

# Wissenschaftliches Arbeiten mit $\text{\LaTeX}$

## Grafiken erstellen mit $\text{\LaTeX}$



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# Grafiken erstellen in $\text{\LaTeX}$

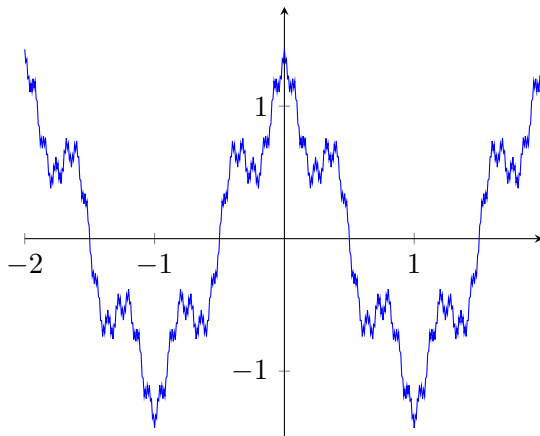
$\text{\LaTeX}$  stellt von sich aus Möglichkeiten bereit, Graphiken zu erzeugen:

- ▶ die `picture`-Umgebung
- ▶ `pict2e`, um die `picture`-Umgebung zu erweitern
- ▶ `epic`, *enhanced picture*
- ▶ `eepic`, *enhanced epic*
- ▶ `pmgraph`, *poor man graphics*
- ▶ `pstricks`
  - ▶ schnell (nutzt Postscript)
  - ▶ funktioniert nicht mit `pdftex` und `luatex`
- ▶ `TikZ`
  - ▶ portabel
  - ▶ langsamer als `pstricks`
  - ▶ subjektiv einfacher als `pstricks`



# Weierstraß-Funktion mit TikZ und Lua

$$x \mapsto \sum_{n=0}^{\infty} a^n \cos(b^n \pi x)$$





# Grundlagen von TikZ



# Wie?

Um TikZ in  $\LaTeX$  zu nutzen:

- ▶ `\usepackage{tikz}`
- ▶ Aller Code zwischen `\begin{tikzpicture}` und `\end{tikzpicture}` wird von  $\LaTeX$  an TikZ abgegeben.

## **ACHTUNG!**

TikZ ist eine eigene „Sprache“!



# Die tikzpicture Umgebung.

---

```
\begin{tikzpicture}
  CODE
\end{tikzpicture}
```

---

Kann zum Beispiel in figure Umgebung eingebettet werden.

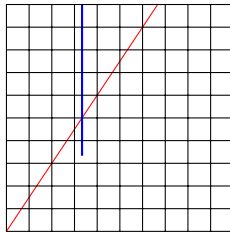
---

```
\begin{figure}[h]
  \centering
  \begin{tikzpicture}
    CODE
  \end{tikzpicture}
  \caption{\label{fig:someref} some caption}
\end{figure}
```

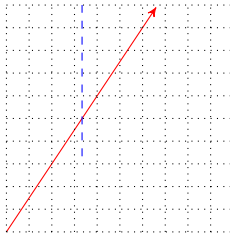
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## Ein paar Linien ...



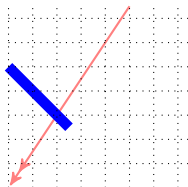
```
\begin{tikzpicture}
  \draw[red] (0,0) -- (2,3); \pause
  \draw[thick,blue] (1,1) -- (1,3); \pause
  \draw[step=.3] (0,0) grid (3,3);
\end{tikzpicture}
```



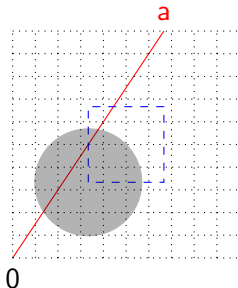
```
\begin{tikzpicture}[step=0.3]
  \draw[red,->] (0,0) -- (2,3); \pause
  \draw[blue,dashed] (1,1) -- (1,3); \pause
  \draw[dotted] (0,0) grid (3,3);
\end{tikzpicture}
```



## Noch mehr Linien ...



```
\begin{tikzpicture}[scale=0.8,step=0.4]
  \draw[red!50,thick,<<-] (0,0) -- (2,3); \pau
  \draw[line width=4pt,blue] (1,1) -- (0,2); \p
  \draw[dotted] (0,0) grid (3,3);
\end{tikzpicture}
```

