has one if and only if its discriminant is zero. And none if the the discriminant is negative." It also says: "If the discriminant is positive or zero, the roots are:"

$$x = \frac{(-b) + \sqrt{\Delta}}{2 \cdot a} \text{ or } x = \frac{-b - \sqrt{\Delta}}{2 \cdot a}$$
$$x = \frac{(-b) + \sqrt{b^2 - 4 \cdot a \cdot c}}{2 \cdot a} \text{ or } x = \frac{-b - \sqrt{b^2 - 4 \cdot a \cdot c}}{2 \cdot a}$$

On the right side of the main content, there is a vertical toolbar with icons for Help, Legal, and navigation. Below the toolbar, there is some code and a status bar indicating "BUILD SUCCESSFUL TOTAL TIME: 2 seconds Ant ready".

check in realistic ActiveMath

build

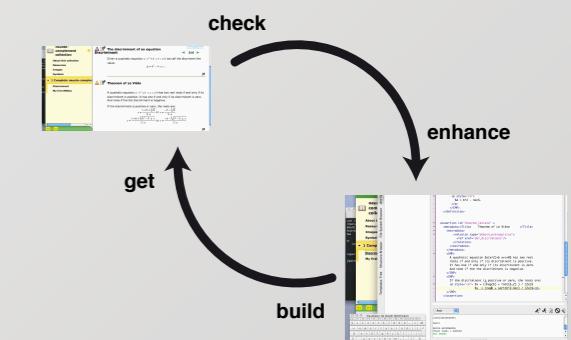
Outline

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Highlight of the thesis

Supported Text Edition

- the source is a structured text
 - tree like, elements, texts, attributes
 - formulæ in compact format
 - kept readable at all times
- lots of XML editing support
- help to get started:
 - tutorials with exact texts
 - copy and paste of formulæ from many places:
 - some TeX
 - Wikipedia, Planet Math, MathML
 - smart paste



Task cont-1: Add first content and see it

The goal of this task is to perform a first content modification and see the content updated in one's ActiveMath. This is half a sanity test.

Prerequisite
create-a-collection

Applications That Should be Running
jEditQOMath, ActiveMath, web-browser

Task description

- go to jEditQOMath, in the file first.qomath
- find a CMP element, for example the hello-world axiom
- inside this element, between and type a rare word or two (say, Möbius)
- let us add a few exotic characters as well: type the sequence of letters D e l t a followed by C-:edit > expand-abbreviation). You should see a capital delta letter, a triangle
- save (press C-S or press the pencil toolbar-button)
- validation happens, verify there's nothing to complain about in the status bar ("XML parsing complete, 0 errors")
 - if not, you have introduced illegal characters or at illegal places, undo a few times then re-insert without "<: " & ">".
- open the AntFarm tab (the top tab on the left-side-bar of the jEdit window)
- inside there, find an item called "fancy-surfaces collection". ActiveMath build file". If there is no listed build yet, press the "+" button and locate the build.xml file of your collection first.
- double click this item, or click it once then click the running man (we are compiling and publishing, more about this in build-process)
- see the operation happening in the "console", ensure it says "build successful"
- go to your browser, open / http://localhost:8080/
- see your collection's automatic book, open it, see your text and the Delta there
- click the search link in the top tool menu
- type one of the rare words.
- see the title of the hello-world axiom, click it and see the same

(Content Modifications and up Task cont-2: add-search-see: add
Previews (cont) an item, find it, see it)

The shape of the triangle is determined by the lengths of the sides also be derived from the lengths of the sides. By Heron's formula

$$T = \sqrt{s(s - a)(s - b)(s - c)}$$

where $s = \frac{a+b+c}{2}$ is the semiperimeter, or half of the triangle's perimeter.

