Das Paket lualatex-math*

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1 Introduction

LuaTeX brings major improvements to all areas of TeX typesetting and programming. They are made available through new primitives or the embedded Lua interpreter, and combining them with existing LaTeX 2ε packages is not a task the average LaTeX user should have to care about. Therefore a multitude of LaTeX 2ε packages have been written to bridge the gap between documents and the new features.

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The lualatex-math package focuses on the additional possibilities for mathematical typesetting. The most eminent of the new features is the ability to use Unicode and OpenType fonts, as provided by Will Robertson's unicode-math package. However, there is a smaller group of changes unrelated to Unicode: these are to be dealt with in this package. While in principle most TEX documents written for traditional engines should work just fine with LuaTEX, there is a small number of breaking changes that require the attention of package authors. The lualatex-math package tries to fix some of the issues encountered while porting traditional macro packages to LuaLATEX.

The decision to write patches for existing macro packages should not be made lightly: monkey patching done by somebody different from the original package author ties the patching package to the implementation details of the patched functionality and breaks all rules of encapsulation. However, due to the lack of alternatives, it has become an accepted way of providing new functionality in LATEX. To keep the negative impact as small as possible, the lualatex-math package patches only the LATEX 2_ε kernel and a small number of popular packages. In general, this package should be regarded as a temporary kludge that should be removed once the math-related packages are updated to be usable with LuaTEX. By its very nature, the package is likely to cause problems; in such cases, please refer to the issue tracker[1].

2 Einführung

LuaTEX bringt zahlreiche Verbesserungen für alle Gebiete des Satzes und der Programmierung mit TEX mit sich. Diese Verbesserungen werden in Form von neuen primitiven Befehlen oder durch den eingebetteten Lua-Interpreter zur Verfügung gestellt, und normale LATEX-Benutzer sollten sich nicht damit beschäftigen müssen, sie in LATEX 2_ε zu integrieren. Aus diesem Grund ist eine Vielzahl von LATEX 2_ε-Paketen entstanden, um die Lücke zwischen existierenden Dokumenten und den neuen Möglichkeiten zu schließen. Das Paket lualatex-math beschäftigt sich mit den zusätzlichen Möglichkeiten für den Mathematiksatz. Die wichtigste davon ist die Möglichkeit, Unicode und OpenType-Schriften zu benutzen, was durch Will Robertsons unicode-math-Paket ermöglicht wird. Allerdings gibt es ein paar Änderungen, die nicht in Bezug zu Unicode stehen: um diese kümmert sich das vorliegende Paket. Während prinzipiell die meisten TEX-Dokumente, die zur Verwendung mit den althergebrachten Engines verfasst wurden, ohne Probleme auch mit LuaTEX funktionieren sollten, gibt es ein paar wenige inkompatible Änderungen, die die Aufmerksamkeit von Paketautoren einfordern. Das lualatex-math-Paket versucht, einige der Probleme zu lösen, die bei der Übertragung einiger vorhandener Makropakete nach LuaLATEX festgestellt wurden.

Im Allgemeinen sollte man nur nach sorgfältiger Abwägung Patches für vorhandene Makropakete verfassen: das Patchen von Code durch jemand anderen als den ursprünglichen Autor macht den neuen Code von der Implementation der gepatchten Funktionalität abhänging, was dem Kapselungsprinzip widerspricht. Dennoch ist diese Art der Programmierung mangels Alternativen zu einer akzeptierten Herangehensweise beim Implementieren neuer Funktionalität für LATEX geworden. Um die negativen Auswirkungen so gering wie möglich zu halten, verändert das lualatex-math-Paket nur den LATEX 2_ε-Kern und einige wenige bekannte Pakete. Generell sollte das vorliegende Paket als eine Zwischenlösung angesehen werden, die zu entfernen ist, sobald die mathematiksatzbezogenen Pakete aktualisiert wurden und korrekt unter LuaTEX funktionieren. Aufgrund seiner Natur ist es wahrscheinlich,

[1] https://github.com/phst/lualatex-math/issues

dass dieses Paket Probleme verursacht; in diesen Fall benutze bitte den Bugtracker[2].

3 Interface

The lualatex-math package can be loaded with `\usepackage` or `\RequirePackage`, as usual. It has no options and no public interface; the patching is always done when the package is loaded and cannot be controlled. As a matter of course, the lualatex-math package needs LuaLaTeX to function; it will produce error messages and refuse to load under other engines and formats. The package depends on the expl3 bundle, the etoolbox package, the luatexbase bundle and the filehook package. The lualatex-math package is independent of the unicode-math package; the fixes provided here are valid for both Unicode and legacy math typesetting.

Currently patches for the LaTeX 2_ε kernel and the amsmath, amsopn, mathtools and icomma packages are provided. It is not relevant whether you load these packages before or after lualatex-math. They should work as expected (and ideally you shouldn't notice anything), but if you load other packages that by themselves overwrite commands patched by this package, bad things may happen, as it is usual with LaTeX.

`\mathstyle`, `\luatexmathstyle`

One user-visible change is that the new `\mathstyle` primitive (usually called `\luatexmathstyle` in LuaLaTeX) should work in all cases after the lualatex-math package has been loaded, provided you use the high-level macros `\frac`, `\binom`, and `\genfrac`. The fraction-like TeX primitives like `\over` or `\atopwithdelims` and the plain TeX leftovers like `\brack` or `\choose` cannot be patched, and you shouldn't use them.

`\frac`, `\binom`, `\genfrac`

4 Schnittstelle

Das lualatex-math-Paket kann wie üblich mit Hilfe von `\usepackage` oder `\RequirePackage` geladen werden. Es besitzt weder Optionen noch eine öffentliche Schnittstelle; der Patchprozess wird automatisch durchgeführt, sobald das Paket geladen wird. Selbstverständlich funktioniert das lualatex-math-Paket nur unter LuaLaTeX; für andere Engines oder Formate bricht das Laden mit einer Fehlermeldung ab. Das Paket hängt von der expl3-Sammlung, dem etoolbox-Paket, der luatexbase-Sammlung und dem filehook-Paket ab. Das lualatex-math-Paket ist unabhängig vom unicode-math-Paket; die hier zur Verfügung gestellten Korrekturen sind sowohl für Unicode- als auch für herkömmlichen Mathematiksatz gültig.

Aktuell werden Patches für den LaTeX 2_ε-Kern sowie für die Pakete amsmath, amsopn, mathtools und icomma angeboten. Es spielt keine Rolle, ob diese Pakete vor oder nach lualatex-math geladen werden. Sie sollten funktionieren wie erwartet (und idealerweise sollte überhaupt keine Änderung bemerkbar sein), aber falls du andere Pakete, die selbst Befehle überschreiben, die von dem vorliegenden Paket gepatcht werden, lädst, können Probleme auftreten, wie bei LaTeX üblich.

`\mathstyle`, `\luatexmathstyle`

Eine für den Benutzer sichtbare Änderung besteht darin, dass der neue primitive Befehl `\mathstyle` (in LuaLaTeX allgemein als `\luatexmathstyle` bekannt) in allen Fällen funktionieren sollte, nachdem lualatex-math geladen wurde, unter der Bedingung, dass die High-Level-Makros `\frac`, `\binom` und `\genfrac` benutzt werden. Die bruchartigen primitiven TeX-Befehle wie `\over` oder `\atopwithdelims` und die Makros aus dem plain TeX-Format wie `\brack` oder `\choose` können nicht gepatcht werden und sollten allgemein vermieden werden.

