

The CeTZ package

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<https://github.com/johannes-wolf/typst-canvas>

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1. Introduction

This package provides a way to draw stuff using a similar API to [Processing](#) but with relative coordinates and anchors from [TikZ](#). You also won't have to worry about accidentally drawing over other content as the canvas will automatically resize. And remember: up is positive!

The name CeTZ is a recursive acronym for “CeTZ, ein Typst Zeichenpaket” (german for “CeTZ, a Typst drawing package”) and is pronounced like the word “Cats”.

2. Usage

This is the minimal starting point:

```
#import "@local/cetz:0.0.1"
#cetx.canvas({
  import cetx.draw: *
  ...
})
```

Note that draw functions are imported inside the scope of the canvas block. This is recommended as draw functions override Typst's functions such as `line`.

2.1. Argument Types

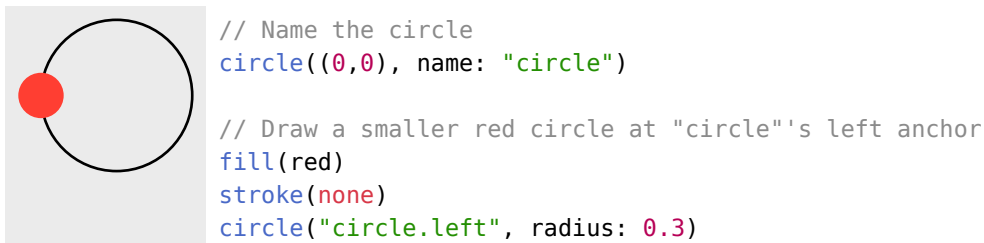
Argument types in this document are formatted in monospace and encased in angle brackets `<>`. Types such as `<integer>` and `<content>` are the same as Typst but additional are required:

<coordinate> Any coordinate system. See Section 4.
<number> `<integer>` or `<float>`

2.2. Anchors

Anchors are named positions relative to named elements.

To use an anchor of an element, you must give the element a name using the `name` argument.



All elements will have default anchors based on their bounding box, they are: center, left, right, above/top and below/bottom, top-left, top-right, bottom-left, bottom-right. Some elements will have their own anchors.

Elements can be placed relative to their own anchors.



3. Draw Function Reference

3.1. Canvas

`canvas`(background: `none`, length: `1cm`, debug: `false`, body)

background <color> (default: none)

A color to be used for the background of the canvas.

length <length> (default: 1cm)

Used to specify what 1 coordinate unit is.

debug <bool> (default: false)

Shows the bounding boxes of each element when `true`.

body

A code block in which functions from `draw.typ` have been called.

3.2. Styling

You can style draw elements by passing the relevant named arguments to their draw functions. All elements have stroke and fill styling unless said otherwise.

fill <color> or <none> (default: none)

How to fill the draw element.

stroke <none> or <auto> or <length> (default: black + 1pt)

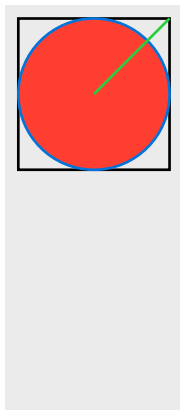
or <color> or <dictionary> or <stroke>

How to stroke the border or the path of the draw element. See Typst's line documentation for more details: <https://typst.app/docs/reference/visualize/line/#parameters-stroke>



```
cetz.canvas({
  import cetz.draw: *
  // Draws a red circle with a blue border
  circle((0, 0), fill: red, stroke: blue)
  // Draws a green line
  line((0, 0), (1, 1), stroke: green)
})
```

Instead of having to specify the same styling for each time you want to draw an element, you can use the `set-style` function to change the style for all elements after it. You can still pass styling to a draw function to override what has been set with `set-style`. You can also use the `fill()` and `stroke()` functions as a shorthand to set the fill and stroke respectively.



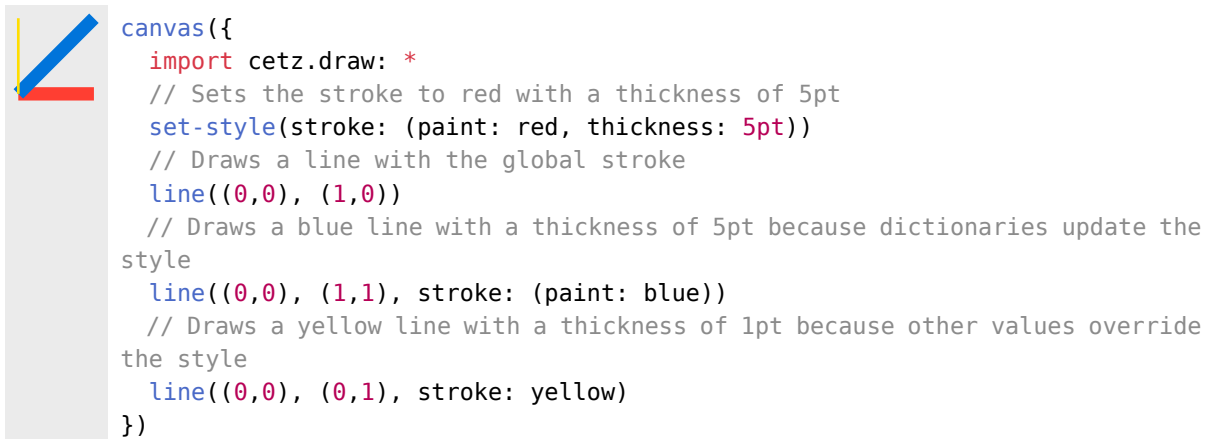
```
cetz.canvas({
  import cetz.draw: *
  // Draws an empty square with a black border
  rect((-1, -1), (1, 1))

  // Sets the global style to have a fill of red and a stroke of blue
  set-style(stroke: blue, fill: red)
  circle((0,0))

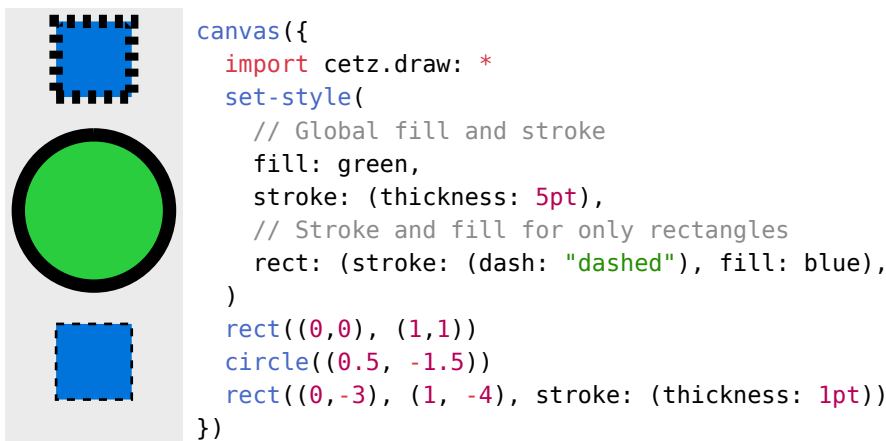
  // Draws a green line despite the global stroke is blue
  line((), (1,1), stroke: green)
})
```

When using a dictionary for a style, it is important to note that they update each other instead of overriding the entire option like a non-dictionary value would do. For example, if the stroke is set to

(paint: red, thickness: 5pt) and you pass (paint: blue), the stroke would become (paint: blue, thickness: 5pt).



