Abstract

With \texttt{pxpic} you draw pictures pixel by pixel. It was inspired by a lovely post by Paulo Cereda, among other things (most notably a beautiful duck) showcasing the use of characters from the Mario video games by Nintendo in \LaTeX.

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1 Documentation

1.1 Drawing pictures

\texttt{\textbackslash pxpic} supports different input modes, all of them have the same basic parsing behaviour. A \texttt{\langle pixel list \rangle} contains the pixel colours. The image is built line wise from top left to bottom right. There are two different syntaxes how a single row is given (dependent on the setting of the \texttt{lines}-key, see subsection 1.2):

- By default each row of pixels should be a single \TeX argument (so either just one token, or a group delimited by \{\}). (This is the behaviour for \texttt{lines=group})
- Alternatively each row of pixels should be right delimited by a space (and since a newline is turned into a space in \TeX with default settings, a newline is also possible). (This is the behaviour for \texttt{lines=space} and \texttt{lines=csv})

Inside each line there are also two different parsing modes:

- By default within each line each pixel in turn should be a single \TeX argument (so either just one token, or a group delimited by \{\}). (This is the behaviour for \texttt{lines=group} and \texttt{lines=space})
- Each pixel except the last one is separated from the next pixel by a comma, no space trimming is applied. (This is the behaviour of \texttt{lines=csv})

The different modes that interpret a single pixel’s input are explained in subsection 1.2.2. The only disallowed token in the \texttt{\langle pixel list \rangle} is the control sequence \texttt{\textbackslash pxpic\textbackslash end} (plus the usual restrictions of \TeX so no unbalanced braces, no macros defined as \texttt{\textbackslash outer}).

There is a small caveat however: \texttt{\textbackslash pxpic} draws each pixel individually, and there is really no space between them, however some \texttt{pdf} viewers fail to display such adjacent lines correctly and leave small gaps (basically the same issue which packages like \texttt{colortbl} suffer from as well). In print this shouldn’t be an issue, but some rasterisation algorithms employed by viewers and conversion tools have this deficit.

Another thing I should mention: The pictures you can draw with \texttt{\textbackslash pxpic} can’t be arbitrary large. Due to the design decision of the output as a single \texttt{\hbox} and the way the output routine works, pictures are limited by \TeX’s memory size to roughly 440 \times 440 pixels in \TeX with the default settings in \TeX Live. The size is unlimited in \LaTeX, due to dynamic memory allocation. In \XeTeX the size should be even smaller than in \pdf\LaTeX.

\texttt{\textbackslash pxpic} \texttt{\langle options \rangle}\{\langle pixel list \rangle\}

\langle options \rangle might be any options as listed in subsection 1.2, and \texttt{\langle pixel list \rangle} is a list of pixels as described above. \texttt{\textbackslash pxpic} parses the \texttt{\langle pixel list \rangle} and draws the corresponding picture. The result is contained in an \texttt{\hbox} and can be used wherever \TeX expects an \texttt{\hbox}. As a result, when you’re in vertical mode a \texttt{\textbackslash pxpic} will form a text line, to prevent this you can use \texttt{\leavevmode} before it. The \texttt{\textbackslash pxpic} will be bottom aligned by default (see the options \texttt{b}, \texttt{c}, and \texttt{t}), you can further tweak this using \texttt{\raisebox} (or, if you want, \TeX’s \texttt{\raise} and \texttt{\lower} primitives).

If you used the \texttt{file} option the mandatory argument should be a file name containing a \texttt{\langle pixel list \rangle} instead of the \texttt{\langle pixel list \rangle} itself.
1.1.1 Examples

Since the above explanation of the \texttt{pixel \_list} syntax might’ve been a bit cryptic, and a good documentation should contain examples (this doesn’t claim this documentation is good), well, here are some examples (you might need to take a look at subsection 1.2 and subsubsection 1.2.2 to fully understand the examples). Examples in this section will use the following \texttt{\pxpicsetup}:

\begin{verbatim}
\pxpicsetup
{ mode = px,
  colours = {k=black, r=[HTML]{9F393D}, g=green!75!black, b=[rgb]{0,0,1}},
  ,skip = ,
  ,size = 10pt
}
\end{verbatim}

We can draw a small cross rather easily:

\begin{verbatim}
\pxpic
{ (.k)
  {kkk}
  (.k)
}
\end{verbatim}

A small multicoloured grid:

\begin{verbatim}
\pxpic
{ {brgk}
  {kbrg}
  {gkbr}
  {rkgb}
}
\end{verbatim}

A heart (shamelessly copied example from \texttt{PixelArt}):

\begin{verbatim}
\pxpic[\texttt{\lines=space}]
{ .rr .rr
  .rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr
A biggish example: Tux.¹ I put two rows of pixels per code line to reduce the size a bit and the code is displayed tinily.