`\frac`, `\binom`, `\genfrac`

[2] https://github.com/phst/lualatex-math/issues

5 Implementation of the LaTeX 2_ε package

5.1 Requirements

```
⟨*package⟩
⟨@@=lltxmath⟩
\NeedsTeXFormat{LaTeX2e}[2009/09/24]
\RequirePackage{expl3}[2012/08/14]
\ProvidesExplPackage{lualatex-math}{2014/06/18}{1.3a}%
  {Patches for mathematics typesetting with LuaLaTeX}
\RequirePackage { etoolbox } [ 2007/10/08 ]
\RequirePackage { luatexbase } [ 2010/05/27 ]
\RequirePackage { filehook } [ 2011/03/09 ]
\RequireLuaModule { lualatex-math } [ 2013/08/03 ]
```

\@@_restore_catcode:N Executing the exhaustive expansion of `\@@_restore_catcode:N`⟨*character token*⟩ restores the category code of the ⟨*character token*⟩ to its current value.

```
\cs_new_nopar:Npn \@@_restore_catcode:N #1 {
  \char_set_catcode:nn { \int_eval:n { `#1 } }
    { \char_value_catcode:n { `#1 } }
}
```

We use the macro defined above to restore the category code of the dollar sign. There are packages that make the dollar sign active; hopefully they get loaded after the packages we are trying to patch.

```
\exp_args:Nx \AtEndOfPackage {
  \@@_restore_catcode:N \$
}
\char_set_catcode_math_toggle:N \$
```

5.2 Messages

luatex-required Issued when not running under LuaTeX.

```
\msg_new:nnn { lualatex-math } { luatex-required } {
  The~ lualatex-math~ package~ requires~ LuaTeX. \\
  I~ will~ stop~ loading~ now.
}
```

different-meanings Issued when two control sequences have different meanings, but should not.

```
\msg_new:nnnn { lualatex-math } { different-meanings } {
  I've~ expected~ the~ control~ sequences \\
  #1~ and~ #3 \\
  to~ have~ the~ same~ meaning,~ but~ their~ meanings~ are~ different.
} {
  The~ meaning~ of~ #1~ is: \\
  #2 \\
  The~ meaning~ of~ #3~ is: \\
  #4
}
```

macro-expected Issued when trying to patch a non-macro. The first argument must be the detokenized macro name.

```
\msg_new:nnn { lualatex-math } { macro-expected } {
  I've~ expected~ that~ #1~ is~ a~ macro,~ but~ it~ isn't.
}
```

wrong-meaning Issued when trying to patch a macro with an unexpected meaning. The first argument must be the detokenized macro name; the second argument must be

the actual detokenized meaning; and the third argument must be the expected detokenized meaning.

```
\msg_new:nnn { lualatex-math } { wrong-meaning } {
  I've~ expected~ #1~ to~ have~ the~ meaning \\
  #3, \\
  but~ it~ has~ the~ meaning \\
  #2.
}
```

patch-macro Issued when a macro is patched. The first argument must be the detokenized macro name.

```
\msg_new:nnn { lualatex-math } { patch-macro } {
  I'm~ going~ to~ patch~ macro~ #1.
}
```

5.3 Initialization

Unless we are running under LuaTEX, we issue an error and quit immediately. Loading the luatexbase module will already have produced an error, but we issue another one for clarity.

```
\luatex_if_engine:F {
  \msg_error:nn { lualatex-math } { luatex-required }
  \endinput
}
```

5.4 Patching

\@@_temp:w A scratch macro.

```
\cs_new_eq:NN \@@_temp:w \prg_do_nothing:
```

\luatexUmathcode
\luatexUmathcodenum
\luatexUmathchardef We need the extended versions of `\mathcode` and `\mathchardef`. The command `\luatexbase@ensure@primitive{`⟨*name*⟩`}` makes sure that the LuaTEX primitive `\`⟨*name*⟩ is available under the qualified name `\luatex`⟨*name*⟩.

```
\luatexbase@ensure@primitive { Umathcode }
\luatexbase@ensure@primitive { Umathcodenum }
\luatexbase@ensure@primitive { Umathchardef }
```

\@@_assert_eq:NN The macro `\@@_assert_eq:NN`⟨*first command*⟩⟨*second command*⟩ tests whether the control sequences ⟨*first command*⟩ and ⟨*second command*⟩ have the same meaning, and prints an error message if they do not.

```
\cs_new_protected_nopar:Npn \@@_assert_eq:NN #1 #2 {
  \cs_if_eq:NNF #1 #2 {
    \msg_error:nnxxxx { lualatex-math } { different-meanings }
      { \token_to_str:N #1 } { \token_to_meaning:N #1 }
      { \token_to_str:N #2 } { \token_to_meaning:N #2 }
  }
}
```

\@@_patch:NNnnn
\@@_patch:cNnnn The auxiliary macro `\@@_patch:NNnnn`⟨*command*⟩⟨*factory command*⟩`{`⟨*parameter text*⟩`}{`⟨*expected replacement text*⟩`}{`⟨*new replacement text*⟩`}` tries to patch ⟨*command*⟩. If ⟨*command*⟩ is undefined, do nothing. Otherwise it must be a macro with the given ⟨*parameter text*⟩ and ⟨*expected replacement text*⟩, created by the given ⟨*factory command*⟩ or equivalent. In this case it will be overwritten using the ⟨*parameter text*⟩ and the ⟨*new replacement text*⟩. Otherwise issue a warning and don't overwrite.

```
\cs_new_protected_nopar:Npn \@@_patch:NNnnn #1 #2 #3 #4 #5 {
  \cs_if_exist:NT #1 {
    \token_if_macro:NTF #1 {
      \group_begin:
      #2 \@@_temp:w #3 { #4 }
      \cs_if_eq:NNTF #1 \@@_temp:w {
        \msg_info:nnx { lualatex-math } { patch-macro }
          { \token_to_str:N #1 }
        \group_end:
        #2 #1 #3 { #5 }
      } {
        \msg_warning:nnxxx { lualatex-math } { wrong-meaning }
          { \token_to_str:N #1 } { \token_to_meaning:N #1 }
          { \token_to_meaning:N \@@_temp:w }
        \group_end:
      }
    } {
      \msg_warning:nnx { lualatex-math } { macro-expected }
        { \token_to_str:N #1 }
    }
  }
}
\cs_generate_variant:Nn \@@_patch:NNnnn { c }
```

\@@_set_mathchar:NN The macro `\@@_set_mathchar:NN`⟨*control sequence*⟩⟨*token*⟩ defines the ⟨*control sequence*⟩ as an extended mathematical character shorthand whose mathematical code is given by the mathematical code of the character `⟨*token*⟩. We cannot use the `\Umathcharnumdef` primitive here since we would then rely on the `\Umathcodenum` primitive which is currently broken.[3]

```
\cs_new_protected_nopar:Npn \@@_set_mathchar:NN #1 #2 {
  \luatexUmathchardef #1
  \luatex_directlua:D {
    lualatex.math.print_class_fam_slot( \int_eval:n { `#2 } )
  }
  \scan_stop:
}
```

5.5 LaTeX 2ε kernel

In LuaTeX, we have 256 math families at our disposal. Therefore we modify the LaTeX allocation macros `\newfam` and `\new@mathgroup` accordingly.

