VarTable

VarTable is a package to make variation table, in a simple way
This package is build on top of <u>Cetz</u>
(version : 0.1.0)

Contents

1 - Introduction

This package is designed to simplify the creation of variation tables for functions. To do this, it gives you a typst function, whose parameters are described in detail in this documentation.

A word of warning: it's quite normal that during the array creation process, The elements, such as the lines between the various elements, aren't created as they should be. For example, the line between the labels and the rest, which doesn't go all the way to the end.

If you encounter any bugs, please report them on my GitHub.

2 - tabvar function

2.1 - general description

tabvar

Return a variation table

Parameters

```
tabvar(
  init: dictionary,
  domain: array,
  contents: array,
  table-style: style,
  arrow-mark: mark,
  arrow-style: style,
  line-0: bool,
  line-style: style,
  first-column-width: length,
  first-line-height: height,
  element-distance
)
```

---

init   `dictionary`

initialitation of the table

- `variable` is a content block which contains the table's variable name (like x or t)
- `label` is an array of 2 arguments that contains in first position the line's label and in second position, if the line is a variation table or a sign table with this following keys : "Variation" and "Sign"

Example : for a variation table of a function f, you should write :

```
init: (
  variable: $x$,
  label: (
    ([sign of $f$], "Sign"), // the first line is a sign table
    ([variation of $f$], "Variation") // the second line is a variation table
  )
)

Default: (
    "variable": [],
    "label": [],
  )
```

---

domain   `array`

values taken by the variable
for example if your funtions changes sign or reaches a max/min for $x \in \{0, 1, 2, 3\}$
you should write this :

```
domain: ($0$, $1$, $2$, $3$)
```

Default: ()

---

contents   `array`

the content of the table
see below for more details

Default: `(()、)`

---

table-style   `style`

Optional
The style of the table,
the style type is defined by Cetz, so I invite you to have a look at the Cetz manual.
Caution : if you haven't entered the mark symbol as none, all lines in the table will have an arrowhead.

Default: `(stroke: 1pt + black, mark: (symbol: none))`

---

arrow-mark   `mark`

the style of the arrowhead, the type of which is defined by Cetz

Default: `(end: "straight")`

---

arrow-style   `style`

Optional
the style of the arrow, as for the `table-style` parameter
Caution : the `mark` section is overwrite by the `arrow-mark`

Default: `(stroke: black + 1pt)`

---

line-0   `bool`

Optional
if you want to change the default bar sign to a bar with a 0

Default: `false`

---

line-style   `style`

Optional
if you want to change the style of all separator lines between signs

Warning: this will only change the default lines, the ||, | or 0 lines will not be changed.

Default: `(stroke: black + 1pt)`

first-column-width   `length`

Optional

change the width of the first column

Default: none

first-line-height   `height`

Optional

change the height of the first line

Default: none

element-distance

Optional

change the distance betwen two elements

Default: none

2.2 - The contents parameter

The contents parameter must be an array with one element per line (per label)

Each element is itself an array with one element per column, with a different format for either sign or variation rows

2.2.1 - Sign rows format

Should contain as much element as the domain less one (one per interval) + one optional end bar style element

Each element is in etheir of these form (can be mixed on a same line):

`()` – Empty : extend previous cell
`body` – Simple body such as `$+$` or `$-$`
`(body, bar_style)` – to specify an optional style for the **previous** bar, with one of `"|"` (simple bar), `"||"` (double bar) or `"0"` (bar with a zero)
NB: the `line-0` parameter change the default bar style to `"|"`

The optional last element is `"||"`

2.2.1.1 - A classical sign array

A sign array must contain contents like `$+$` or `$-$`, but you can put anything else.

Example :
A normal sign table :

```
#tabvar(
  init: (
    variable: $t$,
    label: (([sign], "Sign"),),
  ),
  domain: ($2$, $4$, $6$, $8$),
  contents: (($+$, $-$, $+$),),
)
```

t	2	4	6	8
sign	$+$	$-$	$+$	

More complex usage :

```
#tabvar(
    init: (
      variable: $t$,
      label: (([sign], "Sign"),),
    ),
    domain: ($2$, $4$, $6$, $8$),
    contents: (
      (
        "Hello world !",
        $-$,
        $ 3 / 2 $
      )
    ),
  )
```

t	2	4	6	8
sign	Hello world !	$-$	$\frac{3}{2}$	

Note : on the second example the table is squeezed with the scale function)

2.2.1.2 - Custom separation bar

2.2.1.2.1 style of bar

you can modify the style of the bars (note that this modifies all the default ones, not the others, see 2.2.1.2.2).

the style of the bar is a dictionary, of the type "style" defined by Cetz as said earlier.
To make it simple if you want to modify only the stroke of the bar, you just have to put `stroke:`
`your stroke` in brackets.
For more complex applications, please refer to the Cetz manual.

