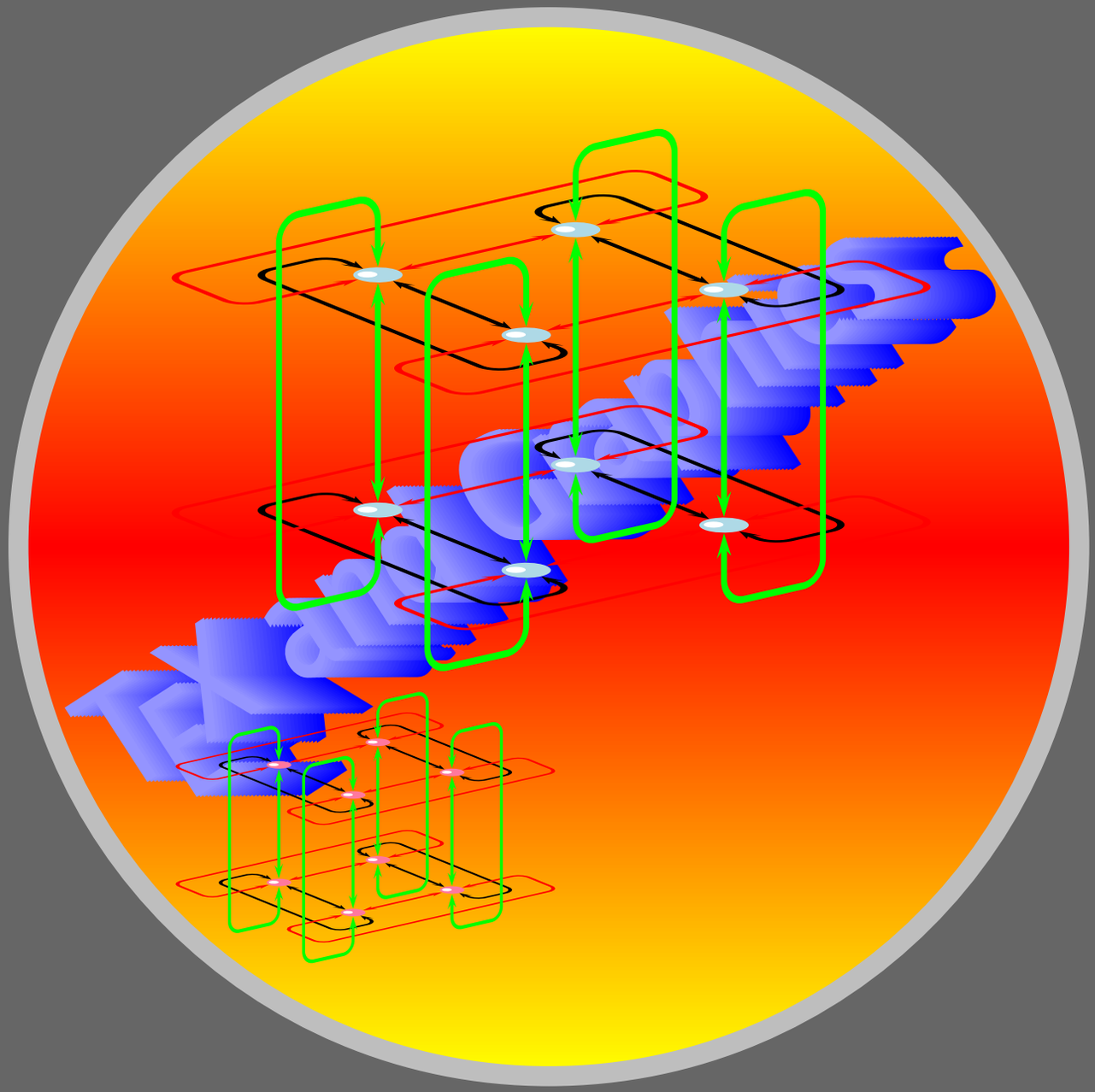

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3. Borderline Tricks

In the first chapter we've seen how we can draw various graphic objects with PSTricks and in the next, we saw how we can add a bit of color to the proceedings. In all these, we've been mostly interested in the *interior* of these objects. In this chapter, we'll see how we can decorate the *boundary*.