First we test whether `\newfam` and `\new@mathgroup` are equal.

```
\@@_assert_eq:NN \newfam \new@mathgroup
```

\new@mathgroup It is enough to modify the maximum number of families known to the allocation system; the macro `\alloc@` takes care of the rest. This would work even if the etex package weren't loaded.

```
\@@_patch:NNnnn \new@mathgroup \cs_set_nopar:Npn { } {
⟨@@=⟩
  \alloc@ 8 \mathgroup \chardef \sixt@@n
⟨@@=lltxmath⟩
} {
  \alloc@ 8 \mathgroup \chardef \c_two_hundred_fifty_six
}
```

[3] http://tug.org/pipermail/luatex/2012-October/003794.html

\newfam We have to reset \newfam to equal \new@mathgroup.

```
\cs_set_eq:NN \newfam \new@mathgroup
```

LuaTeX enables access to the current mathematical style via the \mathstyle primitive. For this to work, fraction-like constructs (e. g., ⟨*numerator*⟩ \over ⟨*denominator*⟩) have to be enclosed in a \Ustack group. \frac can be patched to do this, but the plain TeX remnants \choose, \brack and \brace should be discouraged.

\luatexUstack First we make sure that we can use the \Ustack primitive (under the name \luatexUstack).

```
\luatexbase@ensure@primitive { Ustack }
```

\frac Here we assume that nobody except amsmath redefines \frac. This is obviously not the case, but we ignore other packages (e. g., nath) for the moment. We only patch the LaTeX 2_ε kernel definition if the amsmath package is not loaded; the corresponding patch for amsmath follows below.

```
\AtEndPreamble {
  \@ifpackageloaded { amsmath } { } {
    \@@_patch:NNnnn \frac \cs_set_nopar:Npn { #1 #2 } {
      {
        \begingroup #1 \endgroup \over #2
      }
    } {
```

To do: do we need the additional set of braces around \Ustack?

```
      {
        \luatexUstack { \group_begin: #1 \group_end: \over #2 }
      }
    }
  }
}
```

5.6 amsmath

The popular amsmath package is subject to three LuaTeX-related problems:

- The \mathcode primitive is used several times, which fails for Unicode math characters. \Umathcode should be used instead.
- Legacy font dimensions are used for constructing stacks in the \substack command and the subarray environment. This doesn't work if a Unicode math font is selected.
- The fraction commands \frac and \genfrac don't use the \Ustack primitive.

\luatexalignmark We use the primitives corresponding to the alignment mark (#) and to the inline
\luatexUstartmath math switches; this is more semantical and might lead to better error messages.
\luatexUstopmath

```
\luatexbase@ensure@primitive { alignmark }
\luatexbase@ensure@primitive { Ustartmath }
\luatexbase@ensure@primitive { Ustopmath }
```

\luatexUmathstacknumup Now we require the font parameters we will use.
\luatexUmathstackdenomdown

```
\luatexbase@ensure@primitive { Umathstacknumup }
\luatexbase@ensure@primitive { Umathstackdenomdown }
```

\luatexUmathstackvgap

```
\luatexbase@ensure@primitive { Umathstackvgap }
```

\c_@@_std_minus_mathcode_int
\c_@@_std_equal_mathcode_int

These constants contain the standard TEX mathematical codes for the minus and the equal signs. We temporarily set the math codes to these constants before loading the amsmath package so that it can request the legacy math code without error.

```
\int_const:Nn \c_@@_std_minus_mathcode_int { "2200 }
\int_const:Nn \c_@@_std_equal_mathcode_int { "303D }
```

\@@_char_dim:NN

The macro `\@@_char_dim:NN`⟨*primitive*⟩⟨*token*⟩ expands to a ⟨*dimen*⟩ whose value is the metric of the mathematical character corresponding to the character `⟨*token*⟩ specified by ⟨*primitive*⟩, which must be one of `\fontcharwd`, `\fontcharht` or `\fontchardp`, in the currently selected text style font.

```
\cs_new_nopar:Npn \@@_char_dim:NN #1 #2 {
  #1 \textfont
  \luatex_directlua:D {
    lualatex.math.print_fam_slot( \int_eval:n { `#2 } )
  }
}
```

\l_@@_minus_mathchar
\l_@@_equal_mathchar

These mathematical characters are saved before amsmath is loaded so that we can temporarily assign the TEX values to the mathematical codes of the minus and equals signs. The amsmath package queries these codes, and if they represent Unicode characters, the package loading will fail. If amsmath has already been loaded, there is nothing we can do, therefore we use the non-starred version of `\AtBeginOfPackageFile`.

```
\tl_new:N \l_@@_minus_mathchar
\tl_new:N \l_@@_equal_mathchar
\AtBeginOfPackageFile { amsmath } {
  \@@_set_mathchar:NN \l_@@_minus_mathchar \-
  \@@_set_mathchar:NN \l_@@_equal_mathchar \=
```

Now we temporarily reset the mathematical codes.

```
  \char_set_mathcode:nn { `\- } { \c_@@_std_minus_mathcode_int }
  \char_set_mathcode:nn { `\= } { \c_@@_std_equal_mathcode_int }
  \AtEndOfPackageFile { amsmath } {
```

\std@minus
\std@equals

The amsmath package defines the control sequences `\std@minus` and `\std@equal` as mathematical character shorthands while loading, but uses our restored mathematical codes, which must be fixed.

```
    \cs_set_eq:NN \std@minus \l_@@_minus_mathchar
    \cs_set_eq:NN \std@equal \l_@@_equal_mathchar
```

Finally, we restore the original mathematical codes of the two signs.

```
    \luatexUmathcodenum `\- \l_@@_minus_mathchar
    \luatexUmathcodenum `\= \l_@@_equal_mathchar
  }
}
```

All of the following fixes work even if amsmath is already loaded.

\@begindocumenthook

amsmath repeats the definiton of `\std@minus` and `\std@equal` at the beginning of the document, so we also have to patch the internal kernel macro `\@begindocumenthook` which contains the hook code.

```
\AtEndOfPackageFile * { amsmath } {
  \tl_replace_once:Nnn \@begindocumenthook {
    \mathchardef \std@minus \mathcode `\- \relax
    \mathchardef \std@equal \mathcode `\= \relax
  } {
    \@@_set_mathchar:NN \std@minus \-
```

```
    \@@_set_mathchar:NN \std@equal \=
  }
```

