Karlsruhe Institute of Technology

TikZ Tutorial

KSETA Doktorandenworkshop 2014

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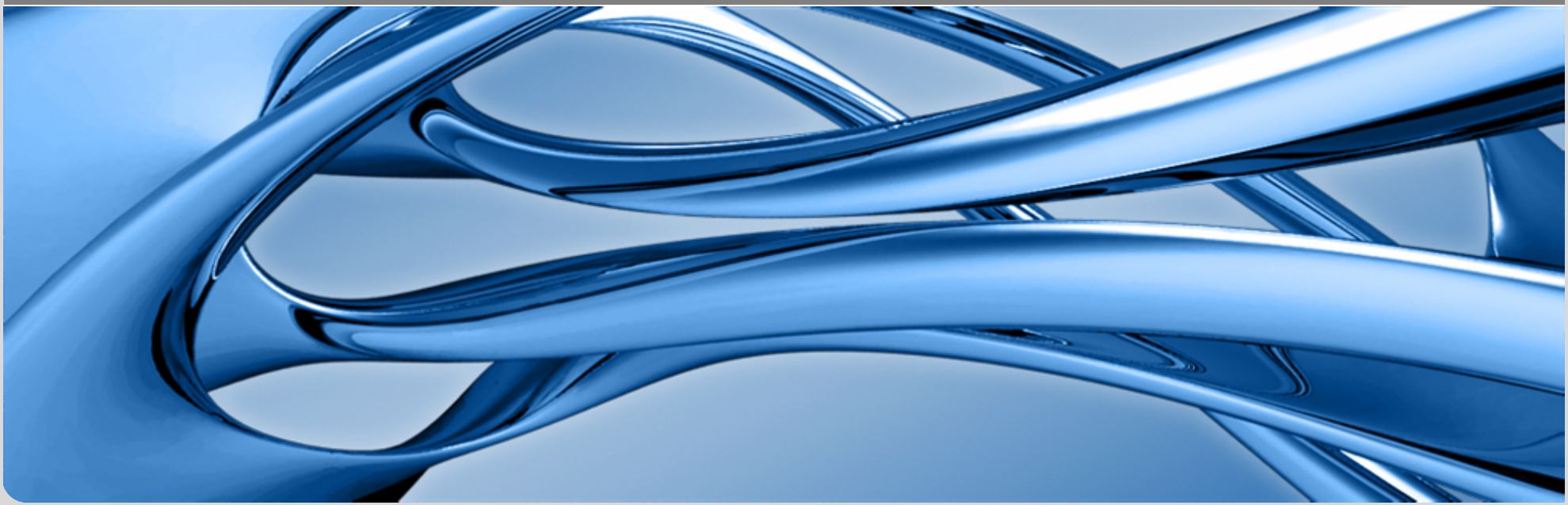
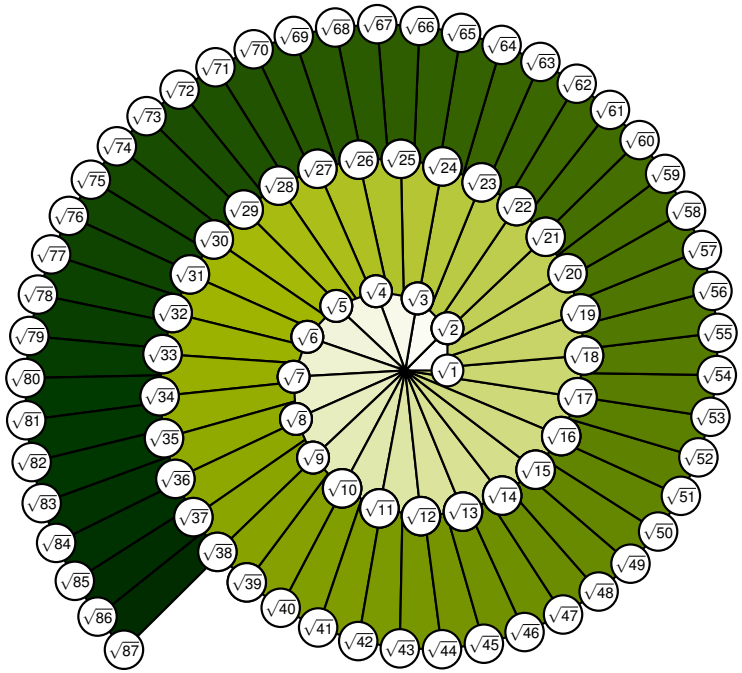


Outline

- 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

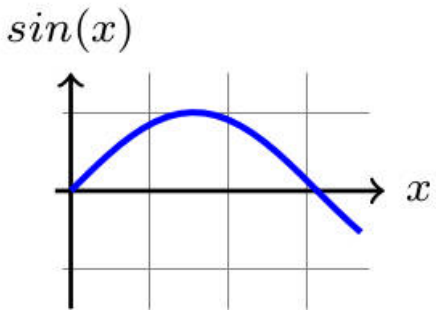
Why using TikZ?

- 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

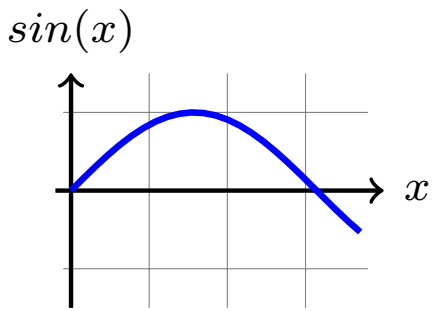
But be warned! It is not easy to learn.

