Conceptual building blocks of visualization – the three types of *visual encoding techniques*

arranging
into meaningful configurations

- horizontal
- vertical
- third dimension
- angular
- radial
- spiral
- vertical array of horizontal axes
- horizontal array of vertical axes
- angular array of radial axes

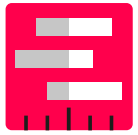
*The **orientations** shown above can be used with **arranging** techniques marked with ●*

picturing

mapping (of spatial locations)

● positioning along a coordinate axis

● extending along a coordinate axis


● diverging along a coordinate axis

● ranging along a coordinate axis

● proportional space-filling

● positioning into category slots

● positioning into ordered slots

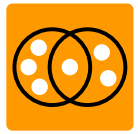
● spatial ordering

nesting

coupling by adjacency

linking
by connectors or boundaries

connecting


grouping by boundary

varying
of visual properties

colour coding

gradient coding

shape coding

sizing

unit-based tallying

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LangVIS

visual encoding technique	types of questions that can be answered	example usage			
picturing	what does it look like?	picture	pictogram	cutaway drawing	exploded view
mapping (of spatial locations)	where?	connection map	bubble map	gradient scale map	cartogram
● **positioning along a coordinate axis**	when? how much or how many? which proportion?	line chart	scatter plot	clock face	parallel coordinates
● **extending along a coordinate axis**	how much or how many? which proportion?	bar chart	area chart	dot plot	Isotype chart
● **ranging along a coordinate axis**	which time range? which range of quantities? (or prop.)	span chart	dumbbell chart	range area chart	
● **diverging along a coordinate axis**	how is this split into two parts?	population pyramid			
● **proportional space-filling**	which proportion?	pie chart	stacked bar chart	100% stacked area chart	treemap
● **positioning into category slots**	which group or category?	table	small multiple of scatter plots		
● **positioning into ordered slots**	which ordered category?	pyramid diagram	bump chart	tree diagram	heat map
● **spatial ordering**	which unique position in an order?	stem and leaf plot	comic strip		

Arranging techniques marked with ● can be specified with an orientation.

LangVIS

visual encoding technique	types of questions that can be answered	example usage			
nesting	does a given relationship hold? which unique position in an order?	nested circle packing	Marimekko chart	treemap	
coupling by adjacency	does a given relationship hold? which unique position in an order? which group or category?	icicle chart	sunburst chart		
connecting	does a given relationship hold? which unique position in an order? which group or category?	flow chart	mind map	arc diagram	bump chart
grouping by boundary	which group or category?	Venn diagram	proportional Venn diagram		
colour coding	which group or category?	lines on a subway map			
gradient coding	which ordered category? which unique position in an order?	heat map	gradient scale map		
shape coding	which group or category?	flow chart			
sizing	how much or how many? which proportion? which ordered category? which unique position in an order?	proportional area chart	bar chart	pie chart	streamgraph
unit-based tallying	how much or how many? which proportion? which ordered category? which unique position in an order?	dot plot	Isotype chart	unit chart	

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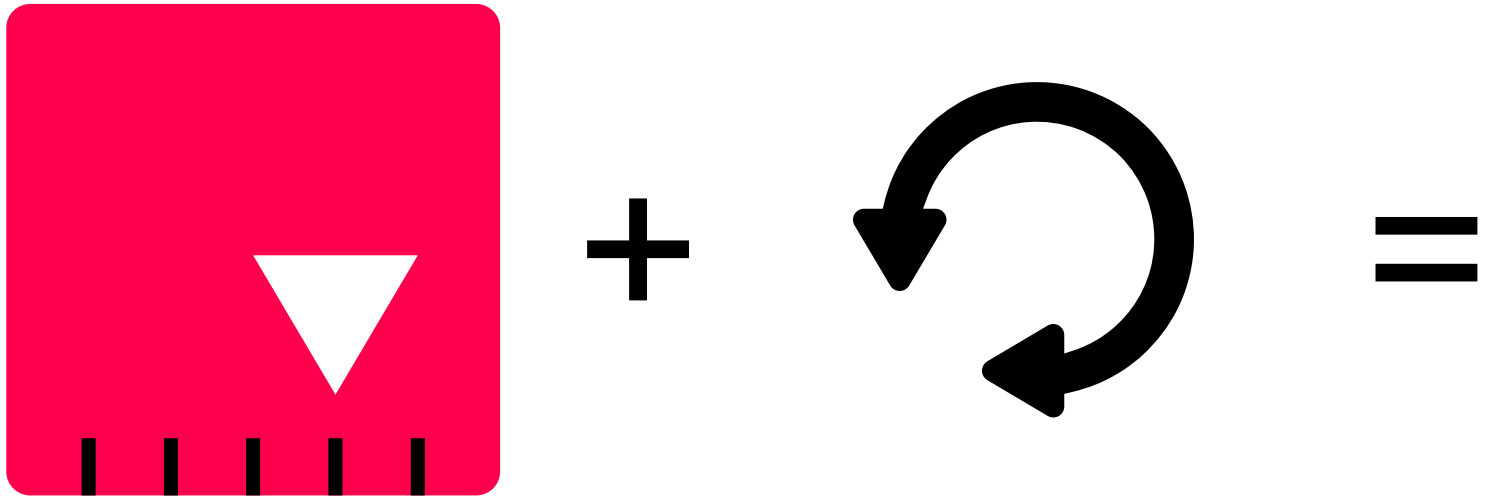

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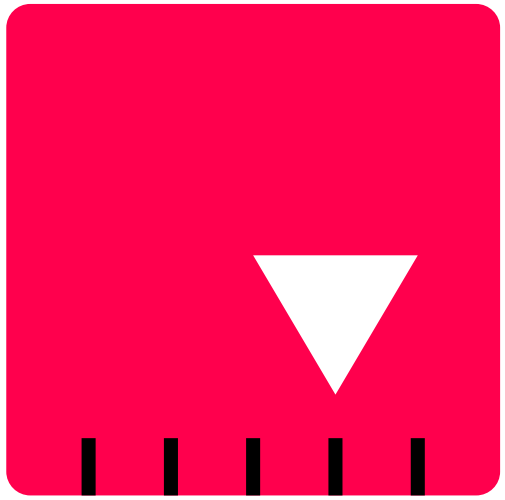

positioning along
a coordinate axis

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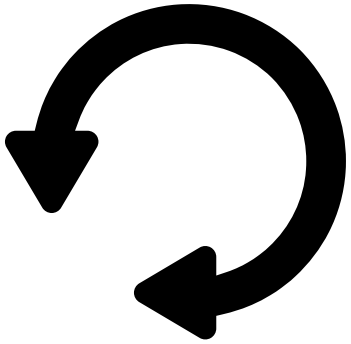

angular

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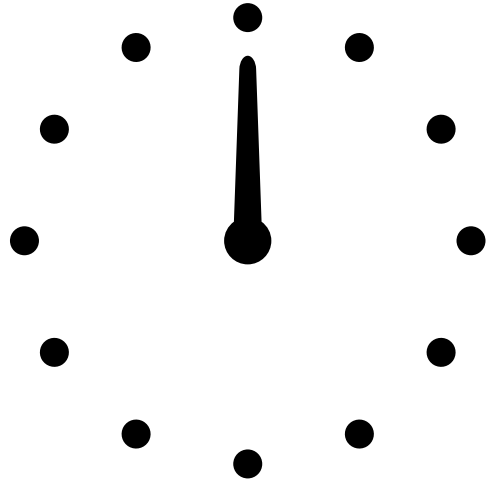

clock face

A **clock face** is composed of a **symbol** (the hand) that is **positioned along an angular coordinate axis** (showing: *when?*).

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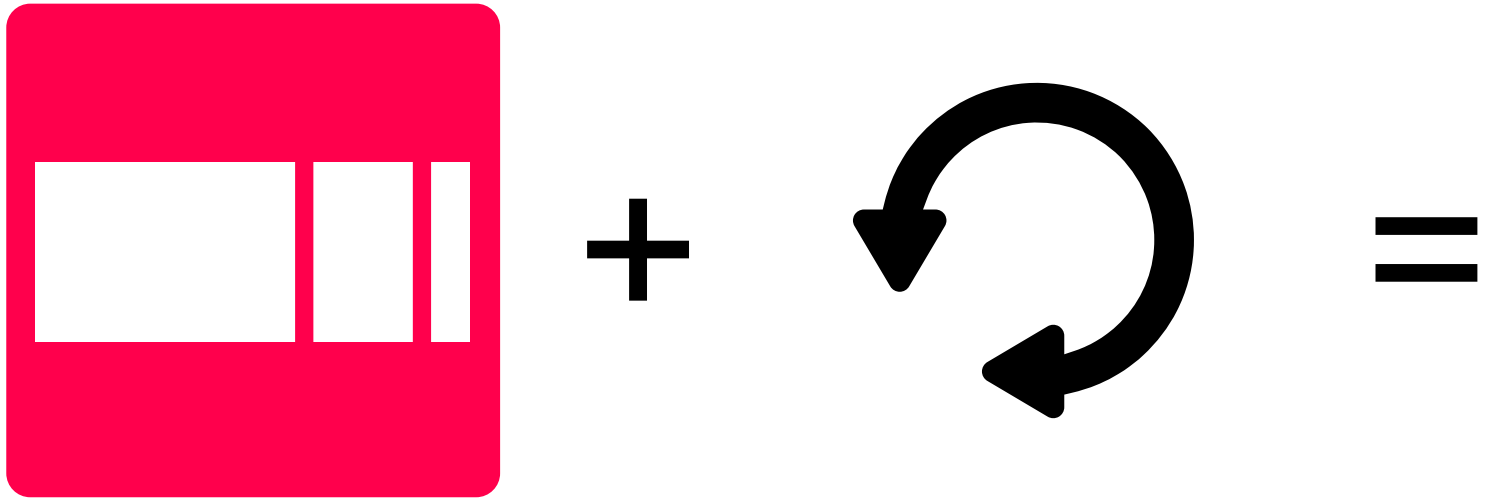

