

# Smart ways of drawing PSTricks figures

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## Abstract

We present a method of using PSTricks in conjunction with free software packages for interactive drawing (Dr. Geo, Dia, Gnuplot, Xfig) to produce various types of figures, via exporting as  $\text{T}\text{E}\text{X}$  and modifying the result.

## 1 Drawing geometric figures

In our institute, we arrange various training programmes for International Maths Olympiad competition, publish the journal *Bona Mathematica*, and produce other mathematical study materials. For all these we need to draw complex geometric figures.

### 1.1 Accuracy requirements

All the mathematical material is in  $\text{L}\text{A}\text{T}\text{E}\text{X}$  format. Faculties require `.eps` files to include in their question papers, notes, books and articles.

In figures, the text used for labels, etc., must all be in the same font. The material is widely distributed among students and others, so from the printing point of view, the figures should be very accurate.

We want to produce such exact figures while not spending excessive amounts of time on drawing them. Also, these figures must be usable in the  $\text{L}\text{A}\text{T}\text{E}\text{X}$  sources.

We want to minimize issues such as license, cost, and support and therefore maximize availability of the software. In general, use of free software is encouraged in the institute.

For drawing geometric figures, the free software package Dr. Geo (home page <http://www.gnu.org/software/dr-geo>) is well-suited for us. Figure 1 shows a typical session in progress. Other free software GUI drawing programs include Dia for flowcharts, among other purposes (<http://www.gnome.org/projects/dia>), Gnuplot for function plotting (<http://www.gnuplot.info>), and Xfig for general drawing (<http://www.xfig.org>).

### 1.2 Convert figures directly to PostScript?

If a figure file is generated by another software program, converted to `ps` or `eps` by an external utility, and then inserted in the  $\text{L}\text{A}\text{T}\text{E}\text{X}$  file, we have observed that the font type and size of labels in the converted

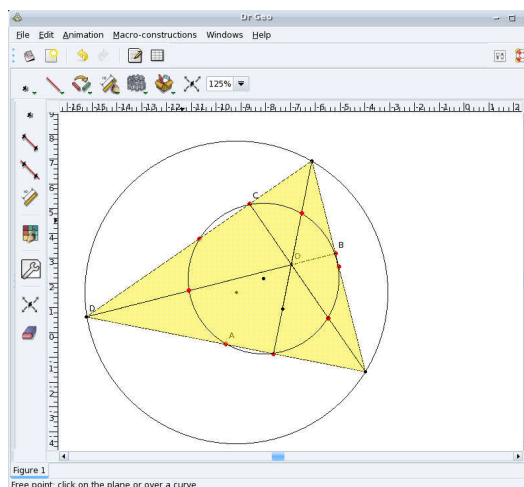


Figure 1: Drawing a figure in Dr. Geo

file is different from that in the  $\text{L}\text{A}\text{T}\text{E}\text{X}$  file, and the sharpness of the figure may not be good.

Of course we wish to avoid such problems.