You can also specify styling for each type of element. Note that dictionary values will still update with its global value, the full hierarchy is function > element type > global. When the value of a style is auto, it will become exactly its parent style.



3.3. Elements

3.3.1. Line

Draws a line (a direct path between two points) to the canvas. If multiple coordinates are given, a line is drawn between each consecutive one.

```
line(..pts, name: none, close: false, ..styling)
```

..pts <arguments of coordinates>

Coordinates to draw the lines between. A minimum of two must be given.

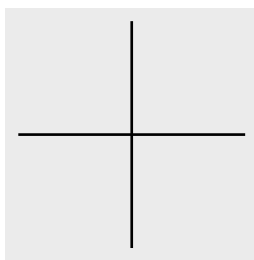
name <string>

Sets the name of element for use with anchors.

close <bool>

(default: **false**)

When true a straight line is drawn from the last coordinate to the first coordinate, essentially “closing” the shape.



```
canvas({
  import cetz.draw: *
  line((-1.5, 0), (1.5, 0))
  line((0, -1.5), (0, 1.5))
})
```

Styling

mark <dictionary> or <auto>

(default: **auto**)

The styling to apply to marks on the line, see Section 3.3.8.

3.3.2. Rectangle

Draws a rectangle to the canvas.

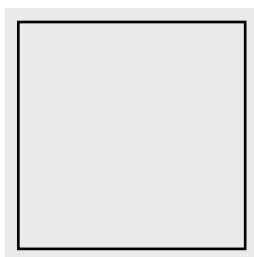
```
rect(a, b, name: none, anchor: none, ..styling)
```

a <coordinate>

The top left coordinate of the rectangle.

b <coordinate>

The bottom right coordinate of the rectangle.



```
canvas({
  import cetz.draw: *
  rect((-1.5, 1.5), (1.5, -1.5))
})
```

3.3.3. Arc

Draws an arc to the canvas. Exactly two of the three values start, stop, and delta should be defined. You can set the radius of the arc by setting the radius style option. You can also draw an elliptical arc by passing an array where the first number is the radius in the x direction and the second number is the radius in the y direction.

```
arc(position, start: auto, stop: auto, delta: auto, name: none, anchor: none,)
```

position <coordinate>

The coordinate to start drawing the arc from.

start <angle>

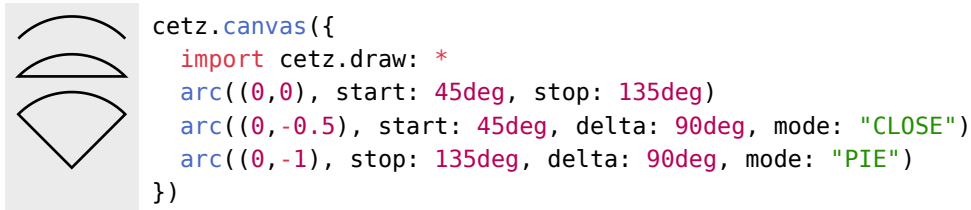
The angle to start the arc.

stop <angle>

The angle to stop the arc.

delta <angle>

The angle that is added to start or removed from stop.



Styling

radius <number> or <array>

(default: 1)

The radius of the arc. This is also a global style shared with circle!

mode <string>

(default: "OPEN")

The options are "OPEN" (the default, just the arc), "CLOSE" (a circular segment) and "PIE" (a circular sector).

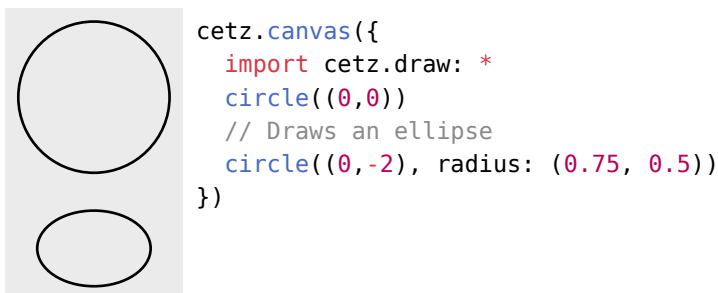
3.3.4. Circle

Draws a circle to the canvas. An ellipse can be drawn by passing an array of length two to the `radius` argument to specify its x and y radii.

`circle(center, name: none, anchor: none)`

center <coordinate>

The coordinate of the circle's origin.



Styling

radius <number> or <length> or <array of <number> or <length>>

(default: 1)

The circle's radius. If an array is given an ellipse will be drawn where the first item is the x radius and the second item is the y radius. This is also a global style shared with arc!

3.3.5. Bezier

Draws a bezier curve with 1 or 2 control points to the canvas.

`bezier(start, end, ..ctrl-style)`

start <coordinate>

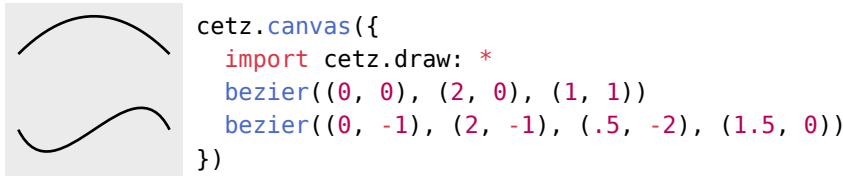
The coordinate to start drawing the bezier curve from.

end <coordinate>

The coordinate to draw the bezier curve to.

..ctrl-style <coordinates>

An argument sink for the control points and styles. Its positional part should be of one or two coordinates to specify the control points of the bezier curve.



3.3.6. Content

Draws a content block to the canvas.

`content`(pt, ct, angle: `0deg`, name: `none`, anchor: `none`)

pt <coordinate>

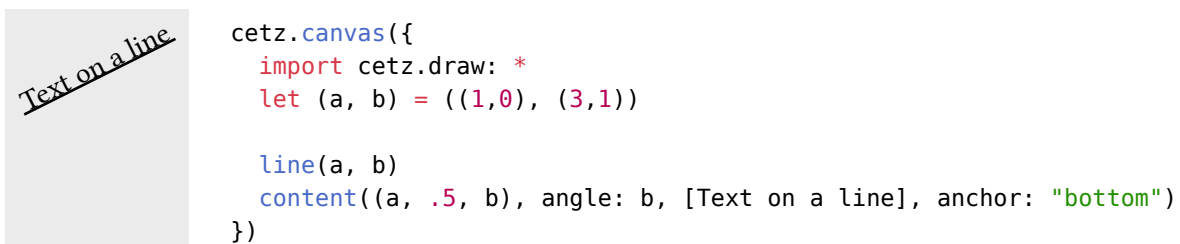
The coordinate of the center of the content block.

ct <content>

The content block.

angle <angle|coordinate>

The angle to rotate the content block by. Uses Typst's rotate function. If passed a coordinate, the angle between pt and angle is used.



