The sTeX3 Manual *

Michael Kohlhase, Dennis Müller
FAU Erlangen-Nürnberg
http://kwarc.info/

2021-12-10

Abstract

TODO

---

*Version 3.0 (last revised 2021-12-10)

Contents

Chapter 1

Stuff

1.1 Modules

Both print this sTeX logo.

1.1.1 Semantic Macros and Notations

Semantic macros invoke a formally declared symbol.

To declare a symbol (in a module), we use `\symdecl`, which takes as argument the name of the corresponding semantic macro, e.g. `\symdecl{foo}` introduces the macro `\foo`. Additionally, `\symdecl` takes several options, the most important one being its arity. `foo` as declared above yields a *constant* symbol. To introduce an *operator* which takes arguments, we have to specify which arguments it takes.

For example, to introduce binary multiplication, we can do `\symdecl[args=2]{mult}`. We can then supply the semantic macro with arbitrarily many notations, such as `\notation{mult}{#1 #2}`.

Example 1

```
\symdecl[args=2]{mult}
\notation{mult}{#1 #2}
$\mult{a}{b}$
```

> $a\,b$

.

Since usually, a freshly introduced symbol also comes with a notation from the start, the `\symdef` command combines `\symdecl` and `\notation`. So instead of the above, we could have also written

$$\symdef[args=2]{mult}{\#1 \#2}$$

Adding more notations like `\notation[cdot]{mult}{#1 \comp{\cdot} #2}` or `\notation[times]{mult}{#1 \comp{\times} #2}` allows us to write `$\mult[cdot]{a}{b}$` and `$\mult[times]{a}{b}$`:

.

Not using an explicit option with a semantic macro yields the first declared notation, unless changed[1].

Outside of math mode, or by using the starred variant `\foo*`, allows to provide a custom notation, where notational (or textual) components can be given explicitly in square brackets.

.

In custom mode, prefixing an argument with a star will not print that argument, but still export it to OMDoc:

·The syntax `*[⟨int⟩]` allows switching the order of arguments. For example, given a 2-ary semantic macro `\forevery` with exemplary notation `\forall #1. #2`, we can write

EdN:1

---

[1] EdNote: TODO

.

When using `*[`n`]`, after reading the provided (nth) argument, the "argument counter" automatically continues where we left off, so the `*[1]` in the above example can be omitted.

For a macro with arity > 0, we can refer to the operator *itself* semantically by suffixing the semantic macro with an exclamation point `!` in either text or math mode. For that reason `\notation` (and thus `\symdef`) take an additional optional argument `op=`, which allows to assign a notation for the operator itself. e.g.

Example 6

```
\symdef[args=2,op={+}]{add}{#1 \comp+ #2}
The operator $\add!$ adds two elements, as in $\add ab$.
```

The operator $+$ adds two elements, as in $a+b$.

.

`*` is composable with `!` for custom notations, as in:

Example 7

```
\mult![\comp{Multiplication}] (denoted by $\mult*![\comp\cdot]$) is defined by...
```

Multiplication (denoted by $\cdot$) is defined by...

.

The macro `\comp` as used everywhere above is responsible for highlighting, linking, and tooltips, and should be wrapped around the notation (or text) components that should be treated accordingly. While it is attractive to just wrap a whole notation, this would also wrap around e.g. the arguments themselves, so instead, the user is tasked with marking the notation components themself.

The precise behaviour of `\comp` is governed by the macro `\@comp`, which takes two arguments: The tex code of the text (unexpanded) to highlight, and the URI of the current symbol. `\@comp` can be safely redefined to customize the behaviour.

The starred variant `\symdecl*{foo}` does not introduce a semantic macro, but still declares a corresponding symbol. `foo` (like any other symbol, for that matter) can then be accessed via `\STEXsymbol{foo}` or (if `foo` was declared in a module `Foo`) via `\STEXModule{Foo}?{foo}`.

both `\STEXsymbol` and `\STEXModule` take any arbitrary ending segment of a full URI to determine which symbol or module is meant. e.g. `\STEXsymbol{Foo?foo}` is also valid, as are e.g. `\STEXModule{path?Foo}?{foo}` or `\STEXsymbol{path?Foo?foo}`

There's also a convient shortcut `\symref{?foo}{some text}` for `\STEXsymbol{?foo}![some text]`

Other Argument Types

So far, we have stated the arity of a semantic macro directly. This works if we only have "normal" (or more precisely: `i`-type) arguments. To make use of other argument types, instead of providing the arity numerically, we can provide it as a sequence of characters

representing the argument types – e.g. instead of writing `args=2`, we can equivalently write `args=ii`, indicating that the macro takes two `i`-type arguments.

Besides `i`-type arguments, SᴛᴇX has two other types, which we will discuss now.

The first are *binding* (`b`-type) arguments, representing variables that are *bound* by the operator. This is the case for example in the above `\forevery`-macro: The first argument is not actually an argument that the `forevery` "function" is "applied" to; rather, the first argument is a new variable (e.g. x) that is *bound* in the subsequent argument. More accurately, the macro should therefore have been implemented thusly:

$$\text{\symdef[args=bi]\{forevery\}\{\forall \#1.\; \#2\}}$$

`b`-type arguments are indistinguishable from `i`-type arguments within SᴛᴇX, but are treated very differently in OMDᴏᴄ and by Mᴍᴛ. More interesting *within* SᴛᴇX are `a`-type arguments, which represent (associative) arguments of flexible arity, which are provided as comma-separated lists. This allows e.g. better representing the `\mult`-macro above:

Example 8

```
 \symdef[args=a]{mult}{#1 \comp\cdot #2}
$\mult{a,b,c,{d^e},f}$
```

$a \cdot b \cdot c \cdot d^e \cdot f$

˙As the example above shows, notations get a little more complicated for associative arguments. For every `a`-type argument, the `\notation`-macro takes an additional argument that declares how individual entries in an `a`-type argument list are aggregated. The first notation argument then describes how the aggregated expression is combined into the full representation.