¹Source: https://www.reddit.com/r/linux/comments/hwpm9j/tux_pixel_art_v10/
Just for Paulo, a duck. Also, showing that the colour definitions in `mode=px` can be arbitrary tokens or multiple letters:

```
\pxpic[colours = {orange, yellow, black},
    skip = \skp]{
    \skp\skp\skp\ylw\ylw\ylw\ylw
    \skp\skp\ylw\ylw\ylw\ylw\ylw\ylw
    \skp\ylw\ylw\ylw\ylw\ylw\ylw\ylw
    \skp\ylw\ylw\ylw\ylw\ylw\ylw\ylw
    \skp\ylw\ylw\ylw\ylw\ylw\ylw\ylw
    \skp\skp\ylw\ylw\ylw\ylw\ylw\ylw
}
```

Another example might be the definition of \pxpiclogo in subsection 2.2. Who still needs picture-mode or complicated packages like pstricks or TikZ with such pretty pictures?

### 1.2 Setting options

To control its behaviour \pxpic uses a key=value interface powered by `exp`. Options can be set either in the optional argument of `\pxpic` or with

```latex
\pxpicsetup{⟨options⟩}
```

Sets the ⟨options⟩ locally to the current \TeX group.

Package options are not supported.

The available options are

- `colors={⟨colour list⟩}`
  Define pixel colours for `mode=px`, see subsection 1.2.1 for a description of the value’s syntax. No pixel definitions are made by the package.

- `colours` see `colors`.

- `color-list={⟨choice⟩}`
  loads a previously through `\pxpicnewcolorlist` defined colour list. No colour lists are defined by the package.

- `colour-list` see `color-list`.

- `exp` see `expansion`

- `expansion={⟨choice⟩}`
  This is a choice to control the expansion of the ⟨pixel list⟩. The choices are:
  - `full` the ⟨pixel list⟩ is subject to one full expansion via \expanded.
  - `none` no expansion takes place, the ⟨pixel list⟩ is used as it is.
  The initial value is `none`, the default used if you don’t provide a value is `full`.

- `file={⟨bool⟩}`
  If you pass in `true` the mandatory argument of `\pxpic` becomes a file name which's contents are used as a ⟨pixel list⟩. Using `false` results in the default behaviour of a ⟨pixel list⟩. If you omit the value the same as `true` is used.
To fix the issues with visible gaps in PDF viewers you can introduce some negative kerns to make the pixels overlap (lines overlap to the top, pixels to the left). This option expects a dimension as its value. A positive value will (maybe) close the gaps, a negative value will introduce real gaps. In any case the outermost pixels’ borders still coincide with the borders of the surrounding \hbox. Take a look at my babbling about this issue in subsection 1.5.

\[ \text{ht}=(\text{dimen}) \] Set the height of the pixels.

\[ \text{lines}=\langle \text{choice} \rangle \]

How the individual lines of a \langle\text{pixel list}\rangle are given. The choices are:

- group The default syntax in which each line is a single \TeX argument (group delimited by \{}\).
- space A different input syntax in which each line should be right-delimited by a space (or newline as, by default, a newline is the same as a space in \TeX).
- csv The same line-wise input as \text{space}, but in each line each pixel should be separated from the next with a comma.

\[ \text{mode}=\langle \text{choice} \rangle \] Set the used mode, see subsection 1.2.2 for available modes. Initial value is \text{px}.

\[ \text{size}=\langle \text{dimen} \rangle \] Set both ht and wd. Initial value is 1.0opt.

\[ \text{skip}=\langle \text{tokens} \rangle \]

Define \langle\text{tokens}\rangle to be a skip (an empty space of width wd) in \text{mode=}px. No skip definitions are made by the package.

\[ \text{wd}=\langle \text{dimen} \rangle \] Set the width of the pixels.

b Set the bottom of the \text{\pxpic} on the surrounding baseline (vertical bottom alignment; this is the default).

c Set the centre of the \text{\pxpic} on the surrounding baseline (vertical centre alignment).

t Set the top of the \text{\pxpic} on the surrounding baseline (vertical top alignment).

