TikZ Tutorial

KSETA Doktorandenworkshop 2014
Christian Amstutz, Tanja Harbaum, Ewa Holt | July 22, 2014
Outline

- What is Tikz?
- Tikz Commands
- Exercises
- Outlook: Potential of Tikz
- Fancy Examples
What is TikZ?

- Language for creating vector graphics in \LaTeX
- TikZ = TikZ ist kein Zeichenprogramm
- Same author as the Beamer class
Why using TikZ?

- Single Design Among the Document
- One Design Flow
- More versatile Image Scaling
- Math Environment within Graphics
- Automatic Graph Generation (Loops)
- combined with \LaTeX-Beamer class: graphics for presentations

But be warned! It is not so easy to learn.
Scaling Effects

Raster Graphic (JPG)  Vector Graphic (PDF)  TikZ

$\sin(x)$

$\sin(x)$

$\sin(x)$
To calculate the horizontal position the kinematic differential equations are needed:

\[ \dot{n} = u \cos \psi - v \sin \psi \quad (1) \]
\[ \dot{e} = u \sin \psi + v \cos \psi \quad (2) \]

For small angles the following approximation can be used:

\[ \dot{n} = u - v \delta \psi \quad (3) \]
\[ \dot{e} = u \delta \psi + v \quad (4) \]

Fermat's Last Theorem states that

\[ x^n + y^n = z^n \]

has no non-zero integer solutions for \( x, y \) and \( z \) when \( n > 2 \).
\documentclass{standalone}

\usepackage{tikz}
\usetikzlibrary{...

\begin{document}

\begin{tikzpicture}
  \% TikZ commands go here
\end{tikzpicture}

\end{document}
\draw (0,0) -- (1,1);
\draw (0,0) rectangle (1,1);
\draw (0,0) circle (0.5);
Coordinates

Cartesian Coordinates \((x,y)\)

\[
\text{\texttt{draw[blue]} (0,0) -- (2,1);}
\]

Polar coordinates \((\text{angle:radius})\)

\[
\text{\texttt{draw[blue]} (0,0) -- (45:1.7);}
\]

Relative Coordinates \(++(\text{rel}_x,\text{rel}_y)\)

\[
\text{\texttt{draw[blue]} (0,0) -- ++(0.5,0.5) -- ++(1,0) -- ++(0.5,0.5);}
\]

Define Coordinates

\[
\text{coordinate (A) at (0,0);}
\text{coordinate (B) at (1,1);}
\text{coordinate (C) at (2,0);}
\text{draw[blue]} (A) -- (B) -- (C);
\]
The \texttt{node} Command

A node is typically a rectangle or circle or another simple shape with some text on it

\begin{verbatim}
\node[rectangle,fill=green](rect) {Rectangle};
\end{verbatim}

Node positioning

\begin{verbatim}
\node[rectangle,fill=green](rect){Rectangle};
\node[circle,fill=red,below=of rect](circ){Circle};
\end{verbatim}

Connect nodes with lines

\begin{verbatim}
\node[rectangle,fill=green](rect){Rectangle};
\node[circle,fill=red,below=of rect](circ){Circle};
\draw[->] (rect) -- (circ);
\end{verbatim}
Style Definitions

Styles are defined by [] behind a command
\draw[red, very thick, dashed] (0,0) -- (1,0.1);

Styles can be named and defined locally or globally
\tikzset{my style/.style={tikz options}}
\tikzstyle{my style}=[tikz options] % deprecated

example
\tikzset{my dot/.style={blue, fill=green, thick}}
\draw[my dot] (0,0) circle (0.2);
\draw[my dot] (0.1,0.6) circle (0.2);
\draw[my dot, fill=red] (0.8,0.2) circle (0.2);
Exercise 1: UML Activity Diagram

- wake up
- tired?
  - yes
  - no
- start the day
- drink coffee
Exercise 1: UML Activity Diagram

