

# langsci-avm

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## 1 Introduction

langsci-avm is a L<sup>A</sup>T<sub>E</sub>X3 package aimed at typesetting beautiful feature structures, also known as *attribute-value matrices*, for use in linguistics. The package provides a minimal and easy to read syntax. It depends only on the `array` package and can be placed almost everywhere, in particular in footnotes or graphs and tree structures. The package is meant as an update to, and serves the same purpose as, Christopher Manning’s `avm` package, but shares no code base with that package. When you come from `avm`, please see Section 4.6 for a quick conversion guide.

To start using langsci-avm, place `\usepackage{langsci-avm}` in your preamble.

*This document is structured as follows:* Section 2 describes the input syntax for AVMs and their parts. Ways to customise your AVM’s layout follow in Section 3, and selected usage cases are presented in Section 4. There’s also an administrative and T<sub>E</sub>Xnical appendix at the end of this document, in case you are interested.

### 1.1 Example

```
\avm{
  [ ctxt & [ max-qud \[
    sal-utt & \{ [ cat \[
      cont <ind & i> ] \}
    ]
  ]
}
```

$$\left[ \begin{array}{c} \text{CTXT} \\ \left[ \begin{array}{c} \text{MAX-QUD} \\ \text{SAL-UTT} \left\{ \left[ \begin{array}{c} \text{CAT} \\ \text{CONT} \langle \text{IND } i \rangle \end{array} \right] \right\} \end{array} \right] \end{array} \right]$$

### 1.2 Acknowledgements

Thanks to Phelype Oleinik for help on recursion and expansion with L<sup>A</sup>T<sub>E</sub>X3. Thanks to Ahmet Bilal Özdemir and Stefan Müller for their contributions in planning and testing this package.

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## 2 Structuring AVMs

---

`\avm`    `\avm [<options>] {<structure>}`

---

The heart of this package and its root document comand is `\avm`. In the scope of the command, delimiter characters are processed to open and close (sub-)structures, as described in Section 2.1. Special elements are described in Section 2.2. For a description of the layout *<options>*, see Section 3.

A *<structure>* is basically the content of a stylised `tabular`: The columns are separated by `&` and a new line is entered with `\\`.

### 2.1 Entering (sub-)structures within `\avm`

---

`[...]`    `[ <structure> ]`  
`<...>`    `< <structure> >`  
`(...)`    `( <structure> )`  
`\{...\}`    `\{ <structure> \}`

---

Within the scope of `\avm`, these delimiters create (sub-)structures that are enclosed by the respective delimiter. Due to the special meaning that curly braces have in  $\text{\LaTeX}$ , these are the only ones that need to be run with an escape token (`\`). It is currently possible to mix delimiters, e.g. with `<<structure>>`, but this may change in future versions.

`langsci-avm` expects your (sub-)structures to have *at most two columns*, so that for every line in each (sub-)structure, there should be no more than one `&`. It is recommended to have at least some lines with a `&` in your *<structure>*. Currently, display issues may appear in some structures if none are given.

<pre>\avm{   [ &lt; ( \{ ... \} ) &gt; ] }</pre>	$\left[ \left\langle \left( \{ \dots \} \right) \right\rangle \right]$
<pre>\avm{   [ \{ ... \} \\     &lt; ( ... ), ( ... ) &gt; ] }</pre>	$\left[ \begin{array}{c} \{ \dots \} \\ \left\langle ( \dots ), ( \dots ) \right\rangle \end{array} \right]$

---

`!...!`    `! <text> !`

---

Escapes the `avm` mode so that all delimiters can be used as usual characters. If you need `!` as a regular character, see Section 3 for how to change the `switch`.

