A Math-Canvas for GNOME

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Summary

- MathML

  brief introdeuction to the markup language for mathematics

- Using `GtkMathView`

  create GTK+ applications with views for mathematics, embedding `GtkMathView`

- `GtkMathView` internals

  porting and adapting

- Future developments

MathML

MathML Presentation: example

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$$\lim_{x \to 0} \frac{\sin x}{x} = 25$$

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MathML Presentation Summary

- tokens (`mi`, `mo`, `mn`)
- general layout schemata (`mfrac`, `msqrt`)
- scripts and limits (`msub`, `msup`, `munder`, `mover`)
- tables and alignment (`mtable`, `mtr`, `mtd`)
- style and attribute inheritance (`mstyle`)
- "live" expressions (`maction`)

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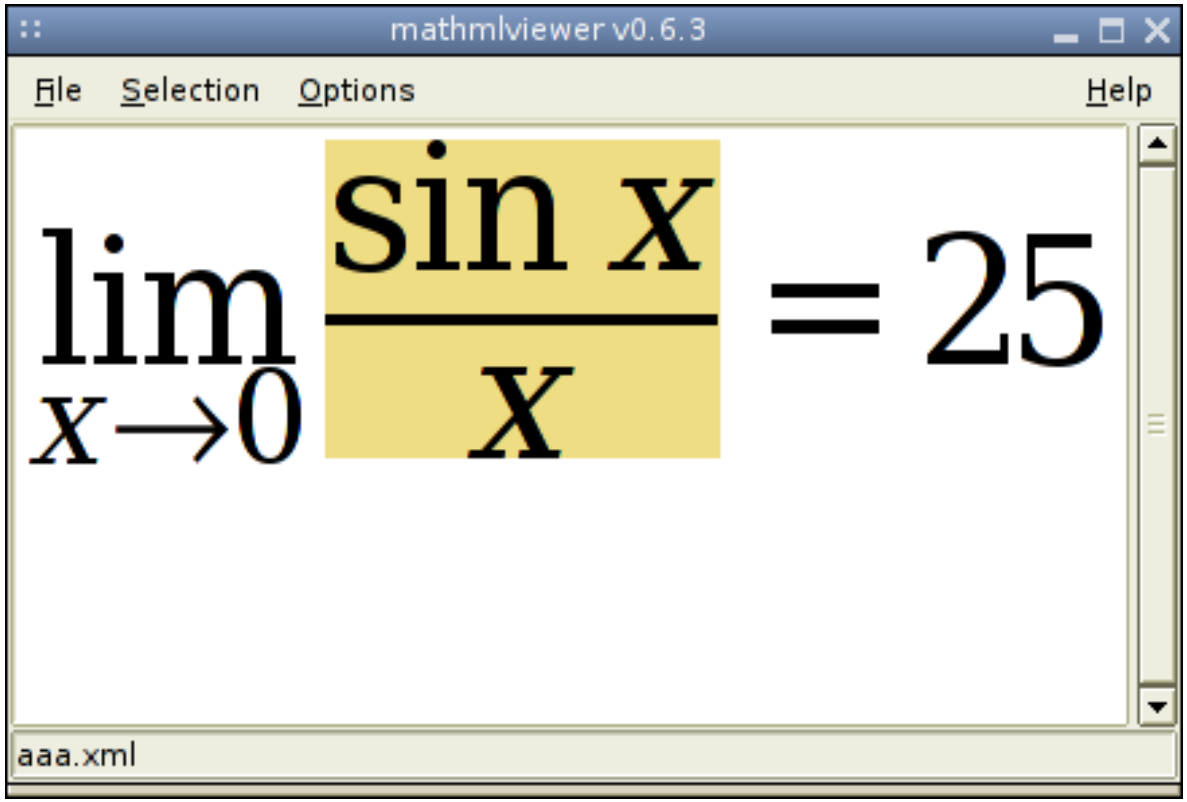
Semantics in presentation elements:

- refine formatting, higher quality
- "meaningful" presentation (conversions)

Usage

Basic Use

- Independent component for displaying MathML markup;
- `mathmlviewer` application.



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or... `gtk_math_view_load_root(view, node);`

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4. `gtk_math_view_unload(view);`

Cursors and Model Identifiers

Cursors:

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- structured document: node id + offset

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Depending on how the source document model is represented, `GtkMathViewModelId` is:

- `GdomeElement*` for `Gdome2`;
- `xmlElement*` for `libxml2`;
- `void*` for custom document models.

Clicking

```
void (*click)(GtkMathView*, const GtkMathViewModelEvent*);

typedef struct _GtkMathViewModelEvent {
  GtkMathViewModelId id;
  gint x;
  gint y;
  gint state;
} GtkMathViewModelEvent;
```