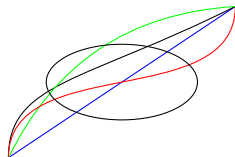


```
\begin{tikzpicture}[step=0.3]
  \tikzset{every node/.style={below}}
  \draw[red] (0,0) -- (2,3) node[above] {a};
  \draw[blue,dashed] (1,1) rectangle (2,2); \p
  \draw[dotted] (0,0) node {0} grid (3,3); \p
  \draw[fill,opacity=0.3] (1,1) circle(1);
\end{tikzpicture}
```



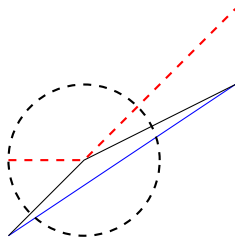


## Jetzt wird's kurvig!



```
\usetikzlibrary{calc}
\begin{tikzpicture}
  \coordinate (a) at (0,0);
  \coordinate (b) at (0,1);
  \coordinate (c) at (1,1);
  \coordinate (d) at (3,2);
  \draw[blue] (a) -- (d);
  \draw (a)..controls (b) and (c)..(d); \pause
  \draw[green,bend left=30] (a) to (d); \pause
  \draw[red,out=90,in=-90] (a) to (d); \pause
  \draw ($(a)!0.5!(d)$) ellipse(1 and 0.5);
\end{tikzpicture}
```





```
\usetikzlibrary{through}
\begin{tikzpicture}
  \coordinate (a) at (0,0);
  \coordinate (b) at (1,1);
  \coordinate (c) at (3,2);
  \draw[blue] (a) -- (c); \pause
  \draw (a)--(b)--(c); \pause
  \begin{scope}[yshift=1cm,dashed,thick] \pause
    \coordinate (a) at (0,0);
    \coordinate (c) at (3,2); \pause
    \draw[red] (a)--(b)--(c); \pause
    \node[draw,circle through=(a)] at (b){};
  \end{scope}
\end{tikzpicture}
```



## Eine andere Sicht.

$T_1$

$T_2$

$T_3$

$T_4$

```
\usetikzlibrary{positioning} % in der Präambel
\begin{tikzpicture}
  \tikzset{tomsbox/.style={rectangle, draw,
    very thick,minimum size=7mm,
    rounded corners=2mm}}
  \node[tomsbox] (1) at (0,0) { $T_1$ };
  \node[tomsbox] (2) [below=of 1] { $T_2$ };
  \node[tomsbox] (3) [below=of 2] { $T_3$ };
  \node[tomsbox] (4) [below=of 3] { $T_4$ };
  \draw (1)--(2)--(3)--(4);
\end{tikzpicture}
```



# Wiederholungen

$T_1$

$T_2$

$T_3$

$T_4$

```
\begin{tikzpicture}
  \tikzset{tomsbox/.style={rectangle, draw,
    very thick,minimum size=7mm,
    rounded corners=2mm}}
  \node[tomsbox] (1) at (0,0) {$T_1$};
  \foreach \i [count=\j] in {2,3,4}
  {
    \node[tomsbox] (\i) [below=of \j] {$T_{\i}$};
    \draw (\j)--(\i);
  }
\end{tikzpicture}
```

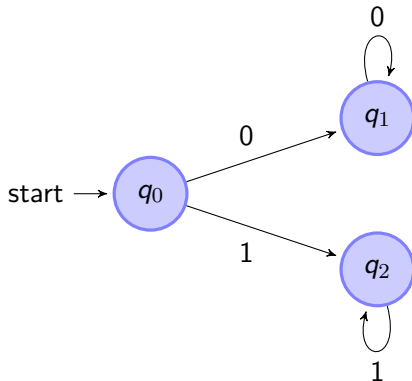


# Bibliotheken

Die Funktionalität von TikZ kann durch externe *Bibliotheken* erweitert werden.

## Beispiel

```
\usetikzlibrary{automata}
```



# Bibliotheken

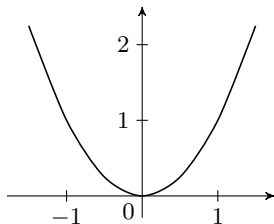
3d, angles, arrows, automata, babel, backgrounds, bending, calc, calendar, chains, decorations, decorations.footprints, decorations.fractals, decorations.markings, decorations.pathmorphing, decorations.pathreplacing, decorations.shapes, decorations.text, er, fadings, fit, fixedpointarithmetic, folding, fpu, intersections, lindenmayersystems, math, matrix, mindmap, patterns, petri, plohandlers, plotmarks, positioning, quotes, scopes, shadings, shadows, shapes.arrows, shapes.callouts, shapes, shapes.gates.logic.IEC, shapes.gates.logic.US, shapes.geometric, shapes.misc, shapes.multipart, shapes.symbols, snakes, spy, svg.path, through, topaths, trees, turtle