Scaling Effects

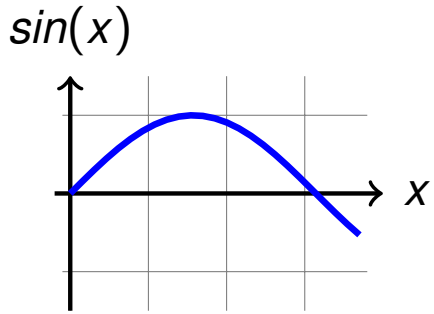
Raster Graphic (JPG)

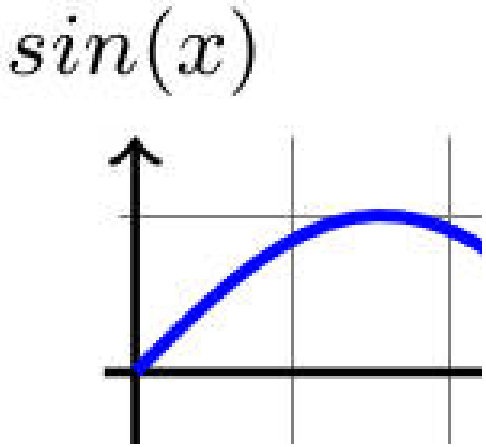


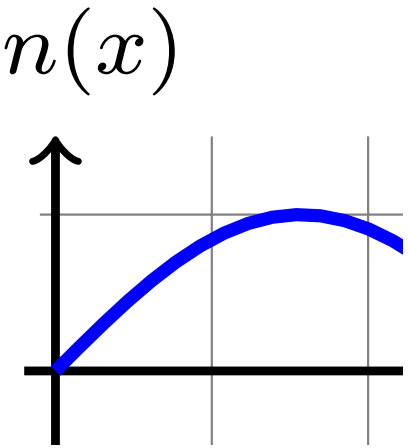
Vector Graphic (PDF)

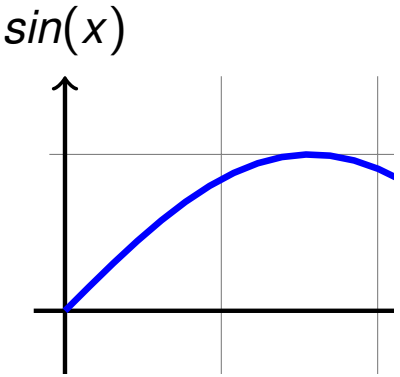


TikZ









Math Environment

A fancy title

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:

$$\dot{n} = u - v\delta_\psi \quad (3)$$
$$\dot{e} = u\delta_\psi + v \quad (4)$$

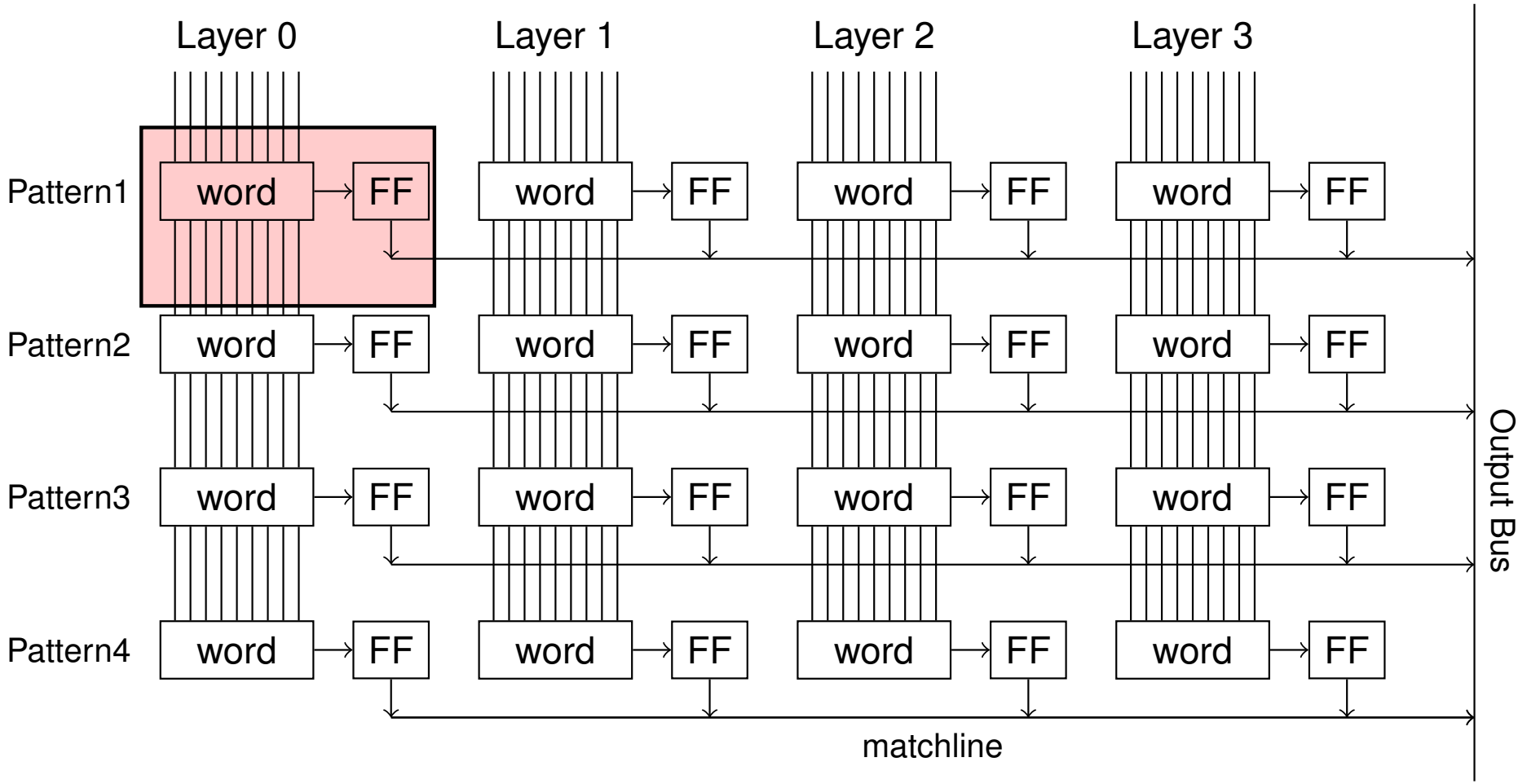
Fermat's Last Theorem

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

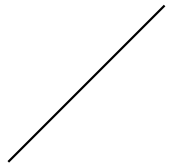

Layer 0
Layer 1
Layer 2
Layer 3
Pattern1
Pattern2
Pattern3
Pattern4
word
FF
Output Bus
matchline