Styling

This draw element is not affected by fill or stroke styling.

padding <length>

(default: `0pt`)

3.3.7. Grid

Draws a grid to the canvas.

`grid`(from, to, step: `1`, help-lines: `false`, name: `none`)

from <coordinate>

Specifies the bottom left position of the grid.

to <coordinate>

Specifies the top right position of the grid.

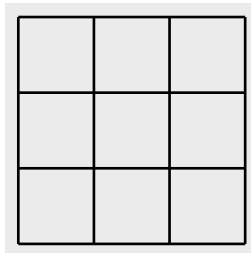
step <number> or <length> or <array of <number> or <length>>

The stepping in both x and y directions. An array can be given to specify the stepping for each direction.

help-lines <bool>

(default: false)

Styles the grid to look “subdued” by using thin gray lines (0.2pt + gray)

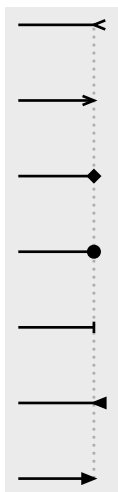


```
cetz.canvas({
  import cetz.draw: *
  grid((0,0), (3,2), help-lines: true)
})
```

3.3.8. Mark

Draws a mark or “arrow head”, its styling influences marks being drawn on paths (e.g. lines).

#mark(from, to, ..style)



```
cetz.canvas({
  import cetz.draw: *
  line((1, 0), (1, 6), stroke: (paint: gray, dash: "dotted"))
  set-style(mark: (fill: none))
  line((0, 6), (1, 6), mark: (end: "<"))
  line((0, 5), (1, 5), mark: (end: ">"))
  set-style(mark: (fill: black))
  line((0, 4), (1, 4), mark: (end: "<>"))
  line((0, 3), (1, 3), mark: (end: "o"))
  line((0, 2), (1, 2), mark: (end: "|"))
  line((0, 1), (1, 1), mark: (end: "<"))
  line((0, 0), (1, 0), mark: (end: ">"))
})
```

Styling

symbol <string>

(default: >)

The type of mark to draw when using the mark function.

start <string>

The type of mark to draw at the start of a path.

end <string>

The type of mark to draw at the end of a path.

size <number>

(default: 0.15)

The size of the marks.

3.4. Path Transformations

3.4.1. Merge-Path

merge-path(body, ..style, close: false, name: none)

body <objects>

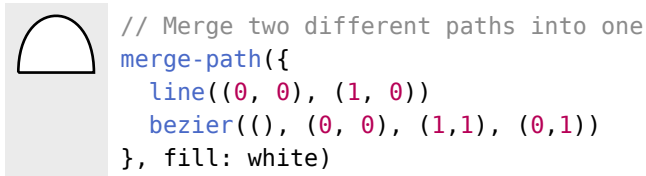
Elements to merge as one path

close <bool>

Auto close the path using a straight line

name <string>

Element name



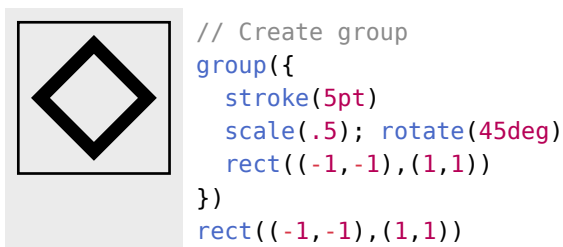
3.5. Groups

Groups allow scoping context changes such as setting stroke-style, fill and transformations.

```
group(body, name: none, anchor: none)
```

Note: You can pass content a function of the form `ctx => draw-cmds` that returns the groups children.

This way you get access to the groups context dictionary.



3.5.1. Anchor

Defines a new anchor inside a group.

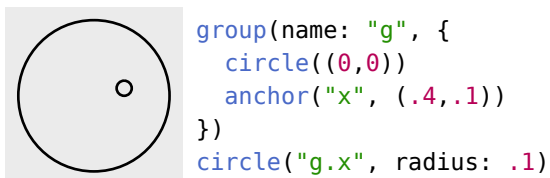
```
anchor(name, coordinate)
```

name <string>

Name of the anchor

coordinate <coordinate>

Position



3.5.2. Copy-Anchors

Copy all anchors of element into current group.

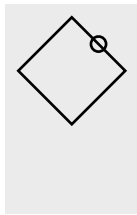
```
copy-anchors(element, filter: none)
```

element <string>

Target element name

filter <array|none>

List of anchor names to copy, all if empty



```
group(name: "g", {
  rotate(45deg)
  rect((0,0), (1,1), name: "r")
  copy-anchors("r")
})
circle("g.top", radius: .1)
```

3.6. Transformations

All transformation functions push a transformation matrix onto the current transform stack. To apply transformations scoped use a `group(...)` object.

Transformation matrices get multiplied in the following order:

$$M_{\text{world}} = M_{\text{world}} \cdot M_{\text{local}}$$

3.6.1. Translate

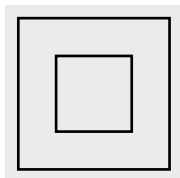
```
translate(coordinate, pre: true)
```

coordinate <vector>

Coordinates to translate for

pre <bool>

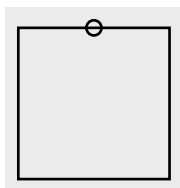
Specify multiplication order. If `true`, translation is multiplied in the order $M_{\text{local}} \cdot M_{\text{world}}$, otherwise the order $M_{\text{world}} \cdot M_{\text{local}}$ is used.



```
// Outer rect
rect((0,0), (2,2))
// Inner rect
translate((.5,.5,0))
rect((0,0), (1,1))
```

3.6.2. Set Origin

```
set-origin(position)
```



```
// Outer rect
rect((0,0), (2,2), name: "r")
// Move origin to top edge
set-origin("r.above")
circle((0, 0), radius: .1)
```

3.6.3. Set Viewport

```
set-viewport(from, to, bounds: (1, 1, 1))
```

from <coordinate>

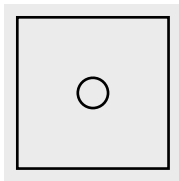
First (bottom-right) coordinate of the viewport rect.

to <coordinate>

Second (top-left) coordinate of the viewport rect.

bounds <vector>

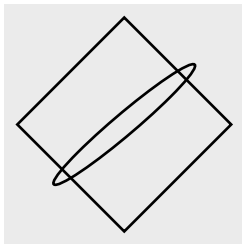
Viewport inner bounds. Negative bounds flip sides.



```
rect((0,0), (2,2))
set-viewport((0,0), (2,2), bounds: (10, 10))
circle((5,5))
```

3.6.4. Rotate

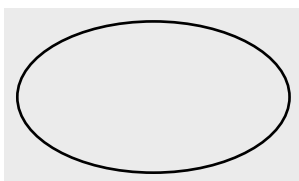
```
rotate(axis-dictionary)
rotate(z-angle)
```



```
// Rotate on z-axis
rotate((z: 45deg))
rect((-1,-1), (1,1))
// Rotate on y-axis
rotate((y: 80deg))
circle((0,0))
```

3.6.5. Scale

```
#scale(axis-dictionary)
#scale(factor)
```



```
// Scale x-axis
scale((x: 1.8))
circle((0,0))
```

4. Coordinate Systems

A *coordinate* is a position on the canvas on which the picture is drawn. They take the form of dictionaries and the following sub-sections define the key value pairs for each system. Some systems have a more implicit form as an array of values and CeTZ attempts to infer the system based on the element types.