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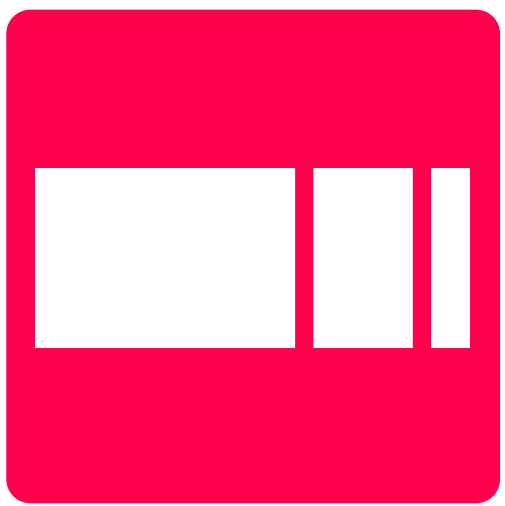

proportional
space-filling

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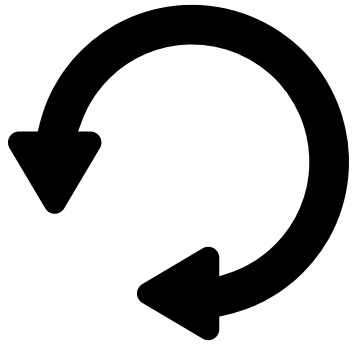

angular

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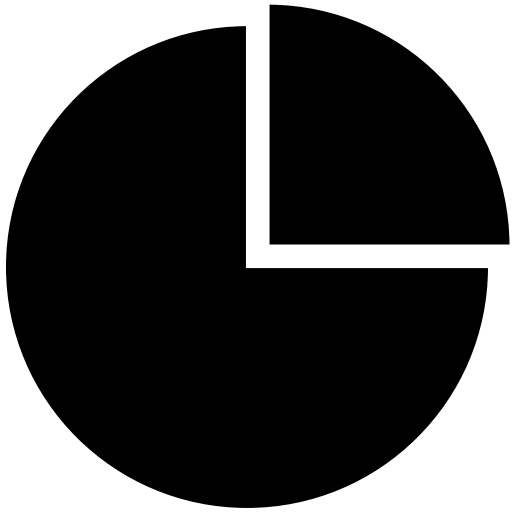
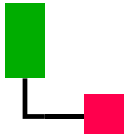


pie chart



A **pie chart** is composed of **segments** that are arranged using **angular proportional space-filling** (showing: *which proportion?*).

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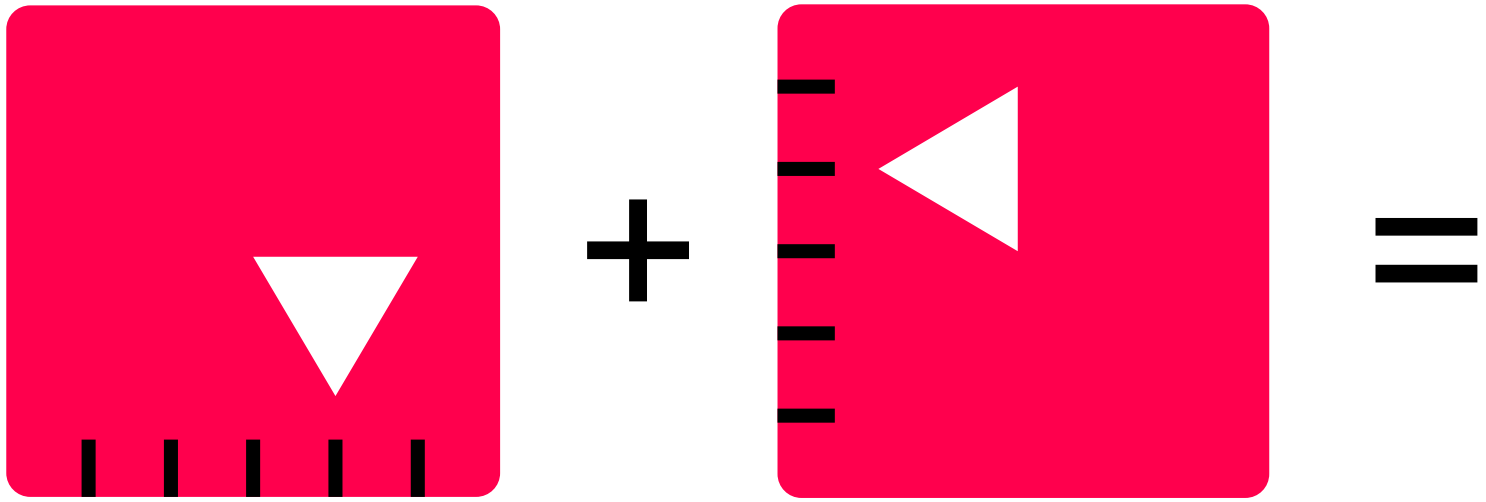

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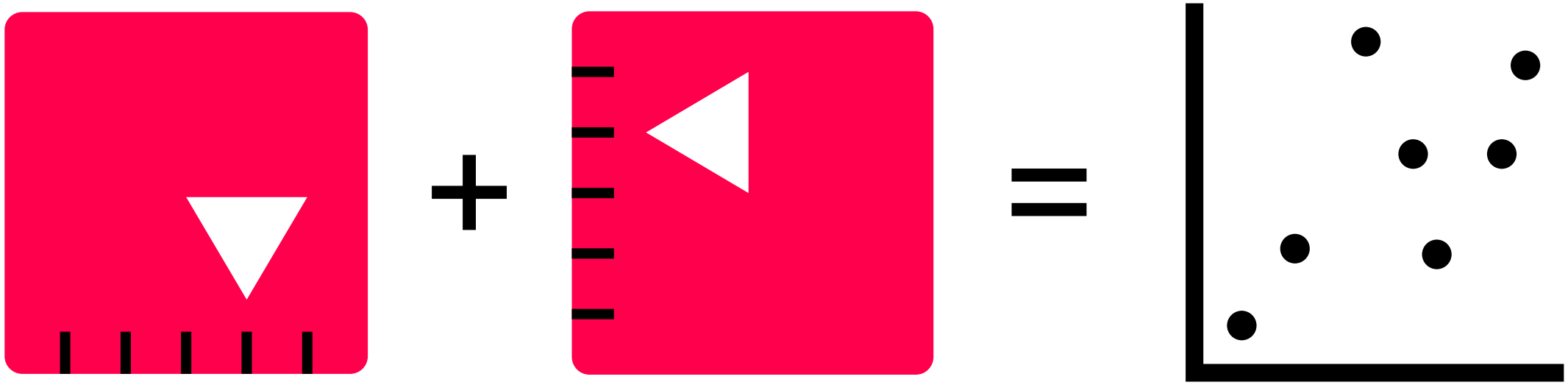

positioning along a coordinate axis

positioning along a coordinate axis

scatter plot

- A **scatter plot** is composed of **symbols** that are
  - **positioned along a horizontal coordinate axis** (showing: *how much or how many?*) and
  - **positioned along a vertical coordinate axis** (showing: *how much or how many?*).

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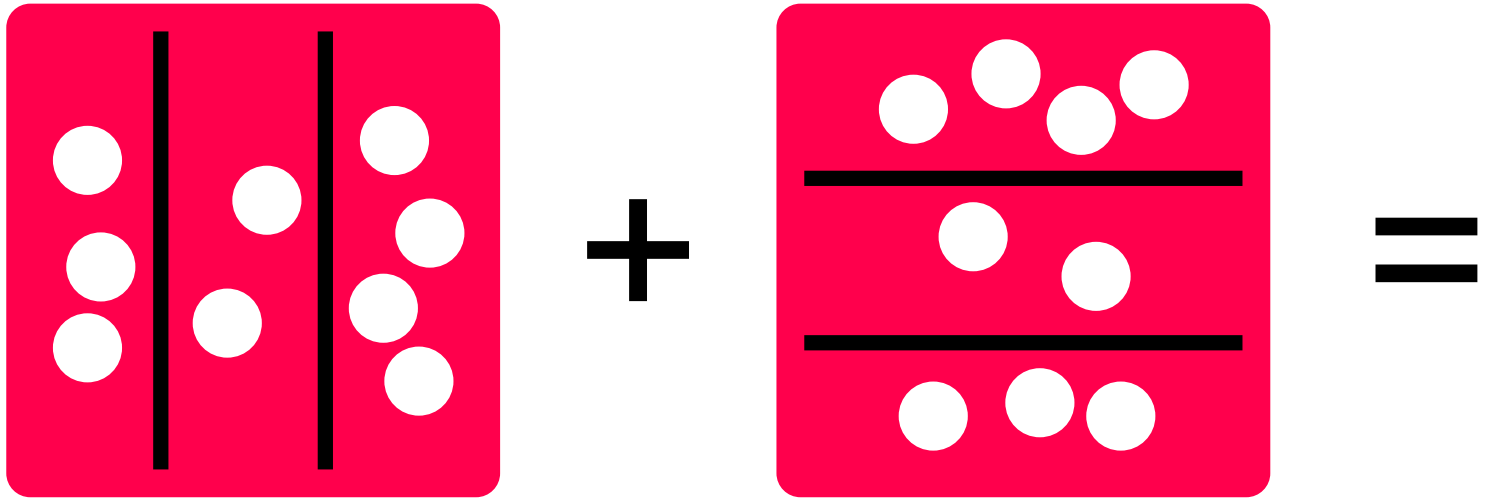

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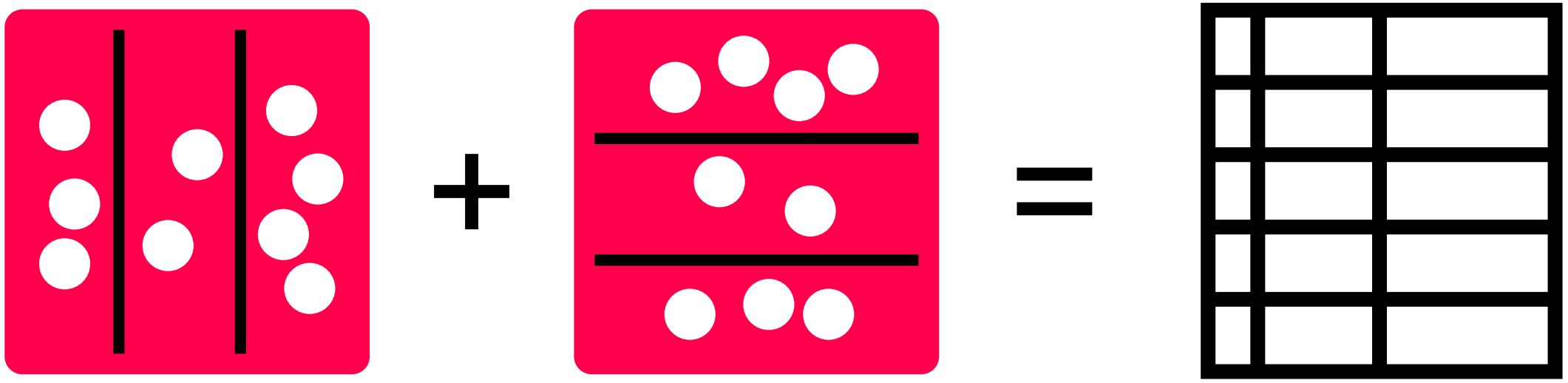

positioning into category slots

positioning into category slots

table

- A **table** is composed of **textual components** that are arranged using
  - **horizontal positioning into category slots** (showing: *which group or category?*) and
  - **vertical positioning into category slots** (showing: *which group or category?*).

