strid – A string diagrams generator

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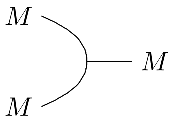
Contents

strid is a string diagrams generator for inclusion into LaTeX files. It is entirely programmed in OCaml[1]. Feel free to drop me a line at `samuel.mimram@pps.jussieu.fr` if you have some comments, bug reports or feature requests about it.

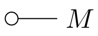
1 Presentation of *strid*

1.1 A first example

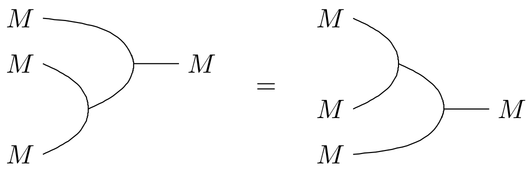
Suppose that $(\mathcal{C}, \otimes, I)$ is a strict monoidal category. A *monoid* in $\mathcal{C}$ is an object $M$ of $\mathcal{C}$ together with two maps $\mu : M \otimes M \to M$, called *multiplication*, and $\eta : I \to M$, called *unit*, respectively drawn as



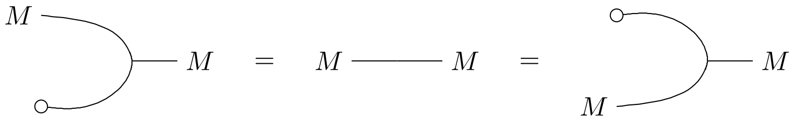
and



such that the equalities

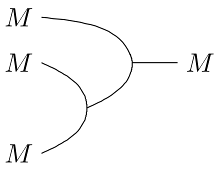


and



hold.

Let's have a look at how we typeset the left member of the associativity equation:



The *strid* code for this figure is

```
matrix {
text(r)[l,t=#$M$#]\\
text(r)[l,t=#$M$#]&&&mult(ull,dl,r)&text(r)[l,t=#$M$#]&\\
&&mult(ul,dl,)\\
text(r)[l,t=#$M$#]\\
}
```

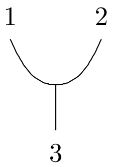
[1] OCaml can be downloaded at `http://caml.inria.fr/`.

Despite it's apparent complexity, this code is very simple! Like every *strid* diagram, this code starts with "`matrix {`" and ends with "`}`". Between those lines comes the actual description of the diagram. It is structured as a matrix whose colums are separated by "`&`" and whose lines are separated by "`\\`".

The rightmost multiplication is typeset by

```
mult(ull,dl,r)
```

Here, "`mult`" is the kind of the operator (a multiplication-shaped one) and its arguments specify that it should be linked to the relative positions $(-2, 1)$ (`ull` means up-left-left), $(-1, -1)$ (`dl` means down-left) and $(1, 0)$. The order in which the links should be specified is indicated on the figure below:



As for other operators, links are specified inputs first and then outputs.

The labels are specified similarly by instructions like

```
text(r)[l,t=#$M$#]
```

This create a "`text`" operator from here to the relative position $(1, 0)$. The brackets "`[l,t=#$M$#]`" are here to specify optional parameters related to this operator. The "`l`" indicates that we are going to add a label and the "`t=#$M$#`" means that the label's text should be "`$M$`". The text between `#` is quoted uninterpreted.

Suppose that we have put the text of this figure in a file named `monoid_assoc_l.strid`. Compiling this file can be simply done by typing

```
strid monoid_assoc_l.strid
```

This generates a file `monoid_assoc_l.tex` which can be used in a LaTeX file like:

```
\documentclass{article}

\usepackage{tikz}

\begin{document}
\input{monoid_assoc_l.tex}
\end{document}
```

You will need the `TikZ` package which can be downloaded at `http://sourceforge.net/projects/pgf/`.

