The \textbf{karnaugh-map} package

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\textbf{Abstract}

This package draws karnaugh maps with 2, 3, 4, 5, and 6 variables. It also contains commands for filling the karnaugh map with terms semi-automatically or manually. Last but not least it contains commands for drawing implicants on top of the map. Below is an example of a two variable karnaugh map of $X_0 \oplus X_1$.

\begin{center}
\begin{tabular}{c c}
\hline
$X_0$ & \hline
0 & 1 \hline
\end{tabular}
\end{center}

\begin{center}
\begin{tabular}{c c}
\hline
0 & 1 \hline
1 & 0 \hline
\end{tabular}
\end{center}

$X_1$

\begin{center}
\begin{tabular}{c c}
0 & 0 & 1 \hline
1 & 1 & 0 \hline
\end{tabular}
\end{center}

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1 Usage

\section*{karnaugh-map} The \emph{karnaugh-map} environment is the base for this package, and everything related to this package happens inside an instances of this environment.

\textbf{Usage:}

\begin{karnaugh-map}
\(*\)
\end{karnaugh-map}

One asterisk for black and white implicants, non for colorized implicants.

\begin{karnaugh-map}
\langle X \text{ size}\rangle
\langle Y \text{ size}\rangle
\langle Z \text{ size}\rangle
\langle X \text{ label}\rangle
\langle Y \text{ label}\rangle
\langle Z \text{ label}\rangle
\end{karnaugh-map}

Number of X-axis cells. Default: "4"
Number of Y-axis cells. Default: "4"
Number of X×Y submaps. Default: "1"
Label for the X-axis. Default: "X_1X_0"
Label for the Y-axis. Default: "X_3X_2"
Label for the submaps. Default: "X_5X_4"

\textbf{Example:}

Four variable karnaugh map, colorized, with X label \emph{X_1X_0}, and Y label \emph{X_3X_2}.

\begin{karnaugh-map}
\end{karnaugh-map}

or

\begin{karnaugh-map}[4][4][1][X_{1X_0}][X_{3X_2}]
\end{karnaugh-map}

Six variable karnaugh map, black and white, with X label \emph{ba}, Y label \emph{dc}, and Z label \emph{fe}.

\begin{karnaugh-map}[4][4][4][ba][dc][fe]
\end{karnaugh-map}
1.1 Terms

\autoterms The \autoterms command fills the remaining unfilled cells of the karnaugh map with the contents of the optional argument.

Usage:
\autoterms \[ ⟨\text{content}⟩ \] Content for the remaining unfilled cells. Default: "-"

Example:
Fill all remaining unfilled cells with ".-".

\begin{karnaugh-map}
\autoterms[-]
\end{karnaugh-map}

\indeterminants The \indeterminants command fills the specified cells with ".-" if they aren’t already filled. Order of the cell numbers does not matter.

Usage:
\indeterminants \{ ⟨\text{cells}⟩ \} Comma separated list of cells to fill with ".-"

Example:
Fill the top left and right cell with ".-".

\begin{karnaugh-map}
\indeterminants{0,2}
\end{karnaugh-map}

\manualterms The \manualterms command fills the 0th cell with the first element in the argument, the 1st cell with the second element in the argument, and so on. If any of the cells already is filled, it is left as it was.

Usage:
\manualterms \{ ⟨\text{content}⟩ \} Comma separated list of cell contents

Example:
Fill the first four cells with 0, 1, 0, and 1 respectively.

\begin{karnaugh-map}
\manualterms{0,1,0,1}
\end{karnaugh-map}
\maxterms The \maxterms command fills the specified cells with "0" if they aren't already filled. Order of the cell numbers does not matter.

Usage:
\maxterms \{ ⟨cells⟩ \} \hspace{1em} \text{Comma separated list of cells to fill with "0"}

Example:
Fill the top left and right cell with "0".

\begin{karnaugh-map}
\maxterms{0,2}
\end{karnaugh-map}

\minterms The \minterms command fills the specified cells with "1" if they aren't already filled. Order of the cell numbers does not matter.

Usage:
\minterms \{ ⟨cells⟩ \} \hspace{1em} \text{Comma separated list of cells to fill with "1"}

Example:
Fill the top left and right cell with "1".

\begin{karnaugh-map}
\minterms{0,2}
\end{karnaugh-map}

\terms The \terms command fills the specified cells with the specified content if they aren't already filled. Order of the cell numbers does not matter.

Usage:
\terms \{ ⟨cells⟩ \} \hspace{1em} \text{Comma separated list of cells to fill with content}
\{ ⟨content⟩ \} \hspace{1em} \text{Content to fill the cells with}

Example:
Fill the top left and right cell with "X".

\begin{karnaugh-map}
\terms{0,2}{X}
\end{karnaugh-map}
1.2 Implicants

The \implicant command draws quadratic implicants on one or multiple submaps. If the implicant shall be drawn on multiple submaps, \{\langle northwest cell\rangle\} and \{\langle southeast cell\rangle\} must be specified as if the implicant was to be drawn on the 0:th submap. When turned on, colorization is done automatically, following a global sequence of available colors.