\resetMathstrut@ amsmath uses the box `\Mathstrutbox@` for struts in mathematical mode. This box is defined to have the height and depth of the opening parenthesis taken from the current text font. The command `\resetMathstrut@` is executed whenever the mathematical fonts are changed and has to restore the correct dimensions. The original definition uses a temporary mathematical character shorthand definition whose meaning is queried to extract the family and slot. We can do this in Lua; furthermore we can avoid a temporary box because ε-TEX allows us to query glyph metrics directly.

```
  \@@_patch:NNnnn \resetMathstrut@ \cs_set_nopar:Npn { } {
    \setbox \z@ \hbox {
      \mathchardef \@tempa \mathcode `\( \relax % \)
      \def \@tempb ##1 "##2 ##3 { \the \textfont "##3 \char" }
      \expandafter \@tempb \meaning \@tempa \relax
    }
    \ht \Mathstrutbox@ \ht \z@
    \dp \Mathstrutbox@ \dp \z@
  } {
    \box_set_ht:Nn \Mathstrutbox@ {
      \@@_char_dim:NN \fontcharht \( % \)
    }
    \box_set_dp:Nn \Mathstrutbox@ {
      \@@_char_dim:NN \fontchardp \)
    }
  }
```

subarray The `subarray` environment uses legacy font dimensions. We simply patch it to use LuaTEX font parameters (and LATEX3 expressions instead of TEX arithmetic). Since subscript arrays are conceptually vertical stacks, we use the sum of top and bottom shift for the default vertical baseline distance (`\baselineskip`) and the minimum vertical gap for stack for the minimum baseline distance (`\lineskip`).

```
  \@@_patch:NNnnn \subarray \cs_set:Npn { #1 } {
    \vcenter
    \bgroup
    \Let@
    \restore@math@cr
    \default@tag
    \baselineskip \fontdimen 10~ \scriptfont \tw@
    \advance \baselineskip \fontdimen 12~ \scriptfont \tw@
⟨@@=⟩
    \lineskip \thr@@ \fontdimen 8~ \scriptfont \thr@@
⟨@@=lltxmath⟩
    \lineskiplimit \lineskip
    \ialign
    \bgroup
    \ifx c #1 \hfil \fi
    $ \m@th \scriptstyle ## $
    \hfil
    \crcr
  } {
    \vcenter
    \c_group_begin_token
    \Let@
    \restore@math@cr
    \default@tag
```

```
    \skip_set:Nn \baselineskip {
      \luatexUmathstacknumup \scriptstyle
      + \luatexUmathstackdenomdown \scriptstyle
    }
    \lineskip \luatexUmathstackvgap \scriptstyle
    \lineskiplimit \lineskip
    \ialign
    \c_group_begin_token
    \token_if_eq_meaning:NNT c #1 { \hfil }
    \luatexUstartmath
    \m@th
    \scriptstyle
    \luatexalignmark \luatexalignmark
    \luatexUstopmath
    \hfil
    \crcr
  }
```

\frac Since `\frac` is declared by `\DeclareRobustCommand`, we must patch the macro `\frac␣`.

```
  \@@_patch:cNnnn { frac~ } \cs_set:Npn { #1 #2 } {
    {
⟨@@=⟩
      \begingroup #1 \endgroup \@@over #2
    }
  } {
    {
      \luatexUstack { \group_begin: #1 \group_end: \@@over #2 }
⟨@@=lltxmath⟩
    }
  }
```

\@genfrac Generalized fractions are typeset by the internal `\@genfrac` command.

```
  \@@_patch:NNnnn \@genfrac \cs_set_nopar:Npn {
    #1 #2 #3 #4 #5
  } {
    {
      #1 { \begingroup #4 \endgroup #2 #3 \relax #5 }
    }
  } {
    {
      #1 {
        \luatexUstack {
          \group_begin: #4 \group_end: #2 #3 \scan_stop: #5
        }
      }
    }
  }
}
```

5.7 amsopn

The amsopn package can be used standalone, but is also loaded by amsmath. It provides the `\DeclareMathOperator` command which breaks when the minus character is a Unicode math character; this issue was brought to my attention by Jean-François Burnol.

\newmcodes@ We only need to patch one usage of `\mathcode` in the internal macro `\newmcodes@`, which is called by all user-defined operators.

```
\group_begin:
\char_set_catcode_other:N \"
\AtEndOfPackageFile * { amsopn } {
  \@@_patch:NNnnn \newmcodes@ \cs_gset_nopar:Npn { } {
    \mathcode `\' 39
    \mathcode `\* 42
    \mathcode `\. "613A
    \ifnum \mathcode `\- = 45 ~ \else
      \mathchardef \std@minus \mathcode `\- \relax
    \fi
    \mathcode `\- 45
    \mathcode `\/ 47
    \mathcode `\: "603A \relax
  } {
    \char_set_mathcode:nn { `\' } { 39 }
    \char_set_mathcode:nn { `\* } { 42 }
    \char_set_mathcode:nn { `\. } { "613A }
    \int_compare:nNnF { \luatexUmathcodenum `\- } = { 45 } {
      \@@_set_mathchar:NN \std@minus \-
    }
    \char_set_mathcode:nn { `\- } { 45 }
    \char_set_mathcode:nn { `\/ } { 47 }
    \char_set_mathcode:nn { `\: } { "603A }
  }
}
\group_end:
```

5.8 mathtools

mathtools' `\cramped` command and others that make use of its internal version use a hack involving a null radical. LuaTEX has primitives for setting material in cramped mode, so we make use of them.

\luatexcrampeddisplaystyle First we make sure that the needed primitives for cramped styles are available.
\luatexcrampedtextstyle
\luatexcrampedscriptstyle
\luatexcrampedscriptscriptstyle

```
\luatexbase@ensure@primitive { crampeddisplaystyle }
\luatexbase@ensure@primitive { crampedtextstyle }
\luatexbase@ensure@primitive { crampedscriptstyle }
\luatexbase@ensure@primitive { crampedscriptscriptstyle }
```

\MT_cramped_internal:Nn The macro `\MT_cramped_internal:Nn`⟨*style*⟩`{`⟨*expression*⟩`}` typesets the ⟨*expression*⟩ in the cramped style corresponding to the given ⟨*style*⟩ (`\displaystyle` etc.); all we have to do in LuaTEX is to select the correct primitive. Rewriting the user-level `\cramped` command and employing `\mathstyle` would be possible as well, but we avoid this way since we want to patch only a single command.

```
\AtEndOfPackageFile * { mathtools } {
  \@@_patch:NNnnn \MT_cramped_internal:Nn
    \cs_set_nopar:Npn { #1 #2 } {
    \sbox \z@ {
      $
      \m@th
      #1
      \nulldelimiterspace = \z@
      \radical \z@ { #2 }
      $
    }
```

```
    \ifx #1 \displaystyle
      \dimen@ = \fontdimen 8 \textfont 3
      \advance \dimen@ .25 \fontdimen 5 \textfont 2
    \else
      \dimen@ = 1.25 \fontdimen 8
      \ifx #1 \textstyle
        \textfont
      \else
        \ifx #1 \scriptstyle
          \scriptfont
        \else
          \scriptscriptfont
        \fi
      \fi
      3
    \fi
    \advance \dimen@ -\ht\z@
    \ht\z@ = -\dimen@
    \box\z@
  } {
```

Here the additional set of braces is absolutely necessary, otherwise the changed mathematical style would be applied to the material after the `\mathchoice` construct.

```
    {
      \use:c { luatexcramped \cs_to_str:N #1 } #2
    }
  }
}
```

5.9 icomma

The icomma package uses `\mathchardef` to save the mathematical code of the comma character. This breaks for Unicode fonts. The incompatibility was noticed by Peter Breitfeld.[4]