1.2.1 Colour syntax

In the value of the \text{colours} option you’ll have to use the following syntax. Use a comma separated key=value list in which each key corresponds to a new pixel name for \text{mode=}px, and each value to the used colour. If the colour starts with an opening bracket use the complete value as is behind \text\{color}, else use the whole value as the first mandatory argument to \text\{color\} with a set of braces added. For example to define \text{r} as the named colour \text{red}, and \text{x} as the colour \text{#abab0f} (in the \text{html} colour model) use:

\[ \text{colours} = \{\text{r}=}\text{red}, \text{x=}[\text{HTML}]\{\text{abab0f}\}\} \]
1.2.2 Available modes

**px**  
As already mentioned, \texttt{px} supports different modes of input. The easiest to use mode is \texttt{px}, in which each element of the \texttt{(pixel list)} has been previously defined as either a coloured pixel (using the \texttt{colour} option) or as a skipped pixel (using the \texttt{skip} option, resulting in a fully transparent pixel). Each element will be \texttt{detokenized}, so (within \TeX{}'s limitations) the name of a pixel can be arbitrary. This is the initial mode \texttt{px} uses. But other options are available as well.

**named**  
Another mode is \texttt{named}, in which each element of the \texttt{(pixel list)} should be a named colour (or colour expression) known to \texttt{xcolor}. Each element will be used like so: {	exttt{\color\{⟨element⟩\}px}}. An exception is an element which is empty ({}), which will be a skipped pixel.

**rgb, cmy, cmyk, hsb, Hsb, tHsb, gray, RGB, HTML, HSB, Gray, wave**  
The modes \texttt{rgb}, \texttt{cmy}, \texttt{cmyk}, \texttt{hsb}, \texttt{Hsb}, \texttt{tHsb}, \texttt{gray}, \texttt{RGB}, \texttt{HTML}, \texttt{HSB}, \texttt{Gray}, and \texttt{wave} correspond to the different colour models supported by \texttt{xcolor}. With these modes each element of the \texttt{(pixel list)} will be the values in these colour models, so they’ll be used like so: {	exttt{\color\{⟨mode⟩\}⟨element⟩\px}}. An exception is an element which is empty ({}), which will be a skipped pixel.

You can define additional modes selectable with the \texttt{mode} option using the macros \texttt{\pxnewmode} or \texttt{\pxsetmode}.

1.3 Other customisation macros

\begin{verbatim}
\pxnewmode\pxsetmode
\end{verbatim}  
You can define your own modes with \texttt{\pxnewmode}. Inside \texttt{(definition)} #1 is the currently parsed item in the \texttt{\px} \texttt{(pixel list)}. You can output a pixel using \texttt{\px}, and skip a pixel using \texttt{\pxskip}. The pixel will use the currently active colour (so if you want to draw a red pixel you could use \texttt{\color\{red\}\px}). \texttt{\pxnewmode} will throw an error if you try to define a mode which already exists, \texttt{\pxsetmode} has no checks on the name.

\begin{verbatim}
\pxnewcolorlist\pxsetcolorlist\pxaddcolorlist
\end{verbatim}  
This defines a colour list (to be used with the \texttt{colour-list} option). The syntax of \texttt{(colour list)} is the same as for the \texttt{colours} option. The pixels aren’t directly defined, but only by the use of \texttt{colour-list=⟨name⟩}. So

\begin{verbatim}
\pxnewcolorlist\{example\}\{r=red,b=blue,g=green,k=black,w=white\}
\pxsetcolorlist\{colour-list=example\}
\end{verbatim}  
would have the same effect as

\begin{verbatim}
\pxsetcolorlist\{colours=\{r=red,b=blue,g=green,k=black,w=white\}\}
\end{verbatim}  
but a colour-list is more efficient if used multiple times. The \texttt{new} variant will only throw an error if the colour list \texttt{(name)} is already defined. The \texttt{set} variant has no such tests, and the \texttt{add} variant will add additional colours to an existing list.
Undefines the \langle px \rangle definition for use in mode=px (or skip symbol) added with the colours (or skip) option.

1.4 Other macros

Inside of a \pxpic the macro \px draws a pixel (of the currently active colour), and \pxskip leaves out a pixel (so this one pixel is fully transparent). Use this in the \langle definition \rangle of a mode in \pxpicnewmode.

These two are dimen registers storing the height and width of the pixels.

This draws the logo of \pxpic. The \langle size \rangle controls the pixel size.

1.5 Miscellaneous

If you find bugs or have suggestions I’ll be glad to hear about it, you can either open a ticket on Github (https://github.com/Skillmon/ltx_pxpic) or email me (see the first page).

A similar package is \pixelart, which, at the time \pxpic was created, was described as a “working draft” by its author. \pxpic wasn’t intended as a direct competitor (I already started coding \pxpic when I learned about \pixelart’s existence), but I took inspiration from the “Bugs, Ideas, Undefined behaviours” section of \pixelart’s documentation for the syntax of mode=px. Also the lines=space option is a copy of the syntax the new stable version of \pixelart is using (so images created with it could be processed with \pxpic and vice versa). A third package that allows drawing pixel art is \pixelarttikz, that uses a csv-syntax for its pixel definition lists (you may have luck and the mode lines=csv works for lists defined for \pixelarttikz).

