

# tikz-flowchart—TikZ 流程图绘制宏包<sup>\*</sup>

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## 摘要

这是一个使用 TikZ 绘制传统程序流程图的简单宏包，通过定义 `proc`、`test`、`io`、`term` 等 TikZ 的 `node` 命令样式实现。该宏包核心代码摘录自 Brent Longborough 设计的流程图绘制样例，参考了 `tikz-image-labels` 宏包的设计思路，提供了 `\flowchartset` 命令以设置绘制参数。

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<sup>\*</sup> 该文档是 `tikz-flowchart` v1.0.01, dated 2019/08/20 的说明文档。

<sup>†</sup> <https://github.com/register/tikz-flowchart>

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## Change History

v1.0.01

General: chang .sty file to .dtx file . 1

## 1 简介

流程图是诸如手册、报告、论文等文档中经常用到的排版元素, `tikz-flowchart` 宏包能够方便地实现传统流程图的绘制。

But why does this task deserve its own  $\text{\LaTeX}$  package? there are several reasons:

- One does not need to edit the image in an external graphics program. They can be input directly into your  $\text{\LaTeX}$  document.
- Since the labels and annotations are processed by  $\text{\LaTeX}$ , all the font settings and the like remain consistent through the whole the document. However, of course the `tikz-flowchart` package allows to configure the style.
- The annotations stay rock-solid if the image needs to be rescaled later.
- Since the arrows are processed by `TikZ`, they are vector graphics and thus, issues with scaling or unsharp/blurry labels, which would result if one labels the image in a graphics software, are avoided.

?? was created with the following code:

```
\begin{annotationimage}[width=6cm]{pleiades.jpg}
\draw[annotation left = {Atlas at 0.3}] to (0.11,0.4);
\draw[annotation left = {Pleione at 0.55}] to (0.11,0.49);
\draw[annotation left = {Alcyone at 0.8}] to (0.39,0.45);
\draw[annotation below = {Merope at 0.5}] to (0.58,0.28);
\draw[annotation right = {Electra at 0.3}] to (0.84,0.45);
\draw[annotation right = {Caleano at 0.75}] to (0.85,0.64);
\draw[annotation above = {Maia at 0.4}] to (0.67,0.72);
\draw[annotation above = {Taygeta at 0.9}] to (0.78,0.82);
\draw[image label = {M45 at south east}];
\end{annotationimage}
```

## 2 Usage

### 2.1 Inclusion of the image

`annotationimage` To include an image, the `annotationimage` environment is used. It has the following syntax:

```
annotationimage[ $\langle grid \rangle$ ]{ $\langle options \rangle$ }{ $\langle file name \rangle$ }
```

The  $\langle grid \rangle$  is an optional parameter. If this parameter is present, i.e. if it has the value `[grid]`, then a coordinate grid is visible. The coordinate grid is used to find the coordinates of the points to be labelled. If the parameter  $\langle grid \rangle$  is omitted, no coordinate grid is drawn. The code

```
\begin{annotationimage}[grid]{width=6cm}{pleiades.jpg}
\end{annotationimage}
```

produces the image shown in ??.

$\langle options \rangle$  is any set of options understood by the `\includegraphics` command, e.g. `width=`, `height=` and so on. It may also be left empty, but in this case, the curly braces need to be there, though.

The  $\langle file name \rangle$  is, obviously, the file name of the image. Like for the  $\langle options \rangle$ , any image format supported by `\includegraphics` may be used.

### 2.2 Adding a label

A label (like the “M45” in ??) can be added to the image using following `\draw` macro:

```
\draw[image label = {\text at \placement}];
```

The  $\langle text \rangle$  parameter is obvious. It contains the text to be put into the label.

The  $\langle placement \rangle$  dictates the placement of the label. It may be one of **north west**, **north**, **north east**, **east**, **south east**, **south**, **south west** or **west**. Also **center** is possible, even though it possibly doesn't make a lot of sense. Figure 1 shows an example with several labels.