Three equivalent ways of writing Heron's formula are

$$T = \frac{1}{4}\sqrt{(a^2 + b^2 + c^2)^2 - 2(a^4 + b^4 + c^4)}$$

```
<assertion id="Heron-Formula">
<metadata><title> The Formula of Heron </title>
</metadata>
<DMP>Given the length  $s$ ,  $a$ ,  $b$ , and  $c$  of a triangle, its area  $A$  can be computed with the formula of Heron:
<p style="color: #0000ff; font-weight: bold; margin-left: 20px;">$A=\sqrt{s(s-a)(s-b)(s-c)}
</p>
</DMP>
</assertion>
```

The Formula of Heron

Given the length a , b , and c of a triangle, its area A can be computed with the formula of Heron:

$$A = \frac{1}{2}\sqrt{a^2 + b^2 + c^2}$$

Highlight of the thesis

Supported Tasks

- the source
- tree like, elements
- formulae in XML
- kept readable
- lots of XML
- help to get started
- tutorials with examples
- copy and paste
- some TeX support
- Wikipedia support
- smart pasting

Task cont-1: Add first content and see it

The goal of this task is to perform a first content modification and see the content updated in one's ActiveMath. This is half a sanity test.

Prerequisite
create-a-collection

Applications That Should be Running
jEditOQMath, ActiveMath, web-browser

Task description

- go to jEditOQMath, in the file first.oqmath
- find a CMP element, for example the hello-world axiom
- inside this element, between and type a rare word or two (say, Möbius)
- let us add a few exotic characters as well: type the sequence of letters D e l t a followed by C-; (edit > expand-abbreviation). You should see a capital delta letter, a triangle.
- save (press C-S or press the pencil toolbar-button)
- validation happens, verify there's nothing to complain about in the status bar ("XML parsing complete, 0 error(s)").
 - if not, you have introduced illegal characters or at illegal places, undo a few times then re-insert without "<", "&" and ">".
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- double click this item, or click it once then click the running man
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- see the operation happening in the "console", ensure it says "build successful"
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- see your collection's automatic book, open it, see your text and the Delta there
- click the search link in the top tool menu
- type one of the rare words.
- see the title of the hello-world axiom, click it and see the same

[Content Modifications and Previews \(cont\)](#) up [Task cont-2: add-search-see: add an item, find it, see it](#)

The diagram illustrates a continuous software development cycle:

- get**: Represented by a curved arrow pointing from the bottom-left towards a screenshot of the jEditOQMath interface.
- build**: Represented by a curved arrow pointing from the bottom-right towards a screenshot of the ActiveMath build process.
- check**: Represented by a curved arrow pointing from the top-right towards a screenshot of a web browser displaying mathematical content.
- enhance**: Represented by a curved arrow pointing from the top-left back to the **get** step.

Below the cycle, three screenshots provide examples of the tools and processes involved:

- jEditOQMath Screenshot**: Shows the interface for editing OQMath files, with a focus on the code editor and toolbars.
- ActiveMath Build Screenshot**: Shows the AntFarm tab in jEdit, where a build process is being managed.
- Web Browser Screenshot**: Shows a web page with mathematical content, likely generated from the build process.

Code Snippet (XML build configuration):

```
<assertion id="Heron-Formula">
<metadata><title> The Formula of Heron </title>
</metadata>
<DP>Given the length sa, sb, and sc of a triangle, computed with the formula of Heron:
<p style="color: #0000ff; font-weight: bold; margin-bottom: 0.5em;">SA= $\sqrt{s(s-a)(s-b)(s-c)}$ 

Text Snippet (The Formula of Heron):



The shape of the triangle is determined by the lengths of the sides. It can also be derived from the lengths of the sides. By Heron's formula


$$T = \sqrt{s(s-a)(s-b)(s-c)}$$


where  $s = \frac{a+b+c}{2}$  is the semiperimeter, or half of the triangle's perimeter.



Three equivalent ways of writing Heron's formula are:


$$T = \frac{1}{4}\sqrt{(a^2 + b^2 + c^2)^2 - 2(a^4 + b^4 + c^4)}$$

```

Paul Libbrecht

CC-BY-SA

23

Authoring for Semantic Mathematical Content for Learning on the Web

H The shape of the triangle is determined by the lengths of the sides also be derived from the lengths of the sides. By Heron's formula

$$T = \sqrt{s(s - a)(s - b)(s - c)}$$

where $s = \frac{a+b+c}{2}$ is the *semiperimeter*, or half of the triangle's

Three equivalent ways of writing Heron's formula are

$$T = \frac{1}{4} \sqrt{(a^2 + b^2 + c^2)^2 - 2(a^4 + b^4 + c^4)}$$

```
<assertion id="heron-formula">
<metadata><Title> The Formula of Heron </Title>
</metadata>
<CMP>Given the length $a$, $b$, and $c$ of a triangle,
computed with the formula of Heron:
<p style="cm">
$A\frac{1}{4}\sqrt{((a^2+b^2+c^2)^2-2\cdot a^4+b^4+c^4),2}$
</p>
</CMP>
</assertion>
```

