

# The `animate` Package

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## Abstract

A LaTeX package for creating portable, JavaScript driven PDF animations from sets of vector graphics or rasterized image files or from inline graphics.

*Keywords:* include, portable, PDF, animation, animating, embed, animated, graphics, LaTeX, pdfLaTeX, animated GIF, PSTricks, pgf, TikZ, LaTeX-picture, MetaPost, inline graphics, vector graphics, dvips, ps2pdf, JavaScript, Adobe Reader

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\*Animated GIF taken from phpBB forum software and burst into set of EPS files using ImageMagick before embedding.

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## 1 Introduction

This package provides an interface to create PDFs with animated content from sets of graphics or image files, from inline graphics, such as  $\text{\LaTeX}$ -picture, PSTricks or pgf/TikZ generated pictures, or just from typeset text. Unlike standard movie/video formats, which can be embedded, for example, using the  $\text{\LaTeX}$  package ‘movie15’ [5], package ‘animate’ allows for animating vector graphics. The result is roughly similar to the SWF (Flash) format, although not as space-efficient.

Package ‘animate’ supports the usual PDF making workflows, i. e.  $\text{pdf\LaTeX}$  and  $\text{\LaTeX} \rightarrow \text{dvips} \rightarrow \text{ps2pdf}$ /Distiller.

The final PDF can be viewed in current Adobe Reader<sup>®</sup>s on all supported platforms.

The ‘animate’ package makes use of Optional Content Groups (OCG), also known as PDF layers, which is a feature provided by the PDF-1.5 specification. Each frame of an animation is associated with an OCG that is hidden or made visible in a dynamic fashion by means of Adobe Reader’s built-in JavaScript engine.

## 2 Requirements

$\text{pdf\TeX}$ , version  $\geq 1.20$  for direct PDF output

Ghostscript, version  $\geq 8.31$  or Adobe Distiller for PS to PDF conversion

Adobe Reader, version  $\geq 6$ , but not 8.0 and 8.1

## 3 Installation

The file ‘animate.sty’ should be stored in a place where  $\text{\LaTeX}$  can find it.

## 4 Using the package

First of all, read Section 8 on problems related to this package. Then, invoke the package by putting the line

```
\usepackage[<package options>]{animate}
```

to the preamble of your document, i.e. somewhere between `\documentclass` and `\begin{document}`.

‘animate’ honours the package options:

```
autoplay
autopause
autoresume
loop
palindrome
draft
final
controls
buttonsize=<size>
buttonbg=<colour>
buttonfg=<colour>
step
poster[=first | none | last]
```

The same options are also available (among others) as command options and will be explained shortly. However, if used as package options they have global scope, taking effect on all animations in the document. In turn, command options locally override global settings.

If PDF is generated via DVI and Postscript by the command sequence `latex` → `dvips` → `ps2pdf`, the ‘graphicx’ package is required. *Important:* The `dvips` option ‘-Ppdf’ should *not* be set when converting the intermediate DVI into Postscript. If you cannot do without, put ‘-X 2400 -Y 2400’ *after* ‘-Ppdf’ on the command line.

## 5 The user interface

Package ‘animate’ provides the command

```
\animategraphics[<options>]{<frame rate>}{<file basename>}{<first>}{<last>}
```

and the environment

```
\begin{animateinline}[<options>]{<frame rate>}
... typeset material ...
\newframe[<frame rate>]
... typeset material ...
\newframe*[<frame rate>]
... typeset material ...
\end{animateinline}
```

While `\animategraphics` can be used to assemble animations from sets of existing graphics files, the environment ‘`animateinline`’ is meant to create the animation from the typeset material it encloses. This material can be pictures

drawn within the L<sup>A</sup>T<sub>E</sub>X ‘`picture`’ environment or using the advanced capabilities of PSTricks or pgf/TikZ. Even ordinary textual material may be animated in this way. The parameter `<frame rate>` specifies the number of frames per second of the animation.

By default, the animation is built frame by frame in the order of inclusion of the embedded material. However, extended control of the order of appearance, superposition and repetition of the material is available through the ‘`timeline`’ option (see Section 6.2).

The command `\newframe` terminates a frame and starts the next one. It can be used inside the ‘`animateinline`’ environment only. There is a starred variant, `\newframe*`. If placed after a particular frame it causes the animation to pause at that frame. The animation continues normally after clicking it again. Both `\newframe` variants take an optional argument that allows to change the frame rate in the middle of an animation.