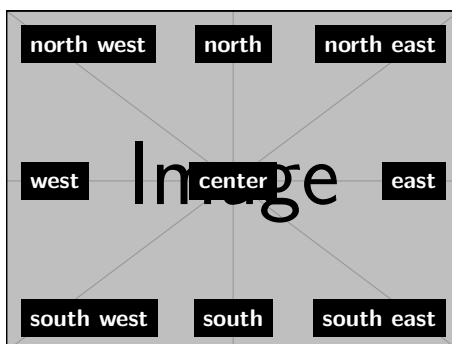


图 1: Example for the placement labels

The label in ?? was drawn using the following code:

```
\draw[image label = {M45 at south east}];
```

Another kind of label is the so-called “coordinate label”. In contrast to the image label, it may be positioned at arbitrary coordinates. The syntax is similar to the image label:

```
\draw[coordinate label = {\text at (\coordinate)}];
```

An example of some coordinate labels is shown in ??.

?? was created using the following code:

```
\draw[coordinate label = {1 at (0.1,0.3)}];
\draw[coordinate label = {2 at (0.4,0.6)}];
\draw[coordinate label = {3 at (0.65,0.25)}];
\draw[coordinate label = {4 at (0.9,0.4)}];
\draw[coordinate label = {5 at (0.62,0.62)}];
\draw[coordinate label = {6 at (0.83,0.8)}];
\draw[image label = {M45 at south east}];
```

## 2.3 Adding annotations

An annotation is added with the aid of the TikZ macro `\draw`. The syntax is as follows:

```
\draw[annotation <placement> = {<text> at <position>}] to (<x>, <y>);
```

The `<placement>` is one of: `above`, `right`, `below` or `left`. It tells on which side of the image the annotation will appear. `<above>` and `<below>` basically determine the  $y$  coordinate of the text, while `<left>` and `<right>` determine the  $x$  coordinate of the text. The remaining coordinate is determined using the `<position>`.

The `<text>` is the actual text of the annotation.

The `<x>` and `<y>` parameters are the actual coordinates where the arrow should point to. Note that `tikz-flowchart` will automatically insert a small distance between the arrow's tip and the coordinate given, such that the arrow is close to the coordinate but does not cover it.

For example, the code

```
\draw[annotation left = {Atlas at 0.3}] to (0.11,0.4);
```

draws the text “Atlas” on the left-hand side of the image, at  $y = 0.3$ . The arrow will point towards coordinate  $(0.11, 0.4)$  but ends shortly before this coordinate such that the interesting feature to be labelled is not covered by the arrow's tip.

## 3 Configuring styles

`\flowchartset` Various options, like font size and so on, can be configured with the `\flowchartset` macro. It uses the key-value syntax from TikZ, e.g.:

```
\flowchartset{<key> = <value>, ...}
```

Multiple `<key>` and `<value>` pairs may be combined. The following sections list all possible configurations.

`\flowchartset` can be put anywhere, but it makes sense to put it into the preamble of a document to ensure all images have the same look.

There is also a default style. If no `\flowchartset` command is present, the default values for all options are taken. The default style used is as follows:

```
\flowchartset{
  coarse grid color = red,
  fine grid color = gray,
  image label font = \sffamily\bfseries\small,
```

```

image label distance = 2mm,
image label back = black,
image label text = white,
coordinate label font = \sffamily\bfseries\scriptsize,
coordinate label distance = 2mm,
coordinate label back = black,
coordinate label text = white,
annotation font = \normalfont\small,
arrow distance = 1.5mm,
border thickness = 0.6pt,
arrow thickness = 0.4pt,
tip size = 1.2mm,
outer dist = 0.5cm,
}

```

The individual keys are described in the following sections.

### 3.1 Grid color

In most cases, it will not be necessary to adjust the grid colors. However, depending on the image, it may be desirable to do so. This is exactly what the  $\langle coarse\ grid\ color \rangle$  and  $\langle fine\ grid\ color \rangle$  are used for. Any color specification compatible to TikZ may be used. The defaults are red for the coarse grid and gray for the fine grid.

### 3.2 Font and color for the labels

The font for the image labels may be configured with  $\langle image\ label\ font \rangle$ . By default, the image labels are typeset with bold, small, sans-serif font.