- application-specific actions
- MathML actions
- context-sensitive popup menus

Activating Actions

```
<maction actiontype="toggle" selection="1">
  <mtext>The answer is...</mtext>
  <msqrt> <mn mathcolor="red">2</mn> </msqrt>
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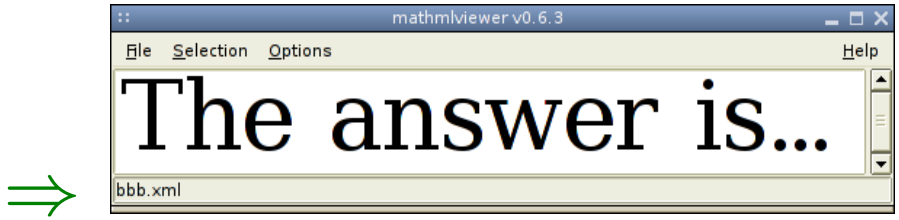

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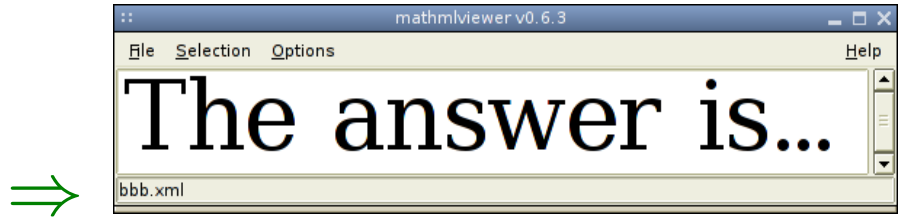

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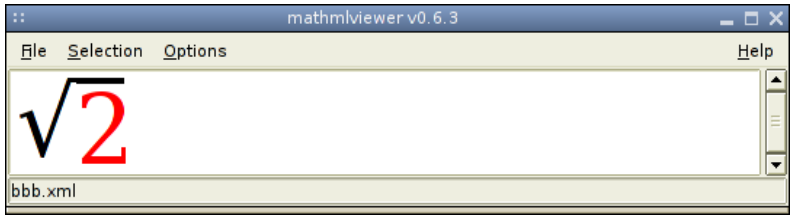

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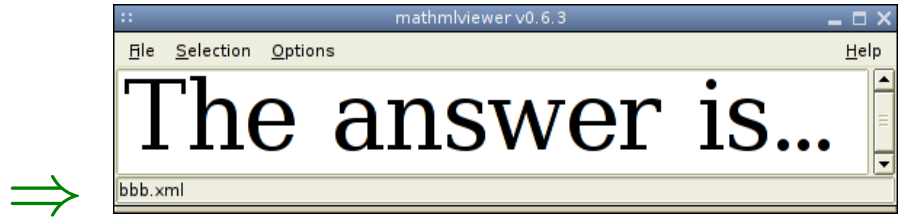

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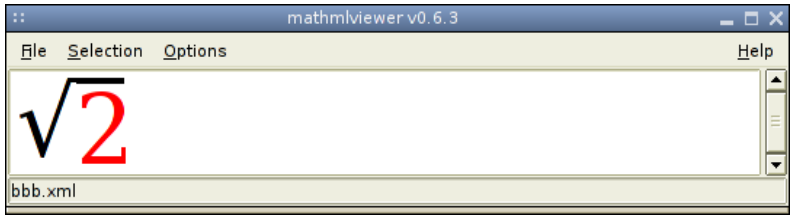

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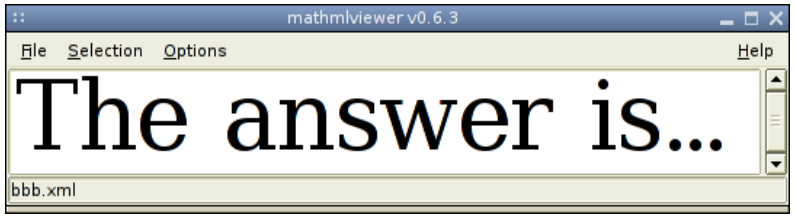

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click(GtkMathView* math_view, const GtkMathViewModelEvent* event)
{
  if (event->id != NULL)
    {
      GtkMathViewModelId action = find_action(event->id);
      if (action != NULL)
        {
          gtk_math_view_freeze(math_view);
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Structured document $\Rightarrow$ several options:

- structural selection
- linear selection (document order)
- linear selection (layout order)

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Moreover, desirable to have multiple selections.

Selecting

Select signal sequences:

$$select\_begin \;\; select\_over^* \;\; (select\_end \mid select\_abort)$$

Signals:

```
void (*select_...)(GtkMathView*, const GtkMathViewModelEvent*);
void (*select_abort)(GtkMathView*);
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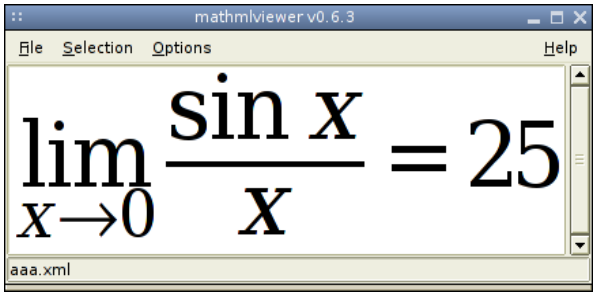
Policy and mechanism are separated.

Methods for selections:

```
void gtk_math_view_select(GtkMathView*, GtkMathViewModelId);
void gtk_math_view_unselect(GtkMathView*, GtkMathViewModelId);
gboolean gtk_math_view_is_selected(GtkMathView*,
                                   GtkMathViewModelId);
```

Structural selection: example

1



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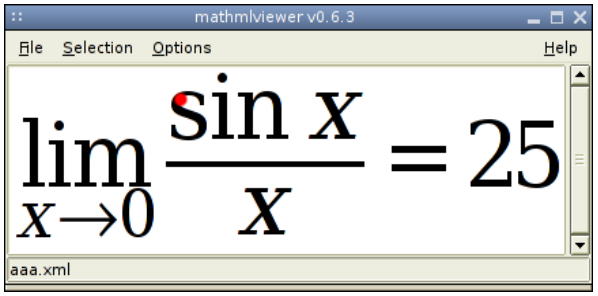