4.1. XYZ

Defines a point x units right, y units upward, and z units away.

x <number> or <length> (default: 0)

The number of units in the x direction.

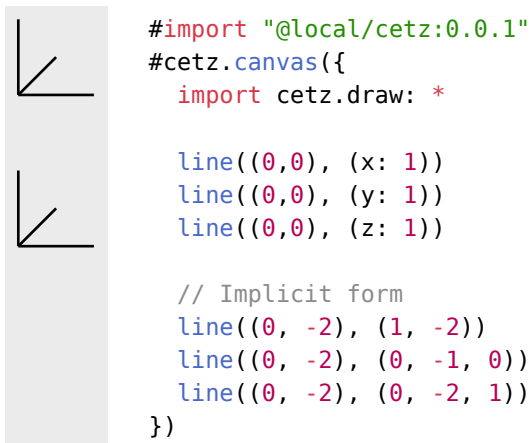
y <number> or <length> (default: 0)

The number of units in the y direction.

z <number> or <length> (default: 0)

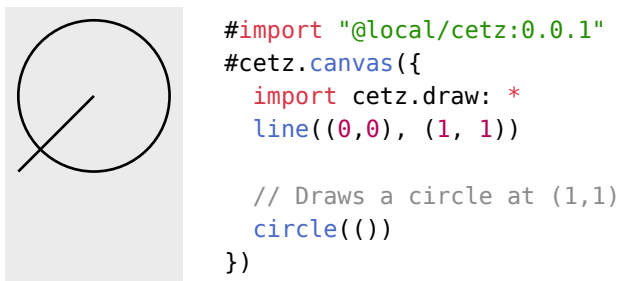
The number of units in the z direction.

The implicit form can be given as an array of two or three <number> or <length>, as in (x,y) and (x,y,z).



4.2. Previous

Use this to reference the position of the previous coordinate passed to a draw function. This will never reference the position of a coordinate used in to define another coordinate. It takes the form of an empty array (). The previous position initially will be (0, 0, 0).



4.3. Relative

Places the given coordinate relative to the previous coordinate. Or in other words, for the given coordinate, the previous coordinate will be used as the origin. Another coordinate can be given to act as the previous coordinate instead.

rel <coordinate>

The coordinate to be place relative to the previous coordinate.

update <bool>

(default: **true**)

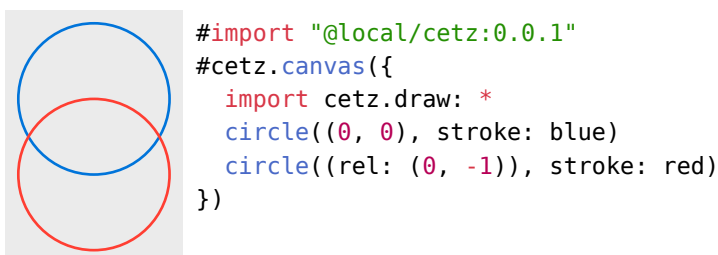
When false the previous position will not be updated.

to <coordinate>

(default: ())

The coordinate to treat as the previous coordinate.

In the example below, the red circle is placed one unit below the blue circle. If the blue circle was to be moved to a different position, the red circle will move with the blue circle to stay one unit below.



4.4. Polar

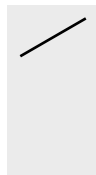
Defines a point a radius distance away from the origin at the given angle. An angle of zero degrees. An angle of zero degrees is to the right, a degree of 90 is upward.

angle <angle>

The angle of the coordinate.


radius <number> or <length> or <array of length or number>

The distance from the origin. An array can be given, in the form (x, y) to define the x and y radii of an ellipse instead of a circle.



```
#import "@local/cetz:0.0.1"
#cezt.canvas({
  import cetz.draw: *
  line((0,0), (angle: 30deg, radius: 1cm))
})
```

The implicit form is an array of the angle then the radius (angle, radius) or (angle, (x, y)).



```
#import "@local/cetz:0.0.1"
#cezt.canvas({
  import cetz.draw: *
  line((0,0), (30deg, 1), (60deg, 1),
    (90deg, 1), (120deg, 1), (150deg, 1), (180deg, 1))
})
```

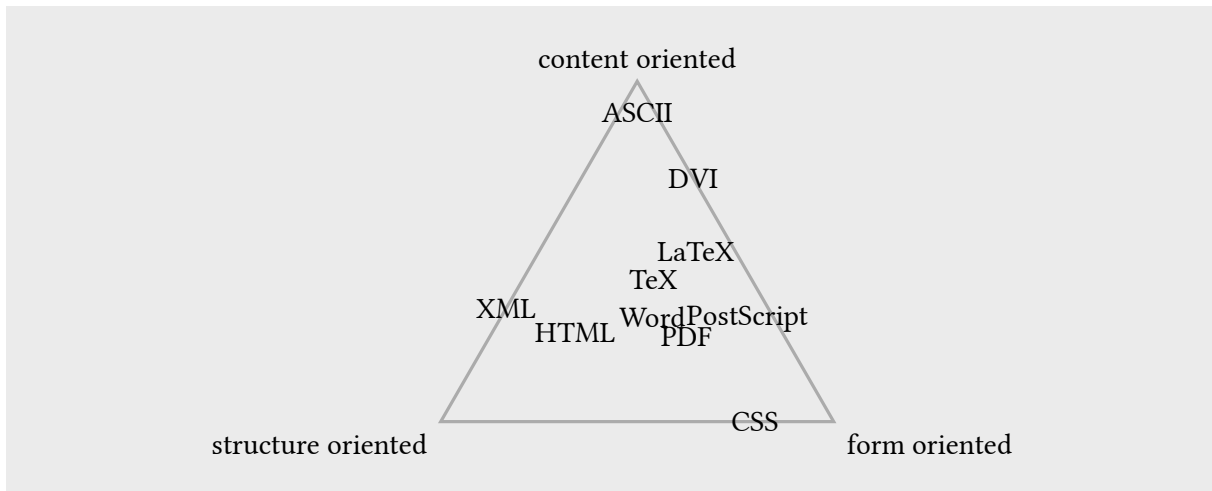
4.5. Barycentric

In the barycentric coordinate system a point is expressed as the linear combination of multiple vectors. The idea is that you specify vectors v_1, v_2, \dots, v_n and numbers $\alpha_1, \alpha_2, \dots, \alpha_n$. Then the barycentric coordinate specified by these vectors and numbers is

$$\frac{\alpha_1 v_1 + \alpha_2 v_2 + \dots + \alpha_n v_n}{\alpha_1 + \alpha_2 + \dots + \alpha_n}$$

