The cartonaugh package

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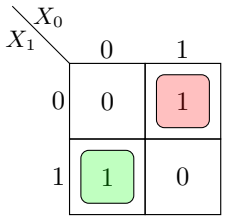
Abstract

This package, a fork of Mattias Jacobsson/2pi's karnaugh-map 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. Cartonaugh is a portmanteau of "cartographer" and "karnaugh". Below is an example of a two variable karnaugh map of $X_0 \oplus X_1$.



Contents

1 Usage

`cartonaugh` The |cartonaugh| environment is the base for this package, and everything related to this package happens inside an instances of this environment.

Usage:

`\begin {cartonaugh}`	
⟨*⟩	One asterisk for black and white implicants, non for colorized implicants
[⟨*X size*⟩]	Number of X-axis cells. Default: "4"
[⟨*Y size*⟩]	Number of Y-axis cells. Default: "4"
[⟨*Z size*⟩]	Number of X×Y submaps. Default: "1"
[⟨*X label*⟩]	Label for the X-axis. Default: "X_1X_0"
[⟨*Y label*⟩]	Label for the Y-axis. Default: "X_3X_2"
[⟨*Submap Seperation Type*⟩]	Whether to seperate the submap by space or by a thick line. Default: 0 (so seperation by space)

Example:

Four variable karnaugh map, colorized, with X label X_1X_0, and Y label X_3X_2.

```
\begin{cartonaugh}
\end{cartonaugh}
```

or

```
\begin{cartonaugh}[4][4][1][$X_1X_0$][$X_3X_2$]
\end{cartonaugh}
```

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

```
\begin{cartonaugh}*[4][4][4][$ba$][$dc$][$fe$]
\end{cartonaugh}
```

Six variable karnaugh map, black and white, with X label ba, Y label dc, and Z label fe, and the submaps are seperated by a thick line in between.

```
\begin{cartonaugh}*[4][4][4][$ba$][$dc$][$fe$][1]
\end{cartonaugh}
```

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`
`[`⟨*content*⟩`]` Content for the remaining unfilled cells. Default: "-"

Example:

Fill all remaining unfilled cells with "-".

```
\DeleteShortVerb{\|}
\begin{cartonaugh}
  \autoterms[-]
\end{cartonaugh}
```

`\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`
`{`⟨*cells*⟩`}` Comma separated list of cells to fill with "-"

Example:

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

```
\begin{cartonaugh}
  \indeterminants{0,2}
\end{cartonaugh}
```

`\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`
`{`⟨*content*⟩`}` Comma separated list of cell contents

Example:

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

```
\begin{cartonaugh}
  \manualterms{0,1,0,1}
```

```
\end{cartonaugh}
```

`\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*⟩`}`	Comma separated list of cells to fill with ”0”

Example:

Fill the top left and right cell with ”0”.

```
\begin{cartonaugh}
  \maxterms{0,2}
\end{cartonaugh}
```

`\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*⟩`}`	Comma separated list of cells to fill with ”1”

Example:

Fill the top left and right cell with ”1”.

```
\begin{cartonaugh}
  \minterms{0,2}
\end{cartonaugh}
```

`\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*⟩`}`	Comma separated list of cells to fill with content
`{`⟨*content*⟩`}`	Content to fill the cells with

Example:

Fill the top left and right cell with ”X”.

```
\begin{cartonaugh}
  \terms{0,2}{X}
```

```
\end{cartonaugh}
```

1.2 Implicants

`\implicant` The `\implicant` command draws quadratic implicants on one or multiple submaps. If the implicant shall be drawn on multiple submaps, `{`⟨*northwest cell*⟩`}` and `{`⟨*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.

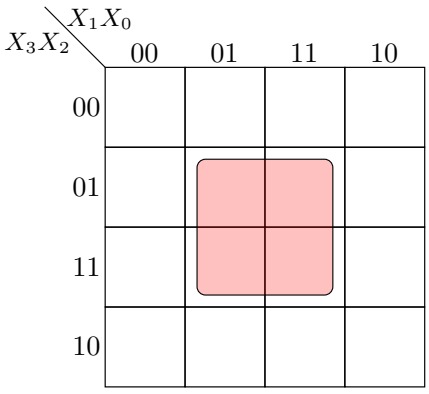
Usage:

`\implicant`	
`{`⟨*northwest cell*⟩`}`	The most northwest cell in the implicant
`{`⟨*southeast cell*⟩`}`	The most southeast cell in the implicant
`[`⟨*submaps*⟩`]`	Comma separated list of submaps the implicant should be drawn on. Default: ”0”

Example:

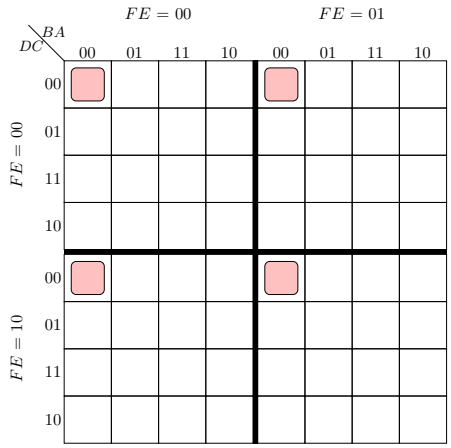
Implicant around the four most inner cells.

```
\begin{cartonaugh}
  \implicant{5}{15}
\end{cartonaugh}
```



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

```
\begin{cartonaugh}[4][4][4]
     [$BA$][$DC$][$FE$][1]
  \implicant{0}{0}[0,1,2,3]
\end{cartonaugh}
```



`\implicantedge` 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:

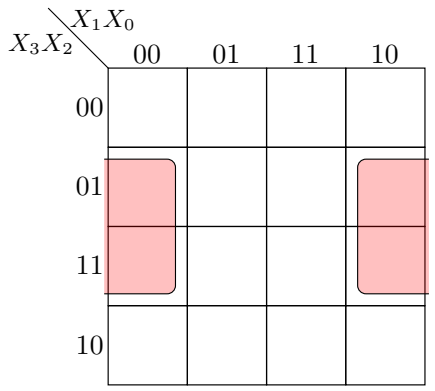
`\implicantedge`

`{`⟨*northwest part - northwest cell*⟩`}`	The most northwest cell in the northwest part of the implicant
`{`⟨*northwest part - southeast cell*⟩`}`	The most southeast cell in the northwest part of the implicant
`{`⟨*southeast part - northwest cell*⟩`}`	The most northwest cell in the southeast part of the implicant
`{`⟨*southeast part - southeast cell*⟩`}`	The most southeast cell in the southeast part of the implicant
`[`⟨*submaps*⟩`]`	Comma separated list of submaps the implicant should be drawn on. Default: ”0”

Example:

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

```
\begin{cartonaugh}
  \implicantedge{4}{12}{6}{14}
\end{cartonaugh}
```



`\implicantcorner` The `\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.

Usage:

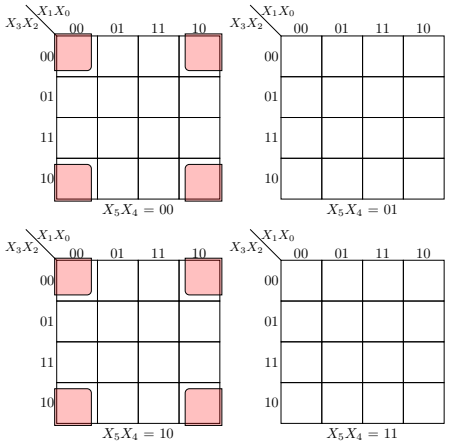
`\implicantcorner`

`[`⟨*submaps*⟩`]`	Comma separated list of submaps the implicant should be drawn on. Default: ”0”

Example:

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

```
\begin{cartonaugh}[4][4][4]
  \implicantcorner[0,2]
\end{cartonaugh}
```



1.3 Options

`\implicantspread` The `\implicantspread` changed the implicant spread

Usage:

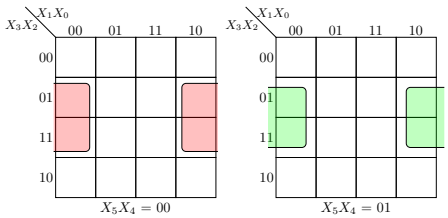
`\implicantspread`

`{`⟨*innerspread*⟩`}` The inner spread's spread, from 0 to 0.5 (as >0.5 will go out of the implicant square)