# Datenvisualisierung

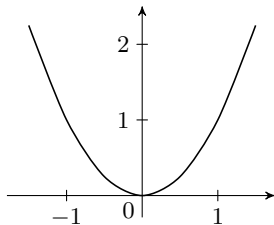




```
\usetikzlibrary{datavisualization}
\begin{tikzpicture}
  \datavisualization [school book axes,
    visualize as smooth line]
  data {x, y
    -1.5, 2.25
    -1, 1
    -.5, .25
    0, 0
    .5, .25
    1, 1
    1.5, 2.25
  };
\end{tikzpicture}
```

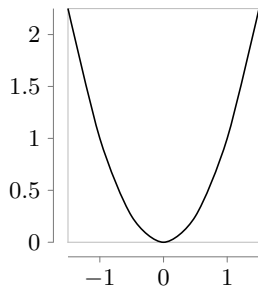






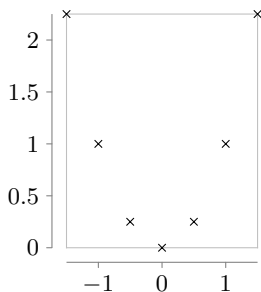
```
\usetikzlibrary{datavisualization,  
  datavisualization.formats.functions}  
\begin{tikzpicture}  
  \datavisualization  
    [school book axes,  
     visualize as smooth line]  
  data [format=function] {  
    var x : interval [-1.5:1.5]  
      samples 7;  
    func y = \value x * \value x;  
  };  
\end{tikzpicture}
```





```
\begin{tikzpicture}
  \datavisualization
    [scientific axes=clean,
     x axis={length=.7\linewidth,
            ticks=few},
     visualize as smooth line]
  data [format=function] {
    var x : interval [-1.5:1.5]
        samples 7;
    func y = \value x * \value x;
  };
\end{tikzpicture}
```

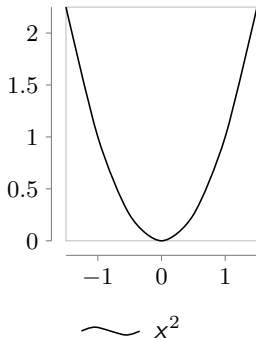




```
\begin{tikzpicture}
  \datavisualization
    [scientific axes=clean,
     x axis={length=.7\linewidth,
             ticks=few},
     visualize as scatter]
  data [format=function] {
    var x : interval [-1.5:1.5]
        samples 7;
    func y = \value x * \value x;
  };
\end{tikzpicture}
```



# Legenden



```
\begin{tikzpicture}
  \datavisualization
    [scientific axes=clean,
     x axis={length=.7\linewidth,
            ticks=few},
     legend={below},
     visualize as smooth
      line/.list={sq},
     sq={label in legend={text= $x^2$ }}]
  data [format=function,set=sq] {
    var x : interval [-1.5:1.5]
        samples 7;
    func y = \value x * \value x;
  };
\end{tikzpicture}
```

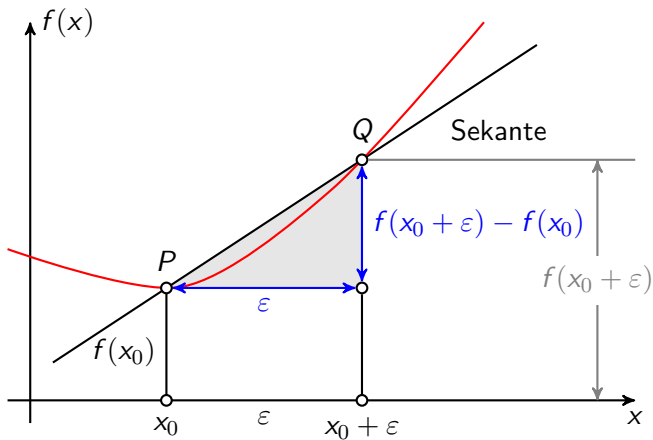




# Ein Tutorial



## Ziel



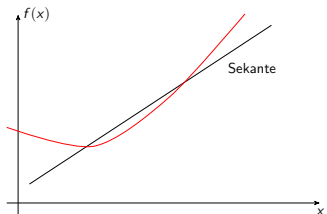


---

```
\coordinate (O) at (0,0);  
\draw[>-] (-0.3,0) -- (8,0) coordinate[label = {below:x}] (xmax);  
\draw[>-] (0,-0.3) -- (0,5) coordinate[label = {right:f(x)}] (ymax);
```

