MathJax Documentation

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Contents

MathJax is an open-source JavaScript display engine for LaTeX and MathML that works in all modern browsers.

CHAPTER 1

Basic Usage

What is MathJax?

MathJax is an open-source JavaScript display engine for LaTeX and MathML that works in all modern browsers. It was designed with the goal of consolidating the recent advances in web technologies into a single, definitive, math-on-the-web platform supporting the major browsers and operating systems. It requires no setup on the part of the user (no plugins to downlaod or software to install), so the page author can write web documents that include mathematics and be confident that users will be able to view it naturally and easily. One simply includes MathJax and some mathematics in a web page, and MathJax does the rest.

MathJax uses web-based fonts (in those browsers that support it) to produce high-quality typesetting that scales and prints at full resolution (unlike mathematics included as images). MathJax can be used with screen readers, providing accessibility for the visually impaired. With MathJax, mathematics is text-based rather than image-based, and so it is available for search engines, meaning that your equations can be searchable, just like the text of your pages. MathJax allows page authors to write formulas using TeX and LaTeX notation, or MathML, a World Wide Web Constortium standard for representing mathematics in XML format. MathJax will even convert TeX notation into MathML, so that it can be rendered more quickly by those browsers that support MathML natively, or so that you can copy and past it into other programs.

MathJax is modular, so it loads components only when necessary, and can be extended to include new capabilities as needed. MathJax is highly configurable, allowing authors to customize it for the special requirements of their web sites. Finally, MathJax has a rich application programming interface (API) that can be used to make the mathematics on your web pages interactive and dynamic.

Getting Started

MathJax allows you to include mathematics in your web pages, either using TeX and LaTeX notation, or as MathML. To use MathJax, you will need to do the following things:

1. Obtain a copy of MathJax and make it available on your server.
2. Configure MathJax to suit the needs of your site.

3. Link MathJax into the web pages that are to include mathematics.
4. Put mathematics into your web pages so that MathJax can display it.

Each of these steps is described briefly below, with links to more detailed explanations. This page gives the quickest and easiest ways to get MathJax up and running on your web site, but you may want to read the details in order to customize the setup for your pages.

Obtaining and Installing MathJax

The easiest way to set up MathJax is to obtain the `MathJax-v1.0.1.zip` archive from the MathJax download page. This includes both the MathJax code and the MathJax webfonts, so this is the only file you need. (This is different from the beta releases, which had the fonts separate from the rest of the code).

Unpack the `MathJax-v1.0.1.zip` archive and place the resulting MathJax folder onto your web server at a convenient location where you can include it into your web pages. For example, making `MathJax` a top-level directory on your server would be one natural way to do this. That would let you refer to the main MathJax file via the URL `/MathJax/MathJax.js` from within any page on your server.

Note: While this is the easiest way to set up MathJax initially, there is a better way to do it if you want to be able to keep your copy of MathJax up-to-date easily. That uses the Git version control system, and is described in the *Installing MathJax* document. If you prefer using Subversion, we also maintain an SVN mirror (see *Installing MathJax via SVN*).

Once you have MathJax set up on your server, you can test it using the files in the `MathJax/test` directory. Load them in your browser using its web address rather than opening them locally (i.e., use an `http://` URL rather than a `file://` URL). When you view the `index.html` file, after a few moments you should see a message that MathJax appears to be working. If not, check that the files have been transferred to the server completely and that the permissions allow the server to access the files and folders that are part of the MathJax directory. (Be sure to verify the MathJax folder's permissions as well.) Check the server log files for any errors that pertain to the MathJax installation; this may help locate problems in the permission or locations of files.

Configuring MathJax

When you include MathJax into your web pages as described below, it will load the file `config/MathJax.js` (i.e., the file named `MathJax.js` in the `config` folder of the main `MathJax` folder). This file contains the configuration parameters that control how MathJax operates. There are comments in it that explain each of the parameters, and you can edit the file to suit your needs.

The default settings are appropriate for pages that use TeX as the input language, but you might still want to adjust some settings; for example, you might want to include some additional extensions such as the `AMSmath` and `AMSsymbols` extensions. The comments in the file should help you do this, but more detailed instructions are included in the *Configuring MathJax* document. There are also ways to configure MathJax other than by using the `config/MathJax.js` file; these are descibed on that page as well.

Linking MathJax into a web page

You can include MathJax in your web page by putting

```
<script type="text/javascript" src="path-to-MathJax/MathJax.js"></script>
```

in your document's `<head>` block. Here, `path-to-MathJax` should be replaced by the URL for the main MathJax directory, so if you have put the `MathJax` directory at the top level of you server's web site, you could use

```
<script type="text/javascript" src="/MathJax/MathJax.js"></script>
```

to load MathJax in your page. For example, your page could look like

```
<html>
    <head>
        ...
        <script type="text/javascript" src="/MathJax/MathJax.js"></script>
    </head>
    <body>
        ...
    </body>
</html>
```

Although it is possible to load MathJax from a site other than your own web server, there are issues involved in doing so that you need to take into consideration. See the *Notes About Shared Servers* for more details. Please do **not** link to the copy of MathJax at `www.mathjax.org`, as we do not have the resources to act as a web service for all the sites on the web that would like to display mathematics. If you are able to run MathJax from your own server, please do so (this will probably give you better response time in any case).

Putting mathematics in a web page

To put mathematics in your web page, you can use either TeX and LaTeX notation, or MathML notation (or both); the configuration file tells MathJax which you want to use, and how you plan to indicate the mathematics when you are using TeX notation. The following sections tell you how to use each of these formats.

TeX and LaTeX input

To process mathematics that is written in *TeX* or *LaTeX* format, include `"input/TeX"` in your configuration's *jax* array, and add `"tex2jax.js"` to the *extensions* array so that MathJax will look for TeX-style math delimiters to identify the mathematics on the page.

```
extensions: ["tex2math.js"],
jax: ["input/TeX", "output/HTML-CSS"]
```

Note that the default math delimiters are `$$...$$` and `\[...\]` for displayed mathematics, and `\(...\)` for in-line mathematics. In particular, the `$...$` in-line delimiters are **not** used by default. That is because dollar signs appear too often in non-mathematical settings, which could cause some text to be treated as mathematics unexpectedly. For example, with single-dollar delimiters, "... the cost is $2.50 for the first one, and $2.00 for each additional one ..." would cause the phrase "2.50 for the first one, and" to be treated as mathematics since it falls between dollar signs. For this reason, if you want to use single-dollars for in-line math mode, you must enable that explicitly in your configuration:

```
tex2jax: {inlineMath: [['$','$'], ['\\(','\\)']]}
```

See the `config/MathJax.js` file, or the *tex2jax configuration options* page, for additional configuration parameters that you can specify for the `tex2jax` preprocessor.

Here is a complete sample page containing TeX mathematics (which assumes that `config/MathJax.js` is configured as described above):

```
<html>
<head>
<title>MathJax TeX Test Page</title>
```

```
<script type="text/javascript" src="/MathJax/MathJax.js"></script>
</head>
<body>
When \(a \ne 0\), there are two solutions to \(ax^2 + bx + c = 0\) and they are
$$x = {-b \pm \sqrt{b^2-4ac} \over 2a}.$$
</body>
</html>
```

There are a number of extensions for the TeX input processor that you might want to add to the *extensions* array. These include:

- *TeX/AMSmath.js*, which defines the AMS math environments and macros,
- *TeX/AMSsymbols.js*, which defines the macros for the symbols in the msam10 and msbm10 fonts,
- *TeX/noErrors.js*, which shows the original TeX code rather than an error message when there is a problem processing the TeX, and
- *TeX/noUndefined.js*, which prevents undefined macros from producing an error message, and instead shows the macro name in red.

For example,

```
extensions: ["tex2math.js","TeX/noErrors.js","TeX/noUndefined.js",
             "TeX/AMSmath.js","TeX/AMSsymbols.js"]
```

loads all four extensions, in addition to the `tex2math` preprocessor.

MathML input

To process mathematics written in *MathML*, include `"input/MathML"` in your configuration's *jax* array, and add `"mml2jax.js"` to the *extensions* array so that MathJax will locate the `<math>` elements in the page automatically.

```
extensions: ["mml2jax.js"],
jax: ["input/MathML", "output/HTML-CSS"]
```

With this configuration, you would mark your mathematics using standard `<math>` tags, where `<math display="block">` represents displayed mathematics and `<math display="inline">` or just `<math>` represents in-line mathematics.

Note that this will work in HTML files, not just XHTML files (MathJax works with both), and that the web page need not be served with any special MIME-type. Also note that, unless you are using XHTML rather than HTML, you should not include a namespace prefix for your `<math>` tags; for example, you should not use `<m:math>` except in a file where you have tied the `m` namespace to the MathML DTD.

Here is a complete sample page containing MathML mathematics (which assumes that `config/MathJax.js` is configured as described above):

```
<html>
<head>
<title>MathJax MathML Test Page</title>
<script type="text/javascript" src="/MathJax/MathJax.js"></script>
</head>
<body>

When <math><mi>a</mi><mo>&#x2260;</mo><mn>0</mn></math>,
there are two solutions to <math>
  <mi>a</mi><msup><mi>x</mi><mn>2</mn></msup>
```

```
  <mo>+</mo> <mi>b</mi><mi>x</mi>
  <mo>+</mo> <mi>c</mi> <mo>=</mo> <mn>0</mn>
</math> and they are
<math mode="display">
  <mi>x</mi> <mo>=</mo>
  <mrow>
    <mfrac>
      <mrow>
        <mo>&#x2212;</mo>
        <mi>b</mi>
        <mo>&#x00B1;</mo>
        <msqrt>
          <msup><mi>b</mi><mn>2</mn></msup>
          <mo>&#x2212;</mo>
          <mn>4</mn><mi>a</mi><mi>c</mi>
        </msqrt>
      </mrow>
      <mrow> <mn>2</mn><mi>a</mi> </mrow>
    </mfrac>
  </mrow>
  <mtext>.</mtext>
</math>

</body>
</html>
```

The `mml2jax` has only a few configuration options; see the `config/MathJax.js` file or the *mml2jax configuration options* page for more details.

Where to go from here?

If you have followed the instructions above, you should now have MathJax installed and configured on your web server, and you should be able to use it to write web pages that include mathematics. At this point, you can start making pages that contain mathematical content!

You could also read more about the details of how to *customize MathJax*.

If you are trying to use MathJax in blog or wiki software or in some other content-management system, you might want to read about *using MathJax in popular platforms*.

If you are working on dynamic pages that include mathematics, you might want to read about the *MathJax Application Programming Interface* (its API), so you know how to include mathematics in your interactive pages.

If you are having trouble getting MathJax to work, you can read more about *installing MathJax*, or *loading and configuring MathJax*.

Finally, if you have questions or comments, or want to help support MathJax, you could visit the *MathJax community forums* or the *MathJax bug tracker*.

Installing and Testing MathJax

MathJax can be loaded from a public web server or privately from your hard drive or other local media. To use MathJax in either way, you will need to obtain a copy of MathJax and its font package. There are three ways to do this: via `git`, `svn`, or via a pre-packaged archive. We recommend git or svn, as it is easier to keep your installation up to date.

Obtaining MathJax via Git

The easiest way to get MathJax and keep it up to date is to use the Git version control system to access our GitHub repository. Use the commands

```
git clone git://github.com/mathjax/MathJax.git mathjax
cd mathjax
unzip fonts.zip
```

to obtain and set up a copy of MathJax.

Whenever you want to update MathJax, you can now use

```
cd mathjax
git status
```

to check if there are updates to MathJax. If MathJax needs updating, use

```
cd mathjax
git pull origin
# if fonts.zip is updated, do the following as well:
rm -rf fonts
unzip fonts.zip
```

to udpate your copy of MathJax to the current release version. If the `fonts.zip` file has been updated, you will need to remove the old fonts directory and unpack the new one bring your installation up to date. If you keep MathJax updated in this way, you will be sure that you have the latest bug fixes and new features as they become available.

This gets you the current development copy of MathJax, which is the "bleeding-edge" version that contains all the latest changes to MathJax. At times, however, these may be less stable than the "release" version. If you prefer to use the most stable version (that may not include all the latest patches and features), use `git tag -l` to see all versions and use `git checkout <tag_name>` to checkout that version of MathJax. When you want to upgrade to a new release, you will need to repeat this for the latest release tag.

Obtaining MathJax via SVN

If you are more comfortable with the subversion source control system, you may want to use our svn mirror. If you want to get the latest svn revision, use the commands

```
svn co http://mathjax.svn.sourceforge.net/svnroot/mathjax/trunk/mathjax mathjax
cd mathjax
unzip fonts.zip
```

to obtain and set up a copy of MathJax. (The SourceForge development page also shows how to do this.)

Whenever you want to update MathJax, you can now use

```
cd mathjax
svn status
```

to check if there are updates to MathJax. If MathJax needs updating, use

```
cd mathjax
svn update
#  if fonts.zip is updated, do the following as well:
rm -rf fonts
unzip fonts.zip
```

to udpate your copy of MathJax to the current release version. If the `fonts.zip` file has been updated, you will need to remove the old fonts directory and unpack the new one bring your installation up to date. If you keep MathJax updated in this way, you will be sure that you have the latest bug fixes and new features as they become available.

This gets you the current development copy of MathJax, which is the "bleeding-edge" version that contains all the latest changes to MathJax. At times, however, these may be less stable than the "release" version. If you prefer to use the most stable version (that may not include all the latest patches and features), use

```
svn co http://mathjax.svn.sourceforge.net/svnroot/mathjax/tags/mathjax-1.0.1 mathajx
cd mathjax
unzip fonts.zip
```

to obtain the version 1.0.1 release. When you wish to update to a new release, you will need to check out a new copy of MathJax with the new release number.

Obtaining MathJax via an archive

Release versions of MathJax are available in archive files from the MathJax download page or the GitHub downloads (click the big download button on the right), where you can download the archives that you need.

You should download the `MathJax-v1.0.1.zip` file, then simply unzip it. Once the MathJax directory is unpacked, you should move it to the desired location on your server (or your hard disk, if you are using it locally rather then through a web server). One natural location is to put it at the top level of your web server's hierarchy. That would let you refer to the main MathJax file as `/MathJax/MathJax.js` from within any page on your server.

Testing your installation

Use the HTML files in the `test` directory to see if your installation is working properly:

```
test/
    index.html          # Tests default configuration
    index-images.html   # Tests image-font fallback display
    sample.html         # Sample page with lots of pretty equations
```

Open these files in your browser to see that they appear to be working properly. If you have installed MathJax on a server, use the web address for those files rather than opening them locally. When you view the `index.html` file, you should see (after a few moments) a message that MathJax appears to be working. If not, you should check that the files have been transferred to the server completely, that the fonts archive has been unpacked in the correct location, and that the permissions allow the server to access the files and folders that are part of the MathJax directory (be sure to verify the MathJax folder's permissions as well). Checking the server logs may help locate problems with the installation.

Notes about shared installations

Typically, you want to have MathJax installed on the same server as your web pages that use MathJax. There are times, however, when that may be impractical, or when you want to use a MathJax installation at a different site. For example, a departmental server at `www.math.yourcollege.edu` might like to use a college-wide installation at `www.yourcollege.edu` rather than installing a separate copy on the departmental machine. MathJax can certainly be loaded from another server, but there is one imporant caveat — Firefox's same-origin security policy for cross-domain scripting.

Firefox's interpretation of the same-origin policy is more strict than most other browsers, and it affects how fonts are loaded with the *@font-face* CSS directive. MathJax uses this directive to load web-based math fonts into a page when the user doesn't have them installed locally on their own computer. Firefox's security policy, however, only allows

this when the fonts come from the same server as the web page itself, so if you load MathJax (and hence its web fonts) from a different server, Firefox won't be able to access those web fonts. In this case, MathJax will pause while waiting for the font to download (which will never happen) and will time out after about 15 seconds for each font it tries to access. Typically that is three or four fonts, so your Firefox users will experience a minute or so delay before mathematics is displayed, and then it will probably display incorrectly because the browser doesn't have access to the correct fonts.

There is a solution to this, however, if you manage the server where MathJax is installed, and if that server is running the Apache web server. In the remote server's `MathJax/fonts/HTML-CSS/TeX/otf` folder, create a file called `.htaccess` that contains the following lines:

```
<FilesMatch "\.(ttf|otf|eot)$">
<IfModule mod_headers.c>
Header set Access-Control-Allow-Origin "*"
</IfModule>
</FilesMatch>
```

and make sure the permissions allow the server to read this file. (The file's name starts with a period, which causes it to be an "invisible" file on unix-based operating systems. Some systems, particularly graphic user interfaces, may not allow you to create such files, so you might need to use the command-line interface to accomplish this.)

This file should make it possible for pages at other sites to load MathJax from this server in such a way that Firefox will be able to download the web-based fonts. If you want to restrict the sites that can access the web fonts, change the `Access-Control-Allow-Origin` line to something like:

```
Header set Access-Control-Allow-Origin "http://www.math.yourcollege.edu"
```

so that only pages at `www.math.yourcollege.edu` will be able to download the fonts from this site. See the open font library discussion of web-font linking for more details.

Loading and Configuring MathJax

You load MathJax into a web page by including its main JavaScript file into the page. That is done via a `<script>` tag that links to the `MathJax.js` file. Place the following line in the `<head>` section of your document:

```
<script type="text/javascript" src="path-to-MathJax/MathJax.js"></script>
```

where `path-to-MathJax` is replaced by the URL of the MathJax directory on your server, or (if you are using MathJax locally rather than through a server) the location of that directory on your hard disk. For example, if the MathJax directory is at the top level of your web server's directory hierarchy, you might use

```
<script type="text/javascript" src="/MathJax/MathJax.js"></script>
```

to load MathJax.

Although it is possible to load MathJax from a site other than your own web server, there are issues involved in doing so that you need to take into consideration. See the *Notes About Shared Servers* for more details. Please do **not** link to the copy of MathJax at `www.mathjax.org`, as we do not have the resources to act as a web service for all the sites on the web that would like to display mathematics. If you are able to run MathJax from your own server, please do so (this will probably give you better response time in any case).

It is best to load MathJax in the document's `<head>` block, but it is also possible to load MathJax into the `<body>` section, if needed. If you do this, load it as early as possible, as MathJax will begin to load its components as soon as it is included in the page, and that will help speed up the processing of the mathematics on your page. MathJax does expect there to be a `<head>` section to the document, however, so be sure there is one if you are loading MathJax in the `<body>`.

It is also possible to load MathJax dynamically after the page has been prepared, for example, via a GreaseMonkey script, or using a specially prepared bookmarklet. This is an advanced topic, however; see *Loading MathJax Dynamically* for more details.

Configuring MathJax

There are several ways to configure MathJax, but the easiest is to use the `config/MathJax.js` file that comes with MathJax. See the comments in that file, or the *configuration details* section, for explanations of the meanings of the various configuration options. You can edit the `config/MathJax.js` file to change any of the settings that you want to customize. When you include MathJax in your page via

```
<script type="text/javascript" src="path-to-MathJax/MathJax.js"></script>
```

it will load `config/MathJax.js` automatically as one of its first actions.

Alternatively, you can configure MathJax efficiently by calling `MathJax.Hub.Config()` when you include MathJax in your page, as follows:

```
<script type="text/javascript" src="path-to-MathJax/MathJax.js">
    MathJax.Hub.Config({
        extensions: ["tex2jax.js"],
        jax: ["input/TeX", "output/HTML-CSS"],
        tex2jax: {
            inlineMath: [ ['$','$'], ["\\(","\\)"] ],
            displayMath: [ ['$$','$$'], ["\\[","\\]"] ],
        },
        "HTML-CSS": { availableFonts: ["TeX"] }
    });
</script>
```

This example includes the `tex2jax` preprocessor and configures it to use both the standard TeX and LaTeX math delimiters. It uses the TeX input processor and the HTML-CSS output processor, and forces the HTML-CSS processor to use the TeX fonts rather that other locally installed fonts (e.g., *STIX* fonts). See the *configuration options* section (or the comments in the `config/MathJax.js` file) for more information about the configuration options that you can include in the `MathJax.Hub.Config()` call. Note that if you configure MathJax using this in-line approach, the `config/MathJax.js` file is **not** loaded.

Finally, if you would like to use several different configuration files (like `config/MathJax.js`, but with different settings in each one), you can copy `config/MathJax.js` to `config/MathJax-2.js`, or some other convenient name, and use

```
<script type="text/javascript" src="path-to-MathJax/MathJax.js">
    MathJax.Hub.Config({ config: "MathJax-2.js" });
</script>
```

to load the alternative configuration file `config/MathJax-2.js` from the MathJax `config` directory. In this way, you can have as many distinct configuration files as you need.

Common Configurations

The following examples show configurations that are useful for some common situations. This is certainly not an exhaustive list, and there are variations possible for any of them. Again, the comments in the `config/MathJax.js` file can help you decide what settings to include, even if you are using the in-line configuration method.

The TeX setup

This example calls the `tex2jax` preprocessor to identify mathematics in the page by looking for TeX and LaTeX math delimiters. It uses `$...$` and `\(...\)` for in-line mathematics, while `$$...$$` and `\[...\]` mark displayed equations. Because dollar signs are used to mark mathematics, if you want to produce an actual dollar sign in your document, you must "escape" it using a slash: `\$`. This configuration also loads the `AMSmath` and `AMSsymbols` extensions so that the macros and environments they provide are defined for use on the page.

```
MathJax.Hub.Config({
    extensions: ["tex2jax.js","TeX/AMSmath.js","TeX/AMSsymbols.js"],
    jax: ["input/TeX","output/HTML-CSS"],
    tex2jax: {
        inlineMath: [['$','$'],["\\(","\\)"]],
        processEscapes: true,
    },
});
```

Other extensions that you may consider adding to the *extensions* array include: `TeX/noErrors.js`, which shows the original TeX code if an error occurs while processing the mathematics (rather than an error message), `TeX/noUndefined.js`, which shows undefined macros names in red (rather than producing an error), and `TeX/autobold.js`, which automatically inserts `\boldsymbol{...}` around your mathematics when it appears in a section of your page that is in bold. Most of the other TeX extensions are loaded automatically when needed, and so do not need to be included explicitly in your *extensions* array.

See the *tex2jax configuration* section for other configuration options for the `tex2jax` preprocessor, and the *TeX input jax configuration* section for options that control the TeX input processor.

The MathML setup

This example calls the `mml2jax` preprocessor to identify mathematics in the page that is in *MathML* format, which uses `<math display="block">` to indicate displayed equations, and `<math display="inline">` or simply `<math>` to mark in-line formulas.

```
MathJax.Hub.Config({
    extensions: ["mml2jax.js"],
    jax: ["input/MathML","output/HTML-CSS"]
});
```

Note that this will work in HTML files, not just XHTML files (MathJax works with both), and that the web page need not be served with any special MIME-type. Also note that, unless you are using XHTML rather than HTML, you should not include a namespace prefix for your `<math>` tags; for example, you should not use `<m:math>` except in a file where you have tied the `m` namespace to the MathML DTD.

See the *mml2jax configuration* section for other configuration options for the `mml2jax` preprocessor, and the *MathML input jax configuration* section for options that control the MathML input processor.