All files of the sequence should exist and be consecutively numbered. (Exception to this rule is allowed in connexion with the ‘`every`’ option, see below). `<file basename>` is the leftmost part of the file name that is common to all members of the sequence. `<first>` is the number of the first and `<last>` the number of the last file in the set. File names may be simply numbered, such as 0...99. If there are leading zeros, make sure that all file numbers have the same number of digits, such as 0000...0099.

There is no file name extension to be specified as a parameter. The possible file formats depend on whether L<sup>A</sup>T<sub>E</sub>X or pdfL<sup>A</sup>T<sub>E</sub>X is used. In the case of L<sup>A</sup>T<sub>E</sub>X, files with the extension ‘`eps`’ are searched for at first, followed by ‘`mps`’ (METAPOST-generated Postscript) and ‘`ps`’. With pdfL<sup>A</sup>T<sub>E</sub>X the searching order is: (1) ‘`pdf`’, (2) ‘`mps`’, (3) ‘`png`’, (4) ‘`jpg`’, (5) ‘`jpeg`’, (6) ‘`jbig2`’, (7) ‘`jb2`’, (8) ‘`jp2`’<sup>1</sup>, (9) ‘`j2k`’<sup>1</sup>, (10) ‘`jpx`’<sup>1</sup>. That is, files capable to store vector graphics are found first. Make sure that all file names have *lower case* extensions.

For example, given the sequence ‘`frame_5.png`’ through ‘`frame_19.png`’ from a possibly larger set that shall be used to build the animation. Then, `<file basename>` would be specified as ‘`frame_`’, `<first>` as ‘`5`’ and `<last>` as ‘`19`’.

## 6 Command options

The following options to `\animategraphics` and ‘`animateinline`’ have been provided:

### 6.1 Basic options

`poster[=first | none | last]`

Specifies which frame (first, last or none) to display and print if the animation is not activated. The first frame is shown by default. Thus ‘`poster`’ or ‘`poster=first`’ need not be explicitly set.

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<sup>1</sup>JPEG2000 is not yet supported by pdfT<sub>E</sub>X.

**every=<num>**

Build animation from every <num>*th* frame only. Skipped frames are discarded and not embedded into the document. In the case of `\animategraphics`, skipped input files may be missing.

**autoplay**

Pause animation when the page is closed, instead of stopping and rewinding it to the default frame.

**autoplay**

Start animation after the page has opened. Also resumes playback of a previously paused animation.

**autoresume**

Resume previously paused animation when the page is opened again.

**loop**

The animation restarts immediately after reaching the end.

**palindrome**

The animation continuously plays forward and backward.

**step**

Step through the animation by one frame per mouse-click.

**width=<width>**

**height=<height>**

**depth=<depth>**

Resize the animation widget. Any valid T<sub>E</sub>X dimension is accepted as a parameter. Option ‘**depth**’ specifies how far the animation widget should extend below the bottom line of the running text. If only one or two of these options are given, the remaining, unspecified dimensions are scaled to keep the aspect ratio.

**scale=<factor>**

Scales the animation widget by <factor>.

**controls**

Inserts control buttons below the animation widget. The meaning of the buttons is as follows, from left to right: stop & first frame, step backward, play backward, play forward, step forward, stop & last frame, decrease speed, default speed, increase speed. Both ‘play’ buttons are replaced by a large ‘pause’ button while the animation is playing.

`buttonsize=<size>`

Changes the control button height to `<size>`, which must be a valid  $\text{\TeX}$  dimension. The default button height is `1.44em` and thus scales with the current font size.

`buttonbg=<colour>`

`buttonfg=<colour>`

By default, control button widgets are drawn with black strokes on transparent background. The background can be turned into a solid colour by the first option, while the second option specifies the stroke colour. The parameter `<colour>` is an array of colon-(:)-separated numbers in the range from 0.0 to 1.0. The number of array elements determines the colour model in which the colour is defined: (1) gray value, (3) RGB, (4) CMYK. For example, `'1'`, `'1:0.5:0.2'` and `'0.5:0.3:0.7:0.1'` are valid colour specifications.

`draft`

`final`

With `'draft'` the animation is not embedded. Instead, a box with the exact dimensions of the animation is inserted. Option `'final'` does the opposite as it forces the animation to be built and embedded. Both options can be used to reduce compilation time during authoring of a document. To get the most out of them it is recommended to set `'draft'` globally as package or class option and to set `'final'` locally as a command option of the animation that is currently worked on. After the document has been finished, the global `'draft'` option can be removed to embed all animations.