Regarding the gap issue: The pixels are output touching each other with no real gap, however some pdf viewers and tools will display such a gap. To make things even worse, the effect depends on the viewers current magnification. \pxpic has the gap–hack option to provide some crude hack that might fix the issue, at the cost that the pixels on the far right and bottom are bigger than they were specified to be. Also pixels next to skipped pixels have a different size (skipped pixels don’t cover pixels to their left or top as they are transparent). You’ll want to find a good trade-off value if you want to use gap–hack, that mitigates the effect but isn’t too big (to make the errors less obvious). You can play with the value and decide for yourself what’s the lesser evil. Or you do like me, don’t use gap–hack and blame the viewers. Here are examples in which you can compare (the
gap-hack is chosen way too big in the first example and skips are used close to white pixels on purpose, but it illustrates the effects):

\pxpicsetup
{   
  colours={k=black, g=green, w=white}
  ,skip=.
  ,size=10pt
  ,t
  }
\pxpic
{   
  {kkkkk}
  {kggk}
  {kwg.k}
  {kg.gk}
  {kgwk}
  {kkkw}
  }

Exploiting the gap-hack to draw a grid: It is possible to exploit the gap-hack option to draw a grid around your pixels (at least for a rectangular picture). For this we simply set a coloured background and use a negative gap-hack value:

\newcommand{\gridpxpic}[3]{   
  \setlength{\fboxsep}{#2}\colorbox{black}{\pxpic[#1, gap-hack=-\fboxsep][#3]}}
\gridpxpic
{[colours={g=green, w=white}, size=8pt]
  {1pt}  
  {{gwg}{wgwg}}}
2 Implementation

Report who we are

\ProvidesPackage{pxpic}[2023-02-11 v1.4 draw pixel pictures]

and load dependencies

\RequirePackage{xcolor}
\RequirePackage{expkv}

These two variables store the height and width of a pixel.

\@ifdefinable\pxpicHT{\newdimen\pxpicHT}
\@ifdefinable\pxpicWD{\newdimen\pxpicWD}
\pxpicHT=p0
\pxpicWD=\pxpicHT

(End definition for \pxpicHT and \pxpicWD. These variables are documented on page 8.)

\pxpic@kern To fix the visible gaps in some \pdf viewers if the user chooses so with the gap-hack option we introduce some \kerns of the length stored in this register.
\@ifdefinable\pxpic@kern{\newdimen\pxpic@kern}
\pxpic@kern=z0

(End definition for \pxpic@kern.)

\pxpic@kern For some simplification of the output box (removing unnecessary kerns) we don’t directly use \kern but one step of indirection. This macro is locally turned into \@gobble if \pxpic@kern is equal to \z0.
\def\pxpic@kern#1{\kern#1\pxpic@kern}

(End definition for \pxpic@kern.)

\pxpic@inner@box \pxpic@after@inner@box To get different vertical alignments we nest one of \vbox, \vtop, and a lowered \vbox inside the outer \box. The macro \pxpic@inner@box will store this information, and since lowering can only be done after the box was set (the alternative would be \vcenter, which ends up on a different height), we need to be able to put the box output with \lower after the box was collected, which is why we need \pxpic@after@inner@box. We default to bottom alignment.
\@ifdefinable\pxpic@inner@box{\let\pxpic@inner@box\vbox}
\@ifdefinable\pxpic@after@inner@box{\let\pxpic@after@inner@box\@empty}

(End definition for \pxpic@inner@box and \pxpic@after@inner@box.)

2.1 Options

We define the options using expkv directly (no fancy options are involved and these are just a few anyway).

The first few options are straightforward. We use expkv’s name space to actually store the skip and px definitions, hence we use \ekvdefNoVal in the code of skip.
\protected\ekvdef{pxpic}{size}
\protected\ekvdef{pxpic}{ht}{\pxpicHT=\dimexpr#1\relax}
\protected\ekvdef{pxpic}{wd}{\pxpicWD=\dimexpr#1\relax}
\protected\ekvdef{pxpic}{gap-hack}{\pxpic@kern=\dimexpr#1\relax}
\protected\ekvdef{pxpic}{skip}{\ekvdefNoVal{pxpic@px}{#1}{\pxskip}}
The colours option is parsed using \ekvparse and \pxpic@setcolor.

\protected\ekvdef{pxpic}{colors}{\ekvparse\pxpic@err@noval\pxpic@setcolor[#1]}\ekvletkv{pxpic}{colours}{pxpic}{colors}

And the mode just checks whether the mode macro is defined and lets the auxiliary macro \pxpic@parse@px to the defined mode.

