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

Source: http://www.texample.net
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 easy to learn.
Scaling Effects

Raster Graphic (JPG)  Vector Graphic (PDF)  TikZ

\( \sin(x) \)  \( \sin(x) \)  \( \sin(x) \)

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

\begin{align*}
\dot{n} &= u \cos \psi - v \sin \psi \quad (1) \\
\dot{e} &= u \sin \psi + v \cos \psi \quad (2)
\end{align*}

For small angles the following approximation can be used:

\begin{align*}
\dot{n} &= u - v \delta \psi \quad (3) \\
\dot{e} &= u \delta \psi + v \quad (4)
\end{align*}

Fermat's Last Theorem states that

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

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

Layer 0

Pattern 1

Layer 1

Pattern 2

Layer 2

Pattern 3

Layer 3

Pattern 4

Output Bus

matchline
\documentclass{standalone}
\usepackage{tikz}
\usetikzlibrary{ ... }

\begin{document}
\begin{tikzpicture}
\tikzstyle{every picture}+=[scale=0.5,transform shape]
\draw (0,0) -- (2,2);
\end{tikzpicture}
\end{document}
The `\draw` Command

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

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

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

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

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

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

Node positioning

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

Connect nodes with lines

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

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

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

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

1. Wake up
2. Tired?
   - Yes: Start the day
   - No: Drink coffee

This diagram illustrates a simple decision process for starting the day.
Exercise 1: UML Activity Diagram

```latex
\tikzset{start/.style ={circle,minimum width=0.3cm,
minimum height=0.3cm, draw, fill}}
\node[start] (start) {};
```

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

\tikzset{decision/.style={diamond, minimum width=1cm, minimum height=1cm, draw}}
\node[decision, below = of action1](decision1){tired?};

wake up

tired?
Exercise 1: UML Activity Diagram

\node[activity, below = of decision1] (action2) {start the day};
\node[activity, right = of action2] (action3) {drink coffee};
\tikzset{end/.style={draw,double=white, circle, inner sep=1pt, minimum width=0.3cm, minimum height=0.3cm}}

\node[end,below of = action2](end){};

\begin{tikzpicture}
  \node[circle,draw] (action1) {wake up};
  \node[rectangle,draw] (action2) {tired?};
  \node[circle,draw] (action3) {start the day};
  \node[circle,draw] (action4) {drink coffee};
  \node[end,below of = action2](end){};
\end{tikzpicture}
Exercise 1: UML Activity Diagram

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

start the day          drink coffee
Exercise 1: UML Activity Diagram

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

wake up

\begin{tikzpicture}
  \node (start) [circle, draw] {wake up};
  \node (tired) [diamond, below of=start] {tired?} edge (start);
  \node (no) [below of=tired, left] {no} edge (tired);
  \node (yes) [below of=tired, right] {yes} edge (tired);
  \node (start_day) [below of=yes, left] {start the day} edge (yes);
  \node (coffee) [below of=yes, right] {drink coffee} edge (yes);
\end{tikzpicture}
Exercise 1: UML Activity Diagram - Solution I

\usetikzlibrary{shapes}
\begin{tikzpicture}
\tikzset{activity/.style={rectangle, minimum width=1cm, minimum height=0.5 cm, 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=0.3 cm, minimum height=0.3 cm, fill}}
\tikzset{start/.style={circle, minimum width=0.3 cm, minimum height=0.3 cm, draw, fill}}
\node[start] (start) {};
\node[activity, below of = start] (action 1) {wake up};
\node[decision, below = of action 1] (decision 1) {tired ?};
\node[activity, below = of decision 1] (action 2) {start the day};
\node[activity, right = of action 2] (action 3) {drink coffee};
\node[end, below of = action 2] (end) {};
\draw[-] (start) -- (action 1);
\draw[-] (action 1) -- (decision 1);
\draw[-] (decision 1) -- node[left, very near start] {no} (action 2);
\draw[-] (decision 1) -- node[above, very near start] {yes} (action 3);
\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={-latex, shorten >=0.5cm, shorten <=0.5cm, very thick}}

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

\begin{tikzpicture}
  \node[positron, right = 8cm of proton1] (positron1) {e^+};
  \node[font=\Huge] at (positron1) {\textbf{e^+}};
  \node[neutrino, right = 8cm of proton2] (neutrino1) {$\nu$};
  \node[font=\Huge] at (neutrino1) {$\nu$};
  \node[proton, below right = 1.25cm and 10cm of proton1] (proton3) {p};
  \node[font=\Huge] at (proton3) {p};
  \node[neutron, below of = proton3] (neutron1) {n};
  \node[font=\Huge] at (neutron1) {n};
  \draw[myarrow] (proton1) -- (collision1);
  \draw[myarrow] (proton2) -- (collision1);
  \draw[myarrow] (collision1) -- (positron1);
  \draw[myarrow] (collision1) -- (neutrino1);
  \draw[myarrow] (collision1) -- (proton3.south west);
\end{tikzpicture}
Feynman Diagram
\begin{tikzpicture}[xscale=0.5, yscale=0.5]
\draw[help lines] (0,0) grid (10,10);
\draw[thick] (0.5,5) -- (3.5,8);
\draw[-latex,thick] (1.5,6) -- (2,6.5);
\node[above] at (2,6.5){q};
\draw[fill] (3.5,8) circle [radius=0.1];
\draw[domain=3.5:6.5, thick, samples=200] plot (\x,\{8+0.1*sin(1000*\x)\});
\node[above] at (5,8){W};
\draw[fill] (6.5,8) circle [radius=0.1];
\draw[thick] (6.5,8) -- (9.5,5);
\draw[-latex,thick] (7.5,7) -- (8,6.5);
\node[above] at (8,6.5){q};
\draw[thick,decoration={markings, mark=at position 0.6 with \arrow{latex}}] (3.5,8) to [out=-90, in=160] (5,5);
\node[left] at (3.7,6.5){q};
\draw[thick,decoration={markings, mark=at position 0.5 with \arrow{latex}}] (5,5) to [out=20, in=270] (6.5,8);
\node[right] at (6.3,6.5){q};
\draw [fill] (5,5) circle [radius=0.1];
\draw [domain=4:5, thick, samples=200, rotate=90] plot (\x,{-5+0.1*sin(1000*\x)});\end{tikzpicture}
\node[right] at (5,4.5)\{g\};
\draw[fill] (5,4) circle [radius=0.1];
\draw[thick] (2,3) -- (5,4);
\draw[-latex,thick] (2,3) -- (3.5,3.5);
\node[above] at (3.5,3.5)\{q\};
\draw[thick] (5,4) -- (8,3);
\draw[-latex,thick] (5,4) -- (6.5,3.5);
\node[above] at (6.5,3.5)\{q\};
\end{tikzpicture}
Plotting Data

\[ f(x) = 1 + \frac{1}{3}x^2 \]
\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}
\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 - Dipolar magnetic field

\[ \vec{B}_r \quad \vec{B}_\theta \]

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