

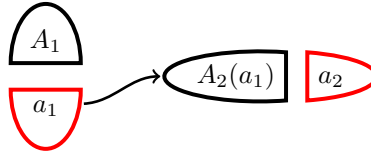
TikZ/PGF shape library for constructing Single-World Intervention Graphs (SWIGs)

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Single World Intervention Graphs (SWIGs) are a graphical formalism for unifying two approaches to building (statistical) causal models (Richardson and Robins, 2013).

Key to the representation is an operation of ‘node splitting’, whereby a single node is divided into two pieces. It is important that the resulting halves can still be seen to have originated from a single node.



It has been hard to draw SWIGs using standard packages in TikZ/PGF. Two separate `semicircle` shapes can be used, but it is difficult to ensure that the two halves arise from the same node and/or without introducing a lot of whitespace. TikZ does contain a shape, called `split ellipse`, but this does not provide a way to add space between the two halves of the shape. (There is no semi ellipse shape.)

We address this by introducing two multipart shapes: `swig hsplit` that creates an ellipse that has been split horizontally, and `swig vsplit` that is split vertically. The latter shape also adjusts the ratio of the two halves depending on the text that is contained.

Preliminaries

The examples included below use the following packages:

```
\documentclass[10pt]{article}
\usepackage{amsmath,amssymb,xcolor}
\usepackage{pgf,tikz}
\usetikzlibrary{arrows,shapes.arrows,shapes.geometric,shapes.multipart,
decorations.pathmorphing,positioning,shapes.swigs,}
\begin{document}
...
```

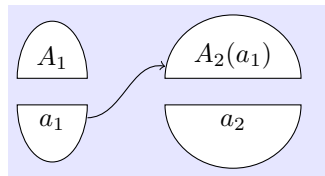
The last library listed here uses the code in the file:

`pgflibraryshapes.swigs.code.tex`

(As this is not part of the TeX distribution, this file should be placed in the working directory.)

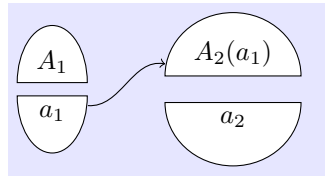
SWIG with horizontal split

Here is a very simple example:



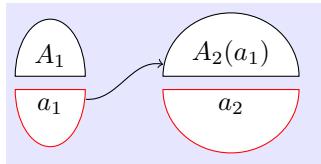
```
\begin{tikzpicture}
\node[name=a1,shape=swig hsplit]{
  \nodepart{upper}{$A_1$}
  \nodepart{lower}{$a_1$} };
\node[name=a2,shape=swig hsplit,right=of a1]{
  \nodepart{upper}{$A_2(a_1)$}
  \nodepart{lower}{$a_2$} };
\draw[->](a1) to[out=350,in=170] (a2);
\end{tikzpicture}
```

The parameter `gap` can be adjusted to change the size of the gap:



```
\begin{tikzpicture}
\node[name=a1,shape=swig hsplit,
swig hsplit={gap=5pt}]{
  \nodepart{upper}{$A_1$}
  \nodepart{lower}{$a_1$} };
\node[name=a2,shape=swig hsplit, right=of a1]{
  \nodepart{upper}{$A_2(a_1)$}
  \nodepart{lower}{$a_2$} };
\draw[->](a1) to[out=350,in=170] (a2);
\end{tikzpicture}
```

This can also be done globally for all split nodes; here we also make the line color red for lower halves.

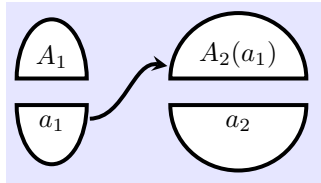


```

\begin{tikzpicture}
\tikzset{swig hsplit={gap=5pt,line color lower=red}}
\node[name=a1,shape=swig hsplit]{
  \nodepart{upper}{$A_1$}
  \nodepart{lower}{$a_1$} };
\node[name=a2,shape=swig hsplit, right=of a1]{
  \nodepart{upper}{$A_2(a_1)$}
  \nodepart{lower}{$a_2$} };
\draw[->](a1) to[out=350,in=170] (a2);
\end{tikzpicture}

```

For black and white publications color may not be sufficient to distinguish upper and lower halves. For this purpose a double line can be used. `inner line width` lower specifies the width of the inner gap.