Both TeX and MathML

This example provides for both TeX and MathML input in the same file. It calls on both the `tex2jax` and `mml2jax` preprocessors and the TeX and MathML input jax to do the job.

```
MathJax.Hub.Config({
    extensions: ["tex2jax.js", "mml2jax.js"],
    jax: ["input/TeX", "input/MathML", "output/HTML-CSS"],
});
```

Notice that no `tex2jax` configuration section is included, so it uses its default options (no single dollar signs for in-line math).

The majority of the code for the TeX and MathML input processors are not loaded until they are actually needed by the mathematics on the page, so if this configuration is used on a page that include only MathML, the TeX input processor will not be loaded. Thus it is reasonably efficient to specify both input processors even if only one (or neither one) is used.

TeX input with MathML output

This example configures MathJax to use the `tex2jax` preprocessor and TeX input processor, but the choice of output format is determined by MathJax depending on the capabilities of the user's browser. The is performed by the `MMLorHTML.js` configuration file that is loaded in the *config*' array.

```
MathJax.Hub.Config({
    config: ["MMLorHTML.js"],
    extensions: ["tex2jax.js"],
    jax: ["input/TeX"]
});
```

With this setup, Firefox or Internet Explorer with the MathPlayer plugin installed will use the NativeMML output processor, while all other browsers will use the HTML-CSS output processor. Since native MathML support is faster than MathJax's HTML-CSS processor, this will mean that the web pages will display faster for Firefox and IE than they would otherwise. This speed comes at the cost, however, as you are now relying on the native MathML support to render the mathematics, and that is outside of MathJax's control. There may be spacing or other display differences (compared to MathJax's HTML-CSS output) when the NativeMML output processor is used.

See *MathJax Output Formats* for more information on the NativeMML and HTML-CSS output processors. See the *MMLorHTML configuration* section for details on the options that control the `MMLorHTML` configuration.

MathML input and output in all browsers

This example configures MathJax to look for MathML within your page, and to display it using the browser's native MathML support, if possible, or its HTML-CSS output if not.

```
MathJax.Hub.Config({
    config: ["MMLorHTML.js"],
    extensions: ["mml2jax.js"],
    jax: ["input/MathML"]
});
```

Using this configuration, MathJax finally makes MathML available in all modern browsers.

See the *MMLorHTML configuration* section for details on the options that control the `MMLorHTML` configuration file, the *MathML configuration* section for the options that control the MathML output processor, and the *mml2jax configuration* section for the options that control the `mml2jax` preprocessor.

Configuration Objects

The various components of MathJax, including its input and output processors, its preprocessors, its extensions, and the MathJax core, all can be configured through the `config/MathJax.js` file, or via a `MathJax.Hub.Config()` call (indeed, if you look closely, you will see that `config/MathJax.js` is itself one big call to `MathJax.Hub.Config()`). Anything that is in `config/MathJax.js` can be included in-line to configure MathJax.

The structure that you pass to `MathJax.Hub.Config()` is a JavaScript object that includes name-value pairs giving the names of parameters and their values, with pairs separated by commas. Be careful not to include a comma after the last value, however, as some browsers (namely Internet Explorer) will fail to process the configuration if you do.

The MathJax components, like the TeX input processor, have their own sections in the configuration object, labeled by the component name, and using an configuration object as its value. The object is itself a configuration object made up of name-value pairs that give the configuration options for the component.

For example,

```
MathJax.Hub.Config({
  showProcessingMessages: false,
  jax: ["input/TeX", "output/HTML-CSS"],
  TeX: {
    TagSide: "left",
    Macros: {
      RR: '{\\bf R}',
      bold: ['{\\bf #1}',1]
    }
  }
});
```

is a configuration that includes two settings for the MathJax Hub (one for *showProcessingMessages* and one of the *jax* array), and a configuration object for the TeX input processor. The latter includes a setting for the TeX input processor's *TagSide* option (to set tags on the left rather than the right) and a setting for *Macros*, which defines new TeX macros (in this case, two macros, one called `\RR` that produces a bold "R", and one called `\bold` that puts is argument in bold face).

The `config/MathJax.js` file is another example that shows nearly all the configuration options for all of MathJax's components.

Configuration Options by Component

The individual options are explained in the following sections, which are categorized by the component they affect.

The Core Configuration Options

The options below control the MathJax Hub, and so determine the code behavior of MathJax. They are given with their default values.

`jax: ["input/TeX","output/HTML-CSS"]`
: A comma-separated list of input and output jax to initialize at startup. Their main code is loaded only when they are actually used, so it is not inefficient to include jax that may not actually be used on the page. These are found in the `MathJax/jax` directory.

`extensions: []`
: A comma-separated list of extensions to load at startup. The default directory is `MathJax/extensions`. The `tex2jax` and `mml2jax` preprocessors can be listed here, as well as a number of TeX-specific extensions (see the *TeX and LaTeX input* section of the *Getting Started* document for more details). There is also a `FontWarnings` extension that you can use to inform your user that mathematics fonts are available that they can download to improve their experience of your site.

`config: []`
: A comma-separated list of configuration files to load when MathJax starts up, e.g., to define local macros, etc., and there is a sample config file named `config/local/local.js`. The default directory is the *MathJax/config* directory. The `MMLorHTML.js` configuration is the only other predefined configuration file.

styleSheets: []
A comma-separated list of CSS stylesheet files to be loaded when MathJax starts up. The default directory is the *MathJax/config* directory.

styles: {}
CSS *selector: rules;* styles to be defined dynamically at startup time.

preJax: null and postJax: null
Patterns to remove from before and after math script tags. If you are not using one of the preprocessors, you need to insert something extra into your HTML file in order to avoid a bug in Internet Explorer. IE removes spaces from the DOM that it thinks are redundent, and since a `<script>` tag usually doesn't add content to the page, if there is a space before and after a MathJax `<script>` tag, IE will remove the first space. When MathJax inserts the typeset mathematics, this means there will be no space before it and the preceeding text. In order to avoid this, you should include some "guard characters" before or after the math SCRIPT tag; define the patterns you want to use below. Note that these are used as regular expressions, so you will need to quote special characters. Furthermore, since they are javascript strings, you must quote javascript special characters as well. So to obtain a backslash, you must use `\\` (doubled for javascript). For example, `"\\["` represents the pattern `\[` in the regular expression. That means that if you want an actual backslash in your guard characters, you need to use `"\\\\"` in order to get `\\` in the regular expression, and `\` in the actual text. If both preJax and postJax are defined, both must be present in order to be removed.

See also the `preRemoveClass` comments below.

Examples:

`preJax: "\\\\\\\\\\"` makes a double backslash the preJax text

`preJax: "\\[\\[", postJax: "\\]\\]"` makes it so jax scripts must be enclosed in double brackets.

preRemoveClass: "MathJax_Preview"
The CSS class for a math preview to be removed preceeding a MathJax SCRIPT tag. If the tag just before the MathJax `<script>` tag is of this class, its contents are removed when MathJax processes the `<script>` tag. This allows you to include a math preview in a form that will be displayed prior to MathJax performing its typesetting. It also avoids the Internet Explorer space-removal bug, and can be used in place of `preJax` and `postJax` if that is more convenient.

For example

```
<span class="MathJax_Preview">[math]</span><script type="math/tex">...</script>
```

would display "[math]" in place of the math until MathJax is able to typeset it.

See also the `preJax` and `postJax` comments above.

showProcessingMessages: true
This value controls whether the *Processing Math: nn%* message are displayed in the lower left-hand corner. Set to `false` to prevent those messages (though file loading and other messages will still be shown).

messageStyle: "normal"
This value controls the verbosity of the messages in the lower left-hand corner. Set it to `"none"` to eliminate all messages, or set it to `"simple"` to show "Loading..." and "Processing..." rather than showing the full file name or the percentage of the mathematics processed.

displayAlign: "center" and displayIndent: "0em"
These two parameters control the alignment and shifting of displayed equations. The first can be `"left"`, `"center"`, or `"right"`, and determines the alignment of displayed equations. When the alignment is not `"center"`, the second determines an indentation from the left or right side for the displayed equations.

delayStartupUntil: "none"
Normally MathJax will perform its starup commands (loading of configuration, styles, jax, and so on) as soon

as it can. If you expect to be doing additional configuration on the page, however, you may want to have it wait until the page's onload hander is called. If so, set this to `"onload"`.

`skipStartupTypeset: false`
Normally MathJax will typeset the mathematics on the page as soon as the page is loaded. If you want to delay that process, in which case you will need to call `MathJax.Hub.Typeset()` yourself by hand, set this value to `true`.

`menuSettings: { ... }`
This block contains settings for the mathematics contextual menu that act as the defaults for the user's settings in that menu. The possible values are:

`zoom: "none"`
This indicates when typeset mathematics should be zoomed. It can be set to `"None"`, `"Hover"`, `"Click"`, or `"Double-Click"` to set the zoom trigger.

`CTRL: false, ALT: false, CMD: false, Shift: false`
These values indicate which keys must be pressed in order for math zoom to be triggered. For example, if `CTRL` is set to `true` and `zoom` is `"Click"`, then math will be zoomed only when the user control-clicks on mathematics (i.e., clicks while holding down the *CTRL* key). If more than one is `true`, then all the indicated keys must be pressed for the zoom to occur.

`zscale: "200%"`
This is the zoom scaling factor, and it can be set to any of the values available in the *Zoom Factor* menu of the *Settings* submenu of the contextual menu.

`context: "MathJax"`
This controls what contextual menu will be presented when a right click (on a PC) or CTRL-click (on the Mac) occurs over a typeset equation. When set to `"MathJax"`, the MathJax contextual menu will appear; when set to `"Browser"`, the browser's contextual menu will be used. For example, in Internet Explorer with the MathPlayer plugin, if this is set to `"Browser"`, you will get the MathPlayer contextual menu rather than the MathJax menu.

There are also settings for `format`, `renderer`, and `font`, but these are maintained by MathJax and should not be set by the page author.

`errorSettings: { ... }`
This block contains settings that control how MathJax responds to unexpected errors while processing mathematical equations. Rather than simply crash, MathJax can report an error and go on. The options you can set include:

`message: ["[Math Processing Error]]`
This is an HTML snippet that will be inserted at the location of the mathematics for any formula that causes MathJax to produce an internal error (i.e., an error in the MathJax code itself). See the *description of HTML snippets* for details on how to represent HTML code in this way.

`style: {color:"#CC0000", "font-style":"italic"}`
This is the CSS style description to use for the error messages produced by internal MathJax errors. See the section on *CSS style objects* for details on how these are specified in JavaScript.

The tex2jax Preprocessor

The options below control the operation of the *tex2jax* preprocessor that is run when you include `"tex2jax.js"` in the *extensions* array of your configuration. They are listed with their default values. To set any of these options, include a `tex2jax` section in your `MathJax.Hub.Config()` call. For example

```
MathJax.Hub.Config({
  tex2jax: {
```

```
    inlineMath: [ ['$','$'], ['\\(','\\)'] ]
  }
});
```

would set the `inlineMath` delimiters for the *tex2jax* preprocessor.

`element: null`
: The id name of the element that should be processed by *tex2jax*. The default is the whole document.

`inlineMath: [['\(','\)']]`
: Array of pairs of strings that are to be used as in-line math delimters. The first in each pair is the initial delimiter and the second is the terminal delimiter. You can have as many pairs as you want. For example,

```
inlineMath: [ ['$','$'], ['\\(','\\)'] ]
```

would cause *tex2jax* to look for `$...$` and `\(...\)` as delimiters for inline mathematics. (Note that the single dollar signs are not enabled by default because they are used too frequently in normal text, so if you want to use them for math delimiters, you must specify them explicitly.)

Note that the delimiters can't look like HTML tags (i.e., can't include the less-than sign), as these would be turned into tags by the browser before MathJax has the chance to run. You can only include text, not tags, as your math delimiters.

`displayMath: [ ['$$','$$'], ['\[','\]'] ]`
: Array of pairs of strings that are to be used as delimters for displayed equations. The first in each pair is the initial delimiter and the second is the terminal delimiter. You can have as many pairs as you want.

Note that the delimiters can't look like HTML tags (i.e., can't include the less-than sign), as these would be turned into tags by the browser before MathJax has the chance to run. You can only include text, not tags, as your math delimiters.

`processEscapes: false`
: When set to `true`, you may use `\$` to represent a literal dollar sign, rather than using it as a math delimiter. When `false`, `\$` will not be altered, and the dollar sign may be considered part of a math delimiter. Typically this is set to `true` if you enable the `$ ... $` in-line delimiters, so you can type `\$` and *tex2jax* will convert it to a regular dollar sign in the rendered document.

`processEnvironments: true`
: When `true`, *tex2jax* looks not only for the in-line and display math delimters, but also for LaTeX environments (`\begin{something}...\end{something}`) and marks them for processing by MathJax. When `false`, LaTeX environments will not be processed outside of math mode.

`preview: "TeX"`
: This controls whether *tex2jax* inserts `MathJax_Preview` spans to make a preview available, and what preview to use, when it locates in-line or display mathematics in the page. The default is `"TeX"`, which means use the TeX code as the preview (which will be visible until it is processed by MathJax). Set to `"none"` to prevent previews from being inserted (the math will simply disappear until it is typeset). Set to an array containing the description of an HTML snippet in order to use the same preview for all equations on the page.

Examples:

```
preview: ["[math]"],     //  insert the text "[math]" as the preview
```

```
preview: [["img",{src: "/images/mypic.jpg"}]],  // insert an image as the preview
```

See the *description of HTML snippets* for details on how to represent HTML code in this way.

`skipTags: ["script","noscript","style","textarea","pre","code"]`
: This array lists the names of the tags whose contents should not be processed by *tex2jax* (other than to look

for ignore/process classes as listed below). You can add to (or remove from) this list to prevent MathJax from processing mathematics in specific contexts.

ignoreClass: "tex2jax_ignore"
: This is the class name used to mark elements whose contents should not be processed by tex2jax (other than to look for the `processClass` pattern below). Note that this is a regular expression, and so you need to be sure to quote any *regexp* special characters. The pattern is automatically preceeded by `'(^| )('` and followed by `')( |$)'`, so your pattern will have to match full words in the class name. Assigning an element this class name will prevent *tex2jax* from processing its contents.

processClass: "tex2jax_process"
: This is the class name used to mark elements whose contents *should* be processed by *tex2jax*. This is used to turn on processing within tags that have been marked as ignored or skipped above. Note that this is a regular expression, and so you need to be sure to quote any *regexp* special characters. The pattern is automatically preceeded by `'(^| )('` and followed by `')( |$)'`, so your pattern will have to match full words in the class name. Use this to restart processing within an element that has been marked as ignored above.

The mml2jax Preprocessor

The options below control the operation of the *mml2jax* preprocessor that is run when you include `"mml2jax.js"` in the *extensions* array of your configuration. They are listed with their default values. To set any of these options, include a `mml2jax` section in your `MathJax.Hub.Config()` call. For example

```
MathJax.Hub.Config({
  mml2jax: {
    preview: "none"
  }
});
```

would set the `preview` parameter to `"none"`.

element: null
: The id name of the element that should be processed by *mml2jax*. The default is the whole document.

preview: "alttext"
: This controls whether *mml2jax* inserts `MathJax_Preview` spans to make a preview available, and what preview to use, when it locates mathematics on the page. The default is `"alttext"`, which means use the `<math>` tag's `alttext` attribute as the preview (visible until it is processed by MathJax), if the tag has one. Set it to `"none"` to prevent the previews from being inserted (the math will simply disappear until it is typeset). Set it to an array containing the description of an HTML snippet in order to use the same preview for all equations on the page.

  Examples:

```
preview: ["[math]"],     //  insert the text "[math]" as the preview
```

```
preview: [["img",{src: "/images/mypic.jpg"}]],  // insert an image as the preview
```

  See the *description of HTML snippets* for details on how to represent HTML code in this way.

The jsMath2jax Preprocessor

The options below control the operation of the *jsMath2jax* preprocessor that is run when you include `"jsMath2jax.js"` in the *extensions* array of your configuration. They are listed with their default values. To set any of these options, include a `jsMath2jax` section in your `MathJax.Hub.Config()` call. For example

```
MathJax.Hub.Config({
  jsMath2jax: {
    preview: "none"
  }
});
```

would set the `preview` parameter to `"none"`.

`element: null`
: The id name of the element that should be processed by *jsMath2jax*. The default is the whole document.

`preview: "TeX"`
: This controls whether *jsMath2jax* inserts `MathJax_Preview` spans to make a preview available, and what preview to use, when it locates in-line or display mathematics in the page. The default is `"TeX"`, which means use the TeX code as the preview (which will be visible until it is processed by MathJax). Set to `"none"` to prevent previews from being inserted (the math will simply disappear until it is typeset). Set to an array containing the description of an HTML snippet in order to use the same preview for all equations on the page.

  Examples:

```
preview: ["[math]"],     //  insert the text "[math]" as the preview
```

```
preview: [["img",{src: "/images/mypic.jpg"}]],  // insert an image as the preview
```

  See the *description of HTML snippets* for details on how to represent HTML code in this way.

The TeX input processor

The options below control the operation of the TeX input processor that is run when you include `"input/TeX"` in the *jax* array of your configuration. They are listed with their default values. To set any of these options, include a `TeX` section in your `MathJax.Hub.Config()` call. For example

```
MathJax.Hub.Config({
  TeX: {
    Macros: {
      RR: '{\\bf R}',
      bold: ['{\\bf #1}', 1]
    }
  }
});
```

would set the `Macros` configuration option to cause two new macros to be defined within the TeX input processor.

`TagSide: "right"`
: This specifies the side on which `\tag{}` macros will place the tags. Set it to `"left"` to place the tags on the left-hand side.

`TagIndent: ".8em"`
: This is the amount of indentation (from the right or left) for the tags produced by the `\tag{}` macro.

`MultLineWidth: "85%"`
: The width to use for the *multline* environment that is part of the `AMSmath` extension. This width gives room for tags at either side of the equation, but if you are displaying mathematics in a small area or a thin column of text, you might need to change the value to leave sufficient margin for tags.

`Macros: {}`
: This lists macros to define before the TeX input processor begins. These are name:value pairs where the *name* gives the name of the TeX macro to be defined, and *value* gives the replacement text for the macro. The *value*

canbe an array of the form *[value,n]*, where *value* is the replacement text and *n* is the number of parameters for the macro. Note that since the *value* is a javascript string, backslashes in the replacement text must be doubled to prevent them from acting as javascript escape characters.

For example,

```
Macros: {
  RR: '{\\bf R}',
  bold: ['{\\bf #1}', 1]
}
```

would ask the TeX processor to define two new macros: `\RR`, which produces a bold-face "R", and `\bold{...}`, which takes one parameter and set it in the bold-face font.

The MathML input processor

The options below control the operation of the MathML input processor that is run when you include `"input/MathML"` in the *jax* array of your configuration. They are listed with their default values. To set any of these options, include a `MathML` section in your `MathJax.Hub.Config()` call. For example

```
MathJax.Hub.Config({
  MathML: {
    useMathMLspacing: true
  }
});
```

would set the `useMathMLspacing` option so that the MathML rules for spacing would be used (rather than TeX spacing rules).

`useMathMLspacing: false`
Specifies whether to use TeX spacing or MathML spacing when the *HTML-CSS* output jax is used.

The HTML-CSS output processor

The options below control the operation of the HTML-CSS output processor that is run when you include `"output/HTML-CSS"` in the *jax* array of your configuration. They are listed with their default values. To set any of these options, include a `"HTML-CSS"` section in your `MathJax.Hub.Config()` call. Note that, because of the dash, you need to enclose the name in quotes. For example

```
MathJax.Hub.Config({
  "HTML-CSS": {
    preferredFont: "STIX"
  }
});
```

would set the `preferredFont` option to the *STIX* fonts.

`scale: 100`
The scaling factor (as a percentage) of math with respect to the surrounding text. The *HTML-CSS* output processor tries to match the en-size of the mathematics with that of the text where it is placed, but you may want to adjust the results using this scaling factor. The user can also adjust this value using the contextual menu item associated with the typeset mathematics.

`availableFonts: ["STIX","TeX"]`
This is a list of the fonts to look for on a user's computer in preference to using MathJax's web-based fonts. These must correspond to directories available in the `jax/output/HTML-CSS/fonts` directory, where

MathJax stores data about the characters available in the fonts. Set this to `["TeX"]`, for example, to prevent the use of the *STIX* fonts, or set it to an empty list, *[]*, if you want to force MathJax to use web-based or image fonts.

preferredFont: "TeX"
Which font to prefer out of the `availableFonts` list, when more than one is available on the user's computer.

webFont: "TeX"
This is the web-based font to use when none of the fonts listed above are available on the user's computer. Note that currently only the *TeX* font is available in a web-based form (they are stored in the `fonts/HTML-CSS` folder in the MathJax directory. Set this to `null` to disable web fonts.

imageFont: "TeX"
This is the font to use for image fallback mode (when none of the fonts listed above are available and the browser doesn't support web-fonts via the `@font-face` CSS directive). Note that currently only the TeX font is available as an image font (they are stores in the `fonts/HTML-CSS` directory).

Set this to `null` if you want to prevent the use of image fonts (e.g., you have deleted or not installed the image fonts on your server). In this case, only browsers that support web-based fonts will be able to view your pages without having the fonts installed on the client computer. The browsers that support web-based fonts include: IE6 and later, Chrome, Safari3.1 and above, Firefox3.5 and later, and Opera10 and later. Note that Firefox3.0 is **not** on this list.

styles: {}
This is a list of CSS declarations for styling the HTML-CSS output. See the definitions in `jax/output/HTML-CSS/config.js` for some examples of what are defined by default. See *CSS Style Objects* for details on how to specify CSS style in a JavaScript object.

showMathMenu: true
This controls whether the MathJax contextual menu will be available on the mathematics in the page. If true, then right-clicking (on the PC) or control-clicking (on the Mac) will produce a MathJax menu that allows you to get the source of the mathematics in various formats, change the size of the mathematics relative to the surrounding text, get information about MathJax, and configure other MathJax settings.

Set this to `false` to disable the menu. When `true`, the `MathMenu` configuration block determines the operation of the menu. See *the MathMenu options* for more details.

tooltip: { ... }
This sets the configuration options for `<maction>` elements with `actiontype="tooltip"`. (See also the `#MathJax_Tooltip` style setting in `jax/output/HTML-CSS/config.js`, which can be overridden using the `styles` option above.)

The `tooltip` section can contain the following options:

delayPost: 600
The delay (in milliseconds) before the tooltip is posted after the mouse is moved over the `maction` element.

delayClear: 600
The delay (in milliseconds) before the tooltop is cleared after the mouse moves out of the `maction` element.

offsetX: 10 and offsetY: 5
These are the offset from the mouse position (in pixels) where the tooltip will be placed.

The NativeMML output processor

The options below control the operation of the NativeMML output processor that is run when you include `"output/NativeMML"` in the *jax* array of your configuration. They are listed with their default values. To set any of these

options, include a `NativeMML` section in your `MathJax.Hub.Config()` call. For example

```
MathJax.Hub.Config({
  NativeMML: {
    scale: 105
  }
});
```

would set the `sale` option to 105 percent.

`scale: 100`
: The scaling factor (as a percentage) of math with respect to the surrounding text. Since the *NativeMML* output relies on the browser's natiove MathML support, MathJax does not control the font size used in the mathematics. You may need to set this value to compensate for the size selected by the browser. The user can also adjust this value using the contextual menu item associated with the typeset mathematics.

