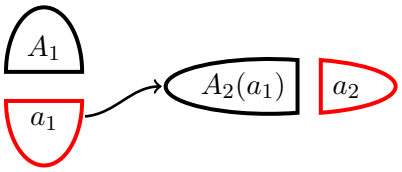
# TikZ/PGF shape library for constructing Single-World Intervention Graphs (SWIGs)

Thomas S. Richardson
Department of Statistics
University of Washington

9 July 2021

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 look as if they arise from a single circle, at least 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 does not appear to be a semi-ellipse shape.)

We address this by introducing two multipart shapes: `swig hsplit` that creates an ellipse that has been split horizontally, and 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.

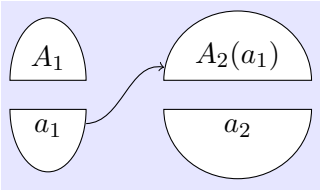
## Preliminaries

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,
swigs}
\begin{document}
...
```

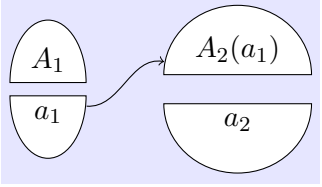
## SWIG with horizontal split

Here is a very simple example:



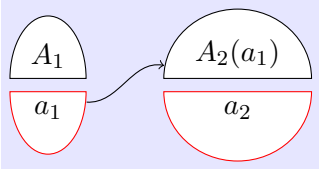

```
\begin{tikzpicture}
\node[name=a1,shape=swig hsplit]{
        \nodepart{upper}{$A_1$}
        \nodepart{lower}{$a_1$}   };
\node[name=a2,shape=swig hsplit,right=of a1]{
         \nodepart{upper}{$A_2(a_1)$}
         \nodepart{lower}{$a_2$}  };
\draw[->](a1) to[out=350,in=170] (a2);
\end{tikzpicture}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

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



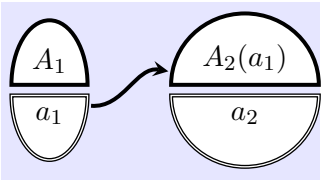

```
\begin{tikzpicture}
\node[name=a1,shape=swig hsplit,
swig hsplit={gap=5pt}]{
        \nodepart{upper}{$A_1$}
        \nodepart{lower}{$a_1$}  };
\node[name=a2,shape=swig hsplit, right=of a1]{
        \nodepart{upper}{$A_2(a_1)$}
        \nodepart{lower}{$a_2$}  };
\draw[->](a1) to[out=350,in=170]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

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



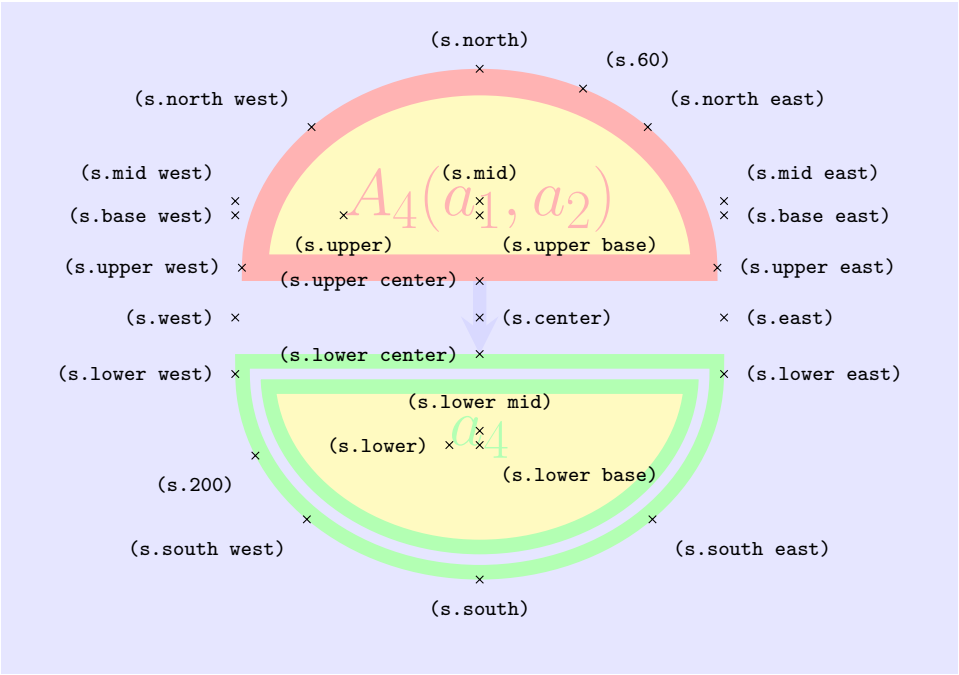

```
\begin{tikzpicture}
\tikzset{swig hsplit={gap=5pt,line color lower=red}}
\node[name=a1,shape=swig hsplit]{
        \nodepart{upper}{$A_1$}
        \nodepart{lower}{$a_1$} };
\node[name=a2,shape=swig hsplit, right=of a1]{
        \nodepart{upper}{$A_2(a_1)$}
        \nodepart{lower}{$a_2$} };
\draw[->](a1) 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 hsplit={gap=4pt,
                 inner line width lower=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}
```

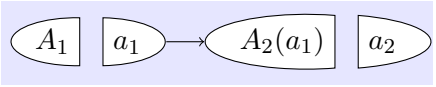
The example below shows the full set of anchors and other options.



