TikZ tutorial

How (and why) do I use TikZ to make my figures?

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Why do I use TikZ?

- When I was a student, I used to make my pictures with \texttt{xfig}. 
Why do I use TikZ?

- When I was a student, I used to make my pictures with xfig.
- Then I started to use psfrag to include LaTeX symbols...

```latex
\begin{center}
\psfrag{transfo}{$\rightsquigarrow$}
\psfrag{W}{$\Sigma$}
\psfrag{Wfleche}{$\Sigma^{(\uparrow)}$}
\includegraphics[width=3cm]{Wfleche}
\end{center}
```
Why do I use TikZ?

- When I was a student, I used to make my pictures with xfig.

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\end{center}

- But I was still not really convinced by the result!
What is TikZ?

TikZ is a \LaTeX\ package for generating vector graphics.

\usepackage{tikz}

You use commands to program your graphic, using either relative or absolute coordinates.

Many examples on http://www.texample.net/tikz/.
Before/After

Sliding block map on the free monoid $\mathbb{M}_2$
Before/After

Sliding block map on the free monoid $\mathbb{M}_2$

$\Phi(x)$

$\phi(p_1)$

$\phi(p_2)$

$\phi(p_3)$
Easy example

\begin{tikzpicture}
\draw (0,0) -- (1,0) -- (2,1) -- (3,1);
\end{tikzpicture}
Easy example

\begin{tikzpicture}
\draw (0,0) -- (1,0) -- (2,1) -- (3,1);
\end{tikzpicture}

\begin{tikzpicture}
\draw (0,0) -- (1,0) rectangle (2,1) -- (3,1);
\end{tikzpicture}

\begin{tikzpicture}
\draw[thick,color=red] (0,0) -- (1,0) rectangle (2,1) -- (3,1);
\end{tikzpicture}

\begin{tikzpicture}
\draw[very thick,color=red, fill=red!25] (0,0) -- (1,0) rectangle (2,1) -- (3,1);
\draw (1.5,0.5) node{$\Sigma_i$};
\end{tikzpicture}
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\draw [very thick, color=red, fill=red!25] (0,0) -- (1,0) rectangle (2,1) -- (3,1);
\draw (1.5,0.5) node {\$\Sigma_i\$};
\end{tikzpicture}
Create your own colors!

\definecolor{orange}{RGB}{255,140,0}

This is blue.
This is red.
This is yellow.
This is green.

This is bleu.
This is rouge.
This is orange.
This is vert.
Wang tiles

\draw [black, fill=vert] (0,0)--(0.5,0.5)--(0,1)--cycle;
\draw [black, fill=bleu] (0,0)--(0.5,0.5)--(1,0)--cycle;
\draw [black, fill=bleu] (1,1)--(0.5,0.5)--(1,0)--cycle;
\draw [black, fill=rouge] (1,1)--(0.5,0.5)--(0,1)--cycle;
\draw [black, fill=vert] (0,1)--(0.5,1.5)--(0,2)--cycle;
\draw [black, fill=bleu] (0,1)--(0.5,1.5)--(1,1)--cycle;
\draw [black, fill=bleu] (1,2)--(0.5,1.5)--(1,1)--cycle;
\draw [black, fill=rouge] (1,2)--(0.5,1.5)--(0,2)--cycle;
Wang tiles

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\draw [black,fill=bleu] (1,1)--(0.5,0.5)--(1,0)--cycle;
\draw [black,fill=rouge] (1,1)--(0.5,0.5)--(0,1)--cycle;
\draw [black,fill=vert] (0,0)--(0.5,0.5)--(0,1)--cycle;
\draw [black,fill=bleu] (0,0)--(0.5,0.5)--(1,0)--cycle;
\draw [black,fill=bleu] (1,1)--(0.5,0.5)--(1,0)--cycle;
\draw [black,fill=rouge] (1,1)--(0.5,0.5)--(0,1)--cycle;