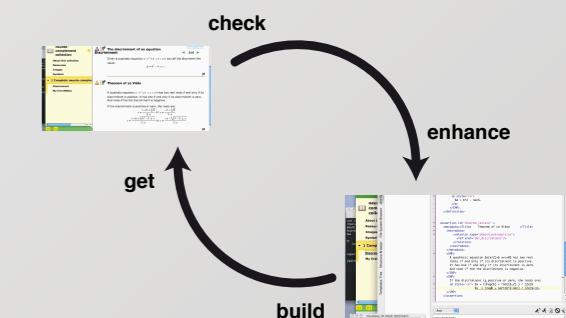
● [Wiki](#)



The Formula of Heron

Given the length a , b , and c of a triangle, its area A can be computed with the formula of Heron:

$$A = \frac{1}{4} \cdot \sqrt{(a^2+b^2+c^2)^2-2\cdot a^4+b^4+c^4}$$



Task cont-1: Add first content and see it

The goal of this task is to perform a first content modification and see the content updated in one's ActiveMath. This is a sanity test.

Prerequisite
create-a-collection

Applications That Should be Running
jEditIOMath, ActiveMath, web-browser

Task description

- go to jEditIOMath, in the file first.qmathm
- find a CMP element, for example the hello-world axiom
- inside this element, between and type a rare word or two (say, Mobius)
- let us add a few exotic characters as well: type the sequence of letters D e l a followed by C; (edit > expand-abbreviation). You should see a capital delta letter, a triangle,
- save (press C-S or press the pencil toolbar-button)
- validation happens, verify there's nothing to complain about in the status bar ("XML parsing complete, 0 errors").
 - if not, you have introduced illegal characters or at illegal places, undo a few times then re-insert without "<", "&" and ">".
- open the AntFarm tab (the top tab on the left-side-bar of the jEdit window)
- inside there, find an item called "fancy-surfaces collection, ActiveMath build file". If there is no listed build yet, press the "+" button and locate the build.xml file of your collection first.
- double click this item, or click it once then click the running man
 - (we are compiling and publishing, more about this in build-process)
- see the operation happening in the "console", ensure it says "build successful"
- go to your browser, open / http://localhost:8080/
- see your collection's automatic book, open it, see your text and the Delta there
- click the search link in the top tool menu
- type one of the rare words.
- see the title of the hello-world axiom, click it and see the same

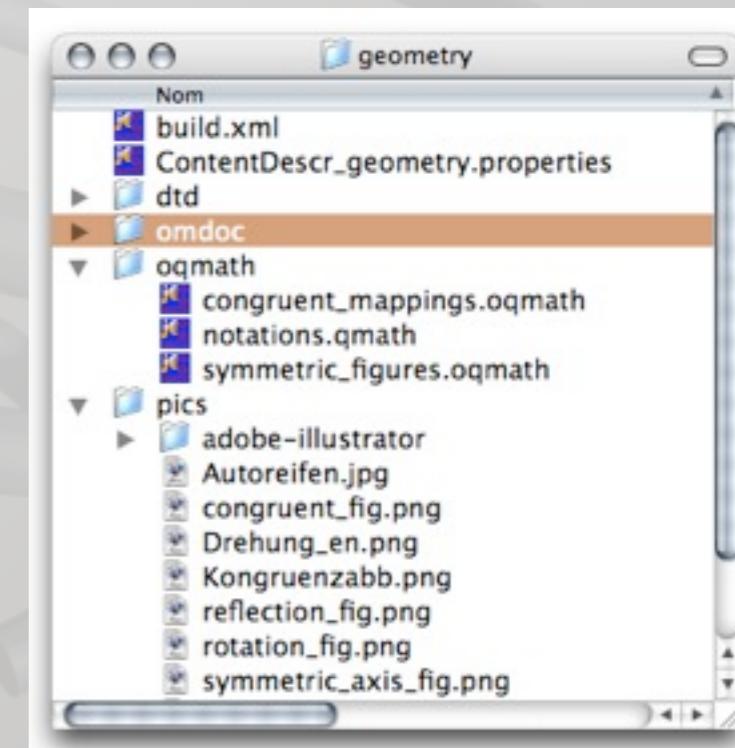
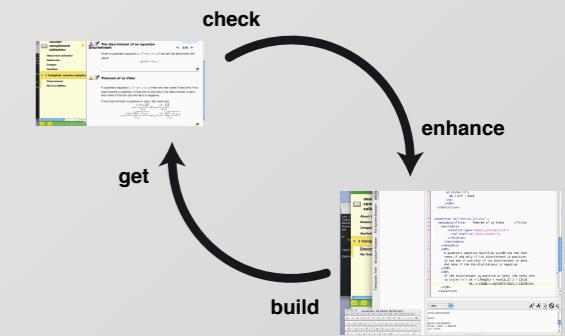
[Content Modifications and Previews \(cont\)](#) [up](#) [Task cont-2: add-search-see: add an item, find it, see it](#)