`showMathMath: true`
: This controls whether the MathJax contextual menu will be available on the mathematics in the page. If true, then right-clicking (on the PC) or control-clicking (on the Mac) will produce a MathJax menu that allows you to get the source of the mathematics in various formats, change the size of the mathematics relative to the surrounding text, get information about MathJax, and configure other MathJax settings.

  Set this to `false` to disable the menu. When `true`, the `MathMenu` configuration block determines the operation of the menu. See *the MathMenu options* for more details.

`showMathMenuMSIE: true`
: There is a separate menu setting for MSIE since the code to handle that is a bit delicate; if it turns out to have unexpected consequences, you can turn it off without turing off other the menu support in other browsers.

`styles: {}`
: This is a list of CSS declarations for styling the HTML-CSS output. See the definitions in `jax/output/NativeMML/config.js` for some examples of what are defined by default. See *CSS Style Objects* for details on how to specify CSS style in a JavaScript object.

The MMLorHTML configuration options

The options below control the operation of the MMLorHTML configuration file that is run when you include `"MMLorHTML.js"` in the *config* array of your configuration. They are listed with their default values. To set any of these options, include a `MMLorHTML` section in your `MathJax.Hub.Config()` call. For example

```
MathJax.Hub.Config({
  MMLorHTML: {
    prefer: {
      Opera: "MML"
    }
  }
});
```

would set the `prefer` option so that Opera browser would prefer MathML to HTML-CSS output (while leaving the settings for other browsers unchanged).

Note that if you use the `MMLorHTML.js` configuration file, you should **not** specify an output processor in the *jax* array of your configuration; *MMLorHTML* will fill that in for you.

`prefer: { MSIE: "MML", Firefox: "MML", Opera: "HTML", other: "HTML" }`
: This lets you set the preferred renderer on a browser-by-browser basis. You set the browser to either `"MML"` or `"HTML"` depending on whether you want to use the *NativeMML* or *HTML-CSS* output processor. Note that

although Opera does process some MathML natively, its support is not sufficient to handle the more complicated output generated by MathJax, so its setting is `"HTML"` by default.

The MathMenu extension

The options below control the operation of the contextual menu that is available on mathematics that is typeset by MathJax. They are listed with their default values. To set any of these options, include a `MathMenu` section in your `MathJax.Hub.Config()` call. For example

```
MathJax.Hub.Config({
  MathMenu: {
    delay: 600
  }
});
```

would set the `delay` option to 600 milliseconds.

`delay: 400`
: This is the hover delay for the display (in milliseconds) for submenus in the contextual menu: when the mouse is over a submenu label for this long, the menu will appear. (The submenu also will appear if you click on its label.)

`helpURL: "http://www.mathjax.org/help/user/"`
: This is the URL for the MathJax Help menu item. When the user selects that item, the browser opens a new window with this URL.

`showRenderer: true`
: This controls whether the "Math Renderer" item will be displayed in the the "Settings" submenu of the mathematics contextual menu. It allows the user to change between the *HTML-CSS* and *NativeMML* output processors for the mathematics on the page. Set to `false` to prevent this menu item from showing.

`showContext: false`
: This controls whether the "Contextual Menu" item will be displayed in the the "Settings" submenu of the mathematics contextual menu. It allows the user to decide whether the MathJax menu or the browser's default contextual manu will be shown when the context menu click occurs over mathematics typeset by MathJax. (The main reason to allow pass-through to the browser's menu is to gain access to the MathPlayer contextual menu when the NativeMML output processor is used in Internet Explorer with the MathPlayer plugin.) Set to `false` to prevent this menu item from showing.

`showFontMenu: false`
: This controls whether the "Font Preference" item will be displayed in the the "Settings" submenu of the mathematics contextual menu. This submenu lets the user select what font to use in the mathematics produced by the *HTML-CSS* output processor. Note that changing the selection in the font menu will cause the page to reload. Set to `false` to prevent this menu item from showing.

`windowSettings: { ... }`
: These are the settings for the `window.open()` call that creates the *Show Source* window. The initial width and height will be reset after the source is shown in an attempt to make the window fit the output better.

`styles: {}`
: This is a list of CSS declarations for styling the menu components. See the definitions in `extensions/MathMenu.js` for details of what are defined by default. See *CSS Style Objects* for details on how to specify CSS style in a JavaScript object.

The MathZoom extension

The options below control the operation of the Math-Zoom feature that allows users to see an enlarged version of the mathematics when they click or hover over typeset mathematics. They are listed with their default values. To set any of these options, include a `MathZoom` section in your `MathJax.Hub.Config()` call. For example

```
MathJax.Hub.Config({
  MathZoom: {
    delay: 600
  }
});
```

would set the `delay` option to 600 milliseconds.

Mathematics is zoomed when the user "triggers" the zoom by an action, either clicking on the mathematics, double-clicking on it, or holding the mouse still over it (i.e., "hovering"). Which trigger is used is set by the user via the math contextual menu (or by the author using the `menuSettings` configuration section).

`delay: 400`
: This the time (in milliseconds) that the mouse must be still over a typeset mathematical formula before the zoomed version is displayed (when the zoom trigger is set to *Hover*).

`styles: {}`
: This is a list of CSS declarations for styling the zoomed mathematics. See the definitions in `extensions/MathZoom.js` for details of what are defined by default. See *CSS Style Objects* for details on how to specify CSS style in a JavaScript object.

The FontWarnings extension

The options below control the operation of the *FontWarnings* extension that is run when you include `"FontWarnings.js"` in the *extensions* array of your configuration. They are listed with their default values. To set any of these options, include a `FontWarnings` section in your `MathJax.Hub.Config()` call. For example

```
MathJax.Hub.Config({
  FontWarnings: {
    fadeoutTime: 2*1000
  }
});
```

would set the `fadeoutTime` option to 2000 milliseconds (2 seconds).

`messageStyle: { ... }`
: This sets the CSS styles to be used for the font warning message window. See the `extensions/FontWarnings.js` file for details of what are set by default. See the *CSS style objects* for details about how to specify CSS styles via javascript objects.

`Message: { ... }`
: This block contains HTML snippets to be used for the various messages that the FontWarning extension can produce. There are three messages that you can redefine to suit your needs:

  `webFont: [ ... ]`
  : The message used for when MathJax uses web-based fonts (rather than local fonts installed on the user's system).

  `imageFonts: [ ... ]`
  : The message used for when MathJax must use image fonts rather than local or web-based fonts (for those browsers that don't handle the `@font-face` CSS directive).

noFonts: [...]
The message used when MathJax is unable to find any font to use (i.e., neither local nor web-based nor image-based fonts are available).

Any message that is set to `null` rather than an HTML snippet array will not be presented to the user, so you can set, for example, the `webFont` message to `null` in order to have the `imageFonts` and `noFonts` messages, but no message if MathJax uses web-based fonts.

See the description of *HTML snippets* for details about how to describe the messages using HTML snippets. Note that in addition to the usual rules for defining such snippets, the FontWarnings snippets can include references to pre-defined snippets (that represent elements common to all three messages). These are defined below in the `HTML` block, and are referenced using `["name"]` within the snippet, where *name* is the name of one of the snippets defined in the `HTML` configuration block. For example

```
   Message: {
     noFonts: [
       ["closeBox"],
       "MathJax is unable to locate a font to use to display ",
       "its mathematics, and image fonts are not available, so it ",
       "is falling back on generic unicode characters in hopes that ",
       "your browser will be able to display them.  Some characters ",
       "may not show up properly, or possibly not at all.",
       ["fonts"],
       ["webfonts"]
     ]
   }

refers to the ``closeBox``, ``fonts`` and ``webfonts`` snippets in
declared in the ``HTML`` section.
```

HTML: { ... }
This object defines HTML snippets that are common to more than one message in the `Message` section above. They can be called in by using `["name"]` in an HTML snippet, where *name* refers to the name of the snippet in the `HTML` block. The pre-defined snippets are:

closeBox
The HTML for the close box in the FontWarning message.

webfonts
The HTML for a paragraph suggesting an upgrade to a more modern browser that supports web fonts.

fonts
HTML that includes links to the MathJax and STIX font download pages.

STIXfonts
HTML that gives the download link for the STIX fonts only. (Used in place of *fonts* when the *HTML-CSS* option for *availableFonts* only includes the *STIX* fonts.)

TeXfonts
HTML that gives the download link for the MathJax TeX fonts only. (Used in place of *fonts* when the *HTML-CSS* option for *availableFonts* only includes the *TeX* fonts.)

You can add your own pre-defined HTML snippets to this object, or override the ones that are there with your own text.

removeAfter: 12*1000
This is the amount of time to show the FontWarning message, in milliseconds. The default is 12 seconds.

fadeoutSteps: 10
This is the number of steps to take while fading out the FontWarning message. More steps make for a smoother

fade-out.

fadeoutTime: 1.5*1000
This is the time used to perform the fade-out, in milliseconds. The default is 1.5 seconds.

Using MathJax in popular web platforms

Most web-based content-management systems include a theme or template layer that determines how the pages look, and that loads information common to all pages. Such theme files provide one popular way to include MathJax in your web templates in the absense of MathJax-specific plugins for the system you are using. To take advantage of this approach, you will need access to your theme files, which probably means you need to be an administrator for the site; if you are not, you may need to have an administrator do these steps for you.

To enable MathJax in your web platform, add the line:

```
<script type="text/javascript" src="path-to-MathJax/MathJax.js"></script>
```

(where `path-to-MathJax` is the web-address of the main MathJax directory for your server) either just before the `</head>` tag in your theme file, or at the end of the file if it contains no `</head>`.

The theme files for various popular platforms are:

WordPress `wp-content/themes/[current_theme]/header.php`

Movable Type `[current_theme_templates]/html_head.mhtml`

Drupal `themes/[current_theme]/page.tpl.php`

Joomla `templates/[current_theme]/index.php`

MediaWiki `skins/[current_skin].php`

TiddlyWiki `*.php` (Whatever you call your TiddlyWiki php file)

Moodle `theme/[current_theme]/header.html`

Keep in mind that this will enable MathJax for your current theme/template only. If you change themes or update your theme, you will have to repeat these steps.

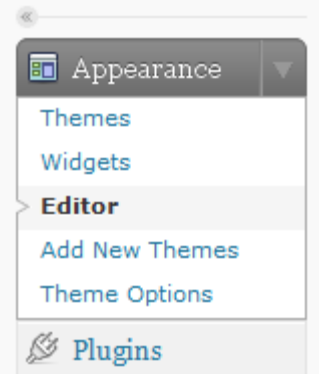
Insructions for Specific Platforms

Some programs, such as WordPress and Moveable Type, allow you to edit template files from inside their administrator interfaces. Specific instructions for these are given via the links below.

Installing MathJax in WordPress

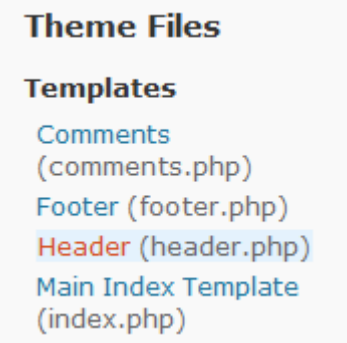
These instructions assume you already have placed the MathJax files on your server (see *Installing MathJax*).

1. Open the WordPress admin interface.
2. In the administration menu on the left, open up the *Appearance* menu and click on the *Editor* submenu option.



When you click on the editor option, WordPress should open up the first stylesheet in the current theme.

3. In the template list on the right side of the page, click on the header file (it should be `header.php`).



This part depends slightly on how your current theme is written. In the `header.php` file, look for the end-of-head tag, `</head>`. If you find it, insert

```
<script type="text/javascript" src="path-to-MathJax/MathJax.js"></script>
```

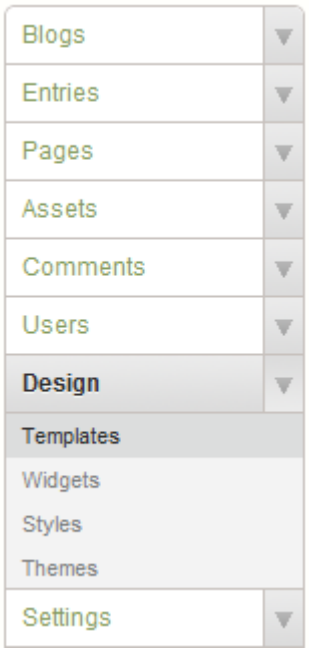
just before that. Otherwise, insert the same code at the very bottom of the file. Here, `path-to-MathJax` should be replaced by the web-address of the main MathJax directory on your server, e.g., `src="/mathjax/MathJax.js"`.

4. Save the file. This should enable MathJax, so you should be able to start adding mathematical content to your pages. Use the `config/MathJax.js` file in the MathJax directory to configure MathJax to your needs (see *Configuring MathJax* for details).

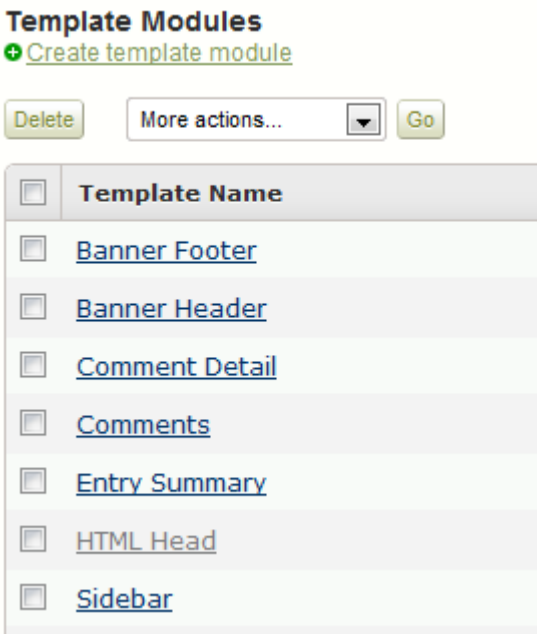
Using MathJax in Movable Type

These instructions assume you already have placed the MathJax files on your server (see *Installing and Testing MathJax*).

1. Open Moveable Type Admin interface for the site on which you want to enable MathJax.
2. In the dashboard menu on the left, open up the Design menu. This should show you the templates you are currently using on the site.



3. Scroll down to the Template Modules section in the template list and open the *HTML Head* template.



4. At the end of the file, insert

```
<script type="text/javascript"  src="path-to-MathJax/MathJax.js"></script>
```

where `path-to-MathJax` is replaced by the web-address of the main MathJax dorectory on your server.

5. Save the file. This should enable MathJax, so you should be able to start adding mathematical content to your pages. Use the `config/MathJas.js` file in the MathJax directory to configure MathJax to your needs (see *Configuring MathJax* for details).

MathJax TeX and LaTeX Support

The support for TeX and LaTeX in MathJax consists of two parts: the *tex2jax* preprocessor, and the TeX input processor. The first of these looks for mathematics within your web page (indicated by math delimiters like `$$...$$`) and marks the mathematics for later processing by MathJax. The TeX input processor is what converts the TeX notation into MathJax's internal format, where one of MathJax's output processors then displays it in the web page.

The *tex2jax* preprocessor can be configured to look for whatever markers you want to use for your math delimiters. See the *tex2jax configuration options* section for details on how to customize the action of *tex2jax*.

The TeX input processor handles conversion of your mathematical notation into MathJax's internal format (which is essentially MathML), and so acts as a TeX to MathML converter. The TeX input processor has few configuration options (see the *TeX options* section for details), but it can also be customized through the use of extensions that define additional functionality (see the *TeX and LaTeX extensions* below).

Note that the TeX input processor implements **only** the math-mode macros of TeX and LaTeX, not the text-mode macros. MathJax expects that you will use standard HTML tags to handle formatting the text of your page; it only handles the mathematics. So, for example, MathJax does not implement `\emph` or `\begin{enumerate}...\end{enumerate}` or other text-mode macros or environments. You must use HTML to handle such formatting tasks. If you need a LaTeX-to-HTML converter, you should consider other options.

TeX and LaTeX in HTML documents

Keep in mind that your mathematics is part of an HTML document, so you need to be aware of the special characters used by HTML as part of its markup. There cannot be HTML tags within the math delimiters (other than `<BR>`) as TeX-formatted math does not include HTML tags. Also, since the mathematics is initially given as text on the page, you need to be careful that your mathematics doesn't look like HTML tags to the browser (which parses the page before MathJax gets to see it). In particular, that means that you have to be careful about things like less-than and greater-than signs (<``and ``>), and ampersands (`&`), which have special meaning to the browsers. For example,

```
... when $x<y$ we have ...
```

will cause a problem, because the brower will think `<y` is the beginning of a tag named `y` (even though there is no such tag in HTML). When this happens, the browser will think the tag continues up to the next > in the document (typically the end of the next actual tag in the HTML file), and you may notice that you are missing part of the text

of the document. In the example above, the ‘‘ we have ...‘‘ will not be displayed because the browser thinks it is part of the tag starting at <y. This is one indication you can use to spot this prooblem; it is a common error and should be avoided.

Usually, it is sufficient to simply put spaces around these symbols to cause the browser to avoid them, so

```
... when $x < y$ we have ...
```

should work. Alternatively, you can use the HTML entities `<`, `>` and `&` to encode these characters so that the browser will not interpret them, but MathJax will. E.g.,

```
... when $x &lt; y$ we have ...
```

Finally, there are `\lt` and `\gt` macros defined to make it easier to enter < and > using TeX-like syntax:

```
... when $x \lt y$ we have ...
```

Keep in mind that the browser interprets your text before MathJax does.

TeX and LaTeX extensions

While MathJax includes nearly all of the Plain TeX math macros, and many of the LaTeX macros and environments, note everything is implemented in the core TeX input processor. Some less-used commands are defined in extensions to the TeX processor. MathJax will load some extensions automatically when you first use the commands they implement (for example, the `\def` and `\newcommand` macros are implemented in the `TeX/newcommand.js` extension, but MathJax loads this extension itself when you use those macros). Not all extensions are set up to load automatically, however, so you may need to request some extensions explicitly yourself.

To enable any of the TeX extensions, simply add the appropriate string (e.g., *“TeX/AMSmath.js”*) to your config’s *extensions* array. The main extensions are described below.

AMSmath and AMSsymbol

The *AMSmath* extension implements AMS math environments and macros, and the *AMSsymbol* extension implements macros for accessing the AMS symbol fonts. To use these extensions, add them to your *extensions* array.

```
extensions: ["TeX/AMSmath.js", "TeX/AMSsymbol.js", ...]
```

See the list of commands at the end of this document for details about what commands are implemented in these extensions.

The *AMSmath* extension will be loaded automatically when you first use one of the math environments it defines, but you will have to load it explicitly if you want to use the other macros that it defines. The *AMSsymbols* extension is not loaded automatically, so you must include it explicitly if you want to use the macros it defines.

Autobold

The *autobold* extension adds `\boldsymbol{...}` around mathematics that appears in a section of an HTML page that is in bold.

```
extensions: ["TeX/autobold.js"]
```

noErrors

The *noErrors* extension prevents TeX error messages from being displayed and shows the original TeX code instead. You can configure whether the dollar signs are shown or not for in-line math, and whether to put all the TeX on one line or use multiple lines (if the original text contained line breaks).

To enable the *noErrors* extension and configure it, use

```
extensions: ["TeX/noErrors.js", ...],
TeX: {
    noErrors: {
        inlineDelimiters: ["",""],   // or ["$","$"] or ["\\(","\\)"]
        multiLine: true,             // false for TeX on all one line
        style: {
            "font-family": "serif",
            "font-size":   "80%",
            "color":       "black",
            "border":      "1px solid"
            // add any additional CSS styles that you want
            //  (be sure there is no extra comma at the end of the last item)
        }
    }
}
```

Display-style math is always shown in multi-line format, and without delimiters, as it will already be set off in its own centered paragraph, like standard display mathematics.

The default settings place the invalid TeX in a multi-line box with a black border. If you want it to look as though the TeX is just part of the paragraph, use

```
TeX: {
    noErrors: {
        inlineDelimiters: ["$","$"],   // or ["",""] or ["\\(","\\)"]
        multiLine: false,
        style: {
            "font-size": "normal",
            "border": ""
        }
    }
}
```

You may also wish to set the font family, as the default is "serif"

noUndefined

The *noUndefined* extension causes undefined control sequences to be shown as their macro names rather than produce an error message. So `$X_{\xxx}$` would display as an "X" with a subscript consiting of the text `\xxx` in red.

To enable and configure this extension, use for example

```
extensions: ["TeX/noUndefined.js", ...],
TeX: {
    noUndefined: {
        attributes: {
            mathcolor: "red",
            mathbackground: "#FFEEEE",
            mathsize: "90%"
        }
```

```
    }
}
```

The `attributes` setting specifies attributes to apply to the `mtext` element that encodes the name of the undefined macro. The default settings set `mathcolor` to `"red"`, but do not set any other attributes. This example sets the background to a light pink, and reduces the font size slightly.

Unicode support

The *unicode* extension implements a `\unicode{}` extension to TeX that allows arbitrary unicode code points to be entered in your mathematics. You can specify the height and depth of the character (the width is determined by the browser), and the default font from which to take the character.

Examples:

```
\unicode{65}                          % the character 'A'
\unicode{x41}                         % the character 'A'
\unicode[.55,0.05]{x22D6}             % less-than with dot, with height .55em and depth␣
↪0.05em
\unicode[.55,0.05][Geramond]{x22D6}   % same taken from Geramond font
\unicode[Garamond]{x22D6}             % same, but with default height, depth of .8em,.
↪2em
```

Once a size and font are provided for a given unicode point, they need not be specified again in subsequent `\unicode{}` calls for that character.

The result of `\unicode{...}` will have TeX class *ORD* (i.e., it will act like a variable). Use `\mathbin{...}`, `\mathrel{...}`, etc., to specify a different class.

Note that a font list can be given in the `\unicode{}` macro, but Internet Explorer has a buggy implementation of the `font-family` CSS attribute where it only looks in the first font in the list that is actually installed on the system, and if the required glyph is not in that font, it does not look at later fonts, but goes directly to the default font as set in the *Internet-Options/Font* panel. For this reason, the default font list for the `\unicode{}` macro is `STIXGeneral, 'Arial Unicode MS'`, so if the user has *STIX* fonts, the symbol will be taken from that (almost all the symbols are in *STIXGeneral*), otherwise MathJax tries *Arial Unicode MS*.

