Grundgesetze.sty for \LaTeX2e Documentation

Marcus Rossberg
University of Connecticut
marcus.rossberg@uconn.edu

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grundgesetze.sty is a \LaTeX2e package for typesetting formulae in Gottlob Frege’s begriffsschrift [concept-script] in the style of his Grundgesetze der Arithmetik (Jena 1893/1903). The package was developed for the 2013 English edition. The package is based on Josh Parsons’s begriff.sty which renders the formalism in the style of Frege’s earlier work, Begriffsschrift (Halle a.S. 1879). It was amended by Richard Kimberly Heck, J.J. Green, Agustín Rayo, and Marcus Rossberg. Thanks to Philip Ebert and Sanford Shieh for testing and suggestions. Frege’s defined function symbols are not rendered by this package, but by J.J. Green’s fge.sty.

1 Options

At present the only package option is bguq, which causes the package to use the bguq font for an alternative universal quantifier (concavity), and this option accepts a value (corresponding to the size to be used, as in bguq=6; default is 5). The bguq font is required for this option. It is included in recent versions of the big \TeX distributions.

2 Basic Commands

\begin{itemize}
    \item \GGhorizontal The horizontal, \hfill
    \item \GGnot The negation-stroke, \hfill
    \item \GGconditional Conditional-stroke: called as \GGconditional{p}{q} yields \hfill
    \item \GGquant Concavity: called as \GGquant{\mathfrak a} gives \hfill
    \item \GGjudge Judgement-stroke, \hfill
    \item \GGdef Definition-stroke, \hfill
    \item \GGbracket Automatically scaling brackets, \GGbracket{\ldots} yields (\ldots) (see examples below) \hfill
    \item \GGsqbracket Analogous square brackets, [\ldots]
\end{itemize}

A complete list of commands and synonyms in the package can be found in Table 4 and the lengths parameterising the appearance of the output in Table 5.

2.1 Examples

- $\text{\textbf{\textit{\textbackslash judge \textbf{\textit{\textbackslash quant{\textfrak a} \mathfrak a = \mathfrak a}}}}}$ yields $\vdash \mathfrak a = \mathfrak a$

- $\text{\textbf{\textit{\textbackslash judge \textbf{\textit{\textbackslash not \textbf{\textit{\textbackslash quant{\mathfrak F} \textbf{\textit{\textbackslash quant{\mathfrak a} \mathfrak{Fa}}}}}}}}}$ yields $\vdash \mathfrak{Fa}$

- $\text{\textbf{\textit{\textbackslash judge \textbf{\textit{\textbackslash conditional{p}{q}}}}}}$ yields $\vdash p \leftrightarrow q$

There are further examples, including Frege’s six basic laws of logic, available for download on [http://www.frege.info/](http://www.frege.info/).

3 Advanced Typesetting

3.1 Left-alignment of terminal formulae: $\textbf{\textit{\textbackslash term}}$

Conditional-strokes, negation-strokes, and concavities that are embedded in conditionals can result in a ragged appearance of the formula:

- $\text{\textbf{\textit{\textbackslash judge \textbf{\textit{\textbackslash conditional{p}{\textbf{\textit{\textbackslash conditional{q}{p}}}}}}}}}$ yields:

- $\text{\textbf{\textit{\textbackslash judge \textbf{\textit{\textbackslash conditional{\textbf{\textit{\textbackslash not q}{\textbf{\textit{\textbackslash not p}}}}}}}}}}$ yields:

In Frege’s original work, the component formulae of conditionals are left-aligned. This can be achieved by marking “terminal formulae” using the command $\textbf{\textit{\textbackslash term{⟨math⟩}}}$; the length $\textbf{\textit{\textbackslash linewidth}}$ specifies the distance of the terminal formula from the left end of the whole formula (typically, ‘\ ’).
\setlength{\GLineWidth}{9.2pt} \Gjudge
\Gconditional
{\Gterm{p}}
{\Gconditional{\Gterm{q}}
{\Gterm{p}}}
yields:
\[
\begin{array}{c}
\mathfrak{p} \\
\mathfrak{q} \\
\mathfrak{p}
\end{array}
\]
\setlength{\GLineWidth}{25.2pt}
\Gjudge\Gconditional{\Gterm{Fa}}
{\Gnot \Gquant{\mathfrak{a}} \Gnot \Gterm{F \mathfrak{a}}}
yields:
\[
\begin{array}{c}
\mathfrak{a} \\
\mathfrak{F} \\
\mathfrak{a}
\end{array}
\]