\tikzset{start/.style ={circle,minimum width=0.3cm, minimum height=0.3cm, draw, fill}}
\node[start] (start) {};
\tikzset{activity/.style={rectangle, minimum width=1cm, minimum height=0.5cm, rounded corners=5pt, draw}}
\node[activity, below of = start] (action1) {wake up};
Exercise 1: UML Activity Diagram

\tikzset{decision/.style={diamond, minimum width=1cm, minimum height=1cm, draw}}
\node[decision, below = of action 1](decision 1){tired?};

\begin{itemize}
  \item wake up
\end{itemize}

\begin{itemize}
  \item tired?
\end{itemize}
Exercise 1: UML Activity Diagram

\node[activity, below = of decision1] (action2) {start the day};
\node[activity, right = of action2] (action3) {drink coffee};

- wake up
- tired?
  - start the day
  - drink coffee
Exercise 1: UML Activity Diagram

```latex
\tikzset{end/.style={draw, double=white, circle, inner sep=1pt, minimum width=0.3cm, minimum height=0.3cm}, node[end,below of = action2](end){};
```

- wake up
- tired?
- start the day
- drink coffee
Exercise 1: UML Activity Diagram

\draw[->](start) -- (action1);
\draw[->](action1) -- (decision1);
\draw[->](action3) -- (action2);
\draw[->](action2) -- (end);

wake up

\tired?

start the day

drink coffee
Exercise 1: UML Activity Diagram

\draw[->](decision1) -- node[above,very near start]{yes}(action3);
\draw[->](decision1) -- node[left,very near start]{no}(action2);

start the day

wake up

tired?

yes

no

start the day

drink coffee
Exercise 1: UML Activity Diagram - Solution I

\usetikzlibrary{shapes}
\begin{tikzpicture}
\tikzset{activity/.style={rectangle, minimum width=1cm, minimum height=0.5cm, rounded corners=5pt, draw}}
\tikzset{decision/.style={diamond, minimum width=1cm, minimum height=1cm, draw}}
\tikzset{end/.style={draw, double=white, circle, inner sep=1pt, minimum width=0.3cm, minimum height=0.3cm, fill}}
\tikzset{start/.style={circle, minimum width=0.3cm, minimum height=0.3cm, draw, fill}}
\node [start] (start) {};
\node [activity, below of=start] (action1) {wake up};
\node [decision, below of=action1] (decision1) {tired?};
\node [activity, below of=decision1] (action2) {start the day};
\node [activity, right of=action2] (action3) {drink coffee};
\node [end, below of=action2] (end) {};
Exercise 1: UML Activity Diagram - Solution II

\draw[-] (start) -- (action1);
\draw[-] (action1) -- (decision1);
\draw[-] (decision1) -- node[above, very near start] {yes} (action3);
\draw[-] (decision1) -| node[below, very near start] {no} (action2);
\draw[-] (action3) -- (action2);
\draw[-] (action2) -- (end);
\end{tikzpicture}
Exercise 2: p-p collision
Exercise 2: p-p collision - Solution I

\begin{tikzpicture}[scale=0.7, transform shape]
\tikzset{proton/.style={circle, black, thick, fill=red, minimum width=1.5cm, minimum height=1.5cm, draw}}
\tikzset{neutron/.style={circle, black, thick, fill=gray, minimum width=1.5cm, minimum height=1.5cm, draw}}
\tikzset{collision/.style={star, star points=8, star point ratio=0.2, black, thick, fill=yellow, minimum width=0.5cm, minimum height=0.5cm, draw}}
\tikzset{neutrino/.style={circle, black, thick, fill=blue, minimum width=0.8cm, minimum height=0.8cm, draw}}
\tikzset{positron/.style={circle, black, thick, fill=yellow, minimum width=1.2cm, minimum height=1.2cm, draw}}
\tikzset{myarrow/.style={->, shorten >=0.5cm, shorten <=0.5cm, very thick}}