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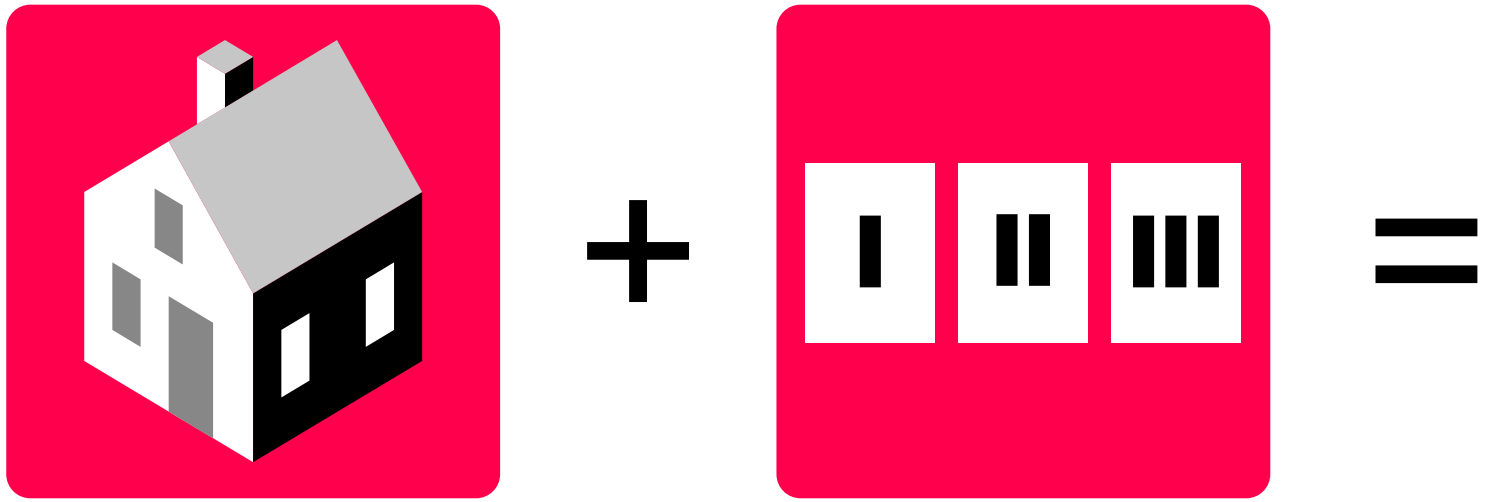

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picturing

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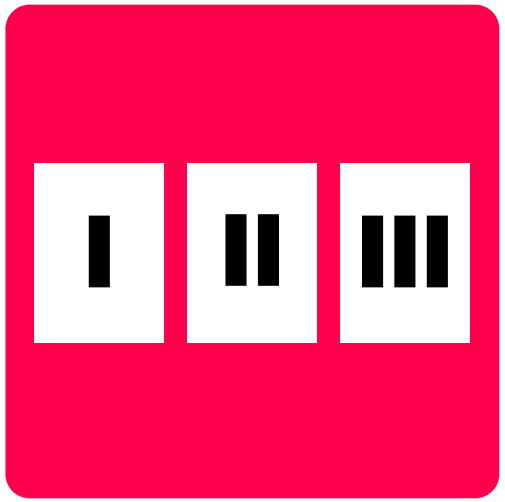

spatial ordering

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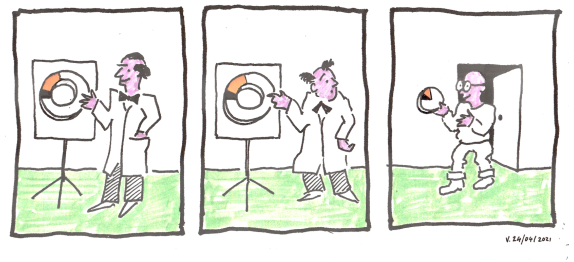

comic strip

A **comic strip** is composed of **pictures** that are arranged in a **horizontal spatial order** (showing: *which unique position in an order?*), and that are composed of **pictorial components** that are arranged using **picturing** (showing: *what does it look like?*).

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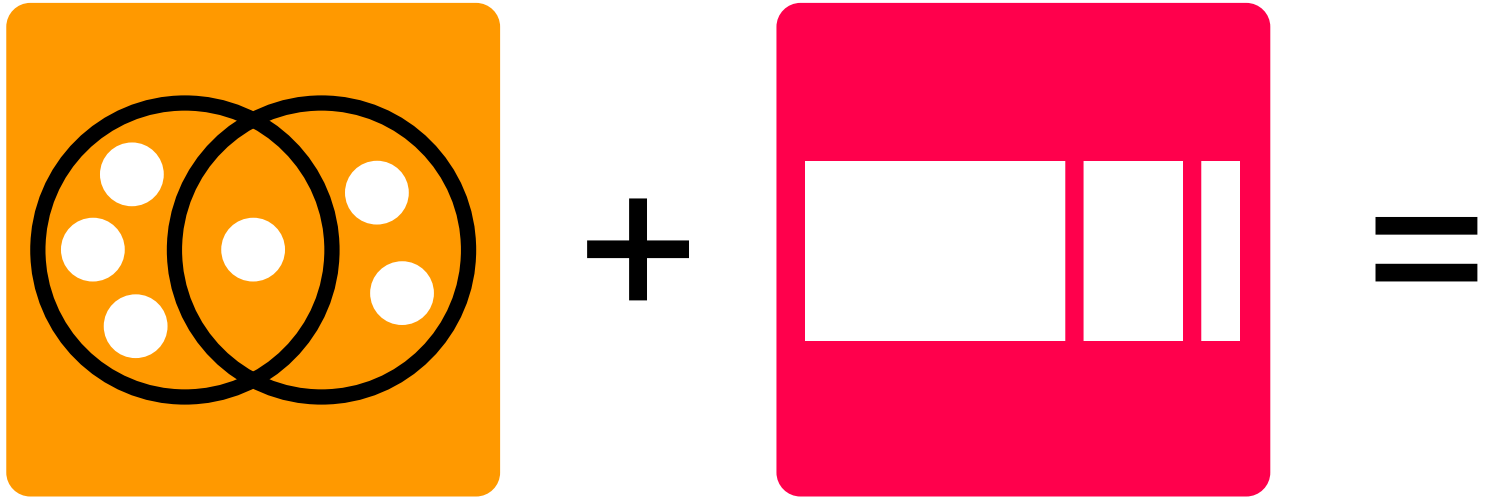

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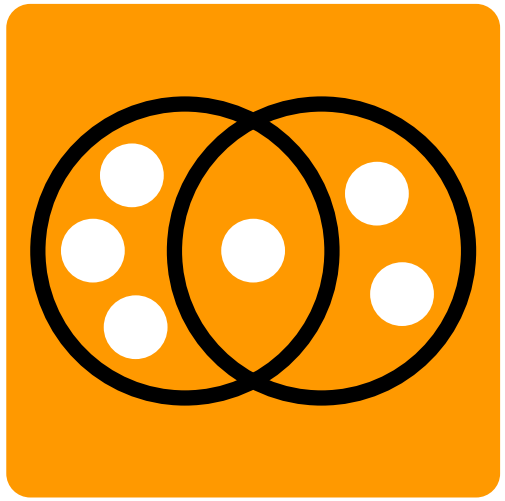

connecting

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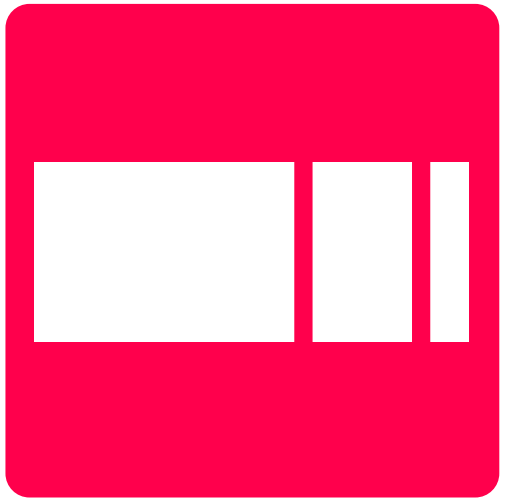

proportional
space-filling

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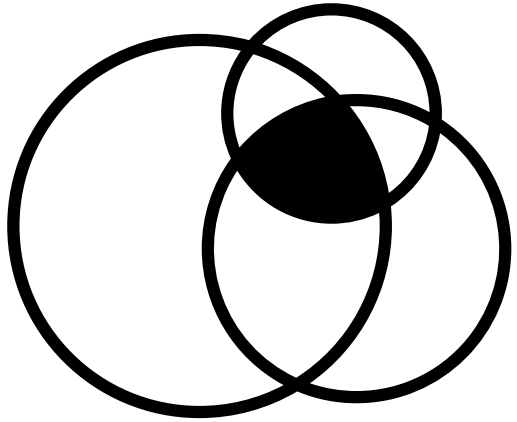

proportional
Venn diagram

A **proportional Venn diagram** is composed of **segments** that are
- **grouped by boundary** (showing: *which group or category?*)

and that are arranged using
- **proportional space-filling** (showing: *which proportion?*).