## 2.2 Commands for tags, types, unusual lines, and relations

<hr/> <code>\tag</code> <hr/>	<code>\tag {⟨<i>identifier</i>⟩}</code>	
<code>\0</code>	<code>\0, \1, \2, \3, \4, \5, \6, \7, \8, \9</code>	
<code>\1</code>	<code>\tag</code> puts its <code>{⟨<i>identifier</i>⟩}</code> in a box, more precisely an <code>\fbox</code> . Within the box, the <code>tags</code> font is applied. <code>\0, \1, ..., \9</code> are shortcuts to <code>\tag</code> and place the respective number in the box. For example, <code>\4</code> is equivalent to <code>\tag{4}</code> . The shortcuts do not take any arguments.	
<code>...</code>		
<code>\9</code>		
<hr/> Updated: 2020-04-29 <hr/>	<p>If you want to use this command outside an AVM, you can obtain, for example, <math>\boxed{4}</math>, by using <code>\avm{\4}</code>, or the equivalent <code>{\fboxsep.25ex\fbox{\footnotesize 4}}</code>.</p>	
	$\begin{array}{l} \text{\avm{[ attr1 \& \4\\}} \\ \text{\quad attr2 \& \4[attr3 \& val3\\}} \\ \text{\quad\quad attr4 \& val4] ]}} \end{array}$	$\left[ \begin{array}{l} \text{ATTR1 } \boxed{4} \\ \text{ATTR2 } \boxed{4} \left[ \begin{array}{l} \text{ATTR3 } val3 \\ \text{ATTR4 } val4 \end{array} \right] \end{array} \right]$
<hr/> <code>\type</code> <hr/>	<code>\type{⟨<i>type</i>⟩}</code>	
<code>\type*</code>	Will output the <code>⟨<i>type</i>⟩</code> in the <code>types</code> font (roman italics by default). The starred variant <code>\type*</code> will span the complete (sub-)structure and <i>can only be placed in the first column</i> of this structure. After the starred <code>\type*</code> , a <code>\</code> is recommended, but can usually be omitted.	
<hr/> Updated: 2020-03-30 <hr/>		
	$\begin{array}{l} \text{\avm{[ \type*{A type spanning a line}\\}} \\ \text{\quad attr \& [\type{type}] ]}} \end{array}$	$\left[ \begin{array}{l} A \text{ type spanning a line} \\ \text{ATTR } [type] \end{array} \right]$
<hr/> <code>\punk</code> <hr/>	<code>\punk {⟨<i>attribute</i>⟩}{⟨<i>type</i>⟩}</code>	
	Some <code>⟨<i>attributes</i>⟩</code> think that the layout of the other attributes in their community leaves no space for them to express their individuality. They desire a life outside the confines of the alignment defined by the others, while still remaining a member of the matrix.	
	Technically, this is a line with no snapping to the column layout, but with spacing between the <code>⟨<i>attribute</i>⟩</code> and <code>⟨<i>type</i>⟩</code> . After <code>\punk</code> , a <code>\</code> is recommended, but can be omitted in “normal” cases.	
	$\begin{array}{l} \text{\avm{[ attr1 \& val1\\}} \\ \text{\quad \punk{a quite long attr2}{val2} ]}} \\ \text{\quad attr3 \& val3\\}} \\ \text{\quad\quad attr4 \& val4} \\ \text{ ]}} \end{array}$	$\left[ \begin{array}{l} \text{ATTR1 } val1 \\ \text{A QUITE LONG ATTR2 } val2 \\ \text{ATTR3 } val3 \\ \text{ATTR4 } val4 \end{array} \right]$
<hr/> <code>\+</code> <hr/>	In the scope of <code>\avm</code> , <code>\+</code> comes out as “ $\oplus$ ”. “ $+$ ” can be obtained normally. <i>In the earlier Version 0.1.0-beta, <code>+</code> produced “<math>\oplus</math>”.</i>	
<hr/> Updated: 2020-03-16 <hr/>		
<hr/> <code>\-</code> <hr/>	In the scope of <code>\avm</code> , <code>\-</code> comes out as “ $\ominus$ ”. To use the “optional hyphenation” meaning of <code>\-</code> , please write <code>!\-</code> .	
<hr/> New: 2020-03-17 <hr/>		
<hr/> <code>\shuffle</code> <hr/>	In the scope of <code>\avm</code> , <code>\shuffle</code> is a shortcut for “ $\bigcirc$ ” to mark the shuffle relation.	
<hr/> New: 2020-03-17 <hr/>		

## 3 AVM layout

### 3.1 Defining styles

You can customise many aspects of how an AVM is printed, including the fonts or spacing between delimiters and content. You can apply them locally via the `[<options>]` of `\avm` or by using `\avmsetup`. And you can also define your own styles and use them via the `[<style = >]` option in `\avm`.

---

<code>\avmsetup</code>	<code>\avmsetup {<i>&lt;options&gt;</i>}</code>
------------------------	---

---

`{<options>}` is a comma-separated list of **key = value** settings. See the list below for all user-configurable options. The `{<options>}` are the same as in `\avm[<options>]`. When inserted in `\avm[<options>]`, they apply locally, and globally if given to `\avmsetup`. Local settings always override global ones, and you can have any feasible number of `\avmsetup`s in your document.

---

<code>\avmdefinestyle</code>	<code>\avmdefinestyle {<i>&lt;name&gt;</i>} {<i>&lt;settings&gt;</i>}</code>
------------------------------	--

---

New: 2020-05-11

Instead of applying settings globally or per AVM, you can also define styles and assign them to AVMs, as in `\avm[style=<name>]{...}`. The `<settings>` are a comma-separated list of **key = value** settings, and should be a subset of the settings from `\avmsetup`. For example, the following `plain` style highlights neither attributes, values, nor types:

```
\avmdefinestyle{plain}{attributes=\normalfont,
                        values=\normalfont,
                        types=\normalfont}
```

The style is applied with `\avm[style=plain]{...}`.

Now to the list of settings you can actually apply:

**style** = *<name>* (initially empty)

In addition to any style that you possibly define yourself, a style **narrow** is pre-defined in the package (see Section 4.1).

**stretch** = *<factor>* (initially 0.9)

Define `\arraystretch`, i.e. a factor in the determination of line height.

**columnsep** = *<length>* (initially 0.5ex)

Define the `\tabcolsep`, i.e. horizontal space between columns. The first and second column will have `0\columnsep` to the left and right, respectively. Between the two the distance is `2\columnsep`. Using relative units (like **ex** or **em**) may be a good idea so that `columnsep` scales well with changes in font size.

**delimfactor** = *<factor>* (initially 1000)

Sets `\delimiterfactor`. The calculation for the minimum height of a delimiter is  $y \cdot f / 1000$ , where  $y$  is the height of the content and  $f$  the value of `delimfactor`. The default 1000 ensure that the delimiters' height is at least that of the structure.