The *unicode* extension is loaded automatically when you first use the `\unicode{}` macro, so you do not need to add it to the *extensions* array. You can configure the extension as follows:

```
TeX: {
    unicode: {
        fonts: "STIXGeneral, 'Arial Unicode MS'"
    }
}
```

Supported LaTeX commands

This is a long list of the TeX macros supported by MathJax. If the macro is defined in an extension, the name of the extension follows the macro name.

```
#
( )
.
/
[ ]
```

```
\!
\#
\$
\%
\&
\:
\;
\\
\_
\{ \}
\|

A
\above
\abovewithdelims
\acute
\aleph
\alpha
\amalg
\And
\angle
\approx
\approxeq AMSsymbols
\arccos
\arcsin
\arctan
\arg
\array
\Arrowvert
\arrowvert
\ast
\asymp
\atop
\atopwithdelims

B
\backepsilon AMSsymbols
\backprime AMSsymbols
\backsim AMSsymbols
\backsimeq AMSsymbols
\backslash
\backslash
\bar
\barwedge AMSsymbols
\Bbb
\Bbbk AMSsymbols
\bbFont
\because AMSsymbols
\begin ... \end
\begin{align*} ... \end{align*}
\begin{alignat*} ... \end{alignat*}
\begin{alignat} ... \end{alignat}
\begin{alignedat} ... \end{alignedat}
\begin{aligned} ... \end{aligned}
\begin{align} ... \end{align}
\begin{array} ... \end{array}
\begin{Bmatrix} ... \end{Bmatrix}
\begin{bmatrix} ... \end{bmatrix}
```

```
\begin{cases} ... \end{cases}
\begin{eqnarray*} ... \end{eqnarray*}
\begin{eqnarray} ... \end{eqnarray}
\begin{equation*} ... \end{equation*}
\begin{equation} ... \end{equation}
\begin{gather*} ... \end{gather*}
\begin{gathered} ... \end{gathered}
\begin{gather} ... \end{gather}
\begin{matrix} ... \end{matrix}
\begin{multline*} ... \end{multline*}
\begin{multline} ... \end{multline}
\begin{pmatrix} ... \end{pmatrix}
\begin{smallmatrix} ... \end{smallmatrix} AMSmath
\begin{split} ... \end{split}
\begin{subarray} ... \end{subarray} AMSmath
\begin{Vmatrix} ... \end{Vmatrix}
\begin{vmatrix} ... \end{vmatrix}
\beta
\beth AMSsymbols
\between AMSsymbols
\bf
\Big
\big
\bigcap
\bigcirc
\bigcup
\Bigg
\bigg
\Biggl
\biggl
\Biggm
\biggm
\Biggr
\biggr
\Bigl
\bigl
\Bigm
\bigm
\bigodot
\bigoplus
\bigotimes
\Bigr
\bigr
\bigsqcup
\bigstar AMSsymbols
\bigtriangledown
\bigtriangleup
\biguplus
\bigvee
\bigwedge
\binom AMSmath
\blacklozenge AMSsymbols
\blacksquare AMSsymbols
\blacktriangle AMSsymbols
\blacktriangledown AMSsymbols
\blacktriangleleft AMSsymbols
\blacktriangleright AMSsymbols
\bmod
```

\boldsymbol
\bot
\bowtie
\Box AMSsymbols
\boxdot AMSsymbols
\boxed AMSmath
\boxminus AMSsymbols
\boxplus AMSsymbols
\boxtimes AMSsymbols
\brace
\bracevert
\brack
\breve
\buildrel
\bullet
\Bumpeq AMSsymbols
\bumpeq AMSsymbols

C
\cal
\Cap AMSsymbols
\cap
\cases
\cdot
\cdotp
\cdots
\centerdot AMSsymbols
\cfrac AMSmath
\check
\checkmark AMSsymbols
\chi
\choose
\circ
\circeq AMSsymbols
\circlearrowleft AMSsymbols
\circlearrowright AMSsymbols
\circledast AMSsymbols
\circledcirc AMSsymbols
\circleddash AMSsymbols
\circledR AMSsymbols
\circledS AMSsymbols
\clubsuit
\colon
\color
\complement AMSsymbols
\cong
\coprod
\cos
\cosh
\cot
\coth
\cr
\csc
\Cup AMSsymbols
\cup
\curlyeqprec AMSsymbols
\curlyeqsucc AMSsymbols
\curlyvee AMSsymbols

```
\curlywedge AMSsymbols
\curvearrowleft     AMSsymbols
\curvearrowright AMSsymbols

D
\dagger
\daleth AMSsymbols
\dashleftarrow AMSsymbols
\dashrightarrow AMSsymbols
\dashv
\dbinom AMSmath
\ddagger
\ddddot AMSmath
\dddot AMSmath
\ddot
\ddots
\DeclareMathOperator AMSmath
\def
\deg
\Delta
\delta
\det
\dfrac AMSmath
\diagdown AMSsymbols
\diagup AMSsymbols
\Diamond AMSsymbols
\diamond
\diamondsuit
\digamma AMSsymbols
\dim
\displaylines
\displaystyle
\div
\divideontimes AMSsymbols
\dot
\Doteq AMSsymbols
\doteq
\doteqdot AMSsymbols
\dotplus AMSsymbols
\dots
\dotsb
\dotsc
\dotsi
\dotsm
\dotso
\doublebarwedge AMSsymbols
\doublecap AMSsymbols
\doublecup AMSsymbols
\Downarrow
\downarrow
\downdownarrows AMSsymbols
\downharpoonleft AMSsymbols
\downharpoonright AMSsymbols

E
\ell
\emptyset
\enspace
```

```
\epsilon
\eqalign
\eqalignno
\eqcirc AMSsymbols
\eqsim AMSsymbols
\eqslantgtr AMSsymbols
\eqslantless AMSsymbols
\equiv
\eta
\eth AMSsymbols
\exists
\exp

F
\fallingdotseq AMSsymbols
\fbox
\Finv AMSsymbols
\flat
\forall
\frac
\frac AMSmath
\frak
\frown

G
\Game AMSsymbols
\Gamma
\gamma
\gcd
\ge
\genfrac AMSmath
\geq
\geqq AMSsymbols
\geqslant AMSsymbols
\gets
\gg
\ggg AMSsymbols
\gggtr AMSsymbols
\gimel AMSsymbols
\gnapprox AMSsymbols
\gneq AMSsymbols
\gneqq AMSsymbols
\gnsim AMSsymbols
\grave
\gt
\gt
\gtrapprox AMSsymbols
\gtrdot AMSsymbols
\gtreqless AMSsymbols
\gtreqqless AMSsymbols
\gtrless AMSsymbols
\gtrsim AMSsymbols
\gvertneqq AMSsymbols

H
\hat
\hbar
\hbox
```

```
\heartsuit
\hom
\hookleftarrow
\hookrightarrow
\hphantom
\hskip
\hslash AMSsymbols
\hspace
\Huge
\huge

I
\idotsint AMSmath
\iff
\iiiint AMSmath
\iiint
\iint
\Im
\imath
\impliedby AMSsymbols
\implies AMSsymbols
\in
\inf
\infty
\injlim AMSmath
\int
\intercal AMSsymbols
\intop
\iota
\it

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MathJax MathML Support

The support for *MathML* in MathJax consists of three parts: the *mml2jax* preprocessor, the MathML input processor, and the NativeMML output processor. The first of these looks for `<math>` tags within your document and marks them for later processing by MathJax. The second converts the MathML to the internal format used by MathJax, and the third turns the internal format into MathML within the page so that it can be displayed by the browser's native MathML support.

Because of MathJax's modular design, you do not need to use all three of these components. For example, you could use the *tex2jax* preprocessor and the TeX input processor, but the NativeMML output processor, so that your mathematics is entered in TeX format, but displayed as MathML. Or you could use the *mml2jax* reprocessor and MathML input processor with the HTML-CSS output processor to make MathML available in browsers that don't have native MathML support. It is also possible to have MathJax select the output processor for you so that MathML is used in those browsers that support it, while HTML-CSS is used for those that don't. See the *common configurations* section for details and examples.

Of course it is also possible to use all three components together. It may seem strange to go through an internal format just to return to MathML in the end, but this is actually what makes it possible to view MathML within an HTML page (rather than an XHTML page), without the complications of handling special MIME-types for the document, or any of the other setup issues that make using native MathML difficult. MathJax handles the setup and properly marks the mathematics so that the browser will render it as MathML. In addition, MathJax provides its contextual menu for the MathML, which lets the user zoom the mathematics for easier reading, get the copy the source markup, and so on, so there is added value to using MathJax even whith a pure MathML workflow.

MathML in HTML pages

For MathML that is handled via the pre-processor, you should not use the named MathML entities, but rather use the numeric entities like `&#x221A;` or unicode characters embedded in the page itself. The reason is that entities are replaced by the browser before MathJax runs, and some browsers report errors for unknown entities. For browsers that are not MathML-aware, that will cause errors to be displayed for the MathML entities. While that might not occur in the browser you are using to compose your pages, it can happen with other browsers, so you should avoid the named entities whenever possible. If you must use named entities, you may need to declare them in the *DOCTYPE* declaration by hand.

When you use MathML in an HTML document rather than an XHTML one (MathJax will work woth both), you should not use the "self-closing" form for tags with no content, but should use separate open and close tags. That is, use

```
<mspace width="thinmathspace"></mspace>
```

rather than `<mspace width="thinmathspace />`. This is because HTML does not have self-closing tags, and some browsers will get the nesting of tags wrong if you attempt to use them. For example, with `<mspace width="1em" />`, since there is no closing tag, the rest of the mathematics will become the content of the `<mspace>` tag; but since `<mspace>` should have no content, the rest of the mathematics will not be displayed. This is a common error that should be avoided.

Supported MathML commands

MathJax supports the MathML3.0 presentation mathematics tags, with some limitations. The MathML support is still under active development, so some tags are not yet implemented, and some features are not fully developed, but are coming.

The deficiencies include:

- No support for the elementary math tags: `mstack`, `mlongdiv`, `msgroup`, `msrow`, `mscarries`, and `mscarry`.
- Limited support for line breaking (they are only allowed in direct children of `mrow` or implied `mrow` elements.
- No support for alignment groups in table.
- No support for right-to-left rendering.

See the results of the MathML3.0 test suite for details.

MathJax Output Formats

Currently, MathJax can render math in two ways:

- Using HTML-with-CSS to lay out the mathematics, or

- Using a browser's native MathML support.

These are implemented by the *HTML-CSS* and *NativeMML* output processors. You select which one you want to use by including either "output/HTML-CSS" or "output/NativeMML" in the *jax* array of your MathJax configuration. For example

```
jax: ["input/TeX","output/HTML-CSS"]
```

would specify TeX input and HTML-with-CSS output for the mathematics in your document.

The HTML-CSS output processor produces high-quality output in all major browsers, with results that are consistent across browsers and operating systems. This is MathJax's primary output mode. It's major advantage is its quality and consistency; it's drawback is that it is slower that the NativeMML mode at rendering the mathematics. (The HTML-CSS processor has not yet been optimized for speed, so you can expect some improvement in the future. Note that IE8 in "IE8 standards mode" is an order of magnitude slower than any other browser when processing math through the HTML-CSS output processor; see *HTML-CSS with IE8* below for some strategies to deal with this.)

The NativeMML output processor uses the browser's internal MathML support (if any) to render the mathematics. Currently, Firefox has native support for MathML, and IE has the MathPlayer plugin for rendering MathML. Opera has some built-in support for MathML that works well with simple equations, but fails with more complex formulas, so we don't recommend using the NativeMML output processor with Opera. Safari, Chrome, Konqueror, and most other browsers don't support MathML natively.

The advantage of the NativeMML output Processor is its speed, since native MathML support is much faster than using complicated HTML and CSS to lay out mathematics via an interpreted language like JavaScript (as the HTML-CSS output processor does). The disadvantage is that you are dependent on the browser's MathML implementation for your rendering, and these vary in quality of output and completeness of implementation. MathJax may rely on features that are not available in some renderers (for example, Firefox's MathML support does not implement some of the named widths, such as negativethinmathspace). The results using the NativeMML output processor may have spacing or other rendering problems that are outside of MathJax's control.

Automatic Selection of the Output Processor

Since not all browsers support MathML natively, it would be unwise to choose the NativeMML output processor unless you are sure of your audience's browser capabilities. MathJax can help with that, however, since there is a special configuration file that will choose between NativeMML and HTML-CSS depending on the browser in use. To invoke it, add "MMLorHTML.js" to your configurations *config* array, and **do not** include an output processor in your *jax* array; MathJax will fill that in for you based on the abilities of your user's browser.

```
config: ["MMLorHTML.js"],
jax: ["input/TeX"]
```

You can customize which choice to make on a browser-by-browser basis or a global basis. See the config/MathJax.js file or the *Configuring MathJax* section for futher details.

MathJax produces MathML that models the underlying mathematics as best it can, rather than using complicated hacks to improve output for a particular MathML implementation. When you make the choice to use the NativeMML output processor, you are making a trade-off: gaining speed at the expense of quality and reliability, a decision that should not be taken lightly. Note, however, that a user can employ the MathJax contectual menu to select the other other renderer if he or she wishes.

HTML-CSS with IE8

Internet Explorer 8 has at least eight different rendering modes in which can operate, and that are triggered by the *DOCTYPE* of the document being viewed. Its "quirks" mode is its fastest mode, and its "IE8 standards" mode is its

slowest. This is the mode triggered by strict HTML document types, and since most modern content management systems now include a *DOCTYPE* that activates "standards" mode, IE8 will operate in its slowest manner. This is particularly apparent when MathJax is used, since IE8 in standards mode runs 20 to 30 times slower than it does in its IE7 emulation mode, and 60 times slower than in quirks mode.

Most users find this speed reduction unacceptable when there is much mathematics on the page. To overcome this problem, you may wish to tell IE8 to use its IE7 emulation mode rather than its IE8 standards mode. You can accomplish this by including the line

```
<meta http-equiv="X-UA-Compatible" content="IE=EmulateIE7">
```

at the top of the `<head>` section of your HTML documents. This lets you keep the strict *DOCTYPE* for validation purposes, while still managing to get reasonable perforance from Internet Explorer 8. Note that this line must come at the beginning of the `<head>`, before any stylesheets or other content are loaded.

Altertnatively, you can use the *MMLorHTML* configuration file described above to select NativeMML output when possible, and request that your users install the MathPlayer plugin, which will render the mathematics much more quickly.

The MathJax Community

If you are an active MathJax user, you may wish to become involved in the wider community of MathJax users. The MathJax project maintains forums where users can ask questions about how to use MathJax, make suggestions about future features for MathJax, and present their own solutions to problems that they have faced. There is also a bug-traking system where you can report errors that you have found with MathJax in your environment.

Forums

If you need help using MathJax or you have solutions you want to share, please use the MathJax Users Google Group. We try hard to answer questions quickly, and users are welcome to help with that as well. Also, users can post code snippets showing how they have used MathJax, so it may be a good place to find the examples you are looking for.

If you want to discuss MathJax development, please use the MathJax Dev Google Group. We made this group to discuss anything beyond what an end-user might be interested in, so if you having any suggestions or questions about MathJax performance, technology, or design, feel free to submit it to the group.

The community is only as good as the users who participate, so if you have something to offer, please take time to make a post on one of our groups.

Issue tracking

Found a bug or want to suggest an improvement? Post it to our issue tracker. We monitor the tracker closely, and work hard to respond to problems quickly.

Before you create a new issue, however, please search the issues to see if it has already been reported. You could also be using an outdated version of MathJax, so be sure to *upgrade your copy* to verify that the problem persists in the lastest version.

"Powered by MathJax"

If you are using MathJax and want to show your support, please consider using our "Powered by MathJax" badge.

CHAPTER 2

Advanced Topics

The MathJax Processing Model

The purpose of MathJax is to bring the ability to include mathematics easily in web pages to as wide a range of browsers as possible. Authors can specify mathematics in a variety of formats (e.g., *MathML* or *LaTeX*), and MathJax provides high-quality mathematical typesetting even in those browsers that do not have native MathML support. This all happens without the need for special downloads or plugins, but rendering will be enhanced if high-quality math fonts (e.g., *STIX*) are available to the browser.

MathJax is broken into several different kinds of components: page preprocessors, input processors, output processors, and the MathJax Hub that organizes and connects the others. The input and output processors are called *jax*, and are described in more detail below.

When MathJax runs, it looks through the page for special tags that hold mathematics; for each such tag, it locates an appropriate input jax which it uses to convert the mathematics into an internal form (called an element jax), and then calls an output jax to transform the internal format into HTML content that displays the mathematics within the page. The page author configures MathJax by indicating which input and output jax are to be used.

Often, and especially with pages that are authored by hand, the mathematics is not stored (initially) within the special tags needed by MathJax, as that would require more notation than the average page author is willing to type. Instead, it is entered in a form that is more natural to the page author, for example, using the standard TeX math delimiters `$...$` and `$$...$$` to indicate what part of the document is to be typeset as mathematics. In this case, MathJax can run a preprocessor to locate the math delimiters and replace them by the special tags that it uses to mark the formulas. There are preprocessors for *TeX notation*, *MathML notation*, and the *jsMath notation* that uses *span* and *div* tags.

For pages that are constructed programatically, such as HTML pages that result from running a processor on text in some other format (e.g., pages produced from Markdown documents, or via programs like *tex4ht*), it would be best to use MathJax's special tags directly, as described below, rather than having MathJax run another preprocessor. This will speed up the final display of the mathematics, since the extra preprocessing step would not be needed, and it also avoids the conflict between the use of the less-than sign, <, in mathematics and asn an HTML special character (that starts an HTML tag).

How mathematics is stored in the page

In order to identify mathematics in the page, MathJax uses special `<script>` tags to enclose the mathematics. This is done because such tags can be located easily, and because their content is not further processed by the browser; for example, less-than signs can be used as they are in mathematics, without worrying about them being mistaken for the beginnings of HTML tags. One may also consider the math notation as a form of "script" for the mathematics, so a `<script>` tag makes at least some sense for storing the math.

Each `<script>` tag has a `type` attribute that identifies the kind of script that the tag contains. The usual (and default) value is `type="text/javascript"`, and when a script has this type, the browser executes the script as a javascript program. MathJax, however, uses the type *math/tex* to identify mathematics in the TeX and LaTeX notation, and *math/mml* for mathematics in MathML notation. When the *tex2jax* or *mml2jax* preprocessors run, they create `<script>` tags with these types so that MathJax can process them when it runs its main typesetting pass.

For example,

```
<script type="math/tex">x+\sqrt{1-x^2}</script>
```

represents an in-line equation in TeX notation, and

```
<script type="math/tex; mode=display">
  \sum_{n=1}^\infty {1\over n^2} = {\pi^2\over 6}
</script>
```

is a displayed TeX equation.

Alternatively, using MathML notation, you could use

```
<script type="math/mml">
  <math>
    <mi>x</mi>
    <mo>+</mo>
    <msqrt>
      <mn>1</mn>
      <mo>&#x2212;<!--  --></mo>
      <msup>
        <mi>x</mi>
        <mn>2</mn>
      </msup>
    </msqrt>
  </math>
</script>
```

for in-line math, or

```
<script type="math/mml">
  <math display="block">
    <mrow>
      <munderover>
        <mo>&#x2211;<!--  --></mo>
        <mrow>
          <mi>n</mi>
          <mo>=</mo>
          <mn>1</mn>
        </mrow>
        <mi mathvariant="normal">&#x221E;<!-- ∞ --></mi>
      </munderover>
    </mrow>
    <mrow>
```