\protected\ekvdef{pxpic}{mode}{% \ifundefined{pxpic@parse@px@#1}% \pxpic@err@unknown@mode[#1]% \% \expandafter\let\expandafter\pxpic@parse@px \csname pxpic@parse@px@#1\endcsname \% \}%}

A similar check is done for the colour-list option.

\protected\ekvdef{pxpic}{color-list}{% \ifundefined{pxpic@colorlist@#1}% \pxpic@err@unknown@colorlist[#1]% \{\csname pxpic@colorlist@#1\endcsname\}% \}%}

\ekvletkv{pxpic}{colour-list}{pxpic}{color-list}

The alignment options set the internals \pxpic@inner@box and \pxpic@after@inner@box.

\protected\ekvdefNoVal{pxpic}{b}{% \let\pxpic@inner@box\vbox \let\pxpic@after@inner@box\@empty \}%}
\protected\ekvdefNoVal{pxpic}{c}{% \def\pxpic@inner@box{\setbox0=\vbox}% \def\pxpic@after@inner@box{\lower.5\ht0\box0}% \}%}
\protected\ekvdefNoVal{pxpic}{t}{% \let\pxpic@inner@box\vtop \let\pxpic@after@inner@box\@empty \}%}

The expansion related option will set an internal. It’s yet another option which will need to check for a defined internal, as it’s a choice of none or full. This is deliberately not defined \protected to allow expansion as far as possible.

\ekvdef{pxpic}{expansion}{% \ifundefined{pxpic@expansion@#1}% \pxpic@err@unknown@expansion[#1]% \{\csname pxpic@expansion@#1\endcsname\}% \}%}
\ekvdefNoVal{pxpic}{expansion}{\pxpic@expansion@full}
\ekvletkv{pxpic}{exp}{pxpic}{expansion}
\ekvletkvNoVal{pxpic}{exp}{pxpic}{expansion}
And we define the choices and the initial behaviour:

```latex
\protected\def\pxpic@expansion@none{\let\pxpic@expansion@none\@firstofone}
\protected\def\pxpic@expansion@full{\let\pxpic@expansion\expanded}
\pxpic@expansion@none
```

Another key is the choice how lines are delimited, either as a single group/argument or by spaces (or newlines). The code defining the choices' behaviour is a bit down the road, here we only initialise the keys.

```latex
\ekvdef{pxpic}{lines}{%\ifundefined{pxpic@@parse@#1}{\pxpic@err@unknown@lines{#1}}{%\csname pxpic@@parse@#1\endcsname}}
```

We also want to be able to grab the $\langle$pixel list$\rangle$ from a file, and we need a key to define this behaviour.

```latex
\ekvdef{pxpic}{file}{%\ifundefined{pxpic@file@#1}{\pxpic@err@unknown@file{#1}}{%\csname pxpic@file@#1\endcsname}}
\ekvdefNoVal{pxpic}{file}{\pxpic@file@true}
```

The macro $\pxpic@@file@or@list$ will get the argument in two sets of braces. In the false case things are easy, we just directly go over to the expansion step. In the true case we input the file.

```latex
\ExplSyntaxOn
\protected\def\pxpic@file@true{\def\pxpic@@file@or@list ##1}{\file_get:nnNTF ##1 {} \l_tmpa_tl}{\ekv@exparg { \expandafter\pxpic@parse\pxpic@expansion } { \expandafter { \l_tmpa_tl } }}{\pxpic@err@file@not@found ##1}}
\ExplSyntaxOff
\protected\def\pxpic@file@false{\def\pxpic@@file@or@list{\expandafter\pxpic@parse\pxpic@expansion}}
\pxpic@file@false
```

### 2.2 User macros

$\pxpic$ expands directly to an opened $\hbox$, the auxiliary $\pxpic@$ checks for the optional argument and inserts the rest of the code. We need to set $\baselineskip$ to $\pxpicHT$ so that the pixels are stacked vertically without gaps. $\pxpic@parse$ will parse the $\langle$pixel list$\rangle$ until $\pxpic@end$ is hit. The final $\egroup$ closes the $\hbox$. The row-wise output is done via a $\vbox$ in which each pixel row will be wrapped inside an $\hbox$. The $\kern$ negates a negative $\kern$ in $\pxpic@parse$ so that the first line isn’t moved.
\newcommand{\pxpic@}[2][]{% 
\pxpicsetup{#1}% \pxpic@inner@box % 
\let\px=\pxpic@px \let\pxskip=\pxpic@skip \ifdim\pxpic@kern=\z@ \let\pxpic@@kern=\@gobble \else \advance\pxpicHT\pxpic@kern \advance\pxpicWD\pxpic@kern \fi \kern\pxpic@kern \pxpic@@file@or@list{{#2}}% \pxpic@after@inner@box % \egroup} \etext{This here is the only spot we use \kern directly instead of the wrapping \pxpic@@kern. Even if this is effectively a \kern0pt the vertical alignment in top-aligned boxes is different this way (aligning at the top of the top row instead of the bottom). \kern\pxpic@kern \pxpic@setup@kwargs{#1} % \pxpic@after@inner@box \egroup} \etext{\ekvsetdef{\pxpicsetup}{pxpic} \etext{End definition for \pxpicsetup. This function is documented on page 5.}}