`\mathcomma` icomma defines the mathemathical character shorthand `\icomma` at the beginning of the document, therefore we again patch `\@begindocumenthook`.

```
\AtEndOfPackageFile * { icomma } {
  \tl_replace_once:Nnn \@begindocumenthook {
    \mathchardef \mathcomma \mathcode `\,
  } {
    \@@_set_mathchar:NN \mathcomma \,
  }
}
⟨/package⟩
```

6 Implementation of the LuaLaTeX module

For the Lua module, we use the standard luatexbase-modutils template.

```
⟨*lua⟩
require("luatexbase.modutils")
require("luatexbase.cctb")
lualatex = lualatex or {}
lualatex.math = lualatex.math or {}
```

[4] https://groups.google.com/forum/#!topic/de.comp.text.tex/Cputk-AJS5I/discussion

```
312 local err, warn, info, log = luatexbase.provides_module({
313   name = "lualatex-math",
314   date = "2013/08/03",
315   version = 1.3,
316   description = "Patches for mathematics typesetting with LuaLaTeX",
317   author = "Philipp Stephani",
318   licence = "LPPL v1.3+"
319 })
```

unpack The function `unpack` needs to be treated specially as it got moved around in Lua 5.2.

```
320 local unpack = unpack or table.unpack
```

```
321 local cctb = luatexbase.catcodetables
```

print_fam_slot The function `print_fam_slot` takes one argument which must be a number. It interprets the argument as a Unicode code point whose mathematical code is printed in the form ⟨*family*⟩␣⟨*slot*⟩, suitable for the right-hand side of e. g. `\fontcharht\textfont`.

```
322 function lualatex.math.print_fam_slot(char)
323   local code = tex.getmathcode(char)
324   local class, family, slot = unpack(code)
325   local result = string.format("%i %i ", family, slot)
326   tex.sprint(cctb.string, result)
327 end
```

print_class_fam_slot The function `print_class_fam_slot` takes one argument which must be a number. It interprets the argument as a Unicode code point whose mathematical code is printed in the form ⟨*class*⟩␣⟨*family*⟩␣⟨*slot*⟩, suitable for the right-hand side of `\Umathchardef`.

```
328 function lualatex.math.print_class_fam_slot(char)
329   local code = tex.getmathcode(char)
330   local class, family, slot = unpack(code)
331   local result = string.format("%i %i %i ", class, family, slot)
332   tex.sprint(cctb.string, result)
333 end
```

```
334 return lualatex.math
335 ⟨/lua⟩
```

7 Test files

Finally six small test files—but not a real test suite.

7.1 Common definitions

```
336 ⟨*test⟩
337 ⟨@@=test⟩
338 \documentclass[pagesize=auto]{scrartcl}
```

Only xparse starting with 2008/08/03 has `\NewDocumentCommand`.

```
339 \usepackage{xparse}[2008/08/03]
340 \usepackage{luacode}
341 \ExplSyntaxOn
342 \AtBeginDocument { \errorcontextlines = \c_fifteen }
```

pass This message is issued when a test passed.

```
343 \msg_new:nnn { test } { pass } { #1 }
```

\@@_pass:x The macro `\@@_pass:x{`⟨*text*⟩`}` issues the `pass` message with description ⟨*text*⟩.

```
\cs_new_protected_nopar:Npn \@@_pass:x #1 {
  \msg_info:nnx { test } { pass } { #1 }
}
```

fail This message is issued when a test failed.

```
\msg_new:nnn { test } { fail } { #1 }
```

\@@_fail:x The macro `\@@_fail:x{`⟨*text*⟩`}` issues the `fail` message with description ⟨*text*⟩.

```
\cs_new_protected_nopar:Npn \@@_fail:x #1 {
  \msg_error:nnx { test } { fail } { #1 }
}
```

\tl_const:Nx We need expanding constants.

```
\cs_generate_variant:Nn \tl_const:Nn { Nx }
```

\c_@@_equal_tl Two shorthands for pretty-printing test results.
\c_@@_not_equal_tl

```
\tl_const:Nx \c_@@_equal_tl { \c_space_tl == \c_space_tl }
\tl_const:Nx \c_@@_not_equal_tl { \c_space_tl != \c_space_tl }
```

\@@_equal_pass:nxnx The macro `\@@_equal_pass:nxnx{`⟨*first expression*⟩`}{`⟨*first value*⟩`}{`⟨*second expression*⟩`}{`⟨*second value*⟩`}` is called when the two values arising from the two expressions are equal.

```
\cs_new_protected_nopar:Npn \@@_equal_pass:nxnx #1 #2 #3 #4 {
  \@@_pass:x {
    \exp_not:n { #1 }
    \c_@@_equal_tl
    #2
    \c_@@_equal_tl
    #4
    \c_@@_equal_tl
    \exp_not:n { #3 }
  }
}
```

\@@_equal_fail:nxnx The macro `\@@_equal_pass:nxnx{`⟨*first expression*⟩`}{`⟨*first value*⟩`}{`⟨*second expression*⟩`}{`⟨*second value*⟩`}` is called when the two values arising from the two expressions are not equal.

```
\cs_new_protected_nopar:Npn \@@_equal_fail:nxnx #1 #2 #3 #4 {
  \@@_fail:x {
    \exp_not:n { #1 }
    \c_@@_equal_tl
    #2
    \c_@@_not_equal_tl
    #4
    \c_@@_equal_tl
    \exp_not:n { #3 }
  }
}
```

\@@_assert_equal:NNNNNnn The macro `\@@_assert_equal:NNNNNnn`⟨*set command*⟩⟨*use command*⟩⟨*compare command*⟩⟨*first temporary command*⟩⟨*second temporary command*⟩`{`⟨*first expression*⟩`}{`⟨*second expression*⟩`}` asserts that the two expressions are equal. The ⟨*set command*⟩ must have the argument specification `Nn`, the ⟨*use command*⟩ `N`, and the ⟨*compare command*⟩ `nNnTF`.
\@@_assert_equal:cccccnn

```
\cs_new_protected_nopar:Npn
```

```
\@@_assert_equal:NNNNNnn #1 #2 #3 #4 #5 #6 #7 {
  #1 #4 { #6 }
  #1 #5 { #7 }
  #3 { #4 } = { #5 } {
    \@@_equal_pass:nxnx { #6 } { #2 #4 } { #7 } { #2 #5 }
  } {
    \@@_equal_fail:nxnx { #6 } { #2 #4 } { #7 } { #2 #5 }
  }
}
\cs_generate_variant:Nn \@@_assert_equal:NNNNNnn { ccccc }
```

\@@_assert_equal:nnn The macro `\@@_assert_equal:nnn{`⟨*data type*⟩`}{`⟨*first expression*⟩`}{`⟨*second expression*⟩`}` is a simplified version of `\@@_assert_equal:NNNNNnn` for data types following the LaTeX3 naming conventions; ⟨*data type*⟩ must be `int`, `dim`, etc.

```
\cs_new_protected_nopar:Npn \@@_assert_equal:nnn #1 #2 #3 {
  \@@_assert_equal:cccccnn
    { #1 _set:Nn } { #1 _use:N } { #1 _compare:nNnTF }
    { l_@@_tmpa_ #1 } { l_@@_tmpb_ #1 } { #2 } { #3 }
}
```