Example

```
#tabvar(
  line-style: (
    stroke: (paint: red, dash: "dashed")
  ),
  init: (
    variable: $t$,
    label: (([sign], "Sign"),),
  ),
  domain: ($2$, $4$, $6$,),
  contents: (
    ($+$, $-$),
  ),
)
```

t	2	4	6
sign	$+$	$-$	

2.2.1.2.2 type of bar

For all signs except the first one, instead of putting the sign directly, you can put a couple, whose first element defines the previous bar's type.
There are 3 differents types of bar:

- "|" : a simple bar
- "0" : a bar with a 0 on the center
- "||" : a double bar, like for the undefined values

NB : the marks-line parameter has no effect on these bars

Example:

```
#tabvar(
  init: (
    variable: $t$,
    label: (([sign], "Sign"),),
  ),
  domain: ($2$, $4$, $6$, $8$, $10$),
  contents: (
    (
      $+$,
      ("|", $-$),
      ("0", $-$),
      ("||", $+$)
    ),
  ),
)
```

t	2	4	6	8	10
sign	$+$	$-$	0 $-$	$+$	

Note: The `line-0` parameter is to default lines to "0" type or "|" type

If you want a double line at the start of the table, you can use a double bar "||" on the very first sign. If you want it at the end, you can add this element "||" at the end of sign array

Example :

```
#tabvar(

  init: (
    variable: $t$,
    label: (([sign], "Sign"),),
  ),
  domain: ($2$, $4$, $6$, $8$),
  contents: (
    (
      ("||", $+$),
      $-$,
      "||"
    ),
  ),
)
```

t	2	4	6
sign	$+$	$-$	

2.2.1.3 - Same sign for more than one value of the variable

For this, it is pretty easy, instead of putting the sign directly, you can put an empty couple

Example :

```
#tabvar(
  line-0: true,
  init: (
    variable: $t$,
    label: (
      ([sign], "Sign"),
    ),
  ),
  domain: ($2$, $4$, $6$, $8$),
  contents: (
    ($+$, (), $-$),
  ),
)
```

t	2	4	6	8
sign	$+$		0	$-$

2.2.2 - Variation table

Should contains as much elements as the domain

Each element is in etheir of these forms :

- `()` to extend the previous arrow
- `(position,body)` with position being one of top, center or bottom
- `(pos1, pos2, "||", body1, body2)` to put in 2 value separated by an undefined value (double bar)
- `(pos, "||", body)` shorthand for `(pos, pos, "||", body, body)` (see previous format)

2.2.2.1 - A classical variation array

A variation array must contain couple with in first position, the element position, and in second position, whatever you want as long as it's of the contents type.

The position can be `top, center` or `bottom`, but no other type of alignment

Example :

```
#tabvar(

  init: (
    variable: $t$,
    label: (([variation], "Variation"),),
  ),
  domain: ($2$, $4$, $6$, $8$),
  contents: (
    (
      (top, $3$),
      (bottom, $0$),
      (center, $1$),
      (top, $4$),
    ),
  ),
)
```


2.2.2.2 - Undefined values

If your function is not defined on some values like $f(x) = \frac{1}{x}$ for $x = 0$, you certainly want to put a double line meaning that the function is undefined on this value, and you can !

⋆ For each values of domain except the start and the end.

The array of one value should look like `(pos1, pos2, "||", contents1, contents2)`
where :

- pos1 and 2 is `top, center, bottom` and pos1 is for the placement of contents1 similary for pos2
- `"||"` is to precise the value is undefine
- contents1 and 2 is type of contents and contents1 one is for before the double bar and contents2 for after

Example :

```
#tabvar(
  init: (
    variable: $t$,
    label: (([variation], "Variation"),),
  ),
  domain: ($2$, $4$, $6$, $8$),
  contents: (
    (
      (top, $3$),
      (bottom, top, "||", $0$, $2$),
      (bottom, $1$),
    ),
  ),
)
```

t	2	4	6
variation			

(diagram: variation row with 3 ↘ 0, and 2 ↘ 1)

If `pos1` and `pos2` is same, you can just fill in one instead of two,
In the same way if `contents1` and `contents2` is same, you can also enter just one

Example :

Instead of `(top, top, "||" , $0$, $0$)` you can use `(top, "||" ,$0$)`

```
#tabvar(
  init: (
    variable: $t$,
    label: (([variation], "Variation"),),
  ),
  domain: ($ 2 $, $4$, $6$, $8$),
  contents: (
    (
      (top, $3$),
      (bottom, "||", $0$, $1$),
      (top, center, "||", $2$),
      (top, "||", $3$),
      (bottom, $1$),
    ),
  ),
)
```

t	2	4	6	8	9
variation					

(diagram: variation row with 3 ↘ 0, 1 ↗ 2, 2 ↗ 3, 3 ↘ 1)