```
      <mfrac>
        <mn>1</mn>
        <msup>
          <mi>n</mi>
          <mn>2</mn>
        </msup>
      </mfrac>
    </mrow>
    <mo>=</mo>
    <mrow>
      <mfrac>
        <msup>
          <mi>&#x03C0;<!-- π --></mi>
          <mn>2</mn>
        </msup>
        <mn>6</mn>
      </mfrac>
    </mrow>
  </math>
</script>
```

for displayed equations in MathML notation. As other input jax are created, they will use other types to identify the mathematics they can process.

Page authors can use one of MathJax's preprocessors to convert from math delimiters that are more natural for the author to type (e.g., TeX math delimiters like `$$...$$`) to MathJax's `<script>` format. Blog and wiki software could extend from their own markup languages to include math delimiters, which they could convert to MathJax's `<script>` format automatically.

Note, however, that Internet Explorer has a bug that causes it to remove the space before a `<script>` tag if there is also a space after it, which can cause serious spacing problems with in-line math in Internet Explorer. There are three possible solutions to this in MathJax. The recommended way is to use a math preview (an element with class `MathJax_Preview`) that is non-empty and comes right before the `<script>` tag. Its contents can be just the word `[math]`, so it does not have to be specific to the mathematics script that follows; it just has to be non-empty (though it could have its style set to `display:none`). See also the `preJax` and `postJax` options in the *Core Configuration Options* document for another approach.

The components of MathJax

The main components of MathJax are its preprocessors, its input and output jax, and the MathJax Hub, which coordinates the actions of the other components.

Input jax are associated with the different script types (like *`math/tex`* or *`math/mml`*) and the mapping of a particular type to a particular jax is made when the various jax register their abilities with the MathJax Hub at configuration time. For example, the MathML input jax registers the *`math/mml`* type, so MathJax will know to call the MathML input jax when it sees math elements of that type. The role of the input jax is to convert the math notation entered by the author into the internal format used by MathJax (called an *element jax*). This internal format is essentially MathML (represented as JavaScript objects), so an input jax acts as a translator into MathML.

Output jax convert that internal element jax format into a specific output format. For example, the NativeMML output jax inserts MathML tags into the page to represent the mathematics, while the HTML-CSS output jax uses HTML with CSS styling to lay out the mathematics so that it can be displayed even in browsers that dont understand MathML. Output jax could be produced that render the mathematics using SVG, for example, or that speak an equation for the blind users. The MathJax contextual menu can be used to switch between the output jax that are available.

Each input and output jax has a small configuration file that is loaded when that input jax is included in the *jax* array in the MathJax configuration, and a larger file that implements the core functionality of that particular jax. The latter

file is loaded when the first time the jax is needed by MathJax to process some mathematics.

The **MathJax Hub** keeps track of the internal representations of the various mathematical equations on the page, and can be queried to obtain information about those equations. For example, one can obtain a list of all the math elements on the page, or look up a particular one, or find all the elements with a given input format, and so on. In a dynamically generated web page, an equation where the source mathematics has changed can be asked to re-render itself, or if a new paragraph is generated that might include mathematics, MathJax can be asked to process the equations it contains.

The Hub also manages issues concerning mouse events and other user interaction with the equation itself. Parts of equations can be made active so that mouse clicks cause event handlers to run, or activate hyperlinks to other pages, and so on, making the mathematics as dynamic as the rest of the page.

The MathJax Startup Sequence

When you load `MathJax.js` into a web page, it configures itself and immediately begins loading the components it needs. As MathJax starts up, it uses its *signaling mechanism* to indicate the actions that it is taking so that MathJax extensions can tie into the initialization process, and so other applications within the page can synchronize their actions with MathJax.

The startup process performs the following actions:

- It creates the `MathJax` variable, and defines the following subsystems:
  - `MathJax.Object` (object-oriented programming model)
  - `MathJax.Callback` (callbacks, signals, and queues)
  - `MathJax.Ajax` (file-loading and style-creation code)
  - `MathJax.HTML` (support code for creating HTML elements)
  - `MathJax.Message` (manages the menu line in the lower left)
  - `MathJax.Hub` (the core MathJax functions)
- It then creates the base `MathJax.InputJax`, `MathJax.OutputJax`, and `MathJax.ElementJax` objects.
- MathJax sets up the default configuration, and creates the signal objects used for the startup and hub actions.
- MathJax locates the `<script>` tag that loaded the `MathJax.js` file, and sets the `MathJax.Hub.config.root` value to reflect the location of the MathJax root directory.
- MathJax determines the browser being used and its version. It sets up the `MathJax.Hub.Browser` object, which includes the browser name and version, plus `isMac`, `isPC`, `isMSIE`, and so on.
- MathJax set up the `MathJax.Hub.queue` command queue, and populates it with the commands MathJax runs at startup. This includes creating the `MathJax.Hub.Startup.onload` onload handler that is used to synchronize MathJax's action with the loading of the page.

Once the `MathJax.Hub.queue` is created, the following actions are pushed into the queue:

1. Post the `Begin` startup signal
2. Perform the configuration actions:
   - Post the `Begin Config` startup signal
   - Execute the content of the `<script>` that loaded MathJax, or load the `config/MathJax.js` file if the `<script>` is empty
   - If the `MathJax.Hub.config.delayStartupUntil` value is set, wait until its condition is met

- load the files listed in the `MathJax.Hub.config.config` array
- Post the `End Config` startup signal

3. Load the cookie values:
   - Post the `Begin Cookie` startup signal
   - Load the menu cookie values
   - Use the cookie to set the renderer, if it is set
   - Post the `End Cookie` startup signal
4. Define the MathJax styles:
   - Post the `Begin Styles` startup signal
   - Load the stylesheet files from the `MathJax.Hub.config.stylesheets` array
   - Define the stylesheet described in `MathJax.Hub.config.styles`
   - Post the `End Styles` startup signal
5. Load the jax configuration files:
   - Post the `Begin Jax` startup signal
   - Load the jax config files from the `MathJax.Hub.config.jax` array
     - The jax will register themselves when they are loaded
   - Post the `End Jax` startup signal
6. Load the extension files:
   - Post the `Begin Extension` startup signal
   - Load the files from the `MathJax.Hub.config.extensions` array
     - Most extensions will post a `Extension [name] Ready` startup message when they are loaded (where `[name]` is the name of the extension)
   - Post the `End Extension` startup signal
7. Wait for the onload handler to fire
8. Set `MathJax.isReady` to `true`
9. Perform the typesetting pass (preprocessors and processors)
   - Post the `Begin Typeset` startup signal
   - Post the `Begin PreProcess` hub signal
   - Run the registered preprocessors
   - Post the `End PreProcess` hub signal
   - Clear the hub signal history
   - Post the `Begin Process` hub signal
   - Process the math script elements on the page
     - Each new math element generates a `New Math` hub signal with the math element's ID
   - Post the `End Process` hub signal
   - Post the `End Typeset` startup signal

10. Post the `End` startup signal

Synchronizing your code with MathJax

MathJax performs much of its activity asynchronously, meaning that the calls that you make to initiate these actions will return before the actions are completed, and your code will continue to run even though the actions have not been finished (and may not even be started yet). Actions such as loading files, loading web-based fonts, and creating stylesheets all happen asynchronously within the browser, and since JavaScript has no method of halting a program while waiting for an action to complete, synchronizing your code with these types of actions is made much more difficult. MathJax used three mechanisms to overcome this language shortcoming: callbacks, queues, and signals.

Callbacks are functions that are called when an action is completed, so that your code can continue where it left off when the action was initiated. Rather than have a single routine that initiates an action, waits for it to complete, and then goes on, you break the function into two parts: a first part that sets up and initiates the action, and a second that runs after the action is finished. Callbacks are similar to event handlers that you attach to DOM elements, and are called when an certain action occurs. See the *Callback Object* reference page for details of how to specify a callback.

Queues are MathJax's means of synchronizing actions that must be performed sequentially, even when they involve asynchronous events like loading files or dynamically creating stylesheets. The actions that you put in the queue are *Callback* objects that will be perfomed in sequence, with MathJax handling the linking of one action to the next. MathJax maintains a master queue that you can use to synchronize with MathJax, but you can also create your own private queues for actions that need to be synchronized with each other, but not to MathJax as a whole. See the *Queue Object* reference page for more details.

Signals are another means of synchronizing your own code with MathJax. Many of the important actions that MathJax takes (like typesetting new math on the page, or loading an external component) are "announced" by posting a message to a special object called a *Signal*. Your code can register an interest in receiving one or more of these signals by providing a callback to be called when the signal is posted. When the signal arrives, MathJax will call your code. This works somewhat like an event handler, except that many different types of events can go through the same signal, and the signals have a "memory", meaning that if you register an interest in a particular type of signal and that signal has already occurred, you will be told about the past occurrances as well as any future ones. See the *Signal Object* reference page for more details. See also the `test/sample-signals.html` file in the MathJax `test` directory for a working example of using signals.

Each of these is explained in more detail in the links below:

Using Callbacks

A "callback" is a function that MathJax calls when it completes an action that may occur asynchronously (like loading a file). Many of MathJax's functions operate asynchronously, and MathJax uses callbacks to allow you to synchronize your code with the action of those functions. The *MathJax.Callback* structure manages these callbacks. Callbacks can include not only a function to call, but also data to be passed to the function, and an object to act as the JavaScript *this* value in the resulting call (i.e., the object on which the callback is to execute).

Callbacks can be collected into *Queues* where the callbacks will be processed in order, with later callbacks waiting until previous ones have completed before they are called. They are also used with *Signals* as the means of receiving information about the signals as they occur.

A number of methods in *MathJax.Hub* and *MathJax.Ajax* accept callback specifications as arguments and return callback structures. These routines always will return a callback even when none was specified in the arguments, and in that case, the callback is a "do nothing" callback. The reason for this is so that the resulting callback can be used can be used in a *MathJax.Callback.Queue* for synchronization purposes, so that the actions following it in the queue will not be performed until after the callback has been fired.

For example, the `MathJax.Ajax.Require()` method can be used to load external files, and it returns a callback that is called when the file has been loaded and executed. If you want to load several files and wait for them all to be loaded before performing some action, you can create a *Queue* into which you push the results of the `MathJax.Ajax.Require()` calls, and then push a callback for the action. The final action will not be performed until all the file-load callbacks (which preceed it int he queue) have been called; i.e., the action will not occur until all the files are loaded.

Specifying a Callback

Callbacks can be specified in a number of different ways, depending on the functionality that is required of the callback. The easiest case is to simply provide a function to be called, but it is also possible to include data to pass to the function when it is called, and to specify the object that will be used as *this* when the function is called.

For example, the `MathJax.Ajax.Require()` method can accept a callback as its second argument (it will be called when the file given as the first argument is loaded and executed). So you can call

```
MathJax.Ajax.Require("[MathJax]/config/myConfig.js",function () {
  alert("My configuration file is loaded");
});
```

and an alert will appear when the file is loaded. An example of passing arguments to the callback function includes the following:

```
function loadHook (x) {alert("loadHook: "+x)}
MathJax.Ajax.Require("[MathJax]/config/myConfig.js",[loadHook,"myConfig"]);
```

Here, the `loadHook()` function accepts one argument and generates an alert that includes the value passed to it. The callback in the `MathJax.Ajax.Require()` call is `[loadHook,"myConfig"]`, which means that (the equivalent of) `loadHook("myConfig")` will be performed when the file is loaded. The result should be an alert with the text *loadHook: myConfig*.

The callback for the `MathJax.Ajax.Require()` method actually gets called with a status value, in addition to any parameters already included in the callback specification, that indicates whether the file loaded successfully, or failed for some reason (perhaps the file couldn't be found, or it failed to compile and run). So you could use

```
MathJax.Ajax.Require("[MathJax]/config/myConfig.js",function (status) {
  if (status === MathJax.Ajax.STATUS.OK) {
    alert("My configuration file is loaded");
  } else {
    alert("My configuration file failed to load!");
  }
});
```

to check if the file loaded properly. With additional parameters, the example might be

```
function loadHook (x,status) {alert("loadHook: "+x+" has status "+status)}
MathJax.Ajax.Require("[MathJax]/config/myConfig.js",[loadHook,"myConfig"]);
```

Note that the parameters given in the callback specification are used first, and then additional parameters from the call to the callback come afterward.

Callbacks to Object Methods

When you use a method of a JavaScript object, a special variable called *this* is defined that refers to the object whose method is being called. It allows you to access other methods or properties of the object without knowing explicitly where the object is stored.

For example,

```
var aPerson = {
  firstname: "John",
  lastname: "Smith",
  showName: function () {alert(this.firstname+" "+this.lastname)}
};
```

creates an object that contains three items, a *firstname*, and *lastname*, and a method that shows the person's full name in an alert. So `aPerson.fullName()` would cause an alert with the text `John Smith` to appear. Note, however that this only works if the method is called as `aPerson.showName()`; if instead you did

```
var f = aPerson.showName;  // assign f the function from aPerson
f();                       // and call the function
```

the association of the function with the data in `aPerson` is lost, and the alert will probably show `undefined undefined`. (In this case, `f` will be called with `this` set to the `window` variable, and so `this.firstname` and `this.lastname` will refer to undefined values.)

Because of this, it is difficult to use an object's method as a callback if you refer to it as a function directly. For example,

```
var aFile = {
  name: "[MathJax]/config/myConfig.js",
  onload: function (status) {
    alert(this.name+" is loaded with status "+status);
  }
};

MathJax.Ajax.Require(aFile.name,aFile.onload);
```

would produce an alert indicating that "undefined" was loaded with a particular status. That is because `aFile.onload` is a reference to the *onload* method, which is just a function, and the association with the *aFile* object is lost. One could do

```
MathJax.Ajax.Require(aFile.name,function (status) {aFile.onload(status)});
```

but that seems needlessly verbose, and it produces a closure when one is not really needed. Instead, MathJax provides an alternative specification for a callback that allows you to specify both the method and the object it comes from:

```
MathJax.Ajax.Require(aFile.name,["onload",aFile]);
```

This requests that the callback should call `aFile.onload` as the function, which will maintain the connection between `aFile` and its method, thus preserving the correct value for *this* within the method.

As in the previous cases, you can pass parameters to the method as well by including them in the array that specifies the callback:

```
MathJax.Ajax.Require("filename",["method",object,arg1,arg2,...]);
```

This approach is useful when you are pushing a callback for one one MathJax's Hub routines into the MathJax processing queue. For example,

```
MathJax.Hub.Queue(["Typeset",MathJax.Hub,"MathDiv"]);
```

pushes the equivalent of `MathJax.Hub.Typeset("MathDiv")` into the processing queue.

See the *Callback Object* reference pages for more information about the valid methods of specifying a callback.

Creating a Callback Explicitly

When you call a method that accepts a callback, you usually pass it a callback specification (like in the examples above), which *describes* a callback (the method will create the actual *Callback* object, and return that to you as its return value). You don't usually create *Callback* objects directly yourself.

There are times, however, when you may wish to create a callback object for use with functions that don't create callbacks for you. For example, the `setTimeout()` function can take a function as its argument, and you may want that function to be a method of an object, and would run into the problem described in the previous section if you simply passed the object's method to `setTimeout()`. Or you might want to pass an argument to the function called by `setTimeout()`. (Altough the `setTimeout()` function can accept additional arguements that are supposed to be passed on to the code when it is called, Internet Explorer does not implement that feature, so you can't rely on it.) You can use a *Callback* object to do this, and the `MathJax.Callback()` method will create one for you. For example,

```
function myTimer (x) {alert("x = "+x)}
setTimeout(MathJax.Callback([f,"Hello World!"]),500);
```

would create a callback that calls `f("Hello World!")`, and schedules it to be called in half a second.

Using Queues

The *callback queue* is one of MathJax's main tools for synchronizing its actions, both internally, and with external programs, like javascript code that you may write as part of dynamic web pages. Because many actions in MathJax (like loading files) operate asynchornously, MathJax needs a way to coordinate those actions so that they occur in the right order. The *MathJax.Callback.Queue* object provides that mechanism.

A *callback queue* is a list of commands that will be performed one at a time, in order. If the return value of one of the commands is a *Callback* object, processing is suspended until that callback is called, and then processing of the commands is resumed. In this way, if a command starts an asynchronous operation like loading a file, it can return the callback for that file-load operation and the queue will wait until the file has loaded before continuing. Thus a queue can be used to guarantee that commands don't get performed until other ones are known to be finished, even if those commands usually operate asynchronously.

Constructing Queues

A queue is created via the `MathJax.Callback.Queue()` command, which returns a *MathJax.Callback.Queue* object. The queue itself consists of a series of commands given as callback specifications (see *Using Callbacks* for details on callbacks), which allow you to provide functions (together with their arguments) to be executed. You can provide the collection of callback specifications when the queue is created by passing them as arguments to `MathJax.Callback.Queue()`, or you can create an empty queue to which commands are added later. Once a *MathJax.Callback.Queue* object is created, you can push additional callbacks on the end of the queue; if the queue is empty, the command will be performed immediately, while if the queue is waiting for another command to complete, the new command will be queued for later processing.

For example,

```
function f(x) {alert(x)}
var queue = MathJax.Callback.Queue([f, 15], [f, 10], [f, 5]);
queue.Push([f, 0]);
```

would create a queue containing three commands, each calling the function `f` with a different input, that are performed in order. A fourth command is then added to the queue, to be performed after the other three. In this case, the result will be four alerts, the first with the number 15, the second with 10, the third with 5 and the fourth with 0. Of course

`f` is not a function that operates asynchronously, so it would have been easier to just call `f` four times directly. The power of the queue comes from calling commands that could operate asynchronously. For example:

```
function f(x) {alert(x)}
MathJax.Callback.Queue(
  [f, 1],
  ["Require", MathJax.Ajax, "[MathJax]/extensions/AMSmath.js"],
  [f, 2]
);
```

Here, the command `MathJax.Ajax.require("extensions/AMSmath.js")` is queued between two calls to `f`. The first call to `f(1)` will be made immediately, then the `MathJax.Ajax.Require()` statement will be performed. Since the `Require` method loads a file, it operates asynchronously, and its return value is a *MathJax.Callback* object that will be called when the file is loaded. The call to `f(2)` will not be made until that callback is performed, effectively synchronizing the second call to `f` with the completion of the file loading. This is equivalent to

```
f(1);
MathJax.Ajax.Require("[MathJax]/extensions/AMSmath.js", [f, 2]);
```

since the `Require()` command allows you to specify a (single) callback to be performed on the completion of the file load. Note, however, that the queue could be used to synchronize several file loads along with multiple function calls, so is more flexible.

For example,

```
MathJax.Callback.Queue(
  ["Require", MathJax.Ajax, "[MathJax]/extensions/AMSmath.js"],
  [f, 1],
  ["Require", MathJax.Ajax, "[MathJax]/config/local/AMSmathAdditions.js"],
  [f, 2]
);
```

would load the AMSmath extension, then call `f(1)` then load the local AMSmath modifications, and then call `f(2)`, with each action waiting for the previous one to complete before being performed itself.

Callbacks versus Callback Specifications

If one of the callback specifications is an actual callback object itself, then the queue will wait for that action to be performed before proceeding. For example,

```
 MathJax.Callback.Queue(
     [f, 1],
     MathJax.Ajax.Require("[MathJax]/extensions/AMSmath.js"),
     [f, 2],
);
```

starts the loading of the AMSmath extension before the queue is created, and then creates the queue containing the call to `f`, the callback for the file load, and the second call to `f`. The queue performs `f(1)`, waits for the file load callback to be called, and then calls `f(2)`. The difference between this and the second example above is that, in this example the file load is started before the queue is even created, so the file is potentially loaded and executed before the call to `f(1)`, while in the example above, the file load is guaranteed not to begin until after `f(1)` is executed.

As a further example, consider

```
MathJax.Callback.Queue(
  MathJax.Ajax.Require("[MathJax]/extensions/AMSmath.js"),
  [f, 1],
```

```
  MathJax.Ajax.Require("[MathJax]/config/local/AMSmathAdditions.js"),
  [f, 2]
);
```

in comparison to the example above that uses `["Require", MathJax.Ajax, "[MathJax]/extensions/AMSmath.js"]` and `["Require", MathJax.Ajax, "[MathJax]/config/local/AMSmathAdditions.js"]` instead. In that example, `AMSmath.js` is loaded, then `f(1)` is called, then the local additions are loaded, then `f(2)` is called.

Here, however, both file loads are started before the queue is created, and are operating in parallel (rather than sequentially as in the earlier example). It is possible for the loading of the local additions to complete before the AMSmath extension is loaded in this case, which was guaranteed **not** to happen in the other example. Note, however, that `f(1)` is guaranteed not to be performed until after the AMSmath extensions load, and `f(2)` will not occur until after both files are loaded.

In this way, it is possible to start asynchronous loading of several files simultaneously, and wait until all of them are loaded (in whatever order) to perform some command. For instance,

```
MathJax.Callback.Queue(
    MathJax.Ajax.Require("file1.js"),
    MathJax.Ajax.Require("file2.js"),
    MathJax.Ajax.Require("file3.js"),
    MathJax.Ajax.Require("file4.js"),
    [f, "all done"]
);
```

starts four files loading all at once, and waits for all four to complete before calling `f("all done")`. The order in which they complete is immaterial, and they all are being requested simultaneously.

The MathJax Processing Queue

MathJax uses a queue stored as `MathJax.Hub.queue` to regulate its own actions so that they operate in the right order even when some of them include asynchronous operations. You can take advantage of that queue when you make calls to MathJax methods that need to be synchronized with the other actions taken by MathJax. It may not always be apparent, however, which methods fall into that category.

The main source of asynchronous actions in MathJax is the loading of external files, so any action that may cause a file to be loaded may act asynchronously. Many important actions do so, including some that you might not expect; e.g., typesetting mathematics can cause files to be loaded. This is because some TeX commands, for example, are rare enough that they are not included in the core TeX input processor, but instead are defined in extensions that are loaded automatically when needed. The typesetting of an expression containing one of these TeX commands can cause the typesetting process to be suspended while the file is loaded, and then restarted when the extension has become available.

As a result, any call to `MathJax.Hub.Typeset()` (or `MathJax.Hub.Process()`, or `MathJax.Hub.Update()`, etc.) could return long before the mathematics is actually typeset, and the rest of your code may run before the mathematics is available. If you have code that relys on the mathematics being visible on screen, you will need to break that out into a separate operation that is synchronized with the typesetting via the MathJax queue.

Furthermore, your own typesetting calls may need to wait for file loading to occur that is already underway, so even if you don't need to access the mathematics after it is typeset, you may still need to queue the typeset command in order to make sure it is properly synchronized with *previous* typeset calls. For instance, if an earlier call started loading an extension and you start another typeset call before that extension is fully loaded, MathJax's internal state may be in flux, and it may not be prepared to handle another typeset operation yet. This is even more important if you are using other libraries that may call MathJax, in which case your code may not be aware of the state that MathJax is in.

For these reasons, it is always best to perform typesetting operations through the MathJax queue, and the same goes for any other action that could cause files to load. A good rule of thumb is that, if a MathJax function includes a callback argument, that function may operate asynchronously; you should use the MathJax queue to perform it and any actions that rely on its results.

To place an action in the MathJax queue, use the `MathJax.Hub.Queue()` command. For example

```
MathJax.Hub.Queue(["Typeset",MathJax.Hub,"MathDiv"]);
```

would queue the command `MathJax.Hub.Typeset("MathDiv")`, causing the contents of the DOM element with *id* equal to `MathDiv` to be typeset.

One of the uses of the MathJax queue is to allow you to synchronize an action with the startup process for MathJax. If you want to have a function performed after MathJax has become completely set up (and performed its initial typesetting of the page), you can push it onto the `MathJax.Hub.queue` so that it won't be performed until MathJax finishes everything it has queued when it was loaded. For example,

```
<script type="text/javascript" src="/MathJax/MathJax.js"></script>
<script>
  MathJax.Hub.Queue(function () {
    // ... your startup commands here ...
  });
</script>
```

Using Signals

Because much of MathJax operates asynchronously, it is important for MathJax to be able to indicated to other components operating on the page that certain actions have been taken. For example, as MathJax is starting up, it loads external files such as its configuration files and the various input and output *jax* that are used on the page. This means that MathJax may not be ready to run until well after the `<script>` tag that loads `MathJax.js` has executed. If another component on the page needs to call MathJax to process some mathematics, it will need to know when MathJax is ready to do that. Thus MathJax needs a way to signal other components that it is initialized and ready to process mathematics. Other events that might need to be signaled include the appearance of newly processed mathematics on the web page, the loading of a new extension, and so on.

The mechanism provided by MathJax for handling this type of communication is the *Callback Signal*. The *Callback Signal* object provides a standardized mechanism for sending and receiving messages between MathJax and other code on the page. A signal acts like a mailbox where MathJax places messages for others to read. Those interested in seeing the messages can register an interest in receiving a given signal, and when MathJax posts a message on that signal, all the interested parties will be notified. No new posts to the signal will be allowed until everyone who is listening to the signal has had a chance to receive the first one. If a signal causes a listener to begin an asynchronous operation (such as loading a file), the listener can indicate that its reply to the signal is going to be delayed, and MathJax will wait until the asynchronous action is complete before allowing additional messages to be posted to this signal. In this way, posting a signal may itself be an asynchronous action.

The posts to a signal are cached so that if a new listener expresses an interest in the signal, it will receive all the past posts as well as any future ones. For example, if a component on the page needs to know when MathJax is set up, it can express an interest in the startup signal's `End` message. If MathJax is not yet set up, the component will be signaled when MathJax is ready to begin, but if MathJax is already set up, the component will receive the `End` message immediately, since that message was cached and is available to any new listeners. In this way, signals can be used to pass messages without worrying about the timing of when the signaler and listener are ready to send or receive signals: a listener will receive messages even if it starts listening after they were sent.

One way that MathJax makes use of this feature is in configuring its various extensions. The extension may not be loaded when the user's configuration code runs, so the configuration code can't modify the extension because it isn't there yet. Fortunately, most extensions signal when they are loaded and initialized via an `Extension [name]`

`Ready` message, so the configuration code can implement a listener for that message, and have the listener perform the configuration when the message arrives. But even if the extension *has* already been loaded, this will still work, because the listener will receive the ready signal even if it has already been posted. In this way, listening for signals is a robust method of synchonizing code components no matter when they are loaded and run.

In some cases, it may be inappropriate for a new listener to receive past messages that were sent to a signal object. There are two ways to handle this: first, a new listener can indicate that it doesn't want to hear old messages when it attaches itself to a signal object. The sender can also indicate that past messages are not appropriate for new listeners. It does this by clearing the message history so that new listeners have no old posts to hear.

The actual message passed along by the signal can be anything, but is frequently a string constant indicating the message value. It could also be a JavaScript array containing data, or an object containing *key:value* pairs. All the listeners receive the data as part of the message, and can act on it in whatever ways they see fit.

Creating a Listener

MathJax maintains two separate signal channels: the *startup signal* and the *processing signal* (or the *hub signal*). The startup signal is where the messages about different components starting up and becoming ready appear. The processing signal is where the messages are sent about processing mathematics, like the `New Math` messages for when newly typeset mathematics appears on the page. The latter is cleared when a new processing pass is started (so messages from past processing runs are not kept).

The easiest way to create a listener is to use either `MathJax.Hub.Register.StartupHook()` or `MathJax.Hub.Register.MessageHook()`. The first sets a listener on the startup signal, and the latter on the hub processing signal. You specify the message you want to listen for, and a callback to be called when it arrives. For example

```
MathJax.Hub.Register.StartupHook("TeX Jax Ready ",function () {
  alert("The TeX input jax is loaded and ready!");
});
```

See the *MathJax Startup Sequence* page for details of the messages sent during startup. See also the `test/sample-signals.html` file (and its source) for examples of using signals. This example lists all the signals that occur while MathJax is processing that page, so it gives useful information about the details of the signals produced by variuous components.

In this example, the listener starts loading an extra configuration file (from the same directory as the web page). Since it returns the callback from that request, the signal processing will wait until that file is completely loaded before it continues; that is, the configuration process is suspended until the extra configuration file has loaded.