\l_@@_tmpa_int Scratch registers for numbers.
\l_@@_tmpb_int

```
\int_new:N \l_@@_tmpa_int
\int_new:N \l_@@_tmpb_int
```

\AssertIntEqual The command `\AssertIntEqual{`⟨*first expression*⟩`}{`⟨*second expression*⟩`}` asserts that the two integral expressions are equal.

```
\NewDocumentCommand \AssertIntEqual { m m } {
  \@@_assert_equal:nnn { int } { #1 } { #2 }
}
```

\l_@@_tmpa_int Scratch registers for dimensions.
\l_@@_tmpb_int

```
\dim_new:N \l_@@_tmpa_dim
\dim_new:N \l_@@_tmpb_dim
```

\AssertDimEqual The command `\AssertDimEqual{`⟨*first expression*⟩`}{`⟨*second expression*⟩`}` asserts that the two dimension expressions are equal.

```
\NewDocumentCommand \AssertDimEqual { m m } {
  \@@_assert_equal:nnn { dim } { #1 } { #2 }
}
```

\AssertMathStyle The command `\AssertMathStyle{`⟨*expression*⟩`}` asserts that the current mathematical style is equal to the value of the integral ⟨*expression*⟩.

```
\NewDocumentCommand \AssertMathStyle { m } {
  \AssertIntEqual { \luatexmathstyle } { #1 }
}
```

\@@_assert_cramped:Nx The macro `\@@_assert_cramped:Nn`⟨*predicate*⟩`{`⟨*name*⟩`}` asserts that we are in math mode and that the current style fulfills the ⟨*predicate*⟩ (identified by the ⟨*name*⟩) which must have the argument specification `n`.

```
\cs_new_protected_nopar:Npn \@@_assert_cramped:Nx #1 #2 {
  \int_set:Nn \l_@@_tmpa_int { \luatexmathstyle }
  \bool_if:nTF {
    \int_compare_p:nNn { \l_@@_tmpa_int } > { \c_minus_one }
    &&
    #1 { \l_@@_tmpa_int }
  } {
    \@@_pass:x {
```

```
      \exp_not:N \luatexmathstyle
      \c_@@_equal_tl
      \int_use:N \l_@@_tmpa_int
      \c_space_tl
      is~ a~ #2~ style
    }
  } {
    \@@_fail:x {
      \exp_not:N \luatexmathstyle
      \c_@@_equal_tl
      \int_use:N \l_@@_tmpa_int
      \c_space_tl
      is~ not~ a~ #2~ style
    }
  }
}
```

\AssertNoncrampedStyle The command `\AssertNoncrampedStyle` asserts that the current mathematical style is one of the non-cramped styles.

```
\NewDocumentCommand \AssertNoncrampedStyle { } {
  \@@_assert_cramped:Nx \int_if_even_p:n { non-cramped }
}
```

\AssertCrampedStyle The command `\AssertCrampedStyle` asserts that the current mathematical style is one of the cramped styles.

```
\NewDocumentCommand \AssertCrampedStyle { } {
  \@@_assert_cramped:Nx \int_if_odd_p:n { cramped }
}
```

\l_@@_tmpa_box Scratch registers for box constructions.
\l_@@_tmpb_box

```
\box_new:N \l_@@_tmpa_box
\box_new:N \l_@@_tmpb_box
```

contains_space The function `contains_space(head, width)` returns `true` if the node list starting at `head` or any of its sublists contain a glue or kern node of width `width`. If `width` is `nil`, returns `true` if there is any glue or kern node. If `width` is the string `"nonzero"`, returns `true` if there is any glue node or kern node of nonzero with.

```
\begin{luacode*}
function contains_space(head, width)
  for n in node.traverse(head) do
    local id = n.id
    if id == 10 then  -- glue node
      if width then
        if width == "nonzero" or n.spec.width == width then
          return true
        end
      end
    elseif id == 11 then  -- kern node
      if width then
        if width == "nonzero" then
          if n.kern ~= 0 then
            return true
          end
        elseif n.kern == width then
          return true
        end
      end
    elseif id == 0 or id == 1 then  -- sublist
```

```
      if contains_space(n.head, width) then
        return true
      end
    end
  end
  return false
end
\end{luacode*}
```

\AssertNoSpace The command `\AssertNoSpace{`⟨*text*⟩`}` asserts that the node list that is the result of typesetting ⟨*text*⟩ contains no glue or kern nodes. When called with a star, the command ignores zero-width kerns.

```
\NewDocumentCommand \AssertNoSpace { s m } {
  \hbox_set:Nn \l_@@_tmpa_box { #2 }
  \int_if_odd:nTF {
    \luatex_directlua:D {
      local~ b = tex.getbox(\int_use:N \l_@@_tmpa_box)
      if~ contains_space(b.head,
          \IfBooleanTF { #1 } { "nonzero" } { nil }) then~
        tex.sprint("0")
      else~
        tex.sprint("1")
      end
    }
  } {
    \@@_pass:x {
      \tl_to_str:n { #2 } ~
      contains~ no~ skip~ or~ kern~ node
    }
  } {
    \@@_fail:x {
      \tl_to_str:n { #2 } ~
      contains~ a~ skip~ or~ kern~ node
    }
  }
}
```

\AssertMuSpace The command `\AssertMuSpace{`⟨*text*⟩`}{`⟨*muskip*⟩`}` asserts that the node list that is the result of typesetting ⟨*text*⟩ contains at least one glue or kern node of with ⟨*muskip*⟩.

```
\makeatletter
\NewDocumentCommand \AssertMuSpace { m m } {
  \hbox_set:Nn \l_@@_tmpa_box { #1 }
  \hbox_set:Nn \l_@@_tmpb_box { $ \mskip #2 \m@th $ }
  \int_if_odd:nTF {
    \luatex_directlua:D {
      local~ b = tex.getbox(\int_use:N \l_@@_tmpa_box)
      local~ s = tex.getbox(\int_use:N \l_@@_tmpb_box)
      if~ contains_space(b.head, s.width) then~
        tex.sprint("1")
      else~
        tex.sprint("0")
      end
    }
  } {
    \@@_pass:x {
      \tl_to_str:n { #1 } ~
      contains~ a~ skip~ or~ kern~ node~ of~ width~
```

```
      \tl_to_str:n { #2 }
    }
  } {
    \@@_fail:x {
      \tl_to_str:n { #1 } ~
      contains~ no~ skip~ or~ kern~ node~ of~ width~
      \tl_to_str:n { #2 }
    }
  }
}
\makeatother
\ExplSyntaxOff
```
⟨/test⟩

7.2 LaTeX 2ε kernel, allocation of math families

The LaTeX 2ε kernel itself allocates four families (also known as "math groups" in LaTeX parlance). Therefore we should still be able to allocate 252 families. We do this alternately with `\newfam`, `\new@mathgroup` and `\DeclareSymbolFont`.