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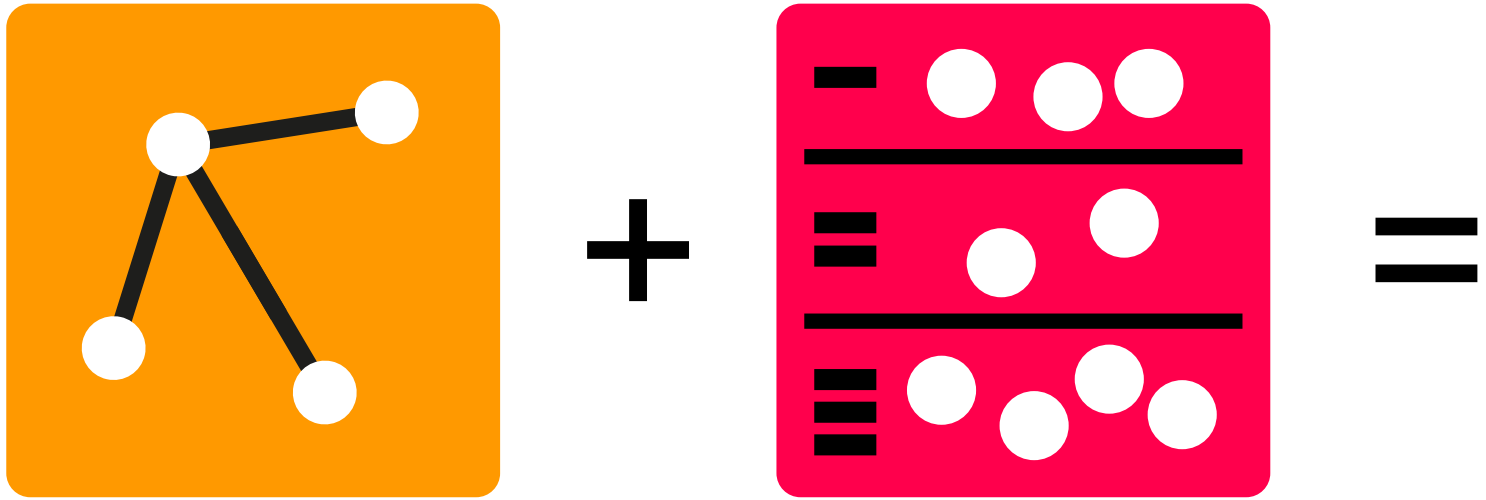

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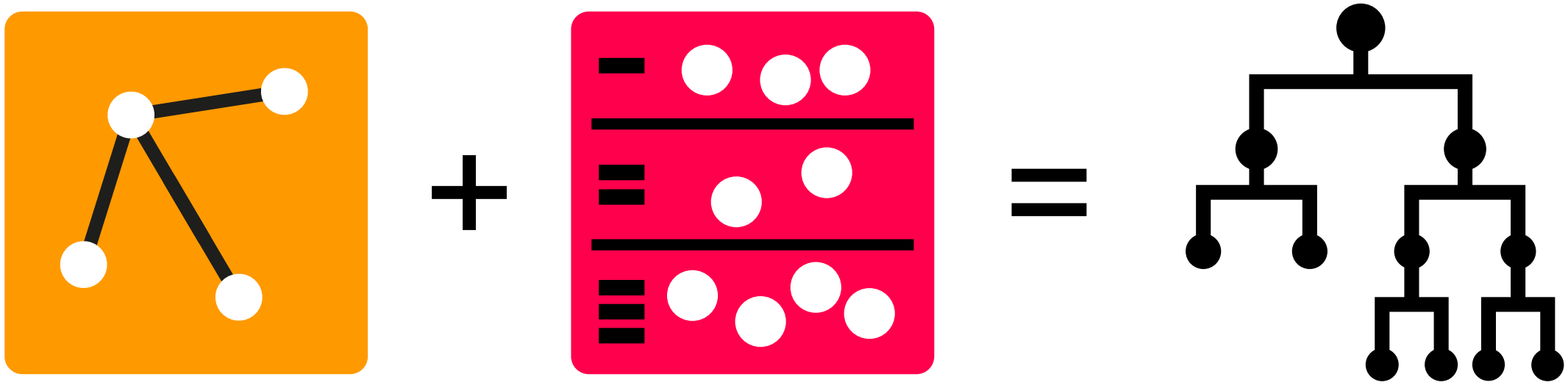

connecting + positioning into ordered slots = tree diagram

A **tree diagram** is composed of **symbols** that are
connected (showing: *does a given relationship hold?*),
and that are arranged using
vertical positioning into ordered slots
(showing: *which ordered category?*).

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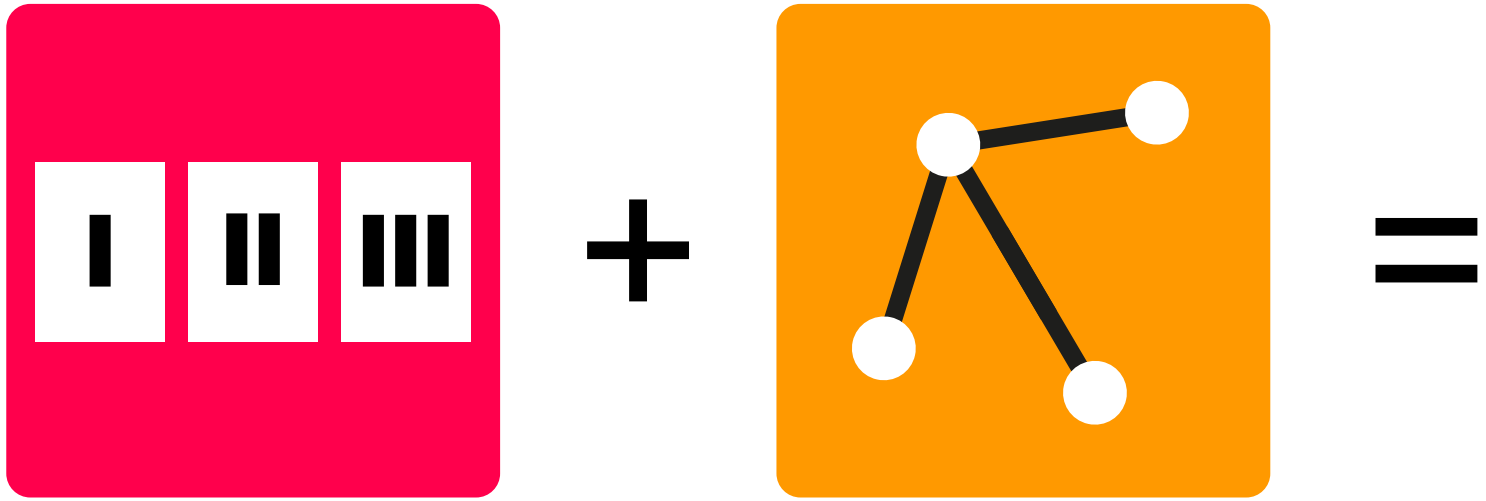

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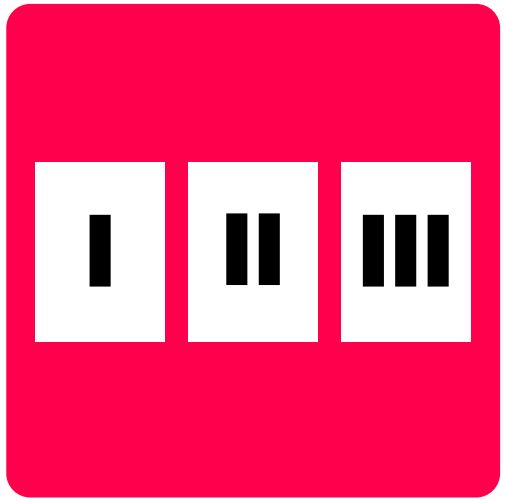

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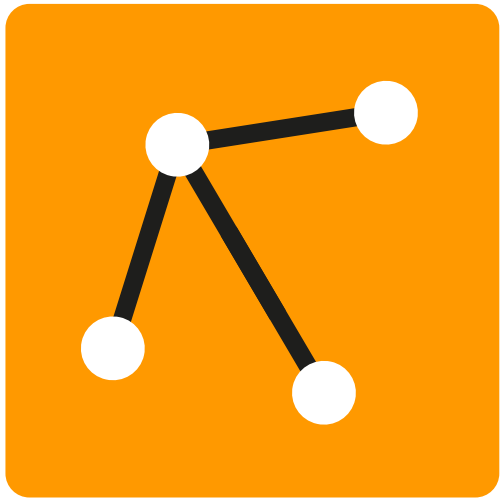

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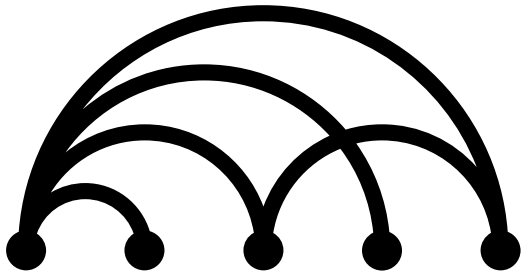

spatial ordering connecting arc diagram

An **arc diagram** is composed of **symbols** that are arranged in a

- **horizontal spatial order** (showing: *which unique position in an order?*), and that are
- **connected** (showing: *does a given relationship hold?*).

