Mathematical Notations in Web Pages

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Abstract

To display mathematical notations on the screen in WYSIWYG environment is always a difficult task; with no exception in including complicated mathematical notations in web pages. The two most popular browsers, Netscape and Internet Explorer, are lacking good built-in HTML tags and mathematical character sets for displaying mathematical notations such as symbols, expressions and graphs in WYSIWYG environment. As a result, additional efforts must be included to achieve its aim. The concepts and some of the techniques of how to handle such notations in web pages will be described in this paper; including the advantages and disadvantages associated with the individual techniques. The notations included in web pages can be in static or dynamic form depending on the nature of the techniques.

Mathematical Notations in HTML

HTML is the important core behind internet browsers in describing how text and graphics are displayed, and multimedia tasks are performed. However, the support of mathematical tags in the latest versions of Netscape Communicator and Internet Explorer is very primitive. Theoretically, mathematical notations which are just symbols arranged in a specific configuration, can be transmitted as text characters into the browser, and then the browser can present and format the characters into the desired display on the screen. It sounds simple, but getting it done correctly requires some consideration because of lack of support from the browsers.

With the Constraints of HTML

Since HTML is both human- and machine-readable, the inclusion of mathematical notations needs to be succinct. The use of <table> tag helps display simple equations and expressions, but multiline equations and expressions are difficult to implement using HTML alone.
There is a set of special built-in characters in the browsers including very limited number of mathematical notations (refer to Table 1). As the characters are in the 8-bit format, so &#n is used to represents a character. For example, when n=60, the numerical code, `&#60` represent a character `'<'` in HTML.

Table 1: Mathematical Notations Provided in the Browser (Incomplete List).

Character	Code
<	&#60
>	&#62
±	&#177
μ	&#181
×	&#215
β	&#223
÷	&#247
∅	&#248

Example 1: $\mu > \pm\beta,$

The source code is:

```
&#181; > &#177;&#223;,
```

For a very simple expression like Example 1, it can be shown on the browser with no difficulty. The current browsers support superscript and subscript, so <sub> and <sup> tags can be used to form some equations and expressions.

Example 2: $ax^2 + bx + c_1 = 0$

The source code is as follows:

```
ax<sup>2</sup> + 
    bx + c<sub>1</sub>
        = 0
```

Now, together with the <table> tag provided in HTML, some of the more complicated mathematical notations can be shown on the web page.

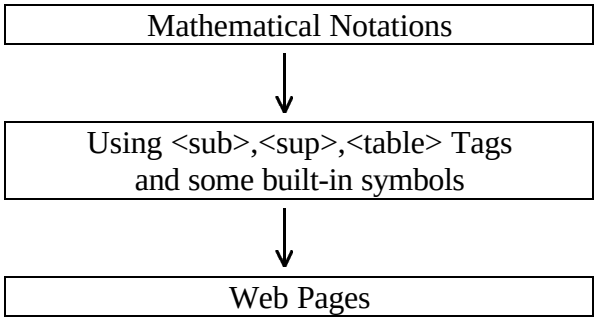
Example 3: $x + \frac{x}{2} + \frac{a_2}{x^2}$

The HTML source code is shown below:

```
<table>
<tr>
  <td align=center>
    <font size=+1>x</font>
    <font size=+1> +</font>
  </td>
<td align=center>
    <table>
      <tr>
      <td width=1 align=middle rowspan=2>
      <font size=+2>&#151;</font>
      </td>
      <td align=center>
      <font size=+1>x</font>
      </td>
      </tr>
      <tr>
      <td align=center>
      <font size=+1>2</font>
      </tr>
    </table>
  </td>
  <td align=center>
  <font size=+1>+</font>
  </td>
  <td align=center>
  <table>
    <tr>
    <td width=1 align=middle rowspan=2>
    <font size=+3>&#151;</font>
    </td>
    <td align=center>
    <font size=+1>a</font>
    <sub>2</sub>
    </td>
    </tr>
    <tr>
    <td align=center>
    <font size=+1>x</font>
    <sup>2</sup>
    </tr>
  </table>
```

```
  </td>
  </tr>
</table>
```

Illustration 1: Working With the Constraints of HTML



Including Mathematical Expressions as Images

We can now see that including mathematical expressions is rather cumbersome using <table> tags. So, by putting mathematical expressions as images and embedding them using `<img>` tags can be a good choice, which is usually the best for in-line equations. Using the Transparency feature of GIFs makes the equation blend into the page more naturally; most GIF creation programs now allow for turning on the Transparency option for the GIFs.