\etext{\pxpicsetup is just directly defined to call expv's parser for the pxpic set. \ekvsetdef{\pxpicsetup}{pxpic}}

\etext{\ekvsetdef{\pxpiclogo@settings}{#1}(pxpic) \etext{End definition for \pxpiclogo. This logo is just a biggish pixel picture. The \lower will move it down a bit so that it appears correctly aligned on the baseline. Since the logo should be part of a normal sentence in most usages we put \leavevmode before it. Also we make sure that the mode and px definitions are correct and the output is bottom aligned. \ekvcompile{\pxpiclogo@settings}{#1}(pxpic) \etext{size=#1,gap=\@z@,b,mode=px,colours={o=[HTML]{9F393D},g=black!75},skip=\@.13ex}}

\etext{\ekvsetdef{\pxpiclogo@settings}{#1}(pxpic) \etext{size=#1,gap=\@z@,b,mode=px,colours={o=[HTML]{9F393D},g=black!75},skip=\@.13ex}}

\etext{\ekvsetdef{\pxpiclogo@settings}{#1}(pxpic) \etext{size=#1,gap=\@z@,b,mode=px,colours={o=[HTML]{9F393D},g=black!75},skip=\@.13ex}}

\etext{\ekvsetdef{\pxpiclogo@settings}{#1}(pxpic) \etext{size=#1,gap=\@z@,b,mode=px,colours={o=[HTML]{9F393D},g=black!75},skip=\@.13ex}}

\etext{\ekvsetdef{\pxpiclogo@settings}{#1}(pxpic) \etext{size=#1,gap=\@z@,b,mode=px,colours={o=[HTML]{9F393D},g=black!75},skip=\@.13ex}}

\etext{\ekvsetdef{\pxpiclogo@settings}{#1}(pxpic) \etext{size=#1,gap=\@z@,b,mode=px,colours={o=[HTML]{9F393D},g=black!75},skip=\@.13ex}}
\pxpicforget

Straight forward, just let the px macro to an undefined macro.
\newcommand\pxpicforget[1]{\expandafter\let\csname\ekv@name{pxpic@px}{#1}N\endcsname\pxpic@undef}

\pxpicnewmode \pxpicsetmode

These are pretty simple as well, the new variant will use \newcommand which will do the
testing for us, the set variant uses \def.
\protected\long\def\pxpicnewmode#1#2{\expandafter\newcommand\csname pxpic@parse@px@#1\endcsname[1]{#2}}
\protected\long\def\pxpicsetmode#1#2{\long\expandafter\def\csname pxpic@parse@px@#1\endcsname\begingroup\edef\unexpanded{#1}{#1}}
\pxpicaddcolorlist

The colour list is first parsed with \ekvpars inside an \edef. \ekvpars will prevent the
parsed list from further expanding, leaving each list element and \pxpic@experr@noval
or \pxpic@setcolor@colorlist before it. In a second \edef these will be expanded,
\pxpic@experr@noval throwing an error for each element missing a colour definition,
and \pxpicsetcolorlist testing for an opening bracket (which we do expand-
ably) and leaving the correct definition protected against further expansion. The add
variant uses a temporary macro for the parsing part and adds the result to the list holding
macro. The second expansion step in set and both in add are done inside a group to
revert any definition (also those letting tokens to \relax by \csname) made at this point
except for the list macro itself.
\protected\def\pxpicnewcolorlist#1{\%\@ifundefined{pxpic@colorlist@#1}{\pxpicsetcolorlist{#1}}{\pxpic@err@defined@colorlist{#1}\@gobble}\\endgroup
\protected\def\pxpicsetcolorlist#1{\expandafter\pxpic@setcolorlist\csname pxpic@colorlist@#1\endcsname}
\protected\long\def\pxpic@setcolorlist#1#2{\%\edef#1{\ekvpars\pxpic@experr@noval\pxpic@setcolor@colorlist{#2}}\begingroup\edef\unexpanded{#1}{#1}}
\pxpicaddcolorlist

\protected\def\pxpicaddcolorlist#1{\%\@ifundefined{pxpic@colorlist@#1}{\pxpicsetcolorlist{#1}}{\pxpic@err@defined@colorlist{#1}\@gobble}\\endgroup
\protected\def\pxpicsetcolorlist#1{\expandafter\pxpic@setcolorlist\csname pxpic@colorlist@#1\endcsname}
\protected\long\def\pxpic@setcolorlist#1#2{\%\edef#1{\ekvpars\pxpic@experr@noval\pxpic@setcolor@colorlist{#2}}\begingroup\edef\unexpanded{#1}{#1}}
\pxpicaddcolorlist

\protected\def\pxpicaddcolorlist#1{\%}
2.3 Parser

These are three helper macros. The first just gobbles everything until the next \pxpic@end, and we borrow a fast test for an empty argument from \expandafter. The last can be used to check for an opening bracket if used like \pxpic@ifbracket\pxpic@end #1.\pxpic@end[#2]\pxpic@end.