Similarly, the right member of the equation is generated in a file `monoid_assoc_r.tex`. To have the equality sign between the two diagrams centered vertically you need to center the two diagrams. This can be done using the `\vcenter` and `\hbox` LaTeX commands as shown in the following example:

```
\[
\vcenter{\hbox{\input{monoid_assoc_l.tex}}}
=
\vcenter{\hbox{\input{monoid_assoc_r.tex}}}
\]
```

1.2 Visualizing your diagram

Making a nice diagram is sometimes hard and LaTeX compilation of the diagrams usually takes some time to complete. If you want to quickly see the diagram generated by *strid* on a file `toto.strid`, type the command

```
strid -g toto.strid
```

This will open a window in which the output diagram is displayed, which is refreshed every time the file `toto.strid` is changed.

1.3 Compiling

Compiling diagrams can quickly become a tedious task : you have to run *strid* to generate a LaTeX file and then use `latex` or `pdflatex` to produce the final document (which can take long to compile). If you want to speed up the compilation of the document, you can have *strid* generate directly pdf files by typing

```
strid --pdf toto.strid
```

The resulting `toto.pdf` file can then be integrated in a LaTeX document as follows.

```
\documentclass{article}

\usepackage{graphics}

\begin{document}
\[
\includegraphics{toto.pdf}
\]
\end{document}
```

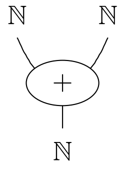
In order to have the pdf files automatically generated from the strid files, a `Makefile` file can be used, containing

```
STRIDFILES=$(wildcard *.strid)
STRIDPDF=$(STRIDFILES:.strid=.pdf)

pdf: $(STRIDPDF)

%.pdf: %.strid
	$(STRID) --pdf $<
```

The pdf files corresponding to the strid files of the current directory can then be generated by simply typing

```
make
```

Be careful, if you use macros in your strid files those won't be known when generating the pdf. The solution is to put your macros in a `macros.sty` file (or whatever name`.sty`) and include those in the tex file used to produce the pdf by using the `--latex-preamble` command of *strid*. For example,



is typeset in a file `add.strid` containing

```
matrix {
text(d)[l,t=#$\N$#]&&text(d)[l,t=#$\N$#]\\
\\
&mult(ul,ur,d)[l,t=#$+$#]&\\
\\
&text(u)[l,t=#$\N$#]&\\
}
```

and is compiled with

```
          strid --pdf --latex-preamble "\\usepackage{macros}" add.strid
```

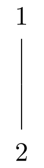
where the `macros.sty` file contains

```
\usepackage{amsfonts}
\newcommand{\N}{\mathbb{N}}
```

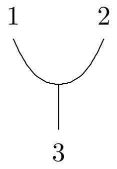
The `Makefile` above can obviously be modified in order to cope with such situations.

2 The operators

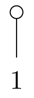
2.1 Line: `line`



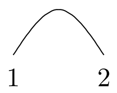
2.2 Multiplication: `mult`



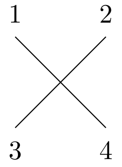
2.3 Unit: `unit`



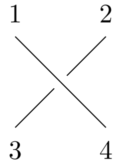
2.4 Adjunction: `adj`



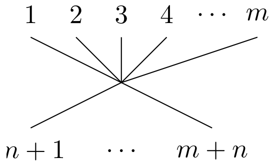
2.5 Symmetry: `sym`



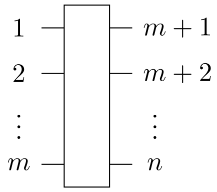
2.6 Braiding: `braid`



2.7 m,n-ary box: m`box`n

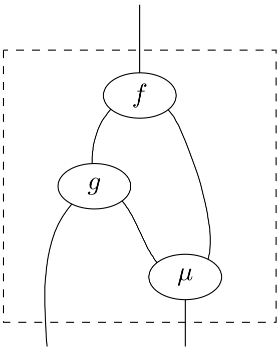


2.8 Vertical box: `vbox`



2.9 Region: `region`

Regions can be delimited:



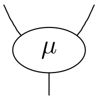
is typeset by

```
matrix {
\\
region(6d6r)&&&&&&\\
&&&mult(dl,dr,uu)[l,t=#$f$#]\\
\\
&&mult(4dl,dr,u)[l,t=#$g$#]\\
\\
&&&&mult(ul,uuu,dd)[l,t=#$\mu$#]\\
\\
}
```

3 Parameters of operators

3.1 Labels

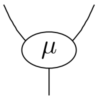
Labels can be added to operators. For example the diagram



can be typeset by

```
matrix {
\\
&mult(ul,ur,d)[l,t=#$\mu$#]&\\
\\
}
```

If you don't like the size of the ellipse surrounding the label, this can of course be changed. For example,



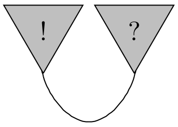
can be typeset by

```
matrix {
\\
&mult(ul,ur,d)[l,t=#$\mu$#,w=0.6,h=0.4]&\\
\\
}
```

Various shapes are available for labels:

3.1.1 Triangles: `triangle` / `t`

For example,

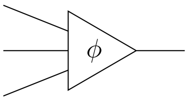


can be typeset by

```
matrix {
\\
&unit(d)[l,t=#$!$#,s=triangle,d=d,c=lightgray]&&
unit(d)[l,t=#$?$#,s=triangle,d=d,c=lightgray]&\\
\\
&&arc(ul,ur)&\\
}
```

Here, the `s` parameter is the *shape*, the `d` parameter is the *direction* of the triangle (here it is pointing down) and the `c` parameter specifies the *color* of the triangle. There are shortcuts for the shapes, for example you can type `s=t` instead of `s=triangle`, which is more concise but less readable.

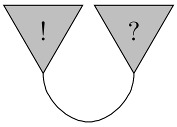
There is a particular case where the direction of the triangle can be guessed and you don't need to specify the direction of the triangle: when there is only one output port. The `operad` operator does precisely this.



can be typeset by

```
matrix {
\\
&&operad(d2l,2l,u2l,2r)[l,t=#$\phi$#]&&\\
\\
}
```

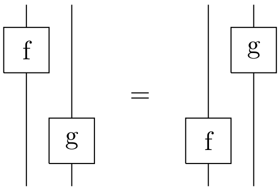
It also provides minor improvements of the drawing for example, the output wire is exactly starting at the vertex of the triangle :



is typeset by

```
matrix {
\\
&operad(d)[l,t=#$!$#,c=lightgray]&&
operad(d)[l,t=#$?$#,c=lightgray]&\\
\\
&&arc(ul,ur)&\\
}
```

3.1.2 Rectangles: `rectangle` / `r`

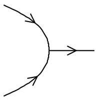


The left member is typeset by

```
matrix {
\\
1box1(u,3d)[l,t=#f#,s=rectangle]\\
\\
&1box1(3u,d)[l,t=#g#,s=rectangle]\\
\\
}
```

3.2 Arrows

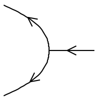
Lines can be oriented using the `a` attribute. For example,



can be typeset by

```
matrix {
\\
&mult(ul,dl,r)[a]&\\
\\
}
```

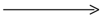
To specify that the direction should be backwards use the `d=b` subattribute. For example,



can by typeset by

```
matrix {
\\
&mult(ul,dl,r)[a,d=b]&\\
\\
}
```

The position of the arrow can be changed by setting the `t` parameter which is a float between `0.` and `1.`. For example, the arrow can be put at the end of a line by using the `t=1.` parameter :



is typeset by

```
matrix {
line(2r)[a,t=1.]&&\\
}
```

4 Configuration files

All parameters can be saved in a configuration file named `strid.conf`. To generate a configuration file, type

```
strid --dump-conf
```

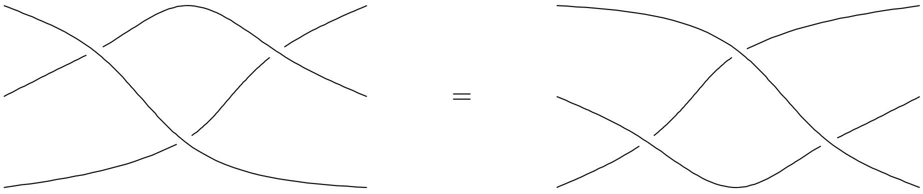
You can then edit `strid.conf`.