**delimfall** = *<length>* (initially 0pt)

Controls `\delimitershortfall`, i.e. the maximum height that the delimiters can be shorter than the enclosed structure. The default `0pt` ensure that the delimiters are not shorter than the contents.

`extraskip` =  $\langle length \rangle$  (initially `\smallskipamount`)  
 If a substructure is immediately followed by a `\\`, an extra amount of vertical skip is added so that the content of the next line, possibly another delimiter, does not clash with the delimiter in that line. This automatic skip insertion can be circumvented with placing a `\relax` before the linebreak, i.e. `\relax\\`.

`attributes` =  $\langle font settings \rangle$  (initially `\scshape`)  
 The font for attributes, i.e. the first column of each structure.

`values` =  $\langle font settings \rangle$  (initially `\itshape`)  
 The font for values, i.e. the second column of each structure.

`apptovalues`=  $\langle code \rangle$  (initially `\`)  
 The  $\langle code \rangle$  is applied after the second column (“append to”). This is useful if `values` is set to `\itshape`, since `\itshape` does not automatically insert italic correction.

`types` =  $\langle font settings \rangle$  (initially `\itshape`)  
 The font used in `\type` and `\type*`.

`tags` =  $\langle format settings \rangle$  (initially `\footnotesize`)  
 The font (size) used in `\tag` and the shortcuts `\1...\9`.

`switch` =  $\langle token \rangle$  (initially `!`)  
 Define the escape token. Change this if you need to use “!” as a text glyph.

`customise` =  $\langle settings \rangle$  (initially empty)  
 An interface to input custom commands to be run at the beginning of every `\avm`.

## 3.2 Defining input patterns

---

<code>\avmdefinecommand</code>	<code>\avmdefinecommand {⟨name⟩} [⟨label⟩] {⟨settings⟩}</code>
--------------------------------	--

---

New: 2020-06-29

Sub-structures often come in patterns. For example, AVMs often have a PHON attribute, which is mapped to a list, the entries of which are in italics. `\avmdefinecommand` can account for this and other input patterns. For example,

```
\avmdefinecommand{custom}{...}
```

will create a command `\custom` available only in the scope of `\avm` (this means that you can have a different meaning in the rest of your document). The `⟨settings⟩` will then be applied to the scope in which `\custom` is called. If an optional `⟨label⟩` is given, the label will be printed, in the current font, before the `⟨settings⟩` are applied.

`\custom` generated in this way automatically advances to the value column after the `⟨label⟩` is printed. This means that commands generated with `\avmdefinecommand` should be called in the attribute column of an existing structure. This behaviour can be circumvented with the starred variant `\name*`, which is automatically generated by `\avmdefinecommand` as well. However, it seems advisable to use the starred variants sparingly.

Here's an example for the aforementioned phon pattern:

```
\avmdefinecommand{phon}[phon]
{
  attributes = \itshape,
  delimfactor = 900,
  delimfall = 10pt
}
```

This creates a command `\phon` (and the variant `\phon*`) within the scope of any `\avm`. It will print the label `phon` in the current font and then apply three settings locally: italics for the attribute (first) column, and two settings for very narrow delimiter fitting.

This results in: (The font of this documentation has little support for IPA.)

<pre>\avm{   [\type*{word}   \phon &lt;lin'gwistiks&gt;\\   synsem &amp; [ ... ] }</pre>	$\left[ \begin{array}{ll} word & \\ PHON & \langle lin'gwistiks \rangle \\ SYNSEM & [...] \end{array} \right]$
--	--

Note that any other structure type would have worked instead of `⟨⟩`. But `⟨⟩` and any other markers for sub-structures are left unchanged by `\phon` and other custom commands. This is why the *attribute* font is changed by `\phon`, although *lin'gwistiks* is technically a value. Remember that `<` creates a new list sub-substructure, and the first content is printed in its attribute font.

## 4 Applications

### 4.1 Spacing and size of delimiters

`langsci-avm` automatically detects if the end of a sub-structure is followed by a line break. This is useful to find cases in which two sub-structures are printed immediately below each other, and to add extra spacing (the `extraskip` from the options). This automatic detection can be suppressed with `\relax`. See below for the effect of that detection:

<pre>\avm{[ [attr1 &amp; val1 \\         attr2 &amp; val2 ] \\         [attr1 &amp; val1 \\         attr2 &amp; val2 ]       ]}</pre>	<pre>\avm{[ [attr1 &amp; val1 \\         attr2 &amp; val2 ] \relax\\         [attr1 &amp; val1 \\         attr2 &amp; val2 ]       ]}</pre>
$\left[ \begin{array}{l} \left[ \begin{array}{l} \text{ATTR1 } val1 \\ \text{ATTR2 } val2 \end{array} \right] \\ \left[ \begin{array}{l} \text{ATTR1 } val1 \\ \text{ATTR2 } val2 \end{array} \right] \end{array} \right]$	$\left[ \begin{array}{l} \left[ \begin{array}{l} \text{ATTR1 } val1 \\ \text{ATTR2 } val2 \end{array} \right] \\ \left[ \begin{array}{l} \text{ATTR1 } val1 \\ \text{ATTR2 } val2 \end{array} \right] \end{array} \right]$