Setting up the Environment in LaTeX

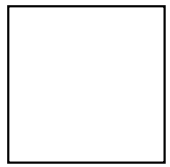
```
\documentclass{standalone}

\usepackage{tikz}
\usetikzlibrary{ ... }

\begin{document}

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

\end{document}
```

The \draw Command

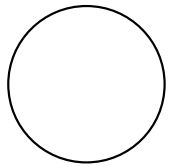
```
\draw (0,0) -- (1,1);
```



```
\draw (0,0) rectangle (1,1);
```



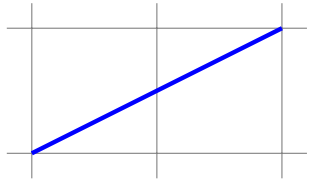
```
\draw (0,0) circle (0.5);
```



Coordinates

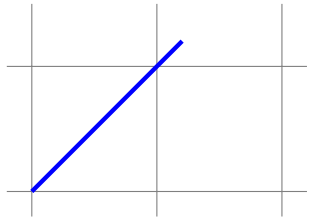
Cartesian Coordinates (x,y)

```
\draw[blue] (0,0) -- (2,1);
```



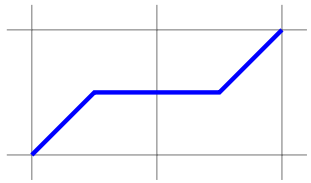
Polar coordinates (angle:radius)

```
\draw[blue] (0,0) -- (45:1.7);
```



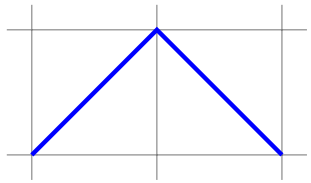
Relative Coordinates ++(rel_x,rel_y)

```
\draw[blue] (0,0) -- ++(0.5,0.5) -- ++(1,0)
            -- ++(0.5,0.5);
```



Define Coordinates

```
\coordinate (A) at (0,0);
\coordinate (B) at (1,1);
\coordinate (C) at (2,0);
\draw[blue] (A) -- (B) -- (C);
```