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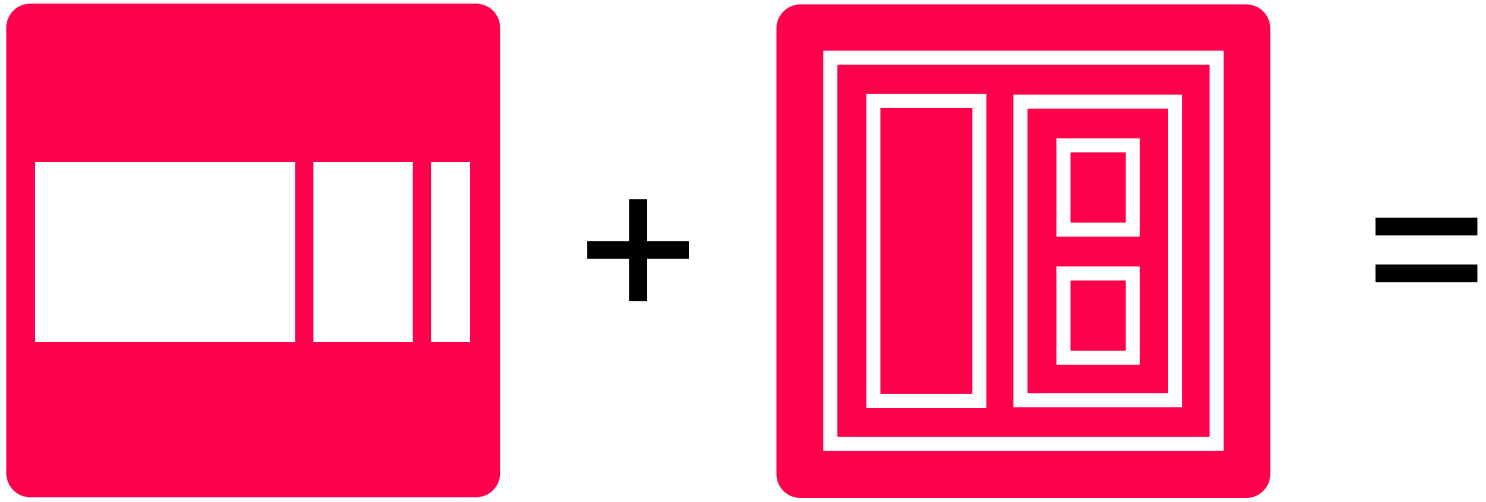

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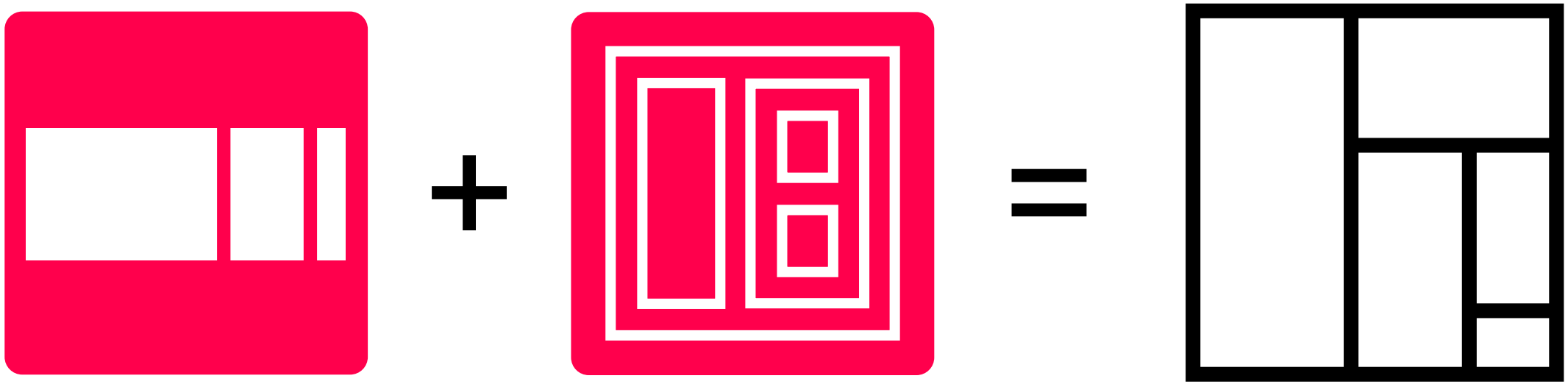

proportional space-filling

nesting

treemap

- A **treemap** is composed of **segments** that are arranged using
  - **proportional space-filling** (showing: *which proportion?*),
  - and that are
  - **nested** (showing: *does a given relationship hold?*).

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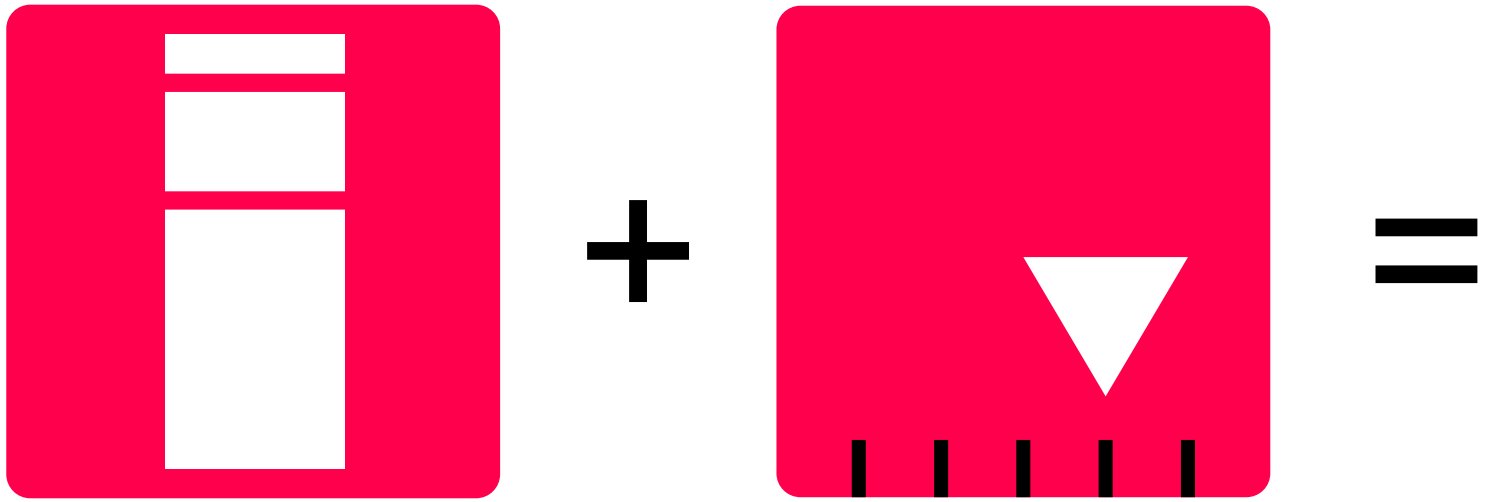

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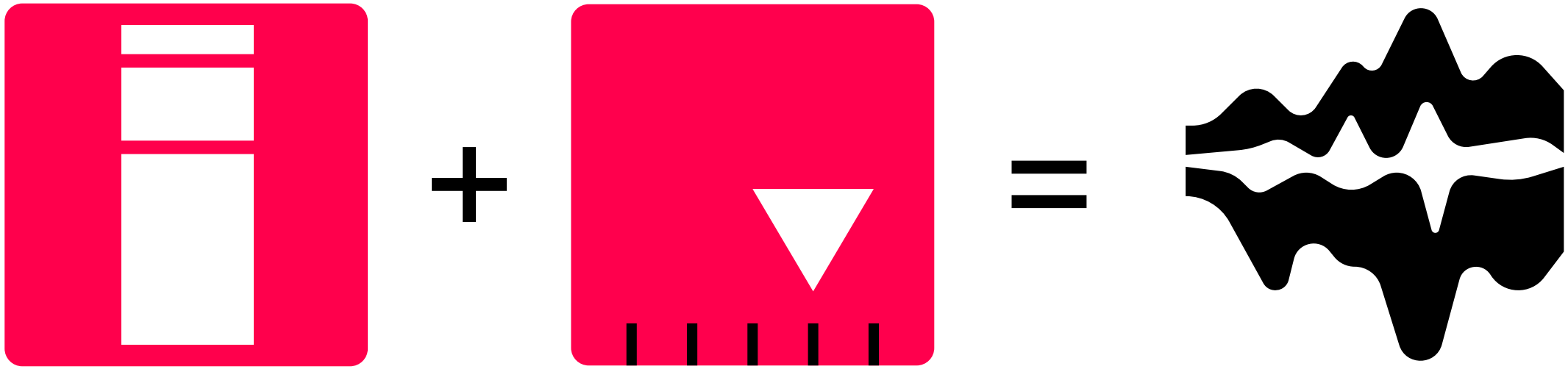

proportional space-filling

positioning along a coordinate axis

streamgraph

A **streamgraph** is composed of **bands** that are arranged using

- **vertical proportional space-filling** (showing: *which proportion?*)

and that are

- **positioned along a horizontal coordinate axis** (showing: *when?*).