If many delimiters are nested, this occasionally results in larger delimiter sizes. There is a pre-defined `narrow` style that resets `delimfall` (to 5pt) and `delimfactor` (to 997), which are the values recommended in the *TeXbook*. This results in a more compact appearance:

<pre>\avm{[ attr \{&lt;\1&gt;\}]} \textit{[ATTR &lt;\{1\}&gt;]}</pre>	<pre>\avm[style=narrow]{[ attr \{&lt;\1&gt;\}]} \textit{[ATTR &lt;\{1\}&gt;]}</pre>
---	---

### 4.2 Disjunctions and other relations

Sometimes AMVs are placed beside other content to express disjunctions or other relations. In `langsci-avm` this is done naturally:

<pre>\avm{ [attr1 &amp; val1\\         attr2 &amp; val2\\         attr3 &amp; val3 ] } \$\lor\$ \avm{ [attr1' &amp; val1'\\         attr2' &amp; val2'\\         attr3' &amp; val3'\\ ] }</pre>	$\left[ \begin{array}{l} \text{ATTR1 } val1 \\ \text{ATTR2 } val2 \\ \text{ATTR3 } val3 \end{array} \right] \vee \left[ \begin{array}{l} \text{ATTR1'} } val1' \\ \text{ATTR2'} } val2' \\ \text{ATTR3'} } val3' \end{array} \right]$
<pre>\textit{sign} \$\to\$ \avm{ [ attribute1 &amp; value1\\         attribute2 &amp; value2\\         attribute3 &amp; value3 ] }</pre>	$sign \rightarrow \left[ \begin{array}{l} \text{ATTRIBUTE1 } value1 \\ \text{ATTRIBUTE2 } value2 \\ \text{ATTRIBUTE3 } value3 \end{array} \right]$

### 4.3 Use as a vector

It's possible to use `langsci-avm` for feature vectors rather than matrices, as may be useful in generative grammar.

$$\backslash\text{avm}[\text{attributes}=\backslash\text{normalfont}]\{[v1\backslash\backslash v2\backslash\backslash v3]\}\$\varphi$$

### 4.4 Combinations with `gb4e`, `expex`, and `linguex`

This package works fine with `gb4e` and its fork `langsci-gb4e`. To align the example number at the top of your structure, please use `\attop` from `gb4e`:

```
\begin{exe}
  \ex\attop{
    \avm{[ attr1 & val1\backslash
          attr2 & val2\backslash
          attr3 & val3]}
  }
\end{exe}
```

$$(1) \begin{bmatrix} \text{ATTR1} & \text{val1} \\ \text{ATTR2} & \text{val2} \\ \text{ATTR3} & \text{val3} \end{bmatrix}$$

The same can be achieved with `expex` using `\envup` from `lingmacros` (see below) or using this *experimental* syntax:

```
\ex \vtop{\strut\vskip-\baselineskip{
  \avm{[ attr1 & val1\backslash
        attr2 & val2\backslash
        attr3 & val3]}
}}
\xe
```

Examples typed with `linguex` can be combined with `\envup` from `lingmacros` to align AVMs (many thanks to Jamie Findlay for pointing this out):

```
\ex. \envup{\avm{[ attr1 & val1\backslash
                  attr2 & val2\backslash
                  attr3 & val3]}
}
```

### 4.5 Combinations with `forest`

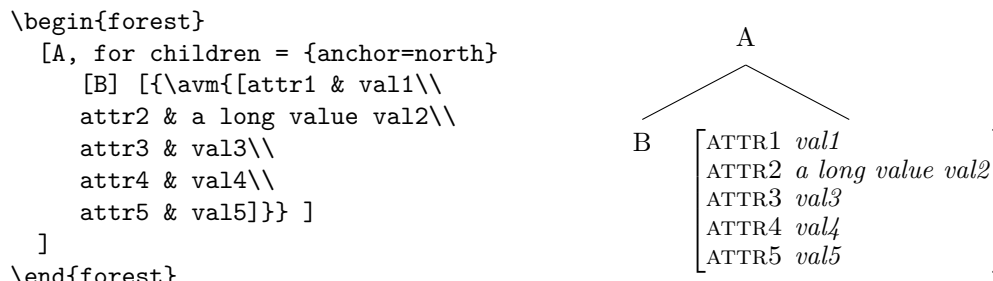
This package also works fine with `forest`. As per the `forest` documentation, it is recommended to protect any `\avm`-statements with `{}` in nodes:

```
\begin{forest}
  [A [B] [{\avm{[attr1 & val1\backslash
                  attr2 & val2\backslash
                  attr3 & val3]}} ] ]
\end{forest}
```

$$\begin{array}{c} A \\ \swarrow \quad \searrow \\ B \quad \begin{bmatrix} \text{ATTR1} & \text{val1} \\ \text{ATTR2} & \text{val2} \\ \text{ATTR3} & \text{val3} \end{bmatrix} \end{array}$$



It may happen that extensive AVMs protrude into the space reserved for other forest nodes or edges. In this case, the forest setting for `children = {anchor=north}` may be useful: (If you like, try this tree without that setting.)



## 4.6 Switching from Christopher Manning’s `avm` package

Switching from `avm` to `langsci-avm` will require some, though hopefully minimal, changes to the code. In particular, `langsci-avm` doesn’t distinguish between “active” and “passive” modes, there is now a single way of sorting (see `\type`, which replaces `\asort` and `\osort`), and tags are now produced without `@` (`\4` instead of `@4`, etc.).