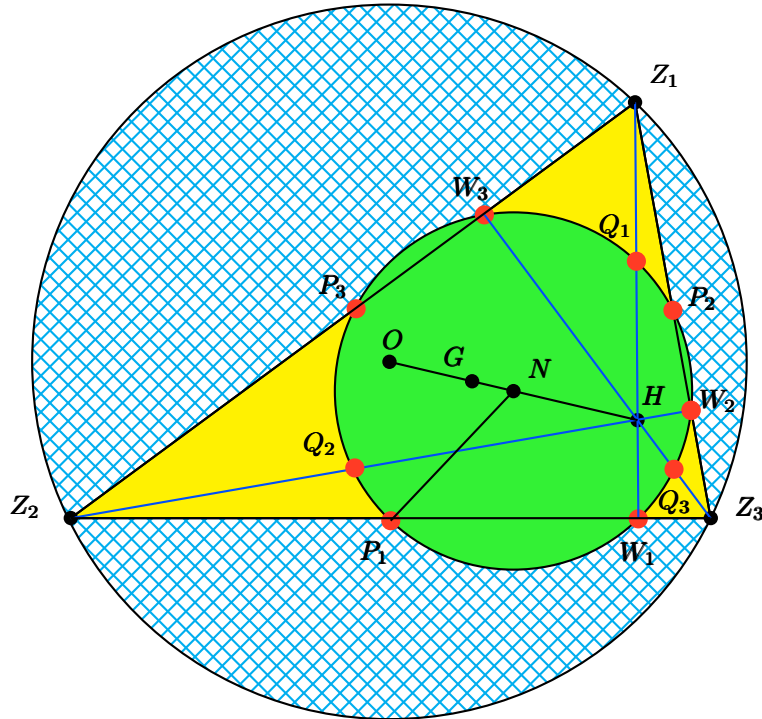
### 1.3 Export figures as $\text{T}\text{E}\text{X}$

As an alternative to PostScript export, software such as the above supports exporting figures in  $\text{T}\text{E}\text{X}$  format. Advantages of this approach include:

- The ‘Export as  $\text{T}\text{E}\text{X}$  file’ options generate the entire code for users.
- The resulting `fig.tex` file has PSTricks code for the figure, which is editable.
- Users may not know every PSTricks command, but they can easily modify the code in useful ways knowing only a small set of commands.
- Users need not calculate  $(x, y)$  co-ordinates, as they are already generated according to the figure. One important thing not to worry about.

### 1.4 Step by step

Here is our process, step by step.



**Figure 2:** Nine point circle, drawn with modified PSTricks code

- Open a graphical tool for drawing geometric figures, e.g., one of those mentioned above. Draw the figure.
- Label the objects at appropriate places, *as near by as possible*. Save.
- Export as a  $\text{\TeX}$  figure.
- Open it in any editor or  $(\LaTeX)$  IDE to edit. We often use Kile ([kile.sourceforge.net](http://kile.sourceforge.net)).
- Change all the labels in the figure to be in math mode, i.e., enclosed in  $\$ \dots \$$ , especially labels of vertices.
- If the positions of labels are not perfect, then adjust the  $x$  and  $y$  coordinates as needed, in the neighbourhood of the  $x$  and  $y$  which have been calculated by Dr. Geo.

## 2 Sequence of drawing objects matters

Sometimes two objects will overlap, so that the object drawn earlier becomes invisible. To see an example, refer to Figure 2, a ‘nine point circle’.

Looking at the points of intersection at  $W_1$  and  $W_3$ , we can see the construction clearly, namely,  $Z_2Z_3 \perp Z_1W_1$  and  $Z_1Z_2 \perp Z_3W_3$ . However, at point  $W_2$ , the red dot marker has obscured that  $Z_1Z_3 \perp Z_2W_2$ . If the dot were drawn before the lines, the lines would be visible, as they are at  $W_1$

and  $W_3$ . (We intentionally left this discrepancy in the figure for expository purposes.)

Drawing sequence is an issue with opaque colors. With transparent colors, the sequence typically does not matter.

## 3 Example

Figure 2 also serves as a general example showing the success of our workflow. In the figure, nine red points can be seen. These points are constructed using Dr. Geo, i.e., Dr. Geo was responsible for correctly finding these nine intersecting points.

With PSTricks, one can use different colours and textures to highlight points and regions, and place labels at the appropriate co-ordinates and use the same font as  $\LaTeX$  file in which figure will be inserted. In this case, we wanted to use the figure on the front page of a journal, and so we needed to make it more colourful.

In a sense, Dr. Geo works here as a front end for PSTricks. With the help of such a front end, users can save considerable time in calculating the co-ordinates for the figure.

To learn about the actual mathematics of the nine point circle, see <http://www.csm.astate.edu/Ninept.html>.