Usage:

\implicant
\{\langle northwest cell\rangle\} The most northwest cell in the implicant
\{\langle southeast cell\rangle\} The most southeast cell in the implicant
\{\langle submaps\rangle\} Comma separated list of submaps the implicant should be drawn on. Default: "0"

Example:

Implicant around the four most inner cells.

\begin{karnaugh-map}
\implicant{5}{15}
\end{karnaugh-map}

Single cell implicant, 0:th cell, on all four submaps.

\begin{karnaugh-map}[4][4][4]
\implicant{0}{0}{0,1,2,3}
\end{karnaugh-map}
The `\implicantedge` command draws quadratic implicants with the middle of the implicant facing the edge of a submap either horizontally or vertically. The function is able to draw the same implicant on one or multiple submaps. However if the implicant shall be drawn on multiple submaps, \{(northwest part - northwest cell)\}, \{(northwest part - southeast cell)\}, \{(southeast part - northwest cell)\}, \{(southeast part - southeast cell)\} must be specified as if the implicant was to be drawn on the 0:th submap. When turned on, colorization is done automatically, following a global sequence of available colors.

Usage:

\begin{verbatim}
\implicantedge
\{(northwest part - northwest cell)\} \quad \text{The most northwest cell in the northwest part of the implicant}
\{(northwest part - southeast cell)\} \quad \text{The most southeast cell in the northwest part of the implicant}
\{(southeast part - northwest cell)\} \quad \text{The most northwest cell in the southeast part of the implicant}
\{(southeast part - southeast cell)\} \quad \text{The most southeast cell in the southeast part of the implicant}
\{\langle submaps \rangle\} \quad \text{Comma separated list of submaps the implicant should be drawn on. Default: "0"}
\end{verbatim}

Example:

Horizontal implicant over the submap edge containing the cells 4, 6, 12, and 14.

```
\begin{karnaugh-map}
\implicantedge{4}{12}{6}{14}
\end{karnaugh-map}
```
The \texttt{\textbackslash implicantcorner} command draws an implicant around only the four corner pieces on one or multiple four variable karnaugh submaps. When turned on, colorization is done automatically, following a global sequence of available colors.

\textbf{Usage:}

\begin{verbatim}
\texttt{\textbackslash implicantcorner} [\langle submaps \rangle]
\end{verbatim}

Comma separated list of submaps the implicant should be drawn on. Default: "0"

\textbf{Example:}

Draw an implicant around all corners on 0th and 2nd submap of a six variable karnaugh map.

\begin{verbatim}
\texttt{\textbackslash begin\{karnaugh-map\}[4][4][4]}
\texttt{\textbackslash implicantcorner[0,2]}
\texttt{\textbackslash end\{karnaugh-map\}}
\end{verbatim}
2 Examples

Draw a karnaugh map for $f(a, b, c, d, e, f) =$
$\Sigma(0, 1, 2, 3, 8, 13, 17, 20, 22, 28, 33, 32, 30, 19, 40, 35, 49, 42, 34, 10, 60, 54, 62, 51, 52)$
$+ d(15, 45, 47)$.

\begin{karnaugh-map}[4][4][4][ba][dc][fe]
\minterms{0,1,2,3,8,13,17,20,22,28, 33,32,30,19,40,35,49,42,34,10,60, 54,62,51,52}
\indeterminants{15,45,47}
\autoterms
\implicantcorner{0,2}
\implicant{1}{3}{0,2}
\implicantedge{4}{12}{6}{14}{1,3}
\implicant{13}{15}{0,2}
\end{karnaugh-map}

\begin{karnaugh-map}[2][2][1][X_0][X_1]
\maxterms{0,2,3}
\autoterms
\implicant{1}{1}
\end{karnaugh-map}

Draw a karnaugh map for $f(X_0, X_1) = \Pi(0, 2, 3)$ in black and white.

\begin{karnaugh-map}*[2][2][1][X_0][X_1]
\maxterms{0,2,3}
\autoterms
\implicant{1}{1}
\end{karnaugh-map}
Draw a variable entered map.

\begin{verbatim}
\begin{karnaugh-map}{4}{2}{1}{\$ab\$}{\$c\$}
\maxterms{0,2,4,5,6}
\minterms{3}
\terms{1}{$d$}
\terms{7}{$d'$}
\implicant{1}{3}
\implicant{3}{7}
\end{karnaugh-map}
\end{verbatim}

3 Dependencies

- tikz
- xparse
- xstring
4 Miscellaneous

Resizing

The karnaugh maps produced with this package have a prespecified size which can not be changed. However you can resize the karnaugh map to your desired size. Resizing can be done using the \resizebox command from the graphicx package. Scaling the karnaugh map to fill the column width while preserving the aspect ratio can be done as follows.

\resizebox{\columnwidth}{!}{
\begin{karnaugh-map}
\end{karnaugh-map}
}

Comma separated lists

Anywhere in this package where a comma separated list is used data should only be comma separated. Therefore a comma and space separated list will for example not work properly.

An example of erroneous usage related to the \(\langle cells\rangle\) parameter in the terms related commands can result in multiple zeros, ones and other terms overlapping in the same cell in the outputted karnaugh map.

Change History

<table>
<thead>
<tr>
<th>Version</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>v1.0</td>
<td>General: Initial version</td>
</tr>
<tr>
<td></td>
<td>content and variable entered maps</td>
</tr>
<tr>
<td>v1.1</td>
<td>\texttt{\textbackslash terms}: Support user specified term</td>
</tr>
</tbody>
</table>