```
MathJax.Hub.Register.StartupHook("Begin Config",
  function () {return MathJax.Ajax.Require("myConfig.js")}
);
```

Here is an example that produces an alert each time new mathematics is typeset on the page. The message includes the DOM *id* of the element on the page that contains the newly typeset mathematics as its second element, so this listener locates the `<script>` tag for the math, and displays the original source mathematics for it.

```
MathJax.Hub.Register.MessageHook("New Math", function (message) {
  var script = MathJax.Hub.getJaxFor(message[1]).SourceElement();
  alert(message.join(" ")+": '"+script.text+"'");
})
```

Listening for All Messages

If you want to process *every* message that passes through a signal channel, you can do that by registering an interest in the signal rather than registering a message hook. You do this by calling the signal's *`Interest()`* method, as in

the following example.

```
MathJax.Hub.Startup.signal.Interest(
  function (message) {alert("Startup: "+message)}
);
MathJax.Hub.signal.Interest(
  function (message) {alert("Hub: "+message)}
);
```

This will cause an alert for every signal that MathJax produces. You probably don't want to try this out, since it will produce a *lot* of them; instead, use the `test/sample-signals.html` file, which displays them in the web page.

See the *Signal Object* reference page for details on the structure and methods of the signal object.

Loading MathJax Dynamically

MathJax is designed to be included via a `<script>` tag in the `<head>` section of your HTML document, and it does rely on being part of the original document in that it uses an `onload` event handler to synchronize its actions with the loading of the page. If you wish to insert MathJax into a document after it has been loaded, that will normally occur *after* the page's `onload` handler has fired, and so MathJax will not be able to tell if it is safe for it to process the contents of the page. Indeed, it will wait forever for its `onload` handler to fire, and so will never process the page.

To solve this problem, you will need to call MathJax's `onload` handler yourself, to let it know that it is OK to typeset the mathematics on the page. You accomplish this by calling the `MathJax.Hub.Startup.onload()` method as part of your MathJax startup script. To do this, you will need to give MathJax an in-line configuration, so you will not be able to use the `config/MathJax.js` file (though you can add it to your in-line configuration's *config* array).

Here is an example of how to load and configure MathJax dynamically:

```
(function () {
  var script = document.createElement("script");
  script.type = "text/javascript";
  script.src = "/MathJax/MathJax.js";   // use the location of your MathJax

  var config = 'MathJax.Hub.Config({' +
                 'extensions: ["tex2jax.js"],' +
                 'jax: ["input/TeX","output/HTML-CSS"]' +
               '});' +
               'MathJax.Hub.Startup.onload();';

  if (window.opera) {script.innerHTML = config}
               else {script.text = config}

  document.getElementsByTagName("head")[0].appendChild(script);
})();
```

Be sure to set the `src` to the correct URL for your copy of MathJax. You can adjust the `config` variable to your needs, but be careful to get the commas right. The `window.opera` test is because Opera doesn't handle setting `script.text` properly, while Internet Explorer doesn't handle setting the `innerHTML` of a script tag.

Here is a version that uses the `config/MathJax.js` file to configure MathJax:

```
(function () {
  var script = document.createElement("script");
  script.type = "text/javascript";
  script.src = "/MathJax/MathJax.js";   // use the location of your MathJax
```

```
  var config = 'MathJax.Hub.Config({ config: "MathJax.js" }); ' +
               'MathJax.Hub.Startup.onload();';

  if (window.opera) {script.innerHTML = config}
               else {script.text = config}

  document.getElementsByTagName("head")[0].appendChild(script);
})();
```

Note that the **only** reliable way to configure MathJax is to use an in-line configuration of the type discussed above. You should **not** call `MathJax.Hub.Config()` directly in your code, as it will not run at the correct time — it will either run too soon, in which case `MathJax` may not be defined and the function will throw an error, or it will run too late, after MathJax has already finished its configuration process, so your changes will not have the desired effect.

MathJax and GreaseMonkey

You can use techniques like the ones discussed above to good effect in GreaseMonkey scripts. There are GreaseMonkey work-alikes for all the major browsers:

- Firefox: GreaseMonkey
- Safari: GreaseKit (also requires SIMBL)
- Opera: Built-in (instructions)
- Internet Explorer: IEPro7
- Chrome: Built-in for recent releases

Note, however, that most browsers don't allow you to insert a script that loads a `file://` URL into a page that comes from the web (for security reasons). That means that you can't have your GreaseMonkey script load a local copy of MathJax, so you have to refer to a server-based copy. In the scripts below, you need to insert the URL of a copy of MathJax from your own server.

Here is a script that runs MathJax in any document that contains MathML (whether its includes MathJax or not). That allows browsers that don't have native MathML support to view any web pages with MathML, even if they say it only works in Forefox and IE+MathPlayer.

```
// ==UserScript==
// @name           MathJax MathML
// @namespace      http://www.mathjax.org/
// @description    Insert MathJax into pages containing MathML
// @include        *
// ==/UserScript==

if ((window.unsafeWindow == null ? window : unsafeWindow).MathJax == null) {
  if ((document.getElementsByTagName("math").length > 0) ||
      (document.getElementsByTagNameNS == null ? false :
      (document.getElementsByTagNameNS("http://www.w3.org/1998/Math/MathML","math").
↪length > 0))) {
    var script = document.createElement("script");
    script.src = "http://www.yoursite.edu/MathJax/MathJax.js";  // put your URL here
    var config = 'MathJax.Hub.Config({' +
                   'extensions:["mml2jax.js"],' +
                   'jax:["input/MathML","output/HTML-CSS"]' +
                 '});' +
                 'MathJax.Hub.Startup.onload()';
```

```
    if (window.opera) {script.innerHTML = config} else {script.text = config}
    document.getElementsByTagName("head")[0].appendChild(script);
  }
}
```

Source: mathjax_mathml.user.js

Here is a script that runs MathJax in Wikipedia pages after first converting the math images to their original TeX code.

```
// ==UserScript==
// @name            MathJax in Wikipedia
// @namespace       http://www.mathjax.org/
// @description     Insert MathJax into Wikipedia pages
// @include         http://en.wikipedia.org/wiki/*
// ==/UserScript==

if ((window.unsafeWindow == null ? window : unsafeWindow).MathJax == null) {
  //
  //  Replace the images with MathJax scripts of type math/tex
  //
  var images = document.getElementsByTagName('img');
  for (var i = images.length - 1; i >= 0; i--) {
    var img = images[i];
    if (img.className === "tex") {
      var script = document.createElement("script"); script.type = "math/tex";
      if (window.opera) {script.innerHTML = img.alt} else {script.text = img.alt}
      img.parentNode.replaceChild(script,img);
    }
  }
  //
  //  Load MathJax and have it process the page
  //
  var script = document.createElement("script");
  script.src = "http://www.yoursite.edu/MathJax/MathJax.js";  // put your URL here
  var config = 'MathJax.Hub.Config({' +
                 'config: ["MMLorHTML.js"],' +
                 'extensions:["TeX/noErrors.js","TeX/noUndefined.js",' +
                             '"TeX/AMSmath.js","TeX/AMSsymbols.js"],' +
                 'jax:["input/TeX"]' +
               '});' +
               'MathJax.Hub.Startup.onload()';
  if (window.opera) {script.innerHTML = config} else {script.text = config}
  document.getElementsByTagName("head")[0].appendChild(script);
}
```

Source: mathjax_wikipedia.user.js

Modifying Math on the Page

If you are writing a dynamic web page where content containing mathematics may appear after MathJax has already typeset the rest of the page, then you will need to tell MathJax to look for mathematics in the page again when that new content is produced. To do that, you need to use the `MathJax.Hub.Typeset()` method. This will cause the preprocessors (if any were loaded) to run over the page again, and then MathJax will look for unprocessed mathematics on the page and typeset it, leaving unchanged any math that has already been typeset.

You should not simply call this method directly, however. Because MathJax operates asynchonously (see *Synchronizing with MathJax* for details), you need to be sure that your call to `MathJax.Hub.Typeset()` is synchronized with the other actions that MathJax is taking. For example, it may already be typesetting portions of the page, or it may be waiting for an output jax to load, etc., and so you need to queue to typeset action to be performed after MathJax has finished whatever else it may be doing. That may be immediately, but it may not, and there is no way to tell.

To queue the typeset action, use the command

```
MathJax.Hub.Queue(["Typeset",MathJax.Hub]);
```

This will cause MathJax to typeset the page when it is next able to do so. It guarantees that the typesetting will synchronize properly with the loading of jax, extensions, fonts, stylesheets, and other asynchornous activity, and is the only truely safe way to ask MathJax to process additional material.

The `MathJax.Hub.Typeset()` command also accepts a parameter that is a DOM element whose contents is to be typeset. That could be a paragraph, or a `<div>` element, or even a MathJax math `<script>` tag. It could also be a the DOM *id* of such an object, in which case, MathJax will look up the DOM element for you. So

```
MathJax.Hub.Queue(["Typeset",MathJax.Hub,"MathExample"]);
```

would typeset the mathematics contained in the element whose *id* is `MathExample`. This is equivalent to

```
var math = document.getElementById("MathExample");
MathJax.Hub.Queue(["Typeset",MathJax.Hub,math]);
```

If no element or element *id* is provided, the whole document is typeset.

Note that the `MathJax.Hub.Queue()` method will return immediately, regardless of whether the typesetting has taken place or not, so you can not assume that the mathematics is visible after you make this call. That means that things like the size of the container for the mathematics may not yet reflect the size of the typeet mathematics. If you need to perform actions that depend on the mathematics being typeset, you should push *those* actions onto the `MathJax.Hub.queue` as well.

This can be quite subtle, so you have to think carefully about the structure of your code that works with the typeset mathematics. Also, the things you push onto the queue should be *Callback* objects that perform the actions you want when they are called, not the *results* of calling the functions that do what you want.

Manipulating Individual Math Elements

If you are not changing a complete DOM structure, but simply want to update the contents of a single mathematical equation, you do not need to use `innerHTML` and `MathJax.Hub.Typeset()` to preprocess and process an elements new content. Instead, you can ask MathJax to find the *element jax* for the math element on the page, and use its methods to modify and update the mathematics that it displays.

For example, suppose you have the following HTML in your document

```
<div id="MathDiv">
  The answer you provided is: ${}$.
</div>
```

and MathJax has already preprocessed and typeset the mathematics within dollar signs (it will be blank). A student has typed something elsewhere on the page, and you want to typeset their answer in the location of the mathematics that is already there. You could replace the entire contents of the *MathDiv* element and call `MathJax.Hub.Typeset()` as described above, but there is more efficient approach, which is to ask MathJax for the element jax for the mathematics, and call its method for replacing the formula shown by that element. For example:

```
var math = MathJax.Hub.getAllJax("MathDiv")[0];
MathJax.Hub.Queue(["Text",math,"x+1"]);
```

This looks up the list of math elements in *MathDiv* element (there is only one) and takes the first one (element 0) and stores it in `math`. This is an *element jax* object (see the *Element Jax* specification for details), which has a *`Text()`* method that can be used to set the input text of the math element, and retypeset it.

Again, since the typesetting should be synchronized with other actions of MathJax, the call should be pushed onto the `MathJax.Hub.queue`, as shown above, rather than called directly. The example above performs the equivalent of `math.Text("x+1")` as soon as MathJax is able to do so. Any additional actions the rely on the equation `x+1` actually showing on screen should also be pushed onto the queue so that they will not occur before the math is typeset.

The actions you can perform on an element jax include:

`Text(newmath)`
: to set the math text of the element to *newmath* and typeset.

`Reprocess()`
: to remove the output and reproduce it again (for example, if CSS has changed that would alter the spacing of the mathematics).

`Remove()`
: to remove the output for this math element (but not the original `<script>` tag).

`SourceElement()`
: to obtain a reference to the original `<script>` object that is assocaited with this element jax.

Note that once you have located an element jax, you can keep using it and don't have to look it up again. So for the example above, if the student is going to be able to type several different answers that you will want to typeset, you can look up the element jax once at the beginning after MathJax has processed the page the first time, and then use that result each time you adjust the mathematics to be displayed.

To get the element jax the first time, you need to be sure that you ask MathJax for it **after** MathJax has processed the page the first time. This is another sitaution where you want to use the MathJax queue. If your startup code performs the commands

```
var studentDisplay = null;
MathJax.Hub.Queue(function () {
  studentDisplay = MathJax.Hub.getAllJax("MathDiv");
});
```

then you can use

```
MathJax.Hub.Queue(["Text",studentDisplay,studentAnswer])
```

to change the student's answer to be the typeset version of whatever is in the `studentAnswer` variable.

Here is a complete example that illustrates this approach

```
<html>
<head>
<title>MathJax Dynamic Math Test Page</title>

<script src="/MathJax/MathJax.js">
  MathJax.Hub.Config({
    extensions: ["tex2jax.js"],
    jax: ["input/TeX","output/HTML-CSS"],
    tex2jax: {inlineMath: [["$","$"],["\\(","\\)"]]}
  });
</script>
```

```
</head>
<body>

<script>
  //
  //  Use a closure to hide the local variables from the
  //  global namespace
  //
  (function () {
    var QUEUE = MathJax.Hub.queue;  // shorthand for the queue
    var math = null;                // the element jax for the math output.

    //
    //  Get the element jax when MathJax has produced it.
    //
    QUEUE.Push(function () {
      math = MathJax.Hub.getAllJax("MathOutput")[0];
    });

    //
    //  The onchange event handler that typesets the
    //  math entered by the user
    //
    window.UpdateMath = function (TeX) {
      QUEUE.Push(["Text",math,"\\displaystyle{"+TeX+"}"]);
    }
  })();
</script>

Type some TeX code:
<input id="MathInput" size="50" onchange="UpdateMath(this.value)" />
<p>

<div id="MathOutput">
You typed: ${}$
</div>

</body>
</html>
```

The MathJax API

The following links document the various components that make up MathJax. These are implemented as JavaScript objects contained within the single global variable, `MathJax`. Although JavaScript includes an objects with some inheritance capabilities, they do not constitute a full object-oriented programming model, so MathJax implements its own object library. This means there is an ambiguity when we speak of an "object", as it could be either a native JavaScript object, or a MathJax object. We will use *Object* (capitalized) or *MathJax.Object* for, when the distinction is important.

You may also want to view the *advanced topics* on the main MathJax documentation page.

The MathJax variable

MathJax has a single global variable, `MathJax`, in which all its data, and the data for loaded components, are stored. The MathJax variable is a nested structure, with its top-level properties being objects themselves.

Main MathJax Components

`MathJax.Hub`
Contains the MathJax hub code and variables, including the startup code, the onload handler, the browser data, and so forth.

`MathJax.Ajax`
Contains the code for loading external modules and creating stylesheets. Most of the code that causes most of MathJax to operate asynchronously is handled here.

`MathJax.Message`
Contains the code to handle the intermittant message window that periodically appears in the lower left-hand corner of the window.

`MathJax.HTML`
Contains support code for creating HTML elements dynamically from descriptions stored in JavaScript objects.

`MathJax.CallBack`
Contains the code for managing MathJax callbacks, queues and signals.

`MathJax.Extensions`
Initially empty, this is where extensions can load their code. For example, the *tex2jax* preprocessor creates `MathJax.Extensions.tex2jax` for its code and variables.

`MathJax.Object`
Contains the code for the MathJax object-oriented programming model.

`MathJax.InputJax`
The base class for all input *jax* objects. Subclasses for specific input jax are created as sub-objects of `MathJax.InputJax`. For example, the TeX input jax loads itself as `MathJax.InputJax.TeX`.

`MathJax.OutputJax`
The base class for all output *jax* objects. Subclasses for specific output jax are created as sub-objects of `MathJax.OutputJax`. For example, the HTML-CSS output jax loads itself as `MathJax.OutputJax["HTML-CSS"]`.

`MathJax.ElementJax`
The base class for all element *jax* objects. Subclasses for specific element jax are creates as sub-objects of `MathJax.ElementJax`. For example, the mml element jax loads itself as `MathJax.ElementJax.mml`.

Properties

`MathJax.version`
The version number of the MathJax library.

`MathJax.isReady`
This is set to `true` when MathJax is set up and ready to perform typesetting actions (and is `null` otherwise).

The MathJax.Hub Object

The MathJax Hub, *MathJax.Hub*, is the main control structure for MathJax. It is where input and output *jax* are tied together, and it is what handles processing of the MathJax `<script>` tags. Processing of the mathematics on the

page may require external files to be loaded (when the mathematics includes less common functionality, for example, that is defined in an extension file), and since file loading is asynchronous, a number of the methods below may return before their actions are completed. For this reason, they include callback functions that are called when the action completes. These can be used to synchronize actions that require the mathematics to be completed before those action occur. See the *Using Callbacks* documentation for more details.

Properties

config: { ... }
: This holds the configuration parameters for MathJax. Set these values using `MathJax.Hub.Config()` described below. The options and their default values are given in the *Core Options* reference page.

processUpdateTime: 500
: The minimum time (in milliseconds) between updates of the "Processing Math" message.

signal
: The hub processing signal (tied to the `MathJax.Hub.Register.MessageHook()` method).

Browser
: The name of the browser as determined by MathJax. It will be one of `Firefox`, `Safari`, `Chrome`, `Opera`, `MSIE`, `Konqueror`, or `unkown`. This is actually an object with additional properties and methods concerning the browser:

  version
  : The browser version number, e.g., `"4.0"`

  isMac and isPC
  : These are boolean values that indicate whether the browser is running on a Macintosh computer or a Windows computer. They will both be `false` for a Linux computer

  isForefox, isSafari, isChrome, isOpera, isMSIE, isKonqueror
  : These are `true` when the browser is the indicated one, and `false` otherwise.

  versionAtLeast(version)
  : This tests whether the browser version is at least that given in the *version* string. Note that you can not simply do a numeric comparison, as version 4.10 should be considered later than 4.9, for example. Similarly, 4.10 is different from 4.1, for instance.

  Select(choices)
  : This lets you perform browser-specific functions. Here, *choices* is an object whose properties are the names of the browsers and whose values are the functions to be performed. Each function is passed one parameter, which is the `MathJax.Hub.Browser` object. You do not need to include every browser as one of your choices (only those for which you need to do special processing. For example:

```
MathJax.Hub.Browser.Select(
  MSIE: function (browser) {
    if (browser.versionAtLeast("8.0")) {... do version 8 stuff ... }
    ... do general MSIE stuff ...
  },