\node[proton] (proton1) {};
\node[font=\Huge] {\textbf{p}};
\node[proton, below = 5cm] (proton2) {}
\node[font=\Huge] at (proton2) {\textbf{p}};
\node[collision, below right = 2.125cm and 4cm of proton1]
Exercise 2: p-p collision - Solution II

\begin{tikzpicture}

\node [positron, right = 8cm of proton1] (positron) {e$^+$};
\node [neutrino, right = 8cm of proton2] (neutrino) {$\nu$};
\node [proton, below right = 1.25 cm and 10 cm of proton1] (proton3) {p};
\node [neutron, below of = proton3] (neutron) {n};

\draw [myarrow] (proton1) -- (collision);
\draw [myarrow] (proton2) -- (collision);
\draw [myarrow] (collision) -- (positron);
\draw [myarrow] (collision) -- (neutrino);
\draw [myarrow] (collision) -- (proton3.south west);
\end{tikzpicture}
Plotting Data

\[ f(x) = 1 + \frac{1}{3}x^2 \]
Plotting data - Code

\begin{tikzpicture}[domain=0.2:6]
\draw[->, >=stealth'] (-0.2,0) -- (7,0) node[right] \{\(x\)\};
\draw[->, >=stealth'] (0,-0.2) -- (0,6) node[above] \{\(f(x)\)\};
\foreach \x in {0.5,1,1.5,2,2.5,3,3.5,4,4.5,5,5.5,6,6.5}
  \draw (\x,2pt) -- (\x,-3pt);
\foreach \x in {0,1,2,3,4,5,6}
  \node at (\x,-6pt) [anchor=north] \{\footnotesize \(\x\)\};
\foreach \y/\ytext in {0.5,1,1.5,2,2.5,3,3.5,4,4.5,5,5.5}
  \draw (2pt,\y) -- (-3pt,\y cm);
\foreach \y/\ytext in {0,1,2,3,4,5}
  \node at (-6pt,\y) [anchor=east] \{\footnotesize \(\ytext\)\};
\draw plot[only marks, mark=x, mark options={kit-blue100, thick}]
  file {working_material/measurement.dat};
\draw[color=kit-green100] plot[smooth] (\x, \{1+pow((1/3)*\x, 2)})
  node[right, xshift=6mm] \{\(f(x) = 1+\frac{1}{3}x^2\)\};
\end{tikzpicture}
Mind Map

Computer Science

- theoretical
- technical
- applied
- databases
- WWW
- practical
  - algorithms
  - data structures
  - programming languages
  - software engineering

TikZ Commands

Christian Amstutz, Tanja Harbaum, Ewa Holt – Short title

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\usetikzlibrary{mindmap,trees}

\begin{tikzpicture}[scale=0.5,transform shape]
  \path[mindmap,concept color=black,text=white]
    node[concept] {Computer Science}
    [clockwise from=0]
    child[concept color=green!50!black] {
      node[concept] {practical}
      [clockwise from=90]
      child { node[concept] {algorithms} }
      child { node[concept] {data structures} }
      child { node[concept] {programming languages} }
      child { node[concept] {software engineering} }
    }
    child[concept color=blue] {
      node[concept] {applied}
      [clockwise from=-30]
      child { node[concept] {databases} }
      child { node[concept] {WWW} }
    }
\end{tikzpicture}
child[concept color=red] { node[concept] {technical} }
child[concept color=orange] { node[concept] {theoretical} };
\end{tikzpicture}
Fancy Examples - Polarizing Microscope

Source: http://www.texample.net
Fancy Examples - Dipolar magnetic field

Source: http://www.texample.net
More information

Website with nice TikZ examples:
http://www.texample.net/tikz/examples

A very minimal introduction to TikZ - A short and good introduction:
http://cremeronline.com/LaTeX/minimaltikz.pdf

TikZ PGF Manual (Version 3.0) - great resource written in clear, comprehensible language:

TikZ Cheat Sheet - Short cheatsheet far from being complete:
http://home.snc.edu/andershendrickson/tex/TikZcheatsheet.pdf

This tutorial with all the sources:
https://github.com/camstutz/tikz_tutorial
Thank you for your attention