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\draw [black,fill=rouge] (1,1)--(0.5,0.5)--(0,1)--cycle;
\draw [black,fill=vert] (0,0)--(0.5,0.5)--(0,1)--cycle;
\draw [black,fill=bleu] (0,0)--(0.5,0.5)--(1,0)--cycle;
\draw [black,fill=bleu] (1,1)--(0.5,0.5)--(1,0)--cycle;
\draw [black,fill=rouge] (1,1)--(0.5,0.5)--(0,1)--cycle;
\draw [black,fill=vert] (0,1)--(0.5,1.5)--(0,2)--cycle;
\draw [black,fill=bleu] (0,1)--(0.5,1.5)--(1,1)--cycle;
\draw [black,fill=bleu] (1,2)--(0.5,1.5)--(1,1)--cycle;
\draw [black,fill=rouge] (1,2)--(0.5,1.5)--(0,2)--cycle;
Wang tiles with a dedicated command

\newcommand{\wang}[6]{
\draw [black,fill=#3] (#1,#2)--(#1+0.5,#2+0.5)--(#1,#2+1)--cycle;
\draw [black,fill=#4] (#1,#2)--(#1+0.5,#2+0.5)--(#1+1,#2)--cycle;
\draw [black,fill=#5] (#1+1,#2+1)--(#1+0.5,#2+0.5)--(#1+1,#2)--cycle;
\draw [black,fill=#6] (#1+1,#2+1)--(#1+0.5,#2+0.5)--(#1,#2+1)--cycle;
}

... 

\begin{document}
\wang{0}{0}{vert}{bleu}{bleu}{rouge}
\wang{0}{1}{vert}{rouge}{bleu}{rouge}
\end{document}
Wang tiles and loops

\begin{tikzpicture}
\foreach \x in {0,...,4} {
    \foreach \y in {0,...,4} {
        \wang{\x}{\y}{vert}{rouge}{vert}{rouge}
    }
}
\end{tikzpicture}
Nested foreach loops in TikZ

\begin{tikzpicture}
\foreach \x in {0,...,4} {
  \foreach \y in {0,...,4} {
    ...
  }
}
\end{tikzpicture}

is allowed!

Better solution: generate TikZ commands with an external program
Nested foreach loops in TikZ

\begin{tikzpicture}
\foreach \x in {0,...,4} {
  \foreach \y in {0,...,4} {
    ...
  }
}
\end{tikzpicture}

is allowed!

\begin{tikzpicture}
\foreach \x in {0,...,4} {
  \foreach \y in {0,...,2*\x} {
    ...
  }
}
\end{tikzpicture}

is not allowed!
Nested foreach loops in TikZ

\begin{tikzpicture}
  \foreach \x in {0,...,4} {
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      ...
    }
  }
\end{tikzpicture}

is allowed!

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  \foreach \x in {0,...,4} {
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      ...
    }
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\end{tikzpicture}

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It is nevertheless possible to use a different syntax to make it work...
Nested foreach loops in TikZ

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It is nevertheless possible to use a different syntax to make it work...

Better solution: generate TikZ commands with an external program
Robinson tileset in TikZ

\newcommand{\robinsonempty}[4]{
\begin{scope}[shift={(#1,#2)},rotate=#3]
\draw[fill=#4] (0,0.1)--(0.1,0)--(0.4,0)-- "blabla" --cycle ;
\end{scope}
}
\newcommand{\robinsonempty}[4]{
  \begin{scope}[shift={(#1,#2)},rotate=#3]
  \draw[fill=#4] (0,0.1)--(0.1,0)--(0.4,0)-- "blabla" --cycle ;
  \end{scope}
}
The clip command

\begin{tikzpicture}
...
"blabla"
...
\end{tikzpicture}
The clip command

\begin{tikzpicture}
\clip (0,0) rectangle (5,5);
...
"blabla"
...
\end{tikzpicture}
Pentagonal Wang tiles in the hyperbolic plane