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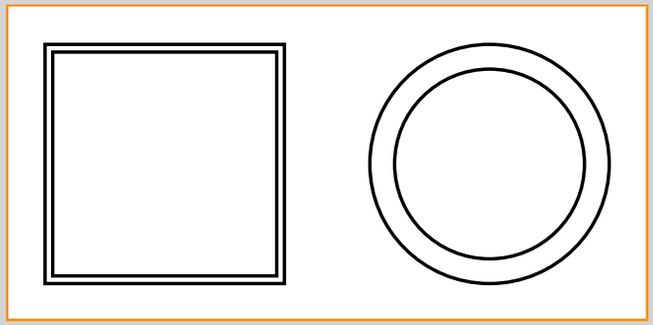
3.1. Double boundary

In the first chapter, we saw that "double lines" could be drawn by setting the parameter `doubleline` to `true`. This setting also draws the boundary of other graphic objects in double. For example

```
\begin{pspicture}(0,0)(2,2)
  \psframe[doubleline=true]%
          (0,0)(2,2)
\end{pspicture}
\hspace{0.5cm}
\begin{pspicture}(0,0)(2,2)
  \pscircle[doubleline=true,%
            doublesep=5pt]%
           (1,1){1}
\end{pspicture}
```



Note that the parameter `doublesep` is used to set the distance between the two lines. Its default value is $1.25 \times$ `linewidth` (remember the parameter `linewidth`?)

The double line can be colored using the `linecolor` parameter as in the example below:

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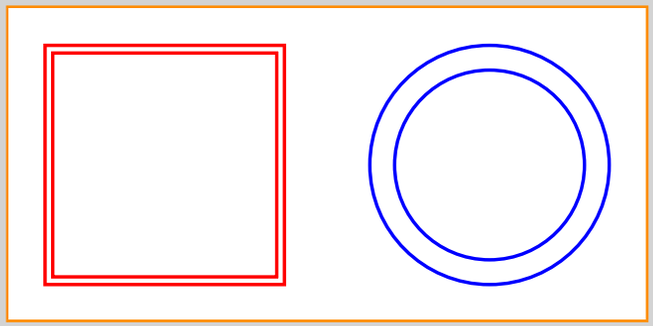
```
\begin{pspicture}(0,0)(2,2)
  \psframe[doubleline=true,%
           linecolor=Red]%
          (0,0)(2,2)
\end{pspicture}
\hspace{0.5cm}
\begin{pspicture}(0,0)(2,2)
  \pscircle[doubleline=true,%
            doublesep=5pt,%
            linecolor=Blue]%
           (1,1){1}
\end{pspicture}
```



The gap between the two lines of the boundary can be filled with color using the parameter `doublecolor` as in the next example:

```
\begin{pspicture}(0,0)(2,2)
  \psframe[doubleline=true,%
           doublecolor=Red]%
          (0,0)(2,2)
 \end{pspicture}
 \hspace{0.5cm}
 \begin{pspicture}(0,0)(2,2)
   \pscircle[doubleline=true,%
```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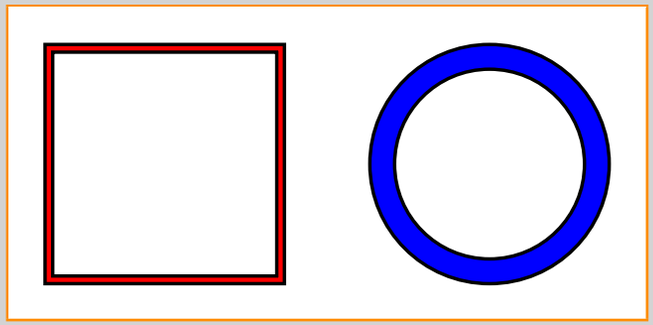
```
            doublesep=5pt,%
            doublecolor=Blue]%
           (1,1){1}
\end{pspicture}
```



Now something funny happens, if you combine `doubleline=true` with `linestyle=dotted`. Look at the example below:

```
\begin{pspicture}(0,0)(4,0)
  \psline[linestyle=dotted,%
          linewidth=2pt,%
          doubleline=true]%
         (0,0)(4,0)
\end{pspicture}
```

