Icon Graphics—Introduction

Facilities for graphical programming in Icon evolved in the period 1990-1994.

A philosophy of Icon is to insulate the programmer from details and place the burden on the language implementation. The graphics facilities were designed with same philosophy.

Icon's graphical facilities are built on the X Window System on UNIX machines. On Microsoft Windows platforms the facilities on built on the Windows API.

Window basics

Before any graphical operations can be done, a window must be opened.

Here is a complete program that opens a window with a specific width, height, and label:

```
link graphics
procedure main() # win1
    WOpen("height=100","width=300",
        "label=A Window")
    WDone()
end
```

As a rule, graphics programs should `link graphics`.

On UNIX the program can be compiled with `icont`, as usual. Use `wicont` on Windows.

On a Windows platform, here's the result:

`WOpen()` accepts zero or more window *attributes* as arguments. Attributes may be specified in any order.

`WDone()` waits until a `q` or `Q` is typed in the window.

Window basics, continued

Window attributes can be queried with `WAttrib(s1, s2, ...)`. The value of each named attribute is generated.

`WWRite()` is like `write()`, but sends output to the window.

Example:

```
link graphics
procedure main() # win2
    WOpen("height=100","width=300",
        "label=A Window")
    every WWrite(WAttrib("height", "width",
                         "size", "label"))
    WDone()
end
```

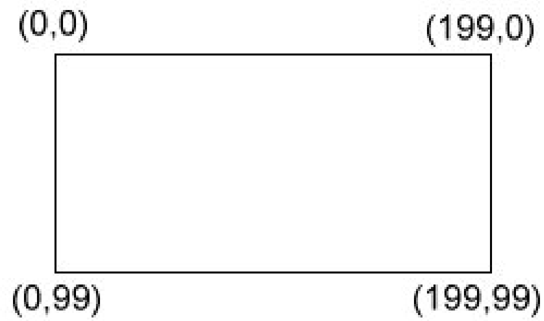
Resulting window:

In essence, `WWrite()` treats the window as a scrolling text window.

`write()` could be used instead of `WWrite()`; output would then go to the "console".

Coordinate system

The coordinate system is integer based with (0,0) in the upper left corner of the window. Here are the corner points for a window with `size=200,100`:



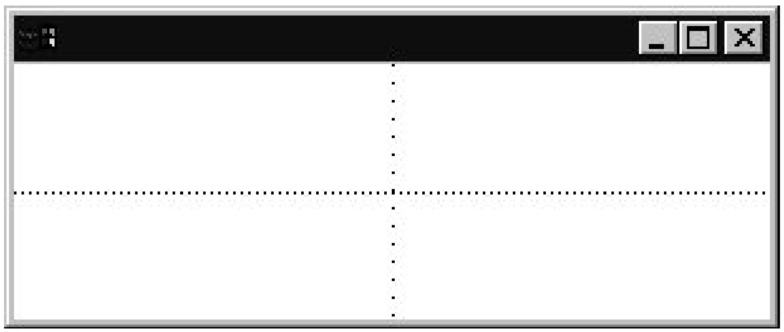
Drawing points

The simplest drawing primitive is `DrawPoint(x, y)`, which draws one pixel at the specified coordinates in the foreground color (black, by default).

Example:

```
link graphics
procedure main() # dp1
    WOpen("size=300,100")

    every x := 0 to 299 by 3 do
        DrawPoint(x, 50)   # horizontal

    every y := 0 to 99 by 7 do
        DrawPoint(150, y)  # vertical

    WDone()
end
```

Result:



Drawing points, continued

Some fun with randomly drawn points:

```
link graphics

$define Height 100   # symbolic constants
$define Width 300    #  via preprocessor

procedure main() # dp2
    WOpen("size=" || Width ||","||Height)

    repeat {
        DrawPoint(?Width-1, ?Height-1)
        }

    WDone()
end
```

Another angle:

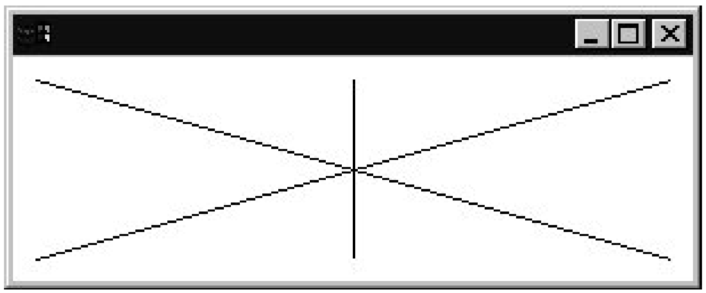
```
link graphics
$define Height 100
$define Width 300

procedure main(args) # dp3
    WOpen("size=" || Width ||","||Height)
    N := args[1] | 1

    repeat {
        x := y := 0
        every 1 to N do x +:= ?(Width/N)
        every 1 to N do y +:= ?(Height/N)
        DrawPoint(x,y)
        }

    WDone()
end
```

Drawing lines

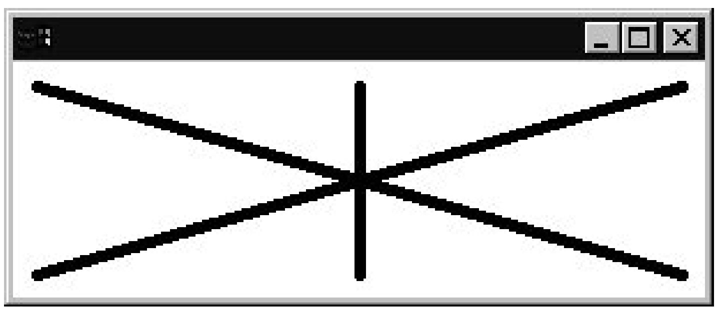
`DrawLine(x1, y1, x2, y2)` draws a line between the points (`x1`, `y1`) and (`x2`, `y2`), inclusive.

```
link graphics
procedure main(args) # dl2
    WOpen("size=300,100")
    WAttrib("linewidth=" || args[1])
    DrawLine(10, 10, 290, 90)
    DrawLine(10, 90, 290, 10)
    DrawLine(150, 10, 150, 90)
    WDone()
end
```

When run with no arguments, a default `linewidth` of 1 is used:



Here is a `linewidth` of 5:

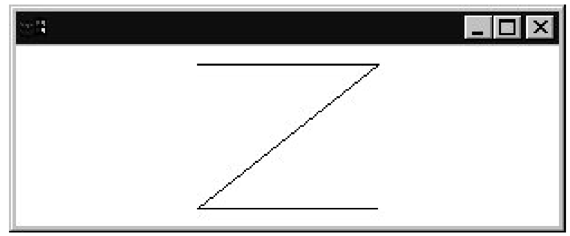


Drawing lines, continued

An arbitrary number of coordinate pairs can be passed to `DrawLine`. It draws a line between the first and second points, then the second and third points, etc.

```
procedure main() # dl3
    WOpen("size=300,100")
    DrawLine(100,10,200,10,100,90,200,90)
    WDone()
end
```

Result:



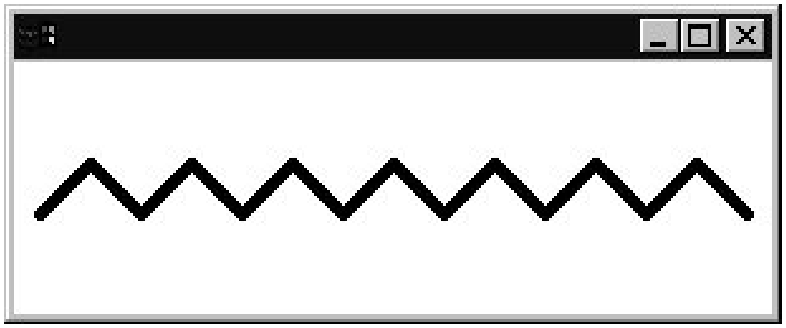
Icon's *list invocation* syntax is often used with drawing functions that accept a variable number of arguments:

```
procedure main() # dl3a
    WOpen("size=300,100")

    zpts := [100,10,200,10,100,90,200,90]
    DrawLine!zpts  # "list invocation"
    WDone()
end
```