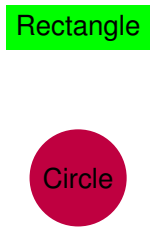
The \node Command

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

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

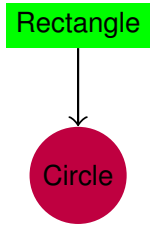
Node positioning

```
\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

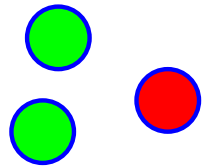
```
\draw[red,very thick,dashed] (0,0) -- (1,0.1);
```

Styles can be named and defined locally or globally

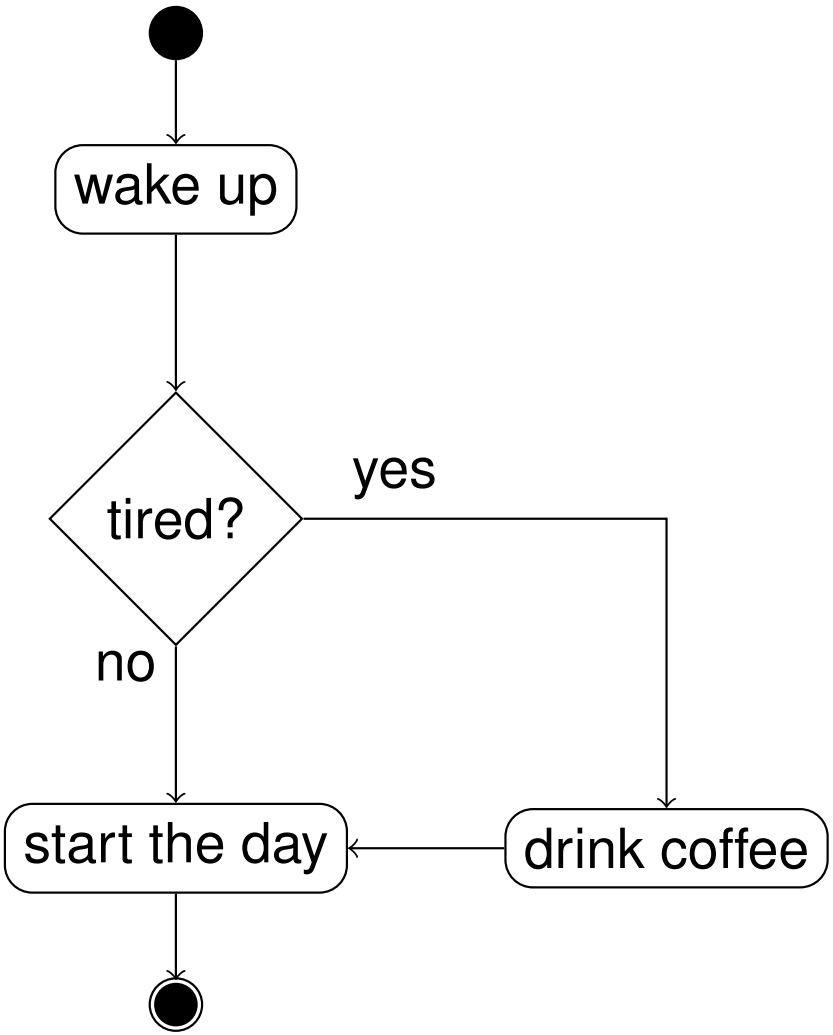
```
\tikzset{my style/.style={tikz options}}
\tikzstyle{my style}=[tikz options]        % deprecated
```

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



Exercise 1: UML Activity Diagram

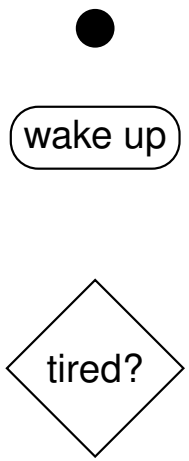
```
\tikzset{start/.style ={circle,minimum width=0.3cm,
                        minimum height=0.3cm, draw, fill}}