Paths can be printed with a normal `|`, and  $\oplus$  and other relation symbols can be input more easily (see Section 2.1), though the package will also work with `!$` and `$\oplus$`.

`langsci-avm` is not yet able to draw lines in elements of AVMs. This feature is planned for Version 0.3.

## 4.7 Spanning both columns

You can use the `multicol` package to span both columns in a (sub-)structure. Please remember that every structure has two columns, so the only sensible usage is

```
\multicolumn{2}{1}{...}
```

but only in the first column of a (sub-)structure. For a special usage case, see `\type` and `\type*` (which do not depend on `multicol`).

## 5 Caveats and planned features

1. There are currently no error messages. If you do not receive the intended output, please make sure that your code fits the syntax described in this documentation. If your code is fine but the output is not, please submit a bug report or feature request at <https://github.com/langsci/langsci-avm/issues>.

These features are planned for the future:

2. A check whether the delimiters are balanced, i.e. whether all (sub-)structures are closed by a `]`, `}`, etc.
3. Introduce the ability to draw (curved) lines between structures and elements.
4. Improve the appearance of (very) large angle brackets so that they vertically span the complete structure they enclose, maybe using `scalere1`.

## 6 Feedback and bug reports

Comments, usage reports, and feature requests are welcome! Please open an issue for any of these at <https://github.com/langsci/langsci-avm/issues>, or write to me at <mailto:felix.kopecky@langsci-press.org> if you feel the need for a feature not listed here, big or small.

## 7 Implementation

```

1 <*package>
2 <@@=avm>
3 \RequirePackage{xparse,array}
4 \ProvidesExplPackage {langsci-avm}
5   {2020-06-29} {0.2}
6   {AVMs and feature structures in LaTeX3}

```

**\avm** This document command initialises an AVM. The first, optional argument is a key-value list of settings (see `\keys_define:nn` below) and the second is the AVM itself, given in the syntax described in this documentation.

`\avm` enters a group so that keys- and macro-assignments remain local. It then initialises the commands and shortcuts and any user customisation, sets its mode to `true` and assigns the keys as given in the optional argument (if any). After the wrapper `\avm_wrap:n` is called, the group is closed.

```

7 \NewDocumentCommand{\avm}{ O{} +m }
8   {
9     \c_group_begin_token
10    \__avm_initialise_document_commands:
11    \__avm_initialise_custom_commands:
12    \tl_use:N \l__avm_defined_commands_tl
13    \bool_set_true:N \l__avm_mode_bool
14    \keys_set:nn { avm } { #1 }
15    \__avm_wrap:n { #2 }
16    \c_group_end_token
17  }

```

*(End definition for \avm. This function is documented on page 2.)*

**\avmsetup** Forward the key-value settings given as the optional argument to `\avm` to the keys defined in `\keys_define:nn { avm }`. For the meaning of these keys and initial values, see Section 2.

```

18 \NewDocumentCommand{\avmsetup}{ m }
19   { \keys_set:nn { avm } { #1 } }
20
21 \keys_define:nn { avm }
22   {
23     stretch .tl_set:N      = \l__avm_arraystretch_tl,
24     stretch .initial:n    = {0.9},
25     columnsep .dim_set:N   = \l__avm_tabcolsep_dim,
26     columnsep .initial:n   = {.5ex},
27     delimfactor .int_set:N = \l__avm_delimfactor_int,
28     delimfactor .initial:n = {1000},

```

```

29   delimfall .dim_set:N = \l__avm_delimshortfall_dim,
30   delimfall .initial:n = {0pt},
31   attributes .code:n = {\cs_set:Nn \__avm_font_attribute: {#1}},
32   attributes .initial:n = {\scshape},
33   types .code:n = {\cs_set:Nn \__avm_font_type: {#1}},
34   types .initial:n = {\itshape},
35   values .code:n = {\cs_set:Nn \__avm_font_value: {#1}},
36   values .initial:n = {\itshape},
37   tags .code:n = {\cs_set:Nn \__avm_font_tag: {#1}},
38   tags .initial:n = {\footnotesize},
39   apptovalues .code:n = {\cs_set:Nn \__avm_deinit_second_column: {#1}},
40   apptovalues .initial:n = {\},
41   singleton .code:n = {\cs_set:Nn \__avm_font_singleton: {#1}},
42   singleton .initial:n = {\normalfont},
43   switch .code:n = {\tl_set:Nn \__avm_mode_switch_character {#1}},
44   switch .initial:n = { ! },
45   extraskip .dim_set:N = \l__avm_extra_skip_dim,
46   extraskip .initial:n = {\smallskipamount},
47   customise .code:n = {\cs_set:Nn \__avm_initialise_custom_commands: {#1}},
48   customise .initial:n = { },
49   style .choice:,
50   style / narrow .code:n = {\delimiterfactor=997\delimitershortfall5pt},
51 }

```

(End definition for `\avmsetup`. This function is documented on page 4.)