`begin={<begin text>}`

`end={<end text>}`

(`'animateinline'` only.) `<begin text>` and `<end text>` are inserted into the code at start and end of each frame. Mainly used for setting up some drawing environment, such as

```
begin={\begin{pspicture}}(...)(...), end={\end{pspicture}}
```

## 6.2 The `'timeline'` option

`timeline=<timeline file>`

`<timeline file>` is a plain text file whose contents determines the order of appearance of the embedded material during the animation. In addition, it allows to freely reorder, repeat and overlay the material at any point of the animation. This may greatly reduce the file size of the resulting PDF, as objects that do not change between several or all frames, such as coordinate axes or labels, can be embedded once and re-used in other frames of the animation.

If a timeline is associated with the animation, the graphics files or inline graphics embedded by `\animategraphics` and `'animateinline'` no longer represent the actual frames of the animation. Rather, they are a collection of *transparencies* that can be played with at will. In order to identify the transparencies within the timeline file, they are numbered in the order of their inclusion, starting at zero.

Each line of the timeline file that is not blank and which does not begin with a comment (%) specifies *one* frame of the animation. There may be more transparencies than animation frames and vice-versa. A frame specification consists of three, colon-(:)-separated fields:

```
[*]:[<frame rate>]:[<frame content>]
```

While any field may be left blank, the colons are mandatory.

An asterisk (\*) in the leftmost field causes the animation to pause at that frame, very much like a `\newframe*` would do; a number in the second field changes the frame rate of the animation section that follows. (In connexion with the `'timeline'` option the asterisk extension and the optional `<frame rate>` argument of `\newframe` cease to make sense and will be tacitly ignored, if present.) The third field `<frame content>` is a comma-separated list of *transparency specifications* that determines the content of the frame. A *single* transparency specification obeys the syntax

```
<transparency ID>[x<number of frames>]
```

where `<transparency ID>` is an integer number that identifies the transparency to be drawn into the current animation frame. As pointed out above, the transparencies are consecutively numbered in the order of their inclusion, starting at zero. The optional postfix `'x<number of frames>'` specifies the number of consecutive frames the transparency is to appear within. If omitted, a postfix of `'x1'` is assumed, which causes the transparency to be shown in the current frame only. Obviously, `<number of frames>` must be a non-negative integer number. The meaning of postfix `'x0'` is special; it causes the transparency to be shown in all frames, starting with the current one, until the end of the animation.

Note that the order in which transparency specifications appear in the timeline file determines their *depth* level. If a frame is composed of more than one transparency, transparency specifications on the left of the input line are closer to the background and will be overprinted by those on the right which are closer to the foreground. That is, the depth *decreases* from left to right within `<frame content>`. Also, if there are transparency specifications which span several frames (using postfix `'x<number of frames>'`), they will be overprinted by transparency specifications that appear on subsequent lines in the timeline file. That is, the depth decreases in top-down direction within the timeline file.

Consider the two timelines

```
::1,0 % zeroth transparency always in the foreground
::2,0
::3,0
```

```
::4,0
...
```

and

```
::0x0,1 % zeroth transparency put to the background
::2
::3
::4
...
```

In the first example, transparency No. 0 appears in the foreground throughout the animation; it will never be obscured by other transparencies' content. In the second example it is put to the background, because it is the first transparency specification in the file, and stays there for the rest of the animation.

*Grouping objects into layers using ';'*

This stack-like concept of animations, where transparencies are always put on top such that they overprint the content of previously deposited transparencies, can be inconvenient in certain situations. For example, it might be desirable to allow for changing the background image in the middle of an animation without affecting objects that are located in the foreground. For this purpose, transparency specifications can be grouped into *layers* using the semicolon (;) as a separator instead of the comma. This is best illustrated by an example:

```
::0x49;2x0,3x0
::      ;4x0,5x0
::      ;6x0,7x0
...
::      ;98x0,99x0
::1x0;100x0,101x0
::      ;102x0,103x0
::      ;104x0,105x0
...
```

In this timeline, the transparencies are grouped into two layers. One is reserved for the background images, transparencies No. 0 & 1, that shall be exchanged after 49 frames, and another one for the foreground objects that are successively added to the scene. As can be seen in this example, layers need not be explicitly populated. The leading semicolons just ensure the proper relationship between transparencies and animation layers. Without setting up two layers, the foreground objects on transparencies 2 through 99 that have been added during the first 49 frames would be overprinted by the new background image, transparency 1, from frame 50 onwards.

See the second animation in Section 7.1 for a working example that makes use of the timeline and the layer concept.