\node[start] (start) {};
```

Exercise 1: UML Activity Diagram

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

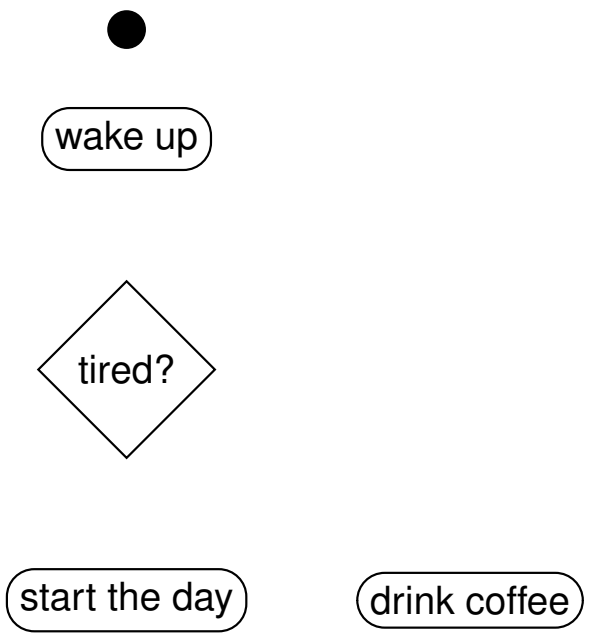
Exercise 1: UML Activity Diagram

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



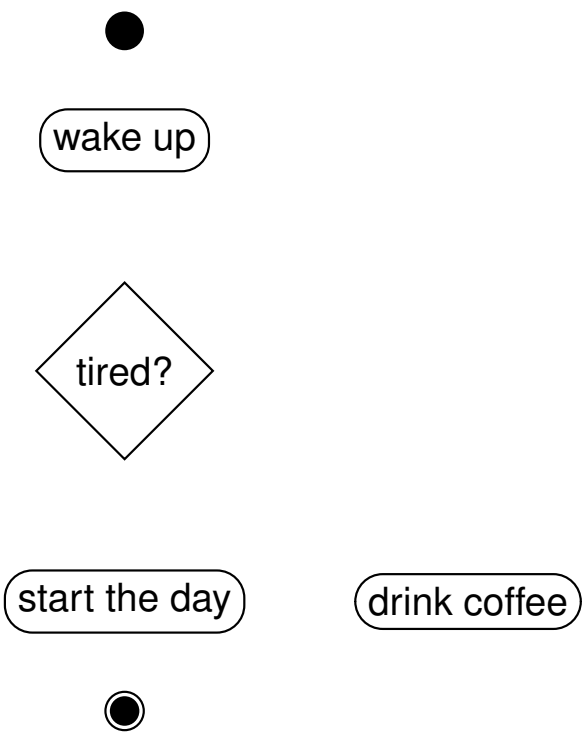
Exercise 1: UML Activity Diagram

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



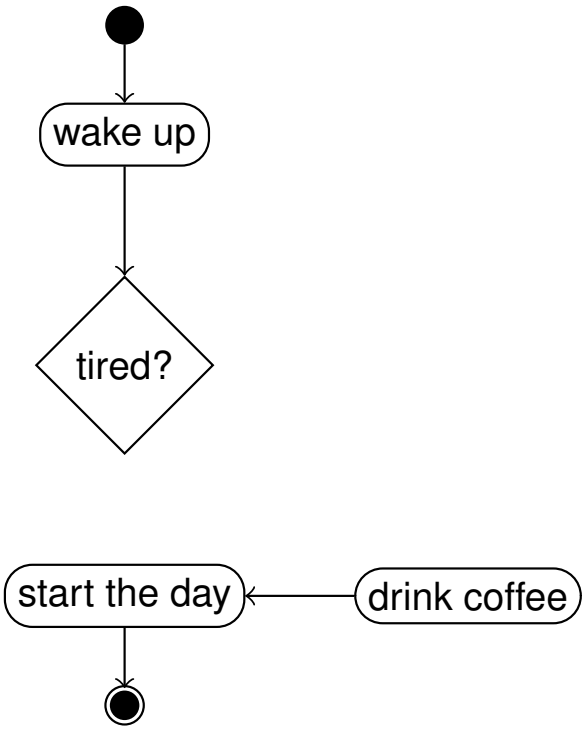
Exercise 1: UML Activity Diagram

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



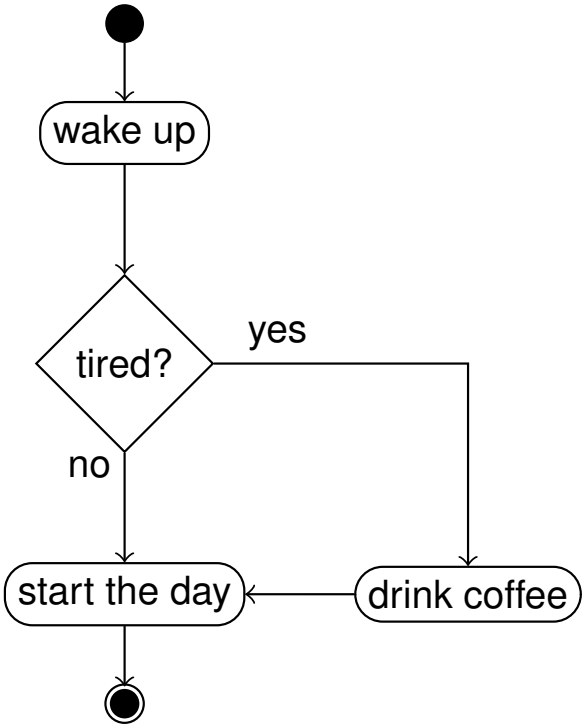
Exercise 1: UML Activity Diagram

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



Exercise 1: UML Activity Diagram

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



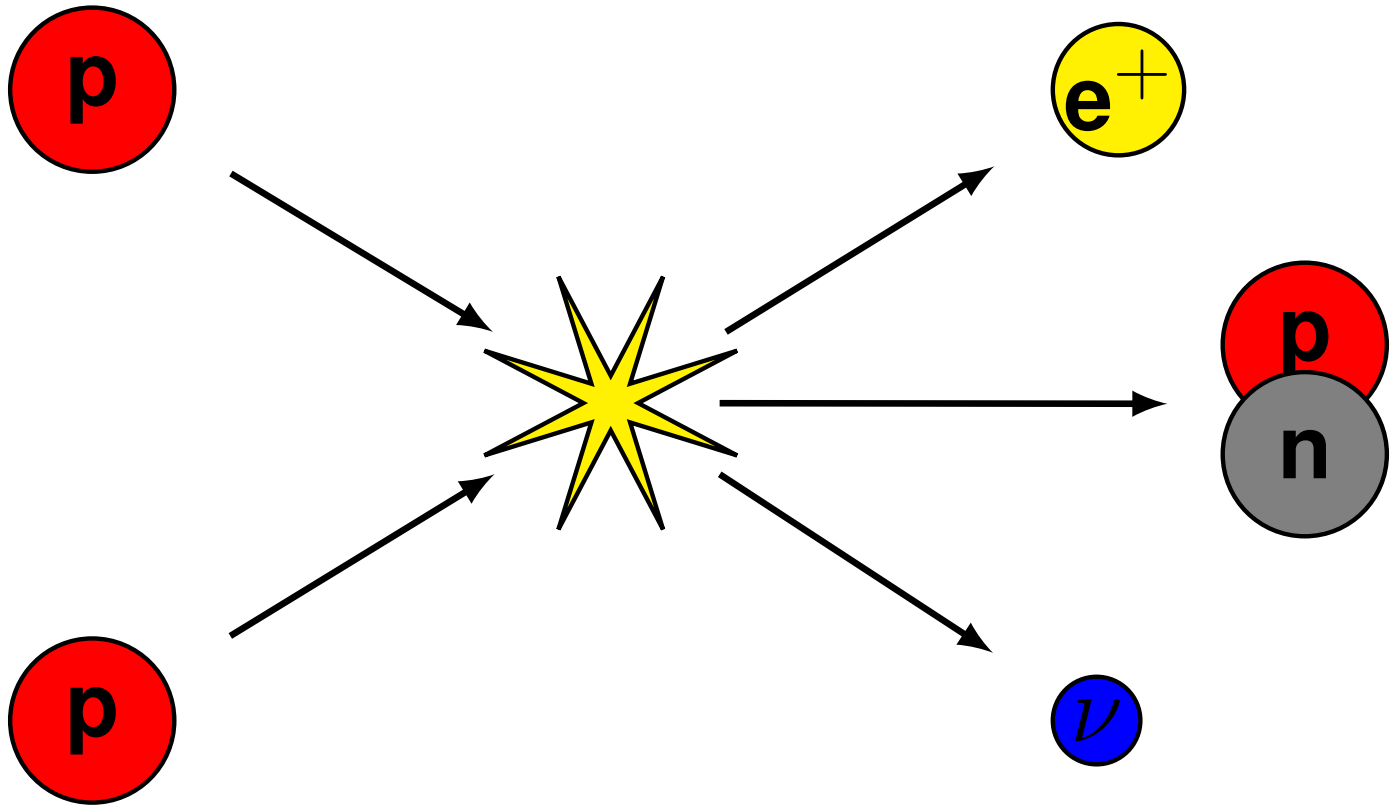
Exercise 1: UML Activity Diagram - Solution I