Outline

- mission: authoring for ActiveMath
- related work
- my contribution
 - WYCIWYG
 - facilitating the input
 - **storage & search**
 - case studies
- summary
- future work

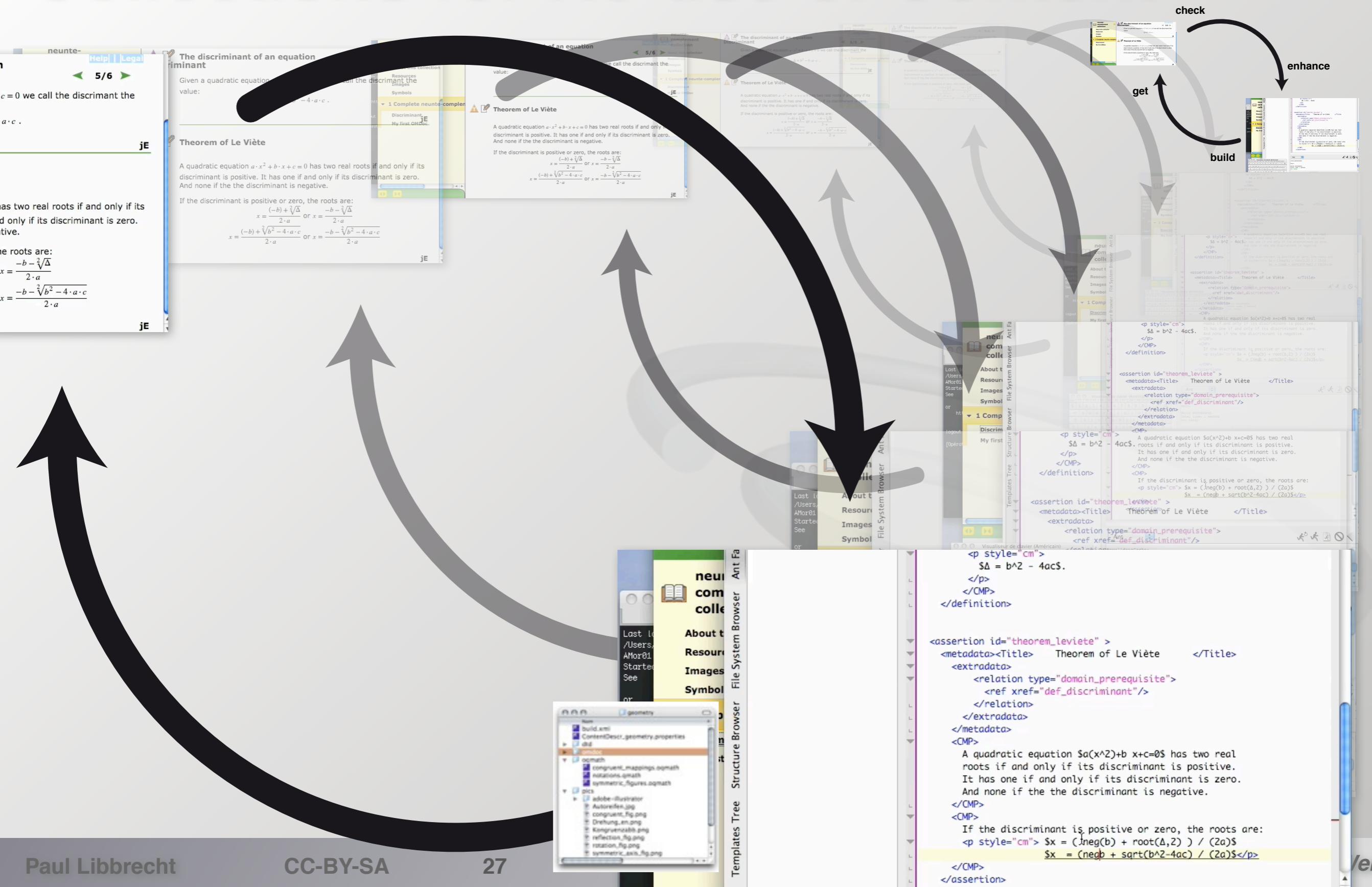
Content Storage

- authors create files
- the files are indexed
 - ActiveMath can serve the content items
- short build cycles:
 - need to check now!
 - ready to serve high-performance
- files are in collections
 - authors know what is where
 - directory with simple organization
 - can be shared



Many WYCIWYG Cycles

Collections for Re-use of Content



Highlight of the thesis

Search

- a tool for learners and authors
- search for text, attributes, formulæ
- display content items, find seen places

The screenshot shows the ActiveMath search interface. At the top right are links for "Print | Help". Below that is a navigation bar with tabs: "simple" (disabled), "advanced" (selected), and "history" (disabled). The main search area has a title "ActiveMath Search" and three dropdown menus:

- "Search for items..." with options: "which contain the text" (set to "derivation"), "contain approximate words" (disabled), and "in language English" (disabled).
- "which..." with options: "are of type" (set to "Theorem or Assertion") and "in language English" (disabled).
- "which contain the formula" (set to " x^2 ").

Below these are buttons for "all criteria" (checked) and "search" (disabled). A "New Search" button is also present. On the left, a sidebar displays a search query: "Search for \"derivation, type: Theorem or Assertion, [formula]\" (English) (among all items)" and "30 objects found". Below this is a list of 30 search results, each preceded by a yellow warning icon and a link:

- ... ▲ The derivative of polynomials