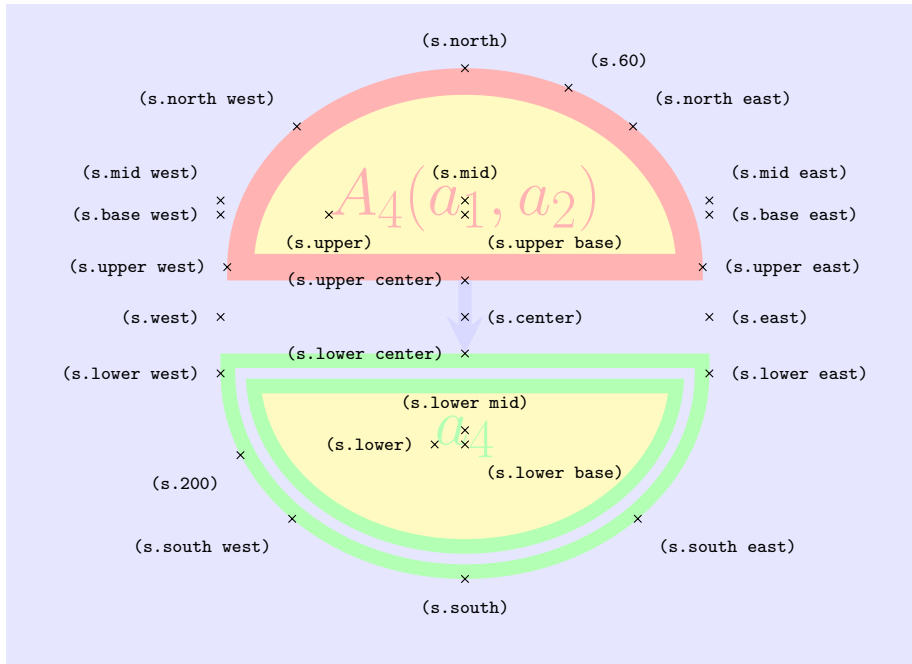


```

\begin{tikzpicture}
\tikzset{line width=1.5pt,
  swig vsplit={gap=4pt,
    inner line width right=0.5pt}}
\node[name=a1,shape=swig hsplit]{
  \nodepart{upper}{$A_1$}
  \nodepart{lower}{$a_1$} };
\node[name=a2,shape=swig hsplit, right=of a1]{
  \nodepart{upper}{$A_2(a_1)$}
  \nodepart{lower}{$a_2$} };
\draw[->,line width=1.5pt,>=stealth](a1)
  to[out=350,in=170] (a2);
\end{tikzpicture}

```

The example below shows the full set of anchors and other options.



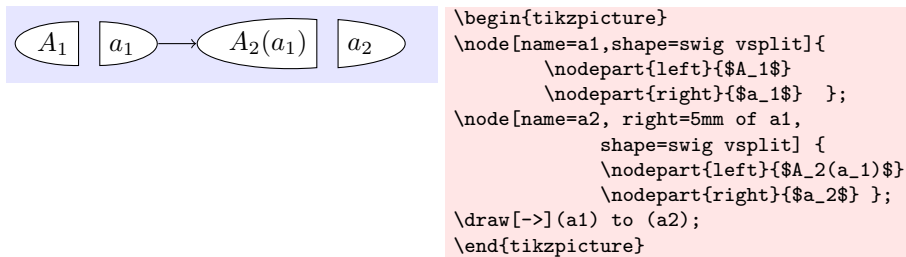
```

\Huge
\begin{tikzpicture}
\pgfsetinnerstrokecolor{blue!10!white} % so inner line col=background
\tikzset{shape example/.style={fill=yellow!5,
inner sep=0.3cm,outer sep=0cm}}
\node[name=s, shape example, shape=swig hsplit,
swig hsplit={
line color upper=red!30,
fill color upper=yellow!30,
line color lower=green!30,
fill color lower=yellow!30,
gap=40pt,
line width upper= 10pt,
inner line width upper = 0pt,
line width lower=15pt,
inner line width lower = 4pt}]
{\nodepart[red!30]{upper}{\mathcal{A}_4(a_1,a_2)}
\nodepart[green!30]{lower}{\mathcal{a}_4}};
\draw[->,line width=5pt, draw=blue!15,>=stealth]
(s.upper center) to (s.lower center);
\foreach \anchor/\placement in
{center/right, upper center/left,
upper/below, lower center/left, lower/left,
60/above right, 200/below left,
mid/above, mid east/above right, mid west/above left,
upper base/below right, base east/right, base west/left,
upper east/right, upper west/left,
north/above, south/below, west/left, east/right,
lower west/left, lower east/right,
north east/above right, south east/below right,
south west/below left, north west/above left,
lower base/below right, lower mid/above}
\draw[shift=(s.\anchor)] plot[mark=x] coordinates{(0,0)}
node[\placement] {\scriptsize\texttt{(s.\anchor)}};
\end{tikzpicture}

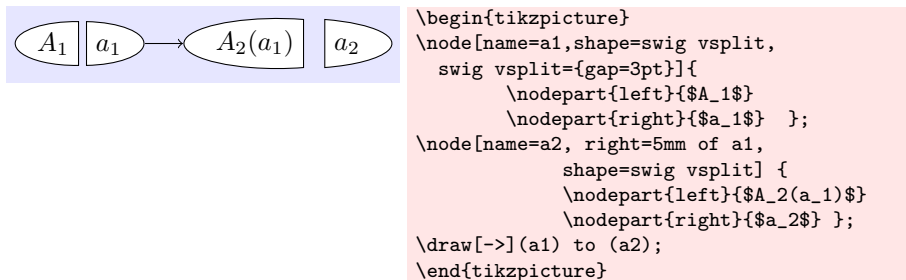
```