Some of the options that can be set are:

- `line_width`: default width of a line
- `label_width`: default width of a label
- `label_height`: default height of a label
- `no_tex_environment`: do not output `\begin{tikz}` and `\end{tikz}`
- `scaling_factor`: scale the diagrams
- `label_triangle_height`: default height of a triangular label
- `label_rectangle_width`: default width of a rectangular label
- `label_rectangle_height`: default height of a rectangular label
- `interpolation`: interpolation method for drawing lines (possible values are `cspline` and `linear`)
- `small_circle_ray`: ray of small circles (used to tweak the drawing of multiplications)

5 Examples

5.1 Yang-Baxter equality for braids



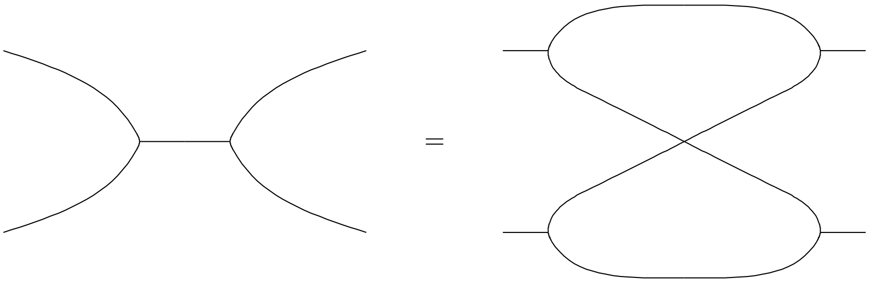
Left member is typeset by

```
matrix {
\\
&&braid(ull,dll,urr,dr)&&&&braid(ull,dl,urr,drr)&&\\
\\
&&&&braid(ul,d4l,ur,d4r)\\
\\
}
```

and right member by

```
matrix {
\\
&&&&braid(u4l,dl,u4r,dr)\\
\\
&&braid(ull,dll,ur,drr)&&&&braid(ul,dll,urr,drr)&&\\
\\
}
```