- ... ▲ The derivative of power functions
- ... ▲ The derivative functions of the hyperbolic functions
- ... ▲ The derivative of the logarithmic function
- ... ▲ The derivative of arbitrary logarithmic function
- ... ▲ The derivative of general power functions
- ... ▲ The derivative of power functions with integer exponents
- ... ▲ The derivative of the arc cosine function
- ... ▲ The derivative of the arc sine function
- ... ▲ The derivative of the arc tangent function

At the bottom right of the search area is a preview window showing the first result: "The derivative of polynomials". It includes a pencil icon for editing, the definition "Let $n \in \mathbb{N}^+$ and f be a real (or complex) polynomial of degree n in x , defined by $y = f(x) = a_n \cdot x^n + \dots + a_2 \cdot x^2 + a_1 \cdot x + a_0$ ", and a note about the derivative being a polynomial of degree $n-1$.

Search

- a tool for learners and authors
- search for text, attributes, formulæ
- display content items, find places
- how does it work?
 - an *index* notes occurrences of each word
 - ranking through:
 - precision to query (title, stemming)
 - desirability for learner
 - formulæ are made into phrases



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presentation
Arithmetic exercise
Let us assume
 $a+b=k$



Highlight of the thesis

Search

- a tool for learners and authors
- search for terms
- display content

OQMath

<title>Arithmetic exercise</title>

<CMP>Let us assume \$a+b=k\$.</CMP>

presentation

Arithmetic exercise

Let us assume

$$a+b=k$$

- how does it work?
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presentation

Arithmetic exercise

Let us assume

$$a+b=k$$

OQMath

```
<title>Arithmetic exercise</title>
```

```
<CMP>Let us assume $a+b=k$.</CMP>
```