(End definition for \pxpic@ifend, \pxpic@ifempty, and \pxpic@ifbracket.)

\pxpic@openbrace

For some weirder \TeX{} programming it is sometimes necessary to insert an unmatched opening brace. This code does exactly that if it’s expanded twice. It is put into a single macro so that one can \expandafter it easier.

\newcommand*{\pxpic@openbrace}{\expandafter{\iffalse}\fi}

(End definition for \pxpic@openbrace.)

\pxpic@parse The parsing loop is pretty simple, first check whether we’re done, else open a new \hbox (which will form a row in the \vbox placed by \pxpic@) in which the inner parsing loop is run. Then call the next iteration. If we’re done just gobble the remainder of the current iteration. First we introduce our \kern which might fix the gap issue. Another \kern is done at the start of each \hbox to compensate the unnecessary \kern done by the first \pxpic@parseline.

This parsing has one step of indirection, the first macro that is called is \pxpic@parse, that’ll set things up with the end marker for the row parser \pxpic@@parse. Both the definition of \pxpic@parse and \pxpic@@parse is dependent on the setting of the lines key, hence they are set up with the two macros \pxpic@@parse@group and \pxpic@@parse@space that represent the choices of said key.

(End definition for \pxpic@openbrace.)
In the `space` and `csv` case we need to make sure that there are no extra spaces that would result in empty lines. We borrow the space trimmer from `expl3` for this.

```latex
\ExplSyntaxOn
\cs_new_protected:Npn \pxpic@@parse@space #1
{\pxpic@parse@aux #1 \pxpic@end #1}
\ExplSyntaxOff
```

Here we set up the default definition. Also the end of the parsing is defined here.

```latex
\long\def\pxpic@parse@aux#1{\pxpic@@parse#1}
\long\def\pxpic@done\pxpic@end{\pxpic@linedone}
\long\def\pxpic@lx{\pxpic@end}{\pxpic@end}
(End definition for \pxpic@parse and others.)
```

\pxpic@linedone For \pxpic@parseline the line parsing loop also checks whether we’re done, if not we place a pixel using the current definition of \pxpic@parse@px (which will be set by the current mode) and afterwards call the next iteration. If we’re done we gobble the remainder of the current iteration and control goes back to \pxpic@parse. Before each pixel we introduce a negative \kern to maybe fix the gap issue by letting the pixels overlap a bit.
2.4 Modes

The modes define how a single element of the \langle pixel list \rangle is parsed.

In the px mode we check whether the pixel is defined (using the name space of \expkv), if so call it, else throw an error and skip. Since this is also the initial mode we \let the auxiliary macro \pxpic@parse@px to this mode here.

\begin{verbatim}
\newcommand\pxpic@parse@px@px[1]{%
  \ekvifdefinedNoVal{pxpic@px}{#1} %
    \csname\ekv@name{pxpic@px}{#1}\endcsname% 
    \pxpic@err@unknown@px{#1} %
  \pxskip 
} 
\let\pxpic@parse@px\pxpic@parse@px@px
\end{verbatim}

(named) just checks whether the skip is empty. If so skip, else call \color with the element and output a pixel.

\begin{verbatim}
\newcommand\pxpic@parse@px@named[1]{%
  \pxpic@ifempty{#1}
    \pxskip 
  {{\@declaredcolor{#1}\px}}%
} 
\end{verbatim}

The colour model modes are all the same in principle. They test for an empty element to introduce a skip, else they call \color with the respective colour model and output a pixel. We use the auxiliary \pxpic@tmp to do all those definitions and undefine it afterwards.

\begin{verbatim}
\def\pxpic@tmp#1%{%
  \pxpicnewmode{#1}%
  {%
    \pxpic@ifempty{##1}
      \pxskip
    {{\@undeclaredcolor[#1]{##1}\px}}%
  }%
} 
\pxpic@tmp{rgb} 
\pxpic@tmp{cmy} 
\pxpic@tmp{cmyk} 
\pxpic@tmp{hsb} 
\pxpic@tmp{Hsb} 
\pxpic@tmp{tHsb} 
\pxpic@tmp{gray} 
\pxpic@tmp{RGB} 
\pxpic@tmp{HTML} 
\pxpic@tmp{HSSB} 
\pxpic@tmp{Gray} 
\pxpic@tmp{wave} 
\end{verbatim}
2.5 Pixel and Skip