If you look closely, you can see that, instead of two lines of dots as we would expect, we get one line of large dots split down the middle. To understand what really happened, let's consider a larger version of this picture, with a grid beneath for easy measurement:

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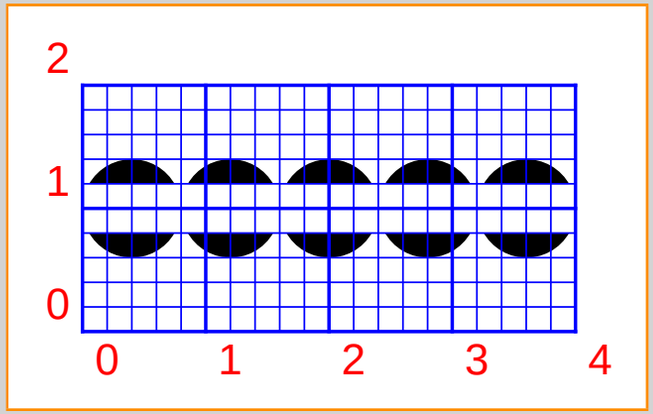

Here, the line is drawn by the command:

```
\psline[linestyle=dotted,%
          linewidth=2mm,%
          doubleline=true,%
          doublesep=4mm]%
          (0,1)(4,1)
```

and the grid is made up of 2 mm squares (we'll talk about such grids later).. Now we can see that each of the circular segments making up the two lines is 2 mm high (the `linewidth`) and the gap separating them is 4 mm (the `doublesep`). Thus in this case, PSTricks creates a row of dots, each of diameter 8 mm (2 + 4 + 2) and splits them down the middle by a cut 4 mm wide. (Now try to work out the diameter of the dots—before they were split—in our first picture, remembering the default `doublesep` is 1.25 × `\linewidth`.)

We can now use this feature to produce some pretty pictures like

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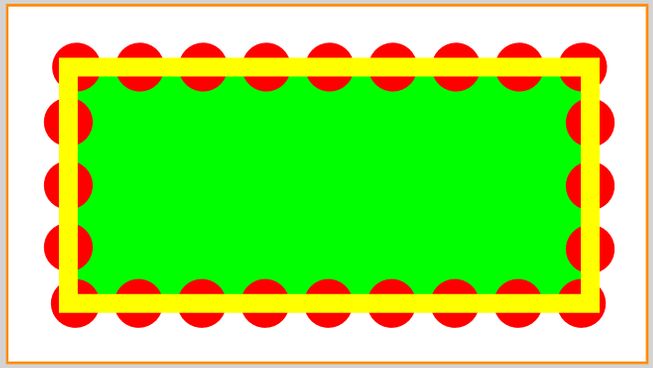
```
\begin{pspicture}(0,0)(4,2)
  \psframe[fillstyle=solid,%
           fillcolor=Green,%
           linestyle=dotted,%
           linewidth=3pt,%
           linecolor=Red,%
           doubleline=true,%
           doublecolor=Yellow]%
          (0,0)(4,2)
\end{pspicture}
```



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3.2. Inside, outside or in the middle?

When we draw a double boundary for an object, one natural question is whether the dimensions of the object are with reference to the outer or inner boundary. For example, if we specify the radius of a circle as 1 cm and give it a double border, is it the inner circle or the outer circle that has radius 1 cm? By default, it's the outer circle, but it can be changed with the help of the `dimen` parameter. Its possible values are `inner`, `middle` and `outer` and the default value is outer. The example below illustrates this:

```
\begin{pspicture}(0,0)(2,2)
  \pscircle[doubleline=true,%
            doublesep=5pt,%
            dimen=outer]%
           (1,1){1}
  \end{pspicture}
  \hspace{.5cm}
  \begin{pspicture}(0,0)(2,2)
    \pscircle[doubleline=true,%
              doublesep=5pt,%
              dimen=middle]%
              (1,1){1}
  \end{pspicture}
  \hspace{.5cm}
  \begin{pspicture}(0,0)(2,2)
    \pscircle[doubleline=true,%
              doublesep=5pt,%
              dimen=inner]%
              (1,1){1}
  \end{pspicture}
```