The background color of the image labels may be set using the  $\langle image\ label\ back \rangle$  key, whereas the text color is specified with the  $\langle image\ label\ text \rangle$  key. Defaults for the background color and for the text color are black and white, respectively.

### 3.3 Distance of image labels to the image border

The  $\langle image\ label\ distance \rangle$  key configures the distance,  $d$ , from the image's border to the border of the image label, as shown in Figure 2. By default, it is set to 2 mm.

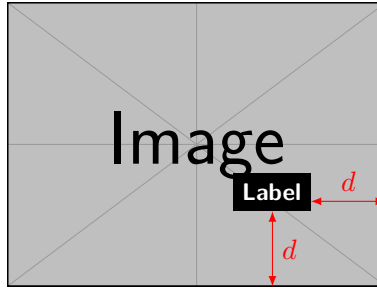


图 2: Illustration of the  $\langle image\ label\ distance \rangle$

### 3.4 Font for annotations

The font used for annotations is set by  $\langle annotation\ font \rangle$ . By default, the `\normalfont` is used with small size.

### 3.5 Distance of arrow tips

As mentioned earlier, the arrows are shortened such that their tips don't cover the desired point. Figure 3 illustrates this. All the arrows point to the same coordinate,  $(0.5, 0.5)$ , but they end at the distance  $x$  away from the point. This distance may be configured using the  $\langle arrow\ distance \rangle$ . By default, this distance is set to 1.5 mm. This ensures that the arrow tips are close enough to the interesting features, but not so close that they cover important parts of the image.

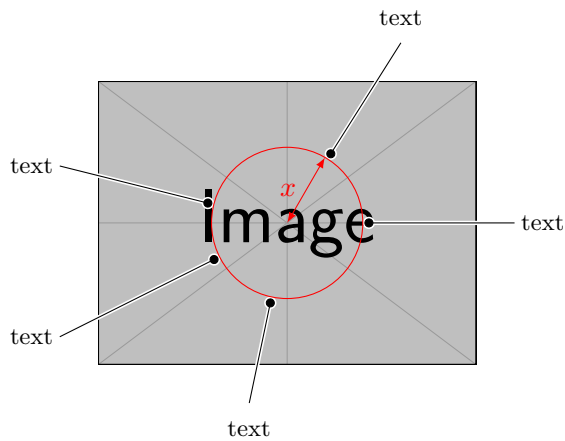


图 3: Illustration of the  $\langle arrow\ distance \rangle$

### 3.6 Thickness and size of the arrows

The arrows themselves consist of two parts: the inner part, which is the actual arrow, and the border, which is, by default, a white border around the arrow. The border is required to ensure that each arrow is visible, no matter on what background it is drawn. The thickness of the black line can be configured using the  $\langle arrow\ thickness \rangle$ , whose default value is 0.4 pt. The thickness of the border around the arrow is configured with the  $\langle border\ thickness \rangle$ , having a default value of 0.6 pt.

The size of the round dot at the end of the arrows is configured using the  $\langle tip\ size \rangle$ . Figure 4 illustrates both, the  $\langle arrow\ thickness \rangle$ , and the  $\langle tip\ size \rangle$ , as parameters  $a$  and  $b$ , respectively.

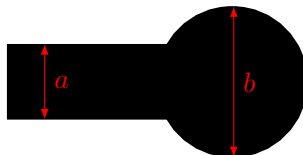


图 4: Illustration of the  $\langle arrow\ thickness \rangle$ ,  $a$ , and the  $\langle tip\ size \rangle$ ,  $b$

### 3.7 Distance of annotation texts from the image

The parameter  $\langle outer\ dist \rangle$  configures how far away from the image the annotation texts will be positioned. By default, this value is 0.5 cm.