The actual definition of pixels and skips is stored in macros to which the frontend macros `\px` and `\pxskip` will be let inside of `\pxpic`.

```latex
\newcommand{\pxpic@px}{\vrule height\pxpicHT width\pxpicWD depth\z@}
\newcommand{\pxpic@skip}{\kern\pxpicWD}
```

(End definition for `\pxpic@px` and `\pxpic@skip`.)

2.6 Parser for colours

First we test whether the colour starts with an opening bracket or not. Depending on that we either just put the colour after `\color`, or put braces around it (as it then is a colour expression for `xcolor` and just a single argument). `\pxpic@setcolor` defines a px in the name space of `exPkv` (this has a slight overhead during definition, but `exPkv` is fast in checking whether one of its keys is defined or not, and reduces the amount of code in this package).

```latex
\newcommand{\pxpic@setcolor}[2]{
  \pxpic@ifbracket{\pxpic@end#2.\pxpic@end}\pxpic@end
  \pxpic@setcolor@a\pxpic@setcolor@b{#1}{#2}\
}
\newcommand{\pxpic@setcolor@a}[2]{
  \expandafter\def\csname\ekv@name{pxpic@px}{#1}N\endcsname
  {{\@declaredcolor{#2}\px}}\
}
\newcommand{\pxpic@setcolor@b}[2]{
  \expandafter\def\csname\ekv@name{pxpic@px}{#1}N\endcsname
  {{\@undeclaredcolor#2\px}}\
}
```

(End definition for `\pxpic@setcolor`, `\pxpic@setcolor@a`, and `\pxpic@setcolor@b`.)

This macro should leave the correct code in the input stream to define a single pixel. It is to be used inside of `\edef`, hence using `\unexpanded`, which doesn’t have an opening brace directly after it so that the `\pxpic@ifbracket` test is fully expanded. Next we expand `\pxpic@setcolor@a/b` twice (which will expand the `\csname` contained in it) and then leave the opening bracket for `\unexpanded` in the input stream. The code should be used inside a group so that all the implicit definitions to `\relax` done by `\csname` are reverted.
2.7 Messages

These are just some macros throwing errors, nothing special here.

```
\newcommand\pxpic@noval[1]{\PackageError{pxpic}{Missing colour definition for name '\detokenize{#1}'}{}}
\newcommand\pxpic@unknown@px[1]{\PackageError{pxpic}{Unknown pixel '\detokenize{#1}'. Skipping}{}}
\newcommand\pxpic@unknown@mode[1]{\PackageError{pxpic}{Unknown mode '#1'}{}}
\newcommand\pxpic@unknown@colorlist[1]{\PackageError{pxpic}{Unknown colour list '#1'}{}}
\newcommand\pxpic@defined@colorlist[1]{\PackageError{pxpic}{Colour list '#1' already defined}{}}
\newcommand\pxpic@unknown@expansion[1]{\PackageError{pxpic}{Unknown expansion mode '#1'}{}}
\newcommand\pxpic@unknown@lines[1]{\PackageError{pxpic}{Unknown lines mode '#1'}{}}
\newcommand\pxpic@unknown@file[1]{\PackageError{pxpic}{Unknown file value '#1'}{}}
\newcommand\pxpic@file@not@found[1]{\PackageError{pxpic}{Couldn't find file #1}{}}
```

(End definition for `\pxpic@noval` and others.)

\pxpic@experr

This macro can be used to throw an error expandably. For this an undefined control sequence `\pxpic@Error:` is used. The group containing `\expandafter` keeps the definition of `\pxpic@Error:` local (it is `\relax` after the `\csname` so that it is undefined when it's used. The `\@firstofone` is needed to get the readable output (now the undefined macro and actual message are always the same argument).

```
\def\pxpic@experr#1\{
  \long\def\pxpic@experr##1\{
    \expandafter\expandafter\expandafter\pxpic@ifend\@firstofone{#1##1.}\}
  \pxpic@end
\}
```

(End definition for `\pxpic@experr` and others.)
With the expandable error throwing mechanism out of the way, the following is straightforward again.

\newcommand{\pxpic@experr@noval}[1]{\pxpic@experr{Missing colour definition for ‘#1’}}

(End definition for \pxpic@experr.)
## Index

The italic numbers denote the pages where the corresponding entry is described, numbers underlined point to the definition, all others indicate the places where it is used.

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</tr>
<tr>
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