`{`⟨*outerspread*⟩`}` The outer spread's spread, from 0.5 and up

Example:

```
\begin{cartonaugh}[4][4][2]
  \implicantedge{4}{12}{6}{14}[0]
  \implicantspread{0.25}{0.7}
  \implicantedge{4}{12}{6}{14}[1]
\end{cartonaugh}
```



`\resetimplicantspread` The `\resetimplicantspread` resets the implicant spread if set by `\implicantspread` to default values

`\changecolor` The `\changecolor` changes the color for implicants

Usage:

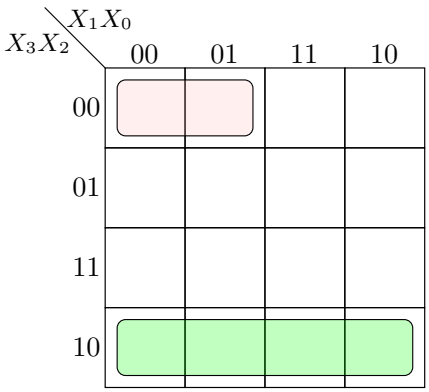
`\changecolor`

`{`⟨*color*⟩`}` The new color for implicants, in Tikz format

Example:

Change the implicant color to pink, then green

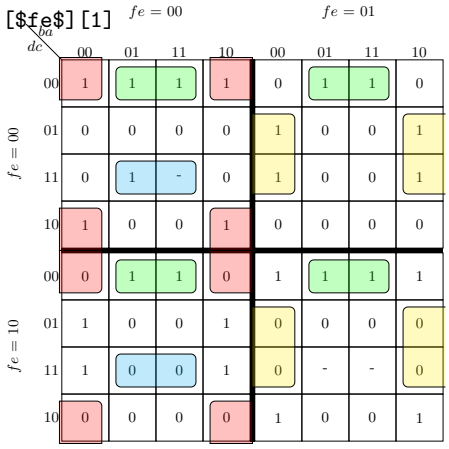
```
\begin{cartonaugh}
  \changecolor{pink}
  \implicant{0}{1}
  \changecolor{green}
  \implicant{8}{10}
\end{cartonaugh}
```



2 Examples

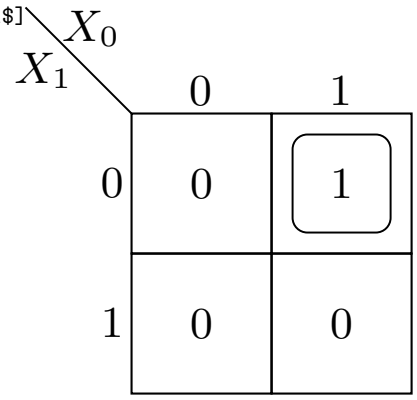
Draw a karnaugh map for $f(a,b,c,d,e,f) =$
$\Sigma(0,1,2,3,8,13,17,20,22,28,33,32,30,19,40,35,49,42,34,10,60,54,62,51,52)$
$+d(15,45,47)$.

```
\begin{cartonaugh}[4][4][4][$ba$][$dc$][$fe$][1]
  \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[0]
  \implicantcorner[0,2]
  \implicant{1}{3}[0,1,2,3]
  \implicantedge{4}{12}{6}{14}[1,3]
  \implicant{13}{15}[0,2]
\end{cartonaugh}
```



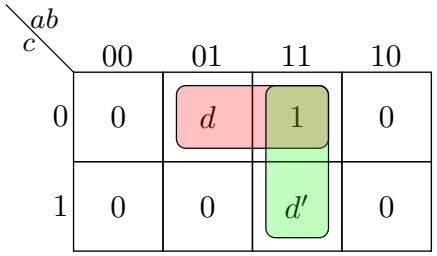
Draw a karnaugh map for $f(X_0, X_1) = \Pi(0,2,3)$ in black and white.

```
\begin{cartonaugh}*[2][2][1][$X_0$][$X_1$]
  \maxterms{0,2,3}
  \autoterms[1]
  \implicant{1}{1}
\end{cartonaugh}
```



Draw a variable entered map.

```
\begin{cartonaugh}[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{cartonaugh}
```



3 Dependencies

- tikz
- xparse
- xstring
- lualatex

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}{!}{
 \DeleteShortVerb{\|}
  \begin{cartonaugh}
  \end{cartonaugh}
}
```

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 separeated list will for example *not* work properly.

An example of errorious usage related to the `{`⟨*cells*⟩`}` 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.