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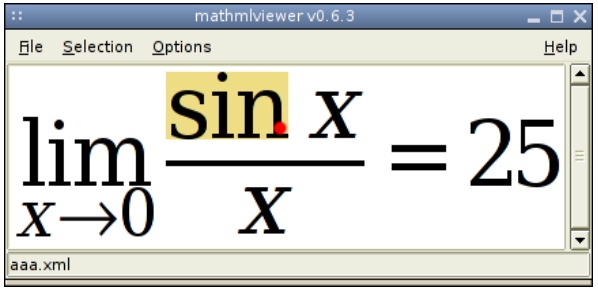

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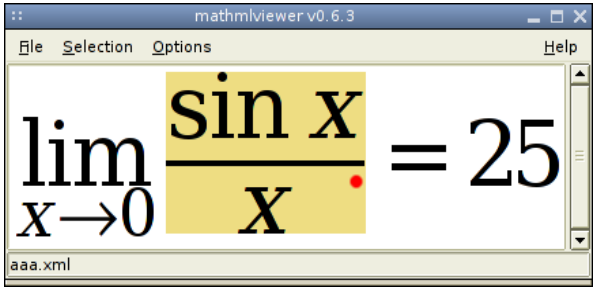

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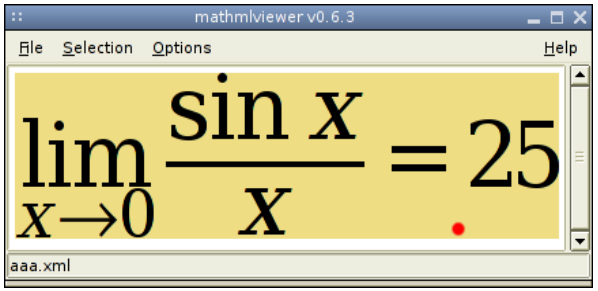

Structural selection: implementation

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static void
select_over(GtkMathView* math_view,
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  if (first != NULL && event->id != NULL)
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No editing API:

```
void gtk_math_view_structure_changed(GtkMathView*,
                                     GtkMathViewModelId);
void gtk_math_view_attribute_changed(GtkMathView*,
                                     GtkMathViewModelId,
                                     GtkMathViewModelString);
```

EdiTEX

Syntax-directed editing using TEX syntax:

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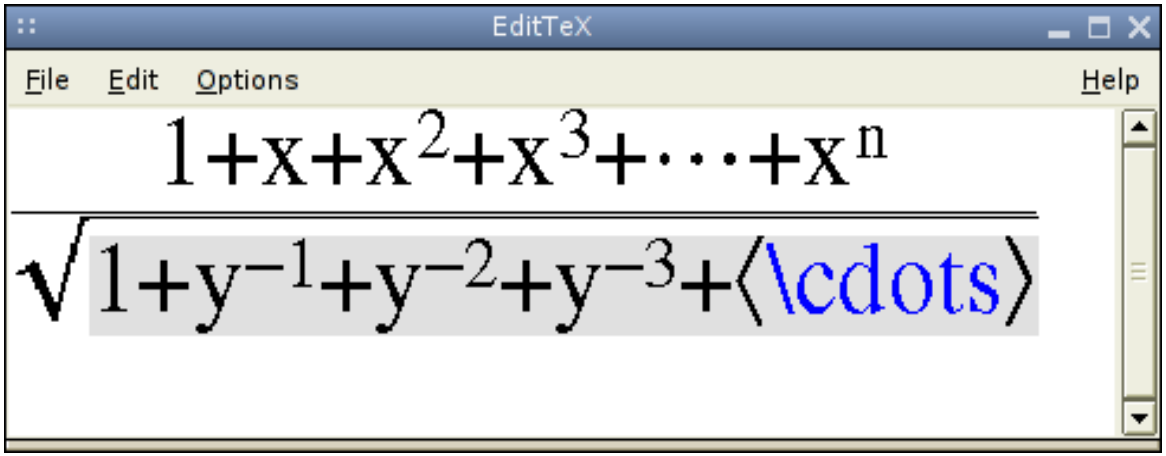

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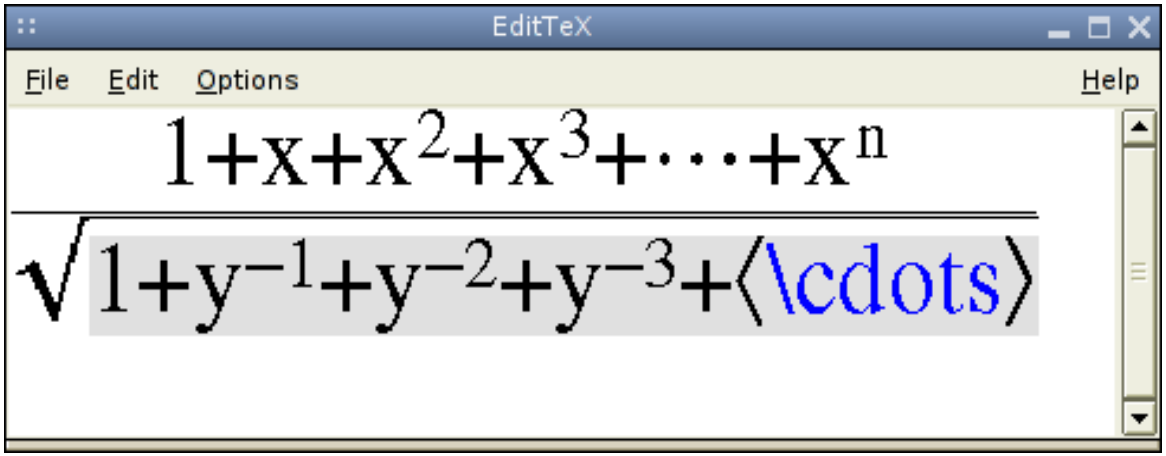

Concrete syntax

$\Rightarrow$ abstract syntax (via incremental parser)

$\Rightarrow$ MathML (via XSLT).