## 7 Examples

### 7.1 Animations from sets of files, using `\animategraphics` command

Animations in this section are made from graphics files that were prepared with METAPOST. Run ‘`mpost`’ on the files ending in ‘`.mp`’ in the ‘`doc/files`’ directory to generate the graphics files. Both examples make use of the ‘`timeline`’ option to reduce the resulting PDF file size.

The first example, originally written by Jan Holeček [3], shows the exponential function  $y = e^x$  and its approximation by Taylor polynomials of different degree.

```
\documentclass{article}
\usepackage{animate}
\usepackage{graphics}

\begin{document}

\begin{center}
\animategraphics[
  controls, loop,
  timeline=timeline.txt
]{4}{exp_}{0}{8}
\end{center}

\end{document}
```

Contents of file ‘`timeline.txt`’:

```
::0x0 % coordinate system & y=e^x, repeated until last frame
::1 % one blue curve per frame
::2
::3
::4
::5
::6
::7
::8
```

The second, somewhat more complex example animates the geometric construction of a scarabaeus. In addition to the use of a timeline, it introduces the layer concept. This example is adapted from Maxime Chupin's original METAPOST source file [1]. The present version separates stationary from moving parts of the drawing and saves them into different files. A total of 254 files, scarab\_0.mps through scarab\_253.mps, is written out by running 'mpost' on the source file 'scarab.mp'. Files 0 through 100 contain the red line segments that make up the growing scarabaeus. Files 101 through 201 contain the moving construction lines and files 202 through 252 contain the gray lines which represent intermediate stages of the construction. The last file, No. 253, contains the coordinate axes, two stationary construction lines and the labels which do not move. A timeline file is written on-the-fly during the L<sup>A</sup>T<sub>E</sub>X run. It arranges the animation into three layers, forcing the gray lines into the background, the coordinate axes into the intermediate layer and the scarabaeus along with the moving construction lines into the foreground. The final animation consists of 101 individual frames.

```
\documentclass{article}
\usepackage{intcalc} %defines \intcalcMod for Modulo computation
\usepackage{animate}
\usepackage{graphics}

\newcounter{scarab}
\setcounter{scarab}{0}
\newcounter{blueLine}
\setcounter{blueLine}{101}
\newcounter{grayLine}
\setcounter{grayLine}{202}

%write timeline file
\newwrite\TimeLineFile
\immediate\openout\TimeLineFile\jobname.tln
\whiledo{\thescarab<101}{
  \ifthenelse{\intcalcMod{\thescarab}{2}=0}{
    %a gray line is added to every 2nd frame
    \immediate\write\TimeLineFile{%
      ::\thegrayLine x0;253;\thescarab x0,\theblueLine}
    \stepcounter{grayLine}
  }
```

```

}{
  \immediate\write\TimeLineFile{%
    ::;253;\thescarab x0,\theblueline}
}
\stepcounter{scarab}
\stepcounter{blueline}
}
\immediate\closeout\TimeLineFile

\begin{document}
\begin{center}
\animategraphics[
  width=0.8\linewidth,
  controls, loop,
  timeline=\jobname.tln
]{12}{scarab_}{0}{253}
\end{center}
\end{document}

```

## 7.2 Animating PSTricks graphics, using ‘animateinline’ environment

This is an inline graphics example adapted from [2].

```

\documentclass{article}
\usepackage{pst-3dplot}

```

```

\usepackage{fp}
\usepackage{animate}

%draws a torus sector
\newcommand{\torus}[1]{% #1: angle of the torus sector
  \psset{Beta=20,Alpha=50,linewidth=0.1pt,origin={0,0,0},unit=0.35}%
  \begin{pspicture}(-12.3,-6.3)(12.3,7)%
    \parametricplotThreeD[xPlotpoints=100](80,#1)(0,360){%
      t cos 2 mul 4 u sin 2 mul add mul
      t sin 2 mul 4 u sin 2 mul add mul
      u cos 4 mul
    }%
    \parametricplotThreeD[yPlotpoints=75](0,360)(80,#1){%
      u cos 2 mul 4 t sin 2 mul add mul
      u sin 2 mul 4 t sin 2 mul add mul
      t cos 4 mul
    }%
    \FPupn\strokewidth{360 #1 sub 360 div 3 mul}%
    \parametricplotThreeD[yPlotpoints=1,linewidth=\strokewidth pt](0,360)(#1,#1){%
      u cos 2 mul 4 t sin 2 mul add mul
      u sin 2 mul 4 t sin 2 mul add mul
      t cos 4 mul
    }%
  \end{pspicture}%
}

\begin{document}

\begin{center}
\newcounter{torusangle}
\setcounter{torusangle}{80}

\begin{animateinline}[poster=last,controls,palindrome]{10}%
  \torus{\thetorusangle}%
  \whiledo{\thetorusangle<360}{%
    \newframe%
    \addtocounter{torusangle}{10}%
    \torus{\thetorusangle}%
  }
\end{animateinline}%

\end{center}

\end{document}