A related function is `DrawSegment`, which draws disjoint segments for each pair of coordinate pairs.

Drawing lines, continued

Problem: Write a program that produces an approximation of this image:



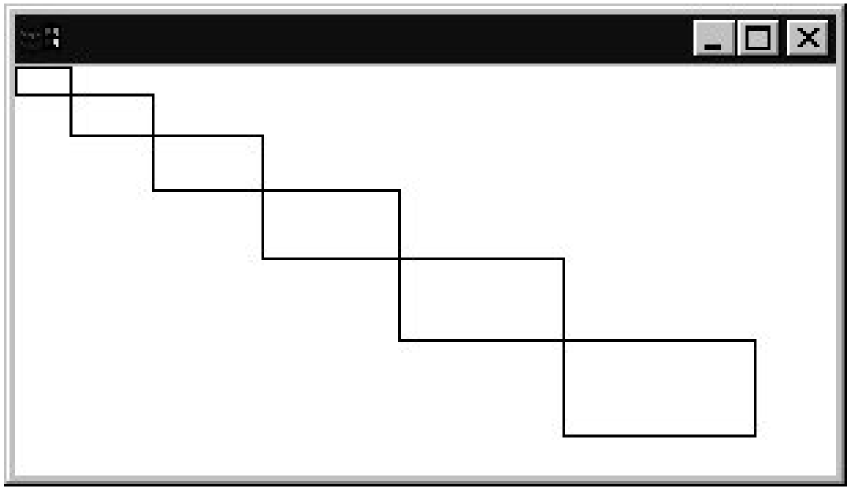
Drawing rectangles

The function `DrawRectangle(x, y, w, h)` draws the outline of a rectangle.

With a line width of 1, the upper left corner is at (`x`, `y`) and the lower right corner is at (`x+w`, `y+h`).

```
procedure main(args) # dr1
    WOpen("size=300,150")
    x := y := 0
    every h := 10 to 35 by 5 do {
        DrawRectangle(x, y, h*2, h)
        x +:= h*2
        y +:= h
        }
    WDone()
end
```

Result:



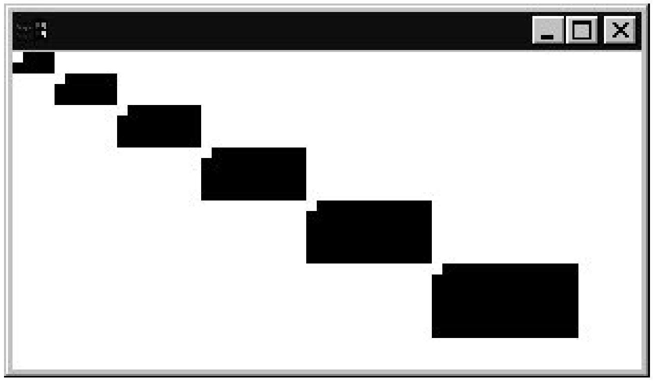
Drawing rectangles, continued

`FillRectangle(x, y, w, h)` is just like `DrawRectangle` but it produces a rectangle filled with the foreground color.