OMDoc

- how does it work
- an interface
- ranking
- presentation
- definition
- formalization

```
<title>Arithmetic exercise</title>
<CMP>Let us assume
<OMOBJ><OMA> <OMS cd=relation1 name=eq/>
  <OMA><OMS cd=arith1 name=plus/>
    <OMV name=a/><OMV name=b/>
  </OMA>
  <OMV name=k/>
</OMA>
.</CMP>
```

Highlight of the thesis

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- search for terms
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OQMath

<title>Arithmetic exercise</title>

<CMP>Let us assume \$a+b=k\$.</CMP>

presentation

Arithmetic exercise

Let us assume

$$a+b=k$$

indexed tokens

title-en: arithmetic exercise

text-en: let us assume (_0 _OMS_relation1/eq

_(_1 _OMS_arith1/plus _OMV_a _OMV_b _)1 _OMV_k _)0

phonetic-en: LT AS ASM

- presentation
 - definition
 - formula
- <OMV><OMS cd="arith" name="plus"/>
<OMV name=a/><OMV name=b/>
</OMA>
<OMV name=k/>
</OMA>
. </CMP>

Highlight of the thesis

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```
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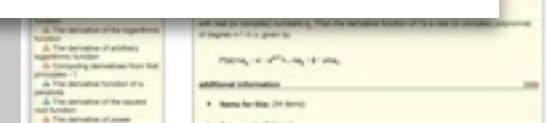
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query

arithmetic

```
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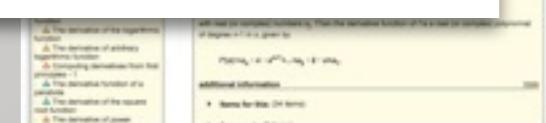
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query
arithmetic

query
assume

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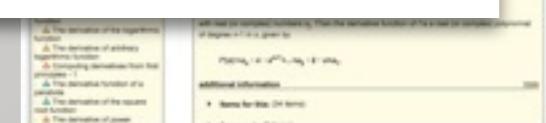
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arithmetic

query
assume

query
 $a+b$

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title-en: arithmetic exercise

text-en: let us assume $(_0 \text{OMS_relation1}/eq$

$_(_1 \text{OMS_arith1}/plus \text{OMV_a} \text{OMV_b})_1 \text{OMV_k })_0$

phonetic-en: LT AS ASM

- desirability for learner

- formulæ are made into phrases

query
arithmetic

query
assume

query
 $a+b$

query
 $? = k$

```
name=eq/>
<OMA><OMS cd=arith1 name=plus/>
<OMV name=a/><OMV name=b/>
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- summary
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Case studies: Authors' Achievements

- no formal experiment
- but long *coaching* of authors
 - e.g. Christian
 - mathematician, TeX-guy
 - strong organization of content
 - e.g. Adrien
 - young developer,
 - full self-learner from tasks
 - meeting intelligent features...
- tool used by ~50 authors
 - who created ~20000 items

Durchschnittliche Steigungen

Definition der durchschnittlichen Steigung zwischen zwei Punkten

Um die durchschnittliche Steigung einer Kurve zwischen zwei Punkten $P = (x_p|y_p)$ und $Q = (x_Q|y_Q)$ zu bestimmen, ersetzt man die Kurve durch die Gerade durch P und Q (also durch die Sekante durch die beiden Punkte P und Q).

Die durchschnittliche Steigung der Kurve zwischen P und Q ist dann definiert als die Steigung dieser Geraden PQ :

$$m_{PQ} = \frac{y_Q - y_p}{x_Q - x_p}$$

400 pages

Activemath

Page d'accueil | Rechercher | Notes | Mon profil | Outils | Imprimer | Se connecter

Généralités

Calcul Numérique > Les opérations > Généralités

Calcul Numérique

Les opérations

Généralités

Règles des signes

Propriétés des opérations

Calcul sur les puissances

Calcul sur les fractions

Règles

Les rapports

Les applications

Les proportions

La règle de trois

Le carré et la racine

Propriétés des racines carrées

3⁴ = 3 · 3 · 3 · 3

3⁴ se dit "3 puissance 4",
5² se dit "5 puissance 2" ou "5 au carré",
7³ se dit "7 puissance 3" ou "7 au cube".