gives

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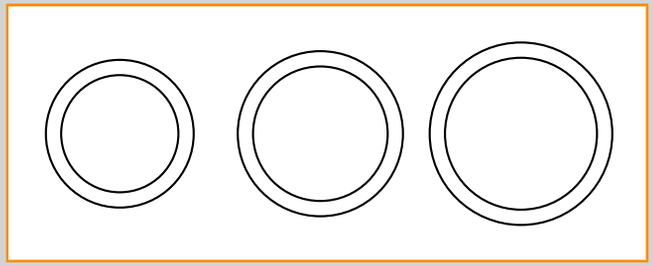
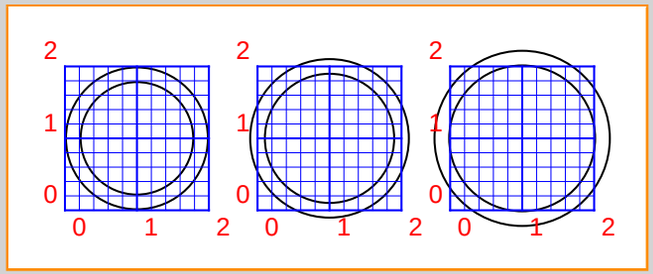


(The value `dimen=outer` for the first circle is actually redundant, since by default, the parameter `dimen` is set to `outer`). Perhaps the difference will be better seen if each figure is provided with a coordinate grid underneath as shown below:



The `dimen` parameter can be applied to such closed graphic objects as `\psframe`, `\pscircle`, `\psellipse` and `\pswedge`, even when `doublelines` is *not* in effect. It then determines whether the measurements refer to the outside, inside or the middle of the boundary. The difference however is noticeable, only for large `linewidth`. The example below illustrates this.

```
\begin{pspicture}(0,0)(5,5)
  \psframe[linewidth=2mm,%
           linecolor=Red,%
           dimen=outer]%
          (1,1)(2,2)
  \psframe[linewidth=2mm,%
           linecolor=Blue,%
```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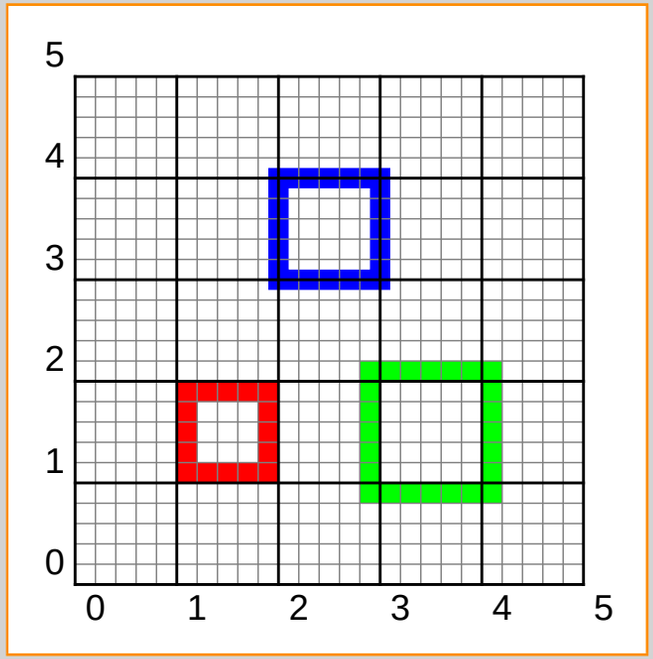
```
            dimen=middle]%
          (2,3)(3,4)
  \psframe[linewidth=2mm,%
           linecolor=Green,%
           dimen=inner]%
          (3,1)(4,2)
\end{pspicture}
```