  Firefox: function (browser) {
    if (browser.isMac) {... do Mac stuff ... }
    ... do general Firefox stuff
  }
);
```

Methods

Config(*options*)
Sets the configuration options (stored in `MathJax.Hub.config`) to the values stored in the *options* object. See *Configuring MathJax* for details on how this is used and the options that you can set.

Parameters

- **options** — object containing options to be set

Returns `null`

Register.PreProcessor(callback)
Used by preprocessors to register themselves with MathJax so that they will be called during the `MathJax.Hub.PreProcess()` action.

Parameters

- **callback** — the callback specification for the preprocessor

Returns `null`

Register.MessageHook(type,callback)
Registers a listener for a particular message being sent to the hub processing signal (where *PreProcessing*, *Processing*, and *New Math* messages are sent). When the message equals the *type*, the *callback* will be called with the message as its parameter.

Parameters

- **type** — a string indicating the message to look for
- **callback** — a callback specification

Returns `null`

Register.StartupHook(type,callback)
Registers a listener for a particular message being sent to the startup signal (where initialization and component startup messages are sent). When the message equals the *type*, the *callback will be called with the message as its parameter. See the :ref:'Using Signals <using-signals>* dcocumentation for more details.

Parameters

- **type** — a string indicating the message to look for
- **callback** — a callback specification

Returns `null`

Register.LoadHook(file,callback)
Registers a callback to be called when a particular file is completely loaded and processed. (The callback is called when the file makes its `MathJax.Ajax.loadComplete()` call.) The *file* should be the complete file name, e.g., `"[MathJax]/config/MathJax.js"`.

Parameters

- **file** — the name of the file to wait for
- **callback** — a callback specification

Returns the callback object

Queue(*callback*, ...)
Pushes the given callbacks onto the main MathJax command queue. This synchronizes the commands with MathJax so that they will be performed in the proper order even when some run asynchronously. See *Using*

Queues for more details about how to use queues, and the MathJax queue in particular. You may supply as many *callback* specifications in one call to the `Queue()` method as you wish.

Parameters

- **callback** — a callback specification

Returns the callback object for the last callback added to the queue

Typeset([*element*[, *callback*]])

Calls the preprocessors on the given element, and then typesets any math elements within the element. If no *element* is provided, the whole document is processed. The *element* is either the DOM *id* of the element, or a reference to the DOM element itself. The *callback* is called when the process is complete. See the *Modifying Math* section for details of how to use this method properly.

Parameters

- **element** — the element whose math is to be typeset
- **callback** — the callback specification

Returns the callback object

PreProcess([*element*[, *callback*]])

Calls the loaded preprocessors on the entire document, or on the given DOM element. The *element* is either the DOM *id* of the element, or a reference to the DOM element itself. The *callback* is called when the processing is complete.

Parameters

- **element** — the element to be preprocessed
- **callback** — the callback specification

Returns the callback object

Process([*element*[, *callback*]])

Scans either the entire document or a given DOM *element* for MathJax `<script>` tags and processes the math those tags contain. The *element* is either the DOM *id* of the element to scan, or a reference to the DOM element itself. The *callback* is called when the processing is complete.

Parameters

- **element** — the element to be processed
- **callback** — the callback specification

Returns the callback object

Update([*element*[, *callback*]])

Scans either the entire document or a given DOM element for mathematics that has changed since the last time it was processed, or is new, and typesets the mathematics they contain. The *element* is either the DOM *id* of the element to scan, or a reference to the DOM element itself. The *callback* is called when the processing is complete.

Parameters

- **element** — the element to be updated
- **callback** — the callback specification

Returns the callback object

Reprocess([*element*[, *callback*]])

Removes any typeset mathematics from the document or DOM element, and then processes the mathematics again, re-typesetting everything. This may be necessary, for example, if the CSS styles have changed and those

changes would affect the mathematics. The *element* is either the DOM *id* of the element to scan, or a reference to the DOM element itself. The *callback* is called when the processing is complete.

Parameters

- **element** — the element to be reprocessed
- **callback** — the callback specification

Returns the callback object

getAllJax(*[element]*)

Returns a list of all the element jax in the document or a specific DOM element. The *element* is either the DOM *id* of the element, or a reference to the DOM element itself.

Parameters

- **element** — the element to be searched

Returns array of *element jax* objects

getJaxByType(*type[, element]*)

Returns a list of all the element jax of a given MIME-type in the document or a specific DOM element. The *element* is either the DOM *id* of the element to search, or a reference to the DOM element itself.

Parameters

- **type** — MIME-type of *element jax* to find
- **element** — the element to be searched

Returns array of *element jax* objects

getJaxByInputType(*type[, element]*)

Returns a list of all the element jax associated with input `<script>` tags with the given MIME-type within the given DOM element or the whole document. The *element* is either the DOM *id* of the element to search, or a reference to the DOM element itself.

Parameters

- **type** — MIME-type of input (e.g., `"math/tex"`)
- **element** — the element to be searched

Returns array of *element jax* objects

getJaxFor(*element*)

Returns the element jax associated with a given DOM element. If the element does not have an associated element jax, `null` is returned. The *element* is either the DOM *id* of the element, or a reference to the DOM element itself.

Parameters

- **element** — the element whose element jax is required

Returns *element jax* object or `null`

isJax(*element*)

Returns `0` if the element is not a `<script>` that can be processed by MathJax or the result of an output jax, returns `-1` if element is an unprocessed `<script>` tag that could be handled by MathJax, and returns `1` if element is a processed `<script>` tag or an element that is the result of an output jax.

Parameters

- **element** — the element to inspect

Returns integer (-1, 0, 1)

Insert (*dst*, *src*)
Inserts data from the *src* object into the *dst* object. The *key:value* pairs in *src* are (recursively) copied into *dst*, so that if *value* is itself an object, its contents is copied into the corresponding object in *dst*. That is, objects within *src* are merged into the corresponding objects in *dst* (they don't replace them).

Parameters

- **dst** — the destination object
- **src** — the source object

Returns the modified destination object

formatError (*script*, *error*)
This is called when an internal error occurs during the processing of a math element (i.e., an error in the MathJax code itself). The *script* is a reference to the `<script>` tag where the error occurred, and *error* is the `Error` object for the error. The default action is to insert an HTML snippet at the location of the script, but this routine can be overriden durring MathJax configuration in order to perform some other action. `MathJax.Hub.lastError` holds the `error` value of the last error on the page.

Parameters

- **script** — the `<script>` tag causing the error
- **error** — the `Error` object for the error

Returns `null`

The MathJax.Ajax Object

The *MathJax.Ajax* structure holds the data and functions for handling loading of external modules. Modules are loaded only once, even if called for in several places. The loading of files is asynchronous, and so the code that requests an external module will continue to run even when that module has not completed loading, so it is important to be aware of the timing issues this may cause. Similarly, creating or loading stylesheets is an asynchronous action. In particular, all actions that rely on the file or stylesheet having been loaded must be delayed until after the file has been downloaded completely. This is the reason for the large number of routines that take callback functions.

Any operation that could cause the loading of a file or stylesheet must be synchronized with the rest of the code via such callbacks. Since processing any mathematics might cause files to be loaded (e.g., little-used markup might be implemented in an extension that is loaded only when that markup is used), any code that dynamically typesets mathematics will need to be structured to use callbacks to guarantee that the mathematics has been completely processed before the code tries to use it. See the *Synchronizing with MathJax* documentation for details on how to do this properly.

Properties

timeout
Number of milliseconds to wait for a file to load before it is considered to have failed to load.

Default: 20 seconds

STATUS.OK
The value used to indicate that a file load has occurred successfully.

STATUS.ERROR
The value used to indicate that a file load has caused an error or a timeout to occur.

loaded
An object containing the names of the files that have been loaded (or requested) so far. `MathJax.Ajax.loaded["file"]` will be non-`null` when the file has been loaded, with the value being the `MathJax.Ajax.STATUS` value of the load attempt.

loading
An object containing the files that are currently loading, the callbacks that are to be run when they load or timeout, and additional internal data.

Methods

Require (*file*[, *callback*])
Loads the given file if it hasn't been already. The file must be a JavaScript file or a CSS stylesheet; i.e., it must end in `.js` or `.css`. Alternatively, it can be an object with a single *key:value* pair where the *key* is one of `js` or `css` and the *value* is the file of that type to be loaded (this makes it possible to have the file be created by a CGI script, for example, or to use a `data:` URL). The file must be relative to the MathJax home directory and can not contain `../` file path components.

When the file is completely loaded and run, the *callback*, if provided, will be executed passing it the status of the file load. If there was an error while loading the file, or if the file fails to load within the time limit given by `MathJax.Ajax.timout`, the status will be `MathJax.Ajax.STATUS.ERROR` otherwise it will be `MathJax.Ajax.STATUS.OK`. If the file is already loaded, the callback will be called immediately and the file will not be loaded again.

Parameters

- **file** — name of the file to be loaded
- **callback** — the callback specification

Returns the callback object

Load (*file*[, *callback*])
Used internally to load a given file without checking if it already has been loaded, or where it is to be found.

Parameters

- **file** — name of the file to be loaded
- **callback** — the callback specification

Returns the callback object

loadComplete (*file*)
Called from within the loaded files to inform MathJax that the file has been completely loaded and initialized. The *file* parameter is the name of the file that has been loaded. This routine will cause any callback functions registered for the file or included in the :meth:`MathJax.Ajax.Require()` calls to be executed, passing them the status or the load (*MathJax.Ajax.STATUS.OK'* or `MathJax.Ajax.STATUS.ERROR`) as their last parameter.

Parameters

- **file** — name of the file that has been loaded

Returns `null`

loadTimeout (*file*)
Called when the timeout period is over and the file hasn't loaded. This indicates an error condition, and the `MathJax.Ajax.loadError()` method will be executed, then the file's callback will be run with `MathJax.Ajax.STATUS.ERROR` as its parameter.

Parameters

- **file** — name of the file that timed out

Returns `null`

`loadError` (*file*)
The default error handler called when a file fails to load. It puts a warning message into the MathJax message box on screen.

Parameters

- **file** — the name of the file that failed to load

Returns `null`

`loadHook` (*file*, *callback*)
Registers a callback to be executed when the given file is loaded. The file load operation need to be started when this method is called, so it can be used to register a hook for a file that may be loaded in the future.

Parameters

- **file** — the name of the file to wait for
- **callback** — the callback specification

Returns the callback object

`Styles` (*styles*[, *callback*])
Creates a stylesheet from the given style data. *styles* can either be a string containing a stylesheet definition, or an object containing a *CSS Style Object*. For example:

```
MathJax.Ajax.Styles("body {font-family: serif; font-style: italic}");
```

and

```
MathJax.Ajax.Styles({
  body: {
    "font-family": "serif",
    "font-style":  "italic"
  }
});
```

both set the body font family and style.

The callback routine is called when the stylesheet has been created and is available for use.

Parameters

- **styles** — CSS style object for the styles to set
- **callback** — the callback specification

Returns the callback object

Note: Internet Explorer has a limit of 32 dynamically created stylesheets, so it is best to combine your styles into one large group rather than making several smaller calls.

`fileURL` (*file*)
Returns a complete URL to a file (replacing `[MathJax]` with the actual root URL location).

Parameters

- **file** — the file name possibly including `[MathJax]`

Returns the full URL for the file

The MathJax.Message Object

The `MathJax.Message` object contains the methods used to manage the small message area that appears at the lower-left corner of the window. MathJax uses this area to inform the user of time-consuming actions, like loading files and fonts, or how far along in the typesetting process it is.

The page author can customize the look of the message window by setting styles for the `#MathJax_Message` selector (which can be set via

```
MathJax.Hub.Config({
  styles: {
    "#MathJax_Message": {
      ...
    }
  }
});
```

Because of a bug in Internet Explorer, in order to change the side of the screen where the the message occurs, you must also set the side for `#MathJax_MSIE_Frame`, as in

```
MathJax.Hub.Config({
  styles: {
    "#MathJax_Message": {left: "", right: 0},
    "#MathJax_MSIE_Frame": {left: "", right: 0}
  }
});
```

It is possible that a message is already being displayed when another message needs to be posted. For this reason, when a message is displayed on screen, it gets an id number that is used when you want to remove or change that message. That way, when a message is removed, the previous message (if any) can be redisplayed if it hasn't been removed. This allows for intermittent messages (like file loading messages) to obscure longer-term message (like "Processing Math" messages) temporarily.

Methods

Set (*message*[, *n*[, *delay*]])
This sets the message being displayed to the given *message* string. If *n* is not `null`, it represents a message id number and the text is set for that message id, otherwise a new id number is created for this message. If *delay* is provided, it is the time (in milliseconds) to display the message before it is cleared. If *delay* is not provided, the message will not be removed automatically; you must call the `MathJax.Messsage.Clear()` method by hand to remove it.

Parameters

- **message** — the text to display in the message area
- **n** — the message id number
- **delay** — amout of time to display the message

Returns the message id nuber for this message.

Clear (*n*[, *delay*])
This causes the message with id *n* to be removed after the given *delay*, in milliseconds. The default delay is 600 milliseconds.

Parameters

- **n** — the message id number
- **delay** — the delay before removing the message

Returns `null`

Log()
Returns a string of all the messages issued so far, separated by newlines. This is used in debugging MathJax operations.

Returns string of all messages so far

The MathJax.HTML Object

The `MathJax.HTML` object provides routines for creating HTML elements and adding them to the page, and int particular, it contains the code that processes MathJax's *HTML snippets* and turns them into actual DOM objects. It also implements the methods used to manage the cookies used by MathJax.

Properties

Cookie.prefix: "mjx"
The prefix used for names of cookies stored by MathJax.

Cookie.expires: 365
The expiration time (in days) for cookies created by MathJax.

Methods

Element(*type*[, *attributes*[, *contents*]])
Creates a DOM element of the given type. If *attributes* is non-`null`, it is an object that contains *key:value* pairs of attributes to set for the newly created element. If *contents* is non-`null`, it is an *HTML snippet* that describes the contents to create for the element. For example

```
var div = MathJax.HTML.Element(
  "div",
  {id: "MathDiv", style:{border:"1px solid", padding:"5px"}},
  ["Here is math: $x+1$",["br"],"and a display $$x+1\\over x-1$$"]
);
```

Parameters

- **type** — node type to be created
- **attributes** — object specifying attributes to set
- **contents** — HTML snippet representing contents of node

Returns the DOM element created

addElement(*parent*, *type*[, *attributes*[, *content*]])
Creates a DOM element and appends it to the *parent* node provided. It is equivalent to

```
parent.appendChild(MathJax.HTML.Element(type,attributes,content))
```

Parameters

- **parent** — the node where the element will be added
- **attributes** — object specifying attributes to set
- **contents** — HTML snippet representing contents of node

Returns the DOM element created

`TextNode` (*text*)
Creates a DOM text node with the given text as its content.

Parameters

- **text** — the text for the node

Returns the new text node

`addText` (*parent*, *text*)
Creates a DOM text node with the given text and appends it to the *parent* node.

Parameters

- **parent** — the node where the text will be added
- **text** — the text for the new node

Returns the new text node

`Cookie.Set(name,data)`
Creates a MathJax cookie using the `MathJax.HTML.Cookie.prefix` and the *name* as the cookie name, and the *key:value* pairs in the *data* object as the data for the cookie. For example,

```
MathJax.HTML.Cookie.Set("test",{x:42, y:"It Works!"});
```

will create a cookie named "mjx:test" that stores the values of `x` and `y` provided in the *data* object. This data can be retrieved using the `MathJax.HTML.Cookie.Get()` method discussed below.

Parameters

- **name** — the name that identifies the coookie
- **data** — object containing the data to store in the cookie

Returns `null`

`Cookie.Get(name[,obj])`
Looks up the data for the cookie named *name* and merges the data into the given *obj* object, or returns a new object containing the data. For instance, given the cookie stored by the example above,

```
var data = MathJax.HTML.Cookie.Get("test");
```

would set `data` to `{x:42, y:"It Works!"}`, while

```
var data = {x:10, z:"Safe"};
MathJax.HTML.Cookie.Get("test",data);
```

would leave `data` as `{x:42, y:"It Works!", z:"Safe"}`.

The MathJax.Callback Class

The `MathJax.Callback` object is one of the key mechanisms used by MathJax to synchronize its actions with those that occur asynchronously, like loading files and stylesheets. A *Callback* object is used to tie the execution of a function to the completion of an asynchronous action. See *Synchronizing with MathJax* for more details, and *Using Callbacks* in particular for examples of how to specify and use MathJax *Callback* objects.

Specifying a callback

When a method includes a callback as one of its arguments, that callback can be specified in a number of different ways, depending on the functionality that is required of the callback. The easiest case is to simply provide a function to be called, but it is also possible to include data to pass to the function when it is executed, and even the object that will be used as the javascript *this* object when the function is called.

Most functions that take callbacks as arguments accept a *callback specification* rather than an actual callback object, though you can use the `MathJax.Callback()` function to convert a callback specification into a Callback object if needed.

A callback specification is any one of the following:

fn
: A function that is to be called when the callback is executed. No additional data is passed to it (other that what it is called with at the time the callback is executed), and *this* will be the window object.

[fn]
: An array containing a function to be called when the callback is executed (as above).

[fn, data...]
: An array containing a function together with data to be passed to that function when the callback is executed; *this* is still the window object. For example,

```
[function (x,y) {return x+y}, 2, 3]
```

would specify a callback that would pass `2` and `3` to the given function, and it would return their sum, `5`, when the callback is executed.

[object, fn]

An array containing an object to use as *this* and a function to call for the callback. For example,

```
[{x:'foo', y:'bar'}, function () {this.x}]
```

would produce a callback that returns the string `"foo"` when it is called.

[object, fn, data...]
: Similar to the previous case, but with data that is passed to the function as well.

..describe:: ["method", object]

Here, *object* is an object that has a method called *method*, and the callback will execute that method (with the object as *this*) when it is called. For example,

```
["length",[1,2,3,4]]
```

would call the *length* method on the array `[1,2,3,4]` when the callback is called, returning `4`.

["method", object, data...]
: Similar to the previous case, but with data that is passed to the method. E.g.,

```
["slice",[1,2,3,4],1,3]
```

would perform the equivalent of `[1,2,3,4].slice(1,3)`, which returns the array `[2,3]` as a result.

{hook: fn, data: [...], object: this}
Here the data for the callback are given in an associative array of *key:value* pairs. The value of *hook* is the function to call, the value of *data* is an array of the arguments to pass to the function, and the value of *object* is the object to use as *this* in the function call. The specification need not include all three *key:value* pairs; any that are missing get default values (a function that does nothing, an empty array, and the window object, respectively).

"string"
This specifies a callback where the string is executed via an `eval()` statement. The code is run in the global context, so any variables or functions created by the string become part of the global namespace. The return value is the value of the last statement executed in the string.

Executing a Callback Object

The *Callback* object is itself a function, and calling that function executes the callback. You can pass the callback additional parameters, just as you can any function, and these will be added to the callback function's argument list following any data that was supplied at the time the callback was created. For example

```
var f = function (x,y) {return x + " and " +y}
var cb = MathJax.Callback([f, "foo"]);
var result = cb("bar");  // sets result to "foo and bar"
```

Usually, the callback is not executed by the code that creates it (as it is in the example above), but by some other code that runs at a later time at the completion of some other activity (say the loading of a file), or in response to a user action. For example:

```
function f(x) {alert("x contains "+x)};
function DelayedX(time) {
    var x = "hi";
    setTimeout(MathJax.Callback([f, x], time);
}
```

The `DelayedX` function arranges for the function `f` to be called at a later time, passing it the value of a local variable, `x`. Normally, this would require the use of a closure, but that is not needed when a *MathJax.Callback* object is used.

Callback Object Properties

hook
The function to be called when the callback is executed.

data
An array containing the arguments to pass to the callback function when it is executed.

object
The object to use as *this* during the call to the callback function.

called
Set to `true` after the callback has been called, and undefined otherwise. A callback will not be exectued a second time unless the callback's *`reset()`* method is called first, or its `autoReset` property is set to `true`.

autoReset
Set this to `true` if you want to be able to call the callback more than once. (This is the case for signal listeners, for example).

isCallback
Always set to `true` (used to detect if an object is a callback or not).

Callback Object Methods

reset ()
Clears the callback's *called* property.

MathJax.Callback Methods

Delay (*time*[, *callback*])
Waits for the specified time (given in milliseconds) and then performs the callback. It returns the Callback object (or a blank one if none was supplied). The returned callback structure has a *timeout* property set to the result of the `setTimeout()` call that was used to perform the wait so that you can cancel the wait, if needed. Thus `MathJax.Callback.Delay()` can be used to start a timeout delay that executes the callback if an action doesn't occur within the given time (and if the action does occur, the timeout can be canceled). Since `MathJax.Callback.Delay()` returns a callback structure, it can be used in a callback queue to insert a delay between queued commands.

Parameters

- **time** — the amount of time to wait
- **callback** — the callback specification

Returns the callback object

executeHooks (*hooks*[, *data*[, *reset*]])
Calls each callback in the *hooks* array (or the single hook if it is not an array), passing it the arguments stored in the data array. It *reset* is `true`, then the callback's *reset()* method will be called before each hook is executed. If any of the hooks returns a *Callback* object, then it collects those callbacks and returns a new callback that will execute when all the ones returned by the hooks have been completed. Otherwise, `MathJax.Callback.executeHooks()` returns `null`.

Parameters

- **hooks** — array of hooks to be called, or a hook
- **data** — array of arguments to pass to each hook in turn
- **reset** — `true` if the *reset()* method should be called

Returns callback that waits for all the hooks to complete, or `null`

Queue ([*callback*, ...])
Creates a *MathJax.CallBack.Queue* object and pushes the given callbacks into the queue. See *Using Queues* for more details about MathJax queues.

Parameters

- **callback** — one or more callback specifications

Returns the *Queue* object

Signal(*name*)
Looks for a named signal, creates it if it doesn't already exist, and returns the signal object. See *Using Signals* for more details.

Parameters

- **name** — name of the signal to get or create

Returns the *Signal* object

The MathJax.Callback.Queue Class

The `MathJax.Callback.Queue` object is one of the key mechanisms used by MathJax to synchronize its actions with those that occur asynchronously, like loading files and stylesheets. A *Queue* obejct is used to coordinate a sequence of actions so that they are performed one after another, even when one action has to wait for an asynchronous process to complete. This guarantees that operations are performed in the right order even when the code must wait for some other action to occur. See *Synchronizing with MathJax* for more details, and *Using Queues* in particular for examples of how to specify and use MathJax *Queue* objects.

Properties

pending
This is non-zero when the queue is waiting for a command to complete, i.e. a command being processed returns a *Callback* object, indicating that the queue should wait for that action to complete before processing additional commands.

running
This is non-zero when the queue is executing one of the commands in the queue.

queue
An array containing the queued commands that are yet to be performed.

Methods

Push(*callback*, ...)
Adds commands to the queue and runs them (if the queue is not pending or running another command). If one of the callbacks is an actual *Callback* object rather than a callback specification, then the command queued is an internal command to wait for the given callback to complete. That is, that callback is not itself queued to be executed, but a wait for that callback is queued. The `Push()` method returns the last callback that was added to the queue (so that it can be used for further synchronization, say as an entry in some other queue).

Parameters

- **callback** — the callback specifications to be added to the queue

Returns the last callback object added to the queue

Process()

Process the commands in the queue, provided the queue is not waiting for another command to complete. This method is used internally; you should not need to call it yourself.

Suspend()
Increments the *running* property, indicating that any commands that are added the queue should not be executed immediately, but should be queued for later execution (when its `Resume()` is called). This method is used internally; you should not need to call it yourself.

Resume()
Decrements the *running* property, if it is positive. When it is zero, commands can be processed, but that is not done automatically — you would need to call `Process()` to make that happen. This method is used internally; you should not need to call it yourself.

wait(*callback*)
Used internally when an entry in the queue is a *Callback* object rather than a callback specification. A callback to this function (passing it the original callback) is queued instead, and it simply returns the callback it was passed. Since the queue will wait for a callback if it is the return value of one of the commands it executes, this effectively make the queue wait for the original callback at that point in the command queue.

Parameters

- **callback** — the function to complete before returning to the queue

Returns the passed callback function

call()
An internal function used to restart processing of the queue after it has been waiting for a command to complete.

The MathJax.Callback.Signal Class

The `MathJax.Callback.Signal` object is one of the key mechanisms used by MathJax to synchronize its actions with those that occur asynchronously, like loading files and stylesheets. A *Signal* object is used to pulicise the fact that MathJax has performed certain actions, giving other code running the the web page the chance to react to those actions. See *Synchronizing with MathJax* for more details, and *Using Signals* in particular for examples of how to specify and use MathJax *Signal* objects.

The *Callback Signal* object is a subclass of the *Callback Queue* object.

Properties

name
The name of the signal. Each signal is named so that various components can access it. The first one to request a particular signal causes it to be created, and other requests for the signal return references to the same object.

posted
Array used internally to stored the post history so that when new listeners express interests in this signal, they can be informed of the signals that have been posted so far. This can be cleared using the signal's `Clear()` method.

listeners
Array of callbacks to the listeners who have expressed interest in hearing about posts to this signal. When a post occurs, the listeners are called in each turn, passing them the message that was posted.

Methods

Post(*message*[, *callback*])
Posts a message to all the listeners for the signal. The listener callbacks are called in turn (with the message as an argument), and if any return a *Callback* object, the posting will be suspended until the callback is exectured. In this way, the `Post()` call can operate asynchronously, and so the *callback* parameter is used to synchronize with its operation; the *callback* will be called when all the listeners have responded to the post.

If a `Post()` to this signal occurs while waiting for the response from a listener (either because a listener returned a *Callback* object and we are waiting for it to complete when the `Post()` occurred, or because the listener itself called the `Post()` method), the new message will be queued and will be posted after the current

message has been sent to all the listeners, and they have all responded. This is another way in which posting can be asynchronous; the only sure way to know that a posting has occurred is through its *callback*. When the posting is complete, the callback is called, passing it the signal object that has just completed.

Returns the callback object (or a blank callback object if none was provided).

Parameters

- **message** — the message to send through the signal
- **callback** — called after the message is posted

Returns the callback or a blank callback

Clear(*[callback]*)

This causes the history of past messages to be cleared so new listeners will not receive them. Note that since the signal may be operating asynchronously, the `Clear()` may be queued for later. In this way, the `Post()` and `Clear()` operations will be performed in the proper order even when they are delayed. The *callback* is called when the `Clear()` operation is completed.

Returns the callback (or a blank callback if none is provided).

Parameters

- **callback** — called after the signal history is cleared

Returns the callback or a blank callback

Interest(*callback*[, *ignorePast*])

This method registers a new listener on the signal. It creates a *Callback* object from the callback specification, attaches it to the signal, and returns that *Callback* object. When new messages are posted to the signal, it runs the callback, passing it the message that was posted. If the callback itself returns a *Callback* object, that indicates that the listener has started an asynchronous operation and the poster should wait for that callback to complete before allowing new posts on the signal.

If *ignorePast* is `false` or not present, then before `Interest()` returns, the callback will be called with all the past messages that have been sent to the signal.

Parameters

- **callback** — called whenever a message is posted (past or present)
- **ignorePast** — `true` means ignore previous messages

Returns the callback object

NoInterest(*callback*)

This removes a listener from the signal so that no new messages will be sent to it. The callback should be the one returned by the original `Interest()` call that attached the listener to the signal in the first place. Once removed, the listener will no longer receive messages from the signal.

Parameters

- **callback** — the listener to be removed from signal

Returns `null`

MessageHook(*message*, *callback*)

This creates a callback that is called whenever the signal posts the given message. This is a little easier than having to write a function that must check the message each time it is called. Although the *message* here is a string, if a message posted to the signal is an array, then only the first element of that array is used to match against message. That way, if a message contains an identifier plus arguments, the hook will match the identifier and still get called with the complete set of arguments.

Returns the *Callback* object that was produced.

Parameters

- **message** — the message to look for from the signal
- **callback** — called when the message is posted

Returns the callback object

ExecuteHook (*message*)
Used internally to call the listeners when a particular message is posted to the signal.

Parameters

- **message** — the posted message

Returns `null`

The MathJax.InputJax Class

Input jax are the components of MathJax that translate mathematics from its original format (like *TeX* or *MathML*) to the MathJax internal format (an *element jax*).

An input jax is stored as a pair of files in a subdirectory of the `jax/input` directory, with the subdirectory name being the name of the input jax. For example, the TeX input jax is stored in *jax/input/TeX*. The first file, `config.js`, is loaded when MathJax is being loaded and configured, and is indicated by listing the input jax directory in the *jax* array of the MathJax configuration. The `config.js` file creates a subclass of the *MathJax.InputJax* object for the new input jax and registers that with MathJax, along with the MIME-type that will be used to indicate the mathematics that is to be processed by the input jax.

The main body of the input jax is stored in the second file, `jax.js`, which is loaded when the input jax is first called on to translate some mathematics. This file augments the original input jax subclass with the additional methods needed to do the translation. MathJax calls the input jax's *Translate()* method when it needs the input jax to translate the contents of a math `<script>` tag.

The *MathJax.InputJax* class is a subclass of the *MathJax Jax* class, and inherits the properties and methods of that class. Those listed below are the additional or overridden ones from that class.

Properties

name
The name of the jax.

version
The version number of the jax.

directory
The directory where the jax files are stored (e.g., `"[MathJax]/jax/input/TeX"`);

Methods

Translate (*script*)
This is the main routine called by MathJax when a `<script>` of the appropriate type is found. The default *Translate()* method simply loads the `jax.js` file and returns that callback for that load function so that MathJax will know when to try the *Translate()* action again. When the `jax.js` file loads, it should override the default *Translate()* with its own version that does the actual translation; that way, when the second Translate call is made, it will be to the actual translation routine rather than the default loader.

The translation process should include the creation of an *Element Jax* that stores the data needed for this element.

Parameters

- **script** — the `<script>` element to be translated

Returns the *element jax* resulting from the translation

Register(*mimetype*)
This registers the MIME-type associated with this input jax so that MathJax knows to call this input jax when it sees a `<script>` of that type. An input jax can register more than one type, but it will be responsible for distinguishing elements of the various types from one another.

Parameters

- **mimetype** — the MIME-type of the input this jax processes

Returns `null`

The MathJax.OutputJax Class

Output jax are the components of MathJax that translate mathematics from the MathJax internal format (an *element jax*) to whatever output is required to represent the mathematics (e.g., MathML elements, or HTML-with-CSS that formats the mathematics on screen).

An output jax is stored as a pair of files in a subdirectory of the the `jax/output` directory, with the subdirectory name being the name of the output jax. For example, the NativeMML output jax is stored in *jax/output/NativeMML*. The first file, `config.js`, is loaded when MathJax is being loaded and configured, and is indicated by listing the input jax directory in the *jax* array of the MathJax configuration. The `config.js` file creates a subclass of the *MathJax.OutputJax* object for the new output jax and registers it with MathJax, along with the MIME-type of the element jax that it can process.

The main body of the output jax is stored in the second file, `jax.js`, which is loaded when the output jax is first called on to translate some mathematics. This file augments the original output jax subclass with the additional methods needed to produce the output. MathJax calls the input jax's *Translate()* method when it needs the output jax to translate an element jax to produce output.

The *MathJax.OutputJax* class is a subclass of the *MathJax Jax* class, and inherits the properties and methods of that class. Those listed below are the additional or overridden ones from that class.

Properties

name
The name of the jax.

version
The version number of the jax.

directory
The directory where the jax files are stored (e.g., `"[MathJax]/jax/output/HTML-CSS"`);

Methods

Translate(*script*)
This is the main routine called by MathJax when an element jax is to be converted to output. The default *Translate()* method simply loads the `jax.js` file and returns that callback for that load function so that MathJax will know when to try the *Translate()* action again. When the `jax.js` file loads, it should override the default *Translate()* with its own version that does the actual translation; that way, when the second Translate call is made, it will be to the actual translation routine rather than the default loader.

You should use `MathJax.Hub.getJaxFor(script)` to obtain the element jax for the given script. The translation process may add modify the element jax (e.g., if it has data that needs to be stored with the jax), and may insert DOM elements into the document near the jax's `<script>` tag.

Parameters

- **script** — the `<script>` element to be translated

Returns the *element jax* resulting from the translation

`Register`(*mimetype*)
This registers the MIME-type for the element jax associated with this output jax so that MathJax knows to call this jax when it wants to display an element jax of that type. Several output jax may register for the same input jax, in which case the first one to register will be the default one for that type.

Parameters

- **mimetype** — the MIME-type of the input this jax processes

Returns `null`

`Remove`(*jax*)
Removes the output associated with the given element jax. The routine can use `jax.SourceElement()` to locate the `<script>` tag associated with the element jax.

Parameters

- **jax** — the element jax whose display should be removed

Returns `null`

The MathJax.ElementJax Class

The element jax is the bridge between the input and output jax, and contains the data produced by the input jax needed by the output jax to display the results. It is tied to the individual `<script>` tag that produced it, and is the object used by JavaScript programs to interact with the mathematics on the page.

An element jax is stored in the `jax.js` file in a subdirectory of the `jax/element` directory, with the subdirectory name being the name of the element jax. Currently, there is only one element jax class, the *mml* element jax, and it is stored in `jax/element/mml`.

The *MathJax.ElementJax* class is a subclass of the *MathJax Jax* class, and inherits the properties and methods of that class. Those listed below are the additional or overridden ones from that class.

Class Properties

`name`
The name of the jax.

`version`
The version number of the jax.

`directory`
The directory where the jax files are stored (e.g., `"[MathJax]/jax/element/mml"`);

Instance Properties

`inputJax`
A reference to the input jax that created the element.

outputJax
A reference to the output jax that has processed this element.

inputID
The DOM *id* of the `<script>` tag that generated this element (if it doesn't have one initially, the MathJax hub will supply one). Note that this is not a reference to the element itself; that element will have a reference to this element jax, and if *inputID* were a reference back, that would cause a reference loop, which some browsers would not free properly during trash collection, thus causing a memory leak.

originalText
A string indicating the original input text that was processed for this element.

mimeType
The MIME-type of the element jax (*jax/mml* in the case of an *mml* element jax).

Other data specific to the element jax subclass may also appear here.

Methods

Text (*text*[, *callback*])
Sets the input text for this element to the given text and reprocesses the mathematics. (I.e., update the equation to the new one given by *text*). When the processing is complete, the *callback*, if any, is called.

Parameters

- **text** — the new mathematic source string for the element
- **callback** — the callback specification

Returns the callback object

Reprocess ([*callback*])
Remove the output and produce it again. This may be necessary if there are changes to the CSS styles that would affect the layout of the mathematics, for example. The *callback*, if any, is called when the process completes.

Parameters

- **callback** — the callback specification

Returns the callback object

Remove()
Removes the output for this element from the web page (but does not remove the original `<script>`). The `<script>` will be considered unprocessed, and the next call to `MathJax.hub.Typeset()` will re-display it.

Returns `null`

SourceElement()
Returns a reference to the original `<script>` DOM element associated to this element jax.

Returns the `<script>` element

Output jax may add new methods to the base element jax class to perform exporting to other formats. For example, a MathML output jax could add `toMathML()`, or an accessibility output jax could add `toAudible()`. These could be made available via the MathJax contextual menu.

The Base Jax Class

The *MathJax.InputJax*, *MathJax.OutputJax* and *MathJax.ElementJax* classes are all subclasses of the base *Jax* class in MathJax. This is a private class that implements the methods common to all three other jax classes.

Unlike most MathJax.Object classes, calling the class object creates a *subclass* of the class, rather than an instance of the class. E.g.,