```
%\usetikzlibrary{shapes}
\begin{tikzpicture}

\tikzset{activity/.style={rectangle,minimum width=1cm,minimum height
\tikzset{decision/.style={diamond,minimum width=1cm,minimum height=1
\tikzset{end/.style={draw,double=white, circle, inner sep=1pt,minimu
\tikzset{start/.style={circle,minimum width=0.3cm,minimum height=0.3

\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){};

\draw[->](start) -- (action1);
\draw[->](action1) -- (decision1);
\draw[->](decision1) -- node [left,very near start]{no} (action2);
\draw[->](decision1) -| node [above,very near start]{yes} (action3)
```

Exercise 1: UML Activity Diagram - Solution II

```
\draw[->](action3) -- (action2);
\draw[->](action2) -- (end);

\end{tikzpicture}
```

Exercise 2: p-p collision



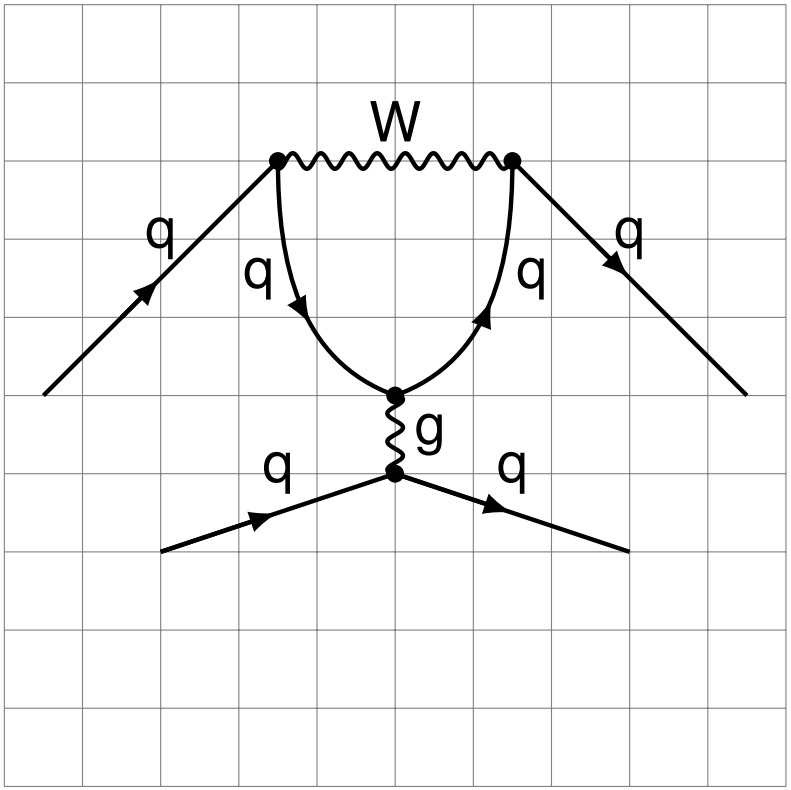
Exercise 2: p-p collision - Solution I

```
\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] {\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

```
                (collision1) {};
\node[positron, right = 8cm of proton1] (positron1) {};
\node[font=\Huge] at (positron1) {\textbf{e$^+$}};
\node[neutrino, right = 8cm of proton2] (neutrino1) {};
\node[font=\Huge] at (neutrino1) {\textbf{$\nu$}};
\node[proton, below right = 1.25cm and 10cm of proton1]
                (proton3) {};
\node[font=\Huge] at (proton3) {\textbf{p}};
\node[neutron, below of = proton3] (neutron1) {};
\node[font=\Huge] at (neutron1) {\textbf{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



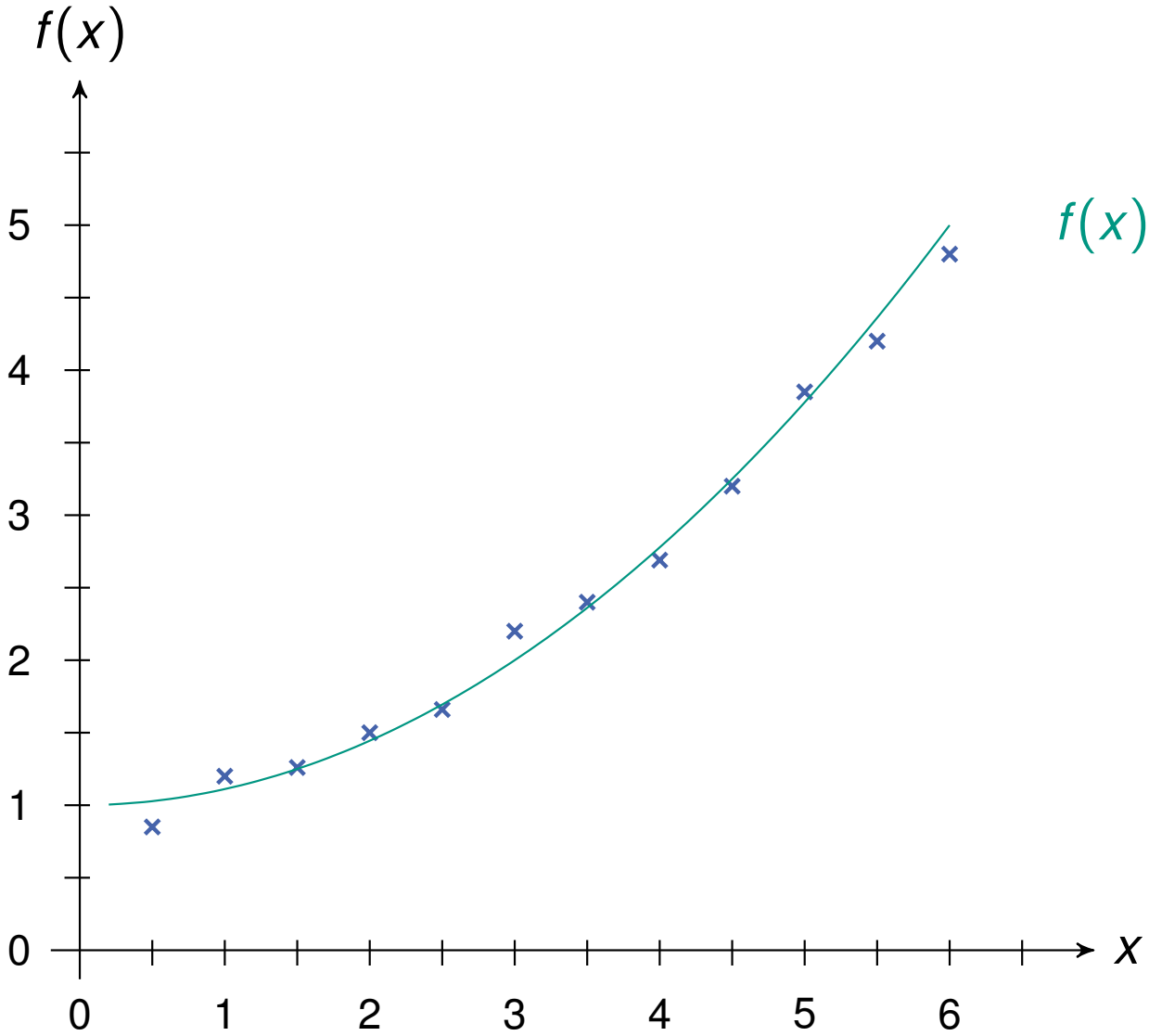
Feynman Diagram - Code I

```
\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(1
    \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 {\ar
                (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
                (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
```

Feynman Diagram - Code II