\newcommand{\hypertilecolored}[4]{
\begin{scope}[shift={(#1,#2)}]
\draw[fill=#4] (0,0) -- (0,1) to [controls=+(45:0.75) and +(135:0.75)] (2,1) -- (2,0) to [controls=+(135:0.375) and +(45:0.375)] (1,0) to [controls=+(135:0.375) and +(45:0.375)] (0,0) -- cycle ;
\draw (1,0.625) node{#3};
\end{scope}
}

\begin{tikzpicture}
\hypertilecolored{0}{0}{good}{bleu!25}
\hypertilecolored{2}{0}{good}{bleu!25}
\end{tikzpicture}
Pentagonal Wang tiles in the hyperbolic plane

\begin{tikzpicture}
\hypertilecolored{0}{0}{good}{bleu!25}
\hypertilecolored{2}{0}{good}{bleu!25}
\end{tikzpicture}
\newcommand{\hypertilecolored}[5]{
  \begin{scope}[shift={(#1,#2)},scale=#3]
  \draw[fill=#5] (0,0) -- (0,1) to \\
  [controls=+(45:0.75) and +(135:0.75)] (2,1) -- (2,0) to \\
  [controls=+(135:0.375) and +(45:0.375)] (1,0) to \\
  [controls=+(135:0.375) and +(45:0.375)] (0,0) -- cycle ;
  \draw (1,0.625) node{#4};
  \end{scope}
}

\begin{tikzpicture}
\hypertilecolored{0}{0}{1}{big}{bleu!25}
\hypertilecolored{2}{0}{1}{big}{bleu!25}
\hypertilecolored{0}{-0.5}{0.5}{small}{bleu!25}
\hypertilecolored{0}{-0.75}{0.25}{tiny}{bleu!25}
\end{tikzpicture}
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  [controls=+(135:0.375) and +(45:0.375)] (1,0) to \\
  [controls=+(135:0.375) and +(45:0.375)] (0,0) -- cycle ;
  \draw (1,0.625) node{#4};
  \end{scope}
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  [controls=+(135:0.375) and +(45:0.375)] (1,0) to
  [controls=+(135:0.375) and +(45:0.375)] (0,0) -- cycle ;
  \draw (1,0.625) node{\scalebox{#3}{#4}};
  \end{scope}
}

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\begin{tikzpicture}
\hypertilecolored{0}{0}{1}{big}{bleu!25}
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\hypertilecolored{0}{-0.75}{0.25}{tiny}{bleu!25}
\end{tikzpicture}
Scale and loops

\begin{tikzpicture}
\foreach \x in {0,...,4} {
    \hypertilecoloredbis{2*\x}{0}{1}{big}{bleu!25}
}
\foreach \x in {0,...,9} {
    \hypertilecoloredbis{\x}{-0.5}{0.5}{small}{bleu!25}
}
\foreach \x in {0,...,19} {
    \hypertilecoloredbis{0.5*\x}{-0.75}{0.25}{tiny}{bleu!25}
}
\end{tikzpicture}
You can also insert a tiny version of your tile inside some text. This pentagonal Wang tile \newcommand{\tuile}{\vbox to 13pt{\hbox{\begin{tikzpicture}[scale=0.2]
\draw (0,0) -- (0,2) to [controls=+(45:1.5) and +(135:1.5)] (4,2) -- (4,0) to [controls=+(135:0.75) and +(45:0.75)] (2,0) to [controls=+(135:0.75) and +(45:0.75)] (0,0) -- cycle ;\end{tikzpicture} \)}}\tuile is cute and can be included inside a block of text. I am writing this last sentence just to complete the line.
Remark

You can also insert a tiny version of your tile inside some text. This pentagonal Wang tile is cute and can be included inside a block of text. I am writing this last sentence just to complete the line.

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\end{tikzpicture}
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\end{tikzpicture}
}}}

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Write \LaTeX\ on images

Here is Edmund!
Write LaTeX on images

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Write \LaTeX on images

\begin{tikzpicture}
  \draw (0,0) node[above right]{\includegraphics[width=0.8\linewidth]{edmund.jpg}};
  \pause
  \draw (2,2) node[draw,fill=white,thick,rounded corners] (a) {Here is Edmund!};
  \pause
  \draw[line width=1pt,color=white,-stealth] (a.north) to[bend left] (4.3,4.3);
\end{tikzpicture}
Write \LaTeX\ on images

Here is Edmund!
Many other things you can do with TikZ

- graphs, finite state automata
- 3D graphics
- and more artistic graphics!
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- and more artistic graphics!

Some resources:
- The *TikZ and PGF manual* (880 pages...)
- https://tex.stackexchange.com/?tags=tikz-pgf
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Thanks you for your attention!!!