

Towards a natural language interface for graphic grammars and for specifying visualisation types

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We propose a system for generating natural language sentences that can be used to describe the declarative, modular and compositional aspects of visualisation grammars, and to specify visualisation types, while being accessible to people who have no acquaintance with formal syntax or coding. The system builds on ‘The Languages of Visualisation’ (‘A building-block approach to the diversity of visualization types’, Y. Engelhardt and C. Richards, 2024), which also includes Gestalt aspects of visualisations – and has in turn informed recent systems such as BlueFish (‘Composing diagrams with declarative relations’, J. Pollock et al., 2024) and GoFish (‘A grammar of more graphics!’, J. Pollock and A. Satyanarayan, 2025).

The system is based on a concise vocabulary (listed here at the end) which is used to populate the following **basic sentence structure**:

A [type of visualisation] is
composed of [type of visual components] to show entities or cases
that are [visuospatially encoded] to show [type of information].

Examples:

A **bar chart** is
composed of **bars** to show **entities or cases**
that are **extending along a coordinate axis** to show **quantities**.

A **gradient scale map** is
composed of **surface locators** to show **entities or cases**
that are **arranged using geographic mapping** to show **spatial locations**, and
that are **gradient coded** to show **ordered categories**.

Some visuospatial encodings may be further specified with an **orientation**.

Here is an example with ‘in an angular orientation’:

A **pie chart** is
composed of **segments** to show **entities or cases**
that are **arranged in an angular orientation using proportional space-filling**
to show **proportions**.

Recursive composition

Visuospatially encoded components can themselves be composed of visuospatially encoded (sub-)components:

A [type of visualisation] is
composed of [type of visual components] to show entities or cases
that are [visuospatially encoded] to show [type of information], being themselves
composed of [type of visual components] to show entities or cases
that are [visuospatially encoded] to show [type of information].

Example:

A **stacked bar chart** is
composed of **bars** to show **entities or cases**
that are **extending along a coordinate axis** to show **quantities**, being themselves
composed of **segments** to show **entities or cases**
that are **arranged using proportional space-filling** to show **proportions**, and
that are **colour coded** to show **categories**.

Some visuospatial encodings use **pathways**, **connector streams**, or **boundaries**.

Examples:

A **Venn diagram** is
composed of **symbols** to show **entities or cases**
that are **grouped using boundaries** to show **categories**.

A **quantitative flow map** is
composed of **symbols** to show **entities or cases**
that are **arranged using geographic mapping** to show **spatial locations**, and
that are **connected** to show **whether a given relationship holds**,
using **directed pathways**
that are **sized** to show **quantities**.

This system currently offers systematic natural language descriptions for 70 different types of visualisation that are commonly found in visualisation catalogues.

The vocabulary

Visuospatial encodings (19) – following ‘that are’

arranged [orientation] into category slots
ordered [orientation] in space
arranged [orientation] into ordered slots
arranged [orientation] along a coordinate axis
extending [orientation] along a coordinate axis
ranging [orientation] along a coordinate axis
diverging [orientation] along a coordinate axis
arranged [orientation] using proportional space-filling
arranged using geographic mapping
composed of components that are arranged using picturing
nested
coupled by adjacency
sized [orientation]
repeated using (unit-based) tallying
gradient coded
colour coded
shape coded
connected (using connectors)
grouped using boundaries

Orientations (9) – which can be used to specify some of the visuospatial encodings

- horizontally
- vertically
- in the third dimension
- in an angular orientation
- in a radial orientation
- in a spiral
- in a horizontal array of vertical dimensions, along each of which they are arranged
- in a vertical array of horizontal dimensions, along each of which they are arranged
- in a angular array of radial dimensions, along each of which they are arranged

Types of visual components (13) – following ‘composed of’

These may be composite marks (see text above, regarding recursion).

- visualisations
- symbols
- bars
- segments
- (directed) pathways
- (connector) streams
- boundaries
- blocks
- line locators
- surface locators
- words or numbers
- pictures
- invisible spatial anchors

Types of information (13) – following ‘to show’

- entities or cases
- categories
- order
- ordered categories
- quantities
- proportions
- ranges of quantities (or proportions)
- divisions into two parts
- points in time
- time ranges
- spatial locations
- what something looks like
- whether a given relationship holds (between two entities)