L'addition et la soustraction n'ont de sens que s'il s'agit de grandeurs de même espèce, par exemple des longueurs, des poids, des sommes

20 pages

Lessons Learned

- task descriptions
 - no imprecision allowed
 - effective to jumpstart
- tangible authoring crucial
 - all: utility of features only if it works
 - far-away expectations ignored
 - short attempt cycles to grasp meaning
- freedom to organize sources
 - *author-important* information at visible places
 - inheritance model

Features of an authoring tool (Murray 2003)

- visual editing and rapid testing
- flexible opportunistic design
- modularity, re-usability
- familiar paradigms
- scriptability, customization

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 - *undo, copy-and-paste, drag-and-drop, files, ...*
- scriptability, customization
 - *source text editing, configurable notations*

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Future work

- **visual tool**
 - remember: *easy input but hard management*
 - architecture and component to be re-used
 - reload, search, CnP, ...
- **fuzzy math search**
 - normalization and rewriting systems exist
 - should x^2-1 match $(x-1)(x+1)$?
- **testable intelligent components**
 - as easy as a WYCIWYG cycle
 - restart course-planning with same user-model



thank you.

supplementary

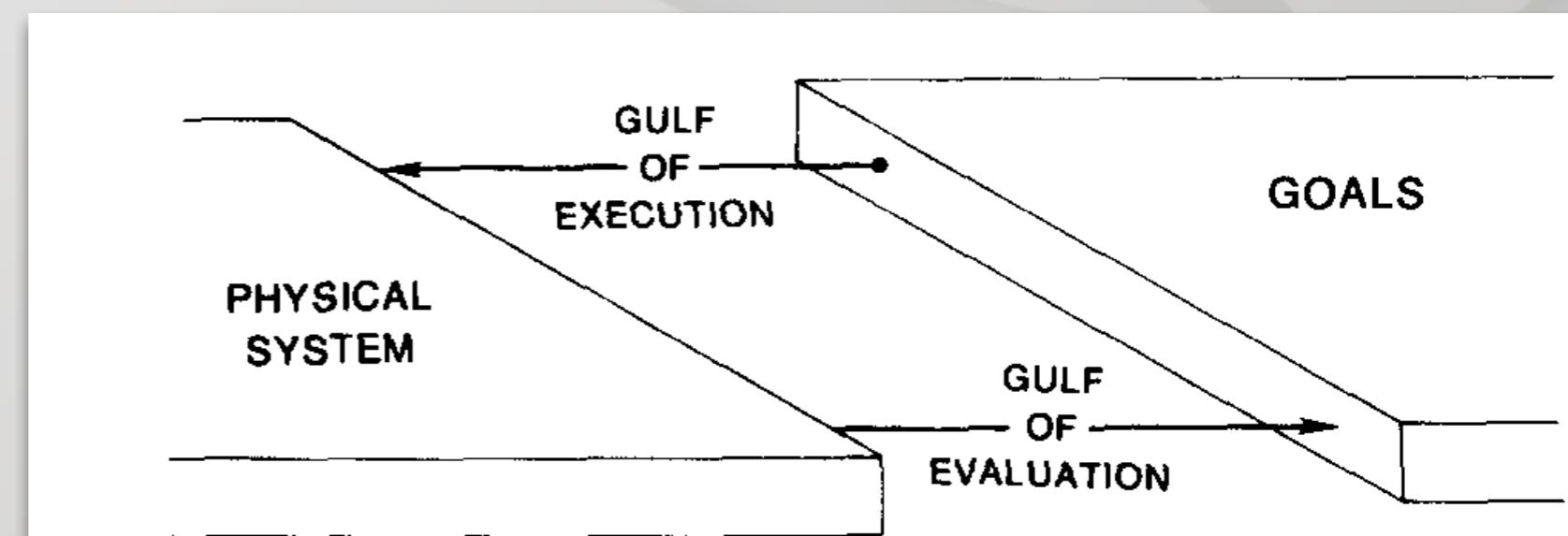
for those who think that...