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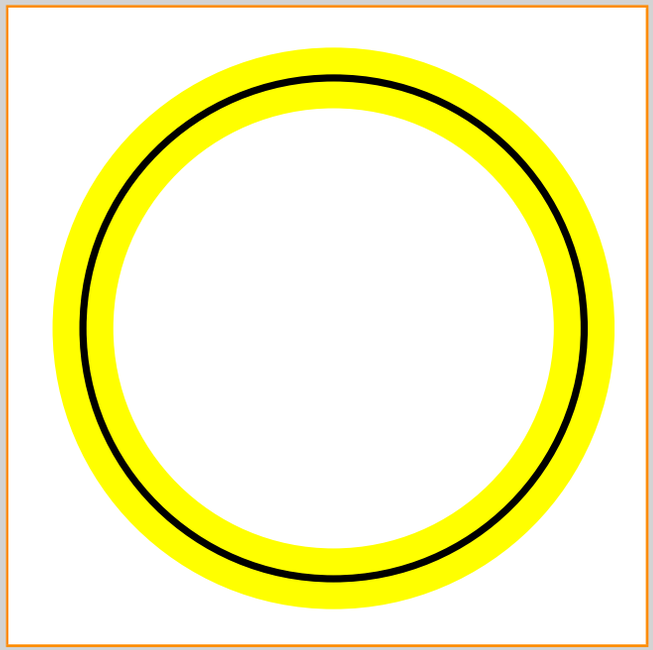
3.3. Borders—visible or invisible

We can put a border around the edge of an object by setting the `border` parameter (default value 0pt) to a positive *length*. The color of the border is set by the parameter `bordercolor`, whose default value is white. For example,

```
\begin{pspicture}(2,0)(3,2)
  \pscircle[border=3pt,%
            bordercolor=Yellow]%
            (2,1){1}
\end{pspicture}
```



Perhaps the edges of a border will be seen better, if its set in a dark background as in

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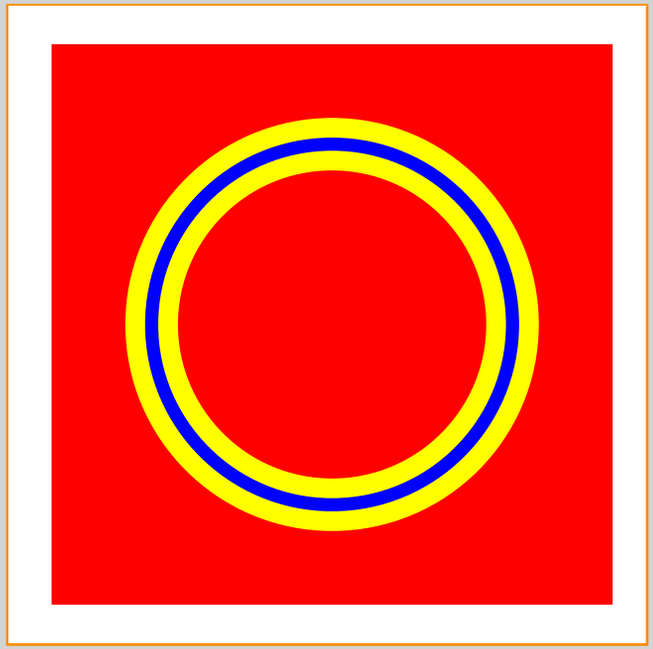
```
\begin{pspicture}(0,0)(3,3)
    \psframe*[linecolor=Red]%
             (0,0)(3,3)
    \pscircle[linewidth=2pt,%
              linecolor=Blue,%
              border=3pt,%
              bordercolor=Yellow]
             (1.5,1.5){1}
 \end{pspicture}
```



An interesting possibility is to make the border color the same as the background color, which makes the border invisible to us, but "seen" by the graphic objects drawn *before* it. This can be used to create the effect of a line *passing over* another, for example. This is illustrated below:

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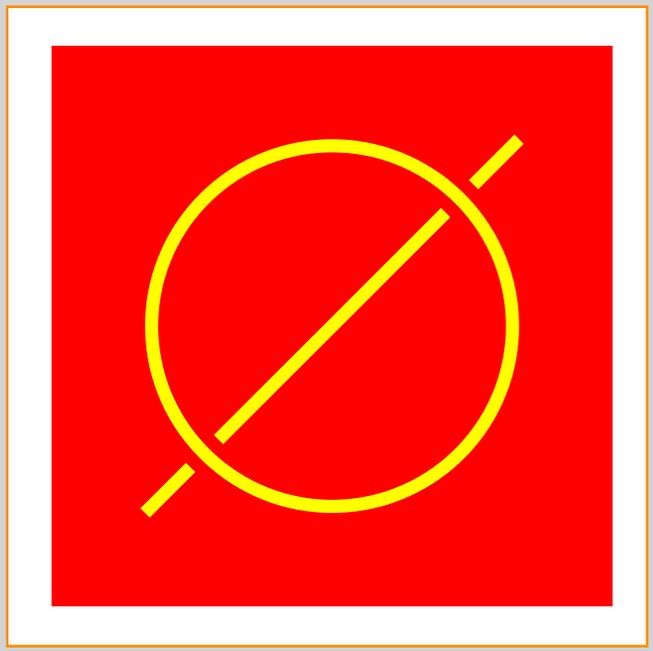
```
\begin{pspicture}(0,0)(3,3)
    \psframe*[linecolor=Red]%
             (0,0)(3,3)
    \psline[linecolor=Yellow,%
            linewidth=2pt]%
           (0.5,0.5)(2.5,2.5)
    \pscircle[linewidth=2pt,%
              linecolor=Yellow,%
              border=2pt,%
              bordercolor=Red]
             (1.5,1.5){1}
\end{pspicture}
```



Note that the circle with the border is placed over the line and the red border blots out pieces of the line. We can reverse this effect by first drawing the circle *without border* and then the line *with border*

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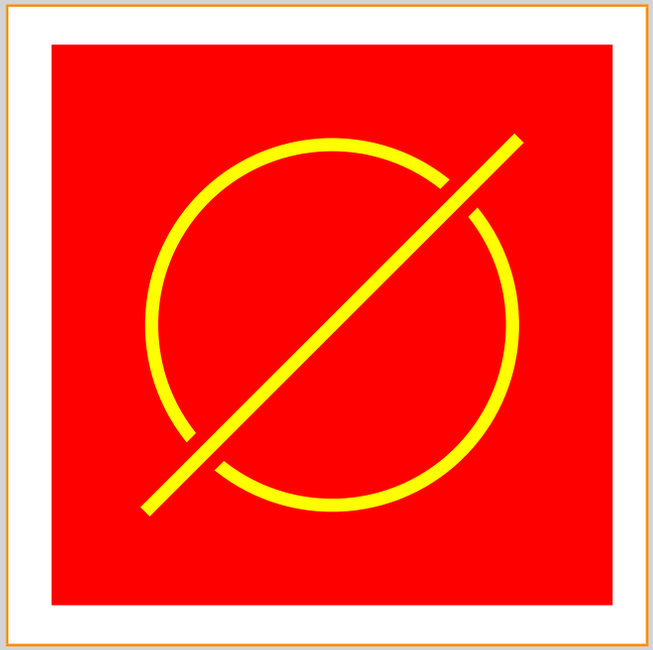
```
\begin{pspicture}(0,0)(3,3)
  \psframe*[linecolor=Red]%
           (0,0)(3,3)
  \pscircle[linewidth=2pt,%
            linecolor=Yellow]
          (1.5,1.5){1}
  \psline[linecolor=Yellow,%
         linewidth=2pt,%
         border=2pt,%
         bordercolor=Red]%
        (0.5,0.5)(2.5,2.5)
\end{pspicture}
```



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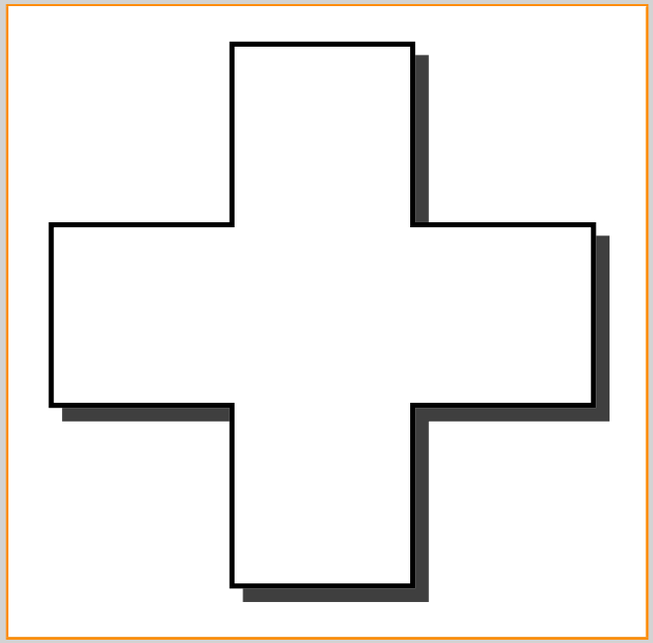
3.4. Shadows