```
\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}{$A_4(a_1,a_2)$}
             \nodepart[green!30]{lower}{$a_4$}};
  \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}
```

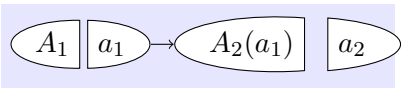
### SWIG with vertical split

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:



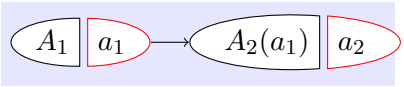

```
\begin{tikzpicture}
\node[name=a1,shape=swig vsplit]{
        \nodepart{left}{$A_1$}
        \nodepart{right}{$a_1$}  };
\node[name=a2, right=5mm of a1,
             shape=swig vsplit] {
             \nodepart{left}{$A_2(a_1)$}
             \nodepart{right}{$a_2$} };
\draw[->](a1) to (a2);
\end{tikzpicture}
```

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



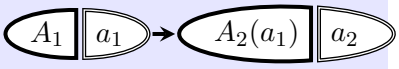

```
\begin{tikzpicture}
\node[name=a1,shape=swig vsplit,
  swig vsplit={gap=3pt}]{
        \nodepart{left}{$A_1$}
        \nodepart{right}{$a_1$}  };
\node[name=a2, right=3mm of a1,
            shape=swig vsplit] {
            \nodepart{left}{$A_2(a_1)$}
            \nodepart{right}{$a_2$} };
\draw[->](a1)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

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



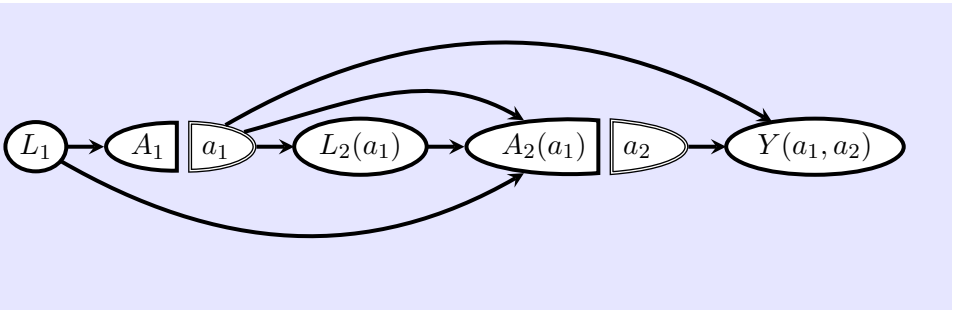

```
\begin{tikzpicture}
\tikzset{swig vsplit={gap=3pt,
                  line color right=red}}
\node[name=a1,shape=swig vsplit]{
        \nodepart{left}{$A_1$}
        \nodepart{right}{$a_1$} };
\node[name=a2,shape=swig vsplit,
                  right=5mm of a1]{
        \nodepart{left}{$A_2(a_1)$}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

As before, a version for black and white publications:



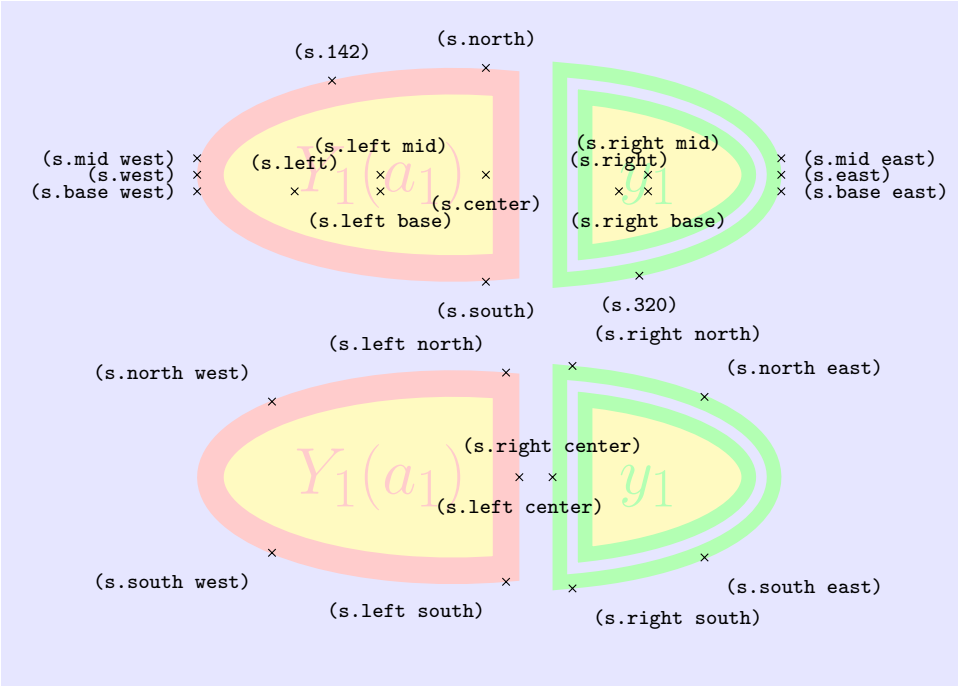

```
\begin{tikzpicture}
\tikzset{line width=1.5pt,
         swig vsplit={gap=3pt,
         inner line width right=0.5pt}}
\node[name=a1,shape=swig vsplit]{
        \nodepart{left}{$A_1$}
        \nodepart{right}{$a_1$} };
\node[name=a2,shape=swig vsplit,
                  right=3mm of a1]{
        \nodepart{left}{$A_2(a_1)$}
        \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]
    (l1) edge (a1)
     (l1) 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.S. and J.M. 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/wp128.pdf`.