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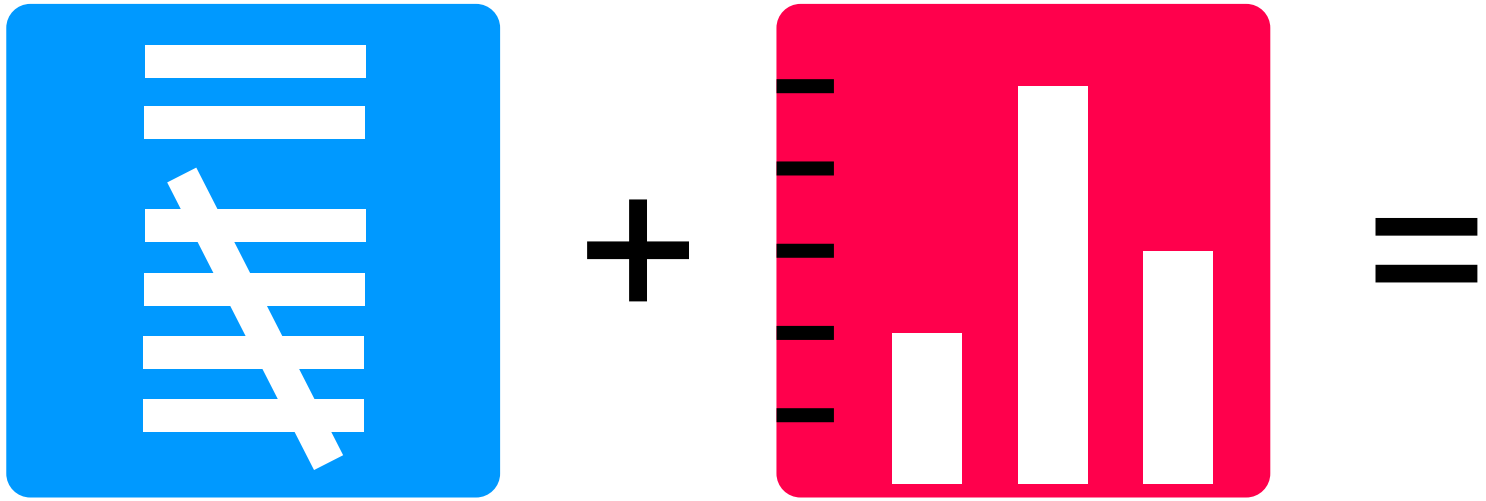

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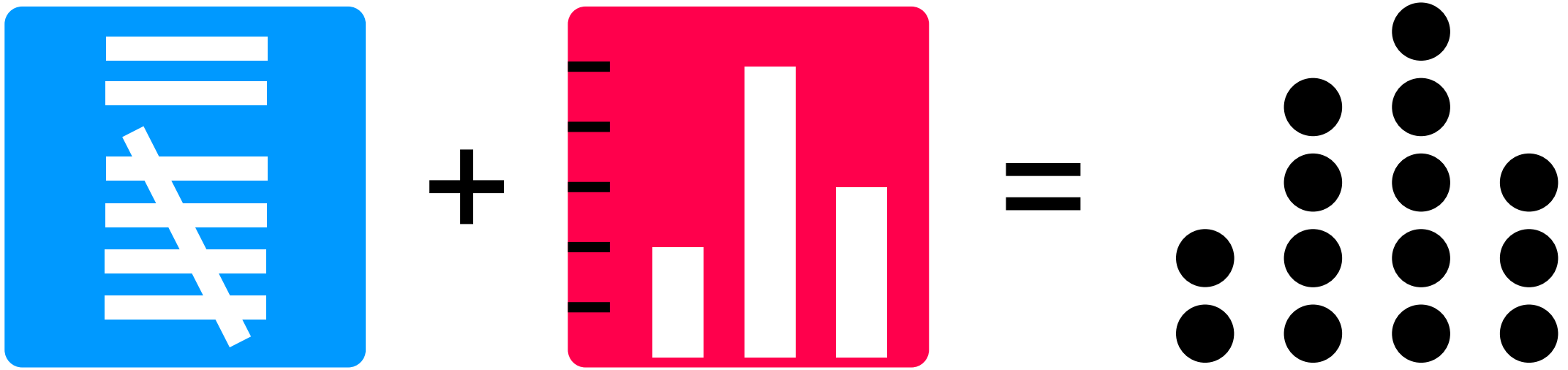

unit-based tallying

extending along a coordinate axis

unit chart / dot plot

A **unit chart** or **dot plot** is composed of **symbols** that are

- **repeated using unit-based tallying** (showing: *how much or how many?*), and that are
- **extending along a coordinate axis** (also showing: *how much or how many?*).

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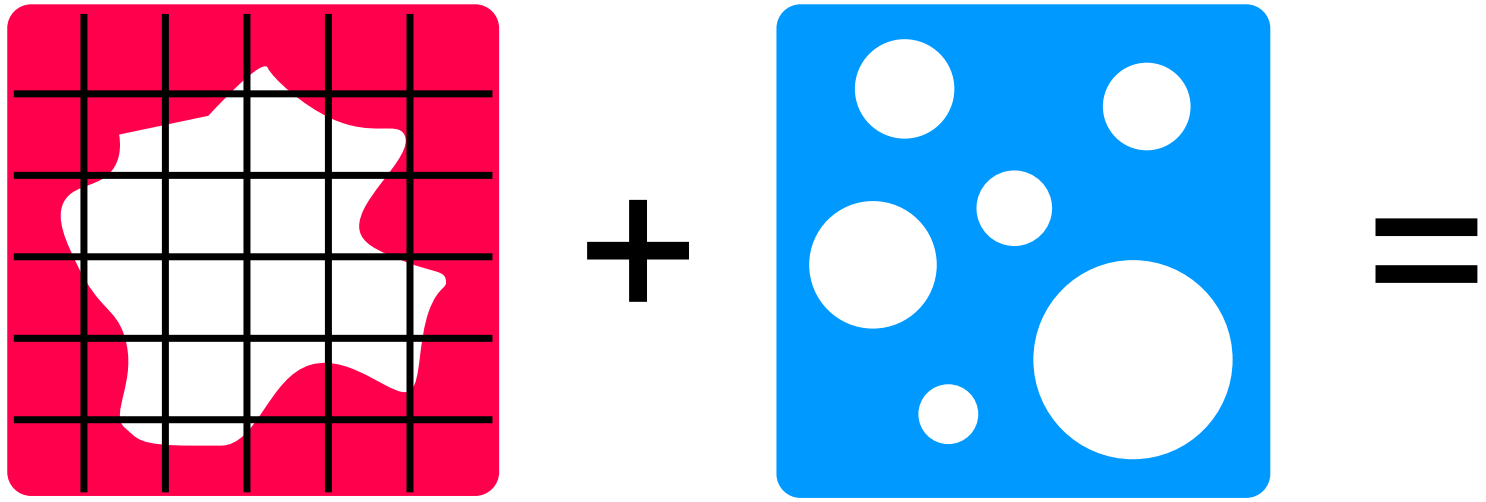

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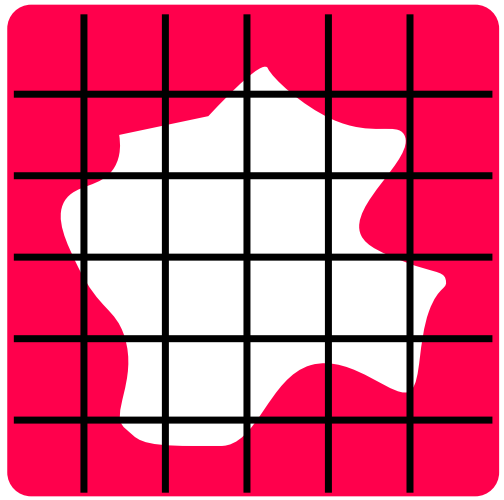

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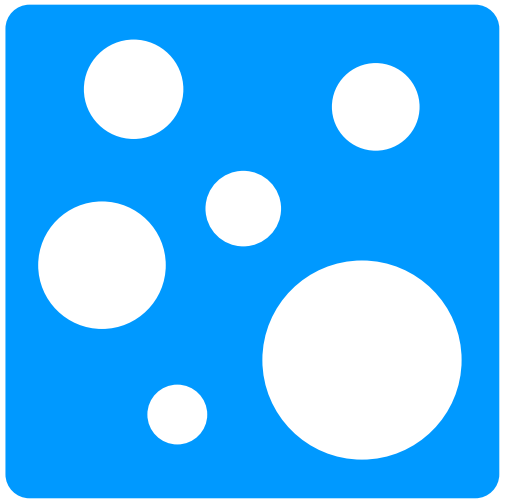
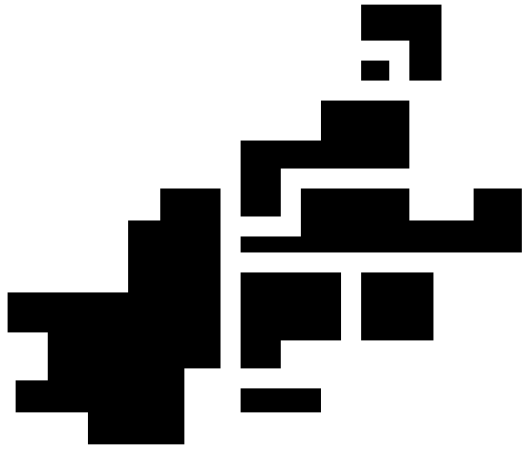
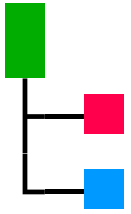


sizing



area cartogram



An **area cartogram** is composed of **surface locators** that are arranged using **mapping** (showing: *where?*), and that are **sized** (showing: *how much or how many?*).

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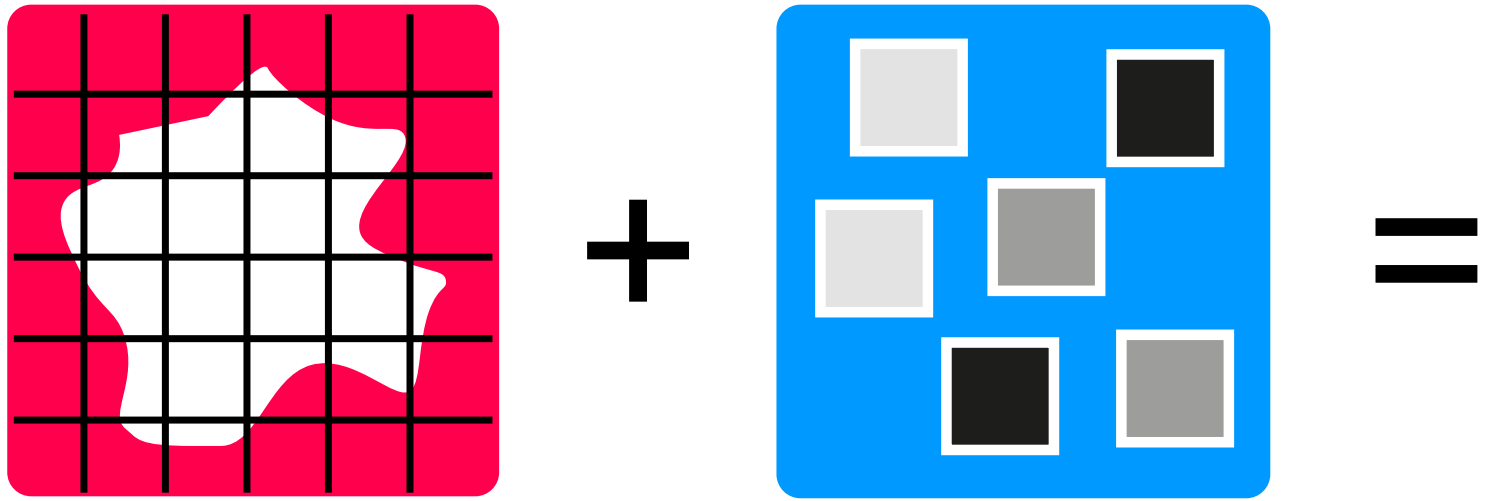