bary <dictionary>

A dictionary where the key is a named element and the value is a <float>. The center anchor of the named element is used as v and the value is used as a .



```

circle((90deg, 3), radius: 0, name: "content")
circle((210deg, 3), radius: 0, name: "structure")
circle((-30deg, 3), radius: 0, name: "form")

for (c, a) in (
  ("content", "bottom"),
  ("structure", "top-right"),
  ("form", "top-left")
) {
  content(c, box(c + " oriented", inset: 5pt), anchor: a)
}

stroke(gray + 1.2pt)
line("content", "structure", "form", close: true)

for (c, s, f, cont) in (
  (0.5, 0.1, 1, "PostScript"),
  (1, 0, 0.4, "DVI"),
  (0.5, 0.5, 1, "PDF"),
  (0, 0.25, 1, "CSS"),
  (0.5, 1, 0, "XML"),
  (0.5, 1, 0.4, "HTML"),
  (1, 0.2, 0.8, "LaTeX"),
  (1, 0.6, 0.8, "TeX"),
  (0.8, 0.8, 1, "Word"),
  (1, 0.05, 0.05, "ASCII")
) {
  content((bary: (content: c, structure: s, form: f)), cont)
}

```

4.6. Anchor

Defines a point relative to a named element using anchors, see Section 2.2.

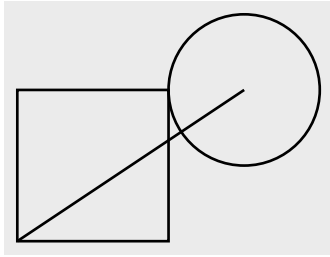
name <string>

The name of the element that you wish to use to specify a coordinate.

anchor <string>

An anchor of the element. If one is not given a default anchor will be used. On most elements this is center but it can be different.

You can also use implicit syntax of a dot separated string in the form "name.anchor".



```
import cetz.draw: *
line((0,0), (3,2), name: "line")
circle("line.end", name: "circle")
rect("line.start", "circle.left")
```

4.7. Tangent

This system allows you to compute the point that lies tangent to a shape. In detail, consider an element and a point. Now draw a straight line from the point so that it “touches” the element (more formally, so that it is *tangent* to this element). The point where the line touches the shape is the point referred to by this coordinate system.

element <string>

The name of the element on whose border the tangent should lie.

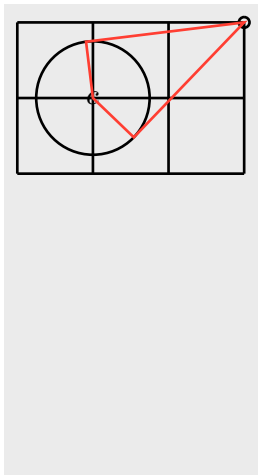
point <coordinate>

The point through which the tangent should go.

solution <integer>

Which solution should be used if there are more than one.

A special algorithm is needed in order to compute the tangent for a given shape. Currently it does this by assuming the distance between the center and top anchor (See Section 2.2) is the radius of a circle.



```
grid((0,0), (3,2), help-lines: true)

circle((3,2), name: "a", radius: 2pt)
circle((1,1), name: "c", radius: 0.75)
content("c", $ c $)

stroke(red)
line(
  "a",
  (element: "c", point: "a", solution: 1),
  "c",
  (node: "c", point: "a", solution: 2),
  close: true
)
```

4.8. Perpendicular

Can be used to find the intersection of a vertical line going through a point p and a horizontal line going through some other point q .

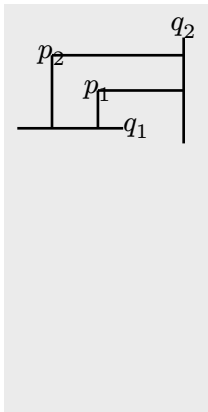
horizontal <coordinate>

The coordinate through which the horizontal line passes.

vertical <coordinate>

The coordinate through which the vertical line passes.

You can use the implicit syntax of (horizontal, "-|", vertical) or (vertical, "|-", horizontal)



```

content((30deg, 1), $ p_1 $, name: "p1")
content((75deg, 1), $ p_2 $, name: "p2")

line((-0.2, 0), (1.2, 0), name: "xline")
content("xline.end", $ q_1 $, anchor: "left")
line((2, -0.2), (2, 1.2), name: "yline")
content("yline.end", $ q_2 $, anchor: "bottom")

line("p1", (horizontal: (), vertical: "xline"))
line("p2", (horizontal: (), vertical: "xline"))
line("p1", (vertical: (), horizontal: "yline"))
line("p2", (vertical: (), horizontal: "yline"))

```

4.9. Interpolation

Use this to linearly interpolate between two coordinates *a* and *b* with a given factor number. If number is a <length> the position will be at the given distance away from *a* towards *b*. An angle can also be given for the general meaning: “First consider the line from *a* to *b*. Then rotate this line by angle around point *a*. Then the two endpoints of this line will be *a* and some point *c*. Use this point *c* for the subsequent computation.”

a <coordinate>

The coordinate to interpolate from.

b <coordinate>

The coordinate to interpolate to.

number <number> or <length>

The factor to interpolate by or the distance away from *a* towards *b*.

angle <angle>

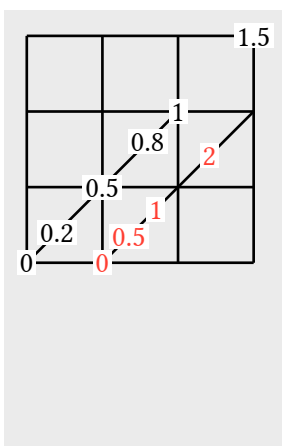
(default: 0deg)

abs <bool>

(default: false)

Interpret number as absolute distance, instead of a factor.

Can be used implicitly as an array in the form (*a*, *number*, *b*) or (*a*, *number*, *angle*, *b*).



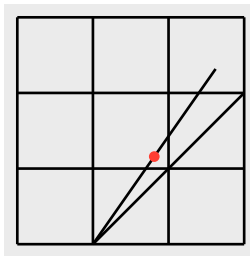
```

grid((0,0), (3,3), help-lines: true)

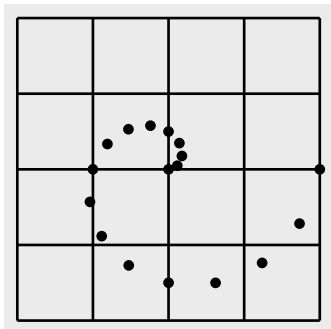
line((0,0), (2,2))
for i in (0, 0.2, 0.5, 0.8, 1, 1.5) { /* Relative distance */
  content(((0,0), i, (2,2)),
    box(fill: white, inset: 1pt, [#i]))
}

line((1,0), (3,2))
for i in (0, 0.5, 1, 2) { /* Absolute distance */
  content((a: (1,0), number: i, abs: true, b: (3,2)),
    box(fill: white, inset: 1pt, text(red, [#i])))
}

