

bezierplot

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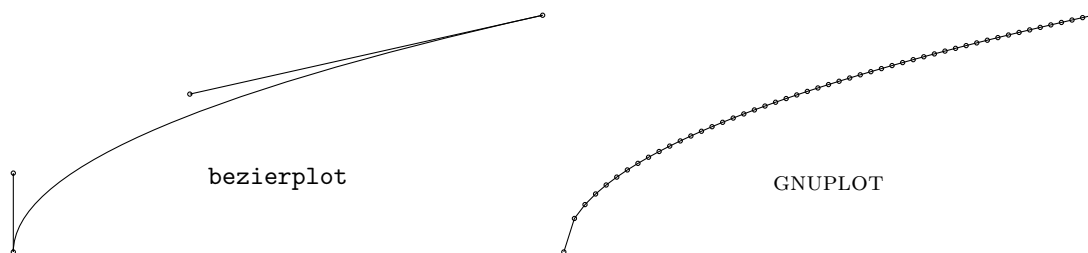
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1 Introduction

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

Given a smooth function, **bezierplot** returns a smooth bezier path written in **TikZ** notation (which also matches **METAPOST**) that approximates the graph of the function. For polynomial functions of degree ≤ 3 and inverses of them, the approximation is exact. **bezierplot** finds special graph 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 whether 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 of **bezierplot** is done in 2 steps:

- copy the files **bezierplot.lua** and **bezierplot.sty** somewhere in your **texmf** tree (e.g. to `~/texmf/tex/lualatex/bezierplot/bezierplot.sty` and `~/texmf/scripts/bezierplot/bezierplot.lua`)
- 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 with the name **bezierplot** to a place, where your OS can find it. Under Linux this usually means copying to the directory `/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.

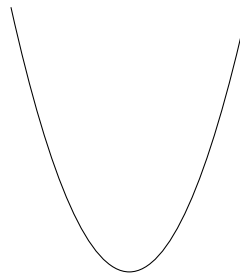
3 Loading

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

4 Usage

A minimal example of \LaTeX document could be:

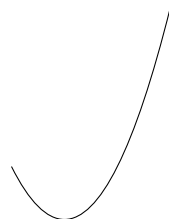
```
\documentclass{article}
\usepackage{tikz,bezierplot}
\begin{document}
\tikz \draw \bezierplot{x^2};
\end{document}
```



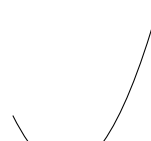
The command `\bezierplot` has 4 optional arguments in the sense of

`\bezierplot [XMIN] [XMAX] [YMIN] [YMAX] {FUNCTION}`

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.

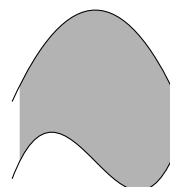
```
\bezierplot [-5] [5] {0.5*x+1}
```

returns $(-5, -1.5) \dashrightarrow (5, 3.5)$, whereas

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

returns the reversed path $(5, 3.5) \dashrightarrow (-5, -1.5)$. 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 $-5 \leq y \leq 5$. The variables XMIN, XMAX, YMIN and YMAX may also be computable expressions like $2\pi+6$:

```
lua bezierplot.lua "sin(x)" -pi pi
```

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 |
| cbrrt | 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 **GNU PLOT** (red). GNU PLOT used 1000 samples per example. The functions are given below the pictures (left: bezierplot, right: GNU PLOT).