```

## 8 Bugs

- The command `\multido` and its relatives from package ‘multido’ do not work if the loop body contains `\newframe`. Use `\whiledo` from package ‘ifthen’ instead. (There is no need to load ‘ifthen’ explicitly; it has already been loaded by ‘animate’.) A counter must be declared to keep track of the number of iterations. Further variables that take fixed point decimals to be used within the loop body can be defined and incremented by means of the commands `\FPset` and `\FPeval` from package ‘fp’. For example:

```
\newcounter{iter} % declare loop counter

\FPset{nInit}{1.0}% initial value of variable ‘n’
\FPset{nIncr}{0.5}% increment of ‘n’

\begin{animateinline}{12}
  %initialize loop counter and ‘n’
  \setcounter{iter}{0}%
  \FPset{n}{nInit}%
  ...
  ... create first frame using ‘\n’ (Mind the backslash!)
  ... (\multido _can_ be used here!)
  ...
  \whiledo{\theiter<50}{% another 50 frames
    %start new frame
    \newframe%
    %increment loop counter by 1
    \stepcounter{iter}%
    %calculate new value of ‘n’
    \FPeval{n}{nInit+nIncr*\theiter}%
    ...
    ... create frame using ‘\n’
    ... (\multido _can_ be used here!)
    ...
  }
\end{animateinline}
```

- The maximum frame rate that can actually be achieved largely depends

on the complexity of the graphics and on the available hardware.

- The Adobe Reader setting ‘Use page cache’ (menu ‘Edit’ → ‘Preferences’ → ‘Startup’) should be *disabled*.
- The `dvips` option ‘`-Ppdf`’ should be avoided entirely or followed by something like ‘`-X 2400 -Y 2400`’ on the command line in order to set a sensible DVI resolution. In times of Type-1 fonts, this does *not* degrade the output quality! The configuration file ‘`config.pdf`’ loaded by option ‘`-Ppdf`’ specifies an excessively high DVI resolution that will be passed on to the final PDF. Eventually, Adobe Reader gets confused and will not display the frames within the animation widget.
- Animations do not work if the PDF has been produced with Ghostscript versions older than 8.31. This applies to all versions of ESP Ghostscript that comes with many Linux distributions.
- Animations with complex graphics and/or many frames may cause L<sup>A</sup>T<sub>E</sub>X to fail with a ‘`TeX capacity exceeded`’ error. Depending on the T<sub>E</sub>X-system in use, enlarge T<sub>E</sub>X’s memory with the (pdf)l<sup>A</sup>T<sub>E</sub>X command line option ‘`--mem-max=...`’ or by increasing the value of ‘`main_memory`’ in the file ‘`texmf.cnf`’. (Changing ‘`texmf.cnf`’ requires the format files to be rebuilt. Run ‘`fmtutil-sys --all`’.)
- Animations should not be placed on *multilayered* slides created with presentation making classes such as Beamer or Powerdot. Although possible, the result might be disappointing. Put animations on flat slides only. (Of course, slides without animations may still have overlays.)
- Originally, package ‘`animate`’ was based on a method suggested by Jan Holeček and Petr Soika [4], but was rewritten to use Optional Content Groups (OCG). OCG-based animations are fully supported in Adobe Reader 8, but have some performance issues. Playback is usually slower in Reader 8 than in older Reader versions, which is probably a bug. The non-OCG approach performs better in Adobe Reader 8, but package/command options ‘`autoplay`’, ‘`autoplay`’, ‘`autoplay`’ and ‘`autoplay`’ do not work. Moreover, the animation position and the play/pause buttons are not properly reset on page change. This is due to usage restrictions that Adobe imposed on some important JavaScript methods in Reader 8. An old, non-OCG version of the package is still available as ‘`animate-noocg.sty`’.

## 9 Acknowledgements

I would like to thank François Lafont who discovered quite a few bugs and made many suggestions that helped to improve the functionality of the package.

## References

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- [5] *The Movie15 Package*. URL: <http://www.ctan.org/tex-archive/macros/latex/contrib/movie15>