## 4 Implementation

The only packages required are `tikz` and `xifthen`. If not already loaded, they will be loaded automatically.

```
1 \RequirePackage{tikz}
2 \RequirePackage{xifthen}
```

Some TikZ libraries are also required for proper operation.

```
3 \usetikzlibrary{
4   arrows.meta,
5   calc,
6   positioning,
7   decorations,
8   decorations.markings,
9   math,
```



10 }

## 4.1 Configuration

For the `\flowchartset` command, a `pgfkeys` family is defined. All configurations (e.g. `<tip size>` and so on) and styles are stored in the PGF key `/flowchart`. This ensures that these configurations don't overwrite any other parameters the user may have set elsewhere.

```
11 \pgfkeys{
12   /flowchart/.is family,
13   /flowchart/.search also={/tikz},
14 }
15
16 \def\flowchartset{\pgfqkeys{/flowchart}}
```

Then, a set of macros is created which stores the values for the individual configuration options.

```
17 \flowchartset{
18   coarse grid color/.store in = \maingridcolor,
19   fine grid color/.store in = \finegridcolor,
20 }
21
22 \flowchartset{
23   image label font/.store in = \imagelabelfont,
24   image label distance/.store in = \flowchartep,
25   image label back/.store in = \imagelabelback,
26   image label text/.store in = \imagelabeltext,
27 }
28
29 \flowchartset{
30   coordinate label font/.store in = \coordinatelabelfont,
31   coordinate label distance/.store in = \coordinatelabelsep,
32   coordinate label back/.store in = \coordinatelabelback,
33   coordinate label text/.store in = \coordinatelabeltext,
34 }
35
36 \flowchartset{
37   annotation font/.store in = \annotationfont,
38   arrow distance/.store in = \arrowddistance,
39   arrow thickness/.store in = \arrowthickness,
40   tip size/.store in = \tipsiz,
41   border thickness/.store in = \borderthickness,
```

```

42 outer dist/.store in = \labeloutersep,
43 }

```

## 4.2 Default configuration

The default configuration is set. This will ensure that each of the previously defined macros has a valid initial value, which may be overwritten by the user.

```

44 \flowchartset{
45   coarse grid color = red,
46   fine grid color = gray,
47   image label font = \sffamily\bfseries\small,
48   image label distance = 2mm,
49   image label back = black,
50   image label text = white,
51   coordinate label font = \sffamily\bfseries\scriptsize,
52   coordinate label distance = 2mm,
53   coordinate label back = black,
54   coordinate label text = white,
55   annotation font = \normalfont\small,
56   arrow distance = 1.5mm,
57   border thickness = 0.6pt,
58   arrow thickness = 0.4pt,
59   tip size = 1.2mm,
60   outer dist = 0.5cm,
61 }

```

## 4.3 Environment declaration

Next, the `annotationimage` environment is declared. It takes 3 arguments, the first of which is optional. If it is omitted, its default value is empty.

```

62 \newenvironment{annotationimage}[3][]{

```

Each time a new `annotationimage` environment is opened, this code will ensure that all the definitions stored under the PGF key `/flowchart` are loaded. Then, a new `tikzpicture` is created.

```

63 \let\tikzset\flowchartset
64 \begin{tikzpicture}

```

The 2nd and 3rd arguments to the `annotationimage` are the size/scaling options for the image, as well as the actual image file. Thus, a new TikZ node

called `image` is created; the node's content is the image.

```
65 \node[anchor=south west, inner sep=0]
66 (image) at (0,0) {\includegraphics[#2]{#3}};
```

Using a scope ensures that the top-right corner always has coordinate (1,1).

```
67 \begin{scope}[x={({image.south east}),y={({image.north west})}]
```

Next, the first (optional) argument's value is checked. If the user said `[grid]` to the first argument, the following code is executed.

```
68 \ifthenelse{\equal{#1}{grid}}{%
```

This actually draws the coordinate grid.

```
69 \draw[very thin, draw=finegridcolor, step=0.02]
70 (0,0) grid (1,1);
71 \draw[thin, draw=maingridcolor, xstep=0.1, ystep=0.1]
72 (0,0) grid (1,1);
```

then, the labels are put to the coordinate axes.

```
73 \foreach \x in {0,1,...,9} {
74 \node [anchor=north] at (\x/10,0) {\tiny 0.\x};
75 }
76 \node [anchor=north] at (1,0) {\tiny 1};
77
78 \foreach \y in {0,1,...,9} {
79 \node [anchor=east] at (0,\y/10) {\tiny 0.\y};
80 }
81 \node [anchor=east] at (0,1) {\tiny 1};
82 }{}
83 }
84 {
```