**`\avmdefinestyle`** Define a style to be used together with the `style` key.

```

52 \NewDocumentCommand{\avmdefinestyle}{ m m }
53 {
54   \keys_define:nn { avm }
55   {
56     style / #1 .code:n = { \keys_set:nn { avm } { #2 } }
57   }
58 }

```

(End definition for `\avmdefinestyle`. This function is documented on page 4.)

**`\avmdefinecommand`** A factory function that creates commands for the layout of sub-structures and saves them to `\l__avm_defined_commands_tl`. The first argument describes the command's name, the second any (optional) label. The manufactured definitions are activated in the AVM group so that they remain local.

```

59 \NewDocumentCommand{\avmdefinecommand}{ m O{ } m }
60 {
61   \tl_put_right:Nn \l__avm_defined_commands_tl
62   {
63     \exp_args:Nc \DeclareDocumentCommand { #1 } { s }
64     {
65       #2 \IfBooleanF { ##1 } { & } \avmsetup{ #3 }
66     }
67   }
68 }

```

(End definition for `\avmdefinecommand`. This function is documented on page 6.)

`\l__avm_mode_bool` We need an auxiliary variable to store the current mode. `\l__avm_parens_tracker` is a stack for a future check whether the delimiters given to `\avm` are balanced. `\l__avm_defined_commands_tl` is a token list that stores any commands provided by the user via `\avmdefinecommand`

```

69 \bool_new:N \l__avm_mode_bool
70 \seq_new:N \l__avm_parens_tracker
71 \tl_new:N \l__avm_defined_commands_tl

```

(End definition for `\l__avm_mode_bool`, `\l__avm_parens_tracker`, and `\l__avm_defined_commands_tl`.)

`\seq_set_split:NvN` In preparation for `\avm_wrap:n`, we need to split the user input at each occurrence of the escape character. Since the character is given in a variable, we need a variant of the sequence splitter that takes the *evaluation* of the variable, rather than the variable itself, as its second argument.

```

72 \cs_generate_variant:Nn \seq_set_split:Nnn { NVn }

```

(End definition for `\seq_set_split:NvN`.)

`\l__avm_in_first_column` A boolean to check whether we are in the first column (value `true`) or in the second (value `false`).

```

73 \bool_new:N \l__avm_in_first_column

```

(End definition for `\l__avm_in_first_column`.)

`\__avm_init_first_column:` These macros apply the settings for the columns in a (sub-)structure. They take care of font selection and report the currently active column back to the system. Knowing which column is active is important when closing the (sub-)structure. If the structure is closed without a second column present, we need to skip back 2`\tabcolsep`.

```

74 \cs_new:Nn \__avm_init_first_column:
75 {
76   \bool_set_true:N \l__avm_in_first_column
77   \normalfont\__avm_font_attribute:
78 }
79
80 \cs_new:Nn \__avm_init_second_column:
81 {
82   \bool_set_false:N \l__avm_in_first_column
83   \normalfont\__avm_font_value:
84 }

```

(End definition for `\__avm_init_first_column:` and `\__avm_init_second_column:.`)

`\__avm_kern_unused_columns:` A helper macro to fill the horizontal space if a row is ended prematurely, i.e. if no `&` is present.

```

85 \cs_new:Nn \__avm_kern_unused_columns:
86 {
87   \bool_if:NTF \l__avm_in_first_column
88     { \span\hspace*{-2\tabcolsep} }
89     { }
90 }

```

(End definition for `\__avm_kern_unused_columns:.`)

`\_avm_extra_skip:` This function is used together with the delimiter replacements. It checks whether the delimiter is followed by a line break, in which case an extra skip is automatically inserted

```

91 \cs_new:Nn \_avm_extra_skip:
92 {
93   \peek_meaning_ignore_spaces:NTF \ \ {\vspace*{\l_ave_extra_skip_dim}} {}
94 }

```

(End definition for `\_avm_extra_skip:`)

`\_avm_module_begin:` The replacement instructions for `\_avm_parse:n`

`\_avm_module_end:`

etc.

```

95 \cs_new:Nn \_avm_module_begin:
96 {
97   \begin{tabular}{@{}
98     >{\_avm_init_first_column:}l
99     >{\_avm_init_second_column:}l
100    <{\_avm_deinit_second_column:}
101    @{}
102  }
103 \cs_new:Nn \_avm_module_end:
104 {
105   \_avm_kern_unused_columns:
106   \end{tabular}
107 }
108 \cs_new:Nn \_avm_replace_lbrace:
109 {
110   \_avm_parse_output:nw
111   { \c_math_toggle_token\left\lbrace\_avm_module_begin: }
112 }
113 \cs_new:Nn \_avm_replace_rbrace:
114 {
115   \_avm_parse_output:nw
116   { \_avm_module_end:\right\rbrace\c_math_toggle_token\_avm_extra_skip: }
117 }
118 \cs_new:Nn \_avm_replace_lbrack:
119 {
120   \_avm_parse_output:nw
121   { \c_math_toggle_token\left\lbrack\_avm_module_begin: }
122 }
123 \cs_new:Nn \_avm_replace_rbrack:
124 {
125   \_avm_parse_output:nw
126   { \_avm_module_end:\right\rbrack\c_math_toggle_token\_avm_extra_skip: }
127 }
128 \cs_new:Nn \_avm_replace_lparen:
129 {
130   \_avm_parse_output:nw
131   { \c_math_toggle_token\left(\_avm_module_begin: }
132 }
133 \cs_new:Nn \_avm_replace_rparen:
134 {
135   \_avm_parse_output:nw
136   { \_avm_module_end:\right)\c_math_toggle_token\_avm_extra_skip: }
137 }
138 \cs_new:Nn \_avm_replace_langle:

```

```

139 {
140   \__avm_parse_output:nw
141   { \c_math_toggle_token\left<\__avm_module_begin: }
142 }
143 \cs_new:Nn \__avm_replace_rangle:
144 {
145   \__avm_parse_output:nw
146   { \__avm_module_end:\right>\c_math_toggle_token\__avm_extra_skip: }
147 }
148 \cs_new:Nn \__avm_replace_plus:
149 {
150   \__avm_parse_output:nw { \ensuremath { \oplus \! } }
151 }
152 \cs_new:Nn \__avm_replace_minus:
153 {
154   \__avm_parse_output:nw { \ensuremath { \ominus \! } }
155 }
156 \cs_new:Nn \__avm_replace_circle:
157 {
158   \__avm_parse_output:nw { \ensuremath { \bigcirc \, , } }
159 }

```

(End definition for \\_\_avm\_module\_begin:, \\_\_avm\_module\_end:, and etc..)

```

\tag
\type
\punk
160 \cs_new:Npn \__avm_controls_tag:n #1
161 { \fboxsep.25ex\fbox{\normalfont\__avm_font_tag: #1} }
162 \cs_new:Npn \__avm_controls_type:n #1
163 { \c_group_begin_token\normalfont\__avm_font_type: #1\c_group_end_token }
164 \cs_new_protected:Npn \__avm_controls_type_starred:n #1
165 {
166   \bool_set_false:N \l__avm_in_first_column
167   \normalfont\__avm_font_type: #1
168   \__avm_deinit_second_column:\span\hspace*{-2\tabcolsep}
169   \peek_meaning_ignore_spaces:NTF \ { } {\} {\}
170 }
171 \cs_new_protected:Npn \__avm_controls_punk:nn #1 #2
172 {
173   \bool_set_false:N \l__avm_in_first_column
174   \normalfont\c_group_begin_token\__avm_font_attribute:#1%
175   \c_group_end_token\hspace{2\tabcolsep}%
176   \c_group_begin_token\__avm_font_type: #2\c_group_end_token%
177   \__avm_deinit_second_column:\span\hspace*{-2\tabcolsep}
178   \peek_meaning_ignore_spaces:NTF \ { } {\} {\}
179 }
180
181 \cs_new:Nn \__avm_initialise_document_commands:
182 {
183   \def\arraystretch{\tl_use:N \l__avm_arraystretch_tl}
184   \tabcolsep=\l__avm_tabcolsep_dim
185   \delimiterfactor=\l__avm_delimfactor_int
186   \delimitershortfall=\l__avm_delimshortfall_dim
187   \cs_if_exist:NTF \tag
188   { \RenewDocumentCommand{\tag}{m}{ \__avm_controls_tag:n {##1} } }

```

```

189     { \NewDocumentCommand{\tag}{m}{    \__avm_controls_tag:n {##1} } }
190 \cs_if_exist:NTF \0
191     { \RenewDocumentCommand{\0}{-}{    \__avm_controls_tag:n {0} } }
192     { \NewDocumentCommand{\0}{-}{    \__avm_controls_tag:n {0} } }
193 \cs_if_exist:NTF \1
194     { \RenewDocumentCommand{\1}{-}{    \__avm_controls_tag:n {1} } }
195     { \NewDocumentCommand{\1}{-}{    \__avm_controls_tag:n {1} } }
196 \cs_if_exist:NTF \2
197     { \RenewDocumentCommand{\2}{-}{    \__avm_controls_tag:n {2} } }
198     { \NewDocumentCommand{\2}{-}{    \__avm_controls_tag:n {2} } }
199 \cs_if_exist:NTF \3
200     { \RenewDocumentCommand{\3}{-}{    \__avm_controls_tag:n {3} } }
201     { \NewDocumentCommand{\3}{-}{    \__avm_controls_tag:n {3} } }
202 \cs_if_exist:NTF \4
203     { \RenewDocumentCommand{\4}{-}{    \__avm_controls_tag:n {4} } }
204     { \NewDocumentCommand{\4}{-}{    \__avm_controls_tag:n {4} } }
205 \cs_if_exist:NTF \5
206     { \RenewDocumentCommand{\5}{-}{    \__avm_controls_tag:n {5} } }
207     { \NewDocumentCommand{\5}{-}{    \__avm_controls_tag:n {5} } }
208 \cs_if_exist:NTF \6
209     { \RenewDocumentCommand{\6}{-}{    \__avm_controls_tag:n {6} } }
210     { \NewDocumentCommand{\6}{-}{    \__avm_controls_tag:n {6} } }
211 \cs_if_exist:NTF \7
212     { \RenewDocumentCommand{\7}{-}{    \__avm_controls_tag:n {7} } }
213     { \NewDocumentCommand{\7}{-}{    \__avm_controls_tag:n {7} } }
214 \cs_if_exist:NTF \8
215     { \RenewDocumentCommand{\8}{-}{    \__avm_controls_tag:n {8} } }
216     { \NewDocumentCommand{\8}{-}{    \__avm_controls_tag:n {8} } }
217 \cs_if_exist:NTF \9
218     { \RenewDocumentCommand{\9}{-}{    \__avm_controls_tag:n {9} } }
219     { \NewDocumentCommand{\9}{-}{    \__avm_controls_tag:n {9} } }
220 \cs_if_exist:NTF \type
221     { \RenewDocumentCommand{\type}{s m}
222       {
223         \IfBooleanTF { ##1 }
224           { \__avm_controls_type_starred:n {##2} }
225           { \__avm_controls_type:n {##2} }
226       }
227     }
228     { \NewDocumentCommand{\type}{s m}
229       {
230         \IfBooleanTF { ##1 }
231           { \__avm_controls_type_starred:n {##2} }
232           { \__avm_controls_type:n {##2} }
233       }
234     }
235 \cs_if_exist:NTF \punk
236     { \RenewDocumentCommand{\punk}{m m}
237       { \__avm_controls_punk:nn {##1}{##2} } }
238     { \NewDocumentCommand{\punk}{m m}
239       { \__avm_controls_punk:nn {##1}{##2} } }
240 }