5.2 Hopf law for bialgebras



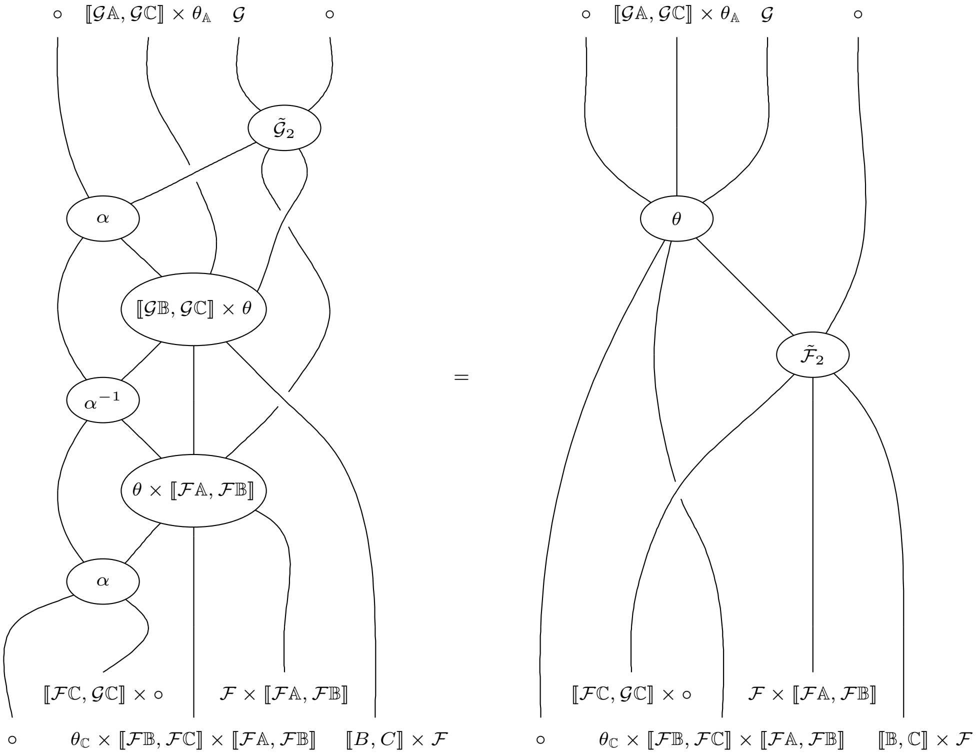
Left member is typeset by

```
matrix{
\\
\\
\\
&&&mult(uu3l,dd3l,r)&&mult(uu3r,dd3r,l)&&&\\
\\
\\
\\
}
```

and right member by

```
matrix{
\\
&mult(u3r,dr,l)&&&&&&mult(u3l,dl,r)&\\
\\
&&&&sym(ull,dll,urr,drr)\\
\\
&mult(ur,d3r,l)&&&&&&mult(ul,d3l,r)&\\
\\
}
```

5.3 Naturality condition for natural transformations between two lax functors between bicategories



$\circ$
$[\![\mathcal{G}\mathbb{A},\mathcal{G}\mathbb{C}]\!] \times \theta_\mathbb{A}$
$\mathcal{G}$
$\circ$
$\tilde{\mathcal{G}}_2$
α
$[\![\mathcal{G}\mathbb{B},\mathcal{G}\mathbb{C}]\!] \times \theta$
α^{-1}
$\theta \times [\![\mathcal{F}\mathbb{A},\mathcal{F}\mathbb{B}]\!]$
α
$[\![\mathcal{F}\mathbb{C},\mathcal{G}\mathbb{C}]\!] \times \circ$
$\mathcal{F} \times [\![\mathcal{F}\mathbb{A},\mathcal{F}\mathbb{B}]\!]$
$\circ$
$\theta_\mathbb{C} \times [\![\mathcal{F}\mathbb{B},\mathcal{F}\mathbb{C}]\!] \times [\![\mathcal{F}\mathbb{A},\mathcal{F}\mathbb{B}]\!]$
$[\![B,C]\!] \times \mathcal{F}$
$=$
$\circ$
$[\![\mathcal{G}\mathbb{A},\mathcal{G}\mathbb{C}]\!] \times \theta_\mathbb{A}$
$\mathcal{G}$
$\circ$
θ
$\tilde{\mathcal{F}}_2$
$[\![\mathcal{F}\mathbb{C},\mathcal{G}\mathbb{C}]\!] \times \circ$
$\mathcal{F} \times [\![\mathcal{F}\mathbb{A},\mathcal{F}\mathbb{B}]\!]$
$\circ$
$\theta_\mathbb{C} \times [\![\mathcal{F}\mathbb{B},\mathcal{F}\mathbb{C}]\!] \times [\![\mathcal{F}\mathbb{A},\mathcal{F}\mathbb{B}]\!]$
$[\![\mathbb{B},\mathbb{C}]\!] \times \mathcal{F}$