```



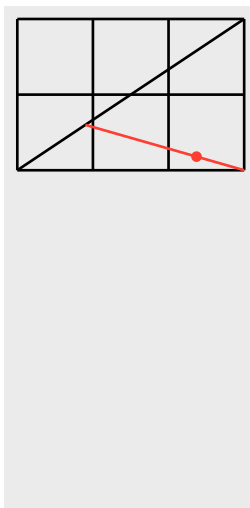
```
grid((0,0), (3,3), help-lines: true)
line((1,0), (3,2))
line((1,0), ((1, 0), 1, 10deg, (3,2)))
fill(red)
stroke(none)
circle(((1, 0), 0.5, 10deg, (3, 2)), radius: 2pt)}
```



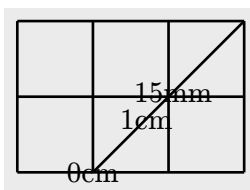
```
grid((0,0), (4,4), help-lines: true)

fill(black)
stroke(none)
let n = 16
for i in range(0, n+1) {
  circle(((2,2), i / 8, i * 22.5deg, (3,2)), radius: 2pt)
}
```

You can even chain them together!



```
grid((0,0), (3, 2), help-lines: true)
line((0,0), (3,2))
stroke(red)
line(((0,0), 0.3, (3,2)), (3,0))
fill(red)
stroke(none)
circle(
  (
    // a
    (((0, 0), 0.3, (3, 2))),
    0.7,
    (3,0)
  ),
  radius: 2pt
)
```

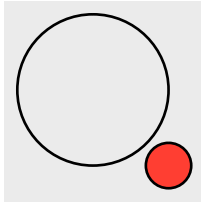


```
grid((0,0), (3, 2), help-lines: true)
line((1,0), (3,2))
for (l, c) in ((0cm, "0cm"), (1cm, "1cm"), (15mm, "15mm")) {
  content(((1,0), l, (3,2)), $ #c $)
}
```

4.10. Function

An array where the first element is a function and the rest are coordinates will cause the function to be called with the resolved coordinates. The resolved coordinates have the same format as the implicit form of the 3-D XYZ coordinate system, Section 4.1.

The example below shows how to use this system to create an offset from an anchor, however this could easily be replaced with a relative coordinate with the `to` argument set, Section 4.3.



```
circle((0, 0), name: "c")
fill(red)
circle((v => cetz.vector.add(v, (0, -1)), "c.right"), radius: 0.3)
```

5. Utility

5.1. For-Each-Anchor

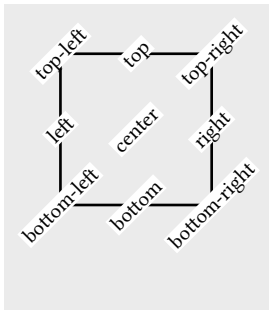
`for-each-anchor`(node-name, callback)

node-name <string>

Target node name

callback <function>

Callback function acceptance the anchor name



```
// Label nodes anchors
rect((0, 0), (2,2), name: "my-rect")
for-each-anchor("my-rect", (name) => {
  if not name in ("above", "below", "default") {

    content((), box(inset: 1pt, fill: white, text(8pt, [#name])),
      angle: -45deg)
  }
})
```

6. Libraries

6.1. Tree

With the tree library, CeTZ provides a simple tree layout algorithm.

```
tree(root-node, draw-node: auto, draw-edge: auto,
  direction: "down", parent-position: "center", grow: 1,
  spread: 1, name: none, ..style)
```

root-node <node>

Tree root node, see Section 6.1.1

draw-node <function|none>

Node render callback (node, parent-name) => (draw, ..)

draw-edge <function|none>

Edge render callback (source-name, target-name, target-node) => (draw, ..)

direction <string>

Tree grow direction: "top", "bottom", "left" or "right"

parent-position <string>

Positioning of parent nodes: "begin", "center" or "end"

grow <float>

Direction grow factor

spread <float>

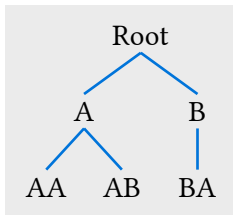
Sibling spread factor

name <string|none>

Object name

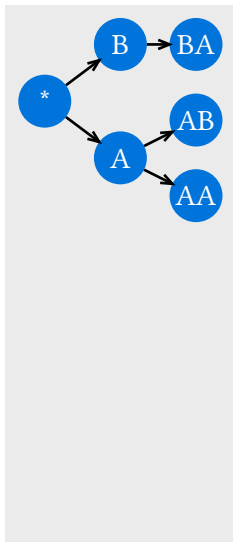
..style <style>

Draw style



```
import "tree.typ"
```

```
let data = ([Root], ([A], [AA], [AB]), ([B], [BA]))
tree.tree(data, content: (padding: .1), line: (stroke: blue))
```



```
import "tree.typ"
```

```
let data = ([Root], ([\*], [AA], [AB]), ([B], [BA]))
tree.tree(data, content: (padding: .1), direction: "right",
  mark: (end: ">", fill: none),
  draw-node: (node, ..) => {
    circle(( ), radius: .35, fill: blue, stroke: none)
    content(( ), text(white, [#node.content]))
  },
  draw-edge: (from, to, ..) => {
    let (a, b) = (from + ".center",
      to + ".center")

    draw.line((a: a, b: b, abs: true, number: .35),
      (a: b, b: a, abs: true, number: .35))
  })
```

6.1.1. Node

A tree node is an array of nodes. The first array item represents the current node, all following items are direct children of that node. The node itself can be of type content or dictionary with a key content.

6.2. Plot

The library plot of CeTZ allows plotting 2D data as linechart.

6.2.1. add

Add data to a plot environment.

Must be called from the body of a `plot(..)` command.

6.2.1.1. Parameters

```
add(
  domain: array,
  hypograph: bool,
  epigraph: bool,
  fill: bool,
  mark: string,
  mark-size: float,
  samples: int,
  style: style,
  mark-style,
  axes: array,
```

```
data: array function
)
```

domain array

Domain tuple of the plot. If data is a function, domain must be specified, as data is sampled for x-values in domain. Values must be numbers.

Default: **auto**

hypograph bool

Fill hypograph; uses the hypograph style key for drawing

Default: **false**

epigraph bool

Fill epigraph; uses the epigraph style key for drawing

Default: **false**

fill bool

Fill to y zero

Default: **false**

mark string

Mark symbol to place at each distinct value of the graph. Uses the mark style key of style for drawing.

The following marks are supported:

- "*" or "x" – X
- "+" – Cross
- "|" – Bar
- "- " – Dash
- "o" – Circle
- "triangle" – Triangle
- "square" – Square

Default: **none**

mark-size float

Mark size in cavas units

Default: **.2**

samples `int`

Number of times the data function gets called for sampling y-values. Only used if data is of type function.

Default: **100**

style `style`

Style to use, can be used with a palette function

Default: (stroke: black, fill: gray)

axes `array`

Name of the axes to use ("x", "y"), note that not all plot styles are able to display a custom axis!

Default: ("x", "y")

data `array` or `function`

Array of 2D data points (numeric) or a function of the form $x \Rightarrow y$, where x is a value inside domain and y must be numeric.