```
    \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

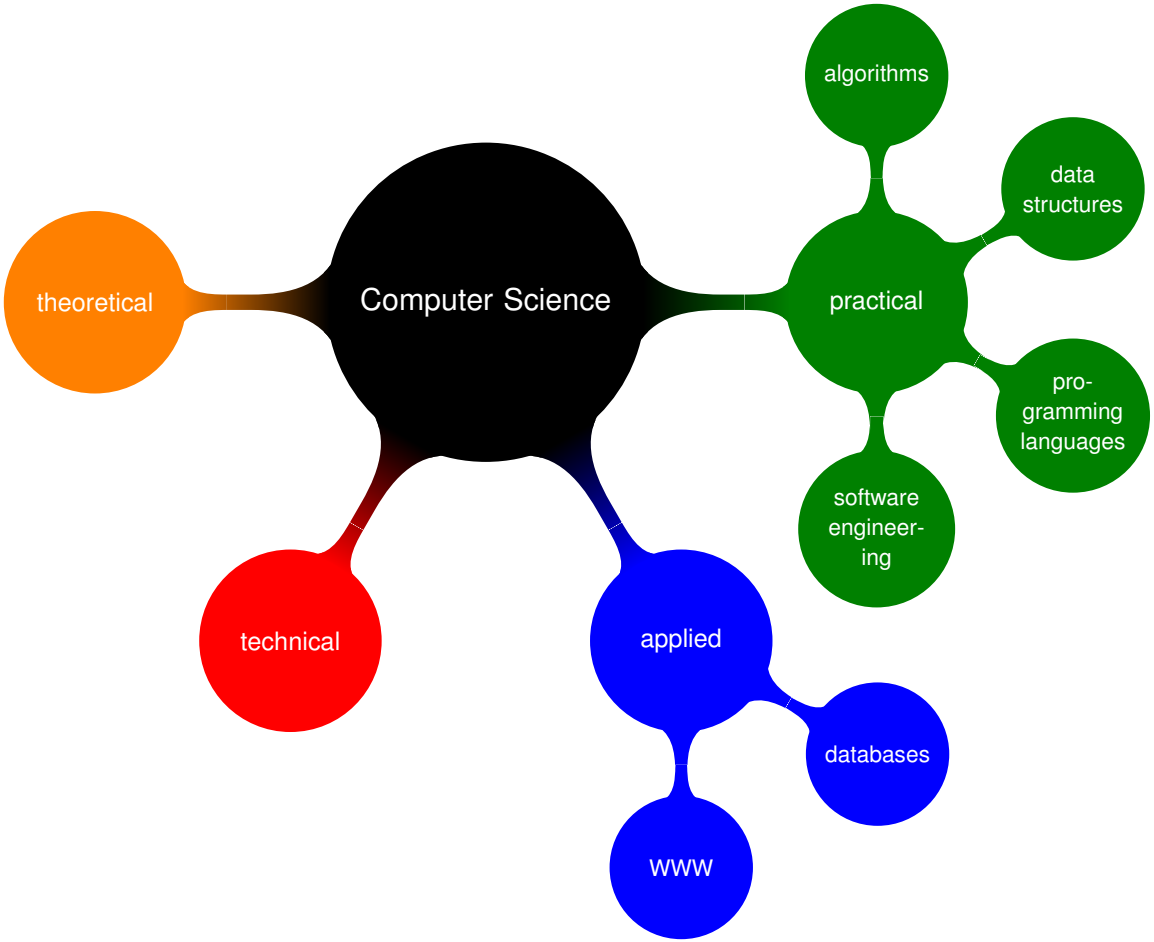


$$f(x) = 1 + \frac{1}{3}x^2$$

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


algorithms
data structures
theoretical
Computer Science
practical
pro-gramming languages
software engineer-ing
technical
applied
databases
www

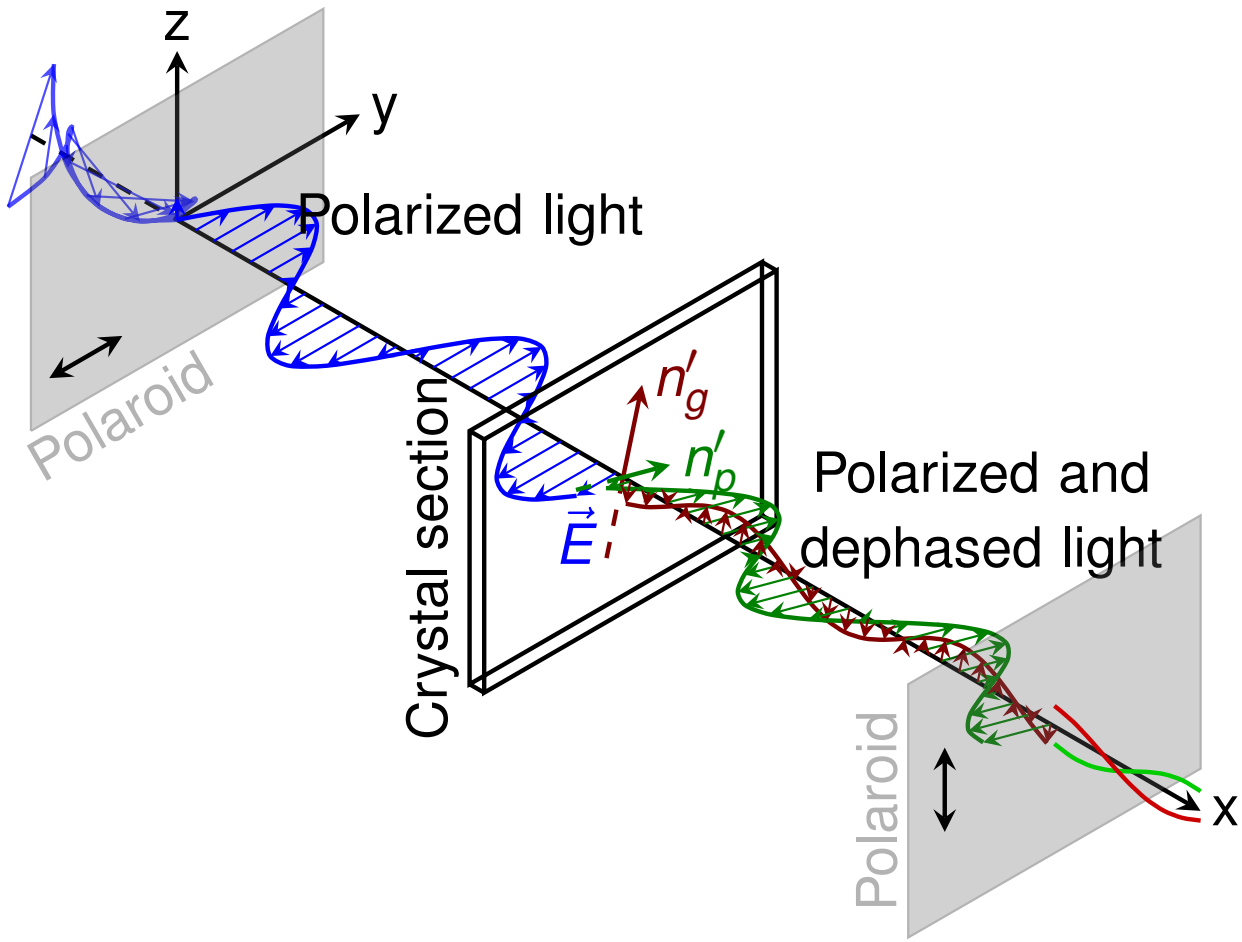
Mind Map - Code I

```
\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] {pro\-gramming languages} }
      child { node[concept] {software engineer\-ing} }
    }
    child[concept color=blue] {
      node[concept] {applied}
      [clockwise from=-30]
      child { node[concept] {databases} }
      child { node[concept] {WWW} }
    }
```