```

(End definition for \tag, \type, and \punk. These functions are documented on page 3.)

`\__avm_wrap:n` The wrapper that first splits the input to `\avm` at each occurrence of `\__avm_mode_switch_character` and then inverses `\l__avm_mode_bool`. It then calls the parser (`\__avm_parse:n`) for each splitted sequence. This wrapping is necessary because there is no known expandable way to switch a boolean.

```

241 \cs_new_protected:Npn \__avm_wrap:n #1
242 {
243   \seq_set_split:NVn \l__avm_wrapper_seq
244   \__avm_mode_switch_character { #1 }
245   \seq_map_inline:Nn \l__avm_wrapper_seq
246   {
247     \exp_args:No \exp_not:o
248     { \__avm_parse:n {##1} }
249     \bool_set_inverse:N \l__avm_mode_bool
250   }
251 }

```

(End definition for `\__avm_wrap:n`.)

`\__avm_parse:n` Finally, the parser. It is build on `\@@_act:NNNnn` from 13t1 (see the sub-section *Token by token changes*). Many thanks to Phelype Oleinik for help on this, and in particular on help with expansion.

```

252 \cs_new:Npn \__avm_parse:n #1
253 {
254   \exp:w
255   \group_align_safe_begin:
256   \__avm_parse_loop:w #1
257   \q_recursion_tail \q_recursion_stop
258   \__avm_result:n { }
259 }
260
261 \cs_new:Npn \__avm_end:w \__avm_result:n #1
262 {
263   \group_align_safe_end:
264   \exp_end:
265   #1
266 }
267
268 \cs_new:Npn \__avm_parse_loop:w #1 \q_recursion_stop
269 {
270   \tl_if_head_is_N_type:nTF {#1}
271   {
272     \__avm_N_type:N #1 \q_recursion_stop
273   }
274   {
275     \tl_if_head_is_group:nTF {#1}
276     { \__avm_replace_group:nw #1 \q_recursion_stop }
277     { \__avm_replace_space:w #1 \q_recursion_stop }
278   }
279 }
280
281 \cs_new:Npn \__avm_N_type:N #1
282 {
283   \quark_if_recursion_tail_stop_do:Nn #1 { \__avm_end:w }
284   \bool_if:NTF \l__avm_mode_bool

```



```

285     { \_avm_replace:N #1 }
286     { \_avm_replace_none:N #1 }
287   }
288
289 \cs_new:Npn \_avm_replace_none:N #1
290 {
291   \_avm_parse_output:nw {#1}
292 }
293
294 \cs_new:Npn \_avm_replace:N #1
295 {
296   \str_case:nnF {#1}
297   {
298     { \+ }{ \_avm_replace_plus: }
299     { \- }{ \_avm_replace_minus: }
300     { \shuffle }{ \_avm_replace_circle: }
301     { [ ] }{ \_avm_replace_lbrack: }
302     { ] }{ \_avm_replace_rbrack: }
303     { ( ) }{ \_avm_replace_lparen: }
304     { ) }{ \_avm_replace_rparen: }
305     { \{ }{ \_avm_replace_lbrace: }
306     { \} }{ \_avm_replace_rbrace: }
307     { < }{ \_avm_replace_langle: }
308     { > }{ \_avm_replace_rangle: }
309   }
310   { \_avm_replace_none:N #1 }
311 }
312
313 \cs_new:Npn \_avm_replace_group:nw #1
314 { \exp_args:NNo \exp_args:No \_avm_replace_group:n { \_avm_parse:n {#1} } }
315
316 \cs_new:Npn \_avm_replace_group:n #1 { \_avm_parse_output:nw { {#1} } }
317
318 \exp_last_unbraced:NNo
319 \cs_new:Npn \_avm_replace_space:w \c_space_tl { \_avm_parse_output:nw { ~ } }
320
321 \cs_new:Npn \_avm_parse_output:nw #1 #2 \q_recursion_stop \_avm_result:n #3
322 { \_avm_parse_loop:w #2 \q_recursion_stop \_avm_result:n {#3 #1} }

```

(End definition for \\_avm\_parse:n.)

```

323 \endpackage

```