An object can be given a shadow, by setting the `shadow` parameter to `true`. (Its default value is `false`.) Look at the example below:

```
\begin{pspicture}(0,0)(3,3)
  \pspolygon[shadow=true]%
            (1,1)(1,0)(2,0)(2,1)
            (3,1)(3,2)(2,2)(2,3)
            (1,3)(1,2)(0,2)(0,1)
\end{pspicture}
```



The color of the shadow is set by the parameter `shadowcolor`, whose default value is `darkgray`.

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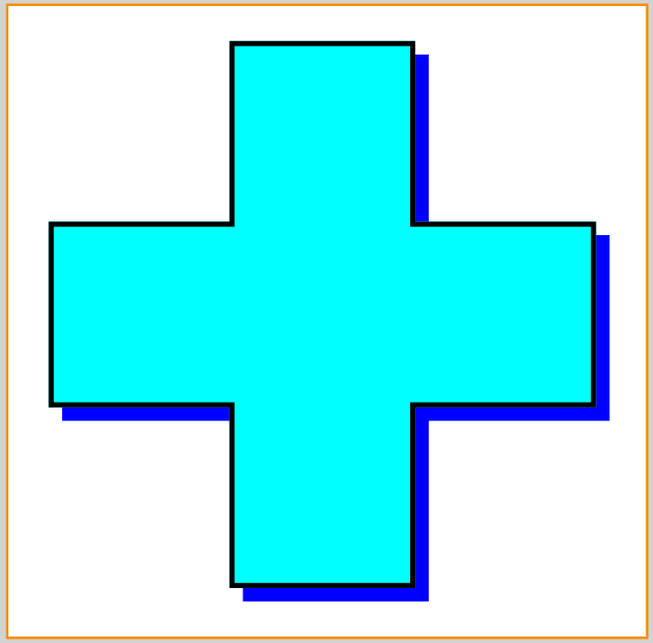
```
\begin{pspicture}(0,0)(3,3)
  \pspolygon[fillstyle=solid,%
             fillcolor=Cyan,%
             shadow=true,%
             shadowcolor=Blue]%
            (1,1)(1,0)(2,0)(2,1)
            (3,1)(3,2)(2,2)(2,3)
            (1,3)(1,2)(0,2)(0,1)
 \end{pspicture}
```



The *size* of the shadow is specified by `shadowsize` (with default value 3 pt). Also, the *position* of the shadow is determined by `shadowangle` which is to be specified as an *angle*. (The default value is -45). These are illustrated in the example below (where we have embellished the original object also with gradient colors and double borders).

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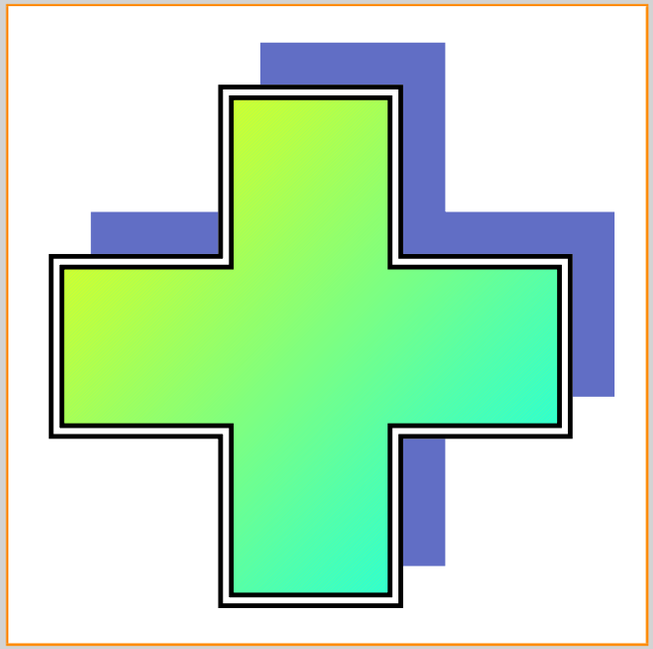
```
\begin{pspicture}(0,0)(3.5,3.5)
  \pspolygon[fillstyle=gradient,%
             gradbegin=Yellow,%
             gradend=Cyan,%
             gradangle=45,%
             gradmidpoint=1,%
             shadow=true,%
             shadowsize=10pt,%
             shadowangle=45,%
             shadowcolor=CadetBlue,%
             doubleline=true]%
            (1,1)(1,0)(2,0)(2,1)
            (3,1)(3,2)(2,2)(2,3)
            (1,3)(1,2)(0,2)(0,1)
 \end{pspicture}
```