| negation-stroke | \(\top\) | 4.4pt |
| conditional-stroke | \(\downarrow\) | 4.4pt |
| concavity | \(\sim\) | 11.6pt |
| judgement-stroke: | \{ | add .4pt |
| present | |  |
| not present | | subtract 2pt |

Table 1: Lengths of embedded symbols

The correct values for \GLineWidth for each formula can be determined by adding up the lengths of the embedded symbols, as given in Table 1 or by using a GUI that allows producing \LaTeX and XML code for \textit{begriffsschrift} formulae by mouse-click. The GUI will calculate and output the correct values. It is available for download on \url{http://www.frege.info/}.

3.2 Adding horizontal lengths manually: \Gnonot, etc.

Readability is sometimes aided by moving, e.g., negations to the right end of the horizontal in a complex formula. For instance, Frege nearly always prefers the rendering displayed on the right in these types of formulae:

(a) \[
\begin{array}{c}
\mathfrak{a} \not\rightarrow \mathfrak{f}(\mathfrak{a}) \\
\mathfrak{a} \not\rightarrow \mathfrak{f}(\mathfrak{a})
\end{array}
\]

(b) \[
\begin{array}{c}
\mathfrak{g}(\mathfrak{a}) \not\rightarrow \mathfrak{f}(\mathfrak{a}) \\
\mathfrak{g}(\mathfrak{a}) \not\rightarrow \mathfrak{f}(\mathfrak{a})
\end{array}
\]

(c) \[
\begin{array}{c}
\mathfrak{a} = \mathfrak{b} \not\rightarrow \mathfrak{f}(\mathfrak{b}) \\
\mathfrak{a} = \mathfrak{b} \not\rightarrow \mathfrak{f}(\mathfrak{b})
\end{array}
\]
The right-hand formulae are produced by inserting commands for horizontals of the appropriate length directly at the position where the “space” should appear. The three right-hand formulae above are created thus, respectively:

(a) \texttt{\textbackslash GGjudge \textbackslash Gconditional}\\
    \{\texttt{\textbackslash GQuant\{\mathfrak a\} \textbackslash Gnot f(\mathfrak a)}\}\\
    \{\texttt{\textbackslash Gnoquant \textbackslash Gnot f(a)}\}

(b) \texttt{\textbackslash GGjudge \textbackslash Gconditional}\\
    \{\texttt{\textbackslash GQuant\{\mathfrak a\} \textbackslash Gconditional\{f(\mathfrak a)\}\{g(\mathfrak a)\}}\}\\
    \{\texttt{\textbackslash Gnoquant \textbackslash Gconditional\{f(a)\}\{g(a)\}}\}

(c) \texttt{\textbackslash GGjudge \textbackslash Gconditional}\\
    \{\texttt{\textbackslash Gnot \textbackslash Gnot f(a)}\}\\
    \{\texttt{\textbackslash Gconditional\{\textbackslash Gnot f(b)\}\{\textbackslash Gnot a=b\}}\}

4 Comparison and compatibility with \texttt{\textbackslash begriff.sty}

Josh Parsons’s \texttt{\textbackslash begriff.sty}, on which \texttt{\textbackslash grundgesetze.sty} is based, is closer in appearance to Frege’s formalism as it is presented in Frege’s first book, \textit{Begriffsschrift} (Halle a.S. 1879). The corresponsing commands were given different names so that both packages can be used in the same \TeX document; see Table 2.