Examples

- $((0,0), (1,1), (2,-1))$
- $x \Rightarrow \text{calc.pow}(x, 2)$

6.2.2. plot

Create a plot environment

Note: Data for plotting must be passed via `plot.add(...)`

Note that different axis-styles can show different axes. The "school-book" and "left" style shows only axis "x" and "y", while the "scientific" style can show "x2" and "y2", if set (if unset, "x2" mirrors "x" and "y2" mirrors "y"). Other axes (e.G. "my-axis") work, but no ticks or labels will be shown.

Options

The following options are supported per axis and must be prefixed by <axis-name>-, e.G. x-min: 0.

- label (content): Axis label
- min (int): Axis minimum value
- max (int): Axis maximum value
- tick-step (float): Distance between major ticks
- minor-tick-step (float): Distance between minor ticks
- ticks (array): List of ticks values or value/label tuples. Example (1,2,3) or ((1, [A]), (2, [B]),)
- format (string): Tick label format, "float" or "sci" (scientific)
- unit (content): Tick label suffix
- decimals (int): Number of decimals digits to display for tick labels

6.2.2.1. Parameters

```
plot(
  body: body,
  size: array,
  axis-style: string,
  ..options
)
```

body `body`

Calls of `plot.add` commands

size `array`

Plot canvas size tuple of width and height in canvas units

Default: `(1, 1)`

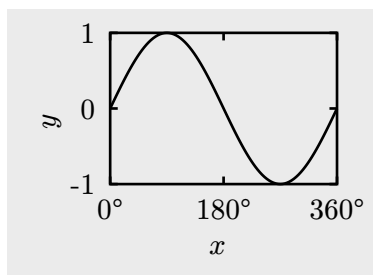
axis-style `string`

Axis style "scientific", "left", "school-book"

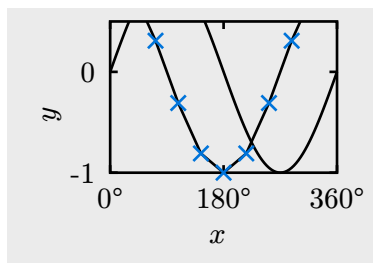
- "scientific": Frame plot area and draw axes y , x , y_2 , and x_2 around it
- "school-book": Draw axes x and y as arrows with both crossing at $(0, 0)$
- "left": Draw axes x and y as arrows, the y axis stays on the left (at $x.min$) and the x axis at the bottom (at $y.min$)

Default: "scientific"

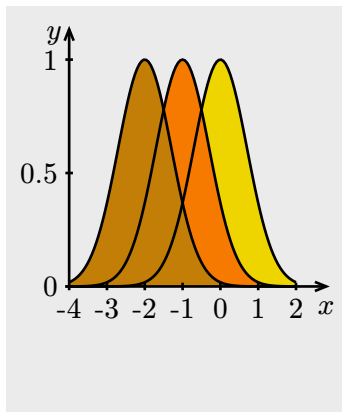
6.2.3. Examples



```
plot.plot(size: (3,2), x-tick-step: 180, y-tick-step: 1,
  x-unit: $degree$, {
  plot.add(domain: (0, 360), x => calc.sin(x * 1deg))
})
```



```
plot.plot(size: (3,2), x-tick-step: 180, y-tick-step: 1,
  x-unit: $degree$, y-max: .5, {
  plot.add(domain: (0, 360), x => calc.sin(x * 1deg))
  plot.add(domain: (0, 360), x => calc.cos(x * 1deg),
    samples: 10, mark: "x", style: (mark: (stroke:
blue)))
})
```



```
// Axes can be styled!
// Set the tick length to .05:
set-style(axes: (tick: (length: .05)))

// Plot something
plot.plot(size: (3,3), axis-style: "left", {
  for i in range(0, 3) {
    plot.add(domain: (-4, 2),
      x => calc.exp(-(calc.pow(x + i, 2))),
      fill: true, style: palette.tango)
  }
})
```

6.2.4. Styling

The following style keys can be used (in addition to the standard keys) to style plot axes. Individual axes can be styled differently by using their axis name as key below the axes root.

```
set-style(axes: ( /* Style for all axes */ ))
set-style(axes: (bottom: ( /* Style axis "left" */ )))
```

Axis names to be used for styling:

- School-Book and Left style:
 - x: X-Axis
 - y: Y-Axis
- Scientific style:
 - left: Y-Axis
 - right: Y2-Axis
 - bottom: X-Axis
 - top: X2-Axis

6.2.4.1. Default scientific Style

```
(
  fill: none,
  stroke: rgb("#000000"),
  label: (offset: 0.2),
  tick: (
    fill: none,
    stroke: rgb("#000000"),
    length: 0.1,
    minor-length: 0.08,
    label: (offset: 0.2),
  ),
  grid: (
    stroke: (paint: rgb("#aaaaaa"), dash: "dotted"),
    fill: none,
  ),
)
```

6.2.4.2. Default school-book Style

```
(
  fill: none,
  stroke: rgb("#000000"),
  label: (offset: 0.2),
  tick: (
    fill: none,
```



```

        stroke: rgb("#000000"),
        length: 0.1,
        minor-length: 0.08,
        label: (offset: 0.1),
    ),
    grid: (
        stroke: (paint: rgb("#aaaaaa"), dash: "dotted"),
        fill: none,
    ),
    mark: (end: ">"),
    padding: 0.4,
)

```

6.3. Chart

With the chart library it is easy to draw charts.

Supported charts are:

- `barchart(. .)`: A chart with horizontal growing bars
 - `mode: "basic"`: (default): One bar per data row
 - `mode: "clustered"`: Multiple grouped bars per data row
 - `mode: "stacked"`: Multiple stacked bars per data row
 - `mode: "stacked100"`: Multiple stacked bars relative to the sum of a data row

6.3.1. barchart

Draw a bar chart. A bar chart is a chart that represents data with rectangular bars that grow from left to right, proportional to the values they represent. For examples see Section 6.3.2.

6.3.1.1. Parameters

```

barchart(
    data: array,
    label-key: int string,
    value-key: int string,
    mode: string,
    size: array,
    bar-width: float,
    bar-style: string,
    x-tick-step: float,
    x-ticks: array,
    x-unit: content auto,
    x-label: content none,
    y-label: content none
)

```

data `array`

Array of data rows. A row can be of type array or dictionary, with `label-key` and `value-key` being the keys to access a rows label and value(s).

Example

```
(([A], 1), ([B], 2), ([C], 3),)
```

label-key `int` or `string`

Key to access the label of a data row. This key is used as argument to the rows `.at(. .)` function.

Default: `0`

value-key `int` or `string`

Key(s) to access value(s) of data row. These keys are used as argument to the rows `.at(...)` function.

Default: `1`

mode `string`

Chart mode:

- "basic" – Single bar per data row
- "clustered" – Group of bars per data row
- "stacked" – Stacked bars per data row
- "stacked100" – Stacked bars per data row relative to the sum of the row

Default: `"basic"`

size `array`

Chart size as width and height tuple in canvas unist; height can be set to `auto`.