SWIG with vertical split

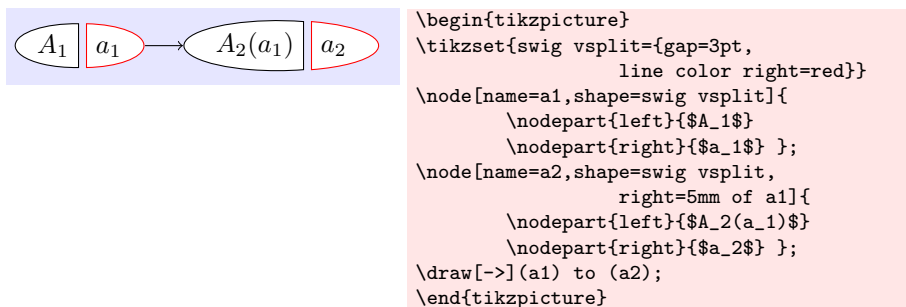
Here we describe the instructions for creating ellipses with vertical splits. These are often more efficient in terms of space. As before, first a very simple example:



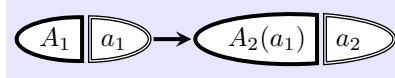
The parameter `gap` can be adjusted to change the size of the gap:



This can also be done globally for all split nodes; here we also make the line color red for right halves.

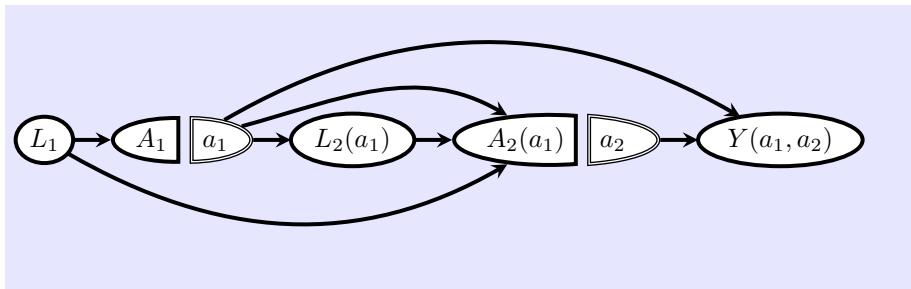


As before, a version for black and white publications:



```
\begin{tikzpicture}
\tikzset{line width=1.5pt,
swig vsplit={gap=3pt,
inner line width right=0.5pt}}
\node[name=a1,shape=swig vsplit]{
\nodepart{left}{$A_1$}
\nodepart{right}{$a_1$} };
\node[name=a2,shape=swig vsplit,
right=5mm of a1]{
\nodepart{left}{$A_2(a_1)$}
\nodepart{right}{$a_2$} };
\draw[->,line width=1.5pt,>=stealth]
(a1) to (a2);
\end{tikzpicture}
```

Here is an example with multiple stages:

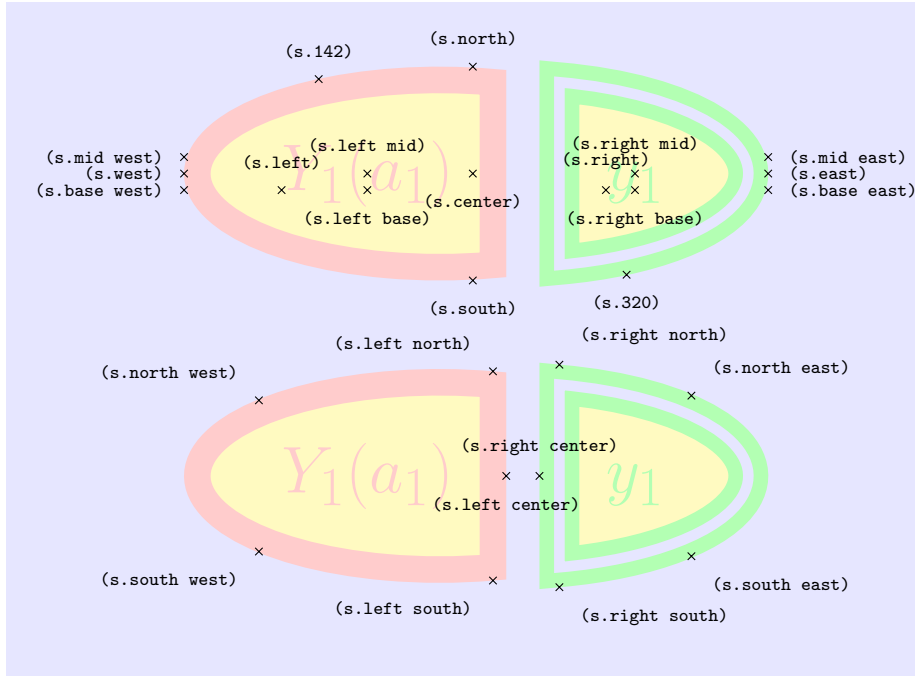


```

\begin{tikzpicture}
\tikzset{line width=1.5pt, outer sep=0pt,
  ell/.style={draw,fill=white, inner sep=2pt,
  line width=1.5pt},
  swig vsplit={gap=5pt,
  inner line width right=0.5pt}};
\node[name=l1, ell, shape=ellipse]{$L_1$};
\node[name=a1,right=5mm of l1, shape=swig vsplit]{
  \nodepart{left}{$A_1$}
  \nodepart{right}{$a_1$} };
\node[name=l2, right=5mm of a1, ell, shape=ellipse]{$L_2(a_1)$};
\node[name=a2,shape=swig vsplit,
  right=5mm of l2]{
  \nodepart{left}{$A_2(a_1)$}
  \nodepart{right}{$a_2$} };
\node[name=y, right=5mm of a2, ell, shape=ellipse]{$Y(a_1,a_2)$};
\draw[->,line width=1.5pt,>=stealth]
(11) edge (a1)
(11) edge[out=330,in=210] (a2)
(a1) edge (l2)
(a1) edge[out=15,in=150] (a2)
(a1) edge[out=30,in=150] (y)
(l2) edge (a2)
(a2) edge (y);
\end{tikzpicture}

```


Expanded nodes showing additional options and anchors.



```

\Huge
\begin{tikzpicture}
\pgfsetinnerstrokecolor{blue!10!white} % so inner line col=background
\tikzset{shape example/.style={draw,fill=yellow!30,
    inner xsep=10pt,inner ysep=25pt,outer xsep=0cm,outer ysep=0cm},
    swig vsplit={line color right=green!30, line color left=red!20,
    gap=25pt, line width left= 10pt, line width right=15pt,
    inner line width left = 0pt, inner line width right = 4pt}}
\node[name=s,shape=swig vsplit, shape example]
    {\nodepart[red!20]{left}{ $Y_1(a_1)$ }
    \nodepart[green!30]{right}{ $y_1$ }};
\foreach\anchor/\placement in
    {north/above, south/below, east/right, west/left,
    left base/below, right base/below, right/above, left/above,
    left mid/above, mid east/right, mid west/left, base east/right,
    base west/left, right mid/above,
    142/above, 320/below, center/below}
    \draw[shift=(s.\anchor)] plot[mark=x] coordinates{(0,0)}
        node[\placement] {\scriptsize\texttt{(s.\anchor)}};
\begin{scope}[yshift=-4cm]
    \node[name=s,shape=swig vsplit, shape example]
        {\nodepart[red!20]{left}{ $Y_1(a_1)$ }%
    \nodepart[green!30]{right}{ $y_1$ }};
\foreach\anchor/\placement in
    {left center/below, right center/above,
    left north/above left, left south/below left,
    right north/above right, right south/below right,
    north west/above left, south west/below left,
    north east/above right, south east/below right}
    \draw[shift=(s.\anchor)] plot[mark=x] coordinates{(0,0)}
        node[\placement] {\scriptsize\texttt{(s.\anchor)}};
\end{scope}
\end{tikzpicture}

```

References

- Richardson, T. and J. Robins (2013). Single world intervention graphs (swigs): A unification of counterfactual and graphical approaches to causality. Working Paper Number 128. Available at <http://www.csss.washington.edu/Papers/>.