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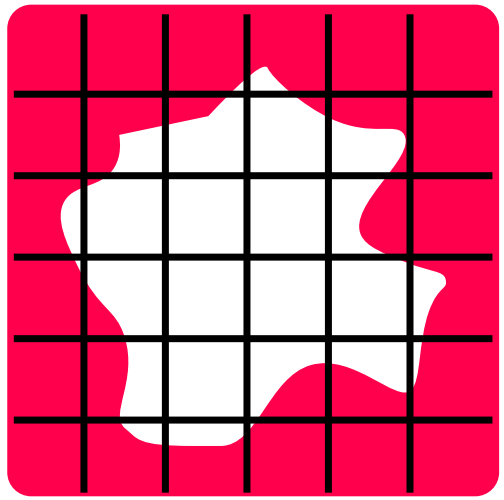
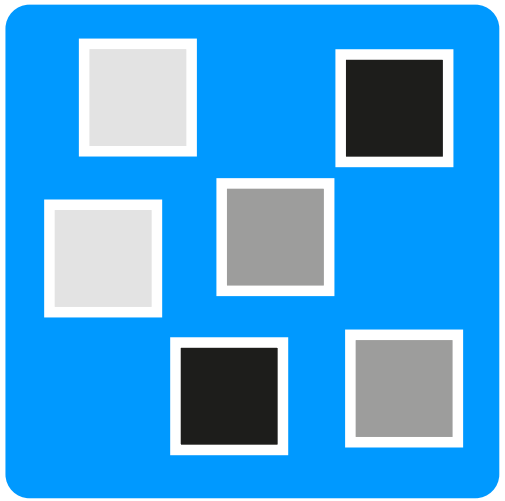


mapping

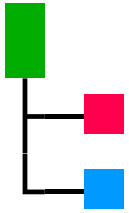
+



gradient coding

=

gradient scale map



A **gradient scale map** is composed of **surface locators** that are arranged using **mapping** (showing: *where?*), and that are **gradient-coded** (showing: *which ordered category?*).

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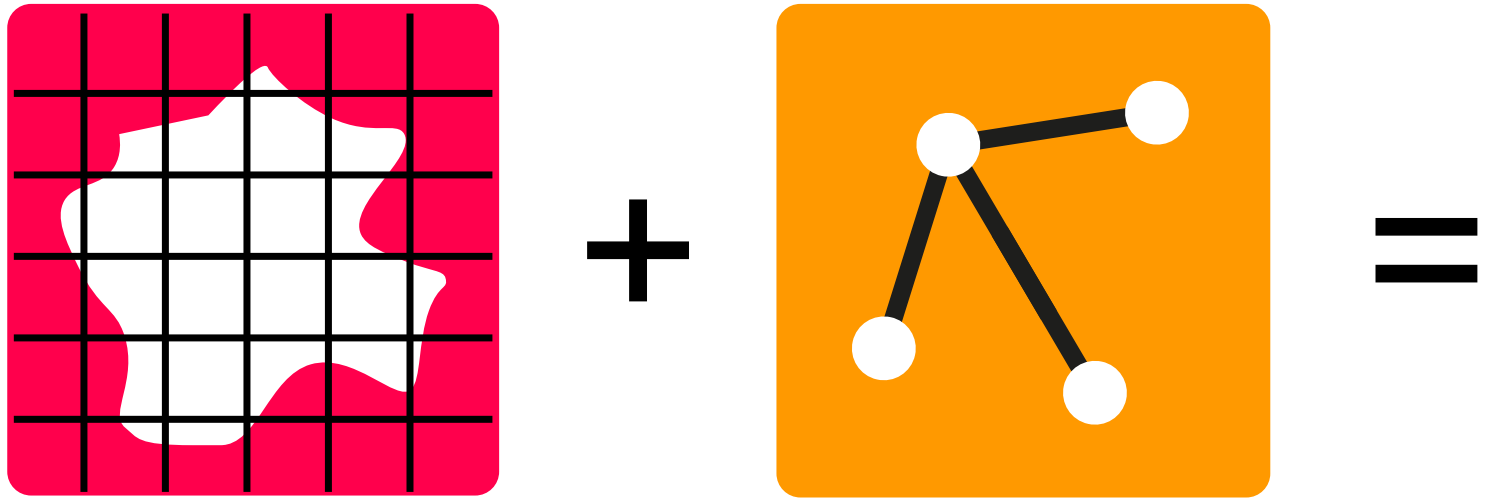

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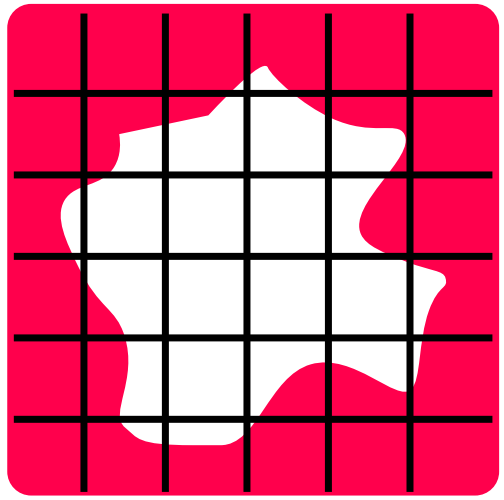
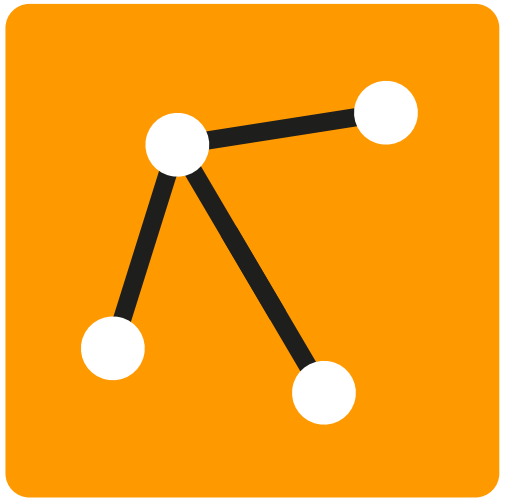
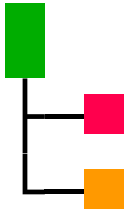


mapping



connecting

connection map



A **connection map** is composed of **symbols** that are arranged using **mapping**, and that are **connected** (together showing: *which pair of spatial locations?*).

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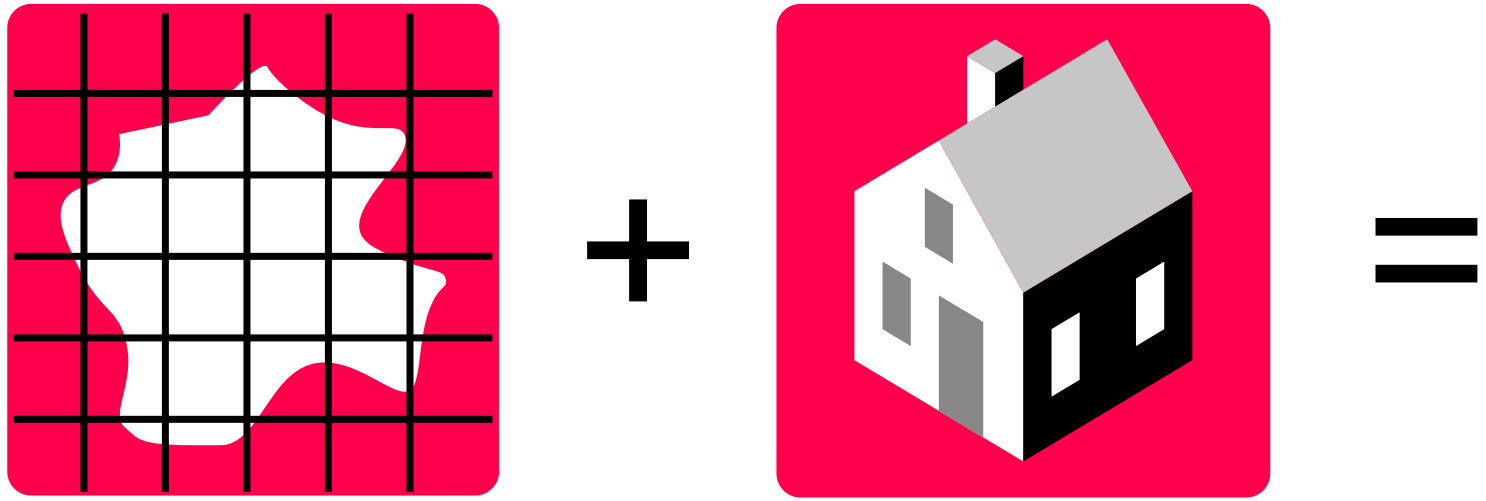

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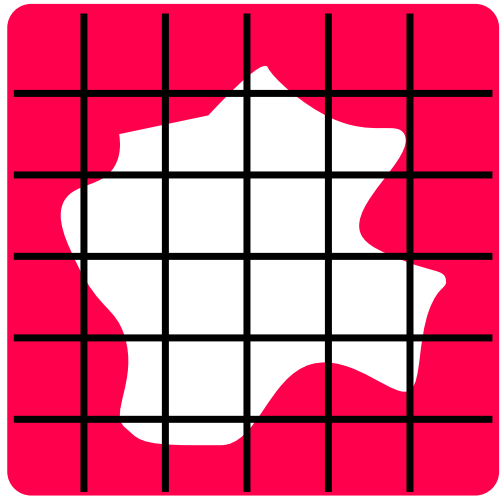
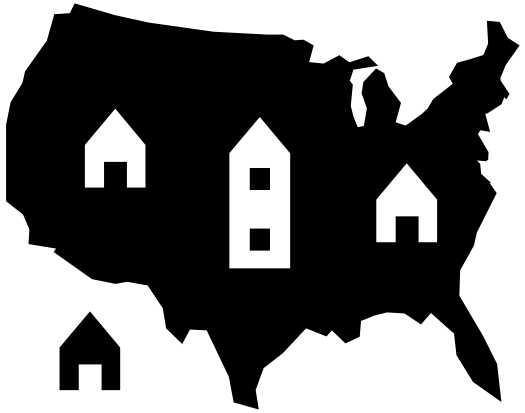


mapping

+

picturing

=



pictorial map

A **pictorial map** is composed of **pictures** that are arranged using
mapping (showing: *where?*), and that are themselves
composed of **pictorial components** that are arranged using
picturing (showing: *what does it look like?*).