```
MathJax.InputJax.MyInputJax = MathJax.InputJax({
  name: "MyInputJax",
  version: "1.0",
  ...
});
```

creates `MathJax.InputJax.MyInputJax` as a subclass of `MathJax.InputJax`.

Class Properties

`directory`
: The name of the jax directory (usually `"[MathJax]/jax"`). Overridden in the subclass to be the specific directory for the class, e.g. ``"[MathJax]/jax/input"`.

`extensionDir`
: The name of the extensions directory (usually `"[MathJax]/extensions"`).

Instance Properties

`name`
: The name of the jax.

`version`
: The version number of the jax.

`directory`
: The directory for the jax (e.g., `"[MathJax]/jax/input/TeX"`).

`require: null`
: An array of files to load before the `jax.js` file calls the `MathJax.Ajax.loadComplete()` method.

`config: {}`
: An object that contains the default configuration options for the jax. These can be modified by the author by including a configuration subsection for the specific jax in question.

Methods

`Translate`(*script*)
: This is the method that the `MathJax.Hub` calls when it needs the input or output jax to process the given math `<script>` call. Its default action is to start loading the jax's `jax.js` file, and redefine the *`Translate()`* method to be the *`noTranslate()`* method below. The `jax.js` file should redefine the *`Translate()`* method to perform the translation operation for the specific jax. For an input jax, it should return the *ElementJax* object that it created.

  Parameters

  - **script — reference to the DOM `<script>` object for** the mathematics to be translated

  Returns an *ElementJax* object, or `null`

`noTranslate`(*script*)
: This is a temporary routine that is used while the `jax.js` file is loading. It throws an error indicating the the *`Translate()`* method hasn't been redefined. That way, if the `jax.js` file failes to load for some reason, you will receive an error trying to process mathematics with this input jax.

Parameters

- **script — reference to the DOM <script> object for** the mathematics to be translated

Returns `null`

Register(*mimetype*)
This method is overridden in the *InputJax*, *OutputJax* and *ElementJax* subclasses to handle the registration of those classes of jax.

Parameters

- **mimetype** — the MIME-type to be associated with the jax

Returns `null`

Config()
Inserts the configuration block for this jax from the author's configuration specification into the jax's `config` property. If the configuration includes an `Augment` object, that is used to augment the jax (that is, the configuration can override the methods of the object, as well as the data). This is called automatically during the loading of the `jax.js` file.

Startup()
This is a method that can be overridden in the subclasses to perform initialization at startup time (after the configuration has occurred).

loadComplete(*file*)
This is called by the `config.js` and `jax.js` files when they are completely loaded and are ready to signal that fact to MathJax. For `config.js`, this simply calls the `MathJax.Ajax.loadComplete()` method for the `config.js` file. For `jax.js`, the actions performed here are the following:

1. Post the "[name] Jax Config" message to the startup signal.
2. Perform the jax's *`Config()`* method.
3. Post the "[name] Jax Require" message to the startup signal.
4. Load the files from the jax's `require` array (which may have been modified during the configuration process).
5. Post the "[name] Jax Startup" message to the startup signal.
6. Perform the jax's *`Startup()`* method.
7. Post the "[name] Jax Ready" message to the startup signal.
8. perform the `MathJax.Ajax.loadComplete()` call for the `jax.js` file.

The MathJax Object-Oriented Programming Model

MathJax uses an object-oriented programming model for its main components, such as the *Input jax*, *Output jax*, and *Element jax*. The model is intended to be light-weight and is based on JavaScript's prototype inheritance mechanism. Object classes are created by making subclasses of *MathJax.Object* or one of its subclasses, and are instantiated by calling the object class as you would a function.

For example:

```
MathJax.Object.Foo = MathJax.Object.Subclass({
  Init: function (x) {this.SetX(x)},
  getX: function () {return this.x},
  setX: function (x) {this.x = x}
});
```

```
var foo = MathJax.Object.Foo("bar");
foo.getX();                 // returns "bar"
foo.setX("foobar");
foo.getX();                 // returns "foobar"
```

Object classes can have static properties and methods, which are accessed via the object class variable. E.g., `MathJax.Object.Foo.SUPER` or `MathJax.Object.Foo.Augment()` for the object in the example above. Static values are not inherited by subclasses.

Static Properties

SUPER
Pointer to the super class for this subclass. (It is a reference to *MathJax.Object* in the example above.)

Static Methods

Subclass (*def* [, *static*])
Creates a subclass of the given class using the contents of the *def* object to define new methods and properties of the object class, and the contents of the optional *static* object to define new static methods and properties.

Parameters

- **def** — object that defines the properties and methods
- **static** — object that defines static properties and methods

Returns the new object class

Augment (*def* [, *static*])
Adds new properties and methods to the class prototype. All instances of the object already in existence will receive the new properties and methods automatically.

Parameters

- **def** — object that defines the properties and methods
- **static** — object that defines static properties and methods

Returns the object class itself

Properties

constructor
Pointer to the constructor function for this class. E.g., `foo.constructor` would be a reference to `MathJax.Object.Foo` in the example above.

Methods

Init ([*data*])
An optional function that is called when an instance of the class is created. When called, the *this* variable is set to the newly instantiated object, and the *data* is whatever was passed to the object constructor. For instance, in the example above, the variable `foo` is created by calling `MathJax.Object.Foo("bar")`, which calls the `MathJax.Object.Foo` object's *Init()* method with *data* equal to `"bar"`. If desired, the *Init()* method can create a *different* object, and return that, in which case this becomes the return value for the object constructor.

Parameters

- **data** — the data from the constructor call

Returns `null` or the object to be returned by the constructor

isa(*class*)
Returns `true` if the object is an instance of the given class, or of a subclass of the given class, and `false` otherwise. So using the `foo` value defined above,

```
foo.isa(MathJax.Object);       // returns true
foo.isa(MathJax.Object.Foo);   // returns true
foo.isa(MathJax.InputJax);     // returns false
```

can(*method*)
Checks if the object has the given *method* and returns `true` if so, otherwise returns `false`. This allows you to test if an object has a particular function available before trying to call it (i.e., if an object implements a particular feature). For example:

```
foo.can("getX");  // returns true
foo.can("bar");   // returns false
```

has(*property*)
Checks if the object has the given *property* and returns `true` if so, otherwise returns `false`. This allows you to test if an object has a particular property available before trying to use it. For example:

```
foo.has("getX");  // returns true
foo.has("x");     // returns true
foo.has("bar");   // returns false
```

Accessing the Super Class

If a subclass overrides a method of its parent class, it may want to call the original function as part of its replacement method. The semantics for this are a bit awkward, but work efficiently. Within a method, the value `arguments.callee.SUPER` refers to the super class, so you can access any method of the superclass using that. In order to have *this* refer to the current object when you call the super class, however, you need to use `call()` or `apply()` to access the given method.

For example, `arguments.callee.SUPER.method.call(this,data)` would call the superclass' *method* and pass it *data* as its argument, properly passing the current object as *this*. Alternatively, you can use `this.SUPER(arguments)` in place of `arguments.callee.SUPER`. It is also possible to refer to the super class explicitly rather than through `arguments.callee.SUPER`, as in the following example:

```
MathJax.Class1 = MathJax.Object.Subclass({
  Init: function(x) {this.x = x},
  XandY: function(y) {return "Class1: x and y = " + this.x + " and " + y}
});

MathJax.Class2 = MathJax.Class1.Subclass({
  XandY: function (y) {return "Class2: "+arguments.callee.SUPER.XandY.call(this,y)}
});

MathJax.Class3 = MathJax.Class2.Subclass({
  XandY: function (y) {return "Class3: "+MathJax.Class2.prototype.XandY.call(this,y)}
});

MathJax.Class4 = MathJax.Class1.Subclass({
```

```
  XandY: function (y) {return "Class4: "+this.SUPER(arguments).XandY.call(this,y)}
});

var foo = MathJax.Class2("foo");
foo.XandY("bar");   // returns "Class2: Class1: x and y = foo and bar"
var bar = MathJax.Class3("bar");
bar.XandY("foo");   // returns "Class3: Class2: Class1: x and y = bar and foo"
var moo = MathJax.Class4("moo");
moo.XandY("cow");   // returns "Class4: Class1: x and y = moo and cow"
```

Since both of these mechanisms are rather awkward, MathJax provides an alternative syntax that is easier on the programmer, but at the cost of some inefficiency in creating the subclass and in calling methods that access the super class.

Since most calls to the super class are to the overridden method, not to some other method, the method name and the `call()` are essentially redundant. You can get a more convenient syntax by wrapping the *def* for the *`Subclass()`* call in a call to `MathJax.Object.SimpleSUPER()`, as in the following example:

```
MathJax.Class1 = MathJax.Object.Subclass({
  Init: function (x) {this.x = x},
  XandY: function (y) {return "Class1: x and y = " + this.x + " and " + y}
});

MathJax.Class2 = MathJax.Class1.Subclass(
  MathJax.Object.SimpleSUPER({
    XandY: function (y) {return "Class2: "+this.SUPER(y)},
    AnotherMethod: function () {return this.x}              // it's OK if a method
↪doesn't use SUPER
  })
);

var foo = MathJax.Class2("foo");
foo.XandY("bar");     // returns "Class2: Class1: x and y = foo and bar"
```

Converting to MathJax from jsMath

MathJax is the successor to the popular jsMath package for rendering mathematics in web pages. Like jsMath, MathJax works by locating and processing the mathematics within the webpage once it has been loaded in the browser by a user viewing your web pages. If you are using jsMath with its `tex2math` preprocessor, then switching to MathJax should be easy, and is simply a matter of configuring MathJax appropriately. See the section on *Configuring MathJax* for details about loading and configuring MathJax.

On the other hand, if you are using jsMath's `<span class="math">...</span>` and `<div class="math">...</div>` tags to mark the mathematics in your document, then you should use MathJax's `jsMath2jax` preprocessor when you switch to MathJax. To do this, include `"jsMath2jax.js"` in the *extensions* array of your configuration, with the *jax* array set to include `"input/TeX"`.

```
extensions: ["jsMath2jax.js"],
jax: ["input/TeX", ...]
```

There are a few configuration options for `jsMath2jax`, which you can find in the `config/MathJax.js` file, or in the *jsMath configuration options* section.

CHAPTER 3

Reference Pages

Describing HTML snippets

A number of MathJax configuration options allow you to specify an HTML snippet using a JavaScript object. This lets you include HTML in your configutation files even though they are not HTML files themselves. The format is fairly simple, but flexible enough to let you represent complicated HTML trees.

An HTML snippet is an array consisting of a series of elements that format the HTML tree. Those elements are one of two things: either a string, which represents text to be included in the snippet, or an array, which represents an HTML tag to be included. In the latter case, the array consists of three items: a string that is the tag name (e.g., "img"), an optional object that gives attributes for the tag (as described below), and an optional HTML snippet array that gives the contents of the tag.

When attributes are provided, they are given as *name:value* pairs, with the *name* giving the attribute name, and *value* giving its value. For example

```
[["img",{src:"/images/mypic.jpg"}]]
```

represents an HTML snippet that includes one element: an `<img>` tag with `src` set to `/images/mypic.jpg`. That is, this is equivalent to

```
<img src="/images/mypic.jpg">
```

Note that the snippet has two sets of square brackets. The outermost one is for the array that holds the snippet, and the innermost set is because the first (and only) element in the snippet is a tag, not text. Note that the code `["img", {src:"/images/mypic.jpg"}]` is invalid as an HTML snippet. It would represent a snippet that starts with "img" as text in the snippet (not a tag), but the second item is neither a string nor an array, and so is illegal. This is a common mistake that should be avoided.

A more complex example is the following:

```
[
  "Please read the ",
  ["a",{href:"instructions.html"},["instructions"]],
```

```
  " carefully before proceeding"
]
```

which is equivalent to

```
please read the <a href="instructions.html">instructions</a> carefully
before proceeding.
```

A final example shows how to set style attributes on an object:

```
[["span",
  {
    id:"mySpan",
    style: {color:"red", "font-weight":"bold"}
  },
  [" This is bold text shown in red "]
]]
```

which is equivalent to

```
<span id="mySpan" style="color: red; font-weight: bold;">
This is bold text shown in red
</span>
```

CSS Style Objects

Many MathJax components allow you to specify CSS styles that control the look of the elements they create. These are described using CSS style objects, which are JavaScript objects that represent standard CSS declarations. The main CSS style object is a collection of *name:value* pairs where the *name* is the CSS selector that is being defined, and the *value* is an object that gives the style for that selector. Most often, the selector will need to be enclosed in quotation marks, as it will contain special characters, so you would need to use `"#myID"` rather than just `#myID` and `"ul li"` rather than just `ul li`.

The value used to define the CSS style can either be a string containing the CSS definition, or a javascript object that is itself a collection of *name:value* pairs, where the *name* is the attribute being defined and *value* is the value that attibute should be given. Note that, since this is a JavaScript object, the pairs are separated by commas (not semi-colons) and the values are enclosed in quotation marks. If the name contains dashes, it should be enclosed in quotation marks as well.

For example, `jax/output/HTML-CSS/config.js` includes the following declaration:

```
styles: {

  ".MathJax .merror": {
    "background-color": "#FFFF88",
    color:   "#CC0000",
    border:  "1px solid #CC0000",
    padding: "1px 3px",
    "font-family": "serif",
    "font-style": "normal",
    "font-size":  "90%"
  },

  ".MathJax_Preview": {color: "#888888"},
```

```
}
```

This defines two CSS styles, one for the selector `.MathJax .merror`, which specifies a background color, foreground color, border, and so on, and a second for `.MathJax_Preview` that sets its color.

You can add as many such definitions to a `styles` object as you wish. Note, however, that since this is a JavaScript object, the selectors must be unique (e.g., you can't use two definitions for `"img"`, for example, as only the last one would be saved). If you need to use more than one entry for a single selector, you can add comments like `/* 1 */` and `/* 2 */` to the selector to make them unique.

It is possible to include selectors like `"@media print"`, in which case the value is a CSS style object. For example:

```
styles: {
  "@media print": {
    ".MathJax .merror": {
       "background-color": "white",
       border: 0
    }
  }
}
```

The various extensions and output processors include more examples of CSS style objects, so see the code for those files for additional samples. In particular, the `extensions/MathMenu.js`, `extensions/MathZoom.js`, `extensions/FontWarnsing.js`, and `jax/output/HTML-CSS/jax.js` files include such definitions.

Glossary

Callback A JavaScript function that is used to perform actions that must wait for other actions to complete before they are performed.

Callback Queue MathJax uses *Queues* to synchronize its activity so that actions that operate asynchronously (like loading files) will be performed in the right order. *Callback* functions are pushed onto the queue, and are performed in order, with MathJax handling the synchronization if operations need to wait for other actions to finish.

Callback Signal A JavaScript object that acts as a mailbox for MathJax events. Like an event handler, but it also keeps a history of messages. Your code can register an "interest" in a signal, or can register a *callback* to be called when a particular message is sent along the signal channel.

HTML-CSS MathJax output form that employs only on HTML and CSS 2.1, allowing MathJax to remain compatible across all browsers.

jax MathJax's input and output processors are called "jax", as is its internal format manager. The code for the jax are in the `MathJax/jax` directory.

LaTeX LaTeX is a variant of *TeX* that is now the dominant TeX style.

See also:

LaTeX Wikipedia entry

MathML An XML specification created to describe mathematical notations and capture both its structure and content. MathML is much more verbose than *TeX*, but is much more machine-readable.

See also:

MathML Wikipedia entry

STIX The Scientific and Technical Information Exchange font package. A comprehensive set of scientific glyphs.

See also:

STIX project

TeX A document markup language with robust math markup commands developed by Donald Knuth in the late 1970's, but still in extensive use today. It became the industry standard for typesetting of mathematics, and is one of the most common formats for mathematical journals, articles, and books.

See also:

TeX Wikipedia entry

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