bezierplot

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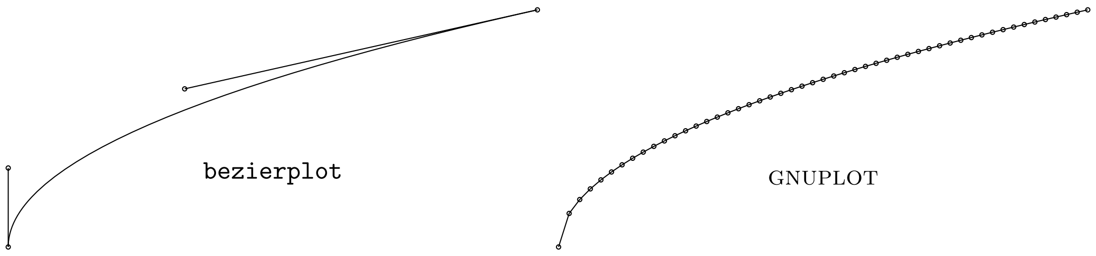
1 Introduction

`bezierplot` is as well a Lua program as a (Lua)LaTeX package. This document describes both.

Given a smooth function, `bezierplot` returns a smooth bezier path written in Ti*k*Z/METAPOST notation that approximates the graph of the function. (For polynomial functions of degree ≤ 3 and inverses of them, the approximation is exact.) It finds special points such as extreme points and inflection points and reduces the number of used points.

The following example will show a comparison of GNUPLOT with `bezierplot` for the function $y = \sqrt{x}$ for $0 \leq x \leq 5$:



GNUPLOT used 51 samples (no smoothing) and is still quite inexact at the beginning, whereas `bezierplot` uses 4 points only and is exact!

2 Installation

As `bezierplot` is written in Lua, the installation depends if you are using LuaLaTeX or another LaTeX engine.

2.1 Installation For LuaLaTeX

If you have installed `bezierplot` by a package manager, the installation is already complete. The manual installation `bezierplot` is done in 2 steps:

- copy the files `bezierplot.lua` and `bezierplot.sty` somewhere in your `texmf` tree (e.g. `/texmf/`)
- update the ls-R databases by running `mktexlsr`

2.2 Additional Installation Steps For Other LaTeX Engines

You will have to call `bezierplot` as an external program via the option `--shell-escape` (`--write18` for MiKTeX). Therefore, `bezierplot.lua` has to be copied under the name `bezierplot` to a place, where your OS can find it. Under Linux this usually means copying to `/usr/local/bin/`, but for Windows this will probably include more steps (like adding to the `PATH`). Of course, Lua has to be installed as well. As soon as you can call `bezierplot` from a command line (e.g. by typing `bezierplot "x^2"`), it should also work with other LaTeX engines.

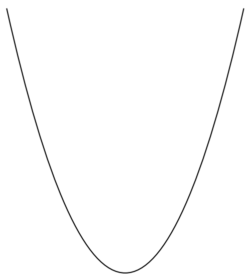
3 Loading

The `bezierplot` package is loaded with `\usepackage{bezierplot}`. There are no loading options for the package.

4 Usage

A minimal example of LuaLaTeX document could be:

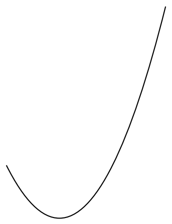
```
\documentclass{article}
\usepackage{tikz,bezierplot}
\begin{document}
\tikz \draw \bezierplot{x^2};
\end{document}
```



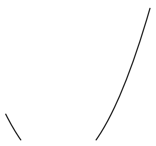
The command `\bezierplot` has 4 optional arguments in the sense of

`\bezierplot[XMIN][XMAX][YMIN][YMAX]`

The defaults are `XMIN` = `YMIN` = -5 and `XMAX` = `YMAX` = 5.



`\bezierplot[-1][2]{x^2}`



`\bezierplot[-1][2][0.5][3]{x^2}`

You may reverse the graph by making `XMIN` bigger than `XMAX`. E.g.