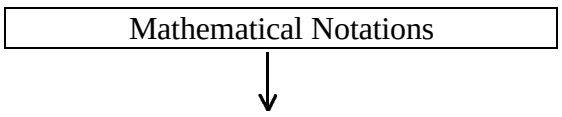
Example 4: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

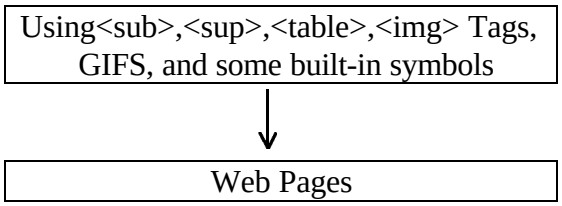
The source code of the above equation as a GIF image is shown below:

```
<img src='quadrant.gif' width=160
    height=85 align=absmiddle>
```

Note that the attributes are used in the tag so that the image will be inline with the text.

Illustration 2: Including GIFs in Web Pages





Example 5: $\mathbf{F(x) = \int_a^x f(t)\,dt.}$

The HTML source code is as follows:

```
<center>
  F(x) = <sub><img src="int.gif">
  <sub>a</sub><sup>
  <sup><sup><sup>x</sup></sup>
  </sup></sup></sub>f(t)dt.
</center>
```

It is obvious that if one wants to include many such expressions in a web page, the process can be tedious because images require some efforts to produce. If one has just a few mathematical equations and symbols in HTML pages, then the fastest and most painless way to get these mathematical typeset into the page is to use MS Word 7 or GIF Construction Set to produce. Alternatively, an image bank can be set up to store those commonly used mathematical expressions and equations.

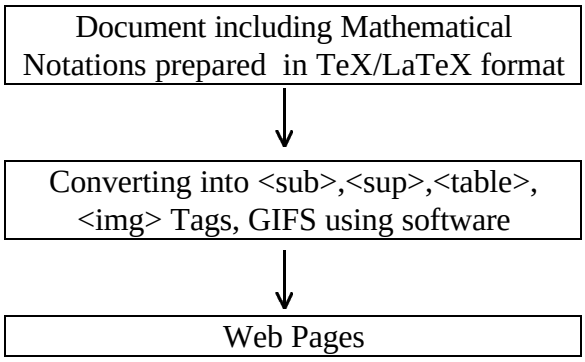
In spite of the time consumed in including mathematical notations in web pages, it is the best solution to use solely HTML and GIF files to implement the inclusion of mathematical notations in web pages because your viewers need not install any software or do anything on the browser to view the web pages.

Solution Via TeX/LaTeX

TeX/LaTex is the most common and popular of the typesetting languages. It is also a syntax-based language which describes how to produce an output document correctly with complicated mathematical expressions and layouts. So, if one has complicated mathematical notations and layouts to put into web pages, then it is a considerably good way to prepare your document in either TeX or LaTeX format. And after having done that, the document can be converted into HTML codes and GIFs using a software available in the market. That is to say that TeX/LaTeX files can be converted into HTML files and GIFs before putting them into the server, or produced on-the-fly using special software when they are browsed. After the conversion, the appearance of web pages is similar to the solution of including mathematical expressions as images.

However, users may prepare their web pages using special software to cut down the work in HTML coding. Similarly, it applies to both TeX and LaTeX files.

Illustration 3: Solution Via TeX/LaTeX



Using Mathematical Soft Fonts

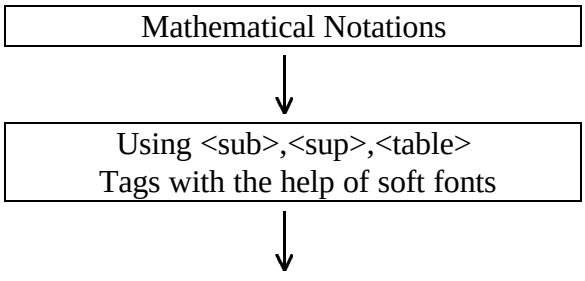
The mathematical notations characters provided by browsers are very limited, especially with regard to important mathematical symbols and Greek characters. Installing additional true type fonts in the computer to enable browsers to display mathematical expressions and equations may be another choice. The good point is the fast display of the screen as compared with that of GIFs. But the drawback is the installation of additional soft fonts at the client computer and there are no standard specifications for mathematical soft fonts at this moment.

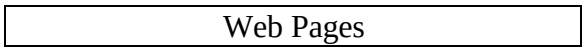
Example 6:

$$\varphi(x) = \sum_{y \to \infty} g(y)\, \varphi(y)$$

Note that the above equation can be typed using extra mathematical true type fonts installed in the computer and it looks exactly the same when shown on the browser. So, using `<table>,<sub>` and `<sup>` tags with true type fonts, it is possible to display the layouts and symbols placements correctly.

