

Creating device independent PostScript

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T_EX and fonts T_EX is a program with a heritage. When it was first written computer typesetting was in it's infancy. There were no high quality, publicly available fonts which it could use. To overcome this problem Knuth wrote METAFONT [3]. This allows the user to create their own fonts by describing them with a fairly simple computer language. Knuth himself designed the computer modern families of fonts with METAFONT and since then a wide range of other metafonts have been created for scripts as varied as Devanāgarī and Klingon.

Since that time many other font formats have been invented. These may be broadly classified into 'bitmap' and 'vector' formats (see figure 10). Type 1 and Type 3 fonts are PostScript fonts developed by Adobe. Type 3 fonts may contain arbitrary PostScript commands, whereas Type 1 fonts can only describe the outlines of characters. Truetype is another outline font format developed by Apple Computers. The .pk and .gf formats are generated by METAFONT¹ and the .bdf and .fon formats are mainly used for on-screen fonts.

Why so many formats!? This plethora of formats can be annoying, 'How do I convert...' is probably the most frequently asked question on `comp.text.fonts`. Each manufacturer made their own format, often the details of these formats were kept secret. Adobe encrypted their fonts in an attempt to prevent unauthorized sharing of their fonts. Only with the publication of the Black Book [1] did they allow others to make Type 1 fonts. It would be nice if there was one international standard for vector fonts and another for bitmaps, but despite encouraging moves, such as the development of OpenType fonts,² for the moment we have to rely on conversion programs.

¹ Actually each .pk file is a compressed .gf file generated by `gftopk`.

² OpenType is a format which aims to be compatible with both Type 1 and Truetype

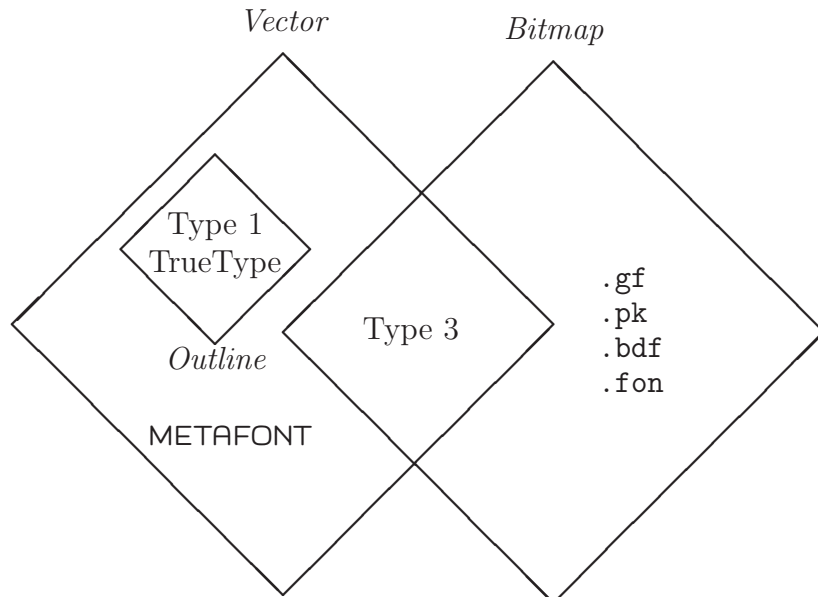


Figure 10: Bitmap and Vector font formats

Easy and hard conversions Converting any font format to a bitmap is usually a simple task. Converting between outline formats is harder, functions used to define the outlines differ between formats, and it may become necessary to approximate the outline. This is what `ttf2pt1` does. Conversion from a bitmap to a vector format requires the font to be traced, either by hand or by computer. Hand tracing usually produces good results, computer tracing can be very good, or can be very poor. As Type 3 fonts can contain any postscript command, direct conversion to an outline format is probably impossible. Often the most cost-effective way of making an outline font from a Type 3 font is to trace a high resolution bitmap.

\TeX itself is not bound to any font format, it does not need to know about the shapes of the glyphs in a font, only their dimensions. This information is stored in a separate file, a `.tfm` file. It is only when the device driver (such as `dvips` or `xdvi`) is used that the actual fonts loaded.

As the fonts generated by METAFONT are bitmaps they cannot be scaled, or printed at a different resolution to that for which they were designed. This creates problems when one wants to share documents created by \TeX electronically.