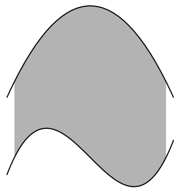
`\bezierplot[-5][5]{0.5*x+1}`

returns `(-5,-1.5) -- (5,3.5)`, whereas

`\bezierplot[5][-5]{0.5*x+1}`

returns the reversed path `(5,3.5) -- (-5,-1.5)`. This is useful, if you want to cycle a path to a closed area:

```
\begin{tikzpicture}
\fill[black!30] \bezierplot[-1][1]{2-x^2}
-- \bezierplot[1][-1]{x^3-x} -- cycle;
\draw \bezierplot[-1.1][1.1]{2-x^2};
\draw \bezierplot[-1.1][1.1]{x^3-x};
\end{tikzpicture}
```



4.1 Running Raw `bezierplot`

Of course, you can run `bezierplot.lua` in a terminal without using LaTeX, e.g.

```
lua bezierplot.lua "3*x^0.8+2"
```

will return

```
(0,2) .. controls (0.03,2.282) and (0.268,3.244) .. (1,5)
```

You can set the window of the graph as follows:

```
lua bezierplot.lua "FUNCTION" XMIN XMAX YMIN YMAX
```

e.g.

```
lua bezierplot.lua "FUNCTION" 0 1 -3 2.5
```

will set $0 \leq x \leq 1$ and $-3 \leq y \leq 2.5$. You may also omit the y–range, hence

```
lua bezierplot.lua "FUNCTION" 0 1
```

will set $0 \leq x \leq 1$ and leave the default $-5 \leq y \leq 5$.

4.2 Notation Of Functions

The function term given to `bezierplot` must contain at most one variable: x (e.g. `"2.3*(x-1)^2-3"`). You must not omit `*` operators:

wrong: ~~`2x(x+1)`~~ correct: `2*x*(x+1)`

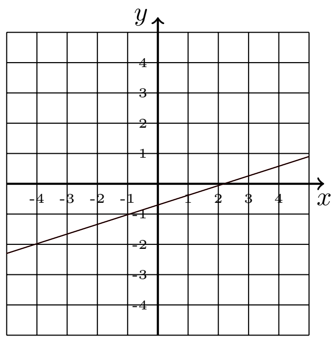
You have two possibilities to write powers: `"x^2"` and `"x**2"` both mean x^2.

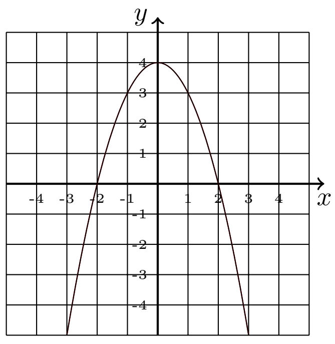
The following functions and constants are possible:

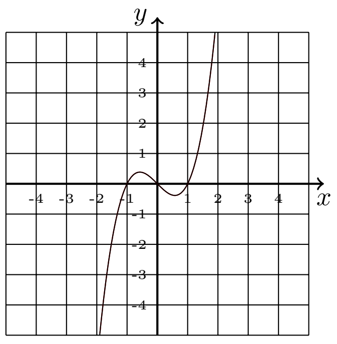
`abs`	absolute value (remember: your function should still be smooth)
`acos`	$\cos^{-1}$ inverse function of cosine in radians
`asin`	$\sin^{-1}$ inverse function of sine in radians
`atan`	$\tan^{-1}$ inverse function of tangent in radians
`cbrt`	cube root $\sqrt[3]{}$ that works for negative numbers, too
`cos`	cosine for angles in radians
`exp`	the exponential function $e^{(\ )}$
`e`	the euler constant $e = \exp(1)$
`log`	the natural logarithm $\log_e(\ )$
`pi`	Archimedes constant $\pi \approx 3.14$
`sgn`	sign function
`sin`	sine for angles in radians
`sqrt`	square root $\sqrt{}$
`tan`	tangent for angles in radians

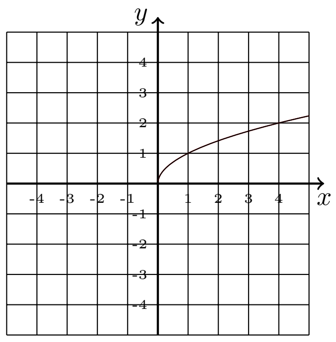
5 Examples of `bezierplot` in Comparison with Gnuplot

The following graphs are drawn with `bezierplot` (black) and Gnuplot (red). Gnuplot calculated 1000 samples per example. The functions are given below the pictures (left: bezierplot, right: Gnuplot).