Illustration 4: Using Soft Fonts

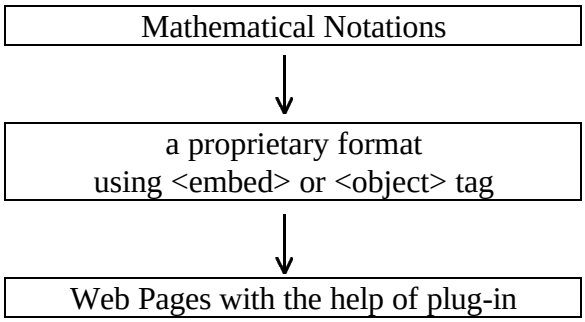




Via Plug-In

A plug-in is an extra piece of software associated with the browser and they are platform dependent, and each of the browsers must have plug-in installed. But the performance of plug-in is excellent in both speed and animation. In addition to displaying mathematical notations in web pages, a plug-in can be a mathematical engine that is able to manipulate mathematical equations and expressions dynamically in a symbolic or algebraic manner. That is to say that dynamic mathematical notations, or even plotting graphs can be shown in the web pages.

Illustration 5: Via Plug-ins



Example 7: To include a quadratic equation which is stored in a file called `"quadrant.thp"` , the source code is:

```
<embed src="quadrant.thp" width=200  height=60>
```

Note that "quadrant.thp" is produced by a special authoring software.

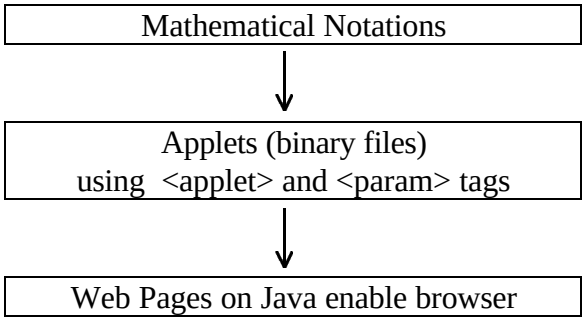
Via JAVA Applets

Java is a programming language, very much like C++ in appearance. It can compile programs into Java applets which are compiled binary files that can run on any computer (platform independent) as long as the computer has a built-in Java virtual machine.

To include mathematical notations in web pages via Java applets, the concept is very similar to that using plug-in except that the Java virtual machine is not a

proprietary format and it comes with the browser. In other words, anyone with a Java-capable browser can read them; no installing fonts, plug-ins or helper applications are needed. However, running applets on the browser is very slow as compared with that of using plug-in. The good point of using applets is that the files are protected from being copied. There are commercial applets available in which the user just can include into web pages directly.

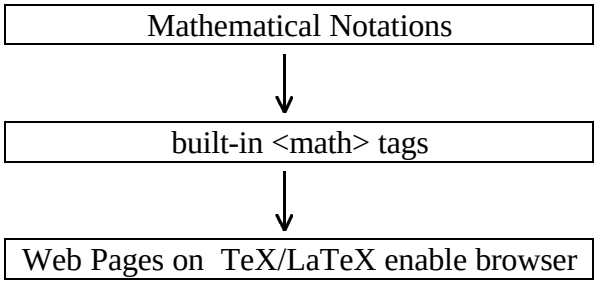
Illustration 6: Via Java Applets



New Browser Solutions

Although there are many mathematical elements in the <math> tag as specified in HTML 3.2 (refer to Table 2), both Nescape and Internet Explorer did not implement them except <sub> and <sup> tags.

Illustration 7: New Browser Solution



If the future versions of the browser will implement HTML specifications fully, and it will be even TeX/LaTeX enable, then including mathematical notations in web pages will be an easy task.

Table 2: Some mathematical elements defined in HTML 3.2.

Element	Functionality
`box`	Used for expressions that include placing one expression over another.
`vec,dot,ddot, bar,tilde,hat`	Used for typical mathematical accents or identifiers.

`above`	It draws a line, symbol, or arrow above the current mathematical expression.
`below`	Same as `above` but draws below expression.
`text`	Used to include textual description with a mathematical expression.
`array`	Used for arrays and matrices.
`root,sqrt`	Used for root and square root of mathematical expression.
`bt,b,t`	Control of fonts used for presentation mathematical expression.

Conclusion

There is no one single correct solution to including mathematical notations in web pages as it depends on the nature of the requirements. But it will be correct to say that it is not easy to include mathematical notations in web pages (even with the help of JavaScript programming), except hoping that new browser will ease the work, of course, including a user-friendly HTML editor.

The next question is whether web pages should be "static" or "dynamic". The techniques discussed in this paper are all good for a "static" solution but not all are good for a "dynamic" solution. In some applications, when a "dynamic" solution is expected, then which technique is more suitable? Or, should we wait for the next generation of browser?

References

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