★ For the first and the end values

It a basic array but with `"||"` this parameter at the array's center
For example `(top, "||", $3$)`

```
#tabvar(
  init: (
    variable: $t$,
    label: (([variation], "Variation"),),
  ),
  domain: ($2$, $4$, $6$, $8$),
  contents: (
      (
        (top, "||", $3$),
        (bottom, $1$),
        (top, "||", $2$),
      ),
  ),
)
```

t	2	4	6
variation	3 ↘ 1 ↗ 2		

2.2.2.3 - Skip a value

When you want to use several functions in the same table, you will probably want to skip some values, to do this, as with sign arrays, you must create an empty array

Example :

```
#tabvar(
  arrow-mark: (end: ">", stroke: red),
  init: (
    variable: $t$,
    label: (([variation], "Variation"),),
  ),
  domain: ($2$, $4$, $6$),
  contents: (
    (
      (top, "||", $3$),
      (),
      (bottom, $2$),
    ),
  ),
)
```

t	2	4	6
variation	3 ↘ 2		

3 - More complex examples

Here is a little bundle of what you can do with the package.

3.1 - <u>**Γ function**</u> on $[0; +\infty]$

Where it takes a minimum on $[0; +\infty[$ for $x = \alpha$

```
#tabvar(
  init: (
    variable: $t$,
    label: (
      ([sign of #sym.Gamma], "Sign"),
      ([variation of #sym.Gamma], "Variation"),
    ),
  ),
  domain: ($0$, $ alpha $, $ +oo $),
  contents: (
    ($-$, $+$),
    (
      (top, "||", $+oo$),
      (bottom, $Gamma(alpha)$),
      (top, $+oo$),
    ),
  ),
)
```

t	0		α		$+\infty$
sign of Γ'		$-$		$+$	
variation of Γ	$+\infty$				$+\infty$
			$\Gamma(\alpha)$		

3.2 - A Rational function

Take $f(x) = \frac{4x^2+12x+29}{4(x^2+3x+2)}$

So we have $f'(x) = \frac{-2x-3}{16(x^2+3x+2)^2}$

And finaly, we get :

Code :

```
#tabvar(
    init: (
      variable: $t$,
      label: (
        ([sign of $f'$], "Sign"),
        ([variation of $f$], "Variation"),
      ),
    ),
    domain: ($ -oo $, $ -2 $, $ -3 / 2 $, $ -1 $, $ +oo $),
    contents: (
      ($+$, ("||", $+$), $-$, ("||", $-$)),
      (
        (bottom, $1$),
        (top, bottom, "||", $+oo$, $-oo$),
        (top, $-20$),
        (bottom, top, "||", $-oo$, $+oo$),
        (bottom, $1$),
      ),
    ),
  )
```

Result :

t	$-\infty$	-2	$-\dfrac{3}{2}$	-1	$+\infty$
sign of f'	$+$	$+$	$-$	$-$	
variation of f	$1 \nearrow 4$	$\nearrow -20$	$-20 \searrow -\infty$	$+\infty \searrow 1$	

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3.3 <u>Hyperbolic function</u>

Code :

```
#tabvar(
  arrow: "|-harpoon",
  stroke-arrow:
gradient.linear(..color.map.rainbow),
  marks-line: "..",
  init: (
    variable: $t$,
    label: (
      ([sign of $cosh$], "Sign"),
      ([variation of $cosh$], "Variation"),
      ([sign of $sinh$ and $tanh$], "Sign"),
      ([variation of $sinh$], "Variation"),
      ([variation of $tanh$], "Variation"),
    ),
  ),
  domain: ($ -oo $, $ 0 $, $ +oo $),
  contents: (
    ($-$, $+$),
    (
      (top, $+oo$),
      (bottom, $1$),
      (top, $+oo$),
    ),
    ($+$, ()),
    (
      (bottom, $-oo$),
      (),
      (top, $+oo$),
    ),
    (
      (bottom, $1$),
      (),
      (top, $-1$),
    ),
  ),
)
```

Result :

t	$-\infty$	0	$+\infty$
sign of cosh	$-$		$+$
variation of cosh			
sign of sinh and tanh		$+$	
variation of sinh			
variation of tanh			

3.3 A weird table for a simple polynomial function

Take $g(t) = t^2 - t^3$

So, we have $g'(t) = 2t - 3t^2$

And has local extrema for $x = 0$ and $x = \frac{2}{3}$

Code:

```
#tabvar(

  stroke: 5pt + red,
  arrow: "X-*-<>",
  arrow-style: (stroke :purple + 1.4pt),
  marks-line: "<-->",
  init: (
    variable: $t$,
    label: (
      ([sign of $g'$], "Sign"),
      ([variation of $g$], "Variation"),
    ),
  ),
  domain: ($ -oo $, $ 0 $, $ 2 / 3 $, $ +oo $),
  contents: (
    ($-$, ("|", $+$), $-$),
    (
      (top, $+oo$),
      (bottom, $0$),
      (center, $ 4 / 27 $),
      (bottom, $-oo$),
    ),
  ),
)
```

Result:

t	$-\infty$		0		$\frac{2}{3}$		$+\infty$
sign of g'		$-$	0	$+$	0	$-$	
variation of g	$+\infty$		0		$\frac{4}{27}$		$-\infty$