For a more interesting example, consider a flexary operator for ordered sequences in ordered set, that taking arguments `{a,b,c}` and `\mathbb{R}` prints $a \leq b \leq c \in \mathbb{R}$. This operator takes two arguments (an `a`-type argument and an `i`-type argument), aggregates the individuals of the associative argument using `\leq`, and combines the result with `\in` and the second argument thusly:

Example 9

```
 \symdef[args=ai]{numseq}{#1 \comp\in #2}{#1 \comp\leq #2}
$\numseq{a,b,c}{\mathbb R}$
```

$a \leq b \leq c \in \mathbb{R}$

.

Finally, `B`-type arguments combine the functionalities of `a` and `b`, i.e. they represent flexary binding operator arguments.

2 3

---

[2]EᴅNᴏᴛᴇ: what about e.g. `\int _x\int _y\int _z f dx dy dz`?
[3]EᴅNᴏᴛᴇ: "decompose" `a`-type arguments into fixed-arity operators?

Precedences

Every notation has an (upwards) *operator precedence* and for each argument a (downwards) *argument precedence* used for automated bracketing. For example, a notation for a binary operator `\foo` could be declared like this:

```
\notation[prec=200;500x600]{foo}{#1 \comp{+} #2}
```

assigning an operator precedence of 200, an argument precedence of 500 for the first argument, and an argument precedence of 600 for the second argument.

sTeX insert brackets thusly: Upon encountering a semantic macro (such as `\foo`), its operator precedence (e.g. 200) is compared to the current downwards precedence (initially `\neginfprec`). If the operator precedence is *larger* than the current downwards precedence, parentheses are inserted around the semantic macro.

Notations for symbols of arity 0 have a default precedence of `\infprec`, i.e. by default, parentheses are never inserted around constants. Notations for symbols with arity > 0 have a default operator precedence of 0. If no argument precedences are explicitly provided, then by default they are equal to the operator precedence.

Consequently, if some operator *A* should bind stronger than some operator *B*, then *A*s operator precedence should be smaller than *B*s argument precedences.

For example:

Example 10

```
\notation[prec=100]{plus}{#1 \comp{+} #2}
\notation[prec=50]{times}{#1 \comp{\cdot} #2}
$\plus{a}{\times{b}{c}}$ and $\times{a}{\plus{b}{c}}$
```

$a+b\cdot c$ and $a\cdot(b+c)$

.

1.1.2 Archives and Imports

Namespaces

Ideally, sTeX would use arbitrary URIs for modules, with no forced relationships between the *logical* namespace of a module and the *physical* location of the file declaring the module – like Mmt does things.

Unfortunately, TeX only provides very restricted access to the file system, so we are forced to generate namespaces systematically in such a way that they reflect the physical location of the associated files, so that sTeX can resolve them accordingly. Largely, users need not concern themselves with namespaces at all, but for completenesses sake, we describe how they are constructed:

- If `\begin{module}{Foo}` occurs in a file `/path/to/file/Foo[.`⟨*lang*⟩`].tex` which does not belong to an archive, the namespace is `file://path/to/file`.

- If the same statement occurs in a file `/path/to/file/bar[.`⟨*lang*⟩`].tex`, the namespace is `file://path/to/file/bar`.

In other words: outside of archives, the namespace corresponds to the file URI with the filename dropped iff it is equal to the module name, and ignoring the (optional) language suffix[1].

If the current file is in an archive, the procedure is the same except that the initial segment of the file path up to the archive's `source`-folder is replaced by the archive's namespace URI.

Paths in Import-Statements

Conversely, here is how namespaces/URIs and file paths are computed in import statements, examplary `\importmodule`:

- `\importmodule{Foo}` outside of an archive refers to module `Foo` in the current namespace. Consequently, `Foo` must have been declared earlier in the same document or, if not, in a file `Foo[.⟨lang⟩].tex` in the same directory.

- The same statement *within* an archive refers to either the module `Foo` declared earlier in the same document, or otherwise to the module `Foo` in the archive's top-level namespace. In the latter case, is has to be declared in a file `Foo[.⟨lang⟩].tex` directly in the archive's `source`-folder.

- Similarly, in `\importmodule{some/path?Foo}` the path `some/path` refers to either the sub-directory and relative namespace path of the current directory and namespace outside of an archive, or relative to the current archive's top-level namespace and `source`-folder, respectively.

  The module `Foo` must either be declared in the file ⟨*top-directory*⟩`/some/path/Foo[.⟨lang⟩].tex`, or in ⟨*top-directory*⟩`/some/path[.⟨lang⟩].tex` (which are checked in that order).

- Similarly, `\importmodule[Some/Archive]{some/path?Foo}` is resolved like the previous cases, but relative to the archive `Some/Archive` in the mathhub-directory.

- Finally, `\importmodule{full://uri?Foo}` naturally refers to the module `Foo` in the namespace `full://uri`. Since the file this module is declared in can not be determined directly from the URI, the module must be in memory already, e.g. by being referenced earlier in the same document.

  Since this is less compatible with a modular development, using full URIs directly is discouraged.

---

[1]which is internally attached to the module name instead, but a user need not worry about that.