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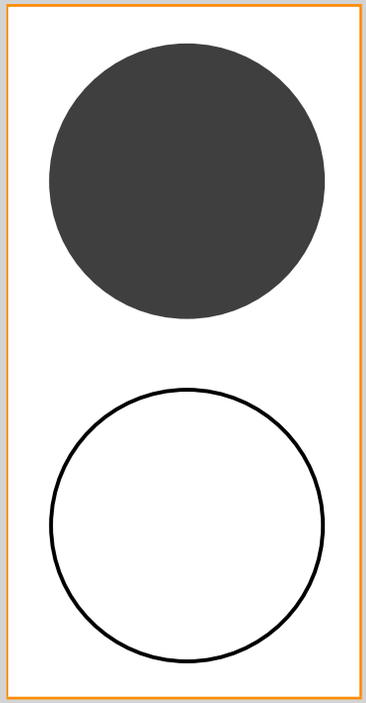
By defining the `shadowsize` suitably large, we can detach the shadow from the object, as in the example below:

```
\begin{pspicture}(0,0)(2,5)
  \pscircle[shadow=true,%
            shadowsize=2.5cm,%
            shadowangle=90]%
           (1,1){1}
\end{pspicture}
```



Note that the “shadow” never overdraws the original object. But we can create an “eclipse” effect by suitably coloring the object and the shadow as in the example below:

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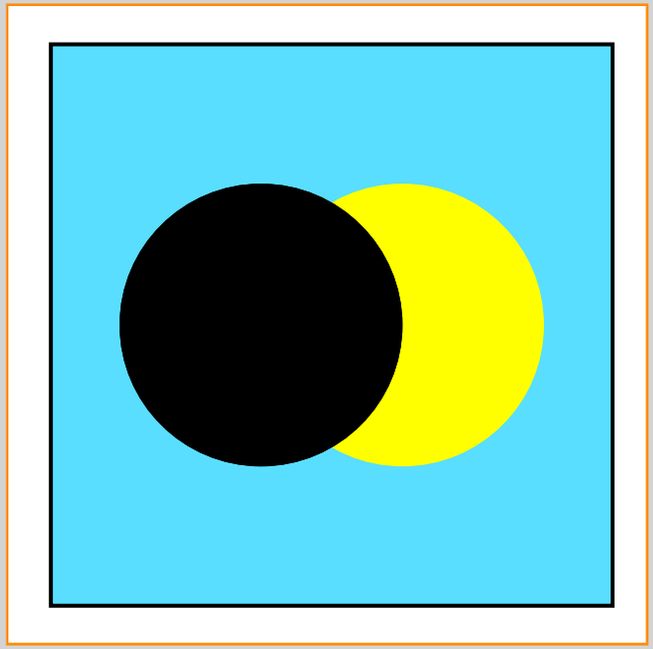
```
\begin{pspicture}(0,0)(5,4)
  \psframe[fillstyle=solid,%
           fillcolor=CornflowerBlue]%
          (0,0)(4,4)
  \pscircle[fillstyle=solid,%
            fillcolor=black,%
            shadow=true,%
            shadowsize=1cm,%
            shadowangle=0,%
            shadowcolor=Yellow]
           (1.5,2){1}
\end{pspicture}
```



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