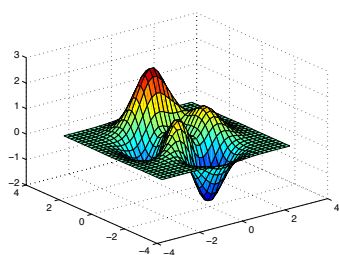# Interactive three dimensional plots for documents

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With Adobe Reader, click your mouse over this graphic.

The web and electronic documents empower interactive exploration of three dimensional graphics. This document outlines two approaches to currently enhance your documents with interactive 3D graphics such as the one to the left (currently only viewable in Adobe Reader).

1 Two alternative international standards

Unfortunately there are two competing standards for interactive 3D graphics:

1. the openly developed system of VRML evolved into the present day X3D;

2. while Adobe promotes its own 'standard' of U3D.

Which should you use? I suggest the following:

- for viewing 3D as a *supplementary file*, use X3D[1] (files are usually characterised by the extension `wrl`);

- whereas for viewing 3D *within* a PDF document use Adobe's U3D (files usually have extension `u3d`).

Why bother with the first, why not just do the second? For two reasons: firstly because 3D graphics may bloat a PDF undesirably; and secondly, currently only Adobe Reader allows interaction with embedded U3D files. The second alternative leaves many of your potential readers 'out in the cold'.

Methods for generating 3D graphics in either alternative varies. Here I only give one approach each using Matlab, and only for LaTeX documents.

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[1] http://anziamj.austms.org.au/ojs/index.php/ANZIAMJ/article/downloadSuppFile/1554/629

2 Supplement documents with WRL graphics

For the example graphic I used
```
[X,Y,Z] = peaks(30);
surf(X,Y,0.3*Z);
vrml(gcf,'peaks')
```

1. Download and install a X3D viewer such as FreeWRL.[2]

2. Generate your 3D graphics in Matlab in a normal figure window.

3. Execute `vrml(gcf,'filename')` to generate the X3D file `filename.wrl`

4. Edit the `wrl` file (plain text):

   - change to `headlight TRUE`;

   - possibly delete any `Viewpoint { ... }` as these seem to cause problems.

5. Open the `wrl` file in your X3D viewer. You will see that axes, annotations and labels have not been translated into X3D. Usually:

   - drag your mouse around over the graphic to twist and turn it;

   - drag your right-button up-down to zoom in and out.

6. Upload the file to the internet: for example, I uploaded the peaks surface as linked on the previous page.

7. In your LaTeX source insert hyperlinks to the location of the `wrl` file on the internet:

   - `\usepackage{hyperref,url}` goes in the preamble;

   - link to the URL of the `wrl` file by `\url{http://...}`;

   - usually best to link via a footnote with `\footnote{\url{http://...}}`

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[2] http://freewrl.sourceforge.net/ for common operating systems.

3   Embed a movie into Adobe PDF

The above is one example of embedding a movie using the `media9` package. I used the following command because the movie is 4×3 (the `VPlayer.swf` is something standard that plays the specified movie called `filename.mov`)

```
\includemedia[
  width=.8\linewidth, height=.6\linewidth, activate=pageopen,
  addresource=filename.mov,
  flashvars={source=filename.mov}
]{}{VPlayer.swf}
```

4   Embed 3D graphics in Adobe PDF

Such embedding is more complicated and, currently, only works for readers using Adobe Reader.

1. Download and install the following three:

   - `media9` package for LaTeX (if you do not already have it) from any CTAN site;[3]

   - `fig2u3d` package (by Ioannis F. Filippidis) for Matlab from Mathworks;[4]

   - Cell Extrema package (by Ioannis F. Filippidis) for Matlab from Mathworks;[5]

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[3] http://www.ctan.org/tex-archive/help/Catalogue/entries/media9.html which empowers you to embed movies, sounds and 3D objects into PDF.

[4] http://www.mathworks.com/matlabcentral/fileexchange/25383-matlab-mesh-to-pdf-with-3d-interactive-object

[5] http://au.mathworks.com/matlabcentral/fileexchange/35983-cell-extrema

- And via github[6] I also had to download the three files `coor_extremals.m`, `plot_scalings.m` and lastly `axes_extremal_xyz.m` (all of which I placed in the fig2u3d folder).

  Also, download `mesh2pdf` package for Matlab from Mathworks[7] and you need not install, but you *must* copy the bin directory to inside the `idtf2u3d` folder of the `fig3u3d` package!

  Depending upon your installation, you may need more packages from Mathworks—see the list in the `README.md` file of fig2u3d.

For the example graphic I used
```
[X,Y,Z] = peaks(30);
surf(X,Y,0.3*Z);
fig2u3d(gca,'peaks')
```

2. Generate your 3D graphics in Matlab in a normal figure window.

3. Execute `fig2u3d(gca,'filename')` which generates files `filename.u3d`, `filename.vws` and `filename.png`

4. In your LaTeX source include `\usepackage{graphicx,media9}` in the preamble. Then in a figure environment (or wherever) include

   ```
   \includemedia[width=\linewidth,
       3Dtoolbar,3Dviews=filename.vws,
       ]{\includegraphics{filename}}{filename.u3d}
   ```

5. Execute `pdflatex`, view in Adobe Reader and view your 3D graphic:

   - drag your mouse around over the graphic to twist and turn it;

   - drag your right-button up-down to zoom in and out (or scroll button).

4.1   A template for including as a figure

In documents, as in Figure 1, we like a conventional 2D projection as well as the rotatable 3D graphic—especially as the 3D graphic has no axis nor labels. The `.png` generated by `fig2u3d()` may do but prefer higher quality. Generate conventional `filename.eps` and `filename.pdf` of the 2D projection as usual, in addition to the `filename.u3d` graphic. Then include with the following template.

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[6] https://github.com/johnyf/plot_utils/tree/master/plot_scalings

[7] http://www.mathworks.com/matlabcentral/fileexchange/25383-matlab-mesh-to-pdf-with-3d-interactive-object
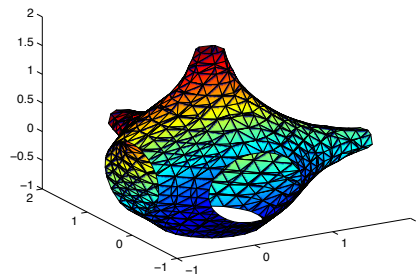
Figure 1: some excruciatingly interesting caption. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Sed congue augue ac sapien porta molestie. Morbi adipiscing ante id urna volutpat faucibus eget luctus nunc. Class aptent taciti sociosqu ad litora torquent per conubia nostra.

```
\begin{figure}
\centering
\includemedia[width=0.5\linewidth,3Dtoolbar,3Droo=7]
    {\includegraphics{filename}}{filename.u3d}
\parbox[b]{0.45\linewidth}{
\caption{excruciatingly interesting caption.}
\label{fig:filename}}
\end{figure}
```

5   Caveat

The above worked for me at the time of writing. But given the huge variety of operating systems and environments, and continual changes to software, it may or may not work for you. Good luck.