Mind Map - Code II

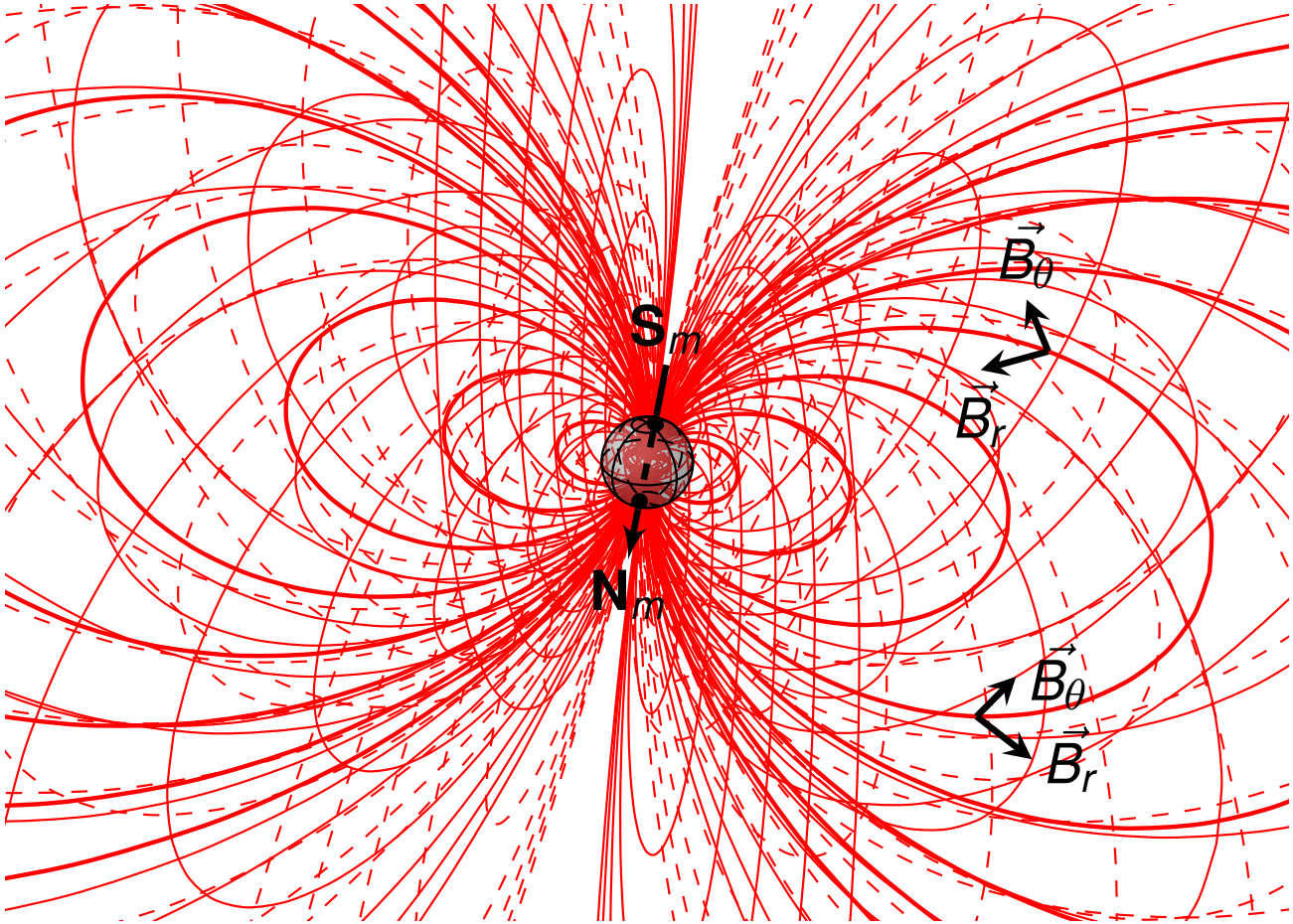
```
    child[concept color=red] { node[concept] {technical} }
    child[concept color=orange] { node[concept] {theoretical} };
\end{tikzpicture}
```

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:

http://mirrors.ctan.org/graphics/pgf/base/doc/pgfmanual.pdf

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