Editing XML Source is not Easy

- **text source editing:**
 - is common and for all skill-levels
 - can be exchanged in emails, etc
 - is versioning-system friendly
- **XML editing:**
 - is much better supported than many other languages (e.g. QMath or wiki)
 - can be kept readable (read: OMDoc book)
 - multiple editors, standardized validation

Direct Manipulation

- Easy?
 - *look at direct manipulation*
 - he formulated „against programming“
 - but a more detailed analysis (Fröhlich 1996)
 - Visualisation of output data seems critical to the benefits of direct manipulation
 - Visualisation of input data may be less important
- Gulf of evaluation



Storage Performance

- focus: fast serving
 - beyond 2000 queries/second
- indexing may take time:
 - LeAM_calculus: old CPU, ~20 minutes
 - new CPU: ~2 minutes
 - 1000 books? ~15 hours
 - comparable to big deployments
- focus for authors: fast reload
 - only reloads changed files
 - motto: keep files small

Copy and Paste for Learners

- for students as well
- based on drag-and-drop of links

- evaluation: unthinkable!
- conclusion: standards

Copy and Paste for Learners

- for students as well
- based on drag-and-drop of links

The screenshot shows a digital interface for learning trigonometric functions. On the left, there is a text area containing mathematical formulas and text. The formulas include $\tan(\pi-x) = \tan(-x) = -\tan x$, $\cot(\pi-x) = \cot(-x) = -\cot x$, and $(\cos x)^2 + (\sin x)^2 = 1$. Below these, there is text about the relationships between trigonometric functions with a negative argument. To the right of this text area is a graph of a trigonometric function, likely tangent, plotted against an x-axis. The graph shows a curve that increases rapidly as x increases, passing through points corresponding to the values labeled 1 and 2 on the axis.

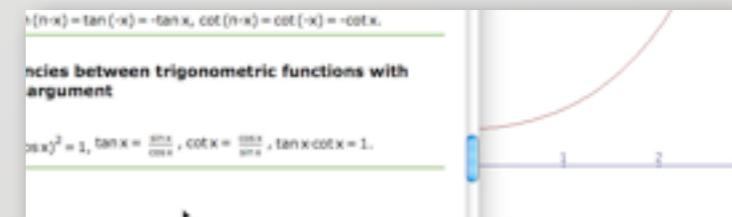
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 - observe discrepancies
 - MicroSoft - DesSci: simili-agreement
 - MathML 3 chapter 6
 - IETF mailing-list: name clipboard flavors

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Authoring for Artificial Intelligence

- in ActiveMath, AI includes:
 - Belief Network Model as the learner-model
 - authors should try to simulate
 - Hierarchical Task Network Planner
 - authors should make sure the course generation delivers sensible courses
 - CAS-evaluation of exercises
 - authors should anticipate answers and make sure evaluation works
 - ranking of search
 - anticipate queries and verify

Authoring for Artificial Intelligence

- approach thus far:
 - limit to knowledge-explanation
 - ==> too theoretical
 - obtain strategies by (strict) interviews
- contribution:
 - limit size of metadata input by inheritance
- future: testable intelligence
 - introspectable user-model
 - reporting course-generation
 - ...

Search Test Suite

- objective:
 - raise utility of the search engine
 - precision: «low-amount of noise»
 - recall: «percentage rightly found»
- created by domain experts
- with books they know well

verbindungsgesetz	0,5	1,0	*	0.083333336	1,0
assoziativgesetz	0,0	NaN	*	0,0	0,0
Bruchrechnung					
Zehnerbruch	1,0	1,0	*	0.166666667	1,0
Bruch in Dezimalzahl	0,5	1,0	*	0.083333336	1,0
bruch in dezimalzahl umwandeln	1,0	1,0	*	0.25	1,0
periode	1,0	1,0	*	0,05	1,0

logarithmique

La dérivée de la fonction cotangente

La dérivée de la fonction tangente

Définition de la fonction logarithmique naturelle

La dérivée de la fonction cotangente

Missing: 8

Evaluate

page 1 de 8

(généraliser la requête à tous les éléments)

	2006 LeAM English	2009 SchulM	2010 SchulM	2010 LeAM Spanish	2010 Kassel
precision	93 %	12 %	53 %	79 %	78 %
recall	63 %	81 %	85 %	87 %	84 %