A related function is `EraseArea`, which accepts the same arguments and fills the rectangular area with the background color (white, by default).

```
procedure main(args) # dr2
    WOpen("size=300,150")
    x := y := 0
    every h := 10 to 35 by 5 do {
        FillRectangle(x, y, h*2, h)
        EraseArea(x, y, 5, 5)
        x +:= h*2
        y +:= h
        }
    WDone()
end
```

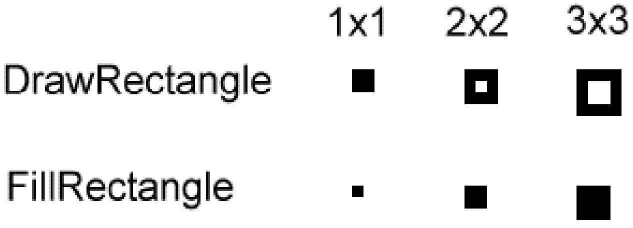
Result:



Drawing rectangles, continued

Appendix I in the text covers some painful but important details about the rendering of various figures.

One example of "interesting" behavior is the difference in the rectangular area when drawn with `DrawRectangle` versus `FillRectangle`:

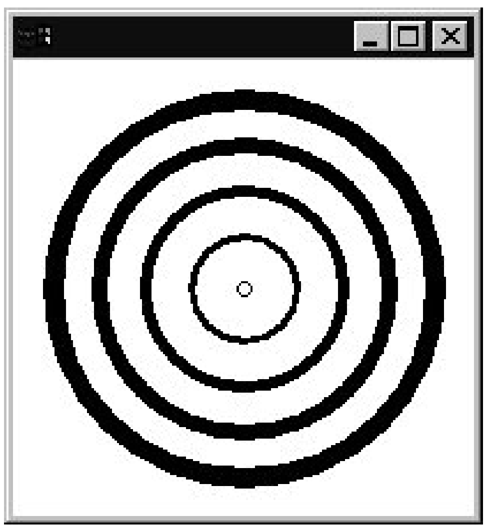


Drawing circles

Circles are drawn with `DrawCircle(x, y, radius)`:

```
procedure main(args) # dc1
    WOpen("size=200,200")

    width := 1
    every r := 3 to 100 by 20 do {
        DrawCircle(100, 100, r)
        WAttrib("linewidth=" || (width +:= 2))
        }

    WDone()
end
```

Result:



Drawing circles, continued

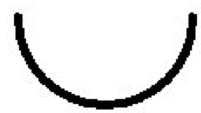
The previous example used some defaults. `DrawCircle` is actually more general:

```
DrawCircle(x, y, r, start, extent)
```

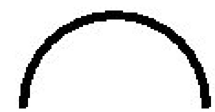
This draws a circular arc centered at (`x`, `y`) with radius `r` starting at `start` radians and continuing through `extent` radians. (Recall that 2π radians equals 360 degrees.)

`start` is measured with zero at 3 o'clock. Positive values for start and extent indicate a clockwise direction; negative values indicate counter-clockwise direction.

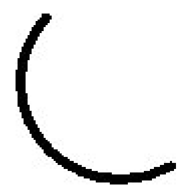
DrawCircle(..., 0, &pi)

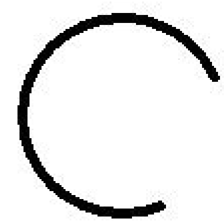


DrawCircle(..., &pi, &pi)



DrawCircle(..., &pi/3, &pi*.9)





DrawCircle(..., -&pi/8, -&pi*3/2)

Drawing circles, continued

Here is a simple-minded test program that exercises `DrawCircle` and its counterpart, `FillCircle`:

```
procedure main(args) # dc3
    WOpen("size=200,240",
        "linewidth=10")

    WWrite(repl("\n",30))
    repeat {
        EraseArea()

        WWrite("f/d, start, extent? ")

        args := split(WRead())
        p := if get(args) == "f"
             then FillCircle else DrawCircle

        every !args *:= (2*&pi)/360

        p!([100,100,90]|||args)
        WRead()
        }
end
```

Notes:

Via defaults, `EraseArea()` erases the entire window.

`WRead()` reads a line of input typed directly into the window.