⟨*test-kernel-alloc⟩
```
\usepackage{lualatex-math}
\makeatletter
\ExplSyntaxOn
\int_step_inline:nnnn { \c_four } { \c_one } {
  \c_two_hundred_fifty_five - \c_one
} {
  \int_case:nnn { \int_mod:nn { #1 } { \c_three } } {
    { \c_zero } {
      \int_new:N \g_@@_family_int
      \newfam \g_@@_family_int
      \AssertIntEqual { \g_@@_family_int } { #1 }
      \cs_undefine:N \g_@@_family_int
    }
    { \c_one } {
      \int_new:N \g_@@_mathgroup_int
      \new@mathgroup \g_@@_mathgroup_int
      \AssertIntEqual { \g_@@_mathgroup_int } { #1 }
      \cs_undefine:N \g_@@_mathgroup_int
    }
    { \c_two } {
      \DeclareSymbolFont { Test #1 } { OT1 } { cmr } { m } { n }
      \exp_args:Nc \AssertIntEqual { sym Test #1 } { #1 }
    }
  } {
    \@@_fail:x { This~ cannot~ happen }
  }
}
\DeclareSymbolFont { Test 255 } { OT1 } { cmr } { bx } { it }
\DeclareSymbolFontAlphabet { \TestAlphabet } { Test 255 }
\exp_args:Nc \AssertIntEqual { sym Test 255 }
  { \c_two_hundred_fifty_five }
\ExplSyntaxOff
\makeatother
\begin{document}
\[
\TestAlphabet{
  abc
  \AssertIntEqual{\fam}{255}
```

```
  \AssertIntEqual{\mathgroup}{255}
}
\]
\end{document}
```
⟨/test-kernel-alloc⟩

7.3 LaTeX 2ε kernel, \mathstyle primitive

Here we only check whether different fractions and other style-changing commands result in the correct mathematical style.

```
⟨*test-kernel-style⟩
\usepackage{lualatex-math}
\begin{document}
\begin{displaymath}
  \AssertMathStyle{0} \sqrt{\AssertMathStyle{1}}
  \frac{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  a^{\frac{\AssertMathStyle{6}}{\AssertMathStyle{7}}}
  \sqrt{\frac{\AssertMathStyle{3}}{\AssertMathStyle{3}}}
  \displaystyle
  \frac{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  \luatexcrampeddisplaystyle
  \frac{\AssertMathStyle{3}}{\AssertMathStyle{3}}
  \textstyle
  \frac{\AssertMathStyle{4}}{\AssertMathStyle{5}}
  \luatexcrampedtextstyle
  \frac{\AssertMathStyle{5}}{\AssertMathStyle{5}}
  \scriptstyle
  \frac{\AssertMathStyle{6}}{\AssertMathStyle{7}}
  \luatexcrampedscriptstyle
  \frac{\AssertMathStyle{7}}{\AssertMathStyle{7}}
\end{displaymath}
\begin{math}
  \AssertMathStyle{2} \sqrt{\AssertMathStyle{3}}
  \frac{\AssertMathStyle{4}}{\AssertMathStyle{5}}
  a^{\frac{\AssertMathStyle{6}}{\AssertMathStyle{7}}}
  \sqrt{\frac{\AssertMathStyle{5}}{\AssertMathStyle{5}}}
  \displaystyle
  \frac{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  \luatexcrampeddisplaystyle
  \frac{\AssertMathStyle{3}}{\AssertMathStyle{3}}
  \textstyle
  \frac{\AssertMathStyle{4}}{\AssertMathStyle{5}}
  \luatexcrampedtextstyle
  \frac{\AssertMathStyle{5}}{\AssertMathStyle{5}}
  \scriptstyle
  \frac{\AssertMathStyle{6}}{\AssertMathStyle{7}}
  \luatexcrampedscriptstyle
  \frac{\AssertMathStyle{7}}{\AssertMathStyle{7}}
\end{math}
\end{document}
⟨/test-kernel-style⟩
```

7.4 amsmath, amsopn, and mathtools

Since mathtools loads amsmath and amsopn anyway, we test all three in one file.

\testbox First a scratch box register.

```
⟨*test-amsmath⟩
```

```
\usepackage{lualatex-math}
\newsavebox{\testbox}
```

We set the mathematical code for the minus sign to some arbitrary Unicode value to test whether the load-time patch works.

```
\luatexUmathcode`\-="2 "33 "44444 \relax
\usepackage{amsmath}
\AssertIntEqual{\luatexUmathcode`\-}{"33444444}
\makeatletter
\AssertIntEqual{\std@minus}{"33444444}
\makeatother
```

Check that we can still declare operators.

```
\DeclareMathOperator{\Operator}{*-/'a-b}
\DeclareMathOperator*{\OperatorWithLimits}{01'*-/}
\DeclareMathOperator{\OperatorWithPunctuation}{a:b*/'-.}
\usepackage{mathtools}
```

The same for the document begin hook.

```
\luatexUmathcode`\="5 "66 "77777 \relax
\begin{document}
\AssertIntEqual{\luatexUmathcode`\=}{"66A77777}
\makeatletter
\AssertIntEqual{\std@equal}{"66A77777}
\makeatother
```

Here we test whether the strut box has the correct height and depth.

```
\sbox{\testbox}{$($} % )
\makeatletter
\AssertDimEqual{\ht\Mathstrutbox@}{\ht\testbox}
\AssertDimEqual{\dp\Mathstrutbox@}{\dp\testbox}
\makeatother
```

Here we test for the various amsmath features that have to be patched: sub-arrays and various kind of fraction-like objects. The `\substack` command and `subarray` environment aren't really tested since it is hard to check whether the outcome looks right in an automated way. All tests are done in both inline and display mode.

```
\begin{equation*}
  \AssertMathStyle{0} \sqrt{\AssertMathStyle{1}}
  \sum_{
    \substack{\frac12 \\ \frac34 \\ \frac56}
  }
  \sum_{
    \begin{subarray}{l} \frac12 \\ \frac34 \\ \frac56 \end{subarray}
  }
  \frac{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  a^{\frac{\AssertMathStyle{6}}{\AssertMathStyle{7}}}
  \dfrac{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  \tfrac{\AssertMathStyle{4}}{\AssertMathStyle{5}}
  \binom{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  a^{\binom{\AssertMathStyle{6}}{\AssertMathStyle{7}}}
  \dbinom{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  \tbinom{\AssertMathStyle{4}}{\AssertMathStyle{5}}
  \genfrac{}{}{}{}{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  \genfrac{<}{/}{0pt}{0}{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  \genfrac{}{}{}{1}{\AssertMathStyle{4}}{\AssertMathStyle{5}}
  \genfrac{|}{]}{4pt}{2}{\AssertMathStyle{6}}{\AssertMathStyle{7}}
  \genfrac{}{}{}{3}{\AssertMathStyle{6}}{\AssertMathStyle{7}}
\end{equation*}
\begin{math}
```

```
  \AssertMathStyle{2} \sqrt{\AssertMathStyle{3}}
  \sum_{
    \substack{\frac12 \\ \frac34 \\ \frac56}
  }
  \sum_{
    \begin{subarray}{l} \frac12 \\ \frac34 \\ \frac56 \end{subarray}
  }
  \frac{\AssertMathStyle{4}}{\AssertMathStyle{5}}
  a^{\frac{\AssertMathStyle{6}}{\AssertMathStyle{7}}}
  \dfrac{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  \tfrac{\AssertMathStyle{4}}{\AssertMathStyle{5}}
  \binom{\AssertMathStyle{4}}{\AssertMathStyle{5}}
  a^{\binom{\AssertMathStyle{6}}{\AssertMathStyle{7}}}
  \dbinom{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  \tbinom{\AssertMathStyle{4}}{\AssertMathStyle{5}}
  \genfrac{}{}{}{}{\AssertMathStyle{4}}{\AssertMathStyle{5}}
  \genfrac{<}{/}{0pt}{0}{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  \genfrac{}{}{}{1}{\AssertMathStyle{4}}{\AssertMathStyle{5}}
  \genfrac{|}{]}{4pt}{2}{\AssertMathStyle{6}}{\AssertMathStyle{7}}
  \genfrac{}{}{}{3}{\AssertMathStyle{6}}{\AssertMathStyle{7}}
\end{math}
```