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- there is no standardized editing behavior for mathematics;
- fine-grained integration in required for decent results (baseline in browsers)

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Solutions available so far. . .

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- Bonobo component;
- BoxML.

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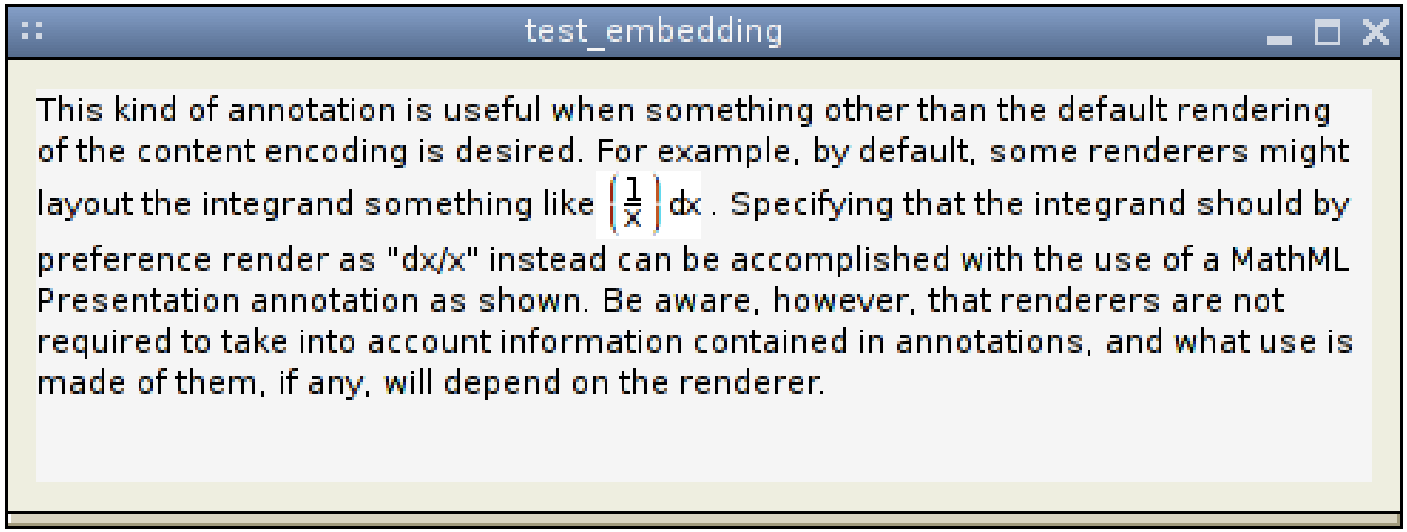
...and problems:

- overhead;
- not precise (missing baseline information);
- ad-hoc.

Embedding in GtkTextView

Can be embedded as an anchored child widget within instances of `GtkTextView` widgets:



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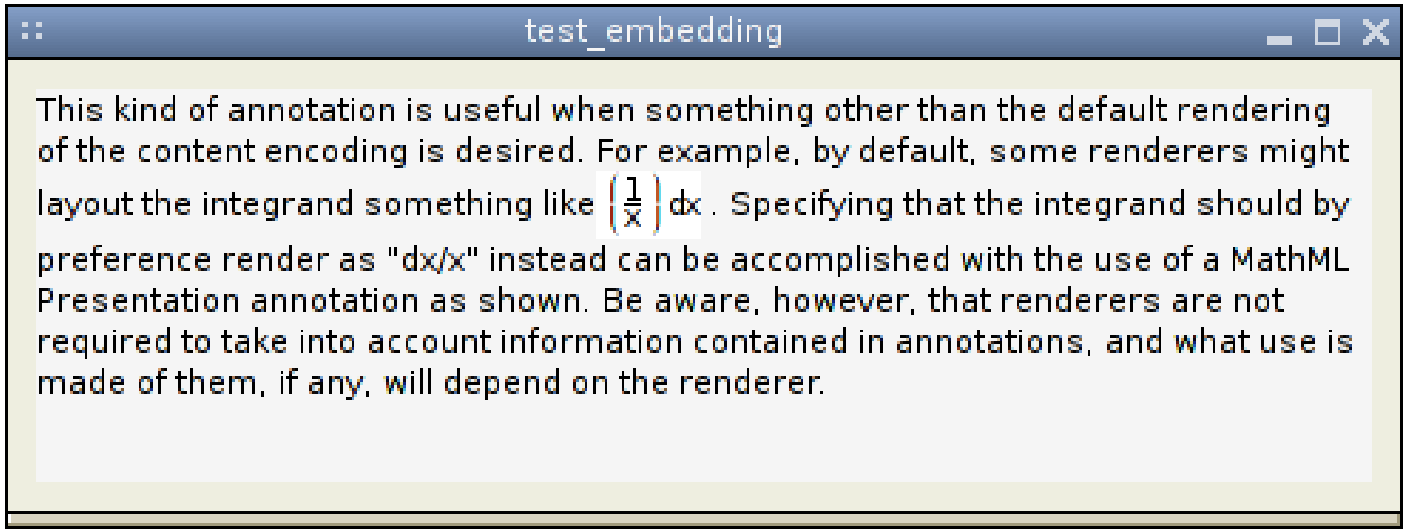

. . . something like $\left(\frac{1}{x}\right) dx$.