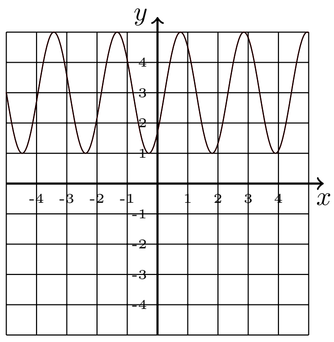

0.32*x-0.7 | 0.32*x-0.7


-x^2+4 | -x**2+4

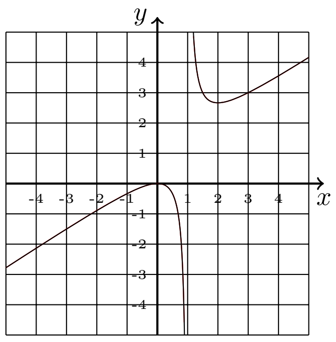

(x+1)*x*(x-1) | (x+1)*x*(x-1)



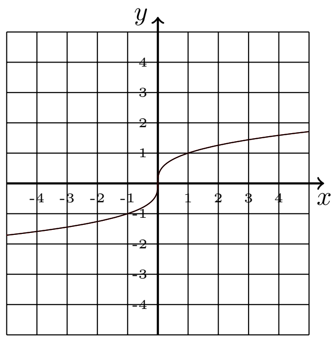
x^0.5 | x**0.5



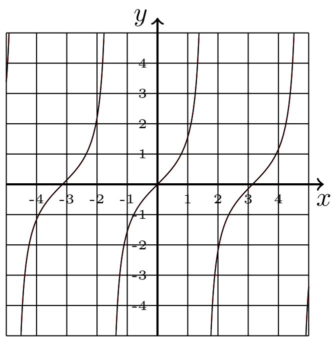
2*cos(3*x+4)+3 | 2*cos(3*x+4)+3



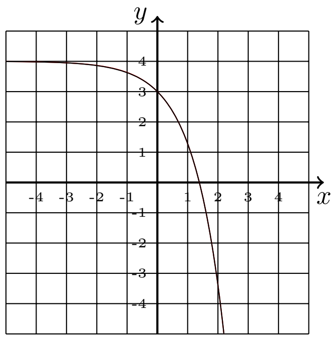
2*x^2/(3*x-3) | 2*x**2/(3*x-3)



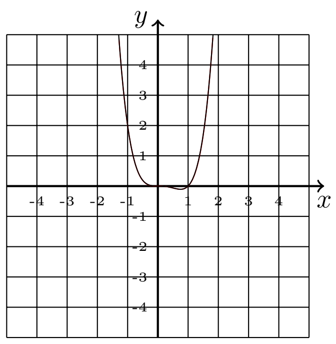
cbrt(x) | sgn(x)*abs(x)**(1/3.)



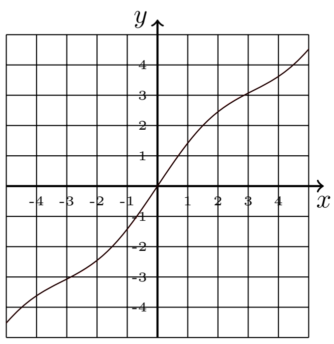
tan(x) | tan(x)



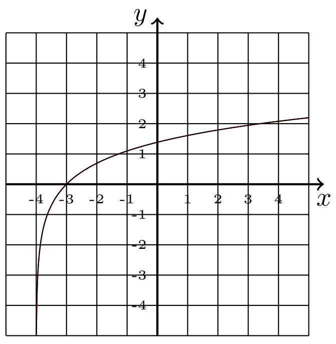
4-exp(x) | 4-exp(x)



x^3*(x-1) | x**3*(x-1)



x+0.5*sin(x) | x+0.5*sin(x)



log(x+4) | log(x+4)