Since mathtools' `\cramped` command uses `\mathchoice`, we cannot test for a single mathematical style since all of them are executed; instead, we just verify that all styles encountered are cramped.

```
\begin{equation*}
  \AssertMathStyle{0}
  a^{\AssertMathStyle{4} a}
  \cramped{\AssertCrampedStyle a^{\AssertCrampedStyle a}}
  a^{
    \AssertMathStyle{4}
    a^a
    \cramped{\AssertCrampedStyle a^{\AssertCrampedStyle a}}
    a^a
    \AssertMathStyle{4}
  }
  a^{
    a^{
      \AssertMathStyle{6}
      a^a
      \cramped{\AssertCrampedStyle a^{\AssertCrampedStyle a}}
      a^a
      \AssertMathStyle{6}
    }
  }
  a^{\AssertMathStyle{4} a}
  \AssertMathStyle{0}
\end{equation*}
\begin{math}
  \AssertMathStyle{2}
  a^{\AssertMathStyle{4} a}
  \cramped{\AssertCrampedStyle a^{\AssertCrampedStyle a}}
  a^{
    \AssertMathStyle{4}
    a^a
    \cramped{\AssertCrampedStyle a^{\AssertCrampedStyle a}}
    a^a
    \AssertMathStyle{4}
  }
```

```
  a^{
    a^{
      \AssertMathStyle{6}
      a^a
      \cramped{\AssertCrampedStyle a^{\AssertCrampedStyle a}}
      a^a
      \AssertMathStyle{6}
    }
  }
  a^{\AssertMathStyle{4} a}
  \AssertMathStyle{2}
\end{math}
```

The amsopn package uses `\mathcode` when executing a user-defined operator command. Test that this was patched out.

```
\AssertNoSpace*{$\Operator$}
\AssertNoSpace*{$\OperatorWithLimits$}
\AssertMuSpace{$\OperatorWithPunctuation$}{\thinmuskip}
\mathcode`\-=45 \relax
\AssertNoSpace*{$\Operator$}
\AssertNoSpace*{$\OperatorWithLimits$}
\AssertMuSpace{$\OperatorWithPunctuation$}{\thinmuskip}
\end{document}
⟨/test-amsmath⟩
```

7.5 unicode-math

This test file loads both amsmath and unicode-math. The latter package contains fixes that somewhat overlap with ours. We have to take care in all packages that no attempt is made to patch a single macro twice. Therefore we treat warnings (that occur when trying to patch a macro with an unknown meaning) as errors here. However, the auxiliary package fontspec-patches uses `\RenewDocumentCommand` from the xparse package, which generates a warning that we don't want to turn into an error. Therefore we treat the offending message `redefine-command` specially.

```
⟨*test-unicode⟩
\ExplSyntaxOn
\msg_redirect_class:nn { warning } { error }
\msg_redirect_name:nnn { LaTeX } { xparse / redefine-command } { info }
\ExplSyntaxOff
\usepackage{amsmath}
\usepackage{unicode-math}[2011/05/05]
\setmathfont{XITS Math}
\usepackage{lualatex-math}
\begin{document}
\begin{equation*}
  \AssertMathStyle{0} \sqrt{\AssertMathStyle{1}}
  \frac{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  a^{\frac{\AssertMathStyle{6}}{\AssertMathStyle{7}}}
  \dfrac{\AssertMathStyle{2}}{\AssertMathStyle{3}}
  \tfrac{\AssertMathStyle{4}}{\AssertMathStyle{5}}
\end{equation*}
\end{document}
⟨/test-unicode⟩
```

7.6 icomma without unicode-math

This test file loads only icomma to test whether our patch works for Computer Modern.

```
748 ⟨*test-icomma⟩
749 \usepackage{lualatex-math}
750 \usepackage{icomma}
751 \begin{document}
752 $1,234 \; (x, y)$
753 \AssertNoSpace{$1,234$}
754 \AssertMuSpace{$(x, y)$}{\thinmuskip}
755 \AssertIntEqual{\mathcomma}{"1C0003B}
756 \end{document}
757 ⟨/test-icomma⟩
```

7.7 icomma with unicode-math

This test file loads both icomma and unicode-math to test whether they interact well.

```
758 ⟨*test-icomma-unicode⟩
759 \usepackage{unicode-math}[2011/05/05]
760 \setmathfont{XITS Math}
761 \usepackage{lualatex-math}
762 \usepackage{icomma}
763 \begin{document}
764 $1,234 \; (x, y)$
765 \AssertNoSpace{$1,234$}
766 \AssertMuSpace{$(x, y)$}{\thinmuskip}
767 \AssertIntEqual{\mathcomma}{"0C0002C}
768 \end{document}
769 ⟨/test-icomma-unicode⟩
```

Change History

v0.1
General: Initial version 1
v0.2
General: Added patch for the icomma package 10
Added test file for icomma with unicode-math 21
Added test file for icomma without unicode-math 21
v0.3
General: Added test file for modified family allocation scheme 16
Patched math group allocation to gain access to all families 5
v0.3a
General: Updated for changes in l3kernel 1
v0.3b
\@begindocumenthook: Another update for a change in l3kernel 7
v0.3c
\@@_char_dim:NN: l3kernel renamed \lua_now:x to \lua_now_x:n 6
\@@_set_mathchar:NN: l3kernel renamed \lua_now:x to \lua_now_x:n 4
General: Added special treatment for redefine-command warning 20
\AssertMuSpace: l3kernel renamed \lua_now:x to \lua_now_x:n 15
\AssertNoSpace: l3kernel renamed \lua_now:x to \lua_now_x:n 15
v1.0
General: Switched to l3docstrip 1

v1.1
\@@_set_mathchar:NN: Update reasoning why \Umathcharnumdef is not used here 4
General: Add fix and unit test for amsopn 9, 18
\AssertNoSpace: Allow testing for nonzero kern nodes 15
contains_space: Allow testing for nonzero kern nodes 14
v1.2
General: Replace removed macro \chk_if_free_cs:N 16
Track renaming of \int_step_inline:nnnn 16
\l_@@_equal_mathchar: Replace removed macro \chk_if_free_cs:N 6
v1.3
General: Stop using the deprecated module function 11
unpack: Integrate Philipp Gesang's patch to make the unpack function compatible with Lua 5.2 11
v1.3a
\@@_char_dim:NN: l3kernel has (currently) dropped \lua_now_x:n 6
\@@_set_mathchar:NN: l3kernel has (currently) dropped \lua_now_x:n 4
\AssertMuSpace: l3kernel has (currently) dropped \lua_now_x:n 15
\AssertNoSpace: l3kernel has (currently) dropped \lua_now_x:n 15