Default: `(1, auto)`

bar-width `float`

Size of a bar in relation to the charts height.

Default: `.8`

bar-style `string`

Style or function (`idx => style`) to use for each bar, accepts a palette function.

Default: `palette.red`

x-tick-step `float`

Step size of x axis ticks

Default: `auto`

x-ticks `array`

List of tick values or value/label tuples

Example

`(1, 5, 10)` or `((1, [One]), (2, [Two]), (10, [Ten]))`

Default: `()`

x-unit `content` or `auto`

Tick suffix added to each tick label

Default: `auto`

x-label `content` or `none`

X Axis label

Default: `none`

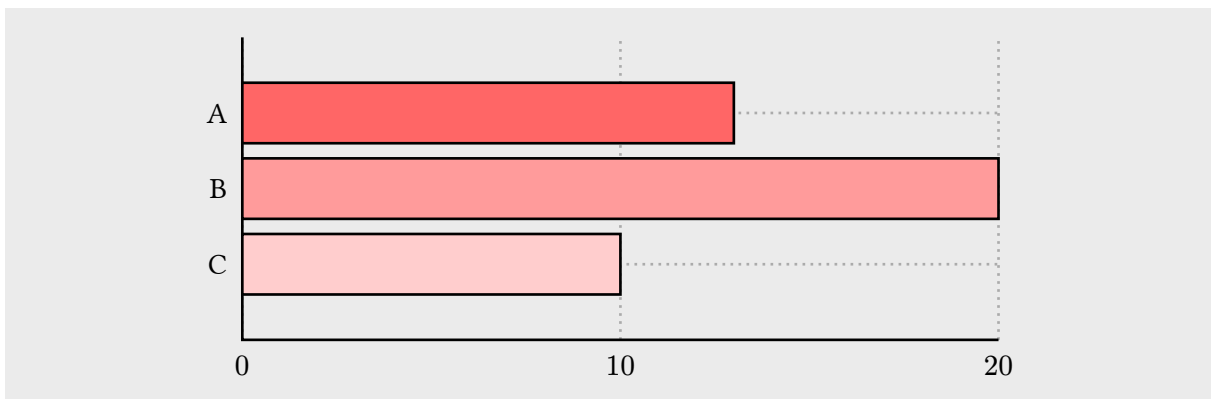
y-label `content` or `none`

Y Axis label

Default: `none`

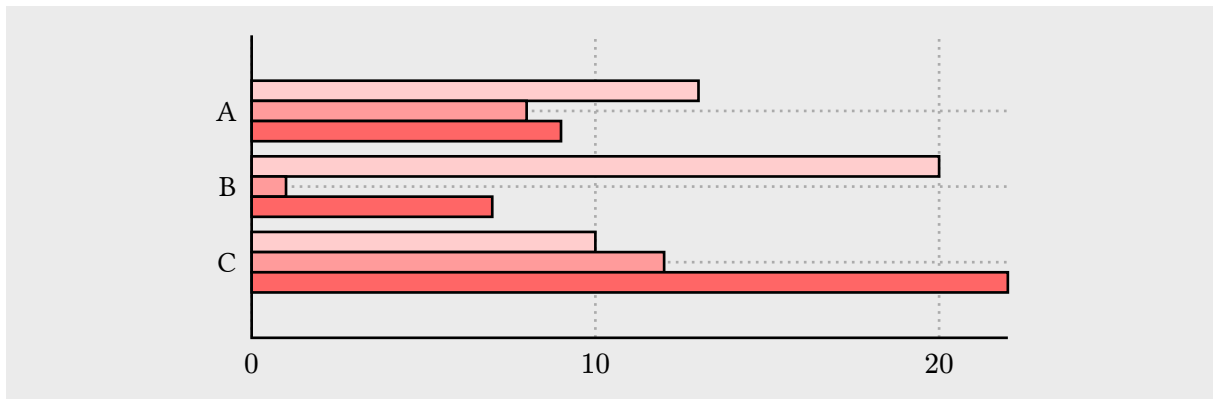
6.3.2. Examples

6.3.2.1. Basic



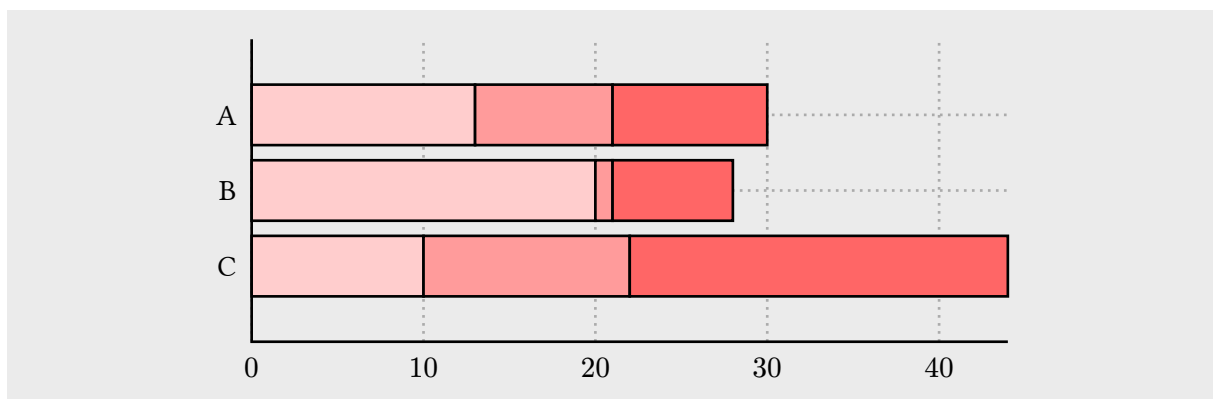
```
let data = (("A", 10), ("B", 20), ("C", 13))
chart.barchart(size: (10, auto), x-tick-step: 10, data)
```

6.3.2.2. Clustered



```
let data = (("A", 10, 12, 22), ("B", 20, 1, 7), ("C", 13, 8, 9))
chart.barchart(size: (10, auto), mode: "clustered",
  x-tick-step: 10, value-key: (..range(1, 4)), data)
```

6.3.2.3. Stacked



```
let data = (("A", 10, 12, 22), ("B", 20, 1, 7), ("C", 13, 8, 9))
chart.barchart(size: (6, auto), mode: "clustered",
  x-tick-step: 10, value-key: (..range(1, 4)), data)
```

6.3.3. Styling

Charts share their axis system with plots and therefore can be styled the same way, see Section 6.2.4.

6.4. Palette

A palette is a function that returns a style for an index. The palette library provides some predefined palettes.

6.4.1. new

Define a new palette

A palette is a function in the form `index -> style` that takes an index (int) and returns a canvas style dictionary. If passed the string "len" it must return the length of its styles.

6.4.1.1. Parameters

```
new(
  stroke: stroke,
  fills: array
) -> function
```

stroke stroke

Single stroke style.

fills `array`

List of fill styles.

6.4.2. List of predefined palettes

- gray



- red



- blue



- rainbow



- tango-light



- tango



- tango-dark