Each time the `annotationimage` environment is closed, the previously opened `scope` and `tikzpicture` environments need to be closed as well.

```
85 \end{scope}
86 \end{tikzpicture}}
```

## 4.4 Style definitions for the annotations

What follows is the definition of the styling for the annotations.

```
87 \flowchartset{
```

This is the style for the annotation arrow itself.

```
88 annotation arrow/.style =
89 {
```

The `preaction` first draws a thick white arrow. This arrow will become the border.

```

90   preaction =
91   {
92     draw,
93     -{Circle[fill=white, length=\tipsize+2*\borderthickness,
94       width=\tipsize+2*\borderthickness]},
95     line width = 2*\borderthickness + \arrowthickness,
96     white,
97     shorten >= \arrowdistance,
98   },

```

After the `preaction` has been performed, this will actually draw the “normal” arrow.

```

99   draw,
100  -{Circle[fill=black, length=\tipsize, width=\tipsize]},
101  black,
102  line width = \arrowthickness,
103  shorten >= \borderthickness + \arrowdistance,
104 },

```

All the annotation texts have a common style. This ensures they have the same font etc. Setting the `inner sep` to `0.5ex` ensures that the distance between the text and the arrow is somewhat aesthetic. It is an empirically determined value.

```

105 annotation node/.style =
106 {
107   font=\annotationfont,
108   inner sep = 0.5ex,
109 },

```

Next comes the styles for the different annotation placements. For an annotation being below the image, this style applies.

```

110 annotation below/.style args = {#1 at #2}{

```

Using the `annotation arrow` style tells `TikZ` to draw an arrow as specified above, using the geometry defined with `\flowchartset`.

```

111   annotation arrow,

```

After the arrow has been drawn, a further path is inserted, which is the actual annotation text. For the annotations being above and below the image special care must be taken: a `\strut` is appended to the label text to ensure that texts being on the same side of the image are on the same line. Without the

strut, the texts may be differently aligned, depending on their letters – e.g. letters “p” and “g” go slightly further down in the *y* direction than “a” or “b”.

```

112   insert path = {
113       (#2,0) ++ (0,-\labeloutersep)
114       node[anchor = north, annotation node] {#1\strut}
115   }
116 },

```

The remaining annotation styles are defined similarly.

```

117   annotation above/.style args = {#1 at #2}{
118       annotation arrow,
119       insert path = {
120           (#2,1.0) ++ (0,\labeloutersep)
121           node[anchor = south, annotation node] {#1\strut}
122       }
123   },
124   annotation left/.style args = {#1 at #2}{
125       annotation arrow,
126       insert path = {
127           (0,#2) ++ (-\labeloutersep,0)
128           node[anchor = east, annotation node] {#1}
129       }
130   },
131   annotation right/.style args = {#1 at #2}{
132       annotation arrow,
133       insert path = {
134           (1.0,#2) ++ (\labeloutersep,0)
135           node[anchor = west, annotation node] {#1}
136       }
137   },
138 }

```

## 4.5 Style definitions for the labels

Next follows the style definition for the image labels. A general style defines the appearance and color.

```

139 \flowchartset{
140   image label style/.style = {
141       rectangle,
142       minimum width = 5mm,
143       minimum height = 5mm,
144       fill = \imagelabelback,

```

```

145     text = \imagelabeltext,
146     font = \imagelabelfont,
147 },
148 coordinate label style/.style = {
149     rectangle,
150     minimum width = 3mm,
151     minimum height = 3mm,
152     fill = \coordinatelabelback,
153     text = \coordinatelabeltext,
154     font = \coordinatelabelfont,
155 },

```

On the other hand, the `image label` style defines the actual image labels.

```

156 image label/.style args = {#1 at #2}{
157     insert path = {
158         (image.#2) node[outer sep = \flowchartep,
159             anchor=#2, image label style] {#1}
160     }
161 },
162 coordinate label/.style args = {#1 at (#2)}{
163     insert path = {
164         node[outer sep = \coordinatelabelsep,
165             anchor=center, coordinate label style] at (#2) {#1}
166     }
167 },
168 }

```