<table>
<thead>
<tr>
<th>\texttt{\textbackslash begriff.sty} command</th>
<th>symbol</th>
<th>\texttt{\textbackslash grundgesetze.sty} symbol</th>
<th>command</th>
</tr>
</thead>
<tbody>
<tr>
<td>\texttt{\textbackslash BGcontent}</td>
<td>-</td>
<td>\texttt{\textbackslash GGhorizontal}</td>
<td></td>
</tr>
<tr>
<td>\texttt{\textbackslash BGnot}</td>
<td>\tau</td>
<td>\texttt{\textbackslash Gnot}</td>
<td></td>
</tr>
<tr>
<td>\texttt{\textbackslash BGconditional{p}{q}}</td>
<td>\begin{pmatrix} q \ p \end{pmatrix}</td>
<td>\texttt{\textbackslash Gconditional{p}{q}}</td>
<td></td>
</tr>
<tr>
<td>\texttt{\textbackslash BGassert}</td>
<td>{</td>
<td>\texttt{\textbackslash Gassert}</td>
<td></td>
</tr>
<tr>
<td>\texttt{\textbackslash BGbracket{\ldots}}</td>
<td>\begin{pmatrix} q \ p \end{pmatrix}</td>
<td>\texttt{\textbackslash GGbracket{\ldots}}</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Compatibility with \texttt{\textbackslash begriff.sty}

Also note the differences in alignment between \texttt{\textbackslash BGbracket} and \texttt{\textbackslash GGbracket} as shown in Table 3.

4.1 Conversion of a \texttt{\textbackslash begriff.sty} document into a \texttt{\textbackslash grundgesetze.sty} document

A straightforward way to convert the a \LaTeX document that uses \texttt{\textbackslash begriff.sty} into one that uses \texttt{\textbackslash grundgesetze.sty} without manually exchanging the commands is to find and replace “\texttt{\textbackslash BG}” by “\texttt{\textbackslash GG}”. Synonyms have been added to \texttt{\textbackslash grundgesetze.sty} to allow the use of all \texttt{\textbackslash begriff.sty} commands “translated” in this way (see Table 4).
\( \mathcal{B} \text{bracket} \): \[
\begin{align*}
(\dot{\epsilon} f(\epsilon) = \dot{\alpha} g(\alpha)) &= \sim \left( \begin{array}{c}
\uparrow \\
\begin{array}{c}
\text{a} \\
\text{a} = \dot{\epsilon} f(\epsilon)
\end{array}
\end{array}
\right) = \sim \left( \begin{array}{c}
\uparrow \\
\begin{array}{c}
\text{a} \\
\text{a} = \dot{\alpha} g(\alpha)
\end{array}
\end{array}
\right)
\end{align*}
\]

\( \mathcal{G} \text{bracket} \): \[
\begin{align*}
(\dot{\epsilon} f(\epsilon) = \dot{\alpha} g(\alpha)) &= \sim \left( \begin{array}{c}
\uparrow \\
\begin{array}{c}
\text{a} \\
\text{a} = \dot{\epsilon} f(\epsilon)
\end{array}
\end{array}
\right) = \sim \left( \begin{array}{c}
\uparrow \\
\begin{array}{c}
\text{a} \\
\text{a} = \dot{\alpha} g(\alpha)
\end{array}
\end{array}
\right)
\end{align*}
\]

Table 3: \( \mathcal{B} \text{bracket} \) and \( \mathcal{G} \text{bracket} \) alignment