The code for the left-hand side of the equation is

```
matrix {
\\
&text(u)[l,t=#$\circ$#]
&& text(u)[l,t=#$[\![\mathcal{G}\A,\mathcal{G}\C]\!] \times \theta_\A$#]
&& text(u)[l,t=#$\mathcal{G}$#]
&& text(u)[l,t=#$\circ$#]&\\

&line(u,)&&line(u,)&&line(u,)&&line(,u)& \\
&&&&&&2box3(ul,ur,0.5dl,d0.5l,d0.5r)[l,t=#$\tilde{\mathcal{G}}_2$#]&&\\
&&&&braid(0.5ur,2ul,1.5d0.5r,0.5dl)&&&&\\
&&sym(3ul,0.5ur,2dl,dr)[l,t=#$\alpha$#]&&&&braid(u0.5r,u0.5l,2dr,2dl)&&\\
\\
&&&&3box3(ul,1.5u0.5r,r,dl,2d,dr)[l,t=#$[\![\mathcal{G}\B,\mathcal{G}\C]\!] \times \theta$#,w=1.6,h=0.8]&&&&\\
\\
&&sym(2ul,ur,2dl,dr)[l,t=#$\alpha^{-1}$#]&&&&braid(ul,2ur,dl,dr)&&\\
\\
&&&&3box3(ul,2u,ur,dl,d,drr)[l,t=#$\theta \times [\![\mathcal{F}\A,\mathcal{F}\B]\!]$#,w=1.6,h=0.8]&&&&\\
\\
&&sym(2ul,ur,dll,dr)[l,t=#$\alpha$#] && &&&&\\
line(,2d)&&&&line(2u,2d)&&line(2u,d)&&line(4ul,2d)\\
&&line(,ur)&&&&&&
\\
&&
text(u)[l,t=#$[\![\mathcal{F}\C,\mathcal{G}\C]\!] \times \circ$#]
&& &&
text(u)[l,t=#$\mathcal{F} \times [\![\mathcal{F}\A,\mathcal{F}\B]\!]$#]
&& \\
text(u)[l,t=#$\circ$#]
&& &&
text(u)[l,t=#$\theta_\C \times [\![\mathcal{F}\B,\mathcal{F}\C]\!]
\times [\![\mathcal{F}\A,\mathcal{F}\B]\!]$#]
&& &&
text(u)[l,t=#$\qquad [\![B,C]\!] \times \mathcal{F}$#]
\\
}
```

and the code for the right-hand side is

```
matrix {
\\
&text(u)[l,t=#$\circ$#]&&text(u)[l,t=#$[\![\mathcal{G}\A,\mathcal{G}\C]\!] \times \theta_\A$#]
&&text(u)[l,t=#$\mathcal{G}$#] &&text(u)[l,t=#$\circ$#]&\\


&line(u,d)&&line(u,d)&&line(u,d)&&line(u,4d)& \\
\\
\\
&&&3box3(2u2l,2u,2u2r,4d2l,3d0.5l,dr)[l,t=#$\theta$#]&&&&&\\
\\
\\
&&&&&&2box3(2u2l,2ur,dl,d,dr)[l,t=#$\tilde{\mathcal{F}}_2$#]&&\\
\\
\\
&&&braid(2u2r,3u0.5l,d0.5r,d0.5l)&&&&&\\
\\
\\
line(5ur,dd)&&line(2u0.5r,d)&&line(2u0.5l,dd)&&line(5u,d)&&line(5ul,dd)\\
\\

&&
text(u)[l,t=#$[\![\mathcal{F}\C,\mathcal{G}\C]\!] \times \circ$#]
&& &&
text(u)[l,t=#$\mathcal{F} \times [\![\mathcal{F}\A,\mathcal{F}\B]\!]$#]
&& \\
text(u)[l,t=#$\circ$#]
&& &&
text(u)[l,t=#$\theta_\C \times [\![\mathcal{F}\B,\mathcal{F}\C]\!]
\times [\![\mathcal{F}\A,\mathcal{F}\B]\!]$#]
&& &&
text(u)[l,t=#$\qquad [\![\B,\C]\!] \times \mathcal{F}$#]
\\
}
```