In defence of bitmaps Eventually nearly all fonts are converted into bitmaps. Even native PostScript printers will internally convert fonts to a pattern of dots when printing. This process is known as *rasterization*. At low resolutions a hand crafted bitmap font will be far superior than an automatically rasterized font. Both Type 1 and TrueType fonts allow the font designer to give *hints* to the rasterizing program about where to place dots at low resolution. METAFONT has it's own system in which the rasterizing can be tuned to a particular output device. The bitmaps generated by METAFONT will usually be superior to those generated by your printer. And if resolution independence is not important this is how you will get the best output.

Bitmap fonts can also be generated from a variety of other sources, most notably from TrueType fonts by `ttf2pk`

Using resolution independent fonts Very often one wishes to generate resolution independent postscript. To do this one need to use scalable PostScript fonts. There are a number of options:

- Use fonts such as Times-Helvetica-Courier throughout your document. These are standard PostScript fonts which are available on all PostScript printers. However this restricts you to a particular system of font families.
- Use Type 1 versions of Computer Modern. Several people have converted the Computer Modern fonts to Type 1, either analytically or by tracing the bitmaps generated by METAFONT.
- Buy a font family. One can purchase high quality fonts from several suppliers—if one is willing to pay the high prices demanded.
- Convert a metafont to PostScript. There are two programs which attempt to do this, `MetaFog` [2] and `mf2pt3` [4]. Both make use of `METAPOST` to make the initial conversion to PostScript.

`MetaFog` is a commercial program that (its maker claims) can produce quality Type 1 fonts from METAFONT sources. This is a hard (in fact insoluble) problem. The conversion is, by necessity, approximate. However the fonts produced in this way are high quality, visually identical to the output of METAFONT and can be used in PDF and by ATM.

On the other hand `mf2pt3` attempts nothing so hard. It produces a Type 3 font, which is scalable, and resolution independent. Figure 12 shows the results of conversion of the METAFONT source to a bitmap at 360dpi, to Type 1 by tracing, and to scalable Type 3.

One problem with `mf2pt3` at the moment are the large PostScript files it generates. Each font will add about 300kB to the size of the PostScript file. Some

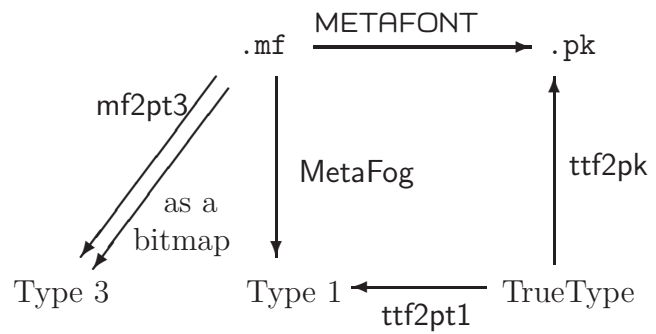


Figure 11: Various conversions that can be done

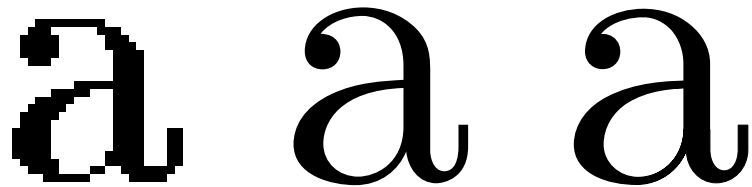


Figure 12: The Computer Modern 'a'. On the left as a scaled bitmap, in the centre the BlueSky Type 1 conversion, on the right the mf2pt3 conversion.

form of compression or partial downloading is required to make the PostScript a reasonable size.

Bibliography

- [1] *The Black Book* available from http://www.adobe.com/supportservice/devrelations/PDFS/TN/T1_SPEC.PDF.
- [2] Richard Kinch *MetaFog: Converting METAFONT Shapes to Outlines* Paper presented at the 1995 T_EX Users Group Conference, St. Petersburg, Florida. Available from <http://www.truetex.com>.
- [3] Donald E. Knuth *The METAFONT Book* Addison-Wesley, (1986) ISBN 0201134446.
- [4] Apostolos Syropoulos. *mf2pt3 The Program* from CTAN:fonts/utilities/mf2pt3