Embedding in GtkTextView

```
buffer = gtk_text_buffer_new(NULL);
gtk_text_buffer_set_text(GTK_TEXT_BUFFER(buffer),
                         "hola  hola", -1);
gtk_text_buffer_get_iter_at_offset(buffer, &start, 5);
anchor = gtk_text_buffer_create_child_anchor(buffer, &start);
t_view = gtk_text_view_new_with_buffer(buffer);
m_view = gtk_math_view_new(NULL, NULL);
gtk_math_view_load_uri(GTK_MATH_VIEW(m_view), "mini.xml");
gtk_math_view_get_bounding_box(GTK_MATH_VIEW(m_view), &m_box);
gtk_text_buffer_get_iter_at_offset(buffer, &start, 5);
gtk_text_buffer_get_iter_at_offset(buffer, &end, 7);
rise_tag = gtk_text_buffer_create_tag(buffer, NULL, "rise",
                    -PANGO_SCALE * m_box.depth, NULL);
gtk_text_buffer_apply_tag(buffer, rise_tag, &start, &end);
gtk_text_view_add_child_at_anchor(GTK_TEXT_VIEW(t_view),
                                  m_view, anchor);
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anchor = gtk_text_buffer_create_child_anchor(buffer, &start);
t_view = gtk_text_view_new_with_buffer(buffer);
m_view = gtk_math_view_new(NULL, NULL);
gtk_math_view_load_uri(GTK_MATH_VIEW(m_view), "mini.xml");
gtk_math_view_get_bounding_box(GTK_MATH_VIEW(m_view), &m_box);
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buffer = gtk_text_buffer_new(NULL);
gtk_text_buffer_set_text(GTK_TEXT_BUFFER(buffer),
                         "hola  hola", -1);
gtk_text_buffer_get_iter_at_offset(buffer, &start, 5);
anchor = gtk_text_buffer_create_child_anchor(buffer, &start);
t_view = gtk_text_view_new_with_buffer(buffer);
m_view = gtk_math_view_new(NULL, NULL);
gtk_math_view_load_uri(GTK_MATH_VIEW(m_view), "mini.xml");
gtk_math_view_get_bounding_box(GTK_MATH_VIEW(m_view), &m_box);
gtk_text_buffer_get_iter_at_offset(buffer, &start, 5);
gtk_text_buffer_get_iter_at_offset(buffer, &end, 7);
rise_tag = gtk_text_buffer_create_tag(buffer, NULL, "rise",
                    -PANGO_SCALE * m_box.depth, NULL);
gtk_text_buffer_apply_tag(buffer, rise_tag, &start, &end);
gtk_text_view_add_child_at_anchor(GTK_TEXT_VIEW(t_view),
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The Bonobo Component

Standard Bonobo interfaces implemented:

- `PersistStream`
- `PersistFile`
- `Control`

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Main issue: communication.

Inside Mozilla/Galeon/Epiphany

`mozilla-bonobo` allows Bonobo components with MIME-type to be used as plugins.

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`mozilla-bonobo` allows Bonobo components with MIME-type to be used as plugins.

`GtkMathView` is faster than the MathML rendering engine in Gecko.

- \+ possible to execute JavaScript code;
- \+ possible to open new pages;
- – no baseline alignment;
- – no size negotiation;
- – border around the plugin.

Inside Mozilla/Galeon/Epiphany

```
<html xmlns="http://www.w3.org/1999/xhtml">
  <body>
    <h1>GtkMathView-Bonobo test page</h1>
    <p>The embedded object should display a mathematical formula.
    <object name="MATH" data="#math1" width="500" height="100"
            type="application/mathml+xml">
      <math id="math1" display="block"
            xmlns="http://www.w3.org/1998/Math/MathML">
        <mfrac> <mi>x</mi> <mn>2</mn> </mfrac>
        <mo>=</mo>
        <mtext>?</mtext>
      </math>
    </object>
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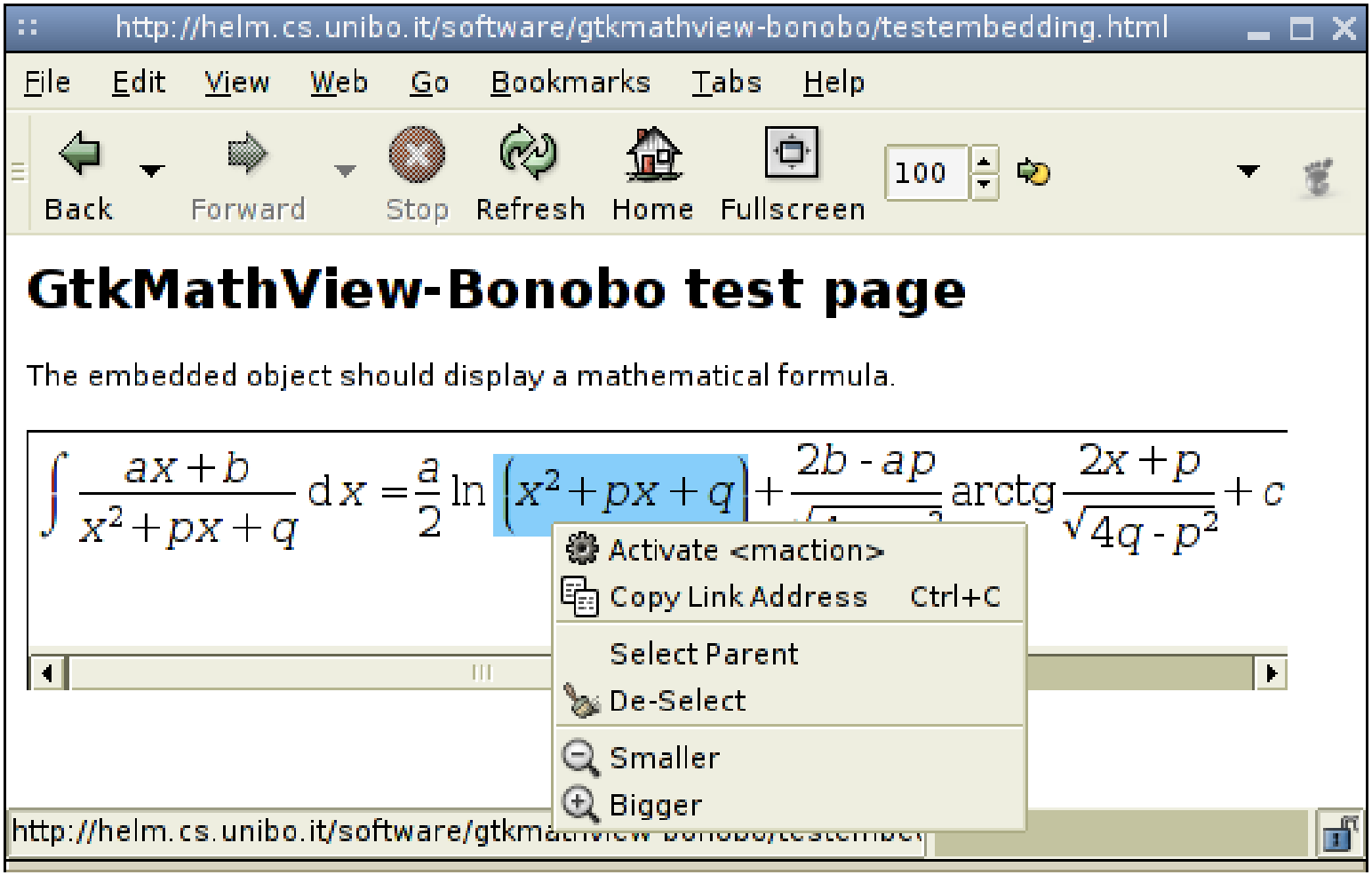
Inside Mozilla/Galeon/Epiphany