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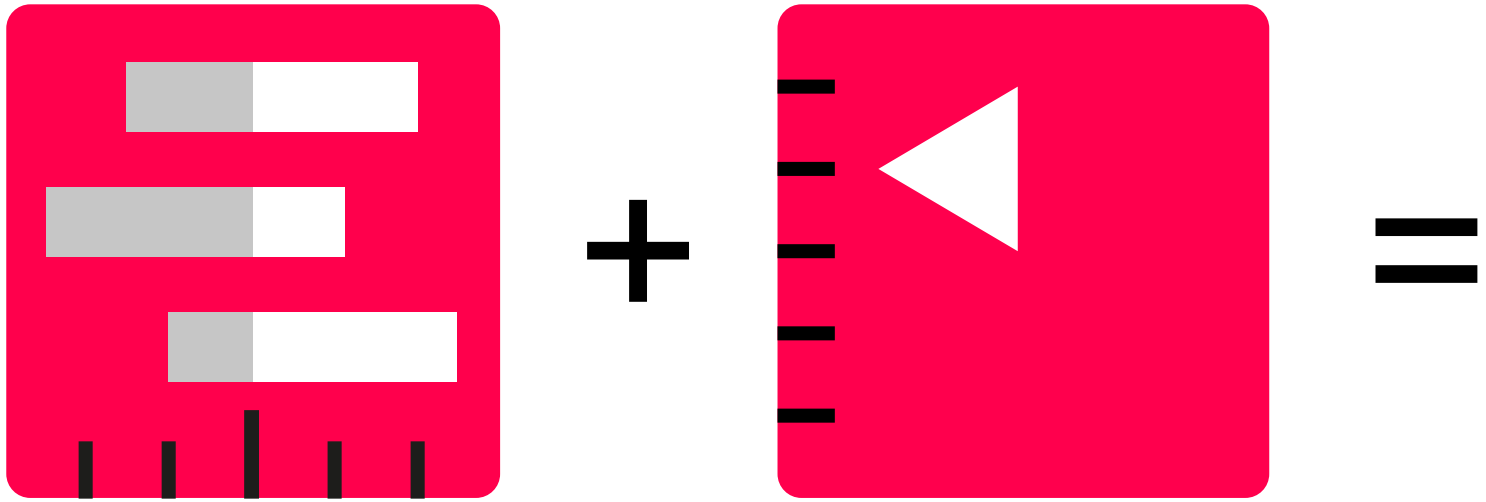

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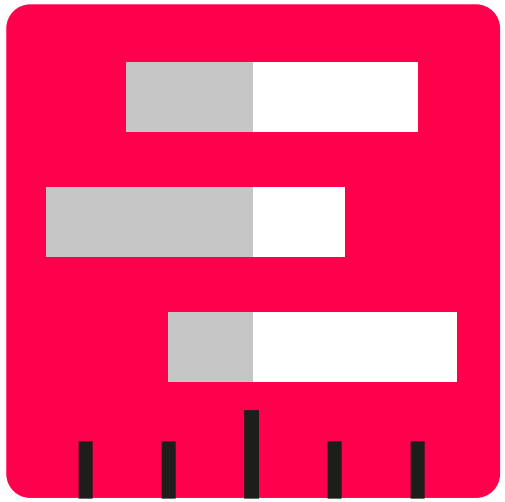
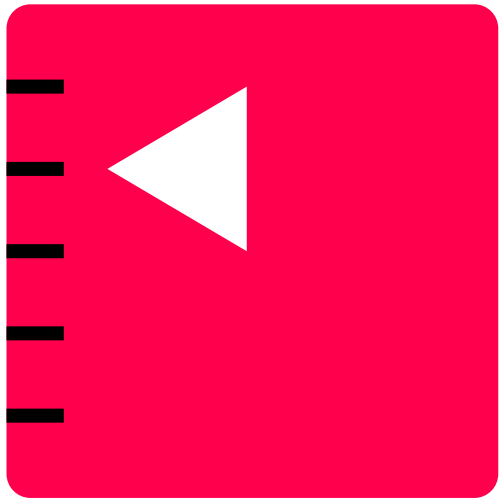


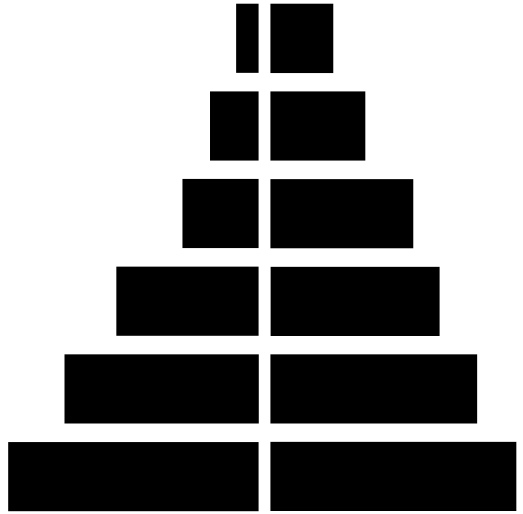
diverging along
a coordinate axis

+



positioning along
a coordinate axis

=



population
pyramid

- A **population pyramid** is composed of **bars** that are
  - **diverging along a horizontal coordinate axis**
    (showing: *how is this split into two parts?*) and
  - **positioned along a vertical coordinate axis**
    (showing: *how much or how many?* – years of age).

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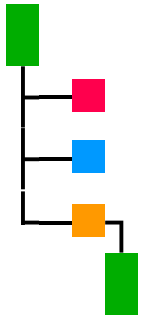
Structure of a LangVIS sentence that describes a type of visualization

A visualization



is composed of **visual components** that may be
arranged (showing: *answers to a certain type of question*), and that may be
varied (showing: *answers to a certain type of question*), and that may be
linked (showing: *answers to a certain type of question*) by
connectors or **boundaries**

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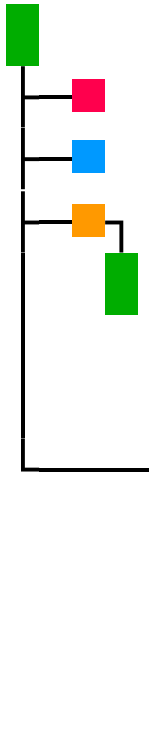
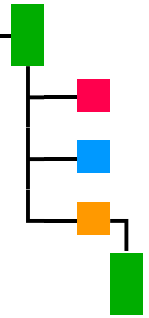
Structure of a LangVIS sentence that describes a type of visualization

A composite visualization



is composed of **visual components** that may be
arranged (showing: *answers to a certain type of question*), and that may be
varied (showing: *answers to a certain type of question*), and that may be
linked (showing: *answers to a certain type of question*) by
connectors or **boundaries**,
and that are themselves



composed of **visual (sub)components of a certain type** that may be
arranged (showing: *answers to a certain type of question*), and that may be
varied (showing: *answers to a certain type of question*), and that may be
linked (showing: *answers to a certain type of question*) by
connectors or **boundaries**.

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types of information	types of questions that visualizations can answer
visual and/or spatial	what does it look like?
	where?
	which pair of spatial locations?
points in time	when?
	which time range?
quantitative	how much or how many?
	what proportion?
	which range of quantities? (or proportions)
	how is this split into two parts?
ordinal	which unique position in an order?
	which ordered category?
nominal	which group or category?
relationships	does a given relationship hold? (between two entities)

visual encoding techniques that can be applied to **visual components** of a visualization

arranging *into meaningful configurations*	linking *by connectors or boundaries*	varying *of visual properties*
picturing — Can be mimetic or *schematic* (e.g. selective exaggeration). Detail-revealing techniques can be used such as in *cutaway* / *exploded* / *ghosted* / *inset-augmented* picturing.		
mapping (of spatial locations) — Can be mimetic or *schematic* (e.g. selective exaggeration). Can be *inset-augmented*.		
mapping (of spatial locations) *with…*	connecting	
● positioning along a coordinate axis		
● ranging along a coordinate axis		
● positioning along a coordinate axis; ● extending along a coordinate axis		sizing; unit-based tallying
● positioning along a coordinate axis; ● extending along a coordinate axis; ● proportional space-filling — *Proportional space-filling* can be *span-equalized* and/or *grid-based*.		sizing; unit-based tallying
● ranging along a coordinate axis		
● diverging along a coordinate axis		
● spatial ordering; nesting; coupling by adjacency	connecting	gradient coding; sizing; unit-based tallying
● positioning into ordered slots		gradient coding; sizing; unit-based tallying
● positioning into category slots; coupling by adjacency	connecting; grouping by boundary	colour coding; shape coding
coupling by adjacency; nesting — *Nesting* can only show *asymmetrical* relationships (e.g. 'is a child of').	connecting	

types of visual components to which *visual encoding techniques* can be applied:

basic components
- symbols
- bars
- segments
- connectors
- directed connectors
- boundaries
- bands
- blocks
- pictorial components
- textual components
- line locators
- surface locators
- invisible components

composite components
- pictures
- visualizations

orientations that can be used with **arranging** techniques marked with ●

- horizontal
- vertical
- third dimension
- angular
- radial
- spiral
- vertical array of horizontal axes
- horizontal array of vertical axes
- angular array of radial axes

LangVIS

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The language of visualization

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Clive Richards: clive.j.richards@icloud.com
Yuri Engelhardt: yuri.engelhardt@gmail.com

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