---





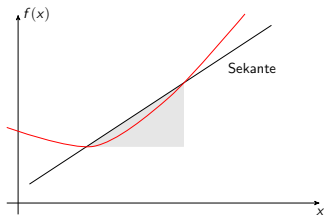
---

```
\draw (0.3,0.5) -- (6.7,4.7) node[pos=0.8, below right] {Sekante};  
\draw[red] plot[smooth] coordinates {(-0.3,2) (2,1.5) (4,2.8) (6,5)};
```

---







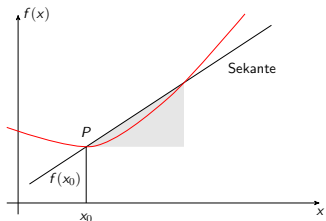

---

```

\usetikzlibrary{intersections} % in der Präambel
\path[name path=x] (0.3,0.5) -- (6.7,4.7);
\path[name path=y] plot[smooth]
  coordinates {(-0.3,2) (2,1.5) (4,2.8) (6,5)};
\begin{scope}[name intersections = {of = x and y, name = i}]
  \fill[gray!20] (i-1) -- (i-2 |- i-1) -- (i-2) -- cycle;
  \draw (0.3,0.5) -- (6.7,4.7) node[pos=0.8, below right] {Sekante};
  \draw[red] plot[smooth]
    coordinates {(-0.3,2) (2,1.5) (4,2.8) (6,5)};
\end{scope}

```






---

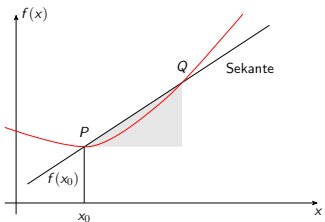
```

\begin{scope}[name intersections = {...}]
  ... (Wie vorher)
  \draw (i-1) node[label = {above:$P$}] {}
    -- node[left,yshift=-3pt] {$f(x_0)$}
      (i-1 |- 0) node[label = {below:$x_0$}] {};
\end{scope}

```

---






---

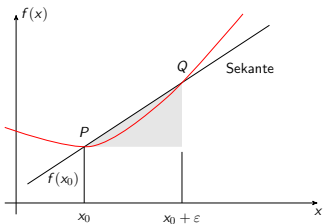
```

\begin{scope}[...]
  ... (Wie vorher)
  \path (i-2) node[label = {above:$Q$}] {}
  -- (i-2 |- i-1) node (i-12) {};
\end{scope}

```

---



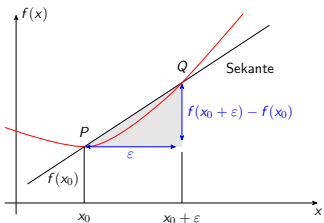


---

```
\begin{scope}[...]  
  ... (Wie vorher)  
  \draw (i-12) -- (i-12 |- 0)  
    node[label = {below:$x_0 + \varepsilon$}] {};  
\end{scope}
```

---






---

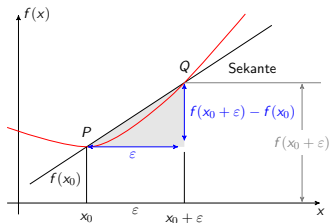
```

\begin{scope}[...]
  ... (Wie vorher)
  \draw[blue, <->] (i-2) --
    node[right] { $f(x_0 + \varepsilon) - f(x_0)$ } (i-12);
  \draw[blue, <->] (i-1) --
    node[below] { $\varepsilon$ } (i-12);
\end{scope}

```

---





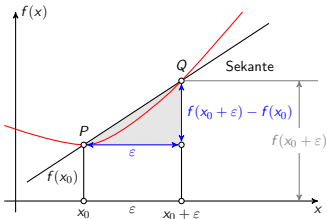

---

```

\begin{scope}[...]
  ... (Wie vorher)
  \path (i-1 |- 0) --
    node[below] {\varepsilon} (i-2 |- 0);
  \draw[gray] (i-2) -- (i-2 -| xmax);
  \draw[gray, <->] ([xshift = -0.5cm]i-2 -| xmax) --
    node[fill = white] {\f(x_0) + \varepsilon}
    ([xshift = -0.5cm]xmax);
\end{scope}

```






---

```

\begin{tikzpicture}[thick, >=stealth',
  dot/.style = {
    draw,
    fill = white,
    circle,
    inner sep = 0pt,
    minimum size = 4pt
  }]

```

...