Embedding in BoxML

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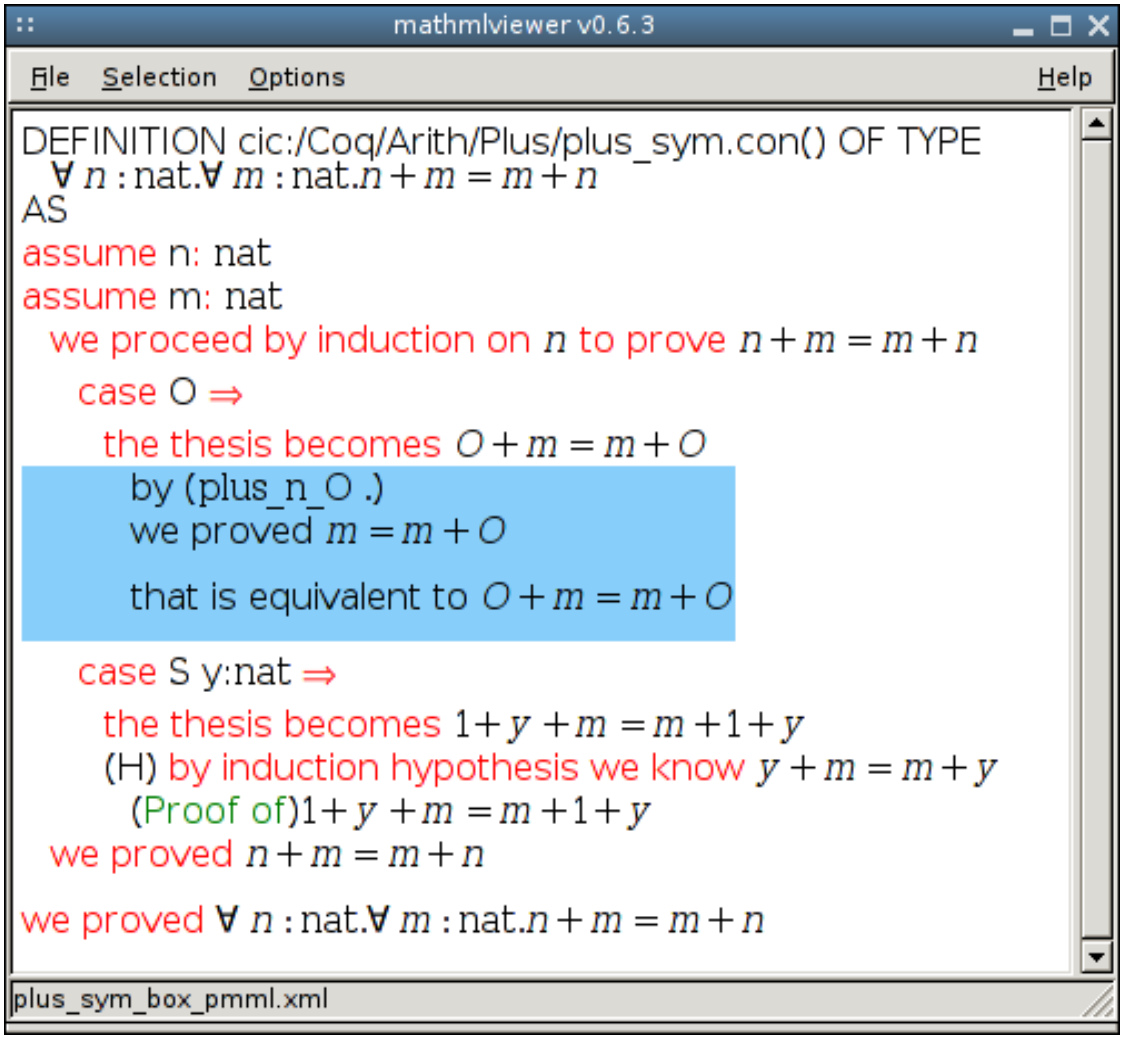