<table>
<thead>
<tr>
<th>command</th>
<th>symbol</th>
<th>synonym / comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textbf{GGterm}{ldots}</td>
<td>_</td>
<td>(marks terminal formula)</td>
</tr>
<tr>
<td>\textbf{GHorizon}tal</td>
<td>_</td>
<td>\textbf{GGcontent}</td>
</tr>
<tr>
<td>\textbf{GJudge}</td>
<td>_</td>
<td>\textbf{GGassert}</td>
</tr>
<tr>
<td>\textbf{GJudgeLong}</td>
<td>_</td>
<td>\textbf{GGjudgealone}, \textbf{GGassertLong}, \textbf{GGassertalone}</td>
</tr>
<tr>
<td>\textbf{GJudgeVar}{length}</td>
<td>_</td>
<td>\textbf{GGassertVar}{length} (variable horizontal length, here: 6pt)</td>
</tr>
<tr>
<td>\textbf{GDef}</td>
<td>|</td>
<td>\textbf{GGdefalone}</td>
</tr>
<tr>
<td>\textbf{GDefLong}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>\textbf{GDefVar}{length}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>\textbf{Gnot}</td>
<td>()</td>
<td>\textbf{GGneg}</td>
</tr>
<tr>
<td>\textbf{Gnotalone}</td>
<td>()</td>
<td>(standalone negation-stroke)</td>
</tr>
<tr>
<td>\textbf{Gdnot}</td>
<td>()</td>
<td>(standalone double negation-stroke)</td>
</tr>
<tr>
<td>\textbf{GConditional}{p}{q}</td>
<td>|</td>
<td>(q) (p)</td>
</tr>
<tr>
<td>\textbf{GQuant}{mathfrak a}</td>
<td>()</td>
<td>\textbf{GGquant}{mathfrak a}</td>
</tr>
<tr>
<td>\textbf{GAll}{a}</td>
<td>()</td>
<td>\textbf{GGquant}{mathfrak a}</td>
</tr>
<tr>
<td>\textbf{GBracket}{ldots}</td>
<td>(\ldots)</td>
<td>(automatically scaling brackets)</td>
</tr>
<tr>
<td>\textbf{GSGBracket}{ldots}</td>
<td>(\ldots)</td>
<td>(ditto square brackets)</td>
</tr>
<tr>
<td>\textbf{Gnonot}</td>
<td>_</td>
<td>horizontal of \textbf{Gnot} length</td>
</tr>
<tr>
<td>\textbf{Gnoquant}</td>
<td>_</td>
<td>horizontal of \textbf{Gquant} length</td>
</tr>
<tr>
<td>\textbf{Gnboth}</td>
<td>_</td>
<td>horizontal of length: \textbf{Gnot} plus \textbf{Gquant}</td>
</tr>
<tr>
<td>\textbf{GNonotalone}</td>
<td>_</td>
<td>horizontal of \textbf{Gnotalone} length</td>
</tr>
<tr>
<td>\textbf{GNomdnot}</td>
<td>_</td>
<td>horizontal of \textbf{GDnot} length</td>
</tr>
<tr>
<td>\textbf{Goddspace}</td>
<td>_</td>
<td>horizontal of length: \textbf{GGquant} minus \textbf{GDnot}</td>
</tr>
<tr>
<td>\textbf{GNonotalonem}</td>
<td>_</td>
<td>horizontal of length: \textbf{GGquant} minus twice \textbf{GDnot}</td>
</tr>
<tr>
<td>\textbf{Gtinniespace}</td>
<td>_</td>
<td>horizontal of length: thrice \textbf{GDnot} minus \textbf{GGquant}</td>
</tr>
</tbody>
</table>

Table 4: All commands (and synonyms) defined by the package
<table>
<thead>
<tr>
<th>length</th>
<th>default value</th>
<th>explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>\GGthickness</td>
<td>0.4pt</td>
<td>thickness of horizontal and vertical lines</td>
</tr>
<tr>
<td>\GGquantthickness</td>
<td>$0.75 \times$ \GGthickness</td>
<td>thickness of the line of the quantifier “dish”. Note that this value is unused if the bguq option has been selected</td>
</tr>
<tr>
<td>\beforelen</td>
<td>2.4pt</td>
<td>length of horizontal before quantifier, conditional, and negation</td>
</tr>
<tr>
<td>\GGAfterlen</td>
<td>2pt</td>
<td>length of horizontal after quantifier, conditional, negation, judgement-, and definition-stroke</td>
</tr>
<tr>
<td>\GGSpace</td>
<td>3pt</td>
<td>space between right end of horizontal and terminal formula</td>
</tr>
<tr>
<td>\GGlift</td>
<td>2pt</td>
<td>lift of horizontal from baseline</td>
</tr>
<tr>
<td>\GGLinewidth</td>
<td>(n/a)</td>
<td>total length from left end of formula (typically, ‘\GJjudge’) and the beginning of the terminal formula (see §3.1)</td>
</tr>
</tbody>
</table>

Table 5: Length parameters and their default values