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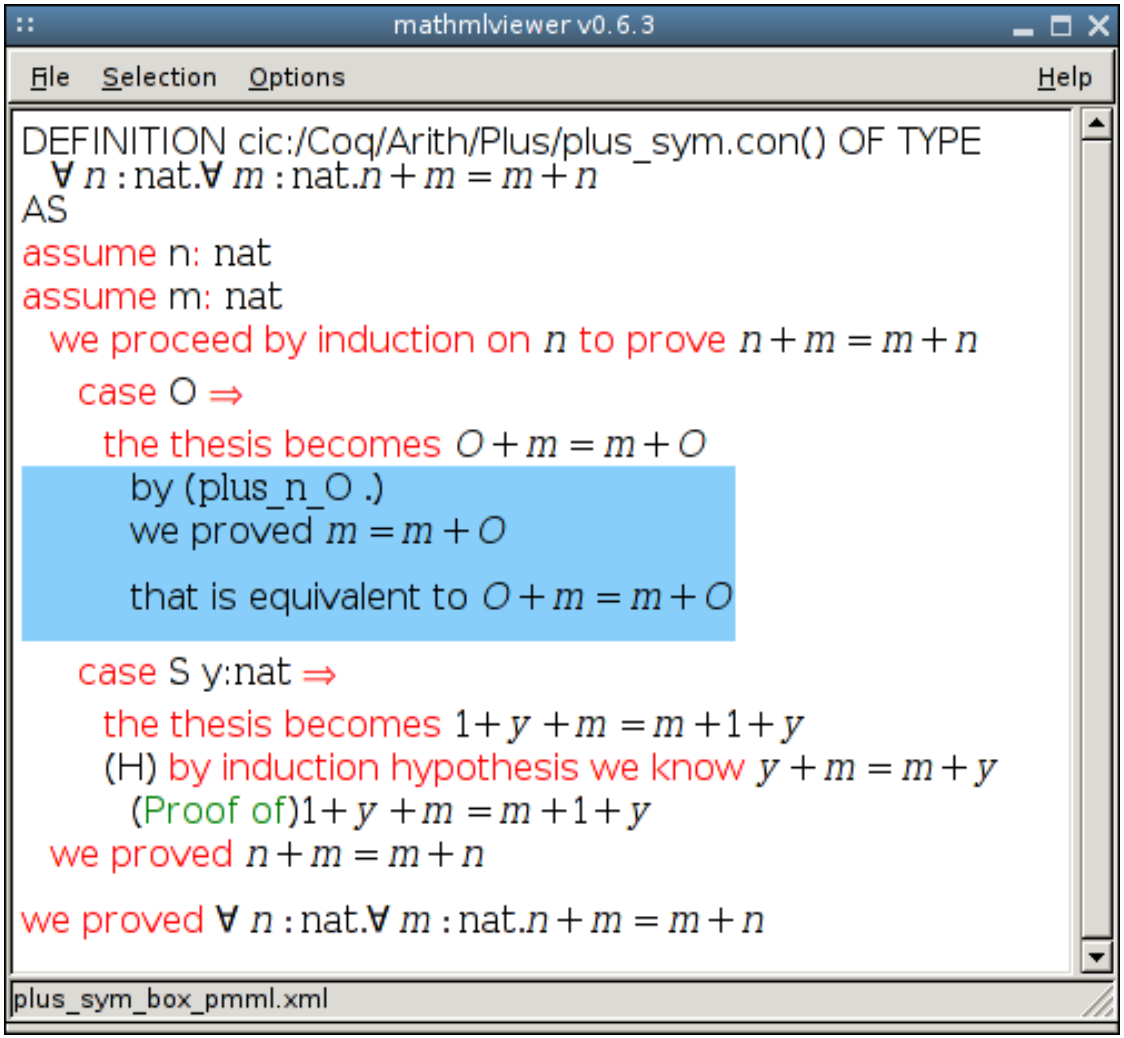

Inspired by TEX boxes and languages for pretty-printing.

Embedding in BoxML

```
<b:box xmlns:b="http://helm.cs.unibo.it/2003/BoxML">
  <b:v xmlns:m="http://www.w3.org/1998/Math/MathML">
    <b:v>
      <b:h>
        <b:text>DEFINITION cic:/Coq/Arith/Plus/plus_sym.con(</b:t
        <b:text>) OF TYPE</b:text>
      </b:h>
      <b:h>
        <b:space width="1em"/>
        <b:h>
          <b:obj>
            <m:semantics>
              <m:mrow>
                <m:mrow>
                  <m:mo mathcolor="blue">&#x2200;</m:mo>
                  <m:mi>n</m:mi>
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                  <m:mi>n</m:mi>
```

BoxML Summary

Element	Attributes	Description
box		root element
action	actiontype, selection	alternative renderings
at	x, y	element at fixed coordinates
h		horizontal box
ink	color, width, height, depth	solid box
layout	width, height, depth	fixed layout box
space	width, height, depth	empty box
v	enter, exit	vertical box
text	color, background, size	text
obj		embedded MathML

Internals

Architecture

Very much compiler-like:

- parse the source document model;
- create internal representation (AST);
- translate the internal representation into low-level representation (area model);
- render the area tree on the output medium.

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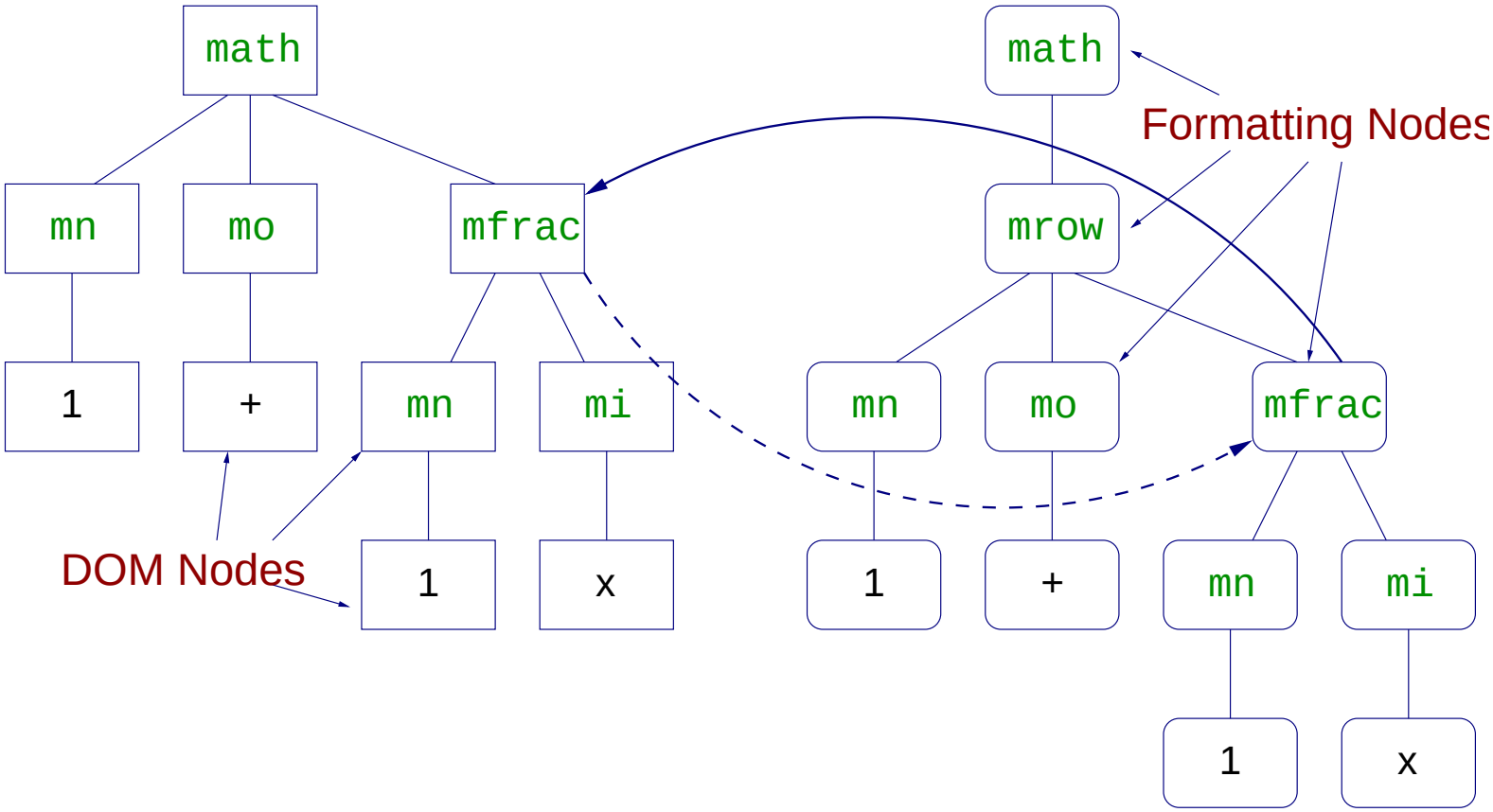
. . . but context-sensitive "code generation" phase.

Architecture



Source MathML tree

Formatting tree

Feeding the widget

In principle: use the GNOME DOM engine

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`GMetaDOM` `http://gmetadom.sourceforge.net`, for C++

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In practice: there is disagreement as to how to deliver XML content to the widgets:

- plain text;
- `libxml2` API;
- private DOM.

Using the GNOME DOM engine

Drawbacks:

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Using `libxml2`?

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Solution: use C++ templates for the model navigation strategy, the actual document model is a template parameter.

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MSXML frontend is now trivial to add.

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- implement shapers;
- implement platform-specific areas.

Fonts for math have many (implicit) parameters with no standardized names. See Knuth's CM fonts.

Must take advantage of these parameters without compromising modularity: the separation of the backend from the engine is delicate.

Areas

Area base class and main (pure) virtual methods:

```
class Area : public Object {
  virtual void render(class RenderingContext&,
                      const scaled& x, const scaled& y) const;
  virtual BoundingBox box(void) const;
  virtual scaled leftEdge(void) const;
  virtual scaled rightEdge(void) const;
  virtual AreaIndex size(void) const;
  virtual AreaRef node(AreaIndex) const;
  virtual void origin(AreaIndex, class Point&) const;
  virtual bool indexOfPosition(const scaled&, const scaled&,
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- some glyphs are not available as Unicode characters ($\underbrace{1 + x + x^2}$).

Conclusion

Version history

	GTK	editing	PostScript	tables	alignment	frontend
0.3.1	1.2	no	yes	yes	yes	`MiniDOM/GMetaDOM`
0.4.3	1.2	yes	yes	yes	?	`GMetaDOM`
0.5.3	2.2	yes	yes	yes	no	`GMetaDOM`
0.6.3	2.4	yes	no	no	no	any

Also available: OCaml bindings up to version 0.5.2.

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Thank you